

# PACIFIC PAGES

## THE NORTH FIJI BASIN ACTIVE SPREADING RIDGE

Jean-Marie Auzende\* describes recent findings at the boundary of two important tectonic plates

The North Fiji Basin (NFB) is one of the marginal basins at the converging boundary of the Pacific and Australian major plates. It forms a deep triangular basin (fig. 1), lying between the arc of the New Hebrides to the west, the Fiji Platform to the east, the Vityaz

The basin began to open about 12 million years ago after the locking of the Vityaz subduction by the Ontong-Java Plateau and the reversal of its polarity. This change of polarity involved the clockwise rotation of the New Hebrides Arc with, as a

part of the basin; meanwhile, north-south spreading was happening in the northern part of the basin and north of the Fiji islands.

### The North Fiji Basin (NFB) Spreading Ridge

The NFB ridge was partially mapped for the first time during the SEAPSO III cruise of the French R/V *Jean Charcot* (December 1985). Since that time it has been extensively surveyed within the French-Japanese joint project Starmer and mapped with full coverage multibeam over an area more than 800 km long and 100 km wide. This mapping was accompanied by detailed rock and water sampling, and with observations of the oceanic bottom by photo-video deep tows and submersibles. There are four major segments:

1. The southernmost segment is characterised by a complex structure with N05° alternating ridges and depressions up to 2500 m high. This segment appears to be either dying rift or incipient rift. The axial magnetic anomaly suggests an active spreading with a 5 cm/y rate.

2. Between 21°00'S and 18°10'S the north-south segment is offset by about 80 km from the southernmost segment; its morphology is typical of fast-spreading ridges with a 8 km wide, 200-300 m high axial dome. The dome is locally cut at its centre by a 50-500 m wide and 20-50 m deep graben where the active spreading is now located. (A graben is a part of the earth's crust that has slipped down along at least two fault lines, like a rift valley. Ed.)

The axial dome is bounded on both sides by north-south depressions and ridges. The average spreading rate since anomaly 2A (about 3 million years ago) is 7-8 cm/y. A peculiarity of this segment is that it

