The volcanic rock grinding stones from Selinunte, Sicily (Italy): Archaeological evidence and geochemical provenance analyses

Christoph Schwall and Tatjana M. Gluhak

Abstract: This study is based on the assemblage of grinding stones from the Greek colony of Selinunte in Sicily. Most were brought to light in well stratified contexts dating to the 6th century BC making them ideal subjects for research on the development of early milling techniques. In addition to saddle querns, Selinunte has Olynthus mills and mills driven by rotary motion were discovered in previous excavations that are also representative of advances in milling technology. The Selinunte assemblage can be compared to contemporary mills from elsewhere throughout the Mediterranean Basin. Based on these comparisons, we suggest a saddle type of mill model comprising of a boat-shaped upper stone and a roughly rectangular-shaped lower stone as a precursor of the Olynthus mill. The sources of the rock point to mainland Sicily, the Aeolian Islands and perhaps from the Aegean Islands bolstering the supposed importance of this coastal settlement as a centre of trade in the central Mediterranean.

Keywords: Selinunte, grinding stones, saddle querns, Olynthus mills, rotary motion, provenance, volcanic rocks

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Introduction

This contribution focuses on the volcanic rock grinding stones brought to light during the excavations conducted by the German Archaeological Institute (DAI) at the Greek colony Selinunte on Sicily. Close examination of these grinding stones provides an opportunity to present new data concerning the development of milling techniques, as well as the opportunity to explore the systems of rock procurement of a Greek colony in the central Mediterranean. Sicily, in particular, offers important insights for the development of two different milling techniques. Firstly, in the 5th century BC, the so-called 'Olynthian' or 'Olynthus' mill was known throughout the eastern Mediterranean Basin and can be interpreted as an advanced grinding mechanism (Frankel 2003, 7; 2007, 222, fig. 15; Alonso and Frankel 2017, 466-67). Secondly, the oldest known circular rotary mills found in the western Mediterranean and dated to the 5th century or possibly the end of the 6th century BC (Alonso 1995; 1996; 1997; Alonso and Frankel 2017, 467-72). The latter mills driven with a rotary motion became common for grain milling during the Roman period throughout the entire Mediterranean as well as in the Roman provinces (Runnels 1981, 128; Mangartz 2008, 192-94; Schaaff 2010, 268-69; Wefers 2012a, 90-95). With regard to the occurrence of these new milling techniques, the grinding stones of Selinunte are of particular interest as they hail from well stratified 6th-century BC contexts and provide new data regarding the debate concerning the development of milling (Wefers 2011, 67-69; 2012a, 87-90; 2012b). In addition, geochemical and petrographical analyses of these artefacts allow us to identify rock procurement systems and trading activities by this central Mediterranean Greek colony.

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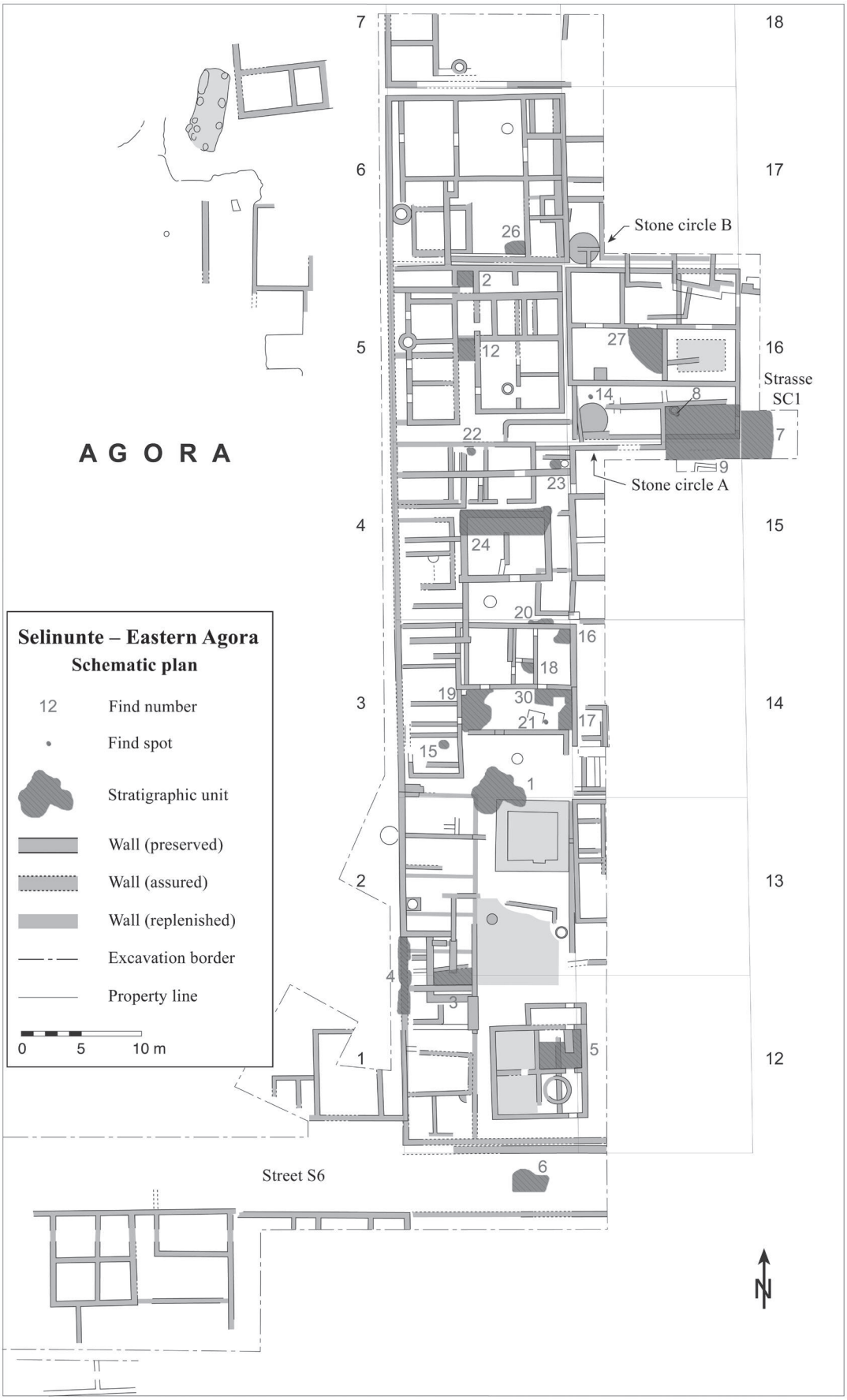

