

MINERALOGICAL REPORT No. 7240
by Alan C. Purvis, PhD.

November 11th, 1996

TO : Mr Andrew Mackie
PNC Exploration (Aust) Pty Ltd
Level 10, 55 Hunter Street
SYDNEY NSW 2000

YOUR REFERENCE : Order No. 252

MATERIAL : 1 rock samples

IDENTIFICATION : 4930

WORK REQUESTED : Thin section preparation, petrographic
description and report with comments as
specified.

SAMPLES & SECTIONS : Returned to you with this report.

PONTIFEX & ASSOCIATES PTY. LTD.

SUMMARY COMMENTS

Samples from western Arnhem Land in the Northern Territory are described in this report using normal thin sections. Some of the offcuts were stained with HF and sodium cobaltinitrite to reveal alkali (potassium) feldspar (stained yellow). This staining also allows plagioclase (white to cream) to be distinguished from quartz (unstained). In the covering letter from Andrew Mackie, it is stated that these samples are largely from the Nimbuwah Complex (intrusive rocks) and Myra Falls Metamorphics (metasediments).

These rocks are predominantly of igneous or meta-igneous origin, from ultramafic to acid, with some rather weathered rocks, and very altered rocks which may include metasediments, but no unweathered and unaltered metasediments were seen.

LITHOLOGICAL GROUPS

Granitoids

The most common granitoid type is a foliated biotite \pm hornblende-bearing tonalite to monzogranite/adamellite with accessory allanite, apatite, minor zircon and alteration, as indicated above, to chlorite, epidote, prehnite and pumpellyite in different proportions. These granitoids include 4930 (granodiorite).

TABLE 1: LIST OF SAMPLES DESCRIBED IN REPORT NO. 7240

| No. | Lithology | Mineralogy | Metamorphism |
|------------|------------------|--|------------------------------------|
| 4930 | Granodiorite | Biotite-hornblende-bearing with some allanite | Unmetamorphosed, some prehnite. |

INDIVIDUAL DESCRIPTIONS

4930 **Foliated biotite-hornblende granodiorite with minor possible allanite.**

| Mineral | Vol |
|-------------------|--------|
| Quartz | 35-40% |
| Plagioclase | 40-45% |
| Biotite | 7-8% |
| Hornblende | 3% |
| Microcline | 8% |
| Oxide, apatite | 1% |
| Allanite, epidote | tr |
| Zircon | tr |

The stained offcut of this sample shows a layered distribution of plagioclase and alkali feldspar, suggesting that this sample may be similar to sample 4928, but foliated. The alkali feldspar, which can be seen on the stained offcut, occurs as grains to 5 mm long, larger than the more abundant plagioclase grains, which are generally 1 to 3 mm long and sericite-clouded. The quartz in this sample occurs as poikilitic grains to 4 mm in length.

Biotite and hornblende occur as in sample 4928, but are foliated. The hornblende is coarse (to 4 mm grainsize) but the biotite is finer (to 1 mm grainsize) with some alteration to clays and/or prehnite. Accessory opaque oxide and apatite occur, mostly in and adjacent to the biotite, and there are rare grains and aggregates of apparent allanite ± epidote. Zircon seems to rare, however.

The mineralogy suggests a foliated granodiorite.

MINERALOGICAL REPORT No. 7411
by Alan C. Purvis, PhD.

27 August 1997

TO : Mr Paul Melville
PNC Exploration (Aust) Pty Ltd
Level 10, 55 Hunter Street
SYDNEY NSW 2000

COPY TO : PNC Exploration (Aust) Pty Ltd
PO Box 761
NIGHTCLIFF NT 0814

YOUR REFERENCE : Order No. 476

MATERIAL : 43 Samples, King River area

IDENTIFICATION : 5901 to 5979

WORK REQUESTED : Thin section preparation, petrographic
description and report, with comments as
specified.

SAMPLES & SECTIONS : Returned to you with this report.

PONTIFEX & ASSOCIATES PTY. LTD.

