

Selected Roman Stone Quarries in Central Jordan: A Cultural Resource

Introduction

It is said that Augustus has found Rome a city of brick and left it, when he died in AD 14, a city of marble (Briggs 1947: 32.38; Abdel Jawad 1970: 271).

Sun-dried brick or even masonry was from the time of Augustus replaced by marble for important buildings, and baked brick was largely used later for the construction of facing houses and utilitarian structures (Briggs 1947:38-40).

Before Augustus, little has survived. Important buildings such as temples, triumphal arches, aqueducts, forums, vaults, domes, *thermae*, theatres, amphitheatres, palaces and roads were carried out by Augustus and other later emperors such as Titus, Trajan, Hadrian, Diocletian and Constantine (Briggs 1947: 35- 46).

Though Rome was magnificent in its buildings and town planning, other Roman Mediterranean cities in North Africa and Western Asia, including Syria, Jordan and Palestine, witnessed that aspect too (Briggs 1947: 46). The great cities of the Decapolis, the forts and legionary camps of the Roman *Limes Arabicus* in Jordan, show good evidences on the greatness of Roman Imperial construction activities outside Rome and display stone as the main and essential available building material (Briggs: 1947: 46).

This paper deals with part of the aspect in question: the places where stone was exploited for the purpose of construction. The study concentrates on three selected stone quarries in central Jordan, two in and around 'Ammān in the north and one at al-Qaṭrāna in the south.

'Ammān (Classical Philadelphia) was the southernmost city of the Decapolis during the Graeco-Roman periods (Khouri 1988: 19-21; Parker 1982: 1; Ghawanmeh 1979: 50-59).

At around 20 km to the west of al-Qaṭrāna, al-Lajjūn — a Roman legionary camp of the *Limes Arabicus* — was established together with other adjacent forts in the beginning of the fourth century AD, after the rise and consequent defeat and destruction of Palmyra (AD 270-275),

when the Romans were faced with the task of re-organization and reconstruction, as a challenge met by Emperor Diocletian in the Late Roman period (AD 284-324, see Parker 1976: 25-27). The number of forts increased rapidly during that period from fourteen to thirty, including the construction of al-Lajjūn, the legionary garrison camp of *legio IV Martia*, together with other forts in the neighbourhood such as Qaṣr Bshir, Khirbat al-Fityān, and Qaṣr ath-Thuraya (Parker 1976: 27).

The Roman Quarries: Cultural Resources

Though the area of Central Jordan was variously explored and archaeologically surveyed, none of the surveys shed light on quarries, in general, as a cultural resource or an aspect of heritage (Parker 1976; 1981; 1982; 1983; Graf 1978; Merrill 1988; Conder 1980; Glueck 1930's; Brünnow 1900). Meanwhile buildings are taken as standing evidences of human activities of construction on the ground over ages, quarries give the physical evidences for many aspects relating the preparations for construction. They show the methods of extracting blocks, the means of transportation, and an aspect of the economical and social life of a part of the community. Moreover, we can learn about the development of tools and equipment even though they changed very little in antiquity (Ward-Perkins 1971: 137-158).

Locations and Geological Setting of the Quarries

1- Al-Qaṭrāna Quarry

Located two kilometers south of the modern village of al-Qaṭrāna, 500 m east of the Desert Highway, and next to the railway line. The area is composed on the surface of sedimentary formations with several outcrops of different successive layers of massive limestone, including oyster coquina in different spots. The stone is sufficiently hard to suit building (Abed 1982: 84-90; Parker 1982: 1-2).

2- Wādī al-'Ish Quarry

Located about 10 km east of 'Ammān. The outcrop of the

site is part of what is known as “Muwaqqar Formation”. The texture is pinkish white limestone with shell inclusions and few voids (Abed 1982: 94; Kanellopoulos 1994: 87).

3- *'Ammān Quarries*

In the city of 'Ammān there are different locations of quarries, such as the one located at Rās al-'Ayn, another existed along the al-Istiqlal Street, adjacent to its junction with al-Urdun Street. A third is along the east Ring Road. The quarries of 'Ammān are of the same outcrop that exists in Wādī al-'Ish, of pinkish to yellowish white limestone with shell inclusions.

Description

1- *Al-Qaṭrāna Quarry (FIG. 1)*

Out of al-Qaṭrāna, after the distance of 200 m to the south of the intersection of the Highway, one can turn left and drive along a dirt path that leads to a railway bridge. Beyond that bridge, one has to drive 200m to the right in a southeastern direction.

