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1955/31

PETROGRAPHY OF ROCK SPECIMENS FROM THE UPPER SEPIK

RIVER AREA, NEW GUINEA

by

R. D. Stevens.

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INTRODUCTION

A group of 10 specimens collected by Mr. W. J. Perry from the Enterprise Company's permit area on the Upper Sepik River, New Guinea, include the following rock-types:-

Biotite schist (AA9), various gneisses (AA29, 30), amphibolite (AAB8), gneissic granodiorite (AA13a) withplitic veins (AA13b), Granodiorite (AA12,14), gabbro (AA16), and hornblende andesite (Eng.23).

Of these, the schist, gneiss, amphibolite and granodiorite constitute part of a relatively near surface plutonic-metamorphic complex and are in close genetic association. The gabbro (represented as dolerite on the sketch map of Permit 21) may or may not be associated with the more acid plutonic rocks and further field data will be necessary to establish its relationships. The andesite is probably genetically unrelated to any of the other specimens examined.

Information relating to the field occurrence and features of these rocks has been derived from various letters and sketch maps on files 106 PNG/6 and A198PNG/1, so that little is known of the actual details of their occurrence and there has been no opportunity for personal communication with Mr. Perry.

PETROGRAPHY.

AA9. Biotite Schist.

Locality: Upper Tai Ck., in vicinity of 4°22'S, 141°08'E.

In hand-specimen this is a fine grained grey rock with a small-scale foliation fabric. Examination with a hand-lens (X10) shows that the rock consists of whitish quartz and feldspar, a black micaceous ferromagnesian mineral, few small red-brown garnets and minute flecks of chalcopyrite.

In thin-section the schistose fabric of the rock is strikingly portrayed by the sub-parallel orientation of the ferromagnesian minerals and their decomposition products, and the sheared lenticular form of the quartz-feldspar aggregates.

The feldspar is largely untwinned and biaxial positive with large 2V (ca 80°) and refractive index lower than 1.537. It is probably an untwinned albite. The feldspar forms completely anhedral and sometimes lenticular grains, usually containing numerous inclusions of quartz, and constitutes about 40% of the rock.

Quartz forms anhedral grains containing many minute dusty inclusions. It makes up some 30% of the essential minerals. Biotite is abundant (20%) as lamellar flakes parallel to the schistose fabric. It is strongly pleochroic with  $X < Y = Z$ , and

X = pale yellow,  
Y = deep red-brown  
Z = " " "

It is often altered almost completely to a pale-coloured chlorite with very low birefringence and sometimes with deep blue anomalous interference colours and is, therefore, probably penninite. The

larger biotites are frequently embedded in a matrix of very fine biotite and quartz.

Other minerals playing a lesser (10%), though still important role in this rock are grains of garnet up to 0.5 mm across and considerably fractured and chloritised, staurolite in prismatic crystals up to 0.25 mm long, tourmaline, apatite, and magnetite. The staurolite is pleochroic from colourless to pale yellow and the tourmaline from colourless to a mottled greenish yellow-brown. Tourmaline carries inclusions of magnetite, quartz, and feldspar, though the latter appears to be replacing the tourmaline. Apatite forms small equidimensional grains sparsely distributed through the rock.

Magnetite is the chief opaque mineral and occurs as dense masses and fine dust aggregated into narrow stringers through the rock and parallel to the general fabric.

#### AA29. GARNET GNEISS.

Locality: Upper Wogarabei Ck. in vicinity of 4°27'S, 141°02'E.

The hand-specimen is distinctly gneissic in structure and dark greenish grey in colour, with whitish elongated and lenticular feldspathic bodies.

The gneissic fabric is expressed in thin-section by roughly lenticular aggregates of very poorly twinned and considerably fractured plagioclase (andesine, 30% of rock), and similar bodies consisting essentially of rounded and strained quartz grains (20%). Both types of structural elements are embedded in a strongly foliated matrix of fine scaly sericite (30%), larger (0.2mm) sheets of strongly pleochroic red-brown biotite (10%) and some muscovite. This foliated matrix is strikingly deflected around the feldspar and quartz aggregates and around large (1 mm) colourless garnet porphyroblasts (10%). The garnet is probably almandine.

