MINERALOGICAL REPORT No. 7742

by Alan C. Purvis, PhD.

December 3rd , 1998

TO :

Mr Paul Melville
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Unit 5/4 Durand Court
COCONUT GROVE NT 0810

YOUR REFERENCE : Your letter dated 29th October 1998

MATERIAL & IDENTIFICATION :

Drill Core (13), 9649 to 9661

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

SAMPLES & SECTIONS : Returned to you with this report.

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SUMMARY COMMENTS

This report discusses twenty-nine samples from Arnhem Land in the Northern Territory, mainly as petrographic descriptions of fifteen samples of drill chips which were mounted in epoxy and made into composite thin sections and fourteen rock and core samples examined in normal thin sections. Opaque minerals were identified using low angle incident light.

CORE AND ROCK SAMPLES

The core samples have a varied composition and texture, as listed below.

• Basalts	9649, 9651, 9652, 9653, 9654, 9656 (part), 9658
• Grit and conglomerate	?9656 (part), 9659 (partly unidentified lithology), 9661
• Massive hydrothermal alteration assemblages of uncertain exact genesis.	9650, 9655, 9657, 9659, 9660

The basalts have good textural preservation and were glassy to aphyric to microporphyritic, and have suffered sericite-chlorite-leucoxene alteration with regularly to irregularly distributed chlorite and sericite-rich domains. It seems that some chlorite alteration has post-dated the initial sericite-chlorite-leucoxene alteration, with some chlorite replacing sericite.

The quartz-rich sediments have abundant sericite partly replacing quartz and locally have hematite and/or rutile and they commonly contain accessory zircon.

The unidentified lithologies have a base of chlorite and/or a colourless phyllosilicate that may be sericite or talc in most of these samples, plus possible brucite (favouring talc as the colourless phyllosilicate). Various combinations of hematite, rutile, granular to recrystallised apatite and zircon also occur in these samples. In addition, sample 9659, apparently a quartz-rich sediment or a heterogeneous granitoid, has abundant coarse-grained quartz in a matrix similar to the assemblage seen in these unidentified lithologies.

Regarding the "chlorite-rocks" referred to in your letter: some of these are altered basalts with chlorite-sericite alteration followed by further chloritisation of sericite. Others represent unidentified lithologies as indicated above. Further determination of the clay species in these rocks, and/or geochemistry, may be useful in attempting to determine the original lithologies more precisely, but no chloritised Kombolgie sandstone was seen.

The single rock sample 9648 is a massive (fresh) anthophyllite-chlorite rock, which objectively (and in isolation) could be interpreted as a metapyroxenite, or a metamorphosed impure dolomite.

INDIVIDUAL DESCRIPTIONS

DRILL CORE SAMPLES

9649 **Basalt, intensely altered variously to extremely fine chlorite and sericite-rich assemblages ± minor quartz, with abundant dispersed leucoxene and narrow quartz veins ± limonite.**

This sample has a texturally homogeneous relict basaltic texture, now dominated by altered plagioclase laths to 1 mm long, within a leucoxene-rich basaltic mesostasis (possibly crystalline or glassy). However it has millimetre to centimetre scale patches rich in sericite (after plagioclase) ± quartz as well as areas that are rich in chlorite throughout, with very little or no sericite or quartz. There are several quartz stringers to 0.2 mm wide, one of which contains filaments of limonite.

