Mining in European History and its Impact on Environment and Human Societies –

Proceedings for the 1st Mining in European History-Conference of the SFB-HIMAT, 12.–15. November 2009, Innsbruck

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Spezialforschungsbereich (SFB) HIMAT
Die Geschichte des Bergbaus in Tirol und seinen angrenzenden Gebieten – Auswirkungen auf Umwelt und Gesellschaft
Universität Innsbruck

The Special Research Program HiMAT is supported by the Austrian Science Fund (FWF), the Autonomous Province of Bozen – South Tyrol, the Countries Tyrol, Salzburg and Vorarlberg, the Stand Montafon, the Municipalities of Bartholomäberg and Silbertal, the City of Schwaz, the University of Innsbruck, transidee transfer center of the Innsbruck University, the Federation of Austrian Industries and the Wilhelm-Momnmertz Foundation.

Universität Innsbruck, Vice-Rectorate for Research
1st edition.

Coverphotos: Dr. Nadja Riedmann
Processing: Mag. Barbara Viehweider
Printed by: Fred Steiner, Rinn

www.uibk.ac.at/iup

ISBN 978-3-902719-69-0

Grotta della Monaca: A Prehistoric Copper and Iron Mine in the Calabria Region (Italy)

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The Grotta della Monaca is located in the municipal district of Sant'Agata di Esaro, in north-western Calabria (southern Italy). Its imposing entrance (600 m above sea level) dominates the Upper Valley of the Esaro River, not far from the Tyrrhenian Sea. It extends for 355 m into the dolomitic Trias limestone, with places different in size and morphology (galleries, chambers, narrow passages). The cavity is characterized by three distinct sectors: the "Pregrotta", a wide entrance gallery; the so-called "Sala dei pipistrelli", a huge chamber in the middle of the cave system; the "Cunicoli terminali", a series of low and narrow final passages.

The Pregrotta is a slightly sloping wide gallery with the floor completely invaded by a chaotic tumble of large boulders. It ends near a small uphill passage, through which it is possible to enter in the Sala dei pipistrelli, the widest underground chamber in the cave (60 m long and 30 m wide). The Sala dei pipistrelli owes its name to the presence of a large colony of bats and descends via a steep clayey slope in its most inner part. The entrances of three Cunicoli terminali can be reached at the end of this slope. The longest of these passages is 60 m. These passages force the visitor to move forward by crawling for most of their length, until they become so narrow that it is impossible to try any further attempt to progress.

The cave contains plentiful iron and, in lesser quantities, copper mineralizations. The most widespread iron mineral is goethite [$\alpha FeO(OH)$], a hydroxide that occurs isolated or associated with another hydroxide, lepidocrocite [$\gamma FeO(OH)$], its polymorph. Goethite occurs everywhere in the cave, from the entrance to the innermost and farthest places from the surface: sometimes it outcrops from deep fractures in the rock, on the roof and on the walls; most frequently it lies on the ground where it has fallen. Furthermore, there are also other iron minerals, such as hematite (αFe_2O_3), an oxide, and yukonite [$Ca_2Fe_3(AsO_4)_4(OH)\cdot 12H_2O$], a hydrated arsenate of iron and calcium.

The copper mineralizations are found only in the final sectors of the cave system, showing as green and, less frequently, dark bluish stains. They are principally carbonates, such as malachite [$Cu_2CO_3(OH)_2$] and azurite [$Cu_3(CO_3)_2(OH)_2$], even if, particularly when occurring on the ground, they sometimes can be associated with copper sulphates and phosphates such as brochantite [$Cu_4(SO_4)(OH)_6$], libethenite [$Cu_2(PO_4)(OH)$] and sampleite [$NaCaCu_5(PO_4)_4Cl\cdot 5H_2O$]. Malachite is the most widespread copper mineral inside the cave: it covers calcite flows and calcareous walls with thin layers and occurs particularly on the surfaces of small stones scattered on the ground or contained in the clayey sediments. It is also often closely associated with iron minerals.

These mineral resources have strongly conditioned the man-cave relation, so the cave was frequented on several occasions during prehistory for the exploitation of both iron and copper minerals. The first ore to be mined was the goethite: the exploitation of this iron hydroxide starts near the cave entrance during the Upper Palaeolithic. In fact, recent archaeological excavations have led to the discovery of numerous flint tools with an atypical shape, mostly scattered inside deep fractures in the rock full of goethite. A human ulna comes from the same levels of this industry; it was deliberately placed under a calcareous boulder, in an isolated position. This ulna was probably placed inside a small hollow dug into goethite and then covered with the boulder. This bone find has given a calibrated radiocarbon date of 18250-17800 cal BC (84.6 %) / 17750-17600 cal BC (10.8 %) (LTL3580A – 16761 ± 100 BP).