After that distance, the outcrop of a slightly merging and westward sloping hill show artificial cuts in the bed-rock (FIGS. 2-4).

The western part of the hill has step-like cut, an indicator of quarried and transported blocks. The horizontal surface of rock, just beyond that cut is channelled with intersected grooves, that look like a network. Channelled blocks range in sizes from 60 to 120 cm in length (FIGS. 3-4).

Channels range in depth from 20-40 cm and in width from 10-15 cm. The rock component is hard white limestone with shell inclusions. The hardness of rock is tempting modern industry to resume quarrying in the neighbourhood, considering the stone as coquina marble. Neither scattered scrap nor debris were compiled on or around the site. No paved road was found to lead to the quarry. It was accessible by dirt route. No settlement was found around it (Parker 1982: 18-19).

Next to the field of grooved blocks there is an artificial depression created as a result of a completely quarried area.

2- *Wādī al-'Ish Quarry (FIGS. 5-6)*

To reach the site one has to drive along the 'Ammān - az-Zarqā' highway to the distance of 6 km, and then turn right towards the location of modern quarries where limestone is crushed into gravel with modern machinery. Driving along that extension road to the distance of 1.5 km, one can see to the left on the summit of the western slope of a rising long hill the site of an ancient quarry. A column drum can be seen from a distance of 200m (FIG. 7).

The quarry consists of two parts located on a north-south axis. At the northern part (FIG. 5), two huge drums



1. Al-Qaṭrāna quarry: general view.



2. Al-Qaṭrāna quarry: quarried portion.



3. Al-Qaṭrāna quarry: rectangular slots.



4. Al-Qaṭrāna quarry: channelling operation.



5. Wādī al-'Ish quarry: rectangular blocks.



6. Wādī al-'Ish: quarried portion.



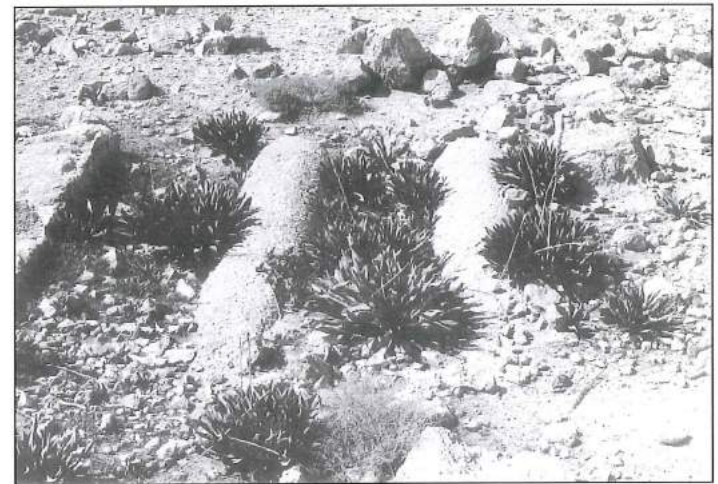
7. Wādī al-'Ish: drum with a flange.

were shifted to the edge of the quarry (FIG. 8). Another drum is still attached, partly channelled. A huge long rectangular block was detached and left *in situ*. An ashlar of a partly hewn small drum can be seen at the edge of the quarry. Impression of few transported blocks could be noticed. Pick marks and chiselling are still clear on the step-cut face.

The southern part of the quarry (FIG. 9) is still embracing three whole column shafts embedded and at-



8. Wādī al-'Ish: huge column of two drums.



9. Wādī al-'Ish: long one-piece columns.

tached horizontally. Little channelling of a few blocks of different forms can be recognized. Impressions of quarried and transported blocks are visible in few spots.

The surface of the limestone outcrop is continuous but with shallow scars (FIG. 5). The quarrymen, in some cases, had to go a few centimeters deeper than the surface so as to avoid scars. The component is semi-pure pinkish hard limestone with very few shell inclusions. No flint or conglomerate rocks are noticed around or in the neighbourhood. The adjacent hills are occupied with modern quarries with machinery for producing gravel by crushing limestone. A small settlement is located on the summit of a high hill to the west of the quarry. Tumbled walls were constructed with roughly trimmed limestone blocks. Roman pottery was collected on the surface.

