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WITH ARSENIC ON THE ETRUSCANS' FOOTPRINTS

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ABSTRACT

In this article, the results of a study in which a convincing link emerged between geochemistry and archaeology are discussed. Research into the origins of strong arsenic anomalies in southwest Tuscany helped in realising the correlation between ancient mining activities and higher levels of the element. Besides an indication about the source of arsenic pollution in this area, these results indicate that arsenic can be used to trace major archaeo-industrial settlements. This research can provide precious information about the medieval period, when land use and ore extraction were regulated, for the first time, by a mining code. Interesting data can also be obtained about the Etruscan population and their ability to extract and work various metals, which confirmed their predominance in central Italy in the pre-Roman period. This kind of study could also be extended to other substances.
Keywords: archaeological sites, arsenic, soil contamination.

1 ARSENIC AS TRACKING ELEMENT FOR ARCHAEO-INDUSTRIAL SITES

Collaboration between science and archaeology has always been extraordinarily fertile, contributing to historiography and to the study of scientific phenomena in the field. Carbon dating of archaeological material is a well-known example, but many other experimental techniques, such as fauna determination, predictive mathematical modeling, analysis of metals, ceramics and maiolica, chemical and physical analysis and aerial photogrammetry, make this collaboration highly interdisciplinary. The world's first mining code, *Ordinamenta super arte argenteriae et rameriae civitatis Massae* (13th Century, State Archives, Florence), issued at Massa Marittima (ancient name Massa Metallorum) – a medieval town of Etruscan origin in SW Tuscany between Siena, Volterra and Pisa – in 1225, is presented, which can be reviewed in the light of local strong arsenic anomalies.

Since the dramatic case of arsenic pollution in Bangladesh, arsenic has become a prominent global environmental problem [1]. Reports of high arsenic level in soil and ground water in southwest Tuscany therefore raised much debate about the origin of this phenomenon and associated risks. To study the various aspects of this case (irregular distribution, mechanisms of dispersion, role of microorganisms in anoxic environments), several programs of analysis was done in the area. Over three years, more than 1200 samples were collected and analyzed for arsenic and heavy metals. These results were merged with data collected in previous studies to produce a geochemical map of the area, from which a geochemical or mineralogical explanation was sought. In these terms, however, all the speculations failed to clarify hot-spot distribution.

The area has been subject to human impact due to mining and metal processing since Etruscan and Roman times. In the Middle Ages, it was exploited intensively for silver and copper. Pyrite (FeS_2) was mined and roasted to produce sulphuric acid and iron until 1995.

A link between arsenic contamination and ancient human activities became evident from the synoptic three-dimensional map of the area (Fig. 1) produced by superimposing the arsenic contour map on the archaeological map of ancient mining and industrial sites. The arsenic grid was generated by interpolation of analytical data using the ordinary kriging method. Dark areas indicate higher arsenic concentrations. The highest arsenic levels were found near mining and smelting sites. The toponym of the most important sites of the area is reported in Fig. 1.

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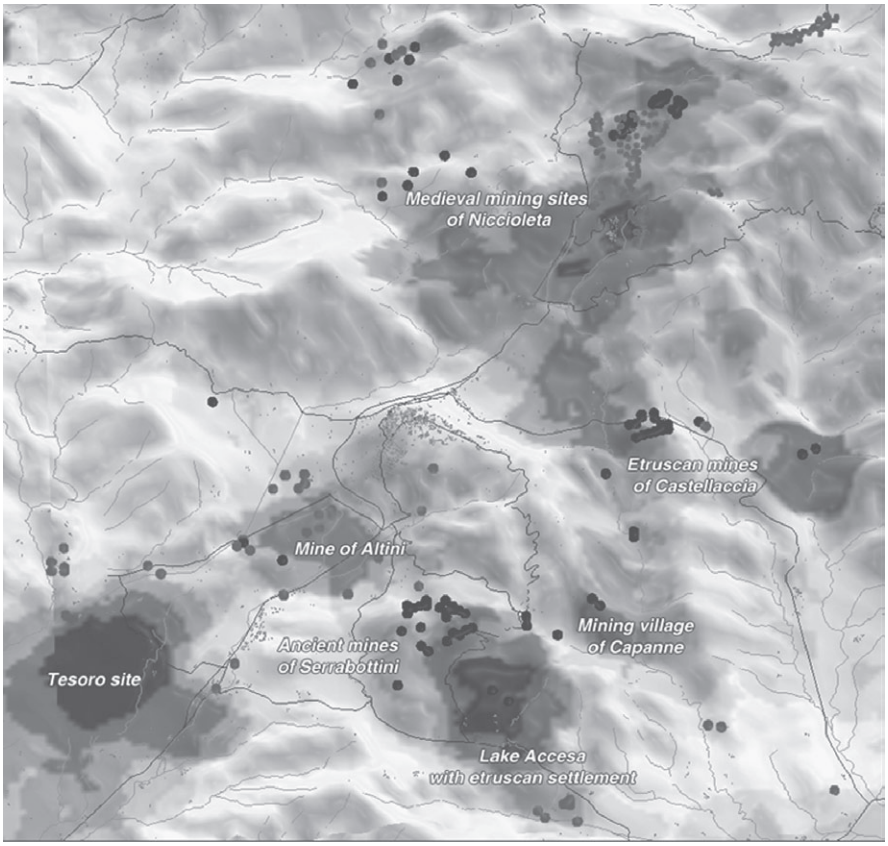

Figure 1: GIS map of the Massa Marittima area showing concentrations of arsenic in soil and sediments. Darker areas indicate high arsenic concentrations (up to 2000 mg/kg). Light and dark points indicate ancient ore mining and processing sites, respectively. Small dots indicate modern civilizations.

Interestingly, this relationship was also found in coastal sites where high arsenic concentrations have been reported (Elba, Montecristo [2] and Giglio Island [3, 4]). These sites were locations for the storage of ores before shipping or for smelting residues. According to Fig. 1, the relationship did not explain all the hot spots. For example, very high arsenic concentrations were recorded in soil at Tesoro site. No ancient mining or industrial sites were known there, however nor had there been any archaeological investigations. The place name provided a clue (Tesoro means treasure) and a preliminary study of the area uncovered signs indicating ancient mining activity (mining tailings, remnant of shafts for ore extraction and occasional slag). It seems probable that this area hides an undiscovered archaeo-industrial site, which could be significant for local history. A systematic archaeological survey is already planned in this and other areas, on the traces of arsenic. Research into hot spots of arsenic contamination may provide significant positive feedback for future archaeological discoveries.

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