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Três Minas: A discussion of some aspects of the evidence for the use of water in mining[1]

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Três Minas is one of the best preserved Roman mining districts in the Northwest of the Iberian Peninsula (Vila Pouca de Aguiar, Portugal) (*Fig. 1*). In the three primary ore-deposits of Três Minas, Gralheira and Campo de Jales the Romans mined gold, silver and other minerals in the 1st and 2nd century AD. In the area of Três Minas they established an industrial complex with a settlement that included thermae and an amphitheatre (Wahl, 1988; 1993). The presence of the military, as well as of free workmen and women, is proved by inscriptions (Wahl, 1997). The geographical and hydrological situation of Três Minas on the top of the hill demanded a highly elaborated system of water supply (Wahl, 2003).

More than 20 years of survey were necessary to collect all the information on the various components of this system, comprising 12 channels on different levels, dams, tunnels etc. dispersed over a surface of about 120km^2 and in parts heavily disturbed by agricultural and forestry activities (*Fig. 2*). By scrutinizing this system it became possible to follow the aqueducts from their origin to the mining area. It is obvious that they were constructed for different purposes.

The discussion about the use of water in the Roman mines on the Iberian Peninsula is often based on the work of Pliny (n. h. 33:74-78), where he refers to the various systems of mining and the use of water. This text or parts of it have been translated and discussed by many scholars among them philologists, archaeologists and engineers. This paper refers to Domergues (2012) latest translations and reflections on the text in connection with the use of water in Roman mining, as well as his criticism of Pérez González et al. (2008), Birds translation and interpretation (2004), the highly technical approach by the Projektgruppe Plinius (1993) and the excellent edition with translation into German and comments by König et al. (1984).

Plinys text is a strange mixture of descriptions to the point, dubious information and a structure jumping from one item to the other, so that it is often difficult to decide about its homogeneousness. Claude Domergue, after having studied and worked with the text for more than 40 years, emphasizes that Pliny was not a mining specialist and therefore not the author of an essay on its techniques. He suggests that Pliny gives us a general impression of working in the mines, of how hard and painful the conditions were, and also of the economic importance of the gold for the financial procurator (Domergue, 2012:134). To add another item which I think is important, Pliny's information is based entirely or at least partly on direct observation, but we do not know which places he really visited.

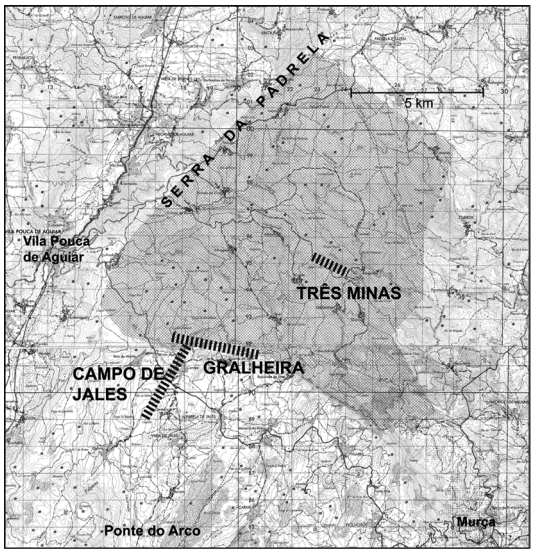

Fig. 1: Roman mining district of Três Minas and Campo de Jales. Broken lines = Ore-deposits of Três Minas, Gralheira and Campo de Jales. Hatched zone = Area of interest for the water-supply for Três Minas. Ponte do Arco = Roman bridge connecting the mining district to the South and the valley of the river Douro. (Carta militar de Portugal Instituto geográfico do Exército 1:50'000. Folhas 6-II (Vila Pouca de Aguiar) and 10-I (Vila Real); draft and realisation: R. Wahl-Clerici).

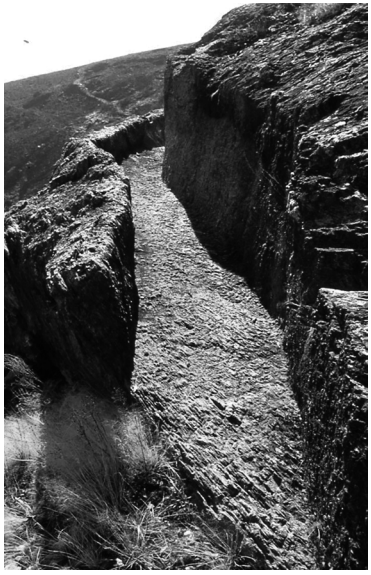

Fig. 2: Aqueduct cut into the rocks, seen from the North (Photo: J. Wahl).

