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Archaeometallurgy in Europe III

Andreas Hauptmann
Diana Modarressi-Tehrani

Archaeometallurgy in Europe III

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Andreas Hauptmann
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Cover

Domus Vettiorum / Casa dei Vettii, Pompeii (Campania, Italy, 63-79 BC), which was excavated in 1894. Section of a Pompeii-style scenic fresco showing Erotes and Psyches in a gold assay laboratory. In the left corner, scales for weighing gold are put on a table. Next to it, one of the Erotes is working with a small hammer on an anvil. On the right side, an assay furnace is shown. Another of the Erotes is holding a small crucible with pincers with the right hand while using a blowpipe with his left hand, supplying the fire with air. The large bellow for the assay furnace is driven by the third of the Erotes.

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Editorial

This volume comprises a range of articles, which were submitted and selected from all the presentations given on the International Conference "Archaeometallurgy in Europe III", held from the 29th of June to 1st of July 2011 at the Deutsches Bergbau-Museum Bochum, Germany.

The present volume is the third in the series "Archaeometallurgy in Europe" , capturing the spirit of the successful series of international conferences on this special theme of research. The first conference "Archaeometallurgy in Europe" had been organized by the Associazione Italiana di Metallurgia and took place in Milano, Italy, from the 24th to the 26th of September 2003. The second conference was held in Aquileia, Italy, from the 17th to the 21st of June 2007. It was also organized by the Associazione Italiana di Metallurgia.

The splendid idea to launch this conference series, a scientific series of meetings limited to the countries of Europe, came from the late Prof. Dr. Walter Nicodemi, formerly President of the Assoziazione Metallurgia di Italia. Thanks to the efforts of Dr. Alessandra Giumlia-Mair, Merano, these conferences have developed into increasingly productive events with a high scholarly quality. Since then three conferences have taken place and the fourth meeting is at an advanced stage of preparation and will take place in Madrid, Spain, from the 1st to the 3rd June 2015.

The title of the conference series covers a research field which is a distinctive part of archaeometry, and which so far was usually included as one of the topics in the program of the "International Symposium on Archaeometry" (ISA), organized every third year at different locations in Europe and in the United States. However it is our opinion, that in the last decade archaeometallurgy has developed as a very important research field, and we are observing a large number of scholarly activities all over the world. We are convinced that such an important topic needs to be organised and presented in conferences specifically dedicated to this field. Therefore the topic of this conference is the history of metals and metallurgy primarily in Europe, but it also includes other regions of the Old World.

The future prospects of the conference series are promising, especially because "Archaeometallurgy in Europe" constitutes an extremely useful broadening and a regional counterpoint to the well-established and successful conference series "The Beginnings of the Use of Metals and Alloys" (BUMA), which was launched in 1981 by Professors Tsun Ko, Beijing, China, and Robert Maddin, then Philadelphia, USA. The focus of the eight BUMA conferences held so far (the last one was held in Nara, Japan, in 2013) lays on the development of metallurgy in South-East Asia and the Pacific Rim. We firmly belief that the two conferences complement each other very effectively and should therefore continue to exist side by side.

With this special volume of *Der Anschnitt*, we are delighted to publish a selection of the lectures presented at the conference at the Deutsches Bergbau-Museum Bochum in 2011. Many of the authors contributed with very instructive and informative papers, which finally resulted in this volume.

We are very much obliged to all these authors who, with patience and persistence, cooperated with us and helped to shape this volume. We would also like to thank the reviewers who decisively contributed in the improvement of the scientific level of this volume.

Our thanks go first to all those colleagues and friends who helped to organize the conference in 2011. The former director of the Deutsches Bergbau-Museum, Prof. Dr. Rainer Slotta, and the present director, Prof. Dr. Stefan Brüggerhoff encouraged and promoted our efforts to organize this scholarly meeting. Dr. Michael Bode, Dr. Michael Prange, and Prof. Dr. Ünsal Yalçın supported the conference planning and realization in every aspect. Many colleagues of the staff of the Deutsches Bergbau-Museum, and many of the students working in our research laboratory offered their assistance and help.

Finally, our thanks go to Mrs. Karina Schwunk and Mrs. Angelika Wiebe-Friedrich who performed the editorial work, design, and layout for this volume.

Andreas Hauptmann
Diana Modarressi-Tehrani

Contemporaneously to the conference in 2011 a volume with abstracts on every lecture given and every poster presented was published:

2011 HAUPTMANN, Andreas, MODARRESSI-TEHRANI, Diana & PRANGE, Michael (eds.), Archaeometallurgy in Europe III. Abstracts. METALLA, Sonderheft 4, 2011.

