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PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS DURING THE QUARTER JULY - SEPTEMBER, 1959

by

W.R. MORGAN

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CONTENTS

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INTRODUCTION

This Record consists of a collection of reports completed by the petrographic and mineragraphic personnel of the Bureau Laboratory during the period July to September, 1959. The reports have been placed in chronological order, and each one has its date of completion, and the relevant file number above its heading.

The Geological Officers responsible for these reports are: W.B. Dallwitz (Senior Geologist), W.M.B. Roberts (Geologist, Grade III), K.R. Walker (Geologist, Grade III), and W.R. Morgan (Geologist, Grade I). Mr. Roberts is in charge of X-ray and mineragraphic work, and Messrs. Dallwitz, Walker and Morgan deal with petrographic work.

The majority of the reports need no elaboration. Those, such as Nos. 5 and 8 were written in the form of letters, and have been slightly altered and given a title.

6th July, 1959.

1. THE PETROGRAPHY OF A SPECIMEN OF 'FREESTONE' FROM 16 MILES N.E. OF HARDEN, N.S.W.

by W.R. MORGAN

This specimen was collected by Mr. W.J. Perry from a locality 16 miles north-east of Harden, N.S.W. Its thin section number is 4652.

The hand specimen is seen to be a cream-grey, medium-grained, rather inequiganular sandstone that is lightly stained with hydrated iron oxide. The rock contains mostly quartz, with an interstitial white powdery substance shown in section to be sericite. Although the rock is quite hard, by rubbing one's fingers over its surface grains are detached. The specimen seems to have a well defined jointing - especially in one direction, where laminations up to 5mm. thick may be seen.

In thin section the rock is seen to be fairly even-grained, and has an average grain-size of 0.2 mm. The grains are angular to sub-angular and have smooth to minutely irregular margins. A faint parallel fabric of the grains maybe seen. Quartz is the dominant mineral present: each grain commonly has sub-parallel lines of minute inclusions or cavities, and these, in places, are seen to disappear at the grain margins, or where "lamellae" of strained extinction cut across them. Here and there, the parallel lines of inclusions are slightly bent, as though strained. Opal forms sub-rounded grains, sometimes partly replaced by sericite. Small, and commonly flexed flakes of muscovite may be seen, oriented roughly parallel to one another, and to the fabric. In addition, very minute flakes of sericite form a sparse interganular matrix, apparently fretting the surfaces of the quartz grains. Some quartz, as well as opal, gives the impression of being replaced by sericite. More rarely, one may see grains consisting entirely of a fine mass of sericite flakes. In examining the possibility of sericite replacing felspar in this rock, numerous partly replaced grains were investigated, and in each case the host mineral had a uniaxial interference figure, showing it to be quartz.

Rare accessory tourmaline, pleochroic from olive-green to very pale green, may be seen. Some apatite, and a rounded grain of zircon were observed to be enclosed by quartz. Leucoxene occurs as small, and in places, highly irregular grains.

The rock contains 90% quartz, 4% opal, 4% sericite, and 1% muscovite. It is a sericitic quartz sandstone.

2. THE PETROGRAPHY OF SPECIMENS FROM A PORPHYRY INTRUSION, AND ITS COUNTRY ROCK, HARMAN, A.C.T.

By W.R. MORGAN.

The specimens described were collected by Mr. E.G. Wilson, and are listed as follows, with their localities:

99033,	Canberra	1-mile	sheet,		205354
99036,	"	"	"	"	205350
99038,	"	"	"	"	205350
99049,	"	"	"	"	205354

A comparison of these specimens with some representative of the Mugga porphyry was required.

Another specimen (99035), representing a quartz vein from a granite (location: Lake George 1-mile sheet 078505) was tested for fluorescence with the ultra-violet ray lamp: none was recorded.

Specimen 99033, slide numbers 2734 and 2735

The hand specimen is light grey, blotched with dull purple-red. It is seen to consist of numberous sub-angular and angular reddish and greyish fragments of fine-grained, sometimes laminated, calcareous material, apparently embedded in a matrix consisting of a fine-to-medium-grained porphyritic igneous rock. The fragments range in size between 0.5 mm. and 4cm.

In thin section the porphyry is seen to have a fine-grained, hypidiomorphic groundmass consisting of quartz and felspar, with some tabular crystals formed of carbonate and chlorite or black iron ore, possibly pseudomorphing pyroxene. The phenocrysts, which measure up to 1.5mm. in size, consist of:- partly sericitized and carbonated felspar, most of which is sanidine, though some plagioclase may be present; tabular phenocrysts of pyroxene which are now pseudomorphed by calcite and chlorite - sometimes both minerals appear together in a phenocryst, but more usually, calcite or chlorite are present alone; some subhedral to rounded quartz phenocrysts are present, and have corroded margins. Nearly all the felspar and "ferromagnesian" phenocrysts have a thin rim of hydrated iron oxide. Some phenocrysts are broken.

Most fragments consist of an inequigranular mixture of calcite and quartz, with subordinate hydrated iron oxide grains and dust. Quartz forms angular fragments, sometimes of triangular shape, and often having re-entrant faces. Calcite occurs as irregular grains. Minor amounts of white, and greenish-brown mica are present, and, rarely, grains of zircon and (?)epidote may be seen. One large fragment has far less calcite in it, and consists of very fine inequigranular grains of quartz, felspar and carbonate together with flakes of white mica. This, and the more carbonate-rich fragments, give the appearance of being carbonated ashstones. Other fragments appear to consist almost entirely of fine-grained calcite. Some large (0.75mm.), sub-rounded grains of quartz are associated with the fragments, apparently embedded in them.

Although in the hand specimen porphyry appears to form a matrix to the calcareous fragments, this is by no means abvious in the thin sections, where numerous fragments are seen to be rafted together, apparently enclosing small amounts of porphyry. In fact, some of the xenolithic material appears to have "flowed" and itself forms a matrix to more competent fragments, and to large grains of quartz.

The specimen contains thin veins of calcite, which cut across phenocrysts and xenoliths, and which connect large, irregular calcite-fille cavities in the groundmass. The calcite in these cavities, and that replacing the phenocrysts, forms large "plate-like" crystals: commonly, the calcite in neighbouring cavities and phenocrysts is in optical continuity. This seems to suggest that calcite is not magmatic: this is borne out by the fact that one tabular phenocryst replaced by calcite is broken across in several places, and the pieces slightly displaced - but the replacing calcite is in optical continuity.

The igneous rock is a carbonate, saussuritized and chloritized porphyritic microgranite: the xenoliths contained within it are of (?) carbonated ashstone, and of calcilutite. The whole rock comprises an intrusion breccia.

Specimen 99036, slide number 2736

The hand specimen is seen to be an extremely porphyritic acid igneous rock. A very fine-grained, greyish groundmass is seen to enclose subhedral phenocrysts of pink and white felspar, quartz, and apparent hornblende. The average size of the phenocrysts is 4mm., but some measured 12mm. Application of dilute hydrochloric acid to the specimen revealed the presence of calcite.

In thin section, the groundmass is seen to be very fine-grained (the average size of quartz grains being 0.035mm.) and hypidiomorphic. Minute tabular crystals of slightly kaolinized felspar with low refractive index are sub-radially arranged within enveloping anhedral quartz grains, giving the impression of an ophitic texture. Minute tabular crystals of chlorite, and anhedral grains of black iron ore are present in minor quantities.

With regard to the phenocrysts, plagioclase forms roughly tabular crystals which are kaolinized and sericitized and in places show alteration to calcite, green chlorite and zoisite. Some replacement by fresh albite, and a zeolite may also be seen. Extinction angles measured on sections normal to the X-bisectrix of plagioclase indicate a composition of An_{26} at the crystal core and An_{8} at crystal edges. Orthoclase forms lightly kaolinized tabular crystals which may sometimes be seen partly enclosing portions of plagioclase phenocrysts. It shows a negative interference figure with a large ZV. Quartz occurs as subhedral crystals with corroded margins which are commonly finely serrated: the serrations are irregular and grade into the quartz-felspar intergrowth of the groundmass. Quartz contains pseudo-inclusions of the groundmass. Pseudomorphs after hornblende, now composed of chlorite, with small amounts of epidote, allanite and (?) prehnite, are present. Chlorite is optically negative, and is pleochroic with x = light greenish-fawn, Y=Z= brunswick-green; it has anomalous blue polarization colours, and therefore is probably penninite.

Accessory zircon, enclosed in chlorite, and apatite, enclosed in felspar, may be seen. Black iron ore is present as anhedral to octahedral grains, whose average size is 0.3mm. Calcite occurs replacing plagioclase, and as large anhedral crystals, apparently occupying cavities in the groundmass, 0.5mm in diameter. A quartz phenocryst is surrounded by a rim, 0.4 to 0.7 mm. thick, composed of small irregular grains of calcite.

An estimation of the percentages of minerals present is:- plagioclase = 40, sanidine = 20, quartz = 30, chlorite = 5, calcite = 5. The relative amounts of sanidine and plagioclase are estimated from the phenocrysts. The rock is a carbonated, saussuritized and chloritized porphyritic microgranodiorite.

Specimen 99038, slide number 2737

The hand specimen is a light grey, fine-grained and porphyritic acid igneous rock, containing phenocrysts of felspar, quartz and a ferromagnesian mineral.

In thin sedtion, the groundmass is seen to be hypidiomorphic-granular, with anhedral quartz, tabular to anhedral (?) albite, and tabular to interstitial green chlorite. Accessory black iron ore forms rather irregular grains: zircon and apatite are present.

Regarding the phenocrysts, albite forms single or clustered tabular crystals, showing some alteration to sericite, and, in places, replacement by calcite and green chlorite. Albite crystals are sometimes strained and broken. Quartz forms anhedral, often strongly corroded phenocrysts, commonly showing cracking and undulose extinction. Small amounts of tabular to anhedral green chlorite, with anomalous blue polarization colours, are present, possibly pseudomorphing hornblende: commonly they are surrounded by a thin rim of hydrated iron oxide.

The rock is cut by highly irregular veins of calcite, and small patches of this mineral, ranging between 0.03mm. and 1.5mm. in size, are scattered generally in the groundmass. At one place, coarse granular and intergrown calcite with minor amounts of interstitial chlorite and granular black iron ore may be seen in a cluster measuring 5mm. across. Some of the calcite grains have a tabular form, and in places in the cluster may be seen replacing remnant grains of albite. It seems likely that this is a cluster of albite ((?)and ferromagnesian) phenocrysts which have been replaced by calcite.

An estimation of the percentage of minerals present is:- albite = 65, quartz = 20, chlorite = 10, black iron ore = 5, The rock is a somewhat granulated carbonated saussuritized and chloritized porphyritic microgranodiorite.

Specimen 99049, slide number 4605

The hand specimen is seen to be of a porphyritic acid igneous rock, containing coarse subhedral phenocrysts of light grey felspar, colourless quartz, and dark ferromagnesian minerals, all of which are enclosed in a fine-grained groundmass. The rock is veined by purpligh calcite, especially along a slickensided face of the specimen. Dilute hydrochloric acid dropped at random on the specimen, away from the veins, shows that some calcite is scattered generally

throughout the rock.

In the thin section, numerous coarse phenocrysts are seen to be crowded together and enclosed in a very fine-grained, xenomorphic-granular groundmass. The groundmass appears to consist of quartz and somewhat sericitized felspar, with small amounts of white mica.

