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Conservation of Ancient Quarry Landscapes
A Survey of the Area of Sagalassos (SW Turkey)[1]

Although the Sagalassos Archaeological Research Project has provided extensive knowledge of the architectural heritage and use of stone in the ancient city, a detailed study into the limestone quarries in its territory has remained limited up to now. During an extensive survey during 1994 and 1995, the remains of two large quarries were recorded.[2] A more detailed survey of the quarries on the site and in the immediate neighbourhood of the city, as part of a stone provenancing project, has been carried out since 1998.[3] The main aim of the quarry survey reported here is to undertake an in-depth study of the ancient quarry landscape and to establish its relationship with the various periods of construction in the town. The work focuses both on the geographical-geological dimension as well as the chronological link between stone extraction and construction periods. As a part of the QuarryScapes project, it also explores the unique opportunity the area provides to view the quarry landscape as the "larger Sagalassos landscape", adding new dimensions both to the quarry landscape and to the ancient town of Sagalassos itself.

The important research questions here are to characterize and classify the quarries according to the significance of the individual quarry and its role in the development of the city, the recognition of workshops and other quarry related features, a more detailed investigation of the geological features of the individual quarries and quarry groups and questioning the quarry organisation and the relationship between volumes quarried and volumes used. Also, the general aims and questions formulated within the QuarryScapes project towards the development of scientific and practical methodologies for documentation, characterisation and conservation of ancient quarry landscapes are looked into, to raise awareness of the significance and vulnerability of such sites and to contribute to legal protection measures and sustainable management of ancient quarry landscapes.

Natural Building Stones at Sagalassos

Throughout the history of the city, locally exploited beige and pink good quality limestone remained the most important building stone. Both high quality white limestone from the territory of the city and several marble types imported from Dokimeion, represent a smaller (but important) fraction of the total amount of building stones used.[4] For wall revetments and pavement slabs, large quantities of Docimian marble (both white and pavanazetto) and coloured varieties from elsewhere (cipollino, Proconnesian real porphyry) were imported, likely as slabs.[5] The beige and pink limestone, used at Sagalassos throughout the history of the city, can be found in the local geological substrate, the Lycian nappes, showing a rapid alternation of facies types over short distances. Different types of limestone can often be found close together in one and the same location.[6] From petrographic and geochemical evidence, it is clear that the limestone (bioclastic pack to wackestone) from the Lycian nappe near monumental Sagalassos can be found in buildings from the late Hellenistic throughout the Julio-Claudian and Hadrianic to Severan period. In late Hellenistic times, however, also an exclusive limestone (radiolarian mudstone) was used.[7]

Quarries and Quarry Groups

Survey already carried out resulted in a preliminary characterization of quarries which can act as a basis for more detailed work.[8] With the new work presented here, the quarries in the territory of Sagalassos can be grouped according to their location (local or regional), their geology (and hence the provenance of the stone used), morphology (topographical features) and production evidence (quarry marks, extraction sites, partially worked objects, spoil heaps, etc.).

On-site Quarries

The quarries have been mapped in detail using GPS and satellite photo (Fig. 1 - Pl. I.13). Distinction is made between quarry areas with visible quarry faces, spoil heaps related to quarrying and smaller, single extractions. Furthermore, areas where subsurface quarries covered by scree deposits or buildings may exist, are also marked. In total, ten individual quarries have been mapped. These quarries are defined as confined areas where the rock faces display multiple evidence of extraction, and it is assumed that they constitute the main local sources for stone within the city. There may be other quarries that are completely covered or overbuilt, for instance around the Upper Agora. 13 single extractions, of which some are new from previous investigations, are also located on the map in Figure 1 (Pl. I.13). These are either trial quarries or very small extractions of one or few objects.

Eastern Quarries

East of the city, evidence of quarrying is found on top of the hill just to the east of the Eastern Necropolis. Little remains of the quarry faces. However, the presence of quite large heaps of limestone chips and fragments, interpreted as quarry spoil heaps, suggest that quite significant quarrying and working of stone took place in this area, and that the quarries were practically exhausted (Fig. 2). It is likely to link these quarries to the nearby necropolis, but the quarries may also have supplied building stone to the city. On the basis of the size and distribution of the spoil heaps, the likely estimate of extracted volumes could be in thousands rather than hundreds of cubic meters, thus exceeding the use of stone in the Necropolis.

