Analysis of Palaeomagnetic Data from Viti Levu, Fiji

Alan James *

David A. Falvey

Department of Geology and Geophysics, University of Sydney, Sydney, N.S.W. 2006

Abstract

Recent palaeomagnetic field sampling of Lower Pliocene sediments and lavas on Viti Levu, Fiji has produced seven new stable sites. These data are comparable with results from nine sites in the same formations previously published by Tarling (1967). Analysis suggests 21° anticlockwise rotation in 4 to 4½ m.y. This is interpreted as active rotation of the whole Fiji Platform, with microplate motion commencing at the close of the Miocene (6 m.y. BP).

Introduction

Rotation of the Fiji Platform in an anticlockwise direction has been a speculative proposal invoked by the 'spiral nebula' shape of the island group. There has been much discussion of this idea (P.J. Coleman, A. Malahoff, *pers. comm.*) but very little has appeared in print. Malahoff, (1970, Figure 63) has used earthquake distribution and submarine morphology to propose active rotation of the Fiji Plateau (North Fiji Basin). No angle of rotation or mechanism was suggested. Green and Cullen (1973) have further interpreted Malahoff's ideas plus geological data from Fiji. They concluded that shear-driven rotation ceased "some considerable time ago" (presumably pre-Pliocene) with present day motion being dominantly transform. By contrast other authors believe Fiji to have been, for most of its history, part of either the Pacific or Indo-Australian plates. Rather poor seafloor spreading magnetic anomaly data from the North Fiji Basin led Chase (1971) to conclude that since the Early Miocene Fiji had been on the Indo-Australian plate and prior to that, on the Pacific plate. On similarly poor data, Falvey (1975) suggested that it had been on the Indo-Australian plate since the formation of the South Fiji Basin in the mid-Oligocene.

Tarling (1967) carried out a diverse palaeomagnetic field sampling programme but was unable to draw tectonic conclusions. The present study involves a reexamination of part of his work in conjunction with some more recent data.

Field sampling and data reduction

New data presented here is from samples collected in the largely shoshonitic Koroimavua and Mba Volcanic Groups, and the Suva Marl. Both rock units are Lower Pliocene (Figure 1). Palaeomagnetic sites were cored with a portable rock drill and cores were oriented *in situ*. Specimens were analysed on a spinner magnetometer at Mineral Physics Laboratories, Commonwealth Scientific Industrial Research Organisation (CSIRO), North Ryde. A site was considered stable if alternating magnetic field demagnetisation procedures resulted in both an improved grouping and stabilisation of specimen magnetisation directions within a site. No rigid confidence limits were imposed upon these data. The location of seven stable sites in post-Miocene rocks are shown in Figure 1. Magnetisation directions for these sites are included in Figure 2 and listed in Table 1. Age data were provided by P. Rodda (*pers. comm.*).

Interpretation

These data show a substantial variation of declination anti-clockwise from the present total field and dipole field directions. A re-examination of data from the same rock units included in Tarling's (1967) study confirmed this rotation. Eight sites, each consisting of more than one sample, from the Mba Volcanics and one site from the Suva Marl are located in Figure 1 and also included in Table 1. Their magnetisation directions (average 'treated' directions) are shown on Figure 2 along with the new data.

The mean pole positions given in Table 1 were derived from the apparent pole positions of all samples in all stable sites.

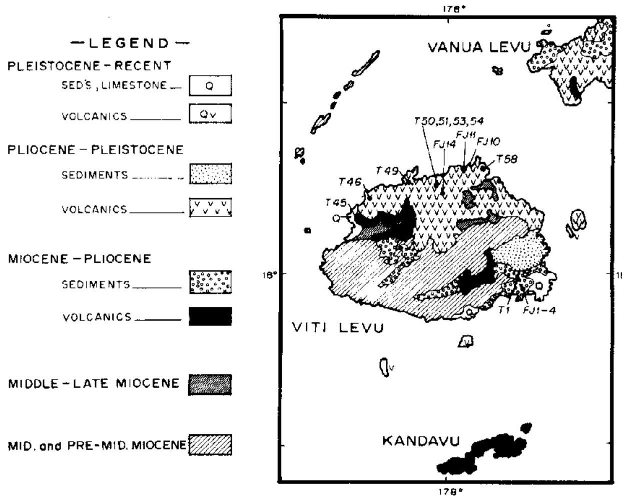

FIGURE 1

Generalised geology of Fiji showing stable Pliocene palaeomagnetic site locations. Site numbers with a "T" prefix are from Tarling (1967) and those with an "FJ" prefix are from the present study.

