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**Fourth Annual Report
For The Period Ending 15 March 1997
EL 45/92 Mt Dundas, Tasmania**

Volume I of II

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CRAE Report No. 22159

ANNUAL REPORT - EL 45/92
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VOL 1 OF 2

Abstract

Exploration has continued on EL 45/92 Mt Dundas for carbonate hosted base-metal deposits within the Gordon Limestone at Zeehan, West Tasmania. Analogies with Irish-style carbonate hosted Zn/Pb deposits are being used to guide exploration.

Work undertaken in the 12 month period 16/3/96 to 15/3/97 consisted of diamond drilling (5 holes for 1524m) and wacker bedrock sampling (388 holes for 1543m). In addition, results from the 1995 detailed helimag survey have been partially interpreted and a basin analysis study completed.

Diamond drilling was completed at Sunny Corner, Blackjacks and King Billy. Wacker bedrock sampling has been undertaken at Blackjacks, Westerway, Tom Creek and Pyramid. Minor wacker bedrock sampling was also conducted at Mariposa.

Numerous sulphide occurrences are recorded in the Sunny Corner and Blackjacks drill-core e.g. DD96DS101 0.75m @ 3.71% Zn and 5.9% Pb. However, no economic base-metal intersections were achieved. Major zones of dolomitisation and siderite alteration have been identified, including up to 600m strike of the basal Siderite Unit and up to 1 km strike of dolomitic breccia at Blackjacks.

A basin analysis study was completed using Geosea Consultants (Dr Clive Burrett). Three formations were recognised in the Gordon Limestone corresponding to differing carbonate depositional environments. The study recognised the Blackjacks area as being near to the basin margin and major facies variations between Blackjacks-Mariposa and Sunny Corner.

The conclusion of the 1996 programme is that the Blackjacks-Mariposa-Sunny Corner area is the most prospective within the Gordon Limestone at Zeehan. Additional target areas include Westerway.

Recommendations for further work include diamond drilling at Blackjacks, Mariposa, Sunny Corner and Westerway. Wacker bedrock infill sampling is recommended for the anomalous samples at Pyramid. Priority focus is to be on the basal limestone/sandstone contact - the Oolite Unit at Sunny Corner and Mariposa as well as on the dolomitic breccia unit in the middle of the limestone at Blackjacks and possibly Westerway.

Environmental rehabilitation consisted of ripping compacted ground around drill-sites, replacement of vegetation for helicopter sites and removal of rubbish and cuttings. Care has been taken to avoid unnecessary damage to vegetation etc.

Expenditure for the 12 month period was \$379,146. Total expenditure for the licence to 15/3/97 is \$1,260,209.

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✓ Tv 1114 ✓	EL 45/92 Mount Dundas, Zeehan Carbonate Sunny Corner Prospect DD96DS99 and DD96DS100 section	1:1,000
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✓ Tv 1115 ✓	EL 45/92 Mt Dundas, Zeehan Carbonate, Blackjacks Prospect, DD96DB112 section	1:1,000
✓ Tv 998 ✓	EL 45/92 Mt Dundas, Zeehan Carbonate, King Billy Prospect, Geology and Drillhole Location Plan	1:2,500
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✓ Tv 1015 ✓	EL 45/92 Mt Dundas, Zeehan Carbonate, Mariposa Prospect, section 59170N.	1:1,000
✓ Tv 1014 ✓	EL 45/92 Mt Dundas, Zeehan Carbonate, Mariposa Prospect, section 59410N.	1:1,000

Appendices

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1. Conclusions and Recommendations

Continued exploration on EL45/92 has provided additional data that confirms the Blackjacks-Mariposa-Sunny Corner area as being the most prospective zone within the Zeehan carbonate area.

No economic intersections in drillcore were made. The increased number of sulphide occurrences is encouraging along with the identification and extension of major alteration zones (including dolomitisation). Stratigraphic correlations imply major basinal movements occurred in the Ordovician, between Blackjacks-Mariposa and Sunny Corner, with localised tectonic pulses recorded at Pyramid e.g. a 100m thick calcic quartzite in DD96ZP65.

Diamond drilling at King Billy has confirmed the presence of the Oolite Unit. This unit has slightly anomalous zinc values at its upper and lower contacts.

The wacker bedrock sampling at Westerway, Tom Creek and Pyramid, provided geological control along with a number of zinc anomalies. This work also suggests that no Zn/Pb orebody crops out in these areas. The best geochemical anomaly (>1000 ppm Zn) of over 600m strike length is located at Westerway within the middle zone of the Gordon Limestone.

The detailed helimag survey results have been received and an initial interpretation made. The siderite zone at the base of DD95DB110 has 600m of surface strike length. There are several smaller scale anomalies also thought to be related to siderite alteration.

The basin analysis study has shown the Blackjacks area to be on the basin margin. Clastic interdigitation with shallow water carbonate sequences at the base of DD95DB111 is seen as evidence for this. Additional evidence is provided by the basal sequence discrepancies between DD95DB111 and DD95DB110. The basal Oolite Unit is seen in the Sunny Corner drill core, but not at Blackjacks. At Mariposa, poor recoveries and extensive siderite alteration precluded any judgement as to the existence of the Oolite Unit.

The collection and compilation of data over the past two years has greatly increased the understanding of the geology of the Ordovician/Silurian sequence. Prior to further drilling or surface work, greater effort should be put into the three dimensional geometry of the limestone and reference made to the unique pattern of carbonate deposition.

A programme of further drilling is recommended:

- Sunny Corner - lower limestone/ sandstone contact below DD96DS100. Use of an RC drill-rig with a diamond tail is recommended to improve recovery of the target zone.
- Mariposa - down dip tests of mineralisation encountered in previous drill holes.
- Blackjacks - continued drilling out of the dolomitic breccia.
- Westerway - drilltest the main anomaly.

In addition and perhaps prior to drilling, there should be a more rigorous interpretation of the helimag data to confirm the validity of the drill targets.

To complete the surface work at Pyramid it is recommended that a wacker bedrock sampling grid be completed around the 1996 anomalous sites.

2. Introduction

Mount Dundas, EL 45/92, was granted to CRA Exploration Pty Ltd. on 16 April 1993 and covers an area of 70 km² east of Zeehan, West Tasmania (Tv 1070). CRAE has a statutory obligation to spend \$35,000 annually.

CRAE is exploring EL 45/92 for stratabound Zn-Pb deposits within the Ordovician Gordon Limestone. Analogies with Irish carbonate hosted base metal deposits are being used to assist exploration.

Six target areas were selected for detailed work in 1996 :- Blackjacks, Sunny Corner, King Billy, Pyramid, Westerway and Tom Creek. This detailed work consisted of diamond drilling and bedrock sampling (wacker drilling).

This report details all exploration activities conducted during the fourth year of tenure, 16 March 1996 - 15 March 1997.

For regional geology and mineralisation see Parkinson 1994.

Sub-divisions of the Gordon Limestone have been delineated on a lithologic/lithostratigraphic basis for utilisation in drillhole logging. An explanation of the formation codes is made in Appendix I.

3. Previous CRAE Work

See Appendix II.

4. Exploration Activities for the Period 16/3/96 to 15/3/97

The following two tables summarise field work undertaken in the past year.

Diamond Drillhole Summary

DDH	Prospect	East (AMG)	North (AMG)	AMG Zone	Elev (mASL)	Tdepth (m)	Azim (AMG)	Dip	Date Drilled	Appendix
DD96DS99	Sunny Corner	366069	5357571	55	183	165.9	099	55	24/1/96	V
DD96DS100	Sunny Corner	366180	5357513	55	148	237.1	102	57	22/2/96	V
DD96DS101	Sunny Corner	366237	5356795	55	170	380.6	097	51	1/4/96	V
DD96DB112	Blackjacks	366611	5360766	55	195	342.5	080	50	12/4/96	VI
DD96ZK124	King Billy	317202	5352304	55	175	126	180	60	1/4/96	VIII
DD96ZK125	King Billy	317202	5352304	55	175	398.7	180	60	12/4/96	VIII

See Appendix III for sample analysis routine.

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Significant intercepts - Summary 1996 Diamond Drilling

DDH	Prospect	From (m)	Width (m)	Zn (%)	Pb (%)	Ag (ppm)	S (%)	Comments
DD96DS99	Sunny Corner	59.5	33	0.23	0.15	2.2	n/a	Dolomitised limestone and rotted dark grey clays.
DD96DS99	Sunny Corner	114.5	1.6	4.99	0.8	5.7	n/a	Semi massive sphalerite in dolomite.
DD96DS99	Sunny Corner	122.5	1.4	1.36	0.8	3.8	n/a	Disseminated sphalerite and galena in clays.
DD96DS99	Sunny Corner	106.1	17.8	0.8	0.3	2.6	8	Rotted and sheared dolomite.
DD96DS99	Sunny Corner	151.7	2.1	1.38	0.2	1.6	n/a	Brecciated dolomite with sphalerite.
DD96DS100	Sunny Corner	115.2	29.7	0.3	0.1	<2	n/a	Top section of the dolomitised Siltstone Unit.
DD96DS100	Sunny Corner	162	5.4	0.32	<0.1	<0.1	n/a	Lower contact of dolomitised Siltstone Unit.
DD96DS101	Sunny Corner	3	9.2	0.79	3.32	29	n/a	Dark grey clays with galena blebs ?leached sphalerite.
including	Sunny Corner	10.5	1.7	0.36	10.0	82.6	n/a	
DD96DS101	Sunny Corner	121.3	0.2	9.2	9.2	27.3	6	Irish style colloform sphalerite.
DD96DS101	Sunny Corner	303	1.5	0.3	3.8	8.7	n/a	Disseminated galena in dolomitic and sideritic limestone/breccia.
DD96DS101	Sunny Corner	312.7 5	0.75	3.71	5.9	32.5	3.8	Ditto
DD96DB112	Blackjacks	164.3	0.2	2.9	0.1	0.5	2.0	Disseminated pale sphalerite in syn-sedimentary breccia.
DD96DB112	Blackjacks	166.7	0.95	1.1	0.3	16.7	1.5	Dolomitic section with disseminated sphalerite.
DD96DB112	Blackjacks	253	0.9	1.26	<0.1	0.9	2.1	Calcareous dark grey clays.
DD96DB112	Blackjacks	251.2	7.8	0.49	<0.1	<1	n/a	Dolomitised limestones and dark grey clays.
DD96DB112	Blackjacks	331.5	10.7	0.28	<0.1	<0.5	n/a	Siderite and dark grey clay unit. Hole terminated at 242.5m.
DD96ZK124	King Billy	12	1.5	0.13	<0.1	<0.5	n/a	Base of surficial clays.
DD96ZK125	King Billy	321	3	0.13	<0.01	0.6	n/a	Top of the Oolite Unit.
DD96ZK125	King Billy	344.7	3.3	0.16	<0.01	<0.5	n/a	Rotted dolomitised argillaceous bioclastic calcarenite.

Wacker Sampling Summary

Prospect	No. of Samples	Depth		Zinc		Lead	
		Range (m)	Mean (m)	Max (ppm)	Mean (ppm)	max (ppm)	Mean (ppm)
Blackjacks	107	0.5-20.3	4.35	8270	616	4600	171
Westerway	97	0.5-16.8	2.9	6080	347	2300	107
Tom Creek	137	0.2-22.5	4.5	3160	154	1330	55
Pyramid	41	1.3-14.5	4.4	3690	386	499	105
Mariposa	6	0.8-3.3	2.3	15	3	27	1
Total	388					Total metreage 1544m.	

See Appendix IV for sample analysis routine.

4.1 Sunny Corner Prospect (Plan Tv 716)

Drilling in 1995 showed major hydrothermal alteration at the northern end of Sunny Corner in particular ferroan dolomite. Major E-W (syndimentary) structures and thicker limestone sequences occur south of this drilling. Thus geochemical targets south of the 1995 drilling were deemed favourable. Both the sub-Siltstone Unit sequence and the basal Oolite Unit were tested.

4.1.1 Diamond Drilling

DD96DS99 55° to 099°(AMG) TD 165.9m Drillrig: LY38 (Helrig)
Diamond Drilling of Tasmania Pty. Ltd.

Aim of Hole

Diamond drill test:

- anomalous surface geochemistry associated with the upper sandstone/limestone contact
- down-dip extent of the Siltstone Unit and its underlying units ie. the "Oceana Horizon"

Results

Hole was collared in Crotty Quartzite before passing into dark grey clay, interpreted as rotted Upper Dolomite Unit (Plan Tv 1114). The remainder of the drill hole consists of dolomitised limestone of the Upper Dolomite Unit. Interpretation of the major analytical elements shows that variations occur within the limestone which may represent different original lithologies. For example, more argillaceous limestones have higher iron and aluminium values but lower magnesium values relative to cleaner calcarenite or micritic units. However, these chemical variations may also be due to weathering effects.

Drilling problems occurred with this hole, in particular loss of water at the bit face, which ultimately caused the abandonment of the hole at 165.9m.

Mineralisation in the hole consisted of scattered veinlets and flecks of semi-massive dark brown sphalerite in dolomite, often within broken core zones (+/- bad recoveries) eg interval of 1.6m x 4.99% Zn from 114.5m.

It is clear from this drill hole and others which drilled the same stratigraphy that there is a regional base metal enhancement associated with dolomitisation at the upper sandstone/limestone contact. Elevated values are in the order of a few thousand ppm zinc, with the unit usually being 30 or so metres thick. This part of the Upper Dolomite Unit suffers no surface depletion due to weathering as the values in drillcore match the wacker bedrock and aircore sampling results. This indicates that large volumes of zinc/lead/sulphur and magnesium-bearing fluids have passed through the upper part of the limestone; fluids that if focused and trapped, may give rise to a sizeable base-metal carbonate hosted orebody.

Other major Upper Dolomite zones like Sunny Corner occur in Blackjacks, Mariposa, Professor Range, Grieves and Firewood Siding.

DD96DS100 57° to 102° (AMG) TD 237.1m Drillrig: LY38 (Helirig)
Diamond Drilling of Tasmania Pty. Ltd.

Aim of Hole

Second attempt at the sub-Siltstone Unit sequence not intersected in DD96DS99

Results

Hole was collared in the Upper Dolomite Unit and passed through the dolomitised Siltstone Unit (Plan Tv 1157). It then intersected >70m of dolomitised syn-sedimentary breccias. As with DD96DS99 it is possible using major element analysis to identify facies variations within the limestones. The Siltstone Unit has a transitional upper contact and a discrete lower contact. It occurs as a chemically distinct dark grey/black fine grained argillaceous clastic unit with occasional coarser quartz sand beds. The hole was abandoned at 237.1m due to poor ground conditions.

Low grade zinc mineralisation occurs in the Siltstone Unit transitional zone and at the base of the Siltstone Unit, as small disseminated flecks and veinlets of sphalerite +/- galena.

There is no evidence for ferroan dolomite in this hole.

The >70m of syn-sedimentary breccias have pyrite disseminations, flecks and veinlets scattered throughout the matrix, locally up to 10% over short distances. This unit represents the greatest concentration of pyrite seen in the carbonates of the Zeehan area and demonstrates the prior existence of sulphur-rich fluids. The missing key element for most of the Zeehan carbonate area is the sulphur source for the formation of sulphides rather than carbonates and silicates etc.

The target zone was intersected in this drill hole, however, the elevated zinc values merely confirmed the continuation of zinc levels from the surface sampling, i.e. there is no surface depletion and no chemical vectors for orebody location.

In the light of DD96DS101 drilling, it is considered worthy to test the lower limestone/ sandstone contact beneath DD96DS100.

DD96DS101 51° to 097° (AMG) TD 380.6m Drillrig: LY38 (Helirig)
Diamond Drilling of Tasmania Pty. Ltd.

Aim of Hole

Diamond drill test of surface geochemistry (wacker bedrock) up to 0.8% Zn, and the lower limestone/sandstone contact.

Results

This diamond drill hole collared in dark grey clay equated with weathered dolomite. (Plan Tv 1158). Dolomite persisted to 42m before becoming more rotted and clay-like. These clays are terminated by a pyritic shear zone. It is possible that the dark grey clay zone represents weathered Siltstone Unit. Dolomitisation persists after the fault to a depth of 100.9m. Thereafter, the sequence is dominated by argillaceous calcarenites and occasional laminated micrite units. None of these units are seen in DD96DS99 and DD96DS100, therefore, it is believed that DD96DS101 after the pyritic shear represents stratigraphy lower than the other two holes. Siderite is present from 241.5m onwards.

The Siderite Unit begins at 264.9m and appears as bands of massive siderite intercalated with dark grey clay zones. Core recoveries in this unit are between 30% and 50%. A dolomitic light grey unit begins at 299.1m, thought to be the Oolite Unit. There are siderite and dark clay zones within the dolomitised Oolite Unit, which itself is believed to have ferroan dolomite alteration. The argillaceous bioclastic unit that often underlies the Oolite Unit occurs from 346.5m to 367.5m and is completely dolomitised. It is only locally affected by siderite alteration. The Silty Transition Unit occurs as dark grey clay with a 30cm basal conglomerate at 376.5m. The hole terminated in the Moina Sandstone at 380.6m.

Mineralisation is sporadic, occurring as either narrow veinlets or disseminations. The most significant intercepts were those at the top of the Oolite Unit and the narrow width of Irish-style colloform sphalerite/ galena seen at 121.3m. (9.2% Zn, 9.2% Pb, 27.3g/t Ag).

There is a poor correlation between the surface bedrock sampling and the down-hole geology. This is attributed to surficial soil creep of inert Moina Sandstone debris masking limestone outcrop. There is significant topographic relief in the limestone valley due to the Moina detritus.

The galena-rich dark grey clays at the top of the hole may represent the leaching of sphalerite from sphalerite/galena mineralisation within a dolomitic unit. The unit is a topographic high, possibly the result of a gravel veneer protecting it from erosion, not preventing the effect of a harsh surficial water flow regime.

4.2 Blackjacks Prospect

The aim of the diamond drilling at Blackjacks was to intersect the dolomitic breccia seen in DD95DB110. It was hoped that this hole plus additional drilling would intersect the breccia and provide a vector towards locating ore. The dolomitic breccia closely resembles the white and black matrix breccias associated with some of the Irish carbonate hosted Zn/Pb deposits (Plan Tv 936).

4.2.1 Diamond Drilling

DD96DB112	50° to 080°	TD 342.5m	Drillrig: LY44 Almac Drilling
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Aim of Hole

To intersect the unique dolomitic breccia of DD95DB110 and confirm the nature of lower limestone/sandstone contact.

Results

This diamond drill hole showed no dolomitic zones similar to the breccia in DD96DB110. However, the first 95m of core was recovered as dark grey clay with occasional dolomitic fragments (Plan Tv 1115), and this could be equivalent to the breccia.

Varying degrees of dolomitisation are pervasive throughout the limestone, occasionally associated with minor amounts of sphalerite mineralisation. There is no further dolomitisation after 318.5m. Beyond this, siderite becomes the dominant alteration phase intermixed with dark grey clay to a depth of 334m. Dark grey, pyritic clays make up the remainder of the core.

There is no sign of the Siltstone Unit unless it occurs within the top-of-hole dark grey clays. Taking into account the helimag siderite-related anomaly and the DD96DB110 geology, it can be deduced that the Gordon Limestone sequence is sub-vertical with a slight dip to the west. Thus the basal contact is conformable and not thrust, and, the stratabound dolomitic breccia unit in DD95DB110 is represented by the dark grey clay in DD96DB112.

Disseminations of pale sphalerite occur in the matrix of a small scale dolomitised syn-sedimentary breccia, between 164.3 and 167.65m. A dark grey clay unit with dolomitisation from 251.2 to 259m contains coarse aggregates of dark brown sphalerite. It is uncertain as to whether these occurrences represent a fault zone or stratabound mineralisation.

The basal part of the hole comprises zinc-rich dark grey clays similar to those in the surface sampling. A substantial amount of semi-massive pyrite occurs beneath the sideritic zone. This was not seen in DD96DB110, although this may be due to the occurrence of major core loss at this interval in the earlier hole.

4.2.2 Wacker Bedrock Sampling

Additional wacker bedrock sampling was undertaken to complete coverage between the Blackjacks and Mariposa areas (Appendix VII).

Sampling confirms the upper and lower sandstone/limestone contacts as having highly anomalous zinc and lead values. The Upper Dolomite Unit is well defined, but the Siderite Unit at the base of the limestone is only moderately delineated. From the data, a >600m long central dolomitic zone emerged, underlying the Siltstone Unit. This may well represent the dolomitic breccia seen in DD95DB110. Elevated zinc values are also associated with this central dolomite.

Descending scree from the eastern hill of Moina Sandstone and Owen Conglomerate has partially covered the basal zone of the Gordon Limestone. Wacker penetration through these gravels is not always possible. A ridge of gravels runs down the centre of the Blackjacks area. This probably represents an old river which may have eroded the dark grey clay unit seen in the top of DD96DB112.

4.3 King Billy Prospect

Near surface geochemical sampling undertaken in 1995 identified that zinc and lead values were relatively anomalous. In addition large scale alteration zones were identified. It is inferred that greater amounts of sulphide/metal fluids passed through the area, offering potential for a large sulphide Zn/Pb orebody.

4.3.1 Diamond Drilling

DD96ZK124 60° to 180° TD 126m Drillrig: LY38 (Helirig)
Diamond Drilling of Tasmania Pty. Ltd.

The drilling result from DD96ZK123 (EL 34/88, CRAE Report No. 22209) indicated a shallow dip to the Gordon Limestone sequence. Thus DD96ZK125 was drilled not only to test the surface geochemical sampling, but to also carry on through to the Moina Sandstone and test the basal contact (Plan Tv 998). The presence of siderite in DD96ZK123 gave further encouragement to make such a test.

Aim of Hole

Diamond drill test surface geochemical anomalies up to 0.17%Zn, associated with the sub-siltstone Unit sequence. Also test lower limestone/sandstone contact.

Results

Hole abandoned at 126m due to drilling problems.

DD96ZK125 60° to 180° TD 398.7m Drillrig: LY38 (Helirig)
Diamond Drilling of Tasmania Pty. Ltd.

Aim of Hole

As for DD96ZK124

Results

DD96ZK125 represents the re-drill of hole DD96ZK124.

A continuous sequence of argillaceous calcarenites laminated micrites and bioclastic calcarenites was intersected (Plan Tv 1111) including a full Myrtle Formation sequence of at least 15 punctuated aggradational cycles (PAC's - see Basin Analysis Report). The distinct Ugbrook Formation begins at 292.1m and includes the Oolite Unit from 325m to 337m. At 375m a major shear zone occurs for 40 cm before passing into weathered sandstone, interpreted as the Moina Sandstone. This unit is then in contact with another sheared zone at 392m, which may be Cambrian or Ordovician siliciclastics. The hole terminated at 397.8m.

Low levels of pervasive dolomitisation occur in the limestones. The strongest levels occur from 344.7m to the sheared basal contact at 377m. The Oolite Unit in the King Billy core is remarkably pure (approximately 40% calcite), and potentially a preferred replaceable horizon for zinc-rich mineralising fluids.

Drill hole assays and lithologies failed to correlate with the wacker bedrock and aircore sampling. In particular, there was no ferruginous unit near the top of the hole. The hole also showed that the sequence was steeply dipping, in contrast to flatter dips intersected in hole DD96ZK123.

4.4 Westerway Prospect

This area lies 1.5 km south east from Mariposa, and is bisected by the Zeehan-Queenstown Highway.

4.4.1 Wacker Bedrock Sampling

A 1995 reconnaissance wacker bedrock sample line returned values up to 8000 ppm zinc. As a result, a follow up grid was cut for further wacker bedrock sampling (Appendix IX). A smaller than expected Gordon Limestone outcrop was mapped from the wacker sampling (Plan Tv 1159). The western margin of the limestone is in contact with a limonitic unit, possibly a mafic lithology from the Cambrian Dundas Group. The eastern margin is overlain by the Crotty Quartzite. A major east-west trending fault truncates the limestone in the south of the grid, and lithologic correlation is difficult south of this fault.

Elevated zinc values up to 0.61% coincide with an increased thickness of limestone. The main values are located in the middle of the limestone, and at its upper contact. Dolomitisation is patchy, often occurring adjacent to the higher zinc values.

4.5 Tom Creek Prospect

The Tom Creek prospect lies a further 1 km south east of Westerway. The Little Henty Fault transects the area in an NE-SW direction, and CRAE undertook reconnaissance geochemical testing of the Gordon Limestone around this fault. The area was flown as part of the helimag survey and the wacker bedrock sampling has assisted with the geological interpretation.

4.5.1 Wacker Bedrock Sampling

Two reconnaissance wacker bedrock sample lines were completed parallel to, and either side of the Little Henty Fault line (Plan Tv 1162). Geological consistency between the two lines which are only 450 m apart is poor (Appendix X). This implies that the fault does exist, contrary to the helimag data interpretation (refer to Section 4.8).

Most anomalous zinc values are associated with the Gordon Limestone, although it is uncertain where they occur in the stratigraphy.

Extensive weathering of the rocks has occurred, including the development of iron rich hard pans. This weathering can reduce the limestone to dark grey clays or even bleached clays with low but detectable calcium values. However, weathering of other more mafic units can also produce clays with low but detectable calcium. Fluvial or fluvio-glacial gravels are not widespread in the area.

4.6 Pyramid Prospect

The Pyramid area lies 2 km south east of the Oceana Mine (4 Mt @ 18% Pb and 4% Zn). The eastern part of the prospect lies on EL45/92, whilst the other half lies on EL 28/88, and is reported in CRAE Report No. 22160.

4.6.1 Wacker Bedrock Sampling

The central and southern parts of the Pyramid prospect have no reliable surface geochemical coverage. Two reconnaissance bedrock sampling lines were completed (Appendix XI). One line was positioned across the middle of the prospect, over the thickest sequence of the limestone. The other line was positioned parallel to the prospect's southern margin, proximal to the Little Henty Fault.

The bedrock sampling provided some geological control and assisted the helimag interpretation. An updated geological map is included (Plan Tv 1018). This shows an inferred north plunging syncline with an overturned western limb.

Limestone outcrop appears restricted near the Little Henty Fault. This may be due to the lack of penetration of fluvially-derived gravels by the wacker drill. Elevated zinc values are associated with the Moina Sandstone/Gordon Limestone contact.

4.7 Mariposa Prospect

Reinterpretation of the geological map has assisted the construction of a series of cross sections for the Mariposa area (Plans Tv 717, Tv 1016, Tv 1015, Tv 1014).

4.7.1 Wacker Bedrock Sampling

Six samples were collected in the north of the prospect in order to correctly position the upper sandstone/ limestone contact (Appendix XII). This work was undertaken in order to prove the collar lithology for a potential diamond drill hole. Collaring in the Crotty Quartzite ought to be avoided if at all possible. See Appendix X for the results.

The interpretation of a thrust lower limestone contact is in doubt, particularly in the light of the Blackjacks drilling.

4.8 Detailed Helimag Survey

The Gordon Limestone of the Zeehan area was flown over as part of a detailed sub-regional helicopter-borne magnetic survey. Line spacing was approximately 60m with an average flight height of 30m and sampling intervals were approximately every 3-4m. A feature of the survey was that the flight lines were aimed at being perpendicular to the strike of the limestone which resulted in time consuming and complex processing.

Relevant parts of the initial report (CRAE Report 22222) are included in Appendix ~~XI~~ ^{XIII}. This report was written just after CRAE decided to joint venture EL 45/92. No major interpretation has been transferred to the geological map.

The Gordon Limestone in the Blackjacks-Mariposa and Sunny Corner areas tend to be magnetically flat. Minor anomalies occur, some coincident with known siderite. The largest anomaly at Blackjacks (South), is over 600m long. In Pyramid, Tom Creek and other areas, the limestone stratigraphy is more discernible than individual siderite anomalies. Certain non-Gordon Limestone Formations are also distinguishable from the data. eg. Moina Sandstone and the Crotty Quartzite.

4.9 Basin Analysis Study

Dr Clive Burrett of Geosea Consultants was contracted to provide a stratigraphic study of the Zeehan carbonate drill sequence using diamond drill core to establish:-

- a stratigraphic column for the Zeehan carbonate sub-basin, including identification of formational boundaries.
- a measure of the variability of carbonate depositional environments and the possible inference of syn-sedimentary faults.

Results from the study highlight the Blackjacks area as having existed on the basin margin (Appendix XIV). The difference in lithological pattern between DD95DB111 and DD95DB110 is cited as evidence for this. Proximity to a basin margin and basin margin faults is considered important as these faults tend to be penetrative structures which can access and focus mineralising fluids.

Drill holes viewed from EL 45/92 were DD95DB110, DD96DB111, DTM-84-6 (inverted) and DD95DS98.

4.10 Honours Project

The included project in Appendix XVI was undertaken by Kim Ely from Melbourne University. Viewed drillcore was supplied by CRAE (Mariposa and Blackjacks ostensibly) and by Pasminco (Oceana and Austral Creek). Conclusions of the work are as follows:

The Zeehan lead-zinc mineral field has been cited as being zoned around the Heemskirk Granite. This zonation is primarily manifested in the change of gangue mineralogy, from pyrite to siderite dominated. However, the relationship of limestone-hosted deposits distal to the granite has been disputed. Several authors have suggested that the deposits of the Gordon Limestone have their origins in an Ordovician mineralisation event, and therefore are not part of the zoned mineral field. Siderite occurs in three main positions within the stratigraphy of the Gordon Limestone, but is not restricted to these zones. The position of siderite appears to be fault controlled. Four types of siderite are recognised in the limestone-hosted deposits. However, all types of siderite are chemically and paragenetically very similar. Galena and sphalerite post-dates the siderite. The variation of the chemistry of siderite sampled from nine locations illustrates a zonation to the south-east of the Heemskirk Granite. This zonation, reflected in both elemental and isotopic composition, overprints regional folding. Siderite crystallisation post-dates Tabberabberan deformation and since mineralisation post-dates siderite, it is therefore younger than Middle Devonian. Thus siderite, and associated mineralisation in the Gordon Limestone, near Zeehan, does not have an Ordovician origin. The limestone-hosted lead-zinc deposits are part of the siderite zone of the zoned mineral field. Mineralisation is most likely related to the intrusion of the Heemskirk Granite in the Late Devonian to Early Carboniferous.

5. Discussion

Some aspects of key Irish-style mineralization include the following:-

- Structurally controlled stratabound deposits are located within the first replaceable horizon above the basement.
- This horizon needs to be proximal to a major basinal structure, with a suitable lithological capping unit. The structure can be a syn-sedimentary fault.
- Deposits generally occur on the downthrow of the structure at the point of maximum throw.

At Zeehan, the first replaceable horizon is the Oolite Unit. This unit exists in Sunny Corner and King Billy but not at Blackjacks (or Mariposa). These latter areas have replaceable horizons higher up in the sequence below the capping Siltstone Unit, with the stratabound dolomitic breccia at Blackjacks thought to be the replaceable horizon. A major syn-sedimentary structure is not easily recognised in tectonised sequences especially if it has been reactivated. Major sedimentological variations occur between Blackjacks-Mariposa and Sunny Corner, whilst localised rapid deposition has occurred at Pyramid. The implication is that the deposition of the carbonates involved syn-sedimentary faults and thus, was not a passive process. Overthrusting of the Gordon Limestone by the Silurian Crotty Quartzite further complicates the issue.

The Blackjacks-Mariposa-Sunny Corner area has been a focus for hydrothermal mineralising fluids. Extensive dolomitisation and siderite alteration are further evidence for the movement of fluids. Besides Grieves, the above mentioned area contains the greatest amount of sulphide mineralisation in drill core.

Low grade zinc mineralisation in the Upper Dolomite Unit is the result of trapped but unconcentrated hydrothermal fluids.

6. Environment and Rehabilitation

A number of activities conducted during 1996 have impacted on the environment. These include:-

- Diamond drilling at Blackjacks
- Diamond drilling at Sunny Corner (Helicopter supported). Temporary repairs were made to the old Mariposa Tramway for vehicle access
- Diamond drilling at King Billy (Helicopter supported).
- Line cutting at Westerway
- Line cutting at Tom Creek
- Line cutting at Pyramid
- Line cutting at Mariposa

Rehabilitation of surface disturbance included:-

- capping of diamond drill hole collars
- raking of drill sites
- recovering sites with the cleared vegetation
- removal of rubbish and cuttings

Drill sites and grid lines will naturally revegetate. No permanent new access tracks were created. Where possible, low-impact technologies were employed in exploration.

All exploration work is discussed on site with Department of Industry Safety and Mines personnel prior to it being undertaken. Their advice allows for the environmental impact of the proposed work to be kept to a minimum.

Diamond drill sites were positioned where possible in areas of previous disturbance. Above ground sumps were used to contain water return, and oil-absorbent products were positioned where needed. Cuttings were removed and drill sites ripped on completion of the programmes. Most wacker lines will revegetate in 2-3 years leaving no lasting impact on the environment.

7. References

- | | | |
|-----------------|------|--|
| Parkinson, R.G. | 1994 | Mount Dundas EL 45/92, Tasmania. Report on Exploration for the First Year of Tenure, 16/4/93 to 15/3/94. CRAE Report No. 19675. |
| Parkinson, R.G. | 1995 | Mount Dundas EL 45/92, Tasmania. Report on Exploration for the Second Year of Tenure, 16/4/94 to 15/3/95. CRAE Report No. 20789. |
| Tear, S J | 1996 | Mount Dundas EL 45/92, Tasmania. Report on Exploration for the Third Year of Tenure, 16/4/95 to 15/3/96. CRAE Report No. 21807. |

8. Location

Queenstown	SK 55-5	1:250 000
Pieman	7914	1:100,000
Zeehan	7914-S	1:50,000

9. Keywords

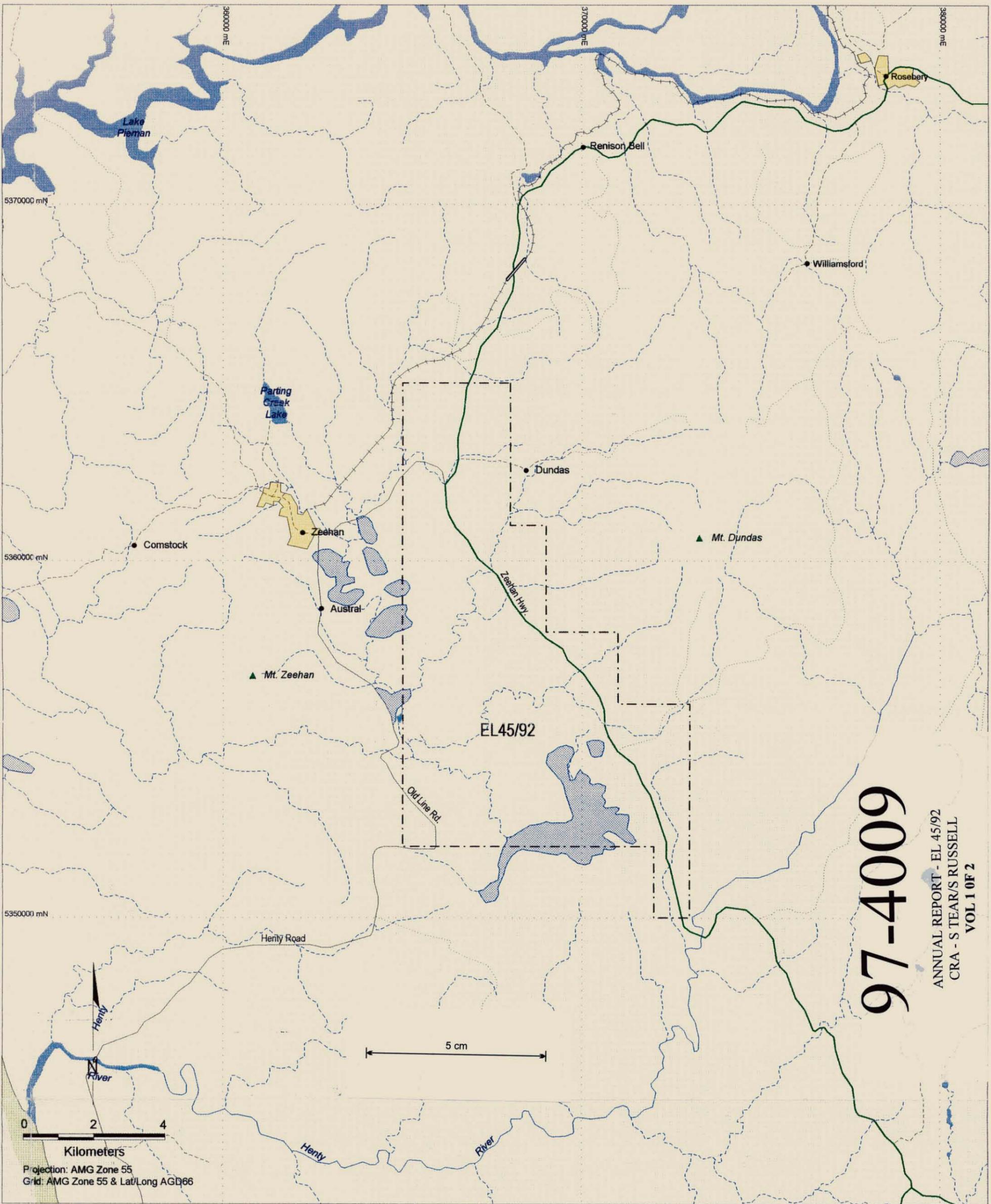
Tasmania, Ordovician, Carbonate-hosted, Gordon Limestone, Diamond Drilling, Wacker Bedrock Sampling, Zinc, Helicopter-borne Magnetics, Siderite, Dolomite, Basin Analysis, Syn-sedimentary faults.

10. DPO Register

**CRA Exploration Pty Limited
DPO Register**

EL 45/92 Mt Dundas

DPO Number	LAB Batch Number	Lab Name	DPO Location	Office Date	Geologist	Tenement Number	Tenement Name	Sample Type	Number of Samples	250,000 Map Sheet	100,000 Map Sheet
77398	11616	Analabs	Zeehan	7/2/96	S. Tear	38/88	Blackjacks	Bedrock	82	SK55-5	7914
82152	11740	Analabs	Zeehan	14/3/96	S. Tear	38/88	Sunny Corner	1/2 DDHQ/NQ	70	SK55-5	7914
82153	11774	Analabs	Zeehan	26/3/96	S. Tear	38/88	Westerway	Bedrock	97	SK55-5	7914
82154	11828	Analabs	Zeehan	18/4/96	S. Tear	38/88	Sunny Corner	1/2 DDHQ/NQ	96	SK55-5	7914
82155	11832	Analabs	Zeehan	19/4/96	S. Tear	38/88	Tom Creek Mariposa Blackjacks	Bedrock	167	SK55-5	7914
82156	11833	Analabs	Zeehan	18/4/96	S. Tear	38/88	Pyramid	Bedrock	63	SK55-5	7914
82161	11875	Analabs	Zeehan	6/5/96	S. Tear	38/88	Sunny Corner	1/2 DDHQ/NQ	85	SK55-5	7914
82164	11934	Analabs	Zeehan	24/5/96	S. Tear	38/88	Blackjacks	1/2 DDHQ/NQ	103	SK55-5	7914
82165	11933	Analabs	Zeehan	24/5/96	S. Tear	38/88	Sunny Corner	1/2 DDHQ/NQ	63	SK55-5	7914
82166	11948	Analabs	Zeehan	28/5/96	S. Tear	38/88	King Billy	1/2 DDHQ/NQ	70	SK55-5	7914



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0 2 4
Kilometers
Projection: AMG Zone 55
Grid: AMG Zone 55 & Lat/Long AGD66



SK55-20 NW-Tas			
Conical Rocks 7814	Pieman 7914	Sophia 8014	
	Cape Sorell 7913	Franklin 8013	
SK55-22 SW-Tas			

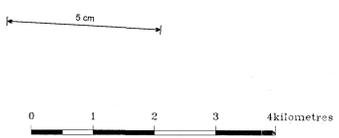
Mapsheets Reference

- Legend**
- Town
 - ▲ Mountain
 - - - EL Boundary
 - Perennial Drainage
 - - - Non-Perennial Drainage
 - Highway
 - Secondary Road
 - Minor Road
 - - - Track
 - +— Railway
 - Lake
 - Swamp
 - Urban

CRA EXPLORATION PTY. LIMITED	
EL45/93 Mount Dundas	
Location Plan	
301020	
Author: Simon Tear	Reference: SW Tasmania SK55-22
Drawn: Tony Sargeant	File Name: Tv1070.wor
Date: June 1996	Report No: 22159
Scale: 1:100,000	Plan No: Tv1070



- 20401 Diamond Drillhole - CRAE 1995
- 20101 Diamond Drillhole - CRAE Pre 1995
- 20451 Diamond Drillhole - Other
- Major Faults
- - - CRAE Tenement Boundaries
- ▨ Ordovician Gordon Limestone (usually covered by peat and gravels)



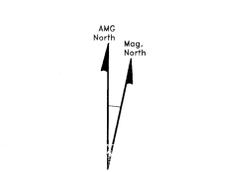
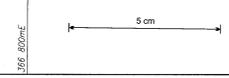
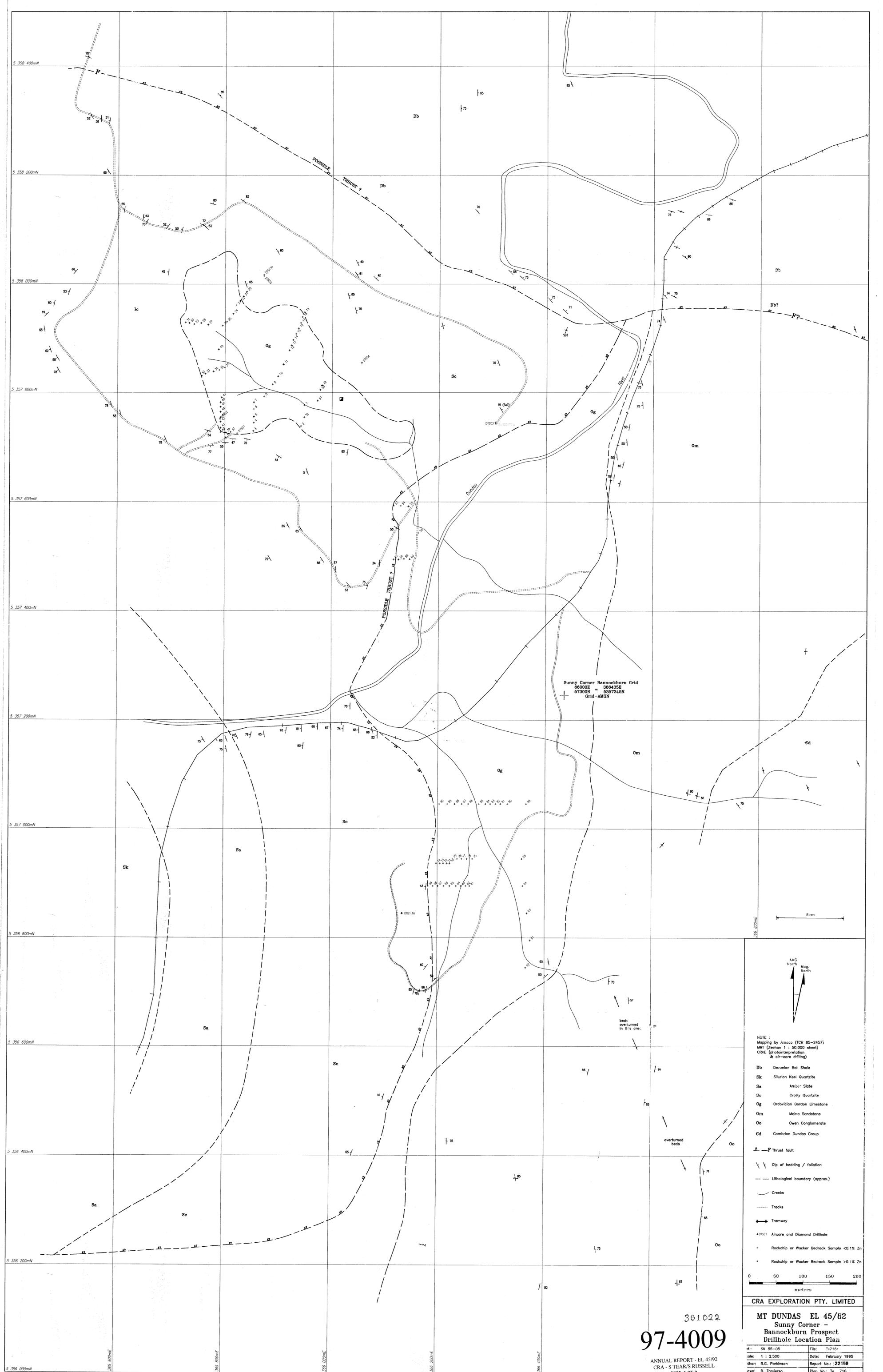
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 ANNUAL REPORT - EL 4592
 CRA - S TEARS RUSSELL
 VOL 1 OF 2

301021

CRA EXPLORATION PTY. LIMITED

ZEEHAN PROJECT
Target Plan

Ref.: SK95 - 5	File: Tv1022.dwg
Scale: 1 : 50000	Date: November 1995
Author: Simon Taar	Report No.: 22159
Drawn: T. Sargeant	Plan No.: Tv 1022



- NOTE:
 Mapping by Amoco (TCR 85-2457)
 MT (Zechar 1 : 50,000 sheet)
 CRME (interpretation & air-core drilling)
- Db Devonian Beif Shale
 - Sk Silurian Keel Quartzite
 - Sa Arnie Slate
 - Sc Cretty Quartzite
 - Og Ordovician Gordon Limestone
 - Om Moins Sandstone
 - Oo Owen Conglomerate
 - Ed Cambrian Dundas Group
- △ F Thrust fault
 - ∖ Dip of bedding / foliation
 - Lithological boundary (approx.)
 - ~ Creeks
 - Tracks
 - ⚡ Tramway
 - * 01811A Aircore and Diamond Drillhole
 - Rockchip or Wacker Bedrock Sample <0.1% Zn
 - Rockchip or Wacker Bedrock Sample >0.1% Zn



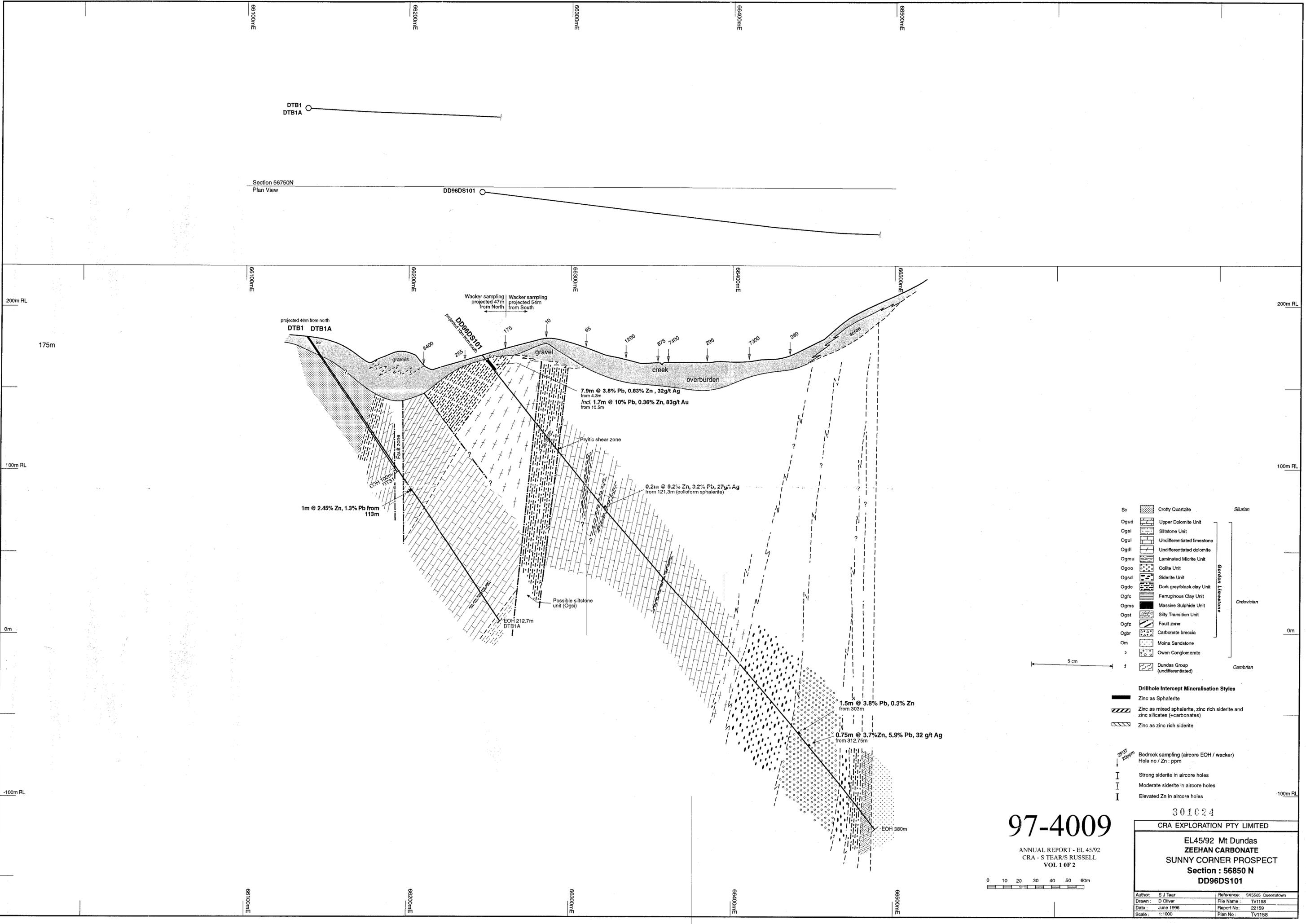
CRA EXPLORATION PTY. LIMITED

301022
97-4009

MT DUNDAS EL 45/82
 Sunny Corner -
 Bannockburn Prospect
 Drillhole Location Plan

ANNUAL REPORT - EL 45/82
 CRA - S TEAR/S RUSSELL
 VOL 1 OF 2

Drawn: R. Trivierse	File: T-716r
Scale: 1 : 2,500	Date: February 1995
Author: R.G. Parkinson	Report No.: 22150
Owner: R. Trivierse	Plan No.: Tv 716



DTB1
DTB1A

Section 56750N
Plan View
DD96DS101

200m RL

175m

100m RL

0m

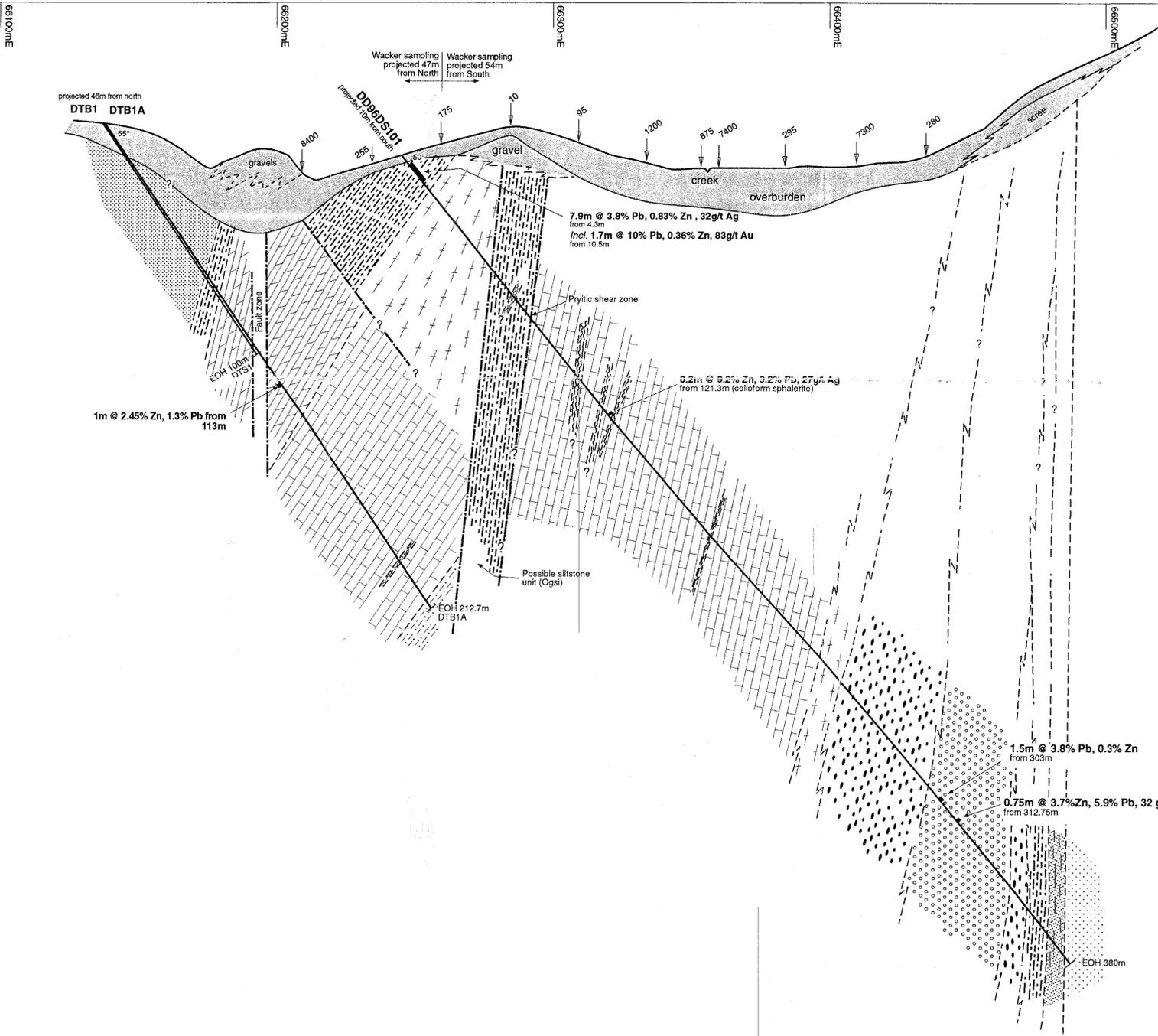
-100m RL

200m RL

100m RL

0m

-100m RL



Sc	Crotty Quartzite	Silurian
Ogud	Upper Dolomite Unit	Gordon Limestone
Ogsi	Siltstone Unit	
Ogul	Undifferentiated limestone	
Ogdl	Undifferentiated dolomite	
Ogmu	Laminated Micrite Unit	
Ogou	Oolite Unit	
Ogds	Siderite Unit	
Ogdc	Dark grey/black clay Unit	
Ogfc	Ferruginous Clay Unit	
Ogms	Massive Sulphide Unit	
Ogst	Silty Transition Unit	Ordovician
Ogfs	Fault zone	Cambrian
Ogbr	Carbonate breccia	
Om	Molna Sandstone	
Oo	Owen Conglomerate	
D	Dundas Group (undifferentiated)	

Drillhole Intercept Mineralisation Styles	
	Zinc as Sphalerite
	Zinc as mixed sphalerite, zinc rich siderite and zinc silicates (+carbonates)
	Zinc as zinc rich siderite
	Bedrock sampling (aircore EOH / wacker) Hole no / Zn : ppm
	Strong siderite in aircore holes
	Moderate siderite in aircore holes
	Elevated Zn in aircore holes

97-4009

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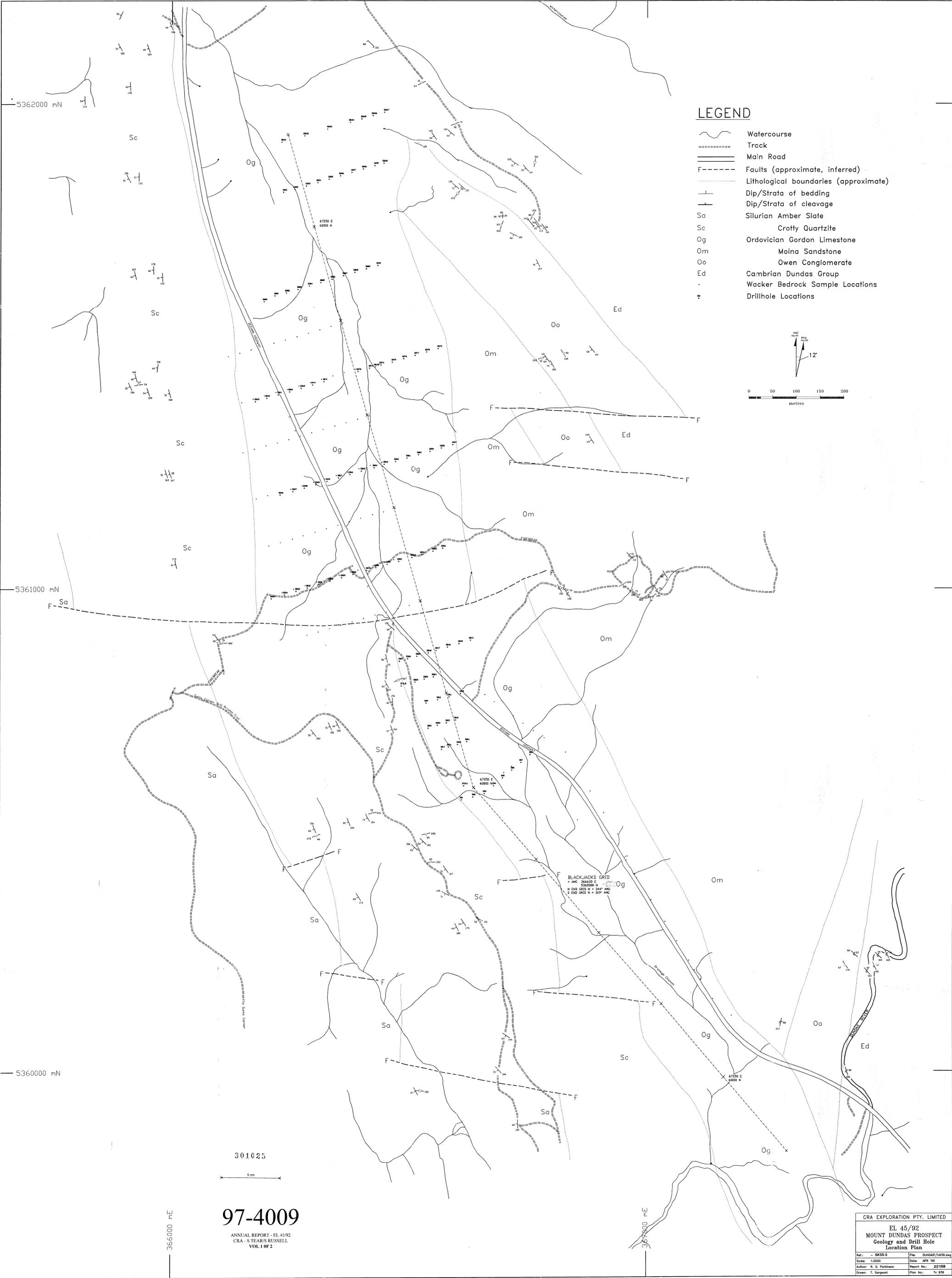


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CRA EXPLORATION PTY LIMITED

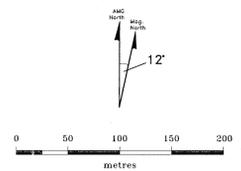
EL45/92 Mt Dundas
ZEEHAN CARBONATE
SUNNY CORNER PROSPECT
Section : 56850 N
DD96DS101

Author: S J Tear	Reference: SK5505 Cuesonstown
Drawn: D Oliver	File Name: TV1158
Date: June 1996	Report No: 22159
Scale: 1:1000	Plan No: TV1158



LEGEND

- Watercourse
- Track
- Main Road
- Faults (approximate, inferred)
- Lithological boundaries (approximate)
- Dip/Strata of bedding
- Dip/Strata of cleavage
- Sa Silurian Amber Slate
- Sc Crotty Quartzite
- Og Ordovician Gordon Limestone
- Om Moina Sandstone
- Oo Owen Conglomerate
- Ed Cambrian Dundas Group
- Wacker Bedrock Sample Locations
- Drillhole Locations

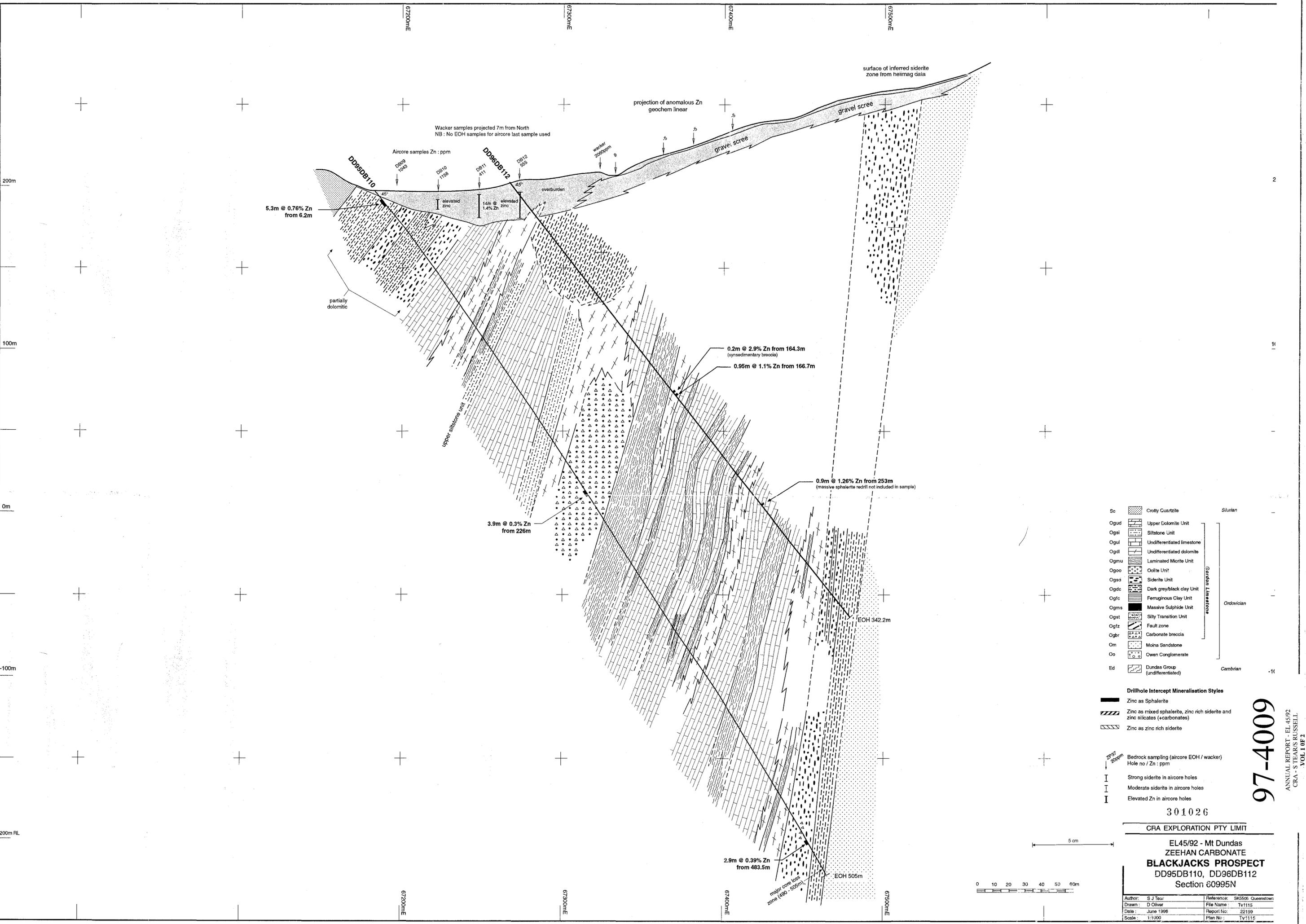


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CRA - S TEAR'S RUSSELL
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CRA EXPLORATION PTY. LIMITED	
EL 45/92	
MOUNT DUNDAS PROSPECT	
Geology and Drill Hole	
Location Plan	
Ref.: - SK55-5	File: DUNDAS_T1438.dwg
Scale: 1:2500	Date: APR '92
Author: R. G. Parkinson	Report No.: 22159
Drawn: T. Sargeant	Plan No.: Tr 938



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Ogud	Upper Dolomite Unit	Gordon Limestones
Ogsi	Siltstone Unit	
Ogul	Undifferentiated limestone	
Ogdl	Undifferentiated dolomite	
Ogmu	Laminated Micrite Unit	
Ogou	Oolite Unit	
Ogso	Siderite Unit	
Ogdc	Dark grey/black clay Unit	
Ogfc	Ferruginous Clay Unit	
Ogms	Massive Sulphide Unit	
Ogst	Silty Transition Unit	Ordovician
Ogft	Fault zone	Cambrian
Ogbr	Carbonate breccia	
Om	Moina Sandstone	
Oo	Owen Conglomerate	
Ed	Dundas Group (undifferentiated)	

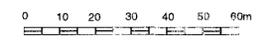
- Drillhole Intercept Mineralisation Styles**
- Zinc as Sphalerite
 - Zinc as mixed sphalerite, zinc rich siderite and zinc silicates (+carbonates)
 - Zinc as zinc rich siderite
- Drillhole Sampling**
- Bedrock sampling (aircore EOH / wacker)
Hole no / Zn : ppm
 - Strong siderite in aircore holes
 - Moderate siderite in aircore holes
 - Elevated Zn in aircore holes

301026

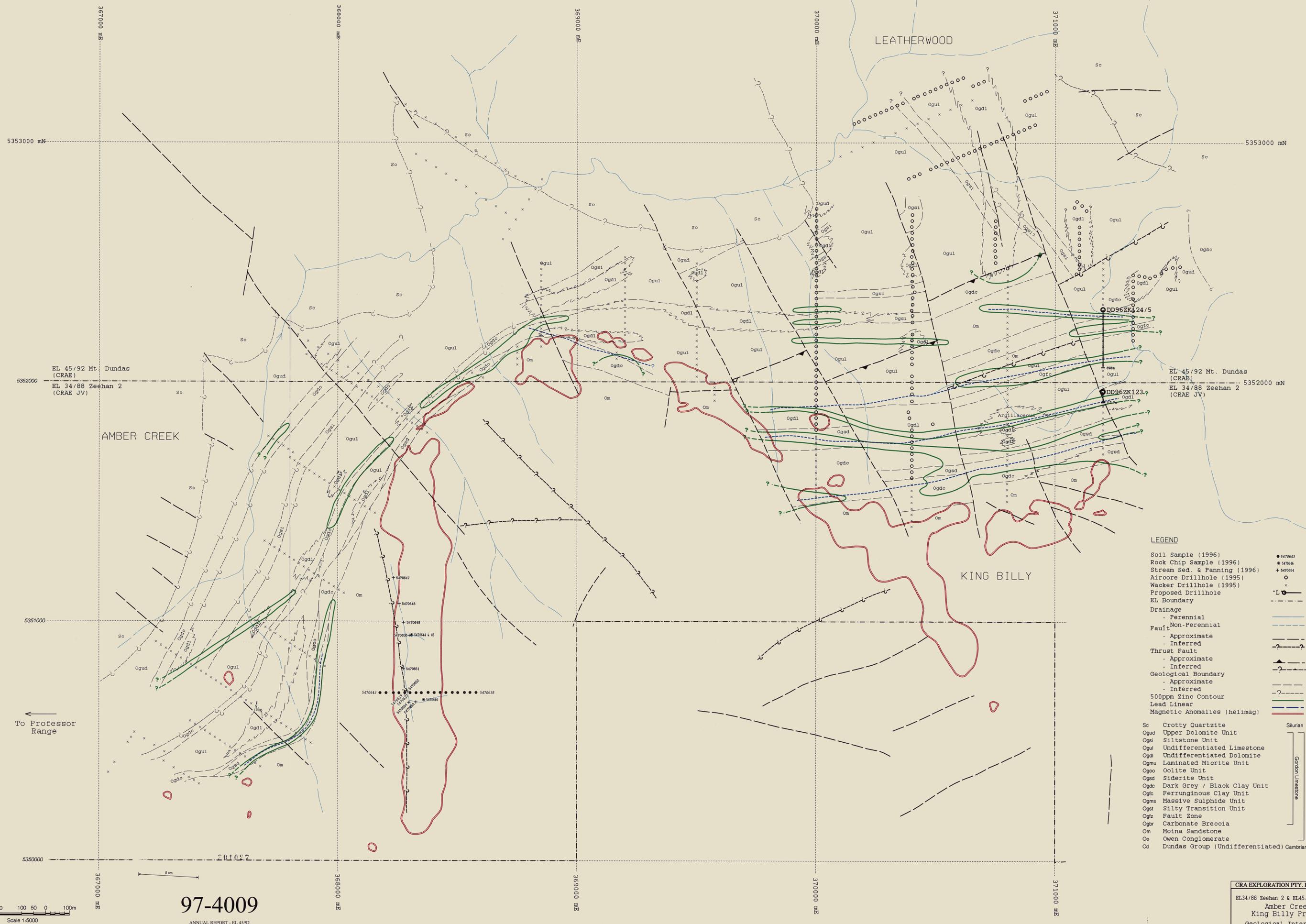
CRA EXPLORATION PTY LIMIT

EL45/92 - Mt Dundas
ZEEHAN CARBONATE
BLACKJACKS PROSPECT
DD95DB110, DD96DB112
Section 60995N

