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FROM SMALL QUARRIES TO LARGE TEMPLES – THE ENIGMATIC SOURCE OF LIMESTONE FOR THE APOLLO TEMPLE AT DIDYMA, W-ANATOLIA

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Abstract

The construction of the Hellenistic-Roman Apollo temple at Didyma involved not only marble as the most prominent building material, but also more than 12.000 m^3 or 33.000 metric tons of limestone, used in the cores of foundations and walls. Whereas the limestone originates undoubtedly from the surrounding Milesian Peninsula, the known ancient quarries are few, very small in size, and thus completely insufficient for supplying the enormous volumes of dimension stone required for the construction of the Apollo temple and associated buildings at Didyma.

Geoarchaeological mapping of the environs of Didyma revealed barren limestone plateaus with a great number of conspicuous barren piles and linear embankments of limestone flakes, distributed either in irregular clusters or in systematically arranged patterns. These flake piles and embankments occur closely associated with poorly recognizable, shallow, overgrown pits. The flakes display a relatively limited size range and characteristic shapes, typically with curvilinear, fractured edges. The limestone features a natural, orthogonal joint or fracture pattern and has been mined by simple technical means, immediately on surface or from underneath a very thin soil cover. Subsequently, the raw blocks have been rough-hewn on site, with the discarded material being left behind as waste piles. The surface-parallel limestone beds have been most suitable for the industrial, extensive near-surface extraction of raw blocks, which must have supplied a major portion of the dimension stone used for the Apollo temple. This technique has resulted in the development of a characteristic landscape, shaped by its ancient mining heritage. The dry and barren limestone plateaus with their piles, embankments, small quarries, and pits represent a landscape devastated by ancient mining, highly unsuitable for ploughing and even unfavourable for the farming of olive trees.

In contrast, the fertile, clay-rich, marl-dominated landscapes and alluvial valley fills of the Milesian Peninsula are geologically, geomorphologically, pedologically, and hydrogeologically far more suitable for agriculture and living. The intensive ancient cultivation is documented by the great abundance of archaeological sites and artefacts found in these landscapes, particularly fragments of oil presses. In contrast, the mining landscape of the barren limestone plateaus features only very few archaeological sites or artefacts.

Keywords: DIDYMA, APOLLO TEMPLE, LIMESTONE, DIMENSION STONE, QUARRIES, MINING, WASTE PILES, FLAKE PILES.

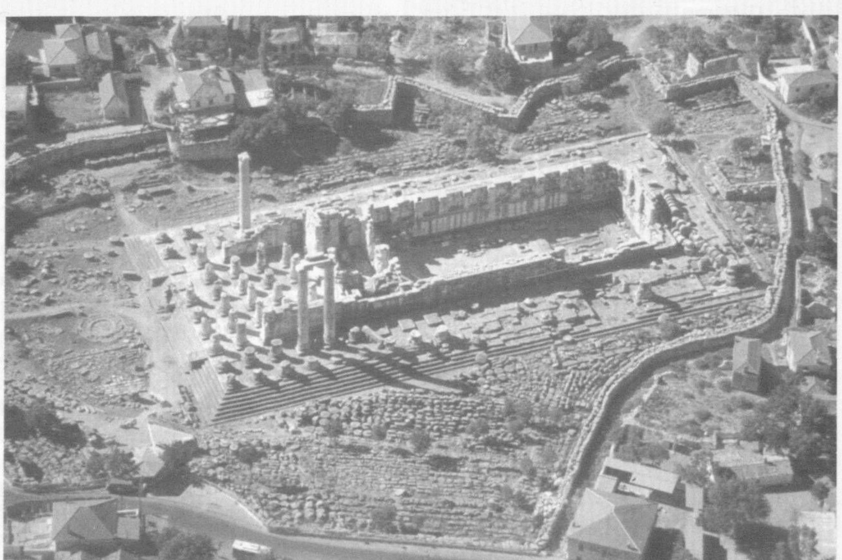

Fig. 1 – Aerial view of the Hellenistic-Roman Apollo temple at Didyma.

Introduction

The temple of Apollo at Didyma in western Anatolia ranks among the largest buildings of the Greco-Roman world. The remains of the temple, as seen today (*fig. 1*), represent the last of three consecutive temples and originate from a long and intermittent building history, which extended from the Hellenistic well into the Roman period. The most obvious building material of the temple is marble, from which the visible parts of the architecture, such as columns and outer parts of walls, have been erected. The marble for this temple has been brought from various sources, of which the closest is located some 25 km towards the southeast, close to the shores of Lake Bafa, a former embayment of the Mediterranean Sea (for more details on the provenance of the temple marbles see BORG *et al.*, 2000, and BORG and BORG, this volume).

