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PROSPECT 7612

CSR LIMITED
MINERALS EXPLORATION AND DEVELOPMENT GROUP

EL 39/85, BULGOBAC RIVER, TASMANIA

SECOND PROGRESS REPORT

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KEYWORDS

BULGOBAC	GEOLOGY
QUE RIVER	GEOPHYSICS
MT. READ	GEOCHEMISTRY
DUNDAS	GRAVITY
VOLCANICS	DOWNHOLE EM
HELLYER	PETROPHYSICS
SOPHIA	UTEM
8014	DRILLING
SK 55-3	GEOCHEMISTRY
EL 39/85	GRIDDING
	CSAMT

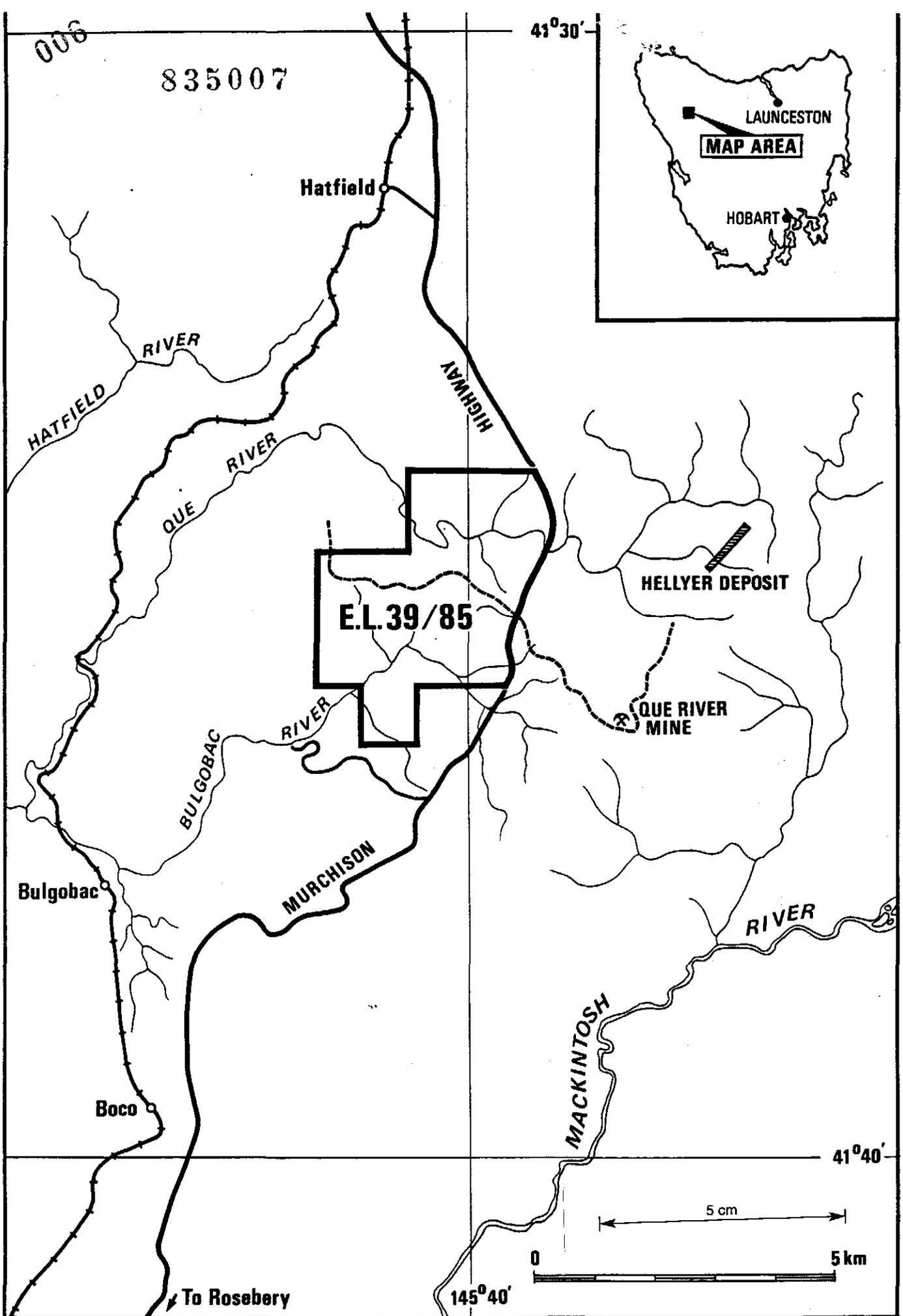


FIG. 1 LOCATION MAP E.L.39/85 BULGOBAC RIVER TAS.

1. INTRODUCTION

EL 39/85, Bulgobac River, is located 60 km south-southwest of Burnie, a major industrial centre and port on the Northwest Coast of Tasmania. The Murchison Highway forms the eastern boundary of the 11 km² title which was granted on 14 February, 1986. Aberfoyle's Que River and Hellyer mines are located immediately east of the adjacent Murchison Highway (Figure 1).

Infrastructure in the area is excellent with major electricity transmission lines passing through Aberfoyle's nearby mining leases; the Murchison Highway being the eastern boundary of the title area; the close proximity of EZ's Burnie to Rosebery railway line; abundant water and current road construction bringing population centres within commuting distances of any possible mining operation.

The exploration target in EL 39/85 is a volcanogenic polymetallic base and precious metal deposit similar to the nearby Hellyer deposit. The Hellyer deposit has a published resource of 15M tonnes indicated at 13.0% Zn, 6.9% Pb, 0.4% Cu, 156 g/t Ag and 2.3 g/t Au with a further 4.0M tonnes inferred (Aberfoyle, 1987).

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2. SUMMARY

EL 39/85, "Bulgobac River", of 11 km², is located on the western side of the Murchison Highway, 60 km southwest of Burnie. The exploration target is a massive base metal sulphide deposit similar to the Hellyer and Que River desposits located immediately east of the Licence.

The majority of the Cambrian rocks exposed on the Licence are higher in the stratigraphy than those hosting the Que River and Hellyer deposits, but the relatively flat-lying stratigraphy suggests potential exists for the location of blind ore deposits.

Exploration completed in the first year of the Licence included geological and geophysical surveys which confirmed the flat-lying stratigraphy and generated diamond drilling targets. Those drill targets were combinations of CSAMT phase anomalies associated with a positive gravity anomaly and interpreted to be in favourable geological positions.

During the second year of the Licence, the following work was completed:

(1) diamond drilling of the following holes were completed

BRD 01, a vertical hole at 2350E/7500N, to a total depth of 860.5 m, and

BRD 02, a vertical hole at 2750E/7400N, to a total depth of 676 m.

(2) downhole EM logging was completed on both DDHs.

(3) laboratory studies including petrophysical measurements, petrography, analysis for O and C isotopes and whole rock and trace element analysis were undertaken.

- (4) a further 32 line kilometres of grid were cut, and
- (5) gravity and UTEM surveys were in progress at the time of writing of this report.

The diamond drilling programme is scheduled to resume in mid-January 1988.

The two diamond drill holes completed have produced the following conclusions:

- (1) the Que River Shale is considerably thicker (430 m in BRD 01) than encountered elsewhere.
- (2) the Hellyer Basalt is thicker in BRD 01 (300 m) than expected.
- (3) visual logging has identified minor/trace sp-ga mineralisation in the Hellyer Basalt intersections.
- (4) the O and C isotope data suggest alteration temperatures were higher (150⁰C) in BRD 01 than in BRD 02 (110⁰C).
- (5) downhole EM logging did not locate any off-hole conductors.
- (6) the geological interpretation has been confirmed albeit that the increased thickness of Que River Shale increases the depth to the target horizon.

Geophysical surveys in progress are expected to generate further drill targets for testing during the third year term of the Licence.

3. PREVIOUS EXPLORATION

Exploration of the area now covered by EL 39/85 was limited to reconnaissance geological mapping, geochemical sampling and an airborne INPUT EM survey. Details of this work can be found in Williams (1987).

Exploration undertaken between the granting of EL 39/85 and 31st March, 1987 is included in Williams (1987). In brief, this included:

- (i) geological mapping
- (ii) gridding
- (iii) geophysical surveys including:
 - (a) aeromagnetics
 - (b) VLF-EM
 - (c) IP
 - (d) CSAMT
 - (e) gravity

This work resulted in the selection of several targets for diamond drilling during the current reporting period.

4. REGIONAL GEOLOGY AND MINERALISATION

The lithologies of exploration interest are the Cambrian calc-alkaline volcanics which host important base metal deposits at Mt. Lyell, Hercules, Rosebery, Que River and Hellyer. The regional geology is described in numerous publications, e.g. Corbett and Lees (1987).

Previous conceptual thinking regarded the volcanics at Que River-Hellyer as forming part of Corbett's "Central Volcanic Sequence". However, recent geological mapping (Komysan, 1986) and trace and whole rock analyses (Crawford, 1987) have resulted in a revised interpretation of the Que River-Hellyer volcanics as forming the basal part of the Dundas Group. This can be equated with Corbett's "Western Sequence" to the northwest of the Henty Fault Zone.

Exploration undertaken since granting of EL 39/85 has extended the area of potential host stratigraphy for Hellyer-Que River-type mineralisation. However, drilled thicknesses of the Que River Shale have exceeded those indicated by previous mapping and drilling on adjacent titles.

5. ACCESS AND GRIDDING

Pre-existing vehicular access to, and within, EL 39/85 was described in Williams (1987). This report also covered walking access cut for creek mapping and the gridding cut for geophysical surveys.

During the current reporting period, a further 32.3 km line kilometres of grid was cut as shown on DRG No. 7612-14. Accurate co-ordinates for this gridding will be surveyed by contract surveyors in the 1987/88 field season.

Also shown on DRG No. 7612-14 are the positions of tracks bulldozed in early 1987 for access for diamond drilling.

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6. GEOLOGICAL MAPPING

Mapping completed during the period, 1st April to December 1987, has been limited to mapping of the tracks bulldozed for access for diamond drilling. This mapping, shown on DRG No. 7612-13, essentially confirmed the geological mapping presented in Williams (1987).

The extensions to the cut line grid will be mapped during the 1987/88 field season.

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7. DIAMOND DRILLING

7.1 Introduction

The following programme was proposed for the period from 1st April, 1987 to 31st March, 1988 which co-incides with CSR's budget year.

DDH BRD 01 - a vertical hole at 2350E/7600N to a depth of 450 m. The target was a CSAMT-phase anomaly at a depth of 370 m. This anomaly was located in the flank of the gravity high.

DDH BRD 02 - a vertical hole at 2750E/7400N to a depth of 500 m. This hole was centred on a gravity high with a CSAMT-phase anomaly at a depth of 400 m.

The following stratigraphy was expected in these holes.

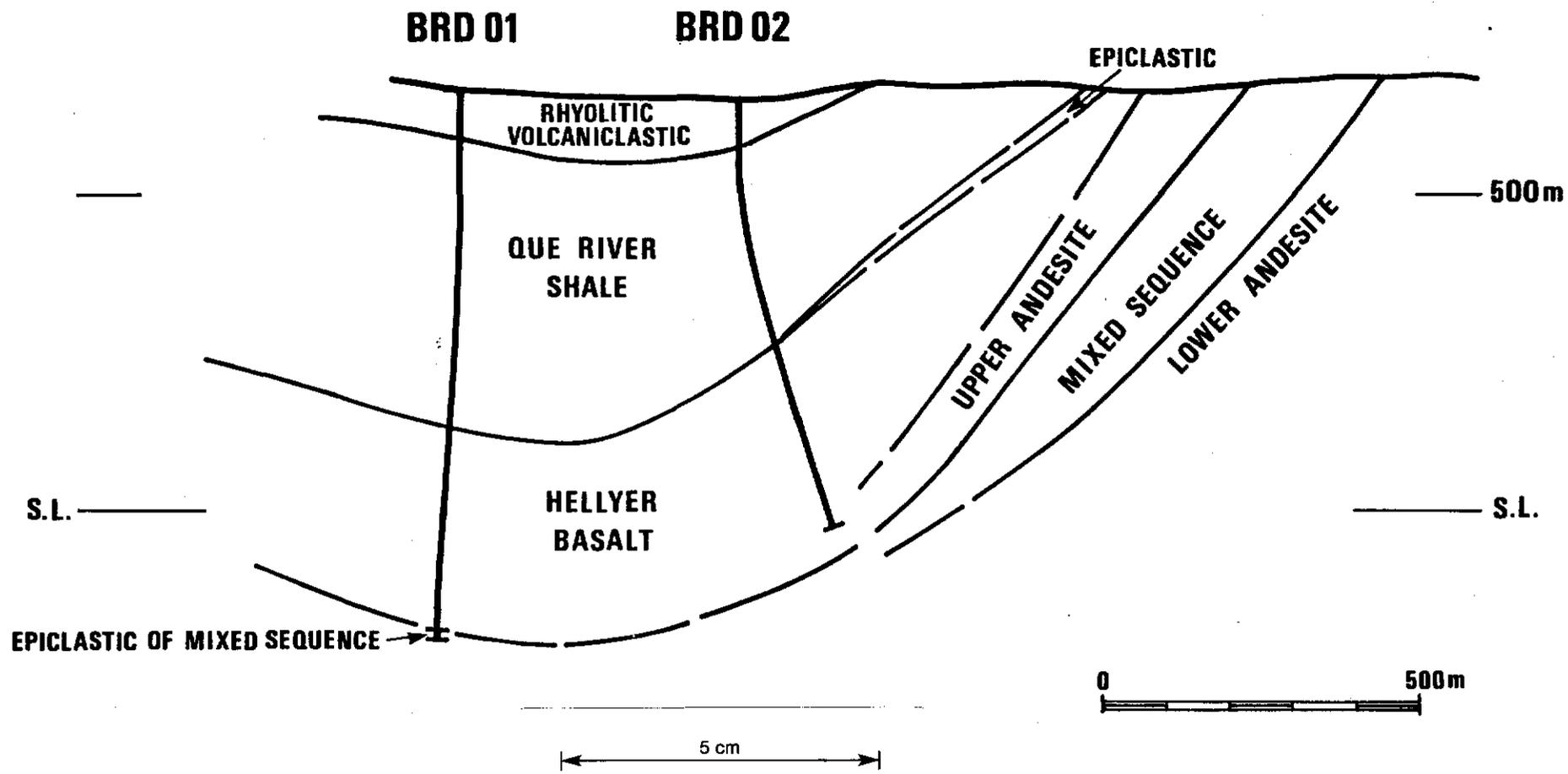
	<u>BRD 01</u>	<u>BRD 02</u>
Acid Pyroclastics	0- 50 m	0 - 50 m
Que River Shale	50-200 m	50-200 m
Volcanics	200-EOH	200-EOH
Drill Target	370 m	400 m

Two additional holes were proposed:

- (i) an angled hole on a westerly azimuth to test the pyritised and altered volcanic stratigraphy west of 1750E on Line 7600N, and
- (ii) a stratigraphic hole immediately south of Que River and west of the Murchison Highway.

Drilling completed to date has totalled two holes as follows:

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NOTE : FOR LOCATION REFER DRG. No. 7612-13

FIG. 2 DRILL HOLE CROSS-SECTION THROUGH BRD01 & BRD02 LOOKING N.N.E. BULGOBAC RIVER, TAS.

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- (i) BRD 01 - as proposed but considerably deeper than expected with a final depth of 860.5 m.
- (ii) BRD 01 - as proposed but with a final depth of 676.0 m.

A cross-section showing both these drill holes is presented as Figure 2.

It is planned to resume drilling in mid-January with the proposed stratigraphic drill hole immediately south of Que River and west of the Murchison Highway.

Core logging was undertaken using a computerised format. Appendix I includes a description of this system and the detailed drill logs for drill holes, BRD 01 and BRD 02.

7.2 DDH BRD 01

This vertical hole was sited at grid co-ordinates 2350E, 7600N and intersected the expected stratigraphy. However, the thickness of the Que River Shale was considerably greater than recognised elsewhere which resulted in the target horizon being at a significantly greater depth. This is tabulated below:

	<u>Proposed</u>	<u>Actual</u>
Acid Pyroclastics	0- 50 m	0 - 75 m
Que River Shale	50-200 m	75 -527.5 m
Hellyer Basalt	200-	527.5-850.5 m
Mixed Sequence	-EOH	850.5-EOH
EOH	450 m	860.5 m

This hole remained remarkably near vertical flattening to -83° at a depth of 750 m. On completion, the hole was cased with plastic casing to the full depth.

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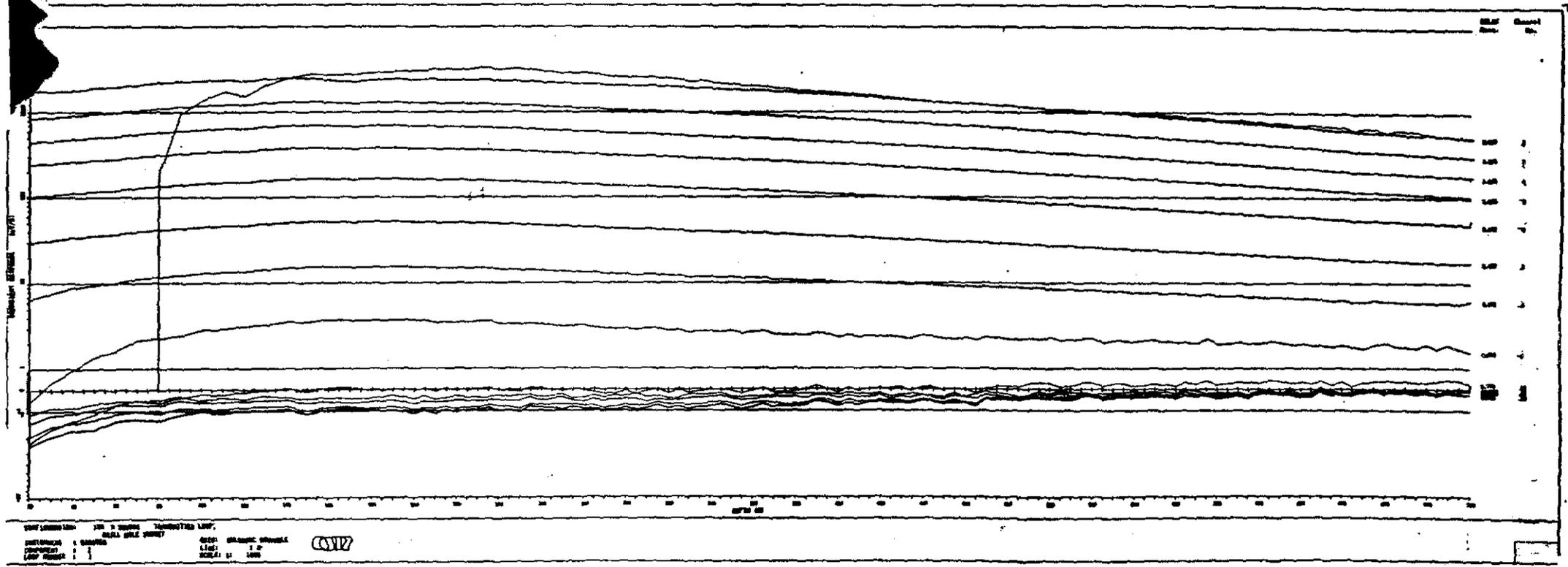


Figure 3: DOWN HOLE EM LOGGING DDH BRD01

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Petrography was completed on 12 samples from BRD 01 and these data are included in Appendix II. This petrography confirmed the visual logging of a basic volcanic unit with pyroxene phenocrysts, but no feldspar phenocrysts over the interval, 529.5 to 850.5 m. This unit is considered to be the Hellyer Basalt. Mineralisation of significance was restricted to minor sphalerite-galena associated with strong quartz-carbonate veining in the top section of the basalt. In addition, sphalerite, galena and iron sulphides occur in vesicles in the basalt.

Re-interpretation of the CSAMT data resulted in the Basalt/Que River Shale Contact being placed at a greater depth and it is considered that the phase anomaly is probably due to an anomalous zone within the Que River Shale.

7.3 DDH BRD 02

Following the limited deflection from vertical experienced in drilling BRD 01, BRD 02 was a vertical hole drilled at 2750E, 7400N. Re-interpretation of the CSAMT data suggested that the phase anomaly may have been due to hangingwall mineralisation above the target stratigraphy. BRD 01 indicated that the CSAMT was penetrating to a maximum depth of 500 m and consequently would not have penetrated to the required target depth. BRD 02 was sited directly over a 0.5 mgal gravity anomaly. However, the hole flattened more rapidly than BRD 01 and consequently deflected on an easterly azimuth and passed into the Hellyer Basalt up dip of the target zone. The hole was continued to 676 m to enable downhole EM to be run and the hole was cased with plastic casing to the full depth.

The lithologies intersected are as tabulated below:



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	<u>Proposed</u>	<u>Actual</u>
Acid Pyroclastics	0- 50 m	0 - 65.8 m
Que River Shale	50-200 m	65.8-373.0 m
Hellyer Basalt	200-	373.0-EOH
Mixed Sequence	-EOH	
EOH	400 m	676.6 m

The hole was terminated in broken ground which created drilling problems.

Petrography was completed on 19 samples from BRD 02 and these data are included in Appendix II. This petrography confirmed that the hole ended in a basic volcanic containing pyroxene phenocrysts, but no feldspar phenocrysts. Thus, the hole is considered to have ended in Hellyer Basalt.

Visually identified base metal mineralisation was more sparse in BRD 02 than observed in BRD 01.

7.4 Downhole EM

Downhole EM, using SIROTEM equipment, was run down both BRD 01 and BRD 02 to ascertain if a conductor (massive sulphide?) was detectable within the search radius. Full details of this work are included as Appendix III.

This work was undertaken by McSkimming Geophysics with a 600 m x 300 m loop with corners at 7800N/2400E, 7800N/2700E, 7200N/2400E and 7200N/2700E. The holes were logged at 5 m intervals and profile results are shown in Figures 3 and 4.

DDH BRD 01 was not logged to the full depth (860.5 m) as the probe would not go past a blockage at 700 m downhole. DDH BRD 02 was logged to the end of the hole (676.6 m). No anomalies were detected.

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TABLE 1 : PETROPHYSICAL MEASUREMENTS

Sample No. m	Conductivity 2.5MH _Z s/m	IP Resistivity m	Specific Gravity gm/cc	Magnetic Susceptibility 10 ⁻⁶ cgs
BRD001				
11.7	n.a.		2.68	
18.4	0.2		2.69	
63.0	0.2		2.69	
101.4	0.2	13	2.73	
200.0	0.2	32	2.76	
300.1	0.3		2.78	
343.2	0.4		2.74	
399.7	0.2	40	2.75	
501.5	0.2		2.77	
516.7	0.2		3.05	
538.7	0.3		2.90	
593.8	0.2		2.90	
647.6	0		2.89	
707.9	0.4		2.77	
759.9	0.4		2.77	
822.0	0.6		2.80	
860.4	0.4		2.73	
BRD002				
20.0	n.a.		2.68	
46.6	n.a.		2.66	
50.7	0.2		2.63	
61.9	0.2		2.70	
96.6	0.3		2.76	
150.0	0.2	32	2.75	
200.0	0.2	206	2.77	
301.4	0.3		2.78	
350.2	0.2		2.78	
379.6	0.2		2.75	
400.0	0.2		2.78	
410.0	0.2		2.76	
446.6	0.2		2.80	
458.6	0.2		2.78	
497.0	0.2		2.84	
550.0	0.3		2.86	
606.6	0.2		2.96	
667.0	0.2		3.00	

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7.5 Petrophysics

Petrophysical measurements were undertaken at the Petrophysics Laboratory, University of Sydney, on drill core from DDHs BRD 01 and BRD 02. Details of the work are included as Appendix IV. Some results were not available at the time of compilation of this report. However, the available results are presented in Table 1.

These results indicate low induced conductivity but galvanic measurements on some core samples indicate the Que River Shales to be quite chargeable.

