



THE EXTRACTION OF TRAVERTINE IN ANTIQUITY ON THE ISLAND OF COS, DODECANESE, GREECE

To the memory of Iakovos Zarraftis,
 Supervisor of Antiquities on the island of Cos.

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ABSTRACT

The use of travertine – known to the locals as ‘amygdalòpetra’ (= almond stone) for its color – in coan architecture of classical antiquity and Italian buildings of the last century initiated a multidisciplinary research on its provenance. After a thorough geological survey of the Pliocene marine and lake deposits on the island, several positions of travertine formations were revealed.

However, it was only near the town of Pyli, 21km west of the city of Cos, that evidence of systematic travertine extraction was confirmed. The site was not mentioned in any ancient or modern literary source, with the exception of an early 20th century scholar, I. Zarraftis. Following his footsteps, we came across an area of rocky cliffs, one of which was a definite quarry. The place was hardly accessible due to dense vegetation and a military camp situated right on top of it. Nevertheless, the ground survey brought to light serious archaeological evidence such as: ancient cutting marks, a sledge path, large blocks of rock and piled-up worked stones. The extracted stone was of high quality, thus justifying the selection of that location. Furthermore, at the very top of the quarry hill, were the remains of a small building of uncertain date (a probable guard-place).

According to the toolmarks, the Pyli quarry was active in the classical and hellenistic periods. Afterwards, it fell into oblivion, since marble extracted largely in Roman and Byzantine eras from Mt. Dikaïos substituted travertine. It was only until the first half of the 20th century A.D. that it became popular once again, as the Italian architecture of Cos vividly shows. An important witness of modern-time exploitation is an iron wedge found *in situ*. Moreover, on the neighboring hill took place an extensive modern extraction of a poor quality ally rock, which caused the leveling of its top surface. It was only at the bottom of this hill where evidence from earlier quarrying still survives.

KEYWORDS: Cos, travertine, amygdalòpetra, quarry, Pyli

INTRODUCTION

The archaeological excavations of the last century on the island of Cos (fig. 1) have brought to light a great number of artifacts made of a local stone, the travertine, otherwise known as 'almond stone'. The recent discovery of a late classical – early Hellenistic temple and of another monumental building in Halasarna, during the excavation conducted by the University of Athens in the site, constructed almost entirely of travertine, and the need to identify the provenance of that stone were the original scientific aims of a project running under the auspices of the Dept. of History and Archaeology (Fact. of Archaeology and History of Art) of the University of Athens, lead by Prof. G. Kokkorou-Alevra.

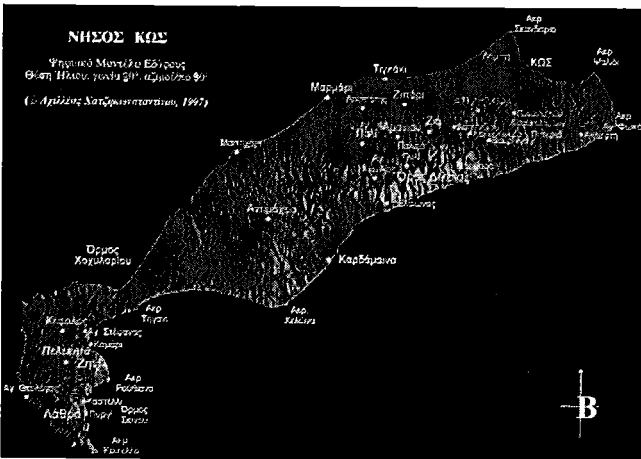


Fig. 1: The island of Kos.

EVIDENCE OF QUARRYING

Travertine is a porous and, sometimes banded, well consolidated limestone, of whitish or yellowish color. It is created by the chemical effect of solutions on calcareous rocks. These solutions are related to spring mineral water, the presence of which is an indication of volcanic activity. This phenomenon was known to Antigonus of Carystos, in the end of the 3rd cent. B.C. (Schneider 1873, vol. II, Frag. 100f. 35, 345-

346), and is, also, mentioned by R. Herzog (1899, 156-157; 1904, 192) and L. Laurenzi (manuscript, note 24).