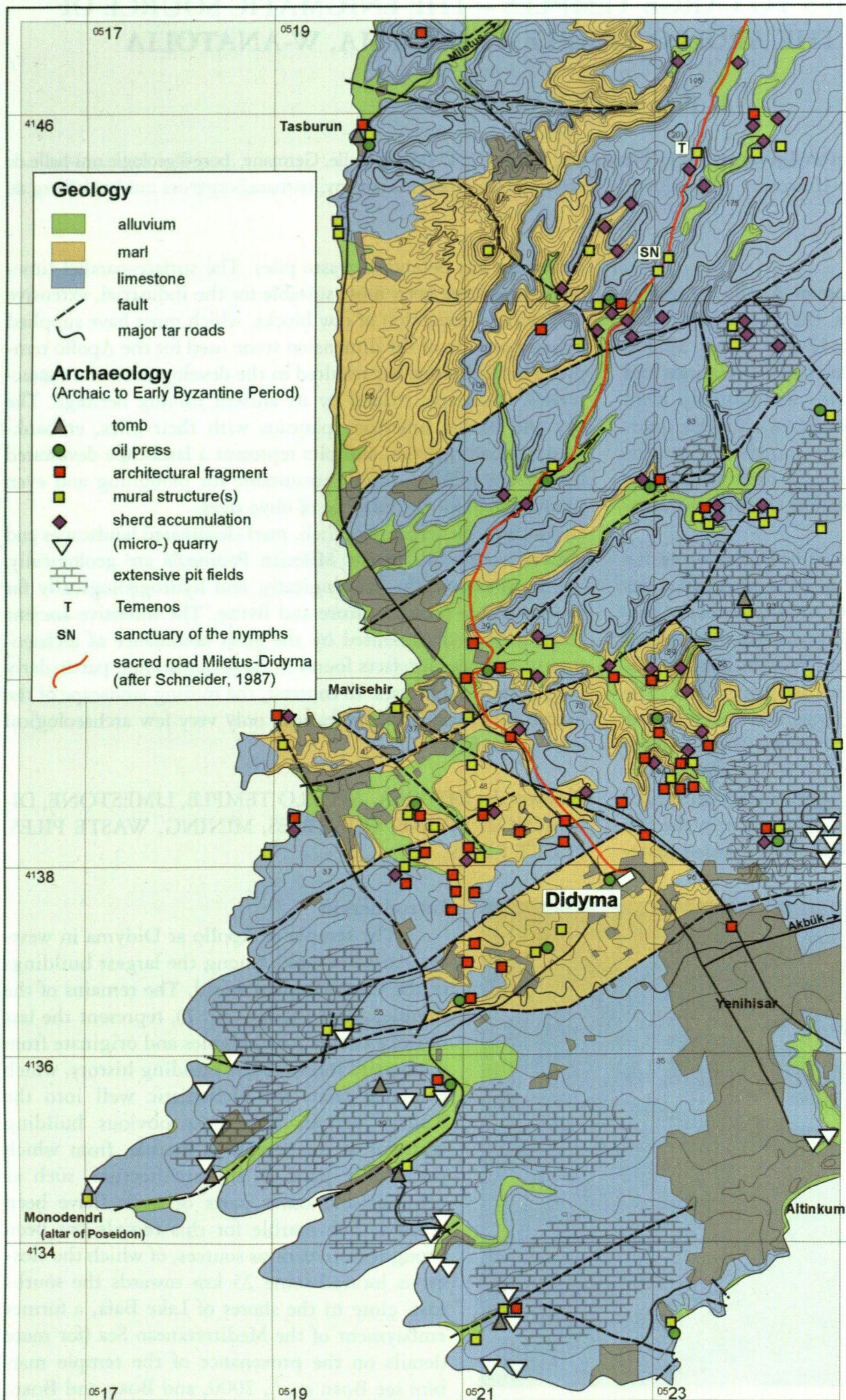

Fig. 2 – Simplified geological map of the south-western Milesian Peninsula, showing limestone plateaus (blue), marl-dominated areas (brown), and valleys filled by alluvial sediments (light green). Superimposed are the locations of various types of archaeological sites and objects, identified during our geoarchaeological mapping project between 1995 and 1999 (n.b. the countless archaeological objects at and around Didyma have been omitted for more clarity). A superimposed grey brick hatching shows limestone plateaus with extensive pit fields (Geology simplified after and archaeological sites from Kakerbeck, 1999; Kärner, 1997; Köppen, 1995; Neumann, 1977).

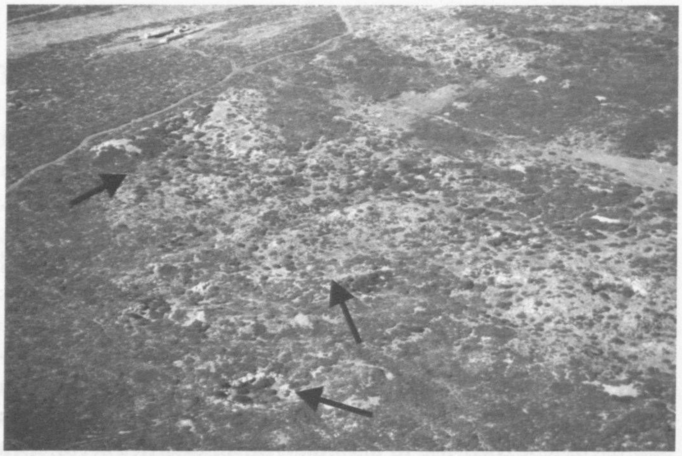

Fig. 3 – Oblique aerial photograph of a cluster of small antique quarries (indicated by arrows), scattered unsystematically in a pit field, 2 km east-northeast of the Apollo temple.

