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## PALAEOMAGNETISM OF THE CENOZOIC VOLCANIC ROCKS FROM EAST AFRICA

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ABSTRACT

Palaeomagnetic results from 269 sites in the East African Cenozoic volcanics are presented. The post-Miocene volcanics were divided into three age groups, 0–1·8, 1·8–7·0 and 13–11 my. and their pole positions calculated. Along with the Miocene pole from Turkana, the Eocene-Oligocene pole from Ethiopia, the pre-Miocene post Karroo pole from Tororo and the mean Mesozoic pole from the rest of Africa, a polar wander path for Africa from Mesozoic to present is suggested.

The small pole displacements of the late Tertiary volcanics are both "far-sided and right-handed". Whereas this could be explained on the basis of Wilson's off-set dipole hypothesis, the much larger displacements shown by the older rocks must be attributed either to polar wander or to the drift of the African plate or to both.

DURING the last ten years the palaeomagnetic research group at the University of Nairobi has carried out detailed studies of a very wide spectrum of Cenozoic volcanics of East Africa. Results of a palaeomagnetic study of the Miocene lavas from Turkana, West of Rudolf form part of an unpublished thesis by Raja[1]. A detailed account of the palaeomagnetism of the volcanics of Central East Africa is given by Reilly[2], in his unpublished thesis. Patel and Gacii[3], have presented the results of their study on the Kapiti phonolites of Kenya. The palaeomagnetism of the Ethiopian flood basalts, believed to be Eocene–Oligocene in age has been reported by Brock *et al.*[4]. Recently Raja and Vise[5], have presented the results of their study on the Carbonatite volcanics of Tororo, S. E. Uganda, which are believed to be "pre-Miocene, post-Karroo" by Davies[6].

This paper presents a summary of the above results.

Rocks of age in the range 13–0 my., were divided into three groups A, B and C. The groups C/B boundary was chosen as 1·8 my. which corresponds to the Plio-Pleistocene boundary of the scale suggested by Berggren[7]. The relatively quiet period of volcanism 11–7 my. enabled the division between groups A and B. The Turkana lavas range in age from 32–13 my.[8]. But most of the basalts showed ages between 23 and 14 my. with a concentration at about 17 my.[9]. Hence the approximate age of 17 my. is assigned to the Turkana lavas considered as one unit.

Table I gives the mean directions and poles for all the groups mentioned above. Along with the mean Mesozoic pole for Africa at 261° E, 65° N[10], it is possible to suggest a polar wander path for Africa from Mesozoic to present. Such a path is shown in Fig. 1. It can be seen that the pole from the Tororo ring complex (TU) fills a wide gap between the Mesozoic pole and the East African Tertiary poles. The close similarity between the Australian polar wander curve for the Cenozoic and the African polar wander curve for the same period enabled McElhinny *et al.*[11], to suggest the existence of a common polar wandering component,

**TABLE I**

*Site mean directions, poles and statistical parameters*

| Group | Approximate age | Number of sites N | Directions | | | | Poles | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | D° | I° | *k* | $\alpha_{95}$° | Longitude °E | Latitude °N | K | $A_{95}$° |
| C | 1·8–0 my. | 54 | 1·3 | −2·4 | 18·3 | 4·7 | 104·0 | 88·7 | 37·8 | 3·2 |
| B | 7–1·8 my. | 102 | 3·3 | −4·8 | 22·0 | 3·1 | 147·6 | 86·5 | 37·8 | 2·3 |
| A | 13–11 my. | 22 | 1·7 | −4·2 | 13·4 | 8·8 | 186·6 | 86·5 | 28·8 | 6·1 |
| Turkana | Miocene ~17 my. | 62 | 4·1 | 1·7 | 35·0 | 3·1 | 163·3 | 84·8 | 69·9 | 2·3 |
| Ethiopia | Eocene-oligocene | 20 | 7·2 | 7·2 | 34·9 | 5·6 | 167·7 | 80·8 | 59·3 | 4·3 |
| Tororo | Pre-Miocene | 3 | 4·5 | −24·2 | 157* | 9·9 | 195·5 | 75·8 | 172·2 | 9·4 |

D—Declination, I—Inclination, *k*, K—Fisher's precision parameter,
$\alpha_{95}$, $A_{95}$—radius of 95% circle of confidence.
* Calculated for specimens.

