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RECORDS.

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REPORT ON PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS DURING 1956

Compiled by

G.J.G. Greaves

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INTRODUCTION

This Record consists of a collection of reports completed by the petrographic and mineragraphic personnel of the Bureau Laboratory during the period January to December 1956. The reports have been placed in chronological order and each one has its date of completion and the relevant file number above its heading.

The officers responsible for these reports are: W.B. Dallwitz, W.M.B. Roberts, R.D. Stevens, J. Ward and J.K. Lovering.

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120NT/6 January, 1956.

Report 1.

1. GRANITES FROM THE ARNHEM BAY AREA, NORTHERN TERRITORY

by

W.B. Dallwitz.

Two specimens of granite from the Arnhem Bay area, Northern Territory, have been examined. One is medium-grained and garnetiferous, the other coarse-grained and porphyritic in potash feldspar.

Specimen B7672 is a greyish white, medium-grained granite containing scattered porphyroblasts of red garnet measuring up to 0.75 cm. across and making up about 5 percent of the rock. The rest of the specimen, apart from about 2 percent of biotite, consists of feldspars and quartz.

In thin section the most abundant mineral is seen to be perthite; oligoclase is also prominent and may be almost plentiful enough for the rock to be an adamellite. Quartz shows marked strain shadows. The plagioclase in the perthite does not have the usual wispy or lenticular shapes, but occurs as more or less equidimensional blebs or straight-sided rods showing perfect parallelism. I have noted this form of perthite only in rocks from the Antarctic, and it may be that it is characteristic of ancient granites and gneisses which have been subjected to very deep-seated metamorphism, or of granites which have crystallized at great depth. Some of the oligoclase is partly sericitized, and some is intergrown with quartz to form myrmekite.

The garnet commonly has inclusions of quartz and biotite, and some grains contain veinlets of biotite; these veinlets are probably a product of retrograde metamorphism of the garnet. All of the biotite in the thin section and in the handspecimen is intimately associated with garnet. This again suggests that there is a metamorphic balance between the two minerals. The biotite is a red-brown variety, and it is occasionally graphically intergrown with quartz; this latter feature also has been noted by me only in Antarctic Archaeozoic rocks.

Minor accessories in this rock are leucoxene, black iron ore and zircon.

The rock is a <u>leucocratic garnetiferous granite</u>.

Specimen B7657 is a coarse-grained light grey granite containing porphyritic crystals of potash-feldspar up to 4 inches across. Garnet is absent. Hornblende is plentiful, and a little biotite is visible in the handspecimen.

Microscopic examination shows that the matrix in which the porphyritic potash feldspar is set consists principally of oligoclase, graphic intergrowths of perthite and quartz (micropegmatite), perthite, olive-green hornblende, and quartz. Most of the plagioclase grains are wholly or partly saussuritized, but some are very little altered. The perthite is a normal type.

Accessory minerals are pleochroic red-brown goethite occurring as cores within hornblende, biotite, black iron ore, hydrated iron oxide, apatite, clinozoisite, zircon and sphene.

A second section was made of one of the porphyritic crystals of perthite. The perthite contains inclusions of subhedral, altered oligoclase, quartz, hornblende, and biotite. Groups of quartz grains are commonly in optical continuity, and give rise to local clots of micropegmatite within the porphyritic perthite. The cores of the larger hornblende grains are occupied by what appears to have been diallage, but this mineral is now largely altered to actinolite; the actinolite or diallage is commonly heavily stained by hydrated iron oxide, and is almost entirely altered to goethite in the matrix in which the porphyritic perthite crystals are set (see above).

The rock is a granophyric porphyritic hornblende granite.

120NT/2/3 10th April, 1956.

Report 2

2. PETROGRAPHIC EXAMINATION OF ROCKS COLLECTED FROM THE DALY RIVER AREA.

by

J.K. Lovering and R.D. Stevens.

The following are descriptions of rocks from the Daly River area, collected in 1955:-

2946: Quartz Greywacke

This rock is a noticeable orange-red colour. It is fine grained and laminated, and contains a considerable amount of mica amongst the quartz grains.

In thin section, the rock appears to be very well sorted. The grainsize of the coarse fraction ranges from 1mm. to 2mm. in diameter and is very regular. Although the grains are slightly angular in places, there is a general tendency for elongate grains to align themselves parallel to the lamination.

The coarse fraction consists of quartz (30%), quartzite fragments (5%), and pseudomorphs of a ferromagnesian mineral (20%). The matrix of chlorite (30%), sericite fibres (5%), and muscovite (5%) parallels the lamination and weaves around fragments of the coarse fraction: Tourmaline and zircon are accessory minerals. Fragments of hematite are mostly derived from the pseudomorphs, together with chlorite. These are possibly pseudomorphs of amphibole. Some biotite is in the process of being pseudomorphed by hematitic and chloritic material.

2945: Quartz Greywacke

The rock is pinkish grey and fairly fine-grained. The groundmass is more abundant than the coarser fraction which consists of quartz and muscovite fragments.

In thin section, it is seen that quartz fragments, measuring about 0.5mm in diameter, make up 40% of the rock. Some pseudomorphs (5%) of possible ferromagnesian minerals and muscovite shreds (5%) are the other coarse constituents.

The groundmass consists of fine chloritic material (30%) and sericitic material (10%) which surrounds the poorly sorted grains. Fine quartz fragments (10%) occur in this matrix with accessory magnetite and tourmaline. Films of brown limonitic material surround many grains.

The pseudomorphs consist mainly of sericite and chlorite with some fine (?) clinozoisite.

3203: Black Quartz Greywacke.

The hand specimen is a dark grey, compact, medium-grained rock. Grains of yellowish hydrated iron ore are numerous, and measure about 1mm. in diameter. Other visible grains include muscovite mica and quartz.

The rock has a slight lamination. The rock fractures unevenly.

In thin section, irregularly-shaped quartz grains are abundant. About 40% of the rock consists of angular quartz grains, quartz aggregates, and quartz-rich rock fragments, of about 1mm. in diameter. These lie in a fine grained matrix composed mainly of sericite fibres (35%). Small angular quartz grains (5%) are about 0.1mm. in size, and, together with muscovite shreds (5%), limonite and patches of chlorite (5%) (after some ferro-magnesian mineral), and accessory tourmaline grains make up the rest of the groundmass.

Most of the quartz grains, both large and small, are coated with a fine layer of limonitic material and dusty particles (possibly clinozoisite).

2941: <u>Quartz Greywacke.</u>
In hand specimen, the rock is greyish and coarse grained. It is notably poorly sorted. Angular and rounded grains of quartz, rock fragments, and other minerals lie at all angles to each other.

In thin section, coarse angular fragments of quartz (15%) and quartzite (5%) and pseudomorphs of ferro-magnesian minerals (5%) make up the coarser part of the rock. These fragments range in grainsize from 1mm. to 2 or 3mm.. Muscovite grains measuring about 1mm. in size, are frequently broken up. The pseudomorphs are made up mainly of fine colourless chlorite and sericite and some limonitic material, and are probably derived from some ferro-magnesian mineral.

In the fine groundmass, sericitic fibres (45%) weave about the larger grains. Small irregularly shaped quartz grains (15%) are abundant in the groundmass. Limonitic particles (5%) are plentiful between the smaller grains. A very few grains of brown hornblende, are often rimmed with clinozoisite (?). Tourmaline grains are accessory.

2943: <u>Quartz Greywacke.</u>
The most noticeable thing about the hand specimen is its pinkish grey colour. The rock is fairly homogeneous and well sorted. There is a slight suggestion of lamination. The grainsize is medium. Rounded quartz grains occur in the pinkish groundmass.

In the thin section, rounded irregularly shaped grains of quartz (45%) and quartzite (5%) are evenly distributed in a fine grained matrix. These grains are all about 1mm in diameter. The quartzite grains are probably derived from some former metamorphosed rock.

The matrix has a grainsize of less than 0.1mm.. It is composed of fine irregularly shaped quartz grains (15%) in a mass of muscovite shreds (5%) and sericite fibres (20%). There are a few small patches of chlorite, which perhaps pseudomorph ferro-magnesian minerals. The matrix has a general pink coloration which is caused by thin films of limonitic material, together with dust particles (clinozoisite?) which curve around other minerals. Tourmaline and zircon are accessory minerals.

The muscovite and sericite fibres parallel the general trend of the poor lamination.

2947: <u>Greywacke</u>
The buff-coloured hand specimen is coarse and irregular in grainsize. Grains of quartz and cherty fragments have an irregular distribution. Although there is a suggestion of lamination, the sorting of the grains is poor.

In thin section, the poor sorting is again noticeable. The coarser fraction, averaging about 1mm. in size, and ranging up to 5 or 6mm., includes rounded and angular quartz grains (35%) muscovite flakes (5%), biotite (10%), and pseudomorphs of a possible ferromagnesian mineral (5%).

The fine matrix consists mainly of sericitic material

(25%) with some fine quartz grains (10%). Throughout this fine matrix, and around the coarser fragments, there is abundant limonitic material. The accessory minerals, about 0.1mm. in size, are tourmaline and zircon.

The pseudomorphs mentioned above, now consist of a mixture of chlorite and limonitic material.

2944a: Quartz Greywacke.

This rock is a medium grained greywacke. It is reddish grey in colour. Although the grainsize is fairly regular, there is no lamination. The coarser fraction appears to be more abundant than the fine matrix. Quartz is the only distinguishable mineral in the hand specimen.

These observations are supported by the examination of a thin section of the rock. Angular quartz and quartzite fragments are abundant, and make up 65% of the rock. The fragments are about 1-2mm. in size. Again there is no evidence of sorting in the rock.

The groundmass is mainly sericitic (20%), with muscovite shreds (3%), and patches of chlorite (10%) both colourless and yellow. The chlorite patches with some limonitic material are probably the result of alteration of augite, of which one small fragment remains. Some hematite is also present. Tourmaline and zircon are accessory minerals.

2944b: Quartz Greywacke.

This rock is similar in general appearance to No. 2944a. It is, however, finer grained, and the proportion of matrix to the coarser fragments is greater.

In thin section, the rock appears to be poorly sorted as in the case of 2944a.

Angular quartz fragments range in size from 0.5mm. to 1.5 mm. and make up 25% of the rock. Large muscovite flakes (5%) are extensively altered to chloritic material.

The fine matrix consists of colourless chlorite (35%), and sericite (10%), with some very fine quartz grains (10%). Irregular patches of hematite are abundant (5%). Tourmaline and zircon are accessory.

Comparison of Greywackes.

The group of greywackes includes Nos. 2941, 2943, 2947, 2944a and 2944b. In these, quartz is the dominant constituent with either sericite or chlorite as the dominant matrix material. It is interesting to note the variations of the proportions of the coarser fraction (usually quartz only), to the matrix. In 2944a, the coarser fraction is considerably greater than the matrix, indicating perhaps that this rock was formed closer to the shoreline than the others. In this rock, too, the sorting of material is poor but the grainsize of the coarse fraction is regular.

In 2943, the ratio of coarse fraction to matrix is about equal to unity. The quartz is well sorted, and the rock shows some evidence of lamination.

In No.2947 the ratio of coarse material to matrix almost approaches unity, but the sorting of this rock is poor.

Nos. 2941 and 2944b have similar characteristics. The matrix is more abundant than the coarser fraction, and, although the sorting is poor, the variation in grainsize is regular. These two rocks may have been further from the source of the quartz.

In all rocks except 2941, tourmaline and zircon are the accessory minerals. 2941 has only tourmaline.

Pseudomorphs of ferromagnesian minerals are found in all types.

On the whole, the group is similar in composition with some environmental differences.

No.3203 is a well sorted quartz greywacke with a coarse fraction to matrix ratio that approaches unity. It has a regular grainsize and is laminated. Quartz is its dominant coarse mineral, and sericite is dominant in the groundmass. Tourmaline and zircon are present and pseudomorphs of ferromagnesian minerals are found. In all this it resembles No. 2943 of the above group. It differs from the above group in its colour, which is derived from the limonitic coating of the quartz grains and possibly from finely-divided carbon. This coating effect indicates that the rock had a different history from those of the other group. Perhaps reworking of the rock by shallow water currents effected the coating.

All these quartz greywackes (Condon,1953) lack feldspathic material and would be called sub-greywackes in the nomenclature of Krumbein and Sloss (1951).

1120: <u>Black Siltstone.</u>
The hand specimen is a black, fine-grained laminated rock.

The thin section reveals a well-banded fine-grained rock, composed of sericite, yellow chlorite, quartz, and clinozoisite grains, with accessory zircon. Quartz veins cut across the bands.

The siltstone was ground finely, and treated with concentrated H.Cl. to remove any soluble iron oxides. The residue was examined, and was found to contain finely-divided dark material in the grains. Some of this was leucoxene, and, possibly ilmenite as well.

The residue, after ignition, assumed a pale buff colour. On examination it was seen that most of the finely-divided dark material had gone, and only leucoxene and ilmenite remained. This seems to be sufficient evidence to conclude that finely-divided carbon is present in the rock. In fact, it may safely be stated that the dark colour of the rock is due mainly to carbon.

2993: <u>Granitic granophyre.</u>
The rock is dark grey, medium-grained, and homogeneous.

The thin section reveals prominent graphic texture. Quartz and potash feldspar are intergrown extensively. The feldspar is commonly altered to mixtures of sericite and some clinozoisite, but the graphic texture is still preserved. A few phenocrysts of intermediate plagioclase are present.

Dark green pleochroic hornblende, and biotite and magnetite fragments, make up the remainder of the rock. Much hornblende is replaced by green chlorite and magnetite granules.

1131: Micaceous Quartz Granulite.

The hand specimen is a coarse inhomogeneous rock, with large porphyroblasts of sericite.

The thin section emphasises the inhomogeneity. There is a layer of recrystallised quartz grains (60%) which are surrounded by sericite (10%), chlorite (15%), magnetite (5%), and muscovite shreds (5%). Penninite pseudomorphs (5%) after biotite retain the pleochroic haloes around zircons. There are some penninite pseudomorphs which may be derived from another ferromagnesian mineral. Another layer in the sediment consists of muscovite and chlorite. This layer was probably an original shale.

An analysis, calculated from the percentages of the minerals in the rock, suggests that the original rock was a sandy shale. This has been metamorphosed, and is now a micaceous quartz granulite.

In view of the evidence provided by specimen 1131, more perhaps can be guessed about the origin of the nearby B2988, which is a mica schist. Again from a calculated analysis, the original rock may have been a slightly ferruginous claystone.

2992: Meta-Rhyolite (Metamorphosed Rhyolite)

The hand specimen is a pale green spotted rock. Numerous chlorite and limonite spots about 1.5mm. in diameter, radiate from a central euhedral quartz phenocryst. These phenocrysts are sometimes partly replaced by chloritic material. The spheres of chlorite and limonite may have been derived from any ferromagnesian mineral. The groundmass consists of quartz grains, chlorite, fine grained clinozoisite and limonitic material. A few chlorite pseudomorphs of amphibole are present.

Bald Hill Volcanics

3039: Fine grained Tholeiitic Dolerite.

The hand specimen is a dark reddish grey homogeneous rock.

The thin section reveals a holocrystalline intergranular texture. Grains are regular in size, averaging about 0.5mm. Labradorite laths, some of which are zoned (An_{65} to An_{68}), surround augite and pigeonite grains. Hematite grains and patches of yellow green chlorite fill in the spaces. Alteration of augite to yellow-green chlorite (chlorophaeite?), is common. A little sericite and clinozoisite are products of feldspar alteration.

As far as petrographic diagnosis is concerned, this is a fine grained tholeiitic dolerite. Field occurrence for this type could be a sill, dyke, or a lava flow.

3021: Tholeiitic Dolerite

This medium grained reddish rock is veined with fine reddish material.

The medium grained material is tholeiitic dolerite consisting of augite, pigeonite grains, and feldspar laths in an intergranular texture. Hematite grains and patches of yellow green chlorite (chlorophaeite?) and brown prochlorite fill in spaces.

Albitisation of the feldspar has been extensive. It is now oligoclase, but it is unlikely that this is the composition of the original feldspar. Sericite and clinozoisite are also products of feldspar alteration. The augite is partly altered to uralite.

Close to the veining material, the dolerite becomes coarser in grainsize. This possibly indicates heating of this part of the rock during the intrusion of the vein.

The vein-material is a fine grained mass of feldspar microlites, hematite grains, prochlorite, yellow green chlorite, calcite and clinozoisite. The green chlorite surrounds patches of calcite which are again surrounded by clinozoisite. Green chlorite pseudomorphs pyroxene, and the released calcium has formed calcite.

3015: This <u>tholeiitic dolerite</u> is coarse and reddish, with large greenish amygdules. Poikilitic laths of andesine enclose grains of augite with margins of iron ore. Hematite, pigeonite, and smaller feldspar grains are present in the spaces. Alteration of augite to uralite and chlorite is extensive. Plagioclase alters to sericite, clinozoisite, and albite. The amygdules are filled with prehnite.

3051: This <u>porphyritic tholeiitic basalt</u> is a dark reddish grey with numerous amygdules filled with greenish material.

Large euhedral altered phenocrysts of feldspar occur in a groundmass of small albitised feldspar phenocrysts, hematite, and patches of colourless chlorite. The amygdules are filled with colourless chlorite, surrounded by a rim of fine sericite.