The phenocrysts are seen to consist of quartz, felspar, and altered ferro-magnesian material. Quartz forms anhedral and, in places, much corroded crystals whose size ranges between 0.2mm. and 3.0mm. Thin cracks in the crystals have been filled with very fine, plae green, apparently mica-like material which is sometimes stained by hydrated iron oxide. Strongly sericitized, and in places, carbonated (?) calcic oligoclase occurs as subhedral, tabular crystals, 0.75mm. average size, one or two of which appear to be partly replaced by fine flakes of green chlorite. Although sanidine was found in specimen 99033, which comes from the same intrusion as this specimen, none was seen here; much of the felspar in this specimen is so strongly altered that determinations could not be made on it. This does not, however, preclude its presence in the unaltered version of this rock. The ferro-magnesian minerals have been pseudomorphed by a variety of alteration products. "Biotite" forms rather ragged flakes, about 0.5mm. in size, and is now represented by an intergrowth of green chlorite with low birefringence, colourless (?)chlorite with first order polarization colours, and carbonate, the minerals being elongated parallel to the original cleavage of biotite. Hydrated iron oxide dust, and granules of leucoxene are also associated with these minerals. As well as biotite, both pyroxene and amphibole (the latter probably being the dominant ferro-magnesian mineral in the rock) appear to have been present, as shapes representing basal sections of both these minerals were seen. Both have been replaced by masses of fine, flakey, green chlorite enclosing irregular granules of carbonate, and, in places, epidote. Some of the pseudomorphs are cut by thin veins composed of a colourless fibrous serpentine-like mineral that has a low refractive index, and first order cream polarization colours. In places, similar veins appear to consist of fibrous, green nontronite. Hydrated iron oxide dust and fine granules of leucoxene are associated with these pseudomorphs.

Accessory apatite and zircon were observed in the groundmass. Leucoxene, also in the groundmass, forms roughly tabular crystals, commonly enclosing round granules of sphene.

Here and there, the groundmass appears to have been replaced by quartz, which forms anhedral, unstrained grains, 0.2 mm. average size, and which encloses numerous minute flakes of green (?)chlorite, and fine, dusty material. The rock is cut by thin, irregular veins of carbonate.

An estimation of the percentages of minerals present in the specimen is: oligoclase = 50, quartz = 25, ferro-magnesian minerals = 20, and the remainder = 5. The rock is a <u>carbonated, saussuritized and chloritized porphyritic microgranodiorite</u>.

<u>Comparison with Specimens of Mugga Porphyry</u>.

A brief examination was made of slides 818-823 which represent specimens of Mugga Porphyry that were obtained

from the Mugga Quarry, A.C.T. (W.B. Dallwitz, Bur. Min. Res. Aust., Records 1949/50). These have a generally similar appearance to the specimens described described above, most of the differences between the two suites being in late stage alterations of their minerals - e.g., the felspars in the Harman specimens are more strongly saussuritized than those in the Mugga Porphyry.

There are two more important differences:

1. The plagioclase is distinctly more calcic in the Mugga Porphyry than it is in the Harman specimens.

2. The ferro-magnesian mineral in the Mugga specimens prior to alteration was brown hornblende (Dallwitz, 1949). In the Harman rocks, amphibole was the dominant mafic, but some biotite and pyroxene were apparently present.

It seems possible that the two intrusions had a similar source. The more sodic nature of the plagioclase in the Harman specimens may be due to late stage enrichment of them in the soda molecule. The presence of small amounts of biotite and pyroxene in the Harman rocks, and their apparent absence in the Mugga Porphyry may be due to local differences in environmental conditions i.e., temperature, pressure, and the availability of water in the magma.

106W/4-d 23rd July, 1959.

3. THE PETROGRAPHY OF CORE5, DIAMOND DRILL HOLE B.M.R. 5, GIRALIA, W.A.

By W.R. MORGAN

The following is a petrographical description of Core 5 (at 500 feet), obtained from Diamond Drill Hole B.M.R. 5, Giralia, W.A.

The hand specimen, a somewhat friable and dark greyish-green rock, is seen to have a fine-grained and cleaved groundmass of argillaceous material enclosing numerous rhombs of carbonate that range up to half a millimetre in size. The specific gravity of the specimen was found to be 2.94.

By mineral separation, a broken down portion of the specimen was found to have the following weight percentages of minerals:- carbonate: 53.1, ferruginous argillaceous material: 46.7, and black iron ore, (?)glauconite, quartz and zircon, 0.2.

In thin section (slide number 4653) the rock is seen to have fairly euhedral rhombs of siderite, ranging from 0.2 mm. to 0.5 mm. in size, set in a groundmass composed of very fine-grained and laminated ferruginous argillaceous material. Small, rounded grains composed of greenish, fine (?)glauconite material may be seen. Rarely, fine, angular grains of quartz are present.

The siderite rhombs have an undulose extinction and are seen, in places, to have cracks along their cleavage planes. Commonly, the rhomb faces and cleavage traces are bent. One or two of the rhombs are replaced by (?)haematite.

The argillaceous material is laminated: the laminations are probably slip planes, as in one place a siderite rhomb appears to have been broken, and a portion of it displaced slightly along one of these planes. Otherwise, the lamination is commonly wrapped around the rhombs.

With regard to the formation of the rhombs, two points arise:

i. They originated prior to the formation of the lamination.

ii. Otherwise, theri good crystal shape suggests that they are the products of diagenesis, and are not an original depositions feature of the rock.

It seems likely that the rock was a clay ironstone and that during diagenesis, iron carbonate was separated from the clay to form rhombs. The rock is now a sideritic shale.

106G/17 27th July, 1959.

4. PETROGRAPHICAL DESCRIPTIONS OF TWO CALCAREOUS SPECIMENS FROM THE GREAT ARTESIAN BASIN, AUSTRALIA.

By W.R. MORGAN

The following are brief petrographical descriptions of thin sections representing two calcareous specimens collected by Georgina Basin field party during the 1958 season.

(a) Slide 4654 10 miles North of Tambo. Tambo 4-mile sheet.

The hand specimen is seen to be a dull brown, rather sandy, medium-grained limestone that reacts violently on the application of dilute hydrochloric acid. Dark brown, rather rounded, grains of glauconite are present.

In thin section, the rock is seen to be medium-to fine-grained, the grain sizes ranging between 0.03 mm. and 0.14 mm. Angular grains of quartz and anhedral to euhedral crystals of felspar, with lesser quantities of rounded grains of ferruginous glauconite, are set in a plentiful matrix of apparently crystalline, somewhat ferruginous calcite. The calcite may have recrystallized from original grains, because rather rounded "ghosts" formed of diffuse hydrated iron oxide dust are occasionally present in the calcite. Flexed flakes of biotite are of rare occurrence. Hydrated iron oxide appears to have replaced a fair amount of the glauconite: this may account for this mineral's brown colour in the hand specimen.

In a visual estimation of the amounts of minerals present, some 35% of the rock is composed of quartz and felspar, 10% is glauconite, and 55% is ferruginous calcite. The rock is a fine-grained, recrystallized quartz-plagioclase-calcarenite.

(b) Slide 4655 Roundstone Dam. 4-5 miles south-west of homestead, Jynoomah Station. Border of Tambo and Augathella 4-mile sheets.

The hand specimen is a fine-to medium-grained, dull cream-brown sandy limestone that reacts vigorously on application of dilute hydrochloric acid. Numerous grains of a black mineral may be seen.

In thin section, the rock is seen to be somewhat inequigranular, and fine-to medium-grained, with grain-sizes ranging between 0.03 mm. and 0.21 mm. The specimen appears to be an oolite, as angular quartz and microcline grains, and anhedral to euhedral plagioclase crystals, all seem to be surrounded by a rim of rather ferruginous calcite. Rounded grains of finely crystalline, greenish glauconite may be seen. Some angular to rounded grains of nearly opaque hydrated iron oxide are present, and are probably the black grains noted in the hand specimen. Rare, flexed flakes of biotite and muscovite were observed, and accessory apatite (enclosed in felspar) and zircon are present. All the grains are set in a calcite matrix.

A visual estimation of the percentages of minerals present in this specimen is:- calcite: 57, quartz and felspar: 25, hydrated iron oxide: 10, glauconite: 5, and biotite, muscovite and the accessory minerals: 3. The rock is a fine-grained, oolitic quartz-felspar calcarenite.

Note

1. The absence of mention of glauconite and hydrated iron oxide in the writer's previous report on these rocks (11th May, 1959, File 106G/17) is probably due to their being dissolved in acid while removing the carbonate.

2. The estimates of mineral percentages given in the earlier report are based upon weighing the separated fractions, and by rough grain counts: these are weight percentages, and are probably more accurate than the mere visual estimates made from these thin sections. Likewise, weight percentages are estimates of the amounts of minerals by their density, whereas the visual estimates from thin sections are of the percentages of area occupied by each mineral in a thin section. There may also have been differences in the quartz-felspar content between the specimens which were used for the earlier report, and those from which the thin sections were cut.

84G/8 5th August, 1959.

5. ANALYSES FOR U_3O_8 FROM MARY KATHLEEN, QUEENSLAND

By W.M.B. ROBERTS

Table I is a list of results of analyses for U_3O_8 on concentrates submitted by Mr. Wallbridge of Mary Kathleen Uranium Ltd. Duplicates were done in each concentrate sample, and the mean figure is given.

Table 1

Lot	$\%U_3O_8$
1	73.93
2	73.65
3	64.97
4	64.8
5	64.57
10	77.48
20	74.29
25	71.81
26	74.2
27	75.82
28	77.2
29	75.86
30	77.12

All figures are $\pm$ 0.5%.

This probable error of $\pm$ 0.5% is considered rather large, and is the result of having to dilute the sample, because the intensity from such concentration of uranium when undiluted would give rise to large dead time losses in the ordinary Geiger-Muller counter used for this analysis, even at the lowest excitation possible, and with masking of the counter.

The samples were diluted by a factor of 4, and combined with an artificial matrix. It is the difficulty of getting absolute homogeniety in the sample under these conditions which causes this error. It might be added that this difficulty does not arise when using a proportional counter for analysis, as the dead time losses in this type of counter are negligible, and hence dilution is unnecessary.

1980/2 4th August, 1959.

6. PETROGRAPHICAL DESCRIPTIONS OF EWEN GRANITE SPECIMENS.

By K.R. WALKER.

The specimens 3754, 3761 and 3762 of Ewen Granite and variants were submitted by E.K. Carter for petrographical description on 28/6/59. The specimens were collected from localities shown in the photo 5175, Dobbyn, Run 7, points 5, 9 & 10.

Specimen 3762:

Hand Specimen:

The hand specimen is light grey and fine-grained and the weathered crust is flesh-coloured: It consists mainly of quartz and feldspar, with biotite in lesser amounts. Segregations of biotite flakes occur in places and measure up to 10 mm. across. The feldspar is milky or soapy-green and the quartz is colourless.

Thin Section: The thin section is allotriomorphic granular but also partly hypidiomorphic granular and has a grainsize in the range 0.5 to 3mm. The main minerals present are quartz, plagioclase, microcline and biotite. Minor constituents are epidote, zircon and opaque iron mineral. Myrmekitic and perthitic intergrowths occur.