3- 'Ammān Quarries

A- *Rās al-'Ayn Quarry* (FIGS. 10-12): Next to the cross-road at which two roads meet, one coming from Nā'ūr, the other from al-Wiḥdāt. At that point there is a high limestone rocky hill, with a northwest extremity deeply cut as a result of old quarrying, forming a sharp vertical



10. Rās al-'Ayn: vertical quarrying.



11. Rās al-'Ayn: methods of quarrying.



12. Rās al-'Ayn: thickness of the limestone.

deep facade, in some parts step-like cut.

The rock consists of slightly hard off-white limestone. Impressions of quarrying tools are defaced. Quarrying was mainly vertical, due to the thickness of the limestone layers which usually dictate the thickness of blocks.

The topography consists of three mountains over-

looking the confluence of the valley of Rās al-'Ayn with a tributary. The valley runs from the southwest and at the point of the quarry site, where it meets an eastern tributary, it turns to the north.

Umm Şwaywīna, a huge settlement of long history including the Roman period, is located after a distance of 300m to the southeast. The site was easily accessible along the main valley from the old city of Philadelphia.

Quarrying was resumed along the valley some 50 years ago, for 30 years, in the form of producing gravel by using machinery to crush limestone rocks. Modern quarrying removed all traces of old quarrying except that of the south hill, which was protected by modern forestry. A portion of the hill, with a shallow layer of dirt, was forested 30 years ago.

B- Al-Istiqlal Road Quarry (FIGS. 13-14): At the intersection of al-Urdun and al-Istiqlal streets, rock abruptly rises up forming a high plateau overlooking a deep north-south valley. The western extremity of that rocky area was vertically quarried in the Classical periods (properly Roman). Pottery fragments were collected on the surface.

The western quarried end looks like a step-like deep facade. Evidence of quarrying is preserved by step cutting and by the impressions of extracted blocks. Tool marks are defaced. The thickness of the layers of rock was sufficient to produce any type of blocks and ashlar. Component is off-white hard limestone.

The quarry was easily accessible. A Roman paved road, possibly the *Via Nova Traiana*, used to pass by, along the modern al-Urdun road. A fragment of that road, with a milestone, is still visible 100 m to the north.

Juraynīn, an old settlement, is about 500m to the east of the quarry. Pottery collected on the surface indicated the Roman period as an episode of its long history that started from the first millenium BC.

Evidence for Ancient Quarrying

1- Al-Qatrāna Quarry

The quarry preserves an exploitation area, where one can see rows of rectangular blocks, on a large sector of the sloping surface of the limestone outcrop isolated by straight parallel channels on four sides but still attached to the bedrock (FIG. 4). The general view looks like a network. A western inclined step-cut face parallel to the north-south trending channels show deep homogenous limestone and display the traces of exploited rectangular blocks (FIG. 2). Cessation of quarrying occurred after a large sector of blocks was extracted and transported to some destination in the neighbourhood.

2- Wādī al-'Ish Quarry

Some huge whole columns and column drums were cut and roughly carved and left *in situ* still attached to the



13. Al-Istiqlal Road quarry: vertical quarrying.



14. Al-Istiqlal Road quarry: threatened.

bedrock. Three huge drums were already extracted from the bedrock and slightly shifted out of the quarry in order to transport them, but cessation of the work hindered that

operation (FIG. 9). Few long rectangular blocks were outlined with deep grooves in different parts of the site (FIGS. 15-17). Vertical faces of the outcrop were step-like cut. Tool marks are clearly visible in different spots such as those of picks and chissels. A domed impression of an already exploited, but not transported, drum can be recognized in the bedrock (FIG. 18).



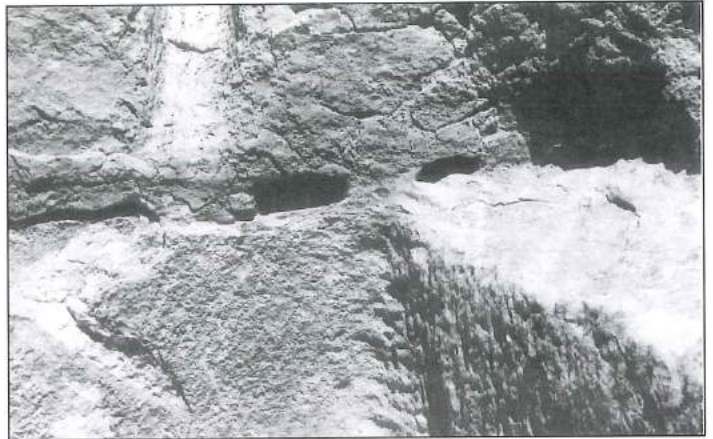
15. Wādi al-'Ish: channelling around a block.



