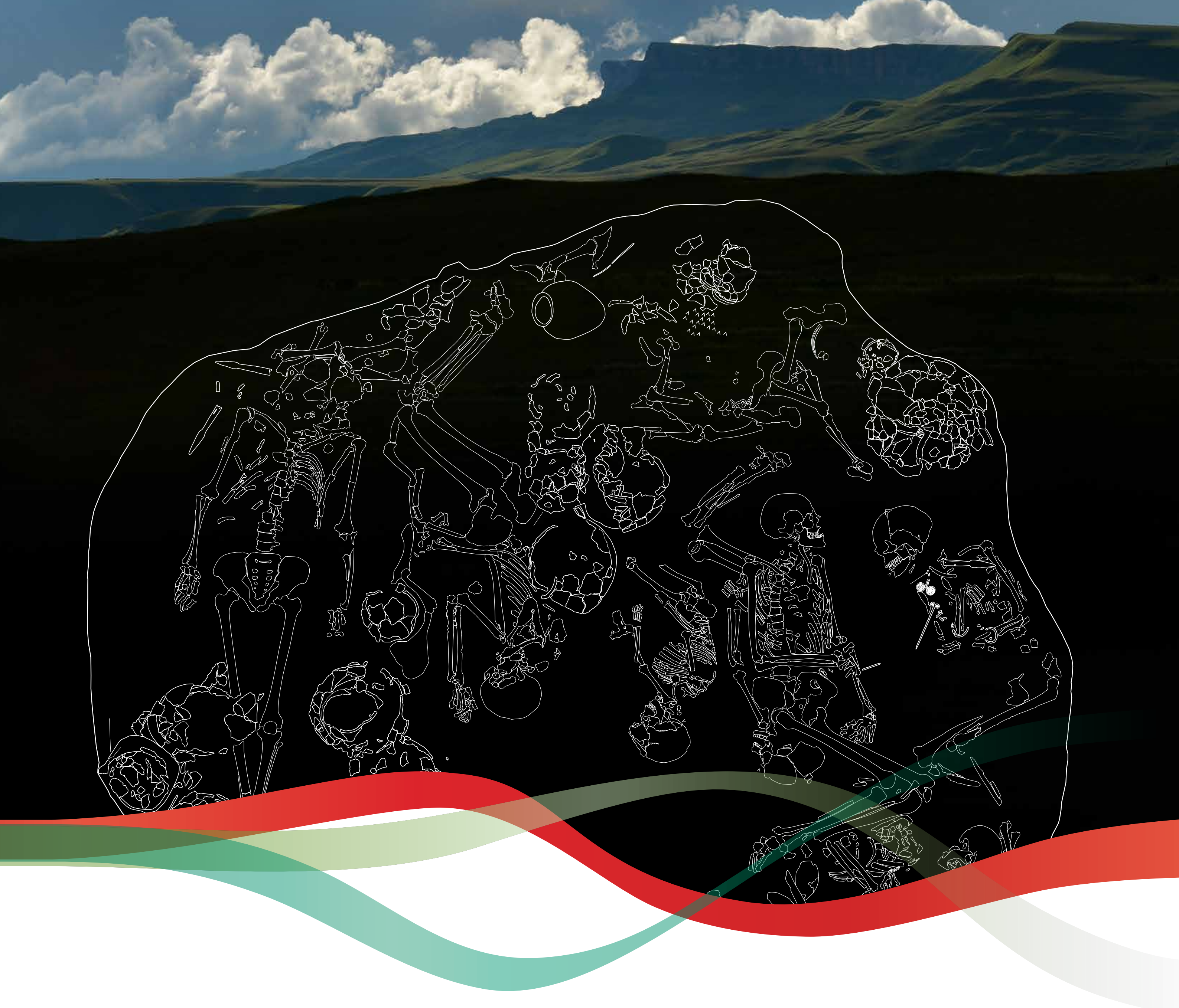
KATHARINA FUCHS

INTERDISCIPLINARY ANALYSIS OF THE CEMETERY KUDACHURT 14

Evaluating indicators of social inequality, demography, oral health and diet during the Bronze Age key period 2200-1650 BCE in the Northern Caucasus



SCALES OF TRANSFORMATION IN PREHISTORIC AND ARCHAIC SOCIETIES | 11

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Preface of the editors

With this book series, the Collaborative Research Centre Scales of Transformation: Human-Environmental Interaction in Prehistoric and Archaic Societies (CRC 1266) at Kiel University enables the bundled presentation of current research outcomes of the multiple aspects of socio-environmental transformations in ancient societies. As editors of this publication platform, we are pleased to be able to publish monographs with detailed basic data and comprehensive interpretations from different case studies and landscapes as well as the extensive output from numerous scientific meetings and international workshops.

The book series is dedicated to the fundamental research questions of CRC 1266, dealing with transformations on different temporal, spatial and social scales, here defined as processes leading to a substantial and enduring reorganization of socio-environmental interaction patterns. What are the substantial transformations that describe human development from 15,000 years ago to the beginning of the Common Era? How did interactions between the natural environment and human populations change over time? What role did humans play as cognitive actors trying to deal with changing social and environmental conditions? Which factors triggered the transformations that led to substantial societal and economic inequality?

The understanding of human practices within often intertwined social and environmental contexts is one of the most fundamental aspects of archaeological research. Moreover, in current debates, the dynamics and feedback involved in human-environmental relationships have become a major issue, particularly when looking at the detectable and sometimes devastating consequences of human interference with nature. Archaeology, with its long-term perspective on human societies and landscapes, is in the unique position to trace and link comparable phenomena in the past, to study human involvement with the natural environment, to investigate the impact of humans on nature, and to outline the consequences of environmental change on human societies. Modern interdisciplinary research enables us to reach beyond simplistic monocausal lines of explanation and overcome evolutionary perspectives. Looking at the period from 15,000 to 1 BCE, CRC 1266 takes a diachronic view in order to investigate transformations involved in the development of Late Pleistocene hunter-gatherers, horticulturalists, early agriculturalists, early metallurgists as well as early state societies, thus covering a wide array of societal formations and environmental conditions.

During recent years, archaeologists from Kiel University carried out intense fieldwork and collaborative efforts in different Eastern European countries. Together with the Eurasia Department of the German Archaeological Institute, Katarina Fuchs conducted analyses on a North Caucasian Late Bronze Age cemetery. The resulting publication on detailed bio-archaeological and archaeological aspects of the site, which is presented here, is extremely helpful for an understanding of Late Bronze Age Caucasian transformation processes.

We are very thankful to Sabine Reinhold from the DAI for cooperation efforts. Moreover, we are very grateful to the author, Katarina Fuchs, and to the graphic illustrator, Agnes Heitmann, for their deep engagement in preparing this publication. We also wish to thank Karsten Wentink, Corné van Woerdekom and Eric van den Bandt from Sidestone Press for their responsive support in realising this volume and Hermann Gorbahn and Julian Laabs for organising the entire publication process.

Wiebke Kirleis and Johannes Müller

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Preface of the cooperation partners

Despite the fact that, during the last decades, the flow of information has rapidly advanced in the scientific community due to modern means of communication and co-operation projects, the Caucasus is still in many respects a rather unfamiliar area to scholars of European archaeology. This high mountain range – one of several that divide the northern parts of Mesopotamia and the vast Eurasian steppe – nevertheless ranks amongst the most important cultural contact and transfer zones in the western parts of Eurasia. It has been an important area of cultural contact for several thousand years. Many cultural and social developments characteristic of the European Bronze Age are first attested here, and impulses from the Caucasus have been crucial for cultural developments in Eastern and Central Europe throughout all epochs.

The cemetery of Kudachurt 14 in the Republic of Kabardino-Balkaria, Russian Federation, was excavated as one of several archaeological sites over the course of nearly 15 years of rescue excavations predating the construction of a large hydroelectric power station in the North Caucasian Čerek valley. They were carried out by the heritage organisation 'Institute of Caucasian Archaeology' headed by Biaslan H. Atabiev, Nalchik. The burial ground was discovered during the rescue excavations along with several other cemeteries and settlements of the Bronze Age and Early Middle Ages and, as the excavations progressed, it became clear that this unique monument had the potential for a completely new level of comprehensive scientific investigation, in particular for an important period in ancient Eurasian history. The materials are even more important, as most contemporaneous Bronze Age sites in the Caucasus Mountains were plundered by early explorers in the 19th century to fill European museum collections in Moscow, Paris, Berlin or Vienna. Kudachurt 14 it is at the moment the only surviving, well-excavated source representing an epoch of thorough cultural transformation.

The presented PhD thesis by Katharina Fuchs, handed in at Kiel University in 2018, is the first in a series of scientific studies on the Kudachurt archaeological complexes. We were delighted by her interest in initiating an anthropological and socio-archaeological study based on the Kudachurt 14 cemetery and the subsequent addition of this important archaeological site for international science. With the finished book in hand, we would like to thank her for the energy and the tremendous amount of labour she invested into the study of the manifold aspects of this archaeological site. The complete edition of all material including that of additional collective burials not treated in this study, as well as a larger, typo-chronological and cultural-historical assessment of this cemetery is scheduled to be published in the series 'Archäologie in Eurasien', edited by the Eurasia Department of the German Archaeological Institute and written by a larger team of Russian and German scholars. It will discuss the site against the overall development of Caucasian and Eurasian steppe cultures.

Katharina Fuchs' thesis, with its bioarchaeological focus, offers a new perspective for socio-archaeological studies, both in the Caucasus and in European archaeology as well. The systematic edition of the physical anthropological material combined with the discussion of how the funeral offerings relate to the social status of the buried persons is a pioneering case-study for the integration of bioarchaeological data in the archaeological discourse. Socio-archaeological studies, *i.e.* the assessment of burial practices and goods using a comparative approach and statistical methods, are rare in Caucasus archaeology. Earlier studies have been directed at Late Bronze Age and Early Medieval case studies, but at that time worked without a physical-anthropological backing. Despite some recent improvement in the integration of physical-anthropological work into archaeological studies, a systematic correlation of all data is still a desideratum. This is the first study with a systematic modern bioarchaeological approach that explores the physical remains of 108 individuals, their sex-age relations, demographic and health status. From this perspective, it is one of the most extensive archaeo-anthropological studies in the Caucasus in general. Physical-anthropological studies edited into monographs featuring a social-archaeological perspective are not abundant in Europe, either. The study is therefore of methodological importance far beyond the regional scope of the case study.

The examination of stable-isotope data relating to diet – *i.e.* the effort to evaluate the economics of the community based on the cemetery – which completes the socio-archaeological analysis is part of an overall in trend in science-based archaeology. The first studies of that kind at Kudachurt were initiated as early as the mid-2000s and since 2015 have been intensified by a comprehensive European Council-funded bioarchaeological project BIOARCCAUCASUS, headed by Svend Hansen and one of the present authors from the Eurasia Department of the German Archaeological Institute (DAI). Its focus is a complex approach towards the economic and demographic developments of Bronze Age Northern Caucasus, and it includes several other case studies on burial mounds in the steppe and piedmont steppe zone. The overall development at Kudachurt 14 outlined in this study fits very well to the current research results on the development of pastoral and agro-pastoral economies in the North Caucasus. Further scientific studies, such as ancient DNA analysis, were likewise started in the BIOARCAUCASUS project by the DAI. They will in perspective substantialise the cultural background of North Caucasus Bronze Age, into which the present study is woven as a foremost case-study.

Sabine Reinhold, Biaslan H. Atabiev, Berlin, Nalchik January 2020

Предисловие

Несмотря на то, что информационное пространство в последние десятилетия благодаря современным средствам коммуникации стал открытым, в том числе для научного сообщества, Кавказ во многих отношениях все еще остается довольно незнакомой для исследователей европейской археологии страницей. Являясь одной из великих горных систем, разделяющих северные части Месопотамии и обширную евразийскую степь, в то же время он на протяжении тысячелетий принадлежал к числу наиболее важных зон культурных контактов и передачи во многом пополненных знаний в западные части Евразии. Многие культурные и социальные события, характерные для европейского бронзового века, впервые засвидетельствованы здесь, и импульсы с Кавказа имеют решающее значение для культурного развития в Восточной и Центральной Европе во все эпохи.

Могильник Кудахурт 14 в Кабардино-Балкарской Республике (Российская Федерация) был раскопан как один из нескольких археологических памятников в ходе почти 15-летних спасательных раскопок, которые предшествовали строительству крупной гидроэлектростанции в Северо-Кавказской долине реки Черек. Раскопки проводились частной научной организацией «Институт археологии Кавказа» под руководством Бияслана Х. Атабиева, г. Нальчик.

Памятник является крупнейшим исследованным погребальным памятником от рубежа до позднего бронзового века, раскопки которого проводились современными методами и, таким образом, представляет реальный интерес для изучения социального и культурного развития обществ кавказского бронзового века. По мере проведения раскопок стало понятно, что всестороннее научное исследование именно этого памятника, который изучался наравне с несколькими могильниками и поселениями бронзового века и раннего средневековья, раскопанных во время спасательных работ, позволит на совершенно ином, чем ранее уровне осветить события, имеющие непреходящее значение для изучения древней евразийской истории.

Материалы представляют особый интерес, так как большинство древних памятников Кавказских гор были фактически разграблены ранними «исследователями» в 19 веке, чтобы заполнить европейские музейные коллекции в Москве, Париже, Берлине или Вене. Без всякого преувеличения можно утверждать, что Кудахурт 14 на сегодняшний день является единственным сохранившимся хорошо раскопанным источником эпохи глубоких культурных преобразований.

Нынешняя кандидатская диссертация Катарины Фукс, переданная в университете Кристиана-Альбрехта в Киле в 2018 году, является первой в серии научных исследований по Кудахуртскому археологическому комплексу.

Мы были рады ее заинтересованностью начать антропологическое и социально-археологическое исследование, на основе могильника Кудахурт 14, как крайне важного для археологической науки в целом археологического объекта и, по мере своих сил, старались содействовать ей в этом.

Полное издание всего материала, включая дополнительные коллективные захоронения, которые не являются частью настоящего исследования, а также более крупная типо-хронологическая и культурно-историческая оценка этого могильника запланирована для серии «Archäologie in Eurasien», изданной Евразийским отделением Германского археологического института и написана более многочисленной группой российских и немецких ученых. На нем будут обсуждаться вопросы, связанные с развитием кавказской и евразийской степной культур в целом.

Диссертация Катарины Фукс с ее биоархеологической направленностью открывает новые перспективы для социально-археологических исследований как на Кавказе, так и в европейской археологии. Систематическое издание физико-антропологического материала в сочетании с обсуждением того, как погребальные подношения соотносятся с социальным статусом погребенных, является новаторским примером для интеграции биоархеологических данных в археологической дискуссии. Социально-археологические исследования, т. е. оценка погребальных практик и предметов с использованием сравнительного подхода и статистических методов, впервые встречается в археологии бронзового века Кавказа. Предыдущие исследования были направлены на анализ материалов позднего бронзового века и раннего средневековья, но к тому времени они работали без физико-антропологической поддержки. Несмотря на некоторое улучшение в последнее время интеграции физической антропологической работы в археологические исследования, систематическое сопоставление всех данных по-прежнему является желательным. Это первое научное исследование с систематическим современным биоархеологическим подходом, которое исследует физические останки 108 индивидов, и их половозрастные отношения, демографический статус и состояние здоровья. С этой точки зрения это одно из самых обширных архео-антропологических изучений на Кавказе в целом. Физико-антропологические исследования, изданные в виде монографий в социально-археологическом ракурсе, также немногочисленны в Европе. Таким образом, данное исследование имеет методологическое значение, выходящее далеко за рамки регионального тематического исследования Евразийских степных культур и их адаптации к условиям предгорий Центрального Кавказа, существенно отличающихся от равнинных.

Изучение стабильно-изотопных данных, связанных с питанием, т.е. попытка оценить экономическую ситуацию общины, похоронившей своих умерших в могильнике Кудахурт 14, которая завершает социально-археологический анализ, является частью общего направления в научной археологии. Первые исследования подобного характера в Кудахурте были начаты еще в середине 2000-х годов, а с 2015 года комплексным биоархеологическим проектом BIOARCCAUCASUS, основанным Европейским Союзом и возглавляемым Свендом Хансеном и одним из нынешних авторов из Евразийского отдела Германского Археологического Института. Основное внимание в проектах уделяется комплексному подходу к экономическому и демографическому развитию Северного Кавказа в эпоху бронзы и включает в себя несколько других исследований по курганам в степной и предгорной степной зоне. Общее направление эволюции, описанное в данном исследовании на базе Кудахуртского могильника 14, очень хорошо согласуется с актуальными исследованиями по развитию скотоводства и агро-пастбищного хозяйства на Северном Кавказе. Дополнительные научные исследования, такие как анализ древней ДНК, также были начаты в рамках проекта BIOARCAUCASUS. В перспективе они предоставят более обширную информацию о культурах бронзового века на Северном Кавказе, в которые настоящее исследование вплетено в качестве основного тематического опыта.

Сабине Рейнхольд, Бияслан Х. Атабиев, Берлин, Нальчик, январь 2020 г.

Preface and acknowledgement of the author

The socio-economic transformations taking place during the Bronze Age period are of great importance for the latest advances in Northern Caucasus archaeological research: The shift from pastoral lifeways in the steppe to sedentary settlements in the high mountains, and the change from hierarchical to egalitarian societies. Here, especially the decisive transitional period from the Middle to the Late Bronze Age (2400-1400 BCE) in the foothill regions left many open questions: Were the populations in cultural proximity to the traditions of the steppe or the high mountains? How were they socially organised? What were the living conditions like back then? What was their disease burden? What food strategy did they pursue? What evidence is available to provide answers to these questions? In the research efforts of the last decade, interdisciplinary approaches, such as landscape archaeology and bioarchaeology, have moved more into focus. Regarding human remains, we are still in the early stages of exploring this indispensable source of information on the lifestyles of Bronze Age communities.

In this context, I was very fortunate to be able to investigate “Kudachurt 14” (Кудахурт 14), a site in the North Caucasian foothills that was excavated in 2004-2006 in the North Caucasian Republic of Kabardino-Balkaria. The site is unique in revealing abundant and extraordinary archaeological finds in terms of both preservation and significance for socio-cultural descriptions. Together with the extensive collection of human remains, Kudachurt 14 offers the most suitable archives to address the questions mentioned above.

The presented study is based on cooperation between the Institute for Caucasian Archaeology, Nalchik, the German Archaeological Institute (DAI), Berlin, and the Graduate School ‘Human Development in Landscapes’ (GSHDL) at Kiel University. I am extremely grateful to Dr. Biaslan Atabiev, head of the Institute of Caucasian Archaeology and chief excavator of the cemetery Kudachurt 14, for giving me the opportunity and confidence to analyse the archaeological material and human remains, which forms the cornerstone of the research presented. My deepest gratitude to him and all colleagues involved for their excellent work on the archaeological finds.

This book is the primary publication of my doctoral thesis at the Faculty of Natural Science and Mathematics at Kiel University (*doctor rerum naturalium*, submitted February 28th, 2018). According to the faculty regulations on publication of doctoral theses, the text was revised only in terms of language, but not in terms of content or integrating newly-published data. I would like to thank the editors, the CRC 1266 speakers Prof. Dr. Wiebke Kirleis and Prof. Dr. Johannes Müller, and the Sidestone Press team for realising the publication within the STPAS series. For text, cover and figure editing of this volume, I owe many thanks to Sarah Martini, Agnes Heitmann, and Carsten Reckweg respectively. This book is a central product of my scientific education in the scope of the interdisciplinary research environment of the Johanna Mestorf Academy and the priority area SECC at Kiel University. Here, the GSHDL represents the most important institution, as it scientifically and financially supported this PhD research. I am grateful for the financial support from the Federal State Funding Schleswig-Holstein at Kiel University in 2012.

As first supervisor and speaker of the GSHDL, Johannes Müller has played a major role in the dissertation progress and my scientific education. I am very thankful to him for discussions regarding specialist issues and encouraging me to remain faithful to my interdisciplinary research interests. Many thanks also to my second supervisor, Prof. Dr. Manuela Dittmar, for her readiness to support me, and her interest in my work. I would like to thank the GSHDL for funding my project, the academic and administrative support, and the great interdisciplinary network it offers. Special thanks to scientific coordinator PD Dr. Mara Weinelt, Jirka Menke, and my PhD candidate and postdoc peers.

Dr. Julia Gresky, head of the 'Arbeitsgruppe Paläopathologie' at the Scientific Department of the DAI, was substantially engaged in my academic training in palaeopathology and other fields, opened scientific networks, provided access to scientific instruments, and advised as well as supported me in dissertation issues. Thank you for this. Sincere thanks to Sabine Reinhold, now referent at the Eurasian Department for the Archaeology of Siberia and the Urals of the DAI. She suggested Kudachurt 14 as the object for my thesis, established all contacts between collaborators, provided access to 'Caucasian perspectives', and shared her knowledge with me.

I was very fortunate to carry out field research in the Northern Caucasus, and to get to know its people and 'Кавказская дружба'. I would like to thank all involved parties for fruitful scientific discussions and also unforgettable times beyond the science. Above all, Nataliya Berezina and her family, Dr. Andreij Belinskij, head of the Heritage Organisation "Nasledie" (Stavropol) and his team, as well as the German team from Berlin.

Many thanks to the Archaeological Stable Isotope Laboratory at Kiel University, Prof. Dr. Cheryl Makarewicz, and back then Dr. Alicia Ventresca-Miller as well as Dr. Isabella von Holstein for 'isotopic guidance'. I am very grateful to Dr. Jutta Kneisel and Dr. Nicole Taylor for our Bronze Age discourses. For comments, proofreading and technical support during the last months I owe my thanks to Julia Gresky, Dr. Stephanie Stratil, Dr. Hermann Gorbahn, Dr. Alina Kabuth, Jutta Kneisel, Johannes Tiffert, Dr. Ralph Grossmann, Cheryl Makarewicz, Carsten Reckweg, and Dr. Kay Schmütz. A warm thank you as well to the CRC 1266 speakers and office colleagues, Johannes Müller, Wiebke Kirleis, Angelika Hoffmann, and Carsten Reckweg for supporting me and transforming my mood on different scales. In this regard, thanks also to the GSHDL office, Jennifer Schüle, and Sabine Zeller.

I am blessed with wonderful family and friends, each of whom know their part in this story. I would like to thank you all for your wholehearted support.

Katharina Fuchs, Kiel, February 2018 and 2020

Предисловие автора и благодарения

Социально-экономические трансформации, происходящие в период бронзового века, имеют большое значение для последних достижений в археологических исследованиях на Северном Кавказе: переход от пастырского образа жизни в степи к оседлым поселениям в горах и переход от иерархического к эгалитарному обществу. Здесь, особенно в решающий переходный период от среднего до позднего бронзового века (2400-1400 гг. До н.э.) в предгорных районах, оставалось много открытых вопросов: находилось ли население в культурной близости с традициями степи или высоких гор? Как они были социально организованы? Каковы были тогда условия жизни? Каково было их бремя болезней? Какого режима питания они придерживались? Какие доказательства доступны, чтобы дать ответы на эти вопросы? В исследованиях последнего десятилетия междисциплинарные подходы, такие как ландшафтная археология и биоархеология, оказались в центре внимания. Что касается человеческих останков, мы все еще находимся на ранних стадиях изучения этого незаменимого источника информации о образе жизни общин бронзового века.

В этом контексте мне очень повезло, что я смогла исследовать «Кудахурт 14 », участок в предгорьях Северного Кавказа, который был раскопан в 2004-2006 годах в Северо-Кавказской республике Кабардино-Балкария. Сайт уникален в раскрытии обильных и необычных археологических находок с точки зрения сохранения, как и значения для социокультурного наследия . Вместе с обширной коллекцией человеческих останков, Кудахурт 14 предлагает наиболее подходящие архивы для решения вопросов, упомянутых выше.

Представленное исследование основано на сотрудничестве между Институтом Кавказской археологии, Нальчик, Немецким археологическим институтом (DAI), Берлин, и Высшей школой «Человеческое развитие в ландшафтах» (GSHDL) при Кильском университете. Я чрезвычайно благодарна доктору Биаслану Атабиеву, руководителю Института археологии Кавказа и главному экскаватору кладбища Кудахурт 14, за предоставленную мне возможность и доверие в анализе археологического материала и останков людей , что является краеугольным камнем представленного исследования. Я глубоко признательна ему и всем коллегам за отличную работу по археологическим находкам.

Эта книга является основной публикацией моей докторской диссертации на факультете естественных наук и математики в Кильском университете (doctor rerum naturalium, представленная 28го февраля 2018 года). Согласно правилам факультета по публикации докторских диссертаций, текст был пересмотрен только с точки зрения языка, но не с точки зрения содержания или интеграции недавно опубликованных данных. Я хотела бы поблагодарить редакторов, докладчиков «CRC 1266», профессора доктора Вибке Кирлейс и профессора доктора Йоханнеса Мюллера, а также команду «Sidestone Press» за реализацию публикации в серии «STPAS». За коррекцю английского языка, редактирование обложки и рисунков этого тома я очень благодарна Саре Мартини, Агнес Хайтманн и Карстену Реквег. Эта книга является центральным продуктом моего научного образования в рамках междисциплинарной исследовательской среды Академии Йоханны Месторф и приоритетной области SECC в Кильском университете. Тут GSHDL представляет собой наиболее важный институт, так как он оказал научную и финансовую поддержку этого исследование для моей докторской работы. Я благодарна за финансовую поддержку государственной стипендии Шлезвиг-Гольштейна в Кильском университете в 2012 году.

Будучи первым научным руководителем и докладчиком GSHDL, Йоханнес Мюллер сыграл важную роль в развитии диссертации и моем научном образовании. Я очень благодарна ему за обсуждение конкретных вопросов и побуждаю меня оставаться верной своим междисциплинарным исследовательским интересам. Большое спасибо также моему второму руководителю, профессору доктору Мануэле Диттмар за ее готовность поддержать меня и ее интерес к моей работе. Я хотела бы поблагодарить GSHDL за финансирование моего проекта, академическую и административную поддержку и обширную междисциплинарную сеть, которую GSHDL предоставляет. Особая благодарность научному координатору, Приват-доценту доктору Маре Вейнельт, Йирке Менке, а также моим коллегам во время аспирантуры и постдокторантуры.

Доктор Юлия Граски, руководитель научной группы «палеопатология» в научном отделе DAI, в основном занималась моей академической подготовкой в палеопатологии и других областях, открыла научные сети, предоставила доступ к научным инструментам, а также консультировала и поддерживала меня в диссертационных вопросах. Спасибо тебе за это. Искренняя благодарность Сабине Рейнхольд, ныне консультант Евразийского отдела археологии Сибири и Урала DAI. Она предложила Кудахурт 14 в качестве объекта для моей диссертации, установила все контакты между сотрудниками, предоставила доступ к «Кавказским перспективам» и поделилась со мной своими знаниями.

Мне очень повезло провести полевые исследования на Северном Кавказе, познакомиться с его людьми и «Кавказской дружбой». Я хотела бы поблагодарить все заинтересованные стороны за плодотворные научные дискуссии, а также незабываемые времена вне науки.

Прежде всего, Наталья Березина и ее семья, доктор Андрей Белинский, руководитель организации «Наследие» (Ставрополь) и его команда, а также немецкая команда из Берлина.

Большое спасибо археологической лаборатории стабильных изотопов при Кильском университете, профессору доктору Шерил Макаревич, а до того доктору Алисии Вентреска-Миллер, а также доктору Изабелла фон Хольштейн за «изотопное руководство». Я очень благодарна доктору Ютта Кнейзель и доктору Николь Тейлор за наши беседы о бронзовом веке. За комментарии, корректуру и техническую поддержку в течение последних месяцев я благодарна Юлии Греськи, доктору Стефани Стратил, доктору Герман Горбан, доктору Алина Кабут, Ютта Кнейзель, Йоханнес Тифферт, доктору Ральф Гроссманн, Карстен Реквег, докторам Кай Шмютц и Александр Иммель. Я также благодарю спикеров и коллег из офиса CRC 1266 Йоханнеса Мюллера, Вибке Кирлейс, Анжелику Хоффманн и Карстена Реквега . В этом отношении также спасибо офису GSHDL, Дженифер Шюле и Сабине Зеллер.

Я благословленна прекрасной семьей и друзьями, каждый из которых знает свою роль в этой истории. Я хотела бы поблагодарить Вас всех за Вашу искреннюю поддержку.

Катарина Фукс, Киль, февраль 2018 и 2020 гг.

Part I

Background and objectives of research

1 Introduction

From the first hominids outside of Africa found in the Georgian mountains, to the many ethnologies and political states present nowadays, the Caucasus region has played a significant role throughout human history (*Homo erectus ergaster georgicus*, Dmanissi; cf. Jöris 2008; Sagona 2018).

Forming a land bridge between the European and Asian continent, the region has been the setting for migration, invasion, trade, and transfer of technical innovation for thousands of years. Sheltering valleys and extensive steppe areas result in an enormous variety of ecosystems and habitats. By undergoing phases of adaptation and development, the modern human has spread over the incredibly geographically diverse geographic territories of the Caucasus. Hence, investigations of past societies from these regions play an important role in shedding light on European prehistory more generally and related human-environmental developments.

As a period of major technical innovations, economic developments, social changes, and cultural heterogeneity, the Bronze Age is of special significance. Traditionally, research on this period of North Caucasian prehistory focused merely on mortuary archaeology and the description of archaeological cultures based on material remains from burial contexts dating between *ca.* 3800-1200 BCE. However, by integrating bioarchaeological approaches, the focus of scientific interest during the last decades moved to holistic questions concerning socio-economic developments. This was accompanied by an expansion of study objectives and research techniques; research topics such as the emergence of mobile and sedentary subsistence economies in the different natural environments and changes in social orders were brought to the fore. While archaeology expanded the evidence of settlements of North Caucasian Bronze Age populations and their trans-regional distributions, stable isotope research became an established scientific tool for tracing mobility and nutrition as proxies for subsistence. However, the interlinkages of archaeological and bioarchaeological data to understand human ways of life and behaviour generally lack comprehensive and primary information about the humans themselves.

Currently, both archaeological and bioarchaeological studies of earlier and later periods describe the transition from the Middle to the Late Bronze Age in the Northern Caucasus as characterised by crucial shifts in social organisation, habitat preference and subsistence. However, the period between 2200-1400 BCE represents a gap in research. This doctoral thesis focuses on the cemetery "Kudachurt 14"; being the only undisturbed graveyard of its size known from the North Caucasian Middle and Late Bronze Age transition, it holds a key position for filling this gap. The large number of burials and human remains provide a large set of archaeological and skeletal material.

This study provides scientific groundwork on social inequality, demography, and the oral health and diet of humans that lived and died between 2200-1650 BCE in the central North Caucasian foothills, and evaluates the disciplinary and interdisciplinary significance of these investigative parameters with respect to the key position of Kudachurt 14. Therefore, a combination of methods from three scientific disciplines–burial archaeology, human osteology and stable isotope analysis–to analyse the abundant archaeological and skeletal remains found at Kudachurt 14.

The main objects of study are the archaeological remains of graves and the bones and teeth of the deceased individuals; the former provide information about funeral rituals and social backgrounds of the burying population at that time while the latter carry primary information about the dead person's life. Socio-ritual parameters from the burial record, such as construction elements, bodily treatment of the deceased and burial gifts, reflect human behaviour and are used for the reconstruction of beliefs and ideology in the funeral procedure. Skeletal remains provide concrete evidences of individual attributes connected to the lived life such as age at death, sex, disease burdens, diet, and activities.

The desirable reconciliation of *intentional* and *functional* information[1] marks the starting point for the interdisciplinary approach applied in this study. In-depth disciplinary examinations of the burial, osteological and isotope record – consisting of 130 graves, 108 human individuals and 59 bone collagen samples respectively – interlink different levels of investigation, addressed as the "socio-ritual sphere" (*intentional* data) and the "physical sphere" (*functional* data). Furthermore, this thesis addresses and evaluates challenges and benefits of interdisciplinary research in the scope of a transitional Bronze Age period on the local scale of "Kudachurt 14".

Part I of the thesis lays the foundations on which the further investigations are based. chapter 1 provides an environmental and archaeological background of the North Caucasian Bronze Age which is supplemented by current topics of research in social archaeology, osteology and stable isotope analyses in the respective time and space described in chapter 1. chapter 2 outlines the motives and central questions of research and briefly describes the general and specific significance of social inequality, demography, oral health, and diet, closing with general methodological remarks. chapter 3 sets the frame for the study object Kudachurt 14, including its location, history of excavation, chronological determination, and the characteristics from which it derives its key position for the North Caucasian Bronze Age.

Part II includes the chapters (4, 5 and 6) analysing the archaeological and osteological remains from Kudachurt 14 with an interdisciplinary method combining burial archaeology, human osteology and stable isotope data. It addresses issues of social inequality, demography, oral health, and diet. The three chapters include detailed descriptions of the chosen disciplinary investigative parameters, methodological principles and approaches, material basis, quantitative and qualitative recordings and analyses of data, and any chronological aspects as well as the discussion and evaluation of results for each of the research fields. Due to the stronger focus on archaeology in Part I, the chapters dealing with human osteology (5) and stable isotopes (6) are both supplemented by sections that discuss the significance and potential of demographic data, oral health, and diet in the scope of related scientific issues.

Part III synthesises major disciplinary results from the socio-ritual sphere and physical sphere and draws the main conclusions. To this end, chapters 7 and 8 make up final analytical and interpretative sections in which results and implications deriving from the investigations of burial practice, demography, oral health, and diet are linked. The final chapter (9) summarises overall findings by directly answering the research questions posed in Part I. Additionally, it provides an overview about future prospects resulting from the doctoral thesis work. The manuscript closes with

1 This concept of *intentional* and *functional* data, refers to Härke (1993) and is more precisely addressed in chapters 1.2. and 2.

short summaries in English, German and Russian, the list of references, tables and figures, including copyright information, and abbreviations.

Part IV provides the material and data on which the doctoral thesis is based in digital form. The grave catalogue contains overviews and basic information about investigated graves and skeletons. A PDF version of the grave assemblage catalogue and a PDF of the appendix containing a summary of isotope data and recording schemes. All relevant recorded and used data are to be found on the Microsoft Access database which provides availability of information. All files are accessible via the online Research Data Exchange Platform hosted by the Johanna Mestorf Academy at Kiel University, Germany (https://www.jma.uni-kiel.de/en/research-projects/data-exchange-platform).

1.1 Environmental and archaeological background

The Bronze Age is of particular interest with respect to technical innovations and socio-economic dynamics (*e.g.* resource extraction, processing, and trade; transfer of knowledge and traditions; inter- and intra-population dynamics). Living in an area with abundant natural resources, the Bronze Age societies from the Northern Caucasus have gone through different processes of change, manifested as cultural heterogeneity, emergence and disappearance, and exploration of new habitats. During a period of approximately 2800 years, Bronze Age cultures characterised by different social structures and subsistence strategies such as the Maikop Culture, the North Caucasian Culture, the different Catacomb Grave phenomena, and smaller regional groups spread over the diverse natural environments.

The following subchapter gives an overview about the broader environmental and prehistoric context of the North Caucasian Bronze Age, its archaeological cultures between 4000-1200 BCE, and the presumed climatic conditions at that time. Brief descriptions of the state of research introduce the major disciplines applied with respect to the geographical and chronological foci of the thesis: social indicators of burial practice, osteological and palaeopathological investigations of human remains, and palaeodietary reconstructions by means of nitrogen and carbon stable isotope analyses.

1.1.1 Topography and environment

In this dissertation, the term “Northern Caucasus” or related forms refer to the following topographic and environmental definitions.

Resulting from a long and controversial geopolitical history, the definitions of the Caucasian territories differ from political to ethno-historical and geographical interpretations. The term “Northern Caucasus” is nowadays known by its geopolitical usage, with the Stavropol Kray and the other different autonomous republics summarized under the term “North Caucasian Federal District” (Western part: Karachay-Cherkessia, Kabardino-Balkaria; Central part: North-Ossetia, Ingushetia; Eastern part: Chechnya and Dagestan). In this study, the definition “Northern Caucasus” complies with the geographical definition. It therefore also includes the steppe regions of the southern parts of the East European Plain (Manytch plain, mainly corresponding to modern Stavropol Kray, the Krasnodar Kray, and Dagestan) and the western foothills (Adygea Republic, cf. Forsyth 2013; O’Loughlin *et al.* 2007; Perović 2015; Tsutsiev *et al.* 2014). From a broader perspective, the discussion whether the Caucasus region belongs to Europe or Asia evades a definite conclusion. The most widely accepted suggestion places the main western part of the region in Europe and the smaller eastern part in Asia (cf. Coene 2010, 5).

Figure 1: The Caucasus region and the location of the site Kudachurt 14 within topographic relief. The rectangular frame marks the region of study (for details, see chapter 2.3, Figs. 4-5).

The working area contains the southern part of the Pre-Caucasus and the northern part of the upper mountain system of the Caucasian region, also called the Greater Caucasus (following information from (Agachanjanc and Burga 2004; Blinnikov 2011; Coene 2010; Eppelbaum and Khesin 2012; Meckelein and Stadelbauer 1998; Stadelbauer 1995; Zech *et al.* 2014), which extends for 1100 km from west-northwest to east-southeast with a width varying from 30-180 km. Its high mountain range and adjacent valleys separate the Greater from the Southern Caucasus. The study area spans the mountainous northern slope and the Pre-Caucasus with its plain area belonging to the Pontic-Caspian steppe, the southwestern periphery of the vast Eurasian steppe. Thus, the north-southern environmental diversity is clearly visible in differences in altitude by steppe, foothill and high mountain areas, including the highest peak and extinct volcano Mount Elbrus (5642 m). This relief is due to tectonic activity between several microplates which are fragments of the Afro-Arabian and Eurasian lithospheric plates. The Tertiary folded land mass consists of highly variable geological substrates and holds many natural resources including oil, gas, zinc, mineral waters, copper, lead, and uranium.

Located around the 43rd parallel north, different climatic and geomorphologic conditions give rise to a highly diverse natural landscape. This diversity includes extreme conditions such as glaciers in the high mountain ranges and desert-like steppe regions as well as fertile, more temperate zones with grasslands, river plains (Terek, Kuban and Kuma tributaries), forests, and plateaus. Lowlands, rugged valleys and elevated planes have formed habitats of high contrasts. Although it is agreed that the Northern Caucasus belongs to the continental belt, it is a region where humid Mediterranean and dry continental air masses meet. The crest of the Greater Caucasus makes up the border between the northern temperate mid-latitude and the southern subtropical climate zone. In the foothills and plain areas, temperate arid to semi-arid and semi-humid climates are dominant, whereas the higher altitudes have temperate-humid, to semi-humid mountain and mountain meadows climates (WWF-Caucasus 2008). The rough relief and elevation-dependent seasons often result in microclimates. Temperatures and precipitation depend on elevation as well as distance to the Black and Caspian Seas: the western part receives heavier annual precipitation than the eastern part, a fact also recognisable in the vegetation. Boreal forests cover the slopes of the western sub-alpine areas but are rare in the east.

1.1.2 The North Caucasian Bronze Age: Cultures and chronology

Over the course of almost 2800 years, the Bronze Age societies of the Northern Caucasus experienced very diverse economic, ritual, and social developments (*ca.* 4000-1200 BCE, Fig. 2; Sagona 2018). At the beginning of this era, the Maikop culture inhabited the steppe, practicing a mixed economy of farming and animal husbandry and exhibiting a sedentary lifestyle. Outstanding funerary equipment and grave monumentality for single individuals indicate that the Maikop societies had a certain degree of hierarchical organisation, expressed by accentuation in ritual practice. The end of the Bronze Age is characterised by the Early Iron Age Koban Culture which occupied the foothills and high mountain area. These societies buried their dead in individual flat graves, creating large cemeteries. Costume and ornament elements reflect social membership rather than emphasising single individuals. Earlier Late Bronze Age (LBA) groups explored the northwestern slope, constructing permanent settlements with stone architecture. They relied on a mixed agricultural-pastoral economy with limited mobility. The settlement arrangements indicate low hierarchical structures.

Comparing these three cultures which are most chronologically and geographically removed from each other brings two main foci of current North Caucasian Bronze Age Archaeology to the fore: (1), the important role of environmental diversity and the adaption to local environmental factors by the societies, (2) differences in social organisation expressed in funeral practices and settlement structures. In the following subchapter, the description of North Caucasian Bronze Age cultures and phenomena provide a more detailed insight into some of the ritual, economic, and social characteristics of these societies.

Giving an overview of the heterogeneous societies also serves to summarize the parameters on which current statements of archaeological research in this region defines itself. For a summary of the chronological setting of archaeological cultures described in the following text, see Fig. 2. At the beginning of the Metal Ages, when the first copper objects appeared, the entire Caucasus was an area of "*(...) fairly modest cultural focus, isolated from the northern regions*" (Chernykh 1992, 54-55). As the exploitation and trade of natural resources and metal objects began, Caucasian metallurgical and metalworking centres played important roles for the entire Eurasian Bronze Age in terms of technical innovation and supra-regional networks. The establishment of the Maikop culture in the northern and the Kura-Araxes culture in the southern part of the high mountain ranges mirrors a shift in Caucasian History (Chernykh 1992, 55).

With the rise of the **Maikop Culture** at the beginning of the 4th mil BCE, epochal innovations (*e.g.* horse breeding, processing of sheep wool, use of wagons, new methods in metallurgy; cf. Hansen 2010; Ivanova 2012b, 11; Trifonov 2004) and early burial monumentality spread not only through the Northern Caucasus but also the southern regions. Large kurgans, often set up in groups, made up the predominant feature in the landscape (Chernykh 1992, 67). Following Russian researchers, the origin of the Maikop Culture[2] was a result of the "Uruk-Expansion", a spreading of cultural attributes from southern Mesopotamian traditions (Korenevskij 2010, 60; Ivanova 2012a, 11; Ivanova 2007). The regional variations of the Maikop

2 Named after the famous Kurgan found in 1897 close to the city of Maikop (Otchot 1997).

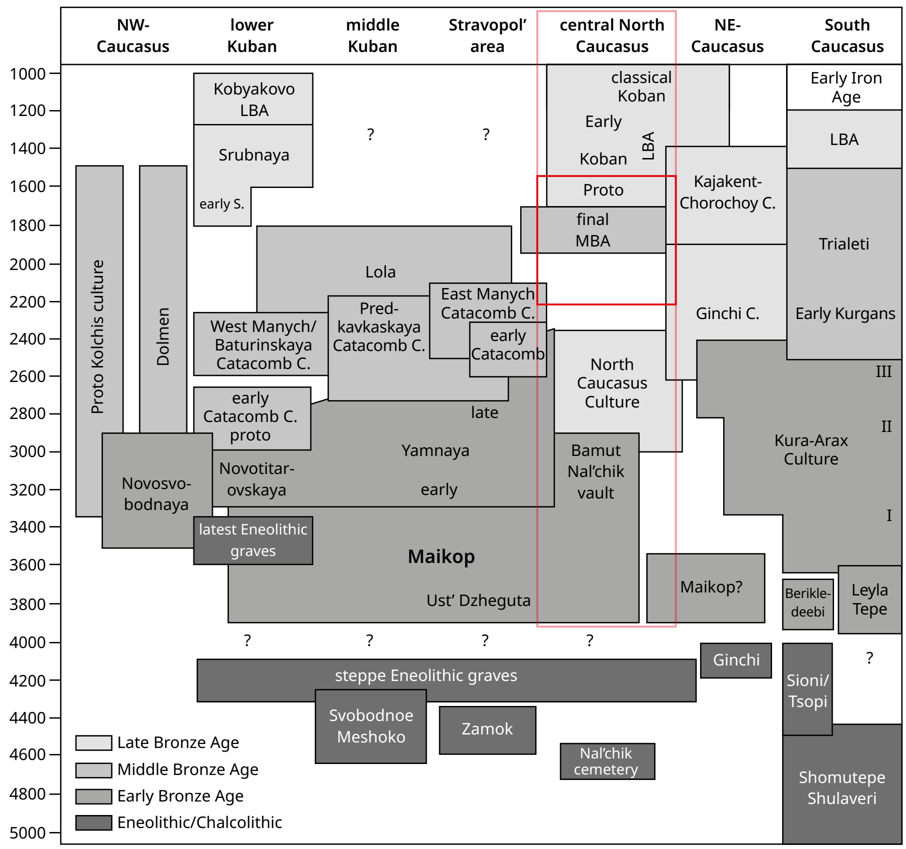

Figure 2: Chronology of Bronze Age cultures in the Caucasus and neighbouring areas after Reinhold et al. (2017, Fig. 8.2, 79). The light red frame highlights the cultures of the central North Caucasian regions, the dark red frame illustrates the chronological setting of the studied time span, 2200-1650 BCE.

Culture[3] characterised the Caucasian Early Bronze Age (EBA) from 4000-2900 BCE (Korenevskij 2004). Within the larger tradition of building kurgans, single burial mounds reveal outstanding grave constructions and furniture; monumental burial mounds reaching a minimum height of 3 m, stone grave chambers, carefully decorated grave goods made of bronze, silver and gold, and weapons emphasize the elite status of single individuals. The most famous such kurgans are found near the town of Maikop, the modern place for which both they, and the entire culture, were named (Chernykh 1992, 67; Korenevskij 2010, 60, 70). Although extensive settlement excavations are lacking so far[4], it is known that the Maikop societies modified their environment by practicing a mixed farming, stock rearing, and pastoral subsistence, expanding through the steppe regions, piedmonts, and higher altitudes In (Shishlina *et al.* 2012a; Korenevskij 2004; Formozov 1965, 89-90). contrast to the assumption that the Maikop societies had a sedentary lifestyle, wagons found in graves and horse keeping indicate a certain degree of mobility. This was potentially restricted to a particular part of the society, *e.g.* for herding (Anthony 2007). In summary, the remains of the Maikop Culture are argued to mirror hierarchically organised societies which demonstrated their military, territorial, and spiritual power through the construction of prestigious burial mounds. However, the settlement remains do not reflect the wealth of the burial complexes (Chernykh 1992, 72).

3 Divided by different traditions in material culture and burial rites, *e.g.* Maikop-Novosobodnaya, Galijugi-Seregin, Dolinskoye, Kuma-Manyč (cf. Korenevskij 2010, 60).

4 As an example, for an excavated Maikop settlement cf. Formozov (1965).

With the beginning of the 3rd mil BCE, a change in the North Caucasian Bronze Age cultural landscape took place, marking the transition from the Early to the Middle Bronze Age (MBA). After the supra-regional Maikop phenomenon, the 3rd and early 2nd mil BCE were shaped by multiple cultures with smaller extents which spread over the steppe, foothill, and high mountain areas. These cultures are described by specific regional occurrence and differences in burial tradition, social organisation, and economic strategies. A compilation of the Middle and Late Bronze Age (LBA) cultures and their attributes has been published by Reinhold (2011a). She points out that the chronological sequence is limited due to a lack of data unbiased by typological classification, such as radiocarbon dating.

During the transition of the EBA to the MBA, Chernykh (1992, 147) states that a change in the frequency and distribution of functional artefacts took place. Tools and weapons were predominant in the earlier periods – for example, shaft-hole axes were used as prestigious symbols of power and daggers and spearheads were common – whereas ornaments and typological variety of the artefacts increased later on. In addition, he argues that gold was found more frequently in EBA than in MBA contexts, where it is almost entirely absent (Chernykh 1992, 150).

The Caucasian versions of the **Catacomb Grave Culture (CGC)** were present from the early to the late 3rd mil BCE in the northern steppe areas[5], summarized under the term "North Caucasian Catacomb Grave Cultures". This term encompasses the regional manifestations of the CGC (Baturinsk, Ost-Manyč, Suvorovo) which developed out of the earlier Novotitorovska and Early Catacomb Grave Culture. Besides burying their deceased in T-shaped catacombs, these regional versions of the CGC share the tradition of small burial mounds but differ in single funeral elements. In general, more than one individual could be buried in the kurgans. Except for wagons and axes, items of outstanding value were not part of the funerary equipment. Compared to the Maikop Culture, exhibiting status in the funeral practice apparently played a minor role, possibly due to less the societies being less hierarchically stratified. Metal artefacts in burials were extremely rare. Findings of wagons, the lack of known contemporary settlements, and hints of wild plant gathering suggest pastoral lifeways for these societies (Reinhold 2011a, 13-14; Shishlina 2008; Gak and Kalmykov 2009; Gej 2008; Sorokina 1986). Cultural variations in the southern and western periphery, especially those of the later stages ("Post Catacomb Bloc": Kuban group, Suvorovo variation), are used by researchers to clarify are used by researchers to clarify differences which appear in the burial shape, body deposition, and grave inventories (Kleshchenko 2015; Kleshchenko 2014). The absence of offerings in graves is supposed to be a continuative, typical post-catacomb phenomenon (Mimokhod 2013, 48).

At the same time as the CGC were inhabiting the northern steppes, a different type of grave monumentality was occurring in the western part of the piedmonts and high mountain range: The **Dolmen culture** with its megalithic tradition. These dolmens have a limited variation in architecture with different floor plans constructed of mainly flat stones and an entrance plate, often these plates often had a roundish hole. It is possible that some of these constructions are the successors of similar megalithic tombs from the local Maikop Culture. The people of the Dolmen Culture used the dolmen as collective graves. Sites like Degugak-Dachovsk, a settlement found in the western piedmont region, suggest a sedentary lifestyle of the related societies during the second half of the 3rd mil BCE (Reinhold 2011a; Trifonov *et al.* 2012; Trifonov 2013; Markovin 1997).

5 Modern-day Krasnodar and Stavropol Kray as well as the northern periphery of Karachay-Cherkessia, Kabardino-Balkaria and North-Ossetia.

Simultaneously, in the eastern region of the North Caucasian slope[6], the **Ginči Culture** was prevalent. Unlike the previous two MBA cultures mentioned, the culture is dated well from the middle of the 3rd to the middle of the 2nd mil BCE. In the foothills, small burial mounds show analogies to the CGC, whereas settlements with stone architecture and large flat graves cemeteries appear in the higher mountains. Burial traditions differ between local cultural variations; single, double, and collective graves have been found. Terrace fields, which supposedly date to the beginning of the Bronze Age, indicate there were farming activities already in earlier periods in this region (Aglarov 1986; Reinhold 2011a, 15; Gadzhiev 1974; Magomedov 1998; Markovin 1994).

Societies of the **North Caucasian culture (NCC)** characterised the MBA in the central foothill and high mountain areas[7] (middle of 3rd to early 2nd mil BCE; Fig. 3.1). The term was defined by Markovin (1960) and aims to summarize major regional cultural phenomena. Within this compilation, he separated three successive groups: Kuban, Koban and Kajakent-Choročoj culture (Markovin 1960, 122-136). His three-phase system is still in use today (2750-1800/1700 BCE, 1700-1500 BCE, 1400-1200 BCE, cf. Bill 2005, 18). Based on differences in pottery decoration, metalwork, and frequencies in bronze objects, Chernykh (1992) followed Hančar (1956, 190-195). By including spatial differences, he distinguishes a "Kuban/western focus", covering the left Kuban and its tributaries riverbanks from a "Terek/eastern focus" spread across the Terek river basin. The shaft-hole-axes represent the typical tool or weapon for both foci. Looking at specific jewellery types, Korenevskij (1984) developed three variations for the Karbadino-Balkarian region: two foothill variations and a mountain variation. As new excavations showed that some of the relevant elements appear also in the northern steppe regions, this classification requires revision (Reinhold 2011a, 14).

Motzenbäcker (1996) points out that the term "North Caucasian Culture" is simply too broad. His classification of the "Sammlung Kossnierska", a collection of 2060 bronze objects from two cemeteries located in the central high mountains, is currently the decisive typo-chronological system. Although the conditions of discovery of the objects do not fulfil the requirements of a "closed find" and the funeral context is inexact, Motzenbäcker achieved a relative typo-chronological reorganisation by taking grave inventories from other Bronze Age cemeteries[8] into account. He claims that the NCC in fact includes different regional phenomena. In addition to the Koban and Terek foci, he addresses the northern periphery of the CGC as it relates to the steppe part of the NCC dispersion.

During the last four decades, such discussions about forming regional NCC groups have intensified (cf. Nagler 1996, 11-14). Reinhold's latest chronological map shows an overlapping area of NCC and CGC Suvorovo variation distribution which would explain the simultaneous prevalence of catacomb graves and those belonging to the NCC (Reinhold *et al.* 2017). Still, a unified classification, or rather a definitively clear definition, of the NCC variations considering both typological and typo-independent data such as radiocarbon dating, is lacking[9].

When compared to contemporary cultures, burials of the NCC stand out as their cemeteries are filled with flat graves as well as small kurgans and the interred individuals are often stretched in the supine position (Chernykh 1992, 115; Nagler 1996; Reinhold 2011a, 14; Batchaev 1984; Berozov and Nagoev 1984; Korenevskij 1990; Miziev 1984; Nechitaylo 1978; 1979). These flat graves are simple pits or stone cists; in the higher altitudes large collective graves and cremations are also present (Reinhold 2007, appendix "Kollektivgräber"). Typical grave inventories consist of vessels and bronze ornaments although stone axes also occur. Overall, the morpho-

6 Modern-day Chechnya and Dagestan.

7 Modern-day Karachay-Cherkessia, Kabardino-Balkaria and North-Ossetia.

8 His work is an important starting point for the classification of the material from Kudachurt 14.

9 For detailed description of the chronological and regional characteristics of the NCC, see Nagler (1996, 11-15).

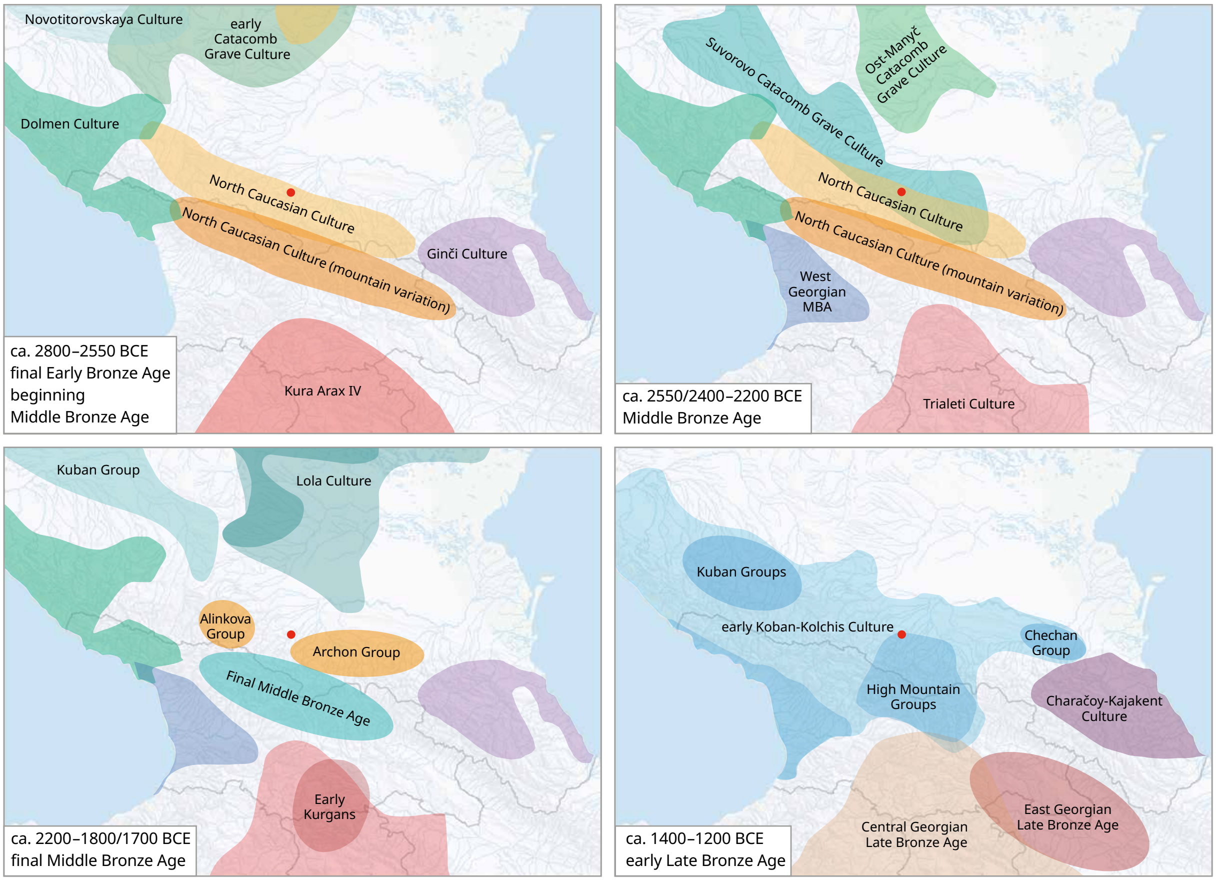

Figure 3: Chronological and spatial distribution of archaeological cultures from the early Middle Bronze to the Early Iron Age in the Northern Caucasus. The red dot marks the location of Kudachurt 14. 1: North Caucasian Culture. 2: Mountain variations of the North Caucasian Culture. 3: Suvorovo variation of the Catacomb Culture. 4: Alinkova Group. 5: Archon Group. 6: Final MBA Mountains. 7: Early Koban-Kolchis Culture. Initial map created by S. Reinhold (based on literature cited in the text for Figure 1 of this chapter; courtesy of S. Reinhold).

logical traditions of material culture reveal much higher diversity in comparison with that of the earlier Maikop culture (Chernykh 1992, 115). In general, the North Caucasian MBA remains a period of less permanently settled societies which focused on animal husbandry (Reinhold 2007, 282); however, divergent subsistence strategies are assumed for the western and eastern areas as well as for the higher altitudes (see above). Although the predominant sites of the North Caucasian Bronze Age are cemeteries/burial locations, and these sites do not necessarily represent the entire settlement area of the societies which created them, it is possible to assume that the surrounding area was likely their primary area of occupation. The distribution of burial sites suggests that the North Caucasian MBA societies inhabited all geographic regions including the rugged landscapes of high altitudes (Reinhold 2007, 283-284).

From the late 3rd mil BCE onwards, the final MBA horizon heralded the transition to the LBA. While the Dolmen culture and variations of the Ginči Culture still existed during this period on the northwestern and northeastern mountain slope respectively, the typical Catacomb traditions of the steppe disappear. Instead, the **Lola Culture**, a culture which was again defined by burials, took shape (Mimokhod 2013). Mimokhod places this culture in the “Post Catacomb Bloc”, identifying the chronological sequence and “genetic linkage” of the Catacomb cultures with those of the final MBA horizon (2013, 325). The deceased were buried in grave pits of different shape or in catacombs located in small kurgans. They were typically placed on their left side in the crouched position with different orientations. Grave inventories did not occur frequently; the rare ones consist of vessels, tools, weapons and jewellery, made of bronze, bone and horn. The absence of known settlements suggests high mobility of the related populations. Although the main distribution of the Lola Culture is in the North Caucasian steppe plain, it also touched the southern foothill areas (Mimokhod 2013, 348-352).

Neighbouring the Lola Culture to the west, settlements and a small number of graves make up a cultural assemblage summarized by Reinhold as elements of the **Kuban group** (Reinhold 2011a, 16). The final MBA in the foothills is hardly detectable. The local **Alinkonovka group** in the western central foothills (*ca.* 1500-1400 BCE; Fig. 3.4) shows no connection to the later LBA traditions and can be considered as an earlier final MBA phenomenon (Reinhold 2007, 221; Korenevskij 1981). Situated farther east, the **Archon group** was defined as a post-catacomb tradition of the Post Catacomb Bloc based on a cemetery close to its name-giving village, Archonskaja (Korenevskij and Mimokhod 2011). Several graves affiliated with this cultural group were considered in a radiocarbon data set of ten samples (human and animal bone). The sum calibration spans a timeframe between 2500-1600 cal BCE (95.4% probability), whereas the highest probability density is between 2060-1750 cal BCE (Mimokhod 2014, 77-79). These radiocarbon dates are the most recently published ones for the late MBA period. Considered as burials of post-catacomb traditions and later as findings of the Suvorovo variation, the data prove that the Archon group was either contemporary with or followed the NCC. In the high mountains various not yet classified cultural remains are summarized under the term "**Final MBA mountains**" (Fig. 3.6).

The LBA (*ca.* 1700-1200 BCE) in the North Caucasian steppe region remains a period without cultural remains (Fig. 3). This stands in sharp contrast to the foothill and high mountain areas, which are dominated by the Early **Koban-Kolchis culture** (1400-1200 BCE; Козенкова 1996) and local traditions, whose presence spans over the final MBA into the LBA; for these groups, mainly defined by material traditions, the exact development is still unclear. The archaeological archives of the **Koban culture** are characterised by large, famous cemeteries such as the name-giving site Koban (Virchow 1883; Kozenkova 2001) and Tli both (Techov 1980; 1981), located in modern-day Ossetia. The amount and typological spectra of objects from these and other cemeteries allow a reliable reconstruction of the LBA to the Early Iron Age transition in the central high mountains (Reinhold 2011a, 16-17). This process occurred *ca.* 1400-1100 BCE with local delays (central, western and eastern variant; Reinhold 2007, 177; Kozenkova 1996) and the stage of Koban A marks the latest LBA phase.

Recent research in the Kislovodsk region, southern Stavropol Kray, and neighbouring areas discovered striking settlement architecture in the foothills and higher altitudes (Reinhold 2011a; Reinhold 2011b; Reinhold 2014). During the earlier stages of this period, the LBA populations had a more mobile lifestyle and began to explore the plateau zones which they would later use as settlement areas (*ca.* 1600 BCE; Reinhold 2011a, 279). From 1400 BCE onwards multifunctional house structures appear; living and stabling spaces, located together in a single structure, nearly mirror each other and are designed for holding a large number of animals. Reinhold interprets the architectural standardisation that spreads with these new structures as an indication of a corporate-acting society practicing "mixed mountain farming". Ancient agricultural terraces in the Kislovodsk basin have also been dated to the Koban culture, including its transition to the Early Iron Age (Borisov *et al.* 2012, 569). Thus, according to Reinhold, the foundations of population growth and extensive land use were in place by the late 2nd mil BCE in this region, and the permanent stone architecture can be seen as predecessor for later Iron Age constructions (Reinhold 2011a, 362).

Overall, the North Caucasian LBA is a period in which cultural activity was focused in the foothills and high mountains and during which sedentism increased.

Data from graves associated with settlements are so far lacking; in general, the tradition of kurgans ended and large cemeteries with flat graves and cromlechs appeared. Thus, this particular characteristic attribute of monumentality was no longer part of the burial tradition (Reinhold 2011a, 363). The cultural identity of these societies has not yet been defined. Pottery decoration shows differences in material from high valley and plateau zones, with one jewellery object showing affiliations to the NCC (Reinhold 2011a, 150). A pin, which has been found in plateau settlement context, shows typological attributes of the MBA, whereas radiocarbon dating of the site is much later (13^{th}-10^{th} cent. BCE; Reinhold 2011a, 304).

Besides cemeteries and settlements, a third category of site has been identified belonging to the final MBA and LBA (*ca.* 1500-1100 BCE, Reinhold 2005b, 349). Hoards of bronze objects have been found in different contexts in the Kuban region, foothills, and central high mountains; differences in compositions and deposition indicate divergent hoarding practices in the western and eastern parts of the Caucasus (Reinhold 2005b, 362). Hoards from the North Caucasian MBA predominantly consist of axes and sickles with some daggers and hatchets also included. Agricultural and multifunctional artefacts are thus emphasized rather than personalised equipment. The tradition of hoard deposition is potentially a transmission from the northern Pontic area, yet it also shows similarities to the European hoard provinces. (Reinhold 2005b, 359-360). In general, it marks a change in behaviour related to ritual, economic and/or territorial practices in the North Caucasian Bronze Age.

With the transition from the late 2^{nd} to the 1^{st} mil BCE, the Early Iron Age (EIA) began in the Northern Caucasus. Populations of the **Koban culture** inhabited the foothill and high mountains, not only of the northern slope, but also in the southern Caucasian regions. The separation of regional groups by the geographic relief is reflected in their divergent material cultures. However, common social structures and close trade relationships still united these regional groups into a single, larger cultural phenomenon. Attributes such as sex, age, and family relations were emphasised, especially in costume items; an accentuation of the individual or strong vertical stratification within communities was not common (Chernykh 1992, 281; Reinhold 2005a, 98). Settlements belonging to these groups have been rarely excavated, but their size and the size of the cemeteries speak for a high population density in the high mountain area in comparison to that of the Bronze Age periods (Reinhold 2012, 88). In the steppe region, the appearance of cultural remains becomes less dense, likely paralleled by a crucial decrease of population density (Reinhold 2007, 282-283).

1.1.3 Climatic conditions

Over the last several decades the study of environmental changes has gained importance for the understanding of human development in the Northern Caucasus. For the Bronze Age, a period characterised by significant changes in social, economic, and technical activities, detecting driving factors is of particular interest (Müller 2015, 652). Thus, the integration of prehistoric environmental conditions as potential triggers of human change should be standard in corresponding discussions. For instance, the 4.2 ka event (lasting *ca.* 2250-2100 BCE) is an important topic in archaeological science related to the later Holocene climate and cultural processes; through the study of different proxies, attempts are made to comprehend potential correlation between climatic change and cultural processes (cf. Meller *et al.* 2015).

Climate, as it determines seasonality, temperature, and humidity on numerous scales, is the key actor in environmental change, besides humans themselves. How humans exploit their natural surroundings – for instance farming, herding, or resource extraction – strongly depends on local environmental factors. Some of the local factors (*i.e.* vegetation, soil properties, and water sources) are strongly influenced by climatic conditions. In case of climatic and ecological change, humans must adapt their lifestyle.

This can result in the exploration of a new habitat or a change of subsistence strategies. According to economic traditions and the level of economic-technical development, these adaptation strategies may differ; of course, the extent of climatic change and given geographic circumstances are additional influential factors.

In this context, the North Caucasian Bronze Age is a special case. In general, the geographic region exhibits a great diversity of living environments in terms of climate and ecological conditions. Furthermore, different proxies indicate that the Bronze Age period in this region was characterised by significant climatic changes. With regard to differences in steppe, foothill, and high mountain habitats, these changes might have been a driving factor for the development of local and supra-regional population groups, especially with respect to subsistence strategies and social response. For the working area, only a few studies about climatic processes and their potential consequences are available.

Temperature reconstructions for the European Holocene based on palynological studies reflect climatic processes (Davis *et al.* 2003, 1708-1709, Fig. 4-5). Some of the pollen data mentioned in these analyses are from southern Europe, including the Northern Caucasus. According to these models, the temperatures rose slightly during the Bronze Age with some fluctuations (~6000-3000 BP, *ca.* 0.8°). Overall, there seems to be a larger difference of seasonal temperatures in the earlier half of the Bronze Age, as seen by the increasing degrees in the winter curve. Consequently, winters potentially became milder.

Investigations of palaeosoils from MBA burial contexts suggest an increase in aridity between 2500-2000 BCE for different North Caucasian steppe regions. Later, the climate became more humid again (Borisov *et al.* 2006; Borisov *et al.* 2011). The authors assume a connection between the cultural change from Catacomb to Post-Catacomb traditions and a shift in subsistence due to a desertification of the environment (Borisov *et al.* 2011, 153; Demkin *et al.* 2010; 2016).

A change of climate and consequently local ecological factors was also the focus of $\delta^{15}N$ and $\delta^{13}C$ isotope analyses of EBA and MBA populations, mainly from the steppe region (Higham *et al.* 2010; Hollund *et al.* 2010; Shishlina 2008; Shishlina *et al.* 2012a). According to the researchers, human isotopic values from different periods and cultures inversely correlate with the precipitation curves: higher carbon and nitrogen values occur at the same time as decreasing amounts of mean annual precipitation over time (Shishlina *et al.* 2012a, 759).

Investigations of carbonates in Chernozem profiles from substrata under Bronze Age mounds in the Chechen depression indicate a relatively dry and warm climate in the Atlantic period (>5000 BP). During the beginning of the Subboreal period there is a shift to higher humidity and cooler temperatures (5000-4000 BP; Khokhlova *et al.* 2001).

Palynological data from two swamps in the western and central high mountains suggest climatic fluctuations during the 2nd mil BCE. These deviations might be reflected in the spreading of coniferous and deciduous forests in the central high valleys (Kvavadze and Efremov 1996; Reinhold 2011a, 72-73; Serebjannyj *et al.* 1984). Reinhold suggests milder winters and better conditions for exploring the higher altitudes, resulted in an increased number of settlements during the LBA in the high valleys (2011a, 73). The increased settlement density during the late MBA to LBA in the higher altitudes and simultaneous abandoning of the steppe region, which is recognisable in the lack of archaeological sites of this period, lead to the assumption of a change in habitat preference. Potentially, this was due to significant climatic changes, which might have caused a shift of the vegetation zones northwards by bringing the previously preferred habitats out of reach (Reinhold 2007, 284; Reinhold 2011a, 283).

These data are still too low in resolution and too local to be reliable indicators, especially on a micro-regional scale. If, or to what extent, the 4.2 ka event is reflected is still not known. However, it should be noted that the climate conditions were not stable during the period of interest.

1.2 State of the art

Due to the monumentality of its several well-known cemeteries, transnational North Caucasian Bronze Age archaeology is characterised by a focus on burial archaeology. Burial rites and the material culture provided by grave inventories have been the main topic of interest, resulting in descriptions of various archaeological cultures and chronological schemes. Comprehensive summaries of the history of research of the North Caucasian Bronze Age and the development of chronological schemes are published by, among others, Sagona (2018), Reinhold (2007; 2011a) and Motzenbäcker (1996).

Summarizing chapter 1.1.2 and 1.1.3, the following aspects should be emphasised in respect to the scope of this thesis:

- The North Caucasian Bronze Age marks a crucial period in terms of social, ritual, technical and economic developments on a local as well as a supra-regional scale.
- Over time, the preferred habitats shifted from the steppe area in the Early Bronze Age to the high mountain ranges in the LBA. From the widespread MBA cultures (Catacomb Grave Culture and variations), a fragmentation into smaller phenomenon (North Caucasian Culture, Post-Catacomb traditions, regional groups) took place.
- Referring to the diachronic shift in preferred habitats and divergent subsistence strategies, the significance of ecological factors in the different steppe, foothill and high mountain environments is agreed upon. Climatic changes might have triggered this shift, with a desertification of the steppe area causing an increase in the attractive qualities of habitats in higher altitudes.
- Diachronic changes in burial practices and subsistence strategies point to divergent patterns of social organisation. The strong emphasis on the construction of individual burials and inclusion of personal equipment during the EBA in the steppe (Maikop Culture) shows attributes of hierarchical structures, whereas the large cemeteries of the LBA and EIA period in the high mountains refer to levelled and egalitarian social models (Koban Culture). The MBA remains a little researched period with heterogeneous burial traditions and few evidences of settlement structures. This is different for the LBA, as new investigations of settlements showed, although reliable conclusions based on associated settlement and burial sites are hitherto lacking.
- The transition from the MBA to LBA (2200-1400 BCE) remains a period hardly detectable in the funeral record. The few known grave inventories and associated radiocarbon datings indicate the co-existence of different regional groups (NCC, Archon-group, Post-Catacomb traditions). This period represents a crucial time span in terms of social development in different respects (social structure, socio-economic strategies, and ritual practice).
- Conclusions of diachronic and regional differences in mobility and subsistence are based on funeral attributes (wagons) as well as the absence, presence, or structure of settlements. In addition, analyses of stable isotopes aim at reconstructing mobility ranges and principal sources of food (see below).
- Due to lack of the use of dating methods unbiased by typological or ritual interpretation, the temporal resolution and consequently the chronological interpretation of social, ritual, and economic developments is not yet satisfying; this is especially true for the MBA-LBA-transition.

The general increased interest in pursuing more holistic research questions in archaeology also provided important research impetus to archaeological studies of the Northern Caucasus. During the last decades, the activity of local enterprises and international project collaborations strengthened subdiciplines of archaeological and bioarchaeological research. Investigations of settlement structures and palaeodietary reconstructions by means of stable isotope analyses make an effort to examine Bronze Age societies through different perspectives. This type of research promises new opportunities to combine knowledge about ritual behaviour, gained from a long research tradition, with new insights into human-environmental interaction and habitual patterns. Additionally, radiocarbon dating has become more important and sheds light on questions related to chronological classifications (Mimokhod 2014).

Although North Caucasian Archaeology, and the Bronze Age period in particular, gained more attention in the last decade, it still bears an enormous unexploited potential. This is especially true when considering the diverse different fields of research that form modern interdisciplinary studies. As this thesis concentrates on three major topics, each of which draws from a different discipline, the state-of-the-art of research concerning each will be discussed more precisely.

1.2.1 Burial practices: Socio-ritual indicators

Comprehensive investigations and supra-regional analyses of cemeteries or burials using modern socio-archaeological approaches which consider both *functional* and *intentional* data[10] (Härke 1993b; Härke 2000; Müller 1994), develop proxies for social queries (Sprenger 1994), and apply further statistical methods (*e.g.* Müller 1994; Siklósi 2013; Taylor 2016), have so far not been conducted for the North Caucasian Bronze Age. Some researchers have, however, begun moving in this direction.

Kaiser (2011) analysed burials of the Yamnaja (*ca.* 3000-2500/2400 BCE, n=195) and Catacomb Grave Culture (CGC, 2800-2000/1900 BCE, n=112) of the Eastern Eurasian Steppe Zone taking into account effort expended in grave construction, included equipment, and age at death of the individuals. She concluded that the transition from the Yamnaja to the Catacomb Grave Culture was accompanied by significant changes in social structures (Kaiser 2011, 193-194). Even though she relied on very little anthropological information and mainly used archaeologically determined age at death, Kaiser found a strong correlation between age at death, number of individuals buried in one grave, and grave pit size for both Yamnaja and CGC burials. Increased effort in grave construction (complexity, size of burial mound) and the inclusion of wagons as grave goods led her to assume a non-egalitarian structure for the Yamnaja societies. Grave goods are rare but appear more frequent in male burials[11]. According to the author, the Yamnaja burial rites probably does not reflect past social conditions. In CGC grave inventories the occurrence of axes and maceheads, as innovative attributes, are interpreted as indicators of individual status rather than of warrior graves. The general variability of grave goods increased in comparison to assemblages of the Yamnaja Culture, but this does not allow further assumptions in terms of social differentiation (Kaiser 2011, 208). Although Kaiser's investigations are outside of the geographical region of interest, this is one of the few broader approaches considering both mortuary and individual information, such as age of death, that has been applied to the North Caucasian Bronze Age.

Reinhold is a second example of a researcher attempting a more comprehensive approach. She discusses the establishment of corporate identities in the EIA, stressing the role of a standardized costume tradition and the repeating compilation of weapons in the funeral context of Kuban Culture cemeteries in the second half of the 2nd mil BCE (Reinhold 2012). Although anthropological data are mainly

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10 While *functional* data have a determined character, *i.e.* anthropological and technical information, *intentional* data are characterised by social action displayed in burial rituals (cf. Härke 1993, 143).

11 Kaiser refers to studies on grave complexes from the northwestern Pontic region, analysed by Ivanonva (2011, 201-202).

unavailable for the analysed cemeteries, the author interprets these patterns as clearly sex-determined. Within distributions of costume (jewellery, clothing, hair ornaments) and weapon elements, Reinhold sees the levelling character of these elements in both male and female burials, though slight regional differences occur and occasional male "warrior" personalities are emphasised (Reinhold 2012, 92). Therefore, according to the author, on the one hand standardized equipment expresses the levelling of "social identities", and on the other hand are personalised within the sex of the individual.

Previous late MBA and LBA collective graves with personalised equipment prevalent in the high mountain range can be interpreted as the first indicators for this social levelling in burial practice. In this respect, Reinhold mentions the cemetery of Kudachurt 14 as a site showing sex-determined equipment for LBA burials, whereas this stays in contrast to the MBA burials from this site (Reinhold 2012, 93). At the time of her publication, these assumptions were only preliminary as the chronological verification and anthropological examination of this cemetery are central topics of this thesis. Additionally, Reinhold compares quantities and qualities of grave inventories in an EBA cemetery located in the western foothills (Klady, Rezepkin 2000) and a LBA-IEA cemetery located in the eastern foothills (Seržen'-Jurt, Kozenkova *et al.* 1992). She concludes that the major difference is in the number of artefacts and the new forms of weapons and tools that make up sets of equipment in the later period; weaponry is more frequent and a standardized costume tradition, which is missing in the EBA, is present in the LBA-IEA cemetery (Reinhold 2012, 99-100).

Finally, Reinhold discusses the monumentality of the Maikop kurgans in respect to the joint effort a population or a certain part of the population has to invest in the construction of such burials for only single individuals[12]. Her attempts to reconstruct social identities by evaluating personalisation and collectivisation in the funeral record represent an advanced approach in terms of incorporating theoretical considerations and archaeological interpretations.

These two selected cases studies demonstrate the existing interest in approaching questions related to the assessment of burial practice as an indicator for social interpretations from a more holistic perspective; still, these examinations point to the desideratum in research for independent and unbiased data taken from the human remains. Reinhold's paper is also important for this thesis as it emphasises the MBA-LBA transition as a significant period in terms of changes in social structures and the according role Kudachurt 14 might play.

Taking into account the considerations made above, we can say that in North Caucasian Archaeology, approaches to detect social inequality and hierarchy in the Bronze Age mainly refer to differences in burial practice. Related indicators often at the same time make up the foundation on which archaeological cultures are defined:

- Monumentality and grave construction: Size of kurgans, stone architecture, catacombs, flat graves
- Size of and number of burials in a cemetery, differing from isolated to grouped kurgans and large flat grave cemeteries
- Emphasising the individual in single graves *vs.* collective inhumation (kurgan, pit, megaliths) as reflecting kinship relations; thus, the number of individuals per burial/kurgan is significant
- The compilation of grave inventories: Presence, absence, quantity and quality of artefacts or materials (for instance status symbols or metal objects); in addition, wagons and cattle remains are used as indicators of mobility and occupational specialisation

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12 Here, Reinhold refers to Korenevskij (2010).

1.2.2 Human Remains: Osteology and Palaeopathology

The first anthropological research of North Caucasian populations was conducted in the late 19th century by Rudolf Virchow and Roderich von Erckert. Their craniometric studies on living people examined morphological differences within the scope of ethnological investigations (Erckert 1888; Virchow 1882; Virchow 1883). Furthermore, Virchow's publication about the LBA Koban cemetery witnesses his extensive interest also in Caucasian prehistory. The excavation of a large number of Bronze Age burials with different states of skeletal preservation since then offers a broad basis for osteological and palaeopathological investigations. However, until recently, very few examinations have been carried out (*e.g.* Buzhilova 1996), especially regarding modern analytical approaches and methods. Within the last five years, pilot studies of skeletal remains from different regions have aimed at shedding light on the life of the people who inhabited the North Caucasus during the Bronze Age. A collaboration between scientists from the DAI (Berlin), the CEZ (Mannheim), the RAW (Moskow) and several local archaeological enterprises and institutes (Stavropol, Nalchik) was the starting point for a joint interdisciplinary research focus. This focus involves osteological and palaeopathological as well as stable isotope analyses (nitrogen, carbon, strontium) of the human remains with respect to their archaeological context. It is also the investigative background of this thesis.

During the last five years, the working group "Anthropology and Palaeopathology" at the Scientific Department of the DAI developed a methodological approach, including new recording schemes and a data base, used for examinations of human remains from different geographical and chronological settings from the Northern Caucasus. Collected data is of importance for investigating diachronic and regional differences within the diverse regions and archaeological cultures. The first years of this project collaboration already provided interesting insights in the living conditions of the North Caucasian Bronze Age populations. Single and multi-discipline case studies dealing with physical stress, nutritional stress and oral health have already been published as abstracts in conference proceedings (Fuchs *et al.* 2013; Fuchs and Gresky 2014; Fuchs and Gresky 2015a; Fuchs and Gresky 2015b; Gresky and Berezina 2013; Gresky and Berezina 2014; Schwarz *et al.* 2015). In the scope of this thesis, the presented cases of scurvy and preliminary results of caries prevalence at Kudachurt 14 are of main interest (see chapter 5, 9).

The latest publication by the working group deals with new cases of trepanations from the 5th to the 3rd mil BCE, accordingly also from Bronze Age contexts, as well as the analyses of multiple traumas found on a "wagon driver" skeleton from the NCC (Gresky *et al.* 2016; Tucker *et al.* 2017). Location on the skull, size and shape of the lesion, and operation technique as well as state of healing indicate a ritual rather than a therapeutic cause for trepanning. This proves the existence of surgical skills and medical or anatomic knowledge in the respective societies as the majority of the individuals survived. It also suggests that ritual acts might be traceable not only within the funeral practice, but also in human interactions affecting the physical being of people while they were still alive.

1.2.3 Stable isotope analyses: Palaeodietary reconstructions

The investigation of subsistence strategies is one of the major topics in the archaeology of the North Caucasian Bronze Age. Prehistoric evidence such as settlement remains or lack thereof, traces of anthropogenic impact on the environment, archaeozoological, and stable isotope analyses are used as economic and dietary indicators for investigating the population's lifeways (Higham *et al.* 2010; Hollund *et al.* 2010; Knipper *et al.* 2018; Reinhold 2011a; Reinhold 2011b; Shishlina 2008; Shishlina *et al.* 2009). The current number of scientific publications about carbon and nitrogen stable isotope analyses conducted on material from the northern slope of the Greater Caucasus is very little especially for the Bronze Age period (Higham *et al.* 2010; Hollund *et al.* 2010; Warren 2005).

Currently, extensive analyses of floral, faunal, and human samples from sites spanning from Eneolithic to LBA cultures and geographic transects reaching from the steppe to high mountain ranges are ongoing. In order to trace mobility as well as dietary patterns, the studies of Corina Knipper and her team include strontium isotopes. The temporal setting of the studies also focuses on the MBA-LBA transition, a period with significant changes in the subsistence strategies but for which palaeodietary reconstructions on the basis of stable isotope analyses are missing completely. The paper recently published by Knipper and colleagues (2018) presents new data and provides a suitable background in which to embed the analyses conducted in this doctoral thesis. Together with the paper written by Hollund and colleagues (Hollund *et al.* 2010), it makes the starting point for the isotope analyses of Kudachurt 14 and therefore detailed discussion of both papers can be found in chapter 6. For the region of the adjacent Eurasian Caspian Steepe, Shishlina and colleagues (2001; 2008; 2009; 2012b; 2012a; Iacumin *et al.* 2004) concentrate more on role of fresh water fish consumption, also in terms of its reservoir effect on radiocarbon dating. In general, the dietary interpretation of enriched values associated with aquatic food sources for populations that are supposed to favour a pastoralist (CGC) or semi-sedentary economy (Maikop) is a controversial issue, especially for the prehistoric Eurasian Steppe. The paper published by Hollund and colleagues (2010) compares faunal and human nitrogen and carbon values from 17 different EBA and MBA sites across the Northern Caucasus predominantly associated with the Maikop, CGC, and other BA cultures, although a few sites date to the Eneolithic. The sites are spread across different geographic zones. The study aims at investigating the presence of aquatic food components as well as potential reservoir effects by means of the parallel testing of human and faunal remains from contemporary contexts. By including assumed subsistence strategies of the different societies and involving results of other publications, the authors provide an overview of the nitrogen and carbon stable isotope distributions for North Caucasian Eneolithic and Bronze Age cultures.

2 Research questions and methodological approach

Based on the research design and structure of the doctoral thesis, each chapter follows specific thematic issues and research questions posed here and at the beginning of each chapter guide the reader through each analytical section. In the concluding chapter, answers to the research questions presented below summarise major results for each analytical unit.

The following derivation of questions includes short discussions on the significance of specific research topics for the scope of this doctoral thesis and shortly describes the investigative approach.

2.1 The cemetery "Kudachurt 14" (chapter 3)

In light of the current discussion around cultural, socio-economic, and chronological questions concerning the North Caucasian Bronze Age, the cemetery Kudachurt 14 holds a key role in many respects. Thus, the verification of the dating of the transition from the MBA to the LBA is crucial. Sufficient regional typo-chronological classifications during the relevant portion of the North Caucasian Bronze Age are not yet available; additionally, the overall regional cultural landscape has so far not been investigated in depth. Kudachurt 14 has revealed a greater quantity of graves and cultural material compared to other regional sites of its period. It provides information about different burial traditions and an extensive collection of cultural material as well as human skeletal archives for bioarchaeological, osteological and paleopathological analyses.

In order to provide the background for subsequent analytical chapters, the first issue addressed by this thesis is the presentation of a summary of North Caucasian Bronze Age archaeological cultures and the placement of the cemetery Kudachurt 14 in this framework. This includes a discussion of the current state of the art with respect to the disciplines applied, the description of excavation and findings at Kudachurt 14, and its contextualisation with regard to other sites of a defined study area by typo-chronological and absolute dating approaches. Therefore, the main questions addressed in chapter 3 are:

What is the environmental, temporal, and cultural setting of the cemetery Kudachurt 14? What is its context in research of the North Caucasian Bronze Age?

2.2 Burial practice: Social indicators (chapter 4)

A funeral tradition expresses ritual, social and ideological ideas and practices of the past and refers to human behaviour following certain beliefs or ideas about the death. As archaeologists, we are able to trace differences in the treatment of the deceased and in the funeral practice, giving us an idea about the mortuary habits of the living population. Burial practice as a proxy for social inequality is descriptive for the ritual context only and is visible, for instance, in the compilation of funeral equipment which highlights individuality or communality, and the display of functional or hierarchical roles within a society. Burial practices can be of different complexity and the archaeological picture has the character that lacks concrete spiritual information, but from which we attempt to derive socio-ritual interpretations. As described in chapter 2, efforts in tracing social inequality and creating social models from burial contexts in the North Caucasian Bronze Age focus on differentiating between individual and collective treatments as expressed in burial items and the number of people included in a single grave. Often, these examinations result in the description of archaeological cultures rather than quantitative and qualitative questioning of the burial record itself in terms of inequality.

Therefore, one major task in the examination of the burial record from Kudachurt 14 is the description of investigative parameters and the detection of disparities among the graves and individuals buried. This includes elements of grave construction, number of people buried per grave, bodily treatment of the corpses, and the grave inventories. The highly heterogeneous burial practices suggest the presence of different MBA-LBA archaeological cultures at Kudachurt 14 (North Caucasian Culture, post-Catacomb Complex, early Koban Culture). However, in this thesis this fact is intentionally disregarded to allow for the detection of inequalities beyond "cultural borders". From this starting point, the first research question relates to the variation in burial practice existent at Kudachurt 14:

What is the information potential of grave construction, burial type, bodily treatment, and grave inventories regarding socio-archaeological issues?

After the examination and evaluation of specific characteristics of funeral practice, the interplay of these investigative parameters provides a more detailed picture. The analyses of correlations between construction elements, size of the inhumation groups, regularities in the corpse arrangement, and the character of the grave assemblages enables the detection of the significance of the investigative parameters and their potential for serving as proxies for social inequality. In the overall context of funeral elements preserved at Kudachurt 14, the leading question therefore is:

What are the major proxies for tracing social inequality in the burial record?

2.3 Human remains: Demography and oral health (chapter 5)

Unlike the ritual practices, basic demographic information such as age and sex of an individual underlie biological mechanisms immutable for a human. From birth, biological sex is determined[1] and the body begins the natural ageing process. Even if the perception of sex and age and its individual expression in the lived reality remain

1 In the majority of cases (excluding *e.g.* hermaphrodites).

hardly detectable in prehistoric records from both archaeological and osteological perspectives, both parameters are biologically determined. Therefore, the physical estimation of sex and age at death provides basic information about an individual which is primarily independent from the social sphere. Furthermore, an understanding of the demographic structure of the buried population allows an estimation of its representativeness in terms of the living population. This is also important regarding mutual inhumations in double or collective graves, as the composition of individuals of different age and sex can be questioned in terms of possible kinship relations. In the North Caucasian Bronze Age, the record of demographic data is very sparse and distributed over different localities; Kudachurt 14 represents a unique opportunity for research. Thus, it is of major concern to identify biological sex as well as age at death of the individuals buried at Kudachurt 14, leading to the question:

What is the demographic composition of the buried population?

In this thesis, the term “oral health” encompasses the physical conditions of the oral cavity and mastication apparatus that have remained as dry bone specimen from the buried population at Kudachurt 14. “Oral health” includes manifestations of diseases and modifications on the dentition and jawbones as supportive structures.

In addition to its communicative function, the oral cavity is the physical feature of vertebrates that enables respiration and nutrient supply and therefore makes up an interface between the environment and the organism. In bioarchaeological investigations, the status of oral health offers a wide array of information about an individual or a population; concerning, for instance, diet, disease, physical stress and occupational habits. In this thesis the characteristics of oral health are presented in detail both by an engagement with specific pathological processes and a discussion of the sum of prevalent lesions.

The intake and preparation of food are essential activities to ensure the survival of an individual, regardless and independent of their sex, age, or social status. Yet, what gets into the mouth and passes towards the subsequent digestive steps differs – partly due to age (nursing of infants, subsequent adaptation to solid food; old adults with tooth loss potentially preferring soft or processed diet), but also driven by individual dietary requirements or preferences and availability as well as accessibility of foodstuffs. In consequence, the oral cavity and specific characteristics localised there can be regarded as an archive for individual dietary habits, potentially reflecting different stages throughout life in the presence of, for instance, dental diseases such as caries and dental macrowear.

Additionally, the masticatory apparatus reflects habitual patterns related to socio-ritual, hygienic, and occupational behaviour. For instance, dental decoration is strongly associated with the ritual sphere and often seen as an ethnic habit, whereas dental modification due to hygienic measures or the use of teeth as a tool (“the third helping hand”) have a rather practical character. Even these practical routines such as dental cleaning or using the masticatory system for material processing can, however, be connected to specific individuals and populations or cultural groups.

The need for hygienic measures can be linked to the type of food consumed (*e.g.* sticky substances or remains of meat in the interproximal spaces) as well as with the occurrence of dental lesions (*e.g.* caries, calculus). Thus, it is strongly associated with diet. At the same time, hygienic measures have a social component, as the required knowledge concerning technical skills as well as gained health benefit is shared.

In order to address these issues, the first analytical part of the oral health status describes specific categories of oral health in order to identify main characteristics of the control sample of the buried population at Kudachurt 14. A defined set of oral health categories functions as investigative parameters for quantitative and qualitative examinations.

What are the main characteristics of oral health in the buried population from Kudachurt 14?

In sum, the investigation of oral health in dry bone specimen provides information about the interface of physical, environmental, economic, and socio-cultural spheres on both the individual and population levels.

From the set of oral health categories investigated, major results are regarded in terms of interrelations and trends between and among individuals as well as with respect to biological sex, age at death, and the burial context. From these considerations, attention is drawn to the physical consequences and socio-economic implications deriving from observed statuses and characteristics of oral health. Due to the key position of Kudachurt 14 in terms of subsistence and social inequality in the North Caucasian Bronze Age, these discussions focus on reaching conclusions about dietary and occupational indicators of oral health, namely caries and dental wear.

What are the physical and socio-economic findings deriving from the demographic structure and status of oral health?

2.4 Carbon and nitrogen stable isotopes: Palaeodietary reconstruction (chapter 6)

The transition from the MBA to the LBA is associated with major changes in subsistence: from mobile pastoralism in the steppe to sedentary pastoral lifeways and new strategies of livestock management in higher altitudes of the North Caucasian mountain ranges. Recent bioarchaeological research suggests C_4 plant cultivation and a strong agricultural component in the EIA subsistence strategy in the macro region. The beginning of crop growing and decreasing significance of animal-derived food components remains unclear. Due to its chronological as well as geographical setting, ritual heterogeneity and buried population size, the archaeological and osteological record from Kudachurt 14 is of special interest for palaeodietary reconstructions.

The analyses of carbon and nitrogen stable isotopes on human and bone collagen from the site aims to provide supplemental data for the North Caucasian foothill region. The analyses deliver a solid isotopic baseline for inter-site comparisons on a local scale and provide a local food web based on animal and human tropic levels. The main research goal is to identify protein sources in the human diet and to evaluate the significance of animal-derived food as indirect evidence for livestock management in the Kudachurt valley at that time. Furthermore, the isotopic composition reflects the potential influence of C_4 plants in the animals' and humans' diet.

Obtained information about the animal sample including species and their feeding habits well as information about age at death and biological sex of the human sample will help to clarifying and interpreting the results. In order to complement these findings, results from oral health connected to carbohydrate components in the diet, the prevalence of dental caries, is taken into account in the analyses as well.

In the overall context of this thesis, food strategies with respect to animal herding and agricultural components are mainly used as indicators for the subsistence strategies of the buried population at Kudachurt 14:

Did livestock management and C_4 plant cultivation contribute to the subsistence strategies of the buried population at Kudachurt 14?

2.5 Interdisciplinary synthesis: Burial practice, human osteology, and stable isotopes (chapter 7)

The final part of the thesis brings together the results gained by the investigation of burial practice, demography, oral health, and palaeodiet. The major task is to cross disciplinary boundaries by linking data from the human, ritual, and physical spheres and to expand upon these results from different perspectives.

One central issue is the interrelation of social inequalities displayed in the burial practice and demographic data obtained from the human remains. By referring to the concept of intentional and functional data (Härke 1993a), it is possible to evaluate the expression and perception of individual attributes such as biological sex and age in ritual practice and to specify the underlying rules that resulted in inequalities in funeral treatment. During the North Caucasian Bronze Age, social organisations underwent developments from hierarchical to merely levelled structures, and discussions about gender roles and hereditary structures still lack human data. Kudachurt 14 changes this situation as it holds both ritual and physical data which can be applied at an individual level, but also with respect to inhumation groups and the whole buried population. Thus, the main research questions of this chapter are:

Were socio-ritual inequalities applied on specific individuals or demographic groups? Does physical information match with suggested gender roles and age-related accoutrements of social status?

The analyses of oral health provided information about different spheres of human life, including the general disease burden and socio-economic implications for both the buried and the burying population. This information represents consequences of the living conditions manifested on the masticatory system; in the scope of *intentional* and *actual* reflections of life in the funeral context it seems obvious to synchronise these with unequal burial treatments. For the North Caucasian Bronze Age, in consequence, another leading issue of the synthesis is:

How do implications of oral health behave toward detected socio-ritual inequalities? Can we observe connections such as "better oral health status" or occupational habits in terms of social inequality?

A supply of essential nutrients is a basic need in human life, but access to foodstuffs may depend on environmental factors and economic strategies as well as social habits and restrictions. Based on the results gained from the three analytical chapters of the thesis, interrelations of socio-ritual inequalities, oral health, and subsistence strategies to supply dietary protein provide an additional linkage between the socio-ritual and physical spheres. This is especially interesting with regard to the inclusion of food items in the funeral equipment, the prevalence of caries, and economic lifeways. Therefore, the following questions will lead the discussion on this issue:

Do signs of deviating dietary habits exist in terms of detected social inequalities? What conclusions can be drawn with regard to social organisation, means of productivity, and economic strategies?

For completing the scope of this thesis, the last research question addresses chronological issues related to synchronous or diachronic patterns in the gained results. This is especially of interest as crucial socio-economic shifts are assumed for the MBA to LBA transition, and the archaeological as well as skeletal material from Kudachurt 14 fills a temporal and geographical gap of information in this respect. The presence of heterogeneous burial practices with attributes of different archaeological cultures and typological analogies known from the northern as well as southern central slope of the Greater Caucasus point to Kudachurt 14 as a cemetery where diverse MBA and LBA traditions concentrate (see chapter 3.4-5).

Based on the approach taken to treat the data record from Kudachurt 14 as one information unit, the results must be discussed regarding chronological aspects of social inequality and living conditions between 2200-1700 BCE, thereby deriving implications for the North Caucasian Bronze Age.

Are there synchronic or diachronic patterns in socio-ritual inequalities, demography, oral health, and dietary habits? What are the implications given for and by current research on the MBA to LBA transition in the Northern Caucasus?

2.6 Basic approach and terminology

As described in the introduction, the basic approach of the doctoral thesis intends to provide a disciplinary and interdisciplinary groundwork.

The main investigations concentrating on the burial tradition and human remains are based on information acquisition and statistical as well as descriptive analyses of data obtained. The archaeological documentation (maps, pictures, sketches) and the dry bone and teeth specimen of human remains provide the primary investigated materials. The palaeodietary reconstruction by carbon and nitrogen stable isotopes and the radiocarbon dating required the chemical analyses of human and animal bone compositions on a molecular level. Specific methodological approaches tailored for the different disciplines of this thesis are explained in their respective analytical chapters (4-6).

All obtained data were logged and linked in the same database (Microsoft Access). For the creation of maps, schemes, and figures Adobe Illustrator and ArcGIS were used (Fig. 1, 5, 22, 29-32). Spreadsheets and further data processing took place with the help of Microsoft Excel. The programs SPSS and Canoco provided the technical tools for all bivariate and multivariate statistical analyses. During recording and data processing, the information was transferred into nominal or scale variables to make them suitable for further statistical analyses. Frequencies and percentage distribution were calculated via univariate analyses, while distributions and correlations of two variables were performed with the help of cross-tabular bivariate analyses by mainly using the program SPSS. In order to test correlations and dependencies of more than three variables, multivariate methods (CA) were applied. Besides the graphic presentation of results, supplemental tables are provided within the manuscript in order to maintain transparency. Further classifications of specific examinations were developed during the analytical processes (*e.g.* indices, quality groups, intensity rates, groups of oral health).

Correspondence analysis (CA) is a computerized procedure that visualizes a contingency table containing frequencies (or presence/absence) of qualitative criteria. It aims at discovering structures and correlations within a certain data set. Compared to cluster analyses or principal component analyses, CA has the advantage of revealing structures that are within the data without any pre-definitions (for latest archaeological applications cf. Siklósi 2013, Taylor 2016). The underlying principle is the multidimensional scaling of the information, which results in a graphic layout of coherent structures in a coordinate system (Backhaus *et al.* 2015, 406). In addition to the classical correspondence analyses (CA), the application of the canonical correspondence analyses (CAA) has the advantage that it allows the addition of external variables which determine the ordination of tested samples. For the computational procedure, the cross-tabulation was prepared in Excel and the calculation itself was conducted by using the program Canoco as it allows both classical as well as canonical correspondence analyses.

In archaeology, correspondence analyses are often used in order to visualise similarities within the attributes of samples, for instance graves, whereas the interpretation of the patterns depends on the character of the data set itself. For instance, a chronological ordering of grave assemblages requires the appropriate definition of burial item types in order to detect chronologically relevant patterns or courses. As the chronological issue is not of main interest in this thesis, the variables for the conducted correspondence analyses are the item categories. In contrast to items types, the item categories are relatively vague; a strong typo-chronological determination of the patterns is therefore less probable. In terms of the character of a "closed find", which is required for answering typological questions, at least the collective burials were used with caution.

During the visualisation of correlations of different conditions of oral health, the investigative units (samples) are the individuals. Here, a chronological pre-determination is given by the age of an individual, as many conditions of oral health are age-dependent. This has been considered in respective analyses. Other examples of applying CA/CCA procedure on data exclusively obtained by osteological analyses of human remains are not known to the author. Demographic data such as biological sex and age at death are primarily used in canonical approaches in order to understand their influence on given patterns of archaeological information, *e.g.* sex-related differences in the burial rites (*e.g.* Burmeister, Müller-Scheeßel 2006; Siegmund 2015; Fuchs 2013).

This thesis is based on the assumption that the human remains found at Kudachurt 14 represent a certain section of a human population, namely the buried population. The term "buried population" addresses the population under study, which makes up a selective control sample of people that died from unknown circumstances. In consequence, the term describes and interprets the information given by this control sample and does not claim to provide a generalised statement for the people who lived in that time and space. The issue of reconstructing living conditions from a "dead" control sample shall not be discussed more in detail here as it is covered in chapter 6. Palaeodemographic methods and investigative tools validating obtained data are a specialized field of their own.

In general, the terms "individual" and "specimen" address the human remains of one person in its dry bone preservation. In this thesis, the term "individual" is also used to specify analytic parameters with regard to "single results". But, in the following, "individual results" means results per skeleton (deceased person). The term "inhumation group" includes different individuals/specimens from the same grave context. "Inhumation groups" gain importance in the last section of the human remains (5) chapter, the following isotope chapter (6) as well as the synthesis of mortuary, osteological and isotope data (7).

The term "significant" or according utilisations are meant in the sense of describing a "relevance" rather than the "statistical significance", as statistical hypothesis testing was not applied.

The terms "subadult" and "adult" describe stages of age at death when addressing the *in situ*-age, while "immature" and "mature" mark individual ages which was estimated by osteological analyses.

3 The cemetery of Kudachurt 14

The following subchapters describe the cemetery of Kudachurt 14 and embed it into its environmental and cultural background by discussing its location in the natural landscape as well as the discovery and excavation of the site. The comprehensive investigation presented here verifies the estimated dating of the cemetery by Reinhold (2012, 93) through typo-chronological comparisons, radiocarbon analyses, and stratigraphic structures. In the following, the meaning and potential of Kudachurt 14 in terms of current North Caucasian Bronze Age (NC BA) questions are discussed alongside the research questions posed in chapter 2:

What is the environmental, temporal, and cultural setting of the cemetery Kudachurt 14? What is its context in research of the North Caucasian Bronze Age?

3.1 Location and environmental aspects

In the overall picture of the Greater Caucasian Mountains, the site Kudachurt 14 is located on the central northern slope. Today the study region is part of the Russian Kabardian-Balkar Republic which covers parts of the northern steppe plain, the foothills, and the mountain range, including the highest point in Europe, Mount Elbrus (5624 m; Fig. 4-5).

Thus, the study region includes all altitudinal and zonal ranges of the Northern Caucasus landscapes: plains; semi-desert, foothill-plains, and forest-plains on chernozems; foothills and central mountains with broadleaf-forests on mountain-forest brown soils; highland-forests (deciduous/coniferous) on mountain-forest brown soils; highland mountain-meadows; and nival-glacial environments (Price 2000, 86).

Based on eco-geographic conditions, A.K. Tembotov determined two variants of altitudinal zonation in Kabardino-Balkaria, the Terek and Elbrus variants (Gorobtsova *et al.* 2016; Tembotov 1972), which are divided by a border running from the south-west to the north-east of the vertical centreline (Fig. 5).

The site of Kudachurt 14 is located in the Terek variation of the altitudinal zonation, which has a more humid and milder climate compared to the Elbrus variation. The Terek variant includes the forest-steppe belt and the foothill and central mountains with broadleaf forests and forest-plains, with an annual average temperature and precipitation of about 9.7°C and 600 mm respectively (Gorobtsova *et al.* 2016, 22; Price 2000, 86). Kashhakatau, a village next to the site of Kudachurt 14, has a humid continental climate (Köppen classification Dfb) with average temperatures and precipitation rates around -4°C and 40 mm in

Figure 4: Examples of the different geo-ecological zones of the research area in the Northern Caucasus presented in order from south to north. 1-4 Karbadino-Balkaria, 5 Stavropol Krai. 1: High mountain range with Mount Elbrus (5624 m) and wooded slopes, view from north (picture: S. Reinhold). 2: Valleys and plateaus of the high mountain range with mountain meadows. 3: Wooded foothill zone; picture shows the Čerek River Valley and the site Kudachurt with view from Kashhatau (see Fig. 6). 4-5: Transitional foothill to semi-desert zone (pictures: K. Fuchs, S. Reinhold).

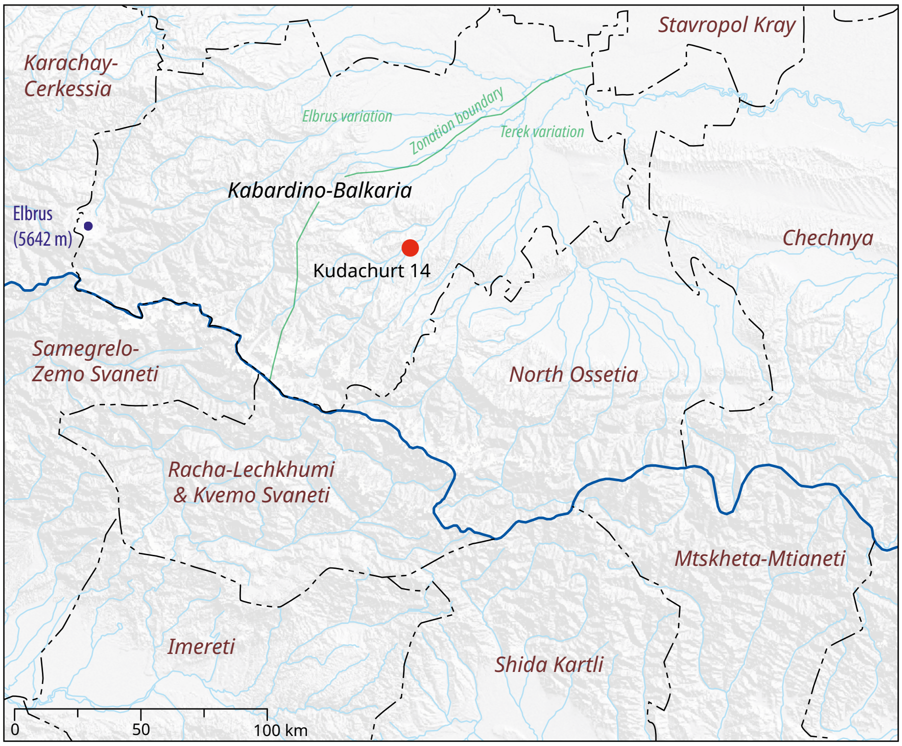


Figure 5: Location of Kudachurt 14 in the region of interest in the central Greater Caucasian Mountains (see Fig. 1). The administrative-territorial districts of South Russia and Georgia are depicted for orientation guidance as well as the altitudinal zonation boundary of the Terek and Elbrus variation according to Tembotov (1972) and Gorobtsova et al. (2016). Map copyright: Institute of Caucasian Archaeology, Nalchik.

January and 20°C and 90 mm in July[1]. Due to its humid climate and fertile soils, the area has been extensively developed for farming in modern times, which has modified and shaped the landscape (Price 2000, 85). Although we cannot directly apply the current environmental conditions to the prehistory (see chapter 1.1.3), we can assume that the climate in the foothill zone has always been moderate compared to more dry and warm conditions in the northern plains and colder temperatures in the southern high mountain zones. Temperature and precipitation fluctuations might not have had such a strong impact on the living environment in the foothills compared to the steppe regions. Even in the absence of high-resolution data about the Bronze Age climate, it is likely that the prehistoric conditions coincide with the current altitudinal zonation. This leads to the conclusion that, already in prehistoric times, the soil and climatic conditions of the region in which Kudachurt 14 is located represented a favourable environment.

The site of Kudachurt was named after a nearby small stream and is located on the nose of a narrow foothill which marks the beginning of the rise in elevation from the plains to the higher altitudes (see Figs. 4.3, 5). Fed by different streams coming from the glacial areas of the high mountains, the Čerek River flows towards the Terek River's fork and shapes the shallow neighbouring valley to west of the ridge. The stream Kudachurt passes the eastern slope of the ridge where it joins the Čerek. Different prehistoric and historic sites were discovered along the hill, on its summit as well as along its slopes, including a prehistoric settlement and a large number of graves from different periods of which many have not yet been investigated. The site name, Kudachurt, and the identification number of the initially associated kurgan, 14, compose the cemetery name Kudachurt 14 (Figs. 6-7).

1 According to: http//en.climate-data.org/location/691520/.

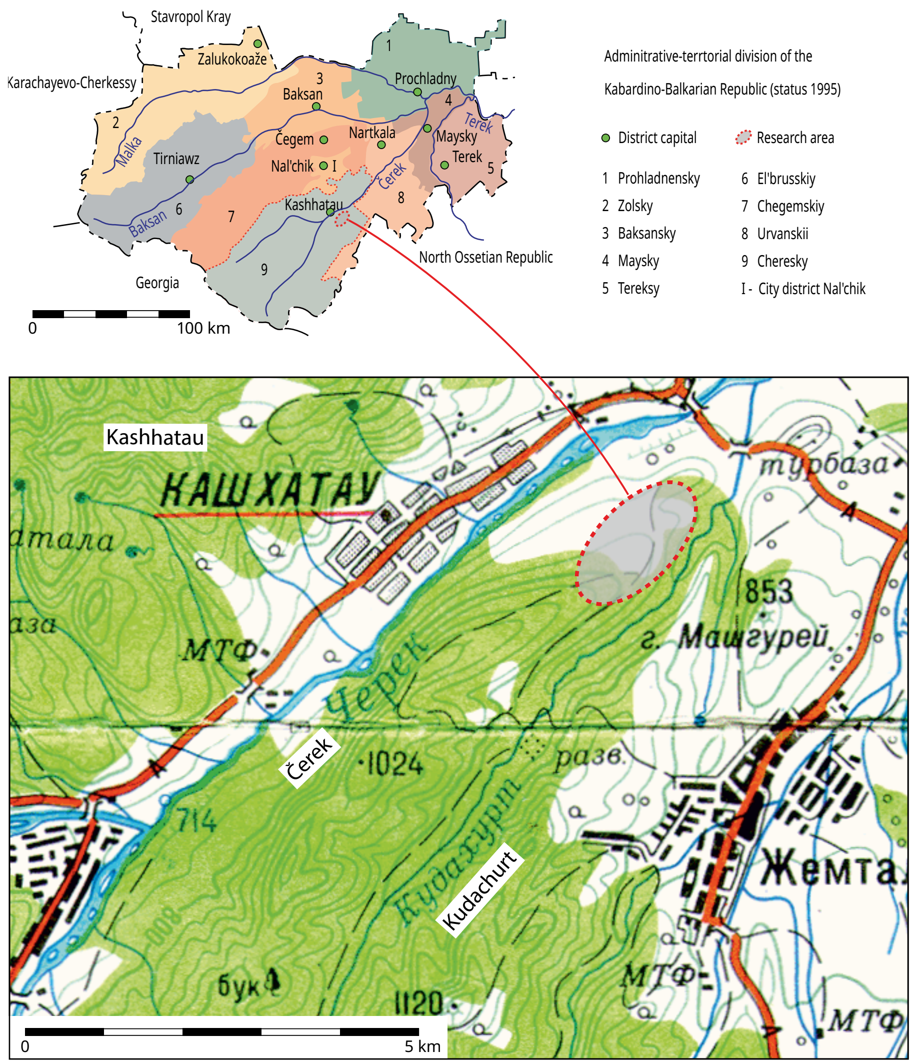


Figure 6: Precise mapping of the site Kudachurt 14 in the Kabardino-Balkarian Republic and location on a foothill ridge. The region belongs to the cultural heritage district of Cherkesky. Map copyright: Institute of Caucasian Archaeology, Nalchik.

3.2 Excavation and subsequent work

Early in the year 2004, construction activities for installing a large water basin started at the southwestern area of the foothill ridge. The construction activities meant to destroy several kurgans identified at this site, which caused extensive archaeological fieldwork in the years from 2004 to 2006. Figure 3 shows some of the kurgans found at this site and the outline of the water basin. The work began with the extensive excavation of the construction pit by hydraulic excavators in the southwestern area of the site (Fig. 8.1).

The prospection permit and planning of the excavation followed in early 2004. Due to the harsh weather conditions during the winter months, the main campaigns took place between March and November. Consequently, the excavators had to deal with three issues: the ongoing removal of the site by the hydraulic excavators, the changing relief due to the construction activities, and the alteration of the site between the excavation campaigns. While the first issue was more of a time-based problem, the altered immediate surrounding by planing and different depths of earth removal often caused difficult situations during the excavation (Fig. 5.1-5). This led to, among others, major problems in reconstructing the original depths of the graves, an issue which is addressed later on in this thesis in detail. Despite these unfortunate conditions, the excavators met the challenges with aplomb, producing the best possible results.

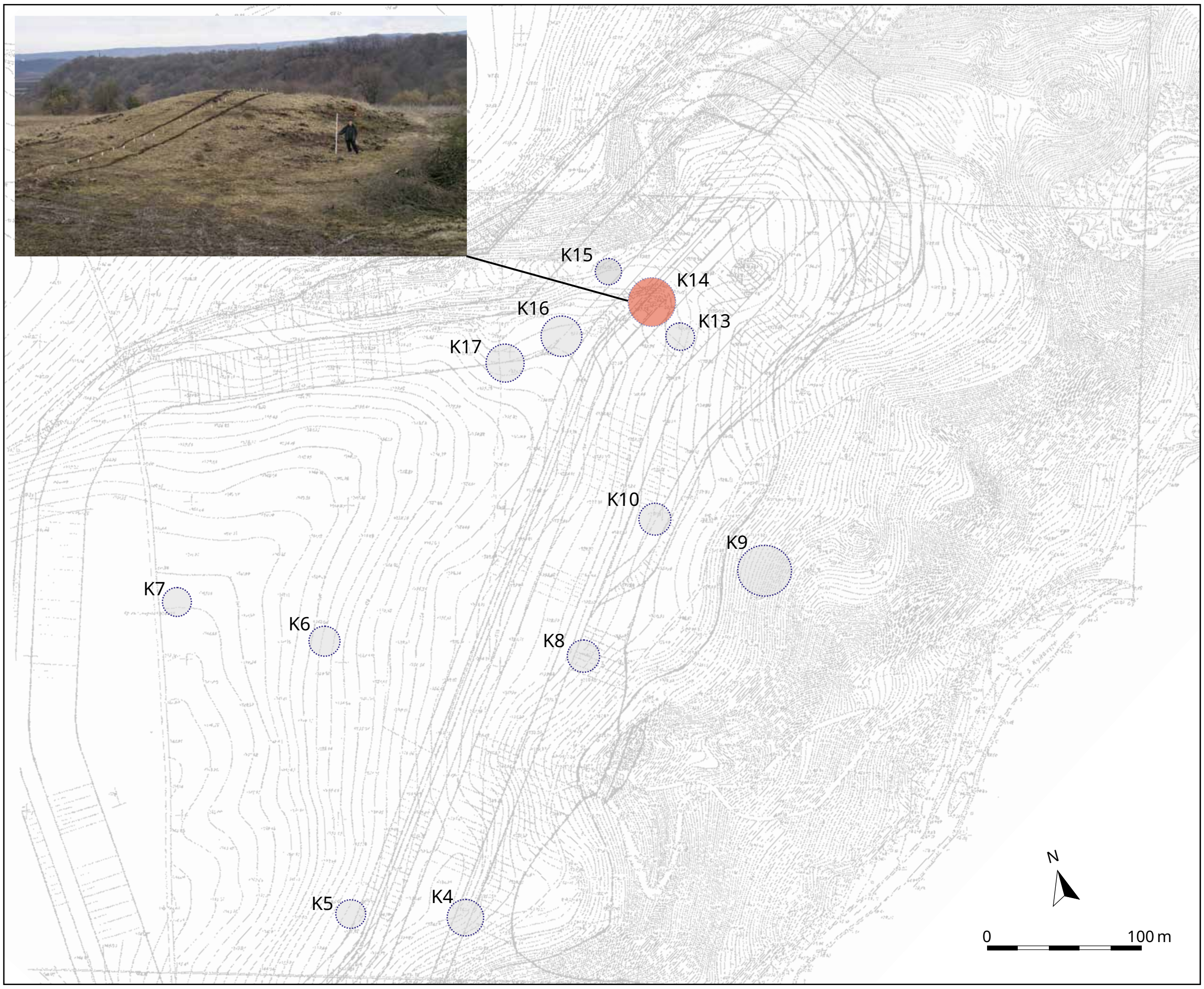


Figure 7: Overview of a selected area of the site Kudachurt focusing on the northwestern part of the foothill ridge and including some of the identified kurgans and the outline of the water basin. The kurgan (number 14) investigated in this thesis, which was supposed to be associated with the Bronze Age graves, is marked in red. Map and picture copyright: Institute of Caucasian Archaeology, Nalchik.

3.2.1 Excavation techniques and on-site documentation

After an inspection of the surface and survey of the kurgans and their surroundings, the simultaneous excavation of Kudachurt 14 and other kurgans began. Due to time constraints, no extensive pre-investigative measures like magnetic prospections were conducted. The Russian colleagues followed an excavation strategy that was based on their expertise in excavating burial monuments of different kinds, including kurgans and catacomb graves. At Kudachurt, during the exposure of burial mounds, a profile was set to maintain the cross-section of the kurgan, whereas its lateral areas were removed by natural layers. The excavation of graves depended on how they were constructed. As soon as a stone marking, grave pit, or dromos outline of the feature was visible in a planum, the grave filling was removed gradually; for catacombs, this slower process started when the dromos became identifiable (Fig. 9.4).

The excavation and discovery of the cemetery of Kudachurt 14 started (Fig. 9.1-3) by the division of Kurgan 14 into a northern and a southern section. Directly situated underneath the topsoil, an irregular layer of raw stones was uncovered (Fig. 9.2). This stone layer was the only construction element of the kurgan found; none of the graves discovered later show a relation to the mound as they were dug into the natural soil mainly outside of the kurgan. At the time of this publication, the dating of the kurgan remains unclear; the possibility cannot be ruled out that this

Figure 8: Difficult excavation conditions during the different campaigns in the years 2004-2006 due to construction work, changing ground relief, and interim levelling in-between the campaigns. Copyrights of all pictures and drawings illustrating the site as well as excavation and grave in situ situations: Institute of Caucasian Archaeology, Nalchik.

Figure 9: Excavation of Kurgan 14. 1: General view of the kurgans (see Fig. 7) from the northwest. 2: Kurgan 14 with removed topsoil revealing the stone layers. 3: Northern profile and discovery of Grave 001. 4: Soil discoloration and stones marking the surface of Grave 126.

and other kurgans at Kudachurt belong to a different period than the graves. The clarification of this issue requires further investigation and relies on information from Russian colleagues from Nalchik. During the ongoing removal of the soil the first burial, Grave 001, was found near the profile line left in the kurgan, underneath a stone packing. In the following campaigns, many more graves were found to the south-east of this first discovery (Fig. 9.3); only Grave 031 was located further west (see cemetery plan). In total, 218 structures were found and labelled in the area surrounding Kudachurt 14; the actual number of burials is larger as some graves were installed one over the other. Some graves clearly date from the Alanic period and in some structures no items were recovered.

The Russian excavators removed the grave pit filling gradually to uncover the funeral setting (Figs. 9, 10). The burial chamber was only considered fully recovered when the bottom of the grave pit, including all its interior findings (human remains, equipment, constructive elements), was reached. In case of complex burial situations, *i.e.* collective graves or two-layer-burials, the excavators left profiles to allow comprehensible stratigraphic distinctions (Fig. 10). The 130 structures which were identified as Bronze Age graves and are the objects of research in this thesis showed various construction characteristics, differing from flat graves with stone markers to catacombs installed deeply in the soil (Fig. 10). Often, catacombs and grave chambers were arranged next to each other; for instance, a connection of the entrances between the two burial chambers Graves 145 and 146 is visible (see Fig. 36). Intersecting and overlying structures were also present, which sometimes led to complex situations during the excavation and aggravated precise documentation (Fig. 10).

Figure 10: Complex grave structures found during the excavation due to intersecting and overlying burial chambers as well as different installation depths. These pictures also show the approach of the Russian colleagues when uncovering a burial by removing the grave pit filling.

The on-site documentation of the different excavation stages, graves (chambers), and burial settings included the following:

(1) Photography (Figs. 8-11): An extensive photographic documentation took place from the very beginning of the excavation, including overview pictures of the excavation area or several graves, pictures of the single grave structures with profile and superior views of the different excavation stages, and close-ups of details, especially of the location of funeral equipment. These pictures, excluding the close-ups, all contain vertical and horizontal scales (yardsticks) as well as a north arrow for maintaining a comprehensible perspective. This extensive photographic material makes up a very valuable documentary supplement and often

provided answers to questions that arose during different parts of the analytical work for this thesis (*e.g.* identification of individuals, absence or presence of items (see Fig. 11.1), stratigraphic sequences).

Figure 11 (above): Close-up pictures of in situ-situations. 1: Grave 181, skeletal remains with green discoloration on the right clavicle resulting from a decayed bronze artefact. 2: Detail picture of Grave 129 showing the position of funeral items; here, is was possible to determine the location of a bracelet on the left wrist (which was confirmed by discolouration of the bones).

(2) Drawings (Fig. 12): scaled drawings of the grave structures and construction elements on graph paper with complex situations shown in multiple sketches were created in the field. These drawings depict at least one profile view as well as at least one top view of the burial. Using these two views, the superior and lateral, the size and height of the grave chamber could be reconstructed. By marking different soil conditions, a distinction between grave filling and naturally developed soil was made. In order to create a comprehensible inventory, the outlines of funeral items and individuals where labelled respectively with Latin (items) and Roman numerals (individuals) in the top view drawing and the artefacts were briefly described (*e.g.* vessel, bronze dagger, beads). The digital sketches (Fig. 12) are based on these graph paper drawings; furthermore, with reference to a measurement system, the outlines of the graves are summarized on a cemetery plan (Fig. 14). The original cemetery plan and the digital grave sketches were created with the program CorelDraw.

3.2.2 Inventory, preparation, and current state

When the excavation and on-site documentation of a grave was completed, the finds were recovered from the grave chamber and, separated according to their nature, packed in wrapping paper without washing (artefacts, animal bones, and human bones). When allowed by the in-situ situation, human remains were separated by body parts (*e.g.* skull, extremities, spinal column). Unfortunately, in some of the complex and often poorly preserved collective graves, bone fragments of different skeletal elements and individuals were mixed up and stored in larger numbers together. Until the osteological investigation conducted by the author, the human remains (and the animal bones) did not have any further treatment. The preparation of the skeletal remains is described in chapter 4, Part II of this thesis.

The large number of documented burial items (min. 2332) were carefully cleaned and dried according to their individual preservation status and material requirements. Many of the vessels were in extremely fragmented condition so that the restoration of the ceramic objects (min. 1086) took quite some effort. Afterwards, the objects were hand-drawn and categorized by allocated grave (Fig. 13). Depending on the object, these drawings included several views and supplemental information, *e.g.* diameter and profile shapes (completing lines). In addition, the objects are assigned with numbers starting at 1 for every grave; unfortunately these numbers do not match with the labels from the on-site documentation so that sometimes cross-checking was required. Following these numbers, some inventories were

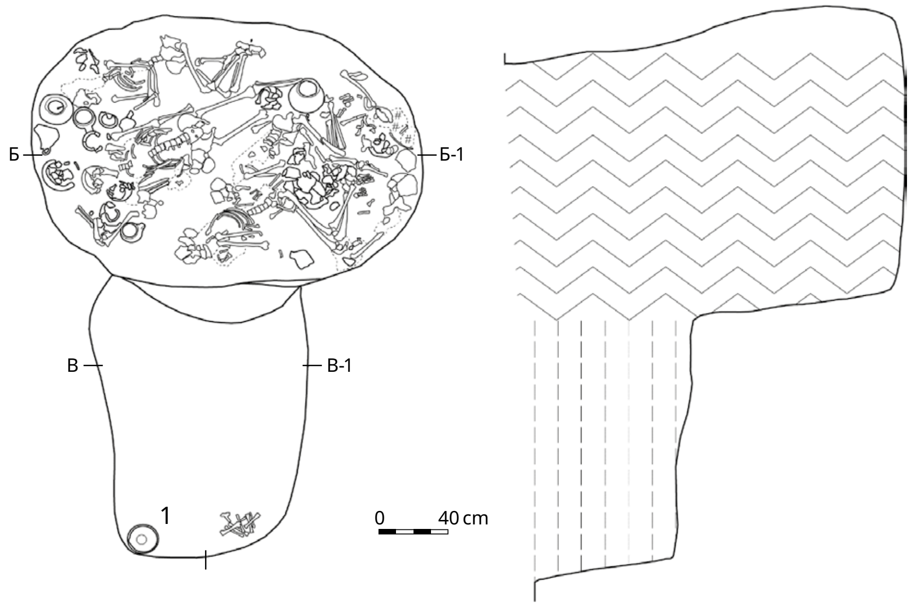


Figure 12: Example of the drawing stage of documentation. The zig-zag lines of the profile indicate the grave filling. Depicted here is the digitalised version of the sketches made on graph paper during excavation for Grave 027.1 (see Part IV, grave catalogue) with outlines and grave size; numbers of funeral items are not illustrated here. Copyright of all grave drawings: Institute of Caucasian Archaeology, Nalchik.

already provided with short descriptions (in Russian) providing size and material-type; however, these are not yet completed and were not available for this thesis. Additional photographic documentation is available for some of the finds (Fig. 13).

Due to fiscal policy issues and the huge amount of material found at the Kudachurt, the Russian colleagues in Nalchik were not able to continue post-excavation documentation for a long period. Therefore, the report writing, which is one element of the reporting system of archaeological antiquities in Kabardino-Balkaria, came to a halt and the descriptions of the finds have not been published. This is also true for the Bronze Age graves from Kudachurt 14.

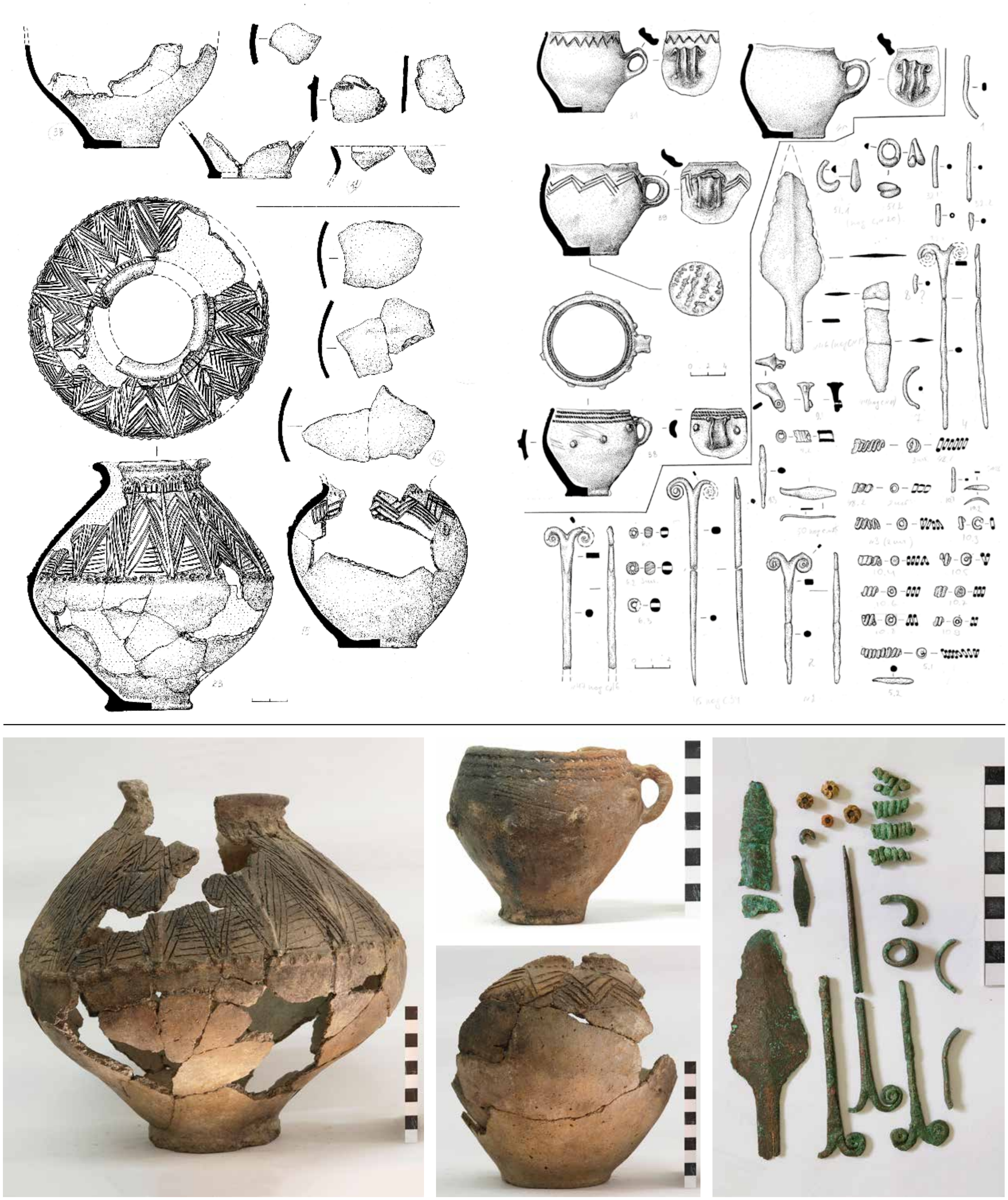
The collaboration of the Archaeological Museum of Nalchik (B. Atabiev) and the German Archaeological Institute (S. Reinhold) brought new research opportunities to Kudachurt, providing the foundation for this thesis. Currently, Reinhold and colleagues are working on an extensive catalogue including a translation of the grave sketches and find descriptions.

3.3 Cemetery plan

The graves have been labelled in accordance with the numbers assigned during the excavation. In general, the grave numbers were assigned consecutively by excavation date, starting in April 2004 (Grave 001) and ending in June 2007 (Grave 219). Some graves were additionally separated into first, second and third layer or into east and west (*e.g.* Grave 211.1, 211.2, 211.3; Grave 136.W, 136.E). As Grave 117 is missing on the original site plan, which served as the template for the created spatial distribution maps, Grave 117 is also missing here. For the purposes of this dissertation, graves of the Alanic period were deleted from the cemetery plan when reliably identified (see below). The contour lines display the topographic situation before excavation.

The 130 graves considered in this thesis spread over an area of *ca.* 65 m x 47 m (Fig. 14). This area includes an elevation in the north[2] (732.82 m above sea level) and a flattening to the south with a total difference of *ca.* 6 m. This elevation is assumed to be a kurgan of unknown chronological period (Fig. 16, marked in light blue);

2 This elevation was supposed to be another kurgan, see preceding section.



however, its archaeological significance is not confirmed at the moment. Graves 1 and 127 were located on the highest elevation (*ca.* 731.25 m asl) and Grave 79 marked the lowest point (727 m asl). The graves were distributed along this slope and consequently were not arranged underneath a central mound. If the assumed kurgan (14) is from the Bronze Age, it covered only a small number of graves with no distinct horizontal separation from the surrounding ones. Disregarding Graves 31 and 141, which are located in the periphery, the outline of the cemetery is slightly roundish. The distribution of the graves within the cemetery does not show any

Figure 13: Example of the drawing and photographic documentation of burial objects after excavation. A selection of the inventory found in Grave 082 is depicted. Copyright of all artefact drawings and pictures: Institute of Caucasian Archaeology, Nalchik.

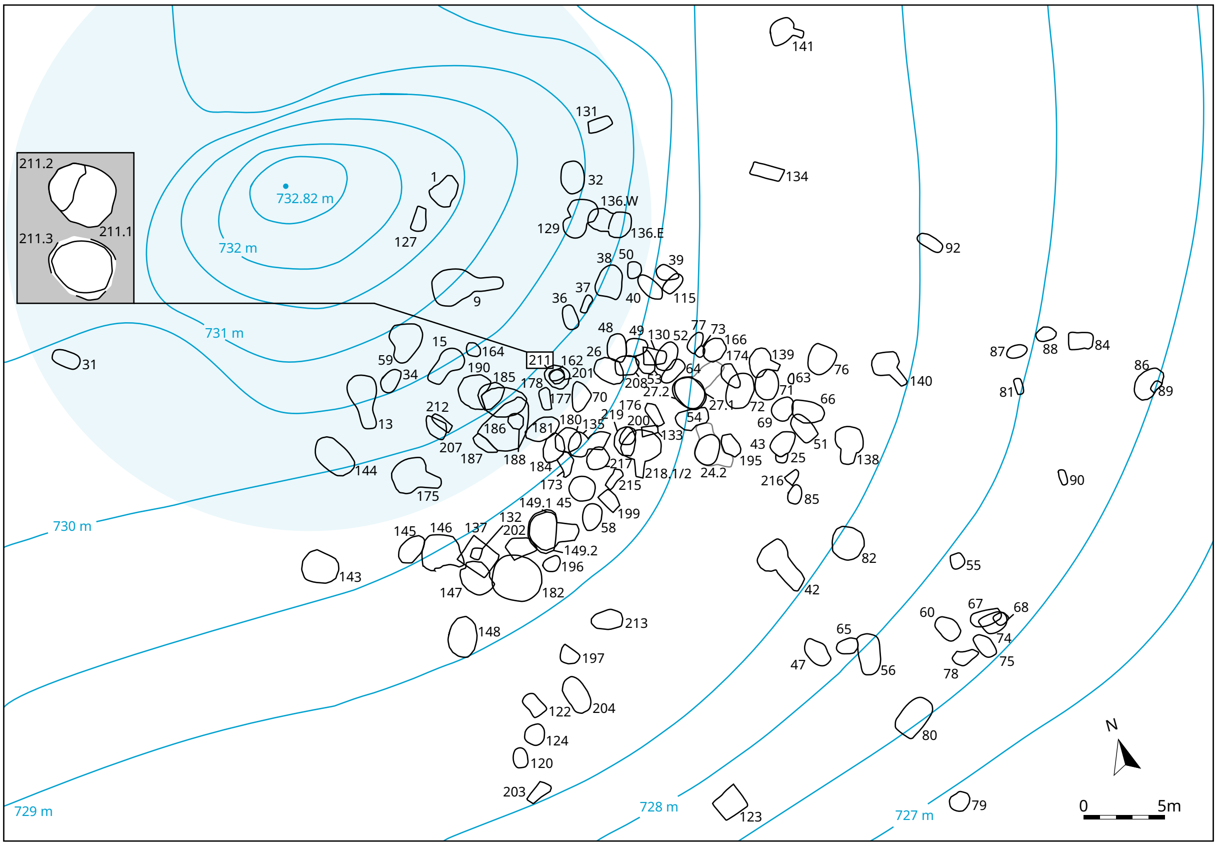


Figure 14: Cemetery plan of Kudachurt 14 (Bronze Age and associated graves considered only). All cemetery plans are based on a site plan created by the Institute of Caucasian Archaeology, Nalchik.

arrangement patterns, *i.e.* the maintenance of a specific orientation or spacing. The majority of the burials were located in the northwestern part of the area at a height of *ca.* 730-729 m asl; in its inner part *ca.* 56 graves form a cluster by direct contact, overlapping or intersecting each other. This section is referred to in the following text as the "central area". The remaining graves spread quite loosely or cluster in small groups. Overlapping structures point to different construction depths and stratigraphic positions of burials. From the information currently available, the burial community did not evenly exploit all parts of the area; it seems that they rather tried to expand or reuse locations, partly in an irregular way.

3.4 Finds and chronology

The site of Kudachurt 14 contained burials of at least two periods: The Bronze Age and the Alanic period. The Alanic population constructed pit graves or catacombs and buried their deceased in a flexed position, which is similar to several Bronze Age traditions in this area. However, the graves also contained characteristic Alanic equipment. Thus, if well preserved, they are easily distinguishable from Bronze Age burials. First chronological classifications of the graves from Kudachurt 14 were made on site and were checked during later preparation based on the funeral inventory. This assessment is reliable due to the archaeological knowledge and experience of the Russian colleagues.

Although Kudachurt 14 holds a key position regarding current typo-chronological questions of the MBA-LBA transition in the Northern Caucasus, these questions are not the object of this thesis. The conducted chronological classification described below intends to:

1. Achieve an association to existing chronological schemes. Due to the state of research, these schemes are based on mainly typo-chronological classifications of weapon and jewellery types. A classification of types and decoration of vessels is not available at this time. These schemes lack calibration of independent data.
2. Place Kudachurt 14 in the regional context of MBA and LBA findings based on comparison of the material culture and its typo-chronological classification. The inclusion of 17 sites from the central Northern Caucasus enables sufficient comparative opportunities.
3. Verify the absolute dating of Kudachurt 14 by means of 15 radiocarbon dates and discuss the significance of stratigraphic structures.
4. Place Kudachurt 14 in the current state of research in the North Caucasian Bronze Age by means of affiliated cultural phenomenon and their burial traditions.

3.4 1 Relative chronology and typological classification

Although dedicated to the temporal assignment of Kudachurt 14, this subchapter does not aim for a comprehensive typo-chronological examination of the grave inventories, as this requires appropriate effort according to recent questions of the MBA-LBA transition in the Northern Caucasus. Currently, Reinhold is working on detailed typo-chronological descriptions, seriation, and cluster analyses of the material culture offered by Kudachurt 14. Her analyses will also include the ^{14}C-dates in order to build a new interpretative framework for typo-chronological classifications of MBA and LBA finds and cultural developments of the associated societies. Therefore, the determination and classification of object types and their explicit chronological significance is not discussed here. The typological terms used consist of older as well as new definitions developed in a mutual approach.

Specific schemes according to Caucasian region, cultural definition based on major sites, and individual researcher draw a diverse and complex image of the North Caucasian Bronze Age. Good overviews are provided by Reinhold (2007) and Motzenbäcker (1996) in German and English. In her dissertation, Reinhold extensively examined typologies, contexts and distributions of LBA, EIA, and MBA finds from the complete Caucasian region and thereby provided a comprehensive catalogue including detailed descriptions and reference work to the primary literature. Her publication serves as the foundation for this subchapter and the following investigations as it includes analyses on material culture as well as elements of burial tradition and distribution of settlements and hoard finds. Famous cemeteries such as Styrfaz and Tli are included in the comparative analyses presented here; as these cemeteries mark the transition line from the MBA to LBA and consequently EIA traditions, this turned out to be helpful in the approximation of the youngest chronological stage also for Kudachurt 14. In his publication, Motzenbäcker works off the “Collection Kossnierska”, a famous collection of antiquities only consisting of bronze artefacts from two cemeteries which are located in the central North Caucasian foothills and higher altitudes:

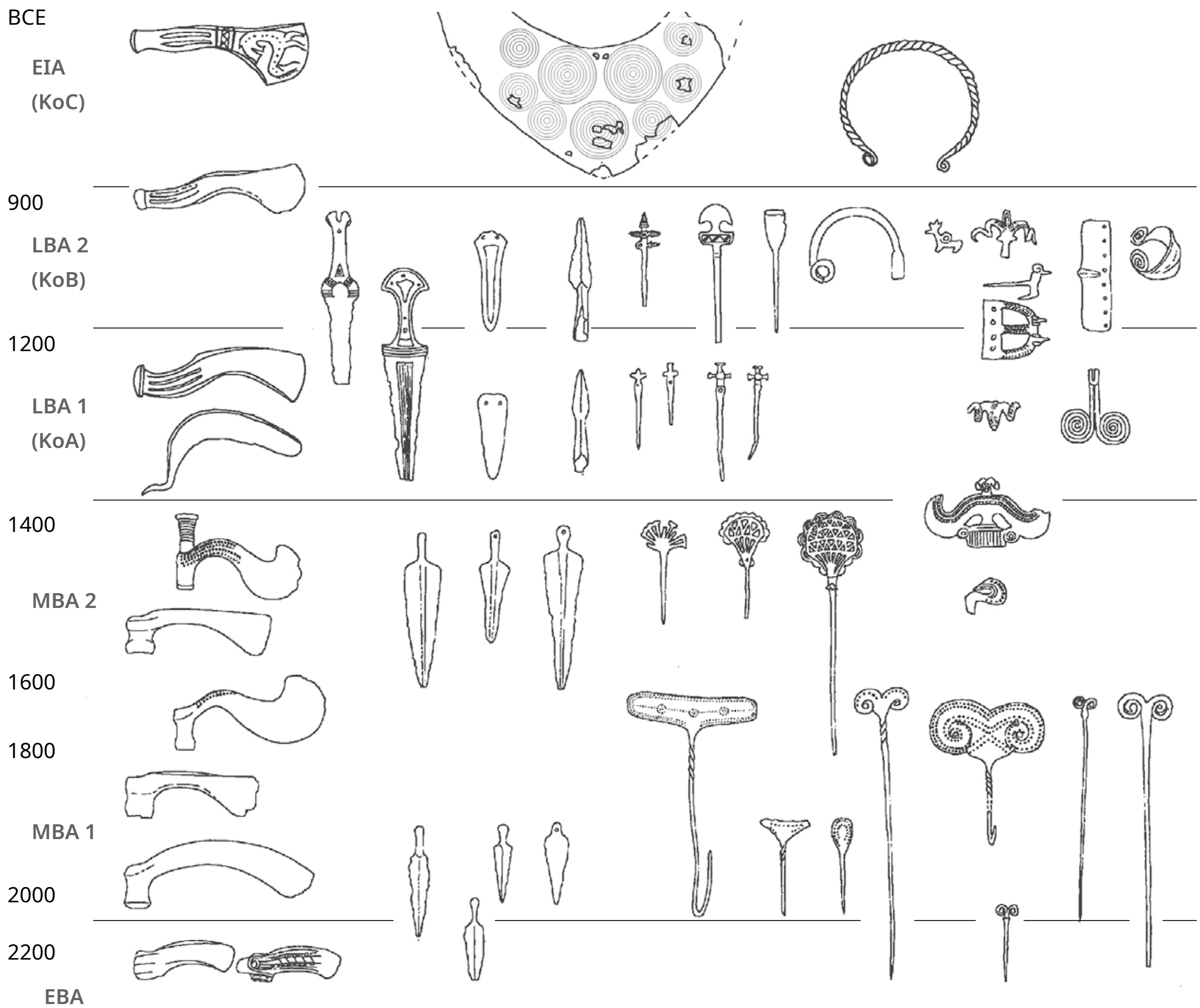


Figure 15: Typo-chronological scheme of the Bronze Age and Early Iron Age from the "Digorija" region based on weaponry, costume, and jewellery type spectra according to Motzenbäcker (1996, Fig. 12, stages of the Koban chronological scheme modified by S. Reinhold). Several types of weaponry and jewellery items from the MBA 1 to LBA 1 (ca. 2000-1200 BCE) are equivalent to those found in graves of the Kudachurt 14 cemetery (see Figs. 17-19). Copyright initial illustration: Staatliche Museen zu Berlin.

> '*The Collection Kossnierska consits of grave finds from the north Caucasian province Digoria (North Ossetia) wherein the cemeteries Faskau by Galiat and Verchnjaja Rutcha by Kumulte hold key positions for the understanding of the Bronze Age Caucasus.*'[3] (Motzenbäcker 1996, 8, line 13-18).

Dated to the MBA and LBA, finds from these sites revealed quite a large amount of typological similarities to those from Kudachurt 14. Unfortunately, the archaeological contexts of these finds are uncertain due to destroyed grave structures, collecting activity, and former research tradition; therefore, these artefacts have lost their temporal significance in terms of "closed finds". However, taking into account typo-chronological classifications and typological similarities of grave items and hoard finds from the close surrounding, Motzenbäcker achieves a relative temporal ranking of the artefacts in the collection (Fig. 15).

The following steps have been taken in order to assign the finds of Kudachurt 14 to existing chronological schemes:

3 Original quote: „Denn bei der 'Sammlung Kossnierska' handelt es sich um Grabfunde aus der nordkaukasischen Provinz Digoria (Nordossetien), die den Gräberfeldern Faskau bei Galiat und Verchnjaja Rutcha bei Kumbulte, herausragende Schlüsselstationen für das Verständnis der bronzezeitlichen Kaukasiens, entstammen".

- Examination of the graves and their inventories with regard to chronological significance. In advance, funeral items were recorded and classified based on typology. This typology considers established types of the NC BA and newly defined ones.
- Recording, mapping, and comparing sites with findings of similar and equal item types (analogies) based on the two main publications mentioned above. The spatial boundary has been defined by a maximum radius of *ca.* 100 km surrounding Kudachurt 14.

3.4.1.1 Kudachurt 14 and typological significance

This section deals with selected grave goods from Kudachurt 14 as parameters for relative typo-chronological considerations. The analytical part of this dissertation discussing grave inventories, characteristic item attributes, and the composition of assemblages as indicators for social differences, includes more detailed descriptions about how the author approached related issues. Some terminology used in the following anticipates these descriptions: object material (first level), functional class (second level), category (third level), and type (fourth level). In brief, functional class is used to refer to the (probable) function or purpose of the item. Whereas meat and vessels both are assumed to represent remains of food, here they are separately addressed due to differences in their chronological significance. Decorative items such as clothing or jewellery make the second functional class, in the following summarized as jewellery items[4]. Weapons and tools define the third and the fourth class. Categories further divide these classes, describing the next level of object definition (*e.g.* pins or pendants, spearheads or dagger). This leads to the fourth level of object definition: the type and the type label, which are congruent in their determination.

According to Reinhold and Motzenbäcker, the major indicators for typo-chronological classifications so far recognized are related to jewellery and weaponry items. Their typo-chronological schemes thus only address these two items, excluding vessels and animal remains (either as food components or as sacral depositions). For the dating of Kudachurt 14 this becomes an issue for graves without any grave goods or with only vessels and animal remains.

