Statistical Analysis of Flint Trace Element Data

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Introduction

The object of the technique is to establish if flint from different prehistoric mine sites could be separated on the basis of the occurrence of certain trace elements, and to use this data, to enable artifacts of unknown provenance to be classified with a source with the least likelihood of error. The methods of chemical analysis and subsequent data analysis and the results, have been published earlier (Sieveking, *et.al.* 1970, 1972), on the basis of the evidence available it was suggested that the method would be satisfactory in the majority of cases. Limitations to the approach were pointed out, and in particular it was noted that if more than the original mine sites were to be used, then an alternative method of data analysis should be used. Such an alternative, Pattern Recognition, has already been applied to the problem by Dutch workens (de Bruin *et.al.*, 1972). This contribution briefly discusses the application of this method to the British data. We also consider further geological and archaeogical data which has recently become available.

Application of Pattern Recognition

The technique of Pattern Recognition has been discussed elsewhere (de Bruin *et.al.*, 1972 and Howarth 1973); both papers give a discussion of the method and references to earlier work. The program used for this preliminary investigation is that developed by Dr. Howarth of the Applied Geochemistry Research Group at Imperial College, London (Howarth, 1973). Some 250 artifacts were classified with original mine sites using both methods (i.e. Discriminant Function and Pattern Recognition Analysis), and the results compared.

Although no attempt was made to optimise the classification produced by the Pattern Recognition method, it was seen that some 70% of the artifacts were classified with the same mine site by both methods. Of the remainder, most belonged to the South Downs Group of mines, which, has had been suggested earlier (Sieveking, *et.al.*, 1970, p. 254), are closely related and may be expected to cause difficulties. It is hoped thhat in the near future further work will be carried out, firstly in order to optimise the classification and secondly to see the effect of increasing the number of mine sites with which to classify. It is hoped that ultimately all the major British Flint Mines can be included in such a classification procedure.

Geological and archaeological considerations

So far we have only considered the internal evidence, i.e. we have set up geological and archaeological hypotheses and have only tested them by reference to materials collected from Flint Mine sites and from archaeological specimens. The initial geological hypothesis was that the pattern of trace elements in the flint was likely to be constant laterally (i.e. at same stratigraphic level), but vary significantly vertically. Thus we would expect greater difference in analysis of material from different mine sites, than between specimens from the same mine site.

A set of samples collected from different stratigraphic levels in the Cretaceous Chalk of Norfolk by N.B. Peake, has recently been analysed by the British Museum laboratory. And, although the results have not been looked at in any detail, it is clear that elements such as Al, Li and P

show a pattern which is related to the stratigraphy of the area. For example flint from the Maastrichtian chalk has moderately high Al and low Li, while at the base of *Belemnitella mucronata* zone both Al and Li are low. In contrast the zone of *Terebratulina lata* is characterised by very high Al and Li. This is also substantiated by samples collected from a borehole near Mildenhall, Norfolk which had been analysed earlier. In this case, samples were analysed from the zones of *Holaster planus* and *T. lata.*

An archaeological hypothesis is that the material from which the larger artifacts were manufactured had been mined and not collected locally (from near the living area). This hypothesis has been tested by collecting local flint from two archaeological sites and their trace element distribution compared with that of artifacts collected from the sites themselves. Again, a preliminary study of the results shows that there is a very wide variation in the trace elements of the 'local' material, while the artifacts form compact groups. For both sites, the majority of artifacts classify with the Cissbury mine site.

Conclusion

Although all of the observations recorded in this contribution are of a preliminary nature, there are a number of positive conclusions which can be drawn. The evidence available shows that the geological and archaeological hypotheses, which are fundamental to this attempt at classifying flint artifacts of unknown provenance, are sound. The only reservation which must be stated at this stage, is that the method applies only to flint, which is defined as the cherty material commonly found as a replacement structure of the chalk rock of the British Cretaceous.

Also it is clear that the method of statistical analysis, known as Pattern Recognition is a satisfactory replacement for the Discriminant Function Analysis used previously (Sieveking *et.al.,* 1970 and 1972). The full results of the work which has been discussed here will be published at a later date, along with the data on which the above conclusions are based.

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