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Iron Age utilization of silver fir (*Abies alba*) wood around the Heuneburg – Local origin or timber import?

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ABSTRACT

The larger area of and around the Early Iron Age fortress Heuneburg is focus of decades of archaeological excavations and observations. Additionally, to deciduous oak (*Quercus* sp.) known as the main timber during this period (Middle to Late Hallstatt c. 750–450 BCE), silver fir (*Abies alba*) was found recently on the Heuneburg plateau itself and its surroundings. Silver fir is now recognized being a significant source of timber during the Iron Age, in a region where its nowadays natural status is debated and its occurrence is rare. The aim of this study was to determine the possible source of the used timber, which might have been taken from the some 80 km distant *Abies*-rich Black Forest on the primary bed rock or from stands developed on younger geological formations nearer to the site. For this approach, radiogenic strontium isotope ($^{87}Sr/^{86}Sr$) analyses were performed on waterlogged wood and on charcoal remains buried in four archaeological contexts from Late Hallstatt period around the princely seat Heuneburg. The $^{87}Sr/^{86}Sr$ ratios were compared to those of living trees, soils and sediments with respect to the diverse geological background. The geological ground of the archaeological wood was narrowed down to molasse for three structures and to loess, moraine or mass chalk sites for one. The isotopic ratio thus points to growing sites more in the surrounding of the concerned archaeological sites and a more distant Black Forest source can be ruled out. Local evidence of *Abies* was additionally supported by palynological data from four archaeological sites and by anthracological data from a funeral context near the Heuneburg.

1. Introduction

The Early Iron Age Heuneburg fortification is one of the largest Celtic settlements in Middle Europe. It is situated on a plateau overlooking the upper Danube river valley. Its size and strategic location already suggests its general importance. Several findings from the Middle and Late Hallstatt period emphasize an economic connection as far as the Mediterranean region (Krausse et al., 2017). This princely seat (Fürstensitz) seems to be one key element in a network of important fortifications from this particular time period (Steffen, 2012). The Heuneburg has been excavated since the 1950's and an archaeological large scale research program is still ongoing (Kimmig, 1983; Fernández-Götz and Krausse, 2013; Krausse et al., 2015). The importance is additionally emphasized by the Bettelbühl necropolis and the large Giessübel-Talhau and Hohmichele tumuli groups that are located northwest of the Heuneburg. The excavated tumuli, the constructions of the Heuneburg lower town (Vorburg), a bridge construction on the northeastern tip of the Heuneburg and the Bettelbühl necropolis in the lowland of the Danube all date to the Middle and Late Hallstatt period (Billamboz, 2008; Bofinger and Goldner-Bofinger, 2008; Krausse et al., 2015, 2017).

The landscape around the Heuneburg was intensively used and shaped already in the Middle Bronze Age (Gersbach, 2006; Fernández-Götz, 2014; Krausse et al., 2015), with all its assumed consequences for the surrounding woodlands: degradation of the forest for agriculture, timber and fuel wood sourcing, strategic needs such as visibility and safety (as Liese-Kleiber, 2016; Rösch and Lechterbeck, 2016 show for other regions). However, detailed palaeoecological analysis is still lacking. Evidences of huge earth-moving operations on top of the Heuneburg plateau – and

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therefore, for clearing the forest – to build a dam for the defense wall are proven already for the Middle Bronze Age (Gersbach, 2006). For the Bronze Age settlements at least 33 houses are reconstructed. Considering the geomorphologic situation of the Heuneburg on a strategic spur overlooking the Danube valley, it is not surprising to have finds already from the Neolithic, even though the proof of a settlement is still lacking (Fernández-Götz, 2014).

Considering the size of the fortified place and its numerous phases of destruction during the Early Iron Age, there was a huge wood need for the frame-based houses and wall constructions on the Heuneburg. Moreover, the Late Hallstatt period settlers expanded their fortified and habitation area during the 6th century BC to the lower town and the external settlement (Aussensiedlung) and erected several necropolises in the vicinity (Giessübel-Talhau, Hohmichele, Bettelbühl). Nowadays, a low proportion of the wooden substance is preserved in carbonized form in destruction layers and pits, as well as in the tumuli. Nevertheless, waterlogged wood preservation could be encountered in a larger scale in two particular situations during the course of the last excavations: in a broken down bridge construction below the NE wall corner of the Heuneburg (Bofinger and Goldner-Bofinger, 2008) and in the tumulus 4 of the Bettelbühl necropolis, embedded in the deposits of the Danube river (Krausse et al., 2017).

