RESULTS OF MORTAR AND STONE MATERIALS SAMPLING DURING THE ARCHAEOLOGICAL MISSIONS OF 2002 AND 2003

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In the course of the Archaeological Mission of the Italian Institute for Africa and the Orient (Is. I. A. O., Rome), as part of the Rabbathmoab Regional Project (Calzini 2004), conducted in Jordan in June-July 2002 and October-November 2003, two sampling campaigns on mortars, plaster and stone material were carried out at the monumental-archaeological site of ar-Rabba, the "Birkah" — a large cistern near the town of ar-Rabba (الربّة) — the archaeological site of al-Qaṣr and a stone quarry located nearby (**Fig. 1**).

This paper will in particular report the results of tests conducted on mortars sampled in the archaeological site of ar-Rabba, as well as on the stone material collected from the quarry in the vicinity of al-Qaṣr.

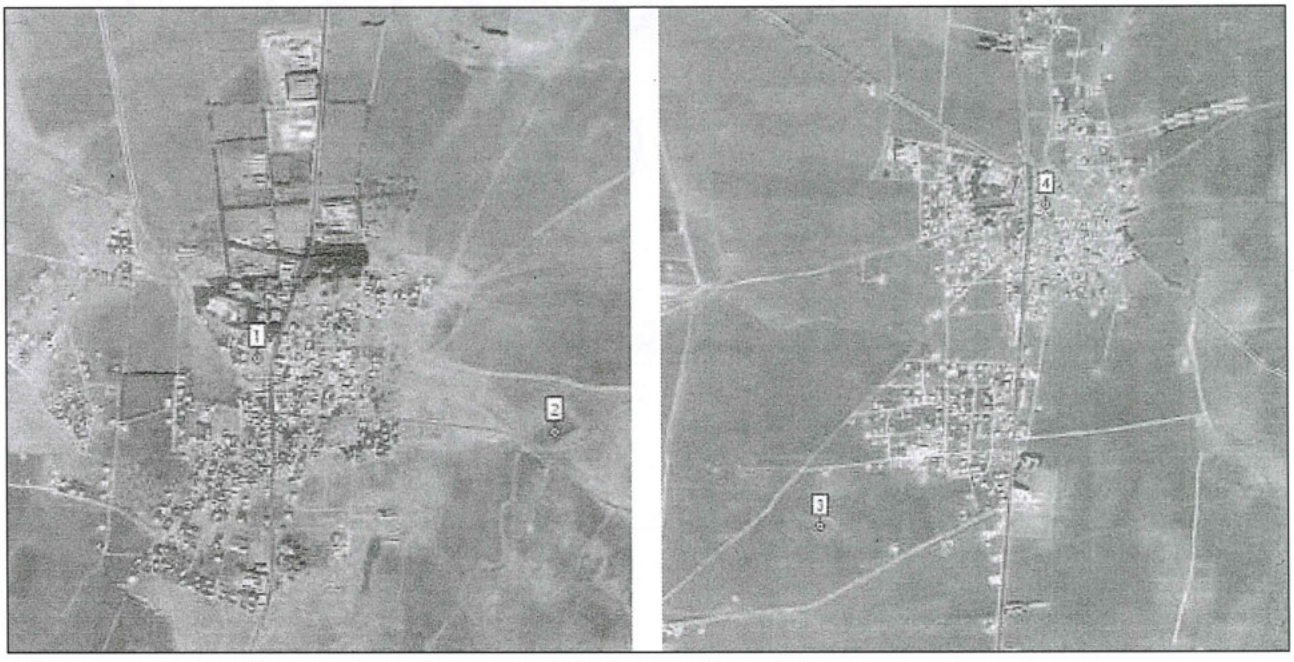
Analysis of Mortar Samples Collected in the Archaeological Area of ar-Rabba

The sampling and analyses conducted on the materials from the ar-Rabba archaeological area purpose to offer elements useful in evaluating the attribution of the different historical phases that concerned the buildings.