The author, based on the typological schemes Reinhold provided, conducted the classification of the cultural material found at Kudachurt 14 in these four levels of definition. In the fourth level of definition, the typological classification includes established types of the NC BA as well as newly defined ones which are so far unique and do not have comparative analogies. Thus, it bridges the gap between existing typological classifications and new ones which are to be made, emphasising the key typo-chronological position of the cemetery.

Table 1 shows the functional classes contained in the graves by providing frequencies of combinations of functional classes as well as the total occurrence of functional classes at Kudachurt 14. The number of included categories and types of each class are not listed here; the table rather gives an overview of the number of available typologically significant grave inventories based on items of jewellery and weaponry (grey). The combinations of classes provide information about the number of graves for which typological cross-checking of graves containing only vessels is possible (light grey). Figure 16 shows the cemetery plan and the typological significance of the graves focusing on the occurrence of items: combination of jewellery/weaponry items and vessels, vessels or typologically irrelevant items, or no items at all.

4 The author is aware of potential functional differences but wishes to stress the artefact level.

n Graves containing…		n Graves containing functional classes				
FCC.	Number	Meat	Vessels	Jewellery	Weaponry	Tools
mvjwt	1	1	1	1	1	1
mvjw	12	12	12	12	12	
mvj	27	27	27	27		
mvw	5	5	5		5	
vjw	2		2	2	2	
vwt	1		1		1	1
mjt	1	1		1		1
vj	5		5	5		
mj	2	2		2		
j	3			3		
mv	36	36	36			
v	19		19			
m	6	6				
none	10					
in total	**130**	**90**	**108**	**53**	**21**	**3**

Table 1: Functional classes and absolute frequencies of occurrence of items in graves of the Bronze Age cemetery Kudachurt 14. The acronyms for the functional class combinations (FCC are "m" for meat, "v" for vessels, "j" for jewellery, "w" for weaponry and "t" for tools; for instance, "mcjw" means that in 12 graves meat, ceramics, jewellery and weaponry items were present.

In summary, the vast majority of the graves contained grave inventories with typologically significant items, either via the direct typo-chronological classification of jewellery and weaponry items or through vessel types which were cross-checked against graves (53 graves). At the time of publication, a typo-chronological classification for 16 graves remains impossible.

Out of 130 graves, ten did not contain any items and six only typologically insignificant items (see Table 2 and Fig. 16). The chronological affiliation to the Bronze Age is not questioned for graves with exclusively vessel depositions as the cross-checking of vessel types via jewellery and weapon types is part of the ongoing work by Reinhold.

In total, 108 graves contained vessels, items of jewellery or clothing were found in 53 graves, and items of weaponry in 21 graves. In 19 burials, vessels were exclusively present and in three, jewellery items; 32 graves contained both vessel and jewellery items, and three both vessels and weapons. In 15 graves, vessels, jewellery items and weapons were present. As this chapter relies on the typological classification of only jewellery and weaponry items, 58[5] graves in total are taken into account here; 56 of these contained typologically significant analogies considered in the comparative approach.

Before moving to the typo-chronological comparison with finds from surrounding sites, typological determinations of jewellery and weaponry from Kudachurt 14 are discussed in the following text. The functional class of jewellery and costume items is divided into 13 categories and 63 types (Tables 3, 4; Figs. 17-19). The defi-

5 The total number is 59; but the jewellery object in Grave 181, which represents its only funeral item, has decayed completely. Green discolouration on the right clavicle witnesses its presence, yet the object type remains unknown. The discolouration is too small for a spearhead or a dagger, therefore a small jewellery item is very likely here.

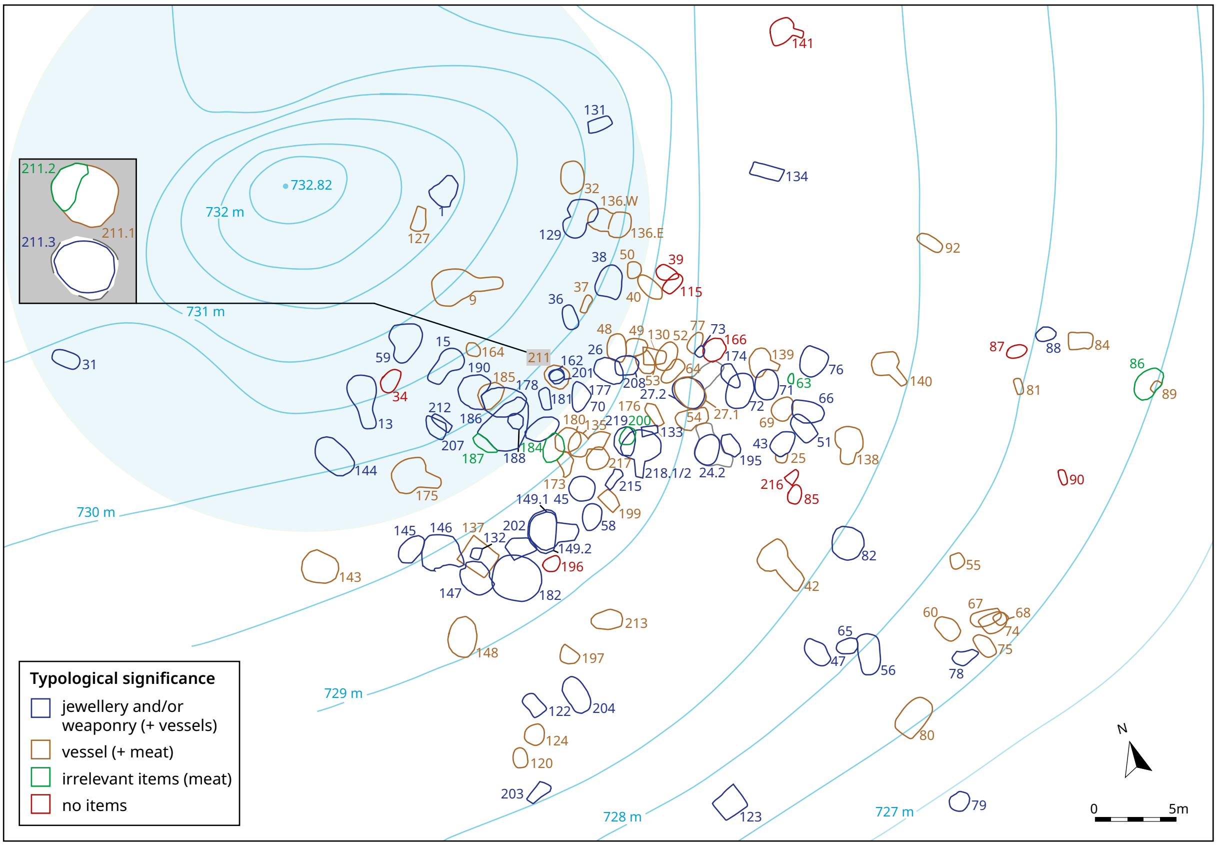


Figure 16: Cemetery plan of Kudachurt 14 and typological significance of the graves in terms of contained funeral items and assemblage.

nition of categories follows the purpose of each item. Some categories represent costume elements such as pins, belt hooks, decoration plates, buttons, or tutuli; others are elements of body jewellery, such as spiral rings or bracelets. For pendants, beads, and spiral rolls it is uncertain if they were originally components of necklaces or costume embroidery or used in different manner.

As all these items have decorative character, although the meaning of each category and each type might have differed in their prehistoric usage, they can be described as "decorative accessories". It should be noted however that costume items, especially pins and belt hooks, have a more practical character than body jewelry as they keep clothing tight. This aspect is discussed in the analytical part of the dissertation (Part II, chapter 4); at this point, all items are addressed as jewellery items.

The division into 63 jewellery types followed existing typological shapes[6] with some extensions. Often newly defined types are very similar to known classifications, *e.g.* the toggle pins (NaB, Fig. 18.1-10) or double spiral pin variations (NaL2B, Fig. 17.26-29). Other types might represent evolutionary developments with a higher complexity, *e.g.* pins with triple branch heads (NaH1B, Fig. 17.20) compared to those with two branches (NaH1A, Fig. 17.19) or bracelets with simple (ArAC, Fig. 18.14) or double spiral ends (ArA4B, Fig. 18.12-14) to those with single spiral ends (ArA4A, Fig. 18.10-11). This might also be true for triangular ram head pendants (AnA1, Fig. 19.1-2) compared to a double ram head pendant (AnA2, Fig. 19.3). Certainly, this will be an issue of the chronological sorting as it reveals something about the development of forms. Other types do not have typological similarities and thus are clearly unique; for instance, drop shaped (AnA4D, Fig. 19.7-9) as well as triangle pendants (AnA2B, Fig. 19.4) or bronze bell tutuli

6 For more detailed typological descriptions see Reinhold (2007, 75 and following).

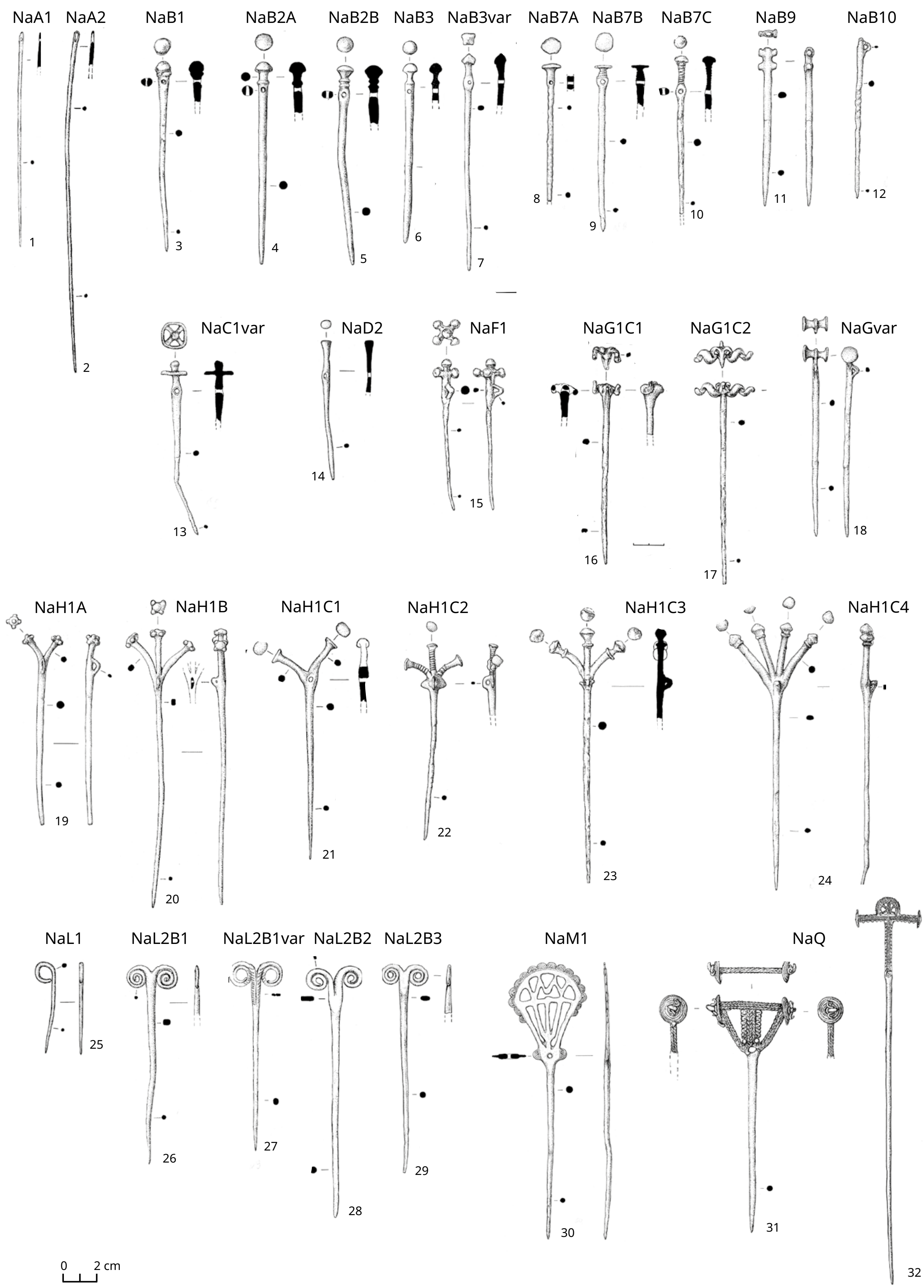
Category	Type	Type label
belt hook	*leaf shaped*	*GhF2var*
	double spiral	*GhK1*
bracelet	single spiral	ArA4A
	double spiral	ArA4B
	simple ends	*ArC*
	sheet double spiral	*ArD2*
decoration elemet	*dec element button*	*ZeA1*
	dec element sf	ZeC1
	hook pendant	AnH1
	inner shell	ZeB1
decoration plate	*dec plate*	*ZbA*
	dec plate	ZbB
necklace	beads 10	beads1-10
	beads 100	beads11-100
	beads 450	beads201-450
	beads 200	beads101-200
	beads 600	beads451-600
	animal teeth	ZAnB1-2
pendant	*triangular ram head*	*AnA1*
	double ram	AnA2
	triangle	AnA2B
	animal shaped	*AnA2D*
	ram shaped	*AnA2E*
	drop shaped	AnA4D
	astragal	*AnAs*
	double axe	*AnAx1*
	small ring	*AnB6*
	small ring	AnB7
	nodded	AnB8
	large ring	*AnGA1*
	large ringcross	*AnGA2*
	large disc	AnGB
	small leaf	AnGC
	large leaf	AnGC
	hook pendant	AnhH2
	shell	AnS1
	ring	AnSF
	animal figurine	*TanA1A*
	animal figurine	*TanA2*
	animal figurine	*TanB2*

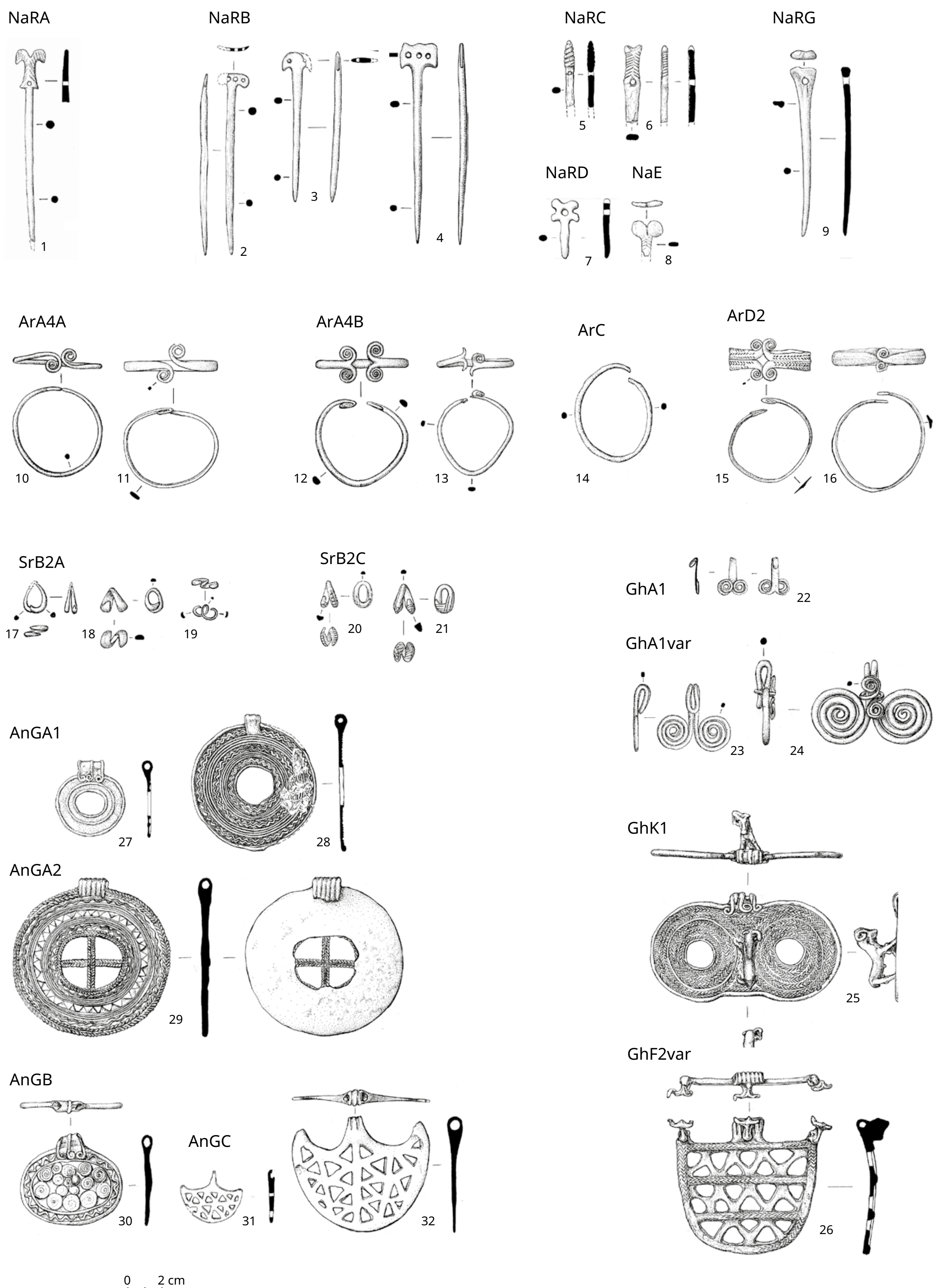
Category	Type	Type label
pin	simple perf	NaA1
	simple loop	*NaA2*
	toggle	*NaB1*
	excep toggle	NaB10
	toggle	NaB2A
	toggle	NaB2B
	toggle	*NaB3*
	toggle	*NaB3var*
	toggle	*NaB7A*
	toggle	NaB7B
	toggle	*NaB7C*
	excep toggle	NaB9
	seal	*NaC1var*
	hole neck	*NaD2*
	quin knob	*NaF1*
	animal	*NaG1C1*
	animal	NaGC2
	drum	*NaGvar*
	double branch knob	*NaH1A*
	trip branch knob	NaH1B
	double branch seal	NaH1C1
	trip branch seal	NaH1C2
	trip branch seal rip	*NaH1C3*
	quat branch seal rip	NaH1C4
	single spiral	NaL1
	double spiral	*NaL2B*
	double spiral	*NaL2B1*
	double spiral	*NaL2B2*
	double spiral	NaL2B2var
	double spiral	*NaL2B3*
	fan	*NaM1*
	complex T shaped	*NaQ*
	ornamented	NaRA-G
spiral buckle	*double spiral buckle*	*GhA1var*
	double spiral buckle	GhA1
spiral ring	*sr simple*	*SrB1*
	Sr open	SrB2
	sr ornamented	*SrB2C*
spiral roll	*spiral roll*	*SpRoeAB*
tutulus	bronze bell tutulus	ZkA1A
	bronze bell tutulus	ZkA1Avar
	bronze plain tutulus	ZkA1B
	bronze dec tutulus	*ZkA1C*
	antimony tutulus	*ZkA1D*
special form	special form	not classif.

Table 2 and 3: Functional class costume and jewellery items and their typological classification in 13 categories and 63 types. Marked in cursive are types for which comparison finds are present (see Table 2 and Fig. 16).

Figure 17 (opposite): Kudachurt 14. Bronze pin types. 1-2: NaA1-2 simple loop/perforated; 3-10: NaB1-B7C toggle; 11-12: NaB9-10 exceptional toggle; 13 NaC1 seal; 14: NaD2 hole neck; 15: NaF1 quin knob; 16 -17 NaG1C1-2 drum, 18: NaGvar drum, 19-24: NaH1A-C4 double-quat branch, knob-seal; 25: NaL1 single spiral, 26-29: NaLB1-3 double spiral; 30: NaM1 fan; 21-32 NaQ complex T. Copyright drawings: Institute of Caucasian Archaeology, Nalchik.

Figure 18 (overleaf): Kudachurt 14. 1-9: Bone pin types. NaRA-G ornamented. 10-26: Bronze jewellery and costume item types. 10-16: ArA4A-C bracelets: 10-11 single, 12-13 double spiral, 14 simple, 15-16 double spiral sheet. 17-21: SrB2A-C spiral rings 17-19: simple, 20-21 ornamented. 22-24: GhA1-F2var spiral buckles/belt hooks: 22 double spiral small, 23-24 double spiral, 25 belt hook double spiral, 26 belt hook leaf shaped. 27-32: AnGA1-GC large pendants. 27-28 large ring, 29 large ring cross, 30 disc, 31-32 leaf shaped. Copyright drawings: Institute of Caucasian Archaeology, Nalchik.


NaA1 NaA2 NaB1 NaB2A NaB2B NaB3 NaB3var NaB7A NaB7B NaB7C NaB9 NaB10
1 2 3 4 5 6 7 8 9 10 11 12
NaC1var NaD2 NaF1 NaG1C1 NaG1C2 NaGvar
13 14 15 16 17 18
NaH1A NaH1B NaH1C1 NaH1C2 NaH1C3 NaH1C4
19 20 21 22 23 24
NaL1 NaL2B1 NaL2B1var NaL2B2 NaL2B3 NaM1 NaQ
25 26 27 28 29 30 31 32
0 2 cm


NaRA
1
NaRB
2
3
4
NaRC
5
6
NaRD
7
NaE
8
NaRG
9
ArA4A
10
11
ArA4B
12
13
ArC
14
ArD2
15
16
SrB2A
17
18
19
SrB2C
20
21
GhA1
22
GhA1var
23
24
AnGA1
27
28
AnGA2
29
GhK1
25
GhF2var
26
AnGB
30
AnGC
31
32
0 2 cm

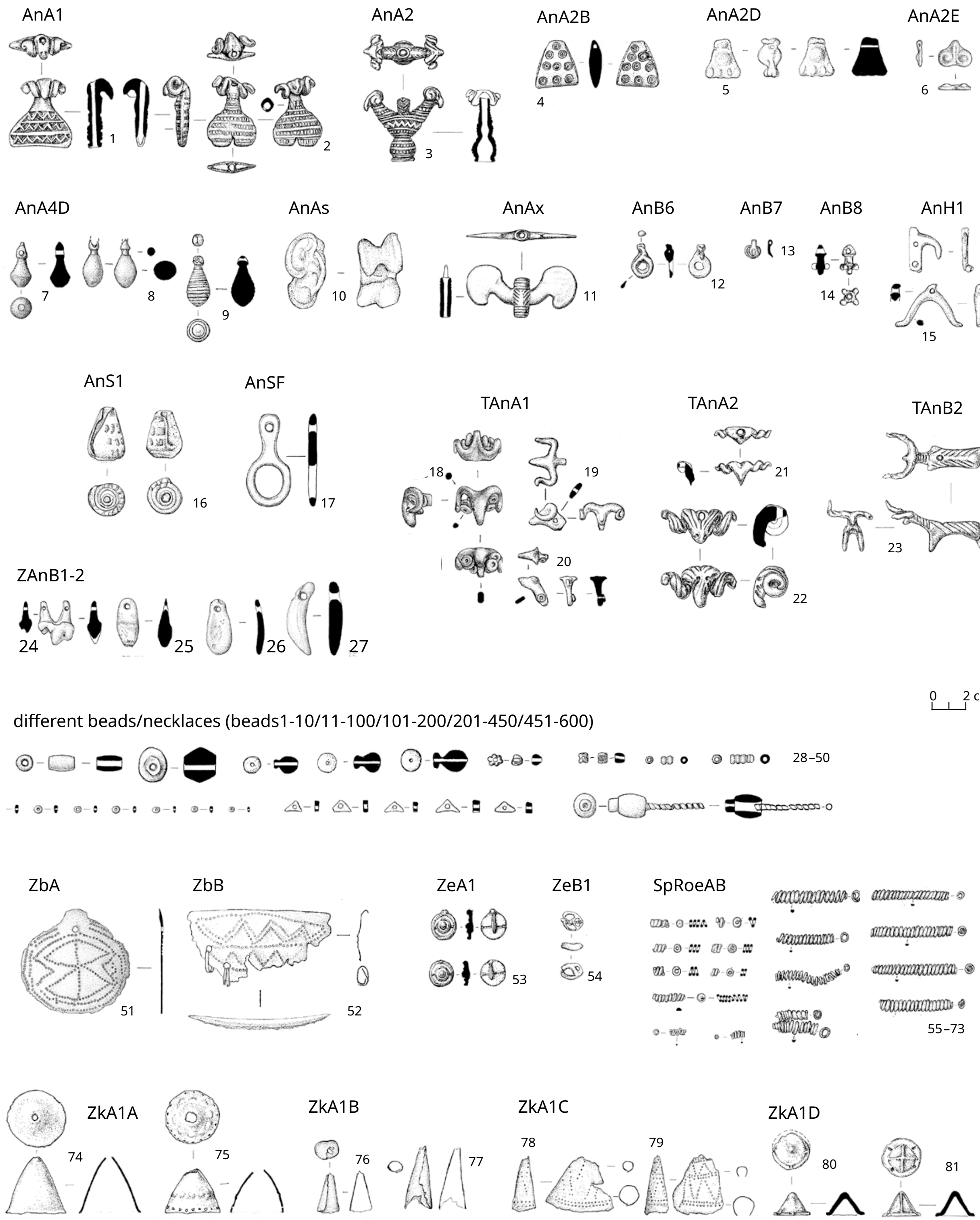


Figure 19: Kudachurt 14. Jewellery and costume item types. 1-3.7-9.11-15.17.18-23.51-52.55-75.78-81 bronze, 4-6.53.76-77 antimony, bone/teeth 10.24-27, shell 16.54, unknown 28-50. 1-7: AnA1-SF pendants: 1-2 triangular ram head, 3 double ram head, 4 triangle, 5 animal, 6 ram, 7-9 drop, 10 astragal, 11 double axe, 12-13 small ring, 14 nodded, 15 hook, 16 shell, 17 ring. 18-23: TAnA1-B2 animal pendants, animal figurine. 24-27: ZAnB1-2 tooth pendants/necklace. 28-50: different beads/necklaces. 51-52: ZbA-B decoration plate. 53-54: ZeA1-B1 decoration element. 53 button, 54 inner shell. 55-73: SpRoeAB spiral rolls, different shapes. 74-81: ZkA1A-D tutuli. 74-75 bell, 76-77 plain, 78-79 plain decorated, 80-81 antimony type. Copyright drawings: Institute of Caucasian Archaeology, Nalchik.

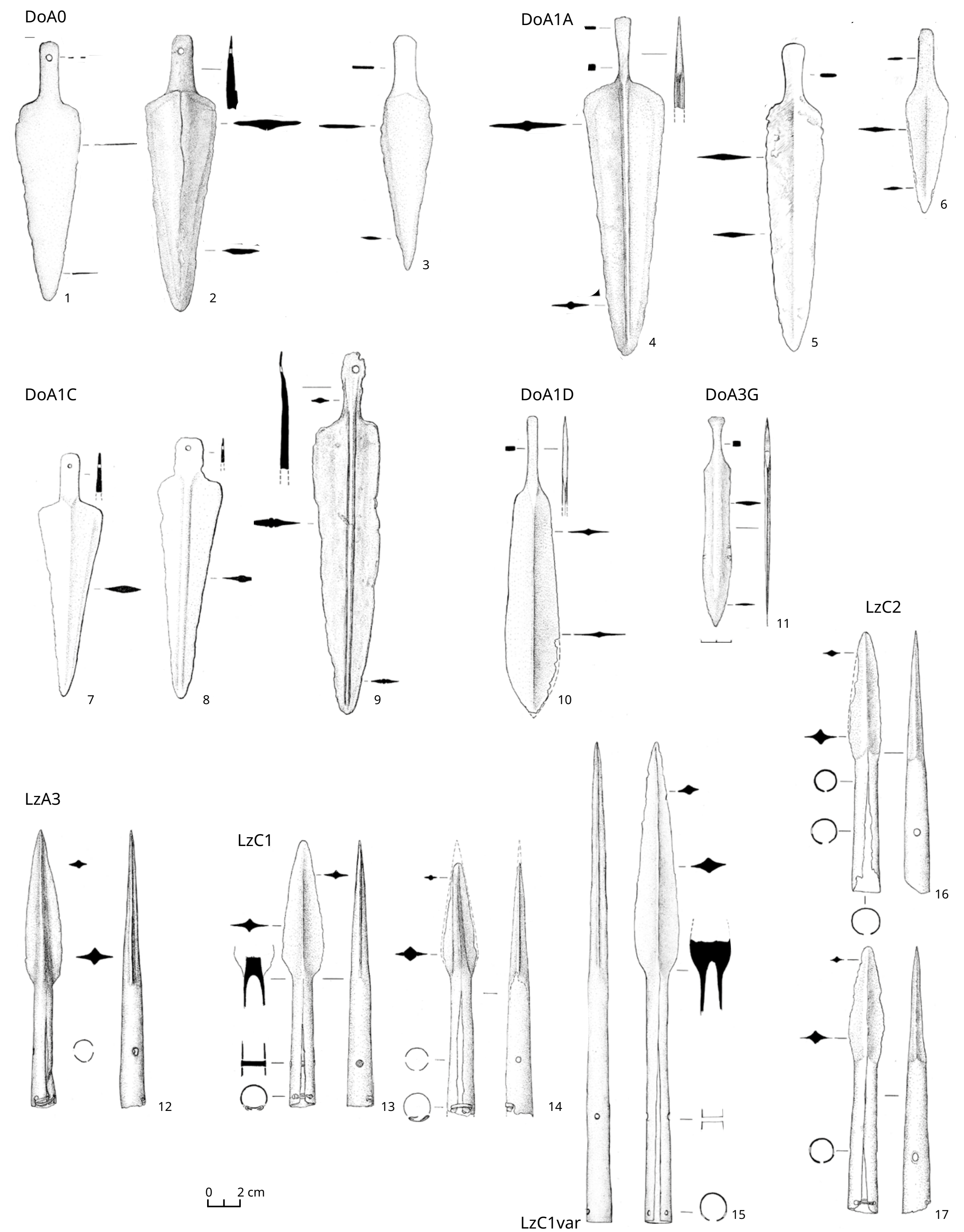


Figure 20: Kudachurt 14. Bronze weaponry items. 1-11: DoA0-DoA3G tanged daggers: 1-2 perforated flatblade, 3 flatblade, 4-6 ripblade, 7-8 perforated ripblade; 10 rhombic, 11 waisted. 12-17: spearheads: 12 slot ripblade, 13-15 long ripblade, 16-17 short ripblade. Copyright drawings: Institute of Caucasian Archaeology, Nalchik.

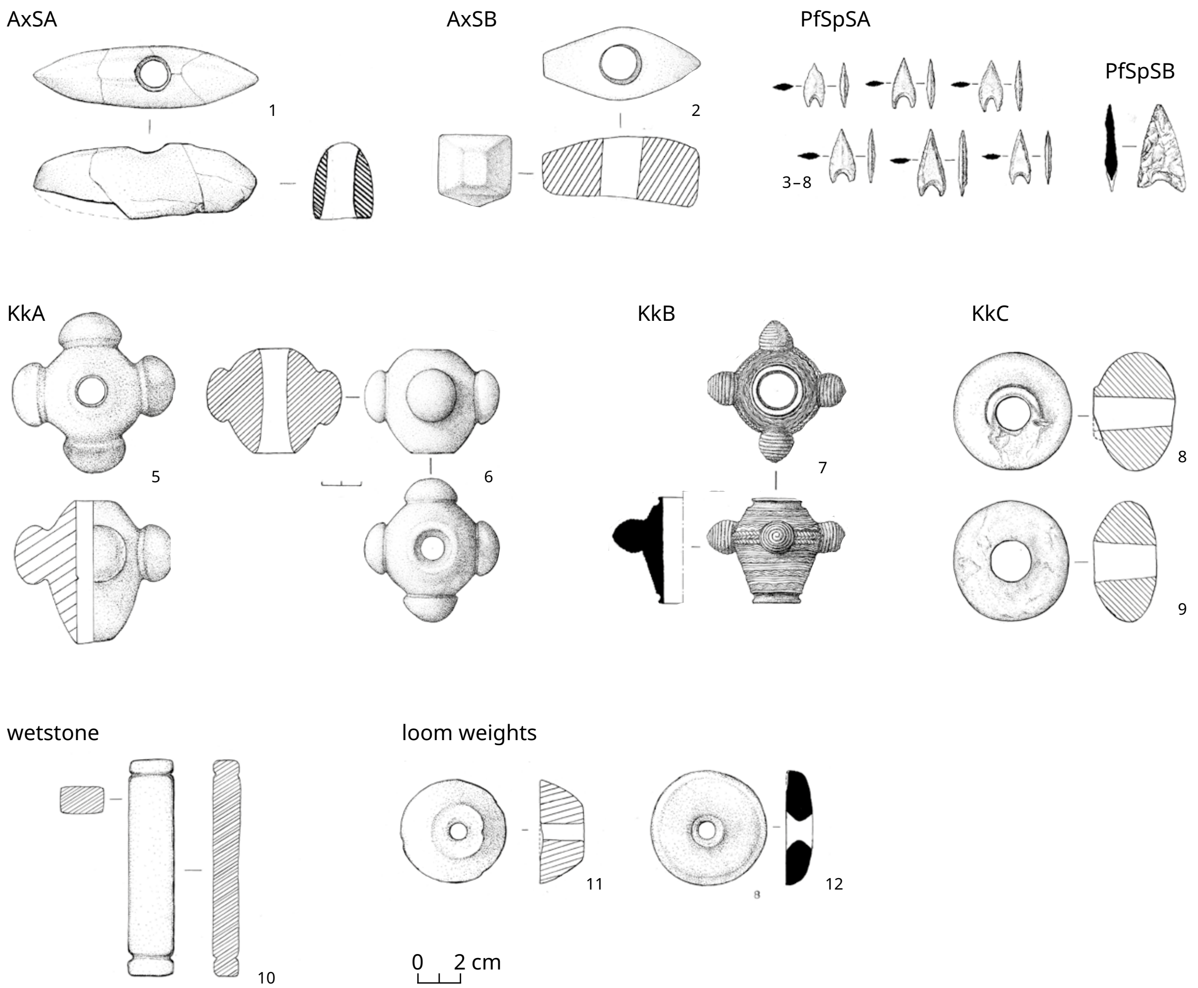


Figure 21: Kudachurt 14. Stone weaponry items and tools. 1-2: AxSA-B stone axes, pointed and blunt neck. 3-9: PfSpSA-B stone arrow heads. 5-9 KkA-B maceheads: 5-6 four knobs, four knobs 7 decorated, 8-9 roundish. 10-13: tools: 10 whetstone, 11-12 loom weights. Copyright drawings: Institute of Caucasian Archaeology, Nalchik.

(ZkA1A, Fig. 19.74-75). In general, the categories pins and pendants have the most varied form spectra, also in relation to their total number.

The majority of the jewellery items are made of bronze. For these items, many more analogies from other sites exist. However, there are no similar findings for the bone pins (NaRA-G, Fig. 18.1-9) so far; similarly, analogies to beads made of different materials (animal teeth, stone, shell, Fig. 19.24-50) are less frequently represented or are lacking completely at the comparison sites. Unfortunately, for some jewellery items of Kudachurt 14 the material from which they were made remains unclear.

The functional class of weaponry items is smaller in total amount as well as the typological spectre (Tab. 5, Fig. 20). Five categories – daggers, spearheads, maceheads, arrowheads, and axes – are split in 17 types. It is interesting that the grave inventories from Kudachurt 14 completely lack bronze axes, even though this category of weaponry represents one of the major artefact groups characterising, for instance, the chronological schemes of the Koban Culture or earlier cultures ("shaft hole axes", "Kolchis axes", cf. Reinhold 2007, 45). The two axes found in Kudachurt 14 are made of stone and are distinctly different from each other (AxASA1-2, Fig. 21.1-2). Arrowheads were also only seldom recovered and differ especially in size (PfspSA1-2, Fig. 21.3-9). Maceheads appear as roundish or slightly longer forms with four knobs (KkA, Fig. 21.5-6), as a decorated variation (KkB, Fig. 21.7), or as roundish stout heads (KkC, Fig. 21.8-9), all made of stone. The bronze dagger types relate to those defined

Category	Type	Type label
arrowhead	arrowhead	PfspSA1
	arrowhead	PfspSA2
axe	axe	AxSA1
	axe	AxSA2
dagger	*flatblade*	*A0*
	perf ripblade	*DoA1A*
	ripblade	*DoA1A*
	perf ripblade	*DoA1C*
	rhombic blade	DoA1D
	waisted blade	DoA3G
macehead	*four knobs*	*KkA*
	four knobs	KkB
	round	*KkC*
spearhead	slot slimblade	LzA3
	long ripblade	*LzC1*
	long ripblade var	LzC1var
	short ripblade	*LzC2*

Table 4: Functional class weaponry items and their typological classification in 13 categories and 63 types. Marked in cursive are types for which comparison finds are present (see Table 2 and Fig. 16).

by Reinhold and Motzenbäcker; Reinhold's definitions were preferred. These types are defined as tanged daggers with perforated or not perforated rivets and flat or ripped blades (Fig. 20.1-11). Two new, exceptional types occurred with rhombic and waisted blades respectively (DoA1D, DoA3G, Fig. 20.10-11). All spearhead types had slot shafts but differ in the shape of the blade and pronunciation of the middle rip where the shaft hole flattens off (LzA3-C1var, Fig. 20.12-17).

3.4.1.2 Comparison of sites and finds

The typo-chronological consideration of the finds from Kudachurt 14 is based on a comparative study following the typo-chronological principle. Put simply, this principle consists of the assumption that typologically equal or significantly similar physical artefact forms (analogies[7]) existed simultaneously, or at least with temporal overlaps, and developed throughout time. Established typo-chronological classification schemes therefore can be used to locate items and their archaeological context; at the same time, these classification schemes might be altered when supplemental information is taken into account (independent data, *e.g.* radiocarbon dates or stratigraphic structures) and the amount of material analysed increases. The reliability of this method also strongly depends on the character of the archaeological context the artefacts are coming from; objects from settlements, graves, and hoards might have different biographies (*e.g.* purpose, duration of use) and are not necessarily explicit in terms of temporal accuracy (referring to the character of a "closed find").

7 The use of the term "analogy" in this respect remains arguable; in this study, it does not mean an exact equal object morphology, but refers at least to a very strong similarity. It also relies on the typological classification of the author(s).

In addition, the spatial distribution of artefact types is always subject to a certain temporary delay. This might, though not necessarily, have an impact on the regional reliability of typo-chronological schemes.

The conducted comparative study only marginally encounters these issues; the reference material focuses on grave inventories in order to minimise potential temporal inaccuracy and at the same time maintain comparability in terms of the contextual meaning of the artefact. The inclusion of one single find as well as one hoard are exceptions here. Unfortunately, due to research traditions, collectors' activities, and preservation issues the objects found at cemeteries from the close surrounding of Kudachurt 14 (Faskau, Verchnaja Rutcha, Kumbulte) and a large number of analogies lack detailed context information. They remained archived in large collections in different archaeological institutes and thus only have limited typo-chronological significance (*e.g.* Collection Kossnierska, see preceding sections).

As mentioned before, this comparative study only considers items of jewellery and weaponry. The catalogues of the publications of Reinhold (2007) and Motzenbäcker (1996) were the main sources of reference material in building typological analogies. The approach only considers the analogies, rather than the whole assemblages in which they are found, as of use; therefore, it does not mirror the whole spectrum of finds but rather distribution tendencies of the selected typological forms throughout the investigated period. Except for a few objects made of antimony, the analogies refer to bronze finds. This excludes stone objects (axes, arrowheads, beads) or artefacts made of animal material (beads, pendants, pins; shell, bone, teeth).

As Reinhold's study area included the whole Greater Caucasus, though split in different regional groups based on current geopolitical borders, a geographical limitation of a 100 km[8] radius around the site of Kudachurt 14 was used to fix the number of possible sites for comparison. From a current perspective, this area includes parts of the Kabardino-Balkarian Republic and North Ossetia in Russia, as well as the Racha-Lechkhumi and Kvemo Svaneti regions in Georgia.

Sites

Table 5 gives an overview of the comparative sites including the name and label used for mapping, the number of recorded analogies, the discovery context, the relative dating, and cultural affiliation as well as, if available, the details related to funeral traditions (grave construction, burial type, inhumation characteristics). In some cases, one site number represents multiple cemeteries or graves which were located closely to each other (*e.g.* 10 Verchnjaja Rutcha and Kumbulte, both site 10, Bylym and Ugol'nyj Bylym, both site 7).

For this reason, a mapped location can refer to several archaeological contexts (cemeteries, single graves, hoard). For many complexes the context information is lacking due to preservation status or the standards of former research and collecting (this is mainly true for the larger collections such as the Kossnierska or Urarvoa).

The relative dating originates from the available literature. In general, these chronological statements have quite a wide range; due to some uncertainties and inconsistencies occurring when combining several chronological schemes, the stated relative dating is only an approximate result for most of the cases. In accordance with the site and each used scheme, this relative dating includes site-specific chronological determinations, such as "KoA-B" or "TliA", indicating the presence of different MBA and LBA stages as well those of the Early Koban Culture.

The recording of jewellery and weapon analogies resulted in 622 artefacts for comparison from 17 sites (Figs. 22, 24-28.; Tables 5-9), spanning a maximum period

8 This is an artificial limitation without considering topographic conditions such as valleys and passages through the mountains, which would be required if the study would include investigations of communication and trade systems.

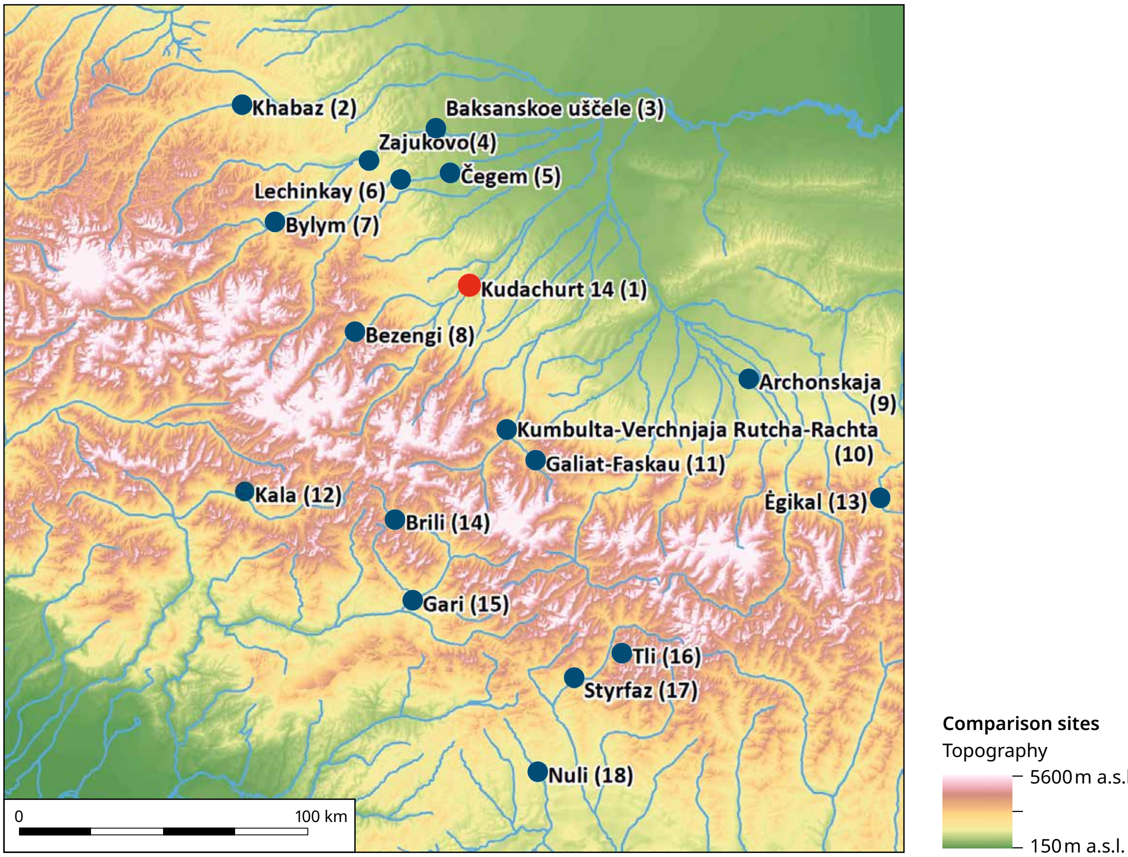


Figure 22: Topographic map of the central region of the Greater Caucasus. Plotted are recorded MBA-LBA(EIA) comparison sites according to the literature (name and site number, see Table 5).

from *ca.* 2400-800 BCE and including finds from the MBA to the EIA. The sites spread over the northern and southern foothills, as well as high mountain ranges of the Greater Caucasus, with only very few findings from the lower altitudes[9]. The cemeteries Baksanskoe uščele and Archonskaja as well as the site Čegem are located in the northern transition zone from the steppe to the foothill elevations; in the moderate altitudes, around the level where Kudachurt 14 is situated, the single grave contexts from Lechinkay and Zajukovo are known from the northern and Nuli from the southern region. The other sites are in the rough environment of the high mountain ranges. In altitudinal order, these are the cemeteries Chabaz and Bylym with both grave and hoard contexts (northern slopes); Gari and Stryfaz (southern slopes); the highest situated sites Égikal, the combined sites Kumbulta/Verchnjaja Ruchta/ Rachta and Faskau/ Galiat-Faskau (all northern slopes) as well as the sites Brili, Kala, and Tli (all southern slopes). All locations, despite their altitudes, have in common that they are situated in or nearby river valleys, potentially mirroring preferred habitats or passable areas through the mountain ranges.

The variety of affiliated cultural phenomenon is as large as the chronological timeframe of interest. Based on the relative chronology, Archonskaja – a kurgan cemetery with stone architecture from the northern foothill slope – is the earliest site and the only one for which radiocarbon dating was conducted. The analyses of ten samples from different grave contexts suggested a dating of 2500-1600 BCE (2sigma-range; Mimokhod 2014, 77-78). Unfortunately, no sample from Grave 3 of Kurgan 1 was included, hence a direct dating of the context of the four recorded

9 This is likely due to the limitation on mainly bronze items of jewellery and weaponry, which excludes sites and graves from the steppe containing only vessels, especially those of the earlier MBA stages which are stated to be poor in bronze artefacts.

analogies (two spiral rings, buttons[10] and a simple loop pin, see Table 6) is lacking. Still, we can consider Archonskaja as a cemetery of the post-catacomb complex following the Surovoro Culture, characterising with its findings the Archon Group, a cultural phenomenon of the late MBA (see chapter 1.2). The latest stage marked by artefacts was found in graves from the large cemeteries Tli and Stryfaz, located south of the high mountain ridges. Both cemeteries revealed quite a large amount of EIA graves from the Koban Culture, but at the same time burial complexes from initial MBA/LBA stages with distinctively differing constructions (mainly collective graves) and funeral equipment (see Reinhold 2007, 288 and following). In the cemeteries relatively dated to somewhere between these two extremes, the association of the cultural material ranges from different manifestations of the North Caucasian Culture, to the unclarified "Final MBA mountains" and the "Digorija Type Spectre" (mainly Kumbulta/Verchnjaja-Ruchta/Rachta and Faskau/Galiat-Faskau). The available burial descriptions are witness to a very heterogeneous picture of funeral practice; stone construction element single and collective graves, primary as well as secondary inhumations[11], and traces of fire impact on the human remains. Only by referring to the spatial distribution of sites revealing typological analogies to the findings from Kudachurt 14 and their stated relative chronology, is the general temporal setting of the MBA-LBA transition confirmed for the object of study.

Finds

In the following, the frequencies of types and total number of analogies, their spatial distribution, and significance in terms of typo-chronological considerations are discussed in more detail, concentrating on the finds' characteristics and how these can be transferred to Kudachurt 14.

The details refer to the descriptions of the material from Kudachurt 14 using the four levels of categorization: functional class (includes only jewellery and weapons), category, type and type label. In a few cases, terms and classifications used so far required renaming in order to achieve a match between the comparison artefact and the types defined for Kudachurt 14. As this chapter is not aiming for a comprehensive typo-chronological investigation in terms of Bronze Age leitmotiv findings and accompanying typological developments, only the analogy artefacts are considered here and not the complete grave inventories. This means that the recording table is not a list of all artefacts found at each site, but a selection of typological analogies. It also should be stressed that, due to the very selective character of the approach only focussing on jewellery items and weapons, an unknown number of MBA and LBA sites were excluded from the beginning of the analysis. Therefore, the following considerations have certain limitations.

The first step of the investigation compares frequencies of types and analogies (meaning the number of associated objects) within the sites and discusses stated typo-chronological meanings; the second step achieves the link to the Kudachurt findings in respect to the grave context. Subsequently, an overall comparison involves the spatial distribution of sites.

Tables 6 summarises comparison item details, relative dating, and number of items per type found at each site, as well as number of graves and analogies from Kudachurt 14. Figures 24-28 display a selection of the recorded artefacts (Lechinkay and Bezengi Fig. 13; Chabaz, Archonsjaka, Zakujuvo and Bylym Fig. 24; Galiat-Faskau Fig. 25, 26.16.-20; Kumbulta/Verchnjaja-Rutcha/Rachta Fig. 26.1-13, 27; Brili, Égikal, Stryrfaz and Tli Fig. 28; Kala and Čegem without illustration). For six objects the exact origin is no longer known; it is either Faskau-Galiat or Kumbulta.

10 Here counted as one item.

11 According to the author, secondary inhumation here means disarticulated skeletal elements in the *in situ*-situation. These can thus also be interpreted as disturbed burials due to re-accessed graves.

Site nr.	Site name	n analog/all	Context	Context label
2	**Chabaz**	3/ca. 7	cemetery	
3	**Baksanskoe uščele**	10/various	unclarified, cemetery	single findings 1921; collection Zichy, Vyrubov; graves
4	**Zajukovo 1**	2/various	cemetery	single findings
5	**Čegem**	8/various	unclarified	collection Zichy, Vyrubov; unclarified contexts
6	**Lechinkay**	3/?	grave	grave finding
7	**Bylym, Ajlama, Ugol'nyj Bylym**	35/various	cemetery, hoard	
8	**Bezengi**	2/?	grave	
9	**Archonskaja**	4/20	cemetery	kurgan 1, grave 3
10	**Kumbulta, Verchnjaja Rutcha, Rachta**	182/various (>200)	cemeteries	2-6/1886; 1/1891; 1,6/1986; 10,15,16/1937-40; 16/1938, 1974-76; collection Kossnierska, Uvarova, Dolzebev
11	**Galiat-Faskau, Faskau**	57/various (>100)	cemetery	destroyed graves
12	**Kala**	1	single find	
13	**Ėgikal**	4/various	crypt	
14	**Brili**	21/various	cemetery?	
15	**Gari**	1/various	cemetery?	
16	**Tli**	175/various (>300)	cemetery	grave 001, 002B, 003, 004, 007, 008, 207, 029a-b, 031, 033, 036, 039, 040b, 042a-g, 044, 045, 046, 056a-b, 058, 059, 073a-c, 059, 116, 138a, 204, 207, 224, 260a, 296a, 334, 335, 339, 395, 451, destroyed; Uvarova, Dolzebev collection
17	**Styrfaz**	88/various	cemetery	cromlech 5, grave 1 and 2; cromlech 6-7; cromlech 9, grave 2; cromlech 10, grave 11; cromlech 11, grave 1 and 2; grave findings 1949; graves 04/05-1-2, 1/10-3, 11/1, 11/5
18	**Nuli**	20/various	cemetery	grave 3, 4

Table 5: List of selected sites from the study area. Site number (nr.) and site name refer to the maps (Figs. 13-16). "n analog s/all" means recorded analogies compared to the total number of artefacts from the site/context.

Burial characteristics	Cultural affiliation	Relative dating	Literature
stone cist, collective grave (5 ind., 2 left-sided flexed, head N/NW, remaining disarticulated)	Early Koban Culture	KoA (1300-1200 BCE)	Reinhold 2007, p. 436
collective graves with cremations	Early Koban Culture	KoA-C (1300-800 BCE)	Reinhold 2007, p. 435
	Early Koban Culture	KoA/B (1300-900 BCE)	Reinhold 2007, p. 445
	Early Koban Culture	KoA-C (1300-800 BCE)	Reinhold 2007, p. 435
	North Caucasian Culture "Foothills 1"	final MBA (1600-1200 BCE)	Mötzenbäcker 1996, p. 38-39; Korenevskji 1984, p. 284
destroyed grave, grave 2, hoard	North Caucasian Culture "Mountain Group"/final MBA mountains/Djigora	older MBA (2000-1400 BCE); MBA2 (1700-1400 BCE); KoA	Mötzenbäcker 1996, p. 38, 40, 92; Reinhold 2007, p. 444
	final MBA Mountains	older MBA	Mötzenbäcker 1996, p. 38-39
single, left-sided flexed	Archon group "Post-Catacomb Complex"	final MBA	Korenevskij/Mimochod 2011, fig. 19; Mimochod 2014
single and 12 collection graves (3->50 ind., subadults and adults; fem right-sided flexed, males left-sided flexed, W/NNW), pits and stone cists, cremations, secondary inhumations	North Caucasian Culture/ Final MBA mountains/ Djigora	MBA1-2 (2000-1700/1200 BCE); LBA1 (1400-1200 BCE); KoB-C (1200-800 BCE)	Motzenbäcker 1996, Reinhold 2007, p. 408-410
collective grave (7 ind.)	North Caucasian Culture/ final MBA mountains/ Djigora	MBA1-2; LBA1; KoA/B	Motzenbäcker 1996, Reinhold 2007, p. 400
	–	MBA2	Motzenbäcker 1996, p. 94, fig. 47
collective grave (ca. 8 ind.), sek. inhumation	final MBA Mountains	MBA (2000-1400/1200 BCE)	Reinhold 2007, p. 433
collective graves, cremations	final MBA Mountains	old/final MBA/ LBA(1400-1200 BCE)	Pantskhava et al. 2001, fig. 1-14
	final MBA Mountains	MBA	Reinhold 2007, p. 530
single and 4 collective graves (up to 6 ind., secondary inhumation, stone constructions)	Early Koban Culture	KoA-C/LBA/Tli A-B (1300-800 BCE)	Reinhold 2007, p. 389-401
single and one collective grave (05-1, 9 ind., disarticulated, secondary inhumation, cromlechs and massive stone covering)	Early Koban Culture	KoA-B	Reinhold 2007, p. 388
collective graves, 4-8 ind., primary inhumation (+3 additional collective graves); grave 3 stone covering, 4 ind., left-sided flexed, heads towards N/W	final MBA Mountains	MBA	Reinhold 2007, p. 587

Table 5 continued.

Site (label)	Relative dating	Object category and type (label)	n site	n Kud 14 (g/n)
Chabaz, Aman Kol (2)	KoA (1300-1200 BCE)	dagger, ripblade (DoA1A)	1	3/3
		spiral ring, sr simple (SrB2A)	1	30/73
		spiral roll, (SpRoeAB)	1	36/249
Baksanskoe uščele (3)	KoB/C (1200-800 BCE)	pin, toggle (NaB3)	1	6/7 (11/31)
		spiral ring, sr simple (SrB2A)	9	30/73
Zajukovo 1 (4)	KoA/B (1300-900 BCE)	spiral buckle, double spiral buckle (GhA1var)	2	13/30
Čegem (5)	KoA-C (1300-800 BCE)	dagger, ripblade (DoA1A)	1	3/3
		pin, double spiral (NaL2B1-3)	1	23/63
		spiral buckle, double spiral buckle (GhA1var)	1	13/30
		spiral ring, sr simple (SrB2A)	5	30/73
Lechinkay (6)	final MBA (1600-1200 BCE)	belt hook, double spiral (GhK1)	1	1/1
		pendant, large ring (AnGA1)	1	2/2
		pendant, large ringcross (AnGA2)	1	1/1
Bylym (7)	older MBA (2000-1400 BCE)	pin, complex T shaped (NaQ)	2	1/1 (2/3)
Bylym, Ajlama (7)	MBA2 (1700-1400 BCE)	dec plate, dec plate (ZbA)	1	1/1
		spiral ring, sr simple (SrB2A)	1	30/73
		macehead, four knods (KkA)	1	3/3
Ugol'nyj Bylym (7)	KoA	bracelet, sheet double spiral (ArD2)	1	6/12
		dagger, ripblade (DoA1A)	1	3/3
		pin, animal (NaG1C1)	1	1/1 (2/5)
		pin, double branch knob (NaH1A)	1	5/6
		pin, double spiral (NaL2B1-3)	1	23/63
		pin, fan (NaM1)	1	2/2
		pin, quin knob (NaF1)	2	1/1
		pin, seal (NaC1var)	2	1/1
		pin, toggle (NaB1)	1	4/5 (11/31)
		pin, toggle (NaB3)	2	6/7 (11/31)
		pin, trip branch seal rip (NaH1C2)	1	2/4
		spearhead, slot slimblade (LzA1)	1	1/1
		spiral ring, sr simple (SrB2A)	14	30/73
		spiral roll (SpRoeAB)	1	36/249
		tutulus, bronze tutulus (ZkA1C)	1	19/62
Bezengi (8)	older MBA	pin, complex T shaped (NaQ)	2	1/1 (2/3)
Archonskaja 89 (9)	final MBA	dec element, antimony button (ZeA1)	1	4/21
		pin, simple loop (NaA2)	1	15/27
		spiral ring, sr simple (SrB2A)	2	30/73
Kumbulta (10)	MBA (2000-1400/1200 BCE)	dagger, ripblade (DoA1A)	3	3/3
		pendant, animal figurine (TanB2)	2	1/1
	LBA1 (1400-1200 BCE)	pendant, animal figurine (TanA1A, TanA2)	2	6/10
	MBA2	pin, fan (NaM1)	1	2/2
	KoB/C	pin, toggle (NaB3)	1	6/7 (11/31)
	MBA	spiral buckle, double spiral buckle (GhA1var)	1	13/30
		spiral ring, sr simple (SrB2A)	1	30/73

Table 6 (above and continued opposite): List of MBA-LBA (EIA) comparison sites, recorded analogies (type and number), the associated relative dating, and synchronized findings from Kudachurt 14.

Site (label)	Relative dating	Object category and type (label)	n site	n Kud 14 (g/n)
Kumbulta-Verchnjaja Rutcha (10)	MBA	dagger, ripblade (DoA1A)	8	3/3
		macehead, round (KkC)	1	1/3
		pendant, animal figurine (TanA1A, TanA2)	1	6/10
		pendant, animal shaped (AnA2D)	3	7/9
		pendant, astragal (AnAs)	2	1/1
		pendant, small ring (AnB6)	6	1/4
		pin, fan (NaM1)	1	2/2
		pin, quin knob (NaF1)	1	1/1
		spearhead, long ripblade (LzC1)	1	12/25
		spiral ring, sr open (SrB1)	1	2/4
		spiral ring, sr simple (SrB2A)	4	30/73
		spiral roll (SpRoeAB)	1	36/249
Rachta (10)	MBA1 (2000-1700 BCE)	dagger, perf ripblade (DoA1C/C1)	1	3/3
	MBA2	pin, fan (NaM1)	1	2/2
	MBA2	spiral ring, sr open (SrB1)	3	2/4
		spiral ring, sr simple (SrB2A)	13	30/73
Verchnjaja Rutcha (10)	MBA2	dagger, flatblade (DoA0/B3)	3	1/1
		dagger, perf flatblade (DoA0/B3/C2)	6	2/2
		dagger, perf ripblade (DoA1C/A2/B2/C1/B1)	4	2/3
		dagger, ripblade (DoA1A/B1)	4	3/3
		Macehead, four knods (KkA)	1	3/3
		pendant, animal figurine (TanA1A, TanA2)	26	6/10
		pendant, animal figurine (TanB2)	1	1/1
	MBA-LBA (2000-900 BCE)	pendant, double axe (AnAx1)	5	2/2
		pendant, ram shaped (AnA2E)	1	2/3
	MBA1 (2000-1700 BCE)	pin, double spiral (NaL2B1-3)	7	23/63
	MBA-LBA	pin, drum (NaGvar)	1	1/2
	MBA2	pin, fan (NaM1)	3	2/2
	LBA1	pin, quin knob (NaF1)	3	1/1
		spearhead, short ripblade (LzC2)	3	3/5
	MBA-LBA	spiral ring, sr diff (SrB2A-C)	31	30/83
		spiral ring, sr simple (SrB2A)	24	30/73
Faskau (11)	MBA	belt hook, leaf shaped (GhF2var)	1	2/2
		pendant, animal figurine (TanA1A, TanA2)	1	6/10
		pendant, animal shaped (AnA2D)	6	7/9
	MB2	pin, fan (NaM1)	3	2/2
	MBA	spiral buckle, double spiral buckle (GhA1var)	1	13/30
Galiat-Faskau (11)	MBA1	dagger, flatblade (DoA0/A2B/A1)	1	4/4
		dagger, perf flatblade (DoA0/A2B/A1)	1	2/2
	MBA2	dagger, perf ripblade (DoA1C/B2)	1	2/3
		dagger, ripblade (DoA1A)	1	6/5
	LBA1	pendant, animal figurine (TanA1A, TanA2)	22	6/10
	MBA	pendant, double axe (AnAx1)	2	2/2
	MBA2	pin, fan (NaM1)	1	2/2
	MBA	pin, hole neck (NaD2)	1	2/3
		pin, toggle (NaB3)	1	6/7 (11/31)
		spiral ring, sr open (SrB1)	1	2/4
		bracelet, simple ends (ArC)	7	7/15
		spiral ring, sr simple (SrB2A)	6	30/73

Site (label)	Relative dating	Object category and type (label)	n site	n Kud 14 (g/n)
Galiat-Faskau/Kumbulte (11)	LBA1	pendant, animal figurine (TanA1A, TanA2)	1	6/10
	MBA	pendant, triangular ram head (AnA1)	1	3/4
		pin, double spiral (NaL2B1-3)	4	23/63
Kala (12)	MBA2	pin, fan (NaM1)	1	2/2
Ėgikal (13)	MBA	pin, simple loop (NaA2)	1	15/27
	MBA	spiral ring, sr simple (SrB2A)	2	30/73
	MBA	tutulus, antimony tutulus (ZkA1D)	1	4/49
Brili (14)	final MBA/LBA(1400-1200 BCE)	belt hook, leaf shaped (GhF2var)	1	2/2
		dagger, ripblade (DoA1A)	2	3/3
		pendant, animal figurine (TanA1A, TanA2)	1	6/10
		pendant, double axe (AnAx1)	1	2/2
		pendant, triangular ram head (AnA1)	1	3/4
		spearhead, long ripblade (LzC1-2)	14	12/25
		spiral ring, sr simple (SrB2A)	1	30/73
Gari (15)	MBA	spiral buckle, double spiral buckle (GhA1var)	1	13/30
Tli (16)	LBA/Tli A (1300-1200)	dagger, ripblade (DoA1A)	5	3/3
	KoA/Tli A (1300-1200 BCE)	pin, toggle (NaB1)	71	4/5 (11/31)
	LBA/Tli A	pin, toggle (NaB7A)	3	5/6 (11/31)
	KoA/B	pin, toggle (NaB3)	15	6/7 (11/31)
	KoB1 (1200-1100 BCE)	spearhead, long ripblade (LzC1)	2	12/25
	KoA/Tli A-B (1300-1100 BCE)	spiral buckle, double spiral buckle (GhA1var)	18	13/30
	KoA-C	spiral ring, sr simple (SrB2A)	60	30/73
	LBA/Tli A	spiral roll, (SpRoeAB)	1	36/249
Styrfaz (17)	KoA/B	bracelet, single spiral (ArA4A)	5	(15/34)
		pin, animal (NaG1C1)	2	1/1 (2/5)
		pin, toggle (NaB3var)	19	1/1 (11/31)
		pin, toggle (NaB1)	24	4/5 (11/31)
		pin, toggle (NaB3)	14	6/7 (11/31)
		pin, toggle (NaB7C)	2	7/10
		spearhead, slot slimblade (LzA1)	2	1/1
		spiral buckle, double spiral buckle (GhA1var)	4	13/30
		spiral ring, sr simple (SrB2A)	9	30/73
		spiral roll, (SpRoeAB)	7	36/249
Nuli (18)	MBA	pin, toggle (NaB3)	20	6/7 (11/31)
All			**622**	**56/756**

Table 6 (continued)

In total, 622 analogies and 45 types (39 connected with particular sites) are available for the comparative approach. Regarding the graves of Kudachurt, 56 out of 58 inventories with jewellery and/or weaponry items are considered; only three burials which contain solely typologically insignificant necklaces cannot be taken into account[12]. The larger archaeological record therefore provides comparative analogies for 697 of 1022 jewellery items (39 of 63 types) and 42 of 58 weaponry items (6 of 14 types) from Kudachurt 14. This large number of analogies is already a first result as it confirms a relative dating of these graves; their inventories are associated with known typo-chronological statements from the MBA to LBA and even EIA periods for the Northern Caucasus. Furthermore, due to the composition of the inventories the selective approach does not exclude graves, as within these 56 inventories at least one of the selected types is present; thus a comprehensive seriation via similarity relations and the extension of typo-chronological examinations across the cemetery are possible.

With respect to functional classes, the amount of jewellery items (553) is significantly higher than weaponry items (69) in the total number of objects (662) from all comparison sites. This also applies for the general form spectra. In order of total frequency, ten jewellery categories (pin/n=219, spiral ring/188, pendant/87, spiral buckle/28, bracelet/13, spiral roll/11, belt hook/3, tutului/2, decoration element/1, decoration plate/1) are further divided into 40[13] types, and three weapon categories (daggers/43, spearheads/23, and maceheads/3) in eight types. Proportionally, keeping in mind that the record only considers selected finds, the spectrum of jewellery items selected for comparison is broader than that of the weapon items. This is also true for the finds from Kudachurt 14. Some types found in Kudachurt 14 lack analogies from the study area and thus are currently considered unique to the site.

The most frequently found category in the functional class of jewellery items is pins (219), objects which are used to fix outer clothing. These are mainly the toggle types NaB1 and NaB3 from the sites Tli (89), Styrfaz (59; Fig. 28) and Nuli (20) located on the southern mountain range. While the associated graves from Tli and Styrfaz date to the early Koban stages (*ca.* 1300-900 BCE), the inventories from Nuli belong to the "Final MBA mountains" horizon (2000-1400/1200 BCE). The remaining six objects from a similar period, all NaB1 or NaB3 types, were found in sites on the northern slopes (Fig. 27.1.25-28). At Kudachurt 14, 12 graves contained 21 toggle pins of NaB1 and NaB3 types in addition to 20 further objects of slightly differing shape (NaB2A-B, NaB7B-10).

In contrast, the markedly less frequent double spiral pins (NaL2B1-B3) are represented by 13 finds from the norther slope of the mountain range (Bylym, Čegem, Kumbulta/Verchnjaja-Rutcha/Rachta and/or Faskau). The chronological classification of these sites ranges from the MBA to the early Koban stage, with a tendency for double spiral pins of these simple forged forms to belong to the earlier periods (Motzenbäcker 1996, 83)[14]. 63 pins with double spiral heads are known from 24 graves at Kudachurt 14; their shape slightly differs from those already known in the region, but still shows the same typological attributes.

Pins with a fan head are a type specific to the MBA whose shape looks like peacock feathers (NaM1); eleven examples from sites on the northern (Bylym, Kumbulta/Verchnjaja-Rutcha/Rachta, Galiat-Faskau; Figs. 24.18, 25.2.44-45.) and one from the southern slopes (Kala) point to a northern-focused regional distribution pattern, similar to the distribution of double spiral pins. At Kudachurt 14, only two graves contained each a single example of this type (Graves 146, 174); the remaining pin types are those with quintupled-knob (NaF1, n=5; Fig. 24.20-21, 27.1), complex-T-shaped (NaQ, n=4; Fig. 23.4-5), animal (NaG1C1, n=3; Fig. 24.19), seal (NaC1var, n=2; Fig. 24.24-25), or simple looped (NaA2, n=2; Fig. 24.8) heads. Pins with drum-shaped heads (NaGvar), double-branch-knob (NaH1A), triple-branch-ripped-seal endings (NaH1C3; Fig. 24.29), and perforated necks (NaD2) occur only once in the regional record. According to Korenevskij's classification of the MBA horizon in the Central Northern Caucasus, complex-T-shaped pins are a typical attribute of the NCC, thus of the earlier MBA stage of the "Mountain Group" (1984, Fig. 13.4-5). This includes the finds from Bylym and Bezengi; at Kudachurt 14 the pin found in Grave 001 is analogous to these finds, whereas the two exemplars from Grave 182 are more complex. The other rarely found pin types all come from the northern foothill sites Bylym, Kumbulta/Verchnjaja-Rutcha/Rachta or Galiat-Faskau; the hoard find from the Almalkyaja cave near Bylym shows a compilation of these types, including unique forms such as pins with double- or triple-branched endings (Ugol'nyj Bylym, Fig. 24.18-29). Compared to the examples from this hoard, the two pins with animal,

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13 Here, the types TanA1A-2, SrB2A and SrB2C and NaL2B1-3 are combined into a single type.

14 He and other authors differentiate between several variations of spiral pins; NaLB1-3 are similar to Motzenbäcker's variations 1 through 4 of the forged pins (1996, 83). Here, these types are combined.

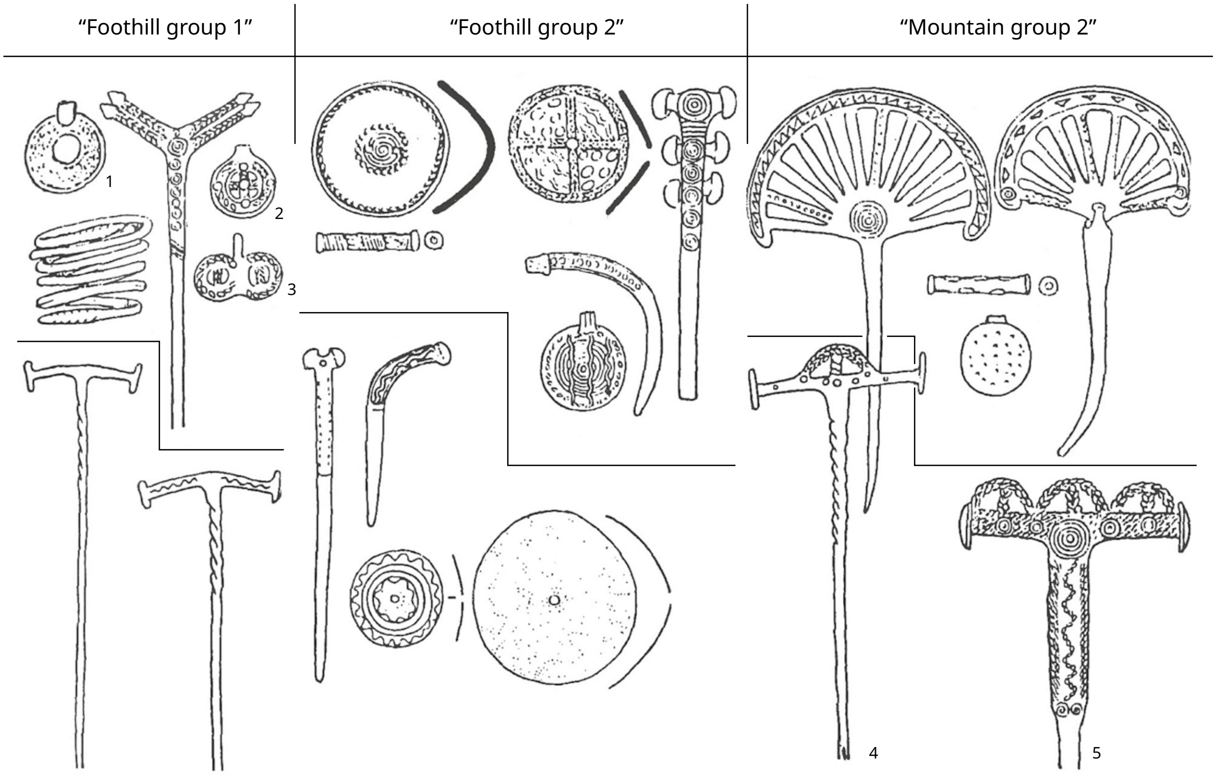

Figure 23: MBA leitmotifs from grave contexts in the Karbadino-Balkarian region (Motzenbäcker 1996, Fig. 14; after Korenevskij 1984, Fig. 25). 1-3 pendants from the site Lechinkay, 4-5 pins from Bezengi.

ram-figurine endings found in Styrfaz (Fig. 28.60-61) have a slightly different shaping, being more similar to those from the EIA Koban stages.

At Kudachurt 14, the distribution is slightly different; with 21 exemplars from 12 graves, simple looped pins are more frequent than the other rare types. This is with the exception of pins with branched endings which not only occur more frequently (NaH1A 6 exemplars/5 graves, NaH1H3 4/2), but also in more variations (NaH1C1 1/1, NaH1C4 1/1, NaH1B 2/2, NaH1C2 4/4) and are often contained in the same assemblages. They are also part of the equipment of Burial 211.3 which appears to be an important grave in terms of its inventory; it comprises further rare or unique pin types such as with an animal (with another variation NaG1G2) or a drum head. Pins with seal or quintupled-knobbed endings are finds which were each only recovered in a single grave at Kudachurt 14.

The second category with the most frequent finds, 188 objects from twelve sites, is spiral rings of different shape (SrB2A-C; Fig. 24.2.10-11.26-27, 25.21.25, 27.45-65, 28.19-20.26-27.43-45.50). Often found in the skull area, these spiral rings are also called "Lockenring" (Motzenbäcker 1996, acc.). The analogies differ slightly in wire thickness and decoration. The spatial distribution and the associated relative dating of the sites suggest these items were rather insignificant in terms of typochronology, as they spread over the southern as well as northern slopes and occur in graves of different chronological stages (Archonskaja until Tli). Despite their simple form, some analogies of the decorated type (SrB2C) do exist and are part of the Collection Kossnierska from the cemetery of Verchnjaja-Rutcha (Motzenbäcker 1996, pl. 233.8). Still, the decoration of spiral rings from Kudachurt 14 (10 objects in 4 graves) is more complex (Fig. 18.20-21). Even at Kudachurt, though, the simple version is more frequent (74/30) and the ornamented variants are always associated with simple spiral rings.

The third category is pendants; 10 types and 87 analogies from 4 sites are available. With 54 objects, the largest group are ram head-shaped pendants in two main variations (animal figurine, TanA1-2); the vast majority were found at

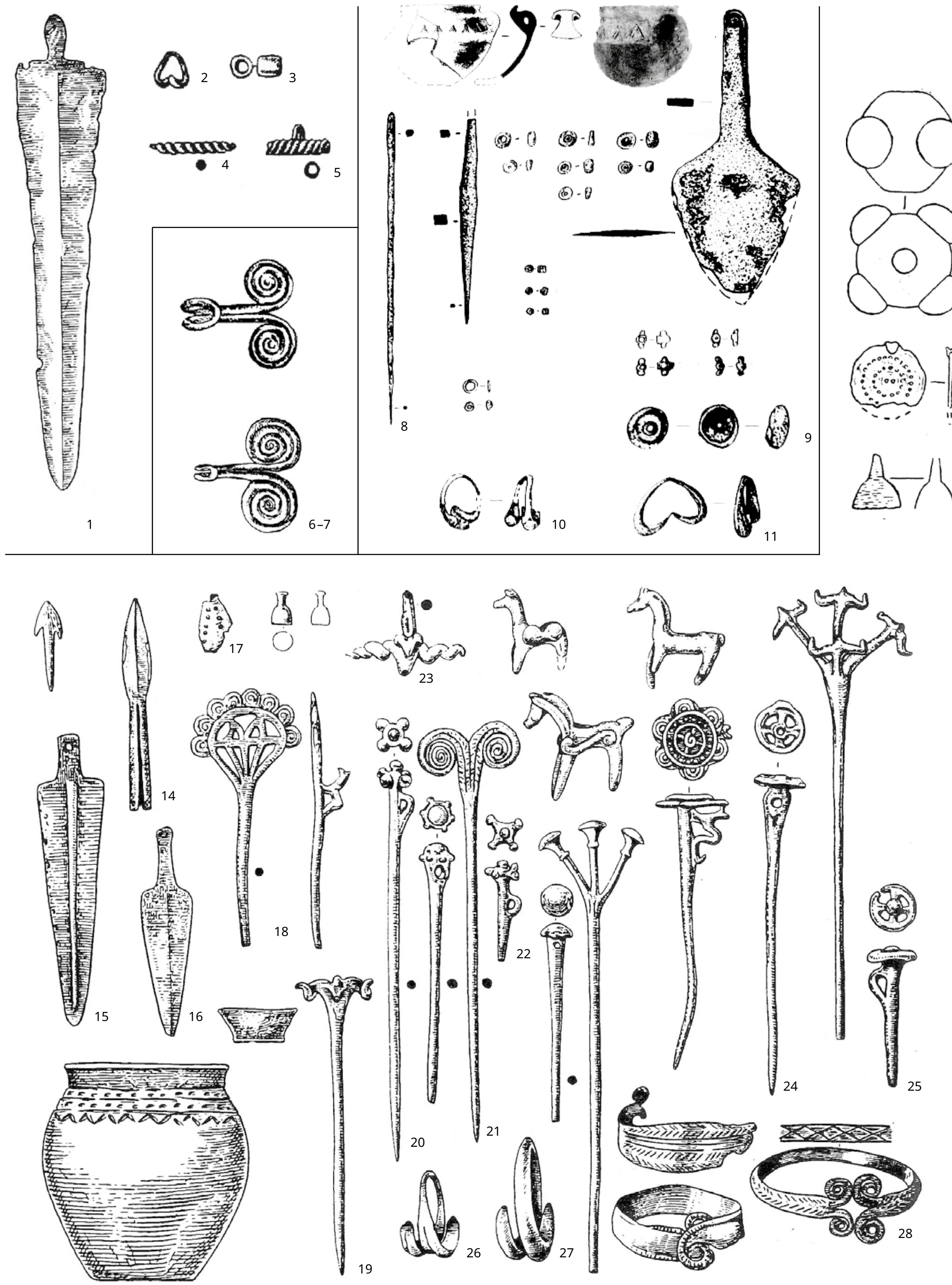

Figure 24: Selection of comparison MBA and LBA grave inventory and hoard items from the northern slope of the Northern Caucasus. 1-5: Chabaz (Reinhold 2007 pl. 270, after Kozenkova 1989,); 6-7: Zakujuvo 1 (Reinhold 2007, pl. 286), 8-11: Archonskaja 89, Kurgan 2, Grave 3 (Mimokhod 2014); 12-13: Bylym, Ajlama cemetery, Grave 2 (Motzenbäcker 1996, Fig. 92; after Batcaev 1984,); 14-28: Ugol'nyj Bylym, hoard (Motzenbäcker 1996, Fig. 15, after Kozenkova 1989). Illustrated are only selected artefacts, not complete assemblages. Without scale.

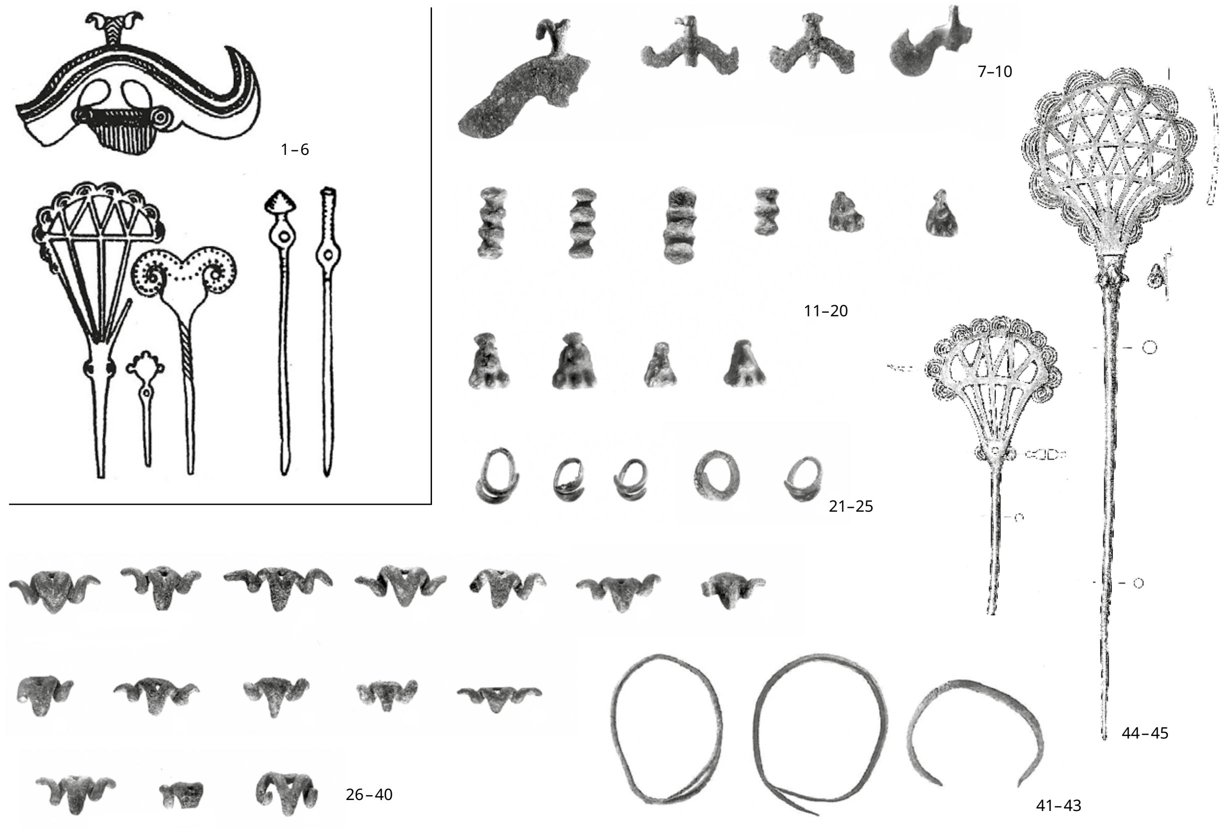

Figure 25: Selection of comparison MBA and LBA items from Galiat-Faskau. 1-6: grave findings (Reinhold 2007, Pl. 214; after Dudko 1960); 7-43: jewellery items of the collection Kossnierska (Motzenbäcker 1996, Pl. 10, 43, 45, 48-49). Illustrated are only selected artefacts, not complete assemblages. Without scale.

Kumbulta/Verchnjaja-Rutcha/Rachta and/or Galiat-Faskau[15] (Fig. 25.26-40, 17.35-44). Only the finds from Brili are from a complex situated to the south of the high mountain range (Fig. 28.22-25). At Kudachurt 14, 11 like pendants belong to the equipment of 6 graves; this also includes type TanB2, a cattle-shaped figurine.

Looking at the other, considerably more seldom encountered types, the spatial distribution at the comparison sites does not change; small animal-shaped antimony pendants (AnA2D; Fig. 25.11-20, 17.4-6), double-axe-shaped (AnAx1; Fig. 25.7.10, 27.29-33), triangular-ram-headed (AnA1; Fig. 28.17) and small-ring-shaped ones (AnB6, Fig. 27.1) were found at sites whose relative dating covers the MBA and LBA transition (2000-1400 BCE). They all seem to be regionally specific for the northern slopes; only those found at Brili point to a distribution through the mountain ranges.

From Kudachurt, 9 animal-shaped pendants from 7 graves are known; the other types are less prevalent and are often associated with AnA2D in the same grave assemblages (*e.g.* small ring AnA2D 6/1, triangular ram head AnA1 3/4, double axe AnAx1 2/2), which points to a strong chronological relation between these types. In general, the spectrum of pendants is broad in terms of both typological variation (double-ram-headed pendant AnA2) as well as unique forms (*e.g.* drop-shaped pendants AnA4D). The larger pendants, roundish discs with central hole (large ring, AnGa1) or decorated with crossed bars (large ring cross, AnGA2) are unique findings from Lechinkay (Fig. 23.1-2); according to Korenevskij, these types are elements of the later MBA stage in the "Foothill Group" of the Northern Caucasus (1984; Motzenbäcker 1996, 38-39). At Kudachurt 14, only Graves 147, 182 (large ring) and 211.3 (large ring cross) contained such types.

15 The object from Bylym (Fig. 14.23). is different to those found at Kudachurt 14.

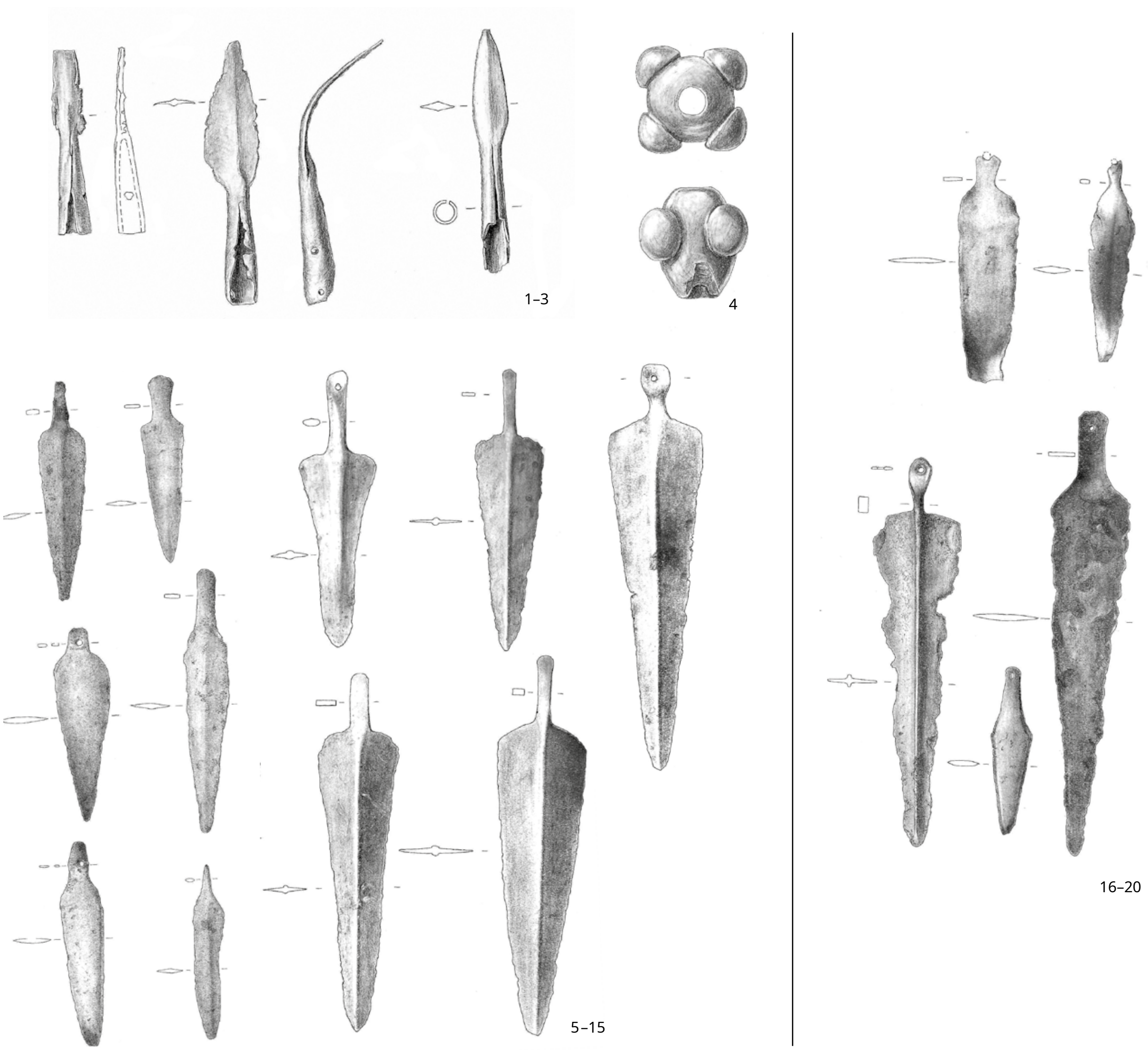

Figure 26: Selection of comparison MBA and LBA items from the northern slope of the North Caucasus. Items of weaponry of the Collection Kossnierska. 1-15: Verchnjaja Rutcha (Motzenbäcker 1996, pl. 18-12, 23; 4 location unknown, Kumbulta or Faskau); 16-20: Galiat-Faskau (Motzenbäcker 1996, pl. 6). Illustrated are only selected artefacts, not complete assemblages. Without scale.

The remaining categories of the jewellery items are spiral buckles (28), bracelets (13), spiral rolls (11), belt hooks (3), tutuli (2), a decoration element (1), and one decoration plate (1). The majority of analogous spiral buckles were found in graves of the cemeteries Styrfaz and Tli (22; Fig, 28.24); the other site south of the high mountain ridge is Gari. Only six analogies come from northern sites (Fig. 24.6.-7). Regarding chronological classification, the spiral buckles from these sites seem to be elements of the later periods whereas those two found in Verchnjaja-Ruchta and Galiat-Faskau represent MBA stages. In comparison, sprial buckles are much more common at Kudachurt 14: 17 graves contained 32 exemplars. The shape of these examples differs slightly from the analogies in size and complexity.

The three bracelet types seem to be specific for each of the sites respectively. One broader wristband with engravings and double spiral ends (ArD2) is known from the hoard from Bylym (MBA, Fig. 24.28). Both bracelets types with simple (ArC) and single spiral endings (ArA4A) are from Galiat-Faskau (MBA; Fig. 25.41-43) and Styrfaz (KoA; Fig. 28.75-78); hence, regional occurrence and chronological differences seem to matter for bracelet types. However, the presence of both ArA4A and ArD2 in Grave 149.2 at Kudachurt 14 disproves this consideration. In addition, 34 further

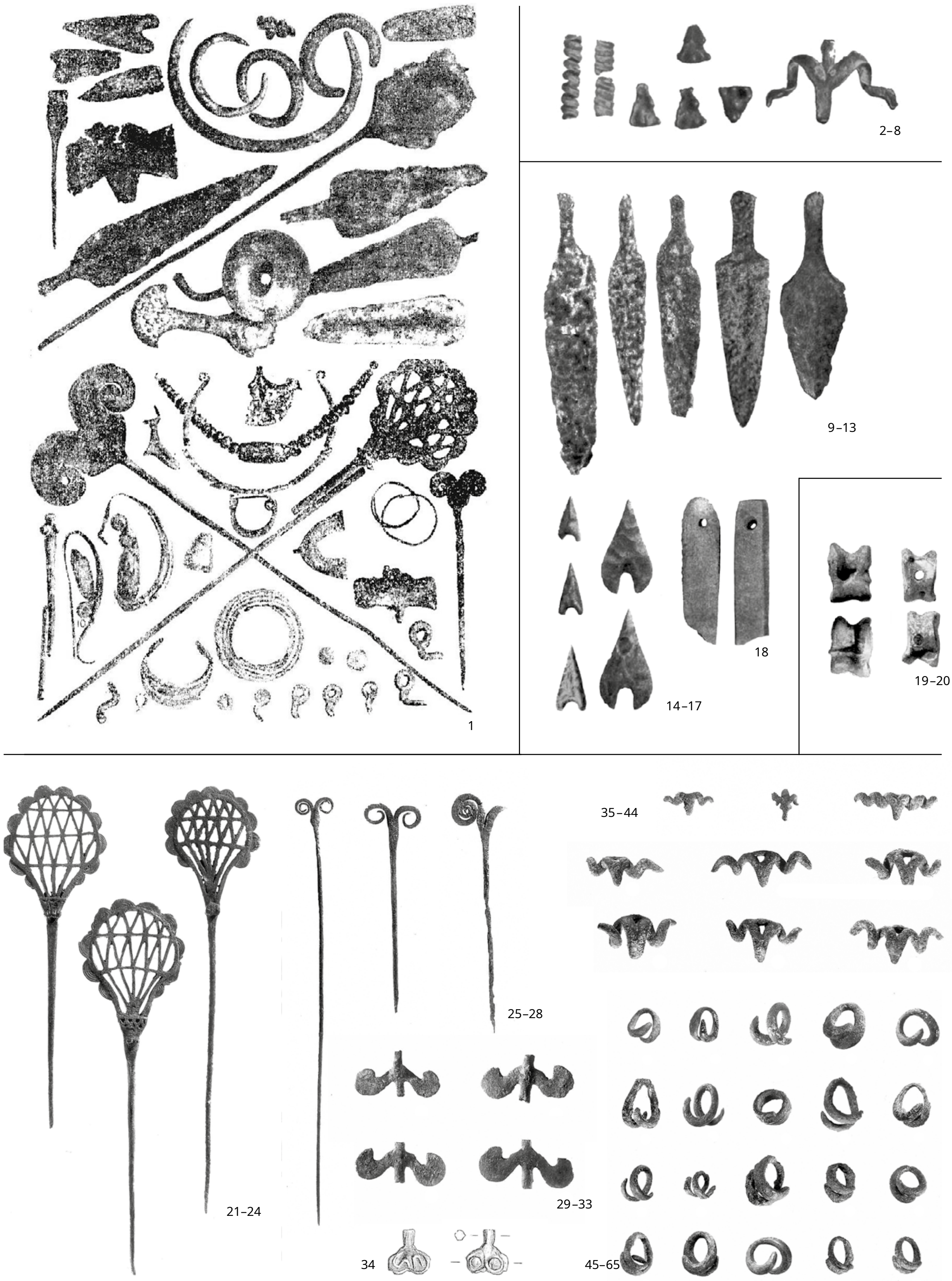

Figure 27: Selection of comparison MBA and LBA grave inventory items from the northern slope of the Northern Caucasus, sites Kumbulte and Verchnjaja-Rutcha. 1: items from Grave 1889/6 (Reinhold 2007 pl. 216, after Alekseeva 1959); 2-8: Grave 1/1937; 9-18: Grave 10/1937; 19-20: Grave 17/1937 (Reinhold 2007, pl. 217-219, after Kurpnov 1951); 21-65: jewellery items from the Collection Kossnierska (Motzenbäcker 1996, pl. 51, 60, 64-65, 79). Illustrated are only selected artefacts, not complete assemblages. Without scale.

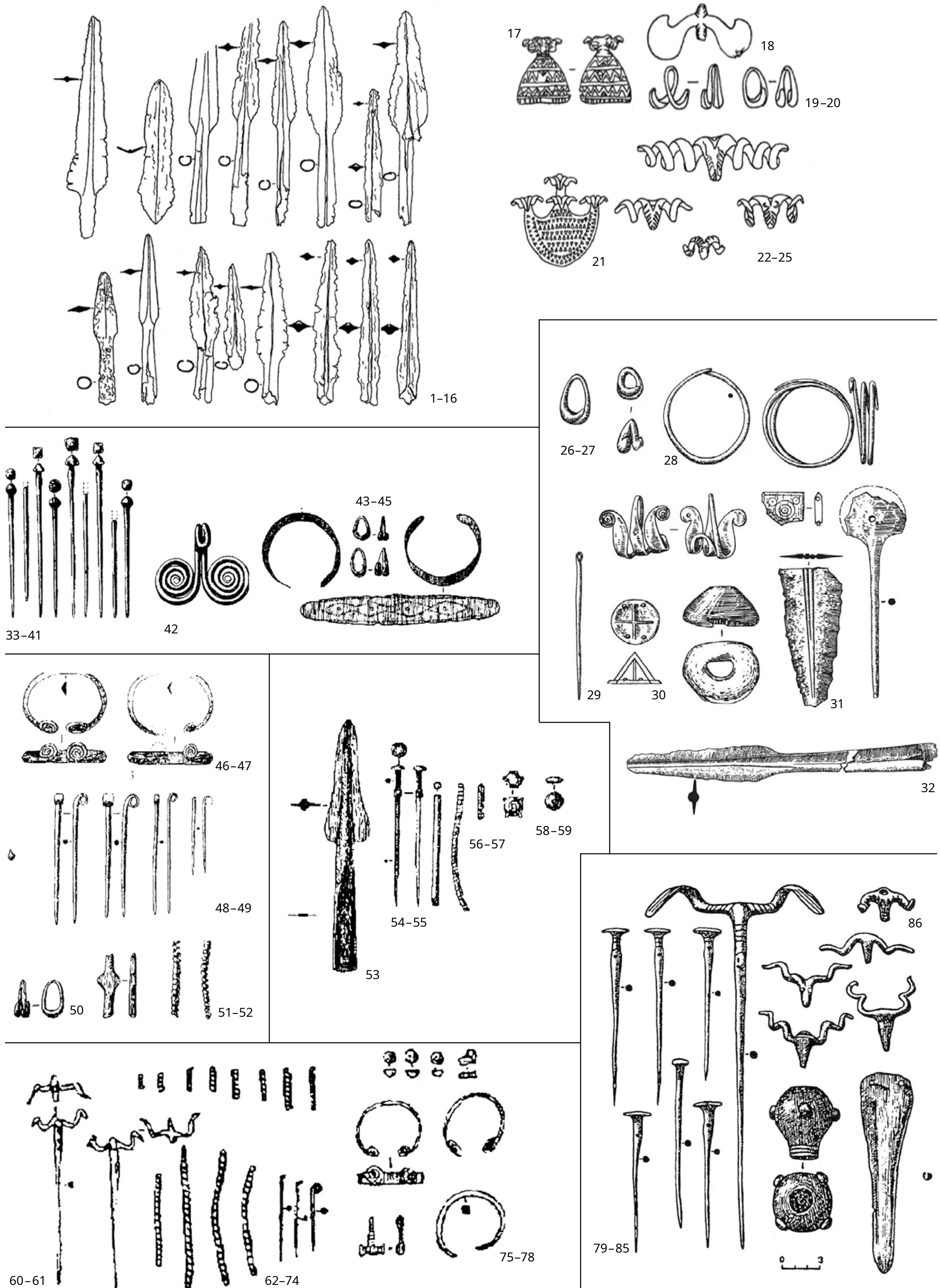

Figure 28: Selection of comparison MBA and LBA grave inventory items from the northern and southern slope of the North Caucasian mountain range. 1-25: Brili (after Pancchava et al. 2001), 26-32: Égikal (Reinhold 2011, pl. 262.6-20, after Markovin 1994b, Fig. 104); 33-78 Styrfaz, 33-45: Cromlech 5, Grave 1, 46-52: Cromlech 9, Grave 2, 53-59: Cromlech 11, Grave 10, 60-78: Cromlech 10, Grave 11 (Reinhold 2007, pl. 179-190, after Techov 2000,); 79-86 Tli, Grave 56 (after Motzenbäcker 1996, Fig. 16). Illustrated are only selected artefacts, not complete assemblages. Without scale.

bracelets of type ArA4A were found in 14 graves and 12 exemplars of ArD2 in 6 graves; thus, these types are in general more frequent in Kudachurt 14 compared to the studied sites. Bracelets with simple ends occur in 5 graves (7 exemplars). Type ArA4B with double-spiral endings is a unique typological variation at Kudachurt which appears in 8 graves.

Spiral rolls or "Schläfenringe"[16] have been found at three sites from the northern foothill area (Chabaz, Verchnjaja Rutcha, Bylym; Fig. 24.4-5, 17.2-3) and at two southern locations (Styrfaz, Tli; Fig. 28.51-52.56-57.62-74); chronologically MBA as well as early Koban graves are represented here. In terms of regional differences, this category seems to play a crucial role. At Kudachurt 14, 36 grave inventories include *ca.* 249[17] exemplars of spiral rolls of different shape and length. They thus occur quite frequently.

The two analogies recorded for belt hook types – one leaf-shaped (or: axe-shaped) with animal decoration (GhF2var; Galiat-Faskau and Brili, Fig. 28.21) and one like a large double spiral buckle (GhK1, Lechinkay, Fig. 23.3) – do not exactly match with the types from Kudachurt 14 (Graves 088, 147, 211.3) but are still very similar. Both are MBA types found at sites on the northern as well as southern slopes. At Kudachurt 14, they are also very rare.

Fragments of a decorated bronze sheet tutulus (ZkA1C) are known from the Bylym hoard; another tutulus type made of antimony and with sharp edges was found in Égikal (Fig. 24.17). Both types are elements of MBA grave inventories and are very rare in the regional record. This contrasts with the situation at Kudachurt 14, especially with respect to bronze sheet tutuli; of the decorated version, 45 objects from 12 graves are known (plain version 17/10). In terms of the antimony tutuli, the equipment seems to be specific for three graves, which together contain 49 such finds (Graves 24.2, 147, and 211.3) distinguishing themselves in shape and location of the fixation holes from other regional examples (Fig. 19.80-81).

The two remaining recorded analogies, a button from Archonsjaka (ZeA1; Fig. 24.9) and a decoration plate (ZbA) from Grave 2, Bylym (Fig. 24.13), are also from MBA complexes. Similar buttons are part of the funeral equipment of four graves (072, 174, 182) wherein 12 of 20 examples come from the same grave (211.3).

In terms of weaponry items, 69 analogies for three categories (dagger, spearheads, maceheads) from eight sites have been recorded. With 43 examples from six sites, daggers (DoA0/11, DoA1A/27, DoA1C/5, further separated by shape of the rivet) are the most frequent analogies, followed by 23 spearheads (LzC1-2) from three sites. Only three objects from two sites represent macehead types (KkA, KkC). Most of the tanged dagger types with flat or ripped blade and with or without rivet perforation (DoA0-A3G) are elements of the Kossnierska Collection and were found at the cemetery Verchnjaja Ruchta and Galiat-Faskau (Fig. 26.5-20, 17.1.9-13). In addition, different spearheads and two of the macehead analogies, one of unique roundish shape, have been found at Verchnjaja Rutchta (Fig. 26.1-4, 17.1). Dagger type DoA1A also occurs in grave inventories from Chabaz, Brili (Fig. 24.1, 18.1), Tli, and Čegem (unclarified context); thus, it seems to be regionally and chronologically less specific compared to the prevalence of DoA0 and DoA1C which are associated with the MBA. This also applies to the spearhead types. In the case of spearheads, the site Brili, located in the southern high mountain range, revealed 14 exemplars of different types (Fig. 28.1-16). The macehead types are found in MBA complexes.

Regarding the distribution of weapon analogies at Kudachurt 14, the different types of the three categories do not show clear tendencies as they are often associated with each other in the same grave assemblages. Although the three different dagger

16 Spiral rolls have been associated to different usages, *e.g.* as decorative hair element, components for necklaces.

17 As these objects are quite fragile, the total count turned out to be problematic; this issue is addressed in chapter 4.

types do not occur in the same graves (DoA0 3 exemplars from 3 graves, DoA1A 6/5, DoA1C 4/3), the distribution of spearhead types seems to be less specific (LzC1, 19/10, LzC2 5/3). Being only associated with one dagger (DoA1C) and both spearhead types, the five maceheads (2 exemplars KkA in 2 graves, KkC 3/1; decorated version KKB 1/1) are also not significant in this context as too few were recovered. Still, the weapon analogies allow regional links to the comparison sites to be established.

In order to illustrate spatial differences in terms of type and analogies, Figures 29-32 show distribution mappings for each functional class including the relevant values for Kudachurt 14[18]. The type variability is represented by the plotting of the total number of types found at one site; the numerical ratios consider the total number of analogies from all sites (553 for jewellery and 69 for weaponry items).

For jewellery items the most important comparison sites are Bylym (7), Kumbulta/Verchnjaja-Rutcha/Rachta (10) and Galiat-Faskau (11). The total numbers as well as the spectra of types, which includes very rare pins with branched endings (NaH1A, NaH1C3), drum, seal or animal heads (NaGvar, NaG1C1, NaC1var), show a strong typological similarity to Kudachurt 14. The finds of site Brili (14) are also worth mentioning as, although the total number of analogies are low, it contains analogies of rare type (belt hook GhF2var, triangular-ram-shaped pendant AnA1) and is located in the southern high mountain range. This is in contrast to the cemeteries Tli and Styrfaz, where typologically as well as spatially less specific types (spiral rings, toggle pins) make the majority of the found analogies. The only exception is the bracelets with simple spiral endings (ArA4A).

About the distribution of weaponry items, the picture is similar but the regional and chronological tendencies are less clear given the significantly fewer types and analogies. The higher value in type variability for Kumbulta/Verchnjaja-Rutcha/Rachta (10) is based on the dagger type DoA0 and both macehead types. The other weapon types seem to be regionally as well as chronologically less significant.

Interim results

Taking the selective character of the approach as well as the state of research – which demands revision – into account, the grave inventories from Kudachurt 14 offer a unique compilation of jewellery finds. No other site revealed comparable amounts of the same object types; of course for each site, especially for the large cemeteries Tli and Styrfaz and those findings stored in the different collections, the inclusion of the full grave assemblages that were not considered in this study would result in much higher spectra of variation. Based on a relative sorting of the cultural material, the artefact forms present at Kudachurt 14 belong to different chronological classifications of the MBA and LBA period, in Tli and Styrfaz also touching the transition to the EIA. The conducted typo-chronological considerations suggest a timeframe from 2200-1200 BCE for at least 56 graves. This needs to be supplemented by examination of the pottery types and the synchronization of graves lacking jewellery items.

According to Motzenbäcker's relative chronological scheme for the form spectrum of the Collection Kossnierska (Fig. 23), which is the current system used in research, leitmotifs are specific weaponry and jewellery items, such as double spiral and fan heads, animal pendants, spiral buckles, and some dagger types. With a timeframe spanning from 2200-1200 BCE, his classification seems to be too widely stretched, as some types in different parts of the schemata are directly associated with each other in the same graves at Kudachurt 14. Still, the regional and chronological distribution of some types suggest long-term traditions (spiral rolls, spiral rings, spiral buckles). In Motzenbäcker's, Reinhold's and other chronological classifications the shape of bronze axes play an important role. Bronze axes were found in no graves in Kudachurt 14.

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18 *I.e.* only considering the types and items for which analogies were found: 40/658 jewellery objects and 6/42 weaponry item.

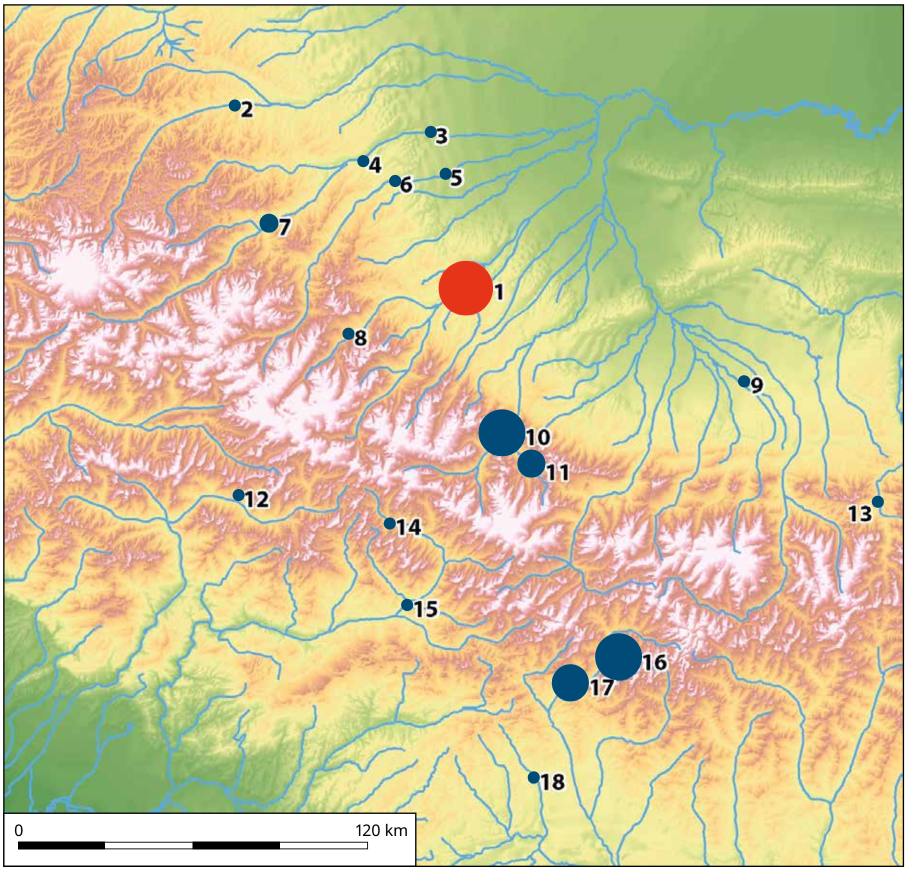

Figure 29: MBA and LBA comparison sites in the Central Northern Caucasus. Mapping of the number of mutual jewellery analogies (n analogies=533, n Kudachurt=697).

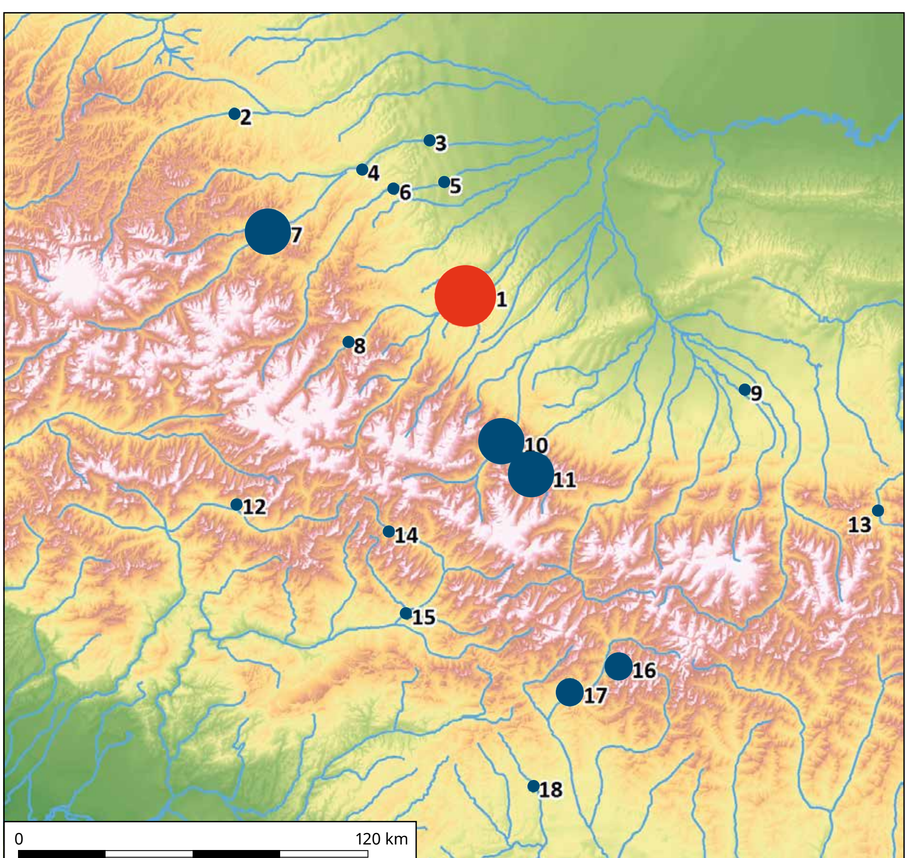

Figure 30: MBA and LBA comparison sites in the Central Northern Caucasus. Mapping of the number of mutual jewellery types (n=39).

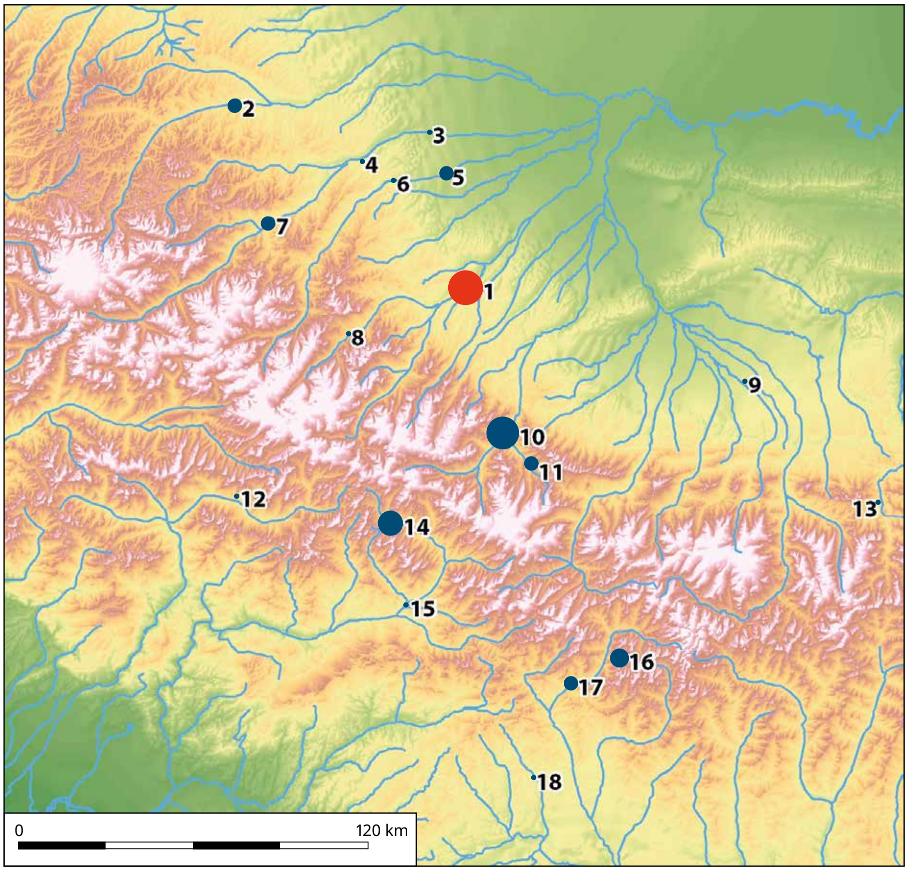

Figure 31: MBA and LBA comparison sites in the Central Northern Caucasus. Mapping of the number of mutual weapon analogies (n analogies=69, n Kudachurt=42).

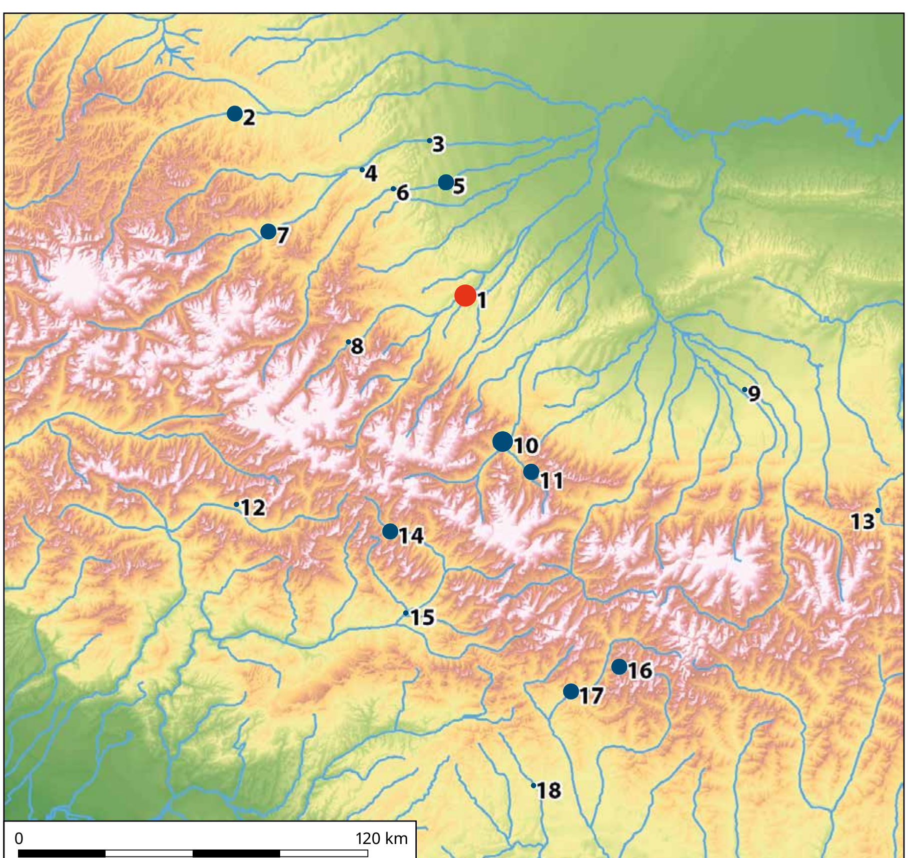

Figure 32: MBA and LBA comparison sites in the Central Northern Caucasus. Mapping of the number of mutual weapon types (n=8).

During the examination, certain graves of Kudachurt 14 gained importance as they were repeatedly mentioned in the typological comparison. On one hand, this is caused by their large number of funeral items which offer more possibilities for comparison (for instance Grave 147, 211.3, 182, 146 or 072). On the other hand, only a few of these grave inventories seem to be also outstanding in their compilation of rare types, especially of jewellery items. This applies to Grave 211.3 and Grave 147 which contain both the most variety of jewellery items and unique types. In addition, Grave 001 revealed a very rare pin type (NaQ) as its sole jewellery item.

3.4.2 Radiocarbon dating and stratigraphy

In the following subchapter the examination of typologically independent information aims for an absolute dating of Kudachurt 14. Therefore, the analysis considers radiocarbon dates from 15 graves and the stratigraphic structures.

3.4.2 1 Radiocarbon dating

Animal collagen from 15 graves was analysed using the radiocarbon dating method. In the scope of this thesis, the description of this complex method is skimped based on the publications of Ramsey *et al.* (2006) and Wood (2015); for detailed methodological information it is referred to related literature (*e.g.* Taylor *et al.* 1992; Taylor and Bar-Yosef 2014; Bronk Ramsey 2008; Bayliss 2009). Simply put, this method is based on the radioactive decay of the carbon isotope ^{14}C. At the time of an organism's death, its ^{14}C content reflects the amount of ^{14}C in the atmosphere. The amount of atmospheric ^{14}C has been quite stable over the last millennia and was primarily produced by cosmic rays. After the death of an organism, the ^{14}C it contains begins to decay (half-life 5730 +/- 40 years). It is, therefore, possible to determine the time that has passed since an organism's death by measuring the amount of ^{14}C present in an archaeological sample and comparing it to the original atmospheric ^{14}C levels. The outcome is the ^{14}C age described by a calendar date before present (BP) and its standard deviation. As the atmospheric ^{14}C content vary over time and space to a certain extent these dates are not exact and require calibration within known distributions of ^{14}C through time, based on different calibration curves established during the last decades of research. By incorporating statistical approaches, the verified values reflect a calibrated range of years for which the ^{14}C age is most suitable depending on the density of probability (cal BCE, sigma ranges). Programs such as OxCal (Bronk Ramsey 2013) facilitate such calibrations. To interpret the results the sample organism has to be put into its environmental an economic context; reservoirs of stored ^{14}C older that the atmosphere can alter the determined age, for instance organisms of marine or freshwater habitats are depleted in ^{14}C. This is crucial when considering food resource exploitations and deviating ^{14}C dates of humans, flora and/or fauna from the same archaeological context (cf. Fernandes 2013; Keaveney and Reimer 2012; Olsen *et al.* 2010; Shishlina *et al.* 2009).

In order to capture a broad variety within a small data set of 15 samples the selected burials represent graves of different funeral traditions (burial types, equipment). Without the intention to anticipate the chapter dealing with the heterogeneity of the funeral record it is necessary to critically question origin and thus the significance of the samples collected.

As an object for chronological analyses graves represent rather single or short-term events of human activity ("closed find"), *e.g.* compared to settlements with a continuous habitation. Therefore, ^{14}C-dates of burials set up a period out of single events, still reflecting a potentially continuous use of a cemetery. Nevertheless, the burial type as well as the burial habit plays a decisive role in terms of chronological significance, *e.g.* when thinking of large collective graves such as megaliths, as some of them were built as last resting places used during several hundred years (*e.g.* Scandinavian Neolithic megaliths, cf. Persson and Sjögren 2013; Persson and Sjögren 2013). Consequently, a single radiocarbon date from a collective grave it is a random sample within a potentially longer life circle of a burial. To gain knowledge about the actual timeframe of the usage of the burial an extensive sample is required.

In the case of Kudachurt 14 the sample burial types differ from single (5) to collective burials (9, 1 is of unknown type). Consequently, the sample burials represent contexts of different chronological significance. For the collective graves a measured ^{14}C-date is associated to a single event, the funeral of one individual (or several individuals simultaneously), in this case determined by the deposition of meat or an animal.

By combining radiocarbon dates of 15 graves the applied approach aims to determine the absolute temporal assignment of Kudachurt 14 within the North Caucasian Bronze Age. As discussed in the preceding subchapter the transition period from the Middle to the Late Bronze Age is of special interest in terms of social and economic transformation in this region. The cultural material of Kudachurt 14 suggests an affiliation to associated typological styles and so do elements of the grave construction. A control sample of 15 out of 130 available graves may seem small but still delivers appropriate information to verify the general chronological classification of the cemetery in this respect. Therefore, aspects of chronological significance as described above are less crucial; according to current standards it is not of interest how long a collective burial has been but rather if it has been used during the relevant timeframe.

The sample for radiocarbon dating focuses on typo-chronological[19] and osteological or palaeopathological[20] considerations. The data set consists of samples taken from 15 burial contexts (047, 050, 076, 135, 149.1/2, 174, 177, 178, 182, 185, 186, 211.3, 218.1, 218.2, see Tab. 7 and Fig. 33). Twelve samples were funded by DFG projects RE2688/1-2 and RE2688/2-2, which were carried out by the Eurasian Department of the German Archaeological Institute (PD Dr. S. Reinhold, Prof. Dr. S. Hansen)[21]. Kudachurt 14 was a relevant comparison site for these projects. The costs for the remaining three measurements were covered by the author's funding provided by GSC 208.

Sample material is bones or teeth of small terrestrial herbivores, omnivores and carnivores as remains of meat or animals as funeral gifts *e.g.* tooth pendant of a boar[22]. The measured dates consequently reflect the time of death of the animal and not the time of its deposition. Nevertheless, the temporal discrepancy between these two "events" can be neglected when we assume that meat was not stored over a longer period or the animal did not die long time ahead. Falsification can be possible when a funeral gift had a long life cycle which is impossible to detect. By sampling animals instead of humans the risk of dating falsification due to dietary radiocarbon reservoir effect could be avoided (cf. Fernandes 2013).

The major part of the sample material was sent to the Curt-Engelhorn-Center Archeometry GmbH (CEZ) in Mannheim, Germany. One was passed to the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. Sample pre-treatment and collagen extraction was carried out by the laboratories following their preferred protocols[23]. Quality requirement of the material was at least 1 % collagen yield of the

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19 Selected by S. Reinhold, DFG projects RE2688/1-2 and RE2688/2-2.

20 Selected by the author.

21 These data will soon be published in: S. Reinhold, A.B. Belinskij, B. Atabiev, The Late Bronze Age in the North Caucasus high mountain zone and beyond. In: M. T. Kašuba/S. Reinhold/Ju. Ju. Pitrovskij, eds., Der Kaukasus zwischen Osteuropa und Vorderem Orient in der Bronze- und Eisenzeit: Dialog der Kulturen, Kultur des Dialoges. Archäologie in Iran und Turan 18 (in press) 405-455.

22 For Graves 047, 050 and 076, samples from the same bone were also used for the stable isotope analyses (see chapter 6).

23 Extraction was conducted via sample ultrafiltration.

Lab nr	Sample code	Grave	Burial type	14C age ± SD	1sig. cal BCE	2sig. cal BCE	C:N	C [%]	Coll [%]
23065	MAMS-23065	182	coll S	3714 ±24	2189-2040	2199-2031	3.1	36.5	2.6
28924	Hd-28924	211.3	single	3653 ±14	2113-1978	2125-1958			
23064	MAMS-23064	177	single	3572 ±27	1946-1891	2018-1828	3.1	40.2	4.7
110561	MAMS-110561	218.2	coll M	3554 ±23	1940-1882	1971-1777			
110561	MAMS-110560	218.1	coll S	3548 ±23	1937-1834	1953-1776			
110562	MAMS-110562	186	coll M	3542 ±27	1928-1784	1946-1775			
23068	MAMS-23068	135	n. d.	3539 ±24	1926-1782	1946-1772	3.1	35.2	8.0
23063	MAMS-23063	174	single	3526 ±24	1907-1776	1938-1757	3.1	36.9	3.4
24082	3-KUD14gshdl	076	coll S	3526 ±25	1905-1777	1932-1768	3.0	35.2	7.4
23067	MAMS-23067	185	single	3508 ±24	1884-1775	1899-1751	3.0	29.3	5.0
23066	MAMS-23066	178	coll S	3501 ±24	1881-1775	1891-1750	3.1	40.6	5.4
23070	MAMS-23070	219	double+	3497 ±26	1881-1772	1892-1746	3.1	40.2	2.4
24080	1-KUD14gshdl	047	coll L	3456 ±25	1871-1697	1879-1692	3.1	33.7	2.1
24081	2-KUD14gshdl	050	single	3456 ±25	1871-1697	1879-1692	3.0	28.6	4.3
23069	MAMS-23069	149.1/2	coll S	3424±23	1746-1691	1870-1658	3.1	40.0	7.3

Table 7: Radiocarbon dating of Bronze Age graves from the cemetery Kudachurt 14, ^{14}C age with standard deviation and calibrated dating with 68.2 % and 95.4 % probability (1sig- and 2sig-range). Coll S/M/L indicates collective graves of different size (for detailed information about the burial type chapter 4). Sample order is in decreasing age. C:N ratio, collagen (coll %) and carbon yield (C%) refers to the fraction during ultrafiltration. Not listed is the $\delta^{13}C$ value, which was used to correct the fractionation effect. Samples coded "Kud14gshdl" were funded by the GSC 208 (DFG). The remaining ones were funded and provided by the DFG projects RE2688/1-2 and RE2688/2-2.

initial sample quantity. All collagen samples were freeze-dried, burned, the CO_2 graphitized and subsequently measured by using a AMS system type MICADAS of the Klaus-Tschira-Archeometry-Center in Heidelberg (Kromer *et al.* 2013). The quality control of the sample material was performed by providing collagen as well as carbon yield and C:N ratios (cf. van Klinken 1999).

The ^{14}C age-outcome (conventional date in calendar years, BP) were calibrated using the program OxCal 4.2 (Bronk Ramsey 2013) which applies the IntCal13 calibration curve (Reimer 2013). Table 7 summarises the results consisting of the uncalibrated ^{14}C age in calendar years BP[24] and related standard deviation, calibrated data BCE within the 1 sigma (1sigma-range) and 2 sigma (2sigma-range) likelihood ranges[25] as well as quality criteria values. Indicators of bone collagen quality show appropriate values for all samples and thus ensure reliable results of the measured dates.

Looking on the single dates grave 182 (2199-2031 cal BCE) and grave 149.1/2 (1870-1658 cal BCE, both 2sigma-range) mark the oldest and the youngest key data for Kudachurt 14. A summarised calibration shows a temporal distribution of dates within the calibrated timeframe (2sigma-range, Fig. 34). The results show a high data density probability between 1940-1680 cal BCE, whereas early dates are less probable, represented by two outliers (grave 182 and 211.3). Thus the radiocarbon

24 Before present, meaning before 1950.

25 These represent the statistical likelihood for the time span in which 68.2% (1-sigma range) and 95.4% (2-sigma range) of the tested events took place.

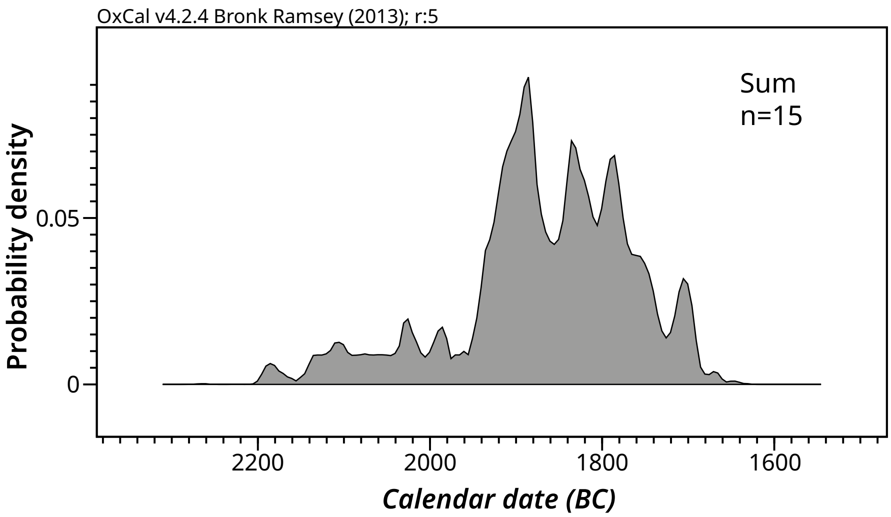

Figure 33: Radiocarbon dating of the Bronze Age graves from the cemetery Kudachurt 14. Sum calibration of all 15 samples.

dates capture the transition from the late 3rd to the early middle 2nd mil BC but the major part dates into the 2nd mil BCE.

In order to set up a more accurate life span for the cemetery of Kudachurt 14 based on the measured ^{14}C dates, available supplemental information was included in a model by using supplemental features of the program OxCal (Tab. 8, Fig. 34). As we assume that the cemetery is a site emerged from funeral events within a certain time span, the dates were enclosed in in a sequence and a boundary command, figuring out start and end in time-scale ranges of the cemetery based on available dating results. By means of using the "span" command the program calculated the probable lifetime of the cemetery in years. Stratigraphic structures, which can be interpreted as temporal distinctions between graves were considered in order to gain a higher resolution of the chronological sequence. Although the spatial distribution displays overlapping as well as intersecting grave pit structures only two of the tested burials show reliable stratigraphic separation[26] (see Fig. 36). Grave 218.1 and 218.2 represent a burial complex with two layers, meaning two burials in one pit and a clear distinction between them, consequently a younger and an older one. This is considered as a single sequence[27] separated by a boundary giving information about the potential time passed between the two funeral periods (Seq_R_Date 218-1, Seq_R_Date 218-2, boundary gap).

Table 8 gives an overview about the modelling results in absolute figures including calculated probability of the starting and ending of the cemetery (boundaries), the period of use (span: timeframe) and the sequence separation of grave 218.1 and 218.2. Calibrated dates are given in raw as well as modelled values. In order to visualise probability distributions of each dating on the time axes, single intervals are plotted against the calibration curve (Fig. 34) as well as on a multiplot (Fig. 35). The single plots combine both data, the intervals of unmodelled calibration in light grey and the modelled ones in dark grey. With respect to the raw values, the modelling procedure resulted into a reduction of the temporal parameters as the time span is shortened by almost 100 years, which is displayed in the few probability of the older dates (grave 182). This is less obvious for the youngest dates with a difference of only a few years. In general, the time range diminishes by cutting off the extreme distribution values that is clearly visible by the single plots on both curve and multiplot. Those graves dating between cal BCE 1964-1692 remain almost

26 Temporal differences of significant overlapping structures visible on the site plan, *e.g.* Graves 178 and 185, were not confirmed by an extensive review (via excavation pictures).

27 OxCal command: sequence.

Name	Unmodelled cal BCE	Modelled cal BCE	A index
Boundary: start cemetery		***2152-1978***	
R_Date 182	2199-2031	2101-1955	72.7
R_Date 211.3	2125-1958	2044-1951	103.5
R_Date 177	2018-1828	2016-1828	100.7
Seq_R_Date 218-2	1971-1777	2011-1877	99.5
Boundary gap		*1948-1791*	
Seq_R_Date 218-1	1953-1776	1922-1771	68.5
R_Date 186	1946-1775	1946-1776	100.2
R_Date 135	1946-1772	1946-1773	100.4
R_Date 174	1938-1757	1941-1762	100.5
R_Date 76	1932-1768	1929-1770	99.8
R_Date 185	1899-1751	1900-1755	100.4
R_Date 178	1891-1750	1892-1754	100.9
R_Date 219	1892-1746	1891-1751	101.5
R_Date 47	1879-1692	1881-1701	96.9
R_Date 50	1879-1692	1881-1701	97.0
R_Date 149	1870-1658	1876-1689	66.8
Boundary: end cemetery		***1823-1653***	
Span: timeframe		**162-388 years**	

Table 8: Radiocarbon dating of Bronze Age graves from the cemetery Kudachurt 14, unmodelled and modelled calibrated dates (sig2-range). "A index" is the individual agreement index of the modelled dates compared to the unmodelled ones. The model as well as the overall agreement index of the modelled dates is 76.2 % and 76.3 %, which confirms its statistical significance.

unchanged (see individual agreement index, Tab. 8). This is also true for grave 177. On basis of this modelling the initial and ending period of the cemetery is between 2152-1978 cal BCE and 1823-1653 cal BCE with a life span of 162-388 years.

Based on the modelled values, there is little chronological patterning within the data set. The dating of grave 182 and 211.3 show a chronological agreement with 182, which is the older one. The largest deviation is between 211.3 and 177. The later dating graves followed by 218.1, 218.2, 186, 135, 174 and 076 show even distribution along the calibration curve with very little offsets. The intervals of 174 and 076 are more influenced by the plateau between 1900-1780 BCE, which is also responsible for the wider distributions of the younger graves 219, 178 and 185. The analyses of grave 047 and 050 resulted into total contemporary values which are slightly younger. This also applies for the dating of grave 149 which shows a more probable dating in the younger range.

The ^{14}C age of the two burials of grave complex 218 had a difference of eight years. After calibration the younger probability range of the upper burial is a little higher and starts *ca.* 20 years later. The modelling shifted this small offset into unclear intervals, as 218.1 show three peaks; consequently, the chronological distinction (boundary gap 1948-1791 cal BCE), meaning the time passed between the two burial events is not very significant.

Having a look on the site plan with the modelled ^{14}C dates visualised there is no spatial distribution in terms of chronological determination; this is easy to recognise as the earliest and latest graves are located next to each other (Fig. 36). Of course, the control sample of 15 graves is small with regard to this question.

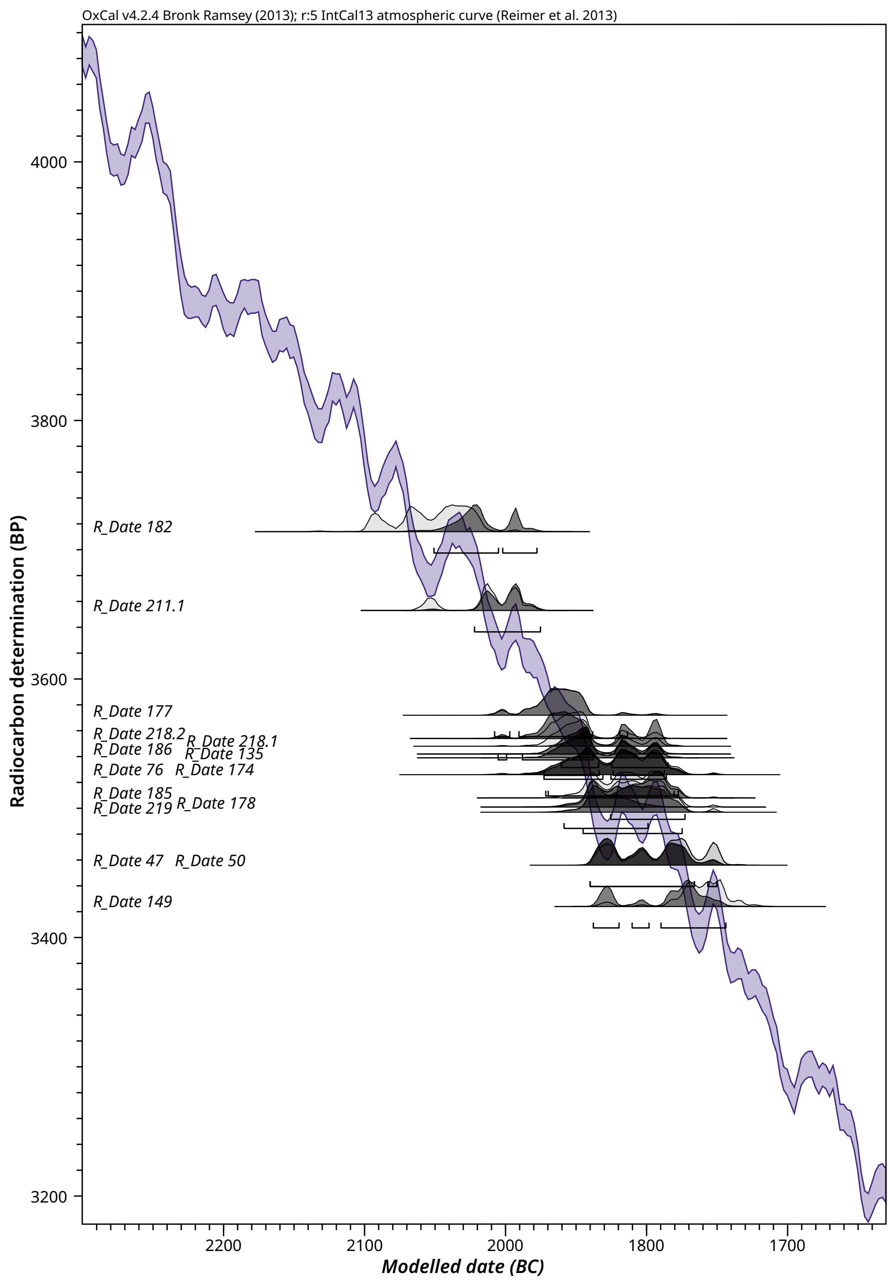

Figure 34: Radiocarbon dating of the Bronze Age graves from the cemetery Kudachurt 14. Modelled (dark grey) and unmodelled (light grey) distribution intervals of the analysed graves plotted against the calibration curve (IntCal13). Data referring to Table 8.

Coming back to the critical considerations in terms of dating collective graves, it should be noted that there is no tendency in terms of chronological distinction within the different burial types.

In conclusion the radiocarbon dating of a sample of 15 graves can be summarised as follows:

- The earliest date was measured for grave 182 with 3714 ±24 BP and 2199-2031 cal BCE, the latest for grave 149 with 3424±23 BP and 1870-1658 cal BCE.
- The sum calibration resulted in a high data density probability between 1940-1680 cal BCE.
- The graves date in a modelled time range of 2152-1978 cal BCE and 1823-1653 cal BCE with a calculated life span of 162-388 years.
- There is little chronological pattern within the data set. Grave 182 and 211.3 date into the turn of the 3rd to the 2nd mil BCE. The other graves are younger. Their

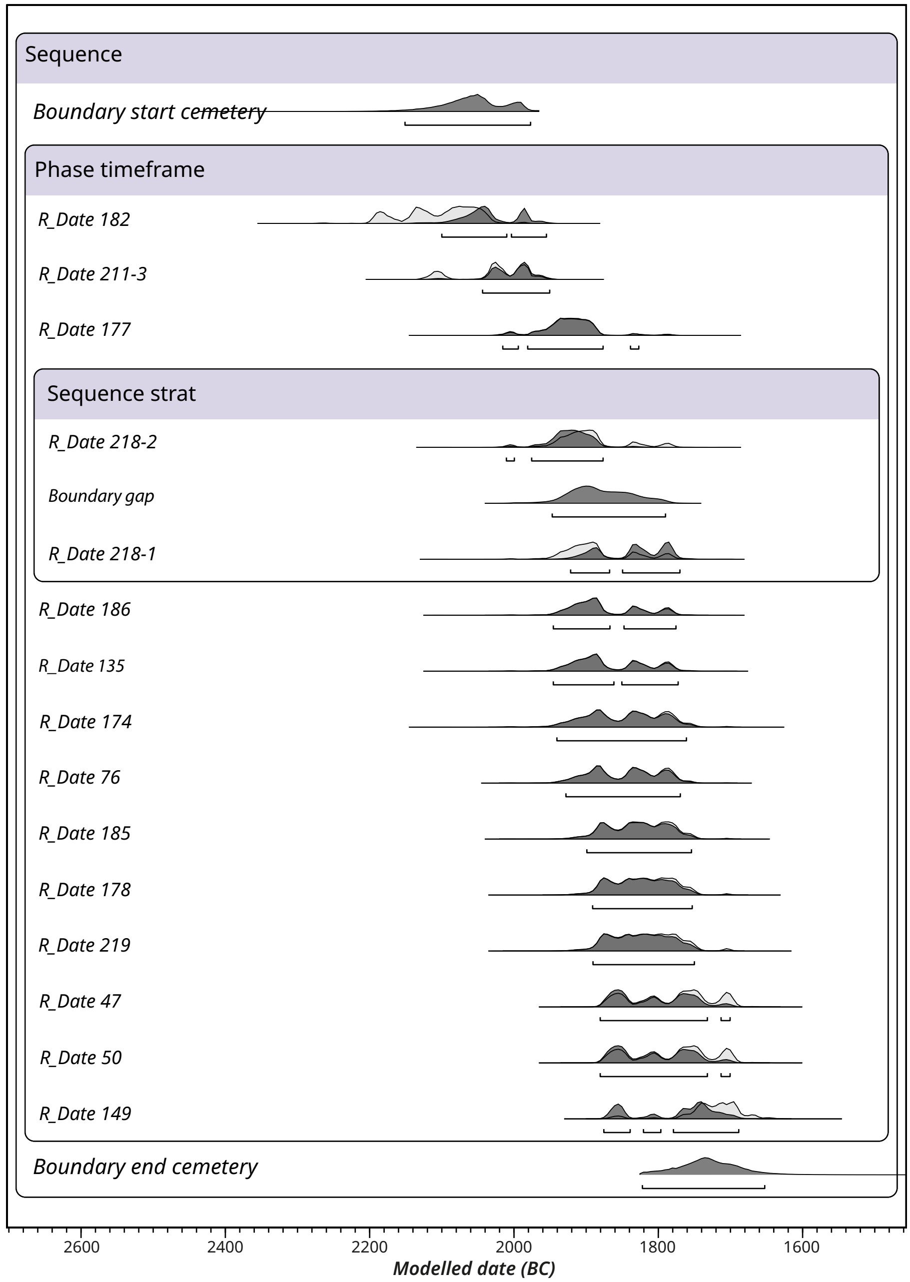

Figure 35: Radiocarbon dating of the Bronze Age graves from the cemetery Kudachurt 14. Multiplot of modelled (dark grey) and unmodelled (light grey) distribution intervals of the analysed graves. Data refer to Table 8.

dating stretches until the beginning of the 17th century BCE with large agreements of the distribution intervals. However, the dating of these graves is influenced by wiggles of the calibration curve around 1900-1780 BCE.

The radiocarbon dating of the control sample verifies that the investigated graves date to the transition of the 3rd to the 2nd mil BCE and following centuries. Under the current assumption that the turn of the MBA to the LBA took place during 1800-1600 BCE, the majority of the radiocarbon dates capture this period. On basis of these results and additional typological classifications made by the Russian and German colleagues, the funeral record is ideally suited for research topics related to the North Caucasian Bronze Age.

3.4.2 2 Stratigraphic structures

On basis of the site plan and pictures taken during excavation, the grave pits had been checked in respect to diagnostic stratigraphic principles such as overlapping, superimposed and intersecting structures. Overlapping or superimposition of graves identifies the lower grave as the older one and the upper as the younger one. Regardless of how much time passed between the installations, including the time needed for installing the grave pit. This also applies for the superimposition of burials. By the author's definition the criteria to distinct between overlapping (a) and superimposition (b) of graves means: the inhumation in a different pit that is positioned on top of the other in different extend (a), potentially intersecting another grave pit, and the reuse of a pit structure but clearly separated by layer(s) of soil (b). Superimposed burials are often marked with the same number and an added .1/.2/.3 whereby the rule is the higher the number the lower the position (218.1, 218.2; an exception is grave 211, because is not clear if the same grave pit has actually been used). In case one grave pit was intersected and destroyed due to digging out another one, the destroyed pit is consequently the earlier one.

As visible on the site plan there are some grave outlines overlapping each other. By reviewing the cases via pictures, it became clear that not all of them are signs of chronological sequencing; this is due to imprecise outlines or measurements caused by different grave pit depths and excavation techniques. For some cases their stratigraphic positions remain unclear (*e.g.* 219/218.1.2, 212/207, 052/130, 137/147). Grave 145 and 146 are a special case here as the displaced human remains from grave chamber 146 into 145 suggest that 145 is the earlier one; but it remains unclear when this happened. A later displacement is possible if the grave pit of 145 touched and disrupted those of 146 and later burial activities caused the opening (Fig. 36); still this scenario seems less likely compared to a subsequent installation of grave chamber 146 and potentially due following inhumations, taphonomic processes caused the displacement into the former entrance area of 145.

Although the increasing grave numbers correlate with later years of excavation this does not necessarily mean that graves of higher number were positioned in deeper soils and are consequently older; the ^{14}C dating supports this[28]. By naming the first excavated as the earlier/lower one, reliable chronological overlapping was proven for following graves (Fig. 37; later/earlier): 067/068/74, 053/130, 026/208, 135/180, 188/186, 137/132 and 162/201/211.1/211.3. Superimposition applies for 027.1/027.2, 149.1/149.2 and 218.1/218.2. Intersecting grave structures are 056/065, 043/025 and 186/187. Given the fact that grave 186 is older than grave 188, this sequence can be summarised as 188/178/185/186/187. As already mentioned in the subchapter describing the spatial distribution, stratigraphic sequences are in principle more prevalent in the central area of the cemetery where the majority of the graves are located. Also, the southern graves installed in confined spaces lead to overlapping and intersection.

