sedimented areas of the Iwo-Jima ridge. These features are interpreted as en echelon shear fractures formed due to collision between the Iwo-Jima ridge and Japan in the Early-Middle Miocene in response to the overall convergence between the Asian and Philippine Sea plates. A continuing state of N-S compression presently exists in the Izu peninsula and the northern Iwo-Jima ridge as inferred from micro-earthquake studies of Huzita *et al.* Further, geological evidence such as the folding of Early Miocene sediments and later thrusting in the South Fossa Magna area described by Matsuda, and the geomorphological evidence presented by Hoshino for the post-Lower Miocene formation of the Suruga Bay supports the proposal of this collision and continuing state of compression in the northern Iwo-Jima ridge.

With such geological evidence in mind, the observed pattern of magnetic lineations and the different basement morphologic fabrics in the east and west parts of this basin can be best explained if a two-limb system generated the Shikoku basin beginning with an interval of rapid separation (4.2 cm yr^{-1}) from 26 to 22.5 m.y.b.p. Significant deformation of the eastern part of the basin subsequently occurred due to the collision and continuing state of compression existing between the Japanese islands and the Iwo-Jima ridge. Significant "intra-plate" deformation has occurred in the basin contrary to what is observed (or assumed) for ridge flanks in the major ocean basins of the world.

From the correlatability, width and amplitude relations of observed magnetic anomalies, we conclude that the width of the accretion zone in the basin was less than several km, very similar to that inferred for mid-ocean ridges. In other words, the accretionary process which formed the crust of the Shikoku basin appears similar to that operating at mid-ocean ridges of the world.

ARC REVERSALS, AND A TECTONIC MODEL FOR THE NORTH FIJI BASIN

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The North Fiji Basin (or "Plateau") is a morphologically complex marginal basin lying between the New Hebrides arc and Fiji. According to the normally accepted view of basin-island arc polarity, it is a reversed marginal basin. The North Fiji Basin is a part of the Pacific plate which overrides the India plate along the New Hebrides arc. Conversely, the adjacent South Fiji Basin (Packham, this volume) is part of the India (Australia) plate which overrides the Pacific plate along the Tonga-Kermadec arc.

The regional seismicity presented by Chase (1971) reflects this tectonic situation. Epicentres occur beneath both trench-arc systems, and show a west dipping slab beneath the Tonga-Kermadec arc, and an east dipping slab beneath the New Hebrides arc. Other distinct lineations of epicentres occur along the Fiji Fracture Zone (north of Fiji) and the Hunter Fracture Zone (southwest of Fiji). Left lateral first motions have been computed for the Fiji Fracture Zone indicating transform motion between the Pacific and India plates. No earthquake epicentres occur anywhere along the Vityaz Trench — the region of ridge and trough topography along the northern margin of the North Fiji Basin. A few earthquakes occur mid basin. It is suggested that the Vityaz Trench is an old trench-arc system long since active.

Previous tectonic reconstructions of the basin have been instructive, but not definitive. Packham and Falvey (1971) and Karig (1971) recognized the region as a marginal basin in which some kind of seafloor spreading had occurred behind an island arc (Watts and Weissel, this volume). Packham (1973) proposed clockwise rotation of the New Hebrides arc about the northern end of the chain commencing just before the Upper Miocene. Chase (1971) correlated seafloor spreading magnetic anomalies trending north and NNE such as to suggest a number of triple junctions and subplates in a complicated, but stable pattern. His reconstructed outer Melanesian arc was dated as Upper Eocene to Middle Miocene. Luyendyk *et al* (1974) suggested that magnetic anomalies in the western part of the basin trended north but did not attempt a kinematic solution. Colley and Warden (1974) presented petrological evidence from the New Hebrides arc which suggested normal subduction of the Pacific plate pre-Upper Miocene. This would be achieved by reconstruction of the Outer Melanesian arc and subduction along the Vityaz Trench as suggested by previous authors.

The kinematic solution of Chase (1971) seems to be unnecessarily constrained by his choice of the pole describing the Pacific-India plate convergence. Magnetic anomalies did not, in this author's opinion, give strongly convincing correlations with the reversal time scale. The complexity of triple junctions and subplates proposed by Chase is largely due to the fact that the Fiji Fracture Zone is *not* a natural transform of the Le Pichon (1968) Pacific -India pole. I also believe that the density of magnetic data in the basin (that was available to both Chase and this author) is insufficient to provide a conclusive kinematic solution or even unambiguous magnetic trends. I have thus attempted a simpler solution which must be prefaced by an acknowledgement of a great degree of uncertainty.

