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COMMONWEALTH OF AUSTRALIA.

**DEPARTMENT OF NATIONAL DEVELOPMENT.**

# BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

**RECORDS.**

1961/131

# MISCELLANEOUS PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS CARRIED OUT IN THE GEOLOGICAL LABORATORY DURING THE QUARTER JULY-SEPTEMBER 1957

Compiled by

Robert Bryan

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## INTRODUCTION

This Record is a collection of reports by the Petrological Section of the Geological Laboratory, during the period July to September 1957. The reports have been placed in chronological order, and the date of completion and relevant file number appear above the title of each report.

The officers responsible for these reports are W.B. Dallwitz and R.D. Stevens.

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Report No.1

120NT/2/5
July 1957.

# PETROGRAPHY AND PARTIAL ANALYSIS OF A SAMPLE FROM THE KAPALGA IRON DEPOSIT, WEST ALLIGATOR RIVER AREA NORTHERN TERRITORY.

by

W.B. Dallwitz.

The following is a brief description, together with a partial chemical analysis, of an iron-rich rock from a locality between the South Alligator and West Alligator Rivers in the Northern Territory. The specimen was originally submitted to the laboratory for examination by P.R. Dunn.

The handspecimen is a fine-grained, broadly banded, dark grey to black rock. The banding is, presumably, due to different concentrations of iron oxide.

In thin section the rock is found to consist principally of hematite granules of rather uniform grainsize (0.05 to 0.08 mm). The grains of hematite are quite separate, and have the appearance of being of detrital origin, even though their margins are not altogether smooth. This lack of smoothness could be accounted for by the partial alteration of the grains to hydrated iron oxide. Alternatively, it is possible that the hematite has metasomatically replaced some pre-existing mineral, such as siderite, which may have been built up into distinct pellets or oolites during precipitation.

The matrix in which the grains of hematite are set consists substantially of fine-grained quartz, some of which encloses minute grains of hydrated iron oxide. An unidentified, highly-refracting, grey mineral, occurring as extremely fine grains associated with the quartz may be siderite, but it could not be satisfactorily identified even under high power. However, slight effervescence appeared to take place when the powdered rock was treated with hot, concentrated HCl, and this seems to confirm the presence of carbonate. A single veinlet of quartz traverses the slide examined.

No magnetite was noted when the powdered rock was tested with a strong hand-magnet.

A partial analysis of part of the specimen was carried out by J.R. Beevers with the following results:-

| | | |
|---|---|---|
| $Fe_2O_3$ | 81.66% | (57.16% Fe) |
| $MnO_2$ | 0.38% | |
| S | 0.27% | |
| $P_2O_5$ | 0.03% | |
| $SiO_2$ | 9.56% | |
| Loss at 120°C | 0.15% | |
| Loss at 900°C | 0.94% | (includes loss at 120°C) |

The sulphur is probably accounted for by very minute grains of (?) pyrite observed to be enclosed in some hematite grains when the polished rock was examined in reflected light.

The rock is a <u>banded siliceous hematitic iron-stone</u>.

Report No.2. 120NT/2/5
July 1957.

A SECOND CHEMICAL ANALYSIS OF THE SAMPLE FROM THE KAPALGA IRON DEPOSIT, WEST ALLIGATOR RIVER AREA, N.T.; NOTES ON THE DISCREPANCIES BETWEEN THE TWO ANALYSES.

By

W.B. DALLWITZ.

The following are the results of the analysis, carried out by J.R. Beevers, of sample B3629 which was collected from an area between the West and South Alligator Rivers, N.T.:-

| | | |
|---|---|---|
| | $Fe_2O_3$ | 51.81% |
| | $TiO_2$ | 22.60% |
| | $Al_2O_3$ | 7.25% |
| | $MnO_2$ | 0.38% |
| | $SiO_2$ | 19.17% |
| | $P_2O_5$ | 0.03% |
| | S | 0.27% |
| | $H_2O-$ | 0.15% |
| | $H_2O+$ | 0.79% |
| Less:- | | 102.45% |
| | O for S | 0.13 |
| Total | | 102.32% |

If the titania is present as ilmenite, the results may be recast as follows::

| | | |
|---|---|---|
| | $Fe_2O_3$ | 29.21% |
| | FeO | 20.34% |
| | $TiO_2$ | 22.60% |
| | $Al_2O_3$ | 7.25% |
| | $MnO_2$ | 0.38% |
| | $SiO_2$ | 19.17% |
| | $P_2O_5$ | 0.03% |
| | S | 0.27% |
| | $H_2O-$ | 0.15% |
| | $H_2O+$ | 0.79% |
| | | 100.19% |
| Less O for S | | .13 |
| Total | | 100.06% |

An additional correction, which will slightly lower the $Fe_2O_3$ percentage and raise that of FeO, could be made on the assumption that S is present as pyrite; this correction would be so small that the effort of going through the necessary arithmetical procedure is not warranted.

It should be explained that the high total iron content originally given for this rock was due to the fact that the ignited ammonia precipitate was assumed to be $Fe_2O_3$, whereas it was actually $R_2O_3$ ($Fe_2O_3$ (including Fe present as FeO), and $Al_2O_3$) and $TiO_2$ and $P_2O_5$. This assumption stemmed from the fact that the chemist was not warned to expect $Al_2O_3$ or $TiO_2$. This lack of warning was, in turn, due to the fact that no titanium - or aluminium-bearing mineral was recognised in thin section or polished section. Had $TiO_2$ in the form of leucoxene been found in thin section (and a check has shown that no material which could be clearly recognized as leucoxene is present) the chemist would have been asked to determine $TiO_2$. In the absence of leucoxene in such a rock the possibility that ilmenite might be present did not occur to me. The distinction between ilmenite and hematite, in the absence of red internal reflections in the latter, is difficult or impossible in polished section. $Al_2O_3$ must be present as hydrated oxide intimately mixed with hydrated iron oxide.

The different result for $SiO_2$ (19.17% against 9.56%) is entirely due to human error. For all other determinations 1.0 gm samples had been taken; for silica, it was intended to take 2.0 gm, but 1.0 gm was taken in error, and the result 9.56% was calculated in the belief that 2.0 gm had been taken.

July, 1957

# COMMENTS ON THE EFFECTS OF THE DISCREPANCIES BETWEEN THE TWO ANALYSES FROM THE KAPALGA IRON DEPOSIT, WEST ALLIGATOR RIVER AREA, NORTHERN TERRITORY.

by

W.B. Dallwitz.

The following are some comments on the discrepancies between two chemical analyses in sample B3629, from the Kapalga Iron Deposit. This lies between the West Alligator and South Alligator Rivers, in the Northern Territory.

(1) When the specimen was first brought to the laboratory an analysis for Mn only was requested.

(2) Later an analysis for Fe was requested, and two reports with differing results for iron percentage were presented to Mr. B.P. Walpole.

(3) I was the first, among several geologists concerned, to realise that an analysis for $TiO_2$ should have been carried out on this specimen if it were of interest as a possible iron ore. As a matter of fact I became aware of the necessity for a determination of $TiO_2$ on the day after the first result was handed to Mr. Walpole, and asked the chemist to determine that constituent.

(4) One of W.M.B. Roberts' main difficulties was always to distinguish between hematite and ilmenite. When red internal reflections were absent he never relied on the polished section alone, but carried our a semi-quantitative spectrographic analysis to find whether Ti was a major constituent of the mineral under examination. If Ti had been suspected by me when the first "iron" analysis was carried out, the chemist would have been asked to carry out an analysis; I should not have felt confident of using the spectrograph, as A.D. Haldane, who was in the field at the time when the specimen was examined, had set up the instrument in a manner unfamiliar to me.

(5) The rock submitted for analysis was a single specimen from an outcrop, not even a sample of the outcrop. Even if the result (81.66%) of the first analysis for iron had been correct, it is doubtful whether the expensive programme of investigation now to be undertaken would have been justified. As a preliminary step it may have been preferable to properly sample the known outcrop and, if warranted, to send out a geologist and a few assistants to test the soil-covered area by pitting and/or auger-boring in order to find out more about the nature of the material underlying the soil. If even a few dozen samples of underlying rock had been systematically taken over the area of interest, much more would have been known about the probable extent and grade of any possible iron-rich material under the soil. On present knowledge, as imparted to me, it is not absolutely impossible that the red soil is actually a terra rossa overlying limestone, or the end-product from the weathering of a basic rock.

(6) The mistake in the analysis has hastened the investigation of the area of interest, and may, therefore, have served a good purpose. The geological set-up appeared to be so tantalizing that it is doubtful whether some of those concerned could have rested content until the area had been adequately investigated. I have a feeling that, even if the correct analytical result had been given at first, some more work would ultimately have been done in the area.

(7) Even if no $TiO_2$ or $Al_2O_3$ had been present in the rock, there would have been no outstanding justification for anything but cautious optimism, for the specimen may possibly have represented the one high-grade portion in the whole area of interest. By the same token, it is possible (on present knowledge) that specimen B3629 represents the one low-grade portion in the whole area of interest.

19th July, 1957

# NOTES ON THE IDENTIFICATION OF (?) RICHTERITE FROM A VEIN IN ULTRABASIC ROCKS ON SANTA YSABEL ISLAND, BRITISH SOLOMON ISLANDS.

by

W.B. Dallwitz.