3.4.2 3 Radiocarbon dating and stratigraphic structures

The combination of the previously established results gives little further information. Grave 211.1, 211.2, 201 and 162 overlap grave 211.3, one of the earliest dating graves; therefore, these graves must be younger than 2044-1951 cal BCE. For the sequence of 188/178/185/186/187 it can be assumed that 187 is older than 1946-1776 cal BCE and grave 188 can be either older, younger or contemporary with grave 178 (1892-1754 cal BCE) and 185 (1999-1755 cal BCE).

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28 It might seem conspicuous that Graves 050, 047 and 076 all belong to the "later half" of ^{14}C dates; but they only represent three of graves excavated during the first campaigns; additionally, they are chronologically associated with graves of higher number through stratigraphy.

Figure 36: Kudachurt 14, displacement of individuals from burial 146 to 145.

Unfortunately, the results cannot be transferred to graves without ^{14}C dating or relevant stratigraphic information. This would require a generally extended radiocarbon analyses, especially of those graves with diagnostic typological equipment. Further statistical analyses, *e.g.* seriation, would help to establish a more detailed chronological system tied to radiocarbon dates.

3.4.3 Summary: Chronology and typological classification

Within the comparative approach, for 56 graves present at Kudachurt 14 a relative dating to the MBA to LBA could be confirmed. The comparison sites are primarily cemeteries and graves with different constructive elements and funeral modes, distributed over the foothills of the northern and southern slopes as well as the high mountain area of the central Northern Caucasus. Form these sites 622 analogies from 17 sites were available. Their relative dating spans a period from 2500-1200 BCE. An association to typological classifications and regional distribution patterns of jewellery and weaponry object types from Kudachurt 14 showed a strong correlation to the findings from the northern slopes and central high mountain area. Additionally, the compilation of jewellery item types in Kudachurt 14 burials suggested a narrowing of Motzenbäckers typo-chronological scheme and emphasis according significance for particular graves (072, 147, 146, 182, or 211.3).

Aiming for a more solid dating of Kudachurt 14 for facing the issue of lacking independent temporal data at the current state of NCC BA research bone collagen samples from 15 graves (14 animals, 1 human) have been measured via radiocarbon dating methods. Additionally, stratigraphic structures have been examined by applying chronological sequencing principles. The raw radiocarbon ages of the earliest and latest grave set the frame between 2199-2031 cal BCE (grave 182) and 1870-1658 cal BCE (grave 149, both 2simga-ranges). After considering supplemental information, the modelled dates narrow it slightly down to a time span beginning 2152-1978 and ending 1828-1653, resulting in a total chronological duration of 162-388 years. In general, the majority of the analysed graves date to the first half of the 2nd mil BCE,

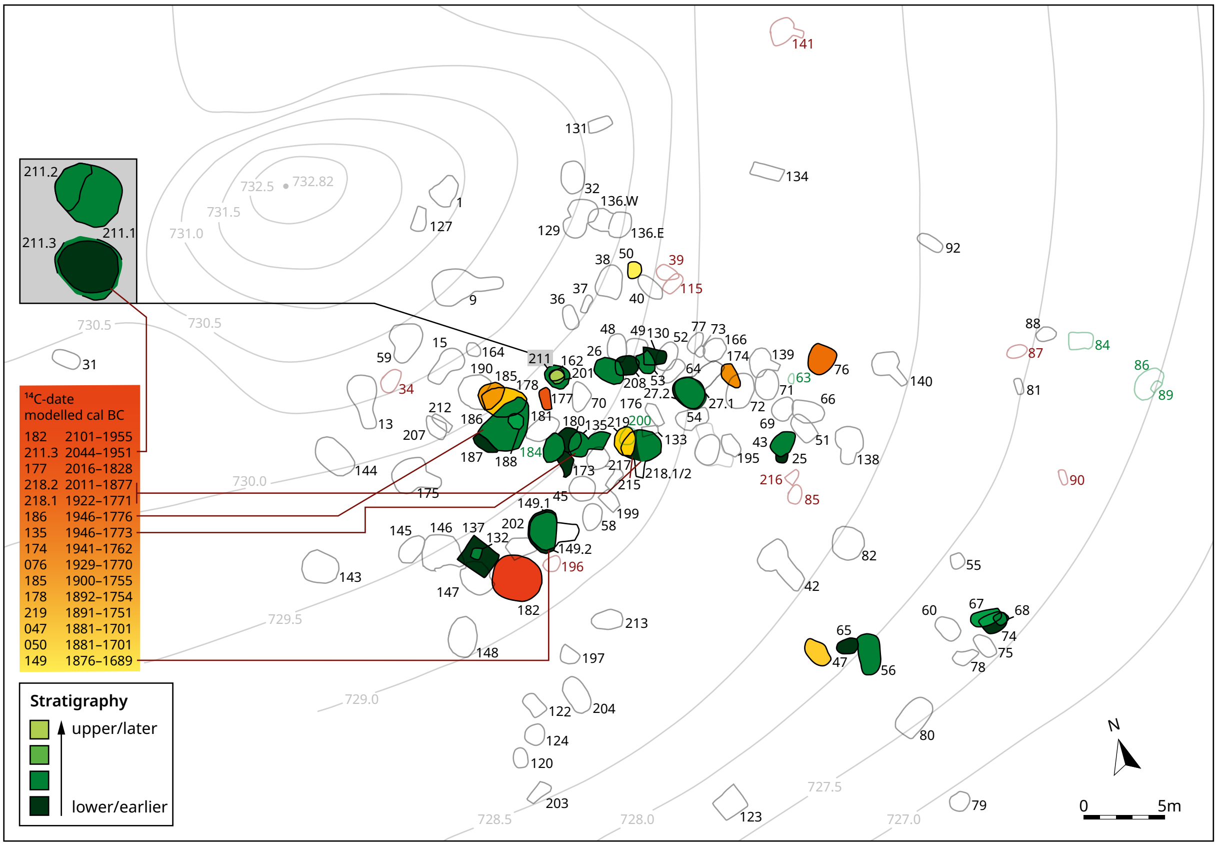

Figure 37: Stratigraphic sequences (green colour) and radiocarbon dating (yellow-red colour) of the graves from the cemetery Kudachurt 14. Highlighted are graves with reliable information. Graves with both information are marked in their stratigraphic position and linked to their ^{14}C dating via line.

whereas grave 211.3 and 182 are the oldest ones from the expiring 3rd mil BCE. The examination of stratigraphic sequencing and radiocarbon dates does not deliver any further results in terms of an expansion of the absolute chronological frame; the oldest was at the same time the lowest burial and the youngest was not overlaid by another burial structure. Still, some graves revealed stratigraphic sequences (see Tab. 9).

The comparative approach only included graves with funeral assemblages including jewellery or weaponry items, whereas the radiocarbon analyses confirmed the chronological association for three further burials without according equipment elements (050, 135, and 185). Furthermore, by considering all chronological approaches (typology, radiocarbon dating, stratigraphic sequences, see Tab. 9) for at least two more graves the dating is solid: grave 201 and 211.1. Both are situated between grave 211.3 and 162. Burials 180 and 187, both of poor preservation and lacking funeral items, are overlaid/disturbed by graves 135 and 186 and therefore must be at least older and are in consequence classified to the MBA-LBA transition. For grave 137 and 068 as well as 067 the case is similar, but these are younger as grave 137 and 132.

In summary, the undertaken selective typo-chronological approach as well as the radiocarbon analyses and the stratigraphic sequences confirmed a certain classification to the NCC MBA-LBA for at least 66 burials. Due to the facts that the radiocarbon dating has proven three graves without typologically significant items[29] to be from the beginning 2nd mil BCE and that the Russian colleagues suppose the pottery to be characteristic for the BA periods, this assumption can be transferred to the remaining 48 graves.

In order to refer to current typo-chronological questions of the NC MBA and LBA, a brief outlook about the significance of the new radiocarbon dates and the associated object types is given in the following. As jewellery items turned out to be both, most frequent in absolute number as well as in type variation, the focus is on the

29 In this selective approach.

Grave	Cal BCE (2sig.)	Inventories: object types
162	-	vessles, SpRoeAB (poor preservation)
201	-	vessels (poor preservation)
211.1	-	vessels
211.3	2125-1958	AnA2B, AnA2D, AnGA2, AnGB, AnGC, AnS1,ArD2, GhA1var, GhK1, NaA2, NaGC2 ,NaGvar, NaH1A, NaH1C4, NaL2B1, beads_10-450, SpRoeAB, SrB2A, ZAnB1-2, ZeA1, ZeB1, ZkA1A, ZkA1B, ZkA1D
218.1	1953-1776	vessels, NaA2, NaH1A, SrB2A
218.2	1971-1777	vessels, DoA1A, LzC2, NaB1, NaB3, NaB7C, SrB2A
188	-	vessels, NaL2B2, ZkA1B, SrB2A, beads_450
186	1946-1775	vessels, DoA1C, LzC1, ArA4B, GhA1var, NaA2, NaL2B1, NaB3, beads_100, SpRoeAB, SrB2A
187	-	(poor preservation)
135	1946-1772	vessels
180	-	(poor preservation)
149.1	1870-1658	vessels, NaA2, NaH1A, SrB2A
149.2	-	vessels, DoA1C, LzC1, AnA1, AnA4D, ArA4A, ArA4B, ArD2, GhA1var, NaA1, NaA2, NaB7A, NaH1B, NaL2B1, NaL2B2, not classified, SpRoeAB, SrB2A, ZbB
027.1	-	vessels, LzC1, SrB2A-C, NaB3, NaB7A, NaL2B2
027.2	–	vessels, AnA4D, NaA2, SpRoeAB, beads_10
056	-	vessels, DoA1A, NaD2, NaG1C1, NaH1A
65	-	vessels, AnA1, AnA2D, NaB2B, beads_10, SpRoeAB, SrB2A, ZkA1C
043	-	vessels, DoA0, LzC3var, ArA4A, NaL2B2, SpRoeA, ZkA1B
025	-	vessels (poor preservation)
026	-	vessels, beads_100, ZkA1C, SpRoeAB, ArC, NaR
208	-	GhA1var, SpRoeAB
067	-	vessels
068	-	vessels
074	-	AnA2D
053	-	vessels
130	-	vessels
137	-	vessels
132	-	NaD2, NaB3, SrB2A, SpRoeAB, beads_100 (poor preservation)

Table 9: Stratigraphic sequence complexes (bundled per colour, upper is later; no chronological sequencing between the complexes), radiocarbon dating (2sigma-range), inventory and object types of the funeral equipment (see Tab. 10).

occurrence of jewellery types and available radiocarbon dates as summarized in Table 10. Within 15 ^{14}C-dated graves, 12 reveal jewellery items of 11 categories and 43 types (316 artefacts in total).

Looking on the distribution of total number in the course of time (read in the table from left later to right earlier), the high amount of jewellery items in the

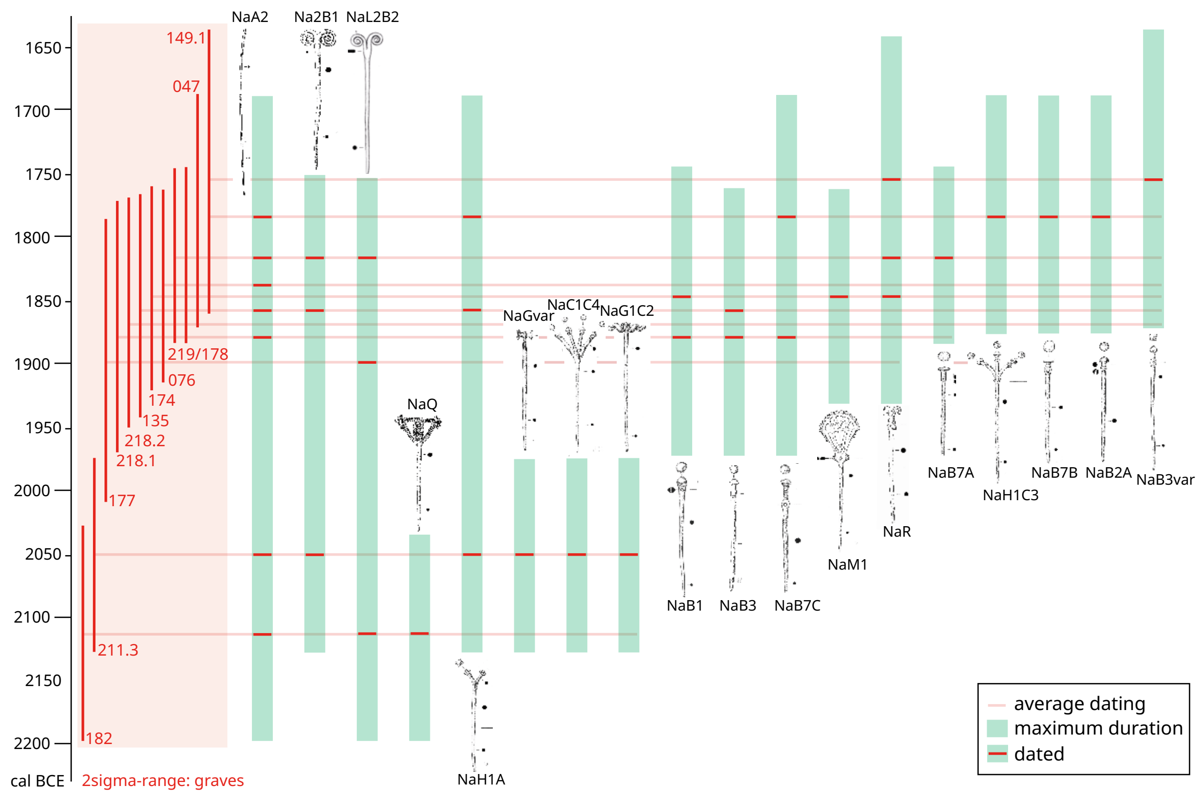

Figure 38: Absolute dating of graves from Kudachurt 14 (n=12, red markings, unmodelled 2sigma-ranges) and pin types (18 types, 65 objects) found in those graves. Light red horizontal lines mark the average dating of the grave and associated pin types, depicted in dark red short lines. Green bars mark the maximal possible time span in which the types date based on the available data.

two earliest graves leads to a rich typological spectre in the expiring 3rd mil BCE compared to those of the 2nd mil BCE; this is especially true for grave 211.3. Taking the total number of items in respect to the number of occurring types into account (n objects/n jewellery types: "type plurality", see chapter 4), there is no clear tendency as few findings still represent different jewellery types[30].

Based on these data and with emphasise that 12 grave inventories are solid for comprehensive statement the following observations can be noted:

- There is no significant chronological distinction in the occurrence of spiral rolls, simple spiral rings, spiral buckles (Gh1var), bronze tutuli (ZkA1A-B) and bracelets
- Belt hook and decoration plates are rare in the record and therefore not significant
- Decoration elements as well as necklaces with more than 200 beads are more frequent in the earlier graves; this is also true for a large amount of pendant types.
- The distribution of pin types is slightly more specific (see Fig. 38). Pins with simple loop (inparticular) or double spiral endings occur frequently and throughout the represented timeframe. Toggle pin types (NaB1-B7C) are more frequent in later graves. Other types are unique and in consequence not significant in this respect (NaQ, NaM1, NaGvar, NaG1C2). According to the typological principle that complexity increases within time this is not confirmed by the pin types with branched endings. The three exemplars of type NaH1A (double branches and knotted tops) are part of grave inventories with dates stretching from 2018-1958 (grave 211.3) to 1979-1692 (grave 047), whereas the exemplar with four branches (NaC1C4) is earlier compared to the one with three branches (NaH1C3). Potentially, the shape

30 The issue of type plurality will be addressed comprehensively in chapter 4.2.3.

Jewellery items	Graves and 14C dating cal BCE (2sigma-range)												all
	149.1	047	178	219	076	174	186	218.1	218.2	177	211.3	182	
	1870 - 1658	1879 - 1692	1891 - 1750	1892 - 1746	1932 - 1768	1938 - 1757	1946 - 1775	1953 - 1776	1971 - 1777	2018 - 1828	2125 - 1958	2199 - 2031	
spiral rolls		5	14	2	5	2	4			13	18	12	**75**
pins	5	7	9	4	1	5	4	4	4	2	13	9	**67**
NaA2		1	3		1		1	3	1		1	1	**12**
NaB1						1			1				**2**
NaB2A		1											**1**
NaB3							1		1				**2**
NaB3var	1												**1**
NaB7A				2									**2**
NaB7B		1											**1**
NaB7C		1							1				**2**
NaG1C2											4		**4**
NaGvar											2		**2**
NaH1A		1						1			2		**4**
NaH1C2		1											**1**
NaH1C3		1											**1**
NaH1C4											2		**2**
NaL2B												1	**1**
NaL2B1				1			2				2		**5**
NaL2B2			4	1						2		5	**12**
NaM1						1							**1**
NaQ												2	**2**
NaR	4		2			3							**9**
tutuli		5	2			7				5	18	8	**45**
ZkA1A		2				2					9		**13**
ZkA1B		3				1					1	1	**6**
ZkA1C			2			4						7	**13**
ZkA1D										5	8		**13**
necklaces		1	3			6	1			6	8	6	**31**
beads_10		1									2	1	**4**
beads_100			3			2	1			3	3	3	**15**
beads_200						1					1	1	**3**
beads_450										1	1		**2**
ZAnB1-2						3				2	1	1	**7**

Table 10: Kudachurt ^{14}C-dated graves (unmodelled) and jewellery types per category. The graves are listed chronologically.

Jewellery items	Graves and 14C dating cal BCE (2sigma-range)												all
	149.1	047	178	219	076	174	186	218.1	218.2	177	211.3	182	
	1870 - 1658	1879 - 1692	1891 - 1750	1892 - 1746	1932 - 1768	1938 - 1757	1946 - 1775	1953 - 1776	1971 - 1777	2018 - 1828	2125 - 1958	2199 - 2031	
dec. elemet						2				1	20	4	**27**
ZeA1						2					12	4	**18**
ZeB1											8		**8**
ZeC1										1			**1**
spiral rings	2	6	1				1	2	2	3	3		**20**
SrB2A	1	2	1				1	2	2	3	3		**15**
SrB2C	1	4											**5**
pendants				1	1	1				1	10	6	**20**
AnA2B											1		**1**
AnA2D											2	1	**3**
AnA2E												2	**2**
AnGA1												1	**1**
AnGA2											1		**1**
AnGB											1		**1**
AnGC						1					1		**2**
AnhH2												1	**1**
AnS1				1						1	4	1	**7**
AnSF					1								**1**
bracelet		2	4		2		2			1	2	5	**18**
ArA4A			2									4	**6**
ArA4B					2		2			1		1	**6**
ArC			2										**2**
ArD2		2									2		**4**
spiral buckles			3		1		1			1	1	3	**10**
GhA1												1	**1**
GhA1var			3		1		1			1	1	2	**9**
belt hook											1		**1**
GhK1											1		**1**
dec. plate		1											**1**
All n obj./types	**7/4**	**27/15**	**36/9**	**7/5**	**10/9**	**17/12**	**14/8**	**6/3**	**6/5**	**33/11**	**94/26**	**53/21**	**316/43**

(amount of branches) was not determined by chronological factors but other considerations.
- The assumption, that the earlier grave inventories show a larger range of jewellery types, is supported by the impression given by taking into account stratigraphic sequences; although reliable absolute dates are lacking here, the few complexes with chronological sequences show a higher variety of findings in the lower, thus earlier, graves.
- The amount of weapons in ^{14}C-dated graves is too little to allow similar considerations. Only four contained weapons (047, 178, 186, 218.2), all dating into the 2nd mil BCE.
- At the current state of research these assumptions do not allow a further temporal differentiation in terms of chronological phases of the graves and in consequence, the cemetery. Therefore, a comprehensive synchronisation of ^{14}C-dated inventories with those without typologically independent data and including pottery styles is required.

Based on the radiocarbon dates of Kudachurt 14 existing typo-chronological schemes require revision. As a result of the comparative approach, Motzenbäcker's temporal classification of the Kossnierska collection (see Fig. 23) which shows a large amount of typological analogies seems too widely stretched for this site. Specific jewellery times which he claims for the MBA or LBA respectively (*e.g.* pins with double spiral ending or fan heads, spiral buckles; animal figurine pendants) at Kudachurt 14 are associated in the same grave inventories. For instance, this included the inventory of grave 146 showing typical MBA (pin with fan head, NaM1; pins with double spiral ending, NaLB1-3) as well as typical LBA types (animal figurine pendant, ram shaped; TanA1). It can be assumed that a comprehensive typo-chronological sorting of the findings of Kudachurt 14 will lead to a shift of Motzenbäcker's intervals to earlier dates for some LBA types.

3.5 Kudachurt 14 and the MBA-LBA transition in the Northern Caucasus

Returning to introductory descriptions of the North Caucasian Bronze Age and affiliated archaeological cultures including crucial social, ritual, technical and economic developments, the key position of Kudachurt 14 can be determined more precisely. In summary presented results are:

- In terms of socio-economic developments of the NC BA, the MBA-LBA transition represents a "missing link". Shifts in habitat preferences (from the steppe to the high altitudes) divergent patterns of social organisation (from hierarchical to egalitarian social models) and changes in subsistence strategies (from mobile to rather sedentary lifestyles) are current objectives of research. Recently these also include bioarchaeological approaches
- Cultural phenomenon in the micro-region, the central North Caucasian foothills are hardly detected for the MBA-LBA transitional horizon and point to a co-existence of different groups, mainly variations of the North Caucasian Culture (NCC), the Archon-Group or Post-Catacomb traditions. The burial practices of these groups differ in grave construction (kurgans, single graves, cemeteries, catacombs, flat graves, cromlechs, stone cists; see Fig. 39) as well as differences in inhumation practice (primary and secondary, number of individuals, cremations).
- The cemetery of Kudachurt 14, situated in the central North Caucasian foothills, reveals a large number of undisturbed graves. The comparative typo-chronological approach as well as the radiocarbon dating of 15 graves proofs the classifi-

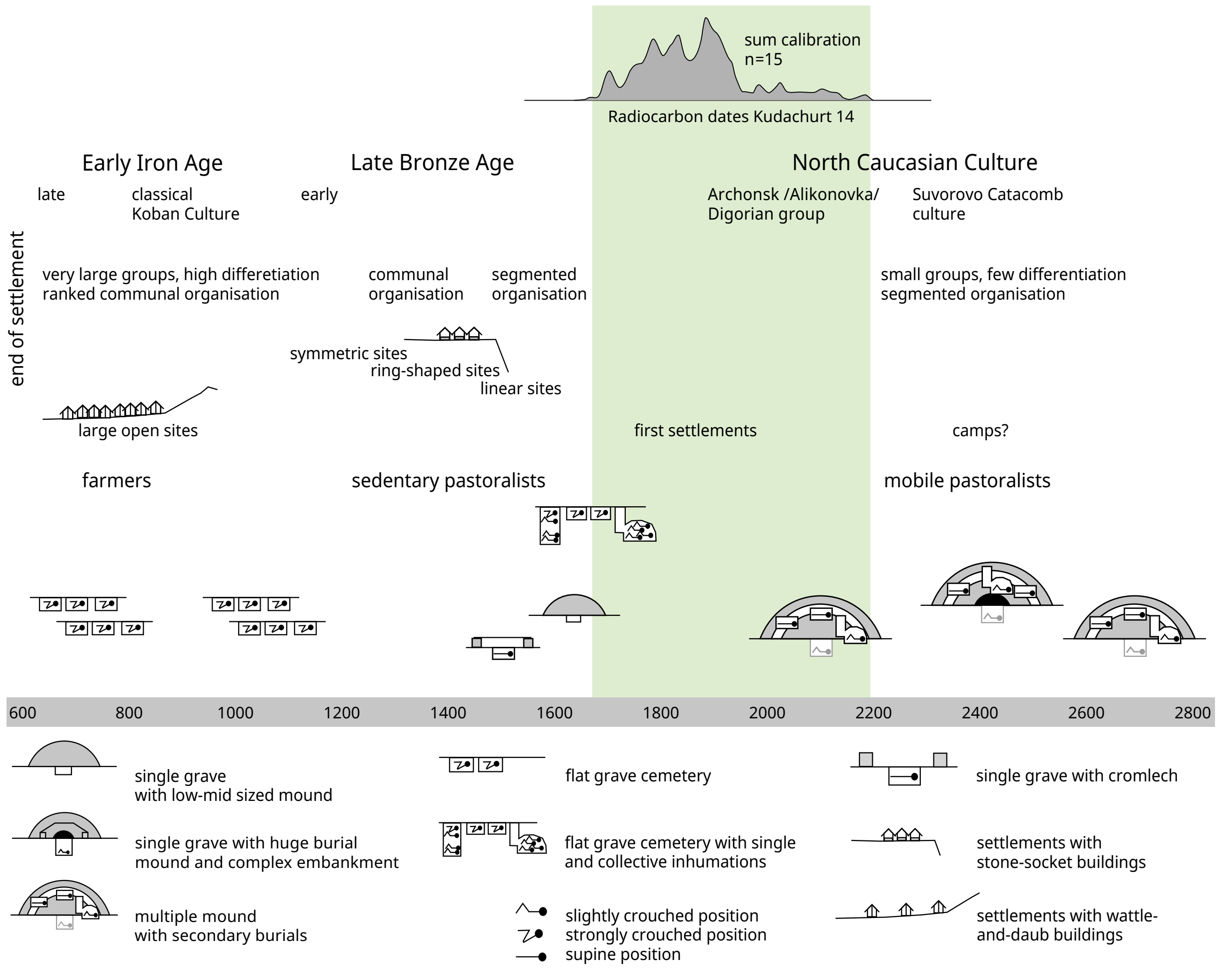

Figure 39: Summary of changes in burial practice and subsistence strategies from the MBA to the EIA in the Northern Caucasus (illustration according to Reinhold 2017, Fig. 2, 258) and the location of Kudachurt 14 within these developments.

cation to the MBA-LBA transition (*ca.* 2200-1650 BCE). It is the first investigated cemetery delivering unbiased dating as well as appropriate cultural material to verify and further develop existing (typo-)chronological schemes.

- The comparative typo-chronological approach based on jewellery and weaponry items achieved associations to NCC as well as Post-Catacomb and early Koban material culture spectrum and according burial practices. A final decision for one archaeological culture or group was not undertaken although a strong typological similarity to regional findings from the high mountain area is confirmed for some graves; this cannot be transferred to all graves of the cemetery.
- The burials of Kudachurt 14 show variations in both, grave construction as well as funeral equipment. This ranges from flat to catacomb graves, from single to multiple burials as well as from graves without any items to assemblages with large numbers of funeral gifts. The sample for radiocarbon analyses currently does not allow a precise dating for the majority of graves which contained only vessels or animal remains; this still has to take place, especially concerning the pottery styles.

In consequence, the key role of the cemetery Kudachurt 14 is not only defined by its typo-chronological significance. A compilation of several factors constitutes its outstanding importance. On the one hand the temporal as well as spatial location matters as it closes the gap of the MBA-LBA transition and at the same time is situated in the foothills, a transitional area between the preferred habitats shifting within the BA (Fig. 39). On the other hand, the preservation of the graves as well as the high heterogeneity of burial practices and funeral equipment accounts for a promising research subject for an approach that addresses major issues of social inequality of that time. In addition, the investigation of the human remains aiming for reconstruction of the living conditions (oral health, nutrition,) of the people buried at Kudachurt 14 will deliver precious information completely independent from the (socio-) archaeological interpretations. The interlinkage of both spheres makes up a further analytical element of the approach by combining intentional and functional data.

Part II

Disciplinary Analyses: Burial Practices, Human remains and isotopes

4 Burial practice: Social indicators

This chapter presents and analyses the burial traditions recognized in the cemetery of Kudachurt 14. The objective is to give a detailed overview of burial behaviours and potential ritualised practices as they are expressed within the archaeological record; this includes grave construction, treatment of the bodies, and grave inventories. Along with the research question posed in chapter 2, the main goal is to test different elements of the burial practice in terms of their suitability as a proxy for social inequality:

What is the information potential of grave construction, burial type, bodily treatment, and grave inventories with regard to socio-archaeological issues?

As described in chapter 3, some graves lack chronologically sensitive items. One could argue that these graves should be excluded from the analyses; however, the absence of burial items, as well as their presence, is an important aspect in terms of social differentiation. Therefore, these graves are included in the analyses. In order to maintain transparency in this respect, the according graves are marked specifically (no rel items, no items).

The following chapter includes a critical discussion of the quality of the gained mortuary data and defines the characteristics that are used for the statistical analyses. The first subchapters covering analytical methods and data processing set the stage for the subsequent presentation and interpretation of the results in the last subchapter. The analytical parts are separated into two subchapters (4.2, 4.3) wherein the first deals with the results related to the different characteristics individually and the second focuses on specific correlations between several criteria in order to answer the second research question:

What are the major proxies for tracing social inequality in the burial record?

4.1 Characteristics of burial practice

According to recent social interpretations of burial practices in the North Caucasian Bronze Age (see chapter 1.1.2), the graves of Kudachurt were examined in terms of specific criteria:

- Effort of grave construction as expressed by different elements such as the inclusion of stones and the nature of the grave pit (shape, shaft structures, dimensions and installation depth).

- The individual *vs.* collective emphasis expressed in the number of individuals interred in a single burial is an important issue for Kudachurt 14. The term "inhumation" refers to the reconstructed number of individuals per burial based on preserved skeletal elements and results in the establishment of burial types. During the examination, the nature of inhumation gained importance and signs of re-access were identified. The positioning of the dead as well as the presence of ochre, represented as red colour distributed over the skeletal remains, were recorded as elements of treatment of a corpse.
- The presence, absence, and composition of grave inventories also appeared to be crucial in terms of questions of social inequality at Kudachurt 14. As described in chapter 3, each inventory and each object found in a burial context was classified by criteria such as artefact material, functional class, category, and object type. The examination of frequencies of artefacts and variation of inventories reveals differences in the burial practice of equipping a grave and forms a basis for further interpretations.
- As the preservation of the burials varies significantly within the record, the results were evaluated in terms of data reliability, resulting in the establishment of data quality groups. These groups reflect the integration of the criteria: overall preservation, skeletal preservation, and reliability of grave inventory completeness.

4.1.1 Spatial distribution

Spatial distribution patterns of burials, *e.g.* separation or clustering of graves or their specific attributes, give information about the utilisation of available space for installing and frequenting graves; different social groups might have made different use of available space or marked specific areas of the graveyard. Thus, the arrangement of graves is of interest for socio-ritual and osteological interpretations and are therefore represent one importance criteria. Therefore, the investigated characteristics of burial practice, *e.g.* elements of grave construction or burial type, are mapped by grave on the cemetery plan figures.

4.1.2 Elements of grave construction

Parameters of the external grave design help to understand the role of grave architecture within the burial tradition. Furthermore, structural analyses can also provide estimates of the amount of effort invested in this component of funeral activity. The criteria defined as important at Kudachurt 14 are: the presence of stone elements, the shape of the grave pits, and the presence of dromos, as well as the dimensions of the grave and the installation depth.

The installation of a tomb is associated with a certain degree of effort depending on the type and technical challenges of the grave construction itself. External factors – such as resource availability, soil conditions, and seasonality – might have had an impact on the invested effort. Although detailed information concerning these external factors is currently lacking, their potential meaning is discussed later. In order to describe the variety of grave construction and to quantify the invested effort, the following parameters are used.

Stone elements were present in two categories: surface markers or vertically arranged stones. Both consisted of flagstones (flat, plate-like stones) or assemblages of larger, round stones. These categories were distinguished in five stone element types (Fig. 40): vertical (flagstones or stones), vertical & surface (vertically positioned flagstones and flagstones or stones), surface flagstones, surface stones, surface flagstones & stones. The absence of stone construction elements was documented as none or, when due to destroyed grave structures, as n. d.

(not determinable). The shape of the grave pit was classified as oval, roundish, trapezoid, irregular, and rectangular. In some cases, the borders of the feature were not preserved, resulting in a destroyed or artificial pit shape. These are marked as n. d. (not determinable). Some graves contained dromos structures (presence: yes, no) that were reconstructed either from the excavation plan, the drawing, or the photos. The dimensions of the grave pit and installation, consisting of its maximum width, maximum length and maximum depth, describe the extent of the burial environment. Grave dimensions were recorded based on the drawings of the grave and photos were used to clarify doubtful measurements. This was mainly the case when measuring the maximum depth, taken as the lowest layer of the grave pit measured from the top level. Due to technical reasons, topography, and overlapping structures, the maximum depth is not equal to the actual height of the grave pit or cavity itself (see Fig. 8). It is rather the approximate depth of construction. Because of this, the maximum depths were summarised into five levels of approximate depth (<30 cm, 30-100 cm, 100-150 cm, 150-200 cm, >200 cm). This both relativized the inaccuracy described above and simplified visualization of the spatial distribution of maximum depths. All metric data was recorded in cm.

4.1.3 Inhumations and burial type

The determination of the number of buried individuals (inhumations) resulted in the classification of burial types and definition of "inhumation groups" (see chapter 2.6) indicating ritual or social proximity. Signs of re-access to the grave as well as treatment of the corpse, including positioning of the body, were assigned as attributes of inhumation processes. In contrast, the skeletal preservation is rather part of the critical assessment of data.

Skeletal *in situ*-preservation (preservation) crucially affects the possible analyses of the buried individuals. To give a good basis for discussion, it is important to consider the conservation status of the remains. Based on the photographic documentation of the *in situ*-situation, the skeletal preservation was classified in terms of completeness in four classes: 100-76 %, 75-51 %, 50-26 %, and 25-0.1 % (see Fig. 43). A mean value was calculated when a grave contained more than one individual; if no human bones were recognised, it was registered as none. In case of superimposed skeletons, only the visible part of the individual was evaluated. The preservation status is a result of either general poor environmental conditions for bone preservation or anthropogenic disturbances of the human remains resulting in missing parts of a skeleton (*e.g.* intersection, secondary activity). This classification is not as accurate as the osteological estimation, still it is a parameter necessary to include.

Specifying the minimal number of individuals per grave (MNIG) and the burial type constitute the major issues concerning burial processes. The burial of deceased individually, in pairs, or even in a larger number of individuals, can be due to different reasons. On one hand, there is a practical component to the construction of large grave cavities that are then re-used for several individuals. The "collective idea" of burying a certain group of individuals together – with, for example, kinship relations – can also be a cause for a multiple burial. On the other hand, the construction of a single, separate grave can emphasize the individual.

The number of individuals per grave (NIG) is one of the major characteristics necessary to understand burial practices in Kudachurt 14; its reconstruction was therefore given appropriate attention. This information is required for analysing the grave items in their function as individual social proxies and for estimating the buried population size. As mentioned before, of the 130 graves, 60 were examined osteologically, although some of them incompletely. The determination of the NIGs was therefore approached with two methods: 1) by osteological analyses of the skeletal remains on hand for 60 graves and, if possible, their *in situ* positioning by examining the photographic documentary, and 2) for the remaining 70 graves, an examination of the grave drawings. Depending on the skeletal preservation and clarity of the *in situ* situation, articulated elements or significant single bones were counted (*e.g.* skull; femur, humerus, pelvis from one body side). In very few cases, only the body stain or significant accumulated jewellery represented an individual. Multi-layered structures, secondary funeral activity, and the destruction of parts of graves were unavoidable disruptive factors. Thus, the estimated number of individuals is not certain for all graves. Although this chapter is dealing with data independent from the osteological analyses, the MNIG calculated osteologically from 60 graves is considered here. This ensures a higher resolution of the actual number of individuals in general. The number of individuals defined using the results of the documentary determination are marked as "individuals *in situ*" (ind *in situ*) [1]. Individuals defined by osteological examinations are marked as "individuals physical" (ind phys), how it is applied in the next chapter. In sum, ind *in situ* and ind phys represent the generated minimum number of individuals per grave (MNIG). The sum of these individual grave MNIGs makes up the minimum number of individuals buried at the cemetery of Kudachurt 14 (MNIC).

With respect to the MNIG, the burial type is determined as follows:

- Single and double burials, containing one or two individuals respectively
- Collective burials, which contained more than two individuals. As the number of individuals varied significantly from three to 13, collective burials were further divided into small (coll S, three to five individuals), medium (coll M, six to eight individuals) and large (coll L, nine to 13 individuals) burials.
- Single+ and double+ burials, containing at least one or two individuals, but maybe more.

Due to poor preservation, the actual number remains unclear (see above). The distinction between one or two individuals was made in order to maintain the categories above; whereas single+ could be a double/collective burial and double+ could be a collective burial. Nevertheless, for the minimum number of individuals per grave (MNIG) one (single+) or two (double+) individuals are assumed.

The treatment and positioning of the deceased may have played an important role during the inhumation process. Although it is recognized that the physical handling of the corpse can include different stages, only the position in which the individual was laid in a grave is reconstructable from the available documentation. Three characteristics were registered for each individual ("ind *in situ*" and "ind phys"): body position, body side (right, left, supine) and orientation in terms of head direction. The body position describes whether an individual was laid down in flexed, hyperflexed (knees significantly higher than pelvis) or stretched position. The eight possible cardinal directions to which the skull could be facing define the orientation of the individual. If these attributes were not possible to ascertain, they were recorded as not determinable (n. d.). In addition, the presence of ochre was registered. The detection of traces of a specific red colouration on skeletal remains and the surrounding soil was simple in most of the cases. Technically, it is arguable that the dispersal of ochre over the corpse was an element of the burial ritual rather than representing a grave good; but, in this context, author considers the dispersal of ochre over the corpse as a ritual behaviour connected with the body of the deceased individual.

1 Individuals defined by osteological examinations are marked as "individuals physical" (ind phys), how it is applied in the next chapter.

4.1.4 Goods for the dead: burial items

The differences in material, function, and form of burial items can be interpreted as potential indicators for social inequalities in the buried population. In general, the evaluation of presence and absence of grave goods follows two main assumptions. First, the object, including its material, was available in general for the buried and burying population. Second, the objects had a certain meaning, either in a personal way and/or in its specific function as an element of the burial practice. Whereas the first aspect points merely to the availability and value of an object itself, indicated by occurrence and frequency ratios, the second aspect refers to the personal, social and/or ideological sphere. In combination, these describe the value of an item as an element of the burial tradition. Thus, within the composition of objects in grave inventories, potential cultural significances of assemblages are detectable; the comparison of different assemblages can therefore provide information about the specific ritual practices involved in equipping individuals in their last resting place.

Aiming to establish and evaluate indicators for social inequalities, all burial objects recovered from the cemetery of Kudachurt-14 were examined in terms of individual characteristics of the artefacts, which had been investigated by applying different descriptive analyses. For these examinations, the artefacts the smallest investigative unit.

The descriptive criteria consist of three main aspects: the material of the artefact, the function of the item (functional class) and the object category. The analyses follow these assumptions:

- Frequencies of object materials allow conclusions concerning (1) the value of each material, and (2) preferences in the funeral ritual.
- Functional classes and their frequencies describe the functional use and character of (1) an object and (2) an assemblage, as well as (3) the meaning of functional classes with regard to the complete burial record.

These functional classes are refined within the classification of categories, which more precisely describe the item itself by considering the artefact form. This enables the differentiation of the funeral equipment in order to explore its variation in more detail and to gain further interpretative outlooks, *e.g.* its individual, social or ritual functions. For instance, a vessel form might be specifically used for certain foodstuffs, making it possible to interpret the compilations of vessel categories in terms of preferred consumables. With regard to items of jewellery, the examination of categories enables a reconstruction of the meaning of costume in terms of collective or individual preferences, and practical purposes (*e.g.* for affixing clothes). As the criterion "category" is independently examined from the functional class itself, it allows a re-evaluation of specific functionality in terms of artefact form.

This approach considers the character of each funeral assemblage. With this, it is possible to establish proxies for social inequality that can lead to hypotheses more nuanced than simply the identification of "poor" or "rich" graves based on the number of items contained in their assemblages. The terms "burial item" or "item" refer in the following to artefacts or other materials recovered from burial contexts. Faunal remains are also included, although the bones might not have been processed. In order to maintain the source criticism according to the preservation status *in situ*, the establishment of data quality groups also considers reliability in this respect.

Four main materials make up the first descriptive criteria. The determination of ceramic and bronze was unquestionable in most of the cases, as it was easily comprehensible within the documentation. Additionally, items made of faunal materials, including bone, teeth and shells, were also identifiable. The identification of stone and antimony was mostly questionable as many objects lacked information necessary for this sort of determination. These were recorded at not determinable (n. d.).

The functional classes consist of items related to food, weaponry, tools, and jewellery. Classifying the items in this approach automatically means a presupposition of their use, namely their function. Thus, it requires adequate critical reflection during its application. The functional class "food" includes vessels and faunal bones; the decision that faunal bones represent the remains of meat was based on the characteristics of the preserved skeletal elements. As it cannot be decided whether the two stone axes represent tools or weapons, they appear in each functional class; the frequency then was divided between the two.

In total, the items were classified in 27 categories. These definitions mostly followed the state of the art regarding typological considerations (see chapter 3), supplemented by a few new categories (*e.g.* decorative element). In order to avoid a potential chronological bias, the definition of the categories tried to omit typological details. Therefore, in this first approach the object types were established independently from those described in chapter 3. With that, a – probably low – degree of uncertainty was accepted. During the analyses, some categories required further refinements in terms of object element numbers or material (*e.g.* differentiation between necklaces consisting of several or numerous beads). To approach the problem of reconstructing a necklace from variable numbers and shapes of beads, further classifications were determined based on the associated object frequencies (according to the documentation "beads1-6"). A detailed list of the categories associated with the functional classes of weaponry and jewellery can be found in chapter 3. As suggested in relation to functional class, the category meat, the category "meat" is congruent with the faunal bones for the functional class of food. The spectrum of vessels was divided into eight categories (cup, pot, large vessels, beaker, goblet, bowl, flat bowl) in accordance with the classification system established and provided by Sabine Reinhold.

The determination of the number of objects was a major challenge due to the highly varying status of their preservation. For example, in the case of the ceramic remains, the fragmentation of the vessels necessitated a revision of the data acquired during the first recording. A minimal number of vessels was determined in this revision based on the information given by the documentation (labelling, preserved vessel regions, ornamentation, and reconstructed form). As the osteological analyses of the faunal remains is still in progress, they were also treated differently. The presence of faunal remains in the graves was determined within the *in situ* -documentation by the author for the analyses of the grave inventories; this was possible thanks to the extensive and detailed photographic documentation. Therefore, although the general presence or absence of faunal remains in burials could be established, the species of the animals is currently unknown (except for the bone samples for the stable isotope analyses). It is very probable that the majority of bones represent the remains of sheep or goat both as these species were identified based on the bones taken as stable isotope samples and because these are well-known domesticated animals belonging to the NC BA (Schroeder *et al.* 2017).

Presence/absence, object frequencies (n/%), and average values constitute the major statistical values; they are derived from a complete registration of all objects. This data then formed the basis for further analyses such as bi- and multivariate examinations of the funeral record including correspondence analyses to query similarities and differences in burial assemblage compilations. The data recording resulted in the establishment of the **number of preserved items per grave** (**NPIG**[2]) as well as of the number of **preserved items** with respect to the whole **cemetery** (**NPIC**). The relation of the NPIG and NPIC with the burial item criteria material, functional class and category forms the foundation for all following analyses. In general – and this is the nature of archaeological investi-

2 This abbreviation was chosen in order to avoid confusion with the NIG, the number of individuals per grave, although technically it is similar to the determination of minimal individuals.

gations – only the preserved items are included in this approach; this means that all data represent minimal numbers.

The **category plurality index (CPI)** combines the number categories related to the number of items (see first formula below). It is calculated by dividing the total number of represented categories by the number of items. This was conducted for the categories in terms of the complete data set, aiming for an average index, as well as for each grave (NPIG). Additionally, the CPI was calculated for items of the same functional classes per grave. Objects of unknown category, generally vessels and some jewellery items, were classified as vessel n. d./jewellery n. d. In summary, the formula for the general CPI and the functional CPI are (jewellery is to be replaces by weapon/food/tool):

$$\text{CPI grave} = \frac{\text{n categories grave}}{\text{NPIG}}$$

$$\text{functional CPI grave} = \frac{\text{n categories jewellery grave}}{\text{NPIG jewellery}}$$

The variability in composition can be compared between assemblages as well as with the general data set by applying the CPI. In addition, by separating the categories according to their functional classes (see second formula above).

To avoid overweighing inventories with only one item, a situation which automatically results in a CPI of 1 and is thus consequently higher compared to inventories with more items than categories, these CPIs were manually set to 0.1.

The category rareness index (CRI) was created to reflect the average distribution of categories present at the cemetery (based on the NPIC) with respect to each grave and to generate a value that gives information about the exclusivity of the assemblage composition (NPIG; see formula below). The overall average number of items for the specific categories (n items per category/n graves) with relation to the complete data record (based on the NPIC) are the starting point for the CRI. The CRI is the summation of the categories present in each grave where each category is represented by its site-wide average number of items per grave. For instance, the assemblage of grave 001 consists of a flat bowl, a large vessel, meat and a pin. The overall average number of items per grave for these categories are 0.04, 0.53, 1.36 and 1.78 respectively and the sum of these is 3.71. As this summation does not only refer to the overall averages, but also to the size of a grave's assemblage, it is divided by the total number of items in said grave (NPIG); for grave 001, the result is 0.92.

$$\text{CRI grave} = \frac{\text{av.cat + av.cat + av.cat + av.cat...}}{\text{NPIG}}$$

In consequence, low values are related to assemblages with rather exceptional items. In order to achieve a comparability to other criteria (n items, n categories, n functional class, CPI), the CRI was rescaled from the largest value equated to 100 and the smallest value to 1 (Müller, 1994). Afterwards, all values were again divided by 10. Graves. Thus, a higher CRI describes an assemblage characterized by rare categories.

Associations between the objects and the individuals was examined in order to achieve a connection between the individual information (both burial and osteological) and the burial items. Here, the crucial criteria were the positioning of the item in relation to the skeletal remains; only certain connections were noted. This was problematic for the double and collective burials. For those burials, the examination focused on jewellery and weaponry items, *e.g.* bracelets on the wrist bones, pins in the thorax regions or spearheads next to the skull or arm bones.

4.1.5 Data quality groups

The archaeological record of the burials of Kudachurt 14 varies significantly due to multifarious reasons, *e.g.* later funeral activities[3], taphonomic processes, and excavation techniques. This results in missing information. Considering the authors remarks of data quality and its importance in archaeological investigations, it was necessary to develop strategies to tackle this issue. First, the skeletal *in situ*-preservation was analysed to collect information about the conditions of the human remains. Second, missing or not determinable information was recorded as "n. d." for all selected characteristics, for instance in the case of destroyed structure lines, unclear body position, or item material. Third, the categorization of graves of unknown type as single+ and double+ gave direct information about the reliability of some burials (see above). Based on this information the graves were classified into five groups of data quality:

1. **MNIG and NPIG are reliable. This** applies to well-preserved graves and inventory; good overview about the *in situ*-situation; number of individuals and body treatment as well as the number and localisation of burial items is as reliable as possible.
2. **NPIG is reliable, MNIG is not**. This is true for graves for which detailed inventory information is available, but the number of individuals is questionable.
3. **MNIG is reliable, NPIG is not.** This is true for damaged graves where parts of a skeleton are missing and consequently potential burial items.
4. **MNIG and NPIG are not reliable.** This is true for damaged and poorly preserved graves for which neither the number of individuals nor the number of burial items can be realistically determined.
5. **Burial character is questionable.** This is true for pits or features similar to graves, but without any proof for inhumation in terms of human remains. These were pits with random artefacts or containing only animal bones.

The approach both takes into account the status of preservation and simultaneously includes aspects of the selected characteristics of burial practice. Consequently, as kind of a "technical calibrator" it is applicable to all further analyses.

4.2 Results 1: Basis of data and single characteristics

This subchapter includes the results of the first analytical approach analysing each of the characteristics (elements of grave construction, inhumation, burial items) individually and independently from each other. An exception is the data quality, as it refers to the reliability of each characteristic. The correlation of the different characteristics is analysed in this chapter.

4.2.1 Elements of grave construction

Table 11 summarises the results for the grave construction parameters – elements, shape, dromos structures, and approximate depth – in absolute and percentage occurrence. Mean values and standard deviations were calculated for each construction element based on complete data to bring the grave construction parameters together with grave dimensions such as size and maximum installation depth. Graves with uncertain measurements were excluded in this step.

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3 For instance, when re-access caused secondary disturbance of the depositional environment.

constuction elements		All (n/%)	Certain (n/%)	Metrics in cm (mean/standard deviation)		
				max depth	max length	max width
Stone element	vertical	24/18.5	22/19.6	95.5/51.1	185.1/58.7	138.4/42.4
	vertical & surface	3/2.3	3/2.6	95.3/83.1	174.3/27.1	113.3/43.1
	flagstones surface	11/8.5	9/8.0	78.0/84.4	174.9/36.8	121.8/39.3
	stones surface	7/5.4	6/5.5	90.3/48.8	229.3/36.0	175.8/20.7
	stones & flagstones surface	2/1.5	2/1.7	50.0/11.3	150.5/43.1	108.0/31.1
	none	73/56.2	62/55.6	47.4/59.1	167.9/55.7	121.0/45.8
	n. d.	10/7.7	8/7.1	106.3/87.3	193.0/17.6	144.6/25.1
Shape	oval	53/40.8	53/47.3	92.6/77.8	185.2/52.4	129.9/42.5
	irregular	20/15.4	18/16	55.5/41.3	195.5/71.1	142.4/63.7
	rectangular	12/9.2	11/9.8	42.8/41.5	180.5/47.3	122.6/35.4
	roundish	9/6.9	9/8.0	55.9/42.7	161.1/26.7	136.1/35.1
	trapezoid	5/3.8	5/4.4	30.6/32.8	133.8/28.9	111.2/32.6
	n. d.	31/23.8	16/14.2	30.6/29.6	147.5/31.9	114.6/30.4
Dromos structures	yes	27/20.8	27/24.1	107.7/64.8	176.8/52.9	142.6/43.8
	no	103/79.2	85/75.9	54.3/61.1	170.1/53.0	124.2/46.3
Approximate depth	<30 cm	49/37.7	39/34.8	12.5/6.3	148.0/47.6	105.23/42.0
	30-100 cm	51/39.2	45/40.1	55.6/19.4	180.8/45.7	131.9/35.5
	100-150 cm	16/12.3	14/12.5	119.6/18.6	189.6/47.8	144.7/43.9
	150-200 cm	6/4.6	6/5.3	166.8/13.4	239.5/57.1	178.2/53.6
	>200 cm	8/6.2	8/7.1	231.8/26.9	224.8/36.6	159.5/19.8
All		**130/100**	**112/100**	**67.2/64.8**	**176.7/52.9**	**128.7/43.8**

Table 11: Grave construction analyses, characteristics and data basis. "Metric in cm" only includes mean and standard deviation of maximum depth, maximum length and maximum width for graves with complete measurements (reliable dimensions). Detailed information for each grave is given in the catalogue.

4.2.1.1 Construction elements

A narrow majority of the burials were built without stone elements (56. 2%); of the graves with such elements, graves with vertical stones are most frequent (18.5 %) followed by flagstones as surface markers (8.5 %). Stone assemblages and the mixed form including flagstones and simple stones on the grave were relatively rare. Pits were mainly of oval shape; irregular and rectangular shapes were less frequent. Shaft structures were documented for 20.8 % of the burials. The vast majority of the graves were installed less than 100 cm deep (76.9 %); 16.9 % of the pits reached a depth between one and two meters and the depths of eight graves (6.2 %) exceeded two meters. With a maximum depth of *ca.* 290 cm, Grave 066 represents the burial with the deepest installation level, followed by Grave 027.2 with *ca.* 250 cm.

Figure 40: Grave construction analyses. Examples of different construction elements. 1: Grave 001, 30-100 cm depth, trapezoid, stone surface. 2: Grave 032, 30-100 cm depth, oval, stones/flagstones surface. 3: Grave 215, <30 cm depth, oval shape, flagstones vertical/surface. 4: Grave 178 upper level, catacomb, lower level 150-200 cm depth, oval shape, flagstones vertical/surface. 5: Grave 218, catacomb with shaft structure, 30-100 cm depth, oval shape, vertical flagstones. 6: Grave 149 upper level, 150-200 cm depth, oval shape, flagstones vertical.

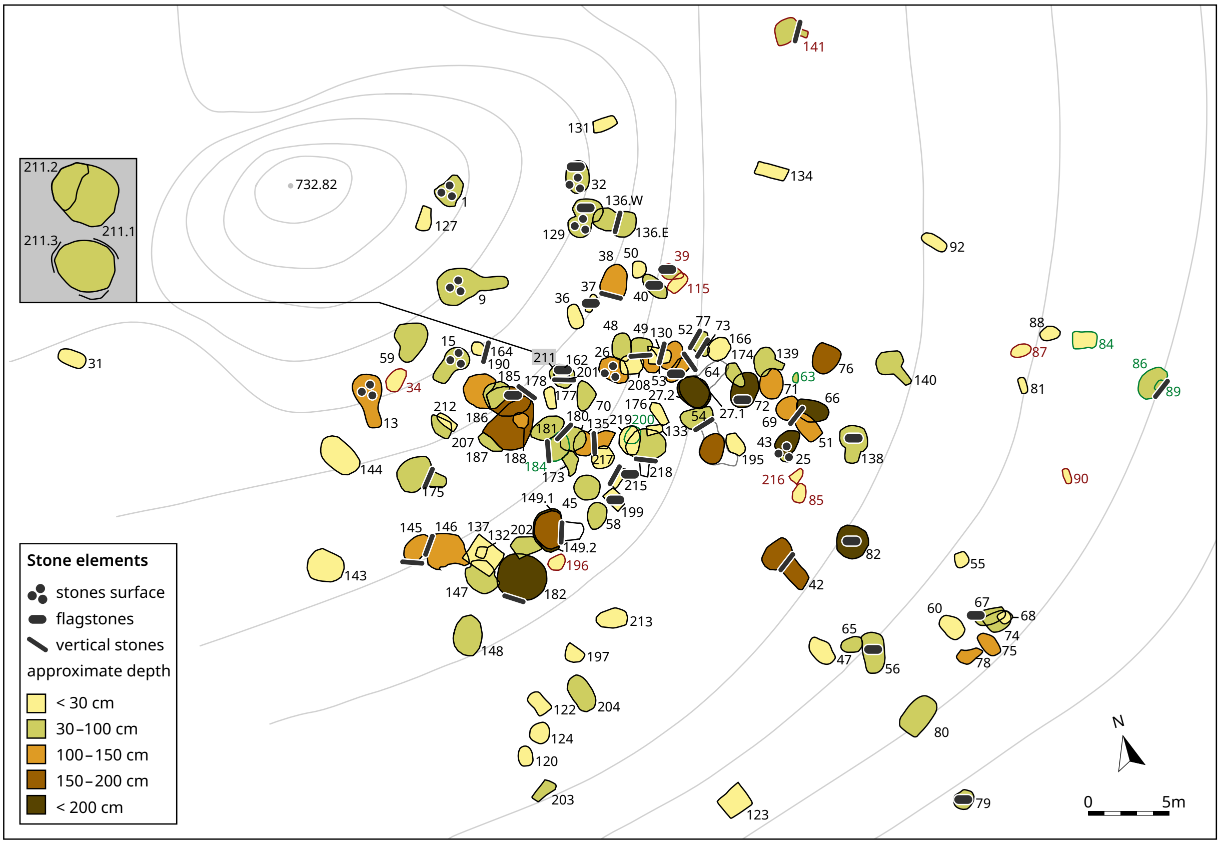

Figure 41: Grave construction analyses. Spatial distribution of approximate depth and stone elements.

4.2.1.2 Construction elements and dimensions

For 112 graves, the combined measurement of maximum length (maxL) and maximum width (maxW) delivered reliable data. The dimensions vary greatly with 79 cm x 64 cm (164), 84 cm x 68 cm (073), and 99 cm x 66 cm (088) as examples of the smallest and 341 cm x 271 cm (186), 320 cm x 250 cm and 296 cm x 278 cm (117) as the largest measurements. The average grave is 176.7 cm in length and 128.7 cm in width and has a maximum depth of 67.2 cm. Most of the mean values of maxL and maxW show that the horiztonal dimensions of the grave pit only slightly correlate with increasing maxD with a maximum grave depth of over 150 cm accompanied by dimensions similar to those of shallower graves; nevertheless, there is a tendency that larger graves are also deeper.

Regarding stone element types and maxD, there are no significant correlations. The average depths of graves with surface markers is not so different than those of graves with vertical stones (excluding mixed forms), the means of maxD differ insignificantly from 79.1 cm to 95.5 cm. However, a difference is visible compared to graves without stone elements, as the mean for those graves is only 47.4 cm[4]. This is due to the fact that more of the graves without stone elements have shallower burial installations. The largest average depths result from graves for which the presence of stone elements remains unclear; hence, these values were not used in the according calculations. The underlying problem is clarified by explaining the single cases with regard to their spatial distribution (see below).

Similar to maxD, the average values of maxL and maxW do not differ significantly based on the inclusion of stone elements (surface markers 185.1 cm/138.7 cm;

4 The mean value of 50 cm for graves with stones and flagstones surface is not considered here as, with only two exemplars, this mean is not statistically relevant.

vertical stones 189.9 cm/138.0 cm). This difference is less pronounced in the single stone elements. Graves without stone construction on average have smaller dimensions. Again, there are graves with missing classifications.

A correlation is indicated between oval shaped grave pits and maxD as their average value is significantly higher compared to all other forms, especially rectangular and trapezoid ones. This might be influenced by the problem of distinguishing features in higher excavation layers and the resulting less clearly documentable grave forms. Nevertheless, on average graves of oval shape were installed at greater depths, though the standard deviation of 77.8 cm points also to the presence of variability. Roundish and rectangular forms had smaller dimensions. The mean values of roundish pits (161.1 cm/136.1 cm) bring the category of "roundish" into question as a difference in length *vs.* width of 25cm is not inconsiderable. However, it is still less than that calculated between the mean length and width of oval shaped pits (55.3 cm).

4.2.1.3 Dromos structures

Dromos structures are significantly more frequent for graves of larger depths, whereas the horizontal extent of the pit seems to be irrelevant. Such corridor-like structures can be understood as entrances to the grave chamber, regardless of whether they were meant for single use or repeated access; the more frequent occurrence in greater depths is comprehensible in terms of practicality. Their installation was not limited to a special pit form, but the majority were found in relation to oval shaped graves (Fig. 40.5, 41). Often these structures were associated with stones in vertical positions; in this regard, the function of vertical stones as elements of a reusable entrance is suggested, although shafts are not exclusively associated with "entrance stones" (Fig. 41). There are also many burials without stone elements or documented shaft structures.

4.2.1.4 Spatial distribution

Figure 41 illustrates the spatial distribution of approximate depth, stone elements and – if documented on the original site plan – shaft structures per grave. Additionally, the original position of vertical stones was reconstructed. Dimensions and shapes were observable in the single grave drawings. Firstly, it is noticeable that graves with greater installation depths cluster in the central area; different installation levels are not surprising there, as this area is characterised by overlapping burial structures. In the periphery, the burials show shallower depths and reveal smaller dimensions. In terms of shape, there is no distribution pattern recognisable. Surface markers such as stone assemblages, flagstones or mixed forms typically occur with graves less than 150 cm in depth; exceptions are Graves 072, 082 and 178. However, the situation for Grave 072 remains unclear and the flagstone of Grave 082 was found not in the direct burial context but too far above the pit; thus, it is uncertain if this burial was in fact marked. The situation for Grave 178 is complex due to neighbouring and overlapping structures; this flagstone may have belonged to another grave. Apart from these three graves, which altered the average calculation of maximum depth (maxD, see Table 11), surface markers seemed to be restricted to burials of shallow depth. Additionally, their distribution is concentrated in the northwestern part of the cemetery, especially in the case of stone assemblages.

4.2.1.5 Summary elements of grave construction

The detailed view of the locations of vertical stones confirms the assumptions made above. First, they occur with graves of greater depths but not exclusively. Second, the positions of the stones are often associated with shafts or contact zones of grave pits; for these cases, a connection of the burial environments must be considered

(145/146, 180, 136.W/136.E, 73/77, 51/69). Third, surface markers and vertical stones are rarely combined as construction elements.

- The following conclusions may be drawn based of the observations made above:
- The grave construction is heterogeneous in terms of dimensions, installation depth, and shape of the grave pit. Graves installed to greater depths tend to have larger surface dimensions.
- Pit shapes are too diverse for gaining significant results.
- Stone elements tend to separate according to those burials with surface markers and shallow installation depth, and those with vertical stones and greater installation depth. The majority of burials contained no stone elements.
- Shaft structures are often associated with vertical stones, though not exclusively, as well as with graves of greater depth. Nevertheless, graves with more than 150 cm depths also existed without comprehensible shaft structures.
- The spatial distribution shows a concentration of graves with surface markers in the north-western part of the cemetery as well as a concentration of graves with widely differing installation depths, overlapping grave structures, and vertical stones in the central area.

Interpreting these results in terms of "effort in grave construction", the following statements can be made:

- Assuming a technological consistency, the installation of a large pit with a great depth requires more work and construction skills compared to the digging of a small pit with a shallow depth. If this is used as an indicator for construction effort, two aspects must be considered: (1) Original chamber dimensions strongly depended on their funerary purpose, differing from single to collective burials (*e.g.* large pit with a single individual in contrast to eight individuals in a small chamber or vice versa). (2) When a grave was re-accessible, the chamber might have been enlarged after the original interment.
- The use of stones is connected to two main aspects of effort: sourcing and transport of the material. The required effort is strongly connected to the size and numbers of stones used, criteria which were not considered in this approach. Therefore, the simple presence of stone built components is the selected indicator for construction effort in further investigations.

Based on these results, we can already conclude that there are distinct differences within the data set in terms of construction dimensions, installation depth and built-in stone elements.

4.2.2 Inhumation and burial types

4.2.2.1 Skeletal *in situ* preservation

124 of 130 graves contained human remains. The conservation status of the skeletons differs significantly from very good (100-76 %) to very poor (25-0.1 %) preservation; all preservations are equally represented (Tab. 12). Six graves did not reveal any evidence for human bones; their relevance will be discussed later (135, 136.W, 136.E, 140, 180, 217).

Bone tissues are variably susceptible to extrinsic factors of taphonomic processes. These processes can be linked to the depositional environment to which the corpse was exposed (natural processes, *e.g.* soil conditions, changes of humidity and temperature, microbial agents, plants, animals) or the burial event itself (*e.g.* accompanying artefacts, body treatment). Bone damage can happen on a chemical (decay) and physical level (disarticulation, fragmentation) and is

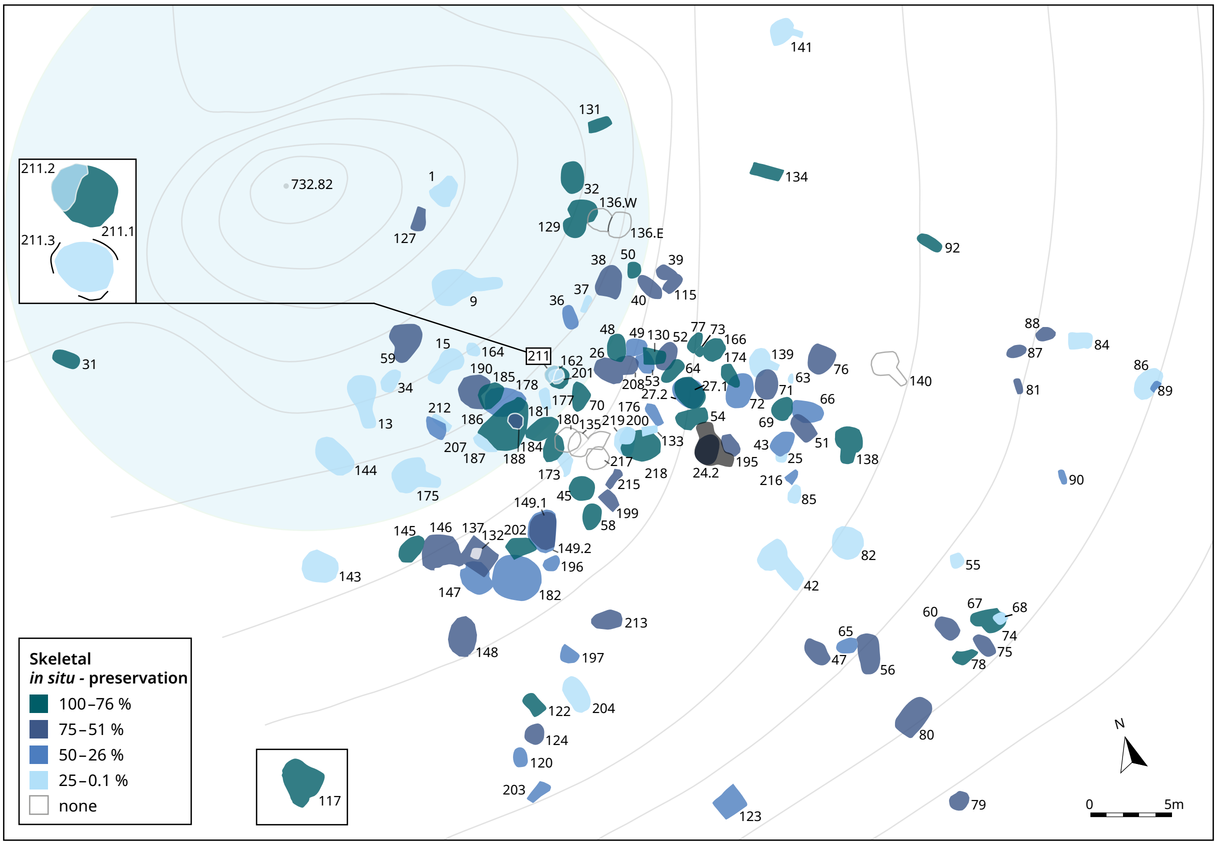

Figure 42: Inhumation analyses. Spatial distribution of skeletal in situ-preservation.

influenced by the time elapsed between deposition and excavation. Additionally, shape, size, and density of the bone itself are major factors (cf. Mays 1998, 17-26; Katzenberg and Saunders 2007, 81-83). For the human remains from Kudachurt 14, poor and very poor preservation is characterised by the decay of bones as well as by missing larger skeletal elements, *e.g.* lower extremities (43.1 %, see Figs. 43-45). In some graves, bones were disarticulated or scattered. Consequently, chemical and physical damage of the skeletonized corpses was intensified due to an increase in exposed surface areas. The spatial distribution of preservation quality does not show clear patterning, at least not on a two-dimensional scale (Fig. 42). Graves with poor skeletal preservation are often located in the western periphery, though this distribution pattern is not statistically significant. Critical differences in environmental conditions, *e.g.* soil acidity, are not existent across the site of Kudachurt 14. However, the correlation between skeletal preservation and burial type is interesting in this respect and will be discussed later; the preservation condition also applies to the funerary accoutrements, particularly the accompanying artefacts and their chemical influences. Considering the local weather conditions and the firm, hard, and sticky ground, unavoidable slight and partial damage during excavation has contributed to the preservation status of the human remains. In summary, the heterogeneous preservation is a result of different circumstances. Faunal bones are generally in better condition and some graves did not contain any human, but exclusively animal remains. These six graves (see above) contained chronologically relevant objects of the Bronze Age Period; their status as a burial can still be assumed even without preserved human remains (in contrast to a pit containing artefacts, appearing only similar to a burial character).

4.2.2.2 MNIC, MNIG and burial type

The estimation of the minimum number of individuals per grave (MNIG) from burials with human remains allowed the calculation of (1) the minimum number of individuals buried on the cemetery (MNIC, Table 13), and (2) the determination of burial types.

According to the documentation, 124 of the examined 130 graves contained human remains from at least 265 individuals (=MNIC). Due to predominantly completely represented skeletons, the overall picture of the human remains visible in the *in situ*-situations of the burials speaks for primary interments[5]. This was confirmed by the osteological analyses (see chapter 7). The majority of the individuals (n=249) were detected in burials with chronologically relevant items, the remaining individuals (n=16) were from contexts with insecure or unknown chronological assignment. The strong positive correlation between good skeletal preservation and increasing number of recognisable individuals (169/100-51% to 96/50-0.1%) emphasises the influence of skeletal preservation on MNI reliability in general. Hence, decayed skeletons presumably lower the MNIC and. in some cases, also the MNIG.

Poor skeletal preservation often resulted in the classification of single+ or double+ burials; the ratios in Fig. 46 and Fig. 47 underline the importance of this issue. Based on this data, the results are as follows:

- Single and collective graves make up the majority of recognized burials, whereas double graves are infrequent (ratio 47 single/11 double/30 collective; Table 12). Burial types of uncertain classification (single+, double+) were related to 42 contexts, the number of “ind *in situ*” remains unclear for according graves.
- Within the burial types, the MNIG differs from one to thirteen individuals without any significant regularity in terms of standardized patterns.
- The peaks in number of “ind *in situ*” (Fig. 46, black dashed line) lead to the burial type classification of small (3-5), medium (6-8) and large (9-13) collective burials as described in the section above.
- Single graves are more frequent compared to double or collective graves, although this trend becomes weaker when eliminating graves with insecure numbers of buried individuals. Figure 46 illustrates this by displaying the total number of “ind *in situ*” against the MNIG (single+, double+; Fig. 46, reliable burial types in terms of MNIG).
- Graves with more than five individuals are less frequent compared to smaller collective graves; the ratio between burial type and number of “ind *in situ*” stays roughly proportional (*e.g.* four coll S burials contain a similar number of individuals as one coll L burial when the interred are added up; Fig. 46, dashed line).
- The majority of the individuals were buried in pairs or groups, as in 47 graves at least 218 skeletons were identified (82.3 %, Tab. 13, Fig. 47).

There is no tendency detectable in the spatial distribution of burial types. Single, double and collective grave are distributed over the entire excavation area (Fig. 48). Only the larger collective graves were set up closely to each other (145, 146, 137, 147). Dromos structures and vertical flagstones link some of the grave pits[6]. Considering the aspect of a “central area”, where most of the graves are located and the MNIG/ MNI reaches the highest concentration, most of the deceased were buried in this central accumulation of tombs.

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5 In contrast to secondary burials for which a selection or ordering of skeletal remains would be expected.

6 In this context, the definition of “one grave” in terms of a sealed funeral environment is problematic for some graves.

GRAVES		All (n/%)	Skeletal *in situ*-preservation (n/%)				
			100-76 %	75-51 %	50-26 %	25-0,1 %	None
Chronological classification	bronze age	114/87.7	33/28.9	30/26.1	19/16.6	27/23.7	6/5,7
	no rel items	6/4.6	1/16.7	0	1/16.7	4/66.7	0
	no items	10/7.7	1/10	3/30	3/30	3/30	0
Burial type	single	47/36.2	23/48.9	16/34.0	4/8.5	4/8.5	0
	double	11/8.5	5/45.5	4/36.7	2/18.2	0	0
	coll S	20/15.4	3/15	9/45.0	7/35.0	1/5.0	0
	coll M	6/4.6	3/50.0	1/16.7	2/33.3	0	0
	coll L	4/3.1	1/25.0	3/75.0	0	0	0
	single+	32/24.6	0	0	6/18.8	26/81.3	0
	double+	4/3.1	0	0	1/25.0	3/75.0	0
	n. d.	6/4.6	0	0	0	0	6/100
Data quality group	1	59/45.5	30/50.8	20/33.9	5/8.5	4/6.8	0
	2	24/18.5	2/8.3	10/41.7	8/33.3	2/8.3	0
	3	7/5.4	3/42.9	3/42.9	1/14.3	0	0
	4	34/26.1	0	0	8/23.5	23/67.6	0
	5	6/4.6	0	0	0	0	6/100
All		**130/100**	**35/26.9**	**33/25.4**	**22/16.9**	**34/26.2**	**6/4.6**

Table 12: Inhumation analyses, database. Distribution of graves according to chronological classification, burial type, data quality group, and skeletal in situ -preservation. Frequencies (n) and percentages (%).

INDIVIDUALS *IN SITU*		All (n/%)	Skeletal *in situ*-preservation per grave (n/%)			
			100-76 %	75-51 %	50-26 %	25-0,1 %
Chronological classification	bronze age	248/93.6	71/28.6	93/37.5	51/20.6	33/13.3
	no rel items	6/2.3	1/10.0	0	1/10.0	4/40.0
	no items	11/4.1	1/9.1	3/27.3	3/27.3	4/36.4
Burial type	single	47/17.7	23/48.9	16/34.0	4/8.5	4/8.5
	double	22/8.3	10/45.5	8/36.7	4/18.2	0
	coll S	75/28.2	10/13.3	34/45.3	26/34.7	5/6.7
	coll M	41/15.4	21/51.2	7/17.0	13/31.7	0
	coll L	40/15.0	9/22.5	31/77.5	0	0
	single+	32/12.0	0	0	6/18.8	26/81.3
	double+	8/3.0	0	0	2/25.0	6/75.0
Data quality group	1	98/36.8	59/60.2	29/29.6	6/6.1	4/4.1
	2	117/44.0	11/9.4	62/53.0	35/30.0	9/7.7
	3	10/3.8	3/30.0	5/50.0	2/20.0	0
	4	40/15.0	0	0	12/30.0	28/70.0
All: MNI		**265/100**	**73/27.4**	**96/36.1**	**55/20.7**	**41/15.4**

Table 13: Inhumation analyses, database. MNI and distribution of individuals in situ, according to chronological classification, burial type, data quality group, and skeletal in situ-preservation. Frequencies (n) and percentages (%).

4.2.2.3 Signs of re-access

In order to be able to address the question of simultaneous or successive inhumation, the *in situ*-situations of the graves were examined in terms of signs for re-access: secondary disturbance and superimposition of individuals. Since secondary disturbances can either be due to animal or human impact, the superimposition of bodies is preferred as an indicator of human activity. Altogether, 39 of 130 graves (30 %, see Table 14) show signs of re-access, wherein the number of graves with superimposition is significantly higher compared to those with secondary disturbances. Overlapping of skeletons – the criteria for superimposition – varies from only parts of one body being covered by parts of other skeletons, to completely overlying bodies (Fig. 49). All but three collective graves show funeral environments with overlapping skeletal layers; in some cases, it cannot be clarified how complex the layering actually was (*e.g.* Grave 137 and 149.2, Fig. 49.2.4). Additionally, five double graves revealed individuals deposited on top of each other. Hence, this practice was not restricted to graves with large numbers of individuals.

Secondary disturbance is assumed for six graves (Tab. 14). All of them also showed superimposition of individuals. Consequently, it is very likely that the accumulation of disarticulated bones is due to secondary human activity. It should be acknowledged, though, that the overlapping of skeletons is not necessarily an indication of repeated grave use as several individuals might have been buried overlying each other during the same funerary event.

Based on the criteria investigated, a vast majority of graves containing more than one individual showed signs of re-access. The majority of these graves are located in the central area of the cemetery and are often next to each other (*e.g.* Grave 132, 137, 145-147, 182, see Fig. 50). This resembles the general pattern of the distribution of the graves.

The relatively few secondary disturbances in contrast to the relatively frequent superimpositions leads to the assumption, that (1) either not much time passed between potential funeral events (and thus the human remains of previously buried individuals were still in a relatively firm articulation resulting in less disturbances by superimposed bodies) or (2) the burying members of the society were very cautious when interring the later individuals in order to preserve previous inhumations. If this was not the case, skeletal disarticulations and accumulations of bones would have appeared more frequently; this was detected in only five burials.

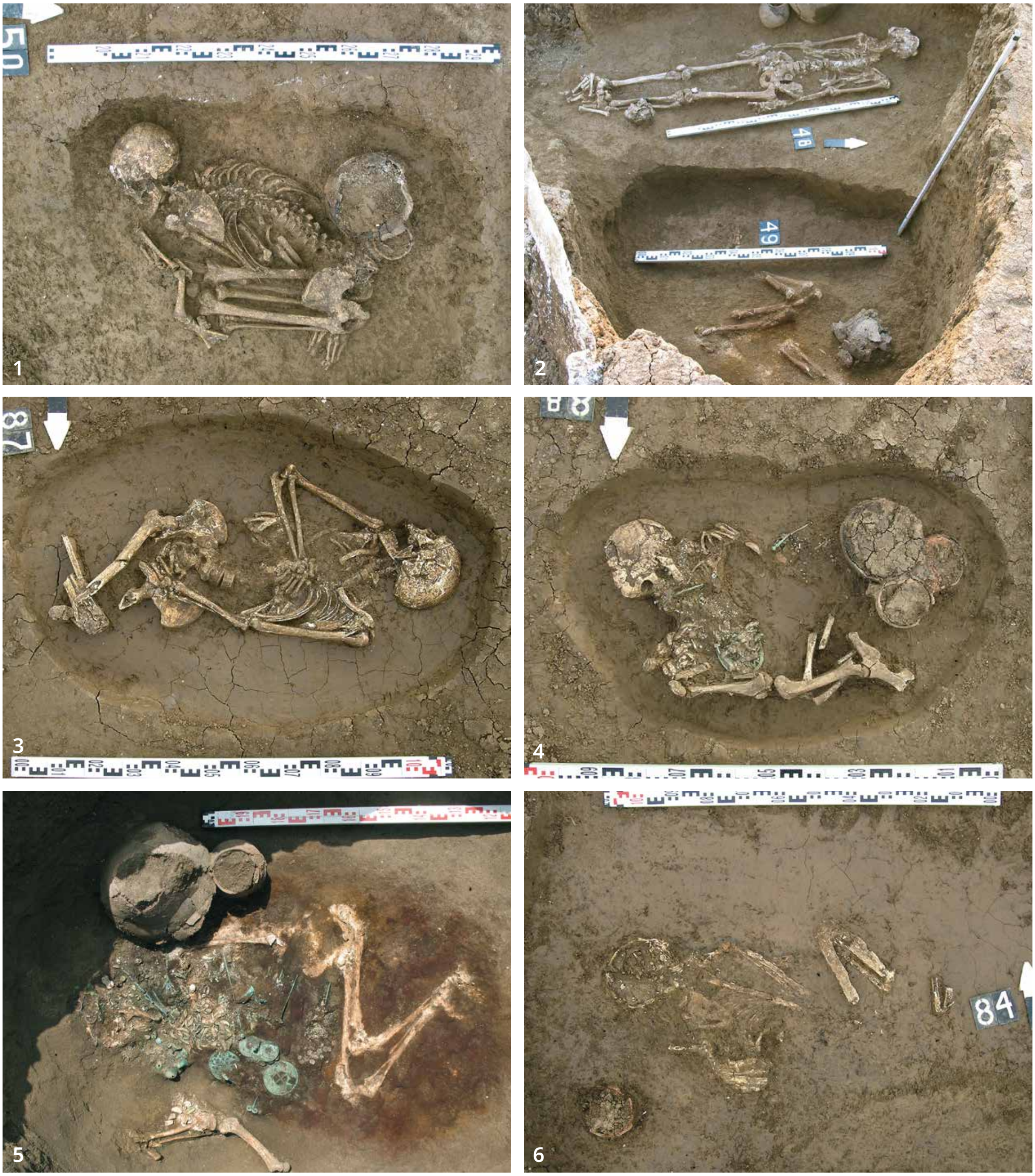


Figure 43: Inhumation analyses. Examples of inhumation characteristics of single burials including skeletal preservation, body positioning, and the dispersal of ochre. For further information, look up respective graves in the catalogue.

Figure 44: Inhumation analyses. Examples of inhumation characteristics of double burials including skeletal preservation, body positioning, and the dispersal of ochre. For further information, look up respective graves in the catalogue.

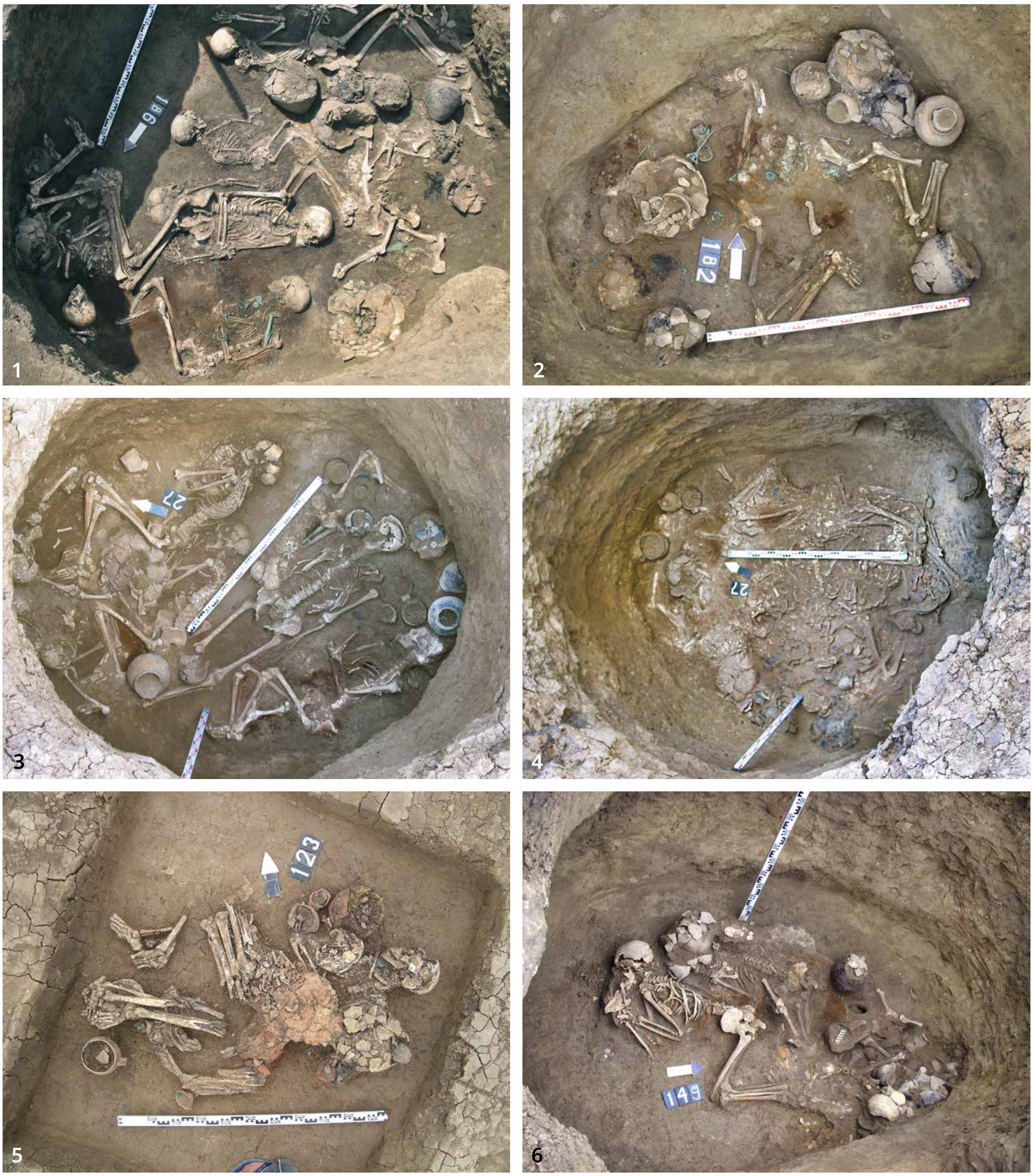


Figure 45: Inhumation analyses. Examples of inhumation characteristics of collective burials of different size including skeletal preservation, body positioning, and the dispersal of ochre. For further information, look up respective graves in the catalogue.

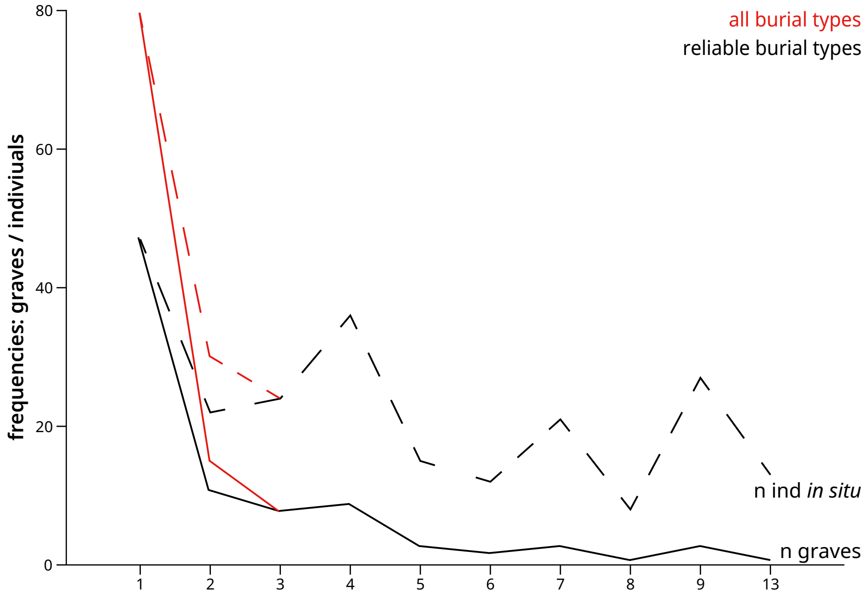


Figure 46: Inhumation analyses. Absolute distribution of graves with human remains (n=124, solid line) and individuals (n=265, "ind in situ", dashed line) against the MNIG. The distribution is separated in burials of all types (red colour, includes singe+ and double+) and those with reliable burial type determination (black colour). Consequently, from 3 MNIG onwards the distribution is congruent (all=reliable, black colour).

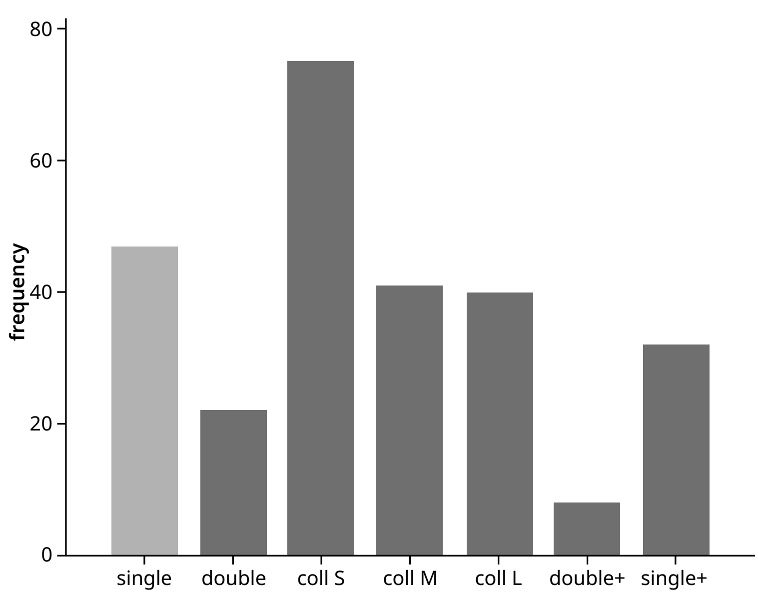


Figure 47: Inhumation analyses. Absolute distribution of individuals' in situ and burial type. The number of individuals from single burials are marked in light grey compared to the number of individuals buried in pairs or groups.

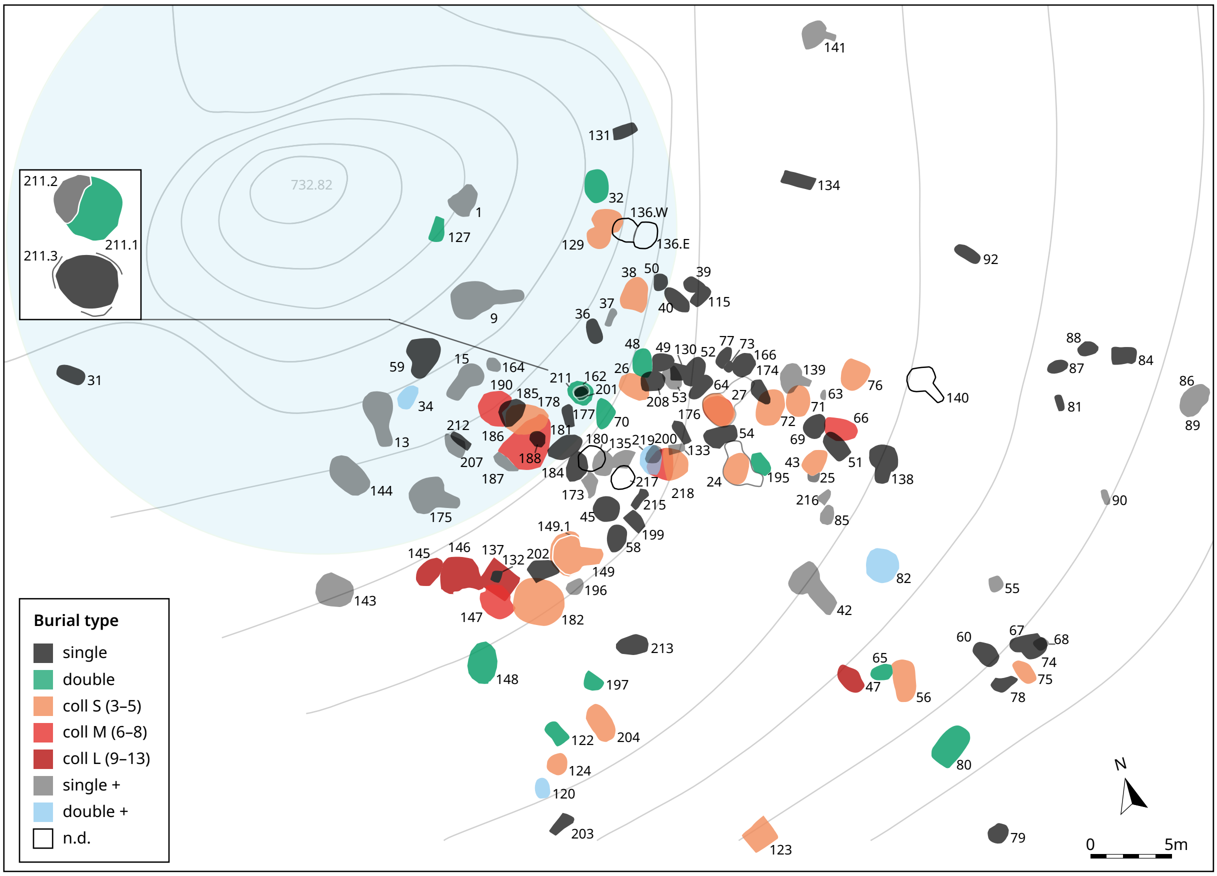


Figure 48: Inhumation analyses. Spatial distribution of burial types.

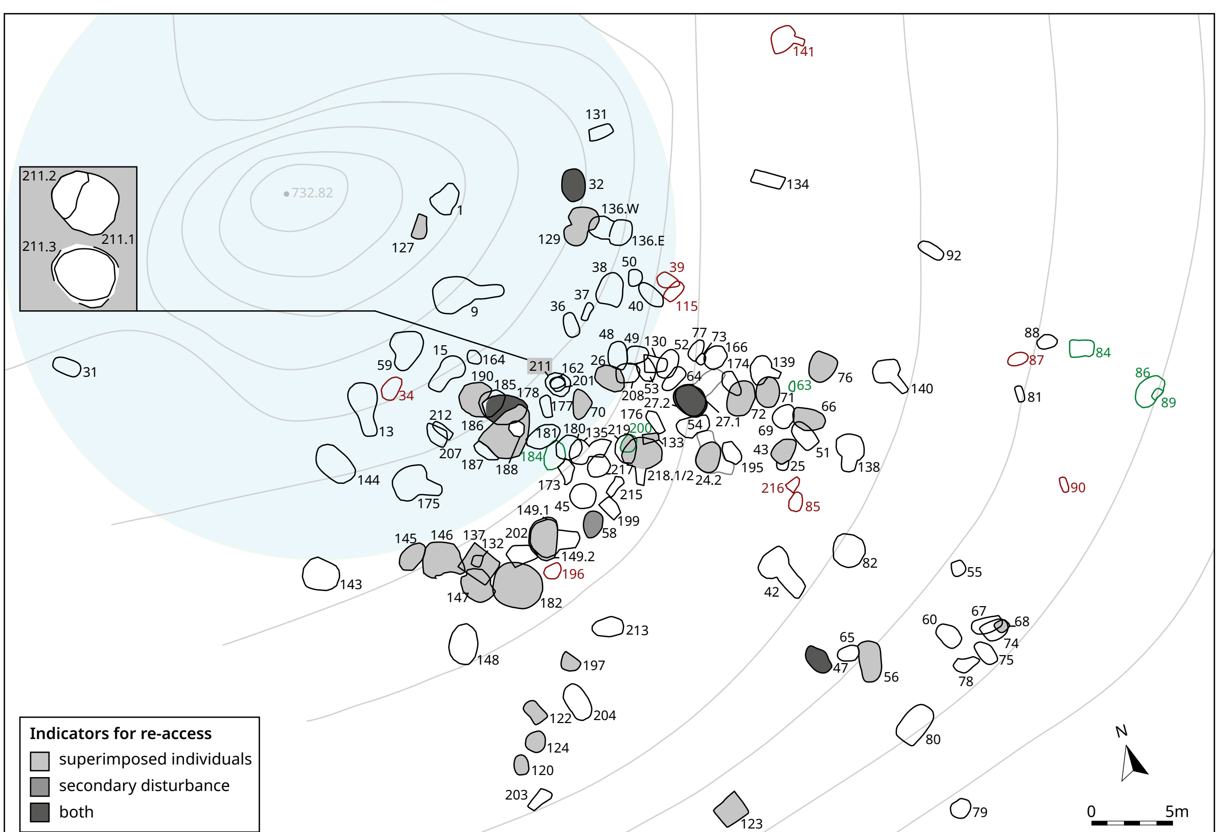
Table 14: Inhumation analyses. Signs of burial re-access and burial type. Frequencies (n) and percentages (%).

BURIAL TYPE	All (n/%)	Signs of re-access (n/%)			
		Skeletal layers	Sec. disturb.	both	none
Single	47/36.2	0	1/14.3	0	46/47.9
Double	11/8.5	5/15.2	1/14.3	1/16.6	6/6.3
Coll S	20/15.4	17/51.5	3/42.9	3/50.0	3/3.1
Coll M	6/4.6	6/18.2	1/14.3	1/16.7	0
Coll L	4/3.1	4/12.1	1/14.3	1/16.7	0
Coll all	30/23.1	27/81.8	5/71.4	5/83.4	3/10.0
Single+	32/24.6	0	0	0	32/33.3
Double+	4/3.1	1/3.0	0	0	0
n. d.	6/4.6	0	0	0	6/6.3
All	**130/100**	**33/25.4**	**7/5.4**	**6/4.6**	**96/73.8**

Figure 49 (opposite above): Inhumation analyses. Examples for signs of re-access in collective graves (overlaying individuals and disarticulated skeletal elements). 1-2 grave 149, upper and lower burials. 3 grave 047 with disarticulated skeletal elements in the western area. 4 grave 137.

Figure 50 (opposite below): Inhumation analyses. Spatial distribution of signs of re-access.


1
149
2
3
47
4
137


141
131
134
32
1
127
136.W
129
136.E
92
211.2
211.1
211.3
732.82
38
50
39
115
9
36
37
40
88
84
87
31
59
15
164
211
162
26
48
49
130
52
77
73
166
174
139
76
140
86
89
81
34
190
185
178
201
53
64
63
208
27.2
71
66
177
70
72
13
212
186
181
180
135
219
200
54
27.1
69
207
184
187
188
133
43
51
138
25
195
217
218.1/2
24.2
144
173
215
216
90
175
149.1
45
85
199
58
145
146
137
132
202
149.2
196
82
55
143
147
182
42
213
60
67
68
74
75
65
148
197
47
56
78
204
122
80
124
120
203
123
79
Indicators for re-access
superimposed individuals
secondary disturbance
both
N
0
5m

TREATMENT		All (n/%)	Body side (n/%)				
			Right	Left	Supine	special	n. d.
Corpse position	flexed	116/43.8	68/94.4	46/85.2	0	0	2/1.7
	hyperflexed	11/4.2	4/5.6	7/13.0	0	0	0/0
	stretched	19/7.2	0	0	18/3.2	0	1/0.8
	special	1/0.4	0	0	0	1/100	0/0
	n. d.	118/44.5	0	1/1.9	0	0	117/97.5
Orientation	N	17/6.4	9/12.5	5/9.3	1/0.2	0	2/1.7
	NE	40/15.1	15/20.8	14/25.9	8/1.4	0	3/2.5
	E	10/3.8	1/1.4	4/7.4	1/0.2	0	4/3.3
	SE	15/5.7	8/11.1	3/5.5	2/0.3	0	2/1.7
	S	6/2.7	3/4.2	1/1.8	0/0	0	2/1.7
	SW	20/7.5	12/16.7	6/11.1	2/0.4	0	0/0
	W	22/8.3	10/13.9	7/12.9	1/0.2	0	4/3.3
	NW	30/11.3	12/16.7	14/25.9	3/0.5	0	1/0.8
	n. d.	105/39.6	2/2.8	0	0	1	102/85
All		**265/100**	**72/27.2**	**54/20.4**	**18/6.8**	**1/0.4**	**120/45.3**

Table 15: Inhumation analyses. Body treatment, considering positioning and direction. Frequencies (n) and percentages (%).

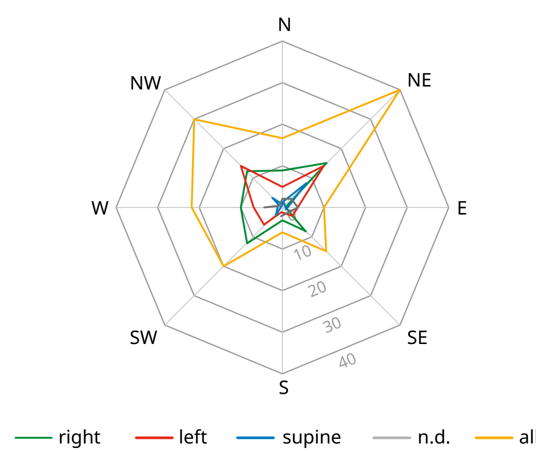


Figure 51: Body positions at Kudachurt 14, orientation and body side (n=265, see Tab. 15).

TREATMENT		All (n/%)	Burial type				
			Single	Double	Coll S	Coll M	Coll L
Corpse position	flexed	116/438	32/68.1	10/45.5	33/44.0	20/48.8	15/37.5
	hyper crou	11/4.2	9/19.1	2/9.1	0	0	0
	stretched	19/7.2	5/10.6	5/22.7	5/6.7	2/4.9	1/2.5
	special	1/0.4	0	1/4.6	0	0	0
	n. d.	118/44.5	1/2.1	4/18.2	37/49.3	19/46.3	24/60.0
Body side	left	54/20.4	18/38.3	3/13.6	13/17.3	9/22.0	8/20.0
	right	72/27.2	23/48.9	9/40.9	20/26.7	11/26.8	7/17.5
	supine	18/6.8	5/10.6	5/22.7	4/5.3	2/4.9	1/2.5
	special	1/0.4	0	1/4.5	0	0	0
	n. d.	120/45.3	1/2.1	4/18.2	38/50.7	19/46.3	24/60.0
Orientation	N	17/6.4	3/6.4	7/31.8	3/4.0	4/3.8	0
	NE	40/15.1	11/23.4	7/31.8	12/16.0	7/17.1	0
	E	10/3.8	3/6.4	0	3/4.0	0	1/2.5
	SE	15/5.7	3/6.4	2/3.1	3/4.0	4/3.8	3/7.5
	S	6/2.7	2/4.3	0	4/5.3	0	0
	SW	20/7.5	5/10.6	0	4/5.3	2/4.9	9/22.5
	W	22/8.3	6/12.8	0	11/14.7	1/2.4	3/7.5
	NW	30/11.3	14/29.8	3/13.6	5/6.7	5/12.2	2/5.0
	n. d.	105/39.6	0	3/13.6	30/40.0	18/43.9	22/55.0
Ochre	yes	29/22.3	5/10.6	0	11/55.0	4/66.7	2/50
	no	101/77.7	42/89.4	11/100	9/45.5	2/33.3	2/50
All		**265/100**	**47/17.7**	**22/8.3**	**75/28.3**	**41/15.5**	**40/15.1**

Table 16: Inhumation analyses. Body treatment and burial type, considering corpse deposition, body site and direction. Frequencies (n) and percentages (%). The data concerning the distribution of ochre refers to the number of graves (n=130).

4.2.2.4 Body treatment

The identification of two body position criteria – orientation and position – was possible for only a little more than half of the individuals (Tab. 15). In terms of corpse position, the vast majority (43.8 %) of the individuals were in a flexed position; extreme positions are significantly less prevalent, also when compared to stretched positioning.

North-eastern and north-western orientations are most common (15.1 % and 11.3 %). Individuals with heads pointing directly to the north are significantly less frequent. The same applies to those pointing in western and southwestern directions (Fig. 51). Southern and eastern orientations make up the fewest cases.

The body side was determinable for 54.7 % of individuals. Individuals placed on their right- and left-side are almost equally distributed. With only 4 left- and 7 right-sided cases of hyperflexed body positioning, this treatment is not common.

In terms of combinations of body sides and orientations, there are no very clear preferences detectable. It seems that right-sided individuals were more often laid to rest with their heads pointed to the north, south-east, and south-west, but this might be due to the slightly uneven distribution of right-and left-sided positions. Individuals interred in supine and stretched positions were more often orientated with their heads pointing to the northeast, but other orientations also appear. Although the burial rites appear to have not been very strict in terms of body treatment, there seems to have existed a tendency towards a flexed position and a northerly orientation. Differences in the burial practises could also have other cultural bases or could represent different social groups and traditions of subgroups (for example, "family traditions").

Grave 122 (Fig. 42.1) represents a special case. Here, an individual (2) was superimposed above another individual (1), which was found in a right-sided, flexed position. The anatomic position of the skeletal remains of individual 2 is exceptional as the upper thorax is extremely bent backwards with a remarkable kink in the spine. Its cranium is located beside its pelvic region, the left leg is bent and the right one is missing. In contrast, the right arm is bent and the left one is missing. This extreme folding of the spine contradicts natural anatomy and exceeds forms of pathological changes which means that an extensive, extrinsic effort was required in positioning this individual. Unfortunately, the skeletal remains were not available for osteological analyses. As there are no hints for general disarticulation of the skeletal elements, although some are missing completely, the soft tissues likely were not completely decomposed when the corpse was buried[7]. The reason for this exceptional position remains unclear. A strong bending due to decomposition or taphonomic processes seem unlikely, as then such a position would be expected to occur more frequently in the cemetery. It is rather probable that the individual was intentionally interred in this position.

There are no significant correlations between burial type and position. However, the determination of body position was less possible when the number of individuals buried in a single grave increased due to overlaying and unclear *in situ*-situations (see Fig. 45). Therefore, the high percentages of flexed and hyperflexed positions in single graves is not significant. This is similar in terms of body side. Individuals laid down in a stretched manner are represented within all burial types. They appear more frequently in graves with more than one individual. The orientation seems not to be correlated with the burial type. The distribution follows more or less the general trend: the direction of orientation is not more varied in collective burials even given the relative lack of space. Often, individuals were positioned in the same manner in double and collective graves (see Figs. 44.2-6, 45.2-3). However, in general, the burial type had no significant influence of how the individuals were laid to rest.

4.2.2.5 Presence of ochre

It was not possible to connect the presence of ochre to specific, single individuals in all cases. Overall, red colouration was identified in 29 graves. In 15 graves it was possible to specify the individual (see Figs. 43.5, 45.1-2). Consequently, ochre played a role in the funeral ritual for less than 25 % graves. Ochre occurs relatively often in collective graves, especially in the smaller ones (3-5 individuals, see Fig. 52). It is, however, possible that this ochre was actually deposited in relation to a single individual within the collective graves (as recognizable in *e.g.* Grave 038, 186; Fig. 45.1). This also explains the higher frequency of ochre in collective burials, as with an increasing number of individuals the probability of ochre being part of ritual habit for at least one of buried individuals also increases. The presence of ochre was therefore independent from the burial type. Signs of re-accessibility (overlaying of skeletons and secondary disturbance) are not connected to the presence of ochre. Referring to the general corpse treatment, ochre dispersal is significantly more frequent for individuals positioned in a flexed manner and on the right side of their body (17 in relation to 6 left-sided and 2 individuals in stretched position). In addition, these individuals had mostly northeastern and northwestern orientations

7 As is visible in the spinal column and the hand bones, the musculoskeletal apparatus, or at least the ligaments, still fixed the bones in anatomic position.

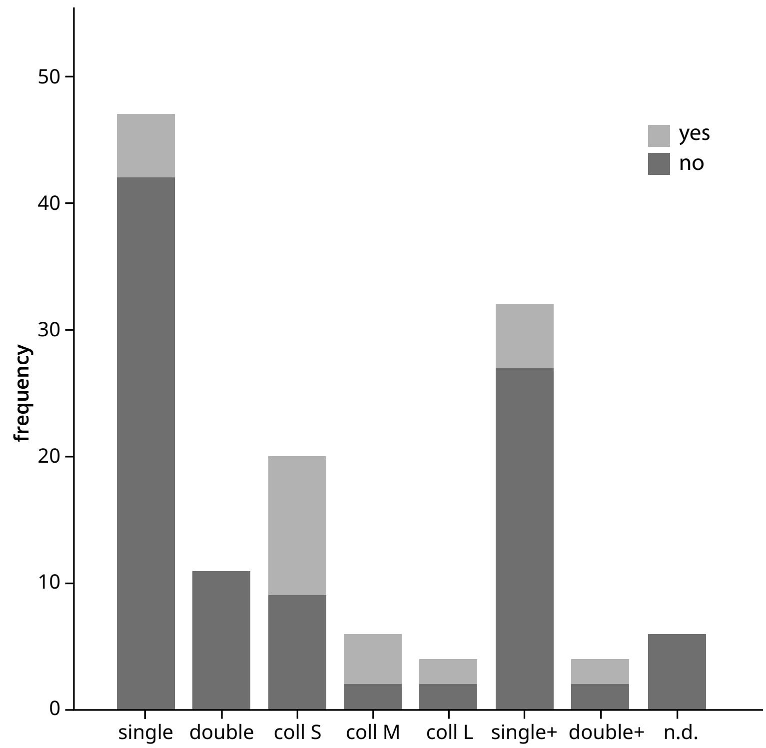


Figure 52: Inhumation analyses. Frequencies of the presence of ochre in correlation with the burial type (n=130).

(8/4); other orientations are less often represented (N: 1, SE: 2, SW: 1). In consequence, the dispersal of ochre is strongly associated with the body positioning, especially with individuals in flexed positions lying on their right side. Still, it remains striking that the dispersal of ochre was not a universal habit within all burials.

In terms of the different elements of inhumations, the results can be summarised as follows:

- The determination of individuals by means of the excavation documentation, supplemented by the numbers resulting from the osteological analyses, resulted in a minimum number of 265 individuals buried at the cemetery (MNIC). Probably the actual number is higher; different stages of skeletal preservation have a strong influence on the reliability of determinable numbers of individuals buried. The burials in general are lacking indications for selective inhumations of skeletal elements and thus represent primary burials.
- The determination of individuals resulted in the minimum number of individuals per grave (MNIG) which lead to the establishment of seven burial types. Single+ and double+ burials describe cases whose information is unreliable due to poor skeletal preservation.
- Single burials represent the most frequent burial type, but the majority of the MNIC were buried in pairs or groups (ratio is 47:218); large collective burials are less frequent compared to smaller ones.
- The different burial types are distributed across the cemetery area without any specific pattern; exceptions are some collective burials which neighbour each other (Grave 145-147, 182; Grave 178, 186, 190).
- 30 % of the burials show signs of re-access. Only three of 30 collective burials are lacking according characteristics. Hence, recurring funeral events are very probable for these graves, although the temporal dimension is hardly detectable. In general, the burying members of the society were very cautious not to disturb older inhumations.
- The treatment of the corpses was reconstructable for less than half of the MNIC. Treatment criteria differ from flexed, hyperflexed, to stretched positions on the

left or right body side or in supine position. Right-sided and left-sided flexed positions are predominant compared to stretched positions. In terms of orientation, NE and NW directions are most frequent. There is no strong correlation between body position, orientation and burial type, hence the interment of the deceased was not dependent on the number of individuals buried in a grave (although often adjoining individuals showed the same positioning).

- The presence of ochre as a funeral element shows rather individual relevance as it was proven to be related to single individuals even within collective burials. It predominantly occurs in relation with individuals in flexed positions on their right side and with northeastern/northwestern orientations. The dispersal of ochre was not a universal part of the funeral ritual.

4.2.3 Burial items

The following subchapter deals with the analyses of the burial items present in the graves of Kudachurt 14. These analyses follow the approach and criteria described in Subchapter 4.1.4. To provide an overview, Figure 53 summarises the criteria that were defined. Figure 54 shows the vessel categories. chapter 3.4.1.2, Tables 2-4 and Figures 17-22 can be consulted with regards to jewellery, weapon, and tool categories. Figure 55 gives an example of items made of organic, composite, and unknown material.

4.2.3 1 Cemetery and data quality

120 of 130 investigated graves contained a total of 2332 burial items (Tab. 17). The average value of items per burial is 19.4. 82.7 % of the items are from graves of data quality groups 1 and 2, for which the NPIG[8] is secure; the remaining 17.3 % of the items were found in burials with less secure determinations of both NPIG and MNIG[9]. The values of general *in situ*-item as well as skeletal preservation in this respect are less favourable, as more than 50% of the items originate from graves with poor preservation. The burial character is questionable for the context of 45 items, all vessel or animal remains, as in these contexts human remains were either never present or were not preserved. These last burials form data quality group 5 (Grave 135, 136.W, 136.E, 140, 180, 217). Ten burials did not contain any items (034, 039, 085, 087, 090, 115, 166, 196, 216; see chapter 3.1.4.1, Table 1, Fig. 16). In general, the graves in which the burial items were found can be considered quite reliable. Figure 56 maps the data quality of each grave in the cemetery. Poor preservation conditions are apparently not the result of any spatially determined process, as the data quality groups are not restricted to specific areas of the cemetery.

4.2.3.2 Cemetery and burial item criteria

Regarding the ratios of materials, ceramic and bronze products make up the vast majority (46.6 % and 34.8 %, respectively), followed by objects made of material derived from animals and antimony. Stone items are rare and objects made of more than one material are extremely rare. For 95 artefacts (4.2 %) the material was not determinable. The number of items associated with the functional classes food and jewellery are almost equally represented (53.6/43.8%). Here, the great difference with items of the functional classes weaponry and tools is striking (2.4/0.2 %; Table 17, Fig. 57).

---

8 Number of preserved items per grave.
9 Minimal number of individuals per grave.

Burial Item Criteria

Materials	Categories	
ceramic	cup	meat (1–2)
animal	beaker	
bronze	pot	pin
stone	can	beads (1–4)
antimony	flat bowl	tutulus
not classified	bowl	pendant
	large vessel	bracelet
	goblet	spiral ring
		spiral roll
Functional classes	spearhead	spiral buckle
	dagger	belt hook
food *(vessels, meat)*	arrowhead	decorative element
jewellery	axe	decorative plate
weapons	whetstone	
tools	loom weight	special form

Figure 53: Definition of burial item criteria. For illustrations of the categories, see Figs. 17-22, 54-55.

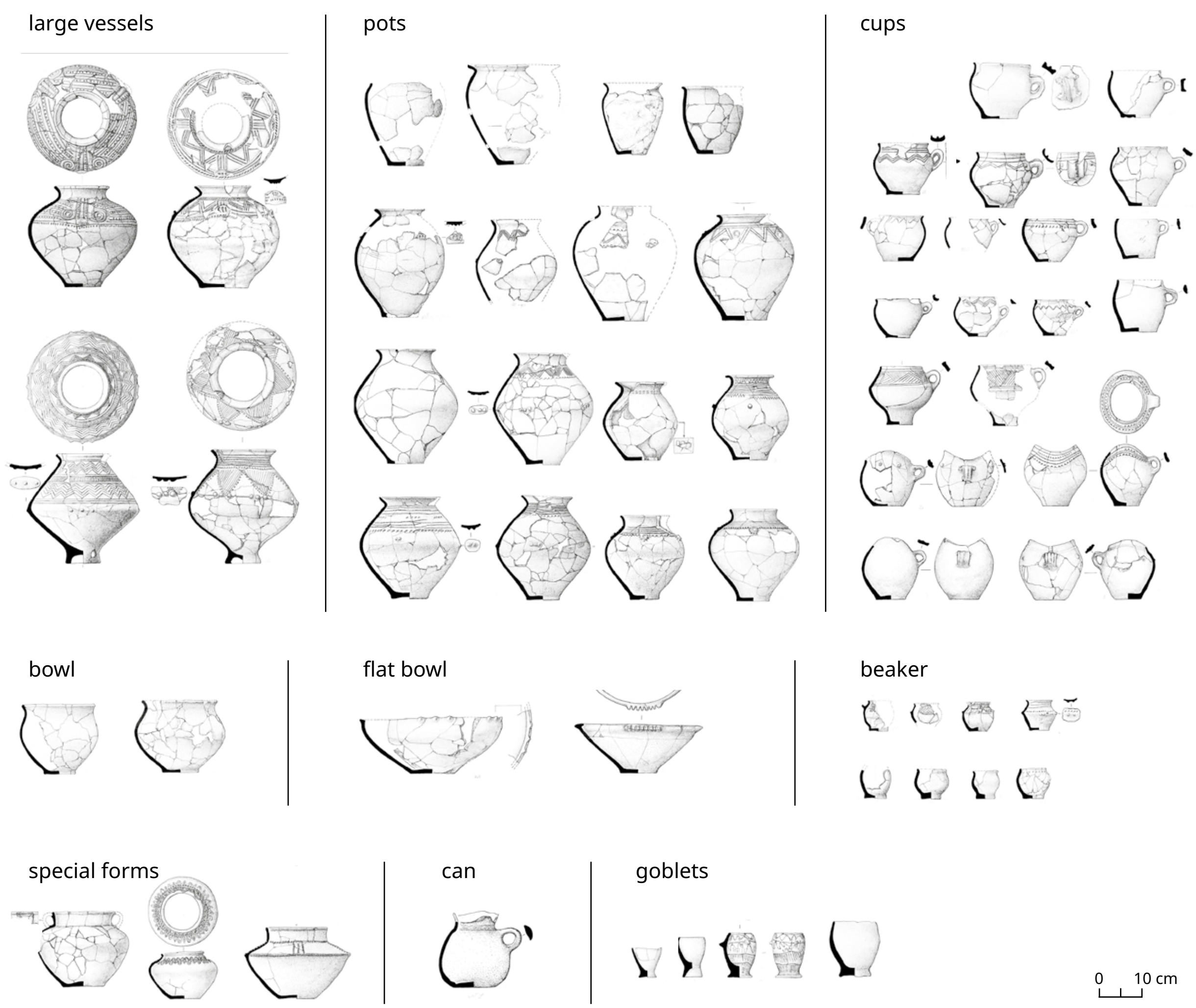


Figure 54: Classification of the vessels in terms of the burial item criteria categories. Classification according to Reinhold 2012.

Figure 55: Burial item analyses. Examples for jewellery items of organic and unknown material. 1: Grave 024, necklace made with animal teeth pendants. 2: Grave 149, composite pendant of a bronze spiral roll and beads of mixed unknown material. 3: Grave 177, different beads of unknown material, antimony tutuli, a stone and a shell pendant. 4-5: Grave 026 and 195, beads of mixed unknown material. 6: Grave 146, different beads of stone and mixed unknown material as well as shell pendants.

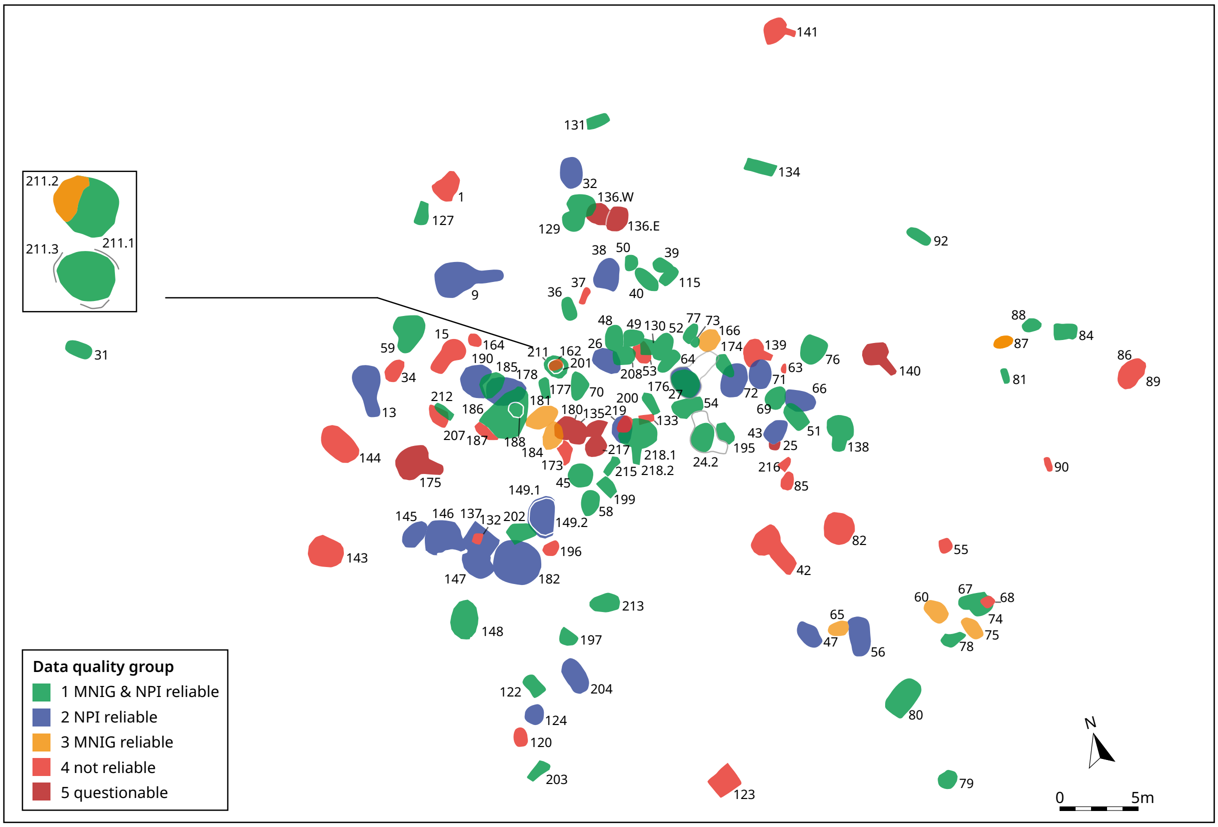


Figure 56: Burial item analyses. Spatial distribution of data quality groups.

BURIAL ITEMS		All (n/%)	Functional class			
			Food	Jewellery	Weapon	Tool
Data quality	1	737/31.6	396/29.5	349/34.1	18/31.0	1/33.3
	2	1251/51.1	597/47.8	578/56.6	38/65.5	2/66.7
	3	30/1.3	20/1.6	10/1.0	0/0	0/0
	4	305/13.1	128/17.5	85(8.3	2/3.4	0/0
	5	45/1.9	45/3.6	0/0	0/0	0/0
***In situ* preservation**	100-76 %	453/19.4	305/24.2	136/13.3	12/20.7	0/0
	75-51 %	625/26.8	370/29.6	229/22.4	24/41.4	2/66.7
	50-26 %	744/31.9	297/23.8	431/42.2	16/27.6	0/0
	25-0,1 %	232/18.6	226/22.1	226/22.1	1/33.1	6/10.3
	0	45/1.9	45/3.6	0/0	0/0	0/0
Material	ceramic	1086/46.6	1068/86.9	0/0	0/0	0/0
	bronze	811/34.8	0/0	767/75.0	44/77.2	0/0
	animal	227/9.7	163/13.1	62/6.1	0/0	2/50
	antimony	78/3.3	0/0	78/7.6	0/0	0/0
	stone	30/1.3	0/0	4/0.4	13/22.8	2/50
	composit	7/0.2	0/0	15/1.5	0/0	0/0
	n. d.	96/4.2	0/0	96/9.4	0/0	0/0
All		**2332/100**	**1249/53.6**	**1022/43.8**	**57/2.4**	**4/0.2**

Table 17: Burial item analyses, database. Number of preserved items cemetery (NPIC) with respect to data quality, in situ-preservation, material, and functional class. Frequencies (n) and percentages (%).

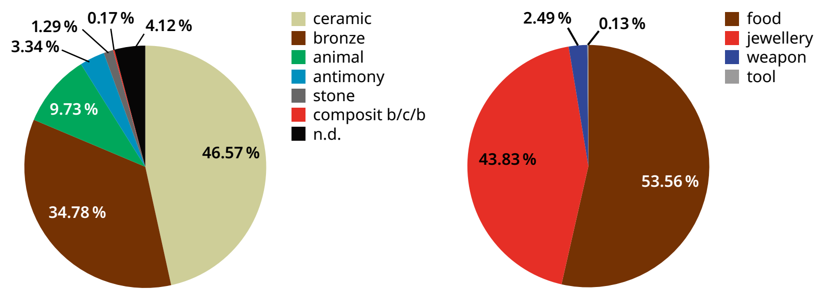


Figure 57: Burial item analyses. The ratios of item criteria material and functional class with regard to the complete record of the cemetery (NPIC).

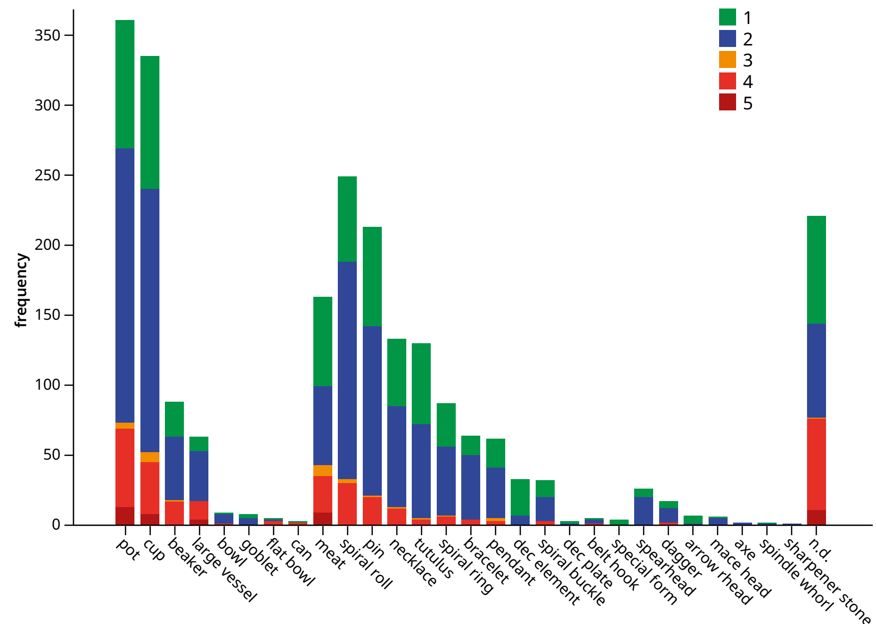


Figure 58: Burial item analyses. The ratios of item categories and data quality group (NPIC=2332).

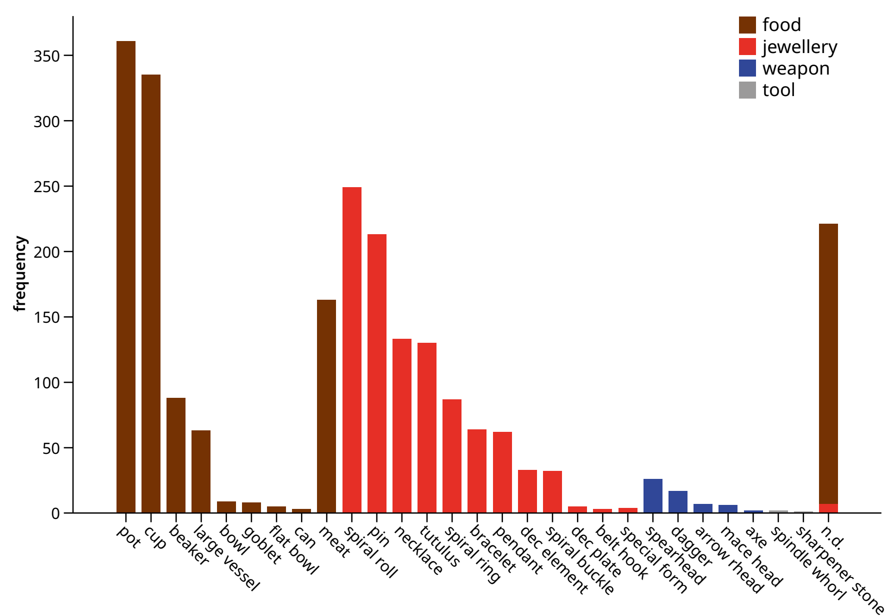


Figure 59: Burial item analyses. The ratios of item categories and functional classes (NPIC=2332).

Within the functional classes, there are distinct tendencies in what kind of material was used to make the items. As the functional class “food” includes vessels and faunal remains, the high amount of pottery and animal materials are not surprising (see Table 17). Within this class, ceramics represent a significantly higher proportion compared to faunal remains. A similar dominance is visible regarding bronze items of the functional class weaponry. Jewellery items show the highest variation, although bronze again forms the majority. In summary, ceramic and bronze are the most used materials for the burial items, in large part because of the large number of vessels and pieces of jewellery.

The most frequent burial items within all functional categories are the vessel forms pot (n=361) and cup (335), followed by spiral rolls (249) and pins (213). Meat (163), necklaces (133), and tutuli (130) are also quite common. With numbers below 100, items of the categories beaker (88), spiral rings (87), bracelets (64), large vessels (63), and pendants (62) are less frequent. Spiral buckles (32), spearheads (26), daggers (17), bowls (9), goblets (8), arrowheads (7), maceheads (6), flat bowls and decorative plates (each 5), special forms (vessels and jewellery forms, 4), can and belt hooks (each 3), spindle whorls and axes (each 2), and a whetstone (1) make up half of the recognized categories; however, they sum to only 163 items, thus *ca.* 7 % of the total record

The proportions of items from less secure contexts are similar to those recognizable in the overall distribution (Fig. 58). Thus, items of better data quality can be considered representative for the entire record, despite the small number of items in some categories like the vessel type can.

Within the different functional classes, the amounts of the associated categories are different for each class (Fig. 59, 60). Pots, cups and meat prevail significantly in the functional class food, followed by beakers and large vessels. Very rare vessel categories are bowls, goblets, flat bowls and cans. The distinct dominance of specific categories is not visible in the jewellery data record. Even if the variation of the categories would be scaled down by combining like categories (*e.g.* decorative element and tutulus, spiral buckle and belt hook), there would be no significant effect. Thus, based on the classifications made, the item plurality for the functional class of jewellery is higher (see below). The majority of the jewellery items consist of spiral rolls, pins, necklaces and tutuli. Together, they make up 71 % of the jewellery category record (Fig. 59). Spiral rings, bracelets, and pendants are less frequent. Decorative elements, spiral buckles, and especially decorative plates and belt hooks represent rare categories.

In the weapons categories there are also no distinct differences in numbers of items. Spearheads and daggers are more common than arrowheads and axes. Due to the very small number of items associated with the functional class of tools, including an axe, a whetstone, and two loom weights, these categories are also not significant in terms of proportions. Objects which were not assignable to a specific category are mostly pottery remains and a few jewellery artefacts.

In conclusion, there are distinct differences within the proportions of the three classified burial item criteria categories in the data set expressed by both frequency and variation. In order to specify these differences more precisely, the distribution of the burial items and each criteria were examined in relation to (1) the total frequency of items found in all graves of the cemetery (n=120; NPIC) and (2) in relation to their composition in the individual grave inventories (NIPG; assemblage characteristics).

Table 18 summarises the number of graves and items with respect to the criteria material, functional class, and category. Figure 61 shows the average number of items for each of the categories (see also Table 18). The average values AVall and AVspec provide information about the mean distribution of a criterion with respect to the complete burial record (graves that contained burial items, n=120) and the

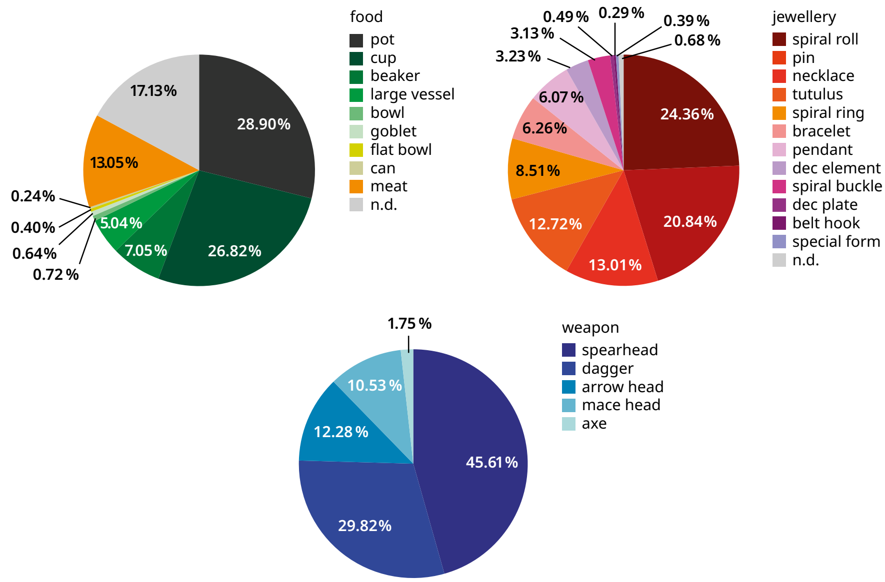


Figure 60: Burial item analyses. The ratios of item categories within the functional classes food, jewellery and weaponry (food, n=1249; jewellery, n=1022; weapons, n=57).

proportion of a criterion with respect to only burials containing the according items. For instance, 8 goblets are represented in the complete data set, resulting in an average of 0.07 goblets per grave (AVall, Fig. 61, red columns). The 8 goblets were found in 7 graves, meaning 1.14 goblets were deposited on average in these graves (AVspec, Fig. 61, blue columns). In consequence, the greater the difference of the AVall and AVspec values, the larger the impact of specific grave inventories according to the criterion (in the example: category goblet).

4.2.3.3 Graves and burial item criteria

There are distinct differences in terms of the burial criterion material. Pottery is a common grave good (in 83.1 % of all graves), which is comprehensible in the high values in both absolute frequencies and average values. For items made of faunal remains, the tendency is similar, although in a lower frequency. Almost half of the burials contained large numbers of bronze objects, and consequently the two average values differ significantly. In terms of antimony, similar assumptions seem reasonable, as only 12 burials contained items made of this material. However, due to the frequent cases of unknown material, rare materials are not completely represented. This also applies for artefacts made of more than one material. Items made of stone are rare in general. The average values are not significant in this respect.

Items associated with food are predominant in 116 burials (89.9 %), which is visible within the total numbers of the functional class food, the material ceramics as well as the high proportion of vessel forms such as pots, cups and beakers. This is confirmed by the averages of similar values and proportional trends of according materials and categories, especially for the functional class of “food.” For other categories such as large vessels and bowls, their small number results in low average values applied to the complete burial record, but not in respect for the specific graves, as the trends are contrary. Hence, these are not only rare but also characteristic categories for certain graves.

Less than half of the burials (46.2 %) contained jewellery items and due to the high proportion of associated artefacts the average values differ distinctively, making up 8.52 objects per grave and 17.53 objects within the graves containing such items. This also explains the generally increased difference between AVall and AVspec (Fig. 61) for the associated categories (spiral roll through special form). Within the jewellery categories, this difference is particularly apparent for spiral

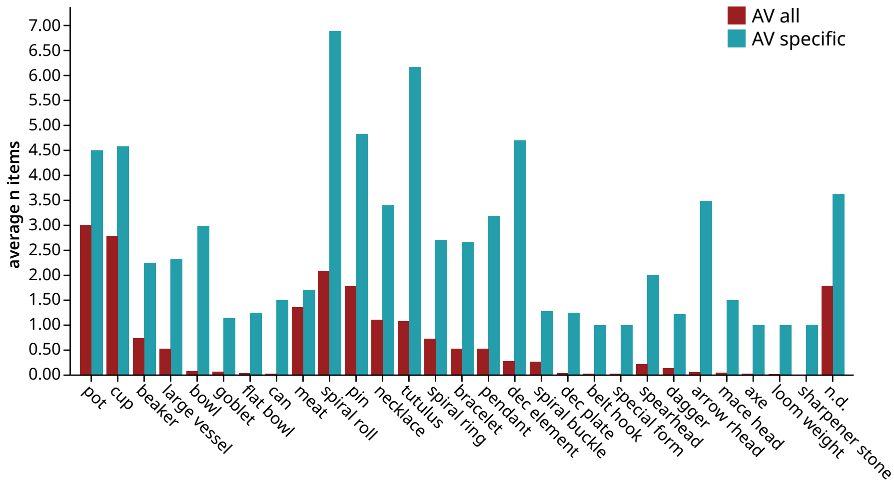


Figure 61: Burial item analyses. Average values of categories with respect to all graves with items (AVall, n=120, red columns) and to graves that contained that specific category (AVspec, blue columns).

rolls (n items=249/ n graves=36), tutuli (130/21), pendants and decorative elements (64/20; 33/7) and results from large numbers of items of certain categories in a comparatively small number of graves. From a critical point of view, spiral rolls are fragile artefacts and multiple countings of fragments of the same objects might have led to increased numbers in total[10], an issue which will be discussed later on.

Tutuli, pendants and decorative elements still are characteristic objects for less than half of the graves with jewellery equipment. With a ratio of 213 objects from 44 graves (AVall 1.78, AVspec 4.84), pins seem not to be specific for certain burials containing jewellery items, but an important category due to the high number. The values of necklaces (133/39), spiral rings (87/32), bracelets (64/24) and pendants (64/20) are in the middle data range and are therefore common jewellery objects. The same applies to spiral buckles, but their number is smaller in general (32/25). Belt hooks (3/3), decorative plates (7/5) and exceptional jewellery forms (4/4) are very rare and consequently special for each of the grave inventories they belong to.

Only 16.2 % of the graves (n=130) contained items of weaponry. Spearheads and daggers are most frequent among them and the general higher proportion of spearheads results in an increased AVspec. The number of maceheads is distinctly lower and their prevalence is exceptionally low as they were recovered from only four graves. Arrowheads are also very exceptional objects and all seven found at the site were associated with only two graves. Axes are similarly very rare and, due to the division of those found into weapons and tools, they are even less represented in the calculations according functional classes.

These axes (n = 2), a loom weight (n=1), and whetstones (n=2) represent very rare findings and thus the average numbers of these item categories are not significant in any way.

4.2.3.4 Grave assemblages and burial item criteria

There is a large range in the number of items that make up the assemblages found within the graves with some containing no items and others as much as 185. Assemblages with 30 items or less are more frequent (101 graves) than those containing more than 100 items (29 graves). Graves 082, 145, 146, 149.2, 147 and 211.3 are remarkable in this respect, as their inventories make up more than 25 % of the complete record (813 of 2332 objects). Differences in numbers of grave goods were examined with respect to spatial patterning (Fig. 62) as well as in the context

10 During recording, each fragment has been counted as one object.

BURIAL ITEM CRITERIA		Frequencies, percentages and averages			
		n items/grave	% Graves	AVall	AVspec
Material	ceramic	1086/108	83.1	9.05	10.06
	bronze	811/60	46.6	6.76	13.52
	animal	227/97	74.6	1.89	2.34
	anitmony	78/12	9.2	0.65	6.50
	stone	30/15	11.5	0.25	2.00
	comp	4/4	3.1	0.03	1.00
	n. d.	96/29	22.3	0.80	3.31
Functional class	food	1249/117	89.2	10.41	10.77
	jewellery	1022/60	46.2	8.52	17.03
	weapon	57/21	16.2	0.48	2.71
	tool	4/3	2.3	0.03	1.33
Category	pot	361/80	61.5	3.01	4.51
	cup	335/73	56.2	2.79	4.59
	n. d. vessel	214/59	45.4	1.78	3.63
	spiral roll	249/36	27.7	2.08	6.92
	pin	213/44	33.8	1.78	4.84
	meat	163/95	73.1	1.36	1.72
	necklace	133/39	30.0	1.11	3.41
	tutulus	130/21	16.2	1.08	6.19
	beaker	88/39	30.0	0.73	2.26
	spiral ring	87/32	24.6	0.73	2.72
	bracelet	64/24	18.5	0.53	2.67
	large vessel	63/27	20.8	0.53	2.33
	pendant	64/20	15.4	0.53	3.20
	dec element	33/7	5.4	0.28	4.71
	spiral buckle	32/25	19.2	0.27	1.28
	spearhead	26/13	10.00	0.22	2.00
	dagger	17/14	10.8	0.14	1.21
	bowl	9/3	2.3	0.08	3.00
	goblet	8/7	5.4	0.07	1.14
	n. d. jew.	7/6	4.6	0.06	1.17
	arrowhead	7/2	1.5	0.06	3.50
	macehead	6/4	3.1	0.05	1.50
	dec plate	5/4	3.1	0.04	1.25
	flat bowl	5/4	3.1	0.04	1.25
	special form	4/4	3.1	0.03	1.00
	belt hook	3/3	2.3	0.03	1.00
	can	3/2	1.5	0.03	1.50
	axe	2/2	1.5	0.02	1.00
	loom weight	2/2	1.5	0.02	1.00
	sharpener stone	1/1	0.8	0.01	1.00
All		**2332/120**		**19.43**	

Table 18: Burial item analyses, database. Frequencies and percentages (n graves=130, including 10 without grave goods) of burial item criteria, items, and graves as well as average values calculated with respect to all graves that contained burial items (AVall, n=120) and to graves which contained items of the specific criteria (AVspec).

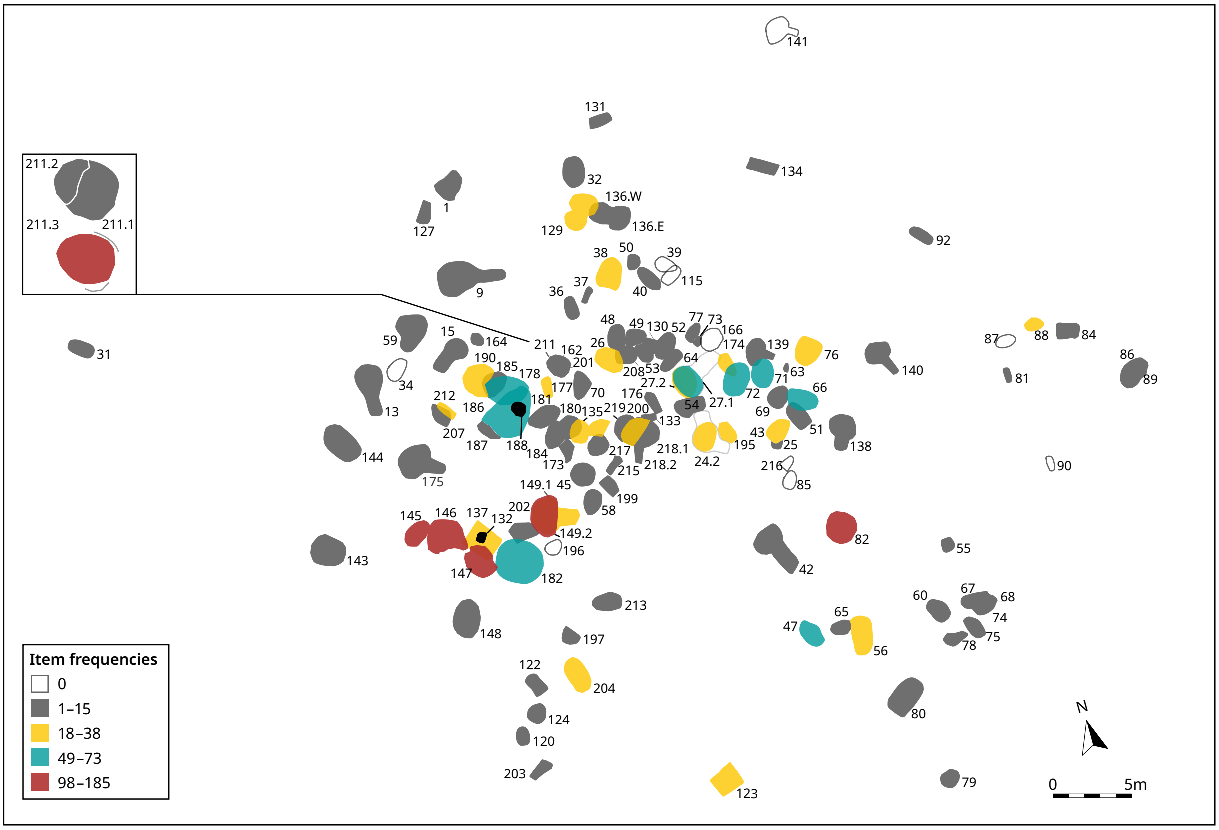


Figure 62: Burial item analyses. Spatial distribution of total item frequencies per grave.

of testing assemblage compilation similarities within the data set (CA II, see Fig. 72). Therefore, four groups of assemblage sizes were classified: 1-15 items, 18-38 items, 49-73 items and 98-185 items. When the data quality of the assemblages is compared with the reliability of the number of grave goods (Fig. 53), it becomes clear that large (*e.g.* Grave 082, 123), medium, and small assemblages (*e.g.* Grave 015, 037, 207) were all associated with poor preservation of the burials. The same applies for graves with good data quality (*e.g.* Grave 186, 145-147; 050, 197, 079, 188, 138).

Concerning the spatial distribution of differences in small and large assemblages, mapping does not show any regular, strict patterning (see Fig. 62). However, several graves with large numbers of funeral goods including graves 145, 146, 147 and 149.1 are located closely to each other (Fig. 62, red colour), while two other graves with large assemblages, Graves 082 and 211.3, were farther away.

Each inventory is illustrated according to the total frequencies of items with respect to material and functional class (Fig. 63 and 64) to examine the differences of the individual grave assemblages. Figure 63 shows the distribution of category frequencies within the inventory record. General tendencies and differences between the grave assemblages are easy to recognize. The allocation of artefact materials clarifies its overall distribution as described above: ceramic and artefacts of animal tissue are present in almost all graves (except Graves 031, 045 and 181) but differ in numbers. As the according objects are associated with the functional class food, this is also recognisable in Figure 64. 54 graves exclusively contained vessels or animal bones.

Bronze objects are generally common in graves, but again with large differences in numbers and in relation to other materials. Only three graves revealed bronze items as the only funeral gifts (031, 045, 181) and all the items were jewellery in these cases. All three graves had been classified with an *in situ* preservation of 100-76%, therefore this is not due to their state of preservation.

