Copy for Chief Geophysicist

COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1960/52

PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS DURING THE QUARTER OCTOBER-DECEMBER, 1958.

Compiled

by

K.R. Walker.

PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS DURING THE QUARTER OCTOBER-DECEMBER, 1958

Compiled by

K.R. Walker

RECORDS 1960/52

PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS DURING THE QUARTER OCTOBER-DECEMBER, 1958.

Compiled by

K.R. Walker.

RECORDS 1960/52

CONTENTS

(Contents ii)

INTRODUCTION

This record contains the petrographic and mineragraphic work by the staff of the Bureau of Mineral Resources Laboratory, which has not been prepared for publication or appeared in Bureau Records elsewhere. The reports were completed during the quarter October to December, 1958, and are arranged in chronological order; each report is headed with its title, file number, and date of completion.

The geological officers responsible for the reports are: W.B. Dallwitz, W.M.B. Roberts, K.R. Walker, and W.R. Morgan.

The reports for this quarter are of rock and mineral descriptions, and they need no elaboration; an indication of their contents can be gained from the titles in the contents. The original presentation of the reports have been modified only slightly, where necessary, so that each has a title, an introductory and a concluding paragraph.

1st October, 1958.

106W/AD

1. DESCRIPTION OF TWO SPECIMENS FROM CORE NO. 10, B.M.R. 5, GIRALIA, CARNARVON BASIN, WESTERN AUSTRALIA, by W.B. DALLWITZ.

Following are brief descriptions of two specimens from 985 feet to 995 feet, core No. 10, B.M.R. 5, Giralia, Carnarvon Basin, Western Australia.

The first specimen, from the upper part of the core, is a fine-grained, somewhat porous, dark grey rock containing a vein of corase, yellow calcite, which is separated from the black rock by a pale buff vein about 1mm. wide. A vein of the pale buff mineral also traverses the dark grey rock at right angles to its junction with the calcite vein.

The dark grey rock consists almost entirely of rudely spherical masses of buff-coloured siderite (or other iron-bearing carbonate) whose size ranges from 0.04 mm. to 0.16 mm., the average being 0.10 to 0.12 mm. Some of these carbonate bodies have a suggestion of a spherulitic or part-spherulitic structure, and all show irregular or wavy extinction. Where the spheres are contiguous they tend to be polygonal in outline, but most are separated by thin films or small pockets of brown, almost isotropic material containing minute grains of hydrated iron oxide and scattered flakes of a green, chloritic mineral. The brown material is probably clay, but may possibly be chamosite.

Pyrite occurs as accessory grains throughout the rock, which is probably best described as a clay ironstone.

The vein separating the clay ironstone from the yellow calcite consists of an iron-bearing carbonate which is very much less deeply coloured than that in the spherules. The vein has a pronounced comb structure, and crystals with sharply-pointed terminations project into the calcite.

The second specimen, from the lower part of the core, is a clay-ironstone similar to that just described, but is notably more friable and porous. The component "spherules" are slightly smaller, and their shapes are highly irregular. A few minute grains of quartz are scattered through the slide. The material which is interstitial between the carbonate-bodies is generally much lighter than that in the previously-described specimen; it appears to be largely chloritic, and may be chamosite.

2nd October, 1958.

120/ACT/1

2. PETROGRAPHY OF TWO SPECIMENS FROM DIAMOND DRILL CORE NO. 2, YARRALUMLA, MOLONGLO WEIR SITE - BY W.R. MORGAN.

D.D.2. YARRALUMLA 58'2". Proposed site for the Molonglo River Weir, Yarralumla.

Hand Specimen. The rock has a light grey, fine-grained groundmass which encloses numerous coarse phenocrysts. The latter are composed of rounded quartz, tabular felspar, and a dark ferro-magnesian mineral. The specimen is cut by veins of calcite.

Thin Section. The specimen has numerous phenocrysts enclosed by an exceedingly fine-grained, holocrystalline groundmass. The latter appears to consist of sericite and chlorite, with some quartz, and opaque dust. The phenocrysts range between 0.06mm. and 6 mm. in size. Quartz forms anhedral, rounded and partly resorbed crystals, showing some cracking, and undulose extinction. It encloses minute, opaque particles, either as "clouds", or as sub-parallel lines. Albite phenocrysts form subhedral, rather tabular crystals, now almost completely sericitized. Some indistinct traces of carlsbad and albite twinning may be seen, while its refractive index is less than that of Canada balsam. A biaxial positive figure, with $2V=85^{o}$ was obtained. An extinction angle measured on a section normal to the X-bisectrix showed a composition of An5. Green chlorite forms flaky, prismatic crystals, which appear to pseudomorph biotite, and it occurs as irregular veins cutting the rock, or sometimes surrounding sericitized albite as a fringe. It is pleochroic : X = very light fawn-green; Y = light green; Z = green; absorption : $Z<Y<X$. It gives a negative interference figure, with $2V=0^{o}$. The biro-fringence = 0.002. Very often ilmenite, decomposed to leucoxene, is present in irregular masses lying along the cleavage traces. Some nontronite is associated with chlorite.

Ilmenite and leucoxene occur as small, irregular masses throughout the rock. A few coarse, prismatic crystals of apatite are present. A little zircon, occurring as small prismatic crystals with pyramidal terminations, may be seen. Calcite cuts the rock in a few thin and irregular veins.

An estimation of the percentage mineralogical composition of phenocrysts is:- sericitized albite 50; quartz = 25; chlorite = 20; the remainder = 5.

The rock is a dacite or granodiorite porphyry, depending on whether it is extrusive or intrusive.

D.D.2. YARRALUMLA 40'0". Proposed site for the Molonglo River Weir, Yarralumla.

Hand Specimen. The groundmass of this specimen is a grey-green and the ferro-magnesian phenocrysts are stained with hydrated iron oxide: otherwise the rock is similar to that at 58'2".

Thin Section. In texture this rock is similar to the previously described specimen. The mineralogy is also closely similar. The main difference is that nontronite predominates over chlorite as an alteration product of biotite, and in the veins cutting the rock. Some apparent xenoliths of a possible quartz-siltstone are present, surrounded by a rim of nontronite. The rock is again a dacite or granodiorite porphyry.

84NT/1 3rd October, 1958.

3. EXAMINATION OF A SAND CONCENTRATE FROM NELLIE CREEK, 17 MILES EAST OF PINE CREEK, N.T. - BY W. M. B. ROBERTS

The concentrate, submitted by C.E. Prichard of the Darwin Office gave 3000 + C.P.M. on the Austronic B.G.R.I. ratemeter. This activity was thought to be due to a mineral in the sample containing radium.

The concentrate was examined under the microscope and found to consist of zircon (some iron-stained), cassiterite, quartz, hydrated iron oxide, a black mineral, probably ilmenite, and a brownish black mineral which could not be identified immediately.

The concentrate was examined in the X-ray spectrograph and the principal elements were Fe, Ti, Zr, Th, Hf, Sn, Mn, Cr, traces of U, and some rare earths in roughly that order of abundance. This confirmed the presence of zircon, cassiterite, and ilmenite, and showed the radioactivity to be largely due to thorium.

The brownish-black mineral which could not be identified was separated from the concentrate by hand picking under the microscope. The resultant separate was examined in the X-ray spectrograph and it was found to be composed of the following elements, in order of abundance: Th, Fe, Y, Er, Ho, Gd, Nd, Yb, La, Dy and Sm.

The mineral was hard, brittle and gave an orange brown powder when crushed for analysis. The elemental composition could be that of either thorite or thorianite, (Si not detectable by X-ray spectrography). However, thorianite gives a greenish black powder whereas thorite gives an orange-brown powder, and this latter mineral is also given as containing a larger quantity of Y and Er.

In view of the fact that uranium is present only in trace amounts (probably the usual quantity associated always with thorium) it is improbable that radium would be the source of radioactivity, as over 1,000 grm. of uranium element contains only 0.34 mgm. of radium. Rather it can be stated that thorium or its radioactive decay products are the causes of the radioactivity in the specimen. Thorium, itself weakly radioactive, loses an alpha particle to give mesothorium I which has the longest half-life of the thorium decomposition products (6.7 years), this short half-life would only allow a very minute quantity of this element to be present, but due to its extremely high radioactivity it could be responsible for the activity of the sample.

15th October, 1958.

64F/1

[illegible]. EXAMINATION OF PHOSPHATE SPECIMENS BY [illegible]. M. B. ROBERTS

Specimens of white to buff coloured phosphate rocks form the base of a phosphate deposit on Bellana Island, British Solomon Islands Protectorate were submitted by W.C. White for identification of the mineral constituents. Wherever possible the minerals were identified by X-ray diffraction, but in the [illegible] of collophane, microscopic identification only was possible, because of the cryptocrystalline nature of this mineral.

Sample No.	Minerals.
453	Collophane, some calcite and crandallite.
260	Collophane, some crandallite, very little calcite.
276	Collophane, some fluor-apatite.
347	As 276
526	Tricalcium phosphate of Whitlockite type.

17th October, 1958.

106W/5D

5. PETROGRAPHY OF CORE SPECIMENS FROM MEDA NO. 1 WELL, KIMBERLEY DISTRICT, WESTERN AUSTRALIA - BY W. B. DALLWITZ

Following are brief descriptions of cores from Meda No. 1 Well, Kimberley District, Western Australia :

Meda No. 1, Core No. 25, 8685-8694'

A fine-grained to medium-grained greenish grey rock with a poorly developed, wavy, irregular cleavage. Small grains of brassy sulphide are scattered through the rock.

In thin section the rock is found to consist of approximately equal amounts of quartz and chlorite, together with a little sulphide and sphene. Most of the sulphide is probably pyrite, though some pyrrhotite may be also present.

Quartz grains interlock closely, and chlorite is intergrown with quartz in such a way that it is obvious that the rock has been completely recrystallized, leaving no sign of original sedimentary features. The chlorite, probably a variety of penninite, is light green and has anomalous brown interference colours, though normal colours are visible in a few places; in favourably oriented sections it is pleochroic from light green to pale buff. A very rough alignment of the long axes of the flakes is noticeable.

The rock is a quartz-chlorite schist.

Meda No. 1, Core No. 25, 8685'-8694' (Bottom of Section)

A pale yellowish grey medium-to fine-grained rock with a rather poorly developed cleavage which makes an angle of about 45° with the length of the core.

In thin section the rock is seen to consist of quartz (60%), chlorite (35%), and dolomite (5%). Zircon, apatite, and needles of a mineral with very high R.I. and strong D.R. (possibly rutile) are accessory. There is a suggestion of parallelism of the long axes of the quartz grains, but the effect is exaggerated by the presence of abundant flakes of chlorite. The chlorite is a colourless variety which is uniaxial or near-uniaxial positive, and has a D.R. somewhat lower than that of quartz. It is most likely the variety clinochlore.

The dolomite occurs as a rather irregular network of short veinlets measuring up to about 0.25 mm. in width. One set of these veinlets is parallel to the cleavage, and another makes an angle of about 70° with the cleavage; however, quite a few veins do not conform to either of these directions.

The rock is a chlorite-quartz schist.

Meda No. 1, Core No. 26, 8744'-8752'.

A medium-grained, light greyish green rock showing signs of a very rough cleavage, and containing irregular veins pockets of white to off-white dolomite. These bodies of dolomite measure up to several millimeters in width. Weak HCl reveals the presence of a little calcite.

In thin section the rock is found to consist of dolomite, quartz, green chlorite, and sericite in decreasing order of abundance. Accessory minerals are, leucoxene, rare green tourmaline, and very rare pyrite.

Originally this rock appears to have been a chlorite-quartz schist similar to that represented by the upper part of Core No. 25, Meda No. 1 well, 8685' to 8694', though it may also have contained a good deal of feldspar, which has, in some places, (presumably) been replaced by dolomite, and in others by sericite. The rock as a whole has been irregularly dolomitized.

