AXIAL ACCRETION IN THE NORTH FIJI BASIN (SW PACIFIC) BETWEEN 16° AND 22° S

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INTRODUCTION

The North Fiji Basin (NFB) is delineated by the Vitiaz trench to the North (paleo subduction zone, Brocher, 1985), the Vanuatu island arc (called before New Hebrides arc) to the West and South, the Hunter Fracture Zone to the South-East and the Fiji islands to the East (Brocher, 1985 ; Larue et al., 1982 ; Carney and MacFarlane, 1982 ; Falvey, 1978).

The NFB is characterized by shallow water depths (about 3 km) (Chase et al., 1982 ; Sclater et al., 1972 ; Karig, 1971), high heat flow (average of 2.29 HFC) (MacDonald et al., 1973 ; Halunen, 1979), strong positive free air anomalies (Worzel, 1965 ; Kogan, 1976 ; Luyendick et al., 1974 ; Solomon and Biehler, 1969) and a geoid anomaly (Malahoff and Larue, 1979) interpreted as a geoid swelling. Few refraction data reveal a relatively thin crust and sediment cover, and the existence of low speeds in the upper mantle beneath the NFB (between 7,1 and 7,7 km/s) (Larue et al., 1982 ; Raitt, 1956), which could indicate the existence of active spreading zone(s) in this area (Barazangi et al., 1974). Global seismicity of the SW Pacific clearly defines the limits of the NFB, as well as the Lau basin (Sykes et al., 1969). But one can note the low level of shallow seismicity of the NFB (Hamburger and Isacks, in press) which concentrates in three distinct trends :

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1. the central part of the NFB is weakly underlined by few shallow seisms trending North-South with focal mechanisms corresponding to extension or strike-slip motion ;
2. a zone trending N70 extending from the central part of the NFB toward the North of the Fijian archipelago associated with strike-slip motions and which corresponds to the North Fiji Fracture Zone (NFFZ) ;
3. an area situated just West of the Viti Levu island (Fiji) between 17° S and 19° S showing a high level of seismicity. This area has been interpreted to be in extension by some authors (Brocher and Holmes, 1985).

Thus as well as the South Fiji (paleo spreading basin) and the Lau (presently spreading) basins, the NFB represents a marginal sea created by back arc spreading behind an active subduction zone (respectively the Lau ridge, the Tonga arc and the Vanuatu arc) resulting from the convergence movement between the Pacific and Indo-australian plates.

Different models of evolution of the NFB have been presented using various data. Five principal models can be recorded (Chase, 1971 ; Gill and Gorton, 1973 ; Dubois et al., 1973b ; Falvey, 1978 ; and Malahoff and al., 1979). They respectively lean on geophysical, volcanological, kinematical, magnetical and paleomagnetical data and aeromagnetical surveys. We shall not speak in detail of each of these models. Yet, we find a certain agreement concerning a number of ideas : the NFB was created about 10 million years ago. The creation of this basin results from the clockwise rotation (around 30°) of the Vanuatu Arc and the counterclockwise rotation of the Fiji Islands (21° to 55°) (James and Falvey, 1978 ; Malahoff et al., 1982) ; the present opening of the NFB takes place along an accretion center schematically oriented N-S, which was set up less than 4 million years ago (Colley and Hindle, 1984 ; Maillet et al., 1986 ; Auzende et al., 1986).

The third leg of SEAPSO cruise of the R.V. Jean Charcot had three essential aims :

1. the exploration and the cartography of the accretion system in the central part of the

NFB ;

2. the exploration of a part of the transverse system which links the spreading centre of the NFB to NFFZ ;
3. finally, the exploration of the complex zone situated West of the Fiji Islands, which presents an alternation of N-S ridges and troughs.

In this paper we shall mainly develop the first objective, which is the study of the active spreading centre of the central NFB between 16° S and 21° S.

RESULTS

THE ACTIVE SPREADING CENTRE

The survey performed during the leg III of the SEAPSO cruise on the active spreading ridge of the central NFB between 16° S and 21°30' S allowed us to locate precisely the spreading axis and to characterize its main morphotectonic features.

Magnetic anomalies

The new data collected and a reinterpretation of the aeromagnetic data show that the main magnetic lineations described between 16° S and 18°30' S are coherent with the structural directions observed (Auzende et al., 1986 ; Gente, 1987 ; Lafoy et al., in preparation). However, the central anomaly is less well defined here than south of 18°30' S. Between 18° S and 21° S, anomalies J and 2 have been identified and 2' on the eastern side.

The width of the axial anomaly varies from 50 to 60 km between 16° S and 21° S. The resulting full spreading rate calculated for the last My is comprised between 6.8 and 8.2 cm/y (Auzende et al., 1986), in good agreement with the results given by Maillet et al. (1986).

Older areas exhibit the same N05 orientations as observed south of 18°30' S in the whole axial domain. Thus the axial domain has been separated first in a southern domain (between 18°20' S and 21° S) where all the structural orientations are N05, and secondly in a northern domain (between 16° S and 18°20' S) whose previous N05 orientation was readjusted 0.7 My ago in 2 segments from north to south, respectively oriented N150-160 and N15-20.

The axial domain

Located between 173° E and 174° E, it is defined by the central magnetic anomaly and the lack of sediment cover visible on single channel seismic reflection profiles.

Three main structural trends characterize the active spreading axis :

1. N155-N160 from 16° S to 16°40' S ;
2. N15-N20 from 17° S to 18°30' S ;
3. N05 from 18°20' S to 21° S.

These orientations are underlined by lineaments, fault scarps, ridges, depressions, as well as the main direction of accretion itself. The axis consists of a succession of "en échelon" segments, shifted by non transform offsets. But for the two northernmost axial areas (from 16° S to 18°30' S), the axial morphological orientations can only be observed on a width of about 25 km on each side of the axis, corresponding to the readjustment of some 0.7 My. as observed with the magnetic data.

