THE ROLE OF CERAMIC FABRIC ANALYSIS IN THE 1998 SIDON EXCAVATIONS

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It will be apparent from the other papers in this volume that the excavation of the "College site" (the site of the former Gerard College for Boys) is of archaeological significance. Previous excavations in the region of Sidon have often concentrated on necropolis and temple sites. It is clear that these sites, wondrous though they are in their own right, will tend to give a blinkered view of life in Sidon in past times. Part of the importance of the excavations at the College site is that they have the potential to provide a very different perspective on life in Sidon by providing archaeological evidence which, while still conditioned by the nature of the site, will probably relate to a more everyday urban existence. This new evidence will complement and broaden understanding of life in Sidon and the changes it underwent in ancient times. The past of a great city will be illuminated a little more fully, and our appreciation of it thereby enriched.

This contribution will attempt to show how physical and chemical analyses of ceramics can provide answers to a range of important and interesting archaeological questions. It will also aim to explain some of the reasons for selecting the particular analytical approaches used so far on the Sidon ceramics and to give an initial indication of some of the results of these analyses.

The analytical work on the ceramic fabrics from the 1998 excavations has been confined to the ceramics recovered from the *in situ* archaeological contexts. Although Hellenistic, Roman and Islamic layers would be expected to be present on the site, excavations early this century in the moat near the land castle penetrated to a considerable depth before hitting any *in situ* archaeological layers and uncovered debris dated to around 1000 BC. Digging of the mediaeval moat around the land castle (St Louis castle) may have resulted in the removal of more recent archaeological layers. It was hypothesised that if there had been a moat around the land castle, there might also have been a moat around the mediaeval city wall and, if so, a similar removal of more recent archaeological material might have occurred. The latter possibility was supported by the absence of archaeological deposits in building works penetrating 3 metres below the present surface just to the north of the College site along the outside of the mediaeval wall. To test the hypothesis and in the hope of proving during the first season that early archaeological layers were indeed present on the College site, the 1998 excavation was conducted in the north of the College site in an area judged to have been just outside the mediaeval city wall. Detailed surveying running concurrently with the excavation proved that the position of the excavation with respect to the mediaeval city wall was indeed that which we had expected on the basis of more approximate judgements. After removing a large amount of recently redeposited rubble, the excavation came upon *in situ* archaeological layers at a depth of some 5 metres below the present surface level. An area of plaster flooring was discovered, and ceramics of a style suggestive of the Early Bronze Age were found. It is the analysis of these ceramics that forms the subject of this paper.

POTENTIAL BENEFITS OF CERAMIC FABRIC ANALYSIS

Although much can be learned from the analysis of the shape and decoration of archaeological ceramics, a great deal of additional information of archaeological interest can potentially be discovered by the analysis of the material of which the ceramic is made. This material is often referred to as the fabric of the ceramic. A typical ceramic fabric is comprised of a fine grained matrix composed of clay minerals and other very small particles. Within the fabric there may also be larger fragments that are called inclusions. The inclusions in a particular fabric may occur naturally in the sediment from which the ceramic has been made or they may have been deliberately added by the potter to modify the properties of the raw material. Some ceramics will also have some form of surface decoration which may be made by modifying the surface of the fabric, for instance by burnishing, or by the addition of extra material such as a paint or a slip.

The stages through which a typical archaeological ceramic fabric has passed prior to excavation will generally include at least the following: obtaining the raw materials; prepa-

ring the raw material to make it workable; forming of the object (pot, tile, brick etc.); drying; firing; use; discard and burial. Each of these stages may have an effect on the constitution of the ceramic: therefore (in principle at least) it is possible to deduce information about each of these stages from the study of the final constitution of the excavated ceramics. A number of factors interfere with this approach including the possible obliteration of evidence of earlier processes by subsequent ones but it is usually possible to find some clues if a sufficiently large body of ceramics can be examined.

A number of archaeologically interesting questions can be addressed fairly directly by analysing the material from which ceramics were made. One may investigate what the ceramics were made of, how they were made, when they were made and what they contained, although dating and analysis of the residues of contents will not be addressed here.

