ADDENDA

SUMMARY

NEDERLANDSE SAMENVATTING

AFFILIATIONS OF CO-AUTHORS

DATA DISSEMINATION

DANKWOORD

CURRICULUM VITAE
Summary

Chapters 1 and 2
The first two chapters of this thesis present the aim and purpose of this thesis, as well as detailed background information on the four isotope systems most often used in archaeology: those of strontium, oxygen, carbon and nitrogen. The original models of migratory patterns in (pre)history were based upon the spatial dispersal of cultural artefacts, with the best known proxies for the analysis of migration being the distribution of typological identical artefacts and the merging of typological groups. This approach to trace ancient migration patterns, however, has led to an active debate about the extent to which the archaeological record represents the actual movement of people, or the diffusion of ideas. A new perspective on this debate, and a tool to enable the development of a method to identify migratory patterns and areas of origin, is provided by the archaeological subdiscipline of archaeological science. The isotopes of lead (Pb), neodymium (Nd), oxygen (O), carbon (C), and in particular strontium (Sr) have been extensively used as tracers of origin. The application of these isotopes to solve archaeological questions has matured over the last three decades. Albeit isotope analysis is not a panacea, it is nowadays one of the most widely utilised research fields in archaeological and forensic sciences. Nevertheless, despite its international success and proven potential, a geochemical approach to understanding ancient migratory patterns was, up to a few years ago, only occasionally applied on Dutch cultural heritage. This PhD project therefore aims to fill in this knowledge gap and focuses on the applicability and integration of strontium isotope research in Dutch cultural heritage. As a whole, this PhD thesis follows two research lines, namely: a conceptual line, which concerned the set-up of a dataset with essential baseline $^{87}\text{Sr}/^{86}\text{Sr}$ data, and an interpretive line, aimed at a broader social-economic and cultural interpretation of the generated data. The main aims of this PhD thesis are to assess the applicability of isotope geochemistry in Dutch archaeology, and to gain more insight into the role mobility might have had in the composition of ancient populations and the possible cultural changes that immigration may have had introduced or catalysed.

Chapter 3
Chapter 3, “Strontium isoscapes in the Netherlands. Spatial variations in $^{87}\text{Sr}/^{86}\text{Sr}$ as a proxy for palaeomobility”, presents the first bioavailable strontium map of the Netherlands. To obtain a full understanding of variations in $^{87}\text{Sr}/^{86}\text{Sr}$ in archaeological samples, spatial variations in bioavailable strontium should be accurately mapped or inferred. The map presented in this chapter is compiled solely from archaeological enamel samples of rodents and selected mammals as they are considered to provide the best proxy of bioavailable Sr. The diversity of the Dutch geological subsurface is directly reflected in the...
spatial distribution of \(^{87}\text{Sr}/^{86}\text{Sr}\) ratios. Six isoscapes are defined: A) Lower terrace of the river Meuse (0.7074-0.7091, n = 2); B) Marine and river Rhine sediments (0.7088-0.7092; n = 85); C) Holland peat area, Kempen and northern sand areas (0.7091-0.7095, n = 14); D) Rur Graben (0.7095-0.7105, n = 11); E) Push moraines (0.7095-0.7110, n = 7) and F) Northern and southern loess areas (0.7104-0.7113, n = 15). Although individual isoscapes may show some overlap, the mean of each isoscope is statistically significant different, except for zones D and E. Five other geological environments yielded no archaeological data, mainly due to poor preservation in acidic soils. To fill this data gap, additional biosphere samples will be collected and analysed. This approach, however, will require validation of the extent to which specific floral are offset compared to the average archaeological bioavailable strontium. The base map presented here now allows such a detailed assessment of potential offsets in the \(^{87}\text{Sr}/^{86}\text{Sr}\) recorded by different proxies at the regional scale.

**Chapter 4**

Chapter 4 presents the first case study in which the map presented in chapter 3 is applied. This chapter, "Breaking traditions: an isotopic study on the changing funerary practices in the Dutch Iron Age (800 - 12 BC)", presents the oldest human and faunal strontium isotopic data included in this thesis. The practice of cremation was the predominant form of disposal of the dead from the Dutch Late Bronze Age (1100 BC) until the Late Roman Period (AD 270). Urnfields in the Dutch river area, however, were replaced by cemeteries with a mixture of cremation and inhumation graves around the 6th century BC. This study provides the first biogeochemical evidence that these Iron Age communities in the Dutch river area were heterogeneous in terms of geological origins. The high percentage of non-locally born individuals (circa 48%) supports the hypothesis that the change in burial practice was the result of the influx of foreign people, who were being allowed to keep their own burial customs, whereas part of the local inhabitants adapted the burial rites of foreign cultures. These processes lead to a heterogeneous burial rite for some centuries.