The specific gravity measurements are not considered to indicate sufficient density contrasts to explain the surface gravity data. However, additional modelling of the gravity data will be undertaken when further data, currently being acquired, can be integrated into the modelling.

7.6 Petrography

Appendix II includes the petrography on thin and polished sections from core samples selected from DDHs BRD 01 and BRD 02. This petrology was undertaken by a consultant, Dr. Jane Barron.

7.7 Geochemistry

No mineralisation warranting split sampling was intersected in either drill hole. However, selected intervals were sampled to confirm the visual estimates of sphalerite and galena mineralisation. In addition, nine samples were analysed for a full suite of whole rock and trace elements. These data are presented as Table 2. Table 3 presents the data for standard samples analysed with the samples shown in Table 2, the accepted values for these standards and the analytical methods utilised.

TABLE 2 : WHOLE ROCK AND TRACE ELEMENT ANALYSES : DDHs BRD 01 AND BRD 02

SAMPLE NO.	A295051	A295052	A295053	A295054	A295055	A295056	A295057	A295058	A295059	A295061	A295062	A295063	A295064	A295065	A295066	A295067	A295068
SiO ₂		52.7					50.4			50.0	48.4	56.0	38.7	49.3	54.2	46.8	
TiO ₂		0.31					0.51		0.58	0.54	0.50	0.51	0.68	0.63	0.67		
Al ₂ O ₃		11.35					11.60		15.75	12.00	10.90	9.25	11.65	11.45	12.90		
Fe ₂ O ₃		7.45					9.35		9.80	10.10	7.50	7.80	9.85	10.05	11.80		
MnO		0.18					0.23		0.14	0.24	0.15	0.19	0.21	0.17	0.28		
MgO		8.30					9.10		6.55	8.30	6.55	7.45	8.70	7.45	9.95		
CaO		7.40					8.37		5.57	11.60	9.55	20.10	10.00	7.30	7.35		
Na ₂ O		1.95					2.65		3.95	2.25	1.90	2.20	2.85	2.25	0.36		
K ₂ O		0.29					0.89		1.51	1.01	2.48	0.52	1.74	1.43	3.66		
P ₂ O ₅							0.33		0.41	0.65	0.35	0.37	0.29	0.30	0.30		
CO ₂		5.66					3.36		0.62	2.42	2.26	10.58	0.95	0.99	2.01		
SO ₃		0.63					0.16		2.20	0.43	0.33	0.33	0.05	0.08	0.10		
LOI		9.01					5.89		3.47	4.14	3.57	12.50	2.30	2.59	5.57		
Ni	177	186	65	94	180	74	85	195	110	60	140	157	165	57	72	-	32
Co	35	45	33	30	38	34	37	42	35	31	40	36	43	28	35	60	15
Cr	750	920	270	260	760	340	370	870	380	110	570	710	710	400	400	1100	9
V	170	180	190	180	170	220	260	180	210	280	220	190	160	230	220	230	30
Zr	90	85	160	120	90	120	130	130	140	140	150	110	110	130	120	130	230
Nb	3	3	8	6	7	5	4	6	5	7	8	9	4	8	9	5	15
Y	15	15	25	20	15	20	20	20	20	20	25	20	20	20	20	25	30
Sr	280	250	290	280	270	230	380	190	450	640	580	280	310	500	560	240	150
Rb	15	10	15	50	7	15	25	10	80	45	30	70	15	45	40	80	20
Ba	220	370	640	1300	190	430	640	230	2400	950	850	1050	310	1600	1250	4000	160
Cu	52	80	133	83	44	11	96	50	65	82	101	68	75	44	73	44	10
Pb	146	30	1300	1050	137	104	37	87	19	12	116	17	10	7	49	183	11
Zn	1600	82	2900	2750	420	1450	79	1250	94	70	160	55	76	48	156	410	70
Ag	<0.1	<0.1	0.3	0.5	0.1	0.1	0.2	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Au	0.001	0.003	0.003	0.001	0.004	0.002	0.001	0.002	0.002	0.002	0.003	0.006	0.003	0.002	0.002	0.003	0.004
As	13	5	20	19	8	5	4	21	16	14	10	12	5	5	10	9	9
Sb	8	<3	3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	4	<3
Mo	6	<3	5	4	<3	5	<3	3	5	6	5	5	<3	6	3	3	8
Sn	<3	3	<3	5	<3	<3	<3	<3	5	<3	<3	<3	<3	6	<3	4	3
W	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
La	50	55	90	60	40	55	70	85	95	87	90	70	70	80	70	120	150

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TABLE 3 : STANDARD SAMPLES - RESULTS AND ACCEPTED VALUES

ANALYTICAL METHODS USED BY ANALABS

	UNI. TAS. BASALT			CSR GXIH		CSR GX10		THESE ANALYSES		
	A156249	A29560	ACCEPTED VALUE	A156250	ACCEPTED VALUE	A161050	ACCEPTED VALUE	METHOD	CODE NO.	DETECTION
SiO ₂	44.8	44.7	44.56					XRF	408	0.1%
TiO ₂	2.35	2.34	2.31					XRF	408	0.1%
Al ₂ O ₃	14.20	13.80	14.14					XRF	408	0.05%
Fe ₂ O ₃	12.90	12.85	12.65					XRF	408	0.05%
MnO	0.17	0.17	0.17					XRF	408	0.01%
MgO	7.90	8.30	8.16					AAS	104	0.01%
CaO	8.08	8.01	7.18					XRF	408	0.05%
Na ₂ O	5.00	5.00	5.43					AAS	104	0.01%
K ₂ O	1.90	1.99	1.86					XRF	408	0.01%
P ₂ O ₅	0.85	0.98	0.97					XRF	408	0.01%
CO ₂	0.26	0.44						LEO	612	0.01%
SO ₃	0.05	0.10						LECO	613	0.01%
LOI	1.44	1.41	1.56					GRAVIMETRIC	615	0.01%
Ni	147	132	153	59	48	5		AAS	102	1 ppm
Co	54	50		10	5.8	2		AAS	102	1 ppm
Cr	150	150	197	160	170	25		XRF	401	5 ppm
V	150	160	164	55		<5		XRF	401	5 ppm
Zr	260	260	261	270		30		XRF	401	5 ppm
Nb	50	55	61	10	13	3		XRF	401	3 ppm
Y	20	20	23	45	42	<5		XRF	401	5 ppm
Sr	1000	990	1012	90	90	<5		XRF	401	5 ppm
Rb	20	20	16.5	340	235	25		XRF	401	5 ppm
Ba	190	190	204	410	400	15		XRF	401	10 ppm
Cu	47	44	64	71	70	4		AAS	102	1 ppm
Pb	6	6	5	11	12	<1		AAS	102	1 ppm
Zn	116	103	118	41	40	6		AAS	102	1 ppm
Ag	<0.1	<0.1		0.3		<0.1		AAS	102	0.1 ppm
Au		0.001		0.057		0.002		CAR. ROD	336	0.001 ppm
As	5	6		12	11	2	2.13	AAS	114	1 ppm
Sb	35	<3		4		<3		XRF	401	3 ppm
Mo	6	8		190	200	<3		XRF	401	3 ppm
Sn	<3	<3		5	9	35	39.75	XRF	401	3 ppm
W	85	45		55	55	<10		XRF	401	10 ppm
La	60	60	43	45	30	<10		XRF	401	10 ppm

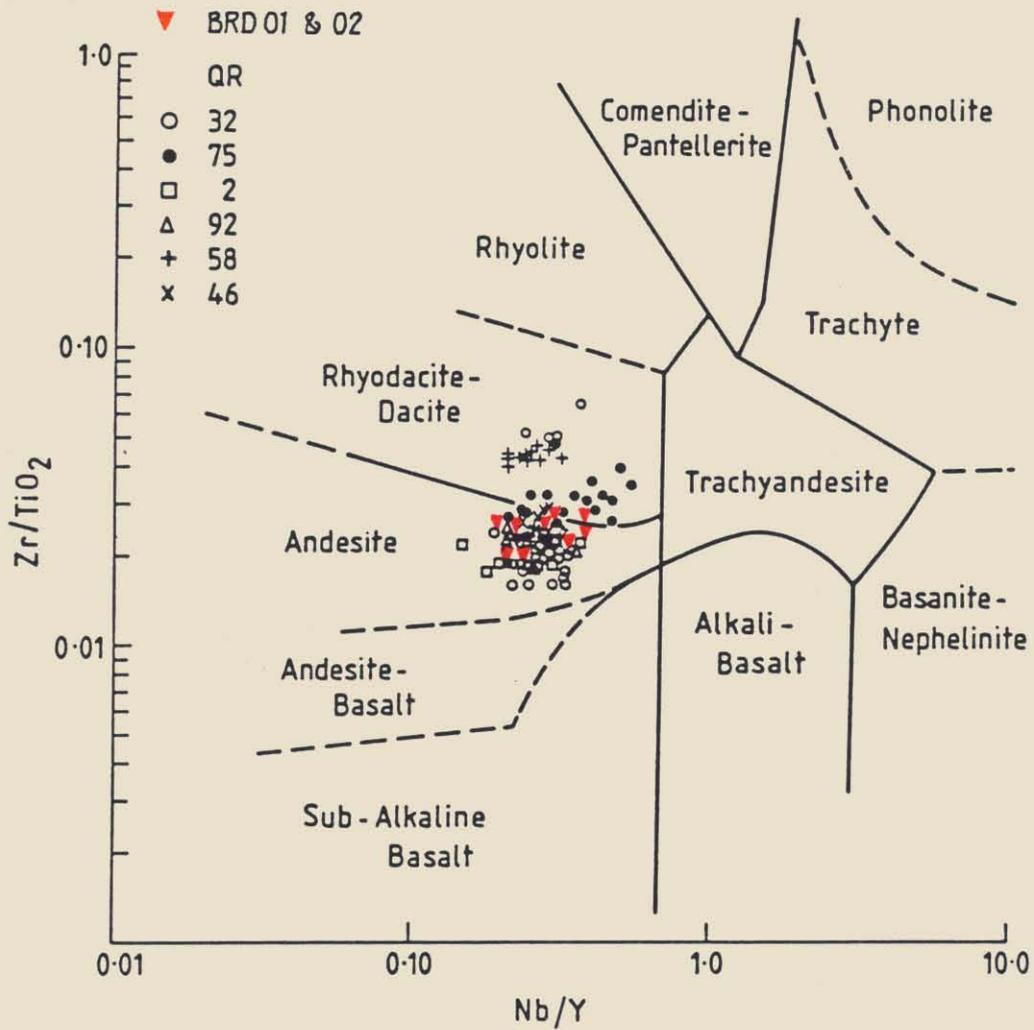


Fig. 5 Plot of Zr/TiO_2 vs Nb/Y for host volcanic rocks at Que River and Bulgobac River Drill Holes. Modified from Fig. 3.8 from Whitford et al (1982).

All the samples analysed for whole rock and trace elements have a related thin section description. All these samples have suffered extensive alteration as indicated by the analyses. However, all the rocks analysed are considered to be low Ti basaltic andesites and are correlated with the Hellyer Basalt. Figure 5 presents these analyses as a plot of Zr/TiO_2 versus Nb/Y ratios in comparison to those analysed by Whitford et al (1982) for the Que River area.

O and C isotopes have been analysed for calcites from the Hellyer Basalt intervals in both BRD 01 and BRD 02. This work was undertaken by the Tasmanian Department of Mines as part of the Mt. Read Project. Preliminary results show temperatures for calcite vesicle infilling to be about $150^{\circ}C$ in BRD 01 against about $110^{\circ}C$ in BRD 02 (G. Green, Pers. Comm.). These data can not be interpreted further until results for research being undertaken on Hellyer drill core are published in 1988.

7.8 Conclusions

The diamond drilling completed to date has produced the following results:

- (i) the presence of the horizon prospective for the location of a Hellyer-type deposit was demonstrated to occur at depth within EL 39/85, however
- (ii) a surprising increase in the true thickness of the Que River Shale (430 m) and the Hellyer Basalt (300 m) has decreased the effective application of geophysics to target drill holes and has increased the hole depth required.

- (iii) CSAMT can be applied as a mapping tool to a depth of 500 m in the area surveyed but the phase anomalies tested do not appear to be of significance.
- (iv) the positive gravity anomaly remains to be explained.
- (v) O and C isotope studies indicate higher temperatures of vesicle infilling in the Hellyer Basalt in BRD 01 than in BRD 02.

8.1 Introduction

The drill targets tested during the reporting period were generated by a combination of CSAMT and gravity surveys. Re-assessment of the CSAMT and gravity data in the light of the drilling data, the downhole EM surveys and the petrophysics measurements, has resulted in a decision to extend the gravity survey and to undertake a UTEM survey during the 1987/88 field season.

8.2 CSAMT

Results for the CSAMT survey were incomplete at the time of compilation of the previous report (Williams, 1987). Appendix V covers further interpretation of the data. The resistivities measured suggested the theoretical depth penetration for CSAMT in the area surveyed should be 450-500 m. This is in accord with the results for drilling on line 7600N.

Interpretation of the northern lines surveyed indicates the Que River Shale, which outcrops on lines 9400N and 9000N, thins to 150-175 m thick. A pseudo-structural contour plan of the base of the Que River Shale was constructed from interpretation of the Cagniard resistivity data. This pseudo-structural contour (not included in this report) indicates a synclinal structure in agreement with the geological interpretation. There is no doubt that in this geological environment the CSAMT surveys provide excellent lithological mapping data to a depth of 500 m. However, the survey technique is comparatively expensive and it is unclear if orebodies would be detected at significant depth.

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8.3 Gravity

Although the positive gravity anomaly which was investigated by DDHs BRD 01 and BRD02 remains unexplained, the method is cost-effective and is considered to be an effective exploration technique for the detection of a Hellyer-type deposit. During December 1987, the gravity survey is to be extended on the 200 m grid with readings at 50 m intervals. In addition, traverse data will be collected along access tracks within the area and infill readings taken to better define the positive gravity anomaly in the vicinity of 2400E/7700N.

8.4 UTEM

As a consequence of data from the CSAMT survey and the petrophysical measurements on drill core from BRD 01 and BRD 02, it has been concluded the UTEM should have a depth penetration of 450 m for a Hellyer-type body under optimum conditions.

The availability of the UTEM equipment in Tasmania will allow a limited survey to be undertaken in December 1987. This survey will be completed with a large loop laid out on lines 800E, 9800N and 8000N, with the eastern edge of the loop being the Murchison Highway. This loop will cover the area north of Que Road (8400N) where the prospective horizon is interpreted to be within the depth penetration capabilities of the UTEM system.

8.5 Developmental Geophysics

With the drillhole data indicating a depth penetration of about 500 m by CSAMT, the problem remains of exploration at depth greater than 500 m. Current thinking is that the large fixed loop EM systems such as UTEM would have no greater depth penetration. Gravity remains as one technique

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in which real data can be collected, but the decrease in anomaly magnitude due to increasing depth, again reduces the ability to detect Hellyer-sized massive sulphides.

Downhole EM is known to detect massive sulphides at depths of at least 1300 m and is thus a viable exploration tool.

Consideration is being given to testing the potential of using a grounded fixed loop EM system in which the grounded section of the loop would be from the bottom of drill holes reaching beneath the Que River Shale. Current thinking is that a large transmitter system such as that manufactured by Zonge could be utilised to generate the primary EM field. A SIROTEM receiver could be used to measure the secondary field.

9. PROPOSED EXPLORATION PROGRAMME

Grid-based geological mapping and geophysical surveys should be completed on the present area of EL 39/85 by April 1989. Adjustment of the EL boundary will occur in 1988 with the expiry of the adjacent EL 12/72. Exploration to be completed during the next calendar year will include the following activities.

(i) Geological Mapping

Additional mapping will be completed on all unmapped cut grid lines and creek sections accessed by these grid lines.

(ii) Geophysics

Gravity data will be collected on all the cut grid lines not surveyed previously. The large, fixed loop, UTEM system will be used to survey a section of the area where the target horizon is considered to be within the depth penetrating capability of this system. The CSAMT system will be used more selectively than the blanket survey completed in 1987. Selective application for CSAMT will be in gathering data for geological purposes and in testing anomalies generated by the gravity and UTEM surveys.

(iii) Diamond Drilling

The proposed stratigraphic drill hole in the area 9400N/2600E will be completed early in 1988. Further drill targets should be generated by the geophysical surveys to be completed during the 1987/88 field season. Further drill testing of the positive gravity anomaly in the 7700N/2400E area may be undertaken when the expanded gravity data base allows further modelling.

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10. CONCLUSIONS AND RECOMMENDATIONS

Exploration has vindicated the original geological concept of the sub-surface extension of the Hellyer-Que River host rocks into EL 39/85. However, no significant mineralisation was intersected in the two diamond drill holes completed to date.

Although the drilling has shown the target stratigraphy to be at a greater depth than originally interpreted, the greater thickness of Que River Shale and the Hellyer Basalt are considered to be favourable factors in the application of the Kuroko-type model to the search for Hellyer-type deposits.

The use of O and C isotopes to determine temperatures of calcite formation in the Hellyer Basalt shows considerable promise as a technique to select favourable areas with a greater search radius than downhole EM logging.

It is recommended that exploration be continued with an emphasis on completing the surface geophysical coverage and drill testing any targets located.

11. REFERENCES

ABERFOYLE (1987)

Annual Report 1986

CORBETT, K.D. and LEES, T.C. (1987)

Stratigraphic and Structural Relationships and Evidence for Cambrian Deformation at the Western Margin of the Mt. Read Volcanics, Tasmania.

Aust. Jour. Earth Sc. 34, pp 45-68

CRAWFORD, A.J. (1987)

Geochemistry of the Mt. Read Volcanics : Internal Correlations and Tectonic Implications.

AMIRA Report 84/P210, August 1987

KOMYSHAN, P. (1986)

Map 1. Geology of the Mt. Charter-Hellyer Area.

Geological Survey of Tasmania

WHITFORD, D.J; SON, S-S; TOGASHI, Y. (1982)

Petrological and Geochemical Studies at Que River : Part 3.

CSIRO Restrict. Invest. Rept. 1332R

WILLIAMS, R.E. (1987)

EL 39/85, Bulgobac River, Tasmania : Progress Report for the Period Ending 31 March, 1987.

Unpublished Report, MEDG, CSR Limited. Rept. No. EMR 75/87

REW/SGL

December 1987

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APPENDIX I
CORE LOGGING SYSTEM
DRILL LOGS BRD 01 AND BRD 02



035
Minerals Exploration And Development Group

TO OVERSEAS GEOLOGISTS

REFERENCE RJF/BW/OSA:43

FROM R J FOUNTAIN

DATE 20 FEBRUARY 1987

DRILL LOGGING FOR INDONESIAN GOLD PROSPECTS
MODIFIED FOR BULGOBAC RIVER PROJECT, TASMANIA

INTRODUCTION

Experience with computer logging formats in 1986 suggested the need for clarification of the underlying principles behind using the system, and also better explanation of the coding systems used, to minimize between geologist variations.

AIMS AND PRINCIPLES OF THE SYSTEM

The basic purpose of a drill log is to provide a geologic framework for interpretation of the assay results encountered in the hole, as well as a record of the important features of the geology encountered. It is neither possible, desirable or economic to record all the geologic features encountered in a drill hole. In the computer logging system, two basic types of data are allowed for, comprising:

- 1) routinely occurring data, such as core recovery, oxidation state, alteration state and mineralogy, sulphide content, vein and fracture density; and
- 2) 'one off' type information such as the occurrence of an unusual mineral, rock type or other fracture, and qualitative descriptions of geological features.

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The first group of data types, if recorded sensibly, can be used to control statistical analyses etc. of assays, or included in routine downhole plots for presentation. The second group of information is not useable for these purposes and is stored in a comment field, together with any fuller explanation of routine occurrences or observations.

To be effective, the system presupposes that every assay interval has a corresponding logged interval. The logging interval, subject to the above comment, can be of any length, although in practical terms there is rarely any point in assaying any interval less than 0.5m long.

DETAILED DRILL LOG SHEET - CODING PROCEDURES

1. Header

This is self evident. The hole number identifies the prospect for the system, eg. WAD001 = Watuasah hole 1, and the type of drilling (eg. WAD = diamond drilling, WAP = percussion, WAR = reverse circulation, WAT = trench samples). The computer system will work provided that all lithology codes and mineral species fields are the same and clearly defined for each prospect.

2. Depth to - Columns 1-5

Record the depth to the base of the logged interval in metres, to 2 decimal places.

3. Core Recovery - Columns 6-9

Record the measured core recovery for the interval, in metres to 2 decimal places.

3. Lithology - Columns 10-15

Space is provided to record up to two lithologies for the logged interval, using a three letter code for each. It is acceptable to use either a standardized general coding system, or to develop a set of prospect or project specific rock type codes, provided that these are consistent and defined for (at least) each prospect. It is helpful if these codes match those used in surface mapping of the prospect.

4. Oxidation - Column 16

Record the extent of oxidation of iron minerals, particularly sulphides, by the extent of limonite development, using single letter codes as follows:

- | | |
|--------------|--|
| 0 (or blank) | Unoxidised-sulphides quite fresh -
no limonites present. |
| 1 | Trace oxidation - sulphides fresh but minor
limonite coating joints or fractures. |
| 2 | Weakly oxidized - most sulphides preserved but
significant limonite developed on joints and in
joint selvages. |
| 3 | Moderately oxidized - sulphides replaced by
limonites in about 50% of the rock. |
| 4 | Strongly oxidized - limonite throughout with
minor remaining sulphides. |
| 5 | Completely oxidized, limonite throughout, no
remaining sulphides. |

Fields 5-11. Record the sulphide content of the logged interval, as follows:

Field 5 (Total %). Record the total of sulphides present, on a volume percent basis, using a two letter code as follows:

- TR present but less than 0.5% by volume
- 01 0.5-1.5% by volume
- 99 98.5-99.5% by volume
- then AL 99.5-100%

Field 6 Grainsize. Record the average grainsize of sulphide minerals present, using single letter codes eg. c = coarse > 2mm, m = medium (0.5-2mm), F = fine <0.5mm.

Fields 7-11. These two character fields record the mode of occurrence and relative proportions of the most common sulphides. Fields are allowed for pyrite (py), chalcopyrite (cpy), pyrrhotite (po), galena (ga) and sphalerite (sp).

Codes used are a single letter code for the dominant mode of occurrence of the mineral in the logged interval, eg.

- D = disseminated A = vesicular
- V = within veins B = banded; bedded
- F = coating fractures

and a single letter/number code to record the relative proportion of each sulphide species of the total sulphide using the codes.

- Blank - mineral not present
- T = trace, mineral present but less than 5% of the total sulphide
- 1 = 5-15% of the total sulphide
- to 9 = 85-95% of the total sulphide
- and A = >95% of the total sulphide.

039 The proportion codes should sum to 10, unless significant proportions of a different sulphide to those listed occurs. The estimated volume percentage of any mineral can be obtained by multiplying the total sulphide percent (field 5) by the proportion code for that mineral and dividing by 10.

Sulphide minerals not included in the above list should be noted in the comments column.

Fields 12 to 24 record alteration mineralogy.

Field 12 - Alteration Intensity - col. 30 - Record alteration intensity as a single number code as follows:

- 0 - Fresh unaltered rock with original texture and >95% of original rock forming minerals intact.
- 1 - Partly altered, original textures preserved and 5-35% of original minerals replaced by alteration products.
- 2 - Moderately altered, overall original textures preserved but 35-65% of original minerals replaced by alteration products.
- 3 - Strongly altered, original textures visible but 65-95% of original minerals replaced by alteration products.
- 4 - Completely altered, original textures still preserved but original minerals replaced by alteration products.
- 5 - Intensely altered - as above but original rock texture only poorly preserved.
- 6 - Fubarite - original rock mineralogy and textures completely obliterated.

040

Fields 13-24 Alteration Mineralogy Cols. 31-54. Twelve two column fields are allowed, to record the presence of specific alteration minerals. For each mineral two columns are provided. The first column for each mineral is for a single letter code for the estimated volume percentage of the mineral;

- blank = not present,
- T = present but less than 5%,
- 1 = 5-15%, 2 = 15-25%, , 9 = 85-95%,
- A = +95%.