9650 **Rock of massive somewhat heterogeneous alteration mineral assemblage, without specific relict textures, composed of muscovite (or talc?)-chlorite-sericite-rutile-limonite, with unusually large and anomalously abundant zircon grains. Origin uncertain, probably ex-mafic but immobile-element geochemistry may be useful this.**

This rock consists of a rather heterogeneous mass of the following hydrothermal alteration products, without any clear preservation of diagnostic relict textures:

- Flakes and fans to rosettes of probable muscovite or possible talc from 0.5 to 2 mm long;5%
- Flakes and rosettes of chlorite, with individual crystals to 3 mm long, some interlaminated with muscovite;3%
- A complex aggregate with millimetre-scale and smaller domains rich in sericite or in chlorite;80%
- Aggregates to 4 mm long, composed of prismatic crystals of dark brown rutile to 0.5 mm long, locally within coarse muscovite or chlorite aggregates;5%
- Diffuse aggregates and disseminations of limonite to hematite, partly interlaminated with chlorite;7%

- Sparsely disseminated rounded crystals of zircon about 0.2 mm long; <1%

This may represent a former igneous rock but selected immobile-element geochemistry would be useful in attempting to determine the protolith. The presence of relatively abundant zircon is puzzling as the rock would seem to be otherwise mafic and, in particular, rich in titanium.

9651 Aphyric basalt, with intense extremely fine chlorite-sericite-leucoxene alteration.

This sample consists of extremely fine hydrothermal alteration minerals: chlorite, sericite and leucoxene. The section includes large areas with abundant former plagioclase microlites, from 0.1 to 0.5 mm long, which have been replaced by sericite, with interstitial chlorite and about 5% leucoxene. These areas have about 40% sericite, but there are areas, commonly with sharp boundaries, within which much of the plagioclase seems to have been altered to chlorite rather than to sericite. In these areas there may be as little as 10% sericite, but the abundance of sericite increases away from the sharp contact with more sericite-rich rock.

The original lithology was an aphyric basalt, but the pattern of alteration is to some extent unusual. When the thin section is viewed macroscopically there seem to be concentric patterns suggesting possibly small pillows or pahoehoe toes.

9652 Plagioclase porphyritic basalt 'toe' with zonally arranged alteration to sericite or chlorite-rich assemblages, with leucoxene and limonite.

In handspecimen, this sample is seen to have a curious pattern of zoning, and the thin section when viewed macroscopically looks like an X-ray picture of a thumb or toe. It may be part of a hyaloclastite or a portion of the surface of a pahoehoe flow. The extensive extremely fine alteration is similar to that in the previous sample, but has slender plagioclase phenocrysts to 2 mm long, altered to sericite, as well as abundant altered plagioclase microlites, also mostly sericite. The various zones have more or less abundant sericite and chlorite, but relatively uniformly disseminated leucoxene. The 'bones' and 'skin' are richer in sericite, whereas the 'flesh' is richer in chlorite. There is also irregularly disseminated limonite commonly in irregular patches a millimetre in diameter.

9653 Ex-sparsely plagioclase, microporphyritic basalt, with extensive intense patchy alteration involving sericite to chlorite-leucoxene. Rare quartz stringers.

Sparsely scattered sericitised plagioclase phenocrysts to 1 mm long are seen in this sample in a groundmass composed of intensely sericitised plagioclase laths less than 0.4 mm long. In much of the rock chlorite is minor (10-25%), but there are diffuse patchy areas with up to 80% chlorite, with much of the former plagioclase altered to chlorite as well as or instead of sericite. There are several quartz stringers, more commonly in the chlorite-rich areas than in the sericite-rich areas, but rare grains of quartz are seen in the sericite-rich areas. Very fine leucoxene is disseminated throughout.

9654 Basalt with irregular diffuse, patchy and intense sericite to chlorite-rich alteration, also irregularly distributed leucoxene.

This sample has millimetre to centimetre scale patchy domains within which unoriented plagioclase laths from 0.5 to 1.5 mm long have been replaced by sericite, with interstitial chlorite and leucoxene, passing into less sericite-rich areas. In the less sericite-rich areas only the cores of plagioclase laths have sericite and the bulk of the rock is chlorite and leucoxene. Superimposed on this heterogeneity is a finer-scale heterogeneity.