Southern Quarries

Two quarries and a number of minor extraction sites have been identified near the southern Necropolis. The westernmost quarry displays a few tall quarry faces, highly deteriorated due to the poor quality of the stone (nodular limestone; similar types are seen in nearby sarcophagi remains). It is difficult to estimate extraction volumes in the quarry, which could range between a few hundred and one thousand m^3. The easternmost quarry can be described as highly irregular, showing several small extraction sites. Scattered quarry marks around the hill suggest that blocks bordered by natural fractures also were extracted, and it is therefore very difficult to estimate extraction volumes. It seems clear however that at least some hundreds of cubic meters were quarried. Measurements of the few carved quarry faces indicate that the quarrying targeted sarcophagi. Furthermore, the scattering of extraction sites in the quarry either indicates a high variation in quality (targeting small 'pockets' of sound quality) or non-systematic production, perhaps as smaller campaigns over a long time. Optimistically viewed, the southern quarries could have supplied raw material for most of the sarcophagi in the area.

In the Necropolis itself, there are several minor extraction sites or trial quarries. Particularly interesting is one site where there is evidence of wedging of stone blocks parallel to natural fracture planes.

Northern/Western Quarries

These include quarries around the northern Necropolis and just north of the stadium. In the former case, extraction traces (quarry steps and channels) are seen by the foot of the cliff below the necropolis. Unfortunately, most of the quarry is probably covered by scree deposits. However, given that such marks are seen through a distance of nearly one hundred metres, it is probable that this quarry could have been a significant source for building stone to the city. Approaching the upper part of the necropolis is a "non-systematic", shallow quarry with numerous small extraction sites. This may have been the source for the few sarcophagi in the necropolis.