Author: S J Teal	Reference: SK5506 Queensland
Drawn: D Oliver	File Name: TV1115
Date: June 1996	Report No: 22199
Scale: 1:1000	Plan No: TV1115



97-4009
 ANNUAL REPORT - EL45/92
 CRA - S TEAR/S RUSSELL
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- LEGEND**
- Soil Sample (1996) ● 5470643
 - Rock Chip Sample (1996) ● 5470646
 - Stream Sed. & Panning (1996) + 5470684
 - Aircore Drillhole (1995) ○
 - Wacker Drillhole (1995) ×
 - Proposed Drillhole ○ with L
 - EL Boundary - - - - -
 - Drainage
 - Perennial ————
 - Non-Perennial - - - - -
 - Fault
 - Approximate - - - - -
 - Inferred - - - - -
 - Thrust Fault
 - Approximate - - - - -
 - Inferred - - - - -
 - Geological Boundary
 - Approximate - - - - -
 - Inferred - - - - -
 - 500ppm Zinc Contour ————
 - Lead Linear ————
 - Magnetic Anomalies (helimag) ————

- So Crotty Quartzite
 - Ogud Upper Dolomite Unit
 - Ogsi Siltstone Unit
 - Ogul Undifferentiated Limestone
 - Ogdl Undifferentiated Dolomite
 - Ogmu Laminated Miorite Unit
 - Ogoo Oolite Unit
 - Ogds Siderite Unit
 - Ogdo Dark Grey / Black Clay Unit
 - Ogfc Ferruginous Clay Unit
 - Ogms Massive Sulphide Unit
 - Ogst Silty Transition Unit
 - Ogiz Fault Zone
 - Ogbr Carbonate Breccia
 - Om Moira Sandstone
 - Oo Owen Conglomerate
 - Cd Dundas Group (Undifferentiated) Cambrian
- Silurian
Gordon Limestone
Ordovician

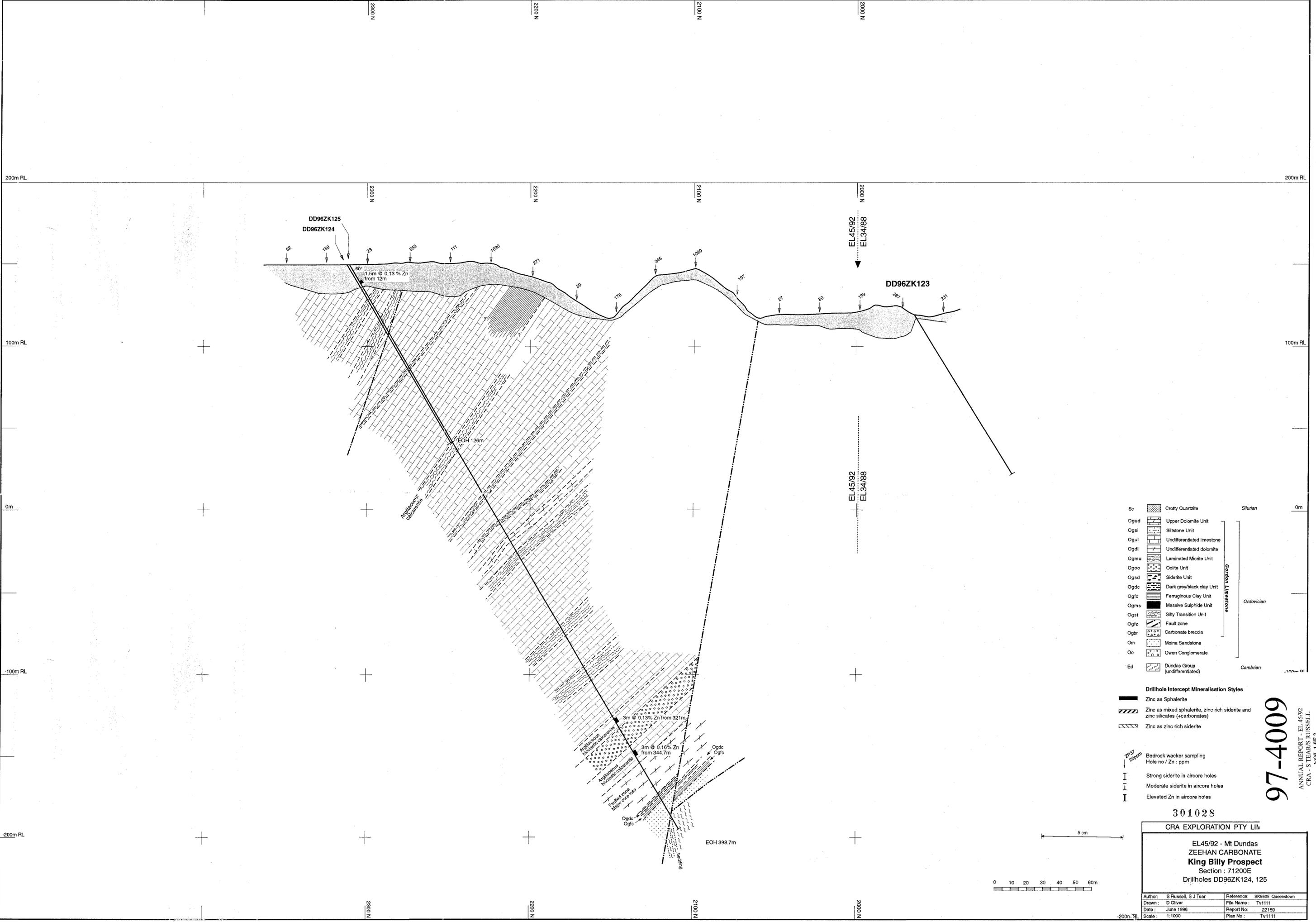
97-4009

Scale 1:5000
Datum: Australian Geospatial Datum 1996 (AGD96)
Grid: Australian Map Grid Zone 55 (AMG55)
Geological information interpreted from deep overburden sampling (wacker and aircore drilling)

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CRA - S TEAR'S RUSSELL
VOL 1 OF 2

CRA EXPLORATION PTY. LIMITED
EL34/88 Zeehan 2 & EL45/92 Mt. Dundas
Amber Creek &
King Billy Prospects
Geological Interpretation

Author: Simon Tear Mapsheet Ref: 9855-20
Drawn: Tony Saravani File Name: 79998.dwg
Date: November 1995 Report No: 22159
Scale: 1:5000 Plan No: 79998



Sc	Croty Quartzite	Silurian
Ogud	Upper Dolomite Unit	Gordon Limestone
Ogsi	Siltstone Unit	
Ogul	Undifferentiated limestone	
Ogdl	Undifferentiated dolomite	
Ogmu	Laminated Micrite Unit	
Ogoo	Oolite Unit	
Ogds	Siderite Unit	
Ogdc	Dark grey/black clay Unit	
Ogfc	Ferruginous Clay Unit	
Ogms	Massive Sulphide Unit	
Ogst	Silty Transition Unit	Cambrian
Ogz	Fault zone	
Ogbr	Carbonate breccia	
Om	Moira Sandstone	
Oo	Owen Conglomerate	
Ed	Dundas Group (undifferentiated)	

- Drillhole Intercept Mineralisation Styles**
- Zinc as Sphalerite
 - Zinc as mixed sphalerite, zinc rich siderite and zinc silicates (+carbonates)
 - Zinc as zinc rich siderite
- Bedrock wacker sampling**
Hole no / Zn : ppm
- Strong siderite in aircore holes
 - Moderate siderite in aircore holes
 - Elevated Zn in aircore holes

301028

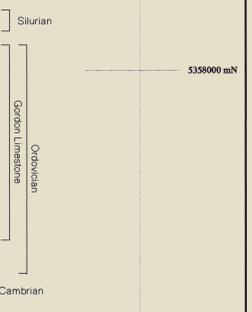
CRA EXPLORATION PTY LIM

**EL45/92 - Mt Dundas
ZEEHAN CARBONATE
King Billy Prospect**
Section : 71200E
Drillholes DD96ZK124, 125

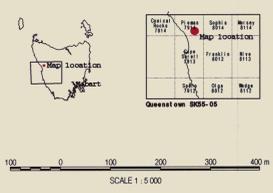
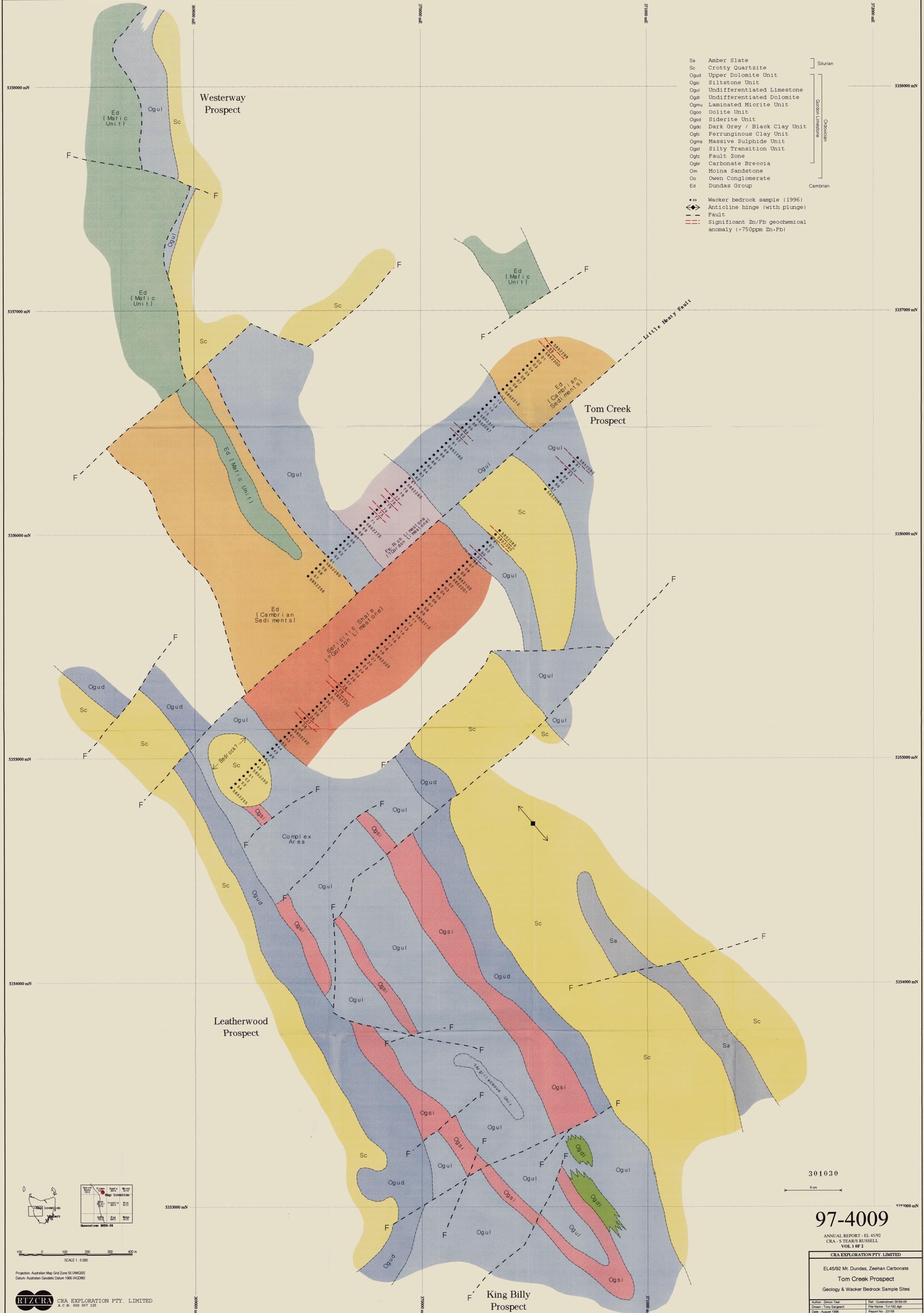
Author: S Russell, S J Tear	Reference: SK5505 Queensland
Drawn: D Oliver	File Name: Tv1111
Date: June 1996	Report No: 22159
Scale: 1:1000	Plan No: Tv1111

97-4009
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CRA - S TEAR/S RUSSELL
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- Sa Amber Slate
- Sc Crotty Quartzite
- Ogud Upper Dolomite Unit
- Ogsi Siltstone Unit
- Ogul Undifferentiated Limestone
- Ogdl Undifferentiated Dolomite
- Ogmu Laminated Micrite Unit
- Ogoo Oolite Unit
- Ogso Siderite Unit
- Ogdc Dark Grey / Black Clay Unit
- Ogfc Ferruginous Clay Unit
- Ogms Massive Sulphide Unit
- Ogst Silty Transition Unit
- Ogfr Fault Zone
- Ogbr Carbonate Breccia
- Om Moira Sandstone
- Oo Owen Conglomerate
- Ed Dundas Group



- Wacker bedrock sample (1996)
- ◄► Anticline hinge (with plunge)
- - - Fault
- Significant Zn/Pb geochemical anomaly (>750ppm Zn+Pb)

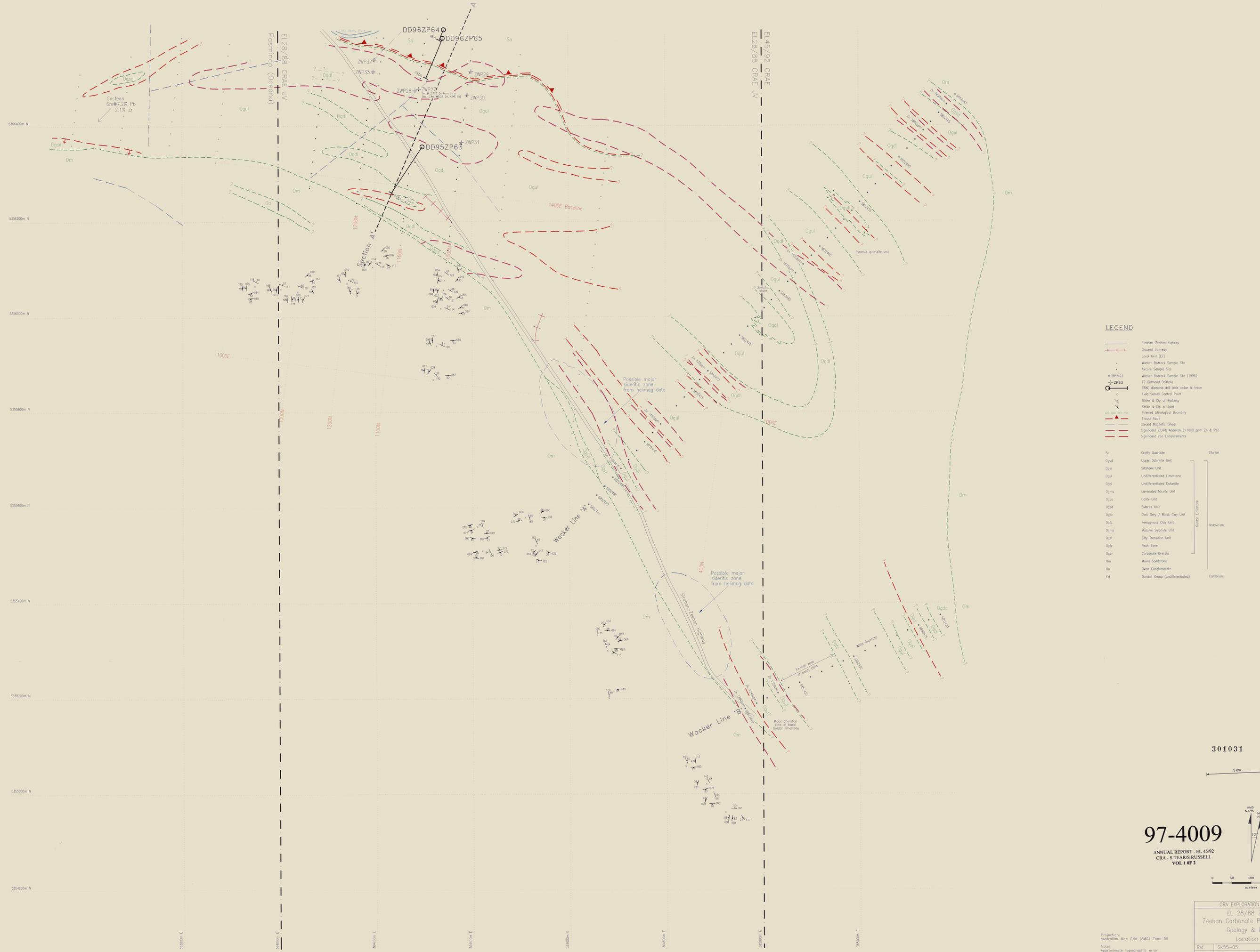


301030
5 cm

97-4009

ANNUAL REPORT - EL 45/92
CRA - STEAR'S RUSSELL
VOL 1 OF 2

CRA EXPLORATION PTY. LIMITED	
EL45/92 Mt. Dundas, Zeehan Carbonate	
Tom Creek Prospect	
Geology & Wacker Bedrock Sample Sites	
Author: Simon Tear	Ref: Queensland SK35-05
Drawn: Tony Sargeant	File Name: T11162.dgn
Date: August 1996	Report No: 23109
Scale: 1:5,000	Plot No: T11162



- LEGEND**
- Skorpion-Zeehan Highway
 - Elevated Survey
 - Local Grid (E2)
 - Wacker Bedrock Sample Site
 - Aircore Sample Site
 - Wacker Bedrock Sample Site (1996)
 - E2 Diamond Drillhole
 - CMAQ diamond drill hole collar & trace
 - Field Survey Control Point
 - Strike & Dip of Bedding
 - Strike & Dip of Joint
 - Internal Lithological Boundary
 - Thrust Fault
 - Ground Magnetic Linear
 - Significant Zn/Pb Anomaly (>1000 ppm Zn & Pb)
 - Significant Iron Enhancements
-
- Sc Cruffy Quartzite
 - Ogdul Upper Dolomite Unit
 - Siltstone Unit
 - Ogul Undifferentiated Limestone
 - Ogdil Undifferentiated Dolomite
 - Ogmu Laminated Micrite Unit
 - Ogdle Oolite Unit
 - Ogdid Siderite Unit
 - Ogdic Dark Grey / Black Clay Unit
 - Ogdic Ferruginous Clay Unit
 - Ogdms Massive Sulphide Unit
 - Ogdit Silty Transition Unit
 - Ogdiz Fault Zone
 - Ogdr Carbonate Breccia
 - Om Main Sandstone
 - Oa Dam Conglomerate
 - Ed Dundas Group (undifferentiated)
- Skorpion
Ordovician
Cambrian

301031



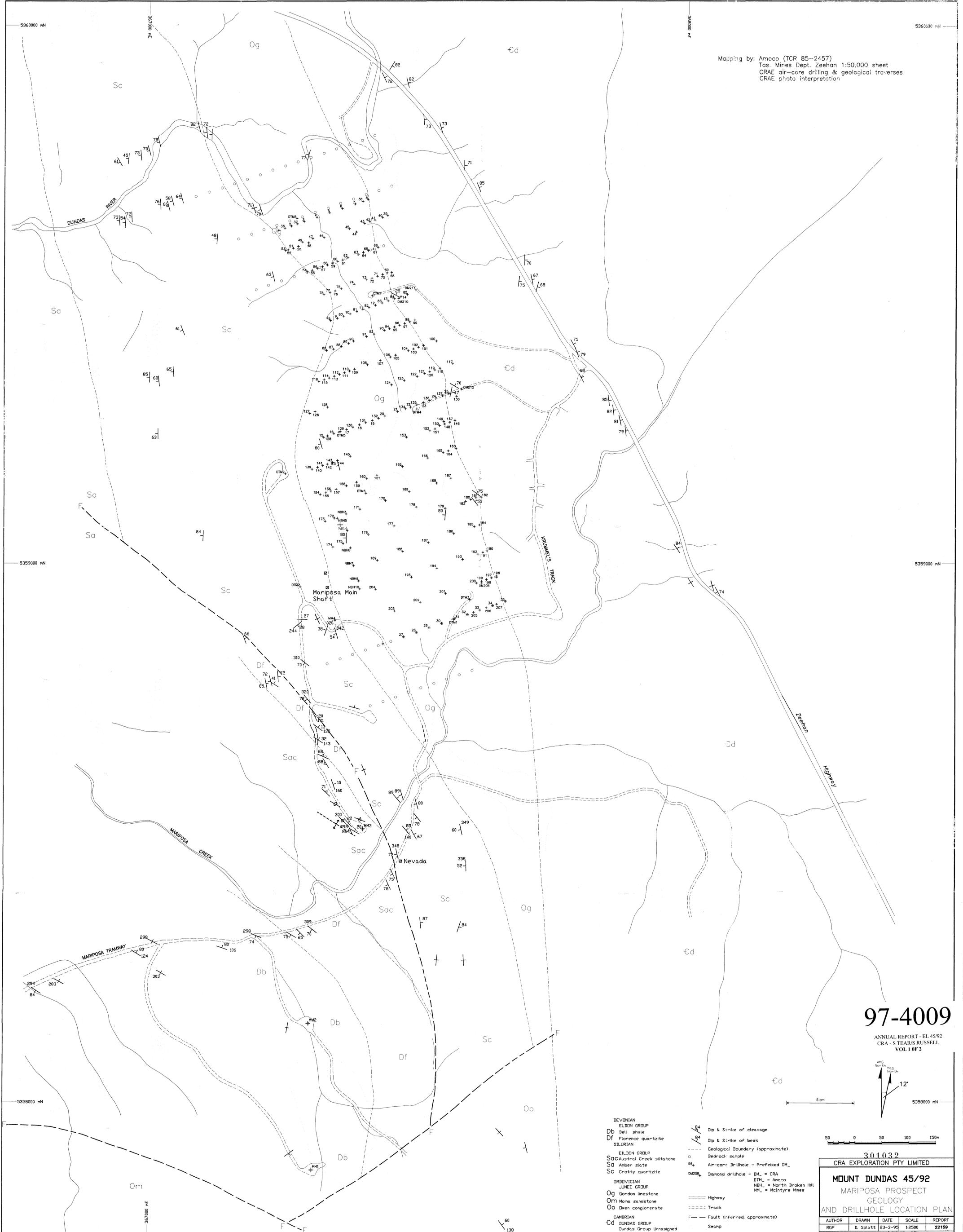
97-4009
ANNUAL REPORT - EL 4592
CRA - S TEAR'S RUSSELL
VOL 1 OF 2



Projection:
Australian Map Grid (AMG) Zone 55
Note:
Approximate topographic error
of up to 2cm.

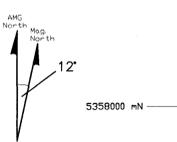
CRA EXPLORATION PTY LIMITED			
EL 28/88 ZEEHAN 1			
Zeehan Carbonate Pyramid Prospect			
Geology & Drillhole			
Location Plan			
Ref.	SK55-05	Drawn	Murderidge Drafting P/L
Author	S.Tear	Report	22159
Scale	1 : 2500	Plan No.	TV 101B
Date	14-11-95		

Mapping by: Amoco (TCR 85-2457)
 Tas. Mines Dept. Zeehan 1:50,000 sheet
 CRAE air-core drilling & geological traverses
 CRAE photo interpretation



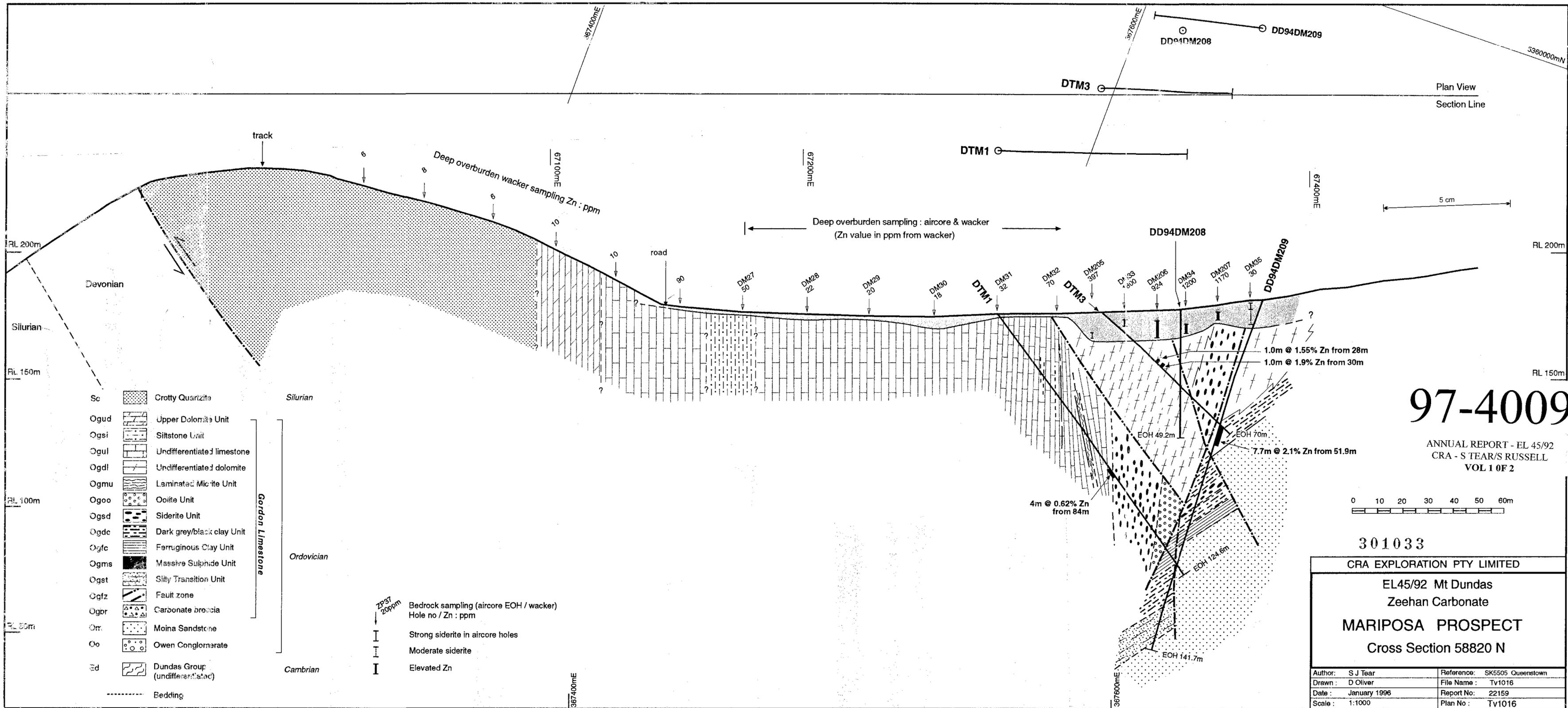
97-4009

ANNUAL REPORT - EL 45/92
 CRA - S TEAR'S RUSSELL
 VOL 1 OF 2



- DEVONIAN
 - ELDON GROUP
 - Db Belt shale
 - Df Florence quartzite
 - SILURIAN
 - EILDON GROUP
 - Sac Austral Creek siltstone
 - Sa Amber slate
 - Sc Grotty quartzite
 - BRIDGEMAN GROUP
 - JUNEE GROUP
 - Og Gordon limestone
 - OMI Home sandstone
 - OO Owen conglomerate
 - CAMBRIAN
 - Cd DUNDAS GROUP
 - Dundas Group Unassigned
- 84 Dip & Strike of cleavage
 - 84 Dip & Strike of beds
 - Geological Boundary (Approximate)
 - o Bedrock sample
 - 54 Air-core Drillhole - Prefixed DM
 - DM206 Diamond drillhole - DM = CRA
 - DM = Amoco
 - NBH = North Broken Hill
 - MM = McIntyre Mines
 - ==== Highway
 - ==== Track
 - - - Fault (Inferred, approximate)
 - Swamp

301032			
CRA EXPLORATION PTY LIMITED			
MOUNT DUNDAS 45/92			
MARIPOSA PROSPECT			
GEOLOGY			
AND DRILLHOLE LOCATION PLAN			
AUTHOR	DRAWN	DATE	SCALE
RGP	D. Splatt	23-3-95	1:2500
REF. Queenstown, SK55-05	367000	5359000	Fig. No. TV17



- Sc Crotty Quartzite
 - Ogud Upper Dolomite Unit
 - Ogsi Siltstone Unit
 - Ogul Undifferentiated limestone
 - Ogdl Undifferentiated dolomite
 - Ogmu Laminated Micrite Unit
 - Ogoo Oolite Unit
 - Ogsd Siderite Unit
 - Ogdc Dark grey/black clay Unit
 - Ogfc Ferruginous Clay Unit
 - Ogms Massive Sulphide Unit
 - Ogst Silty Transition Unit
 - Ogfs Fault zone
 - Ogpr Carbonate breccia
 - Omr Moina Sandstone
 - Oo Owen Conglomerate
 - Ed Dundas Group (undifferentiated)
- Bedding

Gordon Limestone

Silurian

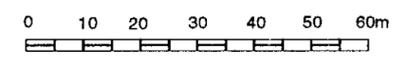
Ordovician

Cambrian

- TP37 20ppm Bedrock sampling (aircore EOH / wacker)
Hole no / Zn : ppm
- I Strong siderite in aircore holes
- I Moderate siderite
- I Elevated Zn

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CRA EXPLORATION PTY LIMITED

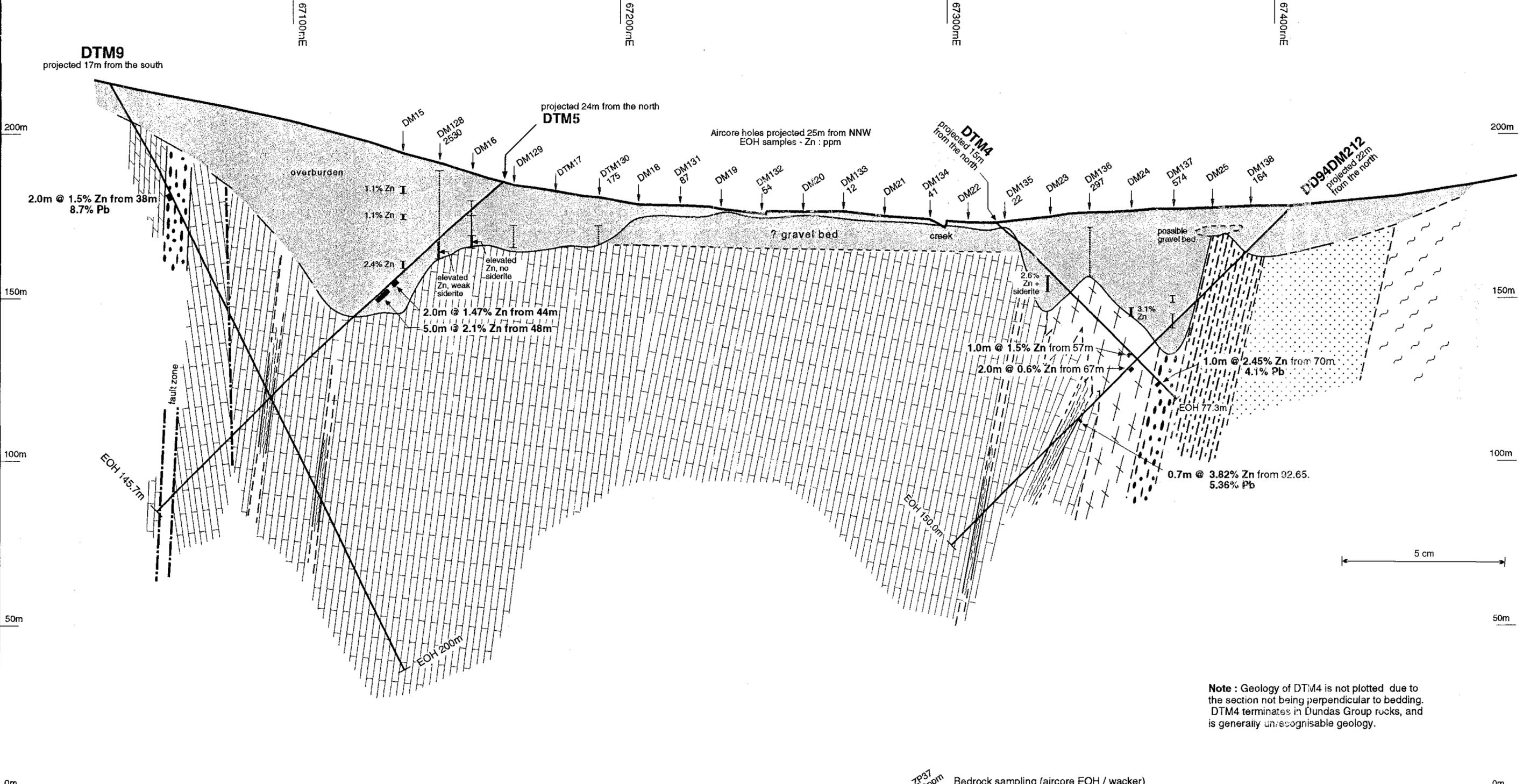
EL45/92 Mt Dundas
Zeehan Carbonate
MARIPOSA PROSPECT
Cross Section 58820 N

Author: S J Tear	Reference: SK5505 Queenstown
Drawn: D Oliver	File Name: Tv1016
Date: January 1996	Report No: 22159
Scale: 1:1000	Plan No: Tv1016

97-4009

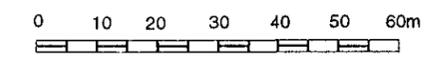
ANNUAL REPORT - EL 45/92
CRA - S TEAR/S RUSSELL
VOL 1 OF 2

Sc		Crotty Quartzite	Silurian
Ogud		Upper Dolomite Unit	Gordon Limestone
Ogsi		Siltstone Unit	
Ogul		Undifferentiated limestone	
OgdI		Undifferentiated dolomite	
Ogmu		Laminated Micrite Unit	
Ogoo		Oolite Unit	
Ogsd		Siderite Unit	
Ogdc		Dark grey/black clay Unit	
Ogfc		Ferruginous Clay Unit	
Ogms		Massive Sulphide Unit	
Ogst		Silty Transition Unit	Ordovician
Ogz		Fault zone	
Ogbr		Carbonate breccia	Cambrian
Om		Moina Sandstone	
Oo		Owen Conglomerate	
Ed		Dundas Group (undifferentiated)	



Note : Geology of DTM4 is not plotted due to the section not being perpendicular to bedding. DTM4 terminates in Dundas Group rocks, and is generally unrecognisable geology.

- Bedrock sampling (aircore EOH / wacker)
Hole no / Zn : ppm
- Strong siderite in aircore holes
- Moderate siderite in aircore holes
- Elevated Zn in aircore holes



301034

CRA EXPLORATION PTY LIMITED	
EL45/92 Mt Dundas Zeehan Carbonate MARIPOSA PROSPECT Cross Section : 59170 N Drillholes DTM4, 5, 9 & DD94DM212	
Author: S J Tear	Reference: SK5505 Queenstown
Drawn: D Oliver	File Name: Tv1015
Date: Decemberr 1995	Report No: 22159
Scale: 1:1000	Plan No: Tv1015

301036

CRA EXPLORATION PTY. LIMITED
ACN 000 057 125

EL45/92
19 MAY 1997
See folio 41

**Progress Report
For The Period Ending 15 March 1997
EL 45/92 Mt Dundas, Tasmania**

Volume II of II

MICROFILMED
FICHE No.014312-21

Author: SJ Tear and SAJ Russell
Date: March 1997
Licence Holder: CRA Exploration Pty. Limited
Submitted to: Chief Geologist, SE District
Copies to: Mineral Resources Tasmania
CRAE - SE District
CRAE - Zeehan
CRAE - ETIG

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97-4009

CRAE Report No. 22159

ANNUAL REPORT - EL 45/92
CRA - S TEAR/S RUSSELL
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Appendix I

The Gordon Limestone Lithostratigraphy

Zeehan Carbonate Project

In the Zeehan sub-basin the Gordon Limestone has a thickness of 500m (DDH ZB1007). Drilling by CRAE has subdivided this formation into lithologic and lithostratigraphic units. These subdivisions have been utilised in the drillhole logging and are displayed below.

Drill Hole Logging Formation / Lithology Codes

Sc	=	Crotty Quartzite		SILURIAN
Ogud	=	Upper Dolomite		ORDOVICIAN
Ogsi	=	Siltstone Unit		
Ogul	=	Undifferentiated limestone		
Ogdl	=	Undifferentiated dolomite		
Ogmu	=	Laminated Micrite Unit		
Ogoo	=	Oolite Unit		
Ogsd	=	Siderite Unit		
Ogdc	=	Dark Grey / Black Clay Unit		
Ogfc	=	Ferruginous Clay Unit		
Ogms	=	Massive Sulphide Unit		
Ogst	=	Silty Transition Unit		
Om	=	Moina Sandstone		
Oo	=	Owen Conglomerate		
Ed	=	Dundas Group (undifferentiated)		CAMBRIAN

An explanation for the sub-divisions is given below.

1) The Crotty Quartzite

This formation is a sequence of deltaic quartzites of Silurian age. However in drillcore there appears to be no consistency in lithologies at its base. The question of faulted contacts is brought to mind and the unit has not been subdivided. In DD95ZM190 the sequence passes from white massively bedded sandstone into interbedded/interlaminated sands, shales and silts before finally passing into dark shales (fissile) and clays (possible fault gouge). This is possibly matched in DD95DS98 but there are considerable thickness variations, as would be expected in the depositional environment.

2) The Upper Dolomite Unit (Ogud)

This is a dolomitised limestone unit that always occurs beneath the Crotty Quartzite contact. Its thickness is variable, up to 100m in DD95ZR104 and down to 25m in DD95ZM190. It is possible that the dolomitisation is fault related, the fault being the Crotty Quartzite/Gordon Limestone Contact.

3) The Siltstone Unit (Ogsi)

This is an argillaceous calcisiltite with bands of bioclastic calcarenite and nodular calcisiltite. Locally it is unreactive to dilute hydrochloric acid. It generally occurs at the base of the top third of the stratigraphic column and has an average thickness of 15m.

There are transitional upper and lower sequences to the main Siltstone Unit.

4) Undifferentiated Limestone (Ogul)

This is a bucket term to fit all limestones that do not separate out into any distinctive lithology subdivision

5) Undifferentiated Dolomite (Ogdl)

Localised zones of dolomitised limestone occur within various parts of the stratigraphic column. Unless it is part of the Upper Dolomite, it is referred to as undifferentiated dolomite. The dolomitisation is attributable to faults and/or due to mineralisation, often Ogdl units have elevated base metal values.

6) Laminated Micrite Unit (Ogmu)

This is a distinctive lithofacies comprising of banded and stylolitic fine grained calcarenites and micrites. Sometimes the laminae consist of argillaceous material. The individual laminated units have an upper thickness limit of generally <3m except in specific circumstances eg DD95ZP63. Birds eye micrite units are often associated with the laminated zones. The unit is not a marker horizon but occurs with sufficiently regularity in drillcore as to be able to assist stratigraphic correlations.

7) Oolite Unit (Ogoo)

This unit occurs in outcrop at the Grieves Prospect as a dolomitised equigranular calcarenite unit - thought to be an oolite. It is believed that the well sorted, clean medium grained bioclastic calcarenite unit, locally oolitic, is really part of a package of well sorted calcarenites seen towards the base of the limestone sequence, possibly representing a sand bar.

8) Siderite Unit (Ogsd)

The Siderite Unit is an alteration facies imposed on and replacing limestone (?dolomitised) at the base of the Gordon Limestone. It is regarded as being part of the alteration associated with the replacement Zn/Pb mineralisation.

Siderite alteration also occurs at Grieves in the middle of the limestone sequence. Siderite is also present at the upper sandstone/limestone contact at Blackjacks (DD95DB110) and Myrtle (DD95ZM190).

9) Dark Grey/Black Clay Unit (Ogdc)

These clays are encountered at surface and in drill core above 300m vertical depth. They generally are to be found at the base of the limestone, although they can occur at the top contact (DD95DB110). Dark clays can also be found in the top of drillholes where surficial weathering of the limestones has produced a black pug - depths of 45 vertical metres have been recorded (DD95ZR103). The exact nature of the clays at the basal part of the limestone is unclear. They always underlie the Oolite Unit, often can be intermixed with siderite zones of the Siderite Unit and can be part of the underlying Silty Transition Unit. Whether they are products of deep surface weathering, paleo-weathering, fault zones or mineral-related alteration remains to be resolved.

10) Ferruginous Clay Unit.

These are light grey, orange, yellow, brown and red coloured clays, often banded. They generally occur beneath the Dark Clay Unit, although at Grieves they can be intermixed with it. In some instances they are sericitic, in others they can be sandy (fine grained quartz grains). They are heavily limonitic and their exact nature is unsure. It is possible that the clays are part of the Silty Transition Unit or even the underlying Moina Sandstone. Alternatively they could be weathering products of mineralisation associated with the dark clay unit.

11) Silty Transition Unit

This is the basal unit of the Gordon Limestone. It comprises of a series of partly dolomitised limestones and fine grained arenaceous units with black siltstones. It appears to have a well defined thickness of between 12-16m and in some instances overlies the Moina Sandstone conformably. Mineralisation would appear to lie immediately above the top contact of the Silty Transition Unit.

12) Moina Sandstone

This sandstone formation is characterised by a silicic quartzite with localised conglomerate bands, often becoming a pink silicic quartzite.

Appendix II

Exploration by CRAE Prior to 16/3/96

Year 1

(Parkinson 1994) Reviews of Amoco-CSR open-file data highlighted the Mariposa and Sunny Corner areas as having anomalous surface geochemistry. At Mariposa prospect, costeans returned best results of 14m @ 3.0% Zn from the historically exploited upper zone, and 8m @ 6.2% Zn and 395 ppm Ag from the lower zone contact with the Dundas Group. Costeans at Sunny Corner produced up to 22m at 3.9% Zn, including 6m at 9.7% Zn and 74 ppm Ag. Percent levels of Zn were also detected in costeans at Blackjacks and Bannockburn.

Limited drilling by Amoco-CSR failed to locate economic mineralisation, although sub-percent levels of Pb and Zn were common over wide areas, indicating substantial alteration systems.

Aircore drilling by CRAE during 1993-94 at Mariposa returned significant intersections from the lower zone contact with the Dundas Group including:-

59450N	DM70	10m	@	4.1% Zn	2.5% Pb	19 ppm Ag
59400N	DM13	6m	@	4.1% Zn	1.5% Pb	16 ppm Ag
59350N	DM97	8m	@	5.0% Zn	2.9% Pb	60 ppm Ag
59300N	DM102	8m	@	18.5% Zn	16.9% Pb	231 ppm Ag
59250N	DM118	8m	@	4.6% Zn	6.5% Pb	95 ppm Ag
59150N	DM150	6m	@	3.5% Zn	2.5% Pb	88 ppm Ag
58850N	DM199	8m	@	4.6% Zn	3.2% Pb	185 ppm Ag

Mineralisation appears to be subvertical and narrow, the widths above being apparent thicknesses.

Year 2

(Parkinson 1995) Diamond drilling at Mariposa consisted of five holes totalling 554m and tested the lower sandstone/limestone contact (DM208-DM212) intersections include:-

58850N	DM209	7.7m	@	2.1% Zn	<0.1% Pb	<5 ppm Ag
59400N	DM210	5.4m	@	1.4% Zn	1.7% Pb	25 ppm Ag
59400N	DM211	1.8m	@	9.8% Zn	6.5% Pb	107 ppm Ag
59200N	DM212	0.7m	@	3.8% Zn	5.4% Pb	45 ppm Ag

Additional work comprised of mapping, petrological studies and resampling of EZ diamond drillholes.

Aircore drilling by CRAE during 1994 at Sunny Corner-Bannockburn returned significant intersections from the Upper Zone contact with Crotty Quartzite including:

DS37	6m	@	3.2% Zn	1.8% Pb	23 ppm Ag
DS38	15m	@	3.6% Zn	2.2% Pb	18 ppm Ag
DS53	3m	@	5.4% Zn	4.8% Pb	23 ppm Ag
DS68	12m	@	1.3% Zn	6.7% Pb	27 ppm Ag

Aircore drilling by CRAE during 1994 at Blackjacks (109 holes) identified substantial thicknesses of siderite alteration up to 50m wide at the Lower Zone contact with underlying clastics. Zinc intercepts were highly anomalous, but generally sub-percent. Better results included:

DB11	14m	@	1.4% Zn
DB35	3m	@	1.6% Zn
DB78	3m	@	1.6% Zn
DB99	3m	@	1.9% Zn
DB109	1.5m	@	2.2% Zn (ended in mineralisation)

Regional reconnaissance and data capture work was completed.

Year 3

(Tear 1996) Two diamond drillholes were drilled at Blackjacks. DD95DB110 intersected a >30m thick dolomite breccia with elevated zinc values up to 0.3% Zn over 3.6m. Siderite alteration and elevated zinc values were also intersected at the upper and lower sandstone/limestone contact. DD95DB111 intersected a sphalerite and calcite breccia zone 0.3m @ 4.46% Zn and 1.89% Pb from 75m.

Diamond drilling at Sunny Corner consisted of 2 holes for 584m.

DD95DS97 - best intercept of

1.4m @ 1.02% Zn and 6.13% Pb from 182.6m (in dolomite)

DD95DS98 - best intercepts are course grained sphalerite associated with the Siltstone Unit of the Gordon Limestone

0.92m @ 10% Zn from 310.8m
0.82m @ 6.2% Zn from 313m.

Aircore drilling at King Billy consisted of 99 holes for 2208m. Results showed minor base-metal intersections:

AC95ZK4	6m	@	0.28%	Zn	0.77%	Pb
AC95ZK46	6m	@	1.3%	Zn	0.2%	Pb
AC95ZK22	3m	@	1.67%	Zn	<0.1%	Pb
AC95ZK39	3m	@	2.64%	Zn	1.3%	Pb

Aircore drilling at Leatherwood (53 holes for 456m) returned disappointing results. Best values were:

AC95DL7	3m	@	0.15%	Zn
AC95DL8	6m	@	0.1%	Zn
AC95DL53	2m	@	0.1%	Zn

A summary of wacker bedrock sampling is included below:

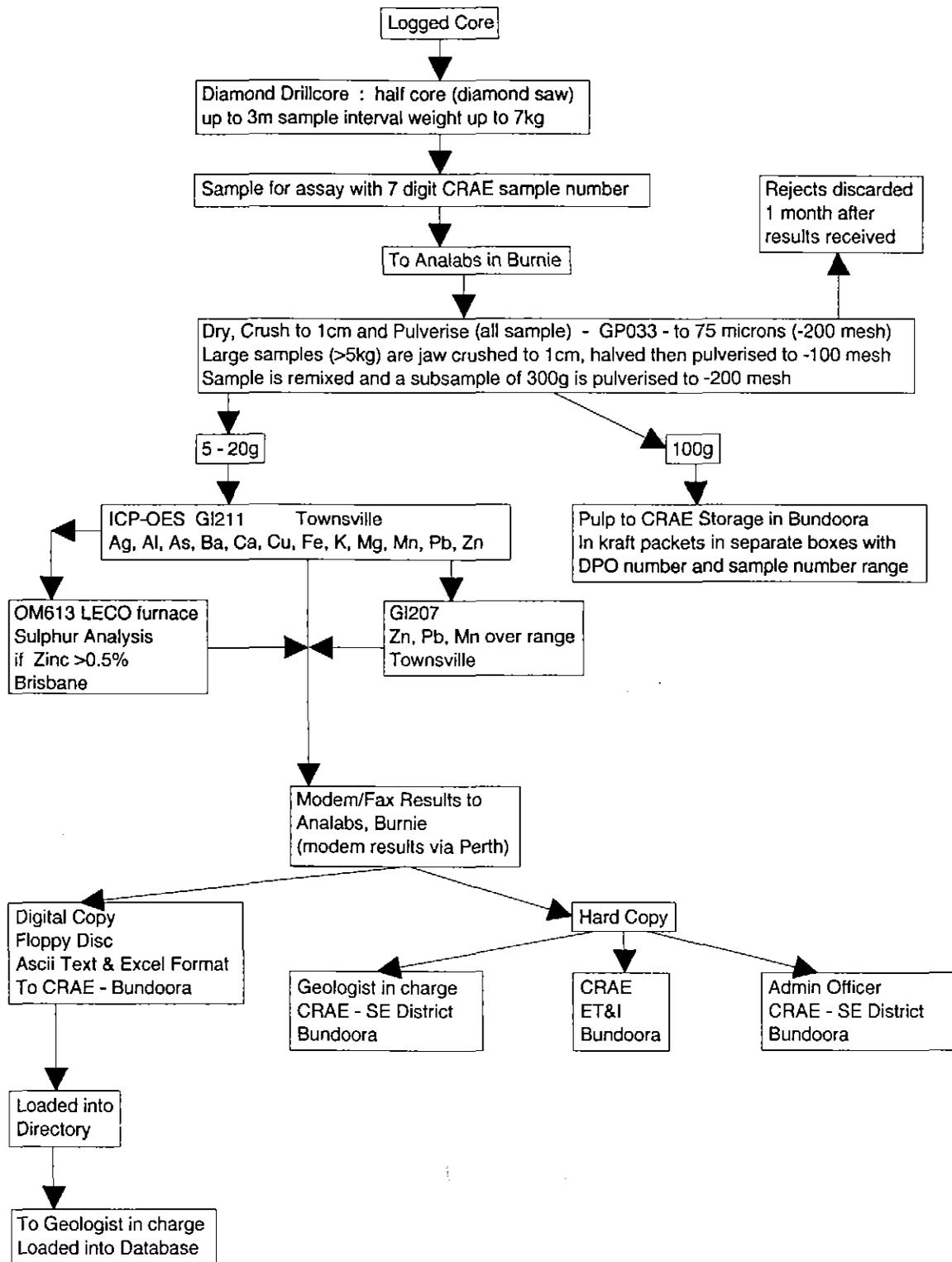
Prospect	No. of Samples	Depth		Zinc		Lead	
		Range (m)	Average (m)	Max (ppm)	Mean (ppm)	max (ppm)	Mean (ppm)
King Billy	74	1.5-35	9.1	3050	172	1590	58
Amber Creek	49	0-24	7.2	730	53	2120	73
Sunny Corner	91	0-19.7	4.9	6700	420	16700	618
S Mariposa	26	0.2-8.1	2.5	4420	420	2260	199
Westerway	15	1.1-12.5	5	8860	1564	3210	479
Blackjacks	22	1.5-25	11.6	2790	817	1920	227

A detailed helimag survey was flown on the basis that mineral related siderite alteration is slightly magnetic. Flight lines were flown perpendicular to the strike of the limestone. Line spacing was approximately 60m with an average flight height of 30m and sampling intervals were approximately every 3-4m.

Appendix III

Flow Sheet for Analysis of Diamond Drillcore Samples

Diamond Drillcore Sampling Flowsheet



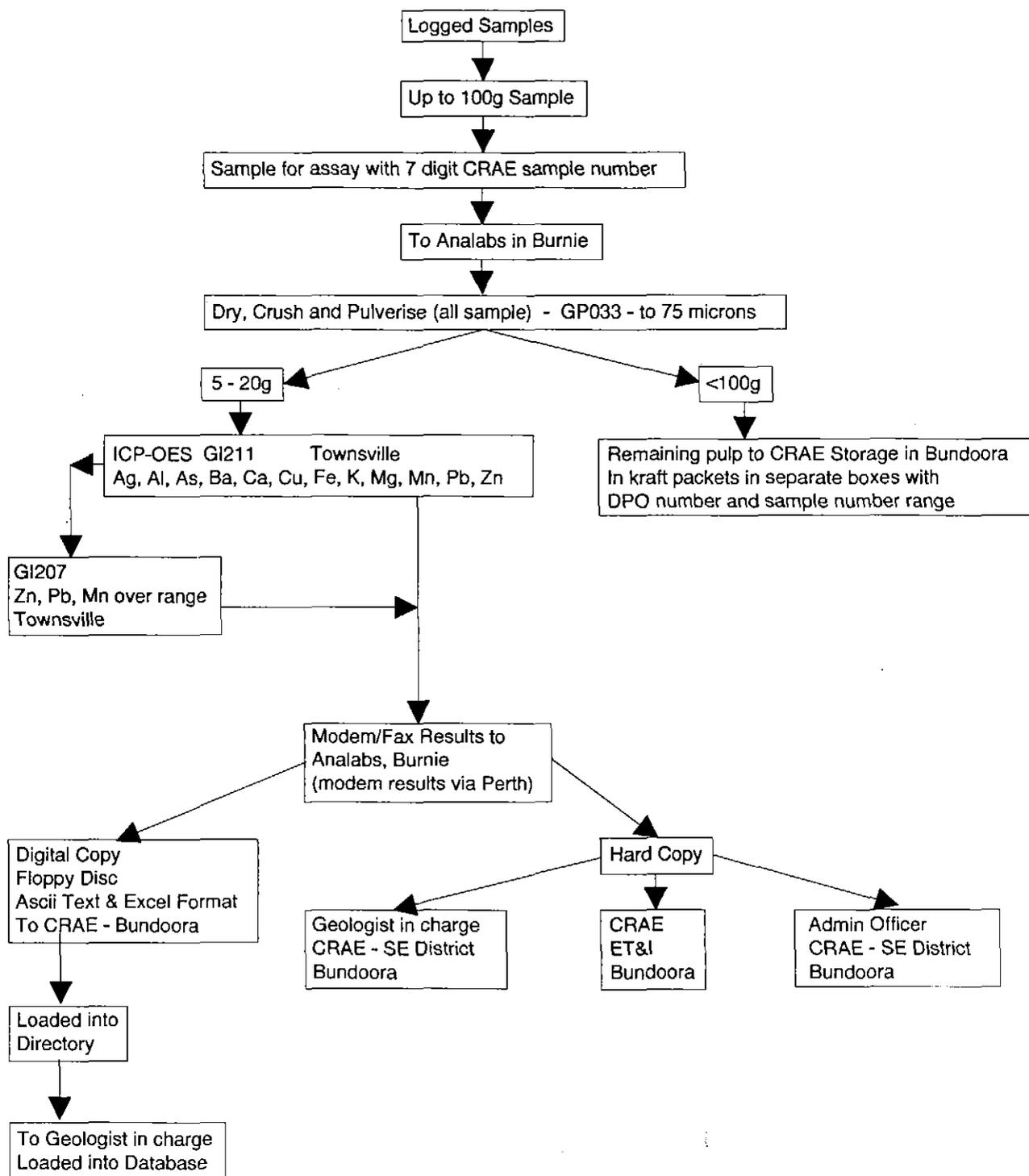
GI211 - Aqua Regia/Perchloric/hydrofluoric acid : acid digest
 GI207 - Aqua Regia/Perchloric/hydrofluoric acid : acid digest

S.J.Tear August 1996

Appendix IV

Flow Sheet for Analysis of Wacker Bedrock Samples

Bedrock Wacker Sampling Flowsheet



GI211 - Aqua Regia/Perchloric/hydrofluoric acid : acid digest
 GI207 - Aqua Regia/Perchloric/hydrofluoric acid : acid digest

S.J.Tear August 1996

Appendix V

Sunny Corner - Diamond Drill Logs and Assay Results (DD96DS99-101)

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 1 of 5

AMG: 56606AE 5357571N

CO-ORDINATES: 081° Mag

DRILLERS: DDTAS COMMENCED 24/1/96

RL COLLAR: 18.3m INCLINATION: 50°

DRILL TYPE: LY38(H) COMPLETED 19/2/96

TENEMENT NAME: MT DUNDAS No.

PLAN - MAP REFERENCE: SUNNY CORNER

DEPTH: 165.9 HOLE No. 0896 DS99

CASING LEFT: DPO No(s) 82152

DEPTH		Core Rec. %	RAD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAC		SUS		REC From	REC To	REC (M)	REC %
				Depth	Value	Depth	Value											
0	8	-	-	Qha	Overburden						8	0	235	0	0	8	0	-
8	17.5	4x	33	Sc	Med/fine grained sandstone with fine grained conglomerate	Bedding 70° to c/a.					8.5	0	24	0	8	11.5	1	29
											9	0	24.5	0	11.5	14.5	1.6	53
											9.5	0	25	0	14.5	20.5	2.05	34
											10	0	25.5	0	20.5	23.5	2.3	77
17.5	22.5	4x	50	Sc	Limonitic fine/med grained sandstone - rotted core becoming grey/green d/hole.		5852801	17.5	20.5		10.5	0	26	0	23.5	26.5	1.8	50
											11	0	26.5	0	26.5	29.5	2.2	73
											11.5	0	27	0	29.5	32.0	2.3	92
22.5	26.5	3x	63	Sc	Med grained brown/grey sandstone with x-bedding; locally coarser and localised core loss.						12	0	27.5	0	32.0	34	1.6	81
											12.5	0	28	0	34.0	35.5	1.5	100
											13	0	28.5	0	35.5	39.1	1.4	53
											13.5	0	29	0	38.1	41.5	3.8	100
											14	0	29.5	0	41.5	44.1	2.5	97
											14.5	0	30	0	44.1	47.4	2.8	86
26.5	30	3x	80	Sc	Mixed lt grey/green clays fine/med sandstones (locally coarse); >1cm qtz clots.						15	0	30.5	0	47.4	50.0	2.6	100
											15.5	0	31	0	50.0	53.5	3.4	97
											16	0	31.5	0	53.5	56.2	2.86	96
											16.5	0	32	0	56.2	58.3	1.75	88
30	52.5	28	90	Sc	Med grained white uniform sandstone with occ limonitic patches; occ silicic look to rock; becoming greyer downhole.	occ fault breccia/clay eq 32m, 41m. Bedding 70° to c/a.	02	31.0	32.0		17	0	32.5	0	58.3	59.5	1.7	100
							03	41.0	42.0		17.5	0	33	0	59.5	61.1	0.4	24
							04	51.0	52.0		18	0	33.5	0	61.1	62.5	1.35	96
											18.5	ck	34	0	62.5	63.8	0.25	19
											19	1	34.5	0	63.8	65.5	1.7	100
											19.5	2	35	0	65.5	66.6	1.1	100
52.5	53.2	4B	80	Sc	Black shale unit	Bedding 75° to c/a.					20	2	35.5	0	66.6	68.5	1.75	92
											20.5	0	36	0	68.5	69.6	0.6	70
53.2	59	2c	63	Sc	White silicic med/fine grained sandstone with localised breccias(?)		05	58.3	59.5		21	0	36.5	0	69.6	70.5	0.4	48
							06				21.5	0	37	0	70.5	71.8	1.3	100
											22	0	37.5	0	71.8	72.5	0.7	100
											22.5	0	38	0	72.5	74.1	1.05	64
59	61.1	5x	67	Ogdc	Rotted dk grey/black/brown clays	Pass. fault breccias at 60.8m	06	59.5	61.1		23	0	38.5	0	74.1	75.6	1.4	95

SURVEYS
 50m 54° to 097°
 98m 52.5° to 099°
 152m 55.5° to 102°

301052

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 2 of 5

TENEMENT NAME... MT. DUNDAS No. 45/92

PLAN - MAP REFERENCE... SUNNY CORNER

DEPTH... 165.9M HOLE No. DS99

CASING LEFT... DPO No(s) 82152

CO-ORDINATES 366069E 535757N AZIMUTH 081 Mag DRILLERS DOTAS COMMENCED 24/1/96
RL COLLAR 183m INCLINATION 50° DRILL TYPE LY38(H) COMPLETED 19/2/96

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAC SUS				REC (From)	REC (To)	REC (M)	REC (To)
61.1	69	5x	83	Ogk	Dark grey clay - possible dolomite		5852807	61.1	62.5		39	0	54.5	0	75.6	78.8	1.57	4.5
							08	62.5	63.8		37.5	0	55.5	0	73.8	80.1	1.2	9.0
69	69.6	5x	50	Ogk	Sandstone fragments in grey light grey clays		09	63.8	65.5		40	0	55.5	0	80.1	81.5	1.15	8.4
							10	65.5	66.6		40.5	0	56	0	81.5	83.2	1.5	8.9
							11	66.6	68.5		41	0	57.5	0	83.2	84.4	1.1	9.4
69.6	70.0	5x	50	Ogk	Sandy clay - metal content? specks of pyrite		12	68.5	69.6		41.5	0	57	0	84.4	86.0	0.8	8.2
							13	69.6	70.0		42	0	57.5	0	86.0	87.6	1.5	9.4
70.0	72.5	5	80	Ogk	Dark grey? sandstone with washed out clays Ferruginous clay 70.7-71.2 NQ @ 72.3m		14	70.0	72.5		42.5	0	58	0	87.6	88.4	0.6	7.4
											43	0	58.5	0	88.4	89.5	0.9	7.9
											43.5	0	59	0	89.5	90.2	0.7	9.6
											44	0	59.5	0	90.2	91.0	0.7	8.5
											44.5	0	60	0	91.0	92.5	1.4	9.3
72.5	91.2	4x	84	Ogud	Dolomitised argillaceous calcarenite - is heavily fractured? fault altered minimal veining; poss syn-sed breccias	Partial to complete dolomitisation @ 73m 3cm clay gouge with galena blebs 75° to c/a.	15	72.5	74.1		45	0	60.5	10	92.5	93.3	0.8	10.0
							16	74.1	75.6		45.5	0	61	0	93.3	94.9	1.6	10.0
							17	75.6	77.2		46	0	61.5	0	94.9	96.5	1.5	9.1
							18	77.2	78.8		46.5	0	62	0	96.5	97.2	0.5	7.4
							19	78.8	80.1		47	0	62.5	0	97.2	97.9	0.7	9.6
							20	80.1	81.5		47.5	0	63	0	97.9	98.5	0.5	8.3
91.2	96.8	968	100	Ogud	Grey dolomitised calcarenite with minor argillaceous material locally small breccias		21	81.5	83.2		48	0	63.5	5	98.5	99.6	1.05	9.5
							22	83.2	84.4		48.5	0	64	0	99.6	101.5	1.7	9.1
							23	84.4	86.0		49	0	64.5	0	101.5	102.9	1.3	9.6
							24	86.0	87.6		49.5	0	65	4	102.9	104.5	1.6	10.0
96.8	98.5	4x	100	Ogud	As before but broken core		25	87.6	88.4		50	0	65.5	5	104.5	106.0	1.5	10.0
							26	88.4	89.5		50.5	0	66	0	106.0	107.5	1.5	10.0
98.5	101	3x	100	Ogud	Broken core but possibly more argillaceous, with clay zones - 60° to c/a.	Minor galena in fractures and calcite/dolomite veins rare pyrite blebs	27	89.5	91.0		51	0	66.5	0	107.5	109.1	1.6	10.0
							28	91.0	92.5		51.5	0	67	0	109.1	110.5	1.4	10.0
							29	92.5	93.3		52	0	67.5	0	110.5	112.0	1.5	10.0
							30	93.3	94.9		52.5	0	68	0	112.0	113.5	1.5	10.0
101	106.1	4x	100	Ogud	Grey dolomite with dolomite veining - locally brecciated. Random vein orientation; occ clay zones.	Minor galena blebs in veins	31	94.9	96.5		53	0	68.5	0	113.5	114.5	1.0	10.0
							32	96.5	97.9		53.5	0	69	0	114.5	116.1		5.0
							33	97.9	99.6		54	0	69.5	1	116.1	117.7	1.6	10.0

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 5
No. 45/921

TENEMENT NAME.....

