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Killing the Cauldron | **Hunting for Use-Wear**

ISSN: 2212-523X

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EXARC JOURNAL 2021 Digest

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Design: Magdalena Zielińska (EXARC)
Print: DrukWerkDeal.nl

Front cover:
Removing the heather saturated with heavy mineral concentrate from the wooden sluice-box. Photo by F. Stremke
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ISSN: 2212-523X

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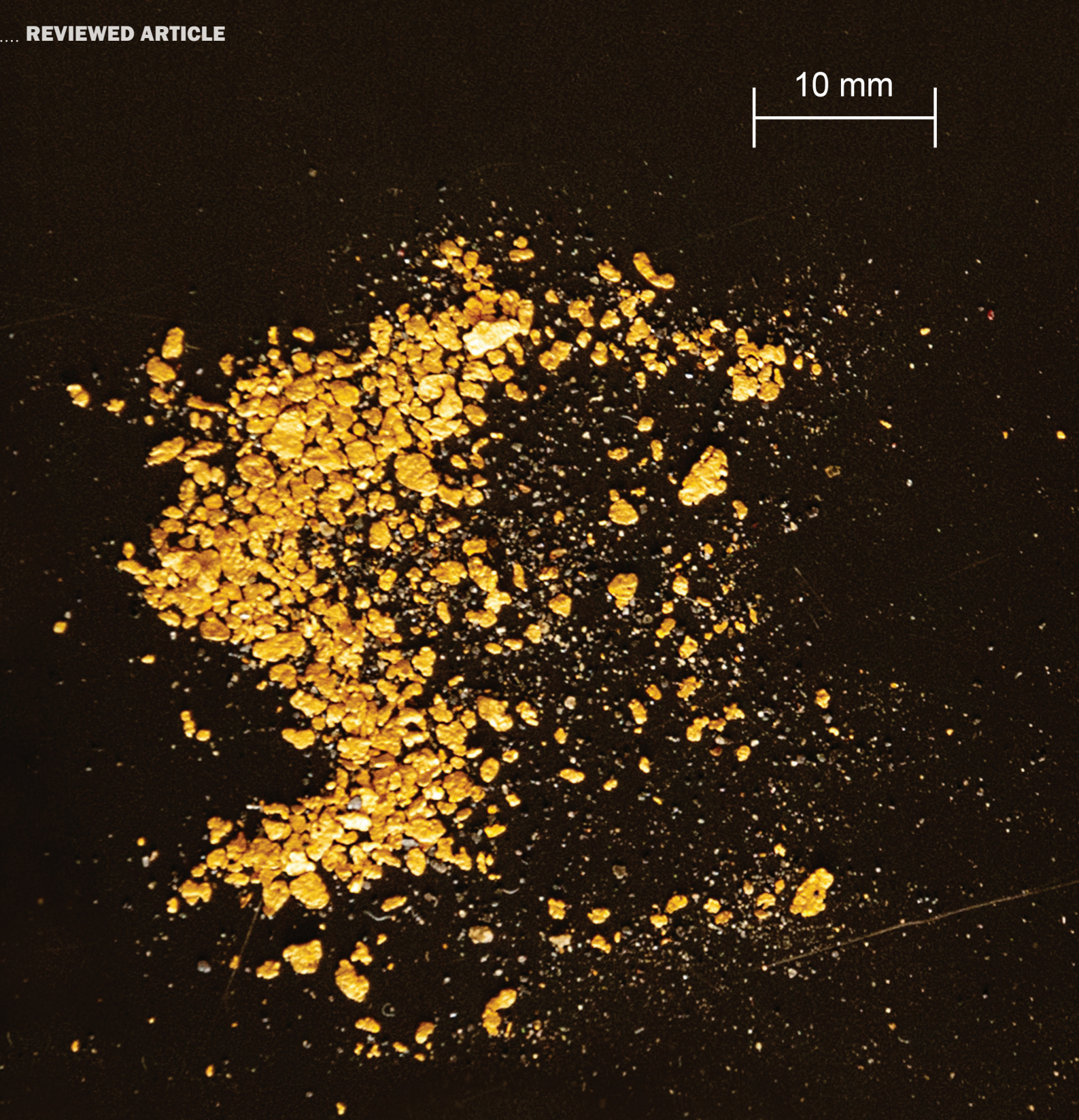

