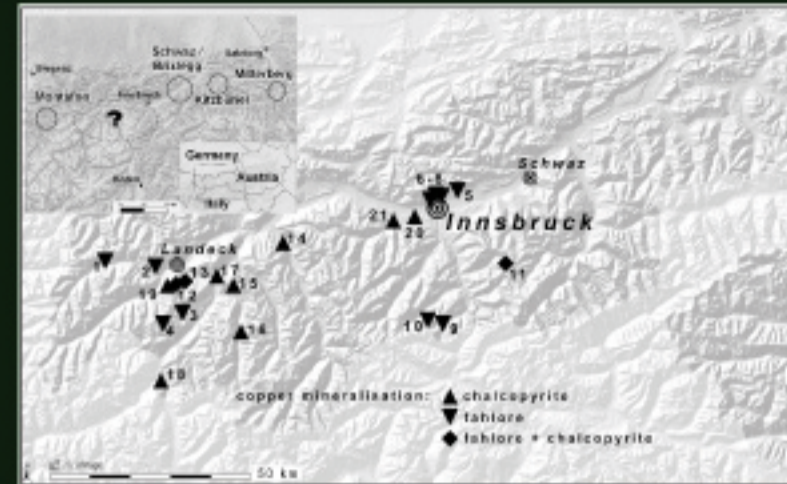


Mining archaeological and mineralogical surveys in western Tyrol: Evidence for prehistorically exploited copper resources?

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Premises

The institutional mining archaeological research in Tyrol of the last years was focused on the "big players" like Schwaz-Brixlegg and Kitzbühel area. Beside these there are more than 70 base metal mineralizations in western North Tyrol - some of them in vicinity of huge prehistoric hoard finds. Therefore the project pursued three main goals in this area: 1) locating any evidence for prehistoric mining 2) mineralogical and geochemical characterization of the copper ores 3) providing a basis for archaeological excavations.



Mining archaeological research gap in western North Tyrol (top left) and mapping of the surveyed and sampled copper mineralizations. For the corresponding site names see Tab. 1. Graph: K.-P. Martinek. Top left: G. Hiebel, C. O. Grutsch

Surveys

On economic geological, topographical and mining based criteria 27 out of over 70 known ore occurrences have been selected. More than 30 surveys were carried out. At 21 sites relevant copper mineralizations could be found and sampled. In addition GPS points of the sampled places and photographs were taken.



Outcrop at Masneralpe/Serfaus. Photo: K.-P. Martinek



Chrysocolla covers the floor of an ancient gallery in Tschingl/Vergötschn. Photo: C. O. Grutsch

Archaeology

Fire-setting and/or stone tools indicated potentially prehistoric workings at *Rotenstein* and *Masneralpe/Serfaus*, *Knappenkuchl/Navis*, *Wildgrube/Obernberg* and *Knappenlöcher/Hötting*. At Navis and Hötting small sondages were carried out, but no further evidence for prehistoric mining appeared. Additional surveys (also for smelting sites) and more extensive excavations to gain exact datings for the fire setted sections in all four mines should be the next steps of procedure.



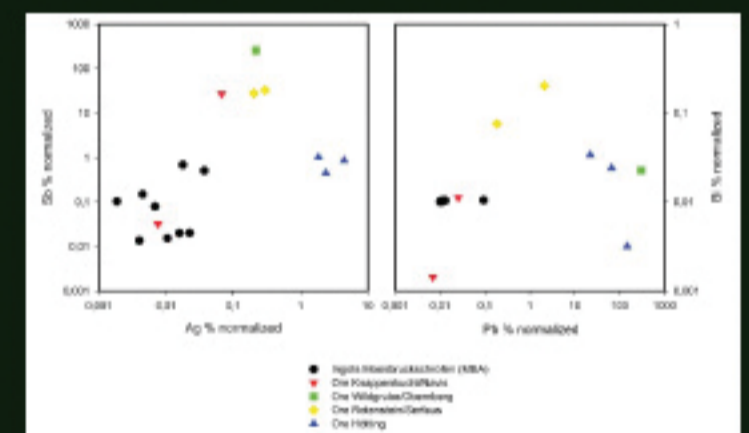
Ancient copper mine with fire-setting, in part reworked by blasting. Knappenkuchl/Navis. Photo: K.-P. Martinek



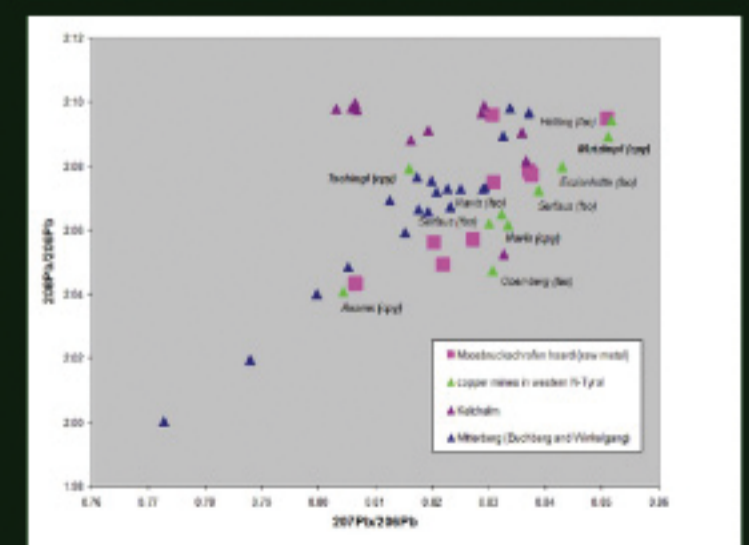
Hammer stone, Knappenkuchl/ Navis. Photo: C. O. Grutsch