SUMMARY COMMENTS

This report discusses a further batch of 8 samples from western Arnhem land, also discussed in the previous reports Nos 7240 (11/11/96) and 7267 (29/11/96). These samples were made into 8 normal thin sections.

These samples are again largely gneissic to massive granitoids, with some vein quartz samples. In some samples pervasive alteration to sericite \pm limonite \pm leucoxene has made precise identification of the original lithology difficult, if not impossible, and one gneiss has been weathered to kaolin, quartz and limonite. However most of the other igneous samples have weak alteration involving albite, sericite, chlorite, clays, prehnite and epidote, with pumpellyite, carbonate and actinolite in relatively fewer samples than the other minerals. The various lithological groups present in this batch are discussed below.

GRANITOID GNEISSES

These are varied in character and also include some samples which are so highly altered that they cannot be classified more precisely than by using the term granitoid gneiss. This is largely due to sericitisation of the feldspar component, also sericite-leucoxene-alteration of former biotite, but in one sample is due to weathering.

Adamellite Gneiss

This group contains sample **5978**, although 5978 is poorer in alkali feldspar than the others in this group and is transitional towards granodiorite gneiss.

MASSIVE GRANITOIDS

One of these samples is a greisen but the others vary from definite to probable quartz monzonite through granodiorite to adamellite, with some granophyric granitoids also represented. Some of these have hornblende as well as biotite and sphene is common, suggesting typical Proterozoic 'I' to 'A'-type granitoids. Alteration including albite, sericite, chlorite, clays and prehnite is common.

Quartz monzonite

Sample **5957** is a quartz monzonite, mostly with deep green to olive-green hornblende and biotite in various proportions. Sample 5957 may be related to the more mafic suite.

Granodiorite

Samples **5958 and 5959** are massive granodiorites, both with hornblende and biotite as in the quartz monzonite group, but sample 5958 has bands rich in alkali feldspar and also quartz-rich lenses.

Adamellites

Samples **5906, 56 and 60** are adamellites. Sample 5906 has some allanite, and the alteration is as seen in the other granitoid samples.

HYDROTHERMAL QUARTZ

Sample **5949** contains or consists of various styles and generations of apparently low-temperature hydrothermal quartz, with low-temperature hydrothermal quartz. Sample 5949 has areas of sericite flooding accompanying one type of quartz.

CONCLUSIONS

This batch seems to possibly represent an area dominated by igneous rocks, with older gneissic granitoids, many of which have strong alteration to sericite ± quartz ± limonite. However some are less altered with similar alteration to that shown by later granitoids, and these include granodiorite, adamellite and granite. The later granitoids include more mafic igneous rocks (quartz monzonite and diorite/gabbro), with a hornblende-biotite assemblage in the more mafic rocks and in granodiorites, but biotite-only adamellites.

Alteration in some gneissic granitoids and most or all of the massive granitoids is usually minor, involving albite, sericite, chlorite, ?vermiculite and prehnite, with pumpellyite, epidote and carbonate less widely distributed. The alteration is “weak propylitic” and suggest temperatures of perhaps 200-300°C. Some granophyric granitoids also occur which may belong to a separate high-level suite. One granitoid sample has late-stage quartz veins.

There is also a single example of very weakly clay-altered olivine-clinopyroxene dolerite with large strongly ophitic clinopyroxene grains, a texture also seen in some basalts from the Antrim Plateau Volcanics. However no conclusions as to the age of this dolerite can be made on the basis of this textural similarity.

Several samples of multi-stage vein quartz \pm sericite \pm limonite are also present, and are undeformed. No sulphides were seen in any of these veins, however.