16. Wādi al-'Ish: channelling around a block.



17. Wādī al-'Ish: detaching a block.



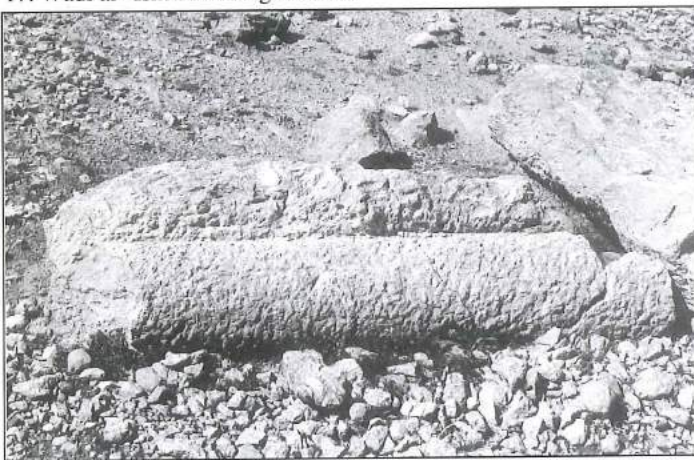
19. Al-Qaṭrāna quarry: lunar slots.

exploited and transported in the form of ashlar blocks or roughly-hewn pieces. One column drum ends with terminal flange to allow a measure of adjustment to the finished length and diameter (FIG. 7). Worked capitals, bases and friezes were found. Few extracted rectangular blocks at the al-Qaṭrāna quarry show unfinished and unsmoothed faces (FIGS. 7, 20).

The absence of debris at all the quarries supports the hypothesis that the final dressing may have been carried out somewhere around the construction destinations. No scrap is disbursed on or around the quarries. Even the broken pieces or those blocks which did not fit the measurements were transported and used as filling material for foundations and broad walls. For the foundations of the great Temple of 'Ammān, mortar mixed with earth and ashes was used to bond the foundation blocks and ashlar which were mainly of uneven surfaces and unequal measurements (Kanellopoulos 1994: 87-88). The masonry blocks of that temple built in the second century AD are said to have been brought from the Wādī al-'Ish quarry (mentioned as quarry east of 'Ayn Ghazāl) and other quarries around the city of 'Ammān (Kanellopoulos 1994: 88-



20. Wādī al-'Ish: partly dressed column.



18. Wādī al-'Ish: partly dressed columns.

3- 'Ammān Quarries

Since the mountains of 'Ammān are steep and high (Saleh 1980: 21-22), an exploitation method was adapted on the vertical faces of the outcrop. Most of the faces were left step-like cut after the cessation of quarrying. Impressions of huge rectangular exploited blocks are still clearly visible. The exaggerated thickness of layers helped the quarrymen to outline any demanded size of blocks.

Quarrying Technology

Impressions of tools noticed at the different quarries indicate that picks, hammers, wedges and chisels were mainly used to outline blocks with grooves and channels to split them free, a method conservatively adopted in ancient Mediterranean quarries over the ages (FIGS. 7, 19). Quarrying methods and tools changed very little in antiquity. Classical methods were still in use at the end of the nineteenth century. The Romans developed the use of metal wedges or plugs, feathers and metal broad chisels or blades and abrasives (Dunkin 1983: 79-80; Ward-Perkins 1971: 137-158).

In the Wādī al-'Ish quarry, rough surfaces or sides of drums and rectangular blocks show that they were ex-

89; Paradise 1994: 111).

The Roman legionary camp of al-Lajjūn and other forts of the *Limes Arabicus* constructed in the vicinity of al-Qaṭrāna in the fourth century AD were built of thick walls, with facing trimmed limestones for interiors (FIG. 21). In between, the filling was executed with rough blocks (Parker 1982: 20; 1981: 178; 1983: 216-277; Homes 1989: 363). The Romans were very skillful in implementing that technique, which they adopted long ago. Moreover they executed walls with concrete, consisting of mortar and stone fragments. Their quarries never suffered of scrap or compiled debris (Abdel Jawad 1970: 284-286).