The leucoxene in this rock is of two types: a microcrystalline variety representing titanium in glass or mafic silicates, and leucoxene after discrete dendritic opaque oxide crystals to 0.3 mm long. There are millimetre-scale domains rich and poor in microcrystalline leucoxene, with leucoxene after dendritic opaque oxide slightly more abundant in those areas lacking microcrystalline leucoxene.

The original lithology was a basalt.

9655 Chlorite-hematite-?brucite-altered, fine granular, former granular rock, of uncertain composition but probably ex-igneous (?mafic) selected immobile-element geochemistry may indicate further identification.

This is a heterogeneous rock but composed largely or irregular diffuse patches of dense microcrystalline dark chlorite to 2 mm in diameter with scattered interstitial patches of possible brucite to 1 mm long. There is also a large diffuse area with up to 10% microplaty hematite, partly decussate and partly in rosettes.

Some areas of the rock have only about 5% possible brucite but others have 10-15%, including rare patches to 4 mm long with the possible brucite disseminated through chlorite. There seems to be no leucoxene in this sample, and only a single grain of zircon was seen, about 60 μm long.

The protolith is uncertain, but a granular igneous rock is likely. The nature of any such protolith could be tested with immobile element geochemistry.

9656 Contact between sericite-chlorite-rutile-altered glassy basalt and a sericite- chlorite-altered probably quartzofeldspathic lithology, possibly a pegmatite, with accessory rutile and zircon, (or a fine-grained quartzofeldspathic conglomerate??).

There is an irregular contact in this thin section, between altered plagioclase porphyritic quenched basalt, and an altered rock with quartz-rich and sericite-rich domains. The basalt has sericitised microphenocrysts of plagioclase less than 1 mm long in a mottled sericite-chlorite-rutile-limonite-altered groundmass with microcrystalline rutile rather than leucoxene. The mottles seem to suggest microspherulitic devitrification of the basalt before alteration. Narrow quartz veins in a rectilinear set have zoned alteration zones to 1 mm wide with sericite and chlorite-rich zones as well a lenses of microgranular dark brown rutile.

The adjacent rock has several components:

- Quartz as single grains to 7 mm in diameter and as lenses to 15 mm in diameter, composed of grains to 3 mm long.40%

- Irregular patches of decussate sericite possibly replacing former grains (?feldspar) to 4 mm long, locally enclosing small zircon grains.50%

- Patches of chlorite, locally with aggregates of dark brown rutile crystals, replacing material that was interstitial to the sericitised grains.7-8%

- Patches and veinlets of microplaty hematite.2-3%

- Zircon as crystals to 0.3 mm long, usually zoned.Tr

This latter lithology may represent a granitoid-related pegmatite, (but it could be a fine quartz-felspar conglomerate).

9657 Massive, very fine and somewhat heterogeneous phyllosilicate-hematite-(?chlorite/brucite-apatite-zircon-rutile) rock. Origin uncertain.

This sample has little or no textural preservation and is composed of a rather heterogeneous mass of very fine components as follows:

- Microcrystalline to fine-grained colourless phyllosilicate, possibly sericite or talc, with some small fans and spherulites, similar in texture to sample 9650, but finer-grained and without the abundant chlorite seen in that sample85%

- Small patches of chlorite or brucite as seen in sample 9650, again commonly in fans and spherulites.5%

- Microplaty hematite, disseminated and in small aggregates, including rosettes.8-10%

- Grains and aggregates of apatite to 2 mm long.1%

- Disseminated rounded and fractured to fragmented zircon grains to 0.3 mm long.Tr

- Very rare rutile, suggesting a titanium-poor protolith.Tr

If the phyllosilicate is sericite then the protolith may have been feldspathic, but selected immobile-element geochemistry may be useful in further determining the original lithology.

9658 Altered glassy basalt with sericite after plagioclase and chlorite after ferromagnesian crystals in a brown, clouded formerly glassy groundmass, cut by chlorite veins.

