LATE BRONZE AGE POTTERY FABRICS FROM THE BAQ'AH VALLEY, JORDAN: COMPOSITION AND ORIGINS

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Introduction

Relatively few studies of pottery technology and provenience (e.g., Bandeit al. 1974) have taken advantage of the mutually complementary nature of archaeological, petrographic, and elemental analysis, although such an approach has often been recommended (Shepard 1905; Peacock 1970; Harbottie 1976). Standard typological characterization is needed to make sense of any large collection of pottery. This section of the study takes this one step further by revealing microscopic evidence for manufacturing techniques (levigation, tempering, etc.). The latter is also the sine qua non for quantitative chemical techniques, since inhomogeneities in the fabric, amount and type of temper, leaching and deposits of salts, and other factors that significantly alter elemental concentrations of the native clay can be identified and possibly corrected for.

In recent years a very extensive and representative collection of Late Bronze Age (LBA) imported and presumed local pottery has been recovered from burial cemeteries in the Baq'ah Valley, Jordan (McGovern 1980, 1981a). A group of fourteen sherds, representing four main types of pottery—Mycenean IIIIB, Base-Bill II, Chocolate-on-White/White Slip, and presumed local—see Plate 1—were selected from this collection for a pilot study of the structure, composition, and provenience.

Petrography

Twelve sherds were thin-sectioned, and the petrographic characters determined with reference to the following eight parameters: percentage of different inclusions, mean diameter and size frequency distribution of 100 randomly selected grains, fabric and slip colors, and the presence/absence of shale, calcrete, and temper. In order to assess the quality of raw materials available to ancient potters, eight clay and six sand/sandstone samples, collected from different sedimentary environments in the Baq'ah Valley, were also examined.

Average diameter and size distribution of mineral inclusions proved to be the most sensitive indicator in defining groups. While grains in the Mycenean and Cyproite sherds were almost exclusively silt-sized (0.039 - 0.062 mm), 60 - 90% of the inclusions in the presumed local sherds were in the sand range (0.062 - 2.00 mm). The Chocolate-on-White and White Slip examples had an intermediate distribution, 30% of the inclusions falling into the sand-sized fraction. The mineralogy of the collection was extremely unnuclastic. Quartz was the main inclusion in all the sherds, but was considered as temper only where it comprised more than 25% of the fabric volume (Rye 1978), as in the case of the Chocolate-on-White wares (BQ10 and 10: estimated at up to 80% and presumed local wares (BQ11-14: estimated at up to 78%). Eight additional minerals, although quite negligible, were identified: colorless amphibole, biotite, calcite, green hornblende, basal line hornblende, muscovite, plagioclase, and sphene. Organic tempering was evidenced by straw impressions on two presumed local sherds (BQ11 and 14). For the untempered sherds, the Base-Bill II pieces (BQ5 - 7), with about 14 mineral inclusions (including shale), could be distinguished from the Mycenean pieces (BQ1 - 4) since the latter contained only about 0.88 mineral inclusions (no shale).

The consistently high standard of all the LBA wares is best explained by intentional levigation, since clay beds are rarely homogeneous, even over short distances (Weaver 1963). For predominantly limestone terrains, greater amounts of calcite, either as a residuum in the clay or as temper, are usually observed.

An examination of the clay samples from the Baq'ah, a limestone/sandstone alkaline environment, revealed that they were distinctly free of primary calcite, in no instance more than 1%. Microcrystalline secondary calcite, which cannot be removed by washing, was also virtually non-existent. The clays were very simple mineralogically; the non-clay fraction was composed almost entirely of quartz with trace amounts of calcite, green hornblende, magnetite, and pyroclasts. However, the absolute percentage of inclusions varied between 18 and 70%, so that levigation would definitely have been required to remove inhomogeneities and to ensure clay purity.

The sand/sandstone samples we examined showed very little calcite contamination so the Baq'ah potter would also have had little difficulty in procuring very pure temper. The sands had come from a mature sedimentary environment: the quartz grains were well-rounded, like those in the presumed local sherds. Trace minerals were limited to occasional grains of green hornblende and black opaques.

Hierarchical agglomerative clustering (Fig. 1a and b) of the petrographic characters using the computer algorithm UPGMA (unweighted pair-group method by arithmetic averages; Sneath and Sokal 1973) generally confirmed the archaeological groupings. However, one White Slip sherd (BQ8) deviated from the archaeological expectations, being closer to the Mycenaean than to the Chocolate-on-White examples. This discrepancy resulted largely from considering the inclusions (35%) in that sherd as naturally occurring, even though the working properties of some clays can be improved by adding temper in amounts less than 5%. A random variation of several per cent may actually reflect the degree of levigation rather than the deliberate withholding of temper. The sand/sandstone samples we examined showed very little calcite contamination so the Baq'ah potter would also have had little difficulty in procuring very pure temper. The sands had come from a mature sedimentary environment: the quartz grains were well-rounded, like those in the presumed local sherds. Trace minerals were limited to occasional grains of green hornblende and black opaques.

Neutron Activation Analysis (NAA)

Since the primary mineral inclusion, quartz, generally acts as a diluent for the elements measured by NAA (Harbottle 1976), thoroughly mixed, 200 mg. samples were considered representative of the overall fabric (Bromund et al. 1976). Sampling procedures (by both drilling and powdering) and irradiation procedures followed those described in Absalom et al. 1974 and Bieber et al. 1978. The resultant data were processed by a series of computer programs, incorporating decay corrections, spectrum analyses, and USGS standards, which led to a final printout of the concentration of twenty-three elements for each sherd (see Table 1).