In the second column, use a single letter code to record the dominant mode of occurrence of the mineral;

- P = pervasively disseminated,
- W = wallrock selvages adjacent to veins or fractures,
- F = coatings on fracture surfaces,
- V = as vein fill material.

The minerals to record are:

- LIMONITE, ALBITE, CHLORITE,
- EPIDOTE, K-FELDSPAR,
- SERICITE, CLAY MINERALS,
- SILICIFICATION (not veining),
- CALCITE, JAROSITE/ALUNITE,
- BARITE, AND MAGNETITE.

Quartz Veining. Space is provided to routinely record only one vein set per logged interval. To make this workable, only quartz and quartz composite (eg quartz-calcite, quartz-barite, quartz-sulphide) veins should be recorded here (N.B. for NTT assume all

041

barite veins have some quartz). Calcite, jarosite-alunite or straight pyrite veining can be accommodated the alteration mineralogy or sulphide columns, with appropriate comments in the comment field.

Field 25 Vein type - Columns 55-56. Record here a two letter code to specify the vein type. Include barite veins with quartz veins. Letter codes QU = quartz, QB - quartz-barite, QC = quartz-calcite TC = tremolite, QE = quartz-chlorite-carbonate-epidote, EC = carbonate-epidote, etc. In the case of breccia fill use codes QX or BX. Attempts to record too many very different vein types in different logged intervals will render the system unworkable from a plotting or statistical point of view.

Field 26 Veining % - columns 57-58. Record the estimated volume percent of veining using 2 digit codes as for total sulphide percentage.

Field 27 Veins/metre (columns 59-60). Record the average number of veins per metre on a 0-99 scale.

Field 28 Angle to core axis (aca) column 61. Record the dominant angle between veins and the core axis using a single number code:

- 0 = parallel to, through to
- 9 = 90° to core axis

or letter codes such as

R = random, or

S = stockwork

Fields 29-32 deal with structure.

Field 29 - Bedding angle (column 62). Record the angle between the bedding trace and core axis using a single digit code, 0 = parallel to 9 = perpendicular.

Field 30 - Fractures/metre (columns 63, 64). Record the average number of fractures (not healed) per metre in the logged interval on a 0-99 numeric scale.

Field 31, Joint angle (columns 65). Record the dominant joint direction with a single digit angle code (0-99) if appropriate, or R for random.

Field 32, Hardness (column 66). This is a potentially very useful measure to assess aspects like ripability or grindability of the rock. Record using a single digit code as follows:

- 1 very soft easily crumbled by hand
- 2 soft - broken by hand with difficulty
- 3 moderate - broken with hammer, but does not ring when hit by hammer
- 4 hard - broken by hammer, and rings when struck by hammer
- 5 very hard - broken with difficulty with hammer.

Fields 33, 34, Faulting. Record the percentage of the logging interval occupied by fault gouge, using a 2 letter percentage code in columns 67-68, and the angle of the zone to the core axis with a single letter code (0-9) in column 69.

Field 35, Unit Code (columns 70-71). This is for a 2 letter or digit code to identify major rock units, to correlate with field mapping units, and/or to control compositing of assay values. In many cases this information will be added or changed by later interpretations, but the ability to lump data together in a controlled way is very important for computer processing of data.

Field 38, Comments. No specific field is allowed on paper sheets - the LOGGER system stores comments in dBASE MEMO fields which can be up to 4K bits of information. On paper sheets subsequent lines can be used as required. Although there is no real limit at present on the length of comments, it is much easier to format drill log reports if they are kept relatively concise.

R J Fountain

(Modification by R E Williams)

LITHOLOGICAL CODING

DDH'S BRD01 AND 02

MST	mudstone
SHA	shale
SLT	siltstone
SST	sandstone
BAS	basalt-massive
BAV	basalt-vesicular
BAP	basalt-pillowed
BPB	basalt-pillow breccia
BAB	basalt-breccia
RVC	rhyolitic volcanoclastics
VCG	volcanic conglomerate
EPI	epiclastic

835045

Project :

RA : 0 Code :

HOLE : BRD001 Coords : 389013.9E 5394846.1N Collar RL : 661.3
 Logged by : REW. PDE. Driller : ORTNER Rig id : J49
 Commenced : 05/04/87 Completed : 04/06/87
 Start Log : 0.00 Total Depth : 860.50
 Tot Oxid Depth : 0.00 Part Oxid Depth : 16.60

Target Description

Target was CSAMT phase anomaly at approx 370m also on flank of positive gravity anomaly. Geological interpn for hole 0-50m rhyolitic volcanoclastics, 50-200 Que River Shale, 200-375 volcanics, target=massive sulphides, footwall volcanics.

Mineralisation

Trace Sp-Gn associated with qtz-cb veining and vesicle infilling in Hellyer Basalt.

Significant Results

sequence 0-75.0 rhyolitic volcanoclastics
 75.0-527.5 Que River Shale
 527.5-850.5 Hellyer Basalt
 850.5-860.6 Epiclastics=Mixed Sequence

Alteration DetailsGeneral Comments

Preliminary results for O & C isotopes indicate calcite infilling in vesicles in Hellyer Basalt=150C, which is greater than in BRD02.

Geological NotesDOWNHOLE SURVEY DATA:

Depth	Dip	Azimuth	Core Size
0.00	-90.00	0.00	HQ
30.00	-90.00	0.00	HQ
60.00	-90.00	321.00	NQ
90.00	-89.00	321.00	NQ
120.00	-89.00	261.00	NQ
150.00	-89.00	256.00	NQ
183.00	-89.00	259.00	NQ
213.00	-88.00	262.00	NQ
243.00	-87.00	276.00	NQ
273.00	-87.00	281.00	NQ
303.00	-87.00	287.00	NQ
333.00	-86.00	289.00	NQ
363.00	-86.00	288.00	NQ
393.00	-84.00	287.00	NQ
423.00	-85.00	288.00	NQ
451.00	-85.00	295.00	NQ

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488.00	-85.00	288.00	NQ
544.00	-84.00	298.00	NQ
600.00	-84.00	304.00	BQ
630.00	-84.00	291.00	BQ
660.00	-84.00	304.00	BQ
690.00	-84.00	307.00	BQ
720.00	-83.00	304.00	BQ
750.00	-83.00	313.00	BQ

835046

Project :

RA : 0 Code :

053

HOLE : BRD002	Coords : 389296.9E 5394519.1N	Collar RL : 642.4
Logged by : REW	Driller : ORTNER	Rig id : J49
Commenced : 22/06/87	Completed : 05/08/87	
Start Log : 0.00	Total Depth : 676.60	
Tot Oxid Depth : 0.00	Part Oxid Depth : 12.60	

Target Description

Target was positive gravity anomaly interpreted at depth of 220m (downhole depth of about 500m) beneath base of Que River Shale. This depth was too great for a massive sulphide target to have been detected by C.S.A.M.T. However a co-incident C.S.A.M.T. phase anomaly was considered to be due to hanging wall mineralisation.

MineralisationSignificant ResultsAlteration Details

preliminary O & C isotope data on calcite vesicle infillings in the Hellyer Basalt indicate temperatures of 120C.

General Comments

Down hole E.M. was run to the end of the hole. No anomalies were detected. Compared to BRD001 the hole was probably stopped 20m short of the 'Mixed Sequence' - HOWEVER the isotope data indicates lower temperatures than in BRD001 consequently there is no likelihood of an ore body beneath the end of the hole. Petrophysics measurements were done on core samples.

Geological NotesDOWNHOLE SURVEY DATA:

Depth	Dip	Azimuth	Core Size
0.00	-90.00	0.00	
90.00	-88.50	102.00	NQ
150.00	-85.00	76.00	NQ
210.00	-79.50	97.00	NQ
270.00	-77.00	100.00	NQ
325.00	-76.00	101.00	NQ
397.00	-73.00	101.00	NQ
472.00	-72.00	96.00	NQ
514.00	-73.50	91.00	NQ
600.00	-73.50	96.00	NQ
660.00	-74.00	96.00	NQ

538
DEPTH CORE Sample LITH'GY O --SULPHIDES-- -----ALTERATION----- VEINING STRUCTURE FAULT SU
TO RECOV Number MAJ MIN X VcGPyCpPoGaSp ILiAlChEpKFSeClSICaJaBaMa TyVoNoA BaJaFm H GgAng tn
I % m/m% m/m% m/m% n pc ri
D t at Comments

520.60	3.00	BAV BAS 0	01FD9D	TD1	1	1P	2P	QC0206R	0 4	
523.60	3.00	BAV BAB 0	TRFD5D	TD4D1	1		2P	QC0608R	0 4	
526.60	3.00	BAB BAV 0	TRFD5	D5	1	TP	1P	QC0608R	0 4	
529.60	3.00	BAV BAB 0	TRFD5	D5	1	TP	1P	QC0305R	0 4	
532.60	3.00	BAV BPB 0	TRFD5	D5	1	TP	1P	QC0505R	0 4	
535.60	3.00	BAS BAB 0	TRFD5	D5	1	TP	1P	QC0510R	0 4	
538.60	3.00	BAS BAV 0	TRFDA		1		1P	QC0510R	0 4	@538.8=A295044 THIN SECT.
541.60	3.00	BAS BAB 0	TRFDA		1		1P	QC0812R	0 4	
544.60	3.00	BAS	0	TRFDA	1		1P	QC0510R	0 4	
547.60	3.00	A295062	BAS BAB 0	02FVA	1		1P	QC0712R	0 4	
550.60	3.00	BAS BAB 0	03FVA		1		1P	QC0608R	0 4	
553.60	3.00	BAB BAS 0	01FVA		1		1P	QC1505R	0 4	
556.60	3.00	BAB BAS 0	02FV9	D1	1		1P1P	QC0508R	0 4	
559.60	3.00	BAS BAB 0	02FDA		1		1P	QC0304R	0 4	@556.9=A295046 THIN SECT. @559.6=A295045 THIN SECT.
562.60	3.00	BAB BPB 0	TRFDA		1		1P	QC04054	0 4	
565.60	3.00	BAB BAS 0	TRFDA	DTD	TD1		1P	QC0705R	0 4	
568.60	3.00	BAB	0	TRFDA	1		1P	QC0303R	0 4	
571.60	3.00	BAS BAB 0	02FDA		1		1P	QC05084	0 4	
574.60	3.00	BAB	0	TRFD9D	TD1		1P	QC0608R	0 4	
577.60	3.00	BAB	0	TRFD5D	TD5 DT		1P	TC03054	0 4	
580.60	3.00	BAB BAV 0	TRFDA		1		1P	QC0305R	0 4	
583.60	3.00	BAB BAV 0	02FVA		1		1P	TC04057	0 4	
586.60	3.00	BAV BAB 0	TRFDA		1		1P	QC0506R	0 4	
589.60	3.00	BAV	0	TRFDA	1		1P	QC0708R	0 4	
592.60	3.00	BPB BAV 0	TRFDA		1		1P	QC0207R	0 4	
595.60	3.00	BAP	0	TRFD5	D5	1	1P	QC0506R	0 4	
598.60	3.00	BAV BPB 0	TRFD5	D5	1		1P	TC04057	0 4	
601.60	3.00	BAP	0	TRFD5	D5	1	1P	QC0308R	0 4	
604.60	3.00	BPB BAP 0			1		1P	QC0206R	0 4	@604.6=A295047 THIN SECT.
607.60	3.00	A295063	BAB	0	TRFDA	1	1P	QC0104R	0 4	
610.60	3.00	BAS	0	TRFDA	1		1P	TC06087	0 4	
613.60	3.00	BAS BAB 0	TRFDA		1		1P	QC02044	0 4	
616.60	3.00	BAB BAS 0	TRFDA		1		1P	TC03066	0 4	
619.60	3.00	BAS BAB 0	TRFDA		1		1P	TC02067	0 4	
622.60	3.00	BAS BAB 0	TRFDA		1		1P	TC03127	0 4	
625.60	3.00	BAB BAS 0	TRFDA		1		1P	TC0306R	0 4	
628.60	3.00	BAV BAB 0	TRFDADT		1		1P	QC01043	0 4	
631.60	3.00	BAV BAB 0	TRFDA		1		1P	QC0504R	0 4	
634.60	3.00	BAV BAB 0	TRFDA		1		1P	QC0506R	0 4	@632.8=A295048 THIN SECT.
637.60	3.00	BAB BAV 0	TRFDADT		0		TP	TC05107	0 4	
640.60	3.00	BAV BAB 0	TRFDA		0		TP	TC05057	0 4	
643.60	3.00	BAS BAV 0	TRFDA		0		TP	TC05077	0 4	
646.60	3.00	BAB	0	TRFDA	0		TP	TC02077	0 4	
649.60	3.00	BAB BAV 0	TRFDA		0		TP	QC0104R	0 4	
652.60	3.00	BAB BAV 0	TRFDA		0		TP	QC0103R	0 4	
655.60	3.00	BAB BAV 0	TRFDA		0	TP TP TP		TC06157	0 4	@653.0=A295049 THIN SECT.
658.60	3.00	BAS BAB 0	TRFVA		0	TP TP TP		TC07107	0 4	
661.60	3.00	BAS BAV 0	TRFDA		1	1P	1P	TC08127	0 4	@661.6=A295050 THIN SECT.
664.60	3.00	BAS BAP 0	TRFDA		0	TP	TP	TC04127	0 4	

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DEPTH	CORE	Sample	LITH'GY	O	--SULPHIDES--	-----ALTERATION-----	VEINING	STRUCTURE	FAULT	SU		
TO	RECOV	Number	MAJ	MIN	X	VoGPyCpPoGaSp	ILiAlChEpKfSeClSiCaJaBaMa	TyVoNoA	BaJaFm	H	GgAng	tn
			I	Z	m%	m%	m%	m%	m%	n	pc	ri
			D			t					at	Comments

667.60	3.00		BAB	BAV	0	TRFDA	0	TP		TP	TC01057	0 4
670.60	3.00		BAS	BAB	0	TRFDA	1	1P		1P1P	QC0710R	0 2 15 3
673.60	3.00	A295064	BAS		0	TRFDA	1	1P		1P1P	QC1010R	0 3
676.60	3.00		BAS		0	TRFDA	1	1P		1P1P	QC0510R	0 1 60 3

APPENDIX II

PETROGRAPHY

DDHs BRD 01 AND BRD 02

061

Sample No. A 295001 43.2 m

Rock Type. Poorly sorted quartz and plagioclase-bearing lithic/vitric tuff, with a subordinate ?carbonaceous matrix component.

Hand Specimen A pale grey distinctly fragmental drill core sample for which K-feldspar staining gave patchy positive results for sparse small crystal chips, as well as deformed volcanic lithic fragments. Traces of fine grained sulphides are present.

Thin Section. Poorly sorted fragmental (pyroclastic) texture is clearly evident in this sample, in which medium to coarse sand sized lithic fragments predominate. Subordinate debris includes broken angular phenocrystic fragments generally less than 2 mm across. The lithic fragments include once-glassy weakly banded acidic volcanic types with perlitic cracks, as well as fragments that enclose cusped outlines of glass shards and altered mineralised feldspar-rich granular intrusive types. The crystal debris includes albitised plagioclase cleavage fragments and angular chips as well as embayed and magmatically rounded quartz crystals. Sites of glass shards now are replaced by polygonised water-clear albite. Accessory mafic sites are replaced by chlorite, and rare degraded oxide sites are degraded to pale brown stained translucent ?leucoxen. Most of the debris in this rock is set in a rather meagre, exceptionally fine grained felsic matrix which appears to be clouded by very fine grained opaque (?carbonaceous) dust suggesting a mixed sedimentary/tuffaceous origin. Cusped glass shards are well defined.

The rock may be described as a poorly sorted quartz and plagioclase-bearing lithic/vitric tuff, with a subordinate ?carbonaceous matrix component. The rock may have been slightly reworked, or else deposited by air fall into fine carbonaceous mudstone.

062

Sample No. A 295002 138.7 m

Rock Type. Very fine grained finely banded and weakly foliated sparsely silty strongly carbonaceous mudstone.

Hand Specimen A dark grey fine grained rather massive carbonaceous drill core sample with a poorly defined fine layering normal to the length of the drill core. No K-feldspar was detected by staining.

Thin Section. Small variations in detrital grain size and proportion of carbonaceous material in this sample have produced a fine primary layering. Rare angular detrital grains of quartz, plagioclase and carbonate reach very fine sand size, but most similar recognisable detrital grains are fine silt size. These grains are "suspended" in a voluminous matrix comprising weakly foliated, strongly carbonaceous mudstone. Wispy sericite flakes define a wavy to crinkled foliation direction throughout the translucent dark brown carbonaceous material. Small well rounded organic remains are now converted to carbonate ± cherty quartz. Rare fine grained sulphides are accessory in several of the relatively coarser bands.

This sample may be identified as a very fine grained finely banded and weakly foliated, sparsely silty, strongly carbonaceous mudstone.

Sample No. A 295003 522.6 m

Rock Type. Very fine grained finely banded sparsely silty moderately carbonaceous mudstone.

Hand Specimen A dark grey fine grained compact drill core sample which is cut by numerous very narrow microfractures filled with white calcite (strong reaction with cold dilute HCL ± traces of dusty sulphides. K-feldspar staining proved negative.

Thin Section. This sample is similar to the previous sample

063

A 295002, but it is somewhat less carbonaceous. It exhibits an extremely fine grained clastic sedimentary texture defined by scattered angular silt sized detrital grains and narrow bands of silt sized grains set throughout a muddy carbonaceous matrix. Recognisable detritus includes angular grains of quartz, weakly sericitised plagioclase cleavage fragments, deformed mica flakes and patches of microgranular sphene (?degraded opaque oxides). These grains are set in a ubiquitous matrix of exceptionally fine grained low birefringent felsic material clouded by very abundant carbonaceous dust, and wispy "sericite" aligned subparallel to a weak foliation direction.

Clusters of very fine grained sulphide crystals (mostly ?pyrite) are concentrated along late stage carbonate filled narrow vein-like microfractures. Rarely, clusters of sulphides are drawn out in chlorite-carbonate-quartz "stringers" parallel to the weak layering.

The sample may be described as very fine grained finely banded sparsely silty moderately carbonaceous mudstone.

<u>Sample No.</u>	A 295004 733.7 m
<u>Rock Type.</u>	Carbonated and silicified, strongly vesicular pyroxene porphyritic intermediate volcanic rock, possibly of trachyandesitic affinity.
<u>Hand Specimen</u>	A pale green-grey fine grained compact mottled sample with sparse large irregular white vein-like patches of calcite (strong reaction with cold dilute HCL). K-feldspar staining gave weak patchy positive results for the matrix.
<u>Thin Section.</u>	This is a partly altered fine grained micro-porphyritic volcanic rock which is very strongly vesicular. Microphenocrysts and clusters are of small euhedral to subhedral clinopyroxene crystals that are partly converted to secondary carbonate. These are set in a groundmass of decussate acicular clinopyroxene crystals, set in a felsic mat of radiating albite bundles intergrown with patchy fine grained

064

secondary quartz and patches of carbonate. Clouded felsic domains could represent partly degraded K-feldspar. Patches of sphene dust are accessory.

Large well rounded to irregular shaped vesicle sites, which account for more than 35% of the total thin section area, now are filled with irregularly zoned assemblages amongst the following phases; granular quartz, colourless to pale green radiating clusters of carbonate, minor pale green chlorite, traces of epidote, and small irregular patches of honey brown sphalerite ± traces of opaque sulphides.

Carbonate alteration and silicification have partly obscured the primary textures and mineralogy of this sample, and it may be only tentatively identified as a strongly vesicular pyroxene porphyritic intermediate volcanic rock, possibly of trachyandesitic affinity.

Sample No.

A 295005 737.6 m

Rock Type.

Strongly vesicular clinopyroxene and ?amphibole porphyritic intermediate volcanic rock, that has undergone strong carbonate-chlorite-epidote-(quartz) alteration.

Hand Specimen

A mid-to pale-grey mottled drill core sample in which acid etching has outlined abundant quite coarse vesicle and phenocryst sites. K-feldspar staining gave positive results for the exceptionally fine grained voluminous groundmass fraction.

Thin Section.

The texture and mineralogy of this sample is closely related to that of the previous sample A 295004. It retains a strongly vesicular and microporphyritic texture, defined by glomeroporphyritic clusters and small euhedral crystals of very pale green (?diopsidic) clinopyroxene, and altered euhedral microphenocryst sites that once could have contained an amphibole. The very abundant fine grained groundmass fraction is crammed with decussate to subradiating acicular clinopyroxene and poorly defined clouded feldspar(s) with ubiquitous clouded sphene dust.

065

Once again the prominent vesicle sites have a zoned secondary assemblage, for example calcite centrally, then sphalerite, then albite ± epidote ± chlorite peripherally. Elsewhere are vesicles filled with patches of carbonate, chlorite and epidote, while still others contain central zones filled with coarse carbonate, and narrow rims of microgranular epidote and chlorite. Rare vesicles are now filled with quartz centrally and chlorite peripherally. A very conspicuous vein (about 5 mm wide) contains intergrown coarse grained epidote, carbonate and minor quartz.

The sample may be described as a strongly vesicular clinopyroxene microporphyritic intermediate volcanic type (?trachyandesite), that has undergone strong carbonate-chlorite-epidote-(quartz) alteration.

Sample No. A 295006 754.7 m

Rock Type. Partly altered, strongly vesicular microporphyritic and trachytic volcanic rock, possibly of trachy-basaltic primary affinity.

Hand Specimen A mid to pale green-grey fine grained drill core sample in which very large rounded to irregular shaped vesicle sites are filled with calcite (strong reaction with cold dilute HCl). K-feldspar staining proved negative.

Thin Section. Microlitic trachytic texture is very well defined in this fine grained coarsely vesicular volcanic rock. Also present are very abundant microphenocrysts and glomeroporphyritic aggregates of very heavily carbonated clinopyroxene. Only small relict "islands" of this phase remain. Rare chlorite-filled microphenocryst sites once may have contained olivine. Wispy albitised prismatic shaped albite microlites are aligned subparallel to somewhat irregular wavy patterns of original magmatic flow. The microlites are in turn set in a microgranular felsic matrix intergrown with ubiquitous small patches of chlorite and sphene dust.

066

The large rounded to irregular shaped vesicle sites are filled with granular carbonate, with patches and narrow rims of fine grained epidote and chlorite ± traces of quartz.

Trachytic, once-vesicular and microporphyritic texture is clearly preserved in this partly altered volcanic rock, the primary composition of which is most likely trachytic to trachybasaltic.

Rock Type. A 295007 762.7 m

Rock Type. Partly altered microporphyritic and vesicular rather basic volcanic rock, possibly of basaltic andesite affinity.

Hand Specimen A fine grained massive mid green-grey sample with abundant small dark crystal sites. K-feldspar staining gave weak positive results. The sample is not magnetic.

Thin Section. The texture of this fine grained volcanic rock is dominated by a decussate mat of narrow elongate plagioclase crystals, as well as very abundant glomeroporphyritic aggregates of fresh (unaltered) subhedral colourless clinopyroxene. The acicular plagioclase crystals also show very little alteration and these have quite shallow extinction angles (possibly andesine compositions). Sparse chlorite filled sites of mafic microphenocrysts once may have contained olivine. The interstitial once-glassy fraction now is very finely devitrified and contains wispy to microgranular clusters of felsic material (K-feldspar-bearing) intergrown with abundant dusty carbonate, sphene, and chlorite. Another interstitial phase appears to have been converted to exceptionally fine grained intergrown chlorite and quartz. Elsewhere are irregular shaped vesicle sites which are filled with aggregates of chlorite and small spherulites of secondary quartz.

Since the relatively fresh plagioclase in this sample is not strongly calcic, but carbonate-chlorite-quartz alteration

067

has affected the rock it may be only tentatively identified as a micro-porphyrific rather basic volcanic rock, possibly of basaltic andesite affinity.

