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Intrusive Rocks of New Britain

by

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SUMMARY

Small to medium-sized stocks and small dykes of tonalite, gabbro, diorite, and rare granodiorite and adamellite of Oligocene age have intruded the Eocene Baining Volcanics in many areas of New Britain. Stocks up to 50 km^2 in area occur in the Torlu-Uasilau, Sai River-Iso River, Lemkong River, Wala River, and Kulu River areas. Smaller intrusions occur in the Ip, Lula, Lae, and Johanna Rivers (Fig. 1). Tonalite is the dominant rock type in the larger intrusions, and gabbro forms the bulk of the smaller stocks. The intrusives are generally rich in quartz, hornblende, and augite, but poor in biotite and potash feldspar. Almost all the pyroxene forms spongy, ragged cores in hornblende, and exhibits exsolution lamellae. Copper sulphides occur sparsely in the Sai River, Uasilau, Torlu River, Wala River, Lae River, and Kulu River areas.

INTRODUCTION

Reconnaissance geological mapping of New Britain, south of 5° latitude, was completed during January-May and September-November, 1969. This report deals with the detailed geology and petrology of the Oligocene and younger intrusive rocks. Johnson (1970 a & b; 1971), Johnson et al. (1970), and Johnson et al. (1971) reported on the Quaternary volcanoes of the north coast and Cape Gloucester. A general geological report, including details of field operations, access, geography, and previous work is in preparation (Ryburn et al.).

OUTLINE OF GEOLOGY (FIG. 1)

Eocene (Tb stage - Binnekamp, 1971) basic and intermediate volcanic and minor derived sedimentary rocks (Baining Volcanics) and Oligocene intrusive rocks make up the 'basement' of the island. This basement is overlain unconformably by patchily distributed volcanic and sedimentary rocks (Merai Volcanics) of upper Oligocene (lower Te stage) age (Binnekamp), and by extensive thick beds of Miocene coralline limestone (Jacquinot Limestone). The Jacquinot Limestone is thickest and most extensive in the east Nakanai and Kol Mountains, and on the southern side of the Whiteman Range. In places, near the coast, the limestone is overlain by late Tertiary clastic sedimentary rocks, probably of beach or fluviatile origin. Two large, deeply dissected andesitic volcanoes, Mounts Schrader and Andewa, dominate the western end of the island; they are probably of Pliocene age. Gently folded beds of sandstone, conglomerate, and siltstone flank these volcanoes to the east and south, and overlie Jacquinot Limestone. A large area between Hoskins and Montagu Harbour is blanketed by Pliocene or Pleistocene rhyolitic tuff (Ania Tuff) which in places overlies a basal conglomerate. A wedge of coarse, immature sediments (Ip Formation) was deposited in Pleistocene time north of the scarp of the Wide Bay fault, from which the sediments were derived. Raised Quaternary coral benches fringe most of the south coast of the island, and these are fringed in turn by Recent coral, and pebbly and sandy beaches. The north coast and Cape Gloucester are dominated by Quaternary to Recent volcanoes which have produced basaltic to rhyolitic lavas.

GENERAL DESCRIPTION

Coarse-grained, porphyritic, and fine-grained intrusive rocks occur throughout New Britain, intruding upper Eocene Baining Volcanics. The largest bodies are in the Sai, Lemkong, and Iso Rivers* southwest of Wide Bay, the Torlu and Evili-Ala River areas (151°E, 5°40'S), the Wala River (150°40'E, 5°50'S), and the Kulu-Daluavu River area (150°E, 5°45'S). Smaller plutonic bodies are located in the Ip, Lula, Metelen, and Johanna Rivers. Minor intrusive bodies (dykes and sills) occur widely in the Baining Volcanics.

* Information recently received from BHP (Fig. 1) shows that the Sai and Iso intrusives are part of a single, larger pluton, that the Lemkong Diorite is smaller than shown on Fig. 1, and that there are several other small intrusive bodies in the Kol Mountains.

Because of poor outcrop, mapping of the intrusive bodies is difficult. Some contacts are accurately located in stream sections, where exposure is best, but generally the presence and extent of intrusive rocks have been inferred from stream float and airphotograph interpretation. Because the intrusive bodies commonly do not have marked topographic expression, airphotograph interpretation is not always possible.

The larger intrusions appear to be single discrete bodies with sharp contacts against the surrounding Baining Volcanics. Hornfels zones are mostly narrow, but there are some exceptions such as in the Torlu River near Au'una, where the zone is at least 300-400 m wide. Outcrop is generally confined to areas where streams have cut deeply into the country rocks, and it is probable that only the highest parts of the intrusive bodies are exposed. The Uasilau and Torlu Tonalites, and possibly the Kulu intrusives, are more deeply exposed, and are more deeply weathered than the other intrusive bodies. The smaller bodies tend to be more basic and the larger bodies intermediate with small, peripheral, probably older basic intrusions.

Preliminary isotopic age data indicate an Oligocene age for specimens from the Uasilau Tonalite and Sai intrusives (R.W. Page, pers. comm., 1971). This is in agreement with the stratigraphic evidence: Tb stage (upper Eocene) ages have been obtained from the host Baining Volcanics, and middle Miocene ages from the Jacquinot Limestone which unconformably overlies the Uasilau Tonalite. In the Sai, Iso, and Torlu River areas, Jacquinot Limestone, and in the Iso River area, Te stage limestone and volcanics, crop out close to coarse-grained intrusive rocks. These beds probably extended unconformably over the intrusives, but have since been eroded away. Most of the intrusions may be subvolcanic, or otherwise related to the Te stage (upper Oligocene) volcanics. Hypabyssal intrusions in the Toki River area are probably upper Miocene or Pliocene.

In the Pandi River area (151°30'E, 5°05'S), the Jacquinot Limestone is intruded by the Toki Andesite, which is a high-level porphyritic andesite or microdiorite petrographically distinct from the plutonic rocks and the nearby Recent volcanic rocks of Mount Ulawun. The Toki Andesite is probably late Miocene or Pliocene.

The dominant rock type is biotite-hornblende tonalite. Hypersthene-augite (or 2-pyroxene) gabbro, and hornblende-2 pyroxene gabbro, both commonly with subophitic texture, and diorite are less common. Granodiorite is uncommon, and adamellite is rare; aplite was collected at two localities. Dolerite, (micro-) gabbro, andesite, and basalt are common as dykes and sills cutting the Baining Volcanics or the associated larger intrusive bodies. The intrusive rocks share the following general characteristics:

1. Potash feldspar is rare or absent in all areas except the Johanna River. Biotite is commonly present, but only in small amounts. Thus the rocks are largely low in potash.

2. Most of the intermediate rocks and some of the basic rocks contain quartz.

3. Pyroxene is almost invariably mantled and corroded by hornblende, and commonly has a subophitic relationship with plagioclase (Fig. 2).

4. Orthopyroxene commonly contains fine lamellae of exsolved clinopyroxene, and may have been formed by inversion of pigeonite. Pigeonite has survived in one specimen (52NG1009 - p. 9).

5. Quartz and potash feldspar usually form micrographic intergrowths (Fig. 3).

6. Recrystallization of ferromagnesians (particularly hornblende) to fibrous or coarsely crystalline actinolite is very common; partial to complete chloritization of biotite is almost ubiquitous.

Potash-rich rocks of the type described by Macnab (1970) from the Central and South Baining Mountains of the Gazelle Peninsula are rare, except as boulders and small outcrops in the Johanna River. The bulk of the intrusive rocks described below are strikingly similar to those which Macnab described from the North Baining Mountains, even to the style of alteration. Many of Macnab's conclusions on the origin of the North Baining intrusives probably apply to the rocks described here. The intrusive rocks of the North Baining Mountains are considered by Macnab to have originated at a depth of about 125 km in the upper mantle, from a southerly dipping Benioff zone. They differentiated at a shallow level before being emplaced. The higher-potash intrusive rocks of the Central and Southern Baining Mountains originated from farther down the Benioff zone.

The rock classification used here is that of Johannsen (1931), and differs from that of Macnab (1970) in that modal quartz in excess of 10% characterizes tonalite and granodiorite, as distinct from gabbro/diorite and mangerite. Some of the rocks named tonalite in Table 1 would be classified as diorite in Macnab's scheme.

DETAILED GEOLOGY AND PETROGRAPHY (Table 1).

1. Larger Intrusive Bodies

Sai intrusives

The 30 km^2 intrusion in the south branch of the Sai River (151°44'E, 5°05'S) is a complex of plutonic rocks that range in composition from granodiorite to gabbro. Gabbro, granodiorite and dolerite also occur in the nearby southeast branch of the Sai River. These rocks have intruded basic volcanic rudites (mainly agglomerate) of the Baining Volcanics.