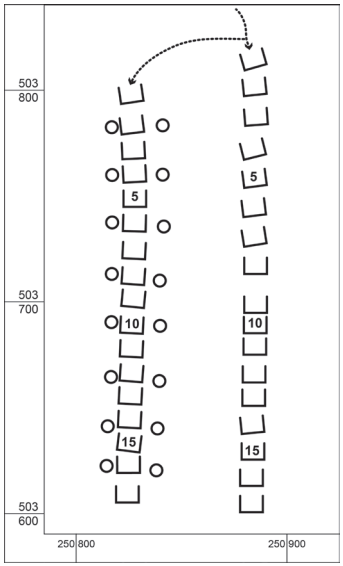

Fig. 3: Situation of the ore-washing facilities. The western line is provided with settling tanks on both sides of every second platform. Dotted line = Aqueducts. Arrows = Direction of water-flow (Draft: J. Wahl; realisation: R. Wahl-Clerici).

It is important to distinguish between the processes of mining and the dressing of the ore, where the use of water was indispensable. Neither fire-setting nor extraction by muscular energy needed water (Wahl, 1998:61-63, Fig. 13-14). It is possible that the Romans substituted the use of vinegar, mentioned by Pliny (n. h. 33:71), with water to intensify the process of wearing down the rocks heated by fire-setting. If this was the case, the quantity of water required was minimal. Water was not indispensable in either crushing or grinding. All the same, the conspicuously smooth surfaces of the cavities in the mortars probably indicate the use of water, although Agricola emphasizes that the so-called wet crushing was only invented after 1512 by Sigismund Maltitz (Agricola, 1994:270). As shown by the about 1000 mortars in Três Minas with their astonishingly constant proportions, crushing-machines were used (Wahl, 1998:65-66, Fig. 13-14), but there is no proof, nor has it ever been mentioned by Wahl, that these machines were activated by water-power (Wilson, 2002:22; Hirt, 2010:35-36). There are various points which make it much more probable that muscular force was used, as e.g. for the lifting devices of the capstan type still visible in the Galeria do Pilar (Wahl, 1988, Abb. 4, Taf. 42a, b).

In any case, water was needed for the process of ore-washing in which the noble metals were separated from the dead rocks (Rosa, 2001). The well known installations consisted of two series of 17 washing platforms, the western ones are complemented by settling tanks on both sides (*Fig. 3*) (Wahl, 1998:66-68, Fig. 15; Wahl-Clerici et al., 2012a:117, Abb. 11a, b). Although detailed research on the ore-washing installations is still lacking, it is obvious that their construction was highly elaborate. The problem was to create a strong enough flow of water to separate the

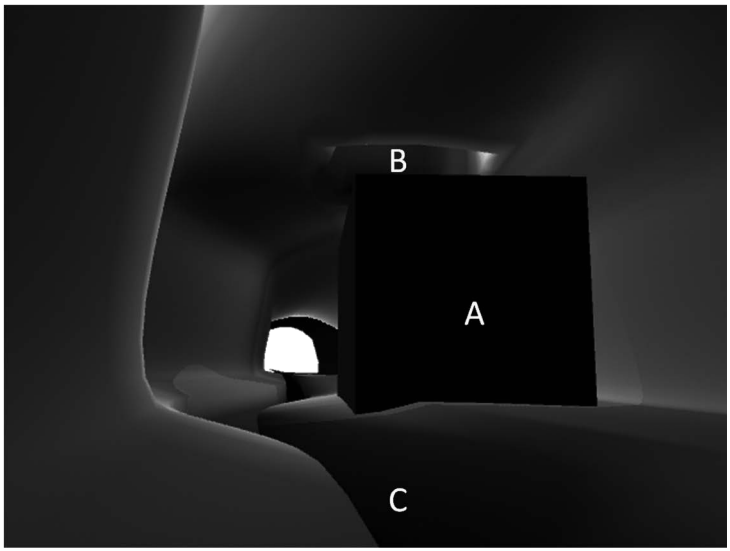

Fig. 4: Galeria do Pilar. Looking south from the entrance towards the end. A = Pillar; B = Pit above the pillar; C = Channel going around the pillar in the enlarged section (Draft: R. Wahl-Clerici; realisation: C. Wahl).

Fig. 5: Galeria do Pilar. Looking north from behind the pillar towards the entrance. Around the pillar the gallery was enlarged towards the East. The channel is visible in the enlargement. The pillar consists of 24 mortars (Photo: C. Wahl).

