APPENDIX VI:

EL 2517, 9354

ALGODO

MASON GEOSCIENCE PTY. LTD.

PETROGRAPHIC REPORT #2357

Mason Geoscience Pty Ltd Report: Drill Sample Listing

SAM#	HOLE	FROM	TO	EL	LITHOLOGY	LAB	TECH	SENT	RETURN
ALG001 206	ALG001	206.30	206.35	9354	Representitve basement. Oenpelli Dolerite	M	PXRD	7/08/97	16/09/97
ALG001 210	ALG001	210.00	210.50	9354	Oenpelli dolerite	M	XRD	7/08/97	16/09/97
ALG001 214	ALG001	214.00	214.05	9354	Oenpelli dolerite	M	XRD	7/08/97	16/09/97
ALG001 233	ALG001	213.00	213.05	9354	Oenpelli dolerite	M	P	7/08/97	16/09/97
ALG002 164	ALG002	164.00	164.05	9354	Nourlangie schist, thin section	M	P	7/08/97	16/09/97
ALG002 180	ALG002	180.00	180.05	9354	Representitive basement, Nourlangie schist, thin section	M	P	7/08/97	16/09/97
ALG002 206	ALG002	206.00	206.05	9354	Representitive basement, Nourlangie schist, thin section	M	P	7/08/97	16/09/97
ALG002 277	ALG002	277.00	277.05	9354	Representitive basement, Nourlangie schist, thin section	M	P	7/08/97	16/09/97
ALG002 280	ALG002	280.60	280.65	9354	Representitive basement, Nourlangie schist, thin section	M	P	7/08/97	16/09/97
ALG003 254	ALG003	254.10	254.15	9354	Representitive basement, Nourlangie schist, thin section	M	P	7/08/97	16/09/97
ALG003 229	ALG003	229.60	229.65	9354	Representitive basement, Nourlangie schist	M	XRD	7/08/97	16/09/97

Mason Geoscience Pty. Ltd.

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REPORT TITLE	**Petrographic Descriptions for Fifteen Drill Core Rock Samples from beneath the Kombolgie Sandstone (West Arnhem Land, NT)**
REPORT #	2357
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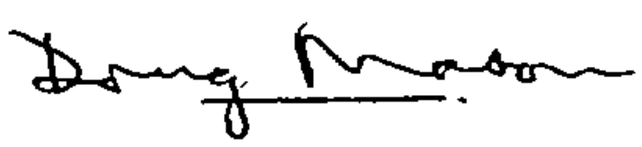
SIGNED	 for Mason Geoscience Pty. Ltd.
DATE	16 September 1997

Petrographic Descriptions for Fifteen Drill Core Rock Samples from beneath the Kombolgie Sandstone (West Arnhem Land, NT)

SUMMARY

1. Rock Samples

- Eight drill core rock samples from beneath the Kombolgie Sandstone (West Arnhem Land, NT) have been studied using petrographic and limited mineragraphic methods. Mineral identifications by X-ray diffraction methods have been obtained for specified samples.

2. Brief Results

- Rock names and mineralogy are summarised in TABLE 1.

- Primary rock types

  - Most samples represent sedimentary rocks of quartzo-feldspathic, pelitic, semi-pelitic or calc-silicate composition.

  - Compositional layering of inferred primary sedimentary origin is identified in some samples. Thin lamination represents compositional layering in a fine-grained sedimentary precursor. Cross-lamination is poorly preserved in some samples. Lensoidal calc-silicate layering is identified in sample ALG 2, 180.0m.

  - One sample of micrographic quartz dolerite is identified (ALG 1, 233.0m).

- Metamorphism

  - All sedimentary rocks have suffered regional metamorphism of medium grade. The presence of staurolite + sillimanite ± garnet in meta-pelitic rocks of ALG 2, confirm that conditions appropriate to the lower to middle amphibolite facies were attained. This is supported by stable assemblages containing dark green-brown hornblende + plagioclase in semi-pelitic to calc-silicate rocks of ALG 2.

  - Micrographic quartz dolerite in ALG 1 lacks metamorphism, and therefore is significantly younger than the meta-sedimentary rocks.

- Alteration has affected most samples:

  - Sericitic alteration has affected quartz dolerite and nearby ?arenite in ALG 1. The alteration event therefore occurred at dolerite or post-dolerite time, much younger than the regional metamorphic event.

  - Low-intensity sericite-chlorite alteration has affected samples in ALG 2. Thin fractures in these rocks may be filled by assemblages of carbonate, chlorite, prehnite, and opaques. K-feldspar is an additional fracture-filling phase in ALG 3.