The northern part of the intrusive mass in the southern branch consists of tonalite, and minor diorite and granodiorite. The southern and larger part of the complex appears to be entirely coarse-grained gabbro and associated dolerite and basalt dykes. The contact between the tonalite-diorite and gabbro bodies is sharp, but the extremely poor outcrop provided no other information on internal features of the complex. Basic dykes are common in the upper headwaters of this branch of the Sai River.

Fifteen specimens from the Sai River intrusives were examined in thin section. The tonalite is coarse-grained, and consists of calcic andesine, quartz, green-brown hornblende with corroded augite cores, biotite, and minor magnetite. Some specimens contain up to 5% interstitial orthoclase. Apatite is in trace amounts, and there is minor alteration of biotite to chlorite, and of hornblende to fibrous actinolite. The diorite is similar to the tonalite except that it contains 5% or less quartz. The granodiorite (54NG0047) is a sheared, leucocratic rock containing andesine, quartz, orthoclase, minor hornblende with relict augite cores, and a little biotite and magnetite. The gabbro in the southern part of the complex consists of labradorite or bytownite, hornblende (which mantles and corrodes pyroxene), augite, and magnetite. One specimen has a subophitic texture, and contains 5% hypersthene; the pyroxenes are heavily altered to actinolite, mica, serpentine, and prehnite. Specimens from the southeast branch of the Sai are a hypersthene-augite dolerite which contains pseudomorphs after olivine, hornblende-2 pyroxene gabbro with a trace of biotite, and an altered leucocratic hornblende granodiorite. The pyroxene of the gabbro is mantled and corroded by hornblende (Fig. 2).

Pyrite and traces of chalcopyrite occur in some specimens of tonalite from the northern part of the intrusive complex in the south branch of the Sai River.

Iso intrusives

A composite mass of tonalite and gabbro in the headwaters of the Iso River (151°43'E, 5°10'S), where the country rocks are volcanic rudite and lava of the Baining Volcanics. Specimens collected from the area include biotite-hornblende tonalite, hornblende tonalite, and altered pyroxene gabbro with a subophitic texture. Plagioclase in the gabbro is partly altered to sericite and prehnite; the pyroxene is partly replaced by actinolite and chlorite. Some or most of the altered pyroxene may have been orthopyroxene.

Lemkong Diorite

A body of diorite and minor adamellite and gabbro crops out in the upper reaches of the Lemkong River (151°52'E, 5°10'S); it intrudes basic volcanic rudite and lava of the Baining Volcanics. The northern part of the intrusion is close to the Wide Bay Fault, and is strongly sheared and fractured. Intrusive relationships in this area are complex: numerous apophyses and dykes of diorite penetrate hornfelsed basic volcanic rocks.

Specimens (Table 1) include four of hornblende diorite, one of augite-hornblende adamellite, and one of augite gabbro. Biotite occurs in two of the diorite specimens (54NG1061A & B), and augite occurs as corroded cores in hornblende in the other two (54NG1061B and 1063A). Micrographic intergrowths of quartz and orthoclase occur interstitially in 54NG1063A. The adamellite consists of calcic andesine, augite mantled and corroded by hornblende and actinolite, and intersertal patches of micrographic quartz and orthoclase.

Uasilau Tonalite

Uasilau Tonalite is the name proposed for a pluton consisting of tonalite and minor diorite, dolerite dykes, and peripheral andesite, which crops out in the Evili, Ala, and Gavuvu Rivers south of Bangula Bay. The name is derived from the large village of Uasilau (150°55'E, 5°35'S) on the banks of the Evili River. Plutonic rocks occupy most of the catchment areas of the Ala and Evili Rivers, and extend into the middle Gavuvu and upper Torlu Rivers. They intrude andesitic and basaltic agglomerate, lava, tuff, and derived sediments of the Baining Volcanics. Mackenzie (1967a) noted that many of the intrusive-country rock contacts are straight, and concluded that they are probably faulted. This conclusion was verified by our mapping, which revealed the presence of faults on two sides of the complex, and within it. Shearing is common in the marginal parts of the intrusion.

The Uasilau area, particularly the headwaters of the Evili River, was the target for detailed geochemical prospecting of Conzinc Riotinto of Australia (Mackenzie, 1967a; Gibbs, 1968a). Mapping by this company outlined a complex zone of granodiorite, andesite (possibly at least partly Baining Volcanics), microdiorite, gabbro, and altered pyritic rhyolites in the Evili River area, along the northeast side of the intrusive mass.

Of fifteen specimens of Uasilau Tonalite examined in thin section, twelve are tonalite; the others are diorite, dolerite, and basalt. The tonalite is coarse-grained and leucocratic, and consists mainly of andesine, quartz, and brownish-green hornblende. Biotite occurs in nine of the tonalite specimens, and is altered in various degrees to chlorite, epidote, and brookite (leucoxene). Ragged, corroded augite mantled by hornblende occurs in three of the biotite-bearing tonalite specimens, and in the diorite. One of the tonalite samples (54NG1099) has been metamorphosed to an assemblage of albite, quartz, epidote, chlorite, actinolite, sericite, magnetite, sphene, and leucoxene. This specimen was collected from a sheared and highly jointed outcrop near the confluence of the Ala and Evili Rivers. The basalt is a fine-grained porphyritic rock made up of labradorite, augite, pseudomorphs of chlorite and sericite after olivine, a little quartz and magnetite, and patches of secondary calcite.

Torlu Tonalite

The Torlu Tonalite, which derives its name from the Torlu River (151°05'E, 5°44'S) in the western Nakanai Mountains, is similar in most respects to the Uasilau Tonalite. It crops out in the middle and upper reaches of the Torlu River, and in the Ua River, and intrudes volcanic rudite (agglomerate), tuff, andesitic and basaltic lavas, volcanolithic sediments, and volcanic breccia of the upper Eocene Baining volcanics. In the Torlu River, the Baining volcanics have been hornfelsed over a zone several hundred metres wide, and the river has cut a deep, steep-sided gorge in the hornfels, which is harder than the surrounding rocks. The Tonalite is deeply weathered, and outcrop is scarce; contacts with the Baining Volcanics were not seen.

The bulk of the Torlu Tonalite is biotite-hornblende tonalite, which is associated with minor amounts of gabbro and diorite. Pyrite is common along joint surfaces in all rock types, and in places is accompanied by a trace of chalcopyrite. Small amounts of chalcocite, malachite, and azurite were detected in stream pebbles. Sulphide mineralization appears to be associated with hydrothermal alteration and recrystallization which have produced quartz-plagioclase mosaics, and chlorite and epidote (after ferromagnesian minerals).

Sixteen specimens of Torlu Tonalite were examined in thin section. Of these, eight are of biotite-hornblende tonalite (one contains 2-3% corroded augite in hornblende), three are of hornblende tonalite, one is a biotite tonalite, three are of pyroxene-bearing gabbro, and one is a biotite-hornblende-2 pyroxene diorite. Biotite is present in eight tonalite specimens, and is partly chloritized or recrystallized in most of these. Up to 2% interstitial orthoclase is present in four of the specimens of biotite-bearing tonalite. Relict, corroded augite grains mantled by hornblende are present in 51NG0512. The gabbro is medium-grained, moderately melanocratic, and altered to various degrees. It consists of labradorite or bytownite (up to An_{80}), augite (mantled and corroded by hornblende in two specimens), magnetite, and accessory apatite and sphene. One of the gabbro specimens contains 3% hypersthene (mantled by hornblende) and 1-2% interstitial quartz. Specimen 51NG2513, from a dyke in the headwaters of the Torlu River, is an altered garnet-pyroxene gabbro in which large, ragged and corroded pale brown-pink garnet grains mantled by augite are set in a mass of calcic plagioclase, tremolite-actinolite, epidote and calcite after pyroxene, and small augite crystals. The altered pyroxene may originally have been hypersthene. The single diorite sample (51NG1034B) is fine to medium-grained, and consists of andesine, quartz, augite, hornblende (which has partly replaced augite, and is largely replaced by actinolite), and partly chloritized biotite. Opaque grains (magnetite?) and accessory apatite and zircon make up about 2-3% of the rock.

Wala Gabbro

Wala Gabbro is the name proposed for a group of gabbro and diorite intrusions that crop out near the middle reaches of the Wala River (150°41'E, 5°53'S), a tributary of the Ania River. The form and extent of the intrusive bodies is incompletely known, because outcrop is scarce, and the area is partly covered by late Tertiary rhyolitic ash (Ania Tuff). The intrusions are probably small and grouped closely together. They intrude basalt, tuff, and volcanolithic sediments of the Baining Volcanics. Hornfelsed basalt is common in stream float, but was not recognized in outcrop because of deep weathering.

