CR 10913

EXPLORATION LICENCES 22631 & 22632 BEAVER DAM 1 & BEAVER DAM 2

BEAVER DAM PROJECT NORTHERN TERRITORY

COMBINED FINAL REPORT FOR THE PERIOD ENDED 16 DECEMBER 2004

Data presented in AGD66 Datum

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SUMMARY

This Combined Final Report describes all work carried out by BHP Billiton Minerals Pty Ltd (BHPB) on Exploration Licences 22631 and 22632, Beaver Dam Project, Northern Territory.

Exploration work was aimed at discovering Ni-Cu magmatic sulphide mineralisation of Voiseys Bay, Norilsk affinities, associated with Proterozoic stratigraphy under thin Cainozoic cover.

The following exploration work was completed by BHPB on the Beaver Dam Project during the annual period ended 16 December 2004.

- a full assessment and re-processing of previous airborne geophysical data;
- identification of a magnetic/EM target – MH2;
- drill testing of target MH2 with one hole for a total 202 m;
- rehabilitation of drill site.

Drilling of target did not intersect Ni-Cu magmatic sulphide mineralisation below the Cainozoic cover as interpreted. Instead, the magnetic high was explained by a coarse magnetic garnetiferous biotite granodiorite with some local intense magnetite and magnetite-silica alteration zones. The EM response was caused by conductive Tertiary clays.

No further targets were identified upon review of the project and BHPB surrendered ELs 22631 and 22632, effective 16 December 2005.

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1. INTRODUCTION

This Combined Final Report describes all work carried out by BHP Billiton Minerals Pty Ltd (BHPB) on Exploration Licences 22631 and 22632, Beaver Dam Project, Northern Territory.

The Beaver Dam Project is located 30 km north of Alice Springs in the southeastern part of the Northern Territory. The project lies within the northwestern corner of the Alice Springs 1:250,000 scale Sheet (SF53-14) (see **Figure 1**).

Exploration work was aimed at discovering polymetallic Ni-Cu-Co magmatic sulphide mineralisation of Voiseys Bay, Norilsk affinities, associated with mafic-ultramafic intrusions under thin Cainozoic cover.

2. TENURE

Tenement details for Exploration Licences 22631 and 22632 are included in **Table 1**.

Background tenure is Pastoral Lease and Crown Land and access negotiations were completed with the Central Land Council and Traditional Owners. A work program was submitted and a site clearance of the MH2 target undertaken prior to the commencement of drilling.

Table 1: Tenement Details

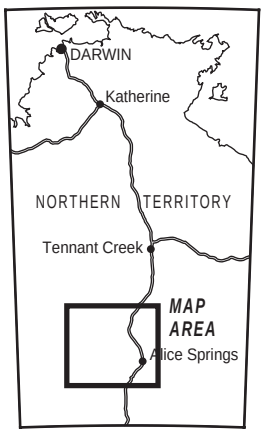
EL	Name	No. of Blocks	Application Date	Grant Date	Surrender Date
22631	Beaver Dam 1	51	1 Jun 00	17 Dec 01	16 Dec 04
22632	Beaver Dam 2	35	1 Jun 00	17 Dec 01	16 Dec 04

3. GEOLOGY

The Beaver Dam Project is located in the Arunta Geological Province. The Arunta Province hosts large Palaeoproterozoic mafic-ultramafic magmatic complexes and is one of the most extensive Paleoproterozoic & Mesoproterozoic terranes in Australia. The inlier stretches across the entire width of the Northern Territory, centred on Alice Springs.

The Arunta Province has had a long and complex history of sedimentation, deformation, metamorphism and plutonism. Meta-sedimentary and meta-igneous units ranging from greenschist to granulite facies occur throughout and are intruded by granites and other igneous rocks ranging in age from 1880-1060 Ma. The metamorphic sequences are not well understood and have complex geological and structural histories. There are significant areas of both Proterozoic outcrop and younger cover sequences. The region hosts numerous small base metal and gold occurrences. Most areas have received minimal modern exploration work.

The Province hosts large Palaeoproterozoic mafic-ultramafic magmatic systems with potential to host major Ni-Cu-Co deposits. Recently completed incompatible element discrimination work identified the Western Arunta Intrusions as sulphur enriched (300-



LOCATION MAP

Scale 1 : 2,000,000

0 20 40 60 80 100 km

Transverse Mercator Projection

BHP Tenement

Major road

Minor road

Track

Railway

Town; homestead

Prepared : RRM	BHP	Centre : Brisbane
Drawn : RRM	**Minerals Discovery Group** **BHP World Minerals** The Broken Hill Proprietary Company Limited A.C.N. 004 028 077	Drawing No.: A4-2470
Date : February 2001	E 22631 BEAVER DAM1 & E 22632 BEAVER DAM 2, NORTHERN TERRITORY	**FIGURE 1**
Revised : Jan 2004	**LOCATION MAP**	

1200 ppm sulphur) and demonstrated they have potential for orthomagmatic nickel-copper-cobalt sulphide associations.

Within the southern Arunta Province, mafic intrusions are structurally aligned parallel to an east-west-trending thrust zone that reflects a major crustal suture; this thrust zone extends for over 600 km along the MacDonnell Ranges. Most intrusions crystallised in-situ and were not tectonically emplaced. They are generally mafic, more homogeneous in composition, poorly layered and without chromitites. Research work by the Northern Territory Geological Survey and Geoscience Australia shows that in the whole of the southern Arunta Province, the Mount Chapple and Mount Hay Complexes are the most highly contaminated by felsic crustal rocks and are sulphur enriched (Hoatson, 2001). These intrusives are considered prospective to host nickel-copper-cobalt deposits in feeder systems or near the base of intrusions.

4. PREVIOUS EXPLORATION WORK COMPLETED

BHPB and Mithril entered a Joint Venture in 2002, with Mithril to fund and operate initial nickel exploration. The work carried out included office-based assessments and interpretations of the region and a review of open-file data, including re-processing of historical geophysical data. New geological and geophysical interpretations and targeting work were conducted and some new target areas identified.

In June 2003, Mithril reviewed the project and withdrew ELs 22631 and 22632 from the Joint Venture. Management of both tenements reverted to BHPB and the project area was then called Beaver Dam. Work completed in the second annual period to December 2003 detailed in White (2004).

5. EXPLORATION WORK COMPLETED DURING YEAR 3

5.1 Introduction

The following exploration work was completed by BHPB on the Beaver Dam Project during the annual period ended 16 December 2004.

- a full assessment and re-processing of previous airborne geophysical data;
- identification of a magnetic/EM target – MH2;
- drill testing of target MH2 with one hole for a total 202 m;
- rehabilitation of drill site.

5.2 Targeting

BHPB identified one combined magnetic/EM target (MH2) for follow-up on the ground with drilling. This target was defined from a desktop review of existing government data sets and previous exploration in the area.

5.3 Drilling

5.3.1 Introduction

A single hole (BDRC04001) was drilled to test MH2 and drilling was completed during March 2004 by Grimwood Davies Pty Ltd of Boulder WA. The drilling rig used was a Schramm T685 Reverse Circulation Drilling Rig mounted on a 8 x 8 MAN truck. Peter Gregory of PW Gregory and Associates Pty Ltd supervised the drilling. A 5.5 inch diameter hole was drilled with 6 m of PVC left in the collar. Samples were collected from a cyclone

every metre and placed in UV treated plastic bags. Chip samples were collected in chip trays for the entire hole.

BDRC04001 first hit water at 58 m under Tertiary cover. Good water flows occurred at 155 m and 195 m and the water appeared potable, although no tests were completed by BHPB.

Drill hole BDRC04001 is summarised in **Table 2** below and collar and logging details for the hole are included in **Appendix 1**.

Table 2: Drilling Summary

Hole	AMG East	AMG North	Depth (m)	Basement (m)	Dip	Az mag	Hole Type
BDRC04001	372775	7417450	202	41	90		RC

5.3.2 Drill Hole Sampling

The following sample and data collection methods were undertaken from the various holes during the drilling programme:

- percussion chip and geochemical assays;
- petrology samples;
- magnetic susceptibilities.

GEOCHEMICAL SAMPLING

Four metre composites were collected for geochemical analysis using a PVC spear with one spear from each of four bags to produce a 3-4 kg sample in a calico bag. Duplicates were collected every 20 samples and in addition, a base metal standard was added every 20 samples as an additional check on the accuracy and reproducibility of the laboratory results. The listing of samples is included in **Appendix 2**.

PETROLOGY

Chip samples were collected from various intervals of interest and sent to Pontifex and Associates in Adelaide for detailed petrology and a report is included in **Appendix 3**.

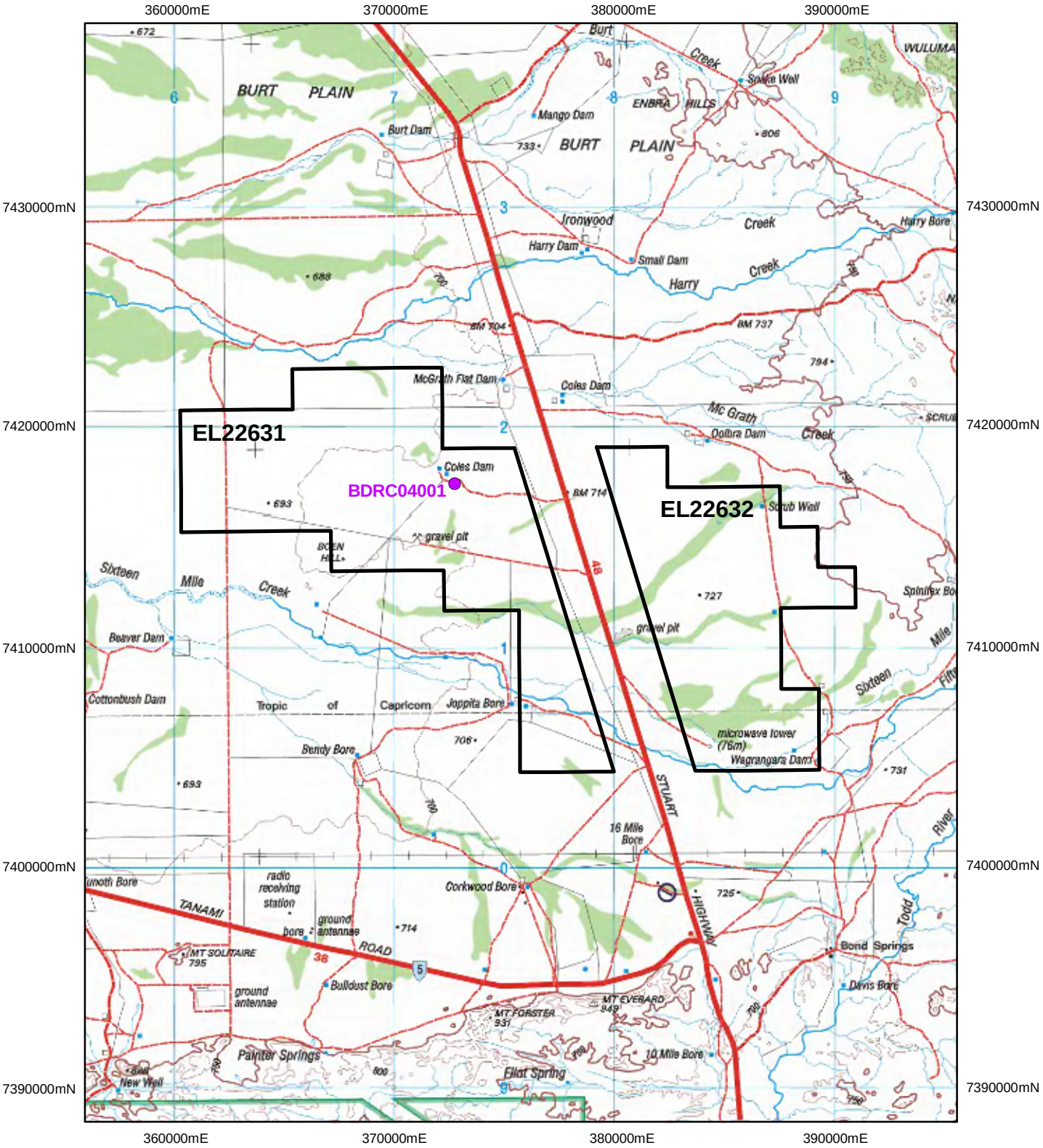
MAGNETIC SUSCEPTIBILITIES

Magnetic susceptibilities were recorded every metre and the results included in **Appendix 4**.