The rock shows distinct signs of strain and contortion; deformation appears to have taken place before dolomitization. Evidence for this contention is provided by the presence of extremely pronounced strain shadows in quartz enclosed in and marginal to dolomite-rich parts of the rock; if dolomitization had preceded shearing the dolomite would have shown signs of directed stress, and the quartz would have largely been shielded from its effects by the less competent dolomite.

Dolomite has replaced all of the major cons-uents of the rock, but quartz, as is probably to be -ected, was the least amenable to replacement; grains of this mineral remain, to the exclusion of all others, even where the rock has been most strongly dolomitized.

The long axes of quartz grains show a very marked parallelism in lightly dolomitized parts of the slide. Flakes of chlorite are, of course, oriented in the same direction.

Aggregates of fine-grained sericite presumably represent original feldspar. Coarser sericite, found especially in one small part of the slide, shows a remarkable parallelism of growth, and has most probably replaced chlorite during hydrothermal activity.

Many of the small tourmaline grains have almost perfect crystal outlines, and it seems almost certain that this mineral has been formed by pneumatolysis.

Because of intense dolomitization this rock has lost almost all trace of cleavage. It may now be described as a dolomitized sericite-chlorite-quartz schist.

General Remarks

To consider quite objectively the evidence provided by these rocks, it is not possible to state with any degree of certainty whether they represent Archaeozoic, Proterozoic, or even Lower Palaeozoic sediments. Although no metamorphism of Lower Palaeozoic sediments has been noticed in the outcrops nearest to Meda No. 1 well, it is probably not impossible that rocks of that age have been locally metamorphosed. However, whatever their age, the significant point arising from the examination is that the observed degree of metamorphism, though apparently (but not necessarily) low, precludes any possibility of finding petroleum lower down in the section, unless the metamorphosed rocks are part of a block raised by overthrust or reverse faulting.

22nd October, 1958.

66G/1

6. EXAMINATION OF A SAND SAMPLE - BY W. B. DALLWITZ

A sand sample was submitted by H.B. Lloyd-Owen on 12th September, 1958, for examination.

Apart from a few small obviously extraneous angular metallic grains, and some dark green to black fragments, the sand consists of virtually pure quartz. Probable pyrite (iron sulphide) forms part of one grain of the small sample submitted, and inclusions of a black mineral can be seen in a few grains with the aid of a lens.

Light to dark grey grains which stand out from the glassy bead-like grains making up the bulk of the sample were found, on microscopic examination, to be quartz also. The darkest of these grains was crushed, and its colour was found to be due to abundant rod-like inclusions of a mineral which could not be identified on account of its small gransize. The lengths of these inclusions range from about 0.0014 mm. to 0.01 mm., and their widths from 0.0007 to 0.0014 mm. Less dark grains contain fewer and even more minute inclusions.

The grains of which this sand is composed are extraordinarily well rounded, and of remarkably uniform size. Most of the grains tend to be spherical in outline, and the size of such grains ranges between 0.77 and 0.92 mm., the average being 0.85mm. Some elongated, more or less oval grains are present; three of these were measured and found to have the following dimensions: 1.08 x 0.72 mm.; 1.13 x 0.77 mm.; 1.23 s 0.56-0.77 mm.

We do not know off-hand where a virtually pure quartz sand consisting of such uniform and well-rounded grains can be found in Australia. It is possible that some of the Botany windblown sand may be suitable. Furthermore, sand from a deposit on the River Murray in South Australia has been used by the C.S.I.R.O. in post-war years for making standard test-bars of concrete.

22nd October, 1958.

66PMG/1

7. EXAMINATION OF BEACH SAND SPECIMENS FROM NORTH WEST OF VANIMO. BY W.R. MORGAN AND W.M.B. ROBERTS.

Specimens of beach sand P102A and P102B from locations 3 miles and 10 miles N.W. of Vanimo respectively, were submitted for examination by J.E. Thompson on 4th July. A representative sample of each has been taken by W.R. Morgan, and examined microscopically after electromagnetic separation. The following estimated percentages of the minerals present were obtained:

P102A

Opaque Minerals (Excluding Magnetite)	Magnetite	Zircon	Monazite	Rutile	Other Minerals	Total
87.6	7.3	0.4	0.1	Trace	4.6	100.0

The "other minerals", in order of abundance, are:- calcite, staurolite, pyroxene, hornblende, quartz, with traces of spinel and garnet.

P102B

Opaque Minerals (Excluding Magnetite)	Magnetite	Zircon	Monazite	Rutile	Other Minerals	Total
87.9	6.9	Trace	Trace	Trace	5.2	100 0

The "other minerals", in order of abundance, are:- feldspar, calcite, garnet, quartz, epidote, spinel, with traces of biotite and staurolite.

Three of the more highly magnetic fractions (excluding magnetite) from each sample, all being concentrates of the opaque minerals, were submitted to W.M.B. Roberts for X-ray spectrometric examination for chromium and titanium. It was found that a considerable amount of the former was present, with much smaller quantities of the latter. It is therefore suggested that the opaque minerals consist mainly of chromite, with minor ilmenite. Microscopic examination confirmed this conclusion, although it was not possible to find the relative amounts of the two minerals.

24th October, 1958.

84W/1

8. EXAMINATIONS OF SLIGHTLY RADIO-ACTIVE CONGLOMERATE SPECIMENS FROM NORTH-EAST OF HALLS CREEK, WESTERN AUSTRALIA BY W.B. DALLWITZ AND W.M.B. ROBERTS.

A specimen of slightly radioactive conglomerate from 22 miles N.E. of Halls Creek, Western Australia, was submitted for examination by Dr. N.H.Fisher.

The matrix of the rock is grey, sandy and medium-grained, and contains quartz pebbles measuring up to about 1.5 cm. across. Limonite-staining and limonite encrustations in cracks and in cavities are visible in places. The specimen was tested for radioactivity and, in the most radioactive part, counts fluctuated between 80 and 140 per minute (average 110) against a back-ground fluctuating between 40 and 100 c.p.m. (average 70). Radioactivity is, thus, about 1.5 times background; this order of activity obviously makes it rather difficult to determine its cause.

In thin section the pebbles were found to consist mainly of vein quartz; some of them contain a little potash-feldspar, probable acid plagioclase, and muscovite. A few pebbles of fine-grained, siliceous sedimentary rocks are also present.

The matrix consists of grains of quartz measuring up to about 2 mm., very fine-grained sericite, abundant black iron ore (mainly magnetite - see below), fine quartz grains, accessory chlorite, hydrated iron oxide and leucoxene, and rare apatite, feldspar, and pinkish (?)zircon (uniaxial positive). The sericite has probably been derived from argillaceous material by low-grade metamorphism.

All except the smallest quartz grains in this rock show pronounced strain shadows.

Quite a few octahedra of magnetite were noted. The presence of these suggests that the iron ore has been formed either by metamorphism (of a ferruginous sediment) or by metasomatism. Certainly the magnetite, in its present state, is not of direct detrital origin, because numerous grains and octahedra of this mineral have grown into the detrital quartz grains. Both metamorphic and metasomatic processes may have been responsible for the formation of the magnetite.

X-ray spectrographic analysis (see below) showed that radioactivity is due to thorium and not uranium, but no separate thorium mineral could be distinguished. It is quite possible that the thorium is associated with one or more of the iron oxides. Thorium has an affinity for iron in sedimentation and probably in lateritic and oxidative weathering generally (c.f. Madigan's Prospect, Bynoe Harbour, N.T.). Separations carried out on powdered rock by gravitational and magnetic methods did not achieve any useful increase in radioactivity in any fraction; but then, the original radioactivity was so low that it would have been difficult, with the ratemeter used, to be sure of any suggestion of an increase in a small fraction of the rock.

A portion of the sample was ground to -100 mesh for X-ray spectrographic analysis, which showed that the slight radioactivity is due to thorium; no uranium in quantity detectable by this method is present. Vanadium and chromium are present as strong traces.

In polished section the rock is seen to contain a fairly high proportion of iron oxides - mainly magnetite, as irregular grains and octahedra, some irregular grains of hematite, and patches of hydrated iron oxide. The magnetite is showing extensive alteration to martite, which forms an irregular lattice along the octahedral cleavage of this mineral. Some hematite has a well developed lamellar twinning which may be the result of some post-depositional stress. If this is so, it would indicate that hematite was an original constituent of the rock. Whether or not the magnetite is of metamorphic origin cannot be determined from the examination of this specimen. The rock is a stressed <u>magnetite-bearing pebble conglomerate</u>.

The question of possible leaching of uranium from this specimen has been raised. As uranium could not be detected by the X-ray spectrograph it must be assumed either that any uranium that was present has been completely leached out or that no uranium was present in the first place. The specimen appears, in most parts, to be sufficiently fresh to preclude absolutely the possibility that uranium has been entirely leached out. In fact, as is well known, secondary uranium minerals are commonly found in rocks that are very strongly weathered. As this rock is only slightly weathered, it must be concluded that the absence of uranium is an original feature.

30th October, 1958.

198NT/1

9. PETROGRAPHY OF DOLERITES FROM SILLS ADJACENT TO THE GOLDEN DYKE AND MASSON FORMATIONAL BOUNDARY AND FROM THE MASSON FORMATION, NORTHERN TERRITORY, BY W.R. MORGAN.

The specimens D1 to D3 and D6 are from a sill near the boundary of the Golden Dyke and Masson Formations, and specimens D4 and D5 are from the Masson Formation. They were submitted by J. Hays for petrographic descriptions.

D.1. Sill close to the Golden Dyke/Masson formation boundary

Hand Specimen. The rock is medium to coarse-grained, hypidiomorphic and basic. It contains a pale, grey-white felspar, which occurs as rather tabular crystal; shiny black amphibole forms subhedral, prismatic crystals. Anhedral grains of quartz are present. The weathered surfaces are stained by hydrated iron oxide.

Thin section. The specimen is holocrystalline, medium to coarse-grained, and non-porphyritic. It is fairly equigranular and hypidiomorphic. Some infillings of secondary minerals are present. An estimation of the percentages of minerals present is:- actinolite, with ripidolite: 50; albite: 30; quartz, with myrmekite: 10; epidote: 5; leucoxene, apatite, calcite and pyrites: 5.

Actinolite occurs as subhedral, prismatic crystals, occasionally showing sub-ophitic ralations to felspar. It is faintly pleochroic, with X= colourless; Y=Z= very pale green: commonly the colouration deepens at the crystal margins. Length slow, $Z \wedge C = 19^{\circ}$. It is biaxially negative, with 2V= 75°, while birofringence = 0.026.

Commonly a chlorite occupies irregular areas enclosed in actinolite. It is pale green, and almost isotropic, with a birofringence of 0.002. It is biaxially positive, with $2V = 3^{\circ}$. The refractive index is, very approximately, 1.61 (i.e., rather less than that of apatite.) In habit, the mineral tends to be fibrous. The optical properties agree with ripidolite, in Winchell's (1951) classification. From the textural position of ripidolite, it seems possible that it is the alteration product of an original pyroxene, made over to chlorite after the process of uralitisation had halted.

Quartz occurs interstitially to actinolite and felspar. Tabular areas, enclosed by quartz, appear to consist of a myrmekitic intergrowth of quartz and felspar - these areas sometimes enclose corroded felspar crystals. In other places, corroded felspar is surrounded merely by quartz. Hence, at a possible late stage, there appears to have been reaction between quartz and felspar.

Commonly, the felspar is strongly saussuritized, but some fairly clear crystals are present. These show rather indistinct multiple twinning, this often appears to be absent in crystal centres. Its refractive index is less than that of Canada balsam, while it is biaxially positive. An extinction angle measured on a section normal to the X-bisectrix shows a composition of An_3 (approximately), hence the felspar is albite. Two late stage reactions may be noted here: albitization, and saussuritization. The saussuritization appears to have been subsequent to the felspar's reaction with the quartz, from textural evidence, while the albitization was completed prior to this.