Irregular, elongated grains of opaque minerals are a common feature of the more micaceous phases and appear under reflected light to be an intergrowth of magnetite with pyrite. Few small grains are included in the garnet.

#### AA30. HORNBLende EPIDOTE GNEISS.

Locality: Upper Wogarabei Ck. in vicinity of 4°27'S, 141°02'E.

A medium grained gneissic rock of light grey colour with parallel oriented black amphibole crystals up to about 3mm long in a base of grey quartz, white feldspar and few pale greenish lenticular masses of epidote.

In thin-section amphibole constitutes about 20% of the rock. It is a common green hornblende, pleochroic from pale yellow-brown to deep green with  $X < Y < Z$  &   
 $X$  = pale yellow  
 $Y$  = deep yellowish green.  
 $Z$  = deep bluish grey-green.

The bluish colour in the Z direction may indicate a somewhat sodic character, but chemical analysis would be necessary to confirm this. It is generally sub-hedral elongated and includes considerable numbers of feldspar grains, giving it a strongly poikiloblastic texture. The larger axes of the amphibole grains are in sub-parallel orientation coincident with the gneissic foliation.

The only other coloured silicate is a finely granoblastic, pale yellowish epidote in ragged, semi-lenticular aggregates with included granular quartz, altered amphibole, prismatic apatite and zaphene. Although abundant in this thin-section, its distribution in the hand-specimen indicates that epidote makes up no more than about 10% of the rock as a whole.

The coloured silicates are set in a foliated base of granoblastic quartz (50%) and feldspar (20%). The quartz grains are completely anhedral, but elongated in the direction of the general fabric. The feldspar is a very poorly twinned, finely granoblastic plagioclase (apparently labradorite) in lenticular and very much drawn-out granular aggregates. It is quite clear and only little altered and stands out in high relief from the enclosing quartz by reason of its relatively high refractive index.

AA28. AMPHIBOLITE (EPIDIORITE)

Locality: Upper Wogarebei Ck., in vicinity of 4°27'S, 141°02'E.

A very fine grained black and white spotted rock with a moderate degree of foliation on polished surfaces. Under the hand lens (X10), the essential minerals are white feldspar and greenish-black amphibole.

In thin-section this is a distinctive rock with characteristic amphibolite texture, viz., small (0.5mm), equigranular, xenoblastic grains of plagioclase and almost idiomorphic crystals of hornblende with their long axes in sub-parallel orientation.

Plagioclase constitutes about 60% of the rock and is very poorly twinned, so that specific identification is difficult. However, it is biaxial negative with 2V approximately 80 to 85° and refractive index only slightly above 1.537. It is, therefore, on acid andesine between the limits Ab 30 to Ab 40. It is slightly albitised and contains occasional magnetite and amphibole inclusions.

The amphibole (30%) is a brownish-green hornblende. It is normally sub-hedral prismatic, but anhedral grains are common.

Magnetite (10%) occurs as small grains of anhedral to cubic outline and usually closely associated with the amphibole. Fine, powdery sphere occurs in close association with the opaque mineral.

Several straight, narrow, amphibole-filled veins traverse the rock in thin-section and probably represent in-filled fractures. In places these veins are widened out and filled with pale green, scaly penninite and fine amphibole relicts not yet replaced by chlorite. These veins intersect the foliation of the rock at fairly high angles (45 to 90°) and may represent original tension fractures formed and filled during the same metamorphism which brought about the amphibolitisation of the original rock.

AA 13a. GNEISSIC GRANODIORITE

Locality: Upper Tai Ck., in vicinity of 4°21'S, 141°08'E.

A medium grained grey rock with a distinct, though finely gneissic structure in hand-specimen. A hand-lens (X10) shows quartz, feldspar, biotite, and dull greenish-black hornblende to be the principal constituents. Pyrite is common.

In thin-section, the plagioclase is in the range of basic andesine to acid labradorite (Ab50 to Ab55). It is fresh and unaltered, and is completely anhedral, constituting about 20% of the rock.

Potash-feldspar (5%) is also unaltered and anhedral. It contains abundant rounded inclusions of quartz giving rise to a semi-poikiloblastic texture.

Quartz constitutes some 45% of the section in the form of anhedral and rounded inclusions. The amphibole is a green hornblende (5%), strongly pleochroic with X = colourless to pale yellow.