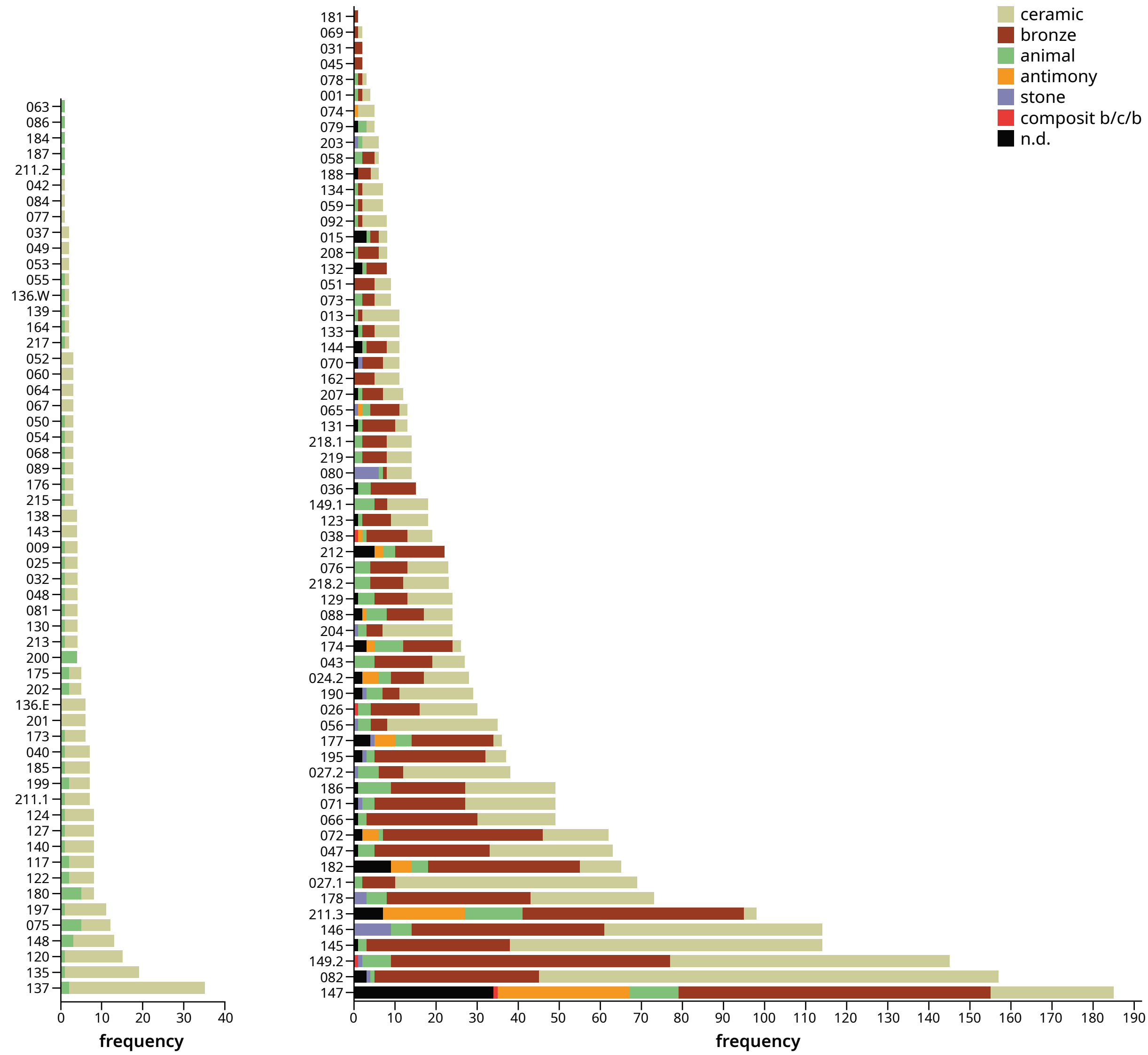


Figure 63: Burial item analyses. NPIG (graves n=120, items n=2332) per grave and item material. The left graph depicts grave assemblages made of ceramic and animal material, the right graph depicts grave assemblages that include other materials.

The occurrence of objects consisting of faunal remains[11] or antimony is not connected to an increased frequency of jewellery items (*e.g.* Grave 024.2, 026, 038) in principal. It is to be expected that the actual number of according items is higher, as numerous objects are of unknown material (probably shell, stone, antimony or other). The general tendency is that objects of these rare materials are more frequent in assemblages with more than 20 items.

The numeric ratios of items belonging to the functional classes food, jewellery, weaponry and tools (Fig. 64) give detailed information about the character of the grave assemblages. As described in the subchapter above, items of the functional classes food and jewellery show significantly higher proportions compared to items of weaponry and tools classes. Except for Graves 031, 045 and 181, all grave assemblages include items related to food. For some assemblages, these items make up the majority (027.1, 056, 082, 186, 144, 190, 204, 218.2).

Other assemblages show similar amounts of items belonging to the categories food and jewellery (*e.g.* 024.2, 043, 047, 066, 076, 149.1, 149.2, 178). It also appears that jewellery items are prevalent. This is especially the case for graves 072, 147, 182, 195, and

11 Animal bones as meat remains not counted.

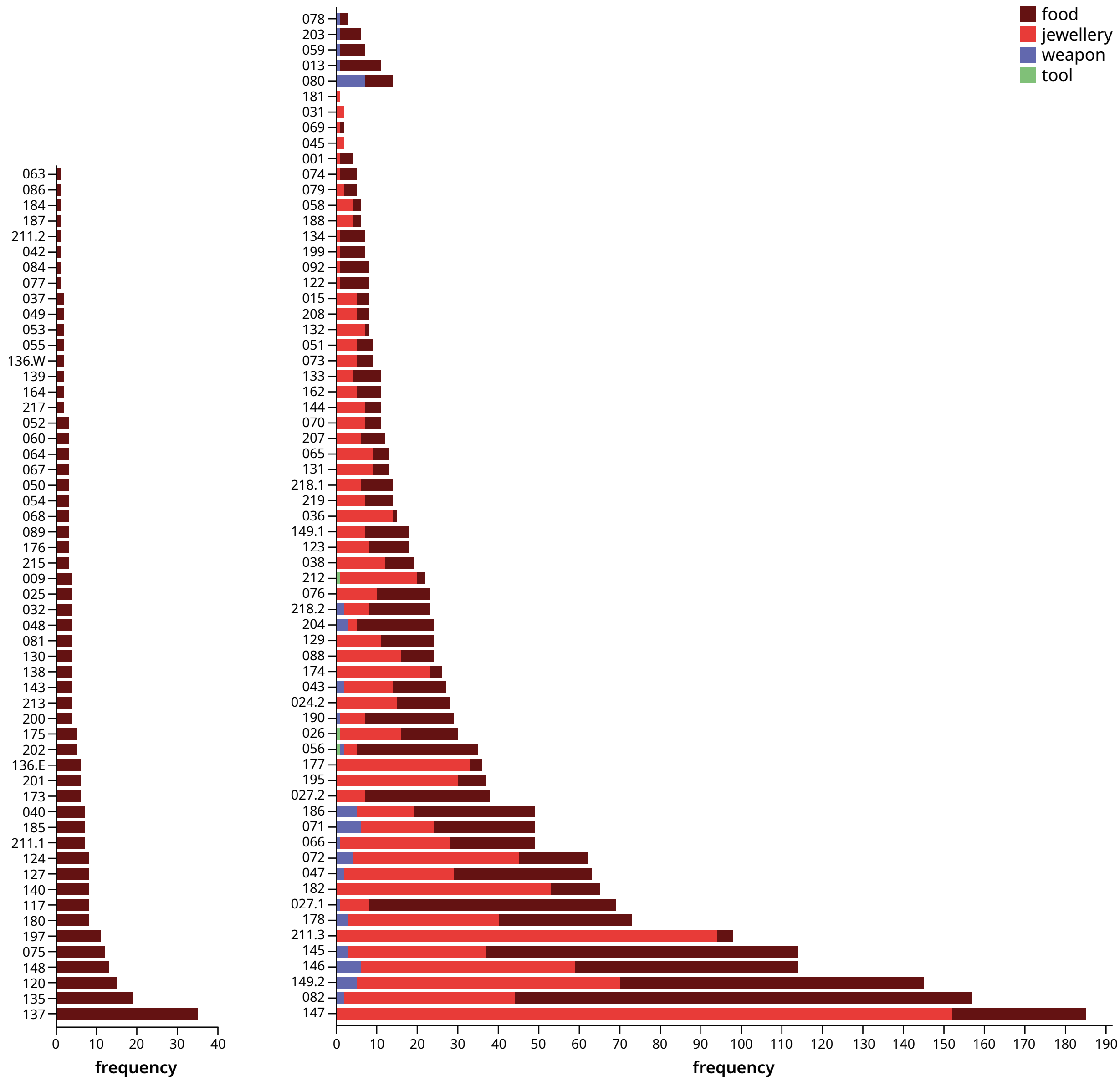


Figure 64: Burial item analyses. NPIG (graves n=120, items n=2332) per grave and functional classes. The left graph depicts graves that contained food items, the right graph depicts graves that contained items from different functional classes.

FUNCTIONAL CHARACTER (n/%)	
food	54/41.5
food>jewellery	10/7.7
food>weapon	5/3.8
food>jewellery>weapon	13/10.0
food=jewellery	16/12.3
jewellery>food	19/14.6
jewellery>food>weapon	3/2.3
none	10/7.7
All	**130/100**

Table 19: Burial item analyses, grave assemblage functional character. The classification was made based on the ratio of items of each functional class (minimum difference: 3 items). The total number of items is not considered.

211.3. Graves 147 and 211.3 show extraordinary values in this respect (152 jewellery/33 food items; 94/4). Assemblages of the remaining graves consist of smaller numbers of jewellery and/or food items. Items of weaponry often appear in the same assemblages; only Graves 013, 027.1, 056, 059 and 066 contained one according item. With 5 or more items, Graves 071, 080, 146, 149.2 and 186 make up half of the record. In 5 graves, no jewellery but weapons and food items were found. This is a remarkably small number compared to inventories combining jewellery and food items. Again, the number of items differ. Items of the functional class tool were found in Graves 026, 056, 071, 190 and 212. These assemblages consist also of jewellery, food and/or weaponry items.

In order to describe the assemblages in their functional class characteristics, the inventories were classified based on the item ratios with respect to following descriptions:

- Food: the assemblage consists of food items only (vessels, meat).
- Food>jewellery: the assemblage consists of more food than jewellery items (min. difference: 3).
- Food=jewellery: the assemblage consists of similar numbers of food and jewellery
- Food>jewellery>weapons: the assemblage consists of more food than jewellery and more jewellery than weaponry items (min. difference: 3).
- Food>weapon: the assemblage consists of more food items than weaponry items
- Jewellery>food: the assemblage consists of more jewellery than food items (min difference: 3).
- Jewellery>food>weapon: the assemblage consists of more jewellery than food and more food than weaponry items.

Disregarding the total amount of items contained in the graves, this classification summarises the considerations made above (Tab. 19). When examining the distribution of graves within this scheme, it becomes even clearer that the majority of the graves are characterised by food items (82 graves). Assemblages characterised predominantly by jewellery items are comparatively rare[12]. Burials containing mainly weaponry items were not found.

4.2.3.5 Functional classes and spatial distribution

The functional assemblage character was plotted on the cemetery plan (Fig. 65) in order to detect potential differences in its spatial distribution. The map, however, does not show any distinct spatial patterning. Graves of different assemblage character spread across the entire cemetery; thus, the burying population did not spatially separate burials with certain funeral equipment. In some cases, burials with the same functional character are located next to each other, but there is no significant concentration (food *e.g.* Grave 184, 217, 123, 180, 135; jewellery>food Grave 147, 182; *etc.*).

According to Figure 66, the inventory variation with respect to the number of categories shows that the majority of graves contained less than 6 different categories of items, with a peak at 2 (83 graves, 69.2 %) and 3 categories (37 graves, 30.8 %). Assemblages with a high variability and more than 12 categories are very rare. The maximum is 19 categories.

Here, a plotting of the data quality points to a correlation in terms of represented categories. The data quality group 3 is represented significantly more often in the 83 graves, which means that the number of items is not reliable due to poor preservation. Hence, care must be taken in all following analyses. Nevertheless, within the 81 graves with good data quality (groups 1 and 2), the general tendencies remain the same. As grave labels are not depicted in Figure 63, important graves are here mentioned sepa-

12 These are Graves 031, 036, 038, 045, 056, 066, 070, 072, 076, 088, 131, 132, 144, 147, 174, 177, 178, 181, 182, 195, 211.3 and 212.

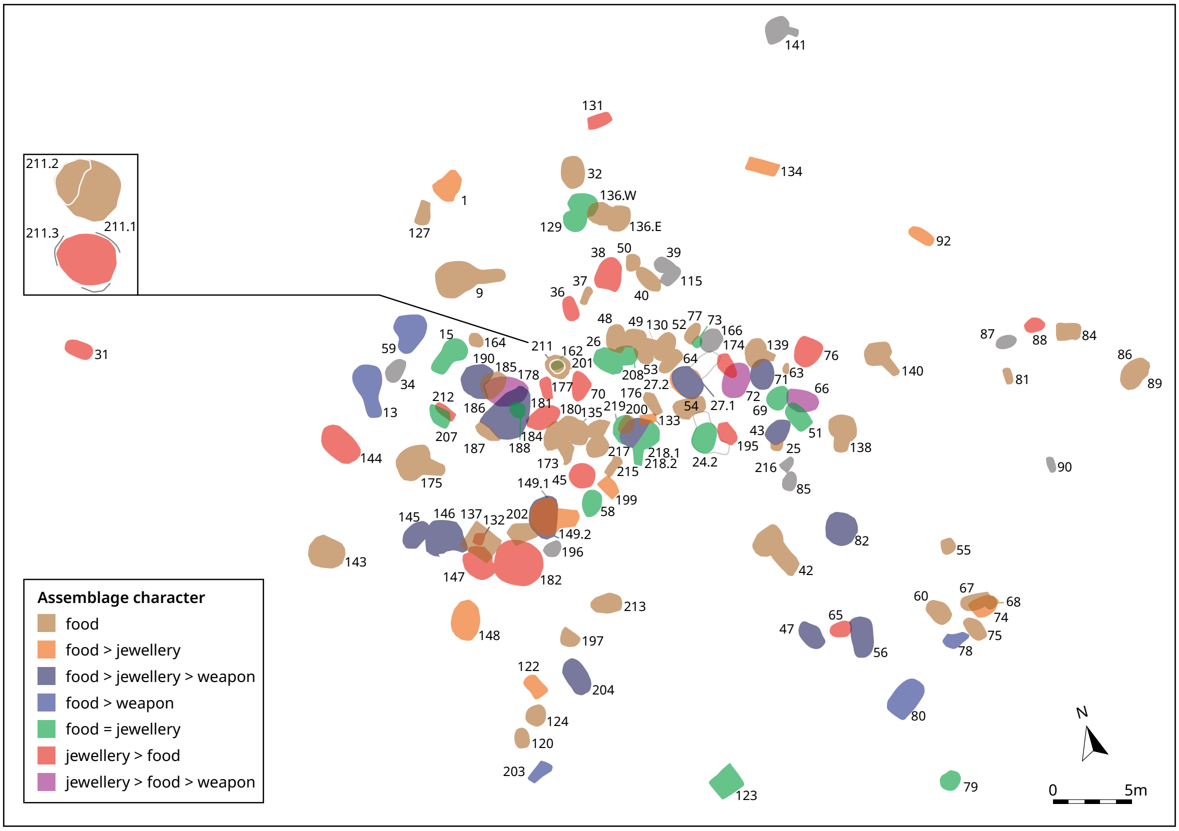


Figure 65: Burial item analyses. Spatial distribution of assemblage functional character.

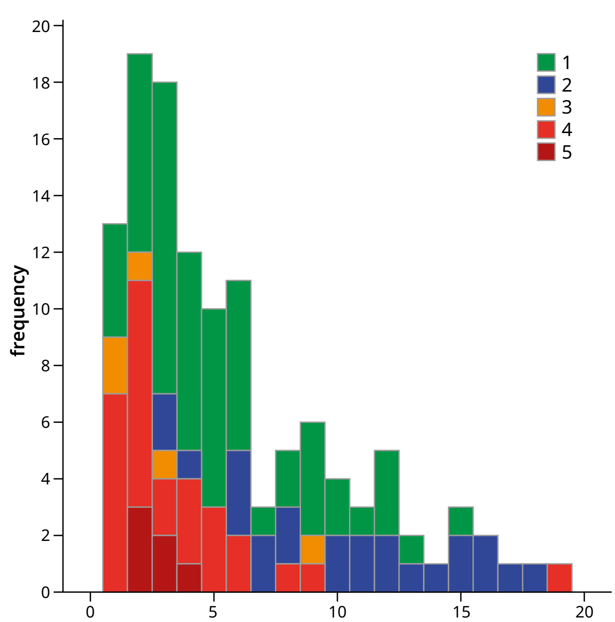


Figure 66: Burial item analyses. Histogram of graves (n=120) and frequencies of contained numbers of categories (n=30).

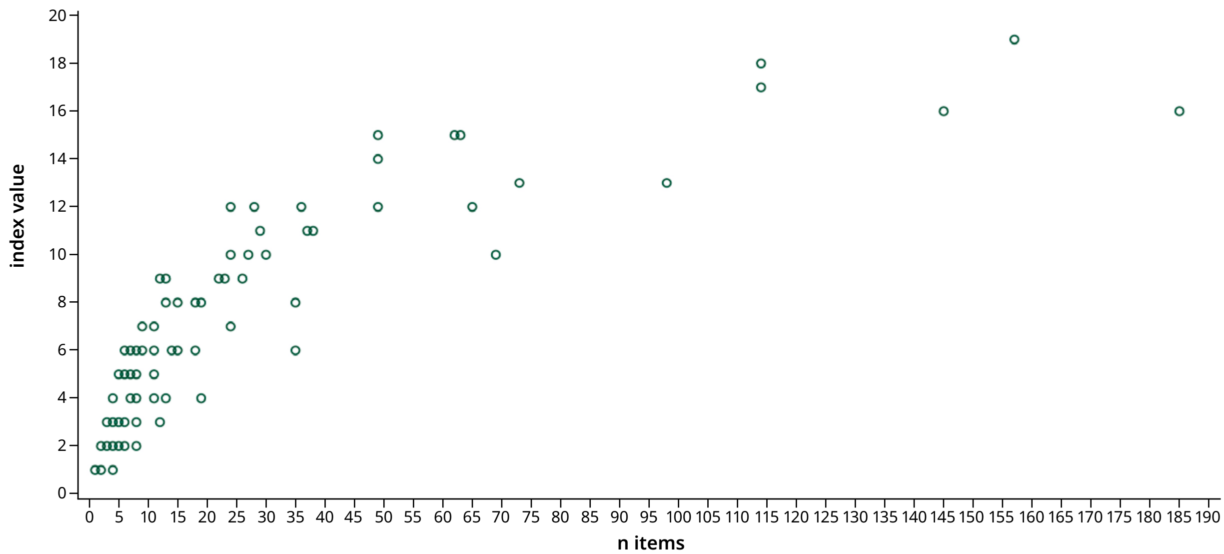


Figure 67: Burial item analyses. Plotted are the grave assemblages (n=120) according to their numbers of items and categories.

rately: Graves 186, 072, 047, 145, 149.2, 147, 146 and 082 show the highest numbers of categories per grave with 15 or more categories each. The number of categories does not significantly correlate with the number of items in total, as illustrated by Figure 67. Although the distribution is almost proportional, many graves do not fit the pattern, for example with assemblages of less than 60 items but more than 12 categories of items. Examples of such graves include, for instance, Grave 186 (15 categories/49 items), Grave 071 (14/49), Grave 066 (12/49), or Grave 129 (12/24) and burials with few items, such as Grave 051 (6/9), Grave 131 (8/13), or Grave 218.2 (9/23; see Fig. 67). This is the starting point for calculating the plurality indices as described in the next subchapter.

In order to gain a better understanding of the assemblage variation, the spectra of categories were examined by means of additional analytical methods:

1. Calculation of a category item plurality index (CPI), according to the complete data set of the individual graves (NPIG) with respect to functional classes (CPI NPIG function).
2. Calculation of a category rareness index (CRI) according to the complete data set of the individual graves (NPIG) with respect to functional classes.

4.2.3.6 Assemblage variation: CPI and CRI

The plurality index provides a measure which enables the evaluation of the category variability of an assemblage by including the total number of items as well as the total number of categories. Referring to the calculation procedure described in chapter 4.1.4, the higher the CPI value, the higher the diversity of the categories[13] of an assemblage in relation to the total number of items.

The histograms shown in Figure 68 illustrate the calculated plurality indices. The overall distribution is depicted in green and below this the frequencies of indices calculated for the functional classes are depicted in brown (food), red (jewellery), and blue (weaponry). With only four tool items from three graves, the plurality index of this functional class was not calculated. Figure 68 includes not just the average and standard deviation values, but also a normal distribution curve for each histogram. The results of the analyses are:

13 Seven jewellery items from six graves and 214 vessels from 59 graves of indeterminable category are included in the analyses in this approach as indeterminable.

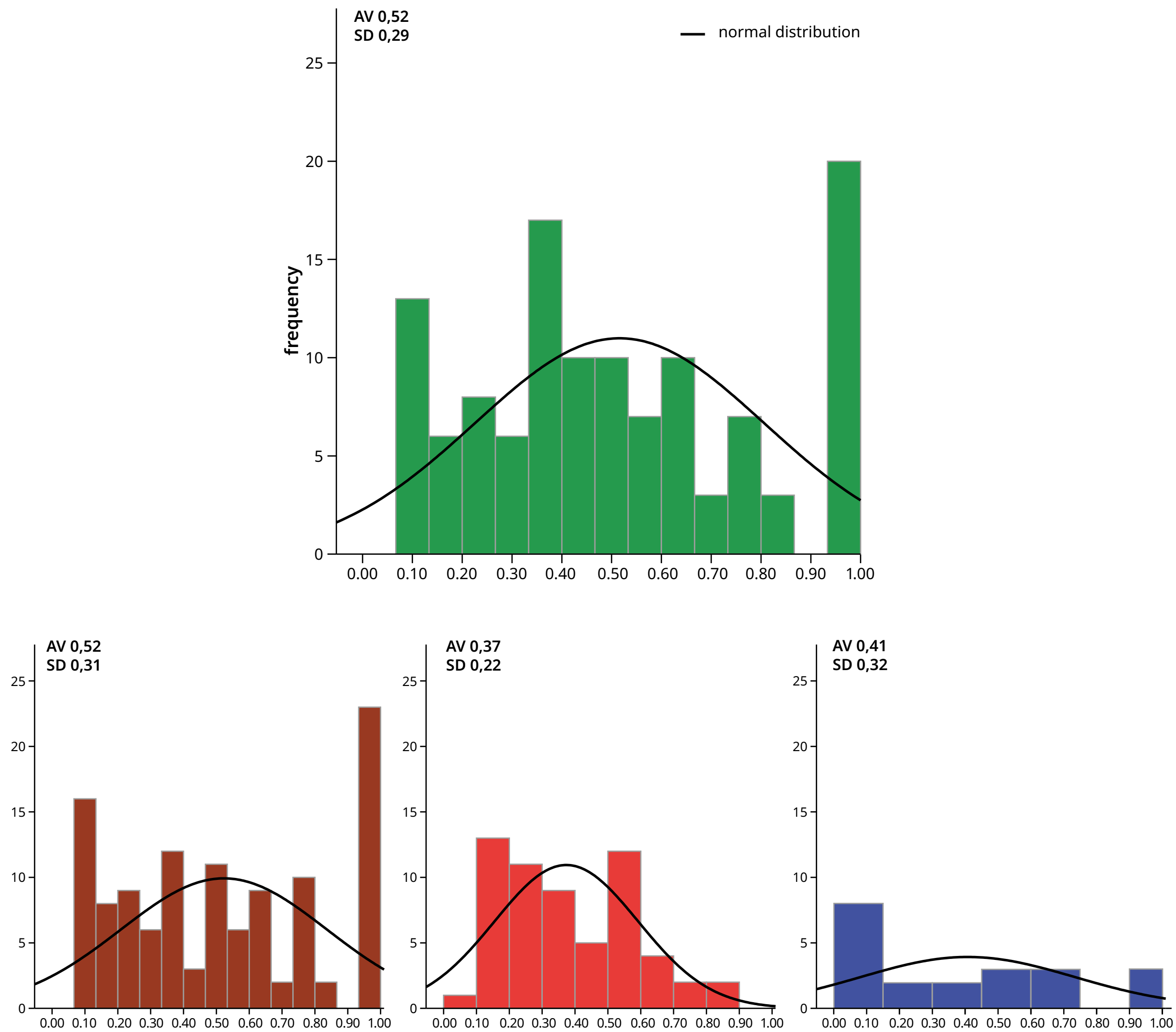


Figure 68: Burial item analyses. Histograms of graves and frequencies of category plurality indices. Green for all categories (n=120), brown for categories of the functional class food (n =117), red for categories of the functional class jewellery (n=60) and blue for categories of the functional class weapon (n=21).

- The average CPI for all categories is 0.52 with a standard deviation of 0.29 (n graves=120, n categories=29, n items=2332). The majority of the inventories (n=70) show lower values. Within this lower value range, the distribution does not follow the curve of the normal distribution as there are peaks in the ranges 0.1 and 0.3-0.4. Values above 0.5 are less frequent and the large number of assemblages (n=20) with the highest values of 1 is due to inventories with a small number of items (max. 2-6) but where each item belongs to a different category. The values for the remaining graves (n=30) range between 0.53-0.86 with decreasing frequencies of increasing values.
- With respect to the functional class food (n graves=117, n categories =11, n items=1249) – which is in particular described by the spectrum of vessel types – the average and standard deviation values of 0.52 and 0.31 respectively. Again, the concentration of graves in the range 0.9-1.0 is due to assemblages with a maximum of 5 items and the same number of categories.
- In terms of jewellery categories, which were assigned to 60 graves (n categories =12, n items=1022), the average is lower with a value of 0.37. Only 13 graves show a value over 0.5. Decreasing frequencies with increasing CPI values are the general tendency, despite the ranges between 0.5 and 0.6.
- The values calculated for graves with weaponry are less significant, as only 21 graves contained 57 such items of 5 categories. The normal distribution curve is

consequently relatively stretched. A deviation from it is remarkable in the low CPI values with 8 assemblages all containing only one item. This is different for graves with two weapons of different categories resulting in a CPI of 1. Different values occur between them.

In summary – and by taking the considerations expressed in the preceding subchapter into account – the calculated CPIs lead to following conclusions:

- There are differences in the category variability of the assemblage compositions. Based on the results, these differences are due to two main factors: (1) Low values result from few items and even fewer categories or high numbers of items but comparatively low numbers of categories. (2) High values point to a more balanced ratio between the number of items and the number of categories.
- The majority of the graves show values below 0.6 with respect to the overall distribution as well as in terms of the functional classes. This means that few assemblages show a higher variability and is especially true for the functional class of jewellery.

Following the absolute proportions of categories with respect to the NPIC, there are distinct differences in frequency. For instance, belt hooks, loom weights or decoration plates are very rare categories with only few objects, whereas certain vessel types (pots, cups) or jewellery items (spiral rolls, pins) show relatively high values. This is also expressed in the overall average distribution (AVall, Fig. 61, red columns). In addition, the average values for graves containing the specific category showed that certain categories seem to be more often found in the same assemblages (AVspec, Fig. 61, blue columns). In consequence, the average occurrence of a category (n items/n graves) gives information about its rareness, but this rareness must not automatically be interpreted as representing very exclusive or individual categories/items (Müller 1994). Still, when we consider the plurality of the categories as a descriptive attribute for the grave assemblages, the rareness of an item should also be considered here. Therefore, the CRI was calculated based on the approach as described in Section 4.1.4. The inventories of Grave 037, 084 and 181 showed poor preservation and a determination of the categories was impossible; they were therefore excluded from the calculations.

In order to evaluate the CRI in terms of spatial patterning, the values were summarised following the previous results and boundaries were used to illustrate the groups (Fig. 70). The CRI values do not appear to be spatially grouped as they are scattered across the entire cemetery.

There is a slight tendency that graves with similar CRI values are more often located next to each other (*e.g.* again graves 145-147 with high values, or graves 048, 049, 130, 064 with low values). As a result, the presence of rare items in the assemblages was not a strong determining factor for the location of the graves.

- The following observations complement the considerations made above and relate to the compositions of the individual assemblages (for locations on the cemetery plan see Fig. 70).
- Inventories with values between 0.01-0.04 consist of one or two vessels, namely pots and cups, which are in general very common. The values increase with the presence of meat and/or beakers (0.2-0.4).
- From 0.4 onwards, the assemblages also include large vessels. The assemblage of Grave 073 is the only one with less common category decoration elements. Other exceptional items of weaponry/tools were found in Graves 056 (dagger), 190 (axe) and 203 (macehead).
- Beginning at 0.5, the assemblages more frequently include jewellery categories with lower average values, such as bracelets, spiral buckles, decorative elements, pendants, and a single belt hook (Grave 088). Spiral rings and pendants

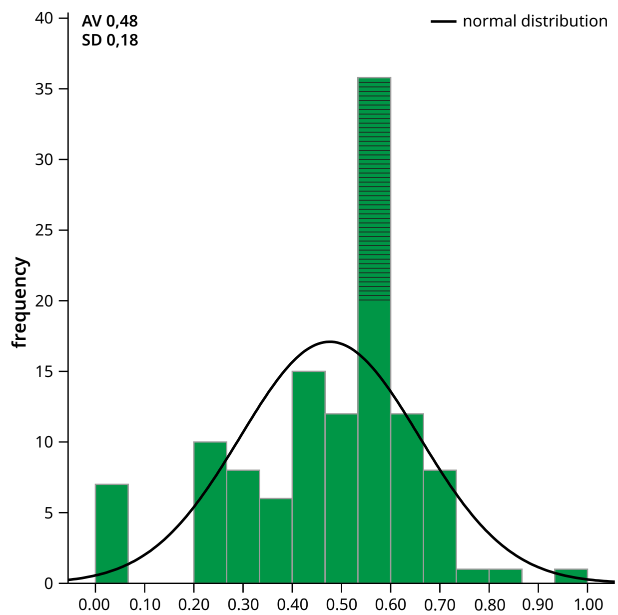


Figure 69: Burial item analyses. Histogram of graves (n=117) and frequencies of category rareness index.

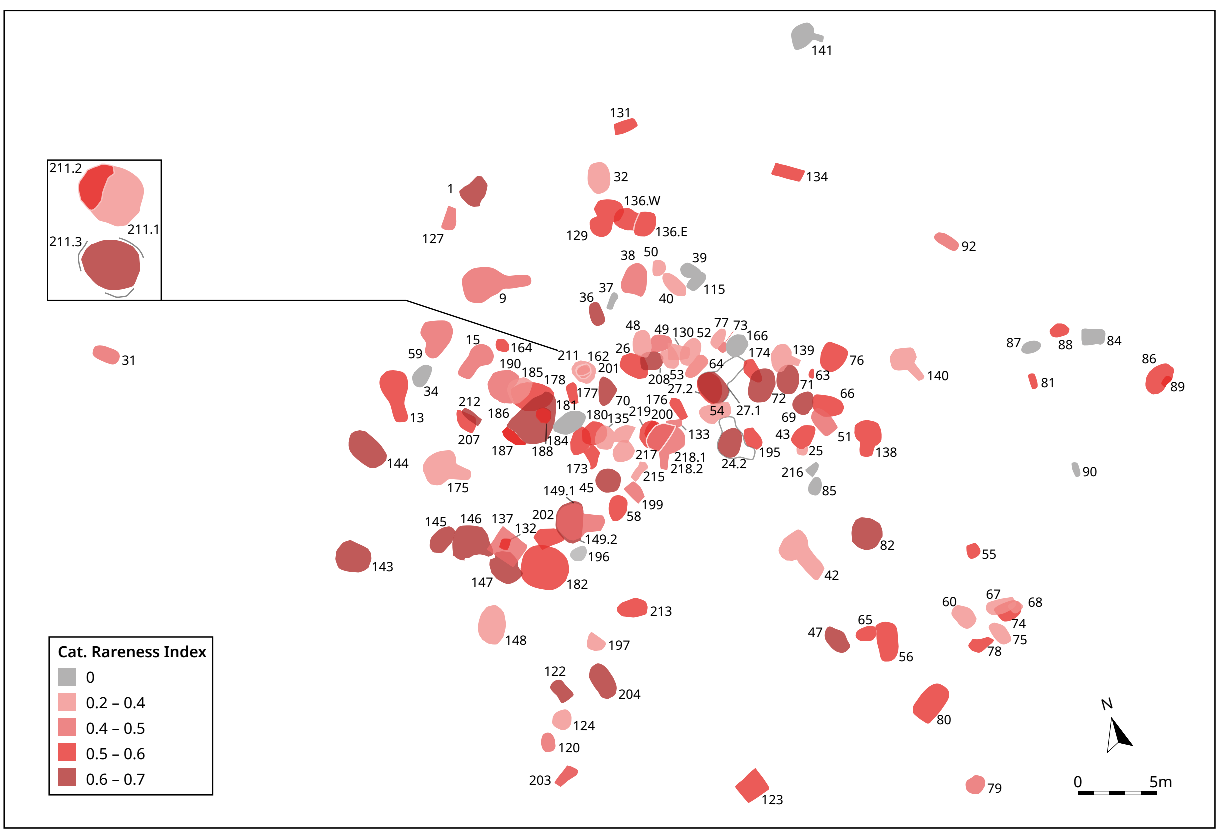


Figure 70: Burial item analyses. Spatial distribution of the category rareness index (CRI). The values were summarised based on the numeric distributions.

are elements often represented. In addition, three assemblages (Grave 027.2, 129, 195) contain the very exceptional vessel types goblet and flat bowl. The occurrence of rare object types becomes more significant in the higher values, where different weapon categories supplement the inventories.

- Above *ca.* 0.61, the assemblages show both the highest variety of categories – which additionally include infrequent items like bowls, flat bowls, goblets, belt hooks, decorative elements and plates, and special forms – and/or the four weapon categories. Items with average values in the middle ranges (beakers, large vessels, tutuli, bracelets, necklaces, pendants, spiral rings) are in general more frequent within these assemblages.
- The three inventories that represent the highest values ranging from 0.71 to 1 consist of only one exceptional category (Grave 069 jewellery, special form, Grave 143 a large vessel, and Grave 045 a spiral ring; due to the n category = 1, the average of the category also represents the CRI).

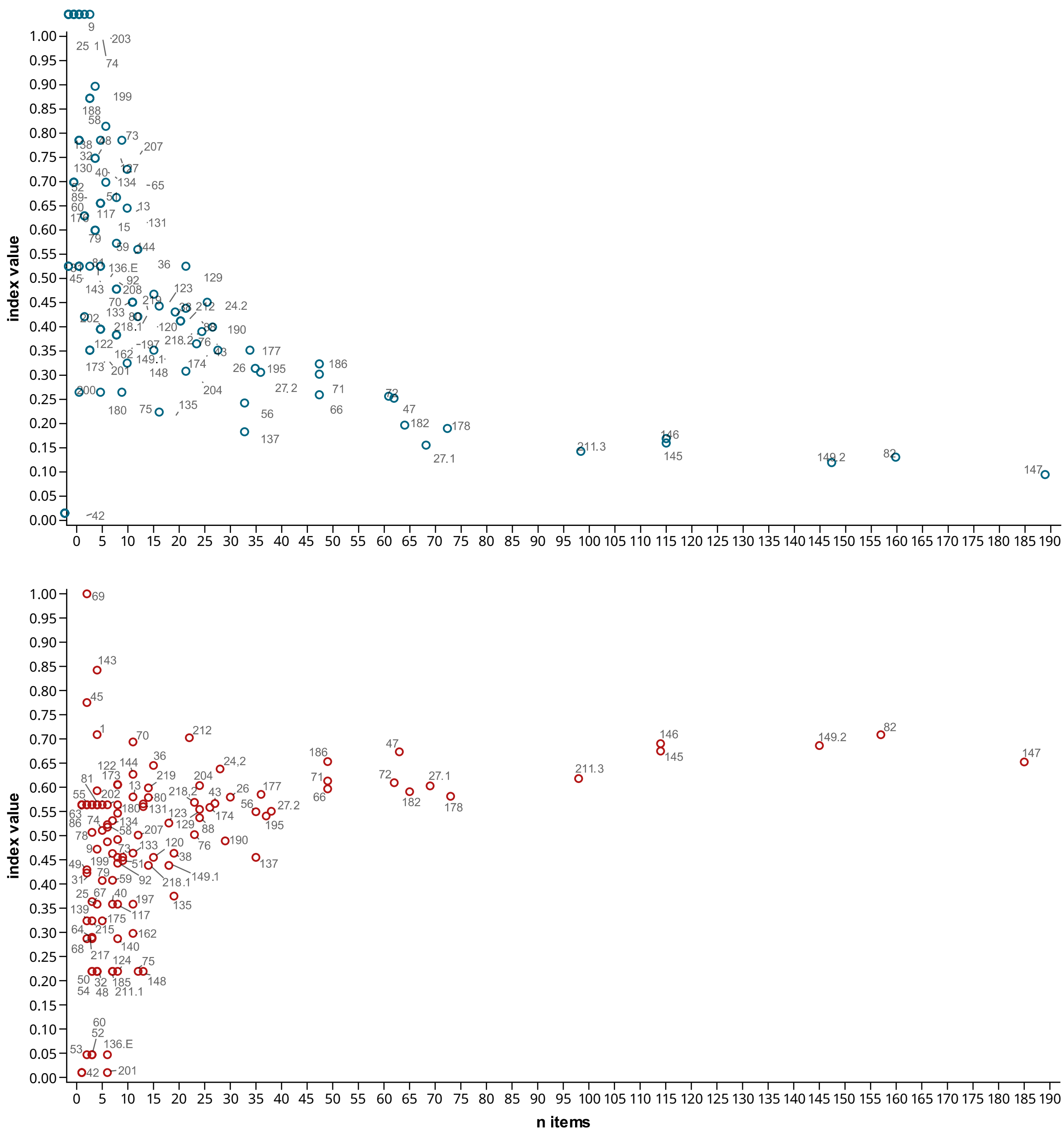
4.2.3.7 Evaluation: significance of CPI and CRI

In the following the indices of category plurality and rareness will be discussed in terms of their significance as parameters for describing the burial item criteria "category" in the grave assemblages. Figure 71 shows both indices for each grave with respect to the number of items of which the inventories consist. These data refer to the complete data set and thus include the total number of items, also those of unknown category. Based on these plots, the already presented preliminary results become more distinct and can be complemented as follows:

- As the CPI is a variable dependent on the x-value "n items", the lower ranges reflect the absolute numbers of items (Fig. 71, upper chart, blue rings). This can be observed in the distribution of graves with at least 35 items (plots Grave 137-147). It is here very clear that assemblages of smaller size show comparatively high variability in their category composition. This is of course a result of the limited number of categories. However, this figure emphasises that differences in category plurality between the assemblages are not only caused by the number of items.
- The CRI of an inventory is not directly correlated to its size, as it is based on the NPIC averages. The opposite pattern of distribution as that in the CPI can be observed with increasing assemblage sizes exhibiting higher rareness indices (Fig. 71, lower chart, red rings). Again, there is a limitation, as the CRI does not increase in inventories with more than 40 items. Instead, these higher values show up in assemblages of smaller size. Thus, rare categories are not only associated with large assemblages. In the smaller assemblages this high value results from the supplementation of rare items for common ones. Exceptions are inventories with vessels of indeterminable categories or of poor data quality.
- In consequence, both assumptions strengthen the interpretation that the size of an inventory is not the only factor which determines differences in either the grave assemblages or the composition of their categories. Secondly, the variability seems to be less significant than the rareness of the categories.

4.2.3.8 Assemblage compositions: Correspondence analyses

In order to detect similarities and differences within the burial assemblages in terms of their compositions, a correspondence analysis was performed. First, in a basic contingency table, each grave inventory was listed according to absence and presence of a category; this CA therefore does not represent differences in the number of items per category but rather differences in numbers of categories per burial (CA I, Fig. 72. In the second approach, the numbers of items for each category were considered in



total frequency (CA II, Fig. 73. The inclusion of both of these correspondence analyses allows the investigation of the assemblage composition from more than one perspective: *i.e.* both the uncovering of general patterns of category associations and the evaluation of the significance of numeric distributions of items within categories.

For the successful application of a CA, the data set requires a sufficient sample size (grave assemblages) and each has to contain at least two different variables, here categories. Therefore, the data set was cleaned by removing grave assemblages that contained less than two categories as well as categories that were represented by only one item. Due to this data cleansing, 26 graves are not part of the examination[14]. Additionally, the category "whetstone" had to be disregarded in both analyses. Furthermore,

Figure 71: Scatter graphs (n=120) of the grave inventories with respect to the category plurality index (CPI, upper graph) and category rareness index (CRI, lower graph), in relation to the number of burial items. CPI (n categories/n items) reflect the variety of an assemblage, the CRI the ratio of rare to common items based on the average category values (see 4.1.4).

14 These are Grave 037, 084, 181, 031, 042, 045, 055, 063, 069, 077, 081, 086, 089, 136.W, 143, 164, 173, 176, 180, 184, 187, 200, 201, 202, 211.2 and 213.

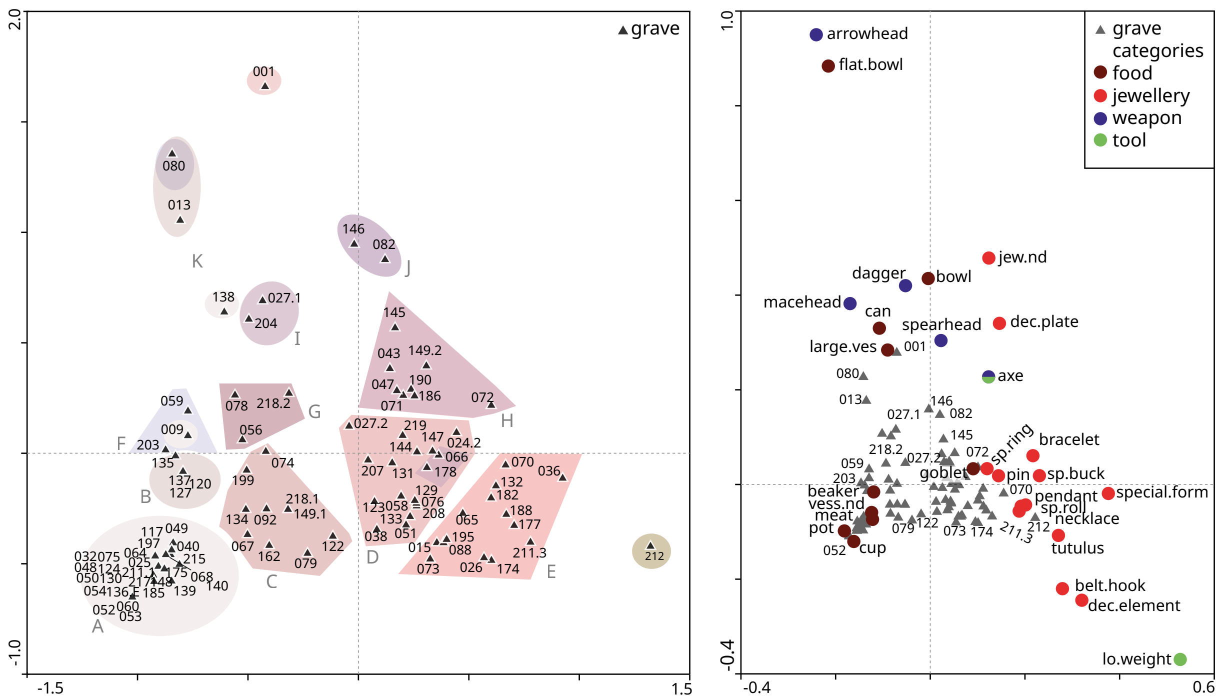


Figure 72: Burial item tradition. Classical correspondence analysis of the grave assemblages (objects, n=98) by means of the category composition (variables, n=28). The underlying contingency table lists presence as 1, absence as 0. In the left scatter plot, the colouring and letters mark the clustering patterns as described in the text below.

the high number of arrowheads in Grave 080 appeared as a significant outlier in the first runs of the CA II. Therefore, the category arrowhead was excluded. Still, this case needs to be considered in the interpretation of the analyses. Vessels and jewellery items of unknown category are included, but labelled accordingly (vess.nd, jew.nd).

Two scatter plots are depicted (Fig. 72-73) for each of the correspondence analyses. The plot on the left shows the distribution of the assemblages labelled by grave number[15] while the plot on the right shows the placement of the categories[16] coloured by functional classes. According to the computational procedure, the analyses were conducted by using inter-species distances (distances between grave assemblages), biplot scaling and without any specific data transformations.

The burial assemblages distribute in a triangular pattern (Fig. 72, left scatter plot) in the scatter plots of the CA I, wherein Grave 001, a cluster of several other graves, and Grave 212 form the points most distant from the centre. In consequence, those are the inventories with the greatest difference in category variation. Graves 080 and 013 are also to be mentioned with their position in the upper left area of the coordinate system representing a strong difference from the graves at the centre expressing the "usual" assemblages. Within the complete scatter plot, the clustering of grave assemblages along the x-axis depict a clear separation of assemblages along this vector. The ordination on the y-axis is visible in that most assemblages have negative y-values, and those with positive y-values are located much farther from the origin. In the interspaces, the assemblages spread loosely, reflecting less strong correlations to the inventories in the outer areas.

By considering the categories as variables in the scatter plot (Fig. 72, right graph), the ordination becomes clearer: jewellery categories are on the right side of the x-axis and food categories (without goblets), on the left side. Several vessel categories, such as pot, cup, and beaker as well as meat describe the narrow cluster in the negative x- and y-value ranges, whereas bowls, large vessels, cans and flat bowls are to be found within the positive range of the y-axis.

15 Due to its common use in the field of ecology, in Canoco these are defined as "species".
16 In Canoco defined as "samples".

The categories decorative element and decorative plate, belt hook, or special form mark the outer scatter area of the jewellery categories. The other jewellery categories are distributed in the middle x and y value ranges. Necklace, spiral roll, and pendant cluster in this middling area as well as pin and spiral ring. Categories of the functional class weaponry scatter in the left upper area with spearheads and axe in stronger correlation to jewellery categories such as decorative plate. The array of the tool categories axe and loom weight appear to not form a distinct cluster but are rather related to assemblages with jewellery and/or weapons.

Returning to the actual composition of the grave assemblages, the CA I scatter plots give further information about the presence and absence of certain categories. By considering previous findings concerning the overall distribution of categories (NPIC), this leads to following interpretations:

- The assemblages are characterised by the functional classes food, jewellery, and weaponry as well as specific categories within these classes.
- Assemblages[17] consisting of common food categories (meat, pot, cup, beaker; Fig. 72) reveal the greatest similarity within the data set (Fig. 072, A). The scatter plot shows a distinct separation from inventories with goblets, large vessels, bowls and flat bowls[18] (Fig. 72, B). Inventories characterized by the presence of large vessels (Grave 009, 138, 013, cluster K) show different affinities to other assemblages.
- There are graves[19] with common food categories, goblets, or some common jewellery categories with a certain degree of variation (spiral ring, pin, spiral roll, pendant, necklace; Fig. 72, C).
- Right of the y-axis, the ordination shows inventories[20] that include spiral buckles and bracelets, wherein Graves 076, 129, and 208 show the highest similarities within the data set of assemblages with jewellery items (Fig. 72, D). Assemblages[21] that contain exceptional jewellery categories – such as tutuli, decorative elements, belt hooks, or special forms – distribute further right along the x-axis (Fig. 72, E). All of these inventories also consist of common food categories, but the amount of jewellery categories increases from the clusters C-D.
- With the additional functional class of tools, represented by a spindle whorl, and meat as the only food category, the inventory of Grave 212 is one of the two most outstanding assemblages that contained jewellery items. It shows the greatest difference to the assemblage of Grave 001 by only sharing the categories meat and pins. Both assemblages did not reveal any common vessel types or weapons.
- Inventories with weaponry categories (cluster F-K) spread above the x-axis – except those of Graves 066 and 178 – and are separated by the presence of different vessel and jewellery categories. Graves 059 and 203 contained common food categories and additionally maceheads and daggers.
- Assemblages of cluster G[22] and H[23] are similar to C and D but are supplemented with spearheads and/or daggers. Graves 071 and 190 additionally contained the two axes.
- The other assemblages with weapons are characterised by the presence of exceptional categories of one or more functional classes respectively (Graves 027.1, 204, 082, 146; cluster I and J). They also contained large vessels, bowls, or flat bowls and/or decorative plates and other jewellery categories and are similar to cluster H (Grave 082, 146).

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17 Graves: 025, 032, 040, 048-050, 052-054, 060, 064, 068, 075, 117, 124, 130, 139, 140, 148, 185, 197, 211.1, 215.
18 Graves: 120, 127, 137, 135; 138.
19 Graves: 067, 074, 079, 092, 122, 134, 149.1, 162, 218.1.
20 Graves: 207, 123, 038, 219, 144, 131, 058, 133, 051, 147, 129, 076, 208;
21 Graves: 015, 036, 065, 070, 073, 088, 132, 174, 177, 182, 188, 195, 211.3.
22 Graves: 056, 078, 218.2.
23 Graves: 043, 047, 071, 072, 145, 149.2, 186, 190.

In the CAII, the ordination of graves and categories reflects the total number of items that are included in each single inventory (Fig. 73). This means this analysis also considers the numeric relation in addition to the composition of associated categories.

Inventories with the greatest variations originate from graves 122 (meat, indeterminable vessels, necklace), 078 (pot, meat, spearhead), and 211.3 (high variety and numbers of jewellery items, in contrast to food categories), which is in contrast to the results of the CA I (Grave 001/060 *etc.*/212, Fig. 73, left scatter plot). The other assemblages are distributed within a triangular shaped coordinate area between these graves, wherein the majority are located in the negative x- and y-value ranges. The three most distinct clusters are separated by dashed lines (Fig. 73, left scatter plot). When the ordinations of assemblages of CA I and II are compared, it becomes apparent that the clustering is not completely congruent, but that the general tendencies are constant. This is a result of food categories commonly occurring in the inventories, and differences in the distribution of jewellery and weapon categories. The ordination of the categories (Fig. 73, right scatter plot) is described along the x-axis, which might be due to the calculation procedure. Jewellery categories still scatter mainly on the right side of the y-axis, whereas food categories are ordinated on the left side. Weapon categories all cluster in the negative x- and y-values. Because of the flipped axis, the weaponry categories scatter in the lower part in contrast to their distribution in CA I. In addition, there seems to be a stronger correlation of spearheads with food categories. Axes represent an outlying category. In this respect, cans, flat bowls, and vessels of unknown types (vess.nd) show few correlations with the other vessel categories, which also contrasts with the results of the CA I.

In consequence, graves in the right half of the right scatter plot revealed inventories which are characterised by jewellery items in both category diversity as well as numerical ratio to food/weapon categories. Assemblages on the left have more items within the food categories. Assemblages located between these areas are graves that reflect the different ratio ranges within these contrary compositions.

If we consider the numeric relation of categories as well as the total NPIG in the interpretation (see Fig. 63, 64, 66; Fig. 73, left scatter plot, n items, coloured triangular), the most important results in this respect are:

- As vessels of indeterminable type represent pottery of poor preservation, they are often associated in the same grave assemblages (122, 140, 185); in consequence, the results of the CA II illustrate the ceramic preservation more precisely compared to those of the CA I, especially in the left upper area of the coordinate system.
- The three most apparent clusters (Fig. 73, left scatter plot, dashed lines) are characterised by assemblages with (1) the high ratio of few and rare vessel types (can, flat bowl) compared to common vessel types (cup, pot, beaker, large vessel; left upper area), (2) by assemblages with only common food categories, goblets as well as weapons and common jewellery categories, wherein the numeric distribution of the categories differ (middle area), and (3) by assemblages that are characterized predominantly by jewellery items, mainly specific categories, few common pottery types and no weapons (right area).
- By considering the NPIG in the scatter plot, it becomes clear that the number of items is not crucial for the inventory diversity. Small inventories consisting of food items only differ from large assemblages with predominantly jewellery items or rare vessel types, but at the same time “rich burials” with more than 49 items cannot automatically be correlated with an increased weapon or jewellery diversity (*e.g.* grave 145, 149.2, 146). This is illustrated by the coloured triangles, each colour of which is found within all three of the described cluster (Fig. 73).

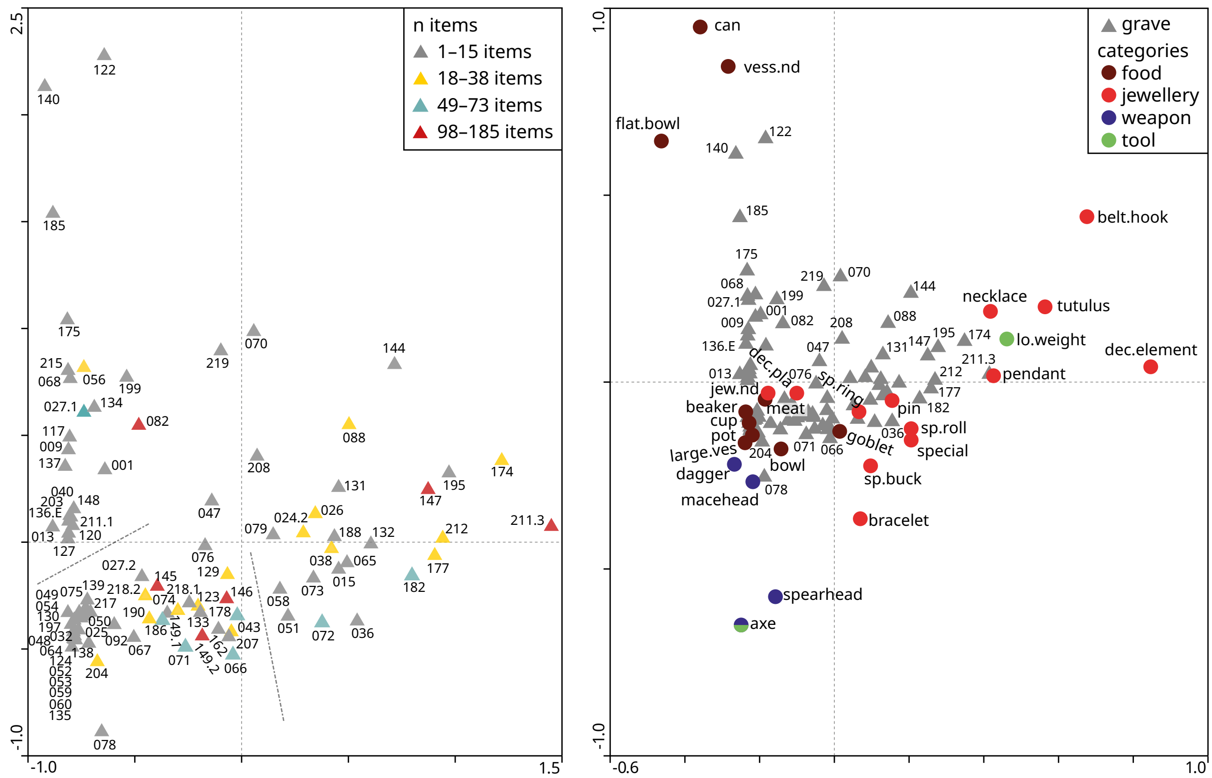

Figure 73: Burial item tradition. Classical correspondence analysis of the grave assemblages (objects, n=97) by means of the category composition (variables, n=27). The underlying contingency table includes total numbers of items in the respective assemblage (marked in the left plot marked in different triangle colours).

- The second and third observation confirm the previous statements concerning the plurality and rareness indices, *i.e.* that not only the numbers, but the function of items are driving factors in the assemblage compositions.

4.2.3.9 Summary burial item analyses

The results of the analyses of the different burial item criteria and methodological approaches can be summarised as follows:

- With respect to the complete data record (NPIC[24]=2332), item frequencies according to artefact material, functional class and category result in unequal distributions. Ceramic and bronze are frequent artefact materials, followed by faunal material and stone. Antimony is an exceptional material. For a part of the artefacts the material was not determinable. The majority of items belong to the functional classes food and jewellery and show significantly higher numbers compared to weaponry and tool items. This is consistent with the artefact material (food: ceramics, animal; jewellery: predominantly bronze). The ratios of item categories allowed the identification of common and exceptional categories. The highest numbers are defined by pot, cup, spiral roll, pins and meat, followed by necklaces, beaker, and spiral rolls. Less frequent are beaker, large vessel, spiral ring, bracelet and pendant. The remaining categories have low frequencies, including spiral buckle, decorative element, spearhead, dagger, bowl, goblets, arrowhead, macehead, flat bowl, decorative plate, can, belt hook, axe, loom weight and whetstone.
- The investigations of the criteria according to the individual assemblages (NPIG[25]) resulted in significant differences between the 130 graves. This applies

24 NPIC: Number of preserved items cemetery.
25 NPIG: Number preserved items per grave.

especially to the numeric proportions: ten graves did not contain any funeral equipment at all. 86 graves contained less than 16 items and 20 graves less than 40 items. The remaining 14 graves revealed over 50% of the complete burial items. Graves 082, 145, 146, 147, 149.2, and 211.3 showed the highest proportions with up to 185 items.
- In terms of overall frequencies and averages of the burial item criteria, the most important results are:
- There are differences within the inventories in terms of common and exceptional items concerning both functional classes as well as categories, which is comprehensible within the total distributions and averages as well as in the artefact variation and assemblage compilations.
- Total and average values enable the partitioning of the assemblages in terms of their functional character from simple food inventories with only common vessel categories and meat to complex inventories with different functional classes, common, and/or exceptional category proportions.
- Analyses aiming to identify assemblage variations in terms of category plurality and rareness showed that the detected differences are not only determined by the size of an assemblage. For instance, the inventory of Grave 212 – consisting of 22 items – included rare categories such as a loom weight and a tutuli and the inventory of grave 080 that consisted of 7 vessels, meat, a dagger, and six arrowheads. In general, assemblages of large sizes show more correlation to higher category rareness indices and accordingly include rare categories more often, though this is not a strict rule.
- The conducted correspondence analyses describe the assemblage similarities with respect to the item category presence/absence as well as total frequencies. The results specified previous conclusions by showing ordination patterns related mainly to functional classes and additionally illustrated the rareness of categories. Again, these analyses strengthen the interpretation that the assemblages are not characterised by the number of items, but their functional character and respective artefact categories.
- There are no significant spatial patterns related to the burial item criteria[26].

4.3 Results 2: Social proxies of burial practice

In the preceding chapter, the analysis revealed high heterogeneity in burial tradition present at the cemetery Kudachurt 14 for each of the selected characteristics: elements of grave construction, inhumation and burial items. Major results are differences in the size and installation depth of the graves as well as in-built stone elements, the number of individuals buried, corpse treatment, number and compilation of funeral goods. In order to draw a concluding picture and to detect connections and interrelations between these characteristics, aim of this subchapter is to correlate individual results.

As the deceased themselves are of central meaning in the burial context, the following investigations concentrate on the individual. This is realized by testing elements of grave construction as well as burial item characteristics in terms of the number of buried individuals (MNIC, MNIG), mainly by considering burial types. In addition, the individual context was reconstructed, naming deposition of the corpse in the grave and according burial items when possible.

26 For stratigraphic aspects, see chapter 3.

4.3.1 Construction elements, burial types and MNIG

It seems obvious that size of a grave chamber is strongly connected to the number of individuals it was installed for, whereas this is not necessarily indicated for the depth. Based on this assumption, the scatter plot depicted on figure 74, showing the approximate installation depth, the maximum size[27] according to maximum length and width of the grave borders, *in situ* for the different burial types, gives more information. It shows that graves with one individual tend to be smaller and to be found in shallower depth (up to 150 cm) compared to collective burials. Outliers[28] are grave 059 (526.2 cm2) and 138 (218 cm2). Double graves more often provided more space but in similar depth as single burials. This stays in contrast to collective burials; they represent the full range of chamber sizes and installation depths, despite their minimal number of individuals. There seem to be a distinct difference in the depth, as all graves located deeper than 170 cm and of good preservation are collective burials with up to 8 individuals (coll S and M). It is remarkable that large collective burials (9-13 individuals minimum) are not equal to significantly enlarged chambers, despite their depth.

Calculating the space per individual and burial type as visible on figure 76, it concludes that it decreases with increasing numbers of individuals buried, including a few exceptions (*e.g.* 059, 117, 148, see Fig. 75, left graph; for further pictures, see Fig. 43-46). In terms of data quality, those of group 2 with unreliable MNIG all are collective burials; taking this into account, the tendency described above would be strengthened. The boxplot on figure 75 verifies that single and double burials provided higher variations in space per individual compared to collective burials.

As we know from the analysis of signs of re-accessibility (see Tab. 14), secondary disturbance and/or superimposition of individuals was detected for most collective burials. In context to the considerations made above, the re-use of the graves happened independently from the installation depth.

In terms of built-in stone elements and burial types, only slight patterns are apparent. Vertical stones as well as surface markers such as simple stones or flagstones are not significant for any burial type. Surface markers (stones, flagstones) are more frequent for single burials. Shaft structures thus are more frequent for small collective burials compared to single and especially double burials, but they also appear.

The correlation of grave construction elements and number of individuals buried can be summed up as follows:

- In average, chamber space for individuals buried in single or double burials was larger and the pits less deepened. With increasing individuals buried, chamber size decreased, but exceptions exist.
- Burials of greater depth all have a collective character, but in general, the re-use of collective burials happened independently from the installation depth.
- One could argue that the differences in dimensions and signs of re-access result from the fact that single and double burials simply has not been used any further, although they were ought to, as the chamber size might indicate. This must be taken into account for those of shallow depth, especially when they reveal stone markers, but can be excluded for those of greater depth, as “initial burials” with only one or two individuals are lacking.

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27 The shape of the burial pit was not considered here, therefore the term “maximum size” really means the maximum size of the grave given in cm^2; it is to be understood as an approximation.

28 The other outlier is 115 with 330 cm^2, but this is inconsistent with the plan; measurement and sketch are contradictive in this case.

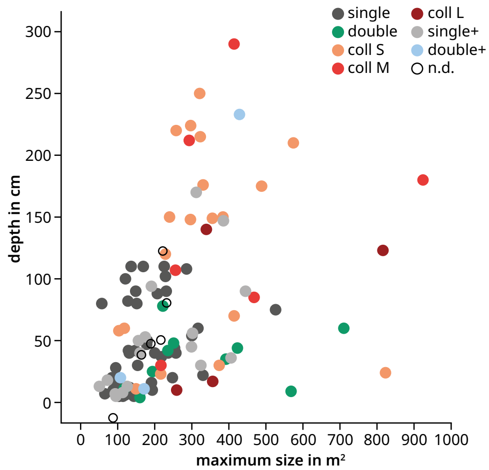

Figure 74 (left): Grave construction and inhumation correlations. Maximum chamber size in cm^2, approximate installation depth and burial type of graves with reliable metric information (n=120). Single+ and double+ mark graves of poor data reliability in terms of MNIG (data quality group 4).

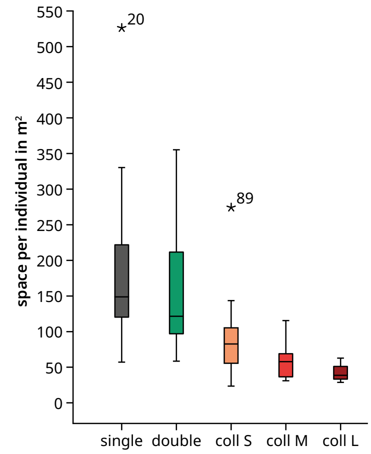

Figure 75 (right): Grave construction and inhumation correlations. Boxplot of average space per individual (maximum chamber size divided by the MNIG respectively) and burial type.

- The presence of stone elements, may they have marking (vertical stones) or highlighting (stones surface), is not typical for one of the burial types.
- Regarding both characteristics as indicators for social inequality, the results lead to following conclusions:
- Considering chamber size per individual as a potential indicator for construction effort leads to the assumption that those deceased buried alone or in pairs experienced a more prominent treatment. This declines when considering them as “initial burials” for later re-use, a fact that requires attention in respect to chronological aspects.
- Considering installation depth as a potential indicator for construction effort or as a highlighting attribute, the fact that only collective burials had been found in greater depth than 139 cm suggest this funeral treatment for a special social or cultural group[29].
- Considering the presence of stone elements in this respect, the majority of built-in components, namely vertical stones, represent the character of re-accessible graves. Those for single and double burials might indicate the suggestion as “initial graves”. Consequently, surface stones, flagstones as well as roundish ones, can be evaluated as constructional add-ons (as far as they do not represent dislocated vertical stones) for at least 19 graves, which are predominantly single burials[30].

4.3.2 Construction elements and burial item criteria

Investigating elements of grave construction in terms of traditions in funeral equipment, none of the burial item characteristics or classified assemblage functional characters show significant correlations to a certain installation depth, chamber size or built-in stone elements. This is true for the numeric proportions of items per grave and their attributes such as material, functional class or category. Included in the analyses are graves and according assemblages of reliable metric information and/or good data quality of 1-3 (n=87).

Smaller assemblages and graves without funeral equipment (<18 items) are in average less deepened compared to those of larger size (>98 items, Fig. 76), which seems less detectable for the maximum chamber size. Consequently, there is a slight correlation of installation depth and assemblage size, which also points to higher

29 Concerning: grave 026, 027.1, 027.2, 038, 043, 066, 072, 075, 145, 149.1, 149.2, 178, 182, 186.

30 Concerning: single burials 039, 040, 059, 067, 079, 138, 199; single+ 001, 009, 013, 015, 037, 201; double/+ 032, 082; coll S: 026, 056, 072, 129.

variations in object material composition for these graves. This is similar to the compilation of functional classes represented by different items; weaponry objects are slightly more frequent in grave assemblages of greater depth, but the value range is still very broad. The installation depth of burials with simple food inventories is below 139 cm[31]. Small graves of shallow depth in consequence are burials with few common food categories (*e.g.* grave 040: 42 cm depth, seven items; food items; cup, beaker, pot, meat) as well as graves that contained multifaceted equipment (*e.g.* 047: 10 cm depth, 63 food, jewellery and weaponry items; inter alia goblet, bracelet, macehead, dagger). Similar considerations are true for the maximal chamber size.

Looking on potential correlations of stone elements and assemblage size as well as functional character (Fig. 76-79), it becomes clear that neither the numeric distributions of items nor their functional compilation is specific for the different types and combinations of built-in stone elements. As most graves lack according construction components, the remaining sample is relatively small. There is a slight tendency of large assemblages having a stronger connection to vertical stones, which correlates with the assumption that these were entrance stones for graves of greater depth and numerus funeral items (see above).

In respect to assemblage functional character (Fig. 79), surface markers are typical for grave inventories lacking jewellery items; but the small sample size is to be considered here as well: Grave 001 and 026 for instance, whose assemblage include jewellery items, also revealed roundish stones as surface markers, but are excluded in the analyses due to poor data quality.

When we consider the complete data set of graves despite their preservation, the presence or absence of a category is not typical in terms of installation depth, chamber size or stone built-in components. Apart from weaponry categories, which are more frequent in graves of greater installation depth, it shall be noted that common as well as rare categories did not exclusively occur in specific grave constructions, *e.g.* five flat bowls found in grave 001, 013, 27.1 and 082, which are of different depth and had different built-in stone elements.

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The results can be summarised as follows:

- The installation depth shows a positive correlation to the assemblage size and functional variation, which stays in contrast to construction elements and chamber size.
- Simple food assemblages only occur in graves that were installed not deeper than 140 cm.
- Inventories found in greater depth are in average larger and do more often represent the three functional classes food, jewellery and weapons.

31 Grave 075, which is missing on the scatter graph as it doesn't have reliable metric information. Grave 052 follows with 102 cm.

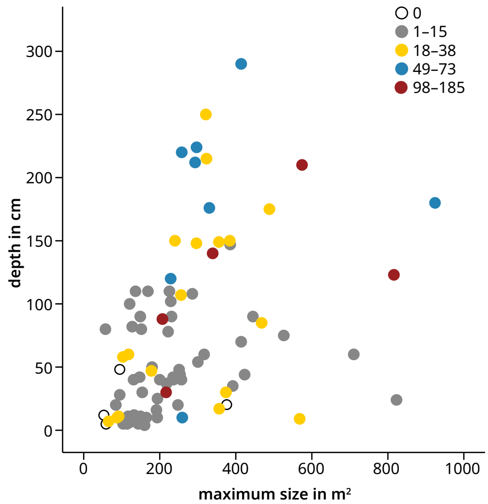

Figure 76 (left): Grave construction and burial item criteria correlations. Grave chamber dimensions and item frequency classes. Includes graves with reliable metric information and good data quality (1-3, graves n=87).

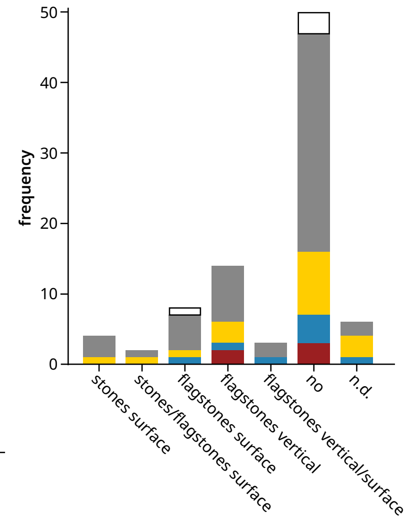

Figure 77 (right): Grave construction and burial item criteria correlations. Built-in stone elements and item frequency classes. Includes graves with reliable metric information and good data quality (1-3, graves n=87).

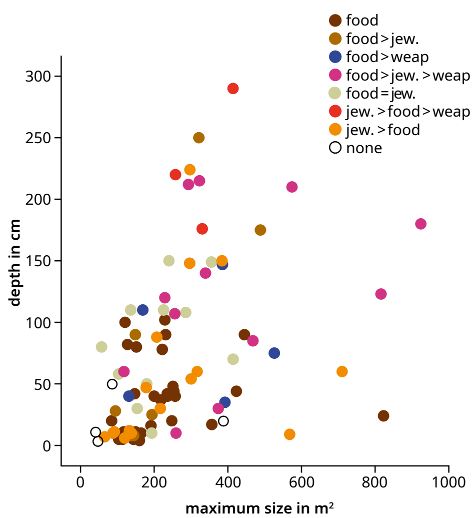

Figure 78 (left): Grave construction and burial item criteria correlations. Grave chamber dimensions and assemblage functional character. Includes graves with reliable metric information and good data quality (1-3, n=87).

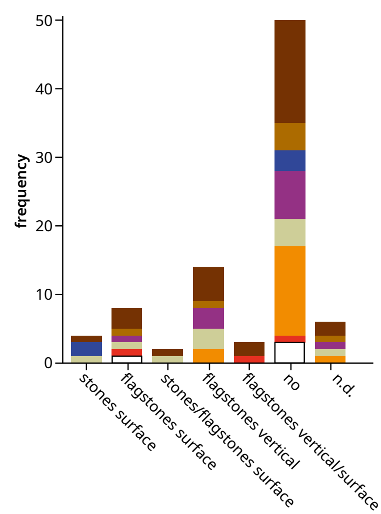

Figure 79 (right): Grave construction and burial item criteria correlations. Stone elements and assemblage functional character. Includes only graves of good data quality (1-3, n=87).

As described above, we can assume a connection between number of buried individuals and chamber size exists, the correlation of item characteristics, burial type and individual context is part of the following section.

4.3.3 Burial item criteria: burial types and individuals

This subchapter follows three main investigative parts: (1) data basis and clearing, (2) analyses of total frequencies and averages of burial items and (3) burial items characteristics in respect to the buried individuals. In order to provide a solid database, this includes a critical evaluation of obtained results and clearing of the data set.

4.3.3.1 Data basis and clearing

The complete data set counts at least 265 individuals from 124 graves and 2332 burial items from 120 graves. Due to the determination of data quality groups, which considers the data reliability of both, number of individuals as well as items per graves, features of poor quality are excluded:

- **Data quality group 5** (burial character questionable): Cenotaphs or no skeletal remains due to poor preservation, burial items only. This applies for six graves (135, 136.E, 136.W, 140, 180 and 217) and 45 burial items (all food items: vessels or meat).
- **Data quality group 4** (MNIG and NPIG is not reliable): 28 graves[32] and 40 individuals[33] , all from single+ or double+ burials and one collective burial (grave 123), containing 305 items in total (218 food[34] , 85 jewellery, and two weaponry items). The proportion of categories follow the overall distributions, so that the selected sample is still representative (see Fig. 58 and 66 for according burial items marked in light and dark red respectively).

As a result, the complete data set of 86 graves, 225 individuals (cMNIC[35]) and 1982 items (cNPIC) for the following investigations are of the remaining three quality groups (see Fig. 56, green, blue and orange coloured graves).

- Out of four graves without funeral equipment, for two the lack of grave goods is certain (039 and 166, data quality group 1) and for two it is not reliable (087, 115, data quality group 3) (all single burials).
- 57 graves are of good data quality (1), meaning that the according number of 96 individuals and 737 burial items is reliable (all burial types, except large collective burials).
- For 24 graves, the total number of 1215 burial items is reliable, but the minimal number of 117 buried individuals is potentially underestimated (data quality group 2; mainly collective burials)
- For 5 graves the number of 10 individuals, but the amount of 30 items is probably underestimated (data quality group 3; mainly double and collective burials).

4.3.3.2 Frequencies per burial type and individual

After the data clearing, the 87 graves building the data set consist of 47 single, 11 double, and 29 collective burials, namely 19 small, 6 medium and 4 of large size. In respect to the item quantities, there are distinct differences in terms of burial type and accordingly the number of individuals buried (Tab. 20).

By calculating the item and category frequencies per individual, the preceding results are specified, which is recognizable though the provided boxplots on figure 80 (B, D). Whereas the values for single burials remain logically stable, the distributions of the other burial types do not differ significantly. With this higher resolution of item and category frequencies in context to the actual numbers of individuals buried, similar median suggest that (1) the average distributions of item numbers per individual do not significantly differ between the burial types, which stays in contrast to (2) the average numbers of categories per individual are higher in collective graves. In general, the value ranges are broader in collective burials for both, item and category numbers per individual. Striking in this respect are the values of grave 036, 212, 088, 174, 177 and 211.3 (single burials), 195 (double) as well as 149.2 and 147 (collective S and M), because for these graves of different burial types, the amount of equipment items are comparatively high, expressed by the boxplots as distinct outliers. For 211.3 and 149.2 this is also true for the category variation.

The boxplots depicted on figure 81 show the distribution of item frequencies (A), category frequencies (C) as well as the category rareness index (E) per burial

32 Grave 001, 015, 025, 037, 042, 053, 055, 063, 068, 082, 086, 089, 120, 123, 132, 133, 139, 143, 144, 162, 164, 173, 175, 187, 200, 201, 207, 211.2.

33 Mainly of unknown body position and orientation (6/flexed, 2/right, 2/left; 4/E-, 3/NE-, 2/NW, 1/W-orientated).

34 Number per category: 56/pot, 37/cup, 17/beaker, 13/large vessel, 3/flat bowl, 2/can, 1/bowl, 63/vessel n.d, 26/meat; 30/spiral roll, 20/pin, 12/necklace, 6/spiral ring, 4/tutuli, 4/bracelet, 3/spiral buckle, 3/pendant, 2/jew n. d., 1/decorative plate; 2/dagger.

35 “c“ for “cleared“.

ITEM NUMBERS & ASSEMBLAGE CHARACTER		All	Burial type					
			Single	Double	Coll S	Coll M	Coll L	Sin/doub+
Item frequencies	min/max grave	0/185	0/98	4/37	8/145	23/185	35/114	0.36
	min/max ind	0/98	0/98	2/18.5	2.6/36.2	3.3/26.4	3.8/12.7	4/11
	average grave/ind	22.7/8.8	8.3/8.3	11.3/5.9	36.8/9.9	67.3/9.85	81.5/8.5	9.7/7.25
Functional character n/%	none	4/4.4	4	0/0	0/0	0/0	0/0	0/0
	food	28/31.1	19/40.4	5/45.5	3/15.8	0/0	1/25.0	1/33.3
	food>jew.	8/8.9	4/8.5	2/18.2	2/10.5	0/0	0/0	0/0
	food>weapon	5/5.5	3/6.3	1/9.1	0/0	0/0	0/0	1/33.3
	food>jew.>weapon	12/13.3	0/0	0/0	5/26.3	4/66.7	3/75.0	0/0
	food=jew.	12/13.3	7/14.9	0/0	4/21.1	0/0	0/0	1/33.3
	jew.>food	17/18.9	10/8.5	3/27.3	3/15.8	1/16.7	0/0	0/0
	jew.>food>weapon	3/3.3	0/0	0/0	2/10.5	1/16.7	0/0	0/0
All graves/items		**90/1982**	**47/939**	**11/130**	**19/700**	**6/404**	**4/326**	**3/29**

Table 20: Inhumation and burial item correlations. Distributions of item frequency per grave as well as individual and assemblage functional character per burial type (based on the total ratios of items according to their function, see chapter 4.2.3, Tab. 19).

type. In general, the average number of items increases from single to collective burials, from 8.3 to 81.5 items per grave (Tab. 20). However, the boxplot shows us that within the single burials significant differences in the data set exist. Most of the burials contained small amounts of funeral goods, below 10 items per grave, whereas a few ones are prominent outliers. Here, grave 211.3 is most striking in this respect by a number of 98 items, followed by grave 177 with 36 items. Double burials contained up to 37 items, namely grave 195 with an outlier of 37; the remaining ones revealed less than 15 items. Within the collective burials, the quantities increase with the MNI respectively. Here the 29 smaller collective burials show the highest variety including grave 149.2 that represents the second largest assemblage of 145 items. Only grave 147, a collective burial of medium MNI, contained more funeral goods (n=185). All double and collective burials did contain inventories, which stays in contrast to single burials. For collective burials, the minimal number is lower, but also seems to depend on the MNI. In terms of category frequencies, the picture is following the trend of increasing categories with increasing MNI. Assemblages from collective burials show the highest spectre with 18 categories, although inventories from few burials with only one or two individuals also have high diversity, which goes along with the item frequency. When we consider the rareness of categories represented within the complete cemetery, the CRI seems to be less distinct in this respect. In average, it slightly increases with burial types of higher MNI, but single burials show the greatest value range from assemblages consisting of common categories only up to a compilation of common and rare ones. In addition, grave 75 and 124 represent small collective graves with only common funeral goods.

Regarding these results in the context of potential social meanings, following conclusion are drawn:

- Graves without funeral equipment all are single burials.
- The distributions of item and category frequencies calculated per burial type (NPIG/grave) and individual (NPIG/MNIG) assume in general similar average distributions on the individual level compared to the outliers for each burial type.
- The average item numbers for individuals buried in single and collective graves are higher and show a broader value range compared to double burials (see Tab. 20).
- The category variation (n cat NPIG/MNIG) increases from single to collective burials, but not proportionally. The proportions of category numbers per grave and individual are more stable in the inter-comparison of the burial types.

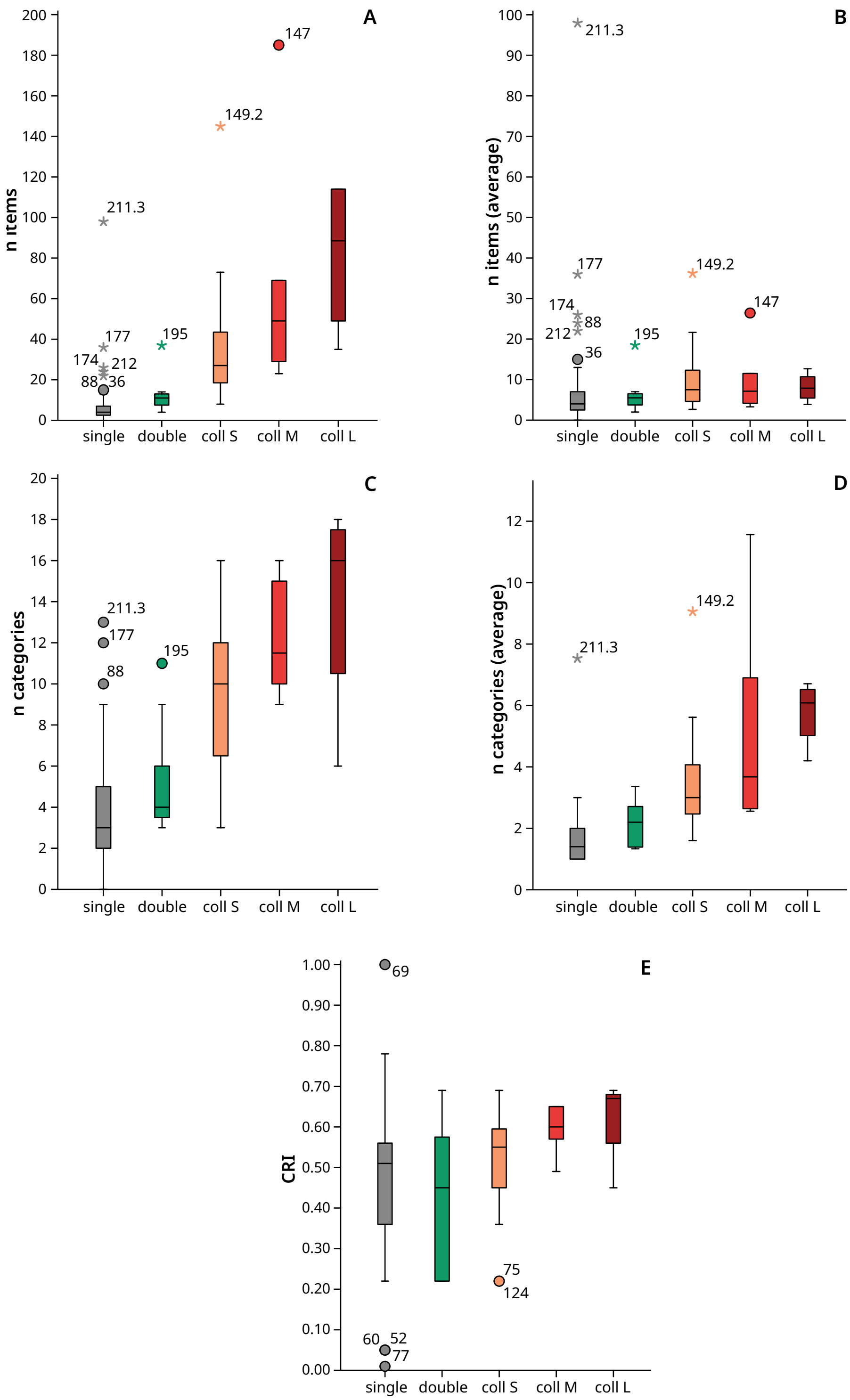

Figure 80: Inhumation and burial item correlations. Boxplots of item (A-B, n items=1982) and category (B, D, n categories=30) frequencies per burial type (A, C; n items=1982, n graves=90) as well as the averages calculated for the specific MNI of each grave (NPIG/MNIG; D; n items=1982, n individuals=225). CRI values are plotted for burial types only. Please consider the different scales. Single+ and double+ are not depicted here (n=4).

4.3.4 Burial item criteria: Assemblage functional character and burial type

In order to reveal differences of the distribution of item characteristics, total frequencies (cNPIC) hsve been investigated in respect to each burial type (Fig. 81 and 82).

The distribution of the burial item criteria material, functional class and category follows almost proportional trends: The materials ceramic, bronze, animal tissues, antimony and stone are represented within different objects of food, jewellery, weaponry and tools, which occur in single, double and collective burials. Single burials show higher proportions of jewellery items compared to objects of food, which is different to collective graves. This is also recognizable in the distribution of categories: here, the jewellery categories are more frequent in single burials compared to the amounts of vessels. In general, none of the different food and jewellery categories occurs exclusively in one of these burial types. This is slightly different for items of weaponry: this functional class, consisting of spearheads, daggers, maceheads, arrowheads and axes is a predominant element of double and collective grave equipment. Out of 54 weapons that come from reliable data quality, only three were found in single graves (059, 078 and 203). This is especially remarkable for the arrowheads, as six of seven exemplars are included in the inventory of gave 080, which is a double burial.

As we know from the distribution of frequencies per grave (see preceding subchapter) and the individual results (see preceding chapter), the inventories differ in item number and compilation, resulting into the determination of assemblage functional characters. These span from simple food inventories with only common vessel categories and meat, to complex inventories including all four functional classes, common as well as rare categories. Considering the burial type in this regard, it becomes clear that the simple food assemblages are predominantly single burials (19/29), followed by double (5/29) and small collective burials (3/29; Tab. 20). In general, graves that contained only one or two individuals revealed more often assemblages that are characterised by food items compared to collective burials. At the same time, 10 of 17 inventories with more jewellery items than food objects are as well single burials. Again, the combination of food, jewellery and weapons is only existent for collective burial assemblages. Following conclusions are important in this regard:

- Object materials are not specific for any burial type, but the distribution of assemblage functional characters' point to differences within grave assemblages that are of different burial types: Simple food assemblages consist of ceramic and animal bones only and lack other materials such as bronze or antimony, which are represented in inventories including weapons and/or jewellery items.
- Jewellery items are slightly more often from some single burial contexts and weapons from double and collective contexts. The distribution of categories reflects this fact.

4.3.5 Burial item criteria: Assemblage composition and burial type

Taking into account the extended data set, as considered in the analyses of burial items (subchapter 4.2.3), supports the observations that the burial type is not a driving factor for the functional character and category compilation of the assemblages. The labelling of burial types in the CAI and II generated for the burial item analyses (section 4.2.3, Fig. 72, 73) confirm these conclusions (Fig. 83). The burial types distribute within the different ordination patterns, which are due to differences in the presence and absence of categories (CA I) as well as according quantities (CA II, see right scatter plots respectively). For instance, the concentration of collective burials in cluster D and H of the left scatter plot as well as in the central left area of the right scatter plot reflect combinations of individual equipment, including common and rare food and jewellery categories as well as weapons. In addition, it visualizes the contrast of single burials characterised by common food in contrast to high proportions of (rare) jewellery categories (right areas of both scatter plots).

4.3.6 Burial item criteria: Assemblage functional character and individuals

Previously explained observations indicate that the individual context of funeral equipment is a crucial factor in the burial tradition. This is evident for instance by vast differences in single burials in respect to item and category number as well as compilation (Fig. 80, A-D). Hence, the conducted approach requires supplemental analysis that considers specific individual contexts: reliable classifications of individuals and items and according characteristics. Due to the nature of the CRI, according values are not suitable for individual contexts (despite single burials, see above).

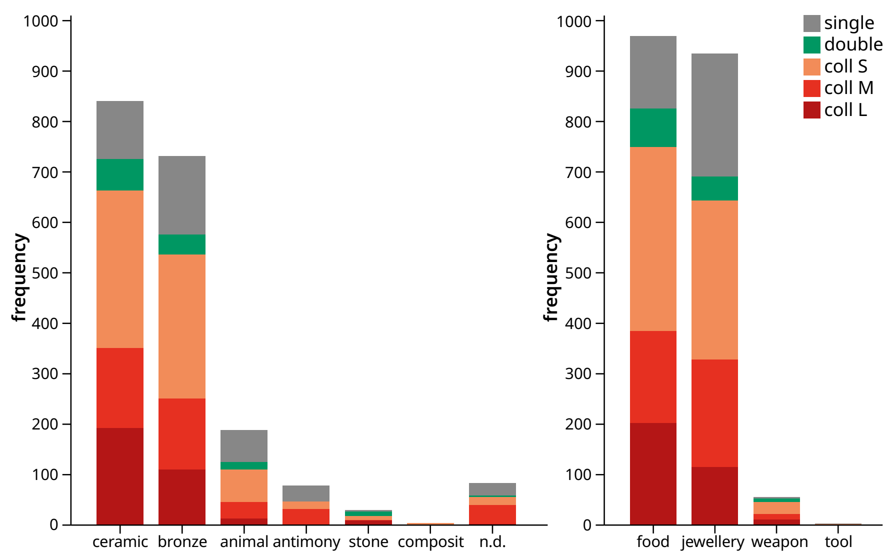

Figure 81: Inhumation and burial item correlations. cNPIC, total frequencies of item characteristics material and functional class per burial type (n graves=87, n items=1953, single+ and double+ burials are excluded here).

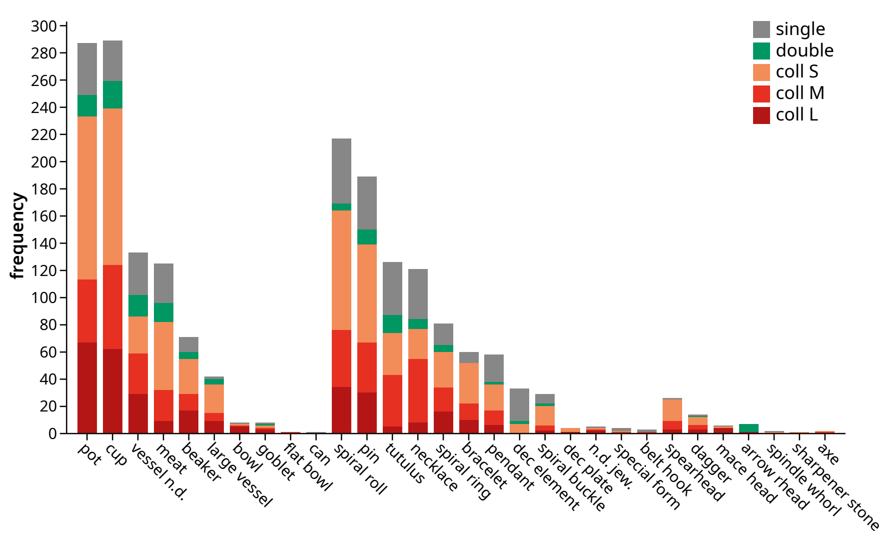

Figure 82: Inhumation and burial item correlations. cNPIC, total frequencies of item categories per burial type (n graves=87, n items=1953, single+ and double+ burials are excluded here).

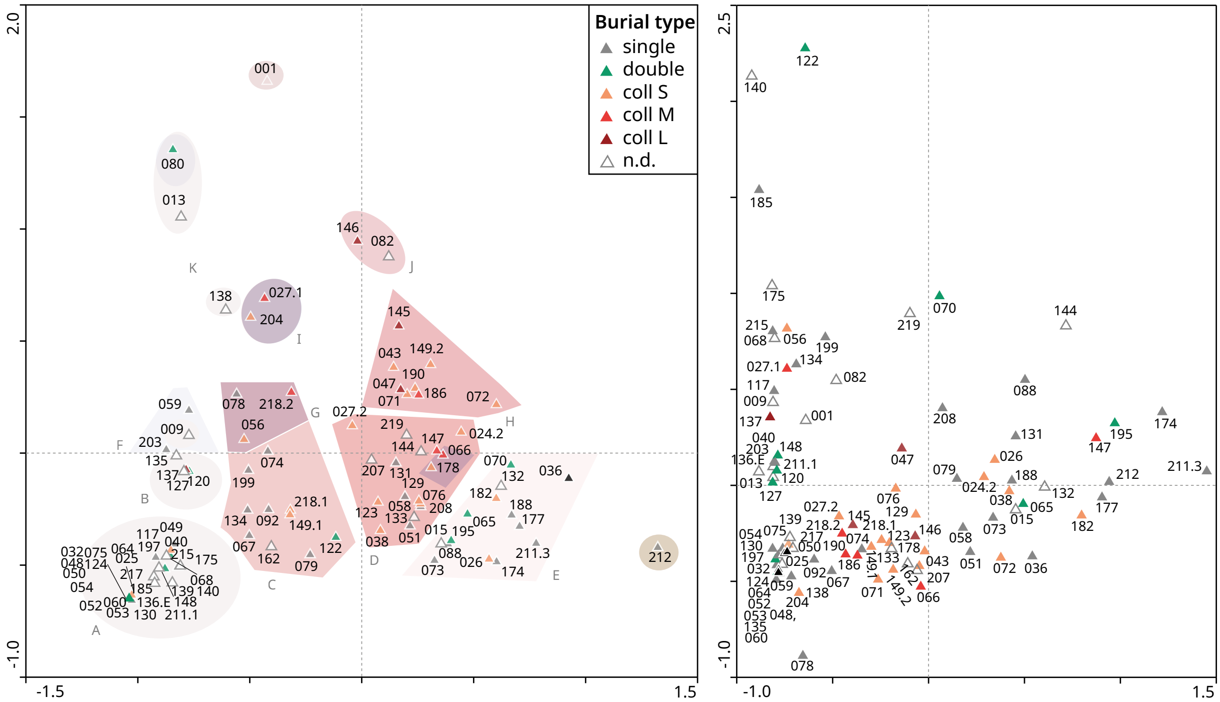

Figure 83 Inhumation and burial item correlations. Illustration burial types in the original correspondence analyses I, including presence and absence of categories (n graves=98) and II, including frequencies of categories (n graves=87). For detailed descriptions of patterns, see subchapter 4.2.3, Fig. 72 and 73).

Additional to the connection of item and individual, this approach also enables to include corpse treatment traditions (body positioning and ochre dispersal) in the analyses. As the personal affiliation of items is unquestionable for single burials, this is different to double and collective burials. Here, identification was only possible for few *in situ* situations that allowed a reliable individual belonging (*e.g.* the bracelet around the arm bones, the spiral ring in the ear region, pins in the shoulder region, see Fig. 84). This was more likely for well-preserved and less dense layered skeletons; an affiliation of all items was not possible for any of these graves. Therefore, the results for individuals from double and collective burials are excerpts only. In general, due to the stronger physical context of jewellery, according items were more frequently affiliated to certain individuals compared to food and weaponry objects. This explains the deviating proportions of food categories with and without individual affiliation; these are, compared to jewellery categories, remarkably lower (Fig. 85).

Altogether, for 114 individuals[36] and 705 items from 78 graves (47/single, 12/6 double, 28/16 coll S, 20/6 coll M, 8/3 coll L burials) direct associations of funeral equipment was possible. This represents:

- 60% of all graves (n=130) and 86.6% of good data quality (n=90),
- 43% of all detected individuals (MNIC, n=265) and 50.7% of good data quality (cMNIC=225),
- 30.2% of all items (NPIC=2332) and 35.6% of good data quality (cNPIC=1982).

4.3.6.1 Single burials

Four individuals were buried without any funeral equipment and 19 with mainly common food categories (pot, cup, beaker; rarely goblet, bowl, meat; Fig. 86.1-2 and 87.1-2) and less than 9 items per inventory. One of the individuals was covered with

36 Including two from single+ individuals.

Figure 84: Inhumation and burial item correlations. Examples of individual item contextualisation in single and collective burials, illustrating specific funeral equipment for different individuals buried in the same grave. 1: grave 038. 2: grave 036. 3: grave 186. 4: grave 146.

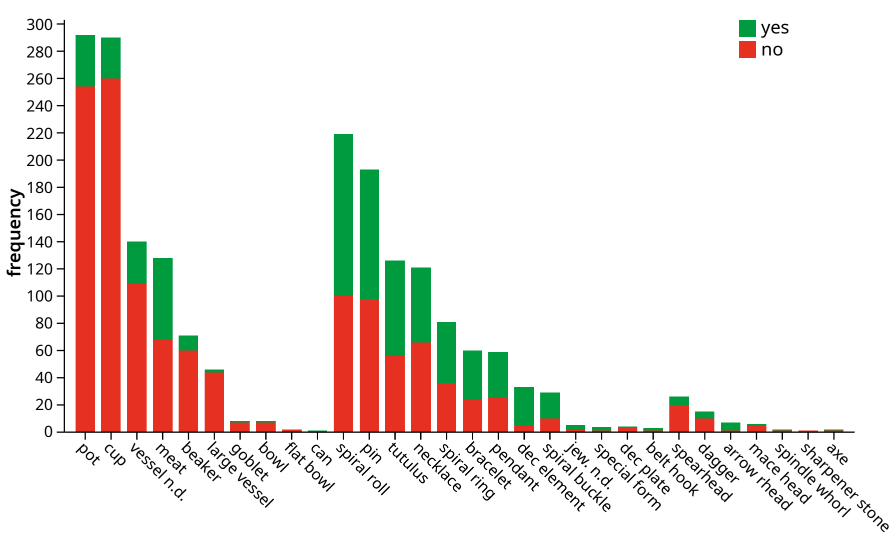

Figure 85: Inhumation and burial item correlations. Positive and negative individual affiliation of categories (cNIPC, n=1982).

Figure 86: Inhumation and burial item correlations. Examples for single burials lacking funeral equipment. 1: grave 166. 2: grave 039.

ochre (grave 049). The corpses were laid down predominantly on the left (13) in flexed (10) or hyperflexed (7) position, two individuals laid stretched on the back.

14 individuals had jewellery or weaponry items with them, but the categories (bracelet, tutulus, spiral roll, necklace, decorative element, pin, spiral ring; dagger, macehead, spearhead; see Fig. 88.1-2) differ among the assemblages which are not larger than nine items. The skeletal remains of one individual, buried in grave 188 with jewellery and food (two cups, spiral ring, necklace, tutulus) items, was additionally discoloured by ochre. The corpses were situated in flexed position on the right body side, with two exceptions; one hyperflexed and one sided left. Two individuals in supine, stretched position were equipped with spearhead (grave 078, Fig. 88.2) or macehead (grave 181).

Ten individuals were equipped with numerous jewellery items, one[37] of them with two pins and one with two spiral rings. For the remaining ones, the decorative equipment is richer, from 15 up to 93 jewellery items for just one individual (grave 211.3, Fig. 43.1). These graves represent outliers within the data set of single burials (Fig. 77, A-D). Common as well as rare categories occur in higher frequencies in the according assemblages, whereas grave 211.3 plays a major role in this respect. With only one exception, the individual buried in grave 031, which was found in stretched position, all other corpses were laid down with flexed legs on the right body side. Additionally, graves 177, 212 (Fig. 89.1.3) and 211.3 that have larger assemblages from 22-98 items revealed ochre discolouration. In contrast to the body position, which shows correlations to the funeral equipment, the orientations lack clear tendencies.

4.3.6.2 Double burials

For 12 individuals from 11 double burials it was possible to achieve item affiliations in 51 of 130 cases (39.2%). The burials did not contain more than 11 items, thus the item number per individual is little, and represent common vessel categories (cup, pot, beaker, large vessel, meat). No ochre was found there.

The corpse depositions are mainly flexed on the right or left side, orientations differ; mostly, the corpse situations are equal for the individuals buried together.

Two graves revealed jewellery or weaponry items additionally to pots, cups, large vessels and meat (1235 in total). Arrowheads and dagger found in grave 080 were directly connected to one of the individuals (Fig. 44.4), a necklace found in context to one individual of grave 122. In general, the number of items remain very little. Both individuals in grave 080 were laid down in stretched, supine position;

37 Ind *in in situ* 031_1, 045_1.

Figure 87: Inhumation and burial item correlations. Examples for graves with assemblage functional character food. Different burial types and corpse treatments. 1-2: grave 064 and 202, singe burials. 3-4: grave 127 and 197, double burials. 5-6: grave 124 and 075, small collective burials. For further examples, see Fig. 43.1, 44.2.3.4., and grave catalogue in part IV.

grave 122 represents an exceptional case (Fig. 44.1), with one skeleton preserved in a flexed position on the left side, the other deformed by a bending in the back.

The remaining three burials contained more jewellery items compared to food objects, up to 37 exemplars (grave 065, 070, 195; 61 items in total, Fig. 44.5-6, 89.4). Whereas the individuals buried in grave 070 show distinct differences with one equipped with different jewellery categories (pin, spiral buckles, spiral rings, necklaces, spiral rolls), and the other lacking alike (see Fig. 89.4). For grave 065 the situation is less significant. In grave 195 both individuals show rich funeral jewellery, which differs in some details (both pins and necklace; 195_1 with decorative elements, spiral rings and decorated tutuli, 195_2 with spiral rolls and plain tutuli, see Fig. 44.5). All six individuals were found in flexed or hyperflexed position on the right body side without any ochre remains.

A main result of the investigation of double burials is that distinct individual differences in funeral equipment do exist, even in the same graves.

4.3.6.3 Collective burials

The greatest part of the data set goes back to collective burials with 152 individuals and 1432 items in total, of which only a part was suitable for individual contextualisation: 24 graves, 57 individuals and 261 items.

Three graves with simple food equipment, all small collective burials with three individuals each and 12 items maximum, contained mainly common vessel types and meat (Fig. 87.5-6); in seven cases, meat was closely found to a specific skeleton (075_1, 075_2, 117_1, 117_2). Pottery objects remain unreliable in this respect. The body position does not show clear tendencies. One large collective burial with eight individuals minimum (137) contained also common food categories exclusively (35 items); unfortunately, body positions were not determinable. None of the individuals buried in these graves revealed ochre discolouration.

Six further small collective grave inventories contained fewer jewellery items or in equal relation to food objects (24.2, 026, 027.2, 129, 149.1, 218.1; 21 individuals and 152 items in total; Fig. 87.4-6) with the highest proportion of 38 items in grave 27.2. (Fig. 45.4). Individual affiliations for predominantly jewellery was possible for 39 items and eight individuals, differing from common objects like pins, necklaces and spiral rings to bracelets, spiral buckles, tutuli and one decorative plate. Additionally, common food categories as well as a goblet and a bowl as well as one loom weight is included in the inventories, for which the contextualisation is lacking. Positions of the corpses differ in both, body side and orientation, but right is more frequent for the individuals with jewellery. Stretched in supine position is rare. Grave 129 is similar to double burial 122 (Fig. 88.3 and 44.1), one individual was laid down right above the other in counter wise position without the crack in the spine. For four individuals only ochre discolouration was found, 24.2_1, 149.1_1, 149.1_2 and 218.1 (Fig. 84.4); in this respect, individual 024.2_1 was most richly equipped.

12 collective burials[38] of different sizes included weapons as additional assemblage elements (80 individuals and 741 items in total), and for 29 individuals and 117 items from 11 graves individual affiliations were possible. Within this information provided, it becomes clear that individuals associated with spearheads and daggers are more often laid down on the back in stretched position (*e.g.* 186_1. 043_1), but this no strict rule (027-1_2186_6). According individuals do not show jewellery equipment; in contrast, the ones that did, were slightly more often found in flexed position on the right body side (7 out of 5), but this is not significant. In general, the category spectre becomes broader including rare categories such as axe, sharpener stone or flat bowls. Disperse of ochre was recognizable for seven

38 Grave 027.1, 043, 047, 056, 071, 145, 146, 149.2, 186, 190, 294, 218.2.

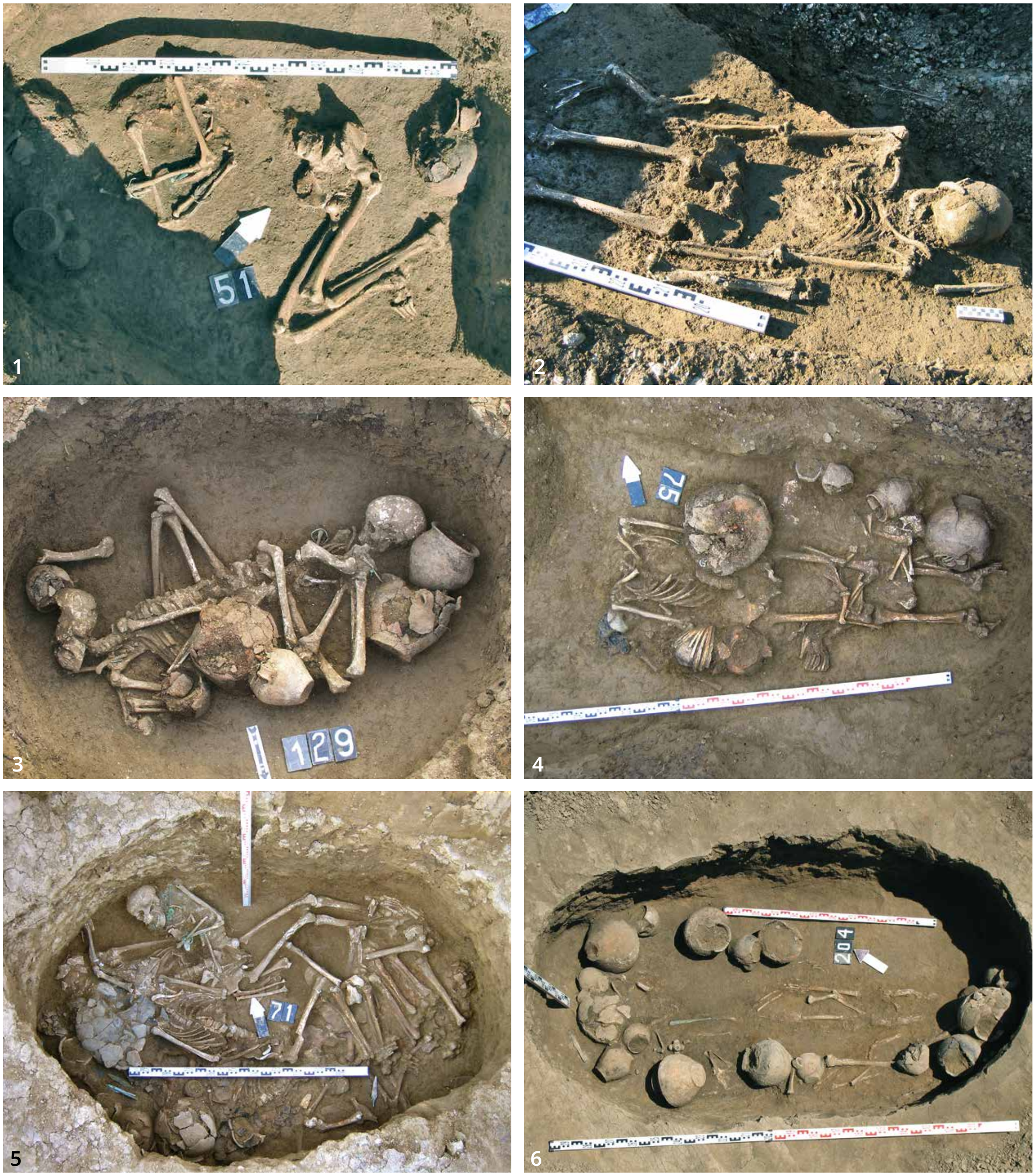

Figure 88: Inhumation and burial item correlations. Examples for graves with assemblage functional character food>jewellery(>weapon). Different burial types and corpse treatments. 1: grave 051, food>jewellery, single burial. 2: grave 078, food>weapon, single burial. 3: grave 129, food>jewellery, small collective burial. 4: grave 218.1, food>jewellery, small collective burial. 5-6: grave 071 and 204, food>jewellery>weapons, small collective burials. Further examples see Fig. 45.3-5, 44.1.4-5, 49.1, and grave catalogue in Part IV.

Figure 89: Inhumation and burial item correlations. Examples for graves with assemblage functional character jewellery>food(>weapon). Different burial types and corpse treatments. 1-3: grave 212, 131 and 177, jewellery>food, single burials. 4: grave 070, jewellery>food, double burial. 5: grave 076, jewellery>food, small collective burial. 6: grave 072, jewellery>food>weapon, small collective burial. Further examples see Fig. 43.4-5, 45.2.4.6, 49.2-3, and grave catalogue in part IV.

individuals which were additionally equipped with jewellery or weapon, laid down in stretched or flexed right-sided position, also in the same graves[39].

The remaining seven collective burials[40] with the assemblage character of jewellery over food and, in two cases, weapons, make the inhumation of 33 individuals and 467 items. They show small and medium sizes and reveal high differences in item numbers from 19 to 185 items. Associations were possible for five graves (038, 066, 072, 076 and 182; Fig. 45.2.6, 89.5-6), containing 13 individuals and 98 jewellery items of different categories. Here, the relation of jewellery equipment and corpse deposition is not significant with four left-sided and six right-sided crouched individuals, whereas both sidings can appear in the same burial. The dispersal of ochre is true for minimum six of the individuals, whereas grave 066 is an exception as all four skeletons revealed such discolorations, and they all had jewellery equipment. In general, the orientations of the individuals buried in collective graves in context of their equipment are not significant in any directions.

Although only a small selection of equipment contexts is comprehensible for the collective burials, one striking result is that the funeral goods differ crucially within the individuals buried in the same grave. Deviating jewellery equipment in terms of item numbers and categories as well as the presence of weapons describe these differences, especially compared to individuals lacking according treatment. In addition, there seems to be a strong correlation between supine body position and weaponry items and a tendency for jewellery and right-sided flexed position.

4.3.6.4 Bodily treatment

Within these detailed investigations of different burial types, the observations suggest a correlation between corpse deposition, item function and the dispersal of ochre. This can be confirmed by the distribution within the whole data set of 1982 burial items (Fig. 86, Tab. 21); we must consider here, that the proportions of food items are not as significant as those of jewellery and weaponry in this respect. Still, jewellery items are more often associated with the right body position (39.5 %; all flexed or hyperflexed) of the individual respectively, whereas weapons are combined with the supine position 67.8%). For food items, and this are mostly individuals from single burials, there is no clear tendency. Additionally, the presence of ochre is more frequent for individuals with jewellery equipment.

4.3.6.5 Interim result: Individual equipment

Based on the investigation of individual contexts of funeral equipment and manner of corpse deposition concerning the different burial types and by taking into account results from the correspondence analyses, the author comes to following conclusions:

- The examination of individuals buried alone resulted into distinct differences in funeral equipment in terms of item numbers, as well as compilation (function and category). This is especially true for jewellery items. Right flexed body side is predominant for inventories characterized by food or jewellery items, stretched supine position for few inventories with weapons. Ochre appeared associated with jewellery items.
- Individuals buried in pairs differ in their funeral equipment but often were laid down in similar manner. Equal as well as unequal numbers and compilation of

39 Grave 027.1, 2 right; 043.1, 1 stretched, 1 right; 186 1 stretched and 1 right; for graves 145, 146, 149, 190 the disperse remains undefinable.

40 Grave 038, 066, 072, 076, 147, 178 and 182.

Table 21: Inhumation and burial item correlations. Distributions of bodily treatment attributes and item functional class based on skeletal affiliations.

BURIAL ITEMS/ INHUMATION		All (n/%)	Functional class			
			Food	Jewellery	Weapon	1/33
Body side	right	448/23	84/9	361/39	2/4	0/0
	left	41/2	24/2	2/0	15/27	0/0
	supine	158/8	63/6	94/10	1/2	2/67
	n. d.	1335/76	815/83	480/51	38/68	1/33
Ochre	yes	252/13	14/1	233/25	4/7	2/76
	no	1730/87	972/99	704/75	52/93	2
All		**1982/100**	**986/100**	**937/100**	**56/100**	**3/100**

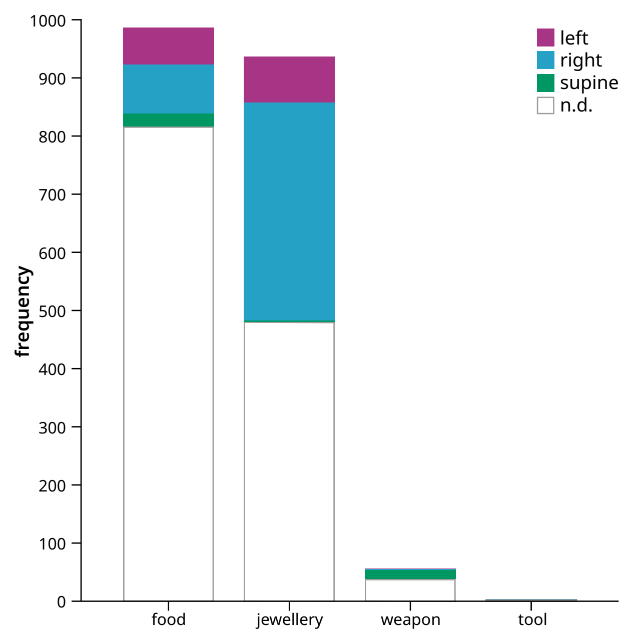

Figure 90: Inhumation and burial item analyses. Correlation of item functional class and body positioning of the individual (n items=1982, with individual affiliation n=705, n individuals=114).

grave goods appear within the same burials, which is true for individual functional character as well as item category. Specific body positioning shows similar trends according to jewellery and weapons as those in single burials.

- For the relatively little representative sample of individuals buried in small to large collective burials similar observations supplement previous results. Individual equipment and the mutual burial caused vast differences in the assemblage character and category compilation within the same graves as well as in the comparative analysis. Correlations of body position as well as the presence of ochre in combination with jewellery equipment are as well detectable.
- In consequence, specific traditions of individual funeral equipment and corpse treatment are present in all burial types. Hence, the number of individuals in the same grave was not a crucial driving factor in this regard.
- The large differences in inventory compositions including item numbers, material, functional class and categories are due to specific personal equipment, which are singular or combined in the burial types. These individual differences appear throughout the data set. This is supported by the distribution of categories, as there is none that is significantly specific for any of the burial types.

4.4 Chronological aspects

In order to detect potential time trends in the results gained, significant characteristics of burial practice analysed in chapter 4.2 will be discussed with regard to chronological data. Table 22 summarises according burial characteristics of graves for which chronological information are available. These include radiocarbon dating, stratigraphic sequencing or both (see chapter 3.4.2). It should be pointed out that with 37 graves the sample is relatively small. Still, it offers a suitable cross-section of the characteristics selected which are depth and stone elements (grave construction), burial type, signs of re-access and presence of ochre (inhumation), assemblage functional character, item and category quantities as well as CRI class (burial items) and data quality group. In the upper part of the table grave sequence units with radiocarbon data are listed (marked in grey/white). The middle part includes graves with ^{14}C-dates and the end of the table stratigraphic sequences.

In terms of grave construction, it is obvious that those pits of earlier stages within the sequences are of greater depth compared to later ones, except those that showed intersection of later burials. Overall, there is no temporal tendency for the installation depths, for instance two of the earliest radiocarbon dates are of depth below 30 cm as well as of over 200 cm depth. This is similar for built-in stone elements or the lack of it; unfortunately, we do not have information for roundish stones as surface markers in this regard.

Looking on the inhumation tradition, the data do not conclude significant chronological regularities of related practices. This is confirmed by the single sequences, *e.g.* a single burial overlaid by a double burial (211.3 and 211.1), or a collective grave overlaid or intersected by a single burial (grave 186 and 188, grave 016 and 208). In addition, available ^{14}C-dated graves do not show tendencies that allow interpretations such as “collective burials are younger and single burials older”. Signs of re-access support this. Additionally, the prevalence of ochre in the burials is evident for early as well as later burials.

Examining the burial item characteristics in this regard, at first sight it seems that graves with predominantly jewellery items are the older ones, for instance regarding the sequence of grave 211.3-162 or the 3 early ^{14}C-dates for according graves (182, 177, and 174; 2199-1768 cal BCE). This is partly misleading, as the two burials with food assemblages date in the middle time range (grave 185 and 135[41]; 1946-1751 cal BCE) and those of food over jewellery and weaponry items are also evident for these dates (*e.g.* 218.2, 186). We also have to consider here, that the number of available ^{14}C-dates for grave inventories consisting of exclusively food items is not sufficient to come to reliable conclusions (3 to 12). Still, the oldest dates come from burials whose inventories are characterised by jewellery items and three cases of older stratigraphic location confirm this observation (grave 132, 047, and 065). Weapons appear in burials that are younger than 1970 cal BCE (grave 178); potentially grave 149.2 could give more information here. Regarding the size of the assemblages or the average number of items per individual, those older graves (211.3, 182, 177) show the highest proportions, which is also due to the fact that jewellery equipment tend to be small-scaled but with many items. In contrast, grave 178, with similar item values, is considerably younger (1891-1750 cal BCE). Here, the radiocarbon dates of grave 149.2 as well as 027.1 and 027.2 would bring clarification. This is also true for the category variability and rareness, which are less distinct in this regard. High CRI and category quantities are evident for the abovementioned older burials as well as for younger ones, such as grave 047 and 186. Nevertheless, the rich single burials (especially 211.3; 177, 174) proof complex assemblages for single individuals in the earlier phase of the cemetery.

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41 Grave 038, 066, 072, 076, 147, 178 and 182.

Grave	Cal BCE (2sig)	Depth	Stone element	Burial type	Re-acc. /ochre	Ass. func. char.	n Item	n Cat	CRI class	Data qual.
162	-	< 30	flagst. vert.	single+	no/no	food=jew.	11	4	1	4
201	-	< 30	flagst. surf.	single+	no/no	food	6	2	1	4
211.1	-	30-100	no	double	no/no	food	7/3.5	4/2	1	1
211.3	2044 -1951	30-100	no	single	yes/yes	jew.>food	98	13	4	1
218.1	1953-1776	30-100	flagst. vert.	coll S	yes/yes	food=jew.	14/3.5	6/1.5	2	1
218.2	1971-1777	30-100	flagst. vert.	coll M	yes/no	food>jew.>weap	23/3.3	9/1.2	3	1
188	-	100-150	no	single	no/yes	food=jew.	6	5	3	1
186	1946-1775	150-200	no	coll M	yes/yes	food>jew.>weap	49/6.1	15	4	1
187	-	30-100	no	single+	no/no	food	1	1	3	4
135	1946-1772	100-150	flagst. vert.	n. d.	no/no	food	19	4	1	5
180	-	30-100	flagst. vert.	n. d.	-no/no	food	8	2	3	5
149.1	1870-1658	150-200	flagst. vert.	coll S	yes/yes	food>jew.	18/4.5	6/1.5	2	2
149.2	-	>200	no	coll S	yes/yes	food>jew.>weap	145/36.3	16/4	4	2
050	1879-1692	<30	no	single	no/no	food	3	3	1	1
047	1879-1692	<30	no	coll L	yes/no	food>jew.>weap	63/7	15/1.7	4	2
219	1892-1746	<30	no	double+	no/yes	food=jew.	14	6	3	2
178	1891-1750	150-200	Flag. vert./ surf.	coll S	yes/yes	jew.>food>weap	73/18.25	13/3.3	3	2
185	1899-1751	30-100	no	single	no/no	food	7	4	1	1
076	1932-1768	150-200	no	coll S	yes/no	jew.>food	23/5.8	9/2.3	3	1
174	1938-1757	30-100	no	single	no/no	jew.>food	26	9	3	1
177	2018-1828	<30	no	single	no/yes	jew.>food	36	12	3	1
182	2199-2031	>200	flagst. vert.	coll S	yes/yes	jew.>food	65/21.7	12/4	3	2
027.1	-	>200	n. d.	coll M	yes/yes	food>jew.>weap	69/11.5	10/1.7	4	1
027.2	-	>200	n. d.	coll S	yes/yes	food>jew.	38/12.7	11/3.7	3	2
056	-	30-100	flagst. surf.	coll S	yes/no	food>jew.>weap	35/6.5	8/1.6	3	2
065	-	30-100	no	double	no/no	jew.>food	13/6.5	9/4.5	3	3
043	-	>200	no	coll S	yes/yes	food>jew.>weap	27/9	10	3	2
025	-	30-100	no	single+	no/yes	food	4	4	1	4
026	-	100-150	stones surf.	coll S	yes/yes	food=jew.	30/7.5	10/2.5	3	2

Grave	Cal BCE (2sig)	Depth	Stone element	Burial type	Re-acc. /ochre	Ass. func. char.	n Item	n Cat	CRI class	Data qual.
208	-	<30	no	single	no/no	food=jew.	8	4	4	1
067	-	30-100	flagst. surf.	single	no/no	food	3	3	1	1
068	-	<30	no	single+	no/no	food	3	3	1	4
074	-	30-10	no	single	no/no	food>jew.	5	5	3	1
053	-	100-150	n. d.	single+	no/no	food	2	2	1	4
130	-	<30	no	single	no/no	food	4	3	1	1
137	-	<30	n. d.	coll L	yes/no	food	35/3.9	6/0.7	2	2
132	-	<30	no	single+	no/no	jew.>food	8	5	3	4

Table 22: Characteristics of burial practice and absolute chronological data (radiocarbon dates, stratigraphy). Sequences are marked per colour (upper graves are later). Item and category number are in total and for double and collective burials in average per individual (MNIG). Upper part radiocarbon dates and stratigraphy, mid radiocarbon dates only, lower part stratigraphy only.

Taking into account typo-chronological tendencies detected for jewellery items (see chapter 3.4, in particular 3.4.4), the presence of chronologically insignificant categories (spiral rolls, spiral rings, spiral buckles, bracelets and tutuli) in all burial types support the assumption that time is not the driving for this element of burial practice.

Additionally, frequent pin types (simple loop, double spiral) also are part of assemblages from different burial types, and the radiocarbon dating points to types with a long time span. This is also true for double-branched pins with knobs. Toggle pins, which are suggested to represent types of the later stage of the cemetery (2nd mil BCE), are also found in all burial types. Specific early types (*e.g.* complex T-shaped, seal and animal-shaped endings) come from a single (211.3) and a collective burial (182). However, these considerations are true for only a selection of burials. In addition to a more comprehensive sample strategy for ^{14}C-dating, a detailed typo-chronological examination of pottery shapes and vessel decorations is necessary and would build a more reliable foundation for chronological interpretations, as the vast majority of graves revealed according remains.

In summary, based on the information given, the interlinkage of heterogeneity in burial tradition related and temporal considerations allows following assumptions:

- Different kinds of burial tradition were practiced simultaneously or at least in a timely manner.
- From what we know about the correlation of functional class and corpse deposition, different ways of body positioning in the same burial as well as chronologically independent scattering of ochre we can conclude that the corpse treatment did not underlie temporal trends.
- This is different for the funeral equipment, as complex assemblages with high proportions of jewellery come from graves with the oldest ^{14}C-dates and simple food inventories tend to be younger. Further radiocarbon dates of simple food assemblages and less complex jewellery assemblages are urgently needed to verify this assumption.
- This effect is not so strong on the composition regarding rare categories, which reflects chronological significance of the categories and associated types (see chapter 3.4).

4.5 Discussion and evaluation: Burial practice and social indicators

The nature of the graves found at the cemetery Kudachurt 14 posed a main challenge for finding answers to questions concerning social inequality. The obvious heterogeneity in terms of grave design as well as funeral goods promised suitable data to detect patterns of conformity, which was proven in different respects (see below). When speaking of "social inequalities" in context of mortuary archaeology, differences in individual treatment and equipment are often used as indicators for inequality, and so for Kudachurt 14. At the same time, the features of collective burials did not allow a scaled comparison of all graves in the sense of a "burial index", as often conducted in the socio-archaeological analyses of prehistoric cemeteries. This became clear during the examination. Average values for individuals from collective burials are not sufficient and quantitative interdependencies impeded according value establishments in this regard (see CPI), and they make the greatest part of the buried population. The distinction in "poor", "rich" or alike classification is possible, but only reliable for single and double burials (see below). Therefore, according results of the single characteristics (grave construction, burial type, inhumation, burial items) and their correlations was performed in a mere qualitative way.

"Collectivity" and "individuality" as proxies for social differentiation had been the starting point of the analyses, as the different burial type suggested alike. But the main result is: "Individuality" is at Kudachurt 14 mainly expressed by differing funeral equipment, but this independently from the "individual" or "collective" character of the grave itself.

In the following, results of the selected characteristics (results 1) and the investigation of correlations (results 2) are discussed successively in their meaning for socio-ritual conclusions.

4.5.1 Grave constructions: Proxies for effort or practicability?

Assuming a technological consistency, the installation of a large pit in great depth requires more workload and constructional skills compared to digging a small pit of shallow depth. If we want to use this as an indicator for constructional effort, we have to consider two aspects: (1) Original chamber dimensions may strongly depend to their funeral purpose, differing from a single to a collective burial (*e.g.* large pit with a single individual in contrast to eight individuals in a small chamber or vice versa).(2) When re-accessible, the chamber might have been enlarged afterwards. In addition, the alignment with number of individuals buried concludes that the chamber size per individual decreased by increasing number of deceased buried.

The use of stones is connected to two main aspects of effort: Sourcing and transport of the material. The required effort is strongly connected to the size and numbers of stones used, which has not been considered in this approach. The distinction of roundish or flat stones on the grave surface compared to vertical stones or no built-in stone components appears to be the major difference.

In conclusion, flat graves (0-100 cm) and graves of medium depth (101-200 cm) with or without stones as well as those of great depth (>200 cm) represent different modes of construction effort. The highest mode of effort accordingly would be a single burial installed in great depth, but this did not exist. In general, all these graves were re-accessible, and their re-use is highly probable.

Remarkable is, that the graves of great depth all are collective burials. In addition, they represent assemblages of large size and high compilation variability in both, functional class as well as categories, by maintaining individual equipment. Burials with simple food inventories are not found in such depths, which leads to the assumption that installation depth played a major role in the burial tradition, whose socio-ritual meaning must not necessarily be connected to construction effort, but to cultural habit. The duration of use of the collective burials remains unclear at this moment, although it is obvious it might have correlate with the number of individuals buried.

In respect to the examination of burial types, the results point to different funeral habits in individuality and collectivity in burying the deceased alone, in pairs or groups of different sizes. Using the same grave chamber over a longer period (collective character) or burying several deceased at the same time in the same grave chamber (multiple character) might both be evidence for social belonging posthumous. Separating individuals from this habit could indicate an outstanding treatment, be it in a positive ("highlighting") or negative ("excluding") meaning, emphasising social belonging or separation of the deceased. In this regard, the majority of the buried population (218) had been integrated in the "funeral habit of belonging" compared to the "funeral habit of excluding/highlighting".

At the same time, graves of different layers (*e.g.* grave 218.1, 218.2) reflect location continuity, which suggest an additional degree of togetherness. In this respect, this would be true for at least 27 individuals from six graves[42]. Similar can be assumed for graves, which are located next to each other or are separated by a vertical stone[43].

Additionally, the heterogeneity of burial types can also be interpreted from a more practical perspective, as strong seasonal influences might have led to favouring collective graves during winter; this at least must be considered for graves that showed signs for re-access.

In general, the complex situation in the central area of the cemetery requires further detailed investigation to detect internal connections of burial situations, which is to be expected by the report of the Russian colleagues soon.

4.5.2 Regularities of bodily treatment?

Different habits of corpse deposition indicate individual treatment of the corpses, whereas a certain degree of regularities exists, especially in the positioning of the body and the addition of ochre. These habits are not specific in respect to the burial types. Rare positions, such as supine, as well as the selective addition of ochre occur together with regular positions in collective graves. In consequence, this individual treatment of the corpse was also practiced within graves with a "collective character".

The scattering of ochre above the layered body was not a common tradition for the buried population, which is evident by the low number of burials and individuals who were favoured for this special treatment. Potentially, this refers to limited availability of this resource, and/or the covering was for specific individuals only.

Apart from supine body position, which is predominantly determined for individuals with the skull pointing to NE, the orientation is not a significant characteristic. NE and NW are most frequent, yet a certain degree of common habit existed among all represented directions. If inventories present, individual contexts showed that bodily treatment regularities also relate to funeral equipment: the right-sided, flexed position correlates with jewellery equipment, and stretched, supine position with weaponry items. This is independent from the burial type.

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42 Grave 027.1 (6 individuals) and 027.2 (3), grave 149.1 (4) and 149 (4) as well as grave 218.1 (4) and 218.2 (7).

43 *E.g.* grave 145 and 146, 180 and 181.

In consequence, as grasped by means of the applied approach[44], the corpse deposition combines regular ways of bodily treatment with individual emphasis at the same time. Correlations to jewellery and weapon items imply that the underlying reasoning also affected individual funeral equipment.

4.5.3 Burial item criteria: Cemetery

Striking in respect to the complete data set are the high proportions of the materials ceramic and bronze as well as the functional classes food and jewellery, especially compared to the numbers of weapons and tools. With respect to the complete data set, the proportions lead to following considerations:

In terms of **food**, pottery is the primary finding for this functional class. Nevertheless, differently to the other classes and categories, vessels do not give direct information about the foodstuffs they contained[45]. Shape and good values of the vessels could help here, because some categories are less frequent then others, such as small beaker, goblets or flat bowl. Frequent vessel categories suggest according utilization, *e.g.* cups and beaker for drinks, pots and large vessels for cereal chime. Additionally, different vessel sizes point to significant differences in capacity, thus the amount of contained food differed[46]. Still, foodstuffs contained in pots, cups and beaker played a crucial role in the compilation of the burial item record, whereas those contained in large vessels, goblets, flat bowls less frequent – or the vessel type was less expendable or very specific for the individuals buried.

The same is true for the **animal remains**, which represent meat as the other funeral good associated with food. There are two facts needed to be considered here: (1) Due to the determination approach, the numbers, as well the amount of meat is probably too low. (2) No osteological analyses of the animal remains have been conducted so far, we lack information concerning the animal species as well as differences for the amount of meat. Sheep and goat are frequently found in BA burial context, but at Kudachurt 14 pig bones are present (see chapter 6). In addition, burial 075 (Fig. 87.6) represents a singular case by revealing animal skulls in contrast to bones of the extremities, as it was the usual case. This might bear rather ritual character as the function of food.

However, the great majority of vessels and animal remains conclude that food was a significant element within the funeral equipment. This could be interpreted in both ways, as supply for the deceased in the afterlife or as offerings to the gods.

Contrasting with the functional class of food, which represents a basic human need, are **jewellery** items. In respect to the main material **bronze**, and this is true also for weaponry items, according objects are of higher value in terms of production and resource availability. Technical complexity and resource requirements of the bronze artefacts has not been analysed, therefore an internal classification defining the "worth" of an object is lacking and the extent of material investment remains to be evaluated.

With 34.8% of the total record, bronze objects were expendable terms of use and material or the underlying funeral rules were more important compared to the requirements of the living population. The majority of bronze artefacts is made up by jewellery items, complemented by items made of antimony and specific animal tissues (shell, teeth; in total 43.8%) and with the functional character of customized decoration of the body or the costume, according items are strongly linked to personalized equipment. Based on the high proportion of 43.8%, these elements of

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44 A more detailed description of the body positions is possible, *e.g.* the positions of the arms and hands.
45 Unless applying further methods, *e.g.* analyses of the residues preserved in the vessel wall.
46 This is confirmed by recording different measures and decoration of the vessels conducted by the author.

funeral equipment are of particular importance in the burial tradition. Common and rare as well as the in general high variation of jewellery categories point to differentiated traditions of body and costume jewellery, which strengthens the individualizing character and/or reflecting socio-cultural belonging. This is also true for the rare materials.

Weapons and **tools** are very rare with respect to the complete data record. Differently to jewellery, according categories can be linked to specific activities: usages as stroking (macehead), missile (spearhead), air (arrow) and thrusting weapons (dagger) and related differences in fighting techniques. It is the nature of weapons representing defensive potential in interpersonal violence and conflicts, but at the same time, they might have been used as hunting weapons or were in domestic use. The lack of bronze axes is of special interest in this context. Frequently found in MBA-LBA burials of the region (see chapter 3), those axes are interpreted as status objects. According items are not present in the burial item record of Kudachurt 14, which will issue of the concluding chapter 8.

Links to certain activities are also possible for tools, whereas the function of axes is of broad use, loom weights are used for textile production and sharpener stones needed to maintain the conditions of blades. Additionally, the materials stone and pottery and/or bone should have been easily available, in contrast to bronze objects.

In general, the small numbers of weapons and tools and linked activities either suggest the insignificance within the funeral tradition and ritual habits or emphasise exceptions to the rules.

4.5.4 Funeral equipment groups: Commonalities or inequalities?

The examination of grave assemblage compilations identified vast differences within the data set of 130 graves. Presence, absence, frequencies and combinations of items primarily according to functional class and category draw a very heterogenic picture of burial item tradition for both, from the perspective of the specific burials as well as on the level of individual context. In general, this two-sided approach concludes that the individual context was the major driving factor for the equipment and not the type of burial. Detected commonalities as well as differences allow assumptions with regard to social inequality linked to the mortuary tradition.

A common habit is the inclusion of food in the funeral ritual. With only 10 graves lacking burial items at all, vessels and meat represent standard equipment, which differs slightly in item number and according category composition. These simple “food” assemblages are true for 55 (29)[47] graves, which equals *ca.* 55 % of the population buried – despite if in single, double or multiple burials. It is to be expected that the actual number is higher, as especially the inventories of collective burials remain as an equipment admixture of different individuals, for which a separation was impossible. Usually, these inventories consist of both, vessels and meat, with only few exceptions. The continuous presence of food items could be interpreted towards a statement of economic productivity.

In addition to this standard food equipment, in 60 (51) graves jewellery items were found, and in remaining 26 graves the reconstruction of individual context was possible in 37 cases, although especially those from the collective burials cannot claimed to be complete. Still, the overall distributions of categories with regard to the grave record as well as the individual context draw a picture of much differentiated equipment, from few, common jewellery objects (*e.g.* spiral roll, pin, spiral ring, necklace) to very elaborated equipment’s (*e.g.* including decoration plates, belt

47 In brackets means of good data quality of 1-3, same for the following.

hooks, different pendants). In some cases, the extent of jewellery items exceeded those of food items (*e.g.* in single burial 211.3, with 94 pieces).

In consequence, only a part of the population was favoured in this ritual and additionally those individuals who were experienced different treatments. The underlying rules for different stages of jewellery equipment, for instance in item number or rareness of category, seem to be independently from the burial type, thus "individuality" and "collectivity" is not implied in this regard. Potentially, by applying additional classifications of jewellery (costume, decorated body region, ca.) these underlying rules could further be specified[48]. This is especially important with regard to typological attributes of the artefacts.

Individual adjunction of weapons has also been confirmed, although the numbers are significantly lower, which emphasises even more the selective character of these items and in consequence the according individuals. For instance, this is true for the individuals from grave 080, a double burial that contained seven of eight arrow-heads, a dagger as well as vessels and meat, or the large collective burial 146, whose large inventory include 3 of 6 maceheads (lacking individual context).

There are only two individuals, whose equipment contained items of both functional classes (ind. 186_6, see Fig. 84.3, left; ind. 190_2), so we can assume that jewellery and weapons were mutually exclusive in the individual equipment. Thus, the traditional regularities seemed to be strict in this regard, supported by regularities of bodily treatment and the scattering of ochre.

Unfortunately, for only a loom weight and an axe (2 of 5 potential tools[49]) the individual context was comprehensible, and both equipments included food as well as jewellery items, so we cannot conclude similar tendencies here. Regarding the functional character of the economic sphere in terms of production, tools played a minor role compared to consumables, costumes and weapons.

These considerations verify specific treatments for the deceased experienced. Based on the functional character of food, weapon, jewellery and tools (see above), these specific treatments draw following equipment groups:

- **No funeral equipment:** *no care for the afterlife.*
- **Foodstuffs (common, rare):** *covers basic needs in the afterlife.*
- **Foodstuffs (common, rare), common jewellery items or weapons/tools (seldom), partly ochre (more food or equal distribution):** *basic needs, reflecting low personality or socio-cultural belonging.*
- **Foodstuffs (common, rare), higher numbers of common and rare jewellery (weapons) and partly ochre:** *basic needs, pronounced personality or socio-cultural belonging.*
- **Foodstuffs (common, rare), outstanding jewellery equipment and partly ochre:** *strong reflection of personality or socio-cultural belonging over basic needs.*

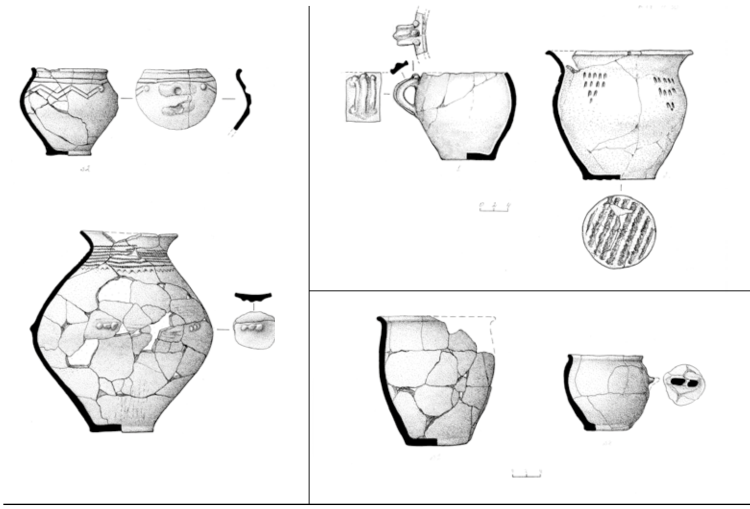
By reviewing the data record, these states are applicable to 103 individuals (34.9 % MNIC) from 73 graves (56.2 %) of data quality 1-3, although funeral equipment of individuals from double collective burials may not be complete and especially focus on jewellery items. From the total number of burial items found at Kudachurt 14, this makes 29.6 %. This is a very good starting point to address potential social meanings, especially with regard to the integration of osteological data (see chapter 8).

The first and the fifth group, which are of greatest difference, are the smallest with 4 and 6 individuals mainly from single grave contexts. The other three groups consist of 33, 36 and 24 individuals. Associations of food items remains often unclear in collective burials, therefore individuals from such contexts are underrepresented

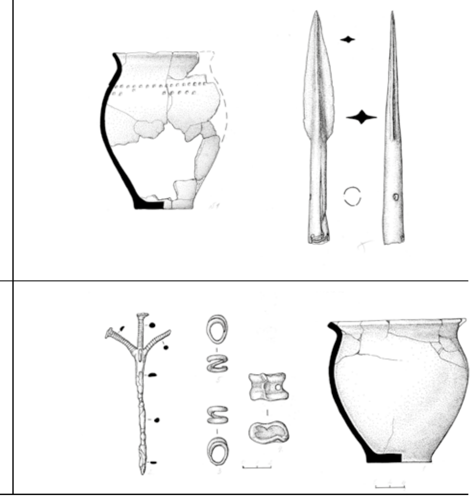
Figure 91 (opposite): Illustration of examples for different states of funeral equipment for single burials. Missing in the depiction are illustrations of meat remains, which also belong to the functional class of food. State 2: Grave 053, 055 and 050 (clockwise). State 3: Grave 078 and 58. State 4: Grave 73, 051 and 203. State 5: Grave 088.

48 As Reinhold did for the EIA.
49 Assuming both axes as tools rather than weapons.

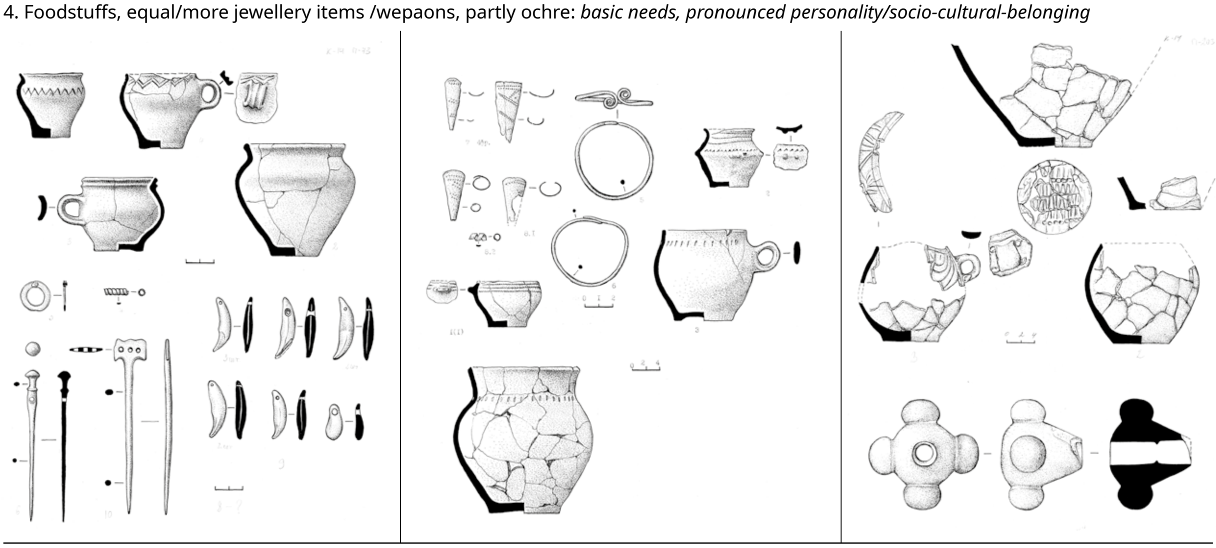
2. Foodstuffs (common, rare): *covers basic needs for the afterlife*



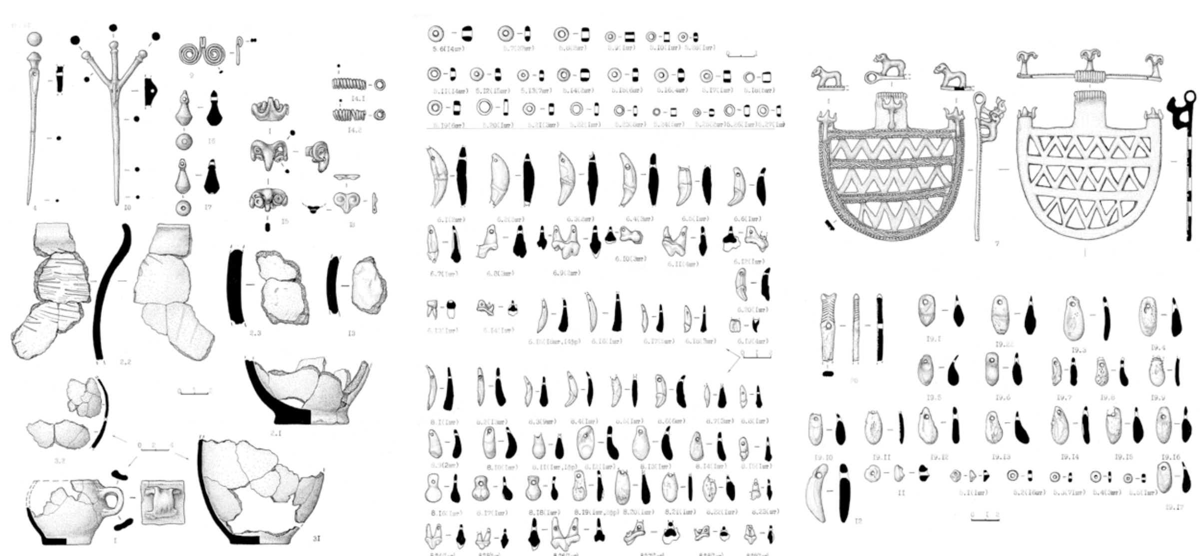
3. Foodstuffs , common jewellery items or wepaons: *basic needs, low personality/socio-cultural-belonging*



4. Foodstuffs, equal/more jewellery items /wepaons, partly ochre: *basic needs, pronounced personality/socio-cultural-belonging*



5. Foodstuffs (common, rare), outstanding jewellery equipment, partly ochre: *personality /socio-cultural belonging over basic needs*



in group 2. Inhumation groups from collective burials show compilations of individuals with different states of funeral equipment.

Overall, the results point out that the funeral equipment expresses several levels, and the decision on which level the dead person experienced apparently was made on an individual basis. By maintaining this tradition, inhumation groups indicate social proximity, and this is true for the majority of the buried population. As a result, we can identify both levels of burial practice, “individuality” as well as “collectivity”.

4.5.5 Social implications of burial practice

Coming back to one of the central research questions related to social inequality, by integrating the current state of social archaeology in the NC MBA to LBA transition, obtained results lead to following considerations.

Cemeteries of the EIA Koban Culture in the North Caucasian foothills report from increasing population density from approx. 1500 BCE onwards, which is synchronised with fewer hierarchical levelling of social identities in the funeral practice, especially compared to the funeral emphasise on elite status present the EBA (see chapter 1.2.1.). In general, Reinhold observed clearly sex-determined funeral equipment in jewellery items for females and weaponry and tools for males, whereas slight differences in the item compilation and amounts points to rather horizontal social levelling and symbolic exchange among both sexes of one or more population groups. Vessels as food item make a common characteristic within the assemblages. Oversupply of single individuals suggests leadership personalities, but with few emphasise to other social members (Reinhold 2003, 2005). Apparently, the status expressed in the funeral equipment reflects social rankings within a community that was acquired during life. In the earlier periods, Reinhold sees the few reliable MBA-LBA collective graves with gender-specific equipment as preceding forms and inhumation groups in the same burials statements of social proximity (Reinhold, 2003, 2005, 2012).

In this diachronic context, we can derive different social implications in the burial tradition at Kudachurt 14. It seems obvious to interpret observed individual differences of equipment in weapon and jewellery at Kudachurt 14 as gender-determined in the sense of “social sex”. As a result, the functional character of these item classes would match with the respective socially perceived gender of the deceased and their roles during life. Following this hypothesis, the great imbalance of weapon items compared to jewellery items in the total record indicates less representativeness of the male sex. In terms of individuals with identified equipment groups, this would suggest 7 inhumations of males against 49 inhumations of females, and 38 of unknown gender aspect reflected in the grave (in addition to remaining 65 % of the buried population). As we know from the total distributions of burial items, weapons are rare objects in the assemblages, which stays in contrast to other cemeteries with known typo-chronological affiliations (see chapter 3.4.). Presuming that jewellery and costume items were exclusively for females and that weapons were rather exceptional personal items, four possible conclusions are obvious:

(1) Males are underrepresented at Kudachurt 14. (2) The funeral equipment of males were merely characterised by food items. (3) When calculating with total number of 58 weapons, max. 22 % of the buried population (265 MNIC) would have been male. (4) Males buried with weapons represented important personalities of the society (*e.g.* “warrior”), which would be supported by the supine positioning of the corpse in double and collective burials only. In contrast, the role of females would be stronger associated to displaying their status by symbolic attributes.

With respect to jewellery and costume items, the heterogeneous equipment observed in the grave assemblages supports a gradual levelling of social identities, even within the equipment groups 3-5. In this case, a small part of the buried female population would reach the highest level (group 5), and only few individuals would have died without traceable social position. The actual number of individuals that experienced a simple burial with only food items remains unclear; but still, the distributions show that not only a small part of the population holds such positions.

The compilation of, when addressing funeral equipment states as such, different social positions within the same inhumation groups supports this assumption. Apparently, the burying population did made a difference in the personal equipment, but not in the "social proximities" in terms of the last resting place; following the "gender aspect", males and females of different social positions, levels or functions belonged to the same "socio-ritual unit". Furthermore, collective burials prove that such different positions existed simultaneously or at least within the time window of repeated grave use. At the same time, separate burials of individuals with different social position also occurred; the "funeral habit of belonging" compared to the "funeral habit of excluding/highlighting" is not applicable to the complete burying population.