Euhedral, tabular crystals of epidote are present, commonly associated with actinolite. It is colourless, and biaxially negative, with 2V = 85°, and has a birefringence of 0.020, these two facts indicating an iron-poor epidote.

Interstitial masses, of various size, of leucoxene are present.

Apatite occurs as small acicular crystals normally enclosed in quartz and albite: a little is partially enclosed by actinolite and chlorite.

Calcite occurs in irregular pockets as a secondary mineral. Pyrites also occurs as small pockets, sometimes associated with calcium.

The rock is an <u>albitized, uralitized and saussuritized quartz dolerite</u>.

D.2 locality as D.1

Hand Specimen. On a fresh surface the rock is seen to be medium to coarse-grained, basic, and hypidiomorphic equigranular. It consists of a grey-cream felspar, which is present as roughly tabular crystals; black hornblende, which appears to have a greenish chlorite associated with it; and anhedral crystals of quartz. Weathered surfaces are brightly stained by hydrated iron oxide.

Thin Section: In texture the specimen is holocrystalline, medium to coarse-grained and non-porphyritic. It is hypidiomorphic; and rather irrequigranular. The mineralogy is very similar to that of specimen D.1, and an estimation of the percentages of minerals present:- albite: 30; actinolite, with ripidolite: 45; quartz with myrmekite: 15; leucoxene, apatite and pyrites: 5. The textural relations of the minerals to each other are also similar to specimen D.1, except that the actinolite tends to be more fibrous, and that ripidolite occurs interstititially as well as in association with actinolite.

The felspar was found to be albite, an extinction angle on a section normal to the X-bisectrix showing a composition of An_1. The crystal on which measurement was made is surrounded by a quartz-felspar myrmekite integrowth, and is partly corroded. The crystal, 1.05 mm. long and 0.22 mm. wide, is surrounded by a very thin rim of quartz, 0.007 mm. thick, containing no felspar. This, in turn, is surrounded by a zone varying between 0.07 and 0.28 mm. thickness, consisting of dendritic growths of felspar enclosed in quartz. The felspar growths are 0.007 mm. thick, and may, in places disappear, leaving small blank areas of quartz.

Quartz, in the rock, is normally interstitial to the remaining minerals, enclosing small, very acicular needles of apatite. However, at one point a vein of quartz, varying between 0.12 and 0.4 mm. thickness, cuts the rock. Where it cuts a quartz grain in the rock, the grain and vein are in optical continuity. The quartz of the vein also encloses numerous needles of apatite, similar to those enclosed in the rock quartz. The apatite is rarely enclosed in any of the other minerals in this specimen, or in D.1. Quartz seems, from these points, to be a late stage product of the rock, and formed interstitially, as well as cutting the already solidified rock as a vein.

The rock is an <u>albitized and uralitized quartz dolerite</u>.

<u>D.3. Locality as D.1</u>

<u>Hand Specimen</u>. On a fresh surface this rock is seen to be greenish and basic. It is medium to coarse-grained and hypidiomorphic. It contains amphibole, felspar, quartz, with some chlorite and pyrites. The weathered surfaces are stained with hydrated iron oxide.

<u>Thin Section</u>. Texturally, the rock is medium to coarse-grained, non-porphyritic, hypidiomorphic and rather inequigranular. The mineralogy is again rather similar to that of D.1, except that actinolite is slightly more greenish, with X= colourless; Y= pale olive; Z= very pale green, sometimes tinged with blue. An estimation of the percentages of minerals present is:- actinolite with ripidolite: 40; albite: 40; epidote: 10; quartz: 5; leucoxene, ilmenite, apatite and pyrites: 5.

Certain textural differences from the previous two specimens are apparent. Firstly, there is less quartz present: with this, there is no development of the myrmekite quartz-felspar structure. Secondly, rather more epidote is present, forming somewhat interstitial granular aggregates. The epidote, on further examination, was found to be zoisite: it has parallel extinction, with a biaxially positive figure, 2V = = 35°: birefringence = 0.010.

Very occasionally, small irregular areas are enclosed within actinolite, containing a mineral with a large extinction angle, and having a refractive index greater than that of actinolite, but less than that of zoisite. The mineral is possibly pyroxene.

Ilmenite occurs, like leucoxene, as interstitial masses. Only small amounts are present, invariably in part altered to leucoxene.

The rock is an <u>albitized, uralitized and partly saussuritized quartz dolerite</u>.

D.6. Locality as D.1

Hand Specimen. The rock is a greenish grey, medium to coarse-grained basic containing tabular, greyish fel-spar, black amphibole and greenish pyroxene. Very small amounts of quartz are present. The rock tends to be slightly porphyritic. The weathered surfaces are stained by hydrated iron oxide.

Thin Section. Texturally, the rock is medium to coarse-grained, rather inequigranular, hypidiomorphic, and non-porphyritic.

The specimen is seen to contain the following percentages of minerals:- tremolite: 30; enstatite and augite: 25; felspar (and its alteration products): 35; quartz: 5; leucoxene, pyrites and apatite: 5.

Pyroxene occurs as prismatic crystals, seen to be in various stages of alteration to tremolite. Enstatite has parallel extinction, and is biaxially positive, with 2V about 70°. Its birefringence is low. Augite has $Z \wedge C = 45^{\circ}$; while it is biaxially positive, with $2V = 50^{\circ}$. Its birefringence = 0.024. Tremolite is colourless, occasionally very slightly tinged with green. It occurs as rather long, fibro-prismatic crystals, or as veins of varying width around pyroxene crystals. $Z \wedge C = 16^{\circ}$. Its birefringence = 0.026. Biaxially negative, $2V = 75^{\circ}$.

Fresh felspar is present in small quantities. Its refractive index is less than that of Canada balsam, and multiple albite twinning is present: from these two vague facts, it appears to be albite, or sodic oligoclase. The small amount of felspar left shows partial alteration to sericite, kaolin and zoisite. Certain areas in the slide consist of a rather fine-medium grained agglomer-ation of sericite and zoisite crystals, sometimes en-closing tremolite and a colourless or faintly green chlorite. The sericite and zoisite and predominant in these aggregates, and are possibly all that remain of the rock's felspar. The chlorite appears to be ripi-dolite. It also occurs in conjunction with tremolite.

Quartz occurs sparsely as interstitial masses, often enclosing needles of apatite, and, in places, tremolite. Leucoxene forms tabular to interstitial grains, sometimes enclosing ilmenite. A little pyrites occurs, enclosed in quartz.

The rock is an albitized, saussuritized, and uralitized enstatite-bearing dolerite.

D.4. Dyke in the Masson Formation

Hand Specimen. The rock is very fine-grained and porphyritic, the phenocrysts being small (up to 0.5 mm. length), and composed mostly of felspar. The ground-mass is dark and basic. The specimen breaks with a sub-conchoidal to rough fracture.

Thin Section. In texture the specimen is holocrystalline, very fine-grained, and porphyritic, the phenocrysts being fairly sparse, and the larger attaining a size of 0.5 mm. The groundmass is hypidiomorphic, and fairly equigranular.

The phenocrysts consist mostly of albite, with some actinolite. Albite forms anhedral to subhedral crystals, tending to a tabular shape, with some sign of corrosion. Its refractive index is less than that of Canada balsam, and it is biaxially positive. Some indistinct multiple twinning is present. Actinolite forms vaguely prismatic crystals, and is pleochroic from pale olive to pale green. It appears to be partially chloritized. In addition to albite and actinolite, some masses (of phenocryst size) of leucoxene occur, also some anhedral grains of hydrated oxide.

The groundmass consists of minute, rather tabular crystals of felspar, with subhedral crystals of amphibole. Flakes, and interstitial grains of a greenish chlorite are present.

A very rough estimation of the percentage of minerals present is:- felspar: 55; actinolite and chlorite: 40; the remainder: 5. The rock is an actinolite spilite, or an albitized basaltic dyke-rock.

D.5. Dyke in the Masson Formation.

Hand specimen. The rock is dark and basic, and is medium-grained, with a hypidiomorphic, rather equigranular texture. Sparse phenocrysts, only slightly larger than the groundmass, may be distinguished. The rock contains greyish felspar as tabular laths, and dark amphibole. A little quartz and epidote may be seen. The weathered surfaces are brightly stained with hydrated iron oxide.

Thin Section. Texturally, the specimen is holocrystalline, medium grained and rather equigranular, and is slightly porphyritic. It is hypidiomorphic.

Felspar forms subhedral, rather tabular crystals, which are strongly sericitized and kaolinized, making determination difficult. However, it has a refractive index greater than that of Canada balsam, and a biaxially negative, with 2V = 85°, was obtained from one crystal. Extinction angles on a section normal to the Z-bisectrix on another crystal suggested that the core is An_{70}, while the edge is An_{46} - these figures should be regarded as approximations, because of the altered state of the felspar. Albite twinning is present. The few phenocrysts in the rock are composed of felspar.

Actinolite forms subhedral, fibro-prismatic stubby crystals giving the impression of pseudomorphing pyroxene. It is pleochroic:- X = colourless; Y = very pale olive green; Z = very pale green. Length slow, $Z \wedge C = 25°$. Its birefringence = 0.022. It is biaxially negative, with a large 2V.

Rather tabular crystals of clinozoizite are present. They are colourless, and biaxially positive, with 2V=80°-90°. They have low birefringence. Clinozoisite may occur as single crystals, or as small clusters, with several somewhat intergrown crystals. Occasionally associated with this mineral are small pockets of interstitial to poikilitic felspar; this mineral, as opposed to the labradorite described above, is absolutely fresh: it shows pericline twinning, and gives a biaxially positive figure, with 2V = 85°. It was not possible that the mineral is albite. Quartz has an occurrence similar to that of (?) albite.

Biotite occurs as subhedral flakes enclosed by actinolite. It is pleochroic:- X= very pale brown; Y=Z=light fawn-brown. It appears to have formed from actinolite.

Small granules of black iron are scattered in the groundmass: apparently both ilmenite and magnetite are present, as their alteration products, leucoxene and hydrated iron oxide, may be seen. Acicular needles of apatite are enclosed in quartz.

An estimation of the percentage of minerals in the rock is:- labradorite/bytownite: 40; actinolite with biotite: 50; the remainder: 10. The rock is a uralitized quartz dolerite.

12th November, 1958.

198NT/1

10. PETROGRAPHIC DESCRIPTIONS OF SEDIMENTARY SPECIMENS FROM A SHAFT AND ITS ENVIRONS AT MT. MASSON BY W.R. MORGAN.

The specimens S1 to S5 have been submitted by J.Hays for description.

S.1. Shaft at Mt. Masson

Hand Specimen. The rock is fine-grained, with a slightly irregular slaty cleavage cutting the bedding at right angles to the latter's direction. The bedding is shown by alternating light and dark grey bands, which have thicknesses ranging between 0.5 cm. and 3 cm. Round to cubic-shaped cavities are present, having an average size of 0.5 mm.

Thin Section. In texture, the rock is fine-grained, and has a rough mineralogical lineation approximately parallel to the rock's cleavage.

The darker bands consist of 35% carbonaceous material, 35% sericite (with some chlorite), and 30% quartz and felspar.

Carbonaceous material is present as minute, somewhat irregular granules, strung out in lines, parallel to the rock's cleavage. Sometimes the grains are enclosed in the other minerals. Sericite and chlorite form flakes which have a fairly general orientation, but showing a slight tendency to be lineated in a direction slightly oblique to the direction of the strung out carbonaceous material. This may account for the slightly irregular cleavage described in the hand specimen. Quartz and felspar form granular grains, sometimes elongated in the direction of the cleavage. The felspar is possibly albite: it has a refractive index less than that of Canada balsam.

The lighter bands contain much less carbonaceous material, only about 5% being present. The remaining minerals are similar to those in the darker bands, but present in greater quantities.