The probable transform nature of the Fiji Fracture Zone is suggested by the earthquake first motions. A synthetic transform which best fits the epicentres and morphology of this feature has been computed from a proposed Pacific-India pole at 60°S, 157°W. An identical pole position with an angular rate of 1.35 degrees/m.y. may be calculated for the India-Pacific rotation using 0-10 m.yrs. b.p. stage poles: Weissel & Hayes (1972) for India-Antarctica 12°S, 145°W, 0.675°/m.y.; Christoffel (1971) for Pacific-Antarctica 82°S, 120°E, 1.04°/m.yrs. Thus one may infer a velocity vector for the India-Pacific convergence about Fiji of about 11 cm. $yr.^{-1}$ on bearing 075°. It is also interesting to note that this Pacific-India pole (60°S, 157°W, 1.35 degrees /m.y.) results in largely transform motion on the Alpine Fault, in contradiction to Christoffel's inference (this volume). While the Fiji Fracture Zone may be an extensional ("leaky") transform in the case where the Pacific-India pole was located nearer to Falconer's (1974) position (56°S, 176°E), his assumptions in obtaining this pole position are not necessarily preferable to those presented here. Thus, pure Pacific-India transform motion will be assumed for the Fiji Fracture Zone, and the kinematic consequences examined.

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It can be seen from the perspective sketch (Fig. 1) that there is an overlap (in terms of distance from the pole) of subduction zones: northern Tonga Trench overlapping with the southern New Hebrides Trench. Furthermore, neither the Fiji Fracture Zone (transform) nor the Hunter Fracture Zone (transform), on seismicity data, extend from one subduction zone to the other. Thus, on simple kinematic grounds alone (since the Vityaz Trench is considered inactive) a zone of extension or lithosphere accretion *must* occur within this overlap, and between the Fiji and Hunter transforms. The full rate of extension must be equal to one subduction rate (about 11 cms. yr.$^{-1}$), or else that overall subduction rate would be locally doubled within the overlap segment.

To find the spreading centre, the magnetic data of Chase (1971) and of Luyendyk *et al* (1974) were re-examined. Satisfactory magnetic lineations trending slightly west of north were found throughout the basin, which were generally normal to the Fiji Transform. Parallel transforms were interpreted lying to the north; the transforms also do not extend west the the New Hebrides Arc. Fig. 1 shows the pattern of anomalies, which were identified with the reversal time scale anomalies 1 through 4. The present day active spreading ridge lies *only* between the Fiji and Hunter Transforms. The interpreted full spreading rate on the Fiji Basin Ridge gives 9.5 cms. yr.$^{-1}$. A reinterpretation of spreading in the Lau Basin (Sclater *et al.,* 1972) gives 1.5 cms. yr.$^{-1}$; making the correct total of 11 cms. yr^{-1}. Clearly the transform rate between the implied Fiji subplate and the India plate is only 1.5 cms. yr. $^{-1}$ corresponding to almost zero seismicity along the eastern Hunter Transform.

The ages of extinct spreading ridges lying to the north of the Fiji Transform increase across each transform in a northerly direction. Old ridges and transforms are marked by scattered and reduced seismicity. Lithosphere to the west is unfractured, giving rise to a unique, progressive growth offset pattern of lithosphere accretion within a simple two plate system of marginal basin growth. The eastern ends of the extinct growth transforms probably extend to the Vityaz arc-trench feature. Published small amplitude gravity anomalies across the feature, as well as zero seismicity, support the proposal that it is entirely inactive. It is suggested that activity of this feature was progressive along strike corresponding to activity of the adjacent Fiji Basin ridge segment and transform. This would have the effect of making the en echelon Vityaz Trench segments originally colinear.

