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# The Petrography of Certain Glozelian Ceramics

D. P. S. Peacock[a]

In a preceding paper Barbetti (1976) presents a case for doubting that two of the Glozelian ceramics examined by him were fired between 1500 BC and AD 1500. As he remarks, his conclusions might be open to question if it could be shown that the material was fired at a distant locality where the geomagnetic field strength variation was different in the past. If the origin of the raw materials could be ascertained this might help in deciding the plausibility of such an explanation since it seems improbable that clay would be transported any great distance before firing. A petrological investigation was therefore thought worthwhile and the object of this note is to record the findings.

Through the courtesy of Dr Barbetti, the writer was able to examine in thin section small samples from artifacts 744106 and 198b1, both of which proved to be similar in mineral composition. Sample 198b1 has numerous ill-assorted inclusions of mineral and rock fragments set in a matrix of brown optically anisotropic clay. They range up to about 1 mm across and vary from subangular to rounded. The largest rock fragments consist of pieces of highly indurated and partly sheared arkosic sandstone and granite, both composed of grains around 0·5 mm across. Most of these comprise cloudy, altered, orthoclase and rarely plagioclase felspar with lesser quartz. These rocks clearly form the source of most of the remaining grains in the sample among which quartz and felspar predominate. In addition, pieces of limonite are scattered throughout the clay matrix while grains of biotite and muscovite can be seen occasionally. A grain of siltstone was also noted as well as a single fragment showing micrographic intergrowth of quartz and felspar.

Sample 744106 was rather smaller, but there was enough to be sure that it is petrologically similar. Under the microscope the field of view is dominated by felspar, quartz and a single fragment of highly sheared arkosic sandstone or granite. In addition, however, there are occasional subrounded grains of cryptocrystalline silica that do not appear in the first section. This difference is probably a sampling phenomenon and is unlikely to be significant.

In April 1976 the writer had the opportunity of visiting Glozel and obtained "clay" samples from the *Champ des Morts* where the Glozelian artifacts are said to have been excavated. The field forms part of a steep hillside and exposures of the subsoil are available at various points in old unfilled excavation trenches. Immediately beneath the topsoil is a uniform and apparently undisturbed hill wash deposit. It is yellowish brown (Munsell 1OYR.5/4) and contains much argillaceous matter, though it is gritty to the touch. Samples of this material were collected and examined in thin section under the petrological microscope. There is little point in furnishing a description for all the sections are similar, and identical in every respect except colour to the samples described

[a]Department of Archaeology, University of Southampton, Southampton, England.

above. The description of artifact 198bl is particularly apt. There is thus every reason to conclude that the two Glozelian artifacts examined in this study were made of clay dug at Glozel and probably in the Champ des Morts itself. Visual inspection of ceramic material in the Glozel museum suggests that it is all similar and thus this conclusion may apply to the whole assemblage.

It could, of course, be argued that there is a possibility of confusion between similar material from widely different localities. However, this seems unlikely for arkoses have a relatively restricted geological distribution and are usually found on or near the parent acid plutonic rocks providing the component minerals. Furthermore, it must be stressed that in this case both clay and artifacts show a remarkable correspondence in alteration of the felspars and textures as well as mineralogical composition. Also neutron activation study has demonstrated comparable trace element content (McKerrell *et al.*, 1974, Figure 2).

It is worth stressing that there is no evidence that the "clay" was treated in any way before firing and Hall's (1975) suggestion that the artifacts could have been fabricated from reconstituted ancient brick seems unlikely. Warren (1975) favours remodelling of plastic underfired ancient ceramics, but Dr Barbetti's study reveals that most pieces were fired at too high a temperature for this to be feasible in all but a few cases.

As the Glozel artifacts were probably made from the local materials, a heavy mineral analysis was carried out on the latter, with the specific objective of searching for highly radioactive minerals that might in some way relate to the thermoluminescent dates. The results were negative for the assemblage recovered is characterized by a flood of iron ore (mainly limonite with some magnetite), with zircon as the most abundant non-opaque mineral. Grains of epidote, tourmaline and garnet are present in lesser quantities.

## Conclusions

The archaeomagnetic dating adds a new facet to the recent Glozel controversy, and the petrology helps to counter one possible criticism of this method. Aitken & Huxtable (1975) have already suggested that the date range 700 BC–AD 100 quoted by McKerrell *et al.* (1974) may be optimistically narrow but the archaeomagnetic limits begin to agree more readily with archaeological expectation (Renfrew, 1975). The evidence is slight and it is perhaps premature to judge, but the problem may soon be one of explaining differing results from two independent scientific approaches rather than a question of reconciling scientific findings with archaeology. If the anomaly lies in the thermoluminescent dates, it is of the utmost importance to discover the cause, or the method may not continue to enjoy the widespread confidence among researchers which it has seemed to warrant until now. Glozel is thus a *scientific* issue of considerable moment.

Thermoluminescence results from the interaction of minerals with their radioactive environment. It is thought unlikely that the analysed samples have suffered artificial irradiation (Aitken & Huxtable, 1975), the internal dose rate has been assessed and the environmental contribution from the soil of the Champ des Morts is currently being measured (McKerrell *et al.*, 1974). In the present study no unusual radioactive minerals were found, but the samples are rich in potash (orthoclase) felspar. This mineral is not rare in pottery but such a high tenor is seldom encountered. It seems likely that any mineral extracts examined for thermoluminescence would contain appreciable amounts of felspar, as McKerrell and his co-workers (1974) record no specific measures to exclude it. This may be relevant in two ways. Firstly the inclusions will have an exaggerated potassium content with the possibility of an exceptionally high level of radioactive $^{40}K$. Secondly, as Wintle (1973) has shown, felspars are prone to anomalous fading of thermoluminescent output. Aitken & Huxtable (1975) have already pointed out that this factor was not taken into account by McKerrell and his colleagues. On the other hand, this may be of little significance, for Wintle's investigations were concentrated on sanidine and the soda-lime plagioclase felspars, not orthoclase. Moreover, Aitken and Huxtable found no anomalous fading in sample 198b1, though they were duly wary of placing too much emphasis on a single piece.

The matter is by no means solved and is clearly worthy of further critical investigation: petrological study has demonstrated an unusually high content of felspar and it now remains for specialists in the thermoluminescent technique to consider whether this could account for the discrepancy between dates obtained by that method and the results of archaeomagnetic analysis.

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