Significant deviations of some elements (most obviously sodium, potassium, rubidium, calcium, and barium) are common in a limestone environment where salts are being leached out and redeposited. Variation in other elements (e.g., lanthanum, manganese, samarium) is unexplained.

Although over-simplified and uncorrected for possibly significant factors (for example, covariance between elements), the NAA dendrogram clearly substantiates the stylistic groupings for the Baq'ah wares. Two pairs of Mycenaean IIIIB specimens merge, and are most similar to the very tight group of Base-Bill II sherds. The presumed local
sherds bunch together, but the Chocolate-on-White and White Slip samples stand well apart from the other groups.

In the hope of establishing specific provenances, a computer search program next compared the Baq'ah samples with the Brookhaven database of world-wide ceramics in which various regions of the Mediterranean and Near East are well-represented. A "match" occurred when a sample had no more than two elemental concentrations outside a 20% logarithmic range of the Baq'ah sherd which was being compared.

The computer search produced some significant results. BQ1 and BQ8 only matched samples from a relatively small area of the northeastern Peloponnese, Attica, and Boeotia, including nine specimens that belonged to Beraati subgroups 1 and 3 (Bieber et al. 1976) of the Oxford "Composition A" group (Cutting et al. 1963). In contrast, the other pair of Mycenaean IIIB sherds completely lacked matches, probably resulting from elemental variations in alluvial metals and earths. The thorium/hafnium ratio, an especially sensitive indicator, supports a mainland Greek origin for all the Mycenaean IIIB samples.

The Base-Ring II sherds (BQ5-7) matched a large number of samples, which were distributed over a large geographical area, including Cyprus, central mainland Greece, Crete, Palestine, and Iran. However, the ten matches from outside Cyprus were not particularly significant because of less precise dating and/or archaeological criteria. Several were modern clay samples (Athens and Vassiliki), which are sometimes distillate to fired wares (Bieber et al. 1976; Peacock 1970). On the other hand, widely separated clay beds in the Mediterranean basin can be virtually chemically identical because of similar geological origins. The nineteen matches from Cyprus came from the northeastern coast (Melissa and Vounari near Phalamosps) and the center of the island (Idalium). Nine samples that clustered with a northeastern coastal subgroup (Phalamosps II) were an important common denominator in establishing a probable origin for the Baq'ah sherds (Bieber et al. 1978). The Phalamosps specimens (Late Cyproite I Red-on-Black and Monochrome) are also comparable in date to BQ5-7.

BQ8-14, the Chocolate-on-White/White Slip and presumed local groups, had no matches. As the first Brookhaven study to incorporate central Transjordanian plateau material, the new evidence did not at least contradict working hypotheses that these wares were of local origin.

Definitive evidence, however, for the provenance of the presumed local wares was provided by recent NAA of Baq'ah clay samples. Whereas five clays (BQ3, 35-37) from different areas of the valley clustered separately, one sample (BQ32) from the wadi below the settlement site (Khirbet Umm ad-\-Danabir), associated with the burial caves, was very close chemically to the presumed local sherds (see Table 1).
Because of prevailing westerlies and nearness to one of the strongest perennial springs in the valley, the wadi site would have been ideal for pottery manufacture. Together with BQ11-14 of LB I date, the clay samples also matched a large group of specimens from an Iron IA burial cave (McGovern 1981b). Thus, despite the evident cultural decline after circa 1200 B.C., potters appear to have used the same clay bed over at least a six hundred year period.

The considerable chemical divergence between the Chocolate-on-White/White Slip group (BQ8-10) and the local group (BQ11-14) strongly suggests a provenience outside the immediate Baqqah Valley-Wadi Zarqa region of Transjordan. Expansion of the Brookhaven ceramic data bank, especially in the areas of northern Jordan and coastal Syro-Palestine where the ware is well-attested, is needed in resolving the question of its origin.

Conclusions

The pilot study of the Baqqah Valley LBA pottery fabrics demonstrates the value of combining several mutually complementary techniques. The archaeological groupings appeared to make sense, but posed questions of provenience and technology that could not be answered at the macroscopic level. The petrographic examination, however, besides confirming the archaeological types and the high technological standard of the all the LBA wares, showed that the presumed local sherds were very likely from the Baqqah because of their affinity to local clays and sands/sandstones. Still, the non-characteristic mineralogy of all the sherds frustrated efforts to establish precise proveniences.

This shortcoming was bypassed with NAA, the accuracy of which is in fact improved for relatively pure wares. The Baqqah Mycenaean IIIB sherds were apparently not local imitations, nor even Cypriote products, but originated from central mainland Greece itself. The Baqqah Base-Ring II sherds are more problematical, though a northeastern coastal Cypriote provenience seems most likely. Although the overlap connection to the Baqqah is still untraced, a maritime trade route may have linked central Greece, northeast Cyprus, and the Levantine coast.

A very significant result was the chemical similarity of the presumed local group to a clay bed in the wadi below the associated settlement site. Later Iron IA pottery also matched the clay, so that a continuous tradition in the initial stage of pottery manufacture (collecting the clay) appears to be attested over a six hundred year period.

The provenience of the Chocolate-on-White and White Slip examples is still an enigma, and more analyses of clay and well-dated, well-provenanced pottery from a wider geographical area are required to elucidate this problem.

Finally, it should be stressed that conclusions are tentative. A much larger collection of Baqqah samples, now being studied, should provide a better statistical basis.

Acknowledgments

The authors especially wish to thank Elaine Rowland (Brookhaven National Laboratory) and William Glanzman (MASCA) for technical support.

References

Olivier, D.C., 1973: Aggregative Hierarchical Clustering Program Writeup (Department of Psychology and Social Relations, Harvard University, Cambridge).