TABLE 1: SAMPLES DESCRIBED IN REPORT NO. 7441

| No | Lithology | Notes |
|------|--------------------|--|
| 5906 | Biotite adamellite | Massive granitoid, weakly altered. |
| 5949 | Vein quartz | Five generations of quartz and sericite. |
| 5956 | Adamellite | Fine-grained with minor muscovite. |
| 5957 | Quartz monzonite | Plagioclase-porphyritic with hornblende and biotite. |
| 5958 | Granodiorite | Heterogeneous with alkali feldspar-rich lenses and quartz-rich lenses also containing plagioclase. |
| 5959 | Cranodiorite | Biotite-hornblende-bearing with abundant sphene and allanite. |
| 5960 | Adamellite | Fine-grained, biotite-only granitoid with allanite. |
| 5978 | Adamellite gneiss | Transitional towards granodiorite, biotite-only. |

INDIVIDUAL DISCRIPTIONS

5906 **Massive altered biotite adamellite or monzogranite with albite-sericite-prehnite alteration of plagioclase and chlorite-leucoxene alteration of biotite.**

Reasonably well-aligned larger feldspars are evident in the hand-specimen of this sample, which is pinkish with a granitoid-like appearance. In thin section, it is seen to be a relatively leucocratic granitoid with albite-sericite-prehnite-altered plagioclase laths, relatively fresh microcline and chlorite-leucoxene-altered biotite flakes. The grainsize is largely about 1 to 4 mm with some microcline to 10 mm in grainsize, largely poikilitic in habit, and some quartz grains to 6 mm. Accessories include fresh zircon and altered possible allanite. The visually estimated mineralogy is as listed below.

- | | |
|---|--------|
| 1. Microcline, clouded throughout or in patches, with small inclusions of quartz and altered plagioclase, also of chloritised biotite | 30-35% |
| 2. Plagioclase with weak to very strong alteration to albite, sericite and prehnite in various proportions | 25-30% |
| 3. Quartz, granular to poikilitic with ragged grain boundaries, but little deformed | 35% |
| 4. Biotite, altered totally to chlorite and leucoxene | 5% |
| 5. Zircon (as euhedral crystals to 0.25 mm long) and altered possible allanite | <1% |

The visually estimated mineralogy suggest a former biotite adamellite (or monzogranite).

5949 Different generations of vein quartz and sericite-flooding.

This is a more massive quartz-rich rock than that in the previous sample and seems to be more similar to sample 5947. In thin section, it can be seen to have various types of vein quartz as listed below, as well as sericite.

1. Coarse deformed to fractured and microfissured vein quartz, to 4 mm grainsize, passing into sericite-flooded areas and apparently early 20-25%
2. Irregular sericite-rich patches with relatively minor, relatively fine grained quartz as rounded to ragged grains 25-30%
3. Coarse granular to prismatic quartz locally with growth defects, to 5 mm in grainsize but not as deformed as quartz-1 35%
4. Very irregular veins with cherty to fine-grained “dog-tooth” fine sparry quartz, usually with very fine grained sericite to fine grained muscovite 10%
5. A 2 mm-wide vein of granular to columnar quartz without sericite, apparently cross cutting all of the other types of quartz 5%

5956 Weakly altered fine grained biotite adamellite with albite, sericite, chlorite, vermiculite(?) and prehnite alteration, also leucoxene after sphene, magnetite and muscovite.

This sample is a pale granitoid, fine grained and apparently equigranular. In thin section, it is seen to have poikilitic quartz grains to 10 mm in diameter and broken to complete chains of feldspar grains, mostly from 2 to 6 mm in length. There seem to be supequal amounts of plagioclase and microcline, the plagioclase having albite to sericite-rich alteration. The microcline is largely fresh but has some plagioclase as inclusions and also as small exsolved lenses, both of which tend to show albite-sericite alteration. There was originally some biotite but this is all altered to chlorite or vermiculite \pm prehnite. Some secondary muscovite is also disseminated and accessories include magnetite and leucoxene after sphene. The visually estimated mineralogy is again as listed:

| | |
|---|--------|
| 1. Quartz, granular to poikilitic, enclosing feldspar etc | 35% |
| 2. Plagioclase with albite-sericite alteration | 30-35% |
| 3. Microcline, weakly perthitic but fresh | 30% |
| 4. Biotite altered to chlorite \pm vermiculite \pm prehnite | 2-3% |
| 5. Muscovite, magnetite and altered sphene. | <1% |

The mineralogy suggests a fine grained adamellite or monzogranite.