3048: <u>Ashstone (Acidic)</u>

The reddish fine grained rock is well banded. Very fine angular quartz fragments, rounded hematite grains and muscovite shreds occur in a partly isotropic, partly feldspathic groundmass. A very irregular banding is formed by concentrations of hematite grains.

1103B: <u>Altered spherulitic Acid Volcanic Rock</u> (Acid Volcanic)

In hand specimen this is a pinkish-brown, moderately soft, somewhat granular rock with a weakly layered structure. The surface is spotted with greenish grey sericitic patches. The general impression in hand-specimen is that of a highly altered acid volcanic.

Thin-section examination bears this out to some extent, though the evidence is not absolutely conclusive. Thus, it is seen in thin-section that the rock consists very largely of pseudo-spherulitic aggregates of quartz and sericite (and also colourless chlorite). These sub-spherical aggregates have an average diameter of about 1.4mm across. Closer examination shows that they consist of abundant, fine flakes of sericite and colourless chlorite distributed in a roughly radial arrangement in a quartz base. The quartz is commonly in optical continuity over a considerable area, but in many instances this feature is obscured by the great abundance of the inclusions.

Also, in every case the aggregates have an outer zone rendered dark by abundant dusty, hydrated iron oxide. Again the aggregates are commonly cut by fine, acicular quartz needles. These are thought to be very probably inverted tridymite.

Other, less abundant components are rounded quartz phenocrysts, some of which retain some semblance of their original crystal from, elongated prismatic aggregates of hematite, quartz, and sericite (probably all that remains of original ferromagnesian minerals), and small, ragged sheets of white mica.

2905A: Metamorphosed Greywacke or Acid Tuff (Calcareous greywacke).

The hand-specimen is a dark grey, fine-grained, highly compact rock flecked with tiny white spots. Its fracture is distinctly sub-conchoidal. There is no indication of bedding.

In thin-section it is seen that the rock is essentially fine-grained, though the grain-size is notably uneven. Sufficient of the original texture remains to show that, prior to metamorphism, the rock was a fine, sandy sediment consisting of angular grains of quartz, quartzite, feldspar and rock fragments, in an abundant fine siliceous matrix. Grains of the coarser phase would have an average diameter of 0.6 mm. across. It is probable that the pre-metamorphic rock would have been a quartz-greywacke (sub-greywacke), or an acid tuff.

The rock consists largely of recrystallised quartz (70%) fine, green biotite (20%), feldspar (8%), carbonate (1%) and iron oxide (1%).

The general texture of the rock is as indicated above, though the original sedimentary characters have been somewhat modified by recrystallisation. The feldspar is of two types - a kaolinised potash feldspar which appears to have been a detrital component, and fine-grained albite which may well have developed from the matrix during metamorphism. The white spots seen in hand-specimen are kaolinised feldspar. Original rock fragments have been changedto very fine, dense aggregates of cryptocrystalline silica, biotite and iron oxides. Rare calcite is quite inconspicuous and is confined to the matrix.

There are no shearing or other deformational effects, and it is thought that the metamorphism has been of a purely static kind and largely thermal. The grade of metamorphism is low as indicated by the presence of unreacted carbonate, and by the fact that biotite is the only new mineral.

2905B: Calcareous Quartz Siltstone. (Chert with limy inclusions)

The hand-specimen is a fine, hard, compact rock of rather lighter grey colour than 2905A. It also differs from 2905A in being lightly stippled with black spots rather than white, and in possessing a fairly conspicuous, narrow colour banding. This, no doubt, indicates the bedding of the rock. It is also interesting to note that the black spots have an elongated form and are oriented roughly normal to the banding. This is particularly obvious where the substance of the dark spot has been modified by differential weathering.

In thin section it is apparent that the rock is an evenly fine-grained quartz siltstone with an average grain-size of 0.04mm in diameter. There is no indication of the bedding in thin-section. The rock thus consists of fine, little-recrystallised quartz grains (85%) in part replaced by patches of crystalline calcite (12%). Other constituents include fine flakes of sericite and occasional, perfect cubes of pyrite.

It is apparent that this rock has been subjected only to a low grade of metamorphism.

2905C: Metamorphosed Greywacke-Siltstone with biotite and garnet. (Black chert)

A hard, dense, dark grey rock with conchoidal fracture in hand-specimen. On cut surfaces it possesses a fine, distinctly spotted appearance. There is no visible indication of bedding in the specimen provided. It does, in fact, look very like a hornfels.

In thin-section it is seen that the rock is very fine-grained, consisting of highly angular chips of feldspar up to 0.2mm across, but generally about 0.1mm, in a very finely crystalline quartzo-feldspathic groundmass. Throughout the rock are numerous, small clots of flaky green biotite measuring 0.2mm. in diameter and crystal aggregates of colourless garnet. These two minerals always form separate aggregates and never occur together.

The feldspar is largely an intermediate to acid plagioclase forming angular chips and crystal fragments. There is also some potash feldspar and fine microperthite. Quartz forms a finely recrystallised mosaic in the groundmass or matrix, usually with admixed feldspar.

The true nature of this rock is a matter of some doubt. As indicated above, it may well have been a feldspathic greywacke siltstone, in which case the biotite would have been derived from original chlorite, and the garnet from original calcareous matter. The regular localisation of clots of these minerals, however, is difficult to explain since the chlorite and carbonate of a greywacke-type sediment is usually evenly and continuously distributed throughout the rock. This aggregation of the metamorphic minerals suggests the possibility that the original rock may have been a tuff or even an acid lava. In any case, metamorphism has masked the original features of the rock and diagnosis is now difficult.

2906: Fine Biotite Quartz Hornfels with altered concretions. (Calcilutite).

The hand-specimen is a fine, dense, dark grey rock with a sub-conchoidal fracture. Lustrous grains of sulphide minerals indicate a mild degree of mineralisation. The rock is particularly remarkable in that it contains numerous, somewhat elongated spheroidal bodies averaging about 1cm. long by 0.7cm wide. These are most conspicuous where the processes of weathering have acted upon them. Where fresh, many are highly calcareous in composition, effervescing strongly in dilute hydrochloric acid. After such etching treatment all that remains is a soft, black, powdery mass of (?) iron oxides.

In thin-section it is apparent that the main mass of the rock is a fine-grained aggregate of recrystallised quartz measuring 0.02mm. in diameter, flakes of green-brown biotite, and a little muscovite. In this base are embedded larger grains of quartz measuring.1mm. in diameter, plagioclase, microcline and potash feldspar. Thus, it is evident that the original rock was probably a somewhat feldspathic quartz greywacke siltstone, in which the chlorite of the matrix has gone over to biotite.

At odd places throughout the rock there are developed occasional crystals of a calcic garnet measuring from 0.05mm up to 0.9mm in diameter. Most are more or less euhedral in outline and appear to be of the nature of porphyroblasts. There are also very rare, small crystals of apatite. Grains of pyrite are common and magnetite rare. Pyrite appears to be introduced.

The spheroidal bodies present a perplexing problem, particularly since they are far from uniform in composition even within the area of one thin-section. Some consist very largely of calcite in a coarsely crystalline state (commonly tending to spherulitic) with included quartz, feldspar, biotite and powdery ore minerals. The quantity of these inclusions is much reduced with respect to the surrounding rock, and both quartz and feldspar show signs of having been replaced by the calcite. Others are filled mainly by more coarsely crystalline, sugary quartz with relic carbonate, grains of feldspar, areas of (?)epidotic material, powdery opaque minerals, and biotite. There are gradations between these two extremes, and in all cases the powdery iron ore is particularly concentrated at their margins. There are also occasional marginal crystals of garnet, but nothing resembling a garnetiferous reaction rim.

There are several possibilities which must be considered with respect to the origin of these spheroidal bodies. It has been suggested that they may have been vesicles in a fine-grained lava, but the fact that the enclosing rock is, almost beyond doubt, a meta-sediment rules out this hypothesis. Again, it has been suggested that they may have been pebbles in the original sediments. This is improbable for two reasons, firstly that it is difficult to visualise the dropping of such large pebbles in a fine siltstone unless under glacial conditions, and secondly, it is even more difficult to visualise how an unstable carbonate pebble could survive in a sedimentary environment of highly stable minerals under normal circumstances. At all events, the shape and size of these bodies are too regular to be those of detrital pebbles whether glacial or not. They could, perhaps, be fossil remains, but there is no evidence in favour of this.

A fourth explanation could be that they are due to metamorphic segregation and concentration, but the degree of metamorphism is low (biotite grade) and the bodies do not have the structure or appearance of concentrations which have been produced by metamorphic processes. However, this theory cannot be discarded without further investigation - it remains as a distinct possibility.

The last, and we think, most probable explanation is that these bodies were, in fact, calcareous concretions in an original siliceous siltstone. Thus they could well have contained inclusions of minerals indigenous to the siltstone, as is observed in their present condition. Prior to metamorphism it is thought that these concretions were silicified to varying degrees, so that some became highly siliceous while others remained essentially calcareous. They then suffered low grade metamorphism with the enclosing rock. The opaque mineral of the concretions appears to be largely powdery pyrite or a similar sulphide. It is not certain whether it is in this case syngenetic or epigenetic in origin.

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57G/1 7th May, 1956
Report 3.

MINERAGRAPHIC EXAMINATION OF A SPECIMEN OF GRAPHITE.

by

W.M.B. Roberts.

The specimens, submitted by Mr. C.L. Packer of 132 Hall Street, Bondi, N.S.W. consisted of four small, strongly magnetic brittle globules.

The specimens were mounted and polished; examination under high power showed the material to be granular in character, the grains were roughly equi-dimensional, and optically isotropic. They were cemented by a moderately anisotropic material which turned black on boiling for ten minutes in a sodium picrate solution, the grains remaining unaffected. The material had a nacreous lustre in obliquely incident illumination, and was probably the iron carbide, pearlite. Two of the globules, when etched with a mixture of nitric acid and amyl alcohol, were shown to have developed a rim of irregular thickness having an acicular texture, probably formed from another type of iron carbide.

The foregoing results indicate that the globules consist of a eutectic intergrowth of a magnetic iron oxide (magnetite) and iron carbides, one of which is probably pearlite. The only carbon present is that in chemical combination with the iron. The globules appear to be the oxidised residue resulting from the exposure of a steel of low to medium carbon content to a fairly intense heat.

106W/5D 6th July, 1956.

Report 4.

PETROGRAPHIC DESCRIPTIONS OF ROCK SAMPLES FROM B.M.R. 3 PRICES CREEK BORE, WESTERN AUSTRALIA.

by

R.D. Stevens.

The following are brief descriptions of rock samples from BMR 3 Prices Creek bore submitted for examination by S.D. Henderson.

Core 7, 635 ft.

A fine-grained rock of very doubtful origin, consisting of a felted aggregate of sericite, chlorite and clay minerals, and numerous granular ferruginous bodies pseudomorphous after original flakes of biotite. It is apparent that the sericitic and micaceous flakes have no preferred orientation. Small grains of quartz have been found, but are very rare. It is considered that this rock is of ultimate volcanic origin, probably of a trachytic or andesitic nature, but it is not possible to say from this specimen whether it is pyroclastic or igneous.

Core 7, 654 ft.

A specimen of dark, feldspathised biotite schist invaded by a (?) tongue of granite. The schist consists of green, biotite sheets considerably altered to hydrated iron oxides and set in a groundmass of granulated alkali feldspar (orthoclase) and quartz. The feldspar is charged with tiny grains of hematite. The invading granite consists of coarse, anhedral quartz with much finer, interstitial orthoclase and large flakes of altered biotite and chlorite. This granitic material has the appearance of having been severely crushed.

Core 7, 656 ft.

Biotite schist containing numerous, thin quartz lenses parallel to the schistosity. The mica schist itself contains little quartz other than as narrow granular stringers, but in large part the biotite has been chloritised. The quartz lenses are of course grained, anhedral quartz with some inclusions of biotite. The quartz has been highly strained and somewhat fractured.

Core 7,658 ft.

Coarsely crystalline vein quartz transected by narrow veinlets of fine-grained orthoclase and calcite. Pockets of chlorite, altered mica, calcite, and hydrated iron oxides are common. The quartz has been highly strained, and the rock, as a whole, has been somewhat shattered.

Core 8, 686 ft.

Fine-grained, biotite-quartz schist of much lighter colour than the previously determined biotite schists, and containing considerably greater quantities of granular quartz (perhaps 70%). Granular pyrite is commonly present in small amount, usually irregularly disseminated, but in some places having a distinct orientation parallel to the schistosity, and rarely filling fractures transverse to the schistosity. Biotite, too, is quite common particularly concentrated in narrow bands parallel to the schistosity. This gives the hand-specimen a thinly lined structure. Such bands may represent original bedding. Poorly developed en eschelon quartz veins are also present, but not common.

Core 9, 689 ft. to 690 ft.

A fine to medium-grained hornfels made up of granoblastic grains of quartz, microcline, microperthite and albite, small flakes of biotite, and a little muscovite, and granular pyrite and magnetite. Biotite and the ore-minerals are commonly included in the granoblastic constituents. In many places the texture becomes finer and distinctly schistose, the rock then becoming a quartz-feldspar-biotite schist relatively rich in opaque minerals.

Core 10, 693 ft.

A fine-grained quartz-biotite hornfels containing a small amount of albite, abundant magnetite, narrow veins of pyrite, and conspicuous scattered glomeroblastic garnet. The garnet has possibly been formed by reaction between small calcareous bodies and the surrounding rock.

160G/1 9th July, 1956
Report 5.

EXAMINATION OF SPECIMENS COLLECTED FROM THE THACKARINGA HILLS AREA NEAR BROKEN HILL, N.S.W.

by

W.M.B. Roberts.

Two specimens were submitted by Mr. P.B. Nye for identification and for determination of the presence of vanadium. The specimens were labelled R.E.B. Vanadium No.I and R.E.B. Vanadium No.2.

Specimen No.1 consisted of four small fragments of a black sub-metallic material having a fairly high specific gravity. All four fragments were polished and examined in reflected light. They proved to consist of rutile containing intergrowths of ilmenite. The rutile was seen to be twinned in one direction, probably the (110), when viewed roughly parallel to the C axis; the intergrowths of ilmenite also occur in this direction. Small exsolution bodies of ilmenite are distributed regularly throughout the rutile; these lamellae and those resulting from the twinning were lenticular and strongly curved, indicating a stress applied subsequent to deposition. No other opaque minerals were present except minor amounts of quartz and feldspar.

The four specimens were broken into approximately equal parts and one half of each was crushed. The crushings were separated on the Isodynamic separator by J. Ward, and gave roughly 60% rutile and 40% ilmenite. Each of these minerals was checked spectrographically for the presence of vanadium, which was found to be present in small amounts in both the rutile and the ilmenite, although to a lesser extent in the latter mineral.

Specimen No. 2 consisted of ten pieces of a black sub-metallic mineral having a coating of sericitic material and granular quartz.

A section from each was polished and examined in reflected light. One consisted entirely of fine grained crystallized ilmenite having an average grainsize of 0.25 mm. in diameter. The other contained rutile with bladed intergrowths of ilmenite in two directions at 50° to each other viewed in the plane containing the a and b axes. These were probably in the direction of the (110) and (100) planes, typical of rutile. Elongated lenticular strain twinning was observed throughout the rutile; the lamellae were strongly distorted indicating some stress operative subsequent to deposition. No other opaque minerals were present.

Small pieces from each specimen were crushed and separated in the Isodynamic Separator. The fine grained specimen of recrystallized ilmenite contained almost 100% ilmenite, and the specimen containing rutile-ilmenite intergrowths contained roughly 50% rutile and 50% ilmenite.

Spectrographic analysis revealed the presence of vanadium in both the rutile and the ilmenite, although, as in specimen 1, less vanadium was present in the ilmenite.

The sericitic material was in places a dark green colour, and in the belief that it may have been the vanadium mica, roscoelite, a scraping was analysed spectrographically and shown to contain only traces of vanadium. The refractive index of less than 1.660, as well as this small amount of vanadium, ruled out the possibility of the mineral being roscoelite. It is probably sericite with a slight vanadium contamination.

The identification of both the rutile and the ilmenite was confirmed by X-ray diffraction.

89NT/1 19th July, 1956

Report 6.

EXAMINATION OF MINERAL SPECIMENS FROM THE SOUTHPORT-BYNOE HARBOUR AREA, N.T.

by

W.M.B. Roberts.

Eighteen specimens from the Southport-Bynoe Harbour area, N.T., were submitted by Mr. K.W.A. Summers, of the Darwin Office, for identification. The examination was carried out with a view to determining which of the specimens contained columbium minerals.

Fifteen of the specimens are greisens; the remaining three are apparently picked fragments of heavy minerals from alluvial or eluvial deposits.

The specimens were crushed, and the dark minerals separated. Samples as nearly representative as possible were taken from each specimen, and placed on a zinc plate over which dilute hydrochloric acid was poured.

In this way the cassiterite was determined immediatly as those fragments on which a coating of metallic tin appeared after five minutes treatment, due to reduction of the SnO_2 by nascent hydrogen.

Those minerals unaffected by this treatment were crushed and examined microscopically to distinguish opaques from non-opaques. The opaque minerals were then analysed spectrographically, a semi-quantitative method being used to determine the tantalum content; they were then X-rayed to identify them positively.