The peculiarity of its geological formation, urged the scholars of the first half of the last century to search for a travertine quarry in the area around the springs of Vourinna and Kokkinonero, whose healing water was related to the cult of Asclepios. As early as the age of Antigonus from Carystus, it was generally accepted that a quarry with big porous blocks existed in the vicinity of the springs: 'that from this spring water the Koans quarried stones, thus building the theater' (Schneider 1873, vol. II, Frag. 100f. 35, 345-346). In the first detailed geological description of the island, H. Gorçeix, a 19th century geologist, mentioned some trachites

with 'noyaux amygdalaires de carbonate de chaux' (=almond-shaped kernels of carbonated calcium) around the spring of Kokkinonero (Gorçeix 1897, 208). He also observed the deposition mechanism of travertine, via water action, which produced thick layers around the spring of Kokkinonero (Gorçeix 1897, 207). R. Herzog was the first who identified this porous amygdalopetra with travertine, a well-known rock in ancient Rome (Herzog 1899, 157). L. Laurenzi (manuscript, note 24), also added that these rocks originating from the spring of Kokkinonero were

used for the building of Asclepieion and the modern city. The information above was confirmed by a recent research of I.G.M.E. (= Institute of Geological and Mineral Research) (Triantafyllis 1999), which verified the presence of marly and travertinoid limestones, called pelsparites, east of Kokkinonero and Vourinna.

All the aforementioned sources were extremely valuable to our survey. Initially we visited the Vourinna spring, around which

Zarraftis Zarraftis (1921, 50) had seen low quarried porous hills, which provided construction material for a nearby fountain. There existed indeed a small-scale, rather unorganized quarry, whose product was a gray limestone instead of travertine. A further investigation east of the spring of Kokkinonero came across a travertine hillock, beside the modern road, in the shape of a long bench, where many hydrophyllous plane-trees grew. To the north, deep into a ravin, existed another travertine occurrence, covered with scarce vegetation, without any ancient tool-marks on it. However, a temporary extraction could have taken place in the area, but the rest of the site still remains inaccessible. Since no further evidence such as chipped stones or pot sherds were discovered, the existence of a travertine quarry in this region seemed far from reasonable.

THE QUARRY AT PYLI

The effort to locate the source of travertine continued in the north-eastern part of Cos, following the geological map and I. Zarraftis's notes (Zarraftis 1921, 109) which described the presence of an organized quarry on a rocky hill east of Mesovouno, by the modern village of Pyli: 'West (of Mesovouno), rise even lower rocky hillocks, on which many ancient remains are visible. Particularly on one of them, one can see white blocks of marble and travertine, from which the ancients cut the white stones for vases and statuettes, and the travertine for urns'. The newly-found area, 500 acres wide, was actually a hill, with its base at 28 meters and top at 91.5 meters above sea level, located as follows: east of the Kos-Pyli road, west of the military camp 'I. Makrygiannis', north of the Stenakas stream and south of an inactive modern quarry (Fig. 2). Unfortunately, it was occupied on



Fig. 2: Plan reconstruction of the newly found area east of the Kos-Pyli road.

the eastern part by the same military camp, which consequently destroyed it, as the accumulation of big blocks with quarrying traces in different parts of the camp proved. A collaboration with the officers enabled us to explore the whole region and verify Zarraftis's exact words.

Nevertheless, judging from what had survived, we have reasons to believe that the best quality was extracted from the western hillside, whose stepped profile was an indication of systematic and long-term activity. Travertine was more apparent on the middle and upper parts of the hillside. The lower and more accessible ones had been destroyed by modern quarrying techniques, preferred for the extraction of granite nowadays (Schumann 1994, 210), such as leveling, pneumatic hammer or hydraulic equipment, the last being easily recognizable by the characteristic cylindrical vertical holes, all of the same size (diam. 2-3,5 mm.) (Fig. 3). Ground survey also recorded a group of six quarrying fronts of low and elongated shape, following the direction and inclination of the geological strata, with the most impressive one being over 200 m. long and 2 m. high.

Among the fronts, on the central part of the hillside, survived a sledge path leading downwards, flanked by pole-holes, of c. 7-10 mm. diameter, on which the cords for the transfer of the extracted blocks should have



Fig. 3: Travertine on the lower part of the hillside showing marks of granite extraction being recognised by the characteristic cylindrical vertical holes.