Fig.1: Excavation plan of the eastern area of the Agora with the find spots of the grinding stones and pounders (map basis: German Archaeological Institute, Rome Department, Excavation Selinunte).

The grinding stone assemblage

Thirty-one stone tools, primarily volcanic rocks, linked to grain processing were collected during the excavations undertaken by the DAI at the Agora of Seliunte in campaigns between 1996 and 2005. Most were discovered in the eastern area of the Agora (Fig. 1). The majority (26) are saddle querns (nos. 3-4., 6-22, 24a/b-27, 29-30)[1]. The others include four pounders (nos. 2, 5, 23 and 28) and one unidentified stone (no. 1) most likely for crushing grain[2].

Almost all, except the three pounders and three upper stones of grinding stones[3], are fragments and the find spot of most cannot be linked to their original function. They were found in secondary position mainly as building material for pavements and streets (nos. 6 and 23) or in the filling of levels of levelling (nos. 1-5, 10, 12-13, 15-20, 24a/b-25, 28-30). Two of the three complete saddle querns (Fig. 2) were found in potential grain processing contexts, whereas the third (Fig. 3, no 13) was in the backfill of a hole cut into the bedrock[4]. One saddle quern grinding stones (Fig. 2b, no. 14) was found in a shallow layer next to a cooking pot in a partially paved horizon (Fig. 4) indicating a use related to food processing. The other (Fig. 2a, no. 21) was beside a razed hearth and next to two subsequent hearths (Fig. 5) indicating that this sector of the building served for food production in subsequent horizons.

In general it is the upper stones (19 examples) that reveal typological features. Only two of three lower stone fragments can be attributed to roughly rectangular slabs (nos. 19 and 25). Upper stones are characterised by an oval, elongated, boat-shape. Only one case is nearly oval and narrows slightly in the middle with two appendages which can be interpreted as handle grips (Fig. 3). The wear of the boat-shaped upper stones clearly reveal their function (Fig. 2a). This type, in fact, represents the majority of the finds discussed in this paper. Their dimensions range from 40-50 cm in length, 15-20 cm in width, and 6-10 cm in thickness. Due to the poor state of preservation of the lower stones it was only possible to measure a maximum thickness of up to 8 cm.

Regarding the chronology (cf. Table 1), 12 of the 31 finds (nos. 3, 12-13, 15, 18-23, 26 and 30) can