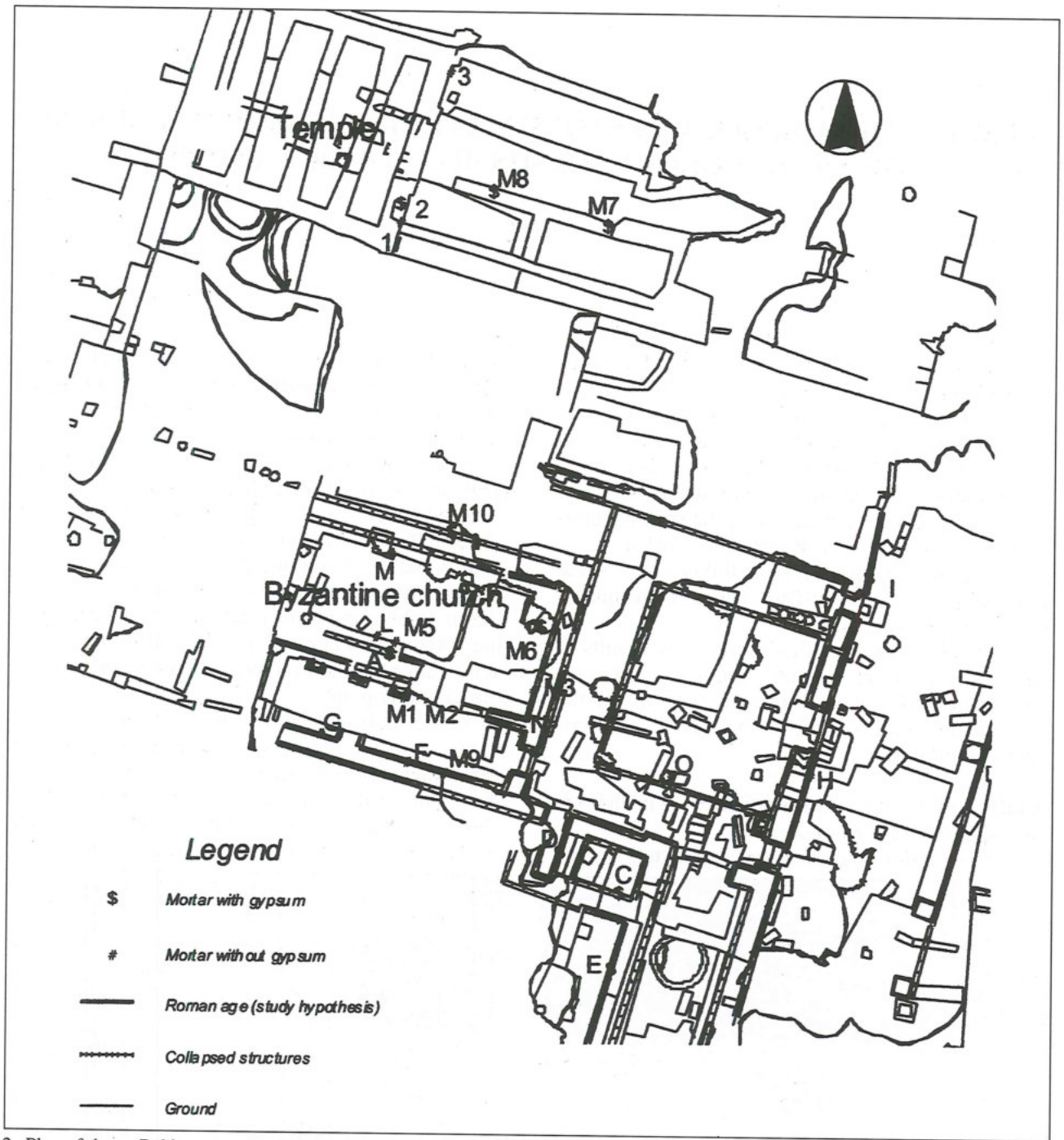
More specifically, it was decided to conduct analyses aimed at verifying the study theses formulated by Dr. Jacqueline Gysens Calzini and architect Roberto Sabelli, concerning the Roman phases and the Byzantine church.

Twenty-four mortar samples were collected at the ar-Rabba archaeological site in the course of the 2002 and 2003 missions, (**Fig. 2**) shows the exact location of each sample and the photograph of the sampling point.

In the analysis phase, a distinction was made on the basis of the presence or absence of gypsum in the cement, in this paper, we shall only describe the results of the analysis of the ten samples which, shown in **Fig. 3**, differ from the other sampled mortars because of the presence of gypsum.



