the generation of high-potassium magmas under apparently oceanic crust in SE Papua does not fit some current ideas of island arc evolution.

Upper Tertiary and Quaternary volcanism in southeast Papua has been dominated by andesitic, calc-alkaline volcanism. The earliest record of this is found at the western end of the Louisiade Archipelago where the eroded remnants of a volcano have been dated at 11 my (Smith, 1973a). Andesitic volcanoes occur on the islands to the west and on the mainland where several centers have erupted within the last 100 years. Although age data are sparse (Smith, 1973b) calc-alkaline volcanism appears to have migrated westward from the Louisiade Archipelago in the late Miocene, through the intervening islands, to the active Quaternary volcanoes on the mainland. It is suggested, that the calc-alkaline volcanics represent migrating volcanism along an arc which has subsequently become fragmented by Quaternay rifting linked with opening of the Woodlark basin. Although other explanations are possible the presence of such an arc is indicative of an episode of limited subduction along the northeast coast of Papua and in the offshore islands, during the late Cenozoic. The polarity of this arc can only be guessed at but the presence of a poorly developed trough along the margin of the Solomon Sea basin north of eastern Papua suggests a southerly dip.

The most recent volcanism in the area has been eruption of peralkaline rhyolites in the eastern D'Entrecasteaux Islands. This type of volcanism forms no part of any island arc association, rather it is characteristic of the early stages of rift development. Peralkaline volcanism in the D'Entrecasteaux Islands was an anomaly in the circum-Pacific context until it was suggested (Milsom, 1970) that the Woodlark Basin which lies to the east is probably an actively rifting basin.

Because southeastern Papua straddles a circum-Pacific plate boundary the geology of the area has, in the past been interpreted in terms of island arc type tectonism and volcanism (eg Karig, 1972). In fact, of the four magma types represented in area only one, the Plocene to Quaternary andesitic volcanism, is of an island arc type. Southeastern Papua cannot be interpreted in terms of simplistic models of island arc development, the area is a complex plate boundary along which both compressional (obduction, subduction) and extensional (rifting, basin formation) episodes have occured several times during the Cenozoic. The sequence of volcanic rock types occuring on circum-Pacific plate boundaries is clearly not always the simple process of events we are sometimes led to believe.

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SUBDIVISION AND GEOCHEMISTRY OF TERTIARY INTRUSIVE COMPLEXES FROM PART OF THE NEW GUINEA MOBILE BELT

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Within the New Guinea Mobile Belt (Dow *et al.*,1968), orogeny reached a climax in mid-Miocene times with emplacement of calc-alkaline intrusive complexes and eruption of effusive equivalents (Page, 1971). The intrusive rocks have been collectively termed the 'Maramuni Diorite' (Dow *et al.*, 1967,1968).

In this paper, intrusions of the 'Maramuni Diorite' in the Western Highlands-South Sepik districts (see Fig. 1) are subdivided on the basis of geographic location, areal extent, and geochemical differences into the following masses:

a) The **Karawari Batholith,** which is fault-bounded on its northern and southern margins, is greater than 350 km^2 in area, and is composed principally of hornblende-clinopyroxene-quartz diorite and hornblende (-biotite) tonalite.

b) The **Lamant and Wale Stocks,** which comprise mafic cumulates, low-Si diorites, and hornblende grandiorites.

c) The **Yuat South Batholith,** which underlies more than 400 km^2, and is composed principally of hornblende granodiorite in the western part and hornblende-biotite granodiorite in the eastern part.

d) The **Yuat North Batholith,** which is greater than 375 km^2 in area, and is composed principally of hornblende-biotite-orthoclase-quartz diorite and biotite microadamellite.

Regional variations in mineralogy and chemistry within these dominantly calc-alkaline rock types are apparent. From south to north, a decrease in modal abundance of clinopyroxene and quartz is counterbalanced by an increase in alkali feldspar and biotite. Mineralogical changes are reflected in a **regional geochemical polarity** that is especially apparent in whole-rock variations of the large alkali and alkaline earth irons, the REE group, and niobium. Fig. 2 shows variation of K_2O and Ba with SiO_2. The rate of increase of K_2O with increasing SiO_2 increases from the Karawari Batholith trend (low- to intermediate-K suite), through the Yuat South Batholith trend ('normal' calc-alkaline trend), to the Yuat North Batholith trend (high-K calc-alkaline suite). A similar variation is observed in the plot of Ba against SiO_2. Generally, BA increases with increasing SiO_2, but for any given SiO_2 content, Ba increases from the lower-K suites through to the high-K suite. Two specimens from a marginal stock of the