The temporal factor is an important aspect in the light of this discussion, as it remains to be clarified, if observed differences underlie diachronic developments in accordance with Reinhold's assumptions. Those graves with the oldest dating to the ending 3rd mil BCE (211.2, 177 and 182) contained individuals that experienced an outstanding jewellery equipment, including objects with potentially symbolic or representative intention (exceptional pin types, belt hook, large pendants; see chapter 3.4). While two graves are single burials, the three individuals from grave 182 had different jewellery equipment; one is associated with group 5 and the other with group 4. Comparative assemblages from contexts of the later stage lack so far, although some objects imply typological continuity to the 2nd mil BCE, and so do other characteristics of burial practice (including bodily treatment). Nevertheless, it seems that during the first half of the 2nd mil BCE the marking of personalities within costume and jewellery elements slightly changed by skipping striking objects such as large pendants. Still, the compilation of the equipment does not suggest a standardisation as Reinhold observed it for the EIA.

In summary, the discussion on social indicators predominantly addresses the equipment and cannot be transferred to grave construction effort.

For further interpretation, it is necessary to integrate osteological information about the individuals and the buried population, in particular demographic data such as age and sex. This information are needed to align identified social differentiations and underlying processes that have led to the formation of described burial practices; for instance, if collective burials are synonymous with family burials of different extents, in how far gender interpretations match estimations of biological sex or if social positions were acquirable or inherited.

4.6 Conclusions

The analyses of burial practice at Kudachurt 14 aimed at exploring the information potential of different investigative parameters with regard to socio-archaeological issues. From the interrelations of investigative parameters major proxies for tracing social inequality were drawn. In total, 130 graves, a minimum number of 265 individuals and 2332 burial items made up the data basis.

The approach included the definition of examination parameters involving characteristics of grave construction, burial type, bodily treatment and burial items, including the establishment of data quality groups as a measure of source criticism. An important working step was the estimation of the minimal size of the buried population at Kudachurt 14 (MNIC) and subsequently the division of graves in single, double and collective burials of small, medium and large size. The identification of inhumations enabled to evaluate individual bodily treatments and funeral equipment as well as compilations in inhumation groups of collective burials.

During the life span of *ca.* 400 years, the cemetery on the ridge next to the Kudachurt stream was repeatedly used as a last resting place for at least 265 individuals that died between the maximum period of 2200-1650 cal BCE. Based on these data, by considering a generation time of 20 years, the cemetery has been frequented by 20-28 generations; disregarding different burial environments, 1.5-2 individuals were buried there per year on average.

Grave construction elements vary and were presumably driven by practical aspects of installation. The majority of the dead population was buried in pairs or small to large inhumation groups in grave chambers of different size and installed in different depths, and only *ca.* 18 % have been buried in single graves. Apparently, individuals of different social positions were integrated in the same funeral environment, and some have been excluded from this habit. The reason for this remains unclear at his point, whereas both social as well as practical possibilities come into question.

In general, there is a large variety within the grave offerings and individual equipment, from inhumations lacking funeral gifts, to simple food inventories and complex compilation of jewellery and costume elements of bronze and antimony objects. While food was a common funeral gift, jewellery and the dispersal of ochre report from different levels of equipment; oversupply with specific decoration elements appears only in the early stage before the turn from the 3rd to the 2nd mil BCE. Individual funeral equipment considered personal attributes of the deceased with regard to jewellery or weaponry attributes, potentially in terms of social positions and gender roles; this is true for at least 26 % of the dead population. As such equipment varies within individuals from the same grave, inhumation groups probably reflect different social orders within a segment of the burying society. Different social ranks within kinship relationships are also possible. Few individuals with weapons often were laid down in stretched supine position, emphasising a different role to individuals in regular flexed positions in the same graves. The role of "gender" remains to be clarified by the alignment with osteological information; this also addresses the issue if the social system was open or restricted to hereditary rules, which might be displayed by the funeral gifts of subadults.

Different to other findings from burial contexts from the time and region, weapons play a minor role in the funeral environment, which stays in contrast to symbolic expression in jewellery and costume tradition as well as food elements, potentially a demonstration of socio-cultural belonging and economic productivity. Simple and elaborated shaft-hole axes make frequent findings in the Collection Kossnierska, which exhibited most typological similarities to those bronze ornaments from Kudachurt 14, and from sites of the later Koban Culture. Interpreting these as symbols of military power, this aspect at Kudachurt 14 is restricted to few maceheads as well as spearheads and daggers of standard shapes.

Overall, the burial context describes the burying community that expressed inequalities of funeral treatment. If we take the personal equipment as an attribute of individual social identity, the underlying rules refer from rather complex social organisation compared to a strict hierarchical one.

5 Human Remains: Demography and oral health

The central research object of this chapter is the analysis of the mortal remains of the individuals that lived and died during the transitional period from the MBA to the LBA and were buried on the shallow mountain ridge near the Kudachurt stream in the foothills of the Northern Caucasus. By analysing a representative sample of this buried population, the taken approach concentrates on gaining information on demographic data and oral health in order to evaluate them with regard to socio-economic considerations about the reality of human life in this period and region.

After a brief introduction into the nature and relevance of human data in archaeological applications, especially with regards to demographic information and oral health, the description of selected investigative parameters, terminology, and methodological approach builds the foundation for the subsequent analytical sections. This is followed by a critical review of the representativeness of the studied osteological and dental material. The analyses of biological sex and age at death is important both at the level of the individual and with regards to demographic structures present within the population, its composition in inhumation groups, and with respect to spatial distribution patterns within the cemetery. In order to provide both levels of data resolution, investigations of nine categories of oral health focus on results per tooth, per individual, and per group defined by demographic parameters. The second analytical part aims to identify interrelations between demographic parameters and aspects of oral health, critically assess the results, and to establish the main characteristics of oral health. After reviewing burial and inhumation contexts, the integration of radiocarbon dates with this data enables the discussion of chronological tendencies between 2200-1700 BCE. The concluding discussion evaluates the meaning of the gained knowledge for socio-economic interpretations of the buried populations and the resulting implications for the living population. Here, demographic, dietary, and occupational aspects are of special interest. Finally, learning from the undertaken approach and drawn conclusions, future research measures are outlined.
The three research questions for the following analyses of human remains are:

What is the demographic composition of the buried population?

What are the main characteristics of oral health in the buried population from Kudachurt 14?

What are the physical and socio-economic findings deriving from the demographic structure and status of oral health?

5.1 Functional data from human remains

Referring to Härke (1993) and his differentiation between intentional and functional data, information gained from the human remains do not influenced by potential selective behaviour of the according social group or – speaking in biological terms – the population. This is different from the archaeological data which can also be collected from mortuary contexts. Information about an individual such as biological sex, age at death, physical constitution, and diseases suffered are encoded directly in the individual's skeleton. Nevertheless, Härke (1993) stresses that methodological inaccuracy in data acquisition represents an important quality criterion when dealing with functional data from skeletal remains. In this respect, not only the subjectivity of evaluation standards for the applied methodology are restraining considerations. Different external factors affect human remains from archaeological contexts. Beginning with the funeral treatment of the corpse and ending with the scientific study of the skeleton, interim stages such as taphonomic processes, excavation strategies, storage, and preparatory work influence the condition of skeletal assemblages. This means that besides representing a carrier of biological life history, human bones also reveal environmental and anthropologic modifications in a broader sense (Duday 2009; Stodder 2008). Additionally, the significance of human remains has a very natural limitation as information medium; we only find what is preserved. For Kudachurt 14, this is bones and teeth.

Even in times of advanced biochemical methods, for instance aDNA and isotope analyses, according research is usually unable to refer to a major part of the body. This is especially salient with respect to diseases. It is only possible to detect attributes, alterations, and modifications that affected bone and dentition during the life of the individual; anything which only influenced the soft tissue becomes invisible. According to the "Osteological Paradox" (Wood *et al.* 1992), the fields of palaeodemography and paleopathology presuppose that statistically calculated data from skeletal series directly link to the demography and health status of the population to which the series belonged. This can lead to transfigured results and misleading interpretations, particularly when combined with assumptions of stationary population states for establishing palaeodemographic parameters (*e.g.* fertility, mortality) or "hidden heterogeneities", "dynamics of death", and "selective mortality" (Wood *et al.* 1992).

The authors specify another paradox in osteological research that refers to pathological processes and the "healthiness of the healed". The detection, examination, and evaluation of pathological changes on bones and teeth are of complex nature, and the increasing importance of differentiating between "active" and "inactive" processes at the time of death is one way to face issues related to questions dealing with reconstructing the disease burden and mortality of past societies. Tracing physical recovery of pathological lesions and survived diseases can indicate states of good health, whereas not detectable lesions can indicate sudden death, thus frailer individuals, who died before the lesion left manifestations on the bones (Wood *et al.* 1992). In response, Wright and Yoder (2003) highlighted progress in the methodological "toolkit" for facing these issues, which consist of statistical and morphological refinements and advances in demographic and genetic modelling. According to Waldron (2008), the dead population examined by osteologists is always just a very selective sample from the actual population which lived. This sample passes through a multi-stage selection process, starting from deconstruction loss of the cemetery record, to the number of actually discovered burials, and ending with the selection of individuals to be examined. Hence, it represents a subsample which may be biased compared to the original population (White and Folkens 2005). The representativeness and bias in skeletal samples and current challenges in bioarchaeology research have also been discussed by Jackes (2011). She stresses that analytical proxies shall carefully be chosen and evaluated before integrating them into more holistic studies, for instance dental pathologies and age at death dependencies. Assessing data from skeletal samples and interpreting these in terms of life conditions of respective populations already is a challenge; but only constant testing and developing of methods and critically questioning comparative approaches can improve our understanding of past societies.

5.2 The significance of biological sex and age at death

Sex and age at death of individuals represent basic components of investigations related to numerous research questions in archaeology, palaeoanthropology, and palaeopathology. Therefore, individual attributes and their summations in populations and further comparative inter-population work built the foundation for osteoarchaeological studies (White and Folkens 2005).

The lively and controversial discussions about social and cultural models of “biological sex” and “gender”, their concepts in cultural and social models, and their application in archaeological research not only reflect present desires for understanding identity formation in modernity but also for discovering their origin and development in past times. To the author’s eye, it seems as a principle urge of humankind to align biologically given disparities with their cognitive socio-cultural behaviour and with increasing abilities to overcome natural laws – which is also true for ageing.

Simply put, biological sex and the reproductive mechanisms of human beings are closely related to the organization of daily life. Basic functional differences of physical constitution are present for all societies, despite their chronological setting and economic, social, and technical level of development. Menstruation, pregnancy, childbirth, and childcare by means of breastfeeding rely upon the physiology of being a woman and naturally distinguish her life reality from those of males (provided she has both the health and will to reproduce). Not only the social consequences of having a baby, but also the physicality of giving birth and feeding a new-born require different bodily demands involving, for instance, hormones and increased blood loss. In counterpart, it seems logical that males would take over “supplier” tasks or those that require increased mobility or independence from caring fellow humans.

From a simplified biological point of view, the functional differences and the concept of binary sexuality and according physical constitutions seem to be comprehensible and their effects on living conditions obvious. But, as Nordbladh and Yates (2014) put it, “biological sex is a composite concept, with several prerequisites. The two main classes female and male are not totally separated but rather two extremes on the same scale. Indeed, they have very much in common” (Nordbladh and Yates 2014). In addition to the fact that cases of intersexuality can be assumed for prehistoric times, the individual recognition and consciousness of biological sex and the actual lived life, including its timing, as well as socialisation and cultivation, are of vital importance for according interpretations.

Hence, detecting and evaluating morphological attributes that indicate male and female functional and constitutional differences on skeletal remains from archaeological contexts is of major concern. It is not only essential for understanding differences in health and diet in respective populations – it builds the foundation for tracing how assumed physiological constitutions might have been recognized and integrated into social life and systems.

Age at death is the other crucial attribute skeletal remains can be used to reconstruct that is used in archaeological, palaeodemographic, and palaeopathological analyses. In principle, the term “age at death” defines the physical age of the individual at their time of death. The estimation of age at death is premised on the life course of a body, including growing stages from new-born to senility. During these different developmental stages, the human organism possesses certain characteristics that determine physical needs, constraints, and performance.

These chronological developments are in general progressive and measureable, *e.g.* from adolescence to reproductivity. However, the continuity of related processes depends on individual parameters (*e.g.* sex, genetic dispositions, disease; Larsen 2015) as well as on the socio-economic and environmental setting in which a population lives (*e.g.* harsh weather, food supply, workload, social responsibility, medical care skills), which have an effect on the fertility and mortality of a population. Therefore, the developmental stages are specific for both individuals and populations. Hence, the age at death applied in bioarchaeological studies means the "physical age" which is congruent with the bodily attributes the skeleton shows, and not with the number of lived years[1] in a chronological sense. Simply put, two individuals with the same chronological age can be at different physical developmental stages (White and Folkens 2005).

Thus, individual age is dynamic, determining a changing life reality from childhood to maturity without the individual's ability to influence the process. In terms of socio-archaeological interpretations, individual behaviour and social realization of this developmental process can potentially be connected to experiences and knowledge gained, acquired skills, and the delegation of tasks and according roles taken on within a society.

Detecting indicators related to the different age stages of childhood, adolescence, and maturity in the skeleton is a challenging task, especially for the later stages of life (see next chapter). The broad spectra and inconsistency of applied age estimation techniques and age ranges used in osteological studies represents a major issue in current research (Falys and Lewis 2011).

Obtained data of biological sex and age at death of the studied individuals makes up the basic information for evaluating their demographic representativeness with regard to the living population. In the context of this thesis, this representativeness is significant for three interpretative parts: (1) to assess the suitability of the data set for (2) discussing results of oral health and dietary strategies in respect to age and sex in order to identify and evaluate biological influencing factors, and to (3) synchronize results from the burial practice analyses with individual sex and age (as well as oral health and dietary strategies) in order to come to final considerations about social inequalities in the mortuary record (see chapter 2).

5.3 Dental pathology and oral health

In the following, the use of the terms "oral health" and "dental pathology" mutually address physical conditions linked to diseases and modifications of the masticatory apparatus. In this regard, "Oral health" relates to the overall status of an individual or a population, whereas "dental pathology" refers to different categories of dental lesions which, supplemented by further anatomical units, describe the oral health status.

From the perspective of the entire human history, the significance of dental remains in physical anthropology starts with the early hominid fossils and the reconstruction of the evolution of dental morphology. However, oral health status and its relevance concerning socio-economic questions has also been recognized for specimens of *Australopithecus anamensis* and *afarensis* (Ungar *et al.* 2010). Throughout the history of humankind, the relationship of oral health status to social,

1 Only analyses of tooth cementum annulations provide information about the chronological age (see Roksandic *et al.* 2009).

cultural, and economic developments, especially diet and subsistence, describe the junction of physical anthropology, archaeology, and bioarchaeology. In current dental medicine, the condition of oral health status from prehistoric and historic periods are repeatedly discussed in German doctoral theses (Geber 2006; Kasa 2002; Zembic 2004). Conversely, like all disciplines of palaeopathology, the field benefits from advances and the latest research in modern medicine.

The course of research history of oral health and dental palaeopathology are telling about the type of questions posed and the development of applied analytical approaches. Connected research questions differ in subject focus, concerning the significance of certain pathological lesions, geographical region, chronological, cultural, or socio-economic characteristics of the specimen or populations. Additionally, and this is true for all osteological disciplines, the standardization, synchronisation, application, and advancement of recording systems and analytical techniques are a constant issue of research. In chapter 30 of *A Companion to Palaeopathology*, the American anthropologist Lukacs briefly summarises the history of dental pathology in English-speaking regions. From the establishment of dental pathology in bioarchaeology in the 19th century, different stages of research development reflect characteristic topic foci. These stages include the detection of cause-and-effect relationships, for instance the interrelation of food consistency, preparation, and tooth wear; the refining and standardization of analytical methods; and the application of these plausibility and method principles (Lukacs 2012).

Providing enormous potential for different disciplines of physical anthropology, research on dental pathology and oral health meanwhile represent a basic objective in the analyses of human remains. Three main factors are important here, which Scott (2002) states as preservability, observability, and variability. Due to their robust microstructure and high proportions of inorganic components, teeth are less susceptible to many more external decomposition processes compared to bones and therefore are often in better preservation, even under less favourable conditions. Additionally, teeth and the oral cavity reveal a large array of information about the dead individual, and the comparison of results within and between populations allows chronological as well as diachronic, and short-term as well as long-term observations. Even when of poor skeletal preservation, information obtained from dental material provides characteristics of age at death, developmental and genetic processes, sex-related morphological attributes, occupational or cultural modifications, and pathological changes, thus reflecting environmental and individual impacts. The growing number of investigative methods developed in the last decades continuously explore new possibilities, for instance analyses of genetic material in dental calculus (Ozga *et al.* 2016; Radini *et al.* 2017; Weyrich *et al.* 2015; Weyrich *et al.* 2017).

The most important feature characterizing the oral cavity and the dentition as an appreciated research objective simultaneously causes certain challenges; due to its function as an alimentary canal of the gastrointestinal tract, the mouth is an organ strongly influenced by external substances and their according chemical and physical textures. Thus, when investigating oral health, it is of main significance to consider the oral cavity as a region of the body where substances encounter the individual's physiological constitution during food intake and mastication, but also during the use of teeth as tools in the context of occupational habits or in the case of cultural modifications. In consequence, dental conditions and oral health are at the interface of physiological, environmental, economic, and cultural contact spheres which yields high potential for answering questions of human-environmental interaction and socio-cultural developments during the Holocene (Larsen 1995, 2015; Listi 2011; Lukacs 2012; Scott 2002). Major topics are changes in subsistence and diet connected to the origin and distribution patterns of dental disease. Related research often focuses on specific pathologies with respect to diachronic perspectives and shifts in subsistence strategies. The diversity of studies derives from both the variety of social formations of different environmental backgrounds across the globe and the manifold potential for application (for instance El-Zaatari 2010; Esclassan *et al.* 2009; Gamza and Irish 2012; García-González *et al.*, 2015; Keenleyside, 2008; Klaus and Tam, 2010; Lieverse *et al.*, 2007; Mahoney *et al.* 2016; Temple and Larsen 2007; Ventresca Miller *et al.* 2014).

At the same time, indicators obtained from the masticatory apparatus strongly interrelate with each other due to physiological, chemical, or mechanical processes or their impacts. For instance, the remains of consumed substances (*e.g.* food), also known as dental plaque, contain micro-organisms and when not addressed with measures of oral hygiene lead to typical dental lesions such as calculus and caries. These may trigger prophylaxis measures, such as tooth picking, which influence the oral milieu, or the lack of those measures, leading to diseases of the alveolar bone (cf. Hillson 2008). Additionally, dental wear and non-masticatory modifications can foster or prevent the severity of pathological processes. In consequence, the selection, definition, and recording of categories of oral health build the foundation for gaining solid results. Separate analyses of these categories is necessary for testing interrelations.

As we are speaking of human tissues, physiology, and chemical processes, the individual's constitution also matters significantly. Individual constitution depends on age, biological sex, and genetic disposition, and it influences most physiological processes and anatomical structures of the oral cavity and the dentition (DeWitte 2012; Grauer and Stuart-Macadam, 1998; King *et al.* 2005; Lukacs and Largaespada 2006). Therefore, correlation of age at death and biological sex make up an integral part of the analyses and provides information for social interpretations. In this regard, using age at death estimated on the basis of dental wear for age-dependent correlations is circular reasoning (Constandse-Westermann 1997; Mays 2014a). In general, as the duration of teeth exposure and, in consequence, the likelihood of any kind of alteration positively correlates, individual age is not the only factor of interest in the scope of the physiological maturation processes (*e.g.* hormonal influences on the chemical composition of saliva, growing disorders during teeth development; Boldsen 2007; Lukacs and Largaespada 2006).

In consequence, oral health represents a very complex field of research, requiring careful and explicit methodological approaches as well as the consideration of a multitude of aspects. This thesis focuses on **nine categories of oral health,** whose terms have been modified to meet respective palaeopathological discussions (*e.g.* abscesses to periapical lesions; for short descriptions cf. Lukacs 2012). With abbreviations and specifications in brackets, these categories are:

- **Enamel hypoplasia**: Deficiency of enamel thickness, disorder in enamel formation processes.
- **Periodontal disease**: Inflammation and destruction of periodontal tissues with reduction of alveolar crest height, resulting from bacterial plaque accumulation.
- **Calculus**: Mineralized plaque, accumulates from a living plaque deposit on the tooth surface.
- **Periapical lesions**: Acute and chronic infection of the pulp, results in sinus cavities in the apical regions of the alveolar bone, partly with an exit to the cortical bone.
- **Antemortem tooth loss (*AMTL*):** Tooth loss during life, evidenced by progressive resorption of the alveolus, resulting from different primary pathological processes (caries, periodontitis, trauma).
- **Carious lesions**: Destructive process due to demineralization of dental hard tissues by organic acids that derive from bacterial fermentation of dietary carbohydrates.
- **Enamel chipping**: Micro fractures including substantial loss due to striking mechanical stress, mainly affects the crown.

- **Masticatory modifications** (***dental wear; occlusal macrowear***): Erosion of the teeth, induced by the rubbing of (occlusal) surfaces during mastication.
- **Extramasticatory modifications** (***dental wear; extramasticatory modifications***): Mechanically induced changes on the tooth that are not connected to masticatory movement (food processing).

Following Lukacs (2012), the list of categories chosen for the analysis of oral health is inspired by the WHO's International Classification of Diseases from 2016 (ICD; World Health Organisation 2016). Block K of this classification system defines ten categories, including diseases of the oral cavity, the salivary glands, and the jaws, which correspond with the categories examined in this thesis: Enamel hypoplasia (K00, Disorders of tooth development and eruption); dental caries (K02); attrition, abrasion (masticatory modification), and dental calculus (K03, Other diseases of hard tissue of teeth); apical processes (abscesses/periapical lesions; K04, Diseases of pulp and periapical tissues); and periodontitis (K05, Gingivitis and periodontal diseases). The two missing categories are antemortem tooth loss (ATML, intravital) and non-masticatory modifications. ATML is not listed in the WHO-ICD as a distinction between extraction and non-invasive loss of a tooth is not possible and the causes for extraction and loss are manifold. Non-masticatory modifications partly are described by K03, which includes the erosion of teeth not caused by mastication; however, the observations of interproximal grooving in the dentition of the individuals from Kudachurt 14 required the formulation of this additional category.

Malocclusion and crowding, both pathological lesions, have not been formally considered in the analyses presented here, yet their potential role is discussed for the results of respective categories (predominantly masticatory and extramasticatory modifications). Physical alterations recognised in the dental record of Kudachurt 14, including hypercementosis and degeneration of the temporomandibular joint, also have been left out of the current analyses.

5.4 Investigative parameters and methods

This subchapter gives an overview of the chosen investigative parameters and the analytical approach, including a description of used terminology, methods, and recording systems applied per parameter as well as steps undertaken as preparatory measures.

It should be noted here that sex, age, and pathology determination methods on skeletal remains are often based on comparison with reference populations. The significance of methods applied, and accordingly the reliability of results, depends on the reference population(s) for which these methods were designed. Inconsistencies could reflect the morphological variation and genetic diversity between individuals and populations across temporal as well as spatial scales which effect, *inter alia*, sexual dimorphism, stature, and susceptibility to disease. Therefore, good research practice suggests aiming for applying best matches in terms of methods and according reference populations to the skeletal series under study.

Due to the hitherto poor state of research on Bronze Age populations from the Northern Caucasus, according reference populations are lacking. To minimize the potential of falsification of results and to ensure data comparability for current and future osteological as well as palaeopathological analyses, the choice of methods is based on best expertise and practice of the author and colleagues (see chapter 2.4.2). In addition to the insufficient numbers of individuals, the lacking reference population is the reason why comprehensive demographic analyses such as of population growth have not been conducted. Furthermore, the descriptions of pathophysiological processes linked to the investigated categories of oral health are limited to the explanations that will be presented in section 5.4.5.

5.4.1 Anatomical terminology

All anatomical terms and directions concerning the human skeleton are taken from established literature used in osteoarchaeology and palaeopathology (Katzenberg and Saunders 2008, Ortner 2011; Roberts and Manchester 2013; Scheuer *et al.* 2008; White and Folkens, 2005). For detailed descriptions regarding anatomical elements, natures of the different tissues, and supply systems please refer to these sources.

Regarding the complete human body, the gross bone specifications can be taken from White and Folkens (2005, Fig. 6.1-2). The recording schemes (see appendix) illustrate the different skeletal developmental stages from an infant to an adult individual, including the division of bones in their growing centres[2]. Anatomic structures related to oral health represent the crucial research objects for this part of the thesis. The author is aware that oral health goes beyond the masticatory apparatus itself, *e.g.* biomechanical load on musculoskeletal units, spreading of germs through mucous membranes, and the digestive system. Nevertheless, the masticatory apparatus is here focused upon as it is the major part of this system which can survive millennia in the archaeological record.

A frequently used term in this thesis is “masticatory system”, referring to the functional unit of the body that includes teeth and their supportive structures, the jaws, the temporomandibular joint, and the muscles involved in mastication as well as the vascular and nervous supplying systems (Soboleva *et al.* 2005). In this thesis, masticatory system means all skeletal and dental remains of according structures. Humans, like almost all other mammals, are diphyodont, which means during their life they have two generations of teeth, the deciduous (“milk teeth”) and the permanent dentition (Scheuer *et al.* 2008;). During the changing phase in childhood and young adolescence, parts of the deciduous and permanent dentition coexist, which must be considered in accordance with the age-related analyses (Ubelaker 1978, 64).

In general, the form of the different dental categories relates to specific functions: incisors with cutting edges, canines with canonical and pointed shape, premolars with small relief, and molars with more relief on the chewing surfaces (Fig. 92.1-2). The permanent dentition usually consists of 32 teeth, bilaterally divided in the upper and lower jaw in four quadrants of eight teeth (anterior: 2 incisors, 1 canine; posterior 2 premolars and 3 molars per quadrant). The deciduous dentition consists of five teeth per quadrant, lacking the premolars and the third molar, and is systematically replaced during maturation by the permanent set of teeth. Although there are different terminology systems available for dental identification (cf. van Beek, 1983), the chosen formula refers to the *FDI System*[3] (Fig. 92.1). This system specifies each tooth by two numbers, including its anatomical (upper, lower, right, left; 1-4 permanent, 5-8 deciduous) as well as occlusal position (1-8 permanent/1-5 deciduous, Fig. 92.3).

In order to identify locations and markers on bones and teeth, standard anatomical directions and planes are applied (Fig. 92).

5.4.2 Preparatory work and recording approach

The practical work with the human remains was conducted in Russia by the author during several research periods (mainly in Kislovodsk and Novopavlovsk, Stavropol region). All further working stages, such as data base work and applying detailed analytical techniques, took place in Germany (Kiel and Berlin).

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2 Diaphysis, metaphysis, epiphysis, apophysis; unfused bones, *e.g.* the pelvis, in its three parts ilium, ischium and pubis and the vertebral corpus and neural arches.

3 *Federation Dentaire Internationale;* for other Systems see van Beek (1983), p. 3-6.

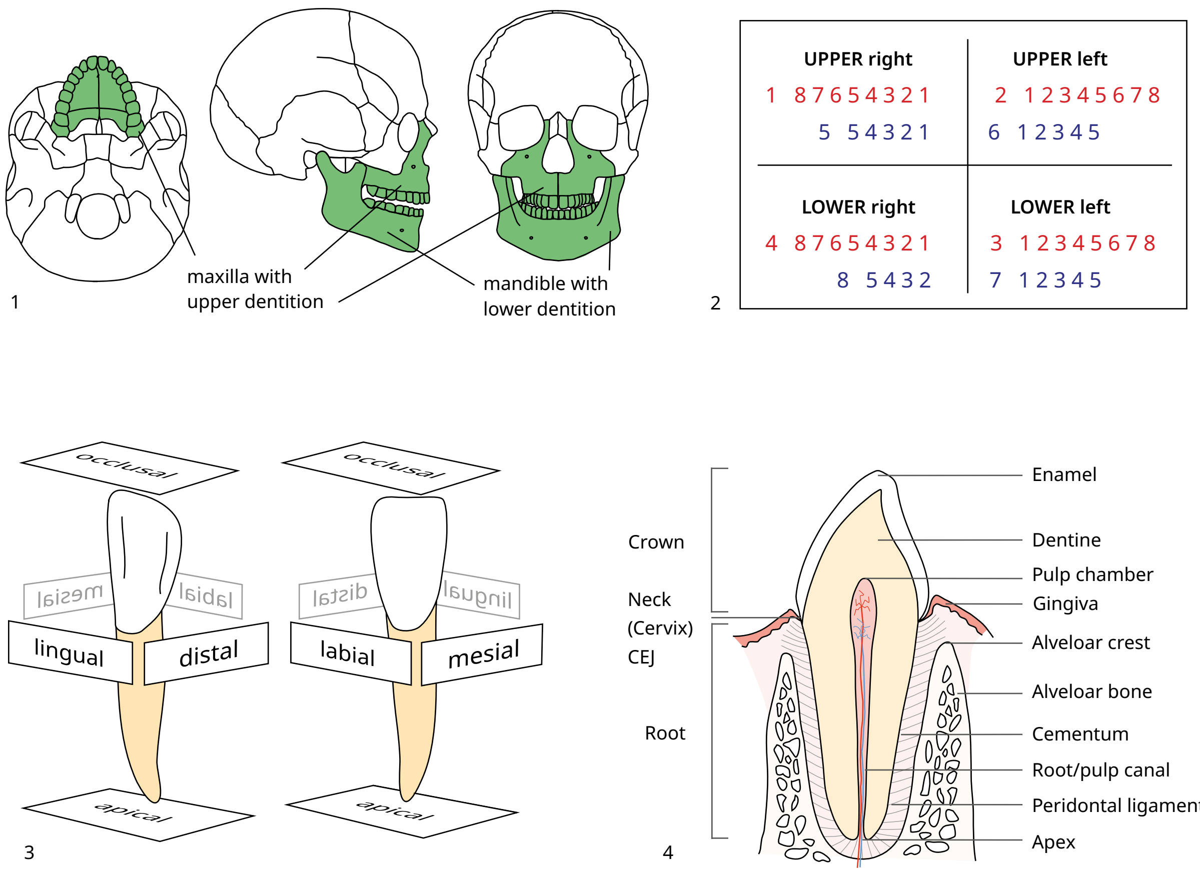

Figure 92: Analyses of human remains. Anatomical and directional terms of the human masticatory system and teeth. 1: Marking of the facial bones belonging to the masticatory apparatus, analysed for the doctoral thesis. 2: Tooth positions of deciduous and permanent dentition, FDI system. 3: Directional terms. 4: Section through a mature mandibular tooth and specification of according tissues. Figures created after White and Folkens (2005), Fig. 8.2 (2-3).

All selected skeletal remains were carefully washed, dried and fragmented pieces were glued back together. Laid out in the correct anatomical position, the overall skeletal preservation and the bone inventory was recorded on age-specific skeletal schemes (see appendix). All macroscopically detectable[4] osteological information and paleopathological changes found on the skeleton were noted down in corresponding recording forms and coding systems (see appendix) and documented within detailed pictures and, if needed, drawings. Measurements of specific bones were taken and are available for optional examinations of physical constitution. During this process, samples for further analyses (*e.g.* bones and teeth for isotopic, microscopic, radiologic, or radiometric analyses) were sent to Germany.

The development of advanced coding systems and the digital data acquisition of the written record as well as the digitalisation of skeletal and dental schemes took place in Germany. For the dental inventory, the recording scheme after Schultz (1988) was modified for the needs of this project (see section 5.4.5). Further analytical approaches (microscopic investigations, sample preparation, plain radiography, and computed tomography[5]) were conducted at the Scientific Department of the DAI, with the help of the team[6] and their cooperation partners[7]. Detailed imaging of exemplary studies of specific dental conditions was conducted using the digital microscope Hirox KH-870031.

4 With the naked eye as well as by means of a magnifying glass.
5 Methods applied for case studies presented as conference contributions, *e.g.* Fuchs and Gresky (2014, 2015).
6 Julia Gresky, Juliane Haelm and Laura Schwarz.
7 Charité Berlin; Michael Brandt, Göttingen University.

The data set used in this thesis focuses on demographic parameters (biological sex, age at death) and the masticatory system, which make up only a small part of the data obtained.

The determination of **skeletal preservation** took place in two stages. After specifying the bones and marking them in the scheme, the overall preservation with regard to the whole skeleton (100 %) was determined within four percentage stages: **0.1-25 %**, **25.1-50 %**, **50.1-75 %** and **75.1-100 %**. Next, based on anatomic principles, each bone of the skeleton was classified in the same way, consequently regarding its single preservation. For some bones, only two stages were applied (**0.1-50%, 50.1-100%**). Additionally, different regions of the long bones, fingers, toes, vertebra, sacrum and pelvis were divided into two (**A/E**), three (**A/C/D**) or five parts (A/B/C/D/E). These parts have been recorded as present or absent[8]. With these two values, the percent preservation of the full skeleton, and that of each bone, specific queries in terms of preservation status are possible. Second, the condition of the bone was described concerning consistency and surface preservation (**very good/good/bad/very bad**), referring the complete skeleton. For the conducted analyses, the overall skeletal preservation is especially of interest in terms of sex and age determination accuracy.

In principle, the evaluation of the masticatory condition of each individual includes the presence or absence of a tooth and the surrounding jawbone with respect to its preservation status and physiological state. For instance, the preservation of teeth in the sockets is distinguished from isolated teeth due to damaged alveolus or lacking mandible/maxilla. In case of postmortem or intravital tooth loss, no dental material is present, but the alveolar region still gives information about potential pathological changes. Based on the morphological constitution of teeth and the significance of anatomic regions in respect to certain pathological lesions, damaged crowns as well as devital tooth were also particularly termed. Additionally, the growing stages were considered in the recording system. This classification refers to Schultz (1988) and was further developed to fit the needs of the project.

5.4.3 Age at death

For determining significant demographic information for an individual, *i.e.* age at death and biological sex, only macroscopic methods were applied. The reliability of these methods is discussed in related scientific literature (Liversidge *et al.*, 2010; Lovell, 1989; Meindl *et al.*, 1985), and therefore will not be further explored in this thesis. To ensure the most valid result, as many of the methods listed below as possible were considered for each individual.

For estimating the individual age at death, osteological methods conform to stages of skeletal development and age-related changes of the mature skeleton. For immature individuals – including infants, children, and juveniles – the mineralisation status of the deciduous and permanent dentition (Anderson *et al.* 1976; Buikstra and Ubelaker 1994) and different indicators of bone development were used (Szilvássy, 1988). Here, ossification status (Schwörer 1975), epiphyseal closure (Brothwell 1981; Gray and Coupland 1967; Haret *et al.* 1927; Kopsch and Rauber, 1952; Schwörer 1975; Szilvássy 1977, 1988; Wolf-Heidegger 1954), and size of the long bones (Stloukal and Hanáková 1978) were highlighted. Age-related changes of the skeleton and teeth during adulthood (Buikstra and Ubelaker, 1994; İşcan 1989; Nemeskéri *et al.* 1970; Szilvássy 1988) were estimated by means of several attributes: attrition of the permanent dentition (Miles, 1963), relief of the auricular surface (Meindl and Lovejoy 1989) and the pubic symphysis (Brooks and Suchey 1990; Katz and Suchey 1986; Todd 1920), as well as stage of cranial suture closure (Meindl and Lovejoy 1985, 1985; Olivier 1960; Rösing 1977; Todd and Lyon 1924; Vallois 1937).

8 See appendix, red marks in the recording schemes.

If none of the mentioned methods were applicable due to preservation status – for instance, only long bone fragments remained – the size of the bone region and its condition (density of the compact and trabecular bone, weight; Nemeskéri *et al.* 1970; Szilvássy 1988) were assessed. This indicator is very imprecise; therefore, the age span is accordingly wide for these individuals (*e.g.* 25-50 years). This is also true for some partially analysed individuals ("skull"), for which the cranial sutures often represented the only attribute available. All methods of age at death estimation result into a chronological age.

Making age at death suitable for analytical approaches, Buikstra and Ubelaker (1994) established seven age classes that span different stages of physical aging in chronological terms of the aging process. Due to methodological uncertainties of age estimation in some cases, these classes have been modified and supplemented. The stage of 17-25 years, which is a result of age estimation based on dental attributes only (Buikstra and Ubelaker 1994; Miles 1963), does not allow a decision as to whether these individuals died during adolescence or in adult age, which makes an additional age class necessary. Adult++ marks individuals without distinct attributes indicating in which stage of adulthood they died. For these cases, only the minimal, not the maximal chronological age can be assumed; the skeletal elements must have been part of a fully-grown (mature/adult) individual. This is true for some partially analysed individuals ("skull") for which the cranial sutures represent the only attribute or for very poorly preserved skeletons (see above). The same applies for poorly preserved immature skeletons ("child"). If the estimated chronological age did not exactly fit in one of these classes, the decision was made based on the predominant part or by choosing the less exact age class[9]. The applied age classes are: **Infant** (0[10]-3 yrs), **Child** (3-12 yrs), **Young child** (3.1-7 yrs), **Old child** (7.1-12 yrs), **Juvenile**[11] (12.1-20 yrs), **Juvenile/young adult** (17-25 yrs), **Young adult** (20-35 yrs), **Middle adult** (35-50 yrs), **Old adult** (50+ yrs) and **Adult**++ (>20 yrs). As depicted in Figure 93, the division of immature classes allows a more detailed splitting of chronological age compared to the adult classes; the issue of deviating age resolution will be discussed later.

In addition to the determinations made for the individuals considered in the osteological analyses, the photographs of each grave were examined with regard to the state of individual skeletal maturity. If possible, the identifiable skeletal remains ("***ind in situ***", NIPG) were classified as **subadult** or **adult**, named as "**age *in situ***". This was implemented only when significant modifications of physical development were obvious, referring to unfused epiphyses of long bones as well as deciduous or changing dentition[12] (see above). Consequently, the age stage of juveniles is split in subadult (=unfused epi- and apophysis) as well as adult (fully fused bone elements). In case of poor preservation of the skeleton and/or funeral environment as well as insufficient photo documentation, the age of the individual remained as not determined. As these determinations are based on picture material, only the imprecise classification that divides subadults from adults was used so as to prevent faulty results.

In order to clearly distinguish between age at death related information obtained by osteological and photographic examination, for those of the first approach the terms "**immature"** (skeleton not fully developed) and "**mature**" (skeleton fully developed) and for the second approach "subadult" and "adult" will be used.

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9 For instance, if the estimated chronological age of an individual was 2-4 years, it is classified as infant rather than a young child (3-7 years).

10 The graves of Kudachurt 14 did not reveal remains of foetal (prenatal) individuals.

11 According to Buikstra and Ubelaker this class is named as "adolescent", juvenile is choice of the author.

12 The developmental stages of the permanent dentition, particularly the third molar, has not been considered.

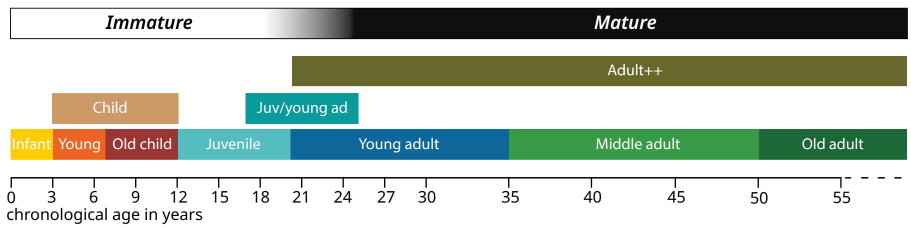


Figure 93: Analyses of human remains. Applied age classes and chronological age determinations according to Buikstra and Ubelaker (1994).

5.4.4 Biological sex

The biological sex of an individual can be determined from several morphological features of the female and male skeleton (cf. Buikstra and Ubelaker 1994; Meindl *et al.* 1985; Sjøvold 1988; White and Folkens 2005). This dimorphism is complex in terms of population differences and can appear more or less pronounced between the sexes. The majority[13] of morphological features are fully formed after the individual has reached maturity; therefore, the immature (≤juvenile age) individuals were, in the first instance, not taken into consideration.

Anthropological standards for estimating the architecture of the pelvis, which is said to be most reliable for sex determination as it is directly influenced by reproductive mechanisms, were used (Acsádi and Nemeskéri 1970, 1970; Buikstra and Ubelaker 1994; Ferembach *et al.* 1979; Phenice 1969, 1969; Sjøvold 1988). Further, cranial differences, which are characterised by greater robusticity of male skulls compared to females (Acsádi and Nemeskéri 1970; Buikstra and Ubelaker 1994; Ferembach *et al.* 1979; Sjøvold, 1988; White and Folkens 2005), were also recorded. This distinctive robusticity can also be recognisable on the postcranial skeleton and was taken into account (Sjøvold 1988).

The accuracy of determining sex on the skeleton depends on two main factors: the number of available features and the diagnostic value of each feature. Hence, problems with a clear identification can be linked either to poor skeletal preservation or weak sexual dimorphism within a population or both. On this account, it is necessary to express this inaccuracy when concerning biological sex, especially in the statistical context:

- Speaking of **male** (**M**) and **female** (**F**) individuals, the determination was certain according to the diagnostic features
- Using **male** > **female** (**M>F**) means that this individual shows features which are more likely to be male than female or vice versa **(F>M)**
- **Male=female** (**M=F**) means that no certain decision was possible (Ferembach *et al.*, 1979)
- Subadults and skeletons of poor preservation lacking attributes of sexual dimorphism remain **indeterminable (n. d.)**.

This determination of biological sex does not claim to specify the actual biological sex; this exactness is also limited when analysing individual nuclear DNA. Another valid information would be the burial situation of an unborn baby in the pelvis region of its mother, but no such inhumation was found, or at least proven, for Kudachurt 14. In consequence, this sex determination rather includes the evaluation of morphological traits that are more or less distinct for males or females, which is addressed by the five classifications applied.

13 Existing methods for sexing subadults are mainly metrical approaches, such as odontometric sex discrimination (*e.g.* Viciano *et al.* 2011), which are not applied to the Kudachurt human remains.

5.4.5 Categories of oral health

The following sections provide descriptions of oral health categories selected for the analyses. This includes definitions, typical morphological characteristics, pathological processes of the lesions, a brief discussion on aetiology, and the significance of current research as well as descriptions of the methodological approach applied for recording categories of oral health. If not otherwise specified, all following information is taken from Lukacs (2012), Hillson (2008), Ortner (2003), or Alt *et al.* (1998). Additionally, the doctoral thesis written by Stantis (2015) delivered an example for chapter structure and thematic foci, especially for the section concerning dental caries.

The basic recording system is based on Schultz' classifications of periodontal lesions, caries defects, calculus manifestations, abrasion, and enamel hypoplasia (1988), and was modified in order to achieve certain degree of comparability.

As this is true for most recorded categories of oral health, the anatomical locality of a lesion was specified considering anatomical unit (crown, neck, root) as well as physical direction (Fig. 92.3-4). When preserved, every single tooth and/or respective alveoli was examined for all lesions listed and confirmed (positive) diagnoses were included in the database. The prevalence of a lesion was calculated per tooth or alveolus respectively to provide overall distributions. Individual frequency in % (number of affected teeth in relation to assessable teeth/alveoli) and intensity (average of grades divided by assessable teeth/alveoli) or other specific parameters enable the correlation of the results with age class and biological sex.

5.4.5.1 Dental calculus

As Hillson (2008) states, the prevalence of periodontal inflammation as well as cariogenic milieus and the following complex interrelations of dental diseases are primarily caused by plaque deposits on the tooth surface. Dental plaque consists of bacterial colonies and their extracellular material, representing a biofilm that grows on tissues of the oral cavity. When removal of this biofilm does not take place, the organic acids of the microorganism by-products demineralise the tooth surface (carious lesions, see section 5.4.5. and 5.6.3.) or the colonies trigger immune responses from the soft, and later on, also the hard tissues (Lieverse 1999). In contrast, the mineralized form of accumulated plaque is known as dental calculus (calcified plaque, tartar). Numerous pathogenic as well as commensal bacteria resident in the oral cavity are represented in dental plaque (Mackie *et al.* 2017). Within a complex process, the plaque bacteria are replaced by calcium phosphate salts and, if not cleaned off, the plaque hardens rapidly and can fully be calcified within two weeks, continuously offering rough surfaces for further bacteria accumulations (Lieverse 1999; *Radini et al.* 2017). In life, dental calculus is covered by viable plaque; typical locations of calculus accumulation are around the tooth crown and more frequently on teeth surfaces close to the major salivary glands (lower anterior, lingual, sublingual and submandibular glands; upper molars, buccal, parotid gland; (White 1997). Continuous accumulation and mineralization of plaque without removal can lead to calculus manifestation of great extent. Two types of calculus are defined by the location of formation: the supragingival type, predominantly observed on the crown surfaces, and the subgingival type, located in the apical areas and associated with periodontal irritations (see 5.4.5.2; Hillson 2008). As dental calculus is reversible and the removal does not leave specific macroscopic traces on the teeth, examined accumulations on archaeological specimen represent the minimum at the time of death.

According to Lieverse (1999), the aetiology of dental calculus formation is multi-causal and the offered explanations for anthropological applications based on mineral precipitation from surrounding oral fluids and high protein diets are over-simplified. Since then, the potential of dental calculus as “a store of wide range of *in situ* biographical information” (Lieverse 1999) has increasingly been recognized and explored in research. The interest in this mineralized archive that can cover a whole lifetime has especially grown in terms of questions related to dietary habits and the evolution of human-associated and environmental microbes, as it entraps and preserves organic content from the bacteria or food remains (Fox *et al.*, 1996; Radini *et al.* 2017). Studies of past populations involving dental calculus address the general status of oral health, often combined with questions concerning diet, as well as try to uncover interrelations of dental diseases (Hardy *et al.* 2009; Stantis, 2015; Whittaker *et al*. 1982).

The significance of dental calculus with regard to the population buried at Kudachurt 14 is two-fold. First, the suggestive inverse relationship of caries and calculus, *i.e.* the assumption that dental plaque leads to deconstruction (high acidity; demineralization, caries) or addition of substance (highly alkaline; mineralization, calculus) needs to be examined. Second, and this is not part of this thesis, samples from dental calculus are currently in preparation in order to identify oral pathogens by aDNA analyses.

Calculus recording system

Supragingival calculus has been recorded in terms of extent, and the five grades after Schultz’ (1988, 493) have been summarised into three grades. This includes positive cases only, and as calculus is prone to post-mortem damage, we can assume that the recorded cases represent the minimum extent of affection only to the time of death. The extent of calculus accumulation has been calculated per tooth in terms of frequency:

Grade 1: **little**, thin line/accumulation (includes Schultz’ grade I)
Grade 2: **moderate**, distinct accumulation, <50% of tooth covered (II-III)
Grade 3: **severe**, gross accumulation, >50% of tooth covered (IV-V)

5.4.5.2 Periodontal disease

The clinical term *periodontium* defines the four anatomical units anchoring the tooth in the jaw (tooth supporting structures), including the cementum of the root surface, the alveolar bone, the periodontal ligament and the gingiva (see Fig. 94.6; Alt and Strohm 1998). Diseases of the periodontium in principle are caused by bacterial deposits in dental plaque located in the contact zone of gingiva. Initiated and progressed by oral microbes, the resulting inflammation of the soft tissues affects the support structure of the tooth, often leading to porosity and resorption of the alveolar crest. Advanced inflammation creates abnormal gaps between the cementoenamel junction (CEJ) and the alveolar rim, abbreviated as CE-J-AC[14] distance. The loss of alveolar bone becomes visible as increased porosity, due to the deconstruction of cortical bone and exposure of trabecular structures (Clarke and Hirsch 1990).

Periodontal diseases include several lesions defined by the tissue affected as well as its prevalent types. *Periodontitis* directly affects the supportive apparatus and consequently is visible on the bone; yet the presence of gingivitis before the affection of deeper periodontal structures is assumed (Clarke *et al.* 1986). Inflammatory forms with osseous response are *periodontitis marginalis* (common form) and *interradicularis* (apical form, predominantly affects the furcation of multiradicular[15] tooth sockets). The resorption of the alveolar crest favours the development of periodontal pockets and abscesses. Severe deconstruction of the supporting tissues

14 Cemento-enamel-junction alveolar crest distance.
15 Teeth with several roots.

leads to successive root exposure, which can result in complete tooth loss. Caused by the invasion of microbial agents, the inflammatory response depends on milieus and anatomic structures of the CEJ, alveolar, and pulp regions. In consequence, the course of infection and pathological changes involves the units of the periodontium differently, resulting in specific, irreversible manifestation on the alveolar bone.

Clinical studies characterize the aetiology of periodontitis as composed of numerous potential bacterial species, from which only some may be causative (Cekici *et al.* 2014; Ekstein *et al.* 2010; Listgarten 1986, 1986; Mullally *et al.* 2000). In general, as plaque can be a constant condition, especially when hygienic measures are lacking, and the disease may appear episodically with intervals of inflammation and relative normality during adulthood. There is a strong connection to the presence of dental calculus, as the manifestation of mineralized plaque fosters the accumulation of pathogenic infectious agents, especially in narrow spaces, for instance in cases of subgingival calculus.

Periodontitis can be confused with other pathological lesions connected to alveolar bone resorption, such as compensatory and continuous eruption (maintaining the occlusal mastication surface). According methodological attempts to distinguish between these processes consider typical anatomic traits (Levers and Darling, 1983; Newman 1999; Whittaker *et al.* 1982; Whittaker *et al.* 1985). In consequence, alveolar height does not represent the crucial symptom (Brägger *et al.* 1990); the distinctive characteristic is the shape and condition of the alveolar crest, sharp and smooth when healthy or false positive[16], porous and uneven when changed by inflammatory processes (cf. Alt and Strohm 1998).

The examination of a skeletal series from medieval London suggested a higher risk of mortality for individuals suffering from periodontitis, which has been confirmed for living populations (DeWitte and Bekvalac 2010). Correlations of sex and age are described by differing oral milieus and immune responses to the inflammatory process with males showing higher severity and susceptibility to infection (Shiau and Reynolds 2010a; 2010b). A connection of increasing CE-J-AC distance during progressing adulthood is detected, caused by erosion and succeeding occlusal movement of the teeth as well as continuous accumulation of infection risks (DeWitte 2012; Glass 1991). Modern clinical studies suggest that higher qualities of nutrient intake prevents the disease (vitamin C, folic acid, magnesium, fiber (Al-Ahmad *et al.* 2010) and that the type as well as the preparation of consumed dairy products has different effects on susceptibility to the illness (Adegboye *et al.* 2012). Inactive and unhealthy lifeways seem to be associated with increased suffering from periodontitis (Bawadi *et al.* 2011; Johnson *et al.* 1988). Obviously, these case studies are not representative for all modern populations and even less for those of prehistoric times. Still, diet and physical constitution have an impact beyond effecting the oral milieu as a primary condition (saliva, dental plaque). For prehistoric and historic populations, correlations between periodontitis and other pathological lesions (especially apical processes, cf. Clarke and Hirsch 1990; sections below) as well as nutrition are discussed (Kerr 1998; Molnar and Molnar1985).

Periodontal disease recording system

The crucial criteria for a positive diagnosis of periodontitis is the porous and ragged condition of the alveolar crest. Measurement of the CE-J-AC distance, as recommended by several authors, has not been conducted by accurate measuring (Clarke 1990; Goldberg *et al.* 1976). Therefore, sockets revealing postmortem tooth loss were taken into account if reference alveolar regions with teeth preservation were available. Schultz' method was applied and includes the progressive atrophy of the alveolar

16 False positive means a disease prevalent, but the individual died before the osseous response.

bone in five grades, which were summarised here to three stages (1988). Stage 2-3 indicate recognizable pathological changes:

Grade 1: mild (includes Schultz' grade I, porous, but few alveolar atrophy)
Grade 2: moderate (II-III, > half of root exposed, distinct alveolar atrophy)
Grade 3: severe (IV-V, only root tips anchoring the tooth in the jaw)

5.4.5.3 Periapical lesions

The term "periapical lesions" includes pathological changes occurring at the apex of a tooth and, in the osteological application, significantly affecting the surrounding alveolar bone. In palaeopathology, periapical lesions find different descriptions of manifestation and accuracy, for instance periapical cavities (2008), alveolar lesions (2015), or alveolar processes (Hillson 2008). Per definition, related lesions are characterized by cavities in the apical locations of the alveoli, whose size, shape and extent of bone damage depends on the underlying pathological process yet are not always easy to distinguish. Compared to periodontal diseases, periapical lesions are different in their aetiology due to the pulp being affected. The three main periapical lesions are granulomas, cysts, and abscesses, which describe different diseases. A short, yet very accurate definition of these three forms is given by Waldron, whose description substantiates the criteria of quite complex processes and their relationships (2008). The three forms are mutual in the infection of the dental pulp but differ in their manifestation, depending on the virulence of the pathogen and the immune reaction. The infection proceeds along the root canal and the apical foramen up to the periapical tissues, and subsequently leads to cavities of the apex region of the alveolar bone. The inflammation can be chronic when of low virulence or an acute process when highly virulent such as in acute abscesses. Both acute and chronic abscesses are characterized by the formation of pus, developing from a granuloma, cysts (secondary), or direct inflammation of the soft tissue (primary). In both cases the pus spreads through the alveolar bone, and eventually drains in the oral or maxillary sinus environment through a fistula, potentially along with osteomyelitis and gross bone loss (Hillson 2008); draining in the vascular system would result in septicaemia. Fistulae and/or rough cavity walls are distinct indicators for primary and secondary abscesses, although the different aetiologies are not comprehensible. In contrast, Waldron (2008) and other researchers define periapical lesions resulting from granulomas and cysts as cavities with smooth walls and no fistulas. Granulomas are smaller (<3 mm) compared to their further developmental stage cysts (>3 mm; Dias *et al.* 2007; Dias and Tayles 1997), which are of same morphology, but filled with fluid. Both are less painful compared to acute abscesses and do not show systemic effects as these latter rapid and advanced inflammations close to the vascular system can cause the lethal distribution of the infection. As bone remodels, the lesion could be reversed when the inflammation resolves.

In principle, periapical lesions result from infection of the pulp (*pulpitis*), and interrelations to dental conditions causing the exposure of the root canal to the oral environment and microbial pathogens are obvious. Associated conditions of enamel and dentine removal or damage are caries (see above), heavy wear (masticatory or non-masticatory), or fractures and cracks. Thus, periapical lesions often are of secondary nature, appearing when contagious pathogens get access to the root canal. In palaeopathology, these interrelations are issues of different studies, and the relationship to caries seem to be the strongest among other dental conditions (Costa 1980; Lucas *et al.* 2010). This is plausible as caries correlate with bacterial infection and dental wear is of erosive character, suggesting rather plaque removal then the addition and increasing inflammation risk. Additionally, dental wear also depends on the type and location of mechanical impact on the tooth. Periapical lesions and periodontal infection occur mutually, since the periodontal tissues and ligaments are periapical structures, and severe destruction processes of the alveolar bone can lead to tooth loss (Clarke and Hirsch 1991). Hillson (2008) states that the correlation of caries, pulpitis, periapical inflammation, and tooth loss is overestimated, although this assumed correlation explained the establishment of the *caries calibration* approach (Erdal and Duyar 1999).

In consequence, the prevalence of periapical lesions and the susceptibility to related diseases depends on internal factors, such as the individual immune response (sex, age, genetic predisposition), as well as external factors, such as the composition of the oral microbiome, tooth-weakening modifications, and measures of oral treatment. Despite these crucial differences in aetiology and disease burden, all forms of apical lesions are often diagnosed as “abscesses” in palaeopathological literature, as Dias and Tayles criticized (1997). Thus, comparative approaches are problematic when referring to past studies. In this thesis, the term periapical lesion will address these three conditions, and the crucial criteria of fistula shall help to face this issue.

Periapical lesions recording system

According to Dias and Tayles (1997) advice for distinguishing between periapical granulomas, cysts, and abscesses, the data deriving from the applied recording system after Schultz’ (1988) was modified into three sizes with the existence of fistulae serving as a secondary characteristic. A description of the cavity wall morphology was not made. In consequence, grade 1 and 2 are likely to represent granulomas and cysts, whereas grade 3, as well as grade 1 and 2 with prevailing fistulae are interpreted as evidence for abscesses. This approach does not allow final diagnoses which would require histological analyses. Radiography and extraction of teeth preserved in the alveoli was not performed, so that the estimated number of lesions represents a minimum of actually present lesions.

Grade 1: small, <3 mm; likely granuloma (Schultz’ Grade I)
Grade 1.fis: small, with fistula <3 mm; small abscess (Schultz’ Grade I)
Grade 2: moderate, 3-5 mm; likely cyst (II+III)
Grade 2.fis: moderate, with fistula, 3-5 mmmoderate abscess (II+III)
Grade 3: severe, >5 mm; abscess (IV+V)
Grade 3.fis: severe, with fistula >5 mm abscess (IV+V)

5.4.5.4 Antemortem tooth loss

The condition antemortem tooth loss (AMTL) describes dental deficits that occurred during life and the subsequent physiological process of socket remodelling. The crucial criteria to distinguish AMTL from postmortem tooth loss (PMTL) is the presence of alveolar healing, which requires a certain temporal distance from the loss itself (Morgan 2011).

In her thesis, Morgan (2011) investigated observable stages and schedules of remodelling processes on specimen from the archive of a modern oral surgeon in comparison with specimen from archaeological contexts. She describes the physiological processes from the time since tooth loss (TSL) to completely remodelled and healed sockets in three stages: (1) Pre-osseous stage (within one week), (2) bony remodelling stage (*ca.* 14 weeks since loss) and (3) healed stage (at least 29 weeks since loss (Morgan 2011). Whereas the first stage is not visible on skeletal remains, the assessable stages 2 and 3 give approximate information about the minimum amount of time an individual survived after the respective tooth was lost. In terms of AMTL causation and healing procedures, she stresses that it interferes with individual accelerating and inhibiting factors (*e.g.* nutritional supply, sex, age, specific and common diseases; Morgan 2011).

The condition itself does not address the causation of tooth loss, which is multifarious. Discussed causes are extraction of the tooth (*ablation*, *e.g.* due to severe inflammation/pain, damaged and loosened tooth; or ritual ablation, cf. Tayles, 1996), severe atrophy of periodontal structures, devital tooth, or trauma (Lukacs 2007). Thus, AMTL results from the intentional removal or subsequent loss of tooth fixation in the jawbone, and represents a secondary condition of physiological, pathological, or traumatic circumstances. Here, a good example are cases of scurvy and leprosy as both diseases are associated with intravital tooth loss caused by the destruction of periodontal tissues but resulting from completely different aetiologies (Mays 2014b; Rodrigues *et al.* 2017). Due to continuous tooth eruption, alveolar atrophy and increasing abrasion during life as well as the suggested strong relationship to dental caries (*e.g.* Cucina and Tiesler 2003), AMTL is associated with advanced individual age (Mays 2014a). Continuing atrophy of the alveolar ridge and decreasing jaw height after tooth loss is also connected to increasing individual age (Reich *et al.* 2011). Morgan (2011) concludes that the often stated significance of advanced individual age needs to be reconsidered with respect to prevalence of dental disease, diet, and oral behaviour. The evaluation AMTL significance requires the identification of these relationships. Thus, the ATML rates are to be considered together with accompanying dental conditions of the individual or the population under study.

AMTL and PPTL recording system

Remodelling stages of AMTL were distinguished in two stages, **healing** (when showing distinct alveolar bone reaction) and **healed** at the time of death (flat, smooth surface or only few ridges of alveolar depression. Stage 1 is equal with Morgan's (2011) stage 2 (TSL >14 weeks), and stage 2 is equal to her stage 3 (TSL>29 weeks).

Additionally, tooth positions with postmortem tooth loss and significant periapical lesions are considered as ***potential perimortem tooth loss*** **(PPTL)** without recognizable osseous response, representing a proxy for loss of teeth close to the time of dead of the individual (similar to Morgan's stage 1) or at least cases with advanced loss of periodontal supporting structures and high risk of loss. This classification is according to the author.

5.4.5.5 Dental wear: Masticatory and extramasticatory traits

The term "dental wear" encompasses a variety of conditions that all have gradual tooth substance loss in common and are characterized by their form of manifestation. In general, according wear patterns result from mechanical influence with degrading impact on the tooth surfaces. In paleoanthropological, osteological, and palaeopathological application, defining, scoring, and evaluating different types of dental wear and their indications has a long and comprehensive history of research. Among others, main issues in related studies are detecting causation linked to dietary, cultural, or occupational habits and significance with regard to individual age (Constandse-Westermann 1997; Scott 2002). Related to these issues, occurring wear patterns can be traced back to chewing movement (masticatory) indicating food processing or to habitual behaviour indicating the use of teeth as a tool (extramasticatory, non-masticatory). In some respects, determining borders of masticatory and extramasticatory indication might be blurry, yet current literature recommends the following characterizations (Alt and Pichler 1998; Bonfiglioli *et al.* 2004; Molnar 2011):

Occlusal or macrowear: Abrasion and attrition[17]

Abrasion and attrition both contribute to dental macrowear and are characterized by ablation due to two different mechanisms. Attrition is substance loss induced by tooth-on-tooth movement, mainly on the occlusal plane (*e.g.* tooth grinding, *bruxism*; Molnar 2011). Abrasion implies the involvement of external substances, for instance food components and contained impurities in the occlusal movement (Hillson 1996; 2008). Although of different aetiology, the effects of attrition and abrasion on enamel and dentine tooth tissues are difficult to distinguish, especially by the naked eye.

The gradual process of occlusal wear in healthy teeth starts with the flattening of the crown cusps in correspondence with their lower or upper antagonists. After enamel removal, the tooth dentine and in more advanced wear the root canal opens; the enamel is more solid compared to dentine, and in these regions, the removal proceeds faster. In severe cases, complete crown removal leaves only root dentine forming the occlusal surface. This process is not uniform and depends on the mechanic pressure impact in terms of direction and angle as well as on tooth anatomy. As the process of dental wear is clearly related to aging, various recording schemes and recommendations exist on how to use it as an indicator for estimating individual age at death in skeletal samples.

Based on their position in the dentition, the morphology of human teeth is shaped by their function in the digestive process of chewing (see section 5.3). Anterior teeth (incisors, canines) are less involved in mastication rather than cutting bite-sized pieces. In contrast, premolars and especially molars take the central task of mastication. Both forms of dental wear depend on the time of tooth integration in the occlusion. Therefore, typical and atypical wear patterns of anterior and posterior teeth and form of substance removal can help to differentiate between dietary and occupational causation (Arnold *et al.* 2007; Hillson 2008; Smith 1984).

Related studies about patterns of dental macrowear refer to simultaneous conditions and discuss their relevance in terms of dietary habits and the erosive effects of food substances. Throughout the research on the development from hunter-gatherers to agriculturalists and beyond, studies focus on correlations of occlusal wear patterns to significant changes in the texture of food (Bonfiglioli *et al.* 2004; Caglar *et al.* 2007; Dawson and Robson Brown 2013; Deter 2009; Eshed *et al.* 2010; Mickleburgh 2016). Here, methodological approaches focusing on dental meso- and microwear aim for a better understanding for these correlations (Borrero-Lopez *et al.* 2015; El-Zaatari 2010; García-González *et al.* 2015; Schmidt 2010). At the same time, occlusal wear can result from occupational habits, *e.g.* using the anterior teeth for skin working or holding objects. Molnar (2011) describes associated lesions as “lingual attrition or abrasion of the maxillary anterior teeth”, but other authors include wear patterns of typical labial and/or lingual rounding of the occlusal surfaces, not limited to maxillary or mandibular teeth. Similar cases were found in recent hunter-gatherer populations (Hillson 2008; Hinton 1981; Scott 2002; Tomenchuk and Mayhall, 1979). Latest research identified sex-related differences in the habitual use of teeth for a Neolithic population, and patterns of tooth wear from living Canadian Inuit of known sex and age confirm this potential differentiation (Clement and Hillson 2012; Lorkiewicz 2011).

Continuous occlusal wear leads to different secondary morphological alterations and pathological lesions. For instance, loss of counter-pressure from the antagonistic tooth and continuous eruption is visible by an increasing CEJ-AC distance. High pressure on the periodontal structures, less alveolar support and remodelling of the bony structures anchoring the tooth can lead to loss of fixation in the jaw and can cause tooth dislocation (Hall 1976; Reinhardt 1983). The exposure of fragile struc-

17 Including erosion, which is loss of tooth substance due to chemical ablation, but not limited to occlusal wear.

tures such as dentine and pulp make the tooth vulnerable to caries and periapical lesions and can potentially result in antemortem tooth loss (see sections 5.4.5.3-4).

As Molnar (2011) states, dental macrowear is always a result of human activity and of intentional or unintentional causation; in its use as a term, it has a collective character. The term used in this thesis, "occlusal macrowear", refers to those traits that correspond to loss of tooth mass on the occlusal surfaces due to mastication activities, whereas these activities do not exclusively mean mastication of food. However, compared to interproximal grooving, notching and polished surfaces, occlusal macrowear is generally induced by food mastication. During the examination it became clear that the shape and the direction of occlusal wear differs, which was taken into account in the methodological approach:

Occlusal macrowear recording system

Originating from Brothwell's (1981) scheme, the recordings have been modified after Hillson's (1996) recommendations to evaluate occlusal attrition stages. The stages (**1, very slight** – **8, severe)** include incisor, canine, premolar and molar wear and take into account the shape of ablation, from beginning abrasion of the crown cusps until the root dentine. In order to supplement these stages in terms of predominantly occlusal or asymmetric wear (distinct lingual/distal/mesial/buccal) patterns, the following evaluation was also performed:

- **o/asy: occlusal/asymmetric**
- **C/N/R: Crown/Neck/Root**
- **E/D: Enamel/Dentine**

For instance, oCE means predominantly occlusal wear of the crown enamel, whereas asyNRD describe asymmetric wear affecting neck and root of the tooth. Additionally, in order to potentially further differentiate between masticatory and non-masticatory occlusal wear, distinct round or smooth edges have been noted if present. In combination with the stage of dental wear (1-8) this allows quite precise statements about the nature of occlusal wear for each tooth as well as about individual patterns.

Interproximal grooving

Approximal or interproximal grooving are artificial grooves of different extents located near the CEJ region from buccal/labial to lingual direction (Brown and Molnar 1990; Formicola 1988; Frayer 1991; Hillson 2008; Molnar 2011; Ubelaker *et al.* 1969). Interproximal grooves have been identified on teeth from human fossils as well as in modern populations from different sites across the globe but are not a frequent phenomenon (Bermúdez de Castro *et al.* 1997; Lukacs and Pastor, 1988). They occur on adjacent teeth bilaterally or one tooth unilaterally, predominantly on cheek teeth (premolars and molars), but Neolithic and Bronze Age skeletons from the study region also show interproximal grooves in the anterior section of the dentition (Molnar 2008; Schulz 1977; Tucker *et al.* 2017). Different from occlusal dental macrowear, the aetiology of interproximal grooving is not associated with food preparation in the sense of chewing but rather reflects habitual use of teeth or therapeutic treatment. Suggested activities are for instance fibre or animal sinew processing or picking with solid, non-flexible objects ("toothpick"). The interpretation of grooves crucially depends on their shape and microstructure relief as well as their location on the tooth. Simultaneously occurring pathological lesions of the according tooth would strengthen the interpretation of therapeutic indication, and co-occurring artificial grooves on other tooth locations (occlusal, buccal/labial, lingual) and positions (anterior/posterior) would suggest material processing (Frayer 1991). Distinct patches with sharp edges, roundish cross-sections and constant direction on the mesial and distal CEJ and nearby root region would mirror the application of a cylindrical toothpick, wherein deepness and continuity could indicate different stages of progression (Bonfiglioli *et al.* 2004; Lukacs and Pastor 1988). Grooves with blunt edges and shallow depths and diameters as well as the affection of buccal and lingual sides of the tooth imply fibre or sinew penetration (Bermúdez de Castro *et al.* 1997). There is a scientific consensus that aetiology and interpretation of interproximal grooves, may it either be more related to oral treatment or craftsmen production, strongly depend on their morphological features.

In this thesis, the definition of interproximal grooves relies on three main criteria: Location (mesial or distal CEJ/root surface), horizontal orientation and circular diameter, even when of shallow depth. Any other occurring modifications were classified as ***occlusal grooving*** (***notching***) and ***unspecific facets***, which includes some of aforementioned groove characteristics.

Interproximal grooving recording system

Modifications identified as interproximal grooving are striations running **horizontally** from the **buccal** to the **lingual/palatinal** direction on the **mesial** or **distal** surface of a tooth (or counter wise). Criteria for the estimation of interproximal grooves are recognisable rims, distinct circular or shallow cross section (divided into distinct and faint), and substance loss of a limited region. Often, striated surfaces of the grooves were identifiable. The location **(C/N/R/d/m)** of a groove was noted by tooth region (crown, neck, and root) and anatomic direction (mesial or distal). The counted number must be considered as a minimum, as it is likely that very faint grooves on teeth preserved in the pockets with small interproximal distance were not identified. Nevertheless, based on the careful examination, the number of overlooked grooves is probably quite small.

Occlusal grooving: Notching

In contrast to interproximal grooving, Bonfiglioli *et al.* (2004) describe notching as distinct grooves that involve the occlusal and eventually additional surfaces of a tooth (Molnar 2011) in horizontal[18], vertical[19], or unspecific direction. Different from interproximal grooving, it might have affected the crown enamel and the underlying tooth tissues. According modifications might appear singularly or in multiple on the same tooth, often affect adjacent teeth, and their morphological criteria are distinct margins. They might be of similar aetiology as interproximal grooving, whereas occlusal notches are rather associated with occupational habits then oral treatment, for instance processing fibre by constantly pulling them through the edges of occlusal cusps and rims. Locations, directions, and groove morphology are less specific. Typically, they are to be found on the anterior teeth (Larsen 1985; Lorkiewicz 2011; Schulz 1977), but this assumption might require revisiting.

Occlusal grooving recording system

In the following analyses, modifications that are of similar nature as interproximal grooving without its typical interdental location but **involving the occlusal surface** in random directions, are defined as occlusal grooving. This definition included grooves that expand from the occlusal to vertical tooth regions (*e.g.* the mesial CEJ, the lingual root).

Unspecific facets and polished surfaces

The findings of extramasticatory modifications prevalent in the population under study required an extension of the conditions that have been defined so far. Called

18 Buccal/labial to lingual.
19 Occlusal to apical.

unspecific facets and polished surfaces, according conditions are most comparable with Molnar's (2011) descriptions of "interproximal striations" or "polished surfaces" or Lukacs and Pastor's (1988) "abrasion of buccal roots". Included are facets on the tooth surface that are different than interproximal and occlusal grooving, have a varying size, lack determinable diameter, vary in orientation, and have a facet surface morphology between striated and polished. Related lesions may belong to modifications resulting from both oral treatment and the use of teeth as tools, and their possible aetiology requires individual investigation.

Facets recording system

Unspecific facets cover the prevalence of distinctively **smooth** or **polished** surfaces of a tooth, predominantly located on CEJ or root surfaces, lacking furrows that are identifiable by the eye and sharp demarcations. Recorded attributes are location and size of the surface.

Dental chipping

Dental chipping describes irregular cracks of the enamel or dentine appearing on the lingual, buccal, or interproximal edges. These cracks are associated with loss of tooth substance, which distinguishes chipping from fractures evident by fracture lines. According lesions are caused by microfractures of the enamel or dentine sections, whose extent could reach gross loss of tooth substance (Bonfiglioli *et al.* 2004). The prevalence of these chippings results from punctual overload of the enamel or dentine, which is in the first case striking, as enamel is extremely resistant yet inflexible. In consequence, teeth with strong dental wear or caries are more prone to chipping; often, the crown remains not a closed enamel cap but a surrounding circle of little wall thickness (Scott and Winn 2011; Stantis 2015). The condition of chipping does not traditionally count as a trait of dental macrowear as it is not caused by gradual removal of tooth substances due to continuous and repeated friction. However, similar to aforementioned conditions, dental chipping alters the tooth irreversibly and has a strong correlation with masticatory and extramasticatory causation Obviously, dental microfractures can also result from dental trauma in the sense of personal injury, but frequency and size of the fractures in the context of the overall dental wear affection would indicate different aetiology. Both dietary (biting and chewing substances harder than dentine and/or enamel) and occupational (fixation or processing) activities come into question (Bonfiglioli *et al.* 2004). Thus, individual chipping rates must be regarded in respect to all aspects of individual dental wear (and caries) present.

Chipping recording system

Microfractures of the enamel and dentine were recorded if the intravital damage was undoubtable. Fractures were recorded in terms of maximal size visible on the tooth surface (**stages 1-4: 0.1-1 mm2, 1-2 mm2, 2-3 mm2, >3 mm2**) and location (**CNR**=abbreviations as for occlusal wear, **o/m/d/l/b** for anatomic direction). In order to avoid overestimation of extremely small microfractures, which often occurred on narrow enamel crests with opened occlusal dentine, multiple fractures on the same tooth have been combined to one maximum extent. In the analyses, those cases become evident by relatively small size but present on several anatomical locations. Consequently, the calculated frequency is an approximate value describing a minimum of those microfractures present.

Further remarks

Understanding the aetiologies of extramasticatory modifications and their potential as indicators for reconstructing oral health treatment or craftsmen activities requires the consideration of the wear patterns of the complete individual dentition as well as the individual's general status of oral health. In reverse, in correlation with age at death, conditions of dental wear also give information about texture, resistance, and possibly shape of the causing external substance or object, may it be dirt particles in food, diameters of toothpicks, or the roughness of animal skins and sinews or fibres. Obviously, this is a specialized field on its own, depending on accurate and detailed identification techniques for the lesions, especially for the study of microstructures, as well as an intensive investigation of possible substances and objects and experimental experience.

5.4.5.6 Carious lesions

Due to its complex aetiology and significance in oral health research of both past and modern population as well as its special importance for the population under study, the condition of dental caries will receive more attention.

According to Lukacs, "Dental caries is a disease process involving progressive, focal demineralization of dental hard tissue by organic acids derived from bacterial fermentation of dietary carbohydrates, especially fermented sugars" (Lukacs 2011; Featherstone 2004; 2012). Although the simplified process of the disease – the chemical dissolution of hard tissues and successive structural damage – is indisputable, the aetiology of caries is complex and multifactorial. The strong correlation of dental caries to dietary habits and its divergent prevalence in populations of different socio-economic formations across the globe predestines the disease as an indicator for individual or comparative studies (Grimoud *et al.*, 2011; Halcrow *et al.* 2013; Kerr 1988, 1990; Lanfranco and Eggers 2010; Lunt 1974; Meinl *et al.* 2010; Saunders *et al.* 1997; Varrela 1991; Vodanović *et al.* 2007; Whittaker and Molleson 1996). In the archaeological record, the caries rates increased significantly after the adoption of agriculture and the beginning of cultivated crop consumption. Even in modern times of dental hygiene, dental caries is still a costly public health issue (Hillson 2008). Methodological advances in diagnosing and recording caries lesions as well as the increasing involvement of modern clinical diagnoses reflect the intensive research engagement of the last decade. Recent studies concern the detection and evaluation of internal (individual, physiological principles) and external (dietary habits, hygienic measures) factors of the cariogenesis and in this sense the explanation of sex differences in caries affected populations. Additionally, within the set of oral health conditions caries has many interrelations, so that the analysis of according lesions is essential in order to understand the overall disease burden of an individual as well as a population.

Like calculus, caries is a condition induced by dental plaque, more precisely by the organic acids produced by certain bacteria. Modern DNA and RNA analyses from saliva and biofilm samples taken from teeth with carious lesions at different affection stages and locations showed that the bacterial composition is tissue dependent; most frequent are *Streptococcus (mutans)*, *Fusobacterium*, *Veillonella*, and *Porphyromonas* (Costalonga and Herzberg 2014; Simón-Soro and Mira 2015). Obviously, the human oral microbiome changed throughout time, but comparative DNA studies of contemporary and ancient specimens confirmed *Streptococcus mutans* as the key carious pathogen since the arise of agriculture (Adler *et al.* 2017).

Independent from the bacteria species, the acids (lactic, formic, acetic, propionic) they produce diffuse in the porous surface tooth they attach on, which demineralizes the inorganic components of the underlying tissues (carbonate, phosphate, calcium). These are primarily the enamel or the root cementum and, when exposed to the oral environment, the dentine or the pulp chamber. This also occurs if the destructive process continues. In general, the disease is of slow progression; dentine and pulp consist of fewer inorganic components, the demineralization has a faster progression in these areas of the tooth.

Featherstone (2004) describes the “caries mechanism” as a concept characterized by the presence of acids, their diffusion into the tooth tissue(s) and the partial dissolution of mineral crystals, eventually leaving cavitation by progressing affection. If non-cavitated, this process can be balanced with diffusion of calcium, phosphate, and fluoride, and this “new mineral crystal surface” is more resistant than the original tissue. This functional circle of demineralization and remineralisation happens several times a day, resulting in repair and reversal, or cavitation. This is true for the enamel cap, but as soon as the dentine tissue is affected, the breakdown of the contained collagen happens rapidly. In consequence, the presence of cariogenic bacteria in the dental plaque does not automatically lead to caries lesions, as the oral system contains protective factors supporting remineralisation. Sufficient saliva flow and its components, favourably rich in minerals and certain proteins, offer mechanisms that could keep the balance with pathological factors (acidogenic bacteria, high frequency of fermentable carbohydrates, reduced saliva; (Featherstone 2004) and maintain appropriate pH-levels above 5.5 (Stantis 2015; Struzycka 2014). Continuous demineralization results from an imbalance of these factors and especially increased presence of acidogenic bacteria in the dental biofilm as well as lacking oral treatment lead to progressive caries.

During the course of the disease there are different morphological manifestations, from slight discolouration of affected areas to large brown lesions and cavities, consequently resulting into the total deconstruction of hard tissues. To the naked eye, carious lesions are visible by brown discoloration and clearly identifiable by loss of tissue. Due to tooth morphological features, there are niches where carious lesions typically occur. The occlusal fissures and fossae of the molars as well as the interproximal areas (approximal) between neighbouring teeth represent narrow reliefs or hardly accessible areas where dental plaque bacteria accumulate. These are typical initial locations for **coronal caries**, meaning primary affection of the crown. This type also occurs when the enamel layer is eroded, laying open dentine or even the pulp canal. Below the crown, when exposed due to alveolar atrophy, caries lesions of the CEJ result in root **surface caries**. Depending on the size and progression of the lesion, coronal caries and **root surface caries** can be difficult to distinguish. It appears symmetrical between right and left body side but differs in upper and lower teeth and category. In modern times of oral treatment, the fissures of the second and third molar are generally the first to be affected, followed by the fissures of the third molar. Next are the respective contact points, incisors are last.

When untreated, the “natural history of caries” (Hillson 2008) from initial coronal lesion gradually leads to affection of the pulp and devitalisation of the tooth, most likely taking many years. Thus, the disease itself has a chronological sequence, independent of the age of the individual itself. Additionally, in terms of individual biography, caries can be a life-long condition, with children and young adults showing occlusal and approximal caries, and later in life suffering from dentine caries and eventually pulp opening. This was observed for a caries-prone group of a modern population of rural agriculturalists, whereas the caries affection of hunter-gatherer groups is rare in younger individuals but predominant in older adults, often connected to advanced tooth wear and chipping. Populations with only very low carbohydrate consumption are almost without caries; the compilation of dietary differences is also reflected in the archaeological record (Hillson 2008).

There are different internal and external factors that influence the susceptibility of an individual to dental caries, despite the consumption of cariogenic food, resulting into divergent prevalence within a population and between them (most of the following considerations accord to Stantis’ more detailed descriptions; Stantis 2015). The morphology and generation of a dentition (niches where plaque accumulates, deciduous/permanent teeth) and the composition of the dental tissues, the chemical and physical composition as well as the supply of saliva, or the time of occlusal exposure rank among internal physical factors. In both historical and modern populations, differences in biological sex have been confirmed and underlying results analysed, mainly considering the role of hormones involved in the chemical composition of the oral environment (Lukacs 2011; Lukacs and Largaespada 2006). Additionally, recent studies on caries aetiology focus on the role of genetic predispositions in enamel formation or other dental caries traits (Bretz *et al.* 2005), its mineral composition resulting resistance or susceptibility to solubility. External factors affect plaque composition and its survival on the tooth surfaces. A major factor for the dental plaque is food, its preparation methods and related eating habits, as Stantis states (2015). Food components have different effects on the oral biofilm and the cariogenesis. Whereas fermentable carbohydrates such as sucrose, glucose, maltose, fructose, and lactose have specific metabolic attributes and impacts on the pH-level (mono- and disaccharide), fat, protein, and trace elements trigger protective mechanisms lowering the pH-level, coating the tooth surface, and reducing enamel demineralization. Trace elements such as vitamins are required for adequate mineral deposition, and the availability of calcium, phosphate, and other minerals is precondition for remineralisation. However, compared to fluoride, their contribution to caries rates is low. Fluoride stimulates the diffusion of minerals and hardens the microstructure, thus playing a key role in the caries balance (see above). Besides the components and nutrients, food preparation including mechanical fragmentation and cooking influence cariogenity, altering the integration of carbohydrates in the dental plaque or their chemical structure (Humphrey *et al.* 2014; McClure and Muller 1958). As a secondary effect, texture of consumed food also affects salivary flow. In consequence, with respect to its aetiological significance, the characteristics of chosen food components and processing matters. From the socio-economic perspective, this reflects environmental (natural food sources and nutritional components), technological (food preparation skills) and social (unequal access to food, eating habits) aspects. Another external factor is the remove of dental plaque, may it be intentionally by means of dental hygiene measures or accidentally, for instance by eroding tooth surfaces during occupational habits (both see "non-masticatory modifications", preceding section). Again, both factors depend on behaviour intertwined in the socio-economic setting of an individual or a population and their eating habits, things that eventually change with time (Larsen, 1983).

The interrelations of caries and other dental conditions are manifold, representing initial, contemporary, or secondary phenomenon, and are the focus of numerous studies (Albashaireh and Al-Shorman 2008; Caglar *et al.* 2007; Costa 1980; Cucina and Tiesler 2003; Lucas *et al.* 2010; Maat and Van der Velde 1987; Malčić *et al.* 2011; Meiklejohn *et al.* 1992). Initial conditions in general are of structure weakening nature, such as defects of the enamel formation (enamel hypoplasia, see following section) and opening or loss of tissues such as tooth wear, micro factures or chipping. The oral environment offers ecological niches to various microorganisms, so that the prevalence of caries and soft tissue inflammation is not surprising, yet the causing bacteria species differ (Costalonga and Herzberg 2014). In fact, gingival recession due to infection provoke the exposure of root surface, which is more prone to demineralization compared to enamel. When caries affects the pulp chamber, bacteria can enter the root canal and neighbouring systemic structures (*pulpitis*). Through the apex, the infection potentially leads to acute or chronic periapical inflammation, destroying and resorbing the tooth supporting structures. Advanced stages of caries with pulp exposure can cause periapical lesions, which can result in antemortem tooth loss. The interrelation of caries, soft tissue inflammation, periapical lesions and antemortem tooth loss is complex (see preceding chapters). This also applies to masticatory and non-masticatory modifications connected to tissue erosion. As caries is progressive, the habit of hygienic treatments can be regarded as secondary condition and may result into the intentional extraction of teeth.

Due to the strong interrelation of caries with dental diseases which could result into antemortem tooth loss, it requires special attention in the statistical calculations for both caries intensity (extent of disease/damage severity) as well as frequency per individual and per population. Besides the establishment of recording systems (Hillson 2001), the "caries correction factor" is the applied methodological approach facing this issue (Duyar and Erdal 2003; Erdal and Duyar 1999; Lukacs 1995).

Caries lesions recording system

The final values represent a combination of Hillson's (2001) and Corbett and Moore's (1976) recommended systems for caries scoring and Schultz' (1988) recording classification. The author points out that the tooth locality of caries origin is crucial for the following interpretation, resulting in a sophisticated system (12 classifications after Corbert and Moore). The Schultz system refers to locality and lesion size separately from each other. As a result, the basic record has been modified in order to combine the criteria to a more simplified system (scoring after Corbett and Moore 1976 in brackets):

Grade 1, C.Occ: crown, occlusal (grade 2/3; occlusal fissure/cusp)
Grade 2, C.Int: crown, interproximal contact zone (grade 5, interstitial contact)
Grade 3, CEJ.Int: CEJ, interproximal contact zone (grade 6, CEJ)
Grade 4, C.bl: crown, buccal/lingual (grade 8/10, buccal, lingual fissure)
Grade 5, CEJ.bl: CEJ, buccal/lingual (grade 9/11, buccal, lingual CEJ)
Grade 6, C.CEJ.gross: crown, CEJ, gross, >50 % crown damaged,
(origin indeterminate) (grade 1/4/7/10, >50 %)
Grade 7, R.gross: root, gross, >50-99 % tooth damaged, incl. CEJ/root
(origin indeterminate) (grade 12)

Additionally, Schultz' lesion size scoring was summarised as follows:

Grade 1: < 3 mm (I + II)
Grade 2: > 3mm (III+IV)
Grade 3: > 50 % destroyed (V, considering all tooth positions)
Grade 4: only root left (VI, considering all tooth positions)

5.4.5.7 Enamel hypoplasia (EH)

Tooth development underlies chronological stages that include the gradual formation of crown, neck, and root and that take place in specific sequences within the different tooth forms of the deciduous as well as permanent dentition. Based on genetic, biochemical, and physical regularities of dentine (*Dentinogenesis*) and enamel (*Amelogenesis*) formation, disorders of these systemic mechanisms can be reflected in the microscopic and, eventually, macroscopic tooth morphology (Arnold 2006). Unlike dentine, enamel does not remodel as its extracellular matrix consists exclusively of mineral crystals and growing defects during formation disruptions in infancy and childhood remain in the crown, visible as deficiencies in enamel thickness. Contributing factors to dental morphological deviations are genetic and/or environmental, and developmental defects connected to formation dysfunction are mostly associated with environmental stress (Scott 2002; Suckling 1989).

One type of defect often recognized in archaeological skeletal material is called *enamel hypoplasia* (EH). Disturbances of enamel development are identified as defects in the concentric growth structure during constant incremental layering. Enamel hypoplasia appear as furrows, steps, or pits in a concentric order around the crown, and from the location and extent, time and duration of its origin can be deduced (Hillson 2008). Most commonly described is the furrow form, due to its morphology called linear enamel hypoplasia (*LEH*, Goodman and Rose 1990). The issue of diagnosing and evaluating defect distinctiveness as well as the determination of individual age of origin has intensively been discussed in palaeopathological literature of the last decades (Birch and Dean2014; Witzel *et al.* 2008). There exist intertooth and intratooth differences of enamel hypoplasia, as they occur more frequently in anterior teeth (Condon and Rose 1992; Goodman and Armelagos, 1985).

The synchronisation of enamel hypoplasia on different teeth of a dentition in sum can tell about the prevalence of stress events or periods: seasonal when repeatedly appearing, or over a longer period when defects are present on large part of the crown (*e.g.*, during winter, weaning, chronic malnutrition or disease). Therefore, EH defects must be examined with respect to the periodicity of enamel mineralization intervals, although it is suggested that size and degree of manifestation do not necessarily stay in correlation with growth disturbance (Hillson 2008; Temple 2016; Wright 1997).

In application, the chronological nature and aetiological indication of physical stress, including birth trauma, low birth weight, infections, systemic illness or malnutrition, make enamel hypoplasia a suitable condition to detect physiological burdens during the early stages in life, even when unspecific (Waldron 2008). Within populations, infants and children are especially prone to crucial changes in the environmental setting. This is particularly of interest for oral health, as the prevalence of associated conditions often correlates with advanced individual age. Investigations of EH has constantly been done throughout the examination human development, exploring early hominid fossils up to socioeconomic contexts of modern populations (Bermudez de Castro *et al.* 1999; Birch and Dean 2014). It plays an important role in bioarchaeological research, commonly used as an indicator for unspecific stress burdens and partly connected to transitional changes within prehistoric and historic populations or internal demographic processes (Boldsen 2007). For instance, studies focus on EH evidence with respect to shift in subsistence strategies (Smith *et al.* 2016), differences in socioeconomic status (King *et al.* 2005; Nakayama 2016), and collapse of societies (Wright, 1997). Other approaches include analysis of skeletal symptoms of stress and disease in order to discuss the causes of enamel malformation (Mittler *et al.* 1992).

Enamel hypoplasia recording system

Following Schultz´ recording schemes (1988), enamel defects have originally been recorded per tooth in terms of form (**pit-shaped** or **linear**), severity (**grade 1-4**), and approximate age and duration of formation (according to Szilvássy 1988; Ubelaker 1978). From this information, it was possible to calculate the affection frequency counted per tooth. Due to the circumstance that the same physiological stress might have led to contemporary dysfunctions in multiple teeth of the same individual, the age of defect origin is crucial. The recorded temporal spans of defect formation relate to the amount of tooth surface exhibiting the EH; as size, shape and development depends on the tooth category, this chronological estimation is broadly encompassed and overlaps within the different tooth categories. Additionally, **intervals on the same tooth** resulting from multiple stress events were also observed. In consequence, besides the **frequencies per tooth**, the approach of individual counting was applied in order to **identify specific age intervals** with EH as a sign for physiological stress (cf. Karsten *et al.* 2015; Lukacs 1992). Due to tooth substance loss caused by advanced dental wear, the number of teeth with diagnosed EH represents a minimum. In addition, due to the purely macroscopic examination, faint disturbances in the incremental enamel layers may not have been recognised.

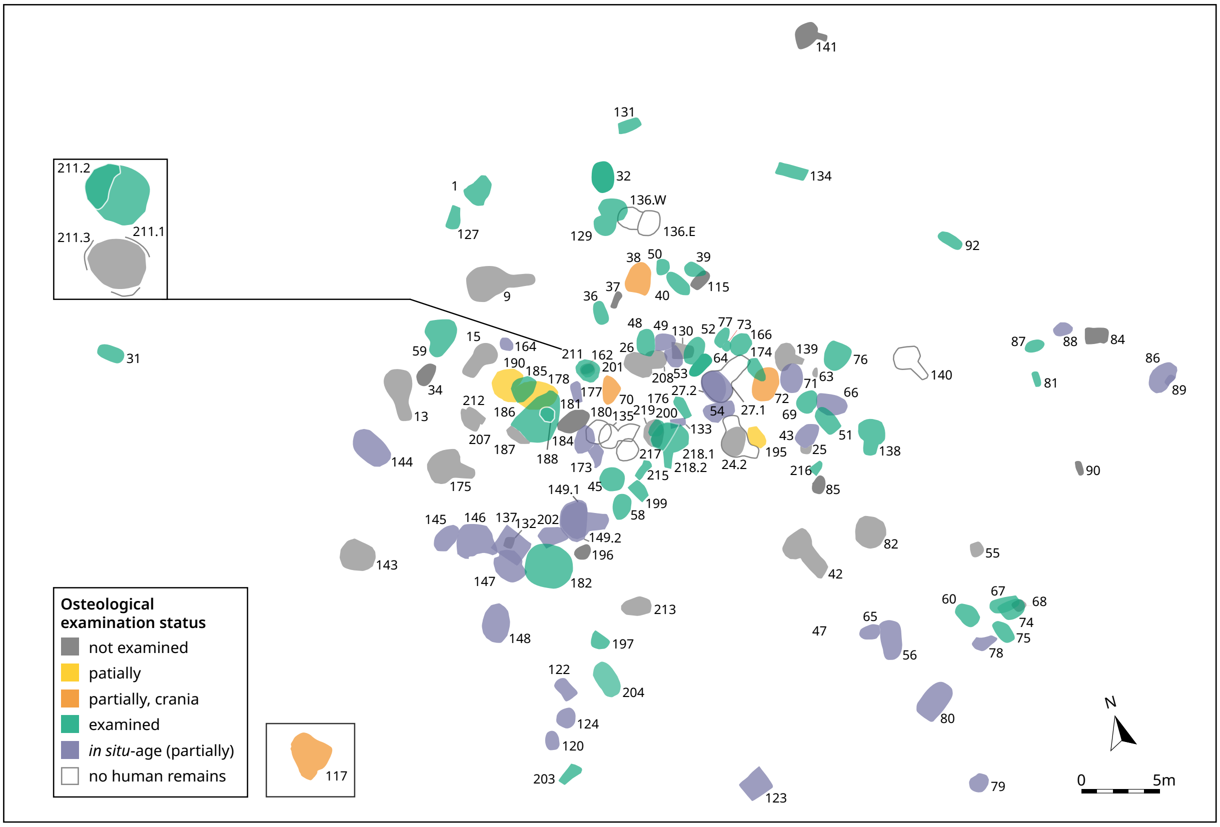


Figure 94: Analyses of human remains. Cemetery plan and status of osteological examination. "Partially" means single individuals investigated (double and collective graves), "crania" mean only remains of the skull analysed. Violet marks graves for which information about the "in situ-age" is available; often, this concerns not all individuals in the context (e.g. Grave 147, 149.1 and 149.2, 190).

5.5 Material: Graves, individuals, and dentitions

In the best-case scenario, the selection of graves and skeletal specimens considered in the osteological analyses was based on (1) stage of the preservation *in situ* and (2) burial context. Unfortunately, due to storage circumstances not all skeletal remains were available at the respective workplaces where the examination took place. Therefore, some of the skeletal specimens are of poor preservation. Single, double, and collective burials of good preservation status and with skeletal elements of unquestioning individual belonging were preferred. Later, graves with more complex *in situ*-situations were added. But, due to inconsistent labelling or missing packages, for some graves only the cranial remains were examined as these elements represent suitable indicators for MNI and oral health. In this respect, sex and age estimations from only cranial elements are of less reliability. Therefore, according individuals are in the following analyses marked with a "c" (for "cranium"). This is true for specimen from Graves 047, 070, 072 and 117.

The osteological investigations included the examination of skeletal remains from 60 of 130 graves under study (46.2 %, Fig. 94, green colour). These graves represent a cross-section of burial practice in terms of grave construction, inhumation type, as well as funeral equipment. From these **60 graves** the remains of **108 individuals (IOC)** were identified and investigated. Based on the minimum number of 265 individuals buried at the cemetery (MNIC, chapter 4), 40.8 % of the total record was examined. For an additional 90 individuals, an *in situ*-age estimation was possible, which supplements the data record regarding adult or immature age at death up to 74.7 % (Fig. 94, violet colour). For some graves with more than one individual buried, osteological and *in situ*-age as well as undeterminable estimations were combined; for instance, in Grave 038 three individuals were physically investigated

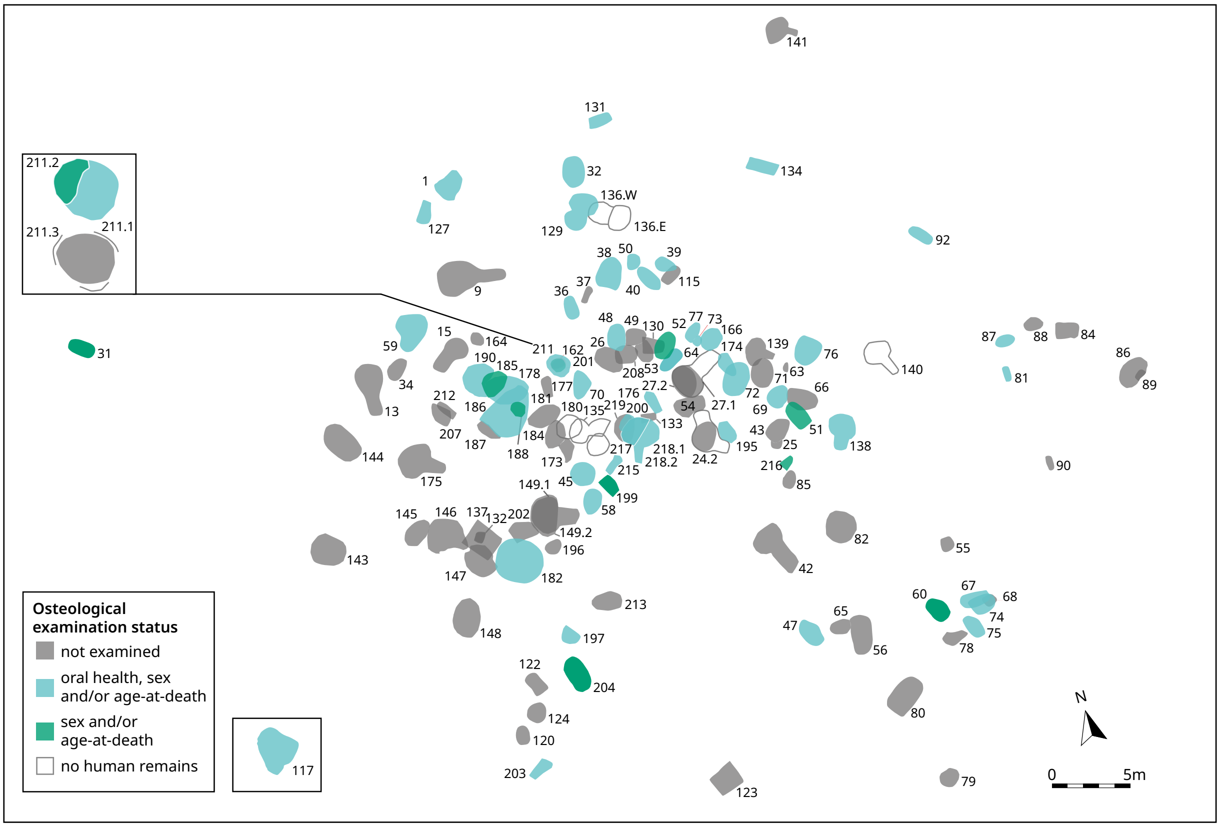


Figure 95: Analyses of human remains. Cemetery plan and status of osteological examination in terms of investigative parameters, excluding age at death on basis of the photographic documentation.

and one only by picture. Additionally, after re-articulating different skeletons, for at least one collective grave the preservation status was too poor for further analyses on individual basis (Grave 178, individuals A-C, 3). Furthermore, the number of individuals labelled on the grave sketches did not always match with the actual number resulting from the osteological analyses. This was, for instance, the case for Grave 129. Pictures and drawings indicated only two individuals and the small bones of an infant were not recognized. Another issue is individuals represented by singular bones, *e.g.* in Grave 186, whose drawings included seven, but the osteological examination counted eight individuals. In consequence, the representativeness of individuals with **osteological diagnoses per grave (IOG)** depended on the *in situ*-preservation as well as the complexity of the funeral situation. Therefore, the IOG does not automatically refer to the complete inhumation group from a burial context.

From a spatial point of view, the graves chosen for osteological analyses show a good representativeness. Only the southwestern corner of the cemetery is not well-represented (Fig. 94). Still, from photographs, some information about the individual age at death *in situ* from this area is available.

Of the 108 specimens examined, **86 individuals** (79.1 % IOC, 32.5 % MNIC) had at least one cranial element of the skull connected to the masticatory system (mandible, maxilla, temporal bone) and **85** individuals had at least one tooth. For **83** individuals both are true, whereas for some only dental (038_2, 038_3, 127_2) and others only cranial elements are preserved (047_9, 072_2, 075_2). These 83 individuals were buried in 50 graves which spread throughout the cemetery (Fig. 95; 38.5 % of the complete grave record). The preservation of maxilla, mandible, and respective dentitions is diverse, ranging from complete sets of teeth and jawbones of good condition to singular isolated, largely damaged teeth without anatomical context. In consequence, the individual significance in terms of questions related to oral health are different. This needs to be considered from the beginning, as according analyses mostly refer to the complete data set.

Figure 96: Analyses of human remains. Examples of skeletal preservation. 1-2: 100-76 %, individual 77_1, 174_2. 3: 75-51 %, individual 174_1. 4: 50-26 %, individual 076_1. 5-7: 25-0.1 %, individual 212-1, 038_2, 127_2. Without scale.

5.6 Results 1: Skeletal preservation, demography, and categories of oral health

This chapter focuses on discussing skeletal and dental preservation as a main material basis for the analysis of human remains with respect to burial as well as individual contexts. Data from sex and age at death estimations are presented with respect to distributions within the **IOC (population under study)** and **IOG (per grave context)**. Individual age at death and biological sex make an integral part of the analyses of oral health categories.

5.6.1 Data basis: Skeletal and dental preservation

The skeletal preservation is split in good (100-76%; n=35, Fig. 96.1-2) and poor (25-0.1%; n=32, Fig. 96.5-7) condition; stages in between are less frequent (n=12 and 13). For 18 of the 108 specimen, only cranial remains were analysed. Overall, the preservation status of the skeletal remains is moderate; distinct differences effect the reliability of information gained. For instance, in several instances individuals were represented by single teeth (*e.g.* 047_4, 038_2, Fig. 96.7), whereas other skeletons lacked elements of the masticatory system (*e.g.* 001_1).

There is a clear correlation between the *in situ* preservation of the funeral situation assessed on basis of documentation and the individual skeletal preservation assessed by the osteological analyses (Fig. 97). Unfavourable deviating values result from poor bone conversation occurring between excavation and osteological examination, whereas favourable deviating values (poor *in situ*, good skeletal pres-

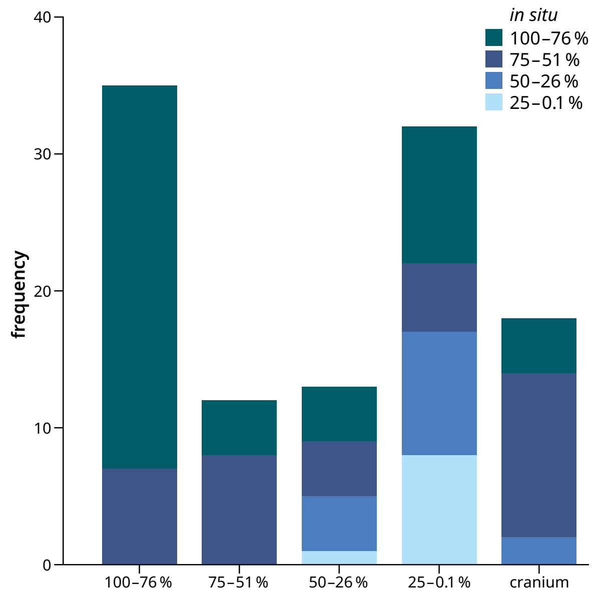
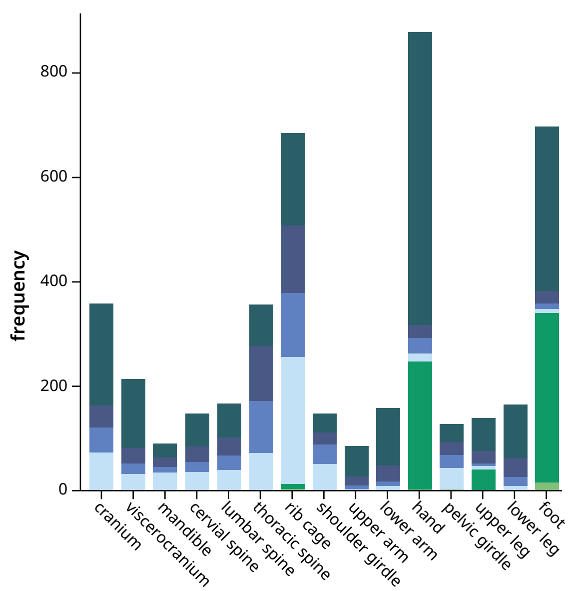


Figure 97: Analyses of human remains. in situ-preservation per grave (see section 4.1.3, 6.2.2; n=60) and skeletal preservation per individual (n=108).



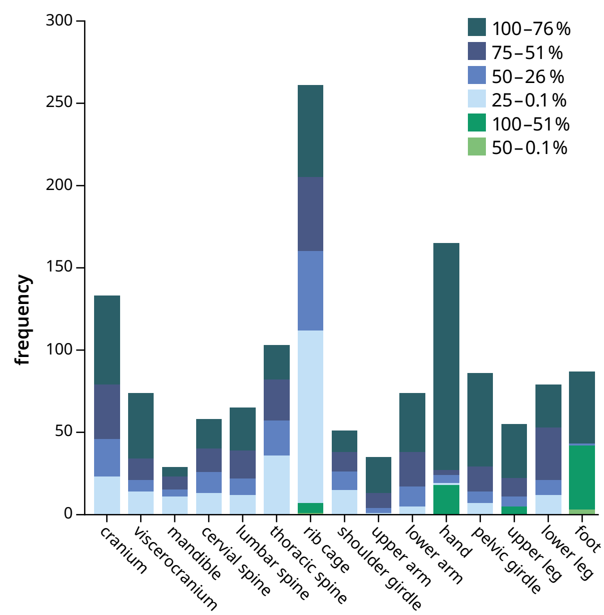


Figure 98 and 99: Analyses of human remains. Total frequencies of bone preservation per anatomical unit for mature (≥juv/young adult, n=4330, left graph) and immature individuals (≤juvenile, n=1355, right graph). Units summarise anatomical elements. Skull: cranium (parietal, occipital, frontal, sphenoid and temporal bone), viscerocranium (facial skeleton; ethmoidal, nasal, lacrimal, zygomatic and maxillary bone), mandible. Spine: Cervical vertebrae, thoracic vertebrae, lumbar vertebrae. Rib cage: Sternum, manubrium, ribs. Upper extremity: shoulder girdle (clavicle, scapula), upper and lower arm (humerus, ulna, radius), hand (carpals, metacarpals, phalanges. Lower extremity: Pelvic girdle (sacrum, pelvis), upper and lower leg (femur, patella, tibia, fibula), foot (tarsals, metatarsals, phalanges. Please consider higher proportions of skull elements due to the investigative approach.

ervation) point to better conservation than visible on the pictures or singular cases of good skeletal preservation within graves of poor *in situ*-preservation.

Due to the recording systems applied, mandibles and frontal bones are counted per left and right side (although only children show that division as unfused bones). In immature skeletons (≤juveniles), the division of the pelvic bone is counted by the singular anatomic elements (ischium, ilium, pubis), so that following distributions refer to 208 bones for mature and 210 bones for

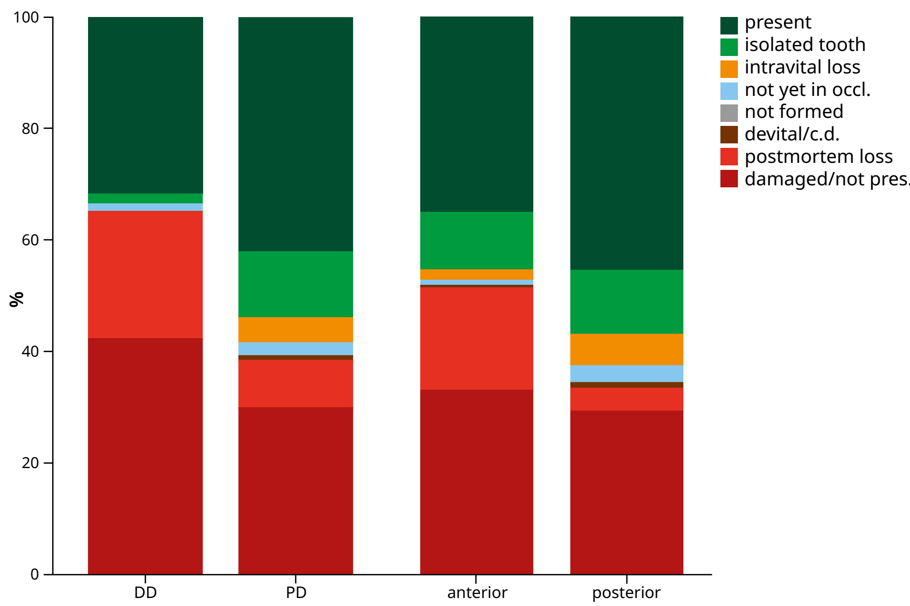


Figure 100: Analyses of human remains. Data basis of human material, dental preservation (individuals n=85; teeth n=2651). Percentages of tooth status in terms of dentition type (DD: deciduous, n=223; PD: permanent, n=2428) and anatomical section (anterior: incisors, canines; 12 per individual, n=1027; posterior: premolars, molars, 10-20 per individual, n=1592), referring to Tab. 23.

Table 23: Analyses of human remains. Data basis of dental material (individuals n=85; teeth n=2651). Total frequencies and percentages of tooth status in respect to dentition (DD deciduous, PD permanent) and anatomical section (anterior: incisors, canines; posterior: premolars, molars).

TOOTH STATUS	All (n/%)	Dentition		Anatomical section	
		DD	PD	anterior	posterior
Present	1103/41.6	72/32.3	1031/42.5	365/35.1	738/45.8
Isolated	283/11.1	2/0.9	281/11.6	105/10.1	178/11.0
Intravital loss	109/4.1	0/0	110/4.5	19/1.8	91/5.6
Not in occl.	58/2.2	3/1.3	55/2.3	10/1.0	48/3.0
Not formed	2/0.1	0/0	2/0.1	0/0	2/0.1
Devitalcrown damaged	19/0.7	0/0	19/0.8	5/0.5	14/0.9
Postmortem loss	260/9.8	52/23.3	208/8.6	192/18.5	68/4.2
Damaged/not present	816/30.8	94/42.2	722/29.7	343/33.0	473/30.8
All	**2651/100**	**223/8.4**	**2428/91.6**	**1039/39.2**	**1512/60.8**

immature individuals (Fig. 98-99). ***The osteological analyses included 5.685 bones from 105 skeletons (excluding those with only dental preservation), consisting of 32 immature and 73 mature individuals.***

Referring to 100 % skeletal preservation, meaning what to expect if all bones of every skeleton would be present, only 20.2 % (n=1355) of immature and 28.5 % (n=4330) of mature bones are actually preserved. From three individuals only dental material remained. Due to the different preservation statuses of the single bones, information quality and quantity regarding sex and age estimation as well as oral health is heterogeneous. Still, the four-levelled skeletal preservation is not equally an indicator for the reliability of sex and age at death estimations, as skeletons and bones of poor preservation may still contain significant attributes. In order to give an impression concerning the representativeness in terms of preservation, Figure 98 and 99 provide the preservation per bone classified by anatomical unit for mature (>juvenile) and immature individuals (≤juvenile) separately.

The investigations of oral health included 333 bones of the skull (71 mandibles, 138 left and right maxillary bones), 2651 tooth positions and 1463 teeth from 86 individuals in total.

Regarding the total data basis, the record counts 2651 tooth positions from 86 individuals, including the status of the alveoli (antemortem, post-mortem tooth loss, or missing according bone regions). The uneven number results from 18 immature individuals with mixed deciduous and permanent dentition (n PD=668). 54.5% % of the available positions are represented by dental material of different status (Fig. 100, Table 23), whereas for 43.8 % of the positions the dental material as well as the bony periodontal structures are preserved; 11 % of the dental material lacks according regions of the jaw. Conversely, teeth are missing for 9.7 % of the positions. For 30.8 %, neither teeth nor periodontal structures remained. The proportion of deciduous to permanent teeth is 8.5 % to 91. 5%. The primary dentition is more prone to postmortem loss and damage; in consequence, teeth and bony structures of children are less available compared to the permanent dentition. This is also true for teeth categories of the anterior section, incisors, and canines. Not fully erupted or not formed teeth are rare for both dentitions. Still, the record represents a solid database for both assessable dental material as well as corresponding alveoli.

5.6.2 Demography: Age at death and biological sex

The following subchapter includes the results of sex and age at death estimations with regard to distributions within the examined control sample taken to represent the buried population on the cemetery (IOC[20]). Additionally, compositions of individual demographic data from single burials or the same burial context, representing complete or incomplete inhumation groups (see chapter 2.6), give information about potential spatial arrangements.

5.6.2.1 Cemetery population (IOC)

The osteological estimation of age at death resulted a ratio of 34 immature (≤juvenile) to 74 mature individuals, which accounts for a ratio of 1:2.2 (Fig. 92, left columns; Tab. 23). In these proportions, the eight specimens belonging to the inaccurate stage of 17-25 years (juvenile/young adult) were included with the mature individuals. In consequence, 31.5 % of the individuals died while of adolescent age and the majority passed away after having reached adulthood or advanced age.

Within the immature age classes the ratios of infant, young children, old children and juveniles is almost balanced, supplemented by four children between 4-12 years. Most mature individuals died within the ages of 17-35 (51.1 %), but the difference with the proportion deceased at older ages is not large (≥35 years 39.2 %). Here the morphological attributes of 2 specimen indicating an advanced age over 50 years represent the rarest age class. The preservation of 7 specimen was too poor for more accurate estimation than age class adult++. With 28.7 % (+7.3 %) and 24.5 %, the proportions of individuals who died in younger stages of maturity is slightly higher than those who died in older. In terms of age at death estimation, poor skeletal preservation often led to use of the broader age classes “child” and “adult++”. In terms of the *in situ*-age of 90 skeletons examined (Fig. 94, blueish colour, and Fig. 101), the generated results supplement the **osteological data with 19 subadults (21.1%) and 71 adults (78.9 %).** This estimation is inaccurate in terms of transitional age stages from juveniles to young adults and certainly lacks identifications of small infant bones; nevertheless, it still reflects the predominance of individuals that died after having survived through adolescence.

20 Individuals with osteological examinations per cemetery.

Figure 101: Analyses of human remains. Examples of in situ age estimation of subadults from different burial contexts. 1 Grave 088, deciduous dentition and immature facial skeleton of individual 088_1. 2-4 Grave 177, 145 and 146, unfused diaphysis and epiphyses of the lower extremities of individual 117_1, 145_1, 146_146_10.

With respect to the summation of gained results from both approaches, the **total ratio of 67 subadults to 137 adults is 1:2.2**, matching that distribution observed solely osteologically. Regarding the MNIC data record of 265 individuals, 23 % died during adolescence or childhood and 51.7 % after reaching physical maturity; age at death was indeterminable for 25.3[21] % of the MNIC.

Prevalent **sexual dimorphism**[22] of the 74 mature individuals resulted in estimations of five morphological classifications ranging between certain female to certain male constitutions (Fig. 104, right column). With **24 skeletons (32.4 %) of female** or female > male to **37 skeletons (50 %) of male** or male > female features, males are more frequent in the data set. Only 11.1 % expressed indeterminate physical morphology; the dominance of males in the record is thus likely valid. The fewer numbers of "M>F" compared to "F>M" point to stronger pronounced morphological features of males, although the database is not sufficiently large to make definitive statements in this respect.

A consideration of skeletal preservation reveals that specimen of male/likely male morphology are in better condition and were therefore easier to evaluate. In general, the probability of making clearly "male" or "female" estimation correlated with good preservation. Still, those individuals whose skull was the only skeletal element examined, a body part with less significant sexual traits, show equal ratios of likely male, likely female or indeterminate characteristics.

Combining results of age at death and biological sex for mature individuals (Fig. 103, Tab. 24), it becomes clear that skeletons of female/likely female constitution

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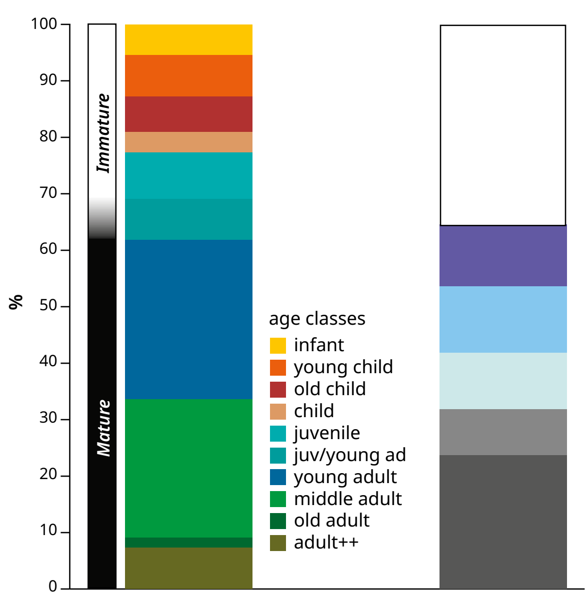
21 67 individuals.

22 Results of this investigation would gain more significance by considering the evaluation of each morphological attribute in terms of manifestation and diagnostic weight.

AGE CLASS	All (n/%)	Biological sex					
		F	F>M	F=M	M>F	M	n. d.
Infant	6/5.6	0/0	0/0	0/0	0/0	0/0	6/15.4
Young child	8/7.4	0/0	0/0	0/0	0/0	0/0	8/20.5
Old child	7/6.5	0/0	0/0	0/0	0/0	0/0	7/17.9
Child	4/3.7	0/0	0/0	0/0	0/0	0/0	4/10.3
Juvenile	9/8.3	0/0	0/0	0/0	0/0	0/0	9/23.1
Juv/young ad	8/7.4	1/8.3	3/27.3	0/0	1/11.1	0/0	1/2.6
Young adult	30/27.7.8	7/58.3	8/72.7	2/16.7	3/33.3	8/32.0	0/0
Middle adult	27/25.0	4/33.3	0/0	3/25.0	4/44.4	15/60.0	0/0
Old adult	2/1.8	0/0	0/0	4/33.3	0/0	2/8.0	0/0
Adult++	7/6.5	0/0	1/8.3	3/25.0	1/11.1	0/0	3/7.7
All	**108/100**	**12/11.1**	**11/10.9**	**12/11.1**	**9/8.3**	**26/24.1**	**39/36.1**

Table 24: Analyses of human remains. Results of age at death (age class) and biological sex estimation of the complete data set (IOC, n individuals=108, n graves=60). For clarification of age classes see Figure 93.



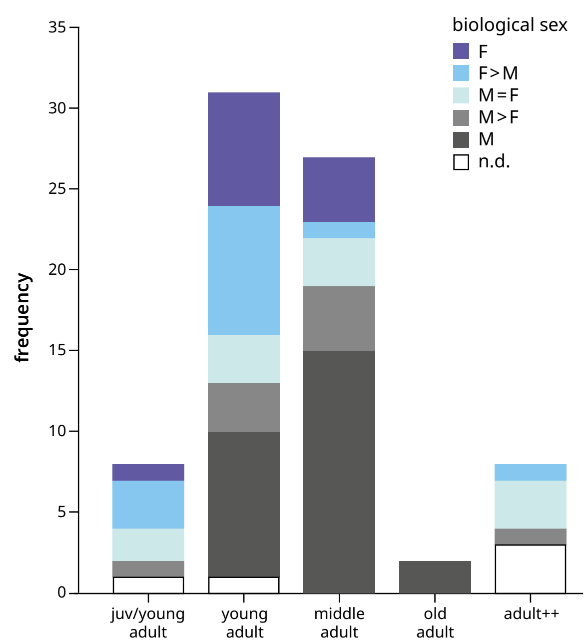


Figure 102 (left): Analyses of human remains. Determinations of biological sex and age at death (age class) estimations per individual (n=110) with regards to the complete data set (IOC, n graves=60) in percent. For clarification of age classes see Figure 93.

Figure 103 (right): Analyses of human remains. Total frequencies of biological sex of mature individuals by age class (n=76).

more often showed attributes of younger age (*ca.* 17-35 years; 19 female to 12 male) and conversely skeletons with male morphologies attributes of older age classes (≥35 years; 4 female to 21 males). Thus, skeletons with signs of advanced age showed predominantly male attributes. These considerations allow the following conclusions

- Physical characteristics advanced age age at death estimations positively correlate with morphological features of males.
- Females of the studied population more often died at younger ages than males, who on average lived longer.
- The lower life expectancies of females suggest females had higher mortality risks in young adulthood, males in later adulthood.

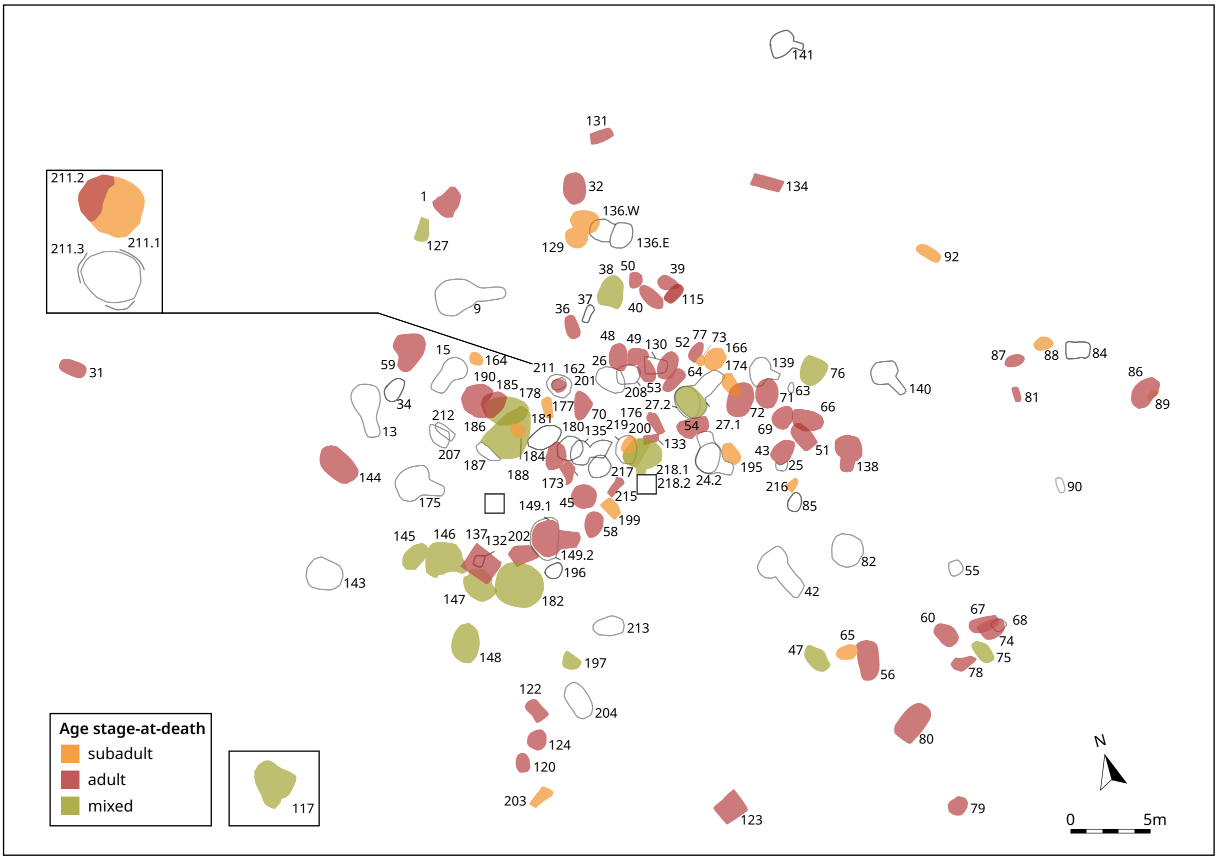


Figure 104: Analyses of human remains. Spatial distribution of age at death stages per grave referring to osteological as well as documentary estimation (n individuals=198). Subadult includes immature individuals (IOC, ≤juvenile), adult includes mature (IOC, ≥juv/young adult).

The distributions of age at death and biological sex again reveal the skeletal series to be a cross-section of the population with regards to age classes and prevalent sexual dimorphism. The application of established age classes allows assignments to different stages of life history, and the physical constitutions prove the presence both sexes in the population under study. In different words, the individuals found at Kudachurt 14 represent a data set lacking a relevant bias in demographic composition.

5.6.2.2 Graves: Inhumation groups and spatial distribution (IOG)

Examining basic demographic parameters with respect to grave context allows statements concerning the age at death and biological sex distribution in terms of two main aspects: (1) the compilation in burials with more than one individual, providing information about which part of the population was interred directly together, and (2) spatial patterning, enabling the investigation of whether the location of graves was determined by a physical trait of the person buried (Fig. 104 and 105). Although it was intended to perform the analyses of burial practice and human remains independently from each other, this approach requires referral to the burial type at this point.

The distribution of individual age at death by grave reveals that no regularities exist in terms of spatial patterning as well as mutual inhumations of different age classes. Including the documentary evaluation of *in situ*-age, Figure 104 depicts the simplified division of individuals into the age stages adult and subadult, as well as mixed for double and collective burials (n individuals=198). According to the cemetery plan, the age of an individual did not determine the location of the grave, as there is no spatial separation of adult and subadult individuals.

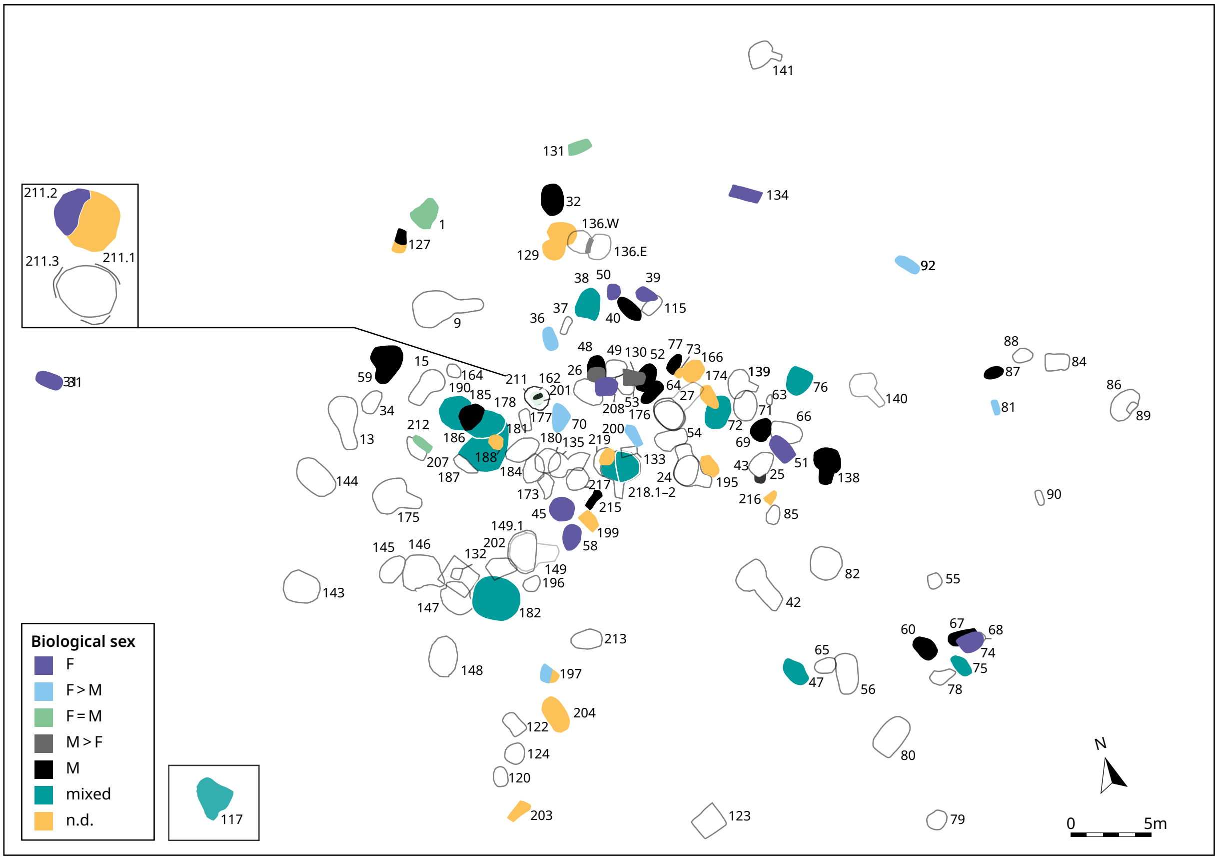


Figure 105: Analyses of human remains. Spatial distribution of determined sexual dimorphism (n individuals=108, n graves=60).

In some cases, these age stages were separated in single, double, and collective burials[23]. In others, adults and subadults of different age classes had been buried together: for instance, Grave 047 with one infant and one old child, three juv/young adults, two young adults and two adults++, or Grave 186 with one young and old child, four young adults as well as two middle adults. Single burials contained individuals from the complete age class spectrum, from infant to old adult.

Similar observations are true for the distribution of biological sex for mature individuals (n=76). The locations of burials (n=50) of individuals with male/likely male and female/likely female constitution do not reflect any spatial patterning (Fig. 105). Individual funerals of males (*e.g.* Grave 077, 064) or females (*e.g.* Grave 051, 050, 039), as well as interments of both sexes in collective burials (*e.g.* Grave 047 or 218.2) exist.

In consequence, the combination of both parameters indicates that the inhumation of males, females, and adolescents of different age classes took place in a diverse manner. Individuals of different ages and biological sex received singular as well as mutual funeral events. The compilation of males, females, and adolescents in the same graves has a collective character, suggesting social and/or kinship relations[24].

23 Burials exclusively of subadults: *e.g.* double burials 195/juvenile and subadult, 211.2/young child, juvenile; collective burials 129/infant, old child, juvenile. Burials of adults exclusively: double burials 032/young and middle adult, 048/juv/young adult and middle adult.

24 For instance, Grave 076/infant, male and likely male adult of young and middle age, as well as an individual of likely female constitution of young adult age, or Grave 047/infant, old child, two young adult females, one young male and further adults of unknown age and sex.

5.6.3 Categories of oral health

The following sections contain the results of the analyses of seven categories of oral health: the presence of calculus, periodontal disease, periapical lesions, antemortem tooth loss, dental wear, caries, and enamel hypoplasia. The results are presented per tooth position and according anatomical characteristics as well as per specimen. The distributions in terms of biological sex and age at death (age class) are also discussed. For recoding strategies, calculation, and procedures of specific descriptive parameters see chapter 2.6.

5.6.3.1 Dental calculus

From the total record of 1386 teeth assessable (52.3 %) from 85 skeletal specimen, 1118 revealed calculus accumulation on the surfaces (81.2 %), and 21 were not determinable in this regard. The remaining 249 teeth showed no deposits recognizable by magnifying glass, either because of no affection or no preservation.

For teeth of the permanent dentition 82.7 % and for deciduous dentition 42.6 % were affected. In total, there is no difference in terms of siding or upper and lower permanent teeth (Tab. 25), and a slightly higher prevalence in posterior over anterior teeth (include 3 and 5 tooth positions respectively). However, regarding the grade of calculus deposition in terms of the single tooth positions, it becomes clear that in fact there is a difference in the distributions; in maxillary teeth, the cheek teeth show more calculus remains in terms of both frequency and severity, for both dentitions (Fig. 106). Mandibular teeth revealed little as well as moderate plaque mineralisation and the molars were less affected. In general, the extent of calculus deposition is low; grade 2 and 3 make in sum only 9 % of the total record. On deciduous teeth the frequency and extent are even smaller. With respect to tooth anatomy, the majority of crowns are affected (supragingival calculus, n=710; 63.4 %; Fig. 109.1), followed by traces covering parts of the crown and the neck region (14.4 %; Fig. 109.2). For 249 teeth, calculus was deposited around the neck or in the apical area, which would suggest supragingival mineralization with advanced alveolar and gingival resorption or supragingival type, including increased CEJ-AC distance (Fig. 109.4-5). Accumulations were found on 2.492 locations, most frequently on the buccal side (29.2 %; Fig. 109.1-2). Other locations are almost equally affected between 22.8 % and 23.8 %; per tooth, calculus is preserved on different surfaces, partly only on one (16 %, *e.g.* only buccal) up to all vertical surfaces (9.3 %), and in 14 cases, calculus remained on the occlusal surface (Fig. 109.4).

Most teeth under study show slight traces of calculus deposition, mainly around the crown and neck regions, reflecting the typical distribution expected with the anatomic relation of maxillary and mandibular salivary glands. Due to less time of oral exposure, rates for deciduous teeth are lower compared to permanent teeth. Few exceptions of more calculus deposition per tooth in terms of surface affected and amount of mineralized plaque exist, predominantly in the maxillary molars, which is also evident for teeth of the deciduous dentition. Occlusal calculus deposition results from lacking removal by mastication (abrasion).

Frequency and intensity per individual

The calculus prevalence for the 85 individuals under study is 94.1 %. It is distributed within all age classes and shows a positive correlation to advanced age in both frequency and intensity, although it seems stronger in terms of intensity as predominantly individuals of middle to old adult age contained the few cases with higher grades (Fig 106-107). This partially confirms the general nature of the lesion increasing gradually during life if not removed but is not true for all specimen. There seems to be little correlation of calculus frequency and biological sex;

CALCULUS PREVALENCE per tooth		Calculus present			*No calculus*		
		All (n/%)	DD	PD	*All (n/%)*	*DD*	*PD*
Anatomy	**maxillary**	534/47.8	18/56.3	516/47.5	*131/52.6*	*26/60.7*	*105/51.0*
	mandibular	584/52.2	14/43.8	570/52.4	*118/47.4*	*17/39.3*	*101/49.0*
Side	**right**	566/51.3	20/62.5	546/50.2	*120/48.2*	*26/60.7*	*94/45.6*
	left	552/48.7	12/37.5	540/49.8	*129/51.8*	*17/39.3*	*112/54.4*
Section	**anterior**	376/33.6	6/18.8	370/34.1	*88/35.3*	*21/48.3*	*67/32.5*
	posterior	742/66.4	26/81.3	716/65.9	*161/64.7*	*22/50.7*	*139/675*
All		1118/100	32/2.9	1086/97.1	*249/100*	*43/17.2*	*206/82.7*

Table 25: Analyses of human remains and oral health. Results of calculus prevalence per tooth (n=1388, n individuals=80).

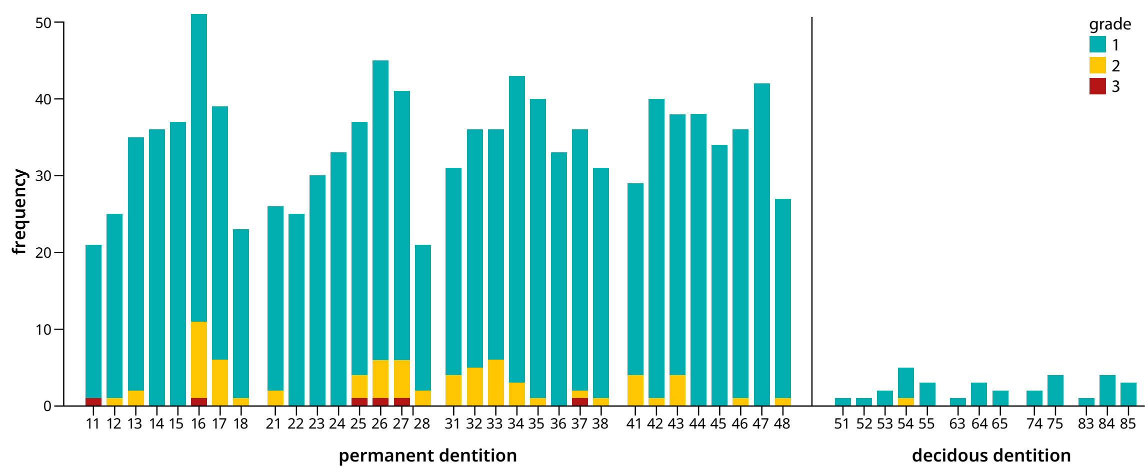


Figure 106: Analyses of human remains and oral health. Distributions of tooth positions with calculus deposition in severity grades for permanent (n teeth=1086) and deciduous dentition (n=32; see Table 25).

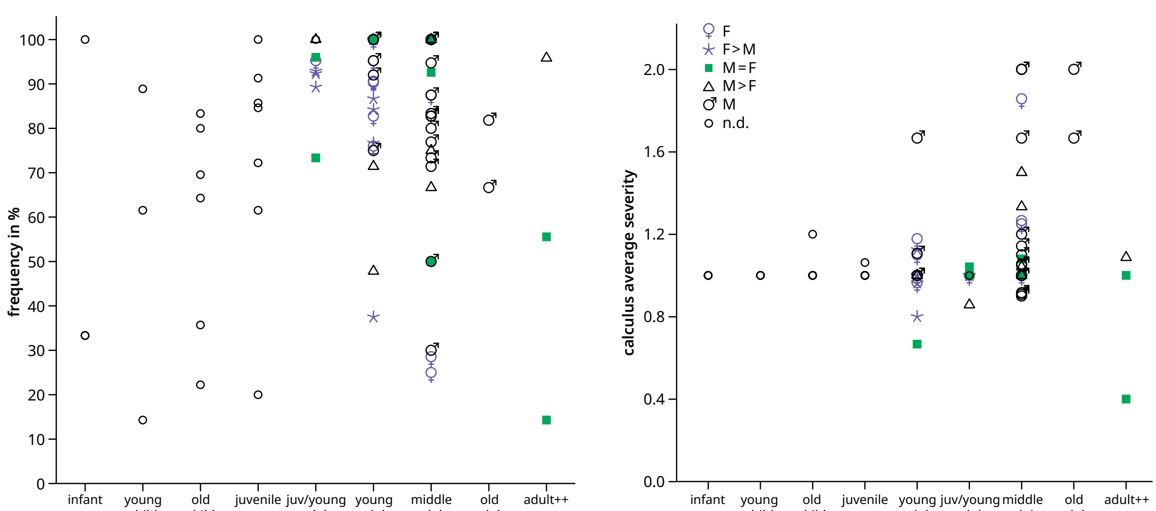


Figure 107 and 108: Analyses of human remains and oral health. Qualitative distributions of calculus prevalence per individual, age class, and biological sex (n=80). Calculus frequency (% of teeth affected) and intensity (average severity grade per in affected teeth).

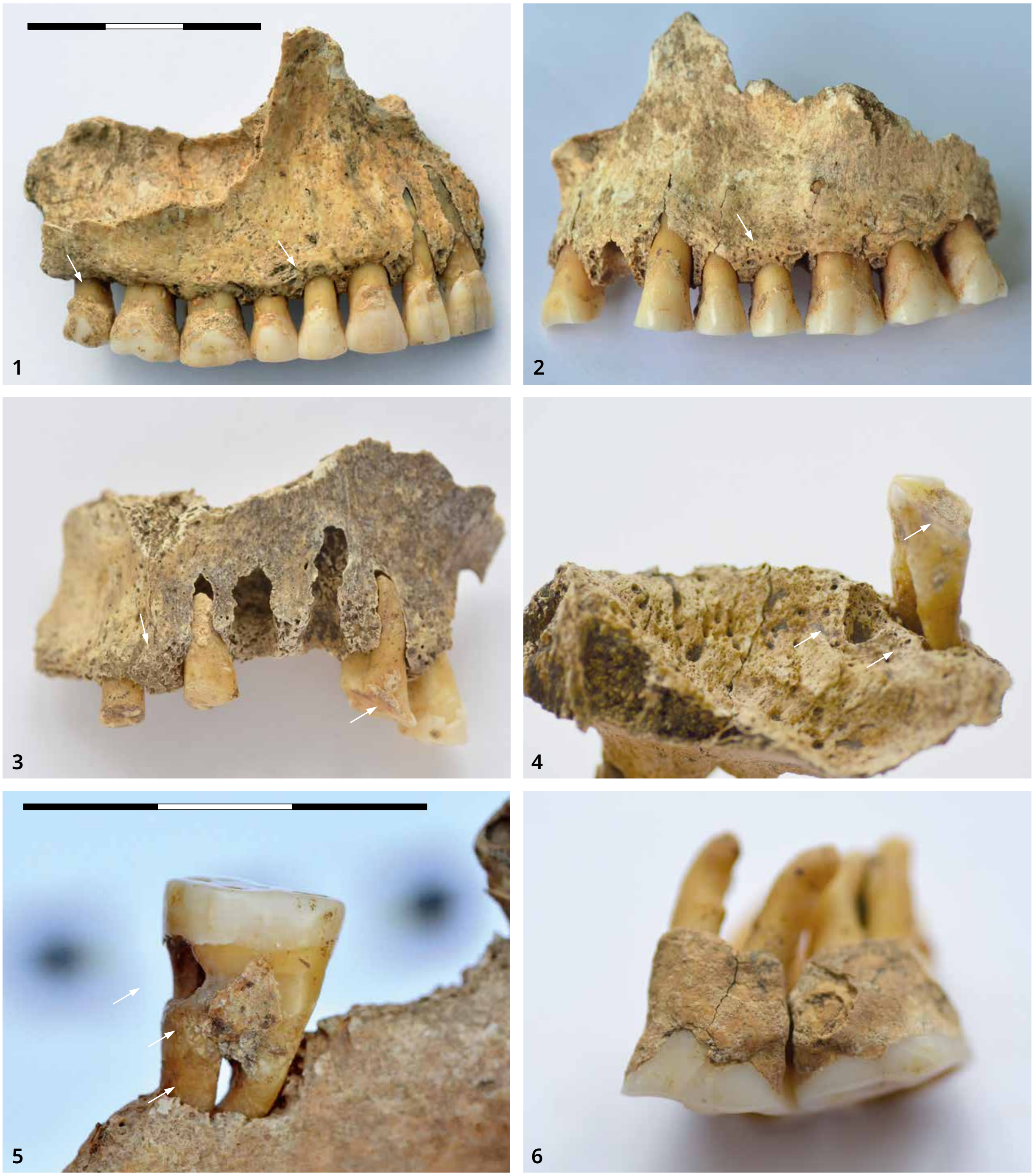


Figure 109: Analyses of human remains and oral health. Examples for calculus prevalence and periodontal lesions (calculus severity grades/periodontal severity grades/additional conditions). 1: Ind. 038_1, right maxilla lateral v., adult++, M>W; 11-18, c. grade 1/p. grade 1-2. 2: Ind. 047_6, left maxilla, lateral v., young adult, M; 21-28, c. grade 1/p. grade 1-2/21-23 dental wear with pulp exposure and smooth edges (11, 21). 3: Ind. 040_1, left maxilla, lateral v., middle adult, M; 21-27, c. grade 1/p. grade 2-3/distinct alveolar atrophy anterior and posterior positions/21-22 apical lesions (1-2)/21-26 heavy asymmetric dental wear with pulp exposure. 4: Ind. 138_1, left maxilla, superior up, medial v., old adult, M; 27 c. grade 1 on occlusal surface/21-28 p. grade 2-3/advanced alveolar atrophy and bone remodelling/27 asymmetric dental wear with pulp exposure. 5: Ind. 127_1, left mandible, medial v., middle adult, M; 37 c. grade 3, deposited in apical bifurcation by external pressure/p. grade 2/37 CEJ caries grade 2 with pulp exposure/37 polished surface lingual/25-26 AMTL completely closed. 6: Ind. 077_1, molars 26-27 buccal v., middle adult, M; c. grade 2, covering crown and neck.

females show slightly lower values compared to males (in average 81.8 % to 82.8 % of the dentition affected). As the ratio of young females compared to older males is imbalanced, individual age might have been a driving factor. Something similar can be assumed for prevalence intensity (Fig. 108). Grade 3 of calculus accumulation was recognized for middle and old adults of both sexes, but grade 2 was more frequent in males. The presented values do not suggest strong differences within the sexes. In general, the results of minimal calculus prevalence point to a constant, rather mild to moderate dental condition present within the majority of studied individuals of all ages, from infancy to old age, with the supragingival type as the most frequent form on the tooth crowns and neck region. Only few exceptions exist (*e.g.* Ind. 127_1, 077_1; Fig. 109.5-6.). The data so far suggest low alkali milieu during lifetime, with few gradual calculus depositions. Other possible reasons of the relative calculus absence could be the removal of calculus due to hygienic treatment or strong and constant abrasion.

5.6.3.2 Periodontal disease

In sum, 1272 alveoli from 78 individuals were assessed in terms of periodontal disease (including statuses: present, postmortem loss, devital/crown damaged). From these 78 individuals, 13 immatures under the age of 12 were excluded and 13 alveoli from the third molar of juveniles (156 sockets), as the porous alveolar crest during dentition change complicates the distinction of pathological and growing alveolar remodelling on a macroscopic level. Additionally, 84 alveoli have been excluded due to poor preservation. As a result, 1175 positions from 65 individuals make up the total data basis (44.3 % of total positions, 76.4 % of individuals), 83.8 % with teeth or at least apical remains preserved.

Changes on the alveolar crest associated with periodontitis have been found for 1041 of the alveoli assessed (88.6 %), and there is no significant difference in terms of anatomical location (Tab. 26). However, 65.8 % of these positions show mild stages of porosity and remodelling (severity grade 1, Fig. 109.1-2, 110).

Pathological changes of grade 2 are more frequent (32.5 %) compared to the advanced grade 3 (1.7%). There is no distinct difference in terms of tooth position related to the total distributions, but the few severe cases are predominantly premolars or molars (Fig. 109.3-4, 110). In summary, the majority of alveoli assessed from the permanent dentition reveal mild to moderate signs of periodontitis.