If the compositions of different fabrics are consistent with their having been produced from a single raw material or group of raw materials, studying these fabrics may allow one to infer something of the technology used by the potter to modify the raw material for particular purposes. If on the other hand an assemblage of ceramics shows that different raw materials have been used for different types of pottery this may reflect deliberate choice of particular materials for particular purposes or it may indicate that the different types of pottery were made in different locations. Still looking at the fabrics of an assemblage in isolation, one may examine them for evidence of the firing technology, particularly with respect to the oxidizing or reducing nature of the firing atmosphere. Detailed examination of the surface may also show what techniques were used in obtaining the surface finish, such as wiping, burnishing, slip coating, painting and glazing.

The above and much more can be learned from the ceramics fabrics themselves. Once this evidence is put into context, however, far more can potentially be learned, albeit that some of the conclusions may depend on information or assumptions not directly deduced from the ceramics. Once fabric groups are established, one may look for correlations of fabric groups with vessel shape or decoration, with context or with stratigraphic layer. This will be an important next step in the work on the Sidon ceramics. Beyond the confines of the excavation, one may seek the origin of the fabrics by comparison with ceramics of known origin (such as those excavated as wasters from kiln sites) or by comparison with geological raw materials of known origin. Examination of the fabrics provides important clues as to the geological regions in which one may hope to find the sources of raw materials. Once possible sources are located a succession of more detailed analyses may be undertaken to compare the archaeological fabrics with the geological deposits in an attempt to narrow down the possibilities and identify the actual source of the raw material and hence the origin of the ceramic.

Answers to questions that can be addressed fairly directly by analysing ceramic fabrics, such as technology of manufacture or origin of raw materials, may also illuminate higher questions concerning the spread of technological knowledge, interaction of people from different geographical areas, cultural contacts, systems of social organization, and systems of trade and exchange. Addressing these greater questions is the subject of future research but that research must have a sound foundation if its products are to be of enduring value. One of the first steps towards these goals is to examine and characterize the various ceramic fabrics found on the site.

Choice of analytical methods

The questions to be addressed clearly condition the type of data that is needed, and that in turn conditions the choice of analytical technique. Knowledge of manufacturing technology and provenance of the ceramics would be of particular interest in the context of trying to understand the sources of knowledge and materials to which the ancient port city had access would provide a basis for addressing higher level archaeological issues. Questions of provenance and technology were thus chosen as the initial field of enquiry. They require comparisons between the constitution

of different ceramics as the constitution of the ceramics reflects the raw materials used and all the processes to which they have been subject during production. The initial aim of the fabric analysis was thus to characterize the ceramic fabrics according to their constitution and to present a preliminary classification of the fabrics to assist in handling future data.

The initial aim of simply characterizing the ceramic fabrics may sound like a modest goal that is readily achievable. However, modern science provides literally dozens of techniques that could be used to characterize ceramic fabrics, each giving a particular sort of information about a particular aspect of the sample, and each having its strengths and limitations. This puts a burden of choice upon the investigator. It is important to choose a group of complementary techniques that will produce in the most efficient way a broadly based body of data that will be useful in answering the archaeological questions outlined above.

Considerable amounts of ceramic were recovered from undisturbed layers in the 1998 excavations and it is envisaged that even larger quantities might be recovered in future years. In order that the sample of the assemblage analysed can have a good chance of being representative of the whole, it is desirable that at least the first level of analysis should be quick enough to be performed on quite large numbers of samples.

In order to optimize the extent to which ceramic fabric analysis can be incorporated into future excavations, it was also considered desirable for at least the first level of analysis to be capable of being used easily by other interested archaeologists. If this could be achieved there would be the prospect of comparable ceramic fabric analysis becoming widespread, with the benefits of the approach increasing as progressively wider ranging comparisons became possible.

