SKRIFTER UTGIVNA AV SVENSKA INSTITUTET I ROM, 4°, 26:6:2–3
ACTA INSTITUTI ROMANI REGNI SUECIAE, SERIES IN 4°, 26:6:2–3

What's beyond the Etruscan bridge?

Analysis and dating of the Vignale plateau

San Giovenale. Results of excavations conducted by the Swedish Institute of Classical Studies at Rome and the Soprintendenza alle Antichità dell'Etruria Meridionale
Vol. VI, fasc. 2–3

Yvonne Backe Forsberg
& Richard Holmgren

STOCKHOLM 2024

SECRETARY'S AND EDITOR'S ADDRESS
Department of Archaeology and Classical Studies
Stockholm University
SE-106 91 Stockholm
secretary@ecsi.se | editor@ecsi.se

DISTRIBUTOR
Eddy.se AB
Box 1310
SE-621 24 Visby

For general information, see https://ecsi.se
For subscriptions, prices, and delivery, see https://ecsi.bokorder.se
Published with the aid of a grant from Stiftelsen Enboms donationsfond

The English text was revised by Rebecca Montague, Hindon, Salisbury, UK

Back cover: Bridge (illustration by R. Holmgren).
Dust jacket: The enigmatic Stone Platform excavated on Vignale in 1959, looking north-west (photograph by C.W. Welin, courtesy of SIR). See p. 183, *Fig. 155*.

ISSN 0081-993X
ISBN 978-91-7042-188-4

Printed by PrintBest (Viljandi, Estonia) via Italgraf Media AB (Stockholm, Sweden) 2024

ABSTRACT
Yvonne Backe Forsberg & Richard Holmgren, *San Giovenale* VI:2–3. *What's beyond the Etruscan bridge? Analysis and dating of the Vignale plateau* (Skrifter utgivna av Svenska Institutet i Rom 4º, 26:6:2–3), Stockholm 2024.

The Etruscan site of San Giovenale has been excavated periodically since 1956. From the beginning the main focus has been the question of settlement remains. However, a fundamental area within the site had still not undergone the inquiry necessary for a complete understanding of the site as a whole. The Vignale plateau, connected to the main site by an Etruscan bridge, was surveyed and partly excavated in 1959–1960, but not published. The Vignale Archaeological Project (VAP) began new investigations in 2006 that aimed to answer the question of "What's beyond the Etruscan bridge?" This publication focuses on the initial investigations of 1959–1960, augmented by new ground- and aerial remote sensing surveys.

The current volume is divided in six chapters. Through an introduction, and geological/topographic and historical/archaeological settings (*Chapters 1–3*), the reader achieves a general understanding of Vignale within a larger framework. The main archaeological studies of various features on the plateau, their function and dating are covered in *Chapter 4*, where Vignale from the Final Bronze Age to medieval times is approached with an emphasis on the Etruscan periods. The study of the latter investigates the connection to Vignale's sister plateau (the Acropolis area), and the plateaus' connection to the surrounding landscape. An intrinsic aspect of Vignale is the association with wine over time. *Chapter 5* therefore elaborates on wild and domesticated vines with emphasis on production, ritual, and material remains, concluding with a summary and synthesis in *Chapter 6*. Two extensive appendices follow, one detailing the material remains and data connected to the southern Bridge Complex, and the other a treatise on the Etruscan awareness of their local mineral salt, alunite.

Keywords: San Giovenale, Vignale, Etruscan, viniculture, viticulture, cisterns, infrastructure, necropolis, remote sensing, LiDAR, aerial, bridge, ram's head, settlement, photography, defence structures, platform, quarry, wine press, alun, alunite

https://doi.org/10.30549/actarom-4-26-6-2-3

AUTHORS
Dr Yvonne Backe Forsberg
Salabacksgatan 5 C
SE-754 32 Uppsala
forsberg.yvonne@gmail.com

Richard Holmgren
ARCDOC Archaeological Documentation
Follingegatan 29
SE-596 33 Skänninge
arcdoc@icloud.com

Appendix 2. The Etruscans and the question of alunite

Alum is a naturally occurring crystalline mineral. It has been in use for thousands of years for its astringent properties. The chemical compound characterizes several substances of similar composition, which until the 20th century AD was mainly used for colours to adhere to fabrics. From the 15th century AD, as we shall see, the extraction of alum became a major industry where the Tolfa Mountains in Lazio came to own one of the world's most exclusive mineral resources. However, this alum was acquired by processing the local mineral alunite. This was a technique that, as far as we know, was not known to the Etruscans. Thus, the alum used by the early cultures should not be confused with the end product that was achieved by the local medieval industry. Whether the Etruscans were aware of the method of gaining alum out of alunite, is not convincingly answered yet. The question is important, as the economic premises of such an manufacturing process would likely have had a transformative effect on the Etruscan economy. Let us therefore approach how such archaeological remains may look like and where in the cultural landscape these could be sought.[1109]

On the Italian peninsula, a good example of the importance of coloured fabrics as a commodity is found in the well-documented town of Pompeii. We find here an important centre for the clothing industry, including a meeting hall for the dyers' guild and several workshops for dyeing. At the entrance to one of these institutions, we can see the depiction of Venus Pompeiana, the guardian of the dyers. The other side of the door depicts Mercury, the god of trade. He carries a bag of money—the symbol of a profitable trade.[1110] Although textile-related objects are very common finds in settlements such as Pompeii, and also in earlier Etruscan habitations, the importance of coloured clothing often tends to be a "hidden" aspect of the trade, receiving less attention than it should. An explanation for this lies primarily in the fact that the organic material in question is seldom preserved.