Fig. 4 – Close-up view of an unfinished limestone block in one of the small quarries shown in *fig. 3*. Bar scale on top of unfinishedblock is 50 cm long.

Fig. 5 – Small antique coastal quarry, immediately north of the Poseidon altar at Cape Monodendri. Bar scale at far end of middle quarry bench is 50 cm long.

Fig. 6 – Typical example of naturally exposed, orthogonally fractured limestone on a limestone plateau east of Didyma. Bedding planes and two orthogonal sets of joints with natural raw block dimensions, suitable for the architectural demands, define the rectangular shape.

Closer inspection of the building, however, reveals that the temple is not a massive marble building but consists of limestone wherever building material was not visible. This refers particularly to the massive foundations of all the stairs, to the cross-linked foundation piers under peristasis and walls, and to the cores of the walls themselves. Additionally, a great number of other buildings and constructions at Didyma, particularly the large paving slabs at the end of the sacred road from Miletus, consist entirely or to a significant extent of the same limestone. Enormous volumes of limestone have thus been used as dimension stone at Didyma. Two calculations, based on the publications by Knackfuss (1941) and Haselberger (1996), may help to get a rough idea about absolute volumes of limestone dimension stone used: The foundation of the stepped platform of the Hellenistic-Roman temple alone required a roughly estimated volume of 8.500 m^3. A further 3.700 m^3 of limestone dimension stone can be estimated to be contained in the cores of the outer temple walls including the socle part of the adyton but excluding the structures between adyton and dodekastylos, which are hard to even estimate but must contain considerable amounts of limestone for both foundation and cores of walls and staircases. Thus, a volume of limestone, significantly exceeding 12.200 m^3 or 33.000 metric tons has been used for the construction of the Apollo temple from the Hellenistic through the Roman period alone. The supply of such large volumes of dimension stone has been a major industrial, i.e. technological and logistical achievement.

The enigmatic origin of the limestone

Past and present scholars agree that this limestone must have been quarried on the Milesian peninsula, i.e. the territory surrounding Didyma and owned by the ancient city of Miletus, to which the sanctuary of Apollo belonged. Ancient inscriptions, giving account of the building activities, their organisation, and costs, seem to support this view (REHM, 1958). These inscriptions mention briefly that the same temple slaves, mining the marble in the Milesian quarries at Lake Bafa, quarried the limestone needed for the temple alternately, just as required, thus implying Didyma's environ as the source of the limestone. Wilski, in his topographical map of the Milesian peninsula of 1906, already recognised the existence of an individual small quarry, some 4.5 kilometres towards northeast of the temple, but it has always been acknowledged that this could never have provided the enormous volumes of limestone used at Didyma. From geological mapping it is also clear that the limestone cannot have been derived from the immediate surroundings of the temple or from deepening of the construction site, since this area consists predominantly of beige to pinkish marls and conglomeratic marls interbedded with clay horizons (*fig. 2*).

A geoarchaeological mapping project of the region surrounding the Apollo temple and the sacred road leading to Didyma from the city of Miletus in the north, has been carried out between 1995 and 1999 (NEUMANN, 1997; KÄRNER, 1998; KÖPPEN, 1998; BORG and BORG, 1998; KAKERBECK, 1999). This interdisciplinary study had the objective to investigate the natural resources, which led to the foundation and subsequent support of both sanctuary and settlement at Didyma such as water, dimension stone, clay, lime, and soils for farming. The mapping was at a 1:10.000 scale (see simplified version in *fig. 2*) and led to the discovery of comparatively few and particularly small quarries, southwest and northeast of Didyma, and of an abundance of archaeological sites and artefacts. Many of these sites and artefacts and some of the quarries were also documented during an independent archaeological survey of the Chora of Miletus by Lohmann (1999, with four quarries, nos. 246, 247 and 481, 484, toward the north-northeast and to the south-southwest of Didyma, all of them being of small size). It may be noted here, that our project was not intended to be a state of the art archaeological survey. The mapping was systematic in the sense that it covered the whole area without any preference to 'promising' find spots, but, in many places, the spacing was less narrow than required of an intensive survey. It is, therefore, highly probable that we overlooked several sites and/or artefacts, but we believe that these would not change the overall picture of the relation between landscape type and usage. This view seems to be supported by the survey map by Lohmann (1999). In accordance with our overall objection, we also refrained from both quantifying our archaeological data (e.g. to decide on whether a find spot is a site, in a more strict sense, or not) and dating the objects (except for a general classification as ancient, i.e. Archaic to Byzantine, as opposed to modern), especially since sites are often multi-component in the sense of ALCOCK *et al.* (1994: 138).