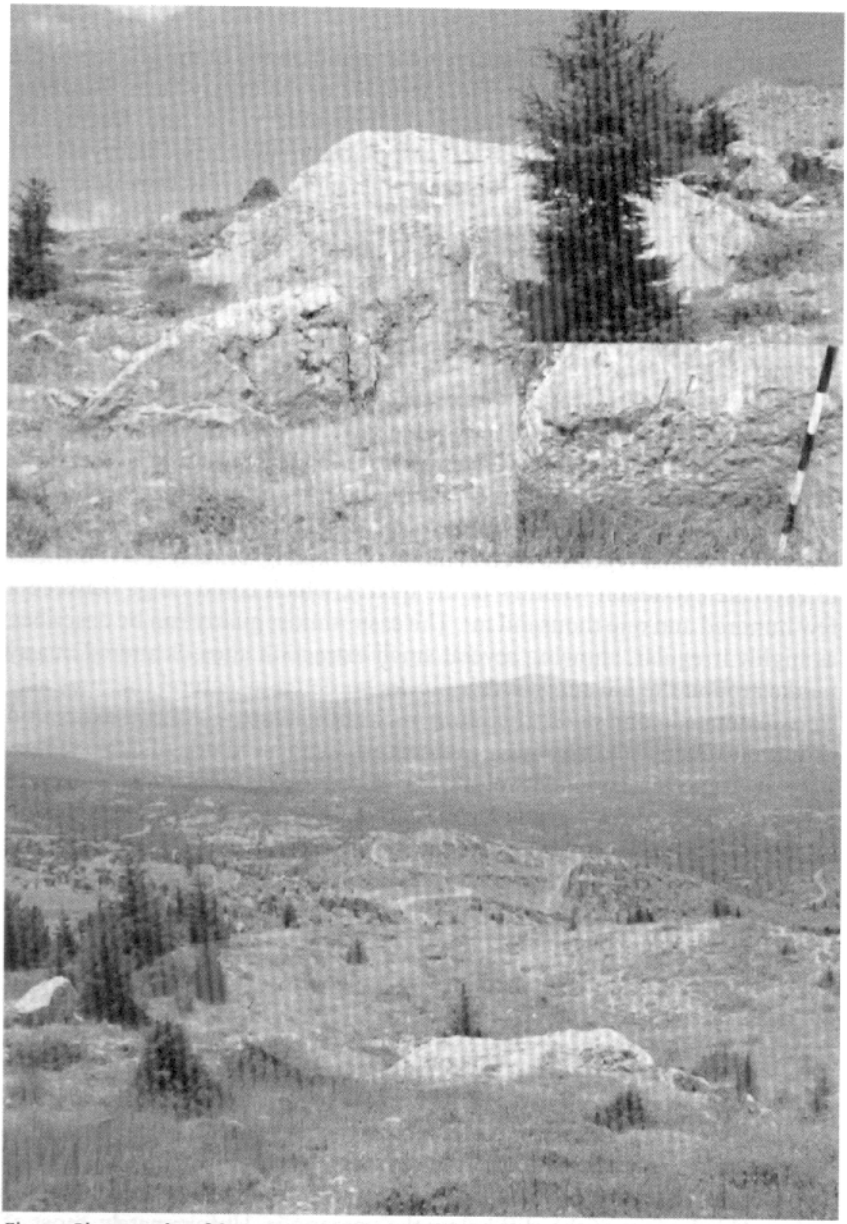

Fig. 2 – Photographs of the eastern quarries at Sagalassos, showing (top) the quarry face (4m high) and (bottom) the spoil heaps in front of the quarry.

North of the stadium are two quarries and some minor extraction sites along the foot of the hill. The westernmost of these quarries is of particular interest, due to the extraction techniques displayed. The limestone deposit has frequent oblique fractures, making systematic channelling difficult. The quarry marks thus indicate that not only were these fractures used as primary block boundaries, but the direction of the existing channels changes frequently in order to maximize the block yield. Volume estimates are difficult, but it is likely that a gross magnitude of volume close to 1000 m^3 was extracted in the area.

Central Quarries

Two, possibly three, quarries exist in the central area of the town. In the eastern part, one possibly major quarry is situated by the domestic area. Frequent step like extraction traces, carved walls, combined with the fact that the quarry continues deep below the present soil surface and that the total length of the corner-shaped quarry face is nearly 90 m, indicate that this could have been a major stone source. Parts of the quarry were modified and/or some quarry marks may relate to construction and not to quarrying alone.

To the west of the Apollo Klarios temple, there is a small hill with traces of quarrying on the top of the hill and on its western slope. At the southeast corner of the temple, a small outcrop displays some traces of quarrying. Traces seem to be related to levelling rather than stone extraction. In the area around the Upper Agora, there are steep quarried walls integrated in the building mass. Given that geological evidence suggests that the area contains (or contained) large volumes of sound quality limestone, one may suggest that stone for building was partially quarried here. Another site where there might have been limestone resources is the theatre; however here there is no evidence of quarrying.

Discussion

An estimate of the amount of stone (ashlars) used in monumental architecture was made on the basis of plans for a number of buildings and streets. It needs to be made clear that only few buildings were measured in this way up to now. As a first result, it can be said that the amount of ashlars used in the Heroon comes to 170 m^3, the Bouleterion constitutes 280 m^3 of stone, the Antoninus Pius temple 500 m^3, the pavement of the upper agora 700 m^3, the pavement of the lower agora 250 m^3, the back wall of the west portico of the lower agora 50 m^3 and the pavement of the colonnaded street 600 m^3. Though many smaller buildings and a large construction as the theatre have not been taken into account, it seems that paving and agorae constitute a larger investment in terms of volume of stone extracted than the monumental architecture. It can also be taken into account that many structures in the city only have a façade of ashlars, and were for the most part constructed with tile,

concrete or *opus caementicium*. Also, many building are constructed with mortared rubble walls instead of ashlars. Though very speculative, one could suggest that the amount of ashlars needed for entire monumental Sagalassos would not exceed 10.000 m^3 of ashlars, but is likely to be as low as 5000 m^3.