**TABLE II**

*Sub-division of group C into brunhes and matuyama age groups*

| Group | Approximate age | Number of sites N | Directions | | | | Poles | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | D° | I° | *k* | $\alpha_{95}$° | Longitude °E | Latitude °N | K | $A_{95}$° |
| $C_1$ (Brunhes) | <0·7 my. | 24 | 2·5 | ±1·7 | 14·9 | 7·9 | 107·1 | 87·6 | 32·6 | 5·3 |
| $C_2$ (Matuyama) | >0·7 my. | 23 | 359·1 | −1·0 | 19·7 | 7·0 | 353·8 | 88·4 | 38·5 | 4·9 |

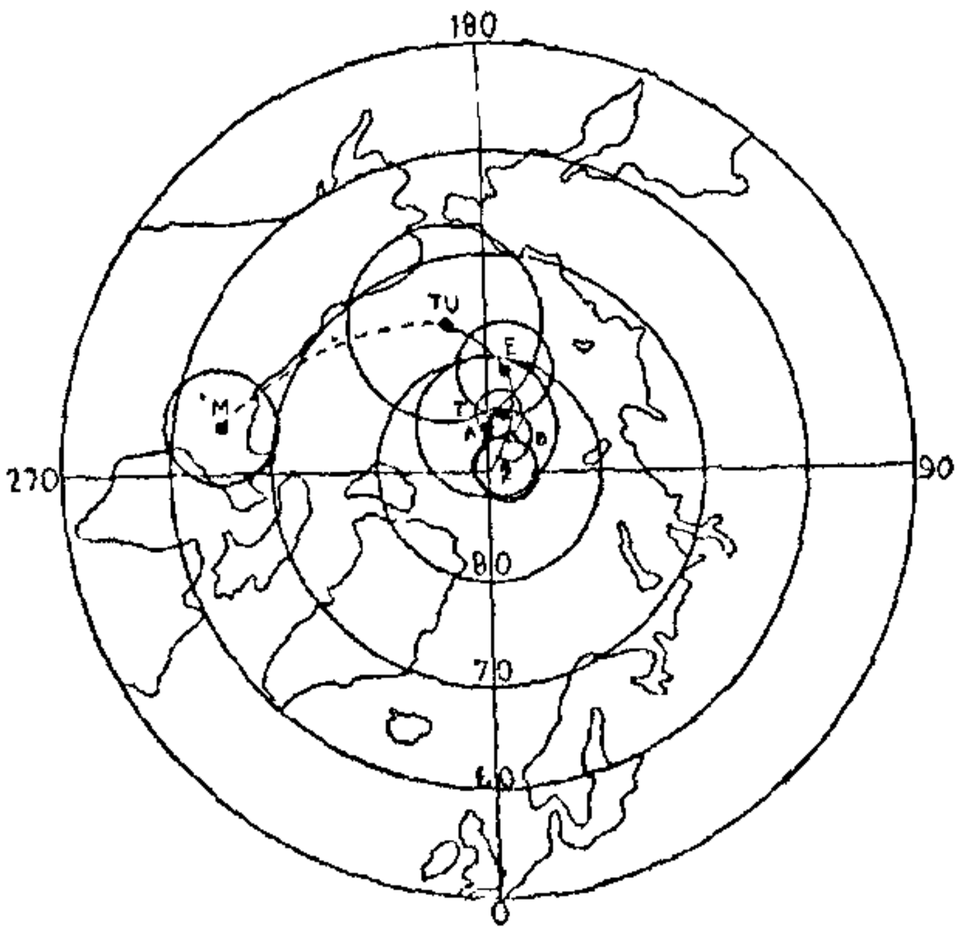


FIG. 1. Polar wander path for Africa from mesozoic to present. C, B, A, Poles from East African volcanics of age groups 1·8–0, 7–1·8 and 13–11 my. respectively; T, Miocene (~ 17 my.) Pole from Turkana; E, Eocene-oligocene pole from Ethiopia; TU, Pre-miocene pole from Tororo (Uganda); M, mean mesozoic pole; (All poles are shown with 95% circle of confidence).

However, Wilson[12] has recently pointed out that the polar wander hypothesis need not be invoked to explain the small displacements of the upper Cenozoic poles. He has shown that the deviations are greatly reduced if the geocentric dipole is displaced northward along the spin axis. (What is known as Wilson's offset dipole hypothesis). In a recent paper, Wilson and McElhinny[13], have shown that "if the northward offset of the dipole has existed, then this offset has been decreasing over late Tertiary time and is (within errors) approaching a small value during Quaternary". Our results as indicated by Fig. 1 and Table I are consistent with this finding.

Recently Watkins[14], analysed Brunhes epoch data from sites in the Indian Ocean and noticed that whereas the northern hemisphere data are consistent with the offset dipole hypothesis, the southern hemisphere data are consistent with the centred dipole hypothesis. Table II shows the subdivision of Group C into Brunhes and Matuyama. It can be seen that the poles for these groups are indistinguishable from the present. They are not only not "far sided", but if anything, "near sided" and as such, consistent with the centred dipole hypothesis which agrees with Watkins'[14], findings.

Table I shows that pole displacement of 5° in the Miocene increases to 9° in the Eocene and to 14° for the Tororo volcanics. If the small pole displacements of the late Tertiary and younger volcanics could be explained by the offset dipole hypothesis, the larger displacements shown by the older rocks must be attributed either to polar wander or to the drift of the African plate or to both.

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