5957 Biotite-hornblende-quartz micromonzonite porphyry with some weak alteration involving albite, sericite, clays, chlorite and prehnite.

In hand-specimen, this sample is fine grained but relatively mafic compared with the previous sample. In thin section it is seen to be porphyritic quartz micromonzonite with a mineralogy as follows:

- | | |
|---|--------|
| 1. Plagioclase phenocrysts to 4 mm long, clouded by sericite ± well-crystallised muscovite | 5% |
| 2. Larger quartz grains, also possibly phenocrysts, to 5 mm long, locally pulled apart and veined by microcline | 3% |
| 3. Smaller groundmass plagioclase grains, usually less than 1 mm long, with irregular clay-sericite clouding | 40-45% |
| 4. Fine-grained microcline, usually fresh | 25-30% |
| 5. Groundmass quartz, usually smaller than 0.5 mm | 10-15% |
| 6. Biotite, altered to chlorite, clays and prehnite, as flakes to 2 mm long | 6% |
| 7. Deep olive-green hornblende as partly poikilitic grains to 3 mm long | 2-3% |
| 8. Magnetite, apatite and sphene. | 1-2% |

The ferromagnesian minerals tend to occur in aggregates with magnetite, sphene and apatite partly concentrated within these aggregates, partly separate. The rock is classified here as a quartz micromonzonite but may be transitional towards adamellite or monzogranite.

5958 Banded granitoid with some alkali (potassium) feldspar-rich lenses and quartz-rich lenses in a tonalite to graodiorite host, and an overall biotite-hornblende granodiorite composition.

This is pale banded rock, largel grey, with some lensoidal pinkish bands seen on the cut surface of the hand-specimen. It seems that the pinkish bands may carry alkali (postassium) feldspar, which may be less abundant in the grey bands. It also seems that ferromagnesian minerals are less abundant compared with the previous sample. The offcut was stained with HF and sodium cobaltinitrite and this highlights the alkali feldspar-rich bands and some parrallel bands which seem to be quartz-rich. It also shows that some areas are relatively massive and lack alkali feldspar, whereas others are relatively more foliated and contain small lenses of alkali feldspar. In thin section the mineralogy is seen to be as listed below.

- | | |
|---|--------|
| 1. Microcline, to 7 mm in grainsize in the coarse alkali feldspar-rich bands referred to above, but finer-grained in those areas in the host rock where it is also disseminated, typically about 1 mm in grainsize. Anhedral but fresh. | 20% |
| 2. Plagioclase, quite coarse in the quartz-rich grey bands referred to above (to 4 mm in grainsize) with some alteration to sericite and prehnite, also finer-grained in the host rock, mostly 0.5 to 2 mm, with weaker alteration. | 40-45% |
| 3. Quartz, quite abundant both in the quartz-rich layers and also in the alkali feldspar-rich layers, as poikilitic grains to 6 mm long, and disseminated as grains 0.2 to 2 mm long, with only the larger of these being poikilitic. | 25-30% |
| 4. Biotite, altered variously to chlorite, clays, epidote and prehnite, with a weak foliation in the host rock zone carrying minor microcline. | 5% |
| 5. Olive-green hornblende as highly poikilitic but gresh grains to 2 mm in diameter. | 3-4% |
| 6. Magnetite, most abundant in the microcline-bearing zone, with very minor apatite generally in and adjacent to the magnetite. | 1-2% |

The mineralogy given may not be representative of the rock as a whole as it depends on the overall abundance of the alkali feldspar and quartz-rich bands seen in the thin section. However an overall granodiorite composition would seem to be appropriate, with some tonalitic, granodiorite and granitic zones and bands.