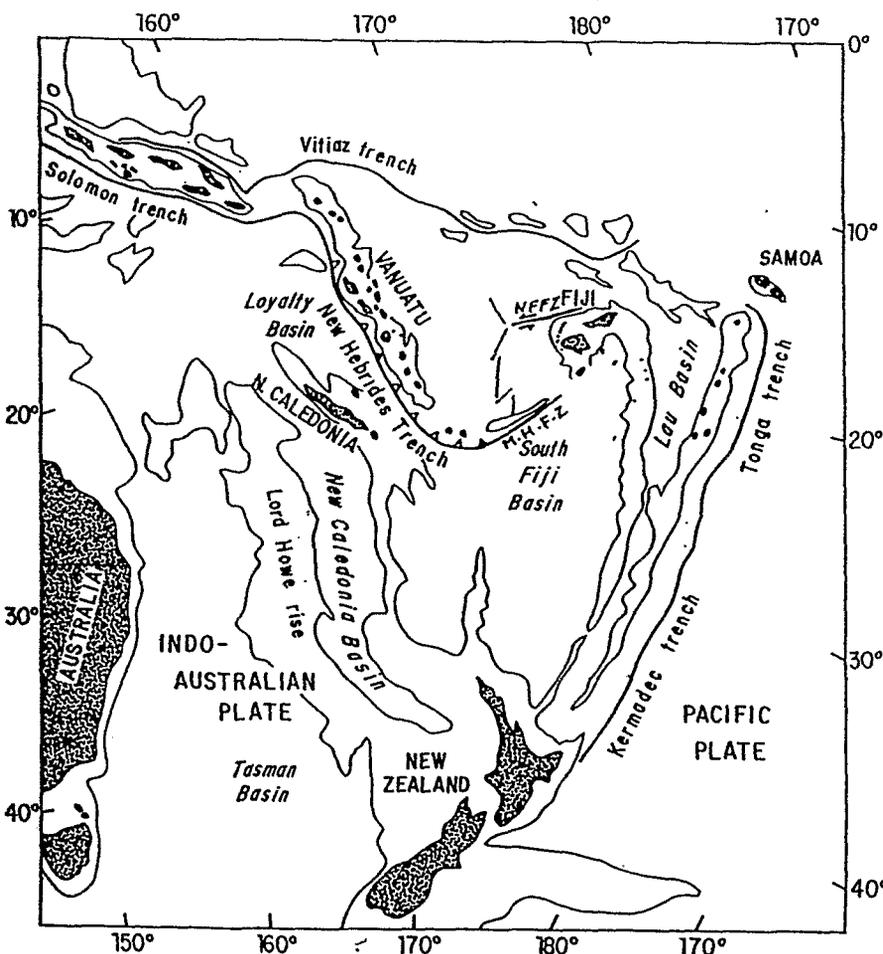


Fig. 1: The North Fiji Basin in the SW Pacific environment

fossil subduction zone to the north and the arc of the Matthew-Hunter zone to the south. (Note that subduction zones are where cold and relatively old material is descending into the earth's mantle to help balance the welling up and spreading at the mid-oceanic ridges of the hot material derived from the mantle. These zones are marked by belts of volcanoes located either along arcs of islands as in Japan or the Philippines, or along a continental rim as in the Andes. Ed.)

secondary effect, the anticlockwise rotation of the Fiji platform. In the first phase the movement had a NW-SE trending spreading axis and N45° to N55° flow lines. The second phase resulted in the beginning of the collision of the New Hebrides Arc with the Loyauté Islands ridge, the change of the traction stresses to an east-west direction and the location of the north-south spreading centre in the central



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Fig. 2: The White Lady hydrothermal chimney.

is propagating to both the south and the north.

3. Between 18°10'S and the 16°50'S Triple Junction, the north-south trend of the spreading ridge changes for a N15° direction. There is a high double ridge in the northern part which culminates at a depth of less than 2500 m, bounding a 1–2 km wide, 100 m deep graben. In the southern part the ridge axis is poorly defined and spotted by numerous isolated small volcanoes.

4. North of the 16°50'S Triple Junction, the spreading ridge is made up of a succession of three grabens 3500–4000 m deep aligned on an N160° direction, typical of slowly spreading ridges; the spreading rate calculated from magnetic field analysis is 5–6 cm/y. The northern tip is marked by a complex structure suggesting the existence of a new triple junction. The magnetic fields have been mapped all along the NFB ridge. The axial anomaly is well defined on the whole axis while the J (Jaramillo) anomaly exists only on the two southern segments. The 2 anomaly is well defined on the central north-south segment and the 2A anomaly has been identified only on the eastern limb of

this segment. The calculated spreading rates vary from 5 cm/y to 8 cm/y.

## Hydrothermal activity on the NFB Ridge

The data acquired by surface ships helped in the selection of diving sites. During the *Nautilie* cruise in June–July 1989 two sites were explored. The first one around 17°S in the axial graben shows important hydrothermal activity characterised by hot (285°C) shimmering waters very poorly loaded with particles. This water is expelled by a 2–3 m high anhydrite chimney dubbed 'The White Lady' (fig. 2). At the foot of the White Lady living colonies of *Bathymodiolus*, gastropods and cirripeds have been observed and sampled.

The second site around 18°50'S shows only low temperature (5–18°C) diffusion colonised by giant mussels, in a narrow active graben characterised by extremely fresh lavas without sulfide deposits. This site has been interpreted as an incipient mag-

matic stage.

The Yokosuka 91 cruise with the Japanese submersible *Shinkai 6500* (fig. 3) aimed to return to the previously explored sites and to explore two new sites at 16°30'S and 18°06'S. These new sites have revealed only active tectonic movement without present-day hydrothermal activity. Since the fourteen *Nautilie* dives in 1989, six *Shinkai 6500* dives have been devoted to the study of the White Lady and of the surrounding active hydrothermal sites.

At present, the White Lady has an anhydrite chimney consisting of a massive 2 m high main conduit with a 2 m diameter and a 1.5 m high secondary chimney. These vents expel the same shimmering water, but the flux is about twice that of 2 years ago. The measured temperature is 265°C, which is 20°C less than the temperature measured in 1989.

Finally, significant changes have been observed in the fauna. The colonies are in all cases more numerous and their territories are expanding towards the top of the mound. These observations confirm that the changes in morphology and in activity of this hydrothermal site are taking place on a human time-scale. The same

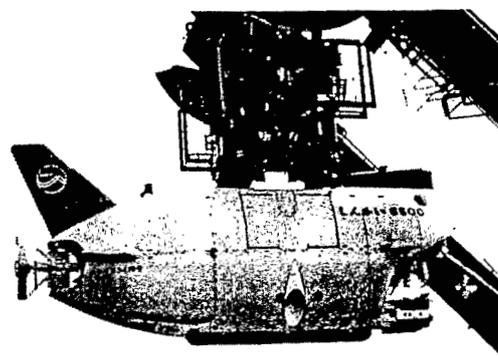


Fig. 3: The Japanese submersible *Shinkai 6500*.

phenomena have been documented on the East Pacific Rise around 13°N, where a 40 cm increase in the height of one chimney was observed within a single month. □

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## Links between the ocean and the atmosphere are studied in the Pacific

International meteorological experiments in the equatorial zone of the Pacific Ocean ended as planned in February, and the long work of analysing the data has now begun. The program, code-named TOGA-COARE (Tropical Atmosphere and Global Program—Coupled Ocean-Atmosphere Response Experiment), employed five oceanographic vessels and seven specially equipped aircraft, which studied a 1500 square kilometre area off Papua New Guinea.