PLAN - MAP REFERENCE. SUNNY CORNER

DEPTH. 165.9m HOLE No. DS99

CASING LEFT..... DPO No(s) 82152

366069C
CO-ORDINATES 5357571N AZIMUTH 081° Mag DRILLERS DDTAS COMMENCED 24/1/96
RL COLLAR 183m INCLINATION 50° DRILL TYPE LY38(H) COMPLETED 19/2/96

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAC				SUS			
										Depth		Value		REC (From)	REC (To)	REC (M)	REC (%)	
106.1	109.1	4x	100	Ogud	Partially rotted dolomite minor veining; minor argillaceous material - broken core.	Scm dol vein @ 108.15m 80° to c/a	34	99.6	101.5		70		85.5	CLL	177	119.1	1.4	100
							35	101.5	102.9		70.5	0	86	S	119.1	120.0	0.9	100
							36	102.9	104.5		71	0	86.5	S	120.0	120.9	0.9	100
							37	104.5	106.1		71.5	0	87	S	120.9	122.5	1.0	62
							38	106.1	107.5		72	2	87.5	S	122.5	123.9	1.0	70
109.1	113.5	4x	100	Ogud	Sheared dolomite with minor dolomite veining - extensive dolomitisation - weathered core.	Minor pyrite / sphalerite / galena occurrences.	39	107.5	109.1		72.5	19	88	S	123.9	125.5	1.6	100
							40	109.1	110.5		73	8	88.5	O	125.5	127.0	1.5	100
							41	110.5	112.0		73.5	5	89	O	127.0	128.5	1.5	100
							42	112.0	113.5		74	4	89.5	Z	128.5	130.1	1.6	100
							43	113.5	114.5		74.5	5	90	S	130.1	131.5	1.4	100
113.5	123.5	5x	95	Ogud	Greater fracturing of core; clay zones; dolomitised limestones	Minor sphalerite; brown/red sphalerite veinlet @ 114.7m Galena + sphalerite dissemin in clay @ 123.3m.	44	114.5	116.1		75	5	90.5	S	131.5	132.4	0.9	100
							45	116.1	117.7		75.5	6	91	6	132.4	134	1.6	100
							46	117.7	119.1		76	4	91.5	S	134	135.3	1.3	100
							47	119.1	120.0		76.5	5	92	8	135.3	136.1	0.8	100
							48	120.0	120.9		77	4	92.5	10	136.1	137.3	0.9	75
123.5	127.0	4x	95	Ogud	Lt grey dolomitised limestone with dolomite veining from 125-126.6m. Lower contact is 45° to c/a.		49	120.9	122.5		77.5	5	93	S	137.3	138.2	0.6	67
							50	122.5	123.9		78	5	93.5	O	138.2	140.1	0.85	50
							51	123.9	125.5		78.5	4	94	O	140.1	141.0	0.8	88
							52	125.5	127.0		79	4	94.5	S	141.0	142.0	0.55	54
											79.5	5	95	S	142.0	142.7	0.45	66
127.0	134.0	4x	100	Ogud	Dolomite with occasional dolomite veining and cavities veining 75° to c/a; occ dol breccia 20cm @ 133.5m.	Sphalerite in dol veining	53	127.0	128.5		80	5	95.5	6	142.7	144.0	1.1	83
							54	128.5	130.1		80.5	5	96	S	144.0	145.0	0.8	81
							55	130.1	131.5		81	8	96.5	S	145.0	145.9	0.7	77
							56	131.5	132.4		81.5	3	97	4	145.9	147.1	0.65	56
							57	132.4	134.0		82	5	97.5	6	147.1	147.8	0.7	100
134.0	151.7	5x	70	Ogud	Brecciated/broken core dolomite with major clay zones (breccia zones) with argillaceous units Clay zones 40° to c/a ? bedding or shearing.	Occ sulphides in the clays	58	134.0	135.3		82.5	5	98	8	147.8	148.5	0.65	90
							59	135.3	137.3		83	5	98.5	S	148.5	149.1	0.35	62
							60	137.3	140.1		83.5	1	99	9	149.1	150.6	0.9	60
							61	140.1	142.0		84	3	99.5	S	150.6	151.7	0.55	50
							62	142.0	145.9		84.5	5	100	1	151.7	152.2	0.3	60
							63	145.9	147.8		85	5	100.5	8	152.2	153.2	0.4	25

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 4 of 5

TENEMENT NAME EL 45/92 No. 4 of 5

PLAN - MAP REFERENCE SUNNY CORNER

DEPTH 165.9m HOLE No. DS99

CASING LEFT DPO No(s) 82152

CO-ORDINATES 366069E S35.7571N AZIMUTH 081° Mag DRILLERS DOTAS COMMENCED 24/1/96
RL COLLAR 1.83M INCLINATION 50° DRILL TYPE LY38(H) COMPLETED 19/2/96

DEPTH		Core Rec. %	RAD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAG		SLS		REC (From)	REC (To)	REC (M)	REC (%)
										Depth	Value	Depth	Value					
151.7	165.9	5x	12	Qgd	As before but with major core loss.		5852865	147.8	149.1		101	5	116.5	3	183.8	184.5	0.15	21
							66	149.1	151.7		101.5	5	118	0	184.5	185.2	-	0
							67	151.7	153.8		102	4	117.5	3	186.2	187.4	0.15	7
							68	153.8	158.5		102.5	2	118	4	187.4	188.5	0.08	7
					HOLE ABANDONED AT 165.9m.						103	1	118.5	5	188.5	189.4	-	0
							69	161.5	162.9		103.5	8	119	4	189.4	190.5	-	0
							70	162.9	165.9		104	5	119.5	5	190.5	191.5	-	0
											104.5	2	120	5	191.5	192.2	0.1	14
											105	5	120.5	6	192.2	192.9	0.1	14
											105.5	0	121	5	192.9	194.5	0.2	12
											106	0	121.5	c/L	194.5	195.4	0.1	11
											106.5	2	122	2	195.4	195.9	0.25	50
											107	0	122.5	6				
											107.5	2	123	c/L				
											108	4	123.5	5				
											108.5	3	124	6				
											109	5	124.5	5				
											109.5	6	125	10				
											110	6	125.5	5				
											110.5	4	126	9				
											111	5	126.5	13				
											111.5	1	127	8				
											112	0	127.5	0				
											112.5	5	128	8				
											113	2	128.5	5				
											113.5	5	129	6				
											114	2	129.5	8				
											114.5	2	130	6				
											115	c/L	130.5	5				
											115.5	c/L	131	5				
											116	0	131.5	5				

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No.
TENEMENT NAME EL 45/92 No. 5 of 5
PLAN - MAP REFERENCE SUNNY CORNER
DEPTH 165.9M HOLE No. DS99
CASING LEFT DPO No(s) 82152

CO-ORDINATES 366069E
535757N AZIMUTH 081° Mag DRILLERS DOTAS COMMENCED 24/1/96
RL COLLAR 18.5M INCLINATION 50° DRILL TYPE LY38(H) COMPLETED 19/2/96

DEPTH		Core Rec. %	RAD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)					
From (M)	To (M)										MAC	SUS	Depth	Value	Depth	Value
											132	5	147.5	5	163	0
											132.5	6	148	5	163.5	CL
											133	9	148.5	4	164	CL
											133.5	9	149	0	164.5	5
											134	15	149.5	CL	165	CL
											134.5	10	150	5	165.5	2
											135	10	150.5	2		
											135.5	5	151	CL		
											136	5	151.5	4		
											136.5	CL	152	3		
											137	5	152.5	CL		
											137.5	5	153	CL		
											138	CL	153.5	4		
											138.5	4	154	CL		
											139	CL	154.5	0		
											139.5	CL	155	CL		
											140	4	155.5	CL		
											140.5	4	156	CL		
											141	8	156.5	CL		
											141.5	CL	157	CL		
											142	6	157.5	4		
											142.5	0	158	CL		
											143	5	158.5	CL		
											143.5	2	159	CL		
											144	6	159.5	CL		
											144.5	5	160	CL		
											145	5	160.5	CL		
											145.5	CL	161	CL		
											146	CL	161.5	5		
											146.5	CL	162	CL		
											147	5	162.5	0		

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bhole	fulldh	DPO	smgno	Prospect	EL	alrom	alo	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLth
bhole	fulldh	DPO	smgno	Prospect	EL	alrom	alo	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLth
DS99	DD96DS99			Sunny Corner	45/92	0	8														Qha
DS99	DD96DS99			Sunny Corner	45/92	8	17.5														Sc
DS99	DD96DS99	82152	5852801	Sunny Corner	45/92	17.5	20.5	-0.5	7.85	44	595	0.07	43	1.92	3.8	0.56	24	98	71	-0.09	Sc
DS99	DD96DS99			Sunny Corner	45/92	20.5	31														Sc
DS99	DD96DS99	82152	5852802	Sunny Corner	45/92	31	32	1.3	1.79	-5	65	-0.05	9	0.27	0.72	0.1	17	47	13	-0.09	Sc
DS99	DD96DS99			Sunny Corner	45/92	32	41														Sc
DS99	DD96DS99	82152	5852803	Sunny Corner	45/92	41	42	-0.5	1.79	-5	76	-0.05	6	0.25	0.8	0.11	12	18	11	-0.09	Sc
DS99	DD96DS99			Sunny Corner	45/92	42	51														Sc
DS99	DD96DS99	82152	5852804	Sunny Corner	45/92	51	52	0.6	4.36	0	320	-0.05	13	0.64	2.15	0.31	15	152	57	-0.09	Sc
DS99	DD96DS99			Sunny Corner	45/92	52	58.3														Sc
DS99	DD96DS99	82152	5852805	Sunny Corner	45/92	58.3	59.5	0.6	1.63	-5	165	-0.05	12	0.19	0.75	0.13	-10	405	243	0.12	Sc
DS99	DD96DS99	82152	5852806	Sunny Corner	45/92	59.5	61.1	2.2	3.25	23	346	0.07	19	0.66	1.55	0.24	19	968	2330	0.53	Ogdc
DS99	DD96DS99	82152	5852807	Sunny Corner	45/92	61.1	62.5	7.3	6.24	33	504	0.09	43	2.04	3.05	0.47	27	2670	4200	1.9	Ogdc
DS99	DD96DS99	82152	5852808	Sunny Corner	45/92	62.5	63.8	6.9	9.4	56	936	0.21	37	3.8	4.46	0.69	28	2970	6490	4.2	Ogdc
DS99	DD96DS99	82152	5852809	Sunny Corner	45/92	63.8	65.5	3.7	9.13	42	1200	0.24	36	2.74	4.68	0.78	26	1420	2030	2.5	Ogdc
DS99	DD96DS99	82152	5852810	Sunny Corner	45/92	65.5	66.6	-0.5	3.24	6	547	0.11	10	0.49	1.76	0.32	-10	57	121	1.1	Ogdc
DS99	DD96DS99	82152	5852811	Sunny Corner	45/92	66.6	68.5	0.7	8.71	48	921	0.39	49	3.14	4.5	0.75	27	290	1110	2.8	Ogdc
DS99	DD96DS99	82152	5852812	Sunny Corner	45/92	68.5	69.6	7.8	4.38	71	281	0.16	78	2.82	2.23	0.33	41	6240	8630	2.8	Ogdc
DS99	DD96DS99	82152	5852813	Sunny Corner	45/92	69.6	70	7.3	5.11	-5	436	0.09	1520	1.93	2.7	0.41	110	1150	3770	0.7	Ogdc
DS99	DD96DS99	82152	5852814	Sunny Corner	45/92	70	72.5	1.2	3.01	21	121	1.61	23	0.94	1.4	0.96	66	1230	1130	0.2	Ogdc
DS99	DD96DS99	82152	5852815	Sunny Corner	45/92	72.5	74.1	1	1.09	9	36	8.3	9	0.43	0.42	4.13	190	1570	587	-0.09	Ogud
DS99	DD96DS99	82152	5852816	Sunny Corner	45/92	74.1	75.6	0.7	1.64	11	62	18.2	10	1.14	0.83	9.86	606	958	775	-0.09	Ogud
DS99	DD96DS99	82152	5852817	Sunny Corner	45/92	75.6	77.2	2.1	2.06	6	64	16.5	14	1.36	1.03	8.98	504	1300	3260	0.11	Ogud
DS99	DD96DS99	82152	5852818	Sunny Corner	45/92	77.2	78.8	1.3	1.64	-5	55	18.3	12	1.27	0.83	9.89	648	2410	1890	-0.09	Ogud
DS99	DD96DS99	82152	5852819	Sunny Corner	45/92	78.8	80.1	0.8	3.15	14	138	14.2	10	1.55	1.58	7.43	426	1270	1630	-0.09	Ogud
DS99	DD96DS99	82152	5852820	Sunny Corner	45/92	80.1	81.5	0.7	3.65	13	199	13.2	5	1.63	1.83	6.88	685	226	1120	-0.09	Ogud
DS99	DD96DS99	82152	5852821	Sunny Corner	45/92	81.5	83.2	2	2.21	13	186	12.8	5	1.28	1.07	6.56	707	1690	3200	-0.09	Ogud
DS99	DD96DS99	82152	5852822	Sunny Corner	45/92	83.2	84.4	1.2	3.03	20	226	10.1	-5	1.6	1.5	5.11	688	305	1210	-0.09	Ogud
DS99	DD96DS99	82152	5852823	Sunny Corner	45/92	84.4	86	0.8	3.03	15	313	8.18	-5	1.47	1.37	4.18	533	254	1040	-0.09	Ogud
DS99	DD96DS99	82152	5852824	Sunny Corner	45/92	86	87.6	0.6	2.24	44	244	8.57	5	1.71	1.05	4.35	544	396	1690	0.27	Ogud
DS99	DD96DS99	82152	5852825	Sunny Corner	45/92	87.6	88.4	0.9	2.5	9	322	5.32	-5	1.09	1.18	2.67	468	611	3730	0.1	Ogud
DS99	DD96DS99	82152	5852826	Sunny Corner	45/92	88.4	89.5	1.3	2.29	16	272	8.48	13	1.12	1.1	4.4	466	403	1240	0.1	Ogud
DS99	DD96DS99	82152	5852827	Sunny Corner	45/92	89.5	91	3.8	2.76	7	131	14.1	8	1.39	1.36	7.35	661	5740	4360	0.1	Ogud
DS99	DD96DS99	82152	5852828	Sunny Corner	45/92	91	92.5	2.2	0.98	13	48	19.3	12	1.73	0.52	10.5	793	461	1070	0.1	Ogud
DS99	DD96DS99	82152	5852829	Sunny Corner	45/92	92.5	93.3	1	0.75	-5	36	19.7	5	1.27	0.38	11	1070	101	285	-0.09	Ogud
DS99	DD96DS99	82152	5852830	Sunny Corner	45/92	93.3	94.9	1.9	0.63	-5	32	20.7	7	1.39	0.34	11.6	1100	1030	576	-0.09	Ogud
DS99	DD96DS99	82152	5852831	Sunny Corner	45/92	94.9	96.5	1.2	0.61	8	30	20.4	13	1.2	0.32	11.2	749	292	401	-0.09	Ogud
DS99	DD96DS99	82152	5852832	Sunny Corner	45/92	96.5	97.9	1	0.26	-5	12	20.8	8	1.04	0.16	11.6	633	174	287	-0.09	Ogud
DS99	DD96DS99	82152	5852833	Sunny Corner	45/92	97.9	99.6	1.6	1.37	-5	77	19.2	6	1.02	0.73	10.6	521	392	644	-0.09	Ogud
DS99	DD96DS99	82152	5852834	Sunny Corner	45/92	99.6	101.5	3.2	1.47	8	84	19.5	14	1.21	0.76	10.8	647	2220	2540	-0.09	Ogud
DS99	DD96DS99	82152	5852835	Sunny Corner	45/92	101.5	102.9	2.9	0.92	12	51	19.4	10	1.37	0.49	10.7	757	2110	2150	-0.09	Ogud
DS99	DD96DS99	82152	5852836	Sunny Corner	45/92	102.9	104.5	1.5	0.39	6	23	21.4	7	1.67	0.22	11.6	1080	370	484	-0.09	Ogud
DS99	DD96DS99	82152	5852837	Sunny Corner	45/92	104.5	106.1	1.8	0.65	-5	16	21.6	11	1.63	0.16	12	1000	785	997	-0.09	Ogud
DS99	DD96DS99	82152	5852838	Sunny Corner	45/92	106.1	107.5	1	0.63	-5	46	19.9	7	1.09	0.34	11.1	587	713	1070	-0.09	Ogud
DS99	DD96DS99	82152	5852839	Sunny Corner	45/92	107.5	109.1	2.6	1.32	-5	81	17.7	17	1.2	0.68	9.95	682	3510	2720	-0.09	Ogud
DS99	DD96DS99	82152	5852840	Sunny Corner	45/92	109.1	110.5	2	0.34	-5	18	20.9	8	1.49	0.2	11.4	780	1970	1410	-0.09	Ogud
DS99	DD96DS99	82152	5852841	Sunny Corner	45/92	110.5	112	1	0.51	5	26	19.8	9	1.01	0.29	11	512	1030	947	-0.09	Ogud
DS99	DD96DS99	82152	5852842	Sunny Corner	45/92	112	113.5	1.9	0.74	-5	34	19.5	10	1.11	0.39	10.8	591	1270	2860	-0.09	Ogud
DS99	DD96DS99	82152	5852843	Sunny Corner	45/92	113.5	114.5	2.9	2.02	5	89	16.6	14	1.21	1.02	8.64	586	4160	5630	-0.09	Ogud
DS99	DD96DS99	82152	5852844	Sunny Corner	45/92	114.5	116.1	5.7	1.82	-5	81	16.8	29	0.93	0.95	8.9	423	7990	49900	-0.09	Ogud
DS99	DD96DS99	82152	5852845	Sunny Corner	45/92	116.1	117.7	2.2	1.24	-5	48	18.1	10	0.83	0.64	9.42	436	2570	4010	-0.09	Ogud
DS99	DD96DS99	82152	5852846	Sunny Corner	45/92	117.7	119.1	2	1.38	-5	61	16.1	10	0.94	0.72	8.32	526	1080	2360	-0.09	Ogud
DS99	DD96DS99	82152	5852847	Sunny Corner	45/92	119.1	120	3.1	2.83	-5	127	13	8	1.2	1.44	6.3	753	1790	4120	-0.09	Ogud
DS99	DD96DS99	82152	5852848	Sunny Corner	45/92	120	120.9	3.7	2.61	17	184	12.7	9	1.25	1.32	8.27	689	2260	4810	0.12	Ogud
DS99	DD96DS99	82152	5852849	Sunny Corner	45/92	120.9	122.5	2.4	2.03	8	179	13.1	8	1.15	0.99	6.55	821	1330	3120	-0.09	Ogud
DS99	DD96DS99	82152	5852850	Sunny Corner	45/92	122.5	123.9	3.8	1.43	26	108	15.9	23	1.46	0.72	8.32	966	7800	13600	-0.09	Ogud
DS99	DD96DS99	82152	5852851	Sunny Corner	45/92	123.9	125.5	0.7	0.45	7	22	20	8	1.55	0.24	10.4	1370	258	594	-0.09	Ogud
DS99	DD96DS99	82152	5852852	Sunny Corner	45/92	125.5	127	1.2	0.51	10	21	20.4	8	1.97	0.28	10.5	1110	228	582	-0.09	Ogud
DS99	DD96DS99	82152	5852853	Sunny Corner	45/92	127	128.5	0.6	0.72	9	35	20.1	8	1.44	0.37	10.4	645	308	900	-0.09	Ogud
DS99	DD96DS99	82152	5852854	Sunny Corner	45/92	128.5	130.1	0.8	0.14	-5	7	20.5	-5	1.14	0.09	10.6	763	232	1020	-0.09	Ogud
DS99	DD96DS99	82152	5852855	Sunny Corner	45/92	130.1	131.5	-0.5	0.15	-5	10	21.4	-5	0.93	0.09	11.6	586	83	220	-0.09	Ogud
DS99	DD96DS99	82152	5852856	Sunny Corner	45/92	131.5	132.4	-0.5	0.16	-5	10	21.2	6	1.02	0.1	11.5	621	156	312	-0.09	Ogud
DS99	DD96DS99	82152	5852857	Sunny Corner	45/92	132.4	134	0.6	0.27	-5	13	21.4	9	1.57	0.13	11.3	1140	122	833	-0.09	Ogud
DS99	DD96DS99	82152	5852858	Sunny Corner	45/92	134	135.3	0.5	0.53	14	31	20.8	6	2.92	0.28	10.4	2210	377	1480	-0.09	Ogud
DS99	DD96DS99	82152	5852859																		

bhole	fullddh	DPO	smjno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	a/e	ak	amg	amn	apb	arn	as	MATLih
DS99	DD96DS99	82152	5852861	Sunny Corner	45/92	140.1	142	-0.5	1.17	9	55	20.4	6	0.84	0.54	10.4	345	296	834	-0.09	Ogud
DS99	DD96DS99	82152	5852862	Sunny Corner	45/92	142	144	1.4	2.94	15	144	12.4	9	1.84	1.48	6.19	647	590	2140	0.15	Ogud
DS99	DD96DS99	82152	5852863	Sunny Corner	45/92	144	145.9	-0.5	2.89	23	121	14.5	8	2.1	1.43	6.97	559	90	317	-0.09	Ogud
DS99	DD96DS99	82152	5852864	Sunny Corner	45/92	145.9	147.8	-0.5	3.88	27	302	12.1	12	2.06	2.07	5.96	387	61	166	0.09	Ogud
DS99	DD96DS99	82152	5852865	Sunny Corner	45/92	147.8	151.7	-0.5	4.23	16	380	11.3	6	1.81	2.17	5.34	280	88	157	0.17	Ogud
DS99	DD96DS99	82152	5852866	Sunny Corner	45/92	151.7	153.8	1.6	1.72	13	93	16.2	11	1.54	0.89	8.14	628	1740	13800	-0.09	Ogud
DS99	DD96DS99	82152	5852867	Sunny Corner	45/92	153.8	158.5	-0.5	1.99	-5	94	17.1	7	1.15	1.04	8.61	341	282	875	-0.09	Ogud
DS99	DD96DS99	82152	5852868	Sunny Corner	45/92	158.5	161.5	1.7	2.04	9	140	15.8	6	1.21	1.02	7.85	413	211	795	-0.09	Ogud
DS99	DD96DS99	82152	5852869	Sunny Corner	45/92	161.5	162.9	-0.5	3.05	-5	203	14.5	-5	1.66	1.54	7.18	440	356	901	-0.09	Ogud
DS99	DD96DS99	82152	5852870	Sunny Corner	45/92	162.9	165.9	-0.5	2.38	-5	185	15.7	-5	2.03	1.2	7.57	1320	245	589	-0.09	Ogud

CRA EXPLORATION PTY. LIMITED
DRILL-HOLE SUMMARY LOG

301059

HOLE NAME: DD96DS100

AMG EAST 366180 NORTH 5357513

PROSPECT: SUNNY CORNER

GFD EAST 65745 NORTH 57568

EL: MT DUNDAS

EL 45/92 RL 148m. DEPTH 237.1m.

DATE DRILLED: 22/2/96

SURVEYS:

LOGGED BY: S.J. TEAR

DEPTH	AZIM (AMG)	DIP	DEPTH	AZIM (AMG)	DIP
0	098°	57°			
50	102°	58°			
101	099°	59°			
156	098°	60°			
200	101°	60°			

DRILLING CO.: D.D. TAS P/L

DRILL TYPE: DIAMOND

DRILL RIG: LONGYEAR 38

LOC DRILL CORE: ZEEHAN

OBJECTIVES OF HOLE:

Second attempt at target 2 for DD96DS99. - the 'Oceana Horizon'

LITHOLOGICAL SUMMARY:

FROM	TO	FORM CODE	COMMENTS
0	2.5	Qha	Overburden
2.5	19.8	Ogdc	Dark grey clay with dolomite fragments
19.8	55.8	Ogud	Dolomitised nodular calcarenite - dedolomitised 19.8-22.4
55.8	75.8	Ogud	Rotted dolomite zone with clays and fault breccias
75.8	95.5	Ogud	Dolomitised burrowed calcarenite with argillite.
95.5	105.5	Ogud	Dolomitised ?micrite.
105.5	123.2	Ogud	Dolomite - broken core
123.2	164.2	Ogsi	Siltstone Unit (upper 13m Transitional)
164.2	201.0	Ogdl	Dolomitised nodular calcarenites and syn-sedimentary breccias
201.0	203.3	Ogdl	Dolomitised laminated micrite unit.
203.3	222.4	Ogdl	Dolomitised synsedimentary breccias
222.4	228.8	Ogdl	Dolomite - broken core + core loss ? fault.
228.8	237.1	Ogdl	Dolomitised calcarenites, locally argillaceous, veined + bioturbated

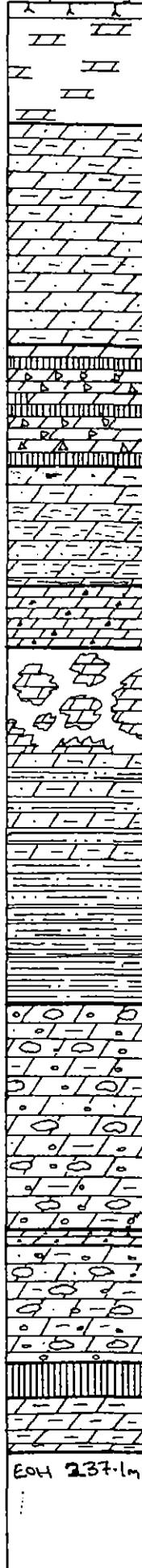
MINERALISATION SUMMARY:

FROM	TO	COMMENTS
115.2	144.9	0.3% Zn (Pb 0.1%) Hosted by dolomitised calcarenite and Siltstone Unit upper transition - Disseminated Sphalerite in veins (vic 1.7m @ 0.64% Zn from 118.8m)
162	167.4	0.32% Zn Hosted by pyritic sub-Siltstone Unit dolomitised calcarenites (vic 1.7m @ 0.53% Zn from 164.2)

CONCLUSIONS:

Hole abandoned due to bad ground.
The synsedimentary breccias have up to 10% pyrite in matrix.
The hole has abundant sulphide facies not seen elsewhere in Zeehan area.
Mineralisation is related to pyritic Siltstone Unit + its transition zones.
Hole is regarded as very significant - lower contact test is needed.
Bedding @ 95m 60° to c/a @ 132m 70° to c/a.

Graphic Log



EOH 237.1m

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 1 of 1

TENEMENT NAME..... MT. DUNDAS No. 45/92

ANG: 366L80E 5357513N.
CO-ORDINATES..... AZIMUTH 086 MAC

DRILLERS DITAS COMMENCED 22/2/96

PLAN - MAP REFERENCE SUNNY CORNER

RL COLLAR 148m INCLINATION 57°

DRILL TYPE L738(H) COMPLETED 26/3/1996

DEPTH 237.1m HOLE No. DS 100

CASING LEFT..... DPO No(s) 82154

From (M)	To (M)	Core Rec. %	RQD DATA	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)								
											MAC				SUS				REC (From)
												Depth	Value	Depth	Value				
0	2.5	0	-	Qha	Overburden							2.5	0	18.0	0	0	2.5	-	-
2.5	19.8	47	Sx	Ogud	Dark grey/grey clay with dolomite fragments - broken core	Dolomite veining in fragments	5852871	2.5	3.9			3.0	0	18.5	2	2.5	3.3	0.8	100
							72	3.9	6.0			3.5	CL	19.0	0	3.3	6.0	1.2	44
							73	6.0	9.0			4.0	0	19.5	0	6.0	9.0	2.0	67
							74	12.0	14.3			4.5	CL	20.0	4	9.0	12.0	-	-
19.8	25.5	100	1	Ogud	Grey dolomite - altered slightly argillaceous calcarenites	Occ quartz veining + some pervasive silicification veins 65° to c/a parallel to a ? syn sed breccia band (20.0m)	75	14.3	15.8			5.0	S	20.5	5	12.0	14.3	0.6	27
							76	15.8	18.0			5.5	CL	21.0	5	14.3	15.8	0.9	60
							77	18.0	19.7			6.0	6	21.5	0	15.8	19.6	1.8	48
							78	19.7	21.0			6.5	CL	22.0	CL	19.6	21.0	1.5	100
							79	21.0	22.4			7.0	10	22.5	4	21.0	22.4	1.3	91
							80	22.4	25.5			7.5	CL	23.0	CL	22.4	25.5	2.0	64
25.5	32.4	100	1	Ogud	Nodular dolomitised argillaceous calcarenite; argillite interstitial infill between nodules. Completely dolomitised.	loss of veining	81	25.5	28.5			8.0	10	23.5	5	25.5	27.0	1.5	100
							82	28.5	30.8			8.5	CL	24.0	15	27.0	28.5	1.5	100
							83	30.8	33.9			9.0	15	24.5	5	28.5	30	1.5	100
												9.5	CL	25.0	5	30	30.8	0.8	100
												10.0	CL	25.5	10	30.8	32.4	1.6	100
												10.5	CL	26.0	9	32.4	33.9	1.6	100
32.4	32.75	100	Sx	Ogfcz	Dark grey clay with brecciated dolomite fragments. lower contact 80° to c/a.		84	33.9	37.0			11.0	CL	26.5	10	33.9	35.5	1.6	100
												11.5	CL	27.0	9	35.5	37	1.5	100
												12.0	0	27.5	5	37	38.6	1.6	100
												12.5	CL	28.0	5	38.6	40.2	1.6	100
32.75	49.5	100	1	Ogud	Nodular dolomitised calcarenite	Dol veining 80° to c/a 4.0cm. disappears after 35.5m. Occ blob of dissem. pyrite.	85	37.0	40.2			13.0	CL	28.5	10	40.2	41.7	1.35	100
							86	40.2	43.4			13.5	CL	29.0	0	41.7	43.4	1.5	88
							87	43.4	45.0			14.0	0	29.5	8	43.4	44.9	1.5	100
							88	45.0	48.0			14.5	CL	30.0	5	44.9	46.9	2	100
49.5	54.7	100	1	Ogud	Grey amorphous looking dolomite more nodular looking lower base	Cleavage-plane alteration 45° to c/a. Minor blob of pyrite.	89	48.0	51.0			15.0	5	30.5	6	46.9	48	1.1	100
							90	51.0	53.8			15.5	CL	31.0	5	48	49.5	1.5	100
							91	53.8	55.9			16.0	30	31.5	0	49.5	51.0	1.5	100
							92	55.9	58.4			16.5	CL	32.0	5	51.0	52.3	1.3	100
54.7	68.2	67	Sx	Ogfcz	Zone of broken core/clay gouges. lumpy dolomite		93	58.4	61.1			17.0	CL	32.5	5	52.3	53.9	1.5	100
							94	61.1	64.2			17.5	CL	33.0	4	53.8	55.4	1.6	100

301060

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 2 of 7
No. 45192

366180E
CO-ORDINATES 5357513N AZIMUTH 086° Mag. DRILLERS ODIAS COMMENCED 22/2/96 DEPTH 237.1M HOLE No. JDS100
RL COLLAR 148M INCLINATION 57° DRILL TYPE LY38 (+) COMPLETED 26/3/96 CASING LEFT DPO No(s) 82154

TENEMENT NAME.....
PLAN - MAP REFERENCE SUNNY CORNER
DPO No. JDS100

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										mac		ZUS		REC (%)	REC (%)	REC (%)	REC (%)
											Depth	Value	Depth	Value	From	To	To	To
68.2	70	100	4f	Qgd	Broken Core - dolomite	Pass fracture planes 75° to c/a	5852895	64.2	66.5		33.5	5	49.0	5	55.4	57	1.4	88
							96	66.5	69.5		34.0	10	49.5	2	57	58.4	0.8	57
70	73.2	100	2	Qgd	Grey dolomite - nodular calcarenite (slightly argillaceous)	Thin veinlets of dolomite irregular orientation.	97	69.5	73.2		34.5	11	50.0	0	58.4	59.4	0.7	70
							98	73.2	74.4		35.0	11	50.5	0	59.4	61.1	0.6	35
							99	74.4	75.7		35.5	10	51.0	5	61.1	61.9	0.5	63
73.2	74.9	100	5x	Qgfz	Sheared dolomite with clay zones (+/- broken core)	Small blebs of galena associated with dol. veining and shearing - dol breccia vein with blebs of pyrite	5852900	75.7	77.5		36.0	10	51.5	10	61.9	63.0	0.6	54
											36.5	8	52.0	10	63.0	65.3	1.4	61
											37.0	8	52.5	12	65.3	66.0	0.7	100
											37.5	10	53.0	5	66.0	66.5	0.5	100
											38.0	12	53.5	CL	66.5	67.5	1.0	100
74.9	82.5	100	1	Qgd	Grey dolomite - probably altered argillaceous nodular calcarenite	Irregular dolomite veining intensity decreasing down hole localised zones of <5mm quartz veining 60° to c/a. @ 81.2 pore bedding 60° to c/a.	5852101	77.5	80.6		38.5	10	54.0	14	67.5	69.0	1.5	100
							02	80.6	82.4		39.0	10	54.5	11	69.0	70.5	1.5	100
											39.5	9	55.0	15	70.5	71.6	1.1	100
											40.0	7	55.5	17	71.6	73.2	1.5	94
											40.5	6	56.0	23	73.2	74.4	1.0	83
											41.0	10	56.5	17	74.4	76.0	1.6	100
82.5	82.7	100	5x	Qgfz	Fault Zone - upper contact 45° to c/a.		03	82.4	85.4		41.5	6	57.0	21	76.0	77.5	1.5	100
											42.0	5	57.5	18	77.5	79.1	1.6	100
											42.5	5	58.0	25	79.1	80.6	1.5	100
82.7	83.7	100	3f	Qgd	Dolomite as before						43.0	CL	58.5	CL	80.6	82.2	1.6	100
											43.5	10	59.0	29	82.2	82.9	0.7	77
83.8	84.0	100	5x	Qgfz	Fault zone - upper contact 45° to c/a.						44.0	8	59.5	CL	82.9	83.4	0.5	100
											44.5	5	60.0	19	83.4	84.6	1.2	100
											45.0	10	60.5	26	84.6	85.4	0.7	88
84.0	85.4	100	3f	Qgd	Dolomite with occ clay fault zones - some faulting sub-parallel to c/a.		04	85.4	88.5		45.5	2	61.0	CL	85.4	86.9	1.5	100
											46.0	0	61.5	16	86.9	88.5	1.6	100
											46.5	CL	62.0	12	88.5	89.6	1.1	100
											47.0	6	62.5	14	89.6	91.5	1.8	95
85.4	94.0	100	3f	Qgd	Nodular argillaceous dolomitised calcarenite; minor clay gouges 50° to c/a; possibly biotitic	Occ zones of <5mm veining dol/silica. Minor galena blebs in veining	05	88.5	91.5		47.5	6	63.0	CL	91.5	92.5	0.9	90
							06	91.5	94.0		48.0	0	63.5	12	92.5	94.0	1.4	93
											48.5	2	64.0	9	94.0	95.5	1.5	100

301061

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 7

TENEMENT NAME No. 45/92

CO-ORDINATES 366180 E 5357513 N AZIMUTH 086° Mag DRILLERS DDTAS COMMENCED 22/2/96 DEPTH 237.1M HOLE No. D096 05100
RL COLLAR 148M INCLINATION 5.7° DRILL TYPE LY38(H) COMPLETED 26/3/96 CASING LEFT DPO No(s) 82154

PLAN - MAP REFERENCE SUNNY CORNER

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAG		SALS		REC (m)	REC %	REC (m)	REC %
				Depth	Value	Depth	Value	REC (m)	REC %	REC (m)	REC %	REC (m)	REC %					
94.0	95.5	100	1f	Qgd	Partially silicified dolomite can argillaceous - Possibly a sandstone unit	Bedding @ 95m. 60° to c/a.	5852107	94.0	96.5		64.5	19	81.0	11	95.5	96.5	1.0	100
											65.0	CL	80.5	12	96.5	97.4	0.9	100
											65.5	11	81.0	6	97.4	98.0	0.6	100
											66.0	10	81.5	10	98.0	98.3	0.3	100
95.5	100	100	4f	Qgd	Dolomitised nodular calcarenite with zones of broken core	Dol veining < 1cm irregular occ with sphalerite or galena blabs eg 99.5m.	08	96.5	99.5		66.5	15	82.0	11	98.3	99.5	1.2	100
							09	99.5	102.5		67.0	15	82.5	9	99.5	101.0	1.5	100
											67.5	14	83.0	9	101.0	102.5	1.5	100
											68.0	11	83.5	5	102.5	104.1	1.6	100
00	105.1	100	1f	Qgd	lt grey dolomite - probably nodular calcarenite with minor argillaceous material. ?Syn set breccia @ 100m.	Dol veining < 7mm regular c/a angle 60° to c/a. Dol vug infill 70° to c/a.	10	102.5	105.5		68.5	14	84.0	10	104.1	105.6	1.5	100
											69.0	12	84.5	4	105.6	106.7	1.0	90
											69.5	10	85.0	10	106.7	107.6	0.6	67
											70.0	12	85.5	11	107.6	108	0.4	100
											70.5	8	86.0	9	108	108.5	0.2	40
105.1	109.8	75	4f	Qgd	Grey dolomite with zones of broken core / clay gouges	Occ dol/ccl veining < 1cm 70° to c/a pos fault zone @ 108.9m 30° to c/a. Blood red sphalerite blabs @ 106.7 - 107.6m associated with veining. Minor dissem of pyrite.	4	105.5	108.5		7.0	4	86.5	10	108.5	109	0.5	100
											71.5	6	87.0	9	109	109.8	0.7	87
											72.0	15	87.5	9	109.8	110.9	1.1	100
											72.5	16	88.0	5	110.9	112.3	1.4	100
											73.0	6	88.5	5	112.3	113.1	0.8	100
											73.5	7	89.0	9	113.1	114	0.8	88
											74.0	11	89.5	5	114	115.2	0.6	60
											74.5	25	90.0	6	115.2	118.8	0.6	36
109.8	113.1	100	1f	Qgd	Massive dolomitised argillaceous calcarenite with occ zones of core loss.	Minor zones of semimassive pyrite associated with more argillaceous zones. Thin dol veining < 3mm 75° to c/a	12	108.5	110.9		75.0	8	90.5	2	118.8	119.6	0.3	38
							13	110.9	113.1		75.5	7	91.0	5	119.6	120.5	0.9	100
											76.0	15	91.5	1	120.5	121.4	0.9	100
											76.5	7	92.0	5	121.4	121.8	0.1	25
											77.0	5	92.5	0	121.8	122.4	0.6	100
113.1	120.5	49	4f	Qgd	As before with increasing dol rein thickness (< 1cm) More broken core	Large Sphalerite blab < 2cm with galena @ 120.1m in dol vein Minor dissem sph in veins.	14	113.1	115.2		78.5	11	93.0	0	122.4	123.2	0.8	100
							15	115.2	118.8		78.0	8	93.5	CL	123.2	123.9	0.6	96
							16	118.8	120.5		78.5	7	94.0	0	123.9	124.9	0.9	90
											79.0	9	94.5	4	124.9	126.2	1.3	100
											79.5	8	95.0	1	126.2	127	0.7	87

301062

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 4 of 7

TENEMENT NAME..... No. 4572

CO-ORDINATES 36680E. 535758N AZIMUTH 086° Mag. DRILLERS. DDTAS COMMENCED 22/12/96
RL COLLAR 148m INCLINATION 57° DRILL TYPE LY38(H) COMPLETED 26/3/96

PLAN - MAP REFERENCE SUNNY CORNER

DEPTH 237.1m HOLE No. DS100

CASING LEFT..... DPO No(s) 82154

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weather, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analyzed by.....)							
From (M)	To (M)										Mag		SUS		REC (%)	REC (%)	REC (%)	REC (%)
											Depth	Value	Depth	Value	From	To	(M)	(%)
20.5	123.8	67	3f	Qgd	Relatively more competent dolomitised calcarenite with minor argillaceous zones.	① 121.3 zone of semi massive pyrite replacement with marcasite/chalcopyrite. 10cm zone (with v. minor sphalerite blobs)	5852117	120.5	123.2		95.5	0	111	4	127	128	0.7	70
											96.0	2	111.5	5	128	128.8	0.7	87
											96.5	4	112	5	128.8	129.4	0.3	50
											97.0	0	112.5	10	129.4	130.3	0.6	67
											97.5	10	113	9	130.3	131.3	0.45	45
											98.0	0	113.5	5	131.3	132.0	0.4	50
											98.5	6	114	5	132.0	132.8	0.5	63
											99.0	4	114.5	CL	132.8	133.6	0.5	63
23.8	129.4	82	3s	Qgd.	More argillaceous bioclastic dolomitised calcarenite with variable bedding angles and Qtz clastic grains (< 3mm), locally coarsely bioclastic dolomite localised shear zones locally completely argillaceous	5-8% Pyrite in some argillaceous zones Rare sphalerite veinlets < 1mm + blobs Pyrite up to 10% in bioclastic fabric bands. Bedding perhaps 50-55° to c/a. Cataenalsphalerite seam @ 129.35m Occ stratobound dissemin pyrite @ 130m bedding 70° to c/a.	18	123.2	126.2		99.5	6	115	8	133.6	134.2	0.3	50
							19	126.2	128.8		100.0	3	115.5	CL	134.2	134.9	0.5	70
											100.5	10	116	CL	134.9	136.1	0.2	17
											101	5	116.5	CL	136.1	137.0	0.25	70
											101.5	10	117	CL	137.0	138.0	0.4	40
											102	9	117.5	CL	138.0	139.1	0.4	37
											102.5	9	118	CL	139.1	139.9	0.5	63
											103	5	118.5	2	139.9	140.5	0.3	50
											103.5	8	119	OK	140.5	142.2	0.25	14
											104	9	119.5	5	142.2	143.2	0.7	70
29.4	142.2	40	3f	Qgsi	Argillite - dolomitised. (Black/dk grey) Occ shear zone and areas of poor recovery	Bedding 70° to c/a. @ 132.6m clastic band (Qtz grains with dissemin and semi massive pyrite for Sem.	20	128.8	132.0		104.5	9	120	5	143.2	144.0	0.8	100
							21	132.0	134.2		105	6	120.5	0	144.0	144.9	0.4	44
							22	134.2	136.1		105.5	7	121	5	144.9	145.9	0.8	80
							23	136.1	139.1		106	5	121.5	CL	145.9	147.0	1.1	100
							24	139.1	142.2		106.5	9	122	5	147.0	149.2	1.2	100
											107	9	122.5	6	149.2	149.2	0.7	70
											107.5	5	123	4	149.2	149.9	0.7	100
											108	8	123.5	5	149.9	151.4	0.3	20
42.2	143.8	87	2f	Qgsi	lt grey bioclastic calcarenite with quartz clast and possible oxides.	Quartz and dolomite veining 5° to c/a and 90° to c/a. and 65° to c/a. Minor sphalerite blobs	25	142.2	143.2		108.5	8	124	9	151.4	152.6	1.0	83
							5852126	143.2	144.9		109	0	124.5	10	152.6	155.7	1.55	50
											109.5	0	125	8	155.7	156.9	0.8	57
											110	0	125.5	2	156.9	158.7	1.8	100
											110.5	4	126	0	158.7	160.5	1.5	81

301063

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 5 of 7
No. 45192

CO-ORDINATES 366180E 5357513N AZIMUTH 086° Mag DRILLERS OOTAS COMMENCED 22/2/96 DEPTH 237.1M HOLE No. DS100
RL COLLAR 1.48M INCLINATION 57° DRILL TYPE LY38(CH) COMPLETED 26/3/96 CASING LEFT DPO No(s) 82154

TENEMENT NAME.....
PLAN - MAP REFERENCE..... SUNNY CORNER
DPO No. 82154

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weather, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)									
From (M)	To (M)									MAG SUS				REC (m)	REC (%)	REC (m)	REC (%)		
43.8	161.7	70	3f	OgSi	Dominantly argillaceous dolomitised limestone	Bedding 35° to c/A @ 145.9m	5852127	144.9	147.0	126.5	5	142	CL	1535	10	160.5	162	1.5	100
					occ clastic beds - more likely a siltstone (black)	Minor brick red blabs of sphalerite in dolomite veining	28	147.0	149.2	127	13	142.5	4	158	CL	162	163.4	1.2	86
					from 151.4 - massive black siltstone, minor qtz clasts <2mm	Dissem blabs of pyrite	29	149.2	151.8	127.5	CL	143	6	1585	5	163.4	164.2	0.6	75
					zone of qtz clasts 161-161.7m <2mm	Bedding 75° to c/A @ 160.5m	30	151.8	155.7	128	4	148.5	5	151	0	164.2	165.9	1.6	94
							31	155.7	158.7	128.5	2	144	7	1595	CL	165.9	167.4	1.5	100
							32	158.7	160.5	129	CL	144.5	8	160	0	167.4	168.5	1.1	100
							33	160.5	162.0	129.5	1	145	5	1605	2	168.5	170.1	1.6	100
										130	2	145.5	5	161	2	170.1	171.6	1.5	100
										130.5	CL	146	4	161.5	4	171.6	173.2	1.6	100
										131.0	0	146.5	5	162	7	173.2	174.6	1.4	100
61.7	164.2	88	2f	OgSi	Laminated black and grey siltstone unit. Upward fining cycles.	Bedding 70° to c/A. Thin layers of dissem pyrite (? sheet form)	34	162.0	164.2	131.5	CL	147	11	162.5	CL	174.6	175.7	1.1	100
										132	0	147.5	5	163	5	175.7	177.0	1.3	100
										132.5	5	148	CL	1635	CL	177	178.6	1.4	100
										133	5	148.5	5	164	5	178.6	180.0	1.4	100
64.2	170.4	97	1f	Ogdl	Dolomitised calcarenite with thin argillite bands and interstitial argillite - ? nodular affect. Brittle shear zone @ 167m.	Small scale semi-massive pyrite or ? cavity fill with dolomite at top of unit. Cleavage 25° to c/A @ 167m. Occ dolomite veining (+/- quartz) mainly irregular. Dissem blabs and veinlets of pyrite.	35	164.2	165.9	133.5	6	149	CL	1645	5	180.0	182.3	2.3	100
							36	165.9	167.4	134	7	149.5	1	165	CL	182.3	183.8	1.5	100
							37	167.4	168.5	134.5	4	150	CL	1655	6	183.8	185.4	1.6	100
							38	168.5	170.1	135	CL	150.5	0	166	6	185.4	186.9	1.5	100
										135.5	CL	151	7	1665	0	186.9	187.5	1.6	100
										136	5	151.5	0	167	6	187.5	190.1	1.6	100
										136.5	CL	152	CL	167.5	7	190.1	191.2	0.9	81
										137	4	152.5	0	168	5	191.2	192.8	1.6	100
										137.5	5	153	CL	168.5	9	192.8	194.5	1.7	100
70.4	201	98	1f	Ogdl	Syn. sedimentary breccias dolomitised, sub-angular to sub rounded fragments <2cm often in a more argillaceous matrix. Possible soft sediment impaction seen in clasts. Occ burrowed ? zones. Zones of more uniform dolomitised calcarenite.	Pyrite blabs interstitial with the breccia fragments - locally. Minor irregular dolomite veining. Zones of pyrite dissem matrix - full veinlets etc. Occ sphalerite vein +/- galena. eg 197m, 200.3m. Pyrite up to 5% locally	39	170.1	172.0	138	10	153.5	CL	169	5	194.5	196.3	1.6	80
							40	172.0	174.6	138.5	CL	154	2	169.5	11	196.3	197.9	1.6	100
							41	174.6	177.0	139	5	154.5	CL	170	10	197.9	199.5	1.6	100
							42	177.0	180.0	139.5	11	155	0	170.5	10	199.5	201.0	1.5	100
							43	180.0	182.3	140	10	156.5	CL	171	11	201.0	202.6	1.6	100
							44	182.3	185.4	140.5	10	156	CL	171.5	10	202.6	204	1.4	100
							45	185.4	188.5	141	CL	156.5	CL	172	9	204	205.5	1.5	100
							46	188.5	191.2	141.5	CL	157	4	172.5	9	205.5	207.0	1.5	100
							47	191.2	193.2										
							48	193.2	196.3										
							49	196.3	197.9										

301064

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 6 of 7

TENEMENT NAME..... No. 85/92

PLAN - MAP REFERENCE SUNNY CORNER

CO-ORDINATES 366180E 5357513N AZIMUTH 086° Mag DRILLERS OOTAS COMMENCED 22/2/96 DEPTH 237.1m HOLE No. DD96DS100
RL COLLAR 148m INCLINATION 57° DRILL TYPE LV38CH COMPLETED 24/3/96 CASING LEFT..... DPO No(s) 82154

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)												
From (M)	To (M)									Mag Susceptibility				Recovery								
										Depth	Value	Depth	Value	Depth	Value	Rec (From)	Rec (To)	Rec (Con)	Rec %			
201.0	203.2	98	1F	Ogd1	Uniform dolomitised grey calcarenite with v. minor argillaceous content.		5852150	197.9	199.5	173	5	185	5	204	5	207	208.5	1.5	100			
							51	199.5	201.0	173	5	189	0	204.5	0	208.5	209.3	0.8	100			
							52	201.0	204.0	174	5	189	5	205	5	209.3	210.9	1.6	100			
203.2	222.2	97	3F	Ogd1	Dolomitised calcarenite with variable argillaceous content (10-75%), and numerous synsedimentary breccias sub angular - sub rounded < 3cm fragments. Generally quartz veins most elasts are more argillaceous abundant between 205+ Also small syn-sed dislocations of bedding in places.	Shear zone @ 205.6m in v. argillaceous material				53	204.0	207.0	174	5	190	0	205.5	210.9	222.4	1.5	100	
							54	207.0	208.5	175	5	190	5	206	5	212.4	214.0	1.6	100			
							55	208.5	210.9	175	3	191	5	208.5	5	214.0	215.4	1.4	100			
							56	210.9	214.0	176	5	191	5	207	5	215.4	216.6	1.2	100			
							57	214.0	216.6	175	5	192	0	207	10	216.6	218.0	1.4	100			
							58	216.6	219.5	177	6	192	5	208	5	218.0	219.5	1.5	100			
							59	219.5	222.4	175	2	193	0	208.5	2	219.5	221.1	1.5	100			
										178	5	193	5	209	2	221.1	222.4	1.3	100			
										178	5	194	0	209	0	222.4	223.1	0.7	47			
222.2	224.8	50	5X	Ogf2	Zone of broken ore typically fractured angular dolomites with crystalline nature.	Fault zone Extensive dolomitization				60	222.4	224.6	179	5	194	5	210	6	223.9	224.6	0.4	57
							61	224.6	227.5	179	5	195	3	210.5	2	224.6	227.5	1.2	41			
							62	227.5	230.3	180	0	195	0	211	5	227.5	228.8	1.3	100			
224.8	232.2	80	2F	Ogd1	Dolomitised grey calcarenites Rare bioclasts + loss of brecciation + increased amount of veining.	Numerous calcite dolomite veins with pyrite aggregates occurring locally + finely disseminated pyrite																
							63	230.3	232.3	181	5	197	0	212.5	0	231.7	232.3	0.5	83			
										182	5	197	5	213	9	232.3	233.7	0.6	43			
232.2	237.1	69	4X	Ogd1	Dolomitised grey calcarenites with increasing argillaceous content towards base. Core is fairly broken up with some shearing at 236m (Graphitic sheen on surfaces of fractures)	(Possible fault zone) Numerous dolomite + quartz veins with galena + minor sphalerite occurring @ 235.7m.																
							64	232.5	235.5	183	5	198	0	214	6	235.5	237.1	1.6	100			
							65	235.5	237.1	183	5	199	0	214.5	8							
										184	2	199	0	215	5							
										184	3	200	0	215.5	6							
										185	8	205	0	216	0							
										185	5	210	0	216.5	5							
										186	5	201	0	217	4							
										186	5	202	5	217.5	5							
										187	0	202	2	218	2							
										187	5	203	0	218.5	4							
										188	0	203	8	219	5							

301065

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 7 of 7

TENEMENT NAME..... No. 45/92

CO-ORDINATES 366180 E
5357513 N AZIMUTH 086° Mag
RL COLLAR 148M INCLINATION 57°

DRILLERS DDIMS COMMENCED 22/2/96
DRILL TYPE LY 38 (H) COMPLETED 26/3/96

PLAN - MAP REFERENCE SUNNY CORNER
DEPTH 237.1m HOLE No. DS100
CASING LEFT..... DPO No(s) 82154

DEPTH		Core Rec. (M)	Core Size	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAG SUS							
											Depth	Value	Depth	Value				
											219.5	4	235	9				
											220	11	235	5				
											220.5	9	236	6				
											221	4	236.5	CL				
											221.5	3	237	CL				
											222	6	237.5	0				
											222.5	CL	238	CL				
											223	5	238.5	0				
											223.5	CL						
											224	CL						
											224.5	5						
											225	CL						
											225.5	CL						
											226	8						
											226.5	CL						
											227	CL						
											227.5	5						
											228	5						
											228.5	4						
											229	3						
											229.5	9						
											230	10						
											230.5	8						
											231	4						
											231.5	10						
											232	CL						
											232.5	2						
											233	CL						
											233.5	0						
											234	3						
											234.5	CL						

COMPLETION
OF MAG
SUS DATA

301066

bhole	lulldch	DPO	smprno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLth
bhole	lulldch	DPO	smprno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLth
DS100	DD96DS100			Sunny Corner	45/92	0	2.5														Qha
DS100	DD96DS100	82154	5852871	Sunny Corner	45/92	2.5	3.9	-0.5	2.25	24	107	14.9	11	1.97	1.15	8.59	919	319	670		Ogdl
DS100	DD96DS100	82154	5852872	Sunny Corner	45/92	3.9	6	-0.5	0.82	-5	43	18.1	-5	3.18	0.39	9.54	2530	118	414		Ogdl
DS100	DD96DS100	82154	5852873	Sunny Corner	45/92	6	9	-0.5	0.83	-5	37	18.6	5	3.08	0.41	9.68	2610	267	607		Ogdl
DS100	DD96DS100			Sunny Corner	45/92	9	12														No recover
DS100	DD96DS100	82154	5852874	Sunny Corner	45/92	12	14.3	-0.5	2.47	15	174	14.1	6	1.46	1.26	8.26	558	710	1250		Ogud
DS100	DD96DS100	82154	5852875	Sunny Corner	45/92	14.3	15.8	1	1.19	7	80	17.8	19	3.38	0.58	9.41	2690	575	1060		Ogud
DS100	DD96DS100	82154	5852876	Sunny Corner	45/92	15.8	18	-0.5	1.91	7	136	13.4	11	3.53	0.89	7.32	2500	631	1020		Ogud
DS100	DD96DS100	82154	5852877	Sunny Corner	45/92	18	19.7	-0.5	3.25	11	268	1.89	28	0.63	1.53	1.06	207	405	551		Ogdc
DS100	DD96DS100	82154	5852878	Sunny Corner	45/92	19.7	21	0.7	3.14	14	274	2.12	71	0.96	1.56	1.17	277	1220	304		Ogud
DS100	DD96DS100	82154	5852879	Sunny Corner	45/92	21	22.4	1.3	3.88	14	343	0.14	22	0.6	1.92	0.2	26	828	715		Ogud
DS100	DD96DS100	82154	5852880	Sunny Corner	45/92	22.4	25.5	0.6	3.41	14	267	10.9	11	2.3	1.73	6.53	669	99	346		Ogud
DS100	DD96DS100	82154	5852881	Sunny Corner	45/92	25.5	28.5	0.6	2.27	10	125	14.6	23	1.51	1.14	8.99	422	50	339		Ogud
DS100	DD96DS100	82154	5852882	Sunny Corner	45/92	28.5	30.8	-0.5	1.64	8	75	13.8	42	1.23	0.84	8.45	364	107	336		Ogud
DS100	DD96DS100	82154	5852883	Sunny Corner	45/92	30.8	33.9	-0.5	2.97	6	151	12.9	25	1.43	1.51	7.91	385	101	390		Ogud
DS100	DD96DS100	82154	5852884	Sunny Corner	45/92	33.9	37	-0.5	2.16	-5	78	16	6	1.34	1.1	9.73	359	24	112		Ogud
DS100	DD96DS100	82154	5852885	Sunny Corner	45/92	37	40.2	-0.5	1.95	-5	65	16.2	6	1.47	1	9.69	381	24	145		Ogud
DS100	DD96DS100	82154	5852886	Sunny Corner	45/92	40.2	43.4	-0.5	1.82	-5	65	17.7	5	1.14	0.94	10	379	35	124		Ogud
DS100	DD96DS100	82154	5852887	Sunny Corner	45/92	43.4	45	-0.5	1.66	9	59	17.6	8	1.13	0.83	9.92	379	26	108		Ogud
DS100	DD96DS100	82154	5852888	Sunny Corner	45/92	45	48	-0.5	1.83	11	69	15.7	5	1.23	0.93	8.59	347	30	119		Ogud
DS100	DD96DS100	82154	5852889	Sunny Corner	45/92	48	51	-0.5	3.52	13	174	12.2	9	1.74	1.83	6.68	479	37	150		Ogud
DS100	DD96DS100	82154	5852890	Sunny Corner	45/92	51	53.8	-0.5	6.3	12	348	9.77	28	2.09	3.23	5.24	401	55	90		Ogud
DS100	DD96DS100	82154	5852891	Sunny Corner	45/92	53.8	55.9	-0.5	4.44	18	216	13	26	3.54	2.29	6.73	947	39	130		Ogud
DS100	DD96DS100	82154	5852892	Sunny Corner	45/92	55.9	58.4	-0.5	5.52	22	264	10.8	10	2.97	2.76	5.43	667	38	147		Ogud
DS100	DD96DS100	82154	5852893	Sunny Corner	45/92	58.4	61.1	-0.5	4.42	10	190	11.3	9	3.05	2.26	5.72	752	59	132		Ogud
DS100	DD96DS100	82154	5852894	Sunny Corner	45/92	61.1	64.2	-0.5	3.16	16	128	13.6	7	2.45	1.62	6.94	528	151	253		Ogud
DS100	DD96DS100	82154	5852895	Sunny Corner	45/92	64.2	66.5	-0.5	3.92	19	161	12.5	16	2.29	2	6.42	513	250	160		Ogud
DS100	DD96DS100	82154	5852896	Sunny Corner	45/92	66.5	69.5	3	4.02	7	177	13.5	10	2.2	2	7.08	925	1400	1790		Ogud
DS100	DD96DS100	82154	5852897	Sunny Corner	45/92	69.5	73.2	1.2	2.48	20	92	15.2	9	1.6	1.27	8.28	552	285	504		Ogud
DS100	DD96DS100	82154	5852898	Sunny Corner	45/92	73.2	74.4	2	1.69	5	68	15.7	11	1.76	0.84	8.71	716	2910	408		Ogud
DS100	DD96DS100	82154	5852899	Sunny Corner	45/92	74.4	75.7	2.1	2.37	6	78	14.8	13	1.62	1.17	8.38	724	1810	1980		Ogud
DS100	DD96DS100	82154	5852900	Sunny Corner	45/92	75.7	77.5	-0.5	0.77	-5	21	16.9	6	0.34	0.4	10	744	163	314		Ogud
DS100	DD96DS100	82154	5852101	Sunny Corner	45/92	77.5	80.6	-0.5	0.72	-5	20	17.9	-5	1.19	0.33	10.9	681	61	221		Ogud
DS100	DD96DS100	82154	5852102	Sunny Corner	45/92	80.6	82.4	0.5	0.89	-5	25	18.1	6	1.2	0.47	9.74	635	130	164		Ogud
DS100	DD96DS100	82154	5852103	Sunny Corner	45/92	82.4	85.4	2.8	2.55	7	113	13.1	9	1.59	1.26	7.9	747	1270	1800		Ogud
DS100	DD96DS100	82154	5852104	Sunny Corner	45/92	85.4	88.5	2.6	2.63	7	111	12	36	1.5	1.3	7.29	625	437	849		Ogud
DS100	DD96DS100	82154	5852105	Sunny Corner	45/92	88.5	91.5	-0.5	2.18	10	83	7.73	-5	1.1	1.08	4.46	345	182	509		Ogud
DS100	DD96DS100	82154	5852106	Sunny Corner	45/92	91.5	94	-0.5	1.71	-5	71	6.24	-5	1.02	0.84	3.64	332	146	280		Ogud
DS100	DD96DS100	82154	5852107	Sunny Corner	45/92	94	96.5	-0.5	2.02	-5	89	6.36	-5	0.79	1	3.76	317	155	442		Ogud
DS100	DD96DS100	82154	5852108	Sunny Corner	45/92	96.5	99.5	0.7	1.1	-5	42	10.3	-5	0.99	0.54	5.99	509	742	1110		Ogud
DS100	DD96DS100	82154	5852109	Sunny Corner	45/92	99.5	102.5	-0.5	1.38	-5	55	13.1	11	1	0.7	7.75	446	77	521		Ogud
DS100	DD96DS100	82154	5852110	Sunny Corner	45/92	102.5	105.5	-0.5	1.47	-5	51	16.9	-5	0.81	0.75	10.1	523	59	158		Ogud
DS100	DD96DS100	82154	5852111	Sunny Corner	45/92	105.5	108.5	0.7	1.74	-5	59	16	5	1	0.89	9.72	529	121	208		Ogiz
DS100	DD96DS100	82154	5852112	Sunny Corner	45/92	108.5	110.9	1.2	1.7	-5	57	16	29	0.97	0.86	9.41	499	162	439		Ogiz
DS100	DD96DS100	82154	5852113	Sunny Corner	45/92	110.9	113.1	1.2	1.66	-5	58	16.9	32	0.98	0.79	9.98	543	240	539		Ogiz
DS100	DD96DS100	82154	5852114	Sunny Corner	45/92	113.1	115.2	1.8	1.46	-5	53	18.4	10	1.08	0.75	11	623	155	512		Ogiz
DS100	DD96DS100	82154	5852115	Sunny Corner	45/92	115.2	118.8	1.2	1.5	-5	49	17.2	16	1.35	0.75	9.1	631	888	1920		Ogiz
DS100	DD96DS100	82154	5852116	Sunny Corner	45/92	118.8	120.5	2.8	0.89	-5	36	18.8	19	1.39	0.47	9.78	964	1810	6440	-0.09	Ogiz
DS100	DD96DS100	82154	5852117	Sunny Corner	45/92	120.5	123.2	20	1.18	10	44	17.7	74	1.87	0.58	9.21	669	1490	3930		Ogiz
DS100	DD96DS100	82154	5852118	Sunny Corner	45/92	123.2	126.2	1.8	2.94	-5	143	11.6	9	1.48	1.52	5.97	577	581	1840		Ogsl
DS100	DD96DS100	82154	5852119	Sunny Corner	45/92	126.2	128.8	2.5	2.68	-5	131	12.6	9	1.31	1.39	6.33	520	513	1680		Ogsl
DS100	DD96DS100	82154	5852120	Sunny Corner	45/92	128.8	132	4	3.76	7	205	9.02	12	1.56	1.85	4.38	821	1100	2370		Ogsl
DS100	DD96DS100	82154	5852121	Sunny Corner	45/92	132	134.2	5.3	3.03	11	145	11.6	12	1.56	1.52	5.74	655	1050	2950		Ogsl
DS100	DD96DS100	82154	5852122	Sunny Corner	45/92	134.2	136.1	2.6	3.22	7	161	12.6	11	1.67	1.64	6.16	1040	1000	2680		Ogsl
DS100	DD96DS100	82154	5852123	Sunny Corner	45/92	136.1	139.1	2.1	3.99	-5	210	8.86	9	1.68	2.02	4.26	892	1030	3510		Ogsl
DS100	DD96DS100	82154	5852124	Sunny Corner	45/92	139.1	142.2	2.2	3.76	-5	247	6.43	17	2.07	1.89	2.99	1200	1630	5160	1.5	Ogsl
DS100	DD96DS100	82154	5852125	Sunny Corner	45/92	142.2	143.2	-0.5	1	-5	81</										

bhole	lulldah	DPO	srmpno	Prospect	EL	afrom	alo	aag	aal	bas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLth
DS100	DD96DS100	82154	5852135	Sunny Corner	45/92	164.2	165.9	1.5	1.9	11	70	16.1	14	2.85	0.97	9.12	590	442	5260	3.4	Ogbr
DS100	DD96DS100	82154	5852136	Sunny Corner	45/92	165.9	167.4	-0.5	2	-5	82	15.7	8	1.21	1.04	8.93	327	85	2840		Ogbr
DS100	DD96DS100	82154	5852137	Sunny Corner	45/92	167.4	168.5	-0.5	1.71	-5	68	16.7	8	1.36	0.91	9.81	349	66	649		Ogbr
DS100	DD96DS100	82154	5852138	Sunny Corner	45/92	168.5	170.1	-0.5	1.76	5	68	16.4	8	1.4	0.94	9.42	372	103	559		Ogbr
DS100	DD96DS100	82154	5852139	Sunny Corner	45/92	170.1	172	-0.5	1.6	-5	60	16.3	-5	1.46	0.84	9.4	412	35	1130		Ogbr
DS100	DD96DS100	82154	5852140	Sunny Corner	45/92	172	174.6	-0.5	1.59	8	54	18.4	7	1.07	0.83	10.6	339	34	351		Ogbr
DS100	DD96DS100	82154	5852141	Sunny Corner	45/92	174.6	177	-0.5	1.61	6	61	18	8	1.19	0.85	10.5	368	31	584		Ogbr
DS100	DD96DS100	82154	5852142	Sunny Corner	45/92	177	180	-0.5	1.76	-5	68	17.4	6	1.46	0.95	10.1	312	55	302		Ogbr
DS100	DD96DS100	82154	5852143	Sunny Corner	45/92	180	182.3	-0.5	2.12	5	102	16.7	6	1.4	1.11	9.57	407	111	1090		Ogbr
DS100	DD96DS100	82154	5852144	Sunny Corner	45/92	182.3	185.4	-0.5	1.38	-5	72	17.1	5	0.97	0.7	6.98	450	88	538		Ogbr
DS100	DD96DS100	82154	5852145	Sunny Corner	45/92	185.4	188.5	-0.5	2.03	-5	97	16.2	-5	1.12	1.1	9.4	362	78	237		Ogbr
DS100	DD96DS100	82154	5852146	Sunny Corner	45/92	188.5	191.2	-0.5	1.84	6	80	17.2	5	1.54	0.98	9.94	347	47	165		Ogbr
DS100	DD96DS100	82154	5852147	Sunny Corner	45/92	191.2	193.2	-0.5	2.16	-5	85	16	5	1.59	1.18	9.31	298	60	413		Ogbr
DS100	DD96DS100	82154	5852148	Sunny Corner	45/92	193.2	196.3	-0.5	1.68	-5	73	18.1	6	1.77	0.91	10.3	42	206	711		Ogbr
DS100	DD96DS100	82154	5852149	Sunny Corner	45/92	196.3	197.9	1.2	1.78	-5	85	15.4	7	1.7	0.96	8.71	505	3620	1320		Ogbr
DS100	DD96DS100	82154	5852150	Sunny Corner	45/92	197.9	199.5	1.6	2.99	9	141	13.6	8	1.99	1.6	7.69	676	1180	2230		Ogbr
DS100	DD96DS100	82154	5852151	Sunny Corner	45/92	199.5	201	-0.5	2	-5	91	15.5	10	1.75	1.07	8.89	562	298	2440		Ogbr
DS100	DD96DS100	82154	5852152	Sunny Corner	45/92	201	204	-0.5	2.97	-5	139	13.5	6	1.37	1.6	7.88	347	108	373		Ogdl
DS100	DD96DS100	82154	5852153	Sunny Corner	45/92	204	207	-0.5	2.36	-5	110	14.3	-5	2.5	1.28	8.18	314	70	145		Ogbr
DS100	DD96DS100	82154	5852154	Sunny Corner	45/92	207	208.5	-0.5	2.33	8	108	14	8	3.22	1.25	8.08	235	235	873		Ogbr
DS100	DD96DS100	82154	5852155	Sunny Corner	45/92	208.5	210.9	-0.5	2.57	-5	126	14.3	-5	1.2	1.4	8.33	226	15	114		Ogbr
DS100	DD96DS100	82154	5852156	Sunny Corner	45/92	210.9	214	-0.5	3.39	-5	170	11.8	-5	1.83	1.82	6.94	170	23	172		Ogbr
DS100	DD96DS100	82154	5852157	Sunny Corner	45/92	214	216.6	-0.5	4.78	13	253	11.2	-5	1.6	2.57	6.59	225	30	210		Ogbr
DS100	DD96DS100	82154	5852158	Sunny Corner	45/92	216.6	219.5	-0.5	4.24	12	226	12.4	10	1.91	2.29	7.23	310	235	443		Ogbr
DS100	DD96DS100	82154	5852159	Sunny Corner	45/92	219.5	222.4	0.6	1.22	-5	58	18.1	5	1.28	0.82	10.6	570	140	297		Ogbr
DS100	DD96DS100	82154	5852160	Sunny Corner	45/92	222.4	224.6	-0.5	1.35	-5	62	18.7	-5	1.51	0.73	10.8	843	303	426		Ogflz
DS100	DD96DS100	82154	5852161	Sunny Corner	45/92	224.6	227.5	0.7	1.25	-5	62	17.3	5	1.16	0.67	9.92	575	350	363		Ogflz
DS100	DD96DS100	82154	5852162	Sunny Corner	45/92	227.5	230.3	-0.5	1.67	-5	106	16.2	-5	1.22	0.91	9.54	519	164	164		Ogflz/Ogdl
DS100	DD96DS100	82154	5852163	Sunny Corner	45/92	230.3	232.3	1	2.63	8	213	14.8	-5	1.69	1.39	8.37	647	380	719		Ogdl
DS100	DD96DS100	82154	5852164	Sunny Corner	45/92	232.3	235.5	1.1	1.19	19	81	17.1	-5	2.12	0.63	9.86	666	579	1330		Ogdl
DS100	DD96DS100	82154	5852165	Sunny Corner	45/92	235.5	237.1	-0.5	0.81	-5	52	19.3	-5	1.3	0.44	11.3	1070	242	746		Ogdl

CRA EXPLORATION PTY. LIMITED
 DRILL-HOLE SUMMARY LOG

301069

HOLE NAME: DD96DS101 AMG EAST 366237 NORTH S356795
 PROSPECT: SUNNY CORNER GRD EAST 65802 NORTH 56850
 EL: MT DUNDAS EL45192 RL 170m. DEPTH 380.6m.

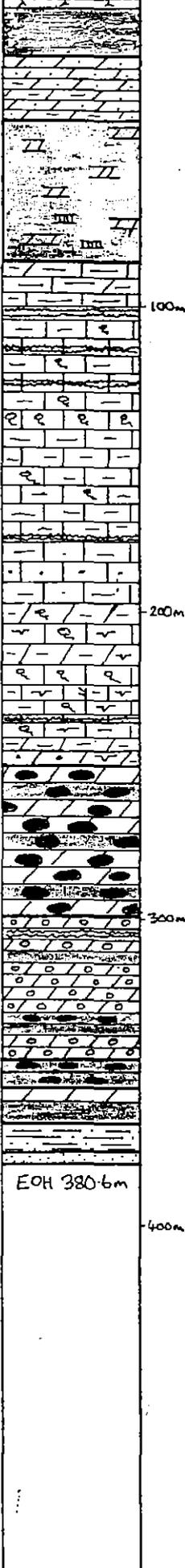
DATE DRILLED: 1/4/96
 LOGGED BY: S.J. TEAR
 DRILLING CO.: DD.TAS
 DRILL TYPE: DIAMOND
 DRILL RIG: LY38 - Helicopter
 LOC DRILL CORE: ZEEHAN

SURVEYS:

DEPTH	AZIM (AMG)	DIP	DEPTH	AZIM (AMG)	DIP
0m	97°	51°	203m	96.5°	47°
50m	97°	51°	251m	97°	49°
98m	97°	51°	300m	82°(?)	50°
149m	97°	49	380m	N/A	52°

(note in casing + double photo.)

Graphic Log



OBJECTIVES OF HOLE:
 Diamond drilltest of surface geochemistry (wacker) up to 0.8% Zn
 and diamond drilltest lower limestone/sandstone contact.