The Wala Gabbro is dominantly gabbro, with lesser diorite, and minor tonalite and porphyritic andesite. The rocks are mostly coarse to medium-grained and closely jointed (5 to 20 cm). Pyrite is abundant in some localities, and some is accompanied by rare chalcopyrite. The gabbro commonly has a subophitic texture, and consists of labradorite or sodic bytownite (65-75%), brown-green hornblende, which has mantled and corroded augite and hypersthene grains, magnetite, and accessory sphene and/or apatite. Three specimens of gabbro contain 1% to 7% quartz; three others contain about 1% altered olivine. There are various degrees of alteration of ferromagnesian minerals to actinolite and chlorite. The diorite is fine to medium-grained, has a subidiomorphic granular texture, and contains calcic andesine (65-75%), brownish-green hornblende (7-20%), magnetite (1-2%), and accessory sphene and/or apatite. Interstitial quartz (1-10%) is present in three specimens; one of these (51NG138B) contains small amounts of augite and hypersthene which are mantled and corroded by hornblende; another (51NG2000) contains 2-3% augite as relict cores in hornblende. Secondary actinolite and chlorite are present in various amounts, replacing hornblende, pyroxene, and in one specimen (1938B), biotite. A hornblende andesite and an olivine-2 pyroxene andesite collected in the Wala River area, and considered to be fine-grained, porphyritic equivalents of the diorites are listed in Table 1 (51NG0575A, 2559B). Specimen 51NG1040F is leucocratic biotite-hornblende tonalite (10-12% quartz) which contains 1-2% relict augite enclosed in partly recrystallized hornblende.

Kulu intrusives

A large area of inadequately mapped plutonic and associated volcanic rocks is exposed in the headwaters and middle reaches of the Kulu and Daluavu Rivers, south of the Willaumez Peninsula. In the course of investigating stream-sediment copper anomalies in the area, Conzinc Riotinto of Australia outlined three main plutonic bodies (Mackenzie, 1967b; Gibbs, 1968b): an area of 'granite' to the south in the Whiteman Range, and area of 'granodiorite' and 'granite' to the north, and, farther south, small, irregular intrusions of 'diorite' and 'gabbro' and some areas of 'rhyolite' and 'andesite'. Sulphide minerals are present in all but the 'granites'. Stream sediment anomalies led to the location of two areas of high soil copper values (up to 13,000 ppm). These areas were drilled to depths of 300 m, but no economic concentrations of minerals were intersected.

Specimens collected from the Kulu Intrusives during our survey include porphyritic hornblende-augite andesite or microdiorite, altered hornblende-biotite dacite, altered hornblende andesite, and biotite-hornblende tonalite. The identification of granite and granodiorite by Conzinc Riotinto is largely based on hand specimen and drill cutting examination. It is likely that most of the sulphide-free rocks are leucocratic tonalites.

2. Smaller Intrusive Bodies

Small stocks and associated dykes of tonalite, diorite, gabbro, and granodiorite occur in the following areas.

Ip River (151 50'E, 5 05'S)

Specimens of hornblende tonalite, altered hornblende-augite gabbro with a subophitic texture, and hornblende diorite (with 5-7% poikilitic orthoclase) were collected from float in the lower reaches of the Ip River. Similar float was noted in the upper reaches of the Ip River and one of its tributaries, where presumably the intrusive rocks crop out.

Lula River (150 31'E, 6 10'S)

Extensive outcrops of gabbro, tonalite, and minor diorite occur in and near the Lula River, on the central south coast of New Britain. The name Lula Gabbro is proposed for these rocks, which intrude tuff, lava, and volcanic breccia of the Baining Volcanics. Outcrop width is at least 5 km along the river.

Of eleven specimens of Lula Gabbro examined in thin section, six were identified as gabbro, four as tonalite, and one as diorite. The gabbro is medium to coarse-grained, and consists of labradorite (60-70%), hornblende (2-20%), quartz (1-20%), and relict clinopyroxene (except in 52NG0508, which contains 5% pyrite) and orthopyroxene (except 0508 and 0510) mantled by hornblende. Two of the 2-pyroxene gabbro specimens also contain small amounts of biotite. The tonalite consists of andesine and or labradorite, quartz (15-35%), green hornblende (3-12%), and biotite (1-2%). One specimen of tonalite contains 2-3% clinopyroxene and orthopyroxene; another, a fine-grained variety, contains 3% augite. The diorite consists of andesine, hornblende with ragged cores of augite, interstitial quartz, and a trace of biotite. Magnetite (1-3%) and accessory apatite occur in all samples from the Lula Gabbro; sphene and zircon are less common accessories. Chlorite, epidote, and actinolite are common secondary minerals, replacing hornblende, biotite and in one specimen, augite.

Lae branch, Metelen River (150°25'E, 5°52'S)

A specimen of biotite-quartz-hornblende mangerite was collected from the Lae River, but the extent and composition of the intrusive body are poorly known. The boundary on Figure 1 is based largely on airphotograph interpretation.

Johanna River (150°03'E, 5°57'S)

Large dykes and small stocks of plutonic rocks intrude massive volcanic rudite and breccia, tuff, and lava of the Baining Volcanics in the headwaters of the Johanna River, in the Whiteman Range. Hornfelsing has been extensive, and float of plutonic rocks is abundant in the streams, but the extent and form of the intrusive bodies are poorly known. Specimens collected from the Johanna River include hornblende granodiorite, quartz-2 pyroxene gabbro, and quartz-augite-hornblende diorite. All are altered in various degrees to actinolite, chlorite, epidote, and calcite. The granodiorite contains large patches of micrographically intergrown quartz and orthoclase (Fig. 3), and some specimens are markedly porphyritic. One (51NG2569) contains acicular crystals of hornblende up to 3 cm long; another contains plagioclase phenocrysts up to 1.5 cm long.

3. <u>Minor intrusive bodies</u>

Small dykes and sills of basic to intermediate rocks intrude the Baining Volcanics in many areas of New Britain (Table 1). The majority of these intrusions are dykes of pyroxene dolerite, microgabbro, and gabbro; less common are tonalite, baslat, andesite, and diorite.

Aplite occurs in the Matlip River (Wide Bay), granodiorite with micrographic texture in the Awio River, dacite in the Mucas River, and a biotite-quartz-hornblende mangerite in the Iglik River. A microgabbro (52NG1009) from the Amgen River contains small, partly altered grains of pigeonite (near-uniaxial), some of which has partly reverted to subcalcic augite and hypersthene, and fresh, colourless, low-2V augite. Electron microprobe analyses of pigeonite and augite grains in this specimen by R.N. England show (Fig. 4) that they are close to the pyroxene trends of Brown (1968), and to the coexisting pyroxene pairs from Skaergaard (Brown, 1957), and Stillwater (Hess, 1960).

Approximate molecular formulae for the two pyroxenes (6 determinations) are:

pigeonite

$$Na_{0.011}\ K_{0.001}\ Ca_{0.218}\ Fe^{2+}_{0.637}\ Mg_{1.093}\ Ti_{0.009}\ Al_{0.049}\ Si_{1.978}\ O_6$$

$$Na_{0.005}\ K_{0.001}\ Ca_{0.231}\ Fe^{2+}_{0.575}\ Mg_{1.171}\ Ti_{0.008}\ Al_{0.049}\ Si_{1.966}\ O_6$$

$$Na_{0.008}\ K_{0.002}\ Ca_{0.124}\ Fe_{0.563}\ Mg_{1.259}\ Ti_{0.007}\ Al_{0.049}\ Si_{1.980}\ O_6$$

augite

$$Na_{0.022}\ K_{0.001}\ Ca_{0.736}\ Fe_{0.419}\ Mg_{0.815}\ Ti_{0.015}\ Al_{0.123}\ Si_{1.903}\ O_6$$

$$Na_{0.022}\ K_{0.001}\ Ca_{0.759}\ Fe_{0.405}\ Mg_{0.822}\ Ti_{0.024}\ Al_{0.113}\ Si_{1.892}\ O_6$$

$$Na_{0.020}\ K_{0.001}\ Ca_{0.748}\ Fe_{0.395}\ Mg_{0.825}\ Ti_{0.018}\ Al_{0.121}\ Si_{1.901}\ O_6$$

The augite analyses show a slight excess of cations over oxygen when compared to the ideal pyroxene. This is probably because silica values are low, and Fe^{3+}, which probably occurs in significant quantities in the augite but not in the pigeonite, was not determined. The occurrence of pigeonite in a medium-grained dyke rock indicates tholeiitic chemical tendencies, crystallization at temperatures of 1020°C or higher (Brown, 1968), and rapid chilling after crystallization.

