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BHP MELBOURNE RESEARCH LABORATORIES

PETROLOGY SECTION, REPORT NO.MRL/43

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To:	Director of Exploration
Copies to:	O.I.C. BHP Exploration Party Arnhem Land, N.T.
	Exploration Superintendent
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	Technical Records
Your Reference and Date:	MR:hd 6.8.71
	MR:hd 26.8.71
	MR:hd 2.9.71
Subject:	E.8/2
Work Required:	Petrological descriptions and identification
Material:	Drill core samples (8)
Field Identification:	AL/D1-79'; AL/D1-86'
	AH 2001-2004
	AH 2005
	AH 3035
MRL Identification:	2056-2057
	2105-2108
	2112
	2130
Keywords:	Adamellite, Andesite, Chalcopyrite, Dolerite, Granite, Galena, Trachyte, Porphyry, Pyrite

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INTRODUCTION

Eight specimens from diamond drill hole AL/D1 have been received for petrological examination.

The drill hole was sited so as to test the extension at depth of a Pb bearing "gossan" outcropping along the eastern side of a linear quartz ridge within the Mirarrmina Complex.

DISCUSSION AND CONCLUSIONS

Figure 1 lists the spatial distribution of the specimens received, together with a summary of the interpreted rock type of each specimen. It is not possible to draw any conclusions either as to the general petrology of the area drilled or the economic potential of the Pb-Cu mineralization encountered.

It may be noted that the volcanics, including the dolerites were unusually Ti-rich. All of the rocks examined have been extensively altered (e.g. feldspar to sericite/saussurite; pyroxenes? to chlorite; ilmenite to sphene/rutile). All of the rock types, except the dolerites have been sheared; penetrative foliations are observed in some specimens, with more irregular shearing having occurred in most of the rocks. Mineralization appears to be associated with either calcite or quartz veins, either in these veins or as disseminations in the nearby rock. Not all veins are mineralized however.

Although the acid plutonic phases (e.g. MRL 2106) apparently intrude the volcanics (e.g. MRL 2105), the two rock groups may be closely

related genetically. Branch (1967) and many others have described acid plutonics intrusive into their own volcanic piles.

The relation of the dolerites may be more difficult to determine. Although they lack the extensive shearing of the other rock types, their metasomatized nature and titaniferous content suggest some genetic relationship with the other more felsic rock types in the section penetrated by AL/D1.

REFERENCE:

Branch, C.D., 1967: Genesis of magma for acid-alkaline volcano-plutonic formations. Tectonophysics, 4, 83-100.

Figure 1

THE BROKEN HILL PTY. CO. LTD. ARNHEM LAND DRILL HOLE AL/D1

Location Mirarrmina Complex Co-ordinates, local. Bearing (Mag.)

Sheet 1 of 1 Angle of depression

Source of information Petrographic Descriptions

Geology	Log	Notes
		Altered ? dolerite
		Altered biotite "granite" (Sheared)
100'		
200'		
		Adamellite (Sheared)
300'		
		Quartz andesite (Sheared)
400'		
		Veined and mineralized calcite-quartz rock
		Sheared trachytic porphyry
		Sheared trachytic porphyry
500'		Altered dolerite

Specimen No: MRL 2056

Location: AL/D1; 79 ft.

Hand specimen description: Fine-grained, highly weathered and altered, brown rock, cut by scattered thin siliceous veins.

Thin section:

	Vol %
clay minerals	40
biotite	40
quartz	5
carbonate	5
opaques	10

Polished section:

hematite	4
ilmenite/sphene)	6
magnetite)	

Discussion: The original texture of this specimen has been almost completely destroyed during alteration and weathering. The specimen is now composed of clot-like aggregates of biotite and clay minerals, with small skeletal, partially altered ilmenite grains (200-800 microns in length) apparently being the only remaining primary mineral. Its morphology, random orientation and distribution suggest that the rock may have had an igneous origin, and also possibly a similarity to sample 2112, occurring at 495'.

Name: Weathered biotite-quartz-ilmenite rock, possibly an altered dolerite.

Specimen No: MRL 2057

Location: AL/D1, 86 ft.

Hand specimen description: A greyish, medium-grained rock consisting of quartz aggregates surrounded by micaceous material.