Mineralogy

More than 50 polished sections of selected ore samples were studied by ore microscopy and electron microprobe analysis. In addition trace element analysis and determination of lead isotope ratios have been carried out on selected samples.



Chemical composition of blister copper ingots from the Moosbruckschrofen hoard (Middle Bronze Age) and ores from western North Tyrol. The data shows that only one sample from Navis matches the ingots. Graph: J. Lutz



Lead isotope data comparing the copper ores from western North Tyrol with the ores from Mitterberg and Kelchalm and the raw metal finds of the Middle Bronze Age hoard from Moosbruckschrofen/Tyrol. Graph: K.-P. Martinek, J. Lutz

Polished ore samples:

Photos K.-P. Martinek

- 1: Tetrahedrite and cobaltite *Rotenstein/Serfaus*
- 2: Tetrahedrite and galenite *Wildgrube/Obernberg*
- 3: Tetrahedrite and chalcopyrite *Knappenhäusl/Landeck*
- 4: Chalcopyrite and gersdorffite *Mutzkopf/Nauders*

mining site	ore minerals	geochemistry
1 Gams	tetrahedrite	Cu, Sb, As, Ag, Hg
2 Färscher Schichte	tetrahedrite, pyrite, gersdorffite, selenite	Cu, As, Bi, Fe, Zn, Ni, Co, Bi
3 Serfaus Rotenstein	tetrahedrite, galenite, jordanite, pyrite, selenite, cobaltite, galenite	Cu, Sb, As, Fe, Zn, Ag, Pb, Bi, Hg
4 Serfaus Masneralpe	tetrahedrite, chalcopyrite	Cu, Sb, As, Fe, Zn, Ag, Co, Bi, Hg
5 Ruan Endershöhe	tetrahedrite, galenite, jordanite	Cu, Pb, As, Sb, Fe, Zn, Ag, Bi, Hg
6 Hötting St. Helens	tetrahedrite, galenite, selenite, selenite, selenite	Cu, Pb, As, Sb, Fe, Zn, Ag, Bi
7 Höttinger Graben	tetrahedrite, galenite, jordanite, pyrite	Cu, Pb, As, Sb, Fe, Zn, Ag, Bi
8 Höttinger Gölz	tetrahedrite, galenite, jordanite, pyrite	Cu, Pb, As, Sb, Fe, Zn, Ag, Bi
9 Oberberg Wildgrube	tetrahedrite, bornite, galenite, selenite	Cu, Pb, As, Sb, Ag, Bi, Hg
10 Oberörtal Gangflote	tetrahedrite, pyrite, chalcopyrite	Cu, Sb, As, Fe, Zn, Ag, Bi
11 Navis Knappenkuchl	tetrahedrite, arsenite, pyrite, chalcopyrite, galenite, gold	Cu, Sb, As, Fe, Zn, Pb, Bi, Hg, Co, Ni, Sn, Au
12 Tobadl Zinnag	tetrahedrite, chalcopyrite, arsenopyrite	Cu, Sb, As, Fe, Zn, Bi, Co, Ni
13 Landeck Knappenhaus	tetrahedrite, chalcopyrite, arsenopyrite	Cu, Sb, As, Fe, Zn, Ag, Bi
14 Nauders Mutzkopf	chalcopyrite, pyrite, pyrrhotite, gersdorffite	Cu, Fe, As, Ni, Co
15 Oberlötzer	chalcopyrite, pyrite	Cu, Fe
16 Vergötschn Tschingl	chalcopyrite, pyrite, arsenopyrite, gersdorffite	Cu, Fe, As, Ni, Co
17 near Kuchl	chalcopyrite, pyrite	Cu, Fe
18 Nauders Mutzkopf	chalcopyrite, pyrite, arsenite, Pb-Bi-sulfide, arsenopyrite, gersdorffite, galenite	Cu, Fe, Pb, Bi, As, Sb, Ag, Ni, Co
19 Tobadl Höttinger	chalcopyrite, pyrite, cobaltite	Cu, Fe, As, Co, Ni
20 Navis Knappenhaus	chalcopyrite, pyrite, pyrrhotite, galenite, arsenopyrite	Cu, Fe, Ag, Bi, As
21 Serfaus Schwabenhof	chalcopyrite, pyrite, pyrrhotite	Cu, Fe

Tab. 1: Site names and the mineralogical and geochemical characterization of the sampled ores.

Graph: K.-P. Martinek, C. O. Grutsch