LITHOLOGICAL SUMMARY:

FROM	TO	FORM CODE	COMMENTS
0	3.0	Qha	Overburden
3.0	18.8	Ogdc	Dark grey clays with pyrite and galena.
18.8	39.9	Ogdl	Dolomite
39.9	85.4	Ogdc	Rotted dolomite/limestone with shear zones
85.4	100.9	Ogul	Partially dolomitised bioclastic calcarenite with argillite
100.9	105.0	Ogmu	Laminated micrite unit.
105.0	238.8	Ogul	Mixed sequence of fine grained calcarenites with laminated micrite units - intertidal facies.
238.8	241.5	Ogmu	Laminated micrite unit.
241.5	243.0	Ogfe	Fault zone
243.0	250.0	Ogul	Rotted limestone inc laminated micrite unit.
250.0	299.1	Ogsl	Siderite Unit with dark grey clays
299.1	346.5	Ogso	Dolomitic Oolite Unit with dark clays and mineral.
346.5	355.5	Ogsl	Siderite unit.
355.5	367.5	Ogdc	Dark grey clays +/- dolomite and siderite
367.5	376.8	Ogst	Silty Transition Unit.
376.8	380.6	Om	Moina Sandstone - ?unconformity bedding 45° E c/A.

MINERALISATION SUMMARY:

FROM	TO	COMMENTS
4.3	12.2	Dark grey clay with disseminated galena circa 3.5% Pb 0.8% Zn 30ft Ag inc 1.7m @ 10% Pb 0.37% Zn.
121.3	121.5	Sphalerite/galena replacing limestone - colloform sphalerite - possible vein. 9.2% Zn, 9.2% Pb - Irish-style in look.
201	238.7	Zone of galena in cal/dol veins.
303	304.5	0.3% Zn 3.8% Pb - Galena (+ sphalerite) locally massive in a ?dolomitic/sideritic breccia
312.75	313.85	3.7% Zn 5.9% Pb - Galena + Sphalerite - locally massive (with core loss) in sideritic dolomite.

CONCLUSIONS:
 The drillhole represents major alteration or having occurred with significant base intercepts. This is perhaps the most mineralised and altered drillhole outside of Greaves. Worthy of further follow up. Mineralisation in the Oolite Unit is significant Bedding @ 65.2m 60° to c/A. @ 100.9 45° to c/A. @ 121.5 60° to c/A @ 196.0 60° to c/A @ 262.8 60° to c/A

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 1 of 12

TENEMENT NAME MT DUNDAS No. E.L. 45/9

AMG: 366237E
CO-ORDINATES S. 35.6795N AZIMUTH 097° (AMC) DRILLERS DDTAS COMMENCED 1/4/96
RL COLLAR 170m INCLINATION 51° DRILL TYPE LY38 (H) COMPLETED 1/5/96

PLAN - MAP REFERENCE SUNNY CORNER

DEPTH 380.6 HOLE No. DD96DS101

CASING LEFT DPO No(s) 82161/8216

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)										Mg		SUS		REC (From)	REC (To)	REC (M)	REC (%)	
												Depth	Value	Depth	Value				
0	3.0	-	-	Qha	Overburden - not recovered							3	5	18.5	CL	0	3	-	0
												3.5	5	19	0	3	4.3	0.65	50
3.0	18.8	35	5	Ogdc	Dark grey/black clay ?rotted dolomite (limestone)	Disseminated blebs of recrystallised (?) pyrite.	5473852	3.0	4.3			4	CL	19.5	CL	4.3	6.0	0.9	69
						pyrite up to 5%	53	4.3	6.0			4.5	0	20	CL	6.0	9.0	2.0	67
						4.3-6.0m (+/- galena)	54	6.0	7.0			5	0	20.5	CL	9.0	12.0	1.2	40
						10.5-12.2 5% galena	55	7.0	9.0			5.5	CL	21	35	12.0	15.0	3.0	100
						as blebs disseminated;	56	9.0	10.5			6	2	21.5	4	15.0	18.0	2.4	80
						occ bleb of galena elsewhere	57	10.5	12.2			6.5	0	22	4	18.0	19.5	1.5	100
							58	12.2	15.0			7	5	22.5	5	19.5	21.0	1.2	80
							59	15.0	18.0			7.5	0	23	2	21.0	23.5	2.5	100
18.8	39.9	85	3f	Ogdl	Dark grey dolomite with weathered surfaces Broken core - brittle nature	Minor vug infill as dolomite (+/- v. minor galena)		18.0	18.8			8	CL	23.5	4	23.5	25.2	1.7	100
								18.8	19.5			61	0	24	4	25.2	27.0	1.8	100
								19.5	21.0			62	0	24.5	5	27.0	28.6	1.6	100
								21.0	23.5			63	0	25	6	28.6	30.0	1.4	100
39.9	42.0	60	5x	Ogfc	Sheared zone of clays, broken core (dolomite)			23.5	25.2			64	CL	25.5	5	30.0	31.5	1.5	100
								25.2	27.0			65	CL	26	5	31.5	33.0	1.5	100
								27.0	28.6			66	CL	26.5	8	33.0	34.6	1.6	100
42.0	52.8	67	5x	Ogfc	Zone of rotted ?dolomite and dark grey/black clays seemingly non calcareous but well rotted.	?possibility of minor siderite alteration		28.6	30.0			67	11	27	4	34.6	36.0	1.4	100
								30.0	31.5			68	10	27.5	5	36.0	39.0	0.75	25
								31.5	33.0			69	0	28	5	39.0	40.0	0.9	70
								33.0	34.6			70	0	28.5	8	40.0	42.0	1.2	60
								34.6	36.0			71	5	29	4	42.0	43.5	1.2	80
52.8	55.9	69	5	Ogdc	Dark grey/black clay Perhaps the Silstone Unit	Zones of small scale disseminated pyrite.		36.0	39.0			72	0	29.5	6	43.5	45.0	0.5	33
						Possible bedding @ 55.6 60° to c/a		39.0	39.9			73	0	30	5	45.0	46.6	1.3	81
								39.9	42.0			74	0	30.5	8	46.6	48.0	0.7	50
								42.0	43.5			75	0	31	5	48.0	49.2	0.8	67
55.9	65.2	89	5	Ogdc	Rotted ?limestone/dolomite non-calcareous. Abundant mica. Poss Omega 63.0-63.7m.	Occ fine dissem of pyrite eg 61.0m.		43.5	45.0			76	4	31.5	5	49.2	50.9	1.7	100
								45.0	48.0			77	CL	32	2	50.9	52.5	0.4	25
								48.0	50.2			78	CL	32.5	0	52.5	54.0	1.0	67
65.2	66.5	90	5	Ogmu	Possible rotted laminated micrite unit	Bedding 60° to c/a		50.2	52.8			79	0	33	0	54.0	55.5	1.2	80
								52.8	55.9			80	CL	33.5	2	55.5	57.0	1.5	100

301070

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 2 of 12

TENEMENT NAME MT DUNDAS No. 45/92

PLAN - MAP REFERENCE SUNNY CORNER

AMG: 366237 E
CO-ORDINATES 5356195 N AZIMUTH 097° AMG DRILLERS DDTAS COMMENCED 1/4/96 DEPTH 380.6 HOLE No DD96DS101

RL COLLAR 170M INCLINATION 51° DRILL TYPE LY38(H) COMPLETED 1/5/96 CASING LEFT DPO No(s) 82161/82165

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag				SUS			
										Depth	Value	Depth	Value	REC (From)	REC (To)	REC (M)	REC (%)	
66.5	76.2	73	S	Ogdc	Dark grey/black rotted limestone/dolomite clay poss ogm unit 75.7-76.0m.	Bedding ss to c/a	57388	55.9	58.6		34	4	49.5	5	57.0	58.6	1.6	100
							82	58.6	61.6		34.5	5	50	2	58.6	60.0	1.4	100
							83	61.6	63.6		35	6	50.5	10	60.0	61.6	1.6	100
							84	63.6	65.1		35.5	5	51	10	61.6	63.0	1.0	63
76.2	76.6	100	S	Ogfc	Possible shear zone - dark grey/black clays	Blobs of galena - large masses of v fine grained (fl. ligree) pyrite. ? recrystallised.	85	65.1	66.5		36	4	51.5	CL	63.0	64.5	1.5	100
						Poss shear to 45°-40° to c/a.	86	66.5	69.0		36.5	5	52	CL	64.5	66.0	1.5	100
							87	69.0	72.0		37	6	52.5	5	66.0	67.5	1.0	67
							88	72.0	75.0		37.5	CL	53	6	67.5	69.0	1.2	80
							89	75.0	76.2		38	CL	53.5	3	69.0	70.6	1.2	75
76.6	82.8	47	Sx	Ogcl	Rotted, broken core Dolomitised (?) limestone with dark grey clays poss loss of dolomite d/hole after 78m.		90	76.2	76.6		38.5	4	54	0	70.6	72.0	1.2	86
							91	76.6	78.0		39	5	54.5	3	72.0	73.5	1.0	67
							92	78.0	81.0		39.5	2	55	2	73.5	75.0	1.0	67
							93	81.0	82.8		40	4	55.5	2	75.0	76.6	1.6	100
											40.5	CL	56	5	76.6	78.0	1.0	63
											41	CL	56.5	5	78.0	81.0	1.0	33
											41.5	CL	57	0	81.0	82.8	0.9	50
82.8	85.4	0	-	Cavity							42	6	57.5	0	82.8	85.4	-	0
											42.5	2	58	2	85.4	87.0	1.4	88
85.4	92.0	81	Sx	Ogcl	Partially rotted argillaceous calcarenite with occ bioherms zones of broken core	dol/cal veining locally more intense minor pyrite with veining	94	85.4	87.0		43	5	58.5	2	87.0	88.4	1.2	86
						Fault zone 89.5-92m.	95	87.0	88.4		43.5	2	59	2	88.4	90.0	1.1	69
							96	88.4	90.0		44	CL	59.5	2	90.0	91.1	0.7	77
							97	90.0	92.0		44.5	CL	60	0	91.1	92.7	1.6	100
											45	10	60.5	2	92.7	94.2	1.5	100
											45.5	5	61	5	94.2	95.8	1.6	100
92.0	93.0	100	2	Ogcl	Dolomitised calcarenite	At 92.8m dol vein with semi massive galena < 3mm thick	98	92.0	93.0		46	5	61.5	0	95.7	97.3	1.5	100
											46.5	20	62	5	97.3	99.0	1.7	100
											47	5	62.5	2	99.0	100.8	1.8	100
93.0	95.2	100	1	Ogcl	Med grained (partially dolomitised) calcarenite with occ bioherms and zones of argillite.		99	93.0	95.2		47.5	CL	63	5	100.8	102.0	1.2	100
											48	CL	63.5	3	102.0	103.4	1.4	100
											48.5	5	64	5	103.4	105.0	1.6	100
											49	7	64.5	4	105.0	106.4	1.0	71

301071

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 12

TENEMENT NAME MT DUNOAS No. 45/92

PLAN - MAP REFERENCE SUNNY CORNER

AMG366237E
CO-ORDINATES 5356195N AZIMUTH 097° AMG DRILLERS DOTAS COMMENCED 1/4/96 DEPTH 380.6 HOLE No. DD96DS101
RL COLLAR 170M INCLINATION 51° DRILL TYPE LY38(H) COMPLETED 1/5/96 CASING LEFT DPO No(s) 82161/82165

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag		Sus		REC (Fe)	REC (Cu)	REC (Mn)	REC (Zn)
										Depth	Value	Depth	Value					
95.2	98.8	100	3	Ogmu	laminated micrite unit.		5473900	95.2	97.3		65	2	80.5	35	106.4	108.0	1.6	100
											65.5	0	81	0	108.0	109.6	1.6	100
95.8	99.0	100	2b	Ogul	Bedded fine grained calcarenite with 1cm beds of argillite small fenestral micrite and argillite laminae @ 97.8-98m.	Bedding 60° to c/a.	5471062	97.3	99.0		66	4	81.5	2	109.6	111.0	1.4	100
											66.5	2	82	CL	111.0	112.8	1.5	100
											67	5	82.5	CL	112.5	113.3	0.8	100
											67.5	2	83	CL	113.3	114.3	1.0	100
											68	2	83.5	CL	114.3	115.8	1.5	100
											68.5	4	84	CL	115.8	117.0	1.2	100
											69	2	84.5	2	117.0	118.5	1.5	100
											69.5	2	85	0	118.5	119.9	1.4	100
											70	2	85.5	CL	119.9	121.5	1.6	100
99.0	100.9	100	2	Ogdl	Dolomitised calcarenite with cal/dol veining	Minor beds of pyrite.	63	99.0	100.9		70.5	4	86	CL	121.5	123.0	1.5	100
											71	0	86.5	5	123.0	124.5	1.5	100
											71.5	2	87	8	124.5	126.0	1.5	100
100.9	105.0	95	2b	Ogmu	laminated micrite unit Argillite laminae; with syn sed brecciation and ool bioclastic band.	Bedding 45° to c/a.	64	100.9	103.4		72	4	87.5	5	126.0	127.6	1.6	100
											72.5	2	88	20	127.6	129.0	1.4	100
											73	3	88.5	CL	129.0	130.5	1.5	100
											73.5	4	89	15	130.5	131.7	1.2	100
											74	2	89.5	28	131.7	133.3	1.6	100
105.0	115.1	100	2	Ogul	Fine grained grey calcarenite with interstitial med grained dark grey argillaceous calcarenite - burrowed Partially rotted; rare bioclasts	?stromatolitic cavities 111.5-111.8m. cal/dol in fill.	65	113.3	115.1		74.5	2	90	15	133.3	134.8	1.5	100
											75	0	90.5	5	134.8	136.4	1.6	100
											75.5	0	91	15	136.4	137.9	1.5	100
											76	0	91.5	15	137.9	141.0	3.1	100
											76.5	0	92	30	141.0	144.0	3.0	100
											77	70	92.5	25	144.0	147.0	3.0	100
											77.5	40	93	25	147.0	150.0	3.0	100
115.1	116.5	100	3b	Ogmu	Interlaminated argillite and micrite unit	Bedding 50° to c/a. Chert band 3cm @ 116.7m.					78	CL	93.5	15	150.0	151.4	1.4	100
											78.5	CL	94	25	151.4	153.0	0.8	50
											79	CL	94.5	10	153.0	155.8	2.8	100
116.5	121.5	100	3f	Ogul	Interbedded fine grained calcarenite and argillite. locally bioclastic - well bedded in places. 55° to c/a.	Occ cal/dol veining; 121.3 121.5 cal/dol vein with 7% Sphaerolite - colloform. + 3% Galena	66	119.9	121.5		79.5	CL	95	12	155.8	158.9	3.1	100
							67	121.3	121.5		80	CL	95.5	8	158.9	162.0	3.1	100

301072

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 4 of 12

TENEMENT NAME MT DUNDAS No. 45192

AMG: 366237E
CO-ORDINATES S352795N AZIMUTH 097° AMG DRILLERS ODTAS COMMENCED 1/4/96

PLAN - MAP REFERENCE SUNNY CORNER

RL COLLAR 10m INCLINATION 51° DRILL TYPE LY38(H) COMPLETED 1/5/96

DEPTH 380.6 HOLE No. DD96DS101

CASING LEFT DPO No(s) 82161/82165

DEPTH		Core Rec. %	R&D	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by)								
From (M)	To (M)										mgg SUS								
												Depth	Value	Depth	Value	Depth	Value	Depth	Value
121.5	123.3	100	2	Ogmu	laminated micrite unit.	Bedding 60° to c/a.	6471068	121.5	123.0			96	10	111.5	0	127	11	142.5	5
												96.5	12	112	4	127.5	5	143	5
123.3	134.8	100	1	Ogul	Non-descript med/fine grained grey calcarenite; large bioclastic unit 125-125.5m. Very rare purple intermixed argillite; locally burrowed	Bedding @ 133.3m 50° to c/a.						97	15	112.5	12	128	13	143.5	5
												97.5	18	113	0	128.5	8	144	5
							69	133.3	134.8			98	10	113.5	5	129	5	144.5	3
												98.5	8	114	10	129.5	5	145	10
												99	15	114.5	8	130	7	145.5	12
												99.5	20	115	2	130.5	10	146	7
												100	30	115.5	7	131	5	146.5	5
												100.5	20	116	0	131.5	10	147	0
												101	5	116.5	8	132	12	147.5	3
												101.5	5	117	5	132.5	10	148	0
												102	17	117.5	6	133	5	148.5	0
												102.5	10	118	10	133.5	6	149	4
134.8	141.0	100	2f	Ogul	Becoming more bioclastic after 134.8m to 141m.		70	139.4	141.0			103	17	118.5	2	134	10	149.5	3
												103.5	5	119	3	134.5	5	150	13
												104	5	119.5	4	135	4	150.5	3
141.0	149.3	100	2	Ogul	Fine grained grey calcarenite with locally micritic zones +/- coarse bioclots; some intermixed argillite.	Calcite vein 147.7-148.4m system						104.5	7	120	8	135.5	5	151	2
												105	6	120.5	2	136	10	151.5	2
												105.5	5	121	7	136.5	5	152	4
												106	5	121.5	15	137	7	152.5	12
												106.5	6	122	4	137.5	6	153	8
149.3	151.5	100	4f	Ogfe	Sheared zone with calcite veining, + occ clay zone.		71	147.0	148.6			107	17	122.5	5	138	5	153.5	0
												72	148.6	150.0		107.5	10	123	5
												73	150.0	151.5		108	8	123.5	2
												74	151.5	153.0		108.5	12	124	4
151.5	167.3	100	1	Ogul	Med/fine grained locally micritic calcarenite with zones + bands of argillaceous calcarenite - burrowed bioclots in argillite. Small equigranular unit 164-164.5m. Oncolites.	Bedding quite steep to c/a ? 70° to c/a.						109	12	124.5	5	140	5	153.5	7
												75	162.0	163.5		109.5	24	125	2
												110	20	125.5	0	141	7	153.5	6
												110.5	6	126	0	141.5	4	157	5
												111	5	126.5	2	142	8	157.5	6

301073

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. S. 12

TENEMENT NAME... MT DUNDAS No. 45/92

PLAN - MAP REFERENCE... SUNNY CORNER

266237E
CO-ORDINATES 5355795N AZIMUTH 097° AMG DRILLERS... ODPAS COMMENCED 1/4/96
RL COLLAR 170M INCLINATION 51° DRILL TYPE L938 (H) COMPLETED 1/5/96

DEPTH 380.6 HOLE No. DD96DS101
CASING LEFT DPO No(s) 82161/82165

DEPTH		Core Rec. %	RQD	Graphical Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag Sus		REC (mm)	REC (Cu)	REC (M)	REC (%)	Depth	Value
167.3	167.6	100	4	Ogfs	Calcite vein and clay shear	75° to c/a. Minor pyrite in shear					158	4	178.5	7	162.0	165.0	3.0	100
											158.5	8	174	8	165.0	168.0	3.0	100
											159	4	174.5	11	168.0	171.0	3.0	100
167.6	168.7	100	3	Ogsl	As before shear						159.5	6	175	6	171.0	174.0	3.0	100
											160	8	175.5	10	174.0	177.0	3.0	100
168.7	170.2	100	3b	Ogmu	Laminated micrite unit mainly non-bedded micrite	Bedding 60° to c/a - Occ brown dol vein.					160.5	10	176	6	177.0	180.0	3.0	100
											161	7	176.5	8	180.0	183.0	3.0	100
											161.5	6	177	5	183.0	186.0	3.0	100
70.2	174.0	100	3	Ogsl	Med/fine grained calcarenite with large coral fragments 10-15cm. Poss minor sinterite @ 172.2m. pos. shear zone @ 173.8m for 10cm.	Brown dol vein, 25° to c/a 10cm Calcite vein 45° to c/a @ 172.8m.	SFA1076	172.5	174.0		162	6	177.5	8	186.0	187.6	1.6	100
											162.5	4	178	10	187.6	189.0	1.4	100
											163	8	178.5	7	189.0	190.6	1.6	100
											163.5	13	179	8	190.6	192.0	1.4	100
											164	4	179.5	10	192.0	193.6	1.4	87
											164.5	8	180	4	193.6	195.0	1.4	100
											165	5	180.5	9	195.0	196.0	0.6	60
174.0	175.6	100	1	Ogsl	Intermixed fine grained grey calcarenite and dark grey argillaceous calcarenite.	Cal/dol brown waning +/- minor galena					165.5	10	181	10	196.0	197.0	-	-
											166	5	181.5	3	198.0	198.8	0.4	50
											166.5	8	182	8	198.8	200.0	1.2	100
											167	7	182.5	2				
											167.5	0	183	5				
175.6	177.4	100	1	Ogmu	Laminated micrite unit argillite laminae and fossiliferous micrite.	Bedding 65° to c/a.					168	6	183.5	4				
											168.5	11	184	2				
											169	4	184.5	12				
											169.5	0	185	5				
177.4	196.0	100	2	Ogsl	Fine grained grey calcarenite with argillite bands large coral fragments + other bioclots nodular in places possibly oncolitic zones of weathering (rotting highlight ptz clasts var. 183.8 - 184.4 bedding 70° to c/a.		S471077	181.0	183.0		170	5	185.5	11				
											170.5	6	186	10				
											171	5	186.5	14				
											171.5	7	187	12				
											172	58	187.5	15				
											172.5	8	188	8				
											173	7	188.5	10				

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 6 of 12

TENEMENT NAME MT DUNDAS No. 4512

AMG: 366237E

CO-ORDINATES 5356795N AZIMUTH 097°MMG DRILLERS ODTAS COMMENCED 1/4/96

PLAN - MAP REFERENCE SUNNY CORNER

RL COLLAR 170m INCLINATION 51° DRILL TYPE LY 38(CH) COMPLETED 1/5/96

DEPTH 380.6m HOLE No. DD96DS101

CASING LEFT DPO No(s) 82161/82165

DEPTH		Core Rec. %	RQD	Graphical Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)											
From (M)	To (M)									Mag Sus											
										Depth	Value	Depth	Value	Depth	Value	Depth	Value				
					Slightly stringy burrowed bedding @ 194m 65°					189	8	201.5	25	220	10	235.5	4				
					Bedding (? result of partial rolling) - bioclastic present (? crinoids), argillaceous bioclastic zones.					189.5	4	205	12	220.5	15	236	5				
										190	10	205.5	8	221	15	236.5	12				
										190.5	4	206	47	221.5	10	237	17				
										191	2	206.5	5	222	10	237.5	6				
										191.5	2	207	2	222.5	35	238	8				
										192	11	207.5	2	223	10	238.5	7				
					Sand/clay zone 195.2 to 196m - core loss.					192.5	10	208	2	223.5	5	239	4				
										193	6	208.5	0	224	7	239.5	5				
										193.5	18	209	30	224.5	7	240	20				
196.0	198.0	-	-	cavity						194	6	209.5	12	225	12	240.5	10				
										194.5	4	210	10	225.5	7	241	CL				
198.0	199.6	75	3	Ogul	Partially rotted argillaceous calcarenite, burrowed.					195	4	210.5	5	226	55	241.5	65				
										195.5	CL	211	5	226.5	10	242	55				
										196	4	211.5	10	227	12	242.5	50				
										196.5	CL	212	22	227.5	5	243	50				
199.6	201.3	95	2	Ogul	Med fine grained bioclastic calcarenite with intermixed argillaceous calcarenite. Sheared zone from 200.8m	Cal/dol veining subparallel to c/a; with galena blebs				197	CL	212.5	14	228	7	243.5	20				
										197.5	CL	213	10	228.5	10	244	75				
										198	8	213.5	3	229	8	244.5	60				
										198.5	24	214	CL	229.5	5	245	2				
										199	43	214.5	5	230	5	245.5	2				
										199.5	22	215	10	230.5	15	246	5				
										200	5	215.5	15	231	15	246.5	5				
										200.5	7	216	12	231.5	30	247	8				
										201	6	216.5	10	232	8	247.5	10				
										201.5	4	217	10	232.5	10	248	25				
										202	4	217.5	15	233	12	248.5	25				
										202.5	10	218	8	233.5	5	249	22				
										203	18	218.5	6	234	3	249.5	CL				
										203.5	80	219	12	234.5	5	250	7				
										204	22	219.5	12	235	10	250.5	CL				

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 7 of 12

TENEMENT NAME MT OUNDAS No. A 45/92

PLAN - MAP REFERENCE SUNNY CORNER

DEPTH 380.6m HOLE No. DD96DS101

CASING LEFT DPO No(s) 82(6) 182(6S)

AMG: 366237E.

CO-ORDINATES 5356795N AZIMUTH 097° AMG DRILLERS DDTAS COMMENCED 1/4/96

RL COLLAR 170M INCLINATION 51° DRILL TYPE LY38(H) COMPLETED 1/5/96

DEPTH		Core Rec. (g)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag		Su		S		REC (mm)	REC (lb)
											Depth	Value	Depth	Value				
200.0	200.6	100	2	Og00	med grained grey equigranular bioclastic calcarenite	Cal/dol 1cm wide vein with galena 10° to c/a.	5852166	198.8	199.6		251	15	266.5	CL	198.8	200.0	1.2	100
							5852167	199.6	201.0		2515	CL	267	140	200.0	201.0	1.0	100
											252	CL	267.5	CL	201.0	202.4	0.9	57
200.8	202.4	62	4X	OgFz	Argillaceous calcarenite and dark grey clay - ? fault zone or rotten limestone.	80° to c/a angle of shearing.	68	201	202.4		2525	5	268	CL	202.4	203.9	1.5	100
											253	7	268.5	15	203.9	205.5	1.4	88
											2535	CL	269	CL	205.5	209.0	1.2	80
											254	5	269.5	CL	207.0	208.4	1.2	86
202.4	215.5	82	2F	OgU1	zone of mixed limestone type beds - fine grained uniform calcarenites; coarsely bioclastic with - possible oncoides	Bedding 70° to c/a cal/dol vein 10° to c/a with galena blebs	69	202.4	203.9		2545	150	270	25	208.4	209.9	1.5	100
							70	203.9	205.5		255	5	270.5	CL	209.9	211.5	1.4	88
											2555	5	271	CL	211.5	213.0	1.5	100
											256	5	271.5	75	213.0	214.5	0.25	17
											2565	7	272	85	214.5	215.5	0.75	75
											257	3	272.5	CL	215.5	217.0	1.5	100
											2575	CL	273	60	217.0	218.6	1.6	100
											258	3	273.5	CL	218.6	219.8	1.2	100
											2585	5	274	200	219.8	221.4	1.1	69
215.5	220.7	100	2F	OgU1	Fine grained almost micritic grey calcarenite with minor argillite bands - ? stylolites	2cm cal/dol vein 15° to c/a with minor galena blebs					259	15	274.5	8	221.4	223.9	2.2	88
											2595	4	275	170	223.9	225.0	1.1	100
											260	0	275.5	5	225.0	226.4	1.1	79
											2605	5	276	CL	226.4	228.0	1.6	100
											261	4	276.5	CL	228.0	229.7	1.1	65
											2615	25	277	CL	229.7	231.0	0.9	69
220.7	222.1	67	5X	OgFz	zone of broken core / ? fault zone		71	221.9	223.9		262	15	277.5	10	231.0	231.9	0.7	70
											2625	150	278	200	231.9	233.3	1.4	100
											263	CL	278.5	CL	233.3	234.5	0.8	80
222.1	224.4	75	3F	OgU1	Coarsely bioclastic bands intermixed with fine grained grey micritic calcarenite and argillite						2635	5	279	15	234.5	235.5	0.8	80
											264	CL	279.5	210	235.5	236.7	0.4	81
											2645	160	280	5	236.7	238.4	1.5	88
											265	75	280.5	10	238.4	240.0	1.1	69
											2655	CL	281	15	240.0	241.5	1.0	67
											266	230	281.5	18	241.5	243.0	0.8	53

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 9 of 12

TENEMENT NAME M.T. OUNDAS No. 45192
PLAN - MAP REFERENCE SUNNY CORNER

AMG 366237E
CO-ORDINATES 535679SN AZIMUTH 097° AMG DRILLERS ODTAS COMMENCED 11/4/96
RL COLLAR 170m INCLINATION 51° DRILL TYPE LY38 (41) COMPLETED 11/5/96

DEPTH 380.6m HOLE No. DD96DS10
CASING LEFT DPO No(s) 82161/82165

DEPTH		Core Rec. (m)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)					
From (M)	To (M)										Mag	SUS	REC (Fe)	REC (Cu)	REC (M)	REC (S)
238.8	240.0	67	1x	Ogmu	light grey massive micrite with birds eyes.						297.5	CL	243.0	244.5	1.0	67
											298	CL	244.5	246.0	1.5	100
											298.5	CL	246.0	247.5	1.0	67
240.0	244.5	67	3x	Ogmu.	laminated micrite - distinctive with abundant argillaceous laminae and very small nodules of micrite <2mm intertwined.	Bedding 70° to c/A Suggestion of possible siderite alteration on ? cleavage planes 25° to clp.	5852175	240.0	244.5		299	180	247.5	249.0	1.5	100
											299.5	5	249.0	250.0	0.4	40
											300	5	250.0	251.0	0.25	25
											300.5	20	251.0	252.4	0.2	14
											301	10	252.4	253.7	0.45	50
											301.5	30	253.7	255.0	0.0	77
241.5	243.0	60	5x	OgFz	Sheared zone - brecciated siderite	Siderite alteration of limestone (part calcareous)	76	241.5	243.0		302	10	255.0	256.5	0.6	40
											302.5	CL	256.5	258.0	0.3	20
											303	5	258.0	259.2	0.3	25
243.0	244.6	70	3f	OgSD	Siderite unit - dark grey black, weakly calcareous with localized hydrothermal brecciation.		77	243.0	244.5		303.5	30	259.2	260.9	0.3	18
											304	CL	260.9	262.1	1.0	83
											304.5	20	262.1	263.4	0.4	31
											305	5	263.4	264.9	0.6	40
											305.5	5	264.9	265.9	0.2	20
244.6	245.8	100	3x	Ogud	Partially rotted argillaceous brownish calcarenites with clays at base.		78	244.5	245.8		306	5	265.9	267.0	0.3	33
											306.5	5	267.0	268.5	0	-
											307	CL	268.5	270.0	0.1	7
											307.5	CL	270.0	271.5	0.1	7
245.8	250.0	70	5x	Ogmu	Rotted laminated micrite unit - on a clay - top of unit with bird eye micrites light grey to 247.5m then with argillaceous laminae. Heavily sheared	Bedding 60° to c/A. Cleavage (brown planes due to siderite - 25° to c/A)	79	245.8	247.5		308	CL	271.5	273.0	0.3	20
							80	247.5	250.0		308.5	CL	273.0	274.5	0.3	20
											309	10	274.5	275.8	0.5	38
											309.5	50	275.8	277.5	0.1	6
											310	20	277.5	279.0	0.4	27
											310.5	CL	279.0	280.2	0.5	42
											311	CL	280.2	280.9	0.5	71
250.0	255.0	40	4x	OgSD	Heavily sheared/rotted zone Dark grey/Dark brown/black partly calcareous rock with clays	Siderite +/- ?dolomite alteration	81	250.0	252.4		311.5	CL	280.9	282.0	0.2	19
							82	252.4	253.7		312	5	282.0	283.5	0.6	40
							83	253.7	255.0		312.5	15	283.5	285.0	0.9	60

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 11 of 12
TENEMENT NAME MT OUNDAS No. 45192
PLAN - MAP REFERENCE SUNNY CORNER
DEPTH 380.6m HOLE No. DD96 DS101
COMPLETED 1/5/96 CASING LEFT DPO No(s) 82161/82165

AMG 366237E
CO-ORDINATES 5356795N AZIMUTH 097° AMG DRILLERS COMMENCED 1/4/96
RL COLLAR 170M INCLINATION 51° DRILL TYPE COMPLETED 1/5/96

DEPTH		Core Rec. (g)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag. SLS		Rec (From)	Rec (To)	Rec (M)	Rec (%)		
										Depth	Value	Depth	Value					
309.0	315.0	46	Sx	Ogdc	Grey/dark grey clays with minor siderite zones	Disseminated sphalerite and galena up to 5% in siderite altered material +/- minor cal/dol veining/veg material. 313-313.5 - Core loss.	547383	309.0	312.0		313	160	328.5	10	285.0	286.5	0.5	33
							14	312.0	312.75		315	CL	329	CL	286.5	287.8	0.5	38
							15	312.75	313.5		314	5	329.5	CL	287.8	289.1	0.9	69
							16	313.5	314.9		314.5	5	330	10	289.1	290.6	0.9	60
											315	3	330.5	45	290.6	292.5	0.6	32
											315.5	2	331	35	292.5	294.4	-	-
											316	CL	332.5	CL	294.4	295.1	0.3	43
315.0	330.0	45	Sx	Ogpo	med grained recrystallised dolomitised ?oolite unit. Grey/light grey - minor dark grey non-calc argillaceous material at top of unit. - note density - v broken core.	Cal/dol veining present	17	314.9	316.2		316.5	2	333	CL	295.1	297.0	0.2	11
							18	316.2	317.3		317	5	333.5	CL	297.0	299.1	0.05	2
							19	317.3	318.4		317.5	5	334	CL	299.1	300.0	0.5	55
							20	318.4	320.0		318	CL	334.5	CL	300.0	304.5	1.0	67
							21	320.0	321.4		318.5	5	335	20	304.5	303.0	0.45	30
							22	321.4	324.1		319	15	335.5	CL	303	304.5	0.5	33
							23	324.1	326.8		319.5	10	336	CL	304.5	306.0	0.3	20
							24	326.8	328.5		320	2	336.5	CL	306.0	309.0	0.6	20
330.0	337.3	22	Sx	Ogdc	Zone of core loss, dark clays and possible siderite alteration		25	328.5	330.0		320.5	20	337	CL	309.0	312.0	1.0	33
							26	330.0	331.5		321	25	337.5	20	312.0	313.5	0.5	33
							27	331.5	334.5		321.5	30	338	15	313.5	315.0	0.75	50
							28	334.5	337.3		322	25	338.5	CL	315.0	316.2	0.4	33
337.3	346.5	50	Sx	Ogpo	Med grained, recrystallised dolomitised ?oolite unit	Cal/dol vey infill and veining present - minor sulphides visible.	29	337.3	340.5		322.5	15	339	25	316.2	317.3	0.5	45
							30	340.5	342.0		323	30	339.5	CL	317.3	318.4	0.3	27
							31	342.0	343.5		323.5	5	340	10	318.4	319.6	0.4	33
							32	343.5	345.0		324	10	340.5	15	319.6	320.0	0.1	25
346.5	355.5	22	3x	Ogpd	Dark grey/black siderite unit with clay zones and cavities with zones of brown siderite	No veining. Major core loss	33	345.0	346.5		324.5	10	341	30	320.0	321.4	0.7	50
							34	346.5	349.5		325	20	341.5	30	321.4	322.5	0.7	63
							35	349.5	351.0		325.5	15	342	30	322.5	324.1	1.2	75
							36	351.0	352.5		326	15	342.5	18	324.1	325.6	0.9	64
							37	352.5	355.5		326.5	CL	343	25	325.5	326.7	0.4	31
355.5	360.3	43	4x	Ogdl	Dark grey ?siderite +/- dolomite zone. Major core loss.		38	355.5	358.1		327	10	343.5	20	326.7	328.5	1.0	59
							39	358.1	359.7		327.5	10	344	25	328.5	330.0	0.1	7
							5473840	359.7	360.3		328	10	344.5	15	330.0	331.5	0.5	50

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 12 of 12

MYG 366237E
CO-ORDINATES S356795N AZIMUTH 097° AMG DRILLERS..... COMMENCED 1/4/96
RL COLLAR 170m INCLINATION 051° DRILL TYPE..... COMPLETED 1/5/96

TENEMENT NAME MT DUNDAS No. 45/92
PLAN - MAP REFERENCE SUNNY CORNER
DEPTH 380.6m HOLE No. DP96DS101
CASING LEFT..... DPO No(s) 82161/82165

DEPTH		Core Rec. (%)	R00	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag		SUS		REC (ppm)	REC (%)	REC (m)	REC (%)
				Depth	Value	Depth	Value	REC (ppm)	REC (%)	REC (m)	REC (%)							
360.3	361.3	100	2	Ogsl	Siderite breccia - or limestone syn-bed breccia with siderite alteration	Angular brecciated fragments	547384	360.3	361.3		345	20	361	90	331.5	334.5	0.1	3
											345.5	25	361.5	10	334.5	337.5	0.0	33
											346	CL	362	10	339.5	340.5	1.5	50
											346.5	10	362.5	20	340.5	343.5	3.0	100
361.3	367.5	17	5x	Ogdc	Dark grey clays - non calcareous - major core loss - possible zones of siderite alteration.	3cm ?dolomitised onlita occurs between 364.5+367.5 + minor pyrite.	42	361.3	364.5		347	10	363	CL	343.5	345.0	0.6	40
							43	364.5	367.3		347.5	10	363.5	CL	345.0	346.5	0.15	10
							44	367.3	367.5		348	CL	364	CL	346.5	349.5	0.6	20
											348.5	CL	364.5	CL	344.5	351.0	0.45	30
											349	40	365	30	351.0	352.5	0.15	10
367.5	376.5	11	5x	Ogsl	Grey/dark grey quartz sandstone - very gritty and rotted - sericitic + sheared at base with clay zones.	Bedding 755° to c/a	45	367.5	370.5		349.5	2	365.5	10	352.5	355.5	0.6	20
							46	370.5	373.5		350	5	366	CL	355.5	358.1	1.0	38
							47	373.5	376.5		350.5	10	366.5	CL	356.1	359.7	1.0	63
											351	5	367	CL	359.7	361.5	1.8	100
											351.5	CL	367.5	5	361.5	364.5	0.3	10
376.5	376.8	100	4x	Ogsl	Quartz conglomerate - silicic		48	376.5	376.8		352	CL	368	2	364.5	367.5	0.45	15
											352.5	10	368.5	CL	367.5	370.5	0.15	5
376.8	380.6	100	3f	Om	lt grey/pinkish silicic quartzite - massive in places, becoming more pinkish dthole.	Bedding 45° to c/a.	49	376.8	378.3		353	180	369	CL	370.5	373.5	0.45	15
							50	378.3	379.1		353.5	100	369.5	CL	373.5	376.5	0.45	15
							5473851	379.1	380.6		354	CL	370	CL	376.5	378.3	1.8	100
											354.5	CL	370.5	5	378.3	379.1	0.8	100
											355	50	371	5	379.1	380.6	1.5	100
											355.5	10	371.5	CL	ppm Value			
											356	5	372	CL	377	2		
											356.5	7	372.5	CL	377.5	0		
											357	CL	373	CL	378	2		
											357.5	CL	373.5	5	378.5	0		
											358	15	374	4	379	0		
											358.5	CL	374.5	CL	379.5	2		
											359	CL	375	CL	380	0		
											359.5	CL	375.5	CL	380.5	0		
											360	4	376	CL	E.C.H.			
											360.5	210	376.5	0				

END OF HOLE (2) 380.6m.

bhole	fulldh	DPO	smjno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	ale	ak	amg	amn	apb	azn	es	MRT/Lth
DS101	DD96DS101	82165	5471071	Sunny Corner	45/92	147	148.6	0.9	0.51	-5	112	31.87	-5	0.41	0.27	0.52	309	30	56		Ogul
DS101	DD96DS101	82185	5471072	Sunny Corner	45/92	148.6	150	1.2	0.81	-5	153	28.16	-5	0.88	0.38	1.35	391	51	44		Ogul
DS101	DD96DS101	82165	5471073	Sunny Corner	45/92	150	151.5	-0.5	1.54	-5	297	19.4	-5	1.58	0.72	1.87	683	489	547		Ogul
DS101	DD96DS101	82165	5471074	Sunny Corner	45/92	151.5	153	0.6	1.57	-5	297	23.17	-5	1.54	0.8	1.48	513	86	65		Ogul
DS101	DD96DS101			Sunny Corner	45/92	163	162														Ogul
DS101	DD96DS101	82165	5471075	Sunny Corner	45/92	162	163.5	0.6	1.32	-5	227	23.89	-5	0.79	0.69	1.62	197	22	71		Ogul
DS101	DD96DS101			Sunny Corner	45/92	163.5	172.5														Ogul
DS101	DD96DS101	82165	5471076	Sunny Corner	45/92	172.5	174	1.3	0.83	-5	243	30.04	-5	0.77	0.44	1.21	558	293	74		Ogul
DS101	DD96DS101			Sunny Corner	45/92	174	181														Ogul
DS101	DD96DS101	82165	5471077	Sunny Corner	45/92	181	183	0.6	1.15	-5	193	24.25	6	1.7	0.6	1.09	793	141	171		Ogul
DS101	DD96DS101			Sunny Corner	45/92	183	192														Ogul
DS101	DD96DS101	82165	5471078	Sunny Corner	45/92	192	193.6	-0.5	0.88	-5	132	27.14	5	1.33	0.47	0.75	699	145	46		Ogul
DS101	DD96DS101			Sunny Corner	45/92	193.6	198.8														Ogul
DS101	DD96DS101	82161	5852166	Sunny Corner	45/92	198.8	199.6	1.4	1.08	-5	151	21.57	6	4.02	0.65	3.54	2260	214	609		Ogul
DS101	DD96DS101	82161	5852167	Sunny Corner	45/92	199.6	201	2.8	0.47	-5	90	27.76	28	1.68	0.25	3.18	889	3250	859		Ogul
DS101	DD96DS101	82161	5852168	Sunny Corner	45/92	201	202.4	3.9	0.99	-5	160	25.38	12	1.11	0.59	3.16	573	4110	324		Ogul
DS101	DD96DS101	82161	5852169	Sunny Corner	45/92	202.4	203.9	1.5	1.21	-5	158	23.12	12	3.28	0.74	2.71	1570	546	416		Ogul
DS101	DD96DS101	82161	5852170	Sunny Corner	45/92	203.9	206.5	2.9	1.29	-5	174	22.11	10	2.59	0.78	2.57	1280	5030	1540		Ogul
DS101	DD96DS101			Sunny Corner	45/92	205.5	221.9														Ogul
DS101	DD96DS101	82161	5852171	Sunny Corner	45/92	221.9	223.9	1.6	1.35	-5	160	24.74	8	1.43	0.84	3.35	625	2270	74		Ogul
DS101	DD96DS101			Sunny Corner	45/92	223.9	229.4														Ogul
DS101	DD96DS101	82161	5852172	Sunny Corner	45/92	229.4	232.1	2.3	1.86	16	145	20.75	9	2.09	1.15	2.72	959	2370	45		Ogul
DS101	DD96DS101			Sunny Corner	45/92	232.1	236.7														Ogul
DS101	DD96DS101	82161	5852173	Sunny Corner	45/92	236.7	238.7	0.9	1.16	-5	109	25.95	-5	3.36	0.73	1.58	1830	197	46		Ogul
DS101	DD96DS101	82161	5852174	Sunny Corner	45/92	238.7	240	2	0.54	-5	69	32.44	-5	0.64	0.36	0.78	358	347	37		Ogmu
DS101	DD96DS101	82161	5852175	Sunny Corner	45/92	240	241.5	-0.5	2.81	-5	170	16.8	7	3.31	1.75	1.04	1740	59	54		Ogmu
DS101	DD96DS101	82161	5852176	Sunny Corner	45/92	241.5	243	-0.5	2.72	10	167	11.39	7	10.33	1.66	3.34	5480	45	55		Ogfu
DS101	DD96DS101	82161	5852177	Sunny Corner	45/92	243	244.5	-0.5	2.76	-5	176	11.39	23	8.65	1.63	5.07	4440	27	48		Ogfu
DS101	DD96DS101	82161	5852178	Sunny Corner	45/92	244.5	245.8	0.9	1.07	-5	90	25.25	-5	3.82	0.68	1.25	2030	25	51		Ogul
DS101	DD96DS101	82161	5852179	Sunny Corner	45/92	245.8	247.5	1.5	1.46	-5	105	27.24	-5	2.53	0.93	0.88	1270	29	46		Ogul
DS101	DD96DS101	82161	5852180	Sunny Corner	45/92	247.5	250	0.9	2.13	-5	122	22.68	-5	2.08	1.34	1.47	923	39	45		Ogul
DS101	DD96DS101	82161	5852181	Sunny Corner	45/92	250	252.4	-0.5	2.77	-5	149	14.71	8	4.15	1.69	4.74	1650	58	68		Ogdl
DS101	DD96DS101	82161	5852182	Sunny Corner	45/92	252.4	253.7	-0.5	2.59	-5	130	17.11	-5	3.26	1.59	4.14	1120	35	98		Ogdl
DS101	DD96DS101	82161	5852183	Sunny Corner	45/92	253.7	255	-0.5	2.56	-5	136	11.99	-5	10.88	1.54	3.49	5630	32	58		Ogds
DS101	DD96DS101	82161	5852184	Sunny Corner	45/92	255	256.5	-0.5	1.92	-5	121	19.57	8	3.87	1.18	2.9	1760	34	96		Ogul
DS101	DD96DS101	82161	5852185	Sunny Corner	45/92	256.5	259.2	-0.5	2.44	-5	129	16.47	5	5.24	1.49	4.96	2550	34	112		Ogdl
DS101	DD96DS101	82161	5852186	Sunny Corner	45/92	259.2	261	0.8	2.77	-5	148	21.2	5	2.05	1.72	1.91	936	24	80		Ogul
DS101	DD96DS101	82161	5852187	Sunny Corner	45/92	261	262.1	-0.5	2.5	-5	179	14.78	-5	6.15	1.53	2.71	3450	257	125		Ogul
DS101	DD96DS101	82161	5852188	Sunny Corner	45/92	262.1	264.9	-0.5	2.27	-5	156	6.99	-5	18.4	1.38	2.57	11700	11	31		Ogds
DS101	DD96DS101	82161	5852189	Sunny Corner	45/92	264.9	267	-0.5	1.83	-5	114	10.09	-5	13.58	1.12	4.13	8640	21	62		Ogds
DS101	DD96DS101			Sunny Corner	45/92	267	268.5														No recover
DS101	DD96DS101	82161	5852190	Sunny Corner	45/92	268.5	270	-0.5	2.32	-5	142	11.46	6	9.87	1.41	4.47	5830	504	127		Ogds
DS101	DD96DS101	82161	5852191	Sunny Corner	45/92	270	271.5	-0.5	2.01	-5	143	6.75	-5	19.29	1.23	2.34	11400	34	46		Ogds
DS101	DD96DS101	82161	5852192	Sunny Corner	45/92	271.5	273	-0.5	2.15	22	144	7.97	6	16.24	1.3	1.98	10300	30	85		Ogds
DS101	DD96DS101	82161	5852193	Sunny Corner	45/92	273	274.5	-0.5	1.71	-5	119	6.83	-5	17.85	1.03	2.89	12600	11	44		Ogds
DS101	DD96DS101	82161	5852194	Sunny Corner	45/92	274.5	275.8	-0.5	2.8	-5	252	11.26	5	11.46	1.65	3.15	6750	45	109		Ogds
DS101	DD96DS101	82161	5852195	Sunny Corner	45/92	275.8	277.5	1.8	1.89	22	176	16.43	26	2.89	1.16	6.42	1500	1730	179		Ogdl
DS101	DD96DS101	82161	5852196	Sunny Corner	45/92	277.5	279	-0.5	2.1	11	213	8.08	5	20.12	1.25	2.1	12000	183	80		Ogds
DS101	DD96DS101	82161	5852197	Sunny Corner	45/92	279	280.2	0.5	1.76	-5	501	6.97	17	16.61	1.05	2.27	11600	858	613		Ogds
DS101	DD96DS101	82161	5852198	Sunny Corner	45/92	280.2	282	1	1.63	18	231	10.03	12	7.9	0.87	4.47	5130	294	603		Ogdl
DS101	DD96DS101	82161	5852199	Sunny Corner	45/92	282	283.5	-0.5	2.04	10	358	10.76	6	10.54	1.19	4.15	6860	852	47		Ogds
DS101	DD96DS101	82161	5852200	Sunny Corner	45/92	283.5	285	-0.5	2.59	15	324	8.4	-5	13.74	1.49	2.24	9920	142	111		Ogds
DS101	DD96DS101	82161	5473801	Sunny Corner	45/92	285	286.5	-0.5	1.44	-5	127	12.55	-5	10.41	0.82	6.15	5920	63	82		Ogds
DS101	DD96DS101	82161	5473802	Sunny Corner	45/92	286.5	287.8	0.8	1.89	5	179	13.17	14	8.27	1.12	6.33	4930	768	84		Ogdl
DS101	DD96DS101	82161	5473803	Sunny Corner	45/92	287.8	289.4	2.5	1.46	18	216	10.24	26	14.81	0.86	4.74	10400	1400	257		Ogds
DS101	DD96DS101	82161	5473804	Sunny Corner	45/92	289.4	290.6	5.8	2.36	39	286	13.29	89	4.06	1.39	6.06	2000	4860	167		Ogdl
DS101	DD96DS101	82161	5473805	Sunny Corner	45/92	290.6	292.5	-0.5	2.23	9	193	8.37	-5	15.32	1.28	4.02	10700	141	117		Ogds
DS101	DD96DS101			Sunny Corner	45/92	292.5	294.4														No recover
DS101	DD96DS101	82161	5473806	Sunny Corner	45/92	294.4	295.1	-0.5	1.59	-5	140	6.66	-5	21.32	0.94	3.15	15500	34	52		Ogds
DS101	DD96DS101	82161	5473807	Sunny Corner	45/92	295.1	299.1	-0.5	0.94	6	101	5.11	-5	27.6	0.55	1.93	19100	70	51		Ogds
DS101	DD96DS101	82161	5473808	Sunny Corner	45/92	299.1	301.5	-0.5	2.83	-5	323	18.27	9	6.29	1.7	1.63	3150	310	189		Ogoo
DS101	DD96DS101	82161	5473809	Sunny Corner	45/92	301.5	303	-0.5	2.41	-5	241	21.95	-5	2.86	1.43	2.3	1540	151	393		Ogoo
DS101	DD96DS101	82161	5473810	Sunny Corner	45/92	303	304.5	8.7	1.73	-5	313	17.18	24	5.6	0.87	4.49	6930	38000	3030		Ogoo
DS101	DD96DS101	82161	5473811	Sunny Corner	45/92	304.5	306	1.3	2.5	-5	434	22.92	8	1.84	1.28	2.09	1360	1290	553		Ogoo
DS101	DD96DS101	82161	5473812	Sunny Corner	45/92	306	309	1.9	2.09	-5	284	20.04	7	3.29	1.07	2.3	1960	2500	623		Ogoo
DS101	DD96DS101	82161	5473813	Sunny Corner	45/92	309	312	4.3	2.03	-5	260	12.71	25	9.52	1.03	5.5	6440	5370	2000		Ogoo
DS101	DD96DS101	82161	5473814	Sunny Corner	45/92	312	312.8	2.2	1.69	-5	233	10.									

bhole	lullddh	DPO	smjno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	ale	ak	amg	amn	apb	azn	as	MRTLith
DS101	DD96DS101	82161	5473815	Sunny Corner	45/92	312.75	313.5	32.5	0.51	-5	88	8.99	519	15.37	0.17	4.22	18700	59000	37100	3.8	Ogsd
DS101	DD96DS101	82161	5473816	Sunny Corner	45/92	313.5	314.9	9.3	2.31	5	351	13.14	26	4.56	1.09	6.06	3350	2540	2520		Ogoo
DS101	DD96DS101	82161	5473817	Sunny Corner	45/92	314.9	316.2	2.1	0.53	-5	247	19.06	9	5.35	0.26	8.51	4480	252	398		Ogoo
DS101	DD96DS101	82161	5473818	Sunny Corner	45/92	316.2	317.3	6.5	0.84	-5	276	18.01	17	5.18	0.41	8.02	4520	6390	2700		Ogoo
DS101	DD96DS101	82161	5473819	Sunny Corner	45/92	317.3	318.4	3.1	1.4	-5	427	18.87	16	5.45	0.53	8.26	5010	680	639		Ogoo
DS101	DD96DS101	82161	5473820	Sunny Corner	45/92	318.4	320	3.6	0.76	-5	293	20.23	11	4.84	0.36	9.19	4950	762	385		Ogoo
DS101	DD96DS101	82161	5473821	Sunny Corner	45/92	320	321.4	1.2	0.67	-5	324	19.38	8	7.9	0.35	7.15	9460	234	199		Ogoo
DS101	DD96DS101	82161	5473822	Sunny Corner	45/92	321.4	324.1	1.1	0.47	-5	292	17.71	-5	9.36	0.25	5.6	12800	87	122		Ogoo
DS101	DD96DS101	82161	5473823	Sunny Corner	45/92	324.1	326.8	1.1	0.63	-5	399	19.74	5	7.7	0.33	7.48	8320	95	171		Ogoo
DS101	DD96DS101	82161	5473824	Sunny Corner	45/92	326.8	328.5	0.6	0.64	-5	482	18.35	-5	8.62	0.33	6.63	10000	113	182		Ogoo
DS101	DD96DS101	82161	5473825	Sunny Corner	45/92	328.5	330	1.7	1.13	-5	650	19.34	10	6.62	0.58	7.79	7240	104	149		Ogoo
DS101	DD96DS101	82161	5473826	Sunny Corner	45/92	330	331.5	2.5	2.32	10	375	14.32	15	11.05	1.18	5.41	8600	2090	1190		Ogsd
DS101	DD96DS101	82161	5473827	Sunny Corner	45/92	331.5	334.5	-0.5	1.35	-5	192	8.91	-5	20.16	0.71	3.7	11800	62	150		Ogsd
DS101	DD96DS101	82161	5473828	Sunny Corner	45/92	334.5	337.3	2	1.55	10	176	14.42	18	5.7	0.72	7.07	2890	334	393		Ogoo
DS101	DD96DS101	82161	5473829	Sunny Corner	45/92	337.3	340.5	0.7	0.99	-5	724	17.54	-5	6.13	0.5	7.42	5950	53	154		Ogoo
DS101	DD96DS101	82161	5473830	Sunny Corner	45/92	340.5	342	1.2	0.51	-5	401	19.59	-5	7.76	0.24	7.59	10600	48	107		Ogoo
DS101	DD96DS101	82161	5473831	Sunny Corner	45/92	342	343.5	0.8	0.37	-5	228	18.94	-5	7.65	0.17	7.27	10800	63	140		Ogoo
DS101	DD96DS101	82161	5473832	Sunny Corner	45/92	343.5	345	1	0.76	5	410	17.86	-5	7.13	0.28	6.74	10600	131	294		Ogoo
DS101	DD96DS101	82161	5473833	Sunny Corner	45/92	345	346.5	0.8	0.76	12	520	18.21	15	6.07	0.36	7.6	7380	99	115		Ogoo
DS101	DD96DS101	82161	5473834	Sunny Corner	45/92	346.5	349.5	-0.5	2.57	-5	607	13.91	8	6.18	1.32	7.01	2620	68	160		Ogdl
DS101	DD96DS101	82161	5473835	Sunny Corner	45/92	349.5	351	-0.5	3.37	12	688	13.07	9	4.23	1.72	6.54	1510	84	79		Ogdl
DS101	DD96DS101	82161	5473836	Sunny Corner	45/92	351	352.5	-0.5	2.81	9	630	5.01	16	17.95	1.42	2.16	8450	188	1460		Ogsd
DS101	DD96DS101	82161	5473837	Sunny Corner	45/92	352.5	355.5	-0.5	2.1	-5	313	5.5	-5	28	0.99	2.2	16300	98	237		Ogsd
DS101	DD96DS101	82161	5473838	Sunny Corner	45/92	355.5	358.1	-0.5	1.79	8	266	17.54	15	2.39	0.93	9.13	920	81	52		Ogdc
DS101	DD96DS101	82161	5473839	Sunny Corner	45/92	358.1	359.7	0.8	1.68	-5	222	16.19	12	6.47	0.86	8.47	4530	990	41		Ogdl
DS101	DD96DS101	82161	5473840	Sunny Corner	45/92	359.7	360.3	-0.5	2.08	-5	273	15.92	15	5.65	1	8.51	3690	86	44		Ogdl
DS101	DD96DS101	82161	5473841	Sunny Corner	45/92	360.3	361.3	0.8	1.89	24	485	1.73	20	29.61	0.95	0.63	21000	439	293		Ogsd
DS101	DD96DS101	82161	5473842	Sunny Corner	45/92	361.3	364.5	0.7	3.53	39	919	10.79	27	5.35	1.76	5.09	3530	730	438		Ogdc
DS101	DD96DS101	82161	5473843	Sunny Corner	45/92	364.5	367.3	-0.5	0.6	-5	365	14.91	-5	8.86	0.27	4.36	13200	20	89		Ogdl
DS101	DD96DS101	82161	5473844	Sunny Corner	45/92	367.3	367.5	-0.5	6.48	92	143	1.18	17	5.72	3.15	0.88	170	511	1320		Ogdc
DS101	DD96DS101	82161	5473845	Sunny Corner	45/92	367.5	370.5	-0.5	5.15	43	1530	0.63	29	1.79	2.42	0.51	283	264	599		Ogsl
DS101	DD96DS101	82161	5473846	Sunny Corner	45/92	370.5	373.5	-0.5	5.99	29	489	0.16	97	2.1	2.97	0.46	114	150	118		Ogsl
DS101	DD96DS101	82161	5473847	Sunny Corner	45/92	373.5	376.5	-0.5	6.7	15	505	0.07	30	1.48	3.39	0.49	140	19	53		Ogsl
DS101	DD96DS101	82161	5473848	Sunny Corner	45/92	376.5	376.8	-0.5	1.92	-5	139	-0.05	13	0.83	0.87	0.1	37	23	337		Ogsl
DS101	DD96DS101	82161	5473849	Sunny Corner	45/92	376.8	378.3	-0.5	1.27	-5	108	-0.05	7	0.86	0.59	0.07	107	-10	37		Om
DS101	DD96DS101	82161	5473850	Sunny Corner	45/92	378.3	379.1	-0.5	0.57	5	64	-0.05	15	0.63	0.26	0.02	101	15	42		Om
DS101	DD96DS101	82161	5473851	Sunny Corner	45/92	379.1	380.6	-0.5	0.55	-5	67	-0.05	6	0.6	0.25	0.02	35	-10	20		Om

Appendix VI

Blackjacks - Diamond Drill Logs and Assay Results (DD96DB112)

DRILL-HOLE SUMMARY LOG

301086

HOLE NAME: DD96DB112 AMG EAST 36661 NORTH 5360766
 PROSPECT: BLACKJACKS GRID EAST 67275 NORTH 60980
 EL: MT. DUNDAS EL45192 RL 195m. DEPTH 342.2.

DATE DRILLED: 12/4/96
 LOGGED BY: S.J. TEAR
 DRILLING CO.: ALMAC
 DRILL TYPE: DIAMOND
 DRILL RIG: L744
 LOC DRILL CORE: ZEEHAN

SURVEYS:

DEPTH	AZIM (AMG)	DIP	DEPTH	AZIM (AMG)	DIP
0m	080°	50°			
50m	081°	51°			
100m					
151m	076°	53°			
202m	079°	46°			
260m	066°	52°			

OBJECTIVES OF HOLE:
 Obtain a vector on the dolomitic breccia of DD95DB110 and confirm its nature on lower limestone/sandstone contact.

LITHOLOGICAL SUMMARY:

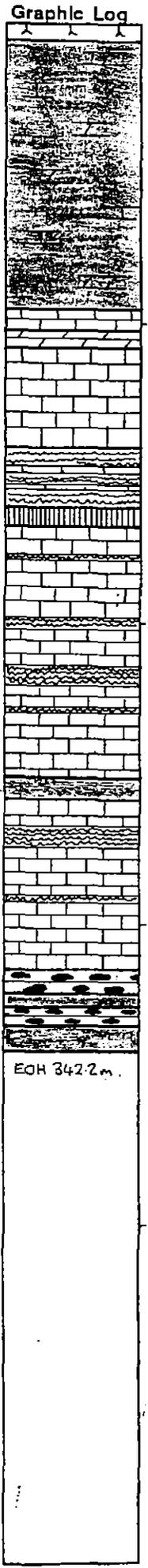
FROM	TO	FORM CODE	COMMENTS
0	5.7	Qha	Overburden.
5.7	95.4	Ogdc	Dark grey/black clays with rotted limestone/dolomite frags.
95.4	101.9	Ogdl	Rotted argillaceous calcarenite/dolomite
101.9	107.9	Ogdl	Partially dolomitised calcarenite.
107.9	141.0	Ogul	Partially rotted argillaceous calcarenite with laminated micrite zones and possible shear zones.
141.0	161.0	Ogmu	Laminated micrite unit.
161.0	167.65	Ogfr	Fault zone with dissem. sphalerite
167.65	316.1	Ogul.	Mixed series of inter-tidal + subtidal argillaceous calcarenites with laminated micrite units and reddened zones.
316.1	322.8	Ogsd	Siderite Unit
322.8	327.9	Ogdc	Dark grey clays
327.9	334.0	Ogsd	Siderite Unit
334.0	342.2	Ogdc	Dark grey clays - Pyritic.

MINERALISATION SUMMARY:

FROM	TO	COMMENTS
251.2	259	0.49% Zn including 0.9m @ 1.26% Zn from 253m. Dark grey clays - ? fault zone - small semi massive sphalerite blebs.
331.8	342.5	0.28% Zn in dark grey clays +/- siderite.
164.3	164.5	2.9% Zn Pale sphalerite in synsed breccia

CONCLUSIONS:
 Hole terminated in dark clays of the lower contact due to budgetary review.
 The dark grey clays at the top of the hole represent rotted dolomite breccia. Sequence is conformable with underlying Moira
 Zinc species are generally sulphidic. Dolomite breccia is stratobound

@ 114.5m 60° to d.A. @ 159.0m 55° to d.A. @ 177.7m 60° to d.A. @ 192.8m 70° to d.A. @ 267.55m 60° to d.A.
 @ 322m 45° to d.A.



EOH 342.2m.

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 1 of 11

TENEMENT NAME EL45/92 MT DUNDAS No.

PLAN - MAP REFERENCE BLACKSACKS

AMG: 36611E 5360766N.

CO-ORDINATES..... AZIMUTH..... 080° AMG DRILLERS ALMAC COMMENCED 12/4/96

DEPTH 342.2m HOLE No. DD96DB112

RL COLLAR 195m INCLINATION 50° DRILL TYPE 1 1/4" DIAMOND COMPLETED 16/5/1996

CASING LEFT..... DPO No(s) 82164

DEPTH		Core Rec. %	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)											
From (M)	To (M)										Mag				SUS				REC (ton)	REC (To)	REC (M)	REC (%)
												Depth	Value	Depth	Value							
0	5	-	-	Qha	Overburden.							5	0	20.5	0	0	5	-	-			
												5.5	0	21	2	5	5.5	0.15	30			
5	5.7	50	Sx	Qha	Overburden clays							6	2	21.5	0	5.5	7.0	1.5	100			
												6.5	2	22	10	7.0	8.5	0.7	20			
5.7	9.4	78	Sx	Ogdc	Dark grey/black clays with rotted limestone fragments and occasional dk grey sand zones. Possibly dolomitic. Maybe minor siderite	A lot of fragments are non calcareous - ? dolomitic. ? Siltstone Unit. minor dissemination of pyrite.	5470901	5.7	9.1			7	0	22.5	10	8.5	9.1	0.5	83			
												2	9.1	11.5	7.5	CL	23	90	9.1	10.6	1.3	87
												3	11.5	14.6	8	CL	23.5	CL	10.6	11.5	0.4	44
												4	14.5	17.5	8.5	0	24	0	11.5	13.0	1.5	100
												5	17.5	20.2	9	0	24.5	CL	13.0	14.5	1.3	87
												6	20.2	23.3	9.5	0	25	5	14.5	16.0	1.1	73
												7	23.3	26.5	10	0	25.5	10	16.0	17.5	1.0	67
												8	26.5	29.3	10.5	0	26	CL	17.5	18.1	0.6	100
												9	29.3	30.7	11	CL	26.5	0	18.1	18.9	0.6	75
												10	30.7	33.5	11.5	0	27	2	18.9	20.2	1.0	77
9.4	10.1	67	Sx	Ogul	Dark grey rotted argillaceous calcarenite with bioclots inc coral (Syringopora) badly broken core + core lags	calcite vein 1cm @ 25° to c/a.						11	33.5	36.7	12	0	27.5	CL	20.2	21.0	0.8	100
												12	36.7	39.6	12.5	0	28	5	21.0	22.3	1.3	100
												13	39.6	42.9	13	0	28.5	0	22.3	23.3	0.7	70
												14	42.9	46.0	13.5	12	29	CL	23.3	24.8	0.8	53
												15	46.0	48.0	14	1	29.5	8	24.8	26.4	0.6	100
10.1	10.9	86	Sx	Ogdc	Dark grey/black sand with small non-calcareous rock fragments.	Numerous small lumps of pyrite 2 nd recrystallised - surface weathering						16	48.0	50.5	14.5	0	30	CL	25.4	26.5	0.3	33
												17	50.5	53.5	15	CL	30.5	0	26.5	28.0	1.2	80
												18	53.5	56.5	15.5	0	31	0	28.0	29.3	1.0	77
												19	56.5	59.4	16	0	31.5	0	29.3	30.7	1.1	79
10.9	107.9	60	Sx	Ogdl	Partially dolomitised calcareous limestone.							20	59.4	62.5	16.5	0	32	0	30.7	32.0	1.3	100
												21	62.5	65.5	17	CL	32.5	10	32.0	32.5	0.2	40
												22	65.5	68.5	17.5	0	33	0	32.5	33.0	0.5	100
107.9	114.5	95	2	Ogul	light grey fine grained calcarenite inter mixed with dark grey argillaceous calcarenite - nodules (up to 1cm) breccia-like; becoming less breccia-like + argillaceous downhole more micritic.							23	68.5	71.5	18	0	33.5	0	33.0	33.5	0.5	100
												24	71.5	74.5	18.5	30	34	195	33.5	34.5	1.0	100
												25	74.5	77.5	19	9	34.5	0	34.5	35.4	0.9	100
												26	77.5	80.5	19.5	0	35	2	35.4	36.7	1.3	100
												27	80.5	83.5	20	5	35.5	0	36.7	37.7	1.0	100

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 2 of 11

TENEMENT NAME MT DUNDAS No. 45192

PLAN - MAP REFERENCE Blackjacks

CO-ORDINATES 366611 E 360766 N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/4/96 DEPTH 342.2m HOLE No. DD96DRI12
RL COLLAR 195m INCLINATION 50° DRILL TYPE LY44 COMPLETED 16/5/96 CASING LEFT DPO No(s) 8264

DEPTH		Cora Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag SIS				REC (m)	REC (%)	REC (m)	REC (%)
114.5	115.9	100	2	Ogmu	Micrite unit with birds eyes not very well laminated; with a small scale open unit present.	Bedding possibly 60° to c/a.	5470928	83.5	86.5		36	450	51.5	8	37.7	38.9	0.7	58
							29	86.5	89.5		35.5	34	52	0	38.9	39.6	0.55	79
							30	89.5	92.4		37	0	52.5	0	39.6	40.3	0.6	86
							31	92.4	95.58		37.5	1	53	CL	40.3	41.5	1.0	83
							32	95.58	98.3		38	0	53.5	0	41.5	41.9	0.3	75
115.9	125.0	70	3F	Ogmu	Partially rotted argillaceous calcareite with distinct argillite interstitial and bands. occ coarse bioclastic band Slightly laminated argillite laminae Micrite unit.	Bedding 60° to c/a.	33	98.3	101.1		38.5	CL	54	CL	41.9	42.9	1.0	100
							34	101.1	101.9		39	0	54.5	1	42.9	44.5	0.6	40
							35	101.9	104.6		39.5	CL	55	0	44.5	45.0	0.4	80
							36	104.6	107.9		40	0	55.5	55	45.0	46.0	1.0	100
											40.5	0	56	0	46.0	47.2	1.2	100
							37	117.7	120.0		41	CL	56.5	40	47.2	47.5	0.3	100
							38	120.0	122.2		41.5	2	57	CL	47.5	48.0	0.5	100
125.0	125.8	100	2	Ogmu	Partially rotted micrite unit; not very well laminated light grey in colour.						42	15	51.5	0	48.0	49.5	1.2	80
											42.5	25	58	0	49.5	50.5	1.0	100
											43	0	58.5	CL	50.5	51.5	0.7	70
											43.5	CL	59	95	51.5	52.3	0.4	50
125.8	130.6	100	1	Ogmu	Zone of intermixed limestone (units - Fine grained grey calcareite with intermixed argillite zones (? large calcareite nodules); occ bioclastic band and occ syn-sed breccias. locally burrowed particularly downhole.						44	0	59.5	72	52.3	53.5	0.8	67
											44.5	0	60	96	53.5	54.3	0.4	50
											45	0	60.5	8	54.3	54.9	0.4	67
											45.5	0	61	0	54.9	55.5	0.5	83
											46	0	61.5	0	55.5	56.5	0.7	70
											46.5	10	62	6	56.5	57.7	0.5	42
											47	65	62.5	0	57.7	58.9	1.0	83
											47.5	0	63	10	58.9	59.4	0.3	60
											48	0	63.5	200	59.4	59.9	0.4	80
											48.5	0	64	0	59.9	61.4	1.3	87
130.6	133.5	75	4X	Og12	Rotted and broken core. badly weathered clays also sheared looking.		39	130.6	133.5		49	0	64.5	0	61.4	62.5	1.0	91
											49.5	0	65	0	62.5	64.0	1.0	87
											50	11	65.5	5	64.0	65.5	1.6	100
											50.5	11	66	0	65.5	66.3	0.8	100
											51	5	66.5	0	66.3	67.1	0.6	75

301088

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 11
No. 45192

TENEMENT NAME.....