If the Etruscans engaged in the dyeing industry on a grander scale than previously anticipated, we should also be able to trace this in the archaeological material.[1111] There are plenty of artefacts that speak of the processing of wool in settlements. This is illustrated in the form of spinning and weaving artefacts such as whorls, looms, and spools.[1112] Such items are found in many archaeological sites in the Mediterranean, but as related to Etruscan culture, the topic may be expanded in combination with other evidence, such as physical installations and circumstantial evidence.

Etruscan settlements are still subject to intensive study and the identification of functional features connected to various buildings is still in its infancy. Therefore, in the discussion of dyeing, it is worth mentioning a particular type of feature that might be important when tracing dyeing activities in Etruria. For example, if we turn to the excavations of the Acropolis at San Giovenale, we find some circular cavities cut in the tufa bedrock north of House 1.[1113] In the publication, which deals with Area F East on the Acropolis, six cavities (next to *Pozzi* 3 and 4) are described as "rock cuts for *dolia*" (*buco di dolia, Bd 1–6*) (*Fig. 242*). Karlsson suggests that larger terracotta *dolia* were placed in these holes, which were cut out in the bedrock in association with Court A. The orifices of the larger holes are about half a metre in diameter, with a depth of about 30–60 cm.[1114] It is tempting to interpret these cavities, originally containing pots, as remnants of some kind of

1109 Holmgren 2000, 11–15.

1110 Balfour-Paul 1997, 70.

1111 Gleba & Mannering 2012, 17–20.

1112 Gleba & Mannering 2012, 1–16.

1113 *San Giovenale* IV:1, figs. 8–9, 266, fold-out plans 1, 4.

1114 *Buco di dolia* = Bd1a–b, Bd2–Bd5, and Bd6–Bd7 two holes for large vessels, one of them with the large jar/*dolium in situ*, in Room C, House II, *San Giovenale* IV:1, 36, 38, 50, figs. 9, 38, 266.

https://doi.org/10.30549/actarom-4-26-6-2-3-13

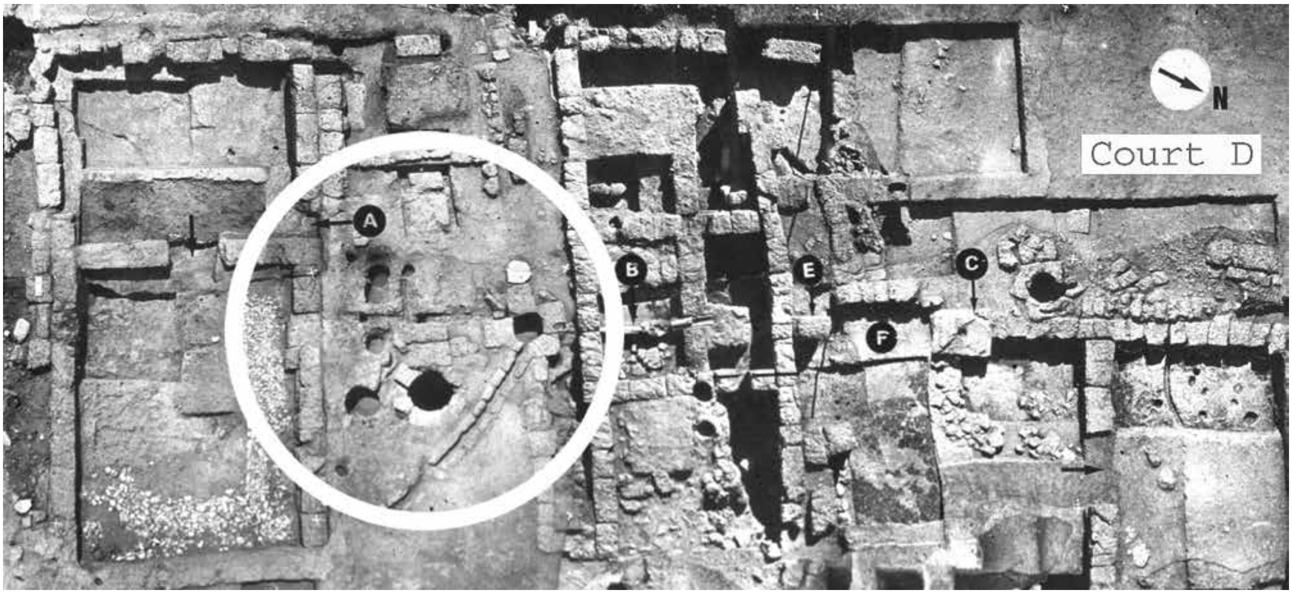

Fig. 242. Photograph plan of Houses I–II in Area F East on the Acropolis of San Giovenale. At the far left, House I is seen flanking Court A, where within the circled area several buco di dolia *are visible alongside* Pozzi *3 and 4 (photograph by B. Blomé after* San Giovenale *IV:1, fig. 9, courtesy of L. Karlsson and SIR).*