4. Younger Intrusives

Toki Andesite

Toki Andesite is the name proposed for stocks of porphyritic andesite and microdiorite which form small (½ km) rounded hills near the Toki River, south of Open Bay (151°31'E, 5°05'S). The andesite intrudes lower Tf stage Jacquinot Limestone, and was thought to be related to the Quaternary to Recent volcano, Mount Ulawun. However, unlike any specimens from Mount Ulawun, the Toki Andesite contains hornblende, and is slightly to moderately altered. On the grounds of intrusive relationships and state of preservation, the andesite is considered to be late Miocene or Pliocene.

Specimens from the Toki Andesite are strongly porphyritic hornblende andesites which contain strongly zoned andesine, and green hornblende phenocrysts. In 54NG0517 and 0519, the hornblende has corroded augite cores, and in 54NG0539 and 0540 it is accompanied by pale green mica, and muscovite, respectively. The groundmass is a fine-grained mosaic of plagioclase, small hornblende crystals, and magnetite, with a trace of quartz in one specimen. Secondary leucoxene (fine-grained anatase or brookite) is abundant in all but 54NG0517.

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TABLE 1. ESTIMATED MODES OF SAMPLES OF INTRUSIVE ROCKS, NEW BRITAIN

1. LARGER INTRUSIVE BODIES

Intrusion/Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz %	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques %	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Sai River (151°46'E, 5°05'S) 54NG0041A	Augite-biotite-hornblende tonalite	70	An_{80-37}		10	5-7	5		5	2(mt)*	Apatite	trace			Calcite	trace	Augite forms corroded cores in hornblende
0041B	Augite-quartz-hornblende-biotite diorite	75-80	An_{47-48}	<1	5	5	2		8	1(mt)	"	tr.			Chlorite	tr.	Augite forms corroded cores in hornblende and biotite.
0042	Biotite-quartz-hornblende diorite	80	An_{42}		5	10	tr.		3	1(mt)	"	tr.					Biotite intergrown with hornblende. Relict augite cores in hornblende.
0043	Biotite-hornblende-tonalite	63	An_{35}	5	15	10	tr.		5	1-2(mt)	"	tr.			Chlorite	tr.	" " " " "
0044	Biotite-hornblende tonalite	65-70	An_{35}	1	15	10	tr.		3	1-2(mt, py)+	"	tr.			Actinolite	1-2	" " " " "
0045	Biotite-hornblende tonalite	55	An_{47}	1	20	10	tr.		5-6	2(mt, py)	"	tr.			Chlorite	tr.	" " " " "
0047	Augite-biotite-hornblende granodiorite	50-55		20	20	3	1		2	1	"	tr.			Actinolite	tr.	Sheared.
0048	Augite-hornblende gabbro	75-80	An_{67}			10	7			3(mt?)	"	tr.			Actinolite	tr.	Corroded augite cores in hornblende.
0049	Hornblende-augite gabbro	63	An_{77}			3	15	5		3(mt?)					Actinolite, mica. Serpentine, prehnite		Subophitic texture.
2548A	(Biotite-)quartz-hornblende gabbro/diorite	80	An_{51}		2-3	15	tr.		1	1-2(mt)	Sphene	tr.			Chlorite Epidote		Corroded augite grains in hornblende Biotite altered to chlorite, epidote, etc.
2548B	Biotite-hornblende tonalite	65	An_{51}		20	10			3-5	1(mt)					Chlorite } Epidote }	after biotite (tr)	Subophitic texture. Biotite partly chloritized.
SE Branch: 2603	Olivine(?)-2 pyroxene dolerite	45-50					15-20	10-15	5	3(mt)	Apatite	tr.			Actinolite Chlorite Muscovite Biotite	5 5 2 2-3	Olivine(?) pseudomorphosed by chlorite, biotite, and muscovite; pyroxene partly altered to actinolite.
SE Branch: 2606	(Biotite-)hornblende -2 pyroxene gabbro	70	An_{57-58}			5	5	7-10	tr.	3(mt) tr(py)					Actinolite Chlorite	3 1	Pyroxene mantled by hornblende.
SE Branch: 2610A	Altered leucocratic hornblende granodiorite	50	An_{45}	7-8	30	2				2(mt)	Sphene	tr.			Chlorite Actinolite Epidote Calcite	5 1 1 tr.	Quartz and orthoclase in recrystallized mosaic pattern
SE Branch: 2610B	(Biotite-)hornblende-2 pyroxene gabbro	70			1	7-8	10-12	5-7	1	1(mt)							Hornblende mantles and corrodes pyroxene.

*mt - magnetite.
+py - pyrite.

1. LARGER INTRUSIVE BODIES (Cont.)

Intrusion/Locality/Sample number	Rock type	Plagioclase		Ortho-clase	Qtz	Hbl.	Aug.	Hyper-sthene	Biotite	Opaques	Accessories		Other primary minerals		Secondary minerals		Remarks
		%	Comp.	%	%	%	%	%	%	%	Mineral	%	Mineral	%	Mineral	%	
Iso River (151°43'E, 5°10'S) 54NG0019	Biotite-hornblende tonalite	70	An_{40}		20	5			2	tr(mt)	Sphene Apatite	trace tr.			Chlorite	trace	Hornblende → biotite + chlorite
0021	Biotite-hornblende	75	An_{50}		15	5			2	tr(mt)	Zircon	trace			Chlorite Anatase Actinolite	trace tr. tr.	Biotite recrystallized and partly replaced by chlorite, anatase/sphene.
1517A	Altered pyroxene gabbro	75			tr.		15		1	3(mt)					Act.3, Ser.1,	Chl.2 Pr.tr	Subophitic texture; px altered to act.chl., plag. to ser., prehnite
2515A	Biotite-hornblende tonalite	60+	An_{52}	2	25	7-8			5	2(mt)	Zircon	trace			Epidote	trace	
2515B	Hornblende tonalite	55+	An_{52}	2	15-20	10				3(mt)	Zircon Apatite	trace tr.			Chl.5, Leuc. <1	Ep.1, Calc. trace	
2515C	Altered augite gabbro	75			tr.		15		1	3(mt)					Act.3, Ser.1,	Chl.2	Subophitic texture; px altered to act.chl., plag. to ser., prehnite
Lemkong Diorite (151°52'E, 5°10'S)																	
54NG1061A	(Biotite-)hornblende diorite	70				15-20			5	2(mt)							Veinlets of quartz and albite, Altered, partly recrystallized.
1061B	Biotite-augite-hornblende diorite	65				15	5		2	2(mt)							Much more altered, fractured and recrystallized than A.
1063A	Quartz-augite-hornblende diorite	60		5	5	20	7			2(mt)							Qtz and Or. graphically intergrown; Aug. partly mantled by hornblende.
1063B	Augite-hornblende adamellite (granophyre)	30	An_{40}	29	30	5	5			1(mt)	Apatite	trace					Qtz and Or. graphically intergrown; augite corroded cores in hbl.; hbl. largely recrystallized to act.(?)
1063C	Augite gabbro	55	An_{65}				20			5(mt)	Apatite	trace			Actinolite Leucoxene Epidote	15 1 1-2	Partly uralitized.
1063D	Quartz-hornblende diorite with quartz-hornblende andesite/dolerite inclusion.																

Intrusion/Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz %	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques %	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Uasilau Tonalite (150°55'E, 5°35'S)																	
51NG0053F	(Biotite-)hornblende tonalite	60	An_{37}	2	30	4			(2)	1(mt)					Chlorite Actinolite	2 1	Biotite replaced by chlorite Hornblende partly replaced by act.
1052	Hornblende micro-tonalite	25-30	Albite		25	3				1(mt)	Sphene	trace			Ep.15 Act.5 Leuc.	Chl.5 Ser. 1-2 trace	Metamorphosed
1053	Altered hornblende dolerite	70-75	Andesine		5					2(mt)					Act.15 Ep.tr. Ser.tr.	Chl.1 Leu.1	Altered or metamorphosed.
1053A	Biotite-hornblende tonalite	45	An_{40}	2	40	7	tr.			1(mt)	Sphene Apatite Zircon	trace tr. tr.			Chlorite Brookite Epidote	2 trace tr.	Biotite pseudomorphed by chlorite + brookite + epidote.
1053B	Biotite-hornblende tonalite	65			20	10			1	1(mt)	Sphene Apatite	trace tr.			Chlorite Brookite Epidote	2 tr. tr.	Biotite largely pseudomorphed by chlorite. cf. A.
1053C	Quartz-hornblende diorite	75			10	5	2			1(mt)	Apatite	1			Actinolite	3	Corroded augite cores in hornblende. Hornblende partly repl.by actinolite
1053D	Leucocratic hornblende tonalite	75-80	Andesine	1	15-20										Chl.3 Cl.2 <1	Calc.1 Sph.tr.	After hornblende.
1054	(Biotite?-)hornblende tonalite	65	An_{35+}		12	15	tr.			1(mt)	Sphene Apatite	tr. tr.			Chlorite	2-3	Biotite pseudomorphed by chlorite. Augite cores in hornblende.
1055	(Biotite?-) hornblende tonalite	70	Andesine	2-3	15	7-8				1(mt)	Sphene Apatite Zircon	trace tr. tr.			Chlorite Brookite(?) Epidote Calcite	2 tr. tr. tr.	Pseudomorphing biotite.
1063	Porphyritic(olivine-)augite basalt	65	An_{65}		2-3		10			3(mt)					Sericite Calcite Chlorite	4-5 5 7	After olivine Repl. groundmass, px.; veinlets After olivine, groundmass
1099	Hornblende tonalite	Sheared and partially altered to actinolite + magnetite + epidote (hbl), sericite (plag.).															
2661A	Biotite-hornblende tonalite	70	An_{40}	2	15-20	5	trace		3	1(mt?)	Apatite	trace			Chlorite Epidote	1 trace	Biotite partly chloritized. Relict augite cores in hornblende
2661B	Biotite-hornblende augite tonalite	65	An_{50+}		15	2	10		1	4(mt?)	Apatite Sphene	trace trace			Chlorite Actinolite	trace tr.	Augite partly repl.by act.,hbl.bi., opaques. Biotite partly chloritized.
2661C	Augite-biotite-hornblende tonalite	?	An_{60}		20	?	5		?	2(mt)	Apatite	trace			Chlorite Epidote	1-2 <1	Biotite 60% chloritized Augite cores in hornblende
2662A	Augite-biotite-hornblende tonalite	55	An_{58-60}	1	30	10	1			tr(mt)	Sphene	trace			Actinolite Chlorite Epidote	trace 2 tr.	Overgrowths and repl. hornblende. After biotite.