Thanks to advanced measurement technology, new information was gained on ocean currents, temperature, salinity at different depths down to 300 m, the state of the surface, winds and turbulence close to the surface, the heat-flow and evaporation at the surface, the atmospheric structure (wind, temperature, pressure and humidity) up to an altitude of 20 km, and the effects of storms on the atmospheric structure and the surface layer of the ocean.

The ocean in this equatorial zone has the highest surface temperature of any of the world's seas, and hence a greater tendency to storms that may be the causes of medium-term climatic changes, such as 'El Niño'.

Meteorological studies were made using the airborne radar 'Astraia', developed cooperatively by the Centre for Research into Environmental Physics (a joint unit at Issy-les-Moulineaux of the French National Centre for Telecommunication Studies, CNET, and the CNRS) and the US National Centre for Atmospheric Research, NCAR. Astraia was carried in a Lockheed Electra turbo-prop aircraft, and its observations were linked to those of other Doppler radars carried in Orion P3 aircraft operated by the US NOAA and sondes carried by a NASA DC8 and an ER2.

The result was a 3-dimensional picture of the air in the interior of a storm, together with details of the vertical structure of the air and of the fields of precipitation.

Early results show that the big storms seem to be broken into parts of up to 50 km long, moving chaotically among themselves but each with an orderly internal structure and a dynamic organisation. They are characterised by a warm humid rising current at the storm front, fed by unstable air from the lower layers, and a cold current produced at the rear and initiated under the anvil.

## French research ship in New Caledonia

The French research ship *Atalante* arrived in Noumea in June to participate in an underwater mapping program and resource study of the French Economic Exclusivity Zone of New Caledonia (EEZ).

The ship, belonging to the French Research Institute for the Development of the Sea (IFREMER), came to take part in ZoNeCo, a program designed to survey and evaluate the marine zone of New Caledonia.

The program consists of three phases: exploratory work to locate hydrocarbons, data collection and a detailed evaluation of targets identified as potential economic interests.

The first stage of exploration was due to begin at the end of June and aimed to cover an area of 5000 square kilometres to the south of the territory over the course of 20 days.

The *Atalante* is the flagship of IFREMER. Launched in 1990, it is one of the foremost research ships in the world for such exploration, equipped with precision instruments for mapping and data gathering.

ZoNeCo is a part of the national program for underwater development in the EEZ, and has a number of other organisations and three New Caledonian provinces as partners.

## Survey for world-record cable completed

Three French ships—the *Atalante*, the *Suroît* and the *Jean-Charcot*—have just completed survey work for the world's longest optical cable, which is set to link France and Singapore next year. It will service eleven countries along the way, over a distance of some 18,000 kilometres.

After 150 days at sea, the three ships, equipped with multifunctional sounders, completed 700 maps, covering 200,000 square kilometres of the ocean floor. The cable will be able to simultaneously transmit 80,000 telephone calls, and will cost more than four billion FF. □

## Readership survey

Issue No 14 of *French Science and Technology* carried a small card asking for your views on the newsletter and inviting your comments. Many thanks to all those of you who responded.

Out of the three and a half thousand cards distributed, fifteen per cent bore fruit. Just over five hundred completed cards were returned, not a great number but enough to draw some general conclusions and proportionally half as many again as in the previous survey in 1989.

We are currently analysing your replies to ensure that the new-look *FST* that will appear from the next number will reflect your wishes. There will be more emphasis on industrial developments, on science with a bias towards innovation and on interesting activities in the region. We shall give a full report on the survey in that number.

This consultation was obviously productive, and in the same vein we encourage you to write to us at any time with your comments and suggestions. We shall be happy to print *brief letters* (under 250 words, please) of general interest about *FST* or its contents, so that *FST* becomes also a forum for your opinions.

Write to the Editor, *FST*, French Embassy, 6 Perth Avenue, Yarralumla ACT 2600, Australia.