During the 2nd century AD, production of free-standing sarcophagi became integrated into elite burial practices covering a time span of approximately 100 years.[9] From Köse's documentation of these burials it is possible to make some estimates as to the volumes of stone used for these purposes over a 100 year period. Stone quarried for the manufacture of sarcophagi could range between 500–1.500m^3 gross volumes, this figure varying in relation to the percentage of waste, given that the total net volume used is approximately 300m^3. In a few instances, stone seems to have been acquired from a quarry 2 km east of the city and perhaps from Sarıkaya 3.5 km away and other sources. The volume of stone extracted over a 100 year period for burials would constitute a significant
 percentage of stone extraction vis-à-vis that for buildings.

The limestone outcrops in and around the city display considerable variations in quality, both regarding use (durability) and quarrying (block potential). The former is important for preservation of the quarries; particularly, brecciated and nodular limestone varieties are severely weathered and extraction marks are usually strongly deteriorated. Block potential is predominantly related to the degree of fracturing in the limestone deposits. In general, less fractured varieties display abundant extraction marks such as carved walls and channels, whilst such evidence is rare in fractured limestone. This is due to extraction of primary blocks bordered by natural fracture surfaces being the main method of quarrying in such quarries.

The keyword for the quarrying of limestone in the city area seems to be *proximity*; in the immediate vicinity of important stone consuming activities, being construction or funerary use, there are quarries, which in size (at least from an optimistic view) fit the volumes in question. The lack of systematic channelling in the quarries likely relates to the stone quality; the abundance of natural fractures in the limestone deposit forced the quarrymen to follow the natural features.

Local Quarries (Fig. 3)

These include quarries located from 1 to less than 10 km from the city centre. The Ağlasun Dağları Quarry (Fig. 4) is situated close to the summit of Ağlasun Dağları mountain range, and is situated in a pinkish variety of limestone. The pink colour of the stone was probably the reason for undertaking quarrying at such high altitude instead of using more readily available sources. The quarry shows signs of extracting blocks along natural fractures, and thus the quarry displays few worked quarry faces. Due to overburden it is difficult to estimate extracted volumes. However, the lack of large spoil heaps indicates that the quarried volumes did not exceed one thousand cubic metres of usable blocks.

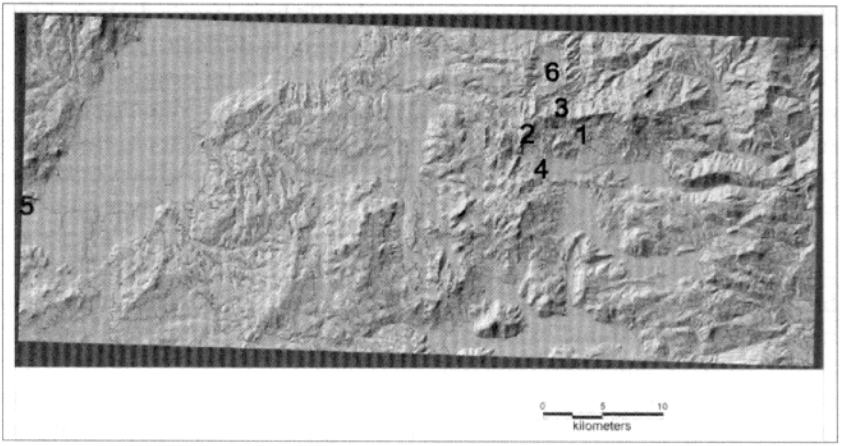

Fig. 3 – On-site to regional quarries in and near the territory of Sagalassos - 1: Sagalassos, 2: Sarıkaya, 3: Ağlasun Dağları, 4: Yeşilbaşköy, 5: Yarıslı, 6: Gölçük.