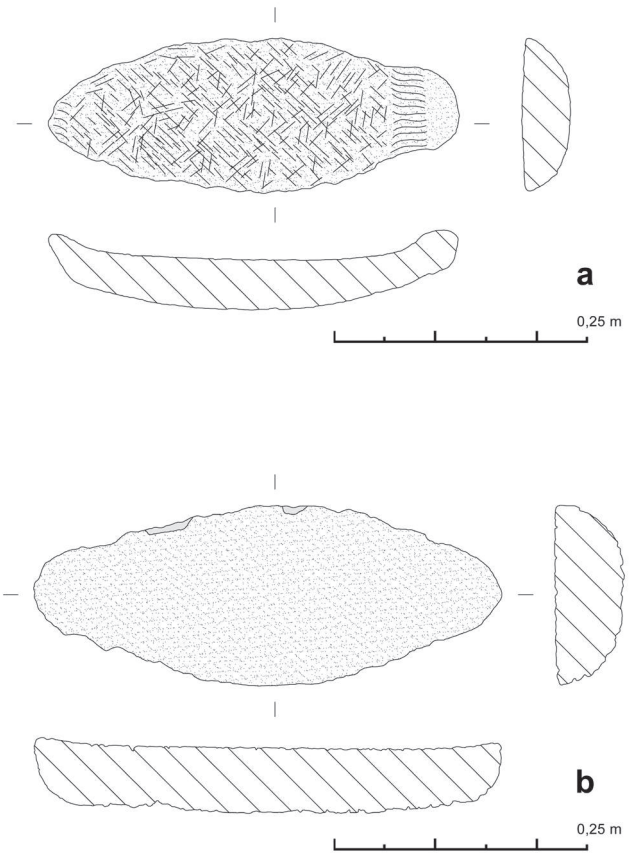

Fig. 2a-b: Boat-shaped upper stones excavated in the eastern area of the Agora of Selinunte.

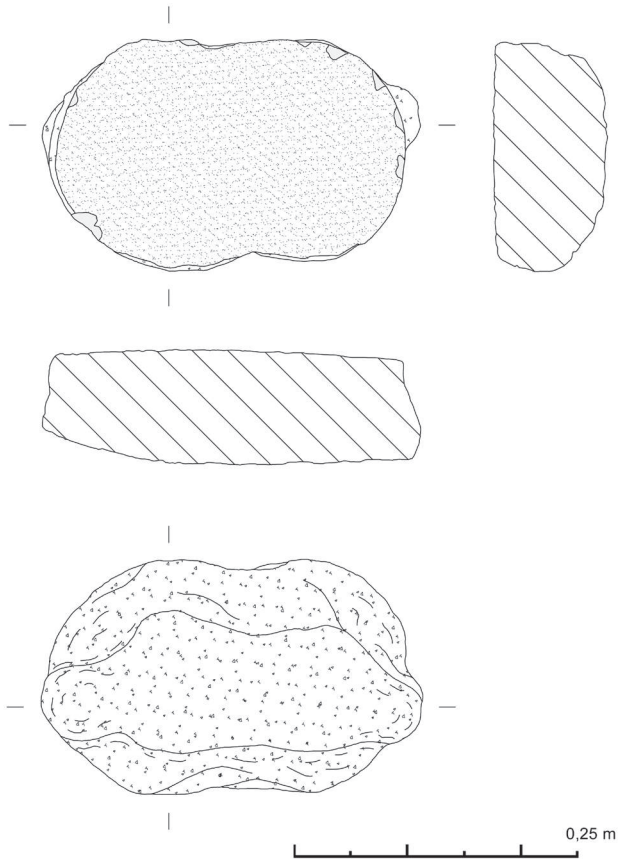

Fig. 3: Upper stone with grips from the north-western area of the Agora of Selinunte.

1. Two fragments (a and b) of a single saddle quern are attributed to no. 24 because they come from different stratigraphic units.

2. In addition to grinding organic or inorganic materials, pounders also served to fashion the querns and peck their working surfaces (*cf.* Graefe 2009, 91-92).

.3 Pounders, nos. 2, 5 and 28; saddle querns: nos. 13-14 and 21 (*cf.* no. fig. 1).

4. No. 13. The nature (upper or lower stone) of five poorly preserved fragments cannot be determined (nos. 6, 9-10, 22, 29).