Frequency and intensity per individual

In terms of disease intensity, only few individuals showed low average values between 0.3-0.5 (n=4). Most of the specimen had mild to moderate (average intensity 0.8 -1.5; n=41; Fig. 109.1-2), and 20 individuals severe signs of periodontitis (Fig. 109.3-4, 110 and 111). Advanced alveolar remodelling and atrophy are primarily associated with multiple prevalence of grade 2 in the same specimen, representing stronger local inflammatory responses in primarily posterior teeth.

The individual age relates to periodontitis intensity (Fig. 111). Individuals who died at juvenile to young adult ages show average intensity grades below 1.5. Exceptions are three young adult individuals with average grades between 1.76 and 2.0, whereas the high value of specimen 047_7 is based on only two preserved sockets, both molars (47 and 48). The remaining group of 17 individuals showing increased values above 1.7 predominantly belongs to the middle adult age class; within this group, severe cases of periodontitis have been identified in nine individuals, often in multiple affection (039_1, 040_1, 138_2, 186_7) of the posterior positions. With respect to biological sex, distributions of average intensity show higher average values for males compared to females (Fig. 112). Six of the nine individuals with

Table 26: Analyses of human remains and oral health. Results of periodontitis per tooth position (n=112, n individuals=77).

PERIODONTITS per tooth position		All (n/%)	PI status PD	
			Affected	*n. Affected*
Anatomy	maxillary	563/47.9	525/50.4	*38/28.4*
	mandibular	612/52.1	516/49.6	*96/71.6*
Side	right	579/49.2	510/49.0	*69/51.5*
	left	596/50.8	531/51.0	*65/48.5*
Section	anterior	453/38.6	339/38.8	*54/40.3*
	posterior	722/61.4	642/61.6	*80/59.7*
All		**1175/100**	**1041/88.6**	***134/11.4***

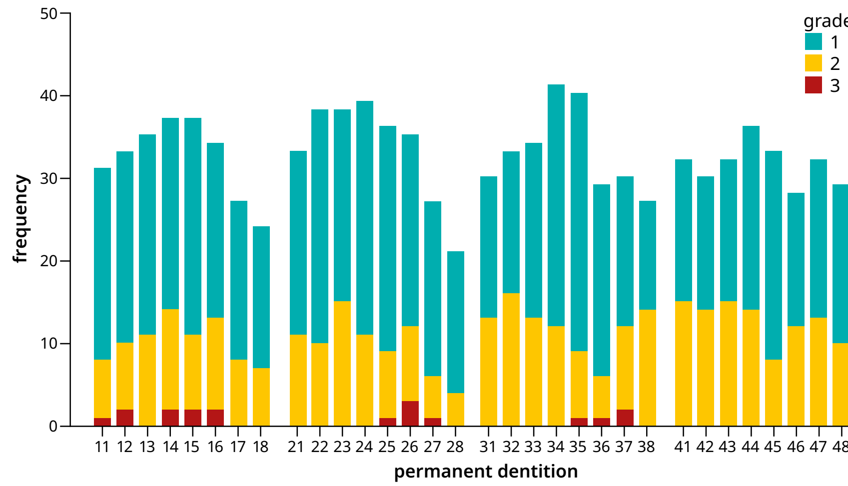


Figure 110: Analyses of human remains and oral health. Distributions of tooth positions with alveolar changes due to periodontitis (permanent dentition, n=1041, individuals=65).

severe periodontitis are of male constitution; but like the prevalence of calculus, this again might be an effect of females dying more frequently in younger age.

Observed correlation of age and periodontal disease matches with the state of the art, as dental plaque as a primary causative factor increasingly accumulates during adulthood (see section 5.4.5.2). The comparison of average calculus and periodontitis intensity with respect to age at death supports this, although it is not mutually dependent. Mild and moderate grades of both conditions are more frequent for individuals who died before the age of 35 years; only a part of individuals with high values of periodontitis intensity also showed increased calculus deposition (064_1, 031_1, 186_7, 138_1, 218.2_1, Fig. 109). This might be due to two reasons: continuous tooth eruption leading to increased CEJ-AC distance in older age or significant post-mortem loss of calculus substance.

5.6.3.4 Periapical lesions

The analyses of periapical lesions included all alveoli of good preservation except those of completely healed antemortem tooth loss status (n=65). As comprehensive radiographic methods were not possible and complete healing is not determinable, the counted number of lesions represent a minimum record.

In total, 28 individuals showed 99 lesions in the apical alveolar areas, making up 35 % of the individuals (n=80) and 6.9 % of the tooth positions (n=1427; Tab. 27). Sockets of deciduous teeth were not affected. Maxillary positions have slightly higher rates (57.6 %). In total, there is no significant difference between the siding

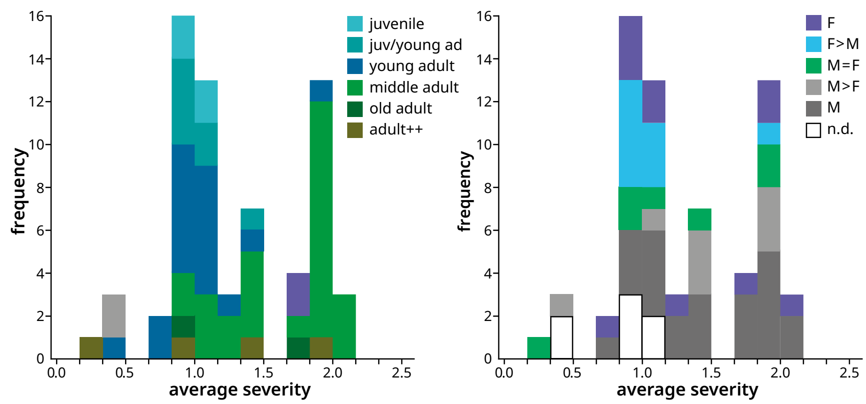


Figure 111 and 112: Analyses of human remains and oral health. Distribution of average periodontitis intensity per individual, age class and biological sex (n=65).

and lower and upper teeth; nevertheless, when looking at the single tooth positions, maxillary periapical lesions were identified for incisors and canines, but mandibular lesions are more frequent in posterior teeth.

In terms of classification and severity, lesions likely to be due to periapical granulomas (<3mm, no fistula) are rare (8 %) compared to cavities probably caused by cysts (3-5 mm, no fistula), which make 44.4 % of the total. Increased alveolar opening (>5mm) or smaller lesions with fistula towards the buccal (40.4 %, Fig. 114.1-6), multiple directions (3 %), or the maxillary sinus (1 %, Fig. 126) representing distinct signs of acute or chronic abscesses make up 43.6 % of the total (see Fig. 113 for total numbers, Fig. 114 for examples). The number of advanced cavity sizes as remains of larger abscesses are low; most frequent are lesions between 3-5 mm (36.4 %). Considering the different characters of these periapical lesions, half of the processes were likely granulomas or cysts without painful and systemic consequences. Almost half of the other lesions point to severe inflammation of the apex region as a primary response to highly virulent pulp infection or secondary process developed from a granuloma or a cyst. In 17 cases, the tooth was lost intravital and the alveolar bone partly remodelled, still revealing the periapical cavity (Fig. 114.5-6). This indicates advanced damage of periodontal supporting structures, although the differentiation of the three forms might not be reliable for grade 1 and 2 of these cases due to the healing process (1 granuloma, 11 cysts). Fistulae or the interiors of abscess cavity areas often show active bone remodelling, recognizable as porous bone or formations of woven bone, which point to ongoing local pathological processes up until the time of death (Fig. 114.1.3.5, Fig. 116.4).

Frequency and intensity per individual

Affected individuals often suffered from multiple lesions of different forms and sizes, which complicates conclusions about the tendencies of lesion intensity (Fig. 115.4-5, 119). The simultaneous occurrence of multiple advanced alveolar response indicates high disease burden for these individuals one the one hand and on the other points to exceptional conditions of their oral environment in terms of causative factors for pulp infections (caries, dental wear; at least individual 050_1, 032_1, 087_1; Fig. 115, Tab. 28), which requires clarifying comparison. Additionally, as abscesses could cause lethal distribution of infection in the vascular system, observed processes probably represented life-threating illness, yet were survived by several individuals for a certain an amount of time. The prevalence of granulomas, cysts, and abscesses in the same individuals suggest gradual development of periapical lesions from primary to secondary infection or different inflammatory processes; here further analytical methods are needed to verify the differential diagnosis of these three types.

Regarding the complete population under study, periapical lesions seem to be significant for a certain group of adult age, including males and females.

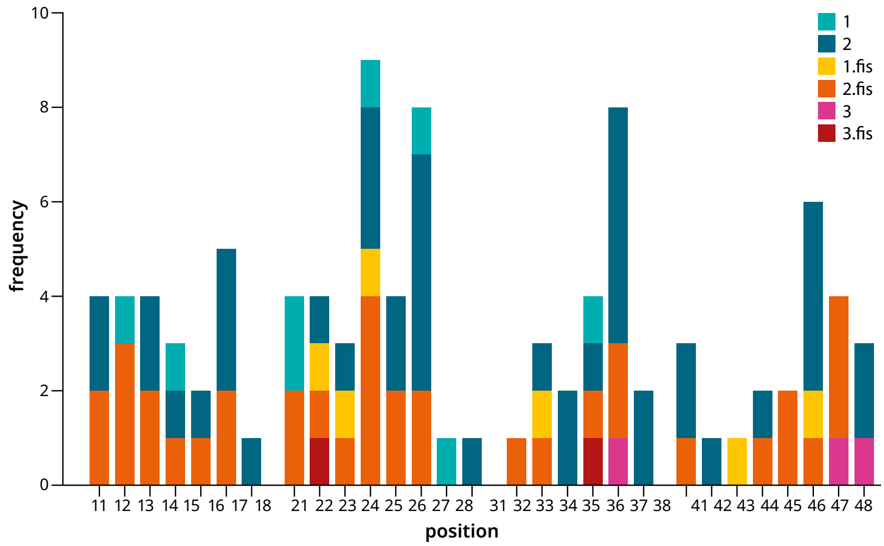


Figure 113: Analyses of human remains and oral health. Periapical lesions per tooth position and severity grade (fis=fistula). Lesions of grade 1 probably granuloma and grade 2 cyst. Lesions of grade 3 or with fistula indicate acute or chronic abscesses

PERIAPICAL LESIONS per tooth positon		All (n/%)	Periapical lesions (PD)	No periapical lesions
Anatomy	**maxillary**	666/46.7	56/56.6	*610/45.9*
	mandibular	761/53.3	43/43.4	*718/54.1*
Side	**right**	708/49.6	47/47.5	*661/49.8*
	left	719/50.4	52/52.5	*667/50.2*
Section	**anterior**	568/39.8	29/29.3	*539/40.6*
	posterior	859/60.2	70/70.7	*789/59.4*
All		1427/100	99/6.9	*1328/93.1*

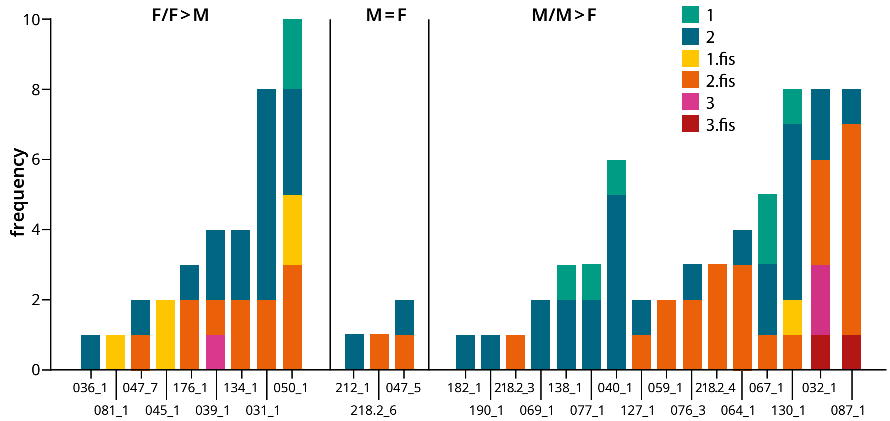
Table 27: Analyses of human remains and oral health. Results of periapical lesions per tooth position, anatomy, and dentition (n=1427, n individuals=80).

PERICAPICAL LESIONS per individual		All (n/%)	Frequency (n/%)		*no lesions (n/%)*
			n ind /les	average/SD	
Age class	**young adult**	20/38.5	6/12	14.2/14.0	*14/26.9*
	middle adult	26/50.0	18/79	28.2/22.3	*8/15.4*
	old adult	2/3.8	2/5	32.9/24.1	*0/0*
	adult++	4/7.7	2/3	16.1/12.6	*2/3.8*
Biological sex	**F**	11/21.2	5/28	48.2/33.8	*2/4.5*
	F>M	9/17.3	4/7	16.9/16.9	*4/9.1*
	M=F	7/13.5	4/7	16.4/9.6	*4/9.1*
	M>F	7/13.5	3/10	18.43/15.5	*5/11.4*
	M	23/44.2	12/47	21.9/12.2	*9/20.5*
All		52/100	28/53.8	24.7/20.5	*24/46.2*

Table 28: Analyses of human remains and oral health. Results of periapical lesions in young to old adult age classes (n=52).

Figure 114: Analyses of human remains and oral health. Examples of periapical lesions and other dental conditions (periapical lesion/other dental conditions), all buccal view. 1 Ind. 077_1, left maxilla, 21-24, middle adult, M; 24 small abscess with fistula (1.fis) and porous bone formation to the time of death/asymmetric dental wear with pulp exposure/periodontitis grade 2. 2 Ind. 218.2_4, left mandible, 31-38, middle adult, M; 36 abscess with drainage (2.fis)/31-32, 36 heavy dental wear with pulp exposure and concave, smooth edges (36)/periodontitis grade 1-2. 3 Ind. 067_1, right maxilla, 11-18, middle adult, M; 16 abscess with fistula (2.fis) and porous bone formation to the time of death/16 heavy dental wear with pulp exposure/periodontitis 11-15 grade 1, 16-18 grade 2. 4 Ind. 134_1, right mandible, 43-48, young adult, F; 46 and 47 with open abscess cavity (2.fis) and porous bone formation to the time of death/46 asymmetric heavy dental wear with pulp exposure/periodontitis grade 1-2. 5 Ind. 032_1, left maxilla, 21-25, middle adult, M; 22 large open abscess with fistula (3.fis) and porous bone formation to the time of death. 24 abscess with fistula (2.fis)/23-25 heavy (occlusal) dental wear with pulp exposure/periodontitis grade 2. 6 Ind. 176_1, right mandible, 31-35, young adult, F>M; 33-34 opened abscess (2.fis) and porous bone formation to the time of death; potential healed trauma of the mandibular corpus.

Figure 115: Analyses of human remains and oral health. Periapical lesions per affected individual, biological sex, and severity grade (fis=fistula; n=28). Lesions of grade 1 probably granuloma and grade 2 cyst. Lesions of grade 3 or with fistula indicate acute or chronic abscesses.



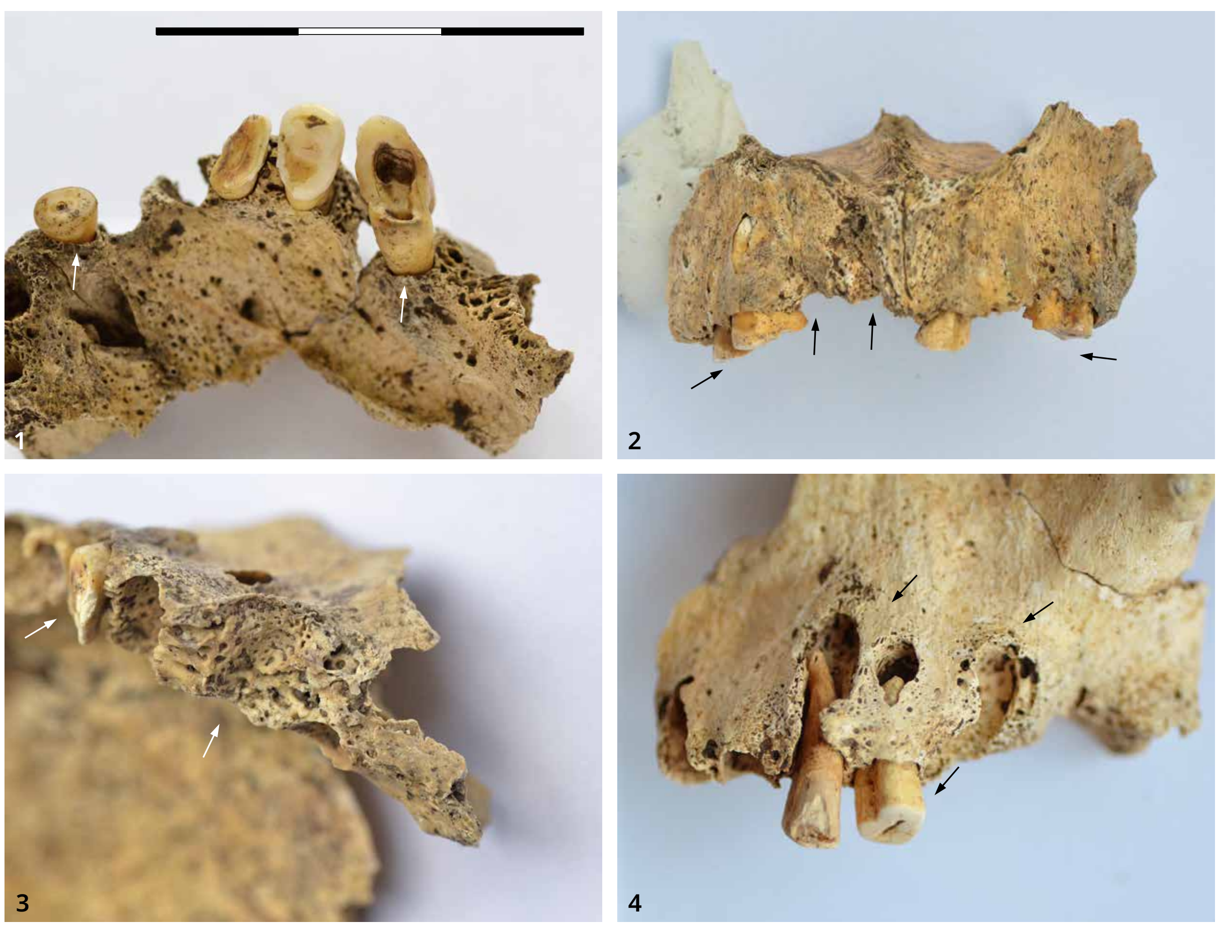


Figure 116: Analyses of human remains and oral health. Examples of periapical lesions, ATML, and other dental conditions (periapical lesion/AMTL status/ other dental conditions). 1: Ind. 040_1, left maxilla, 21-26, palatinal v., middle adult, M; 21-22, 26 abscess (1-2, not visible), 27 completely healed/26 occlusal caries grade 2/periodontitis grade 2-3/21, 24, 27 heavy (asymmetrical) dental wear with pulp exposure and smooth edges (11)/21 tooth dislocation. 2: Ind. 039_1, right and left maxilla anterior v., 11-15, 21-25, middle adult, M; 11 abscess/12 completely healed/periodontitis grade 2-3/ heavy (occlusal) dental wear with pulp exposure. 3: Ind. 039_1, left maxilla, 24-26, distal-palatinal v.; 26 abscess (2.fis) with visible alveolar remodelling processes/periodontitis grade 2-3/24 heavy occlusal dental wear with pulp exposure. 4: Ind. 87_1, left maxilla buccal v., 21-26; 23-25 abscesses (2.fis) and porous bone formation to the time of death/25 PPTL, 26 partly closed/periodontitis grade 2-3/23-24 heavy (occlusal) dental wear with pulp exposure.

5.6.3.4 Antemortem and perimortem tooth loss

Analyses of antemortem tooth loss (AMTL) included 1182 tooth position from 60 individuals older than juvenile age. As described in section 5.4.5.3, potential perimortem tooth loss (PPTL) is also considered.

Almost half of the studied individuals (43.3 %) in total lost 110 teeth during life (9.3 %), independently from masticatory system side, but significantly more frequent in the lower tooth positions (80.9 %, Tab. 29). Loss of the posterior teeth, especially the molars, occurred most frequent. Considering the healing progress in two stages, the majority of the teeth were lost at least 29 weeks before the time of death (59.1 %), and 45 positions showed different phases of alveolar closing (Fig. 116, 119). In contrast, 31 positions with advanced periapical lesions indicating potential perimortem tooth loss were more frequently upper and anterior teeth, especially the incisors. Regarding the total distribution in terms of singular tooth positions (Fig. 117), the considerably higher numbers of lower molars in order of their occlusal exposure is obvious for both early stage of healing and fully closed alveoli. The differences within anterior and posterior positions in terms of documented and potential tooth loss lead to two assumptions. (1) Posterior teeth were more prone to antemortem tooth loss, which would be supported by slightly higher caries and periapical lesion rates as potential causative factors. (2) Severe inflammatory processes in anterior apical areas pointing to perimortem tooth loss suggest that this stage in general is underestimated; still, available data capture rather long TSL periods before death.

AMTL and PPTL per individual

The number of teeth lost during life among the 28 individuals differ from only one tooth to 13 teeth (ind. 138_1, 218.2_1; with PPTL up to 15 teeth, ind. 050_1, Fig. 118). In cases of multiple intravital tooth loss, multiple healing stages were visible in the same individual, reflecting different times of tooth loss before death; thus, the period the individual survived since then (Fig. 119.1-2.4-6).

Antemortem tooth loss is used as an indicator for advanced adult age; correlations of AMTL and PPTL to age classes might represent circular reasoning for individuals estimated by the cranial elements exclusively, but additional parameter such as dental wear and the obliteration of cranial sutures are corrective in this regard. Nevertheless, ATML was found in five of 20 young adult individuals, all affecting the first or second lower molar (Fig. 119.3). Within the older age classes, the number of lost teeth increases, especially with respect to simultaneously occurring PPTL (middle adult 30.8 %/34.6 %, n=26; old adult 100%, n=2). In terms of biological sex, AMTL is less frequent in individuals of female constitution (35 %, n all=20) compared to males (48.4 %, n all=31), but the unequal age distribution potentially influences this result. Both male and female individuals show high frequencies of ATML and PPTML with respect to their complete dentition, up to maximally 81.3 % (218.2_1, Fig. 123.6). In females, the incidence of potential perimortem tooth loss due to severe periapical lesions increased (Fig. 117). This could mean that these women, which died on average at a younger age, were more prone to the lethal character of those inflammatory processes or to the generally increased disease burden. In contrast, males more likely survived the circumstances that led to intravital tooth loss and show on average longer TSL periods until death.

In general, AMTL and PPTL represent a significant lesion for almost half of the adult individuals, and multiple affections certainly had an effect on mastication abilities (for instance individual 138_1, 040_1 and 218.1 (Fig. 117, Fig. 119.2.5-6), all males, or the women buried in grave 050). Additionally, these high individual rates indicate a certain degree of robusticity, as they were often survived and completely healed, especially for males. Nevertheless, the actual number of PPTL is certainly underestimated. On the other hand, the causative factors for ATML apparently were continuous during life and

AMTL per tooth positon		All (n/%)	AMTL	PPTL	No AMTL
Anatomy	**maxillary**	539/45.6	21/19.1	*19/61.13*	*499/47.8*
	mandibular	644/54.4	89/80.9	*12/38.7*	*544/52.2*
Side	**right**	580/49.0	54/49.1	*15/48.4*	*511/49.0*
	left	603/51.0	56/50.9	*16/51.6*	*532/51.0*
Section	**anterior**	435/36.8	19/17.3	*14/45.2*	*402/38.5*
	posterior	748/53.2	91/82.7	*17/54.8*	*641/61.5*
Category	**incisor**	290/24.5	15/13.6	*12/38.7*	*263/25.2*
	canine	145/12.3	4/3.6	*2/6.5*	*139/13.3*
	premolar	310/26.2	16/14.6	*12/38.7*	*282/27.0*
	molar	438/37.0	75/68.2	*5/16.1*	*359/34.4*
All		1183/100	110/9.3	*31/2.6*	*1043/88.1*

Table 29: Analyses of human remains and oral health. Results of AMTL and potential perimortem tooth loss (PPTL) per position, anatomy, section, and category from adult individuals (n positions=1183, n individuals=60).

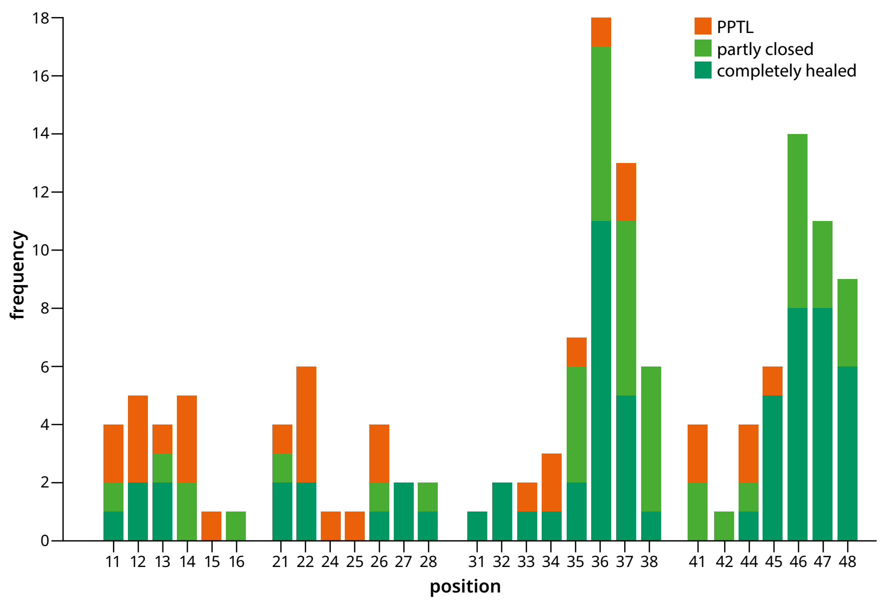


Figure 117: Analyses of human remains and oral health. Distributions of AMTL and potential perimortem tooth loss (PPTL) healing stages per position (n=141, n individuals=28). PPTL: no tooth present, periapical abscess of stage 2-3.fis; partly closed TSL>14 weeks; completely closed TSL>29 weeks.

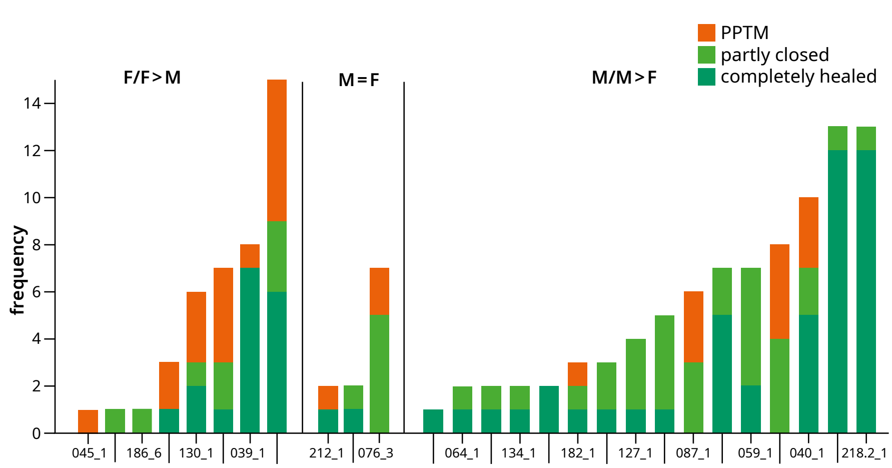


Figure 118: Analyses of human remains and oral health. Distributions of AMTL and potential perimortem tooth loss (PPTL) healing stages per individual with respect to biological sex (n=27). PPTL: no tooth present, periapical abscess of stage 2-3.fis; partly closed TSL>14 weeks; completely healed TSL>29 weeks.

Figure 119: Analyses of human remains and oral health. Examples for PPTL, AMTL, and other dental conditions (healing stages/other dental conditions). 1: Ind. 087_1, maxilla, right buccal-anterior v., 11-26, middle adult, M; 16 partly closed, 14-15 PPTL/14-15 abscesses (2.fis)/periodontitis grade 2-3/13 heavy dental wear. 2: Ind. 138_1, left maxilla, palatinal v., 21-28, old adult, M; 21-22, 26, 28 completely healed/periodontitis grade 3. 3: Ind. 218.2_4, right mandible buccal v., 43-48, middle adult, M; 46 completely healed/45 gross root, 47-48 CEJ caries lesion/47 abscess (2.fis)/periodontitis grade 2. 4: Ind. 127_1, left mandible buccal v., 31-38, middle adult, M; 32 completely healed, 35, 36, 38 partly closed/37 tooth dislocation, CEJ caries, abscess (2)/periodontitis grade 2/34 heavy dental wear. 5: Ind. 040_1, mandible, right buccal v., 41-48, middle adult, M; 45 partly closed, 46-48 completely healed/advanced loss of mandibular corpus height. 6: Ind. 218.2_1, mandible occlusal v., 31-38, 41-48, middle adult, M>F; 31-37, 45-48 completely healed.

started in early adulthood, accompanied by the typical decrease of mandibular and maxillary height due to jaw atrophy and dislocation of singular teeth caused by lacking pressure of neighbouring teeth (Fig. 119.4-5).

5.6.3.5 Dental wear: Masticatory and extramasticatory traits

The analyses of different aspects of dental wear involved 1187 teeth from 69 individuals with full permanent dentition (≥juvenile age class), and the results are compared to those of 117 teeth from 13 individuals with deciduous or mixed dentitions. This separation was made in order to consider the different exposure times of the dentition and to possibly discover non-masticatory use of teeth already in childhood. Indeterminable tooth surfaces and those that were in the process of erupting at the time of death were excluded from analyses.

Occlusal wear

The data set of permanent teeth represents all of Hillson's established stages of dental wear (1996), ranging from hardly visible ablation of the crown cusp enamel (grade 1) until severe substance loss of crown enamel and dentine as well as root dentine (grade 7-8). Most common are mild to moderate dental wear stages affecting mainly the crown enamel and dentine (19.7 %/n=5 24.9, Tab. 29). Occlusal wear of different grades is evenly present in both sides, but there is a distinct difference in terms of upper and lower teeth for the highest grades 7 and 8, which seem to be significantly more frequent in maxillary teeth. In contrast, lower teeth more often show grades 4-6. Additionally, there is a trend in terms of tooth type and function, comprehensive within both section and category. Taking into account the ratio of anterior to posterior teeth (12/20), except grade 7, higher degrees of dental wear almost continuously increase in anterior positions but decrease in posterior ones. Looking at the tooth category, this trend is caused by on average higher values of both incisors and canines (Tab. 30). The boxplots in Fig. 120 illustrate this misbalance of wear grades in maxillary and mandibular positions as well as in terms of the functional tooth category.

Considering the nature of dental wear, most recorded abrasion patterns affected the occlusal surfaces only; here early stages of beginning enamel until predominantly dentine loss is observable (oCE-oCD 88.5%). This goes along with the wear stages 1-5 and is true for all tooth positions (Fig. 121). Distinct deviating asymmetric abrasion patterns were found on crowns, but more frequently also include neck and root regions, which points to different degrees of inclination of eroding mechanism, apart from being masticatory or non-masticatory, or dislocation of the respective tooth (12.2%). In this respect, such kind of asymmetric wear patterns (asyOD-asyNRD) are significant for maxillary teeth independent from the body side.

Upper incisors, canines and premolars are almost equally affected, in contrast to molars. These distributions are especially remarkable when considering the lower numbers of anterior teeth represented (due to ATML or postmortem loss). The few cases of heavy occlusal wear without predominance of any oral direction (oNRD) occur mainly in the upper first four positions. In contrast, remains of roots with roundish or distinct smoothly abraded occlusal surfaces, observed in 28 teeth (2.4 %), were not exclusively found in upper anterior teeth, but also in lower posterior teeth (3 premolars, 3 molars; Fig. 121).

Based on these interim results, three aspects shall be noted here: (1) Apart from the chronological interrelation of time of occlusal exposure, tooth use and abrasion, which available data confirm by representing different stages of wear and tooth substance loss, the distributions within the functional tooth types are striking. Anterior teeth, whose primary function is to split up food in chewable size, show higher wear stages than molars, whose primary function is mastication.

OCCLUSAL WEAR per tooth positon		All (n/%)	Stages according to Hillson (1996)							
			1	2	3	4	5	6	7	8
Anatomy	maxillary	578/48.7	51/51.5	107/45.7	36/52.9	77/41.6	131/44.3	59/44.0	85/65.4	31/79.5
	mandibular	606/51.3	49/48.5	127/54.3	32/47.1	108/58.4	165/55.7	75/56.0	45/34.6	8/20.5
Side	right	586/49.4	49/48.5	110/47.0	37/54.4	94/50.8	141/47.6	70/52.2	66/50.8	10/48.7
	left	601/50.6	52/51.5	124/53.3	31/45.6	91/49.2	155/52.4	64/47.8	64/49.2	20/51.3
Section	anterior	397/33.4	10/9.9	60/25.6	14/20.6	68/36.8	124/41.9	63/47.0	38/29.2	20/51.3
	posterior	790/66.6	91/90.1	174/79.4	54/79.4	117/63.2	172/58.1	71/52.0	91/70.8	19/48.7
Category	incisor	241/20.3	3/3.0	28/12.0	6/8.8	46/24.9	88/29.7	42/31.3	15/11.5	13/33.3
	canine	156/13.1	7/6.9	32/13.7	8/11.8	22/11.9	36/12.2	21/15.7	23/17.7	7/17.9
	premolar	338/28.5	38/37.6	68/29.1	17/25.0	48/25.9	79/26.7	25/18.7	53/40.8	10/25.6
	molar	452/38.1	53/52.5	106/45.3	37/54.4	69/37.3	93/31.4	46/34.3	39/30.0	9/23.1
All		1187/100	101/8.5	234/19.7	68/5.7	185/15.6	296/24.9	134/11.3	130/11.0	39/3.3

Table 30: Analyses of human remains and oral health. Results of occlusal dental wear stages of teeth from fully permanent dentitions (n=1187, n individuals=69).

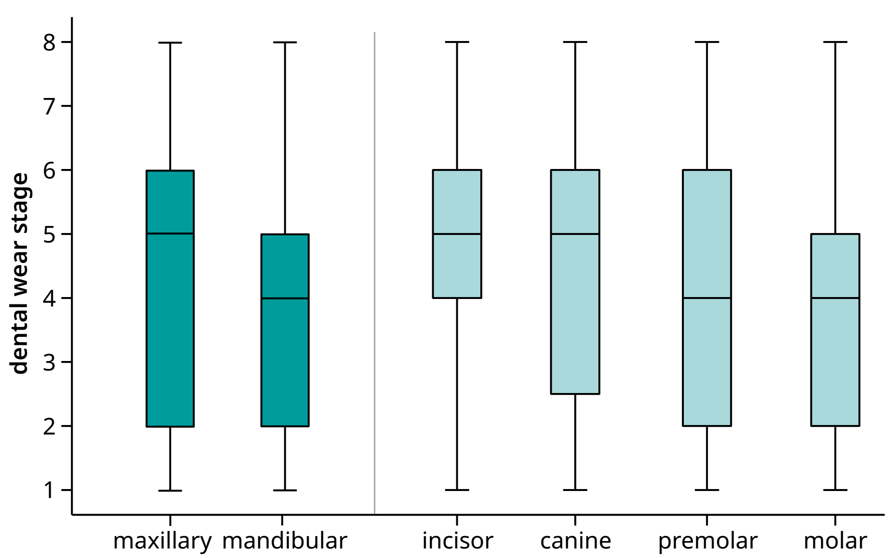


Figure 120: Analyses of human remains and oral health. Boxplots considering dental wear stages in terms of anatomy and tooth functional category (n=1187, n individuals=69).

Considering this, the described patterns of dental wear are potentially not only due to the mastication of food. (2) The unequal distribution of upper and lower wear patterns supports this assumption, as usually during mastication maxillary and mandibular teeth contact (exceptions are jaw and tooth dislocations). (3) By considering the nature of occlusal abrasion, different kinds of forces might have led to asymmetry in predominantly upper teeth and heavy wear with rounded occlusal surfaces of root remains.

The wear patterns of deciduous teeth (n=67) are limited to the crown areas, mostly the cusp enamel (84.4 %), and distinct asymmetry was found for one tooth only. This is also demonstrated by frequent wear stages 1-4 (83.6 %); extensive opening of enamel with dentine exposure is rare. In terms of tooth position, the few higher values are found on all functional categories and in upper as well as lower teeth.

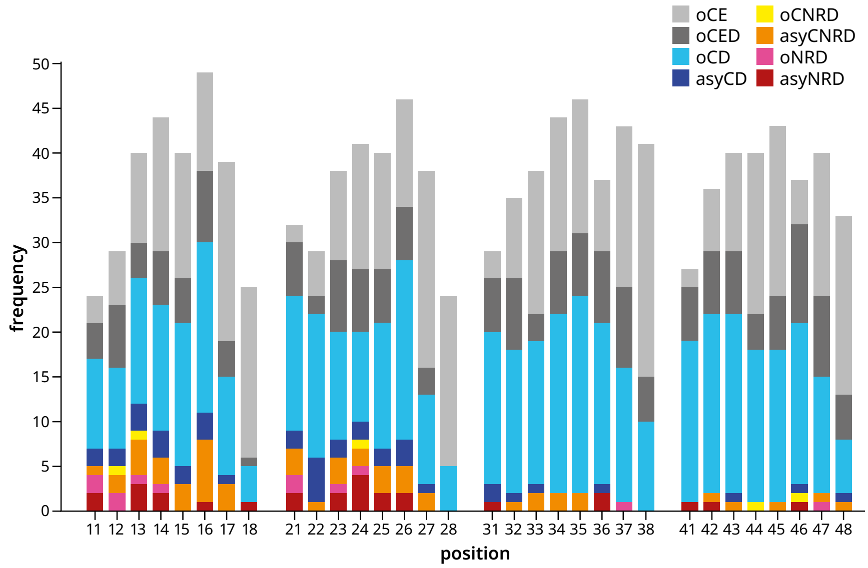


Figure 121: Analyses of human remains and oral health. Nature of occlusal dental wear occurring on teeth of the full permanent dentition (n=1187, n individuals=69). Abbreviations: o=occlusal, asy=mesial/distal/buccal/lingual, C=crown, N=neck, R=root, E=enamel, D=dentine.

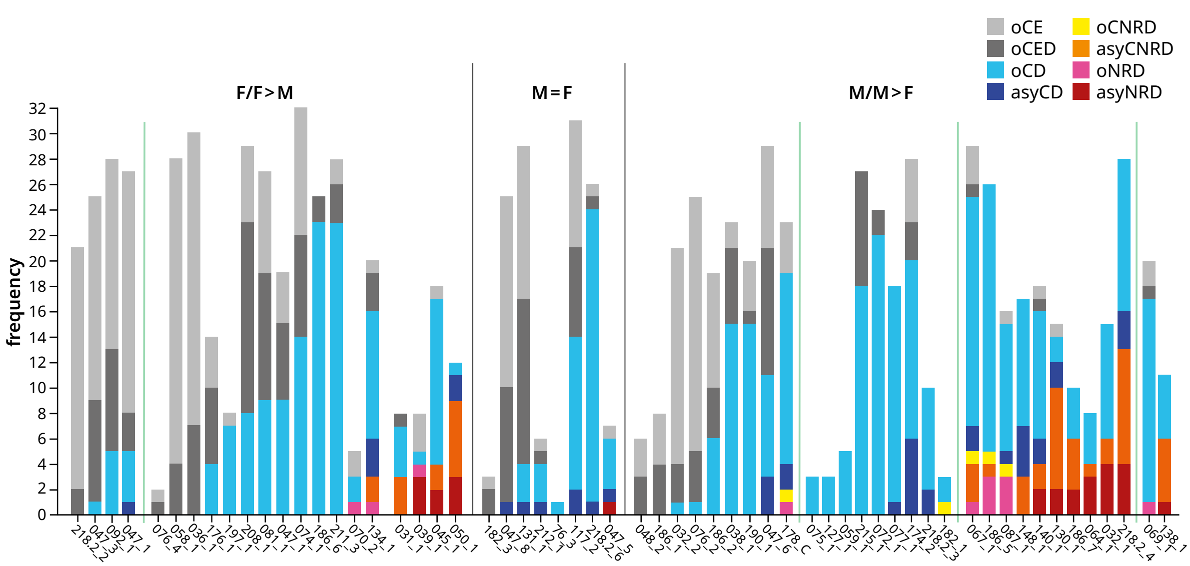


Figure 122: Analyses of human remains and oral health. Nature of occlusal wear per tooth (n=1187) and individual older than juvenile age (n=63) considering biological sex and age class (females juv.young/young/middle adult, males young/middle/old adult).

Accordingly, the observations made for the permanent dentition are not true for the deciduous dentition. The considerably shorter time of use as well as the change in consumed food from a milk-based to solid diet might play a role here. However, non-masticatory induced occlusal wear cannot be excluded. In order to specify and verify these assumptions, differences of wear patterns per individual dentition are crucial.

Occlusal macrowear per individual

Occlusal wear is a condition that naturally occurs by using the teeth during the lifetime of an individual, predominantly by mastication. Ablation of tooth tissue visible to the naked eye is present for all individuals with dental preservation (n=85), but in different severity and nature. In order to specify the results gained from the analyses based on each tooth, the following calculations consider only individuals older than juvenile age (n=63). Therefore, comparisons of wear patterns are easily manageable. Figure 122 shows the distributions of the different natures of occlusal wear found per skeleton; black lines separate the results according to the estimation of biological sex, and the green lines separate the age classes in chronological order. This graph additionally provides information about the number of included teeth per individual. Expectedly, there is a positive correlation of increasing dental wear and advanced individual age, as in many cases abrasion patterns represents at least one indicator for age estimation. Additionally, the wide range of chronological age in years per age class (17-25/20-35/35-50/50+) is reflected in different wear patterns within the age classes, pointing to the fact that individuals of the same age class did not necessarily die at the same chronological age.

For instance, the dentition of young adults of male or likely male constitution (048_2-178_C) show increasing tooth wear from crown enamels with beginning opening of the dentine areas up to full abrasion of the cusp reliefs. This is true within the age classes, but with some specifications for single individuals. Furthermore, the variety of occlusal wear nature in the same individuals could reflect both the different times of tooth exposure in the masticatory system as well as specific wear patterns not exclusively caused by mastication. Due to the aforementioned interdependency of dental wear and age estimation, it is obvious that severe abrasion (CNRD/NRD[25]), of the teeth occurred more frequently in the older age classes, and there seem to be no significant differences between the sexes. The impression given by Figure 122, that males had higher rates of stronger dental wear, must be seen in relation to the differences in average age at death between the sexes.

As Figure 122 gives no information about wear patterns with respect to the tooth position, it is necessary to take a descriptive look at some individuals specifically. Individuals of female constitution dentitions exhibit severe asymmetric wear (134_1-050_1) often, but not exclusively, in the upper anterior teeth (Fig. 138.4, 136.2-3). A suitable example for selective abrasion is individual 134_1 where the upper anterior teeth and the premolars are more worn down compared to the lower ones. In the mandible, the first right and the second left molar are especially affected, 37 almost symmetrically until the tooth root, and 47 asymmetrically towards the buccal side. Additionally, 36 and 47 was lost antemortem (Fig. 119. 2.4). This wear pattern points to a more locally induced abrasion, not to be expected by mastication only. The tooth crowns of the incisors of individual 045_2 are completely eroded, and the neighbouring teeth are in similar condition, but other teeth are distinctively less affected. The pattern of individual 050_1 (Fig. 134.4) is similar, but shows in general more substance loss and several teeth with smooth and concavely shaped occlusal surfaces (13, 13, 21, 24, 16, 17; In contrast, teeth of individual 039_1 show both severe asymmetric wear in the upper and lower sections (Fig. 116.2-3). Apart from individual 070_2 and 134_1, the origin of selective abrasion and beginning of asymmetric wear patterns per tooth as well as in respect to the complete dentition cannot clearly be identified in the younger age class. Gradual, equal abrasion of all occlusal surfaces was predominant and sometimes the wear stages were higher in anterior than posterior teeth (*e.g.* 092_1, 081_1, 186_6).

The observations made for individuals of male or likely male constitution are different. In general, there are several individuals with exceptional wear patterns. Examples are the individuals 064_1, who revealed severe asymmetrically worn down teeth of gradually decreasing values from mesial to distal and smooth, almost polished rims, and similarly specimen 040_1 (Fig. 109.3, 116.1). Additionally, the progress from symmetric or asymmetric moderate to heavy dental wear can be observed within different individuals, from affecting the CNR-regions until full erosion of the tooth crown. For instance, individual 186_5, showed strong occlusal abrasion of the upper anterior teeth, but usual wear patterns in the remaining

25 Crown/neck/root dentine affected; neck/root dentine affected.

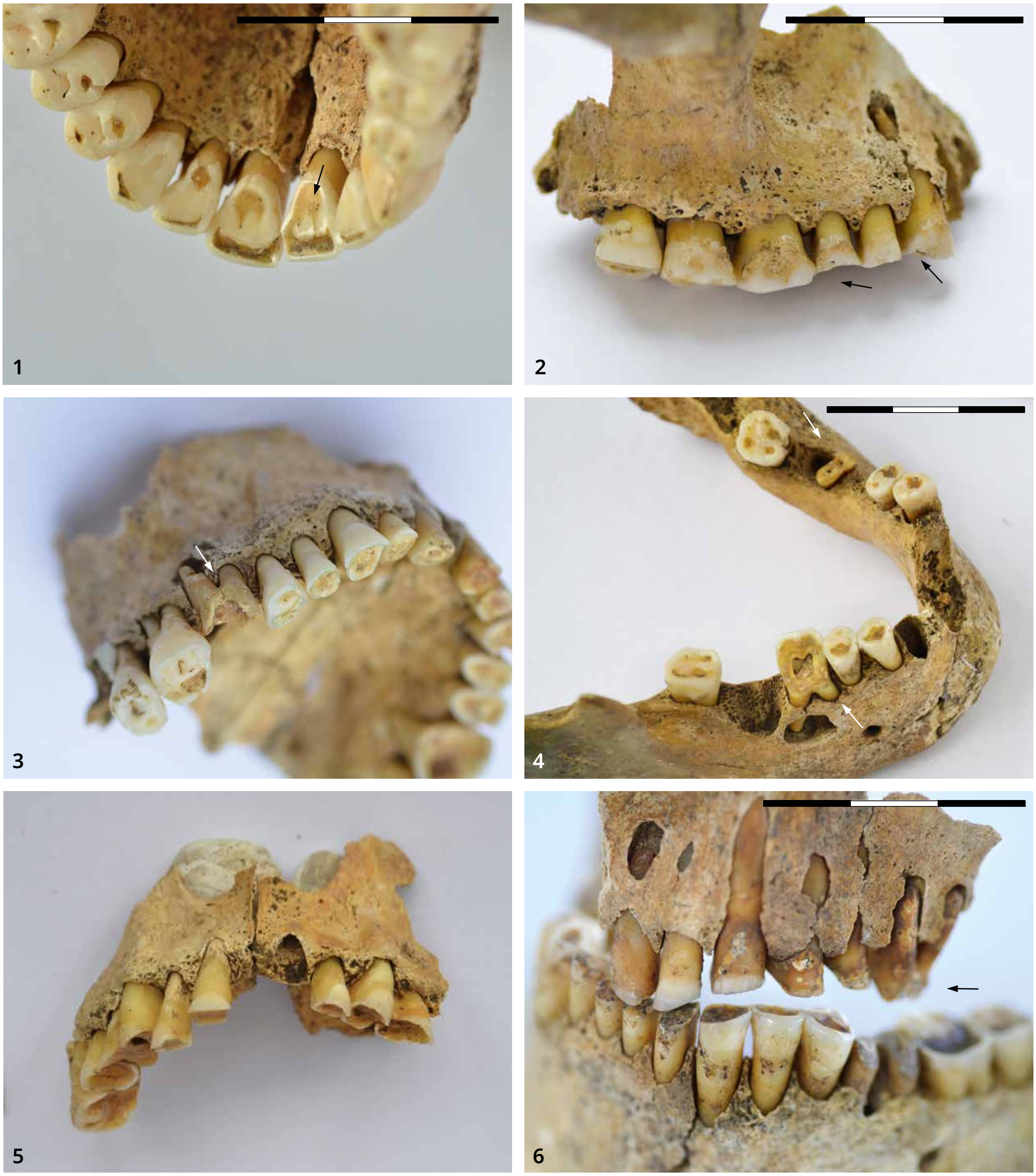


Figure 123: Analyses of human remains and oral health. Examples for occlusal wear (stage/nature)/other dental conditions. 1: Ind. 131_1, maxilla, right palatinal v., from buccal to lingual, 11-16, 21-26, juv/young adult, M=F; 11-12 and 21-22 with lingual abrasion/periodontitis 1. 2.4: Ind. 134_1, right maxilla, buccal v., mandible, right occlusal view from buccal, young adult, F; 13-15 6-7/oCD-asyCNR, 16-18 7-7/oCD-oCED; 34-35, 38, 44-45, 48 5/oCD; 37 8/oNRD, 46 7/asCNR/36 and 47 ATML/46, 47 abscesses (2.fis)/periodontists 1-2. 3: Ind. 067_1, maxilla palatinal v. from right buccal, 18-26, young adult, F; 11-12, 16, 21-22 7-8/oCNR-oNR-asyCRNR, remaining 2-6/oCE-oCD/16 abscess (2.fis)//13, 16-19, 23, 26-27 with caries lesions/ periodontitis 1-2. 5: Ind. 077_1, maxilla, anterior-palatinal v., 11-16, 22-25, middle adult, M; 5-7/oCD/13-14, 23 caries lesions/periodontitis 2. . 6: Ind. 218.2_4, left maxilla and mandible anterior-buccal v., 21-26, 31-38, 41-43, middle adult, M; 13-16 6-7/asyCD-CNRD-NRD, 31-32 7-8/asyCNRD-NRD, 33 7/asyCD, 34.35 5/oCD, 36 8/asyNRD, smooth, 37-38 5/OCD/21, 36 abscess (2.fis)/26, 37 caries lesions/periodontitis 1-2.

ones[26] and individuals 067_1 and 218.2_4 both showed heavy anterior wear specifically of the first molars (Fig. 114.2, 119.3.6, 123.6). Heavy occlusal wear of the anterior teeth has also been observed, for instance in individual 077_1 (Fig. 116.1, 121.6), 087_1 (Fig. 116.4, 119.1) or 032_ 1 (Fig. 116.5). Wear patterns of individuals 174_2_2, 178_C, and 218.2_3 suggest the development of local asymmetric wear in young adult age. Furthermore, slight asymmetric ablation of the lingual surfaces found on the upper incisors of a young adult individual of sexually unspecific skeletal constitution (ind. 131_1, Fig. 119.1). Smooth occlusal edges were found on different tooth categories in specimens 032_1, 040_1, 064_1, 130_1, 138_1, 186_5/7 and 218.2_4, suggesting deviating abrasive mechanisms.

In summary, the described patterns of occlusal macrowear lead to following assumptions: (1) several patterns of occlusal wear are atypical for abrasion induced by mastication, as severe substance loss of the anterior maxillary teeth would not be expected in this case. In principle, abrasion caused by chewing would rather affect both upper and lower teeth. This is supported by advanced local wear within dentitions as well as the prevalence of smooth occlusal edges. (2) Differences within these patterns exist; in case they are due to non-masticatory activities, different habits of tooth use are likely. (3) Similarities in patterns of macroscopic occlusal wear were observed in specimens of both male and female constitution. This leads to the hypothesis that related activities causing these patterns were not conducted by one sex only. This assumption requires detailed investigations of the individual dentitions (microstructures, affected teeth, missing antagonistic teeth, ethnological/experimental examinations). (4) Considering the factor of time, the data indicate the expected correlation in terms of increased age at death and advanced tooth wear. Although lacking exact dimensions of this temporal factor, the development for observed patterns required continuous extensive use during lifetime for some individuals.

Interproximal grooving

Within the total record of 1105 preserved teeth[27] of individuals older than juvenile[28] age, 68 teeth had traces of 92 interproximal grooves (6.2 %, Tab. 31; see Fig. 125). There is a slightly higher prevalence of this lesion in upper teeth, but no difference between left and right body side. In their total prevalence (n=92), interproximal grooves are more frequent on posterior teeth, even if considering the different representativeness (*e.g.* ratio anterior/posterior of 3/5; average 9.3/12.8). The tooth category with the highest average value is the premolar (14.5), but considering the single tooth positions, the upper first molar presented the highest number of grooves (n=10). In contrast, first upper (n=1) and lower incisors (n=2) and the third molars (n=1) showed the lowest rates. The grooves appear equally on the mesial and distal interproximal spaces (50 % each), most frequent occurring near the CEJ (neck, 60.8 %) or more towards the apical region (root, 31.5 %), which indicates increased CEJ-AC distance for these teeth. Two grooves were found on the crown enamel. A distinct circular cross-section is not a typical characteristic, the majority of grooves were of faint nature (68.5 %), which seems to be correlated to the tooth category: interproximal grooves present on incisors and canines are exclusively of faint cross-section, premolars and molars exhibited both. The most frequent occurrence is mesial grooving on the molar CEJ, both of faint and distinct circular cross-section, followed by distal premolar CEJs (n=10). Doubled grooves on the same tooth surface, for instance as visible on tooth 16 of individual 032_1 in the distal neck and root region, could be a result of both shifted (*e.g.* first neck, with increasing CEJ-AC distance later the root; Fig. 125.1) or simultaneous activity.

26 Higher grades in the molars compared to anterior teeth.
27 Considered are teeth preserved in the alveoli as well as those without jaw context (isolated).
28 Younger individuals lack interproximal grooving.

INTERPROXIMAL GROOVING per tooth		All (n/%)	Prevalence		
			yes	*no*	total pres.
Anatomy	maxillary	541/49.0	40/58.8	*501/48.3*	53/57.6
	mandibular	564/51.0	28/42.2	*536/51.7*	39/42.4
Side	right	547/49.5	34/50.0	*513/49.5*	51/55.4
	left	558/50.5	34/50.0	*524/50.5*	41/44.6
Section	anterior	397/33.4	19/27.9	*344/33.2*	28/30.4
	posterior	790/66.6	49/72.1	*693/66.8*	64/69.6
Category	incisor	241/20.3	10/14.7	*211/20.3*	16/17.4
	canine	156/13.1	9/13.2	*133/12.8*	12/13.0
	premolar	338/28.5	23/33.8	*182/27.5*	29/31.5
	molar	452/38.1	26/38.2	*408/39.3*	35/38.0
All		1105/100	68/6.2	*1037/93.8*	92

Table 31: Analyses of human remains and oral health. Total distributions of interproximal grooves per tooth (total pres. = total n of grooves) on dentitions of individuals older than juvenile (n=1105, n individuals 63).

INTERPROXIMAL GROOVING per individual		All (n/%)	Freq. (n ind./ gro.)	*No grooves (n/%)*
Age class	juv/young	8/12.7	0	*8/16.0*
	young adult	22/34.9	2/2	*20/40.0*
	middle adult	26/41.3	11/90	*15/30.0*
	old adult	2/3.2	0	*2/4.0*
	adult++	5/7.9	0	*5/10.0*
Biological sex	F	11/17.5	3/5	*8/16.0*
	F>M	10/15.9	1/1	*9/18.0*
	M=F	8/12.7	1/5	*7/14.0*
	M>F	8/12.7	1/1	*7/14.0*
	M	23/36.5	7/80	*16/32.0*
All		63/100	13/92/20.6	*50/79.4*

Table 32: Analyses of human remains and oral health. Total distributions of interproximal grooves per individual older than juvenile (n=63).

In summary, a minority of available teeth revealed interproximal grooves. Present distributions according to tooth and groove characteristics report an equal affection of mesial and distal interproximal areas, potentially due to contemporary substance ablation of neighbouring teeth. Differences in distinctiveness and groove shape could point to deviations in causative activity patterns, *e.g.* by the material of tool used/processed, applied mechanical force or duration. Here, detailed investigations of the surface microstructures would give more information. Exemplary microscopic examinations identified fine furrows, mainly horizontally orientated, for some grooves, indicating a certain degree of firmness of the material (Fig. 125). Usually, the interproximal spaces of the posterior teeth are wider compared to the anterior ones, which might explain its higher affection in terms of frequency and cross-section.

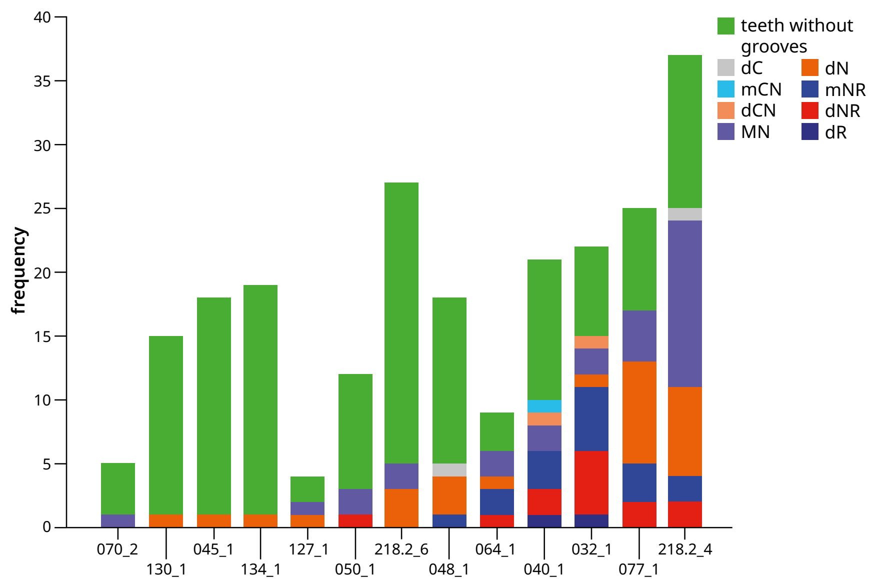


Figure 124: Analyses of human remains and oral health. Occurrence of interproximal grooves for affected individuals (n=13). Teeth without grooves are counted per position, grooves per total number. Description of location is as follows: d=distal, m=mesial, C=crown, N=neck (CEJ), R=root.

Interproximal grooving per individual

Within individuals who died at an older age than juvenile, 20.6 % revealed interproximal grooves (n=13; Tab. 32). Vast differences in terms of number of teeth with grooves as well as total grooves per dentition exist: Individual 045_1 showed a singular groove at the distal CEJ of the lower second premolar (Fig. 125.5-6), whereas in individual 218.2_4 a minimum[29] of 50 % of the dentition exhibited 25 different horizontal striations.

Few grooves per dentition are most frequent within these individuals (n=9); on the remaining four dentitions the counted numbers of grooves range from eight to 16. Figure 126 summarises different occurrences of interproximal grooves identified for the 13 individuals, including location (red-orange: mesial, bright-dark blue: distal, from crown to root) and number of teeth lacking such grooves (green). When looking at the positions of teeth affected, different patterns can be observed. For instance, specimen 032_1 revealed slight grooves predominantly on the mandibular positions and on the right body side, and it is very likely that the causing penetration affected neighbouring teeth (*e.g.* 41 NRd, 42 NRm/NRd, 43 NRm, a.s.o.; min. 25 % of dentition affected), resulting in an increased rate. The predominantly faint striations on the dentition of individual 040_1 are concentrated on the upper right and lower left posterior teeth, and doubled values for the lower positions are true, but also distinct shapes occur (Fig. 125.2.4.7). In specimen 077_1 they appeared in almost all maxillary positions (16-17/28 not preserved) and were also of faint shape (Fig. 125.3); singular teeth without grooves are 13, 27, 33, 35, 44, 45 and 48, which in return means that 40 % of its dentition was affected. The high rate found on the teeth of individual 218.2_4 results from mesial and distal locations of neighbouring tooth positions, in consequence the same interdental spaces (11 cases), but also from singular appearance. Striations lack on most anterior mandibular teeth. However, two grooves in the mesial neck region of tooth 17 and only one distal groove on 16 prove that the inducing activity did not automatically affect both teeth of the same interdental space equally, which is often present in posterior positions. Within the individuals with lower frequencies, there are no clear tendencies. For individual 050_1 the grooves seem to be seems locally limited to teeth 16 and 26, for 48_1 the five grooves distribute within the positions, and for individual 064_1 whose mainly left posterior teeth are preserved, the prevalence is stronger in the mandible.

29 In total 16 of 32 teeth; here with 28 teeth preserved.

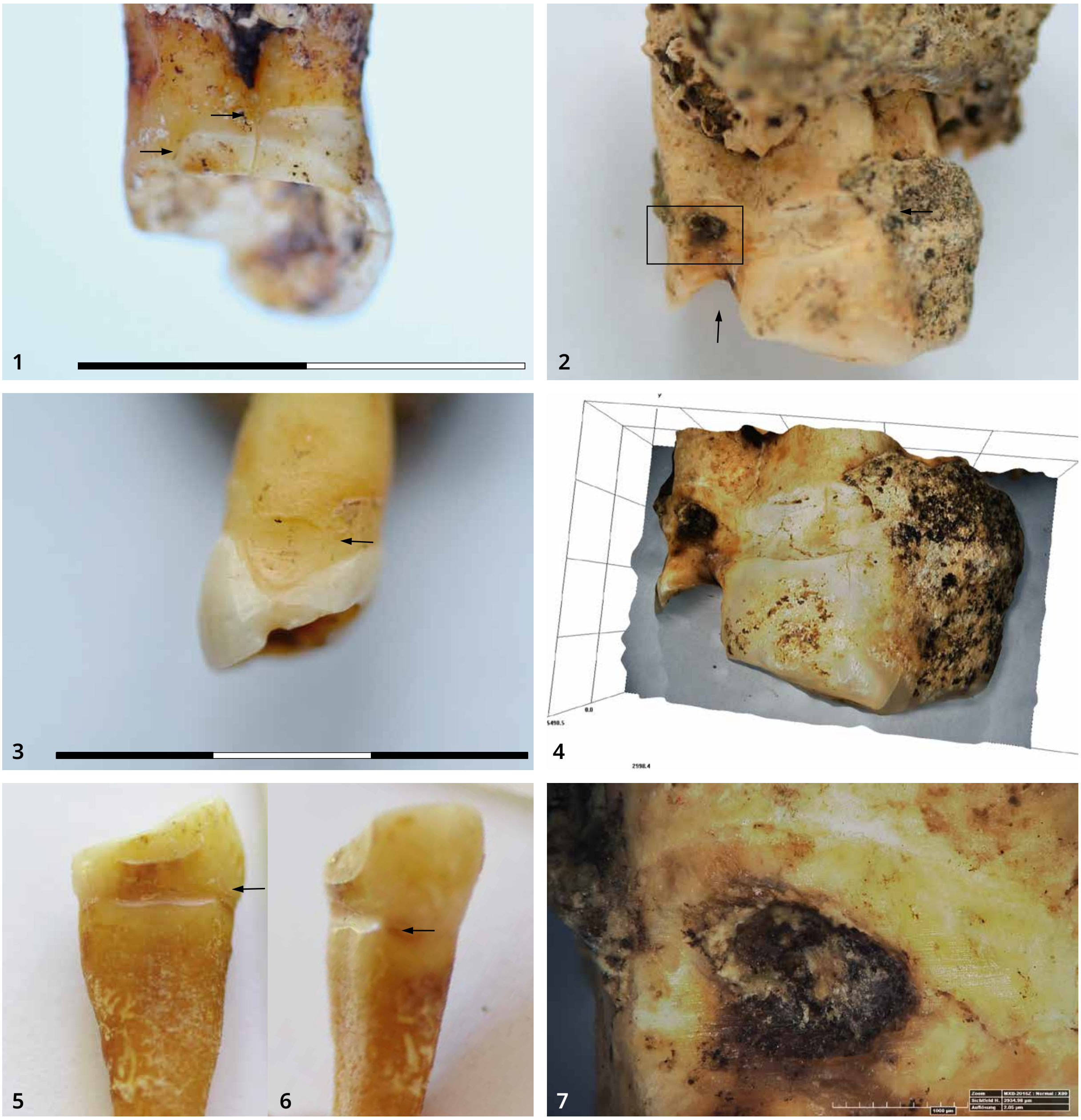


Figure 125: Analyses of human remains and oral health. Examples for different conditions of non-masticatory dental wear: 1-4.-6.7 Interproximal grooving (IG). 1 Ind. 32_1, 16, distal v., middle adult, male; IG in neck and root region, distinct circular cross-section/asyCNR occlusal wear stage 7/ periodontitis grade 2. 2.4.7. Ind. 040_1, 17, distal v., different scales, middle adult, male; IG on root surface with distinct circular cross-section and horizontal furrows, and occlusal-lingual noting/calculus 2/periodontitis 2/CEJ.int caries/oC occlusal wear stage 6. 3. Ind. 077_1, 22, distal v., middle adult, male; IG on neck, faint cross-section/oC occlusal wear stage 6. 5-6 Ind. 218.2_6, 25, distal and buccal v., adult++, M; distinct IG in CEJ region.

Consequently, available data not only leads to the conclusion that a minority of individuals with dental preservation[30] revealed interproximal grooves, but that these individuals had certain habits leading to different patterns, from singular and local, to broad and extensive affections.

The fact that interproximal grooving was proven for individuals of middle adult age almost exclusively points to two hypotheses; either the inducing activity was typically practiced by these age class, or earlier stages of striations in younger age have not been identified (Tab. 31). As the different natures of observed grooves suggest, from faint to distinct cross-sections, the second assumption seems quite likely. Considering results of sexual dimorphism estimated for the individuals, there is a distinct higher frequency for male individuals both per individual (4/8) and per groove number (6/80). Even when taking into account the temporal factor of developing visible grooving and the younger average age at death of females, the data lead to the hypothesis that males predominantly practiced groove-inducing activity.

Occlusal grooving: Notching

In total, 14 cases of occlusal grooving were observed in seven individuals, which makes 1.3 % of the teeth of individuals older than juvenile age (n=1105). They are of different shape and size and seem to be specific to the individuals.

The grooves identified on positions 13 and 21 of individual 039_1 are buccal-lingual, horizontal striations on the occlusal surface of teeth with heavy wear. On 21 two impressions are visible; all are of different size and the rims are not distinctively sharp. It is possible that other neighbouring teeth were also affected but are not preserved (Fig. 126.4.7). A similar modification, yet of less extent, is present on tooth 45 of specimen 218.2_6. In this case, a notch of slightly v-shaped form is located on the mesial crest of the crown, probably horizontally orientated. In contrast, individual 190_1 revealed vertically orientated grooves on both upper first molars originating from the lingual mesial enamel crest down the mesial root, pointing towards apical direction. On tooth 26, the striation stops at the level of an abscess cavity, opened towards the maxillary sinus. Tooth 24 shows the beginning traces of similar grooving on the lingual tooth surface (Fig. 126.8-9). Striations of similar shape and the same location were found on tooth 16 of individual 045_1, but without maxillary context. Specimen 040_1 has similar notching on tooth 18, but on the distal side, which merges into the interproximal groove. Here, the similar circular cross-sections of the interproximal and occlusal groove become visible. Both lower left premolars of individual 138_1 exhibit notches running vertically from the occlusal level to the buccal or rather mesial root surface (Fig. 126.11). On the second right lower premolar of individual 031_1, the notch on the distal side is broader and opens in a distal root facet (Fig. 126.12). Similar notches are present on the left lower premolars, 35 with a wider one on the buccal surface, and 35 with a narrow notch on the distal side.

Furthermore, the first right incisor of the dentition from individual 047_1 shows a very narrow, faint groove running from an occlusal origin up the buccal crown surface, close to the interdental contact zone to tooth 21 (Fig. 126.2). Compared to the modifications of individual 040_1, 045_1 and 190_1, this could be an earlier stage of the notching progress. Both upper left incisors of individual 178_A reveal occlusal notching, tooth 11 a slight notch on the lingual enamel crest, and tooth 12 a narrow furrow on the lingual crown surface, from mesial to distal direction (Fig. 126.1.3.). This furrow is filled with calculus, so it formed some time before death. Additionally, both teeth exhibit an opening of the occlusion in their interdental contact zone, but the enamel rims are rough, so occlusal grooving is unlikely here.

30 This is not due to the overall status of dental preservation, as only nine dentitions consist of less than five teeth.

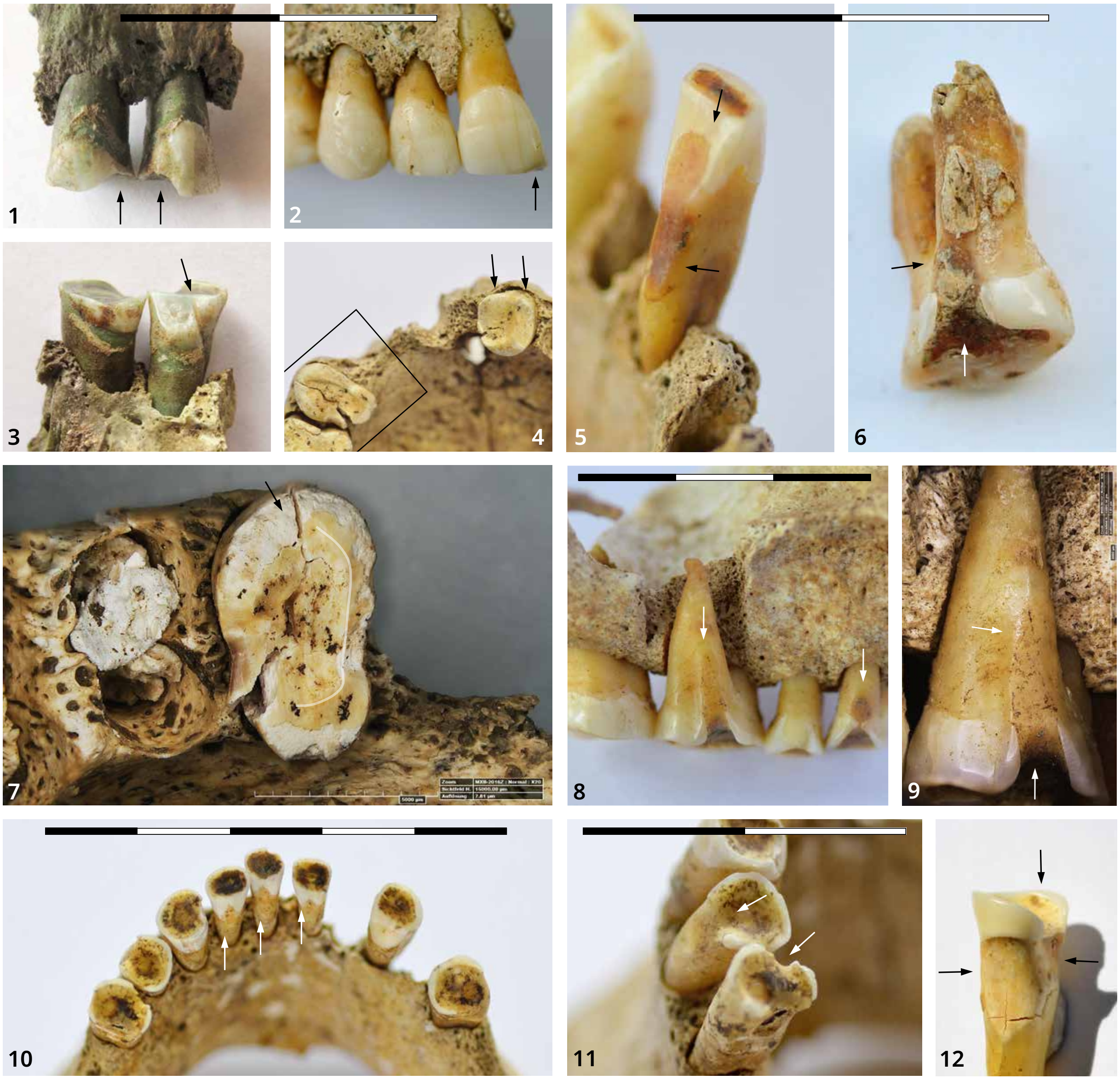


Figure 126: Analyses of human remains and oral health. Examples for occlusal grooving (notching) and unspecific facets/other dental conditions. 1.3: Ind. 178_A, left maxilla, 21-22, buccal and lingual v., adult++, sex n. d.; 1: occlusal opening with rough rims. 3: 21 with occlusal-lingual furrow/occlusal wear grade 6/periodontitis 2/calculus 1. 2 Ind. 047_1, right maxilla, 11-13, buccal v., juv/young ad, F>M; 11 occlusal notching mesial edge/furrow on buccal surface. 4.7: Ind. 039_1, (right) maxilla, occlusal v., middle adult, F; occlusal wear 8/periodontitis 2. 4: maxilla, 13 and 21 with occlusal grooves.7: right maxilla, 13, detail with marked grooving rim. 5: Ind. 190_1, left mandible, 42 lingual v., young adult, M>F; unspecific lingual facet, similar to occlusal notching/occlusal wear 5/periodontitis 2. 6 Ind. 045_1, 16 lingual v., middle adult, F; occlusal grooving lingual-distal cusp down the lingual root. 8-9: Ind. 190_1, left maxilla 24-27/26, lingual v.; 24, 26 occlusal notching, 26 up the lingual root up to opening of abscess cavity/occlusal wear 7-5/periodontitis 1-2. 10-11: Ind. 138_1, mandible, old adult, M; occlusal wear 6-7/periodontitis 2. 10: mandible, 31-53, 41, 43, 45, lingual v., 31-32, 41 unspecific facets on lingual surface. 11: 33-35 distal-occlusal v., occlusal grooving 34 on buccal, 35 on mesial side /distal CEJ caries 2. 12: Ind. 031_1, 45, lingual v., unspecific facet on the lingual distal CEJ and root, occlusal notching distal crown/neck/root.

In summary, notching is more frequent for maxillary teeth and not typical for one functional tooth category. Most of the grooves are vertically orientated, but the size, extent, and shape differ among the seven specimens. Due to its rare frequency, further statistical analysis has not been conducted. However, it shall be noted that the individuals are of both male and female constitutions and, except individual 047_1, all died in middle adult age.

Unspecific facets

Two main forms of unspecific facets have been observed on 23 teeth (2.1 %). One form is lingual ablations of lower anterior teeth, affecting the crown, neck, and root region, but not the occlusal relief. Here, masticatory-induced abrasion is easy to distinguish as both modifications are clearly separated from each other. Five of these were recognised in at least two individuals, 040_1 and 138_1 (Fig. 126.10). Such facets can be discussed as similar to occlusal notching, as the penetrating procedure was probably vertically orientated and rather local.

In contrast, the second form of unspecific facets includes distinctively smoothed or polished areas of the tooth, often affecting more than one surface, for instance the lingual-buccal root. Such facets occurred on 16 teeth (1.4 %). Due to irregular shapes and blurry borders, measuring these facets was complicated. Nevertheless, they differ from very small (2 mm^2, neck, lingual tooth 42 of ind. 31_1) to large (20x25 mm; crown, neck and root; lingual and distal, *e.g.* ind. 218.2_1, tooth positions 16, Fig. 127.3). On teeth 16 and 17 of individual 050_1, the facets run through both lingual roots and point to the same inducing activity affecting several teeth (Fig. 127.1). The facets appear on both maxillary and mandibular positions (12/8), most frequently on the neck and root region of molars (1/1/2/13) and often in a buccal, lingual or lingual-buccal position. The first mentioned observation might be misleading, as molars exhibit larges surfaces for the manifestation. Consequently, the CEJ-AC distance of teeth with these facets is higher in general. In some cases, single apical areas are fully remodelled, and teeth anchored only by one or two roots to the jaw. Here, individual 218.2_1 is a special case (Fig. 127.3-4). With AMTL of 17-18 and advanced maxillary remodelling in this region, the socket of tooth 16 also shows advanced atrophy. Both distal areas of the lingual and buccal root and neck as well as both buccal and lingual tooth surfaces are polished, and calculus impressed into the buccal bifurcation. Additionally, the distal side of the buccal roots is detached from the maxilla and the tooth is dislocated in the buccal-mesial direction. This results from continuous tension of the tooth in this direction, probably caused by the same facet-inducing activity, also visible by the smooth area that stretches almost up until the tooth's apical tip.

The nature of the facets differs from smoothly-matt to shiny-polished, and they sometimes are characterised by either lacking calculus or by calculus being pressed into the apical bifurcation or other niches (Fig. 127.3-5). Both might give information about the temporal factor of time since formation; shiny surfaces would imply an activity pattern close to the time of death in contrast to matt, but of course this might also be due to different textures of the causing object. However, impressed or otherwise affected calculus implies activity after its accumulation and lacking calculus potentially no formation of calculus due to continuous wear. Because these facets are not characterised by a distinct cross-section or sharp rims, the object material was probably soft and flexible, especially in comparison with interproximal grooving.

In total, seven individuals show according facets, and individuals 031_1, 050_1 and 064_1 facets on multiple teeth and surfaces. They appear in both sexes, and the ratio of two female/likely female to five male/likely male is slightly imbalanced. However, similar to the results of occlusal notching, the small data set is not statistically significantly valid in any direction. All individuals are of middle adult age

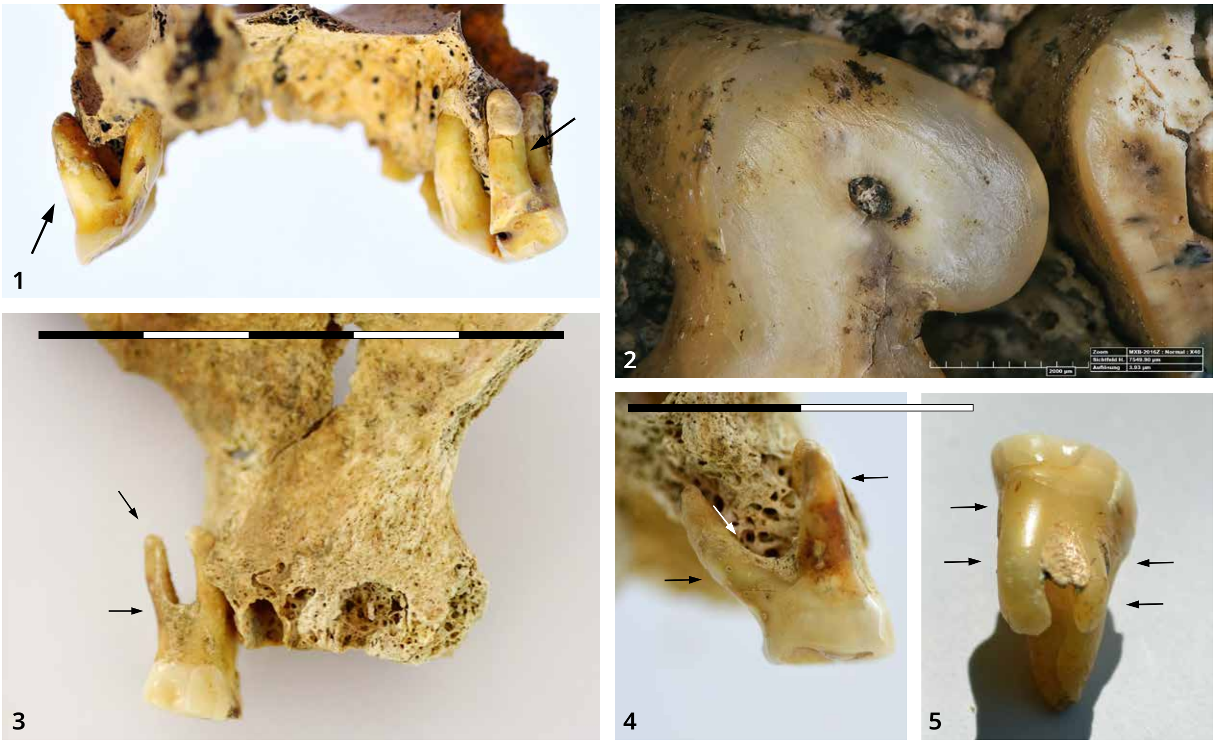


Figure 127: Analyses of human remains and oral health. Examples for unspecific smooth surfaces and roundish occlusal wear. 1: Ind. 050_1, maxilla, distal v., 16-17, 27 with smooth/polished facets on lingual/lingual-distal root and neck surfaces; frontal opening of the occlusion due to heavy wear of the anterior teeth/asymmetric occlusal wear 6-7/periodontitis 2-3. 2: Ind. 032_1, left maxilla, 23-24, occlusal v., middle adult, M; heavy occlusal wear (8); potentially non-masticatory due to convex shape, roundish edges and micro relief. 3-4: Ind. 218.2_1, left maxilla, 16, middle adult, M>F; polished facet on buccal and distal neck and root region, impression of calculus in both bifurcations, detached distal root, and tooth dislocation in buccal-mesial direction/13-14 AMTL/periodontitis 2/calculus 3/occlusal wear 3. 5: Ind. 031_1, 16, apical-buccal v., middle adult, F; polished neck and root surfaces buccal and distal, with calculus impressed in the apical bifurcation.

Dental chipping

The analyses of dental chipping included 1385 teeth from 85 specimen. In total, 20.8 % of the studied teeth showed lesions of microfractures of different extents, predominantly affecting the occlusal surface of crowns (83 %, Fig. 129.3-4; Tab. 33).

In general, there are no significant differences in terms of maxillary and mandibular teeth or right and left body side (Tab. 33). With lower frequency in the relative comparison to permanent dentition (22.6 %), dental chipping occurred also in milk teeth (8.2 %). In a ratio of 12/20 anterior to posterior teeth, teeth in posterior positions more often showed micro damages (in average 8.1 to 9.6). Considering the different tooth functionalities, this is confirmed for both categories premolars and molars which show slightly increased average values (10.5 and 9 to 7.8 incisors and 8.8 canines). Nevertheless, chipped teeth are evident for all tooth positions (Fig. 128). With respect to maximum extent of tooth substance loss, small damages between 0.1-2 mm^2 (stage 1 and 2 both 38.8%, Fig. 129.3-4) are most frequent, and large cracks relatively rare (9.8 %). There is no significant correlation between lesion size and functional tooth category. Small lesions (stage 1-2) occur more often on teeth of the right body side (3-4, Fig. 129.1-2), and large on the left; however, these differences are each below 10 % so this tendency is not significant.

Despite of two lesions, on the CEJ and the root region both of large extent, cracks were found on the crown and the occlusal surface was involved in 83.4 % of diagnosed chippings. Here, distal, mesial, or buccal sides or cusps are almost equally affected (45.7 %, 37.7 %, and 37.0 %); predominant are occlusal mesial

CHIPPING per tooth		All (n/%)	Prevalence		
			Chipping	extent av/SD	*No chipping*
Anatomy	**maxillary**	677/48.9	156/54.0	2.0/1.0	*521/47.5*
	mandibular	708/51.1	133/46.0	1.9/0.9	*575/52.5*
Side	**right**	695/50.2	146/50.5	1.9/0.9	*549/50.1*
	left	690/49.8	143/49.5	2.0/1.0	*547/49.9*
Dentition	**DD**	73/5.3	6/2.1	2.5/0.8	*67/6.1*
	PD	1312/94.7	283/97.3	1.9/0.9	*1029/93.3*
Section	**anterior**	469/33.9	97/33.6	2.0/1.0	*374/33.9*
	posterior	916/66.1	192/66.4	1.0/0.9	*724/66.1*
All		1385/100	289/20.8	-	*1096/79.2*

Table 33: Analyses of human remains and oral health. Total distributions of chipping present on all preserved teeth (permanent and deciduous dentition, n=1385, n individuals=85).

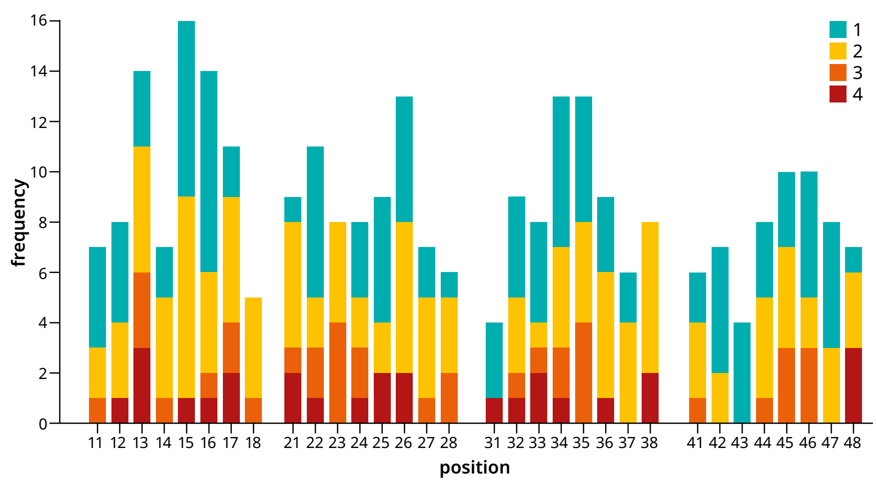


Figure 128: Analyses of human remains and oral health. Distribution of chipping lesion size (1=0, 1-1 mm^2, 2 1-2 mm^2, 3=2-3 mm^2, 4=>3 mm^2) per tooth position of affected teeth (n=289, n individuals=52).

or distal areas with small to larger substance loss. In 32 cases (11.1 %), chippings are located on the lingual tooth section. Damages limited to the vertical crown surfaces are rare (7.6 %). These observations do not point towards specific patterns for tooth section or functional category.

As an interim result, with an overall prevalence of 20.8 %, the majority of observed microfractures were induced from the occlusal direction. Based on rare findings on the lingual regions, punctual overload was mainly directed on mesial, distal, and/or buccal tooth areas. Although premolars and molars exhibit increased values, incisors and canines were also exposed to causative factors, so that chipping due solely to mastication is unlikely. Additionally, lacking distribution patterns in terms of siding, tooth position, or anatomic direction might indicate that related activities or causative factors were not specific and rather involved the complete dentition. Based on the prevalence in milk teeth, associated causes already existed during childhood.

Dental chipping per individual

Within the individuals with dental preservation, 61.2 % revealed dentitions with chipped teeth (Tab. 34). The probability of identifying chipping correlates with the number of teeth preserved, but there are individuals with almost complete dentitions that lack such lesions.

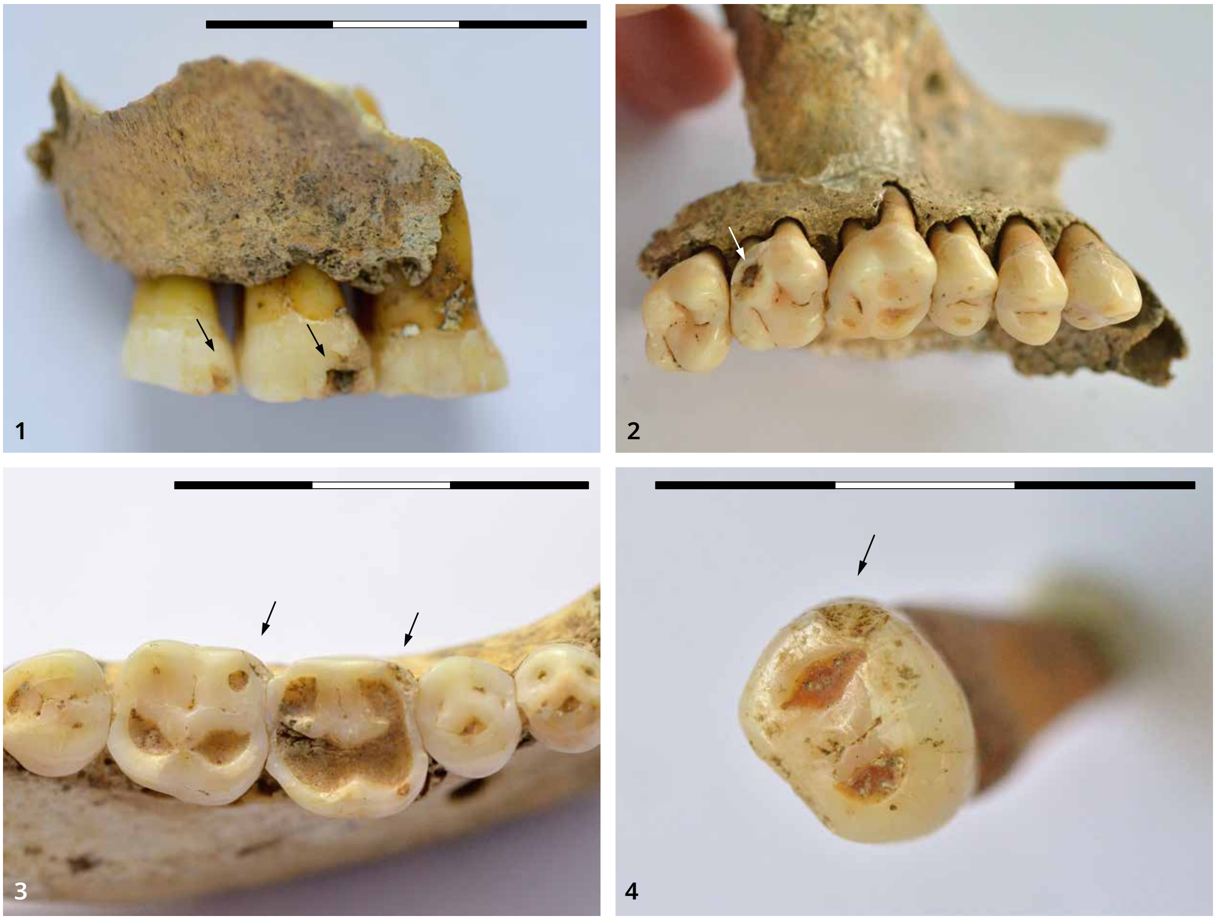


Figure 129: Analyses of human remains and oral health. Examples for dental chipping of different location and extent/other dental conditions. 1: Ind. 215_1, right maxilla, 16-18, buccal v., middle adult, male; 17 and 18 C.obm chipping, 3/occlusal wear 6-5/periodontitis 1. 2: Ind. 047_8, right maxilla, 13-18, buccal-occlusal v., juv/young adult, M=F; 16 C.od 2, 17 C.obd, 4/occlusal wear 1-4/periodontitis 1-2. 3: Ind. 038_1, right mandible, 44-48, lingual-occlusal v., adult++, M>F; 46 and 47 C.oml 2/occlusal wear 4-5. 4: Ind. 047, 45, occlusal v., young adult, F>M; C.obm 4/occlusal wear 4.

Affected individuals show different amounts of chipped teeth as well as extents of tooth damage, from one small chipping up to a 100 % dentition with an overall maximum extent of 41 mm^2 (Ind. 134_1). In the majority (53.8 %) of the population with chipping, the lesions appear on less than five teeth; frequencies from 5-10 teeth have been found in 30.8 % of individuals affected. For the remaining eight individuals, 15.4 %, eleven to 20 teeth exhibit this kind of microfractures. When calculating the maximum extent per individual (addition of max. lesion sizes), there is a general correlation to the number of lesions; for instance, individual 134_1, showing lesions on all 20 preserved teeth with a maximum of 41 mm^2 tooth surface damage. In contrast, individual 117_2 exhibited 28.1% affected teeth, but with nine lesions reaching a maximum extent of 28 mm^2. Furthermore, single but large chipping occurred, as observed for individuals 047_5 and 039_1. Many chippings but all smaller than 2 mm^2 were also diagnosed, for instance in individuals 190_1 (6 lesions/ max. 9 mm^2), 208_1 (9/12), or 032_1 (7/10). Along with the general distributions of lesion size and tooth locations, dental chipping is a diverse condition within the population under study, but there are no distinctive individual patterns (Fig. 132). Taking into account their preservation status, individuals show chipping on maxillary as well as mandibular positions and on the left as well as right body side. Individual 092_1 revealed chipping only on anterior teeth (7/22), and so did individuals 032_2 and 036_1, but these show a lower frequency in general (1/20 and 2/28). Individual 092_1

CHIPPING per individual		All (n/%)	Chipping n	Chip. extent n/ av/SD	*no chipping*
Age class	**infant**	5/5.9	1/1.9	2/-	*4/12.1*
	young child	4/4.7	2/3.8	3.5/2.1	*2/6.1*
	old child	6/7.1	0/0	0/0	*7/18.2*
	juvenile	7/8.2	3/5.8	3.7/2.1	*4/12.1*
	juv/young	8/9.4	4/7.7	8.5/4.8	*4/12.1*
	young adult	22/25.9	15/28.8	113.2/13.6	*7/21.2*
	middle adult	26/30.6	22/42.3	12.7/9.8	*4/12.1*
	old adult	2/2.4	3/5.8	3.0/2.8	*0/0*
	adult++	5/5.9	3/5.8	3/5.8	*2/6.1*
Biologcal sex	**F**	11/12.9	9/17.3	14.4/15.4	*2/6.1*
	F>M	10/11.8	5/9.6	12.0/9.7	*5/15.2*
	M=F	8/9.4	6/11.5	14.3/13.3	*2/6.1*
	M>F	8/9.4	6/11.5	12.3/6.8	*2/6.1*
	M	23/27.1	20/38.5	29.4/8.6	*3/9.1*
	n. d.	25/29.4	6/11.5	3.3/1.8	*19/57.6*
All		**85/100**	**52/61.2**	**-**	***33/39.8***

Table 34: Analyses of human remains and oral health. Presence of chipping per individual including extent of chipping in terms of maximum size (single lesion sizes added up; N=85).

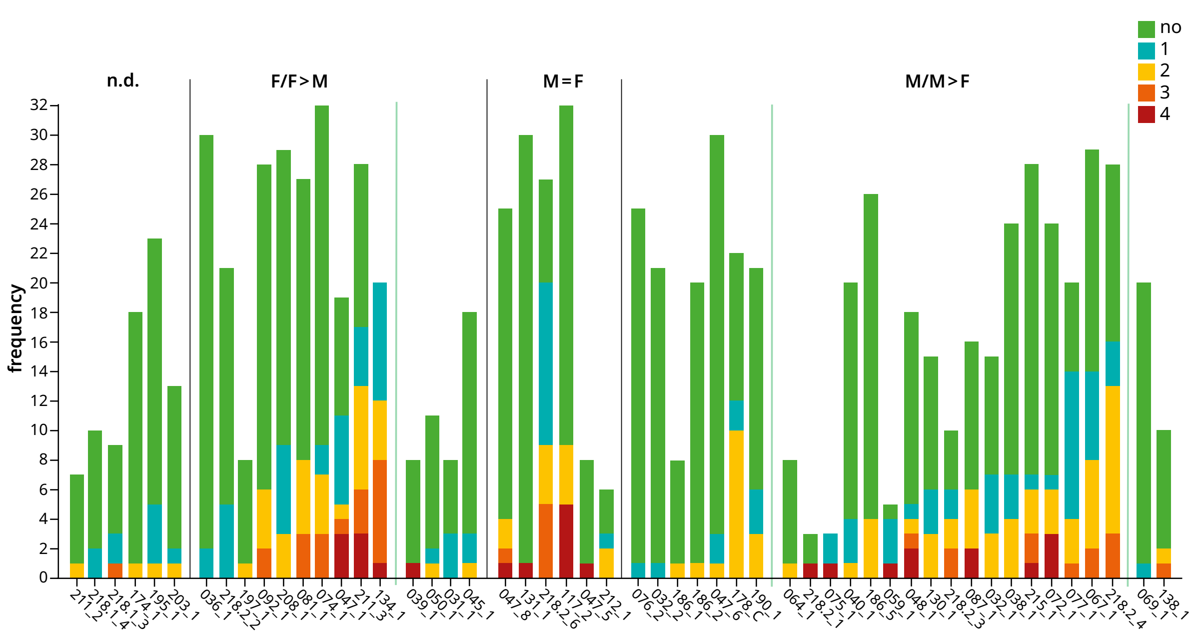


Figure 130: Analyses of human remains and oral health. Chipping affection per tooth and individual with respect to lesion extent considering biological sex and age class (n. d.; females: juv.young/young/middle adult, males young/middle/old adult).

is an exception in this regard. Lacking distinct patterns in terms of chipping size and location on the tooth confirm this. In consequence, the observations made per tooth position are also reflected in the individual prevalence. Specific distribution patterns are lacking, meaning that the inducing activity was an individual habit performed on favourable tooth positions. Still, 39.8 % of the population under study did not reveal chipping lesions, so that potentially related activity or consumption of hard substances was not exercised by all individuals.

In terms of age at death and chipping, a connection between advanced age class and gradually increasing frequencies as well as extents is visible (Fig. 130; Tab. 33). As chipping is an attribute of dental wear, this is not surprising. Nevertheless, the chipping affection illustrated in Figure 132 shows that also children and individuals of younger age classes revealed moderate to higher frequencies (*e.g.* 178_C) or large lesions (*e.g.* 218.1_3). The fact that chipping was diagnosed in children under the age of 6 years emphasises that this condition started early in life, even though this was true for only few subadults in that age. For individuals of adult age, the different values of chipping affection might either be due to different frequencies and intensities of punctual overload and potential differences in activity patterns; the other explanation would be that the chronological duration of an age class with *ca.* 15 years is too wide to identify potential differences.

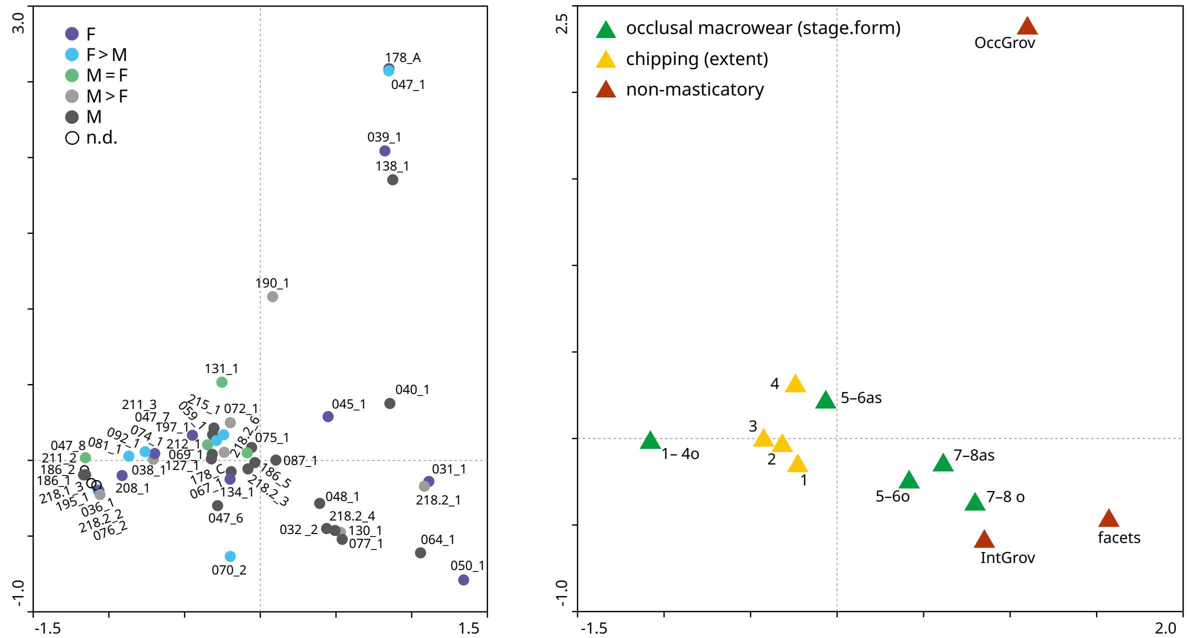
Chipping occurred in individuals of both male/likely male constitution and female/likely female constitution with percentage differences from 83.9 % to 66.7 %; accordingly, individuals with male morphological attributes show a higher rate. Based on the demographic data estimated, values of frequency and extent suggests females experienced dental chipping earlier in life (Fig. 130, Tab. 34). Additionally, individual 134_1 with highest chipping frequency and extent rates is of female constitution and died in her young adult life (20-35 years). Ind. 211_3 and 047_7. Individual 218_4 and 067_1, both of male constitution and deceased at a middle adult age, show high values, but lower compared to the aforementioned female.

Similar to other dental conditions (*e.g.* caries, hypoplasia), presence of chipping strongly interrelates with conditions that affect the tooth anatomy towards stability and resistance. This is especially true for abrasion, other conditions of dental wear, and caries. Additionally, in order to generate valid results, AMTL must also be considered in terms of dental representativeness and individual frequency rate.

5.6.3.6 Interrelations of dental wear: individual dentitions

As previously mentioned, different categories of dental wear influence each other; for instance, teeth with advanced occlusal wear can be more prone to dental chipping. Additionally, one major aspect in the investigation of dental wear is to distinguish between masticatory and non-masticatory conditions, which is straightforward for grooving and facets, but not for chipping and occlusal wear. Therefore, the approach of correspondence analysis (CA) was applied in order to visualize and summarise trends of dental wear (Fig. 131).

To do so, the available record per tooth was calculated per individual by adding up occlusal and asymmetric wear (each per stage; 1-4, 5-6, 7-8), chipping (extents 1-4), and presence of occlusal and interproximal grooving as well as unspecific facets. For instance, individual 134_1 revealed eight teeth with chippings of extent 1, three teeth of extent 3, seven teeth with extent 3, four teeth with stage 4, eight teeth with asymmetric occlusal wear stage 5-6, five with occlusal and two with asymmetric wear stage 5-6, and one tooth with an unspecific facet. These numbers are listed in the contingency table as basis for the *CA.* Individuals with only one diagnosed category were excluded, which was mainly true for specimen that revealed occlusal wear only, predominantly immature ones (n=34). Nevertheless, two young children (211.1_2, 218.1_3) as well as one juvenile (195_1) with chipping



are included. In total, the analysis considers 333 tooth positions from 50 individuals with 715 diagnosed categories of dental wear. The result of the CA illustrated in Figure 131 shows the correlations per individual[31], including the estimation of biological sex, and per dental wear category[32]. The left graph depicts correlations of individual patterns and the right graph correlations of the different categories.

Figure 131: Analyses of human remains and oral health. Classical correspondence analysis of dental wear categories (right graph) per individual (left graph; n individuals=50). The underlying contingency table lists categories of dental wear per tooth affection (n teeth=333, n information dental wear=715).

Individuals scattering further from the ordinate origin revealed fewer categories of oral health, which can either be due to lacking teeth (post- or antemortem loss) or with teeth but lacking according conditions ("healthy teeth"). In the right upper part individuals cluster exhibiting occlusal grooving, in the right lower those with facets and/or interproximal grooving. The group to the left located around the second principle axis are individuals with slight or moderate grades of dental wear, especially mild to moderate abrasion and little chipping. Further centrally ordinated are individuals revealing more chippings; the largest group are individuals characterised by dentitions with frequent chippings of different extents and strong, predominantly asymmetric wear (5-6). Considering the biological sex in this regard, the left graph brings together the observations made for each category of dental wear: Interproximal grooving seems to be characteristic for males, which stays in contrast to occlusal grooves and unspecific facets, which occur in both males and females. Dentitions with one or multiple non-masticatory conditions often showed heavy occlusal or asymmetric wear, and this is true for both sexes.

As occlusal wear is involved in estimating age at death of an individual, the increasing stages from the left to the right part of the x-axis also reflect the chronological gradient, with immature age classes to young adults on the left side, mixed age classes in the central group, and rather middle adults on the right side.

One hypothesis deriving from these analyses is that the dentitions of certain individuals were more strongly altered by non-masticatory activities than others. These are individuals scattering on the right side of the y-axis, characterised by severe occlusal and asymmetric wear, interproximal grooving, and/or unspecific facets. The factor of increased age at death potentially represents an important aspect in this

31 "Samples".
32 "Species"; for detailed description of the analysis's procedure see chapter 2.6.

regard. The examination of dental wear suggested that severe wear stages occurred frequently in maxillary teeth and on anterior positions, characteristics that are less typical for masticatory induced patterns. The second hypothesis in question is that these non-masticatory conditions are specific for individuals, resulting from certain occupational habits, and that younger individuals did not develop according wear patterns during their lifetime. To test these hypotheses, more accurate age estimations independent from the dental record are needed, especially in the middle adult age class (35-50 years). In addition, further knowledge about the temporal dimensions as well as the object material would help to understanding the development of such modifications (*e.g.* required duration and frequency of occupational habit). Regarding the distributions of biological sex, apart from interproximal grooving, these observations are true for both, males and females. Thus, habits that lead to observed patterns were not determined by individual sex. However, interdental grooving seems to be different in this context as only few grooves were found in females. Again, a better understanding of the temporal factor would also be helpful here since females more frequently died at a younger age.

5.6.3.7 Carious lesions

The results of caries prevalence include three investigative parts: (1) caries lesions in terms of dentition, tooth position, frequency, and nature of teeth affected, (2) caries prevalence within the population under study considering age at death and biological sex, and (3) the calibration of caries frequencies considering postmortem and intravital tooth loss as well as heavy dental wear.

To this end, 1405 teeth from 85 individuals were examined; 138 of them show caries lesions connected to hard tissue decay, two lesions on the same tooth were present in 15 cases. Thus, in total, 8.2 % of the preserved dental record is affected by substance loss of different extents. The majority of the lesions were found on teeth of the permanent dentition, but they also appear on deciduous teeth, and evenly occur in terms of siding, anatomy, and section category (Tab. 35). Independently from the dentition, caries incidence is most frequent in molars (Fig. 132). By considering the different ratios of tooth categories, this result remains valid (average values: incisors 1; canines 2.5; premolars 5.5; molars 7.5). Additionally, premolars and molars exhibit large caries cavities. Incisors and canines exclusively show lesions smaller than 3 mm; in general, 95.5 % of the lesions are of this small size (Fig. 134.1-2), whereas advanced caries with over 50% of premolar or molar crown decay are very rare (Fig. 132, 134.5). The locations of the lesions suggest that the major initial affected areas were the interproximal CEJ (41.4 %), interproximal contact zones of the crowns (22.6 %), and the occlusal surfaces (20.3 %). Gross caries, equal to severity grades 3 and 4, relate to advanced enamel and dentine destruction with only the root preserved in three tooth positions (tooth 34, two 46; Fig. 134.5-6). Incisors and canines are predominantly affected on crown locations. In contrast, the demineralisation processes in posterior teeth started more frequently in the tooth contact zones and interdental spaces (Fig. 132, 133.1-6). The mutual affection of neighbouring teeth caused by accumulation of bacterial acids of plaque in mesial and distal areas, especially the tooth contact zones, might artificially raise the caries rates, as each lesion was counted. This is true for 13 cases, predominantly in the posterior section (concerns 26 caries lesions).

Carious lesions per individual

From 85 individuals with dental preservation, 49.5 % showed caries lesions of different frequencies and intensities (Tab. 36). The caries rates among this group differs from one to maximum eleven teeth affected (67_1, Fig. 134.3), on average 24.7 % of the dentition. Deviating intensity rates result from different severity rates as well as the

CARIES PREVALENCE per tooth		All (n/%)	Caries present			*No caries*		
			All (n/%)	DD	PD	*All (n/%)*	*DD*	*PD*
Anatomy	**maxillary**	688/49.0	58/29.2	4/50.0	54/49.1	*630/49.0*	*40/61.5*	*590/48.3*
	mandibular	717/51.0	60/50.8	4/50.0	56/50.9	*657/51.0*	*25/38.5*	*632/51.7*
Side	**right**	709/50.5	64/54.2	6/75.0	58/52.7	*642/50.1*	*38/58.5*	*607/49.7*
	left	696/49.4	54/45.8	2/25.0	52/47.3	*641/49.9*	*27/41.5*	*615&50.3*
Section	**anterior**	474/33.7	22/18.6	1/12.5	21/19.1	*452/35.1*	*24/36.9*	*428/35.0*
	posterior	931/66.3	96/81.4	7/87.5	89/80.9	*835/64.9*	*41/61.1*	*794/65.0*
All		1405/100	118/8.4	8/6.8	110/93.2	*1287/91.6*	*65/5.1*	*1222/94.9*

Table 35: Analyses of human remains and oral health. Results of caries prevalence per tooth, anatomy, and dentition (n=118, n individuals=41).

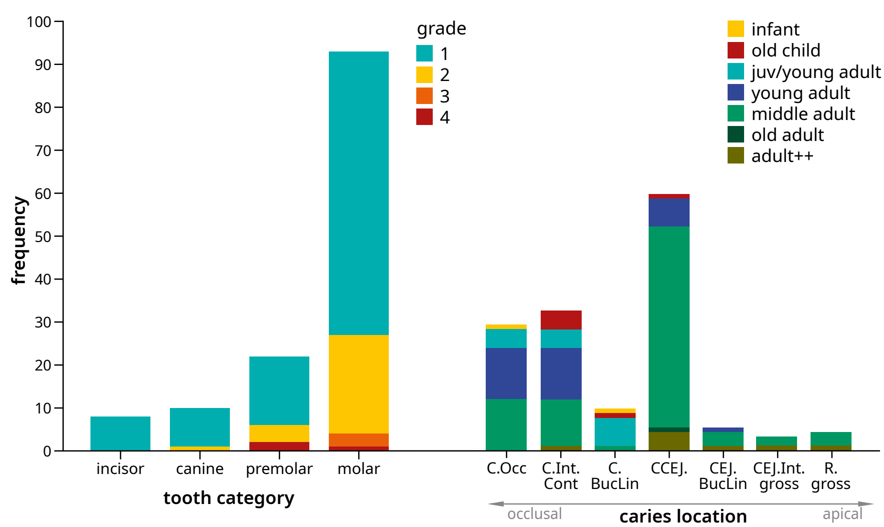


Figure 132 and 133: Analyses of human remains and oral health. Prevalence of caries lesions (n=133) per tooth (n=118; n individuals=41). Total distributions of caries severity per tooth category and caries locality per age class.

number of lesions, and there is no strong correlation between these values (Fig. 135). In some individuals the decay was mild, but on different teeth and locations (*e.g.* 047_3), in others advanced decay was found for single teeth or jaw areas (*e.g.* 045_1).

Considering individual age, and thus the length of time of tooth exposure to the oral environment, the chronological interrelation with caries prevalence due to its progressive character becomes clear. Frequency (over 20% for adults) as well as intensity (over 1.5 in average) increases in advanced ages of both dentitions, whereas juveniles and young adults show lower values. The age-dependency is also visible in the location of caries, as defects of older individuals (middle to old adult) more often appear in the area of the CEJ, potentially due to plaque accumulation in the areas of increased CEJ-AC distances, as well as gross decay as a sign of advanced tooth decay over time. In the deciduous teeth of immature individuals, caries occurs predominantly on the crowns and without destroying more than 50% of the surface (Fig. 133).

Considering the exposure time of deciduous teeth with caries lesions since eruption, it is possible to estimate a maximum time span during which the demineralisation of the dental tissues was initiated. Most of these lesions are of small extent but are found in different tooth localities. Taking into account tooth exposure times and the change from deciduous to permanent dentitions, one could approximate the earliest age of caries prevalence as well as the maximum time for demineralisation processes to manifest on the tooth. Among immature individuals with deciduous dentition[33], cariogenic condi-

33 047_2, 6-8 years; 182_2, 8-11 years; 127_2, 9-11 years; carious teeth: 53-55; 54; 42.

CARIES PREVALENCE per individual		All (n/%)	Frequency (n/%)		Intensity	*no caries (n/%)*
			n ind /les	av./SD	av./SD	
Age class	**infant**	5/5.9	2/2	13.3/4.7	1/0	*3/6.3*
	young child	4/4.7	0	-	0	*4/9.1*
	old child	6/7.1	3/6	17.5/19.4	1.4/0.5	*3/6.8*
	juvenile	7/8.2	0	-	0	*7/15.9*
	juv/youngad	8/9.4	2/14	20.9/24.3	1.2/0.4	*6/13.6*
	young adult	23/27.1	12/29	19.5/27.4	1.1/0.2	*11/25.0*
	middle adult	26/30.6	19/73	31.1/24.3	1.5/0.7	*7/15.9*
	old adult	1/1.2	1/1	9.0/-	2.0/-	*0/0*
	adult++	5/5.9	2/8	29.4/21.3	2.0/1.4	*3/6.8*
Biological sex	**F**	11/12.9	9/27	18.3/14.9	1.3/0.3	*2/4.5*
	F>M	11/12.9	7/31	30.3/33.4	1.2/0.2	*4/9.1*
	M=F	4/9.4	4/14	42.0/41.6	2.1/1.3	*4/9.1*
	M>F	8/9.4	3/8	50.0/28.9	1.2/0.3	*5/11.4*
	M	22/25.9	13/45	18.4/11.5	1.4/0.7	*9/20.5*
	n. d.	25/29.4	5/8	15.8/5.1	1.3/0.4	*20/45.5*
All		85	41/49.5	24.7/23.3	1.4/0.6	*44/51.5*

Table 36: Analyses of human remains and oral health. Results of prevalence per individuals (both affected and without lesions) in terms of age class and biological sex considering frequency and intensity.

tions were present from approx. 2-4 years (3-5 years) at the earliest and acted over max. 4-8 years. For individuals that died during their 17th to 25th year of life[34], the different eruption times of tooth positions point to caries initiation around 6 years of age, whereas lesions on the third molars suggest a maximal caries formation time between 0-6 years.

Caries occur in both sexes; 43.6 % of affected teeth were found in females, and 39.8 % in males (Tab. 35). With respect to the size of carious lesions, advanced tooth decay is true for both sexes with two cases of totally destroyed crowns appearing in males (067_1, 076_3; Fig. 134.6) and two with over 50 % deconstruction in female individuals (039_1, 045_1). Smaller lesions are almost equally distributed, as due to the chronological relationship of lesion size males are both older and show more often lesions larger than 3 mm^2 as well as on CEJ locations. The extent of caries affection within individual dentitions is not dependent on the sex (Fig. 135, Tab. 29). The high values (3.5) for individuals 076_3 and 127_1 result from the low number of teeth preserved due to postmortem and antemortem loss, which points to the importance of the caries calibration conducted later in this section. This is also true for individuals with over 50% of the dentition affected (076_4, 182_1, 219.2_1).

The comparison with the remaining 51.5 % of the population without caries confirm the age correlation observed, as the percentages of caries prevalence increases with age from young, unaffected juvenile dentitions (Fig. 136). This stays in contrast to biological sex as females show higher percentages in overall incidence, while males show in average more severe forms of dental decay due to caries.

34 047_1, 047_3, 058_1, 81_1. Carious teeth: All categories (incisors, canines, premolars, molars).

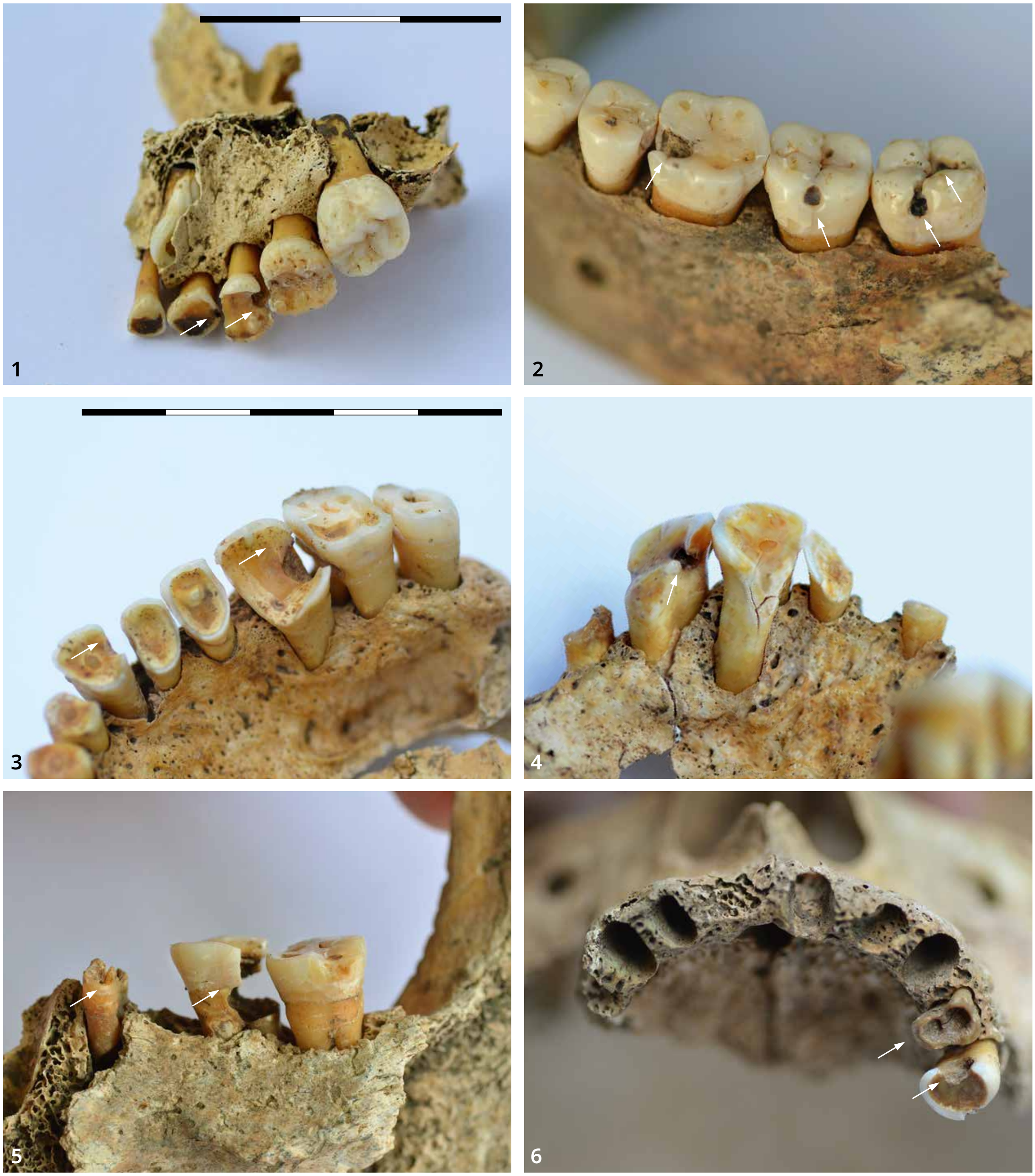


Figure 134: Analyses of human remains and oral health. Examples for caries prevalence and other dental conditions (caries grade, location/other dental conditions). 1: Ind. 047_2, right maxilla, medial-palatinal v., 52-55, 16, old child; deciduous crown interproximal contact lesions grade 1. 2: Ind. 047_3, left mandible, buccal v., 34-36, juv/young adult, F>M; crown buccal and occlusal lesions, grade 1-2. 3: Ind. 67_1, left maxilla, medial-palatinal v., 21-28, middle adult, M; CEJ interproximal lesions grade 1-2/asymmetric dental wear, 21-26 with pulp exposure/periodontitis grade 1-2/23-24, 26 periapical lesions grade 1-2. 4: Ind. 050_1, right maxilla, medial-palatinal v., 23, 25-28, middle adult, F; CEJ interproximal lesion, grade 1/heavy asymmetric dental wear with pulp exposure/periodontitis grade 2-3/28 crown damage with pulp exposure/24 a. 28 partial AMTL. 5: Ind. 047_5, right mandible, lingual v., 46-48, adult++, M=F; root and CEJ gross lesions 46, 47/periodontitis grade 2/46 devital tooth with pulp exposure, distal root postmortem loss/47 l abscess. 6: Ind. 076_3, maxilla, occlusal v., 21-25, 11-13, middle adult, M=F; 24-25 root gross and CEJ interproximal lesions grade 4 and 2, with pulp exposure/periodontitis grade 2/11 AMTL.

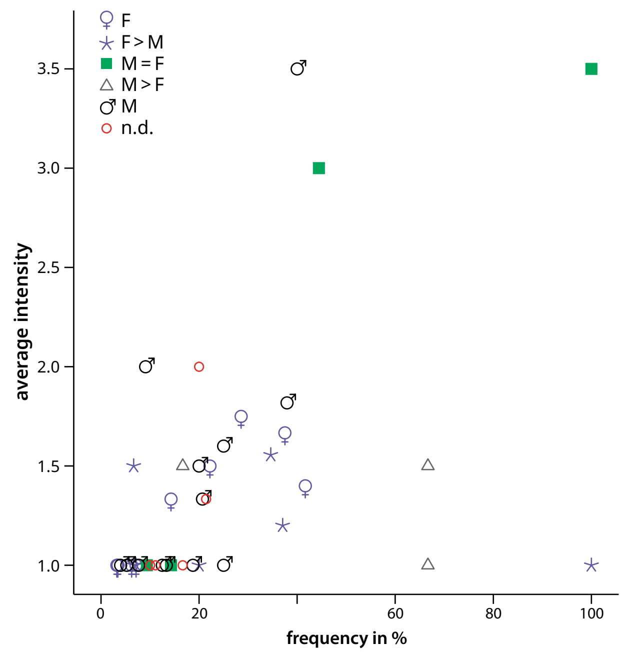


Figure 135: Analyses of human remains and oral health. Individual caries frequency (% affected teeth) and average intensity with respect to biological sex (n=41).

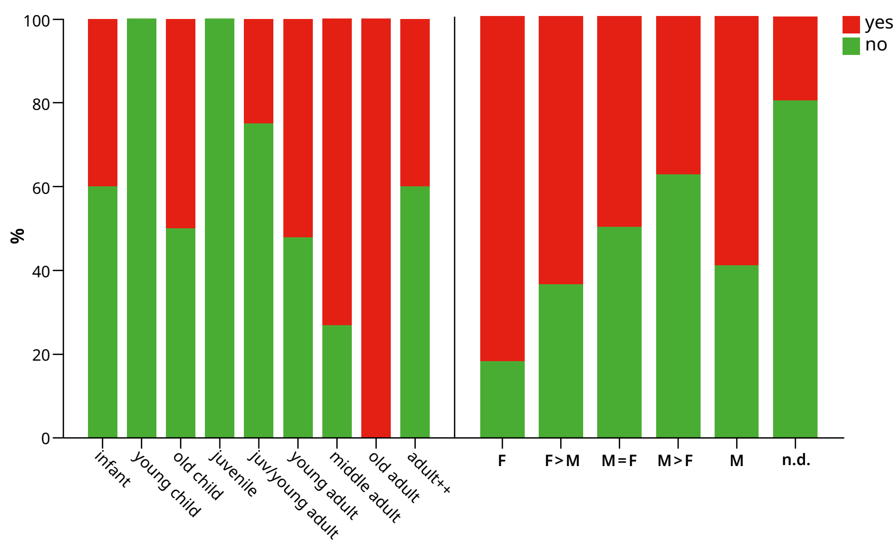


Figure 136: Analyses of human remains and oral health. Percentages of caries prevalence in terms of age class and biological sex (n=85; for detailed numbers see Table 35).

5.6.3.8 AMTL calibration: Caries and dental wear

The combined approach of caries calibration is based on the fact that missing teeth, either lacking due to postmortem or antemortem tooth loss, are not considered in the calculation of caries rates (observed carious teeth *vs.* real number of carious teeth; cf. Lukacs, 1995). The applied approach uses a method described by Lukacs, 1995) and Duyar and Erdal (2003) and includes two main factors that influence the caries affection rate:

(1) Antemortem tooth loss. As pulp exposure is the primary condition for periapical lesions and subsequently intravital tooth loss, tooth decay due to caries or dental wear is an important contributing factor for AMTL. In consequence, for a more accurate estimation of the real caries rate, Lukacs (1995) developed the "Caries Correction Factor" (CCF) by including existing research focusing on this issue. Calculation steps include the estimation of number of teeth lost due to caries (by determining caries-induced and attrition-induced pulp exposure), of total number of

Parameter	Description (*formula*)	anterior	posterior
a	n teeth observed	368	757
b	n AMTL observed	19	92
c	*n teeth min (a+b)*	387	849
d	n caries observed (%) (*a*)	13 (3.5 %)	87 (11.6 %)
e	n pulp exposed due to caries	0	6
f	n pulp exposed dental wear	122	110
g	*r pulp exposed to caries (e/f)*	0	0,05
h	*n AMTL due to caries (a x g)*	0	38
i	*n calibrated caries (d + h)*	13	125
	Caries Correction Factor (i/c)	**3.5 %**	**16.5 %**
	Proportional Correction Factor (CCF x 0.375/0.625)	**1.5 %**	**10.3 %**
	CCR VIA CCF & PCF	**11.8 %**	
	CCR complete population (immatures: 281/7)	**145/10.3 %**	

Table 37: Analyses of human remains. Procedure of caries calibration according to Lukacs (1995) and Duyar and Erdal (2003). The calculation includes mature individuals only (older than juvenile, n=62, n teeth=1126). OCR of immatures is 2.5 % (7 carious, 281 non-carious teeth).

teeth with caries, and of the total number of originally existing teeth (Tab. 37; for detailed descriptions cf. Lukacs (1995).

(2) Different proportions of postmortem loss in anterior and posterior teeth. This was confirmed for the population under study with anterior positions being more prone to postmortem loss. The observation that teeth of the anterior positions show fewer caries lesions compared to posterior ones, which is also true for the population under study, might result in an artificial increase of caries rates when there is disproportional loss of anterior teeth. Therefore, the proportional correction method considers this imbalance by calibrating anterior and posterior caries rates according to their 3/5-ratio, called the “Proportional Correction Factor” (PCF; factor 0.375 for anterior, and 0.625 for posterior teeth).

Although based on the observed caries rate (OCR) of 8.4 % in the 1406 examined teeth from the complete population, the undertaken calibration focuses on that of mature individuals with fully developed permanent dentition (older than juvenile; n ind=62, n teeth=1126), who exhibited 100 teeth with carious lesions (OCR 8.8 %) and 111 positions of AMTL (Tab. 36). For determining wear-induced AMTL (parameter f), occlusal abrasion stages ≥6 for anterior (n=122) and ≥7 for posterior were counted. For determining caries-induced AMTL, teeth with lesions ≥3 are considered, which is a low estimate (especially for anterior teeth, n=0; posterior n=6).

After considering numbers of AMTL and the probable ratios caused by caries (e) or severe attrition (f), the intravital loss of 37.85 posterior teeth (38) was probably caries-induced (h), while the primary cause of anterior tooth loss was likely the opening of the root canal to severe dental wear. In consequence, the corrected numbers of carious teeth are 13 for the anterior and 125 for posterior positions. In summary, the real number of carious teeth was about 138 (i), resulting in a corrected caries rate of 20.00 % (3.5 % + 16.5 %). The application of the PCF results in final rates of 1.5 % carious anterior teeth and 10.3 % carious posterior teeth. In total, the corrected caries rate (CCR) for the mature population of Kudachurt 14 is 11.8 %, with a difference to the OCR of 3 %. For the CCR of the complete population, including immature individuals, the rate increases from 8.4 % to 10.3 % (145 teeth in total).

In consequence, specimen that exhibited both caries and AMTL probably had more carious teeth during their life, and potentially lost these teeth due to bacterial infection of periodontal tissues which entered through the caries cavity. This is true for at least 19 individuals; those that lost teeth intravitally but do not showed carious lesions on remaining ones might also have been affected. Thus, we can assume that besides a general higher CCR, the number of affected individuals was actually higher than the originally observed 49.5 %.

Besides an increase of the CCR and probably more individuals suffering from caries, the generated results also stress that severe dental wear was probably the main causation for AMTL in anterior positions (providing pathogenic agents access to the pulp canal, initiation of periapical lesions accompanied by loss of tooth supporting structures, abscesses and subsequent intravital loss). This interrelation is probably true for several individuals (032_1, 039_1, 087_1; Fig. 118.5, 121.2-4, 128.4.7), although caries-induced AMTL cannot be excluded completely.

5.6.3.9 Extramasticatory traits: Occupational habits or hygienic measures?

According to the current state of research, extramasticatory dental wear derives from three main principles (see chapter 5.4.5.5): (1) occupational use of teeth as a tool, (2) dental treatment, and (3) socio-cultural behaviour. Although the potential of extramasticatory modifications present in the examined dental record has not yet been explored completely, some indications given for the first two mentioned principles will briefly be discussed in the following text.

Atypical patterns of occlusal macrowear, specifically abrasion of local tooth positions and excessive wear of the anterior teeth, can be evaluated as indicators for the use of teeth as a tool during occupational working processes. The analyses of occlusal macrowear suggest that such patterns were existent in several individuals from Kudachurt 14 (see chapter 5.6.3.5; Fig. 119), and that related activities differed between the individuals. For reconstructing such activities, for instance determining differences in the type of processed material or movement patterns, at least further investigations of dental microwear as well as ethnological comparisons are necessary. Nevertheless, the following aspects should be stressed:

- The temporal dimension of the occupational use of teeth is hardly detectable. Severe dental wear in general indicates a certain degree of continuity and repetitive character of related activity patterns, especially in the initial phase in which the enamel still fulfils its function as a protective tooth cover. This is especially true for individuals with the tooth crown fully worn down. At the same time, examples of calculus that have been polished or impressed in apical bifurcations within the inducing activity, lead to the conclusion that such occupational habits either allowed the accumulation and subsequent mineralisation of plaque in such niches, or that the calculus was gradually aligned (127_1, 37, Fig. 109.5; 218.2_1, 17; 031_1, Fig. 123.5-7). The second hypothesis would mean that the individual started with the occupational habit after the accumulation of calculus, in consequence after an appropriate time span. Additionally, changing patterns of tooth use during the course of life is obvious, especially with increasing number of intravital tooth loss or progressive dental decay.
- In this regard, the performed estimations of age at death, age class spans, and explicit investigations of wear patterns are not sufficient to allow clearer statements. Nevertheless, the fact that such extramasticatory modifications have not been found in children or juveniles suggests three considerations. Either immature individuals did not practice related working processes or did, but in a very short and irregular manner. A third option is that the exposure time of the deciduous dentition was too short for according manifestations.

- There are different evidences that the use of teeth as tools stands in no relation to its physical consequences, for instance tooth dislocations, alveolar atrophy, and periapical inflammations (see below; *e.g.* 218.2_1, 16, Fig. 127.3; 050_1, 17, Fig. 127.1; 032_1, Fig. 134.5). Individuals with such patterns kept on repeating related habits, although this was accompanied with loosening of teeth, loss of supportive structures, infections, and potentially tooth loss.
- Although the principle of the use of teeth as tools is accepted to be very likely for some individuals, there are also indications for the second principle, dental treatment. Removal of calculus and dental plaque by toothpicks is one major interpretation for the appearance of interproximal grooving. The mutual occurrence of occlusal notching and interproximal grooving with pathological lesions supports the indication of therapeutic treatment in different respects. Different observations made on the dental material under study not only support this hypothesis, but also expand it by additional aspects:
- Several individuals exhibited interdental grooves with carious lesions on the same surface (see Fig. 137; 040_1; 050_1, tooth position 16; 218.2_4, 27, 47, 48; 218.2_6, 24). The pictures taken by the digital microscope showed that inside of the caries cavity grooving in at least two cases, which indicates that the "tooth picking" was directly associated with the dental condition, and that either the individual died shortly after or that the demineralisation process has stopped (040_1, Fig. 137.6. ; 050_1, 26). It cannot decide if the penetration of the cavity was intentional or random, so it is not a decisive proof of trying to clean out the carious lesion. For the example of individual 040_1, the striations are not horizontally but vertically directed, which stays in contrast to the horizontal grooves. This indicates at least a singular targeted picking at the lesion (Fig. 137.6). More cases of striations inside of the caries cavity are currently not known from the dental record of Kudachurt 14, this would require re-investigations with more precise methods. Nevertheless, based on the literature research conducted, this is the first evidence of caries lesions showing such furrows in prehistoric skeletal material. In general, the fact that the interdental spaces make the primary areas of caries initiation, and that the horizontal grooves are located in these regions, support the hypothesis of interproximal grooves as measures of oral treatment.
- In general, the overall prevalence of mineralised plaque does not allow conclusions in this regard. For instance, individual 077_1 exhibited large accumulations of calculus on buccal and lingual tooth surfaces but interproximal grooves on the interdental areas only, meaning that the interdental spaces were cleaned, yet did not prevent the formation of caries lesions and the lingual and buccal tooth surfaces were not cleaned. Facets on the lingual surface in the CEJ area or on the root might result from removal of calculus in these locations, which are very prone to such accumulations. Similar indications might be present for individuals 138_1 and 190_1 (Fig. 124.5-6.10-11) and for mesial and distal notches from the occlusal tooth surfaces of other individuals (138_1, Fig. 126.10.-11; ind. 040_1, Fig. 123.2.4.7). This stays in contrast to striations found on the occlusal surfaces of anterior teeth of individual 039_1 (Fig. 124.4.7). Hence, the author suggests re-classifying such occlusal grooving as vertical grooves.
- Even though the modification on the right upper third molar of individual 040_1 is not of circular shape typical for interproximal grooving but rather of smooth nature, the polished edges of the cavity rim suggest a continuous activity pattern after the carious demineralisation had begun (Fig. 137). Additionally, there are only very few grooves where calculus deposition was evident (*e.g.* 048_1, 16; 040_1, 17). Altogether, this suggests that individuals practicing interdental cleaning did this probably until death.
- The case of specimen 190_1 (Fig. 124.8-9) is an example for co-occurrence of severe periapical inflammation and vertical grooving on the lingual root. Up

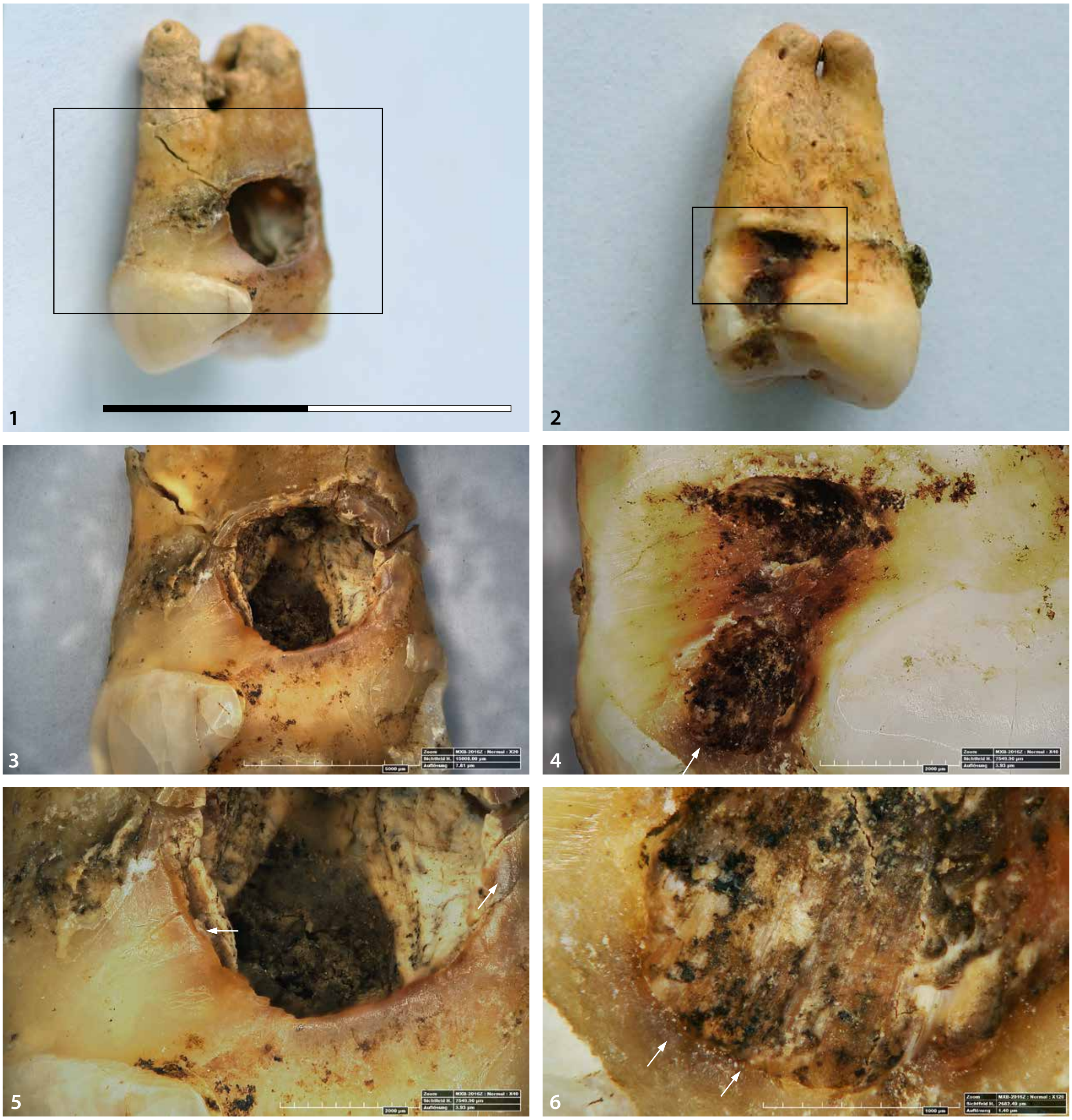


Figure 137: Analyses of human remains and oral health. Examples for co-occurrence of interproximal grooving, vertical grooving, and caries on different scales by using the digital microscope (3-6). 1-6: Ind. 040, middle adult, M. 1.3.5: 18, mesio-buccal v., interproximal groove of faint cross-section, rather polished surface below the CEJ as well as vertical facet from the occlusal direction, and caries lesion grade 3. Surrounding and rims of the cavity are polished (5). 2.4.6: 27, mesial v., interproximal groove with furrowed surface and striations inside the caries cavity (6).

until the time of death, the inflammation of the lingual periapical bone led to an opening of the abscess cavity to the maxillary sinus by drainage. The furrow on the lingual root ends approximately on the cavity level. The roughened and porous bone of the cavity wall indicates that the inflammation was acute around the time of death, but it is not clear if the grooving took place at the same moment. Two hypotheses are possible: Either the periapical abscess was provoked due to bacterial contamination resulting from the grooving activity, or the grooving was a treatment measure as a response to the inflammation. At least 35 % of examined individuals revealed periapical lesions of different forms, and 19 individuals with large cavities or pus drainage fistula. However, individual 190_1 is the only case for direct co-occurrence of a periapical abscess and vertical grooving. Additionally, interproximal grooving seemed to be a practice that was typically performed by males. Thus, is it not very likely that such grooving represented a regular dental treatment in terms of periapical disease.

In general, the co-occurrence of extramasticatory modifications and periodontal disease, including both gums and periapical tissues, is confirmed for the population under study. Interproximal and vertical grooving as well as polished surfaces can be associated with atrophy of alveolar bone and increasing CEJ-AC distance resulting from periodontitis, depending on where the furrows and facets were located (CEJ, root).

Injury of the immediate periodontal tissues (gum) was certainly a significant side effect for individuals practicing such occupational or therapeutic habits. This is especially true for those modifications associated with the use of teeth as a tool, including severe occlusal macrowear, as the overall load on the tooth and tooth- supporting structures was probably higher within the course of such activity patterns. Additionally, surfaces with increased dentine exposure are more prone towards demineralisation and thus to cariogenic processes. This relates to the loss of enamel and root cementum tissues caused by extramasticatory (and masticatory) dental wear. Conversely, continuous ablation of dentine might have prevented the development of caries lesions.

In consequence, individuals exhibiting these traits presumably suffered from a higher oral disease burden compared to individuals not practicing related habits. Within the population under study, this is potentially evident by two categories of oral health: the prevalence of periapical lesions and AMTL as well as singular cases of tooth dislocation. On the other hand, cleaning of interdental spaces and, in singular cases, lingual CEJ regions, as well as continuous ablation of specific tooth surfaces during working processes could have led to lower caries prevalence.

5.6.3.10 Enamel hypoplasia

From a dental record of 1462 teeth from 86 individuals, 34.0 % exhibited enamel hypoplasia (n=489; Tab. 38). There is no difference in terms of upper and lower positions or body side. Regardless of the uneven total record of deciduous and permanent dentitions, the prevalence rate is almost equal with 32.5 % and 33.6 % affected teeth respectively. In terms of tooth position and function in the masticatory system and the different proportions, anterior teeth, especially canines, show increased rates. The average value for anterior teeth is 71.3 and for posterior 55.4, whereas the average affection for canines is 48.3 teeth, followed by 15.8 for molars (incisors 13.9; premolars 10.9). The average for deciduous canines and premolars is 1.75, and for incisors 0.5, but the sample size for deciduous teeth is not sufficient for determining significant differences between the two tooth generations (Fig. 140).

Two forms of EH are present, pit-shaped (32.3 %, Fig. 139.1-3) and linear (59.3 %, Fig. 141.4-7). In some cases, both forms have been identified on the same tooth (8.4 %, n=41, all permanent). Pit-shaped defects seem to be typical for the deciduous dentition, as only one milk teeth showed a transversal furrow; in permanent teeth, linear EH are predominant (62.3 %). The functional inter-tooth comparison of the permanent dentition concludes that incisors and premolars were more prone to linear EH (average affection 11.6 linear/1.1 pit-shaped; 9.5/1.75). Canines and especially molars exhibit both forms (13.5/5.3; 6.25/7.5). Pit-shaped defects occurred frequently on the permanent canines as well as the second and third molars (Fig. 138).

With respect to defect size and degree, four stages of Schultz' classification (1988) were observed. According to these stages, the majority of defects are of faint nature (stage 1-2, 70.3 % and 27.0 %; Fig. 139.4-5), despite their appearance on deciduous and permanent teeth. Eleven of 13 teeth with defects of larger

Table 38: Analyses of human remains and oral health. Total distribution of enamel hypoplasia (pit-shaped and linear) per tooth and anatomy (n individuals=86).

ENAMEL HYPOPLASIA per tooth		All (n/%)	Prevalence		
			EH present	average	*no EH*
Anatomy	**maxillary**	717/49.0	246/50.3	-	*471/48.5*
	mandibular	745/51.0	243/49.7	-	*500/51.5*
Side	**right**	738/50.5	250/51.1	-	*487/50.2*
	left	724/49.5	239/48.9	-	*484/49.8*
Dentition	**DD**	77/5.3	25/5.1	-	*52/5.4*
	PD	1385/94.7	466/94.9	-	*919/94.6*
Section	**anterior**	484/33.1	214/43.8	71.3	*270/27.8*
	posterior	978/66.9	275/56.2	55.4	*701/72.2*
Category	**incisor**	291/19.9	111/22.6	13.9	*180/19.9*
	canine	193/13.2	103/21.0	48.3	*193/13.2*
	premolar	377/25.8	86/17.6	10.9	*377/25.8*
	molar	601/41.1	189/38.7	15.8	*601/41.1*
All		1462/100	489/34.0		*971/66.0*

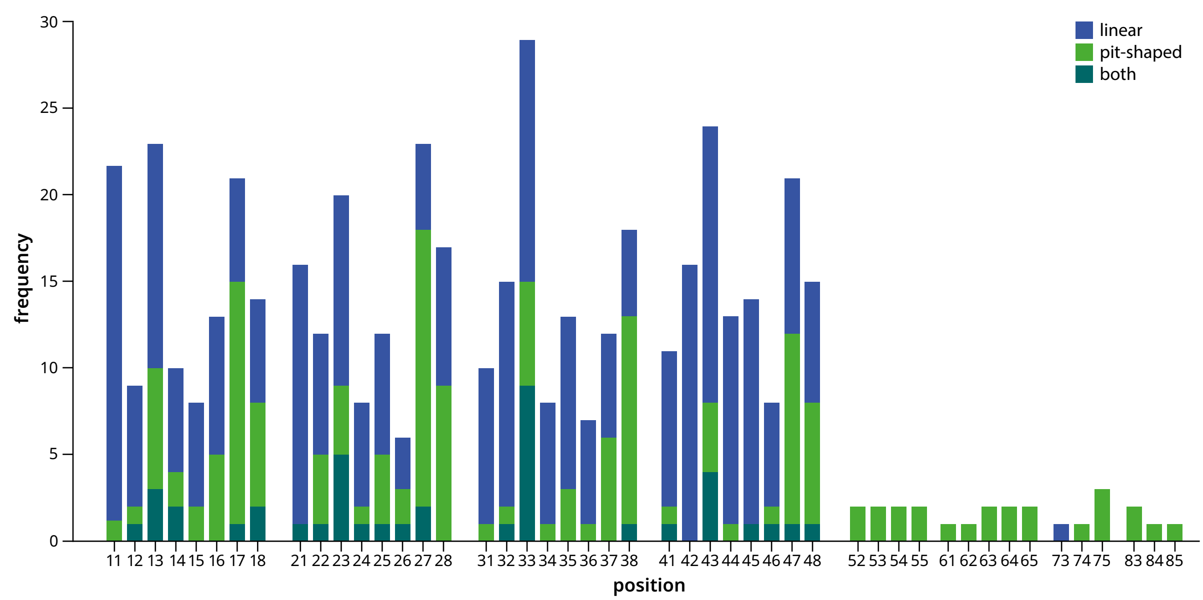


Figure 138: Analyses of human remains and oral health. Distribution of enamel hypoplasia per tooth position and defect appearance; all age classes, deciduous and permanent dentition (n teeth with hypoplasia=491, n individuals=69).

degree are permanent canines and molars; defects of remarkable depth are all of linear form. Stage 3 defects were identified for both forms.