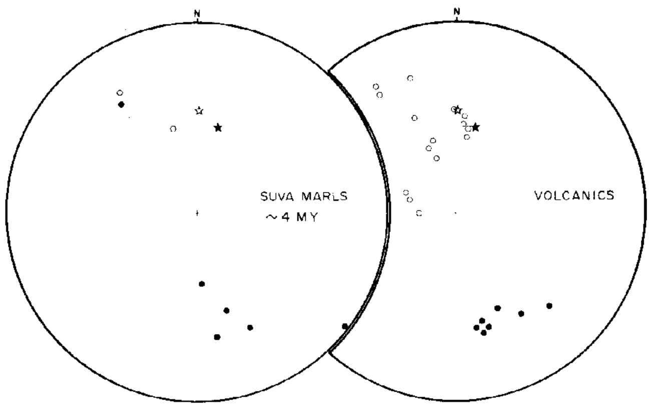

FIGURE 2

Directions of magnetisation in all stable specimens in all stable sites given in Table 1

*Note Present Address. Esso Exploration Australia Ltd, G.P.O. Box 4047, Sydney, N.S.W. 2001

Mean Site NRM data – Viti Levu, Fiji

Site No.	Rock Description	Age	No. Cores	Site average (palaeodirection after structural correction) Decl.	Incl.	A_{95}	Sample (core) average pole position Lat.	Long.	A_{95}
FJ 1	Suva Marl	Early Pliocene	2	173.4	34.4	63°			
FJ 2	" "	" "	2	159.6	26.4	30°			
FJ 3	" "	" "	1	343.8	–42.3	–	–66.2	–79.4	13.8°
							(Suva Marl only)		
FJ 4	" "	" "	2	316.9	10.6*	60°			
T 1	" "	" "	1	327	–17	–			
FJ10	Nduthui Intrusive	" "	4	169.5	26.1	5°			
FJ11	Narewa Andesite	3.9 m.y.	4	6.4	–41.0	5°			
FJ14	Nandarivatu Volcanics	4.3 m.y.	4	296.5	–64.0	17°	–69.3	–103.3	8.8°
							(All sites)		
T 45	Koroimavua Andesite	Early Pliocene	3	341	–57	31°			
T 46	Mba Volcanics	" "	2	135	19	17°			
T 49	" "	" "	3	342	–47	15½°			
T 50	Nandarivatu Volcanics	" "	2	327	–14	41½°			
T 51	" "	" "	3	336	–33	7°			
T 53	" "	" "	2	359	–33	22½°			
T 54	" "	" "	2	147	25	17°			
T 58	Rakiraki Volcanics	" "	2	157	32	7°			

* Both stable normal and reversed polarity samples within site

These pole positions, together with their circles of confidence (A_{95}) are plotted in Figure 3. The fine grained Suva Marl was expected to produce a reliable pole and is plotted separately. The overlapping circles of confidence define a zone suggesting 15° – 30° microplate rotation anticlockwise relative to the present pole position of the Pacific plate. The mean rotation would be approximately 21° corresponding to a mean age of 4-4½ m.y.

Gill and McDougall (1973) concluded that the change from Namosi calcalkaline volcanism to Koroimavua/Mba shoshonitic volcanism took place between 5 and 6 m.y. BP, and further concluded that it was due to the opening of the Lau Basin. Weissel (1977) suggested that the opening began about 4 m.y. BP. It is possible that the Namosi to Koroimavua/Mba volcanic transition is related also to the microplate rotation of the Fiji Platform. If so, the older date (6 m.y. BP) probably marks the onset of microplate motion. This age is in agreement with that established by Falvey (*this issue*) for the opening of the North Fiji Basin and the clockwise rotation of the New Hebrides island arc. A reconstruction of the Fiji Platform within the Lau-Tonga and New Hebrides-Vityaz double arc is presented by Falvey (*this issue*) and Carney and Macfarlane (*this issue*).

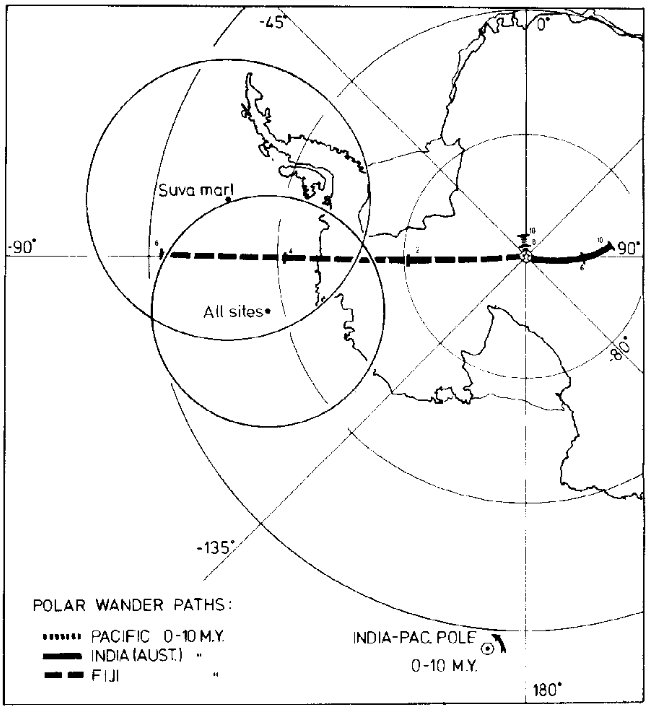

FIGURE 3

Apparent pole positions for Fiji in the Early Pliocene (4-4½ m.y BP. The data from the five Suva Marl sites are shown separately. The dashed line shows the synthetic polar wander path computed by Falvey (*this issue*) corresponding to an anticlockwise rotation of 30½° with respect to the Pacific plate and 35½° with respect to the Indo-Australian plate since 6 m.y. BP