The most obvious quarries, some 2 km east-northeast of Didyma (*fig. 2*), form an unsystematic cluster of shallow pits (*fig. 3*). These quarries are surrounded by overgrown waste piles and have been exploited for one, locally two limestone beds of 0.7 m to 0.9 m, locally up to 1.5 m in thickness. These pits are, in fact, the largest and deepest ones identified in the area, reaching approximately 4-5 m in depth. The excavated clay, which had originally occurred in layers between the limestone beds, has allowed shallow macchia bushes to cover large parts of the waste piles, making them hard to recognise from a distance. Unfinished architectural blocks (*fig. 4*) and columns (fig. 5 and 6 in BORG and BORG, 1998) are preserved in some of these quarries and document their use in antiquity. Small quarries occur both relatively far inland (*figs. 3* and *4*) and immediately on the coast, as for example the small quarry just north of the Poseidon altar at Cape Monodendri (*figs. 2* and *5*).

However, the newly found quarries, most of them being even smaller than the one recognized by Wilski, added little to the supply of limestone for building activities at Didyma, particularly if we take into account that several tombs, scattered over this very area, were built from the same material. Thus, the visible limestone quarries of the Milesian peninsula could have provided only a very small portion of the required volume of dimension stone for the Hellenistic-Roman temple (and its precursors) and the other monuments at Didyma. Yet, the geological setting and a fresh study of some conspicuous anthropogenic structures, known and discussed for long, suggested that extensive pit fields with surface-parallel mining or simple extraction of orthogonally jointed raw blocks from the immediate land surface have been the other major source of limestone for the building activities at Didyma besides the more typical quarries.

Geological characteristics of the limestone

The limestone used at Didyma is dense, locally cavernous, whitish to cream-coloured, and generally fossil-poor. It is relatively easy to format and has good physical building properties when protected from weathering. The limestones of the Milesian peninsula are of Upper Pliocene and Lower Miocene age and occur as up to 1.5 m thick layers in a sequence of interbedded limestone, marl, conglomerate, and rare tuffaceous intercalations. The layers are nearly flat lying, generally dipping south with 3° to 5°. Tectonic extension has caused faulting of the sequence and resulted in the formation of fault-bounded blocks (*fig. 2*), which display individual directions of (shallow) tilt. The same tectonic regime has also determined the orientation and geometry of the joint or fracture pattern, which has broken up the individual limestone beds into natural blocks. This joint pattern is approximately orthogonal and, together with the bedding planes, has resulted in regular, rectangularly shaped raw blocks, commonly visible on the limestone plateaus and only thinly covered by soil (*fig. 6*). Where stronger erosion has removed the soil completely, the orthogonal blocks have become fully exposed and their natural shape and size has started to deteriorate from surface weathering (*fig. 7*).

Generally, sizes of these raw blocks range between 1.2 × 1.0 × 0.8 m and 1.6 × 1.3 × 1.2 m (even bigger sizes are not uncommon), permitting the production of several sizes of dimension stone used in various architectural contexts at the sanctuary (see for example Knackfuss, 1941, pl. 28, Z 241). A rather specific, oncolithic white limestone occurs in even bigger natural dimensions of up to 1.8 × 1.6 × 0.4 m due to its interlocking micro-texture, which also results in its specific hardness and resistance to abrasion. This particularly distinctive rock occurs in few areas of the south-western Milesian Peninsula, so, for example, in quarries and pits on the limestone plateau east-northeast of Didyma, and has been used for buildings and particularly for the large paving slabs of the sacred road already mentioned.

Ancient mining from 'invisible' quarries and ancient waste management

The surface of large portions of these limestone plateaus is characterised by either i) barren or slightly soil-covered limestone (*fig. 6*), ii) abundant completely exposed limestone blocks covering the surface (*fig. 7*), or iii) by 'moon landscapes', which are pockmarked by inconspicuous, small, shallow, funnel-shaped pits with adjacent low piles of limestone flakes (*fig. 8*). Some of these flake piles occur intermittently aligned and locally form embankments of flakes of up to 150 m length (*fig. 9*). The height of these flake piles and flake embankments generally does not exceed 1.4 to 1.8 m, with diameters or widths of between 6 and 10 m. Flake piles situated immediately adjacent to individual pits tend to be half-moon shaped and follow part of the outer rim of the pits with the slope of the flake pile grading smoothly into the slope of the pit. The pits are shallow, funnel-shaped negative morphological features, not deeper than 1.3 to 1.5 m, with rubble and soil-covered slopes and a dense cover of macchia and grass, severely obstructing the visibility of these pits (*fig. 8*). Slightly more conspicuous on the ground (*figs. 8* and *9*) and very obvious from the air (*fig. 10*) are the white limestone flake piles, which are almost void of any vegetation. The absence of vegetation, at least from the upper part of the flake piles and embankments, is due to the fact that these consist almost entirely of 'naked' limestone fragments of very specific size and shape (*fig. 11*). The limestone fragments display predominantly sharp, fractured sides, 'flaked' edges (*figs. 11* and *12*), and have dimensions which commonly do not exceed 20 × 12 × 7 cm. Recently, individual flake piles have been mined ('recycled') and partly removed for road gravel (e.g. 3 km southwest of Didyma), thus exposing the inner part of these piles. Here, it can be observed, that the flake piles rest on the natural surface of the limestone plateau and have a larger percentage of bigger, irregular blocks in their core. Similar flake piles (although consisting of marble flakes) are a common feature within marble quarries along the shore of Lake Bafa. Here a number of these up to several meter high conical piles have recently been opened and crudely excavated to their central basal portion – obviously because of misunderstanding the piles as ancient tombs. These marble flake piles display a similar internal sorting pattern, which is the result of discarding the waste material from formatting (marble) dimension stone.