PLAN - MAP REFERENCE..... Blackbacks

CO-ORDINATES ^{366611E} S36°07'66"N AZIMUTH..... 080° AMG DRILLERS..... A.M.A.C. COMMENCED 12/14/96

DEPTH..... 342.2m HOLE No. DD96DB12

RL COLLAR..... 195M INCLINATION..... 50° DRILL TYPE..... 1444 COMPLETED 16/5/96

CASING LEFT..... DPO No(s) 82164

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										Mag Sus		Rec (mm)	Rec (%)	Rec (m)	Rec (%)		
133.5	141.0	100	1	Ogpl	Fine grained grey calcarenite locally micritic with thin beds of argillite and interstitial argillaceous calcarenite. Possibly burrowed. Small scale syn-sed brecciation eg 138.5m.		5470940	136	137.5		67	0	82.5	3	67.1	68.5	1.2	86
											67.5	5	83	0	68.5	69.6	1.0	90
											68	0	83.5	0	69.6	70.7	1.0	90
											68.5	2	84	CL	70.7	71.5	0.5	63
											69	CL	84.5	0	71.5	73.0	1.0	67
											69.5	5	85	CL	73.0	74.5	1.6	100
											70	0	85.5	CL	74.5	76.0	1.2	80
											70.5	0	86	CL	76.0	77.5	0.3	20
141.0	152.7	100	1	Ogmu	Inter-laminated fine grained calcarenite and argillite. Occ birds eye micrite bands between laminae. From 146m more argillite dominant - loss of laminae where interbeds of calcarenite and argillite to 148m. ? a laminated micrite unit. After 150m back to a more recognisable laminated micrite unit.	Bedding 80° to c/a. becoming more 70°-65° to c/a.	41	144.8	146.0		71	35	86.5	0	77.5	79.0	0.9	60
											71.5	2	87	0	79.0	79.6	0.6	100
											72	0	87.5	4	79.6	80.5	0.7	77
											72.5	CL	88	50	80.5	81.5	1.0	100
											73	0	88.5	20	81.5	82.5	0.8	90
											73.5	0	89	CL	82.5	83.5	0.7	70
											74	0	89.5	0	83.5	84.5	0.5	50
											74.5	0	90	0	84.5	85.5	-	0
											75	0	90.5	CL	85.5	86.5	0.3	30
											75.5	0	91	0	86.5	87.5	1.0	100
											76	4	91.5	0	87.5	88.3	0.9	100
											76.5	CL	92	0	88.3	89.5	0.8	67
											77	CL	92.5	5	89.5	90.8	1.0	77
152.7	153.3	100	1	Ogbr	Syn-sedimentary breccia unit - porosity now filled with calcite. Bottom contact a calcite vein 0.8cm thick partially forms contact. Bottom of a PAC.	Minor pyrite.	42	152.7	153.3		77.5	0	93	CL	90.8	92.4	1.3	81
											78	0	93.5	0	92.4	93.6	1.0	83
											78.5	0	94	CL	93.6	94.6	0.7	70
											79	0	94.5	10	94.6	95.5	0.7	74
											79.5	5	95	4	95.5	96.9	1.3	100
											80	0	95.5	5	96.9	98.3	0.9	64
											80.5	0	96	4	98.3	99.6	0.3	23
											81	0	96.5	9	99.6	100.6	0.3	30
153.3	153.8	100	1	Ogmu	Grey birds eye micrite - well developed. Not very laminated.						81.5	0	97	0	100.6	101.1	0.3	60
											82	5	97.5	CL	101.1	101.9	0.7	89

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 4 of 11
No. 45192

TENEMENT NAME.....

PLAN - MAP REFERENCE Black Jacks

CO-ORDINATES 366611 E 536.0766 N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/4/96 DEPTH 342.2m HOLE No. DD96DB112
RL COLLAR 195M INCLINATION 50° DRILL TYPE LY44 COMPLETED 16/5/96 CASING LEFT..... DPO No(s) 82164

From (M)	To (M)	Core Rec. %	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
										Mag		SUS		REC (mm)	REC (to)	REC (m)	REC (g/g)
										Depth	Value	Depth	Value				
153.8	159.0	100	1	Ogul Sequence of mixed limestones including equigranular bioclastic units, argillaceous interbeds with med fine grey calcarenite.	minor blabs of pyrite in bioclastic units					98	0	118.5	CL	101.9	102.7	0.6	75
										98.5	0	114	8	102.7	103.0	0.3	100
										99	CL	114.5	0	103.0	104.0	0.35	35
										99.5	CL	115	0	104.0	104.6	0.45	75
										100	10	115.5	5	104.6	106.0	0.7	50
										100.5	CL	116	5	106.0	106.8	0.4	50
159.0	161.0	100	1	Ogmu Micrite unit with oncolites passing into an interlaminated argillite & fine calcarenite unit as seen higher up hole coarsening d/hole.	Bedding - 55° to c/a.					101	6	116.5	0	106.8	107.9	0.8	72
										101.5	0	117	5	107.9	109.0	1.0	90
										102	6	117.5	4	109.0	109.6	0.4	67
										102.5	4	118	5	109.6	112.0	2.4	100
										103	0	118.5	2	112.0	114.0	2.0	100
										103.5	CL	119	CL	114.0	115.0	1.0	100
161.0	164.3	100	1	Ogul Shallow unit with micrites and calcite filled stromatolite cavities, intermixed with argillaceous calcarenite zones. Stick bryozoa from 161.8-162.1 including small scale laminated micrite units coarse bioclastic bank @ 163.9m	Minor blabs of pyrite in argillite	5470943	163.1	164.3		104	0	119.5	CL	115.0	116.5	1.3	87
										104.5	5	120	5	116.5	117.7	1.2	100
										105	CL	120.5	5	117.7	120.0	1.3	57
										105.5	5	121	0	120.0	121.0	0.7	70
										106	0	121.5	CL	121.0	122.0	0.3	30
										106.5	0	122	0	122.0	124.0	1.5	75
										107	0	122.5	0	124.0	125.0	0.8	80
										107.5	CL	123	0	125.0	127.0	2.0	100
										108	4	123.5	5	127.0	130.0	3.0	100
164.3	164.5	100	1	Ogbr Syn-sedimentary breccia unit	Disseminated blabs of sphalerite in matrix up to 0.5cm in size.	44	164.3	164.5		108.5	4	124	9	130.0	131.2	1.0	83
										109	5	124.5	5	131.2	132.1	0.7	77
										109.5	CL	125	10	132.1	133.2	0.8	72
										110	6	125.5	5	133.2	134.6	1.4	100
164.5	167.65	63	5x	Ogfs Zone of broken core and core loss, pos fault zone	Small dolomitic section 166.9 - 167.1 with minor dissem sphalerite	45	164.5	165.6		110.5	0	126	20	134.6	136.0	1.4	100
						46	165.6	166.7		111	0	126.5	5	136.0	139.0	3.0	100
						47	166.7	167.65		111.5	CL	127	5	139.0	142.0	3.0	100
167.65	175.3	100	1	Ogul Fine grained locally micritic bioclastic calcarenite with argillaceous bioclastic calcarenite zones		48	167.65	169.0		112	0	127.5	8	142.0	144.2	2.2	100
										112.5	0	128	5	144.2	147.0	2.8	100
										113	6	128.5	9	147.0	148.8	1.8	100

301090

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 5 of 11
TENEMENT NAME 45/92 No. DD96DE
PLAN - MAP REFERENCE Backjacks
DEPTH 342.2m HOLE No. DD96DE/12
CASING LEFT..... DPO No(s) 82164

366611E
CO-ORDINATES 5360766N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/4/96
RL COLLAR 195m INCLINATION 50° DRILL TYPE LY44 COMPLETED 16/5/96

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAG SUS		Rec (m)	Rec (%)	Rec (m)	Rec (%)		
					Distinctive white 'blobs' of calcareous bioclots in grey micrite @ 170m. Shallow sub-tidal facies.	minor calcite veining (irregular)					129	8	144.5	5	148.8	150.0	1.2	100
											129.5	14	145	8	150.0	150.9	0.9	100
											130	6	145.5	11	150.9	154.0	3.1	100
											130.5	20	146	8	154.0	154.9	0.8	88
											131	0	146.5	5	154.9	156.3	1.4	100
175.3	177.7	100	1	Ogul	Shallow deep intertidal facies with micrite units interbedded with argillaceous bioclastic calcarenites						131.5	CL	147	10	156.3	159.0	2.7	100
											132	5	147.5	11	159.0	162.1	3.1	100
											132.5	CL	148	5	162.1	163.1	1.0	100
											133	10	148.5	2	163.1	164.3	1.2	100
											133.5	2	149	11	164.3	165.6	0.8	62
177.7	179.1	100	1	Ogmu	laminated micrite unit with bird eyes micrite bands between laminae of argillaceous and micritic calcarenites.	Bedding 60° to c/a.	5470949	177.7	179.1		134	10	149.5	9	165.6	166.7	0.8	72
											134.5	12	150	2	166.7	167.1	0.3	75
											135	CL	150.5	3	167.1	167.5	0.3	75
											135.5	9	151	5	167.5	169.0	1.0	67
											136	5	151.5	5	169.0	172.0	3.0	100
179.1	185.8	100	1	Ogul	Argillaceous bioclastic calcarenites with micrite bands, burrowing						136.5	6	152	8	172.0	175.0	3.0	100
											137	10	152.5	4	175.0	177.0	2.0	100
											137.5	7	153	5	177.0	180.0	3.0	100
185.8	197.8	100	1	Ogul	Fine grained almost micritic bioclastic calcarenite with distinct argillaceous bands (?Stylocumulus) but with bioclasts becoming slightly nodular @ 195m.	Bedding 60° to c/a.	50	187.0	197.5		138	11	153.5	2	180.0	181.2	0.9	76
											138.5	12	154	10	181.2	184.0	2.8	100
											139	10	154.5	2	184.0	187.0	3.0	100
											139.5	9	155	5	187.0	190.0	3.0	100
											140	5	155.5	9	190.0	193.0	3.0	100
							51	196.0	197.5		140.5	9	156	11	193.0	196.0	3.0	100
											141	6	156.5	6	196.0	199.0	3.0	100
197.8	202.0	100	1	Ogmu	laminated micrite unit with birds eye micrites	Bedding 70° to c/a.					141.5	14	157	9	199.0	200.2	1.2	100
											142	4	157.5	9	200.2	202.0	1.2	67
											142.5	10	158	6	202.0	202.4	0.3	75
202.0	214.5	100	1	Ogul	Fine grained micritic calcarenite with fine grained bioclasts. Interstitial argillaceous calcarenite - v. shallow sub-tidal.						143	11	158.5	12	202.4	202.7	2.3	100
											143.5	8	159	9	202.7	207.0	2.3	100
											144	4	159.5	10	207.0	207.7	0.2	29

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 6 of 11
No. 45192

TENEMENT NAME.....

PLAN - MAP REFERENCE..... Blackjacks

CO-ORDINATES 5360766N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/4/96

DEPTH 342.2m HOLE No. DD96DB12

RL COLLAR 195m INCLINATION 50° DRILL TYPE LY44 COMPLETED 16/5/96

CASING LEFT..... DPO No(s) 82164

DEPTH		Core Rec. %	RAD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)										MAG		SUS		REC (G/T)	REC (G)	REC (M)	REC (%)
					locally coarse bioclastic zone, coarse coral fragments @ 209.4m 205.7m.	Bedding @ 214.5 70° G/c/d	5490952	205.5	207.0		160	10	175.5	9	207.7	209.3	1.6	100
					? small beach deposit 212-212.5 bioclastic unit.						160.5	10	176	10	209.3	212.2	2.9	100
											161	6	176.5	10	212.2	214.0	1.8	100
											161.5	6	177	4	214.0	216.1	2.1	100
											162	15	177.5	10	216.1	217.8	2.7	100
											162.5	0	178	12	217.8	220.5	1.7	100
											163	2	178.5	10	220.5	223.0	2.5	100
214.5	220.5	100	1	Ogmu	Partially laminated micrite unit within fine grained calcarenite 217.0-218.0 argillaceous beds < 3cm thick inter bedded with fine calcarenite as argillaceous bioclastic calcarenite	Bedding 70° to c/a.					163.5	2	179	6	223.0	225.5	2.5	100
											164	6	179.5	14	225.5	226.9	1.4	100
											164.5	25	180	5	226.9	228.4	1.5	100
											165	24	180.5	0	228.4	230.7	2.3	100
											165.5	0	181	CL	230.7	233.8	3.1	100
											166	9	181.5	11	233.8	236.0	2.2	100
											166.5	0	182	15	236.0	237.4	1.2	86
220.5	223.0	100	1	Ogmu	Mixed unit of argillaceous bioclastic calcarenites, argillite bands, channel units (equigranular bioclastic calcarenites)		540953	220.5	222.0		167	79	182.5	15	237.4	238.4	0.7	70
											167.5	10	183	10	238.4	239.0	0.5	83
											168	CL	183.5	11	239.0	239.8	0.4	44
											168.5	6	184	10	239.8	240.3	0.4	80
											169	5	184.5	12	240.3	241.2	0.8	72
											169.5	12	185	14	241.2	241.9	0.35	50
223.0	225.0	100	1	Ogmu	med grained equigranular bioclastic unit.						170	10	185.5	15	241.9	242.2	1.2	92
											170.5	15	186	10	242.2	244.3	0.7	63
											171	12	186.5	5	244.3	245.6	0.3	23
225.0	227.7	100	1	Ogmu	Interbedded argillite and fine grained calcarenite with burrowed zones Sub-tidal - possibly deep.	Calate breccia var 227.7-228.05	5470954	227.7	228.2		171.5	10	187	15	245.6	246.2	-	-
											172	13	187.5	13	246.2	247.0	0.2	25
											172.5	10	188	5	247.0	249.0	0.15	15
											173	10	188.5	5	249.0	248.7	0.5	71
											173.5	10	189	5	248.7	249.4	0.5	71
228.05	228.2	100	5	Ogdc	Dark grey clay probable fault zone.						174	15	189.5	10	249.4	250.0	0.3	50
											174.5	10	190	5	250.0	251.2	0.9	75
											175	13	190.5	15	251.2	253.0	1.0	56

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 7 of 11
No. 45192

366611E
CO-ORDINATES 5360766N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/4/96
RL COLLAR 195m INCLINATION 50° DRILL TYPE L444 COMPLETED 16/5/96

TENEMENT NAME
PLAN - MAP REFERENCE Blackjacks
DEPTH 342.2m HOLE No. DD96DB112
CASING LEFT DPO No(s) 82164

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)										MAG				SUS				
												Depth	Value	Depth	Value	Rec (mm)	Rec (%)	Rec (m)	Rec (Pw)
228.2	230	100	1	Ogmu	Top of a PAC unit, with a small laminated micrite unit underlain by birds eye micrite.							191	15	206.5	8	253.0	253.9	0.4	44
												191.5	15	207	6	253.9	254.4	0.4	80
												192	10	207.5	CL	254.4	255.6	1.0	83
												192.5	9	208	4	255.6	257.1	0.9	60
												193	15	208.5	10	257.1	258.0	0.45	50
230.0	235.0	100	1	Ogud	Intermixed sequence of fine grained calcarenites, equigranular bioclastic calcarenites; bioclastic bands. Discrete argillite bands occ with birds eye micrite and argillaceous bioclastic calcarenites.							193.5	10	209	10	258.0	259.8	0.4	40
												194	5	209.5	5	259.8	259.5	0.3	60
												194.5	7	210	12	259.5	260.0	0.5	100
												195	10	210.5	6	260.0	260.5	0.1	20
												195.5	CL	211	10	260.5	261.0	-	-
												196	10	211.5	15	261.0	261.5	0.4	80
												196.5	13	212	10	261.5	263.0	1.3	87
												197	10	212.5	5	263.0	263.7	0.3	43
												197.5	15	213	9	263.7	265.0	1.3	100
235.0	239.0	80	1	Ogud	Zone of rotting of units possible fault zones. Dark grey clays, broken core and minor core loss.	Shearing evidence.	5470955	235.0	236.4			198	15	213.5	5	265.0	265.5	0.4	80
							56	236.4	238.4			198.5	CL	214	0	265.5	267.5	2.0	100
							57	238.4	239.0			199	8	214.5	7	267.5	270.0	2.5	100
												199.5	9	215	0	270.0	271.2	1.2	100
												200	5	215.5	CL	271.2	272.0	0.6	75
239.0	240.5	50	5	Oguz	fault zone comprising dark grey clays and brecciated fragments of limestone (no obvious dolomite) Rotted limestone - ? cavity.		58	239.0	240.3			200.5	5	216	2	272.0	273.0	0.8	80
												201	0	216.5	8	273.0	274.6	1.6	100
												201.5	CL	217	6	274.6	276.9	2.3	100
												202	4	217.5	10	276.9	277.9	0.9	90
												202.5	5	218	CL	277.9	278.6	0.4	80
												203	0	218.5	10	278.6	279.0	0.3	75
												203.5	7	219	7	279.0	279.6	0.3	50
240.5	251.2	50	2f	Ogud	Med fine grained, locally micritic and locally argillaceous bioclastic calcarenite zones of rotted core. more argillite zone @ 250-250.5m		59	248.0	249.4			203.5	7	219	7	279.6	280.4	0.2	25
							60	249.4	251.2			204	9	219.5	8	280.4	281.1	0.4	57
												204.5	5	220	4	281.1	281.5	0.3	75
												205	15	220.5	0	281.5	282.2	2.7	100
												205.5	15	221	10	282.2	284.2	2.1	100
												206	10	221.5	5	284.2	286.6	0.15	50

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 8 of 11

TENEMENT NAME No. 45192

PLAN - MAP REFERENCE Blacklocks

CO-ORDINATES 366611E 5360766N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/4/96

DEPTH 342.2M HOLE No. DD96 DB11Z

RL COLLAR 195M INCLINATION 50° DRILL TYPE LY44 COMPLETED 16/5/96

CASING LEFT DPO No(s) 82164

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)						
From (M)	To (M)										MAG		SOS	From REC	REC (Tn)	REC (M)	REC (%)
251.2	259.0	60	5	Ogdc	Calcareous dark grey clay - ? cavities	@ 254.5 large pieces of massive sphalerite - redmill - source unknown	5470961	251.2	253.0	222	10	237.5	5	286.6	287.5	0.3	50
							62	253.0	253.9	222.9	5	238	8	287.1	287.9	0.2	50
							63	253.9	254.4	223	6	238.5	2	287.9	287.9	0.3	30
							64	254.4	255.6	223.5	5	239	5	287.9	290.2	1.0	77
							65	255.6	257.1	224	7	239.5	CL	290.2	291.0	0.2	25
259.0	267.55	77	2F	Ogcl	med fine grained intermixed argillite and bioclastic calcarenite.		66	257.1	259.0	224.5	5	240	0	291.0	292.0	1.0	100
							67	259.0	260.5	225	6	240.5	7	292.0	294.0	2.0	100
							68	260.5	261.5	225.5	9	241	CL	294.0	294.6	0.4	67
										226	9	241.5	4	294.6	295.1	0.25	50
267.55	274.6	90	2	Ogmu	laminated micrite unit with zones of fenestral micrite; argillaceous laminae	Bedding 60° to c/a	69	273	274.6	226.5	10	242	5	295.1	295.4	0.1	33
										227	9	242.5	6	295.4	296.0	0.3	50
										227.5	2	243	CL	296.0	296.4	0.1	25
										228	0	243.5	CL	296.4	296.8	0.3	75
										228.5	0	244	6	296.8	297.4	0.2	50
274.6	281.4	70	1	Ogcl	Fine grained almost micritic calcarenite with minor bands of argillite - stylolites. minor birds eyes zone of rotted inst.					229	0	244.5	CL	297.4	297.9	0.1	20
										229.5	2	245	CL	297.9	298.5	0.4	67
										230	2	245.5	6	298.5	299.5	1.0	100
										230.5	0	246	CL	299.5	299.8	0.2	67
										231	2	246.5	9	299.8	300.5	0.5	71
										231.5	9	247	0	300.5	301.6	0.9	81
281.4	281.8	110	3	Ogmu	laminated micrite unit with fenestrate micrite and argillaceous laminae	Bedding 65° to c/a				282	6	247.5	CL	301.6	302.0	0.4	100
										232.5	CL	248	10	302.0	303.0	0.3	30
										233	0	248.5	10	303.0	303.8	0.6	75
										233.5	6	249	6	303.8	305.1	1.3	100
281.8	286.2	100	2	Ogcl	Argillaceous fine grained calcarenite locally bioclastic burrowed.		70	284.2	286.2	234	0	249.5	3	305.1	305.7	0.1	17
										234.5	4	250	11	305.7	306.9	0.9	75
										235	0	250.5	CL	306.9	308.0	0.8	72
										235.5	0	251	11	308.0	308.6	0.2	33
286.2	290.8	50	4x	Ogcl	Zone of broken and rotted core, including clay zones possible micrite units	Gyr. sed breccia 287.9-298.05				236	8	251.5	5	308.6	309.0	0.1	25
										236.5	6	252	14	309.0	309.8	0.2	25
										237	8	252.5	0	309.8	311.2	1.4	100

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 9 of 11
No. 45/92

TENEMENT NAME.....
PLAN - MAP REFERENCE.....

CO-ORDINATES ^{366611E} 5360766N AZIMUTH 080° AMG DRILLERS PUMAC COMMENCED 12/4/96 DEPTH 342.2M HOLE No. D096DB112
RL COLLAR 195M INCLINATION L444 DRILL TYPE L444 COMPLETED 16/5/96 CASING LEFT..... DPO No(s) 82164

DEPTH		Core Rec. %	RCD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)					
From (M)	To (M)										MAG		SUS			
											Depth	Value	Depth	Value	Depth	Value
290.8	292.8	100	3f	Ogmu	Laminated micrite unit	Bedding 70° to e/a. Minor calcite (+dolomite) veining irregular pattern	5470971	291	292.8		253	0	268.5	5	284	5
											253.5	CL	269	10	284.5	6
											254	14	269.5	7	285	2
											284.5	5	270	4	285.5	CL
292.8	294.4	62	1	Ogul	Argillaceous bioclastic calcarenite		72	292.8	294.4		255	16	270.5	25	286	2
											255.5	14	271	5	286.5	0
											256	12	271.5	2	287	9
294.4	294.7	100	5	Ogul	Rotted limestone - ? micritic calcarenite		73	294.4	295.1		256.5	CL	272	2	287.5	0
											257	5	272.5	7	288	5
											257.5	10	273	0	288.5	CL
294.7	296.2	67	4	Ogul	Calcite (+dolomite) vein locally breccia veining	Minor pyrite	74	295.1	296.2		258	5	273.5	9	289	0
											258.5	CL	274	10	289.5	0
											259	10	274.5	10	290	0
296.2	296.6	80	5	Ogul	Block rotted argillaceous calcarenite		75	296.2	296.6		259.5	8	275	0	290.5	CL
											260	0	275.5	CL	291	10
											260.5	0	276	2	291.5	5
296.6	296.8	100	1	Ogul	Red calcareous unit possible calcite/hematite vein	Minor dissemin blobs of pyrite	76	296.6	296.8		261	5	276.5	CL	292	4
											261.5	10	277	6	292.5	10
											262	6	277.5	CL	293	6
											262.5	7	278	10	293.5	13
296.8	297.4	50	5	Ogul	Cal/dol vein		77	296.8	297.4		263	2	278.5	0	294	0
											263.5	CL	279	5	294.5	6
297.4	298.5	63	4x	Ogul	Broken core - core loss light grey clay/sand argillaceous limestone		78	297.4	298.5		264	5	279.5	0	295	CL
											264.5	7	280	CL	295.5	12
											265	7	280.5	5	296	9
											265.5	7	281	50	296.5	5
298.5	299.5	90	3b	Ogmu	Tectonised laminated micrite unit with cal/dol veining		79	298.5	299.5		266	10	281.5	0	297	10
											266.5	10	282	6	297.5	4
											267	8	282.5	10	298	CL
299.5	301.0	100	1	Ogul	Argillite dominant unit						267.5	2	283	2	298.5	0
											268	6	283.5	5	299	5

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 10 of 11
No. 45192

TENEMENT NAME.....

PLAN - MAP REFERENCE Blackjacks

CO-ORDINATES 366611E 5350766N AZIMUTH 080° AMG DRILLERS ALMAC COMMENCED 12/14/96 DEPTH 342.2m HOLE No. DD96DB112
RL COLLAR 195m INCLINATION 50° DRILL TYPE L444 COMPLETED 16/5/96 CASING LEFT..... DPO No(s) 82164

DEPTH		Core Rec. %	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)						
From (M)	To (M)										NAG		SUS				
										Depth	Value	Depth	Value				
301.0	302.0	80	5x	Ogul	Rotted limestone - dark sandy clay & fragments						299.5	6	315	0			
											300	10	315.5	5			
											300.5	10	316	5.5			
302.0	306.8	55	2	Ogul	Fine grained grey locally micritic calcarenite with intermixed dark grey argillaceous med grained calcarenite. Poss nodular fine grained calcarenite	Cal/dol veining					301	0	316.5	200			
											301.5	5	317	19.9			
											302	6	317.5	15.0			
											302.5	CL	318	20			
											303	10	318.5	20			
											303.5	5	319	200			
											304	9	319.5	200			
306.8	309.8	50	4x	Ogul	Partially rotted argillaceous calcarenite with reddened limestone zones - Broken con - poss laminated unit 309.1m - 309.8m.		5470980	306.8	308.0		304.5	8	320	4.5			
											305	10	320.5	9.5			
											305.5	CL	321	8.2			
											306	10	321.5	15.0			
											306.5	0	322	15.0			
											307	7	322.5	200			
309.8	315.0	78	2f	Ogul	Fine grained grey calcarenite with interstitial argillite becoming argillite dominant core becoming more rotted d/hole.	Bedding 60° to c/a.	81	313.1	315.0		307.5	8	323	CL			
											308	6	323.5	CL			
											308.5	CL	324	CL			
											309	4	324.5	CL			
											309.5	CL	325	30			
											310	9	325.5	CL			
315.0	316.1	72	5x	Ogul	Rotted reddened limestone with calcareous sand zones - clay zones.		82	315.0	316.1		310.5	4	326	30			
											311	5	326.5	CL			
											311.5	6	327	CL			
											312	10	327.5	CL			
316.1	322.8	90	2f	Ogul	Light brown/fawn and dark brown grey siderite replacing limestones initially + then replacing of 2 clothes Bracciated bedded units. Occ clay zones.	Reddened clay zone 317.5 - 318.5m. Bedding 60° to c/a 317.0m. " 45° to c/a @ 322m.	83	316.1	317.5		312.5	CL	328	7.2			
											84	317.5	318.5	313	10	328.5	7.5
											85	318.5	319.5	313.5	6	329	CL
											86	319.5	321.0	314	10	329.5	CL
											87	321.0	321.9	314.5	25	330	5

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bhole	fullddh	DPO	smpno	Prospect	EL	afrom	alo	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLth
DB112	DD96DB112			Blackjacks	45/92	0	5.7														Oha
DB112	DD96DB112	82164	5470901	Blackjacks	45/92	5.7	9.1	-0.5	6.86	25	442	0.06	56	2.51	3.85	0.75	30	315	386		Ogdc
DB112	DD96DB112	82164	5470902	Blackjacks	45/92	9.1	11.5	-0.5	6.86	11	437	0.05	33	2.38	3.68	0.72	37	176	498		Ogdc
DB112	DD96DB112	82164	5470903	Blackjacks	45/92	11.5	14.5	-0.5	7.32	19	515	-0.05	23	2.26	4.01	0.84	39	641	1020		Ogdc
DB112	DD96DB112	82164	5470904	Blackjacks	45/92	14.5	17.5	-0.5	7.96	26	555	-0.05	15	2.27	4.42	0.87	39	96	3270		Ogdc
DB112	DD96DB112	82164	5470905	Blackjacks	45/92	17.5	20.2	-0.5	8.07	35	519	0.08	22	3.81	4.15	0.81	59	359	1890		Ogdc
DB112	DD96DB112	82164	5470906	Blackjacks	45/92	20.2	23.3	-0.5	6.17	15	432	1.45	16	3.25	3.57	1	82	145	660		Ogdc
DB112	DD96DB112	82164	5470907	Blackjacks	45/92	23.3	26.5	-0.5	2.34	-5	129	18.09	7	2.52	1.26	6.42	679	94	541		Ogdi
DB112	DD96DB112	82164	5470908	Blackjacks	45/92	26.5	29.3	-0.5	5.54	54	321	8.43	14	3.47	3.04	3.16	652	118	514		Ogdc
DB112	DD96DB112	82164	5470909	Blackjacks	45/92	29.3	30.7	-0.5	8.87	21	602	0.34	18	1.93	4.82	0.69	54	126	528		Ogdc
DB112	DD96DB112	82164	5470910	Blackjacks	45/92	30.7	33.5	-0.5	7.26	22	486	0.95	15	3	3.95	0.99	83	217	821		Ogdc
DB112	DD96DB112	82164	5470911	Blackjacks	45/92	33.5	36.7	-0.5	5.93	38	413	1.88	38	2.95	3.37	1.02	140	140	858		Ogdc
DB112	DD96DB112	82164	5470912	Blackjacks	45/92	36.7	39.6	-0.5	6	26	421	0.05	14	1.92	3.36	0.6	38	84	228		Ogdc
DB112	DD96DB112	82164	5470913	Blackjacks	45/92	39.6	42.9	-0.5	6.65	22	436	0.09	12	2.67	3.36	0.61	39	85	276		Ogdc
DB112	DD96DB112	82164	5470914	Blackjacks	45/92	42.9	46	-0.5	9.11	15	580	-0.05	18	2.33	4.41	0.8	43	49	247		Ogdc
DB112	DD96DB112	82164	5470915	Blackjacks	45/92	46	48	-0.5	7	25	447	0.08	17	2.87	3.71	0.7	44	85	603		Ogdc
DB112	DD96DB112	82164	5470916	Blackjacks	45/92	48	50.5	-0.5	7.27	36	442	0.13	19	3.61	3.61	0.69	49	141	1080		Ogdc
DB112	DD96DB112	82164	5470917	Blackjacks	45/92	50.5	53.5	-0.5	6.85	12	440	0.15	15	2.71	3.54	0.68	44	74	677		Ogdc
DB112	DD96DB112	82164	5470918	Blackjacks	45/92	53.5	56.5	-0.5	7.22	25	486	0.13	28	1.96	3.79	0.68	48	95	3820		Ogdc
DB112	DD96DB112	82164	5470919	Blackjacks	45/92	56.5	59.4	-0.5	7.46	14	507	0.19	13	1.49	4.03	0.73	41	55	205		Ogdc
DB112	DD96DB112	82164	5470920	Blackjacks	45/92	59.4	62.5	-0.5	7.02	13	465	0.15	18	2.64	3.72	0.69	46	72	1100		Ogdc
DB112	DD96DB112	82164	5470921	Blackjacks	45/92	62.5	65.5	-0.5	6.86	22	446	0.08	15	2.59	3.51	0.65	39	35	408		Ogdc
DB112	DD96DB112	82164	5470922	Blackjacks	45/92	65.5	68.5	-0.5	7.91	21	548	0.09	16	2.6	4.15	0.75	42	60	283		Ogdc
DB112	DD96DB112	82164	5470923	Blackjacks	45/92	68.5	71.5	-0.5	8.77	-5	660	0.14	16	2.56	4.74	0.83	46	45	325		Ogdc
DB112	DD96DB112	82164	5470924	Blackjacks	45/92	71.5	74.5	-0.5	8.1	13	606	0.05	12	2.53	4.28	0.72	46	62	341		Ogdc
DB112	DD96DB112	82164	5470925	Blackjacks	45/92	74.5	77.5	-0.5	8.45	6	625	0.05	16	2.35	4.35	0.68	51	75	429		Ogdc
DB112	DD96DB112	82164	5470926	Blackjacks	45/92	77.5	80.5	-0.5	7.99	13	574	0.05	16	3.16	4.01	0.76	58	25	133		Ogdc
DB112	DD96DB112	82164	5470927	Blackjacks	45/92	80.5	83.5	-0.5	8.12	5	625	0.06	13	2.64	4.45	1.02	81	24	180		Ogdc
DB112	DD96DB112	82164	5470928	Blackjacks	45/92	83.5	86.5	-0.5	9.64	9	683	0.05	15	2.9	4.84	0.97	73	28	154		Ogdc
DB112	DD96DB112	82164	5470929	Blackjacks	45/92	86.5	89.5	-0.5	8.72	10	628	0.05	18	2.27	4.69	0.77	58	30	132		Ogdc
DB112	DD96DB112	82164	5470930	Blackjacks	45/92	89.5	92.4	-0.5	8.48	-5	666	-0.05	14	1.99	4.98	0.83	45	33	210		Ogdc
DB112	DD96DB112	82164	5470931	Blackjacks	45/92	92.4	95.55	-0.5	6.37	37	348	7.2	19	3.92	3.22	2.08	177	919	6120	3.1	Ogdc/Ogu
DB112	DD96DB112	82164	5470932	Blackjacks	45/92	95.55	98.3	-0.5	1.43	-5	79	22.26	-5	1.63	0.81	5.07	563	20	65		Ogul
DB112	DD96DB112	82164	5470933	Blackjacks	45/92	98.3	101.1	-0.5	1.03	-5	54	19.6	-5	2.27	0.51	8.51	880	22	40		Ogdi
DB112	DD96DB112	82164	5470934	Blackjacks	45/92	101.1	101.9	-0.5	5.55	21	383	2.05	9	2.93	3.07	1.35	110	97	612		Ogdc
DB112	DD96DB112	82164	5470935	Blackjacks	45/92	101.9	104.6	-0.5	1.44	-5	85	17.44	7	1.83	0.78	7.57	680	33	114		Ogdi
DB112	DD96DB112	82164	5470936	Blackjacks	45/92	104.6	107.9	-0.5	1.65	-5	100	22.61	-5	1.46	0.94	5.49	532	43	85		Ogdi
DB112	DD96DB112			Blackjacks	45/92	107.9	114.5														Ogul
DB112	DD96DB112			Blackjacks	45/92	114.5	115.9														Ogul
DB112	DD96DB112			Blackjacks	45/92	115.9	117.7														Ogul
DB112	DD96DB112	82164	5470937	Blackjacks	45/92	117.7	120	0.9	0.96	-5	99	24.15	-5	1.18	0.43	6.45	1500	122	195		Ogdi
DB112	DD96DB112	82164	5470938	Blackjacks	45/92	120	122.2	0.5	0.3	-5	29	24.14	-5	1.28	0.13	7.99	1660	102	323		Ogdi
DB112	DD96DB112			Blackjacks	45/92	122.2	130.6														Ogul
DB112	DD96DB112	82164	5470939	Blackjacks	45/92	130.6	133.5	0.5	1.45	-5	88	29.44	-5	1.36	0.85	1.28	418	43	114		Ogul
DB112	DD96DB112			Blackjacks	45/92	133.5	136														Ogul
DB112	DD96DB112	82164	5470940	Blackjacks	45/92	136	137.5	0.7	0.65	-5	38	30.94	-5	0.44	0.4	0.94	154	12	23		Ogul
DB112	DD96DB112			Blackjacks	45/92	137.5	144.8														Ogul/Ogmu
DB112	DD96DB112	82164	5470941	Blackjacks	45/92	144.8	146	-0.5	1.52	-5	96	25.64	-5	0.64	0.89	1.26	183	-10	16		Ogmu
DB112	DD96DB112			Blackjacks	45/92	146	152.7														Ogmu
DB112	DD96DB112	82164	5470942	Blackjacks	45/92	152.7	153.3	-0.5	2.96	-5	107	24.84	-5	1.28	0.9	3.44	869	21	41		Ogmu
DB112	DD96DB112			Blackjacks	45/92	153.3	163.1														Ogmu/Ogfi
DB112	DD96DB112	82164	5470943	Blackjacks	45/92	163.1	164.3	0.7	1.51	-5	76	26.92	-5	0.84	0.91	1.84	605	61	337		Ogfi
DB112	DD96DB112	82164	5470944	Blackjacks	45/92	164.3	164.5	0.5	1.43	-5	261	17.78	-5	3.97	0.8	6.25	11300	35	29000	2	Ogfi/Ogdi
DB112	DD96DB112	82164	5470945	Blackjacks	45/92	164.5	165.6	-0.5	1.96	-5	95	22.82	6	2.3	1.05	6.13	1620	58	1000		Ogfi/Ogdi
DB112	DD96DB112	82164	5470946	Blackjacks	45/92	165.6	166.7	0.5	1.27	-5	69	28.5	-5	1.98	0.73	2.29	1140	44	256		Ogfi
DB112	DD96DB112	82164	5470947	Blackjacks	45/92	166.7	167.7	16.7	1.05	-5	44	27.27	15	3.79	0.48	3.21	18100	2810	11000	1.5	Ogfi
DB112	DD96DB112	82164	5470948	Blackjacks	45/92	167.65	169	1.6	1.32	-5	69	31.09	-5	0.75	0.75	1.59	1120	99	672		Ogul
DB112	DD96DB112			Blackjacks	45/92	169	177.7														Ogul
DB112	DD96DB112	82164	5470949	Blackjacks	45/92	177.7	179.1	0.6	0.89	-5	51	15.9	-5	0.46	0.49	0.66	167	-10	14		Ogul
DB112	DD96DB112			Blackjacks	45/92	179.1	187														Ogul
DB112	DD96DB112	82164	5470950	Blackjacks	45/92	187	188.5	-0.5	0.67	-5	40	30.18	-5	0.75	0.36	1.75	327	37	60		Ogul
DB112	DD96DB112			Blackjacks	45/92	188.5	196														Ogul
DB112	DD96DB112	82164	5470951	Blackjacks	45/92	196	197.5	1	1.52	-5	75	31.37	-5	0.77	0.88	1.14	152	16	21		Ogul
DB112	DD96DB112			Blackjacks	45/92	197.5	205.5														Ogul
DB112	DD96DB112	82164	5470952	Blackjacks	45/92	205.5	207	-0.5	1.17	-5	55	30.49	-5	1.06	0.69	2.61	250	11	23		Ogul
DB112	DD96DB112			Blackjacks	45/92	207	220.5														Ogul
DB112	DD96DB112	82164	5470953	Blackjacks	45/92	220.5	222	-0.5	1.55	-5	72	24.82	-5	1.41	0.85	2.96	260	13	21		Ogul

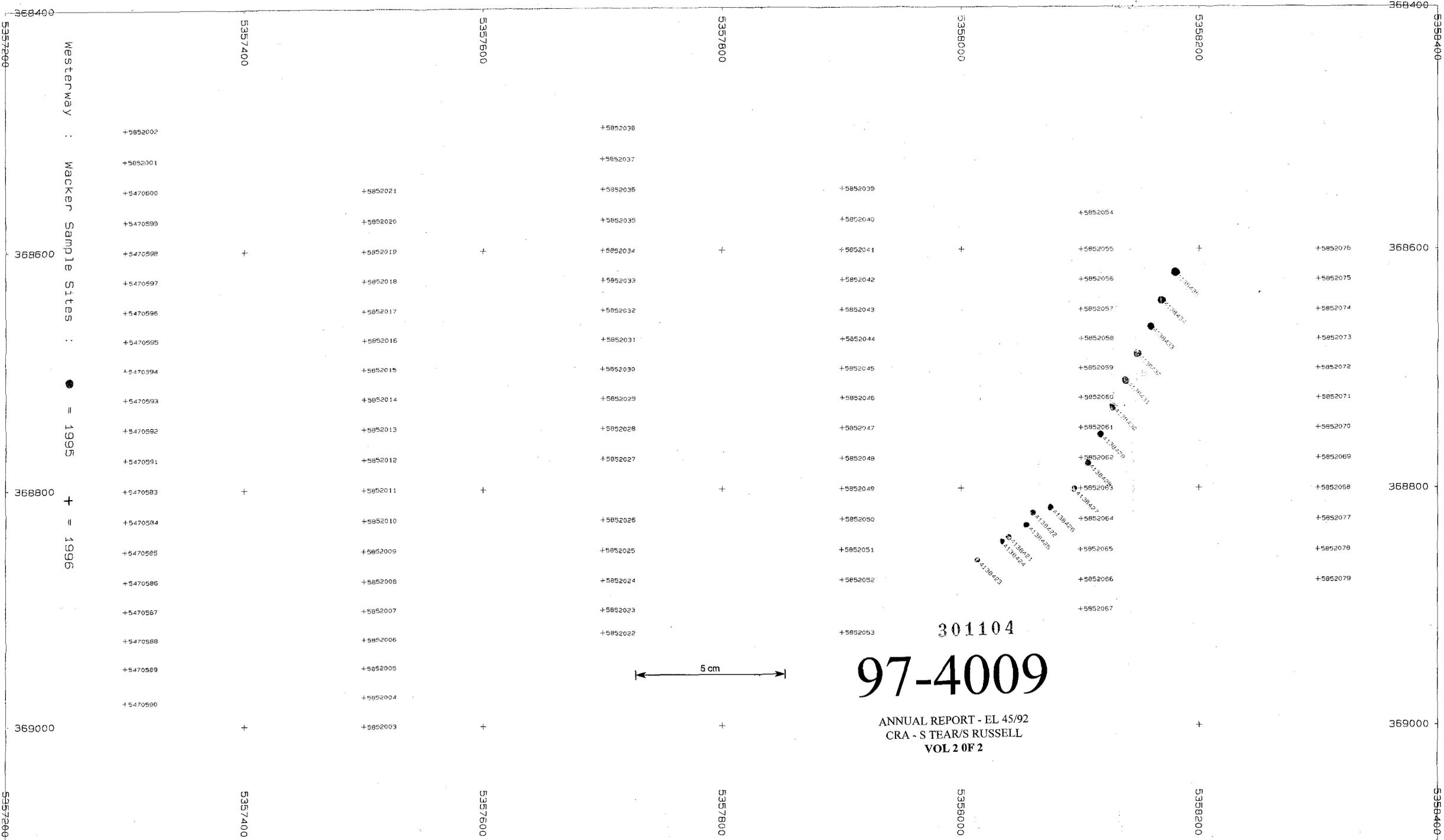
bhole	fulldh	DPO	smpno	Prospect	EL	alrom	alo	aag	aal	aas	aba	aca	acu	afe	ak	amg	arnn	apb	azn	as	MRTLth
DB112	DD96DB112			Blackjacks	45/92	222	227.7														Ogul
DB112	DD96DB112	82164	5470954	Blackjacks	45/92	227.7	228.2	1.4	1.44	-5	52	31.07	-5	0.86	0.73	0.99	495	24	268		Ogul
DB112	DD96DB112			Blackjacks	45/92	228.2	235														Ogul
DB112	DD96DB112	82164	5470955	Blackjacks	45/92	235	236.4	-0.5	1.44	-5	61	25.73	-5	1.41	0.82	3.88	313	27	142		Ogdl
DB112	DD96DB112	82164	5470956	Blackjacks	45/92	236.4	238.4	0.8	1.47	-5	60	27.58	-5	1.12	0.8	3.26	291	22	124		Ogul
DB112	DD96DB112	82164	5470957	Blackjacks	45/92	238.4	239	-0.6	1.36	-6	56	22.28	-5	1.23	0.76	3.91	262	15	56		Ogdl
DB112	DD96DB112	82164	5470958	Blackjacks	45/92	239	240.3	-0.5	2.14	5	87	22.09	7	1.41	1.19	3.78	189	27	182		Ogul
DB112	DD96DB112			Blackjacks	45/92	240.3	248														Ogul
DB112	DD96DB112	82164	5470959	Blackjacks	45/92	248	249.4	-0.5	1.73	-5	73	29.07	-5	1.18	0.97	1.97	236	34	200		Ogul
DB112	DD96DB112	82164	5470960	Blackjacks	45/92	249.4	251.2	-0.5	2.73	-5	116	35.98	7	1.68	1.38	2.76	736	744	382		Ogul
DB112	DD96DB112	82164	5470961	Blackjacks	45/92	251.2	253	-0.5	3.47	-5	152	13.95	11	2.78	1.74	3.23	1340	297	2340		Ogul
DB112	DD96DB112	82164	5470962	Blackjacks	45/92	253	253.9	0.9	3.58	13	166	13.88	13	3.86	1.83	6.34	1900	657	12600	2.1	Ogdl
DB112	DD96DB112	82164	5470963	Blackjacks	45/92	253.9	254.4	-0.5	5.69	22	255	5.8	22	6.25	2.75	1.75	2480	459	2980		Ogul
DB112	DD96DB112	82164	5470964	Blackjacks	45/92	254.4	255.6	-0.5	6.18	17	269	4.43	21	5.95	2.85	1.93	1990	612	2490		Ogul
DB112	DD96DB112	82164	5470965	Blackjacks	45/92	255.6	257.1	1	4.94	-5	210	10.28	15	4.05	2.35	4.32	1840	606	8210	1.7	Ogdl
DB112	DD96DB112	82164	5470966	Blackjacks	45/92	257.1	259	-0.5	4.15	6	190	14.26	11	2.82	2.16	4.25	1030	406	3040		Ogdl
DB112	DD96DB112	82164	5470967	Blackjacks	45/92	259	260.5	1	1.61	-5	77	32.45	-5	1.15	0.91	1.57	293	102	647		Ogul
DB112	DD96DB112	82164	5470968	Blackjacks	45/92	260.5	261.5	-0.5	1.71	-5	78	27.3	-5	1.4	0.95	1.92	479	134	2830		Ogul
DB112	DD96DB112			Blackjacks	45/92	261.5	273														Ogul
DB112	DD96DB112	82164	5470969	Blackjacks	45/92	273	274.6	-0.5	1.9	-5	87	25.6	-5	1.01	1.01	1.82	300	17	74		Ogul
DB112	DD96DB112			Blackjacks	45/92	274.6	284.2														Ogul
DB112	DD96DB112	82164	5470970	Blackjacks	45/92	284.2	286.2	-0.5	2.14	-5	92	24.67	-5	1.89	1.21	3.48	445	14	31		Ogul
DB112	DD96DB112			Blackjacks	45/92	286.2	291														Ogul
DB112	DD96DB112	82164	5470971	Blackjacks	45/92	291	292.8	-0.5	1.76	-5	71	22.52	-5	1.14	0.94	2.31	452	-10	21		Ogul
DB112	DD96DB112	82164	5470972	Blackjacks	45/92	292.8	294.4	0.5	1.63	-5	70	26.56	-5	1.56	0.91	4.07	656	13	44		Ogdl
DB112	DD96DB112	82164	5470973	Blackjacks	45/92	294.4	295.1	0.9	0.57	-5	26	30.5	-5	1.15	0.34	3.11	536	19	149		Ogul
DB112	DD96DB112	82164	5470974	Blackjacks	45/92	295.1	296.2	1.2	0.39	-5	19	24.23	-5	2.4	0.23	7.56	1190	12	69		Ogdl
DB112	DD96DB112	82164	5470975	Blackjacks	45/92	296.2	296.6	-0.5	2.24	-5	86	19.28	-5	2.44	1.18	7.41	1840	301	1110		Ogdl
DB112	DD96DB112	82164	5470976	Blackjacks	45/92	296.6	296.8	1.5	1.12	-5	37	29.12	-5	1.57	0.44	3.18	1830	110	2220		Ogul
DB112	DD96DB112	82164	5470977	Blackjacks	45/92	296.8	297.4	0.9	0.32	-6	15	27.32	-5	1.95	0.19	6.05	1140	37	183		Ogdl
DB112	DD96DB112	82164	5470978	Blackjacks	45/92	297.4	298.5	-0.5	0.93	-5	41	31.1	-5	0.78	0.54	1.44	257	27	273		Ogul
DB112	DD96DB112	82164	5470979	Blackjacks	45/92	298.5	299.5	-0.5	1.94	-5	82	24.92	-5	1.11	1.06	2.39	420	12	28		Ogul
DB112	DD96DB112			Blackjacks	45/92	299.5	306.8														Ogul
DB112	DD96DB112	82164	5470980	Blackjacks	45/92	306.8	308	3.2	1.78	-5	73	23.81	6	1.89	0.96	3.15	2670	620	3130		Ogul
DB112	DD96DB112			Blackjacks	45/92	308	313.1														Ogul
DB112	DD96DB112	82164	5470981	Blackjacks	45/92	313.1	315	-0.5	2.36	-5	101	23.45	-5	3.16	1.29	3.26	874	32	147		Ogul
DB112	DD96DB112	82164	5470982	Blackjacks	45/92	315	316.1	48	3.36	-5	141	14.56	77	4.46	1.69	3.92	1580	163	2550		Ogdl
DB112	DD96DB112	82164	5470983	Blackjacks	45/92	316.1	317.5	-0.5	2.11	23	87	1.49	10	43.5	0.86	0.48	3820	292	405		Ogsc
DB112	DD96DB112	82164	5470984	Blackjacks	45/92	317.5	318.5	-0.5	10.07	7	390	3	28	15.23	4.29	2.13	2200	127	1310		Ogsc
DB112	DD96DB112	82164	5470985	Blackjacks	45/92	318.5	319.5	-0.5	3.4	-5	147	0.74	8	32.5	1.65	0.39	9150	243	437		Ogsc
DB112	DD96DB112	82164	5470986	Blackjacks	45/92	319.5	321	-0.5	1.9	-5	94	0.82	-5	33.8	0.99	0.28	12300	28	255		Ogsc
DB112	DD96DB112	82164	5470987	Blackjacks	45/92	321	321.9	-0.5	2.57	12	130	0.73	-5	40	1.38	0.34	12900	35	529		Ogsc
DB112	DD96DB112	82164	5470988	Blackjacks	45/92	321.9	322.8	-0.5	1.3	-5	70	0.74	-5	44.3	0.7	0.2	9970	72	776		Ogsc
DB112	DD96DB112	82164	5470989	Blackjacks	45/92	322.8	325.2	-0.5	1.23	18	59	0.29	12	4.08	0.67	0.18	986	20	366		Ogdc
DB112	DD96DB112	82164	5470990	Blackjacks	45/92	325.2	326	-0.5	1.59	23	75	0.28	13	4.01	0.87	0.22	601	32	496		Ogdc
DB112	DD96DB112	82164	5470991	Blackjacks	45/92	326	328.4	-0.5	3.58	17	160	0.33	16	18.76	2.15	0.43	3860	51	717		Ogdc/Ogsc
DB112	DD96DB112	82164	5470992	Blackjacks	45/92	328.4	330	-0.5	4.22	12	184	0.48	17	21.76	2.3	0.43	6900	135	813		Ogsc
DB112	DD96DB112	82164	5470993	Blackjacks	45/92	330	330.5	-0.5	2.45	20	108	0.25	15	8.91	1.31	0.28	2040	120	682		Ogsc
DB112	DD96DB112	82164	5470994	Blackjacks	45/92	330.5	331.5	-0.5	3.63	-5	163	0.58	9	25.58	2	0.42	9280	475	953		Ogsc
DB112	DD96DB112	82164	5470995	Blackjacks	45/92	331.5	332.5	-0.5	1.64	-5	60	0.68	-5	35.2	0.87	0.23	21500	26	1520		Ogsc
DB112	DD96DB112	82164	5470996	Blackjacks	45/92	332.5	333.1	-0.5	1.94	52	78	0.37	10	20.18	0.98	0.23	6150	92	2360		Ogsc
DB112	DD96DB112	82164	5470997	Blackjacks	45/92	333.1	334	-0.5	1.6	9	68	0.47	-5	40	0.89	0.22	14300	39	1820		Ogsc
DB112	DD96DB112	82164	5470998	Blackjacks	45/92	334	335.5	-0.5	6.6	59	344	0.05	54	4.87	4.47	0.8	771	253	4880	3.1	Ogdc
DB112	DD96DB112	82164	5470999	Blackjacks	45/92	335.5	336.5	-0.5	10.31	44	396	-0.05	42	3.47	5.36	0.97	125	149	4060		Ogdc
DB112	DD96DB112	82164	5471000	Blackjacks	45/92	336.5	337.3	-0.5	5.73	177	222	0.05	38	4.72	3.24	0.56	264	117	2440		Ogdc
DB112	DD96DB112	82164	5471059	Blackjacks	45/92	337.3	339.5	-0.5	6.75	88	279	-0.05	19	2.52	3.63	0.63	42	107	2010		Ogdc
DB112	DD96DB112	82164	5471060	Blackjacks	45/92	339.5	340.9	-0.5	4.43	145	194	0.05	15	7.27	2.58	0.46	298	314	1720		Ogdc
DB112	DD96DB112	82164	5471061	Blackjacks	45/92	340.9	342.2	-0.5	6.02	273	243	-0.05	39	4	3.28	0.58	58	745	4160		Ogdc

Appendix VII

Blackjacks - Wacker Bedrock Sampling: Geology and Results

SamplNo	DPO	Prospect	EL	LocalE	LocalN	AMGE	AMGN	SamplType	Depth	Bedrock?	MHTLth	FieldID	Texture	All/Min	Colour	Comments	82153	Ag	Al	As	Ba	Ce	Cu	Fe	K	Mg	Mn	Pb	Zn
5470501	77398	BLACKJACKS	4592	67500	60600	366954	5360911	WACKER	3	Y	Om	Ss			BLB	Rotated med grained sandstone	5470501	-0.5	1.17	-5	78	-0.05	11	0.47	0.58	0.06	17	-10	11
5470502	77398	BLACKJACKS	4592	67525	60600	366973	5360927	WACKER	2	Y	Om	Ss			BLB	Rotated med grained sandstone	5470502	-0.5	0.88	-5	44	-0.05	-6	0.44	0.07	11	-10	0	
5470503	77398	BLACKJACKS	4592	67450	60600	366916	5360579	WACKER	7.2	Y	Ogdc	Ccy			OGN	Non-calcareous	5470503	-0.5	5.82	60	232	0.05	19	3.72	2.85	0.56	28	106	187
5470504	77398	BLACKJACKS	4592	67425	60600	366886	5360563	WACKER	8	Y	Ogdc	Ccy			LGDDA	Mixed clay units	5470504	-0.5	7.73	8	413	-0.05	71	1.46	4.41	0.93	25	287	86
5470505	77398	BLACKJACKS	4592	67400	60600	366877	5360547	WACKER	8	Y	Ogdl	Sst			DGG	Poss. dolomite	5470505	-0.5	1.83	-5	71	20.0	-5	1.31	1.06	4.83	216	45	107
5470506	77398	BLACKJACKS	4592	67375	60600	366858	5360531	WACKER	9.8	N	Oha	Cg			LGG	Sst mixed fragments	5470506	0.6	2.25	-5	172	19.4	-5	2.01	0.67	6.41	2750	117	617
5470507	77398	BLACKJACKS	4592	67350	60800	366839	5360515	WACKER	1.8	Y	Ogdl	Sst			LGBB	Sand material - calcareous/dolomitic (saccaroidal)	5470507	1.1	0.18	-5	8	19	-5	1.19	0.09	9.17	500	58	210
5470508	77398	BLACKJACKS	4592	67325	60600	366820	5360499	WACKER	1.6	N	Oha	Cc		Oz	LQGB	Weakly calcareous int qtz veining	5470508	1.1	0.43	-5	23	13.4	-6	2.3	0.28	6.44	991	21	54
5470509	77398	BLACKJACKS	4592	67300	60600	366801	5360483	WACKER	3.8	Y	Ogdl	Sls			GDGN	Calcareous	5470509	-0.5	2.65	-5	127	22	-5	1.07	1.55	2.48	228	51	125
5470510	77398	BLACKJACKS	4592	67275	60600	366782	5360467	WACKER	2	Y	Ogdl	Sls			GDG	Sandy calcareous material	5470510	1.1	0.89	-5	55	28.4	-5	0.83	0.55	3.15	355	83	172
5470511	77398	BLACKJACKS	4592	67250	60600	366763	5360450	WACKER	3.2	Y	Ogdl	Sls			DG	Poss. dolomite	5470511	1.3	1.35	-5	95	19	-5	2.82	0.68	10.4	1750	208	1670
5470512	77398	BLACKJACKS	4592	67225	60600	366744	5360434	WACKER	5.8	Y	Ogdc	Ccy			DBDG	Poss. siderite	5470512	-0.5	7.99	49	495	0.07	13	2.77	4.21	0.69	20	141	1080
5470513	77398	BLACKJACKS	4592	67200	60600	366724	5360418	WACKER	3.4	Y	Sc	Sa			LGYY	Frable rotted sandstone	5470513	-0.5	1.14	-5	67	-0.05	-5	0.3	0.6	0.1	13	-10	12
5470514	77398	BLACKJACKS	4592	67175	60600	366705	5360402	WACKER	1.6	Y	Sc	Sa			B	Clay component	5470514	-0.5	1.5	-5	86	-0.05	-5	0.43	0.74	0.1	13	-10	17
5470515	77398	BLACKJACKS	4592	67150	60400	366684	5360383	WACKER	1.5	Y	Sc	Sa			BW	Med grained white sandstone	5470515	-0.5	0.12	-5	19	-0.05	-5	0.48	0.06	0.02	17	-10	12
5470516	77398	BLACKJACKS	4592	67125	60400	366669	5360367	WACKER	0.8	Y	Sc	Sa			B	Brown med. sandstone	5470516	-0.5	0.42	-5	24	-0.05	-5	0.4	0.21	0.03	-10	-10	8
5470517	77398	BLACKJACKS	4592	67100	60400	366654	5360351	WACKER	1.2	Y	Sc	Sa			B	Brown med. sandstone	5470517	-0.5	1.58	-5	101	-0.05	-5	0.4	0.06	0.11	-10	-10	11
5470518	77398	BLACKJACKS	4592	67075	60400	366639	5360335	WACKER	1.2	Y	Sc	Sa			BG	Frable	5470518	-0.5	2.59	-5	157	-0.05	-5	0.52	1.38	0.18	14	14	8
5470519	77398	BLACKJACKS	4592	67050	60400	366624	5360319	WACKER	8.4	Y	Sc	Ss			BGW	Frable	5470519	-0.5	0.91	-5	54	-0.05	-5	0.31	0.48	0.07	-10	-10	6
5470520	77398	BLACKJACKS	4592	67100	60400	366776	5360303	WACKER	4	Y	Sc	Sa		Lm	OGW	Frable	5470520	-0.5	4.37	-5	203	-0.05	-5	0.48	1.97	0.3	-10	17	6
5470521	77398	BLACKJACKS	4592	67125	60400	366785	5360287	WACKER	6.2	Y	Sc	Sa			GW		5470521	-0.5	0.11	-5	15	-0.05	-5	0.22	0.06	0.01	-10	-10	6
5470522	77398	BLACKJACKS	4592	67150	60400	366814	5360271	WACKER	3	Y	Ogdl	Sls/Sst			GW	Calcareous	5470522	1.9	0.93	-5	15	27.9	-5	1.66	0.14	4.61	8410	295	3350
5470523	77398	BLACKJACKS	4592	67175	60400	366833	5360255	WACKER	0.5	Y	Ogdc	Ccy			DGNDB	Calcareous - poss siderite	5470523	1.6	0.8	-5	30	25.4	-5	2.48	0.43	1.01	911	131	265
5470524	77398	BLACKJACKS	4592	67200	60400	366853	5360239	WACKER	1.5	Y	Ogdl	Sls			GWLG		5470524	0.9	0.56	-5	19	33.5	-5	0.6	0.35	2.14	125	-10	18
5470525	77398	BLACKJACKS	4592	67225	60400	366872	5360223	WACKER	2.8	Y	Ogdc	Ccy		Py	DGN	Dissem pyrite	5470525	-0.5	5.84	14	332	2.83	9	3.5	3.25	0.78	160	34	259
5470526	77398	BLACKJACKS	4592	67250	60400	366891	5360207	WACKER	2.5	Y	Ogdl	Sls			LGG	Poss. siderite	5470526	-0.5	2.01	-5	109	20.3	-5	7.56	1.23	2.27	1150	48	107
5470527	77398	BLACKJACKS	4592	67275	60400	366910	5360191	WACKER	1.8	N	Oha	Cy			GDGB	Mixed fragments	5470527	-0.5	1.02	-5	51	9.50	-5	0.7	0.57	1.58	81	-10	23
5470528	77398	BLACKJACKS	4592	67300	60400	366929	5360175	WACKER	2	Y	Ogdl	Sls			DGG		5470528	1.8	1.09	5	79	28.4	-5	1.54	0.53	3.43	3240	357	1280
5470529	77398	BLACKJACKS	4592	67325	60400	366948	5360159	WACKER	3	Y	Ogdl	Sls			DGG		5470529	1.5	0.87	38	24	34.3	-5	1.35	0.58	0.68	231	24	20
5470530	77398	BLACKJACKS	4592	67350	60400	366968	5360143	WACKER	5.8	Y	Ogdl	Sls			DDGW	Targillaceous calcarenite unit	5470530	-0.5	2.32	-5	77	21.2	-5	1.17	1.43	5.51	191	12	34
5470531	77398	BLACKJACKS	4592	67375	60400	366987	5360127	WACKER	8	Y	Ogdl	Sls			LGG	7micrite unit	5470531	-0.5	2.95	-5	124	21.8	-5	1.27	1.78	1.96	218	17	57
5470532	77398	BLACKJACKS	4592	67400	60400	367006	5360111	WACKER	9.2	Y	Ogdl	Sls			G	Poss. dolomite	5470532	1	1.92	-5	65	21.5	-5	1.84	1.18	0.23	348	27	172
5470533	77398	BLACKJACKS	4592	67425	60400	367025	5360095	WACKER	20.8	Y	Ogdc	Ccy			N	Non-calcareous clay	5470533	-0.5	6.32	21	305	0.18	15	2.89	3.61	0.88	25	65	422
5470534	77398	BLACKJACKS	4592	67450	60400	367044	5360079	WACKER	9	Y	Ogdc	Sa			DG	Mixed frags in dark clays	5470534	0.6	6.66	85	185	0.86	28	24.3	2.42	0.54	6490	843	4810
5470535	77398	BLACKJACKS	4592	67475	60200	367182	5360289	WACKER	9.8	Y	Om	SsSah			BGWLB	Mixed buff calyx and sands	5470535	-0.5	4	-5	173	-0.05	81	0.64	2.07	0.3	25	224	218
5470536	77398	BLACKJACKS	4592	67400	60200	367134	5360273	WACKER	1.8	Y	Om	Ss			PW	Pink sandstone	5470536	0.6	0.24	6	14	-0.05	-5	0.4	0.12	0.02	25	-10	20
5470537	77398	BLACKJACKS	4592	67375	60200	367115	5360257	WACKER	8.8	Y	Om	Ssh			WLG	Buff & grey shales - non calcareous	5470537	-0.5	7.23	-5	337	0.09	-5	0.66	3.94	1.04	11	623	148
5470538	77398	BLACKJACKS	4592	67350	60200	367096	5360241	WACKER	9.8	Y	Ogdl	Sls			OLGN		5470538	1.2	3.12	-5	125	25.3	9	0.58	1.9	0.61	730	82	298
5470539	77398	BLACKJACKS	4592	67325	60200	367077	5360225	WACKER	0.5	Y	Ogdl	Sls		Lm	DG	Limestone frags in 7gravel +/- dolomite	5470539	-0.5	3.72	9	141	12.2	27	8.31	2.16	4.55	1390	30	35
5470540	77398	BLACKJACKS	4592	67300	60200	367058	5360209	WACKER	1.6	Y	Ogdl	Sls			DGN	Targillaceous calcarenite	5470540	-0.6	1.21	-5	37	27.4	-5	1.4	0.74	1.73	196	56	95
5470541	77398	BLACKJACKS	4592	67275	60200	367039	5360193	WACKER	0.8	Y	Ogdl	Sls			N	Rotated argillaceous limestone	5470541	0.8	3.15	-5	104	21.4	-5	0.88	1.85	1.29	312	32	43
5470542	77398	BLACKJACKS	4592	67250	60200	367020	5360177	WACKER	2	Y	Ogdl	Sls		Ce	LGG	Caliche veining	5470542	2.2	1.04	-5	20	31.4	-5	0.54	0.58	0.86	328	60	331
5470543	77398	BLACKJACKS	4592	67225	60200	367000	5360161	WACKER	1.5	Y	Ogdl	Sls			DGN		5470												

5470579	77398	BLACK JACKS	45/92	67425	59800	367411	5359950	WACKER	2.6	Y	Ed	Sa		DP	Purple sst/shale	5470579	-0.5	7.25	11	265	0.05	46	5.63	2.88	1.34	364	50	143
5470580	77398	BLACK JACKS	45/92	67450	59800	367430	5359986	WACKER	1	Y	Ed	Sai		DPG	Purple well cleaved siltstone	5470580	-0.5	9.25	-5	289	0.05	49	6.2	3.52	2.15	378	33	145
5470581	77398	BLACK JACKS	45/92	67475	59800	367449	5359982	WACKER	2	Y	Ed	Ssh		YLBG	Mixed shale unit	5470581	-0.5	8.17	22	268	-0.05	19	5.79	3.15	1.47	255	72	160
5470582	77398	BLACK JACKS	45/92	67500	59800	367468	5359988	WACKER	1.2	Y	Ed	SaiCcy		BOR	Cleaved sst/siltstone with overlying clays	5470582	-0.5	8	8	283	-0.05	16	5.39	2.86	1.81	232	19	68
5852500	82155	BLACK JACKS	45/92	67200	60900	366531	5360648	WACKER	2.5	Y	Sc	Sas	Sand	LGW	Sugery sandstone	5852500	-0.5	0.07	-5	9	-0.05	-5	0.23	-0.05	-0.01	13	-10	-5
5853301	82155	BLACK JACKS	45/92	67225	60900	366550	5360664	WACKER	5.3	Y	Sc	Sas	Sand	LGOW	Croby quartzite	5853301	-0.5	3.17	12	185	-0.05	27	1.13	1.81	0.27	12	29	18
5853302	82155	BLACK JACKS	45/92	67250	60900	366570	5360680	WACKER	6.4	Y	Ogul	Sia	Sandy clay	DBG	Calcareous	5853302	-0.5	1.8	-5	94	18.69	-6	1.23	0.81	1.58	240	40	369
5853303	82155	BLACK JACKS	45/92	67275	60900	366589	5360699	WACKER	4	Y	Ogdc	Ccy	Sandy clay	DBDG	?siderite non calcareous	5853303	-0.5	8.12	157	223	0.48	10	6.81	2.5	0.55	40	52	4540
5853304	82155	BLACK JACKS	45/92	67300	60900	366608	5360712	WACKER	3.6	Y	Ogdc	Ccy	Clay	DBDG	?siderite non calcareous	5853304	-0.5	6.43	306	299	0.06	28	4.12	3.08	0.62	33	4600	6930
5853305	82155	BLACK JACKS	45/92	67325	60900	366627	5360729	WACKER	10.4	Y	Ogdc	Ccy	Clay	DGHW	non calcareous rotted limestone	5853305	0.8	8.88	13	405	-0.05	15	2.05	3.46	0.71	30	1100	8270
5853306	82155	BLACK JACKS	45/92	67350	60900	366646	5360745	WACKER	3.3	Y	Ogdc	Ccy	Clay	DBG	non calcareous rotted limestone ?siderite	5853306	-0.5	6.62	26	440	-0.05	22	2.32	3.58	0.87	43	1060	578
5853307	82155	BLACK JACKS	45/92	67375	60900	366665	5360761	WACKER	1.5	N	Om	Sss	Sand	LBW	White friable sandstone	5853307	-0.5	0.26	-5	23	-0.05	5	0.16	0.11	0.02	11	12	13
5853308	82155	BLACK JACKS	45/92	67400	60900	366684	5360777	WACKER	1.4	N	Om	Sss	Sand	LBW	White friable sandstone	5853308	-0.5	1.39	-5	104	-0.05	7	0.28	0.87	0.1	13	16	9
5853309	82155	BLACK JACKS	45/92	67425	60900	366704	5360793	WACKER	1.2	N	Om	Sss	Sand	LBW	White friable sandstone	5853309	-0.5	0.07	-5	8	-0.05	-5	0.15	-0.05	-0.01	10	-10	-5
5853310	82155	BLACK JACKS	45/92	67450	60900	366723	5360809	WACKER	1.3	N	Om	Sss	Sand	LBW	White friable sandstone	5853310	-0.5	0.2	-5	22	-0.05	-6	0.19	0.07	-0.01	13	-10	-5
5853311	82155	BLACK JACKS	45/92	67475	60900	366742	5360825	WACKER	1	N	Om	Sss	Sand	LBW	White friable sandstone	5853311	-0.5	1.3	-5	72	-0.05	-5	0.31	0.82	0.08	14	-10	-5
5853312	82155	BLACK JACKS	45/92	67150	60800	366557	5360539	WACKER	1	Y	Sc	Sas	Sand	WQ	White friable sandstone	5853312	-0.5	3.53	-5	235	-0.05	-5	0.69	1.6	0.21	16	24	6
5853313	82155	BLACK JACKS	45/92	67175	60800	366576	5360555	WACKER	0.5	Y	Sc	Sas	Sand	W	White friable sandstone	5853313	-0.5	0.14	-5	12	-0.05	-6	0.2	-0.05	-0.01	13	-10	5
5853314	82155	BLACK JACKS	45/92	67200	60800	366596	5360572	WACKER	3.7	Y	Ogul	Sdl	Sandy clay	DBG	Non calcareous	5853314	-0.5	4.94	40	215	-0.05	22	3.16	1.95	0.32	44	217	1020
5853315	82155	BLACK JACKS	45/92	67225	60800	366615	5360588	WACKER	7.4	Y	Ogul	Ccy	Clay	NDG	Black clays and flecks of pyrite	5853315	-0.5	7.29	54	257	0.23	15	3.7	3.48	0.8	40	48	730
5853316	82155	BLACK JACKS	45/92	67250	60800	366634	5360604	WACKER	3	Y	Ogul	Stc	Sandy clay	G	Fine grained calcarenite ?micrite	5853316	0.8	1.04	-5	80	22.37	-6	1.31	0.54	4.02	252	79	332
5853317	82155	BLACK JACKS	45/92	67275	60800	366653	5360620	WACKER	5.5	Y	Ogdc	Ccy	Clay	NDG	Black clay + disseminated flecks of pyrite	5853317	-0.5	6.51	24	667	2.96	12	2.59	3.52	2.13	166	183	1340
5853318	82155	BLACK JACKS	45/92	67300	60800	366672	5360636	WACKER	6.4	Y	Ogdc	Ccy	Sandy Clay	DBDG	?siderite non calcareous	5853318	-0.5	8.37	204	156	1.06	8	7.39	1.72	0.46	62	104	4240
5853319	82155	BLACK JACKS	45/92	67325	60800	366691	5360652	WACKER	4	Y	Ogdc	Ccy	Sandy Clay	BG	siderite appearance	5853319	-0.5	7.55	42	948	0.14	15	1.83	3.44	0.61	31	495	8030
5853320	82155	BLACK JACKS	45/92	67400	60800	366749	5360700	WACKER	4	Y	Ogdc	Ccy	Clay	DBDG	siderite appearance	5853320	-0.5	7.34	18	949	0.13	20	1.65	3.97	0.7	45	77	218
5853321	82155	BLACK JACKS	45/92	67425	60800	366768	5360716	WACKER	15.3	Y	Ogdc	Ccy	Clay	DGN	non calcareous clay	5853321	-0.5	6.78	62	542	0.15	23	2.31	3.18	0.78	31	48	1840
5853322	82155	BLACK JACKS	45/92	67450	60800	366787	5360732	WACKER	3.3	Y	Ogdc	Ccy	Clay	DBDG	siderite appearance	5853322	-0.6	5.74	7	578	0.08	25	1.82	2.75	0.67	25	899	130
5853323	82155	BLACK JACKS	45/92	67475	60800	366806	5360748	WACKER	1	Y	Om	Sss	Sand	KW	friable uniform sandstone	5853323	-0.5	0.78	-5	74	-0.05	-5	0.23	0.35	0.04	15	-10	7
5853324	82155	BLACK JACKS	45/92	67500	60800	366825	5360764	WACKER	1	Y	Om	Sss	Sand	WLB	Friable white quartzite	5853324	-0.5	0.00	-5	33	-0.05	8	0.18	-0.05	-0.01	10	-10	-5



Westerway : Wacker Sample Sites : ● = 1995
 + = 1996

5 cm

301104
97-4009
 ANNUAL REPORT - EL 45/92
 CRA - S TEAR/S RUSSELL
 VOL 2 OF 2

5357200
 368400
 368500
 368800
 369000
 5357200

5357400
 5357400
 5357400

5357600
 5357600
 5357600

5357800
 5357800
 5357800

5358000
 5358000
 5358000

5358200
 5358200
 5358200

5358400
 368600
 368800
 369000
 5358400

Appendix VIII

King Billy - Diamond Drill Logs and Assay Results (DD96ZK124/ZK125)

**CRA EXPLORATION PTY. LIMITED
DRILL-HOLE SUMMARY LOG**

JUL 1996

Graphic Log

HOLE NAME: DD96ZK124 AMG EAST 371202 NORTH S352304
 PROSPECT: KING BILLY GRID EAST 71202 NORTH 2304
 EL: MT DUNDAS EL45192 RL 175m. DEPTH 126m

DATE DRILLED: 1/4/96
 LOGGED BY: SAJ RUSSELL
 DRILLING CO.: DDTAS.
 DRILL TYPE: DIAMOND
 DRILL RIG: LY38 - HELICOPTER
 LOC DRILL CORE: ZEEHAN

SURVEYS:

DEPTH	AZIM (AMG)	DIP	DEPTH	AZIM (AMG)	DIP
0	180°	60°			
51m	182°	60°			
102m	184°	58°			

OBJECTIVES OF HOLE:
 Diamond Drilled surface geochemical anomalies up to 0.17% Zn possibly near 'middle zone'. Also, in light of possible shallow dip of beds in ZK123, test lower contact.

