Papers

Part 4

Plate Boundary Evolution in the Solomons Region

THE SOLOMONS AS A NON–ARC

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The Solomon Islands have been described as a fractured island arc (Coleman, 1970) and, more recently, as an arc which has undergone polarity reversal (Karig and Mammerickx 1972) probably within the last 10 m.y.. Both situations are envisaged as in keeping with the current widely accepted model of arc development as a consequence of the subduction process (Karig, 1974; Coleman, 1975). This in turn implies that during the Palaeogene the bulk of the Solomons was built as a result of subduction, south-dipping, bordering the northeastern flank. The evidence for such subduction is indirect and ambiguous, especially if the relationship of the Solomons to the Ontong Java Plateau (crust about 40 km) is considered (for localities and relevant illustrations *see* Hackman, 1973). Supporting features include a belt of high heat flow to the south of and parallel to the Solomons (Halunen and von Herzen, 1974); the suggestion of hanging, remnant slabs of lithosphere, an inference derived from the pattern of hypocentres south-east of Bougainville (Denham, this volume); a set of troughs (up to 6000 m) on the north-east flank, interpreted as a possible old trench; and the supposed obduction of the Ontong Java Plateau over the Solomon block (Kroenke, 1972). Against the notion of a NE-facing arc are the pattern and distribution of rock types and the apparent absence of discernible morphologic arc elements, on land or submarine. The presence of basal hi-T amphibolites and amphibolite schists on the northeastern side but of lower grade metamorphics on the other side does not support a north-east polarity, nor does the comparative dearth of calc alkaline rocks. The supposed old trench is actually on the Ontong Java Plateau. It might just as well be the expression of a fracture zone. As regards another supposed arc feature, the partial double chain character of the group is more apparent than real and does not in itself prove the existence of an inter-arc basin: the double chain can be explained as the effect of Neogene displacement of a single chain (Bougainville–Choiseul–Santa Isabel–Gaudalcanal–San Cristobal). The gravity picture, in which the higher positive values tend to lie along the southwestern side, is ambiguous. If it could be proved that the outer Pacific edge (e.g. Malaita, Ulawa) was a tectonic flake from the Ontong Java Plateau then this would be compelling evidence that the Plateau had indeed chcked off an active subduction zone. But the evidence in support of this can also be used to support the idea of a left-lateral shearing collision between the Plateau and the Solomon chain. That this outer Pacific edge is indeed an uplifted part of the Ontong Java Plateau is accepted. Finally, there is no evidence of a tholeiite-calcalkaline-high K progression. The case for viewing the Solomons as a NE-facing arc during the Palaeogene is not proven.

This being so, it is premature to talk of a later polarity reversal. The presence of the Bougainville Trench and of a defined Benioff zone, steeply dipping to the north-east and of contemporary andesitic volcanism show that subduction is indeed proceeding below Bougainville. This subduction zone is usually linked with another, northerly dipping, which extends from Guadalcanal past San Cristobal to Santa Cruz. The San Cristobal Trench is supposedly its surface expression and the many records of both shallow and intermediate hypocentres (Denham, 1969) are offered as evidence of its action; the hypocentres do not define a Benioff zone. It is strange, however, that there are no volcanic by-products of this supposed subduction and also that the breater bulk of Late Tertiary-Holocene volcanics (islands of the New Georgia Group, with several active volcanoes) lies between the accepted western subduction zone and the queried eastern one. The difficulty is not explained altogether satisfactorily by postulating that the deeper earthquakes originate from hanging slabs and that subduction to the north was initiated only within the last few million years. If this were so, the pattern of hypocentres to depth should show marked discontinuities in the shallow region, but apparently it does not; there seems to be a fairly even clustering at least to 100 km depth.