A further consideration in selecting analytical approaches was that the chosen approach should facilitate future on-site identification of the ceramic fabrics. Data that can be generated on site while the excavation is still underway may be very valuable in optimizing excavation strategy in the light of the latest evidence. If an approach that can be used on site were developed, this aspect might encourage its adoption at other sites. In due course this would facilitate comparison of Sidon ceramic fabrics with those from other sites. In summary, the qualities desired of a first level approach to fabric analysis are that it should be quick and easy to perform and capable of being undertaken on site.

The generally accepted method of fabric analysis in the field is to examine a freshly broken edge of a sherd. While this is certainly an improvement on examining worn and dirty old breaks, it still gives a somewhat unrepresentative view of the fabric. One reason is that a fracture surface travels through a material following the course of least resistance, running wherever the fracturing stress exceeds the tensile strength of the material. The fresh break thus preferentially exposes the areas of the fabric that have low tensile strength. The fresh break may for example travel around inclusions because the inclusions themselves are stronger than the bond between the inclusion and the surrounding matrix. Fractures may also preferentially travel through any glassy or micaceous phases if these are the route of least resistance. Because firing introduces progressive changes in the constitution and bonding of a ceramic fabric, the appearance of a fresh fracture through a given fabric may be considerably affected by the way in which the fabric is fired. As firing conditions may vary considerably between different parts of the same firing, the effects of firing may complicate fabric classification if fresh fractures are used.

In order to overcome these difficulties, the technique chosen for use in Sidon was to cut plane sections with a thin, water-cooled circular saw with a diamond impregnated rim. Provided mains electricity and water for cooling are available (as they were at the College site) this is a quick and easy approach once one has a little practice. The equipment is reasonably priced and the fine cut of the (specially made) wafering blade used at Sidon provides a clear and unbiased view of the constitution of the fabric with a minimum loss of material. It also permits study in cross-section of any features near to the surface that might give clues as to the technology of manufacture and decoration.

Describing ceramic fabrics in words is difficult and remembering the appearance of many specimens viewed one after another down a microscope is also difficult. In order to facilitate the future identification of fabrics on site and to facilitate their comparison with the fabric classification scheme, it is intended that photographs of the fabrics taken down a low power microscope will be used. The essential advantage of using photomicrographic prints is that they can be laid out on a table and viewed simultaneously. Ideally a low power microscope should be available on site to examine future sections, but the reference photographs can be used as an aid to fabric classification even when using the naked eye or a hand lens provided one has some means of making plane sections. (In the absence of a saw one could just rub the edge of a sherd on a flat grindstone). Initially, unknown fabrics will be identified by comparing them in section to the photographs and hand specimens from the previously classified reference collection. With experience fabrics become recognisable in their weathered forms and sections only need to be made from occasional sherds where an unusual fabric is encountered. The reference photographs will also be useful for comparison with other ceramic fabrics from other sites.

Photomicrographs of the 1998 material were produced after the excavation in the laboratory by reflected light photomicrography of polished mounted sections of the ceramic fabrics. It would, however, be quite possible to produce photomicrographs of fabrics on site if suitable equipment and access film processing were available. This would be quite an advantage since it is much easier to group fabrics with the aid of a set of magnified photographic prints laid out on a table than to do the same solely from memory, examining the sections one at a time down the microscope. Having prints of the fabrics also facilitates discussion of the fabrics by the excavation team, including correlations of fabrics with object types and excavation contexts. The opportunity to discuss such matters during the course of the excavation helps to optimize the productivity of the excavation and would help to fully integrate fabric analysis into the mainstream of the excavation process rather than allowing it to be relegated to a specialist report to be conducted at a later date. It is hoped that it will be possible to establish this integrated on-site approach to ceramic fabric analysis at Sidon in future seasons.

In addition to examination by reflected light, samples are also being examined in thin section by polarized light microscopy. This will provide a check on the preliminary conclusions reached in the field and allow refinement of groups. The technique allows far more detailed identification of mineral, rock and fossil fragments in the fabric, provided these are present as sufficiently large inclusions for details of their optical properties and structures to be determined. It is an essential component in identifying sources of raw material where this is done on the basis of matching inclusions in the ceramic to those in potential sources. In principle thin section petrology could be done in the field as the author and some of his students have done in the past. Sample preparation of thin sections is, however, far more time-consuming than for reflected light sections and interpretation requires additional expertise and equipment.