LITHOLOGICAL SUMMARY:

FROM	TO	FORM CODE	COMMENTS
0	2.5	Ora.	Overburden.
2.5	15.1	Ogdc	dk brown non calcareous clays
15.1	23.8	Ogul.	fine grained calcarenite
23.8	28.6	Ogmll.	Birdseye micrite. poorly developed laminations.
28.6	39.9	Ogul.	fine grained calcarenite + local micrites + coarser channels.
39.9	47.5	Ogmll.	laminated micrite unit.
47.5	49.0	Ogf2.	Faulted calcarenite.
49.0	73.5	Ogul.	More argillaceous calcarenite + occasional channels.
73.5	77.0	Ogmll.	pale grey laminated micrite.
77.0	81.5	Ogul.	calcarenite with common 1-2cm argillaceous bands
81.5	84.2	Ogmll.	laminated micrite (+ birdseyes)
84.2	124.0	Ogul.	Calcarenite + intercalated argillaceous material.
124.0	126.0	Ogmll.	laminated micrite unit.

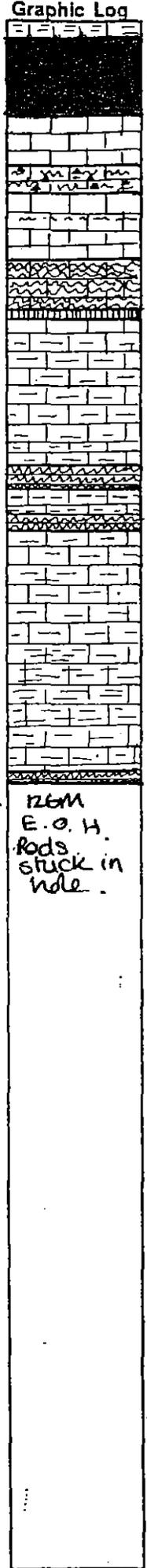
126m
E.O.H.
Rods stuck in hole.

MINERALISATION SUMMARY:

FROM	TO	COMMENTS

CONCLUSIONS:
 Bedding: 20° to CIA @ 45m; 45° to CIA @ 55m, 48° to CIA @ 70m, 70° to CIA @ 82m
 70° to CIA @ 99.5m; 80° to CIA @ 120m

Rods stuck at 126m. Could not be retrieved. Re-drilled hole (see DD96ZK125) parallel + adjacent to rods using same collar.



AMG: 371202E 5352304 N

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHE 28
TENEMENT NAME KING, BILLY No. 45 A2

LOCAL
CO-ORDINATES 11202E 2304N AZIMUTH 180° DRILLERS D. OTAS COMMENCED 1/4/96 DEPTH 126m HOLE No. DD962K124
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38 (H) COMPLETED 11/4/96 CASING LEFT DPO No(s) 82166
PLAN - MAP REFERENCE

DEPTH		Core Rec. Log	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Mag Susceptibility											
From (M)	To (M)									Depth	Value	Depth	Value	Depth	Value	Rec From	Rec (TO)	Rec (M)	Rec (910)		
0	1.5	0			Grd No Recovery						1.5	0	17	CL	32.5	7	0	1.5	0	0	
1.5	2.5	100	5	Grd	Pale grey buff clays from weathering profile		385284	1.5	2.5		2	0	17.5	4	33	8	15	3.0	1.4	93	
							42	2.5	4.1		2.5	-	18	11	35.5	7	3.0	6.0	1.6	53	
2.5	4.1	90	5	Ogdc	Dk brwn non calcareous clays + small frags of dk grey mottled limestone						3	2	18.5	5	34	10	6.0	9.0	2.5	83	
											3.5	0	19	6	34.5	8	9.0	12.0	2.8	93	
											4	0	19.5	6	35	9	12.0	15.0	1.5	50	
4.1	6.5	40	5	r	Pale grey clays + some qz veining. Some small frags of weathered limestone		43	4.1	6.5		4.5	0	20	10	35.5	5	15.0	18.0	1.3	43	
											5	0	20.5	5	36	5	18.0	21.0	3.0	100	
											5.5	CL	21	5	36.5	7	21.0	28.7	1.6	59	
6.5	10.6	95	5	Ogdc	Dk brwn/grey non calcareous clays.		44	6.5	9.0		6	0	21.5	8	37	9	23.7	28.8	3.1	100	
							45	9.0	10.6		6.5	0	22	CL	37.5	5	26.8	28.8	3.0	100	
10.6	12.0	70	5	Ogdc	Dk brwn/grey clays + possible siderite alteration??		46	10.6	12.0		7	0	22.5	CL	38	7	28.8	32.6	2.8	100	
											7.5	0	23	4	38.5	10	32.6	35.7	3.1	100	
12.0	15.1	40	5	Ogdc	Non calc. dk grey-black clays	Some graphite + poss shearing.	47	12.0	13.5		8	0	23.5	0	39	6	35.7	38.7	3.0	100	
							585248	13.5	15.1		8.5	0	24	1	39.5	7	38.7	41.5	2.8	100	
15.1	28.8	75	2F	Ogul	Fine grained calcarenite, locally micritic. Occasional small bioclasts. Increasing silty content towards base	Minor calcite veining. Graphitic shear zones locally.				No further sampling (see DD962K125)	9	0	24.5	1	40	2	41.5	44.2	2.7	100	
											9.5	0	25	2	40.5	4	44.2	48.0	3.8	100	
											10	4	25.5	4	41	4	48.0	56.8	2.6	93	
23.8	28.6	100	2F	Ogmu	Birdseye micrite unit. Grey/pale grey in colour with poorly developed laminations overall.	Clearance @ 40° to CIA					10.5	0	26	4	41.5	2	50.8	54.0	3.2	100	
											11	0	26.5	5	42	2	54.0	51.0	3.0	100	
											11.5	2	27	5	42.5	2	57.0	60.0	3.0	100	
											12	0	27.5	5	43	7	60.0	63.0	3.0	100	
											12.5	0	28	4	43.5	5	63.0	66.0	3.0	100	
28.6	36.2	100	3F	Ogul	Fine grained calcarenite, locally micritic. Minor-moderate bioturbation in places.	Graphitic edges - showing shearing. Minor pyrite in calcite. Inst argillaceous material					13	0	28.5	7	44	5	66.0	69.0	3.0	100	
											13.5	CL	29	8	44.5	5	69.0	72.0	3.0	100	
											14	0	29.5	6	45	3	72.0	75.0	3.0	100	
											14.5	0	30	2	45.5	0	75.0	78.0	3.0	100	
36.2	37.2	100	2F	Ogmu	Channel unit - equigranular coarser material - typical (pale grey in colour).						15	0	30.5	1	46	2	78.0	81.0	3.0	100	
											15.5	7	31	3	46.5	5	81.0	84.0	3.0	100	
											16	CL	31.5	2	47	4	84.0	87.0	3.0	100	
											16.5	CL	32	2	47.5	1	87.0	90.0	3.0	100	

301107

CO-ORDINATES 5352304N 317202E AZIMUTH 180° DRILLERS OOTAS COMMENCED 1/4/96
 RL COLLAR 17.5m INCLINATION 6.0° DRILL TYPE L438(H) COMPLETED 11/4/96

PLAN - MAP REFERENCE..... DEPTH 126m HOLE No. 010962K124
 CASING LEFT..... DPO No(s) 82166

DEPTH		Core Rec. (%)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Magnetic Susceptibility									
From (M)	To (M)									Depth	Value	Depth	Value	Depth	Value	Rec From	Rec To	Rec (m)	Rec %
37.2	39.9	100	3F	Ogul	Arg. calcarenite grey/dk grey in colour, fine-med. grained unit.	Clean calcite veins through unit.				48	5	68.5	0	79.0	4	90.0	93.0	3.0	100
39.9	47.5	100	3F	Ogmu	Grey/pale grey laminated unit - essentially micritic	Tetradiumas?? Fine calcite veinlets				49	5	64.5	5	79.5	5	93.0	96.0	3.0	100
					Thin argillaceous deformed bands occur throughout.	Shear zones @ 45° to CIA Bedding - 20° to CIA? - cleavage 45° CIA				49.5	4	65	9	80.5	5	99.0	102.0	3.0	100
47.5	49.0	93	3F	Ogfrz	Broken core + minor brecciated sections. Calcarenite.	cleavage @ 25° to CIA.				50	4	65.5	6	81	5	102.0	105.0	3.0	100
49.0	60.9	98	3F	Ogul	Grey/dk grey medium grained calcarenite with significant arg. component	Cleavage @ 45-50° to CIA Laminations @ 45° to CIA. (Locally micritic). Py in breccia nr. 51.0m.				50.5	0	66	4	81.5	4	108.0	111.0	3.0	100
60.9	62.0	100	1F	Ogpo	Coarse grained channelised unit. Equigranular blocky calcarenite.					51	5	66.5	6	82	6	108.0	111.0	3.0	100
62.0	63.4	100	2C	Ogul	Grey medium grained calcarenite + 1/2 30% arg. component					51.5	2	67	8	82.5	2	110.0	114.0	4.0	100
63.4	63.9	100	1F	Ogul	Coarse grained pale grey calcarenite + common blocky.					52	4	67.5	7	83	6	114.0	117.0	3.0	100
63.9	68.1	100	3C	Ogul	Fine-med. grained calcarenite + rare blocky. Variable arg. component	Cleavage @ 45 to 50° to CIA Calcite veining				52.5	1	68	5	83.5	6	117.0	120.0	3.0	100
68.1	73.5	100	2C	Ogul	Grey, med. grained calcarenite + zones of intermixed arg. calcarenite.	Bedding @ 45-50° to CIA Py in calcite veins.				53	5	68.5	10	84	5	120.0	123.0	3.0	100
73.5	77.0	100	2C	Ogmu	Pale grey laminated micrite Small birdseyes (poss. tetradiumas?)	laminations @ Cleavage @ 65-70° to CIA Calcite veins + angular frags of calcarenite.				53.5	2	69	9	84.5	6	123.0	126.0	3.0	100
										54	5	69.5	6	85	2				
										54.5	6	70	6	85.5	1				
										55	5	70.5	7	86	CLL				
										55.5	5	71	9	86.5	6				
										56	5	71.5	8	87	2				
										56.5	9	72	6	87.5	3				
										57	4	72.5	7	88	4				
										57.5	10	73	5	88.5	3				
										58	9	73.5	8	89	5				
										58.5	5	74	4	89.5	6				
										59	8	74.5	6	90	4				
										59.5	9	75	2	90.5	4				
										60	6	75.5	4	91	5				
										60.5	9	76	5	91.5	5				
										61	4	76.5	5	92	5				
										61.5	4	77	6	92.5	5				
										62	5	77.5	7	93	5				
										62.5	0	78	5	93.5	3				
										63	6	78.5	5	94	4				

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 3

TENEMENT NAME KING BILLY No. 45/192

PLAN - MAP REFERENCE

CO-ORDINATES 37202E 3352304N AZIMUTH 180° DRILLERS DOTAS COMMENCED 11/4/96 DEPTH 126m HOLE No. DD9621024
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38(H) COMPLETED 11/4/96 CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (m)	RAD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)					
From (M)	To (M)										Depth	Value	Depth	Value	Depth	Value
77.0	81.5	100	2C	Ogul	Grey medium grained calcarenite + variable arg. content, freq. in 1-2cm bands. Common bivalves	Minor calcite veining + local distortion along small shear zones					94.5	4	110	8	125	1
											95	7	110.5	5	120	3
											95.5	4	111	4		
											96	6	111.5	8		
81.5	84.2	100	1C	Ogmu	Pale grey laminated micrite (pass birdseyes)	Laminations @ 65 to 75° to CIA - May be affected by cleavage					96.5	5	112	5		
											97	4	112.5	8		
84.2	92.3	100	1C	Ogul	Grey med grained calcarenite + 1-5cm arg. bands. Graphitic shear zones.	occasional calcite veins Common synsedimentary slumping + deformation					97.5	6	113	7		
											98	5	113.5	8		
											98.5	4	114	5		
											99	9	114.5	4		
92.3	92.6	100	2F	Ogul	Coarser grained equigranular calcarenite + probable channel unit.						98.5	6	115	5		
											100	9	115.5	5		
											100.5	5	116	6		
92.6	95.4	100	2F	Ogul	Med - grained calcarenite + 260% arg. content. Pass. also part of channel						101	7	116.5	5		
											101.5	5	117	7		
											102	6	117.5	8		
95.4	99.5	100	1C	Ogul	Med. grained grey calcarenite + intercalated arg. material. Moderate bioturbation						102.5	8	118	5		
											103	7	118.5	6		
											103.5	4	119	5		
99.5	99.9	100	1C	Ogmu	Laminated micrite unit, pale grey coloration	Cleavage @ 70° to CIA, laminations fit to cleavage					104	6	119.5	5		
											104.5	7	120	5		
99.9	114.0	100	2C	Ogul	Med grained calcarenite + intercalated arg. material. Local micrite units						105	5	120.5	4		
											105.5	7	121	4		
											106	5	121.5	7		
114.0	124.0	100	1C	Ogul	Med grained calcarenite + distinct argillaceous banding 0.5-1cm in thickness	Bedding ≈ 80° to CIA Cleavage 45° to CIA					106.5	5	122	10		
											107	6	122.5	8		
											107.5	8	123	1		
											108	6	123.5	5		
124.0	126.0	100	2C	Ogmu	Laminated micrite unit with local calcarenites.	Cleavage 45° to CIA					108.5	10	124	0		
											109	9	124.5	1		
											109.5	6	125	4		

END OF HOLE 126m

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bhole	fulldh	DPO	smjno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLih
bhole	fulldh	DPO	smjno	Prospect	EL	afrom	ato	aag	aal	aas	aba	aca	acu	afe	ak	amg	amn	apb	azn	as	MRTLih
ZK124	DD96ZK124			King Billy	45/92	0	1.5														Qha
ZK124	DD96ZK124	82166	5852541	King Billy	45/92	1.5	2.5	-0.5	10.57	-5	443	0.07	-5	0.49	6.11	1.13	11	21	106		Qha
ZK124	DD96ZK124	82166	5852542	King Billy	45/92	2.5	4.1	-0.5	6.47	9	266	-0.05	10	0.3	3.67	0.64	-10	29	129		Ogdc
ZK124	DD96ZK124	82166	5852543	King Billy	45/92	4.1	6.5	-0.5	4.43	13	209	-0.05	6	0.25	-0.05	0.54	-10	20	60		Ogdc
ZK124	DD96ZK124	82166	5852544	King Billy	45/92	6.5	9	-0.5	6.92	26	301	0.06	74	1.16	4.72	0.83	10	90	216		Ogdc
ZK124	DD96ZK124	82166	5852545	King Billy	45/92	9	10.6	-0.5	7.39	47	335	0.06	21	1.58	4.61	0.9	11	41	420		Ogdc
ZK124	DD96ZK124	82166	5852546	King Billy	45/92	10.6	12	-0.5	7.49	44	290	0.12	27	1.7	4.15	0.74	14	51	771		Ogdc
ZK124	DD96ZK124	82166	5852547	King Billy	45/92	12	13.5	-0.5	9.21	62	340	0.24	30	2.96	4.88	0.85	20	69	1300		Ogdc
ZK124	DD96ZK124	82166	5852548	King Billy	45/92	13.5	15.1	-0.5	7.8	38	283	0.2	19	2.17	3.78	0.68	16	32	796		Ogdc
ZK124	DD96ZK124			King Billy	45/92	15.1	23.8														Ogul
ZK124	DD96ZK124			King Billy	45/92	23.8	28.6														Ogmu
ZK124	DD96ZK124			King Billy	45/92	28.6	39.9														Ogul
ZK124	DD96ZK124			King Billy	45/92	39.9	47.5														Ogmu
ZK124	DD96ZK124			King Billy	45/92	47.5	49														Oglz
ZK124	DD96ZK124			King Billy	45/92	49	73.5														Ogul
ZK124	DD96ZK124			King Billy	45/92	73.5	77														Ogmu
ZK124	DD96ZK124			King Billy	45/92	77	81.5														Ogul
ZK124	DD96ZK124			King Billy	45/92	81.5	84.2														Ogmu
ZK124	DD96ZK124			King Billy	45/92	84.2	124														Ogul
ZK124	DD96ZK124			King Billy	45/92	124	126														Ogmu

DRILL-HOLE SUMMARY LOG

HOLE NAME: DD962K125

AMG EAST 371202 NORTH 5352304

PROSPECT KING BILLY

GAD EAST 71202 NORTH 2304

EL: MT ANDAS EL 45/92 RL

175m DEPTH 398.7m

DATE DRILLED: 12/4/1996

SURVEYS:

LOGGED BY: SAI RUSSELL

DEPTH	AZIM (AMG)	DIP	DEPTH	AZIM (AMG)	DIP
0	180°	60°	251m	184°	54°
51m	182°	60°	308m	185°	52.5°
102m	184°	58°	369m	182°	54°
150m	182°	57°	396m	182°	54°
200m	181°	55°			

DRILLING CO.: DDIAS

DRILL TYPE: DIAMOND

DRILL F.G.: LY38-HELICOPTER

LOC DRILL CORE: ZEEHAN

OBJECTIVES OF HOLE:

Diamond drill-test surface geochemical anomalies up to 0.17% Zn, possibly nr. 'middle zone'. Also in light of possible shallow dip of beds in 2K123, test lower contact.

LITHOLOGICAL SUMMARY:

FROM	TO	FORM CODE	COMMENTS
17.2	23.8	Ogw.	Calcarene, locally micritic.
23.8	28.6	Ogmu	Birdseye micrite unit.
28.6	39.9	Ogul.	Argillaceous calcarenite + local channels.
39.9	47.5	Ogmu	Laminated micrite.
47.5	63.0	Ogul.	Argillaceous calcarenite + local channels.
63.0	124.8	Ogul.	Calcarene + argillaceous bands + local micrites.
124.8	127.1	Ogul.	Bioclastic calcarenite, locally micritic.
127.1	132.5	Ogul.	Argillaceous calcarenite.
132.5	185.8	Ogul.	Calcarene + interbedded argillaceous calcarenite.
185.8	192.5	Ogul.	Intermixed argillaceous + non-argillaceous calcarenite.
192.5	192.7	Ogul.	Massive pyrite aggregate within argillaceous unit.
192.7	283.7	Ogul.	Sequence of PAs - minor dolomitisation nr 195m.
283.7	292.1	Ogmu.	Micrite - poorly developed laminations + some birdseyes.
292.1	327.6	Ogul.	Bioturbated + burrowed argillaceous calcarenite.
327.6	339.0	Ogao	Equigranular bioclastic unit (oolitic).
339.0	351.3	Ogul.	Argillaceous bioclastic calcarenite.
351.3	370.0	Ogfz.	Dark grey calcisilite in fault zone. Significant core loss.
370.0	377.0	Ogul.	Calcarene + dark clays + ferruginous clays (375-377m).
377.0	391.5	Om	Light grey competent quartzite.
391.5	398.7	Om?	Variably doloured sst + some chert? alteration. Poss. Cambrian seds.

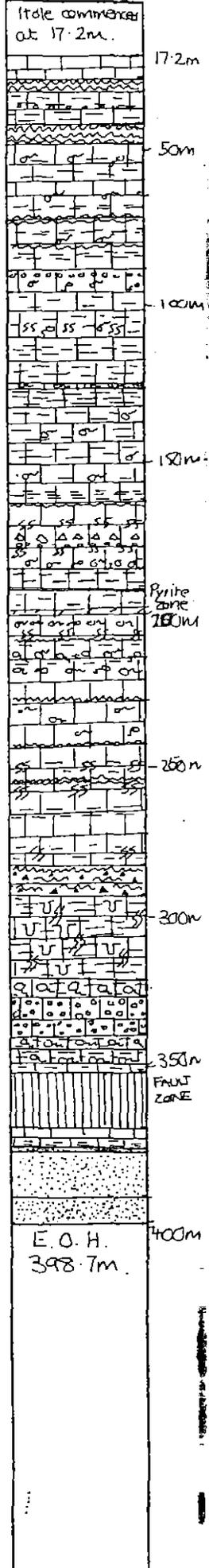
MINERALISATION SUMMARY:

FROM	TO	COMMENTS
321	324	0.13% Zn Partially dolomitised limestone above oolite unit
348	351	0.16% Zn Dolomitised argillaceous bioclastic calcarenite below the oolite unit. ?Griesen double horizons?

CONCLUSIONS:

Hole commenced at 17.2m drilling parallel to the struck rods in DD962K124. Same collar also used. Two elevated horizons occur at and around the oolite unit and the basal argillaceous bioclastic calcarenite. Good section for stratigraphic correlation.

Graphic Log



AMG: 371202E 53S2307N

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 1 of 15

TENEMENT NAME KING BILLY No. 45/92

CO-ORDINATES LOCAL 7202E 2307N AZIMUTH 180° DRILLERS DOTAS COMMENCED 12/4/1996 DEPTH 398.7m HOLE No. DD962K125
RL COLLAR 17.5m INCLINATION 60° DRILL TYPE LY 38(A) COMPLETED 7/5/1996 CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (%)	ROD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by)										
From (M)	To (M)									MAG		SUS		Feen		(Tm)		(Uk)		
										Depth	Value	Depth	Value	Depth	Value	Rec	Rec	Rec	Rec	
					Hole commenced at 17.2m after rods got stuck at 126m in DD962K124. Rods could not be retrieved. DD962K125 drilled parallel from 17.2m using same collar						17.5	3	33	6	48.5	2				
											18	6	33.5	0	49	2				
											18.5	5	34	4	49.5	4				
											19	5	34.5	5	50	4				
											19.5	5	35	5	50.5	5				
											20	5	35.5	5	51	5				
											20.5	4	36	0	51.5	3	17.2	18.0	0.4	50
											21	10	36.5	5	52	5	19.0	21.0	2.5	83
											21.5	8	37	5	52.5	5	21.0	24.0	2.0	66
											22	3	37.5	2	53	3	24.0	26.8	2.8	100
											22.5	2	38	6	53.5	6	26.8	29.7	2.9	100
17.2	23.8	70	2F	Qgl	Fine grained grey calcarenite, locally micritic with occasional anastomosing argillaceous bands. Occasional small bioclasts. Increasing silty content towards base.	Minor calcite veining. Graphitic shear zones occur locally. (Relatively minor)	58523A	24.0	25.0		23	5	38.5	5	54	5	21.9	32.9	3.0	100
											23.5	8	39	4	54.5	5	32.9	36.0	3.0	97
											24	4	39.5	6	55	5	36.0	39.0	3.0	100
											24.5	2	40	0	55	7	39.0	42.0	2.8	93
											25	4	40.5	2	56	7	42.0	44.0	2.5	96
											25.5	5	41	4	56.5	8	44.6	48.5	3.0	77
											26	5	41.5	5	57	4	48.5	51.0	2.0	80
											26.5	4	42	5	57.5	2	51.0	54.0	2.7	90
											27	5	42.5	4	58	6	51.0	57.0	3.0	100
23.8	28.6	100	2F	Qgm	Birdseye micrite unit with locally developed laminations. Generally poorly developed - grey/pale grey in colour. Birdseyes have been elongated / smeared out along cleavage (?) planes.	Relatively silty with obvious shearing + graphitic component. Voids on core ends. Cleavage = 35° to CIA					27.5	8	43	4	58.5	5	57.0	60.0	3.0	100
											28	5	43.5	5	59	4	60.0	63.0	3.0	100
											28.5	5	44	4	59.5	6	63.0	65.5	2.5	100
											29	4	44.5	4	60	4	65.5	68.6	3.1	100
											29.5	10	45	2	60.5	2	68.6	71.6	3.0	100
											30	5	45.5	3	61	2	71.6	74.1	2.5	100
											30.5	0	46	0	61.5	0	74.1	78.0	3.9	100
											31	4	46.5	0	62	4	78.0	81.8	3.8	100
											31.5	0	47	5	62.5	5	81.8	83.3	1.5	100
											32	4	47.5	2	63	2	83.3	86.4	3.1	100
											32.5	2	48	2	63.5	0	86.4	89.5	3.1	100

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 2 of 5

TENEMENT NAME KING BILLY No. 45/192

37202E

CO-ORDINATES 5352307N AZIMUTH 180° DRILLERS DDTAS COMMENCED 12/4/96 DEPTH 398.7m HOLE No. DD92K125
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38(H) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

PLAN - MAP REFERENCE

DEPTH		Core Rec. (g)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)									MAG SU3		REC (Fe)	REC (TO)	REC (M)	REC (S)			
28.6	36.2	100	3F	Qg1	Calcarene - pale grey + fine grained with silty argillaceous component. MICRITIC clean appearance locally micritic. Minor bioturbation in places. Occasional block clasts including (tetradium(?))	Graphitic edges showing shearing. Minor pyrite in calcite veins + argillaceous bands					64	0	81.5	5	81.5	92.7	3.2	100
											64.5	3	82	5	82.7	95.5	2.8	100
											65	0	82.5	3	85.5	98.6	3.1	100
											65.5	4	83	5	86	101.7	3.1	100
											66	6	83.5	3	101.7	104.8	3.1	100
											66.5	4	84	2	104.8	108.0	3.2	100
											67	2	84.5	4	108.0	111.2	3.2	100
											67.5	3	85	8	111.2	114.0	2.8	100
											68	3	85.5	8	114.0	116.3	2.8	100
36.2	37.2	100	2F	Qg05	More equigranular unit probably representing a channel of slightly coarser material through the sequence.						68.5	2	86	5	116.2	119.9	3.1	100
											69	5	86.5	4	119.9	123.0	3.1	100
											69.5	2	87	5	123.0	126.4	3.3	97
											70	2	87.5	4	126.4	128.8	2.5	96
											70.5	6	88	3	128.8	131.9	3.0	97
37.2	39.9	96	3F	Qg1	Argillaceous calcarenite grey-dk grey in colour. Fine-medium grained. Probably a deeper env of deposition. Relatively undisturbed calm facies.	Clean calcite veins ± 5cm Ø through unit. Shaley texture where shearing has occurred	585250	37.5	39.0		71	5	88.5	5	131.9	135	3.0	88
											71.5	4	89	5	135	138	3.0	100
											72	4	89.5	4	138	140.6	3.6	100
											72.5	5	90	5	140.6	142.7	3.0	97
											73	6	90.5	2	142.7	146.9	3.0	100
											73.5	3	91	2	146.9	150	3.0	97
39.9	47.5	95	3F	Qgmu	Grey/pale grey laminated unit, essentially micritic but appears locally like a calcarenite. Thin argillaceous deformed bands occur throughout. More typical micrite towards base of unit.	Tetradiums? Fine calcite veinlets. Graphitic shear zones @ 45° to c/a					74	2	91.5	3	150	153	3.0	100
											74.5	2	92	2	153	156	2.9	97
											75	2	92.5	0	156	158.2	2.7	96
											75.5	8	93	4	158.2	162	3.0	100
											78	10	93.5	4	162	165	2.9	97
											78.5	5	94	5	165	168	3.0	100
											79	5	94.5	0	168	171	2.9	97
											79.5	2	95	2	171	174	3.0	100
47.5	49.0	80	3F	Qg2	Broken core + minor brecciated sections - calcite + angular micrite argillaceous material.	Cleavage @ 65°-c/a.					80	3	95.5	4	174	177	3.0	100
											80.5	2	96	2	177	180	3.0	100
											81	2	96.5	2	180	183	3.0	100

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 15
TENEMENT NAME KING BILLY No. 45/92
PLAN - MAP REFERENCE

371202E
CO-ORDINATES 5352307N AZIMUTH 180°
RL COLLAR 175m INCLINATION 60°
DRILLERS DATAS COMMENCED 12/4/96
DRILL TYPE LY38 (H) COMPLETED 7/5/96

DEPTH 398.7m HOLE No. DP962K125
CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (%)	R&D	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)							
From (M)	To (M)									MAGNESIUM				CALCIUM			
										Depth	Value	Depth	Value	(Flg)	(To)	Rat. Com.	Rat. %
19.0	60.4	95	3F	Ogsl	Grey/dk grey medium grained calcarenite with significant argillaceous component. Occasional bioclastic horizons containing brachiopods + gastropods.	cleavage/laminations distinct @ 45°-4/A Bedding disrupted by this lamination. Minor calcite veinlets + replacement of bioclasts.	5352551	49.0	51.0	917	4	112.5	4	183	186	3.0	100
										915	8	113	2	186	189	3.0	100
										918	2	113.5	2	189	192	3.0	100
										985	2	114	4	192	195	2.8	93
										99	4	114.5	3	195	199	4.0	98
										995	4	115	4	199	200	1.5	94
										100	2	115.5	2	200	201	3.0	97
60.4	61.4	100	1F	Ogsl	Coarser grained calcarenite possible channel unit Equigranular bioclastic limestone. 20-30% argillaceous material.					1005	2	116	6	203	207	4.7	96
										101	2	116.5	5	209	210	1.0	100
										1015	4	117	4	210	212	2.5	100
										102	3	117.5	5	212	215	3.1	100
										1025	4	118	7	215	219	3.4	100
61.4	63.0	100	2C	Ogsl	Grey medium grained calcarenite with large argillaceous component (50%) giving relatively silty look.					103	6	118.5	5	219	222	3.0	100
										1035	4	119	3	222	225	3.0	100
										104	6	119.5	4	225	228	3.0	100
										1045	7	120	3	228	231	2.9	97
63.0	63.7	100	1F	Ogsl	Coarse grained pale grey calcarenite with common bioclastic occurrence. Possible channel unit.	Minor calcite veining.	5352552	63.0	65.5	105	4	120.5	7	231	234	3.0	100
										1055	5	121	5	234	237	3.0	100
										106	4	121.5	6	237	240	3.0	100
										1065	4	122	5	240	243	3.0	100
63.7	67.0	100	3C	Ogsl	Fine-medium grained calcarenite with rare bioclasts. Variable argillaceous content.	cleavage(?) @ 50° to c/A. Some calcite veining.				107	3	122.5	5	243	246	3.3	100
										1075	5	123	8	246	248	2.0	95
										108	3	123.5	6	248	251	3.0	100
67.0	73.4	100	2C	Ogsl	Grey-medium grained calcarenite with zones of intermitted argillaceous calcarenite.	Bedding @ 65° - c/A. Minor pyrite associated with argillaceous anastomosing units (appear like stylolites).	5352553	70.0	71.6	1085	5	124	6	251	254	3.1	100
										109	7	124.5	8	254	257	3.1	100
										1095	2	125	3	257	260	3.2	100
										110	5	125.5	0	260	264	3.2	100
										105	5	126	2	264	267	3.0	100
73.4	76.8	100	2C	Ogsl	Grey/pale grey laminated micrite. Fine grained Possible small birdseyes (Tetradium?).	Some calcite veins containing angular brecciated fragments. Laminations @ 70° - c/A.				111	3	126.5	2	267	270	3.0	100
										1115	6	127	4	270	273	3.0	100
										112	4	127.5	8	273	276	3.0	100

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 24 of 15

TENEMENT NAME KING BILLY No. 45192

PLAN - MAP REFERENCE

CO-ORDINATES 371202E 5352307N AZIMUTH 180° DRILLERS DDTAS COMMENCED 12/4/96 DEPTH 398.7 HOLE No. DD962KK125
RL COLLAR 175M INCLINATION 60° DRILL TYPE LY38(CH) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (%)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)									MAG		SUS	Flow To	Rec (M)	%			
76.8	81.7	100	2C	Ogul	Grey medium grained calcarenite with variable bioclastic + argillaceous content. Common bralves + argillaceous material forms distinct 1-2cm bands in the limestone.	Minor calcite veining + local dislocation along small shear planes.					128	6	1435	4	276	219	29	97
											128.5	7	144	2	271	282	3.0	100
											129	4	144.5	2	282	285	3.0	100
											121.5	5	145	2	285	287.4	2.4	100
											130	3	145.5	2	287.4	290.5	3.1	100
											130.5	3	146	2	290.5	291	2.6	100
											131	4	146.5	2	291	296.1	3.0	100
81.7	84.3	100	1C	Ogmv	Fine grey/grey laminated micrite + minor calcite inalls (tridacms/bivalves)	laminations @ 45° to CIA	58525574	81.8	83.3		131.5	2	147	2	296.1	299.2	3.1	100
											132	2	147.5	4	299.2	302.5	3.3	100
											132.5	4	148	4	302.5	305.2	2.7	100
84.3	92.2	100	1C	Ogul	Grey medium grained calcarenite with 1-5cm argillaceous bands occurring throughout. Concentration of bioclasts (bivalves + gastropods) @ 91.4m otherwise fairly sparse in occurrence. - Graphite at core ends indicative of shoaling	Occasional calcite veins possibly replacing arg. bands - in places. Veins @ 45-30° - CIA. Synsedimentary slumping + deformation is common. Minor py along cleavage + deformed contacts. Arg bands - 30° to CIA.					133	2	148.5	3	305.2	308.2	3.0	100
											133.5	2	149	2	308.2	311.7	2.7	77
											134	2	149.5	2	311.7	315.7	2.7	90
											134.5	3	150	0	315.7	318.3	2.6	100
											135	5	150.5	0	318.3	321	2.3	85
											135.5	3	151	2	321	324	2.3	77
											136	4	151.5	2	324	327	2.6	87
											136.5	5	152	5	327	330	3.0	100
											137	5	152.5	4	330	333	3.0	100
											137.5	3	153	5	333	336	3.0	100
92.2	92.7	100	2F	Ogvo	Coarser grained equigranular bioclastic unit. Probable channelised unit.	Minor py in calcitic/argillaceous bands/veins.					138	3	153.5	6	336	339	3.0	100
											138.5	5	154	4	339	342	2.1	70
											139	5	154.5	3	342	344.7	2.1	78
92.7	95.3	100	2F	Ogul	Medium-coarse grained calcarenite with >60% argillaceous component. Minor bioclastic content possibly also part of channel.	Minor pyrite along some fine fractures containing argillaceous material.					139.5	3	155	4	344.7	348	1.6	43
											140	3	155.5	3	348	351	2.0	68
											140.5	5	156	3	351	353.4	0.9	38
											141	5	156.5	5	353.4	355.1	0.8	47
											141.5	4	157	5	355.1	356.0	0.7	47
95.3	102.7	100	1C	Ogul	Grey calcarenite - medium grained, with intercalated argillaceous calcarenite;	Minor calcite veining.	585255	105.5	97.5		142	4	157.5	4	356	360	0.5	15
											142.5	5	158	5	360	362.2	0.9	41
											143	6	158.5	3	362.2	364.2	2.4	41

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 5 OF 15

TENEMENT NAME KING BILLY No. 45/192

371202C
CO-ORDINATES 5352307N AZIMUTH 180° DRILLERS DDTAS COMMENCED 12/4/96
RL COLLAR 175M INCLINATION 60° DRILL TYPE LY38 (H) COMPLETED 7/5/96

PLAN - MAP REFERENCE
DEPTH 398.7M HOLE No. D0967K125
CASING LEFT DPO No(s) 82166

DEPTH		Core Rec (%)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)									MAG		SLS		From	To	Rec	%	
										Depth	Value	Depth	Value					
					Moderate bioturbation + minor borrowing in places					159	3	1745	4	37	312	1.1	37	
					Sub-rounded fragments of pale grey fine grained calcarenite in an argillaceous matrix	Significant pyrite content within argillaceous calcarenite				159.5	7	175	4	7	372	375	0.2	7
102.7	103.0	100	5F	Ogul			5352552	102.7	103.7	160	6	175.5	3	40	375	378	1.2	40
										160.5	6	176	2	7	378	381	0.2	7
										161	2	176.5	2	35	381	383	0.9	35
										161.5	3	177	0	31	384	387	1.8	31
103.0	113.7	100	3C	Ogul	Medium grained calcarenite with intercalated argillaceous material. Moderate bioturbation present. local micritic units	laminations oriented @ $\approx 60-65^\circ$ to C/A.				162	2	177.5	5	50	387	390	0.7	50
										162.5	3	178	0	73	390	393	2.6	73
										163	3	178.5	0	100	393	395	2.8	100
										163.5	2	179	2	100	395	397	2.0	100
										164	3	179.5	5					
113.7	124.8	100	2F	Ogul	Grey medium grained calcarenite with intercalated argillaceous bands varying from 4cm \rightarrow 15cm in thickness. Rare bioclasts (bivalves + gas horpods)	Bedding @ 80° to C/A Cleavage/laminations @ 45° to C/A Py on fracture surfaces. Minor calcite veins + veinlets.	5382557	116.8	119.0	164.5	7	180	4					
										165	4	180.5	6					
										165.5	7	181	3					
										166	4	181.5	3					
										166.5	3	182	5					
										167	6	182.5	3					
124.8	126.3	97	2F	Ogul	Calcarenite - fine-medium grained, locally micritic. Rare bioclasts + minor argillaceous component.	Py in argillaceous filled fractures + assoc. with calcite fractures. Cleavage @ 45° to C/A				167.5	3	183	3					
										168	5	183.5	3					
										168.5	6	184	2					
126.3	127.1	96	2F	Ogul	Medium to coarse grained bioclastic calcarenite with abundant bivalves + gastropods.	Minor dissem. pyrite Minor calcite veining				169	5	184.5	0					
										169.5	6	185	0					
										170	3	185.5	0					
										170.5	2	186	0					
										171	3	186.5	3					
127.1	132.5	97	2C	Ogul	Argillaceous calcarenite with common graphite rich sheared edges to core pieces, aligned with pervasive cleavage direction ($60-65^\circ$ to C/A)	Occasional bioclastic rich units + minor calcite veinlets				171.5	3	187	5					
										172	4	187.5	5					
										172.5	0	188	3					
										173	3	188.5	1					
										173.5	5	189	3					
										174	4	189.5	7					

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 6 of 10

TENEMENT NAME KING BILLY No. 45192

PLAN - MAP REFERENCE

CO-ORDINATES 371202E 5352307N AZIMUTH 180° DRILLERS JDRAS COMMENCED 12/4/96 DEPTH 398.7M HOLE No. DD962K125
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38(H) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (%)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)			
From (M)	To (M)										MAG	SLCS	Depth	Value
132.5	134.8	90	1C	Ogul	Fine grained relatively clean grey calcarenite uniform, with calcite veinlets oriented @ 85° to CIA. Occasional argillaceous bands	Flecks of sphalerite in some calcite veinlets					190	3	285	4
											190.5	3	286	3
											191	2	285	2
											191.5	3	287	5
											192	2	201.5	5
											192.5	5	208	15
134.8	143.7	95	3C	Ogul	Grey/dk grey calcarenite with interbanded argillaceous calcarenites	Well developed cleavage @ 85° to CIA. Occasional blocky rich horizons. Significant pyrite content in fractures & small veins.	5852553	138.0	140.6		193	2	285	7
											193.5	2	201	6
											194	5	201.5	4
											194.5	6	210	3
											195	12	210.5	6
											195.5	10	211	3
143.7	150.5	98	2C	Ogul	Fine grained calcarenite/microtic appearance. Cleavage not so well developed in the less argillaceous sections.	Small amounts of fine sphalerite in calcite veins through unit. BIPs @ 80-85° to CIA. Cleavage @ 60° to CIA	5852551	143.7	144.3		196	10	211.5	4
							60	146.7	147.2		196.5	5	212	2
											197	2	225	3
											197.5	2	213	3
											198	0	235	4
150.5	152.1	100	2C	Ogul	Grey medium grained calcarenite with variable argillaceous + bioclastic component.						198.5	0	214	2
											199	0	248	5
											199.5	0	215	5
											200	2	215.5	4
152.1	152.3	100	2F	Ogul	Wide calcite vein with argillaceous stylolites close to contact with wall rock.						200.5	4	216	6
											201	3	216.5	3
											201.5	4	217	4
											202	4	217.5	3
152.3	160.0	96	1C	Ogul	Alternating bands of argillaceous dk grey calcarenite + grey calcarenite. Mixed with more claved + deformed units where the arg. material is more intermixed.	Fine calcite veinlets. Cleavage @ 60-65° to CIA. Bedding @ 85-90° to CIA. (can be affected by cleavage). Fault @ 153.9m clay gouge filled ± 70° to CIA angle					202.5	4	218	3
											203	3	218.5	4
											203.5	3	219	1
											204	3	219.5	3
											204.5	0	220	0
											205	0	220.5	0

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 7 of 15

TENEMENT NAME KING BILLY No. 45192

CO-ORDINATES 371202E 5352307N AZIMUTH 180° DRILLERS DDTAS COMMENCED 12/14/96 DEPTH 398.7m HOLE No. DD962K425
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38 (H) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

PLAN - MAP REFERENCE

DEPTH		Core Rec. (%)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)			
From (M)	To (M)										MAG		SUS	
											Depth	Value	Depth	Value
160.0	163.7	98	2C	Ogul	Grey calcarenite with fine bands of argillaceous calcarenite aligned with predominant cleavage orientation. Occasional bands of bioclastic rich calcarenite.	Calcite veins/veinlets in places, disturbed by later fracturing possibly minor dolomitisation.	5352561	160.0	162.0		221	C	235	C
											221.5	3	237	3
											222	4	237.5	7
											222.5	4	238	3
											223	2	238.5	2
											223.5	3	239	3
											224	2	237.5	4
163.7	165.3	97	3F	Ogml	Laminated micrite unit with partial dolomitisation. Pale grey colouration + fine grained.						224.5	2	240	3
											225	2	240.5	2
											225.5	2	241	3
											226	2	241.5	C
165.3	174.4	100	2C	Ogul	Series of minor (~3) micritic units at the top of each cycle, + more argillaceous + variably bioturbated at the base of each sequence.	v. minor calcite veins + veinlets. Bedding @ 70° to c/A. Cleavage @ 65-70° to c/A.	62	172.0	174.0		226.5	1	242	2
											227	4	242.5	2
											227.5	2	243	3
											228	3	243.5	0
											228.5	2	244	C
											229	2	244.5	3
											229.5	2	245	3
											230	6	245.5	4
174.4	175.6	100	1F	Ogbr	synsedimentary breccia unit, with sub-rounded clasts of pale grey calcarenite supported by a dk grey argillaceous matrix. Clasts = 1-2cm ø.						230.5	4	246	4
											231	3	246.5	2
											231.5	2	247	2
											232	2	247.5	3
											232.5	2	248	C
											233	2	248.5	3
175.6	176.9	100	1F	Ogul	DK grey calcarenite, significant argillaceous component with disturbed bedding, local syn-sed deformation.	Bedding @ ~ 75° to c/A.					233.5	3	249	3
											234	2	249.5	2
											234.5	4	250	2
											235	5	250.5	4
											235.5	3	251	3
											236	0	251.5	3

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 3 of 15

TENEMENT NAME KING BILLY No. 4592

37202E
CO-ORDINATES 5352307N AZIMUTH 180° DRILLERS DOTAS COMMENCED 12/4/96 DEPTH 398.7m HOLE No. 0096ZK125
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38CH COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (%)	RSD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weather, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)			
From (M)	To (M)										MAY SIS			
											Depth	Value	Depth	Value
176.9	177.3	100	1F	Og	Channel unit with medium-coarse grained equiaxed bioclastic limestone.	NO obvious bedding or cleavage.					252	7	2675	10
											252.5	5	268	3
											253	4	2685	7
											253.5	3	269	6
177.3	179.2	100	2F	Og	Grey medium grained calcarenite - locally micritic with laminations dominantly @ 70° to CIA.	Some significant calcite veining + pyrite present in association with veining + more argillaceous regions.					254	4	2695	5
											254.5	3	270	3
											255	2	2705	4
											255.5	5	271	7
											256	2	2715	3
179.2	181.2	100	1C	Og	Grey-dk grey fine grained calcarenite, with argillaceous bands (1cm in thickness) + abundant bioclasts of bivalves = 1cm Ø. Locally micritic.	Bedding @ 75° to CIA Cleavage @ 45° to CIA					256.5	4	272	5
											257	3	2725	7
											257.5	7	273	3
											258	3	2735	7
											258.5	3	274	7
											259	4	2745	9
181.2	1830	100	1C	Og	Micritic unit with poorly developed laminations, locally disturbed by fractures + poss cleavage.	Minor calcite veining. Bedding @ 85° to CIA Poorly developed cleavage.					259.5	3	275	10
											260	2	2755	10
											260.5	3	276	3
											261	0	2765	12
1830	185.8	100	3F	Og	Intermixed argillaceous + non-argillaceous calcarenite.	Bedding @ 65° to CIA Pyrite occurs along anastomosing fractures.					261.5	5	277	7
											262	3	2775	7
											262.5	3	278	7
185.8	187.7	100	2C	Og	Silty/argillaceous calcarenite; fine grained character.	Bedding @ 75° to CIA.	585258	186.0	189.0		263	3	2785	7
							64	189.0	192.5		263.5	4	279	5
187.7	192.5	100	1F		Relatively uniform fine grained grey calcarenite with significant mud/argillaceous component. Rare to no bioclasts (macroscopic).	Minor pyrite aggregates occur in some argillaceous bands Cleavage @ 25-30° to CIA. Bedding @ 90° to CIA. Minor calcite veining.					264	5	2795	5
											264.5	4	280	5
											265	6	2805	8
											265.5	3	281	7
											266	3	2815	5
											266.5	5	282	3
											267	6	2825	5

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 10 of 15

TENEMENT NAME KING BILLY No. 45192

871202E

CO-ORDINATES 5352307N AZIMUTH 180° DRILLERS O.P.T.A.S. COMMENCED 12/4/96 PLAN - MAP REFERENCE
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY 38(H) COMPLETED 7/5/96 DEPTH 398.7m HOLE No. P.D.9624125

CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (%)	RWD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)						
From (M)	To (M)										MAG SILS						
										Depth Value	Depth Value						
206.0	208.9	90	2F	Ogml	Grey/blk grey fine grained calcarenite with increasing argillaceous material upwards. Angular brecciation of limestone within calcite veins. Becomes more micritic at base with definite laminations. Possibly minor bioturbation.	Large calcite veins with clean regular wall rock contacts. Minor pyrite along fractures.					314	CL	321.5	0			
											315	4	330	0			
											315	3	330.5	0			
											315	3	331	0			
208.9											316	3	331.5	0			
											316.5	8	332	0			
											317	5	332.5	0			
											317.5	5	333	0			
											318	20	333.5	0			
208.9	209.5	100	1F	Ogmu	Well developed micrite with evidence of relatively intense local syn-sedimentary deformation - anastomosing fine argillaceous stylolites(?)	Bedding + cleavage are poorly developed					318.5	5	334	0			
											319	0	334.5	0			
											319.5	2	335	0			
											320	3	335.5	0			
											320.5	10	336	0			
209.5	216.3	100	3C	Ogml	Grey - dk grey fine - medium grained calcarenite with variable argillaceous content. Variably developed cleavage possible showing indicated by graphitic rich core ends.	Clearance = 45° to CIA. Bedding = 70-90° to CIA. Minor pyrite. Minor calcite veining.	5352508	210.0	212.5		321	2	336.5	0			
											321.5	0	337	2			
											322	0	337.5	2			
											322.5	0	338	3			
											323	2	338.5	2			
											323.5	3	339	0			
											324	2	339.5	2			
216.3	216.6	100	2C	Ogmu	Laminated micrite unit with laminations oriented @ ≈ 85° to CIA.						324.5	2	340	4			
											325	3	340.5	3			
											325.5	0	341	0			
216.6	218.5	100	2C	Ogml	Grey fine grained calcarenite with indistinct bedding.	Clearance @ 75° to CIA.					326	0	341.5	0			
											326.5	0	342	0			
											327	0	342.5	2			
218.5	220.0	100	2C	Ogmu	Clean micritic horizon with weakly developed laminations. Pale grey colouration.	Minor calcite veinlets.					327.5	0	343	5			
											328	0	343.5	2			
											328.5	0	344	2			
											329	0	344.5	1			

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C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 11 of 15

TENEMENT NAME KING BILLY No. 45192

CO-ORDINATES 371202E 5352307N AZIMUTH 180° DRILLERS ODTAS COMMENCED 12/4/96 DEPTH 398.7m HOLE No. DD967UK25
RL COLLAR 175m INCLINATION 60° DRILL TYPE L38(H) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

PLAN - MAP REFERENCE

DEPTH		Core Rec. (%)	RQD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)										MAG		SUS						
220.0	224.7	100	1C	Ogul	Grey medium grained calcarenite with evidence of local bioturbation, disrupting original bedding structures. local micritic horizons.	ite calcite veining, cleavage @ 65° to c/a. Occasional calcite veins.	5852569	225.0	228.0										
											345	3	360	0					
											345.5	CL	361	4					
											346	0	361.5	2					
											346.5	0	362	2					
											347	2	362.5	2					
224.7	226.7	100	1C	Ogmu	Clean pale grey micrite with no obvious laminations.						347.5	0	363	5					
											348	0	363.5	3					
226.7	230.6	98	1C	Ogul	Grey calcarenite with horizons containing relatively abundant bioclasts. There are also some intermixed regions of argillaceous calcarenite, localised micrite unit within sequence with possible minor development of calcite filled fenestral	Bedding @ 80-90° to c/a. Cleavage indistinct.					348.5	0	364	2					
											349	0	364.5	0					
											349.5	CL	365	CL					
											350	CL	365.5	CL					
											350.5	5	366	CL					
											351	0	366.5	CL					
											352	2	367	CL					
											352.5	CL	367.5	CL					
											352.5	0	368	CL					
											353	6	368.5	CL					
											353.5	2	369	2					
228.6	234.1	100	2C	Ogmu	pale grey micrite with poorly developed laminations.	Cleavage = 60-70° to c/a. Pyrite occurs along fractures + cleavage planes					354	2	369.5	CL					
											354.5	0	370	CL					
											355	CL	370.5	CL					
234.1	239.5	100	3F	Ogul	Grey fine grained calcarenite, less obvious cleavage + bedding. Possible that bedding has been aligned with cleavage @ ≈ 50° to c/a. Occasional bioclasts.		5852570	237.0	240.0		355	2	371	8					
											356	0	371.5	3					
											356.5	2	372	5					
											357	CL	372.5	CL					
											357.5	CL	373	CL					
											358	CL	373.5	CL					
											358.5	CL	374	CL					
239.5	240.4	100	2C	Ogmu	Laminated micrite unit with significant bioturbation present.	Cleavage @ 35° to c/a.					359	CL	374.5	CL					
											359.5	CL	375	2					
											360	0	375.5	0					

304122

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 12 of 15

TENEMENT NAME KING BILLY No. 45/92

CO-ORDINATES ^{371202E} S352307N AZIMUTH 180° DRILLERS DOTAS COMMENCED 12/4/96 DEPTH 398.7m HOLE No. DD962K125
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38 (H) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

PLAN - MAP REFERENCE

DEPTH		Core Rec. b/d	RSP	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath, Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by.....)								
From (M)	To (M)										MAG SUS		Depth	Value	Depth	Value			
240.4	246.0	100	2C	Ogvl	Grey/dk grey calcarenite with distinct argillaceous 1-2cm wide bands through majority of unit. Local micrites occur.	Minor calcite veining Bedding @ 80-85° to CIA. Cleavage @ 40-45° to CIA - well developed in places. Minor pyrite.						376	CL	371.5	10				
												376.5	CL	372	7				
												377	CL	372.5	20				
												377.5	CL	373	4				
												378	O	373.5	25				
												378.5	2	374	40				
246.0	253.0	97	1F	Ogvl	Dark grey medium grained calcarenite with syn-sedimentary dislocation of local bedding. Also some bioturbation.	Minor calcite veining. Occasional flecks of sphalerite in veins. Cleavage only weakly developed.	5852571	246.3	248.4			379	CL	374.5	20				
												379.5	CL	375	48				
												380	CL	375.5	45				
												380.5	CL	376	27				
												381	CL	376.5	22				
253.0	259	100	2C	Ogvl	Bioturbated intermixed argillaceous + non-arg. calcarenite. Possible fenestration development locally micritic.	Poorly developed bedding + cleavage.						381.5	O	377	17				
												382	O	377.5	5				
												382.5	CL	E.O.H.					
												383	CL						
												383.5	CL						
255.9	257.7	100	4C	Ogmv	Laminated micrite with well developed cleavage @ 70° to CIA.	Pyrite along fracture surfaces. Minor calcite veins.						384	CL						
												384.5	CL						
												385	CL						
257.7	258.5	100	1C	Ogvl	Calcite veined medium grained grey calcarenite with possible tetradiums towards base.	" "						385.5	CL						
												386	CL						
												386.5	CL						
												387	CL						
258.8	263.0	100	1F	Ogmv	Dominantly pale grey micrite with poorly developed laminations. DK grey argillaceous shalyites are common. Graphitic shear zone @ 261.2-261.4m.	Lack of bedding + cleavage.	5852572	258.3	260.8			387.5	CL						
												388	CL						
												388.5	CL						
												389	O						
												389.5	O						
												390	2						
												390.5	2						
												391	O						

301123

C.R.A. EXPLORATION PTY. LIMITED
DRILL CORE LOG

SHEET No. 14 of 15

TENEMENT NAME KING BILLY No. 45/192

PLAN - MAP REFERENCE

CO-ORDINATES 371202E 5352307N AZIMUTH 180° DRILLERS DDTAS COMMENCED 12/4/96 DEPTH 398.7m HOLE No. DD962K125
RL COLLAR 175m INCLINATION 60° DRILL TYPE LY38(H) COMPLETED 7/5/96 CASING LEFT DPO No(s) 82166

DEPTH		Core Rec. (m)	RCD	Graphic Log	CORE DESCRIPTION	SPECIAL FEATURES Weath. Alteration, Fracturing, Veining, Mineralization	Sample No.	From (M)	To (M)	Rec (M)	ASSAY VALUES (Analysed by			
From (M)	To (M)													
283.7	292.1	100	3C	Ogm	Pale grey-grey micrite lacking well-developed laminations + cleavage Poss. tetradiums/biradials	Minor calcite Cleavage where developed = 80° to CIA Bedding also 80° to CIA??	5852574	288.0	270.5					
292.1	310.7	80	1C	Ogw	Grey-lak grey medium grained calcarenite with moderate bioturbation Relatively argillaceous.	Minor pyrite after calcite.	5852577	305.2	308.2	308.2	311.7			
310.7	320	85	4F	Ogw	Burrowed argillaceous calcarenite with moderate bioclastic component	Cleavage = 45° to CIA. Bedding = 80-85° to CIA Poss. fault zone - broken core	79	317	315.7	318.2	318.4			
320	327.6	80	2F	Ogw	Argillaceous bioclastic calcarenite Dark grey in colour + medium- coarse grained in nature	Cleavage 45° to CIA Pyrite + poss. minor siderite alteration nr 318.3m.	81	318.2	318.4	321.0	324.0	327.0		
327.6	337.0	100	1F	Ogw	Uniform grey equigranular bioclastic w/ite. Abundant < 0.5cm Ø bioclasts	Bedding = 80° to CIA	85	327.0	330.0	333.0	336.0	339.0		
339.0	351.0	60	4F	Ogw	Argillaceous bioclastic calcarenite in an overall fault zone. Very broken core, + graphitic shear zones.	Minor pyrite. Calcite veining Possible tetradiums.	89	337.0	342.0	344.7	348.0	351.0		
351.0	351.3	100	4F	Ogmv	Laminated pale grey micrite.	Bedding @ 90° to CIA	91	344.7	348.0	351.0	353.4	355.1		
351.3	370.0	40	5X	Ogfv	Dark grey/black calcisiltite V. fine grained with large graphite content. V. broken core + significant core loss	Calcite veining. Fault zone. Indistinct bedding.	94	353.4	355.1	356.6	360.0	362.2	369.2	

301125

bhole	lulldh	DPO	smpno	Prospect	EL	alrom	alo	aag	aal	aas	aba	aca	acu	ale	ak	amg	amn	apb	azn	as	MATLih	
bhole	lulldh		smpno	Prospect	EL	alrom	alo	aag	aal	aas	aba	aca	acu	ale	ak	amg	amn	apb	azn	as	MATLih	
ZK125	DD96ZK125			King Billy	45/92	0	17.2														Ogbr	
ZK125	DD96ZK125			King Billy	45/92	17.2	24															Ogul
ZK125	DD96ZK125	82166	5852549	King Billy	45/92	24	25	-0.5	1.29	-5	59	34.74	-5	0.5	0.81	0.87	80	29	24		Ogul	
ZK125	DD96ZK125			King Billy	45/92	25	37.5															Ogul
ZK125	DD96ZK125	82166	5852550	King Billy	45/92	37.5	39	-0.5	2.98	-5	134	24.97	-5	1.23	1.84	1.98	134	33	74		Ogul	
ZK125	DD96ZK125			King Billy	45/92	39	40.5															Ogul
ZK125	DD96ZK125			King Billy	45/92	40.5	44															Ogmu
ZK125	DD96ZK125			King Billy	45/92	44	49															Ogul
ZK125	DD96ZK125	82166	5852551	King Billy	45/92	49	51	0.9	0.59	-5	27	37.13	-5	0.71	0.36	1.11	209	29	48		Ogul	
ZK125	DD96ZK125			King Billy	45/92	51	63															Ogul
ZK125	DD96ZK125	82166	5852552	King Billy	45/92	63	65.5	0.9	1.22	-5	61	32.34	-5	0.75	0.73	1.71	121	22	44		Ogul	
ZK125	DD96ZK125			King Billy	45/92	65.5	70															Ogul
ZK125	DD96ZK125	82166	5852553	King Billy	45/92	70	71.6	-0.5	1.22	-5	42	30.3	-5	0.99	0.7	2.64	146	29	51		Ogul	
ZK125	DD96ZK125			King Billy	45/92	71.6	74.7															Ogul
ZK125	DD96ZK125			King Billy	45/92	74.7	76.5															Ogmu
ZK125	DD96ZK125			King Billy	45/92	76.5	81.8															Ogul
ZK125	DD96ZK125	82166	5852554	King Billy	45/92	81.8	83.3	-0.5	1.45	-5	53	29.34	-5	0.67	0.8	0.9	170	28	230		Ogmu	
ZK125	DD96ZK125			King Billy	45/92	83.3	95.5															Ogul
ZK125	DD96ZK125	82166	5852555	King Billy	45/92	95.5	97.5	-0.5	1.19	-5	44	29.34	-5	0.82	0.59	1.19	223	29	121		Ogul	
ZK125	DD96ZK125			King Billy	45/92	97.5	102.7															Ogul
ZK125	DD96ZK125	82166	5852556	King Billy	45/92	102.7	103.7	-0.5	2.5	-5	97	25.56	6	0.8	1.11	0.85	104	39	91		Ogul	
ZK125	DD96ZK125			King Billy	45/92	103.7	114															Ogul
ZK125	DD96ZK125			King Billy	45/92	114	116.8															Ogul
ZK125	DD96ZK125	82166	5852557	King Billy	45/92	116.8	119	-0.5	1.26	-5	46	29.2	-5	0.8	0.71	2.46	107	18	31		Ogul	
ZK125	DD96ZK125			King Billy	45/92	119	138															Ogul
ZK125	DD96ZK125	82166	5852558	King Billy	45/92	138	140.6	-0.5	2.23	-5	92	26.22	-5	1.09	1.34	1.53	153	22	118		Ogul	
ZK125	DD96ZK125			King Billy	45/92	140.6	143.7															Ogul
ZK125	DD96ZK125	82166	5852559	King Billy	45/92	143.7	144.3	-0.5	1.35	-5	56	31.01	-5	0.93	0.78	1.51	113	31	96		Ogul	
ZK125	DD96ZK125			King Billy	45/92	144.3	146.7															Ogul
ZK125	DD96ZK125	82166	5852560	King Billy	45/92	146.7	147.2	-0.5	0.99	-5	40	33.22	-5	0.53	0.59	1	87	18	78		Ogul	
ZK125	DD96ZK125			King Billy	45/92	147.2	160															Ogul
ZK125	DD96ZK125	82166	5852561	King Billy	45/92	160	162	-0.5	1.41	-5	59	30.44	-5	0.69	0.87	1	100	18	48		Ogmu/Ogul	
ZK125	DD96ZK125			King Billy	45/92	162	172															Ogul
ZK125	DD96ZK125	82166	5852562	King Billy	45/92	172	174	-0.5	1.57	-5	64	30.86	-5	0.93	0.93	1.99	133	19	29		Ogul	
ZK125	DD96ZK125			King Billy	45/92	174	177															Ogbr
ZK125	DD96ZK125			King Billy	45/92	177	181															Ogul
ZK125	DD96ZK125			King Billy	45/92	181	182															Ogmu
ZK125	DD96ZK125			King Billy	45/92	182	186															Ogul
ZK125	DD96ZK125	82166	5852563	King Billy	45/92	186	189	-0.5	1.37	-5	71	28.16	-5	0.67	0.77	1.39	168	19	68		Ogul	
ZK125	DD96ZK125	82166	5852564	King Billy	45/92	189	192.5	-0.5	1.51	-5	71	26.86	-5	0.57	0.88	1.56	140	17	20		Ogul	
ZK125	DD96ZK125	82166	5852565	King Billy	45/92	192.5	192.7	-0.5	3.21	712	111	8.74	15	14.09	1.45	2.81	254	60	111		Ogul	
ZK125	DD96ZK125	82166	5852566	King Billy	45/92	192.7	194	-0.5	1.45	-5	52	21.89	-5	0.95	0.76	3.49	200	19	17		Ogul	
ZK125	DD96ZK125	82166	5852567	King Billy	45/92	194	197	-0.5	0.28	-5	11	20.62	-5	1.84	0.14	6.72	324	32	87		Ogdl	
ZK125	DD96ZK125			King Billy	45/92	197	203.5															Ogul
ZK125	DD96ZK125			King Billy	45/92	203.5	210															Ogmu
ZK125	DD96ZK125	82166	5852568	King Billy	45/92	210	212.5	-0.5	0.92	-5	44	24.97	-5	0.5	0.55	1.9	88	27	22		Ogmu	
ZK125	DD96ZK125			King Billy	45/92	212.5	225															Ogmu
ZK125	DD96ZK125	82166	5852569	King Billy	45/92	225	228	-0.5	0.73	-5	32	36.53	-5	0.45	0.43	1.17	102	26	26		Ogmu	
ZK125	DD96ZK125			King Billy	45/92	228	233.5															Ogmu
ZK125	DD96ZK125			King Billy	45/92	233.5	237															Ogul
ZK125	DD96ZK125	82166	5852570	King Billy	45/92	237	240	1.1	0.86	-5	30	32.54	-5	0.46	0.5	1.5	86	28	20		Ogul	
ZK125	DD96ZK125			King Billy	45/92	240	246.3															Ogul
ZK125	DD96ZK125	82166	5852571	King Billy	45/92	246.3	248.4	-0.5	1.26	-5	38	22.82	-5	0.89	0.73	4.76	149	28	62		Ogdl	
ZK125	DD96ZK125			King Billy	45/92	248.4	258.3															Ogul
ZK125	DD96ZK125	82166	5852572	King Billy	45/92	258.3	260.8	-0.5	0.6	-5	24	36.72	-5	0.55	0.35	0.8	133	23	21		Ogul/Ogmu	
ZK125	DD96ZK125			King Billy	45/92	260.8	267															Ogul
ZK125	DD96ZK125	82166	5852573	King Billy	45/92	267	270	-0.5	0.68	-5	26	30.41	-5	0.64	0.39	4.25	154	18	23		Ogdl	
ZK125	DD96ZK125			King Billy	45/92	270	274.6															Ogmu/Ogul
ZK125	DD96ZK125	82166	5852574	King Billy	45/92	274.6	276	0.9	0.65	-5	26	34	-5	0.79	0.36	0.94	175	33	22		Ogul	
ZK125	DD96ZK125			King Billy	45/92	276	279															Ogul
ZK125	DD96ZK125	82166	5852575	King Billy	45/92	279	282	-0.5	0.83	-5	28	30.26	-5	0.68	0.48	4.07	107	19	19		Ogbr	
ZK125	DD96ZK125			King Billy	45/92	282	288															Ogbr/Ogmu
ZK125	DD96ZK125	82166	5852576	King Billy	45/92	288	290.5	1	0.44	-5	20	35.21	-5	0.26	0.26	0.55	99	14	14		Ogmu	
ZK125	DD96ZK125			King Billy	45/92	290.5	305.2															Ogmu/Ogul
ZK125	DD96ZK125	82166	5852577	King Billy	45/92	305.2	308.2	-0.5	2.62	-5	104	23.33	-5	1.09	1.51	2.6	169	34	70		Ogul	
ZK125	DD96ZK125	82166	5852578	King Billy	45/92	308.2	311.7	-0.5	1.04	-5	48	30.6	-5	0.69	0.6	1.31	158	19	49		Ogul	