The blue vein mineral collected from an ultrabasic plug intrusion on Santa Ysabel Island, has been examined and described as follows:-

In thin section the rock containing the blue mineral is found to consist largely of calcite (about 85%). Other minerals present, apart from the blue mineral, are pockets and streaks of fine-grained (?) tremolite, an unknown, colourless, uniaxial positive mineral of low double refraction and maximum refractive index about 1.66, and rare black iron ore and hydrated iron oxide. The blue mineral, as can be well seen in handspecimen also, occurs as narrow compressed streaks within the calcite; some of the calcite shows strain-shadows and gliding along twin-planes.

The blue mineral is pleochroic from pale greyish blue to very pale greyish yellow or almost colourless. It is biaxial negative with a medium to high optic axial angle. Its refractive indices were found to range between 1.602 and 1.633, but its composition is probably variable, as suggested by the fact that a few fragments of similar optical orientation were found not to be uniform in colour (i.e., the blue colour varied in intensity from one part of the grain to another) and refractive index; part of one such grain was well above 1.620 in refractive index, and part was well below this figure. In spite of the range of refractive indices given, the interference colours are usually low (greyish white); this is probably partly due to the fact that several fibres of slightly different orientation lie within the thickness of a thin section, with the result that interference colours tend to be partly reduced by mutual cancellation. Furthermore, the mineral does not extinguish evenly; this suggests that it is made up of twisted fibres; its extinction angle is, therefore, hard to measure, but appears to reach a maximum, in favourably oriented sections, of $6^{o}$ to $8^{o}$, but may be lower.

An X-Ray powder photograph shows that the mineral is an amphibole; X-Ray powder data for amphiboles are very meagre, but d-spacings for the blue mineral were found to correspond, to some extent, with those given all amphiboles listed in the A.S.T.M. index, namely: tremolite, actinolite, hornblende, riebeckite, and crocidolite; the best correspondence of all was with crocidolite, the fibrous variety of riebeckite. No X-Ray data for glaucophane and soda-tremolite ([illegible]) are available.

Following is a comparison of the first 16 d-spacings for the blue mineral and for crocidolite:

| Blue Mineral | | | Crocidolite | | |
|---|---|---|---|---|---|
| Cobalt Radiation | | | Copper Radiation | | |
| Line No. | Intensity | d A° | Line No. | Intensity | d A° |
| | | | 1 | 2 | 9.35 |
| 1 | 10b* | 8.48 | 2 | 9 | 8.45 |
| 2 | 3 | 4.81 | 3 | 3 | 4.86 |
| 3 | 4 | 4.49 | 4 | 7 | 4.48 |
| 4 | 0.5 | 4.13 | | | |
| 5 | 1 | 3.87 | | | |
| 6 | 0.5 | 3.62 | 5 | 1 | 3.60 |
| 7 | 2 | 3.39 | 6 | 4 | 3.38 |
| 8 | 2 | 3.25 | 7 | 2 | 3.24 |
| 9 | 7 | 3.10 | 8 | 5 | 3.08 |
| 10 | 2 | 2.93 | 9 | 1 | 2.95 |
| | | | 10 | 1 | 2.76 |
| 11 | 8b* | 2.69 | 11 | 10 | 2.68 |
| 12 | 3 | 2.59 | 12 | 3 | 2.56 |
| 13 | 8 | 2.52 | 13 | 5 | 2.52 |
| 14 | 2 | 2.31 | 14 | 2 | 2.30 |
| 15 | 2 | 2.24 | 15 | 2 | 2.24 |
| 16 | 4 | 2.16 | 16 | 2 | 2.15 |

*b - broad, somewhat diffuse.

The very weak4.13A° line in the data for the blue mineral may be due to a minute amount of goethite as impurity; the 3.87A° line may also be due to an impurity, as examination of the thin section shows that it would be very difficult to obtain a perfectly clean sample of the mineral. Any variation in intensities of lines in the two minerals is most probably due to the fact that cobalt radiation was used in one case and copper radiation in the other.

Although the X-Ray powder data for the Santa Ysabel mineral and crocidolite correspond very well, the optical data are not in agreement. Following is a tabulation of optical data, taken from mineralogical texts, for certain sodic amphiboles and for the blue mineral:

| | Sign & 2V | $N_x$ | $N_y$ | $N_z$ | $N_z-N_x$ | Extn Angle | Pleochroism |
|---|---|---|---|---|---|---|---|
| Blue Mineral | (-)Med to lge. | 1.602 | ? | 1.633 | (?) 0.031 | (?)6-8° or less | Pale greyish blue very pale greyish yellow to almost colourless. |
| Richterite(a) or Soda-tremolite | (-)Med. | 1.606 | 1.616 | 1.623 | 0.017 | 24° | Not given. |
| Richterite | (-)69° | 1.615 | 1.629 | 1.637 | 0.022 | 17° | Not given. |
| Richterite | (+)?° | 1.606 | 1.613 | 1.623 | 0.017 | (?)0° | Colourless to yellow-green. |
| Glaucophane | (-)41° | 1.615 | 1.632 (calc.) | 1.634 | 0.019 | 6-8° | Not given. |
| Glaucophane | - | | 1.665 | 1.668 | | 7° | Not given. |
| Glaucophane | (-)42° | 1.655 | 1.664 | 1.668 | 0.013 | X∧C= 27-35° | Pale blue, pale violet, pale yellow |
| Riebeckite | (+)68° | 1.688 | - | 1.691 | 0.003 | Y∧C= 1° | Light green, light yellow dark blue-black. |
| Riebeckite | (-)Lge. | ? | 1.693 | ? | V.weak | 0-4° | Not given. |
| Riebeckite | (-)?° | 1.695 | - | 1.703 | 0.008 | X∧C= 8° | Not given. |
| Riebeckite | (-)?° | 1.695 | 1.699 | - | 0.004 | X∧C= 3° | Not given. |
| Crocidolite | (+)Lge. | 1.697 | 1.703 | 1.700 | 0.006 | Y∧C= 0° | Pure Yellow, deep violet, deep bluish-violet. |
| Crocidolite | (-)Lge. | 1.64 | 1.65 | 1.66 | 0.02 | 3-15° | Not given. |

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(a) Containing 45% soda-tremolite ($Na_2CaMg_5(OH)_2Si_8O_{22}$), 29% tremolite ($Ca_2Mg_5(OH)_2Si_8O_{22}$), and 22% glaucophane ($Na_{2-3}CaMg_3Al_2(OH),O_2)\ Si_8O_{22}$).

Inspection of these data shows that the blue mineral from Santa Ysabel Island corresponds fairly well, in range of refractive indices, to two of the specimens of richterite listed, but that its extinction angle is much lower than those given for the first two examples in the table. Actually, the refractive indices given for one specimen of glaucophane fall almost within the range determined for the blue mineral, but glaucophane is generally more strongly pleochroic, as are riebeckite and crocidolite also.

No amphibole cleavage can be seen in the thin section containing the blue mineral, but this is probably because it tends to be fibrous and rather soft. The incipiently separable fibres developed are of the slip-fibre type, as they lie along the lengths of the veinlets.

X-Ray and optical data, taken in conjunction, indicate that the mineral is a sodic amphibole of indefinite composition, probably richterite .

Report No.5.



1020/1
2nd August, 1957.

# COMMENTS ON THE LETTER OF THE PRESS SECRETARY TO THE MINISTER OF SUPPLY CONCERNING REFRACTORY FURNACES AND HIGH TEMPERATURE ARTIFICIAL PRODUCTS

by

W.B. Dallwitz

The following are some critical comments on a recent letter from the Press Secretary to the Minister of Supply, concerning refractory furnaces and high temperature artificial products.

The stated temperature of 7,000°F is equal to about 3,870°C. Such a temperature cannot be attained in a normal type of furnace; 2,000°C is attainable in specially-lined types of laboratory furnaces, but even 1,500°C is a fairly high temperature for such furnaces. In fact, 1,000°C to 1,200°C is a common working temperature in the laboratory. To demonstrate the impossibility of attaining a temperature of 3,870°C even in furnaces lined with very refractory materials, some data on such materials are given here:

| Substance | Melting Point | Boiling Point. |
|---|---|---|
| Magnesium silicate (forsterite) | 1,890°C | - |
| Boron carbide | 2,350° C | .. .. .. 3,500°C |
| Zirconium silicate (zircon) | 2,550°C | |
| Magnesium Oxide | 2,500-2,800°C | - |
| Tungsten carbide | 2,777°C | 6,000°C |
| Carbon | (?) 3,700°C (volatilizes) | (?)4,200°C |

(The estimated temperature of the sun is, incidentally, about 5,700°C, less than 2,000°C above that said to have been attained in the treatment of sample B.)

Very little residue remains on treating the specimen of magnesite with hot concentrated HCl, and the solution is only slightly coloured by ferric chloride.

According to A.D. Haldane the preparation of a kind of cement by mixing an aqueous solution of magnesium chloride with magnesite is well known, but the nature of the products formed is quite uncertain. Due to hydrolysis of the magnesium chloride in aqueous solution some HCl is formed, and this reacts with the magnesite. The final compounds formed as a result of the primary reaction and subsequent interaction between the original components and various intermediate products are thought to be magnesium oxychloride and magnesium hydroxycarbonate, both of uncertain chemical composition and optical properties.