Within the present model of arc development, the Solomons has anomalous features that go beyond acceptable limits of individual variation. These anomalies provoke the outrageous notion that the Solomons arose within the Pacific plate as a volcanic chain along a strongly linear oceanic fracture zone. The igneous basement was built up during the Late Cretaceous (?) — Early Tertiary and became subaerial in large part in Late Oligocene — Early Miocene. The basement rocks on the older islands are of roughly the same age which would imply that the parent fracture tapped crust and mantle materials at one and the same time along its entire length: the Line Islands offer a parallel (Jackson *et al*., 1974). Because of the chronic lack of data on both oceanic chains and great fracture zones it is not possible to test this notion against actual examples. Some if not most of the primary rock types of the Solomons have been dredged as samples from fracture zones and the gross topography of the chain, even to its *en echelon* arrangement, can be paralleled, for example, in that of the Romanche Fracture Zone (Tomczak and Annutsch, 1970). That such abyssal fractures could tap magmas simultaneously along their length is perhaps a strange idea, but again we have the Line Islands example.

To pursue this notion, the Solomons, unlike such possible analogues as the Line Islands and the Marshall-Gilbert chain, were directly affected by the change in direction of relative motion of the Pacific plate (recent estimates, 42-48 m.y.b.p.), and by the complications which arose from additions to the India plate in the region, beginning in the Eocene, and the consequent northerly movement of the Australasian continental mass relative to Antarctica. From being possibly in line with the New Hebrides (*see* Falvey, this volume) the Solomons, it is suggested, were partly rotated anticlockwise and disrupted. This calls for some subduction to the south in the Palaeogene, possibly along the Inner Melanesian line. As new seafloor was created in the Southern Ocean and Coral Sea basin a shearing collision arose between westwards-moving Pacific plate and northwards-moving India plate. In the Solomons region, accommodation was partly met by Neogene subduction marked by the New Britain trench (and, just possibly, by the younger San Cristobal trench) and partly by shattering of lithosphere into chunks (sub-plates) with overall strong, sinistral transcurrent movement between them. The Solomons became partly locked into the India plate and underwent a shearing collision with the Ontong Java Plateau roughly 10 m.y.b.p.. Along with New Ireland and the northern part of the Bismarck Sea and the Ontong Java Plateau, the Solomons are now moving as part of the Pacific plate.

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CRUSTAL VARIATIONS IN THE SOLOMON–PAPUA–NEW GUINEA REGION BASED ON SEISMIC INVESTIGATIONS

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Explosion seismic investigations provide the definition required to enable the variations in gross crustal structure over quite small areas to be outlined. Typifying the crustal structure in any particular area may however be misleading. A number of seismic surveys have now been conducted which outline the variations in crustal structure between the Barkley Tablelands of northern Australia and the Ontong Java Plateau of the western Pacific. These surveys involved a number of different shooting/recording configurations; land shooting and recording, marine shooting/land recording and marine shooting and recording.

The upper mantle is usually taken to begin where the P wave velocity approaches 8 km/s but over the region this is shown to vary between 7.7 and 8.6 km/s and occur at depths ranging from less than 5 km to 43 km. Some crustal thicknesses in "continental" Australia (27 km) appear to be much thinner than those on the Ontong Java Plateau (43 km) with considerable variation throughout the region in between. The parameters controlling the stability or otherwise of a region would therefore appear not to be those of the crust but those of the deeper mantle.

OPHIOLITE BASEMENT COMPLEX IN A FRACTURED, ISLAND CHAIN, SANTA ISABEL, BRITISH SOLOMON ISLANDS

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Introduction

As part of a continuing programme involving the structural, petrological, and geochemical evolution of the British Solomon Islands, attention has now centred, among other islands, on Santa Isabel, where a well developed basement ophiolite sequence is exposed. Further work in the area will involve the geochemical relationships between the various members of the ophiolite basement. The Solomons lies within Suess's outer 1st Australian Arc, now regarded as the margin between the India and Pacific lithospheric plates (Le Pichon, 1968) and have been termed a composite, fractured island chain (Coleman and Hackman, 1974). The Group comprises a double en échelon chain of islands, which is believed to reflect a system of basins and anticlinal horsts now progressively offset by sinistral shear (Carey, 1968: Krause, 1967; Hackman, 1973). Five Provinces were originally recognised in the region (Coleman, 1965) and these were subsequently amended to four (Hackman, 1973).

Santa Isabel is some 230km in length and up to 25 km wide, and rises to over 1200 km at Mt Marescott and together with Choiseul and Malaita comprise the outer en échelon chain of the Solomons. Initial geological publications on the island