Every care was taken to obtain a representative sample from each specimen, but it is possible that minor amounts of other heavy minerals were not picked during the sampling.

It would have been preferable, if, in addition to rock specimens, concentrates prepared from representative bulk samples had been sent for examination.

The following are the results obtained:-

Specimen B6501 - greisen.

The accessory mineral was identified as cassiterite, containing small quantities of columbite-tantalite as intergrowths. These latter were identified from the spectrographic analysis, which showed appreciable amounts of columbium and tantalum in the concentrate.

Specimen B6502.

This specimen of picked fragments of heavy mineral, consists wholly of columbite which contains only a trace of tantalum.

Specimen B6503 - greisen.

The accessory mineral in this specimen is cassiterite.

Specimen B6504 - greisen.

The accessory mineral was identified as cassiterite.

Specimen B6505 - greisen.

The accessory minerals consist of 20% cassiterite and 80% columbite; the latter contains less than 5% tantalum.

Specimen B6506 - greisen.

The accessory minerals are cassiterite and columbite.

Specimen B6507 - greisen.

The accessory mineral in this specimen is cassiterite.

Specimen B6508 - greisen.

The accessory mineral was identified as cassiterite.

Specimen B6509 - greisen.

The accessory mineral in the specimen is cassiterite.

Specimen B6510 - greisen.

The accessory mineral is cassiterite.

Specimen B6511.

The specimen, a concentrate, contained about 20% cassiterite and 80% columbite. The columbite contains approximately 5% tantalum.

Specimen B6512 - greisen.

The accessory minerals are tourmaline and a very small amount of a black opaque mineral which could not be identified. Spectrographically it was shown to contain no tantalum or columbium. An X-ray powder photograph yielded a very diffuse pattern for which no data were available in the A.S.T.M. index. The mineral is slightly radioactive, and gave a positive test for uranium with the sodium fluoride bead.

Specimen B6513 - greisen.

The accessory minerals are cassiterite and columbite, which form intimate intergrowths with each other. Examination of the thin section shows that the dark minerals consist of approximately 60% columbite and 40% cassiterite.

Specimen B6514 - greisen.

The accessory mineral was identified as columbite which contains less than 5% tantalum.

Specimen B6515 - greisen.

The accessory minerals are cassiterite 40% and columbite 60%.

Specimen B6516 - greisen.

The accessory mineral in this specimen is cassiterite.

Specimen B6517 - greisen.

The accessory minerals are approximately 50% cassiterite and 50% columbite.

Specimen B6518

The sample, a concentrate, contains approximately 85% cassiterite and 15% columbite; the latter contains less than 5% tantalum.

It is of interest to note that most of the cassiterite present in the specimens shows a strong pleochroism from colourless to wine-red. Pleochroism is reported as being only very rarely observed in this mineral.

A feature of the greisens is the complete absence of feldspar in all of the specimens.

170ACT/2
Report 7.

2nd August, 1956

EXAMINATION OF ROCK SPECIMENS FROM THE UPPER COTTER DAM SITE C.

by

W.B. Dallwitz and W.M.B. Roberts.

Four specimens were submitted from the Upper Cotter Dam Site C by L.C. Noakes in July 1956.

Specimen UC.C.36.

This specimen is composed almost entirely of quartz and biotite. The quartz occurs as a mosaic of grains whose size ranges from 0.03 to 0.65 mm. in diameter , the average being about 0.15 mm.. Biotite is irregularly distributed as an interstitial filling, thought most of the quartz grains are contiguous. The mica occasionally forms small partial rosettes ranging up to 0.35 mm. across; this structure indicates that the mineral is not detrital, but probably the metamorphic equivalent of a chloritic cementing medium in the original sandstone. The biotite makes up 5-8 percent of the rock.

Hydrated iron oxides, zircon, and black iron ore are accessory minerals.

The rock is a biotite quartzite.

Specimens UC and UC C36M.

The rock labelled UC consists mainly of extremely fine-grained sericite containing occasional splintery fragments of quartz ranging up to 0.1 mm. in length.

Distributed throughout the rock are rings of hydrated iron oxide which measure an average 0.15 mm. across; these contain as their centres sericite having a slightly coarser grainsize than that which forms the bulk of the rock. The rock has a spotty appearance in thin section. The rings are probably the result of a metamorphic process whereby centres of coarsely crystalline sericite have begun to form, and free iron oxide has been expelled, giving rise to an incipient "Liesegang" effect.

Specimen UC C36M is essentially of similar composition to specimen UC. However, there is a decided directional structure present which is entirely lacking in the latter rock, and the diffusion rings of iron oxide have spread until they are lost in the main body of the rock, leaving only the centres of coarser sericite, from which the rock derives its "oolitic" appearance. A minor difference is the presence of a small quantity of chlorite.

The two major differences suggest that specimen UC C36M has been subjected to a slightly higher degree of metamorphism than specimen UC, i.e. it is located nearer an intrusive rock.

The presence in both specimens of splintery quartz fragments suggests that they were originally tuffaceous rocks, probably rich in feldspar, which has been converted to sericite by a process of retrograde metamorphism.

There is also the possibility that the original rock was a shaly type, in which progressive metamorphism could have brought about changes resulting in the same mineral assemblages.

However, the presence of the splintery quartz fragments could not be so readily explained in a true argillaceous sediment so their presence may be regarded as favouring a volcanic origin for the specimens, which may therefore be called spotted sericitised hornfelsic ashstone.

As it is a metamorphic process which is responsible for the spotted appearance of specimen C36M, it would be inadvisable to use the bed from which it was taken as a marker on the basis of this feature alone, because the spatial relationship of the bed to the intrusive rock body may not be constant.

Specimen UC C.32.

This specimen is composed almost entirely of quartz grains in a matrix of radial actinolite. A small quantity of hydrated iron oxide occurs moulding quartz grains. The ratio of quartz to actinolite is about 6:4.

The quartz grains are sub-angular to rounded, and their size ranges from 0.02 mm. to 0.4 mm., they show some evidence of recrystallisation, in that throughout the rock groups of grains form larger masses having a mosaic texture. The commonly radial form of the actinolite indicates that it is not of detrital origin, in which case the recrystallisation of the quartz grains and the formation of actinolite are the result of metamorphism of an impure dolomitic sandstone.

The rock is an actinolite quartz hornfels.

Specimen C 1.

Upper Cotter Dam-Site C.

Microscopic examination of this specimen shows it to consist of a very fine grained sericitic rock interbedded with rock consisting of rounded quartz grains having a sericitic interstitial filling. The rock, an interbedded phyllite and quartz siltstone, has been derived from an interbedded claystone and siltstone by very low grade dynamic metamorphism. This metamorphism has impressed upon the rock a cleavage parallel to the bedding as well as a crenulation at 45° to it. The quartz bands, the individual grains of which are sub-microscopic to 0.03mm. in diameter, show well defined graduation in their grainsize, and are obviously the original graded beds virtually unaltered by the stress.

Specimen C81A.

Upper Cotter Dam-Site C.

The specimen is fundamentally similar to specimen UC.C.36 described previously. Minor differences are a slightly higher percentage of quartz, chlorite interstitial fillings instead of biotite, and a small amount of introduced tourmaline. It is possible that some clusters of very fine grained sericite represent sericitised felspar, but this could not be positively determined.

The chlorite forms irregular masses and radial aggregates ranging up to 0.1 mm. across; the radial structure denotes their metamorphic origin. Many of these areas are being replaced by tourmaline which forms small euhedral crystals and irregular grains, the form of the latter probably determined by that of the original chlorite.

The rock, a <u>chloritic quartzite, containing some tourmaline</u> could have been formed either by:

1. metamorphism of the original matrix of the sandstone to chlorite and a late stage hydrothermal introduction of tourmaline, replacing the chlorite;

2. the matrix of the original rock has been altered to biotite as in specimen UC. C.36 and the late stage hydrothermal activity which gave rise to the tourmaline has retrogressively metamorphosed the biotite to chlorite.

This latter mode of origin is the more probable in view of the field evidence which suggests that this specimen is located closer to the granite than specimen UC. C.36. It would be expected that as the latter specimen has reached the biotite grade the specimen closer to the granite would have at least done so.

1980/2 14th August, 1956.
Report 8.

PETROGRAPHIC EXAMINATION OF SUSPECTED CALC-SILICATE ROCKS FROM A BELT WEST OF SELWYN, QUEENSLAND.

PART I

by

W.B. Dallwitz.

Following is a petrographic report on rocks collected by W.C. White from a belt west of Selwyn, Queensland.

A number of the 23 rocks examined was thought, on field evidence and macroscopic examination, to be possible calc-silicate rocks or altered calcareous rocks. Microscopic examination shows that no calc-silicate rocks are among those described, and that only one (specimen B5001) had been carbonate-bearing; it is uncertain whether the carbonate was of sedimentary origin or whether it was introduced prior to being replaced, as described below, by chalcedony and hydrated iron oxide.

Metasomatism has been active in some of the rocks, and has resulted in the formation of porphyroblasts of muscovite in several, and in the crystallization of microcline in two; in one of these latter, tourmaline has also been introduced.

A clay mineral occurs as a "matrix" in many of the sedimentary rocks, and as veinlets in two or three; no satisfactory explanation of its origin has so far been found.

Specimen B3362(a): 1 mile west of McKinley track, 2 miles South of Chatsworth track junction with McKinley track. A very fine sandy rock containing flakes of muscovite.

In thin section the rock is seen to consist mainly of quartz (65 per cent), feldspar (15 per cent +) and muscovite (10 per cent). The average grainsize of these minerals is about 0.08 mm. Most of the quartz grains have been recrystallized to some extent, because some of the grains interlock, and others show straight edges, but the recrystallization has not been sufficiently severe to give the rock the character of a quartzite. The feldspars are orthoclase, albite, and oligoclase. Some of the mica flakes are of such size, disposition, and form (partial rosettes) that one must conclude that they are not detrital but have been built up by a metasomatic process, though it is clear that most of the flakes are of sedimentary origin.

Accessory minerals are black iron ore (possibly hematite), very irregularly distributed aggregates of a clay mineral, hydrated iron oxide, green tourmaline, and zircon. The shapes of the hematite grains are such that the mineral appears to have been introduced.

The rock is a <u>very fine, micaceous, feldspathic sandstone.</u>

Specimen B3362(b): Same locality as B3362(a).

The hand specimen consists of several bands of varying thickness up to 4 cm; this variation in thickness is probably due to current-bedding. As far as the hand specimen is concerned the variation in appearance of the bands seems to be due to differing contents of minerals other than quartz, notably mica. The section has been prepared from one of the mica-rich bands, which have a more porous appearance, at least on the cut surface, than have the bands which are poorer in mica.

In thin section the rock is found to consist of partly recrystallized quartz, a colourless clay mineral (R.I. less than that of balsam), bleached biotite and muscovite with accessory black iron ore (probably magnetite or hematite), tourmaline, feldspar, and zircon.

The rock is a <u>very fine micaceous quartz greywacke or very fine clayey, micaceous, sandstone</u>.

<u>Specimen B3349</u>: Four miles West of Answer Mine.

A silty rock containing rather coarse pockets of muscovite and quartz; some of the larger pockets have a drusy aspect, and appear to have been formed by the weathering-out of some pre-existing mineral, leaving mainly quartz, or they may have been left as cavities after pneumatolytic processes (see below) were completed.

The thin section shows that the rock consists of a "matrix" of bleached biotite, (?)clay mineral (R.I. less than that of balsam), quartz grains (0.04 mm.), and detrital muscovite in which are embedded porphyroblasts of muscovite (and rarely of biotite), commonly about 0.2mm. long, and irregularly shaped pockets rich in muscovite and quartz. The detrital flakes of biotite and muscovite have a marked parallel alignment, but the muscovite porphyroblasts have a fairly random orientation. These porphyroblasts (which commonly enclose small quartz grains) and the muscovite-rich pockets have been produced by some pneumatolytic (metasomatic) process. The origin of the (?)clay mineral in this and other rocks to be described is a matter for further consideration.

Accessory minerals are black iron ore and tourmaline.

The rock is a <u>biotitic greywacke siltstone containing porphyroblasts of muscovite and muscovite-rich pockets</u>.

<u>Specimen B5015</u>: Approximately 7½ miles West of Tip Top mine. 7/5224.

The hand- specimen is dark pink and sandy, and is intersected by (?)quartz veins up to 2mm. wide.

In thin section the rock is seen to be made up of formerly well-rounded quartz grains averaging 0.4 mm. in diameter and set in a cement of clay mineral (R.I. almost invariably less than that of balsam) and small quartz grains (0.06 ± mm.). The margins of the large quartz grains are corroded; the grains themselves have commonly been partly recrystallized, and most of them show marked strain shadows, which are probably an original feature, as the rock shows no sign of crushing.

The clay mineral, determined by X-Ray as being disordered kaolinite, makes up about 25 per cent of the rock; it may be of detrital origin or it may have formed by metasomatic change of the original matrix. It is charged with dusty hematite or hydrated iron oxide. It may also occur in pockets up to 3 mm. long; these pockets contain little quartz and no coarse quartz grains.

Accessory minerals are sphene, zircon, and (?)epidote, all present in very small quantity.

This rock, pending final consideration of the origin of the clay mineral, may be tentatively described as a quartz-greywacke.

Specimen B3369: North end of ridge, 2 miles South-west of Mariposa claims (originally referred to as agglomerate).

A porous, sedimentary breccia with a red-brown, sandy matrix in which are embedded numerous angular fragments of light grey to buff fine-grained rocks. These fragments range in size from about 0.5mm. to 3 cm.

The original quartz grains of the matrix were fairly well rounded, and ranged in size from 0.1 to 0.6mm. Every one of them has a shell of secondary silica which has grown out in optical continuity with the quartz of the detrital grains, whose original borders are now clearly marked by a film of hematite or hydrated iron oxide. In the course of this process crystal faces have been locally developed. It seems probable that the greater part of the original matrix between the quartz grains has been replaced by silica; there is no clue as to what this matrix actually was, but it seems likely that it was rich in iron, which is still prominently represented as hematite or hydrated oxide. Accessory minerals in the silicified matrix are muscovite (by far the most plentiful), black iron ore, probable bleached biotite, tourmaline, and zircon.

The angular fragments which are embedded in the matrix consist of fine-grained, siliceous sediments, some of which contain appreciable amounts of sericite and altered (?)biotite.

The rock is a silicified, ferruginous, quartzose, sedimentary breccia.

Specimen B3369(a): Same locality as specimen B3369, and interbedded with the breccia.

A purple-grey, porous, bedded, sandy rock resembling the matrix of the breccia just described.

In thin section this rock is closely similar to the matrix material in the breccia; it consists of quartz grains with well-developed secondary outgrowths, a fine-grained mosaic of interstitial quartz, and accessory muscovite, hematite or hydrated iron oxide, altered (?)biotite, and rare tourmaline.

The rock is a silicified, ferruginous and micaceous sandstone.

Specimen B3373: 1 mile West of Mariposa claims (a rock-type associated with B3369).

A medium-grained, porous, sandy micaceous rock spotted with flecks of iron oxide.

In thin section the rock is found to be composed of quartz (70 per cent), a colourless clay mineral feldspar (mainly albite, but some microcline) together amounting to 25 per cent, muscovite (3 per cent), and small amounts of dusty iron ore, zircon and tourmaline. Probably some of the clay mineral is detrital, but some of it is derived from albite or other feldspar. The average size of the quartz grains is 0.1 mm.; the grains are rather angular, and show some sign of having been partly recrystallized. There is no evidence that the albite is anything but detrital, though it may be partly or wholly authigenic; there is no sign of any veining by albite. Some weak partial rosettes of muscovite are present, and this suggests that some mica may have been formed by pneumatolytic (metasomatic) activity; however, most of the muscovite flakes have a sub-parallel alignment - a depositional feature in this case.

There is no clue as to the origin of the pore-spaces in this or any of the other rocks so far described.

The rock is a very fine silicified quartz greywacke.

Specimen B3393: At 160' in diamond drill hole ½ mile North of main shaft, Mount Cobalt.

A fine-grained, granular rock containing quartz, biotite, and scattered grains of pale pink garnet. The core has broken at one end along a biotite-rich layer.

The thin section shows that the rock is composed essentially of a finely granular mosaic of quartz (80 per cent +), flakes of biotite, and poikiloblastic porphyroblasts of garnet measuring up to 0.4 mm. across. Accessory minerals are oligoclase-andesine, microperthite, black iron ore, probable ferrosalite ($FeSiO_3$), apatite, zircon, and a single grain of calcite. A veinlike zone in which patchy albitization has taken place traverses the slide; this zone is about 0.5 mm. wide, and the albite has been partly sericitized. The calcite grain is closely associated with the albite.

The rock is a garnetiferous biotite quartzite.

Specimen B5008 (K77): 6 miles West-south-west of Agate Downs homestead. 6/5050.

A sheared, porphyritic rock containing phenocrysts of plagioclase measuring up to 3 or 4 mm.

In thin section the groundmass of the rock is seen to be made up of finely granular quartz, acid plagioclase, orthoclase, black iron ore, and rare microcline. The influence of shearing is visibly expressed particularly in trains of particles of iron ore which wrap round the phenocrysts, many of which have become somewhat rounded, others more or less lenticular, and still others marginally or completely granulated. The most abundant porphyritic crystals are oligoclase: orthoclase is much less plentiful, and, where marginally stressed and granulated, microcline has formed from this mineral. Quartz phenocrysts were scarce, and every one of them has been completely granulated.