Sample No. A 295008 766.6 m

Rock Type. Deformed and finely recrystallised poorly sorted lithic/vitric tuff (ignimbrite), containing flattened intensely altered microlitic and vesicular once glassy volcanic fragments of acid-intermediate affinity.

Hand Specimen A mottled and distinctly fragmental well foliated sample in which dark grey lensed and flattened fragments are set throughout a mid grey fine grained matrix. Elongation of fragments defines well the foliation which is subparallel to the length of the drill core. K-feldspar staining gave weak patchy positive results.

Thin Section. The sample has undergone intense selective alteration and fine grained recrystallisation, as well as partial deformation and foliation. Nevertheless very abundant poorly defined once-glassy and microlitic vesicular lithic fragments and deformed ?shards drawn out parallel to the foliation are now converted to green chlorite, while sparse sites of ?plagioclase microphenocrysts now are converted to microgranular albite and quartz. Sparse angular quartz chips are present, particularly concentrated in narrow lenses, and equally sparse are glomeroporphyrific sites that now contain microgranular quartz ± carbonate ± chlorite and dusty aggregates of sulphides. The barely recognisable lithic and crystal debris is set in a fine grained cherty and felsic matrix dominated by microgranular quartz ± traces of ?K-feldspar intergrown with carbonate, chlorite and wispy sericite. Rutile is accessory. The sample is cut by a foliated zone of finely recrystallised carbonate.

This sample may be identified as a deformed and finely recrystallised, poorly sorted lithic/vitric tuff (ignimbrite) containing flattened and intensely altered microlitic and vesicular once-glassy volcanic fragments of acid-intermediate primary affinity.

068

Sample No. A 295009 775.7 m

Rock Type. Weakly mineralised and intensely altered lithic tuff containing abundant once glassy pumiceous volcanic lithic fragments and minor phenocrystic quartz debris.

Hand Specimen A rather massive fine grained mid green-grey coloured sample containing numerous vague outlines of angular dark green-grey fragments. K-feldspar staining gave weak patchy positive results.

Thin Section. Intense but mostly selective alteration has affected this sample, but outlines of well rounded vesicle sites are well preserved as are sparse subhedral shaped sites of previous microphenocrysts. A single coarse grained quartz phenocryst exhibits a strongly embayed and magmatically well rounded outline. Elsewhere are outlines of cusped glass shards. The pumiceous lithic fragments now are pseudomorphed by intergrown assemblages amongst the phases chlorite, carbonate, quartz ± albite ± traces of K-feldspar. The barely recognisable fragments and sparse small angular crystal debris are set in an abundant matrix of very fine grained cherty quartz and albite clouded by dusty carbonate, chlorite and sphene. Clusters of fine grained sulphides including traces of sphalerite are selectively located in sites of certain fragments, or else in interfragment sites that once may have comprised voids later infilled with finely banded layers of ?chalcedonic or opaline silica, and finely recrystallised.

The sample comprises an altered lithic tuff containing very abundant finely vesicular (pumiceous) once glassy volcanic lithic fragments of fairly acidic affinity, and sparse phenocrystic quartz debris, with clusters of dusty fine grained sulphides, mostly located in a cherty siliceous interfragment matrix fraction.

069

Sample No. A 295010 788.7 m

Rock Type. Partly altered strongly vesicular microporphyritic trachytic volcanic rock, with traces of dusty sulphides mainly located in vesicle sites.

Hand Specimen A mid grey fine grained rather massive drill core sample that contains numerous small rounded pale grey to white patches (?vesicle sites), as well as sparse medium grained dark green-grey ?mafic crystal sites. A single large elongate white amygdale and a narrow veinlet is filled with calcite (strong reaction with cold dilute HCl). No K-feldspar was detected by staining.

Thin Section. This is a partly altered, fine grained strongly vesicular volcanic flow rock. It retains a well defined feathery trachytic texture defined by very abundant wispy albite microlites, while sparse microphenocrysts comprise relict "islands" of colourless clinopyroxene enclosed within patches of secondary carbonate. Other sparse microphenocrysts comprise albite which is also largely converted to carbonate, while a group of microphenocryst sites now contains cherty quartz, chlorite and sphene. The ubiquitous exceptionally fine grained once-glassy interstitial groundmass fraction now is converted to pale green chlorite with dusty sphene and carbonate granules. The well rounded large vesicle sites now contain abundant quartz, chlorite ± carbonate, or else almost monomineralic carbonate. Sparse vesicle sites also contain epidote and dusty sulphides.

Trachytic, strongly vesicular and microporphyritic texture are characteristic of this partly altered fine grained volcanic flow rock of intermediate (?trachytic) primary composition. The secondary assemblages now characteristic in the large vesicle sites are associated with traces of sulphides.

Sample No. A 295011 801.7 m

Rock Type. Intensely altered, poorly sorted lithic tuff, comprising once-vesicular and glassy microporphyritic fragments of intermediate composition, separated by siliceous and weakly mineralised interfragment infill.

070

Hand Specimen Poorly sorted fragmental texture is evident in this patchy mottled dark green-grey to pale green-grey drill core sample. K-feldspar staining gave positive results for small irregular shaped interstitial patches throughout the sample. Dusty sulphides are accessory.

Thin Section. This sample is very similar to the previous sample A 295009. Unsorted pumiceous volcanic lithic fragments greatly predominate, and these are rather poorly defined due to extensive patchy alteration. Within the fragments are well preserved rounded vesicle sites, altered sites of feldspar microphenocrysts and rare relict "islands" of fresh colourless clinopyroxene. Intense patchy alteration now has produced assemblages amongst the phases chlorite, quartz, carbonate, albite and sphene.

Interfragment spaces now are filled with abundant cherty to granular quartz with poorly defined brown dusty inclusions suggesting initial deposition of the silica from solution (most likely as chalcedony or opal). Poorly defined narrow zones also comprise chlorite ± albite, while irregular shaped central zones of interfragment spaces commonly contain granular secondary quartz which is free of inclusions and associated with similar clear carbonate and sulphides (particularly sphalerite).

The sample may be identified as a poorly sorted lithic tuff, comprising altered, once vesicular and microporphyrific fine grained to once glassy fragments of intermediate primary composition, with ?epithermal siliceous and carbonated interfragment infill associated with traces of sulphide mineralisation.

Sample No. A 295012 803.7 m

Rock Type. Unsorted lithic fragmental rock containing a variety of intermediate volcanic lithic fragments, set in a very fine grained felsic to cherty clouded matrix.

071

Hand Specimen Large elongate ragged dark green-grey lithic fragments are drawn out parallel to a distinct foliation direction. These are set in an abundant pale grey fine grained rock matrix. K-feldspar staining gives strong positive results for a very large conspicuously vesicular and mineralised lithic fragment, as well as numerous smaller ones.

Thin Section. Unsorted lithic fragmental texture is very well defined in this altered and substantially mineralised sample. A single lithic fragment, more than 5 cm across, comprises a strongly porphyritic and vesicular type in which abundant deformed coarse ?vesicle (or mafic ?phenocryst) sites are filled with dense chlorite \pm carbonate. Other irregular shaped sites are filled with carbonate, quartz, chlorite \pm K-feldspar and sulphides. The host lithology comprises ubiquitous clouded patches of K-feldspar, patches of secondary quartz, chlorite and sphene. Rare recognisable carbonated phenocryst sites retain traces of relict clinopyroxene. Similarly altered once vesicular and glassy volcanic fragments themselves may be fragmental, while accessory lithic fragments retain clearly trachytic relict textures. Partly altered feldspar cleavage fragments include K-feldspar.

The fragments are set in a very fine grained ?cherty matrix with a vague finely fragmental relict texture. This matrix is heavily clouded by dusty sphene and sulphide granules. There are no clear outlines of glass shards, and this rock could represent intermixed volcanic fragmental and fine grained clastic sedimentary material.

The sample may be identified as an unsorted lithic fragmental rock containing a variety of altered and mineralised volcanic lithic fragments of intermediate affinity, set in an exceptionally fine grained felsic matrix clouded by dusty sphene.

Sample No. A 295013 833.2 m

Rock Type. Intensely altered, weakly foliated and veined, poorly sorted lithic ?tuff, containing very abundant porphyritic and vesicular volcanic lithic fragments most likely of intermediate primary composition.

072

Hand Specimen A mottled and patchy pale green-grey to dark green-grey distinctly fragmental drill core sample in which unsorted angular to irregular shaped porphyritic and vesicular volcanic lithic fragments are set in a fine grained matrix. The sample is cut by sparse narrow white (calcite filled) veins that react with cold dilute HCl. No K-feldspar was detected by staining.

Thin Section. Intense alteration has affected this rock and largely has obscured primary mineralogy and some textural features. However, the rock clearly contains very abundant unsorted volcanic lithic fragments from several texturally different sources. Most retain microporphyritic and vesicular relict textures, while others are microporphyritic and microlitic. Still others retain a crowded porphyritic distinctly feldspathic relict texture. The matrix fraction is very poorly defined, and comprises abundant, much smaller lithic fragments similar to those described above, as well as altered and broken crystal fragments and abundant patchy secondary phases.

Very little primary mineralogy remains as such, (traces of albitised plagioclase) and this sample is largely converted to secondary assemblages amongst the phases carbonate, chlorite, quartz, albite and sphene. The rock is cut by narrow discontinuous veinlets filled with granular carbonate, water clear albite and quartz. In several domains aggregates of euhedral to subhedral epidote crystals are now converted to clouded carbonate. These crystals are associated with coarse granular carbonate and albite. A weak foliation is present and minor traces of dusty sulphides occur in narrow wavy trails outlining small flattened fragments. The sulphides pre-date late stage carbonate veins.

The sample may be only tentatively identified as a poorly sorted lithic tuff, containing very abundant porphyritic and vesicular volcanic lithic fragments of intermediate primary composition, that has undergone intense carbonate-chlorite-albite-quartz alteration.

073

Sample No. A 295014 839.3 m

Rock Type. Partly altered and weakly mineralised, strongly vesicular and porphyritic rock of basaltic andesite affinity, that is cut by a network of branching carbonate veins.

Hand Specimen A coarsely fragmental sample, containing abundant dark green-grey fine grained volcanic lithic fragments that are conspicuously porphyritic and vesicular. They are set in a pale grey carbonate (calcite) rich matrix which gives a strong positive reaction with cold dilute HCl. K-feldspar staining proved negative.

Thin Section. Strongly vesicular and microporphyritic texture is well preserved in this sample. The abundant microphenocrysts include crystals and clusters of fresh pale green clinopyroxene, and scattered euhedral crystal sites now filled with green chlorite that almost certainly once contained olivine. The conspicuous large rounded vesicle sites now are filled with somewhat zoned assemblages amongst the secondary phases chlorite, carbonate, epidote, albite, sphene and sulphides. The voluminous groundmass fraction of this sample comprises very abundant decussate plagioclase microlites with interstitial chlorite, dusty carbonate and sphene. The plagioclase is not particularly calcic (possibly oligoclase).

The sample is cut by substantial veins and patches of finely recrystallised carbonate (calcite), which could be responsible for the fragmental appearance of the hand specimen.

Identification of exact primary lithology is obscured by partial carbonate-chlorite-epidote-sphene alteration of this rock. The presence of abundant phenocrystic clinopyroxene, possible olivine sites and oligoclase microlites suggests a basaltic andesite primary composition. The rock is most likely related to the previous sample A 295007.

074

Sample No. A 295015 851.5 m

Rock Type. Partly altered poorly sorted polymictic volcanic conglomerate.

Hand Specimen An unsorted fragmental or conglomeratic sample containing a variety of lithic clasts (up to more than 5 cm across) of pale grey (limestone), mid brown-grey, dark green-grey massive and ?porphyritic volcanic lithic types, all set in a pale grey fine grained ?cherty matrix. No K-feldspar was detected by staining.

Thin Section. This sample exhibits an unsorted chaotic texture comprising abundant poorly defined lithic and crystal clasts and fragments. Many lithic fragments enclose glomeroporphyritic clusters of albitised and lightly sericite-clouded plagioclase set in a fine grained groundmass dominated by secondary albite and chlorite ± traces of carbonate and "sericite". In other plagioclase porphyritic fragments dense wispy sericite ± montmorillonite dominates in the altered groundmass fraction, and the original fragment shape is flattened and deformed. Still other plagioclase porphyritic fragments have groundmass textures dominated by albite-chlorite ± carbonate intergrowths. Sparse angular crystal debris includes abundant cleavage fragments of albitised plagioclase, as well as sparse quartz chips. The single subrounded pale grey large carbonate-rich lithic clast is not represented in the present thin section.

The poorly defined rock matrix shows weak wavy foliation comprising discontinuous trails of chlorite, sphene dust and sulphide dust set throughout an exceptionally fine grained recrystallised cherty felsic mosaic.

A variety of lithic fragments is represented in this drill core sample, and several show distinct rounding most likely due to sedimentary reworking. The rock may be tentatively identified as a partly altered, poorly sorted polymictic volcanic conglomerate.

075

Sample No. A 295016 860.6 m

Rock Type. Substantially altered lithic tuff (or conglomeratic volcanic lithic arenite) containing a variety of ?related fragments from a plagioclase porphyritic and once-glassy intermediate volcanic source.

Hand Specimen A patchy and mottled mid green-grey to dark green-grey compact drill core sample containing poorly defined outlines of abundant lithic fragments. K-feldspar staining proved negative.

Thin Section. Lithic fragments in this sample are very poorly defined. Nevertheless substantial differences in relict textural features are preserved in adjacent areas of the present thin section. These include the following types; once glassy perlitic types, plagioclase microporphyritic and trachytic types; coarsely plagioclase porphyritic types with perlitic once-glassy groundmass textures; and fine grained holocrystalline types with decussate albitised plagioclase laths. Some small lithic clasts have distinctly subrounded shapes. The matrix fraction of this rock is very indistinct since ubiquitous alteration has produced a patchy polygonised secondary assemblage amongst the phases quartz, albite, sericite (\pm montmorillonite), carbonate, and dusty sphene. Sparse, very fine grained disseminated sulphide crystals and clusters (mostly pyrite) are accessory.

This sample comprises very abundant volcanic lithic debris from a plagioclase porphyritic once partly glassy source of intermediate primary composition. A variety of ?related textural types is represented, and the presence of rounded clasts could suggest partial sedimentary reworking. The sample may be described as a substantially altered, poorly sorted lithic tuff (or conglomeratic volcanic lithic arenite) containing a variety of ?related fragments from a plagioclase porphyritic and once glassy intermediate volcanic source.

076

PETROGRAPHIC DESCRIPTIONS

- Sample No. A 295032 374.6 m
- Rock Type. Exceptionally fine grained carbonaceous (radiolarian cherty marl, intermixed with microporphyritic and microlitic carbonated and chlorite-altered intermediate volcanic rock with rare small quartz phenocrysts.
- Hand Specimen Irregular shaped patches up to more than 7 cm across of fine grained pale grey material are set in a compact very fine grained dark grey matrix. The rock is cut by numerous narrow branching white veinlets of calcite (strong reaction with cold dilute HCl). A discontinuous narrow band rich in sulphides is present along the boundary of these two types in the small offcut. No K-feldspar was detected by staining.
- Thin Section. The paler grey fine grained fraction of the hand specimen is a sparsely microporphyritic, strongly microlitic and once glassy volcanic type in which the sparse small phenocrysts comprise a selectively carbonated prismatic shaped phase, none of which remains. Dusty opaque oxide inclusions suggest that at least some of these sites once contained a mafic phase. Other carbonated sites contain clusters of a red-brown translucent spinel. Elsewhere are rare small magmatically embayed quartz phenocrysts. The abundant groundmass encloses ubiquitous wipsey plagioclase (oligoclase) microlites set in a once glassy low birefringent chlorite-altered groundmass.
- This lithology has a sharp irregular boundary against an exceptionally fine grained carbonaceous and cherty sedimentary type that is also heavily carbonated. Small round quartz-rich sites mark microfossil remains (?radiolaria).
- A carbonated margin within the volcanic lithology is marked by abundant dusty sulphides.
- The rock is an exceptionally fine grained carbonaceous (radiolarian) cherty marl intermixed with microporphyritic and microlitic carbonated and chlorite altered intermediate volcanic rock with rare small quartz microphenocrysts.

077

Sample No. A 295033 377.2 m

Rock Type. Weakly mineralised carbonate-chlorite-quartz altered microporphyritic and sparsely vesicular intermediate volcanic rock.

Hand Specimen A rather massive fine grained mid-grey sample with sparse irregularly distributed medium to fairly large white calcite patches that react strongly with cold dilute HCl. K-feldspar staining proved negative.

Thin Section. This is a heavily carbonated fine grained, sparsely microporphyritic volcanic rock. The scattered prismatic shaped microphenocryst sites now are converted to dense very fine grained cherty quartz intermixed with relatively minor chlorite and carbonate. The voluminous groundmass fraction of this rock contains a mat of decussate narrow plagioclase (oligoclase) microlites set in abundant small patches of carbonate with subordinate chlorite, granular quartz and sphene granules. Small irregular shaped patches of granular quartz most likely represent vesicle fill rather than microphenocrysts.

The sample contains about 5% of irregularly distributed very fine grained disseminated sulphides (mostly pyrite), and traces of sphalerite. Late stage carbonate and quartz veining is not particularly associated with the mineralisation.

This intensely altered sample may be only tentatively identified as a weakly mineralised carbonate-chlorite-quartz altered microporphyritic and sparsely vesicular intermediate volcanic type.

Sample No. A 295034 393.1 m

Rock Type. Veined and weakly mineralised, carbonate-chlorite-quartz-altered microporphyritic and vesicular volcanic rock of ?intermediate primary composition.

078

Hand Specimen A massive fine grained mid grey drill core sample that is cut by a conspicuous white calcite vein. Both host rock and vein give a strong positive reaction with cold dilute HCl, and K-feldspar staining gave weak patchy positive results in interstitial groundmass sites and around rare sulphide patches. Fine dusty sulphides are not particularly obvious in the hand specimen.

Thin Section. This sample is mineralogically and texturally very similar to the previous sample A 295033. It is a sparsely micro-porphyrific volcanic type in which subhedral prismatic shaped phenocrysts are mostly converted to clouded carbonate, and fewer to cherty quartz. Small irregular shaped to branching vesicle sites are filled with dense green chlorite and small patches of spherulitic quartz. The voluminous groundmass fraction contains a mat of narrow wispy plagioclase (oligoclase) microlites set in abundant carbonate intergrown with chlorite, minor K-feldspar (see staining) and abundant sphene granules.

Disseminated fine grained pyritic sulphides account for about 5% of the sample, with coarser grained sulphide patches located in altered phenocryst sites (including pyrite and sphalerite). Carbonate veins also carry minor sulphides.

This sample may be identified as a veined and weakly mineralised carbonate-chlorite-quartz altered volcanic rock of ?intermediate primary composition similar to the previous sample A 295033.

Sample No. A 295035 398.6 m

Rock Type. Veined and mineralised fine grained banded and lensed silty carbonaceous sediment, with a substantial K-feldspar-rich tuffaceous contribution. Certain bands contain abundant carbonate.

Hand Specimen An extremely fine grained dark grey to mid grey sample with a poorly defined lensed layering. K-feldspar staining gave strong positive results except for crosscutting white (calcite) veins

079

which gave a strong positive reaction with cold dilute HCl.

Thin Section.

This sample shows distinct lensed layering and fine grained clastic texture. It contains quite abundant angular silt sized quartz and albitised plagioclase cleavage fragments, as well as abundant small patches of microgranular K-feldspar that almost certainly once comprised tuffaceous material. The very abundant matrix comprises abundant carbonaceous dust, chlorite, cherty felsic material, and patches of carbonate. Narrow bands that are relatively poor in carbonaceous dust contain relatively abundant quartz with sparse angular grains reaching 0.3 mm across.

Substantial narrow lensed and discontinuous partly recrystallised branching quartz-carbonate veins lack K-feldspar (except marginally) and enclose small patches of sulphides (mostly pyrite and sphalerite). The host rock also contains patchy disseminated sulphides. (See separate description).

The sample may be identified as a veined and mineralised fine grained banded silty carbonaceous sediment with a substantial tuffaceous contribution (see K-feldspar staining).

<u>Sample No.</u>	A 295036 400.8 m
<u>Rock Type.</u>	Carbonate-chlorite-quartz altered and veined fine grained microporphyratic and once-vesicular volcanic rock of intermediate affinity, that is cut by a breccia zone with fragments of carbonaceous mudstone.
<u>Hand Specimen</u>	A mid grey fine grained massive sample containing sparse well rounded white (calcite-rich) vesicle sites and white to pale grey (calcite-rich) veins. Vesicle sites and veins react strongly with cold dilute HCl. K-feldspar staining gave very weak positive results for the fine interstitial groundmass fraction. The rock is cut by a deformed 1 cm wide fragmental (brecciated) zone.

080

Thin Section. This sample is very similar to the previous two samples A 295033 and A 295034. It is intensely altered, but retains a clear microporphyritic and once-vesicular, microlitic volcanic texture. Possible mafic phenocryst sites are now pseudomorphed by carbonate and/or dense cherty quartz, and one albitised plagioclase phenocryst is present. Abundant wispy feldspar (oligoclase) microlites in the abundant groundmass fraction remain unaltered, but are set in dense carbonate, patchy chlorite and clouded sphene. Small rounded vesicle sites are filled with quartz.

A brecciated zone cuts across the sample, and this contains deformed angular fragments of carbonaceous sparsely silty mudstone set in a matrix of partly recrystallised vein carbonate.

Patchy fine grained disseminated sulphides (mostly pyrite) in this rock account for about 5% of the total thin section area.

The intense alteration of this sample precludes accurate identification. It may be described as a carbonate-chlorite-quartz altered and veined fine grained microporphyritic and once-vesicular volcanic rock of intermediate affinity, that is cut by a narrow breccia zone with silty carbonaceous mudstone fragments.

<u>Sample No.</u>	A 295037 430.7 m
<u>Rock Type.</u>	Microporphyritic and once vesicular trachy-andesitic volcanic rock that is partly brecciated and mixed with fragments of limestone set in limy carbonaceous mudstone.
<u>Hand Specimen</u>	A fairly massive mid grey fine grained drill core sample that is cut by sparse narrow white carbonate (calcite) veins that show strong reaction with cold dilute HCl. K-feldspar staining gave strong positive results for the fine grained groundmass fraction and outlines a zone of fine brecciation. The rock is very weakly magnetic.

Thin Section. Microporphyritic and vesicular textures are characteristic of this sample. Phenocrysts include abundant equant euhedral crystals of pale green clinopyroxene, rare crystals of clouded plagioclase, and possibly a second mafic phase now converted to chlorite. The voluminous groundmass contains a mat of wispy decussate plagioclase (oligoclase) microlites set in patchy K-feldspar, carbonate, leucoxene, altered titaniferous oxides and disseminated fine grained sulphides. Vesicle sites are now filled with carbonate ± chlorite.

A complex brecciated zone encloses angular lithic fragments of a similar volcanic type, carbonated volcanic fragments, weakly banded weakly recrystallised limestone, and ?tuffaceous limestone, set in poorly sorted partly carbonated fine grained tuffaceous and carbonaceous mudstone.

The presence of substantial groundmass K-feldspar in this porphyritic and once-vesicular volcanic rock suggests a trachy-andesitic parent type. Partial brecciation of volcanic material mixed with limestone suggests an unstable shallow marine volcanic environment. The volcanic and limestone fragments are set in fine grained carbonaceous mudstone.

Sample No. A 295038 472.6 m

Rock Type. Mixed lithic tuffaceous sediment in which chlorite-carbonate altered once glassy volcanic lithic fragments are set in a fine grained cherty matrix (possibly with glass shards).

Hand Specimen A distinctly fragmental sample containing scattered strongly vesicular but broken dark green-grey lithic fragments up to several cm across, set in a fine grained pale grey matrix with numerous discontinuous branching pale grey veinlets. No K-feldspar was detected by staining. A substantial calcite vein cuts across the rock.