Intrusion/Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques %	Accessories Mineral	Accessories %	Other primary minerals Minerals	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Torlu Tonalite (151°05'E, 5°44'S) 51NG0512	Augite-biotite-hornblende tonalite	50	An_{45}	2	20	15	2-3		5	2(mt)	Apatite Sphene	tr. tr.			Actinolite Chlorite	2 tr.	Hornblende partially uralitized; rock sheared; biotite partly recrystallized.
1021A	Biotite-hornblende tonalite	60-65	An_{60}	1-2	15	10			tr.	2(py?)	Apatite	tr.			Chlorite Actinolite Sphene Epidote	5 1 1 <1	Coarse-grained. Biotite largely chloritized; hornblende partially replaced by actinolite.
1021B	Quartz-2 pyroxene-hornblende gabbro	70+	An_{52+}		1-2	12	5-6	3		2(mt)	Apatite Sphene	tr. tr.			Actinolite Epidote	1-2 tr.	Corroded cores of augite in h'blende Hornblende partly recry. to actinolite
1021C	Hornblende tonalite	65	An_{37}		10	20				3(mt?)	Apatite Sphene	tr. tr.			Actinolite Brookite	1-2 tr.	Hbl. partly recrystallized to act.
1031	Biotite-hornblende tonalite	60	Andesine		10	15	tr.		5	3(mt, py)	Sphene Apatite	tr. tr.			Chlorite Muscovite Epidote	2 tr. tr.	Biotite partly chloritized. Relict augite cores in hornblende.
1032	Biotite-hornblende tonalite	60	An_{40}	1-2	20	10			3	2	Apatite Sphene	tr. tr.			Chlorite Epidote Brookite	2 tr. tr.	Biotite partly chloritized. Inclusion of qtz-san-bi-hbl. diorite
1033	Biotite-hornblende tonalite	65	An_{40}		20	5-7			3	1-2	Apatite Sphene Zircon	tr. tr. tr.			Chlorite Brookite Sericite	1 tr. tr.	Biotite partly chloritized.
1034A	Biotite-hornblende tonalite	65	Andesine	2	17-18	10			2-3	1(mt?)	Apatite Sphene	tr. tr.			Chlorite Calcite Sericite Epidote	2 tr. 1-2 tr.	Biotite partly chloritized.
1034B	Biotite-hornblende -2 pyroxene diorite	70	Andesine		5	1-2	5	1	1-2	2(mt?)	Apatite Zircon	tr.			Chlorite Actinolite	<1 5	Hornblende largely replaced by actinolite; aug. partly repl. by hbl., partly by actinolite.
1034C	Biotite-hornblende tonalite	45-50	An_{40}		30	15			3	1-2	Apatite Zircon Sphene	tr. tr. tr.			Chlorite Muscovite	tr. tr.	Biotite recrystallized & interleaved with muscovite and chlorite. Hornblende recrystallized.
1034D	Biotite-hornblende tonalite	65	An_{45}		18	15	tr.		3-5	2(mt?)	Apatite				Chlorite Epidote Actinolite	1 1 2-3	Relict augite cores in hornblende; hornblende partly recryst. to actinolite, biotite partly chloritized.
1034E	Hornblende micro-tonalite	55	An_{40}(?)		30	10			tr.	2	Apatite	tr.			Chlorite Sericite	tr. tr.	Biotite partly chloritized.
2513	Garnet-pyroxene gabbro(?)	Consists of plagioclase, pale brown garnet mantled and corroded by augite, augite crystals, and much secondary epidote, calcite and tremolite-actinolite.															
2518A	Biotite tonalite	75	An_{43}		12-15				5	1(mt)	Apatite	tr.			Chlorite	1	Biotite, partly chloritized.
2518B	Augite-hornblende gabbro	75	An_{80}			20	1-2			3(mt)	Apatite	tr.			Chlorite	tr.	Corroded augite cores in hornblende
2519	Altered hornblende tonalite	Recrystallized mosaic of quartz, plagioclase (some relict phenocrysts), chlorite and epidote (after hornblende), and opaque grains (mostly pyrite). Hydrothermally altered.															

Intrusion/Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Quartz %	Hornblende %	Augite %	Hypersthene %	Biotite %	Opaques %	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary Minerals Mineral	Secondary Minerals %	Remarks
Wala Gabbro (151°41'E, 5°53'W)																	
51NG 0574	Hornblende-2 pyroxene-microgabbro	70	An_{52}			3-4	10-12	5		1-2(mt)	Apatite	tr.	Olivine (?)	1	Actinolite Chlorite Muscovite	3 2 tr.	Pyroxene partly altered. Subophitic texture.
0575A	(Olivine-) 2 pyroxene andesite porphyry	60	Andesine		1	2-3	10	5					Olivine	1	Actinolite Biotite	5 2-3	Pyroxene partly altered to actinolite, + biotite + opaques. Plag.-qtz incln.
0575B	Hornblende-2 pyroxene gabbro	70	An_{55+}			2-3	10	2-3		5(mt)			Olivine (?)	2	Actinolite	1-2	Olivine largely altered. Ophitic texture .
0580G	Hornblende microdiorite porphyry.	Consists of plagioclase, actinolite and chlorite (after hornblende), quartz, relict hornblende, and magnetite.															
0580H	Hornblende-pyroxene gabbro	Altered to actinolite, epidote, and chlorite.															
1037	Uralitized hornblende-pyroxene gabbro	70	An_{60}		5	2-3	3			2(mt)					Actinolite	15	Subophitic texture.
1038B	2 pyroxene-quartz-hornblende diorite	65	An_{45-50}		7	15	3-4	1		2(mt)	Apatite Sphene	tr. tr.			Chlorite Brookite Epidote	2 tr. tr.	Corroded pyroxene cores in hornblende; chlorite replacing biotite and some hornblende.
1038C	2 pyroxene-quartz-hornblende gabbro	65+	An_{67-25}		7	15	3	2		2(mt, py, cc‡, hem)	Sphene	tr.			Chlorite Actinolite	1 <1	Biotite pseudomorphed by chlorite; hbl. partly alt. to chl.+act. Subophitic
1038D	Aplite	Consists of plagioclase, quartz, orthoclase, pyrite, epidote, actinolite, and zircon or brookite.															
1039	2 pyroxene-hornblende gabbro	75	An_{77}			15	4	2		2(Ti-mt)	Apatite	tr.			Epidote	tr.	Relict pyroxene cores in hornblende Subophitic texture.
1040B	Quartz-hornblende diorite	75	An_{38-40}		10	7-10	1			1-2(mt)	Apatite	<1					Relict augite cores in hornblende.
1040D	Quartz-hornblende-2 pyroxene gabbro	65+	An_{72} (An_{83-52})		1-2	4-5	8-10	8-10	tr.	1(mt)	Sphene	tr.			Actinolite Muscovite	2-3 1-2	Olivine replaced by muscovite: hornblende partly repl. by act. & biot.
1040E	Biotite-hornblende tonalite	75-80	An_{50}		10-12	7	1-2		tr.	1	Apatite	tr.			Epidote	tr.	Relict augite cores in hornblende
2000	Quartz-augite-hornblende diorite	70	Andesine		3	20	2-3			1-2(mt)	Apatite Sphene	tr. tr.			Actinolite	tr.	Relict augite cores in hornblende; hornblende partly alt. to actinolite.
2551A	Hornblende diorite porphyry	?			1	?				1-2(mt)	Apatite	tr.			Calcite Actinolite	1 tr.	Hornblende slightly altered (actinolitized)
2552A	Hornblende-2 pyroxene gabbro	70	An_{70}			5	10	10		3(Ti-mt?)			Olivine (?)	tr.	Chlorite	tr.	Olivine(?) pseudomorphed by chlorite and opaques.
2554E	Hornblende diorite porphyry	Fresh hornblende, altered plagioclase.															
2559A	Augite-hornblende tonalite	65	An_{44}		15	15	1		tr.	2(mt)	Apatite	tr.			Epidote Muscovite Chlorite	tr. tr. tr.	Recrystallized hornblende largely replaced augite.
2559B	Hornblende andesite porphyry	70			5	10				3(mt)	Apatite	tr.			Actinolite Epidote	10 2	Hornblende partially recrystallized to actinolite.
Kulu River (150°E, 5°40'S) 49NG 2501D	Porphyritic hornblende-augite andesite/microdiorite.																
2501E	Altered hornblende-biotite dacite.																
2502A	Altered hornblende andesite.																
Daluavu River (150°06'E, 5°43'S) 49NG 2556	Biotite-hornblende tonalite	60	An_{37}	1-2 (Microcl.)	20	10			5	2(mt?)	Sphene Apatite	tr. tr.			Chlorite Epidote	3 tr.	Biotite 60% chloritized.