colour-bath installation. Jenny Balfour-Paul's study of living traditions of textile colouring with indigo in the Arab world includes images of several structures that may be compared to the evidence from Etruscan settlements.[1115] Balfour-Paul demonstrates how vats, or larger free-standing vessels, were used as dyeing baths, in a similar manner to that documented at Pompeii.[1116] Her study also shows how, in the Arab world, clay vessels placed directly in cavities in the ground were common in the yard areas—both inside and outside the villages—for use for dyeing cloth (*Fig. 243*).[1117] The categories of artefacts found in House I and Court A on the Acropolis at San Giovenale potentially provide an indirect picture of wool processing, alongside other activities; in addition, there are several features interpreted as water installations that could also have served the cloth-dyeing process.[1118] Loom weights, spindle whorls, and spools are common in House A, and belong to the same context as the round cavities in Court A.[1119]

Similar cut features, such as the "rock cuts for *dolia*" found in San Giovenale, are also found in the Etruscan site of Acquarossa, Zone E.[1120] In discussion with Brita Alroth, working with the material from the site, these cavities emerge as some of the more difficult-to-understand installations. Of course, it is hard to draw any specific conclusions from round cavities cut out from the rock, with embedded ceramic containers, but the tentative connection to cloth dyeing deserves to be mentioned alongside the equally non-specific definition currently in use, "rock cuts for *dolia*", especially considering that the actual vessels, the *dolia*, are often absent. An interpretation within the domain of dyeing could be a credible point of departure. After all, the lack of widely documented features connected to the process of dyeing in Etruscan culture may be due to an inability to correctly identify the evidence at hand. Attention to residues deriving from possible colour pigments, for example, inside features such as Vignale's cistern WI-4, if representing a larger dyeing vat, would of course be good indicators for such activities.

The best depictions of Etruscan costumes are perhaps found in the necropoleis of Tarquinia.[1121] The tombs' wall paintings not only provide ideas of the various types of Etrus-

[1115] Balfour-Paul 1997.
[1116] Maiuri 1957, 125.
[1117] Balfour-Paul 1997, 84, 97–98, 112.
[1118] *San Giovenale* IV:1, figs. 9, 297, fold-out plan 4. For the need of water and water installations close to the vats see also Gleba & Mannering 2012, 20.
[1119] Pers. comm. by Lars Karlsson, see further in *San Giovenale* IV:1, 61, 63, 66, 70–76, 78, 134–135, table a, fig. 263, pls. 20–21 on weaving implements from Court A, Houses I and II. For weaving tools in House III, pp. 81, 84–85, 88, 97–98, 103, 106, 108, 112. See further Landenius Enegren's textile project at San Giovenale, and Acquarossa, forthcoming.
[1120] Östenberg 1975, 69.
[1121] Rizzo 1989; Menichelli 2014; Bonfante 1975; Steingräber 2006. See also the 19th-century acquarelles from tombs in the Monterozzo necropolis in Capoferro & Renzetti 2017; SIR's Digital Collections, the Morani Collection of watercolours, http://isv.digitalcollection.org/morani-acquarelli-lucidie