Transversal morphology

Profiles done during this cruise are oblique or perpendicular to the axis. However, they allow to characterize the across strike morphology of the northern and southern domains previously structurally defined.

The northern domain. The morphology of the northern domain is very rough, marked by a succession of ridges and grabens showing vertical changes reaching more than 1 500 m. This rough morphology is mainly observed within 30 or 40 km maximum from the axis.

On both sides of the highly accidented axial domain, the vertical displacements observed are less important, reaching a maximum of 500 m, and giving to the flank of the spreading ridge a smoother morphology. The spreading axis itself exhibits in this northern domain a high morphological variability. It is sometimes marked by an axial graben on the top of a 15 km to 50 km wide dome. The width of the axial graben varies from 2 km to more than 20 km. This morphological variability increases when approaching the triple junction of 16°40' S.

The southern domain. The transversal morphology of the southern domain is smoother, with maximum vertical variations never over 500 m. The morphology of the axial area is a 15 to 20 km wide dome, or a plateau some 15 km wide, or without any striking feature, the axial domain consists of a series of ridges and grabens 100 to 300 m deep. A full Seabeam map realized between 19°50' S and 20°20' S shows that the spreading axis is well lined up along a N-S direction. This axis is underlined on both sides by ridges and depressions 200 m deep maximum, with the same direction. The axial ridge is well limited by the 2 800 m isobath. This ridge is 4 to 5 km wide, reaching 6.5 km wide near 20°05' S. Its top is cut by a graben, which can be considered as the present axis.

Along strike morphology

The along strike morphological profile of he spreading axis of the NFB between 16° S and 1° S was established from the Seabeam data of EAPSO leg III and slightly extrapolated.

The North domain, from 16° S to 18°20' S, s characterized by important along strike epth variations of 400 to 500 m. These varia- ions divide the axis into bulged segments 30 o 50 km long.

The South domain exhibits a long smooth ulge shape whose extremities correspond in the orth to the junction to the North domain by a ropagating rift system (Hey, 1977), and in the outh to a fracture zone at 21° S. The depth of ese depressions reaches 3200 m. The summit of his along strike bulge rised to 2700 m depth. e depth variations of the axis between 18°20' and 21° S are much less important than in the rth domain (less than a few hundred meters).

ULIAR FEATURES IN THE AXIAL DOMAIN

The longitudinal section of the North jian spreading ridge evidences that it is re- larly cut by transverse structures, such as erlapping Spreading Centres (MacDonald et al., 984), non transform offsets and a triple junc- on. The SEAPSO leg 3 survey gave us the pos- ibility to distinguish some of these transver- e structures with a good precision, particular- y the 16°40' S triple junction (Lafoy et al., 987), the 18°20' S transverse accident, the 9°50' S overlapping spreading centre and final- y the 21° S fracture zone.

EVIDENCE OF HYDROTHERMAL ACTIVITY WITH GEOCHEMICAL ANOMALIES IN SEAWATER

Existence of submarine hydrothermal con- ction has been demonstrated after the discove- of hydrothermal plumes in the seawater co- mn along the axis of the Pacific and Atlantic dges.

In view of searching methane and manga- se anomalies in the seawater column in the at locations of suspected hydrothermal ac- ity, seven hydrocasts were taken between and 20° S during the SEAPSO leg III cruise.

Seawater samples were collected during -Rosette lowerings. Total dissolve manganese M) concentrations were measured in these ples on board using the leucomalalchite en colorimetric method which has been ap- ed to direct seawater measurements by Bou- e et al. (1983).

The enrichment of TDM and methane toward bottom observed at different concentration ls on the seven hydrocasts reflects the pre- e of submarine hydrothermal systems between and 20° S. The sizes and shapes of the anomalies vary in latitude along the axial zone defined by Lafoy et al. (1987). These changes may result from the complex configurations and depth of the axial valley. However, the TDM and methane enrichment seems to be progressively increasing along the axial zone from 20° toward 16° S, to be stronger near the triple junction around 16°40' S, when CH_4 anomalies are 10 times the background of deep Pacific waters. The presence of manganese and methane anomalies, very characteristic of hydrothermal plumes, tends to show that this axial zone is active with a maximum activity at the Hy-05 ; Hy-06 latitude (16°20' S).

CONCLUSIONS

The present accretion system of the southern part of the NFB between 16° S and 22° S is schematically located on a North-South direction. It was created approximately 3 My ago according to this general direction together with the opening of the Lau Basin toward the East. The magnetical data allow us to estimate the present opening rate at 6.8 to 8.2 cm/y. This NS accretion system is located on an older system generally oriented N145, which is probably a proof of the rotation of the New-Hebrides block (starting around 10 My ago).

In detail the ridge of the NFB is morphologically and structurally comparable to the East Pacific Rise. It consists of offsets in the axial graben, Overlapping Spreading Centers and peculiar structures resulting from constraints affecting the whole area. The 16°40' S triple junction represents a particular structure which has been shown and which results from a recent change (0.6-0.7 My) of the accretion system linked to the functioning of the NFFZ. From North to South near the 16°40' S triple junction the first data concerning the presence of hydrothermalism seem to show a significant increase in methane and manganese anomalies near the seafloor.

The dredges performed along the axis gave fresh basalts and glass the analyses of which show there is a close link between them and the MORB lavas.

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