Transport of Timber – A Matter of Ancient Concern: New Results on Prehistoric Transport of Timber by Means of Anatomical Wood Species Identification

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Abstract

The prehistoric salt mine in Hallstatt is one of the most prominent archaeological sites in Europe. A huge demand for timber within this complex Bronze Age mining structure required a sophisticated transport system. Although research related to wood transport had been done, further information was needed to reconstruct the whole process of transportation. In this study, wood species identification of wedges, withies, and residues was carried out to address old and emerging questions related to ancient...
wood transport. It was found that mainly hardwoods were used for the specialized parts in the transport system and that the harvesting season of withies is similar to that of mining timber, namely outside the vegetation period.

Keywords
transport of timber – Hallstatt – Bronze Age – wood anatomy – wood utilization

1 Introduction

Until Roman times, almost all buildings north of the Alps were constructed from wood, a material which retains its importance as a major building material until now. In wetland settlements around the Alps, thousands of waterlogged wooden remains from the Neolithic and the Bronze Age were preserved. However, these timbers only show little indication of the first step in the construction of a wooden building: the transport from the forest to the construction site (Arnold 1986, 88; Pillonel 2007, 97). Traces of transport do appear when focusing on prehistoric mining remains in the Eastern Alps, where evidence for mortises is present in logs at a Bronze Age site in the “Mitterberg”-area (Thomas 2018, 64) and at “Dürrnberg” for an Iron Age site (Lobisser 2005, 44).

Moreover, mining timbers from the Bronze Age salt mine in Hallstatt show traces, which can be assigned to the transport of the logs, potentially containing the information needed to reconstruct the whole transportation process.

Due to perfect preservation in rock salt, many organic artifacts like leather, fur, textiles, ropes, and various wooden items are still in good condition in this prehistoric salt mine. They form the basis for various detailed investigations (Barth 1993/94, 2003; Reschreiter & Kowarik 2019; Kowarik 2019; Kern et al. 2009). Many traces on these objects give insights into production processes and can help to obtain a better understanding of the whole workflow inside and around the prehistoric mine.

Thus, Totschnig (2013) focused on the means of transport, namely the skid-like shape of the timber, wedges, withies, and mortises as well as on traces resulting from the transportation itself, such as abrasion and indentations. He identified two different transportation systems, both found in great number, with withies fastened by wedges within mortises in the one system (Figure 1) and an eye on the pulling side of the logs in the other (Figure 2).

However, a lot of questions remained unanswered or emerged from the mentioned work, as well as from numerous experiments trying to reconstruct traces
of transport, such as abrasion on transported logs (Rudorfer & Reschreiter 2014).

This paper is intended to present additional investigations related to transport of timber in the Bronze Age salt mine “Christian von Tusch Werk, alter Grubenoffen” in Hallstatt by means of anatomical wood identification and to point out recent research questions resulting from this new data.

Several questions are addressed within this study, namely:

(a) Which wood species were used for wedges and was this selection related to mechanical demands?
(b) Which wood species were used for withies and were these species locally available?
(c) Were withies sourced from branches of trees felled as mining timber or selectively harvested from other individuals?
(d) At what time of the year were withies harvested and does this time correspond to the felling season of mining timber?
(e) Do species identified at objects related to the transportation system appear among processing residues found within the mine?
2 Material and Methods

All items related to the transport of timber as listed in Totschnig (2013, 51-53) originating from the excavation site “Christian von Tusch Werk, alter Grubenoffen” of the Bronze Age mine in Hallstatt available at the time of this study were analyzed. The transport system consisted of a mortise, where a wedge was holding a withy in place. Additionally, processing residues found in the same excavation area were taken into account to gain additional information of wood processing within the mine. In total 42 wedges, 87 withies, and 637 processing residues were analyzed (after separating all fir or spruce processing residues, mainly originating from processing mining timber and by far the biggest group, which were not further worked on), wood species were determined, and the harvesting season of the withies was estimated.

Wood species were determined either by macroscopic identification or by obtaining freehand microsections as described by Grosser (2003, 50) or Schweingruber (1990, 208) with subsequent microscopic wood identification. In the latter case, sampling was carried out by using a 5 mm outside diameter hollow core drill so as not to damage any marks or traces from processing at the worked ends of the items.

Harvesting season was estimated by examining the outermost ring of the withies magnified by using a binocular reflected-light microscope on sanded or cut cross sections of the cores and classifying the season as recommended by Miles (1997, 42). When the outermost ring appeared to be incomplete, harvesting within the vegetation period in spring or summer was assumed, while winter felling was supposed otherwise.