Thin Section:

	Vol %
quartz	40
sericite	40
biotite	18
opaques	2

Polished section:

hematite	2

Discussion: Irregular, patchy aggregates of quartz (0.5-3.2 mm in diameter) are set in a matrix of schistose sericite and both primary and secondary biotite. The rock is extensively sheared and fractured. Deformation is reflected in the quartz aggregates composed of grains which exhibit strong undulose extinction, sub-grain growth and internal interlobate grain boundaries.

Based on present composition and texture, it is thought that this may have been a "granite" containing significant quantities of primary biotite.

Name: Altered and sheared biotite "granite".

Specimen No: MRL 2106 Field No. AH 2002

Location: AL/D1, 227 ft.

Hand specimen description: Sheared, medium-grained green to light grey rock, containing K-feldspar, plagioclase and quartz.

Thin section:

	Vol %	
K-feldspar (perthite)	45	
quartz	24	
plagioclase/sericite	28	($\pm$ An_{20})
muscovite	2	
chlorite	1	
zircon	<1	
opaques	<1	

Polished section:

pyrite	1	

Discussion: Phenocrysts of K-feldspar (up to 1 cm in diameter) are set in a groundmass of sericitized plagioclase (ca. 1200 microns in diameter), quartz (up to 1200 microns in diameter), and primary muscovite. The phenocrysts are cut by quartz veins up to 200 microns wide and contain small quartz inclusions (up to 400 microns in diameter). Deformation is similar in type and degree to that observed in specimen no.2057, taken at 86' in this drill hole.
This rock type has been described as intruding the specimen to follow, taken at 322' in the drill hole.

Name: Sheared porphyritic adamellite.

Specimen No: MRL 2105 Field No: AH 2001

Location: AL/D1; 322 ft.

Hand specimen description: Fine-grained, grey-green rock, exhibiting flow or shearing textures. The rock gave a strong positive stain for plagioclase.

Thin Section:

	Vol %
plagioclase	65
quartz	15
chlorite	15
opaques	5

Polished section:

rutile	5
pyrite	<<0.5

Discussion: Plagioclase crystals, although deformed, tend to be lath-like indicating the primary igneous nature of the rock. Possible flow structures can be recognised, although interpretation is made difficult by later shearing. The possibly primary flow foliation is outlined by aggregates of opaque minerals. Quartz is associated with chlorite in minor bands parallel to the foliation. Later shearing, with associated coarser chlorite, sometimes parallels this foliation.

Name: Sheared quartz andesite.

Specimen No: MRL 2130 Field No: AH 3035

Location: AL/D1; 418.5 ft.

Hand specimen description: The sample features a vein system (approx. 35 volume % of the specimen) cutting a carbonate-rock. The vein consists of parallel bands of calcite, quartz and sulphide material consisting of pyrite, pyrrohotite and minor chalcopyrite. Small veinlets of chalcopyrite and pyrrhotite occur between the large carbonate grains of which the actual rock is composed. Such mineralization occurs approximately 0.5 cm away from the major vein.

Thin section:

	Vol %
calcite	72
quartz	10
?dolomite	5
chlorite)	
)	5
clay minerals)	
opaques	8

Polished section:

pyrite	5
pyrrohotite	2
chalcopyrite	1
galena	< 0.5

Discussion: Alteration has made the original rock type difficult to determine. Less altered parts of the rock consist of irregular areas composed of quartz grains having curved or partially recrystallized grain boundaries. These are surrounded and often replaced by both large and small calcite grains (6 mm to 150 microns).

The presence of fault gouge materials containing angular quartz fragments suggests that alteration and replacement may be concentrated along a local shear zone. The presence of later crosscutting chalcedonic quartz and carbonate veins, together with curved cleavages in the larger carbonate grains suggest that further deformation has occurred after replacement and mineralization.

Sulphide mineralization consists of euhedral pyrite crystals up to 3 mm in diameter, containing small blebs of galena (ca. 5-20 microns in diameter), associated with anhedral pyrrhotite and minor chalcopyrite. Small blebs and grains of chalcopyrite and pyrrhotite mostly occur away from the pyrite veins disseminated through the surrounding rock.

Name: Veined and mineralized calcite-quartz rock.

Specimen No: MRL 2107 Field No: AH 2003

Location: AL/D1; 448 ft.

Hand specimen description: Fine-grained, dark grey compact rock with coarse-grained calcite patches, and cut by quartz veins.

Staining techniques have indicated that a large part of the rock is composed of K-feldspar. Grains of plagioclase have also been tentatively identified, but these could not be confirmed in thin section.