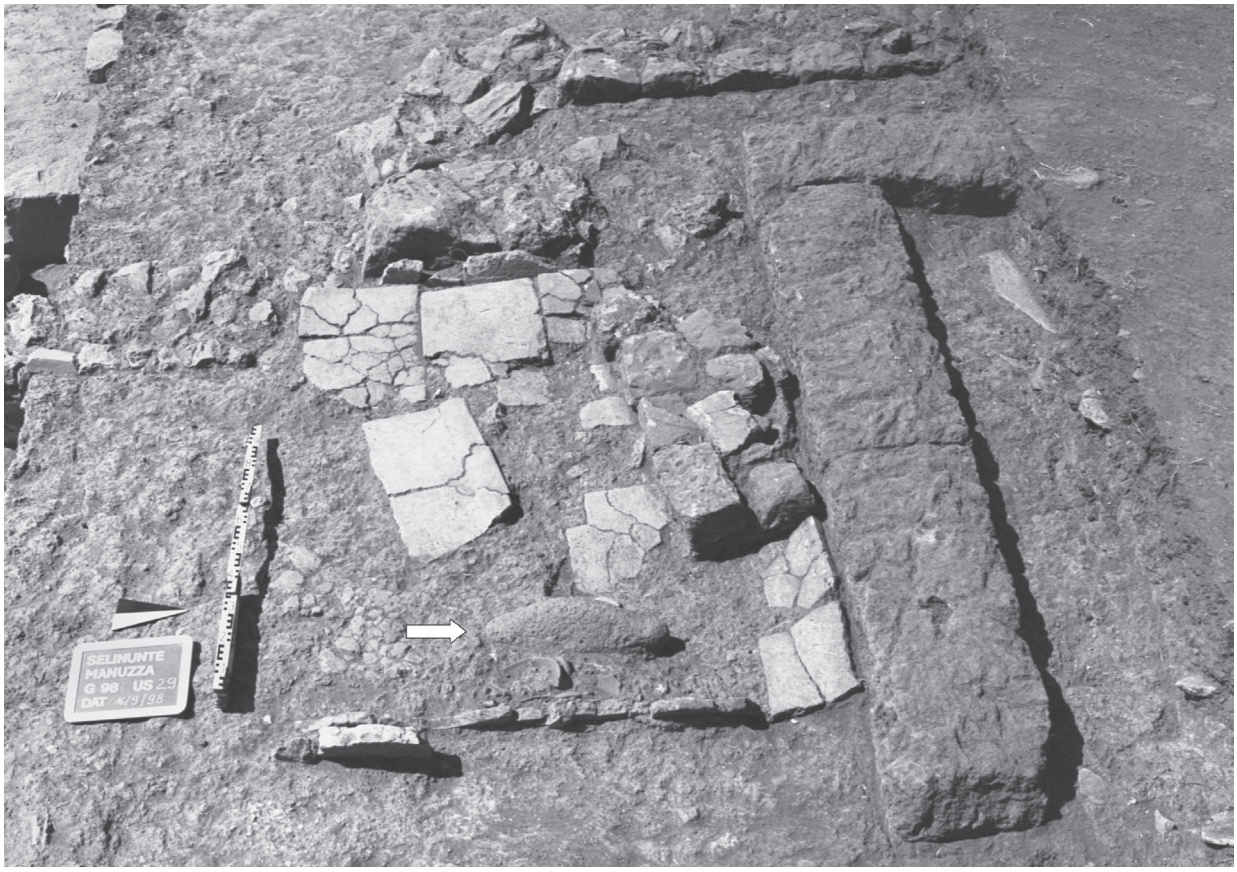

Fig. 4: Find spot of a boat-shaped upper stone of a quern (no. 14; cf. fig. 2b) next to a cooking pot (photo: German Archaeological Institute, Rome Department, Selinunte Excavation).