082

Thin Section. Intensely chlorite-altered once-glassy, strongly vesicular volcanic lithic fragments account for about half this sample, and have a fairly even distribution throughout. No primary igneous mineralogy remains, but selective replacement of sparse mafic microphenocryst sites by carbonate outlines a clear microporphyritic relict texture. Other microphenocryst sites are selectively replaced by sulphides, cherty quartz and chlorite. Well rounded large vesicle sites now are filled with chlorite or sulphides, \pm carbonate \pm quartz. A second type of heavily carbonated volcanic lithic fragment contains abundant recognisable volcanic flow-aligned feldspar microlites defining a trachytic texture.

The rock matrix comprises exceptionally fine grained clouded chert which appears to be partly carbonaceous. The rock is cut by several partly mineralised branching carbonate veins.

This sample may be classed as a mixed lithic tuffaceous sediment in which chlorite-carbonate altered microporphyritic and strongly amygdaloidal once-glassy and trachytic lithic fragments are enclosed in a very fine cherty matrix (possibly with glass shards).

Sample No. A 295039 492.1 m

Rock Type. Strongly altered poorly sorted lithic tuff containing fragments of microporphyritic and strongly vesicular andesitic types.

Hand Specimen A poorly sorted lithic fragmental sample in which angular dark green-grey porphyritic volcanic lithic fragments up to several centimetres across are set in an abundant fine grained mid green-grey matrix. K-feldspar staining gave positive results for parts of the rock matrix and sparse small patches within the fragments. The sample is not magnetic. White calcite patches react with cold dilute HCl.

Thin Section. The dark green-grey lithic fragments in this sample contain scattered fresh pale green clinopyroxene microphenocrysts and aggregates as well as fewer completely altered mafic crystal sites that once may have contained ?olivine. The latter now are filled with

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patchy granular quartz and chlorite ± carbonate. Also present are abundant well rounded vesicle sites now filled with chlorite ± quartz, ?montmorillonite, carbonate, albite and secondary K-feldspar. Certain phenocryst sites once may have contained feldspar. The groundmass fraction comprises sparse small prismatic shaped clinopyroxene crystals set in very dense wispy secondary ?amphibole and chlorite. The rock matrix contains smaller volcanic lithic debris clearly related to the larger fragments (described above) set amongst brown stained and clouded felsic patches, wispy amphibole, chlorite and abundant carbonate (calcite).

The rock may be described as a lithic tuff comprising microporphyritic and strongly vesicular altered lithic fragments of rather basic andesitic affinity.

<u>Sample No.</u>	A 295040 498.5 m
<u>Rock Type.</u>	Altered poorly sorted lithic tuff (or partly reworked volcanic conglomerate) containing debris of trachyandesitic primary composition.
<u>Hand Specimen</u>	Unsorted subrounded lithic fragments of fine grained pale grey strongly vesicular and sparsely porphyritic volcanic lithic types range up to more than 6 cm across and are set in a meagre patchy dark green to white matrix. Staining of fragments gave strong positive results for K-feldspar.
<u>Thin Section.</u>	Very fine grained but well defined trachytic textures are marked in these volcanic fragments (or clasts) by albitised feldspar microlites well aligned parallel to a previous direction of flow. Sparse clusters and phenocrysts of fresh euhedral clinopyroxene are present, as are rare mafic phenocryst sites now converted to chlorite and minor carbonate ± sulphides. The latter once may have contained olivine. Rare plagioclase phenocrysts also are present. Abundant large very well rounded vesicle sites now are filled with patchy and zoned assemblages amongst the phases prehnite, quartz, chlorite, albite and carbonate. The very abundant trachytic groundmass fraction of the fragments comprises a low birefringent K-feldspar-rich finely devitrified mosaic.

084

The meagre rock matrix comprises smaller volcanic lithic debris set in secondary products including prehnite, chlorite, quartz, sphene, albite etc.

The rock may be described as an altered lithic tuff (or partly reworked volcanic conglomerate) containing debris of trachyandesitic primary composition.

<u>Sample No.</u>	A 295041 503.6 m
<u>Rock Type.</u>	Partly altered lithic tuff containing closely related porphyritic and vesicular lithic fragments of trachyandesite set in a weakly mineralised vein-like matrix of secondary products.

<u>Hand Specimen</u>	The majority of this drill core sample comprises a single fine grained mid grey strongly vesicular ?fragment or part of a flow. The small offcut shows distinctly fragmental texture. Staining gave very strong positive results for lithic fragments. Sparse white (calcite) veinlets react with cold dilute HCl.
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<u>Thin Section.</u>	Trachyandesitic lithic fragments are again characteristic in this sample. They are very strongly vesicular and contain various proportions of fresh euhedral pale green to pale yellow-green clinopyroxene microphenocrysts and glomeroporphyritic aggregates. Several of the fragments show distinctly chilled margins. In one fragment the well rounded vesicle sites now are filled with almost monomineralic radiating quartz with minute albite crystals peripherally, while the vesicles in the chilled marginal zone have chlorite-quartz-sphene assemblages
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The meagre interfragment infill comprises a secondary assemblage including quartz, K-feldspar, albite, carbonate, prehnite and minor patchy sulphides (including ?pyrrhotite and red-brown iron-rich sphalerite).

This sample is a partly altered lithic tuff containing closely related porphyritic and vesicular lithic fragments of

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trachyandesite set in a weakly mineralised vein-like matrix of secondary products.

Sample No. A 295042 505.0 m

Rock Type. Well banded coarse to fine grained volcanic lithic arenite containing mainly fine grained K-feldspar-rich trachytic lithic fragments and sparse fresh clinopyroxene crystal debris.

Hand Specimen Distinct layering is developed at about 53° to the core axis in a mid green-grey fine to medium grained host rock. Certain layers contain abundant poorly defined mid grey fragments up to 5 mm across. K-feldspar staining gave strong positive results for certain bands. Sulphide mineralisation is fine grained and concentrated in several narrow bands.

Thin Section. This is a distinctly banded but partly lithic fragmental sample. The very strong K-feldspar staining of the hand specimen is clearly due to the presence of abundant trachytic lithic debris in certain bands. The coarsest lithic debris reaches 4 mm across, and comprises partly altered clinopyroxene-microporphyritic and vesicular trachytic types. In other bands abundant clouded and partly degraded angular once glassy to trachytic clasts, together with cleavage fragments of fresh clinopyroxene are set in an argillic matrix of wispy clouded birefringent ?montmorillonite.

Three narrow mineralised bands (mainly less than 3 mm thick) are located in the finer grained layers containing fewer K-feldspar-rich fragments, but abundant patchy secondary albite, quartz and patches of clouded prehnite.

Several substantial but narrow discontinuous veins contain patchy granular carbonate, quartz, minor epidote ± chlorite and sulphides.

The rock may be described as a well banded coarse to fine grained volcanic lithic arenite, containing mainly fine grained K-feldspar-rich trachytic lithic fragments and sparse fresh clinopyroxene crystal debris.

Sample No. A 295043 512.2 m

Rock Type. Veined weakly mineralised and partly altered microporphyrritic and once-vesicular pyroxene-rich trachyandesite.

Hand Specimen A massive fine grained mid grey drill core sample with scattered large and small very well rounded white (calcite-rich) amygdales which react strongly with cold dilute HCl. K-feldspar staining gave weak positive results for the groundmass fraction, and particularly for narrow central zones in several veins.

Thin Section. Microporphyrritic texture is very well defined in this sample by scattered euhedral crystals and glomeroporphyritic aggregates of pale yellow-green clinopyroxene. Also present are slightly subordinate mafic phenocryst sites that retain euhedral shapes suggesting the presence of olivine. These are now completely pseudomorphed by granular carbonate, patches of microgranular to spherulitic quartz, sphene, and chlorite. The groundmass fraction contains abundant decussate to trachytic plagioclase microlites and dusty sphene patches set amongst patchy carbonate, chlorite and polygonised microgranular K-feldspar. Large rounded vesicle sites are now filled with carbonate (calcite). Several veins contain carbonate and subordinate quartz with late stage patchy sulphides.

The sample may be described simply as a veined, weakly mineralised and partly altered microporphyrritic and once-vesicular pyroxene-rich trachyandesite.

Sample No. A 295044 536.8 m

Rock Type. Partly altered porphyritic and sparsely vesicular clinopyroxene-rich andesitic volcanic rock.

Hand Specimen A massive mid grey fine grained drill core sample containing sparse well rounded white (calcite-rich) amygdales that react strongly with cold dilute HCl. Also present are small dark green-grey mafic microphenocrysts. K-feldspar staining gave weak positive results for the very fine grained matrix fraction.

Thin Section. The texture of this sample is distinctly porphyritic with abundant small very pale green to colourless clinopyroxene phenocrysts and aggregates predominating. Subordinate subhedral to euhedral mafic crystal sites that are now converted largely to carbonate and chlorite ± patchy prehnite once may have contained a second pyroxene or ?olivine. Small well rounded vesicle sites are filled with a zoned assemblage of chlorite peripherally with carbonate centrally. The voluminous groundmass fraction comprises wispy decussate plagioclase microlites set in dense chlorite dusty sphene and relatively minor K-feldspar. Sparse narrow veinlets contain patchy quartz, chlorite, carbonate and minor sulphides.

The once-glassy groundmass of this sample is largely converted to chlorite with patchy sphene and minor felsic patches. The sample may be only tentatively identified as a porphyritic and sparsely vesicular pyroxene-rich andesitic rock since it has undergone substantial groundmass alteration.

Sample No. A 295045 559.6 m

Rock Type. Very finely recrystallised K-feldspar-rich ?vitric tuff into which altered and partly mineralised intermediate and intermediate-basic 'crowded' porphyritic clinopyroxene-rich 'tongues' have been 'intruded'.

Hand Specimen A patchy very fine grained mid-grey coloured

drill core sample enclosing highly irregular shaped medium grained green-grey domains with moderately abundant sulphides. Staining gave very strong positive results for the very fine grained fraction.

Thin Section. The mid grey fraction of this sample is exceptional fine grained, comprising an almost cryptocrystalline K-feldspar-rich felsic mosaic intergrown with dusty sulphides, minor carbonate and sphene granules. Traces of prehnite are also present, and this part of the rock is cut by a network of extremely narrow quartz-rich veinlets. Branching narrow 'tongues' of volcanic material comprise a type rich in wispy feldspar microlites in part of the sample, while in other parts the igneous 'tongues' and deformed patches comprise dense aggregates of fresh clinopyroxene microphenocrysts ('crowded' porphyritic texture ?cumulate material), as well as rare phenocrysts of plagioclase set in meagre proportions of (once glass mineralised chlorite with sphene granules and sparse barely recognisable feldspar microlites. Sparse deformed vesicle sites contain granular quartz \pm K-feldspar, chlorite and sphene.

This sample most likely represents a very finely recrystallised K-feldspar-rich vitric tuff into which altered and partly mineralised intermediate and intermediate-basic clinopyroxene porphyritic volcanic 'tongues' have been 'intruded'.

<u>Sample No.</u>	A 295046 556.9 m
<u>Rock Type.</u>	Partly altered and weakly mineralised clinopyroxene-rich microporphyritic and vesicular volcanic rock of trachyandesitic affinity.

Hand Specimen A rather massive mid green-grey drill core sample containing sparse large rounded white (calcite-rich) vesicle sites (strong reaction with cold dilute HCl) and abundant small dark green mafic crystal sites. K-feldspar staining gave strong positive results for the fine grained groundmass fraction. Very fine grained sulphides are not particularly obvious in the hand specimen.

Thin Section. This sample contains very abundant microphenocrysts and glomeroporphyritic aggregates of clinopyroxene, as well as sparse but coarser grained euhedral crystal sites that retain shapes suggesting the presence of previous olivine. The latter now are filled with microgranular secondary quartz \pm chlorite and dusty sulphides. The groundmass fraction of the sample includes a decussate mat of wispy narrow feldspar microlites (\sim oligoclase) set in microgranular K-feldspar, chlorite, sphene dust and sparse patches of quartz, as well as patchy disseminated sulphides. Narrow wavy veinlets and large but sparse rounded vesicle sites contain mainly carbonate \pm quartz \pm chlorite \pm sulphides.

The presence of abundant groundmass K-feldspar once again suggests trachytic affinity and this sample may be described as a partly altered and weakly mineralised clinopyroxene-rich microporphyritic and vesicular volcanic rock of trachyandesitic affinity.

Sample No. A 295047 604.6 m

Rock Type. Substantially altered poorly sorted lithic tuff containing abundant porphyritic and vesicular volcanic fragments of trachyandesitic primary composition.

Hand Specimen. A mid green-grey coloured rather fine grained sample with sparse large (up to 2 cm across) angular to irregular shaped pale green-grey to pale grey distinctly porphyritic fragments. K-feldspar staining gave strong positive results for the angular broken porphyritic and vesicular volcanic lithic fragments and smaller ?shards.

Thin Section. Unsorted angular and broken crystal and lithic debris in this sample mostly is from a clinopyroxene-porphyritic and possibly ?olivine porphyritic source. Groundmass textures vary in adjacent fragments from K-feldspar-rich very heavily clouded massive fine grained types to trachytic types rich in sphene granules and dusty sulphides, as well as types in which the once-glassy groundmass fraction now comprises a polygonised

K-feldspar rich mosaic throughout which are vague outlines of plagioclase microlites and abundant sphene granules. In some fragments are small resorbed quartz xenocrysts with narrow reaction rims of fine grained clinopyroxene. Vesicles and interspaces in the rock matrix are filled with partly zoned assemblages amongst the following phases; quartz, chlorite, clouded K-feldspar, pumpellyite and traces of carbonate.

The poorly defined rock matrix comprises altered once glassy volcanic debris similar to that above set in similar granular secondary products.

This sample is a substantially altered poorly sorted lithic tuff, comprising abundant porphyritic and vesicular volcanic fragments of trachyandesitic primary composition.

<u>Sample No.</u>	A 295048 632.8 m
<u>Rock Type.</u>	Altered and partly carbonated strongly microporphyritic and vesicular volcanic rock, most likely of trachyandesitic affinity.
<u>Hand Specimen.</u>	A fine grained mid grey drill core sample with mottled alteration patches and abundant well rounded white (calcite) to pale grey amygdales. K-feldspar staining gave negative results except for minor traces of this phase.
<u>Thin Section.</u>	The mottled alteration of this rock is due to development of granular carbonate which is particularly dense in well developed vesicle sites. In the carbonated domains relict textural features are poorly preserved, but elsewhere are well developed porphyritic vesicular and trachytic textures similar to those in previous samples. Small phenocrysts and aggregates comprise colourless clinopyroxene while a second phenocrystic mafic phase is converted to cherty quartz with patches of chlorite, carbonate and sulphides. The abundant groundmass contains trachytic to decussate wispy feldspar microlites set amongst minor K-feldspar-bearing microgranular felsic patches, dominant chlorite, sphene dust and carbonate.

Well rounded vesicle sites are filled with granular epidote, quartz, chlorite and traces of pumpellyite.

Minor patchy sulphide mineralisation is associated with discontinuous quartz rich veinlets and quartz filled vesicle sites.

The sample may be described as an altered and partly carbonated, strongly vesicular microporphyritic intermediate volcanic rock, most likely of trachyandesitic affinity.

<u>Sample No.</u>	A 295049 652.0 m
<u>Rock Type.</u>	Partly altered poorly sorted lithic tuff containing debris mainly from a clinopyroxene-porphyritic trachyandesitic volcanic source.
<u>Hand Specimen.</u>	A mottled and patchy dark green-grey to pale green-grey drill core sample for which vesicular and porphyritic lithic fragments give a strong positive stain for K-feldspar. Small angular and cusped K-feldspar rich shards and small once-glassy pumiceous fragments are present in the rock matrix.
<u>Thin Section.</u>	This is a sample of very poorly sorted lithic tuff in which sparse very large fragments of clinopyroxene-porphyritic strongly amygdaloidal trachyandesite are set in an abundant much finer grained tuffaceous rock matrix containing much finer grained once-glassy and vesicular debris of similar composition, especially with numerous fresh clinopyroxene phenocrysts. Rare small angular quartz chips and a single magmatically well rounded and resorbed quartz crystal is present. The latter has a narrow partial rim of small clinopyroxene crystals.

Alteration is to carbonate, clouded K-feldspar and minor quartz in the large lithic fragment, while in the rock matrix polygonised K-feldspar and chlorite predominate, with patchy carbonate and microgranular quartz and traces of epidote, sphene and pumpellyite.

The rock may be classed as a partly altered poorly sorted lithic tuff containing debris mainly from a clinopyroxene-porphyritic

trachyandesitic volcanic source.

Sample No. A 295050 661.6 m

Rock Type. Partly altered microporphyritic and vesicular trachytic (or trachyandesitic) volcanic rock.

Hand Specimen. A rather massive dark green-grey drill core sample with sparse small pink patches. K-feldspar staining gave very strong positive results for the groundmass fraction and outlines abundant small phenocryst and vesicle sites.

Thin Section. Abundant almost colourless fresh clinopyroxene microphenocrysts are present in this otherwise clouded and selectively altered sample. Subordinate subhedral shaped sites of a second mafic phase now are filled with microgranular quartz with patches of chlorite and carbonate. On the other hand, abundant small irregular shaped to rounded vesicle sites are filled with chlorite \pm minor patchy quartz and carbonate. There are only vague outlines of poorly defined wispy feldspar microlites defining a weak trachytic texture in the groundmass fraction. This also contains microgranular felsic patches throughout which are abundant sphene granules and patchy chlorite. Discontinuous veinlets contain chlorite, carbonate and minor dusty sulphides. Highly irregular shaped branching elongate microgranular quartz-rich patches enclose broken clinopyroxene crystals and quartz chips, and most likely represent tuffaceous material incorporated into the volcanic host rock.

The sample is strongly selectively altered but retains a groundmass that is very rich in exceptionally fine grained clouded K-feldspar with poorly defined trachytic texture. The rock may be described as a partly altered microporphyritic and vesicular trachytic (or trachyandesitic) volcanic rock.

Sample No. A 294901 676.6 m

Rock Type. Intensely selectively altered microporphyritic and once-vesicular volcanic rock of ?acid-intermediate affinity, containing sparse small phenocryst (or ?xenocrysts) of strongly resorbed quartz.

Hand Specimen. A massive fine grained mid green-grey drill core sample with sparse large well rounded white (calcite-filled) vesicle sites (strong reaction with cold dilute HCl). K-feldspar staining proved negative.

Thin Section. This sample has undergone extreme selective alteration of abundant carbonate and albite and quartz altered small subhedral shaped phenocryst sites and glomeroporphyritic aggregates defining a distinct microporphyritic texture. Also present are sparse small magmatically rounded and resorbed quartz phenocrysts (or xenocrysts), all of which have narrow altered rims (suggesting some disequilibrium with the host). The voluminous groundmass fraction contains very abundant wispy decussate plagioclase microlites set in dense chlorite, dusty sphene granules and minor carbonate. Sparse well rounded vesicle sites contain dense carbonate ± chlorite and quartz.

The exact primary composition of this sample is masked by its intense but selective alteration. It may be rather tentatively described as a microporphyritic and once-vesicular volcanic rock of ?acid-intermediate affinity, containing sparse small phenocrysts (or ?xenocrysts) of strongly resorbed quartz.

MINERAGRAPHIC DESCRIPTIONS

Sample No. A295035

Hand Specimen. The fine grained, laminated matrix is cross-cut by 0.5 to 2 mm veinlets, the majority of which are at high angles to bedding. Opaque phases in this sample differ in texture in the host rock relative to veinlets.

Polished Thin Section Pyrite, and to a lesser extent sphalerite are the major opaque phases present in the matrix occurring as small (1 to 5 micron) relatively irregular shaped disseminations. The total volume occupied by sulphides is less than ten percent. Some pyrite grains occur as framboidal masses suggesting sedimentary origin, however the majority show evidence of subsequent recrystallisation. Such grains commonly show growth zones defined by orientated inclusions of sphalerite, ?Ni-rich pyrite, and chalcopyrite. Pyrite overgrowths also are present. Minor cataclasis of recrystallised pyrite is evidenced by remobilisation of chalcopyrite and very minor galena into fractures. Sphalerite grains tend to be larger than pyrite with some greater than 5 microns across. Orientated inclusions (0.1 micron) of chalcopyrite, most likely representing a replacement product, are common in sphalerite.

In the veinlets, pyrite (~ 0.1 mm and smaller) and sphalerite (~ 0.05 mm) are coarser grained than those in the groundmass. The total volume of sulphides in the veinlets is small, being less than 10%. Pyrite commonly occurs as euhedral cubes, the sphalerite being anhedral. Orientated chalcopyrite inclusions hosted by sphalerite are also common. In transmitted light, sphalerite is deep red in colour, contains very few internal reflections under oil immersion reflected light observation, suggesting a Fe-rich composition.

The entire section was scanned with a mechanical stage using a X 20 oil immersion objective for gold. None was observed.

095

Sample No. A295042

Hand Specimen. Fine grained laminated sample. Opaque phases are concentrated in specific laminae whose sizes vary from 0.5 mm to in excess of 3 mm. A single sulphide-bearing (0.4 mm) veinlet crosscuts the sample lamination.

Polished Thin Section In the sulphide-bearing laminations total sulphide volumes approach 50%. The grains vary in size from 1 to 5 microns with a proportion up to 0.1 mm and are relatively shapeless. Pyrite and pyrrhotite are the major sulphides present with their distribution being, apparently, antipathetic. Some laminae contain pyrrhotite exclusively, others pyrite. There is no evidence of replacement of one phase by the other.

Associated with both pyrite and pyrrhotite are trace amounts of chalcopyrite and galena, commonly occurring as fracture infillings within cataclased grains.

Also present within the matrix are laminations containing ?titaniferous phases. These occur as small (1 micron) overgrowths on silicate phases that are themselves small (3 microns). The ?Ti-rich phase has a low reflectivity in reflected light and has a deep red/brown colour in transmitted light.

Pyrite is the dominant sulphide within the veinlet with crystals ranging in size from 5 to 15 microns.

The entire sample was scanned with a mechanical stage using a X 20 oil immersion objective for gold. None was observed.

096

Sample No. A 295069 (Hellyer andesite)

Rock Type. Partly altered lithic tuff containing porphyritic and vesicular fragments mainly from a trachyandesitic volcanic source.

Hand Specimen. A rather dark grey medium to fine grained sample containing scattered dark grey (mafic) crystal sites and sparse pale grey felsic crystal sites. K-feldspar staining gave strong positive results for the groundmass fraction of very abundant unsorted fragments.

Thin Section. Unsorted small to medium sized volcanic lithic fragments are characteristic of this sample. Most exhibit a distinctly porphyritic texture, with almost equal proportions of plagioclase and clinopyroxene crystals. Subhedral sites of a second mafic phase now are converted to chlorite, sphene and pumpellyite. Conspicuous irregular shaped vesicle sites are filled with various secondary assemblages amongst the following phases; prehnite, albite, pumpellyite, epidote, (quartz, chlorite and sphene). Certain small patches of sulphides show zonal distribution within the vesicle sites, and these include minor sphalerite, and ?pyrite. The groundmass fraction of most fragments contains ubiquitous minute trachytic feldspar (albite) microlites, set in abundant chlorite and sphene. Slight variations in texture and proportions of phenocrysts indicate the presence of volcanic material from several sources.

The rock matrix contains abundant cherty quartz, chlorite, sphene and smaller altered lithic and crystal debris similar to that described above.

The sample may be described as a partly altered lithic tuff containing porphyritic and vesicular fragments mainly from a trachyandesitic volcanic source.

Sample No. A 295071 (DDH BRD 01 584.0 m)

Rock Type. Partly altered and veined volcanic rock of trachytic affinity containing abundant clusters of clinopyroxene microphenocrysts.

097

Hand Specimen. A fine grained mid grey to pale grey drill core sample for which K-feldspar staining gave strong patchy positive results. Minor white patches and veinlets contain calcite (strong reaction with cold dilute HCl).