Several square-shaped cavities were noted in the section; these were probably, at one time, occupied by pyrites. Very often a vein of sericite or quartz is present on the surfaces of the cavities. A little hydrated iron oxide is present as small blobs in the rock.

The rock is carbonaceous slate.

S.2. Shaft at Mt. Masson

Hand Specimen. The rock is fine-grained, and is dominantly light grey, with two thin dark bands, one 0.5 mm. thick, the other being 3 mm. thick. The latter grades into the pale material on the side away from the first band. A rough cleavage is present, cutting across the bands. Grains of pyrites are present, some forming clusters elongated in the direction of cleavage.

Thin Section. The specimen is fine-grained, with a rough lineation of the micaceous minerals in the direction of cleavage. The darker bands of the hand specimen contain carbonaceous material, which is practically absent in the lighter layers. In the latter, about 30% of the rock consists of small, rounded flakes of a greenish brown biotite, which is very slightly pleochroic. About 45% of the rock consists of minute, rather tabular flakes of sericite. The remainder appears to consist of granular quartz, sometimes elongated in the direction of the cleavage. Some grains of quartz are rather larger than the general groundmass; here, the mica flakes are wrapped around them. Occasional very thin quartz-rich layers are present, running parallel to the banding. These layers tend to be discontinuous, and are sometimes represented by a line of "balls" of quartz grains.

A little micro-faulting, possibly an incipient false cleavage, is present, running in a direction at right angles to the slaty cleavage.

The rock is a slate.

S.3. Shaft at Mt. Masson

Hand Specimen. The rock is very fine-grained, with a slaty cleavage cutting the lithological layering at an angle of approximately 35°. The specimen consists for the most part, of dull greenish grey material, containing three layers, from 2 to 4 mm. thick, of darker, carbonaceous material. Numerous cube-shaped cavities are present, but no pyrites was seen.

Thin Section. The specimen is fine-grained, with a cleavage imparted to it by sub-parallel arrangement of the micaceous mineral, and by lines of carbonaceous material. Sericite occurs as rather tabular flakes, mostly with parallel lineation, though some have a more random orientation. Grains of quartz are present. In the darker bands, about 40% of the material present is carbonaceous, arranged as strings of granules, or as continuous lines, parallel to the cleavage. Some "lines" of hydrated iron oxide are present. A little micro-faulting, at right-angles to the cleavage, may be seen. The rock is a slate.

S.4. Mary River

Hand Specimen. The rock is exceedingly fine-grained, with a fine cleavage which is parallel to the bedding. Stratification is marked by alternating red and yellow layers, the former being 5mm. thick, the latter 2-3 mm. thick. Numerous cavities are present on the weathered surfaces of the red bands; these are almost certainly places from which pyrite has been removed.

Thin Section. The specimen is fine-grained, and consists of hydrated iron oxide, sericite, quartz and very small amounts of chlorite in the red layers, while in the yellow bands, hydrated iron oxide is practically absent. The red beds have 35-45% of hydrated iron oxide, which occurs as small granules and scales. In both types of layer, sericite occurs as small, tabular flakes, mostly orientated parallel to the cleavage; quartz occurs in smaller quantities as rather angular grains, often elongated parallel to the cleavage. Several "cubic" shaped cavities may be seen, some being lined with quartz showing pressure shadows: the shadows were probably formed around pyrite. Section S4A shows several apparent composite grains of quartz, elongated parallel to the cleavage: it is possible that the quartz fills old cavities.

The rock is a banded ferruginous slate. The concentration of hydrated iron oxide in certain bands is probably due to the oxidation of pyrites.

S.5. Five miles west of Mt. Masson

Hand Specimen. The rock consists of a somewhat friable, fine-grained greyish-white material which has a poor cleavage. This encloses pebbles which run in a layer at a direction approximately 70° to that of the cleavage. The pebbles measure, on the average, 10 mm. by 5 mm. and are elongated parallel to the cleavage, while the cleavage itself is "wrapped around" the pebbles. Approximately 5 mm. thickness of rock next to the weathered surface is quite hard and not friable. The thin section is cut at right-angles to both the cleavage and the pebble elongation.

Thin Section. The specimen has a fine-grained, inequigranular, groundmass of angular fragments, enclosing rather rounded pebbles. A cleavage is imparted to the groundmass by the preferred orientation of sericite flakes.

In the groundmass quartz occurs as exceedingly angular grains showing sharp corners, and, frequently, concave surfaces, the general aspect being that of a tuff. Quartz grains tend to be elongated parallel to the bedding (i.e., the pebble band), and therefore inclined at a large angle to the cleavage. Sericite forms long streaky flakes. Streaks of hydrated iron oxide are present, running parallel to the cleavage.

Most of the pebbles consist of (?)tuffaceous material; quartz and (?)felspar are present, forming fine, highly angular grains; some chlorite occurs. (?)Felspar is cloudy with alteration products, and has a higher refractive index than that of quartz. One pebble consists almost entirely of rather equidimensional grains of quartz, and its constituent grains are rather more coarse than those of the other pebbles. The pebble has two prolongations, making it an oval shape. The prolongations consist of elongated, parallel and rather intergrown plates or rods of quartz. The trend of elongation is oblique to that of the cleavage, although the tips of the prolongations have been turned nearly parallel to it, as though the pebble had been rotated.

Thin veins cut irregularly across the rock, and contain (?)fluorite. This mineral has a very pale pink colour, and has a negative refringence, with high relief. It is isotropic. The vein cuts the quartz pebble described above, and it appears to be associated with finely granular, interstitial epidote which lies either side of the vein in the pebble.

The rock appears to be a roughly cleaved ashstone containing a band of lapilli tuff, the fragments largely consisting of material similar to that of the groundmass, but probably representing felsitic lapilli of the same composition as the pulverised lava making up the ashstone.

13th November, 1958.

94Q/3

11. PETROGRAPHIC DESCRIPTIONS OF ROCKS FROM CHUMVALE HOMESTEAD, CLONCURRY 4 MILE SHEET AREA, NORTH WESTERN QUEENSLAND BY K.R. WALKER.

Specimens 3727 (1) and (2) collected adjacent to Chumvale homestead, Cloncurry, by E.K. Carter, are described below.

Specimen 3727 (1) is a pink-grey and fine-grained rock with an aphanitic groundmass in which pink felspar and hornblende grains can be recognized.

The distribution of mineral grains in the thin section shows a rude parallelism, particularly the large hornblende grains which occur in a granoblastic base of quartz, felspar (microcline and acid plagioclase), hornblende and accessory iron ore, sphene, apatite, and epidote. Iron ore grains also conform roughly to the directional arrangement of the other minerals. Apart from hornblende set in the groundmass, large grains of soda felspar also occur. Lenticular aggregates in which microcline (unaltered) is mingled with plagioclase (altered) possibly represent veining. All mineral grains in the rock are xenoblastic, and grainsize in the base averages 0.05 mm., whereas the larger hornblende and felspar grains measure between 0.5 and 1 mm. The parallel distribution of mineral grains may correspond to original bedding planes.

A most distinctive feature of the rock is the rough orientation of the long axes of the hornblende grains. These grains are in two sizes, 0.1 mm. to 0.3 mm. and 0.5 to 1 mm. The parallel arrangement does not appear to result from a stress effect, as most of the grains are poikiloblastic, the inclusions being groundmass minerals. Hornblende shows X = light yellow-green, Y = grass-green and Z = blue-green, $X<Y<Z$.

Quartz grains measure up to 0.1 mm. and constitute most of the base. The xenoblastic grains are granoblastically developed with lesser amounts of microcline, clouded plagioclase, hornblende, and iron ore.

The felspar is mostly a potash variety. Microcline (0.02 to 0.1 mm.) grains show typical grid-iron twinning. They are mostly small and fresh whereas soda felspar forms large grains (up to 1 mm.) and less commonly small grains (0.05 mm.) in the base. The latter felspar contains albite twin lamellae whose maximum extinction approached 15^{o} indicating a composition of Ab_{92} An_{8} as the R.I. is less than that of Canada balsam. The albite grains show a turbid brown alteration that is partly flecked with sericite flakes. This suggests that either differential alteration of plagioclase has occurred as compared to microcline, or that the rock shows the effects of polymetamorphism.

Iron ore grains (0.1 mm.) are discrete or associated with sphene, both showing a roughly linear distribution of parallel bands. However, there are other larger grains (0.3 mm.) scattered throughout.

Minor constituents are apatite, epidote, and sphene.

A visual estimate of relative abundance of minerals can only be very approximate. Quartz 55%, microline 15%, hornblende 15%, albite 10% and iron ore 5%.

The nature and possible genesis of the rock is discussed below.

Specimen 3727 (2) is not unlike (1) but it is light grey and shows only pink felspar crystals in an aphanitic base.

The thin section is not distinctly banded as that of (1) but contains the same mineral constituents. However, only plagioclase forms large crystals which measure up to 1 mm. The base consists of xenoblastic grains of quartz, microcline, and hornblende, and subordinate sphene, iron ore, and apatite. The base is granoblastic and grains average 0.1 mm.

Quartz is the most abundant mineral and grains range from 0.02 and 0.1 mm. in size. It constitutes most of the base. Other minerals in the base include microcline that can be distinguished from plagioclase and quartz rarely by twinning but more commonly by its freshness and negative relief. The plagioclase is albite with an R.I. approximately equal to that of Canada balsam. Large grains in the groundmass measure up to 10 mm. and show turbid brown alteration which is sufficiently intense to obliterate twinning in nearly every grain.

Hornblende forms only equidimensional grains in the groundmass; it shows a rudely banded distribution. In this respect it is similar to the distribution of iron ore and sphene. Hornblende shows X= light yellow-green, Y = olive-green, and Z = dark blue-green, X<Y<Z.

The minor constituents are sphene and apatite. Both rocks 3727 (1) and (2) are <u>plagioclase-hornblende-microcline-quartz hornfelses</u>; they are probably products of metasomatic alteration of impure (calcareous) quartzites.

One cannot confidently distinguish between rocks of igneous and metasomatic origin on the basis of two hand specimens. Careful selection of a suite of representative specimens would be necessary, upon which detailed studies could be carried out. Furthermore, the relevant field information is required. The following interpretation of the petrogenesis of Specimens 3727(1) and (2) must be accepted with caution, more particularly because the author's views are biased by the results of studies on rocks from the Duchess area which appear to be similar. Following the study of the rocks from Duchess, and similar rocks from other areas in the North-western Queensland region (Carter, Brooks & Walker, in preparation) it was shown that many rocks which have the appearance of acid volcanics in hand specimen can be demonstrated to be quartz-felspar and felspar-hornblende porphyroblastic rocks interstratified with calc.-silicate rocks of the Corella Formation or with strata of the Argylla Formation.

Petrographical examination of specimens 3727 (1) and (2) shows no tangible evidence that they had an igneous origin, and possibly they are similar in their field occurrence to the previously studied rocks. Evidence at Duchess suggests that potash metasomatism followed soda metasomatism; the petrography of specimens 3727 (1) and (2) would support this interpretation. If these rocks are polymetamorphic it appears that the plagioclase porphyroblasts developed first and that subsequent metasomatic alteration (mainly potash) was responsible for the development of microcline and the alteration of the original plagioclase.

Three other features of these rocks support a metasomatic origin for them:

(i) Quartz is unusually abundant for an igneous rock. Furthermore, no relict igneous structures or minerals have been recognized.

(ii) Although mineral grains in the rock commonly have a linear distribution and a directional arrangement, it seems unlikely that these features were caused by stress as the base of the rocks is granoblastic and the hornblende porphyroblasts are poikiloblastic. These are features which more commonly reflect the effect of the thermal factor in metamorphism.

(iii) The directional trend of mineral grains, especially those of hornblende and iron ore, is probably best explained by suggesting that the bands reflect original bedding, particularly lime-rich and iron-rich layers.