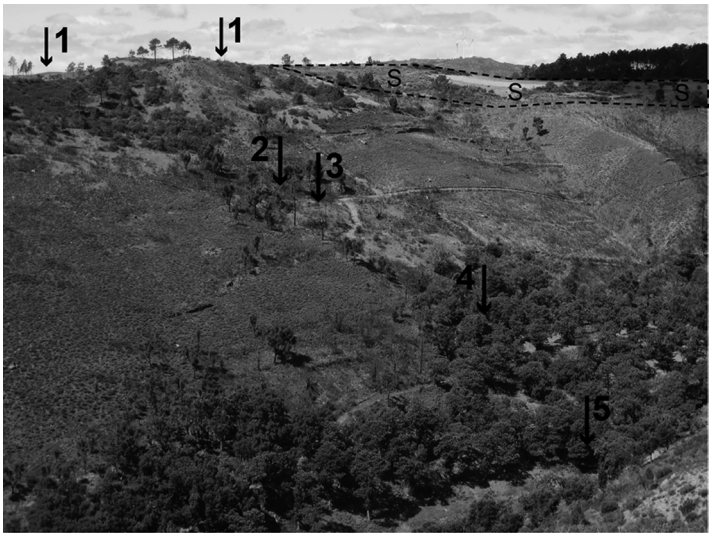

Fig. 6: Northern hillside of the Corta de Covas seen from the North-East. 1 = Corta de Covas; 2 = Entrance of the Galeria Jürgen Wahl; 3 = Entrance of the pit above the pillar (v. Fig. 5, B); 4 = Entrance of the Galeria do Pilar; 5 = Entrance of the Galeria do Texugo. S = Visible parts of the settlement (Photo and realisation: R. Wahl-Clerici).

valuable components of the ore (especially gold) from the rock, but not too strong, as otherwise all the material including the gold would be flushed away. It seems that these washing platforms were sometimes cut into the mountain, as Jones et al. (1972) suggest for Braña la Folgueirosa (Oviedo, Spain) and Dolaucothi (Wales, UK) (Jones et al., 1972:39-44).

The smelting process: In the area of the "Forno dos Mouros" (Vila Pouca de Aguiar, Portugal) there is a concentration of remains of the ore-dressing processes: mortars, grinding mills and a large heap of ground slag (Wahl, 1988:12, Abb. 1; Bachmann, 1993; Wahl-Clerici et al., 2012 b). Water was supplied by a special aqueduct (Wahl-Clerici et al., 2012b, Abb. 12). For any discussion of how much of this water was needed for which of the processes it will be necessary to excavate the site on a large scale.

It is important to discuss in detail the possibilities of sustaining the extraction-work by water-power. Two alternatives are generally mentioned. One is that already extracted material was transported to the surface by water-power (Domergue, 1990:479). It seems that this sometimes would have been connected to an ore-extracting method (Sánchez-Palencia, 1984/85:356; Sánchez-Palencia et al., 2000b:216). The other is the so-called system of ruina montium, a system to make the mountain collapse (Domergue, 1990, Fig. 25; Domergue, 2008, Fig. 76; Pérez García et al., 2000:183). Both of these systems were largely used at the sites of secondary deposits (e.g. Sánchez Palencia et al., 2000a; Matías Rodríguez, 2006; Matías Rodríguez, 2008). Some authors propose that water-power was also used to attack the mountain at primary gold-deposits, as e.g.

in Dolaucothi (Bird, 2004:62; Burnham et al., 2004:207-223), whereas an unpublished report by Béatrice Cauuet proposes that most of the works were executed by tools and fire-setting (Hirt, 2010:36; confirmed by S. Timberlake in Innsbruck 2012). Another well known example is the spectacular site of Puerto del Palo (Prov. Oviedo, Spain) (Lewis et al., 1970:180-181; Domergue, 1990, Fig. 32) or the already mentioned sites of Braña de la Folgueirosa or Fresnedo (Jones et al., 1972:37-48, Abb. 3. 4).

There are various indications in Três Minas to show that the possibility of water-powered or water-sustained works can be excluded. We will emphasize the situation in the Galeria do Pilar, which was part of the opencast Corta de Covas. Various phases of construction can be distinguished, so the whole length of more than 250m was only established and in use at an advanced stage of the works in the opencast (Wahl-Clerici, 2010).

For the present discussion the emphasis will be on the incline of the gallery, the channel along the Eastern wall and the situation around the pillar. The difference in height between the entrance and the end visible is only 4.5m along the whole length, giving an incline of less than 2%. In fact, this slope and in consequence the speed of flow of water, were not strong enough to move any material.

It is also important to scrutinize the situation around the pillar which, as the circumvention shows, was built before the channel was cut into the soil (*Fig. 4*) (Wahl-Clerici, 2011). Together with the channel narrowing from about 2 Roman ft. to about 1.5 Roman ft. this would have been a serious obstruction for the transport of material by water (*Fig. 5*).

Another important aspect is the position of the various dumps on the surface, which also exclude any water-powered facility for extraction work in the mine, but this would go beyond the scope of this paper and will be discussed elsewhere (*Fig. 6*).

This short discussion shows that without both sophisticated research on the preserved remains of the system of water-supply for the mining district and the discussion of possible traces of their use, the results will remain incomplete.

Endnote

[1] This article is related to the paper „Underground surveying with 3D-laserscanning of the “Galeria dos Alargamentos” in the Roman gold mining district of Três Minas and Campo De Jales (Northern Portugal)“ by Markus Helfert, Britta Ramminger & Regula Wahl-Clerici, in this volume.

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