TABLE 1: SUMMARY OF ROCK NAMES AND MINERALOGY

SAMPLE	ROCK NAME	MINERALOGY*		
		Primary**	Metamorphic/alteration***	Veins
ALG 1, 206.3m	Sericite-altered rock (altered ?arenite)	Zir	Ser,cla,Feox,rut	-
ALG 1, 233.0m	Sericite-altered micrographic quartz dolerite	Cpx,pla,opq,qtz,Kf,hbl,bio,apa	Ser,serp	-
ALG 2, 164.55m	Sericite-chlorite altered muscovite-biotite quartzo-feldspathic gneiss	-	Qtz,mus,rut,opq,apa; Ser,chl,rut,opq	-
ALG 2, 180.0m	Sericite-chlorite altered layered para-amphibolite:			
"	Para-amphibolite	-	Pla,hbl,bio,qtz; Chl,opq,car	Car
"	Sericite-chlorite altered calc-silicate layer	-	Pla,zoi,gar,apa; Chl,ser,opq	Chl,opq
ALG 2, 206.0m	Weakly chlorite-sericite altered mica-staurolite-garnet schist	-	Qtz,mus,bio,stt,gar,tou,?sil; Ser,chl	-
ALG 2, 277m	Mica-staurolite-garnet schist	-	Qtz,mus,bio,pla,stt,gar,tou,?sil; Ser	-
ALG 2, 280m	Fractured and altered, veined para-amphibolite	-	Hbl,pla,qtz,bio; Ser,pre,opq	Pre,cal,chl
ALG 3, 254.10m	Fractured and veined, quartzo-feldspathic schist	?Pla	Pla,qtz,bio,apa; Chl,ser	Cal,Kf,chl

NOTES ON TABLE 1: SUMMARY OF ROCK NAMES AND MINERALOGY

NOTES:
*: Minerals are listed in each paragenesis according to approximate decreasing abundance.
**: Only primary minerals currently present in the rock are listed. Others may have been present, but are altered.
***: Earlier parageneses are separated from later parageneses by a semicolon.

Mineral abbreviations:
Apa = apatite; bio = biotite; cal = calcite; car = undifferentiated carbonate minerals; chl = chlorite; cla = undifferentiated clay mineral; cpx = clinopyroxene; cpy = chalcopyrite; Feox = undifferentiated Fe-Ti oxide minerals (magnetite, ilmenite); gar = garnet; grp = graphite; hbl = hornblende; hem = hematite; Kf = K-feldspar; ill = illite; leu = leucoxene; mus = muscovite; opq = undifferentiated opaque minerals; pla = plagioclase; pre = prehnite; py = pyrite; qtz = quartz; rut = rutile; ser = sericite; serp = serpentine; sil = sillimanite; stt = staurolite; tou = tourmaline; zir = zircon; zoi = zoisite; ? = uncertain mineral identification.

1. INTRODUCTION

Eight drill core rock samples were received from Mr Daniel Alonso (AFmeco Mining and EXploration Pty Ltd, Winnellie, NT) on 19 August 1997.

It was indicated that the samples originate from various locations beneath the Kombolgie Sandstone in West Arnhem Land. Particular requests were:

i) To prepare a thin section and a routine petrographic description (service code PETRO 2) for 8 samples.

ii) To obtain mineral identification by X-ray diffraction (XRD) methods for 2 specified samples.

The SUMMARY and TABLE 1 of the report were provided by facsimile to Mr. Alonso at the Darwin office of AFmeco Mining and EXploration Pty Ltd on 16 September 1997. This report contains the full results of this work.

2. METHODS

The samples were examined in hand specimen and marked for section preparation. Thin sections and one polished thin section were obtained from an external commercial laboratory (Pontifex & Associates Pty Ltd, Rose Park, South Australia).

At Mason Geoscience Pty Ltd, conventional transmitted polarised light microscopy was used to prepare the routine petrographic descriptions. Additional reflected light mineragraphic observations were included in a combined petrographic and mineragraphic description where a polished thin section was available.

Mineral identifications by X-ray diffraction methods were obtained from Amdel Ltd (Thebarton, South Australia). The full results are reported in APPENDIX 1.

3. PETROGRAPHIC DESCRIPTIONS

The petrographic descriptions are provided in the following pages.

SAMPLE : ALG 1, 206.3m

SECTION NO. : ALG 1, 206.3m

HAND SPECIMEN : The drill core rock sample represents a uniformly fine-grained cream-coloured sandstone, in which indistinct layering is defined by thick yellowish-cream layers and more diffusely distributed reddish-brown materials.