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Analysis of Palaeomagnetic Data from the New Hebrides

David A. Falvey

Department of Geology and Geophysics, University of Sydney, Sydney, N.S.W. 2006

Abstract

Palaeomagnetic samples have been collected on eight islands of the New Hebrides island arc. Data are presented for 31 stable sites out of 46 with ages ranging from Pleistocene to early Late Miocene. These data show 30° clockwise rotation of the arc commencing 6 m.y. BP. Synthetic polar wander paths corresponding to microplate rotation may be computed from known major plate polar wander paths. Thus a physiographically reasonable reconstruction of the New Hebrides plate is shown to have a polar wander path which compares well with the observed data. A reconstruction of a pre-Late Miocene double arc, consisting of the Solomons, New Hebrides-Vityaz, Fiji and Lau-Tonga island arcs, is possible which supports interarc geological correlations and which suggests Plio-Pleistocene growth of the North Fiji Basin by r-r-r *triple junction development concomitant with the development of the Lau Basin.*

Introduction

Gill and Gorton (1973) presented a reconstruction of the New Hebrides island arc prior to 8-10 m.y. BP. These authors rotated the island chain about 45° anticlockwise to align it adjacent to the Vityaz Trench. Prior to that time, subduction was presumed to proceed in a southwesterly direction. The Fiji Platform was also rotated in their reconstruction about 45° clockwise, placing it in line between the New Hebrides arc and the Lau Ridge. This reconstruction was based upon subduction polarity profiles for Fiji and the New Hebrides which suggested both arc reversal (in the case of the New Hebrides) and easterly migration of the Tonga island arc from Pliocene to Recent times. The resultant 70° bend made by the Tonga-Vityaz trench near Fiji roughly follows the present day 625 km earthquake contour. This extreme case of arc rotation is clearly supported by physiography and arc polarity as indicated by a pre-Late-Miocene change in volcanism (Colley and Warden, 1974), but lacks supportive data.

Other authors have suggested less dramatic rotation. Chase (1971) carried out a reconstruction of the New Hebrides and Fiji blocks based upon interpretation of seafloor spreading magnetic anomalies in the North Fiji Basin. The proposed tectonic history was complex. The present day New Hebrides microplate (M) is considered to be quite young. In the interval to 10 m.y. BP the New Hebrides was part of the Pacific plate, and from 10 to 21 m.y. BP it was part of the Indo-Australian plate. Prior to that time it was back on the Pacific plate. The palaeogeography for the 10-21 m.y. BP interval places the

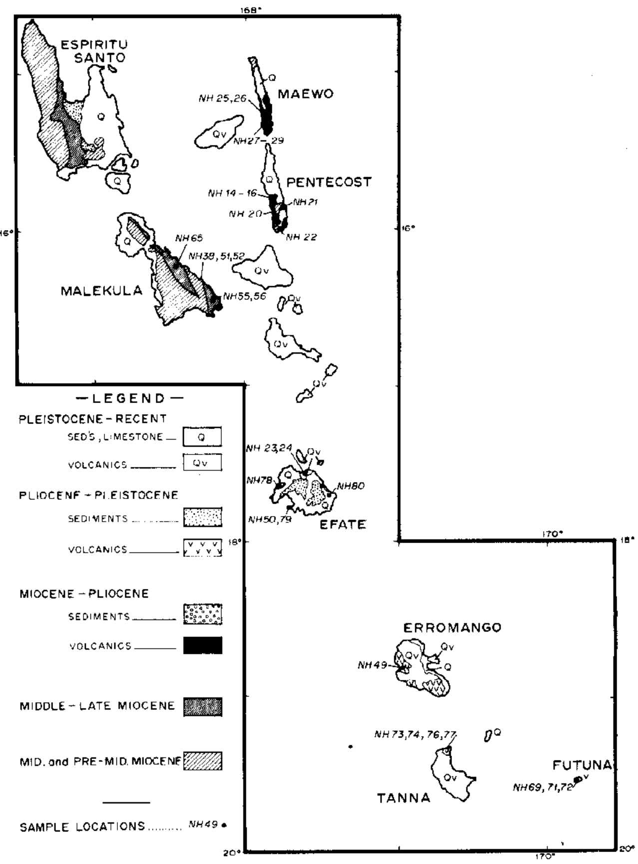

FIGURE 1

Generalised geology of the New Hebrides showing stable Upper Miocene to Pleistocene palaeomagnetic site locations