Quartz grains are xenomorphic and range in size from 0.2 to 2mm. They are commonly cracked and strained and may contain trains of minute inclusions. Small inclusions of potash feldspar (o.1 mm) are present in some quartz grains, but occur in insufficient numbers to form poikiloblastic texture.

Much of the potash feldspar appears to be perthitic microcline, which forms xenomorphic grains that range in size from 0.1 to 2 mm. Twinning is indistinct in a number of grains, and is always typically that of microcline. Potash feldspar shows slight brown clouding; its alteration, however, is not as extensive as that of plagioclase.

Plagioclase forms xenomorphic and sub-idiomorphic crystals that measure up to 3 mm. It has an R.I. greater than that of Canada balsam, and its composition measured from albite - Carlsbad twins (two measurements) shows a range from An_{66} to An_{44}; the zoning is normal. Alteration of plagioclase is to sericite and rarely to chlorite, flakes of which fleck the crystals.

The dark mineral is almost exclusively biotite which is well-cleaved and partly altered to pale green chlorite. The biotite flakes are pleochroic from honey-brown to dark coffee-brown, and many of them contain small inclusions surrounded by pleochroic haloes. These inclusions are probably zircon, and some of them are lens-shaped and occupy cleavages. Epidote may also be associated with biotite but is generally independent or occurs in the vicinity of grains of opaque iron ore.

A modal analysis by point counter shows that the thin section contains 34.2% potash feldspar, 34.0% quartz, 26.3% plagioclase and 5.6% biotite. The rock is, therefore, most appropriately called an adamellite.

Specimen No. 3761: Thin section number 2444

Hand Specimen:

The hand specimen contains red feldspar phenocrysts that measure up to 3 cm. These occur in a finer-grained groundmass which is fairly rich in chlorite. The remainder of the base is composed of quartz and feldspar. The rock appears to be a red granite porphyry.

Thin section: The thin section is partly granulated and consists of microcline phenocrysts surrounded by smaller grains of plagioclase, microcline, quartz and flakes of chlorite. The rock is porphyritic and although many of the grains in the base are angular and fractured, the texture of the groundmass is mainly allotriomorphic granular. All the grains show strain and have undulose extinction, and all the feldspar shows turbid brown alteration. The phenocrysts in the thin section measure up to 10 mm. whereas the grains in the groundmass range in size from 0.1 to 1 mm.

The microcline phenocrysts are xenomorphic and show coarse grid iron twinning. They are broken by numerous fractures. Plagioclase inclusions are common, and the distribution of altered zones, including relict plagioclase, indicate that the phenocrysts are mostly patch perthite. An exsolution form of perthitic microcline also occurs. Opaque iron mineral is localized along some cleavage and fracture planes; patchy turbid brown alteration characterizes all grains.

Plagioclase grains are xenomorphic and commonly fragmental in the groundmass. Grainsize ranges from less than 0.1 mm. up to 1 mm. size. Grains show simple twins and abundant parallel twin lamellae. Their composition, determined from the twinning, is oligoclase, An_6 to An_{10}, as their R.I. is equal to, or slightly less than, that of Canada balsam, and the maximum extinction of the albite twin lamellae approaches 15°. The R.I. of the plagioclase inclusions in microcline is greater than that of the surrounding microcline. Turbid brown alteration characterises all grains, and in some grains opaque iron mineral has developed along cleavages and fractures.

The chlorite flakes are pleochroic from pale yellow-green to bright lettuce-green. Flakes measure up to 1 mm. and are commonly found in bundles, being flexed and containing contorted cleavage traces. Bi-refrigence colours are mauve-blue which are typical of penninite. Possible small zircon inclusions are surrounded by pleochroic haloes.

Both granular opaque iron mineral and sphene are closely associated with the chlorite.

There is a paucity of quartz in the thin section, although a corresponding rock examined previously by Joplin and Walker (in preparation) from the same area contained appreciable quartz more typical of a granitic rock. The quartz percentage given in the modal analysis shown below is possibly fortuitously low owing to the thin section cut. In the thin section examined quartz mostly forms small xenomorphic interstitial grains. Quartz is commonest in granulated patches of the groundmass where it may form

bundles of fine and sinuous veins penetrating the feldspar.

Small sericite flakes, derived from the alteration of plagioclase, and rare grains of epidote are accessory minerals. Furthermore, zircon, opaque iron mineral and sphene grains are widespread and fairly common in the finer-grained parts of the thin section.

The rock is an unusual granitic one in which, as mentioned, quartz occurs only in small amounts. Patch perthite and perthitic microcline are exceedingly abundant and constitute most of the thin section. A modal analysis by point counter shows that the thin section contains 51.5% potash feldspar, 33.2% plagioclase, 9.5% chlorite and 5.9% quartz. Whether the formation of so much patch perhtite results from potash metasomatism and the replacement of original plagioclase by microcline (hence the consequent paucity of quartz) or whether the perthitic development is a feature of the original magmatic feldspar, cannot be established conclusively from the thin section. However, one gathers the impression that the original plagioclase was fractured and then partly replaced along these fractures to form almost entire porphyroblasts of patch perthite. The delicate veining by silica in places also suggests movement of silica subsequent to consolidation of the original granitic rock.

Disregarding the low quartz content of the thin section examined, the rock is probably best called a porphyritic alkali granite. However, such low percentage of free quartz suggests quartz-syenitic affinities.

Specimen 3754a Thin section number 2441.

Hand specimen:

A medium-grained granitic rock which consists of clear to milky quartz, pink and flesh-coloured feldspar and also of biotite and chlorite.

Thin section: The texture of the thin section is allotriomorphic granular and the thin section consists of quartz, plagioclase, patch perthite, biotite and some chlorite. Grainsize ranges from 1 to 6 mm. and averages about 3 mm. Accessory minerals are zircon, muscovite, calcite and apatite.

Quartz grains are xenomorphic and measure from 1 to 4 mm. They are transgressed by trains of small inclusions, forming roughly parallel lines in some cases. Undulose extinction is common.

Xenomorphic grains of patch perthite are composed of microcline that shows indistinct grid iron twinning and contains sub-idiomorphic and xenomorphic inclusions of plagioclase. Most of the plagioclase incusions in the patch perthite are in optical continuity and maximum extinction of albite twin lamellae approaches 15°, which indicates a composition of about An_{33}. Perthitic microcline also occurs. Potash feldspar forms grains from 1 to 6 mm. in diameter.

Plagioclase has a pitted appearance and, in places, a turbid brown surface, being flecked with sericite flakes which measure up to 0.5 mm. across. Crystals are mostly sub-idiomorphic and range from 1 to 3 mm. They are not uncommonly surrounded by larger crystals of perthitic microcline and generally show simple, complex or penetration

twins. Extinction measurements on albite-Carlsbad twins indicate that the composition of the feldspar is between An_{33} and An_{37}; zoning is not common, but a broad outer zone of fairly sodic feldspar may envelop some of the multiple twinned crystals.

The biotite is a light medium-green variety which is partly altered to chlorite; it contains lenses of what may be zircon in its cleavages. Brown pleochroic haloes are widespread. Cleavage is pronounced and commonly flexed. Both opaque iron mineral and sphene are generally associated with groups of biotite flakes and these groups measure up to 0.5 mm. across whereas the single flakes are mostly from 0.5 to 2 mm.

Modal analysis by point counter shows that the percentages of the four main constituent minerals are: Potash feldspar 39.3%, quartz 36.1%, plagioclase 22.3%, and green biotite 2.4%.

The rock is an alkali granite:

Specimens 3754 b & c Thin section numbers 2442 and 2443.

Hand specimens:

Specimens 3754 b & c are similar but 3754b is somewhat less weathered. The fresher rock is porphyritic andflesh-coloured, and contains, in a fine-grained base, clear quartz and flesh-coloured feldspar phenocrysts which measure up to 4 mm. across. Specimen 3754c has a darker colour owing to slight weathering and contains flesh-coloured feldspar phenocrysts up to 10 mm. Both specimens show greenish-opaque patches or outlines of idiomorphic feldspar and bundles of chlorite. However, the rocks are generally poor in ferromagnesian minerals.

Thin sections: The thin sections are porphyritic and have allotriomorphic granular textures. Phenocrysts are mostly idiomorphic quartz and potash feldspar that includes patch perthite. Granophyric texture is common in the vicinity of the phenocrysts and also interstitiatly. Some quartz phenocrysts show corrosion embayments. Potash feldspar phenocrysts measure up to 30 mm. and quartz phenocrysts up to 8 mm., and the grainsize of the groundmass ranges from 0.1 to 1 mm. Accessory minerals are biotite, sericite and opaque iron mineral. However, dark minerals are generally scarce and these rocks are essentially leucocratic.

The potash feldspar is mostly perthitic-microcline or patch perthite in which the potash feldspar shows indistinct grid iron twinning. The phenocrysts are idiomorphic or sub-idiomorphic whereas smaller grains in the groundmass are allotriomorphic. The grainsize of the potash feldspar in the groundmass ranges between 0.5 and 1 mm. The phenocrysts are simply twinned and many contain edges of graphically intergrown quartz and potash feldspar.

Apart from the phenocrysts, the quartz grains are xenomorphic and range from 0.1 to 1 mm. Undulose extinction is characteristic of all grains. The phenocrysts are cut by trains of small inclusions and at their margins the quartz is intergrown with potash feldspar.

Plagioclase has a turbid brown appearance and is commonly flecked with sericite. Grains are sub-idiomorphic and measure mostly between 0.5 and 1 mm. The maximum extinction of albite twin lamellae approaches 15° which indicates a composition of about An_7. Similar measurements were made on the patch perthite and the inclusions of plagioclase all extinguish together. The R.I. of plagioclase is lower than, or equal to, that of Canada balsam but greater than that of the potash feldspar.

In the thin section 3754c bundles of radiating white mica flakes have a greenish tint and are probably sericite. They measure up to 0.5 mm. across.

Modal analysis by point counter of these two specimens gave fairly similar mineral percentages and the results are shown in Table II.

Table II

Specimen No.	Potash Feldspar	Quartz	Plagioclase	Sericite
3754 b	48.3	38.3	12.3	1.0
3754 c	44.7	35.5	18.4	1.4

These rocks are alkali microgranite or granitic porphyry which are partly granophyric.

198Q/2 4th August, 1959.

7. THE PETROGRAPHY OF A PARTLY GRANULATED RHYOLITE FROM QUEENSLAND

By K.R. WALKER

Specimen 3774 was submitted for petrographical description by Mr. E.K. Carter on 14/7/59. It comes from Mt. Isa /6/5075/ point 39 and was described in the field as being a sheared (?)granitic rock (?)intruding Judenan Beds.

Hand Specimen:

The rock is deformed and inclined to disintegrate, breaking along parallel fractures. It contains numerous phenocrysts of milky quartz and cream feldspar which measure up to 4 mm. The groundmass is fine-grained and mostly micaceous. The colour is patchy owing to weathering and ranges from buff to rusty-brown.

Thin section (number 2440)

The thin section is porphyritic and contains xenomorphic potash feldspar and corroded quartz phenocrysts which measure up to 4 mm. in an extremely fine-grained groundmass. Deformation caused the phenocrysts to be strained, fractured and partly granulated, particularly in their marginal zones. Furthermore, a series of irregular cracks, which are arranged and roughly conform with the poor alignment shown by the micaceous minerals, are mostly filled with micaceous material where they cut the groundmass. Similar mica occurs within potash feldspar phenocrysts but not in the quartz. Mica also forms bundles of flakes in the thin section, and in some cases may pseudomorph original ferromagnesian minerals. Opaque iron mineral occurs sparingly.