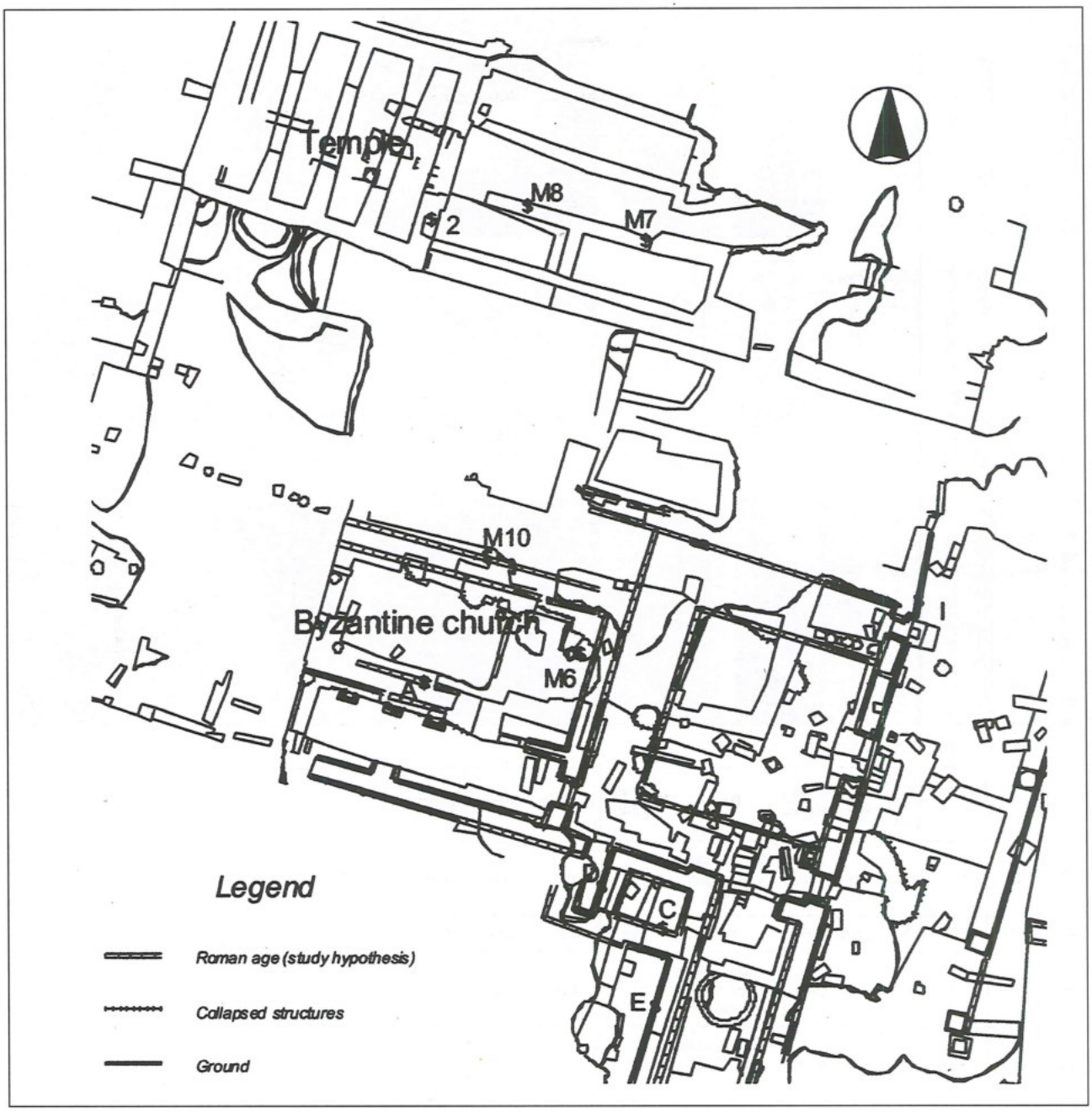
1. Monumental-Archaeological site of ar-Rabba; 2. the"Birkah"; 3. the Quarry; 4. Temple of al-Qaṣr.



2. Plan of the ar-Rabba monumental archaeological site (survey performed by architect Roberto Sabelli), the collection points of all mortar samples.

Nine of the ten gypsum-bearing samples present very similar features (**Fig. 4**): the intact samples are whitish in colour, moderately porous and have small-sized aggregates, rarely larger than 0.5cm. The fine portion is composed of percentages of calcium carbonate between 42% and 56%, of gypsum between 35% and 52%, and a scarce quantity (4 - 10%) of clayey minerals. The aggregate is almost entirely formed by gypsum crystals, accompanied by sporadic white, light grey or light brown flint. In several samples, sporadic grains of quartz, brick and carbon fibers are observed.