‡ cc = chalcopyrite

2. SMALLER INTRUSIVE BODIES

Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz %	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques %	Accessories Mineral	Accessories %	Other primary minerals Mineral %	Secondary minerals Mineral	Secondary minerals %	Remarks
Ip River (151°50'E, 5°05'S) 54NG2501B	Hornblende tonalite	cf. 54/0023B... has 5-7% Or, more plag. than 0023B.														
2501H	Altered hornblende(?) augite gabbro	60	An_{60}			tr	20			3(mt)	Sphene Apatite	tr tr		Act. 5-7, Chl. 5 Ser. 2, Pr. 1		Similar to 54/1517A, but less altered, subophitic texture.
2502D	Hornblende diorite	70	An_{42}	5-7	2-4	15				2(mt)	Apatite Sphene	tr tr		Calc. tr Chlorite Epidote	 tr tr	Orthoclase poikilitic
Lula River (150°31'E, 6°10'S) 52NG0500A	Biotite-augite-hornblende microtonalite	45	An_{38-40}		35	12	3		1	2(mt)	Apatite	tr		Epidote	tr	Granulitic texture; hbl tends to replace augite
0500E	Biotite-quartz-hornblende-2 pyroxene gabbro	70	An_{53}		5	5	7	7	tr	2(mt)				Actinolite	1-2	Pyroxene mantled and corroded by hornblende; hbl alt. to act.
0500G	Biotite-hornblende tonalite	70	An_{55}		15	10			2	1-2(mt)	Apatite Sphene	tr tr		Chlorite epidote muscovite	1 tr tr	Coarse-grained; biotite partly chloritized; plag. slightly sericitized
0501	Biotite-hornblende tonalite	55	An_{63}		25	3				1(mt)	Apatite sphene	tr tr		Chlorite epidote	2 1	Leucocratic. Biotite chloritized.
0504	Quartz-hornblende-2 pyroxene gabbro	65	An_{72}		1-2	5	10	12		2-3(mt)				Actinolite	1-2	Subidiomorphic granular; hypersthene is exsolved pigeonite.
0507	Biotite-2 pyroxene-hornblende tonalite	65	An_{44}		15-20	5	1-2	1	2	3(mt)	Apatite	tr		Actinolite		Pyroxene as corroded cores in hornblende; hbl partly alt. to act.
0508	Pyritic quartz-hornblende gabbro	70	An_{58-70}		7-8	2-3				1(mt/ilm) 5+(py)	Apatite	tr		Epidote actinolite	3 7	Hornblende largely replaced by actinolite and chlorite.
0510	Pyritic quartz-augite-hornblende gabbro	60-65	An_{65}		5	5	2			2(mt) 1(py)	Apatite	tr		Actinolite	15-20	Hornblende largely replaced by actinolite, has augite cores.
2002A	(Biotite-) augite-quartz-hornblende diorite	70+	An_{45}		5-7	15	2		tr	1(mt)	Apatite	tr		Epidote	tr	Ragged augite cores in hornblende.
2003A	Biotite-2 pyroxene-hornblende-quartz gabbro	70	An_{53}		10	7	5	5	1	2(mt)	Apatite	tr				Pyroxene forms corroded cores in hornblende.
2003B	2 pyroxene-quartz-hornblende gabbro	60	An_{56}		8-10	20	2-3	1-2		2(mt)	Apatite sphene	tr tr		Chlorite	1-2	Pyroxene forms corroded cores in hornblende, both partly chloritized.
Lae Branch, Metelen River. (150°20'E, 5°65'S) 51NG2548	Biotite-quartz-hornblende mangerite	65-70	An_{45}	10	6	7	tr		4	2(mt)	Apatite zircon sphene	tr tr 1		Calcite zoisite chlorite	tr tr 1	Biotite partly chloritized. Relict augite in hornblende

2. SMALLER INTRUSIVE BODIES (Cont.)

Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz %	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Johanna River – (150°20'E, 5°56'S) 51NG2568A	Altered quartz-augite-hornblende diorite. Ferromagnesians altered in part to chlorite, actinolite, and epidote.																
2568B	Altered hornblende granodiorite	35	Andesine	10	35					2(mt)					Actinolite chlorite calcite	15	
2569	Hornblende granodiorite granophyre	50+	Andesine	20	20	5				3(mt)	Apatite	1					Graphic intergrowth of quartz and orthoclase. Acicular hornblende and plag. up to 2 cm.
2733A	Altered quartz-2 pyroxene gabbro	65	An_{67}		5				1	2(mt)	Apatite	tr			Chlorite actinolite	5 2-3	Orthopyroxene(?) pseudomorphed by chlorite, actinolite and biotite.
2733B	Altered quartz-2 pyroxene gabbro. Similar to 2733A, but less quartz (2-3%), more pyroxene.																
2735A	Altered hornblende granodiorite granophyre	45	-	15	30					1(mt)					Chlorite epidote calcite	5-6 2-3 1	Hornblende replaced by chlorite, plagioclase heavily altered to epidote and calcite.
3. MINOR INTRUSIVE BODIES																	
Siblong River – (151°57'E, 5°13'S) 54NG0035	Quartz-hornblende diorite	70			3	10				2(mt)					Epidote Chlorite	10 5	Hornblende partly recrystallized to actinolite, altered to ep and chl.
Matlip River – (152°04'E, 5°17'S) 54NG2553	Aplite	5		40	45				1	1(mt)							
Naip River – (152°06'E, 5°19'S) 54NG2533	Hornblende micro-tonalite	65			10	5				5(mt)	Apatite	tr			Chlorite Calcite Epidote	5 5 1	Altered
2534	Augite microgabbro	67	An_{67}				5			1(mt)					Actinolite Chlorite	25 2	Uralitized
2535B	Uralitized hornblende-augite gabbro																
2537	Uralitized gabbro																
Ikoi River – (151°48'E, 5°13'S) 54NG1052B	Porphyritic pyroxene dolerite	70	An_{63}				10			2-3(py)			Glass	15 →	alt. to biotite, Fe oxides, actinolite.		
1054B	Porphyritic olivine-augite dolerite	75	An_{63}				15			5(mt?)			Olivine	7-8			
Kogigi River – (151°58'E, 5°27'S) 54NG2546B	Altered augite dolerite. Altered to tremolite-actinolite, prehnite, calcite and laumontite; relict plagioclase, augite and magnetite/ilmenite.																
2546B	Augite gabbro	65	An_{80-22} av. An_{57}	2	5		15			7(mt)	Apatite	tr			Actinolite Chlorite Calcite	5 1 tr	Augite partly uralitized Qtz and Or graphically intergrown

