Available online at www.sciencedirect.com
ScienceDirect
Dendrochronologia 27 (2009) 87–94
DENDROCHRONOLOGIA
www.elsevier.de/dendro

Dendrochronological analysis and dating of wooden artefacts from the prehistoric copper mine Kelchalm/Kitzbühel (Austria)

Thomas Pichler[a,*], Kurt Nicolussi[a], Gert Goldenberg[b]

[a]*Institute of Geography, University of Innsbruck, Innrain 52, 6020 Innsbruck, Austria*
[b]*Institute of Archaeology, University of Innsbruck, Langer Weg 9-11, 6020 Innsbruck, Austria*

Abstract

The potential of dendrochronological analysis of wood found in prehistoric and historic mining areas in Tyrol has remained unattended for a long time. For the first time, systematically analysed wooden artefacts from a prehistoric mining area in Tyrol (Kelchalm near Kitzbühel) can be presented here.

The investigated artefacts, related to mining and everyday life, were found in the course of archaeological excavations, which were carried out between 1932 and 1953 by Richard Pittioni and Ernst Preuschen. Taking an adequate number of tree rings and well-preserved wood wane into account, 21 pieces of mining timber were pre-selected for a dendrochronological analysis. The identified wood species are spruce (*Picea abies*, $n = 18$) and fir (*Abies alba*, $n = 3$). The length of the established tree-ring series ranges from 13 to 145. We cross-dated the tree-ring series of seven wooden artefacts among each other, which resulted in a spruce-fir tree-ring record of 153 values (Kelchalm mean curve). The last tree ring measured of the Kelchalm spruce-fir mean curve dates back to 1237 BC. This accurate dendro-result dates the Bronze Age mining activities at the Kelchalm to about two centuries earlier than the long-lasting assumption proposed by Richard Pittioni. His assumption was based on the typology of ceramic and metal artefacts.

The established dendro-date for the Bronze Age mine at the Kelchalm matches with available ^{14}C results from other important copper-mining areas in the north-eastern Alps (NE Alps). The activities at these other sites are dated between the 17th and 6th century BC. Furthermore, the radiocarbon dating, as well as the dendro-result from the Kelchalm, suggests a transition from earlier mined copper-ore deposits in the eastern areas of the NE Alps, to the later mined ore deposits in the western section. This has led to both parallel and sequential mining activities in several ore districts during the last two millennia BC in the NE Alps.

Keywords: Dendrochronology; Prehistoric mining; *Abies alba*; *Picea abies*; Bronze Age; Eastern Alps

Introduction

Metal-mining activities in the Alpine region go back to prehistoric times. The earliest findings so far were located in the region of Schwaz/Brixlegg in the lower Inn valley, Tyrol, Austria (Fig. 1) and indicate copper production during the second half of the 5th millennium BC (Huijsmans, 1996; Höppner et al., 2005). The development of mining, in a long-term perspective, is characterised by phases of expansion, consolidation, and regression. In medieval and more recent times (until 20th century) mining on metal ores played an important

*Corresponding author. Tel.: +43 512 5075674; fax: +43 512 5072895.
E-mail address: t.pichler@uibk.ac.at (T. Pichler).

1125-7865/$ - see front matter © 2009 Elsevier GmbH. All rights reserved.
doi:10.1016/j.dendro.2009.06.003