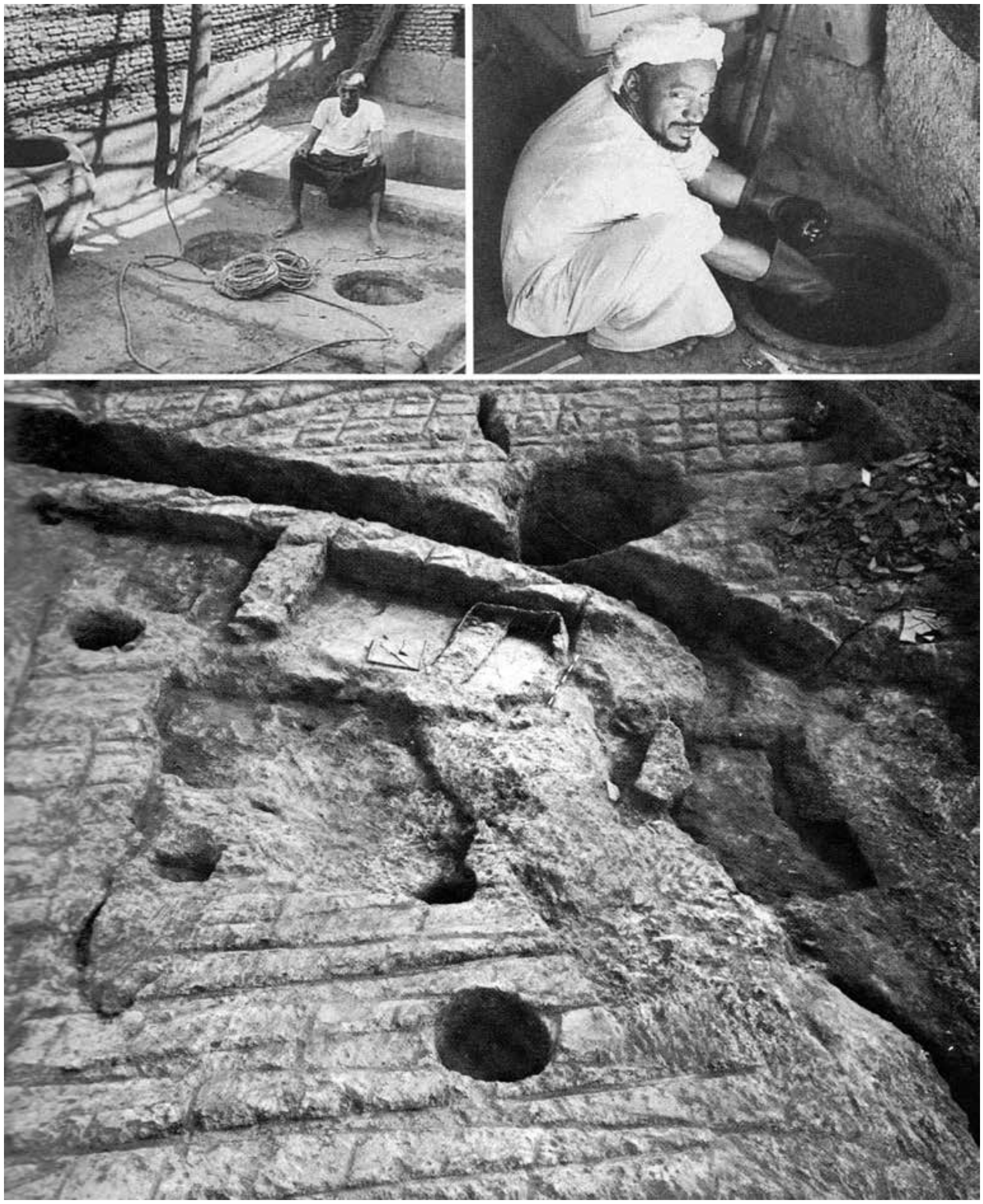

Fig. 243. Top left: modern textile dyeing in Yemen where the dyeing process takes place in large open vessels, in the courtyards or outside the city walls. Top right: in Oman, it is more usual for the work to be done indoors and in smaller vessels placed in cavities in the ground. Below: difficult-to-interpret Etruscan settlement remains in Acquarossa, Zone E, in the form of tub-shaped bedrock cavities (excluding the larger cavity in the background which is a cistern). Could such features be dyeing troughs? (upper photographs from Balfour-Paul 1997, pls. 3c, 6b; lower photograph from Östenberg 1975, 69, courtesy of SIR).

can clothing, but also the vivid coloration of wool and textiles.[1122] An interesting example of the importance of cloth dyeing is indicated by the quite specific information we have gained of the *toga praetexta* (*tebenna*).[1123] The ancient authors Pliny the Elder and Livy argued that the actual garment originated from the Etruscans. It was said that the *praetexta* was hemmed with a broad purple band, and was introduced by Tullus Hostilius as the suit of royal office.[1124] During the Roman Republic the garment was adopted by the magistrates, and later the colour purple came to symbolize divinity and imperial power.[1125]

Returning to a more recent example, an interesting passage is found in Carlo Landberg's description of traditional dyeing with indigo in Yemen at the beginning of the 19th century. Indigo was used in combination with alum, a mineral salt, as

[1122] Gleba 2016.
[1123] On *tebenna* see, Plin. *NH* 8:48; Livy 1:8.
[1124] Plin. *NH* 8.48; Livy 1.8.
[1125] Bussagli 1987, 563.

Fig. 244. Satellite map of the coastal strip of Lazio. Note how the mountain areas protrude towards the coast in the Etruscan heartland (circled area). This gave the mineral-rich areas around Tolfa and Allumiere an exceptionally favourable strategic position. During the 15th century AD the location became vital in the production of alum and its trade from the mountains to the nearby port of Civitavecchia. Could this mirror earlier mining of alunite by the Etruscans? Flanking this rich area in the north and south are the prominent Etruscan cities of Tarquinia and Caere (Cerveteri) (image edited by R. Holmgren after Apple Maps 2017).

a fixing agent to stain wool.[1126] Indigo belongs to the so-called indigoid group of dyes, which also includes the purple-colour shellfish dye made from the sea snails *Bolinus brandaris* and *Hexaplex trunculus*, earlier known as *Murex* sp. (the so-called "royal purple" dye).[1127] During antiquity this latter dye was known as the legendary purple from Tyrus, more specifically Tyre on the coast of present-day Lebanon. Tyrus was also famous for its early purple industry.[1128] Coloured clothing, especially that involving the exclusive purple dyes, was dependent on an effective mordant to attach the colorants to wool and textiles.