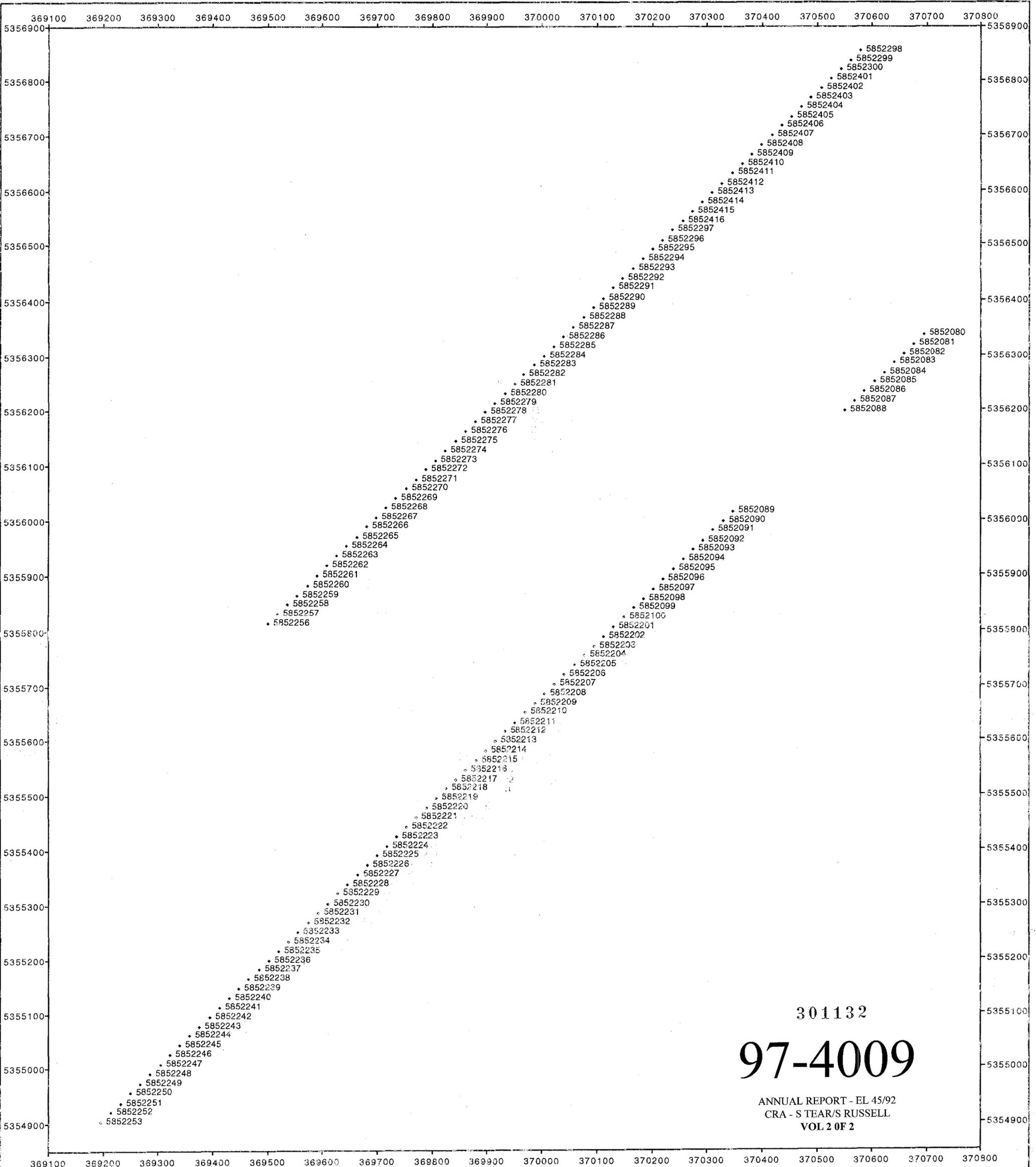
bhole	fullddh	DPO	smpno	Prospect	EL	afrom	ato	aaq	aal	aas	aba	aca	acu	ale	ak	amq	amn	apb	azn	as	MRTLlh
ZK125	DD96ZK125	82166	5852579	King Billy	45/92	311.7	315.7	-0.5	2.31	-5	96	21.43	-5	1.62	1.35	3.49	288	30	78		Ogul
ZK125	DD96ZK125	82166	5852580	King Billy	45/92	315.7	318.2	-0.5	1.55	-5	63	25.09	-5	1.64	0.89	2.98	407	17	14		Ogul
ZK125	DD96ZK125	82166	5852581	King Billy	45/92	318.2	318.4	-0.5	2.32	-5	94	12.8	-5	15.68	1.27	3.18	4100	24	-5		Ogul
ZK125	DD96ZK125	82166	5852582	King Billy	45/92	318.4	321	-0.5	1.68	-5	61	25.81	-5	1.38	0.89	2.4	379	23	99		Ogul
ZK125	DD96ZK125	82166	5852583	King Billy	45/92	321	324	0.7	0.84	-5	39	26.32	-5	0.8	0.48	3.17	405	40	1300		Ogul
ZK125	DD96ZK125	82166	5852584	King Billy	45/92	324	327	0.6	0.26	-5	13	30.74	-5	0.56	0.15	1.12	266	22	51		Ogul/Ogoc
ZK125	DD96ZK125	82166	5852585	King Billy	45/92	327	330	2.3	0.11	-5	6	40.46	-5	0.52	0.06	0.5	317	28	55		Ogoc
ZK125	DD96ZK125	82166	5852586	King Billy	45/92	330	333	1.3	0.1	-5	6	39.4	-5	0.34	0.06	0.55	261	17	25		Ogoc
ZK125	DD96ZK125	82166	5852587	King Billy	45/92	333	336	1.7	0.24	-5	11	40.79	-5	0.42	0.1	0.84	287	20	50		Ogoc
ZK125	DD96ZK125	82166	5852588	King Billy	45/92	336	339	2	0.48	-5	24	40.61	-5	0.6	0.27	1.92	370	21	111		Ogoc/Ogul
ZK125	DD96ZK125	82166	5852589	King Billy	45/92	339	342	2.1	0.95	-5	44	36.45	-5	0.67	0.51	2.74	550	22	202		Ogul
ZK125	DD96ZK125	82166	5852590	King Billy	45/92	342	344.7	1.4	1.74	-5	70	31.79	-5	1.01	0.94	4.03	931	27	151		Ogdl
ZK125	DD96ZK125	82166	5852591	King Billy	45/92	344.7	348	-0.5	1.97	-5	78	27.89	-5	1.56	1.06	4.12	991	113	1640		Ogdl
ZK125	DD96ZK125	82166	5852592	King Billy	45/92	348	351	-0.5	2.31	-5	83	22.88	-5	1.61	1.17	7.27	1010	38	133		Ogdl
ZK125	DD96ZK125	82166	5852593	King Billy	45/92	351	353.4	-0.5	2.34	7	84	23.06	-5	1.5	1.11	5.68	693	75	566		Ogdl
ZK125	DD96ZK125	82166	5852594	King Billy	45/92	353.4	355.1	-0.5	2.2	-5	85	21.93	-5	1.42	1.17	6.96	1020	40	311		Ogdl
ZK125	DD96ZK125	82166	5852595	King Billy	45/92	355.1	356.6	-0.5	1.42	-5	59	24.69	8	1.1	0.77	5.54	835	58	166		Ogdl
ZK125	DD96ZK125	82166	5852596	King Billy	45/92	356.6	360	-0.5	1.49	-5	65	23.36	-5	1.04	0.8	3.77	652	97	64		Ogdl
ZK125	DD96ZK125	82166	5852597	King Billy	45/92	360	362.2	-0.5	0.98	-5	44	23.46	-5	0.76	0.53	2.79	510	21	66		Ogdl
ZK125	DD96ZK125	82166	5852598	King Billy	45/92	362.2	369.2	-0.5	1.58	-5	66	16.53	-5	1.16	0.85	7.23	780	15	67		Ogdl
ZK125	DD96ZK125	82166	5852599	King Billy	45/92	369.2	372	-0.5	1.23	-5	66	22.21	-6	1.19	0.69	3.03	473	11	64		Ogmu/Ogul/O
ZK125	DD96ZK125	82166	5852600	King Billy	45/92	372	375	0.5	1.36	-5	76	23.11	-6	1.11	0.71	2.3	357	29	163		Ogdc
ZK125	DD96ZK125	82166	5471285	King Billy	45/92	375	376	-0.5	5.58	22	379	0.25	19	2.55	2.89	0.5	452	209	233		Oglz
ZK125	DD96ZK125	82166	5471286	King Billy	45/92	376	378	-0.5	2.33	-5	129	0.05	14	0.4	1.21	0.2	20	28	50		Om
ZK125	DD96ZK125	82166	5471287	King Billy	45/92	378	381	-0.5	3.72	5	147	0.07	7	0.55	1.05	0.21	44	35	186		Om
ZK125	DD96ZK125	82166	5471288	King Billy	45/92	381	383.6	-0.5	2.14	-5	145	0.07	7	0.47	0.94	0.14	18	12	13		Om
ZK125	DD96ZK125	82166	5471289	King Billy	45/92	383.6	389.4	-0.5	1.54	63	102	-0.05	11	2.29	0.69	0.1	15	29	108		Om
ZK125	DD96ZK125	82166	5471290	King Billy	45/92	389.4	390.6	-0.5	0.99	-5	97	0.18	14	1.1	0.43	0.1	482	24	94		Om
ZK125	DD96ZK125	82166	5471291	King Billy	45/92	390.6	391.5	-0.5	0.71	84	69	0.24	10	3.04	0.33	0.08	51	13	72		Om
ZK125	DD96ZK125	82166	5471292	King Billy	45/92	391.5	393	-0.5	6.9	8	584	0.26	8	4.28	3.15	0.95	268	21	95		Om
ZK125	DD96ZK125	82166	5471293	King Billy	45/92	393	395.8	-0.5	6.04	23	569	0.26	10	5.19	2.95	1.19	724	-10	69		Om
ZK125	DD96ZK125	82166	5471294	King Billy	45/92	395.8	397.8	-0.5	3.76	13	376	0.71	-5	3.16	1.88	0.83	331	-10	28		Om

Appendix IX

Westerway - Wacker Bedrock Sampling: Geology and Assay Results

Sample	DPO	Prospect	EL	LocalE	LocalN	AMGE	AMGN	Sample	Depth	Bedrock?	MRT	Utm	FieldID	Texture	AM/Mn	Colour	Comments	82153	Ag	Al	As	Ba	Ca	Cu	Fe	K	Mg	Mn	Pb	Zn
5470584	82153	WESTERWAY	4592	8800	57300	368800	5357300	WACKER	1.2	Y	Ed	Sss	GRITTY SAND	Se	W	POSS FELDSPAR AND CHLORITE	5470584	-0.5	5.15	-5	198	-0.05	8	0.82	1.47	0.19	13	20	37	
5470584	82153	WESTERWAY	4592	8825	57300	368825	5357300	WACKER	1.4	Y	Ed	Sss	GRITTY SAND	Se	W	POSS FELDSPAR AND CHLORITE	5470584	-0.5	5.44	-5	229	-0.05	9	0.87	1.71	0.23	15	60	24	
5470585	82153	WESTERWAY	4592	8850	57300	368850	5357300	WACKER	1.4	Y	Ed	Sss	GRITTY SAND	Se	LB	ROTTED SST	5470585	-0.5	6.98	-5	156	-0.05	23	0.68	1.37	0.2	15	15	21	
5470586	82153	WESTERWAY	4592	8875	57300	368875	5357300	WACKER	3.5	Y	Ogdc	Ccy	CLAY	DGN	NON CALCAREOUS	5470586	-0.5	7.97	60	425	-0.05	18	2.42	3.47	0.7	42	38	1140		
5470587	82153	WESTERWAY	4592	8900	57300	368900	5357300	WACKER	2.5	Y	Ogdc	Ccy	CLAY	BG	NON CALCAREOUS	5470587	-0.5	7.14	37	240	-0.05	39	3.42	2.87	0.68	17	1150	1170		
5470588	82153	WESTERWAY	4592	8925	57300	368925	5357300	WACKER	1.4	Y	Ed	Sss	SAND	LGW	FINE SST FRAGS	5470588	-0.5	3.96	8	245	-0.05	-5	0.4	1.49	0.2	-10	27	10		
5470589	82153	WESTERWAY	4592	8950	57300	368950	5357300	WACKER	2.7	Y	Sc	Sss	SANDY CLAY	LGW	FINE SST SLTST HORIZONS	5470589	-0.5	1.94	-5	146	-0.05	-5	0.32	0.81	0.13	-10	-10	5		
5470590	82153	WESTERWAY	4592	8980	57300	368980	5357300	WACKER	1	Y	Ed	Sss	SAND	LGW	MED GRAINED SST	5470590	-0.5	0.12	-5	8	-0.05	-5	0.34	-0.05	0.01	11	-10	-5		
5470591	82153	WESTERWAY	4592	8775	57300	368775	5357300	WACKER	1.5	Y	Ed	Sss	GRITTY SAND	M	LBW	MED GRAINED SST	5470591	-0.5	0.94	-5	250	-0.05	-5	0.04	1.22	0.2	12	-10	19	
5470592	82153	WESTERWAY	4592	8750	57300	368750	5357300	WACKER	1.3	Y	Ed	Sss	CLAY	Se, Li	LBO	MED GRAINED SST	5470592	-0.5	10.3	27	591	-0.05	42	3.67	3.38	0.45	29	35	18	
5470593	82153	WESTERWAY	4592	8725	57300	368725	5357300	WACKER	1.3	Y	Ed	Sss	SANDY CLAY	Li	LBW		5470593	-0.5	10.1	38	304	-0.05	37	2.61	3.07	0.48	29	13	28	
5470594	82153	WESTERWAY	4592	8700	57300	368700	5357300	WACKER	4.6	Y	Ed	Sss	SANDY CLAY	Se	W		5470594	-0.5	8.7	41	184	-0.05	129	2.56	1.93	0.36	20	15	23	
5470595	82153	WESTERWAY	4592	8675	57300	368675	5357300	WACKER	2.2	Y	Ed	Sss	SANDY CLAY	Li	BG		5470595	-0.5	6.69	16	139	-0.05	44	0.8	1.51	0.84	81	15	47	
5470596	82153	WESTERWAY	4592	8650	57300	368650	5357300	WACKER	1.2	Y	Ed	Sss	GRITTY SAND	Li	BG	ROTTED SST	5470596	-0.5	4.29	7	83	-0.05	5	0.84	0.9	0.13	14	97	15	
5470597	82153	WESTERWAY	4592	8625	57300	368625	5357300	WACKER	1.2	Y	Ed	Ccy	CLAY	Py	DG	POSS CHLORITE (GREEN HUE)	5470597	-0.5	7.53	24	155	0.08	49	5.55	1.93	1.76	157	29	191	
5470598	82153	WESTERWAY	4592	8600	57300	368600	5357300	WACKER	3	Y	Ed	Ccy	SANDY	Cl	GV	POSS GREYWACKE (SSH FRAGS)	5470598	-0.5	5.94	18	225	0.16	214	1.27	1.10	0.25	26	56	88	
5470599	82153	WESTERWAY	4592	8575	57300	368575	5357300	WACKER	1.6	Y	Ed	El	GRITTY SAND	Cl	GV	PROBABLE VOLCANICLASTIC	5470599	-0.5	0.01	14	122	0.06	43	2.17	1.03	0.59	68	14	123	
5470600	82153	WESTERWAY	4592	8550	57300	368550	5357300	WACKER	1.4	Y	Ed	El	GRITTY SAND	Cl	GV	PROBABLE VOLCANICLASTIC	5470600	-0.5	6.07	21	190	-0.05	45	3.81	1.28	1.02	130	27	104	
5852001	82153	WESTERWAY	4592	8525	57300	368525	5357300	WACKER	1	Y	Ed	Sss	SANDY CLAY	Li	LB	FINE SST	5852001	-0.5	7.77	17	487	-0.05	-5	0.59	2.15	0.3	17	33	14	
5852002	82153	WESTERWAY	4592	8500	57300	368500	5357300	WACKER	1.1	Y	Ed	Ccy	CLAY	Se	W	POSS SHALE	5852002	-0.8	10.2	15	808	-0.05	-5	0.57	0.81	0.38	13	22	9	
5852003	82153	WESTERWAY	4592	9000	57500	369000	5357500	WACKER	3.5	Y	Ed	Ccy	CLAY	Li	LGW	NON CALC POSS LMST/ LAMINATED	5852003	-0.8	8.88	7	265	-0.05	39	0.44	2.91	0.7	20	83	76	
5852004	82153	WESTERWAY	4592	8975	57500	368975	5357500	WACKER	5.3	Y	Ogdc	Ccy	CLAY	DGN	NON CALC POSS ROTTED LMST	5852004	-0.5	8.09	66	391	-0.05	17	1.92	3.73	0.96	40	76	1240		
5852005	82153	WESTERWAY	4592	8950	57500	368950	5357500	WACKER	1.9	Y	Ed	Sss	SANDY CLAY	Li	DB	MED GRAINED SST	5852005	-0.5	6.1	20	293	-0.05	7	0.32	2.71	0.65	14	25	10	
5852006	82153	WESTERWAY	4592	8925	57500	368925	5357500	WACKER	2.5	Y	Ed	Sss	GRITTY SAND	Li	DB	COURSE ROTTED SST	5852006	-0.5	4.77	-5	258	-0.05	6	0.53	2.22	0.48	16	47	7	
5852007	82153	WESTERWAY	4592	8900	57500	368900	5357500	WACKER	4.4	Y	Ed	Sss	SANDY CLAY	Li	B	POSS ROTTED SHALE	5852007	-0.5	1.12	-5	35	-0.05	10	0.35	0.29	0.06	17	-10	8	
5852008	82153	WESTERWAY	4592	8875	57500	368875	5357500	WACKER	7.5	N	Oha	Cs	GRITTY SAND	Li	DB	ROTTED SST?	5852008	-0.5	1.08	-5	32	-0.05	-5	0.34	0.27	0.06	15	-10	7	
5852009	82153	WESTERWAY	4592	8850	57500	368850	5357500	WACKER	5.2	Y	Ed	Sss	SANDY CLAY	Li	LBW		5852009	-0.5	5.66	9	201	-0.05	10	0.84	1.42	0.25	24	16	12	
5852010	82153	WESTERWAY	4592	8825	57500	368825	5357500	WACKER	2	Y	Ed	Sss	SANDY	Se	WLG	FRIABLE FINE SST	5852010	-0.5	2.21	-5	44	-0.05	8	0.56	0.65	0.17	47	-10	82	
5852011	82153	WESTERWAY	4592	8800	57500	368800	5357500	WACKER	6.4	Y	Ed	Ccy	CLAY	Se	W	MIXED CL ?	5852011	-0.5	8.17	-5	305	-0.05	-5	1.15	2.28	0.35	17	31	10	
5852012	82153	WESTERWAY	4592	8775	57500	368775	5357500	WACKER	2	Y	Ed	Ccy	SANDY CLAY	Se	WLG	NON CALC POSS SSI	5852012	-0.5	5.08	-5	174	-0.06	7	0.75	1.82	0.26	15	20	40	
5852013	82153	WESTERWAY	4592	8750	57500	368750	5357500	WACKER	3.6	Y	Ed	Ccy	CLAY	Li	WR		5852013	-0.5	3.98	-5	138	-0.06	115	0.06	1.11	0.27	12	-10	7	
5852014	82153	WESTERWAY	4592	8725	57500	368725	5357500	WACKER	3.4	Y	Ed	Sss	SANDY CLAY	Li	KL	FINE LAMINATIONS/BEDS	5852014	-0.5	6.57	16	153	-0.05	56	1.86	1.27	0.23	24	27	19	
5852015	82153	WESTERWAY	4592	8700	57500	368700	5357500	WACKER	4	Y	Ed	Ccy	CLAY	Li	WLG		5852015	-0.5	12.6	7	298	-0.05	94	2.23	3.09	0.66	54	23	41	
5852016	82153	WESTERWAY	4592	8675	57500	368675	5357500	WACKER	3.5	Y	Ed	Ccy	CLAY	Se	WLG	POSS CHLORITE (SLIGHT GREEN HUE)	5852016	-0.5	11.8	36	328	-0.05	428	4.03	3.29	1.29	137	33	229	
5852017	82153	WESTERWAY	4592	8650	57500	368650	5357500	WACKER	2.3	Y	Ed	Ss	SANDY CLAY	Se, Li	LGB		5852017	-0.5	8.97	31	151	-0.05	43	4.11	1.81	1.08	86	22	59	
5852018	82153	WESTERWAY	4592	8625	57500	368625	5357500	WACKER	1	Y	Ed	Sss	SANDY CLAY	Li	B	POSS CL? ROTTED SST?	5852018	-0.5	8.51	27	145	-0.05	10	2.96	1.61	0.93	66	17	57	
5852019	82153	WESTERWAY	4592	8600	57500	368600	5357500	WACKER	1	Y	Ed	Sss	SANDY	Li	B	FINE SST	5852019	-0.5	7.29	-5	110	-0.05	24	4.12	0.9	1.3	138	21	109	
5852020	82153	WESTERWAY	4592	8575	57500	368575	5357500	WACKER	0.8	Y	Ed	El	SANDY CLAY	Cl	GV	PROBABLE VOLCANICLASTIC	5852020	-0.5	9.5	12	274	0.11	199	7.15	2.43	1.74	174	25	291	
5852021	82153	WESTERWAY	4592	8550	57500	368550	5357500	WACKER	1.1	Y	Ed	Sss	GRITTY SAND	Li	B		5852021	-0.5	9.26	18	243	-0.05	41	0.85	1.97	0.28	28	18	42	
5852022	82153	WESTERWAY	4592	8920	57700	368920	5367700	WACKER	7.2	N	Oha	Cs	SANDY CLAY	Li	DB	ROTTED SST?	5852022	-0.5	6.18	11	220	-0.05	20	0.9	2.34	0.56	27	94	298	
5852023	82153	WESTERWAY	4592	8900	57700	368900	5367700	WACKER	14.8	Y	Ogdc	Ccy	CLAY	Py	DGN	LAMINATED/SHEARED NON CALC	5852023	-0.5	8.66	16	484	0.1	13	1.36	3.74	1.25	56	35	551	
5852024	82153	WESTERWAY	4592	8875	57700	368875	5367700	WACKER	16.8	Y	Ogdc	Ccy	CLAY	Py	DBG	NON CALC	5852024	-0.5	5.15	15	209	0.09	17	0.83	2.04	0.47	26	64	396	
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5852061	82153	WESTERWAY	45/92	8750	58100	368750	5358100	WACKER	1.1	Y	Ogdc	Ccy	CLAY		DGN	NON CALC-POSS SIDERITE ZONE	5852061	-0.5	6.28	81	407	0.28	16	2.45	2.9	0.48	27	2080	6080
5852062	82153	WESTERWAY	45/92	8775	58100	368775	5358100	WACKER	4	Y	Dgul	Sls	SANDY CLAY		DGN	CALCAREOUS	5852062	-0.5	6.15	48	241	10	17	2.14	3.17	1.78	172	139	604
5852063	82153	WESTERWAY	45/92	8800	58100	368800	5358100	WACKER	2.1	Y	Ogdc	Ccy	CLAY		DGN	NON CALC-ROTTED LMST	5852063	-0.5	5.59	19	211	4.51	12	0.64	3.35	0.65	54	36	56
5852064	82153	WESTERWAY	45/92	8825	58100	368825	5358100	WACKER	12	Y	Dgul	Ccy	CLAY		DG	CALCAREOUS-ARGILLACEOUS	5852064	-0.5	0.95	-5	42	26.3	-5	0.65	0.62	3.65	120	119	268
5852065	82153	WESTERWAY	45/92	8850	58100	368850	5358100	WACKER	2.4	Y	Ogdc	Sss	CLAY		DG	NON-CALCAREOUS-C-ROTTED LMST?	5852065	-0.5	7.67	86	361	0.07	23	2.12	4.3	0.75	21	401	1900
5852066	82153	WESTERWAY	45/92	8875	58100	368875	5358100	WACKER	1.2	Y	Sc	Sss	CLAY		LBW	POSS SSI	5852066	-0.5	4.38	-5	207	0.18	-5	0.42	2.65	0	14	57	14
5852067	82153	WESTERWAY	45/92	8900	58100	368900	5358100	WACKER	1	N	Oha	Cs	SANDY		WLB	FINE GRAINED SST	5852067	-0.5	0.58	-5	36	-0.05	5	0.31	0.36	0	11	-10	11
5852068	82153	WESTERWAY	45/92	8900	58300	368900	5358300	WACKER	0.5	Y	Sc	Ccy	SANDY		WLB	FINE GRAINED SST	5852068	-0.5	0.03	-5	-5	-0.05	5	0.29	-0.05	0.01	10	-10	14
5852069	82153	WESTERWAY	45/92	8775	58300	368775	5358300	WACKER	3.8	N	Oha	Sss	SANDY CLAY		DBM	FINE GRAINED SST	5852069	-0.5	0.61	6	31	0.26	46	0.49	0.29	0.06	24	14	62
5852070	82153	WESTERWAY	45/92	8750	58300	368750	5358300	WACKER	15.4	Y	Ogdc	Ccy	CLAY		DGN	NON CALCAREOUS	5852070	-0.5	7.66	64	258	0.25	39	1.83	4.28	0.69	61	171	4170
5852071	82153	WESTERWAY	45/92	8725	58300	368725	5358300	WACKER	7	Y	Ed	Sss	SANDY CLAY		LB	FINE GRAINED SST	5852071	-0.5	3.4	-5	181	-0.05	8	0.67	1.45	0.26	26	100	30
5852072	82153	WESTERWAY	45/92	8700	58300	368700	5358300	WACKER	1.1	Y	Ed	Ccy	CLAY	LI	WO		5852072	-0.5	10.4	202	651	-0.05	26	2.05	5.11	0.59	22	32	317
5852073	82153	WESTERWAY	45/92	8675	58300	368675	5358300	WACKER	0.8	Y	Ed	Sss	SANDY		W	LARGE QZ CLAST, POSS CHLORITE AND FELDSPAR	5852073	-0.5	4.06	10	73	-0.05	10	1.48	0.8	0.39	50	12	31
5852074	82153	WESTERWAY	45/92	8650	58300	368650	5358300	WACKER	1.3	Y	Ed	Ssi	SANDY CLAY	LI	LVO		5852074	-0.5	6.74	32	175	-0.05	144	8.52	1.43	1.86	198	32	152
5852075	82153	WESTERWAY	45/92	8625	58300	368625	5358300	WACKER	2.1	Y	Ed	Sss	SANDY		W		5852075	-0.5	6.25	22	261	-0.05	15	1.42	2.12	0.28	24	270	27
5852076	82153	WESTERWAY	45/92	8600	58300	368600	5358300	WACKER	1.4	Y	Ed	Ccy	CLAY	LI	DB		5852076	-0.5	8.75	49	183	-0.05	66	10.4	1.16	0.45	54	68	40
5852077	82153	WESTERWAY	45/92	8625	58300	368625	5358300	WACKER	2.8	Y	Ogdc	Ccy	CLAY		G	NON CALC. POSS ROTTED LMST	5852077	-0.5	9.28	22	296	-0.05	81	9.43	3.1	0.45	29	22	29
5852078	82153	WESTERWAY	45/92	8650	58300	368650	5358300	WACKER	1.5	Y	Sc	Ssh	SANDY CLAY		GB		5852078	-0.5	9.8	21	817	-0.05	22	1.09	5.09	0.55	25	13	21
5852079	82153	WESTERWAY	45/92	8875	58300	368875	5358300	WACKER	1.4	Y	Sc	Ssh	SANDY CLAY		BG		5852079	-0.5	8.47	20	533	-0.05	14	0.88	4.82	0.55	20	26	20



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ANNUAL REPORT - EL 45/92
CRA - S TEAR/S RUSSELL
VOL 2 OF 2

EL 45/92 Mt. Dundas

CRA Exploration Pty Limited		
Tom Creek		
Sample Location Map		
Wacker Bedrock Sampling		
Geol: S Russell	Scale: 1:5000	Report:
Drawn: S Russell	Date: 13/6/96	Plan:

map 100m

5 cm

Appendix X

Tom Creek - Wacker Bedrock Sampling: Geology and Assay Results

Sample	DPO	Prospect	EL	LocalE	LocalN	AMGE	AMGN	SampleType	Depth	Bedrock?	MRL/Lth	FieldID	Texture	All/Min	Colour	Comments	B2153	Ag	Al	As	Ba	Ca	Cu	Fe	K	Mg	Mn	Pb	Zn
5852080	82155	TOM CREEK	45/92	2125		370684	5356339	WACKER	2.8	Y	Ogul	Coy	Sandy clay		LGW	Poss. siltstone, significant clays	5852080	0.5	3.85	-5	235	0.24	17	1.36	1.53	0.37	187	98	432
5852081	82155	TOM CREEK	45/92	2100		370676	5356322	WACKER	9.3	Y	Ogul	Coy	Sandy	Li	LGO	Partly calcareous	5852081	-0.5	6.24	-5	201	10.4	23	3.08	2.82	1.15	480	136	549
5852082	82155	TOM CREEK	45/92	2075		370658	5356304	WACKER	7.5	N	One	Os	Sandy		DB		5852082	-0.5	3.98	-13	108	0.05	22	0.85	1.58	0.33	-10	1330	1560
5852083	82155	TOM CREEK	45/92	2050		370640	5356287	WACKER	22.5	Y	Ogul	Sls	Sandy clay		GLG	Fine grained calcarenite	5852083	-0.5	3.43	-5	188	25.12	8	0.87	1.83	0.48	355	71	318
5852084	82155	TOM CREEK	45/92	2025		370622	5356269	WACKER	13.5	Y	Ogul	Sls	Sandy clay		GLG	Possible dolomite	5852084	-0.5	9.24	-23	344	1.36	42	1.45	3.59	0.78	70	121	350
5852085	82155	TOM CREEK	45/92	2000		370604	5356252	WACKER	1.4	Y	Ogul	Sls	Sandy clay		G	Fine grained calcarenite	5852085	-0.5	1.52	-5	140	28.11	-5	1.05	0.82	2.32	348	37	229
5852086	82155	TOM CREEK	45/92	1975		370588	5356235	WACKER	3.3	Y	Ogul	Sls	Sandy clay		LG	Calcarenite - possible micrite	5852086	-0.5	2.79	-5	127	28.31	7	0.89	1.57	0.57	376	21	63
5852087	82155	TOM CREEK	45/92	1950		370568	5356217	WACKER	1.5	Y	Sc	Sss	Clay	Se	LGW	siltstone/sandstone	5852087	-0.5	8.52	-5	531	0.07	-5	0.86	4.2	0.81	17	-10	15
5852088	82155	TOM CREEK	45/92	1925		370550	5356200	WACKER	1.1	Y	Sc	Sls	Sandy		LBW		5852088	-0.5	0.44	-5	29	0.05	-5	0.11	0.18	0.02	-10	-10	8
5852089	82155	TOM CREEK	45/92	1825		370347	5356186	WACKER	1.8	Y	Sc	Sss	Gritty sand		BLB		5852089	-0.5	1.82	-5	116	-0.05	-5	0.27	0.82	0.11	14	-10	17
5852090	82155	TOM CREEK	45/92	1800		370329	5356199	WACKER	7.8	Y	Sc	Coy	Sandy clay	U	BO	Heavy limonite stained clays	5852090	-0.5	7.7	-30	378	0.05	49	16.7	3.35	0.77	3500	185	886
5852091	82155	TOM CREEK	45/92	1575		370311	5356182	WACKER	5.5	Y	Ogul	Sdl	Sandy		OG	Siliceous calcarenite	5852091	-0.5	2.19	-5	111	17.68	-5	8.3	1.15	4.15	2150	19	26
5852092	82155	TOM CREEK	45/92	1550		370293	5356164	WACKER	3.6	Y	Sc	Sss	Gritty sand		LGW	Coarse grained sandstone	5852092	-0.5	1.65	-5	116	0.09	-5	0.81	0.17	45	12	32	
5852093	82155	TOM CREEK	45/92	1525		370275	5356147	WACKER	3.3	Y	Sc	Sss	Gritty sand		LGB		5852093	-0.5	7.18	-8	495	0.2	17	3.21	2.43	1.56	174	23	107
5852094	82155	TOM CREEK	45/92	1500		370257	5356130	WACKER	3.5	Y	Sc	Sss	Sandy		W		5852094	-0.5	2.78	-5	205	-0.05	-5	0.22	1.19	0.23	15	49	23
5852095	82155	TOM CREEK	45/92	1475		370239	5355912	WACKER	3.2	Y	OgdC	Coy	Sandy		LGW	Non-calcareous clays	5852095	-0.5	4.27	-8	384	1.84	13	24.77	1.84	0.85	4820	418	1500
5852096	82155	TOM CREEK	45/92	1450		370221	5355895	WACKER	1.5	Y	Sc	Sss	Gritty sand		LGW		5852096	-0.5	4.89	-5	473	0.23	7	2.02	1.89	0.9	177	15	99
5852097	82155	TOM CREEK	45/92	1425		370203	5355877	WACKER	1.1	Y	Sc	Sss	Sandy		LYW	Micaceous sandstone	5852097	-0.5	6.36	-5	477	0.23	8	3.32	2.04	0.92	186	24	75
5852098	82155	TOM CREEK	45/92	1400		370185	5355860	WACKER	1.2	Y	Sc	Sss	Gritty sand	U	WLG		5852098	-0.5	7.14	-5	574	0.13	-5	3.73	2.52	1.15	166	24	89
5852099	82155	TOM CREEK	45/92	1375		370167	5355843	WACKER	0.2	N	One	Coy	Sandy	U	RO	Very iron rich (hem) poss. iron pan	5852099	-0.5	0.77	-5	71	-0.05	-5	46.8	0.06	0.02	2120	20	13
5852100	82155	TOM CREEK	45/92	1375		370149	5355825	WACKER	1.2	N	One	Coy	Sandy	U	RO	Very iron rich (hem) poss. iron pan	5852100	-0.5	2.73	21	238	0.08	-5	28.2	0.74	0.21	1170	26	26
5852101	82155	TOM CREEK	45/92	1350		370131	5355808	WACKER	1.1	Y	Sc	Coy	Sandy clay	O	LGV	Possible chlorite - volcanoclastic	5852101	-0.5	6.2	-5	747	0.13	-13	3.57	2.7	2.41	256	22	101
5852102	82155	TOM CREEK	45/92	1325		370113	5355791	WACKER	1.1	Y	Sc	El	Sandy		GV	Possible volcanoclastic	5852102	-0.5	7.96	-5	704	0.85	11	3.3	2.55	2.54	305	24	78
5852103	82155	TOM CREEK	45/92	1300		370095	5355773	WACKER	2.1	Y	Sc	Os	Sandy		OBR	Probable volcanoclastic	5852103	-0.5	0.9	-5	269	0.07	8	2.86	0.17	0.03	43	-10	20
5852104	82155	TOM CREEK	45/92	1275		370077	5355756	WACKER	3.5	N	Sc	Sss	Sandy	Li	LGW	Bedrock??	5852104	-0.5	2.01	-5	308	0.85	13	0.48	0.91	0.15	26	15	39
5852105	82155	TOM CREEK	45/92	1250		370059	5355739	WACKER	1.3	Y	Sc	Coy	Clay	Li	WO		5852105	-0.5	8.65	-5	842	-0.05	13	4.8	3.96	0.98	50	21	42
5852106	82155	TOM CREEK	45/92	1225		370041	5355721	WACKER	1.6	Y	Sc	Coy	Clay	Li	WB		5852106	-0.5	8.28	-5	527	-0.05	10	5.19	3.28	0.56	29	15	23
5852107	82155	TOM CREEK	45/92	1200		370023	5355704	WACKER	2.4	Y	Sc	Coy	Clay	Li	WO		5852107	-0.5	12.25	-5	813	-0.05	18	5.06	5.55	0.79	108	17	88
5852108	82155	TOM CREEK	45/92	1175		370005	5355686	WACKER	1.1	Y	Sc	Sss	Sandy Clay		W		5852108	-0.5	0.28	-5	34	-0.05	-5	0.23	0.1	0.02	12	-10	13
5852109	82155	TOM CREEK	45/92	1150		369987	5355668	WACKER	1.1	Y	Sc	Coy	Clay		B	Possible siltstone	5852109	-0.5	10.83	-5	1660	-0.05	8	0.4	4.74	0.88	10	128	13
5852110	82155	TOM CREEK	45/92	1125		369969	5355652	WACKER	9.5	Y	Sc	Sss	Sandy Clay	W	W	Fine grained sandstone	5852110	-0.5	1.78	-5	488	-0.05	8	0.27	0.5	0.13	18	152	80
5852111	82155	TOM CREEK	45/92	1100		369951	5355634	WACKER	5.4	Y	Sc	Sss	Sandy Clay		WLG	Fine grained sandstone	5852111	-0.5	9.89	-5	453	-0.05	35	0.71	2.82	0.51	24	40	70
5852112	82155	TOM CREEK	45/92	1075		369933	5355617	WACKER	2.6	Y	Sc	Coy	Clay		WLG	Non calcareous clays	5852112	-0.5	6.34	-5	458	-0.05	-5	0.71	2.46	0.49	23	13	20
5852113	82155	TOM CREEK	45/92	1050		369915	5355600	WACKER	6.5	Y	Sc	Coy	Clay		W	Minor limonitic staining	5852113	-0.5	7.58	-5	460	-0.05	20	0.89	3	0.79	39	37	50
5852114	82155	TOM CREEK	45/92	1025		369897	5355582	WACKER	2.1	Y	Sc	Sss	Sandy		LB	Fine grained sandstone	5852114	-0.5	1.25	-5	70	-0.05	-5	0.33	0.51	0.07	19	-10	8
5852115	82155	TOM CREEK	45/92	1000		369879	5355565	WACKER	5.3	Y	Sc	El	Clay		WLVG	Possible chlorite volcanoclastic	5852115	-0.5	9.32	-5	825	-0.05	17	1.63	2.84	0.8	61	43	38
5852116	82155	TOM CREEK	45/92	875		369861	5355547	WACKER	5.4	Y	Sc	Coy	Clay		WLV	Possible volcanoclastic	5852116	-0.5	6.49	-5	451	-0.05	10	0.67	2.49	0.47	24	24	21
5852117	82155	TOM CREEK	45/92	850		369843	5355530	WACKER	5.4	Y	Sc	Coy	Clay		LG		5852117	-0.5	11.24	-5	492	-0.05	36	0.88	3.07	0.62	29	19	23
5852118	82155	TOM CREEK	45/92	825		369825	5355513	WACKER	1.1	Y	Sc	Sss	Gritty Sand		RWV	Mixed clasts, variable colours	5852118	-0.5	6.17	-5	317	-0.05	10	3.27	1.77	1.62	126	19	56
5852119	82155	TOM CREEK	45/92	800		369807	5355495	WACKER	5.2	Y	Sc	Coy	Clay		LG	Non calcareous, poss. rotted limestone	5852119	-0.5	9.97	-5	454	-0.05	19	0.72	2.99	0.44	28	38	27
5852120	82155	TOM CREEK	45/92	875		369789	5355478	WACKER	4.5	Y	Sc	Coy	Clay	U	WL	Possible siltstone	5852120	-0.5	14.31	-5	598	-0.05	81	7.04	3.46	0.85	49	32	57
5852121	82155	TOM CREEK	45/92	850		369771	5355461	WACKER	4.6	Y	Sc	Coy	Clay	U	WO	Possible siltstone	5852121	-0.5	10	-5	519	-0.05	53	5.42	2.76	0.52	52	30	44
5852122	82155	TOM CREEK	45/92	825		369753	5355443	WACKER	7.3	Y	Sc	Coy	Clay		W		5852122	-0.5	8.33	-5	484	-0.05	34	1.07	1.95	0.41	24	22	42
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5852258	82155	TOM CREEK	45/92	50	369536	5355850	WACKER	2.5	Y	Sc	Ccy	Sandy clay	GB	Poss. siltstone	5852258	-0.5	5.97	13	426	-0.05	6	166	1.98	0.84	124	13	63
5852259	82155	TOM CREEK	45/92	75	369554	5355867	WACKER	5.8	Y	Sc	Sss	Grity sand	G	Medium grained sandstone	5852259	-0.5	2.82	9	139	0.07	10	0.75	0.86	0.21	44	42	175
5852260	82155	TOM CREEK	45/92	100	369572	5355884	WACKER	1.4	Y	Sc	Sss	Grity sand	WB	Crystalline natural/micaeous	5852260	-0.5	5.92	-5	516	0.34	11	2.43	1.88	0.82	193	19	47
5852261	82155	TOM CREEK	45/92	125	369590	5355902	WACKER	6.3	Y	Ogul	Sls	Grity sand	G	Partially rolled + some eal contamination	5852261	-0.5	7.61	12	391	4.99	22	3.52	1.92	1.52	437	94	205
5852262	82155	TOM CREEK	45/92	150	369608	5355919	WACKER	1.6	Y	Ogdc	Sss	Grity sand	DG	Dominantly sst. minor rolled limestone??	5852262	-0.5	7.74	-5	581	0.21	11	2.69	2.5	1.35	166	21	65
5852263	82155	TOM CREEK	45/92	175	369626	5355937	WACKER	5.3	Y	Ogul	Sls	Grity sand	G	Coarse grained calcarenite	5852263	-0.5	1.38	-5	58	21.35	-5	7.91	0.59	2.72	2800	47	241
5852264	82155	TOM CREEK	45/92	200	369644	5355954	WACKER	8.4	Y	Ogul	Sls	Grity sand	G	Coarse grained calcarenite	5852264	-0.5	1.40	-5	75	18.82	-5	3.04	0.78	5.7	1380	17	58
5852265	82155	TOM CREEK	45/92	225	369662	5355971	WACKER	1.3	N	Oha	Ca	Grity sand	GV	Possible intrusive? Clastic sandstone??	5852265	-0.5	7.76	-5	423	0.82	12	3.52	1.73	1.99	315	20	80
5852266	82155	TOM CREEK	45/92	250	369680	5355989	WACKER	1.6	Y	Ogul	Sls	Grity sand	G	Calcarenite containing rounded non calcareous fragments	5852266	-0.5	5.59	9	403	3.75	12	4.91	1.88	1.41	2750	36	351
5852267	82155	TOM CREEK	45/92	275	369698	5356006	WACKER	7.2	Y	Ogdc	Ccy	Clay	DG	Weathered calcarenite	5852267	-0.5	7.46	22	485	0.33	26	3.55	2.4	1.1	205	54	318
5852268	82155	TOM CREEK	45/92	300	369718	5356023	WACKER	2.1	Y	Sc	Sss	Grity sand	B	Coarse grained sandstone	5852268	-0.5	6.07	7	454	0.19	11	2.82	1.63	0.93	206	22	93
5852269	82155	TOM CREEK	45/92	325	369734	5356041	WACKER	1.5	N	Oha	Sss	Grity sand	Li	Bedrock??	5852269	-0.5	4.93	-5	325	0.11	12	2.15	1.44	0.73	117	31	62
5852270	82155	TOM CREEK	45/92	350	369752	5356058	WACKER	3.1	Y	Sc	Sss	Grity sand	WLB	Arkosic sandstone	5852270	-0.5	5.67	12	422	0.17	21	3.63	1.98	1.34	762	39	96
5852271	82155	TOM CREEK	45/92	375	369770	5356075	WACKER	1.7	Y	Sc	Sss	Grity sand	GB	Coarse arkosic sandstone	5852271	-0.5	6.36	-5	540	0.56	21	4.69	2.47	2.26	481	33	128
5852272	82155	TOM CREEK	45/92	400	369788	5356093	WACKER	1.1	Y	Sc	Saa	Grity sand	GB	Coarse arkosic sandstone	5852272	-0.5	7.09	7	484	0.49	20	4.21	2.37	1.64	220	31	102
5852273	82155	TOM CREEK	45/92	425	369806	5356110	WACKER	8.5	Y	Sa	Ssi	Clay	Li	Probable siltstone	5852273	-0.5	7.56	-5	408	0.34	34	3.16	3.55	1	142	218	575
5852274	82155	TOM CREEK	45/92	450	369824	5356127	WACKER	1.5	Y	Sa	li	Grity sand	VDV	Dark green intrusive	5852274	-0.5	7.67	-5	434	1.55	9	4.12	1.96	2.14	398	36	96
5852275	82155	TOM CREEK	45/92	475	369842	5356145	WACKER	3.6	Y	Sa	Ssa	Grity sand	DGV	Intrusive?	5852275	-0.5	5.36	-5	475	6.7	14	3.71	1.96	1.51	352	21	120
5852276	82155	TOM CREEK	45/92	500	369860	5356162	WACKER	5.2	Y	Ogdc	Ccy	Clay	DG	Non calcareous clays-rotted lsmt	5852276	-0.5	5.6	19	229	2.38	17	2.4	2.75	1.79	247	83	606
5852277	82155	TOM CREEK	45/92	525	369878	5356180	WACKER	3.3	Y	Ogul	Sls	Clay	G		5852277	-0.5	2.57	-5	128	-0.6	6	0.53	1.89	0.99	93	15	203
5852278	82155	TOM CREEK	45/92	550	369896	5356197	WACKER	0.7	Y	Sa	Ssl	Sandy	DGN	Competent laminated shale/siltstone	5852278	-0.5	6.96	-5	592	0.21	7	3.44	2.77	2.1	224	14	82
5852279	82155	TOM CREEK	45/92	575	369914	5356214	WACKER	0.8	Y	Sa	Ssl	Grity sand	WLG	Crystalline-poss. quartzite	5852279	-0.5	5.84	-5	614	0.25	10	3.38	2.27	1.08	254	23	58
5852280	82155	TOM CREEK	45/92	600	369932	5356232	WACKER	1.4	Y	Sc	Sss	Grity sand	GLG		5852280	-0.5	6.71	-5	560	0.18	15	3.45	2.35	1.75	208	15	81
5852281	82155	TOM CREEK	45/92	625	369950	5356249	WACKER	2.5	Y	Sc	Ssh	Clay	DGN	Shale/siltstone-v. micaeous	5852281	-0.5	6.7	-5	540	0.11	7	3.37	2.4	2.44	226	15	80
5852282	82155	TOM CREEK	45/92	650	369967	5356268	WACKER	10.7	Y	Ogdc	Ccy	Clay	DG	Non calcareous rotted lsmt	5852282	-0.5	7.86	6	428	-0.05	36	1.56	3.98	0.81	26	68	348
5852283	82155	TOM CREEK	45/92	675	369985	5356284	WACKER	7.5	Y	Sa	Ssh	Sandy	DGN	Shale-laminated	5852283	-0.5	6.88	18	465	-0.05	21	1.4	3.53	1.13	45	28	82
5852284	82155	TOM CREEK	45/92	700	370003	5356301	WACKER	5.5	Y	Ogdc	Ccy	Sandy clay	DG	Non-calcareous dark clays	5852284	-0.5	6.26	44	292	0.11	49	0.68	2.51	0.8	19	54	27
5852285	82155	TOM CREEK	45/92	725	370021	5356318	WACKER	2.1	Y	Sc	Sss	Sandy	WLG	Medium grained sandstone	5852285	-0.5	5.79	-5	549	-0.05	6	2.65	2.18	0.97	181	21	58
5852286	82155	TOM CREEK	45/92	750	370039	5356336	WACKER	3.5	Y	Sc	Ccy	Sandy clay	Li	Possible siltstone	5852286	-0.5	6.39	6	377	0.05	20	1.17	1.8	0.49	71	54	138
5852287	82155	TOM CREEK	45/92	775	370057	5356353	WACKER	8.8	N	Oha	Ca	Sandy clay	Li	Bedrock??	5852287	-0.5	2.85	-5	226	-0.05	13	0.59	0.99	0.22	38	28	74
5852288	82155	TOM CREEK	45/92	800	370075	5356371	WACKER	18.5	Y	Sc	Ssl	Sandy clay	WLB	Dominantly white fine grained siltstone	5852288	-0.5	6.82	8	258	0.05	46	0.86	3.36	0.79	25	163	213
5852289	82155	TOM CREEK	45/92	825	370093	5356388	WACKER	7.3	Y	Ogul	Sls	Clay	G		5852289	-0.5	6.9	-5	37	25.85	-5	0.66	0.53	1.65	141	12	22
5852290	82155	TOM CREEK	45/92	850	370111	5356405	WACKER	6.4	Y	Ogul	Sls	Clay	G		5852290	-0.5	2.44	-5	82	23.42	5	1.26	1.47	2.35	175	15	26
5852291	82155	TOM CREEK	45/92	875	370129	5356423	WACKER	0.7	Y	Sc	Ssa	Grity sand	W	Coarse sandstone	5852291	-0.5	1.32	-5	124	0.09	8	0.3	0.66	0.09	15	-10	13
5852292	82155	TOM CREEK	45/92	900	370147	5356440	WACKER	3.6	N	Oha	Ca	Grity sand	WLB	Bedrock??	5852292	-0.5	5.51	-5	363	0.08	10	2.26	1.86	0.84	133	24	118
5852293	82155	TOM CREEK	45/92	925	370165	5356457	WACKER	12.8	Y	Ogdc	Ccy	Clay	DG	Non calcareous rotted limestone	5852293	-0.5	4.81	47	161	3.89	16	3.3	2.62	2.33	195	164	925
5852294	82155	TOM CREEK	45/92	950	370183	5356475	WACKER	2.4	Y	Sc	Sss	Grity sand	WLB	Coarse grained sandstone	5852294	-0.5	2.83	-5	236	-0.05	-5	0.65	1.27	0.29	47	-10	20
5852295	82155	TOM CREEK	45/92	975	370201	5356492	WACKER	8.5	Y	Ogul	Sls	Sandy clay	G		5852295	-0.5	1.97	-6	74	18.31	7	5.1	1.14	0.89	1140	23	53
5852296	82155	TOM CREEK	45/92	1000	370219	5356509	WACKER	2.4	Y	Ogul	Sls	Clay	G		5852296	-0.5	5.3	-5	260	7.18	32	1.1	2.75	1.08	93	55	138
5852297	82155	TOM CREEK	45/92	1025	370237	5356527	WACKER	3.1	Y	Ogul	Sls	Grity sand	WLG	Fine grained sandstone	5852297	-0.5	2.27	-5	179	2.22	27	0.64	1.1	0.3	63	14	18
5852298	82155	TOM CREEK	45/92	1500	370578	5356858	WACKER	1.3	Y	Sc	Ssa	Grity sand	W	Coarse sandstone	5852298	-0.5	0.31	-5	29	-0.05	12	0.15	0.13	0.02	10	-10	10
5852299	82155	TOM CREEK	45/92	1475	370581	5356839	WACKER	7.5	N	Oha	Ca	Grity sand	DB	Bedrock??	5852299	-0.5	4.78	26	256	0.08	598	0.63	2.18	0.31	50	488	883
5852300	82155	TOM CREEK	45/92	1450	370543	5356822	WACKER	3.4	Y	Sc	Sss	Sandy clay	Li	Micaeous sandstone	5852300	-0.5	2.78	-5	254	-0.05	6	0.34	1.42	0.17	13	13	17
5852401	82155	TOM CREEK	45/92	1425	370525	5356804	WACKER	1.5	Y	Sc	Sss	Grity sand	W	Coarse grained sandstone	5852401	-0.5	0.07	-5	11	-0.05	6	0.13	-0.05	0.01	-10	-10	9
5852402	82155	TOM CREEK	45/92	1400	370507	5356787	WACKER	1.1	Y	Sc	Ssa	Sandy	W	Medium grained sandstone	5852402	-0.5	0.05	-5	9	-0.05	-5	0.14	-0.05	0.01	-10	-10	7
5852403	82155	TOM CREEK	45/92	1375	370489	5356770	WACKER	1.5	Y	Sc	Sss	Sandy	WLB	Medium grained sandstone	5852403	-0.5	1.75	8	154	-0.05	-5	0.29	0.99	0.13	12	-10	9
5852404	82155	TOM CREEK	45/92	1350	370471	5356752	WACKER	1.3	Y	Sc	Sss	Sandy	WBG	Medium grained sandstone	5852404	-0.5	1.81	5	168	-0.05	-5	0.28	0.97	0.12	11	-10	9
5852405	82155	TOM CREEK	45/92	1325	370453	5356735	WACKER	1.5	Y	Sc	Sss	Sandy	WLB	Medium grained sandstone	5852405	-0.5	1.59	-5	136	-0.05	5	0.26	0.87	0.11	13	-10	10
5852406	82155	TOM CREEK	45/92	1300	370435	5356718	WACKER	2.5	Y	Sc	Sss	Sandy	WLB	Medium grained sandstone	5852406	-0.5	2.09	-5	179	-0.05	-5	0.32	1.12	0.14	14	11	11
5852407	82155	TOM CREEK	45/92	1275	370417	5356700	WACKER	1.6	Y	Sc	Sss	Sandy	WLB	Medium grained sandstone	5852407	-0.5	2.03	-5	176	-0.05	-5	0.29	1.07	0.13	12	-10	9
5852408	82155	TOM CREEK	45/92	1250	370399	5356683	WACKER	1.3	Y	Sc	Sss	Sandy	WLB	Medium grained sandstone	5852408	-0.5	2.29	-6	194	-0.05	-5	0.37	1.2	0.16	16	-10	13
5852409																											

Appendix XI

Pyramid - Wacker Bedrock Sampling: Geology and Assay Results

SampNo	DPO	Prospect	EL	LocalE	LocalN	AMGE	AMGN	SampType	Depth	Bedrock?	MRTL#h	FieldID	Texture	Alt/Min	Colour	Comments	82153	Ag	Al	As	Ba	Ca	Cu	Fe	K	Mg	Mn	Pb	Zn	
5852423	82156	PYRAMID	4592	450		365385	5355377	WACKER	6 N	Oha		Coy	Clay			DGB	Bedrock? possible sandy layers	5852423	-0.5	5.34	21	193	-0.05	21	0.55	2.4	0.4	23	97	73
5852424	82156	PYRAMID	4592	425		365343	5355366	WACKER	2.5 Y	Ogdl		Sdt	Sandy Clay			LG	?Micritic limestone/dolomitic	5852424	-0.5	1.49	-5	51	18.4	-5	1.39	0.6	4.61	408	178	183
5852425	82156	PYRAMID	4592	400		365320	5355355	WACKER	2.3 Y	Ogul		Sls	Sandy Clay			LGG	Sparry calcarenite / argillaceous	5852425	-0.5	1.61	-5	84	16.8	-5	1.47	0.68	2.80	420	96	216
5852426	82156	PYRAMID	4592	375		365298	5355344	WACKER	6.2 Y	Ogdl		Sdt	Sandy Clay	CA		LG	Calcite veining in ?micritic/dolomitic	5852426	0.6	1.64	-5	62	24.7	-5	2.13	0.83	6	883	43	188
5852427	82156	PYRAMID	4592	350		365275	5355333	WACKER	J Y	Ogul		Sls	Sandy Clay			GLG	Sparry calcarenite ?dolomite	5852427	-0.5	3.57	-5	202	13.5	7	7.2	1.24	3.47	3590	23	56
5852428	82156	PYRAMID	4592	300		365230	5355311	WACKER	3.4 Y	Om		Sss	Sand			WLG	White quartzite ?Moina-not sugary	5852428	-0.5	5.35	-5	361	0.21	21	2.3	1.84	0.81	182	31	106
5852429	82156	PYRAMID	4592	275		365208	5355300	WACKER	7.2 Y	Om		Sss	Sand	BI		LGW	White quartzite ?Moina-not sugary	5852429	-0.5	4.42	-5	292	0.09	20	1.87	1.21	0.67	126	21	98
5852430	82156	PYRAMID	4592	250		365186	5355289	WACKER	2.5 Y	Om		Sss	Sand	CHL		LGW	White quartzite ?Moina-not sugary	5852430	-0.5	6.07	-5	437	0.07	19	2.67	2.01	1.06	194	25	110
5852431	82156	PYRAMID	4592	225		365163	5355278	WACKER	4.4 Y	Ogk		Ssh	Clay			RO	Red/purple fragments ferruginous shales	5852431	-0.5	6.87	24	396	0.07	32	4.32	3.37	0.62	218	277	333
5852432	82156	PYRAMID	4592	200		365141	5355267	WACKER	3.5 Y	Om		Ssh	Clay	SE		LGW	Buff/white sordicite shale	5852432	-0.5	6.29	-5	723	0.07	13	3.18	3.08	0.82	129	30	140
5852433	82156	PYRAMID	4592	175		365118	5355256	WACKER	2.3 N	Oha		Cq	Sand	BI/CHL		DGLG	?Siliceous quartzite ??Bedrock	5852433	-0.5	7.89	-5	583	0.48	24	3.48	2.19	1.57	303	34	107
5852434	82156	PYRAMID	4592	150		365096	5355245	WACKER	3.1 N	Om		Ssh	Sandy clay	CHL		DGGLG	Bedrock? Sandstone fine grained and silty/shale	5852434	-0.5	7.99	-5	562	0.31	17	3.65	2.79	1.45	230	38	181
5852435	82156	PYRAMID	4592	125		365073	5355234	WACKER	2.6 Y	Oha		Cq	Sandy clay	LI		LGOW	Ferruginous gravels	5852435	-0.5	7.71	-5	525	-0.05	9	3.08	3.04	0.5	41	23	83
5852436	82156	PYRAMID	4592	100		365051	5355223	WACKER	2.2 Y	Oha		Cq	Sandy clay	LI		LGOW	Possible ferruginous gravels and shales	5852436	-0.5	6.76	5	430	-0.05	19	4.14	2.32	0.92	175	53	130
5852437	82156	PYRAMID	4592	75		365028	5355212	WACKER	3.4 Y	Oo		Sss	Sandy clay	LI/FSP		BORW	Ferruginous Owen conglomerate	5852437	-0.5	6.94	150	360	-0.05	120	12.5	2.77	0.44	2000	813	1250
5852438	82156	PYRAMID	4592	50		365006	5355201	WACKER	3.1 Y	Oo		Sss	Sandy clay	LI/FSP		BORW	As above -red shale fragments	5852438	-0.5	8.78	46	397	0.05	54	6.58	4.1	0.71	518	280	700
5852439	82156	PYRAMID	4592	1150		365387	5356450	WACKER	1.4 Y	Om?		Sss	Sand			OG	Slight pink hue to sugary sandstone	5852439	-0.5	2.13	-5	108	-0.05	-5	0.27	0.81	0.13	12	-10	6
5852444	82156	PYRAMID	4592	1125		365370	5356431	WACKER	1.3 N	Ogul?		Sss	Sand			DGG	Bedrock?? Possible dolomite	5852444	-0.5	1.33	62	108	2.07	-5	36.3	0.6	0.17	10700	220	2490
5852445	82156	PYRAMID	4592	1100		365354	5356412	WACKER	3 Y	Ogul?		Sls	Sand			LG	Possible mica	5852445	0.8	2.2	-5	100	31.9	8	1.7	1.11	0.7	385	21	48
5852446	82156	PYRAMID	4592	1075		365337	5356394	WACKER	1.5 Y	Ogul		Sls	Sand			LG	Possible mica	5852446	-0.5	0.43	-5	29	18.8	-5	0.75	0.2	0.46	183	13	75
5852447	82156	PYRAMID	4592	1050		365321	5356375	WACKER	4.7 Y	Ogdc		Coy	Clay			N	Non calcareous black clay	5852447	-0.5	6.22	14	238	1.28	30	3.65	2.87	0.52	86	498	3890
5852448	82156	PYRAMID	4592	1025		365304	5356356	WACKER	3.1 N	Om		Sss	Sand			KWLB	Poss. Moina/Owen ss??Bedrock	5852448	-0.5	2.6	-5	278	0.07	-5	0.4	1.13	0.16	22	-10	24
5852449	82156	PYRAMID	4592	1000		365288	5356338	WACKER	11.4 Y	Ogdl		Sdt	Sandy clay			G	Fine calcarenite/dolomite	5852449	-0.5	2.14	-5	76	21.8	5	1.83	1.04	6.82	286	150	50
5852450	82156	PYRAMID	4592	975		365271	5356319	WACKER	3.2 N	Om		Sss	Sand			LGWK	?Moina ss??Bedrock	5852450	-0.5	2.58	-5	221	0.1	-5	0.38	1.09	0.16	16	12	12
5852451	82156	PYRAMID	4592	950		365255	5356300	WACKER	8.7 Y	Ogul		Sdt	Sand			G	Gray calcarenite/dolomite	5852451	-0.5	3.37	-5	143	15.8	-5	2.47	1.61	5.16	312	47	155
5852452	82156	PYRAMID	4592	925		365238	5356281	WACKER	9.8 Y	Ogul		Sls	Sandy clay			G	Gray calcarenite	5852452	-0.5	2.33	-5	108	25.8	-5	1.89	1.13	3.35	268	43	123
5852453	82156	PYRAMID	4592	900		365221	5356263	WACKER	1.8 Y	Ogul		Sdt	Sandy clay			GO	Ferruginous clay overlying limestone	5852453	-0.5	2.79	-5	127	27.8	-5	1.82	1.26	0.7	172	49	118
5852454	82156	PYRAMID	4592	875		365205	5356244	WACKER	12.6 Y	Ogul		Sls	Sand			G	Argillaceous limestone/calcarenite	5852454	-0.5	1.45	-5	71	31.5	-5	1.15	0.72	1.66	279	12	30
5852455	82156	PYRAMID	4592	850		365188	5356225	WACKER	2.5 N	Om		Sss	Sand			W	White medium ss1 with chlorite and white mica (?Bedrock)	5852455	-0.5	5.13	-5	308	0.19	17	1.77	1.68	0.55	58	83	72
5852456	82156	PYRAMID	4592	825		365172	5356207	WACKER	4.4 Y	Ogul		Sls	Sand			G	Medium fine grained calcarenite	5852456	-0.5	1.19	-5	56	26.8	-5	1.06	0.57	2.3	130	17	149
5852457	82156	PYRAMID	4592	800		365155	5356188	WACKER	14.5 Y	Ogul		Sls	Sandy clay			G	?Bedrock Non calcareous (light green section)	5852457	-0.5	3.92	12	213	8.17	16	2.17	1.48	1.35	99	111	393
5852458	82156	PYRAMID	4592	775		365139	5356169	WACKER	3.2 N	Oha		Cs	Sand			OG	?sandy? dolomite? non-calcareous	5852458	-0.5	2.61	18	138	0.14	12	1.11	1.23	0.27	20	197	201
5852459	82156	PYRAMID	4592	750		365122	5356150	WACKER	4.5 N	Oha		Cs	Sandy clay			WLG	Crutty fragments	5852459	-0.5	1	-5	83	9.7	-5	0.46	0.44	0.29	66	-10	34
5852460	82156	PYRAMID	4592	725		365106	5356132	WACKER	3.4 Y	Ogul		Sls	Sand			LGG	Fine grained calcarenite	5852460	-0.5	1.5	-5	73	28.9	-5	2	0.78	1.73	442	36	132
5852461	82156	PYRAMID	4592	700		365089	5356113	WACKER	1.5 Y	Ogul		Sls	Sandy clay			LGGB	Mixed limestone and overlying brown sand	5852461	-0.5	3.47	-5	158	11.4	-5	0.55	1.77	0.6	53	191	152
5852462	82156	PYRAMID	4592	675		365073	5356094	WACKER	5.7 Y	Ogul		Sdt	Sand			G	Fine grained calcarenite/dolomitic	5852462	-0.5	3.10	-5	148	17.3	-5	1.43	1.58	4.83	254	248	1620
5852463	82156	PYRAMID	4592	650		365058	5356075	WACKER	4.2 Y	Ogul		Sls	Sand			G	Mixed limestone and overlying brown siltstone	5852463	0.8	1.97	-5	99	23.9	-5	1.27	0.96	0.94	288	346	870
5852464	82156	PYRAMID	4592	625		365039	5356057	WACKER	2.8 Y	Ogul		Sls	Sand			LGG	Fine grained calcarenite/dolomitic	5852464	-0.5	2.21	-5	102	16.8	-5	1.05	1.11	0.95	314	41	95
5852465	82156	PYRAMID	4592	600		365023	5356038	WACKER	2 Y	Ogul		Sls	Sandy clay			LGW	Mixed limestone and non calcareous shales	5852465	-0.5	3.72	-5	148	18.0	-5	0.74	1.89	0.82	83	18	35
5852466	82156	PYRAMID	4592	575		365006	5356019	WACKER	7.2 Y	Ogk		Ssh	Sandy clay			LGWO	Shaley non calcareous (sordicite)	5852466	-0.5	7.73	-5	292	0.17	25	1.52	3.02	0.77	51	74	105
5852467	82156	PYRAMID	4592	550		364990	5356001	WACKER	4.5 Y	Ogul		Sdt	Sand			GLG	Fine grained calcarenite/dolomitic	5852467	-0.5	2.13	-5	102	11.7	-5	0.77	1.09	4.06	111	56	218

Appendix XII

Mariposa - Wacker Bedrock Sampling: Geology and Assay Results

Sampno	OPO	Prospect	EL	LocalE	LocalN	AMGE	AMGN	SampType	Depth	Bedrock?	MRTLith	FieldID	Texture	Al/Min	Colour	Comments	82153	Ag	Al	As	Ba	Ca	Cu	Fa	K	Mg	Mn	Pb	Zn
5852417	82155	MARIPOSA	4592	67185	59410	367308	5359452	WACKER	3.2	Y	Sc	Sss	Sand		WO	Possible dolomite	5852417	-0.5	1.77	-5	172	0.06	5	0.42	0.75	0.08	10	27	-5
5852418	82155	MARIPOSA	4592	67160	59410	367284	5359443	WACKER	3	Y	Sc	Sss	Sand		W	White sand	5852418	-0.5	0.08	-5	10	-0.05	8	0.18	-0.05	-0.01	11	10	-5
5852419	82155	MARIPOSA	4592	67135	59410	367261	5359435	WACKER	3.3	N	Sc	Sss	Sand		WOR	Mixed sand ??bedrock poss. dolomite	5852419	-0.5	1.3	-5	59	-0.05	-5	0.45	0.51	0.06	-10	-10	15
5852420	82155	MARIPOSA	4592	67110	59410	367237	5359427	WACKER	2.4	Y	Sc	Sss	Sandy clay		WO	Ferruginous sand	5852420	-0.5	6.21	-5	305	-0.05	-5	1.35	2.48	0.3	17	21	14
5852421	82155	MARIPOSA	4592	67085	59410	367213	5359419	WACKER	1.1	Y	Sc	Sss	Sand		WLG	Sugary sandstone	5852421	-0.5	0.07	-5	16	-0.05	5	0.17	-0.06	-0.01	12	10	-5
5852422	82155	MARIPOSA	4592	67060	59410	367190	5359411	WACKER	0.8	Y	Sc	Sss	Sand		WLG	Sugary sandstone	5852422	-0.5	0.11	-5	14	-0.05	7	0.18	-0.05	-0.01	11	-10	5

Appendix XIII

Detailed Helimag Data

CRA EXPLORATION PTY. LIMITED
ACN 000 057 125

**Preliminary Notes and Observations of the
Helicopter-borne Magnetic Survey
Zeehan, Tasmania**

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J Tesselaar

Date: July 1996

Submitted to: Chief Geologist, Vic/Tas

Copies to: Mineral Resources Tasmania
CRAE - SE District
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Appendix I Flight Line Maps

1. Introduction

Drillcore from the Gordon Limestone of the Zeehan area shows zinc mineralisation being related to weakly magnetic siderite alteration. This alteration predominantly occurs at the base of the Limestone just above its contact with the underlying Moina Sandstone. Siderite alteration can occur at the limestone's upper contact with the overlying Crotty Quartzite eg at Blackjacks and Myrtle whilst intense alteration is also associated with limestones in the middle of the Gordon Limestone eg the Oceana Mine and the Grieves South area. The magnetic response of the siderite is weak, in the range of 50-200 x 10⁻⁵ SI, but is deemed detectable by an airborne magnetic survey. Forward modelling indicated that the siderite would give weak aeromagnetic anomalies (1-5nT). Thus a helimag survey was commissioned to fly over all the Gordon limestone outcrops of the Zeehan under licence to CRAE.