The aphanitic groundmass is too fine-grained to measure its grainsize. It appears to be mostly siliceous and such of it consists of incipiently crystallized quartz. Patches of larger quartz grains form widely distributed aggregates. Also, the groundmass is flecked with very fine mica flakes.

Quartz phenocrysts contain pseudo-inclusions and the larger crystals are commonly cracked and, in some cases, fragmental. Trains of small inclusions cutting across the crystals probably represent another relict igneous structure. Undulose extinction characterized the deformed crystals whereas the smaller crystals, including small phenocrysts, do not show the effects of deformation to same extent. Fine micaceous flakes have accumulated around margins of many of the larger phenocrysts.

The potash feldspar phonocrysts show distinctly lower R.I. than that of Canada balsom. No twinning can be recognized beneath the heavy turbid brown alteration. Golden brown mica flakes and bundles of flakes form inclusions in the feldspar.

Mica occurs mostly in bundles of radiating flakes which are strongly cleaved and flexed. Small single flakes are widely distributed throughout the thin section.

Bundles measure up to 2mm. but single flakes are mostly less than 0.3 mm across. Pleochroism is not strong and is from pale green-brown to a light golden-brown. The mica is probably a form of biotite.

A few skeletal grains of opaque iron mineral measure up to 1mm. These grains are extensively altered and are probably after ilmenite.

The rock is a partly granulated rhyolite which shows partial reconstitution from low grade metamorphism involving a strong stress factor.

84G/8 11th August, 1959.

8. ANALYSES FOR U_3O_8 IN SAMPLES SUBMITTED BY THE BROKEN HILL PTY. CO., LTD.

By W.M.B. ROBERTS.

Samples were submitted by the Raw Materials and Exploration Section of Broken Hill Pty. Co., Ltd., to find the percentages of U_3O_8 present. The results are listed:-

TABLE III

	% U_3O_8
P.C.1	5.63
P.C.2	0.820
P.C.3	0.280
P.C.4	3.12
P.C.30	7.31
P.C.31	0.447

Charts were run on samples P.C.1, P.C.4 and P.C.30, and a rough quantitative analyses of the principal accompanying elements, excluding Fe, is:

Ag - Trace
Au - Not detectable because of spectral interference by tungsten target.
Cb - Trace
Zr - Less than 0.2%
Y - " " 0.2%
Pb - 1-2%
Cu - 0.5-1.0%
Ni - Less than 0.2%
Co - Trace
Mn - Less than 0.2%

63PNG/1 8th August, 1959.

9. MINERAGRAPHIC EXAMINATION OF SPECIMENS FROM EFONTERA, T.P.N.G.

The specimens were submitted by J.E. Thompson for mineragraphic examination. They are listed, with their localities:-

P.156 Costeans in gully of main mineralization 80 feet from Efontera CK.

P.188) Efontera CK., 300 feet upstream from gully
P.189) of main mineralization.

Specimens 156 and 188 have the same mineral composition which is: sphalerite, pyrite, galena, marcasite, chalcopyrite and pyrrhotite, in that order of abundance.

Pyrite, with associated marcasite, appears to have been the first of the sulphide minerals emplaced. It forms euhedral and subhedral crystals, and irregular masses all of which are commonly associated with a quartz gangue. The pyrite is fractured somewhat and has been partly replaced by sphalerite and galena; these minerals mould the pyrite crystals and corrode them extensively.

Chalcopyrite and pyrrhotite are very minor constituents of the ore; both minerals forming as minute oriented exsolution bodies in sphalerite. The largest of these exsolved areas measured 0.01 mm. across. Specimen 189 is identical in its textural relationships as 156 and 188, but, in addition to the previously mentioned minerals, it contains numerous euhedral crystals of arsenopyrite enclosed in sphalerite. They form small aggregates the individual crystals of which exhibit the usual rhomb and blade-like forms common to this mineral. The larges crystal measures 0.6mm. in length and the majority have a well-developed zonal texture.

It can be stated with reasonable certainty that pyrite and arsenopyrite are the earliest-deposited minerals; the position of marcasite is obscure, it could have formed with pyrite, or it may be the result of alteration of pyrrhotite to pyrite and marcasite. Galena, sphalerite, chalcopyrite and pyrrhotite all belong to the same period of deposition- subsequent to that of the pyrite and arsenopyrite.

The evidence of a solid solution having existed between pyrrhotite and sphalerite shows that these minerals must have been deposited at very high temperature - from the point of view of ore formation. Kullerud (1953) showed experimentally that homogenous solid solution between these minerals occurs at 894 ^{o}C, although in nature, various factors could have a modifying effect on this temperature.

63PNG/1 17th August, 1959.

10. THE PETROGRAPHY OF FIVE SPECIMENS FROM EFONTERA, NEW GUINEA

By W.R. MORGAN

P.159. Slide number 4689. Costeans in gully of main mineralisation, 40 feet from Efontera CK.

The hand specimen is seen to a medium-grained greyish quartz-mica rock that appears to have an indistinct shear-fabric, although the chlorite flakes have random orientation. The weathered surfaces are stained by hydrated iron oxide.

In thin section the rock is seen to be medium-grained and xenomorphic-inequigranular. Quartz forms angular to sub-angular and, in places, granulated grains showing strained extinction. The grains range in size between 0.06mm. and 0.3 mm., and tend to be interstitial to mica. Sericite occurs as intergrown flakes restricted to granular-to tabular-shaped areas whose size averages 0.2 mm., and is apparently pseudomorphing felspar. In places there are larger sericitic tabular areas, probably phenocrysts, measuring up to 1.2 mm. length, in some of which the sericite flakes are arranged parallel to the felspar basal cleavage; this "cleavage", in one place, is seen to be diverted by an apparent Carlsbad twin plane, which runs along the length of the tabular area. Very pale green to colourless chlorite forms randomly oriented, flexed flakes that have much leucoxene dust spread along their cleavage planes. The flakes range from 0.1 mm. to 0.4 mm. in length. The chlorite is uniaxial negative, and has a birefringence of 0.009. Accessory tabular leucoxene, prismatic apatite, and zircon were observed to be present. A few veinlets of hydrated iron oxide traverse the slide.

Fine, randomly oriented, flakes of greenish chlorite occupy a vein that ranges between 0.03 mm. and 0.4 mm. thickness. This vein is cut by other irregular, bifurcating veins containing hydrated iron oxide and, in places metallic sulphides.

An estimation of the percentages present is:- sericite: 35, quartz: 33, chlorite: 35, and accessory minerals: 2. The rock appears to be a granulated, sericitized and chloritized sparsely porphyritic microgranodiorite (or microgranite).

P.161 Slide number 4690. Costean in Oroki CK., tributary of Efontera CK., half mile south of main gully of mineralization.

The small hand specimen shows fine-grained material which has been veined by metallic sulphide and quartz.

From examination of the thin section, it seems that fine-grained quartz-sericite rock has been invaded by coarser-grained quartz-metallic sulphide material. Later, the whole was cut by quartz veins.

The quartz-sericite material is composed partly of a fine, granular mosaic of quartz grains, the average grain-size being 0.02 mm. Variable amounts of sericite may be present; in places it forms flakes 0.002 mm. in size and comprises only 5-10% of the rock. Elsewhere, it may form up to 60% of the rock, and occur as flexed flakes measuring up to 0.03 mm. length. Prior to the mineralization there appears to have been some banding of sericite-poor, and sericite-rich, material, but this is, at present, difficult to see, owing to the effects of the mineralization. Present also in this fine-grained material are cubes of metallic sulphide, ranging from 0.004 mm. in size to 0.2 mm., and larger, highly irregular grains of metallic sulphide, measuring up to 0.7 mm., these were presumably formed during the mineralization. Enclosed in the fine material are large granulated quartz grains showing strong strained extinction.

Cutting the material described above are thick, irregular veins composed of very inequigranular quartz and metallic sulphide. The quartz grains range between 0.03 mm. and 1.1 mm. size, and commonly show strained extinction. The metallic sulphide forms somewhat irregular masses that range from 0.2 mm. to 1 mm. in size, and which are shattered and granulated.

Both the fine quartz-sericite material, and the metallic sulphide-quartz vein matter are cut by a later vein composed of inequigranular quartz ranging between 0.03 mm. and 0.2 mm. in size. The quartz is relatively unstrained, showing only undulose extinction. This vein contains fragments of quartz-sericite rock, and of metallic sulphides. It also sends minor offshoots into the surrounding country rock.

The rock is difficult to name, but it may be called a veined and mineralized quartz-sericite rock. It is apparent that between the emplacement of the quartz-pyrite matter, and the intrusion of the quartz vein, some granulation took place.

P.185. Slide 4691. D.D.H. No. M64E3. 245 feet.

The hand specimen is seen to be of a grey, medium- to coarse-grained, sheared acid igneous rock that contains white felspar, quartz, and some micaceous material.

In thin section, the rock is seen to be fairly coarsed-grained, and is xenomorphic-inequigranular, with a pronounced shear-texture.

Oligoclase (An_{30}) forms sub-tabular to rounded grains that are elongated in the direction of shearing. The grain margins are irregular and somewhat intergrown with those of neighbouring minerals. Quartz is drawn out into strongly lenticular grains that are wrapped around oligoclase, and shows foliated strained extinction commonly oriented parallel to the direction of shearing. Biotite, almost entirely pseudomorphed by pale green penninite, forms streaky, flexed, and often intergranular flakes.

Sericite and epidote are alteration products of plagioclase. Accessory zircon and apatite are present. Small amounts of pyrite and vein quartz were observed.

An estimation of the percentages of minerals present is:- oligoclase: 60, quartz; 35, and chlorite & biotite: 5. The rock is a sheared, chloritized and somewhat saussuritized granodiorite.

p. 186. Slide number 4692. D.D.H. M64E3. 240 feet.

The impression gained from examination of both the thin section and the hand specimen is that the sample is a coarse-grained acid igneous rock that is cut by a flexed shear zone. The minerals in the outer parts of this zone are streaked out and elongated: in the centre of the zone are lenticular pockets of granular material, whose average grainsize is less coarse than that of the original igneous rock, although there is little or no parallel orientation of the minerals.

The original igneous rock appears to have been a granite or adamellite, and contained oligoclase, quartz and microcline-perthite, with some ferro-magnesian material. Away from the shear-zone these minerals give the rock a coarse xenomorphic-inequigranular texture, the grain sizes ranging from 0.25 mm. to 7.0 mm., with quarts and felspar showing straining and granulation, and sericite being fine-grained, intergranular, and streaky.

In the sheared area, no microcline-perthite was seen. In the outer parts of the shear-zone, quartz is somewhat granulated, and is seen to have strong foliated extinction, and the grains are elongated parallel to the shearing. Oligoclase grains are similarly granulated and elongated, and are commonly strongly saussuritized. They commonly contain granules of quartz. Bands of fine sericite flakes are streaked out in the direction of shearing in between the quartz and felspar grains. Minute "streaks" of black iron ore may be found enclosed by sericite, elongated parallel to the shearing. Occurring with the sericite are coarse flakes of muscovite that have irregular edges and show some flexing. Muscovites cleavage may lie parallel, or obliquely, to the direction of sericite banding. Medium- to coarse-grained flakes of colourless to pale green chlorite are intergrown with the coarse muscovite.