With the exception of sample M6, collected in the apse of the Byzantine church, and sample M8, collected from the arches opposite the façade of the Temple, all these very homogeneous samples were collected in association with structures identified as dating to the Roman period, thus strengthening



3. Plan of the ar-Rabba monumental archaeological site, the collection points of gypsum-bearing mortar samples.

the hypotheses formulated.

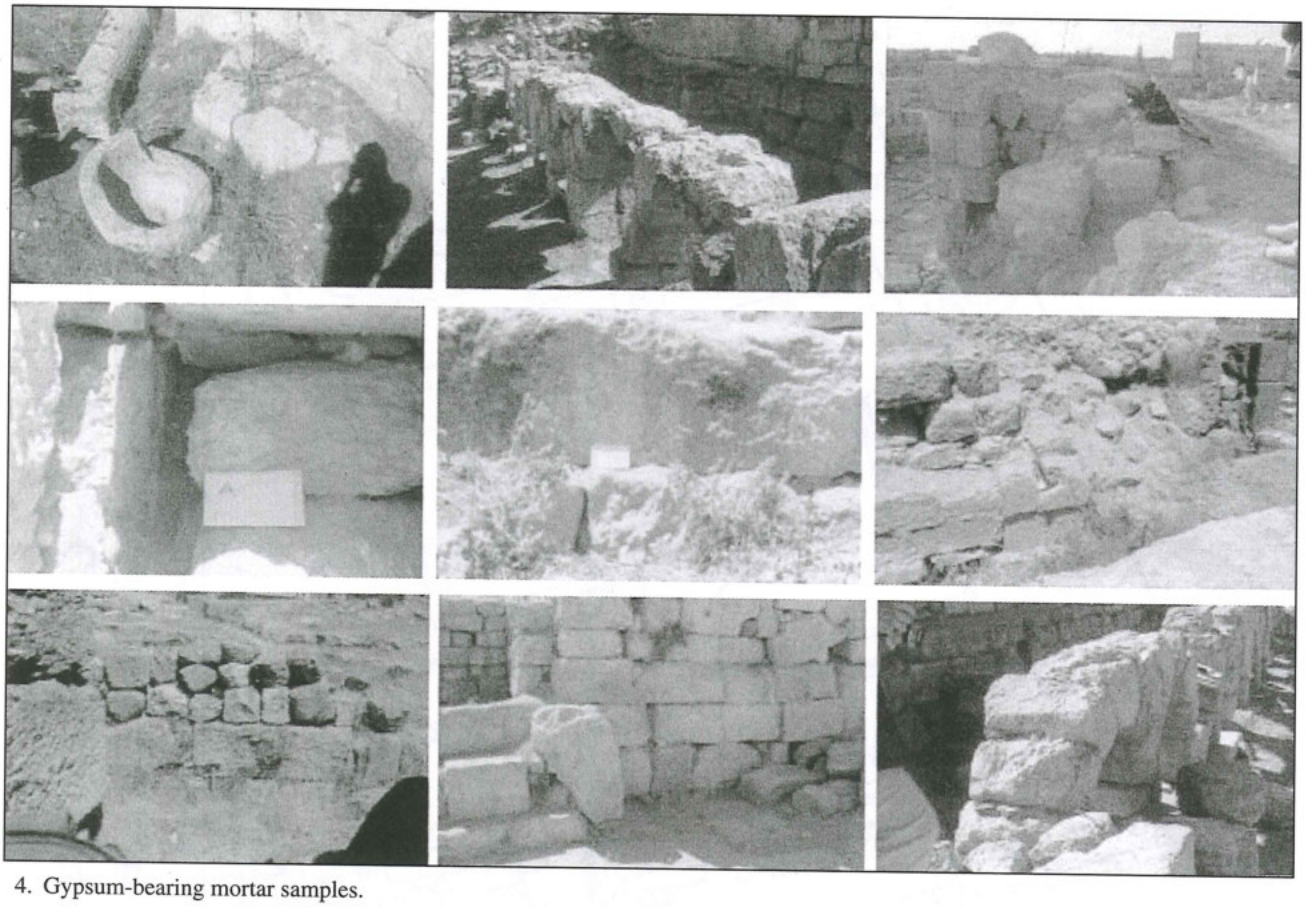
The tenth gypsum-bearing sample, M7, shows no affinities with any of the others, especially its higher percentage of calcium carbonate (78%) and large quantity of brick contained in the aggregate (**Table 1**).