Thin Section. Very fine grained microlitic to radiating spherulitic textures are developed in this sample. Microlites generally are albite and these are intergrown with wispy K-feldspar. The poorly defined (once partly ?glassy) micro-spherulitic domains comprise mostly K-feldspar. Euhedral microphenocrysts and glomeroporphyritic aggregates of clinopyroxene have an irregular patchy distribution, and this phase also is present as abundant very fine grained interstitial crystals. Accessory secondary phases include ubiquitous dusty sphene, chlorite, dusty opaque sulphides and carbonate, while small irregular shaped vesicle sites now contain almost monomineralic chlorite. Very narrow discontinuous veinlets and small patches contain carbonate (calcite).

The sample retains a simple igneous mineralogy with abundant K-feldspar, and may be described as a partly altered and veined volcanic rock of trachytic affinity containing abundant clusters of clinopyroxene microphenocrysts.

Sample No. A 295072 (DDH BRD 01 691.8 m)

Rock Type. Substantially altered autobrecciated volcanic flow rock (or tuff) of intermediate composition, containing strongly vesicular once-glassy fragments with abundant fresh clinopyroxene microphenocrysts.

Hand Specimen. A mottled mid green-grey fine grained drill core sample with small pale grey and dark green grey mafic crystal sites. K-feldspar staining gave positive results for numerous small angular to irregular shaped patches.

Thin Section. This sample is fragmental, but it could represent an autobrecciated flow rock since recognisable volcanic lithic fragments are set in a matrix of a similar volcanic type. This lithology comprises

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irregularly distributed clusters of clinopyroxene microphenocrysts and abundant small well rounded vesicle sites set in a coarsely polygonised felsic mosaic of clouded secondary albite and subordinate K-feldspar. This fraction contains few feldspar microlites and almost certainly was once-glassy. Vesicle sites commonly are filled with patchy or zoned assemblages amongst the following phases; chlorite, K-feldspar, epidote, carbonate, and hydrogarnet.

Original textures in this sample are partly masked by its coarsely polygonised secondary assemblage. It may be only tentatively identified as a substantially altered autobrecciated volcanic flow rock (or tuff) of intermediate primary composition, containing strongly vesicular once-glassy fragments with abundant fresh clinopyroxene microphenocrysts.

<u>Sample No.</u>	A 295073 (DDH BRD 01 831.0m)
<u>Rock Type.</u>	Substantially altered tuff or brecciated volcanic flow rock containing once-glassy pyroxene-microporphyrritic and vesicular fragments.
<u>Hand Specimen.</u>	A mottled medium to fine grained green-grey drill core sample containing scattered irregular shaped pale grey and dark green-grey patches. K-feldspar staining gave positive results for abundant small wispy cusped to irregular shaped patches.
<u>Thin Section.</u>	Relict textures in this sample are partly obscured by intense patchy alteration. Nevertheless there are clearly recognisable outlines of abundant finely vesicular and microporphyrritic volcanic fragments. Phenocrysts comprise subhedral to euhedral prismatic crystals of clinopyroxene, and sparse altered mafic crystal sites (?olivine \pm amphibole) that are converted to secondary chlorite and quartz \pm carbonate. The small well rounded to irregular shaped vesicle sites now are filled with assemblages including the following phases; chlorite, albite, quartz, K-feldspar, carbonate. The once glassy groundmass fractions of fragments now are converted to pale brown clouded K-feldspar, intergrown with chlorite and clouded ?prehnite. Several large irregular shaped alteration patches contain dense fine grained pumpellyite and clouded felsic material \pm chlorite.

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Interfragment domains contain polygonised albite, K-feldspar, as well as fibrous radial spherulites and granular patches of quartz, chlorite, minor carbonate and wispy sericite.

This fragmental sample contains abundant broken lithic debris from an intermediate-basic, clinopyroxene-microporphyritic and vesicular once-glassy volcanic source. It is substantially altered to a low grade (pumpellyite-bearing) assemblage, and equally it could be of tuffaceous or brecciated flow origin.

Sample No. A 295076 (Hellyer basalt)

Rock Type. Intensely carbonated fragmental ?pyroxene-microporphyritic and vesicular volcanic rock, with fine grained carbonate-rich sedimentary interfragment infill.

Hand Specimen. A mid-grey fine grained sample containing large angular volcanic fragments that enclose scattered small well rounded white amygdales filled with calcite (strong reaction with cold dilute HCl). Interfragment domains are fine grained pale grey and weakly banded. No K-feldspar was detected by staining.

Thin Section. Intense carbonate alteration has affected this sample and no primary igneous mineralogy is preserved. Nevertheless, the alteration is partly selective and defines the locations of numerous stout prismatic shaped sites of previous ?pyroxene microphenocrysts. Narrow prismatic shaped sites now are filled with chlorite while well rounded vesicle sites are filled with carbonate ± chlorite and quartz. The groundmass fraction now is represented by a microgranular cherty mosaic intergrown with wispy sericite and dusty sulphides (mostly pyrite).

The interfragment domains are finely, but irregularly banded, and consist of dense fine grained carbonate. The banding is defined by wavy subparallel trails of dusty sulphides. Rare angular quartz chips are accessory. The rock is cut by numerous narrow carbonate veinlets.

The exact primary composition of this sample is masked by its intense carbonate alteration. Relict textures suggest a fragmental ?pyroxene-microporphyritic and vesicular volcanic parent of intermediate composition, with fine grained carbonate-rich sedimentary interfragment infill.

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835102

APPENDIX III
DOWNHOLE EM LOGGING

Minerals Exploration And Development Group

TO R WILLIAMS/ P ELLIS REFERENCE PRG/JM 42:42

FROM P R GIDLEY DATE 27TH AUGUST, 1985

BULGOBAC RIVER EM LOGGING

During August 1987 the two drillholes BDH-001 and BDH-002 were logged for EM at Bulgobac River. The aim of the logging was to ascertain if a conductor was detectable within the search radius (estimated at approximately 80-90 metres) around each hole but which was not intersected by drilling.

Survey and Results

The downhole EM logging was undertaken by McSkimming Geophysics using SIROTEM equipment. The transmitter loop was 600 x 300 metres with corners at 7800N/2400E, 7800N/2700E, 7200E/2400E and 7200E/2700E. A loop resistance of 11.3 ohms meant available current, using a SATX high current transmitter, was typically 9.6 to 10.7 Amps. The holes were logged down with 5 metre intervals and profile results are shown in Figures 1 and 2.

Results for hole BDH-001 indicate an early time negative at the top of the hole which is as theory would predict with the hole only 50 metres outside the loop. A preliminary check was undertaken before logging to ensure correct polarity of the probe. This was done by moving the probe inside the loop at surface and checking for all channels positive. The hole was logged to 700 metres before a blockage in the poly-ethylene casing prevented deeper measurement.

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Results show no significant anomaly was recorded over the full length of the hole. A decreasing response is observed downhole as the probe moves away from the transmitter loop as is normally the case.

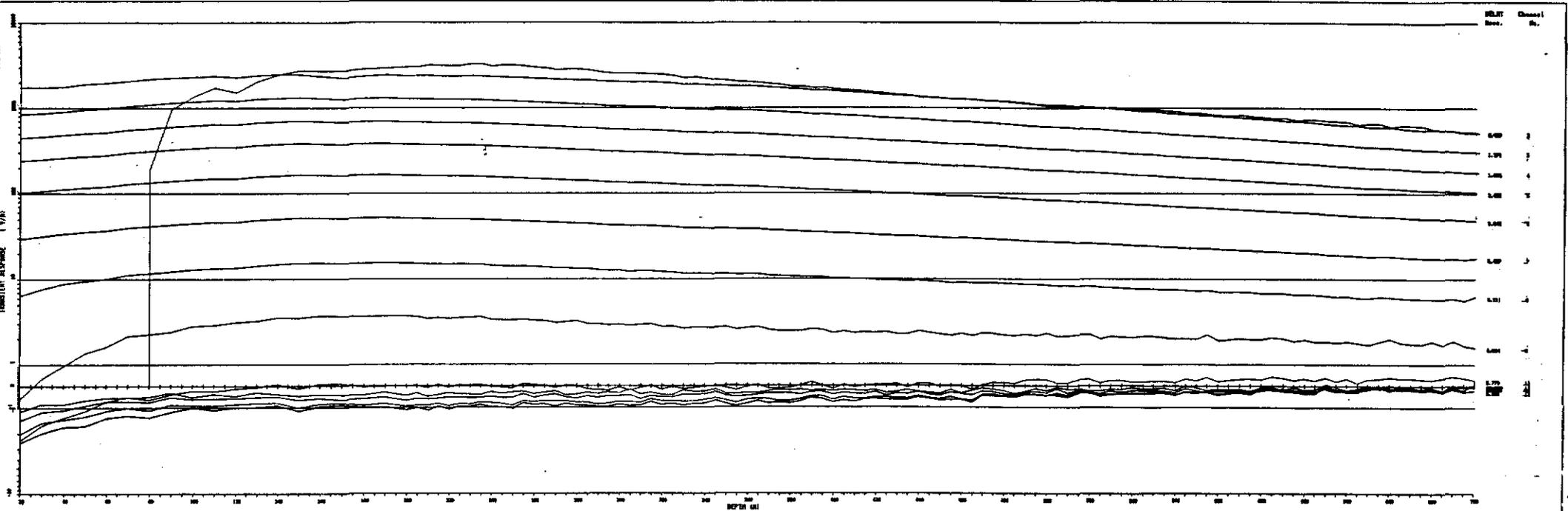
Results for hole BDH-002 are very similar to those of BDH-001. No observable EM anomaly is observed in the data. Again the decay of the response away from the transmit loop is as expected with no conductor nearby.



P R Gidley

cc CGA

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CONFIGURATION: 100 ft DEPTH TRANSMITTER LOOP
INSTRUMENT: SCOUTER
COMPONENT: 1
LOOP NUMBER: 1
WELL: MEGABAC BOWHOLE
LINE: 1 P
SCALE: 1: 100



FIG 1

835105

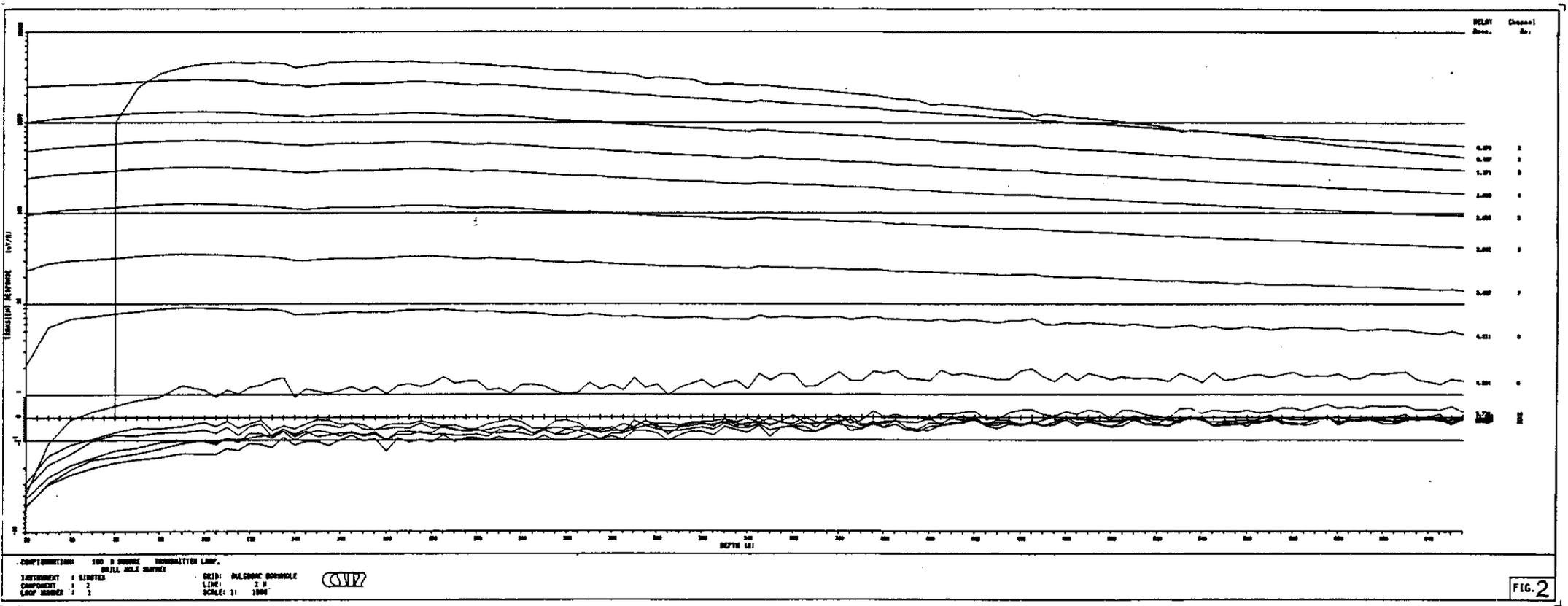


FIG. 2

APPENDIX IV
PETROPHYSICAL MEASUREMENTS



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 Minerals Exploration And Development Group

TO R E WILLIAMS

REFERENCE PRG/BW.43:47

FROM P R GIDLEY

DATE 27 NOVEMBER 1987

re BULGOBAC RIVER PETROPHYSICAL MEASUREMENTS

Following discussions with you and P Ellis I submitted a series of drill cores from holes BRD001 and BRD002 to Prof. D W Emerson of the Petrophysics Laboratory, University of Sydney for physical property determinations. Included in these determinations were measurements for specific gravity, induced and galvanic conductivities. Magnetic susceptibilities and remanences were also requested within the basic volcanics of the intersected rocks.

The results of the physical property measurements are indicated in Table 1 below. I also include some notes by Prof. Emerson describing the method of electrical rock measurements undertaken.

TABLE 1

Sample No. m	Conductivity 2.5MHz _Z s/m	Ip Resistivity Ω m	Specific Gravity gm/cc	Magnetic Susceptibility 10 ⁻⁶ cgs
BRD001				
11.7	n.a.		2.68	
18.4	0.2		2.69	
63.0	0.2		2.69	
101.4	0.2	13	2.73	
200.0	0.2	32	2.76	
300.1	0.3		2.78	
343.2	0.4		2.74	
399.7	0.2	40	2.75	
501.5	0.2		2.77	
516.7	0.2		3.05	
538.7	0.3		2.90	

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Sample No.	Conductivity 2.5MH ₂ s/m	Ip Resistivity Ω m	Specific Gravity gm/cc	Magnetic Susceptibility 10 ⁻⁶ cgs
593.8	0.2		2.90	
647.6	0		2.89	
707.9	0.4		2.77	
759.9	0.4		2.77	
822.0	0.6		2.80	
860.4	0.4		2.73	
BRD002				
20.0	n.a.		2.68	
46.6	n.a.		2.66	
50.7	0.2		2.63	
61.9	0.2		2.70	
96.6	0.3		2.76	
150.0	0.2	32	2.75	
200.0	0.2	206	2.77	
301.4	0.3		2.78	
350.2	0.2		2.78	
379.6	0.2		2.75	
400.0	0.2		2.78	
410.0	0.2		2.76	
446.6	0.2		2.80	
458.6	0.2		2.78	
497.0	0.2		2.84	
550.0	0.3		2.86	
606.6	0.2		2.96	
667.0	0.2		3.00	

RESULTS

The frequency domain determinations of conductivity indicate that throughout the measured core, there is only a low level of induced conductivity. These background values suggest most EM systems should have good depths of penetration with little current dispersion occurring within any of the intersected rock units. By contrast, recently published data (Eadie, 1987) models the Hellyer orebody to surface EM data using conductances greater than 100 Siemens and hence a moderate to strong EM response over lithologies and containing a similar conductor measured should be observed.

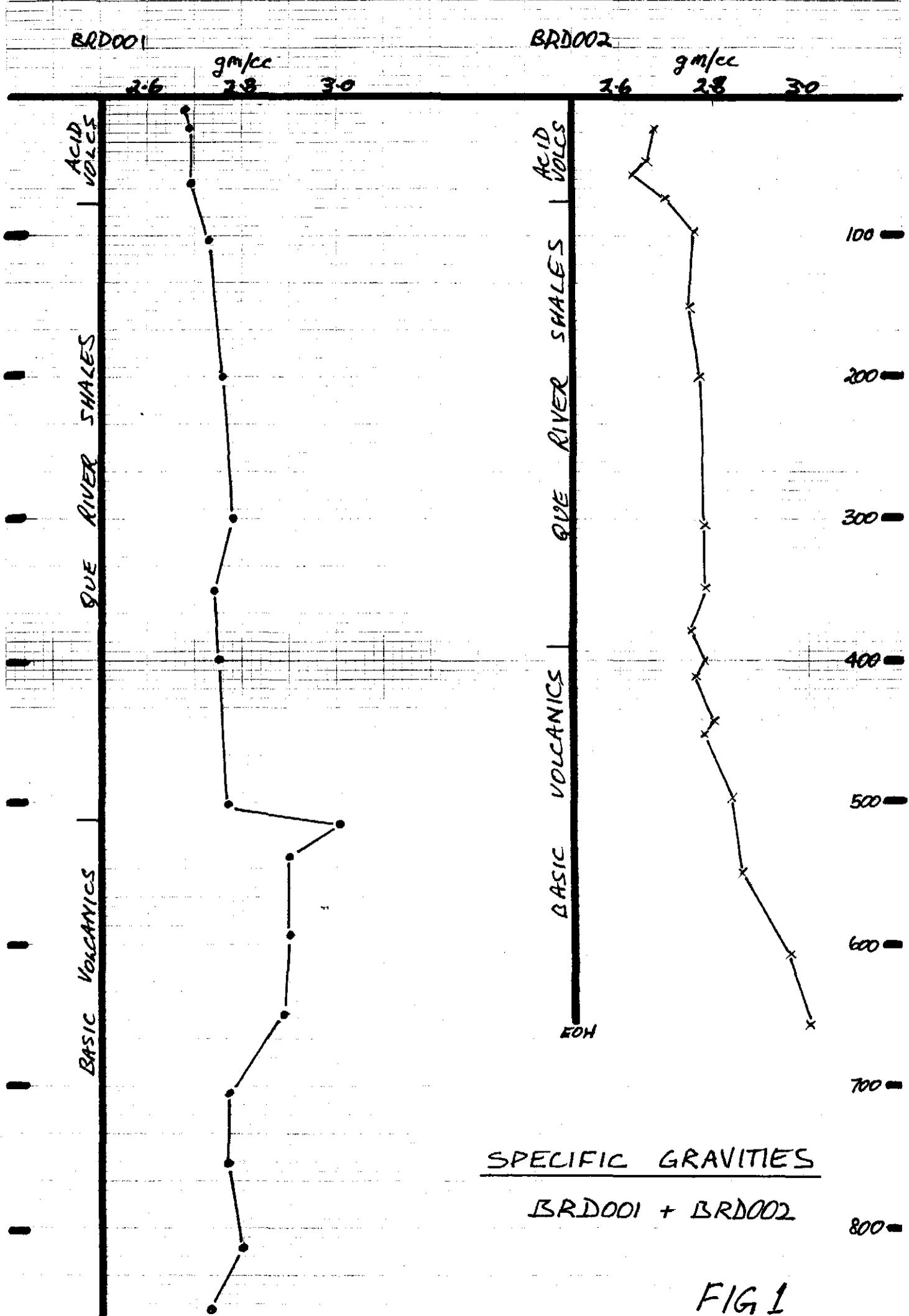
109

Galvanically however, there appears to be 'lenses' within, particularly the Que River Shales, which are quite chargeable. This effect is presumably due to higher pyrite content. These effects are also observed in surface IP responses as recorded in the western portions of the grid and where the shales come closer to surface. Some elevated EM response would be expected by the QRS due to their large thickness and this is evident in INPUT results as previously reviewed.

The specific gravity measurements show obvious contrasts between lithological units and this is indicated in Figure 1. The contrasts themselves however are small in general, and at this stage do not appear large enough to explain the surface gravity responses observed. The largest contrast seen is at 510 metres in BRD001 (0.15 gm/cc) between Que River Shales and underlying basic volcanics. Additional modelling shall be required when current gravity survey data becomes available to provide higher resolution. This shall be undertaken in consultation with David Leaman.

Magnetic susceptibility measurements on tested samples are all very low and fall in the range 10-80 x 10⁻⁶ cgs units. Although remanence results have not yet been received it is probable that no useful depth calculations will be derived from these measurements in an attempt to determine the top of the basic (Hellyer) volcanics.


P R Gidley



SPECIFIC GRAVITIES

BRD001 + BRD002

FIG 1

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Petrophysics Laboratory
 Department of Geology & Geophysics
 The University of Sydney.

NOTES ON ROCK ELECTRICAL MEASUREMENTS WITH ALTERNATING ELECTRIC OR MAGNETIC FIELDS WHEREBY GALVANIC RESISTIVITY OR INDUCTIVE CONDUCTIVITY ESTIMATES ARE MADE.

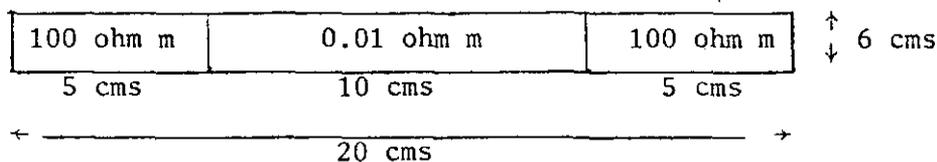
Galvanic resistivity measurements involve rock specimen energisation, at frequencies from DC to k Hz, with two electrodes. These can be used as measuring electrodes also, either in conventional or bridge techniques, but care needs to be taken in low impedance rocks because electrode contact (R) effects up to several hundred or thousand ohms can be unwittingly incorporated together with unwanted phase (C) effects. In four electrode techniques two additional electrodes measure voltage drops and compare phases. These techniques can be applied to resistive and conductive specimens..

Inductive conductivity measurements involve non contact energisation at 100 k Hz and 2.5 M Hz. These techniques are useful only for conductive specimens: $\sigma > 0.5$ s/m in large diameter cores, but usually $\sigma = 1$ s/m is the minimum.

For homogeneous conductive specimens: similar results should be obtained as in the case of our calibrating water 'cores' that contain KCl and Cu SO₄ solutions of various salinities.

For inhomogeneous specimens with layering, streaks, blebs or diseminations: the results will differ sometimes quite markedly.

Consider (Y.B. Schaub, Izv. Geophys. Ser., 1964 No.10 p.920) a large core with a lot of semiconducting sulphides in its middle part, such that its resistivity is quite low, faced on either side with medium resistivity country rock as shown. Then 2 electrode galvanic techniques would indicate an overall apparent resistivity of 50 ohm m*; four electrode techniques should indicate 0.01 ohm m if the measuring electrodes are placed on the central section;



*if deleterious electrode effects are avoided
 otherwise $\rho_a \gg 50$ ohm m.

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inductive techniques would indicate 0.011 ohm m approx. i.e. +10%. This is a somewhat artificial example, but it demonstrates the utility of the techniques for massive sulphide studies.

Disseminated sulphides, as blebs and veinlets, commonly occur in a resistive matrix. In these cases the galvanic electrode measurement results largely reflect the resistive matrix. The magnetic inductive methods respond to the conductive inclusions sometimes quite strongly. It is unusual to get good agreement between galvanic and inductive data in these cases. However, each measurement has its uses e.g. the galvanic result on resistive samples is a better apparent resistivity, but the inductive response, although unrealistic, gives information on semiconducting inclusions that perhaps crudely correlate with IP effects and assay data.

To summarise : different apparent resistivities are obtained when irrotational quasistationary electric fields and rotational magnetic fields are applied to inhomogeneous rocks with low to moderate conductivities.

As an additional comment it should be noted that field resistivity/IP and EM data interpretations could give fundamentally different gross conductivity estimates for heterogeneous ore bodies that often are modelled with simplistic geometries and petrophysical data.

D.W. Emerson
17 November, 1984.