ROMAN GOLD WASHING AS DESCRIBED BY PLINY THE ELDER

| Brigitte Cech and Heimo Urban (AT)

As part of a four-year interdisciplinary research project of a Roman gold mine in the landscape known as the "Karth" to the south of Vienna, Austria, a reconstruction of gold washing took place as described by Pliny the Elder in book 33 of his Natural History (Austrian Science Fund Project P30790-G25).

Topography and Geology of the Karth

The "Karth" is the local name of a hilly landscape about 70 km south of Vienna. It is bordered to the north by the Wiener Becken, to the east by the valley of the Pitten, to the south by the valley of the Hassbach and to the southwest by the Syhrngraben (See Figure 3). Here the Romans mined a secondary deposit called the Loipersbach Formation.

The Remains of Roman Gold Mining

Since the gold is randomly distributed, the Romans invented hydraulic mining, a method by which the deposit is eroded by the power of water. In the 33rd book of his Natural History, Pliny describes hydraulic mining from first-hand experience (Plin. NH, 33, pp.76-78, In: Bird, 2004, p.59). Aqueducts, which are known as "leats" in a mining context, were built to conduct water to large tanks above the deposit. After the surface of the deposit was cleared of vegetation and overburden, the sluice gates of the tanks were opened, and water was led over the deposit to erode it. The accumulated sediment was then washed to obtain the gold.

Since the "Karth" was never used for agriculture and is heavily forested, remains of Roman gold mining are exceptionally well preserved. Five leats with a total length of about 122 km leading to the individual mining areas with their tanks have been discovered. The mining area, together with the catchment area of the leats, covers an area of approximately 130 km² (See Figure 2).

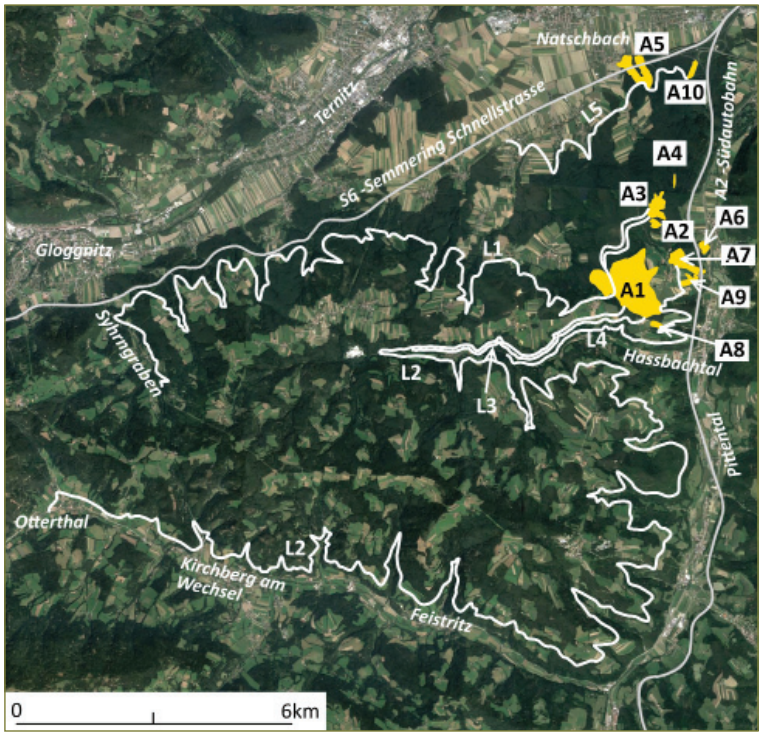

Fig 2 (Above). The "Karth": Overview of Roman goldmines and leats (A – Mining area, L – Leat) (Mapping: B. Cech) (Google Earth 2019: Image Landsat/ Copernicus).