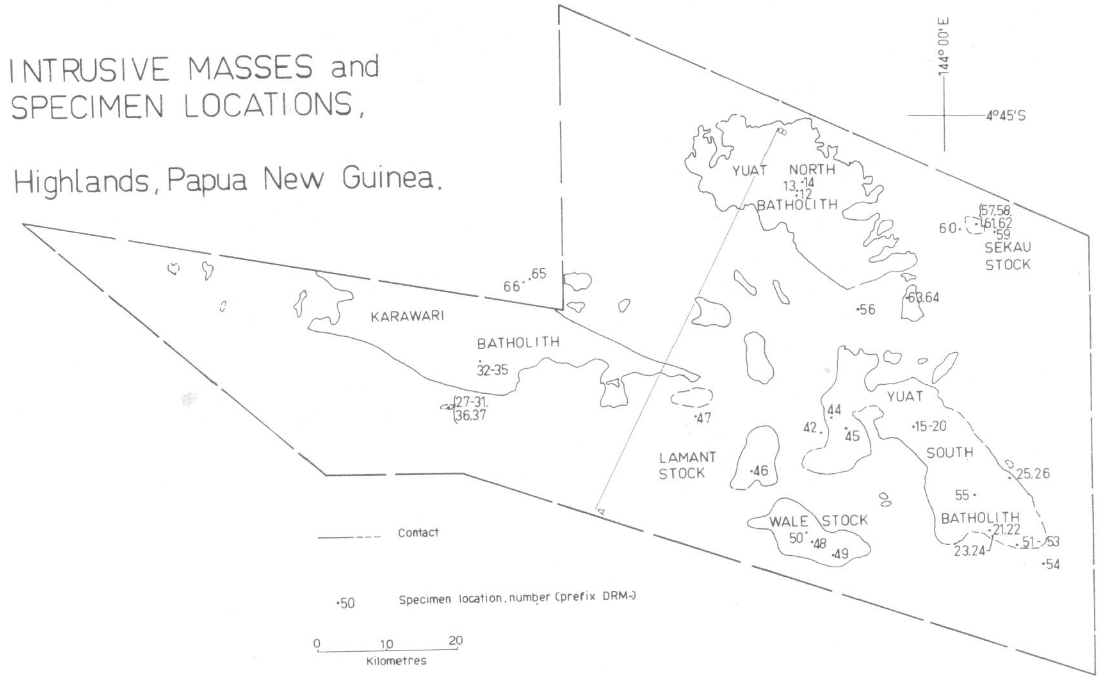

Figure 1
Nomenclature for intrusive masses, Western Highlands-South Sepik districts, Papua New Guinea.

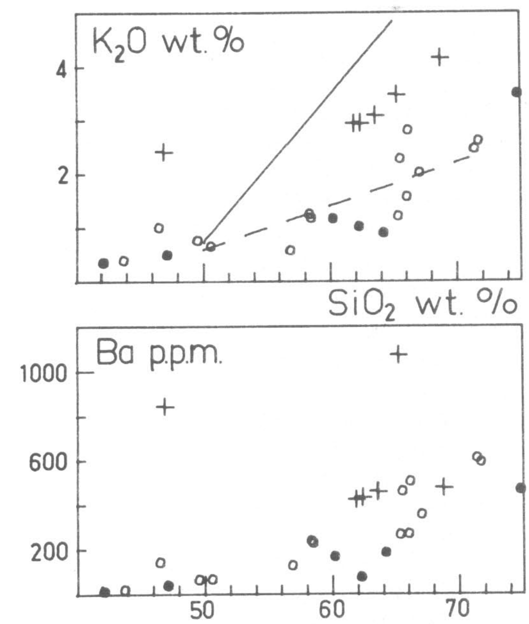

Figure 2
Variation diagrams for K_2O and Ba against SiO_2. Filled circles, Karawari Batholith; open circles, Yuat South Batholith; crosses, Yuat North Batholith. For comparison, regression lines have been drawn, in the plot of K_2O against SiO_2, for the Gazelle Peninsula (New Britain) plutonic suites of Macnab (1970) (full line, South and Central Bainings Mountains high-K calc-alkaline suite; dashed line, North Bainings Mountain 'normal' calc-alkaline suite).

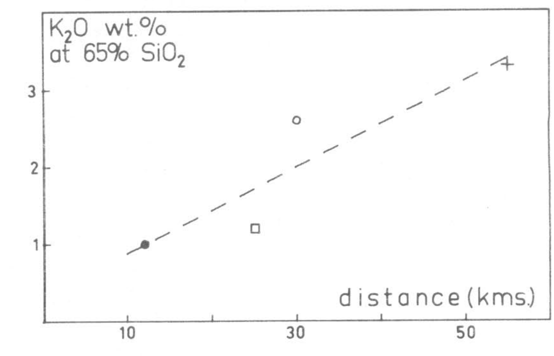

Figure 3
K_2O (at 65% SiO_2) against distance along AB in Fig. 1. Full circle, Karawari Batholith; open square, Yuat South Batholith (western region); open circle, Yuat South Batholith (eastern region); cross, Yuat North Batholith.

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

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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

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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