ROCK NAME : **Sericite-altered rock (altered ?arenite)**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Sericite	98	Alteration
Clay (?illite, ?kaolinite)	1	Alteration
Iron oxide (?hematite)	Tr	Alteration
Rutile	Tr	?Alteration
Zircon	Tr	Relict clastic

In thin section, this sample displays a massive, compositionally uniform, fine-grained alteration texture, with only a trace of preserved primary minerals and no preserved primary textures.

Sericite completely dominates the rock. It occurs as small but well-crystallised flakes mostly ~0.05-0.1 mm in size, but ranging up to ~0.2 mm. They form a densely packed, massive mat throughout the rock.

Clay is identified locally as cryptocrystalline, dense, massive patches ~0.5-1.0 mm in size. They may represent thoroughly altered precursor mineral grains (e.g. feldspar), but no independent evidence (e.g. crystal shapes or remnant crystal kernels) remains for confirmation. The complete lack of colour and very low birefringence suggest that the clay may be illite or possibly kaolinite.

Iron oxide occurs in trace amount as small ragged grains sparsely and irregularly scattered through the rock. The deep dark red-brown to opaque colour in plane transmitted light allows the phase to be goethite or hematite. No reflected light observations are available for confirmation.

Rutile occurs as small ragged grains and granular aggregates sparsely scattered through the rock. The size and shape of the crystals confirms it is of alteration origin.

Zircon occurs in trace amount as small equant growth-zoned crystals, mostly ~0.1-0.2 mm in size. Most are subrounded in shape, and some display fractured shapes. These features confirm that the zircon occurred as clastic grains in a precursor clastic sediment.

INTERPRETATION:

This sample represents an unknown precursor rock, probably of clastic sedimentary origin, that has suffered strong pervasive alteration, generating the assemblage sericite + minor clay (?illite, ?kaolinite) + trace rutile + iron oxide (?goethite, ?hematite).

Zircon represents the only preserved primary phase. It formed subrounded, fractured crystals of clastic sedimentary origin. It is therefore suggested that the precursor rock was an arenaceous clastic sediment, possibly of feldspathic composition.

SAMPLE : ALG 1, 233.0m

SECTION NO. : ALG 1, 233.0m

HAND SPECIMEN : The drill core rock sample represents a massive, medium-grained grey rock in which paler cream-coloured areas and darker greenish black areas are evident.

The sample responds weakly to the hand magnet, suggesting minor magnetite is present.

ROCK NAME : **Sericite-altered micrographic quartz dolerite**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Plagioclase	15	Relict igneous
Clinopyroxene	35	Igneous
Opaques (incl. magnetite)	2	Igneous
Quartz	7	Igneous
K-feldspar (orthoclase)	3	Igneous
Hornblende (brown to green)	2	Igneous
Biotite	2	Igneous
Apatite	Tr	Igneous
Sericite	32	Alteration (after plagioclase)
Serpentine (incl. fine opaques)	2	Alteration (after ?olivine)

In thin section, this sample displays a well-preserved subophitic massive doleritic texture, with local micrographic intergrowths.

Plagioclase was abundant, forming randomly oriented prismatic crystals ~0.4-1.5 mm long (mostly ~1 mm). Most have suffered complete replacement by fine-grained dense mats of randomly oriented sericite sheaves, but some have escaped alteration and display their primary polysynthetic twinning and normal compositional zoning.

Clinopyroxene is moderately abundant, forming large anhedral grains ~1-2 mm in size. They display a pale fawn-brown colour, and commonly enclose or partly enclose smaller plagioclase prisms in characteristic subophitic relationship.

Opaques occur in different forms:

i) Some occur as large subhedral crystals ~1-2 mm in size, partly enclosing plagioclase crystals. These clearly represent primary Fe-Ti oxide crystals (including magnetite).

ii) Some opaques occur as aggregates of small grains scattered through the rock, and appear to represent late-forming primary opaques.

iii) A small amount of opaques occur as dense aggregates of tiny grains in dark green serpentine patches of angular form. These appear to represent altered olivine crystal sites.

Quartz forms clear grains that occur as angular interstitial patches, and as micrographic intergrowths with dusty brown K-feldspar (orthoclase).

Biotite occurs as pleochroic brown flakes that mantle opaque grains, and may occur as dense interstitial aggregates.

Hornblende forms minor subhedral to euhedral crystals, pleochroic from dark brown to green. Margins of crystals may display deep green colours. They clearly represent late-forming interstitial magmatic crystals.