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New excavations at smelting sites in Trentino, Italy: archaeological and archaeobotanical data

Summary

The south-eastern Alpine region is rich in copper ore deposits (mostly mixed copper sulphides, chalcopyrite). Archaeological research shows that they have been exploited intensively throughout prehistory. Evidence of ancient metallurgical activity in Trentino was found in about 200 archaeological sites, mainly dated to the Late/Final Bronze Age. In the last years the research activity of the Archaeological Heritage Office of Trento has been focused on three smelting sites, Segonzano, Transacqua and Luserna, aiming to investigate the archaeological remains of the ancient smelting processes and improve our understanding of the technological aspects of the chaîne opératoire. Furnace remains, fire structures interpreted as roasting beds, slag and "slag sand" heaps have been unearthed. Dendrochronological and palynological analyses have been carried out at the Segonzano smelting site. Preliminary results are presented here. The archaeobotanical research was aimed at investigating the environmental context and the utilization of landscape during the exploitation of the smelting area. A first essay of tree-ring analysis was conducted on a wooden sample coming from a horizontal carved beam and led to the construction of a 49 years long sequence.

Introduction

An archaeometallurgical research project, which was carried out in Trentino by the Archaeological Heritage Office of Trento and the Deutsches Bergbau-Museum Bochum during the 1980's and the 1990's, provided extensive evidence of exploitation of local copper ores (mainly chalcopyrite) during prehistory. Evidence of ancient metallurgical activities in Trentino has been found at many archaeological sites which date back to two distinct periods: the Late Copper Age/Early Bronze Age and the Late/Final Bronze Age according to the Italian chronology (Perini 1992; for the chronology see Marzatico et al. 2010). During the Late/Final Bronze Age in particular, i. e., Bronzo Recente and Bronzo Finale (XIV/XIII-XI century BC), smelting sites were located in mountain areas over 1.000 m above sea level (asl) in eastern Trentino. This has been proven by slag heaps and related remains, although rarely preserved, of smelting furnaces built on slopes near water and timber resources, e. g., at Mocheni Valley, Tesino, Lavarone and Luserna Plateau, Vezzena. About two hundred smelting sites have been found (Cierny et al. 1998; Cierny 2008).

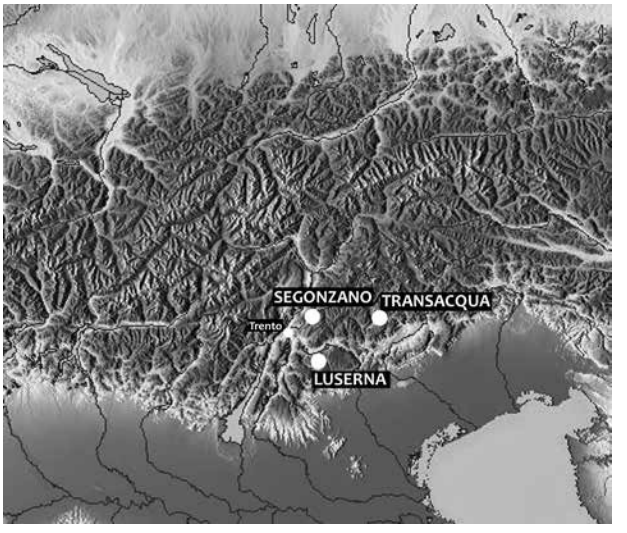

Fig. 1: Map of the region with the location of the smelting sites cited in the text.

In the last decade, new excavations have been carried out at three Late/Final Bronze Age smelting sites: Segonzano Peciapian (Cembra Valley, Cierny 2008 Cat. No. D1-18), Transacqua (Primiero area) and Luserna Platz von Mozze (Luserna plateau, Cierny 2008, Cat. No. D6-12) (Fig. 1; Bellintani et al. 2010).

Preliminary results of these excavations will be described in the following chapters.

Segonzano Peciapian

In Segonzano Peciapian (1350 m asl) a smelting site near a peat bog was found, with a heap of crushed slag known under the term of "slag sand" (Fig. 2). At the bot-

Fig. 2: The “slag sand” heap in Segonzano Peciapian.