5.3.3 Drilling Results and Geological Summaries

BDRC04001

BDRC04001 was drilled near Coles Dam in EL 22631 (see **Figure 2**) to test a combined magnetic/EM target, interpreted to represent a possible feeder dyke to a large body of magnetic granite defined from historical drilling (Gregory, 2004). The shallow GEOTEM feature coincident with the magnetic anomaly was interpreted to be due to conductive



● *BHPB drill hole*

Scale 1:250,000

0 5 10 15 20km

UTM Projection. MGA Zone 53. GDA94 Datum.

Prepared : C.J.W	Centre: Brisbane	bhpbilliton **Minerals Exploration** BHP Billiton Limited ABN 49 004 028 077	**FIGURE 2** EPM's 22631 & 22632, NORTHERN TERRITORY **DRILL HOLE LOCATION PLAN**
Drawn : C.J.W	Revised:		
Date : March 2005	Drawing No.: A4-2601		

Tertiary clays. This was substantiated by drilling. The hole intersected 41 m of Tertiary sediments, comprising clay, lateritised clayey grit, lateritic hard cap and clayey gravel. This overlies basement of coarse biotite–garnet granodiorite that appears undeformed. The granodiorite has some primary magnetite but is also cut by bands, veins and patches of magnetite with associated silica alteration. The most prominent magnetite zones are 116-136 m and 152-160 m.

5.4 Rehabilitation

Drill site preparation was low impact with little environmental impact and no access tracks were created. Following the completion of drilling all sample bags and rubbish were removed from site. The drill hole was not rehabilitated at the request of the Bond Springs Station owner. The hole was temporarily capped to secure until the landowner equipped the hole as a source of stock water, and this was acknowledged and accepted by the Director of Mines by way of letter dated 16 June 2004.

Authorisation No. 0205-01 was issued to carry out the drilling programme on the Beaver Dam Project. A copy of the Closure Certificate for this Authorisation is provided in **Appendix 5**.

5.5 Expenditure

Expenditure for Year 3 was $34,310 for EL 22631, and $775 for EL 22632.

An itemised life to date expenditure statement is set out below:

	Year 1 16-Dec-02 Mithril Resources		Year 2 16-Dec-03 BHPB		Year 3 16-Dec-04 BHPB		TOTAL
	22631	22632	22631	22632	22631	22632	
Computing	39	26					65
Contractors/Consultants	292	201			5,826	775	7,094
Employee Costs	1,233	1,181	2,376	1,945	2,195		8,930
Freight	99						99
Geochemistry	485	368			1,199		2,052
Drilling					18,643		18,643
Travel & Vehicles	906	640			2,516		4,062
Supplies					811		811
Admin	456	361			3,120		3,937
Total Exploration Costs	3,510	2,777	2,376	1,945	34,310	775	$45,693

6. CONCLUSIONS

Drilling of the magnetic/EM target MH2 did not intersect Ni-Cu magmatic sulphide mineralisation below the Cainozoic cover as interpreted. Instead, the magnetic high was explained by a coarse magnetic garnetiferous biotite granodiorite with some local intense magnetite and magnetite-silica alteration zones. The EM response was caused by conductive Tertiary clays.

No further targets were identified on review of the project and BHPB surrendered ELs 22631 and 22632, effective 16 December 2005.

7. REFERENCES

Gregory, P.W, 2004. Open File Review of Exploration Data in the area of the Beaver Dam Tenements, Arunta Complex, NT. *Unpublished Memorandum to BHP Billiton by PW Gregory & Associates.*

Hoatson D.M. 2001 Metallogenic Potential of mafic-ultramafic intrusions in the Arunta Province, Central Australia: Some new insights. AGSO research Newsletter. 34. 29-33.

White, M.J., 2004. Exploration Licences 22631 & 22632, Beaver Dam 1 & Beaver Dam 2 Beaver Dam Project, Northern Territory. Annual Report Year Ended 16 December 2003.

APPENDIX 1

Drill Hole Collar and Logging Data Files

Appendix 1

Drill Hole Collar Data

Hole	AMG East	AMG North	AMG Zone	Locality	State	Tenement	Program	Project	Hole Type	Inclination	Azimuth	Hole Depth	Basement Depth	Water Depth
BDRC04001	372775	7417450	53 AGD66	Beaver Dam	NT	22631	Andrew Young East	Beaver Dam	RC	90		202	41	155, 195

Appendix 1

Drill Hole Collar Data

Oxidation Depth	Basement Age	Basement Lith	Drilling Company	Drill Rig Type	Date Started	Date Finished	Logged By	Comments
66	PROT	ANDREW YOUNG COMPLEX	GRIMDAVIES	RC	14.03.04	15.03.04	P GREGORY	

Appendix 1 Drill Hole Summary Sheet

Hole	From	To	Comments	Comments
BDR04OO1	0	1	Sand	Overburden
BDR04OO1	1	4	Ferruginous clayey grits	
BDR04OO1	4	6	Lateritic hard cap	
BDR04OO1	6	8	Clayey grits	
BDR04OO1	8	20	Grity clay, ferruginous bands	Limonitic to haematitic hard bands
BDR04OO1	20	24	Lateritic hard cap	Pisolitic in part
BDR04OO1	24	40	Ferruginous clay	
BDR04OO1	40	41	Clayey gravel	
BDR04OO1	41	66	Clay weathered granodiorite	Andrew Young Complex
BDR04OO1	66	202	Biotite-garnet-magnetite granodiorite	Bands, veins, patches of magnetite alteration with some associated silica, especially 116-136m, 152-160m. Pink garnet locally to 15%.

Lithology

Hole	From	To	Geol Type	recovery	flag	Rock Type 1	Rock Type Qualifier					Rock Type 2	Rock Type Qualifier				Colour			Weathering	Grain Size	Texture	Qualifiying Minerals (RTM) Amounts (RTA)									
							M1	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4	Light	Hue 1	Hue 2				A1	M1	A2	M2	A3	M3	A4	M4	A5	M5
BDR04001	0	1	LL		OB	SAND	QZ	AE									5	R	U	7	3		7	QZ	6	CY	3	HE				
BDR04001	1	4	LL			GRIT	QZ	CY	FE	LR	SF						5	K	U	7	3		7	QZ	7	CY	3	HE				
BDR04001	4	6	LL			LRCH	QZ	FE	SF			GRIT	QZ	CY			3	U		7	4		8	QZ	6	HE	4	CY				
BDR04001	6	8	LL			GRIT	QZ	FE	CY								7	E		7	3		8	QZ	6	CY						
BDR04001	8	9	LL			CLAY	CY	GT									7	E		7	0		8	CY	6	QZ						
BDR04001	9	16	LL			CLAY	CY	GT	FE								5	B		7	2		8	CY	6	QZ						
BDR04001	16	20	LL			CLAY	CY	SA	HE								5	E	U	7	2		8	CY	6	QZ	3	OQ				
BDR04001	20	24	LL			LRCH	QZ	SF	FE	PI							4	R	U	7	3		8	QZ	4	HE	3	CY				
BDR04001	24	26	LL			CLAY	CY	FE									5	R	U	7	2		8	CY	5	QZ	3	HE				
BDR04001	26	40	LL			CLAY	CY	GT	FE								6	K	U	7	2		8	CY	5	QZ	2	HE				
BDR04001	40	41	LL			GRAV	CY	GT									7	E		7	5		7	QZ	6	CY						
BDR04001	41	56	LL		BS	GRDR	CY	MS									6	K	U	6	4		9	CY	5	QZ						
BDR04001	56	58	LL			GRDR	FD										6	E		2	5		7	FD	7	QZ	4	BI	2	GA		
BDR04001	58	60	LL			GRDR	CY	MS									5	G	E	7	5		8	CY	6	QZ						
BDR04001	60	62	LL			GRDR	CY	MS									5	G	E	5	5		5	CY	6	QZ	6	FD				
BDR04001	62	66	LL			GRDR	CY	MS									5	G	E	5	5		6	CY	6	QZ	6	FD				
BDR04001	66	68	LL		BO	GRDR	FD	MS									6	E		1	5		7	FD	7	QZ	4	BI	1	MA	2	CY
BDR04001	68	70	LL			GRDR	FD	MS									6	E		0	5		7	FD	7	QZ	4	BI	4	MA		
BDR04001	70	72	LL			GRDR	FD	MS									6	E		0	5		7	FD	7	QZ	4	BI	2	MA		
BDR04001	72	78	LL			GRDR	FD	MS									6	E		0	5		7	FD	7	QZ	4	BI	4	MA		
BDR04001	78	90	LL			GRDR	FD	MS									6	E		0	5		7	FD	7	QZ	4	BI	3	MA		
BDR04001	90	104	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	4	BI	2	MA		
BDR04001	104	117	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	4	BI	3	MA		
BDR04001	117	132	LL			GRDR	FD	MS									6	E		0	5		7	FD	7	QZ	3	BI	6	MA		
BDR04001	132	134	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	4	BI	2	MA		
BDR04001	134	136	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	3	BI	4	MA		
BDR04001	136	140	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	4	BI	1	MA		
BDR04001	140	142	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	3	BI	4	MA		
BDR04001	142	152	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	4	BI	2	MA		
BDR04001	152	160	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	3	BI	6	MA		
BDR04001	160	166	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	4	BI	2	MA		
BDR04001	166	170	LL			GRDR	FD	MS	GA								6	E		0	5		7	FD	7	QZ	3	BI	4	MA		
BDR04001	170	172	LL			GRDR	FD	MS	GA								7	E		0	5		7	FD	7	QZ	4	BI	2	MA		
BDR04001	172	173	LL			GRDR	FD	MS	GA								7	E		0	5		7	FD	7	QZ	3	BI	5	MA		
BDR04001	173	202	LL			GRDR	FD	MS	GA								7	E		0	5		7	FD	7	QZ	5	GA	5	BI		

Hole	From	To	Structure					Mineralisation											Veining								Alteration						Comments
			Depth (m)	Type	Spatial	Dip	Azimuth	Sulphide Mineralisation Q1	Sulphide Mineralisation Q2	Pyrite	Pryrrhotite	Chalcopyrite	Galena	Sphalerite	Other	%	Other	%	Qualifier	Total	Mineral (VTM) Amounts(VTA) A1	M1	A2	M2	A3	M3	Type	Mineral 1	Mineral 2	Type 2	Mineral 1	Mineral 2	
BDR04001	0	1																															
BDR04001	1	4																															
BDR04001	4	6																															
BDR04001	6	8																															
BDR04001	8	9																															
BDR04001	9	16																															
BDR04001	16	20																															
BDR04001	20	24																															
BDR04001	24	26																															
BDR04001	26	40																															
BDR04001	40	41																															
BDR04001	41	56																															
BDR04001	56	58																															
BDR04001	58	60																															
BDR04001	60	62																															
BDR04001	62	66																															
BDR04001	66	68																															
BDR04001	68	70																										PA	MA					
BDR04001	70	72																										DI	MA					
BDR04001	72	78																										PA	MA					
BDR04001	78	90						JF		T																		PA	MA					
BDR04001	90	104						JF		T																		DI	MA					
BDR04001	104	117						JF		M																		PA	MA					
BDR04001	117	132																										PV	MA	QZ	PV			
BDR04001	132	134																										DI	MA					
BDR04001	134	136																										PV	MA	PV	QZ			
BDR04001	136	140																										DI	MA					
BDR04001	140	142						VN		T																		PD	MA					
BDR04001	142	152						JF		T																		PD	MA					
BDR04001	152	160						VN		M																		PV	MA	MV	MA			
BDR04001	160	166																										DI	MA					
BDR04001	166	170																															
BDR04001	170	172																										DI	MA	VN	MA			
BDR04001	172	173																										VN	MA	PV	MA			
BDR04001	173	202																										DI	MA	VN	MA			