There is little evidence of any ferromagnesian mineral. A very small amount of biotite and chlorite was detected, and these minerals are usually accompanied by sphene, black iron ore, and quartz; other lenticular bodies consist of the last three minerals alone, and it seems possible that former biotite has been replaced by these minerals mainly.

Accessory minerals, in addition to biotite and chlorite, are apatite, (?)allanite, and zircon.

It is difficult to estimate the relative amounts of potash -feldspar and plagioclase in the groundmass of this rock, so that it is not possible to say with certainty whether it belongs to the adamellite or the granodiorite clan. It is also not possible to determine whether the rock is extrusive or intrusive.

Following are the possible names:

Clan	Extrusive	Intrusive
Adamellite	Toscanite	Adamellite Porphyry
Granodiorite	Dacite	Granodiorite Porphyry

I favour either of those underlined.

Specimen B3338(b): 1 mile North-west of Belgium Mine.

A micaceous and sericitic rock, containing abundant off-white clots up to 5mm. across set in a light rust-brown matrix. A rough directional structure results from a rather poor alignment of the muscovite flakes.

The thin section presents a confusing picture, but the general impression is that the rock was either igneous (a porphyry or a granitic rock) or a granitized argillaceous sediment. Any feldspar which may have been present has been converted to sericite and a clay mineral.

Clots consisting of granulated quartz, irregular masses of clay mineral (R.I. less than that of balsam), and generally small amounts of sericite are set in a matrix of sericite, muscovite, and slightly pleochroic material heavily stained with hydrated iron oxide. This iron-stained material is commonly found in irregular masses, separate from the white mica, though some is also mixed with it; it shows traces of cleavage, and has the appearance of strongly bleached biotite. The larger books of muscovite were probably present in the rock before general sericitization and alteration took place.

Accessory minerals are scattered grains of black iron ore and blue-green tourmaline.

The rock is a sericitized and "kaolinized" acid gneiss or granitic rock.

Specimen B3338(a): Same locality as specimen B3338(b).

A soft, strongly sheared rock consisting of very pale grey streaks and flat lenticles separated by abundant iron-stained more siliceous material which corresponds to the rust-brown substance referred to in the description of specimen B3338(b). The largest grey streaks are up to 3mm. wide and several centimeters long, but the narrowest are only a fraction of a millimeter wide.

In thin section it is seen that the grey streaks and lenticles consist largely of well-aligned flakes of sericite and muscovite; some quartz hydrated iron oxide, and clay also occur as streaks and clots within the mica. The ferruginous material separating the micaceous streaks consists of finely granular quartz, probable iron-stained, bleached biotite, less easily recognizable than that in specimen B3338(b), a clay mineral (R.I. less than that of balsam), and hydrated iron oxide.

Granular black iron ore and blue-green tourmaline are accessories as in specimen B3338(b).

The rock is a <u>ferruginous "kaolin" bearing quartz-sericite</u>, /gneiss and is clearly a more strongly sheared form of the rock represented by specimen B3338(b).

<u>Specimen B3350(a)</u>: Chatsworth, track 4½ miles South-west of McKinley track.

A porous, brown, ferruginous, micaceous, silty rock, which, in thin section, is found to consist mainly of quartz (60 per cent +) and detrital muscovite (30 per cent +). The quartz grains are about 0.04 mm. across, and are rather angular; they show signs of having suffered some recrystallization. A number of muscovite books, which are several times thicker than the detrital mica flakes, lie across the direction of the bedding, as indicated by the sub-parallel flakes, and are undoubtedly porphyroblasts, probably developed through pneumatolytic activity.

Accessory minerals are black iron ore (possibly hematite), hydrated iron oxide, tourmaline, and probable bleached biotite. It is impossible to tell whether the black iron ore is detrital or not, especially as the shapes of the grains may have been modified through metamorphism (pneumatolysis).

The rock is a <u>ferruginous micaceous quartz siltstone</u>.

<u>Specimen B3350(b)</u>: Same locality as specimen B3350(a).

A pinkish buff, fine-grained, sandy rock, containing a few flakes of muscovite and some well-spaced, thin, dark bands which indicate bedding. Adhering to one side of the specimen is a portion of an argillaceous band, and the contact between this and the sandy rock is parallel to the dark bands.

In section the rock is seen to be composed of quartz (63 per cent), clay mineral (25 per cent), feldspar (10 per cent), and accessory black iron ore, muscovite, zircon, and very rare tourmaline. The average grainsize of the quartz, feldspars (orthoclase, acid plagioclase, and microcline), and interstitial clots of fine-grained clay mineral (R.I. less than that of balsam) is about 0.08 mm.. Some recrystallization has taken place in the quartz, and the grains commonly interlock or have straight contacts with one another. The feldspars are either quite unaltered or contain only isolated flecks of clay mineral, so it does not appear that the latter has been derived directly from detrital feldspars; furthermore, no transitional stages (such as 50 per cent clay, 50 per cent feldspar) between clay mineral and feldspar were noted, and most contacts between these two substances are quite sharp. Either the clay mineral is original (sedimentary), or it is an alteration-product of some other mineral which was introduced (possibly replacing original matrix or cement), or the clay mineral as such directly replaced matrix or cement (low-temperature alumina metasomatism), or it is a replacement of some mineral formed during diagenesis. Strong evidence favouring one of the last three possibilities is provided by the presence of three clay-mineral veinlets making an angle of about 45° with the bedding, and an irregular clot of clay mineral about 1mm. in diameter.

Speculation about the origin of this clot is possible, but will be avoided. One of the veinlets penetrates the argillaceous band noted in the handspecimen.

The pinkish colour of the rock is due mainly to the presence of dusty hydrated iron oxide in the clay mineral. The dark bands noted in the handspecimen are due to concentrations of black iron ore.

The rock is a "kaolinitic" feldspathic quartz siltstone.

The "argillaceous" band consists almost entirely of very fine-grained sericite.

Specimen B3391: East side of ridge 1½ miles South of Mount Doré.

A hard, grey, fine-grained rock with a fairly good cleavage. Flat circular discs (1-3 mm. in diameter) of a pale blue-green mineral lie along the cleavage and along cracks and joints. These discs commonly show concentric banding; X-Ray analysis showed that they were composed of turquois, and a confirmatory test for phosphate was obtained after ignition. Optical examination showed that the turquois is finely granular, as is common with this mineral; its refractive index, although determined only approximately, is of the correct order for turquois, and this information helps to confirm the X-Ray and chemical tests.

In thin section the rock is seen to be composed almost entirely of recrystallized quartz (80 per cent +) and sericite (15 per cent). Accessory minerals are iron oxides (hematite, etc.) and leucoxene. The average grainsize of the quartz is 0.04 mm., and the grains are generally elongated in the direction of cleavage as defined by the parallel sericite flakes. The rock contains a system of quartz-veinlets and lenticles, which fill rather irregular fractures.

The rock is a sericite-quartz schist, probably derived from a sericitic quartz siltstone.

Specimen B3333 (a): Chatsworth track, 3 miles South-west of McKinley track.

A brownish-puce, silty rock with abundant porphyroblasts of muscovite.

The thin section shows that the rock is composed of equidimensional angular quartz grains (34 per cent) whose diameter is about 0.04 mm., and porphyroblasts of muscovite (15 per cent) set in a fairly evenly distributed matrix of rather clear clay (48 per cent). Accessory minerals are thin streaks and granules of hematite or hydrated iron oxide, leucoxene, and very rare black iron ore and tourmaline.

The porphyroblasts of muscovite have a random orientation, and were probably formed through pneumatolytic activity; their size is variable, but many measure about 0.4X0.2 mm.. Some detrital sericite may be present, but it is not possible to differentiate such material from the porphyroblasts with any certainty.

The origin of the clay mineral (R.I. less than that of balsam) is again a matter for speculation. It does not appear to be detrital, and may have been derived from feldspars, or it may have a metasomatic or diagenetic origin, as explained for specimen B3350(b). It occasionally occurs in clots up to 0.5 mm. across; these clots contain little or no quartz.

Assuming that the clay is either detrital or derived from detrital feldspars the rock would be called either a silty claystone with porphyroblasts of muscovite or a kaolinized arkose siltstone with porphyroblasts of muscovite, but if the clay or its progenitor ((?) feldspar) is of metasomatic (pneumatolytic) origin neither of these names would be applicable; until the probable origin of the clay can be ascertained from other evidence, it is almost impossible to allot a correct name, particularly if the clay should have the second general mode of origin postulated.

Specimen B3333(b): Same locality as specimen B3333(a).

A very fine sandy to silty ferruginous rock containing scattered flakes of mica and a network of veinlets of creamy white to pinkish iron-stained clay mineral, which has been identified by X-Ray as a disordered kaolinite. These veinlets range in width from a small fraction of a millimeter to about two millimeters.

In this rock the problem of the origin of the clay mineral in the sedimentary rocks reaches its climax. It is difficult to estimate the percentages of the various minerals in thin section, because of the variable amounts of clay mineral in different parts of the rock; however, approximate figures are: quartz, 67 per cent; kaolin, 25 per cent; granular black iron ore ((?)hematite) and streaks of hydrated iron oxide, 5 per cent; muscovite, 3 per cent; and rare tourmaline. The quartz grains are of irregular outline, and their size ranges, in different bands, on either side of the size limit (0.06 mm.) set by M.A. Condon (1951) for the division between very fine sand and silt. The muscovite is porphyroblastic, as in specimen B3333(a).

Kaolin, generally iron-stained, is the matrix of the quartz grains, and is rather irregularly distributed in this form. Clots of kaolin virtually free from quartz, and measuring up to 1mm. in diameter, are distributed through the rock, but are very plentiful in one band. Veinlets of clay mineral, subparallel to the bedding but also commonly lying at angles of up to 60° thereto, are plentiful. The kaolin is much coarser-grained than any of that so far described, and most of it occurs in platy forms or in curved, straight, and sigmoidal concertina-like shapes.

No more need be said about the origin of the kaolin at this stage, beyond stating that, in this rock, it can obviously not be of simple detrital origin.

The rock may be tentatively named a ferruginous kaolinitic, quartz siltstone with porphyroblastic muscovite.

Specimen B3357: West side of track, 1½ miles North of Labour Victory Mine.

This specimen almost wholly represents the matrix of a rock that was originally mapped as an agglomerate, but members of the 1956 field party thought it may be a calc-silicate breccia. The rock is medium-grained, saccaroidal, very porous, and coloured red-brown by iron oxide; some parts of it are fine-grained, and are probably fragments in the matrix. A hard mineral, which shows up because of its good cleavage, appears to be feldspar.

As seen in thin section this rock, in many places, has the appearance of an igneous rock, and resembles granite aplite very closely. It consists of grains of microcline (average size about 0.4 mm.) and very much less plentiful quartz of generally much finer grainsize, both stained with dusty hematite, and having interstitial hydrated iron oxide (probably goethite) and leucoxene irregularly distributed between them. A little spherulitic chalcedony is also present. Many of the microcline grains are peppered with granular black iron ore; this feature is fairly rare in the quartz.

Considered in conjunction with the field evidence, the general impression gained is that this rock (with its large fragments) is a sedimentary breccia which has been heavily feldspathized. Other possible interpretations - if less weight is given to the field evidence, and also to some of the microscopic evidence - are that the rock is a feldspathized agglomerate or an aplitic sill with numerous rock fragments caught up in it. Against the suggestion that it is altered agglomerate is the fact that the rock unit is continuous and of fairly constant thickness over considerable strikelength, is apparently interbedded with sediments, and grades into what have been called calc-silicate rocks. The same evidence may, to some extent, also be taken to militate against the idea that it is an aplite.

Whether the rock was an agglomerate or a sedimentary breccia, it is impossible to say, with any degree of certainty, what the matrix (specimen B3357) was before feldspathization. It was almost certainly not a calc-silicate breccia; it may have been calcareous, though there is nothing whatever to suggest that it was.

Some fragments of the finer-grained material mentioned in describing the handspecimen appear in the thin section. They are all of the same kind, have irregular margins, and are "veined" and broken up by the same type of material as forms the matrix; the apparent veining by the coarser material is most probably due to metasomation also. They have exactly the same mineralogical composition and texture as has the coarser matrix, and contain some larger grains of microcline measuring up to 0.4 mm. across. This similarity of composition and texture suggests strongly that the whole rock is a feldspathized breccia, and not an aplite with fragments, because it is unlikely that fragments could be so strongly feldspathized if merely enclosed in an aplite. The finer internal grainsize of the fragments is probably attributable to an originally fine grainsize in the unaltered rock; the coarser grainsize of the matrix most likely also reflects a coarser original grainsize, but not necessarily so: if the matrix had been more permeable than the fragments, or carbonate-bearing, or both, it may have been more amenable to metasomatism and to the consequent development of coarser texture.

The weight of the evidence suggests that this rock, considered as a whole, is a <u>feldspathized sedimentary breccia</u>; that it is a <u>feldspathized agglomerate</u> seems to be less likely.

<u>Specimen B3359</u>: West side of track, $1\frac{1}{2}$ miles North of Labour Victory Mine.

This rock is part of a fragment from the breccia described above (Specimen B3357). It is a slightly porous, fine-grained, massive, and light purplish brown, and contains numerous dark specks (about 0.3 mm. in diameter) and a few flakes of biotite; the mica is best visible in weathered parts of the specimen. The rock has the appearance of a rhyolite.

The thin section shows that the rock consists of acid plagioclase and microcline (together equal to 60 per cent), interstitial small, irregular, interconnected pockets of chalcedony (35 per cent), grains of black iron ore, apatite, (?)brookite, minute flecks of sericite, quartz grains, dusty hydrated iron oxide, very sparsely distributed books of biotite and rare (?)epidote. The outlines of the pockets of chalcedony are commonly cuspate. The average grainsize of the feldspars is 0.03 mm.. The chalcedony has a refractive index considerably less than that of balsam; some larger drusy pockets of it may represent altered feldspar phenocrysts. The few quartz grains present have a size up to 0.3 mm., and are possibly phenocrysts. Dark specks noted in handspecimen turn out to be poikilitic black iron ore, and are most probably pseudomorphs of original porphyritic crystals of a ferromagnesian mineral.

The specimen is probably a <u>chalcedonic rhyolite or dacite</u>

<u>Specimen B5001</u>: 1 mile north-north-west of Triggie Vous Mine. 6/5051 (thought to be a possible calc-silicate breccia).

This rock, I believe, is part of the same bed or body represented by specimens B3357 and B3359. The handspecimen has the appearance of a sedimentary breccia or an agglomerate, and consists of fragments of rounded to angular pinkish buff, greyish brown, and brown, fine-grined rocks, embedded in a hard mottled brown and black matrix. The fragments range in size from a fraction of a millimeter to 2.5 cm; some of them are fairly hard, and others are quite soft. The brown material in the matrix is generally slightly cellular.

The matrix of this rock consists of medium-grained quartz, partly spherulitic chalcedony, greenish-to bluish-grey tourmaline, accessory microcline, and rare sericite. The tourmaline is commonly very concentrated, and the black clots noted in handspecimen are generally rich in tourmaline. The brown areas consist of somewhat cellular chalcedony containing hydrated iron oxide as crack-fillings and irregular clots; some long streaks of iron oxide simulate the pattern of cleavages in coarsely crystalline dolomite. The rock fragments show some variations; a few consist entirely of ironstained, fine-grained microcline, and therefore resemble the fine-grained material of specimen B3357; others consist of tourmaline and subordinate quartz; and still others are made up of feldspar (microcline with or without acid plagioclase), quartz, rhombic pseudomorphs in chalcedony and hydrated iron oxide, tourmaline, and sparsely distributed sericite. The first and last of these three types of fragments most probably represent feldspathized sediments. The rhombic pseudo-morphs are, in general, outlined in iron oxide, and their interiors consist of chalcedony and subordinate iron oxide; the average length of their long diagonals is about 0.08 mm., and they undoubtedly represent a former carbonate, probably ferriferous dolomite or siderite. The same applies to the much larger chalcedony-iron oxide bodies in the matrix.

There is no doubt that this rock is an altered sedimentary breccia, and it may be described as a <u>feldspathized and tourmalinized, silicified, chalcedonic, sedimentary breccia</u> representing a stage of change beyond that seen in specimen B3357. There is scarcely any chance that it was a calc-silicate breccia, but it was undoubtedly a carbonate-bearing rock at one time. Whether the carbonate was of sedimentary origin or whether it was introduced can not be decided. It is even possible that the feldspathized and tourmalinized fragments with rhombic pseudomorphs represent dolomitic limestone in which the calcareous matrix has been replaced by feldspar and some tourmaline, but this suggestion must be regarded as mere conjecture, as there is absolutely no concrete evidence on which to base such an idea.

The four rocks now to be described present considerable difficulties, because they are so altered that one can not be at all certain in deciding what they were originally. They were collected from two small bodies close to a stock of dolerite, and they may have been altered by that intrusion. On the other hand, the alteration may be due, either wholly or in part, to lateritic weathering, or to autometasomatism, for the rocks are almost certainly igneous.

<u>Specimen B3370(b)</u>: 4 miles due West of Selwyn.

