

Charcoals from a prehistoric fire-set pit in the Austrian Alps - dendro-dates, wood demand and forest utilization

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Summary: Fire-setting was the most important technique in prehistoric times to exploit ore deposits. Remains of these workings found in a small pit in the mining area of Schwaz/Brixlegg (Tyrol, Austria) enable dendrological and dendrochronological investigations. With the results obtained even issues as wood demand and forest utilization can be addressed. This work will be continued to refine the knowledge on the history of mining in the Alpine Region, particularly for prehistoric times.

Key words: dendrochronology, copper-mining, wood utilization, Iron Age, Austria

INTRODUCTION

The huge number of pits located in the mining area of Schwaz/Brixlegg indicates ore deposits, which already were exploited in prehistoric time (Goldenberg and Rieser, 2004). One of these small pits called MaukE (47°26'14'' N, 11°57'12'' E; 997 m asl) was explored in the 1990s for the first time by Gert Goldenberg and again more closely between 2007 and 2010 (Figs. 1 and 2). The pit is located at a steep slope and extends about 25 m into the dolomite rock. Copper ore was exploited in the pit MaukE in prehistory. Large quantities of charcoal were recovered from different positions within the pit. Radiocarbon results suggest ages at the transition from Late Bronze Age (LBA) to Early Iron Age (EIA).

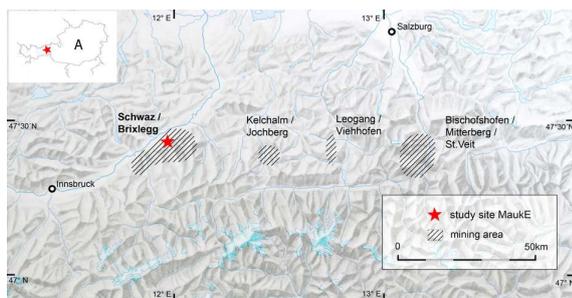


FIGURE 1. Location of the study site MaukE and other prehistoric mining areas within the mining region Schwaz/Brixlegg. (map basis: Alpen Reliefkarte - Tirol Atlas).

MATERIALS AND METHODS

Out of the assemblage of charcoals (completely charred) and - in rare cases - charred wood (partly charred) of different size tree-ring width (TRW) measurements were carried out on 240 samples so far. We determined the tree species, extrapolated the pith age for samples without preserved pith to give details on the size of the utilized timber and documented whether the samples originate from a log or branch. Based on several radii measured per artefact, average ring-width series of each object were established. Reference chronologies of the tree species fir (*Abies alba*),

Norway spruce (*Picea abies*) or stone pine (*Pinus cembra*) samples were available for dendrochronological dating. AMS-Radiocarbon dating (at the Vienna Environmental Research Accelerator laboratory -VERA- Institute for Isotope Research and Nuclear Physics of the University of Vienna) was used for a first estimation of the time range of the MaukE charcoal samples.

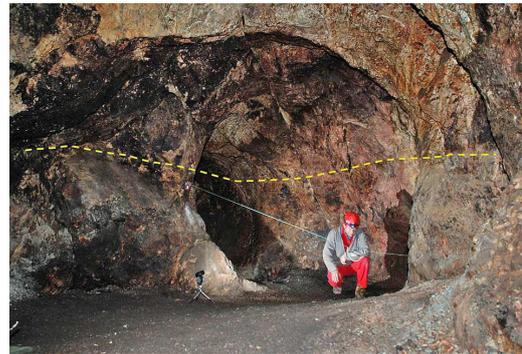


FIGURE 2. The "great hall" of the pit MaukE. The dashed line marks the level of already removed deposits which belong to modern mining activities (photo: G. Goldenberg, 2008).

Within the interdisciplinary research project *HiMAT* (*The History of Mining Activities in the Tyrol and adjacent areas - Impact on Environment and Human Societies*) one partner (surveying and geoinformation) provides 3D data of the pit MaukE. Based on this information we can approximately estimate the volume of the mined ore. Moreover, numerous fire-setting experiments (e.g. Py, 2004) help us to estimate the amount of wood needed to exploit a certain amount of rocks by applying fire-setting as mining technique. The results of these experiments show that an ore/wood ratio 1:1 (simplified) can be assumed. Due to the rough estimate of timber used in the pit MaukE we assessed the impact of mining on the local forests.