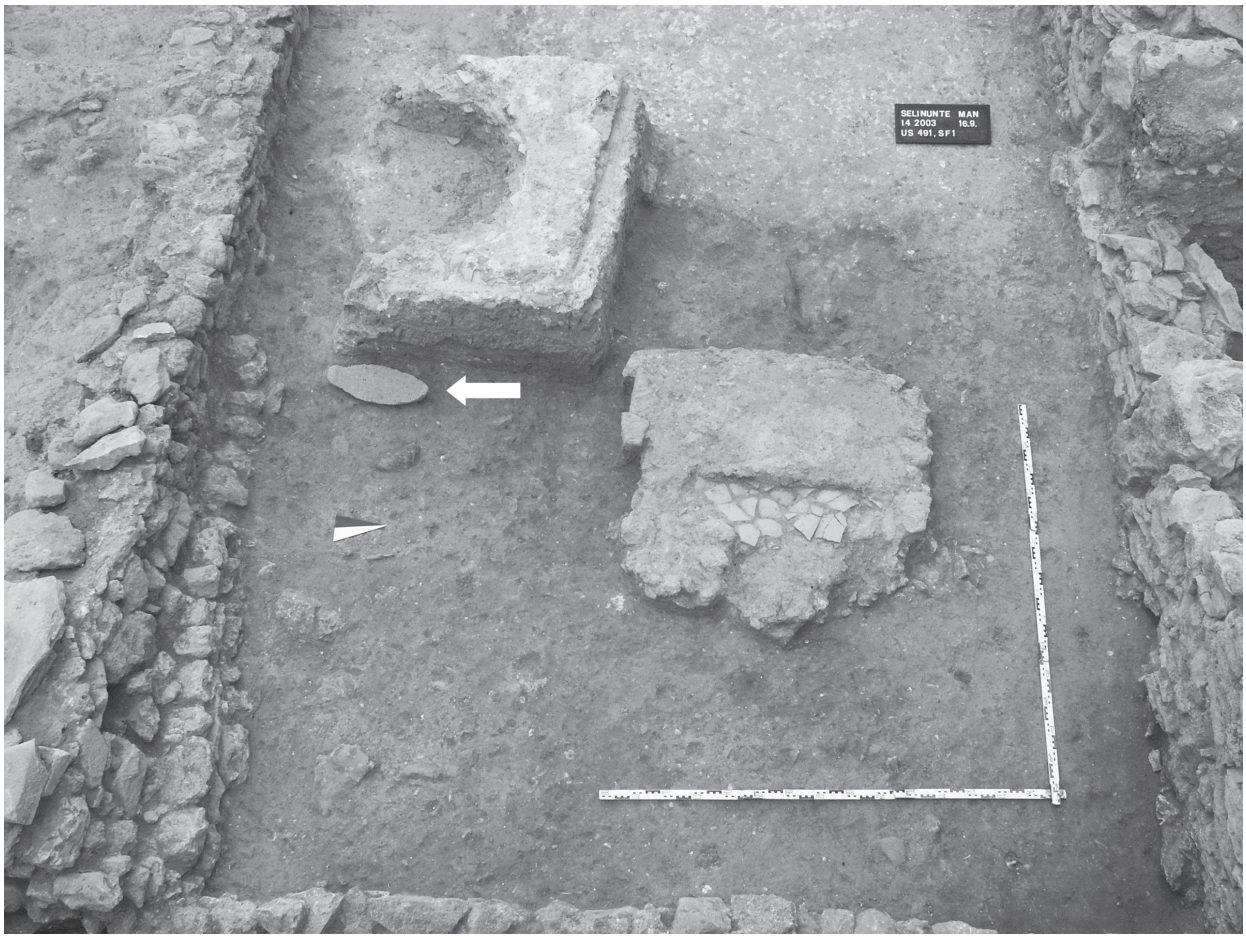

Fig. 5: Find spot of a saddle quern (no. 21; fig. 2a) close to hearths of different horizons (photo: German Archaeological Institute, Rome Department, Selinunte Excavation).

Fig. 6: Map indicating the geographical regions cited in the text and sites with similar boat-shaped saddle querns.

be assigned to the 6th century BC. Nine examples (nos. 1-2, 4-5, 8, 10, 14, 17, 24b) fall between the 4th and 3rd century BC, three (nos. 16, 24a and 27) were collected in clear contexts from the 6th to 5th/4th century BC, and two (nos. 28-29) from medieval layers and only five (nos. 6-7, 9, 11 and 25) are not dated. Correlating the different shapes with their particular dating, it becomes clear that the boat-shaped upper parts of the saddle querns are prevalent in the 6th century BC.

Boat-shaped saddle quern parallels

Saddle querns like those found at Selinunte are common in Sicily as well as other sites in the Mediterranean (Fig. 6). They are present in both western and eastern Sicily such as at Morgantina (Prov. Enna; White 1963, 201-202, pl. 47, 3-4), in the vicinity of Mount Etna (stored in the Museo Archeologico Etneo in Adrano, Prov. Catania; Franco 1969, 45-46, fig. 1), in the sanctuary of Palike near Rocchicella (Prov. Catania; Randazzo 2008, 290, fig. 160, 362) and from the presumed shipwreck close to San Vito lo Capo (Prov. Trapani; Rocca 2006, 8-11). Similar upper stones are also known at the sanctuary of Bitalemi near Gela (Prov. Caltanissetta; Orsi 1906, 591-92, fig. 400), at Megara Hyblaea (Prov. Siracusa; Gras *et al.* 2004, 115, fig. 11) and at Cozzo Scavo near Caltanissetta (Prov. Caltanissetta; Amata *et al*. 1994, 228, fig. 2,A; Modeo 2006, 249, no. 3748). This type of boat-shaped upper stone is also known along the north-eastern coast of Spain such as at Puig de Sant Andreu close to Ullastret (Prov. Girona; Genís 1986, 107; 110; Portillo 2006, fig. 29.1-7) where it is coupled with rectangular lower stones. A similar coupling is interpreted for the finds of the shipwreck of Cala Sant Vicenç near Pollença (Prov. Islas Baleares; Vivar Lombarte 2006, 260-61) off the northern coast of Mallorca and for certain stones recovered at Lattes (Dépt. Hérault; Py 1992, 185) along the southern coast of France. In the eastern Mediterranean, boat-shaped saddle querns are found at the Greek sites Olynthus (Per. Kentriki Makedonia; Robinson 1930, 70-71; Robinson and Graham 1938, 326-27, pl. 79,1-7; Moritz 1958, pl. 2c), Athens (Per. Attiki; Runnels 1981, 117-19, 340, fig. 24, ST 255; pl. 19, ST 692) and Halieis (Per. Peloponnisos; Runnels 1981, 117-119, 338, fig. 22, HS 395; 339, fig. 23, HS 396). The type of quern consisting of boat-shaped upper stone coupled with a roughly rectangular lower stone is evidenced by recent finds from Selinunte's pottery district (Insula S 16/17-E) (Bentz *et al*. 2013, 79, fig. 6)[5].

5. We thank Prof. Dr. M. Bentz and J. M. Müller M.A. (University of Bonn) for providing detailed information and unpublished photographs of these recent finds.