This rock is soft, and consists of a light grey matrix speckled with granules of black iron ore and containing irregularly oval to spheroidal white bodies ranging from a fraction of a millimeter to about 2 mm. in diameter. A veinlet of the substance of which these bodies are composed traverses the rock, but is not included in the thin section; this veinlet is about 1 mm. wide.

The grey matrix containing the white bodies is, on microscopic examination, found to consist of amorphous clay mineral (50 per cent) quartz (about 35 per cent), black iron ore, calcite, hydrated iron oxide, leucoxene, and rare zircon.

The quartz is anhedral and granular, and its average grainsize is about 0.05 mm; some of the larger clots have the appearance of having been recrystallized.

The white clots consist of "vermicular" concertina-like "plates" of kaolin with or without calcite. They probably represent original feldspar.

The rock is either a <u>kaolinized aplite</u> or a <u>kaolinized porphyry</u>. If the rock was an aplite it was probably derived from an intermediate or basic parent.

<u>Specimen B3370(a)</u>: Same locality as specimen B3370(b).

A soft, mottled rock consisting of pockets of creamy-white clay mineral set in a brick-red ferruginous matrix.

In thin section the rock is found to be made up of areas of slightly iron-stained kaolin separated by streaky to vein like masses of hydrated iron oxide containing a yellowish-brown mineral which is probably leucoxene. Lesser quantities of iron oxide and leucoxene are included in the neighbouring clay mineral. The appearance of the leucoxene masses suggests that the rock has been crushed.

The kaolin was probably derived from feldspar, and the iron oxide and leucoxene from a ferromagnesian mineral.

The rock may be crushed kaolinized and ferruginized basic pegmatite or a crushed kaolinized and ferruginized diorite or gabbro.

Specimen B3351(b): 4 miles due West of Selwyn.

A pink and off-white, fairly soft mottled rock consisting of clay mineral, bodies of quartz up to 3 mm. long, and specks of black iron ore. The specimen is veined and marginally stained by "limonite".

Microscopically the rock is found to be made up of completely kaolinised feldspar speckled with hydrated iron oxide and containing lenticular bodies and streaks of crushed, recrystallized quartz, and a few grains of sphene and black iron ore. Quartz makes up about 15 per cent of the rock. The quartz bodies have a roughly parallel alignment, and the magnetite and sphene grains are also elongated in the same direction. Some of the sphene grains have transverse fractures normal to the long axes of the quartz bodies.

The rock is a sheared kaolinized intermediate or basic pegmatite or a sheared coarse-grained kaolinized highly feldspathic acid igneous rock.

Specimen B3351(a) - Same locality as specimen B3351(b).

A heavily slickensided, mottled, unevenly porous, red-brown rock containing pockets of quartz and kaolin in a ferruginous clayey matrix.

The thin section shows that the rock consists of rather large bodies of partly crushed quartz in a matrix of almost completely kaolinized feldspar stained with hydrated iron oxide and containing a few grains of black iron ore and zircon. The quartz bodies are not sheared and lenticular as in specimen B3351(b).

The rock is a crushed, kaolinized, intermediate or basic pegmatite or a crushed, kaolinized coarse-grained, highly feldspathic acid igneous rock.

1980/2 5th September, 1956.

Report 8.

PETROGRAPHIC EXAMINATION OF SUSPECTED CALC-SILICATE ROCKS FROM A BELT WEST OF SELWYN QUEENSLAND.

PART II

by

W.B. Dallwitz.

Of the twenty specimens described several may be calc-silicate rocks, though in only one case (specimen B5011) is it certain that the rock is not a metamorphosed basic igneous type.

The exact identity of several other specimens is uncertain because even the low-grade metamorphism to which they have been subjected has changed them sufficiently to obliterate certain minerals which may have been present, and so raise doubts as to whether the rocks were of volcanic or sedimentary origin.

The problem of the origin of the clay mineral in certain sediments has cropped up again, but only very little progress has been made towards its solution.

Specimen B5009.

3½ miles N55°W of Labour Victory Mine. 7/5222.

A fine-grained biotite schist containing porphyroblasts of a buff-coloured mineral. These porphyroblasts are from 0.5 to 1.5 mm. in diameter.

In thin section the rock is found to be made up largely of biotite flakes which have, with comparatively few exceptions a pronounced parallel alignment. Accessory minerals associated with the biotite are tourmaline and apatite, both occurring as rather stumpy prisms. The tourmaline is commonly euhedral, and is pleochroic from light blue-green to colourless; it is very commonly zoned.

The identity of the porphyroblasts has not been altogether satisfactorily established. At first sight they appeared to be slightly sericitized orthoclase, but closer examination showed that this possibility could be discounted because the estimated negative optic axial angle of unaltered material is about 40°. The refractive index of the mineral is distinctly less than that of balsam. The possibility that it is cordierite seems to be the strongest on present evidence (the refractive indices of cordierite are also commonly higher than those of balsam; cordierites with low refractive index are rich in magnesia.) This suggestion is supported to some extent by the form taken by the alteration-product (sericite) in some porphyroblasts; this form is in keeping with that commonly seen in cordierite. Unfortunately no pleochroic haloes appear in the (?)cordierite, and so we are without benefit of what would have been all-important diagnostic feature (if it had been observed); however, absence of these haloes is not a disqualifying factor. Some of the sericitic alteration-product is iron-stained, and this lends some support to the suggestion that it has been derived from cordierite.

Small grains of tourmaline having about the same density of distribution as those in the surrounding biotite are enclosed in the (?)cordierite, and this suggests that the (?)cordierite has been formed from biotite by thermal metamorphism at a time subsequent to the introduction of tourmaline.

The rocks is a <u>porphyroblastic (?)cordierite-biotite schist</u>.

<u>Specimen B5007</u>. 4½ miles WSW of Agate Downs Homestead. 6/5050.

A fine-grained greenish black rock apparently consisting almost entirely of hornblende, and having a rather rough cleavage.

The thin section shows that green hornblende makes up about 90 percent. of the rock. It occurs as elongated grains measuring about 0.1 mm. in the longest dimension. The long axes of the grains have a marked parallel alignment. Scattered through the rock are small grains and groups of grains of albite or oligoclase. A few groups of small epidote grains are present, and sphene, apatite, and black iron ore are rare accessories.

It is impossible to say whether the rock has been derived from a basic igneous rock or a highly chloritic, calcareous sediment.

The rock is a fine-grained <u>amphibolite</u>.

<u>Specimen B5004</u>. 1 mile NNW of Labour Victory Mine. 7/5221.

A fine-grained, dark grey rock resembling dolerite, and containing small grains of probable pyrrhotite.

In thin section the rock is found to consist of light blue-green hornblende (60%), untwinned oligoclase (35%) and pyrrhotite (5%). The bladed grains of hornblende are of very variable size (average about 0.2mm.), and have an absolutely random orientation. Granules and prisms of hornblende measuring about 0.05 mm. are commonly enclosed in the plagioclase.

As for specimen B5007, it is again impossible to be sure of the ultimate origin of the rock, but the general impression is that it is igneous rather than sedimentary.

The rocks is an <u>oligoclase amphibolite</u>.

<u>Specimen B5010</u>. 2 miles N of Tip Top Mine. 7/5221.

A medium-grained, well-cleaved, greenish-black amphibolite containing porphyroblasts of light brown garnet measuring up to 0.5 cm. in diameter.

The slide shows that, apart from garnet, the rock is composed almost entirely of hornblende, which is strongly pleochroic with X = pale buff, Y= bright green, and Z= light blue, and has an average grainsize of about 0.6 mm.. The blades of hornblende have a subparallel disposition. Included in the hornblende are numerous small grains of quartz and a few grains of saussuritized plagioclase. Magnetite makes up about 5 percent. of the rock. The porphyroblasts of garnet enclose numerous small grains of quartz and magnetite and a few grains of chlorite, hornblende, and epidote. A little hydrated iron oxide has been formed from the magnetite, both in hornblende and in garnet.

There is no way of telling from the section whether this rock is of sedimentary or igneous origin.

The rock is a porphyroblastic garnet amphibolite.

Specimen B5011. 1 mile NNW of Farley homestead. 6/5053.

A very fine-grained, light greenish grey rock showing some sign of bedding. The rock breaks most readily in the direction of bedding.

Two distinct bands can be seen in thin section. One consists of oligoclase, pale actinolite, subordinate diopside, accessory sphene, and rare hematite. The other consists of oligoclase, diopside, very subordinate actinolite, and accessory sphene and hematite; this band was, apparently, originally richer in lime. The first of these two bands, near its junction with the diopside-rich band, is very much enriched in actinolite at the expense of oligoclase; the actinolite-rich part is between 4 and 5 mm. wide.

The oligoclase in both bands is rarely twinned and is very fine-grained - slightly finer in the actinolite-rich band (about 0.03 mm.); it is extremely difficult, for these reasons, to tell whether there is any quartz present, but tests with the universal stage, carried out by J.K. Lovering, suggest that there is some quartz in both bands, possibly more in the diopsidic band. The actinolite mostly occurs in needles with random orientation; these measure about 0.12 mm. x 0.01 mm., but a few very much larger tabular grains are distributed through the slide.

The separate bands in this rock are diopside-actinolite-oligoclase hornfels or granulite and actinolite-diopside-oligoclase hornfels or granulite.

Specimen B4516. 3 miles S of Limestone Creek. 9/5143.

A very pale grey, hard, siliceous, fine-grained rock containing ovoid to lenticular bodies about 1 mm. in diameter and slightly darker than the rest of the rock. These bodies are most easily seen on the cut surface. The rock has a rather poorly developed cleavage.

In thin section this rock is found to consist almost entirely of fine-grained quartz (55%) and sericite (40%). The sericite flakes have only moderately well developed parallelism. The average size of the quartz grains is about 0.06 mm. The lenticular bodies are made up of quartz grains about 0.1 mm. in diameter.

Accessory minerals are small grains of subhedral to euhedral green tourmaline, leucoxene, black iron ore, hematite and (?)brookite or (?)anatase.

It is not possible to name this rock with absolute confidence. Were it not for the discrete lenticular bodies of coarser quartz one would be inclined to call it a sericite-quartz schist, but the existence of these bodies and the hardness of the rock favour an idea that the rock is, in fact, a sheared, sericitized quartz porphyry, in which the (groundmass) feldspar has been entirely sericitized, and in which the lenticular bodies represent recrystallized quartz phenocrysts drawn out by shearing. The tourmaline has almost certainly been introduced, probably at the time when the feldspar was sericitized; a little tourmaline is also present in most of the lenticular bodies of recrystallized quartz.

Specimen B3335. N. side of Limestone Creek, 11 miles W of Selwyn. 8/5188.

A hard, fine-grained, pale grey, distinctly banded rock containing numerous grains of pyrite and voids after pyrite. Around the weathered pyrite and the voids the rock has been whitened or, in some places, stained pink or light brown by iron oxide. The walls of the voids are commonly stained brown by "limonite".

The true nature and origin of this rock are problematical. In thin section it is found to consist mainly of extremely fine-grained ((?) recrystallized) quartz (60%) and feldspar (37%+), whose grainsize ranges between 0.01 and 0.04 mm.

Accessory minerals are iron-stained leucoxene, minute flakes of fresh biotite, apatite, black iron ore, and very rare zircon. No pyrite appears in the section. The feldspars are oligoclase and orthoclase; the former is rarely twinned, and it is virtually impossible to judge how much of each feldspar is present, though plagioclase is much more plentiful than is orthoclase.

Although the rock appears to be a pyritic chert in hand-specimen, this diagnosis is difficult to sustain on examination of the thin section, unless it be assumed that the chert was (authigenically) feldspathized and recrystallized during diagenesis - an assumption which may not be unreasonable. The rock if it was originally chert, may also have been pyritized and feldspathized by igneous emanations during orogenesis. It is also possible that the rock is a pyritized arkose siltstone or a pyritized and feldspathized quartz siltstone.

However, the small flakes of fresh biotite may be an important clue to the origin of the rock. These are most likely to have survived if the rock is a pyritized and silicified non-porphyritic dacite, and this tentative diagnosis is the one favoured at present. Some support for this diagnosis is afforded by the fact that Mr. White has stated that specimen B3335 is associated with specimen B4516, which appears to be a sheared and sericitized acid porphyry; it is to be noted, in this connexion, that the percentages of feldspars in B3335 and of sericite in B4516, respectively, are about the same. The pyrite may, it seems, have replaced a porphyritic ferromagnesian mineral in specimen B3335, and if this rock is a dacite the banding noted would, of course, be flow banding.

It must again be emphasized that the naming of this rock is not to be regarded as final, though the suggestion that it is a dacite seems to involve least difficulty and speculation on present evidence. However, the high percentage of quartz argues against dacite, unless this is assumed to be a leucocratic variety, or unless silica has been introduced. And a fresh biotite, may, after all, be derived from sedimentary chlorite by metamorphism (of a very slightly chloritic arkose siltstone).

How helpful I've been with this rock! A guess on field evidence may be best, after all.

<u>Specimen B5012</u>. 2 miles S.W. of Farley Homestead. 6/5053.

A mottled yellowish-brown to red-brown rock containing angular quartz fragments up to 5 mm. long and scattered dark brown pebbles up to 7 mm. long.

The thin section shows that the rock consists essentially of subangular to angular quartz fragments (50%) of various sizes in a matrix of ferruginous clay (45%+). The clay has a refractive index less than that of Canada balsam, and is strongly impregnated with brown hydrated iron oxide; in some places the matrix is heavily charged with red-brown iron oxide. Several fragments of what may be altered granite or aplite were observed. Accessory minerals are tourmaline, dark golden brown (?)sphene, black iron ore altering to hydrated iron oxide, and zircon.

None of the dark brown pebbles appear in the section.

The rock is a <u>ferruginous clayey grit</u>. The matrix is uniformly distributed, and shows no directional features, so the rock is unlikely to be a fault breccia.

<u>Specimen B5002</u>. 1 mile NNE of Labour Victory Mine. 7/5221.

A fine-grained, porous, siliceous, light grey rock with a purplish tinge. The pore-spaces are lined with red-brown iron oxide, and are probably voids after pyrite.

Under the microscope the rock is found to be made up very largely (90-95%) of angular quartz grains of size-range 0.03 to 0.16 mm. (average size about 0.08-0.1 mm.). Most of these grains have obviously been partly recrystallized, as they have irregular interlocking margins, and their shapes are not those of unmodified detrital grains. Nevertheless, the rock is still rather friable when scratched, so that recrystallization has not been sufficiently great to give the rock the hardness and cohesiveness of a quartzite.

A veinlet of hematite or hydrated iron oxide traverses the slide.

Accessory minerals are hematite or hydrated iron oxide, biotite, very fine-grained black iron oxide, tourmaline, and rare zircon. Some iron-stained sericite, which is difficult to distinguish from biotite, may also be present.

The rock is a <u>very fine quartz sandstone</u>; the voids probably represent places where pyrite has been weathered away.

<u>Specimen B5003</u>. 1 mile NNE of Labour Victory Mine. 7/5221.

A fine-grained, hard, grey, siliceous rock with a moderately well-developed cleavage; it is greyish white or contains greyish white flecks where weathering has taken place.

An inordinate amount of time was spent - and largely wasted - in the microscopic examination of this rock, as it seemed to offer some promise of contributing to the solution of the problem of the origin of the clay minerals in certain sedimentary rocks of the area. Some of these rocks were described in the previous report dated 14/8/56.

Quartz makes about 65 percent. of the rock; it has been recrystallized, and its grainsize ranges between 0.02 and 0.2 mm., though by far the most grains fall in the range 0.06 to 0.15 mm.. Accessory minerals are leucoxene, black iron ore, hematite, and rare zircon.

A number of flakes and ragged porphyroblasts of muscovite are scattered through the rock. Many of these appear to be corroded and partly altered to a rather murky clay mineral (very low D.R., R.I. less than that of balsam), but the most abundant mineral, next to quartz, is one whose interference colours range up to high first order and low second order. This mineral has the appearance of a clouded muscovite, but its maximum interference colours are lower than those of muscovite; it is generally closely associated with the clay mineral, which commonly occurs marginally to it or is intermingled with it. This unknown mineral has a refractive index less than that of balsam, but greater than that of the clay mineral; it has straight extinction as measured along a (?)micaceous cleavage where visible, and is optically positive and either uniaxial or biaxial with a small optic axial angle (whether it is uniaxial or biaxial could not be satisfactorily determined). The unknown mineral has been directly replacing muscovite and, in many places, being in turn replaced by the clay mineral of low D.R. and R.I.. This replacement of the unknown mineral by clay mineral is also a very common feature throughout the rock in places where there is no muscovite; irregular clots consisting of these two minerals are, in fact, very plentiful, and make up about 20% of the rock; many of them are several times larger than are the biggest quartz grains.

In addition to the minerals described in the previous paragraph numerous irregular bodies of more or less kaolinized and/or sericitized (?)feldspar (probably orthoclase) are scattered through the rock. These have the same general size and form as the bodies consisting of the unknown mineral and clay minerals. This similarity of size and form suggests that the irregular bodies consisting of unknown mineral and clay mineral have been derived from the orthoclase, and stages in this transformation can, in fact, be seen in many places in the section.

Another puzzling feature seen in thin section is that part of the rock contains little or none of the clay mineral or of the unknown mineral, but contains in their place only slightly sericitized (?)feldspar and a little muscovite whose ragged forms suggest that it is pseudomorphous after (?)feldspar. Whether the further alteration of the feldspar to unknown mineral and clay mineral, as seen in the greater part of the slide, is due to weathering or to hydrothermal activity is uncertain, but it is most likely due to the latter.