REFERENCE

CARTER, E.K., BROOKS, J.H. and WALKER, K.R. (in preparation). The Precambrian Mineral Belt of North-western Queensland. Bur.Miner.Resour.Aust. Bull. 51.

46NT/1

18th November, 1958

12. PETROGRAPHIC DESCRIPTIONS OF ROCKS FROM THE MT. HARRIS AREA, NORTHERN TERRITORY

by

K.R. WALKER

Six thin sections of granite and five thin sections of hornfels have been examined for J. Hays, Mines Branch, Darwin.

The thin sections of hornfels (1 to 5) were cut from specimens collected between 6 inches and 200 yards from the contact against the Cullen Granite in the Mt. Harris area. The remaining specimens (6 to 9) are of granite and specimen 10 of fine-grained granite, which have been collected in the granite between 6 inches and 250 yards from the same contact.

Specimens 6 to 9 are of flesh-coloured to light grey, medium-grained rocks. They show felspar, quartz and small flakes of biotite evenly distributed throughout. The thin sections are allotriomorphic granular and each has a fairly wide range of grainsize between 0.5 and 3 mm. They contain alkali felspar, plagioclase, quartz, biotite and accessory iron ore, zircon, and saussurite in some cases. Graphic intergrowth between quartz and microcline occurs in a number of places, and the quartz grains in such occurrences may be mostly in optical continuity. Some of the perthitic microcline forms phenocrysts measuring up to 10 mm.

Microcline (0.5 to 1 mm, and some grains up to 10 mm.) is the most abundant mineral. Much of it forms large grains that are cracked and show undulose extinction. Grid iron twinning is common and slight perthitic intergrowth also occurs. Such intergrowth is commonly depicted by turbid brown alteration. Alteration of microcline is not as extensive as that of plagioclase and takes the form of patchy brown clouding.

The plagioclase (0.5 to 2 mm) forms mainly hypidiomorphic grains, most of which are zoned and twinned. However, many grains are heavily altered and show flecks of sericite amongst the turbid brown alteration product. The few little-altered zoned grains indicate that there is not a wide range in composition· two determinations on Carlsbad-albite twins gave the composition as $Ab_{72}An_{28}$.

Quartz (0.5 to 3 mm) is evenly distributed throughout and is next to microcline in abundance. Large grains are broken by fine cracks and transgressed by grains of small inclusions; extinction is generally undulose.

Biotite flakes (0.5 to 2 mm) are pleochroic from straw-yellow to chocolate-brown. Biotite is the only coloured mineral except for rare chlorite that has been derived from biotite alteration. Small pleochroic haloes in the biotite flakes surround possible zircon grains. Lenses of a zoisite-like mineral commonly occur in cleavage traces.

Magnetite forms rare grains. Alteration products of probable allanite can be seen in some of the specimens of granite.

A visual estimate of the relative mineral abundance indicates 30-40% microcline, 25-35% quartz, 15 to 20% plagioclase and 5 to 15% biotite. These rocks are alkali granite in which slight differences may be attributed mainly to alteration by weathering.

Regarding specimens 7 and 7A., specimen 7 shows slightly greater alteration than 7A, but in the specimen supplied there is no ferruginous material present, other than very minor staining along cracks in some grains.

On the other hand the fine band represented by specimen 10 contains more abundant plagioclase. However, alteration has discoloured all the plagioclase grains turbid brown, and a determination of composition is impossible. The thin section contains glomeroporphyritic patches of quartz and less commonly microcline and plagioclase in an allotriomorphic granular groundmass. The grainsize in the groundmass ranges from 0.5 to 2 mm. and glomeroporphyritic patches measure up to 7 mm. across. Groundmass minerals are microcline, plagioclase and quartz, which occur in approximately equal amounts and also biotite. Small biotite flakes (0.2 to 1 mm) show greater alteration to chlorite than those in the coarser-grained granite, but other characteristics are the same. The fine-grained granite is probably a related, but possibly a slightly more soda-rich phase of the granite described above.

In some of these six granitic rocks (specimens 6 to 10) the ratio of potash felspar: plagioclase may be high enough for the rocks to be termed adamellites; however, micrometric analyses would be necessary to be sure of this point.

Specimens 1 to 5 represent part of the metamorphic aureole surrounding the granite. They include quartz-felspathic rocks (4 & 5) and pelitic hornfelses (1 to 3). Specimen 3 is partly ferruginized. Although specimens 4 & 5 are from outcrops adjacent to the contact, they do not show as distinctive metamorphic alteration as the pelitic rocks which are more remotely placed with respect to the same contact.

Specimens 1 to 3 come from between 200 yards and 10 feet of the contact and show the effects of contact alteration against the Cullen Granite. They are indurated fine-grained, grey rocks flecked with mica. In some rocks large grains of iron ore (1 mm) can be recognized. Specimen 1 is finely banded and 3 has a ferruginous crust surrounding a weathered buff micaceous rock.

Specimen 1 is a finely banded sericite-biotite-quartz hornfels in which seams of fine iron ore grains and the directional arrangement, or banded distribution, of biotite flakes give the thin section a banded appearance. The grainsize averages 0.1 mm, but a few pyrrhotite grains measure 0.5 mm. and some flakes of muscovite reach 0.4 mm. Green tourmaline is a rather uncommon accessory. The development of indistinct spots up to 2 mm. in diameter is apparent in the groundmass, and these probably represent the incipient development of a metamorphic mineral, possibly cordierite. However, the spots, although optically continuous, contain myriads of small inclusions of groundmass minerals.

Specimen 1 is a thermally altered <u>sericite-biotite-quartz hornfels</u> which is either in the greenschist or albite-epidote-amphibolite facies.

Both specimens 2 & 3, which come from outcrops 50 yards and 10 feet from the contact are hornfelses. However, 3 is partly iron-stained and the red-brown material formed includes granulated and fractured mineral grains from the body of the rock. Evidently the iron-rich solutions exploited a fracture and permeated its walls that were partly sheared and granulated.

Thin section of specimen 3, including the iron-stained portion, consists mainly of muscovite, andalusite, quartz and iron ore. The grainsize of minerals in the base, namely quartz and micas, average 0.1 mm., whereas andalusite forms porphyroblasts up to 2 mm. and is poikiloblastic. Inclusions are mainly quartz and less commonly iron ore. Iron ore forms small grains (0.1 mm), some of which form groups. The rock is a muscovite-quartz-andalusite hornfels

The thin section of specimen 2 is not unlike that of 3 but it also contains abundant cordierite and biotite. Both cordierite and andalusite are porphyroblastic and measure between 1 & 2.5 mm; they are strongly poikiloblastic. Inclusions are mainly groundmass minerals; iron ore inclusions are not as abundant, or as large, in the cordierite as in the andalusite, whereas biotite flakes form inclusions in cordierite but are more common between the andalusite and cordierite porphyroblasts.

Iron ore is mostly evenly distributed throughout as small grains (0.1 mm) but includes a few larger grains (0.5 mm). The rock is a biotite-andalusite-cordierite-muscovite hornfels.

The presence of muscovite in both specimens 2 & 3 in conjunction with andalusite and abundant cordierite in the case of 2, and also textural features of each, suggest that these rocks are in the amphibolite facies of thermal metamorphism.

Specimens 4 & 5 were both collected 6 inches from the granite contact. These are quartzo-felspathic rocks which contain mostly quartz, lesser amounts of felspar, biotite and subordinate muscovite, iron ore and sphene. There may also be some small interstitial cordierite grains. The grainsize ranges from 0.1 to 1.5 mm. Biotite flakes and small iron ore grains are strung out in a series of narrow roughly parallel bands.

Many of the quartz grains are fractured and cracked and show undulose extinction. Grains range between 0.2 and 1.5 mm and they are poorly sorted and subangular but show some reconstitution of grain margins.

Felspar forms grains up to 2 mm, but most of the felspathic material is interstitial to the quartz grains. It is mostly altered and shows a turbid brown colouration. The brown alteration product is flecked with small sericite flakes. Possibly some of the larger acid plagioclase grains are derived by felspathization of the sediment by the granite adjacent to its contact. These grains have irregular margins and commonly contain inclusions of quartz and rarely muscovite.

The biotite is a red-brown variety and flakes average about 0.1 mm. The presence of some pale golden-brown mineral associated with biotite may be a chlorite derived from the biotite by alteration.

There is nothing distinctive about the metamorphism of these rocks, but probably they are of comparable grade to that shown by specimen 3. Specimens 4 and 5 are quartzo-felspathic rocks.

198PNG/1 19th November, 1958

13. PETROGRAPHIC DESCRIPTIONS OF ROCKS FROM MT VICTOR PROSPECT (KAINANTU), SALAMAND PENINSULA, MUBO AREA, AND TAMBU B.V.T.P.N.G.

98901

Hand Specimen. The rock has a very fine-grained, greenish matrix enclosing many phenocrysts composed of felspar and its alteration products, and epidote. The phenocrysts have an average measurement of 1-5 mm, though some are as large as 3mm.

Thin Section. The specimen is very porphyritic, and has a holocrystalline, very fine-grained granular groundmass enclosing the phenocrysts which are coarse and hypidiomorphic. The rock shows incipient brecciation, and has a meshwork of cracks in places, along which late minerals have been deposited.

The groundmass consists mainly of minute tabular felspar crystals, the crystal margins commonly being somewhat sutured. Some sericite flakes are admixed, and a little granular quartz is present. The grain size ranges between 0.003mm. and 0.01mm.

The size of the phenocrysts ranges between 0.08mm and 1.25mm as seen in the section. The majority consist of tabular, strongly sericitized plagioclase, probably oligoclase. It has indistinct albite and carlsbad twinning, and its refractive index is approximately equal to that of balsam. It is biaxially negative. The remaining phenocrysts are pseudomorphs of both amphibole and pyroxene, the outlines of basal sections of both minerals being seen. The alteration products of these minerals consist of epidote, chlorite and (?) talc. Epidote occurs as granular to tabular crystals, sometimes occupying the whole of a pseudomorph, but more often have a thin rim of chlorite and talc. Frequently, isolated grains of epidote may be surrounded by flaky or fibrous crystals of chlorite and talc, with occasional chlorite, in any one pseudomorph. Epidote is pleochroic in fairly bright yellow, and has a birefringence of 0.055, though some crystals are seen to be zoned, with a lower double refraction occurring towards crystal centres. Chlorite is faintly pleochroic in apple-green, with low birefringence. (?) Talc is colourless, and occurs as flakes and fibres of a similar size to the flakes of sericite enclosed in the felspar. However, the birefringence is greater than that of the sericite, although in other respects it is very similar. Hence, it is thought to be talc. Very often talc and chlorite are rather intergrown, so that it appears as though chlorite has a high birefringence. Quartz occurs sparsely as anhedral, somewhat corroded crystals.

The cracks in the rock appear to be filled with a fine-grained aggregate of epidote and chlorite.

Accessory black iron ore and hydrated iron oxide are present as "square-shaped" crystals in the groundmass, and as irregular grains associated with the epidote, chlorite and (?) talc. Zircon and apatite occur as small prismatic crystals.

The estimated percentages of minerals in the specimen is:- oligoclase: 55, "amphibole and pyroxene": 35, quartz: 5, the accessories: 5. The rock is a brecciated quartz-bearing saussuritized andesite porphyry (or andesite, if the rock is extrusive).

98903

Hand Specimen. This rock is largely similar to specimen 98901, except that with the application of dilute hydrochloric acid, some reaction takes place, suggesting the presence of calcite.

Thin Section. Texturally, this rock is very similar to 98901, and its original mineralogy, i.e., plagioclase, amphibole and pyroxene, was probably largely similar. The main differences are the alteration products of the minerals. Felspar has been partly sericitized, and encloses irregular areas of calcite. Several felspar crystals have large areas which have been altered to a colourless mass of finely divided flakes of chlorite, this mineral frequently enclosing the two other minerals mentioned. The felspar itself has a refractive index lower than that of balsam, and some crystals have indistinct traces of albite twinning: these facts suggest that it is albite. It is probably altered from a more calcic plagioclase.