Fig. 4: Quarry at Pyli. Sledged path leading downwards, flanked by pole-holes.

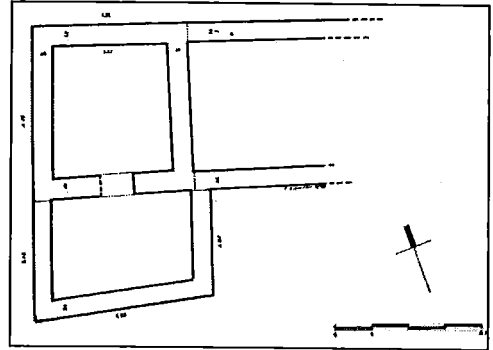


Fig. 5: Quarry at Pyli. Linear plan of a post-roman building.

been winded (Orlandos 1994, 91-92, figs. 36-37; Korres 1994, 34-35) (Fig. 4). Chipped stone and cut blocks laid scattered all over the place, while a large accumulation of worked material was situated higher up on the hill.

On the hilltop were the architectural remains of an East-West oriented, probably post-roman building. It consisted of three rooms and the lower parts of the walls were constructed with rubble stones and pot-sherds compacted with mortar; some of them were of the characteristic late and post-roman combed ware (Fig. 5). A use connected to the quarry cannot be excluded, as the close parallels from Euboia (Kozelj and Wurch-Kozelj 1995, 17-31) and Thasos (Mponias 1999) show, but the late date of the building was rather confusing.

The extraction methods and the detected tool-marks on the quarry fronts, may indicate that the quarry, active mainly in the post-classical period, did not cease to function until the end of the Hellenistic. The general overview of the quarry had many similarities to the large 4th cent. BC Mt. Goritsa quarries in Magnesia (Bakhuizen 1991, 53-79). A hypothesis of an earlier extraction, even in the archaic period, can be founded upon the form of the wedge-holes and the so-called *pointillé* technique. On the contrary, a later extraction during the post-roman and byzantine periods should be excluded, because of the absence of the *festoni* technique. These preliminary conclusions are due to the similarities of the



Fig. 6: Wedge-holes at Pyli quarry.



Fig. 7: Grooves at Pyli quarry.

detected tool-marks of Pyli quarry with those of published well-dated quarries; in particular:

1. The wedge-holes (c. 3-5 cm. x 7-10 cm.) resembled those at the archaic quarries of Naxos (Fant 1988, 105, fig. 14) (Fig. 6).
2. The continuous grooves (15-20 cm. wide) around the traces of extracted blocks, which replaced the series of dense wedge-holes, are common in quarries of late classical and hellenistic periods, such as those at Belevi (Fant 1988, 105-106; Kokkorou – Alevra 1992, 118-119, note 54, fig. 14) (Fig. 7).
3. The *festoni* technique (= diagonal series of shallow carvings, caused by the use of light quarry pick, in a way that they form the fish-bone pattern), which is dated by some scholars (Fant 1988, 97; Waelkens *et al.* 1990, 59) in the post-roman and in the byzantine period, was not detected in Pyli quarry. Even though, M. Korres (personal communication) does not accept this technique as a chronological criterium and attributes the formation of that pattern to the manner, in which every quarryman works inside the allongated deep grooves around the block, which would be extracted, regardless of a certain point of time.
4. The *pointillé* technique (= a series of dense point strokes, which replaces the series of wedge-holes) already appeared in the archaic period (Herz – Waelkens 1988, 17-18; Waelkens *et al.* 1990, 64-65; Kokkorou – Alevra 1992, 115) (Fig. 8). Even though the related *Keilrinne* /*Keilgraben* technique (= series of point strokes or wedge-holes carved in shallow trenches around the blocks to be extracted), which occurs in many Imperial granite quarries (Röder 1957, 265-266; Röder 1965, 524-528; Kraus – Röder 1962, 724) was not detected in Pyli quarry. However, the dating criterium from the absence of that technique cannot be adopted neither for the quarries of marble (Fant 1988, 104-105), nor travertine.

