Prehistoric copper production in the Alps

In the earliest time periods, written historical records simply did not exist. By considering landscapes as markers of early society, **Professor Philippe Della Casa** seeks to fill in some of the knowledge gaps

Could you describe how your research journey has developed over the past few decades, and explain what motivates you in your work?

Societies and their economies at the onset of human alpine population have been one of my key research interests since the 1990s. My first focus was on colonisation processes whereby I investigated how and why people would inhabit the Alps in the first place. One must keep in mind that on a European scale, the Alps are among the inhospitable areas – a reputation that they kept at least through to the Roman period or even the Middle Ages. Why, then, would people want to live in the Alps? I think the answer lies in the specific resources offered by mountain areas: game for the hunters and gatherers of the early post-glacial periods, Alpine meadows for the pastoralists and – in particular – mineral resources such as flint and greenstone for tool production in the Neolithic Age and metal ores in the Bronze and Iron Ages. Investigating the relationships between human cultural evolution and the use of resources is a thrilling field of research.

What innovative methods are you using in this project?

Since very little research has been done in our research area to date, we started with limited baseline indicators. A key element in our research is that the starting point is a simulation model of copper production – the widely used term is 'chaîne opératoire' (operational sequence), and not the survey in the landscape itself. The simulation model tells us what kinds of sites we have to look for in which areas, as well as what kinds of materials they could be associated with. Of course, the expertise of our project partners in other regions of the Alps is of great help in this.

Could you highlight the most significant or surprising findings you have made to date?

When we set out in 2013, we were expecting to find Late Bronze Age (c. 1200-800 BCE) copper production. However, all the sites that we have found and investigated so far in the upper part of the Oberhalbstein valley in Grisony seem to pertain to an early phase of the Celtic Iron Age (c. 800-500 BCE). This is what radiocarbon and dendrochronological dates on charcoal tell us, be it from ore extracting sites or from smelting furnaces. By definition, the Iron Age is the period when people in Europe started to produce iron, replacing bronze as the most important raw material, even though bronze remained important for the production of ornaments and vessels. So the big question now is: where did the Oberhalbstein copper go? And what was it used for within the economic network that we must assume for the period in question?

Do you face any major challenges in your fieldwork?

Topography, exposure, climate and unpredictable weather changes are challenges to all field projects in the Alps. I remember investigating a steep ore outcrop near Septimer Pass on 25 June 2015 at temperatures around 0° C, in dense fog and with horizontal snowfall. Field seasons are usually short and extremely busy, which can be challenging. You certainly need a good deal of endurance in Alpine fieldwork! Fortunately, the team and the university students participating in the fieldwork are well prepared for this.

How important is international collaboration in advancing the goals of this research project?

I see it as a key success factor. On the one hand, it offers the opportunity to draw upon scientific expertise gained in other areas but similar settings, such as the Inn valley or Mitterberg in Austria, and to be in constant exchange with research teams that work on a parallel set of topics. On the other hand, each research area within the tri-national project has its specificities, be it in the geological framework (different ores), the time sequences (different periods) or the technology, which offers excellent ground for comparison. The Mitterberg region in Austria, for example, appears as the quasi-industrial big copper producer of the Bronze Age – this was certainly not the case with the Oberhalbstein valley.

Waste rock dump at the ore extracting site of Ochsenalp, Grisony

Aerial view of an excavated smelting furnace in Gruba, Grisony

Copper and clues from the past

A multinational collaboration of archaeologists and anthropologists offers a rare insight into the large-scale dynamics of Europe's metal industry in the Bronze and Early Iron Ages. Researchers at the **University of Zurich** are exploring what they can learn from the Alps of Grisony

HUMAN PREHISTORY IS split into three time periods, which are named after different materials: the Stone, Bronze and Iron Ages. The Iron Age is the most recent of these, lasting from around 800 BCE to the beginning of the Roman Empire. It was preceded by the Bronze Age, around 2,200-800 BCE, and the Stone Age, which predates the development of metalworking altogether.