One of the particular mentioned above raises the interesting topic which may relate to the Etruscans and their footing in Lazio: the fixing agent of alum, and whether or not cultures from the 1st millennium BC, in the district around the Tolfa Mountains, knew how to extract alum as a mineral salt from the local alunite (*Fig. 244*). During the 15th century AD, the alunite found in this area was considered the purest and finest in the known world.[1129] The question whether the Etruscans knew how to obtain alum through the calcination of alunite has not yet been compellingly answered and the subject has been studied by one of the present authors.[1130] If the local alum was used by the Etruscans it would have been to the benefit of the local tanning and dyeing industries involving leather, wool, and textiles. A deeper knowledge of such practices would enrich our understanding of Etruscan animal husbandry, economy, and trade in general. Even if there are indications that alum specifically from alunite in the Tolfa Mountains was not obtained before the 15th century AD, one should consider the following arguments.

The question of the early importance of alum in Etruria was touched upon decades ago. Östenberg, for example, put forward the question of what interest the Mycenaean merchants may have had in the Lazio coast area in particular during the Bronze Age.[1131] Östenberg then suggested that the Mycenaean sherds found at Luni sul Mignone could simply be regarded as resulting from single expeditions;[1132] he argued, though, that the number of sherds from different periods was too great to be explained by temporary contacts. It seems that these expeditions occurred repeatedly, suggesting that there was a great Mycenaean interest in something in the region. Östenberg suggested that one should rule out the idea that the Greeks might have had an interest in the products of the Apennine Bronze Age culture, as it was not comparable to the refined contemporary Greek craftsmanship. Instead he argued that the trade concerned valuable raw materials. That this would have been copper, he deemed unlikely, as this raw material was easier to trade from, for example, Cyprus. He then speculated that it may possibly have been the alum that attracted the Mycenaeans to trade in this region.[1133] Östenberg was inspired to research the topic of the ancient exploitation of alum in Tolfa by an article by Pugliese Caratelli, which mentioned the importance of alum as commodity in the Middle East. In a recovered Mycenaean Linear B fragment from Pylos, a list of commodities contains the word "*TURUPTERIJA*". The word finds its closest equivalent in the Greek στρυπτηρία, which has been interpreted as a form of the word alum. The word στρυπτηρία has been identified in Ionic documents from the 3rd century BC.[1134] However, Östenberg did not consider the main issue—that of access to alunite and its processing method. To obtain alum from the Tolfa Mountains, it is necessary to process the alunite mineral. This is a very important con-

[1126] Landberg 1913, 417–418; Balfour-Paul 1997, 93.
[1127] Balfour-Paul 1997, 3. On recent discoveries of textiles dyed with royal purple shellfish in tombs at Perugia, see Gleba 2014, 804–805.
[1128] Leggett 1944, 64–69. On dyeing and dye sources see Gleba & Mannering 2012, 17–20.
[1129] Ferber 1776, 310–325.
[1130] Holmgren 2000.
[1131] Östenberg 1967, 251–252.
[1132] Bengtsson 2017, 18–19, fig. 4.
[1133] Östenberg 1967, 251–252. On the Mycenaean sherds found at Luni sul Mignone, see also Bengtsson 2001, 24–25, nn. 100–104. On dating, see Bengtsson 2006–2007, 14. In Bengtsson 2017, 18, 21, fig. 4, he also refers to Jones *et al.* 2014, regarding provenance for the Italo-Mycenaean sherds. For a Mycenaean IIIC sherd from San Giovenale, see Malcus 1979. See also note 72 in *Chapter 2*.
[1134] Pugliese Caratelli 1962, 5.

sideration, since there is a big difference between alunite (the mineral that has to be refined into alum powder) as opposed to the rare crystalline alum that occurs naturally in volcanic regions. Ongoing discussions of various trade routes in the Mediterranean during the Bronze Age also show that further studies are needed to support any hypotheses of direct trade between different peoples.[1135] The attentive reader also finds a contradiction in Östenberg's argumentation: he argued that the Mycenaeans would not be attracted to potential copper assets further west, for instance in Etruria, due to richer and closer sources, such as, for example, Cyprus. The situation is, however, essentially the same when it comes to alum: why would the Mycenaeans turn to the Tolfa Mountans, considering the vast resources of alum in the Eastern Mediterranean? Even though Östenberg raised an interesting question back in the 1960s, we know today that the issue is not that simple.

The extent to which the alum in the Tolfa Mountains was exploited during this early period is difficult to answer. In a discussion of the metalliferous veins containing alunite in the Tolfa massif, Claudio Giardino writes that alum could have been an important asset for the ancient economy.[1136] Pliny the Elder wrote in the 1st century AD, in his *Naturalis Historia*, that alum was found in Cyprus, Spain, Egypt, Armenia, Macedonia, Pontus, Africa, Sardinia, Melos, Strongyle (Stromboli), and Lipari. The most highly regarded alum was said to be from Egypt and the second best from Melos—the latter of which consisted of two subdivisions, liquid and solid alum.[1137] But why then did Pliny mention all these places as important for the extraction of alum, without mentioning the Tolfa region? The answer is probably that during the time of Pliny, the sources of alunite in the Tolfa region were yet to be explored, as the extraction of alum from alunite was not recognized—or perhaps not considered worthwhile compared to the acquisition of alunite from more-easily accessible sites. Or does it simply reflect economic or political factors that made this area less convenient for trade than the Aeolian Islands—an analogy to North Africa being the breadbasket of Rome?