Analysis of Stone Material Samples Collected at the al-Qaṣr Quarry

Field inspection performed in the course of the 2003 Archaeological Mission on several anomalies in the morphology of the territory detected by means of the stereoscopic observation of aerial photographs, among other interesting observations led to the discovery of a rectangular-shaped quarry measuring about 80 x 30 metres, and situated in the middle of a large flat field, 1.4km SW of the Temple of al-Qaṣr (**Fig. 5**).

Three walls of the quarry descend vertically for more than three metres, while the SW side of the rectangle slopes slightly and it too, formed the quarry floor (**Figs. 6, 7**).

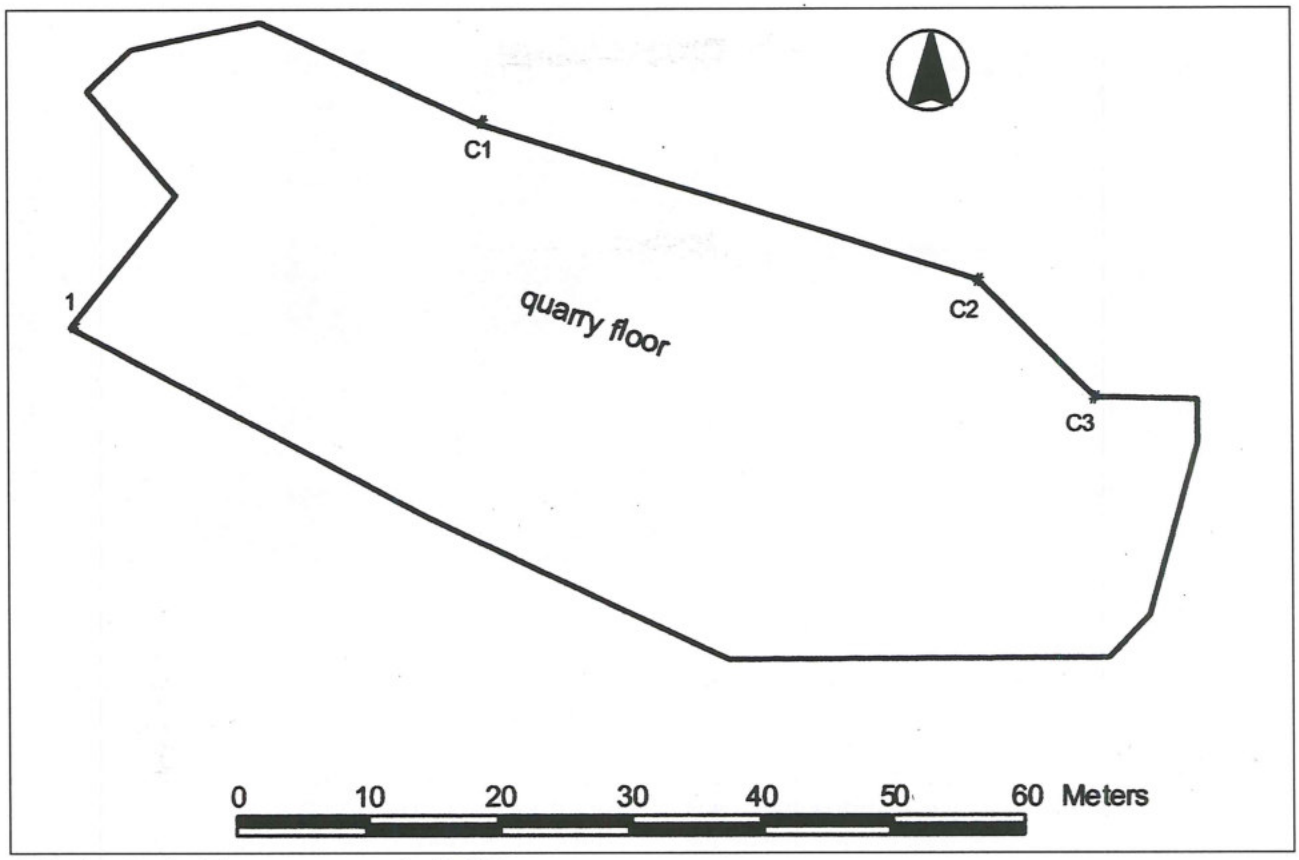
In the foreground of the photo on the upper right are three holes about 25cm in diameter and