Close examination of the al-Qaṭrāna quarry proved that running drill was used vertically in the case of extracting huge boulders which fitted the size of blocks used in framing the four gates of al-Lajjūn camp (FIG. 22). Two —1.5 m spaced— clear vertical rounded indentations of drilling were noticed. The diameter of drilling hole is 4 cm, and the depth is 1.5m. Once drilling was executed, hammered metal wedges were accommodated in holes to split the drilled blocks.

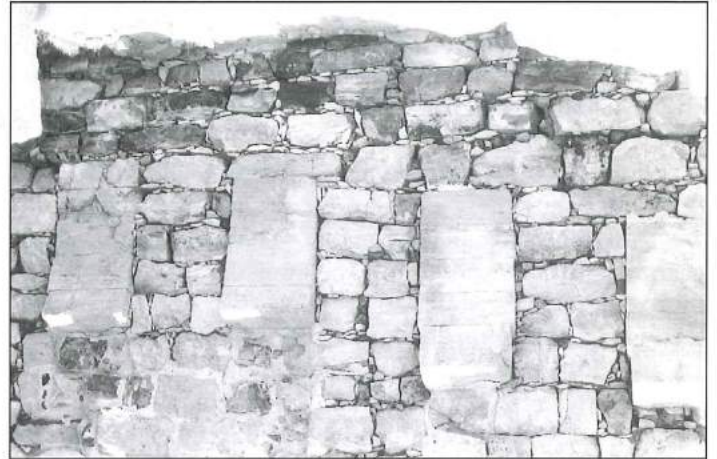
Bases of some vertically channelled blocks show lunate horizontal holes for the accommodation of water soaked wood and/or hammered metal wedges in an attempt to exploit them (FIG. 19). Each block shows at least two horizontal, nearly 20-30 cm spaced holes. Widths of holes range from 6-12 cm. Sections vary from semi rounded to long lunate or oval.

Chisel and pointed pick marks are still visible vertically and diagonally on a few channelled blocks. Channelling or grooving operations, as shown on some spots, were executed by chiselling the outline of the channel, then picking besides chiselling started in a next step.

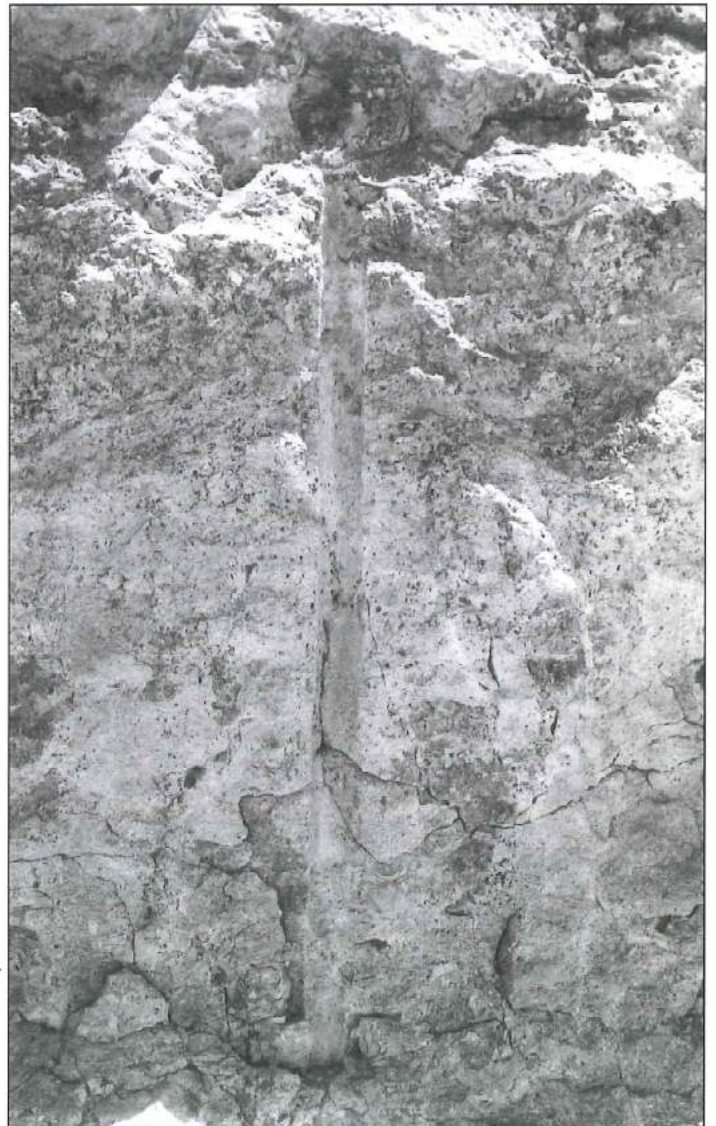
Who did the Quarrying ?