As a complement to polarized light microscopy, samples are also being examined by scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS). The SEM allows higher magnifications than are possible with light microscopy. More importantly in the present context, however, SEM-EDS will be able to provide elemental analyses of inclusions which will complement their petrographic analysis, particularly if the inclusions are opaque or fine grained. It will also provide elemental analyses of the fine grained clay matrix and any paint or slip to provide further independent data suitable for comparing ceramics and raw materials. If necessary, the samples will also be analysed by the similar but more sensitive technique of electron probe microanalysis.

Sampling strategy

The sherds to be sampled were selected by eye after washing and laying out to dry on large wire-mesh trays. Samples were taken with the aim of representing all the ceramic fabrics represented by sherds from the *in situ* archaeological contexts. Where a particular fabric appeared to be common, a number

of samples were taken with the aim of gaining an indication of the range of diversity within what appeared to be a single fabric group. No attempt was made, however, to reflect in the samples taken the proportion of each fabric present in the assemblage: this will become apparent when the sherds that were not sampled (the vast majority) are classified according to fabric. It is possible that further fabric types are present in the Sidon 1998 assemblage which were missed in the initial sampling but with the benefit of the preliminary classification any missed fabrics should be quickly identified.

Where possible the samples were taken from diagnostic numbered sherds so that the fabrics could later be related back to particular drawn sherds of known form and style of decoration. Small samples were sliced from the sherds using the thin saw, taking care that the slice removed did not diminish the diagnostic value of the remaining sherd in terms of its shape or decoration.

The ceramic fabric groups

It should be recognized at the outset that characterization of so complex a material as a clay based ceramic is not a finite activity that can be undertaken and may then be considered completed. No matter how much characterization is done, it is always possible to do more, to look at the ceramics with other techniques or from another point of view. The results presented here constitute the basic current working model but lay no claim to being definitive: indeed it is fully to be expected that the classification of the ceramic fabrics will evolve and change as study of the samples continues and new information emerges. This description does not attempt to describe all of the fabrics but attempts to give an overview of what has been found so far.

The fabrics have been numbered with no significance intended by the order of numbering. It is tempting to give descriptive names to the fabric groups but these might carry unintended connotations and might prove to be inappropriate in the light of future research. Many of the samples taken for analysis fell into three broad fabric groups labelled 1, 2 and 3. Because of the aims of the sampling and the sampling strategy adopted, this does not necessarily imply that the majority of the assemblage is made of these two fabrics, although this may in practice prove to be the case. It would have been possible to define some sub- groups of the first three groups, but the sub-group boundaries and definitions will probably need modification in the light of future work so subdivisions have only been defined for group 1 where they seem particularly clear. Nevertheless, what may appear as distinct sub-divisions when only a limited number of samples are available may in reality prove to be parts of a continuous range of variation when many samples are examined.

Fabric group 1

This fabric comprises an iron-rich, fine-grained matrix with occasional rounded limestone inclusions. Its distinguishing characteristic is the presence of frequent, normally rounded and elongate, iron-rich argillaceous rock fragments (ARF) present as inclusions. Some of these elongate ARF inclusions show fractures parallel to their long axes. They are probably shale fragments. Some sherds show only the more elongate shale inclusions, the occasional limestone inclusions and almost no quartz. These may for the present be identified as sub-group 1A.

One of the samples contained the fine grained elongate ARF inclusions but the matrix contained numerous fine grained limestone inclusions which gave the fabric a distinctive appearance under the microscope. This fabric constitutes group 1B.

Group 1C sherds also contain occasional larger rounded limestone inclusions but not the mass of fine limestone inclusions seen in 1B. Group 1C contain other types of ARF which are generally more spherical and contain quartz inclusions. In some sherds the coarser more spherical inclusions may outnumber the elongate inclusions. The matrix of group 1C sherds contains numerous fine grained angular to sub-angular quartz grains and this is its most immediately obvious distinguishing characteristic under the polarized light microscope.