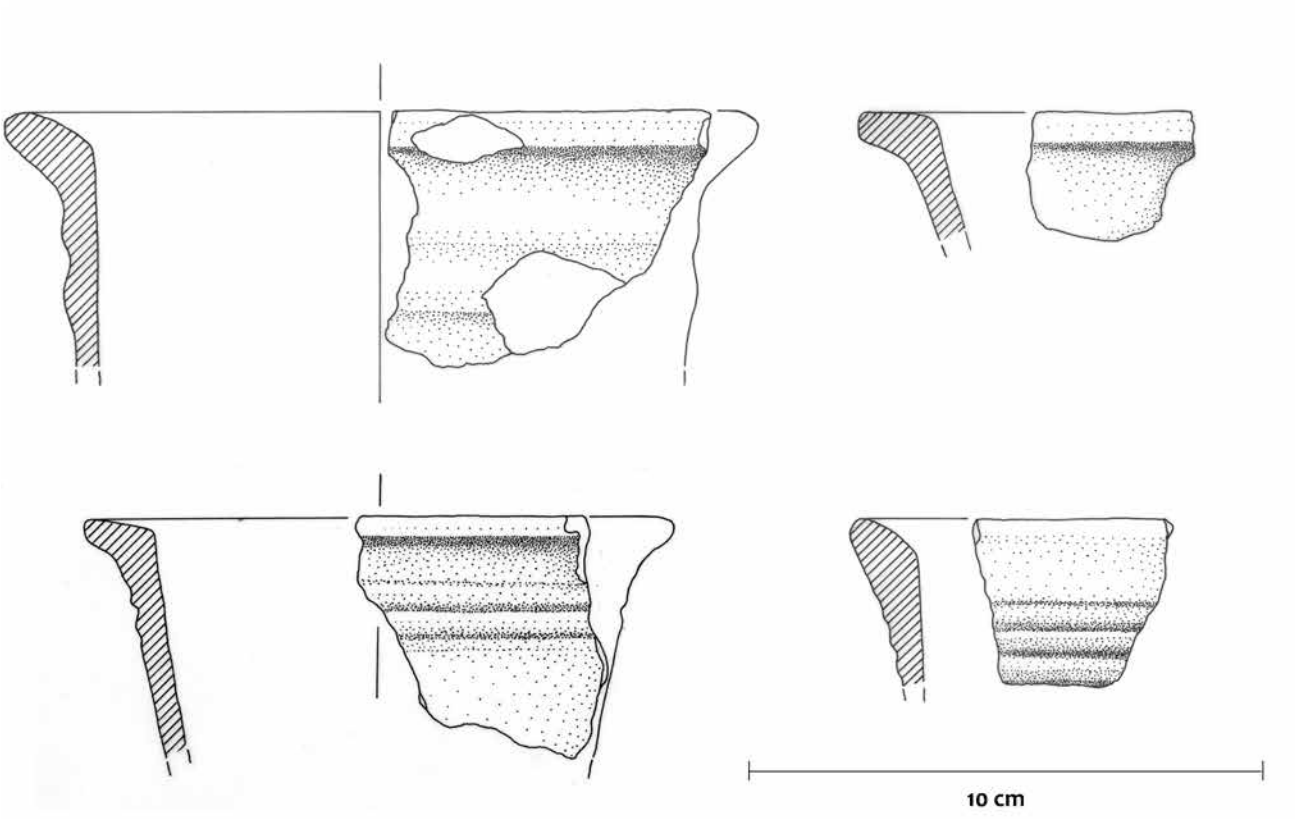

Fig. 3: Late Bronze Age pottery fragments from Segonzano Peciapian.

Sample Name	Laboratory Code	Radiocarbon Age (BP)	$\delta^{13}C$ (‰)	Calibrated Date cal BC (1σ)	Calibrated Date cal BC (2σ)
Nr 13 SU 6 BASE SEPE	**LTL2790A**	**2996 ± 45**	**-27.1 ± 0.2**	1291 – 1128	1393 - 1059
Nr 18 SU 15 SEPE	**LTL2791A**	**3019 ± 45**	**-20.5 ± 0.1**	1291 – 1128	1401 - 1126
Nr 92 SU 15 SEPE	**LTL2792A**	**2969 ± 45**	**-23.1 ± 0.2**	1260 - 1120	1376 - 1041

Tab. 1.: Radiocarbon ages and calibrated dates from the samples of Segonzano-Peciapian. The calibrated ranges were obtained by the maximum intercept method (Stuiver & Reimer 1986), using the IntCal13 calibration curve (Reimer et al. 2013) and the program OxCal v4.2.4 (Bronk Ramsey 2009).

tom of the deposit, under the crushed slag layers, the excavation uncovered some horizontal wooden poles, still well preserved by the bog water. The discovery of the site opened important research possibilities, mainly due to the moist soil which makes it possible to preserve organic materials. Archaeological finds (Fig. 3) allow the site to be dated to the Late/Final Bronze Age. This dating has been confirmed by AMS radiocarbon dating (CEDAD, Lecce, Tab. 1). Sample no. 13 has been taken from layer 6, which is made of slag fragments, the samples no. 18 and 92 have been taken from SU 15, one of the horizontal wooden poles underneath the slag sand heap (Fig. 4).

Our research included dendrochronological and palynological analyses. The archaeobotanical research was aimed at investigating the environmental context and the utilization of landscape during the exploitation of the smelting area. Palynological and micro-charcoal analyses were undertaken on 14 samples, respectively 7 from a small trench in the peat bog (called C1), excavated around 20 meters east from the smelting site, and 7 from the smelting site (Trench 1). A selection of remains is shown in Figs. 5 and 6.