Apatite occurs in trace amount as acicular crystals in interstitial areas.

INTERPRETATION:

This sample represents a doleritic igneous rock. Early-forming phases (plagioclase, clinopyroxene, ?olivine, Fe-Ti oxides) were followed by later-forming interstitial phases (biotite, hornblende, quartz, orthoclase, apatite).

Two petrographic aspects suggest that the rock formed as a fractionated, late-forming product within a differentiated mafic intrusion:

i) The abundance of interstitial quartz and its association with orthoclase in micrographic intergrowths suggests that the magma was significantly fractionated, compared with an unfractionated basaltic magma.

ii) The relatively coarse grain size supports crystallisation in a relatively large intrusive body.

The significant amount of quartz confirms that the doleritic magma was fractionated from a quartz-tholeiite basaltic magma.

Invasion of the rock body by low volumes of hydrothermal fluid allowed partial replacement of plagioclase by sericite.

SAMPLE : ALG 2, 164.55m

SECTION NO. : ALG 2, 164.55m

HAND SPECIMEN : The drill core sample represents a medium-grained, compositionally uniform, moderately foliated rock in which alignment of small pale grey grains and dark green grains defines the foliation.

ROCK NAME : **Sericite-chlorite altered muscovite-biotite quartzo-feldspathic gneiss**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Quartz	40	Metamorphic
Muscovite	5	Metamorphic
Rutile	Tr	Metamorphic / alteration
Apatite	Tr	Metamorphic
Opaques	Tr	?Metamorphic / alteration
Sericite	44	Alteration (after feldspar)
Chlorite (green and colourless)	10	Alteration (after biotite)

In thin section, this sample displays a well-preserved medium-grained foliated granoblastic metamorphic texture, modified by selective pervasive alteration.

Quartz is abundant, forming anhedral unstrained grains distributed more-or-less uniformly through the rock. They range in size ~0.5-1.0 mm long, and larger grains and polycrystalline quartz aggregates tend to be elongated in the trace of the foliation.

Feldspar was abundant, forming anhedral grains up to ~1 mm long in granoblastic relationship with quartz. All of the feldspar has suffered complete replacement by fine-grained mats of sericite and ragged patches of very fine pale green to colourless chlorite (see chlorite below). No feldspar is preserved, but the presence of mimicked twin lamellae in some grains suggests that plagioclase was the principal feldspar.

Chlorite occurs as pseudomorphous replacements of well-crystallised, foliated biotite flakes up to ~1 mm long. All have suffered complete replacement by colourless chlorite (?Mg-rich) peppered with small granules of rutile. A lesser amount of pleochroic green chlorite (Fe-rich) also occurs as replacements in some biotite crystal sites. Strong preferred orientation of the biotite crystals contributed to definition of the strong foliation through the rock. Although all of the large biotite flakes have been altered, rare tiny ragged biotite flakes are preserved where they occur entrapped within a single larger quartz grain.

Muscovite forms large, well-crystallised flakes similar in size to the biotite flakes. They are distributed sparsely through the rock, and their strong preferred orientation also contributes to the foliation.

Apatite occurs in trace amount as small stumpy colourless crystals enclosed in quartz. Their preferred orientation contributes to the foliation through the rock.

Rutile occurs in two forms:

i) Some occurs as tiny granules in chlorite-altered biotite crystal sites. This rutile clearly is of alteration origin.

ii) Some occurs as larger angular grains up to ~0.1 mm in size. They are closely associated with primary metamorphic muscovite and biotite crystal sites, and therefore are inferred to be of metamorphic origin.

Opaques are uncommon, forming elongate crystals very sparsely scattered through the rock. Some display very fine-grained, deep red granules near margins: this suggests that hematitic alteration of precursor Fe-Ti oxide grains has occurred.

INTERPRETATION:

This sample represents a gneissic rock, originally composed of the foliated assemblage of feldspar (plagioclase) + quartz + biotite + muscovite + rutile. The metamorphic mineral assemblage is not unique, allowing middle greenschist to amphibolite facies grades. However, the relatively coarse grain size and well-crystallised nature of the phases supports a higher rather than lower grade (e.g. amphibolite rather than greenschist facies). No precursor minerals or textures are preserved to allow identification of the precursor rock, but a pelitic to quartzo-feldspathic sedimentary precursor is inferred.

Subsequent invasion by hydrothermal fluids resulted in selective pervasive alteration to the assemblage sericite + chlorite (both green and colourless) + rutile + ?hematite. Metamorphic plagioclase and biotite suffered complete replacement by sericite and chlorite + rutile respectively, but metamorphic quartz, muscovite and rutile survived the alteration event.