Finally, it should be mentioned that there is a distinct possibility that the so-called (?)feldspar is, in fact, one of several zeolites which can occur in sedimentary rocks. It was not possible, on the basis of the few optical properties determinable, to eliminate the possibility that the mineral is a zeolite. Such a zeolite could form during diagenesis, or it may, it is tentatively suggested, take the place of scapolite in parts of the area west of Selwyn - that is, it may be formed under metasomatic conditions different from those responsible for the introduction of scapolite. The form of the (?)feldspar or (?)zeolite certainly suggests that it has been metasomatically introduced.

Following now is a very tentatively suggested metasomatic paragenesis for the problematical group of minerals in this rock:

1. Formation of feldspar or zeolite.

2. Partial to (locally) complete replacement of feldspar or zeolite by sericite and muscovite.

3. Partial to (locally) complete replacement of feldspar or zeolite and sericite and muscovite by the unknown mineral and/or a clay mineral. This second stage of replacement may result in direct formation of clay mineral, but most commonly the unknown mineral appears to be an intermediate product.

If there is any truth in this suggested paragenesis, it may be that a similar set of events, with certain variations, has been responsible for the formation of clay minerals in other sedimentary rocks, from this area. But one difficulty comes to mind immediately: why has detrital feldspar survived in almost perfectly fresh condition in one or two of these rocks? Could this survival mean that the first metasomatic product was a zeolite or some other mineral which later altered much more readily than feldspar?

No doubt this rock description and the speculations, doubts, and difficulties brought into the discussion will leave the field geologists confused. But their confusion will be slight compared with that engendered in the writer when he examined specimen B5003 closely. Had the examination been only superficial he might have been perfectly satisfied to call it a clayey sericitic quartzite or a sericitic quartz greywacke. And perhaps it can, after all, be given either of those two names, for it may be that prolonged close inspection and the consequent state of exasperation have resulted in such impairment of the judgment that the writer can only suggest that the rock should simply be called a <u>metasomatized quartzite</u> until more information is available.

<u>Specimen B5005.</u> 1½ miles NNW of Labour Victory Mine. 7/5221.

A very pale grey, strongly sheared rock containing numerous grey lenticles measuring, on an average, about 1 mm. x 0.5 mm. in cross section, and about 2 to 2.5 mm. in their longest dimension, i.e., along the cleavage face of the rock.

In thin section this rock is found to be almost certainly a highly sheared and altered acid porphyry. The groundmass consists of very fine-grained quartz and sericite in roughly equal amounts, and accessory green tourmaline in minute prisms, leucoxene, and black iron ore.

The prominent lenticles seen in hand-specimen consist of fine-grained biotite and sericite together with varying amounts of quartz. Those which are richer in biotite probably represent an altered porphyritic ferromagnesian mineral such as hornblende or augite; those containing little biotite probably are altered phenocrysts of feldspar. Original quartz phenocrysts have been recrystallized to a granular mosaic.

Although this rock appears to be a <u>slightly tourmalinized sheared and altered acid porphyry or lava,</u> it is just possible that it is a sheared and altered argillaceous hornfels in which porphyroblastic cordierite is represented by biotite, sericite, and quartz, and porphyroblastic andalusite by granular quartz; however, it is much more likely that andalusite would have been altered to sericite, and so the presence of the bodies of granular quartz supports the contention that the rock is of ultimate igneous origin.

The tourmaline prisms lie at all angles to the direction of schistosity, and so it seems that they were formed by metasomatic activity after the rock had been sheared and when it was no longer under active stress.

<u>Specimen B3343.</u> 1 mile E of Chatsworth track 5 miles from McKinley track.

This rock is slightly cellular, but otherwise resembles specimen B5005 in handspecimen, especially on the cut surface; however, the dark lenticles show up scarcely at all on the cleavage surface, whereas they are very prominent in specimen B5005.

In thin section only a general resemblance to specimen B5005 is apparent, but there is, nevertheless, little doubt that the two rocks were originally similar. The lenticular bodies have very irregular margins, and consist mainly of a reticulate mass of cellular light brown chalcedony (R.I. less than that of balsam). The convolute walls of these sponge-like bodies of chalcedony, have a uniform thickness of 0.016mm.; the spaces between the walls are commonly filled in by brown chalcedony, quartz grains, sericite, iron-stained clay, black iron ore, and, less commonly, colourless partly spherulitic chalcedony with refractive index only slightly less than that of balsam. The walls of the spongy brown chalcedony commonly have a fibrous structure.

There can be scarcely any doubt, with the information previously provided by specimen B5005 at our disposal, that the lenticles just described represent original phenocrysts in a porphyritic rock. One point worthy of note is that quartz phenocrysts appear to be absent from specimen B3343.

The matrix in which the lenticles are set consists of sericite, quartz, brown chalcedony, and accessory iron-stained clay, black iron ore, and green tourmaline.

This rock is a <u>sheared, sericitized, and silicified acid porphyry or lava.</u> Is it possible that the silicification took place under conditions of lateritic weathering? Such an explanation might most easily account for the differences between this rock and specimen B5005.

<u>Specimen B5013.</u> Photo 7/5224.

A medium-grained, light grey, acid igneous rock in which feldspar, quartz, hydrated iron oxide, and black iron ore can be distinguished with the help of a lens.

In thin section the rock is seen to have a granitic texture, and the average grainsize of the main constituents, oligoclase and quartz, is found to be between 0.75 and 1mm.. These two minerals, which are commonly intergrown as coarse-textured myrmekite, make up about 85 percent. of the rock (quartz alone 35-40%). Chlorite is the next mineral in order of abundance. Then follow, in accessory quantity only, iron-stained (?)nontronite, leucoxene, sericite, biotite, calcite, black iron ore, and zircon. The (?)nontronite bodies very commonly have rhombic outlines, so that they appear to be pseudomorphs after a carbonate mineral (dolomite or siderite).

Strain shadows are very marked in the quartz; they are far less prominent in the oligoclase.

No potash feldspar was noted in the slide.

The rock is an altered <u>granodiorite</u>.

<u>Specimen B5014</u>. About 8 miles W of Tip Top mine. 7/5224.

A fine-grained, light purplish brown, siliceous, porous rock consisting, macroscopically, of quartz, a little black iron ore, and scattered flakes of muscovite.

In thin section it is seen that nearly 95 percent. of the rock is made up of quartz and feldspars in the ratio of about 3:2. The average grainsize of these minerals is about 0.06 mm., and the size-range is about 0.02 to 0.15 mm.. Some recrystallization of the quartz, at least, has obviously taken place, because many of the grains have irregular, interlocking boundaries. The feldspars are orthoclase, acid plagioclase, and subordinate microcline; they invariably contain dusty particles of black iron ore.

Accessory minerals are granular black iron ore (probably hematite), muscovite, hydrated iron oxide (mainly as interstitial films), tourmaline, and rare zircon. The muscovite occurs as ragged books, not as thin detrital flakes, and is clearly of metasomatic origin.

The rock is a <u>very fine-grained arkose</u>.

<u>Specimen B5006</u>. 1 mile SE of Agate Downs Homestead. 6/5052.

A very fine-grained, fairly hard, buff-coloured rock containing numerous, small, light grey flecks whose sizes range from 0.5 mm. downwards.

In thin section this rock is found to be made up mainly of very fine grained quartz and sericite through which are distributed abundant dusty granules of probable iron-stained leucoxene and (?)clay. The quartz is somewhat more plentiful than is the sericite; the average grainsize of these two minerals lies between 0.02 and 0.04 mm.. The sericite shows only a slight degree of preferred orientation.

Tourmaline in very small grains is a fairly rare accessory.

The light grey flecks noted in hand specimen were found to consist largely of quartz whose average grainsize is considerably greater than that of quartz in the surrounding rock. Minor amounts of sericite and a little dusty (?)leucoxene are associated with the quartz. These quartz-rich bodies are puzzling, and cause some difficulty in naming the rock. In their absence the rock could be a <u>sericitic quartz siltstone</u> or possibly a greywacke siltstone. However, if one wishes to speculate about the origin of the quartz flecks, one could, for example, call the rock a <u>sericitic fine acid tuff</u> or a <u>sericitic acid ashstone</u> in which the quartz bodies represent silicified phenocrysts derived from lava, or they may merely be recrystallized former quartz phenocrysts.

On microscopic evidence alone it is not possible to be absolutely sure of the ultimate origin of the rock, so its correct naming must be left in abeyance.

Specimen B3346. 3 miles W of Answer Mine.

A strongly sheared rock consisting of siliceous brick-red matrix containing numerous discontinuous layers of soft, micaceous mineral, which when powdered, has a decidedly greasy feel. The widths of these layers range from a fraction of a millimeter up to 4 mm..

Microscopic examination shows that the rock consists broadly of discontinuous layers of quartz separated by discontinuous layers of clay mineral. The average size of the quartz grains is about 0.1 mm., but many grains are much larger; the larger grains, especially, are commonly elongated in the direction of cleavage. A small (generally less than 10) percentage of iron-stained clay mineral is present as a cement between the quartz grains. The clay mineral in the discontinuous layers occurs as thin micaceous plates showing strong parallel alignment, and having first order grey interference colours and refractive index less than that of balsam. Associated with it are clots and streaks strongly coloured by hydrated iron oxides. Some of these consist largely of hydrated iron oxide, but most consist of clay mineral strongly impregnated with iron oxide. In a few places sericite accompanies the clay mineral; here it appears that the mica has altered to clay mineral, and it is probable that all of the latter has been formed by such a process of alteration. It may be that the iron-stained clay mineral has been formed from a ferromagnesian mineral.

Accessory minerals are introduced blue tourmaline and rare zircon and chalcedony.

In its general structure and appearance this rock closely resembles specimen B3338(a) which was described in the report dated 14/8/56. The outstanding difference, when the two rocks are compared, is that clay mineral substitutes for the grey sericitic streaks in specimen B3338(a), and re-examination of this rock shows that there is a strong suggestion that sericite is partly replaced by "kaolin".

Specimen B3346 is a ferruginous "kaolin"-quartz gneiss, or, better, a ferruginous kaolinized acid gneiss, derived from an acid feldspathic gneiss or a sheared, coarse-grained granitic rock. Incidentally, specimen B3338(a) would be more satisfactorily named a ferruginous "kaolin"-bearing quartz-sericite gneiss instead of a "schist" as was done in the report of 14/8/56; this alteration in the text should be made.

Specimen B3371. Limestone Creek, 4 miles W of Selwyn.

A light grey, silty rock weathering rust-brown and red-brown.

Microscopic examination shows that, apart from quartz, the most plentiful constituent of this rock is a clay mineral with refractive index less than that of balsam and first order grey interference colours. Biotite and sericite are also important constituents.

The average size of the quartz grains is about 0.03 mm., and a few grains measuring about 0.15 x 0.08 mm. are scattered through the slide. Hematite in dispersed grains and streaks is a rather uncommon accessory, but much of the clay is stained by hydrated iron oxides. Several quartz veinlets, probably parallel to the direction of bedding, occur in the section; they containssome hematite, clay, biotite, sericite, and hydrated iron oxide.

Apart from being present throughout the body of the rock, the clay mineral occurs as elongated lenses or discontinuous layers up to about 0.25 mm. thick. In these layers the "kaolin" occurs in concertina-like forms which lie with their cleavages parallel to the lengths of the veins and give to them a kind of comb-structure. Nothing concrete can be said about the origin of the clay. It seems very doubtful whether it was derived from feldspar, because, if it had been, one would hardly have expected biotite to have survived either entirely unaltered or only moderately bleached.

Taking account only of the mineralogy of the rock, and ignoring any possible mode of origin for the clay mineral, one would call it a micaceous greywacke siltstone or a micaceous "kaolin"-bearing siltstone.

Specimen B3372. 2 miles S of Limestone Creek, 5 miles W of Selwyn.

A fine-grained, rather massive, grey rock containing slightly darker lenses and pockets. The larger of these measure from about 4 cm. x 4 mm. down to 7 mm. x 3 mm. as seen on the cut surface, where they are most easily visible, but pockets as little as 1 mm. long are also present. The long axes of the lenses lie more or less parallel to bedding or cleavage.

Whether this rock contained some or any feldspar when deposited is not possible to decide with absolute certainty. It is most likely that the rock was originally either a sericitic siltstone ((?)greywacke siltstone) or a similar rock in which sericite was formed by metamorphism. Finely granular black iron ore, biotite, and rare zircon are accessories in this rock. Grains of quartz, microcline, acid plagioclase, and rare porphyroblasts of muscovite are distributed throughout, and, as their grainsize (0.1 mm.) is much greater than that of the bulk of the quartz, it is possible that these minerals have been formed by metasomatic processes. This evidence of difference of grainsize is, in itself, obviously not of diagnostic importance, because sediments do commonly contain grains of coarser-than-average size, and such grains may be present in small or large quantity. However, when the coarser quartz and feldspar grains are considered in conjunction with the darker lenses and pockets noted in handspecimen the case for their metasomatic origin is greatly strengthened.

These lenses and pockets consist of feldspars (oligoclase, microcline, microperthite, and microcline-perthite) quartz, subordinate biotite, accessory black iron ore, and rare apatite, tourmaline, zircon, and micropegmatite. The grainsize of most of the quartz and feldspars lies between 0.05 and 0.1 mm. A concentration of sericite occurs along one margin of one of the feldspathic lenses, and several such concentrations are visible in hand-specimen; this suggests that the sericite in the rock has been partly expelled or pushed aside as these lenses have grown. Some of them do also contain a little sericite, but generally only where two lenses have met and partly coalesced. In one place the material of the lenses has broken across the bedding or cleavage for a short distance, then lensed out again, then broken across, and then lensed out - the whole giving the impression of a cedar-tree laccolith - and has finally continued in a zig-zag pattern for a short distance. Furthermore, the ends of lenses, in places, are not sharp, but grade or finger into the neighbouring rock. It is not a very far cry from the features just described to arrive at a condition where relatively large grains of feldspar and quartz become distributed more or less evenly through the rock, and it is considered, therefore, that these grains owe their origin to the same metasomatic processes which have given rise to the lenses and pockets of feldspars and quartz.

The rock is <u>feldspathized sericitic quartz siltstone</u> or <u>greywacke siltstone</u>.

<u>Specimen B3313</u>. N. side of Limestone Creek, 11 miles W of Selwyn. 8/5188.

A very fine-grained, soft, moderately well-cleaved, purplish grey rock containing very sparsely distributed, soft, white flecks about 0.5 to 1 mm. across. One of these flecks has a square outline, as though it were pseudomorphous after pyrite. A quartz veinlet containing a few iron-stained voids intersects the rock.

In thin section the rock is found to consist of fine-grained sericite (50%), quartz (30%), (?) clay (15%), and hematite or hyrdrated iron oxide (5%). The iron oxide occurs in particles which are about 0.01 mm. in diameter, and the sericite flakes show almost perfect parallelism. Conspicuous in the highly sericitic background are thin streaks of quartz measuring about 0.2 x 0.02 mm. on an average. These evidently represent grains of quartz which were originally more nearly equidimensional, but which have now been drawn out by shearing.

Only one of the soft, white flecks appears in the section. This consists almost entirely of an amorphous clay mineral, but a little sericite, (?) silica, and iron oxide are also present. The outline of the mass suggests that it represents a pseudomorph after a single twin of feldspar. However, any such resemblance is almost certainly fortuitous, for if the feldspar had been a crystal in a tuff it would have been elongated at the time when the rock was sheared. It is, therefore, far more likely that the mineral which has now been replaced by clay, etc., was formed in the rock after shearing. What this mineral was can only be guessed at. It is possible that it was pyrite, and that the sulphuric acid released during weathering has attacked the sericite and converted some of it to clay. The (?)clay and iron oxide distributed throughout the rock may also have been formed through the weathering of pyrite and accompanying alteration of sericite.

It is not possible to say whether this rock, in its present state of metamorphism, is a <u>sericitized ashstone</u> or a <u>sericitized quartz siltstone</u> (or greywacke siltstone, or arkose siltstone), but in the absence of any surviving evidence of tuffaceous origin, it is probably safer to regard it as a normal sediment.

Specimen B3336. N side of Limestone Creek, 11 miles W of Selwyn. 8/5188. (Interbedded with rock represented by Specimen B3313).

A fine-grained, massive, black rock containing numerous small porphyroblasts of muscovite.

On microscopic examination the rock, apart from the porphyroblasts, is found to consist of quartz, a clay mineral (R.I. less than that of balsam), and subordinate finely-divided graphite or carbonaceous material and fine-grained hydrated iron oxide. The quartz grains are generally elongated, and their average width is about 0.01 mm..

The porphyroblasts of muscovite are invariably crowded with inclusions of graphite. They have no preferred orientation, and their size, though by no means constant, is generally about 0.4 x 0.2 mm.. In the direction of cleavage the muscovite is marginally altered to a colourless clay mineral. This clay mineral is generally free from graphite, and the band which borders either side of the porphyroblast is of fairly constant thickness in any one porphyroblast; in different porphyroblasts its thickness ranges from 0.01 to 0.04 mm.. In rather rare cases the layers of clay mineral are, in turn, bordered by a layer of quartz, which is mostly about 0.02 mm. thick.