3. MINOR INTRUSIVE BODIES (Contd)

Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz %	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques %	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Rak River (151°51'E, 5°29'S) 54NG0023B	Hornblende microgranodiorite	60	An_{57}	10-12	20	5				2-3(mt)	Sphene	tr			Chlorite Epidote	1 tr	Hornblende partly altered. Clast in conglomerate
Yamule River - (151°01'E, 5°34'S) 51NG0548	Augite gabbro	65-70	An_{53}				20		2	1-2(mt)	Apatite	tr			Actinolite Chlorite	5 2	Pyroxene(ortho-?) altered to actinolite and chlorite. Subophitic.
0557B	Hornblende tonalite																Partly uralitized.
Melkoi River - (150°58'E, 5°50'S) 51NG1084	Quartz-biotite-hornblende- 2 pyroxene gabbro	70	An_{75}		5	5	10	5	3	2(mt)	Apatite	1					Aug, hbl., bi. form ragged, messy clumps with aug.repl. by hbl and bi.
2503	Hornblende-pyroxene diorite porphyry																Epidotized and uralitized.
Muces River - (150°50'E, 5°54'S) 51NG0125	Altered dolerite	70			5		1-2			3(mt)	Apatite Sphene	tr tr			Chlorite calcite epidote	15 5 tr	Augite largely replaced by chlorite and calcite.
0127	Altered augite microgabbro	70			2		5			3(mt)					Actinolite chlorite epidote	10 5 1	Augite largely replaced by actinolite chlorite-magnetite
0128	Uralitized augite gabbro	Subophitic texture. Plagioclase; actinolite, epidote, calcite, opaques after pyroxene; minor chlorite, apatite. Veins of act.,qtz-plag.															
0129	Ferruginized andesite. Porphyritic; plag, chl., aug., opaques.																
0130	Pyroxene basalt/ andesite	70			2		15			1					Chl.5,calc.3, Ep.2, leuc 2.		Altered. Quartz micro phenocrysts
0134	Altered augite basalt	70			2	1	5			5(mt)					Chlorite Calcite	7-10 3	Heavily altered. Plag. and aug. phenocrysts
0136	Altered andesite porphyry																
0137	Altered dacite	75	Andesine	?	10		5			5(mt)					Calcite zeolite chlorite	1-2 tr 1-2	
0140	Altered hornblende-augite andesite	60	Andesine		1	1	15			5(mt)					Chlorite ser, Kaol. calcite	5 10 1-2	May contain some hypersthene.
0141	Altered pyroxene gabbro	70	An_{62-64}		2-3		5			2(mt) 2(py)	Apatite	1			Chlorite actinolite	10 5	Subophitic texture; pyroxene partly alt. to chl. and act.

3. MINOR INTRUSIVE BODIES (Contd)

Locality/Sample number	Rock type	Plagioclase %	Plagioclase Comp.	Orthoclase %	Qtz %	Hbl. %	Aug. %	Hypersthene %	Biotite %	Opaques	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Amgen River - (150°51'E, 6°08'S) 52NG1009	Pigeonite-augite microgabbro	65	An_{82}				20		1	2(mt) tr(hem)			Pigeonite	2	Actinolite calcite muscovite chlorite	5 tr tr 1	Pyroxenes, especially pigeonite, heavily altered; pigeonite partly exsolved to augite and hypersthene. Augite has low (45°) 2V.
1010	Porphyritic(olivine-) augite microgabbro	65+	Labr.				20			2(mt)					actinolite chlorite calcite zeolite	2 5 1 1	Olivine and hypersthene (?) altered to chlorite-actinolite-calcite. Veinlet of zeolite.
1011A	Uralitized augite-hornblende tonalite	60	An_{35}	1-2	15	2	1			2(mt)	Apatite	tr			Chlorite epidote actinolite	5 1 12	Relict augite and hornblende, largely replaced by actinolite-chlorite-epidote-opaques.
1012	Augite-hornblende tonalite	55	An_{80-44}	3	15	1	1			1(mt)					Actinolite chlorite epidote	10 10 5	Hornblende and pyroxene largely altered to actinolite-chlorite. Epidote in plagioclase. Orthoclase intergrown with quartz.
Agaris River (150°38'E, 6°10'S) 52NG2518A	Quartz-biotite-augite-hornblende diorite	70			7-8	15	2		2	1(mt)	Apatite	tr			Chlorite actinolite	tr 1	Hbl partly replaced by act. Bt partly chloritized.
2518C	Altered augite-hornblende tonalite		An_{50}														Hornblende and augite altered to actinolite and chlorite
2518F	Altered augite-hornblende tonalite																Alteration to chlorite, actinolite and epidote.
Au River (150°12'E, 6°12'S) 52NG2554B	Altered augite-hornblende gabbro																Cores of aug. in hbl.; f/ms* alt. to chl., act., ep.; veinlets of K-felds.
Awio River (150°06'E, 6°08'S) 51NG2537A	Altered porphyritic quartz-2 pyroxene basalt	75-80	An_{60}		5+		10			2(mt)	Apatite	tr			Chlorite	3	Hypersthene pseudomorphed by chlorite
2538	Altered dolerite	Consists of plagioclase, chlorite, calcite, quartz, and opaques. Relict subophitic texture. Pseudomorphs after pyroxene; plagioclase altered and fractured.															
2541B	Altered pyroxene granodiorite	60	An_{50}	7-8	15		5			2(mt)	Apatite	1			Actinolite chlorite	4 4	Actinolite and chlorite pseudomorphs after orthopyroxene(?) Graphic quartz-orthoclase intergrowths.
2553B	Altered augite gabbro	65	An_{78}				15			2(mt)					Chlorite actinolite leucoxene prehnite	5 5 5 1	Subophitic texture. Plagioclase heavily kaolinized. Pyroxene partly altered to chlorite-actinolite-leucoxene-prehnite.

* ferromagnesian minerals

3. MINOR INTRUSIVE BODIES (Contd)

Locality/Sample Number	Rock type	Plagioclase %	Plagioclase Comp.	Ortho-clase %	Qtz %	Hbl. %	Aug. %	Hyper-sthene %	Biotite %	Opaques	Accessories Mineral	Accessories %	Other primary minerals Mineral	Other primary minerals %	Secondary minerals Mineral	Secondary minerals %	Remarks
Metelen-Iglik – (150°25'E, 5°49'S) 51NG2008	Hornblende-2 pyroxene gabbro	Very weathered and altered.															
Iglik River – (150°15'E, 5°25'S) 51NG2531B	Altered quartz-pyroxene gabbro	75-80	Labr.		2		5			2(mt)					Actinolite epidote calcite chlorite	5 1 1 5	Augite largely replaced by actinolite-chlorite-epidote-calcite.
2533	Porphyritic augite dolerite	Ferruginized. Labradorite and relict brownish-green augite.															
4. YOUNGER INTRUSIVES																	
Toki Andesite – (151°30'E, 5°05'S) 54NG0517	Hornblende-augite andesite																Hypabyssal. Augite mantled and corroded by hornblende.
0519	Hornblende-augite(?) andesite	63				5	3-4(?)			2			pale green mica	10	Leucoxene	5-10	Hypabyssal. Augite mantled and corroded by hornblende.
0539	Hornblende (-muscovite) andesite	70			tr	10				5	Apatite	1	Muscovite	10	Anatase	3	
0540	Hornblende (-muscovite) andesite	70			tr	10				5	Apatite	1	Muscovite	10	Anatase	3	