Macroscopic examination of specimens B and C, the artificial products forwarded for comment, shows that they contain numerous spherical pores, presumably due to $CO_2$ bubbles formed during the reactions. Many sandy grains were also noted. Small portions of B and C were roughly crushed and treated with hot concentrated hydrochloric acid strong effervescence due to evolution of $CO_2$ took place, and numerous sandy grains, forming about 25 per cent of the original sample taken, remained when effervescence was complete. The solutions of both specimens B and C were strongly coloured by $FeCl_3$; the solution of specimen C was the more strongly coloured.

The presence of sand grains is a somewhat disturbing feature as the Press Secretary's letter gives the fairly clear impression that the only substances used in the preparation of these specimens were magnesite, water and magnesium chloride. However, it is stated in the letter that the people concerned "had treated the magnesite", whatever that means. There is an indication, at the end of paragraph 9 of the Press Secretary's letter, that river sand may have been added, but there is no direct statement to this effect.

Examination of the thin section of specimen B shows that it consists of an isotropic matrix in which are embedded grains of quartz, quartzite, feldspar, epidote-bearing quartzite, actinolite, and rare carbonate. It appears that nearly all of the magnesite, which must have been very finely divided, was used up in the reaction. The matrix consists of two isotropic substances, one with R.I. above that of balsam, and the other (somewhat more plentiful) with R.I. below that of balsam. Both substances are more or less colourless, but that with higher R.I. is fairly commonly pale yellow. These materials are locally clouded by impurities, and are traversed by irregular cracks.

Specimen C, the material which was heated, is essentially similar to specimen B. Cloudiness of the matrix is more pronounced, and cracking is a little more distinct. Part of the exterior of the handspecimen appears to have been calcined.

One thing is certain: specimen C has not been subjected to a temperature even approaching 1,000°C. Magnesium carbonate loses all of its $CO_2$ when heated in air at 900°C. It can, therefore, be safely assumed that the carbonate (as (?) magnesium hydroxycarbonate) in specimen C would have been decomposed if a temperature of 900°C had ever been maintained for any appreciable time. It seems likely, in fact, that the specimen was heated very little above red heat, perhaps to about 700-800°C.

There is considerable uncertainty as to what is meant by the statement "the fire-clay broke down" at the end of paragraph 8 of the Press Secretary's letter. The likely behaviour of clay on heating depends partly on whether a solid specimen of kaolin, or a compressed lump of wet clay, or simply powdered clay were placed in the furnace; and partly on whether the clay were placed in an already heated furnace or in a cold furnace, and, if in a cold furnace, on the rate of heating. "Breaking down" may merely mean that it crumbled, which is just what would happen if a solid specimen or a compressed, wet lump were placed in a hot furnace- in fact, it might even explode, if heated rapidly enough. It seems probable that crumbling on heating is the type of breakdown meant by the writer.

Kaolin, after it loses water, begins to change to mullite (+ silica) at 900°C; at 1810°C mullite decomposes to corundum and silica.

Report No.6. 94PNG/1

26th August, 1957.

BRIEF NOTES ON ROCKS COLLECTED BY D.E. GARDNER FROM THE RANGARERE AREA, NEW BRITAIN.

by

W.B. Dallwitz.

The following are brief descriptions of rocks collected by D.E. Gardner, from the Rangarere area, New Britain.

Specimen 634, east bankof Bulmaka River, 1000 ft. south of road to Nimke village.

A medium-grained, holocrystalline igneous rock consisting macroscopically of feldspar and subordinate hornblends and biotite.

In thin section the rock is seen to consist of subhedral plagioclase (65%), hornblende (20%), biotite and associated chlorite (5%), accessory quartz, orthoclase, magnetite, and rare hematite, sphene, and apatite.

The plagioclase is commonly rather strongly zoned, and its composition is very difficult to determine. Cores of some of the crystals gave An67, An58, and An48. Probably its average composition is that of a basic andesine. Orthoclase and quartz are interstitial between the plagioclase grains.

The rock is a hornblende quartz diorite.

Specimen 635, bed of Bulmaka River, 800 feet south of road to Nimke village.

A hard, dense, fine-grained, greenish grey rock containing two bands which are conspicuous because of the presence of abundant white grains measuring about 0.5 mm. across. These bands are 0.75 to 1 cm. thick.

In thin section the bulk of the specimen is seen to consist of fine-grained plagioclase and chlorite, with rather rare pyrrhotite. Some of the plagioclase grains are lath-shaped, but most are angular; the average size of the larger angular grains is about 0.03 mm. The rock is most probably a basaltic ashstone.

One of the bands containing abundant white grains appears in the section. This band consists of fragments of partly epidotized labradorite (the white grains) and of chloritized basalt embedded in a matrix of finely divided, altered, basaltic material. Pyrrhotite is much more abundant in this band than in the ashstone.

The plagioclase-rich band is most probably a chloritized basaltic tuff.

Specimen 635A, bed of Bulmaka River, 800 feet south of road to Nimke village.

A medium-grey, fine-grained, compact rock having the appearance of basalt. It contains scattered pockets of chlorite ranging up to 3 mm. across.

In thin section the rock is found to be an altered basalt. It consists mainly of acid plagioclase (probably oligoclase), chlorite, and augite. The plagioclase is crowded with minute grains of chlorite, and its composition is, therefore, difficult to determine. Most of the chlorite in the rock occurs interstitially between the plagioclase laths, and may be an alteration-product of glass.

Black iron-ore is the most abundant accessory. Quartz is a very minor constituent. The chloritic pockets noted in hand specimen may consist of chlorite alone, but they generally contain quartz as well; some also contain prehnite and calcite, with or without epidote. Scattered small pockets consisting of prehnite alone and epidote alone are sparsely distributed through the slide. A veinlet of prehnite and quartz was noted.

This rock appears to be a fairly old basalt, which has undergone extensive chloritization; prehnite and epidote, although present in small quantity only, are indicative of changes which might be expected in the greenschist facies of regional matamorphism.

The rock may be briefly referred to as a chloritized basalt.

Specimen 636, rill immediately north of mouth of Bulmaka River.

The handspecimen has the appearance of a basaltic agglomerate or breccia. Black, fine-grained rock fragments measuring up to 3 cm. across are embedded in a dark greenish grey matrix containing numerous irregular pockets of white mineral or minerals; these pockets measure up to several millimetres in length.

Under the microscope the black fragments consist of apparently finely amygdaloidal pyroxene basalt; the (?) amygdales are mostly filled with chlorite, but some contain minute spherules of (?) chalcedony, and/or prehnite, and/or epidote as well.

The matrix in which these fragments are embedded is basaltic also, but is more strongly altered. It consists of chlorite, plagioclase, minute spherules of probable chalcedony, augite, accessory leuxocene, and rare epidote. The white pockets noted in handspecimen are made up of one or more of the following minerals; quartz, prehnite, calcite, chlorite, and (?) analcite.

The rock is an altered and chloritized basaltic agglomerate.

Specimen 637, high divide, south of Rangarere. Chipped from legendary "meteorite" on which German missionaries chiselled name before World War I.

Macroscopically this is a dense, fine-grained medium-grey rock having the appearance of an altered basalt.

Under the microscope the rock is found to consist of plagioclase, fine-grained actinolite, subordinate chlorite and black iron ore, accessory leucoxene, scattered prehnite-bearing pockets, and rare epidote and calcite. Porphyritic crystals of plagioclase (labradorite) are common. The actinolite has replaced pyroxene, none of which remains.

The rock is a chloritized and uralitized plagioclase basalt.

Specimen 640, Doilene area, Bo ehole No. 1, 80'-83'.

Macroscopically this is dark grey basaltic rock containing numerous phenocrysts of plagioclase measuring up to about 3 mm. in length.

The thin section shows that the rock is an altered basalt. The porphyritic crystals of plagioclase are acid labradorite (An 50-55). The few large porphyritic crystals of pyroxene which were present have been pseudomorphed by actinolite; this mineral has also replaced pyroxene in the groundmass. Black iron ore in minute grains is abundant in the groundmass, and leucoxene is a rare constituent. A few grains of ilmenite bordered by leucoxene are scattered through the rock.

Several amygdales filled entirely, or almost entirely, by actinolite are present; one contains brown hornblende and plagioclase in addition to actinolite, and one or two contain a little plagioclase and micaceous hematite as minor constituents. A few veinlets of actinolite traverse the slide.

The rock is a uralitized plagioclase basalt.

Specimen 641, Cairngorm area, Borehole R10, 86'4" - 93'4".

A dense, hard, fine-grained, irregularly mottled rock consisting of pale pinkish buff, very pale greenish buff, and pale grey parts.

Apart from a little limonite staining all the minerals in this rock are colourless or almost colourless when observed in polarized light. Their average grainsize is about 0.1 mm.

Probable vesuvianite is the most plentiful mineral. Grains of this mineral generally show anomalous brown interference colours. Some grains, however, have a zone with normal double refraction (first order white to grey) surrounding an anomalous zone; a few grains have normal double refraction throughout.

Scopolite is the next mineral in order of abundance. It occurs as rather well-cleaved prismatic grains with straight extinction.

Both vesuvianite and scapolite are fairly evenly distributed, but the third mineral of importance, lime-garnet, is very irregularly dispersed.