Dendrochronological work shows that deciduous oak (*Quercus robur* or *Quercus petraea*, Middle European deciduous oak species cannot differentiated based on their wood anatomy) was the predominantly used timber during Iron Age in southwest Germany (Gersbach, 1996; Billamboz, 2008). A substantial amount of the Heuneburg and in Bettelbühl wood was taxonomically identified as *Abies* based on wood anatomy (Schweingruber, 1990a, b). *Abies alba* (silver fir) is the only Central European *Abies* species, therefore, in the following we assume silver fir utilization. In the above mentioned bridge construction, fir is the second most important timber species with 23% (Bofinger and Goldner-Bofinger, 2008). A further evaluation of the tree-ring series from the same construction has been made by means of dendrotypology (categorization of tree stems according to growth trend and tree age, cf. Billamboz, 2014a), revealing changes in the former age structure of the exploited woodland and/or different timber sources from old growth and from young forest stands (Billamboz, 2008). At a substructure of a wall construction of the Heuneburg period IIIa/building phase 10, between c. 530 and c. 490 BCE, beside *Quercus*, *Abies* wood was used "at a large scale" (Gersbach, 1996, p. 50). Finally, in the Bettelbühl tumulus 4 are, also besides oak, two floor planks made of fir (Krausse et al., 2017). Interestingly, fir trees from the bridge construction and the grave both were felled in the year 583 BCE.

This importance of silver fir timber in ancient times contrasts to its rarity today in the region. The modern natural distribution of *Abies alba* is assumed to be on its margin at the Heuneburg region (Fig. 1; Kölling et al., 2004). The precipitation today is sufficient for fir growth in the region (Kölling et al., 2011). The species is usually associated with common beech (*Fagus sylvatica*) in oligotrophic to eutrophic mixed beech forests in submontane and montane elevations (Bohn et al., 2000). However, the map of the Natural Vegetation of Europe (Bohn et al., 2000) assumes the Swabian Alb north of the Heuneburg with a south subatlantic calciphilous *Fagus* forest without *Abies alba*. The potential natural vegetation map of Baden-Württemberg (Reidl et al., 2013) indicates the limit of natural *Abies* distribution in a corridor c. 10 km south and c. 30 km north of the Heuneburg. According to floristic data, directly north and east of the Heuneburg *Abies* nowadays is not present or has a "cultivated" status, while west and south it is recorded as indigenous (Floraweb, 2013). Thus, its status today is debated.

A further discussion should take the different aspects underlying the *Abies*-status within the course of the Hallstatt period into account: climatic and edaphic factors; migration reasons of the species; fir wood selection for specific utilization (shingles, bridge constructions); relocation of sources due to the overexploitation of the surrounding forests. For a better understanding of this question, including also the ecological status of *Abies alba* in the modern landscape, it is important to identify first the timber source. Procurement of timber from more distant sources should be taken into account, since the Hallstatt society was well organized and its mobility network was widespread. This network is evidenced by archaeological finds of trackways and parts of carts from Middle and Late Hallstatt period in the wider region between the Heuneburg and the lake Federsee (Gersbach, 1996; Köninger, 2002; Heumüller and Million, 2013; Dieckmann et al., 2015).

Dendroprovenancing is a frequently applied approach to find geographical information about the origin of wooden materials (e.g. Bridge, 2012; Guiterman et al., 2016). One very common method is tree ring cross correlation, but a clear reference based on a network of chronologies at regional scale is necessary. This method is not applicable in this study, due to a lack of such reference for silver fir from the Early Celtic period, and second because of its high suitability for teleconnections (Büntgen et al., 2014). Radiogenic strontium isotope ($^{87}Sr/^{86}Sr$) analysis is a common tool in Anthropology for provenance studies of human remains (e.g. Egtved Girl in Frei et al., 2015). This method is increasingly applied to wood in dendroarchaeological studies and projects (English et al., 2001; Reynolds et al., 2005; Bridge, 2012; Rich et al., 2012, 2016a, b; Wills et al., 2014), since strontium is incorporated by water uptake in the wood.

For the aim of our study fir wood and wood charcoal material has been analyzed from four archaeological structures presented below as well as samples taken in natural context (living trees, soils, rocks) for the comparison of their $^{87}Sr/^{86}Sr$ ratios. Furthermore, pollen and charcoal data were integrated in the interpretation, acting as an independent "cross-checking" of evidence for local presence of fir in the Middle and Late Hallstatt period.

2. Study area

2.1. Regional setting

The region of this study is a c. 50 km wide west-east broad strip in the middle of southern Germany from Black Forest to Swabia. The geology changes from sandstone in the Black Forest to moraines, loess and the northern part of the tertiary molasse basin that reaches from the Swabian Alb to the Allgäu. Eastern parts of the Black Forest constitute the catchment of the rivers Brigach and Breg, and their confluence at the city Donaueschingen forms the origin of the Danube river. Mean temperature is 7.2 °C and mean annual precipitation is 793 mm (weather station Sigmaringen-Laiz: 48.07°N, 9.20°E, 580 m above sea level (asl); Mühr, 2009).

2.2. Archaeological sites

The main archaeological site is the Middle and Late Hallstatt princely seat Heuneburg that is located on a spur, overlooking the Danube river valley (Fernández-Götz and Krausse, 2013; c. 605 m asl). Around that fortification are at least three tumuli groups from the same time period, Bettelbühl to the south (540 m asl), Hohmichele to the west (c. 602 m asl) and Giessübel-Talhau to the northwest (605 m asl), and a quadrangular enclosure from Late Iron Age, La-Tène period (Viereckschanze, c. 610 m asl).

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