Three samples of wood and one sample of charcoal were preliminary analyzed from the small trench C1 in the peat bog in order to have a first idea of the plant species used in the smelting activities.

Fig. 4.: Segonzano Peciapian. Detail of SU (stratigraphic unit) 16, the wooden pole unearthed completely preserved underneath the crushed slag heap.

The trench is not immediately adjacent to archaeological features (21 m east from the site), thus provides a unique opportunity to characterize vegetation change near the area.

In the ancient levels, the landscape is characterized by woodland, mostly represented by conifers, in particular fir/*Abies alba*, spruce fir/*Picea excelsa* and pine trees/ Pinus sp. *Birch/Betula* and linden/*Tilia trees* grew up on the background near the site. The wild landscape of the area is underlined by micro-charcoal curves which record the lowest values. In the following zones extensive woodland clearance occurred, highlighted by the increase of plant species typical for pastures and grazing. Woodland clearance in the area is also underlined by micro-charcoal curves that record a positive peak linked to the use of fire for smelting and wood clearing activities. The exploitation of coniferous wood is pointed out by the macro remains analyses (Fig. 7): at the depth of 70 - 75 cm from the ground level, xylological remains are represented by silver fir and spruce wood (*Abies alba* and *Picea excelsa:* 8 records with cutting marks), anthracological remains suggest the use of the same species plus pine (*Pinus sp.*); at the depth of 50 - 60 cm xylological remains are represented by silver fir, spruce and beech (*Abies alba, Picea excelsa* and Fagus: 6 records with cutting