It is not known whether the muscovite porphyroblasts, with their abundant inclusions of graphite, crystallized as such, or whether they are pseudomorphs after some other mineral, such as andalusite. It is unusual to find so many inclusions of graphite in muscovite, but if the mica has formed from andalusite it is curious that each crystal of andalusite has been replaced by a single book of muscovite; what usually happens is that the andalusite is replaced by matted sericite.

Rare pseudomorphs consisting of clay mineral and hydrated iron oxide are also present.

The rock is a <u>carbonaceous "kaolin"-quartz hornfels containing porphyroblasts of muscovite</u>."

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20th August, 1956.

EXAMINATION OF SPECIMENS FROM RANGARERE, NEW BRITAIN.

by

W.M.B. Roberts.

Three specimens from drill cores and one from a gossan were submitted by D.E. Gardner. All were from Rangarere, New Britain.

Specimen R.B.11.
Drill hole M28 RA 52'10" - 59'10".

This sample consisted of small fragments of skarn material and hydrated iron oxide containing irregular masses of sulphide.

Polished sections of several fragments showed the sulphide to be pyrite altering extensively to goethite.

Spectrographic analysis showed that copper is present in the specimen, but no trace of gold.

Specimen R.B.12.
Drill hole M29 R20 30'-35'

The sample, sludge from the above drill hole, was separated on the Haultain superpanner; the heavy mineral fraction was found to form approximately 10% of the sample, and consisted of pyrite and magnetite. One grain of chalcopyrite was observed. Several grains of magnetite showed a grid-like arrangement of hematite lamellae, probably due to alteration along their octahedral planes.

Spectrographic analysis showed copper to be present in both the sulphide and the lighter mineral fraction. No gold is present.

Specimen R.B.13.
Drill hole M29 R.20 35'-40'

This sludge sample was treated as sample RB12. The heavy mineral fraction formed approximately 4% of the total and consisted of pyrite and magnetite. Spectrographic analysis showed copper in both the sulphide and the lightmineral fraction. No gold is present.

Specimen R.B.14.
Shear zone above drill hole M29 R20.

The specimen is of cellular limonite with some "crystals" of brown material ranging up to 12 mm. across; these "crystals" have a vitreous lustre and a hardness of about 2.5.

The "crystals" were broken open, and all contained a core of unaltered pyrite; X-ray examination of a powder from the "crystals" showed them to be the hydrated iron oxide, goethite. They are pseudomorphs after the original pyrite.

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20th August, 1956.

PETROGRAPHIC DESCRIPTION OF SEDIMENTARY ROCKS. FROM THE GOSFORD AREA.

by

R.D. Stevens.

Following are descriptions of sedimentary rocks submitted by Dr. H.G. Raggatt.

Specimen R.6130 (Quartz Greywacke or Redistributed Tuff)
(Loc. Gosford Area; N.E. side of headland at N. end of Forrester's Beach F2)

In hand-specimen this is a moderately hard, pale grey, thinly-bedded, fine-grained sandy sediment, with an all-over slightly calcareous character and with widely spaced, more highly calcareous bands.

In thin-section it is apparent that, according to Condon's classification (1953), the rock is of quartz greywacke type, consisting of detrital quartz, orthoclase, plagioclase, microperthite and accessory biotite, chlorite, apatite, zircon, leucoxene and tourmaline in a very fine matrix. The detrital grains are moderately well sorted, having an average diameter of about 0.1 mm. and a maximum observed diameter of 0.16 mm.. The finer grains grade by decrease in size into the matrix. All grains are angular in outline, and many of the more elongated ones possess a weak preferred orientation parallel to the bedding.

Detrital quartz (approx. 4%) is clear, but slightly strained; it is apparent that this strain is a pre-depositional character of the quartz. Many grains have a notably angular outline, commonly with re-entrant angles, and such a feature suggests very little abrasion and probably short transport. Orthoclase grains are generally more or less highly altered by kaolinization and sericitization, together with some replacement by calcite. A little microperthite and possible microcline has also been detected. The potash feldspars together make up about 10% of the sediment. Crystal fragments of plagioclase (albite - Ab92) total some 5%. They are usually fairly fresh, though occasionally sericitized and kaolinised, and tend to retain an angular, rectangular outline. The accessory detrital minerals together total about 2%, and are randomly distributed throughout the rock. Biotite is rarely fresh, having nearly in every case been highly chloritised. Chlorite varies from yellowish-brown to deep green, the latter resembling glauconite when amorphous. In nearly all cases it is apparent that the chlorite has been derived from original mica. The tourmaline is a green variety. Both apatite and zircon tend to retain a distinct prismatic form. One grain of possible (?)brookite was detected.

The matrix (45%) is a very fine-grained paste, apparently consisting of finely divided sericite, silica and clay, together with about 10% of calcite. This material is commonly aggregated into more or less rounded bodies of roughly the same dimensions as the major detrital grains. This feature suggests that such aggregates may actually represent detrital grains of feldspar or matrix material from a fine volcanic rock.

It is possible that this sediment may be, in part at least, a redistributed tuff. Such an interpretation is suggested by the forms of the quartz grains, the presence of crystal chips of plagioclase, and the partly aggregated nature of the matrix material.

According to Pettijohn this rock should be named sub-greywacke.

Specimen R.6131. (Tuffaceous Sandstone or greywacke).
(Loc. Gosford Area; Point between Tuggerah entrance rock baths and Blue Bay).

In hand specimen this is a moderately hard, pale brownish-grey, medium to fine-grained sandstone, with thin, grey-brown shale chips up to 1 cm. long distributed parallel to the bedding. The sediment is somewhat friable owing to paucity of cementing material. It is also porous and slightly permeable.

In thin-section it is seen that the rock is a medium-grained, polymictic sandstone consisting of detrital grains of quartz, orthoclase, plagioclase, quartz-feldspar-sericite fragments and grains of altered, sericitic quartzo-feldspathic volcanic material, together with accessory tourmaline, leucoxene, zircon, ilmenite, biotite and (?)sphene. Cementing material is quite subordinate in quantity and is of siliceous-sericitic composition.

Detrital grains are fairly well sorted, having an average diameter of about 0.24 mm., and a maximum of 0.4 mm.. The separate mineral grains have distinctly angular outlines, but the volcanic grains are more rounded. There is no indication of bedding within section. The quartz grains are clear and only slightly strained. Some have an aggregate internal structure resembling vein quartz or meta-quartzite, and others contain tiny, lath-like inclusions of albite and streams of bubbles. Many show signs of having been fractured. Detrital quartz makes up about 30% of the rock. The orthoclase (5%) has generally been altered by kaolinisation and sericitisation, in many cases very highly so. Such feldspar grains are usually rather more rounded than the quartz grains. Plagioclase (10%) is almost pure albite (Ab98); it is well twinned, and slightly kaolinised and sericitised. Rounded fragments of very fine-grained volcanic rock constitute roughly 50% of the sediment. These include fine, felted aggregates of sericite, quartz and feldspar, fragments of a finely porphyritic volcanic rock consisting of albite phenocrysts in a sericitic, feldspathic and siliceous groundmass, rare grains of a symplectic intergrowth of quartz and orthoclase, grains of felted sericite, and rare grains of chlorite. The roundness of these grains indicates that they have undergone some degree of transportation. Accessory detrital grains include leucoxene, green and blue tourmaline, zircon, leucoxenised ilmenite, chloritised biotite, and possible sphene. Rare sheets of clay minerals have been derived from original mica.

It is suggested that the rock may be redistributed tuff with added quartz sand. It is apparent that the volcanic material is of acid to intermediate-acid composition. In Condon's classification the sediment would be a "mictite".

Specimen R.6132. (Argillaceous and Dolomitic Quartz sandstone).
(Loc. Gosford Area: Northern quarry, Gosford township).

In hand-specimen this is a moderately hard, medium-grained light-grey, weakly bedded sandstone containing thin, discontinuous, dark-grey, films parallel to the bedding. These may be carbonaceous, but none were included in the thin-section, though several isolated grains of graphite have been detected.

In thin-section it is seen that the sediment consists mainly of angular quartz grains (60%) and some quartzo-sericitic grains (15%) probably representing original detrital feldspar. A few unaltered grains of microcline have been detected. Accessory detrital minerals (2%) include leucoxene, green tourmaline, zircon, muscovite, altered biotite, sphene and rare rutile. The detrital grains are held in a matrix (23%) of finely felted quartz and sericite, with abundant carbonate (5%). Three grains of crystalline graphite were observed.

The mineral grains are mainly angular, and moderately well sorted. The average grain diameter is about 0.15 mm., with an observed maximum of 0.5 mm., ranging down to a minimum of 0.08 mm.. There is no indication of bedding in thin-section.

Quartz grains contain inclusions of brown tourmaline, streams of fine bubbles, sericite, chlorite, possible apatite, and dusty iron oxides (?). Some are slightly strained, and a few possess an aggregated mosaic structure internally. It is possible that much of the quartzo-sericitic material of the matrix may have been derived from original feldspar, very little of which now remains. The carbonate is authigenic in origin and well crystallised. It forms areas and partial crystals in places enclosing several of the detrital grains. The optical characters of the carbonate, together with the absence of effervescence in dilute HCL, suggest that it is an iron-bearing dolomite. Also, in rare places the matrix has become somewhat ferruginised.

<u>Specimen R.6133.</u> (Greywacke of Tuffaceous Sandstone).
(Loc. Gosford Area; First outcrop on sea beach NE. of Lake Wamberal)

The hand specimen is similar to R.6130, though a little coarser-grained, being a pale-grey, fine to medium-grained sandstone without visible signs of bedding. It also differs from R.6130 in being non-calcareous.

In thin-section it is seen that this sediment is mineralogically similar to R.6130, consisting of abundant angular quartz grains (40%), abundant quartzo-sericitic grains (30%), and smaller quantities of biotite, chlorite and muscovite (5%), plagioclase (1%) and orthoclase (3%), together with accessory tourmaline (green and green-brown), zircon, leucoxene rutile and possible brookite, in a finely felted matrix of sericite, quartz and clay.

The detrital constituents are only moderately well sorted, ranging from 0.08 mm. to 0.32 mm. across. The average grain diameter is about 0.16 mm. Most grains are highly angular in outline, and a slight degree of preferred orientation of the more elongated fragments indicates the bedding of the rock in thin-section.

A few of the detrital quartz grains show slight indications of secondary growth, but most are highly angular fragments exhibiting undulose extinction and a fairly common internally granular quartz. Some of the detrital orthoclase similarly has an internally granular structure, and all of the potash feldspar has been somewhat kaolinised and sericitised. The plagioclase is a sodic albite. The detrital quartzo-sericitic grains seem to be fragments of highly altered, fine-grained igneous material, originally of feldspathic character. Some even contain microphenocrysts of altered orthoclase or albite. These grains are of essentially the same composition as the matrix, and it is probable that the matrix has been derived from such material.

The above features suggest that the sediment is a tuffaceous sandstone or a greywacke-type deposit derived from a nearby volcanic terrain, possibly being of the nature of a redistributed tuff with considerable sandy admixture.

Specimen R.6134. (Coarse-grained Argillaceous Quartz Sandstone). (Loc. Gosford Area; Top of hill between Terrigal and Avoca Beach)

The hand-specimen is a coarse-grained, light brown, slightly ferruginous sandstone with weakly expressed bedding and high porosity, but only moderate permeability.

Thin-section examination shows that the sediment is a coarse-grained quartz sandstone with a subordinate argillaceous cement. The detrital quartz grains (90%) are of sub-angular to angular outline and show slight indications of secondary growth. Some of the quartz has an internal granular or mosaic texture suggesting that it may well have been derived from quartz veins in a metamorphic terrain. Streams of dusty inclusions are common, and many of the grains exhibit strong undulose extinction; a feature indicating the operation of considerable stresses in the parent material. Some have reached the stage of shearing and granulation. Rare inclusions of muscovite and (?)rutile have been detected.

Minor constituents include rare, highly altered grains of (?)feldspar, and accessory hydrated iron oxides. The cementing material is argillaceous, sericitic and siliceous, being a fine aggregate of these substances, commonly with some hydrated iron oxide. A striking feature is the patchy distribution of this cement, which forms randomly distributed "pockets". Such a feature suggests that it may have been formed from the decomposition of original detrital feldspar, and some of it may represent grains of finely crystalline volcanic material. The slight secondary outgrowth of the quartz grains also contributes to the cementation of the sediment.

Specimen R.6135. Quartz Greywacke or Argillaceous Quartz Sandstone). (Loc. Gosford District; from ridge between two quarries at Gosford).

The hand-specimen is a medium to fine-grained, light brown, somewhat ferruginous sandstone without notable bedding, though mica flakes are clearly visible, but not abundant. The rock is moderately hard, porous, and only slightly permeable.

The thin-section shows that this is a medium-grained sandstone containing fine quartz pebbles in addition to quartz sand. The main bulk of the rock is made up of sub-angular quartz sand(40%) and grains of internally aggregated (and granulated) quartz (10%). No feldspar, as such, was detected though highly sericitic and argillaceous aggregates (20%) in the matrix may represent original feldspar, and/or fragments of fine-grained rock, sedimentary or volcanic, including several grains of very fine, sericitic (?)chert. Accessory detrital minerals include muscovite, altered biotite, hydrated iron oxides, leucoxene, (?)brookite, zircon, and small amounts of tourmaline and apatite, largely as inclusions in the quartz grains. The matrix is of finely divided argillaceous and sericitic matter, with some fine silica.

The detrital constituents are rather poorly sorted, ranging from fine sand (0.08 mm) to very coarse sand (2.25 mm) as "pebbles" carried in the sediment. Grain-outlines are generally sub-angular, and there is a suggestion of secondary growth on the quartz grains, most of which also carry streams of dusty inclusions. The hydrated iron oxide in the matrix is significantly crystalline, and is thus probably of authigenic origin. Numerous plates of (?)illite have apparently formed from detrital mica. It is such sheets of micaceous clay minerals which are seen in the hand-specimen.

<u>Specimen R.6136</u>. (Fine Redistributed Tuff or Greywacke.)
(Loc. Gosford Area?).

The hand-specimen is a fine-grained, chocolate-coloured sediment with fairly distinct bedding, and exhibiting a distinctive, curved, spalling cleavage. The rock is moderately hard, only slightly porous and slightly permeable.

In thin-section it is seen that the sediment is a very fine-grained, polymictic sand consisting of detrital grains of quartz (15%), sericitised and kaolinised feldspar (5%), fine-grained fragments of rock material (60%), altered mica (5%), hydrated iron oxides (5%), and accessory biotite and leucoxene, with a ferruginous, argillaceous cement (10%).

The detrital material is fairly well sorted, the average grain diameter being around 0.08 mm., with a maximum of 0.15 mm. and a minimum of about 0.03 mm. Most grains are highly angular in outline, and there is no indication of bedding in their orientation.

Quartz grains are slightly strained, and commonly clouded with dusty, undetermined inclusions. The feldspathic material appears to consist of albite and possible orthoclase, though the fine grainsize and high degree of alteration to sericite, kaolin and (?)silica makes positive identification difficult. The fragments of "rock-material" are very fine-grained, but appear to consist largely of finely divided sericite, quartz and alkali feldspar. It would thus appear that they are probably of igneous origin, though some may be fragments of indurated mudstone. The majority, however, have the appearance of extremely fine-grained groundmass material of a volcanic rock. Other similar grains may represent completely decomposed feldspar. One grain of undoubted, trachytic-textured, feldspathic lava was detected.

Many of the definite feldspar grains are sub-rectangular crystal fragments, and some of the quartz fragments have curved and splintery shapes, so that, all features considered, it is most probable that the sediment is of tuffaceous origin and approaching a greywacke in composition.

<u>Specimen R.6137.</u> (Ash-stone or silty claystone).
(Loc. Gosford Area; as for R.6131)

The hand-specimen is a very fine-grained, relatively soft, medium to dark grey sediment without distinguishable bedding.

In thin-section it is seen that the rock is an ash-stone or silty claystone consisting principally of exceedingly finely divided clay, chlorite and silica, carrying numerous angular to splintery silt-sized grains and chips of quartz (7%), flakes of sericite (3%), acid plagioclase feldspar (1%), chlorite (2%), and (?)chert (2%). A slight degree of parallel orientation of sericite flakes and fibres, and quartz splinters provides a weak indication of the sedimentary bedding. Powdery leucoxene and possible carbonaceous films are present in minor quantities.

The presence of splintery quartz fragments tends to favour the rocks being an ash-stone rather than a silty claystone; it is possible that the ash-stone has been re-distributed, and that extraneous material has been added to give rise to the rock as now constituted.

84N/1 August, 1956

Report 11.

EXAMINATION OF A RADIOACTIVE SPECIMEN FROM CONDOBLIN, N.S.W.

by

W.M.B. Roberts.

A small specimen of a black sub-metallic material from Condoblin, N.S.W. was submitted by Mr. L.C. Noakes for examination to determine the cause of the radioactivity. The sample measured approximately $\frac{3}{8}$" x $\frac{1}{4}$" x 3/16" and when tested with the Austronic B.G.R.1 counter gave a reading of 4000-5000 C.P.M.