Drill Log Codes

MINERAL

actinolite	AC	galena	GL	rutile	RU
albite/albitisation	AB	garnet	GA	scapolite	SC
almandine	AM	ga adj to vns	VG	scheelite	SH
amphibole	AX	garnet bands	GB	sericite	SR
andalusite	AA	glauconite	GN	serpentine	SE
anhydrite	AH	glaucophane	GC	siderite	SD
ankerite	AK	goethite	GO	siliceous alt	SS
anorthite	AN	gold	AU	sillimanite	SI
anorthoclase	AF	graphite	GR	specular hematite	HS
apatite	AT	gypsum	GY	sphalerite	SP
arsenopyrite	AS	halite	HA	sphene	SN
bands of magnetite	MB	hornblende	HB	spinels	SL
barite	BA	hydrozincite	HZ	staurolite	ST
beryl	BE	illite	IL	stibnite	SB
biotite	BI	ilmenite	IM	sulphates	SA
biotite-hornblende	BH	iron oxides	FE	sulphides	S=
bleaching	BL	K-feldspar/microclin	KM	sulphides (oxidized)	SX
Blue qz	QB	K-feldspar/orthoclas	KF	talc	TA
bornite	BO	kaolinite	KA	talc-carbonate	TC
calc-silicate	C-	kyanite	KY	tourmaline	TO
calcite	CA	leucocratic c-	LC	tremolite	TR
carbonate	CB	leucoxene	LE	unknown	UN
cassiterite	CT	limonite	LI	uraninite	UR
cerussite	CE	lithic fragments	LF	uranium minerals	UX
chalcedony	QY	mafic minerals	MF	vermiculite	VM
chalcocite	CC	maghemite	MH	white mica	WM
chalcopyrite	CP	magnesite	MG	zincite	ZC
chert	CH	magnetite	MA	zircon	ZI
chiastolite	IA	malachite	ML		
chlorite	CL	manganese	MN		
chloritized mafics	MC	mang carbonate	MY		
chloritized olivine	OC	marcasite	MR		
chloritoid	CD	mica	MI		
chrysocolla	CK	Mn-garnet	SG		
clay	CY	Mn oxides	MX		
clinopyroxene	CX	Mn silicates	MS		
clinozoisite	CZ	molybdenite	MO		
copper	CU	monazite	MZ		
cordierite	CO	muscovite	MU		
corundum	CM	olivine	OL		
covellite	CV	opaques	OQ		
cuprite	CI	orthopyroxene	OR		
diffuse carb vnlts	DT	oxides	OX		
diopside	DI	pentlandite	PN		
dissem garnet	DG	plagioclase	PF		
dissem magnetite	DM	platinoids	PT		
dissem oxides	DX	pyrite	PY		
dissem sulphides	DS	pyrobole	PR		
dolomite	DO	pyromorphite	PM		
earthy hematite	HE	pyroxene	PX		
epidote	EP	pyrrhotite	PO		
epidote-chlorite	EC	qz	QZ		
feldspar	FD	qz-carbonate	QC		
fibrous Ax	FX	qz-epidote	QE		
fibrous Px	FY	qz-pyrite-calcite	QP		
fluorite	FL	qz-sericite	QS		
forsterite	FO	qz-tourmaline	QT		
fuchsite	FU	qz crystals	QX		
gahnite	GH	qz vein	QV		

OCCURRENCE

alteration rims	H
blebs	B
boxwork	W
breccia, matrix	X
cavity fill, vughs	A
clasts	C
coatings	E
crystal clusters	R
crystalline	T
disseminations	D
euhedral crystals	U
eyes, augen	I
fracture coatings	F
gouge	G
interstitial, cement	J
laminations	L
macro-veins	>
massive	M
matrix	Y
micro-veins	<
nodules, pistolites	N
patches (as in quilts	Q
pervasive	P
pseudomorphs	#
selvages	S
spots	O
stockwork	K
unsure	?
veins	V

ROCK TYPE

acid rock	ACID	gossan brec	GGBX	pebbles u-	PEBB	talc schist	TASC
acid volcanic	ACVL	granite	GRAN	pebbly snst	PBSN	tectonic brec	TEBX
adamellite	ADAM	granodiorite	GRDR	pegmatite	PEGM	tillite	TILL
albite-mag rock	ABMA	granofels	GRFL	pelite	PELT	tonalite	TONL
albitite	ALBT	granophyre	GRPH	peridotite	PERD	tourmalinite	TOUR
alluvium	ALUV	granulite	GRLT	phyllite	PHYL	trachy-andesite	TCAN
amphibolite	AMFB	graphitic schs	GISC	pisolite	PISL	trachyte	TRAC
andesite	ANDS	gravel	GRAV	porphyry	PORP	transported latr	TRLT
anorthosite	ANOR	greenschist	GRSC	psam + bisc, IB	BIAS	tuff	TUFF
arenite	AREN	greisen	GRES	psammite	PSAM	ultramafic	ULMF
arkose	ARKS	greywacke	GRWC	psammitic schist	ASSC	uncon over	UCOB
BIFF	BIFF	grit	GRIT	psammopelite	PSPE	unknown rock	UNRK
basalt	BASL	gritstone	GTST	pyroclastic rock	PCRK	vein	VEIN
basaltic tuff	BSTF	gypsum	GYPS	pyroxenite	PYRX	void	VOID
basic rock	BASC	hardpan	HARD	qz-albite rock	QALB	volcanic	VOLC
basic volcanic	BAVL	hornfels	HORN	qz-arenite	QZAS	volcanic agglom	VLAG
BIF, calcic	CABF	igneous	IGNS	qz-carbonate	QZCB	volcanic conglom	VLCG
bi-qz schist	BSXX	ignimbrite	IGNM	qz-epidote	QZEP	volcaniclastic	VLCT
biotite gneiss	BIGN	intrusive	INTR	qz-feldspar porp	QFPP	wacke	WACK
biotite schist	BISC	ironstone	IRON	qz-magnetite BIF	QMBF		
black shale	BLSH	jaspilite	JASP	qz basalt	QZBS		
breccia	BREC	kimberlite	KIMB	qz diorite	QZDR		
calc-silicate	CASI	lag	LAGS	qz gabbro	QZGB		
calcareous soil	CASO	laterite	LATR	qz monzonite	QZMZ		
calcrete	CALC	latr cap, hard	LRCH	qz porphyry	QZPP		
C$ siltst	CSSI	latr cap, soft	LRCS	qz vein	QZVN		
cb-mafic alt	MFCA	latr mottled zone	LRMO	qz, massive	QZMS		
cb rock	CARB	latr pallid zone	LRPL	quartzite	QZIT		
cb veins/alt	CAAA	limestone	LIST	redox front	REDX		
cavity	CVTY	lost core	LOST	residual latr	RSLT		
chert	CHER	lower saprolite	LWSP	rhyodacite	RYDC		
cherty qzite	QZCH	mafic altn	MFAA	rhyolite	RHYL		
chlorite schs	CLSC	mafic arenite	MFAS	rock	ROCK		
chromitite	CHRM	mafic rock	MFRK	sand	SAND		
clay	CLAY	mafic volcanic	MFVL	sandstone	SNST		
clay zone	CLZN	magnetite	MAGN	sandy sist	SNSI		
claystone	CYST	magnetite-mafic alt	MFMA	saprock	SPRK		
clinopyroxenite	CLPX	marble	MARB	saprolite	SAPR		
conglomerate	CONG	marl	MARL	schist	SCHS		
dacite	DACT	massive sulphides	MSS=	sediment	SEDM		
diorite	DIOR	metasediment	MTSD	semi-mss=	SMS=		
dolarenite	DOAS	metavolcanic	MTVL	serpentinite	SERP		
dolerite	DOLR	mica schist	MISC	shale	SHAL		
dolomite	DOLM	mi qz aren	MAQA	silcrete	SILC		
do breccia	DOBX	migmatite	MIGM	siliceous altn zone	SLAZ		
do limestone	DOLS	mill rock	MILL	silicified list	SFLI		
do shale	DOSH	monzonite	MONZ	silicified sist	SFSI		
do sist	DOSI	mottled zone	MTZN	silificified rock	SFRK		
evaporite	EVAP	mud uncons	MUDD	sility snst	SILI		
fault gouge	FAGO	mudstone	MDST	si-mu-ga schist	SHMU		
fault zone	FAZN	mu-bi-qz-schist	SHXX	silt, uncons	SILT		
feldspar porp	FDPP	mu schist	MUSC	siltstone	SIST		
ferricrete	FERC	norite	NORT	Silty snst	SISN		
ferrug zone	FEZN	olivine gabbro	OLGB	skarn	SKAR		
gabbro	GABR	orthogneiss	ORGN	slate	SLAT		
gahnite-qzite	QZGH	orthopyroxenite	ORPX	soil	SOIL		
garnet qzite	GAQZ	overburden	OVER	stringer mx	MSST		
gneiss	GNES	paragneiss	PAGN	syenite	SYEN		
gossan	GOSS	pebble cong	PBCG	talc-cb rock	TACB		

FLAG

base of oxidation	BO
base of partial oxid	BP
BIF type unit	BF
comment	CC
Contact	C-
contact zone 1	C1
continuation	XX
depth to water	DW
dissem oxide zone	DX
dissem sulphide zone	DS
Dyke	D-
fault zone	FZ
faults 1	F1
footwall	FW
fracture zone	FR
hanging wall	HW
major alteration zone	AA
marker bed 1	B1
massive suphide zone	M=
massive vein	MV
overburden	OB
petrology	PP
Prot basement	BS
seam	E-
shear zone	S-
stringer min	ST
sulphides	S=
Unconformity	UN
vein	VN
veins 1	V1

ROCK QUALIFYER / TEXTURE

acid	AC	ferruginous	FE	meta-	MT	trachytic	TC
aeolian	AE	fine - med bands (<1cr	<B	micaceous	MI	tuffaceous, shardy	TF
albitised, albitic	AB	fine -med size	+F	microfaulted	<F	ultrabasic	UB
alkali	AL	flaggy	FY	microveined (<2mr	<V	ultramafic	UM
altered	AA	flame textures	IF	migmatitic	MM	unconsolidated	U-
amygdaloidal	AM	flow banded	FB	mineralised	MX	uniform	UF
andesitic	AN	fluvial	FU	mylonitic	MY	unmetamorphosed	UN
angular unconf	<A	fluvio-glacial	FV	oolitic	OO	vein	V-
arkosic	AK	folded	FT	matrix supported	OS	vein breccia	VB
banded	BN	folded, gentle	FG	ortho-	OR	veined	VN
basaltic	BS	foliated	FO	oxidized	OX	vesicular	VS
basic	BA	footwall	FW	pebbly	BP	volcanic	VL
bedded	BD	fossiliferous	FS	pegmatitic	PG	volcaniclastic	VC
BIF associated	BF	fracture zone, fractured	FR	pelitic	PE	vuggy	VG
bituminous	BT	friable	IA	phyllitic	PH	xenolithic	XE
bleached	BL	gabbroic	GB	pillowed	PW		
botryoidal	BO	garnetiferous	GA	pisolitic	PI		
boudinaged	BJ	glacial	GC	plutonic	PT		
brecciated	BX	glassy	GS	porous	PU		
calcareous	CA	gneissic	GN	porphyritic	PP		
carbonaceous	C$	goethitic	GE	porphyroblastic	PB		
cataclastic	CX	gossanous	GG	possible	??		
cavernous	CV	graded bedding	GD	potassic	K+		
cemented	CE	granitic	GR	psammitic	PS		
Chaledonic	CW	granoblastic	GX	psammo-pelitic	PZ		
cherty	CH	granophyric	GO	pseudobreccia	PX		
chilled margin	CM	granulose, granular	GL	pyritic	PY		
clastic	CL	graphic	GP	pyroclastic	PC		
clayey / clay size	CY	graphitic	GI	pyrrhotitic	PO		
close structured	CS	gravelly	GV	qz-fd porphyritic	QF		
coarse bands (>1cm)	>B	gritty	GT	qz porphyritic	PQ		
coarse - pebble size	+C	hanging wall	HW	quartzitic, quartzos	QZ		
colloform	CF	hematitic	HE	rare trace	<-		
composite	CJ	heterogeneous	HT	recrystallized	RX		
conglomeratic	CG	homogeneous	HO	red rock(HE + AB)	RR		
crenulated	CR	hornfelsic	HF	relict	RL		
crystalline	XL	igneous	IG	replaced	RP		
dacitic	DC	indurated	ID	retrogressed	RE		
deformed	DE	inequigranular	IQ	reworked	RW		
dioritic	DR	interbedded	IB	rhyolitic	RY		
dirty	DT	intermediate	IT	sandy	SA		
disrupted	DP	interstitial	IS	schistose	SC		
dissem ma	DM	intrusive	IN	sericitic	SR		
doleritic	DL	irregular	IR	shaly	SH		
do	DO	kaolinitic	KA	sheared	S-		
drag folded	DF	laminated	LM	siliceous	SS		
dyke	DY	lateritic	LR	siliceous altn	QA		
epiclastic	EP	layered	LY	silicified	SF		
equigranular	EQ	leached	LH	sill	I-		
evaporitic	EV	lensoid, lenticular	LN	silty/silt size	SI		
fault breccia	FX	leuco	LE	spherulitic	SO		
fault zone, fault	FZ	lineation/lineated	LD	spinifex	XF		
faulted	F-	lithic	LI	spotty, spotted	SP		
FD porphyritic	PF	macrofaulted	>F	stressed	SE		
FD, cream-white	WF	macroveined (>2mm)	>V	sub-volcanic	SV		
FD, green-grey	GF	mafic	MF	sugary	SG		
FD, pink-orange	OF	ma-bearing	MA	sulphidic	S=		
feldspathic	FD	massive	MS	texturally altered	TX		
felsic	FC	med to gravel size	+M	tholeiitic	TH		