3 Results

Of the 42 analyzed wedges (example in Figure 3), 21 (50%) were of beech \((Fagus sylvatica)\), 10 (24%) of maple \((Acer spp.)\), 2 (5%) of ash \((Fraxinus excelsior)\), and 1 (2%) of alder \((Alnus glutinosa)\). The remaining 8 wedges (19%) were made from different softwood species.

All the 87 withies (example in Figure 4) analyzed were from hardwood: 29 (34%) from alder \((Alnus glutinosa)\), 15 (17%) from beech \((Fagus sylvatica)\), 15 (17%) from \(Sorbus\), 12 (14%) from willow \((Salix spp.)\), 10 (12%) from hazel \((Corylus avellana)\), 2 (2%) from viburnum \((Viburnum lantana)\), and 1 (1%) each from elm \((Ulmus spp.)\) and ash \((Fraxinus excelsior)\), one undetermined hardwood, and one that could not be assigned to any wood species (together accounting for the remaining 2%).
Among the analyzed withies, 7% of the last rings ended with earlywood, indicating felling in spring, 13% with cells of the earlywood–latewood transition area indicating felling in late spring or early summer, and 80% with latewood-cells that mark felling after the end of tree ring formation in autumn and before the start of the new vegetation period in spring the next year.
By far, most processing residues (example in Figure 5) were from spruce or fir. All other wood species were separated by macroscopic examination and further identified. From these, 637 residues were not spruce or fir; of these, 396 (62%) were beech (*Fagus sylvatica*), 153 (24%) maple (*Acer* spp.), 69 (11%) ash (*Fraxinus excelsior*), 16 (3%) larch (*Larix decidua*), and 1 each of oak (*Quercus* spp.), yew (*Taxus baccata*), and *Sorbus* (which altogether constituted less than 1%).

*Figure 5*  Processing residues
4 Discussion

Most wedges were made of hardwood, which is a logical choice when keeping in mind the huge amount of load they had to bear while in use, given their rather higher compression strength and dynamic load capacity (Grabner 2017, 13–14). Although eight items were identified as softwood, it is not absolutely clear if all of them were used for transportation purposes, since some were slightly different in shape.

Processing residues showed a considerable high share of maple (Acer spp.) compared to the wood species share found among mining timber (Klein 2006, 73). Similar shares of maple only appear among the wedges, but as they served presumably for transportation purposes, residues from processing them would not appear within the mine.

Withies were exclusively made from hardwood species, most among them growing in the high valley of Hallstatt in the Bronze Age (Kral, 1974; Festi et al. 2021). The most obvious choice – taking branches of the felled tree – is therefore rejected, since most mining timber was from softwood species (Klein 2006, 73; Grabner et al. 2014, 146; Grabner et al. in Kowarik 2019). Although withies were selectively taken from hardwood, no specific species was preferred, numerous were used. While in the case of most wedges it is possible to assign them to the transportation system with certainty, it is hard to tell whether individual fragments of withies were a part of it or served as other binding material. A harvesting season outside of the vegetation period was most common, and therefore, at the same time as the harvesting of mining timber (Radlberger 2010, 16; Grabner 2014, 146). In addition, recent examples of withy production indicate that there was harvesting outside of the vegetation period, taking place in spring before the start of sap flow and annual wood formation (Grabner 2014, 155). Nevertheless, the cutting season of the withies does not necessarily correspond to the season of transport.

5 Conclusion

Even though it was possible to add information to wood transport-related findings from the Bronze Age salt mine in Hallstatt by means of wood species identification, many questions remain unanswered.

Further research has to be done to explain the big predominance of maple (Acer spp.) residues from processing of wood. Up to now, very few mining timbers from maple have appeared; thus, we hypothesize that processing residues of this species originate from tooling the maple wedges. But whether this
indicates a further transport within the mining chambers, and therefore an application or reapplication of the transportation system or a timber joint at the wood construction site, cannot be construed at present, since both options seem to be quite unlikely. The use of the withy-wedge system as a timber joint would not explain the position of the wedge, which is always opposite of the skid-like side of the log.

Aside from the question of the unassigned maple residues, it would also be desirable in the future to focus on mechanical requirements and properties of withies, to gain better knowledge about the prehistoric transport of timber at the Hallstatt salt mine.

Furthermore, future work will focus on the question whether all withies found in the mine workings were used as timber joint and transport gear or might have also served other functions, especially the group of thinner withies. Over the last years withies have been found in a variety of contexts (Hafner 2015, Steiner et al. 2016).

References