The organization, transportation and extent of trade in the stone reached its peak by people of specialty within the Roman Empire. (Ward-Perkins 1971: 137-158). In the case of Roman quarries of Jordan, there is no decisive indication as to the type or class of the quarrymen. In a papyrus from Kanaris, dated to AD 107, there is a clue. It mentions the work of legionaries as stone cutting all day in south Jordan after the annexation of the new Arabian province by Trajan, who was responsible of the construction of the *Via Nova Traiana* (Bowersock 1983: 81).

Alistair Killick referred to extensive limestone quarries discovered in 1980 near Udhrūḡ in south Jordan. He gives the possibility of relating these quarries with the legionaries mentioned in the papyrus of Kanaris. Moreover, he related the work of those legionaries and the limestone quarries to the construction of the military and trade roads of Trajan rather than to a civilian project (Killick 1980: 175). If that were the case, it would be applied to the con-



21. Al-Lajjūn: interior coating with limestone blocks.



22. Al-Qaṭrāna quarry: drilling marks.

struction of the military “rather than civilian” projects.

And since al-Qaṭrāna quarries supplied the military projects with demanded blocks, then the same type of

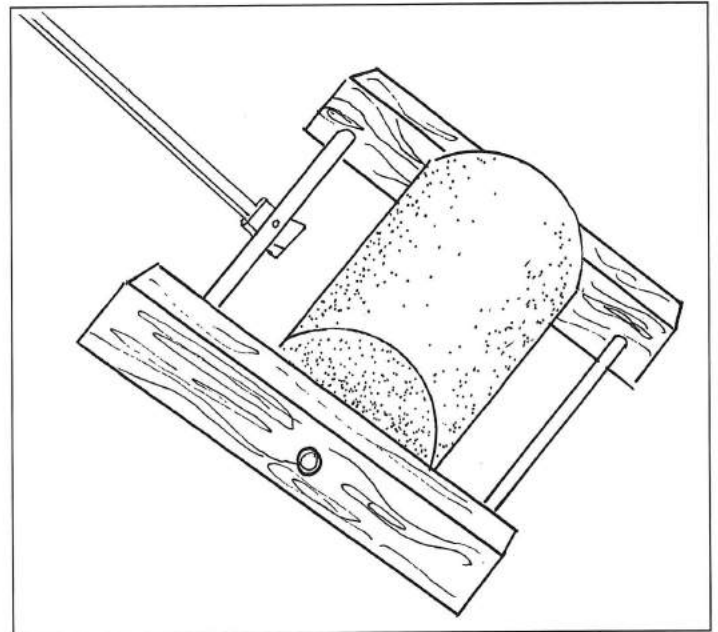
stone quarrymen had been employed. To support this hypothesis we should note that no installation of any permanent civic settlement was found near those quarries. Probably a temporary shelter of military type had been efficiently used.

As for the 'Ammān quarries, it should be mentioned that a big settlement is still located 200 m to the southwest of the Wādī al-'Ish quarry. There is no reason to argue against the possibility of considering the work of that settlement as stone cutting and trading. Roman pottery is scattered on the surface. Projects of building in Philadelphia were various, in number and utility, and generally of a civic rather than military character (Hadidi 1974: 71-73; Northedge 1992: 52-59). The area of east 'Ammān is plotted with different limestone quarry sites, since most of the outcrops of that area and the area to the south are of the same white and pinkish limestone used in constructing Classical Philadelphia (Northedge 1992: 20). To the south of 'Ammān, next to the quarry of Rās al-'Ayn there exists Umm Ṣwaywīna, a huge settlement of different successive dates, starting from the Iron Age to the modern time, including the Roman period (Abu Dayyah 1991: 391, nos. 48-37.1).