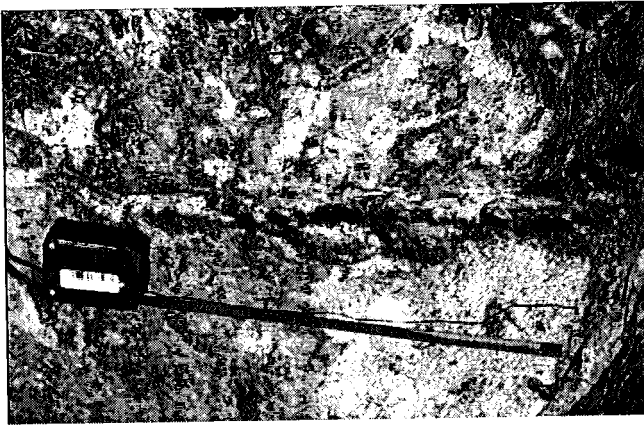


Fig. 8: The pointillé technique at Pyli quarry.

The contemporary extraction on the lowest levels of the hillside is manifested not only by the traces cited above, but also by modern quarrying implements such as the integral iron wedge (14 cm. high, 3,5-2,5 cm. wide, 2,5 mm. thick) found together with ten secondary sheets ('παρρασφίνια') (each of them is 2,5 mm. thick, all of them are 14 cm. wide with the wedge), inside a block of stone (fig. 9). This wedge resembles the one



Fig. 9: Iron wedge found together with secondary sheets inside a block of stone.

discovered in the ignibrite quarry at cape Tigani (Chiotis and Papadimitriou 1995, fig. 3-4).

Abandoned travertine objects were absent, except from a few half-worked column drums (fig. 10) and plinths (Fig. 11). Moreover, close to the quarry we observed a marble architrave and a part of a volcanic rotary quern. It is probable that other remains from the ancient extraction were utilized in the masonry of the neighboring military buildings or that they lie embedded in the earth-filling of the quarry, which

is particularly thick in the middle parts of the hillside.

A cut-out unfluted travertine column, lying by the shore of a small lake (Fig. 12), just a few meters north of the quarry and probably near the ancient road, indicates that the material was transported from its source, initially through the sledge paths of the quarry and, subsequently on carriages (four-wheel carriages), all the way to the coast, where it was loaded on boats, the stone-carrying boats.

ANCIENT USE OF TRAVERTINE ON KOS ISLAND

According to a wide-spread theory (Morricone 1950, 56), the use of travertine is attested in the coan architecture, in the late classical period and the 3rd cent. B.C., that is, since the foundation of the new polis on the northeast coast, on the Cape Scandario, and until the systematization of the marble-quarries of Mt. Dikaos (366-20 B.C.). However, a probable earlier use of coan marble, dictates a reconsideration of the coan travertine quarries dating. The fragmentary publications of italian excavations, conducted before the World War II, and the common misinterpretation of identity of the stone material used in the architecture of the island were a serious obstacle to our study. Such an example is a certain type of local white



Fig. 10: Abandoned travertine objects (half-worked column drums).



Fig. 11: Abandoned travertine objects (plinths).



Fig. 12: A cut-out unfluted travertine column.

limestone, used in the classical sanctuary of Demeter in Kyparissi, 'che in bellezza non la cede al marmo' (Laurenzi 1931, 623). The lack of references on the provenance of Koan limestone and the unique features of a stone as luxurious as marble, used in Kyparissi, enabled us to identify that stone with the non-porous travertine from the Pyli quarry, whose best quality is compared with alabaster (=gypsum) or onyx. Since, no limestone quarry that could have provided this certain type of rock has been discovered on the island, except from the two limestone quarries on the cape Ag. Fokas, which were not organized and whose limestone is gray (quarry of Aklafti) and purple (quarry of Piperia), of poor quality and on the other hand, the import of such a common material seems rather awkward, one can argue that the sculpture stones from Demeter's sanctuary may have come from the Pyli quarry.