EH age formation intervals

Estimation of age intervals based on specific growing stages for each tooth position related to EH was performed on 489 teeth with 741 intervals (Fig. 140). In 318 cases, EH was distinct for one interval (65.0 %), in 126 cases (25.8 %) the defects were observed for two intervals, and in 45 cases (9.2 %) pit-shaped or transversal line-shaped EH formed during three age intervals. These age intervals represent both overlapping age spans, for instance from 2-4 and from 3-5 years, or age spans with gaps in-between, for instance 3-6 months and 3-5 years. Overlapping spans point to amelogenesis disruption over a longer duration, *e.g.* representing seasonal stress events, whereas EH with temporal gaps (and potentially of different shape) suggest periods in which no comparable stress conditions were given. Due to the broad spans of tooth growing stages and the applied approach, the identification of "stress events" for EH with singular age intervals is also quite inaccurate.

Disturbances of enamel development have been observed for all stages of crown mineralization. Thus, with respect to the complete dental record, physical stress causing EH occurred in all stages of infancy, childhood, and early juvenile age. Formation age intervals until 8 months include EH present on deciduous teeth in 29 cases and on permanent teeth in 17 cases (molars and incisors, 3-9 months). According to the smaller number of deciduous compared to permanent teeth, the total number of these age intervals is lower in general. In total, disturbances of enamel formation of pit-shaped form occurred more frequently with longer distance from birth (17 to 26 months). During the formation stages of permanent teeth, the major phase of enamel formation happens in between one to five years of age; for instance, during the 3rd year of life, contemporary crown mineralization processes of up to 28 teeth takes place. This one aspect needs to be considered in the observation that 51.7 % of all enamel defects occurred during these years of late infancy to young childhood for the population under study (max 2-6 years). This trend is also reflected in the correlation of decreasing enamel defects with increasing age intervals; still, obtained data suggest that EH causing stress events also occurred in juvenile to early adult age, as defects on the third molar on different crown heights are evident, but were most frequent in the early childhood. In the intra-tooth comparison[35], of multiple EH on the same tooth at distinctively different enamel formation stages (incl. min/max values >0.5 years), including inconspicuous surface in-between, are rare with ten cases; in conclusion, repeated punctual stress events with temporarily healthy enamel formation over several months represent exceptions. Furthermore, inter-tooth comparison gives more information about multiple events or periods of physical stress in the same individual.

Figure 141 summarises two criteria of EH formation age, on the x-axis the maximum of the age interval and on the y-axis the mean formation age. Depicted are EH form (left graph) and severity (right graph) per tooth. This distribution shows that the shape of enamel defect, if linear or pit-shaped, is not typical for certain maturity phases of childhood and adolescence, although it is known that those formed during infancy are predominantly pit-shaped. Longer formation periods for pit-shaped defects is determined by its nature, as such pits are larger in vertical diameter compared to linear hypoplasia, and consequently reflect a longer time span of enamel development. With respect to the depth of enamel depression, the few cases of severity grades 3 and 4 (n=13) mainly formed during infancy (*ca.* 0-1.5 years) and early childhood (2-4 years). One pit-shaped defect was caused in late childhood and two linear depressions of grade 4 during early juvenile age. Based on the assumption that the severity of EH correlates with the degree of physical stress, such events more often occurred during infancy and early childhood, potentially representing exceptional events for according individuals or their sensitivity towards factors of physical stress. Mild manifestations are not significant in any direction.

EH per individual

For calculating the individual frequencies and age intervals of EH, three steps were undertaken: (1) Calculating the affection rate in terms of frequency by considering teeth assessable for EH, which included removal of teeth with severe dental wear (stage 7-8, exhibiting no enamel defects; Tab. 38, fourth column, "n teeth ass."). Depending on the degree of wear, EH of early age formation stages or even later stages could be missing.

35 Ind. 032_1, 11/21; 174_1, 22; 047_1, 22; 178_C 22; 174_1, 33; 117-2, 33; 038_2, 36; 211_1, 43.

Figure 139: Analyses of human remains and oral health. Examples for linear and pit-shaped enamel hypoplasia (l/pEH; formation age)/other dental conditions. 1: Ind. 047_2, right maxilla, 53-55, buccal v., infant (2-4 years); 53-55 p EH, grade 2 (0-0.2 year)/occlusal wear 5-6. 2: Ind. 200_1, 36, mesial v., infant (2-4 years), pEH, grade 2 (01.5-2.5 years). 3: Ind. 218.1_4, 83, buccal v., infant (2-4 years), pEH, grade 2 (0-0.2 year). 4: Ind. 117_2, right maxilla, 13-15, buccal v., middle adult, M=F; 13 lEH, grade 2 (01.5-2.5 years/13, 15 buccal chipping 4/periodontitis 1. 5 Ind. 174_1, mandible, 31-32, 41-43, lingual v., juvenile (12-4 years); all transversal 2 (0.6-1.3 years)/periodontitis 1. 6: Ind. 032_1, right mandible, 43-45, buccal v., middle adult, M; 43 lEH (3-5 years)/dental wear 6-7/periodontitis 1-2. :7 Ind. 081_1, mandible, 32-33, 42-43, buccal v., young adult, F>M; 32, 42 LEH grade 4 (0.5-1 year), 43 LEH grade 2 (0.6-1.3 years)/dental wear 3-4/calculus 1/periodontitis 1.

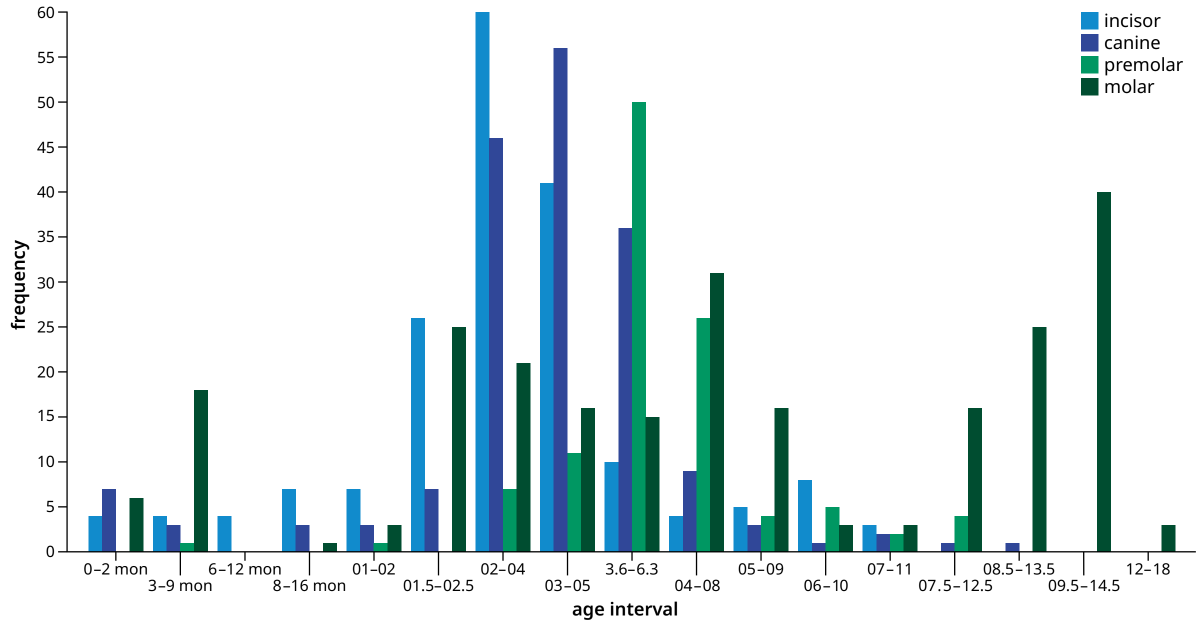


Figure 140: Analyses of human remains and oral health. Distribution of enamel hypoplasia per recorded age formation interval and tooth category (n=741, n teeth=491, n individuals=69). Age intervals in months (1-4) and years of chronological age.

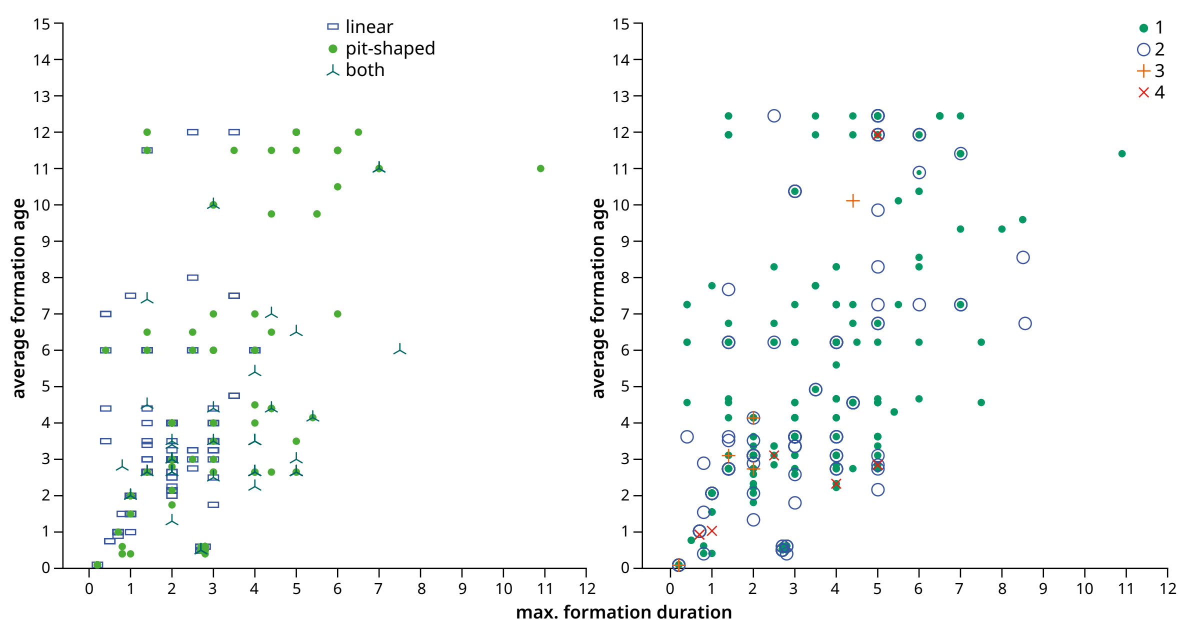


Figure 141: Analyses of human remains and oral health. EH from and manifestation severity related to formation age (n teeth=498, n individuals=69). Average formation age is a summation of all mean EH formation values present on one tooth, and maximum formation duration describes the maximum period during which the dysfunction in enamel development took place. EH form and severity grade according to Schultz (1988).

(2) Calculating the average EH severity: added sum of severity grades divided by the number of teeth affected. (3) Calculating the average age intervals of EH appearance per individual and tooth. Therefore, the mean formation age per tooth was calculated, *e.g.* for age interval 2-4, the mean value is 3. For teeth exhibiting multiple age intervals (171 cases), one mean value for the maximum age span was calculated. Distinct gaps between enamel defects in the intra-tooth comparison as indicators for separable stress

ENAMEL HYPOPLASIA per individual		All (n/%)	EH (n/%)	n teeth ass-es./% affected	*no EH (n/%)*
Age class	**infant**	5/5.8	7/7.2	38/44.7	*0*
	young child	4/4.7	2/2.9	0	*2/11,8*
	old child	7/8.1	7/10.1	116/38.8	*0*
	juvenile	7/8.1	6/8.7	143/58.0	*1/5,9*
	juv/young	8/9.3	8/11.6	191/43.5	*0*
	young adult	22/25.6	19/27.5	419/41.7	*3/17,6*
	middle adult	26/30.2	19/27.5	225/36.4	*7/41,2*
	old adult	2/2.3	1/1.4	14/7.1	*1/5,9*
	adult++	5/5.8	2/2.9	31/9.6	*3/17,6*
Biological sex	**F**	11/12.8	10/14.5	184/39.1	*1/5,9*
	F>M	10/11.6	9/13.0	184/57.1	*1/5,9*
	M=F	8/9.3	5/7.2	162/26.5	*3/17,6*
	M>F	8/9.3	7/10.1	101/26.7	*1/5,9*
	M	23/26.7	17/24.6	269/29.7	*6/35,3*
	n. d.	26/30.2	21/30.4	343/47.2	*5/29,4*
All		**86/100-**	**69/80.2**	**-**	***17/19.8***

Table 39: Analyses of human remains and oral health. Prevalence of enamel hypoplasia (EH) per individual (n=86). Third column addresses total numbers of teeth assessable and respective frequency of those exhibiting EH.

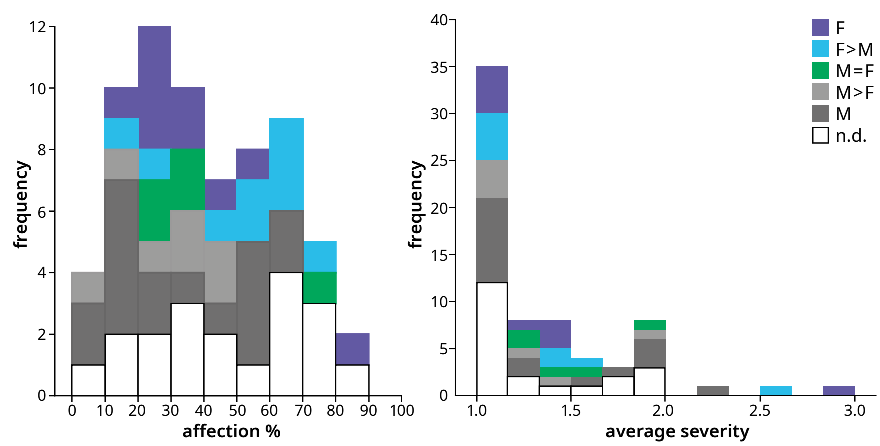


Figure 142: Analyses of human remains and oral health. Prevalence of EH per individual (n=69) and biological sex in terms of affection rate (related to the individual number of assessable teeth) and average severity (summation of EH grades divided by the number of teeth affected).

events are not considered in this approach. Figure 145 illustrates both results by displaying the boxplot EH mean age values for each tooth affected accompanied by a label of the affection frequency.

With 69 of 86 individuals with dental preservation affected, EH is a common condition (80.2 %) (Tab. 39). As more than 30 % of the dentitions were in assessable condition for the majority of non-affected skeletons, the non-prevalence of EH in these individuals is probably not due to preservation. In terms of general EH prevalence and non-prevalence, it appears in both sexes and among all age classes. For individuals lacking EH, males are slightly more frequent. In the affected population, females show significantly higher rates of teeth with EH compared to males. This is evident by the total numbers of teeth exhibiting enamel hypoplasia (F/F>M n=178;

M/M>F n=107), especially with respect to the rates of assessable teeth (39.1/57.1 % to 26.6/29.6 % exhibiting EH; Tab. 39, Fig. 141). Based on the summation of all mean values, average EH formation age for males and females differs 1.5 years, from 5.9 to 4.4. This suggests that children and juveniles of female sex experienced more frequent stress events and at younger ages.

The frequency rates per dentition differ from 4.2 % to 85.0 % of teeth affected (n assessable >2). On average, 40.9 % of teeth per dentition exhibit EH (approx. 13 teeth). The distribution does not show a distinct peak for low and high frequencies (Fig. 142); most frequent is an affection between 20-30 %. The correlation to biological sex follows the above-mentioned trend. In terms of EH extent, severity grades from 1 to 4 appear of different nature within the individuals. Most specimen showed defects primarily of grade 1, and a few of grade 2. Six individuals show very pronounced pits and transversal furrows in the enamel surface, often with multiple manifestations within their dentitions (grade 3: 047_2, 127_1, 032_1, Fig. 139.6). Individual 081_1 (Fig. 139.7) and 134_1 are noteworthy in this regard, as both exhibited multiple EH of grade 4, which occurred in temporal association with milder manifestations on other teeth, but for individual 134_1 during infancy and early childhood, and individual 134_1 during juvenile age (see Fig. 141). Both skeletons were of female constitution.

As enamel develops during childhood and adolescence, in principle EH occurs independently from the age at which an individual died; here, the opposite could be true, as tooth damage due to dental wear and caries in advanced age could prevent from diagnosing EH, especially related to that which formed during early age stages (Fig. 149.6-7). This might be evident in the correlation of decreasing frequencies in classes of increasing age. In this context, observed sex-related differences in EH rates and average formation age might be due to higher grades of dental wear for individuals of male/likely male constitution. The highest rates are found in infants and juveniles, whose dentitions largely lack advanced dental wear (see Fig. 139)

Within the population affected, the inter-individual comparison of mean EH formation ages allows the following observations (Fig. 143):

- Different mean formation ages and durations of EH exist (Fig. 143; see also Fig. 141). Hence, underlying physical stress occurred at different ages of childhood and adolescence and over different time spans in a continuous or periodic pattern.
- A positive correlation in increasing number of assessable teeth and increasing values of EH numbers and age of formation intervals is suggestive, as the different tooth categories represent age stages in shifts of crown development. Based on the EH frequency rate calculated for each individual, this is not confirmed as a rule. There are several individuals with low frequency rates, yet EH reflecting issues during early as well as older ages, thus long time spans of EH formations (similar are 047_8, 130_1, 072_1, 218.2_2). This means that comparatively few teeth had enamel defects formed at different age stages. At the same time, some individuals with similar frequencies show shorter average time spans of defect formations (*e.g.* 045_5, 176_1).
- What needs to be considered here is individual age, as children, especially of young age, could not develop EH in later age stages (Fig. 139, white boxplots for immatures). For instance, individual 129_1 presented 21 of 32 teeth with EH (65.6 %), but most of them formed during early childhood. Accordingly, the EH age intervals were shorter and earlier in life. Still, even within immature individuals, observed differences exist already during infancy and early childhood (ind. 211_2 and 218.1_3, both between 3-6 years).
- In consequence, it is questionable if the distributions of males, females, and individuals of indeterminate constitution all of whom had developed their full

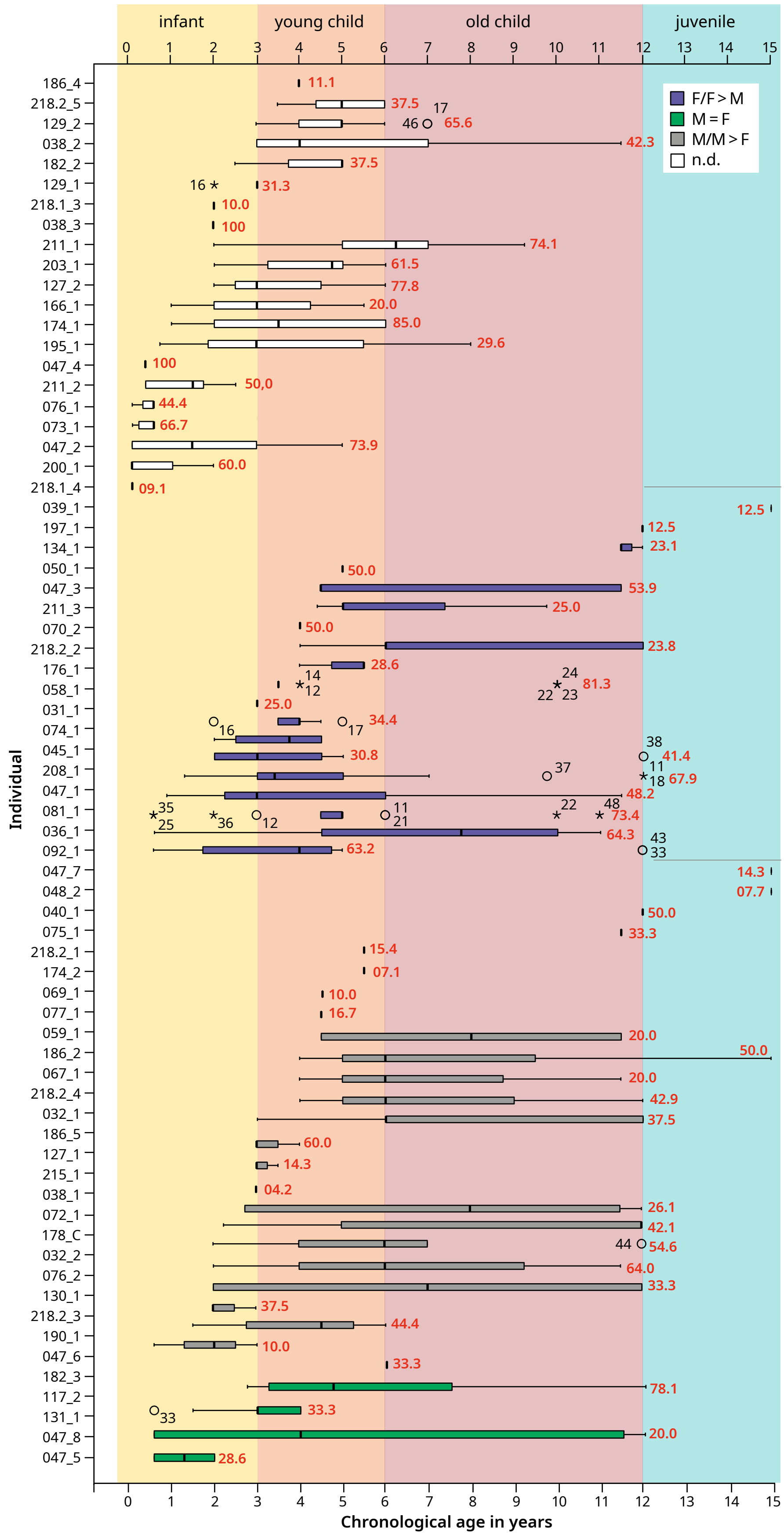


Figure 143: Analyses of human remains and oral health. Boxplots of individual EH formation ages (mean values per EH) and frequency rates per biological sex. Except 038_2 (juv/adult), all individuals of indeterminate physical sex (n. d., white boxplots) died at subadult age.

dentition before death and thus express older enamel formation stages, show similar tendencies. Here, dentitions from young adults with fully developed crowns and little occlusal tooth loss (17 female/likely female, 8 male/likely male), are reliable indicators. Except individuals 031_1, 039_1, 050_1 and 045_1, all individuals of female constitution died in that age class and show almost all variabilities of EH occurrence in terms of frequency, first and last formation age, and maximum formation age spans. This tendency is also true for males, but the shift towards older age stages remains (032_2, 047_8, 076_2, 178_C, 186_2). Due to fewer affected teeth, their boxplots reflect rather inaccurate values, whereas for females distinctions between the single teeth are visible by the outliers of according boxplots; for instance, specimen 036_1 and 076_2, whose dentitions exhibited EH for similar formation ages, but manifested in different frequencies on the teeth.

With respect to physical stress being the causation for EH, the summation of all result lead following assumptions:

- The general presence of EH concerns the majority of the population under study, but differences in terms of frequency and age formations exist within the different age classes, suggesting deviating patterns of causative physical stress or in the biological mechanisms of amelogenesis from early childhood on.
- Frequency peaks in the age between 2.5-4 years result from the number of teeth developing during that age, and earlier as well as later age formation stages prove that the causing circumstances were not related to a certain stage of physical maturation. To detect such patterns, a more accurate approach is necessary.
- Intra-tooth, intra-individual, inter-tooth, and inter-individual comparisons showed that related physical constrains appeared in most individuals on a continuous or periodic basis, affecting singular or multiple teeth of a dentition. The fact that many individuals reached adulthood experiencing this stress, be it seasonally or otherwise provoked, suggests that they recovered from a physical burden that was not life threating but was drastic enough leading to EH.
- EH occurred contemporaneously on different teeth but in different extents. This either would support the hypothesis that different teeth were more susceptible to disruptions of incremental enamel layering, in this case resulting from the same stress event, or could reflect different stress events happening at brief intervals. In terms of susceptibility towards EH, whether it be due to the nature of stress event or the respective physical conditions, the results suggest that differences within the population under study were existent, and that the biological sex was an important aspect in this regard.
- Higher frequency rates of EH for females could result from two reasons. Females either experienced heavier physical strains already in childhood and adolescence or were in general more prone to dysfunctions in amylogenesis and thus reacted sensitively to external influences.

5.6.4 Summary oral health: Results 1

The osteological and dental analyses of human remains from Kudachurt 14 included 60 graves (of 130, 46,.2 %) and 108 individuals (of 265 MNIC, 41.5 %). Additionally, 90 *in situ*-age estimations resulted in a total of 198 individuals of known immature or mature physical state of age at death (75.5 % MNIC). 86 individuals provided dental and/or skeletal material for the investigation of 7 oral health categories (32.45 % MNIC). Within the cemetery, the graves under study show a sufficient representativeness in terms of spatial distribution. Due to heterogenic skeletal and/or *in situ* preservation, the osteological record within the burials is fragmentary, meaning that the inhumation groups of double and collective burials have not been investigated completely. The skeletal population under study makes up a representative sample for the buried population at Kudachurt 14.

Regarding the population, the osteological estimations of biological sex and age at death display ratios of immature to mature individuals of 1:2.2 (30 %:70 %), with all age classes (except new-borns/foetus) represented. Most individuals died at young (31) and middle adult (27) ages, although the latter covers the largest chronological span (20-45 years). Including the *in situ*-age estimations, the ratio slightly shifts to 55 immature and 174 mature individuals (1:2.7). Within the skeletal record of mature individuals, the sexual dimorphism shows a slight imbalance between males (37[36]) and females (24[37]; ratio 1.5:1) and the combination of both parameters shows that females had a higher mortality in younger age classes. Based on the spatial distribution as well as the variable compilation of immature individuals, males, and females in inhumation groups, there is no evident patterning in demographic parameters in terms of grave contexts. Different kinds of social and/or kinship relations among inhumation groups are possible.

The investigation of oral health categories focused on independent analyses of dental calculus, periodontal disease, dental caries, periapical processes, antemortem tooth loss (AMTL), dental wear including masticatory and extramasticatory modifications, and enamel hypoplasia, based on 2561 tooth positions and 1462 teeth (57.1 %). Results were generated per tooth and per individual, along with the calculation of specific descriptive parameters.

Calculus and periodontal disease were common conditions within the population under study. Calcified plaque was found in almost all specimen (94.1 %) and in mild prevalence. Among individuals with permanent dentition, alveolar remodelling due to periodontal disease is common (88.6 %) and occurred predominantly in mild form within the different tooth positions; higher intensity rates with distinctively increased CEJ-AC distance and loss of tooth supportive structures were found in 21.8 % of the population. Periapical lesions of different sizes and aetiological indications are present in 35 % of the population, whereas nearly half of these lesions showed signs of acute or chronic abscesses with inflammation of the apex region and loss of periodontal tissues (43.6 %), including fistulae. Affected individuals often suffered from multiple lesions, indicating high disease burden at their time of death. In 31 cases, where there was no tooth preserved in an alveolus with advanced remodelling and signs of acute inflammation, perimortem tooth loss was possible. The condition of PPTL was established as an additional investigative parameter (potential perimortem tooth loss, often in frontal teeth) in the subsequent analyses of AMTL. With 110 alveoli showing signs of healing, 43.3 % of the individuals experienced tooth loss during life with different distances to the time of death. Lower positions of premolars and molars were primarily affected, and the inter-individual comparison displayed different stages of frequency, from only one position to 13 positions with intravital tooth loss.

Main findings of the analyses of macrowear are that advanced ablation of teeth involving the CEJ and/or the root (12.2 %) and of asymmetric as well as occlusal nature, is predominant in maxillary teeth and in anterior positions. This contradicts the typical mastication-induced pattern expected for premolars and molars, which is also apparent on the other teeth, and is true for at least 21 mature individuals (33.3 %). In deciduous teeth, such a pattern was not distinct. With a prevalence of 61.2 %, chipping is frequent among the population; different frequencies and extents (max 42 mm^2) of tissue loss show a certain degree of variation, but without distinct correlations to specific tooth positions or locations. Extramasticatory modifications

36 M=26; M>F=9.
37 F=12; F>M=12.

such as interproximal grooving, occlusal grooving, and facets seem to be more specific for 20 individuals. With 65 teeth showing 95 interproximal grooves, 14 cases of occlusal notching, and facets on 23 teeth, interproximal grooves were most frequent. These individuals showed multiple of such lesions, and the horizontal grooves differ slightly in shape and extent. Most of the notching grooves are of similar shape but are vertical in direction and except two individuals showing both forms, interproximal and occlusal notching are not associated. Yet, both modifications were presumably induced by a firm external material (toothpick or similar). Smooth and polished facets are of different extent, some run through several tooth locations and within several locations on the same tooth, indicating rather flexible and soft inducing material. Three individuals exhibited both interproximal grooves and facets. As these extramasticatory modifications, chipping, and occlusal macrowear have been investigated in the same category of dental wear and interrelations among them are suggestive, their mutual occurrence has been investigated by applying correspondence analyses. The result concludes that the dentitions had differently been altered throughout life, and although individual age has a strong impact on some modifications, individual habits connected to dental treatment or occupational activities also played important roles.

Within the dental record, 8.4 % of teeth exhibited caries lesions, mainly in premolars and molars with major initial locations in the interproximal CEJ and there was a frequent affection of neighbouring teeth. Both sets of teeth, deciduous as well as permanent, revealed caries. Small lesions are most frequent, but also gross dental decay due to caries occurred. With 49.5 %, almost half of the population was affected, showing different severities and frequencies in the inter-tooth and inter-individual comparison. A strong causative relationship is suggestive for AMTL, caries, and occlusal macrowear, resulting in underestimations of observed caries rates due to intravital loss of affected teeth. As all three conditions of oral health represent important findings at Kudachurt 14, the *Caries Correction Factor* and the *Proportional Correction Factor* were calculated for the mature population under study. The procedures resulted in a calibrated caries rate of 11.8 % in mature individuals (138 teeth), 3 % higher than the OCR. Regarding the complete population, the CCR is 10.3 %, an increase of 1.9 %. As an additional result, the calculation suggests that AMTL was primarily due to severe occlusal macrowear, especially in anterior positions.

The discussion of aspects of extramasticatory modifications provides qualitative analyses of their possible causation by bringing together indicators for the occupational use of teeth as a tool and for dental treatment. Excessive occlusal wear on local or anterior positions as well as unspecific facets suggest longer period of inducting occupational practice for certain individuals, disregarding physical consequences, whereas the starting age of these habits remains undetected in younger individuals. Immature individuals did not reveal such wear patterns, which might be due to too short tooth exposure or not using teeth as tools. Interproximal grooving is seen as an indicator of therapeutic treatment and the traces of occlusal notching are of similar nature at Kudachurt 14. Co-occurrence of caries and vertical or horizontal striations in the interdental spaces on the same tooth locality are present in four individuals, and distinct scratching traces inside of two caries cavities strengthen the assumption of treating caries lesions. Facets on lingual tooth surfaces, which are prone to calculus accumulation rather than caries, suggest removal of calcified plaque in these regions of the mouth; therefore, these notching facets are conspicuous for dental treatment, as is interproximal grooving, which suggests the re-classification of vertical grooves. The case of individual 190_1 is an example for vertical grooving and a severe apical abscess with opening to the sinus cavity. Although it remains unclear if the picking was a treatment measure that potentially at the same time triggering the inflammation, the high number of similar abscesses and lacking striations on the according tooth positions suggests that this was not a commonly practiced dental treatment for periapical lesions. In general, the physical side effects of occupational or therapeutic treatments are indicated by increasing CEJ-AC distance, loss of periodontal structures and infection risks, potentially resulting into periapical lesions and AMT, and a higher disease burden on the individuals practicing related habits.

As a seventh oral health category, different forms of enamel defects report unspecific stress during adolescence for 80.2 % of the individuals, thus EH represents a quite common dental condition. Due to tooth development and decay, only well-preserved dentitions with little abrasion provide reliable marker in this respect. Average formation ages and formation intervals describe rather periodic or continuous physical stress events, rather than periods of childhood and adolescence being prone to such events.

In terms of individual age at death, all categories of oral health except EH showed interrelation with individual age, with higher risks of affection, condition grades, or frequency in older age classes, which is to be expected due to increasing possibilities of alteration in longer tooth exposure times in the oral environment and physiological side effects. The prevalence of caries in children is remarkable. The next section addresses the issue of age-dependency and inaccurate age classifications more in detail. None of the conditions appeared exclusively in males or females. Among the common conditions such as calculus, periodontitis, and chipping, there are not remarkable differences in the relative comparison. Due to the observation that males died at an older age on average, age-dependent dental conditions show similar distributions, especially higher severity grades or frequencies, but also occur in females. In the prevalence of caries, females are relatively more often affected compared to males, and apparently also suffered more frequently and at a younger age from stress events displayed in enamel hypoplasia. With 4 females and 8 males, especially the number of interproximal grooving (4 to 81) is more common in individuals of male constitution, although the temporal factor should not be disregarded.

5.7 Results 2: Statuses of oral health and burial context

In order to compare inter-individual statuses of oral health, results of the different dental conditions were summarised and analysed by applying classical (CA) and canonical correspondence analyses (CCA). These classifications enable the characterisation of individual statuses of oral health and their contextualisation in the burial environment.

5.7.1 Correlations of oral health categories: Inter-individual comparison

For comparing statuses and correlations of oral health categories between the individuals, the correspondence analysis was again used as the analytical tool. In addition to the classical correspondence analyses (CA), the application of the canonical correspondence analyses (CAA) has the advantage that it allows the addition of variables which determine the ordination of tested samples. Both demographic parameters were considered, biological sex in the CA and age class as the determining variable for the C*CA*. The prevalence of enamel hypoplasia is excluded from these analyses as this category is more strongly influenced by tooth alterations during the course of life and results from stress events or periods in childhood and adolescence; therefore, creating a direct connection would in this sense be misleading. In addition, the prevalence within the population of Kudachurt 14 is too complex for required classifications.

In order to achieve a comparability between the individuals and to prepare the underlying spreadsheets, it was necessary to rescale the results of the oral health categories from tooth to individual level or to classify individual frequency or intensity rates. The different forms of dental wear are separated (occlusal macrowear, occlusal grooving, interproximal grooving, facets, chipping). Underlying spreadsheets consider presence and absence for formulated classifications. Based on the specific distributions, hitherto used descriptive parameters per tooth/individual have been summarised and classified by applying following approaches:

- **Calculus (calc)**: intensity 0.1-1=**calc1**, 1.1-2 =**calc2**
- **Periodontitis (peri)**: intensity 0-1.5= **peri1**, 1.6-2 **peri2**
- **Caries (car):** average[38] intensity 0.1-1=**car1**, 1.1-2=**car2**, 2.1-4=**car3**
- **Periapical lesions (pal)**: (1) Tooth-position summations per individual: 1-2=1 (cysts and granulomas), 1-2 with fistulae=2, 3-4(**.fis**)= 3; (2) Calculation of average intensity per individual from 1. (3) Classifying resulting values as 0-0.2=**pal1**, 0.21-0.39=**pal2**, 0.4-1=**pal3**.
- **AMTL**: min frequency rate 3.1-19.2 %=**amtl1**, 20-30%=**amtl2**, 30-81.3 %=**amtl3**
- **Occlusal microwear (omw)**: (1) Tooth-position summations per individual[39]: 1-4. o=1 (slight-moderate), 5-6, occlusal=2 (distinct), 5-6, asymmetric=3, 7-8 occlusal=4 (severe), 7-8, asymmetric=5. (2) Calculation of average values per individual from 1. (3) Classifying resulting values as 0-1.3=**omw1**, 1.5-3=**omw2**, 3≥**omw3**.
- **Unspecific facets (fac)**: presence=fac1
- **Occlusal notching (OG)**: presence=**OG1** (incl. *vertical grooving*)
- **Interproximal grooving (IG)**: min frequency rate, ≤49.9 %=**IG1**, ≥50%=**IG2**
- **Chipping (chip)**: average extent, 0-1=**chip1**, 1.1-2.05=**chip2**

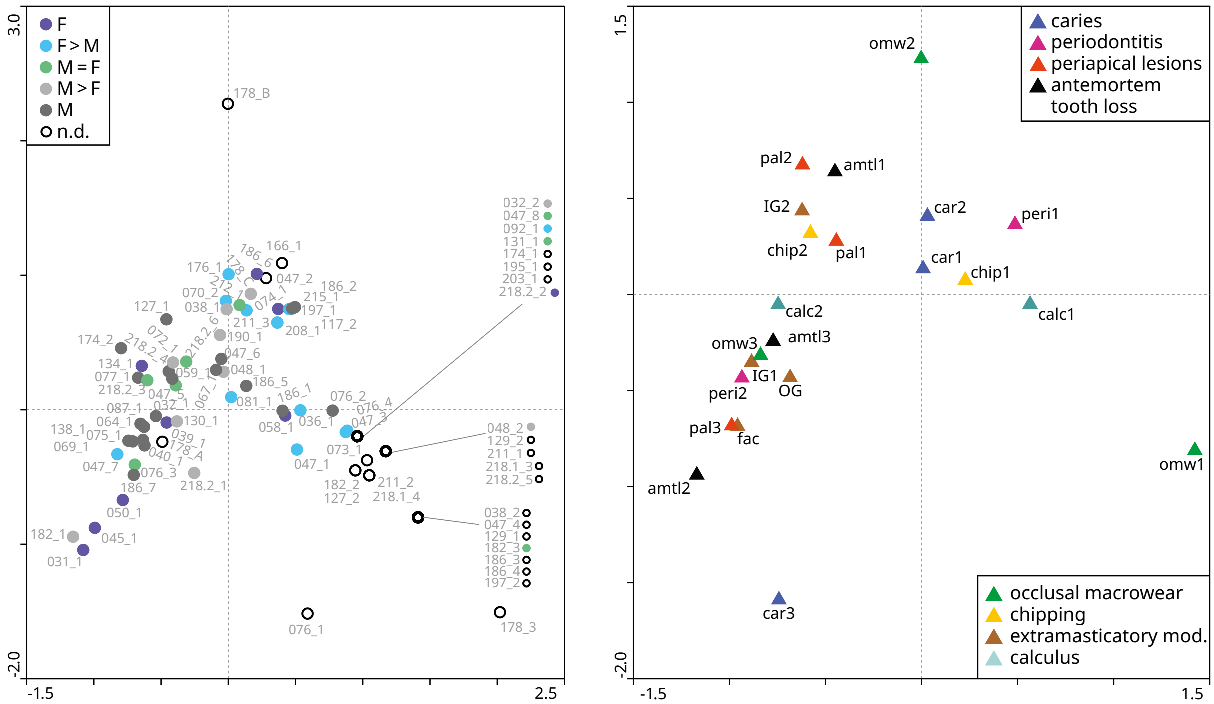
The resulting CA shows that there is a clear structure within the data set of oral health categories with respect to category intensity/frequency as well as the occurrence of certain dental conditions (Fig. 144, A-B). This is evident in the ordination of the individuals (samples, left graph A) clustering in groups as well as the ordination of the categories (variables, right graph B), whose values increase along the x-axis (lower grades on the right, higher grades on the left). This confirms the assumption made in the preceding subchapter, that there is a correlation between increasing values of periapical lesions, periodontitis, and AMTL, especially in connection with extramasticatory traits and advanced occlusal macrowear. As occlusal macrowear was assessed for almost all individuals (except 038_3, 200_1) it is constantly represented within the data set and thus a major factor for the parabolic ordination of the scatter plot.

Speaking of individual diagnoses, specimen with low values of occlusal macro wear, calculus, and periodontitis are located on the right side of the y-axis, and closer to or above the x-axis if their dentitions also exhibited caries or small extents of chipping. In the upper periphery cluster specimen with higher grades of caries and occlusal macrowear. Individuals located in the upper left quarter of the ordinate system are characterised by the additional occurrence of periapical lesions, higher extents of chipping, low frequencies of AMTL, and some with interproximal grooving. On the left side of the x-axis, the individuals either show severe and potentially atypical patterns of occlusal macrowear or different types of extramasticatory traits and high inflammation values due to periapical abscesses. In the periphery, individuals also suffered from high caries prevalence. As known from the caries calibration, frequencies as well as intensities are underestimated in the examined record, especially for those individuals with high AMTL and occlusal macrowear values.

The labels of biological sex in the illustration of the individuals summarise single results of sex-related tendencies observed in the respective analyses of the dental

38 Average values all were calculated based on all preserved teeth/tooth positions (not on affected ones).

39 According to chapter 5.6.3.6.



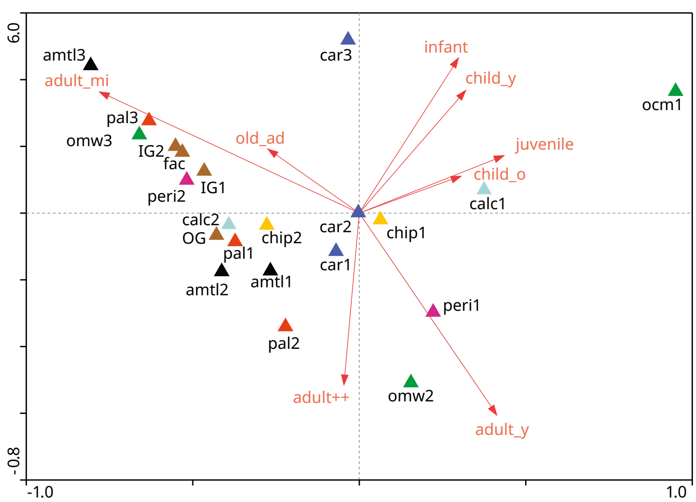


Figure 144: Analyses of human remains and oral health. Graphs of classical correspondence analyses (CA, A-B) and canonical correspondence analyses (CCA, C) of oral health categories (variables) in terms of presence/absence per individual (samples). A: CA, illustration of individuals per biological sex (samples, n=86). B: CA, illustration of variables (n=22). C: CCA, illustration of oral health categories (variables, n=22) and the external variable "age class" (n=8).

conditions. Compared to males, individuals of likely female constitution are more often represented on the right side of the left graph and thus are in general more often associated with lower values of the different conditions, but four of five individuals with high caries prevalence are females. Males/likely males more often appear in connection with interproximal grooving, low to moderate periapical processes, and frequent intravital tooth loss. By adding age class as an external parameter to the analyses, the obvious correlation of advanced individual age with appearance or increasing frequencies and/or intensities of the different dental conditions is easily recognizable (Fig. 144, B). Along the gradient from immature to old age (almost clockwise with increasing age), the ordination of increasing values took

place. The only link is the high caries prevalence in an infant (76_3). This is not surprising with respect to the fact that occlusal macrowear and AMTL function as parameters for estimating age at death.
Nevertheless, both the CA and CCA emphasis following aspects of oral health:

- The general ordination of the dental conditions in the CA and CCA remains almost equal, which confirms that the underlying correlations are mainly due to differences in individual age at death.
- The CCA probably reflects a more detailed chronological resolution of individual age compared to the application of age classes.
- Based on the assumption that females on average died at a younger age, they were in general of better oral health at their time of death compared to males, with few exceptions.
- The correlation of increased AMTL, periapical inflammations, and periodontitis for individuals with distinct dental decay due to extramasticatory traits is confirmed.

5.7.2 Statuses of oral health, burial contexts and spatial distribution

After analysing different categories of oral health and discussing interrelations and individual differences within the population under study, the obtained results can be linked with the burial context and inhumation groups (in double or collective burials). Therefore, statuses of oral health are classified by considering the most important aspects. By mapping these classifications on the cemetery plan, spatial distributions of singular or mutually buried individuals as well as their spatial distribution will be revealed. For basic information regarding data basis and demographic information see Fig. 95, 103 and 104.

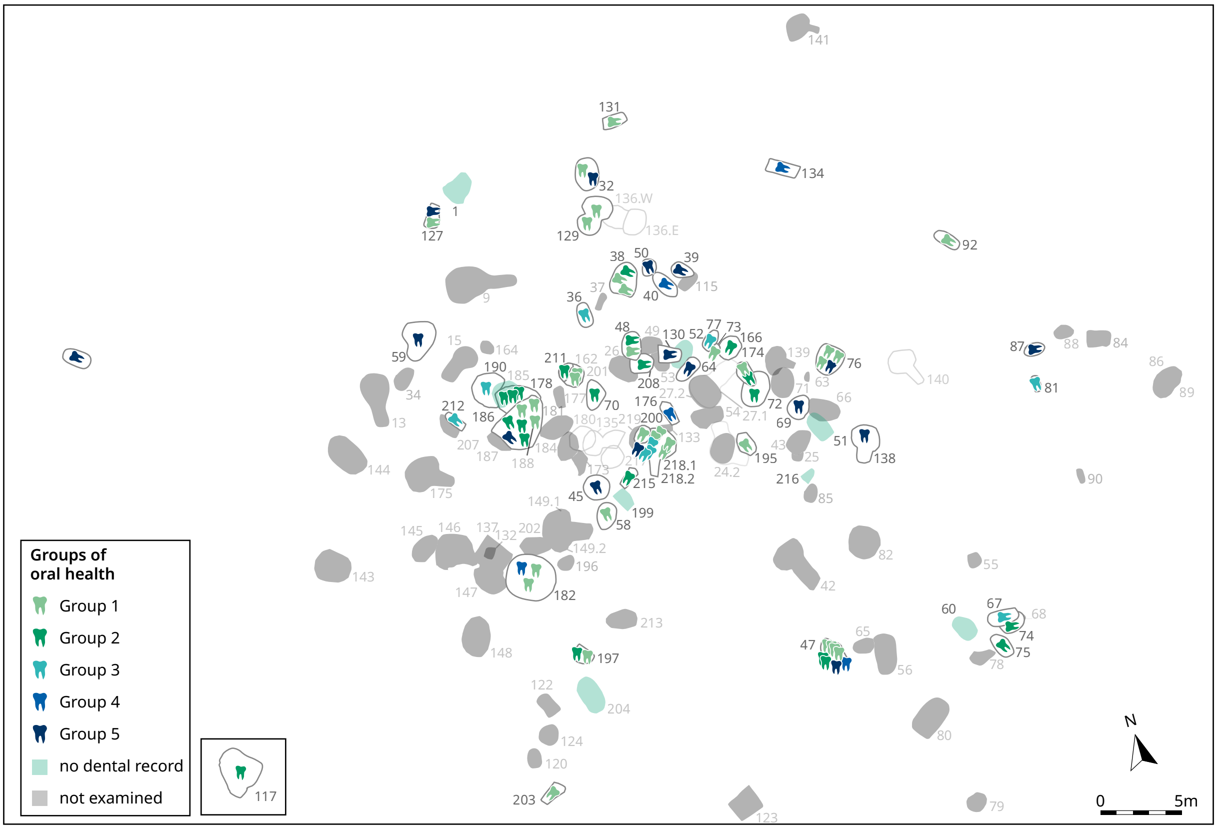
The dental conditions represent different aspects of oral health, unspecific physical stress, and occupational behaviour, which are important in terms of physical side effects and socio-economic considerations. The classification of individuals focused on the following results:

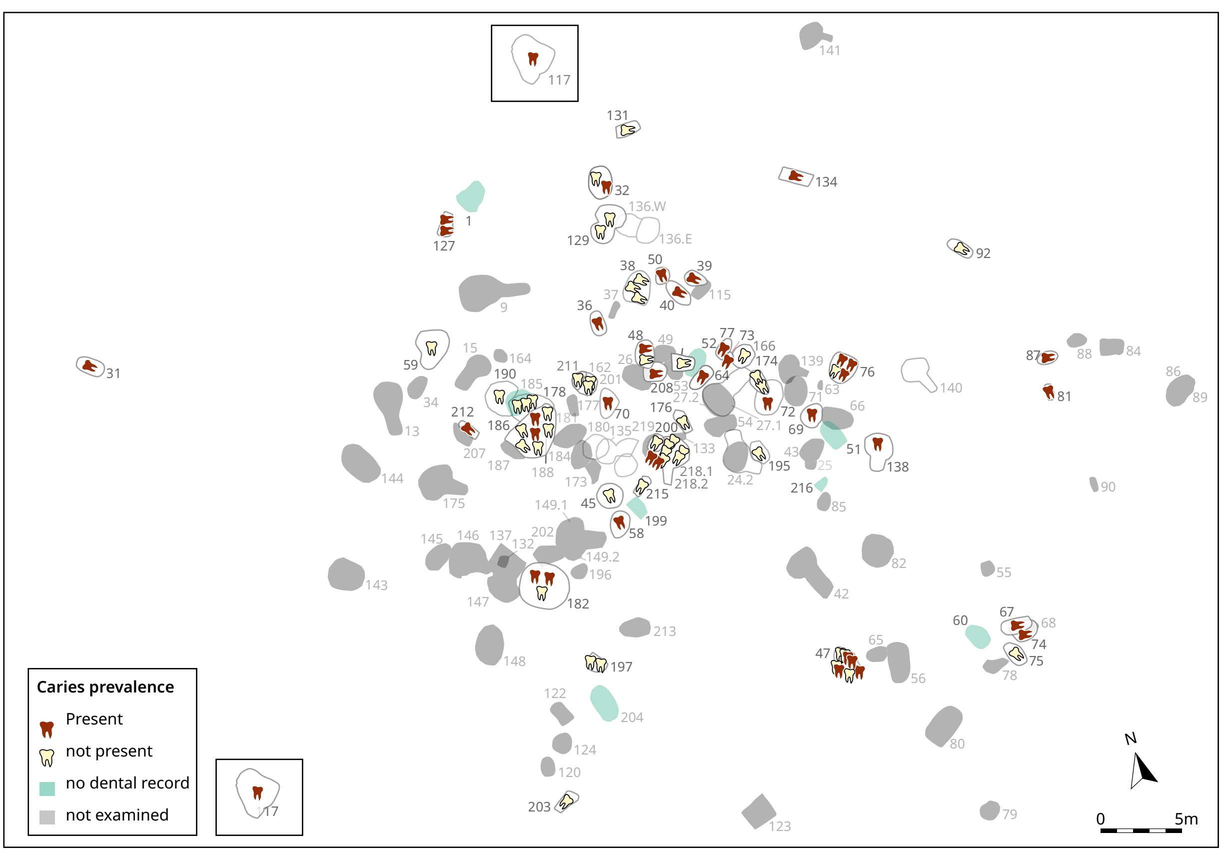
Groups of oral health: Summarizing statuses of disease/dental condition affection in terms of calculus, periodontitis, dental chipping, occlusal macrowear, periapical lesions, and AMTL. A higher group number indicates higher disease burden with respect to periapical inflammation (acute or chronic) and higher numbers of intravital tooth loss:

- **Group 1**: Individuals with **low to moderate values** of calculus, periodontitis, dental chipping (all value 1-2) and occlusal macrowear of value 1 (calc1-2, peri1-2, chip1-2, omw1).
- **Group 2**: Similar to 1, but **with occlusal macrowear** of value 2-3 (omw2-3).
- **Group 3**: Similar to 2, **periapical lesions and/ or AMTL value 1** (pal1, amtl1).
- **Group 4**: Similar to 2, **periapical lesions and AMTL, values 2/1** (pal1-2, amtl1-2)
- **Group 5**: Similar to 2, **periapical lesions and AMTL, values 3/2** or 1 (pal1-3, amtl1-3).

Presence/absence of caries (car), **atypical patterns of occlusal wear** (if value=3) as well as **extramasticatory** modifications (per trait: ig=interproximal grooving, og=occlusal grooving, fac=facet).

Enamel hypoplasia: This indicator of unspecific physical stress provides actually three information sets: the temporal dimension in terms of formation age(s), periodicity by formation intervals, and severity. As the individual diagnoses in chapter 5.6.3.10 refer to formation ages, the following classification focuses on


Groups of oral health
Group 1
Group 2
Group 3
Group 4
Group 5
no dental record
not examined
N
0
5m


Caries prevalence
Present
not present
no dental record
not examined
N
0
5m

the average severity by summarising individual values to groups (**1**=1.0; **2**=1.25-1.51; **3**=1.67-1.80; **4**=2.00; **5**≥2.33; see Fig. 142).

In general, the distributions of biological sex and age class within the five groups of oral health summarise the previously discussed results. The distributions of biological sex and age class within the five groups reflect the aforementioned results. Until young adult age, group 1 (33.7 %) and 2 (4.66 %) show low values of calculus, periodontitis, chipping, and occlusal macrowear without any recognized osteological evidence for periapical lesions or intravital tooth loss. Within the age group of 20-35 years (young adult), according individuals exhibited all categories of oral health, but group 3 (3.49 %), 4 (2.33 %) and 5 (1.16 %) are rare compared to group 1 (6.98 %) and 2 (11.63 %). The reverse situation is true for individuals who died at an older age (group 2 6.98 %; group 3 5.81 %; group 4 2.33 %; group 5 15.12 %). In comparison, slight differences between the sexes are not significant, especially when considering the differences of age at death in correlation to increased disease burden in individuals of older ages. According tendencies in terms of caries, occlusal macrowear, and extramasticatory modifications remain as described in the preceding sections.

Different statuses of oral health appear in the same inhumation groups and lack spatial patterns in the cemetery. There is no spatial separation of individuals with different oral health group associations visible (Fig. 145). In the northern part of the cemetery, graves are arranged in a greater density, so that the minor tendency of higher frequencies of individuals with higher disease burden (blue and dark blue marks) in this area is misleading. Distributions of the different oral health groups do not reflect specific patterns with regard to single burials, between or within the inhumation groups in double or collective graves (*e.g.* 047, 076, 186). These patterns are also not recognizable for burial contexts of individuals exhibiting dental caries (OCR). Affected individuals and individuals lacking carious lesions have been found in the same collective graves (17 affected, 26 not; Fig. 146), buried in pairs (6/6) in any possible combination or separately (18/12), and there is no spatial pattern apparent among them.

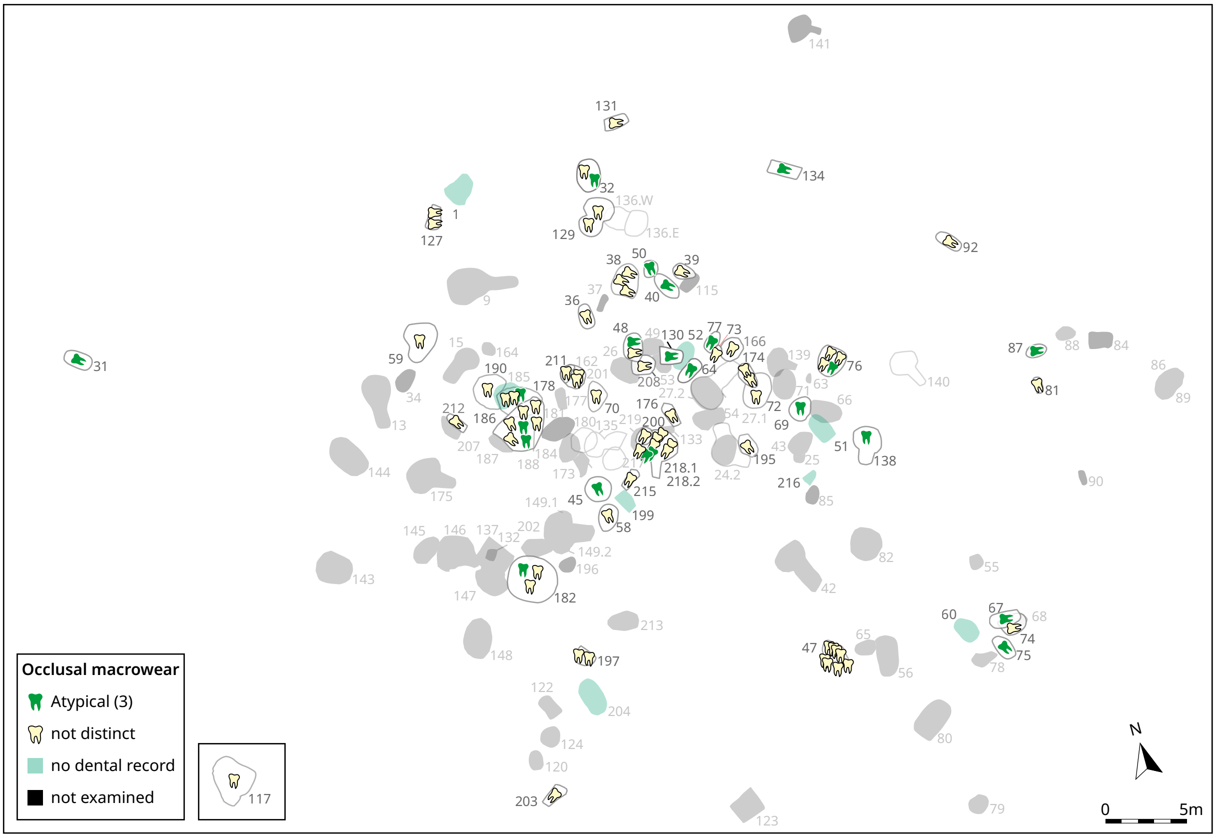
This observation also holds true in terms of atypical patterns of occlusal macrowear (true for min. 26.7 %; single burial 17/13, double burial 3/9, collective 6/37, Fig. 147) and extramasticatory traits (24.4 %; 11/19, 4/8, 6/37, Fig. 149). With respect to forms of extramasticatory modifications, interproximal and occlusal grooving, and unspecific facets, individuals exhibiting the first were predominantly buried in single (n=7) and double burials (n=4; collective n=1). Facets and occlusal grooving are not conclusive in this respect. Individuals with dentitions revealing different forms of extramasticatory modifications are of both sexes and were buried in separate graves, (31_1, 40_1, 045_1, 064_1), except for individual 218.2_4. In general, proportionally higher prevalence for both categories of dental wear in single burials results from the fact that the immature individuals lacking such modifications were more often buried in double or collective burials (see section 5.6.2.2).

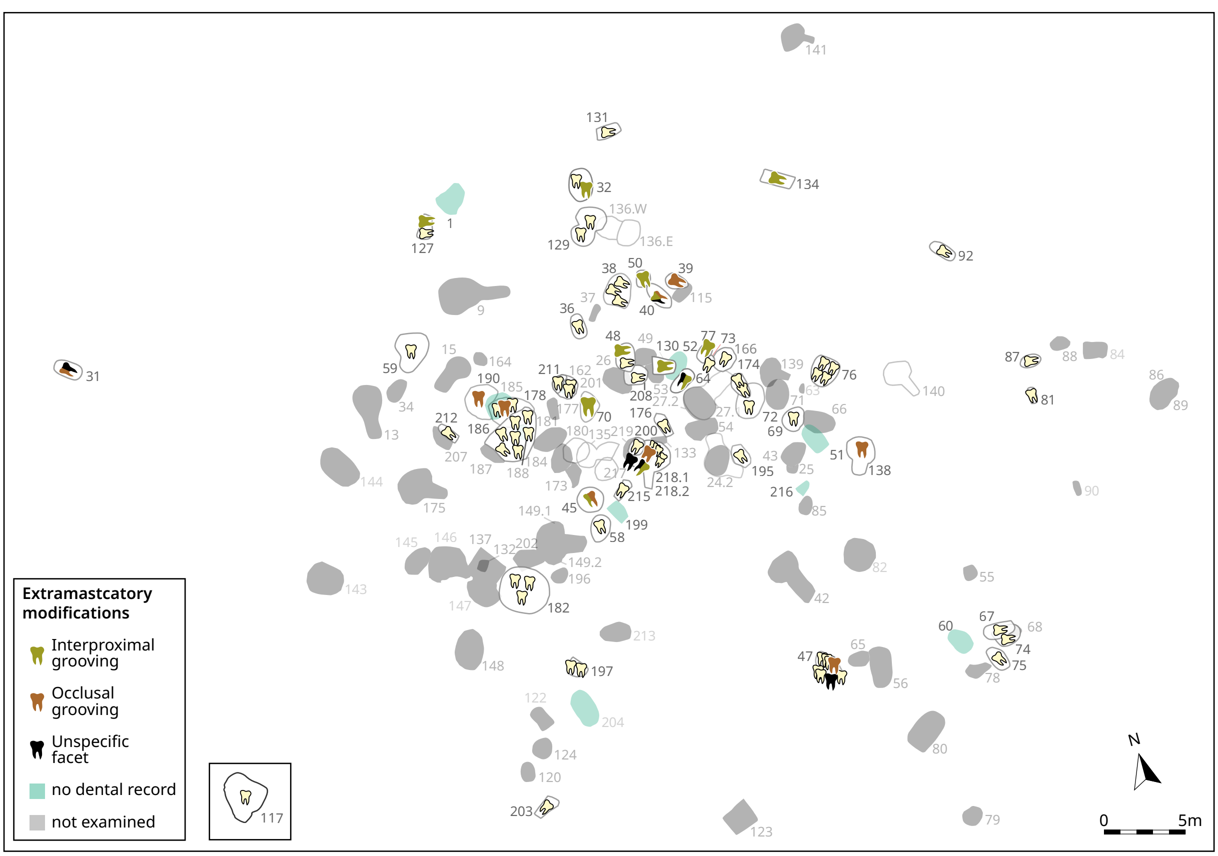
The manifestation of unspecific stress as disruptions of enamel formation is present in individuals distributed among the complete cemetery and all burial types (Fig. 149). From 17 specimens not showing EH, 8 had less than 5 teeth with crown preservation, so that the negative rate is potentially too high. Individuals with different averages of severity grades, meaning distinctiveness of the enamel defect, were found in single burials as well as in collective contexts, and there is no pattern observable. The inhumation group from Grave 186 is noteworthy in this regard, as two young adults (186_1, 186_6) and a young child (186_3) show low vales compared to other collective burials[40]; apparently, EH was less developed in this inhumation group compared to Graves 047, 218.1, or 218.2.

Figure 145 (opposite above): Analyses of human remains and oral health. Cemetery plan and results for the individual classification of oral health groups (n graves=50, n individuals=86). For criteria of oral health groups see section 5.7.1.

Figure 146 (opposite below): Analyses of human remains and oral health. Cemetery plan and caries presence/absence per individual (n graves=50, n individuals=86).

40 Ind. 076_3 and 076_4 showed poor dental preservation.


Occlusal macrowear
Atypical (3)
not distinct
no dental record
not examined
117
N
0
5m


Extramastcatory modifications
Interproximal grooving
Occlusal grooving
Unspecific facet
no dental record
not examined
117
N
0
5m

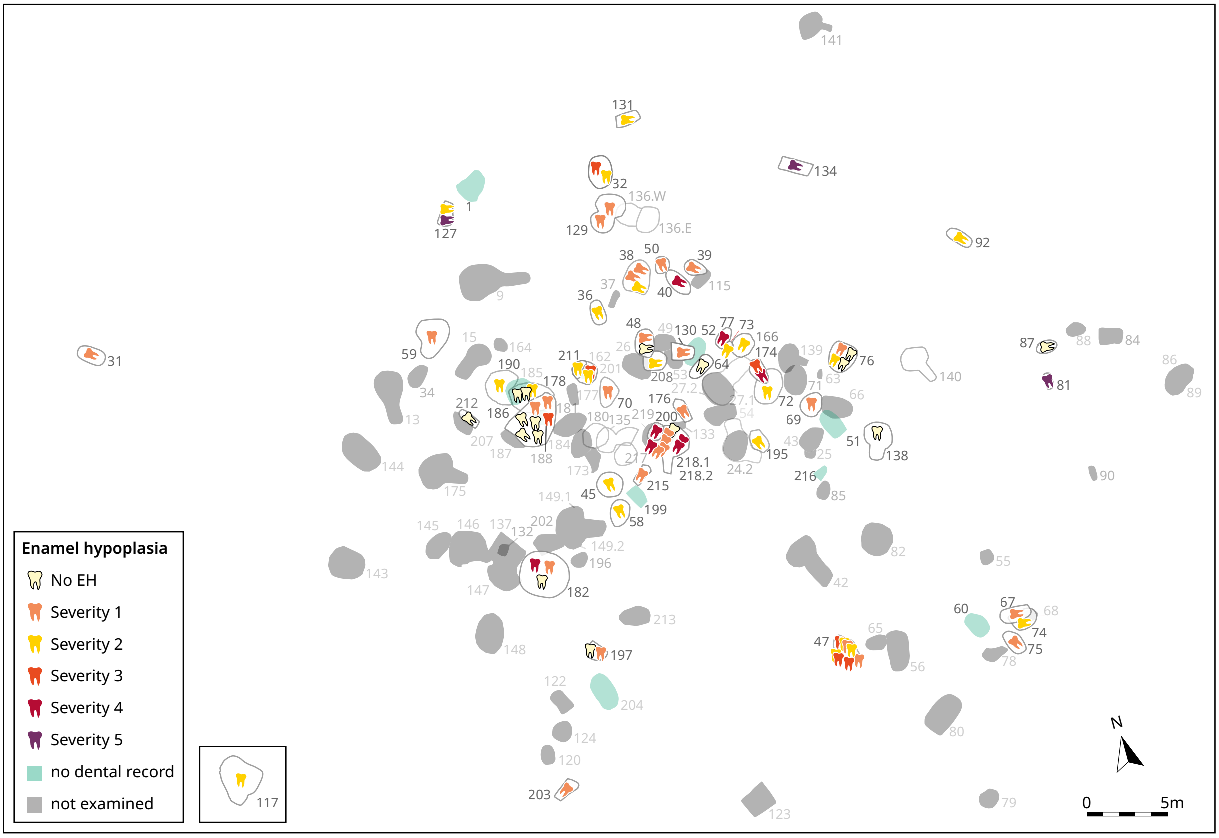


Figure 149 (above): Analyses of human remains and oral health. Cemetery plan and average severity of enamel hypoplasia (EH) per individual (n graves=50, n individuals=86).

Additionally, in comparison with the average grade of enamel defects, average formation ages are not specific for individuals from singular or mutual inhumation contexts (see Fig. 143).

5.8 Chronological aspects

Absolute chronological information (^{14}C-dates, stratigraphy) is available for 15 graves and 46 individuals. The radiocarbon dates span from the oldest to one of the youngest graves (182, 2199-2031 cal BCE, and 50, 1879-1629 BCE; Tab. 39). From these graves, 7 have a collective character. In consequence, these dates identify the temporal setting of one funeral event, while in the collective burials, especially large ones, repeated use is suggested. The “collective date” is thus very inaccurate when applied to the single individuals interred collectively.

Based on the available data, within a maximum time span of approximately 2200-1700 BCE, there is no chronological pattern in demographic composition or oral health characteristics recognisable. Individual compilations of oral health groups, caries prevalence, extramasticatory modifications, and EH prevalence make up inhumation groups with early as well as late dates, and so do the related structures of age at death and biological sex. Characteristic dental categories such as caries and atypical wear patterns have been found in individuals from burials with the earliest and latest dates. In addition, radiocarbon dates from burials with *in situ*-age determination confirm the mutual as well and single inhumation of adult and subadult individuals between *ca.* 2200-1650 BCE[41].

The observations made on this small representative sample lead to following conclusions:

41 149.1_1-4, 177_1, 211.3_1, 219_1-2.

Figure 147 (opposite above): Analyses of human remains and oral health. Cemetery plan and presence/absence of atypical occlusal macrowear per individual (n graves=50, n individuals=86).

Figure 148 (opposite below): Analyses of human remains and oral health. Cemetery plan and presence/absence of extramasticatory modifications per individual (n graves=50, n individuals=86).

Grave	Chronology	Individual (age/sex)	Characteristics of oral health
050 (single)	1879-1692	050_1 (35-50 years/F)	5; caries; atyp. owm; int. groov.; EH 50.0/1
		047_1 (17-25 years/F>M)	1; caries; occusal grooving; EH 67.9/1.6
		047_2 (07-12 years)	2; caries; EH 73.9/1.5
		047_3 (17-25 years/F>M)	1; caries; EH 53.8/1.5
047 (collective)	1879-1692	047_4 (01-03 years.)	1; EH 100/1
		047_5 (25-50 years/M = F)	4; caries; EH 28.6/1.5
		047_6 (20-35 years/M)	2; EH 10.0/1
		047_7 (20-35 years/F>M)	5; facets; EH 63.2/1.1
		047_8 (17-25 years/M=F)	1; EH 20.0/1.,6
		047_9 (25-50 years)	no dental record
185 (single)	1899-1751	185_1 (20-35 years/M)	no dental record
178 (collective)	1891-1750	178_3 (03-06 years)	1
		178_A (25-50 years)	2; atyp. owm; occlusal grooving
		178_B (25-50 years)	2
		178_C (20-35 years/M>F)	2
076 (collective)	1932-1768	076_1 (01-03 years)	1; caries; EH 64.0/1.3
		076_2 (20-35 years/M)	1; caries;
		076_3 (35-50 years/M=F)	5; caries; atyp. owm;
		076_4 (20-35 years/F>M)	1
174 (single)	1938-1757	174_1 (12-17 years/n. d.)	1; EH 85.0/1.7
218.1 (collective)	1953-1776	218.1_2 (20-35 years/M=F)	no dental record
		218.1_3 (03-06 years)	1; EH 10.0/2
		218.1_4 (01-03 years)	1; EH 9.1/2
218.2 (collective)	1971-1777	218.2_1 (35-50 years/M>F)	5; caries; facets; EH 33.3/2
		218.2_2 (17-25 years/F)	1; EH 23.8/1
		218.2_3 (35-50 years/M)	3; atyp. owm; EH 37.5/1
		218.2_4 (35-50 years/M)	3; caries; atyp. owm; int. groov., facets; EH 20/1
		218.2_5 (12-17 years)	1; EH 37.5/1
		218.2_6 (35-50 years/M=F)	3; occlusal grooving;
		218.2_7 (03-06 years)	no dental record

Table 40 (continued on following page): Analyses of human remains. Summary of individual oral health characteristics (oral health group; caries; atypical occlusal macrowear; extramasticatory modification; enamel hypoplasia freq/av. severity) per grave and chronological information (^{14}C 2sigma-range cal BCE, stratigraphy; upper is younger).

Grave	Chronology	Individual (age/sex)	Characteristics of oral health
186 (collective)	1946-1775	186_1 (20-35 years/M)	1; caries
		186_2 (20-35 years/M)	2; EH 20/1
		186_3 (03-06 years)	1
		186_4 (07-12 years)	1; EH 11.1/ 1
		186_5 (35-50 years/M)	2; caries; atyp. owm; EH 56.3/1.6
		186_6 (20-35 years/F)	2
		186_7 (35-50 years/M)	5; atyp. owm
		186_8 (20-35 years/M>F)	no dental record
211.1 (double)	younger	211_1 (12-17)	1; EH 74.1/1.2
		211_2 (03-06)	1; EH 50.0/1.8
211.2 (single)	younger	211_3 (20-25/F)	2; caries; EH 25.0/1.2
211.3	2044-1951	211.3_1	no skeletal remains
182 (collective)	2199-2031	182_1 (35-50 years/M>F)	4; caries; atyp. owm.
		182_2 (07-12 years)	1; caries; EH 37.5/1
		182_3 (20-35 years/M=F)	1; EH 33.3/2
067 (single)	younger	067_1 (35-50, M)	3; caries; atyp. owm; EH 50.0/1
074 (single)	older	074_1 (20-35, F)	2; caries; EH 34.4/1.3

- The temporal resolution for collective graves is too low to come to explicit results for the majority of individuals (40).
- The separate or mutual inhumation of individuals of different ages and sex is true for the complete captured time span between 2200-1700 BCE. In terms of mortality, the data do not suggest an in general lower life expectancy for a certain period or a higher mortality risk for one of the sexes, as children and individuals of both constitutions were found in early as well as late burials.
- Apparently, conditions with appropriate amounts of carbohydrates and cariogenic bacteria in the oral biofilm for developing dental caries were constantly present within these 500 years.
- The use of teeth as tools recognisable as typical patterns of occlusal macrowear was practiced during the entire span of 2200-1700 BCE. Other extramasticatory modifications of occupational and/or therapeutic treatments are evident for the beginning 2nd mil BCE.
- In this context, there is no chronological determination in terms of "good" or "bad" oral health status; this is strongly interrelated with individual age and co-existing dental conditions.
- Intervals or events of unspecific stress during childhood and adolescence expressed in enamel defects occur constantly between 2200-1700 BCE, and there is no chronological correlation to individual defect frequency or severity within this time range.
- In summary, neither the demographic structures of inhumation groups nor the oral health conditions changed between 2200-1700 BCE. Precise information for the temporal depth of utilisation of the collective burials as well as additional data from single graves are urgently needed for confirmation of these conclusions.

5.9 Discussion and evaluation: Demography and oral health at Kudachurt 14

In the preceding sections, a representative sample of skeletal remains were investigated along the lines of the research interests stated in chapter 4. The gained results were focused toward finding answers to two basic questions: What is the demographic composition of the buried population? What are the main characteristics of oral health?

In the following, the discussion concentrates on a third question: What are the physical and socio-economic findings deriving from the demographic structure and status of oral health? Therefore, specific findings are briefly discussed in terms of potential implications. Assumptions on both individual as well as population levels are stated in order to come to conclusions in terms of human lifeways between 2200-1650 BCE in the Kudachurt valley.

5.9.1 Demographic and palaeopathological implications

The intention to not apply life tables or other statistical methods to gain parameters such as life expectancy and mortality for specific demographic group goes back to the unsuitability of Kudachurt 14 as a statistical cohort. The taken approach rather follows Roksandic et al. for age classes (2009). The population under study represents only a fraction of the lived population, namely the one that actually *died*. This means that available skeletons are remains of people that were differently vulnerable to risks of death and mortality, and that illness and trauma had different effects, which we as osteologists recognise in obtained age at death distributions. As Milner *et al.* state, "*…the sample is still biased toward the people in each age interval who experienced the greatest risk of death, often because they were the sickest*." (2008, 567). With respect to the population buried at Kudachurt 14, and although underestimation of especially infants in the archaeological record might also be true here, according ratios address statuses of oral health only. With a ratio of *ca.* 30 % immature to 70 % mature individuals found at the cemetery and detected differences in the disease burden, most individuals survived childhood. The data set includes only few infants (5.5 %), those that presumably died before or around weaning stage, and slightly higher numbers of individuals of early and late childhood (17.6 %) and juvenile age (8.3 %), so that immature individuals of older age seem to be more vulnerable. The highest frailty, however, is demonstrated in mature age classes. In general, when using mortality in children as a sensitive indicator for population health status, the low rates suggest appropriate conditions for the people buried at Kudachurt 14 between 2200-1650 BCE (Goodman and Armelagos, 1989). This might be supported by the high rates of survived physical stress during childhood observable in dysfunctions of enamel formation, although the data indicate that related stress events happened earlier in female's life, which goes along with the trend described in the following. Similar interrelations of childhood stress and adult age mortality have been identified in a Bronze Age population from Denmark (Boldsen 2007).

Reflected in the composition of inhumation groups, this heterogeneous image of mortality within the buried population is evident for individuals for which a biological or social relationship is certain. Although we do not know about the temporal stretch of the burial events of such inhumation groups, the available data do not point to a particular part of the society in terms of age at death, which would be expected if biological requirements did not match biological resources (cf. Goodman and Armelagos 1989; Milner *et al.* 2008). Most likely, this is applicable to the complete population under study.

5.9.2 Dietary implications

In its function as a digestive organ, the masticatory system in dry bone specimen reveals valuable information about dietary practices, and oral health has often been used to detect and interpret subsistence transitions in the past (see chapter 5.3.). During the MBA-LBA transition, current archaeological and bioarchaeological research posit a shift in subsistence strategies from mobile pastoralists in the steppe to sedentary pastoralists in the high mountains, whereas the agricultural share remains unclear (see following section). Due the geographical and chronological key position of Kudachurt 14, this discussion is of special interest for the population under study and vice versa. This thesis provides the first comprehensive data set about oral health to that time and region.

In the following, two conditions of oral health serve as an indicator for respective discussions: diseases connected to the oral biofilm (calculus and caries) and dental wear. As comparative data from the time and region currently do not exist, references for brief evaluations of the results from Kudachurt 14 focus on specific literature data from other regions.

The erosive effect of food components and dental chipping

Comparative analyses of hunter-gatherers and agriculturalists try to estimate the degree of dental wear due to the mastication of different food substances, and often average occlusal dentine exposure is higher in hunter-gatherer societies or deviating wear patterns between populations suggest different food managements (Eshed *et al.* 2006). According to Smith, patterns of molar plane wear have become more even with the introduction of grains and cooked foodstuffs (1984). Besides extramasticatory indication, microfractures known as dental chipping might be an indicator for punctual load in processing foodstuffs of hard substance (Scott and Winn 2011).

The population under study is not suitable to test for typical "hunter-gatherer" or "agricultural" wear patterns *a priori*, as we do not know about their actual subsistence means. Both indicators are present in the dental record, erosion of tooth crowns of plane and asymmetric natures and dental chipping. In addition, observed atypical wear patterns and extramasticatory modification complicate the interpretation in this regard, and often upper and lower patterns differ in the same individuals. Overall, the fact that rather plane erosion occurs simultaneously with local asymmetries or higher grades in frontal teeth suggests a certain degree of uniformity of chewed substances, although discrepancies within the population under study exist (see Fig. 116-129). Children did not exhibit such asymmetric wear patterns as mature individuals did, but notable ablation of the crown cusps is observed from the age of 4 years onwards (ind 186_3).

Presuming that dental chipping was not exclusively of extramasticatory origin, most individuals processed hard food components or chewed other firm substances, for instance impurities from food preparation. Simultaneous occurrence of plane wear and chippings strengthen this assumption, but exceptions exist, for instance large chipping lesions and little abrasion (ind. 215_1, Fig. 129.1). Chippings on deciduous teeth are very rare, especially in early childhood (3 individuals). In addition, there are no patterns in the distribution of microfractures in terms of functional tooth category or location, so that interpretations toward food preparation techniques or dietary habits, as undertaken by Scott and Winn (2011), are not conclusive here.

In summary, the results do not allow a clear interpretation in terms of typical "hunter-gatherer" or "agricultural" patterns of dental wear, as indicators for both exist and suggest a certain degree of variety within the population. First evidences of mastication and therefore potential indicators for the introduction of solid food are observable in infants and children of *ca.* 3-4 years. Certainly, more detailed examinations and the application of additional methods would enable more precise conclusions (*e.g.* dental microwear, metric approaches of wear patterns, statistical methods).

Dental plaque: calculus and caries

The oral biofilm covers the tooth surfaces during life and often remains as calculus (calcified plaque) on dry bone specimen. Its chemical composition as well as contained organic residues of food and microbes represent a valuable bioarchaeological archive in terms of dietary, pathological and other questions (see chapter 5.4.5.1; Buckley *et al.* 2014; Mackie *et al.* 2017; Fox *et al.* 1996; Preus *et al.* 2011). The aetiology of calculus is multifocal. Calcium and phosphate concentrations in the oral fluids play a decisive role in the calcification process, and in addition to the salivary flow rate, these concentrations show high individual variation. Calculus prevalence among populations with different subsistence and dietary backgrounds do not support former assumptions that its formation is closely interrelated with foods high in protein. Diet is, nevertheless, one contributor among others, and high carbohydrate intake causes plaque accumulations facilitating both calculus and caries formation (Hillson 1996; Lieverse 1999). Preserved calculus deposits on the Kudachurt dental material are a common condition among all specimen in mild precipitation rates, with few greater degrees of accumulation. In addition, the results confirm the co-occurrence of calculus and caries lesions. In summary, the available information indicates sufficient abundance of calcium and phosphate in the saliva, sufficient abundances of carbohydrates and cariogenic bacteria in at least 49.5 % individuals of different sex and age.

Caries has a complex aetiology, and its prevalence and extent among and in-between populations depends on various physiological, ecological, and socio-economic factors which shall not be discussed here in detail. Nevertheless, two conditions are required for the development of caries lesions that are visible to the naked eye: appropriate abundance of both cariogenic bacteria and fermentable carbohydrates and a sufficient period of co-existence in the dental plaque. Due to this, caries rates have often been used in order to distinguish diets of hunter-gatherers and agriculturalists, and values have been reported from different chronological and geographical contexts. In this regard, the OCR of 8.4 % and the CCR of 10.3 % detected for the buried population at Kudachurt 14 match with rates typical for societies practicing agricultural lifeways or mixed economies. For example, hunter-gatherer and pastoralist societies with diets assumed low in carbohydrates range between 0.0-0.9 % in the mid-Holocene Cis-Baikal region (Lieverse *et al.* 2007) or 0.0-0.1 % in the Bronze Age Eurasian steppe (Ventresca-Miller *et al.* 2014) and are 1.9 % in Mesolithic populations from Western Europe (Meiklejohn *et al.* 1984). In contrast, caries rates of Neolithic populations from Western Europe are 4.2 %, for which the adoption of agricultural lifeways is expected (Meiklejohn *et al.* 1984). In populations of prehistoric Pakistan (Harappa 2500-2000 BCE), Lukacs interprets the OCR of 6.2 % and CCR of 12.1 % (43.6 % of the population affected) as a sign for agricultural intensification in Bronze Age South Asia and observes an increase in dental diseases with intensification of subsistence activities such as food preparation and storage technology (1992). In the populations from Harappa, the oral health status is similar to Kudachurt 14 in terms of occlusal wear, periapical lesions and AMTL (cf. Lukacs 1992; Fig. 4, 140). Additionally, Lukcas interprets higher caries rates in females (10.1 % to 6.4 % per tooth) as an indicator of gender-dependent access to different foodstuffs as a result of occupational division (hunting, crop fruit processing), a hypothesis, which is supported by other studies (Lukacs 1992; Lukacs 2011; Lukacs and Largaespada 2006). Among other dental indicators, the caries rates in populations form Chalcolithic to Bronze Age sites in Spain with OCR between 5.4 % to 17.1 % support the assumption that the rates at Kudachurt represent mixed agriculture of different crops and animal husbandry economies (Polo-Cerdá *et al.* 2007, Tab. 1). Turner provides a summary of reference values from prehistoric and modern contexts across the globe (1979) for hunting and gathering (0-4.6 %), mixed (0.44-10.3 %) and agricultural economies (2.3-26.9 %).

As these reference data are very selective, uncovering additional comparative data, and especially integrating other dental conditions, is required for a more precise placement of the population from Kudachurt 14 in this respect. This is also true for evaluating other factors influencing the caries prevalence (*e.g.* genetic effects in enamel firmness, influences on oral acidity such as fluoride in the water, type and abundances of cariogenic bacteria; see chapter 5.4.5.6.).

As reference examples, the Bronze Age populations from the Eurasian Steppe sites Bestamak (2032-1939 cal BCE) and Lisakovsk (1860-1680 cal BCE) as well as from the Indus Valley site Harappa in Pakistan (2500-2000 BCE) showed in comparison very different oral health statuses connected to caries prevalence, severe dental macrowear, and periapical inflammation (Lukacs 1992; Ventresca Miller *et al.* 2014). The authors refer to the populations' ecological and economic backgrounds representing significant differences between pastoral lifeways and animal-based diet and a sedentary society with intensified agriculture and more efficient storage technology. In direct comparison, the observed caries rate from Kudachurt 14 of 8.4 % is much more similar to the observed caries rates in the Pakistan population (CCR 6.4 % versus 0-0.1 % OCR Eurasian sites), although the ecological background of the foothill setting and the steppe area in the North is more similar to the Eurasian sites. This strongly indicates an agricultural share of the diet for the population under study, or at least a diet rich in fermentable carbohydrates, for instance fruit sugars or starchy foodstuffs, providing adequate bioavailability and stickiness for the microbial portion of the dental plaque. Due to its antibacterial effects, clinical studies prove honey to be contraindicative for the development of caries lesions (Ahmadi-Motamayel *et al.* 2013; Atwa *et al.* 2014; Nassar *et al.* 2012).

Due to the only few mature individuals of advanced age and good dental preservation that apparently did not develop caries during life, this was probably true for the majority of the population. Slight sex-dependent differences in caries frequency rates per individual are not valid, as the caries calibration demonstrates that the rates in general are underestimated due to intravital tooth loss.

As this was often found in males of later age, the slightly higher rates in females are misleading. What caries lesions on deciduous teeth tell us, and this confirms the observations of occlusal wear, is that carbohydrates were included in at least some of the children's diets; two lesions found in infants are of questionable character and require revision.

Prospects

In summary, the prevalence of calculus and caries suggest appropriate amounts of calcium and phosphate in the saliva as well as carbohydrates and cariogenic bacteria in the dental plaque of the people buried at Kudachurt 14, which indicates an agricultural or mixed economy. Variations within the population are supported by data from occlusal wear and chippings. These findings are remarkable with respect to the question of shifts in subsistence during the MBA-LBA transition, as no chronological differentiation seems apparent (see preceding section).

The results raise many new questions, but due attention is beyond the scope of this thesis: What kind of foodstuffs containing appropriate amounts of carbohydrates should be considered? Were low or high cariogenic foodstuffs part of the daily diet or did restrictions exist, for instance due to seasonality? Did the supply of these foodstuffs require plant cultivation? What about the consistency and stickiness of food components? In addition, how did the processing of food alter its nature and bioavailability?

Besides a more detailed examination of the dental record as such, further direct evidences about consumed foodstuffs would be desirable, for instance food residues in calculus. In order to understand the development of dietary influence on oral health, comparisons to other Bronze Age populations from the Northern Caucasus are needed. The carbon and nitrogen stable isotope analyses presented in the following chapter represent one attempt to trace dietary components manifested in the bone collagen, especially with regard the protein portions of the interred individuals' diets.

5.9.3 Occupational habits

Within the mature individuals buried at Kudachurt 14, 30 showed dental modification that indicated either therapeutic treatment or the use of teeth as a tool during life. This makes up 47.6 % of the mature population with dental preservation. Only three individuals that died in advanced age lack such modifications, so that for the vast majority of individuals who survived their mid-30s non-dietary tooth alterations were visible. As males died at an older age than females, the imbalance between the sexes is presumably driven by age at death.

In section 5.6.3.9 the discussion of aspects of occupational or therapeutic indications of presented extramasticatory modifications tried to disentangle the nature of atypical occlusal wear, interproximal and occlusal grooving, and unspecific facets. To date, it remains unclear whether interproximal and vertical grooving primarily represent traces of attempts to clean out interdental spaces, carious cavities and lingual neck and root regions, although pathological causations are suggestive for some cases. Further methodological approaches are required to come to solid conclusion in this regard.

Comparative examples of non-alimentary tooth use are known from different chronological and geographical settings, and palaeopathological studies integrate ethnographic descriptions in order to interpret observed patterns in terms of occupational activities (*e.g.* Bonfiglioli *et al.* 2004; Brown and Molnar 1990; Clement *et al.* 2007; Minozzi *et al.* 2003; Molnar 2011, 2008; Lukacs and Pastor 1988; Lorkiewicz 2011; Scott and Jolie 2008). As these discussions are very detailed and comprehensive analyses of each extramasticatory trait requires its own study (for instance, the reconstruction of movement patterns or identification of processed materials), the following considerations are general statements.

Due to the different natures of extramasticatory traits, it seems obvious to assume different occupational activities for the individuals that performed related habits (Fig. 150). For instance, the prevalence of atypical occlusal macrowear[42], which is associated with the softening and processing of leather or fibre material (Hinton 1981; Lorkiewicz 2011, Fig. 2-5; Lukacs and Pastor 1988; Tomenchuk and Mayhall 1979), suggests that at least 35 % of the mature population and both sexes were involved in this kind of production process. Furthermore, 60 % of these dentitions showed other non-dietary modifications, mainly interproximal grooving, but also unspecific facets. Occlusal grooving is, together with interproximal grooving, seen in close relation to sinew or fibre processing and frequently identified in prehistoric populations, for instance from Palaeolithic Morocco, or Neolithic Pakistan and Sweden (Molnar 2008; Molnar2011). Unspecific facets represent a modification rare in palaeo-odontological studies so far. The most similar case is a facet present on a lower molar of a male individual from Bronze Age Sweden (Lindström and Söderlind 2009; Molnar 2011), whose funeral items suggest “leather-craftsmanship”,

The prevalence of extramasticatory traits within the population at Kudachurt 14 leads to the assumption that working processes grossly involving the maxillary occlusal surfaces were most commonly performed. In contrast, pulling of soft tissues around tooth arches (facets) or poking of firmer material over occlusal surfaces in varying directions are rather rare activity patterns (Fig. 150.1-2; Larsen 1985, Fig. 4; Lukacs and Pastor 1988). Multiple evidences on the same dentitions show that these habits were not distinctively “exclusive” in their performance, so that we can assume repeated occupational habits for some individuals, but not in general identify “professions” in a specialised sense. This is also because we do not know about the extent and time of habitual activities, aspects which require further work.

42 Heavy asymmetric wear and/or lingual and/or labial rounding of occlusal tooth surfaces.

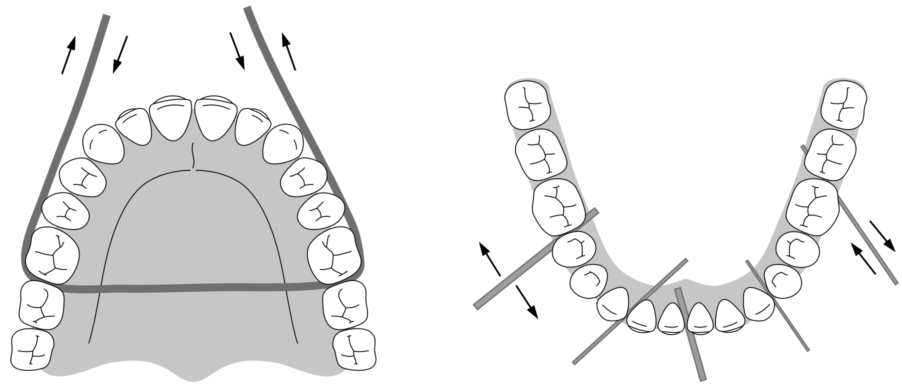


Figure 150: Analyses of human remains. Examples for activity patterns for occupational use of teeth. Possible modes of interproximal groove or facet formation in maxillary and mandibular teeth. Illustration after Lukacs and Pastor, 1988, Fig. 8; based on Merbs (1983) and Schulz (1977).

What we do know is that related working processes have been performed beyond the physical strain of the mastication system, especially the periodontal structures, as shown by observed correlations to tooth dislocation, alveolar remodelling, periapical lesions and intravital tooth loss (*e.g.* ind. 218.2_1, Fig. 127.3-4). Although we cannot transfer the modern perception of oral health to past populations, available results suggest appropriate production intensity connected to the use of teeth "as a third hand" or a multifunctional tool that disregarded the physical consequences.

In summary, associated occupational habits that are in accordance with presented extramasticatory traits relate to the processing of animal skins, sinews, fibres, or other fabrics and materials. Known from the grave assemblages, the production of costume and jewellery items would come into question here, but this is a very selective example. Tools are extremely rare in the funeral equipment; personal items could possibly help to identify occupational roles.

5.9.4 Social implications

In the overall context, the presented findings suggest considerations in terms of social aspects for the buried population at Kudachurt 14, which gives us insights into the reality of life between 2200-1700 BCE in the North Caucasian Bronze Age. This is especially of interest as the demographic structure describes a cross-section of a living population rather than a segmental part. In the following, some of these aspects are briefly discussed.

Age and biological sex

Individual results of oral health point to some key issues in individual biographies in terms of past living condition. For the vast majority of the population, events or intervals of unspecific stress occurred during childhood and are manifested as enamel hypoplasia. Therefore, we can assume that causing circumstances affected not a selective part of the society, although it seems that female children were either more prone to enamel dysfunction or experienced more often according physical stressors; a higher resolution of the temporal dimension of EH would be helpful. During the immature life span, dentitions from children report the introduction of solid and cariogenic food components from *ca.* 3 years onwards, thus potentially marking the age of adjustment of their diet to that of mature individuals. During young adulthood, potentially after reaching the reproductive state, females showed a higher mortality rate than males. Due to the obviously different biological states and physical demands compared to males, it remains unclear how strong menstruation cycle, tasks, and risks of motherhood have influenced the higher frailty of females. Certainly, other possibilities come into question here, for instance different life realities in terms of higher infection risk due to closer interaction with other people or animals, high workload, malnourishment, targets for violence, or a combination of all (Pfeiffer *et al.* 2014). Conversely, the demographic data suggest lower mortality risks for males in young mature age. Observed caries rates do not conclude significant sex-related differences access to food containing carbohydrates that would suggest occupational division (see preceding section). Some individuals, predominantly males, reached advanced physical maturation before they eventually died of life-threatening oral disease (periapical inflammation). Others survived them, visible in the rate of intravital tooth loss. In general, the dentitions from the mature part of the buried population reveal occupational habits during adulthood connected to the processing of materials or manufacture of products. Although it is not possible to address related activities as "professions", we can state that some individuals used their teeth in specific ways, and this is true for both females and males. Such working processes were until death and the youngest age of tooth modification was in individuals that died around 17-25[43] years of age. During the course of mature life, we can assume increasing technical skills. As interproximal and vertical grooving on teeth can also derive from therapeutic actions, which co-occurring oral pathologies suggest, such hygienic measures were not commonly shared habits but were undertaken by both males and females.

Single inhumations and inhumation groups

In the context of the funeral background, mutual inhumations obviously imply relationship among the individuals, whether this be biologically (kinship), socially (belonging to a certain group), ritually (deceased were seen in the same spiritual context), or a combination within these spheres. The temporal dimension of this "mutuality" remains unclear now. Furthermore, the *acting society*, meaning the *burying population*, plays an important role in this regard; although we cannot disentangle the degree of autonomy or socio-ritual control that authorised the funeral event and eventually the belonging of a deceased to an inhumation group or the separation from it, gathered information from the human remains give some food for thought.

In most cases, inhumation groups (collective and double burials) consist of immatures, females, and males with no clear rule towards demographic structuring. Inhumation groups reflect the same value concerning the relative ratio of adult vs subadults of 2:1 as the buried population does (n=204, by determined osteological as well as *in situ* age estimation). With a shift toward 3.4:1, this ratio is different for single grave contexts; subadults preferably have been buried in groups, and adults more often have been buried separately[44]. Hypothetically, mutual funeral environments suggest kinship relations, especially in larger inhumation groups of complex demographic structure that potentially captured several generations (*e.g.* 047, 186, 218). At the same time, inhumation groups consisting predominantly of immature individuals (*e.g.* 065, 129, 195, 204) represent a vulnerable part of a population toward diseases and/or supply bottlenecks, so that similar times of death could also be decisive in this regard.

Based on the data from the human remains, the burying population followed no prevailing rule in their habit of singular or mutual inhumations. This is also true for the oral health status as well as potential occupational activities the deceased conducted during life. If the extramasticatory modifications represent occupational professions, carriers of such traits were both integrated in inhumation groups and were buried individually. Considering inhumation groups as a kinship or social unit, their belonging would have been more important compared to "emphasising their role" in separate graves.

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43 047_1, tooth position 11.

44 Although we cannot exclude that single burials of small children may have not been recognised in their actual number; see excavation situation, chapter 3.

6 Carbon and nitrogen stable isotopes: Palaeodietary reconstruction

Dedicated to the significance of diet and nutrition as a means of existence, this chapter focuses on the reconstruction of palaeodietary trends in the population buried at Kudachurt 14 by means of carbon (C) and nitrogen (N) stable isotope analyses.

The adaptation to changing environments and the establishment of subsistence strategies – described by natural resource utilisation and alteration, and mobility models – as well as needs for social control made up crucial developmental stages of human existence. M. Schoeninger and Moore (1992) state, attempts of palaeodietary reconstruction ideally consider information from diverse archaeological and palaeo-ecological records including remains and traces of foodstuffs from different exploitation stages (production, utilisation and availability of food resource, preparation, ingestion, physical manifestation, and excretion), cultural material as well as the technical knowledge that becoming visible by the nature of artefacts.

The basic principle of dietary reconstruction by means of stable isotopes is that the chemical composition of bones and teeth can be linked to the chemical composition of consumed food. In the sense of "you are what you eat", isotopic compositions of foodstuffs manifest in the consumers tissues through the metabolism of nutrients. In this regard, the applied approach for dietary reconstruction primarily sheds light on the tracing of consumption patterns within a specific food web existing between plants, animals, and humans. In principle, this includes an assessment of organisms' access to bioavailable carbon and nitrogen for the synthesis of organic matter and production of energy, particularly that stemming from proteins. Therefore, the isotopic compositions of carbon and nitrogen in animal and human specimen give insight into three aspects of exploitation stages: availability and utilisation of protein sources, ingestion, and physical manifestation (in bone collagen).

For an introduction into the topic, the basic principles of stable carbon and nitrogen isotope analyses are discussed to provide a methodological and terminological framework for the following sections. By discussing recent bioarchaeological approaches to reconstructing Bronze Age subsistence strategies in the Northern Caucasus, this isotopic study is contextualised in the current state of the art. The specific importance of Kudachurt 14 is briefly discussed with respect to formulated research aims and working hypotheses, followed by the description and interpretation of gained results. In general, the analyses concentrate on answering the questions of research:

Did livestock management and C_4 plant cultivation contribute to the subsistence strategies of the buried population at Kudachurt 14?

6.1 Principles of stable isotope analyses

If not otherwise referenced, information for the following explanations are taken from the standard work of Sharp, Principles of Stable Isotope Geochemistry (2007), Hoef's Stable Isotope Geochemistry (2009), and Katzenberg's summary Stable Isotope Analysis: A Tool for Studying Past Diet, Demography, and Life History (2008). The explanations focus specifically on stable C and N isotope analyses of bone collagen as a tool for dietary reconstruction. More detailed descriptions of stable isotope ecology, the chemical background, and analytical methods as well as opportunities for broader applications in bioarchaeology are beyond the scope of this thesis.

6.1.1 Basic concept and terminology

Isotopes are atoms that have the same number of protons, and are thus the same element, but different numbers of neutrons in their nuclei; this causes mass variations between isotopes of the same element. Atomic weight is determined by the number of neutrons, resulting in "lighter" and "heavier" isotopes. Unlike radioactive or primordial isotopes, such as ^{14}C, stable isotopes (non-reactive isotopes) do not decay after the death of an organism[1]. The stable isotope composition of an element bound in teeth, bones, or soft tissues, namely the ratio of light to heavy isotopes, thus reflects the isotopic composition of said material at the organism's time of death.

Due to the variation in atomic weight, isotopes of the same element behave differently in physical reactions, while underlying chemical processes remain unaffected. Increasing atomic weight causes decreasing relative vibrational frequency, energy, and velocity so that heavier isotopes react more slowly compared to lighter isotopes. Bonds of lighter isotopes break more readily in chemical reactions and therefore preferentially diffuse out of a system. There is thus a discrimination against the heavier isotope in reactions. The term "kinetic isotopic effect" describes the differences in reaction rates due to these physical and chemical characteristics of heavy and light isotopes. The kinetic isotope effects occurring during chemical reactions cause differences in isotope ratios of the involved substances: the isotopic composition of the product differs from the isotopic composition of the same element in the educt. This difference in isotope ratio from educt to product is called "fractionation". As an example, within the global carbon cycle, atmospheric CO_2 (product) has less of the heavier ^{13}C isotope relative to the lighter isotope ^{12}C in comparison with CO_2 in the ocean (source). Thus, the fractionation occurring during this step of carbon exchange describes a relative decrease of ^{13}C compared to ^{12}C. In samples, these fractionation effects can be determined by using an isotope-ratio mass spectrometer (IRMS). Its electronic detector distinguishes between the isotopes of an element by measuring the concentration of known molecules with different masses.

The presentation of stable isotope data refers to a value expressing the ratio of the heavy to the light isotope of the element of interest. In this thesis, these are the stable isotope ratios of the elements carbon and nitrogen, namely $^{13}C/^{12}C$ and $^{15}N/^{14}N$. In order to achieve a comparability of stable isotope ratios among samples and laboratories, an equation that considers a reference standard[2] is used and the calibrated result is marked with a delta notation (δ). Since the fractionations during chemical processes are very small, the results are multiplied by 1000 and reported as per mill (‰). For the following analyses, these equations are:

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1 For the principle of radiocarbon dating, see chapter 3.4.2.1.

2 For a review of international standards and samples used for calibration of carbon and nitrogen values, see Sharp (2007).

$$\delta^{13}C = \frac{^{13}C/^{12}C \text{ sample} - {}^{13}C/^{12}C \text{ VDB standard}}{^{13}C/^{12}C \text{ VDB standard}} \times 1000 ‰$$

$$\delta^{15}N = \frac{^{15}N/^{14}N \text{ sample} - {}^{15}N/^{14}N \text{ AIR standard}}{^{15}N/^{14}N \text{ AIR standard}} \times 1000 ‰$$

In consequence, positive δ values mean that the analysed sample has more of the heavier isotope relative to the reference standard, and negative δ values express more of the lighter isotope relative to the reference standard.

Terms describing the state of fractionation often used in stable isotope studies are "isotopic signature", "depleted", and "enriched". The "isotopic signature" of a sample is defined by the ratio of all isotopes of a particular element in the investigated material. In the scope of this thesis, this term refers to the isotopic signatures of carbon and nitrogen only. "Depleted" and "enriched" describe the state of the isotopic signature with respect to a specific stable isotope and its abundance in a sample. Referring to the previously mentioned example, atmospheric CO_2 is depleted in the heavier isotope ^{13}C compared to CO_2 in the ocean. On the contrary, an enrichment of the heavier isotope ^{15}N takes place in organisms throughout metabolic processes and with increasing trophic levels in a food web.

6.1.2 Stable C and N isotopes from bone collagen

The structure of bone from multicellular organisms is composed of an organic portion (*ca.* 30 %) and an inorganic portion (70 %; dry bone by weight). The major organic component is collagen (85-90 %) which forms a matrix that provides a structure for the inorganic substances, predominantly hydroxyapatite. In its function as a connective tissue in inorganic substances, bone collagen may be preserved for long periods and therefore often works well as a record of study in bioarchaeological investigations. The amounts of carbon and nitrogen contained in collagen (*ca.* 35 % and 11-16 %, respectively) make it a suitable sample material for respective isotope analyses.

Due to bone turnover rates, which are specific for different skeletal elements and for the individual's age, constitution, nutrition and health, the isotopic compositions of bone collagen represent averages from the last years of life before death (Bocherens and Drucker 2003). Preferred macronutrients (carbohydrates, lipids, proteins) contribute differently to the synthetisation of body tissues, which means that an analysis of bone collagen only cannot detect the whole diet (DeNiro and Epstein 1977; Lee-Thorp 2008; Stantis 2015; Tieszen *et al.* 1983). Collagen is composed of both essential and nonessential amino acids. While essential amino acids are synthesised from ingested protein, nonessential amino acids can come from protein or other dietary sources. This is different from carbonate, which can originate from carbohydrates, lipids or protein (Katzenberg 2008). In consequence, and as confirmed by numerous bioarchaeological studies (Ambrose and Norr 1993; Krueger and Sullivan 1984; Lee-Thorp *et al.* 1989; Lee-Thorp 2008; Tieszen and Fagre, 1993), isotopic carbon compositions in bone collagen reflect mainly the protein proportion of the diet and low protein food may be underrepresented. Proteins are also the main suppliers of nitrogen for collagen synthesis. The isotopic composition of collagen in bone is thus suitable for tracing protein consumption.

As almost all body tissues from archaeological contexts, collagen is prone to diagenesis and both chemical and physical processes must be considered in discussions of taphonomy. The degree of diagenesis and the vulnerability of tissues depend on both environmental factors (*e.g.* temperature, humidity, oxygen supply, microbial and faunal activity) and the physical state of the bone (*e.g.* compacta/cancellous bone, if fragmented, porous or alike). Such diagenesis can alter isotopic compositions of bones (Balasse *et al.* 1999; Nelson *et al.* 1986; Price *et al.* 1992). In order to establish that the measured isotopic composition represents an unaltered one, different methods of assessing bone collagen preservation have been developed; three have been applied in the analyses for this thesis. The three methods are the estimation of collagen yield, %C and %N per weight, and the detection of carbon to nitrogen mass ratios. All three measures must fall into specific value ranges that match reference samples of unaltered material (Ambrose 1990; van Klinken 1999).

For the sample preparation, it is necessary to extract the collagen portion of the bone, *i.e.* to remove the inorganic substances and contaminations and gain the pure bone collagen. Different protocols and pre-treatments are used within laboratories and for samples. It has been recognized that preparation can influence the results of measured isotopic compositions, which needs to be taken into account in comparison studies (Jørkov *et al.* 2007; Sealy *et al.* 2014; Tuross *et al.* 1988; Yunusbayev *et al.* 2012).

6.1.3 Stable C and N isotopes in palaeodietary reconstructions

The principle of dietary reconstruction by means of stable C and N isotope analyses is based on the fact that their ratios in plant, animal, and human tissues differ within ecological zones and trophic levels in the food web. Carbon and nitrogen are essential for the synthesis of organic matter and are therefore suitable elements for tracing isotopic effects between diet and body tissues. As the elements relate to different aspects of the diet (carbon for the consumption of primary producers, nitrogen for trophic levels; see below), the analyses of bone collagen from animal and human samples from Kudachurt 14 follow the conjunctional approach of testing both carbon and nitrogen.

Natural abundance ratios are the result of different pathways of carbon and nitrogen cycles. For interpreting $\delta^{13}C$ and $\delta^{15}N$ in ancient plant, animal, or human tissues it is necessary to consider how C and N enter the biosphere and which factors may have altered related processes. The interplay of natural abundances of C and N isotopes, the topographic situation, climate, and soils form different environments in terrestrial and marine biotopes, in which complex feeding connections between floral and faunal species constitute ecological communities. In consequence, the best sampling practice for related studies should not only seek to include representations of heterotrophic levels within the food web, but also autotrophic organisms as primary producers of biomass. Furthermore, variations in $\delta^{13}C$ and $\delta^{15}N$ values can result from different metabolic pathways as well as specific principles of tissue formation and physical demands of both floral and faunal species. In the following, principles of food webs, some basic information about variations in stable C and N ratios, and their significance for diet reconstruction will briefly be discussed.

6.1.3.1 Food webs

Simply put, food webs are intended to provide a diagram that describes trophic relationships in different food chains between species in ecosystems. It includes known food chains in an environment from autotrophic species through different levels of heterotrophs in predator-prey relationships, up to the top predator. The complexity of food webs in different environments can be traced and understood by trophic fractionation of $\delta^{13}C$ and $\delta^{15}N$ values, and this principle has been used in ecological as well as bioarchaeological studies aiming to place an investigated organism within the feeding community (Stantis 2015; Zanden and Rasmussen 2001). The lowest trophic level in a simple food chain refers to the autotrophs as primary producers of biomass. They synthesise organic compounds from inorganic elements and energy potential. Heterotrophs make up the next trophic levels by relying on living or non-living organic matter as energy resources (Wiegert and Owen 1971). Within the heterotrophic species, herbivores make the second trophic level by consuming plants, carnivores are on the third trophic level by consuming the herbivores, and apex predators make up the fourth by consuming the carnivores. The binary character of species interaction in such chains or webs does not accurately depict the reality of nature because the interactions are not necessarily constant or equally strong, and neither is the environmental background (Pimm 2002). Additionally, trophic levels are not easy to determine as omnivores can incorporate materials originating from both plant and animal tissues, and species on the same trophic level can consume each other (Pimm and Lawton 1977).

Dietary reconstruction by means of stable isotope analyses seeks to place the investigated organism within this food web, thus, to understand what it has eaten and, potentially, which species would have eaten it. This is possible by considering $\delta^{13}C$ and $\delta^{15}N$ fractionations within organisms of different trophic levels, as enrichments of the heavier isotope in higher trophic levels are recognized. As $\delta^{13}C$ and $\delta^{15}N$ values of animals differ among species as well as across body tissues, the determination of distinct value shifts from the first to the second trophic level is challenging (Schoeninger and Moore 1992). In addition to the given natural environment, feeding habits, movement spaces, and physical constitutions (*e.g.* size, nutrition demands) influence an animal's exploitation of food sources; this situation becomes even more complicated with anthropogenic interventions in the food web (fertilisation, herding, supplemental feeding).

6.1.3.2 $\delta^{13}C$

Carbon biosphere pathways and $\delta^{13}C$ values

From the global carbon cycle, atmospheric carbon and ocean carbon enter the biological system through photosynthesis by plants and through chemosynthesis by bacteria, where inorganic carbon becomes available for organic carbon molecules. In the atmosphere, the ratio of ^{13}C to ^{12}C ranges between 1.1 % and 98.9 %. Based on the isotopic effects during carbon fixation, organic matter is generally depleted in ^{13}C, which is expressed in negative $\delta^{13}C$ values (Boutton, 1991).

In ecosystems, the type of photosynthetic pathway influences the $\delta^{13}C$ values of a plant. In terrestrial species, three main types of photosynthesis are defined by the metabolic path of carbon fixation from carbon dioxide: C_3, C_4, and CAM (Edwards 1983; Ehleringer and Cerlin 2002; Yamori *et al.* 2014). In the basic C_3 pathway, the first product of the Calvin Cycle compounds three carbon atoms (3-phosphycerat). In the C_4 metabolic pathway, 4-carbon compounds (malate, oxaloacetate) are first produced in another physiological unit (bundle sheet cells) before the Calvin Circle begins. The C_4 pathway is an adaption to warmer and drier environments, as its metabolic process has a higher efficiency of carbon and hydrogen management compared to the C_3 pathway (greater CO_2 fixation and reduced photorespiration). The CAM photosynthesis carbon fixation pathway is developed for arid conditions, as it has separate reaction cycles in order to reduce evaporation during the daytime[3]. Based on their photosynthetic pathway, terrestrial floral species are defined as C_3, C_4, or CAM plants.

3 As CAM (crassulacean acid metabolism) plants are not of interest in this thesis, this plant type is not considered in the following.

Although atmospheric CO_2 is already depleted in ^{13}C compared to oceanic CO_2 ($\delta^{13}C$ atmosphere= $\delta^{13}C$ ocean -9 ± 2 ‰), the depletion continues during both carbon fixation (photosynthesis, chemosynthesis) and production of organic matter. Organisms in marine ecosystems are naturally enriched in ^{13}C values compared to terrestrial organisms (marine flora about +7 ‰). In terrestrial flora, the metabolic differences in C_3, C_4 and CAM photosynthetic pathways cause different isotopic effects resulting in specific variations of $\delta^{13}C$ values among the plant types. C_3 plant $\delta^{13}C$ values range from -23 ‰ to -33 ‰, whereas C_4 plants exhibit ranges from -9 ‰ to -16 ‰ (Sharp 2007). Thus, C_3 plants show depleted $\delta^{13}C$ values compared to C_4 plants. Different sources of carbon contribute to freshwater environments (lakes) and cause, among other factors, substantial variations in $\delta^{13}C$ values between about -15 ‰ and 0 ‰. Most freshwater organisms share the C_3 photosynthetic pathway, and among macrophytes and plankton the $\delta^{13}C$ ranges are quite broad[4] (Boutton 1991).

In addition to the photosynthetic pathways, there are other factors that contribute to secondary effects on the $\delta^{13}C$ values of plants: re-assimilation of depleted CO_2 (*e.g.* under the canopy), temperature and elevation, water stress, osmotic stress, low nutrient content, and reduced CO_2 partial pressure all have specific effects (cf. Tieszen, 1991).

Trophic levels

The largest shift within C isotope compositions takes place within photosynthesis or chemosynthesis, thus during the transformation from inorganic to organic carbon compounds (see above). As plants are the primary producers of organic matter (autotrophs), their tissues serve as a basic component on which heterotrophs rely. Due to isotopic effects during the synthesis of collagen and the incorporation of plant-derived carbon (or from other autotrophs), bone collagen of herbivores is enriched in ^{13}C by approximately 3-5 ‰ (Ambrose and Norr 1993; DeNiro and Epstein 1977; Tieszen and Fagre 1993). Differences in $\delta^{13}C$ values from herbivore to carnivore are usually too small to identify considerable trophic levels based on carbon (0-2 ‰; Bocherens and Drucker 2003). Therefore, carbon isotope compositions in faunal bone collagen are more suitable to understand the type of primary producers in a food web; in principal, the floral nutritional basis based on the given terrestrial or marine environmental background (Schoeninger and DeNiro 1984; Stantis 2015).

6.1.3.3 $\delta^{15}N$

Nitrogen biosphere pathways and $\delta^{15}N$ values

Unlike with carbon, the transformation of the chemical form of inorganic nitrogen in the atmosphere to bioavailable nitrogen is not a simple, one-step process (N_2, 99 % of the global source; ^{15}N to ^{14}N ratio is 0.36 % to 99.64 %; Schoeninger and Moore, 1992).

Different chemical forms of nitrogen[5] are transformed and circulated among ecological spheres within the nitrogen cycle. Starting with the fixation of atmospheric N_2 by bacteria (to ammonium), subsequent *nitrification* by other bacteria under aerobic conditions takes place in the soil (to nitrate). Nitrogen fixation of atmospheric N_2 also happens by lightning strikes. Both ammonium and nitrate are bioavailable to plants, but plants generally prefer nitrate. Faunal excretions and other organic waste contain organic residues and urea that bacteria and fungi transform to ammonium (ammonification[6]). This again may undergo nitrification, thus repro-

4 Macrophytes lake -30 ‰ to -12 ‰, plankton lake -42 ‰ to -26 ‰ and river -30 ‰ to -25 ‰ (Boutton 1991).

5 These are ammonium (NH^+_4), nitrite (NO^-_2), nitrate (NO^-_3), nitrous oxide (N_2O).

6 Or *mineralisation*.

ducing (recycled) nitrate. Under anaerobic conditions, soil microbes reduce nitrate back to N_2 gas (denitrification), which enters the atmosphere as inorganic nitrogen. In marine ecosystems, similar processes take place, whereas rivers and groundwater contribute to both freshwater and marine nitrogen pools in N_2. Thus, nitrogen fixation as well as ammonification are the major processes for nitrogen entering bio systems and both rely on the abundance of microbes in soil and water (Hoefs 2009).

Nitrogen fixing organisms are defined as diazotrophs and often occur "freely-living" in soils, although others form a symbiotic relationship with terrestrial plants by living on their roots (*e.g. Rhizobiaceae*). In free-living diazotrophs, the fixation of nitrogen has no significant isotopic effect; the isotope ratios are similar to that of the atmospheric N_2. Hosts of the symbiotic relationship, so-called nitrogen-fixing plants, show approximately 2 ‰ higher $\delta^{15}N$ values than non-nitrogen fixing plants, but the ranges are not significant (Schoeninger and Moore 1992; Unkovich 2013). The nitrogen isotope composition of plants correlates with ecological factors of their environment and microbial activity including form and abundance of nitrogen contained in soils (*e.g.* ammonification leads to increased $\delta^{15}N$ values due to reuse of enriched organic matters from faunal excretion), abundance and type of bacteria, depth of plant roots (deeper soils tend to be enriched), soil permeability, salinity, and other factors (Ambrose 1991; Amundson *et al.* 2003; Peterson and Fry 1987). Additionally, compositions can differ within the different sections of a plant (Unkovich 2013). In general, variations from -8 ‰ to 18 ‰ have been observed (Kelly 2000; Stantis 2015). Marine ecosystems are generally enriched in ^{15}N and so are their organisms (Peterson and Fry 1987; Schoeninger and Moore 1992).

Trophic levels

There is a stepwise enrichment of ^{15}N within the trophic levels of a food web. Due to fractionation of protein during metabolism processes, the consumer's $\delta^{15}N$ value is about 3-6 ‰ higher than its diet. For instance, herbivores have 3 ‰ higher values than the average of consumed plants, and a carnivore would exhibit 6-12 ‰ higher values than the plant its herbivorous prey ate. An omnivore would exhibit value ranges in-between, reflecting its prey's as well as the plants' signature, and a carnivore feeding on both herbivores and omnivores would have a mixed signature of +3-6 ‰ above. This stepwise enrichment would follow the food chain up to the top predator (DeNiro and Epstein 1977; Schoeninger and DeNiro 1984; Schoeninger and Moore 1992). The accuracy and validity of this 3-6 ‰ spacing in $\delta^{15}N$ values for determining trophic levels based on bone collagen are controversial (Bocherens and Drucker 2003). Due to the already mentioned differences in $\delta^{15}N$ in terrestrial and marine ecosystems, marine food webs exhibit a higher enrichment of ^{15}N along the food chain relative to terrestrial food webs, and it is possible to distinguish between these two. According to Schoeninger and DeNiro (1984), marine carnivores have about 8.5 ‰ higher $\delta^{15}N$ values than terrestrial carnivores although there are overlapping ranges among herbivores.

There are many factors that influence the nitrogen isotopic signature within heterotroph species and specimen, including water stress (in arid environments, hot or cold temperatures; enriches ^{15}N in body tissue) and changing feeding practices during the course of life (Ambrose 1991). The effect of breastfeeding causing higher $\delta^{15}N$ values in infants due to the incorporation of enriched mother's milk is of special interest, in particular in connection with detecting weaning ages and practices (cf. Beaumont *et al.* 2015; Reynard and Tuross 2015; Tsutaya 2017).

6.2 Recent research on subsistence and diet in the North Caucasian Bronze Age

Contrasts in topography, vegetation, and climate form the diverse environments characterising the Northern Caucasus and were exploited differently in terms of preferred habitats and subsistence strategies during the Bronze Age. In archaeology, the exploration of North Caucasian prehistory historically focused on burial rites and cultural material from graves in order to trace the origin and distribution of archaeological cultures (see chapter 2.2., 2.4.;), whereas the detection and investigation of socio-economic developments of the inhabiting populations has only gained more significance during the past decade (Knipper *et al.* 2018; Reinhold *et al.* 2017; Reinhold *et al.* 2007).

In the overall context of archaeology, the establishment of Neolithic lifeways in western Eurasia was not a continuous development from the first introduction of plant cultivation and animal domestication in the 6th and 5th mil BCE. Beginning in the late 4th millennium, mobile pastoralism and the exploitation of peripheral landscapes constituted the major form of subsistence in the Eurasian steppe. This epoch ended during the 2nd mil BCE (MBA-LBA) with the re-emergence of communities living in settlements which still, however, relied on animal herding. Populations practicing intensive cereal cultivation accompanied by the alteration of landscape are well documented for the late 2nd and early 1st mil BCE (Knipper *et al.* 2018). The examination of dietary practices and subsistence strategies is currently a major topic in bioarchaeological research on Bronze Age populations of the Northern Caucasus. Many chronological periods and spatial areas remain unexplored with regards to the development of sedentary life along a north-south axis in the North Caucasian regions, especially during the MBA and LBA.

From an archaeological perspective, the lack of settlements as well as the lack of research examining existing structures in the southern steppe and foothill regions have resulted in the assumption that the people of the MBA cultures primarily followed pastoral lifeways (NC Catacomb Grave Cultures, Surovoro Culture, North Caucasian Culture; *ca.* 3000-2000 BCE, see Fig. 2 and 3, chapter 1.2). New results from a high mountain site verify the existence of settlements during the late 3rd and early 2nd mil BCE (Reinhold *et al.* 2017). The MBA-LBA transition, or the final MBA horizon, remains a period of regionally fragmented archaeological constructs (Alinkova Group, Archon Group, Late MBA High Mountains, *ca.* 2200-1500 BCE; see 1.2). According to Reinhold *et al.* (2017), building structures with different activity zones, cereal findings, and a kiln from a site dating to the beginning of the LBA (Koban A, Ékazevsk, *ca.* 1500 BCE) prove that particular communities had developed sedentary strategies. The authors stress that a purely mobile lifeway was questionable in the central mountain ranges and slopes at that time; permanent villages and resource management on a local basis are evident after the final MBA horizon (Reinhold *et al.* 2017).

Major efforts have been made to understand settlement behaviour, land use strategies, and related social processes taking place during the LBA and EIA in the Kislovodsk region, which is adjacent to the study region on its western border (see Fig. 5.). During the past six years, Reinhold, Knipper, and colleagues conducted multidisciplinary[7] examinations of associated archaeological sites, aiming to reconstruct mobility patterns and dietary compositions. Their approach includes analyses of stable carbon and nitrogen isotopes in order to verify the shift in dietary practices suggested by the archaeological remains from a biochemical perspective. Archaeological and geoarchaeological investigations discovered over 200 settlements with characteristic forms of stone architecture in the foothills, valleys and high mountain plateaus, creating a new archaeological phenomenon of the LBA and EIA for that

7 Archaeological fieldwork, geoinformatic modelling, geo- and bioarchaeological methods.

region (*ca.* 1550-400 cal BCE; Knipper *et al.* 2018; Reinhold *et al.* 2017). The team succeeded in identifying multifunctional byre-dwellings and postulating animal alpine husbandry and winter stabling. Based on zooarchaeological data and spatial extrapolations for 190 contemporaneous settlements, they reconstructed herd sizes and conclude that the demands on required pasture were too high for local animal herding[8]. The authors therefore propose summer pasturing on territories in higher altitudes as a strategy to increase the economic capacity of the region. Additionally, the evidence of crop imprints in ceramics from the site Kabardinka 2 point to at least small-scale crop growing. Based on these results, the authors suggest a "combined mountain economy" for populations inhabiting the plateaus of the micro-region at that time (Knipper *et al.* 2018). The authors emphasise that the formations and transformations of the economic systems and the development of sedentary models were accompanied by the reorganisation of social space and new realities of relationships between humans and animals (Knipper *et al.* 2018; Peters *et al.* 2014; Reinhold *et al.* 2017). In the EIA (Koban Culture), large permanent villages and the growing and consumption of cereals including C_4 plants were fully established processes that took place in the valleys. In this context, the EIA site of Klin Yar, a large settlement with an associated cemetery of the Koban Culture, provided human and animal skeletal material for according isotopic investigations of the subsequent period (Higham *et al.* 2010; Reinhold *et al.* 2017).

In summary, diachronic shifts in preferred habitats and subsistence took place over the course of the late EBA to LBA (*ca.* 3000-1300 BCE), accompanied by changes in the socio-environmental interaction and exploration of more elevated and diverse landscapes. This occurred simultaneously with the rise and decline of archaeological cultures, their increasing fragmentation, and heterogeneity. Cultures developed from regional lifeways based on pastoralism and a mixture of sedentary and mobile components in the steppe regions during earlier periods, to predominantly sedentary lifeways in permanent villages in the high mountain plateaus in the later period. With the beginning of the EIA (Koban Culture, *ca.* 1100 BCE), the moderate valleys became the preferred habitats and the importance of pastoral components decreased while the agricultural component increased, accompanied by C_4 plant consumption (Higham *et al.* 2010).

From these results, Reinhold, Knipper and colleagues derived research questions for subsequent isotope analyses, focusing on tracing postulated dietary shifts and on integrating bioarchaeological and archaeological arguments related to crop cultivation (Knipper *et al.* 2018). Results from a pilot study have recently been published and constitute suitable reference for the stable isotope approach presented in this thesis, especially because Knipper and colleagues included grave 186 and 212 from the Kudachurt 14 cemetery in their analyses. Therefore, their conclusions will briefly be discussed regarding spatial and chronological significance. The study provides the integration of new results of stable carbon and nitrogen isotope analyses from two MBA and MBA-LBA cemeteries, Kabardinskij 9 (Kabardinka) and Kudachurt 14, with data gained by Hollund *et al.* (2010) and Higham *et al.* (2010). The data set consisted of bone collagen samples from 12 humans and 1 animal from Kabardinskij 9 and 7 humans from Kudachurt 14, supplemented by 40 human values from 8 sites and 12 faunal values from 4 sites taken from aforementioned literature.

The late MBA necropolis Kabardinskij 9, specifically the graves located in kurgan 1 (grave 3, 12, 13) and kurgan 2 (grave 1b, 2; *ca.* 2600-1800 BCE, cf. Reinhold *et al.* 2017), showed slightly older radiocarbon dates than Kudachurt 14, with the exception of grave 2 which represents a later burial (729-431 cal BCE, EIA; Knipper *et al.* 2018). The necropolis is located *ca.* 100 km as the crow flies from Kudachurt 14 and

8 1.500 multifunctional houses, 7000-10.000 inhabitants, up to 17.000 cattle and potentially 150.000 sheep/goats; extrapolation based on the site Kabardinka 2 (Knipper *et al.* 2018).

preceded the later appearance of settlements with stone architecture in this area. The grave architecture is characterised predominantly by stone cists covered by a burial mound that is marked with concentric cromlechs. The burial equipment consists of few grave goods, and mortuary practice as well as the material culture show affiliations to the North Caucasian Culture[9].

In general, little isotope data has so far been published for the period studied here. Apart from papers dealing with the earlier BA periods primarily in northern steppe contexts as mentioned in chapter 1.2.3. (*e.g.* Iacumin *et al.* 2004; Shishlina 2008; Shishlina *et al.* 2009; Shishlina *et al.* 2012a; Shishlina *et al.* 2012b), Hollund and colleagues aimed at examining the human palaeodietary adaptation during the Eneolithic and Bronze Age in the Northern Caucasus (Hollund *et al.* 2010). Their analyses included 43 animal and 51 human samples from 17 sites across different ecological zones (dry steppe, humid steppe, forest, and forest-steppe; Hollund *et al.* 2010; see chapter 2.4.3) In summary, major results of the paper are: (1) The isotopic values of the terrestrial herbivores and the humans consuming them reflect the climatic and environmental diversity of test regions, with a strong north-south division. The highest values are from sites located in the dry steppe area. (2) Humans show significantly enriched $\delta^{15}N$ values compared to local terrestrial herbivores and carnivores, which indicates exploitation of aquatic food resources. (3) There are no radiocarbon offsets for the nine human-animal sample pairs. Additionally, the authors emphasize how the strong correlation of isotopic values and local factors complicates the interpretation of human diet and recommend further supra-regional studies (Hollund *et al.* 2010, 2979). By dividing the sites in northern and southern groups and averaging respective values, the authors observe enriched $\delta^{15}N$ and $\delta^{13}C$ values in animals from northern sites (averages -18.2‰ and 9.5 ‰) compared to those from southern sites (-19.7 ‰ and 7.0 ‰), and a broad variability, especially in nitrogen values. In terms of building an isotopic baseline, it is problematic that from the presented values, sheep/goat (Ovis) is the only herbivore represented at all sites, whereas the full faunal record includes other herbivore species[10]. Thus, the faunal isotope signals can only be used for isotopic baselines for locations with specific ecological backgrounds which belong to a limited period, and different dietary behaviours and metabolic characteristics within the species do not allow reliable linkages between the sites. The authors achieved direct connections of faunal and human values in five burials from two sites[11].

Due to this strong environmental impact, in their study Knipper and colleagues included sites that share the most similar ecological background to Kabardinskij 9 and Kudachurt 14 (Knipper *et al.* 2018; Fig. 151, 1-2, 4-6; see appendix). These are mostly burial grounds of the EBA Maikop Culture, which thus belong to an earlier period or are of unspecific chronology. Two sites from northern steppe burial mounds delivered five faunal values (Goryadchevodski and Inozyemtsevo, Fig. 151.8-9) for the isotopic baseline. Available comparative data for human signals are provided by six sites, nowadays located in the humid steppe or forest-steppe regions from north of the central mountain slopes, with annual precipitation between 400-800 mm. The six sites with human values are Baksanyonoyk (Maikop), Zamankul (unknown), Zaragizh (BA unspecific), Nezhinskaya (Maikop), Zanozina Balka (Maikop) and two burials from unspecific grave contexts of Kudachurt itself (one MBA unspecific, one Maikop). Nowadays, the sites Zaragizh, Zamankul and Kudachurt share the most

9 Excavated by Reinhold and colleagues in 2011, unpublished material.

10 Such as horse (*Equus c.*), donkey (*Equus a.*), cattle (*Bos*, domestic or wild) and gazella (*Gazella s.*). Other faunal remains include pig (*Sus d.*) as an omnivore, and snake, bear (*Ursus a.*), wolf (*Canis l.*) and dog (*Canis f.*).

11 Aygurskiy (Ayg 2/22/15, 2/22/16) and Goryadchevodskiy (grave Gor2/3/3, 2/3/5, 2/3/6); Hollund *et al.* (2010).

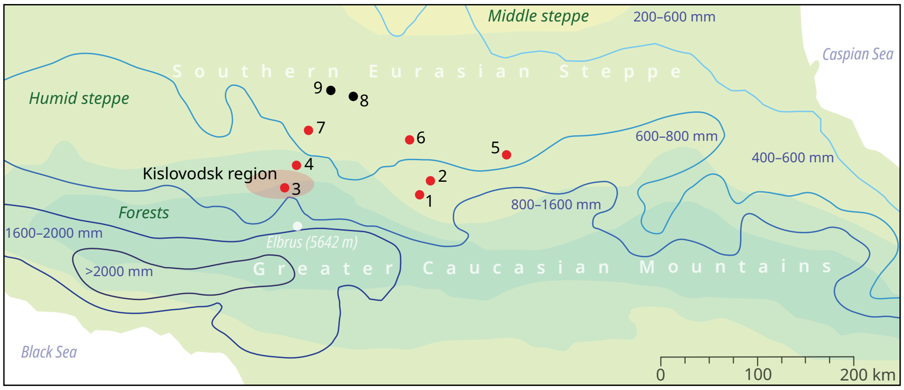


Figure 151: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Map of Bronze Age sites with carbon and nitrogen stable isotope analyses in the study area based on Hollund et al. (2010, 2975-2976, Fig. 2 and 3), Knipper et al. (2018), and Higham et al. (2010). Shades of green show modern vegetation zones, blue lines modern annual precipitation (adapted from Hollund et al. 2010; Gadzhiev et al. 2000; Volodicheva 2002). Black dots are faunal data and red dots are human data; Kudachurt 14 and Kabardinskij 9 have both. The red shaded area marks the Kislovodsk region. 1: Kudachurt 14 (MBA-LBA), Kudachurt (MBA). 2: Zaragizh (BA). 3: Kadardinskij 9 (MBA, NCC). 4: Nezhinskaya (EBA, Maikop). 5: Zamankul. 6: Baksanyonoyk (EBA, Maikop). 7: Zanozina Balka (EBA, Maikop). 8: Goryadchevodskiy (EBA, Maikop). 9: Inozyemtsevo (EBA, Maikop), 10: Klin Yar (LBA/IEA, Koban).

similar ecological backgrounds (mid/low-altitude Caucasian Quercus robur forest zone with open meadows, F168; Knipper *et al.* 2018). Except Zaragizh, all sites are burials or cemeteries. The two burials from Kudachurt investigated in this study lack further information. As there is no detailed archaeological context provided, it remains unclear if the samples come exactly from Kudachurt 14 or from other burials located in the same valley.

While these data were collected from the earliest archaeological sites within the study, Knipper and colleagues integrated already measured data from the EIA Koban settlement and cemetery of Klin Yar (Higham *et al.* 2010) in order to provide a diachronic perspective. This data is composed of 24 human values from burial contexts and 8 faunal values, one from a burial and the others from settlement features (Higham *et al.* 2010, Tab. 4, 5). Originally, the study of Higham and colleagues aimed at identifying diet-derived offsets in ^{14}C-age within the different epochs present at Klin Yar (Samartian, Alannic). Of actual interest are the human values of the Koban population, as their significantly higher δ^{13}C values suggest C_4 plant consumption.

It should be noted that the paper by Knipper and colleagues represents the current state of research and the data presented are part of a pilot study. The authors mention that substantial faunal data is lacking, and that this data is required for a solid interpretation of the human values (Knipper *et al.* 2018). A critical review of inconsistent pre-treatment protocols[12] was not undertaken so far and the data from the literature for the comparison sites lack information about collagen yield and C/N ratio as standards for assessing collagen preservation.

Additionally, Knipper and colleagues as well as Hollund and colleagues used AIR for nitrogen and VPDB for carbon reference standards, while according information is missing from Higham and colleagues for the Klin Yar data. Thus, the current state of the art does not fully meet recommendations for handling and reporting information from stable isotopes (cf. Roberts *et al.* 2017; Szpak *et al.* 2017).

12 Collagen extraction and pre-treatment protocols: Knipper and colleagues followed Oelze *et al.* (2011), Hollund and colleagues followed the procedures established at Oxford Radiocarbon Accelerator Unit at Oxford University (similar to Richards and Hedges 1999), and Higham and colleagues followed the protocol by Richards and Hedges (1999). The protocols commonly include removal of bone surfaces, mechanical cleaning and the use of hydrochloric acid (0.5M) for decalcifying the bone, but differ in sample preparation (bone powder, fragments).

In summary, the main results of the previous study by Knipper *et al.* (2018) are:

- The measured elemental compositions from Kabardinka (equal to the site Kabardinskij) and Kudachurt 14 fulfil the quality criteria for reflecting in vivo isotope signals (collagen yield, anatomic C:N ratios; see preceding and following sections).
- The only available δ^{13}C and δ^{15}N faunal values from Kabardinka (sheep/goat; -20.0 ‰ and 6.6‰) fall within the range of the EBA, MBA, and IEA sites Inozymetsevo (Fig. 155.9, sheep/goat, -19.3/-19.0 ‰ and 5.5/5.9 ‰), Goryachevodsky (Fig. 155.8, sheep, pig, horse, -19.5/-19.5/-20.0 ‰ and 7.4/5.8/5.1 ‰) and Klin Yar (Fig. 155.10, sheep -19.7/4.8 ‰ and -19.2/6.5 ‰, pig -17.8/8.1 ‰, cattle -18.8/7.3 ‰; Higham *et al.* 2010, Tab. 5). The mean and SD δ^{13}C and δ^{15}N values of these three sites combined are -19.3 ±0.7 ‰ and 6.6 ± 1.1 ‰. Assuming a trophic enrichment in δ^{13}C values of 5 ‰ from plants into the mammal collagen, the isotopic baseline indicates C_3 plant consumption by the primary consumers (10 herbivores, 2 omnivore).
- Both of the studied populations show homogenous and very similar carbon isotope ratios (Kabardinka δ^{13}C mean -19.4 ± 0.2 ‰ SD, Kudachurt 14 -19.3 ± 0.1 ‰ SD) that either directly reflect the signal of C_3 plant (humans as primary consumer), or the ratio derived from consumed meat and dairy products from the animals (humans as secondary consumer).
- The nitrogen isotope ratios again show similar value ranges: Kabardinka mean values of 11.2 ± 0.6 ‰ SD (10.5-12.4 ‰) and Kudachurt mean values of 10.6 ± 0.4 ‰ SD (10.1-11.3 ‰). For Kabardinka, a relevant trophic shift of at least 3.9 ‰[13] from the faunal signal suggests considerable consumption of animal-based foodstuffs from herbivores, but the faunal data set is too small to exclude other dietary components with enriched δ^{15}N values, for instance specific food plants (*e.g.* legumes) or aquatic resources. For Kudachurt 14, faunal values from the same site were not available at that time and corresponding analyses follow in this thesis. The highest δ^{15}N at Kabardinka was found in a young child (12.4 ‰), potentially influenced by the nursing effect, whereas this was not the case for individual 186_3 from Kudachurt 14, which was slightly older. At Kudachurt 14, individual 186_1, a young adult man, showed the highest nitrogen isotope ratio (11.3 ‰).
- The authors see the postulated diachronic shift in diet in the results of the isotope analyses. The human values from EBA and MBA sites presumably reflect local environmental δ^{13}C signals deriving from C_3 plants as primary consumers or secondary consumers of animal products (see above), and the enrichment of δ^{15}N at relevant trophic levels points to the importance of animal-based food components, which goes along with the pastoral lifeways for these populations and environmental conditions of the local vegetation zones (see section 6.1). With respect to the results from Kabardinka and Kudachurt, the authors discuss slight differences in nitrogen values as indicative for the decreasing importance of dietary animal products during the MBA. This is questionable when considering the complete ranges for the EBA and MBA human values and the lack of baseline data. In the EIA, the offset in δ^{13}C in faunal (-20.3-17.8 ‰) and human values (one outlier -18.8‰; remaining 16.0-13.4 ‰) suggest dietary intake of C_4 plants for humans only. The faunal values fall in similar ranges as those of the EBA and MBA sites. The intensive cultivation of millet (*Panicum miliaceum*) specifically for human consumption could be responsible for these postulated differences in terrestrial carbon supplies, as extensive exploitation of marine resources seems unlikely. Archaeobotanical remains of other C_4 plants, such as amaranth (*Amaranthus*), are known from EBA burial contexts in the steppe region, but these types of plants are typical for drier environments and regions more distant from Klin Yar.

13 Knipper and co-authors mention 4.5 ‰ in this respect, referring to the mean values.

- Based on their results from isotopic and archaeological studies, the authors conclude that the studied North Caucasian Bronze Age populations practiced pastoral lifeways with different models of mobility and animal-based foodstuffs (meat, diary) as main dietary components. These lifeways are characterised by rather sedentary communities in the EBA and LBA with specific strategies of animal herding and livestock management, and mobile communities during the MBA. The regular consumption of cultivated C_4 plants was established during the EIA, and although permanent settlements stand witness to a sedentary state of subsistence, animal herding in mountain environments still required a certain degree of mobility.

6.3 The significance of Kudachurt 14

Taking into account the aforementioned results, the stable carbon and nitrogen isotope data from Kudachurt 14 presented by Knipper and colleagues indicate a belonging of the buried population, specifically the individuals found in graves 186 and 212, to a community practicing a subsistence strategy relying on the consumption of C_3 plants and/or animal-based foodstuffs such as meat and dairy products. The main argument for this scenario is a presumed trophic shift in nitrogen values from herbivore animals to humans consuming these animals or their secondary products. This argument is based on inter-site comparisons from similar ecological contexts, as faunal samples from Kudachurt were not available. This argument is not sufficiently indicative to suggest the subsistence strategy and range of economically driven mobility of the population buried at Kudachurt 14. Contemporaneous human specimen from slightly higher altitudes include an individual from Kabardinskij 9. However, as the nearby settlements and associated models of mountain economics are younger, clear evidence also for their means of subsistence are lacking. We can exclude the consumption of C_4 plants due to depleted $\delta^{13}C$ values.

According to personal communication with the excavator responsible for Kudachurt 14, a non-excavated settlement is located near the cemetery, and pottery sherds found on-site suggest a BA dating. It remains an open question whether this settlement is in any way connected to the population buried at the cemetery (approachable through excavation, radiocarbon dating, typo-chronological comparison of the material culture). The large number of graves and the temporal depth of inhumations prove continuous or at least repeated utilisation of the necropolis, but repeated ritual use of a place is not a decisive argument for the presence of a settled population in its close vicinity.

From the analyses of preceding chapters of this thesis, three major results are of interest at this point: (1) The burial practice suggests unequal treatments of individuals in the funeral context, but grave goods associated with food (vessels, meat) made up standard equipment, though of different type, quality, and quantity. Thus, food played an important role in ritual practice, possibly as a supply of foodstuffs for the afterlife. Currently, the heterogeneity of burial practices and material culture do not allow a definite association with one of the major cultural phenomena at that time, but the functional class of food is a continuous element in the grave equipment, either as the only grave goods or supplemented by jewellery, weapons or tools. (2) In consequence, the animal bones found in the burials presumably represent remains of meat as a foodstuff of the living population and their funeral gift for the afterlife of the deceased. (3) The analyses of oral health concluded a high prevalence of caries. Dental caries is a characteristic disease arising with the adoption of agriculture and processing of cereals. Even though the aetiology of caries is complex and multifactorial (see chapter 5.4.5.6), a prerequisite for the development of caries is the co-existence of bacteria and sugars in the dental plaque; the fermentation processes carried out in the metabolic system of the bacteria produce the acid which demineralises the tooth tissues. Besides potential differences in individual physical susceptibilities towards developing imbalances of demineralisation and remineralisation, this co-existence was evident in at least half of the buried population, and this rate is probably underestimated. As described in the preceding section, the stable carbon and nitrogen isotopes from bone collagen of BA populations from the Northern Caucasus suggest animal-based food production and the potential dietary contribution of C_3 plants. Previous studies have shown that this is also the case for the few measured individuals from Kudachurt 14. Thus, the agricultural share in the diet of the buried population remains unclear, and the prevalence of caries is a remarkable finding in this context.

In consequence, the analyses of carbon and nitrogen stable isotopes of bone collagen samples from animal and human specimen from Kudachurt 14 has three main aims:

- Providing supplemental data of faunal and human samples from a specific site located in the foothills of the North Caucasus dating to the MBA-LBA transition. This fills a chronological gap in the current state of research and delivers a solid isotopic baseline for inter-site comparisons at a local scale.
- Verifying the significance of preliminary results from Knipper and colleagues for a larger part of the population buried at Kudachurt 14. By means of available radiocarbon data, a selection of graves will contribute to the discussion on diachronic changes. Additionally, estimations of individual biological sex and age at death are available to trace potentials of inter-individual differences in isotope compositions.
- The nitrogen and carbon isotope values are discussed with respect to the prevalence of caries, although assumptions related to the consumption of carbohydrates are not directly testable by measuring bone collagen.

6.4 Working hypotheses

The palaeodietary analyses of the Kudachurt human and animal specimen aim to test the following research hypotheses in a qualitative way:

(H1) The isotopic compositions of carbon and nitrogen from herbivores will show a dependence on C_3 plants as a food source, indicating a reliance on natural vegetation for supporting animal herds. This would be reflected in the evaluation of herbivore $\delta^{13}C$ values pointing to C_3 plants as primary food source (-23 ‰ to -33 ‰).

(H2) The isotopic compositions of nitrogen from humans will show a relevant trophic level compared to the animals, which proves the consumption of meat or dairy products and identifies the animal specimen as potential livestock species for the population buried at Kudachurt 14. This will be shown by a relevant trophic level between animal and human samples. By comparing of animal and human values from the same graves, relevant trophic levels would confirm the supply of meat from these species for the afterlife.

(H3) The isotopic compositions of humans with and without caries affection will show differences in $\delta^{13}C$, $\delta^{15}N$ or both values. $\delta^{13}C$ values of humans with caries differ from those of the primary producers, displaying a different carbon source for affected individuals. Unequal affections of caries reflect the differences in the consumption of proteins and different access to food plants.

6.5 Material and methods

The study was undertaken in collaboration with the Archaeological Stable Isotope Laboratory (ASIL). at the Institute of Pre- and Protohistoric Archaeology at Kiel University. Prof. Dr. C. Makarewicz, Dr. I. von Holstein, and Dr. A. Ventresca-Miller guided me through sample preparation, and C. Makarewicz took over the determination of animal species. Sample measurement was conducted by the Stable Isotope Laboratory at Boston University (USA).

6.5.1 Sample selection

During the osteological analyses of the human skeletal remains, bone and teeth were taken as sample material available for different kinds of analyses. For isotopic sampling, 33 graves were selected by considering their representativeness in terms of spatial distribution, burial type, and presence/absence of funeral gifts (Fig. 152).

In total, 41 individuals from these 33 graves were measured, making up 38 % of the total number of specimen and 55 % of the osteologically examined graves[14]. In order to maintain a cross section through the population studied in terms of age at death and biological sex, the selection conformed to a relative balance of immature (n=10) to mature individuals (n=31) as well as female/rather female (n=12) to male/rather male (n=18) individuals. Within immature specimen, three individuals could be expected to display isotopic effects due to nursing or weaning at their time of death[15]. Concerning the prevalence of caries, a relative representation is provided by 22 specimen showing caries lesions and 19 not, although in the latter group it is not possible to completely discount the presence of caries on teeth not available for examination. The measurements for individuals 186_1, 186_4 and 186_7 provided a control reference for the analyses conducted by Knipper and colleagues on the same individuals. In general, the selection of bone fragments for collagen extraction aimed for ribs; skull and long bone fragments made up the second and third choices.

After the excavation, human and animal bones were partly stored separately, but often faunal remains were found in the human skeletal packages. 14 of the animal samples come from such contexts, and 4 others are from burial complexes that lack osteological examination (137, 140, 145, 180). In 9 cases, direct links between human and animal values are provided as they originate from the same burial contexts[16]. Estimated from single bone fragments, the represented animal species comprise 12 ruminant herbivores – a mixture of sheep and goat (5 *Capra*, 2 *Ovis*, 5 *Capra/Ovis*) – and 3 omnivores, likely pigs (*Sus*). The sample material represents different skeletal elements. To date, more detailed archeaozoological examinations of the complete animal record from Kudachurt 14 are pending. Most specimen stem from collective or double burial contexts.

6.5.2 Methods

Sample pre-treatment and collagen extraction

From each bone sample, small chunks were collected for further analyses. In order to remove most of the inorganic and organic filth, the chunks were rinsed under the tap or, in case of contamination with very fine substrate, cleaned in an ultrasonic bath. Dried bone chunks were weighed (1.3-11.2 mg). Subsequent collagen extraction from

14 Osteologically examined total record of 108 specimens from 60 graves.
15 047_4 (2-4 years), 073_1 (3-4 years), and 076_1 (1-2 years).
16 Grave 047, 075, 076, 050, 048, 127, 174, 186 and 197.