The inner part of the shear zone consists of granular material whose grain-size ranges from 0.05 mm. to 0.56 mm. Quartz forms rounded to irregular grains with intergrown margins. Oligoclase grains are similar, and may be partly or wholly replaced by large, randomly oriented, flakes of muscovite; in places, however, they are strongly saussuritized.

Rarely, symplectic intergrowths of muscovite and quartz may be seen: these are not restricted to either the sheared or unsheared zones. Likewise, rare metallic sulphide has random distribution; in places, this mineral forms small irregular grains intergrown with quartz or muscovite; elsewhere it forms euhedral cubes enclosed in quartz.

Accessory zircon and apatite are present.

The rock is a sheared and griesenized granite or adamellite. From this thin section it is not known for certain whether the muscovite replaces sericite in the shear zone, or if sericite has resulted from the breakdown of muscovite during the shearing.

P.187. Slide number 4693

The hand specimen is seen to be of a dark greyish-green, fine-grained, possibly vesicular microporphyritic igneous rock. The (?)vesicles are 0.5 mm. to 1.mm. in size, and are filled with a white mineral, none of which was preserved in thin section.

In thin section the rock is seen to be microporphyritic, with a fine-grained, interstitial hypidiomorphic-granular groundmass. The lean tabular groundmass shows some flow-texture.

The microphenocrysts are little larger than the groundmass, their sizes ranging between 0.1 mm. and 0.4 mm. They consist of stubby, rhomb-shaped crystals which are suggestive of anorthoclase, although in fact the optical data show them to be albite: it is possible that they result from albitization of anorthoclase.

The groundmass felspar is also albite (approximately An_9 in composition) and forms euhedral, lean lath-like crystals that are commonly flow oriented, and whose length ranges between 0.02mm. and 0.25 mm. Some granular to tabular epidote is present, but most of the ferromagnesian material is represented by flaky green chlorite lying interstitially to albite. Much (?)leucoxene dust appears to be associated with chlorite.

The (?)vesicles noted in the hand are represented in the section by numerous sub-rounded cavities. Some material was scratched from the vesicles in the hand specimen and examined, but was not identifiable. It is colourless, with a refractive index of, very approximately, 1.54, and is isotropic.

Some octahedra of pyrites were observed.

A visual estimation of the percentages of minerals present is: albite: 70, and chlorite, opidote and leucoxene: 30. The rock is a micropophyritic albite trachyte, or keratophyre.

120ACT/1 21st August, 1959.

11. THE PETROGRAPHY OF SIX SPECIMENS OF POPHYRY COLLECTED FROM THE AREA NORTH OF CANBERRA, A.C.T.

The following specimens were submitted by Mr. E.G. Wilson for petrographic examination. They are listed, with their localities:-

A.1514	- Lake George	1-mile	sheet	100532
A.1516	- "	"	"	084526
A.1521	- "	"	"	059521
A.1557	- "	"	"	082500
A.1566	- "	"	"	066546
A.1593	- "	"	"	081529

An attempt has been made to compare and contrast these specimens in an effort to aid correlation.

A.1514, A.1516 and A.1557 Slide numbers 4643, 4644 and 4645 respectively.

These three specimens are all very similar to one another, and so are described together. The hand specimens are seen to be pale grey, porphyritic acid igneous rocks, in which phenocrysts of tabular felspar, rounded quartz, and apparently prismatic ferromagnesian minerals are enclosed in a fine-grained quartzo- felspathic groundmass. The weathered surfaces are stained with orange-brown hydrated iron oxide.

In thin section, the specimens are seen to have a hypidiomorphic-granular groundmass, with average grain-sizes ranging between 0.03 mm. for A.1514, and 0.1 mm. for A.1557. The groundmass encloses numerous hypidiomorphic phenocrysts that range in size between 0.1 mm. and 5.0 mm.

The groundmass contains stubby tabular to granular, partly sericitized plagioclase that has a low refractive index, indicating that it is sodic. Quartz is granular to interstitial. Green chlorite occurs as fibrous intergrowths replacing a tabular ferromagnesian mineral, possibly amphibole. Some interstitial chlorite is also present.

With regard to the phenocrysts, labradorite occurs in specimens A.1514 and A.1516 (An_{63} and An_{60} respectively), and andesine (An_{40}) in A.1557. In all three specimens it is commonly saussuritized, and forms subhedral to euhedral tabular crystals that often have corroded margins. Quartz occurs as anhedral phenocrysts with embayed margins and pseudoinclusions.

The original phenocryst ferromagnesian mineral appears to have been prismatic, and, in places, acicular, amphibole, although some of this was probably pseudomorphed by biotite. Both are now replaced by late stage minerals. Amphibole not pseudomorphed by biotite. Both are now replaced by late stage minerals. Amphibole not pseudomorphed by biotite has been coverted to apple-green chlorite which forms masses of sub-radiating flakes having grey polarization

colours; granular sphene, carbonate and epidote are also present, and, in places, some flakes of nontronite are intergrown with chlorite. The biotite pseudomorphs commonly have an amphibole-like outline, but the chlorite (penninite) replacing it has a well marked biotite-like cleavage. Prismatic sphene, epidote and prehnite are also commonly present, and are all elongated parallel to the "biotite" cleavage. In specimen A.1557, sericite is also present.

Accessory apatite forms stubby prismatic crystals commonly associated with the ferromagnesian minerals. Zircon may be found in the groundmass and, with allanite, enclosed in chlorite, causing pleochroic haloes in that mineral. Granules of leucoxene may be found in the groundmass.

In specimen A.1514, rare amygdules may be seen, commonly filled with fibrous chlorite. One, with a diameter of 2 mm., has a rim of chlorite 0.24 mm. thick, and its interior is filled with quartz. In specimen A.1516 and A.1557, some apparent irregular cavities are filled with carbonate, and others with chlorite.

An estimation of the percentages of minerals present in these specimens is:- plagioclase: 55-60, quartz: 20-25, ferromagnesian pseudomorphs: 20-25. The specimens are somewhat saussuritized and chloritized granodiorite porphyries.

One or two of the specimens (e.g., A.1514) contain inclusions composed of very fine-grained white mica.

A.1593. Slide number 4646.

The hand specimen is seen to have a dark grey, very fine-grained groundmass that encloses phenocrysts of tabular white felspar, prismatic ferromagnesian minerals, and rounded quartz. The phenocrysts range between 0.5 mm. and 2 mm. in size, and, on the average, tend to be smaller, and occur more sparcely, than those observed in the previously described specimens. The phenocrysts also show some flow orientation. The weathered surface has a thin crust of hydrated iron oxide-enriched material.

In thin section the rock is seen to have a fine-grained idiomorphic-inequigranular groundmass, in which abundant lean laths of plagioclase show strong flow texture. The groundmass encloses and flows around anhedral to euhedral phenocrysts.

The phenocrysts consist of plagioclase, altered ferromagnesian mineral, and quartz. Labradorite (very approximately, An_{60}) forms tabular crystals that are, in places, strongly saussuritized. The ferromagnesian mineral appears to have been amphibole, some of which was later probably psuedomorphed by biotite, as in the previously described specimens. Both are now replaced by green chlorite, epidote, carbonate and sphene: epidote occurs more commonly in the altered "biotites". Quartz forms anhedral to subhedral, embayed phenocrysts.

The groundmass is composed mainly of lean, lath-like plagioclase crystals that range in size from 0.003 mm. breadth and 0.01 mm. length to 0.01 breadth and 0.06 mm. length. The plagioclase has a refractive index higher than that of Canada balsam, indicating that it is more calcic than the groundmass plagioclase of the previously described specimens Chloritized (?)amphibole forms euhedral prismatic crystals. Some chlorite occurs interstitially to plagioclase. Quartz

is present as granular, slightly poikilitic crystals. The whole groundmass is dusted with somewhat sparse granules of hydrated iron oxide.

The rock is cut by several veins, 0.02 mm. thick, containing fine dusty opaque material. Two or three other veins, of a similar thickness, contain quartz, carbonate and small amounts of epidote.

Accessory leucoxene, zircon and apatite may be found in the groundmass. Zircon may sometimes be seen enclosed in chlorite, and causing pleochroic haloes in that mineral.

An estimation of the percentages of minerals present in the rock is; labradorite: 65, ferromagnesian minerals: 20, and quartz: 15. The rock is a deuterically altered granodiorite porphyry, or dacite.

A.1566. Slide number 4647

The hand specimen has a grey, fine-grained groundmass enclosing phenocrysts of tabular white felspar, prismatic ferromagnesian minerals, and rounded quartz. The phenocrysts have an average size of 1 mm., although some measure up to 4 mm. Rarely, small masses of hydrated iron oxide enclosing apparently granular pyrites may be seen. The weathered surface is stained with dull brown hydrated iron oxide. The general appearance of this specimen is more similar to specimen A.1521 than to the others.

In thin section, the groundmass is seen to be fine-grained, and hypidiomorphic-inequigranular, with grainsizes ranging from 0.02 mm. to 0.13 mm. A flow-texture is present. Sodic plagioclase forms lean tabular, flow-oriented crystals. Quartz is granular, and somewhat poikilitic. Chlorite is interstitial, and forms small prismatic crystals. The groundmass is dusted with granular leucoxene. Accessory zircon, epidote, sphene and apatite may be seen: the last named mineral is faintly brown, and shows some absorption.

The phenocrysts range between 0.25 mm. and 3.75 mm. in the slide. Albite (An_0) forms subhedral, somewhat corroded tabular crystals that show some alteration to sericite and chlorite: it commonly encloses small irregular granules of opaque ore that show some alteration to leucoxene. Quartz occurs as large subhedral to anhedral, corroded and embayed phenocrysts containing, here and there, pseudoinclusions of groundmass material. Pyroxene and amphibole form subhedral crystals which have been pseudomorphed by chlorite and nontronite. (?)Biotite appears to have been replaced by muscovite, chlorite and nontronite, and the flakes enclose irregular granules of leucoxene.

A small area, 0.6 mm. in diameter, is composed of a cluster of cubes of pyrites that is now almost entirely replaced by hydrated iron oxide.

Some veins and irregular cavities are filled with fine radial clusters of green chlorite.

An estimation of the amounts of minerals present is:- albite: 65%, quartz: 15%, ferromagnesian minerals: 20%. The rock is a quartz keratophyre, or deuterically altered albite granodiorite porphyry.

A.1521. Slide number 4648.

The hand specimen has a similar appearance to that described for A.1566. The groundmass tends to be amygdaloidal. On the weathered surfaces, felspar and quartz phenocrysts stand out in relief.

In thin section the specimen seen to be porphyritic, and has a fine-grained amygdaloidal groundmass which shows some flow lineation of the tabular felspars.

The phenocrysts consist of felspar, ferromagnesian minerals, and quartz. Albite-oligoclase (An_{10}) forms subhedral to euhedral, commonly corroded tabular crystals, that are in places, strongly saussuritized. The crystals range in length between 0.25 mm. and 3.25 mm. Potash felspar occurs as tabular, somewhat kaolinized, phenocrysts, having a refringence lower than that of Canada balsam, and a large negative optic axial angle. Quartz occurs as rounded, commonly embayed phenocrysts that have pseudo-inclusions in places. Amphibole has been pseudomorphed by a variety of alteration products: green chlorite, yellowish epidote, brownish montronite, and leucoxene. Some unaltered, and partly chloritized, augite is present as rare clusters of small euhedral phenocrysts.