The limestone flake piles and embankments have been recognised for a long time (e.g. Paton and Myres, 1896: 245 n. 3; Wiegand, 1929) and interpreted by previous authors as stones cleared from fields for farming and/or as tombs (Lohmann, 1997). However, the close and systematic spatial association of most of the flake piles and embankments with shallow pits – overlooked so far – favour a rather different explanation, namely, a common industrial instead of an agricultural origin of these positive and negative morphological features. The rocks piled up next to the pits represent either flaked parts of limestone blocks chipped off during extraction and particularly during formatting of the limestone blocks or smaller stone fragments excavated from the pits and discarded onto the piles as waste. The shapes of the flakes with their typical sharp edges as well as their limited size range argue strongly against these flakes being stones simply removed from adjacent fields to allow or improve ploughing. This becomes clear by comparison with modern habits: In the rare cases where fields are cultivated in the respective area, chipped stones like those on the flake piles and embankments typically cover the ploughed fields and are not removed by the farmers since they actually make up a large proportion of the substrate on which the crops grow. Accordingly, stones collected from fields and deposited at their margins are generally much bigger and display signs of weathering all around, particularly the typical, irregular karst dissolution pipes. Locally, individual modern fields even cut across these flake embankments, with the limestone flakes ploughed under (fig. 14 in Borg and Borg, 1998), which would be a highly counterproductive behaviour had the limestone flakes of the embankment been cleared for easier farming.

The distinctly flaked shape of a very high percentage of the rocks on these piles rather documents that these limestone flakes have originated from the formatting of dimension stone instead. The surface of the limestone plateaus, exposed adjacent to and between virtually all flake piles and most flake embankments, is either flat, barren rock from which suitable raw blocks of limestone have been removed, or consists of overgrown pits from which a number of raw blocks have been extracted by relatively simple means of levers or winches. In both cases, the surface is a typical small-scale mining landscape and has been left highly unsuitable for farming. Agricultural use has been very limited in these areas, possibly permitting the local planting of irregularly and wide-spaced olive trees and almost completely preventing the ploughing of fields for crops.

The aerial view allows a further distinction between two sub-types of these ancient mining landscapes. These are i) unsystematic fields of small quarries and pits (*figs. 3* and *8*) and ii) areas where highly systematic rows of flake piles and flake embankments criss-cross each other (*figs. 9* and *10*). The surfaces

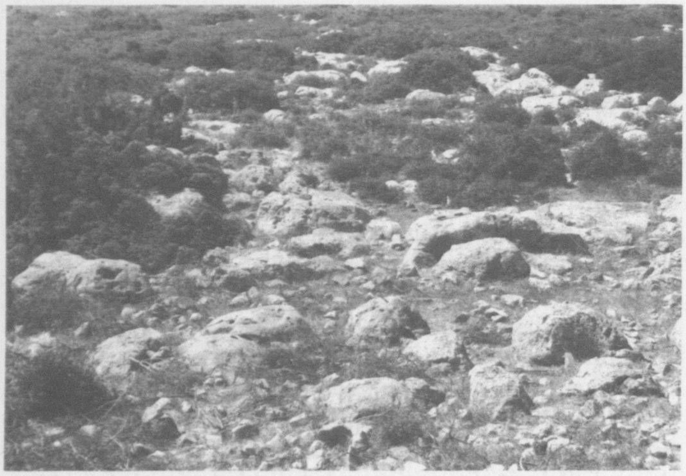

Fig. 7 – Natural surface of a typical limestone plateau, some 4 km southwest of Didyma, densely covered by weathered blocks of limestone and highly unsuitable for cultivation.

enclosed by these rows of flake piles and flake embankments, in many cases, display very small geometrical shapes, which, together with their crater-pitted surface, make cultivation impossible or difficult and inefficient. Both types of pit fields grade into each other and cannot be mapped separately and are, therefore, shown by one grey hatching in the map of *fig. 2*.

