9. Conclusion

9.1. Filling research gaps in prehistoric Germany

The general goal of this thesis was to fill the gaps in isotope research within Germany. This has been accomplished by the following: first, the human and animal samples from the LBK sites of Derenburg, Halberstadt and Karsdorf are the most substantial and detailed dataset of carbon and nitrogen isotopes available for prehistoric Germany and include unique information on LBK subsistence such as human diet and animal husbandry strategies. It therefore provides a relevant reference for future dietary studies on LBK people and later agricultural societies in Central Europe. Additionally, assumptions from palaeogenetic studies of lactose intolerance could be directly tested from the stable isotope analysis of human remains and may encourage future combined research between palaeogenetic and palaeodietary studies. Second, the strontium and oxygen dataset obtained from the Singen population is the first for Bronze Age Germany and the Bronze Age period in continental Europe. This data will be a useful reference in discussing Bronze Age mobility and socioeconomic networks, especially since current isotopic evidence disagrees to previous assumptions of a semi-migratory nature of this population. Further, the data strongly contradicts the findings of freshwater food consumption obtained by carbon, nitrogen and sulphur isotopes at a Late Bronze Age site in Germany (Nehlich and Wahl 2011), providing a new scope of research for future studies on aquatic resource utilization in the Bronze Age. Third, the site of Magdalenenberg yielded detailed isotopic information on migratory backgrounds of the elite individuals within this cemetery. Groups of individuals could be assigned to certain provenance regions as a result of the various lines of evidence provided by the different isotope analyses. Hence, issues of individual origin could be addressed. Also, the sphere of influence of the local political centre, represented by the central princely burial, was outlined. In this respect the findings of this isotope study are unique for Germany and Central Europe. Furthermore, the dietary data obtained from the Magdalenenberg community is the only other reference dataset for the western Hallstatt culture, and greatly adds to the first isotope study focussed on diet in the eastern Hallstatt culture, which was published more than twenty years ago. Fourth, the strontium biosphere data collected for the purpose of this thesis provides a foundation for future strontium isotope studies in the region, including all major geological formations in south-western Germany. This approach could demonstrate an alternative to the

sampling of faunal remains, which were not available in sufficient numbers at the sites of Singen and Magdalenenberg to determine the locally bioavailable strontium isotope signatures. As this may be the case at other archaeological sites as well, the results from this thesis encourage similar sampling strategies, especially because the use of modern reference material provided an even higher strontium isotope resolution and precision than the analysis of prehistoric faunal material used in other studies (Bentley and Knipper 2005).

9.2. Early Neolithic subsistence

Apart from these contributions to isotope studies in Germany, direct evidence of prehistoric life history could be achieved. Dietary reconstruction using stable isotopes gave insight on different aspects of Neolithic subsistence and animal husbandry in Germany. The Neolithic humans practiced an omnivorous diet consisting of domestic plant crops in addition to a significant amount of animal meat from livestock. The C_4-plant millet was not an important staple food of these early farmers, although there is evidence for the presence of millet at LBK sites. Moreover, the consumption of unfermented dairy products is unlikely for the site of Derenburg due to direct palaeogenetic evidence of lactose intolerance previously identified in three burials (Burger *et al.* 2007). The overall lower quantities of animal protein consumed at this site may support this interpretation. Apart from this the site of Derenburg is characterized by a different burial custom (circular cemetery instead of interments in house pits), which many be an expression of cultural difference to the populations of the nearby site of Halberstadt and the more distant site of Karsdorf. It seems plausible that the contemporary populations from the sites of Halberstadt and Karsdorf were lactose intolerant as well. This hypothesis certainly requires further genetic investigation. With few exceptions, isotopic variation was quite similar within the LBK communities and no significant differences in the access to animal protein could be found between the sexes. At the site of Halberstadt, one male had higher amounts of animal protein in his diet. Given his remote burial location and his diverging diet this individual could be considered an immigrant to this LBK group. At the site of Karsdorf, one female had a dietary signal consistent with local herbivores indicating this female had a primarily vegan diet without regular animal protein. According to the data obtained from infant remains LBK children were solely fed with mother's milk until of one or two years of age. By three years of age, the children

were fully weaned and ate diets similar to adults. Isotopic signatures obtained from the large faunal dataset at the site of Karsdorf indicate the application of different livestock management strategies. Sheep and goats, assuming that both species were actually present in the faunal assemblages, fed on similar pastures even though they habitually have different feeding demands. According to isotope data, pigs were fed a more omnivorous diet from locations ranging from open landscapes to forested areas. The comparison of aurochs and domestic cattle indicates that the two species fed in distinct habitats. While the pastures of wild cattle may have overlapped with those of domestic sheep and goats, domestic cattle were kept on nitrogen enriched pastures. This enrichment could either be the result of an intensive stocking rate and pasture utilization resulting in the manuring of fodder plants, or conversely, could indicate that cattle were kept in the highly productive flood plains of the Unstrut River. If this proposed separation of wild and domestic cattle is correct, this could also imply that Neolithic farmers intentionally tried to avoid the introgression of aurochs in their domestic cattle populations.