Thin section:

	Vol %
K-feldspar	62
quartz	5
calcite	5
chlorite	20
plagioclase?	5
opaques	3
apatite?	< 0.5

Polished section:

ilmenite/sphene	3	(skeletal)
pyrite	<0.5	

Discussion: Lath shaped and anhedral K-feldspar and ? plagioclase phenocrysts (up to 1000 microns in diameter) are set in a groundmass of feldspar, schistose chlorite, minor quartz, calcite and opaques.

The rock has been deformed, with a foliation being outlined by chlorite aggregates. Crosscutting veins of calcite-quartz and pure calcite, together with

irregular shears, form about 10% of the rock. Coarse chlorite patches also occur.

The texture and composition of the less altered and deformed areas of the rock suggest that the rock was of volcanic origin and of intermediate composition.

Name: Sheared and altered, slightly porphyritic trachyte.

Specimen No: MRL 2108 Field No: AH 2004

Location: AL/D1; 465 ft.

Hand specimen description: One third of the piece of core received, consists of coarse crystalline calcite. The remainder of the specimen has been thin-sectioned and consists of a dark, medium-grained rock, containing K-feldspar phenocrysts set in a fine-grained groundmass. These phenocrysts apparently become more numerous as the calcite vein is approached. Irregular darker areas occur in the vicinity of the calcite vein (xenoliths?)

A barren quartz vein (ca. 0.8 cm wide) cuts across the K-feldspar rock in the proximity of the massive calcite at an angle of 70° to the long core axis. Another quartz vein (0.8 cm wide) containing pyrite and minor chalcopyrite cuts the rock approximately 4.5 cm from the first one. The latter cuts the core at about 80° to the L.C.A. The polished section has been prepared from the site of the mineralized vein.

Thin section:

	Vol %
K-feldspar	60
calcite	15
quartz	15
chlorite	10
opaques	0.5

Polished section:

pyrite	10
ilmenite/rutile	0.5
chalcopyrite	<0.5

Discussion: K-feldspar and scattered quartz phenocrysts up to 4 mm in diameter are surrounded by a groundmass of K-feldspar, quartz and chlorite. Each phenocryst is surrounded by a zone which stains differentially to the remainder of the phenocryst, possibly reflecting some metasomatic event postdating crystallization. As far as can be estimated from the specimen examined, the development of phenocrysts has been patchy as very few occur at the opposite end of the specimen from the calcite vein.

The presence of xenolith-like fragments suggest either some form of brecciation or the inclusion of small fragments of nearby intruded rock. The latter appears more likely as shearing is not pronounced in this specimen.

In the mineralized vein, pyrite occurs as euhedral crystals, ca. 1 mm in diameter, surrounded by finer grained dendritic pyrite. Chalcopyrite occurs as small veins about 150 microns wide.

Name: K-feldspar porphyry (trachytic)

Specimen No: 2112 Field No: AH 2005

Location: AL/D1; 495 ft.

Hand specimen description: Dark, medium-grained, rock with a doleritic texture. Local fine-grained areas (xenoliths?) (up to 2 cm long) were found to consist of plagioclase rimmed by amphibole and K-feldspar (by staining).

Thin section:

	Vol %
plagioclase/saussurite	45
K-feldspar/sericite) quartz))	32
chlorite) biotite))	20 (penninite)
actinolite	1.0
sphene	< 0.5
apatite	<< 0.5
calcite	<< 0.5
opaques	2

Polished section:

ilmenite/sphene	2
pyrite	<< 0.5

Discussion: Laths of plagioclase, (up to 0.3 cm long) now largely altered to a mixture of epidote and chlorite are set in a groundmass of chlorite-amphibole, K-feldspar and skeletal ilmenite.

Former euhedral pyroxenes (2-3 mm in length) are apparently now pseudomorphed by chlorite rimmed by actinolite. Rodlike apatite crystals up to 0.5 mm in length and skeletal ilmenite crystals up to 2 mm in length indicate rapid crystallization.

The unusually high K-feldspar content of the groundmass of this rock, together with the presence of alteration rims of K-feldspar and actinolite (now chlorite) around xenoliths suggest that this rock has been subjected to extensive metasomatism.

Remnants of the original texture and mineralogy indicate that this rock is an altered dolerite.

Name: Altered and metasomatized dolerite.