Prehistoric eras, by definition, lack written historical accounts, making it challenging to understand what life was really like during these periods. Exploring prehistory therefore depends on looking for clues that extend beyond the written word. For instance, we know that prehistoric human societies were dependent on local metallurgic economies. These early economies, and related activities such as mining, shaped the way societies and landscapes developed by, for example, influencing the location of settlements, the establishment of trade routes and the shift from agarian to early industrial lifestyles. We can understand the past better by discovering how these early trade and economic networks were built up – processes that were inextricably linked to metal production activities.

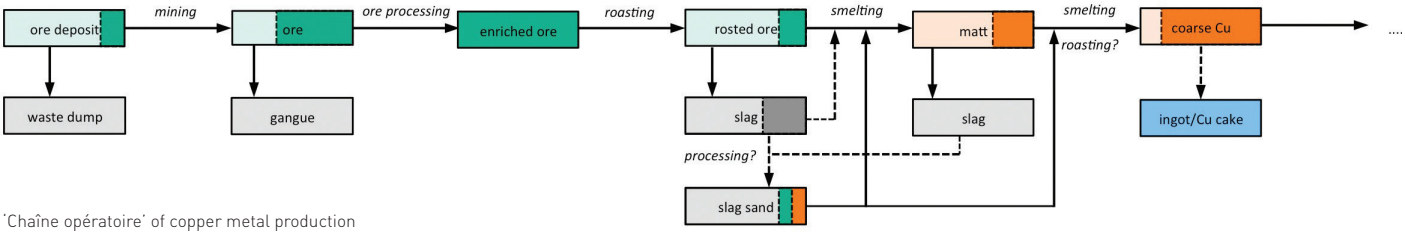
MINING NETWORKS

Prehistoric metal production activities are the focus of a multinational German-Austrian-Swiss collaboration. The projects are split between three different locations considered to be key for metal production in Central Europe during the Bronze and Early Iron Ages: the Schwaz/Brixlegg district of North Tyrol, Austria, the Mitterberg district in Salzburg, Austria, and the Oberhalbstein district in Grisony, Switzerland. Advanced knowledge about prehistoric sites in these regions affords a rare opportunity for studying the inter-region dynamics of large-scale metal production within and beyond the three locations.

One arm of this research is being led by Philippe Della Casa, Professor of Prehistoric Archaeology at the University of Zurich, in collaboration with local heritage services, the Universities of Innsbruck and Bochum, and the Curt-Engelhorn-Center for Archaeometry in Mannheim. By combining theory, novel methods and intensive fieldwork, Della Casa hopes to build a comprehensive picture of the metallurgic economies and activities around prehistoric settlements in the Oberhalbstein valley in the Alps of Grisony. He plans to outline a general picture of early metal production in the Alps of Grisony by combining archaeological, anthropological and historical approaches with spatial knowledge, including details of local landscapes and analysis of metallurgical data, particularly about ores, slags and copper metal.

FINDING ARCHAEOLOGICAL SITES

Della Casa and his team adhere to the concept of 'chaîne opératoire', which considers the operational chain of a material's life, from origin to discard. This includes all technical processes involved, such as ore extraction, beneficiation, smelting and refinement. It also includes analysis of the social acts pertaining to the material, including how the material was used, diffused and discarded. By modelling and predicting the location of probable sites, the fieldwork is directed by theory and experience.



'Chaîne opératoire' of copper metal production

The first challenge of Della Casa's project is to determine sites where copper production and processing are likely to have been carried out. This requires combining theory with fieldwork and detailed surveys. Based on the assumption that copper production is largely determined by the landscape, it is logical to surmise that copper production sites are usually situated near to their two most important resources: copper ore and firewood. This means that sites are most likely to be found near forested areas, typically at the timber line, and also near to the steep rock faces from which ore can be obtained.