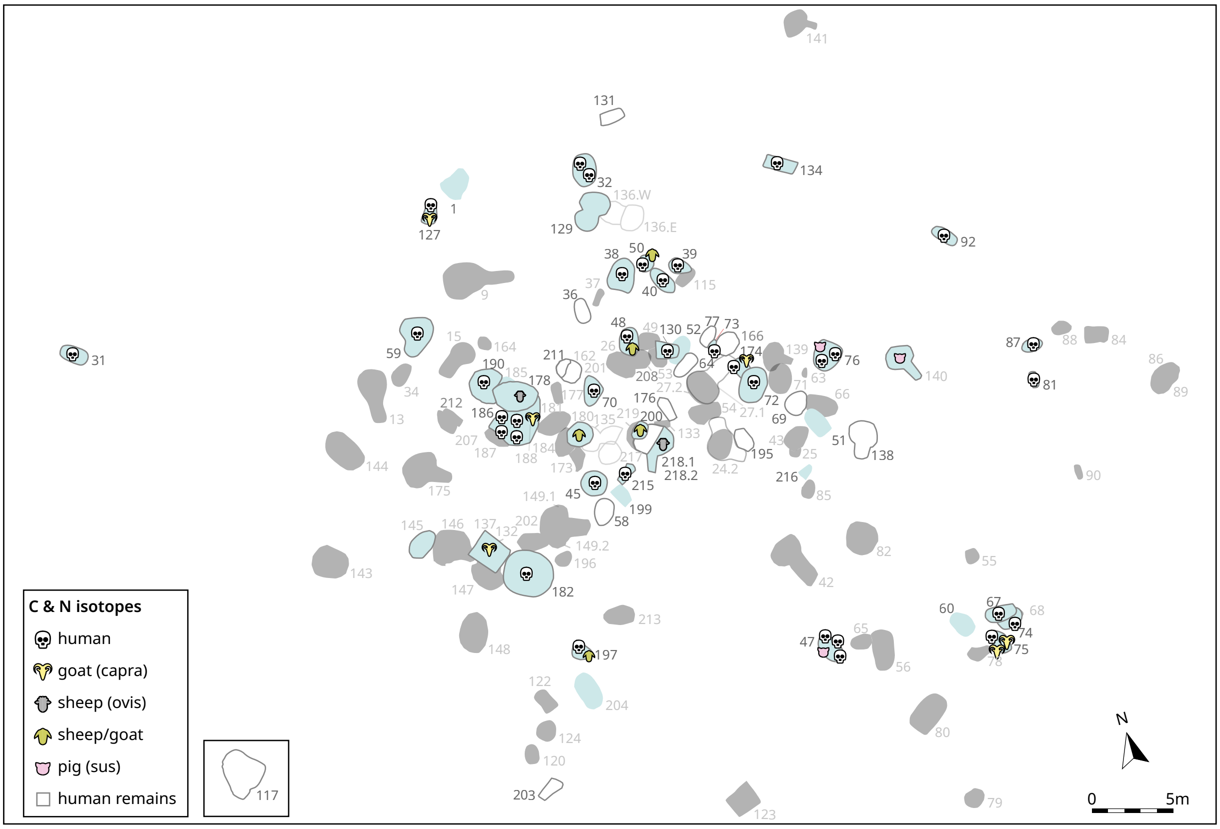


Figure 152: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Cemetery plan displaying graves and material included in the isotope analyses (n graves=30, n animals=18, n humans=41).

dry bone fragments followed the ASLI standard protocol after Tuross *et al.* (1988). Different from many other protocols, this pre-treatment uses EDTA[17] for dissolving the mineral matrix from the collagen instead of HCl (Ambrose 1990; Jørkov *et al.* 2007; Richards and Hedges 1999). The bone chunks were demineralised in 50 ml of 0.5 M EDTA (pH=7.4) solution at room temperature and in continuous movement until the collagen replica was recognisably purified through its translucent consistency. The EDTA was renewed after an appropriate period of time. When fully demineralised, each sample was rinsed with deionised water (dH_2O) to remove contaminative EDTA from the collagen isomorph and was subsequently freeze dried. The dried sample was weighed in order to calculate the collagen weight for assessing collagen preservation. Using a scalpel, small fragments of 0.01 mg weight were cut off from the isomorph and prepared in a tin boat to be measured at the Boston University Stable Isotope Lab. Due to this sampling, the results reflect isotope ratios from a very small part of the bone collagen which may not represent full body ratios.

Measurements and accuracy

Continuous flow measurement of the samples took place in a GVI IsoPrime and Eurovector CN analyser. $\delta^{13}C$ and $\delta^{15}N$ values were calibrated with reference to international standards. For $\delta^{13}C$V-PDB the gas was calibrated against NBS 20 (Solenhofen Limestone) and NBS 22 (Hydrocarbon Oil), and for ^{15}NAIR it was calibrated against atmospheric N_2 and IAEA standards N-1, N-2 and N-3 (ammonium sulphate). Accuracy is reported as at least 0.2 ‰ for both carbon and nitrogen. Control samples are analysed per sample tray with peptone and glycine to calibrate against expected values (for $\delta^{13}C$ -14.7 ‰ and 34.0‰ and for $\delta^{15}N$ 7.4 ‰ and 10.7 ‰).

17 Ethylene diamine tetra-acetic acid.

Quality of bone collagen

Two main criteria are relevant for estimating the quality of collagen preservation as reference for the validity of measured C and N isotopes – C/N anatomic mass ratio and collagen yield. The continuous flow mode provides %C and %N data for calculating the C/N ratio. The collagen yield was calculated from dry bone and purified collagen weights.

6.6 Results

All 41 samples were successfully measured on the first try. The laboratory report proves that measured values meet the tolerance of internal standards. Tables 40 and 41 summarise the results by providing all measured values displayed in Figure 154, sample material, and contextual information. Tables 42 and 43 give an overview of average values and standard deviations, and Table 44 provides offset $\delta^{13}C$ and $\delta^{15}N$ values of animal and human samples from the same grave contexts as depicted in Figure 155.

6.6.1 Collagen quality

According to DeNiro (1985), the range of carbon to nitrogen content of a sample should fall between 2.9 and 3.6. %C and %N values provided by Boston Laboratory for each sample enabled the calculation of this ratio. %C values range from 31.1 % to 45.7 % (mean 43.6 %) and %N contents from 11.9 % to 17.9 % (mean 16.8 %). The resulting C/N anatomic ratio values show small fluctuations between 3.0-3.1, proving that all samples retained the characteristic ratios of in vivo collagen and thus match the quality criteria for collagen preservation required for respective C and N isotope analyses. In terms of total preservation weight, values are less consistent by showing yields between 2.7 % to 17.9 % (mean 11.3 %), whereas only few samples retained more than 50 % of in vivo collagen content (max. 27 %).

6.6.2 Animal values

In sum, the total range of the animal samples for $\delta^{13}C$ is -20.9 ‰ to -18.1‰ with an average of -19.9 ± 0.6‰ and a maximum span of 2.1 ‰ (Tab. 41, 43, Fig. 153). Herbivore specimen show on average -0.8 ‰ lower $\delta^{13}C$ values compared to omnivores, but the omnivore sample size of three is too small (n herbivores=12). In the inter-specimen comparison, the pig sample from grave 140 shows the largest difference with +1.0 ‰ compared to the sheep/goat specimen from grave 200 (-19.1 ‰). The other omnivore specimen falls within the range of herbivores. Due to the fact that five herbivore samples were not assignable to sheep or goat, the herbivore inter-species comparison remains indeterminable; but, as the two values from sheep are in the same value range as those from goat specimen, a differentiation between the two species is unlikely.

The $\delta^{15}N$ values range from 4.3 ‰ to 7.1‰, representing a maximum span of 2.8 ‰ and an average of 6.0 ± 0.8 ‰ SD. Here, the samples from two goats and a sheep mark the lowest and very similar values between 4.3 ‰ to 4.5 ‰. The next values fall in the range of 5.5 ‰ to 7.1 ‰ without any remarkable gaps; between these two value ranges is an offset of 1 ‰. However, two Capra specimens, one from each $\delta^{15}N$ value range, come from the same burial context (grave 075, 4.3 ‰ and 6.4 ‰). In consequence, the variation in nitrogen isotope composition of goats is greater compared to the other species. The three pigs displayed values of 6.0 ‰ to 6.4 ‰ and fall in the medium range. Accordingly, there is no distinct separation in terms of herbivore and omnivore species in the nitrogen isotopes.

In conjunction, it becomes clear that the most frequent isotope compositions lie within the ranges -19.1 ‰ to -20.9 ‰ for $\delta^{13}C$ and 5.7 ‰ to 7.1 ‰ for $\delta^{15}N$. The four outliers are defined by +1 ‰ enrichments in either ^{13}C or ^{15}N, but not in both. Herbivores show the greatest internal species variation, whereas omnivores have very similar $^{15}N/^{14}N$ ratios but differ in their carbon composition. The linear averages show no proportional correlation in $\delta^{13}C$ and $\delta^{15}N$ values (Fig. 153).

Although the presented sample size is not sufficient for solid conclusions[18], the isotope signatures apparently do not correlate with the burial type. The three animals displaying low $\delta^{15}N$ values are from both single and collective burials, and the few animals from double burial contexts span almost the whole range of $\delta^{13}C$ values.

6.6.3 Human values

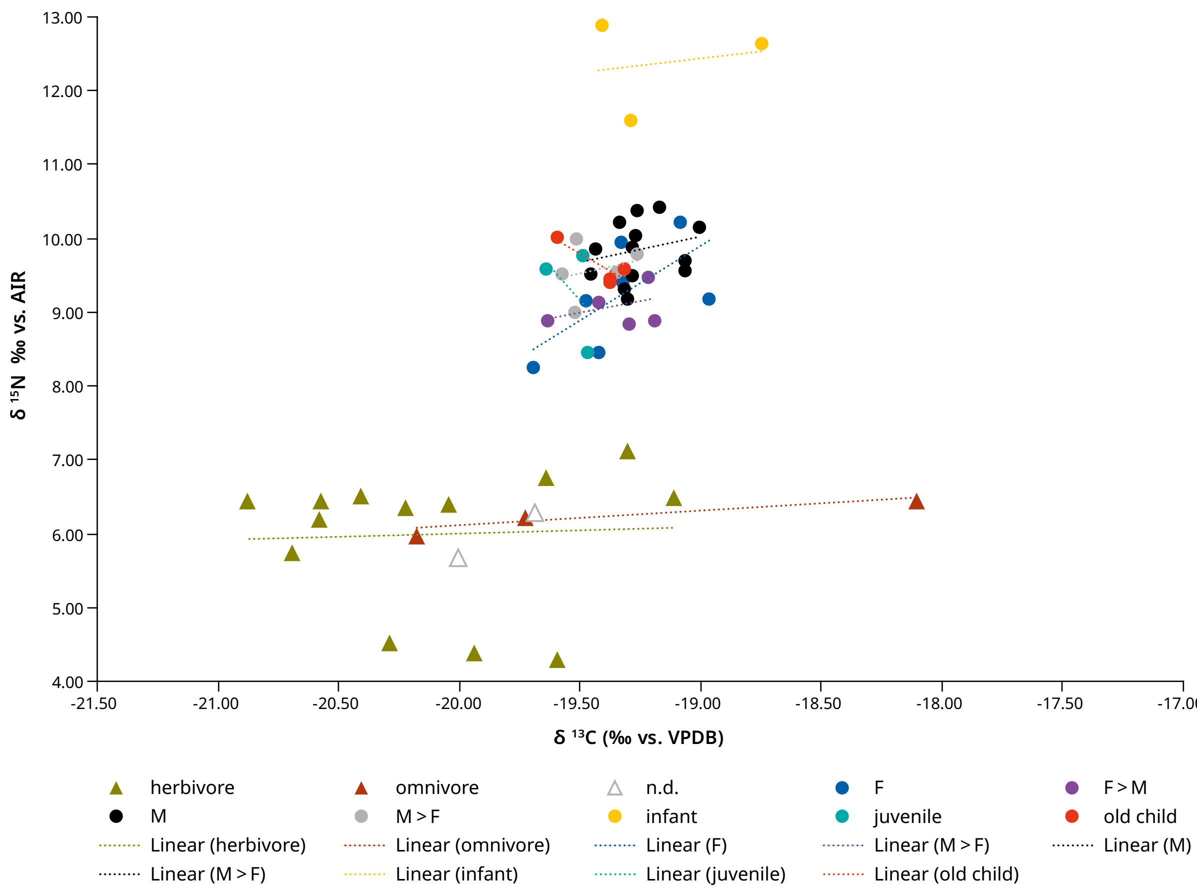
Human $\delta^{13}C$ values span from -19.7 ‰ to -12.6 ‰, have an average of -19.2 ± 1.1 ‰, and have a maximum range of 7.1 ‰ (Tab. 42, 43, Fig. 153-154). Remarkable within this span is individual 031_1 which displays a considerable enrichment in ^{13}C of +6.2 ‰ compared to the remaining individuals with almost equivalent signatures between 19.0 ‰ to 19.7 ‰. This offset causes the standard deviation of 1.1 ‰; by excluding the female from grave 031, the average changes to 19.3 ± 0.2 ‰ and the maximum span to 0.9 ‰.

Within the small range of 0.9 ‰ is almost no difference between the sexes (F/F>M mean 19.4 ± 0.2 ‰; M/M>F mean 19.3 ± 0.2 ‰). This is also true in terms of age classes, as value offsets are all less than 1 ‰. Children, juveniles, and young adults tend to have slightly higher values on average, whereas this is not recognised for infants; the $\delta^{13}C$ of the three infant specimens are minimally enriched. The average $\delta^{13}C$ values of individuals with and without caries prevalence are nearly the same (-19.3 ± 0.2 ‰ and 19.4 ± 0.2 ‰). In summary, except individual 031_1, the $^{13}C/^{12}C$ ratios in humans have very little variation.

With a total range from 8.2 ‰ to 12.9 ‰, the nitrogen isotope compositions show a larger variability with a maximum span of 4.7 ‰ (average 9.7 ± 1.0 ‰ SD). Here, individual 031_1 again is noteworthy as it has the lowest $\delta^{15}N$ value (8.2 ‰). Most of the specimen (n=38) show values between 8.2 ‰ and 10.4 ‰ (mean 9.4 ± 0.6 ‰ SD). The highest values were expressed by three individuals enriched in ^{15}N by 2.5 ‰ 2.3 ‰ and 1.2‰ with respect to the remaining sampled population (internal group average 12.4 ± 0.6 ‰, max. span 1.3 ‰).

On average, males show slightly higher $\delta^{15}N$ values of *ca.* +0.7 ‰ compared to females, and the inter-individual comparison concludes that within the main group of values, males make the upper range limit (032_2, 215_1, 087_1) and females the lower (031_1, 208_1). In terms of age at death, the individuals most enriched in ^{15}N are the youngest of the data set, 2-4 years, 1-2 years, and 3-4 years in descending $\delta^{15}N$ order. Among the remaining immature individuals, the younger individuals generally have a higher $\delta^{15}N$, but a juvenile represents the lowest immature individual's value with -1.1 ‰ spacing to the next lowest (195_1 to 203_1). At the same time, young adults express very similar $\delta^{15}N$ values to those of older children; in general, the signatures of immature individuals, excluding infants, fall within the range of adult individuals. There is almost no difference between individuals who died at a young or a middle adult age (mean 9.5 ± 0.6 ‰ and mean 9.6 ± 0.5 ‰). In terms of caries prevalence, the individuals that revealed no such lesions are on average slightly enriched in ^{15}N compared to those who did exhibit lesions (+0.3 ‰). By excluding the three outliers (two infants with and one infant without caries), the distributions are almost equal (mean 9.7 ± 0.9 ‰ SD and 9.7 ± 1.0 ‰ SD). In summary, except the high values for infants, the isotopic signature of nitrogen falls

18 2 animals are from single, 3 from double and 9 from collective burials.



within a narrow value range, with little evidence for correlation with biological sex and no separations in terms of caries prevalence.

The variability of $\delta^{15}N$ values is higher compared to that of $\delta^{13}C$ values, except individual 031_1. Within the $\delta^{13}C$ range of 0.9 ‰, there is a very small proportional correlation in enrichments of both ^{13}C and ^{15}N in adults, and it is strongest in females (Fig. 154, dotted lines). In old children and juveniles this trend is revered, and in infants ambivalent.

As individuals of different sexes and age classes were buried in the same graves, according combinations of value ranges are present in the same burial contexts (Fig. 153). For instance, in grave 047 three immature individuals were buried together; the old child and the juvenile have almost the same isotope signatures while the infant showed the highest $\delta^{15}N$ value and all three have very similar $\delta^{13}C$ values. In grave 076, the infant's isotopic signature reflects an enriched composition in both ^{13}C (+0.6 ‰) and ^{15}N (+2.7 ‰) compared to the middle adult male. The four individuals tested from grave 186 show a very narrow value range, with a maximal spacing of 0.3 ‰ in $\delta^{13}C$ and 0.7 ‰ in $\delta^{15}N$ values.

Figure 153: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Results of $\delta^{13}C$ and $\delta^{15}N$ values ‰ with human/animal, biological sex of adults (>juvenile), and immature age class (<juvenile) marked. Triangles are animal samples (n=18), dots human samples (n=40). Dotted lines represent correlation trends of $\delta^{13}C$ and $\delta^{15}N$ per parameter. The results of individual 031_1 are not included here.

Grave	Burial type	Species		Skeletal element	δ13C	δ 15N	%C	%N	coll yield %	C/N atomic	Sample No.
047	collective	Sus	ominvore	n. d.	-20.2	6.0	40.9	15.9	n. d.	3.0	2845
		n. d.	-	n. d.	-20.0	5.7	42.5	16.3	4.2	3.0	2846
048	double	Ovis/Capra	herbivore	Mandible	-20.7	5.8	43.9	17.0	15.0	3.0	2847
050	single	Ovis/Capra	herbivore	Ulna	-19.6	6.8	43.0	16.7	9.0	3.0	2848
075	collective	Capra	herbivore	Mandible	-20.9	6.4	43.9	17.1	8.3	3.0	2849
				Phalanx	-19.6	4.3	43.6	17.0	17.9	3.0	2850
076	collective	Sus	omivore	n. d.	-19.7	6.2	44.6	17.2	n. d.	3.0	2851
127	double	Capra	herbivore	Calcaneus	-19.3	7.1	43.5	16.6	7.3	3.1	2852
137	collective	Capra	herbivore	Femur, dist.	-20.4	6.5	43.7	17.0	13.5	3.0	2853
140	n. d.	Sus	omivore	Radius	-18.1	6.4	43.4	16.8	12.3	3.0	2854
145	collective	n. d.	-	Vertebra	-19.7	6.3	44.1	17.1	12.6	3.0	2855
174	single	Capra	herbivore	Phalanx	-20.3	4.5	43.8	16.9	8.7	3.0	2856
178	collective	Ovis	herbivore	Metatarsal	-20.6	6.4	44.3	17.0	n. d.	3.0	2857
180	n. d.	Capra/Ovis	herbivore	MT/MC	-20.0	6.4	42.3	16.3	2.8	3.0	2858
186	collective	Capra	herbivore	Femur prox.	-20.2	6.4	44.3	17.1	15.3	3.0	2859
197	double	Capra/Ovis	herbivore	Femur prox.	-20.6	6.2	43.9	16.8	12.8	3.0	2860
200	n. d.	Capra/Ovis	herbivore	Pelvis	-19.1	6.5	42.6	16.0	5.9	3.1	2861
218.1	collective	Ovis	herbivore	Tibia	-19.9	4.4	45.5	17.9	n. d.	3.0	2862

Table 41: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Results and additional information for faunal samples.

Grave	Burial type	Individual	Skeletal element	Age at death/Sex	Caries prevalence	δ13C	δ 15N	% C	% N	coll. yield %	C/N atomic	Sample No
031	single	031_1	Rib	middle adult/**F**	yes	-12.6	8.2	43.8	16.4	14.4	3.1	2331
032	double	032_1	Rib	middle adult/**M**	no	-19.3	9.2	44.6	17.3	12.8	3.0	2332
		032_2	Rib	young adult/**M**	yes	-19.2	10.4	41.4	16.0	10.4	3.0	2333
038	collective	038_1	Calotte	adult++/**M>F**	no	-19.3	9.6	41.1	16.0	8.4	3.0	2334
039	single	039_1	Rib	middle adult/**F**	yes	-19.5	9.2	42.9	16.4	12.0	3.1	2335
040	single	040_1	Rib	middle adult/**M**	yes	-19.3	9.5	44.4	17.1	14.6	3.0	2336
045	single	045_1	Rib	middle adult/**F**	yes	-19.4	8.5	43.9	16.9	14.7	3.0	2337
047	collective	047_2	Rib	old child (6-8 y.)	yes	-19.4	8.9	43.0	16.4	8.3	3.1	2338
		047_3	Rib	juv/young ad/**F>M**	yes	-19.6	8.9	45.7	17.4	11.8	3.1	2339
		047_4	Rib	infant (2-4 y.)	no	-19.4	12.9	44.1	17.0	6.2	3.0	2340
048	double	048_2	Calotte	juv/young ad/**M>F**	no	-19.6	9.5	44.2	17.1	9.8	3.0	2341
050	single	050_1	Rib	middle adult/**F**	yes	-19.3	9.9	44.5	17.3	9.8	3.0	2342

Table 42: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Results and additional information for human samples.

Grave	Burial type	Individual	Skeletal element	Age at death/Sex	Caries prevalence	δ13C	δ 15N	% C	% N	coll. yield %	C/N atomic	Sample No
059	single	059_1	Rib	middle adult/**M**	no	-19.0	10.1	43.6	16.6	10.1	3.1	2343
067	single	067_1	Rib	middle adult/**M**	yes	-19.3	9.3	43.7	16.8	9.0	3.0	2344
070	double	070_2	Rib	young adult/**F>M**	yes	-19.2	9.5	43.6	16.9	9.5	3.0	2350
072	collective	072_1	Calotte	middle adult/ **M>F**	yes	-19.3	9.8	42.7	16.6	1.9	3.0	2345
073	single	073_1	Rib	infant (3-4 y.)	yes	-19.3	11.6	42.7	16.4	14.4	3.0	2346
074	single	074_1	Rib	young adult/**F**	yes	-19.3	9.4	45.2	17.6	9.8	3.0	2347
075	collective	075_1	Rib	middle adult/**M**	no	-19.5	9.5	42.9	16.7	12.2	3.0	2558
076	collective	076_1	Rib	infant (1-2)	yes	-18.8	12.6	45.0	17.5	15.7	3.0	2348
		076_2	Rib	young adult/**M**	yes	-19.4	9.9	44.2	17.1	11.8	3.0	2349
081	single	081_1	Rib	young adult/**F>M**	yes	-19.3	8.8	43.3	16.5	8.0	3.1	2351
087	single	087_1	Rib	middle adult/**M**	yes	-19.3	10.2	44.7	17.3	8.6	3.0	2352
092	single	092_1	Rib	juv/young ad/ **F>M**	no	-19.2	8.9	44.0	17.1	2.7	3.0	2353
127	double	127_1	Rib	middle adult/**M**	yes	-19.3	10.0	43.6	16.8	12.6	3.0	2559
129	collective	129_1	Rib	old child (11-13 y.)	no	-19.3	10.0	43.9	17.3	13.8	3.0	2560
		129_2	Fibula	juvenile (14-16 y.)	no	-19.5	9.8	44.7	17.2	18.8	3.0	2561
130	single	130_1	Rib	middle adult/**M** >F	no	-19.5	9.0	42.7	16.8	11.9	3.0	2562
134	single	134_1	Rib	young adult/**F**	yes	-19.0	9.2	44.0	16.7	11.2	3.1	2563
174	single	174_2	Rib	young adult/**M**	no	-19.1	9.7	43.9	17.1	9.4	3.0	2564
182	collective	182_2	Rib	old child (8-11 y.)	yes	-19.6	9.4	43.8	17.0	5.2	3.0	2567
186	collective	186_6	Rib	young adult/**F**	no	-19.1	9.6	44.7	17.3	19.3	3.0	2568
		186_1	Rib	young adult/**M**	yes	-19.1	10.2	42.7	16.5	6.1	3.0	2842
		186_4	Phalanx	old child (10-13 y.)	no	-19.4	9.5	44.2	17.1	9.7	3.0	2843
		186_7	Rib	middle adult/**M**	no	-19.3	9.9	44.6	17.3	20.9	3.0	2844
190	collective	190_1	Rib	young adult/**M>F**	no	-19.5	10.0	44.4	17.4	14.9	3.0	2570
195	double	195_1	Rib	juvenile (14-16 y.)	no	-19.5	8.4	44.9	17.1	11.7	3.1	2571
197	double	197_1	Rib	young adult/**F>M**	no	-19.4	9.1	44.4	17.1	11.9	3.0	2572
203	single	203_1	Rib	juvenile (14-17 y.)	no	-19.6	9.6	31.5	11.9	12.3	3.1	2573
208	single	208_1	Femur (shaft)	young adult/**F**	yes	-19.7	8.3	44.3	17.2	15.9	3.0	2574
215	single	215_1	Rib	middle adult/**M**	no	-19.3	10.4	44.6	17.2	11.7	3.0	2577

Table 42: continued.

Parameter	n	Av. δ13C	SD	Av. δ13C	SD
all animals	18	-19.9	0.6	6.0	0.8
herbivores	13	-20.1	0.5	6.0	0.9
omnivores	3	-19.3	0.9	6.2	0.2
capra	6	-20.1	0.5	5.9	1.1
ovis	2	-20.3	0.3	5.4	1.0
capra/ovis	5	-20.0	0.6	6.3	0.3
sus	3	-19.3	0.9	6.2	0.2

Parameter	n	Av. δ13C	SD	Av. δ13C	SD
all humans (no outl.)	41 (40)	-19.2 (-19.3)	1.1 (0.2)	9.7 (9.5)	1.0 (0.66)
F/F>M	8/5	-19.4	0.2	9.1	0.4
M/M>F	13/5	-19.3	0.2	9.8	0.4
infant	3	-19.2	0.3	12.4	0.6
old child	4	-19.4	0.1	9.4	0.4
juvenile	3	-19.5	0.1	9.3	0.6
juv/young adult	3	-19.5	0.1	9.3	0.6
young adult	12	-19.3	0.6	9.5	0.6
middle adult	15	-19.3	0.1	9.6	0.5
no caries	19	-19.4	0.2	9.7	0.9
caries (no outl.)	20	-19.3	0.2	9.7	1.0

Table 43 and 44: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Results of average and standard deviation values for animal and human samples (outl.=outlier, ind. 031_1).

6.6.4 Animal and human values

In total, animal values have a wider range in $\delta^{13}C$ compared to the humans and, except the pig specimen from grave 140, bone collagen tends to be enriched in ^{13}C in humans. There is an overlap between 19.7 ‰ and -19.1 ‰ for six animal and 35 human specimens (except ind. 031_1). On average, the $\delta^{15}N$ values of humans are 3.7 ± 0.2 ‰ higher compared to the animals, whereas the smallest spacing is 1.2 ‰ (goat from grave 127, middle adult female 208_1) and the largest is 6.1 ‰ (goat from grave 075, young adult male 032_2) or 8.6 ‰ (compared to infant 047_7).

The comparison of animal and human samples from the same grave contexts point to relevant spacings in $\delta^{15}N$ values in eight of nine cases for at least one animal and one human specimen respectively (Tab. 45). For tracing trophic levels, shifts between 3-6 ‰ are expected, and detected values vary between 3.1 ‰ and 5.2 ‰ (7.4 ‰ for infants). Offsets in the isotopic compositions of carbon are smaller, but all in positive values in humans (0-1.1 ‰).

Table 45 (opposite above): Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Trophic shifts in $\delta^{13}C$ and $\delta^{15}N$ values of animal and human samples from the same grave contexts.

Figure 154 (opposite below): Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Results of $\delta^{13}C$ and $\delta^{15}N$ values ‰ from the same burial contexts (n graves=11, n animals=11, n humans=17). Triangles label animal samples, dots human samples. Burial contexts are marked by colour lines connecting samples from the same grave (empty dots are human samples without animal "counterparts").

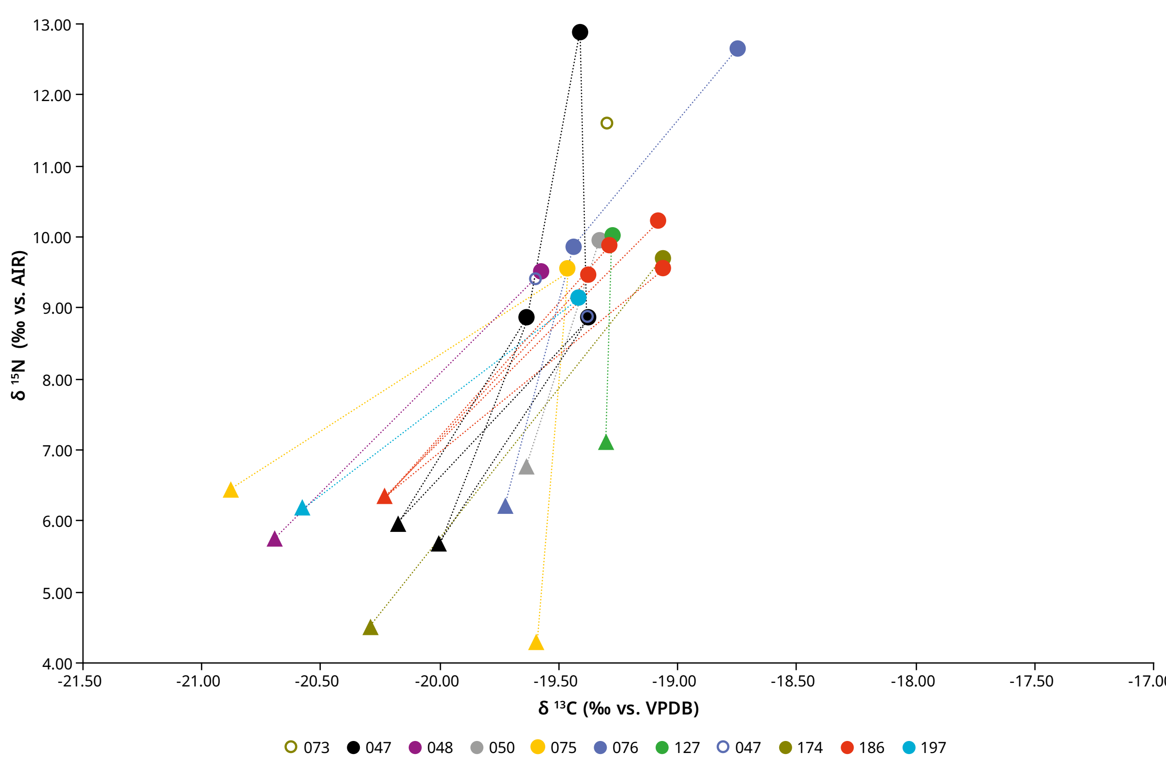
6.7 Discussion and evaluation

In the following, the results of the isotope analyses will be discussed and evaluated in the scope of the working hypotheses stated in section 6.3. As the analytical approach does not include statistical hypothesis testing, the discussion takes place on a qualitative level.

(H1) The isotopic compositions of carbon and nitrogen from herbivores will show a dependence on C_3 plants as a food source, indicating a reliance on natural vegetation for supporting animal herds. This would be reflected in the evaluation of herbivore $\delta^{13}C$ values pointing to C_3 plants as primary food source (-23 ‰ to -33 ‰).

Considering a maximal trophic shift from primary producers to herbivores of 3-5 ‰ in $\delta^{13}C$, the minimal and maximal value ranges of the isotopic $^{13}C/^{12}C$ ratio of consumed plants lays within -23.9 ‰ to -24.1‰ and -21.1 ‰ to -25.9 ‰. These

Grave	Burial type	Label	Parameter	δ13C	δ15N	δ13C/δ15N spacing ‰ (min ; max)
047	collective	n. d.	animal	-20.0	5.7	0.4/3.9; 0.8/4.7 (7.2)
		sus	omnivore	-20.2	6.0	
		047_3	juv/young ad/F>M	-19.6	8.9	
		047_4	infant (2-4 y.)	-19.4	12.9	
		047_2	old child (6-8 y.)	-19.4	8.9	
048	double	ovis/Capra	herbivore	-20.7	5.8	0.9/3.7
		048_2	juv/young ad/M>F	-19.6	9.5	
050	single	ovis/Capra	herbivore	-19.6	6.8	0.3/3.1
		050_1	middle adult/F	-19.3	9.9	
075	collective	capra	herbivore	-19.6	4.3	0.1/3.1 ; 0.6/5.2
		capra	herbivore	-20.9	6.4	
		075_1	middle adult/M	-19.5	9.5	
076	collective	Sus	omnivore	-19.7	6.2	0.3/3.7 ; 0.9/6.4 (3.7)
		076_2	young adult/M	-19.4	9.9	
		076_1	infant (1-2)	-18.8	12.6	
127	double	capra	herbivore	-19.3	7.1	0/2.9
		127_1	middle adult/M	-19.3	10.0	
174	single	cCapra	herbivore	-20.3	4.5	1.2 /5.2
		174_2	young adult/M	-19.1	9.7	
186	collective	capra	herbivore	-20.2	6.4	0.8/3.1 ; 1.1/3.8
		186_4	old child (10-13 y.)	-19.4	9.5	
		186_6	young adult/F	-19.1	9.6	
		186_7	middle adult/M	-19.3	9.9	
		186_1	young adult/M	-19.1	10.2	
197	double	capra/ovis	herbivore	-20.6	6.2	0.8/3.9
		197_1	young adult/F>M	-19.4	9.1	



values indicate the consumption of C_3 plants, although values between -21.1 ‰ to -23 ‰ are beyond the upper limit for C_3 terrestrial vegetation and could imply drier environments, higher altitudes or small proportions of C_4 plants in the diet (Kohn 2010). To date, the isotopic compositions from plants growing in the foothill environments of the Northern Caucasus are unknown, so that evidence for direct comparisons is lacking. As there are no real offsets between the herbivore species in terms of $\delta^{13}C$ values, different feeding habits cannot be traced. The herbivore $\delta^{15}N$ values, which range from 4.3 ‰ to 7.1 ‰ reflect the ^{15}N isotopic composition of the consumed plants, which is within the natural variability of C_3 species of terrestrial ecosystems (McCutchan *et al.* 2003). In consequence, there is no indication of a manuring effect on the vegetation consumed by animals (Makarewicz 2014). The results imply that the stated hypothesis is true.

(H2) The isotopic compositions of nitrogen from humans will show a relevant trophic level compared to the animals, which proves the consumption of meat or dairy products and identifies the animal specimen as potential livestock species for the population buried at Kudachurt 14. This will be shown by a relevant tropic level between animal and human samples. By comparing of animal and human values from the same graves, relevant trophic levels would confirm the supply of meat from these species for the afterlife.

The comparison of animal and human average $\delta^{15}N$ values reveals that the human bone collagen is generally enriched in ^{15}N by about 3.7 ± 0.2 ‰. Both herbivore and omnivore animal species reflect isotopic compositions related to the second trophic level (first heterotrophic level), whereas humans apparently make the third, as there is no overlap between animal and human values. Additionally, relevant spacing in $\delta^{15}N$ values between human and animal samples from the same burials provide trophic levels for specimen sharing common funeral contexts. Besides immature individuals, who show slightly different tendencies, this trophic level is also suggested by the proportional shifts in $\delta^{13}C$ values. Thus, both nitrogen and carbon isotope compositions reflect the incorporation of animal products (meat and/or dairy) as dietary proteins. Sheep and goats could have supplied either of these forms of products, while pigs could only have supplied meat. The contribution of vegetable protein to the humans' diet remains unclear, but there is no indication given to consider ^{15}N-enriched plants, such as legumes. If so, the isotopic signature of such plants would not be very different from the animals. Hence, the initial statement is confirmed.

(H3) The isotopic compositions of humans with and without caries affection will show differences in $\delta^{13}C$, $\delta^{15}N$ or both values. $\delta^{13}C$ values of humans with caries differ from those of the primary producers, displaying a different carbon source for affected individuals. Unequal affections of caries reflect the differences in the consumption of proteins and different access to food plants.

As there are no differences in either $\delta^{13}C$ or $\delta^{15}N$ values among individuals with and without caries affection, this hypothesis is rejected. Both groups show full value ranges. The data do not suggest a connection between the prevalence of caries and plant or animal protein.

Based on the evidence of animal product consumption and concurrently occurring dental caries in at least 20 specimens, the results suggest that among all age classes and both sexes diet included animal protein as well as appropriate amounts of fermentable carbohydrates. It is highly likely that this was true for more than these 20 individuals, as caries strongly correlates with age (younger individuals are less affected), and the calibrated caries rate is likely an underestimation of its prevalence (per individual as well as in respect to the population studied). However, isotope compositions of bone collagen do not reflect the carbohydrate proportion of the diet, thus the applied approach is not suitable for drawing final conclusions.

This hypothesis relies on the presupposition that the caries prevalence in the buried population at Kudachurt 14 was caused by dietary carbohydrates. The causes of caries are multifactorial, and the condition arises from disorders in the functional circle of demineralisation and remineralisation of dental tissues. Other possible reasons come into consideration, for instance lack of fluoride in the water, increased activity and abundance of cariogenic bacteria, stickiness of food, or genetic factors (for references and descriptions see chapters 5.4.5.6, 5.9.2). Hence, the rejection of the hypothesis opens a discussion on caries aetiology.

Additionally, there are further results not connected to the working hypotheses worth mentioning as aspects for future research:

The higher variation of $\delta^{13}C$ values in faunal samples compared to the extremely small value range in humans indicates that animals might have had a carbon supply from a different source. This represents an interesting aspect in terms of animal husbandry strategies and the exploitation of different environments (herding in different altitudes, seasonal strategies, foddering).

Furthermore, individual 031_1 displayed $\delta^{13}C$ values that are associated with the consumption of C_4 plants (-12.5 ‰) and additionally the lowest $\delta^{15}N$ values within the human data set (8.2 ‰). The carbon isotope composition is distinctively different from the environmental isotope baseline given by the animal values. Although this does not exclude the consumption of food products derived from such animals, in this case individual 031_1 must have relied on another protein source that was noticeably enriched in $\delta^{13}C$ and not available to the other animals and humans studied. A similar situation applies to the animal signal from grave 140; the high $\delta^{13}C$ value suggests some proportion of C_4 plants in the pig's diet.

Third, the $^{15}N/^{14}N$ ratios in two infants, individuals 047_4 (12.9 ‰) and 076_1 (12.7 ‰), reflect a fourth trophic level within the food web. Offsets of +2.4 ‰ and +2.2 ‰ enrichments in ^{15}N compared to the main value range are sufficient for suggesting the presence of breastfeeding effects (Fuller *et al.* 2006; Ma *et al.* 2016), even though potential maternal isotope signatures are missing from the respective grave context. Both $\delta^{15}N$ values of the old child (6-8 years) and the juvenile from grave 047 fall in the main range of values expressed by adults. Unfortunately, there are no samples from young children as representatives of the next age class available, which would help to clarify not just the effects of weaning practices but likely also what those practices were (what type of food was replacing breastmilk). In general, the investigation of breastfeeding periods and the associated implications for inter-birth intervals and population fertility requires appropriate attention, which is beyond the scope of this thesis, although significant for socio-economic considerations (cf. Tessone *et al.* 2015; Tsutaya *et al.* 2015; Tsutaya 2017; Tsutaya and Yoneda 2015).

In this regard, the prevalence of caries for individual 047_4 is remarkable, as it suggests both nursing and supplemental feeding with cariogenic food[19]. This leads to three possible scenarios: (1) This individual's isotope values do not reflect the nutritional state at the time of death, but an earlier one during which the individual breastfed; the temporal gap was long enough to develop caries under the new nutritional state. (2) Breastfeeding and supplemental feeding took place at the same time. (3) Either the estimation of caries or the isotope values are incorrect. Due to the higher bone turnover rates in immature individuals and the young age of individual 076_1, the first scenario seems unlikely (Katzenberg, 2008). The young age of the individual, (1-3 years) would also stand against scenario, because it is quite likely that not much time passed between breastfeeding and the time of death. Therefore, an estimation error must be considered and needs further verification.

19 For critical remarks referring to this, see previous page.

6.8 Chronological aspects

From the complete data set of 30 graves, radiocarbon dates are available for four cases[20]. This includes isotope data from seven human and two animal specimens and covers a time span from 2199-2031 to 1879-1692 cal BCE (see chapter 3.4.2), almost the entire period of use identified by radiocarbon dating for the cemetery. The mutual plotting of ^{14}C-dates, δ^{13}C, and δ^{15}N values shows that neither the moderate variation in the nitrogen nor the small variation in the carbon isotope compositions correlate with the ^{14}C-dates in any chronological direction (Fig. 155). This supplements the observation that variations of δ^{13}C and δ^{15}N values have been observed in the same graves. While two dates confirm trophic levels from the animal to the human tissues in specimen from the same grave between 1925-1692 cal BCE (Fig. 154 and 157; Grave 186 and 047), the isotopic composition from individual 182_2 marks the earliest chronological evidence, with average δ^{15}N values and relatively low δ^{13}C values. With grave 047, the nursing effect for the infant is associated with the beginning of the 2nd mil BCE.

In summary, the variation in carbon and nitrogen isotopic ratios seems unspecific in terms of available radiocarbon dating; there is no argument against the interpretation that the results described above are true within the represented time span of the MBA and LBA transition. Because included burials have a collective character, except grave 050, conclusions that are more specific are not drawn at the moment.

6.9 Context of current C and N isotope research in the North Caucasian Bronze Age

In order to place the generated results in the context of current research, the new data are plotted against the data provided by Knipper *et al.* (2018) by considering available radiocarbon dates of Kudachurt 14 (Fig. 155).

Combining isotope data from the literature with the results generated for this thesis leads to the following conclusions:

Comparability and control sample

All C and N isotope data derive from bone collagen, but the samples come from different skeletal elements and the studies followed different pre-treatment protocols. Therefore, primary standards for ensuring data comparability are not maintained. This is of some importance because the measured compositions of the control samples from Kudachurt 14 (grave 186) are different from those of Knipper and colleagues. All three of the samples have lower δ^{15}N and higher δ^{13}C values and the difference is greater in the nitrogen isotope composition (1.0 ‰, 0.9 ‰ and 0.8 ‰; δ^{13}C offsets are 0.1 ‰, 0.2 and 0.3 ‰). Collagen was extracted from the same bone fragments, so if intra-individual differences are responsible for this offset, they occurred on a small physiological scale. The combined data plot shows that the new data from Kudachurt 14 in general tend to display lower values in δ^{15}N and higher values in δ^{13}C, especially for the humans. The mismatch of the control samples does not mean that the new Kudachurt 14 data is internally unreliable yet must be taken into account in the following comparisons with other data sets.

An obvious reason for this difference would be the different laboratory procedures, although the utilisation of EDTA for collagen extraction is suggested to have an effect of increasing rather than decreasing δ^{15}N values compared to HCl (Tuross

20 Grave 047, 050, 186 and 182.

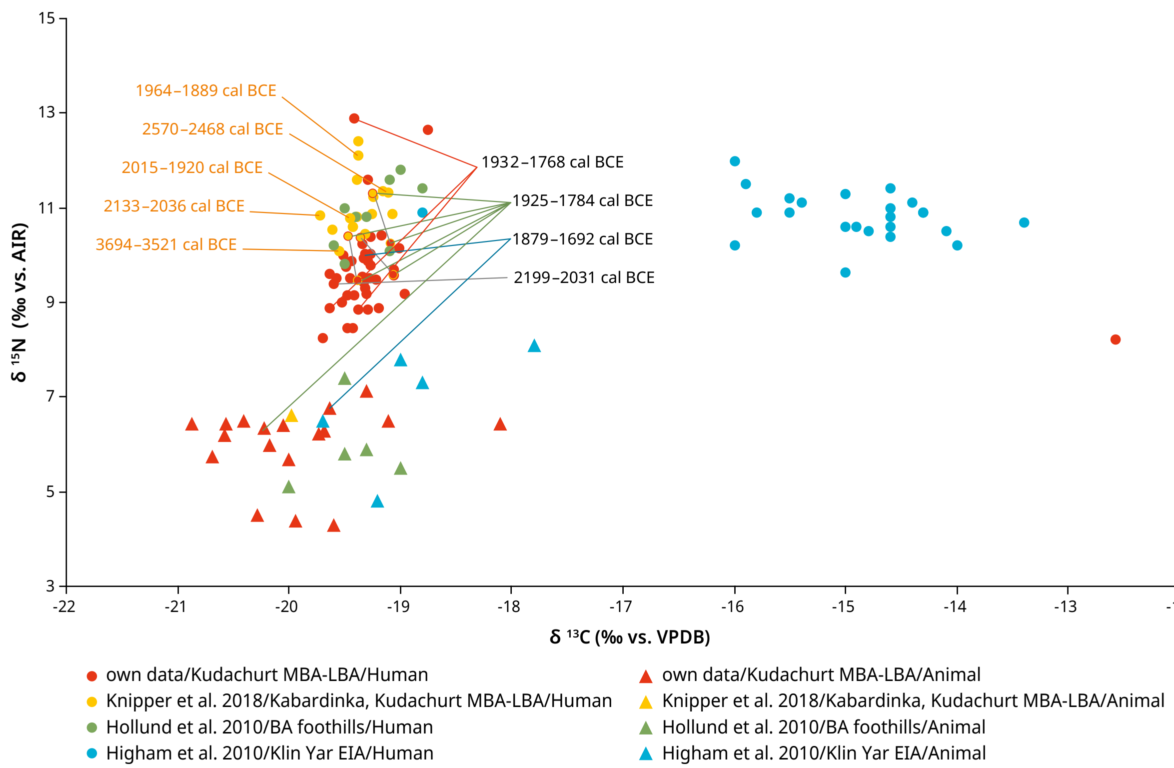


Figure 155: Paleodietary reconstruction, carbon and nitrogen stable isotope analyses. Combined plot of own results with literature C and N isotope data for BA sites from the low and mid-altitude central Northern Caucasus (see Fig. 151).

et al. 1988). More work needs to be done to trace the underlying causes in order to achieve comparability in the future (*e.g.* more control samples, use of a different protocol, identification of the error, and calibration of the results).

Human values from sites of similar environmental backgrounds[21] but no control sample to Kudachurt 14 are Zamankul, Zaragizh (both Maikop) and Kudachurt (MBA?). On average, they show a +1.3 ‰ offset in δ^{15}N values (10.8 ± 0.7 ‰) compared to the mean of adult individuals from Kudachurt 14 (9.5 ± 0.5 ‰). Further information concerning biological sex and age at death about the six individuals from these other sites lacks, so that a further interpretation of their values is problematic (*e.g.* nursing effects). Climatic and thus ecological conditions might have changed throughout the EBA and into the LBA causing lower δ^{15}N values in humans from these sites. Because other faunal data for the creation of a more solid isotopic baseline for the micro region are not available, this scenario remains to be clarified. Additionally, the δ^{13}C values from this ecological micro region show almost no variation.

If the offset in nitrogen values is the result of a measurement error as described above, the assumption made by Knipper and colleagues of the decreasing importance of animal-derived protein in the later BA periods cannot be confirmed by the bone collagen data alone (Knipper *et al.* 2018). If this offset is actually real, the new data from Kudachurt 14 with its lower δ_{15}N values might contrastingly support this hypothesis.

Besides a possible error to be expected in both δ^{15}N and δ^{13}C values, the new data from Kudachurt 14 fall within the broader variation in isotope compositions described for the EBA and MBA sites of the research area. The later dates from Kudachurt 14 touch the transition to the LBA and therefore the latest period of the Bronze Age.

21 Mid to low altitude (400-700 MASL) forest zones with meadows and humid steppe contribution; see chapter 3.1, Fig. 5; this chapter, Fig. 155.

With respect to described shifts in economic strategies during the BA, the results are important in these aspects:

C_3 plants made up the primary food source for the majority of herbivore and omnivore animals during the Bronze Age in different locations of low to mid altitude environments.

The variation in $\delta^{13}C$ values is greatest in animals from Kudachurt 14, although the data set is made up by samples from the same locality. This might be due to two reasons: (1) The EBA sites (Fig. 151, black dots; Fig. 151 green triangles) are located in the drier steppe, and thus the C_3 plants as primary producers as well as the heterotrophs were enriched in ^{13}C in a more narrow value range. (2) Faunal specimens buried at Kudachurt 14 exploited more variable grazing environments in terms of humidity, climate, and/or altitude during life, which is reflected in a larger $\delta^{13}C$ range. This could support the hypothesis of livestock management that included the utilisation of different ecological zones (seasonal strategies, mountain economic systems). Data from plants growing in these different environments as well as additional faunal data from Kabardinka would help to supplement and extend the isotopic baseline for subsequent studies on this issue. Sampling of modern as well as prehistoric material is desirable.

Cultivation of C_4 plants is not common in BA societies of the Northern Caucasus and remains a development of the EIA.

Here, individual 031_1 and the pig isotopic signature from grave 140 represent outliers. In the case of the human, the value is even beyond the range known from Klin Yar. In both cases, a review of the chronological determinations is necessary in order to come to further conclusions.

Animal husbandry was a means of way of life during the EBA-LBA periods.

Consumption of animal-derived proteins by human populations from the EBA to LBA is evident by the trophic levels reconstructable from their isotopic signatures (3694-3521 to 1889-1682 cal BCE). Exact types and proportions of meat and dairy products remain to be examined and are likely to cause variations in the inter-individual comparison.

Nevertheless, based on recent findings from Kudachurt 14 and the current state of the art, several discussion questions remain open:

The MBA to LBA transition: From mobile pastoralists to settled pastoralists between 2200-1200 BCE?

The archaeological record of villages with stone architecture, houses with animal-stabling, and mountain economy is evident for the Kislovodsk region (*ca.* 1700-1200 BCE), but the presented isotope study alone is not indicative for similar processes taking place to the east in the foothill regions. On the one hand, this is due to the limited significance of $\delta^{13}C$ and $\delta^{15}N$ bone collagen as it reconstructs the protein proportion of the diet only. On the other hand, archaeological background information beyond burial contexts is lacking. Further analytical approaches that could be undertaken in order to understand livestock managements between 2200-1650 in the Kudachurt valley include: Surveys and excavations of settlements, zooarchaeological examinations, and expansion of materials (botanical remains, carbonates from dental and osseous tissues) and elements examined through stable isotope analyses (*e.g.* combined with strontium and oxygen (Balasse *et al.* 2002; Knudson *et al.* 2015; Price *et al.* 2012).

Agricultural revolution: C_4 plant cultivation in the second half of the 2nd mil BCE?

Except two samples, whose datings are still unknown, the data from this study conclude that the contribution of C_4 plants to the human diet was not established in the Kudachurt valley between 2200-1650 BCE. Agricultural production and formation of cultivated landscapes is traceable for the EIA Koban Culture around 1100 BCE at the earliest, arising farther to the west. Thus, a period of *ca.* 550 years of LBA settlements with pastoral mountain economies are known for a specific area, but the transition to agriculture remains unclear.

6.10 Conclusion: Trends and limits of dietary reconstructions at Kudachurt 14

The stable carbon and nitrogen isotope study provides a new data set of bone collagen samples from animal and human specimens for palaeodietary reconstructions for the North Caucasian Bronze Age. Available ^{14}C-dates of included burials span the period between *ca.* 2200-1650 BCE and thus touch the MBA to LBA transition. In the context of the North Caucasian Bronze Age, this transition marks a crucial period as ongoing bioarchaeological research suggests a shift in subsistence from mobile pastoral societies in the lower altitudes to sedentary societies with mountain economic livestock management in the higher altitudes.

The data from Kudachurt 14 support the hypothesis that animal husbandry has been a means of existence also in this transitional period, as the nitrogen values prove the consumption of animal-derived protein by humans. Variations within animal δ^{13}C values suggest the exploitation of variable environments and potentially different access to carbon sources from C_3 plants than humans, as the latter groups' δ^{13}C range is very small. While the isotope data provide direct evidence of animal foodstuffs playing a role in supplying dietary protein, the proportions of carbohydrates remain unclear at the moment. Nevertheless, from the prevalence of dental caries we have indirect evidence that fermentable carbohydrates were part of the humans' diet. The co-occurrence of a high trophic level represented in nitrogen isotope values and dental caries in the same individuals without any correlation to the isotope signatures emphasises that a currently unknown source of carbohydrates contributed to the food supply. Furthermore, these carbohydrates did not derive from C_4 plants, so that scenarios such as relevant dietary proportions of C_3 crops, including cereals and fruit potentially from agricultural production, are possible.

Within the human samples, there are slight differences in the lifetime average δ^{15}N values of males and females, but with a large overlap. Weather these inter-individual differences are due to divergent proportions of dietary protein or the type of foodstuff, dairy or meat, is not clear at this stage. This is also true for old children and juveniles, where 2 of 3 infants displayed nursing effects. Here, besides considering intra-individual differences in body tissues, an intensive study on impacts of isotope signatures of animal primary and secondary products and nutrient pathways in collagen synthesis are needed.

The generated results confirm a trophic level shift from the animal to the human body tissue within samples from the same burial contexts. From the ritual perspective, this means that it is highly likely that the animal bones contained in the graves represent remains of meat as funeral gifts (sheep, goat and pig). Additionally, this suggests that other burial items associated with food, such as different kinds of vessels, represent important research objects for complementing the knowledge about protein intake with observations on lipids and carbohydrate supply in foodstuffs that could have been contained in such vessels.

Although the study emphasises that for data validity and comparability a review and expansion of methods and materials is necessary, the gained results contribute to ongoing discussions of subsistence strategies in the North Caucasian Bronze Age. The results confirm the significance of livestock management to a MBA-LBA foothill cemetery population, but do not exclude agricultural practices connected to C_3 plant utilisation. The 40 human specimens represent a homogenous data set in stable carbon and nitrogen isotope compositions. Small value ranges suggest similar means of dietary foodstuffs for 38 % of the buried population from different burial contexts. Apparently, detected differences in burial rites were not related to distinct differences in protein intake or the consumption of C_3 versus C_4 plants, an issue which is discussed in the next chapter.

Part III

Interdisciplinary synthesis and conclusion

7 Interdisciplinary synthesis: Burial practice, human remains, and stable isotopes

By linking information from the socio-ritual and physiological spheres, this chapter aims to expand upon previously mentioned interpretations of burial practice, demography, oral health, and palaeodiet. It furthermore emphasizes the benefit of the interdisciplinary approach applied to the material from Kudachurt 14. More specifically, this chapter compares the social inequalities observed in the funeral practice with the information gained about demographic parameters, regularities in grave equipment as well as conditions of oral health. Implications of the reconstructed palaeodiet will be discussed in accordance with their socio-economic significance for subsistence strategies in the North Caucasian Bronze Age.

As outlined in chapter 2, the leading research questions for the following analyses are:

Were socio-ritual inequalities applied on specific individuals or demographic groups? Does physical information match with suggested gender roles and age-related accoutrements of social status?

How does oral health implications of oral health behave toward detected socio-ritual inequalities? Can we observe connections such as "better oral health status" or occupational habits in terms of social inequality?

Do signs of deviating dietary habits exist in terms of detected social inequalities? What conclusions can be drawn in terms of social organisation, means of productivity and economic strategies?

Are there synchronic or diachronic patterns in socio-ritual inequalities, demography, oral health, and dietary habits? What are the implications given for and by current research on the MBA to LBA transition in the Northern Caucasus?

Due to restrictions of burial item allocations to individuals, representativeness of the human skeletal record and the two-sided approach of age estimation (physical and *in situ*), the data base quality for linkages of burial and osteological data is heterogeneous. Table 45 summarises the obtained data set with respect to the archaeological, osteological, and isotope information (left column) as well as how much of this data could be linked to the funeral equipment groups as defined in chapter 4.5.4 (right column). Classifications to funeral equipment groups were

SYNTHESIS OF BURIAL, OSTEOLOGICAL AND ISOTOPE DATA (N/%)		
Cemetery record	**n total**	**Equipment Group (n/%)**
Graves	130	73/56.2
Individuals (MNIC)	265	103/38.9
Bodily treatment	147	94/64.0
Individual age (in situ+physical)	198 (108/90)	96/48.5 (31/65)
Biological sex	-	52/19.6
Burial items (NPIC)	2332	697/29.9
Osteological record		
Graves	60	60
Individuals (IOC)	108	63/58.3
Bodily treatment	68	63/92.6
Individual age	108	63/58.3
Biological sex	69	52/48.1
Individuals: oral health	85	50/58.8
Individuals: C & N stable isotopes	41	19/46.3
Burial items	793	362/45.6

Table 46: Interdisciplinary synthesis. Data base for linkage of burial, human, and isotope data referring to the total data record obtained. Figure 156 and 157 as well as tables 47, 48 and 49 refer to this data.

possible for 103 individuals from 73 graves of data qualities 1-3, of which 65 specimens were analysed by hand. For an additional 31 individuals the maturity stage was estimated *in situ* (subadult/adult). Furthermore, 697 burial items and 94 estimations of bodily treatment were examined. Poor representativeness in terms of information linkage is especially true for the association of biological sex and equipment group; from a total of 265 *in situ* counted individuals, for only 19.6 % are both analyses available (Tab. 46 right column).

The osteological and dental record rely on 108 individuals from 60 graves of data qualities 1-4, and burial item associations for 63 as well as bodily treatment for 68 of these individuals could be reconstructed. For 50 individuals information about both oral health and funeral equipment is available. With respect to this material basis, the following results are applicable to the analysed part of the buried population and the associated actors – the burying population.

7.1 Cemetery: Age, sex, and funeral equipment

The combinations of age at death and biological sex with the burial item characteristics functional class and category clarify sex- and age-dependencies in funeral equipment and set the baseline for discussion at the level of the individual (Tab. 47-48).

Figure 156 displays the total distribution of items per age class and item functional class as well as artefact category and Table 46 the total and average dis-

AGE CLASS (n)	Burial items: functional class (n/average)				
	All	Food	Jewellery	Weapon	Tool
Infant (1)	10/10	4/4	6/6	0/0	0/0
Young child (3)	8/2.7	2/0.7	5/1.7	0/0	0/0
Old child (3)	33/11	1/0.3	32/10.7	0/0	0/0
Juvenile (5)	57/19	15/3	41/8.2	1/0.2	0/0
Juv/young ad (6)	52/8.7	11/1.8	41/6.8	0/0	0/0
Young adult (22)	106/4.8	48/2.2	55/2.5	4/0.2	0/0
Middle adult (15)	56/3.7	34/2.7	21/1.4	1/0.1	0/0
Old adult (2)	6/3	5/2.5	1/0.5	0/0	1/0.5
Adult++ (2)	26/13	5/2.5	20/10	0/0	0/0
Subadult (7)	61/8.7	13/1.9	48/6.9	0/0	0/0
Adult (22)	138/6.3	22/1.0	106/4.8	10/0.5	0/0
All (88)	**553/6.3**	**160/1.8**	**376/4.3**	**16/0.2**	**1/0.01**

Table 47: Interdisciplinary synthesis. Data basis and distributions of burial item functional class and individual age including both age estimation approaches.

BIOLOGICAL SEX (n)	Burial items: functional class (n/average)				
	All	Food	Jewellery	Weapon	Tool
F (11)	53/4.8	22/2.0	30/2.7	1/0.1	0/0
F>M (10)	60/6.0	19/1.9	41/4.1	0/0	0/0
M = F (6)	53/8.8	10/1.7	42/7.0	0/0	1/0.2
M > F (3)	13/4.3	4/1.3	9/3.0	0/0	0/0
M (16)	55/3.4	48/3	3/0.5	4/0.3	0/0
All (46)	**234/5.1**	**103/2.2**	**125/2.7**	**5/0.1**	**1/0.02**

Table 48: Interdisciplinary Synthesis. Data basis and distributions of burial item functional class and biological sex.

tributions of age class and items per functional class; here, subadult and adult mark results for individuals with *in situ* age estimation. One major result is that jewellery items were not restricted to adults. Although the ratio of subadults to adults associated with jewellery (1:4.4) is not equal to general distributions calculated for the buried population (1:2.2), the number as well as compilation of ornaments that were found on remains of subadults reflect personality or social status of the buried individuals. Even rare categories such as belt hooks, large pendants, tutuli, or necklaces made of animal teeth were part of the funeral assemblages for subadults as well as adults. In general, there is no evidence for age-dependent jewellery categories.

The average distributions of functional items per age class clearly show that fewer subadults were gifted with a large number of jewellery objects than adults. Overall, subadults had 6.9 items per burial, and adults 3.5. However, these numbers are biased by the frequency of simple food assemblages for subadults, which are likely to be underrepresented especially in collective graves. When the ratio of subadult to adult of 1:2 is taken into consideration, the averages are more levelled to 5.8 and 5.3 jewellery items per individual, which still underlines that deceased children and adolescents received this funeral treatment.

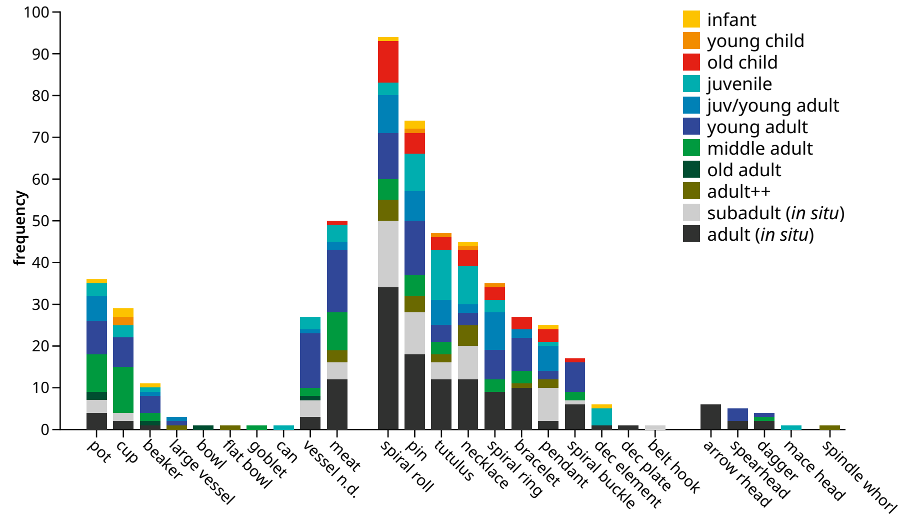


Figure 156: Interdisciplinary synthesis. Combination of individual age at death and the burial item characteristics functional class and category. Age determinations include results of the physical as well as the in situ-approach (n graves=70; n individuals=91; n items=568). Item categories are sorted by functional class.

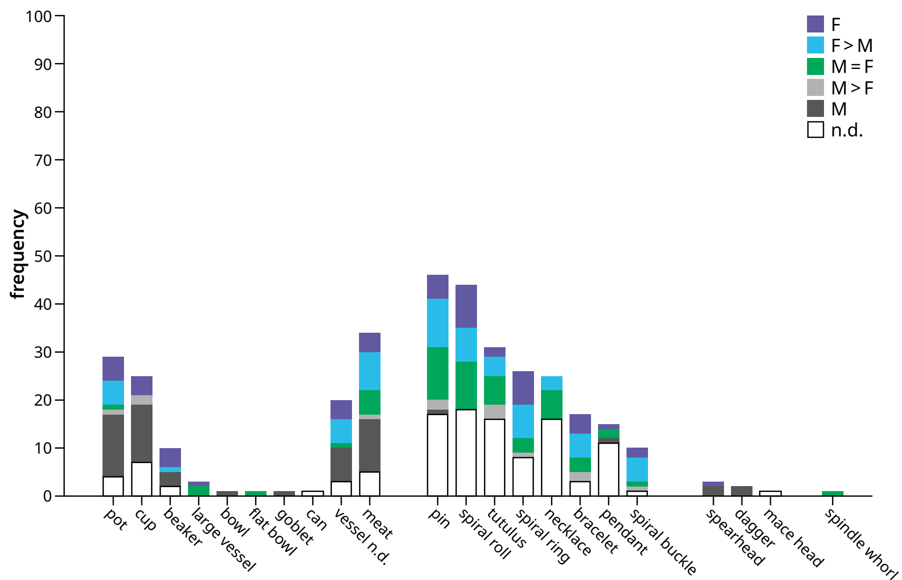


Figure 157: Interdisciplinary synthesis. Combination of biological age of adult individuals and the burial item characteristics functional class and category. Age determinations include the results of the physical as well as the in situ-approach (n graves=70; n individuals=91; n items=568). Item categories are sorted by functional class.

While jewellery was intended for the youngest members of the buried community, a very different association is visible for the equipment with weapons. Although the small number of weapons found – only 16 – must be taken into consideration, the youngest individual is a juvenile, buried together with a macehead. Thus, it appears that weapons were a type grave equipment intended for individuals that had already undergone early adolescence. In comparison with the distribution of jewellery items, this suggests that traditions connected to equipment symbolically ornamental or martial were practiced differently. The inclusion of food as a grave good was a common tradition and evident for almost all age classes.

The combination of biological sex and burial item characteristics reveals clearly sex-determined burial equipment habits (Tab. 47, Fig. 156). The majority of jewellery objects were associated with skeletons of female constitution (56.8 %), and only few with skeletons of male constitution (9.6 %); this is reversed for weapons. In terms of jewellery, there were no “male-specific” categories.

In conclusion, the data show that biological sex did play a role in the ritual context and accordingly in social perception; “social sex” reflected in the burial item class and biological sex as determined from the skeletal remains match for the vast majority of the individuals under study, supporting the assumption that some sort of concept of gender existed. For a large portion of the studied individuals, the skeletal attributes were not explicit; if we accept the sex-determined equipment as accurate, many of these individuals were female in the sense of socially perceived gender. In addition, for the predominantly subadult individuals for whom sex was not determined (Fig. 153, "n. d."), it can be argued that those individuals with jewellery equipment were female juveniles or girls. However, it is also possible that subadult age was connected to symbolic ornamentation regardless of biological sex. Similar to their distribution across age classes, food elements appeared evenly within grave assemblages for males and females and no differences could be ascertained regarding different types of food (*e.g.* foodstuffs contained in vessels, meat). One exception here is that foodstuffs contained in cups appeared more frequently in burials of males, or the use of cups was more strongly related to male eating or drinking habits.

Considering that the funeral equipment group 2 determined by food items is underrepresented in this association study, it is possible to draw another conclusion. Within equipment groups 3 and 4, more females were emphasised with jewellery and costume ornaments than males were buried with a weapon. Males were more commonly equipped with simple food assemblages (equipment group 2). Apparently, the status for receiving the ornamental marking was more frequently reached and/or represented compared to the status of receiving weapons. Moreover, this division was already applied for premature individuals, meaning that simple food equipments of children and juveniles would indicate the buried individuals were more likely boys or male teens. Only upon reaching a certain degree of maturity were these individuals equipped with weapons.

Considering the high value of bronze and rare materials such as antimony, as well as the amount of effort required to produce elaborate jewellery items, the equipment of females generally holds more value, possibly emphasizing the important role of at least some females in the social system.

Furthermore, the occurrence of jewellery in the equipment of small children less than 6 years old suggests that higher social statuses could be held by members of the society before reaching adulthood. Apparently, ornaments were not used to mark forms of status associated with the different stages of biological growth, but rather status that could also exist in the childhood of specific individuals. This presents a clear argument against acquirable social status and speaks instead to the presence of structures of inheritance.

7.2 Individual contexts: Burial practice, social inequality, and demography

By examining the specific context of funeral equipment assemblages, it was possible to establish five equipment groups for 103 individuals from 73 graves. These groups are based on the presence and complexity of burial item functional classes and categories (1 = no items, 2 = simple food items, 3-5 = increasing number and complexity of jewellery or weapon items; see chapters 4.3-5).

The group classification of assemblages could then be combined with age at death (n=65 osteological, 31 *in situ* estimation) and biological sex (52) observations as well as funeral characteristics such as burial type (73) and bodily treatment (95). Figure 159 summarises the individual results by funeral equipment group. In table 48, the correlations of sex-determined bodily treatment and the application of these rules on subadults and individuals of unknown biological sex are presented. Conclusions drawing from this comparison of data are as follows.

INDIVIDUALS	bodily treatment		
	flexed, right	flexed, left	supine
Biological sex			
F/F>M (19)	14	4	1
M = F (6)	6	0	0
M/M>F (20)	3	13	4
Suggested "gender"	**F**	**M**	**M**
Subadult (incl. immature)	16	2	1
Adult	13	6	4
All max	**52**	**25**	**10**
(Physical)	**49**	**21**	**9**
Ochre	**13**	**2**	**1**

Table 49: Interdisciplinary synthesis. Correlations of bodily treatment with biological sex (n individuals=45) and interpretation of social gender by transferring the results to individuals of unknown sex due to immature age or lacking information (n individuals=42; all n= 87).

Burial types and representativeness

The first two equipment groups (no items/food items) are associated with single burials, whereas groups 3-4 more often appeared in double and collective burials (Fig. 158); as we know from the preceding chapters, this is due to few possibilities to identify groups 1 and 2 in complex funeral environments. This is true for predominantly male individuals; in contrast, females and children with simple or complex jewellery items can be identified in mutual graves. This is in accordance with the observation that inhumation groups often included subadults.

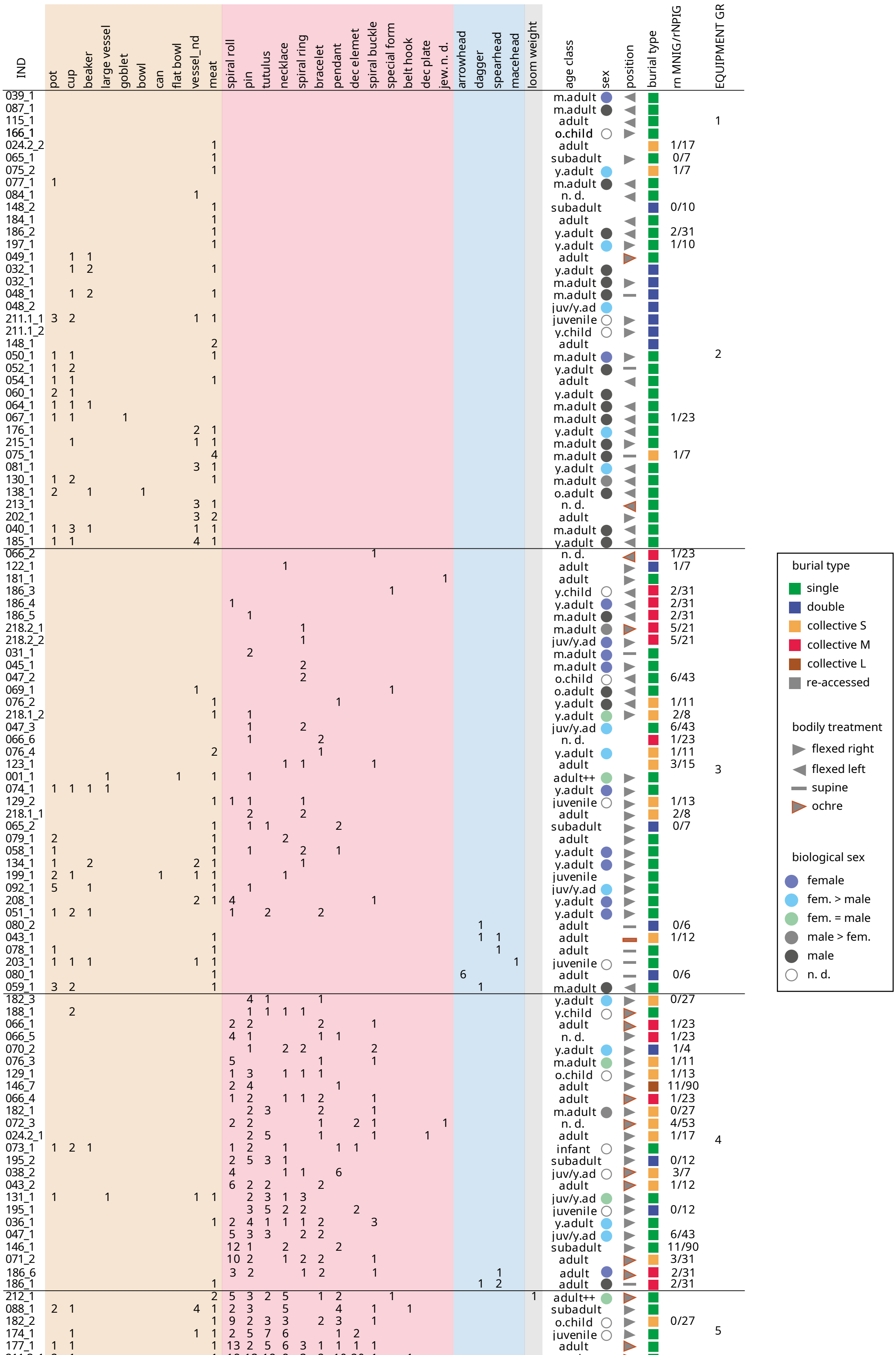
Specification of and expansion on the observations made related to age and sex-determined burial practices

In accordance with the results of the preceding sections of this chapter, males are more frequent in group 2, and females in group 3 and 4 wherein only males with weapons are also included. (Fig. 158). Three of six individuals from group 5 displaying oversupply and rare item categories are subadults; interpreting this in terms of social organisation, it emphasises the inheritance of social status. The presence of subadults in the other equipment groups supports this, whereas the near lack of subadults in the first group could be due to the lower probability of finding graves of children buried with no items. Furthermore, due to the observation that females died earlier in life than males did, the mean ages of individuals with equipment of groups 3-5 are younger compared to that of group 2.

In addition to influencing funeral equipment, sex evidently played a role in determining bodily treatment (Tab. 49). Of the 20 males, 13 were laid down on their left side and 4 in supine position; of the 19 females, 14 were found on their right side and 1 in supine position. In 7 cases the positions were swapped, and 6 individuals were of unspecific sexual morphology. Still, there is a clear regularity in how individuals were positioned in the graves based on their biological sex. Furthermore, associations of right-sided positions to jewellery and supine positions to weapons supports this assumption from the perspective of burial equipment.

Applying this "ritually perceived gender" to subadults and adults lacking osteological data, it is possible to increase the number of recognized females and males (suggested "gender", Tab. 49). Assuming that osteological data might be incorrect, the maximum number of females expressed in the ritual habit are 52, including 16 girls or female juveniles, and the maximum number of males 35, including 3 boys or

Figure 158 (opposite): Interdisciplinary synthesis. Individual contexts of burial item characteristics burial type, bodily treatment, individual age at death, and biological sex as well as funeral equipment groups (numbers see Tab. 46 and text). The establishment of funeral equipment includes allocable items; remaining grave goods are summarised "r NPIG" (remaining NPIG). "r MNIG" similarly refers to remaining individuals (remaining MNIG). The ordination of the individuals to the respective groups is determined by the number of allocable items as well as the presence of weapons in the assemblages.


IND
pot
cup
beaker
large vessel
goblet
bowl
can
flat bowl
vessel_nd
meat
spiral roll
pin
tutulus
necklace
spiral ring
bracelet
pendant
dec elemet
spiral buckle
special form
belt hook
dec plate
jew. n. d.
arrowhead
dagger
spearhead
macehead
loom weight
age class
sex
position
burial type
rn MNIG/rNPIG
EQUIPMENT GR
burial type
single
double
collective S
collective M
collective L
re-accessed
bodily treatment
flexed right
flexed left
supine
ochre
biological sex
female
fem. > male
fem. = male
male > fem.
male
n. d.

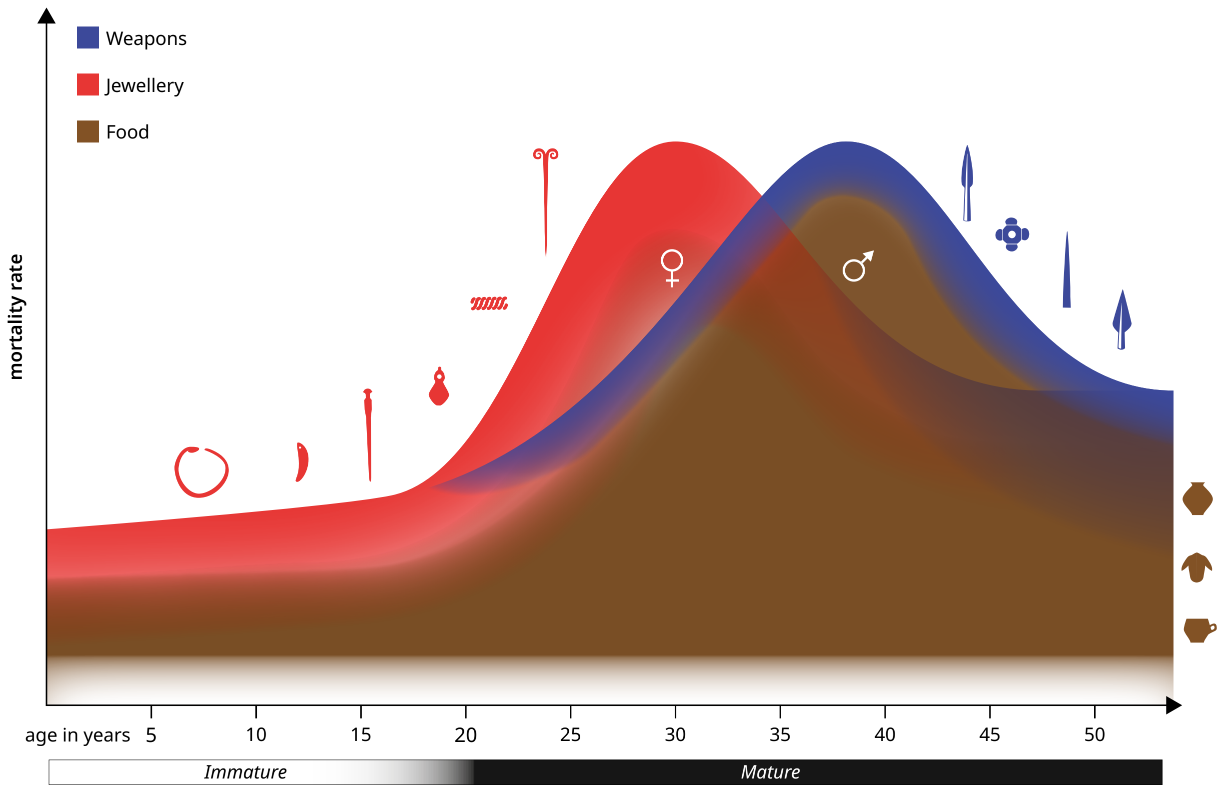


Figure 159: Interdisciplinary synthesis. Theoretical model of social inequality and demography deriving from the funeral and osteological data from Kudachurt 14. The illustration is based on sex- and age-determined distributions of equipment groups: simple food assemblages displayed in brown colour (equipment group 1), increasing complexity of jewellery items in red colour (group 3-5) and the addition of weapons in blue colour (group 3w-4w). Order of item symbols are random. Mortality rate refers to expected demographic distributions. Not displayed are sex-determined bodily treatments (females flexed right, males flexed left, adult males in supine position). "Immatures" includes subadult in situ-age, and "matures" adult individuals.

male juveniles. If the contradicting cases and individuals of unspecific physical constitution are excluded, there is a ratio of 43 females to 30 males. Following this interpretation, the surplus of males found during the osteological analyses is changed into a surplus of females, especially female children and juveniles. According to the observation that the dispersal of ochre is associated with poor skeletal preservation (*e.g.* ind. 213.1_1, Fig. 43.5), the osteological evidence for associating this funeral treatment with biological sex is poor (*e.g.* ind. 186_6, Fig. 45.1). However, red discolouration is more often found on right-sided skeletons equipped with jewellery items, so that a connection to the female sex is suggested.

In summary, there is a strong correlation between female sex and subadult age to equipment groups 3 through 5 with a gradual increase of jewellery complexity and relative decrease in food items, as well as right flexed body side and ochre. Male individuals were predominantly buried with food items and laid down on the left body side, and in rare instances with weapons and in exceptional cases ochre (Fig. 158).

Equipment groups and bodily treatment express a social system apparent in the ritual context of death

In combination with the osteological data, the separation of simple food equipment from the gradual increase of jewellery complexity as well as the inclusion of weapons for some men suggest the interpretation of burial good assemblages as reflecting the design of a social model (Fig. 159). This model is based on (1) demographic results (estimation of biological sex, ratio of immature to mature individuals, younger age at death of females compares to males) and (2) variations in equipment compilations from no items (group 1, white colour), to food items (group 2, brown colour), and increasing amounts and complexity of jewellery items relative to food items (groups 3-5, red colour) as well as weapons as funeral gifts (groups 3w-4w, blue colour).

In addition to the information displayed in Figure 159, the model is supported by regularities of bodily treatment. Assuming that the funeral situation reflected the actual lived reality, this social system included a large part of the population under study, while burials without items might represent exclusion from or the bottom of the system. Among women and subadults, potentially only female adolescents, decreasing frequencies of burial items with increasing jewellery complexity and ochre dispersal speak for a vertical system, even though hierarchical levels are not sharp, but blurry. As weapons are comparatively rare, this dimension is of lesser extent, but in addition the role of some men is stronger emphasised by supine body position. Another interpretation would be that the social roles or functions of specific women and children were more prominent.

7.3 Grave contexts: Social inequality, demography, oral health, and diet

The synthesis of obtained results on an individual or inhumation group level provides the grave context or each burial. Additionally, the integration of radiocarbon dates allows chronological considerations of the interlinking of the socio-ritual and physical spheres (Fig. 160). Based on the human record of 108 specimen, figures 160 and 161 summarise information about burial practices including construction elements (burial type, stone elements, depth, catacomb), bodily treatment, and skeletal data as well as oral health characteristics (oral health groups, caries prevalence, atypical macrowear, extramasticatory traits, and enamel hypoplasia[1]). Relevant information from the palaeodietary reconstruction by means of stable isotope analyses are also taken into account but illustrated in a separate figure (Fig. 167). In some cases, it was not possible to assign an individual to one of the funeral groups, and others lack oral health data. Nevertheless, the following conclusions can be drawn from the available information:

Construction effort and social inequality

Stone elements and installation depths as indicators for increased construction effort were not specific for males, females, or subadult ages, but flagstones were more often parts of single graves for older adult individuals. The flagstones are furthermore often associated with male individuals with simple food items or female individuals of group 3, although this is not always the case (graves 072, 129; Fig. 161).

Socio-ritual structures in single contexts and inhumation groups

While single burials make up the resting places of females, males, and subadults, and each reflect a variety of the position within the social system, double and collective burials show different compositions in this regard. Apparently, the unitary character or "social proximity" of a shared grave did not mean that the buried individuals shared a social status or experienced the same funeral care. Assuming inheritance of social status and that variation in demographic structures among inhumation groups represent the inclusion of family members from all stages of life, the results suggest mutual graves contained kinship groups with a variety of social

1 For classifications of oral health group and enamel hypoplasia see chapters 5.6.3.10, 5.7.1.

rankings. Here, the well-preserved funeral environment of grave 186 provides a suitable example, containing four males of different age, two with weapons and one in supine position (186_1), one women richly equipped with jewellery, a spearhead and ochre dispersal (186_6) , as well as two children with singular jewellery items, plus numerous food items for all individuals[2]. In this inhumation group, individual 186_1 and 186_6 gain attention compared to the others. This is similarly true for other graves (038, 076; Fig. 161-162). However, the highlighting of adult individuals was no overall rule; for instance, the child in grave 182 was equipped more elaborately than the adults interred in the same grave. Unfortunately, individuals of groups 1 and 2 often remain unidentified in these communal contexts.

Socio-ritual structures and oral health groups

The formation of oral health groups relied on the identification of the degree of manifestations of common (1-2; mild to moderate calculus, periodontitis, chipping, dental wear) and less common conditions (3-5; as 2 but in advanced stages, plus periapical lesions and antemortem tooth loss affections). One general result of the analyses of oral health is that these classifications strongly relate to the age of the individual, as is expected for dental conditions (see chapter 5.). Due to this, the imbalance of immature and mature individuals buried in single or communal graves gives the impression that double and collective graves were intended for those of better oral health (see Fig. 160-161). It also seems that individuals of poor oral health predominantly were associated with to funeral equipment groups 2-3. Higher numbers of immature individuals in a grave group decrease the group's overall estimated affection, while specific members exhibit the whole range of dental conditions including antemortem tooth loss, periapical lesions, and advanced dental wear. The author assumes that this circumstance is primarily driven by the age-dependency of these conditions, but would like to stress that data of higher resolution about specific dental conditions as well as the application of further statistical approaches with regard to socio-ritual formations are needed to verify this assumption. At this stage, we cannot confirm statements such as "individuals of higher social status had better oral health during lifetime, thus their life reality was different in terms of…". According considerations rather consider poor oral health as a side-effect of caries and the habitual use of teeth.

Socio-ritual structures and dietary indicators

Information about human diets is available from two analytical approaches, and the integration of caries prevalence and the carbon and nitrogen stable isotope analyses in the preceding chapter concluded that the sampled population relied on both animal protein and carbohydrates derived from C_3 plants. Small variations in $\delta^{13}C$ and $\delta^{15}N$, potentially due to occasional consumption of different types or changing proportions of dairy products and meat, as well as the high prevalence of caries do not suggest crucial differences in the dietary means of existence. With an average offset of 0.7±0.4 ‰, $\delta^{15}N$ values of males are slightly higher. Therefore, the diet of 38 % of the individuals that have been osteologically analysed was characterised by a mixed economy of livestock farming and an unknown agricultural share. Measurement of multiple samples within the same inhumation groups confirmed intragroup variation in isotope composition as well as trophic level shifts from the animal to the human bone collagen.

Considering the importance of food in the funeral tradition, the differences in vessel types and meat proportions potentially mark inequalities in equipment groups, speaking for deviating accessibilities to foodstuffs.In terms of the carbohydrates consumed, caries prevailed among individuals from different so-

2 See burial item plates 50-51: Part IV, 16. Item plate catalogue (online data).

cio-ritual contexts in single, double, and different sizes of collective graves and within all equipment groups. In conclusion, cariogenic oral conditions were a lived reality despite the social position or functional role of an individual, and access to foodstuffs rich in carbohydrates was not restricted to a specific part of the society. With respect to dietary protein, neither the average values of $\delta^{13}C$ and $\delta^{15}N$ per equipment group, nor the plotting of groups in the distribution graph display any crucial tendencies (Fig. 162). For instance, although numerically underrepresented, the values of individuals 182_2 and 039_1 show almost identical compositions between equipment groups 1 and 5. Values from the three equipment groups 2, 3 and 4 show the complete range of variations in $\delta^{15}N$. Here, the infant from grave 073 with apparently high social status died during the nursing period. All $\delta^{15}N$ values from males with weapons are higher than 9.45 ‰, but still lay within the general distribution of measured individuals. Hence, the C and N isotope signatures do not show any major differences in the consumption of dietary protein among the social positions reflected in the funeral equipment.

Overall, the combination of results describes the buried population as peoples with a similar means of subsistence regardless of social positions, roles, or functions, although the taken approach does not allow the reconstruction of the type, nutritional quality, or proportions of different foodstuffs consumed. Besides further bioarchaeological analyses, estimating the amount of food likely present in grave assemblages (vessel volume, type, weight) would be a promising method to approach these issues. Presumably, the common subsistence strategy was a mix of animal husbandry and agricultural during the transitional period of 2200-1650 BCE.

Socio-ritual formations, occupational use of teeth, and therapeutic measures

Non-dietary use of teeth connected to working processes appeared in the form of atypical attrition of the maxillary teeth, unspecific facets, and occlusal grooving in 30 mature individuals, while interproximal grooving could also be a sign of hygienic treatment as co-occurring pathological lesions suggest. As described in chapter 5, different occupational habits in the use of teeth as “a third hand” or in processing materials come into question. Even though the use of teeth as a tool provides a very fragmentary insight into production processes, the findings from Kudachurt 14 imply that most individuals that lived longer than ~35 years practiced related habits. Thus, such modifications directly reflect which part of the society was involved in these productive processes, for instance sinew and leather processing, and that participation in these processes was not a matter of biological sex. With respect to social inequality, possible correlations of equipment groups as a proxy for individual social function or position and signs of occupational activity were examined. Assuming that an increased number of jewellery or weapon objects in the funeral equipment expresses superordinate social positions, and that extramasticatory tool-use represents a particular group of producers within the society, corresponding or mutually exclusive occurrences could indicate hierarchically organised division of socio-economic tasks.

In general, related dental traits were found in individuals from different socio-ritual contexts, including single, double, and collective graves. Thus, members of the society that were “productive” in this regard, were integrated in the socio-ritual units of inhumation groups. This indicates that such inhumation groups represent not only a demographics cross-section of a society, but also combinations of people that performed specific working habits[3].

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3 Including other activities that manifest in osseous changes, potentially also specific working processes; respective cranial and postcranial markers, *e.g.* enthesal changes, have not yet been analysed for this thesis.

GRAVE	burial type	catacomb	stone element	depth	IND	corpse	funeral equipment	sex	age class	oral health group	caries present	atypical macrowear	extramasticataory traits	enamel hypoplasia
001				30–100	001_1		3		adult++	no dental record				
031				< 30	031_1		3		m.adult					25.00/1
036				< 30	036_1		4		y.adult					73.3/1.4
039				30–100	039_1		1		m.adult					12.5/1
040				30–100	040_1		2		m.adult					7.7/2
045				30–100	045_1		3		m.adult					30.8/1.5
051				100–150	051_1		3		y.adult	no dental record				
052				100–150	052_1		2		y.adult	no dental record				
058				30–100	058_1		3		y.adult					81.3/1.3
059				30–100	059_1		3w		m.adult					16.7/1
060				< 30	060_1		2		y.adult	no dental record				
064				100–150	064_1		2		m.adult					
067				30–100	067_1		2		m.adult					50.0/1
069				100–150	069_1		3		o.adult					7.1/1
073				30–100	073_1		4		infant					66.7/1.1
074				30–100	074_1		3		y.adult					34.4/1.3
077				30–100	077_1		2		m.adult					10.0/2
081				< 30	081_1		2		y.adult					
087				< 30	087_1		1		m.adult					48.1/2.6
092				< 30	092_1		3		juv/y.ad					64.3/1.1
130				< 30	130_1		2		m.adult					33.3/1
131				< 30	131_1		4		juv/y.ad					33.3/1.2
134				< 30	134_1		3		y.adult					23.1/3
138		⊣		30–100	138_1		2		o.adult					
166				< 30	166_1		1		o.child					20.0/1.3
176				< 30	176_1		2		y.adult					28.6/1
185				30–100	185_1		2		y.adult	no dental record				
188				100–150	188_1		4		y.child	no dental record				
199				< 30	199_1		3		juvenile	no dental record				
200				< 30	200_1				infant					60/2
201				< 30	201_1				y.adult	no dental record				
203				< 30	203_1		3w		juvenile					
208				< 30	208_1		3		y.adult					41.4/1.5
211.2				30–100	211_3				y.adult					25/1.2
212				< 30	212_1		5		adult++					
215				< 30	215_1		2		m.adult					14.3/1
216				30–100	216_1				y.child	no dental record				
032				30–100	032_1				m.adult					42.9/1.7
					032_2				y.adult					54.5/1.25
048				30–100	048_1				m.adult					
					048_2				juv/y.ad					14.3/1
070				< 30	070_2		4		y.adult					50.0/1
127				< 30	127_1				m.adult					60.0/2.3
					127_2				o.child					77.8/1.1
195				< 30	195_1		4		juvenile					29.6/1.1
197				30–100	197_1		2		y.adult					12.5/1
					197_2				juvenile					
211.1				100–150	211_1				juvenile					74.1/1.2
					211_2				y.child					50.0/1.8
038		⊣		100–150	038_1				adult++					4.2/1
					038_2		4		juv/y.ad					42.3/1.4
					038_3				o.child					100/1
072		⊣		> 200	072_1				m.adult					26.1/1.2
					072_2				m.adult	no dental record				
075				100–150	075_1		2		m.adult					50.0/1
					075_2		2		y.adult	no dental record				
					075_3				y.child	no dental record				
117				< 30	117_2				m.adult					78.13/1.3
					117_3				child	no dental record				
129				30–100	129_1		4		o.child					31.3/1
					129_2		3		juvenile					65.6/1
					129_3				infant	no dental record				
204				30–100	204_1				child	no dental record				
					204_2				child	no dental record				
					204_3				child	no dental record				
					204_4				juvenile	no dental record				
					204_5				y.adult	no dental record				
190		⊣		100–150	190_1				y.adult					44.4/1.1

Figure 160: Interdisciplinary synthesis. Grave contexts of characteristics of burial practice, demographic attributes, and oral health based on the human record. For description of labels, see Fig. 161. The "w" in equipment refers to the presence of weapons.

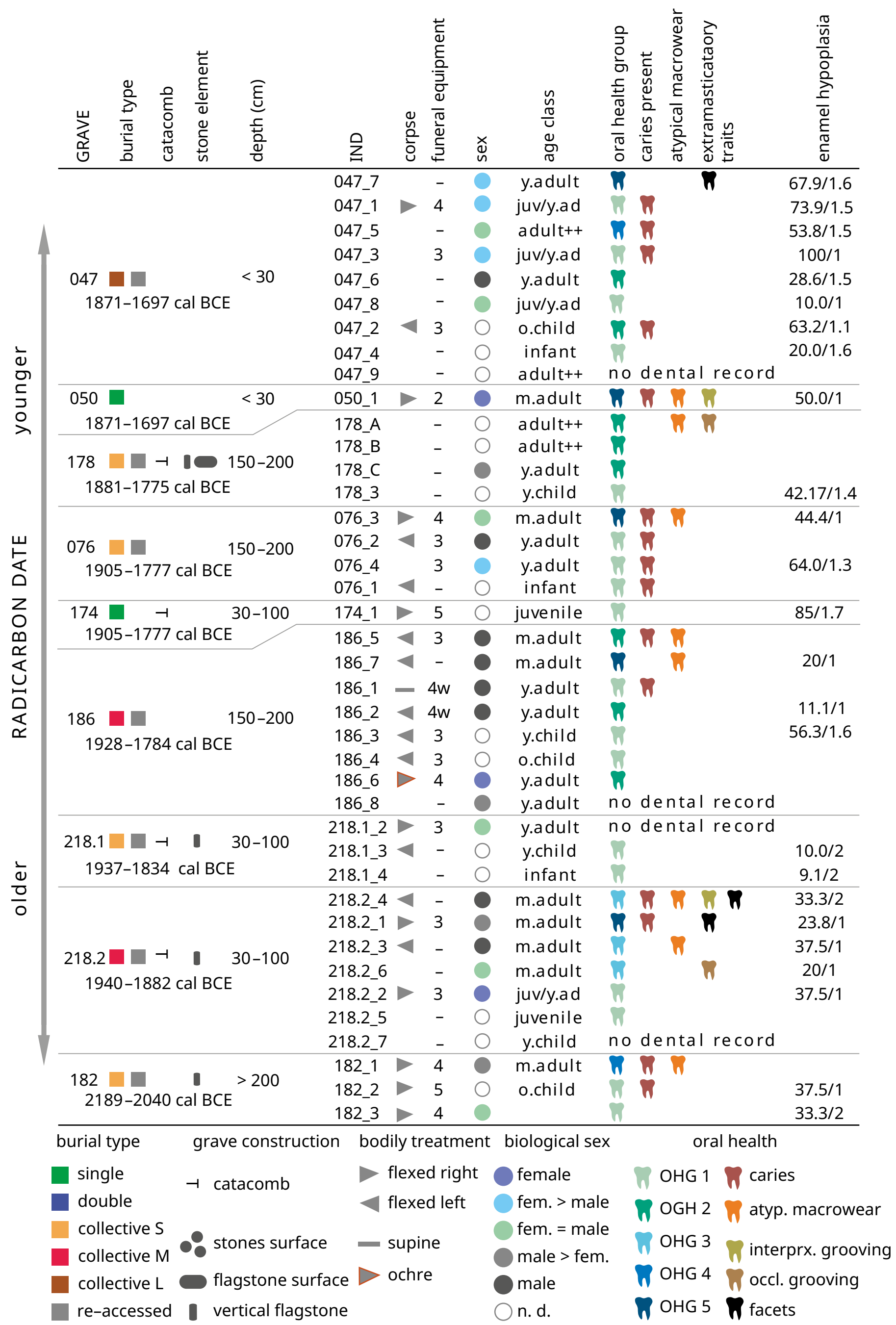

Figure 161: Interdisciplinary synthesis. Grave contexts of characteristics of burial practice, demographic attributes, and oral health based on the human record. Sorted by [14]C-chronology (2sigma-range) and oral health characteristics. The "w" in equipment refers to the presence of weapons.

In the context of mutual graves, interlinkages of individual equipment groups and specific extramasticatory traits show occupational tooth use in individuals associated with equipment group 4 (076_3, 186_5, 182_1; Fig. 158; 160-161). From this group, individual 070_2 exhibited interproximal grooving as a singular trait, which could also be a result of hygienic measures. If we exclude this one, six separately buried individuals, males and females, showed non-dietary tooth alteration and were classified in equipment groups 1, 2 and 3. Including the appearance of interproximal grooving as an occupational marker, eight individuals from single and double burials were interred with simple food inventories and three individuals with a few additional jewellery items (group 2 and 3), and most of them are males.

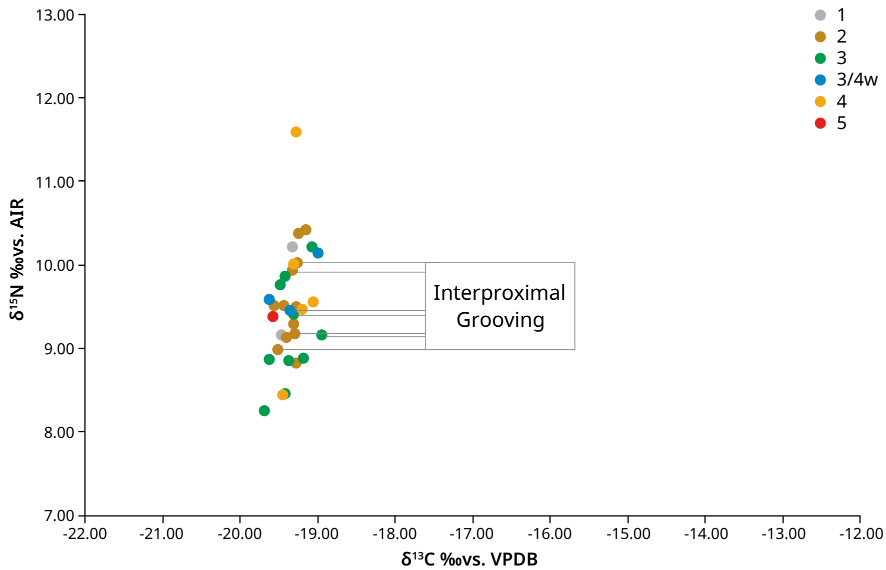

Figure 162: Interdisciplinary synthesis. Socio-ritual structures and dietary indicators. Results of C and N stable isotope analyses per funeral equipment group. Average values are ($\delta^{13}C/\delta^{15}N$ in ‰): 1, -19. 4±0.1/9.7±0.5; 2 -19.4±0.1/9.6±0.5; 3 -19.4±0.2/9.2±0.6; 4 -19.3±0.1/9.8±1.0; 3/4w -19.3±0.3/9.7±0.3; 5 -19.6/9.4.

The second interpretation of these striations is that they represent traces of repeated cleaning of interdental spaces and carious lesions from dental plague (including meat and plant fibres) and calculus. As this habit is connected to dietary residues, individual correlations to isotopic compositions and foodstuffs included in the funeral equipment are worth considering. Disregarding the ritual context, nitrogen isotopic compositions in individuals with interproximal grooving stretch from 9.0 to 10.0 ‰ and lay in the upper two thirds of the mature population value range (mean $\delta^{15}N$ 9.8±0.6 ‰). The inter-individual differences could be related to the type or form of the animal-derived food component (Fig. 162). For instance, a potential scenario would be that increased meat consumption lead to increased activity in removing of meat fibres from the interdental spaces. However, based on the given isotopic and archaeological data, such conclusions are not possible at the moment, as estimations of amount of meat consumed are lacking and the impact of protein proportions and type of consumed animal food products on $\delta^{15}N$ values remains unclear.

Among adults from the three burial types, different combinations of equipment group and extramasticatory traits occur. Thus, we can state that the data do not show a clear correlation of socio-ritual inequality and habitual use of teeth. Occupational activities related to tooth use were practiced of members of different positions within the presented social model, which would speak against the social division of related production processes. Is should be noted here, that subadults do not show respective markers (perhaps due to the factor of time) and in addition there remains an invisible frequency of equipment groups 1-3 in collective grave contexts.

Socio-ritual structures and unspecific stress during childhood

Defects in enamel formation are indicative for unspecific stress during childhood, for instance diseases, malnutrition, high physical demands, low birth weight, or birth traumas (see chapter 5.4.5.7, 5.6.3.10). The dental record from Kudachurt 14 describes repeating or continuous intervals of physical burdens for most of the examined population from infancy or early childhood onwards, although only children, juveniles, and young adults provided reliable values. Female children[4] were more prone to the formation of enamel hypoplasia (EH).

4 Estimation based on the social sex reflected in the funeral equipment.

In the scope of social inequalities and lived reality, it seems logical to consider the hypothesis that children of high social status experienced fewer or less frequent stress intervals than children of low social status, because their standard of living was better in terms of nutrition and lower physical burden. The combination of individual equipment group as well as EH affection frequency and average defect severity does not support this hypothesis (Fig. 160-161, right column). Individual variations distribute within single or mutual inhumations as well as within the different equipment groups. For instance, the juvenile found in grave 174 revealed quite high values of EH but displayed a high social status; the juvenile buried in grave 211.3 had similar EH values but was only associated with equipment group 2. Low as well as high frequency rates occur in the same inhumation groups, and variations among individuals from separate graves exist as well.

What we can say is that holding a certain social position did not protect an individual from such stress events; on the other hand, it also did not increase exposure to related stress events. In order to come to more valid conclusions with respect to the aforementioned hypothesis, namely to detect a correlation between physical burden as a proxy for living standards and social position within the given system, data of higher resolutions and a better understanding of the EH prevalence at Kudachurt 14 are required. Most importantly, this needs to be reconciled with other physiological stress markers on the skeleton (*e.g.* disease, deficiencies, physical activity).

Chronological tendencies

So far, three main results characterise chronological aspects from the single analytical parts: (1) Temporal trends are not evident for burial types or regularities of bodily treatment, but complex jewellery assemblages are more strongly associated with graves of older dates. (2) Between 2200-1700 BCE, there are no crucial temporal trends in the demographic composition or oral health categories. (3) Neither the isotopic variations in carbon and nitrogen of human and animal bone collagen nor the caries prevalence show chronological developments, and a mixed economy of animal husbandry and agriculture was likely the means of existence between 2200-1700 BCE. The modelled use span of the cemetery lays between 168-388 years.

In general, due to the sampling strategy for radiocarbon dating and the current use of only jewellery types for typo-chronological information, graves with simple food assemblages, which make up equipment group 2, are significantly underrepresented in chronological considerations. This is also true for graves without burial items. In summary, radiocarbon dates from 15 graves are available; from 9 of these we have osteological as well as dental data, and from 6 isotopic information. This complicates the evaluation of chronological developments. Furthermore, unknown temporal depths of collective graves as well as consecutive plateaus in the calibration curve between 1900-1750 cal BCE hamper a detailed temporal resolution. Nevertheless, the simple listing of construction attributes, individual funeral treatments, and demographic attributes as well as characteristics of oral health from the 9 graves with radiocarbon dates supports the previously stated results (Fig. 161; for isotopes see Fig. 155 chapter 6.8). Overlapping and consecutive dating suggest synchronic appearances of similarities and dissimilarities among socio-ritual characteristics (burial type, equipment group, bodily treatment), demographic compositions in inhumation groups (sex, age), oral health conditions, and subsistence (isotopes, caries). Hereby, the choice of installing separate or mutual graves and the grave good compilation describe the largest dissimilarities, while bodily treatment, oral health, and indicators of diet appear as rather stable attributes between 2200-1650 cal BCE.

8 Conclusions

In this concluding chapter, the main research objectives and findings are summarised by reviewing the initial research questions. This serves also as a review of the research design and overall gained results. Finally, an outline of future research prospects deriving from the thesis' investigations emphasises further required and desirable scientific work.

8.1 Research questions and answers

8.1.1 The cemetery of Kudachurt 14 (chapter 3)

What is the environmental, temporal, and cultural setting of the cemetery Kudachurt 14? What is its context in research of the North Caucasian Bronze Age?

Living in an area with abundant natural resources, the Bronze Age societies from the Northern Caucasus went through different transformation processes, witnessed by cultural heterogeneity, the occurrence and disappearance of phenomena, economic strategies and the exploration of new habitats. During a period of approximately 2800 years, Bronze Age cultures with very different social structures and subsistence strategies spread over diverse territories, such as the well-known Maikop Culture (3900-2900 BCE), the North Caucasian Culture (3100-2300 BCE), different Catacomb Grave Culture phenomena (2600-2100 BCE) in the steppe, and smaller regional groups in the mountain areas (2000-1700 BCE). Archaeological research has predominantly focused on mortuary archaeology, resulting in descriptions of various archaeological cultures and chronological schemes that lack typologically independent data. A major current research issue is the shift in the socio-economic lifeways during the transition period from the MBA to LBA (2200-1700), namely the change from mobile pastoralism to permanent settlement and from preferred habitats in the steppe to high mountain areas as well as the re-organisation of social and economic structures.

Located on a narrow foothill 640 m.a.s.l. on the northern slope of the Greater Caucasus, the cemetery under study, Kudachurt 14, consists of 130 graves associated with the Middle and Late Bronze Age. Nowadays, the surroundings of the site belong to the forest-steppe belt and have a humid-continental climate. With its foothill location, Kudachurt 14 fills a blank spot in the map of archaeological cultures of the North Caucasian Bronze Age normally discussed in terms of steppe and mountain traditions, especially with regard to the large amount of archaeological and osteological material recovered at the cemetery from unrobbed graves.

Excavations during the years 2004 through 2006 discovered burials of heterogenic preservation status, complex finding situations, and large differences in inhumation types and burial items. By means of typo-chronological comparisons of jewellery and weapon types, the author was able to synchronise 61 graves with findings from 17 surrounding MBA and LBA sites in the steppe, foothill, and high mountain areas. The greatest typological similarity in terms of number of analogies as well as types was found to those of the "final MBA horizon" of the high mountains, but a few pin types also suggest associations to early LBA graves of the Koban Culture. Radiocarbon dates from 15 graves at Kudachurt 14 set the absolute temporal span between 2199-2031 cal BCE and 1940-1658 cal BCE (2 sigma-range), while, by integrating stratigraphic information, the modelled data suggest a use of the cemetery for 162-388 years between 2152-1653 cal BCE. In summary, both relative as well as absolute chronological information confirm the cemetery's MBA-LBA dating and therefore the key position of Kudachurt 14 in the North Caucasian Bronze Age, emphasised by the high variation in grave construction at the site potentially influenced by both steppe and high mountain traditions.

8.1.2 Burial practice: Social indicators (chapter 4)

What is the information potential of grave construction, burial type, bodily treatment, and grave inventories with regard to socio-archaeological issues?

Within the archaeological record of 130 graves, the buried population of at least 265 individuals and 2332 burial items of various data qualities, the burial assemblages, and the identification of inhumation groups provided the greatest potential for social-archaeological analyses.

High variation in grave construction (installation depth, stone elements) was probably strongly connected to practicality or cultural habits. Regularities in bodily treatment existed within burial modes of single, double, or collective inhumations, which the highest variety was found in collective graves. Overall, northeastern and northwestern orientations were most common. Regarding the complete record of grave goods, imbalanced distributions of burial item criteria are observed in the comparison of grave inventories. The number and compilation of assemblages describe great differences in functional classes, item categories, and calculated indices as well as in terms of common or rare funeral gifts. Apparently, food and jewellery items were of most interest to the burying population for equipping their deceased, especially given the comparatively low number of weapons. These differences hold true within inter-grave as well as inter-individual comparisons and among inhumation groups.

None of the burial characteristics exhibited spatial patterning across the area of the cemetery. Random distributions of the investigative criteria describe not patterned use of the site and show no separation of specific socio-ritual groups.

What are the major proxies for tracing social inequality in the burial record?

During the exploration of investigative criteria, burial items and individual contexts represent the most exploited proxies in terms of outlining social inequality.

Regular corpse depositions in left-or right-sided flexed and supine positions and the dispersal of ochre are exceptions. The calculation of average numbers of burial item and item category frequencies per individual enabled the conclusion that the individual rather than the burial type (separate, double, or different numbers of inhumations) was crucial for the variation of grave assemblages. Positive correlations of supine position with weapons as well as crouched position on the right body side with jewellery items revealed further internal social structures regarding bodily treatment and funeral equipment. In terms of funeral equipment, the greatest difference is found from no grave goods, to simple food assemblages (vessels, meat), and complex inventories consisting of high amounts of common as well as rare jewellery items, often supplemented by food items. Based on these individual differences, 5 levels of funeral equipment describe different emphases on covering basic needs, personality, or socio-ritual belonging in the funeral context. With respect to the archaeological background of the North Caucasian Bronze Age, functional implications of personal equipment suggest socially expressed gender as well as a complex social system with gradual levels rather than strict hierarchical rules. The related different social positions are displayed in separate burials, but also together within inhumation groups. Thus, the distinction between singular or mutual funerals played only a minor role in the social context, or perhaps had other ritual meaning.

Although most complex jewellery assemblages date to the end of the 3rd mil BCE, and therefore in the early stage of the cemetery's use, the general tendencies do not show chronological developments of the described social inequalities.

8.1.3 Human remains: Demography and oral health (chapter 5)

What is the demographic composition of the buried population?

On the basis of osteological examinations of 108 individuals from 60 graves as well as *in situ*-age from an additional 90 individuals, the obtained results concerning age at death as well as biological sex present a cross-section through a living population rather than only a selected segment. At a ratio of 1:2 immature to mature individuals, children and juveniles are slightly underrepresented, and the demographic data showed that females had a lower life expectancy compared to males. In the grave contexts, the burial of individuals of different ages and sexes together make the presence of kinship relations possible. Although immature individuals were more frequently integrated in mutual burials than buried alone, separate burials are not specific in terms of age at death-or sex.

What are the main characteristics of oral health in the buried population from Kudachurt 14?

Detailed examinations of 9 categories of oral health on 2651 tooth positions from 85 individuals identified the prevalence of caries and multiple patterns of dental wear as major characteristics which probably led to serious side-effects such as severe periapical inflammation, alveolar remodelling, and advanced antemortem tooth loss in the mature population. As expected, these categories showed strong age-dependency, but caries was also found in children. Additionally, different forms of dental wear suggest occupational use of teeth as well as the application of hygienic measures in the oral environment. The occurrence of enamel formation dysfunctions reveals periodical or continuous stress events during childhood for most of the population under study.

Based on the analytical approach used, there are no crucial differences between males and females in terms of oral health; as males died more often at an older age, they frequently exhibit higher grades of the age-related dental conditions. In the overall context, the integration of radiocarbon dates does not show chronological changes in terms of occurrence or development of oral health categories.

What are the physical and socio-economic findings deriving from the demographic structure and status of oral health?

The interrelation of high frequency of survived childhood stress among all age classes, frequent deaths of mature individuals, and multiple cases of high oral disease burden as well as advanced antemortem tooth loss imply adequate living conditions, which allowed the individuals to survive related physical strains.

In comparison to populations from other archaeological settings, observed as well as calibrated caries rates at Kudachurt 14 fall within those of populations considered to rely on an agricultural economy. Dental chipping and general attrition patterns support this finding. Furthermore, at least for some immature individuals, a cariogenic diet high in fermentable sugars was already consumed in early childhood. For some mature individuals, the accumulation of dental plaque and calculus as well as the development of dental caries may have led to the cleaning out of interdental spaces and carious lesions, which suggests a certain degree of illness perception and adjustment of behaviour. In contrast, habits connected to the use of teeth as tools were practiced disregarding its side effects, including loss or dislocation of teeth. Such occupational habits were probably connected to the processing of sinews, fibres, or leather; while atypical attrition of maxillary teeth seems rather common, more specific modification patterns are comparatively rare. If the use of teeth as tools was related to some division of labour, it was not determined by sex.

8.1.4 Carbon and nitrogen stable isotopes: Palaeodietary reconstruction (chapter 6)

Did livestock management and C_4-plant cultivation contribute to the subsistence strategies of the buried population at Kudachurt 14?

Based on a sample of 40 humans and 14 animals as well as the integration of the results into the current state of the art of isotope research in the North Caucasian Bronze Age, livestock herding was identified as an important means of existence for the population at Kudachurt 14. The intake of animal-derived protein is displayed by the trophic level shifts from the faunal to the human bone collagen and, in some cases, the presence of this offset within a single grave context confirmed the meat grave goods as potential dietary resources. Of the “meat grave goods”, herbivores such as sheep and goats make up the greatest part. The measured $\delta^{13}C$ values of these animals reflect the natural vegetable baseline of predominantly C_3 plants as primary producers from which the animals were receiving sustenance. The fact that the human $\delta^{13}C$-range is smaller than their presumed livestock indicates deviating carbon sources for animals and humans, but probably C_4 plants contributed to the human’s diet. Although there is no correlation between caries data and nitrogen values indicating a specific pattern in terms of high-carbohydrate or high-protein diet, this result cannot be considered conclusive and requires further work. The isotope signatures of three infants show breastfeeding effects.

One individual represents an outlier in the data set; specimen 031_1 displayed the values significantly enriched in $\delta^{13}C$ that would be expected for C_4 plant consumption. Hence, an absolute dating of grave 031 is necessary to potentially identify the first evidence of C_4 plant consumption in the North Caucasian foothills; at the moment, the material culture does not allow considerations in terms of more accurate chronological affiliation.

8.1.5 Interdisciplinary synthesis: Burial practice, human osteology, and stable isotopes (chapter 7)

Were socio-ritual inequalities applied on specific individuals or demographic groups? Does physical information match with suggested gender roles and age-related accoutrements of social status?

The combination of socio-ritual (*intentional*) and physical (*functional*) data substantially contributed to the interpretation of hitherto outlined social inequalities. Clear correlation of female sex with right-sided flexed body positioning as well as different jewellery equipment and males with left-sided flexed or supine body positioning and weapons makes the assumption of socially perceived gender in the mortuary context for at least 20 % of the buried population more concrete. Thus, concepts of gender existed in the MBA and LBA transition in the Northern Caucasus.

Women's and immature individuals' jewellery assemblages show higher variations in symbolic ornaments, while men's equipment was predominantly characterised by food items, as weapons were rare. In addition, the oversupply or large amounts of jewellery items associated with infants and children suggest inheritance structures rather than acquirable social status. Often assemblages of subadults are more similar to those of females; outstanding "male status" in terms of weapons and supine body position was restricted to individuals that had reached at least juvenile age.

In accordance with these results, kinship relations represented in inhumation groups are still reasonable; if so, different hereditary social rankings within family structures are plausible. Demographic compositions and ritual attributes do not reveal specific patterns in the sense of displaying structured rankings (*e.g.* "male/female head of a family", preferred children, as well as subordinate members); detection of such structures is, however, hampered by the great differences in the size of inhumation groups from an MNI of 3 to 13.

The sex-deterministic regularities in bodily treatment allowed the application of this rule to individuals lacking osteological information. This is a good example how the interplay of intentional and functional data can expand respective interpretative limits.

The available results do not suggest any temporal development or shift in the designed social model.

How do implications of oral health behave toward detected socio-ritual inequalities? Can we observe connections such as "better oral health status" or occupational habits in terms of social inequality?

Based on the combination of funeral and dental data sets, the correlation of higher disease burden of oral health with advanced age is observed. In contrast, the funeral equipment group seems independent of individual age. Malocclusion, periapical inflammation, alveolar remodelling, and antemortem tooth loss are interpreted as physical side effects of caries; dental macrowear, including manifestations of occupational tooth use, are less frequent or severe in younger adults and immature individuals, and not specific for males and females. Social inequality, in terms of markers of status primarily displayed in burial equipment, was primarily driven by sex and due to inheritance structures presumably from childhood onwards. The females that were predominantly buried with equipment groups 3-5 died earlier in life and therefore less frequently developed severe stages of oral health conditions; this is also true for immature individuals. The available data do not suggest a causal relation regarding low social status and poor oral health or the reverse, even though there is no exemplary case of a female that died in older age, exhibiting poor oral health but rich jewellery equipment. In conclusion, oral health was presumably a matter of age rather than social status.

The situation is similar for the occupational use of teeth, as such modifications were often found in older individuals and are connected to higher disease burden. This predominantly affected males with simple food equipment, and few females. Apparently, life experience, including specialised occupational skills that involved the use of teeth as a third hand or for processing materials (facets, occlusal wear; eventually interproximal grooving), was not explicitly considered in the funeral ritual of personal gifts. Less specific patterns of dental wear (maxillary attrition) were observed in all funeral groups.

Do signs of deviating dietary habits exist in terms of detected social inequalities? What conclusions can be drawn with regard to social organisation, means of productivity, and economic strategies?

None of the dietary indicators – carbon and nitrogen stable isotope data and dental caries – showed any correlation to the described structures of social inequality. This suggests one of two scenarios. (1) The taken approach does not provide information of suitable quality, as neither analytical tool provides direct evidence of what kind and to what extent carbohydrates and animal-derived protein were consumed, so that differences in food accessibility or nutritional quality and according social restrictions remain undetected. (2) Social positions played no role in determining access to foodstuffs. Both isotope signatures as well as caries are indirect indicators of diet, reflecting physiological and pathological manifestations of nutrients, and not the foodstuffs themselves.

In terms of subsistence and productivity, the obtained results do not allow the identification of organisational structures regarding "producing" and "receiving" members of the buried population, despite the natural higher investment in children. Presuming a mixed economy that included livestock breeding, horticultural, and/or extensive cultivation of C_3 plants, some organisation of labour and working processes would be expected. Although further considerations require additional work, the significance of food offerings as a common component in burial practice suggest either its importance in a ritual sense, reflecting basic human needs, its high availability, or both. Here, meat and different vessel types may represent a wide variety of available foodstuffs. In contrast, tools as potential signs of productivity, craft specialisation, and technological advance make a negligible part of the grave inventory. With regard to the elaborately worked jewellery and other items, the tools to do this were not relevant to their ritual identity. This is true for almost the complete population under study and emphasises even more the major role of symbolic ornaments and minor role of "military" demonstration.

Are there synchronic or diachronic patterns in socio-ritual inequalities, demography, oral health, and dietary habits? What are the implications given for and by current research on the MBA to LBA transition in the Northern Caucasus?

With regards to Kudachurt 14's key position in determining socio-economic processes in the MBA-LBA transition and the heterogeneity in burial practice and typological affiliations on a supra-regional scale, it remains unclear to what extent this cemetery represents a "melting pot" of archaeological cultures versus a snapshot of diachronic developments.

In the preceding sections, the interlinkage of the ritual and human physical spheres revealed social inequalities expressed in the funeral treatment of the deceased. Characterised by clearly sex-dependent bodily treatments and burial assemblages, hereditary structures with gradual levelling, and an emphasised role of ornaments in women's and immature individual's burial equipment, this social system is reconstructed based on the assumption that the system remained stable throughout the entire period of use of Kudachurt 14. This is also true for the significance of socio-ritual formations with respect to oral health conditions, occupational habits, and dietary trends.

The presented cultural material and characteristics of burial constructions suggest affiliations to different archaeological cultures and a merging of steppe and mountain traditions (North Caucasian Culture, Post-Catacomb-Complex, Final MBA Spectre, Early Koban Culture; see chapter 3.4-5; Tab. 5). Examples are diverse bronze ornaments with strong affiliation to final MBA high mountain groups, but also later jewellery types, catacombs as potential remnants of the Suvorovo phenomenon, flat collective graves from high altitude locations with co-occurring single burials, supine body position as a typical attribute of the NCC, and inequalities in grave gifts quantities and qualities from typical post-catacomb to high-mountain equipment compositions. The greatest similarity is observed with findings connected to the regional phenomenon of the final MBA in the high mountains; the validation of this observation requires intensive analyses of the archaeological findings exceeding the scope of the thesis. Nevertheless, it justifies a reconsideration of the obtained results regarding social inequality, oral health, and subsistence in terms of potential synchronous or diachronic developments.

One scenario describes Kudachurt 14 as a burial ground commonly frequented by different cultural groups on a synchronous (parallel) or diachronic (consecutive) basis, reflected in typology and burial practice, but eventually also in deviating social organisations. In this case, the observed inequalities might not represent a closed social system; the assumed nuances in social inequality and gradual mechanisms would not be valid. In this scenario, the lifeways of different groups might have been similar in terms of economic strategies, or dissimilar, reflecting deviating use of natural resources and technological standards. Here, mobile versus sedentary and pastoral versus extensive agriculture would come into question.

In the second, very different scenario, Kudachurt 14 represents a burial ground frequented by a one burying population that underwent diachronic developments reflected in rather linear chronological trends or crucial shifts such as decreasing social hierarchy, as in later EIA developments, or changes in diet and economic lifeways from pastoralists to a mixed economy. According dental health characteristics could be expected to reflect such shifts.

With respect to the "melting pot" or the "diachronic" scenario, the analyses in this thesis allow the rejection of the latter model. The available chronological data do not suggest gradual developments between 2200-1650 cal BCE and burial practices remain heterogeneous throughout the whole use span of the cemetery. Oral health and dietary habits also show no distinct shifts which would suggest crucial changes of the living conditions. Although the absolute dating is not yet satisfactory in terms of resolution, obtained results indicate *continuity* in the following respects:

- In the high significance of "food for all" in the burial context as a basic component. Abundant presence of different vessel types and meat proportions also demonstrates productive potential in terms of food economy.
- In the strong sex-deterministic arrangement of the corpse. Flexed body positions on the left and right body side are also known from different grave contexts of the high mountain sites, including single and collective graves, for which a gendered intention was assumed (see chapter 3.4-5). Apparently, the deposition of the corpse represented a rather conservative funeral element compared to offerings. The use of gender-specific equipment, *i.e.* jewellery and weapons, was similarly previously proposed. Now, reliable osteological information proves both of these propositions for the MBA-LBA transition in the Kudachurt valley.
- In the relatively small significance of demonstrating military power of predominantly adult males or according personalities in the funeral context. This indicates either lower conflict potential and need for demonstrating leadership or the exact reverse case, as weapons were intended for certain male persons. The lack of bronze axes supports the first assumption and contrasts with the final MBA in the

high mountains (*e.g.* sites of the Kossnierska Collection; Motzenbäcker 1996) as well as later LBA graves of the early Koban Culture (*e.g.* Tli, Styrfaz; Reinhold 2007).

- In inequalities of equipment by maintaining emphasis of symbolic ornaments for specific females and immature individuals and hereditability of social positions. This is true for inhumations in single or mutual burials with different funeral efforts. Although the most complex grave inventories had the oldest radiocarbon dates, the general trend of unequal treatments remain. This is different than Reinhold's interpretation of the late LBA and early EIA (Reinhold 2012).
- In the consumption of carbohydrates as supported by indirect evidence of dental caries as well as animal protein as products of a mixed economy. Neither oral health nor the isotopic compositions suggest crucial shifts from pastoral to agricultural lifeways, which indicates that the buried population shared similar means of subsistence regardless of potentially deviating cultural backgrounds. Furthermore, livestock breeding was a continuous means of existence in the Kudachurt valley and the agricultural growth of C_3 crops or other foodstuffs high in fermentable carbohydrates was important as well.
- In the occupational alteration of teeth in both males and females, which suggests that related working processes were not determined by sex. Here, comparative information from other Bronze Age contexts are not yet available. One exception is "the wagon driver", an adult male skeleton found at the Maikop site Sharakhalsun (3356-3033 cal BCE), *ca.* 200 km north from Kudachurt 14. The dental conditions of this individual prove that interproximal grooving was present 1000 years before that in Kudachurt, as well as childhood stress, abscess formation, and advanced occlusal wear (Tucker *et al.* 2017).
- Adequate living conditions for some individuals to survive childhood stress and increasing physical side effects of masticatory overload and dental caries with increasing age (*e.g.* severe inflammation of periapical structures, including advanced antemortem tooth loss).

8.2 Evaluation and research prospects

As often is the case in science, the answers to the posed questions raised new issues, and limits of the material, the methodological approach, and the research design became apparent. Preceding the closing summary of the thesis' research significance, the following critical assessment of suitability and application of the taken approach is in accordance with good scientific practice. Afterwards, some specific topics that gained importance with respect to verifying and expanding the results will be briefly discussed.

The envisaged aim of the thesis approach turned out to be the main challenge: the application and interlinkage of three disciplinary fields by meeting specific demands of humanities, natural sciences, and medicine. The interpretation of social inequalities would have benefited from a dialogue on social theory, models, and their application in archaeology. This is also true for mortuary rituals, their possibilities and limits of interpretation. The lesson learned from osteological analyses is to first carefully review the most recent methodological standards in order to achieve comparability for further examinations without the need for additional data re-classifications. This is especially true for some dental categories, for instance enamel hypoplasia and caries. In addition, the decision to concentrate on oral health was made due to the extraordinary results while examining the complete skeleton, and an a priori focus on this topic would have helped to perform the analyse more straightforward, especially in terms of increased sample size. Nevertheless, the choice to focus on oral health was made from deeper knowledge about the physical constitution of the skeletal sample, including all body parts.

Although both quantitative and qualitative analyses were used, the analytical parts of the thesis, both disciplinary and interdisciplinary, would have gained more significance by applying statistical tests rather than qualitative descriptions. During the analyses, some objectives gained more importance than others, for instance burial items versus grave construction, or establishment of oral groups versus pathogenesis of dental conditions.

Besides the comprehensive publication of the burial record in preparation by S. Reinhold, B. Atabiev and colleagues, some issues raised considerable need for future research on the archaeological and osteological material from Kudachurt 14:

Chronology and material culture

This issue addresses three of chronological significance. First, a general increase in number of radiocarbon dates to underpin the temporal setting of the cemetery with regard to the MBA to LBA transition. Thereby, multiple samples from the large collective graves would provide insights into their utilisation span and habit and meaning toward kinship relations. In combination with ^{14}C-dates from graves with simple food items, the typo-chronological synchronisation with vessel styles would contribute to a better understanding of the temporal setting of material culture from Kudachurt 14. This includes supra-regional analogies as well as the significance of equipment group 2 in term of social inequality (41 graves remain to be examined; see chapter 3, Tab. 1).

Burial practice and social inequality

Regarding social inequality, the identification of specific belongings of food items or absence of funeral equipment in collective graves would contribute to the interpretation of equipment groups 1 and 2 in inhumation groups and the assumed decrease in jewellery complexity after the turn of the 2nd mil BCE, especially in terms of typo-chronological (vessels) and radiocarbon data. This would specify potential diachronic tendencies in social inequality that did not became visible in the analyses conducted.

There remain many attributes unexplored in terms of socio-ritual significance and social organisation. For instance, differences in construction demands (*e.g.* labour investment, excavation volume, size and weight of stones); material value and production effort of ceramics, bronze, and other objects (*e.g.* by weight, elaboration); quantities and qualities of food (vessel types, volumes, animal species, amounts of meat); and bodily placement of ornament symbols and potential functional significances (types, wearing habits, distinction between costume and body jewellery types, communication structures). The last point would especially be of interest in reconsidering status as represented by women's jewellery and costume items and as a predecessor of the later Koban traditions in the higher altitudes which are characterised by standardised equipment that can be interpreted with respect to sex-specific communication systems (Reinhold 2003; 2013).

Demographic developments

In light of discussions on growing population density in the LBA and EIA in the North Caucasian mountain region, the size and utilisation continuity of Kudachurt 14 potentially displays preceding processes in denser inhabitation of the foothill regions, although the numbers are not comparable to the large necropolises of the Koban period. The demographic data from Kudachurt 14 cannot be projected for the purpose of examining population dynamics, for instance changing mortality rates of specific demographic groups at the end of the 3rd and beginning of the 2nd mil BCE. Although it seems that lower life expectancy of women and low mortality rates of children were present during the entire use of the cemetery from 2200-1700 cal BCE, the available data are not yet sufficient and more skeletal evidence as well as a review of the age classes are required. The integration of palaeopathological information from the full skeleton would strengthen this approach.

Oral health and palaeopathology

An expansion of the methodological spectrum used to examine conditions of oral health, for instance the analyses of microwear structures on teeth to gain a better understanding of masticatory and extramasticatory modification, processed substances or materials, and activity patterns, or investigations of dental calculus with respect to microfossils in dietary contributions or genetic evidence for pathogens, is highly desirable. In order to put the results of oral health into a wider context and therefore detect their significance with respect to the general disease burden, analyses of available pathological data – for instance inflammatory diseases (*e.g.* the mucous membranes), indicators for malnutrition (*e.g.* anaemia), physical activity and overload, injuries, and others – are necessary. Currently, S. Kornell, PhD student at the aDNA Laboratory of the Institute of Clinical Molecular Biology at Kiel University, is screening a set of calculus samples from Kudachurt individuals for detecting genetic remains of oral pathogens (*e.g. Streptococcus mutans* as one causal agent for dental caries).

In the early stage of this PhD, possible cases of scurvy on immature individuals from Kudachurt, one steppe, and one mountain site from the North Caucasian Bronze Age were presented (Fuchs *et al.*, 2013). At Kudachurt 14, one juvenile (211.1_1) and two children (218.1_3, 218.1_4) showed the typical prevalence of calcified haemorrhages expected from the high demand for or lack of vitamin C in their diets close before death, suggesting general or seasonal shortages of fresh foodstuffs or diets low in vitamin C. As this topic is of high interest in terms of dietary habits and food supply, it urgently needs further work, including diagnostic analyses (*e.g.* microscopic studies on haemorrhage pathogenesis).

Subsistence and diet

As subsistence strategies are one leading topic in research on the North Caucasian Bronze Age, and dental as well as isotope data suggest mixed economy for Kudachurt 14, it remains to be clarified how the buried population sustained themselves. Here, the excavation of the nearby settlement would be a starting point; if a connection to the cemetery is possible, issues of sedentism, ranges of mobility, and landscape use can be addressed. Research on the settlement would also greatly contribute to knowledge of livestock breeding, residence habits, economic production, and the creation of social space; compared to the ritual sphere investigated in this thesis, settlement data would give new insights into the economic and social spheres to be linked with the analyses already performed at Kudachurt 14. Evidence of MBA and/or LBA settlement structures in the foothill region between 2200-1650 BCE would be proof of early residence in lower altitudes preceding the establishment of permanent settlements in the Kislovodsk and higher mountain regions.

To gain a better description of subsistence strategy and associated socio-economic implications, detected indicators of mixed economy require supplemental information. The analyses of faunal remains as well as the aforementioned investigation of vessels and food residues would make good starting points to explore the burial record in this regard, and to potentially recognize the foodstuffs themselves rather than their nutritional manifestation on teeth and in bone collagen. With respect to stable isotope research, it would be of benefit to analyse the carbonate portion of human and animal tissues for carbon signatures in order to evaluate the carbohydrate contribution in the diet, supporting the discussion on the aetiology of dental caries as an indicator for the consumption of fermentable sugars.

Beyond these future prospects, the presented results provide a foundational scientific work on social inequality, demography, oral health, and diet of the humans that lived and died between 2200-1650 BCE in the central North Caucasian foothills. The interdisciplinary approach makes a substantial contribution to current research on socio-economic developments of the North Caucasian Bronze Age for a relatively unstudied and archaeologically underrepresented spatial area and chronological period.

9 Short summary

The central aim of this doctoral thesis is to provide foundational scientific work on social inequality, demography, oral health, and diet of humans that lived and died between 2200-1650 BCE in the central North Caucasian foothills. Based on the analysis of the burial ground Kudachurt 14, this thesis makes a substantial contribution to current research on socio-economic developments assumed for the transition of the Middle to the Late Bronze Age – a period characterised by the shift from pastoral lifeways in the steppe to sedentary settlements in the high mountains and the change from hierarchical to egalitarian societies. Primary information on the deceased populations of the North Caucasus are hitherto insufficient, and interdisciplinary research approaches have only recently been pursued. This doctoral thesis delivers the first comprehensive data collection and investigation that combines burial, osteological, palaeopathological, and stable isotope information and achieves a connection between the living and the dead at that time and in that space. Overall, 130 graves, 2332 burial items, at least 265 buried humans, skeletal remains from 108 individuals, 2651 tooth positions, and 59 human and faunal samples have been analysed using descriptive, statistical, spatial, morphological and molecular methods.

The findings from Kudachurt 14 describe a cross-section within a population that was buried between 2200-1650 BCE. Absolute dating confirms the temporal classification, and similarities in burial practice and cultural material demonstrate affiliations to high mountain variations of the North Caucasian Culture touching typo-chronological borders beyond the Greater Caucasian Mountain crest. While elements of grave constructions and inhumation processes were presumably driven by practical, cultural, or kinship factors, the positioning of the body as well as the functional character of grave gifts was strongly determined by biological sex. This reflects the perception of gender and inheritance of social status in the funeral context. Socio-ritual proximities of individuals buried in collective graves either reflect different rankings within kinship relations or cross sections of diverse social levels. Results show that females died at a younger age than men, but according to age-correlations of most dental conditions, they did not develop oral health burdens connected to inflammations and antemortem tooth loss as serious as men did. In general, children survived continuous or periodic stress and adult's poor oral health, indicating otherwise adequate living conditions. The occupational use of teeth was practiced disregarding physical side effects. The high caries rate of 49.5 % indicates the consumption of fermentable carbohydrates, also for children, and isotope data prove the intake of animal protein. Thus, the economy of the buried population consisted of both livestock breeding and agriculture. Social inequality is prominent in the burial context, but not displayed in oral health and dietary trends. This indicates rather similar living conditions for individuals from different socio-ritual statuses.

Analysis of burial practice, oral health, and diet suggest that the population from Kudachurt 14 can be placed in the centre of shifts in subsistence, preferred habitats, and social orders during the Bronze Age and in the diverse natural environments of the Northern Caucasus. The presented results not only serve as a missing link for the foothill regions and the Middle to Late Bronze Age transition, but also provide biological and ritual evidences for often stated gender concepts, deviating expression of social status, and living conditions, as well as the first indications for early agricultural ways of life.

10 Kurzzusammenfassung

Der Übergang von der Mittel- zur Spätbronzezeit im Nordkaukasus (2200-1400 v.u. Z.) ist als eine Zeit entscheidender sozialer und subsistenzwirtschaftlicher Veränderungen charakterisiert, eingehend mit dem Rückzug pastoraler Subsistenzweisen aus den Steppenregionen und der sesshaften Aufsiedlung des Hochgebirges sowie der sozialen Reorganisationen von hierarchischen zu egalitären Gesellschaften. Primärinformationen zu verstorbenen Populationen liegen unzureichend vor und interdisziplinäre Forschungsansätze werden erst jüngst verfolgt. Situiert im zentralen Vorgebirge des Nordkaukasus repräsentiert das Gräberfeld von Kudachurt 14 zeitlich und räumlich eine Schlüsselposition im Kontext dieser substantiellen Entwicklungen.

Zentrales Ziel der vorliegenden Dissertation ist die Vorlage einer interdisziplinären Grundlagenarbeit zu sozialer Ungleichheit, Demographie, Mundgesundheit und Ernährung für die Nordkaukasische Bronzezeit anhand des Bestattungskollektives von Kudachurt 14. Unter der Anwendung sozialarchäologischer, osteologischer, paläopathologischer und chemischer Analyseverfahren wurden 130 Gräber, 2332 Grabbeigaben, 265 *in situ* gezählte und 108 osteologisch erfasste Individuen, 2651 Zahnpositionen sowie 59 menschliche und tierische Proben von Knochenkollagen untersucht.

Radiokarbondatierungen zwischen 2200-1650 v.u. Z. bestätigen die Zugehörigkeit zur Übergangsphase und betonen Verbindungen zur finalen Mittelbronzezeit im Hochgebirge. Die demographische Struktur des Bestattungskollektives beschreibt einen repräsentativen Bevölkerungsquerschnitt. Variationen in Grabarchitektur sowie Anzahl der Bestattungen waren eher durch praktische, kulturelle oder verwandtschaftliche Faktoren geprägt. Positionierung der Leichname, funktionalen Eigenschaften und Anzahl der Beigaben sowie Individualdaten zeugen jedoch von sozialer Ungleichheit im rituellen Kontext. Überlebte Phasen körperlicher Belastung im Kindes- und Jugendalter sowie überlebte Fälle multipler Entzündungen und Zahnverlust weisen auf adequate Lebensbedingungen hin. Frauen verstarben früher als Männer und entwickelten seltener schwerwiegende Erkrankungen des Kauapparates. Die Kariesrate von 49.5 % verweist auf den Verzehr kohlenhydratreicher Nahrungsmittel, und in Kombination mit dem Konsum tierischen Eiweißes kann für das Bestattungskollektiv von Kudachurt 14 eine gemischte Ökonomie mit Tierhaltung und agrarischer Komponente postuliert werden. Unterschiede im sozio-rituellen Status spiegeln sich nicht in aktivitätsbedingten Zahnmodifikationen oder den Nahrungsindikatoren wider, was möglicherweise auf eine Trennung von ideologischer und realer Lebenswelt hindeutet.

Durch die Verknüpfung sozio-ritueller und biologisch-physischer Informationseben wurden erstmals konstatierte Genderkonzepte verifiziert, während Erblichkeitsstrukturen, Nutzung von Zähnen in Arbeitsprozessen und Indikatoren für frühe agrarische Lebensweise neue Aspekte im Kontext sozioökonomischer Entwicklungen der Nordkaukasischen Bronzezeit darstellen. Chronologische Tendenzen beschreiben eher stabile Verhältnisse im zentralen Vorgebirge des Nordkaukasus zu Zeiten des Übergangs von der Mittel- zur Spätbronzezeit, dessen kulturelle und chronologische Klassifizierung neu diskutiert werden muss.

11 краткая информация

Переход от среднего к позднему бронзовому веку на Северном Кавказе (2200-1400 гг. до н.э.) характеризуеться как период решающих социальных и натуральных экономических изменений с отступлением пастбищных хозяйств из степных районов и расселения в высокогорных районах, а также социальными реорганизациями из иерархических в эгалитарные общества. Первичной информации об бывших популяций недостаточно, и междисциплинарные исследования начали проводиться лишь недавно. Расположенное в центральном предгорье Северного Кавказа, кладбище Кудахурт 14 занимает ключевое место в контексте этих важных событий.

Основной целью данной диссертации является представление междисциплинарной основной работы по социальному неравенству, демографии, здоровью полости рта и питанию для северокавказского бронзового века на основе Кудахуртского могильника 14. 130 могил, 2332 могильных предметов, 265 на месте зарегистрированных и 108 остеологическими методами определенных останков людей, 2651 положений зубов, а также 59 образцов костного коллагена человека и животных были исследованы с помощью социально-археологических, химических методов анализа.

Радиоуглерод, датируемый 2200-1650 гг. до н.э., подтверждает принадлежность к переходной фазе и подчеркивает связь с последним средним бронзовым веком в высокогорных районах. Демографическая структура погребального коллектива характеризует репрезентативный срез населения. Различия в архитектуре и в количестве захоронений в значительной степени зависят от практических, культурных или родственных факторов. Однако расположение тел погибших, функциональные характеристики и количество захоронений, а также индивидуальные данные свидетельствуют о социальном неравенстве в ритуальном контексте. Выжившие фазы физического стресса в детстве и подростковом возрасте, а также случаи множественных воспалений и выпадения зубов указывают на адекватные условия жизни. Женщины умирали раньше мужчин но реже болели тяжелыми заболеваниями жевательного аппарата. Уровень кариеса в 49.5% относится к потреблению насыщенных углеводородами продуктов питания, так что в сочетании с потреблением животного белка экономика состоявшая из животноводство и сельского хозяйства может быть постулирована для могильника Кудахурт 14. Различия в социально-ритуальном статусе не отражаются на активности зубов или пищевых показателях, что возможно свидетельствует о разделении идеологической и реальной жизни.

Связав социально-ритуальные и биологическо-физические уровни информации, впервые были проверены устоявшиеся гендерные концепции, а наследственность структур, использование зубов в рабочих процессах и показатели раннего сельскохозяйственного образа жизни представляют новые аспекты в контексте социально-экономического развития Северо-Кавказского бронзового века. Отсутствующие хронологические события характеризуют довольно стабильную обстановку в центральных предгорьях Северного Кавказа в период перехода от среднего к позднему бронзовому веку. Культурную и хронологическую классификацию этого перехода необходимо обсудить заново.

12 References

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13 Tables, figures and abbreviations

13.1 List of tables (short captions)

13.2 List of figures (short captions)

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Fig. 92.9:	Modified after Scheuer *et al.* 2008, fig. 10.
Fig. 150:	Modified after Lukacs and Pastor 1988, fig. 8.

13.3 Abbreviations

av	average
AMTL	antemortem tooth loss
asy	asymmetrical
b	buccal/labial
BA	Bronze Age
BCE	before common era
BP	before present
C	carbon
CA	(classical) correspondence analysis
ca.	circa
CCA	canonic correspondence analysis
CCF	caries correction factor
CCR	calibrated caries rate
cal	calibrated
calc	calculus
cent	century
CEJ	cemento-enamel junction
CE-J-AC	cemento-enamel junction alveolar crest distance
cf.	confer/conferatur
CGC	Catacomb Grave Culture
chip	chipping
cm	centimeter
coll	collective
CPI	category plurality index
CRI	category rareness index
C/R/N	crown/root/neck
D	dentine
d	distal
E	enamel
EBA	Early Bronze Age
e.g.	exempli gratia
EH	enamel hypoplasia
EIA	Early Iron Age
etc.	et cetera
et al.	et alii
F	female
fac	facet(s)
Fig.	figure
fis	fistula
i.e.	id est
IG	interproximal grooving
int	interproximal
IOC	individuals with osteological examination per cemetery
IOG	individuals with osteological examination per grave
ind	individual
juv	juvenile
L	large
l	lingual/palatinal
LBA	Late Bronze Age
M	male (individual) or medium (*e.g.* collective grave)
m	mesial
max.	maximum

mm	millimeter
MBA	Middle Bronze Age
mil	millennium
MNIC	minimal number individuals per cemetery
MNIG	minimal number per grave
N	nitrogen
n	number
n.d.	not determinable
NC	North(ern) Caucasus
NCC	North Caucasian Culture
NPIC	number preserved items per cemetery
NPIG	number preserved items per grave
O	occlusal
OCR	observed caries rate
OG	occlusal grooving/notching
omw	occlusal macro wear
pal	periapical lesions
PCF	proportional correction factor
peri	periodontitis
PPTL	potential perimortem tooth loss
S	small
spec	specific
Tab.	table
TSL	time since tooth loss

Part IV

Online data: catalogue and appendix

Online Data: Catalogue and Appendix

Documents of Part IV are online available via the Research Data Exchange Platform of the *Johanna Mestorf Academy*:
https://www.jma.uni-kiel.de/en/research-projects/data-exchange-platform

14. Appendix

14.1 Isotope tables

14.2 Recording schemes

15 Grave catalogue

16 Item plate catalogue

17 Data base

STPAS: Scales of Transformation in Prehistoric and Archaic Societies

The book series 'Scales of Transformation in Prehistoric and Archaic Societies' (STPAS) is an international scientific series that covers major results deriving from or being associated with the research conducted in the Collaborative Research Centre 'Scales of Transformation: Human-Environmental Interaction in Prehistoric and Archaic Societies' (CRC 1266). Primarily located at Kiel University, Germany, the CRC 1266 is a large interdisciplinary project investigating multiple aspects of socio-environmental transformations in ancient societies between 15,000 and 1 BCE across Europe.

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INTERDISCIPLINARY ANALYSIS OF THE CEMETERY KUDACHURT 14

Evaluating indicators of social inequality, demography, oral health and diet during the Bronze Age key period 2200-1650 BCE in the Northern Caucasus

Representing both a barrier and a corridor between the Eurasian and Asian continents, the Caucasus has constituted the setting for various socio-economic transformations throughout prehistory. The transition from the Middle to the Late Bronze Age in the Northern Caucasus is a period characterised by a shift from pastoral lifeways in the steppe to sedentary lifestyles in the high mountains, and the change from hierarchical to egalitarian societies. In this context, this book provides basic scientific research on social inequality, demography, oral health, and diet of humans that lived between 2200-1650 BCE in the central North Caucasian foothills. Due to the outstanding preservation of its archaeological and human remains, the cemetery Kudachurt 14 represents a hitherto missing link for a transformative period in this region.

Archaeologically, the heterogeneity of the burial remains appears as a melting pot of different cultural phenomena, but showing strong typological affiliation to the so-called North Caucasian culture of the high mountain area. Furthermore, biological and ritual evidence confirms often-stated gender concepts and expression of differences in social status. Individuals suffered from poor oral health due to the occupational use of their teeth and high caries prevalence occurred among both adolescents and adults. Together with information from C and N stable isotopes, the data provide evidence for early agricultural practices in a mixed subsistence economy. While social inequality is prominent in the burial context, it is not displayed in oral health and dietary trends. This indicates rather similar living conditions for individuals from different socio-ritual statuses.

The presented doctoral research delivers the first comprehensive data collection and investigation that combines burial, osteological, palaeopathological, and stable isotope information, and achieves a connection between the living and the dead in this time and place.

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