SAMPLE : ALG 2, 180.0m

SECTION NO. : ALG 2, 180.0m

HAND SPECIMEN : The drill core sample represents a fine-grained, foliated, dark green rock in which indistinct layering is defined by slight colour variations and by the presence of coarser-grained lenses.

ROCK NAME : **Sericite-chlorite altered layered para-amphibolite**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Para-amphibolite		
Plagioclase	40	Metamorphic
Hornblende	40	Metamorphic
Biotite	15	Metamorphic
Quartz	5 (2-10)	Metamorphic
Chlorite	Tr (0-20)	Alteration
Opaques	Tr	Alteration / fracture filling
Carbonate	Tr	Fracture filling
Altered calc-silicate layer		
Plagioclase	20	Metamorphic
Zoisite	15	Metamorphic
Garnet	10	Metamorphic
Apatite	1	Metamorphic
Chlorite (incl. fine quartz)	34	Alteration (after ?pyroxene)
Sericite	20	Alteration
Opaques	Tr	Alteration

In thin section, this sample displays a strongly foliated granoblastic metamorphic texture in most of the rock, and coarser-grained massive granoblastic metamorphic texture in a lensoidal layer.

Para-amphibolite is dominated by plagioclase and hornblende. Plagioclase forms anhedral grains ~0.2-0.4 mm long, slightly elongated in the trace of the foliation. They are quite fresh. Hornblende forms larger elongate grains ~1 mm long, pleochroic in greens, whose preferred orientation contributes to the foliation through the rock.

Biotite is moderately abundant, forming well-crystallised flakes ~1 mm long, pleochroic from dark tan brown to straw yellow. They are quite fresh, except for local replacement along cleavage traces by green chlorite.

Quartz occurs in minor amount as anhedral grains that occur in variable amounts in different horizons.

In some horizons, fine-grained pale green chlorite has pseudomorphously replaced precursor small blocky to anhedral grains (possibly pyroxene, but none is preserved for confirmation).

A small amount of carbonate occurs as granular fillings in rare thin fractures subparallel to foliation.

Altered calc-silicate layer displays a coarse-grained granoblastic texture that is variable in grain size and mineralogy from place to place in the layer. Plagioclase occurs as stumpy subhedral to anhedral grains. Zoisite forms equant euhedral colourless crystals with characteristic lack of pleochroism, high relief, straight extinction, and anomalous blue-yellow interference colours.

Garnet occurs in significant amount as subhedral crystals and aggregates of grains with very pale drab pinkish brown colour.

Pale green chlorite and intergrown patches of fine-grained pale brown quartz have pseudomorphously replaced large ragged grains and smaller subhedral crystals of an Fe-Mg silicate phase (probably diopsidic clinopyroxene, but none is preserved).

Sericite occurs as fine-grained massive replacements of precursor large ragged grains that may have been scapolite (but none is preserved).

The margins of the calc-silicate lensoidal layer are composed almost entirely of elongated foliated grains of dark green hornblende, within which ragged patches of green alteration chlorite and fine-grained dense opaques (probably sulphide, e.g. pyrite) are aligned along the foliation.

INTERPRETATION:

This sample represents a layered sedimentary rock, mostly semi-pelitic to calc-silicate in composition, and containing layers of calc-silicate composition. The rock suffered regional metamorphism in the amphibolite facies, causing recrystallisation to assemblages appropriate to the precursor compositions:

i) Semi-pelitic layers (most of the rock) recrystallised to the foliated, even-grained, granoblastic assemblage of plagioclase + hornblende + biotite + minor quartz. Local layers may have contained pyroxene.

ii) Calc-silicate layers recrystallised to coarse-grained, massive assemblages of plagioclase + zoisite + garnet + ?diopside + ?scapolite. Margins of these layers recrystallised to dense mats of hornblende.

Subsequent low-grade retrogressive alteration resulted in complete replacement of ?diopside by chlorite + quartz, complete replacement of ?scapolite by sericite, partial replacement of biotite by chlorite, and development of minor elongated patches of chlorite + opaques (?sulphide) along the foliation planes.

SAMPLE : ALG 2, 206.0m

SECTION NO. : ALG 2, 206.0m

HAND SPECIMEN : The drill core sample represents a foliated grey rock, in which indistinct layering on the centimetre scale is defined by slight colour variations reflecting mineralogical variations.