A veinlet consisting of quartz and basic plagioclase traverses the slide. A little colourless (?)chlorite is also present.

The rock is a garnet-scapolite-vesuvianite hornfels or skarn.

General.

The basaltic rocks described above do not appear to be of Late Tertiary or Recent age. It seems likely, judging by their state of alteration, that they have suffered slight regional metamorphism during an orogeny, and may, therefore, be of Early or Middle Tertiary age.

Report No.7.

226.
28th August, 1957.

# DESCRIPTIONS OF 16 SAMPLES OF GRANITIC ROCKS FROM THE KATHERINE - DARWIN AREA, N. T.

by

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The following are descriptions of various granite samples from the Northern Territory, from which extracted micas have been sent to M.I.T. for age determinations.

The specimens described below are as follows:-

| No. | Name | Rock Type. |
|---|---|---|
| B.3272 | Allia Creek Granite | Granodiorite |
| B.3273 | Hermit Hill Granite | Muscovite-biotite granite |
| B.3274 | Mt. Litchfield Granite | Garnetiferous adamellite |
| B.3275 | Brock's Creek Granite | Granite |
| B.3277 | Waterhouse Granite | Gneissic granite |
| B.3281 | Rum Jungle Granite No.1 | Gneissic granite |
| B.3280 | Rum Jungle Granite No.2 | Granite |
| B.3282 | Rum Jungle Granite No.3 | Crushed albite granite |
| B.3276 | Price's Springs Granite | Sodi-potassic biotite granite |
| B.3278 | Fenton Granite | Granite |
| B.3279 | Burton Creek Granite | Gneissic granite |
| B.3283 | Cullen Granite | Sodi-potassic biotite granite |
| B.3284 | Cullen Granite (Edith R.) | Gneissic biotite granite |
| B.3288 | Middle Creek Granite | Kaolinised microgranite |
| B.3286 | Mt. Bundey Granite | Hornblende-biotite granite |
| B.3285 | Mt. Goyder Syenite | Quartz syenite |

Specimen B.3272

## Allia Creek Granite

A moderately coarse-grained granodiorite having an average grainsize of about 2.2 mm, but in which individual grains range from 0.2 mm to 5.0 mm across. In hand-specimen the rock is medium-grey and of apparently even grainsize, and possesses a slight lineation. There is no megascopic indication of the presence of xenolithic material.

In thin-section the rock is seen to be a subhedral-granular aggregate of feldspar, quartz, biotite, chlorite, muscovite and accessory iron oxide, apatite, epidote and zircon. Quartz and feldspar are present in approximately equal amounts and together make up about 70 percent of the rock. The quartz forms completely anhedral grains and aggregates with markedly undulose extinction. Inclusions of feldspar, biotite and iron-oxide are fairly common. The feldspar is entirely plagioclase of labradortitic composition, ranging from $An_{50}$ to $An_{55}$. It has been subjected to apparently random and irregular alteration, which in many places has resulted in more or less intense sericitisation with associated development of very finely-divided, white, powdry material (probably clay), and rare coarser-grained muscovite. Ra Rare epidote may be found in such places. Plagioclase crystals are generally subhedral to almost euhedral, and inclusions of biotite and the accessory minerals are not uncommon.

The biotite (approx. 23 percent) is a deep red-brown variety, strongly pleochroic from deep red-brown to straw-brown, and is therefore presumably an iron-rich type with $(-)2V=0^{o}$. Generally the biotite is quite fresh, but commonly possesses marginal zones or mantles very rich in flaky or granular iron oxide. In some instances iron oxide also forms elongated inclusions and penetrations lying along cleavage planes. Inclusions of euhedral apatite are quite common, and numerous, small zircon crystals included in the mica are surrounded by strongly developed pleochroic haloes. Sheets and flakes of colourless mica and films of an unidentified, colourless, granular mineral of low birefringence are also included along cleavage planes in many of the biotites. In some few places the biotite is partly replaced by a pale green chlorite and/or very fine, clay-like material. This chlorite is probably penninite.

Muscovite (approx. 5 percent) occurs as quite colourless sheets and flakes which, from purely textural indications, would seem to have crystallised before the biotite, for the coloured mica is quite commonly moulded on and around it, and occasional completely included muscovite sheets are in totally different physical (and optical) orientation. In other cases the orientation of included muscovite is quite clearly governed by the biotite cleavage planes. The muscovite contains similar inclusions but has not marginal rims of granular iron oxide.

Fibrous, commonly radiating or sheaf-like masses of pale green chlorite occur in intergranular positions and make up about 1 percent of the rock. The chlorite has the typical anomalous interference colours of penninite. One grain of garnet was found in such a chloritic aggregate.

There is no clear evidence of recrystallisation and no indication of shearing, but the marginal alteration of the biotite to granular and flaky iron oxide suggest the operation of elevated temperatures (Winchell, 1951, p.376).

Specimen B.3273

## Hermit Hill Granite

The rock is a coarse-grained, light grey muscovite-biotite-granite of completely massive structure, having no foliation, lineation or other internal directional features. Joint planes are calcite-coated, such coatings in places reaching 1 mm in thickness. No xenolithic material is evident in handspecimen or thin-section.

In thin-section the texture is seen to be typically granitoid with an average grain-diameter of approximately 4 mm though individual grains may range from 0.5 mm to 8mm. The larger grains are usually feldspar crystals which in some instances are subhedral in form but generally containing numerous inclusions. It is apparent that the rock has suffered a moderate degree of alteration.

Constituent minerals (in approximate amount) are: quartz (30%), feldspar (65%), mica (5%) and accessory zircon, fluorite and apatite. Approximately three quarters of the feldspar is microcline perthite and microperthite. The remaining feldspar is andesine ($An_{30}$). All feldspars are slightly altered, but the plagioclase rather more so than the potassic types. Alteration is mainly by way of very fine sericitisation, with flaky sericite in some cases developing into distinct sheets of muscovite. On the other hand, small sheets of primary biotite and muscovite are commonly included in the feldspar. Similarly, small grains of plagioclase are included in the potassic feldspars.

The muscovite is not as clear and colourless as this mica usually is. Its pale-brownish, cloudy appearance seems to be due to tiny film-like inclusions along cleavage planes and generally oriented in the direction of the cleavage planes. Such included material is very fine, and consequently unidentified, but has a brownish colour and refractive indices higher than those of the mica. Its birefringence is very low compared to the muscovite.

Biotite is a brown variety, strongly pleochroic from pale yellow-brown to grey-brown. In most cases the biotite does not appear to be fresh, but this apparent alteration is largely due to abundant film-inclusions along the cleavage. Much of this included material is dark, but indeterminate. A second, and highly contributary factor to this aparent alteration is the presence of quite abundant crystal-inclusions surrounded by strong pleochroic haloes. In many instances these crystal-inclusions are euhedral zircons, but in other cases are too small to identify. It is also apparent that at least some of the closely-spaced film inclusions have given rise to anomalous pleochroic phenomena where their concentration is particularly high.

There is no evidence of recrystallisation or shearing in the texture of the rock, and neither is there any detectable mineral orientation.

Specimen B.3274

## Mt. Litchfield Granite

The rock is medium to coarse-grained garnetiferous adamellite of pale grey colour and with a moderate degree of foliation in hand-specimen. This foliation is due to an irregular platy segregation of micas in some parts of the rock. Mica (both muscovite and biotite) is a conspicuous feature of the rock in hand-specimen.

In thin-section the texture is seen to be granitoid, and the essential constituents are quartz (30%), potash feldspar (30%), plagioclase (25%), muscovite (10%), biotite (5%), with accessory garnet, apatite and zircon. (The percentages quoted above are only approximate.) Average grain size is about 2.8 mm. but ranges from 0.1 to 4.5 mm.

In many cases the potash feldspar is irregularly perthitic, but by no means invariably so. Poikilitically included plagioclase grains are very common, a texture which strongly suggests that the plagioclase has been partly replaced by potash feldspar. Generally, the orthoclase and microperthite have been lightly kaolinised and finely sericitised. In some cases the sericite is more coarsely crystalline and forms distinct flakes of muscovite in the feldspar, so that there is considerable difficulty in distinguising between muscovite formed by alteration and that included in the feldspar during crystallisation.

The plagioclase is generally more heavily altered after the same fashion. It is an acid andesine ($An_{32}$) with distinct albite-type twinning, and appears to have been in large part replaced by potash feldspar. Fine myrmekitic intergrowths are common around the margins of such plagioclase.

Sheets of muscovite are a conspicuous feature of the rock, and this mica is quite fresh. The biotite is a very dark brown, in some cases almost opaque variety. It has a "dirty" appearance owing to the presence of abundant included iron oxides. This material is particularly abundant along cleavage traces and may be due to alteration of the mica.

Small anhedral to subhedral crystals of clear, colourless garnet are found throughout the section. It is generally included in feldspar crystals.

Specimen B.3275

## Brock's Creek Granite

A massive, even-grained, grey granite without any apparent directional textures in hand-specimen. In thin-section it is seen that the rock has a typically granitoid texture and consists essentially of potash feldspar (40%), quartz (35%), plagioclase (15%), biotite (8%), muscovite (2%) and accessory zircon, apatite, and fluorite. The percentages indicated above are only approximate. The average grain-size of the rock is about 1.6 mm, and individual grains range from 1 mm to 3.3 mm across.

