Letter to the Editors

Palaeomagnetism of the Lisbon Volcanics: a Discussion of a Recent Paper by N. D. Watkins and A. Richardson

K. M. Storetvedt

Summary

A critical examination of some recent palaeomagnetic data from the Lisbon volcanics has revealed a strong disagreement between estimated palaeomagnetic directions and the corresponding tabulated experimental results. This discrepancy appears to have resulted from an inadequate analytical procedure. The data presented are regarded as unacceptable as basis for further conclusions.

Some recent palaeomagnetic data of the Lisbon volcanics by Watkins & Richardson (1968) have been applied in testing the rotation hypothesis of the Iberian peninsula. The adopted lava mean directions are shown in Fig. 1. The estimation of each of these directions is based essentially on a suggestion of Irving, Stott & Ward (1961). In the present case any one of four demagnetization steps of each specimen (100–400 oersteds) is combined with similar directions of other specimens for obtaining a maximum resultant vector \((R)\) for each lava.

The examination of these lavas includes a number of bulk rock properties such as: susceptibility, \(Q\)-ratio, Curie point, coercivity spectra, titanomagnetite grain size, rate of oxidation etc. The reliability of the estimated mean directions is assessed as follows: ‘The fact that widely differing Curie points, widely differing stabilities, and range of oxidation states occur in lavas of the same polarity is strong evidence that the polarity is independent of the ferromagnetic constituents, and confirms the minimum scatter \((K_{max})\) computational procedure as being more realistic than applying a single demagnetizing field to all specimens, since the latter process would include an assumption of uniformity of coercivity. There is no reason to suspect that the NRM is other than that due to the original Eocene geomagnetic field.’

A striking contrast to this reliability statement is provided by the data of Table 3 in the paper by Watkins & Richardson giving magnetization results for each specimen at the different demagnetization steps applied. In nearly all the lavas concerned there are, to a greater or lesser extent, systematic directional changes. There is a clear tendency in these changes: movement in a southerly direction. This directional trend may collapse and the magnetization intensity may increase after treatment in an alternating field of 400 oersteds. Considering the relatively low intensity of magnetization here concerned the reason for such ‘deviating’ results is most likely that spurious components have been added during the a.c. treatment. The directional behaviour of a number of the specimens is reproduced in Fig. 2.

The experimental results appear to leave no doubt that at least two important components of magnetization are represented. However, there is no experimental
Fig. 1. Estimated palaeomagnetic directions as given in Table 5a of Watkins & Richardson (1968).

Fig. 2. Some examples of the directional behaviour of specimens against increasing alternating field (100–400 oersteds). Direction changes are indicated by arrows. Data from Table 3 in Watkins & Richardson (1968).
verification that the most stable of these components (possibly the original one) has been deduced. In view of the large number of systematic direction changes it would be highly unrealistic to assume that the few specimens which exhibit stability in the range of a.c. fields applied, reflect original field directions. It appears most likely that the magnetization of these specimens is governed by a more stable type of secondary magnetization, the elimination of which may pose severe experimental problems (cfr. Chamalaun & Creer 1964; Storetvedt & Halvorsen 1968; Storetvedt, Halvorsen & Gjellestad 1968).

On a whole the present data reveal a gradual change of the magnetization vector towards a reversed polarity direction. A possible explanation of this observation is that the Lisbon volcanics were originally reversely magnetized, the polarity being later changed due to nearly complete remagnetization in a normal field direction.

In a short communication Van der Voo (1968) has presented some independent palaeomagnetic data from the Lisbon volcanics which apparently confirm those given by Watkins & Richardson. Detailed experimental results are lacking, but according to the author 'a similar magnetic behaviour as reported by Watkins & Richardson' has been observed and there were difficulties encountered in the analysis of the soft NRM. Therefore, the data presented by Van der Voo can at present not be regarded as evidence against the remagnetization hypothesis.

The reason why results as those shown in Fig. 2 have been adopted as meaningful palaeomagnetic data is probably that an inadequate analytical procedure has been applied. Thus, there may be serious doubt whether the method of minimum dispersion (Irving et al. 1961) is a realistic approach to many palaeomagnetic problems. This method appears acceptable only when the secondary magnetization is easily removable, i.e. where secondary and primary magnetization differ sharply in stability and where the latter one has a reasonable intensity of magnetization. However, cases of more complex remagnetization appear to be far more common than generally realized (Storetvedt 1968) and a proper derivation of original magnetization remains may be extremely difficult; the experimental success of removing secondary components of magnetization may vary greatly even within the same hand sample. As a consequence application of the method of minimum dispersion might easily lead to serious misinterpretations and because the NRM direction (or directions achieved after initial phases of demagnetization) may exhibit the closest grouping it may incorrectly be adopted as the palaeomagnetic direction in question. It is suggested that this has happened in the analysis of the Lisbon volcanics.

It is not a priori possible to justify the application of the method of minimum dispersion and, therefore, this analytical procedure should not be regarded as a realistic alternative to a rigorous analysis of the directional behaviour of separate specimens.

There are strong reasons for believing that the answer to several palaeomagnetic problems will be found at low intensity levels (Storetvedt 1968). This is because secondary components of either chemical or moderate temperature origin may well be as stable as any primary magnetization present. However, there may be a small difference in blocking temperatures (or in Curie temperatures) of the components involved, whereby valuable information can be obtained immediately before the total disappearance of the remanence. For this reason there may be serious doubt concerning a general application of many bulk rock properties in assessing palaeomagnetic reliability.

In conclusion, the remanent magnetization of the Lisbon volcanics appears to be more complex than suggested by Watkins and Richardson. At present, it is not possible to decide whether the most stable component is of primary or of secondary origin but it seems not advisable to apply the data presented for testing the megatectonic problem under consideration.

Department of Geophysics, University of Bergen.
References