ROCK NAME : **Weakly chlorite-sericite altered mica-staurolite-garnet schist**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Quartz	55	Metamorphic
Muscovite	20	Metamorphic
Biotite	15	Metamorphic
Staurolite	5	Metamorphic
Garnet	2	Metamorphic
Tourmaline	Tr	Metamorphic
?Sillimanite	Tr	Metamorphic
Sericite	1	Alteration
Chlorite	1	Alteration

In thin section, this sample displays a medium-grained, foliated, granoblastic metamorphic texture, modified by slight alteration.

Quartz is abundant, occurring as unstrained anhedral grains ~0.2-0.4 mm in size. They are distributed more-or-less uniformly through the rock.

Muscovite is moderately abundant, forming large well-crystallised flakes ~0.2-2.0 mm long (mostly ~0.5-1.0 mm). They are more abundant in some horizons.

Biotite is moderately abundant, forming well-crystallised flakes, similar in size to muscovite. It is pleochroic from reddish tan brown to very pale yellow, suggesting a relatively reduced composition. In some horizons, the biotite forms smaller flakes. Some biotite flakes display partial replacement by pale green chlorite.

Staurolite occurs in significant amount as anhedral grains up to ~1 mm in size, somewhat spongy from small quartz inclusions. The staurolite displays the characteristic optical features of this phase: high relief, pleochroic from yellow to colourless, moderate birefringence, parallel extinction.

Garnet is uncommon, forming large poikiloblastic grains up to ~2 mm in size, very sparsely scattered through the rock. The pale buff pink colour suggests an almandine-rich composition.

Tourmaline occurs in minor amount as large equant euhedral crystals ~1 mm in size, pleochroic in drab green colours.

Sillimanite may be present in trace amount, forming tiny acicular crystals in diffuse clouds in some quartz grains. Identification at this fine grain size is difficult.

Sericite occurs in minor amount as fine-grained replacements of precursor small ragged grains that were concentrated in particular horizons. It may be altered staurolite or possibly cordierite, but none is preserved in the altered grain sites.

INTERPRETATION:

This sample represents a sedimentary rock of broadly pelitic composition. It has suffered regional metamorphism in the lower to middle amphibolite facies, generating the foliated granoblastic assemblage of quartz + muscovite + biotite + staurolite + garnet + tourmaline + trace ?sillimanite. The well-crystallised nature of the rock and lack of strain in the quartz confirms that the rock achieved equilibrium recrystallisation, but a regional compressional regime constrained phyllosilicate phases (muscovite, biotite) to grow with strong preferred orientation, defining the foliation through the rock.

Subsequent slight alteration resulted in replacement of a minor unknown phase by sericite, and incipient replacement of biotite by chlorite.

SAMPLE : ALG 2, 277m

SECTION NO. : ALG 2, 277m

HAND SPECIMEN : The drill core sample represents a medium-grained, strongly foliated, grey rock in which the foliation is enhanced by dark foliae.

ROCK NAME : **Mica-staurolite-garnet schist**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Quartz	60	Metamorphic
Muscovite	20	Metamorphic
Biotite	15	Metamorphic
Plagioclase	2	Metamorphic
Staurolite	2	Metamorphic
Garnet	<1	Metamorphic
Tourmaline	Tr	Metamorphic
?Sillimanite (incl. fibrolite)	Tr	Metamorphic
Sericite	Tr	Alteration (after staurolite)

In thin section, this sample displays a foliated granoblastic metamorphic texture, mostly even-grained but somewhat coarser-grained in some horizons richer in phyllosilicates.

Quartz is abundant, occurring as anhedral equant unstrained grains ~0.2-0.6 mm in size (average ~0.4 mm).

Muscovite is moderately abundant, forming well-crystallised flakes ~0.4 mm in average length. The strong preferred orientation contributes to definition of the foliation through the rock. The muscovite is coarser-grained and more abundant in some horizons.

Biotite builds well-crystallised flakes, similar in size to muscovite. It is pleochroic from reddish brown to pale straw yellow, suggesting a relatively reduced composition.

Plagioclase occurs in minor amount as small anhedral grains, generally aligned in the trace of the foliation. It is readily distinguished from the quartz by the presence of weakly developed twinning, and tendency to suffer incipient replacement by minute sericite flecks.

Staurolite occurs in minor amount as small anhedral grains that display the characteristic high relief and strong yellow pleochroism of this phase. Uncommon larger grains up to ~2 mm in size occur in the phyllosilicate-rich horizon. Some staurolite grains display partial replacement by fine-grained massive sericite along microcracks and around grain margins. Small sericite-altered grains in the rock are considered to have been staurolite.