Through Johann Jacob Ferber's descriptions of natural history and his travels during the mid-1700s—let's call it a mineralogical eyewitness account—we can take part of the mining and processing of alum in the Tolfa Mountains during this period.[1138] This is a unique account describing traditional mining and processing of alunite into alum—and as such is perhaps of great value in understanding ancient methods. The report says that after having been mined and broken into manageable pieces, the alunite was transported a short distance from the opencast mine to the ovens for calcination. The ovens were circular in plan and shaped like an upturned truncated cone. The diameter of the oven in the area of its upper opening was roughly eight feet (*c*. 2.4 m). To start the processing, the separate combustion chamber at the base of the oven was filled with firewood, which was ignited through a square side-opening. Then the alunite rock was thrown down into the cone until the oven was filled up to the brim—this would be to a height of about nine to ten feet (*c*. 2.75–3 m). The stone material was then burnt for about four hours. Here, Ferber adds a remark describing the actual calcination in detail. The calcination, or rusting, is carried out in order to dissolve and break down the rock and to force out the volatile vitriolic acid, which is released by the fire. The vitriolic acid must remain in the alunite in order to fully calcinate the stone. Excessive heat causes the acid to evaporate and the resulting alum is of a lesser quality. The producers of alum therefore recommended a burn time of about four hours, while the entire procedure took 12 to 14 hours. The raw material was burnt intensively during the first four hours and once the vitriolic acid had been released, the fire was aloud to burn out with the temperature gradually lowering for the remaining eight to ten hours.[1139]

In Michele Mercatis' *Metallotheca* from 1719, we learn about the entire manufacturing process, which is also illustrated in a copperplate engraving (*Fig. 245*).[1140] When the calcination process was completed, the raw material was rinsed and then soaked in water. This was undertaken outdoors in large waterproof wooden boxes, so-called *caissons*. As the raw product soaked in the *caissons*, the water gradually dissolved its components until it reached a sludgy mass. It is noted that in the summer it could take 25–30 days before the stone was reduced to this form, while in the winter the process could take up to six weeks. As the stone began to soften, it took on a bright reddish colour, which the alum retained during the later crystallization. The softened alum mass was then transferred to large cooking vessels filled with water, which were then boiled over a fire. When the water had become an alum-rich liquid, the solution was channelled through wooden gutters into wooden crystallization *caissons*, which in turn were directed into even larger *caissons*. These were then sealed and stored to allow the crystallization to occur. When allowing the solution to flow from the cooking vessels into the *caissons* for crystallization, it was held back in the gutters for a time to allow the urine and lime to be added (to separate out the iron sulfate).[1141]

After learning from these vivid 18th-century accounts, it would perhaps be pertinent to ask if this kind of procedure

1135 For example, Preziosi & Hitchcock 1999, 196–197.
1136 Giardino 1995, 109–115.
1137 Plin. *HN* 35.52, 183–190.
1138 Ferber 1776, 310–325.
1139 Ferber 1776, 321–322.
1140 Mercatis 1719, 55.
1141 Ferber 1776, 322–323.

Fig. 245. Copperplate engraving depicting the manufacture of alum in Tolfa during the 18th century. 1) transport of alunite to the processing site; 2) calcination kiln; 3) rinsing of the raw material; 4) boiling of the alum mass and 5) crystallization caisson *(illustration after Mercatis 1719, 55).*

could be traceable among the Etruscan material remains? First of all, it is important to understand that any possible fabric dyeing waste found, or any discoveries of alum crystals, cannot prove that the Etruscans used the alunite from the Tolfa Mountains. Such remains may simply have been imported processed alum, or alum used in its rare, natural crystal form. Therefore one must emphasize the importance of locating features that could directly show that processing of alunite was undertaken—such as material remains that are similar to, or reminiscent of, those used for the 18th-century procedures.

Iron and copper production has hitherto dominated the perception of both large-scale and small-scale metal extraction among prehistoric and classic societies. To establish that these metals were used in large or small-scale production at the site studied, it is usually considered sufficient to find traces of iron and copper handling, such as in the form of melting furnaces. The traces of iron and copper handling are often visible within or in the immediate vicinity of ancient settlements: it is also at these places that most of the archaeological documentation usually takes place. As we can see in Ferber's description, the 18th-century alum production in Tolfa took place outside habitation areas.[1142] The processing required a favourable location, with a short distance between the mining and calcination areas, and in an area rich in woodland and with access to plenty of fresh water. Given that sites such as these are generally not targeted by archaeologists, it should not be surprising that traces of early processing of alunite have not yet been found in and around Tolfa. Furthermore, we can only assume that production of alum during the Etruscan era would have been performed in a manner similar to that described by Ferber in the 18th century. As alunite has been exploited intensively by mining in the Tolfa Mountains over the last 500 years, the remnants of early mining activities have since long been erased. What one may hope to find in the archaeological record would be the remains of ovens used for the calcination of the alunite. The evidence we have suggests that such calcination ovens were large.