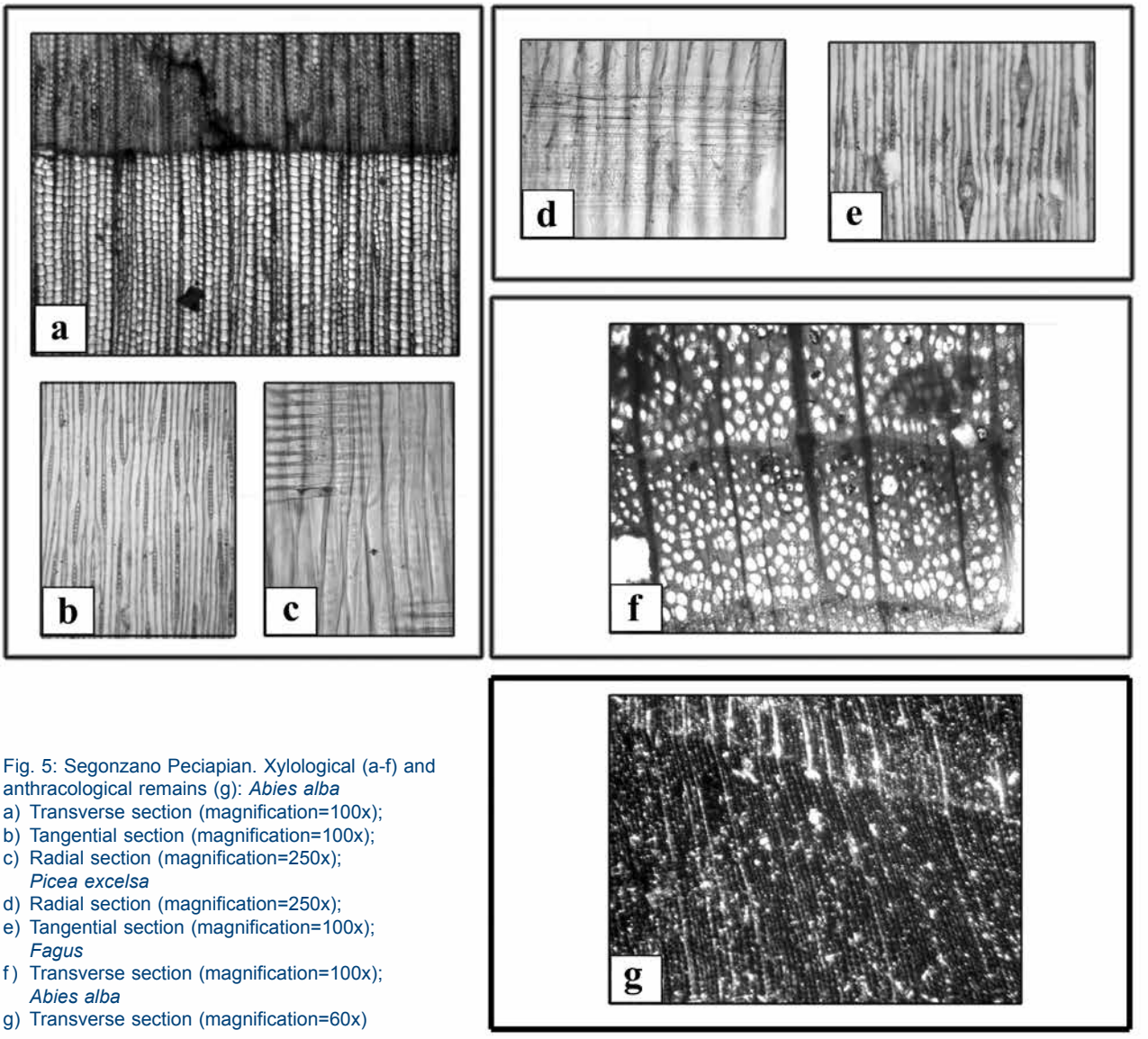

Fig. 5: Segonzano Peciapian. Xylological (a-f) and anthracological remains (g): *Abies alba*
a) Transverse section (magnification=100x);
b) Tangential section (magnification=100x);
c) Radial section (magnification=250x); *Picea excelsa*
d) Radial section (magnification=250x);
e) Tangential section (magnification=100x); *Fagus*
f) Transverse section (magnification=100x); *Abies alba*
g) Transverse section (magnification=60x)

marks); further, at the depth of 30 - 50 cm xylological remains are represented by pine (Pinus sp.). These zones in the peat bog may be correlated to the smelting site, in which the woodland clearing was still being carried out on a large scale. The following zone marks the end of human activities in the area, where palynological data suggest abandonment: conifers and broad-leaved plants increase while micro-charcoal, pasture and grazing species decrease.

The preservation of wooden remains makes the site of Segonzano Peciapian an ideal archaeological context for dendrochronological research. The great amount of waterlogged trunks and fragments in the peat bog nearby, above all, could allow the creation of coniferous local chronologies for high-precision absolute dates of the wooden artefacts found in the smelting site.

A first tree-ring analysis was conducted on a spruce sample coming from a horizontal carved beam (SU 16, Fig. 4), that had the longest tree-ring sequence. The identification of this wood was carried out according to microscopic features as reported in Schweingruber (1990). The cross-section of the wooden specimen was prepared using a razor blade until an optimal surface resolution was obtained. Ring widths were measured to the nearest 0.01 mm with the LINTAB device by F. Rinn. Data were collected and stored using the CATRAS® and TSAP® programs (Aniol 1983; TSAP-Win 2003).

The spruce sample led to the construction of a 49 years long sequence (Tab. 2 and Fig. 8). Spruce is a tree species well suitable for dendrochronology and widely attested in the Trentino-South Tyrol region, the longest regional chronology spanning the period 1362-1988 AD (Bebber et al. 1992). Spruce is present among the other wooden remains from the peat bog, therefore these first results made us confident on the future success of the analysis.