Fig 3. The remains of Roman hydraulic gold mining in Las Médulas. Photo by B. Cech

Fig 1 (Previous page). Gold obtained by washing gravel sediment with the reconstructed Roman sluice-box. Photo by F. Stremke

Read more about the project at www.karthgold.com

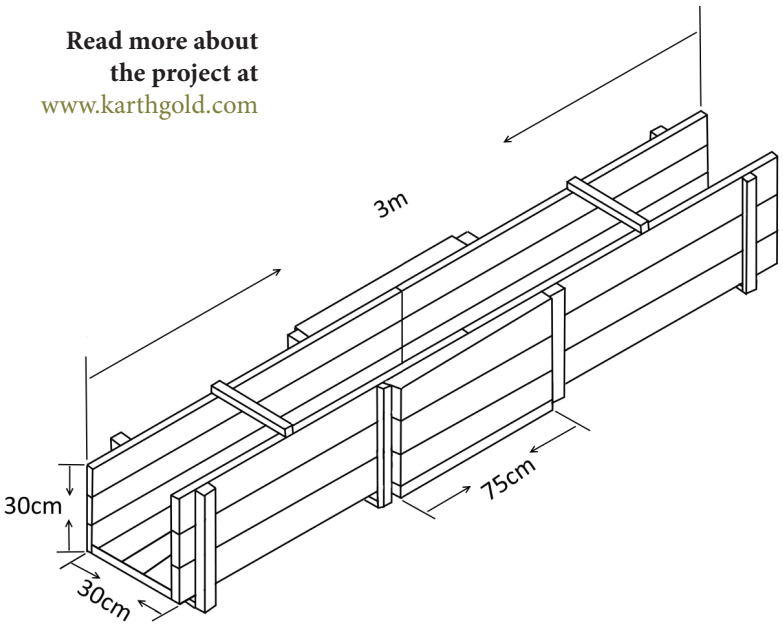

Fig 4 (Above). Technical drawing of the reconstructed Roman sluice-box. Image by F. Stremke

Fig 5. Attaching the wooden strips to the bottom of the sluice-box. Photo by F. Stremke

Gold Washing, according to Pliny the Elder

Pliny describes washing the sediment obtained through hydraulic mining as follows:

> *"Even now there is another task on the level ground. Ditches are dug out – they call them agogae – through which the torrent of water can flow, and then they are strewn at intervals with ulex. This bush is like rosemary, rough and able to catch the gold. The sides [of the agogae] are enclosed with boards and the channels are supported over broken ground. Thus, the earth flowing onwards slides away into the sea, and the shattered mountain is washed away. …. The debris which is removed with great effort in the previous method, so that it does not choke the shafts, in this [method] is carried away by water. … The ulex is dried, burned and its ash washed over grassy turf so that the gold settles"* (Plin. NH, 33, pp.76-78, In: Bird, 2004, p.59).

Ulex has often been interpreted as gorse (*Ulex europaeus*), it is more probable that Pliny means heather (*Calluna vulgaris*), an abundant native plant of Northwestern Spain and the "Karth".

Pliny describes stationary channel-like sluice-boxes sunk into the ground with only the sides reinforced by wooden boards. If the natural surface consists of rock or hard clay, the heather can be fixed to it directly. If the natural surface is gravelly, the bottom would also have been covered by boards. Portable wooden sluice-boxes were most certainly used in addition to stationary ones. Pliny writes that the channels are strewn with heather at intervals. The most probable interpretation would be the long channels were lined with heather interspersed with sections without heather.