9.3. Early Bronze Age and Early Iron Age mobility and provenance

The multiple isotope analysis on the Early Bronze Age necropolis of Singen revealed rather unexpected results. Although some grave goods can be connected to distant regions of Europe, this population can be considered to be of local origin and residence. As no complete contemporary settlement has yet been found, it remains unclear whether the main population lived locally or brought their dead to the necropolis at the foot of the Hohentwiel volcano. In this thesis the location of the Singen settlement could be quite confidently assigned to the proximity of the cemetery or at least to the Hegau region as no non-local isotope values were found and the sampled dentine and enamel pairs matched in their strontium signatures. By analysing different isotope systems, various mobility or migration ‘scenarios’ could be excluded for those individuals with good skeletal preservation. Travelling over large distances, e.g. from the Atlantic regions of France or Britain, did not occur during childhood. There is no evidence for long-term stays in coastal areas in adulthood or for exogamy. To explain the exotic artefacts at the necropolis of Singen the participation of this group in supra-regional exchange networks should be reconsidered. It seems possible that the Singen group controlled the regional copper mines and traded copper against imported exotic goods. The closest ores which could have been

utilized for copper mining are located approximately 80km south-west from this region in the mountainous area of Grisony and the Montafon Valley. We cannot exclude the possibility that the Singen people were mobile in the region between Lake Constance and these mines as this would not necessarily be visible in the isotopic signatures of teeth and bones. The results of this isotope study may encourage archaeologists to develop novel concepts for the ascendancy of local copper mining industries and for the distribution and transfer of metals throughout Europe in the Early Bronze Age.

We also reconstructed mobility and provenance in the elite burial population from the site of Magdalenenberg and found very heterogeneous isotopic patterns indicating multiple regions of origin. While previous isotope studies on Iron Age populations in Central Europe and Britain focused on dietary behaviour, this is the first comprehensive study on the mobility of Iron Age humans using multiple isotope analysis. The dietary reconstruction had two major findings that were quite similar to those reported for other Iron Age sites in Central Europe. First, there were no gender related restrictions in the access to animal protein. Second, a small group of males, including the prince and two 'warrior' burials, were distinct in their dietary patterns, either due to different regional dietary habits or social status. Specifically, their diets were characterised by larger amounts of animal protein and small inputs of millet.

The isotopic information on Iron Age provenance and mobility presented in this work is unique and strongly supports the general assumption of a highly mobile Iron Age society. We identified three large clusters of human provenance in the wider region, as well as individuals that emigrated from distant locations. Only a fraction of the burial population could be inferred to be of local origin. These individuals likely originated from the settlement within the nearby Kapf hillfort and the surrounding territory, which is characterised by scattered Iron Age burial mounds. The Kapf had been described as a rather humble settlement according to its poor artefact assemblage. However, according to isotopic evidence it is likely that a part of the Magdalenenberg elite lived at this site. It is suggested that the archaeological interpretation of the Kapf hillfort should be reconsidered. Another major portion of the burial community can confidently be assigned to the Black Forest and probably to different areas within this mountainous region. This finding is quite unexpected as no Iron Age sites are known from the Black Forest itself with the exception of the large burial mound 'Bürgle' located in the western

foothills close to the River Rhine (Pare 1992). From the isotopic evidence we have possibly found evidence for a direct connection between the upper Rhine Valley and the source of the Danube through the Black Forest Mountains. Another larger cluster of individuals can be assigned to the region between the site of Magdalenenberg and Lake Constance, although it has to be noted that isotope signatures within this region are relatively uniform over larger distances where more precise attributions are impossible. Some individuals from this cluster may be related to the tumulus graves found at nearby Mauenheim, which presumably represent members of a small settlement. Apart from these larger provenance regions, the combination of isotopic information allowed the assignment of several individuals to specific geographical areas, which are also evident in the material culture represented at the site of Magdalenenberg. Two females likely originated from the prominent chiefly site of Heuneburg located at the Danube as their strontium data is identical to what is reported from this site. Additionally, a group of four individuals may have originated from the cultural sphere of the site of Hallstatt in Austria as their oxygen and strontium isotope values suggest they were raised in a region of alpine limestone. A similar alpine oxygen pattern was found in a single male, which may have derived from the carbonate highlands according to his strontium isotope values. Three more individuals likely emigrated from a warmer climate, likely from southern Europe. Two of them were buried in the same grave; their isotope values suggest they may have spent their childhood in northern Italy, an interpretation supported by the inclusion of a north Italian style pendant in this grave. Hence, this multi-isotope study supports assumptions made according to archaeological findings in some cases. In others, isotopic evidence contradicts the interpretations of grave inventories and the claimed heritage of their owners.

Comparing the Bronze Age to the Iron Age, a significant shift in human mobility patterns can be observed. While the Bronze Age population from the site of Singen was of local origin and residence, the elite burial population at the Magdalenenberg tumulus had various migratory backgrounds and likely originated from the large area between the Black Forest and the northern Alps and probably even beyond. According to the data presented in this dissertation, the transfer of prestige goods like metal over long distances in ’barbarian’ Bronze Age Europe did not necessarily feature individual migration. Thus, other concepts explaining metal ore distribution across Europe need to be considered. For the Iron Age the contrary seems to be the case. Here the biochemical data strongly support a relationship between the presence of foreign raw

materials and object styles and the migratory background of human individuals. However, exotic materials are not necessarily deposited in the migrant's graves themselves, but their inclusion in 'local' individuals' graves may have been a result of exchange or the inheritance of the object by other kin. Finally, direct evidence in this work strongly confirms Wells' general statement that Iron Age "individuals and groups moved regularly through the landscape, for purpose of trading, raiding, migrating, visiting relatives, on pilgrimage, and for many other reasons" (Wells 2002: 341). There are multiple possible reasons why people moved to the region of the Magdalenenberg, for example marriage or the maintenance of trading networks. However we cannot exclude that people were brought to the site from a larger catchment area merely for burial and to express social status and affiliation with the Magdalenenberg 'prince'. Due to methodological limitations in current archaeological science this last question will remain unanswered, but may give food for thought for archaeologist focussing on early metallurgical societies in Europe.