Although exact parallels for this type of quarrying the surface of almost a complete plateau seem to be still unknown, similar quarry-pitted ancient landscapes have been described from various sites, among these Delphi (Amandri, 1981; Waelkens *et al.*, 1990), the island of Aegina (quarries for the Aphaia temple: Wurster, 1969), Dokimeion (Röder, 1971), and central and western Makedonia (Vakoulis *et al.*, 2000, and this volume).

The contrasting landscapes around Didyma and their specific ancient utilization

Three distinctly contrasting types of landscapes make up the (south-western) Milesian Peninsula. These are geologically, geomorphologically, pedologically, and hydrogeologically well-defined and have been utilised rather differently in antiquity, with the dimension stone for Didyma derived from one of them, the barren limestone plateaus.

Virtually all of the limestone plateaus of the south-western peninsula expose the favourably jointed limestone blocks and slabs described above. Modern agricultural use of these plateaus is very limited, due to the general lack of soil and the resulting barren and/or block-covered land surface (*figs.* 6 and 7). In addition, these plateaus are particularly dry, due to strong karstification of the limestone beds where the rainwater drains extremely fast into the deeper subsurface. Thus, the retention capability of these plateaus is very poor, making these landscapes even less favourable for farming, although, at some places, a few terraces on top or on the flanks of these limestone plateaus indicate some limited ancient agricultural use, e.g. some 3 km west-southwest of Didyma. Accordingly, the barren limestone plateaus display comparatively few archaeological sites or artefacts such as mural structures, sherd accumulations, worked architectural fragments, and especially oil presses (*fig. 2*), and there is extremely little 'background scatter'. This seems to support the view expressed by Snodgrass (1990: 124) that «the level of off-site density is an index of agricultural activity, and specifically of contemporary (that is, in this case, ancient) agricultural activity. The general areas of high density are areas of intensive ancient cultivation. Since in many cases these will coincide with areas of similar but later activity, we can see why it is that sites in the low-density areas are not only few, but also 'weak', in the sense that their interior density of finds is low: there has not been the same frequency of farming operations over subsequent centuries to bring their material to the surface».

As an exception to the rule, the limestone-dominated area in the north-easternmost part of the map features many archaeological sites (*fig. 2*). However, in contrast to the limestone plateaus discussed above, this area displays steep topographic gradients and is geomorphologically characterised by relatively deep, narrow valleys with steep flanks, separated by equally narrow limestone ridges. Locally, fertile alluvial sediments permitting intensive farming fill the valley floors. Several of the narrow flat summits at the tip of steep limestone ridges feature mural structures, some clearly identifiable as terraces or buildings respectively, roof tiles, and dense clusters of sherds, suggesting that these places were sites in the more narrow sense of permanent or temporary settlements. The hydrogeological setting of these deeply incised valleys has also been favourable, with seasonal and even perennial springs emanating along the valley floors, where the cavernous and permeable limestone is closely underlain by relatively impermeable marl. Geoarchaeological in-

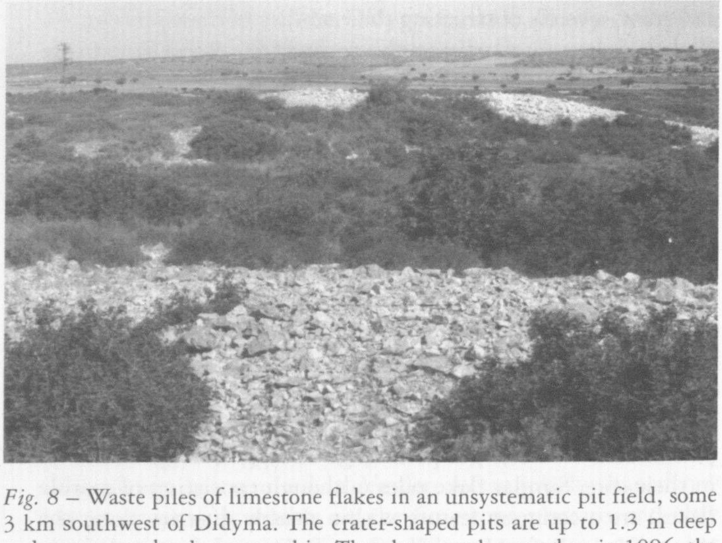

Fig. 8 – Waste piles of limestone flakes in an unsystematic pit field, some 3 km southwest of Didyma. The crater-shaped pits are up to 1.3 m deep and overgrown by dense macchia. The photograph was taken in 1996; the area has been affected by building activity since then.