The shape, the traces of wear and the dimension of these finds confirm that boat-shaped upper stones were coupled with rectangular lower stones[6].

Furthermore, comparable saddle querns from eastern and western Mediterranean are dated between the 7th and 3rd century BC, a chronological range that corresponds to the saddle querns from Selinunte.

Evidence concerning the development of grinding mechanisms

Despite the absence of Olynthus mill and mills driven with a rotary motion among the recent finds from the Agora, both types are known elsewhere at Selinunte, notably at the Acropolis[7].

An early grinding development is the coupling of boat-shaped upper stones, at times with grips, with rectangular lower stones (Fig. 7b), a system already in place during the 6th century BC that represents an advancement over the earlier saddle quern (Fig. 7a). The presence of grips indicates they were driven by hand with a to-and-fro movement in a kneeling position.

A subtype of the elongated upper stone, with two grips and a central hopper (Fig. 7c), presumably originating in the Eastern Aegean or Western Anatolia (Moritz 1958, 42-43; Frankel 2003, 8, 18; Lucas 2006, 11), appears to be a prototype of the Olynthus mill (Fig. 7d).

The more efficient Olynthus mill, characterised by its central hopper which allowed grains to be fed in during the grinding process and operated by a lever with the person in a standing position (*cf.* Frankel 2003, 2-8)[8], ultimately became widespread and dominated in the eastern Mediterranean. The earlier type coupling a boat-shaped upper stone and a rectangular lower stone (Fig. 7b) therefore represents a 'technical link' to the later Olynthus mills.

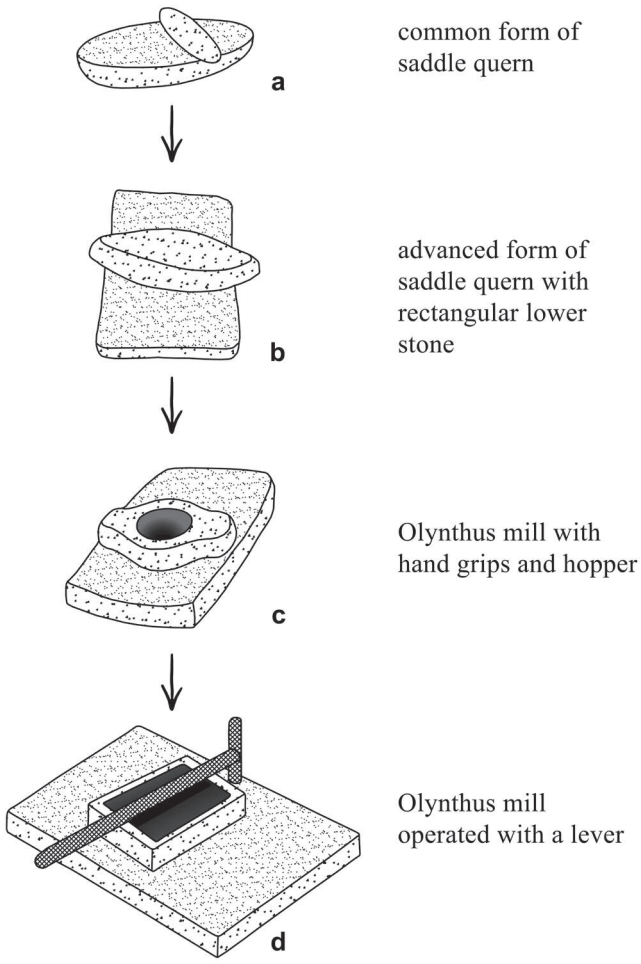

Fig. 7a-d: Schema of the typological development of grinding mechanisms (drawings by Ch. Sshwall based on 7a, d: Mangartz 2008, 25, fig. 4; 7b: Genís 1986, 107, fig. 4; 7c: Lucas 2006, 12, fig. 1.3).

Summary of the results of the provenance analyses

The geochemical major and trace element compositions revealed by WDXRF spectrometry for the provenance of 22 grinding stones, undertaken by Gluhak and Schwall (2015), indicate that the volcanic rocks come from different geodynamic settings. The Mediterranean region has a complex geological history with a number of varying geodynamic settings (for a detailed presentation and discussion see Lustrino and Wilson 2007 and Lustrino *et al.* 2011) that result in volcanic rocks with different compositions. It is the study of the compositions that is the key to unravelling their origin. This methodology is described in detail in Gluhak and Schwall (2015).

An origin from the Hyblean Mountains in south-eastern Sicily was established for stones 17, 20, and 26 while nos. 2, 9, 14, 27, 29, by contrast, are linked to Mt. Etna/Mongibello in the north-west of the Sicily. The compositions of stones 4, 6, 7, 8, 10, 11, 12, 16, 18, 19, 21, 23, 24a/b, 25 strongly correlate with the Aeolian Islands indicating these islands could be the source. However, the exact location of the source in the Aeolian archipelago cannot be determined due to the similarity in the rock formations of the different islands. Furthermore, on the basis of the geochemical data alone, it is not possible to completely exclude the possibility that at least some of the grinding stones were imported from the Aegean, especially taking into account the exchanges between the Greek colony

6. *Cf.*, for example, Robinson 1930, 70-71; Robinson and Graham 1938, 326-27; White 1963, 202; Vivar Lombarte 2006, 260-61.