All the group 1 fabrics may be derived from naturally weathered and redeposited shale. Shale deposits do occur in the Lebanon and surrounding countries although it has not yet been possible to examine and sample them for comparative purposes. Results from SEM-EDS analysis concur with the impression gained from light microscopy that this is a fairly distinctive and coherent group, albeit with minor variations. It should be noted, however, that there is considerable variation in the appearance of the fabric depending on how it has been fired.

Fabric group 2

These fabrics are calcareous, fairly iron rich and tend to contain irregular elongate voids. They generally contain some rounded limestone fragments, some fossils, some chert, a little chalcedony, some rounded ARFs and fine iron rich inclusions. The group could perhaps be further subdivided as the larger inclusions are predominantly sub-rounded monocrystalline quartz in some sherds, while in others they are rounded limestone and chalk inclusions. As there are intermediate varieties the temptation to subdivide the fabric group has been resisted for the present. A further possible sub-division might distinguish fabrics with an apparently lower iron content but further SEM-EDS work is needed to investigate the validity of such a sub-group.

Fabric group 3

This fabric is generally similar to fabric group 2 with the important exception that large angular, often rhombic crystals of calcite are present. As calcite is a soft and fissile mineral not normally found exposed at the surface of the earth as large crystals, the presence of these large freshly broken fragments is suggestive of their having been deliberately added by the potter. Their significance and purpose in the fabric is thus a matter of some interest.

Fabric group 4

This is a distinctive iron-rich fabric containing many fossil fragments including gastropods, limestone, chalk, chert, chalcedony and, most notably, a fragment of a relatively coarse grained basalt. It might be possible with the benefit of geological fieldwork to determine the origin of this fabric fairly precisely because of the collocation of the different elements.

Fabric group 5

This is a distinctive very fine grained light buff coloured calcareous fabric containing many foraminifera and other small fossil fragments. In thin section the fabric looks mottled down the microscope, and contains no noticeable quartz.

Conclusions & Future work

The analyses of the ceramic fabrics and the resulting classification scheme pave the way for all the diagnostic sherds from the 1998 excavations to be classified according to fabric. Fabrics can then be correlated to vessel shapes and decoration, and the occurrence of different fabrics in different contexts of the excavation can be assessed. No correlation of fabric with context is apparent on the basis of the samples analysed hitherto but this may be a result of the small sample size or the localized extent of the 1998 excavations. Correlation of fabrics with shape and decoration will be a matter of considerable interest, particularly in the case of the calcite tempered group 3 fabrics.