The groundmass consists of flow-oriented tabular sodic felspar; green chlorite pseudomorphing prismatic crystals, and occurring as interstitial masses; and granular quartz. Accessory black iron ore, leucoxene, apatite, epidote and zircon were observed to be present.

In the groundmass are several amygdale- and schlieren-like structures, ranging up to 1.25 mm. in size. Commonly these have a thin rim of zeolite that encloses fine, scaly, green chlorite. Some, however, differ in being composed of augite and zeolite, with, in places, quartz. The augite was found to have a birefringence of 0.026, and on a universal stage, was found to be biaxial positive, with an apparent 2V of 52°, and to have $Z \wedge C = 43^{\circ}$. The schlieren are connected by very thin veins containing zeolite and chlorite, and, in places, fine dusty opaque material.

An estimation of the amounts of minerals present is: Plagioclase: 50%, potash felspar: 5%, ferromagnesian minerals: 25%, quartz: 15%, and others: 5%. The rock is a deuterically altered granodiorite porphyry, or dacite.

Discussion.

1. In addition to petrographical description, some comment on possible similarities of the specimens to one another is required.

2. Specimens A.1514, A.1516 and A.1557 are similar to one another mineralogically and texturally, and so have been described together.

3. Specimen A.1593 is mineralogically similar to those referred to above, but in texture it differs, in that its phenocrysts and groundmass minerals are finer-grained, and that the groundmass has a flow texture, whereas the groundmass of specimens A.1514, etc., is granular, with little or no flow texture. Mr. Wilson states that specimens A.1514, etc., are intrusive, and he considers that specimen A.1593 is representative of an extrusive rock. Both rock types come

from the same general locality. Therefore, two possibilities arise:

(a) That A.1593 has no relationship to the others.

(b) That A.1593 is an extrusive equivalent of the other specimens. Bearing in mind the mineralogical similarities, it seems more likely that this second alternative is the correct solution provided that field evidence does not conflict with this finding.

4. Specimen A.1566 has a rather similar texture to that of A.1593. However, its plagioclase is albite. It may, therefore, be a sodic variety of A.1593. Whereas in A.1593 biotite pseudomorphed amphibole prior to its being replaced by late-stage minerals, in A.1566 altered biotite appears to have been primary. Hence, another difference becomes apparent. It is possible, therefore, that the rock represented by this specimen is not co-magmatic with that of A.1593.

5. Specimen A.1521 has a texture fairly similar to that of A.1593, but seems to be mineralogically distinct from that specimen, and from A.1566, in that its plagioclase is An_{10}, some potash felspar is present, and the biotite appears to have been absent. In addition, some largely unaltered augite may be seen.

6. To summarize, it seems that specimens A.1514, A.1516, and A.1557 are similar to one another, and it is possible that specimen A.1593 is representative of an extrusive equivalent of these specimens. Specimens A.1526 and A.1521 appear to be distinct from one another, and from those mentioned above.

It is unfortunate that in the country around Canberra, so many of the extrusive and miner intrusive rocks of different ages are dacitic in character. Attempted correlation by petrographical means alone is uncertain. For example, the textural and mineralogical points of difference referred to above could easily be accounted for by differences in the cooling history, and stages of differentiation, of derivatives from a common magma. Hence, the conclusions arrived at above should not be relied upon to any great extent Evidence obtained from some other source at a future date may be more conclusive.

Mineralogical Note.

The occurrence of mostly unaltered augite in amygdales and, more rarely, as small phenocrysts in an acid igneous rock (specimen A.1521) in which the dominant ferromagnesian mineral, amphibole, has been altered to late-stage minerals, appears to be anomalous. M'Lintock (1915) has noted fresh purple augite in amygdales found in an olivine basalt on the island of Rum, North-West Scotland. The augite in the main mass of this rock has mostly been chloritized. M'Lintock observed, however, that where the olivine basalt has been thermally metamorphosed by an intruding granophyre, the purple augite is replaced by hornblende. However, he states, new colourless augite was formed during this metamorphism by reaction been chlorite and scolecite (a lime-rich zeolite), or prehnite.

It would be interesting, therefore, to note the field relationships of the rock represented by specimen A.1521, to any later intruding rock. If one exists, then a collection of specimens should be made, in order to note the distribution of augite around this rock, to see whether or not the mineral does result from thermal metamorphism. Such an investigation should also show if any other mineralogical reactions have taken place.

Reference.

M'Lintock, W.F.P. (1915) - On the zeolites and associated minerals from the Tertiary lavas around Ben More, Mull. Trans. Roy. Soc. Edin., Vol. LI, Part I, pp.1-33.

151N/1 24th August, 1959.

12. THE PETROGRAPHY OF AN ALTERED VITRIC TUFF FROM SWANSEA, N.S.W.

By W.B. DALLWITZ.

This is a description of D.D.H.2, sample No. 4702, at 750', of Rio Tinto Exploration, and submitted for examination by the Joint Coal Board.

The piece of core sent by Mr. R.O. Chalmers, of the Australian Museum, consists of two parts which appear to be in fairly sharp contact. One part consists of fine-grained, massive pale yellowish grey rock containing scattered, more or less spherical clots of light grey calcite measuring from 1 to 3.5 mm. across. The other part is a fine-grained mottled rock consisting of a "matrix" of pale buff calcite containing highly irregular bodies of hard, greyish-buff material which does not react with cold, dilute HCl. Mr. Chalmers, in the petrological report attached to the covering letter, mentions "rounded ..... masses of pinkish limestone from ½ to 1 cm. in diameter"; no masses of this size were noticed in the specimen sent by him, and it thus seems clear that he had additional material for study. This conclusion is confirmed by his mention of "hollow casts" of the calcareous material in the specimens studied by him - none of these casts appears in the rock that was sent to Canberra. These matters are mentioned merely to explain why there is no description of the two features mentioned in this report.

Two thin sections of the specimen were made. One of these represents the pale yellowish grey rock only and is cut parallel to the contact between the two seemingly different rocks making up the specimen; the other is cut perpendicular to the contact and includes both kinds of rock. Study of this section shows that the rock is an altered vitric tuff bordering on welded tuff (see below). Fragments of quartz and feldspar (predominantly acid plagioclase) are fairly sparsely distributed in the glass; the average size of these fragments is about 0.2mm.

The appearance of the rock as a whole is very much like that of a vitric tuff and of a welded tuff illustrated in Figures 50B and 50C of "Petrography", by Williams, Turner, and Gilbert (W.H. Freeman & Company, 1954). (Plates 19A & 19C in "Sedimentary Rocks" by F.J. Pettijohn, Harper, 1949, also illustrate rocks which have some features in common with the rock from Swansea.) Commonly the glass shards, which show typical curved and pointed shapes and concave borders, are somewhat flattened and deformed but it is doubtful whether these changes have gone far enough for the rock to be called a welded tuff. All of the glass has been devitrified or otherwise altered; some of it has been changed to very fine-grained sericite, some is merely devitrified, and a little has changed to probable zeolite, which is water-clear and has very low double refraction and a refractive index markedly less than that of Canada balsam. Small grains and groups of grains of hydrated iron oxide are unevenly distributed through the altered glass.

The contact between the two different types of rocks noted in the description of the handspecimen is seen to be gradational.

The more or less spherical bodies of calcite noted in one part of the rock owe their origin to localized replacement (generally not complete) of the glass; this

replacement has, somewhat unexpectedly, resulted in marked accentuation of textural detail in the glass. The calcite bodies, as viewed in section, generally consist of aggregates of several irregular grains of carbonate, though some of the smaller ones consist of a single crystal grain. The glass in this part of the rock has been altered largely to sericite, but some of it is merely devitrified to a microcrystalline aggregate which has a refractive index less than that of balsam; (?)zeolitic replacement of glass shards is quite rare.

The rock described above grades into one which is fundamentally the same, but differs in that

(a) devitrified glass is the dominant constituent - sericitized glass is virtually absent;

(b) replacement by calcite is more extensive - ultimately an irregular, sponge-like meshwork of carbonated glass ramifies through the devitrified glass (this is the mottled rock noted in the handspecimen, the hard, greyish-buff material being the devitrified glass); and

(c) replacement of glass shards by (?)zeolite is much more common.

The rock may, as stated above, conveniently be called an altered vitric tuff, but a more complete name would be carbonated, devitrified, and sericitized vitric tuff.

34G/1 24th August, 1959.

13. SPECIFIC GRAVITY MEASUREMENTS ON SPECIMENS SUBMITTED BY METALS EXPLORATION, MT. ISA.

By W.R. MORGAN

Two bags of drill core specimens were received from Metals Exploration, Mt. Isa. One was labelled "Sedimentary Suite," and the other, "Greenstone Suite." Otherwise no names or localities were supplied. From reading Mr. B.P. Walpole's minute of 23rd July, 1959, it appears that lensity measurements on these specimens were required, in order to find if there is any significant difference between the two suites.

The density of each core specimen was measured by means of a Walker Steelyard Balance. The results for the Sedimentary Suite may be found in Table 1, for the Greenstone Suite in Table 11. The numbering and lettering of each specimen was applied in the laboratory for the purpose of indentification.

TABLE IV - SEDIMENTARY SUITE.

Group 1	Group 2.	Group 3.
(a) = 2.74	(a) = 2.82	(a) = 2.82
(b) = 2.80	(b) = 2.81	(b) = 2.72
(c) = 2.74	(c) = 2.78	(c) = 2.89 (M)
(d) = 2.81	(d) = 2.76	(d) = 2.79
(e) = 2.69		(e) = 2.76
(f) = 2.78		(f) = 3.02 (M)
Average = 2.76	Average = 2.79	Average = 2.83

Average for Sedimentary Suite = 2.79

Certain of the specimens in this suite are mineralized - marked (M) in Table I. The average for the suits was re-calculated omitting them, and was found to be 2.77.

TABLE V - GREENSTONE SUITE.

Group 1	Group 2.	Group 3.
(a) = 2.86	(a) = 2.70	(a) = 2.74
(b) = 2.82	(b) = 2.69	(b) = 2.665
(c) = 2.78	(c) = 2.83	(c) = 2.81
(d) = 2.81	(d) = 2.79	(d) = 2.67
(e) = 2.71	(e) = 2.78	(e) = 2.785
(f) = 2.825	(f) = 2.735	(f) = 2.795
		(g) = 2.81
		(h) = 2.775
Average = 2.80	Average = 2.75	Average = 2.76

Average for Greenstone Suite = 2.77

84NT/17 24th August, 1959.

14. EXAMINATION OF DRILL CORES FROM ADELAIDE RIVER, N.T.

By W.M.B. ROBERTS.

Seven drill cores were submitted by C.E. Prichard of the Darwin Office for Mineragraphic examination. Four of the cores contained veins of a black mineral, thought to be pitchblende, and the remaining three contained sulphides.

The four cores containing suspected pitchblende, nos. 195722, 195723, 195724, 195725, could not be polished suitably for mineragraphic examination; as a result the black mineral in the veins was extracted and identified by X-Ray diffraction. In all four cores the mineral is pitchblende.

The remaining three cores were polished and examined mineragraphically.