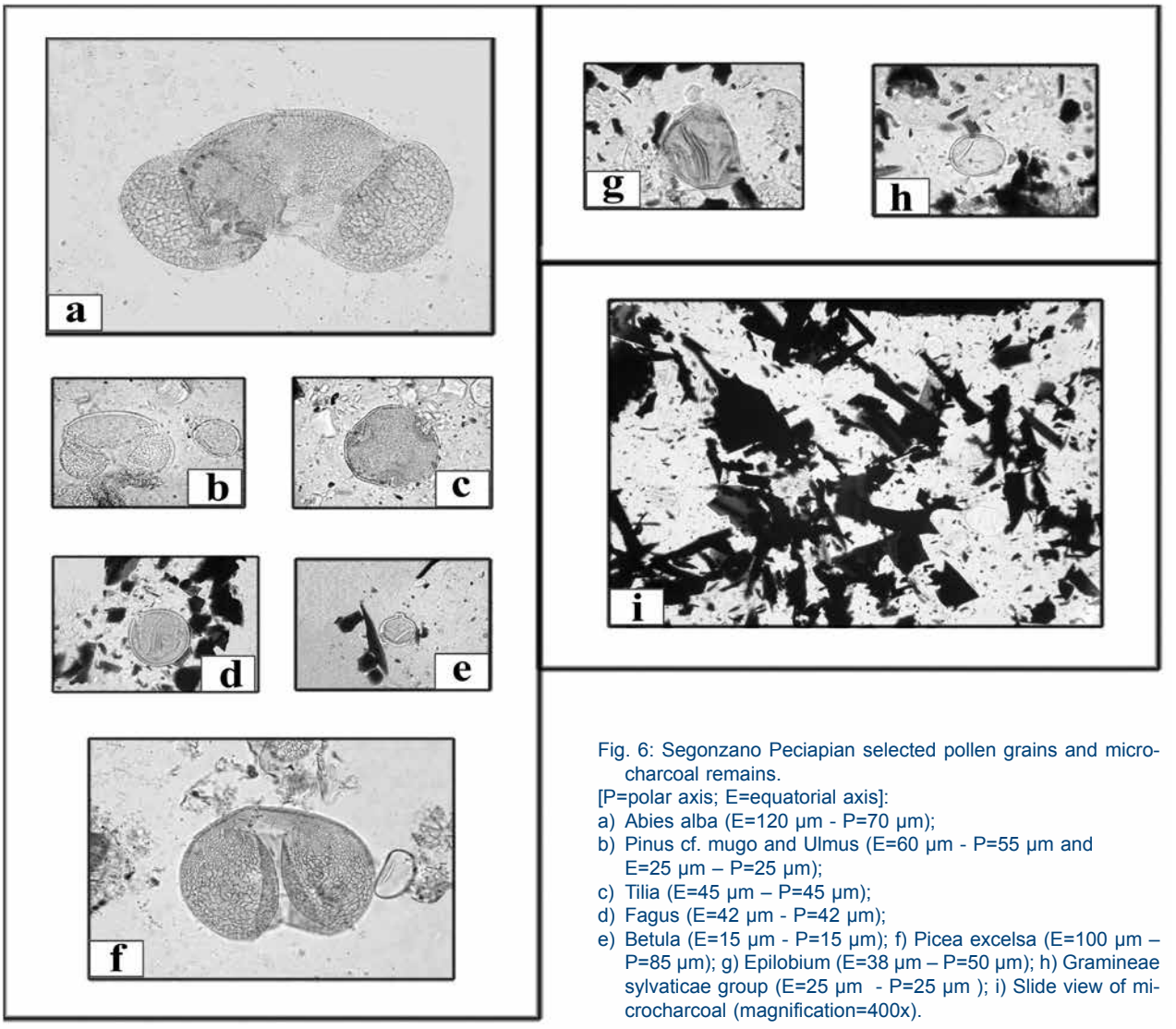

Fig. 6: Segonzano Peciapian selected pollen grains and microcharcoal remains.
[P=polar axis; E=equatorial axis]:
a) Abies alba (E=120 µm - P=70 µm);
b) Pinus cf. mugo and Ulmus (E=60 µm - P=55 µm and E=25 µm – P=25 µm);
c) Tilia (E=45 µm – P=45 µm);
d) Fagus (E=42 µm - P=42 µm);
e) Betula (E=15 µm - P=15 µm); f) Picea excelsa (E=100 µm – P=85 µm); g) Epilobium (E=38 µm – P=50 µm); h) Gramineae sylvaticae group (E=25 µm - P=25 µm); i) Slide view of microcharcoal (magnification=400x).

Transacqua

In Transacqua Pezhe Alte slag heaps, ore dressing tools and remains of fire structures have been found. The archaeological findings can be dated back to the Late/Final Bronze Age. In a second site one kilometre far from Pezhe Alte, in a locality called “Acquedotto del Faoro”, some burnt clay levels had been unearthed by a road construction. The preserved part of the structures is around 2.5 meters long, with two different layers (1004 and 1005) of burnt clayey silt rich in charcoal on top of a layer made of slags and stones (Fig. 9). The fired area is delimited by stones. These structures could have been roasting beds, but they have been cut by the road so a safe interpretation of the evidence is limited.

Luserna

The site called Platz von Mozze near Luserna (Nicolis et al. 2007), already known in the archaeological context thanks to evidence that emerged from previous surveys (Cierny 2008, Cat. No. D6-12), is situated at an altitude of approx. 1.300m asl. The recent research involved extensive investigation, which unearthed a large area dedicated to Late/Final Bronze Age metallurgical activities.

The probable remains of two smelting furnaces, with a N-S orientation and at a distance of about 5 m from each other, have been found. Some long oval shaped structures made of burnt clay and surrounded by stones, interpreted tentatively as roasting beds, have been identified (Fig. 10). The site is not directly related to the presence of ore nearby, the closest copper mines being at Calceranica and Vetriolo in the Valsugana, both about 10 km to the north.