5959 Biotite-hornblende granodiorite with sphene and allanite-epidote grains, also disseminated apatite.

There seems to be relatively minor quartz in this hand-specimen, also irregularly disseminated mafic closts about 1 centimetre in diameter. In thin section the mineralogy seems to be as listed below:

- | | |
|---|--------|
| 1. Plagioclase laths with irregular sericite-(carbonate-prehnite) lateration. | 50-55% |
| 2. Quartz in irregular lenses with ragged coarse grains. | 20-25% |
| 3. Biotite with some secondary clays, epidote and prehnite. | 12-13% |
| 4. Microcline, generally rimming and possibly replacing plagioclase, with some grains carrying myrmekite-like droplets of quartz. | 7-8% |
| 5. Hornblende, usually dark green and granular. | 3-4% |
| 6. Sphene and zoned composite allanite-epidote grains, also apatite. | 1-2% |

The plagioclase occurs as laths to 6 mm in length with weak and irregular alteration to sericite \pm carbonate \pm prehnite. However there are also common lenses of quartz to 8 x 4 mm containing ragged grains. The ferromagnesian clost seen in the hand-specimen are somewhat more sparse in thin section but contain biotite and/or deep green hornblende to 2 mm grainsize. In these areas, hornblende is much less abundant than biotite but is fresh, whereas some of the biotite has clay alteration and some has minor epidote and/or prehnite as well as or instead of clay alteration. Sphene and composite partly altered allanite-epidote grains occur and quite common apatite occurs, largely enclosed in the ferromagnesian grains. There is relatively minor microcline in this rock, locally rimming plagioclase and locally with inclusions of quartz. The rock seems to represent a granodiorite, however, according to the mineralogy as presented above.

5960 Fine grained biotitite adamellite with secondary sericite, chlorite, clays and prehnite.

This fine grained grey aplitic rock is seen in thin section to have a weak foliation defined by partly altered biotite. It is relatively even-grained with most grains from 0.4 to 2 mm in size, apart from some poikilitic quartz grains to 4 mm long and has the composition of an adamellite. The biotite is also relatively fine grained, with flakes 0.2 to 1 mm long showing some alteration to clays, chlorite and/or prehnite. The plagioclase also shows alteration to sericite, albite and prehnite but the microcline is largely fresh. The visually estimated mineralogy is as listed:

| | |
|--|--------|
| 1. Quartz, granular to poikilitic | 35% |
| 2. Plagioclase, strongly altered to sericite and relatively coarse muscovite | 30% |
| 3. Microcline, granular to subhedral and fresh | 25-30% |
| 4. Biotite variously altered to chlorite, clays prehnite and epidote | 7% |
| 5. Deuteric muscovite as poikilitic flakes | <1% |
| 6. Zircon, allanite and apatite | tr |

The rock is a fine grained biotite adamellite.

5978 Foliated altered adamellite gneiss, transitional towards granodiorite gneiss with albite, sericite, chlorite, clays, prehnite and epidote.

There is a strong planar foliation in this sample which seems to be fresher than the previous three samples of granitoid gneiss, with generally pinkish feldspars visible in hand-specimen, and a foliation partly defined by probable biotite. The visually estimated mineralogy is as listed below:

- | | |
|---|--------|
| 1. Quartz as grains to 5 mm long, elongate parallel to the foliation | 35% |
| 2. Plagioclase grains to about 2 mm long, variably altered to albite and sericite with a few residual fresh cores, typically in lenses elongate parallel to the foliation, alone or with microcline | 35-40% |
| 3. Microcline, fresh and granular, to 3 mm grainsize, generally in lenses with plagioclase, locally with some myrmekite | 20-25% |
| 4. Biotite, fine grained and foliated with various alteration styles to chlorite, clays, epidote and prehnite | 5% |
| 5. Magnetite, apatite, altered probable allanite and zircon | <1% |
| 6. Late-stage muscovite and intergranular carbonate films | <1% |

The mineralogy indicates a former adamellite gneiss, transitional towards granodiorite gneiss.