Clear evidence of a subsequent exploitation of goethite is found both in the so-called "Buca delle impronte", a secondary branch of the Sala dei pipistrelli, and in the "Ramo delle vaschette", near the point of access to the Cunicoli terminali. A series of radiocarbon dates have been determined by CEDAD (Università degli Studi del Salento – Italy):

Sample	**Typology**	**Hypogean sector**	**Radiocarbon Age (BP)**	**Calibrated date (2σ range)**
LTL3581A	charcoal	Buca delle impronte	4880 ± 45	3780BC (89.8 %) 3630BC 3580BC (5.6 %) 3530BC
LTL3582A	charcoal	Buca delle impronte	4935 ± 45	3800BC (95.4 %) 3640BC
LTL3583A	charcoal	Ramo delle vaschette	5183 ± 50	4230BC (2.3 %) 4200BC 4170BC (4.9 %) 4090BC 4080BC (79.4 %) 3920BC 3880BC (8.9 %) 3800BC
LTL3584A	charcoal	Ramo delle vaschette	5010 ± 50	3950BC (95.4 %) 3690BC

The tools used for mining the iron hydroxides left numerous marks, sometimes excellently preserved on the surfaces of the veins. It is possible to identify blows by picks made of deer antler and goat horn, but also marks made by small shovels, probably due to the use of pig scapulas. We have not found any of these bone tools, apart from the tip of a goat horn radiocarbon-dated to 3540-3360 cal BC (78.3 %) / 3640-3560 cal BC (17.1%) (LTL3579A – 4684 ± 50 BP). It seems that prehistoric miners preferred a type of strongly hydrated goethite, which can even be moulded by finger pressure. This high malleability is what has allowed the preservation of many antler or horn tool marks. The hardest and most compact variety of goethite was discarded: it can be often be found piled behind lengths of dry-stone walling, built to free the most narrow underground passages. In some mining sectors with potential risk of collapse we have found goethite pillars, left to support the possibly unstable roof.

Alongside the exploitation of iron hydroxides, during the fourth millennium BC mining began that was evidently directed at the copper ores, particularly malachite. Different types of mining tools were used for the winning of iron or copper minerals: deer antler picks and other bone tools for mining iron ores; hammerstones with more or less deep grooves for the extraction of copper carbonates. Grooved tools are found widely scattered on the ground in all the underground sectors where copper ores outcrop, proving the relation between these tools and copper minerals. 45 examples of these grooved hammerstones have been found to date; most of them are complete, but a few are fragmentary. These tools differ in size, weight and lithology. The groove usually runs around the body of the tool and it can sometimes be associated with notches. Grooves and notches are functional for hafting, which must have used organic materials. The opposite ends of these artefacts can be more or less rounded or angular. When excluding the fragmentary finds, three typological classes are recognizable with certainty, called “hammer-axes”, “mallets” and “picks”. The biggest grooved tool found to date is 3,115 g (19.1 cm long, 12 cm wide and 8.5 cm thick), while the smallest is only 677 g (9.7 cm long, 9.1 cm wide and 4.8 cm thick).

Copper minerals were acquired out by two techniques, which we have conventionally called “scraping” and “stripping”. Scraping represents an immediate solution for mining because it consists in the direct detachment of the minerals that can be seen on the rock walls. It is easy to recognize, particularly inside the Cunicoli terminali, thanks to clear scratches on the greenish stains of malachite, which stick to the dolomitic limestone rock. On the contrary, stripping is the violent destruction of deposits on the ground for the copper ores which they contained. This technique was recognized archaeologically after stratigraphic excavations that led to the finding of completely broken up stalagmites, stalagmitic crusts and calcite flows. The association of these with complete or fragmentary hammerstones is irrefutable evidence that human activity caused the breaking of these concretions. The stripping of the deposits on the ground allowed the collection of minuscule malachite clots and, in particular, small calcareous stones with concretions of malachite on their surfaces. Stripping made possible the acquisition of a greater quantity of copper minerals than scraping, with a considerable saving of time and energy for their extraction.

The prehistoric mining at Grotta della Monaca ended during the Bronze Age (second millennium BC), when the deepest sectors of the cave were used for funerary purposes. The mining of iron hydroxides started again in the post-Medieval period, when artificial galleries were dug using metallic picks under the natural ground surface of the Pregrotta and the Sala dei pipistrelli.

An interesting observation that may be drawn from the archaeological study of this ancient Calabrian mining context regards the role sometimes played by karstic caves, especially if located in places with high mining vocation. In fact they may have functioned as particularly profitable “access keys” to the precious underground sources, thus easily attainable without too much effort. Therefore they represent an excellent research field for the identification of ancient mining activity.

Fig. 1: The wide entrance of Grotta della Monaca seen from the inside (photo by D. Lorusso).

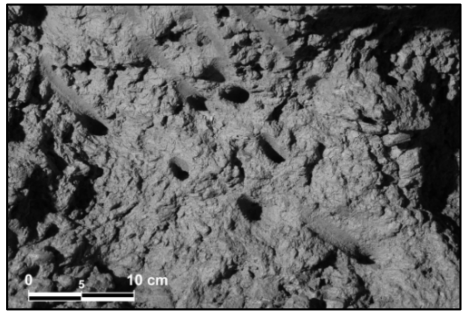

Fig. 2: Marks on hydrated goethite left by working with a deer antler pick (photo by F. Larocca).

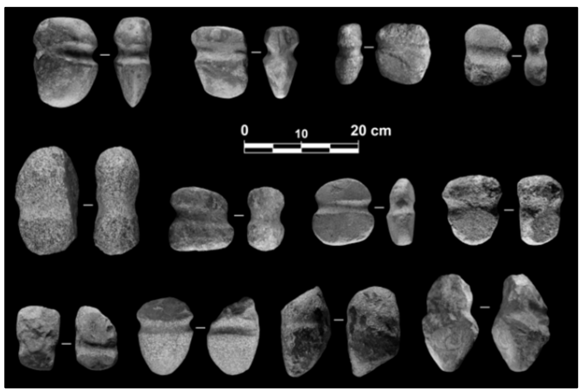

Fig. 3: Grooved hammerstones found in the deepest sectors of the cave (photo by F. Larocca & S. Marino).

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