RESULTS AND DISCUSSIONS

The results of the dendrochronologically analysed charcoal samples indicate that usually only softwood

was used in the EIA fire-set pit MaukE: 88% of the samples were spruce, 10.4% were fir, 0.4% larch (*Larix decidua*), 0.8% were spruce or larch and 0.4% were alder (*Alnus* spp.). Other species have not been documented so far. The fact that pieces of hardwood were not observed cannot be attributed to a lack of such species in the vicinity of the pit: dendrochronological analyses on wooden remains from the prehistoric ore processing site Schwarzenberg Moos confirm a variety of species growing in the surrounding area of the fire-set pit MaukE (Nicolussi *et al.*, 2009). Therefore, wood procurement can be assumed. Only two pieces were classifiable as part of twigs or branches. Even if we consider that small-sized branches were totally burned and therefore not preserved the results suggest that fuel wood was mainly processed from stem wood.

The tree-ring series established vary between 6 and 138 values. The median value ($m=35.0$) indicates that most of the examined charcoal samples show short tree-ring series. While comparing the established tree-ring series with each other we often detected high similarities regarding both growth level and year-to-year variability among each other. Based on these dendrotypological features we combined tree-ring series of 110 samples to 12 different groups - called *trees*. For these *trees* we estimated the diameters by applying the pith offset data established for the charcoals. The results suggest that the prehistoric miners processed timber between *ca.* 15 and 30 cm in diameter. All in all tree-ring series of 133 samples were cross-dated so far to a 149-year long local chronology. The last measured tree ring marks the year 707 BC. The best match (*overlap* = 105, *Gleichläufigkeit* 69%, *t*-values: t_{BP} , 8.4, t_H , 10.4) was obtained by comparison with the reference chronology from Villingen-Magdalenenberg, Southern Germany, which is based on fir samples (Billamboz and Neyses, 1999). The radiocarbon results prove the dendrochronological dating: because of the known distance between two ^{14}C -samples wiggle matching was possible: e.g. sample VERA 4870 (9 tree rings): single calibration (2σ): 760–410 BC; wiggle matching calibration (2σ): 765–685 BC; dendrochronological date of the ^{14}C -sample: 716–708 BC.

Due to the burning process the waney edges (the last-formed tree ring before felling, sampling, or death of the cambium) of the trees utilized as fuel wood were usually not preserved. However, we were able to identify a waney edge at one charcoal indicating a felling date in 708 BC. Interestingly the last measured tree ring of 16 series from different layers range between 707 and 712 BC. This implies that the fire-setting activities in the pit MaukE lasted only relatively few years and that the felling dates of the trees are close to 710 BC. Taking the stratigraphy of the dated samples at the different excavated positions into account we presume a single-phase exploitation of the pit MaukE. However, at the current state of the investigations it is not possible to decide if the pits in the surrounding of MaukE are from the same time period (late 8th century BC) or how long the copper-ore exploitations lasted all in all at that location.

The analyses of the charcoals also allow assessing the possible impact on the local forest. Considering some assumptions (e.g. seasonal workings in the pit MaukE over several years by few miners, specific gravity of the exploited ore, the ratio between rock exploited and fuel wood) it can be inferred that impact was limited. The prehistoric miners were able to cover the wood demand from the local forests which were utilized at a small scale (preliminary assumption). This assumption is supported by the observation that only few charcoals and with that *trees* show clearing effects. Moreover, the effects observed must not be related to the activities but could be a result of natural events (e.g. windbreaks). Additionally, the dominance of samples with relatively small tree rings indicate the utilization of naturally grown (closed) forests by the prehistoric miners.

CONCLUSIONS

All in all the dendrochronological results presented provide a deeper insight into a fire-set pit in the prehistoric mining area of Schwaz/Brixlegg. It can be stated: i) selective wood procurement (only softwood and mainly stem wood) was typical; ii) tree-ring data provide an accurate dating of the mining activities in the pit MaukE in the late 8th century BC (around 710 BC); iii) tree-ring width analyses imply a small scaled wood utilization of usually closed forests.

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