Garnet is present in minor amount as small subhedral to anhedral grains, concentrated in small garnet-quartz patches ~2 mm in size, very sparsely scattered through the rock.

Tourmaline occurs in trace amount as small equant euhedral crystals, pleochroic in drab greens.

Possible sillimanite may occur in trace amount in two forms: as poorly-crystallised sheaves after biotite in fibrolitic foliated mats, and as tiny acicular crystals enclosed in quartz.

INTERPRETATION:

This sample represents a broadly pelitic sedimentary rock that has suffered regional metamorphism in the lower to middle amphibolite facies, generating the foliated granoblastic assemblage of quartz + muscovite + biotite + plagioclase + staurolite + garnet + possible trace sillimanite + tourmaline.

Weak retrogressive alteration has caused partial replacement of staurolite by fine-grained massive sericite.

SAMPLE : ALG 2, 280m

SECTION NO. : ALG 2, 280m

HAND SPECIMEN : The drill core sample represents a greenish grey foliated rock, in which an early thicker ptygmatic felsic veinlet is cut by a later planar fracture with indistinct pale selvedge alteration.

ROCK NAME : **Fractured and altered, veined para-amphibolite**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	**Vol.%**	**Origin**
Hornblende	50	Metamorphic
Plagioclase	22	Metamorphic / vein filling
Quartz	10	Metamorphic / vein filling
Biotite (incl. chlorite)	7	Metamorphic
Sericite	10	Alteration (after plagioclase, biotite)
Opaques	Tr	?Alteration
Prehnite	Tr	Fracture filling
Calcite	Tr	Fracture filling
Chlorite	Tr	Fracture filling

In thin section, this sample displays a foliated granoblastic metamorphic texture, with indistinct early discordant veins, cut by late thin fractures and associated selective pervasive alteration.

Hornblende is abundant, occurring throughout the rock as small anhedral grains ~0.2-0.4 mm long aligned in the trace of the foliation. The hornblende displays pleochroism from dark green to pale brown.

Plagioclase is moderately abundant, occurring in two sites:

i) Most occurs as small anhedral grains ~0.1-0.2 mm in size, distributed uniformly through the rock in granoblastic relationship with hornblende. Many grains have suffered partial to complete replacement by fine turbid sericite.

ii) A small amount of plagioclase occurs as larger anhedral grains, concentrated in coarse-grained veins that are discordant to foliation but display indistinct margins with wall rock.

Quartz occurs in minor amount as small equant grains, distributed sparsely but uniformly through the rock in granoblastic relationship with hornblende and plagioclase. A small amount of quartz occurs as larger grains in the coarser-grained plagioclase-rich veins.

Biotite is present in moderate amount as small flakes, pleochroic from reddish brown to straw yellow. Most flakes display partial replacement by pleochroic green chlorite.

Opaques occur in minor amount as small granular aggregates, sparsely scattered through the rock.

Calcite occurs only in a single discordant fracture, where it forms ragged sparry grains. Ragged plates of prehnite also occur in the fracture, and prehnite also forms diffuse ragged replacement

grains in selvedges marginal to the fracture. A small amount of chlorite has formed along the margins of the fracture.

INTERPRETATION:

This sample represents a semi-pelitic sedimentary rock. It suffered regional metamorphism in the amphibolite facies, generating the foliated granoblastic assemblage of hornblende + plagioclase + quartz + biotite. During this metamorphic event, local migration of felsic components resulted in development of coarse-grained discordant ptygmatic veins of plagioclase + quartz.

A subsequent event caused widely-spaced fracturing of the rock body, and invasion by low-temperature hydrothermal fluids. This resulted in the following effects:

i) Filling of fractures by prehnite + calcite + chlorite.

ii) Development of thin alteration selvedges of prehnite marginal to fractures.

iii) Selective pervasive alteration of wall rock plagioclase by sericite.

SAMPLE : ALG 3, 254.10m

SECTION NO. : ALG 3, 254.10m

HAND SPECIMEN : The drill core sample represents a weakly foliated, compositionally uniform (i.e. non-layered), dark greenish grey rock. It is cut by a single thin fracture, with pale creamish-green selvedge alteration for distances ~2 mm each side away from the fracture.

The thin fracture effervesces in reaction with dilute HCl, suggesting calcite is present in the fracture.