The identification of tools that can be tied to the production of alum would be of key significance for identifying a site where calcination was performed. Blocks of burned and unburned aluminous rocks, alongside other identifiable installations, such as vats for rinsing and soaking, could guide us in the right direction. Ferber's description, although written millennia after the Etruscan era, is currently one of the best pieces of evidence we have of early endeavours in this kind of industry in the Tolfa Mountains.

The perhaps best-preserved ancient processing site for calcination of alunite is the documented Late Roman workshop in the Bay of Kalloni on Lesbos.[1143] In a large quadrangular building, four sizeable and tapering pits were found adjacent to large furnaces for the treatment of the base material—the extraction and production of alum, confirmed through on-site analysis. The workplace was sited near a river, providing the necessary fresh water. In the area of the workshop, the raw material comprised volcanic stones consisting of quartz, feldspar, and alunite. When exactly the Late Roman production of alum was initiated has not been confirmed, but the site's earliest ceramic material dates back to the 1st–2nd centuries AD. In her article Aglaia Archontidou also mentions that the production of alum on surrounding islands is mentioned in written sources from the 15th century AD.[1144]

1142 Ferber 1776, 310–325; Mercatis 1719, 55.
1143 Archontidou 2005, 85–88.
1144 Archontidou 2005, 85–88.

Nearby, in the north-east Aegean, the inscriptions on the funerary Lemnos Stele, discovered in Kaminia and dating from the mid-6th century BC, are written in a language akin to Etruscan.[1145] The discovery could be interesting in the context of the Etruscans and their possible extraction of alum. The question regarding the origins of the Etruscans has long been the subject of scholarly debate. Eastern elements in Etruscan religious practices and oriental influences in Etruscan art have led many scholars to believe that there is a core of truth in Herodotus' statement that the Etruscans originate from Asia Minor.[1146] In the current discussion it suffices to note that the Etruscans possessed elements of orientalism and that they acquired insights and knowledge from Asia Minor. Perhaps the Etruscans also gained insights into the production of alum through their eastern contacts? A parallel to such a transfer of knowledge regarding alum, from the East to the area of the Tolfa Mountains, can be found in the sequence of events that led to the discovery (or perhaps rediscovery) of the valuable asset in the Tolfa region during the 15th century AD.

The Renaissance spread throughout Europe in the 16th to the 18th centuries, and almost everywhere a seed was planted in the fertile soil that consisted of prominent economies of national size. Contrary to this, Italy was divided into a large number of small independent nations with economies that were too small to develop successful industries. As a result of this, it was rare to see newly developed technologies reach an industrial scale on the Italian peninsula.[1147] There was however, one major exception.

In 1461, Giovanni di Castro found large and outstandingly pure quantities of alunite on the Pope's Land in Tolfa. Giorgio Nebbia, writes that the road to the discovery began with di Castro's early stay in Constantinople as a commercial agent for a textile company. He amassed a fortune by colouring Italian-made clothes in Constantinople and he also gained knowledge of the area's production and extraction of alum.[1148] In the mid-15th century Constantinople fell into Turkish hands, and for Western nations the supply of alum resources from the East could no longer be relied on. This brought di Castro back to his home region on the Italian peninsula. He found similarities in the geology and flora shared between the alum-producing areas of the East and the Tolfa Mountains, which led him to try to calcinate the white minerals he found there (*Fig. 246*). In this way he obtained alum using the methods he knew from Constantinople.[1149] In 1462 Pope Pius II granted di Castro the rights to initiate mining in the area. Alum from the Tolfa Mountains, known as Roman alum, soon came to be regarded as the finest alum in the world. The alum became the most important source of income for the Papal States from its discovery up to the late 19th century. It is during the 19th century that synthetic dyes produced in France, gained in importance (*Fig. 247*).[1150] Alum came to be found in other places in Italy, where extraction sites were primarily linked to

Fig. 246. Holly, Ilex aquifolium. *The shrub with evergreen dark and jagged leaves bears small white flowers in bunches and small red characteristic berry-like fruits. In Ferber's description from 1776 (p. 324), it is said that the shrub was a good indicator of alunite-rich ground. Holly is found scattered in the Apennines and even in the lowlands, a distribution that is also noted in Ferber's description. During excavations in San Giovenale in 1999, the current authors were told by an elderly countryman how these bushes could help in locating alunite—thus, it is a well-known tradition into modern times (illustration after Thomé 1885).*

1145 Bonfante & Bonfante 1985, 24; Bonfante 1990, 11–12, fig. 4.
1146 Hdt 1.94–97.
1147 Astarita 1980, 208.
1148 Holmgren 2000, 10.
1149 Singer 1948, 142.
1150 Astarita 1980, 209.

Fig. 247. Samples of alunite. Compare the relatively pure and almost chalk-white larger pieces from the Tolfa Mountains (marked A) with the other samples from Greece and Turkey, among others (photograph by R. Holmgren, specimens from J.J. Berzelius' mineral collection at the Swedish Museum of Natural History in Stockholm, 1999).