7. Several upper and lower stones of saddle querns, Olynthus mills and the lower stone of a Morgantina mill were found in the southern area of the Acropolis (*cf.* White 1963, 202-04) in a room near the Corpo di Guardia (GPS coordinates: N 37.58212°, E 12.82545°, 31.05.2011; *cf.* Helas 2011, 100). Since the precise contexts were not recorded, they can only be dated by the *termius ante quem* corresponding to the abandonment of Selinunte during the First Punic War (250 BC).

8. A different use has been suggested by J. Chausserie-Laprée (1998, 229, fig. 17) based on finds at Martigues on the southern coast of France.

Table 1: Provenance of the analyzed grinding stones as determined by Gluhak and Schwall (2015).

Dating	Provenance	Object / Sample no.	Tool
6th century BC	Aeolian Islands?	12	saddle quern (upper stone)
6th century BC	Aeolian Islands?	18	saddle quern (upper stone)
6th century BC	Aeolian Islands?	19	saddle quern (lower stone)
6th century BC	Aeolian Islands?	21	saddle quern (upper stone)
6th century BC	Aeolian Islands?	23	pounder
6th century BC	Hyblean Mountains	20	saddle quern (upper stone)
6th century BC	Hyblean Mountains	26	saddle quern (upper stone)
6th–5th/4th century BC	Aeolian Islands?	16	saddle quern (upper stone)
6th–5th/4th century BC	Aeolian Islands?	24a	saddle quern (upper stone)
6th–5th/4th century BC	Mt. Etna	27	saddle quern (upper stone)
4th/3rd century BC	Aeolian Islands?	4	saddle quern (upper stone)
4th/3rd century BC	Aeolian Islands?	8	saddle quern (upper stone)
4th/3rd century BC	Aeolian Islands?	10	saddle quern (?)
4th/3rd century BC	Aeolian Islands?	24b	saddle quern (upper stone)
4th/3rd century BC	Mt. Etna	2	pounder
4th/3rd century BC	Mt. Etna	14	saddle quern (upper stone)
4th/3rd century BC	Hyblean Mountains	17	saddle quern (upper stone)
Medieval times	Mt. Etna	29	saddle quern (?)
Undated	Aeolian Islands?	7	saddle quern (upper stone)
Undated	Aeolian Islands?	11	saddle quern (upper stone)
Undated	Aeolian Islands?	25	saddle quern (lower stone)
Undated	Mt. Etna	9	saddle quern (?)
Undated	Aeolian Islands?	6	saddle quern (?)

of Selinunte and the Greek mainland. The Aegean Sea, as well as the Tyrrhenian Sea, is strongly influenced by subduction, and its volcanism shows great geochemical uniformity. Neither major nor trace element compositions allow a clear distinction between the volcanic rocks of the Tyrrhenian and Aegean Islands. The results of the provenance analyses are compiled in Table 1.

Provenance and procurement systems

With the exception of one sample (no. 6), the source of all the grinding stones of Selinunte can be determined with a relative degree of precision. Besides local Sicilian volcanic sources at the Mount Etna (5 samples) and the Hyblean Mountains (3 samples), 13 are presumably from the volcanic outcrops of the Aeolian Islands to the north-east or possibly the Aegean Islands. It must be highlighted, nonetheless, that the source cannot be definitely provenanced due to the issues advanced above.

It is therefore of note that the majority of the sampled stones come from external rock sources, beyond Sicily. Five of the seven sampled grinding stones dated to the 6th century BC, can be sourced either to the Aeolian or the Aegean Islands. Only two saddle querns of these early stones are from volcanic rocks from the Hyblean Mountains. Exploitation of the Hyblean Mountains is not surprising due to its proximity with the settlement of Megara Hyblaea, the mother colony of Selinunte, on the eastern coast of Sicily.

Of particular interest is the absence of stone imports at Selinunte from the western volcanic sources such as Ustica, Pantelleria and Sardinia (*cf*. Mangartz 2008, 202-04), outcrops that were intensively exploited for millstones later during the Roman period. Factors such as of the quality and accessibility of the raw material or the expansion of the Punic sphere of interest to western and north-western Sicily could be behind the absence of these imports in the 6th century BC[9].

9. Provenance studies of contemporary finds from Greek and Punic colonies as well as indigenous settlements in Sicily would be valuable to verify this hypothesis. At the moment the only published data are from the indigenous Sicilian sites of Monte Castellazzo di Poggioreale (Ferla *et al*. 1984; Spatafora 1993), Rocca di Entella (Daniele 1997; 1999; Canzanella 1997), and Morgantina (Santi *et al*. 2015).