APPENDIX V

CSAMT DATA

Minerals Exploration And Development Group



TO R E WILLIAMS REFERENCE PRG/BW.43:51
 FROM P R GIDLEY DATE 1 DECEMBER 1987

re: CSAMT - BULGOBAC RIVER TENEMENT

A complete set of CSAMT results for the Bulgobac River survey is now available and has been interpreted. The survey coverage is as follows:

<u>Line</u>	<u>Coverage</u>
6800N	2025E - 2775E
7000N	1675E - 3075E
7200N	2225E - 2975E
7400N	2025E - 2875E
7600N	1225E - 2975E
7800N	1975E - 2775E
8200N	1525E - 2775E
8600N	2025E - 2575E
9000N	2225E - 2675E
9400N	2225E - 2625E

The CSAMT technique utilises a fixed remote current source providing a predictable signal where apparent resistivity and phase angle soundings are measured. The technique provides high lateral resolution with excellent depth penetration. Penetration depth is proportional to the square root of the ratio of the resistivity to the signal frequency. This means at Bulgobac River, maximum depths being examined were up to 450-500 metres since background resistivities of 4-5000 ohm metres are common.

The CSAMT survey used an east-west transmitting dipole of 1500m length about 10km south of the prospect. Initially a test line along 7600N was read and a deep conductor was defined. The additional lines north and south were then

read. A collection of Cagniard resistivities determined from this work is shown in Drawing No. 7612-9. Interpretation of CSAMT data can be complex due to the extensive volume of data produced plus the number of data transformations which can be performed. These computer enhancements have enabled a detailed interpretation to be made which is shown in Figures 1-10.

Interpretation

The major interpreted elements of the CSAMT work are indicated in Drawing No. 7612-10 and in conjunction with the gravity data. This data reveals a conductor (<10 ohm metres) being detected on adjacent lines beneath 2375E/7600N and 2725E/7400N. The conductor on 7400N appears next to a possible major fault/lithological boundary which strikes consistently between lines in a north-south direction and beneath the eastern gravity gradient of the gravity high. It is possible this boundary represents a fault or lithological change suggesting a possible feeder for mineralisation. On line 7800N the conductor is not observed and the boundary zone is less well defined than to the south. Additionally, on 7800N there is some suggestion of a lowered resistivity at depth at about 2525E indicating an 'off-line' conductor. The depth to the conductor is estimated at about 250-300m on line 7600N but deepening south to about 350m on line 7400N. The primary evidence for the defined deep conductor comes from high phase values in long period frequencies. This effect has been shown at Marionoak (Eadie, 1987) and Mt. Lyell (Bishop, 1987) to be indicative of low conductivity units. The technique is unable to discriminate between sulphides and graphitic conductors but the high phase responses suggest the conductor is probably polarisable, and therefore more likely to be due to sulphides.

Stratigraphically the CSAMT accurately defines the main lithologic units of the area and indicates discontinuities which may be associated with faults or changes of lithology. The boundary zone mentioned above appears continuous and in general strikes north-south. The feature is present on nearly all lines until about 8200N in the north.

In general the interpreted sections suggest a broad shallow syncline in the south with some discontinuities and faults causing changes in apparent resistivity. This is not evident in the QRS response due to its medium-high conductivity (20-100 ohm metres). Lying above the shales are higher resistivity interbedded shales and graded sediment layers with resistivities of 50-150 ohm metres. Beneath the shales is high resistivity bedrock with apparent resistivities from 400 to 4-5000 ohm metres. These bedrock units probably equate to andesitic and pyroclastic rocks and represent the host rocks for Hellyer. Frequent discontinuities/faults are observed within these basement rocks.

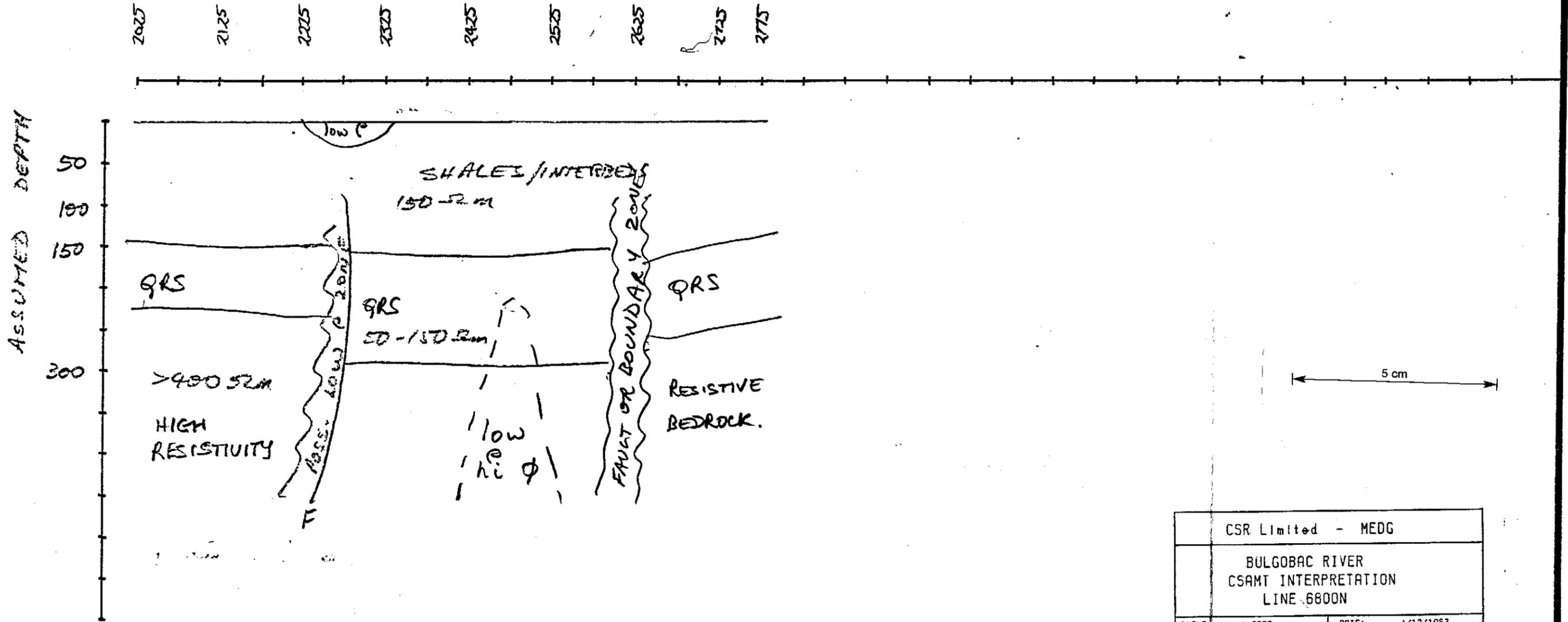
North of 8200N the Que River Shales are observed to shallow and in fact outcrop on the eastern end of 9000N. Although no discrete conductors have been defined by the CSAMT in this northerly portion of the grid, it is obvious that the same lithologies hosting Hellyer would be considerably closer to the surface than further south. The thickness of QRS is also less than to the south, thinning to be approximately 150-175 metres thick.

Based on recent drilling and petrophysical measurements, the obvious area for future exploration should be in the northern portion of the grid where thinner and shallower QRS is observed. The higher conductivities associated with these shales should not present a problem to inductive EM techniques since the conductivities have been shown to exist in unconnected lenses and pods with only minor increases in bulk conductivities.



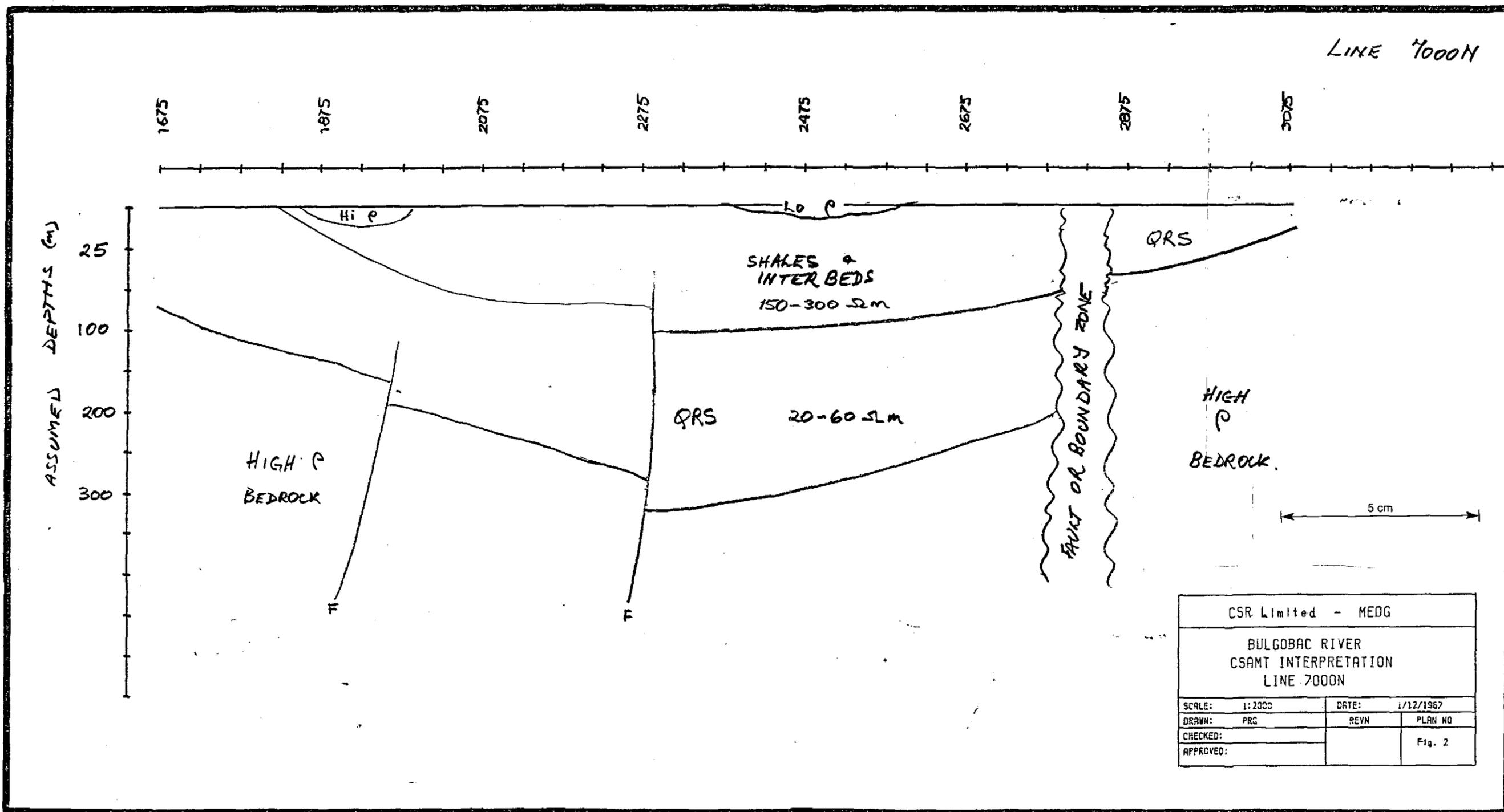
P R Gidley

LINE 6800N



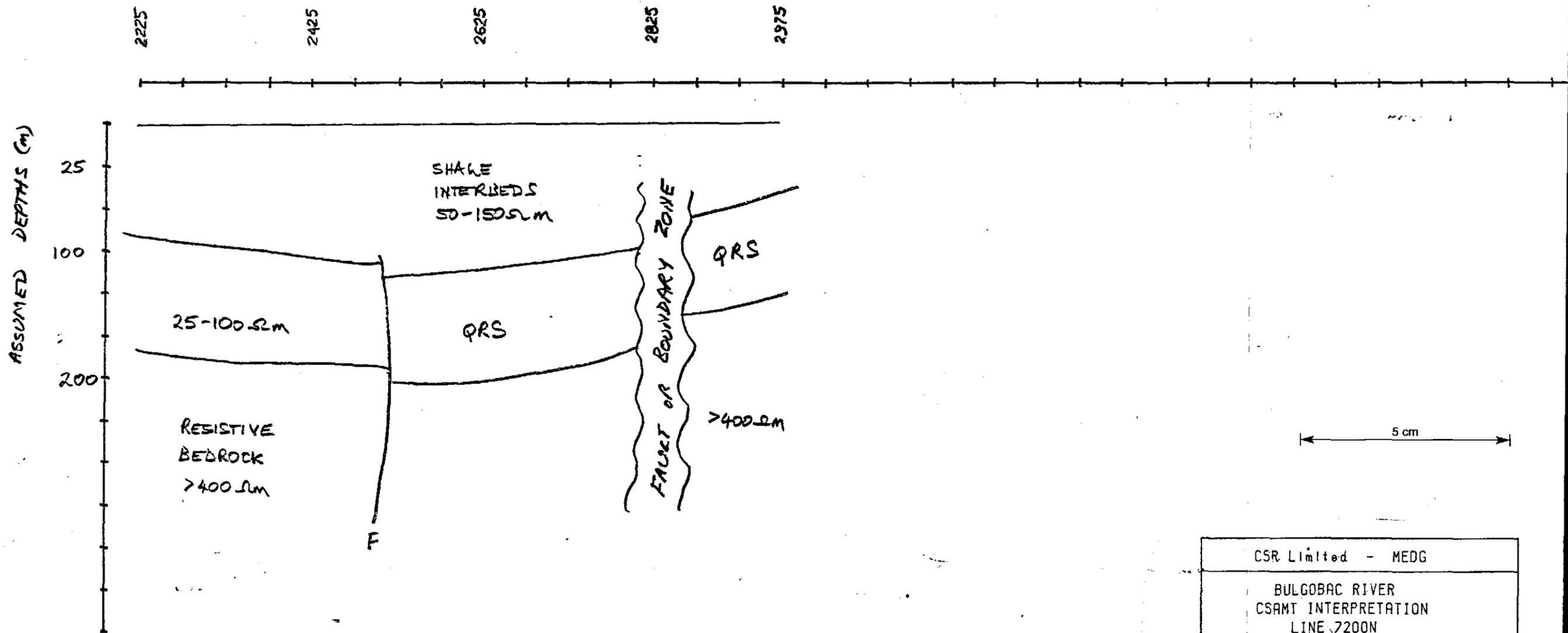
CSR Limited - MEDG			
BULGOBAC RIVER CSAMT INTERPRETATION LINE 6800N			
SCALE:	1:2000	DATE:	1/12/1967
DRAWN:	PRG	REVN	PLAN NO
CHECKED:			Fig. 1
APPROVED:			

117



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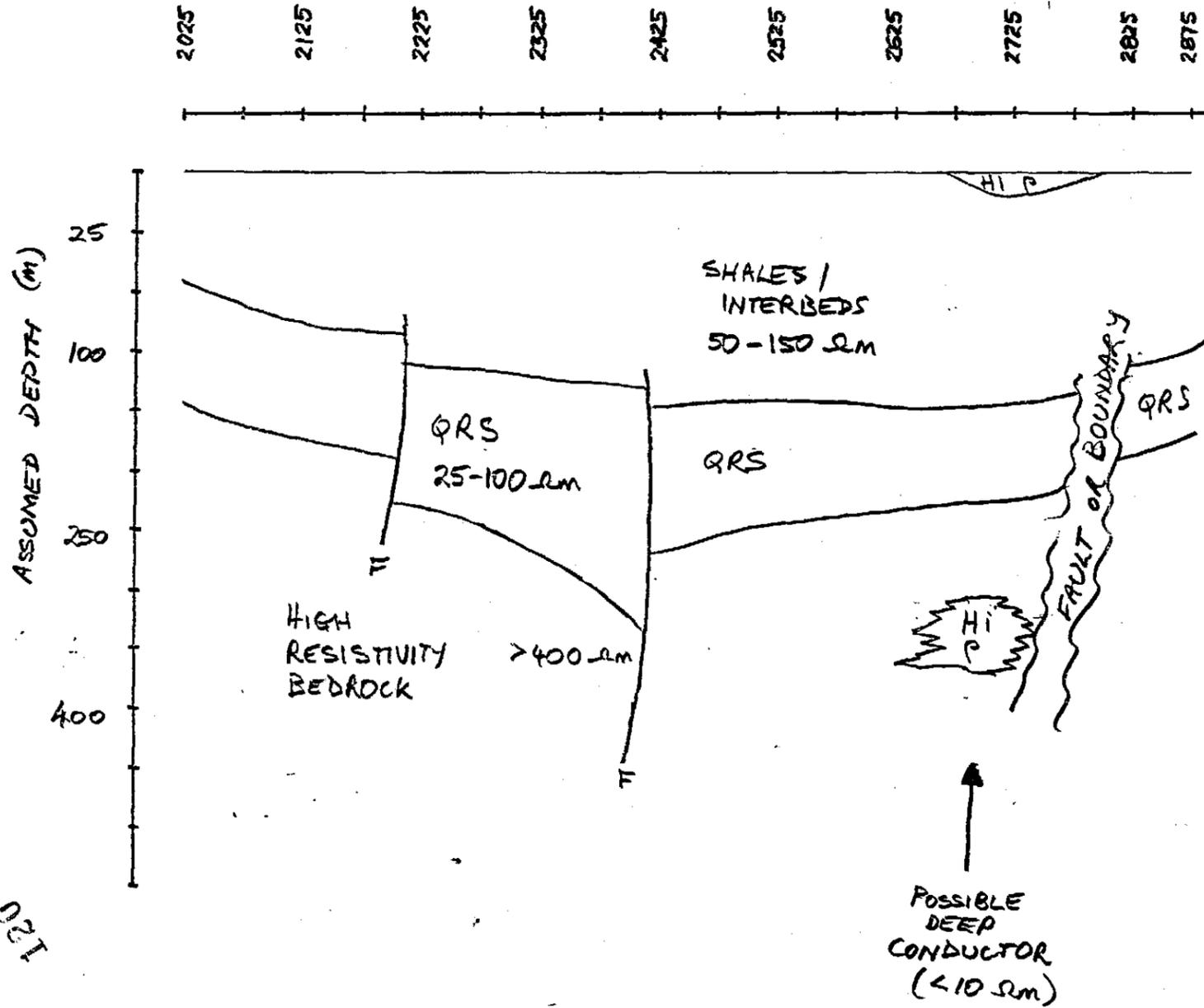
LINE 7200N



CSR Limited - MEDG		
BULGOBAC RIVER CSAMT INTERPRETATION LINE 7200N		
SCALE: 1:2000	DATE: 1/12/1987	
DRAWN: PRC	REVN	PLAN NO
CHECKED:		
APPROVED:		Fig. 3

111

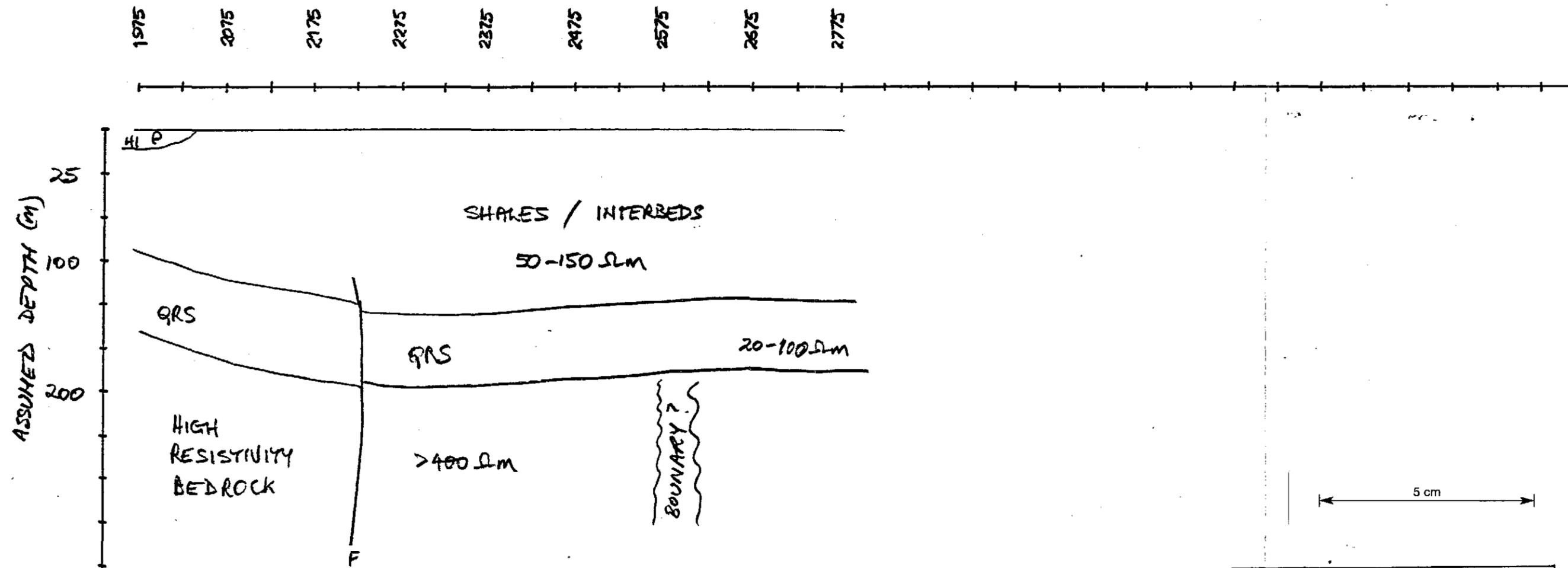
LINE 7400N



CSR Limited - MEDG			
BULGOBAC RIVER CSAMT INTERPRETATION LINE 7400N			
SCALE:	1:2000	DATE:	1/12/1967
DRAWN:	PRG	REVN	PLAN NO
CHECKED:			Fig. 4
APPROVED:			

1301

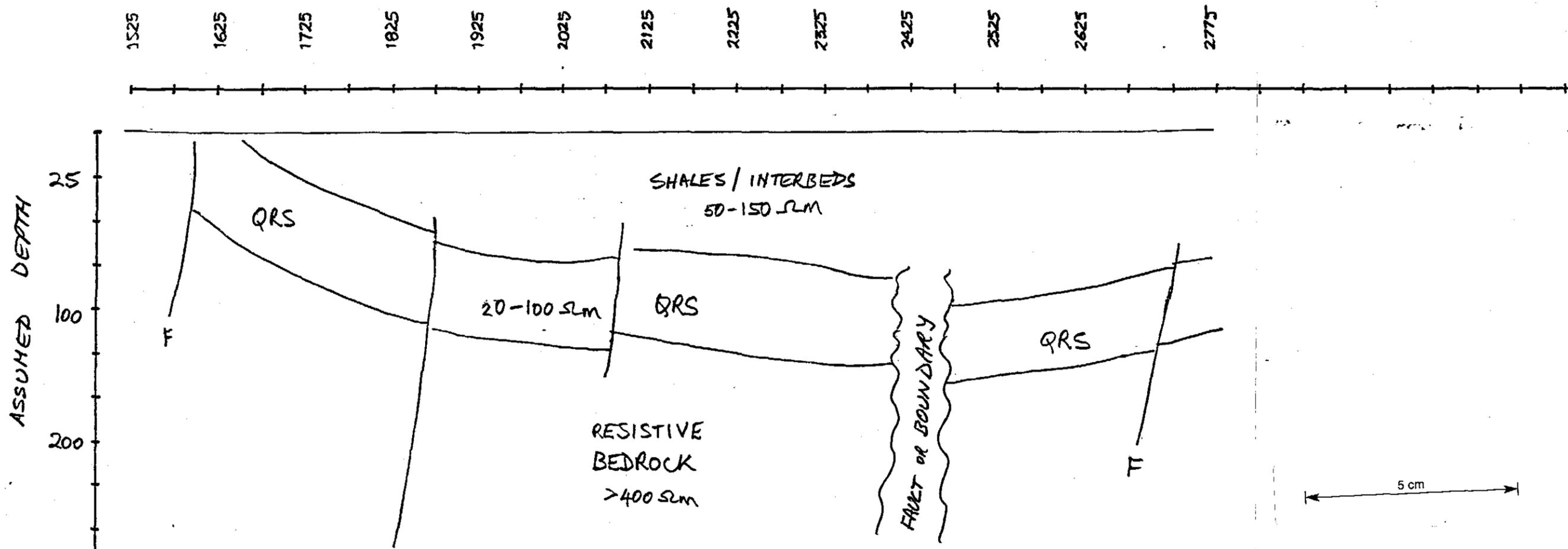
LINE 7800N



CSR Limited - MEDG		
BULGOBAC RIVER CSAMT INTERPRETATION LINE 7800N		
SCALE: 1:2000	DATE: 1/12/1987	
DRAWN: PRG	REVN	PLAN NO
CHECKED:		Fig. 5
APPROVED:		