The detailed observation of lithic architectural material leads to the safe suggestion that travertine had been already used since the late classical period. As a matter of fact, by the end of the 4th cent. B.C. travertine had appeared in many buildings in the town of Cos, in combination with marble or volcanic material: e.g. in the lower parts of the temple B in the second terrace of Asclepieion (Herzog-Schazmann 1932, 34-36), in the superior part of the external walls, the pedestal and the doric colonnade of the internal portico of the Agora (Morricone 1950, 71-72), in the East Stoa of the harbour quarter, entirely built of travertine (Morricone 1950, 64-65; Livadiotti-Rocco 1996, 121), in the

Gallerie of Tuff, found east of *Cardo* (Morricone 1950, 231), where travertine was combined with tuff, the seats of Stadium (Morricone 1950, 223-224; Zervoudaki 1972; Livadiotti-Rocco 1996, 152) and the theatre (Livadiotti-Rocco 1996, 158). In Demeter's sanctuary in the town of Cos, where a renovation took place during the third constructive phase of the temple, travertine must have replaced limestone (Kantzia 1988, 180). In general, during the 4th cent. B.C., there is a steady preference to travertine mainly for massive constructions, such as the city walls, in combination with volcanic material (Morricone 1950, 60, 220). The same practice continued as late as the first half of the 2nd cent. B.C., when the supporting walls of Asclepieion terraces were built. This way they gave a monumental and rather theatrical appearance to the famous sanctuary, following the architectural mentality of that era (Politt (1986), 231-233).

In the provincial architecture of the same period, an extensive use of travertine is also observed; e.g. in the orthostates of the recently discovered late-classical or early hellenistic Temple C of Halasarna, as well as in the superior part of the Temple (Κοκκορού – Αλευρά 2001, 93-96). It also appears in another unpublished monumental building of Halasarna, to the east of Temple C, which has not been completely unearthed by the Univ. of Athens excavation team. A chronological affinity between these two buildings is probable (Kokkorou-Alevra, unpubl. 1).

In the hellenistic period, the architectural use of travertine focuses on the lower parts of the buildings, whereas white and gray marble is preferred for their upper parts. That is the case for the main public buildings established during that period in the harbor quarter: the double Sanctuary of Aphrodite and the Sanctuary of Hercules, as well as the oecus west of it, which is dated earlier (Morricone 1950, 62-63, 66, 67). In the West Gymnasium (Morricone 1950, 225; Livadiotti-Rocco 1996, 145ⁿ, in the quarter named *Porta Nuova*, a

similar presence of travertine can also be confirmed.

Further uses of travertine in the hellenistic period are seldom mentioned in literature. It was completely improper for any kind of sculpture or architectural decoration, except for simple carving patterns, e.g. architectural simae or cornices. Travertine vases are rare too; only a fragment was found in the destruction layer inside the Temple C in Halasarna. The inscribing of travertine blocks was exceptionally difficult, because the porosity of the material would have caused inevitable gaps in the text. Nevertheless, such inscribed blocks are often mentioned in the recent literature (Segre 1993, inscriptions ED 210 (1st cent. B.C.), ED 232 (2nd cent. B.C.), EV 127 (2nd cent. A.D.), EV 196 (after the 3rd cent. B.C.), EV 328 (6th-5th cent. B.C.), EV 330 (5th cent. B.C.), EV 331 (3rd cent. B.C.), EV 332 (4th cent. B.C.), EV 333 (5th cent. B.C.), EV 335 bis (1st cent. B.C.)]. Two important inscriptions on travertine blocks were found during the Halasarna excavation, but unfortunately one is in very bad condition (Kokkorou-Alevra, unpubl. 2, art. nos. 11, 15). Other secondary uses include bases, pedestals (e.g. Kokkorou-Alevra 2001, 96) of statues, supports of basins (*perirranteria* or *louteria*) and tables. It seems probable that stone-carvers preferred travertine, because of its lower cost in comparison with the marble.

CONCLUSIONS

While our research all over Kos is still continuing, the ancient quarry at Pyli remains so far the only reasonable candidate for travertine extraction. However, judging from the ancient remains, it is safe to suggest that the extracted quantities suffice only for local needs and not for export trade. The best quality of the rock must have been exhausted in the hellenistic period, after which marble totally replaced it. Since the travertine used on modern italian buildings of Cos looks significantly different from its hellenistic counterpart, this is a hint for an Italian origin

of the first. In our opinion, the contemporary use of travertine by the Italians in Cos underlines an attempt to preserve a local

tradition which echoes the special 'flavour' of ancient Coan architecture.

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