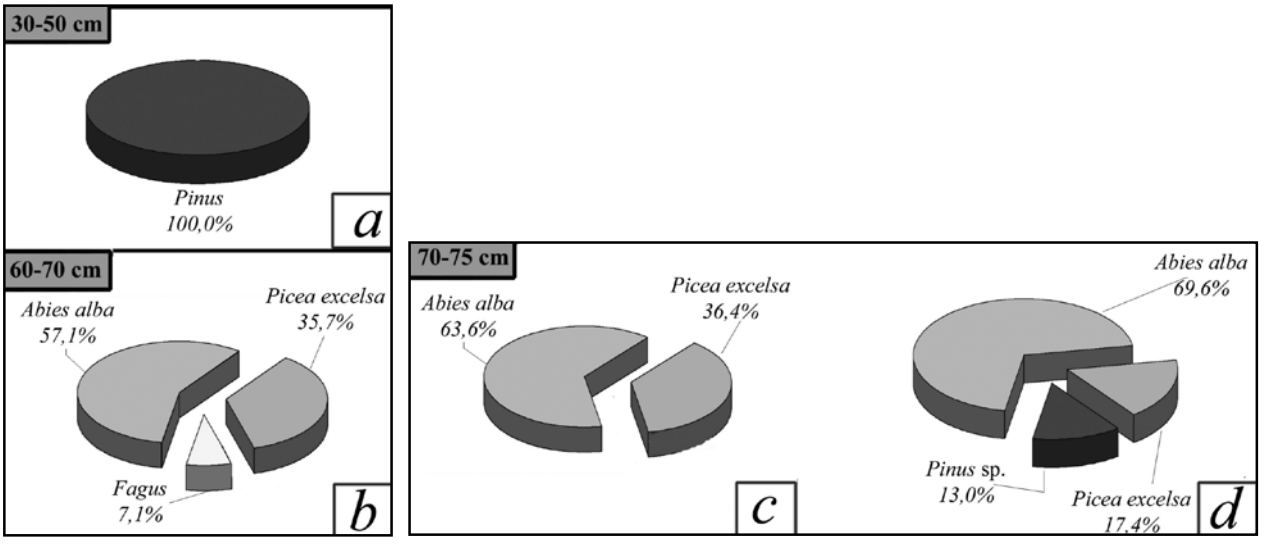

Fig. 7: Percentage xylological spectra (a-c) and percentage anthracological spectra (d).

Mean Ring Width (10^{-2} mm)	Standard Deviation	First-order Autocorrelation	Mean Sensitivity
151.7	90.9	0.910	0.191

Tab. 2: Main statistical parameters of the tree-ring sequence from the sample SEGONZANO SU 16.