Sericitised microphenocrysts of plagioclase to 0.8 mm long, and less abundant chloritised ferromagnesian crystals to 0.4 mm long, are scattered through this rock, within an altered devitrified groundmass. The groundmass has abundant microlites of plagioclase is a brown glass that is now altered but is clouded and the mineralogy is indeterminate. It may be dominated by sericite but other minerals, such as quartz, albite or chlorite are also possible. There are several stringers filled by chlorite and diffuse areas that seem to have been flooded by microcrystalline quartz.

The original lithology was a glassy basalt.

9659 Quartz-phyllosilicate-chlorite-?brucite-altered grit or heterogeneous granitoid, with aggregates of apatite, also accessory rutile and zircon.

Large single crystal quartz grains, to 4 mm in diameter, comprise about 35-40% of this rock, scattered through a matrix similar to sample 9657. This matrix has abundant colourless phyllosilicate, talc or sericite with up to 10% dull green chlorite (showing a low birefringence) as well as a second uniaxial positive micaceous mineral which is colourless and has a higher birefringence than the chlorite. This mineral, which comprised up to 5 % of the rock, is possibly brucite.

There are also grains and recrystallised aggregates of apatite to 1.5 mm long and patches of hematite to 2 mm long. Rutile is disseminated, to 0.4 mm in grainsize, but is uncommon to rare. Accessory zircon occurs as grains about 0.1 mm long.

The overall texture of this sample, as viewed macroscopically, would seem to permit a quartzofeldspathic sandstone to grit, or a heterogeneous granitoid, with all non-quartzose components completely altered.

9660 **Heterogeneous chlorite-phyllosilicate-?brucite rock with leucoxene, zircon, rutile and apatite, as a hydrothermal alteration assemblage replacing a possible ex-basalt to dolerite, but with poor textural preservation. Immobile-element geochemistry may help elucidate the precursor.**

The textures seen in this massive altered rock seem to have been flattened, defining a weak foliation but they are too poorly preserved to specifically identify a former rock type. The mineralogy is similar in some respects to some of the previous samples with:

- Irregular lenses to 3 mm long of relatively coarse-grained unoriented colourless phyllosilicate, possibly talc, with a common elongation direction, defining a foliation.40%
- A matrix rich in dull green microcrystalline, almost isotropic chlorite with some leucoxene.55-60%
- Small patches of possible brucite as seen in some of the previous samples.2%
- Rare zircon grains to 0.15 mm (150 μm) long.Tr
- Lenses of apatite to 2 mm long.<1%
- Rare rutile as small grains and aggregates to 0.4 mm in diameter.Tr

The original lithology may have been a basalt to dolerite but this is unclear and selected immobile-element geochemistry may assist in the interpretation. The presence of lenses of apatite and disseminated zircon is difficult to explain.

9661 **Fine-grained quartz-rich conglomerate or grit with an extensive sericite matrix, and rare altered detrital biotite. Minor poorly defined and discontinuous laminae or lamellae of fine to medium grained sandstone rich in zircon and leucoxenised opaque oxide, rare patches of hematite with a possible alunite or jarosite-group mineral. Probably Kombolgie ferromagnesian with hydrothermal sericitic alteration.**

Abundant rounded single crystal quartz grains, mostly 1 to 5 mm in diameter, indicate that this is a fine-grained conglomerate or grit. An unusually abundant sericite matrix is present and may have replaced some of the quartz. Rare chlorite-leucoxene and

sericite-leucoxene pseudomorphs of probable biotite flakes occur and there are rare patches of hematite with a microcrystalline rhombic mineral that may belong to the alunite or jarosite group.

Narrow lamellae occur with single crystal quartz grains about 0.25 mm in diameter (fine to medium grained sandstone) and almost all of the zircon in the rock occurs in these lamellae, with a grainsize of about 0.2 mm.. Leucoxenised opaque oxide grains also occur in and adjacent to these lamellae.

This is probably part of the Kombolgie Formation, but with an extensive intensively sericitised matrix.