Moreover, since ore is difficult to transport, much of its processing occurs close to the source; as Della Casa points out: "Many of our newly discovered sites adhere to this pattern, which teaches us a lot about the organisation and use of space through time". Thus surveys locate and confirm the locations of extraction, processing, smelting and working sites, including washing plants, roasting hearths, furnaces and slag heaps. Unknown sites will be detected by field walking, observation of vegetation, sub-surface testing, geomagnetic survey and other remote sensing techniques.

FROM EXTRACTION TO ECONOMIES

Many steps taken in the copper production process leave traces that can be examined in the field or laboratory. For instance, some properties and by-products of metal production can be observed: "Mineralogical gangue, trace elements and lead isotopes are hallmarks of Oberhalbstein copper, and can eventually be tracked in the archaeological record of Europe," Della Casa explains. Thus it is possible, with intensive field and lab work, to trace the movement of Oberhalbstein copper throughout Europe.

This work is well under way and the group in Zurich has already discovered and relocated 40 sites of the copper industry spread over a range of geographical locations across the valley and in smaller, neighbouring valleys. The majority of these are slag heaps – the waste product of copper smelting – but they have also discovered ore extraction sites, six of which were used until subrecent periods, making it difficult to determine which activities were prehistoric without the use of radiocarbon and dendrochronological dating.

FUTURE WORK, WIDER IMPACT

By adding to the collective knowledge of social and economic structures in early Europe, Della Casa's work is deepening our understanding of prehistoric and long-term cultural evolution on this continent. In time, he hopes to address a range of further questions: What characterised Alpine populations at the threshold between agrarian subsistence and economic expansion? How important was the use of specific resources such as copper ores for the evolution of these societies? How was the Alpine area linked to other regions of Europe?

Mines from different regions produce copper using different types of copper ore, which they likely did at different but overlapping periods. For example, the Oberhalbstein copper is geochemically distinguishable from Fahlore copper and Eastern Alpine copper. Precise chronological data can be obtained using dendrochronology, accompanied by geochemical analyses and econometric evaluations. This will enable the wider project to include a comparison between the different mines from the three locations that are under scrutiny, and so allow a large-scale analysis of the prehistoric copper trade in Central Europe – something which has not been done before.

Della Casa's drive to learn about the human occupation of mountain environments remains strong, with his plans for future work potentially extending to further regions of the globe: "A few years ago, we started an archaeological knowledge transfer programme with the kingdom of Bhutan in the Himalayas, and several of our students work on topics in the Andes in South America," he says. "I see great potential for comparing cultural and metal production processes between distant regions."

> Steps taken in the copper production process leave traces in the landscape that can be examined in the field or laboratory

Students of Zurich University working in a mining gallery at Vals, Grisony

PREHISTORIC COPPER PRODUCTION IN THE ALPS

OBJECTIVES

- To trace the prehistoric production of copper metal in the Alps of Grisony, Switzerland
- To identify the technological processes in early copper production
- To model the diffusion of copper products within Bronze Age European networks

KEY COLLABORATORS

Dr Rouven Turck; **Leandra Reitmaier-Naef MA**; **Dipl.-Ing. Anja Buhlke**, University of Zurich, Switzerland • **Dr Thomas Reitmaier**, Archaeological Heritage Service of Grisony, Switzerland • **Professor Gert Goldenberg**, University of Innsbruck, Austria • **Professor Thomas Stöllner**, University of Bochum, Germany • **Professor Ernst Pernicka**, Curt-Engelhorn-Center for Archaeomtery, Germany

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PHILIPPE DELLA CASA completed his PhD in 1994 at the University of Zurich. The key topics of his research are theory, methods and field practice in Alpine and Mediterranean landscape and settlement archaeology, with a particular focus on social and economic processes. Since 2002, he has been Professor for Prehistoric Archaeology at the University of Zurich.

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