With regard to the ferro-magnesian minerals, if the rock is compared with 98901, epidote is seen to be a minor product of alteration. A study of crystal outlines show that alteration from pyroxene and amphibole have taken place, and that the products may be grouped:-

1. After amphibole (a). The pseudomorphs consist of dominant green chlorite, with intergrowths and grains of calcite, and with (?) talc forming a rim around the whole "crystal".

(b). The pseudomorpha consist almost entirely of calcite, with a rim of intergrown flakes of (?) talc and green chlorite. Enclosures of talc and green chlorite also occur.

2. After pyroxene. A few large phenocrysts with the shape of pyroxene basal sections were seen, and consisted of an intimate intergrowth of colourless chlorite and calcite, with some green chlorite. Some leucoxene also occurs.

The above is rather a generalization, but it gives some idea of the grouping of alteration products.

The accessory minerals include black iron ore, leucoxene, apatite, and zircon. Apatite grows to quite large crystals. The rock is an albitized, chloritized and carbonated andesite porphyry, (or andesite, if the rock is extrusive).

98907

Hand Specimen. This rock is very similar in textural appearance to 98901. Here however, the felspar phenocrysts have a much more fresh appearance, while the epidote in the other phenocrysts is made obvious by a bright yellow-green colour. Some pyrite is present as irregular granules.

Thin Section. The textural characteristics are similar to 98901. Felspar is very fresh, only being slightly altered to sericite. The ferro-magnesians are altered mostly to epidote, some to a mixture of chlorite and epidote. Some good pseudomorphs after amphibole are present: pseudomorphs after pyroxene may be present as vertical sections, though no basal sections were seen.

The felspar phenocrysts are tabular in shape, showing signs of corrosion; they have a refractive index greater than that of balsam. Albite and carlsbad twinning may be seen, and most of the crystals show oscillatory zoning. They are biaxially positive, with 2V = 85°. An extinction angle on a section normal to the bisectrix showed a composition of An_{44} at the crystal centre, and An_{35} at its edge.

Some large, rather irregular shaped masses of pyrite occur.

The other main difference from 98901 is that the groundmass is rather more coarse, having a xenomorphic-granular texture.

The rock is an epidotized and chloritized andesite porphyry (or andesite, if the rock is extrusive).

98908

Hand Specimen. The sample is a coarse-grained, hypidiomorphic and leucocratic igneous rock. It contains tabular to anhedral white felspar, some of which appears to be poikilitic about anhedral to subhedral flakes of chlorite and biotite. Small irregular masses of epidote appear to be associated with chlorite and felspar. Some poikilitic quartz is present.

Thin Section. The specimen is very coarse-grained, but inequigranular; it is hypidiomorphic. Oligoclase forms rather tabular crystals, showing albite and carlsbad twinning. It is slightly sericitized and kaolinized. The refractive index is equal to or rather less than that of balsam, but is appreciably greater than that of the neighbouring microcline-perthite. It is biaxially negative, with 2V = 85°. Extinction angles on (010) suggest a composition of An_{18}. Oligoclase shows corroded margins where it is bounded by microcline-perthite; a very thin "shell" of clear albite has grown around the plagioclase.

Microcline perthite occurs as anhedral, interstitial and poikilitic crystals enclosing oligoclase and the ferro-magnesian minerals. Exsolution lamellae of plagioclase, and rather indistinct cross-hatch multiple twinning are present. It is rather kaolinized.

A little fresh biotite occurs, pleochroic from dark reddish brown to light fawn. It is mostly altered to a pale green chlorite. Pseudomorphs after hornblende, now composed of chlorite, sometimes associated with yellowish epidote, are present. Epidote occurs as granular to tabular crystals, often enclosed by oligoclase.

Quartz forms anhedral, interstitial crystals, enclosing oligoclase and the ferro-magnesian minerals, but seemingly enclosed by microcline perthite.

Some granules of pyrites are present, associated with chlorite. Small irregular grains of ilmenite, commonly with a rim of leucoxene, occur enclosed in chlorite: these are absent in unaltered biotite. Minute euhedral prisms of apatite are present, enclosed in quartz and felspar.

An estimation of the amounts of minerals present is: oligoclase: 55%; microcline-perthite: 20%; the mafic minerals and their alteration products: 10%; quartz: 7%; epidote: 5%; the accessory minerals: 2%. The rock is tonalite, or quartz diorite.

98910

Hand Specimen. The rock has a very fine-grained, pale grey groundmass enclosing numerous subhedral to euhedral phenocrysts of tabular white felspar and prismatic hornblendes. The groundmass is speckled with pyrite.

Thin Section. In texture, the specimen has a fine-grained, xenomorphic-granular groundmass, the average grain size being 0.02mm: this encloses numerous subhedral to euhedral phenocrysts, ranging in size between 0.06mm. and much larger, tabular crystals measuring 0.35mm by 1.35mm.

The groundmass consists mostly of granular to slightly tabular crystals of felspar, which are partially kaolinized, and which have a refractive index greater than that of balsam. Traces of multiple twinning may sometimes be seen. Small amounts of quartz are present. Hornblende occurs as prismatic crystals, while a few granules of epidote may be seen.

The phenocrysts consist of plagioclase and hornblende. The plagioclase is andesine. It forms subhedral to anhedral, tabular crystals showing various stages of corrosion, and is slightly altered to sericite and kaolin. Albite and carlsbad twinning are present, and most of the crystals show pronounced oscillating zoning. It is biaxially positive, with 2V = 85°-90°. Symmetrical extinction angles on carlsbad twins, and an extinction angle on a section normal to the X-bisectrix suggest a composition of An_{38-42}.

Hornblende forms anhedral, though partially corroded, phenocrysts, sometimes enclosing small crystals of felspar. Small granules of black iron ore are included in some crystals. Hornblende is pleochroic:- X = pale olive; Y = green; Z = deep green, slightly olive. $Z \wedge C = 21°$. The birefringence = 0.026.

Prismatic crystals of apatite are present in the groundmass, and enclosed in felspar, but they are not nearly so obvious as those occurring in the more altered specimens described above. A little zircon is present. Pyrites forms irregular grains of phenocryst size, some partly or wholly enclosing the rock's minerals.

An estimation of the percentage of minerals present is:- andesine: 60; hornblende: 35; the remainder: 5. The specimen is an hornblende andesite porphyry, and probably represents an unaltered version of the previously described specimens (excluding 98908), although no pyroxene, or pseudomorphs of pyroxene are present here. If the rock is extrusive, it may simply be called hornblende andesite.

98911

Hand Specimen. This sample is very similar in aspect to specimen 98910, the main differences being that the phenocrysts are even more numerous, and that the rather acicular hornblendes show a slight flow lineation.

Thin Section. Texturally and mineralogically the specimen is very similar to 98910, the main textural differences being, firstly, a greater crowding of phenocrysts, and secondly, a rather more coarse groundmass. Hornblende and felspar have rather similar properties to those of 98910. The main mineralogical difference is in the presence of epidote, which occurs as granular masses, occasionally of phenocryst size, sometimes associated with both andesine and hornblende, but more often occurring on its own in the groundmass, commonly enclosing groundmass grains.

Andesine shows oscillatory zoning and commonly one or two of the zones are altered to kaolin, or to a colourless to very pale pink, isotropic substance which has a refractive index less than that of the andesine.

The rock is a porphyritic hornblende andesite porphyry (hornblend andesite, if the rock is extrusive).

SG1/a

Hand Specimen. The rock is basic and apparently porphyritic. It has a fine-grained, dark green groundmass speckled with white, which encloses numerous black "phenocrysts" of pyroxene. The "phenocrysts" are subhedral, and measure up to one or two millimetres in size. A possible slickenside bounds the specimen on one side: the surface of the rock here has a thin coat of a black, shiny mineral.

Thin Section. The specimen has a fine to medium-grained, hypidiomorphic and amygdaloidal groundmass, which surrounds large plates of augite, which ophitically enclose groundmass crystals. The groundmass consists of tabular laths of plagioclase, with a pale green, nearly isotropic chlorite occupying the interstitial spaces. Plagioclase is strongly kaolinized: its refractive index is greater than that of balsam, and indistinct albite twinning may be seen. It is biaxially positive, and some extinction angles suggest that it is labradorite. As well as the chlorite, augite occurs as small interstitial grains.

Augite also occurs as large plates, ranging between 0.5 and 2.25mm. in size, which commonly enclose groundmass felspar laths. It is colourless, and forms, often, very irregular crystals. It is biaxially positive, with 2V = 55°. Augite is often altered to a green chlorite, which occurs in irregular patches in the host mineral.

The amygdales tend to be elongated in a common direction. They are filled with a very pale green, fibrous chlorite, which has its larger fibres tending to be oriented parallel to the elongation. Small crystals of a brownish green (?) amphibole occasionally occur, enclosed by chlorite. A vein, cutting at right-angles to the amygdale elongation, contains pale green chlorite at its centre, and (?) nontronite on its edges. Leucoxene occurs as irregular crystals in the groundmass.

An estimation of the percentages of minerals present is:- felspar: 45, olivine and augite: 30, chlorite (excluding the amygdales): 20, leucoxene: 5. The rock is a kaolinized dolerite, or basalt.

SG.1/6

Hand Specimen. The rock is dark and basic: it has a fine-grained groundmass enclosing very small, sparse phenocrysts. The sample is cut by irregular veins.

Thin Section. (For your information, the section has been cut rather more thinly than usual, giving apparently low birefringences.)

In texture, the rock is fine-grained, hypidiomorphic and seriate prophyritic, the small crystals of pyroxene being clustered. The phenocrysts are pyroxene, either augite or diopside. The form colourless prismatic to granular crystals; it is biaxially positive, with 2V = 55°. 2 C = 41°.

Pyroxene is found as small, granular crystals in the groundmass. Rather fibrous prehnite also occurs in the groundmass, interstitially to the pyroxene. Very fine chlorite, greenish or almost colourless, may be found as a background to the other minerals. Numerous very small irregular grains of sphene, which are pleochroic in shades of brownish yellow, are present. Occasionally, small crystals of (?) pumpellyite (which see later) may be seen, distinguished by their being pleochroic from almost colourless to bright green.

The rock is cut by thin veins of very pale green chlorite; the veins appear to be interrupted by micro-faults. Apart from these, a thick vein with a large pocket is present. The major part of the vein and pocket consists of prehnite, which is colourless, with a fairly strong relief. It is biaxially positive, with 2V = 50-60. The mineral tends to occur as coarse, sub-radiating columnar bodies. Small, irregular bodies of are enclosed. An unidentified mineral, which may be pumpellyite, occurs in the vein. It has high relief, with a refractive index of 1.68 - 1.71, i.e., slightly greater than that of pyroxene. Its pleochroism is X = pale green yellow; Y = pale yellow-green; Z = deep green, with absorption: Z·Y.X. The estinction is oblique, but is difficult to measure because incomplete and "wavy" extinction. The birefringence is approximately 0.027. An interference figure was not obtainable. The properties mentioned agree to a certain extent with those of pumpellyite, except for the scheme of pleochroism: Winchell (1951) and Bloxam (1958) state that the absorption scheme should be $Y \leq Z < X$ in the former reference, and Y, Z = X in the latter.

The rock itself appears to be an altered prehnite-bearing basalt.

SG.15/d

Hand Specimen. The specimen is dark greenish black, with pink, irregular streaks running through it: a cut surface gives the appearance of serpentine. Small amounts of olivine may be seen, as may a black, shiny mineral.