Core No. 195726

The principal opaque mineral in this section is pyrite, which forms large subhedral crystals which range up to 0.5 mm. in width. These crystals are strongly fractured and have been partly replaced by chalcopyrite. Some marcasite, as small irregular grains is intergrown with the pyrite. No other opaque minerals are present.

Core No. 195727

The opaque minerals in this section are chalcopyrite, linnaeite, pyrite, marcasite and galena, listed in order of abundance.

Pyrite, the earliest-formed mineral, forms euhedral crystals and irregular areas which are moulded by chalcopyrite and linnaeite. Marcasite, which appears to be contemporaneous with pyrite, occurs as isolated irregular grains in chalcopyrite.

Linnaeite appears to be the next mineral in the sequence; it forms large irregular areas moulding both pyrite and marcasite, and is in turn replaced by chalcopyritd, which forms a groundmass for the other sulphides. The chalcopyrite is composed of an aggregate of interlocking grains the largest of which measures 1.5 mm. across.

Core No. 195728

The opaque minerals in this core are - chalcopyrite, arsenopyrite, pyrite, marcasite, and pitchblende, listed in their order of abundance.

With the exception of pyrite, all of these minerals are strongly fractured, marcasite to a greater extent than the others.

Arsenopyrite and pyrite, which occur as subhedral crystals and irregular areas ranging up to 0.75 cm. across, are moulded by marcasite and chalcopyrite. Pitchblende forms along fractures in the arsenopyrite, and as small irregular areas in the chalcopyrite; in places it is altering along its edges to a mineral having a lower reflectivity and hardness - probably a further stage in its oxidation.

It appears that pyrite and arsenopyrite are the earliest-formed opaque minerals. Marcasite has then been deposited as a coarsely-granular aggregate moulding pyrite and arsenopyrite. All of these minerals have been strongly fractured, marcasite evidently having been the most susceptible to the fracturing process, which has resulted in its breaking up into a finely granular mass having an average grainsize of 0.03 mm. The original grainsize of this mineral is indicated by optically continuous groups of grains within the fractured mass; those groups measure approximately 0.5 mm. across.

106W/1 1st September, 1959.

15. THE PETROGRAPHY OF A VOLCANIC ROCK AND A SILICIFIED LIMESTONE, FROM RIPON HILLS, W.A., AND OF A CALCITE - ROCK FROM LAKE LUCAS, W.A.

By W.R. MORGAN

The three specimens were submitted by Mr. A.T. Wells for petrographical description.

F/51-5. Slide number 4685.

The hand specimen is seen to be a pale cream-grey, fine-grained and apparently siliceous rock. It contains irregularly distributed round white "spots" that range from 0.5 mm. to 4 mm. in diameter. Some of the spots are zoned; a typical example has a white rim 0.5 - 1.0 mm. wide surrounding material which is apparently similar to that enclosing the spots. The interiors of some other spots are stained brown or red by hydrated iron oxide. Where several spots are close together, they appear to have coalesced.

In thin section, the material enclosing the spots is found mainly to be fine-grained, with an average grain-size of 0.001 - 0.005 mm. It consists mostly of chalcedony and sericite, and has a fine but irregular dusting of opaque ore ((?)leucoxene). When the slide is rotated under crossed nicols, its material shows a mass extinction: this appears to be due to optical parallelism of the sericite flakes, which are accumulated into sub-parallel streaks. Some sericite occurs in tabular areas, measuring up to 0.1 mm. long and 0.02 mm. broad, that resemble pseudomorphs of felspar. In places sericite forms hard-shaped grains. A few angular and fretted grains of quartz measuring up to 0.1 mm. in diameter are present. The rock gives the impression of being an altered volcanic rock, possibly a tuff, but this is by no means certain.

Most of the spots, as seen in the section, are zoned. The cores are composed of material much like that enclosing the spots and have the "mass extinction" characteristic of the enclosing material; rare flakes of brown (?)nontronite were observed to be present in one place. The rims of the spots contain less sericite and more chalcedony than in the cores and the enclosing material. On the whole, there appears to be less (?)leucoxene dust within the spots than outside them. In one place in the slide, four or five spots are close together, and have interfered with one another's growth. Each is separated from its neighbour by a thin zone of sericite-poor material, similar to that comprising the rims of other spots.

Because of the nature of the adjacent spots just described, it is considered that they grew in situ during the alteration of the rock to its present sericite - chalcedony mineral assemblage. It seems probable that the spots are a form of Liesegang structure. It was thought that these structures may have been remnant vesicles in a volcanic rock, but the similarity between the spots and the enclosing material (apart from the differences noted above) seems to be against this idea. Likewise, there is no great difference in texture between the enclosing material and the spots which might suggest that they are vesicles.

3608 Slide number 4686.

The hand specimen is composed of layers of colourless and pink iron-stained quartz. The layers are slumped, and, in places, somewhat brecciated. The layers range between 1 and 5 mm. in thickness. The colourless layers are sometimes cavernous, the cavities being lined with prismatic and pyramidal quartz.

In thin section, the pink layers are seen to be composed of a mosaic of somewhat intergrown quartz grains whose average size is 0.03 mm. Intergranular hydrated iron oxide dust is present. The colourless layers appear to have been cavities which have subsequently been filled with quartz. At the margins of the "cavities", quartz forms sub-prismatic crystals, whose average size is 0.12 mm., which have interfered with one another's growth. Inside this layer, quartz forms granular grains, 0.2 mm. in size. In the cavities, small amounts of hydrated iron oxide dust form bands which are roughly parallel to the cavity sides.

The rock appears to be a silicified slumped and brecciated limestone. This name is given partly on information derived from Mr. Wells, who states that the rock concerned occurs in a limestone sequence.

F/52-2. Slide number 4687.

The hand specimen is seen to be composed mainly of fibro-tabular aggregates of pink barytes; somewhat irregular veins of calcite are present.

The thin section shows sheaf-like aggregates of fibro-tabular crystals of barytes. Calcite occurs in irregular cavities and openings between individual barytes crystals, and between aggregates. The larger masses of calcite enclose tabular crystals of barytes. A very small amount of hydrated iron oxide dust is present, and in one place, a part cube of opaque ore was seen to be present; it possibly pseudomorphs pyrites. The specimen is a calcite-barytes vein rock.

206PNG/8 8th September, 1959.

16. A BRIEF NOTE ON SELECTED SPECIMENS OF LAVA, FROM MANAM ISLAND, T.P.N.G.

By W.B. DALLWITZ

Following is a very brief note on selected specimens of lava from Manam Island, T.P.N.G. The specimens were submitted by Mr. G.A. Taylor. All mineralogical determinations are tentative only, and must be closely checked.

The following specimens were examined:

A. Old Lavas

MO/3, between Waris and Aberia

MO/10, old flow of young appearance, ((?)northern wall of) N.E. valley.

B. Flow samples from N.E. Valley

MK/1, new flow front descending 10/1/58

MK/3, " " " " 16/1/58

C.S.E. Valley flows

MW/5, new flow ((?)pre) 6/3/58, north branch of main flow.

MW/6, " " " " " " " " " (surface cobs)

D. Large samples from Nuees.

MP/1, nuee debris, 18/10/57, small blocks

MP/3c " " " , boulders, massive porphyritic.

MP/12 " " 13/10/57, cob lava

MP/15 " " 25/1/58, boulder, nodular, Budna.

E. Ejectaments.

ME/1 Liquid bomb collected Jan. 1959 from S.E. Valley.

Tabulated data on these specimens follow. Mineralogical data were determined by W.B. Dallwitz, except specimens MK/1, MK/3, MP/15, & ME/1, which were examined by K.R. Walker. Both augite and hypersthene are pale yellowish buff, and it is therefore, difficult to distinguish between them. Hypersthene was found to be a minor constituent of some of the rocks, but it may not necessarily be absent from those wherein it is not recorded in this report. Plagioclase is bytownite (An 70-90) throughout; the intensity of zoning is variable in the different rocks and even in the same rock, and both normal and oscillatory zoning were noted. Inclusions of glass, which, when elongated, have their long axes parallel to the edges of crystals, are common in the plagioclase. Olivine grains are fairly commonly closely associated with or even completely surrounded by grains of augite, but the augite has not been formed from olivine by reaction. Pyroxene

grains are commonly grouped into clots; many of the grains are euhedral. Olivine appeared to be both positive and negative optically, and its forsterite content is probably between 70 & 85 per cent.

COMMENTS

All these rocks may conveniently be called bytownite basalts. According to "Petrography" (Williams, Turner & Gilbert), rocks with a silica percentage of less than 52 may be called basalt; the average silica content of the Manam rocks is 52.2. Furthermore, these authors state that rocks with a colour index of more than 40 should be called basalt rather than andesite; it is difficult to say what the true colour index of these rocks is, because the groundmass is too fine.

However, the fact that the plagioclase is bytownite seems to turn the scale in favour of basalt. A noteworthy feature is that all rocks examined are perfectly fresh. There is no sign of any (OH)- or water-bearing mineral.

The percentages of Fe_2O_3 and FeO given in the chemical analyses are, on the face of it, disconcerting. It seems impossible to fit them in with the mineralogy. All analyses of fresh basalt that are given in textbooks have FeO considerably in excess of Fe_2O_3. The chemical analyses may be found on file 206PNG/8

TABLE VI

MANAM VOLCANO, 1957-58 ERUPTION

Notes on handspecimens & estimated percentage composition of lavas.

Spec. No.	Hand Specimen	Groundmass	Porphyritic crystals: Plagioclase	Augite	Olivine	Hypersthene	Iron Ore	Remarks
MO/3	Grey, vesicular, pore spaces 30%, porphyritic green pyroxene, olivine, and milky plagioclase.	50; very fine-grained plagioclase, augite, iron ore; (basaltic texture).	35; An_{83} (3 determinations) (one crystal gave Core An_{83}, shell An_{73})	10	5 2V ca 90°	Trace	Trace	Rare inclusions of hypersthene in augite. Some augite zoned, as seen between crossed nicols.
MO/10	As for MO/3; pore spaces 20%	70; As above.	25; An_{82}, An_{85}, An_{88}.	4	1	Nil	Trace	
MK/1	Greyish black, pore spaces 10%. Plagioclase, green pyroxene, olivine.	65; As above.	17; An_{71}, An_{76}, An_{80}.	15	3	Nil	-	
MK/3	Similar to MK/1	60; As above.	14; An_{71}, An_{71}, An_{72}, (An_{65}?) An_{78}.	23	3	Trace	Nil	Rare inclusions of hypersthene in augite.
MW/5	Similar to MK/3; Dark grey; pore spaces 20%.	60; As above.	14; An_{77}, An_{77}.	23	3	Nil	Nil	Some augite zoned; faintly noticeable in ordinary light, much more so between crossed polarizers.
MW/6	Highly vesicular; silver-blue iridescence on greyish black rock	(?)55; Brown glass with microlites of plagioclase and pyroxene.	(?)22; An_{85}, An_{87}, An_{89}.	(?)18	5	Trace	Nil	

TABLE VI (Cont.)