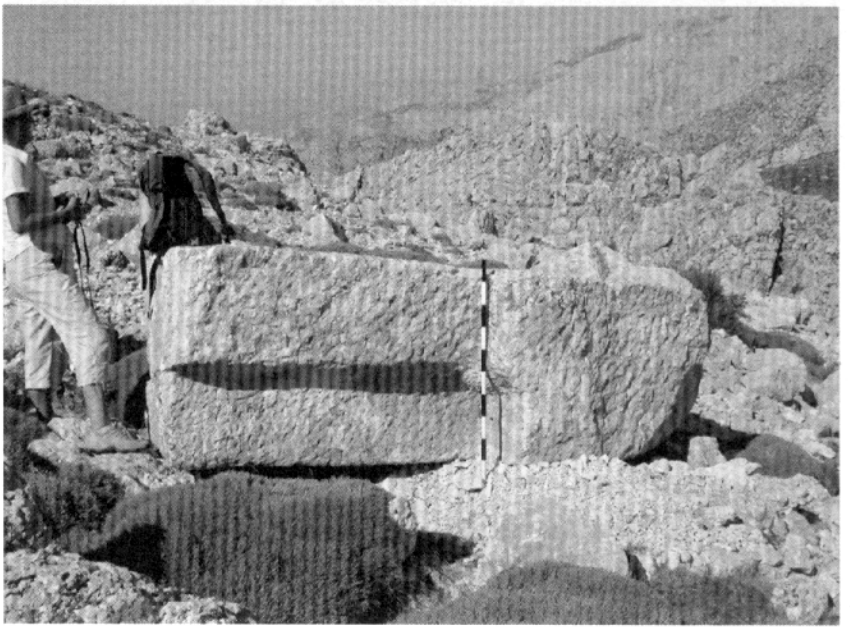

Fig. 4 – Photograph of a worked block in the Ağlasun Dağları quarry in the territory of Sagalassos (scale is 1m).

The Sarıkaya Quarry (Fig. 5) is located 3-4km southwest of Sagalassos in the lower part of a steep cliff. Although clear evidence of stepped block extraction can be seen, weathering and rock falls have largely destroyed the quarry face, so that the actual size of the quarry is difficult to determine. Based on the observations of extraction marks, and by extrapolating the natural cliff, it is likely that the extracted volume defined a wedge shaped body providing an estimated maximum of 3000m³ gross extracted rock, enough to provide several large building projects. The Sarıkaya quarry shows outcrops of white-beige limestone and red nodular limestone. The stone type quarried is unique to the quarry as it can be microscopically classified as a radiolarian mudstone. This type of stone seems to have been used only in late Hellenistic buildings (Bouleterion, Doric Temple) at Sagalassos.[10] Radiolarian mudstones are not found in quarries elsewhere on the territory and were no longer used in buildings from the Julio-Claudian period onwards. This indicates that the quarry may have been one of the main suppliers of building stones during the late Hellenistic period. Sagalassos red slip ware sherds found in front of the main quarry face, date from the early imperial period and may constitute a *terminus ante quem* for the exploitation of the quarry.

Fig. 5 – Photograph of the Sarıkaya quarry in the territory of Sagalassos showing the quarry face (F, 30m high) and spoil heaps in front of it.

Travertine quarries are located near the village of Yeşilbaşköy. Travertine is applied in the 2nd century AD theatre and in the 5-6th century AD domestic areas. Based on petrographical and geochemical evidence,[11] there are reasons to believe that the limited travertine deposit at Yeşilbaşköy was the source for Sagalassos, as well as supplying raw material for buildings in the immediate vicinity of the quarry. Remains of quarry faces are still seen, indicating quite significant extraction of travertine. Wherever these observed quarries represent the actual extraction site in antiquity is, however, not clear.

Other quarries not identified during the survey are quarries of volcanic tuff and diorite. Based on petrographical and geochemical evidence is can be proven that these building stones at Sagalassos come from the region of Gölçük,[12] but no ancient quarries can be identified there due to on going modern quarrying activity and intense weathering.

Regional Quarries

The Yarıslı quarry is the possible ancient source of a crystalline white limestone, extensively quarried in the hills southwest of the plain of Burdur under the commercial name "White Antique"—illustrating the assumed connection to quarrying of the same stone in Antiquity. The aesthetical "marble-like" appearance, the white colour and the technical quality were important reasons for exploiting such a relatively remote source of stone for Sagalassos.[13] It remains unclear whether the stone had a wider use in Antiquity. During the survey, disputable traces that may represent weathered quarry marks were found in the quarry. There might be other remains of ancient quarries in the region, but the intensive presence of modern quarrying as well as the size of the potential source area make a survey for ancient exploitation time consuming and difficult.