ROCK NAME : **Fractured and veined, quartzo-feldspathic schist**

PETROGRAPHY :

A visual estimate of the modal mineral abundances gives the following:

Mineral	Vol.%	Origin
Plagioclase	64	Metamorphic
Quartz	25	Metamorphic
Biotite	7	Metamorphic
Apatite	Tr	Metamorphic
Chlorite	2	Alteration / fracture filling
Sericite	1	Alteration
Calcite	Tr	Fracture filling
K-feldspar	Tr	Fracture filling

In thin section, this sample displays an inequigranular disequilibrium granoblastic metamorphic texture with moderate foliation, modified by widely-spaced thin fracturing and veining, with associated weak alteration.

Plagioclase is abundant, forming anhedral grains ~0.2-1.5 mm in size. Larger grains display a moderate degree of normal compositional zoning, and some of these larger grains display prismatic crystal forms modified around margins by metamorphic sculpting. Most grains have suffered slight replacement by small ragged sericite flakes.

Quartz is moderately abundant, forming anhedral grains ~0.2-1.0 mm in size (mostly ~0.2-0.4 mm). All are quite unstrained (i.e. they lack shadowy strain extinction or other deformational effects).

Biotite is moderately abundant, forming small but somewhat ragged flakes ~0.2-0.4 mm in length. They are pleochroic from dark reddish brown to straw yellow, suggesting a relatively reduced composition. Chlorite has completely replaced biotite in the selvedges of uncommon fractures (see fractures below).

Apatite forms small acicular to prismatic crystals in quartz grains.

Cutting the rock is a thin vein filled by ragged sparry calcite grains, fine-grained aggregates of K-feldspar, and small aggregates of pleochroic green chlorite. Chlorite has completely replaced wall rock biotite in fracture selvedges up to ~2 mm away from the vein. A thinner fracture elsewhere in the rock also displays chloritic alteration of biotite in the fracture selvedge.

INTERPRETATION:

This sample represents a quartzo-feldspathic precursor rock that has suffered regional metamorphism of medium grade, generating the assemblage plagioclase + quartz + biotite + trace apatite. The metamorphic assemblage is not unique, but confirms that the metamorphic grade reached biotite grade in the greenschist facies. The grain size and texture suggest a higher grade was achieved (i.e. amphibolite facies, as indicated by other assemblages in other samples in this suite).

At a later time, widely spaced fracturing of the rock body allowed invasion by hydrothermal fluids. Particular effects of this event include the following:

i) Deposition of assemblages of calcite + K-feldspar + chlorite in thicker open fractures.

ii) Replacement of wall rock biotite by chlorite in fracture selvedges.

iii) Weak partial replacement of wall rock plagioclase by sericite.

APPENDIX 1: XRD RESULTS

Mineral identifications for two samples were obtained by X-ray diffraction methods. The full report is provided in this Appendix.

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26 August 1997

Mason Geoscience Pty Ltd
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Attn: Dr Doug Mason

REPORT G327/97

MINERAL IDENTIFICATION

YOUR REFERENCE:	Letter dated 19 August 1997
SAMPLE IDENTIFICATION:	ALG 1, ALG 3
MATERIAL:	2 rock samples
DATE SAMPLES RECEIVED:	19 August 1997
DATE AUTHORISATION RECEIVED:	19 August 1997
WORK REQUIRED:	Mineral identification by X-ray diffraction
INVESTIGATION AND REPORT BY:	Michael Till

Keith Henley

Dr Keith J Henley
Manager, Mineralogical Services

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QUALITY MANAGEMENT SYSTEM

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Manager, Mineralogical Services

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MINERAL IDENTIFICATION

1. INTRODUCTION

Rocks were received from Dr Doug Mason of Mason Geoscience Pty Ltd with a request for XRD analysis of specified portions.

2. PROCEDURE

The yellowish-cream patches in ALG 1, 214m were drilled. For the other samples a broken or cut portion was pulverised and then analysed by X-ray diffraction. Sample ALG 3, 229m was re-analysed after the addition of glycerol, to identify a smectite component.

3. RESULTS

ALG 1, 206.3m		ALG 1, 210m	
Muscovite (two types) Chlorite	D Tr-A	Illite (two types) Chlorite ?Anatase	D Tr Tr
ALG 1, 214m A yellowish-cream patches		ALG, 214m B whole rock	
Illite Chlorite	D Tr	Chlorite Illite Illite with a minor proportion of interstratified smectite Quartz	D SD Tr-A Tr
ALG 3, 229m			
Quartz Illite Chlorite Illite with a minor proportion of interstratified smectite Dolomite	D SD A Tr-A Tr		

Semi-quantitative abbreviations

D = Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.

SD = Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.

A = Accessory. Components judged to be present between the levels of roughly 5 and 20%.

Tr = Trace. Components judged to be below about 5%.