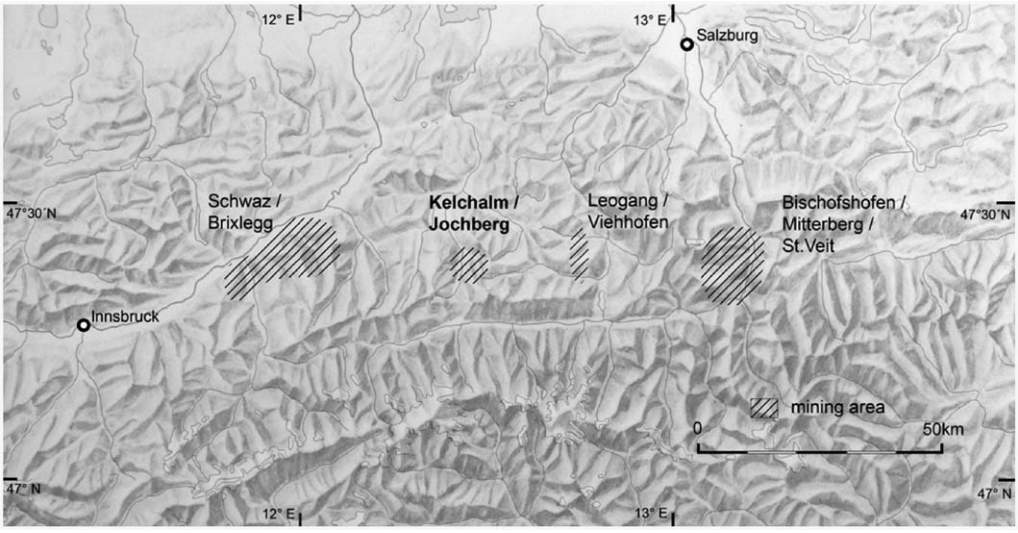

Fig. 1. Location of the prehistoric copper mine areas in the northern part of the Eastern Alps (map: Alpen Reliefkarte-Tirol Atlas).

economical role in the Alps, whereas today it is only of marginal importance. When copper mining experienced its revival in the 19th century, traces of prehistoric mining activities were for instance discovered at the Kelchalm (10 km south-east of the well-known winter sports resort Kitzbühel) and the Mitterberg (province of Salzburg, about 50 km east of the Kelchalm). It can be asserted that prehistoric mining was not limited to near-surface ore deposits there. Several underground mines that had partly been back-filled by the miners or collapsed after the abandonment of the mine provide evidence of early deep mining and copper production in the mining areas of the Northern Alps. Archaeological excavations at the Kelchalm and other sites mentioned above provided a huge number of artefacts confirming mining activities in the Bronze Age (e.g. Preuschen and Pittioni, 1937, 1954; Goldenberg, 2004; Goldenberg and Rieser, 2004; Stöllner et al., 2009). In Tyrol and Salzburg there were four important copper-mining areas in prehistory (Fig. 1). These were the Leogang/Viehhofen and Bischofshofen/Mitterberg/St.Veit districts in Salzburg and the Kitzbühel/Kelchalm/Jochberg and Schwaz/Brixlegg districts in Tyrol (Fig. 1). In most of the mentioned mining districts, including the Kelchalm site, chalcopyrite is the dominating primary ore, whereas in the mining area of Schwaz/Brixlegg fahlores mainly occur.

In the Kelchalm area archaeological excavations were carried out in the mid-20th century (e.g. Preuschen and Pittioni, 1937, 1954). Based on the typology of ceramic and metal artefacts found at the Kelchalm, Richard Pittioni stated that this copper mine, and therefore the whole prehistoric mining activity at this location, started at the turn of the 2nd millennium BC (Pittioni, 1968). However, a huge number of wooden artefacts were also excavated at the Kelchalm. The first investigations of the wooden material by Josef Kisser were limited to macroscopic descriptions followed by the interpretation of the tree-ring width, to give a first estimation of a possible altitude of the growth site. Furthermore, he classified the wooden pieces according to their species (Kisser, 1937). In principle, dendrochronological dating of wooden samples achieves more accurate results than when it is only done by archaeological typological dating.

Up to now, tree-ring analyses on mining timber from Tyrol have hardly commenced. In adjacent areas, the number of such investigations is still limited as well (e.g. Ruoff and Sormaz, 1998, 2000; Grabner et al., 2007). One possible reason was the lack of a database for the dating of prehistoric samples. However, such multi-millennial chronologies for the conifer species *Pinus cembra* and *Larix decidua* have been established recently (Nicolussi et al., 2004).

The main goal of this study was to date the prehistoric wooden artefacts from the Kelchalm mining area, which were excavated more than 50 years ago. Thus, the established dendro-dates will enhance and refine the chronological understanding of the development of mining in the Alpine region. Additionally, the species used for the artefacts probably show a specific selection, according to their properties.

The local geology of the study area is dominated by the Northern Alpine Greywacke Zone (paleozoic bedrock), which holds rich copper-ore deposits. Rounded and densely forested mountains are characteristic of the Greywacke Zone. The highest peak of the Kelchalm ridge is 1812 m asl. In the mid-19th century, new copper mines were opened in the region of the Kelchalm (E 12°27′, N 47°23′). During the development of these modern mines, remains of former copper mines were discovered. The implements found and analysed by