SUALLOW SEISMICITY IN THE NORTH FIJI BASIN

MICHAEL W. HAMBURGER and BRYAN L. ISAACS
Department of Geological Sciences, Cornell University, Ithaca, New York 14853

ABSTRACT

This paper presents a new compilation of shallow seismicity and focal mechanism data that help constrain the model of extension in the North Fiji Basin. Earthquakes are broadly distributed throughout the basin, in marked contrast to the narrow earthquake zones observed near mid-ocean ridge spreading centers. Areas of relatively high activity include the Fiji Fracture Zone, the Hazel Holme Ridge, the western Hunter Fracture Zone, and the proposed spreading center immediately west of Fiji. Areas of deep water in the northern and western North Fiji Basin are notably aseismic and may represent older, presently undeforming portions of the basin. Twenty-three focal mechanism solutions for the basin indicate that the region is dominated by strike-slip deformation. We observe no simple basin-wide system of stress distribution, but consistent stress orientations for groups of mechanisms provide evidence for (1) transcurrent faulting along the Fiji Fracture Zone; (2) hinge faulting of the Indo-Australian Plate near the Hunter Fracture Zone; (3) strike-slip faulting near the Hazel Holme Ridge; (4) strike-slip faulting within the central North Fiji Basin; and (5) normal faulting in the western North Fiji Basin. The orientations of the normal faulting events' tension axes and the strike-slip events' fault planes are at odds with the configuration of the major spreading centers proposed by previous investigators. A model of “diffuse extension” in the North Fiji Basin provides an explanation for the broadly distributed shallow seismicity, the paucity of normal faulting mechanisms, the obliquity of earthquake fault planes to the strike of proposed spreading centers, and the lack of a uniform basin-wide pattern of stress orientation.

INTRODUCTION

The North Fiji Basin is a prominent example of back-arc extension associated with the tectonics of convergent plate boundaries. Among the world's marginal basins, it stands out as one of the only sites where multiple back-arc basin spreading centers have been directly identified. Compared to the world's other marginal basins, the North Fiji Basin is characterized by a significantly high level of shallow seismic activity. This crustal seismic activity presents us with a unique opportunity to observe the processes of active crustal deformation in a tectonically complex area of back-arc extension. This paper reviews the seismological evidence for deformation within this marginal basin, and presents a new, updated compilation of shallow seismicity and focal mechanism data that bear on the existence of and possible sense of motion along the North Fiji Basin's active spreading centers.

We must bear in mind that the North Fiji Basin is by no means a textbook version of the ideal back-arc basin. The basin is located in a strange position, sandwiched between two subduction zones of opposite polarity at the Tonga and New Hebrides Trenches (Figure 1). It is unusual in its geometry: where most back-arc basins form narrow, elongate troughs separating a single active arc from its relict island arc or continental mainland (e.g., Marianas, Lau Basin, Sea of Japan and others), the
North Fiji Basin is a broad, trapezoid-shaped basin, bounded on two sides by inactive trenches and on two sides by island-arc platforms. Furthermore, the North Fiji Basin exhibits profuse internal complexity that reflects the complex tectonic histories of the arcs bounding the basin. Lastly, the North Fiji Basin is unique among the world’s active back-arc basins in the position of its active spreading centers: in contrast to most basins, where the spreading centers are located within 150 km of the active volcanic arcs (Taylor and Karner, 1983), the North Fiji Basin’s spreading centers appear to be distributed up to 800 km from the nearest convergent plate boundary at the New Hebrides Trench.