When the heather was saturated with black sand, it was removed from the sluice-box, dried and burnt. The ashes were then washed over a bed of grass. Unfortunately, Pliny does not describe this process in detail. The reconstruction by López (López, 2005, p.67) of this part of the washing process however makes perfect sense (See Figure 4). The ashes were washed on a wooden washing table whose lower part was covered by a dense bed of grass cut very short with its roots still attached. The light ashes would get swept away and the heavy

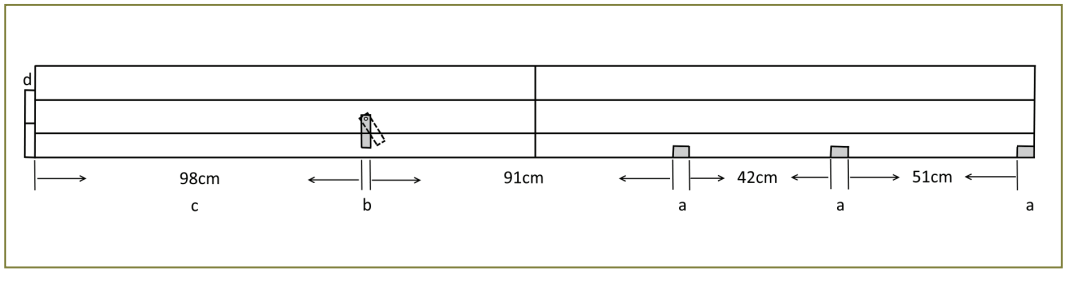

Fig 6. Section of the reconstructed sluice-box (a – wooden strips at the bottom, b – coarse separator, c – feeding area, d – boards enclosing the feeding area) . Image by B. Cech

gold would get caught in the grass. At the end the grass was removed and shaken so that the gold fell out. It can be assumed with great certainty that this concentrate was then washed in a pan.

Constructing the Sluice-box

For the size of our reconstructed sluice-box, we decided to use Roman units of measurements. Accordingly, our sluice-box was 3 metres (~ 10 Roman feet) long and 30 cm (~ 1 Roman foot) wide and high. The sluice-box was built in two separate halves, with a length of 1.5 m each, which were then joined together. The gaps between the boards were made water-tight with wood putty (See Figure 5).

Inside the lower half of the sluice-box, three wooden strips were fixed to the bottom to prevent the gold not trapped in the heather from being swept away (See Figure 6). The upper end was closed with two boards. About 1 m from the upper end, a hinged wooden flap was fixed to create an opening of 3 cm height. This served as a coarse separator to prevent large stones from being swept across the heather. Bunches of heather were bent in a U-shape, and the lower half of the sluice-box was lined with these bunches. The heather was fixed in place with twigs (See Figure 7).

Gold Washing with the Reconstructed Roman Sluice-box

The experiment was carried out in the Tobelbach, a brook running out of the "Karth", the sediment of which contains gold. The approximate equivalent of 2 m^2 of heather was collected in the forest.

Pointed wooden poles were attached as legs to each end of the sluice-box in order to support it in the brook. As the water flow of the Tobelbach was very low, water was pumped into the sluice-box by two pumps to ensure constant supply of water. For quality control, to check all the gold was being collected by the heather, a modern sluice-box was installed directly below the reconstructed Roman one.

Sediment from the brook was shovelled into buckets and poured into the sluice-box (See Figure 8). The sediment, swept over the heather, had to be kept in constant movement by hand. On the morning of the first day the heather became saturated after 41 buckets of sediment and had to be changed. The heather and heavy mineral concentrate were removed from the sluice-box and transferred into two buckets. The sluice-box was then lined with fresh heather and further 40 buckets of sediment were fed into it. At the end of the first day we had four buckets of heather saturated

Fig 7. Lining the bottom of the sluice-box with heather and fixing it with thin wooden strips and twigs. Photo by F. Stremke

Fig 8 (Below). Keeping the sediment in constant movement while removing stones. Photo by F. Stremke

with gold-bearing heavy mineral concentrate. The heather was then rinsed to separate most of the heavy mineral concentrate, which was then washed in a modern sluice-box. By doing this, the one bucketful of material obtained from the Roman sluice-box was reduced by 50%. This concentrate was then washed in a pan to obtain the gold. It can be assumed that the Romans also fed this concentrate again into a sluice-box before further refinement. Additionally, material that had accumulated in the modern quality-control sluice-box was washed in a pan. To our great joy, we did not find even one tiny flake of gold in this material, so we felt sure the heather had done its job.