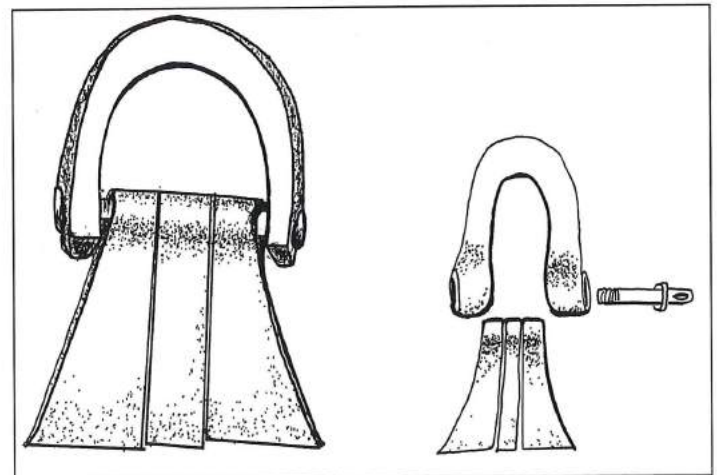
Transportation of Quarried Blocks

Even though it is not within the scope of this paper to deal with mechanisms, a brief notice should be mentioned about the method of transporting the quarried blocks. Small blocks could be easily transported on wheeled carriages, but in the case of huge blocks it was not an easy matter considering the local uneven topography. In the Wādī al-'Ish quarry, huge columns and drums have already been exploited with round forms. It is believed that a square socket was carved in the center of each side of the drum so as to fix pivots on both sides. The pivots are fixed in a wooden square frame that could be pulled (FIG. 23). The rounded block served as a wheel, a mechanism called Chersiphron's after the Greek architect who supervised the construction of the Artemis Temple at Ephesus in the fourth century BC (Kanellopoulos 1994: 88; Toorn 1995: 174; Nasiri 1977: 583). Large rectangular blocks could have been pulled along rollers to the site and then slid into position by men operating pulleys through windlasses (cranes) (Adam 1977: 31-63).

A lifting device (called lewis, FIG. 24) consisting of three metal pieces was used to lift blocks. A replica was manufactured and used to lift blocks during the anastylosis projects of the great Temple of 'Ammān. Lewis sockets were hewn on certain sides of the blocks such as the upper surfaces of column drums, and anta elements and capitals and some of the architrave blocks. In heavy blocks more than one lewis were used. The number and depth of sockets depended on the hardness of the stone (Kanellopoulos 1994: 89).



23. Chersiphron's transportation method.



24. Replica of an original lewis.

Destination and Dating

It is worth to quote that "in the absence of documentary evidence, the dating of quarrying operations poses particular problems, as very similar practices continued for centuries and even millenia. Quarrying and stoneworking are among the most conservative of trades maintaining the traditional techniques in defiance of the passing of time, in many parts of the world. Classical quarrying methods were still in use at the end of the nineteenth century A.D. Hence exact dating indicators are few" (Durkin 1983: 79).

The method of grooving and channelling around blocks, particularly rectangulars, which is evident at al-Qaṭrāna quarry and to some extent at the Wādī al-'Ish quarry, was practiced in ancient quarries of all ages throughout the Mediterranean area. This system persisted although the Romans had developed by the early first century AD the use of metal wedges and feathers, that would be ham-

mered, and were aware of the use of saw and metal blades and abrasive sand to cut stone and to help in fixing joints (Durkin 1983: 80; Kanellopoulos 1994: 87-88).

Insertion of metal wedges, plugs and feathers all around the periphery of blocks noticed at the Wādī al-'Ish quarry, was practiced in quarries of the Roman empire. Metal wedges were even used for stone-dressing. (Durkin 1983: 82). Pliny, in his *Naturalis Historia* (XXXVI, IV, 14) mentioned the use of wedges to split blocks by the Romans. Herson of Alexandria referred, in the middle of the first century AD to the striking of wedges, in the operation of detaching blocks (Durkin 1983: 82).

The use of wooden wedges, expanded by soaking in water, should be considered. The quarry of Wādī al-'Ish and other quarries in 'Ammān show some traces and indicators for the use of wooden wedges. Some bases of gooves are exceptionally broad and have rectangular rather than lunar or triangular ends.

The nearest Roman construction projects to al-Qatrāna quarry were the military compound of al-Lajjūn and the adjacent forts of Khirbat al-Fityān, ath-Thuraya, Rujm Banī Yāsir and Qaṣr Bshir, all constructed in the fourth century AD (Parker 1983: 227). The Wādī al-'Ish quarry and other quarries in and around 'Ammān undoubtedly supported the numerous projects carried out in Philadelphia of the second century with heavily demanded elements of architecture. The city with its multi and huge projects in that period looked as a burst of activity. The Great Temple and the Roman complex on the Citadel Hill, the Theatre, the Odeon, the Nymphaeum and Forum stand as symbols and indicators. (Northedge 1992: 59; Kanellopoulos 1994: 87-89).