Y = yellow-green  
Z = deep green

It commonly forms prismatic crystals of typical amphibole section up to 1mm long. These are usually at least partly broken down into aggregates of smaller amphibole grains with interstitial quartz and biotite.

The biotite (20%) is usually very closely associated with the amphibole and often included in it. The nature of these included biotites suggest that the amphibole has developed at the expense of the biotite, which in turn suggests metamorphism of an original granodioritic rock. The biotite is a strongly pleochroic brown variety as in the previously described rocks.

Occasional masses of magnetite, amphibole and chlorite appear to be pseudomorphous after an earlier mineral, possibly pyroxene. They consist of a dense magnetite core with included pyrite, surrounded by deep green amphibole and chlorite. Magnetite makes up about 2% of the rock.

The principal opaque mineral, however, is pyrite in irregular grains scattered through the rock. Apatite is the main accessory mineral.

#### AA13b. MICROGRAPHIC APATITE

Locality: Upper Tai Ck., in vicinity of 4°21'S, 141°08'E. as veins in the gneissic granodiorite (AA13a)

In hand-specimen this rock is white with yellow-brown iron stains along fractures. Grain-size is medium and the rock consists almost entirely of quartz and feldspar with few small flakes of black biotite.

In thin-section the rock consists of large (up to 3 mm) micrographic intergrowths of quartz and feldspar in a fine mosaic groundmass of completely anhedral quartz and feldspar grains. The feldspar is largely orthoclase with very fine veins of albite in microperthitic intergrowth and is slightly kaolinised. Very rare, small crystals of acid plagioclase can be detected in the granular groundmass. Quartz constitutes 40% and feldspar about 60% of the rock.

Chloritized biotite is occasionally detected but does not make up more than 2% of the constituent minerals. Chlorite and limonite have been deposited along fracture surfaces through the rock.

#### AA12. BIOTITE GRANODIORITE.

Locality: Upper Tai Ck in vicinity of 4°22'S, 141°08'E.

A medium grained leucocratic granitic rock with clear glassy quartz, milky white feldspar, abundant black mica and occasional grains of pyrite clearly visible in hand-specimen.

In thin-section, quartz forms clear anhedral about 1mm across and constitutes about 40% of the rock. It is generally free from inclusions but contains few small epidote, apatite and corroded feldspar crystals.

The feldspar also makes up some 40% of the essential minerals and consists of plagioclase and orthoclase in approximately equal amounts. The orthoclase is fairly heavily kaolinised and replaced by epidote, leucxene and chlorite. It forms sub-hedral-tabular to anhedral crystals up to 1mm across. The plagioclase is an acid andesine varying from Ab65 to Ab75 and is commonly zoned between these limits. Close polysynthetic twinning is a characteristic feature and some crystals tend to be antiperthitic. The plagioclase is generally less altered than the potash feldspar, but still shows some kaolinisation.

Biotite sheets up to 1mm long make up about 10% of the section and are commonly strained and bent. It is a normal, strongly pleochroic brown biotite with X = pale yellow-brown  
Y = Z = deep red-brown.

Apstite inclusions are quite common in the mica, which also tends to be chloritised. Irregular interstitial masses of chlorite, epidote and kaolin make up the remaining 10% of the rock.

There is no directional fabric in this rock.

#### AA14. BIOTITE GRANODIORITE

Locality: Upper Tai Ck., in vicinity of 4°22'S, 141°08'E.

A medium-grained grey rock in hand-specimen with no visible gneissic structure. Minerals identified in hand-specimen are quartz, feldspar and biotite with a little chlorite.

In thin-section plagioclase (50%) is the dominant feldspar. Twinning is only poorly developed and normal continuous zoning from basic oligoclase (Ab70) to albite is a conspicuous feature. Pseudo-inclusions of quartz are abundant and minute rods of rutile can be detected. Potash-feldspar (10%) is normally intergrown with quartz.

The quartz (30%), as in the preceding types, is anhedral and clear, with occasional needle-like inclusions. Biotite amounts to about 10% and is strongly chloritised, often being completely altered. Unaltered flakes are dark greenish-brown and distinctly pleochroic to straw-yellow. There is a little associated muscovite.

The opaque mineral is largely magnetite in small grains and cubes almost exclusively associated with the biotite.