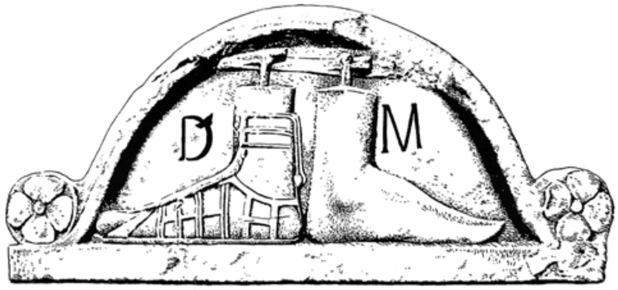

Fig. 248. The great importance and wide use of alum in antiquity is well illustrated in this tombstone. It belongs to a shoe manufacturer, alutarius*, where the professional title refers to the use of alum. The stone dates from the 1st century AD and was found at Porta Angelica in Rome. The illustration shows the upper part of the tombstone, depicting the manufacture of sandals (illustration after Singer 1948, fig. 1).*

the Kingdom of Naples and cities and islands such as Pozzuoli, Lipari, and Ischia. There, experienced workers from Asia Minor and the disintegrated Eastern Empire came to Italy and shared their knowledge of fabric colouring.[1151] Today alunite is known to be present in several regions in Italy, and it is also found in Asia Minor, and on the islands of the Aegean among other places in Europe—yet still by far the finest alunite is that found in the Tolfa Mountains.[1152]

Even if the above-mentioned workshop in the Bay of Kalloni on Lesbos had already started processing alunite in the Eastern Mediterranean by the 1st century AD, it could have represented an early enterprise of this kind. Or perhaps this was one of several places where traditions of past skills were resumed or continued at a small scale. The genesis of alunite exploitation should perhaps be traced further east and inland, among the civilizations of Mesopotamia, where there are signs to suggest that the exploration of alunite had begun more than a millennium earlier. Was it from there that the method later advanced to places such as the Bay of Kalloni?

As we await more substantial evidence—are we presumptuous to ask if the knowledge of the properties of alunite spread from Mesopotamia to the coast of Asia Minor, and was eventually brought further west by early settlers in Etruria? We are here fumbling blindly, but in the context of properties connected to that of alum, a hint might be found in the Akkadian written language with a reference to alum which is defined as "aban", stone that is. Martin Levey was one of the early authors to argue that the widespread significance of alum, obtained from alunite, in Mesopotamia laid the foundation for its various uses in Classical times.[1153]

Returning to the Italian peninsula, Giardino has shown how the river Marangone represented an important communication link between the Tyrrhenian Sea and the higher Tolfa massif during the Early Iron Age.[1154] The Etruscan Castellina del Marangone proves to have served as a metal processing site for ores deriving from various exploitation centres in the mountains.[1155] If the same means of production was there applied to alunite, it is an exciting thought to see this line of transport as an early version of the line of transport represented by the 15th-century AD alum magazines positioned in the port of Civitavecchia. In any case, it reminds us of the area's fine and unique strategic position between the rich Tolfa Mountains and the nearby coast.

In conclusion, we must admit that it would be remarkable if the Bronze and Iron Age cultures that processed both iron and copper in the area of Tolfa would not have known the relatively simple method that allows the production of alum out of alunite, as the awareness of minerals and their various refining processes appears advanced in these periods. However, whether or not cultures from the 1st millennium BC, in the region of Tolfa, knew how to extract alum out of the local alunite has not yet been answered definitively. We can conclude that the Etruscans sat on a fortune of very large measures and if they didn't realize, it could compare to the feat of importing oil to Kuwait.

1151 Singer 1948, 139.
1152 *Encyclopedia Italiana* 1929, 726–727.
1153 Levey 1958, 169.
1154 Giardino 1995, 109–115.
1155 Zifferero 1991, 215–216.

The study of alum in the ancient world has great potential. It is quite clear that alum was an extremely important product due to its extensive use within the early colouring and tanning industry, but also as a valuable and practical commodity for many other uses (*Fig. 248*). An interesting aspect presented here is a perhaps new understanding of the rebuilding of the Apollo temple in Delphi and its Egyptian subsidy in the form of alum. According to Herodotus, Pharao Amasis of the 26th dynasty (570–526 BC) sent a respectable 1,000 talents' worth of alum (στυπτηρίης) from Egypt. This was the Egyptians' contribution to the reconstruction of the Apollo temple in Delphi after the building, together with much of its paraphernalia, was severely damaged by a devasting fire in the middle of the 6th century BC.[1156] The full picture of all fundings for the re building of the temple is not clear. It is however very interesting that the Egyptian subsidy was given in the form of alum. In many contemporary states during the period, alum must have been a highly valued product and as such had a huge exchange value. Considering the properties of alum, we should perhaps not be surprised by the Egyptian choice of gift: with high probability, it was not meant to be exchanged into another value, but rather was to be used directly as an important material constituent in the rebuilding of the temple itself. Alum was not only used as a mordant for colouring cloth and for tanning hides, but also for its fire-retardant properties when soaked into wood.[1157] In the case of the burnt-down temple of Apollo, we would therefore suggest that the alum sent from Egypt was primarily intended to help protect the new timbers of the temple roof construction.

[1156] Hdt 2.180; Parke & Wormell 1956.

[1157] Zifferero 2017a. On the topic of alum in antiquity and medieval periods, see Borgard *et al.* 2005.