Thin Section. The rock is a strongly serpentinized dunite: it consists of scattered grains of olivine separated by masses of lamellar serpentine. Groups of the olivine grains are seen to extinguish together, indicating that these are parts of original crystals. The olivine is biaxially negative, with 2V = 85°, showing it to be chrysolite. Some subhedral to anhdral grains of chromite are present: they are nearly opaque, showing a dark red translucency in strong light.

SG.19/a

Hand Specimen. The rock consists mostly of mottled-grey and black serpentinous material, partially enclosing a region of black serpentine. The mottled zone appears to be related to the weathered surface.

Thin Section. The rock is composed almost entirely of serpentine, which consists of a meshwork of "veins" of a fibrous mineral pleochroic in very pale yellow-green, enclosing large lamellae of almost colourless material which has a slightly lower refractive index, and is biaxially negative, with 2V = 20°. None of the serpentine minerals present have a refractive index less than that of balsam.

A few relict grains of olivine are present. Probable magnetite, a by-product of serpentinization of olivine, occurs in veinlets of chrysotile. Anhedral to subhedral crystals of chromite occur: it also forms small granules along the "veins" mentioned above. Some staining by hydrated iron oxide was noted.

The rock is serpentine, almost certainly derived from dunite.

SG.19/c.

Hand Specimen. The rock is dark grey, and very coarse-grained. It consists mostly of pyroxene, with some greenish chloritic material. A very indistinct "foliation" that is apparently present in the hand specimen is seen in section to be caused by small parallel veins.

Thin Section. The specimen is very coarse-grained and is composed mostly of enstatite: it has parallel extinction, and is biaxially positive, with 2V = 85°. Small, euhedral "square-shaped" crystals of chromite are sparsely scattered in the rock. A little alteration to colourless tremolite has taken place along numerous sub-parallel cracks in enstatite. The cracks are rarely parallel to the cleavage. Other, rather thicker veins, which are fewer in number, occur, and are parallel to enstatite cleavages: these are connected to the thin veins, and contain tremolite.

The rock is a slightly uralitized enstatite pyroxenite.

SG.19/d.

Hand Specimen. The rock is basic and coarse-grained, consisting of serpentine. It may be scratched with a knife, and has a "soapy" feeling. Scattered crystals of shiny black (?) chromite can be distinguished.

Thin Section. The specimen is rather similar to SG.19/a in that it is a serpentinized dunite. Rather more chromite is present along the "veins". Anhedral to subhedral crystals of chromite are also present.

REFERENCES

Bloxam, T.W. (1958) - Pumpellyite from South Ayrshire. Min. Mag. Vol. XXXI, No. 240.

Winchell, A.N., and Winchell, H, (1951) - Elements of optical mineralogy, Part II. John Wiley & Sons Inc., New York.

130 ACT/1

20th November, 1958.

14. PETROGRAPHIC DESCRIPTIONS OF ROCKS FROM THE PROPOSED WODEN WEIR SITE

by

W.B. DALLWITZ

Following are descriptions of two specimens collected from the proposed Woden weir site:

Specimen No. W1, North Bank, Woden Weir Site, A.C.T.

This is a brown, weathered, medium-to fine-grained, closely-jointed rock which, on examination with a lens, appears to have the texture of an igneous rock (such as dolerite) rather than a sedimentary one. Veinlets of calcite are common along the joints.

In thin section the feldspar in some parts of the rock is so arranged as to call to mind the texture of a dolerite. The feldspar is albite-oligoclase. Ferromagnesian minerals have been replaced largely by intermingled siderite or other ferriferous carbonate and hydrated iron oxide. Some pale green chlorite is also present. Veinlets of calcite and of pale chlorite traverse the rock; these may be associated as multiple veinlets, and lenses of ferriferous carbonate may be enclosed in the chlorite veinlets.

Red iron oxide, possibly goethite, is a minor constituent, and may also be a by-product of the alteration of ferromagnesian minerals. Leucoxene represents original black iron ore (ilmenite or magnetite).

The rock is probably an albitized and carbonated dolerite.

Specimen W2, North Bank, Woden Weir Site, A.C.T.

This is an iron-stained, somewhat sheared, and roughly cleaved rock containing porphyritic quartz grains.

In thin section phenocrysts of quartz and strongly sericitized feldspar are seen to be set in a felsitic groundmass consisting of quartz, sericite, and subordinate chlorite. Multiple twinning is still visible in a few of the porphyritic feldspar grains, and it seems likely, judging by the rather uniform nature of alteration products, that the only feldspar in the rock was an acid plagioclase. The maximum grainsize of porphyritic feldspar is about 1 mm.; small clots of brown hydrated iron oxide are common in the altered plagioclase.

The quartz phenocrysts have been shattered and strongly strained, and veinlets of calcite have been introduced along cracks. The largest grain measures 5.5 mm.

Porphyritic books of biotite have been altered to vermiculite, which may contain inclusions of hydrated iron oxide and/or leucoxene.

Veinlets of hydrated iron oxide are common in the rock, and the most concentrated group of these veins has associated with it chlorite and abundant calcite. Calcite can be recognized in places throughout the groundmass, but it is impossible to distinguish in many cases between very fine-grained calcite and sericite.

Rare apatite is the only accessory.

The rock is a sericitized and carbonated crushed dacite or dacite porphyry.

1980/1

28th November, 1958.

15. PETROGRAPHY OF ROCKS FROM NO. 5 TAILINGS DAM TUNNEL, MOUNT ISA, QUEENSLAND

by

K.R. WALKER

1. Hand specimen - white siliceous rock which mostly consists of quartz but which is flecked with sericite and partly coated with kaolin.

In the thin section granoblastic quartz is seen to constitute most of the rock. The grainsize ranges from 0.1 to 0.7 mm. with a few grains reaching 1 mm. across. Quartz grains have undulose extinction. Other minerals include a few flecks of mica and rare grains of zircon, leucoxene, and iron ore.

The rock is quartzite.

2. Hand specimen - The rock is reddish purple, fine-grained and somewhat schistose.

The thin section is granulated by dislocation and consists of angular fragmental quartz grains between which occur micaceous minerals. Fracturing of mineral grains has determined the grainsize, and fragments measure 0.1 to 0.3 mm.

The mechanical break-down of larger quartz grains gave rise to abundant angular fragments that have slight undulose extinction.

The fine micaceous flakes (0.5 to 0.1 mm long) have low birefringence colours, mostly shades of grey, and are probably chlorite. Within the micaceous groups of flakes dispersed between angular quartz fragments are mineral patches which may be clay, possibly kaolin. On the other hand, these could also be fibrous chlorite. Much of the chlorite is heavily stained by limonite. The kaolin commonly shows concertina-like forms. The only accessory mineral is rutile.

The rock is a mylonitic chlorite-quartz schist, a product of dislocation metamorphism.

3. Hand specimen - the rock is a friable cream schist in which individual minerals are too fine-grained to be recognized in hand specimen. The rock disintegrates into a fine, white, gritty powder.

The thin section mainly consists of sericite and quartz. Quartz grains are evenly distributed throughout the schistose base. Tourmaline, and less commonly rutile, grains are liberally scattered throughout but are unsorted. The grainsize ranges from 0.02 to 0.1 mm. Both quartz and chlorite appear to form veins that correspond with the schistosity of the rock.

Sericite is the most abundant mineral and flakes measure about 0.02 mm. long. Flakes show a strong directional arrangement.

Quartz grains (0.02 to 0.1 mm.) have irregular margins and most are angular. Although distribution is fairly even, sorting is not apparent. Less commonly bands of granular quartz suggest veining.

Because tourmaline and rutile grains are irregular and prismatic and have a random distribution and orientation it is possible that they were introduced during metamorphism. However, on the other hand, the possibility that they are heavy minerals which have survived metamorphism cannot be entirely excluded. Grains range between 0.01 and 0.1 mm. across. The tourmaline is pleochroic from almost colourless to green.

The rock is a low grade pelite or quartz-sericite schist containing tourmaline and rutile.

4. Hand specimen: Cream siliceous mica schist with a white powdery surface exhibiting planes with silky lustre and a talcy feel.

The thin section consists mainly of a mosaic of quartz grains which have a poor granoblastic arrangement. Fine sericite flakes occur between the quartz grains; the remaining mineral grains are tourmaline, rutile and rare zircon and iron ore. Tourmaline is a green variety and pleochroic from colourless to grass-green. The thin section is transgressed by granoblastic quartz, many grains of which are cracked and have undulose extinction. The grainsize ranges between 0.01 and 0.5 mm.

The rock is a sericite-quartz schist, but probably is better referred to as a micaceous quartzite in which occurs rare grains of possible heavy mineral. Its metamorphism is comparable with that of 3 above.

5. Hand specimen: white siliceous rock coated with fine powder, possibly finely micaceous. Slip planes are micaceous and have a pearly lustre.

The reconstituted siliceous rock is widely granoblastic as seen in thin section. Flecks and bundles of white mica are common and dispersed between the irregular-shaped quartz grains. There is a fairly wide range in grainsize from 0.05 to 1mm., and this feature is shown particularly by quartz.

Recrystallization and partial crushing of quartz has made most grain margins highly irregular, some of the larger grains appear to be composite grains whose extinction is patchy. Undulose extinction is a feature of all grains. Fine fractures and small inclusions are also common.

Sericite flakes have a rough directional arrangement and measure 0.1 to 0.3 mm. long. They are faintly pleochroic from colourless to a green tint.

Other grains are rare rutile and green tourmaline.

The rock is a micaceous quartzite.

6. Hand specimen: A fairly siliceous but noticeably sheared white rock exhibiting numerous slip planes that are striated. The surface of the rock is coated with a white powder which is probably finely micaceous because the rock has a soapy feel.

The rock in thin section is not unlike 5 above, but it can be seen in thin section that 6 is not as siliceous as 5. Texturally the rocks are similar, but the greater abundance of sericite in 6, which has a strong directional arrangement, gives the rock a poor lepidoblastic fabric. However, the reconstituted quartz grains are essentially granoblastic, but they too have a rude directional arrangement. The grainsize ranges between 0.1 and 0.8 mm. Accessory minerals include rare sphene and iron ore.

The irregular quartz grains are strained and marginally crushed, and cracked by roughly parallel fractures and contain numerous extremely small inclusions. In many places crushing has completely broken down the original quartz grains to a fine-grained mosaic (mortar structure).

Flakes of sericite measure up to 0.3 mm. are evenly distributed between quartz grains.

The rock is a sericite-quartz schist.

7. Hand specimen: the rock is an extremely fine-grained schist which disintegrates into a soft white powder, and which has a soapy feel. The powder may be finely micaceous. The exposed planes of schistosity have a pearly lustre and are faintly tinted green.

The thin section consists mainly of lenses and clots of kaolin amongst which occur lesser amounts of quartz and accessory iron ore. The grainsize ranges between 0.05 and 0.2 mm There are patches of false-cleaved kaolin and also clots of possible chlorite. A small amount of sericite is associated with the kaolin in places. Some of the kaolin shows concertina-like and partially radiating forms.

Quartz grains are mostly angular or have serrated edges; they measure from 0.05 to 0.2 mm. Most grains have undulose extinction and commonly are formed into lens-shaped aggregate of angular grains which contain only a little micaceous material.

The only heavy mineral is rutile, which generally occurs as aggregates of small grains.

The rock is a quartz-kaolin schist; the fact that the kaolin is concentrated into lenses and clots suggests that it owes its origin to alumina metasomatism.

8. Hand specimen: Green schistose rock showing slickenside and cleavage faces which have a greasy lustre and soapy feel. The minerals are too fine-grained to identify with the unaided eye but the rock probably includes a high proportion of chlorite.

The thin section is schistose and consists mainly of alternating bands of chlorite flakes and quartz grains, but also contains some bands which have green-brown biotite in addition. Poor false cleavage occurs in places. Accessory minerals are rutile and rare apatite and green tourmaline. The grainsize ranges from 0.01 to 0.4 mm.