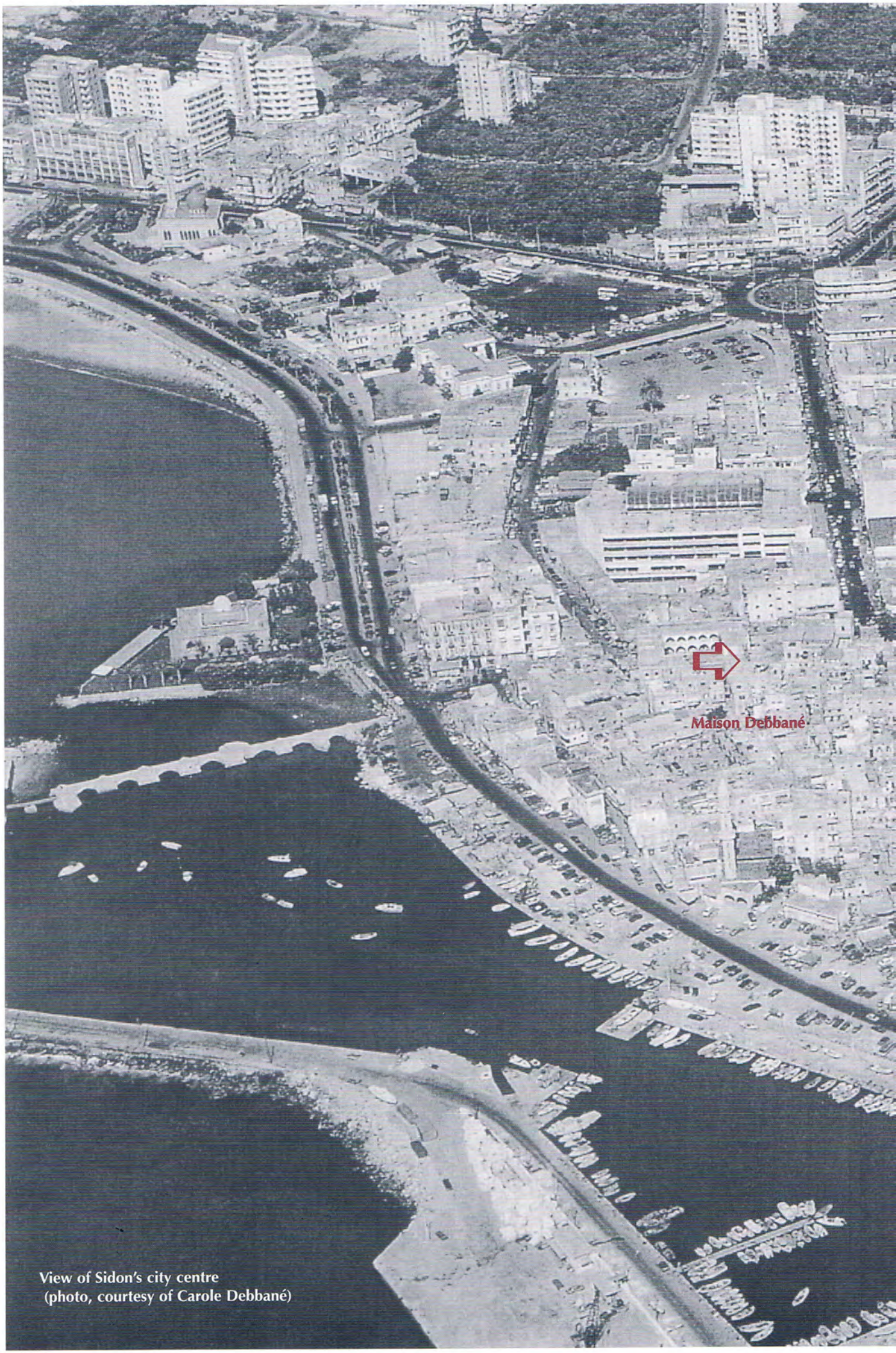
Although in the first year of excavation the identification of the fabric groups had to be carried out after the excavation, in future years it should be possible to record many of the fabric types at the time a sherd is catalogued. As further excavation yields more material, it is to be expected that new fabric types will have to be added, but these should be relatively easy to identify with a record of the established types available for comparison. Feedback on the identification of new fabric types will occur during the course of the excavation and it will be possible in principle to review fabric/form/decoration/context correlations on a daily basis.

It will be of great interest to compare the fabrics from the 1998 contexts to those from future excavations on the College site and also to ceramic fabrics from other sites in the Sidon area and beyond. Although many ceramic sherds from other sites may not yet have been analysed in terms of their