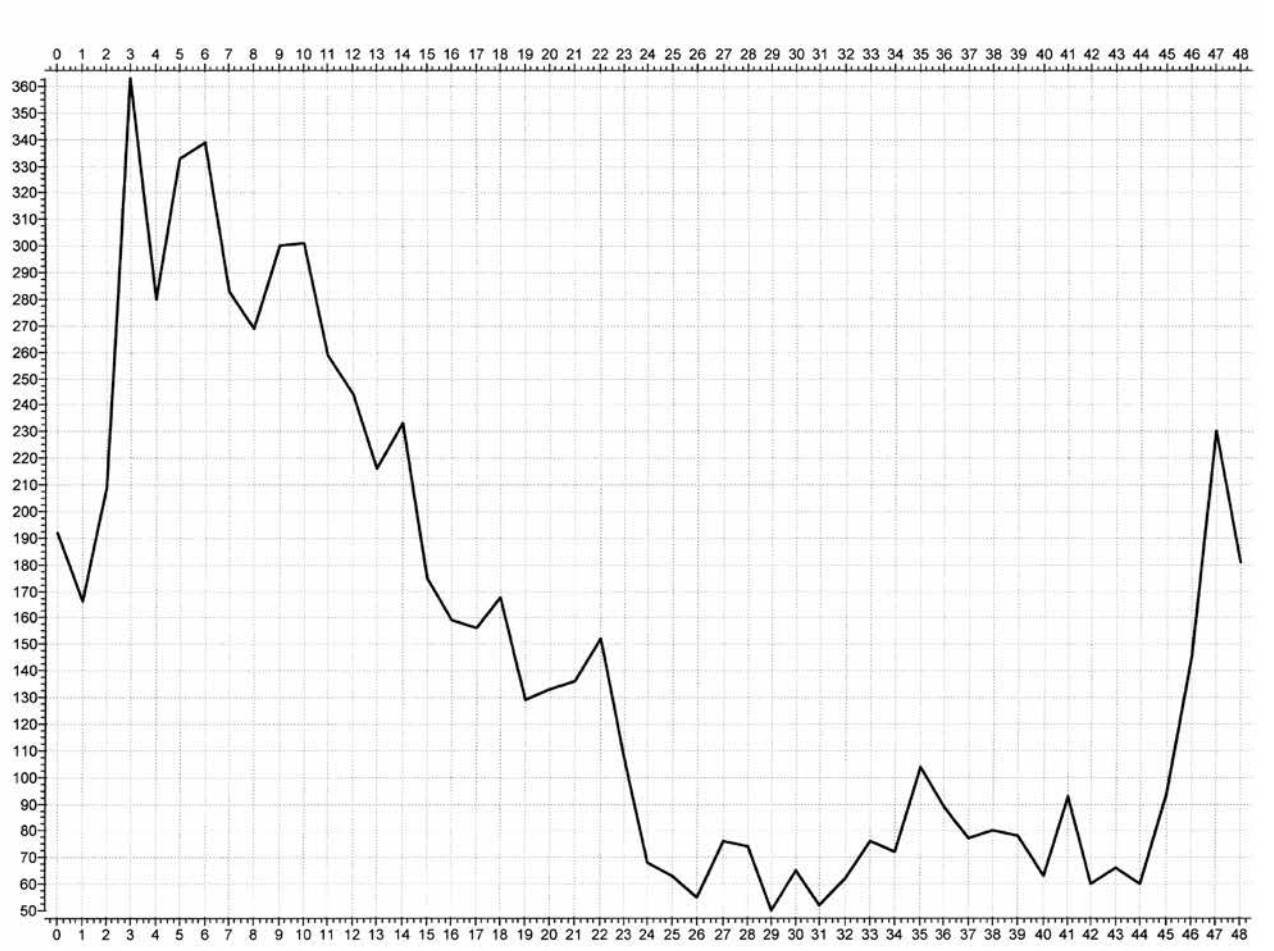

Fig. 8: Dendrochronological curve from the sample SEGONZANO SU 16.

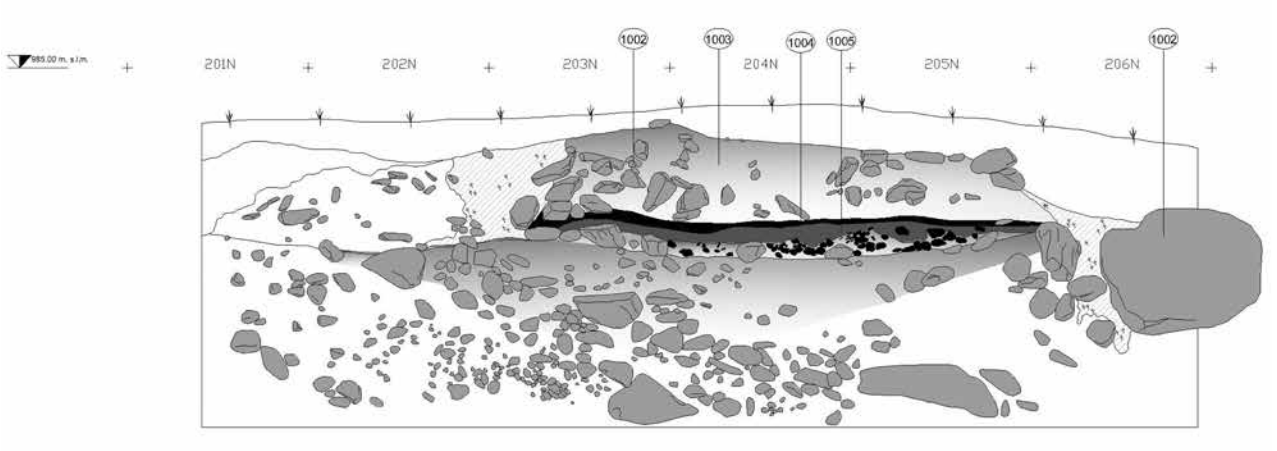

Fig. 9: Cross section of the fire structure in Transacqua locality Acquedotto del Faoro. The slags underneath the layer 1005 have been drawn in black.

Fig. 10: Oval shaped structure made of burnt clay surrounded by stones, unearthed in Luserna Pletz von Mozze.

Conclusions

The archaeological research carried out recently at three smelting sites in the Trentino region, Segonzano, Transacqua and Luserna, is improving the knowledge of the ancient metallurgy in the area. Furnace remains have been found, but also fire structures interpreted tentatively as roasting beds have been unearthed in Luserna and Transacqua. In all the investigated smelting sites, the slag types (plate slag, slag cakes, massive slag, “slag sand” or crushed slags) have been found in distinct layers. The slag heaps have been sampled systematically to understand the quantity of treated mineral and investigate the nature of the different slag types.

The archaeological data available from stratigraphic excavations have been the starting point for a larger research project, involving several disciplines (archaeometry, experimental archaeometallurgy, technological study of the stone tools). The part of the research project

focused on archaeometrical analyses of slags is being carried out in collaboration with the Department of Geosciences at the University of Padua and, more recently, with the Deutsches Bergbau-Museum Bochum[1].

The main aim of the research is to improve our understanding of the technological and physico-chemical processes regarding the extraction and smelting of mineral ores in the Trentino region. The work is in progress and the potential information coming from the sites is enormous, especially from Luserna, extensively investigated, and Segonzano, where the preservation of the wooden remains has been confirmed during the 2011 excavation campaign in the peat bog.

Footnote

1 The study is part of the PhD dissertation of one of the authors, E. Silvestri, under the supervision of A. Hauptmann (DBM Bochum and Ruhr-University Bochum), and it is mainly focused on the formation process of the plate slags, very common and typical of the Late Bronze Age smelting sites of the Alpine area.

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