STRUCTURE CODE

angular unconf	<A
axial plane	AY
banded sulphides	B=
bn, compositional	CB
bn, metamorphic	MB
bedding	BD
breccia	BX
breccia zone	BZ
cleavage	KV
contact zone	C-
crenulations	CR
dyke	DY
fault	F-
fault breccia	FX
fault zone	FZ
fold phase 1	F1
foliation	FO
footwall	FW
fracture zone	FR
hanging wall	HW
joint set	JS
laminations	LM
lineation	LD
lower contact	LO
macrovnd (>2mm	>V
massive vein	MV
microvnd (<2mm)	<V
migmatitic fo	MM
mylonitic fo	MY
qz vein	QV
schistosity	SC
shear	S-
sill	I-
slickensides	SJ
strong fo	SF
unconformity	<U
upper contact	UO
vein	VN
vein breccia	VB
weak fo	WF

GRAIN SIZE

very fine-grained	<
very cse-grained (>>1cn	>
clay/glass(<0.004mm)	0
fine silt/aphantic	1
med-cse silt/aphantic	2
fine sand/fine	3
med-cse sand/fine	4
gravel/medium	5
small pebbles/coarse	6
large pebbles/coarse	7
cobbles/pegmatite	8
boulders/megapeg	9
cse-grained (4mm-1cm)	C
fine-grained (<1mm)	F
heterogeneous	H
med-grained (1-4mm)	M

LIGHTNESS

darkest	1
very dark	2
dark	3
medium-dark	4
medium	5
medium-light	6
light	7
very light	8
palest	9
banded	B
mottled	M
black	N
patchy	P
spotty	S
white	W

HUE

aqua	Q
black	N
blue	B
brown	U
Cream	C
green	G
grey	E
khaki	K
lime	L
mauve	M
orange	O
pink	I
purple	P
red	R
tan	T
violet	V
white	W
yellow	Y

AMOUNT

rare trace (<<1%)	<
totally dominant (100%	>
<1% widespread trace	1
1-2%	2
2-5%	3
5-10%	4
10-20%	5
20-40%	6
40-60%	7
60-80%	8
80-99%	9
co-dominant (25-50%)	C
dominant (>50%)	D
minor (1-5%)	M
subordinate (5-25%)	S
trace (<1%)	T

MINERALISATION MODE

amorphous	AO	dissem sulphides	DS	massive vein	MV
amygdaloidal	AM	drusy cavities	DV	microvein swarm	<I
banded	BN	dyke	DY	microveined (<2mm)	<V
bands (<1cm)	<B	euhedral crystals	EU	macrovein (>2mm)	>S
bn laminae sulphides	B=	fault breccia	FX	microvein (<2mm)	<S
bedded	BD	fault zone, fault	FZ	patchy	PD
BIF associated	BF	grain coatings		pervasive	PV
blebs	BB	and dissems	DG	stockwork	SW
boxworks	BW	joint film	JF	stringer textures	ST
cavity, vuggy infill	VI	laminated	LM	vein	V-
coarse bands (>1cm)	>B	lm sulphides	L=	vein breccia	VB
colloform	CF	layered	LY	vein selvedge	VE
intergrowths	IW	lensoid, lenticular	LN	vuggy	VG
crackle bx and veinle	VX	lineations 1	L1		
VX swarm	KR	macrovein swarm	>I		
crystalline	XL	macroveined (>2mm	>V		
dissem	DI	massive	MS		
dissem and blebby	DB	massive sulphide	M=		

VEIN QUALIFYER

axial plane	AY
boudinaged	BJ
crackle bx and sulph v	VX
disrupted	DP
faulted	F-
folded	FT
macrovein swarm (>2r	>I
macroveined (>2mm)	>V
microvein swarm (<2n	<I
microveined (<2mm)	<V
mineralised macrovns	>S
mineralised microvns	<S
stockwork	SW
vein breccia	VB

ALTERATION

albitic alteration	AB	pervasive	PV
banded	BN	red rock altn	RR
banding, compositiona	CB	relict patches of roc	RL
banding, crude	LB	Replacement	RP
banding, irregular	BI	silicification	SF
banding, textural	TB	texturally altered	TX
bleached zones	BL	vein selvedges	VE
disrptd isolated		veins	VN
patches & rems	DR	weak	WK
dissem selvages			
adj to veins	DV		
dissem	DI		
irregular patches	PA		
mafic alteration	MF		
rock type is alteration	RT		
massive zone	MA		
moderate	MD		
patchy	PD		

GEOL LOG TYPE

Alteration	AL
Comments	CC
Com additional 1	C1
Lithology	LL
lith additional 1	L1
Mineralization	MI
Min additional 1	M1
Structure	ST

WEATHERING

not weathered	0
very low	2
low (weakly, minc	3
fairly low	4
moderately	5
fairly well	6
highly	7
very highly	8
extremely highly	9

APPENDIX 2

Drill Hole Sampling Data

Hole	From	To	Sample No.	Duplicate	Standard	Sample Type
hole_name	from_depth	to_depth	sample_number	original_sample_number	code_quality_assurance	code_sample_category
BDRC04001	0	4	GH7001			RC
BDRC04001	4	8	GH7002			RC
BDRC04001	8	12	GH7003			RC
BDRC04001	12	16	GH7004			RC
BDRC04001	16	20	GH7005			RC
BDRC04001	20	24	GH7006			RC
BDRC04001	24	28	GH7007			RC
BDRC04001	28	32	GH7008			RC
BDRC04001	32	36	GH7009			RC
BDRC04001	36	40	GH7010			RC
BDRC04001	40	44	GH7011			RC
BDRC04001	44	48	GH7012			RC
BDRC04001	48	52	GH7013			RC
BDRC04001	52	56	GH7014			RC
BDRC04001	56	60	GH7015			RC
BDRC04001	60	64	GH7016			RC
BDRC04001	64	68	GH7017			RC
BDRC04001	68	72	GH7018			RC
BDRC04001	72	76	GH7019			RC
BDRC04001	76	80	GH7020			RC
BDRC04001	68	72	GH7021	GH7018		RC
			GH7022		OREAS 44P	
BDRC04001	80	84	GH7023			RC
BDRC04001	84	88	GH7024			RC
BDRC04001	88	92	GH7025			RC
BDRC04001	92	96	GH7026			RC
BDRC04001	96	100	GH7027			RC
BDRC04001	100	104	GH7028			RC
BDRC04001	104	108	GH7029			RC
BDRC04001	108	112	GH7030			RC
BDRC04001	112	116	GH7031			RC
BDRC04001	116	120	GH7032			RC
BDRC04001	120	124	GH7033			RC
BDRC04001	124	128	GH7034			RC
BDRC04001	128	132	GH7035			RC
BDRC04001	132	136	GH7036			RC
BDRC04001	136	140	GH7037			RC
BDRC04001	140	144	GH7038			RC
BDRC04001	144	148	GH7039			RC
BDRC04001	148	152	GH7040			RC
BDRC04001	152	156	GH7041			RC
BDRC04001	156	160	GH7042			RC
BDRC04001	120	124	GH7043	GH7033		RC

			GH7044		OREAS 44P	
BDRC04001	160	164	GH7045			RC
BDRC04001	164	168	GH7046			RC
BDRC04001	168	172	GH7047			RC
BDRC04001	172	176	GH7048			RC
BDRC04001	176	180	GH7049			RC
BDRC04001	180	184	GH7050			RC
BDRC04001	184	188	GH7051			RC
BDRC04001	188	192	GH7052			RC
BDRC04001	192	196	GH7053			RC
BDRC04001	196	200	GH7054			RC
BDRC04001	200	202	GH7055			RC

APPENDIX 3

Petrology Report by Alan Purvis

MINERALOGICAL REPORT No. 8527

by Alan C. Purvis, PhD & Ian R. Pontifex, MSc.

July 8th, 2004

TO :	Mr James Merrilees BHP Billiton Minerals Exploration Level 3, 40 McDougall Street MILTON QLD 4064
YOUR REFERENCE :	Your letter dated 18/6/04
MATERIAL :	RC chips from Arunta Drilling
IDENTIFICATION :	Various depth holes: AYRC04001, 02, 03, 04, 06, 07, 09, BD040001
WORK REQUESTED :	Thin and polished thin section preparation, description and report with comments as indicated in the covering letter.
SAMPLES & SECTIONS :	Returned to you with this report.
DIGITAL COPY :	Enclosed with hard copy of this report.

PONTIFEX & ASSOCIATES PTY. LTD.

SUMMARY COMMENTS

Twenty-one samples of drill chips mounted in epoxy and made into 9 thin and 12 polished thin sections as appropriate are described in this report. These samples are from eight drillholes in the Arunta Inlier in the Northern Territory, seven of which target EM anomalies on the Mt Rennie 1:250,000 map sheet area which are associated with the igneous Andrew Young Complex and Dufaur Mafic Suite. One hole BD04001 tests a magnetic anomaly is also associated with possible Andrew Young Complex intrusives .

The seven drillholes on Mt Rennie are AYRC04001-9 (excepting 5 and 8) and the chip samples from these are petrologically found to include mafic and ultramafic lithologies, as well as metasediments ranging from pelite to quartzofeldspathic and quartz-rich sandstones. Zones of metasomatised rock and of rare granitoid also occur. The mafic rocks are mostly metamorphosed to form amphibolites, but some also have minor to abundant biotite or phlogopite, and may represent Dufaur Suite mafic intrusions, (as at least some Andrew Young Complex bodies are unmetamorphosed). Phlogopite also accompanies tremolite-actinolite in metapyroxenite chips. Quartz and plagioclase dominate the meta-sandstones, with biotite, muscovite and chlorite variously developed, but these micas are more abundant in pelitic schists. In AYRC04007 samples between 82 and 90m indicate shearing and post-tectonic introduction of tourmaline and sulphide mostly within metasediments. Mafic to ultramafic rocks occur deeper in this hole 4007. Heterogeneous quartz-garnet-hornblende-biotite-chlorite schist in drillhole AYRC04006 (136m) may represent an annealed metasomatic zone.

Reflected light microscopy of the polished thin sections indicates mostly minor, but locally abundant pyrrhotite, rarer finer chalcopyrite, also scattered ilmenite, especially in the amphibolites. Also there is possibly low-temperature or supergene pyrite in both samples from AYRC04006. Sparse minute exsolution pentlandite flames in pyrrhotite in AYRC04009 at 198m, in a metamorphosed quartz-bearing gabbro, suggest that these sulphides are of primary magmatic origin. Sulphides in other samples seem to be metamorphic and/or epigenetic.