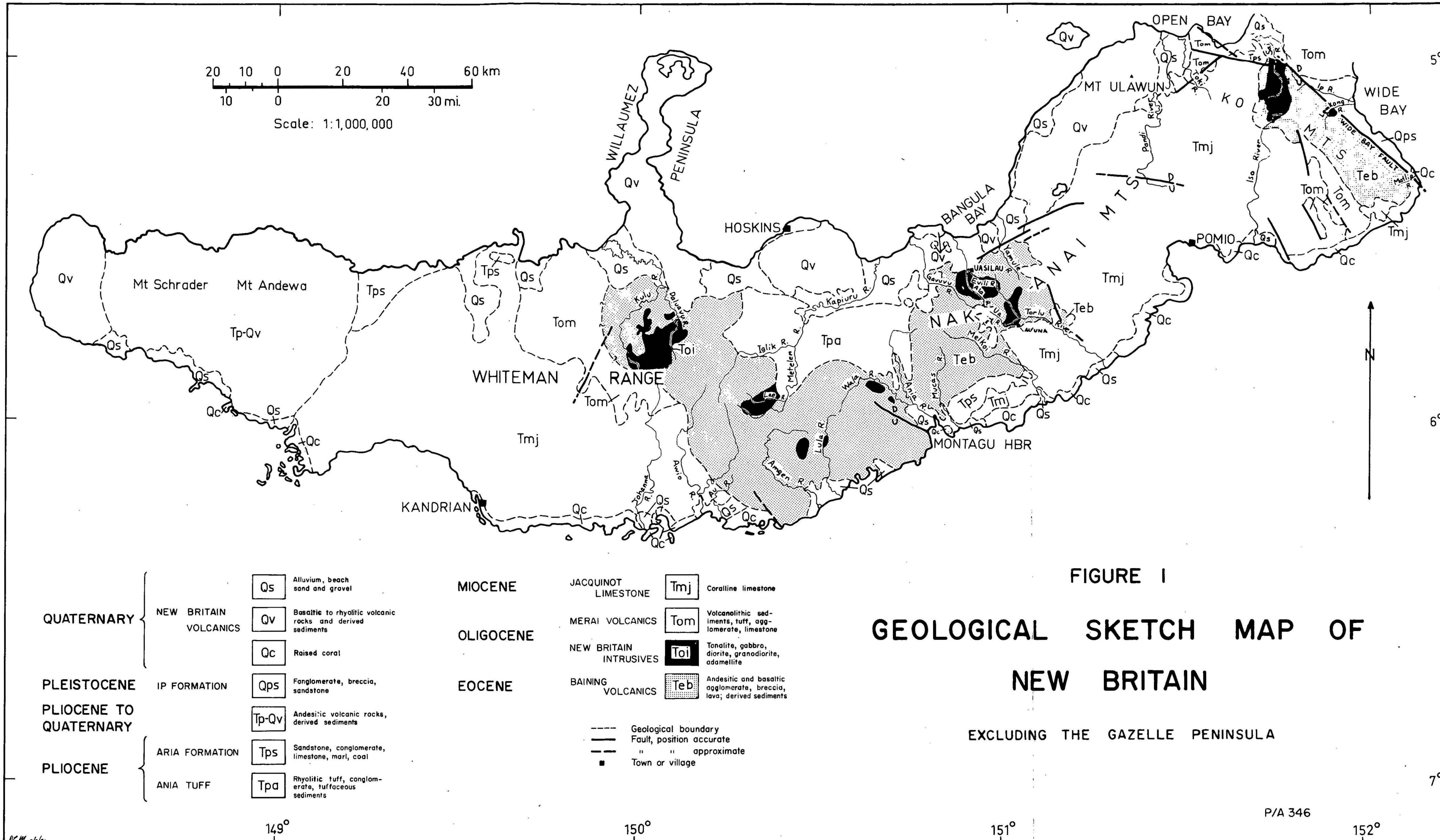

FIGURE 1

GEOLOGICAL SKETCH MAP OF NEW BRITAIN

EXCLUDING THE GAZELLE PENINSULA

To accompany Record 1971/70

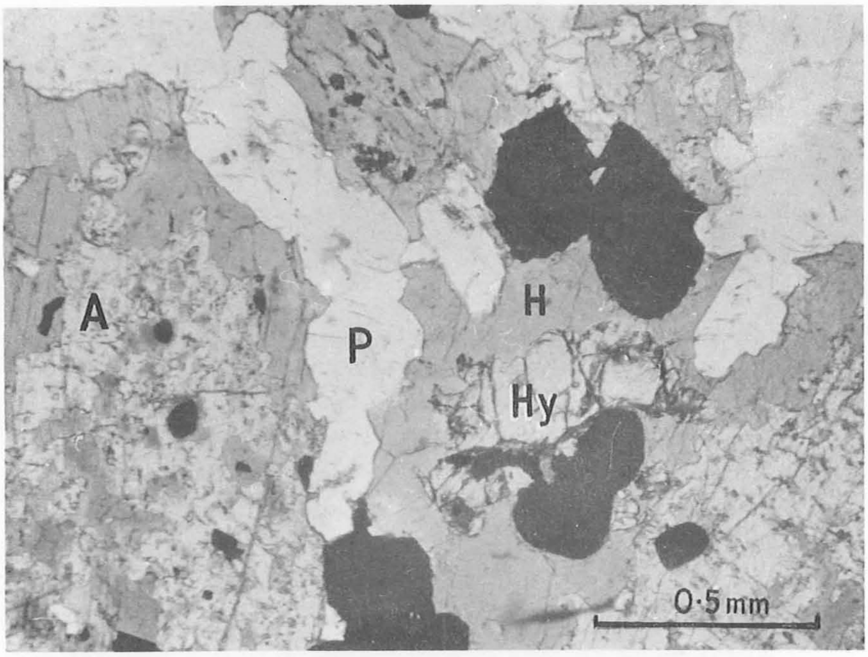

Fig. 2. Gabbro from the Sai intrusive complex, showing corroded augite (A) and hypersthene (Hy) mantled by hornblende (H) which has a subophitic relationship to plagioclase (P). Opaque grains are magnetite. Specimen 54NG2610B. Neg. M1203.

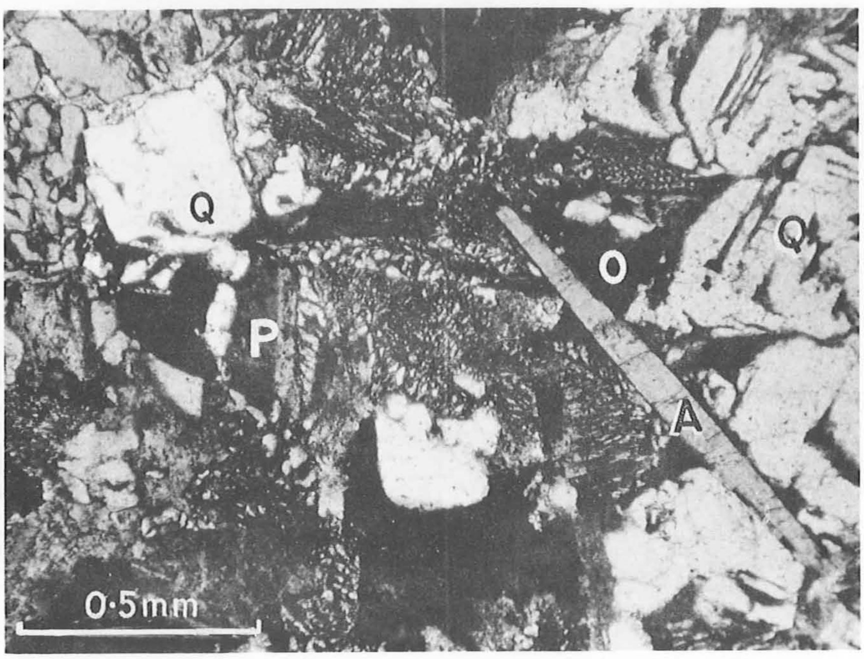

Fig. 3. Granodiorite from the Johanna River, showing graphic quartz (Q) — orthoclase (O) intergrowths. P-plagioclase; A-apatite. Specimen 51NG2569 Neg. M1203.

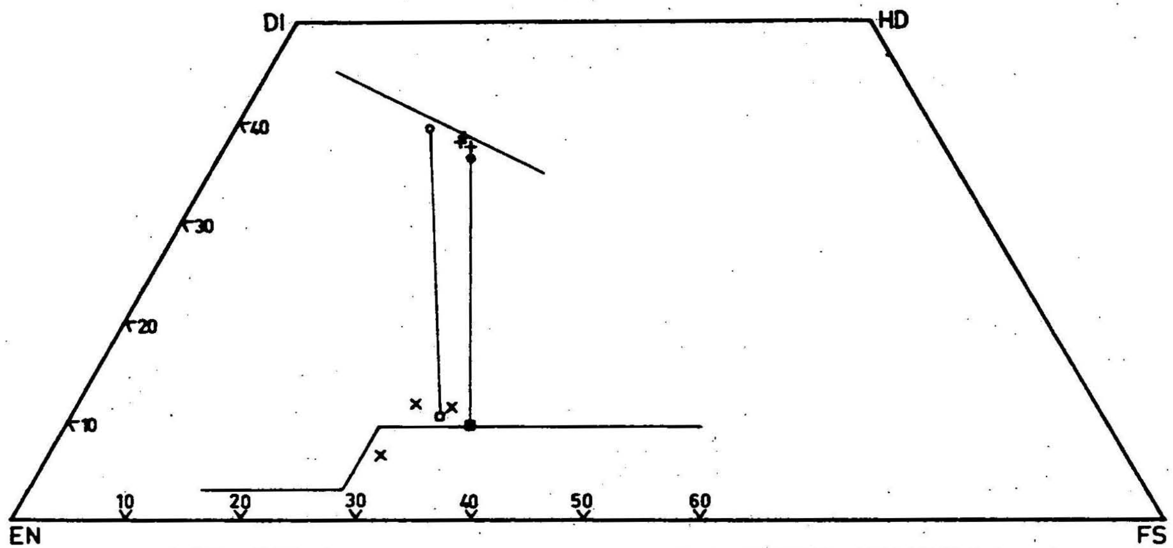

FIGURE 4 - PYROXENES FROM SPEC. 52NG1009

SHOWING TRENDS OF BROWN (1968); + - augite from 1009, × - pigeonite from 1009; •–▫ - Stillwater pyroxene pair; •–▪ - Skaergaard pyroxene pair.

To accompany Record 1971/70