The potash feldspar is mainly microperthite, microcline and microcline microperthite. The microcline is quite fresh, but the albitic component of the perthitic feldspar is lightly kaolinised. Generally, the potash feldspar crystals tend to be subhedral and inclusions of plagioclase are common. The plagioclase is an acid to intermediate andesine ($An_{34}$) and has in nearly all cases been quite heavily sericitised. Quite commonly this sericite is sufficiently coarse-grained to be identified as sheets of muscovite and irregular patches of fluorite may be abundant. Myrmekitic rims and patches marginal to plagioclase grains are abundantly developed, and the many corroded and resorbed plagioclase grains included in the potash feldspar indicate that the plagioclase has, at least in part, been replaced by the latter.

The biotite is a brown, strongly pleochroic variety with occasional inclusions of zircon, fluorite and grains of opaque material. Generally it is fresh, but in some cases has suffered some chloritisation. Muscovite has formed mainly from the alteration of plagioclase.

Fluorite has two distinct modes of occurrence in this rock. Strongly coloured purple fluorite occurs in intergranular positions and in the biotite, while irregular patches of colourless fluorite are commonly found amongst the alteration products of the plagioclase feldspars. Such a feature suggests that fluids responsible for the alteration may have been rich in fluorine.

The most conspicuous textural feature of the rock is that due to partial resorption of the plagioclase and replacement by potassic feldspars.

Specimen B.3277

Waterhouse Granite

A very coarse-grained, deep red-brown, distinctly gneissic granite with numerous oriented "phenocrysts" up to 4 cm. in length.

Thin-section examination shows that the approximate proportions of the major constituents are quartz (30%), potash feldspar (35%), plagioclase (25%), muscovite and sericite (7%), and chlorite and associated biotite (3%). Accessory constituents include calcite, tourmaline, magnetite, pyrite, leucoxene, sphene and hematite.

The plagioclase is a highly sodic albite ($An_2$) with quite well developed twinning. Though the rock contains plagioclase and potash feldspar in adamellitic proportions, the plagioclase is by no means a typical adamellite type, and it is therefore considered best to regard the rock as a sodipotassic granite. In general, the albite has been heavily sericitised so that most crystals are rendered almost translucent by such alteration. This alteration renders the albite clearly distinguishable from the potash feldspar which is practically unaltered. The potash feldspar is mainly orthoclase, microcline and microperthite, and in the latter the albitic phase is sericitised in a similar way to the single plagioclase grains. Both potassic and sodic feldspar occur as large, "porphyritic" crystals with distinct marginal granulation and replacement by fine, granular quartz. In places, narrow zones of granulation transect a single, large feldspar crystal.

The feldspars are set in a much finer, granular (0.1 mm) aggregate of equidimensional grains of quartz, microcline and albite, with abundant, fine muscovite and chlorite. Most of the accessory minerals are found in this material. These finely granular zones are disposed parallel to the gneissic foliation of the rock and constitute its most conspicuous textural feature in thin-section.

Specimen B.3281

## Rum Jungle Granite No.1

A dark, pinkish-grey, strongly "porphrytic", gneissic granite with large, pink feldspar crystals up to 3 mm across and averaging about 1.5 mm across.

Thin-section examination shows that the rock is a deformed and recrystallised biotite granite whose essential constituents occur in the following approximate proportions:- potassic feldspar (47%), quartz (35%), plagioclase (10%), biotite (5%), and chlorite (2%). Accessory minerals include iron oxides, muscovite, calcite, apatite and zircon. The matrix between the porphyritic feldspars is of fairly even grainsize (about 0.06 to 0.15 mm) and consists of more or less equidimensional, interlocking grains of quartz, microcline, albite, mica and chlorite. Areas of coarser-grained (0.3 to 2 mm) quartz and feldspar probably represent the original groundmass texture and composition prior to deformation.

The potash feldspar is mainly microcline and microporthite, with inclusions of quartz and plagioclase. Zones of intense granulation consisting of aggregated quartz, feldspar, biotite and chlorite quite commonly cut through the larger feldspars. The phenocrysts exhibit marginal granulation in all cases. Plagioclase shows evidence of considerable resorption, and in most cases is moderately sericitised. The larger plagioclase crystals, and those included in potash feldspar, have the composition of an acid andesine ($An_{34}$), while the small plagioclase grains in the finely granular phase of the rock approach pure albite in composition.

Large quartz grains in what is considered to be relicts of the original texture exhibit strongly undulose extinction, but the smaller, recrystallised quartz grains of the fine phase exhibit perfectly uniform extinction phenomena. This feature, in itself, is evidence in support of the supposed recrystallisation of this material.

Biotite flakes are small and confined to the fine, recrystallised phase of the rock. It is a deep green-brown, strongly pleochroic mica in a completely fresh condition, and usually of subhedral to euhedral form. Very finely granular, translucent inclusions are abundantly concentrated along cleavage planes in the mica, and in basal sections this material appears to be either leucoxene on very finely divided sphene. A small number of muscovite sheets can usually be found in association with the biotite.

The accessory apatite is remarkable and distinctive in being markedly colour-zoned. The core is of deep grey colour and moderately pleochroic to grey-brown, passing rapidly into a quite colourless outer zone of typical appearance. It forms euhedral crystals and is most abundant in the finely granular, biotite phase. Calcite occurs as a rare, fine replacement in potash feldspar.

Specimen B.3280

## Rum Jungle Granite No.2

A coarse-grained, pink granite without any notable foliation or other directional fabric. Individual feldspar crystals reach up to 1.5 mm across.

Thin-section examination shows that the rock approaches a sodi-potassic granite in composition, the major component minerals being quartz (40%), potash feldspar (40%), plagioclase (17%), chlorite (2%) and iron oxides (1%). Percentages quoted here are approximate only. Accessory minerals include zircon apatite, fluorite, calcite and sphene. Plagioclase makes up about 30 percent of the total feldspar.

The texture is granitoid, tending to porphyritic. The phenocrysts are of microcline and microcline microperthite, and the margins of such large feldspar crystals generally show evidence of granulation and subsequent partial recrystallisation. The potassic feldspar is commonly quite fresh, but the plagioclase (including that perthitically included in the potassic feldspar) has been considerably kaolinised and sericitized. The kaolinised material has taken on a red, ferruginous stain. Such altered plagioclase has been determined as albite ($An_8$), but it is not possible to estimate what its composition may have been prior to alteration. Highly resorbed relicts of the plagioclase are included in nearly every large crystal of potasaic feldspar.

The finely granulated material marginal to, and between the larger feldspars consists mainly of quartz, microcline and albite (untwinned), with smaller amounts of chlorite, iron oxides (largely magnetite), and the various accessory minerals. The flaky, pseudomorphous form of the chlorite indicates that it has formed by the alteration of original biotite. Purple fluorite is found amongst such material.

It is apparent that the rock has suffered moderate deformation and alteration, some of which (granulation) would seem to have been of post-crystallisation age.

<u>Specimen B.3282</u>

## Rum Jungle Granite No.3.

A dark grey, moderately coarsely crystalline rock in hand-specimen without any visible textural orientation, but with a slickensided joint surface.

Thin-section examination shows that the rock has been heavily crushed and recrystallised, with the consequent development of new minerals such as epidote, calcite and muscovite. The rock is essentially a crushed albite granite whose main constituents occur in the following approximate proportions:- quartz (35%), plagioclase (45%), potash feldspar (5%), biotite (6%), sericite (7%), epidote (2%), and accessory amounts of apatite, sphene, calcite and zircon. Texturally, the rock consists of an aggregate of plagioclase, quartz, and potash feldspar units separated by lenticular and irregularly sheeted areas of highly sheared, fine grained, foliated aggregates of sericite, biotite, quartz, a little feldspar, and epidote. Such areas, if taken in isolation, have the composition and texture of a quartz-mica-schist, whose average grainsize is about 0.06 mm. The feldspars of the uncrushed phase of the rock have an average grainsize of approximately 1 mm, though many reach up to 2mm across. The original quartz of the rock, even in the uncrushed phase, has been severely deformed and recrystallised to oriented mosaic aggregates of finer grainsize.

The plagioclase is albite approximating in composition to $An_8$. It has been considerably altered, mainly by a very fine but intense sericitisation. Small-scale replacement by calcite also occurs, and, in rare cases, epidotisation. The potash feldspar is microcline and micro-perthite, and is quite fresh.

Biotite is a green variety and is entirely fresh. However its virtual confinement to zones of crushing casts considerable doubt on its primary origin, and in many cases it clearly encloses and is moulded upon flakes of muscovite and sericite which was certainly developed as a result of the crushing. Such textural relations suggest that the biotite is even later in origin than the sericite. Finely granular aggregates of epidote are commonly abundant in the biotite-rich zones of the rock, and calcite is quite a common constituent of the sericitic crush zones.

It is apparent that this rock has suffered considerable post-crystallisational deformation, and this process is responsible for its most striking textural features.

Specimen B.3276

Price's Springs Granite

A coarse-grained, light grey, massive granitic rock without any apparent directional structures in hand-specimen. In thin-section it is seen that the rock is a sodi-potassic biotite granite of typical granitoid texture and consisting of quartz (30%), microcline and orthoclase (50%), altered plagioclase (15%) and biotite (5%), with accessory amounts of apatite, zircon and magnetite. The proportions indicated above are approximate only.