Spec. No.	Hand Specimen	Groundmass	Plagioclase	Porphyritic crystals				Remarks
				Augite	Olivine	Hypers-thene	Iron Ore	
MP/1	Grey, vesicular; pore spaces 15%; Porphyritic green pyroxene and white plagioclase.	65; Basaltic texture; coarser-grained than in all above specimens. Plagioclase-augite, iron ore, and a little glass.	18; An_{83}, An_{86}; Core; An_{90} Shell An_{70}	13	2	(?) 2	Trace	Hypersthene pleochroic from X = very pale greenish buff to Z = very pale reddish buff.
MP/3C	Grey: pore spaces 20%; coarsest grained and lightest coloured of all; abundant green pyroxene.	40; Stumpy grains of plagioclase and augite, iron ore, trace of glass.	25; An_{75}, An_{80},	30	Trace enclosed in an augite aggregate.	4	1	Hypersthene more plentiful than in any other rock; augite moulded on some crystals. This rock may be a differentiate in which divine is represented by hypers-thene
MP/12	Dark grey; highly vesicular.	50; Very dark glass containing plagioclase and augite.	30; An_{72}, An_{74}, An_{75}.	17	2	1	Nil	
MP/15	Similar to MP/1, but less porous.	60; Basaltic; fine-grained, as in specimens MO/3 to MW/6. Traces of olivine.	20; An_{73}; An_{75}	17	3	Nil	Nil	
ME/1	Dark grey; very vesicular; bread-crust structure.	60; Basaltic, fine-grained, as in MP/15.	20; An_{71}; An_{71}, An_{80}(?)	17	3	Nil	Trace	-

a7Q/1 14th September, 1959.

17. EXAMINATION OF GOLD ORE FROM CRACOW, QUEENSLAND.

By W.M.B. ROBERTS.

Two specimens, labelled I and 2 were submitted for mineragraphic examination by the Queensland Government Geologist. Both specimens contained sulphide minerals visible in the hand specimen, chalcopyrite predominating in specimen No. 1 and chalcopyrite and sphalerite, roughly equal, forming the bulk of specimen No. 2.

In polished section specimen No. 1 was seen to consist of large irregular areas of chalcopyrite ranging up to 1.0 cm. across, forming roughly 95% of the total sulphide mineral content of the specimen.

Enclosed within these areas of chalcopyrite are euhedral crystals of pyrite, the largest of which is 0.15 mm. across; only rarely are crystals of this mineral isolated in the quartz gangue.

Sphalerite is of very minor importance; it was observed only once in the polished sections examined from this specimen, as a small irregular area in chalcopyrite.

The polished section of specimen No. 2 showed a marked increase in the sphalerite content of the ore, chalcopyrite and sphalerite being the principal sulphide constituents of the specimen. There has been extensive solid solution between these two minerals, as shown by the exsolution textures now developed between them. Chalcopyrite has exsolved from sphalerite and has formed along preferred crystallographic planes in the sphalerite to give a chevron-like texture, shown in Fig. i.

Pyrite forms large irregular areas and masses of euhedral crystals ranging up to 1.5 mm. across. These have all been fairly strongly fractured and are recemented and replaced by the later generation sulphides of copper, lead and zinc. Galena is a minor constituent of the ore, forming irregular areas mainly associated with, and apparently replacing, sphalerite. The largest area of galena measures 0.25 mm. across.

No free gold was observed in either of the specimens, although the X-ray spectrograph showed traces of gold in both. It appears that the gold is present as a solid solution in one or more of the sulphide minerals.

Cassiterite is present in the ore, forming small "strings" of crystals approximately 0.05 mm. across, and irregular masses formed between the quartz grains.

The principal gangue mineral is quartz, which is associated with some sericite, chlorite and less commonly with apatite.

Pyrite is obviously the earliest deposited sulphide, crystals of which have been fractured and replaced to some extent by chalcopyrite and sphalerite, which have been deposited contemporaneously. It is possible that some chalcopyrite has been deposited later than the sphalerite/ chalcopyrite solid solution; this later chalcopyrite is now

represented in specimen No. 2 as the larger irregular masses of this mineral containing residual areas of unreplaced sphalerite. Galena appears to be replacing sphalerite and therefore may be later than it.

The presence of cassiterite in the ore indicates a high temperature of formation - probably above 500°C; in support of this, there is the evidence of solid solution between sphalerite and chalcopyrite, which is reported not to take place beneath 350°C.

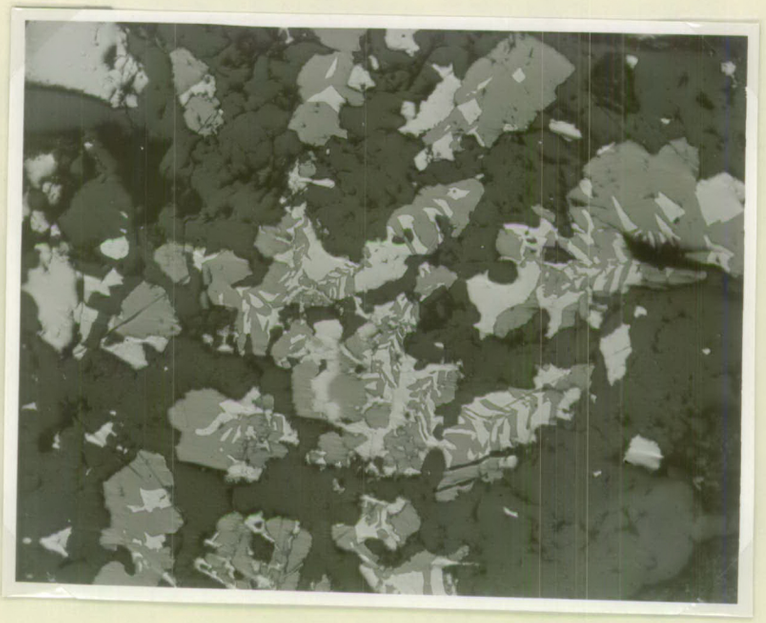

Fig. i

Chevron-like texture developed between chalcopyrite (white), and sphalerite (grey), as the result of exsolution of chalcopyrite from sphalerite. Specimen No. 2. X50.

120ACT/1 15th September, 1959.

18. THE PETROGRAPHY OF AN ALTERED ACID VITRIC TUFF, FROM BARE TRIG, WODEN DISTRICT, A.C.T.

By W.B. DALLWITZ.

Following is a brief description of a rock collected by Mr. D.E. Gardner at Bare Trig, Woden District, A.C.T.

The rock is hard, pale pink to pale yellow, and apparently very fine grained, except for some small, angular light-coloured particles visible on the cut surface with the aid of a lens. Veinlets of quartz and of iron oxide and quartz occur along joints, which are well developed in five directions. Small pores, lined with iron oxide, are quite plentiful.

In thin section (slide 4768) the rock is found to consist mainly of what appears to be devitrified glass; the finely crystalline aggregate has a relief below that of balsam. Distributed evenly through the altered glassy matrix are small angular grains of quartz, anorthoclase, and (?)sanidine, clots and dusty particles of leucoxene and hydrated iron oxide, sphene, and zircon. Some of the quartz grains are curved and pointed in the manner characteristic of tuffs. The iron-stained pores noted in hand-specimen probably result from partial or complete removal of feldspar grains.

A puzzling feature of the rock is that quite a number of quartz fragments are completely bordered by anorthoclase or, rarely, (?)sanidine. No convincing explanation of this feature can be put forward. The obvious one is that the anorthoclase crystallized round the quartz prior to extrusion, but this does not seem really probable; another is that some mineral originally enclosed by the feldspar has been replaced by quartz.

The rock is an altered acid vitric tuff.

 25th September, 1959.

19. THE PETROGRAPHY OF A SPECIMEN OF BANDED IRON ORE, FROM MOURILYAN HARBOUR, INNISFAIL, NORTH QUEENSLAND.

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Following is a description of a specimen of banded iron ore from mourilyan Harbour, Innisfail, North Queensland, submitted by Mr. D.A. White.

The handspecimen is fine-grained, and made up of alternating layers of light grey, buff, yellowish buff, and brownish black material. The light-coloured layers are stained by iron oxide in varying degree. The thickness of the different layers ranges from about 2 cm. to 2 mm. or even less. The yellowish buff layer was found to be very rich in apatite. The iron-rich material is slightly magnetic.

In thin section (slide 4764) the following successive layers are represented, moving stratigraphically downwards:

(1) Very fine quartzite, of uneven grainsize (average about 0.06 mm.), containing accessory grains and "octahedra" of hematite after magnetite, chlorite, and very rare apatite. A few minute grains resembling zircon save for apparently low double refraction were also noted.

(2) Very fine-grained iron oxide with usually small but varying amounts of quartz and chlorite. Those layers which are richer in quartz are bedded, and show an unconformable contact with the siliceous layer below, due to infilling of small washouts or irregularities.

(3) Similar to layer (1), but iron oxide grains more abundant; films and clots of hydrated iron oxide between the quartz grains. No apatite noted.

(4) Similar to layer (2). One thin band is rich in apatite. Hydrated iron oxide is common in places.

(5) Fine-grained apatite, accessory iron oxide, chlorite, hydrated iron oxide, and quartz.

(6) Narrow, irregular, discontinuous bands of iron oxide mingled with apatite, hydrated iron oxide and chlorite.

(7) Fine-grained apatite, subordinate quartz, hydrated iron oxide, and rather rare iron oxide, grading by increase of hydrated iron oxide into

(8) a layer consisting of iron oxide, subordinate apatite, stained by hydrated iron oxide, and quartz. Probable current bedding is visible in part of this layer.

(9) Sheared, fine-grained quartzite with accessory apatite, iron oxide, hydrated iron oxide, rare chlorite, and a very rare mineral of high R.I. and low D.R. apparently similar to that noted in layer (1). The quartz grains are 3 to 4 times as long as they are broad.

A polished section shows that the iron oxide in rock is martite, which has been derived from magnetite by

replacement along the (III) cleavage planes. Octahedra of magnetite are quite common in the siliceous layers. The magnetite must have been formed by metamorphism of the original banded siliceous ironstone.

There are two other points of interest in this rock. One is the unusual abundance of apatite in three or four of the layers (5, 6, 7, and 8). The other is the evidence of strong shearing in one of the quartzite layers (9). In layer (1) individual quartz grains are of irregular shape and more or less equidimensional. They interlock closely, and a number of grains show slight to moderate undulose extinction. In layer (3) the number of quartz grains per unit area showing wavy extinction is very much greater, and the irregularities in extinction are decidely more pronounced. The quartz grains in parts of this layer are elongated in a direction nearly at right angles to the banding. Elongation of the quartz grains is almost uniformly developed throughout layer (9), again at right angles to the banding; strain shadows are prominent in the quartz, and most of the grains show parallelism in optical orientation as well as in dimensional orientation. Veinlets of quartz traverse the rock layer (9) to layer (5), making an angle of about 60° with the bedding. These veinlets are most plentiful in layer (7); small elongated pockets of quartz, lying more or less at right angles to the veinlets or else parallel to the bedding, are common in this layer. The quartz grains in the veinlets and pockets are elongated parallel to the trend of the veinlets. No explanation of the increase in intensity of diredtional structure shown by the quartz in layers (1), (3), (7) and (9) can be offered, and the feature is, therefore, merely recorded without significant comment. If the elongation of the quartz grains had been consistently developed throughout the rock it would have been possible to suggest without hesitation that its direction is probably parallel to the axial plane of a fold, but the uneveness of its development is puzzling. This uneveness is not reflected in the appearance of the hand-specimen.

The rock is an <u>apatite-bearing, banded siliceous ironstone</u>.