Yuat North Batholith display very high Ba contents (of the order of 1000 p.p.m.) and are shoshonitic in their affinities. The different calc-alkaline suites can also be distinguished with varying degrees of clarity on plots of Nb, (La+Ce+Y), and Sr against K_2O.

Fig. 3 emphasises the regional increase in K_2O across the Mobile Belt. From Harker-type variations diagrams of K_2O versus SiO_2 (cf. Fig. 2), K_2O has been determined at the 65% SiO_2 level for the different calc-alkaline suites, and has been plotted against distance along the line AB in Fig. 1. At the 65% SiO_2 level, K_2O increases from 1% in the south to 3.3% in the north.

The geochemical data presented above could have important **palaeotectonic implications.** The development of the New Guinea Mobile Belt can be envisaged in either of two contrasting tectonic settings. Either it developed as a continental margin feature, or it developed as an island arc complex somewhat removed from the Australian continental margin. Dow (1973) has supported the former idea. The data presented here, however, would appear to support the latter proposition. If interpreted in terms of plate tectonics theory, the geochemical polarity northwards across the intrusive rocks of the Mobile Belt implies development of the Belt as an island arc complex above a north-dipping Benioff Zone, necessarily removed from the continental margin. This tectonic regime would have ceased in Oligocene-early Miocene times consequent upon the collision of this arc complex with the Australian continental block. Intervening oceanic (or marginal basin) crust not involved in subduction processes could have been emplaced as Alpine-type ultrmafic bodies (April Ultramafics of Dow *et al.*), or metamorphosed to fault-bounded blocks of glaucophane schist and eclogite (Gufug Gneiss) that occur in this region.

The present expression of the proposed Benioff Zone on the southern margin of the New Guinea Mobile Belt is considered to be the Lagaip Fault Zone. It is a well-defined structural break between the Mobile Belt and the continental shelf-type sediments to the south. It is also the southerly limit of Alpine-type ultramafic bodies, high-pressure metamorphic rocks, and Miocene intrusive complexes.

Regional mapping in the Western Highlands (B.M.R., 1972) has defined the more complex nature of the Lagaip Fault Zone toward the east where the edge of the Australian continental block bends southward. It is suggested that the proposed Benioff Zone differed in this region, as there are no Alpine-type ultramafic bodies or high-pressure metamorphic rocks, and the Miocene volcanic rocks are geochemically different from those in the western part of the New Guinea Mobile Belt (cf. Mackenzie, this volume).

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HIGH-POTASH ISLAND ARC VOLCANICS OF THE FINISTERRE AND ADELBERT RANGES AND THEIR TECTONIC SIGNIFICANCE

A.L. Jaques

Geological Survey of Papua New Guinea

The Finisterre and Adelbert Ranges consist of Cainozoic sedimentary and volcanic rocks which are exposed as a series of north-tilted fault blocks with northwesterly trend. The sequence consists of basal Eocene argillite conformably overlain by Oligocene to early Miocene volcanics (Finisterre Volcanics) which are unconformably overlain by Neogene clastic sediments and limestone. The province is distinct from the adjacent Central Highlands where upper Mesozoic to earliest Tertiary metamorphics are capped by Tertiary limestone and are overthrust by ophiolite slabs. The two provinces are separated by the Ramu-Markham Fault Zone, a major sinistral transcurrent fault.

A high proportion of the Finisterre Volcanics are volcaniclastic (autoclastic, pyroclastic, hydroclastic and epiclastic) and the overall sequence is lithologically similar to that found in island arc assemblages. The lavas are dominantly basalt and low silica andesite (48-56% SiO_2) and are highly porphyritic in clinopyroxene, plagioclase and olivine, and to a lesser extent in hornblende and pleochroic orthopyroxene. They are potash-rich, with K_2O content ranging from 1.5-6.5%, and have low TiO_2 content typical of lavas from circum-oceanic areas. Two main groups can be recognized: one shoshonitic (absarokite, shoshonite, rare leucite trachyte) which is the more abundant, and the other, high-K, high-Al basalt (with some high-K, low-Si andesite).

The Finisterre Volcanics are chemically similar to high-K lavas described from island arcs elsewhere in the southwest Pacific and in the Mediterranean. However, unlike many other island arcs there is no evidence of a three stage evolution from arc tholeiite to shoshonite.

It is envisaged that the volcanic sequence formed as an island arc on the oceanic crust of the Pacific plate north of a north-dipping subduction zone as a result of early Tertiary plate interaction. Consumption of intervening lithosphere led to a continent-island arc collision. The island arc is now being welded onto the continental margin and present day plate interaction is concentrated north of the Finisterre and Adelbert Ranges.

PLATE MODEL FOR LATE CAINOZOIC VOLCANISM AT THE SOUTHERN MARGIN OF THE BISMARCK SEA, PAPUA NEW GUINEA

R.W. Johnson

Bureau of Mineral Resources, Canberra, A.C.T.

Two Late Cainozoic volcanic arcs can be recognised at the southern margin of the Bismarck Sea, Papua New Guinea. Both arcs provide striking examples of the geodynamic complexity to be expected in regions characterised by small plates whose instantaneous poles of rotation are nearby (cf. Krause, 1973).