4. Gypsum-bearing mortar samples.

	% $CaCO_3$	% fine mat.	% aggregate	aggregate dimensions	flint	gypsum crystals	carbon	brick	quartz	
2	45	45	10	up to 1cm	spor, white, grey, light brown	yes	no	no	spor.	
M6	55	37	8	up to 3mm	no	yes	spor.	spor.	spor.	
M8	54	40	6	above 5mm	spor, white, grey, light brown	yes	spor.	spor.	no	
M10	42	52	6	up to 3mm	spor, white, grey, light brown	yes	no	no	no	
A	50	40	10	up to 2mm	spor, white, grey, light brown	spor.	spor.	spor.	no	
C	52	44	4	up to 5mm	spor, white, grey, light brown	yes	spor.	no	no	
D	56	37	7	up to 5mm	spor, white, grey, light brown	yes	spor.	no	no	
E	42	48	10	up to 3mm	spor, white	yes	no	no	no	
I	55	35	10	up to 2mm	spor, white, grey	yes	spor.	no	no	ab. = abundant
M7	78	12	10	up to 3mm	grey, white	yes	ab.	50%	yes	spor. = sporadic

Table 1: Mortar samples with gypsum in the cement.



5. Outline sketch of the quarry, surveyed with GPS.

6. The quarry, overview from the SE summit.

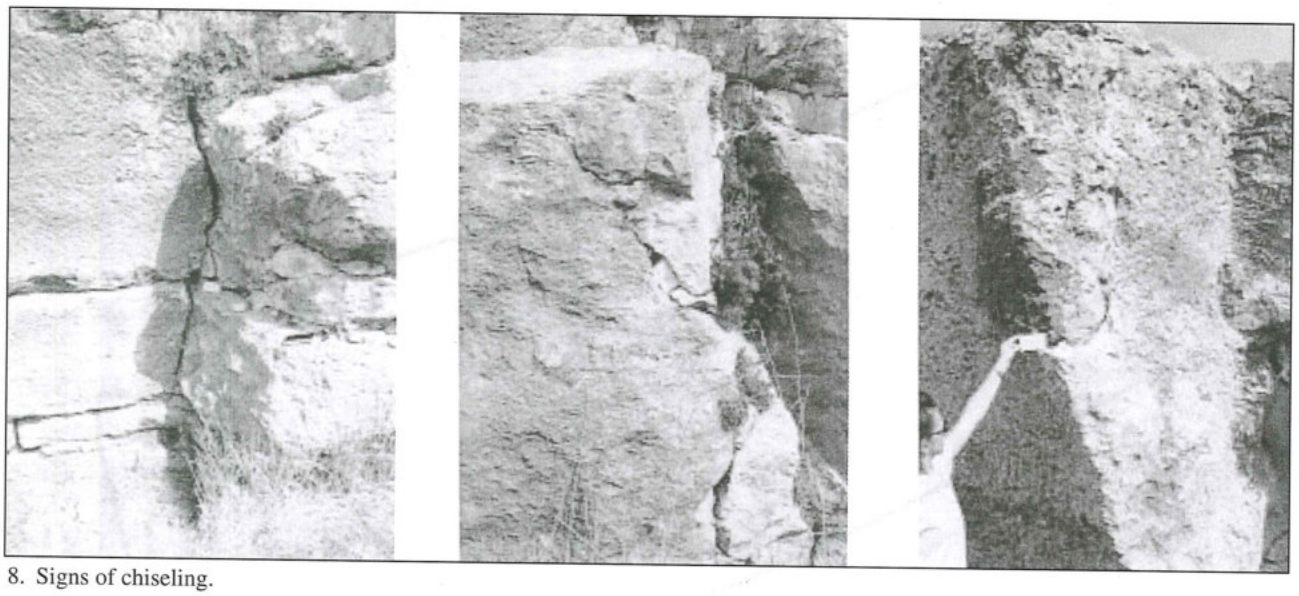
7. The quarry, overview from the SW summit (waypoint 1).

depth, made in the outcropping rock, presumably to secure the structures of a hoist.

The quarried material is a light fossiliferous silified limestone, subdivided into three layers, inclined about 20° southward. The base layer (C1) emerges at about 90cm; the intermediate layer (C2) is about 3m, and the upper layer (C3) about 2.5m. The uppermost layer, generally finer grained than the underlying layers, at its base presents a richer level of fossils than the others, with lamellibranches of dimensions of up to one decimetre, often filled with calcite crystals. It also presents large nodules or light brown levels of a strongly silified fossiliferous material.

Despite the frequent vertical fractures cutting through the layers, this site may have yielded blocks longer than 5 metres in length, especially layer C2 (**Fig. 8**), where the signs of chiseling and the forms resulting from the removal of blocks 50cm thick are still visible.