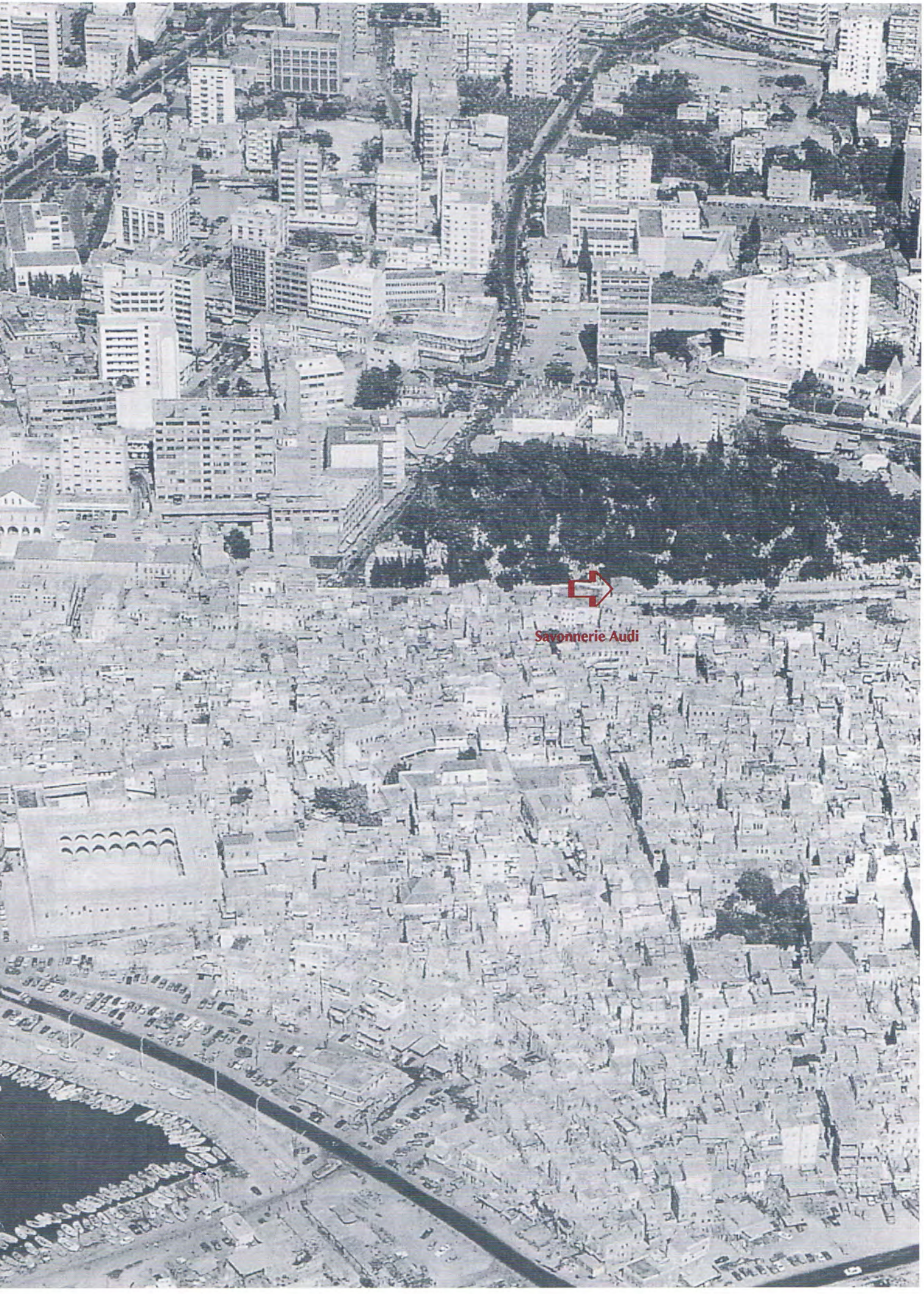
fabrics, it would be easy enough in principle to examine the fabrics in plane cross-section, with minimal equipment. Again the existence of the reference samples and photographs from the College site should facilitate comparisons.

It will also be important to try to gain some closer indication of the possible geographic origins of some of the fabrics, by comparison with ceramics from known production sites and by comparison with material gathered from known geological sources. If sources can be identified for some or all of the ceramics this will provide valuable indications of the areas with which the occupants of the College site may have had direct or indirect contact. At present it would seem that the fabrics found in the limited context so far excavated may all have their origin in the Levant but it will nevertheless be of considerable interest to narrow down the possible regions of origin.

The demonstration that early archaeological layers are in place on the College site provides an important spur to further work, for there is every indication that later contexts may be present elsewhere on the site. The full integration of ceramic fabric analysis into the excavation strategy that is now planned for the College site will provide invaluable additional insights as the excavations reveal an unparalleled record of the fortunes of the port city of Sidon over the millennia.



View of Sidon's city centre
(photo, courtesy of Carole Debbané)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