The quartz has been highly strained and shows evidence of slight internal granulation. It also contains "streams" of minute inclusions. The potash feldspars are quite fresh and show no indication of deformation. Plagioclase is generally deeply sericitised, and calcite is also found amongst the fine alteration material. Remnants of less altered plagioclase have the composition of albite (An5). In some cases the plagioclase is normally and continuously zoned, and the more albite zones are less altered.

Biotite is a strongly pleochroic brown variety with abundant inclusions of apatite and rarer inclusions of zircon and magnetite. Very thin films of opaque material are commonly included along cleavage planes. Strongly developed pleochroic haloes surround inclusions of both apatite and zircon. In general the biotite is quite fresh, but in rare instances it is more or less chloritised, and in places completely so.

Specimen B.3278

Fenton Granite

A very coarse-grained, pink granite with feldspar crystals up to 2 cm across. There is no indication of gneissic foliation or impressed tectonic features of any kind in the hand-specimen provided.

Thin-section examination shows the rock to have a coarse granitoid texture and to be composed of quartz (40%), potassic feldspar (43%), plagioclase (15%) and biotite (2%), with accessory amounts of chlorite, apatite, zircon and fluorite. The above percentages are only approximate, but it is apparent that the rock is a biotite granite of quite ordinary composition.

The quartz is clear and only moderately strained. A notable feature is the presence of oriented "streams" of minute inclusions in the quartz. The orientation of these streams is fairly constant in all quartz grains throughout the section. Potassic feldspar includes microperthite, and microcline microperthite, while the plagioclase is sericitised albite ($An_8$). Such albite is distinct from that of the microperthites, and occurs as more-or-less subhedral crystals and as inclusions in the potassic feldspars. Such inclusions are commonly in the form of irregular blebs distributed throughout the host feldspar, but all in perfect optical continuity one with the other, and often with larger plagioclase units outside of the host feldspar. It is therefore evident that much of the plagioclase has been resorbed and replaced by potassic feldspar.

The biotite is brown and strongly pleochroic. It is generally fresh, but a marginal development of leucoxene and slight chloritiation are found. Films of opaque material commonly lie along cleavage planes, and fluorite and (?) epidote are found in a similar way. Inclusions are of apatite and zircon.

Specimen B.3279

Burton Creek Granite

A medium-grained, grey, gneissic granite consisting essentially of quartz (30%), potassic feldspar (50%) plagioclase (15%), biotite (4%), and muscovite (1%), with accessory chlorite, apatite and epidote. The texture is gneissic, and the average grainsize is about 2 mm, though large feldspar crystals up to 7 mm across occur fairly commonly.

The quartz has been strained and considerably recrystallised into a fine mosaic texture in most places. The grain orientation in such recrystallised masses is parallel to the overall gneissic foliation of the rock. Potassic feldspar includes microcline and orthoclase. Microcline forms smaller, perfectly clear grains, while orthoclase occurs as larger, slightly altered grains carrying highly altered relicts of plagioclase as inclusions, or as wide rims around partly resorbed plagioclase nuclei. The plagioclase is a calcic oligoclase ($An_{30}$) outwardly zoned to sodic oligoclase or rimmed by orthoclase. Alteration of the more calcic plagioclase has been intense and mainly involves deep kaolinisation with subsidiary sericitisation. Myrmekitic intergrowths are a conspicuous feature of the rock.

The biotite is a strongly pleochroic brown variety occuring as elongated sheets oriented parallel to the gneissic foliation of the rock. Generally, it is quite fresh and contains minute zircon inclusions surrounded by pleochroic haloes. In rare instances the mica has been partly or completely chloritised. Inclusions of apatite are common.

Epidote, though listed as an accessory mineral, is fairly certainly of secondary origin as it is found as small grains in altered plagioclase.

Specimen B.3283

Cullen Granite

A coarse-grained, pale brownish-grey granitic rock without any indication of directional structure in hand-specimen.

Thin-section examination shows that specimen to be a coarse sodi-potassic biotite granite with typical granitoid texture and a fairly even average grainsize of about 5 mm. The approximate proportions of the constituent minerals are quartz (35%), potassic feldspars (45%), plagioclase (17%), biotite (3%) and accessory amounts of chlorite, apatite, iron oxide, zircon and calcite.

The quartz is coarse-grained and strained, but shows no evidence of recrystallisation. It is transected by numerous "streams" of minute inclusions and by fractures. Potassic feldspar includes microcline, microcline microperthite. All are fresh apart from cloudy alteration of the perthitic albite component. Corroded and resorbed relicts of early crystallised (more basic) plagioclase remain as inclusions in some of the potassic feldspars. The early-formed plagioclase tends to form tabular crystals, but has generally been considerably modified by corrosion and absorption. In nearly all cases the plagioclase has been deeply altered by kaolinisation and subordinate sericitisation, so that it is difficult to be in any way certain of the composition. However, it appears to an albite approaching $An_5$. An interesting feature of the rock is that the alteration of the plagioclase appears to have taken place before the final stage of crystallisation of that feldspar, for the altered material is very commonly surrounded by a narrow zone of quite fresh, clear plagioclase of (apparently) the same composition. Some of the plagioclases also exhibit weak normal compositional zoning.

The biotite is a deep brown, "dirty" variety containing much finely-divided opaque material, and having dark pleochroic haloes around minute inclusions, some of which are certainly zircons. Films and lenses of leucoxene and (?) epidote are found included along cleavage planes, and small euhedral crystal inclusions of apatite are common.

Specimen B.2384

Cullen Granite (Edith River)

A coarse-grained porphyritic, dark pink-grey gneissic granitic rock carrying large, euhedral, pink crystals of feldspar up to 3 cm long. The rock has a fairly distinct foliation due to a sub-parallel alignment of the feldspar phenocrysts.

Thin-section examination shows that the rock is a gneissic hornblende-biotite-adamellite consisting of quartz (10%), potash feldspar (35%), plagioclase (35%), biotite (10%) and hornblende (10%), with accessory amounts of sphene, zircon, apatite, opaque oxides. The average grainsize of the groundmass constituents is about 1.5 mm and the texture is anhedral-granular. There is no indication of any severe deformation.

The large, pink feldspar phenocrysts are of a peculiar combination of microperthite and microcline giving rise to a kind of chequer-board texture. Generally, these feldspars are fresh, but there is commonly a moderate sericitisation of the albitic phase of the microperthite. The plagioclase is more heavily, though quite irregularly, sericitised. It has the composition of andesine ($An_{35}$), and myrmekitic intergrowths are a very common feature. The plagioclase is confined to the groundmass but also occurs as highly corroded inclusions in the potash feldspar phenocrysts. It is thus apparent that at least the plagioclase phase of the groundmass crystallised before the very much larger phenocrysts, which must therefore have grown in a partly crystalline "mush", much after the manner of porphyroblasts.

The mafic minerals include brown biotite and green hornblende in approximately equal amounts. Here again, the situation is somewhat anomalous, for there are textural indications that the crystallisation of biotite preceeded that of hornblende. Both minerals are quite fresh and there is no apparent reaction relationship between them. However, the amphibole commonly includes and is moulded on sheets of biotite in such a way that there is no structural orientation between the two minerals. Crystals of apatite are common as inclusions in both and magnetite in the amphibole. Large crystals of sphene are found in the concentrations of dark minerals.

There is no distinct orientation of either biotites or hornblendes as individual grains, but whole aggregates of such minerals are elongated parallel to the gneissic foliation of the rock.

Specimen B.3288

Middle Creek Granite

A fine-grained, massive, pale pinkish-brown granitic rock with analmost sub-conchoidal fracture in hand-specimen.

Thin-section examination indicates that the rock is a deeply kaolinised microgranite with rare quartz phenocrysts. The main constituents are quartz (40%), altered feldspar (58%) and altered biotite (2%) with accessory fluorite, sphene and zoisite.

Owing to the intense kaolinisation of the feldspars it is not possible to be certain of their original nature. However, it appears to have been mainly microperthite with very subordinate plagioclase of indeterminate composition. The biotite has been very largely chloritised and only a few relicts of less-altered mica remain. Abundant colourless to purple fluorite and colourless to yellow zoisite is commonly more or less closely associated with the altered mica.

The rock is even-grained, anhedral granular with an average grainsize of 0.5 mm. The corroded quartz phenocrysts reach up to 3 mm across and are generally euhedral.

Specimen B.3286

Mt. Bundey Granite

A very coarse-grained pink-coloured, hornblende-biotite granite. Texture is typically granitoid tending to be porphyritic in pink feldspar, but showing no clear evidence of directional features in hand-specimen. Hand-specimen examination shows the upper limit of grainsize to be of the order of 2.0 cm, while thin-section shows the lower limit to be about 0.3 mm.

The rock consists mainly of microperthite (approx 60%) quartz 15%, plagioclase 15%, hornblende 6%, biotite 2%, sphene 1%, magnetite 1% and accessory apatite and zircon. Quartz is clear and only very slightly strained. The potassic feldspar is lightly kaolinised and partly sericitised in most cases. In general it is microperthitic in veined manner, though patchperthite is also found. Inclusions of biotite, plagiclase, hornblends, zircon and apatite are not uncommon. Where plagioclase and microperthite are in contact there is in some cases a development of very fine-grained symplectic intergrowth (myrmekite), and in many instances it appears that the microperthite has actually replaced the plagioclase.