The four samples from BD04001 include norite with quartzofeldspathic veins (tonalite?) at 86-87m, and a very high-grade metapelite at 195-196m with garnet enclosing granular sillimanite and spinel, also with possible cordierite. The chips from 117-118m and 158-159m

are mostly microdiorites with accessory disseminated magnetite, ilmenite and sparse pyrite, but include mafic and felsic (tonalite) chips at 117-118m. There is an apparently primary foliation in the shallower chips in this hole but the deeper chips seem to have been sheared, with biotite or phlogopite and a pale bluish amphibole. The norite at 86m is similar to bodies mapped as Andrew Young Complex, and may have been responsible for the very high-grade metamorphism at 195m, but the microdiorites in the other two samples may be later but do not appear to be replacement products of granodiorite as questioned in notes accompanying the samples.

The petrographic identification of rock types and/or statement of essential mineralogy compositions, together with interpreted protoliths, are listed in Table 1 below. The (opaque) sulphides and oxides and their estimated abundances, as seen in the selected polished thin sections, and under binocular microscope in other samples, are also listed. These may have some bearing on the target EM and magnetic anomalies being tested.
The characteristics of the samples are listed below in Table 1.

Table 1: Samples Described in Report No 8527

	Drillhole and depth		Rock type or mineralogy	Protolith	Sulphides	%	Oxides	%
TS	AYRC04001	144	Amphibolite	Gabbro/dolerite	po>cp	tr	il	3-4
PTS		165	Amphibolite (most chips)	Gabbro/dolerite	po>cp	1	il	2
			Quartzofeldspathic (one chip)	Granitoid	po-rich	5	-	-
PTS		169	Quartzofeldspathic	Sandstone	po>cp	3	-	-
			Biotite-hornblende-rich	Mafic or sediment?	po>cp	3	il	tr
			Biotite schist	Pelite	-	-	il	tr
TS		200	Tremolite-phlogopite	Pyroxenite	po	tr	il	1-2
TS	AYRC04002	182	Quartzofeldspathic ± biotite	Sandstone	po	1	?il	tr
			Quartz-rich ± biotite	Sandstone	-	-	-	-
PTS	AYRC04003	134	Quartz, biotite, muscovite, sulphide	Sediments	po>>>cp	5	-	-
			Brecciated quartz + sulphide		-po>>>cp	25	-	-
TS	AYRC04004	122	Phlogopite amphibolite	Magnesian gabbro	-	-	?il	<1
PTS	AYRC04006	34	Amphibolite	Quartz dolerite	py>>>cp	4	il	tr
PTS		136	Quartz, garnet, hornblende, biotite	Shear zone	po, py	5	-	-
			Chlorite, epidote, sulphides		mc, cp	3	-	-
PTS	AYRC04007	82	Phyllonitic schists + tourmaline, sulphides	Sheared metasediment	po>>cp	8	il	1
TS		86	Quartz-plagioclase-biotite-chlorite + tourmaline, sulphides	Sheared metasediment	po>>cp	1	il	1
PTS		88	Quartzofeldspathic, biotite		po>cp	2	-	-
			Quartz-plagioclase-biotite-chlorite, sulphides, abundant tourmaline,		py, po>>cp	5	il	1
PTS		98	Tremolite-phlogopite	Pyroxenite	po>py	2	-	-
			Amphibolite	Dolerite	po>cp	3	il	1
			Quartzofeldspathic	Intermediate/felsic	po	<1	il	tr
PTS		122	Quartz-plagioclase-biotite-chlorite	Metasediment	po>py>>cp	1	il	tr
			Amphibolite	Mafic	po>py>>cp	1	il	1
TS	AYRC04009	42	Quartz-biotite (1 chip)	Sandstone	-	-	-	-
			Tremolite-phlogopite (7 chips)	Pyroxenite	-	-	?	<1
PTS		198	Amphibolite	Gabbro with quartz	py>cp, pn	1-2	il	3-5
TS		206	Quartz-rich (5 chips)	Sandstone	-	-	-	-
			Quartzofeldspathic (5 chips)	Sandstone	-	-	-	-
			Quartz-biotite (1 chip)	Pelite	po>cp	1-2	-	-
			Hornblende-quartz (1 chip)	Mafic or sediment?	po	tr	il	tr

	Drillhole and depth		Rock type or mineralogy	Protolith	Sulphides	%	Oxides	%
TS	BD04001	86	Quartz-plagioclase-biotite (1 chip)	Granitoid veins	-	-	-	-
			Orthopyroxene-plagioclase (all other chips)	Norite	-	-	-	-
PTS		117	Biotite-hornblende-rich	Microdiorite	py	tr	mg, il	2
			Hornblende-rich	Mafic	py	tr	mg, il	3
			Quartz-biotite-plagioclase	Tonalite	py	tr	mg, il	2
PTS		158	Biotite-hornblende-rich	Sheared microdiorite	py	tr	mg, il	8
TS		195	Quartz-K-spar-plagioclase-garnet	Very high grade pelite	py	tr	il+mg	2
			sillimanite-spinel-cordierite-oxide					

Notes:

1. Sample AYR04006, 136 to 138 was received (and described), but not included in your covering notes
2. The section types listed are thin section (TS), polished thin section (PTS)
3. The (opaque) sulphide and oxide grains are precisely identified in the polished thin section. Identifications of opaque in the normal thin sections are reasonably confident by binocular microscopy, but if critical, require check in (new) polished sections
4. The % abundances listed are visual estimates more or less as a % of each whole section. Tr = trace = <<1%
5. Abbreviations of opaque minerals are pyrrhotite (po), pyrite (py), chalcopyrite (cp), pentlandite (pn), marcasite (mc), ilmenite (il), magnetite (mg).

INDIVIDUAL DESCRIPTIONS

AYRC04001, 144-145m **Mafic amphibolite, interpreted as metamorphosed mafic gabbro or dolerite, with amphibole (hornblende or actinolite) > plagioclase, accessory opaque oxide, (probably recrystallised ilmenite), biotite and quartz. Trace sulphide and apatite.**

Field Note: *Pyroxenite*

The chips in this sample are relatively homogeneous and have about 60% amphibole, 35% plagioclase, 3-4% opaque oxide, <1% biotite and <1% quartz. The amphibole is largely granular and has formed from pre-existing granular, prismatic and subophitic pyroxene from 0.4mm to 4mm in grainsize. Plagioclase is not abundant but occurs as irregularly zoned grains to 1mm long and partly as a recrystallised micromosaic. In one chip, most of the plagioclase occurs as a micromosaic with abundant fine-grained, partly schistose amphibole. Aggregates of opaque oxide, possibly recrystallised ilmenite, occur to 1mm in diameter and there are rare quartz grains to 1mm in diameter. The identification of the same oxide in polished thin section at 165m as ilmenite indicates this oxide also to be ilmenite. Trace much smaller grains of sulphide are seen under binocular microscope as apparent pyrrhotite > chalcopyrite. Small patches of decussate fine-grained biotite accompany the opaque oxide in some areas. Rare apatite was noted.

This sample represents mafic gabbro or dolerite with possibly some accumulated clinopyroxene but a high content of trapped magma which would suggest an orthocumulate. There is too much plagioclase for a pyroxenite as questioned in the field notes.

AYRC04001, 165-166m **Mafic amphibolite, derived from dolerite or gabbro, with accessory ilmenite and rare fine sulphide. One quartzofeldspathic chip with more abundant sulphide (5%) which is pyrrhotite, within vein quartz in this chip.**

Field Note: *Pyroxenite with traces of pyrrhotite-pyrite vein*

Almost all of the chips in this sample are predominantly mafic with abundant inequigranular hornblende as grains, prisms and bundles of prisms to 3mm long. Larger prisms and parallel bundles of prisms seem to have replaced large single pyroxene grains. The various chips also contain between 5 and 35% plagioclase, rarely more than 1mm in diameter and mostly as a micromosaic of grains about 0.2mm in diameter, with as much as 2 or 3% quartz in several chips. Accessory fine ilmenite (2%) is disseminated as small, recrystallised aggregates, with minor decussate biotite in some chips, but sulphide is rare. Most of the trace disseminated sulphide in these mafic chips is pyrrhotite, with rarer chalcopyrite. These mafic chips represent mafic metadolerite or metagabbro.

There is a single chip dominated by plagioclase and quartz, with rare quartz grains to 2.5mm in grainsize probably representing a vein, as well as areas of quartzofeldspathic micromosaic. This chip has more abundant sulphide (5-7%) than the more mafic chips, and this is all pyrrhotite and located in the small area of vein quartz. This chip is possibly a recrystallised quartz microdiorite or tonalite, but is too small to allow a representative mineralogy to be estimated.

AYRC04001, 169-170m **Variously quartzofeldspathic and biotite ± hornblende-rich schists, apparently metasediment ± metamorphosed mafic lithologies. One chip dominated by muscovite rather than hornblende. Minor pyrrhotite > chalcopyrite in several chips, variably scattered and in veinlets parallel to the foliation. Total sulphide content is approximately 5% of the whole section.**

Field Note: *Biotite schist with rare pyrite-pyrrhotite-chalcopyrite veinlets and segregations.*

The chips in this thin section are partly quartzofeldspathic but also contain minor to abundant mafic silicates, mostly biotite and/or hornblende. Minor fine sulphides are scattered and occur in veinlets parallel to the foliation. One chip shows a contact between a quartzofeldspathic zone and a more mafic, schistose lithology with the contact parallel to the foliation.

One of the coarser quartzofeldspathic chips is quartz-rich and has quartz from 0.2mm to 3mm in grainsize with irregular areas of plagioclase-rich micromosaic. Small lenses of schistose biotite also occur in this chip, with less abundant disseminated green hornblende. Another chip has plagioclase to 2mm in grainsize with areas of quartzofeldspathic micromosaic, patches rich in biotite, minor hornblende and scattered pyrrhotite and minor chalcopyrite. A third chip has parallel lenses of quartz and disseminated plagioclase to 0.5mm in diameter as well as a quartzofeldspathic micromosaic. Minor schistose muscovite occurs in this chip, as well as biotite. The quartzofeldspathic layer in contact with the more mafic lithology has quartz and plagioclase to 0.8mm in grainsize as well as minor biotite and hornblende. These chips seem to represent metamorphosed impure sandstones.

There are 5 or 6 chips that are dominated by a very fine-grained plagioclase-rich micromosaic but also contain about 10% biotite as small, strongly schistose flakes. These commonly contain minor sulphide, again mostly pyrrhotite with lesser chalcopyrite, disseminated in lenses to 1.5mm long, or in veins parallel to the schistosity. The host rock seems to represent metasiltstones. Another 6 chips have between 2 or 3% micromosaic and as much as 35%

micromosaic (quartz and/or plagioclase) as well as abundant mostly schistose hornblende and biotite in various proportions. These chips are mostly fine-grained, but there is one chip with coarse schistose biotite and hornblende that also contains large lenses of pyrrhotite rimmed by chalcopyrite, to 4 x 2mm. Fine-grained ilmenite occurs in some of the amphibole-rich chips. These chips have little or no sulphide and may represent altered metasediment or potassium-enriched mafic lithologies. A single large chip is mostly schistose biotite, with flakes about 0.5mm in grainsize defining a folded schistosity. This chip also contains quartzofeldspathic lenses and a small lens of hornblende.

AYRC04001, 200-202m **Metamorphosed fine-grained feldspathic pyroxenite with accessory fine opaque oxide and biotite. Rare trace much finer sulphide.**

Field Note: *Biotite schist*

The chips in this thin section are somewhat heterogeneous but are dominated by inequigranular amphibole (80-85%), actinolite or hornblende, with 10-20% plagioclase in various chips. Larger grains of amphibole, to 1mm long, may represent altered residual pyroxene grains but most of the amphibole is fine-grained and recrystallised. Most of the plagioclase is recrystallised and defines a micromosaic, with rare larger grains to 0.8mm in diameter. Several chips have minor (3-5%) biotite as decussate small flakes, and others have 1-2% opaque oxide, probably recrystallised ilmenite. Fine schiller-like aggregates of opaque oxide occur in some amphibole grains, and were apparently inherited from former pyroxene. Rare chlorite occurs in several chips, mostly as unoriented flakes to 0.5mm in diameter. One chip has a trace of sulphide.

These chips seem to represent metamorphosed possibly fine-grained pyroxenite with some plagioclase and accessory opaque oxide, but biotite is very minor and occurs in only a few chips.