The excellent quality of the quarried material, its dimensions and the relative proximity to the temple of al-Qaṣr, have led to the hypothesis that this may have been one of the temple quarries. In order to verify this hypothesis, samples were taken from each of the three outcropping layers to be



8. Signs of chiseling.

subjected to X ray diffractometry and thus be able to perform a comparative test with samples collected previously (1999 Mission) from the Temple of al-Qaṣr.

Figure 9 shows the diffractograms of the samples taken from layers C1, C2 and C3, and Figure 10 shows the results from their interpretation, each of which are flanked by the data of the comparable samples collected at the Temple.

Table 2 shows the excellent association of the samples collected at the quarry with those of the temple, in particular, sample C1 with sample Q6, sample C2 with samples Q3b and Q4a, and sample C3 with samples Q2c and Q9.

The eight samples under examination all belong to bioclastic rock that formed in a sea environment above the storm level, with intermittent energy, and all recrystalized (diagenised). The bioclasts are formed for the most part by lamellibranches of dimensions of several centimetres. They can be classified as biomicrites (Folk) or as bioclastic floatstones (Durham). Lithologically speaking, they are bioclastic calcirudites except from samples C3, Q2c and Q9 (bioclastic calcilutites).

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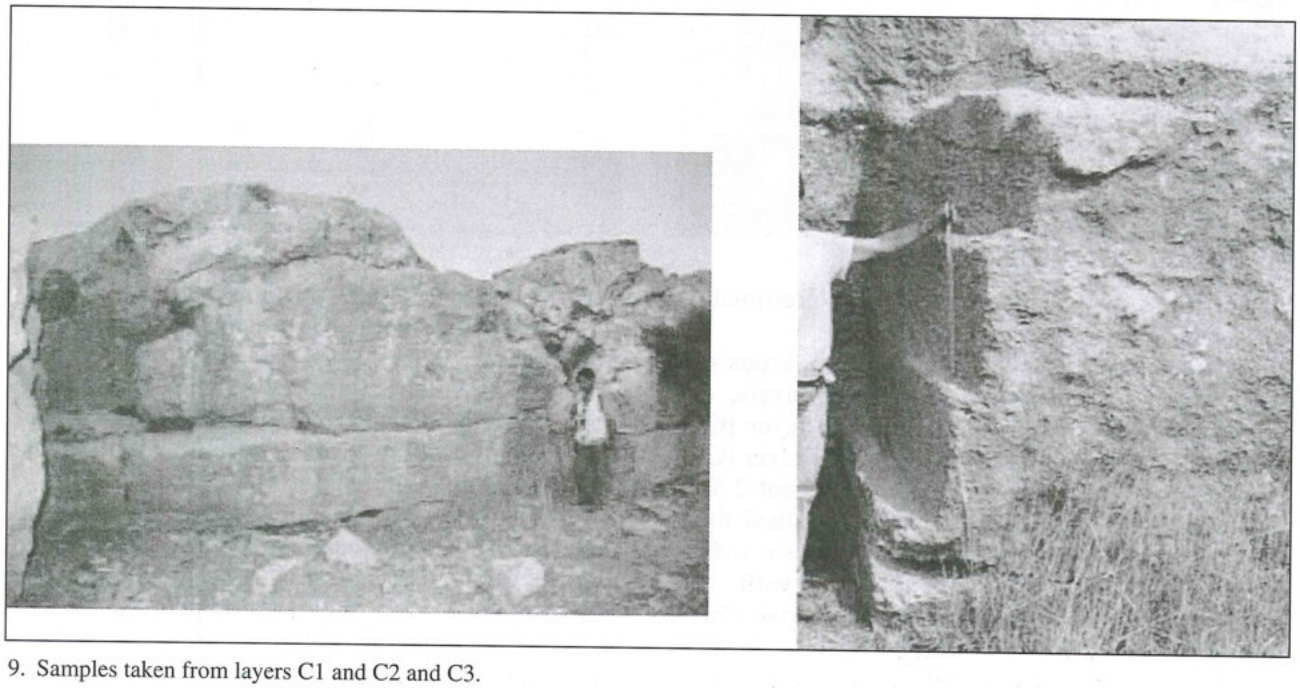
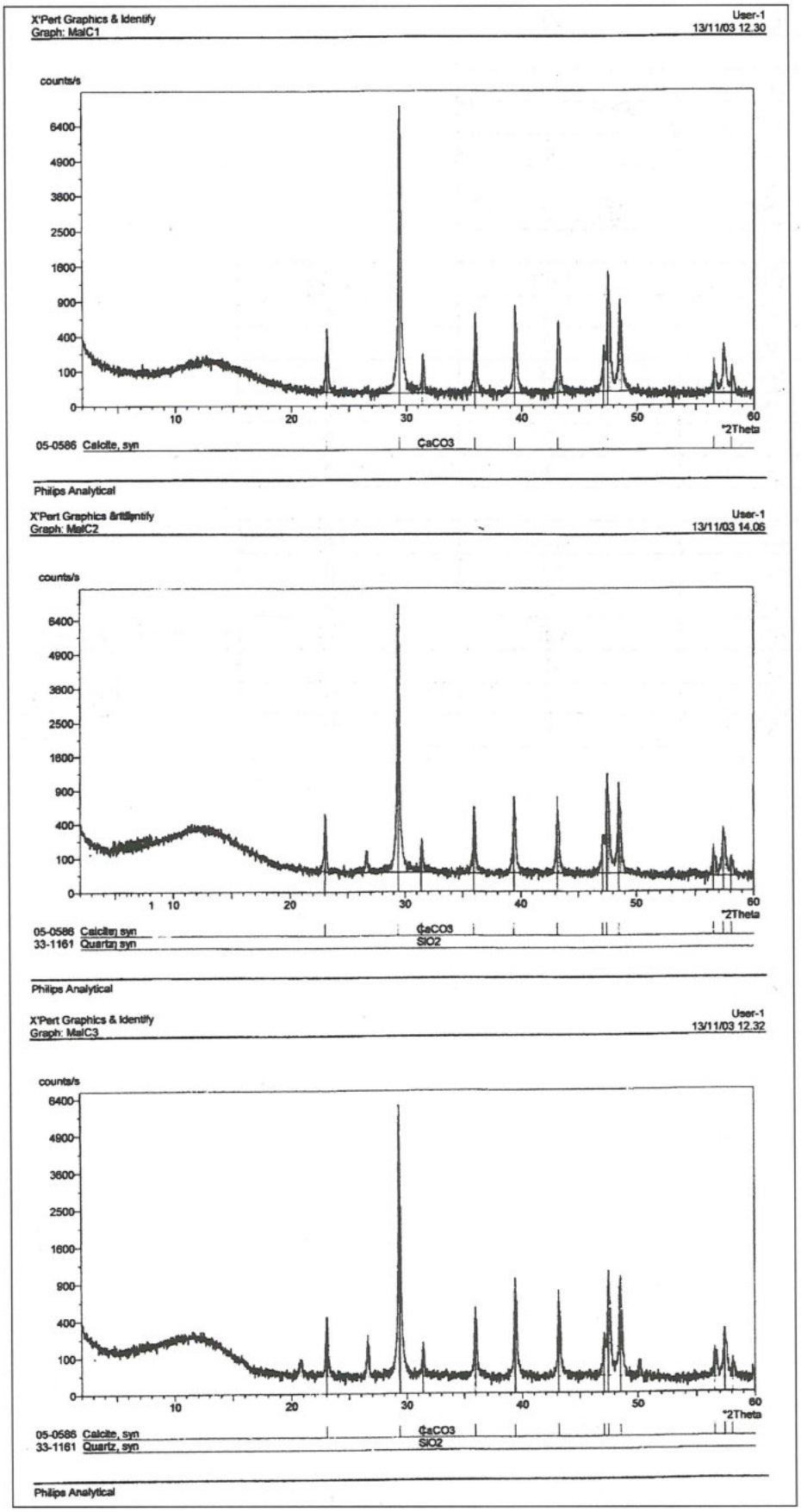


9. Samples taken from layers C1 and C2 and C3.



10. Diagrams of the results.

	C1	Q6
Quartz %	2	3
Feldspar %	0	0
Limestone %	96	95
Dolomite %	0	0
Phosphate %	0	0
Phyllosilicate %	2	2

	C2	Q3b	Q4a
Quartz %	4	3	4
Feldspar %	0	0	0
Limestone %	94	94	94
Dolomite %	0	0	0
Phosphate %	0	0	0
Phyllosilicate %	2	3	2

	C3	Q2c	Q9
Quartz %	12	11	8
Feldspar %	0	0	0
Limestone %	85	85	89
Dolomite %	0	0	0
Phosphate %	0	0	0
Phyllosilicate %	3	4	3

Table 2: Association of the samples collected at the quarry with those of the temple.