Stone from Remote Sources

The presence of a variety of stone types imported from remote sources (i.e. Dokimeion, Aphrodisias, Cippolino Verde), particularly applied in prestige contexts, implies that Sagalassos was also part of a stone-trading network.

Discussion

For the QuarryScapes project, Sagalassos is an important case study concerning the use of predominantly local stone for large building activities in Antiquity. The selective exploitation of usable local stone in a natural landscape differs significantly from other case studies in the project, which can contain huge ancient 'industrial' quarry landscapes, which significantly reshaped the natural landscape. Thus, at Sagalassos, we are confronted not

with a "quarry landscape" but with "quarries in the landscape". Also, the obvious relation between quarrying and nearby use of the stone in a monumental city provides excellent opportunities for the promotion of the significance of this quarry landscape to the wider public. The importance of the quarries can easily be seen when presented as an integral part of the extended "town landscape" of antique Sagalassos.

Concerning risk assessment, significant threats to the quarry landscape are not present. Apart from vandalism and natural weathering, the quarries near monumental Sagalassos are not at risk. Quarries situated further away from the monumental centre (here termed local to regional quarries), are at risk through disturbance by farming (e.g. Sarıkaya and Yeşilbaşköy) or by modern exploitation (e.g. Yarıslı). However, it needs to be determined whether these "quarries in the landscape", situated away from the "town landscape", might be of a more limited significance rather than unique "quarry landscapes". It may therefore be questioned whether preservation of such quarries not integrated in the "town landscape" is a priority. Conversely, and perhaps more importantly, it needs to be stated that the use of more distant quarries in itself is a very important issue to be raised. The 'why' of going about the trouble of getting a stone from a distant source in every case needs to be studied in depth and connected to the importance and hence conservation and preservation of the site. When the quarries of the Sagalassos area are seen as an integral part of the monumental town, their conservation and protection become evident and their significance can be clearly demonstrated to the public. This is especially true for the quarries here defined as on-site and local quarries. For instance, the significance of the Sarıkaya and Ağlasun Dağlarğ quarries is inseparably connected to the monumental city of Sagalassos. The quarries mentioned are providers of unique stone types for several building projects in the city throughout several periods of construction. Conversely, in the case of very significant stone extraction in terms of distance of transport or number of occurrences throughout the (known) world (e.g. stone from remote sources at Sagalassos), such quarry sites become of unique socio-economic importance in itself.

Abstract

A classification of the ancient quarries in the territory of Hellenistic-Roman Sagalassos was undertaken, looking into the relationship between stone extraction and the various periods of construction in the town and exploring the opportunity of integrating the quarry landscape into the larger Sagalassos landscape. The geological features of the quarries, the quarry organisation and the relation between volumes quarried and volumes used are investigated. This information feeds into the larger QuarryScapes project, developing scientific and practical methodologies for documentation, characterisation and conservation of ancient quarry landscapes, in order to raise awareness of the significance and vulnerability of such sites.

Résumé

Dans cette étude, une classification des carrières hellénistiques-romaines sur le territoire de Sagalassos a été entreprise. La relation entre l'extraction des pierres et les différentes périodes de construction dans l'ancienne ville est envisagée ainsi que l'intégration des carrières dans l'environnement de Sagalassos. Les caractéristiques géologiques, l'organisation des carrières et le rapport entre les volumes exploités et ceux utilisés sont également déterminés. Ces recherches font parties intégrantes du projet QuarryScapes, consacré à la conservation des carrières, dont le but repose sur la détermination et le développement de critères à la fois scientifiques et pratiques permettant de documenter, de caractériser et de conserver des carrières anciennes afin de mesurer l'importance et la vulnérabilité de ces paysages.

Keywords – cultural heritage, conservation, quarries, landscape, Sagalassos, Hellenistic, Roman

Mots clefs – héritage culturel, conservation, carrières, paysage, Sagalassos, hellénistique, romain

notes

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