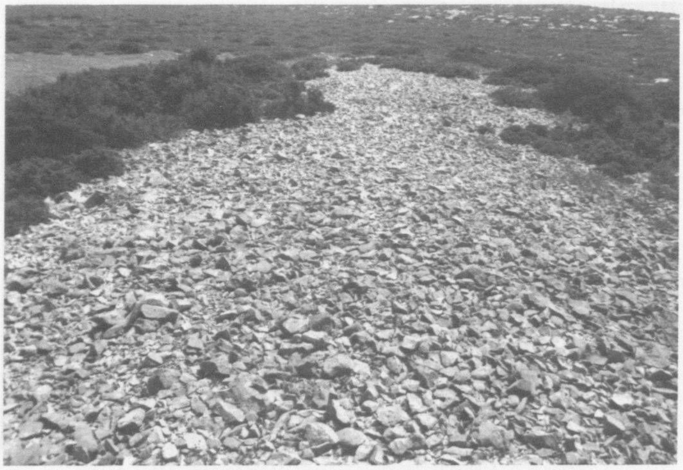

Fig. 9 – Quasi-linear embankment, southwest of Didyma, consisting of relatively equally sized, sharp-edged flakes of limestone. The embankment is some 6-8 m wide and up to 3.5 m high, shrubs of macchia obscure the sloping sides of the embankment.

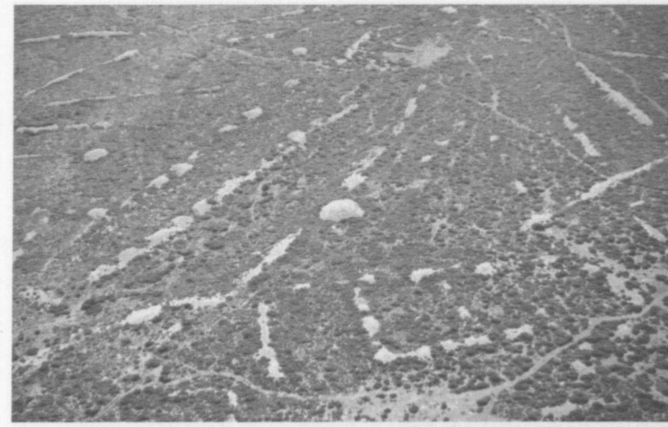

Fig. 10 – Oblique aerial photograph of a highly systematic pit field, 2.5 km east-northeast of Didyma, with regularly arranged flake piles and embankments of limestone flakes from the systematic exploitation of the limestone plateau for dimension stone.

Fig. 11 – Close-up view of the surface of the flake embankment in *fig. 9*, showing the particularly limited range of sizes and shapes of the limestone flakes. Bar scale in top left part of the picture is 50 cm.

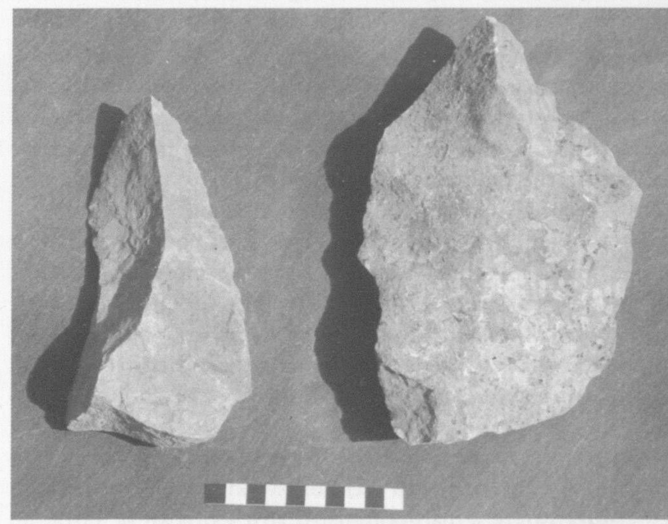

Fig. 12 – Two typical flakes of limestone with distinctly chipped ('flaked') surfaces and sharp edges from a flake pile adjacent to a limestone pit. Bar scale is 10 cm.

vestigations of the so-called 'sanctuary of the nymphs' (Bumke *et al.*, 2000), at a prominent perennial spring (*fig. 2*), revealed such a hydrogeological situation (Köppen, 1998). To the present day, the villages of the southern Milesian peninsula derive most of their water from fountains and reservoirs in this region. In addition to the favourable conditions for cultivation, long transport distances to both building sites have hindered quarrying of dimension stone in this area for either Didyma or Miletus; thus the lack of quarries is not surprising.

Another type of landscape comprises areas consisting predominantly of interbedded layers of beige marl, brown to pinkish marly conglomerate, and maroon clay (shown in beige in *fig. 2*). The marls and clays weather to relatively deep and fertile soils, and only the rare marly conglomerates form locally exposed scarps or individual rounded blocks. However, even these marly conglomerates are very vulnerable to weathering, and 'crumble' rapidly where exposed on surface due to a relatively high content of serpentinised ultramafic clasts. Although occurring in lenses of up to 2.5 m thickness, the conglomerate is of very limited use as dimension stone since it can only be used where completely protected from weathering. Marl (locally referred to as 'poros') has been used for the earliest temple at Didyma, the Sekos I or so-called 'Poros building', erected at about 700 B.C. (Tuchelt, 1992), but is very rare to absent in the Hellenistic-Roman temple and other building structures discussed in this paper. This pinkish marl crops out in the immediate surroundings and north-western vicinity of the Apollo temple, at the flanks of the valley extending from Mavisşhir toward the east, and in a more

Fig. 13 – Oblique aerial photograph of a marl-dominated region southeast of Taşburun with relatively deep soils under intensive cultivation. The area in the middle ground to the right shows systematic terraces of uncertain age.