**Chapter 5**

The fifth chapter, "Beyond isolation: understanding past human-population variability in the Dutch town of Oldenzaal through the origin of its inhabitants and its infrastructural connections", presents combined strontium and oxygen isotopic data of a medieval (< AD 1500 and > AD 1500) population from Oldenzaal. It differs from the other chapters, as this manuscript focusses on the processes behind ancient residential mobility and presents a first attempt to interpret the isotopic data from a historic and geographical perspective. Because, although a biomolecular approach potentially provides a detailed reconstruction of the development of ancient populations in terms of palaeodemography and (cultural) origin, it is vital to understand the wider controlling factors in any population change. This chapter presents a first assessment of the mechanisms and
potential controls behind ancient residential mobility through the integration of isotopic data and recently reconstructed early-medieval and early-modern route networks. Strontium (\(^{87}\)Sr/\(^{86}\)Sr) and oxygen (\(\delta^{18}\)O) isotope data are presented from 198 (post)medieval individuals from Oldenzaal, the Netherlands. Based on the detailed reconstruction of historical route networks and network persistence, it is concluded that the town of Oldenzaal was infrastructurally well-connected throughout the Middle Ages and early-modern times (ca. AD 800 – 1600). Despite this conclusion, the isotopic data indicate a population characterized by low variability in terms of origin. Four possible scenarios are proposed that, independently or in combination, may explain the low observed variation in isotopic data, and with that the observed low population dynamism in terms of variety of geological/geographical origins. Besides intrinsic factors such as a biased dataset and interpretative limitations, the historical data clearly shows that broader socio-cultural factors are of crucial importance in the population structure of Oldenzaal. These factors also play an important role in overarching connectivity patterns. In conclusion, the data presented here underline the importance of analysing bioarchaeological data in a multidisciplinary and integrated manner in order to obtain a broad historical and geographical perspective.

CHAPTER 6

The city of Alkmaar was the first city in the Netherlands that successfully withstood the Spanish army in AD 1573 during the Eighty Years’ War (AD 1569-1648). This victory marked a turning point in the revolution and eventually led to the recognition of the Dutch Republic as an independent country. There is a wealth of historical and archaeological data from this important period in Dutch history, but few human skeletal assemblages from the Netherlands can be directly associated with the violence of the Eighty Years’. Two mass graves were encountered during archaeological excavations in the cemetery of the Franciscan Friary in Alkmaar in 2010. The organisation of both graves and the presence of numerous bullets linked the mass graves to a violent event, which in Alkmaar’s history must be the siege of Alkmaar in AD 1573. Strontium isotope investigations identified two possible refugees. This chapter, “The Alkmaar mass graves: A multidisciplinary approach to war victims and gunshot trauma” presents the results of the osteological, isotopic and forensic research on the human remains found in the mass graves and demonstrates ways in which this multidisciplinary approach can contribute to a fuller understanding of the siege of Alkmaar. Moreover, additional carbon and nitrogen isotopic data is presented in the appendix “Subsistence in times of war – a palaeodietary assessment of the victims of the siege of Alkmaar using carbon and nitrogen isotopes”. The primary aim of this supplementary study was to assess the palaeodiet of the individuals in both mass graves and to identify possible differences in dietary habits between the suspected male soldiers (S404) and civilian victims (S403). Despite the differences in context between three datasets (i.e., probable civilian victims, soldiers and individuals whose death was not associated with war), differences in palaeodietary pattern are absent.
Chapter 7

The Dutch East India Company (VOC) intended the Cape of Good Hope to be a refreshment stop for ships travelling between the Netherlands and its eastern colonies. The indigenous Khoisan, however, did not constitute an adequate workforce, therefore the VOC imported slaves from East Africa, Madagascar and Asia to expand the workforce. Cape Town became a cosmopolitan settlement with different categories of people, amongst them a non-European underclass that consisted of slaves, exiles, convicts and free-blacks. This chapter, “Dynamics of Indian Ocean slavery revealed through isotopic data from the Colonial era Cobern Street burial site, Cape Town, South Africa (1750-1827)”, integrated new strontium isotope data with carbon and nitrogen isotope results from an 18th-19th century burial ground at Cobern Street, Cape Town, to identify non-European forced migrants to the Cape. The aim of the study was to elucidate individual mobility patterns, the age at which the forced migration took place and, if possible, geographical provenance. Using three proxies, \(^{87}\text{Sr}/^{86}\text{Sr}\), \(\delta^{13}\text{C}_{\text{dentine}}\) and the presence of dental modifications, a majority (54.5%) of the individuals were found to be born non-locally. In addition, the \(^{87}\text{Sr}/^{86}\text{Sr}\) data suggested that the non-locally born men came from more diverse geographic origins than the migrant women. Possible provenances were suggested for two individuals. These results contribute to an improved understanding of the dynamics of slave trading in the Indian Ocean world.

Chapter 8

The final chapter of this thesis, “Strontium isotopes in Dutch cultural heritage research: a critical evaluation” contextualises, summarises, and critically evaluates the results of the research carried out in this thesis, assesses the implications of strontium isotope research in Dutch archaeological contexts, and sheds light on potential future directions of research. This study and additional unpublished commercial projects have produced over 1,300 isotope analyses (Sr-O-C-N). The work demonstrates the potential of in particular strontium isotope analysis as a mean to place constraints on the geological origins of both archaeological humans and animals, and to infer information about the cultural or demographic development of a population. Although in most studies specific geological origins could not be defined, the isotope analyses executed to date contributed significantly to our understanding of our (pre)history, as we have now been able to elucidate the population composition in terms of (possible) provenance, and to examine individual dietary behaviour patterns. Theories that were defined more than a decade ago, could now be investigated and confirmed in a quantitative manner. This all contributes to our improved understanding of the socio-cultural dimensions of ancient populations. More importantly, isotope research has now been firmly incorporated in Dutch commercial archaeology. The main conclusion therefore is that the work executed within the framework of this PhD thesis contributed to a more systematic anchorage of the application of biogeochemical methodologies in Dutch commercial archaeology.