The plagioclase is andesenic ($An_{32}$) in composition. It is commonly more or less replaced by microperthite, but numerous large crystals still remain. Most of these larger crystals are subhedral or approach euhedral form. Rare plagio-

clase crystals exhibit strong oscillatory zoning of the normal type, and in such cases the more calcic core is particularly intensely altered to a fine-grained aggregate of sericite, epidote, and indeterminate "dust" in a base of (?) albite. The outer zones are of almost pure albite.

Hornblende crystals are generally euhedral and average about 1 mm, in length. It is a brownish-green type with moderate pleochroism from brownish-green to bottle-green. There is a distinct colour zoning in some cases (-)2V ca.75°, X-pale-brown, Y-green-brown, and Z-bottle-green. The amphibole is entirely fresh and unaltered, and contains inclusions of magnetite and apatite.

The biotite is a straw-brown variety, strongly pleochroic to deep brown. In some cases it is considerably altered to strongly pleochroic green chloritic material in the same optical orientation, and even the fresh mica has tiny inclusions along the cleavage planes. Some of the larger flakes are distinctly bent, and inclusions of magnetite, sphene, quartz and feldspar are found, but are not abundant.

Sphene and magnetite are both present in more than accessory amounts. The sphene is a very prominent feature of the rock, forming large, deep honey-coloured euhedral crystals. This is a characteristic which should be compared with the Mt. Goyder Syenite.

Specimen B.3285

## Mt. Goyder Syenite

This rock is a quartz-syenite, and is in many ways similar to the Mt. Bundey Granite (B.3286), yet also differs from it in certain respects. In hand specimen it is a dark pinkish-grey rock with a tendency to be porphyritic in feldspar. There is a slight suggestion of orientation of those phenocrysts in the specimen provided.

The essential constituents are potassic feldspar (65%), amphibole (20%), plagioclase (10%), sphene (2%), magnetite 1%), and apatite (1%). These constituents are arranged in a subhedral granular texture with an average grainsize of about 3mm. but in which feldspar crystals may reach up to 1 cm. across.

The potassic feldspar is generally microperthitic like that of the Mt. Bundey Granite, the perthite being mainly of the fine vein type. Also, it is usual for the feldspar to be moderately kaolinised and charged with very fine indeterminate dust. Simple twinning is commonly displayed and inclusions of plagioclase, amphibole and sphene are found. Plagioclase crystals are generally very poorly twinned but are commonly zoned in an oscillatory manner and a very thin myrmekite-like zone often occurs at the interface between microperthite and plagioclase where the two feldspars are in contact. The plagioclase is in oligoclase range ($An_{10-12}$) but in many cases has been considerably altered.

The amphibole is a pale green variety with (-)2V=ca. 75-80° and pleochroic from pale greenish-brown to green. It is quite fresh and unaltered. It differs from the amphibole of the Mt. Bundey Granite in being much paler coloured, and considerably more abundant. The amphibole quite commonly forms clusters of more or less euhedral crystals of moderate size.

Sphene forms abundant, euhedral, deep honey-coloured crystals in considerable abundance. Abundant grains of magnetite are usually associated with clusters of amphibole crystals. Apatite is also conspicuous as large euhedral crystals.

The conspicuous apatite, abundant and distinctively coloured sphene, and vein-type microperthite bear a strong similarity to similar features in the Mt. Bundey Granite, and it is probable that the two rocks are comagmatic.

Report No.8.

66N/1
30th August, 1957.

# EXAMINATION OF HEAVY MINERAL SAND FORWARDED BY CLUTHA DEVELOPMENT LIMITED, SYDNEY.

by

W.B. Dallwitz

The following is the weight-percentage mineral composition of a sample of heavy-mineral sand which was recently forwarded for examination. The sample was stated to have been collected at Port Macquarie:

| | |
|---|---|
| Ilmenite | 31.1 |
| Rutile | 35.0 |
| Zircon | 25.4 |
| Monazite | 1.7 |
| Cassiterite | 0.3+ |
| Topaz | 2.4 |
| Quartz | 1.3 |
| Other minerals | 2.8 |
| | 100.0 |

Other minerals consist of leucoxene, feldspar, magnetite, hematite, garnet, siderite, tourmaline, epidote, brookite, anatase, spinel, hornblende, staurolite, sphene, and a somewhat yellowish metallic substance which may be brass or some other extraneous manufactured material. Only three grains of the yellowish metallic substance were seen in the 4,000 - odd grains counted during the examination of this sand.

This sample of sand shows very poor sorting as compared with that normally found in beach sands. The size of the grains ranges from about 0.8 mm. to about 0.08 mm. Furthermore, the rounding of the grains is poor. The grains of monazite are far from smooth and rather iron-stained, and not at all like those present in most eastern Australian beach sands.

These characteristics suggest that the sample was taken from a stream or lake deposit, rather than from a beach where the sand grains are normally exposed to prolonged and repeated abrasion through wave-action.

3rd September, 1957.

DESCRIPTIONS OF ROCKS COLLECTED BY THE EINASLEIGH FIELD PARTY, NORTH QUEENSLAND.

by

R.D. Stevens.

The following are descriptions of certain rocks collected by the Einasleigh Party during 1956:

Specimen B.2320

Biotite Granite (no locality given).

The rock is a medium to fine-grained, pink biotite granite approaching biotite adamellite in composition. It has no foliation or other directional structure, and is entirely non-porphyritic.

The essential constituents in their approximate proportions are quartz (40%), potash feldspar (40%), plagioclase (18%), biotite (2%) and accessory magnetite, apatite and zircon. Texture is typically granitoid and relatively even-grained with an average grainsize of about 1.5 mm.

Quartz is moderately strained, somewhat fractured, and carries streams of minute bubble-like inclusions. The potash feldspar is mainly microperthite and is generally moderately kaolinised. Plagioclase grains tend to be subhedral and commonly included in the potash feldspar. It is an acid oligoclase (An12) and in some cases is considerably sericitised.

Biotite occurs as brown, strongly pleochroic sheets which are in various cases either fresh or moderately chloritised. Inclusions of magnetite and apatite are common.

Specimen B4194

Quartz-labradorite-biotite granulite and quartz-hornblende-biotite gneiss.

(Locality: Einasleigh 4-mile sheet, 11.2 miles N.N.E. of Einasleigh and 1.6 miles east of Forsayth- Almaden railway).

Specimen B4194(a) is a fine to medium-grained quartz-labradorite-biotite granulite consisting essentially of those minerals, but also carrying minor amounts of apatite, (?) zircon, magnetite and (?) garnet. Micrometric analysis shows the mineralogical composition to be quartz (54.16%), plagioclase (36.29%), biotite (8.84%), magnetite (0.30%), other accessories (0.38%).

Such weak foliation as is exhibited by the rock in thin-section is due to sub-parallel orientation of biotite flakes. Mineralogical banding, due to bands of higher biotite concentration, represents original sedimentary layering.

Specimen B4194(b) is essentially a hornblende-biotite schist interbedded with granulite as above. The main constituents are hornblende, biotite, quartz and plagioclase in the following proportions:

hornblende 46.5%, biotite 18.2%, quartz 14.2%, plagioclase 20.5%, and accessories 0.6%.

The rock is strongly foliated owing to a high degree of orientation of amphibole and biotite. Where in contact with the granulite there is a conspicuous development of brown biotite, the latter becoming the most abundant mineral, while amphibole disappears . This phase passes into normal granulite over a distance of between 0.5 mm. and 1.0 mm. Accessory minerals include apatite and magnetite. The plagioclase is similar to that of the granulite.

Specimen B4193

Calcareous quartz-sericite siltstone (cf. B4191)

(Locality: Pt. 36, ph. 5060, Gilberton run 2).

A finely banded, almost unmetamorphosed calcareous quartz-sericite siltstone with an average grainsize of about 0.03 mm. There is no schistosity, but abundant porphyroblasts of chlorite are present. Grains of magnetite and crystals of pyrite are common.

The degree of alteration of this rock should be compared with the quite strongly metamorphosed garnetiferous calc-schist (B4191). It is apparent that matamorphism is not due to proximity to the dolerite sheet.

Specimen B2358

Uralitised Basalt.

(Locality: Pt. 1, ph. 5175, Atherton run 4).

The rock has been almost completely converted to a felted mass of uralite with numerous relict laths of original plagioclase. The composition of this residual plagioclase is difficult to determine, but it appears to be in the labradorite range.

The numerous amygdules contained in the rock have been considerably metamorphosed, and now consist of aggregates of epidote, vesuvianite and garnet.

Report No.10

66Q/1.
9th September, 1957.