Fig. 14 – Oblique aerial photograph of a shallow, flat-bottomed valley, east of Mavişehir, filled by alluvial sediments under intensive cultivation. The adjacent limestone plateaus are covered by rocks and macchia and show little agricultural use.

distant area, southeast of Taşburun (*fig. 2*). These marl-dominated areas are generally void of any rocks suitable as dimension stone but, with their deep soils, lend themselves to agricultural cultivation. The clay-rich soils retain rain and groundwater far better than the limestone plateaus, and most of the few natural springs occur at the interface between marl and overlying limestone. Photographs of these marl-rich areas, taken at oblique angles from a low-flying airplane, show the intensive (modern) agricultural use of these landscapes (*fig. 13*). The geoarchaeological mapping revealed that, in general, the marl-dominated areas feature a high density of archaeological sites and artefacts (*fig. 2*; for better readability, the large number of archaeological objects found in the marl-dominated area at and around Didyma has been omitted). In particular, fragments of oil presses occur predominantly associated with these marl-dominated landscapes.

Surprisingly, a marl-dominated area southeast of Taşburun (*figs. 2* and *13*) does not feature any substantial number of archaeological sites or objects. This may be explained by the high topographical gradient of this area, which can be as steep as 30°, and the physical properties of the soils. The steep gradient and the clay-rich soils of this area result in increased surface run-off of rainwater and cause very strong soil erosion. Any archaeological objects or traces of settlements in this step marly area have been eroded in the upper part and eroded or buried in the lower parts.

The third important type of landscape is the flat valley floors, which are filled by alluvial sediments (*fig. 2*). These valleys are characterised by deep, fertile soils and by high and relatively 'stable' groundwater levels as documented by numerous antique and modern wells along the valleys. The intensive agricultural use of these valley floors, contrasting with the barren, rock- and macchia-covered limestone plateaus, can be seen particularly well from the air (*fig. 14*). The cultivated valley floors feature abundant archaeological sites and artefacts, usually situated along their edges. In particular, fragments of oil presses have been identified in several cases, either immediately on the edge of the valley floors or on the rim or slope of the neighbouring limestone plateaus (*fig. 2*). In fact, the only fragment of an oil mill, which has been found in the centre of the large limestone plateaus southwest of Didyma, lies immediately adjacent to an unusually wide valley floor covered by alluvium and cultivated soils. Thus, it is the locally favourable setting with fertile soils which has led to the establishment of a settlement as documented by the remains of a Hellenistic building also found at this site (Kakerbeck, 1999; Lohmann, 1999, no. 255).

Conclusions

The enormous volumes of limestone used for the construction of the impressive temple of Apollo and other associated buildings and architectural structures at Didyma originated not only from the few small quarries previously known from the south-western Milesian Peninsula, but also from inconspicuously small pits, which cover most of the limestone plateaus in the immediate and wider vicinity of the sanctuary.

These plateaus were mined extensively for raw blocks for dimension stone by means as simple as they were efficient. The miners extracted individual blocks by simple levers and winches, after exposing the rock surface where necessary. Subsequently, the raw blocks were rough-hewn into the required shapes in order to reduce weight. This preliminary formatting was carried out 'on site', inside or immediately adjacent to the small quarries and pits with the limestone flakes left behind as waste (i.e. the flake piles). The blocks were then transported to the respective building sites. Intermittent, regularly arranged rows of flake piles and emban kments of flakes document more systematic near-surface mining activities of the limestone plateaus. Here, rows of pits, from which the raw blocks have been extracted, occur parallel to the embankments and resulted from discarding the waste onto these embankments until the distance became inefficiently far and a new row of waste piles was deposited.

The resulting land surface is devastated by the pit fields from ancient mining. Consequently, the agricultural utilization has been clearly subordinate to the mining industry for dimension stone due to the lack of (levelled) soil and ground water, a conclusion strongly supported by a significant scarcity of archaeological sites and artefacts. Two different types of landscapes, i.e. the marl-dominated areas and the sediment-filled valleys, are in stark geological, geomorphological, pedological, and archaeological contrast to the limestone plateaus. Here, the utilization has been dominated by farming, documented by the significantly higher density of sites or archaeological objects. These fertile, cultivated areas did not suffer from the conflicting interests between farmers and miners since these 'farmlands' lacked the potential for suitable dimension stone required at the various construction sites, not least the one of the Apollo temple of Didyma. The contrasting types of landscapes, surrounding the Apollo temple at Didyma, have thus served very different purposes in antiquity. These ancient landscapes have distinctly separate geological potentials, which determined their predominant use by either miners or farmers.

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