AYRC04002, 182-184m **Chips of co-dominant fine quartzo-feldspathic and quartz-rich schists, variably with biotite > muscovite > tourmaline, apatite, rare zircon. Accessory very fine pyrrhotite and opaque oxide in a few chips. Interpreted as metamorphosed impure fine sandstones.**

Field Note: *Biotite schist*

The numerous small chips in this thin section are fine grained inequigranular and heterogeneous. Most contain an abundant micromosaic with plagioclase usually more abundant than quartz, but many chips have minor to abundant mica, with biotite and/or muscovite in various proportions. As much as 15-20% biotite > muscovite occurs in some chips, with flakes to 1mm in the most schistose chips, but mostly less than 0.25mm in size. One of the more micaceous chips has abundant partly schistose biotite but a micromosaic dominated by quartz, with little or no plagioclase. This chip also has small lenses of partly altered very fine pyrrhotite, and rarer pyrrhotite occurs in one or two other chips. Several chips have single-crystal quartz grains and aggregates from 0.25mm to 2mm long, possibly representing former detrital grains varying from medium to very coarse sand. Larger plagioclase grains are rare, however, suggesting that most of the plagioclase has been recrystallised. Accessories include apatite, opaque oxide, zoned green to brown tourmaline and rare possible zircon. Weak clay alteration is seen in the plagioclase and there are areas with chloritised biotite. One chip has a crosscutting vein with adularia and magnesian chlorite.

This sample seems to represent metamorphosed impure sandstones.

AYRC04003, 134-136 **Variously quartz, biotite, muscovite and pyrrhotite-rich metasediments and deformed and brecciated quartz-rich to pyrrhotite-rich possible veins. Trace chalcopyrite accompanied pyrrhotite.**

Field Note: *Micaceous quartz arenite*

The various chips in this thin section have different proportions of three main components: quartz, muscovite and sulphide. Two types of quartz occur: vein quartz, partly in sulphide-cemented breccias, and recrystallised detrital quartz. The detrital quartz varies from 0.1mm (very fine sand) to 0.8mm (coarse sand) in different chips, usually with minor to common schistose mica (muscovite and/or biotite). Minor tourmaline is widespread, but may be partly of authigenic or metamorphic origin. Lenses of sulphide occur in some of these chips, mostly parallel to the schistosity. Some of the more muscovite-rich chips have a crenulated schistosity, but most have a planar schistosity, with some disruption where there are irregular lenses of sulphide. Again, most of the sulphide is pyrrhotite with very minor chalcopyrite. One chip has sulphide parallel to a crenulation cleavage in quartz-rich quartz-muscovite schist.

Even more micaceous chips, mostly rich in muscovite, seem to represent siltstones and shales, and have well-developed spaced crenulation cleavages. Minor biotite, possibly passing into phlogopite, occurs in these chips. The most micaceous chip has abundant crenulated and kinked muscovite, but also has layers that contain or consist of quartz, locally with filaments of sulphide, and layers of deformed probable phlogopite flakes. This may represent a former pelite but may have suffered potassic alteration.

The quartz-rich to sulphide-rich chips contain minor to abundant quartz as highly deformed grains, to 3mm long where they are abundant, as well as veins and interstitial masses of sulphide, essentially all pyrrhotite, but with very minor chalcopyrite in one chip, and seem to represent deformed quartz-sulphide veins.

AYRC04004, 122-124m **Foliated phlogopite amphibolite, with subordinate sericitised plagioclase and trace fine opaque oxide. Metamorphosed magnesian gabbro or dolerite with potassic alteration.**

Field Note: *Micaceous quartz arenite*

These chips are not seen petrographically to contain arenite, but are composed of schistose magnesian biotite or phlogopite amphibolite. Lenses and lamellae of schistose phlogopite commonly form about 20% of the chips intricately intergrown with more abundant fine granular to prismatic amphibole (50-55%). This amphibole is colourless or very pale brownish, suggesting tremolite-actinolite or magnesiohornblende. It varies from microcrystalline to about 1.5mm in grainsize. Lesser (25-35%) plagioclase is also scattered, partly microcrystalline, partly with sericitised euhedral cores to 1.3mm long and fresh rims, partly poikilitic and enclosing amphibole ± biotite. Traces of opaque oxide are present.

This sample seems to represent a magnesian, mafic gabbro or dolerite that has been metamorphosed and altered, with potassium enrichment indicated by the abundance of biotite/phlogopite. Anastomosing clay-filled fractures are present and there is rare epidote in plagioclase.

AYRC04006, 34-35m **Massive amphibolite representing metamorphosed quartz-bearing dolerite. Minor scattered fine with titanite, ilmenite and pyrite, rare-trace chalcopyrite. [Probably metamorphosed Dufaur Suite mafics as suggested in the fieldnote.]**

Field Note: *Pyritic metadolerite of the Dufaur Mafic Suite*

This sample consists of homogeneous amphibolite chips similar to meta-mafic lithologies in AYRC001 and 004, suggesting that those may also represent Dufaur Suite mafic intrusions. Abundant randomly interlocking green hornblende (~55%) occurs as prisms and parallel or garbenschiefer bundles to 3mm long, apparently replacing former pyroxene. Plagioclase (~35%) > quartz and granophyre are scattered interstitially. Sparse elongate plagioclase laths occur, to 1mm long, as well as fine-grained recrystallised plagioclase and lenses of recrystallised quartz (~3%). Sparse quartzofeldspathic areas (2%) seem to represent recrystallised granophyre, and usually contain needles of apatite as well as hornblende prisms. Oxide grains (2%) have been recrystallised as to form disseminated fine ilmenite, some altered to microcrystalline titanite. Accessory sulphides (total 3-4%) are disseminated, mostly pyrite but with rare trace finer chalcopyrite.

AYR04006, 136-138m **Chips composed of various combinations of fine granular quartz, garnet, (schistose) hornblende, biotite, chlorite, epidote. Disseminated fine pyrrhotite > pyrite, rare marcasite and chalcopyrite. Probably from and annealed alteration or shear zone.**

Field Note: *[None, supplementary sample: not listed.]*

About half of the chips in this sample have various proportions of quartz, garnet and amphibole, commonly with minor calcic plagioclase, epidote or chlorite. Minor sulphide is disseminated in several chips. One chip is pure quartz as a micromosaic and may represent former chert, sandstone or vein quartz, but another chip is quartz-free, with garnet to 1mm in diameter in schistose dark green hornblende with sulphides and small radioactive grains. Minor irregularly disseminated fine sulphides, overall 3 to 5% consist of pyrrhotite > pyrite.

The other chips have minor to abundant quartz as a micromosaic, usually with minor plagioclase or epidote. One contains apparently relatively calcic garnet in a quartz-rich host containing minor epidote, but most of the garnet is less calcic. The plagioclase has a high refractive index and seems to be quite calcic. Rosettes of hornblende (± chlorite) are abundant and locally enclose large grains of garnet, but some rosettes and garnet grains are independent of each other. In these chips, minor fine sulphides occur mostly in fractures in garnet and in the amphibole ± chlorite rosettes. Areas of disseminated biotite and/or chlorite also occur in some of these chips. The chlorite is pale green and optically positive, suggesting Fe-Mg chlorite with low Al. Transitions from rosettes or massive amphibole lenses to schistose lenses of amphibole ± biotite are seen in other chips, with minor to abundant garnet as inclusion-poor to inclusion-rich grains to 2mm in diameter. Fine sulphides again occur mostly in fractures in garnet or in amphibole-rich areas, and are mostly pyrrhotite with minor chalcopyrite.

One chip has a carbonate-clay vein cutting a tourmaline-rich area, with pyrite adjacent to the vein.

These lithologies are mostly similar to those seen in annealed metasomatic zones, originally containing quartz-chlorite-sericite-carbonate assemblages.

AYRC04007, 82-84m **Phyllonitic or mylonitic schists with quartz, plagioclase, biotite/phlogopite, muscovite/sericite, chlorite, tourmaline. Fine to coarser pyrrhotite and lesser fine chalcopyrite in various proportions, total about 8%, rare titaniferous magnetite or ilmenite. Probably represents high strain zones in metasediments, with alteration and sulphide formation.**

Field Note: *Semi-massive pyrite-pyrrhotite in silicified metasediment*

The chips in this thin section have phyllonitic or mylonitic fabrics but also contain some massive lenses and layers, mostly rich in quartz ± tourmaline. The phyllonitic areas have sparse to abundant apparently residual grains of quartz and apparently sodic plagioclase to 1mm in diameter as well as abundant microcrystalline material (quartz ± plagioclase?) and fine schistose mica (biotite/phlogopite and/or muscovite/sericite). Planar or contorted schistosities are evident and many chips are heterogeneous with planar or irregular quartz-rich, quartzofeldspathic and micaceous domains. Some chips have lamellae rich in microcrystalline quartz and sericite, with irregularly distributed sulphides. One chip has lenses and lamellae of schistose chlorite as well as quartz, biotite and sulphide. Another chip seems to have been cut parallel to the schistosity and has irregular sericite-sulphide and quartz-rich domains, with minor apatite mostly in quartz-rich areas.

Some of the coarser sulphide occur together with tourmaline in quartz-rich or micaceous or chloritic areas, including domains with patches of massive quartz-rich micromosaic or lamellae of micaceous material as well as granular to prismatic tourmaline. The tourmaline is mostly orange-brown or greenish brown and either inclusion-rich and granular or inclusion free and prismatic. The tourmaline and quartz-rich areas seem to have developed after deformation, partly within earlier sulphides and partly with possibly coeval sulphides. Other irregular lenses, clusters and short veinlets of sulphide may have been remobilised during deformation.

Pyrrhotite is by far the most abundant sulphide in this thin section total about 8%, with rare finer chalcopyrite also accessory ilmenite showing incipient alteration to leucoxene.

AYRC04007, 86-88m **Metasediments with various proportions of fine quartz, plagioclase, biotite and chlorite, tourmaline and pyrrhotite ± chalcopyrite?. Minor zircon suggests protoliths of siltstone, shale and fine to medium-grained sandstone, with rare opaque oxide and apatite.**

Field Note: *Silicified metapsammite with pyrite-pyrrhotite veins and disseminations*

The chips in this thin section are heterogeneous and inequigranular but overall indicating a variety of meta-sediments. Some ten chips are poor in micaceous minerals (3-7%) and vary from quartz-rich to feldspathic, with more abundant micaceous minerals (7-20%) in the other six chips. Most of the chips are very fine-grained with grains less than 0.2mm in length, and have a schistosity defined by biotite and/or chlorite. It seems likely that the chlorite is later than biotite, commonly crosscutting the biotite and in parts poorly oriented, but there is no evidence of chlorite replacing biotite. Two of the chips have chlorite-rich microshears oblique to the biotite schistosity. Several chips have lenses or layers that contain or consist of plagioclase grains 0.4mm or more in diameter, and others have abundant quartz from 0.2mm to 0.5mm in grainsize, with grains and lenses elongate parallel to the schistosity.

Several chips have bands and lenses rich in variously greenish or brownish tourmaline, with sparse disseminated very fine pyrrhotite ± chalcopyrite mostly in tourmaline-rich areas. Other chips have sparse small blocky masses of limonite, possibly derived from pyrite. Fine grains of oxide and apatite occur as accessories, as well as zircon from 20 to 70μm in diameter, suggesting former fine to medium-grained sandstone. Some of the chips have only microcrystalline radioactive grains, however, suggesting siltstone or shale.

There is no evidence for silicification in this thin section (as questioned in the field notes).

AYRC04007, 88-90m **Modified feldspathic and quartz-feldspar-biotite-chlorite-rich schistose metasediments with minor to locally abundant tourmaline, pyrrhotite > pyrite ± marcasite locally in veins. Also chips with plagioclase and amphibole ± chlorite, > pyrrhotite ± tourmaline. Trace extremely fine chalcopyrite.**

Field Note: *Silicified metapsammite with pyrite-pyrrhotite veins and disseminations*

There are several chips of modified metasediment in this thin section, apparently quartzofeldspathic but no clear evidence of silicification as questioned in your field notes. One chip is mostly granular plagioclase about 0.5mm in grainsize with very minor chlorite, biotite carbonate and opaque oxide. Other chips have similarly large plagioclase and quartz grains, disseminated or in lenses, in a microcrystalline possibly quartz-rich or quartzofeldspathic matrix with microcrystalline biotite. Possibly later lamellae of schistose chlorite occur in some chips of this type, and others show minor to extensive granular to prismatic tourmaline, mostly greenish to orange-brown in colour, with or without iron sulphides. The tourmaline is mostly undeformed, but one chip is almost entirely composed of prismatic tourmaline to 4mm in grainsize, including bent and fractured prisms. Chlorite, apatite and sulphides also occur in this chip, with a small area of quartz-rich micromosaic. . Pyrrhotite is the most widespread sulphide but passes into porous and granular probably low-temperature pyrite, with very minor marcasite in some areas, particularly along margins of one or two veins. Trace much finer chalcopyrite are present.