Based on finds like imported amphorae, intensive trade links dating to at least the first half of the 6th century BC are evident with the Greek mainland, the Eastern Aegean and colonies of Magna Graecia. Punic pottery, on the other hand, is rare in the eastern area of the Agora of Selinunte (Dehl-von Kaenel 2003)[10]. Nevertheless, Sicily's strategic position seems to have favoured trans-Mediterranean trade. In this context, F. de Angelis assumes the existence of trade with the Greek mainland and that cereals were important exchange goods for Selinunte at least since the 5th century BC (2003, 194–95). Archaeobotanical studies have revealed that the agricultural conditions in the interior of Sicily, as opposed to the coastal hinterland of Selinunte, were favourable to grain cultivation (Stika *et al.* 2008, 147). Possible connections to indigenous settlements in Selinunte's hinterland are suggested by two saddle querns recovered during the excavations at the Monte Castellazzo di Poggioreale (Ferla *et al*. 1984, 46-47, 50; Spatafora 1993, 169). Both are dated to the early 6th century BC and are of volcanic rock from eastern Sicilian sources. It is, however, questionable whether these stones reached the settlement by maritime or land routes.

Conclusions

To conclude, the assemblage of volcanic grinding stones from the Greek colony of Selinunte indicate provenance from local insular sources as well as longer distance (probably Aeolian or possibly Aegean Islands) outcrops exploited as early as the 6th century BC. The position of Selinunte on the coast would have favoured maritime exchange of volcanic rocks and other products. Therefore it can be assumed that indigenous settlements supplied the Greek colony with grain for its own needs as well as for trade. This could also explain the presence of Greek imports found at the indigenous settlements. Hence it is evident that Selinunte served as an important trading post in the central Mediterranean region for a number of goods including basic mechanisms such as volcanic saddle querns.

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10. This picture is also bolstered by pottery finds in the Sanctuary of Malophoros at Selinunte (*cf*. Dehl-von Kaenel 1995; Kerschner 2000, 490-91).

11. F. de Angelis assumes that trading with the Greek mainland existed and that cereals were important goods for Selinunte at least since the 5th century BC (2003, 194-95).

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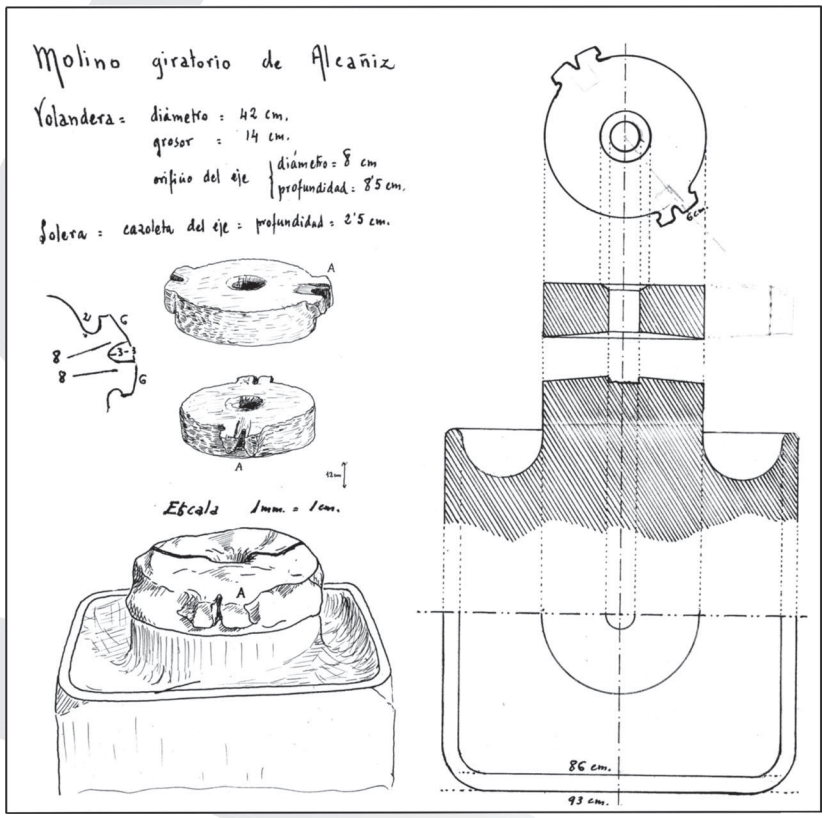

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Proceedings of the Colloquium held at the Museum of Archaeology of Almería, Spain
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Timothy J. Anderson and Natàlia Alonso

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Dedication photograph: David Peacock at Ostia during the excursion of the colloquium Bread for the people: The Archaeology of Mills and Milling, Proceedings of a Colloquium held at Rome.

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