Table 1

Code	Rock type	Declination, D°	Reference
A	Kenya trachyte	12 ± 7	4
B	Olduvai basalt	5 ± 1	5
C	Olduvai trachyandesite	359 ± 3	6
D	Nairobi basalts	359 ± 5	3, 7
E	Rungwe lavas	16 ± 16	4
F	Kerichwa tuffs	12 ± 11	4
G	Basalts and phonalites	7 ± 13	4
H	Turkana lavas	2 ± 3	3
I	Ethiopian lavas	3 ± 7	8

a clockwise rotation cannot, however, be drawn until the errors and uncertainties associated with each determination are known.

In discussing the rotation, Girdler uses the palaeodeclination or azimuth of Nairobi. This quantity can be obtained from the original authors' data, for it is virtually identical with the declination of the mean palaeomagnetic direction of the rock unit concerned. In most cases the original data also include the circle of confidence (α_{95}) of the mean direction. Where this is not given, it can usually be calculated from the data. If the mean direction and the circle of confidence are known, it is a simple matter to find whether the direction is significantly different from that predicted by the geocentric axial dipole hypothesis, and thus to find whether or not the results imply movement of some sort. When rotation alone is being considered, Irving and Tarling[2] have pointed out that the relevant quantities are the declination (D) and its error, which is given by α_{95} sec I, where I is the inclination.

Proceeding in this way, I have constructed Table 1 (corresponding to Girdler's Table 1) showing the declination and its error for each of the nine Tertiary results. The data used are taken either direct from the original authors or from calculations based on the original data made by Raja *et al.*[3]. In several cases, where unit weight was assigned to samples rather than to sites or flows, the error is probably underestimated.

It can be seen that in only four of the nine cases does the declination differ significantly from true north (D = 0), and the evidence for a significant rotation depends on these cases alone. This approach, using the statistical properties of the palaeomagnetic data, is always useful, but it would be wrong to regard it as complete. For it is also necessary to enquire whether the sampling is such as to average out secular variation. Only when this condition is satisfied can a "rotation" be regarded as established, and even then one may prefer to interpret it as a movement of the palaeo-pole rather than as a continental rotation.

In this case it is probable that only three of the rock formations (*D*, *H* and *I*) have been sampled adequately. Of those showing significant rotations, the Kenya trachyte (*A*) is represented by four flows, the Olduvai basalt (*B*) by only one flow and the Rungwe lavas (*E*) by three flows. The Kerichwa tuffs (*F*) seem to have been sampled at only two sites. In none of these cases can it be assumed that secular variation has been averaged out. Indeed, it is more likely that the deviations from true north shown here are directly due to the effects of secular variation.

The difficulty is that most of the results available for the Tertiary of Africa are those given by Nairn[4] in a paper which does not pretend to be more than a preliminary survey of the field.

More detailed work was initiated some years ago at this laboratory, and a large body of data collected by Dr A. E. Mussett, Mr P. K. S. Raja and Mr T. A. Reilly is now being prepared for publication. A total of 168 sites covering a time from the Upper Miocene to the present was sampled in East Africa. It is believed that the number and spread of sites are such as to eliminate the disturbing effects of secular variation, and the results should therefore provide a more substantial base for conclusions about continental movements than do the figures available. Full details of these new results will be published elsewhere, but preliminary calculations suggest that there has been no significant movement of the palaeomagnetic pole relative to Africa for the past 7×10^6 yr.

Finally, it is worth noting that McElhinny *et al.*[9] have prepared a review of all palaeomagnetic results from Africa. The review presents a slightly different polar wander path for the Phanerozoic of Africa based on more extensive work than that summarized by Girdler.

A. BROCK

Department of Physics,
University of East Africa,
Nairobi.

Received May 8, 1968.

[1] Girdler, R. W., *Nature*, **217**, 1102 (1968).

[2] Irving, E., and Tarling, D. H., *J. Geophys. Res.*, **66**, 549 (1961).

[3] Raja, P. K. S., Reilly, T. A., and Mussett, A. E., *J. Geophys. Res.*, **71**, 1217 (1966).

[4] Nairn, A. E. M., *Overseas Geol. Min. Resources*, **9**, 302 (1964).

[5] Grommé, C. S., and Hay, R. L., *Nature*, **200**, 360 (1963).

[6] Grommé, C. S., and Hay, R. L., *Earth and Planet. Sci. Lett.*, **2**, 111 (1967).

[7] Mussett, A. E., Reilly, T. A., and Raja, P. K. S., *Proc. E. Afr. Acad.*, **2**, 27 (1964).

[8] Grasty, R. L., thesis, Univ. London (1964).

[9] McElhinny, M. W., Briden, J. C., Jones, D. L., and Brock, A., *Reviews of Geophysics*, **6**, No. 2 (1968).

Drifting and Rifting of Africa

THE purpose of my recent article[1] was to bring together various geophysical data relating to the development and evolution of the East African rift system. I do not deduce a clockwise rotation of Africa from palaeomagnetic data alone as Brock presumes in the previous communication. All I say is ". . . there is some suggestion of a change in direction of rotation of Africa . . . consistent with the interpretation of the magnetic anomalies over the Red Sea . . ." and the question mark in Fig. 5 emphasizes this. I also discussed the difficulty of separating polar wander from continental movement.

I am fully aware of the limitations given by Brock, but it was obviously impossible to make a critical appraisal of each set of palaeomagnetic data in an article of this kind. Of course one should examine each set of data as Brock suggests, but one should also inquire why it is that eight of the nine azimuths for the Tertiary are of the same sign (declination east of north) whereas all the azimuths for rocks of age 110 to 250×10^6 yr are of opposite sign (declination west of north). Brock states that eight of the nine sets of palaeomagnetic results exhibit clockwise rotations of between 0° and 16°, but this is not my deduction. The point is that since 110×10^6 yr ago Africa rotated anticlockwise and, because eight of the nine results have declination east of north, the possibility exists that Africa rotated anticlockwise to a point beyond the present north azimuth (D = 0) for Nairobi (Fig. 5). Some time during the Tertiary or Quaternary or both, therefore, there might have been a subsequent clockwise rotation for Africa to reach its present orientation.

It must be remembered that all this assumes that continental movement is more important than polar wander for the interpretation of virtual magnetic poles. Regarding this, it should be noted that further palaeomagnetic results[2] for late Tertiary and Quaternary rocks from South Arabia give westerly azimuths contrasting with the easterly azimuths for African rocks and thus suggesting that continental movement is the more important. This may not be so, but the interpretation is seemingly consistent with the interpretation of other geophysical data for the Red Sea and Gulf of Aden.

R. W. GIRDLER

School of Physics,
University of Newcastle upon Tyne.

Received June 5, 1968.

[1] Girdler, R. W., *Nature*, **217**, 1102 (1968).

[2] Tarling, D. H., Sanver, M., and Hutchings, A. M. J., *Earth Planet. Sci. Lett.*, **2**, 148 (1967).