On the second day of the experiment, the heather was saturated after 44 buckets of sediment had been fed into the sluice-box. Instead of using fresh heather, the saturated heather was rinsed in a bucket filled with water and put back into the sluice-box. A total of 80 buckets of sediment were fed into the sluice-box on the second day. Eight buckets containing a volume of 15 litres of heather and sediment were collected during the two days of using the reconstructed Roman sluice-box.

Fig 9. Burning the heather. Photo by F. Stremke

Drying and Burning the Heather and Washing the Ashes

After completing work at the brook, the heather was spread out on plastic sheets to dry (See Figure 9). On the third day of the experiment, the semi-dry heather was shaken into buckets to remove any remaining heavy mineral concentrate and was then burnt in a fire bowl. After 90 minutes, all the heather was reduced to a very fine ash, which was poured into a bucket filled with water.

Next, the heavy mineral concentrate removed from the heather before burning, as well as the concentrate that remained on the plastic sheets, were all washed in a pan. Finally, the ashes were also washed in a pan. Because the amount of heavy mineral concentrate obtained was relatively small, we skipped the washing over a bed of grass mentioned by Pliny.

Conclusions

Reconstructing Roman gold washing as described by Pliny the Elder yielded interesting new insights into the practice of Roman gold washing. These included details not mentioned by Pliny of the construction of stationary and portable sluice-boxes that are necessary for a successful outcome.

First, the wooden strips attached inside the bottom of the sluice-box prevented the gold not trapped in the heather from being swept out of the sluice-box and thereby being lost. Heather cannot be put into the sluice-box any odd way but has to be bent in a U-shape and put into the sluice-box with the U pointing upstream against the current of the water. Thereby a dense carpet of heather was created. The way it was put in, with the U pointing upstream, insures that the water and sediment can flow evenly across the heather without being impeded by small twigs and branches rising up against the current and thereby catching stones and sand. The heather must be fixed to the sluice-box so that it is not swept away by the water. This could be done with thin strips of wood or twigs. The heather should not cover the whole length of the sluice-box, and the upper end, where water and sediment are fed into the sluice-box, should remain free of heather. The coarse separator flap that we installed is not necessary if large stones are removed before the sediment is fed into the sluice-box, and an even and constant water supply is ensured.

It seems our decision to make a portable sluice-box of a length of ten Roman feet was a good one. It can easily be carried and installed by two men, and it can be set up even in difficult terrain. It can be supposed that several of these sluice-boxes were installed one after the other, with the water flowing from one sluice-box to the next.

It also became clear that heather saturated with heavy mineral concentrate can be used numerous times. The heather can be rinsed in a bucket and reused. Only when the small leaves, in which gold and heavy minerals get trapped, start to fall off does it need to be changed. It is also clear that the heather was rinsed in a bucket before it was burnt. The concentrate collected in buckets was most certainly pre-washed in portable sluice-boxes in order to reduce its volume further. Only then was it washed over a bed of grass together with the ashes of the heather. The grass was then shaken to obtain the gold. Depending on the desired purity of the gold, the material shaken from the bed of grass was finally washed in a pan.

A total of 0.132 g of gold was obtained from washing 161 buckets of sediment in the reconstructed Roman sluice-box (See Figure 1). The amount of gold obtained depends not on the efficiency of the reconstructed sluice-box, but on the amount of gold contained in the sediment.

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