The Laurion shafts, Greece: ventilation systems and mining technology in antiquity

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ABSTRACT: Geological exploration of the shafts at Laurion (Attica, Greece) have been carried out yearly since 2002, research being concentrated on the Spitharopoussi area. Among these shafts, remarkable for their regularity, are some which are vertical and deeper than 80m. Observations raised the problem of identifying the technology used to achieve sufficient circulation of air for respiration when sinking these shafts. This question is far from being answered in detail, and even the special case of a single vertical shaft has not previously received due attention. Our initial purpose is to establish what means were required to permit respiration below a certain depth in both winter and summer seasons. We then describe the two most common shaft types already explored, partitioned and twisted, and then some other oddly-shaped shafts. Finally, as work in progress, we report the measurements which are currently being recorded on site in order to develop further theoretical and numerical approaches.

The Laurion mines of antiquity

The Laurion mines (Attica, Greece) are among the most important in antiquity. The ancient authors Herodotus, Thucydidus, Aristotle and Xenophon in particular recorded the mines' influence on the politics and economies of Athens, and their documents are complemented by epigraphy (Hopper 1968; Domergue 2008). On the surface, mining, ore dressing and metallurgical remains extend over several tens of square kilometers. Several of these have been excavated, but underground explorations have been rare, except of some drifts which could easily be entered by the slopes close to the ancient city of Thorikos; in addition there is a shortage of accurate land surveys. Previously, major deep workings have been ignored, except of some workings reaching 100m in depth are rare. Ancient timbers were found in the Indian mines of Rajasthan and Karnataka at depths exceeding 200m (Willies et al 1984; Willies 1987 and 1992; Allchin 1962). However, none of these mines exhibit long vertical shafts as in the Laurion, where a lot of well-preserved square-shaped absolutely vertical shafts close to or deeper than 100m have been explored.

The mines are related to the geological conditions of important lead-silver mineral deposits, i.e. the so-called 3rd contact (Ardaillon 1897). These impressive vertical shafts provide a model of remarkable engineering and, in the ancient world, are the only systems which reached underground networks excavated deep down to several levels. Their study is of great importance for geological analysis and mapping (Photiades et al 2004).

In addition to geological study, the aim is to highlight the strategy of mineral exploitation during antiquity. Field investigations were located on a particularly well defined geomorphological area which covers the site of Spitharopoussi on the western side of the lauréot cuesta upstream of the Soureza Valley, well known for