Other chips consist of plagioclase and/or amphibole (tremolite-actinolite or hornblende?) as well as minor to abundant tourmaline, and these may have igneous protoliths. One of these chips has large plagioclase grains, to 4mm long, fractured and veined by chlorite. On one side of the chip is a layer of schistose pale amphibole with lenses of decussate chlorite. On the other side is an aggregate of granular to prismatic tourmaline, to 2mm in grainsize, including fractured grains veined by chlorite and quartz. Another lens of tourmaline occurs locally between plagioclase and schistose amphibole. A second chip has plagioclase with sericitised euhedral cores and clear anhedral overgrowths as well as irregular areas of schistose amphibole and less strongly foliated chlorite. Minor fine pyrrhotite > pyrite are scattered through these chips.

AYRC4007, 98-100m **Amphibole-phlogopite chips (metapyroxenite), mafic amphibolites (metadolerite), also fine feldspathic or quartzofeldspathic chips, possibly intermediate or felsic protoliths. Rare coarse pyrite, accessory very fine disseminated pyrrhotite, trace finer ilmenite and chalcopyrite.**

Field Note: *Metadolerite (Dufaur Mafic Suite) with moderate veins and disseminations of pyrite-pyrrhotite*

Three of the chips in this thin section are ultramafic composed of fine prismatic tremolite to 2mm in size as well as interstitial phlogopite ± tremolite as mostly smaller grains. Some of the amphibole has green zones and seems to represent fragmented grains that may have been as much as 4mm in diameter. There are also apparently shredded phlogopite flakes to 2mm long. A large grain of pyrite (3mm) occurs in one of these chips. The protolith to these chips seems to have been pyroxenite.

More abundant mafic chips are dominated by interlocking green amphibole prisms to 1.5mm in size, within a fine-grained matrix of amphibole, plagioclase, biotite and opaque oxide. The larger amphibole grains are greenish brown throughout or have brown cores and pale green rims. Some larger plagioclase grains occur, but most of the feldspar and amphibole have been recrystallised and are very fine-grained. One chip seems to be transitional from ultramafic to mafic and is largely composed of zoned actinolite-hornblende with rare pale brown zones. Interstitial plagioclase is present, to 2mm in grainsize and is partly altered to sericite. These chips contain sparse very fine pyrrhotite > ilmenite > chalcopyrite and may represent metabasalt or metadolerite as well as a more pyroxene-rich lithology.

There are also several plagioclase-rich chips with an apparently plagioclase-rich micromosaic as well as mostly minor fine-grained hornblende and/or biotite. One of these chips has amphibole possibly replacing mafic phenocrysts and another has slightly coarser, apparently quartzofeldspathic lenses as well as disseminated biotite. These also have sparse very fine scattered pyrrhotite > chalcopyrite, and seem to represent felsic or intermediate igneous lithologies, originally fine-grained and possibly from dykes.

AYRC04007, 122-124m **Co-dominant chips of quartz-plagioclase-biotite-chlorite metamorphosed very fine ?tuffaceous sandstone, and metamorphosed fine-grained, partly porphyritic (or coarser) mafic lithologies. Accessory very fine disseminated pyrrhotite > pyrite, trace chalcopyrite. One chip consists of vein quartz and coarse pyrite.**

Field Note: *Pyrite-pyrrhotite veinlets in silicified metapsammite*

This thin section contains co-dominant pale chips of metasediment and darker amphibole-rich mafic chips. One chip consists of quartz vein with sulphide. The metasediment chips have disseminated larger grains and aggregates of quartz and plagioclase to 1mm in grainsize in a finer micromosaic with partly schistose lenses of biotite and/or chlorite. Sparse fine ilmenite and sulphides are disseminated, with pyrrhotite to 0.5mm with rarer chalcopyrite and pyrite to 0.3mm. One quartz-rich metasediment chip has a lens of pyrrhotite 2mm long and 1mm wide, with coarse pyrite and trace chalcopyrite in another chip. One of these chips has a narrow quartz vein oblique to the schistosity. Related to these chips is a microcrystalline phyllonitic chip with a possibly quartzofeldspathic micromosaic and intersecting lamellae of microcrystalline biotite in two orientations at low angles to each other.

The darker (green) mafic chips are fine-grained with sparse plagioclase phenocrysts altered to sericite, in a fine-grained schistose amphibolite with minor biotite. Related to this lithology are chips with abundant schistose biotite and minor chlorite as well as microcrystalline plagioclase ± quartz. There is sparse disseminated sulphides, mostly pyrrhotite and rare chalcopyrite. Rare chips have granular to prismatic hornblende to 1mm long as well as inequigranular plagioclase, partly as laths to 1.5mm long, partly recrystallised and microcrystalline with trace fine sulphide.

A single chip is composed of subequal amounts of mostly fine-grained vein quartz and a grain of pyrite to 3mm. Trace chalcopyrite is partly attached to the pyrite and partly disseminated through the quartz.

AYRC04009, 42-44m

1. **One chip of biotite-bearing quartzite (metasandstone)**
2. **Seven chips of tremolite-actinolite to phlogopite-rich metamorphosed ultramafic rock (pyroxenite or peridotite) with chlorite, talc and trace indeterminate extremely fine opaque oxide.**

Field Note: *Muscovite schist*

One of the chips in this thin section is quartz-rich with sparse coarse-grained quartz to 1mm in quartzofeldspathic micromosaic, with 5% biotite from 0.05mm to 0.5mm in grainsize. The other chips are dominated by tremolite-actinolite (30-50%) with various proportions of phlogopite (15-65%) and chlorite (0-15%), as well as talc (0-10%) and possible cummingtonite (<3%). Several chips have phlogopite more abundant than amphibole, with grains mostly less than 1mm long, but others are richer in amphibole, commonly with lenses of poorly oriented chlorite flakes as well as mostly granular amphibole. Trace extremely fine indeterminate oxide is disseminated. The quartz-rich chip seems to represent metamorphosed quartz sandstone, but the other chips are of ultramafic origin, possibly derived from pyroxenite or peridotite, with potassic alteration. There is no muscovite in any of these chips, however. The sulphide is mostly pyrite, possibly derived from pyrrhotite, with rare chalcopyrite.

AYRC04009, 198-199 **Massive amphibolite derived from quartz-bearing gabbro. Sparse extremely fine pyrrhotite > chalcopyrite > rare-trace minute pentlandite inclusions in pyrrhotite.**

Field Note: *Pyroxenite with trace of pyrrhotite-pyrite-chalcopyrite: veins?*

Mostly about 60% of these chips consist of randomly interlocking prisms of subordinate amounts of plagioclase > quartz are interstitial and there is accessory scattered very fine, ilmenite, titanite and apatite. Sparse disseminated very fine sulphide may be of primary magmatic origin.

The hornblende seems to have replaced granular to prismatic pyroxene to 3mm or more in crystal size. There are also random laths of plagioclase and these seem to consist of two phases, possibly small blocks of andesine enclosed in bytownite. [Two-phase plagioclase of this type indicates a miscibility gap that is stable at 500-650°C.] Plagioclase also occurs as a recrystallised micromosaic together with quartz. Accessory scattered opaque oxide has been partly recrystallised to ilmenite and partly to completely replaced by titanite at a later stage. There are small lenses of quartz micromosaic and prisms of apatite, partly more than 1mm long. The sparse fine sulphides include pyrrhotite with trace minute enclosed flames of pentlandite ± chalcopyrite and separate grains of chalcopyrite. These associations suggest an inherited primary magmatic origin.

This sample represents metagabbro with minor quartz opaque oxides and rare sulphide.

AYRC04009, 206-208m

1. **Eleven chips of quartz-rich to quartzofeldspathic metasandstone with biotite, muscovite.**
2. **One chip of fine biotite-rich schist with quartz and trace sulphide: pelitic schist.**
3. **One chip of hornblende-biotite-quartz schist with sparse opaque oxide: metamorphosed altered pelite or mafic lithology?**

Field Note: *Biotite schist with rare to trace pyrite-pyrrhotite ± chalcopyrite veinlets and disseminations*

This sample has eleven pale chips composed of small grains in finer micromosaic of quartz to quartzofeldspathic composition. There is also one chip of fine biotite schist and one of hornblende-quartz schist. The pale metasandstone chips have single-crystal quartz and plagioclase grains, locally over 1mm in diameter (very coarse-grained sandstone) in a fine-grained schistose matrix with as much as 5% schistose biotite as well as quartz ± plagioclase. Trace to 2 or 3% muscovite is also disseminated and is mostly parallel to the schistosity defined by the biotite. Apatite is a common accessory, as well as trace extremely fine opaque oxide and sulphide.

The biotite schist has 5% disseminated quartz as well as 1-2% sulphide, probably pyrrhotite. Some of the biotite defines a folded schistosity, with less abundant biotite axial plane to the folds. This is apparently of pelitic origin.

The hornblende-rich schist has about 15-20% microcrystalline quartz and 10% schistose fine-grained biotite as well as schistose fine-grained hornblende. This chip has about 1% extremely fine probable ilmenite, but lacks plagioclase, allowing a metasomatic zone in a metapelite as well as an altered mafic protolith as potential protoliths.

BD04001, 86-87 **Most chips are massive, unmetamorphosed hornblende-biotite-bearing norite. One chips has a tonalite lens partly separated from norite by biotite-rich zones. Some clay alteration is seen in the orthopyroxene. Trace fine pyrite in one chip.**

Field Note: *Biotite granodiorite with 0.5% disseminated pyrite*

One of the chips in this thin section is partly quartz-rich and composite with a granitoid domain as well as areas of norite. All other chips are all noritic.

In the composite chip, there is an area of granitic rock about 15mm long and 5mm wide, with norite along one side and a margin of biotite-rich schist along the other. Quartz is abundant as grains to 4mm long with undulose extinction, but mostly fine-grained plagioclase is more abundant. There are also lenses of relatively coarse-grained biotite to 2mm in grainsize, with kinked cleavage planes and aggregates of finer, recrystallised biotite and accessory apatite is present. This area may represent tonalite or trondhjemite. The biotite-rich schist margin has lenses of plagioclase and grains of apatite as well as abundant schistose biotite and limonite-filled fractures. It may represent a xenolith in the tonalite or a shear zone. The norite in this chip has abundant plagioclase to 3mm in grainsize as well as partly clay-altered orthopyroxene and minor biotite, possibly formed as a result of being adjacent to the tonalite. Another chip has a quartz-rich lens with plagioclase and biotite rimmed by biotite-rich microshears or reaction zones, and also has norite with partly clay-altered orthopyroxene.

All other chips in this sample are norite, composed of major plagioclase to 6mm in grainsize, mostly as euhedral crystals, together with 25-40% orthopyroxene to 5mm in grainsize, mostly granular or subophitic. Minor pale brown hornblende rims some of the orthopyroxene, which has bronzite-type exsolution parallel to (100). Biotite is rare (0-2%) and there are very rare grains of clinopyroxene. Trace extremely fine opaque oxide is disseminated but unidentifiable in thin section.

BD04001, 117-118m

1. **Six chips of biotite to hornblende-rich foliated quartz-bearing microdiorite, with minor scattered magnetite-ilmenite-apatite aggregates, trace fine pyrite and zircon or monazite**
2. **One chip of hornblende-rich mafic lithology, with accessory magnetite, ilmenite and apatite**
3. **One chip of foliated biotite-hornblende tonalite with accessory magnetite, ilmenite, pyrite, apatite and zircon. Minor scapolite.**

Field Note: *Magnetite-quartz zone with minor pyrite as replacement of granodiorite*

Subordinate to co-dominant micas in most of the chips define a weak to definite location within fine granular aggregates of intermediate composition, is one mafic chip and one felsic quartz-rich chip that seem to represent tonalite or trondhjemite.