Using the magnetic lineations, interpreted as isochrons, 3, 6 and 9 m.y.b.p. reconstructions of the New Hebrides Arc, Fiji, the Lau Ridge and Tonga Arc may be achieved (Fig. 2). The closing of other smaller basins is either inferred or indicated from DSDP data. A simple, north-east to east facing curved arc is inferred prior to 9 m.y. At this time the normal subduction of the Pacific Plate was interrupted by the arrival of firstly the Ontong-Java Plateau, and later the Border Plateau, causing arc reversal and marginal basin growth within the overlap segment. This growth was attenuated firstly in the north as parts of the Vityaz Trench

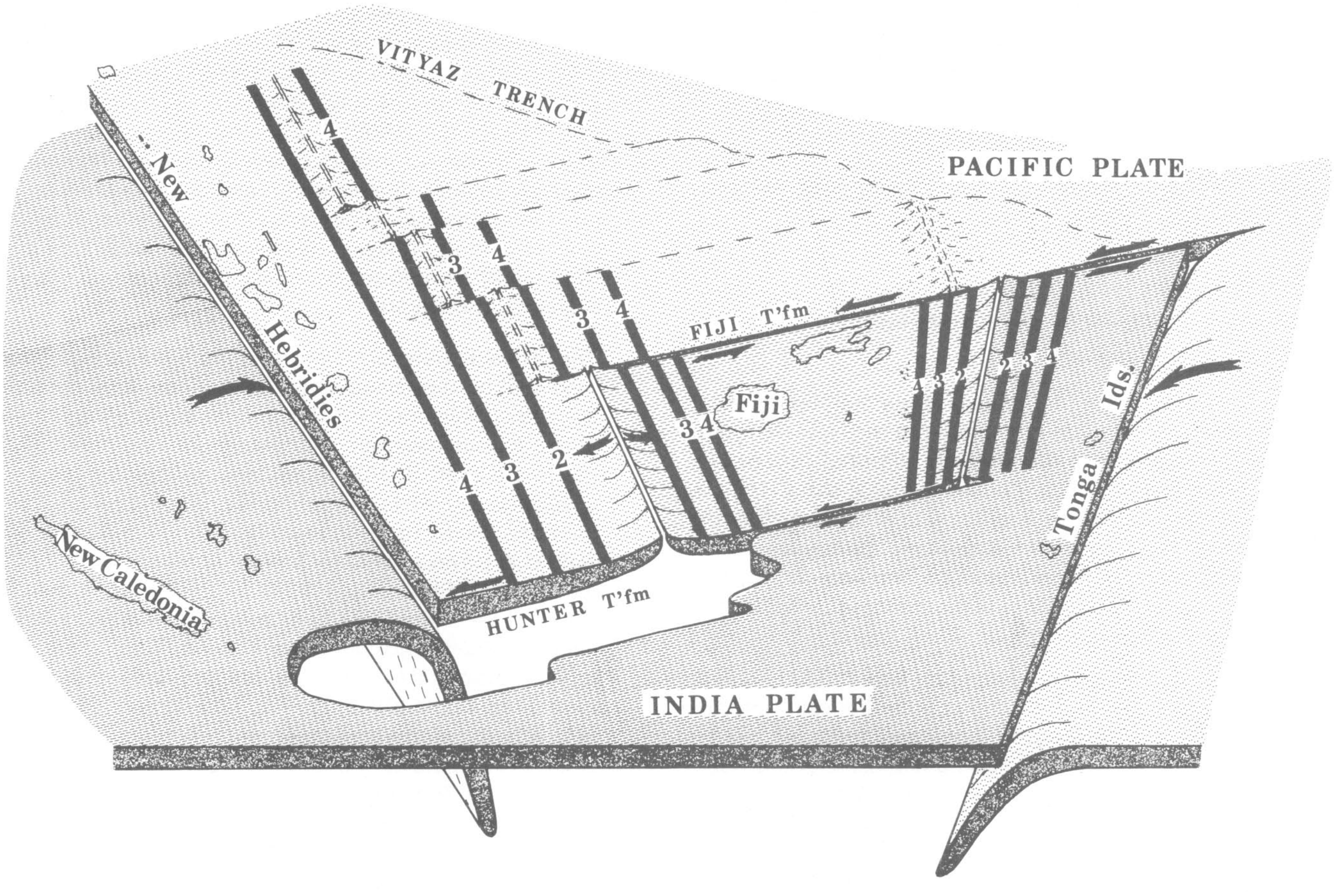
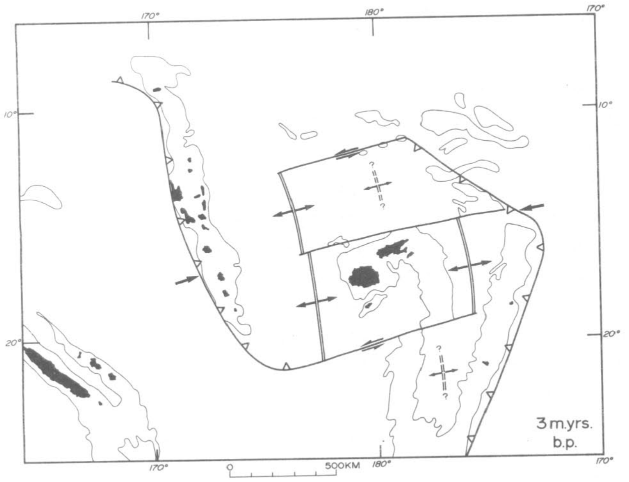
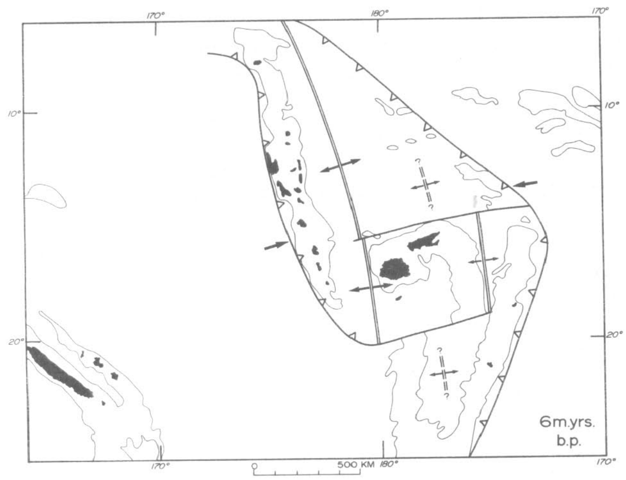