In polished section it is shown to consist of pyrolusite, which forms irregular grains ranging up to 0.35 mm. across, the interstices between which are filled with an apparently isotropic material, but which at very high magnifications is resolved into a mass of extremely fine crystals having similar optical properties to those of pyrolusite.

No separate uranium or thorium mineral could be identified in the section. A crushed portion of the specimen was repeatedly tested with the sodium fluoride bead and the sodium-zinc acetate methods. All tests gave a negative result for uranium.

Spectrographic analysis for uranium and thorium showed no detectable amounts of either element. A Gamma/Beta-Gamma ratio of .01 was obtained from the material, which is too low for uranium or thorium.

In view of these results it appears that the high radioactivity of the specimen is due to a concentration of radioactive daughter products formed from the disintegration of uranium; these have probably been absorbed by the manganese oxide structure during its formation.

A167/PNG/1 12th September, 1956.
Report 12.

PETROGRAPHIC DESCRIPTION OF FOUR ROCK SPECIMENS FROM SULOGA POINT WOODLARK ISLAND, PAPUA.

by

J.K. Lovering

The following are petrographic descriptions of four rock specimens from Suloga Point, Woodlark Island.

W.1 Basic Tuff

The greenish-black hand-specimen is fine-grained and has a subconchoidal fracture.

The thin-section reveals a well-developed lamination which is defined by stretched rock fragments. The rock is composed of fragments of pyroxene, andesine, quartz, altered biotite, chlorite, magnetite and pyrite and hematite flakes.

The rock fragments are pyroxene-rich and very fine-grained and were probably fragments of partly solidified lava.

W.5 Uralitised Basic Tuff

The hand-specimen is made up of dark phenocrysts in a greenish-grey groundmass.

The thin-section reveals a similarity to specimen No. W.1. The rock is extensively uralitised; uralitised fragments of pyroxene, together with fragments of feldspar, quartz, chlorite and magnetite constitute this rock.

Throughout the rock are rounded aggregates which consist of colourless recrystallised granules of pyroxene and andesine surrounded by green uralite.

W.2 Basaltic Agglomerate

The greenish-black hand-specimen consists of fairly coarse fragments in a fine groundmass.

Coarse basaltic fragments occur in a medium groundmass which consists of fragments of pyroxene, uralite, plagioclase, altered biotite, chlorite and magnetite.

The rock fragments are usually medium to coarse-grained and consist of phenocrysts of uralitised pyroxene and needles of plagioclase in a medium groundmass of uralitised pyroxene, plagioclase and magnetite.

W.4 Uralitised Dolerite

The hand-specimen is greenish-grey and fine-grained.

The thin section reveals a sub-ophitic texture for the rock which is composed of uralitised pyroxene and plagioclase with accessory epidote and interstitial secondary minerals including calcite and chlorite.

66NT/1 13th September, 1956.
Report 13

SAMPLE OF HEAVY MINERAL BEACH SAND
FROM EAST KIJI - IMPINI BEACH, MELVILLE IS. N.T..

by
J. Ward.

1. The sample which was of the order of 2,200 grams was first reduced with a Jones Sampler to some 34 grams. The heavy minerals in the reduced sample were then concentrated by gravity methods; initial concentration was made with an Haltane Superpanner and final cleaning of the concentrate was effected by heavy liquid separation. Acetylene tetrabromide was the liquid used for this purpose.

The reduced sample yielded some 17.5 grams of heavy mineral concentrate, i.e. the sample contained 51.4 per cent of heavy minerals.

2. The heavy mineral concentrate was first subjected to electro-magnetic separation with a Franz Isodynamic Separator. With an amperage of 0.4 amps, and transverse and longitudinal slopes of 10° and 25° respectively, an opaque mineral - Fraction A - closely resembling hematite, was drawn off. Many of the grains in the fraction had a reddish coating of what appeared to be ferric oxide, but the powdered product was grey instead of the expected reddish streak of hematite. A polished section of the mineral was not prepared because of a pending overseas trip by the mineragrapher, but spectographic analysis showed a strong line for titanium. Boiling of the mineral in concentrated HCl for $\frac{3}{4}$ hour - conditions under which hematite is readily soluble - effected only a 14 per cent loss in weight. After treatment with the acid, the mineral grains were coated with a white to greyish substance similar in appearance to leucoxene. It is concluded that the mineral of Fraction A is weathered ilmenite or more precisely a hydrous iron-titanium mineral intermediate between ilmenite and rutile and referred to by B.H. Flinter* as "var. rutile".

A weakly magnetic fraction - Fraction B - was removed from the balance of the concentrate. This fraction was made up principally of "var. rutile" and tourmaline with minor amounts of monazite, staurolite and rutile. Fraction C - a non-magnetic fraction of zircon and rutile containing a minor amount of topaz - was separated into its component minerals with a laboratory-type electrostatic separator.

3. Grain-count analyses were carried out on all fractions.

4. Percentage composition of the heavy mineral concentrate determined by methods described above, is as follows: -

Hydrous Ilmenite - Rutile	=	32.8%
Zircon	=	34.4%
Rutile	=	30.5%
Tourmaline	=	0.7%
Monazite	=	0.2%
Staurolite	=	0.2%
Topaz	=	1.2%

Reference:

* B.H. Flinter - A brief guide to the identification of the dark opaque and semi-opaque minerals known to occur in Malayan alluvial concentrates - Geological Survey Federation of Malaya - Geological Note. No. 8.

63T/1 21st September, 1956.
Report 14

EXAMINATION OF BORE CORES FROM THE COPPER-NICKEL PROSPECT NEAR ZEEHAN, TASMANIA.

by

W. M. B. Roberts.

Ten bore cores were submitted by Dr. Horvath of the Geophysical Section for examination of rock types and opaque mineral content. The cores were from the Cu-Ni Prospect near Zeehan, Tasmania where drilling is being carried out in an attempt to locate a basic dyke thought to be the source of the copper-nickel mineralisation in the area.

For this preliminary report five core sections were selected on advice from Dr. Horvath, three from D.D.H. M.9 and two from D.D.H. M.6.. The description of each individual core section follows.

D.D.H. M.6 90'

This section is taken from the junction of a tuff and an extremely fine grained volcanic ash. The tuff consists of angular fragments of a plagioclase feldspar, quartzite and quartz, the largest fragment measuring 0.65 m.m. across, set in a matrix of finely crystalline material which appears to consist essentially of the same constituents as the coarsely fragmentary section of the rock.

A large amount of siderite and chlorite has been introduced, both minerals have replaced the groundmass to form veins and large irregular areas.

The volcanic ash has an extremely fine grain-size, the only mineral large enough for determination was quartz, which occurs as angular fragments, the largest of which measures 0.03 m.m. across.

The remainder of the rock is of such fine grain-size as to appear partly isotropic. Close to the junction with the tuff a large amount of siderite has been introduced forming a reticulate pattern of veinlets. This has been accompanied by a somewhat lesser amount of chlorite than that associated with the coarser grain-sized rock.

The opaque minerals present are confined solely to the volcanic ash sections; they are pyrite and chalcopyrite, both of which form small irregular grains ranging up to 0.015 m.m. across. The ratio of pyrite to chalcopyrite is roughly 20:1.

D.D.H. M.6 70'

This section consists of angular fragments of volcanic ash similar to that described previously from the 90' depth. The largest of the fragments measures roughly 10.0 m.m. across and many of them have developed a marked schistosity, apparently a local effect due to shearing.

The rock has been recemented by siderite which forms approximately 75% of the total mineral content of the specimen. Minor quantities of quartz and chlorite have been introduced with the siderite and form veins and discrete particles enclosed in this mineral.

Pyrite, the only opaque mineral present forms small irregular areas, the majority of which are randomly distributed throughout the fragments of volcanic ash. A minor amount only is present in the carbonate.

D.D.H. M.9 200'

The rock in this section consists of extremely fine grained sericite and quartz with a subordinate amount of chlorite and hydrated iron oxide. It contains veins, subhedral crystals and irregular masses of carbonate, probably calcite, which have been introduced subsequent to a very low grade metamorphism which has impressed in the rock a faint parting in two directions at 10 to 15° to each other. The more marked of these two partings has been filled with later introduced carbonate and chlorite., the latter mineral tending to line the edges of the veins and the calcite to fill the centres. The subhedral crystals and irregular masses of calcite range up to 0.65 m.m. across and are distributed randomly throughout the section. Occasional small grains of opaque mineral are in evidence, ranging up to 0.04 m.m. across. The rock is a ferruginous volcanic ash.

D.D.H. M.9 209'

The section contains fragments of brecciated tuff and mudstone recemented by calcite, which contains opaque minerals. Fragments of tuff range up to greater than the width of the core and consist of angular fragments of quartz (0.06 to 0.8 m.m.) calcite (0.04 to 0.8 m.m.) and chalcedony (0.06 to 0.8 m.m.) in a matrix of chlorite and hydrated iron oxide. Also present in the section are angular fragments and tongues of a very fine grained rock which consists almost entirely of chlorite. Individual minerals cannot be determined because of the extremely fine grain-size; it appears likely that the rock was originally a sandstone which has been chloritised by the same agency which introduced the chlorite into the matrix of the tuffaeeous rock. The carbonate cement is entirely calcite and forms veins varying up to 9.0 m.m. across in which are individual crystals measuring 1.0 m.m. across.

The polished section shows the only opaque mineral to be pyrite, which occurs as small subhedral to euhedral crystals ranging from 0.01 m.m. to 0.25 m.m. across. These crystals are concentrated along the edges of the calcite veins in contact with the country rock, although some slight diffusion has allowed a small quantity of pyrite to be deposited in the rock fragments themselves.

D.D.H. M.9 211'

This rock consists of fragments of quartz and sericite forming an average grain-size of 0.02 m.m. which are set in a matrix of chlorite and hydrated iron oxide. It has a faint parallel arrangement of the sericite flakes which imparts to it a slightly schistose appearance in thin section. A variety of clay mineral is present which could not be identified; it forms irregular grains averaging 0.08 m.m. across which show the typical semi-opaque alteration product.

Thin veinlets containing chlorite, quartz and calcite cut across the section in two directions at 60° obviously following cleavages imposed by some slight stress. Small grains of opaque mineral are regularly distributed throughout the section, having an average size of 0.04 m.m..

The polished section shows the opaque minerals to be pyrite and chalcopyrite in the rates of roughly 10:1. Pyrite forms subhedral crystals and irregular areas varying up to 0.18 m.m. arranged principally in the form of veinlets, although small angular pyrite grains are distributed randomly throughout the section. Chalcopyrite forms irregular masses moulding pyrite and has probably been deposited after this mineral.

Conclusion:

No basic rock type was observed in the foregoing examination, although fragments of plagioclase feldspar in the section from D.D.H. M.6 90' indicate the breaking up of a basic rock type. The widespread introduction of carbonate and chlorite and their associated sulphides could indicate the presence of a basic intrusive phase close to the drill holes, but as both these minerals could be derived from other sources this mineralisation must be taken as an indication only.

So far in the examination of rocks from this Prospect no actual basic rock type has been seen; I would be grateful if a specimen of the basic rock could be sent up for examination so as to establish its identity for use in further investigations.

47NT/5

Report 15 2nd October, 1956.

PETROGRAPHIC DESCRIPTION OF COUNTRY ROCKS FROM THE HATCHES CREEK AREA.

by

J.K. Lovering.

No. 2 NORTH CROSSCUT, 206' LEVEL

The dark grey handspecimen is fairly homogenous.

Recrystallised irregularly-shaped grains of quartz, oligoclase, biotite commonly altered to penninite, and accessory sphene, epidote and magnetite, are intergrown in a hornfelsic texture.

Patches of quartz and feldspar showing myrmekitic intergrowth indicate relict phenocrysts. Accumulations of green biotite, clinozoisite, sphene and magnetite are common in the rock; the same minerals are found in veins.

The original rock was probably an acidic igneous rock; there is a very slight possibility that the rock might have been a conglomerate but this is very unlikely. After metasomotism and recrystallisation the rock is now an oligoclase-quartz hornfels.

No. 3 E DRIVE 206' LEVEL

Typical fine-grained country rock.

This homogeneous black handspecimen is fine-grained and consists of grains about 0.3 mm. in diameter of quartz, biotite, and penninite. Clear anhedral recrystallised quartz grains are surrounded by small flakes of biotite and muscovite. Larger biotite grains, commonly containing pleochroic haloes, have been partly reconstituted and are lepidoblastic in texture.

Patches of penninite replacing biotite, occur throughout the rock. Magnetite and tourmaline are accessory.

Cracks in the rock are filled with biotite, penninite, quartz and some tourmaline.

The rock has been metamorphosed and has reached the biotite facies - introduction of material probably occurred at the same time. The original rock was sedimentary - relict lamination can be seen; the former shaly sandstone is now a biotite-quartz hornfels.

No. 5 DELLA LODE 206' LEVEL.

Typical coarse-grained country rock.

The black homogeneous handspecimen has a hornfelsic texture combining grains about 1-2 mm. in size, of quartz, feldspar, biotite, secondary minerals and accessories.

Quartz grains are commonly recrystallised; quartz-orthoclase micrographic patches are common. Oligoclase is seen as patches in quartz. Euhedral grains of plagioclase have been completely altered to sericite and epidote. Orthoclase, with quartz and as euhedral grains, has been kaolinised.

Small recrystallised grains of biotite cluster into the space of former large grains. Pleochroic haloes around zircon grains occur in biotite and in corundophilite which replaces biotite.

Ferrohastingite, a greenish-yellow to blue-green pleochroic amphibole with a small negative optic angle, contains globules of quartz in a sieve-like texture and has probably been reconstituted from brown-yellow hornblende, remnants of which are surrounded by ferrohastingite.

Magnetic grains are irregular in shape. Apatite is accessory.

The rock, a quartz-rich amphibolite, is probably the result of metamorphism of a rock of the composition of a diorite.

With no field data, it is impossible to guess at the origin of this rock.

No. 6 SOUTH CROSSCUT 206' LEVEL OLIGOCLASE-QUARTZ HORNFELS.

The black handspecimen is a fine-grained homogeneous quartz-rich rock.

Quartz, oligoclase, muscovite and biotite occur in a fine-grained hornfelsic rock. Zircons in biotite, apatite needles and grains of magnetite, are the accessory minerals.

The original rock was probably a sandstone; metamorphism has resulted in the partial recrystallisation of most grains.

No.7 200' WEST OF MAIN SHAFT IN COSTEAN.

The porphyritic handspecimen is very weathered.

Shattered grains of quartz, iron ore and pseudomorphs of ferromagnesians lie in a groundmass of recrystallised quartz and iron ore.

Euhedral and shattered pseudomorphs of some ferromagnesian mineral, consist of sericite, fine quartz and red flakes of hydrated iron oxide.

The rock may have been a quartz-amphibole porphyry but it has been extensively sheared and this specimen is extremely weathered.

No.9 8' PIT APPROX. 100' WEST OF MAIN SHAFT.

The compact red handspecimen is fine-grained and homogeneous and extremely weathered.

The rock consists of fine ragged grains of quartz in a matrix of hydrated iron oxide. Through the rock are quartz veins containing rutile needles, and a vein of iron ore surrounded by a zone of hydrated iron oxides.

The rock has been metamorphosed and has probably been deformed; it may have been an acid volcanic, a granophyre, or an aplite.

No. 12. LOST CORNER.

The grey handspecimen is fine-grained and in thin section has a hornfelsic texture in which grains of quartz, biotite and muscovite are intergrown.

The rock is a quartz-mica hornfels and could be derived from sediments or volcanics. Field workers consider the rock to be part of a series of volcanics in which case the original rock was an acid volcanic.

No. 14. BRANSEN'S LEASE

The reddish weathered handspecimen appears to be porphyritic in texture.

Pseudomorphs of about 2 mm. in diameter lie in a groundmass of fine quartz, red flakes of hematite and sericite grains.

The pseudomorphs consist of radially-oriented quartz grains clouded with sericite grains and rimmed with hematite flakes.

The rock was an acid volcanic or porphyry.

No. 15. BRANSEN'S LEASE.

The porphyritic handspecimen has numerous quartz phenocrysts up to a half inch long in a fine-grained grey groundmass.

The quartz phenocrysts are seen to be accumulations about 2 mm. in size of recrystallised quartz grains, which represent former phenocrysts which comprised 40% of the rock.

The groundmass is an interlocking mass of fine recrystallised grains of quartz, phlogopite and hematite particles.

The rock was a porphyritic acid volcanic, and is now recrystallised.

No. 16. FROM DUMP OF INACCESSIBLE SHAFT COPPER SHOW MINE

The fine-grained homogeneous hand specimen has been extensively sheared.

Fine recrystallised grains of biotite and quartz are the main constituents of the rock. A few muscovite grains pseudomorph feldspar grains. Accumulations of biotite are probably pseudomorphing a former ferromagnesian mineral.

The rock is now a mica schist and is probably sedimentary in origin.

No. 17. <u>WEST DRIVE, WATER SHAFT, HIT OR MISS.</u>

Typical country rock.

The handspecimen is black and porphyritic.

Blasto-porphyritic quartz grains (10%) showing evidence of stress during metamorphism, sericitic pseudomorphs of former feldspar phenocrysts (5%) and biotite pseudomorphs of former ferromagnesian phenocrysts (7%) lie in a groundmass of recrystallised grains of quartz (55%), biotite (5%) and sericite (20%).

The rock was a <u>porphyritic acid volcanic</u>.