Close investigation of the camp site of al-Lajjūn showed that the builders used any type of available rocks to carry out the construction of the outer and enclosure walls of the camp, and even the interior details (FIG. 21). Huge amounts of roughly dressed conglomerate or even flint and basalt blocks of different sizes and shapes were used. But for the construction of the four main gates of the enclosure wall, and for vaulting and arching, neatly dressed rectangular blocks of limestone were used (FIG. 25). This kind of blocks was used for the execution of the inner faces of many structures and for framing different doors. Columns and bases were executed of the same material. The texture of the limestone used in the camp matches that of the outcrop of the al-Qatrāna quarry. The component is coquinoïdal off-white with small voids and shell inclusions. Sizes and shapes of blocks on both are compatible. Most blocks on the camp are rectangular, with the exception of a few huge ones that show semi triangulation. Impressions of a few exploited blocks at the quarry site show the same phenomena

The geology of the close environment of the camp show that the surface outcrop is a mixture of conglomer-



25. Al-Lajjūn:roughly dressed blocks.

ate and successive fragmentary layers of coquinoïdal limestone that could not help to locate any fixed productive quarry. Probably some scattered limestone boulders were collected and dressed. But that undependable and critical situation forced the architects to look for a more convenient quarry site that could provide them with demanded architectural elements, despite the remoteness.

Diameters of average drums at the Wādī al-'Ish quarry range from 130 to 142 cm. The same measurements are found on the columns of the Great Temple. The texture of material of the temple matches with the texture of Wādī al-'Ish and other quarries in and around 'Ammān (Kanellopoulos 1994: 87). Roman pottery fragments were collected on the surface of the Wādī al-'Ish quarry could be dated to the second century AD. The 'Ammān quarries started in the Early Roman period or before that, but continued in use during all the phases of the Roman era.

Conclusion

The great distribution and variety of stone monuments and installations throughout the highland of Jordan provide us with a strong evidence that stone was used as a most substantial and locally available material for the construction of official and domestic buildings, or even towns and cities, over the ages, particularly in the Roman era, in Jordan. The massive Coquinoïdal Limestone Component of "Amman-Muwaqqar" and "Middle Jordan" formations provided building material that made most of the Roman structure look white except those of North Jordan, where igneous black basalt is the most available component of the outcrop.

The limestone horizon ranges in thickness from 70 to 80m, essentially composed of sedimental dense grain cemented oyster shell. Colour ranges from chalky white to off and pinkish white. The quarries in question supplied limestone of the same given component. Different elements of masonry were quarried up to the standardization and transported as ashlar blocks or roughly hewn and dressed rounded unfluted columns and drums, to be finally finished and smoothed at the construction destinations.

Different means of transportation were adapted. Rectangular blocks and long columns were carried on wheeled carriages, or on rollers. Huge drums were rooled in a

Chersiphron's method, pivoted on each side and fixed in wooden frames to be pulled as roofers.

Quarries were chosen and opened as needed. Villages or settlements of quarrymen were established adjacent to some quarries. The people who worked in quarrying were sometimes of the legionaries in case of official and urgent cases. In other cases civic quarrymen practiced stone trading.

Since big stone elements are heavy and liable to break or crack, quarries were planned to be as near to construction destinations as possible.

In the absence of documentary records or evidence, it was not easy to give a firm and decisive or even a narrow dating for quarries depending on quarrying methods which were conservatively changed over ages. The existence or scattering of any typologically dated evidence, such as pottery fragments on the surface, could help to give semi absolute dating. The comparison of the embedded or exploited elements at the quarries with the masonry of different neighbouring monuments contribute to the narrowing of the absolute dating.

Even though Roman roads reached in their extension and branching to different communities and fortifications, no paved roads could be traced to reach stone quarries. Dirt routes were probably efficiently used.

To conclude this study it is worth to mention that, at least from the point of view of archaeology, architecture should be taken and considered as an operation of two components, the building operation on the one hand and the quarries as a place of supply on the other hand. That is to say quarries should not be low classified as a cultural resource. They should be recognized and protected as a heritage material as well as the standing monuments.

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