EXAMINATION OF BEACH SAND CONCENTRATES FORWARDED FROM CLUTHA DEVELOPMENT LTD. SYDNEY.

by

D.W. Dallwitz

Two samples of beach sand concentrates have been examined with results in weight-percentages as given hereunder. These samples were stated to have been collected at Bowen, North Queensland.

| Mineral | Sample 64642 | Sample 64643 |
|---|---|---|
| Magnetite | 11.4 | 12.2 |
| Ilmenite | 25.1 | 30.9 |
| Zircon | 2.2 | 1.8 |
| Rutile | 0.2 | Less than 0.1 |
| Hornblende | 17.9 | 13.3 |
| Epidote | 6.9 | 5.8 |
| Feldspar and quartz | 31.7 | 31.6 |
| Other Minerals | 4.6 | 4.4 |
| | 100.0 | 100.0 |

Other minerals in both samples are sphene, (?) dumortierite, leucoxene, garnet, apatite, topaz, tourmaline, and monazite. A single grain of cassiterite was noted among over 10,000 grains counted during the examination of sample 64642. A few grains only of monazite were noted in both samples; this mineral appeared to be slightly more abundant in sample 64642, but amounted to less than 0.1 per cent , even so. Sphene is the most plentiful "other mineral" in both samples.

The weight-percentage of "heavy"mineral in sample 64642 is 38.9% and that in sample 64643 is 44.9. Recalaculating the "heavy" minerals to 100% gave the following weight-percentage composition:-

| Mineral | Sample 64642 | Sample 64643 |
|---|---|---|
| Magnetite | 29.3 | 27.2 |
| Ilmenite | 64.5 | 68.8 |
| Zircon | 5.7 | 4.0 |
| Rutile | 0.5 | Less than 0.1 |
| | 100.0 | 100.0 |

Report No.11

84Q/6
12th September, 1957.

# X-RAY EXAMINATION OF SAMPLES FROM WESTMORELAND URANIUM PROSPECT, NORTH-WEST QUEENSLAND.

by

W.B. Dallwitz

The minerals of the Westmoreland Uranium Prospect have been determined by X-Ray powder photography, and only those specimens containing a reasonable amount of radioactive mineral have been examined.

## Specimen 1204

Felspathic sandstone with yellow and brown mineral. Section A, 1490 feet. Yellow mineral is carnotite. The brown material is most likely carnotite mingled with hydrated iron oxide.

## Specimen 1216

Yellow-green mineral in felspathic sandstone. Section B, near rich pod. The yellow-green mineral is torbernite.

## Specimen 1220

Coarse felspathic sandstone with dense yellow mineral. Lowest mineralized level from gorge.

Two specimens submitted. The dense yellow mineral in one specimen is renardite, and the macroscopically similar mineral in the other specimen is soddyite. A dirty yellow-green or greenish brown mineral encrusting part of the specimen containing soddyite is phosphuranylite. The phosphuranylite is weakly fluorescent in yellow-green under a very powerful U V lamp.

## Specimen 1226

Rich pod of yellow, green and dark brown mineral, Section B. Both the yellow-green and brown parts of this specimen are, or contain, carnotite. (Carnotite may be yellow-green and compact, though it is generally yellow and powdery). The brown material gives a weak X-Ray powder pattern as compared with that given by the yellow-green, but no extraneous lines are present. Therefore it appears that the brown colouring is due to some amorphous material.

## Specimen 1210 and 1223.

Felspathic sandstone with yellow mineral. Specimen 1210 is from section A, 1490 feet; specimen 1223 is from section B, 1390 feet. The radioactive mineral in these specimens has not been identified. The outcrop from which specimen 1210 was taken gave 50c/s on a Philips counter, and that from which specimen 1223 was taken gave 40c/s. When the powdery yellow material was X-Rayed it gave a very strong pattern for quartz, but several other lines were also present; these, however, could not be related to those for any secondary uranium mineral for which X-Ray powder data are available. However, the powder gave a strong reaction for uranium with the sodium fluoride head. An assay by the S.A. Department of Mines on specimen 1210 gave 0.055%, $U_3O_8$ (1.2 lb, per ton).

From the somewhat unexpected presence of two different, but macroscopically similar, yellow to orange minerals, renardite and soddyite, in two specimens (1220) taken very close together it is very likely that additional minerals, apart from those identified by me, will be discovered at Westmoreland.

Report No.12. 66NT/1.
17th September, 1957.

## EXAMINATION OF HEAVY MINERAL SAND, OENPELLI AREA, NORTHERN TERRITORY.

by

W.B. Dallwitz

This sand was collected from a creek in the Oenpelli area, and submitted by W. Patterson of Enterprise Exploration Co.Pty. Ltd.

Portion of the sample was submitted to a tin test, but no grains of cassiterite were found. The black mineral which has a high R.I. and a good cleavage was examined in some detail. Under the microscope it was found to have a conchoidal fracture; it is pale golden-brown in transmitted light, and its sign is uniaxial positive. Some lamellar twinning is also present.

The specific gravity of the mineral was determined as 4.25. The mineral is very feebly magnetic, but this property can only be observed when the mineral is finely crushed and tested with the strong hand magnet which we find so useful.

The colour, optical sign, and specific gravity of the mineral pointed strongly to rutile, and this diagnosis was confirmed by an X-Ray powder photograph.

The well-developed cleavage, generally not seen in detrital rutile, was, at first, somewhat puzzling, but Dana states that in rutile the (110) cleavage is distinct, (100) less so, and that (111) occurs in traces. Certainly the 110 cleavage is extremely well developed in the specimen forwarded. Obviously, the rutile has travelled only a short distance.

Report No.13.

120NT/9
26th September, 1957.

# DESCRIPTIONS OF ROCKS FROM SETTLEMENT CREEK VALLEY, CALVERT HILLS AREA, NORTHERN TERRITORY.

by

W.B. Dallwitz.

These rocks were collected in the Settlement Creek Valley, Calvert Hills 4 - mile Sheet. They were collected by Mr. J.B. Firman.

Specimen No. 1401. Labelled "quartz dolerite from basal sill in Peters Creek Volcancis"

Under the microscope this rock is found to have doleritic texture. The principal minerals, partly sericitized andesine and actinolite, in some places show signs of former ophitic intergrowth between plagioclase and original pyroxene. A few grains of augite remain in some of the actinolite clots.

Accessory minerals, apart from augite, are quartz, calcite, orthoclase, black iron ore, chlorite, pale biotite and apatite. The apatite occurs in long thin needles which may traverse more than one grain of andesine. Chlorite is most common as inclusions in plagioclase, though some has been formed directly from pyroxene.

The rock is a uralitized quartz dolerite.

Specimen No. 1402. Labelled "flow banded andesine(?) from Peters Creek Volcanics".

In handspecimen this is a brownish pink and grey rock showing distinct banding. The cut surface reveals a mottling in brownish pink and light grey superimposed on the banding.

Under the microscope the rock presents puzzling appearances and even more puzzling mineralogy, certainly at first sight, and especially in view of your tentative field name. The brownish pink parts consist of albite, subordinate dolomite and orthoclase, accessory quartz and pale yellow-green chlorite, and rare euhedral rutile. The grainsize of the albite, orthoclase, and quartz is about 0.06 mm; the associated dolomite is several times coarser than this. The albite is heavily stained by dusty hydrated iron oxide, and is most readily distinguishable from lightly - stained orthoclase and clear quartz by virtue of this staining; multiple twinning in the albite is uncommon.

The identity of the rutile was established partly through the presence of one or two geniculate twins.

The light grey clots, which may measure up to 5 mm. across, consist mainly of coarse-grained dolomite whose cleavage - traces are generally irregularly bent. Ignoring the effects of undulose extinction, the dolomite may be optically continuous over areas measuring up to several millimeters across. Small quantities of all the constituents of the brownish pink part of the rock (see above) are commonly enclosed in the dolomite. Dolomite makes up about 45% of the rock.

The texture of the fel spathic parts of this rock resembles that of a fine-grain d aplite. This feldspathic material seems to ramify through the coarse dolomite as discontinuous veinlets and as pockets. It seems that the best name for this rock is feldspathized (largely albitized) dolomite. It seems far less likely that the rock is a dolomitized igneous rock (e.g. porphyry). Whether the felspathization took place during diagenesis or during subsequent matasomatism by solutions of deep-seated origin is impossible to say from microscopic examination alone.

Specimen 1403. Labelled "quartz greywacke (green mineral for determination) from dolomite sequence".

In handspecimen this is a flaggy, well-bedded medium-grained sandstone. The bedding is shown up mainly by variation in concentration of a green mineral. There is some evidence of current-bedding in the handspecimen.

In thin section the rock is found to consist mainly of semi-rounded and rounded quartz grains of average diameter 0.15 mm. Quite a few of the grains show secondary outgrowths of quartz in optical continuity with that in the detrital grains. Much more commonly the material interstitial between the quartz grains is glauconite.

The green mineral which is concentrated in certain beds (see above) is glauconite. This occurs either as rounded grains of almost pure material, as concentric shells round grains of quartz or leucoxene, or as rounded grains (of various shades of green, greenish brown, and greenish yellow) containing irregularly distributed impurities of leucoxene or other indeterminate dark material. The glauconite grains themselves are generally larger then the quartz grains, and are internally very fine-grained. This mineral makes up only about 5 percent or, at the most, 10 percent - depending on what part of the rock is examined - of the whole rock.

Certain rounded grains, iron-stained in varying degree, make up between 5 and 10 percent of the rock. These appear to be fragments of a fine - to very fine-grained siliceous rock.

Accessory minerals are leucoxene, hydrated iron-oxide (mostly as intergranular films), and rare sericite muscovite flakes, tourmaline, zircon, and microcline.

The rock is a fine glauconitic quartz sandstone.