Bands of chlorite flakes in parallel arrangement are pleochroic from colourless to light green and flakes range from 0.1 to 0.2 mm. long.

Alternating with the chlorite-rich bands are seams that consist mostly of mosaic quartz. Quartz grains (0.05 to 0.4 mm.) show undulose extinction and irregular cracks.

Biotite flakes (0.01 to 0.4 mm.) also have a banded distribution and, as for quartz, may form lens-shaped aggregates or bundles which conform with the directional arrangement of other mineral grains. Biotite is pleochroic from light golden-brown to mid-brown.

Accessory minerals are evenly distributed throughout, and measure between 0.05 and 0.15 mm.

The rock is a biotite-quartz-chlorite schist. It should be compared with 9 below, as the possibility exists that it represents the marginal and more sheared and metasomatically altered representative of a deformed basic igneous rock, possibly basalt. However, it must be emphasized that nothing remains in rock 8 to identify that it was originally igneous, as it is now a product of dislocation metamorphism.

9. Hand specimen: The rock is green and schistose and false cleavages can be recognized in places. It has a greasy lustre and feel. Micaceous flakes are too fine-grained to identify with the unaided eye but are probably chlorite.

The thin section has a schistose fabric and is heavily weathered; much of it is turbid brown alteration product. It consists mainly of chlorite, quartz, plagioclase, iron ore, and various alteration products. Accessory minerals include a few flakes of biotite and grains of rutile. Most grains measure about 0.1 mm. but a few larger grains approach 0.4 mm. The thin section is transgressed by a vein that consists of fractured, strained, quartz grains; chlorite flakes (0.1 to 0.4 mm.) are pleochroic from colourless to light green.

Quartz grains (0.1 to 0.2 mm.) are mostly strained and irregularly cracked. Many fractured grains are dispersed amongst the chlorite flakes and other alteration products.

Some of the less altered parts of the rock show abundant multiple twinned plagioclase (measuring up to 0.2 mm.). The R.I. is slightly below that of Canada balsam and probably therefore the plagioclase is albite-oligoclase. Careful examination of the felspar occurrences reveals a few partly destroyed relic felspar laths.

Much of the iron ore (up to 0.2 mm.) is partly altered to leucoxene.

The rock is a quartz-chlorite schist which has probably been derived by the chlorifization and shearing of a basaltic rock.

This chlorite schist is possibly a less deformed representative, and has suffered less chemical reconstitution and readjustment, than 8 described above. Regardless of whether this rock 9 is extrusive or intrusive, it must be conceded that its emplacement was pre-metamorphism and pre-deformation of the surrounding country rocks; these rocks consequently show the same grade and type of metamorphism. Many of the rocks described above have undergone low grade dislocation metamorphism.

10. Hand specimen: A soft cream fissile rock that disintegrates into small platy fragments. Minerals are too fine-grained to be recognized with the unaided eye.

The thin section consists mainly of fine sericite flakes in which numerous angular quartz grains are distributed. Iron ore occurs in subordinate amounts. The fabric is lepidoblastic and the thin section is cut by a few veins of granoblastic quartz which are parallel to the schistosity. The grainsize averages about 0.1 mm. One part of the thin section is heavily iron-stained.

Abundant sericite flakes measure up to 0.1 mm. long and have a strong parallel arrangement; they deviate only where they envelop quartz grains or form false cleavage.

Quartz grains are fairly even-grained and measure about 0.1 mm. across. They are mostly fragmental and have undulose extinction.

Some of the fairly abundant iron ore (0.01 to 0.1 mm. but some grains up to 0.4 mm.) is represented by iron hydrates that stains the mica flakes in places. However, not all grains are similarly altered. Iron ore is a common constituent of a few quartz veins.

The rock is a quartz-sericite schist which is not unlike 3 and which is a product of low grade regional metamorphism.

11. Hand specimen: the rock is a flesh-coloured quartzite which is fine-grained.

The thin section consists mostly of quartz grains between which occur subordinate amounts of sericite. Brown chlorite, rare zircon and rutile are accessory. The fabric is granoblastic and the range in grainsize is from 0.1 to 0.6 mm.

A feature of this quartzite that contrasts with the others described (1, 5 and 6) is the paucity of quartz grains with undulose extinction or other disfigurements which indicate strain or earlier alteration. Cracked grains are not common in 11.

The mica flakes (0.1 to 0.2 mm.) are not plentiful.

The rock is a micaceous quartzite that differs from the other quartzites described in the absence of strain effects. However, it shows fairly complete reconstitution.

Although the eleven rocks described represent different horizons of strata within the cross-cut, and each shows different features to the others, they may be roughly grouped according to the following; they either show low grade regional or dislocation metamorphism.

1 Quartzite
5 and 11 Micaceous Quartzites
4 and 6 Sericite-quartz schists.
3, 7 and 10 Quartz-sericite schists.
8 Biotite-quartz-chlorite schist.
9 Quartz-chlorite schists.
2 Mylonitic chlorite-quartz schist.

The brief study of these thin sections in conjunction with the accompanying map (tracing A-65), does not enable much to be said about the cause of the lithological change from schist to quartzite.

In order to resolve this problem it would be necessary to examine a series of specimens from the same lithological horizon and thus follow the progressive change from a particular schistose rock exposed in the cross cut to the quartzite that crops out on the hill. That this change takes place appears established on present evidence but the change involved cannot be followed at present because all the available specimens are of different lithological types presumably representing different horizons and therefore not directly related to one another.

Thus, if further investigation into this problem is desired more specimens would be necessary and it is suggested that these be collected from the western slope and, so far as possible, from outcrops corresponding to strata from which specimens 2 to 9 were collected (vide enclosed A65 - particularly specimens from outcrops which correspond to 3, 8 and 9). If this is not possible more specimens collected in situ from anywhere on the surface would be useful; in order to determine whether the surface quartzite shows straining that is common to all the rocks from the cross-cut.

It can be seen from the descriptions above that most of the specimens supplied possibly contain heavy minerals, particularly rutile and tourmaline. Quite probably many of these are introduced but some of them may be detrital. If the heavy minerals are detrital they should be retained by the quartzite after its transformation from a schist and that is why specimens from horizons represented by 3, 8 and 9 are suggested for further examination. Specimen 9 is of particular interest as it may also represent a basic flow interstratified with the other sediments and may not be unlike some of the basic rocks recognized in the Mount Isa Shale.

106W/5D

1st December, 1958.

16. PETROGRAPHIC DESCRIPTIONS OF A BORE CORE SPECIMEN FROM BMR 4A., WALLAL, WESTERN AUSTRALIA

by

W.B. DALLWITZ

Following is a brief description of a rock from the bore BMR4A at Wallal, W.A. The specimen was designated as part of core 9, from a depth of 2220' to 2223'.

The handspecimen represents a grey, closely sheared, gneissic rock containing light grey lenses rich in feldspar; these lendes are up to 5 cm. long and 0.5 cm. thick. Chlorite is developed along some of the stronger shear-planes. Films and isolated grains of pyrite occur along a few of the shear-planes and joints and a thin film of epidote lies along one crack or joint which is approximately at right angles to the cleavage.

In thin section the rock is seen to be made up mainly of altered acid plagioclase (albite-oligoclase) and quartz, with accessory epidote, biotite, chlorite, and pyrite, and rare leucoxene, zircon, and apatite.

The feldspar and quartz occur as more or less anastomosing lenticular streaks. The grainsize of the feldspar is fairly even, and is about 0.1 mm.; that of quartz is less even but of about the same order of average size. The plagioclase is sericitized in varying degree, - in some places completely - and epidote is a subordinate product of its alteration. Along narrow planes where shearing appears to have been most intense, the sericite occurs as parallel shreds. Altered felspar, excluding epidote, makes up about 55 percent of the rock, and quartz about 35. Some epidote has been concentrated into veinlets which run across the quartz - feldspar lenses.

Biotite has been broken up into small shreds, which are admixed with quartz and felspar. It appears that, along the strongest shear-planes, biotite has been later altered to chlorite by hydrothermal activity; this activity may also have been responsible for the formation of the cross-cutting veinlets of epidote and for the introduction of pyrite.

One long prismatic crystal of zircon has been broken during shearing, and quartz and sericite have moved in to seal the break.

More than one mode of origin can be postulated for this rock, and its naming varied accordingly. It may, for example, be described as a partly mylonitized porphyritic biotite granodiorite, or, more non-commitally, a crushed biotite-quartz-oligoclase gneiss.

84W/1

7th December, 1958

17. EXAMINATION OF A RADIOACTIVE SPECIMEN FROM HALLS CREEK

by

W.M.B. ROBERTS

A specimen, submitted by B.P. Walpole for determination of the cause of radioactivity, is similar to that described in a previous report (see 8 above) but much more weathered; it is a magnetite bearing conglomerate.

The radioactivity is approximately twice background, measured in the Austronic B.G.R.1 ratemeter.

The specimen was crushed, and a representative sample analysed by X-ray spectrograph, which showed a small quantity of thorium as being the major cause of the radioactivity.

A further sample of the rock was run on the superpanner and the heavy fraction analysed on the spectrograph. This showed a slight increase in thorium intensity. A heavy fraction from the previous examination (see 8 above) from which the magnetite has been separated was also analysed spectrographically, and showed a much higher thorium content as well as a trace of uranium, roughly in the ratio thorium/uranium 40/1.

Other elements present are, in order of abundance: zirconium (approx. 1%), copper, titanium, hafnium, neodymium, praseodymium, gadolinium, samarium, yttrium and manganese.

The copper is present as chalcopyrite, and the rare earth elements are most probably contained in the thorogummite.

Considering that this fraction examined represented at the most liberal estimate, only a fraction of one percent of the original sample, no significance can be attached to the relatively high thorium or trace Uranium results obtained from it, for, as previously mentioned, in an examination of the whole sample thorium only gave a strong trace and uranium no trace at all.

This fraction was then examined under the binocular microscope and the presence noted of a reddish-brown mineral on which yellow coatings were formed. In order to get sufficient of this mineral for X-ray diffraction, the magnetite was separated from the heavy concentrate of the second sample, and further treatment with heavy liquid removed any quartz, etc.

From these combined samples, sufficient of the reddish-brown mineral was separated for X-ray, the results of which showed the mineral to be thorogummite. ($Th\ SiO_4\ _{1-x}\ OH\ _{4x}$). No X-ray data are available for the identification of the yellow coatings on this mineral but descriptions from the literature indicate that it is almost certainly the products of thorite weathering - hydrothorite. The weathering of thorite proceeds via thorogummite, nicolayite-pilbarite, to hydrothorite as the end product. This would indicate that thorite ($ThSiO_4$) was the original thorium mineral deposited in the sediment. The uranium content, as shown on the spectrogram of the concentrate of the first-examined specimen is related directly to the thorium content, and appears to vary with it.

Uranium is commonly associated with such thorium minerals, amounts up to 27% UO_3 have been recorded.

120PNG/1

23rd December, 1958.

18. ~~20.~~ **BRIEF NOTES ON ROCK SPECIMENS FROM THE SAMARAI AREA, NEW GUINEA**

by

W.B. DALLWITZ

The following are some very brief notes (mainly names) on the specimens from the Samarai area which Mr. J.E. Thompson recently handed to Mr. L.C. Noakes for examination.

P.311 Basalt or very fine-grained dolerite, with porphyritic augite. Vein of (?) gypsum and/or (?) zeolites. Some serpentinous alteration products.

P.317 Saussuritized and partly chloritized dolerite

P.321 Probable altered pyroxene andesite. Pyroxene fresh, but groundmass altered.

P.322 Fine-grained dolerite (or coarse basalt)

P.323 Fine-grained dolerite (or coarse basalt)

P.326 Porphyritic fine-grained quartz dolerite (or coarse basalt). Large porphyritic crystals of augite. Subhedral crystals of quartz.

P.371 Fresh dolerite of normal grainsize. Plagioclase quite strongly zoned.