The intermediate chips are rich in mostly granular plagioclase with about 5-7% quartz, also granular, from 0.2mm to 1.5mm in grainsize. Mafic silicates make up 15-20% of the various chips, varying from biotite-rich to hornblende-rich, with a hornblende-rich aggregate at one end of one of the chips. The biotite is generally more strongly foliated than the hornblende, both minerals being rarely more than 1mm in grainsize. Small aggregates of magnetite and ilmenite are common, with apatite in and adjacent to many of these aggregates, and sparse very fine pyrite is disseminated. Sparse pyrite also occurs in small fractures in plagioclase and mafic grains. Elongate grains, possibly zircon rather than monazite, are mostly seen in biotite-rich areas and are as much as 0.25mm long.

The more mafic chip has 55-60% plagioclase, 35% hornblende, 5% biotite and 2-3% opaque grains (magnetite, ilmenite and pyrite) as well as accessory apatite, but is less foliated than the intermediate chips. **The felsic chip** also has 55-60% plagioclase, but also has 30% quartz, 8% biotite, and 2-3% each of hornblende and opaque grains (magnetite, ilmenite and rare pyrite, again partly in fractures). Accessory apatite is present in this chip, which has grains to 2mm long and is strongly foliated with a largely allotriomorphic granular texture, apart from more euhedral biotite and hornblende. Some of the plagioclase has been replaced

by scapolite with a low birefringence, suggesting a NaCl-rich variety. Rare zircon is present and minor carbonate accompanies the scapolite.

This sample seems to represent mainly quartz microdiorite with mafic zones and areas of fine-grained tonalite or trondhjemite, with a probably primary igneous foliation. The accessory oxides (magnetite and ilmenite) are probably primary, with possibly secondary sparse pyrite, especially in small fractures.

BD04001, 158-159m **Heterogeneous apparently sheared and altered quartz-bearing microdiorite. Minor fine magnetite-ilmenite + apatite disseminated and in very small composite grains, rare pyrite and monazite.**

Field Note: *Magnetite-quartz zone as replacement of granodiorite*

These chips are massive fine crystalline, with up to 50% plagioclase grains to 0.5mm in grainsize, together with minor (~5%) quartz and various combinations of phlogopite or biotite and amphibole (15-25%). The amphibole is partly colourless and partly pale bluish green in colour. The pale bluish amphibole has a relatively low birefringence and 2V, suggesting possibly a sodic-calcic or sodic amphibole. The colour of the mica also varies, with pale probable phlogopite in some chips and darker probable biotite in others. Some chips have relatively wide shear zones rich in fine phlogopite, and others have lamellae of phlogopite/biotite and/or amphibole.

Single grains of magnetite and ilmenite are ubiquitous as grains about 0.2mm, commonly forming small composites and form up to 8% of each chip. Trace fine pyrite is present and some of the pyrite in one chip is in a crosscutting fracture rich in bluish amphibole. Accessory apatite is disseminated with rare probable monazite to 0.2mm in grainsize. This sample seems to be a sheared and altered quartz microdiorite.

BD04001, 195-196m **Heterogeneous and inequigranular, quartz-orthoclase/ microcline-plagioclase-garnet-sillimanite gneisses with minor altered possible cordierite. Minor opaque oxide, spinel and trace sulphide. Interpreted as very high-grade metamorphosed pelitic sandstone.**

Field Note: *Biotite-garnet-magnetite granodiorite with green clay on joints*

These chips are heterogeneous and inequigranular and may be interpreted as very high-grade pelite, or possible S-type granitoid. Metapelite seems most probable. Various combinations of minerals in different chips include quartz, orthoclase and garnet to 8mm in grainsize, as well as smaller grains of other components.

- Quartz occurs as anhedral grains to 8mm long as well as smaller recrystallised grains.
- Orthoclase is microperthitic and occurs as grains to 8mm long with some areas containing mosaic-textured microcline as well as larger grains of orthoclase. Apparently isotropic, low-relief grains occur rimmed by microcline and may be altered former cordierite.
- Plagioclase is less abundant than orthoclase + microcline, in lenses possibly defining a foliation, to 3mm in grainsize. Minor myrmekite is present in some areas.
- Lenses and grains of garnet are disseminated, to 10mm or more in length. The larger lenses enclose granular sillimanite as well as opaque oxide and deep green spinel (hercynite).
- Granular and prismatic sillimanite occur, mostly in and adjacent to garnet, to 3mm in grainsize, accompanied by spinel and minor opaque oxide grains, which may be ilmenite and magnetite.
- Biotite occurs as irregular plates to 2mm long and seems to postdate the other minerals.
- Rare filaments of low-temperature pyrite are present.
- Rare zircon occurs, to 0.1mm in grainsize, allowing a granitoid or a fine to medium-grained sandstone, but partly rounded (inherited or detrital).

This sample seems to represent an impure pelitic sandstone reconstituted by very high grade metamorphism, possibly granulite or pyroxene hornfels facies. It may represent a contact effect of the norite in the same drillhole.

APPENDIX 4

Magnetic Susceptibilities

Appendix 4 Magnetic Susceptibilities

Hole	From	To	Magsus	Scintalometer	Date	Comments
BDRC04001	0	2	2		15.03.04	
BDRC04001	2	4	2		15.03.04	
BDRC04001	4	6	2		15.03.04	
BDRC04001	6	8	2		15.03.04	
BDRC04001	8	10	2		15.03.04	
BDRC04001	10	12	2		15.03.04	
BDRC04001	12	14	5		15.03.04	
BDRC04001	14	16	5		15.03.04	
BDRC04001	16	18	5		15.03.04	
BDRC04001	18	20	5		15.03.04	
BDRC04001	20	22	5		15.03.04	
BDRC04001	22	24	5		15.03.04	
BDRC04001	24	26	5		15.03.04	
BDRC04001	26	28	5		15.03.04	
BDRC04001	28	30	5		15.03.04	
BDRC04001	30	32	5		15.03.04	
BDRC04001	32	34	5		15.03.04	
BDRC04001	34	36	5		15.03.04	
BDRC04001	36	38	5		15.03.04	
BDRC04001	38	40	5		15.03.04	
BDRC04001	40	42	5		15.03.04	
BDRC04001	42	44	5		15.03.04	
BDRC04001	44	46	5		15.03.04	
BDRC04001	46	48	5		15.03.04	
BDRC04001	48	50	5		15.03.04	
BDRC04001	50	52	5		15.03.04	
BDRC04001	52	54	5		15.03.04	
BDRC04001	54	56	5		15.03.04	
BDRC04001	56	58	5		15.03.04	
BDRC04001	58	60	5		15.03.04	
BDRC04001	60	62	5		15.03.04	
BDRC04001	62	64	5		15.03.04	
BDRC04001	64	66	5		15.03.04	
BDRC04001	66	68	10		15.03.04	
BDRC04001	68	70	2500		15.03.04	
BDRC04001	70	72	250		15.03.04	
BDRC04001	72	74	900		15.03.04	
BDRC04001	74	76	1000		15.03.04	
BDRC04001	76	78	2500		15.03.04	
BDRC04001	78	80	600		15.03.04	
BDRC04001	80	82	600		15.03.04	
BDRC04001	82	84	1500		15.03.04	
BDRC04001	84	86	1300		15.03.04	
BDRC04001	86	88	800		15.03.04	
BDRC04001	88	90	600		15.03.04	
BDRC04001	90	92	300		15.03.04	
BDRC04001	92	94	1200		15.03.04	
BDRC04001	94	96	450		15.03.04	
BDRC04001	96	98	700		15.03.04	
BDRC04001	98	100	700		15.03.04	
BDRC04001	100	102	600		15.03.04	
BDRC04001	102	104	700		15.03.04	
BDRC04001	104	106	300		15.03.04	
BDRC04001	106	108	400		15.03.04	
BDRC04001	108	110	1000		15.03.04	
BDRC04001	110	112	1150		15.03.04	

Appendix 4 Magnetic Susceptibilities

Hole	From	To	Magsus	Scintalometer	Date	Comments
BDRC04001	112	114	2700		15.03.04	
BDRC04001	114	116	600		15.03.04	
BDRC04001	116	118	2200		15.03.04	
BDRC04001	118	120	6000		15.03.04	
BDRC04001	120	122	5500		15.03.04	
BDRC04001	122	124	4500		15.03.04	
BDRC04001	124	126	4500		15.03.04	
BDRC04001	126	128	5500		15.03.04	
BDRC04001	128	130	5500		15.03.04	
BDRC04001	130	132	2750		15.03.04	
BDRC04001	132	134	600		15.03.04	
BDRC04001	134	136	3500		15.03.04	
BDRC04001	136	138	300		15.03.04	
BDRC04001	138	140	200		15.03.04	
BDRC04001	140	142	2750		15.03.04	
BDRC04001	142	144	250		15.03.04	
BDRC04001	144	146	300		15.03.04	
BDRC04001	146	148	300		15.03.04	
BDRC04001	148	150	350		15.03.04	
BDRC04001	150	152	800		15.03.04	
BDRC04001	152	154	3250		15.03.04	
BDRC04001	154	156	5000		15.03.04	
BDRC04001	156	158	7000		15.03.04	
BDRC04001	158	160	5600		15.03.04	
BDRC04001	160	162	300		15.03.04	
BDRC04001	162	164	300		15.03.04	
BDRC04001	164	166	300		15.03.04	
BDRC04001	166	168	2000		15.03.04	
BDRC04001	168	170	1750		15.03.04	
BDRC04001	170	172	400		15.03.04	
BDRC04001	172	174	5250		15.03.04	up to 10, 000
BDRC04001	174	176	250		15.03.04	
BDRC04001	176	178	250		15.03.04	
BDRC04001	178	180	250		15.03.04	
BDRC04001	180	182	450		15.03.04	
BDRC04001	182	184	300		15.03.04	
BDRC04001	184	186	200		15.03.04	
BDRC04001	186	188	450		15.03.04	
BDRC04001	188	190	350		15.03.04	
BDRC04001	190	192	300		15.03.04	
BDRC04001	192	194	250		15.03.04	
BDRC04001	194	196	350		15.03.04	
BDRC04001	196	198	300		15.03.04	
BDRC04001	198	200	300		15.03.04	
BDRC04001	200	202	300		18.03.04	

APPENDIX 5

Closure Certificate

Northern Territory Government
Department of Business, Industry & Resource Development

APPLICATION FOR A CLOSURE CERTIFICATE

Section 46 of the Mining Management Act

Mines Division	30 September 2003	PF1-013

π AMENDMENT TO CURRENT AUTHORISATION # **0205-01**

DETAILS OF OPERATOR

NAME OF OPERATOR	BHP Billiton Minerals Pty Ltd
ADDRESS	Level 3, 40 McDougall Street
	Milton, Brisbane
	Postcode 4064
CONTACT PERSON	Lynne O'Donnell
PHONE	Business: 07 3307 9600
FAX	07 3307 9500
E-MAIL	Lynne.O.ODonnell@BHPBilliton.com

NAME OF MINING SITE	Exploration Licence 22631

In accordance with Section 46(1) and Section 46(3) of the *Mining Management Act* this application for a Closure Certificate is accompanied by / follows the submission of evidence supporting the attainment of closure criteria specified in the Mining Management Plan for the site.

TITLE OF MINING MANAGEMENT PLAN	Small Operations (Exploration) Exploration Licence 22631 Drilling Programme

Signed: I Wallace Date: 12 April 2005

Name: IAN WALLACE

(Please print name)

OWNER REVOCATION OF OPERATOR APPOINTMENT

If there is more than one owner of the mining interest, please ensure that all owners have signed.

OWNER'S NAME	BHP Billiton Minerals Pty Ltd
POSTAL ADDRESS	Level 3, 40 McDougall Street
	Milton, Brisbane
	Postcode: 4064
CONTACT PERSON	Lynne O'Donnell
PHONE	Business: 07 3307 9600
MINING INTEREST (TENEMENT NUMBERS)	Exploration Licence 22631

I confirm that the appointment of the above operator has been terminated/resigned as per Section 10(6) of the Mining Management Act and that as per Section 15(b)(ii) adequate resources have been provided to complete the closure activities of the management system.

Signed (Owners)	Name (Please Print)	Date
L Wallace	IAN WALLACE	12 April 2005