A western arc is associated with the boundary between the South Bismarck and Indo-Australian plates. The rocks are mainly tholeiitic basalts and andesites, but rare dacites are also present, rhyolites appear to be atsent. The chemical compositions of the rocks change along the arc — i.e., in a direction parallel to the strike of a postulated subducted lithospheric slab. These changes can be explained by identifying Late Cainozoic poles of rotation in the northwestern part of mainland Papua New Guinea, and by postulating eastwardly increasing rates of plate convergence.

An eastern volcanic arc is associated with the boundary between the South Bismarck and Solomon Sea plates. The rocks are mainly andesites, but also include tholeiitic basalts and dacites; rhyolites are present, but rare. The volcanoes are arranged in an unusual zig-zag pattern, and the compositions of the volcanic rocks change with increasing depths to the northward dipping New Britain Benioff zone — i.e., in a direction at right angles to the strike of the Benioff zone, and to the axis of the New Britain submarine trench. The existence of a thrust slice in the northwestern corner of the Solomon Sea is postulated to account for the distribution pattern of the eastern-arc volcanoes.

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LINEATIONS IN THE BISMARCK SEA

L.A. Tilbury
Bureau of Mineral Resources, Canberra, A.C.T.

The Bismarck Sea is a complex tectonic region lying in a zone of interaction between the Pacific and Australian Plates. Several small crustal plates have been outlined in the region. Although the Bismarck Sea has a crustal thickness of about 20 km it appears to be oceanic in origin.

Data from some 10 000 n.mi. of traversing in the Bismarck Sea has thrown some light on the understanding of the structure and evolution of the area. Oceanic basement occupies the northern two thirds of the Bismarck Sea region while the southern third appears to be primarily of andesitic composition. Minor northeast magnetic trends underlie major east-west trends associated with volcanic ridges. These minor trends appear to have arisen from sea floor spreading. Preliminary interpretation indicates the anomalies are possibly of Oligocene age.

A simple but speculative evolution consistent with most of the facts can be put forward.
a) The Bismarck Sea region formed during the **Oligocene** on the southern limb of a spreading ridge. The ridge is now possibly situated between Manus Island and the PNG margin.

Until this time the Northern New Guinea Arc, New Britain Arc and the West Melanesian Arc formed a continuous island arc to the south.

b) About **early Miocene** the Northern New Guinea Arc collided with the Australian plate. Subduction ceased along the island arc and a shear zone was formed along the southern boundary of the West Melanesian Arc to release stress.

c) Between the **early Miocene to early Pliocene** the West Melanesian Arc moved 1000 km northwest along shear zone (rate about 7 cm/yr). Shearing could explain the absence of volcanism during this period, the formation of tensional features in the eastern Bismarck Sea, and the 'arc type' volcanics of Oligocene/Miocene age on the northeast of the West Melanesian Arc.

d) Post Pliocene saw the readjustment of plate boundaries and resumption of subduction under New Britain. The left-lateral Bismarck Sea fault was formed to accommodate movement originally along the West Melanesian Arc. A zone of andesitic volcanism from eastern New Britain to the Schouten Islands formed by subduction of the Australian plate to the north and northeast.

HELWIG-HALL CONCEPTS OF OROGENIC MODE AND UNDERTHRUSTING MODE

Emile Rod
9 Minns Road, Gordon, N.S.W.

A few years ago, the fact that thick piles of undeformed sediments occur in some trenches, caused several geologists to doubt the reality of subduction. However, in 1971, Oxburgh and Turcotte published the results of a study on the origin of paired metamorphic belts and concluded that in a convergent plate boundary periods of active subduction must episodically alternate with periods of cessation of movements along the subduction zone.

Several geologists in Australia (Packham, 1973: Packham and Leitch, 1974; Leitch, 1974; Rod, 1974) reached the same conclusion during their investigations of the origin of the Tasman orogenic belt and of the emplacement of ultramafic rocks. Convincing evidence was produced that during such brief periods when the leading edge of the continental crust was strongly compressed and deformed, there was also a very substantial uplift.

Helwig and Hall (1974) analysed the structural phenomena caused by plate convergence along a plate boundary and proposed a model whereby the plate convergence at a subduction zone operates in two distinct but not exclusive modes.

Firstly, in the orogenic mode, the continental edge is coupled to the oceanic lithosphere. The trench contains undeformed sediments and most of the plate convergence is expressed by thrusting along the imbricate wedges and other intense deformation in the upper (continental) plate, up to 200 km from the trench axis.

Secondly, when the continental edge is uncoupled from the oceanic lithosphere, most of the plate convergence is accomodated by movements along the Benioff zone. This is the underthrusting mode which produces more or less continuous accretion of trench sediments.

As stressed by Helwig and Hall, all transitions between the two modes can be envisaged. Thus the paradox of continuous plate motion and episodic orogeny finds an elegant explanation.

When applied to an analysis of the evolution of the old orogenic belts in the Southwest Pacific area, the concept of bimodal behaviour of subduction zones proposed by Helwig and Hall is of great importance. Combined with a study of the structural deformations accompanying the Chilean and