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LINE 8200N

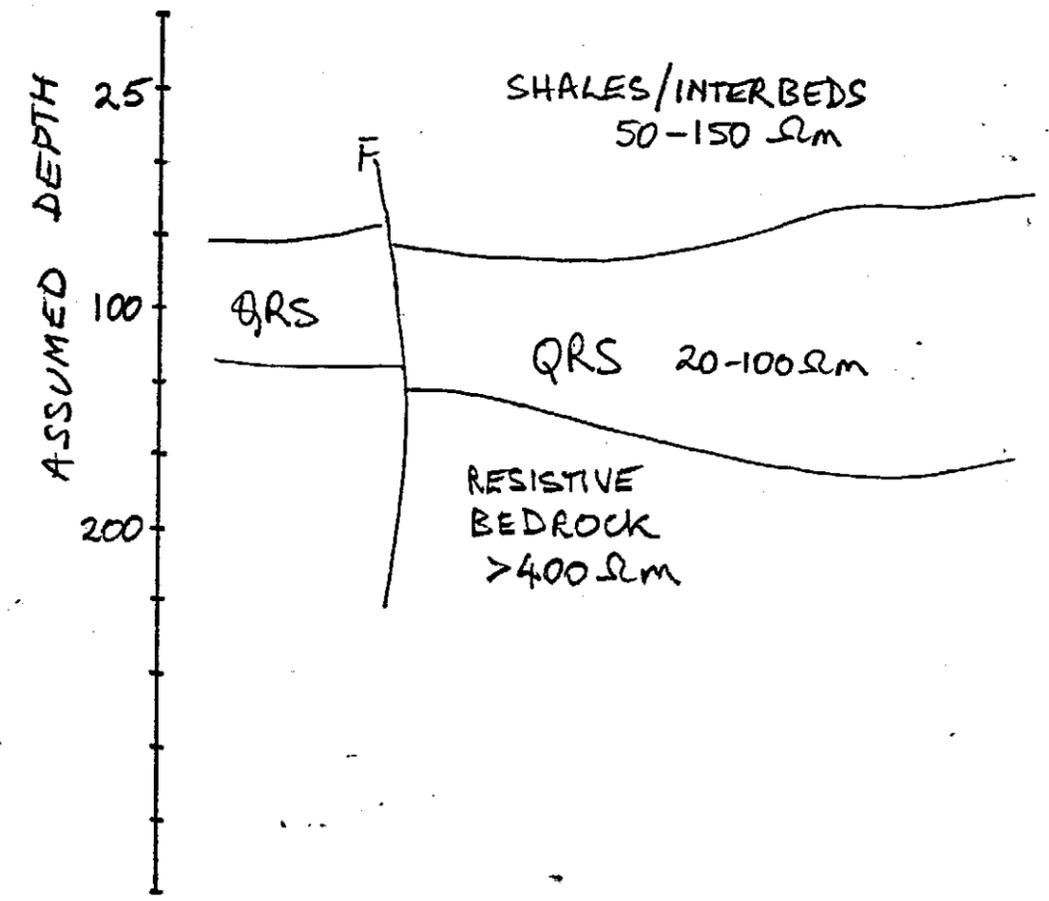


CSR Limited - MEDG		
BULGOBAC RIVER CSAMT INTERPRETATION LINE 8200N		
SCALE: 1:2000	DATE: 1/12/1967	
DRAWN: PRG	REVN	PLRN NO
CHECKED:		Fig. 7
APPROVED:		

1221

LINE 8600N

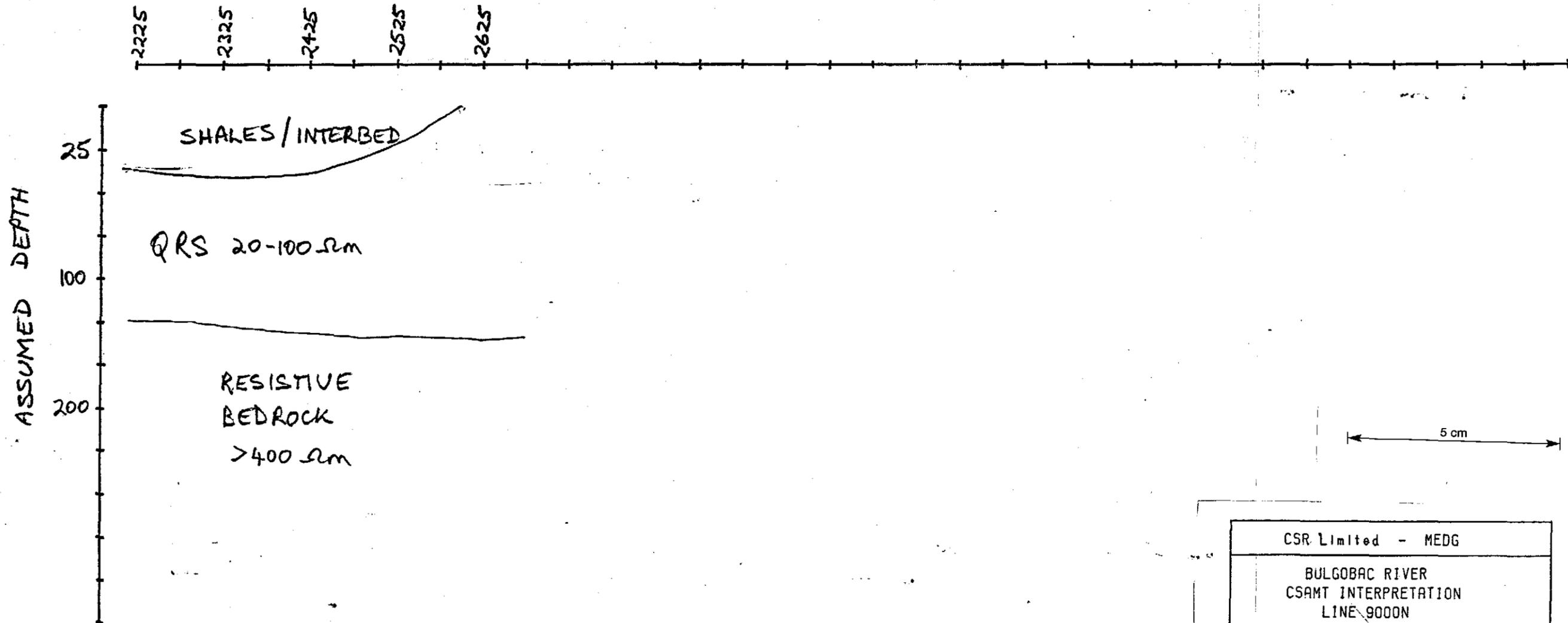
2025 2125 2225 2325 2425 2525



123

CSR Limited - MEDG			
BULGOBAC RIVER CSAMT INTERPRETATION LINE 8600N			
SCALE:	1:2000	DATE:	1/12/1967
DRAWN:	PRG	REVN	PLAN NO
CHECKED:			Fig. 8
APPROVED:			

LINE 9000N

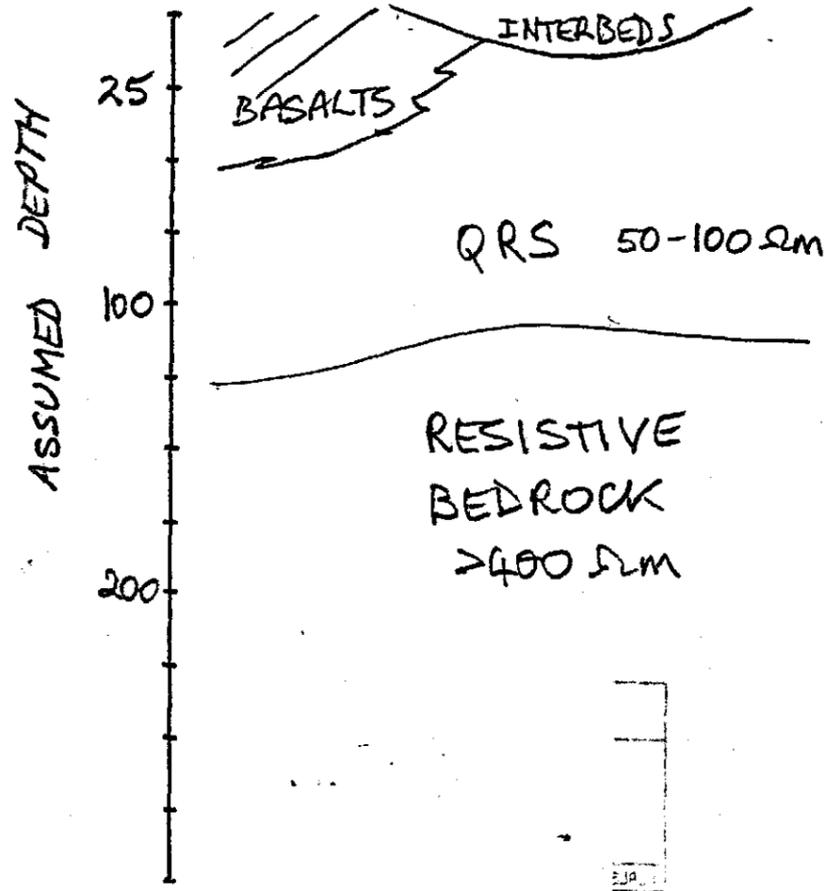


121

CSR Limited - MEDG		
BULGOBAC RIVER CSAMT INTERPRETATION LINE 9000N		
SCALE: 1:2000	DATE: 1/12/1967	
DRAWN: PRG	REYN	PLAN NO
CHECKED:		Fig. 9
APPROVED:		

LINE 9400N

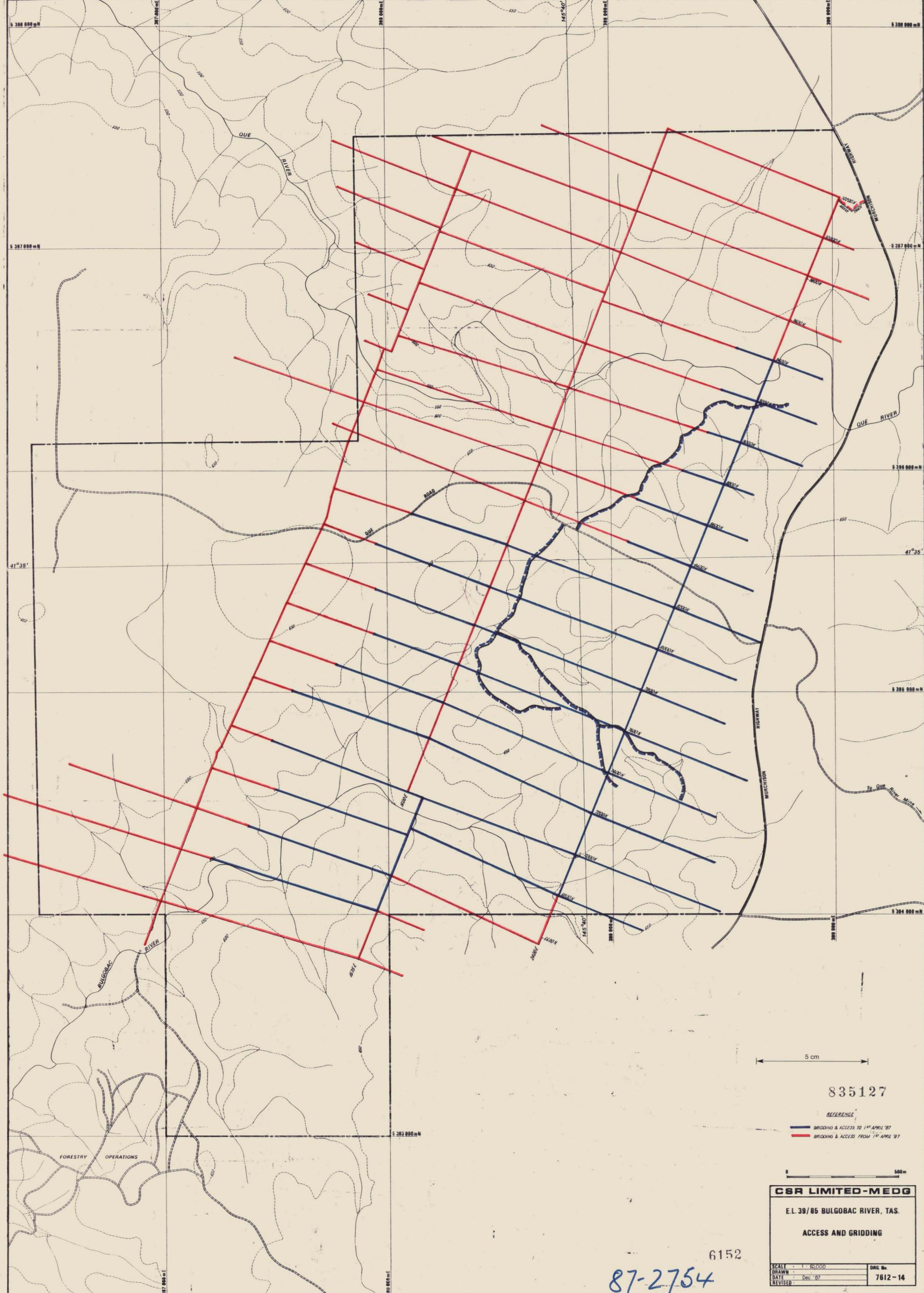
2225 2325 2425 2525 2625



5 cm

CSR Limited - MEDG		
BULGOBAC RIVER CSAMT INTERPRETATION LINE 9400N		
SCALE: 1:2000	DATE: 1/12/1967	
DRAWN: PRG	REVN	PLAN NO
CHECKED:		Fig. 10
APPROVED:		

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835127

REFERENCE

- BRIDDING & ACCESS TO 1ST APRIL '87
- BRIDDING & ACCESS FROM 1ST APRIL '87



CSR LIMITED-MEDG

E.L. 39/85 BULGOBAC RIVER, TAS.

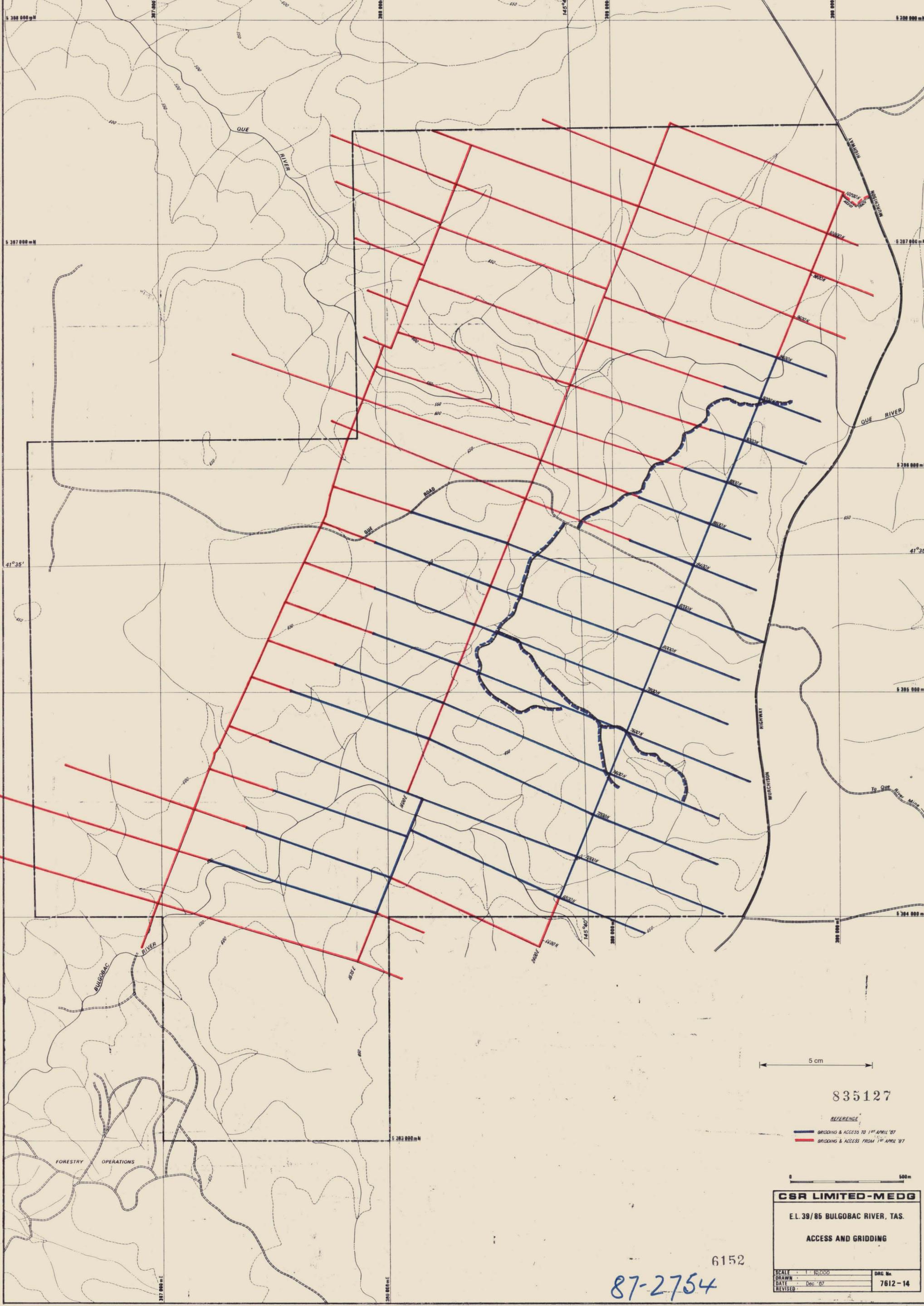
ACCESS AND GRIDDING

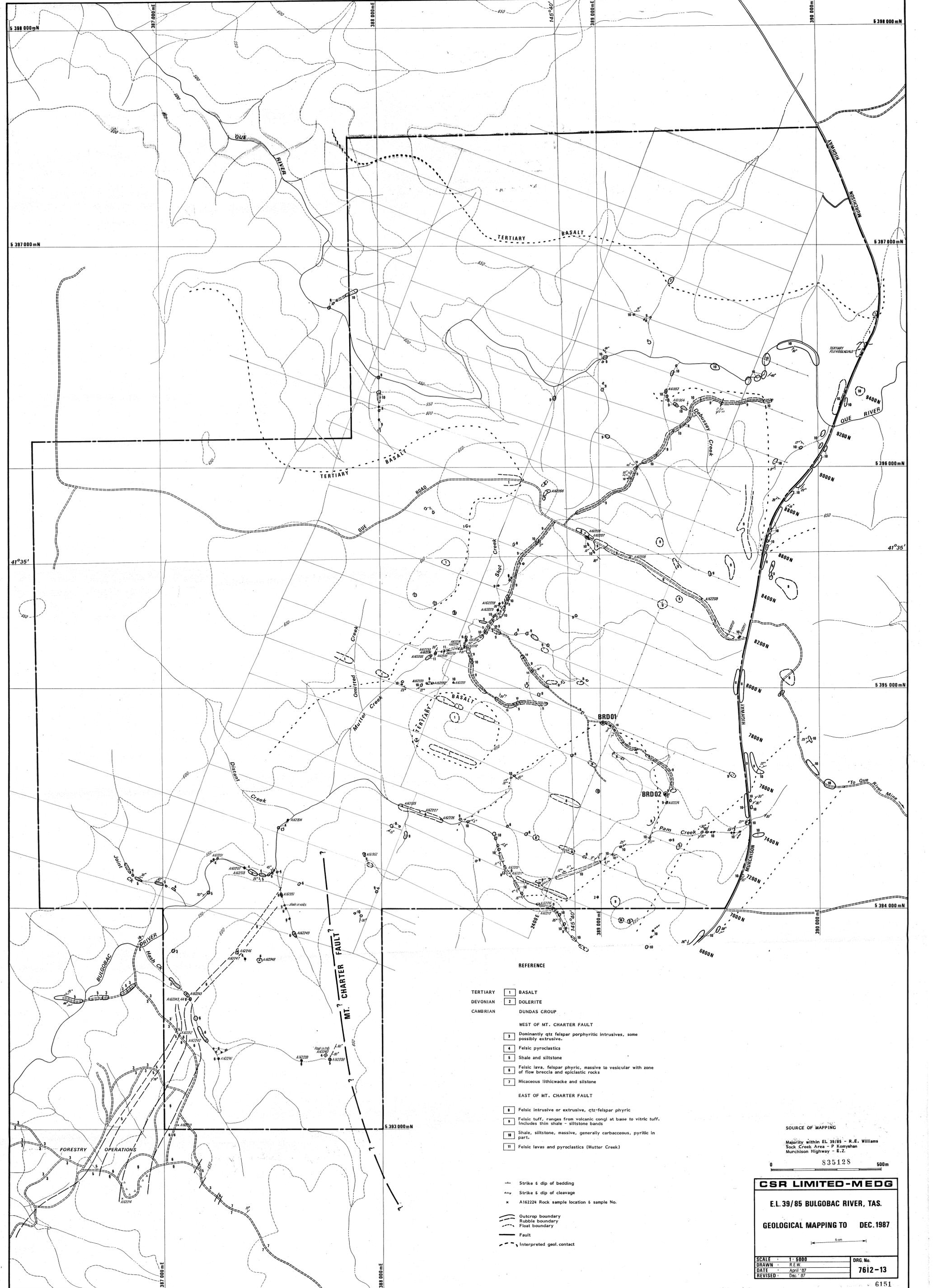
SCALE	1:10,000	DRG No.	7612-14
DRAWN			
DATE	Dec '87		
REVISED			

6152

87-2754

FORESTRY OPERATIONS





- REFERENCE**
- | | | |
|----------|---|--------------|
| TERTIARY | 1 | BASALT |
| DEVONIAN | 2 | DOLERITE |
| CAMBRIAN | | DUNDAS GROUP |
- WEST OF MT. CHARTER FAULT**
- 3 Dominantly qtz felspar porphyritic intrusives, some possibly extrusive.
 - 4 Felsic pyroclastics
 - 5 Shale and siltstone
 - 6 Felsic lava, felspar phyrlic, massive to vesicular with zone of flow breccia and epiclastic rocks
 - 7 Micaceous lithicwacke and siltstone
- EAST OF MT. CHARTER FAULT**
- 8 Felsic intrusive or extrusive, ctz-felspar phyrlic
 - 9 Felsic tuff, ranges from volcanic congl at base to vitric tuff. Includes thin shale - siltstone bands
 - 10 Shale, siltstone, massive, generally carbaceous, pyritic in part.
 - 11 Felsic lavas and pyroclastics (Mutter Creek)

- Strike & dip of bedding
- Strike & dip of cleavage
- x A162224 Rock sample location & sample No.
- Outcrop boundary
- Rubble boundary
- Float boundary
- Fault
- - - Interpreted geol. contact

SOURCE OF MAPPING

Majority within EL 39/85 - R.E. Williams
 Sock Creek Area - P. Komysan
 Murchison Highway - E.Z.

0 835128 500m

CSR LIMITED-MEDG

E.L. 39/85 BULGOBAC RIVER, TAS.

GEOLOGICAL MAPPING TO DEC. 1987

SCALE: 1:5000 DRG. No. 7612-13
 DRAWN: R.E.W.
 DATE: April '87
 REVISED: Dec '87

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