#### AA16. GABBRO.

Locality: August River, 2 miles upstream from Tai Ck. junction. 4°22'S, 141°08'E.

In hand-specimen this rock is equigranular, medium to coarse grained and dark greenish-grey in colour. It consists essentially of plagioclase and augite. Multiple twinning is strongly developed in the feldspar, and is clearly visible even without the aid of a lens. There is no indication of deformation structures.

In thin-section the dominant minerals are plagioclase (50%) and augite (50%), the latter being mantled with secondary amphibole. The plagioclase is an intermediate to acid labradorite (Ab46) in sub-hedral to anhedral grains about 2mm across. Polysynthetic twinning is well developed and the feldspars are entirely unaltered. Few small inclusions of pyroxene are encountered, and even less frequent minute green amphiboles and magnetites are enclosed in the feldspar.

The pyroxene is a colourless augite with large 2V in anhedral to subhedral crystals about 1 to 1.5mm across. Small magnetite grains and rods are common as inclusions and plagioclase is included in nearly every pyroxene grain. A very characteristic feature of the pyroxene is the development of later amphibole as rims around the grains and irregularly internally. This amphibole is considered to be a primary mineral developed by progression through the Reaction Series during crystallisation of the magma. It is a normal green-brown hornblende with  $X < Y = Z$  and

X = pale yellow-brown

Y = Z = deeper yellowish green-brown

It is probable that in its early stages of crystallisation this gabbro contained olivine. The evidence for this lies in a peculiar association of magnetite and oxidised chlorite with pyroxene and amphibole in aggregate masses. A central mass of granular to semi-dendritic magnetite with associated yellowish-brown oxidised chlorite and fibrous iddingsitic material is surrounded by coarse granular pyroxene and an outer zone of amphibole.

Eng. 23. HORNBLENDE ANDSITE.

Locality: Sepik River, between West and October Rivers; approx 4°07'S, 141°02'E.

A very fine-grained dark grey rock with whitish feldspar and a black ferromagnesian mineral as the major constituent.

In thin-section the rock consists essentially of feldspar (50%), green chloritised amphibole (40%), magnetite (5%) and interstitial quartz (5%).

The feldspar, though essentially fresh, is usually so crowded with inclusions as to render specific determination very difficult. However, it appears to be an intermediate andesine, very poorly twinned and slightly albitised. It forms sub-hedral to anhedral grains, the more lath-like crystals being so oriented as to give the rock a sub-trachytic fabric. Inclusions are very abundant, the dominant ones being minute, acicular, sometimes radiating, needles of pale green amphibole resembling very fine actinolite. Other inclusions are grains of magnetite and stumpy green hornblendes.

The amphibole is a sub-hedral, almost flaky hornblende with X = pale straw-coloured  
Y = green, sometimes bluish  
Z = deep yellowish green

It is often somewhat chloritised, giving rise to a zoned appearance.

Quartz anhedral are interstitial to all other components and contain inclusions of feldspar, amphibole, magnetite and apatite. Magnetite grains average about 0.25 mm across and are closely associated with the amphibole which sometimes includes the magnetite and at other times is included in the latter. Inclusions of apatite are also found in the magnetite.

CONCLUSION.

With the exception of the hornblende andesite (Eng. 23) these rocks belong to a single plutonic-metamorphic complex in which granodiorite and gneissic granodiorite have been emplaced in schists and phyllites. Gneissic phases are commonly, though not necessarily, marginal to plutonic igneous masses, resulting from primary flow mechanisms or from viscous drag of partly consolidated magma against the country rocks. This structure has, however, more probably resulted from a post-emplacement metamorphism of the granodiorite. The appearance of garnet prophyroblasts and granular epidote in the gneissic granodiorites, the development of amphibole from biotite and a general granulation of these rocks strongly suggests a later dynamic metamorphism. This may have been effected by the emplacement of the gabbro (AAL6) which shows no indication of having suffered any deformation and is, therefore, presumably of younger age. More field information is necessary to establish the true nature of the relation between the gabbro and the acid plutonics.

On the other hand, it is perhaps more probable that the post-emplacement metamorphism has resulted from such tectonic processes as faulting or folding in the plutonic terrain.

The hornblende andesite (Eng. 23) probably belongs to a later volcanic suite petrogenetically and tectonically unrelated to the acid plutonics.

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