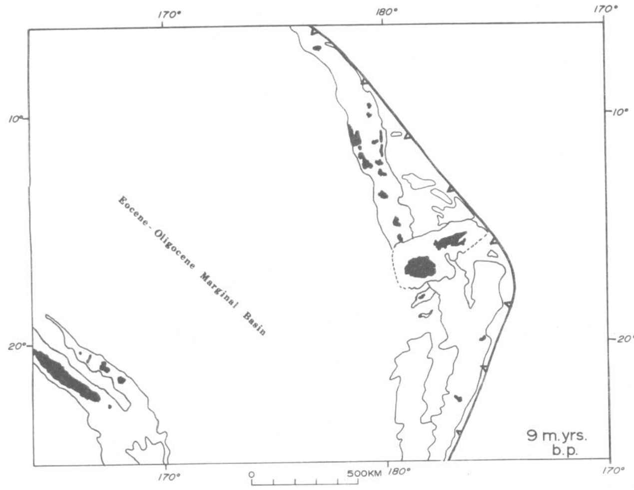
Figure 1: Perspective diagram of the North Fiji Basin region showing subduction zones (underthrusting of oceanic lithosphere), transforms, and active and extinct spreading centres. Seafloor spreading magnetic anomalies are numbered 2, 3, 4 according to the traditional scheme, and were reinterpreted by the author from the raw data of Chase (1971), Sclater et al. (1972) and Luyendyk et al. (1974).



(a) **North Fiji Basin 3 m.y. before present. Spreading and subduction are active in the next segment to the north of the Fiji Transform.**



(b) **Up until 6 m.y. b.p. spreading was active in most of the basin and subduction continued along the Vityaz Trench. Between 6 and 3 m.y.b.p. progressive cessation of activity commenced in the north.**



(c) **Before 9 m.y.b.p., the Solomons-New Hebrides-Fiji-Tonga-Kermadec arc faced the Pacific plate.**

became inactive. A progressive growth offset pattern of lithosphere accretion resulted.

Given the preceding model, the North Fiji Basin is a case of a marginal basin which formed in response *only* to arc reversal and overlap of reverse facing subduction zones. An effective two plate system is retained, since the zone of extension if part of the continuous plate boundary. This model may have implications concerning the development of other marginal basins following continent-arc collision.

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FIGURE 2