The aim of the survey was to identify mineral-related siderite zones for follow-up diamond drilltesting. The target is a stratabound zinc/lead orebody hosted by the Ordovician Gordon Limestone with analogies to Irish-type Zn/Pb orebodies.

A separate survey was flown over the Gordon Limestone of McLean Creek. This area is known to have a large magnetic anomaly - attributed to a magnetite skarn - known as the Avebury target. In addition the nickel target areas at Melba Flats were also flown.

This report provides technical details of the survey and processing as well as some geological interpretations of the results. Locations of the prospects are shown in plan Tv1022.

The survey was flown in March 1995 by Universal Tracking Systems Pty. Ltd. with initial results received in December 1995. Data processing and some interpretation was undertaken by Tony Doe and John Tesselaar (CRAE - Orange).

Sub-divisions of the Gordon Limestone for drillhole logging purposes have been made on a lithostratigraphic and lithologic basis and is included elsewhere in this report.

2. Flight Survey and Data Processing Details

The flight line height was a nominal 30m with the line spacing approximately 60m with readings taken every 4-5m. A total of 2400 line km was completed covering the following prospects :- Sassafra, Blackjacks-Mariposa-Sunny Corner-Pyramid, Professor Range-Amber Creek-King Billy-Leatherwood, Myrtle-Grieves-Baura-Firewood Siding-Rose Valley. New areas between Leatherwood and Mariposa were also investigated and this included the Westerway and Tom Creek areas. Flight line maps are shown in Appendix I.

The data from the helimag survey was obtained as an XYZ file of easting, northing and total magnetic intensity. No terrain clearance data was provided with the original XYZ file.

Over each area of Gordon Limestone to be interpreted, a small (<3km²) data subset was selected. These areas were designed to include all of the Gordon Limestone but as little as possible of the surrounding rocks, particularly the Dundas Group which tended to 'swamp' the more subtle magnetic data variations of the limestone. This data was then imaged.

The vertical derivative of the magnetic data was produced along the flight line using TRAKPAK. This data was then imaged with the previously existing geology data superimposed. Some of the small linear anomalies coincided with mapped siderite. Other lithological units were also mapped eg the Moina Sandstone and the Crotty Quartzite.

Where applicable, magnetic inversion using MAGMOD was undertaken over the siderite-like anomalies. In most cases, anomalies over 1nT were able to be successfully inverted. These models should only be used as a guide as to the geometry of the source of the anomalies. This is due to :-

- There is no account of terrain clearance;
- The anomalies have small amplitudes;
- Not all lines were perpendicular to strike;
- The problem of "non-uniqueness" in magnetic inversion.

3. Magnetic Interpretations

Initial raster images failed to highlight major zones of inferred siderite alteration (plan Tv1026). Removal of regional gradients and the selective use of sub-area vertical derivative data greatly improved the resolution (plan Tv 1027). From the modelling it was impossible to distinguish between siderite zones and other stratabound weakly magnetic units.

As a result of this work a much better understanding was gained of the geology of the Ordovician-Silurian sequence in the Zeehan area.

The Gordon Limestone is relatively more magnetic than the surrounding clastic sequences whilst the Siltstone Unit of the limestone is less magnetic than the limestone. The high magnetic susceptibility of the surrounding Cambrian Dundas Group of sediments, volcanoclastics and basic intrusions caused imaging problems. Major units which appeared as magnetic highs included the Upper Dolomite Unit of the Gordon Limestone (possibly other dolomitic zones are relatively magnetic but lack of geochemical surface control could not confirm them) and the Amber Slate of the Silurian clastic sequence. Major structures are difficult to identify and follow. Interpreted linears deemed to represent faults show a lack of continuity eg the Firewood Siding Fault and the Little Henty Fault.

The Blackjacks-Mariposa-Sunny Corner-Pyramid area has reduced magnetic relief relative to other areas. This may be due to the swamping effect in the imaging of the high amplitude Cambrian sediments and the Silurian Amber Slate unit.

Comments on the interpretation of these sub-areas are :-

3.1 Blackjacks (plan Tv 1134)

- Two main zones of siderite alteration, recognised from drillcore and wacker sampling, have a weak magnetic signature :-
 - Immediately south of the proposed conformable contact between the Gordon Limestone and the Moina Sandstone as seen in DD95DB110 and DD96DB112 - strike length of 600m (centred on 366950mE, 5360650mN). This anomaly is the longest siderite related one in the Blackjacks-Mariposa-Sunny Corner area.
 - At and around the lower sandstone/limestone contact as seen in DD95DB111 - 366530mE, 5361500mN. A downhole magnetic profile of DD95DB111 is included; sampling intervals are every 1m (plan Tv 1135) and every 10cm (plan Tv 1136).
- Between these two anomalies lies a small but more intense anomaly at the junction between siderite and dolomite zones at the lower contact (366450mE, 5361200mN).
- Modelling of the anomalies indicates that the siderite bodies dip to the west implying that the alteration is stratabound. Other potential siderite zones are too small to model.
- There appears to be an anomaly associated with the siderite at the Upper Contact - visible in DD95DB110 (366520mE, 5360800mN).
- West of the upper contact of the Gordon Limestone, within the Crotty Quartzite, lies significant linear magnetic anomalies. These anomalies should be checked in field eg. 366000mE, 53661200mN.

3.2 Mariposa (plan Tv 1137)

- The limestone of this area is magnetically bland.
- The main magnetic anomalies appear to lie in Moina Sandstone/Dundas Group sediments just east of the lower limestone contact and apparently show the inferred siderite alteration dipping to the west. However caution needs to be exercised as the magnetic amplitudes are so low that the modelled body could be dipping to the east eg. 367750mE, 5359100mN.
- Major linear magnetic anomalies lie further to the east within the Dundas Group.
- Additional linear anomalies with siderite-like amplitudes occur in the Crotty Quartzite in the west of the area (367100mE, 5359300mN).
- The main anomaly within the limestone lines up with the siderite horizon identified by the North Broken Hill and Amoco drilling (367350mE, 5359000mN).

3.3 Sunny Corner (plan Tv 1138)

- There are a few weak magnetic anomalies in the area.
- The strongest anomaly occurs in the NW of the area and is associated with siderite and dolomite seen in aircore drilling and DD95DS98. The anomaly appears to be loosely stratabound (365800mE, 5357900mN).
- A second anomaly coincides with the siderite and ferroan dolomite intersected in DD95DS97. The siderite alteration effect increases down dip and is offset to the south by a major cross cutting E-W fault. South of the fault the anomaly has 200m of strike length and is co-incident with mapped siderite alteration (bedrock wacker sampling). The anomaly continues northwards extending beyond and underneath the overthrust Devonian Bell Shale (3666550mE, 5357650mN).
- A third anomaly, possibly siderite, occurs stratigraphically one third down the Gordon Limestone sequence above the inferred position for the Siltstone Unit. This anomaly may relate to the 30m enhanced zinc unit in DD96DS100 (366300mE, 5357050mN).
- There is no evidence of siderite alteration at surface up dip from the 100m thick unit intersected in DD96DS101.

3.4 King Billy (plan Tv 1140)

- The southern margin of the Gordon Limestone is marked out as a major anomalous zone. In part, the anomalous horizon is coincident with the Dark Clay and Siderite Units at the base of the Gordon Limestone which have elevated zinc values. However, it is possible that the limestone is flat dipping with underlying unconformable Cambrian sediments (?volcaniclastics locally) close to the surface and thus causing an anomaly 'over-shoot' into the Gordon Limestone outcrop (370000mE, 5351500mN).
- The southern margin anomaly is one order of magnitude greater than those anomalies which have been used for other potential siderite modelling.
- There is a large magnetically elevated zone at the west end of the prospect which is associated with an inferred cross fault, siderite and particularly dolomite alteration. There is a facies thickness variation implying that this cross fault may be a re-activated syn-sedimentary fault (369450mE, 5352000mN).
- A very high amplitude N-S striking linear magnetic anomaly lies Southwest of the Gordon Limestone (2 orders of magnitude greater than any limestone anomaly). This N-S anomaly is hosted by Cambrian sediments. An initial field inspection suggests that the cause is a mafic breccia unit similar to the breccias seen at Tennant Creek in the Northern Territory (368350mE, 5350800mN).

3.5 Tom Creek and Farrell (plans Tv 1145 and 1146)

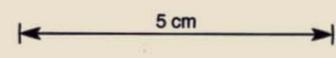
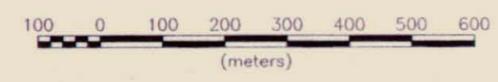
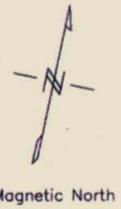
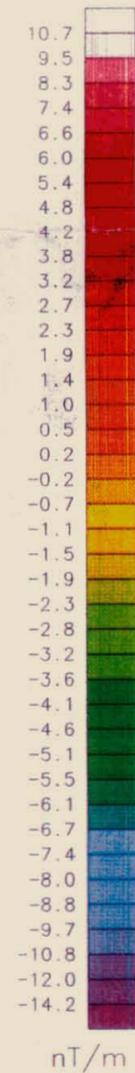
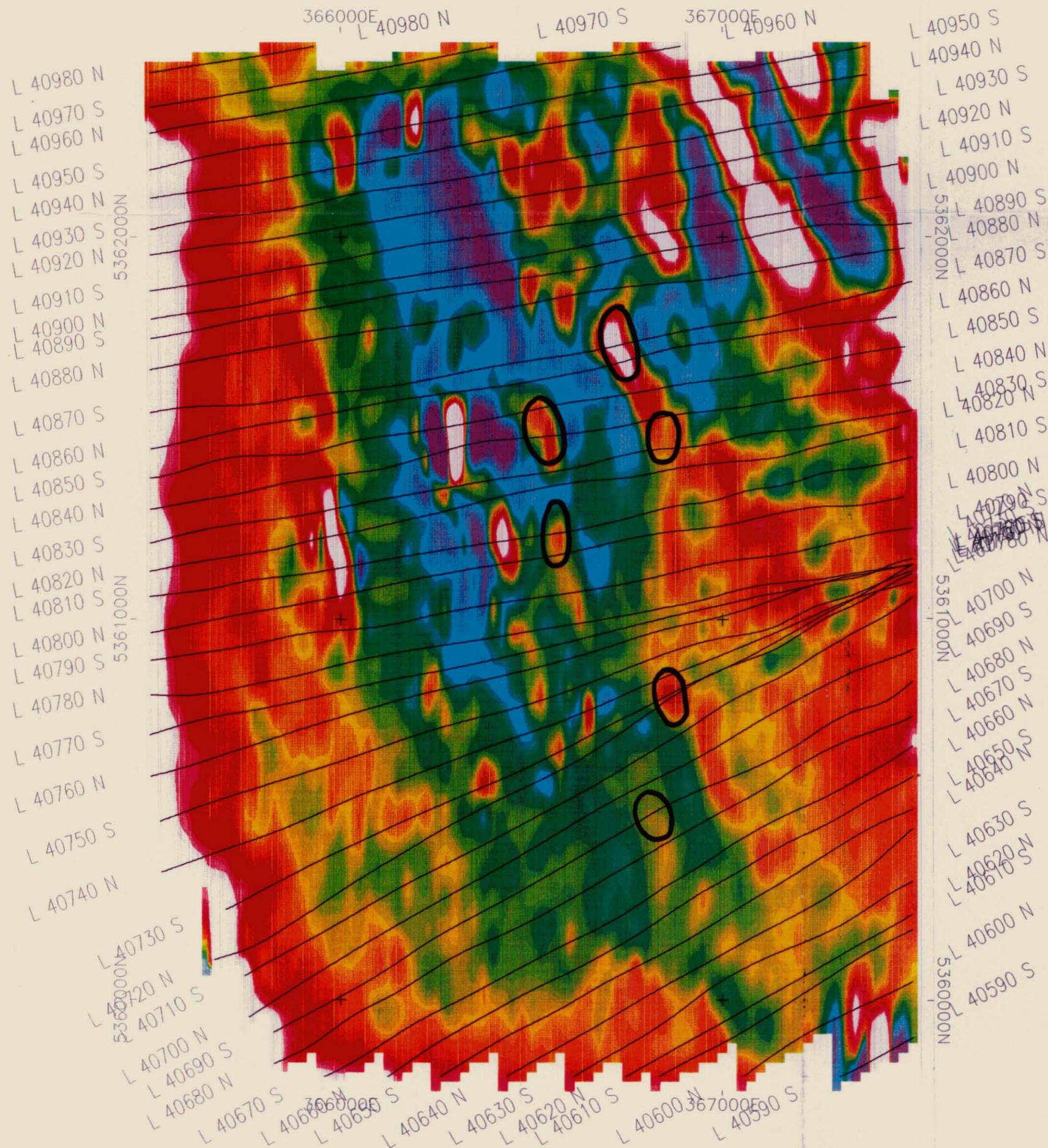
- This is a very complex area magnetically.
- A large, relatively intense magnetic zone exists in the Northwest of the area and includes the mafic sub-unit that bounds the west margin of the limestone at Westerway further north (Dundas? Group).
- The Balstrup Fault is thought to be recognisable but about 1km further south than currently mapped.
- Limestone and non-limestone areas from the wacker bedrock sampling cannot at present be reconciled with the magnetic data.

4. General Geological Interpretation Summary

- The Amber Slate is a non-calcareous slate of Silurian age which is recognised in the dataset as a magnetic high.
- The Crotty Quartzite appears on the vertical derivative map as a magnetic low.
- The Gordon Limestone appears as a magnetic high except for the non-calcareous, argillaceous Siltstone Unit eg King Billy, Amber Creek, Grieves, Myrtle, Baura and Firewood Siding. The Siltstone Unit is not apparent in the magnetic data at Blackjacks, Mariposa, Sunny Corner Tom Creek and Pyramid.
- The Moina Sandstone is a magnetic low near the overlying Gordon Limestone. At Grieves this low unit is 200-300m thick before passing down sequence into a magnetic high. This high unit may be part of the Owen Conglomerate.
- The Owen Conglomerate is generally a magnetic high eg Professor Range and Pyramid.
- Major, brittle faults are not readily identifiable, often disappearing along strike eg the Balstrup Fault in the Pyramid and Tom Creek areas.
- Parts of the Gordon Limestone display more continuously intense magnetic zones eg at Grieves and Firewood Siding South. This may be a reflection on mineral fluids having altered the limestone particularly via dolomitisation. Alternatively these highs may be a reflection of powerful surface weathering producing surficial de-calcified clays. It is possible to say that the rotting of variably composed limestone may give rise to differential surface effects that have different magnetic susceptibilities.
- The diamond drilling identified siderite zones at Blackjacks, Mariposa and Grieves can be seen in the magnetic data. However numerous anomalies of a similar intensity occur elsewhere, generally in areas of the Gordon Limestone considered as non-prospective.

- There are several targets in the magnetic data that lie at the base of the Gordon Limestone which require drill testing.

Simon Tear
John Tesselaar

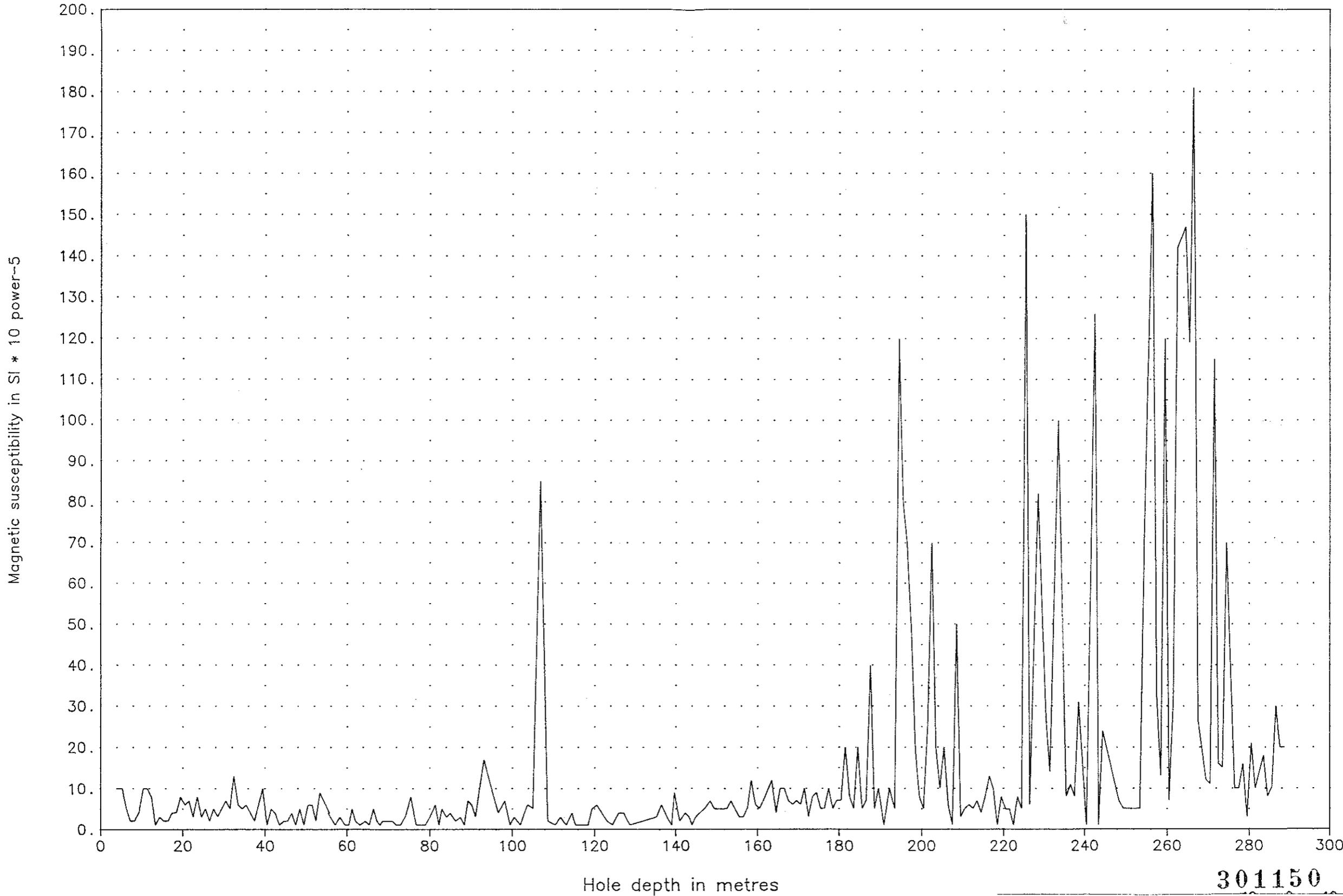


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CRA EXPLORATION PTY. LIMITED	
Zeehan Helimag Survey	
EL45/92 Mt. Dundas - Blackjacks Prospect	
Vertical Derivative Image, Flight Line Overlay & Modelled Anomalies	
Author: John Tesselaar	Reference: SK55-05
Drawn: John Tesselaar	File Name:
Date: July 1996	Report No: 22222
Scale: 1:10,000	Plan No: Tv1134



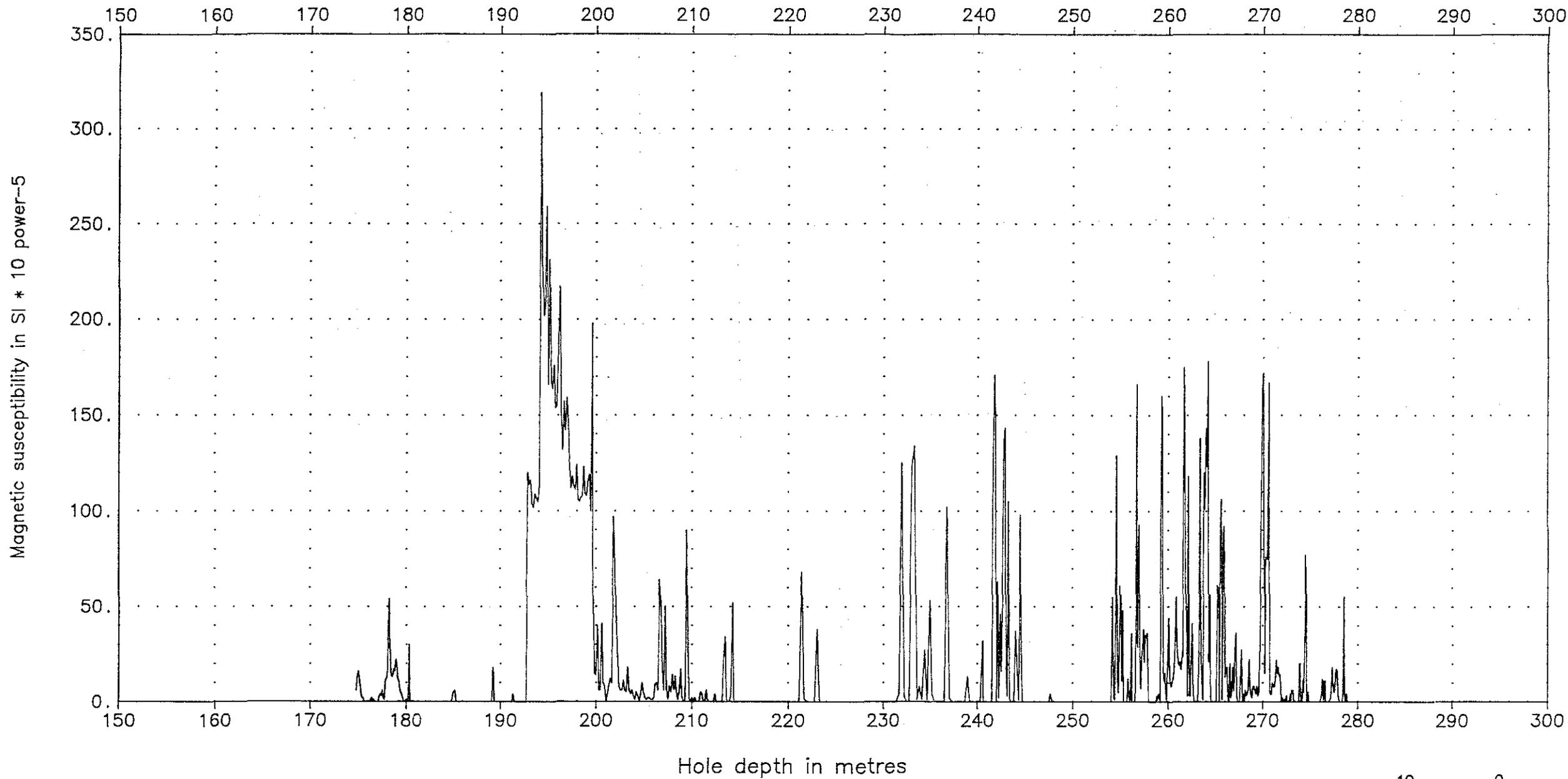
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CRA EXPLORATION PTY. LIMITED	
Zeehan Carbonate	
EL45/92 Mt. Dundas - Blackjacks Prospect	
DD95DB111 Magnetic Susceptibility	
Author: John Tesselaar	Reference: SK55-05
Drawn: John Tesselaar	File Name:
Date: July 1996	Report No: 22222
Scale: 1:1,000	Plan No: Tv1135

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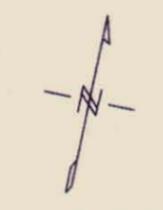
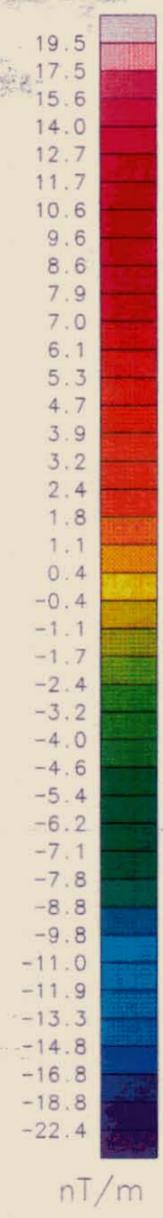
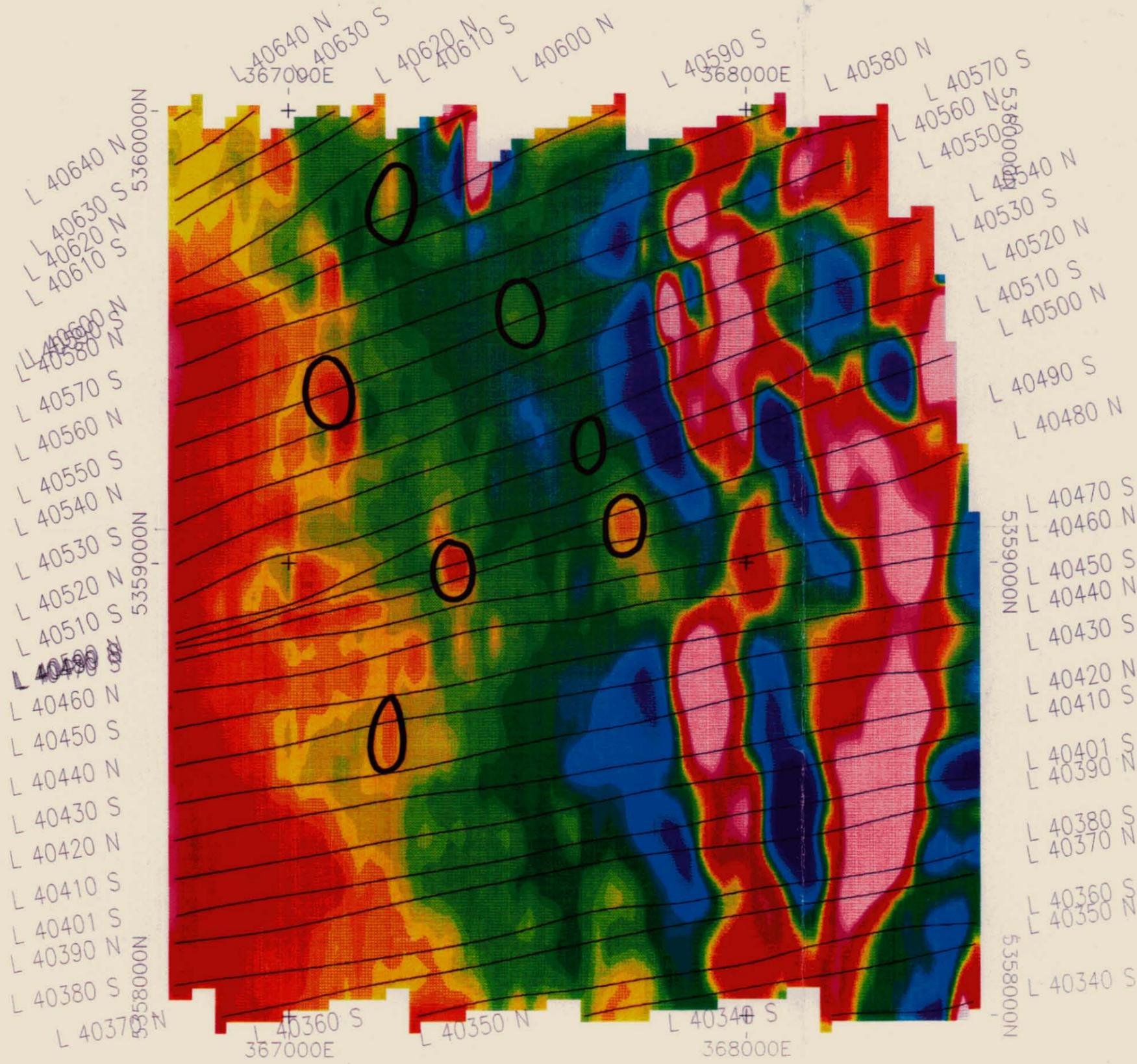
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CRA EXPLORATION PTY. LIMITED	
Zeehan Carbonate	
EL45/92 Mt. Dundas - Blackjacks Prospect	
DD95DB111 Magnetic Susceptibility (10cm reading interval)	
Author: John Tesselaar	Reference: SK55-05
Drawn: John Tesselaar	File Name:
Date: July 1996	Report No: 22222
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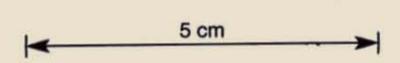


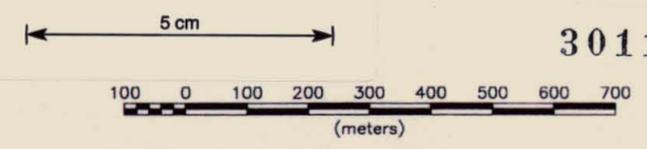
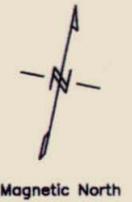
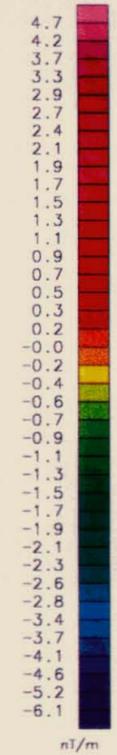
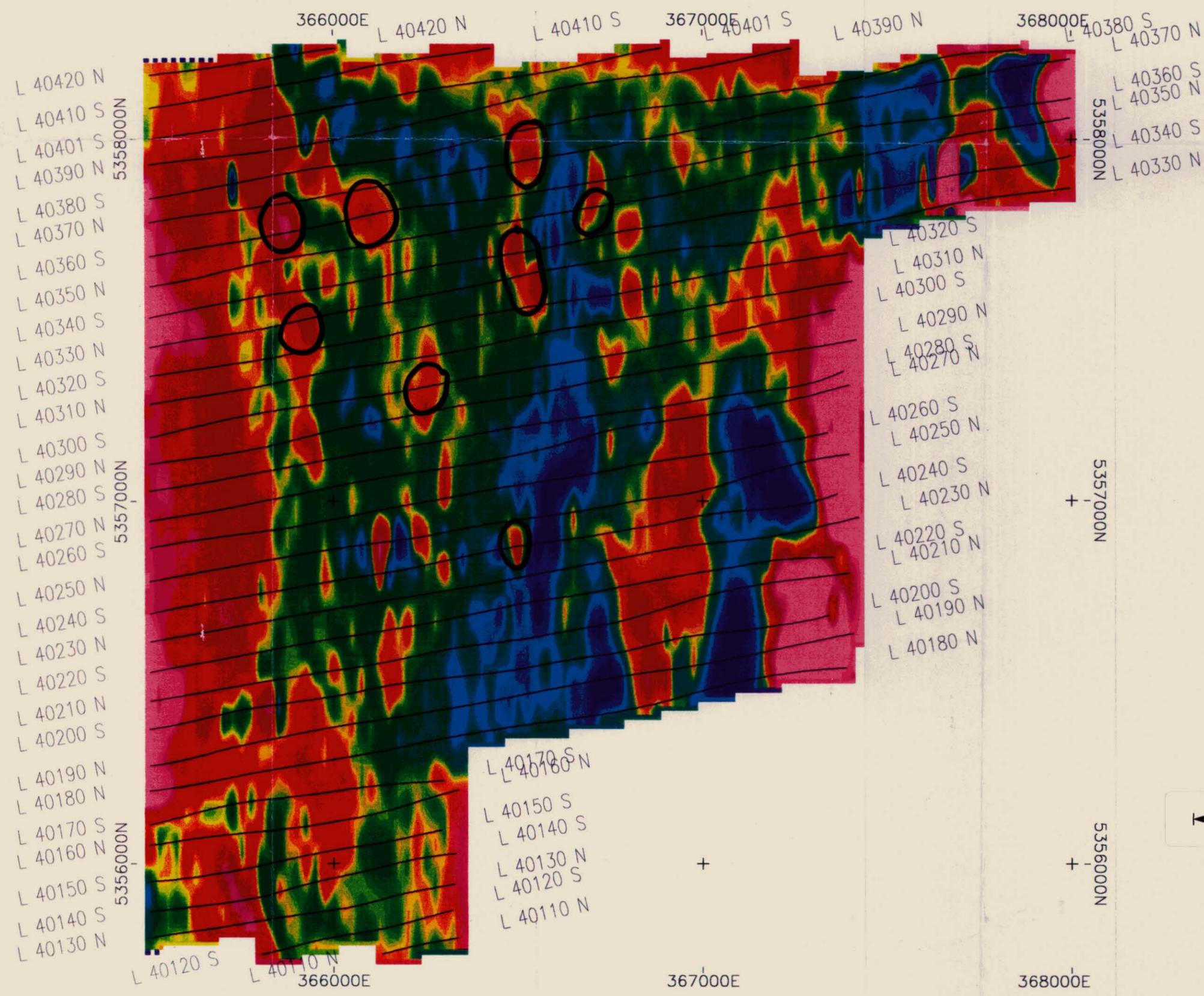
Magnetic North

301152



CRA EXPLORATION PTY. LIMITED	
Zeehan Helimag Survey 97-4009	
EL45/92 Mt. Dundas - Mariposa Prospect	
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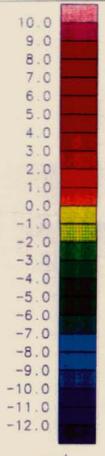
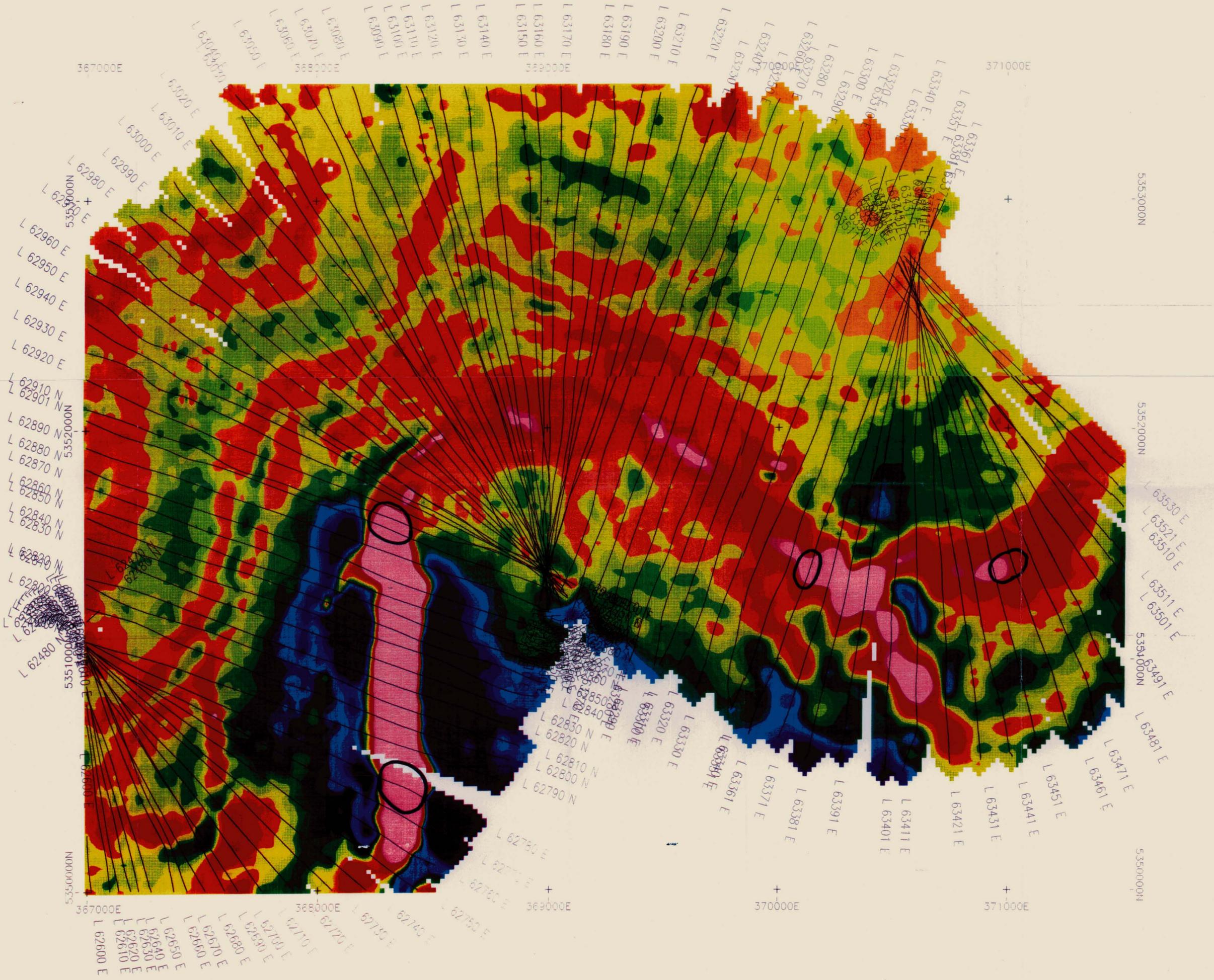


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CRA EXPLORATION PTY. LIMITED	
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EL45/92 Mt. Dundas - Sunny Corner Prospect	
Vertical Derivative Image, Flight Line Overlay & Modelled Anomalies	
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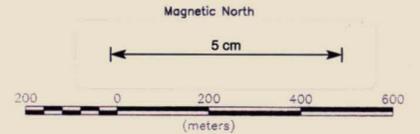
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EL34/88 Zeehan 2 & EL45/92 Mt. Dundas Amber Creek & King Billy Prospects	
Vertical Derivative Image, Flight Line Overlay & Modelled Anomalies	
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Drawn: John Tesselaar	File Name:
Date: July 1996	Report No: 22222
Scale: 1:10,000	Plan No: Tv1140

368000E

369000E

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L 50890 N
L 50880 N
L 50870 N
L 50860 N
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L 50841 N
L 50830 N
L 50820 N
L 50810 N

370000E
L 50800 N
L 50790 N
L 50780 N
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L 50760 N
L 50750 N
L 50740 N
L 50730 N
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L 50710 N

5357000N

L 50900 N
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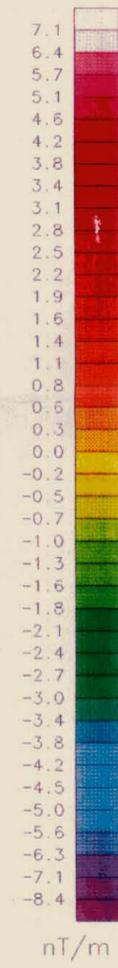
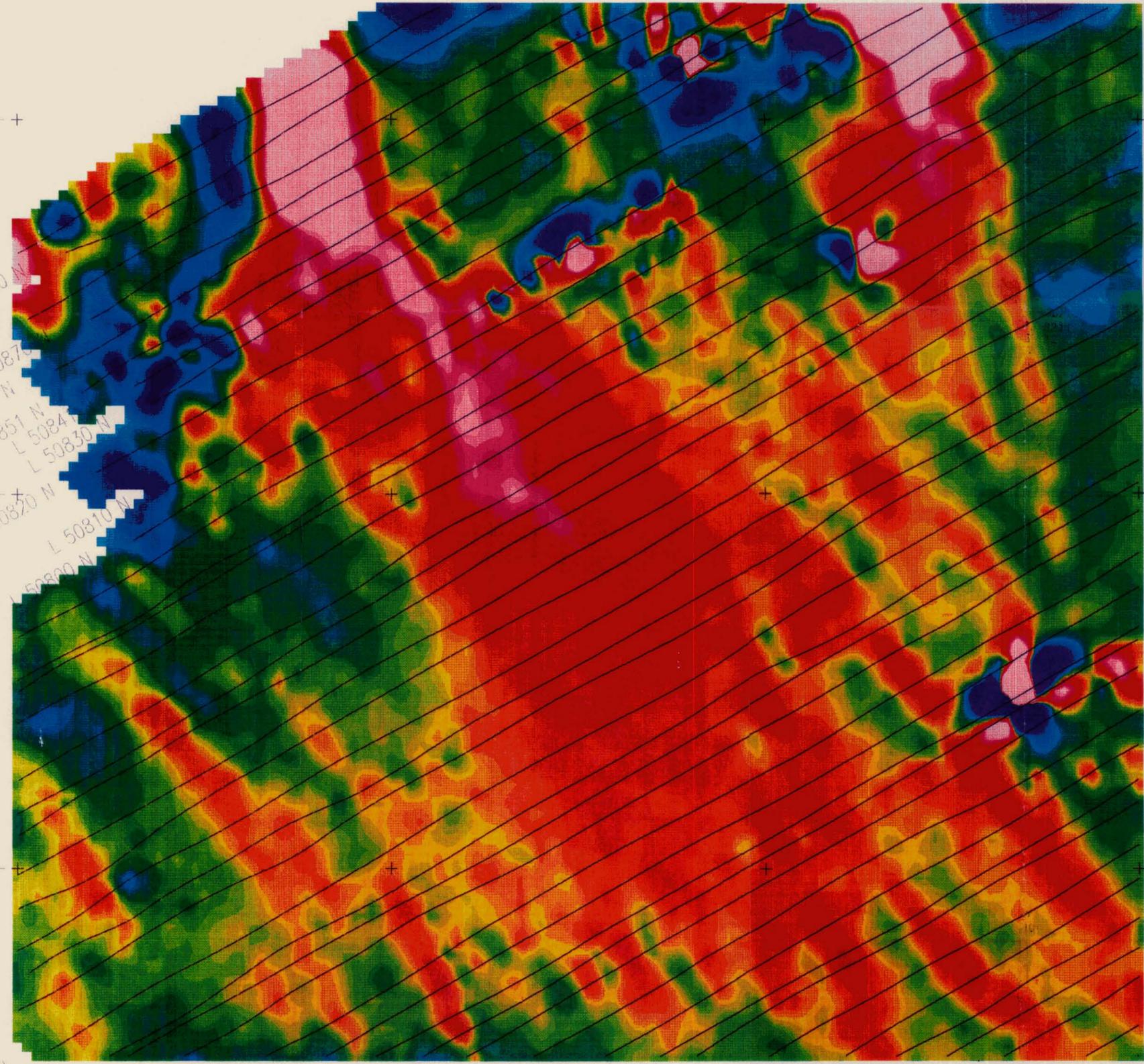
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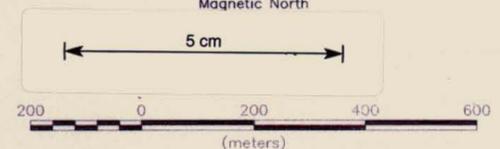
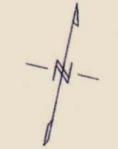
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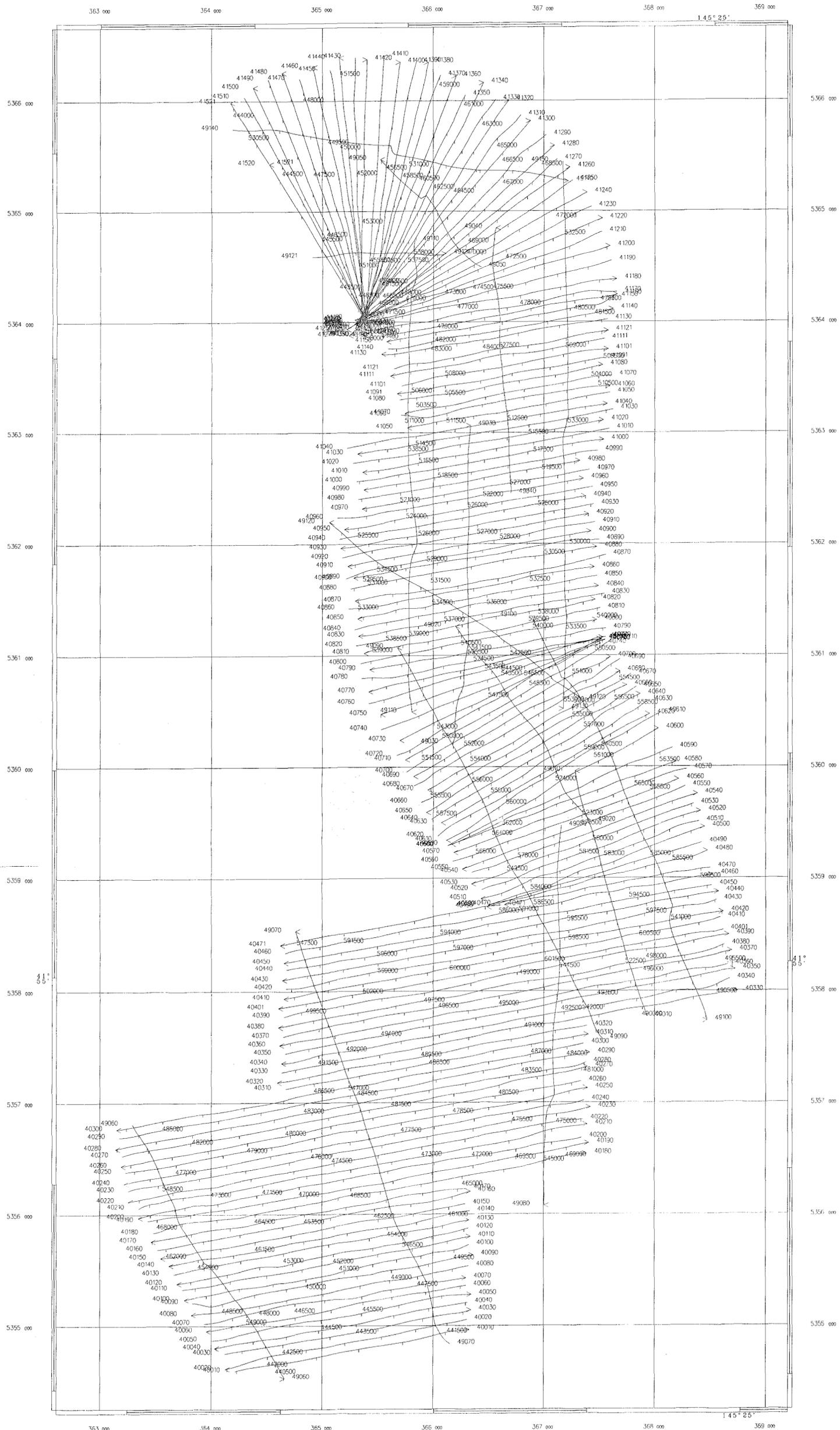
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CRA EXPLORATION PTY. LIMITED	
Zeehan Helimag Survey	
EL45/92 Mt. Dundas - Tom Creek Prospect	
Vertical Derivative Image & Flight Line Overlay	
Author: John Tesselaar	Reference: SK55-05
Drawn: John Tesselaar	File Name:
Date: July 1996	Report No: 22222
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Appendix I
Flight Line Maps



AIRBORNE SURVEY SPECIFICATIONS

Flight Line Direction:	CRA Digitised
Flight Line Separation:	CRA Digitised
Tie Line Direction:	CRA Digitised
Tie Line Separation:	CRA Digitised
Mean Terrain Clearance:	30 metres
Sample Interval:	3-4 metres
Navigation:	Differential GPS
Survey Flow:	March 1995

AIRBORNE SURVEY EQUIPMENT

Aircraft:	AS350B Helicopter
Magnetometer:	Geometrics G-833 Helium
Resolution:	0.001 nT
Sensitivity:	0.001 nT
Recording Interval:	10 Hz
Compensation:	RMS AADC II Compensator

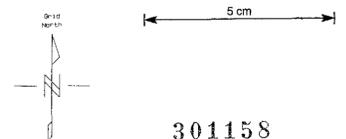
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Tie Line Levelling Applied:	
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3rd contour interval:	100nT
4th contour interval:	1000nT

PRELIMINARY
UTS GEOPHYSICS

97-4009

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UTS GEOPHYSICS PTY LTD

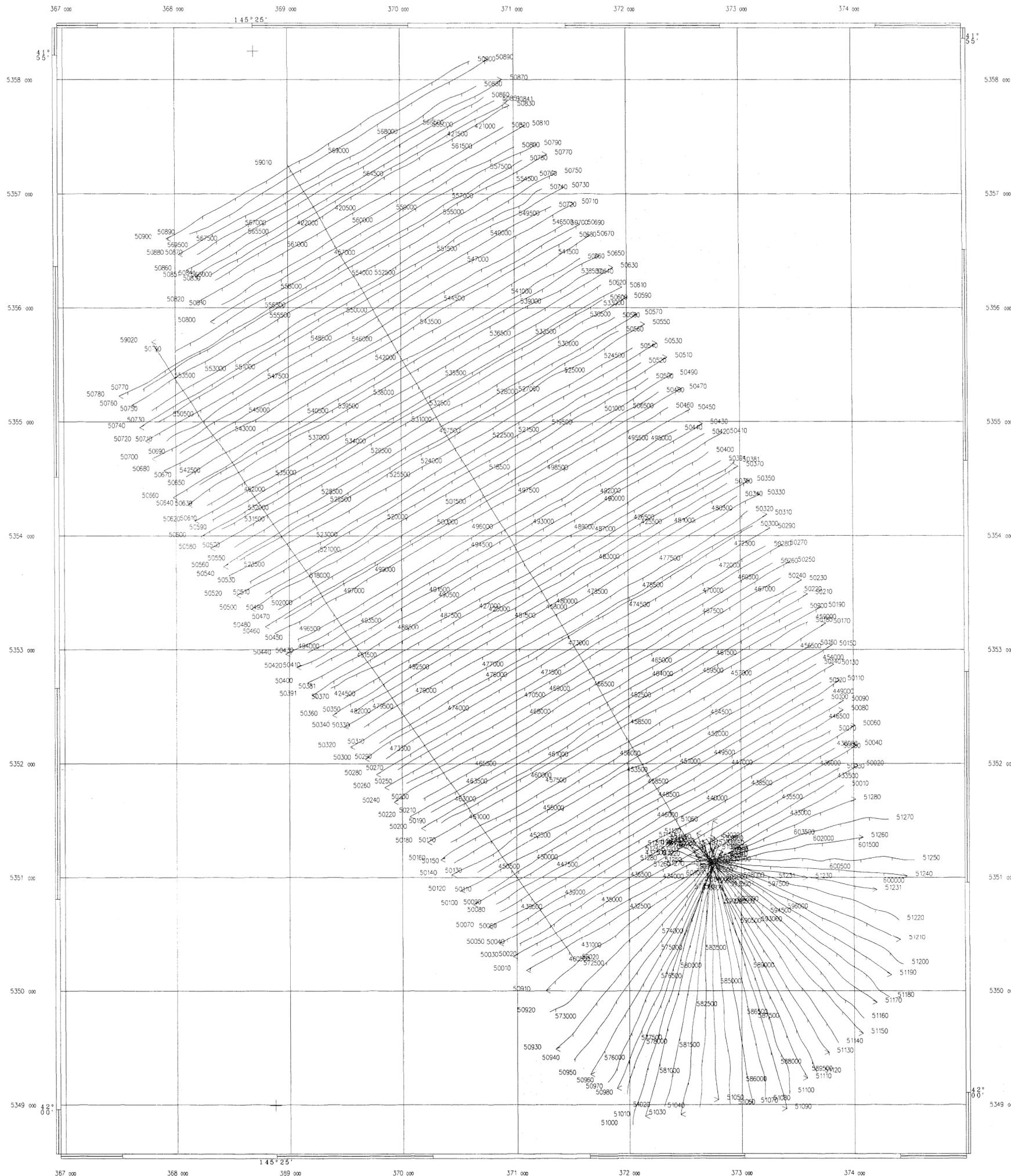
CRA EXPLORATION PTY LIMITED

AREA 4 - TASMANIA

DETAILED HELI-MAG SURVEY

FLIGHT PATH MAP

DRAWN: UTS GEOPHYSICS	SCALE: 1:20000
DATE: 15 MAY 1995	JOB: A067 - AREA 04



AIRBORNE SURVEY SPECIFICATIONS

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Tie Line Separation:	CRA Digitised
Mean Terrain Clearance:	30 metres
Sample Interval:	3-4 metres
Navigation:	Differential GPS
Survey Flown:	March 1995

AIRBORNE SURVEY EQUIPMENT

Acquisition:	UTS Geophysics
Aircraft:	AS350B Helicopter
Magnetometer:	Geometrics G-833 Helium
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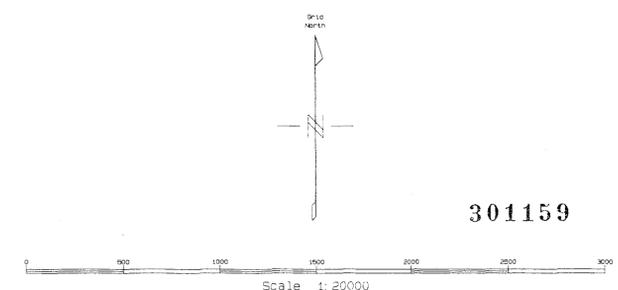
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Diurnal Corrections Applied
Tie Line Levelling Applied

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UTS Geophysics

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CRA EXPLORATION PTY LIMITED

AREA 5 - TASMANIA
DETAILED HELI-MAG SURVEY

FLIGHT PATH MAP

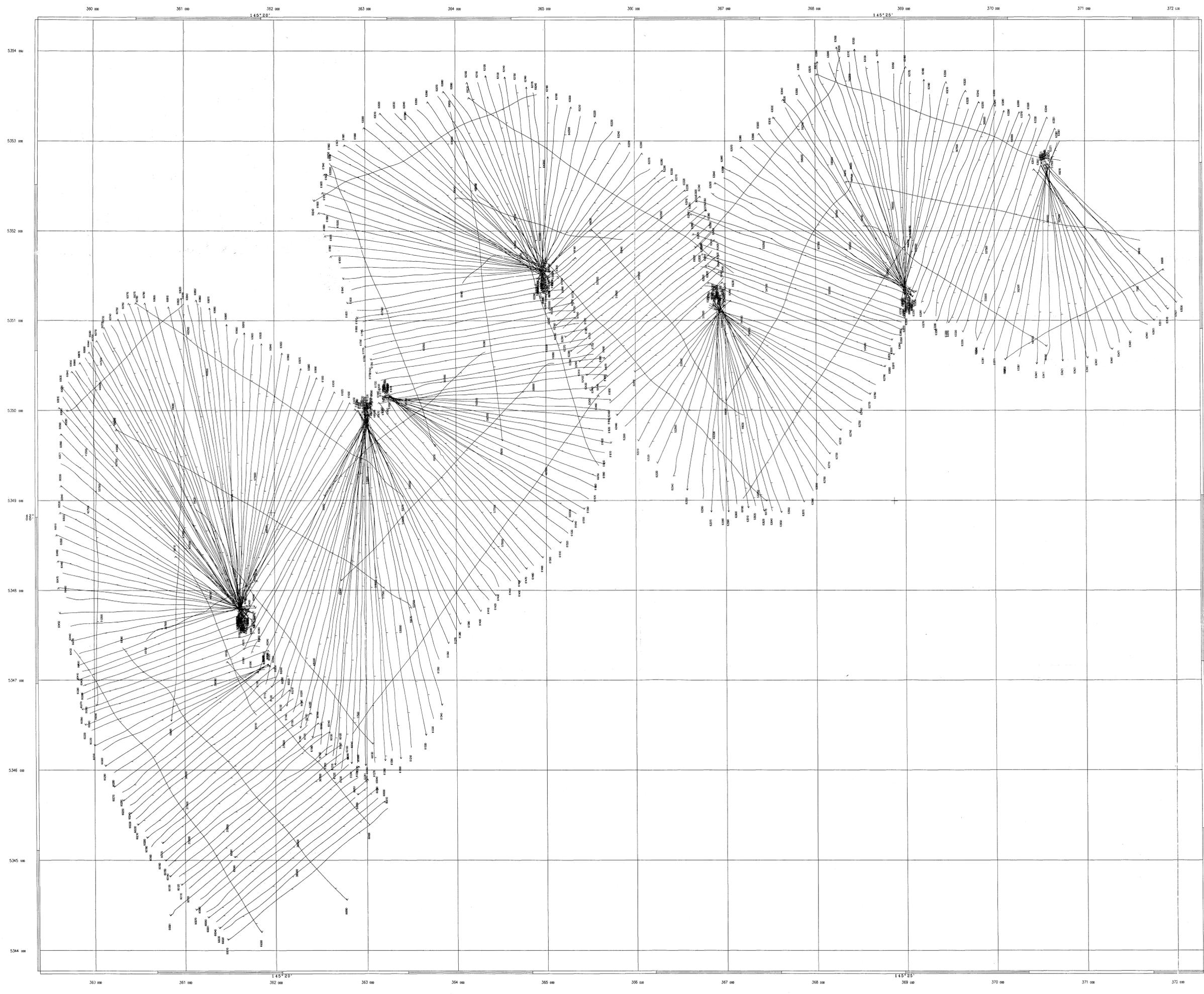
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DATE: 1 JUNE 1995

JOB: A067 - AREA 05

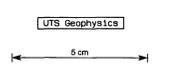
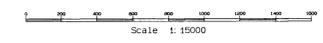
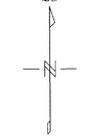


AIRBORNE SURVEY SPECIFICATIONS
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 Flight Line Separation: CRA Digitised
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 Mean Terrain Clearance: 30 metres
 Sample Interval: 3-4 metres
 Navigation: Differential GPS
 Survey Flow: March 1995

AIRBORNE SURVEY EQUIPMENT
 Acquisition: UTS Geophysics
 Aircraft: AS350B Helicopter
 Magnetometer: Geometrics G-633 Helium
 Resolution: 0.001 nT
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 Recording Interval: 10 Hz
 Compensation: RMS AADC II Compensator

PROCESSING DETAILS
 Diurnal Corrections Applied
 Tie Line Levelling Applied

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PROFESSOR

CRA EXPLORATION PTY LIMITED
 AREA 6 - TASMANIA
 DETAILED HELI-MAG SURVEY
 FLIGHT PATH MAP
 SHEET 1 OF 1

DRAWN: UTS GEOPHYSICS	SCALE: 1:15000
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Appendix XIV

Başın Analysis Report

ORDOVICIAN GORDON GROUP CARBONATES,
ZEEHAN REGION, TASMANIA, AUSTRALIA -
STRATIGRAPHY AND PALAEOENVIRONMENTS

CLIVE BURRETT,
GEOSEA CONSULTANTS,
22 HINMAN DRIVE,
KINGSTON, TASMANIA,
AUSTRALIA, 7050

Final Report 15-11-1995

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ABSTRACT

The Gordon Group in the Zeehan area comprises 3 conformable formations; the Ugbrook, Myrtle (new) and Black Jacks (new). The Ugbrook Fm, first defined in the Mole Creek area, was deposited in protected shallow subtidal to low intertidal waters in an offshore bar to lagoonal to lagoonal-island environment during the Early Caradoc.

The basal Ugbrook interdigitates with the siliciclastic Moina Fm and suggests that the Early Caradoc shoreline was at or very close to Black Jacks. A transgression shifted these environments northwards and eastwards during the Caradoc and Ashgill.

The tidal flat complex of the Myrtle Fm developed throughout the area in the mid-Caradoc and consists of fifteen 1m to 4m thick Punctuated Aggradational Cycles (PACs) which can be correlated throughout the area. The Myrtle Fm is similar lithologically, environmentally and chronostratigraphically to the Lower Limestone Member of the Florentine Valley.

The Myrtle Fm is succeeded by mainly shallow to moderately deep subtidal alternating micrites and shales with minor PACs, belonging to the Black Jacks Fm which is similar to the Upper Limestone Member of the Florentine Valley. The lack of PACs in the Upper Black Jacks and the very common occurrence of coarse carbonates in the Myrtle stratigraphic drillcore suggests that the Myrtle area might have been in a slightly deeper and more rapidly subsiding region. The Lords Member of the Black Jacks Fm is present in several of the drillcores and, as is normal elsewhere in the state, varies in thickness and lithology from mudstones to coarse sandstones. Minor PACs and some faunal horizons help in the correlation of the Black Jacks.

INTRODUCTION

At the request of CRA, 8 full days in October 1995 were spent logging core through Ordovician sedimentary sequences from drillholes in the Zeehan area. An extra four days were allocated to plotting, drafting, report preparation and the examination of thin sections and fossils. Logging concentrated on the Gordon Group carbonates but short sections of the underlying Denison Group (Moina Fm) and overlying Eldon Group (Crotty Fm) siliciclastics were also examined.

The Gordon Group carbonates are deformed and the extent of stratigraphic loss or repetition is difficult to establish from the numerous veined and crushed intervals. In any sedimentary basin analysis it would be desirable to plot isopachs in order to define the basin shape and its evolution through time. Unfortunately, depending on the relation of bedding to the principal axis of the strain ellipsoid, bedding thickness may be increased or decreased substantially. Tectostylolites, which are pervasive in the Zeehan cores, will decrease stratigraphic thickness. They preferentially affect more argillaceous sections and the amount of section loss will (as with cleavage) depend on their angle of incidence with bedding. This problem is soluble but not within the confines of this study. A full palinspastic study would also need to remove, in map view, the Devonian folding and the thrust faulting.

LITHOSTRATIGRAPHY

Several major lithostratigraphic units are recognisable in the Zeehan cores. The Gordon Group comprises the Ugbrook Fm, the Myrtle Fm (new name) and the Black Jacks Fm (new name). The Black Jacks Fm includes the Lords Siltstone Member (Fig.1). The positions and suggested correlations of these units are shown in Fig. 5 (large diagram in pocket). All thicknesses are uncorrected downhole distances rather than dip-corrected stratigraphic thicknesses.

Denison Group, Moina Formation

The Moina Fm of the Denison Group underlies the Gordon Group in northern and western Tasmania (Fig. 2). The boundary between the Moina Fm and the Gordon Gp is everywhere marked by a siltstone-mudstone transitional zone that may be a metre thick or 30m thick. This transition is 200m thick in the Florentine Valley and is known as the Florentine Valley Fm. The separation between the Denison Gp and the Gordon Group is based on the dominance of siliciclastics (Denison Gp) and limestone (Gordon Gp). The siltstone-mudstone transition is therefore historically and pragmatically regarded as the topmost part of the Moina Fm and the base of the Gordon Gp is defined on the incoming of carbonates. However, where there is an interdigitation of siliciclastics and carbonates, as in DB111, or where the lowest limestones are replaced by siderite or are mineralised then the placement of the boundary may be arbitrary. In all sections, delineation of the boundary has to be regarded as a matter of taste. In most sections I have taken the boundary to be the first obvious and definite limestone.

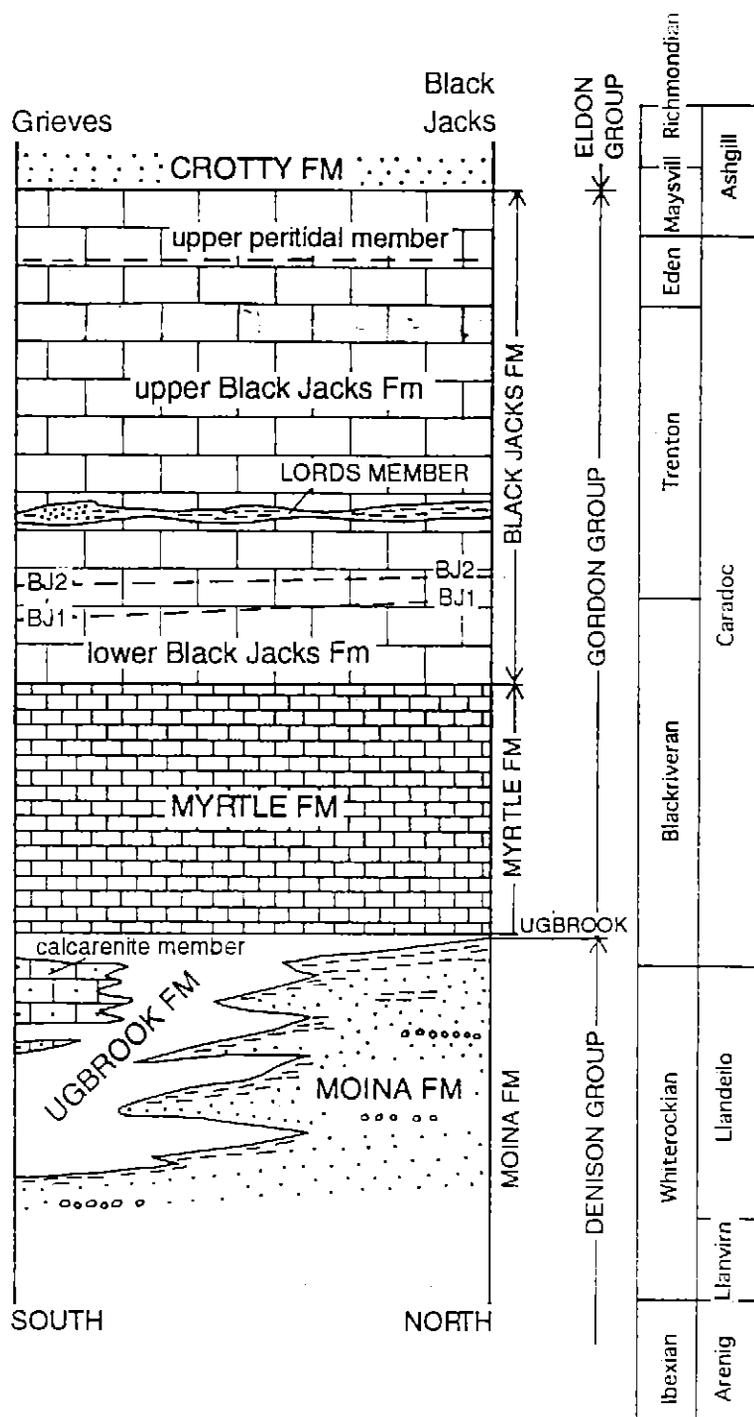


Fig.1 Summary of Ordovician lithostratigraphy in the Zeehan region. Chronostratigraphic units are based on the standard North American scheme and the standard British scheme. Correlations are most easily made to the American scheme but the British scheme is used in the text because of its greater familiarity.

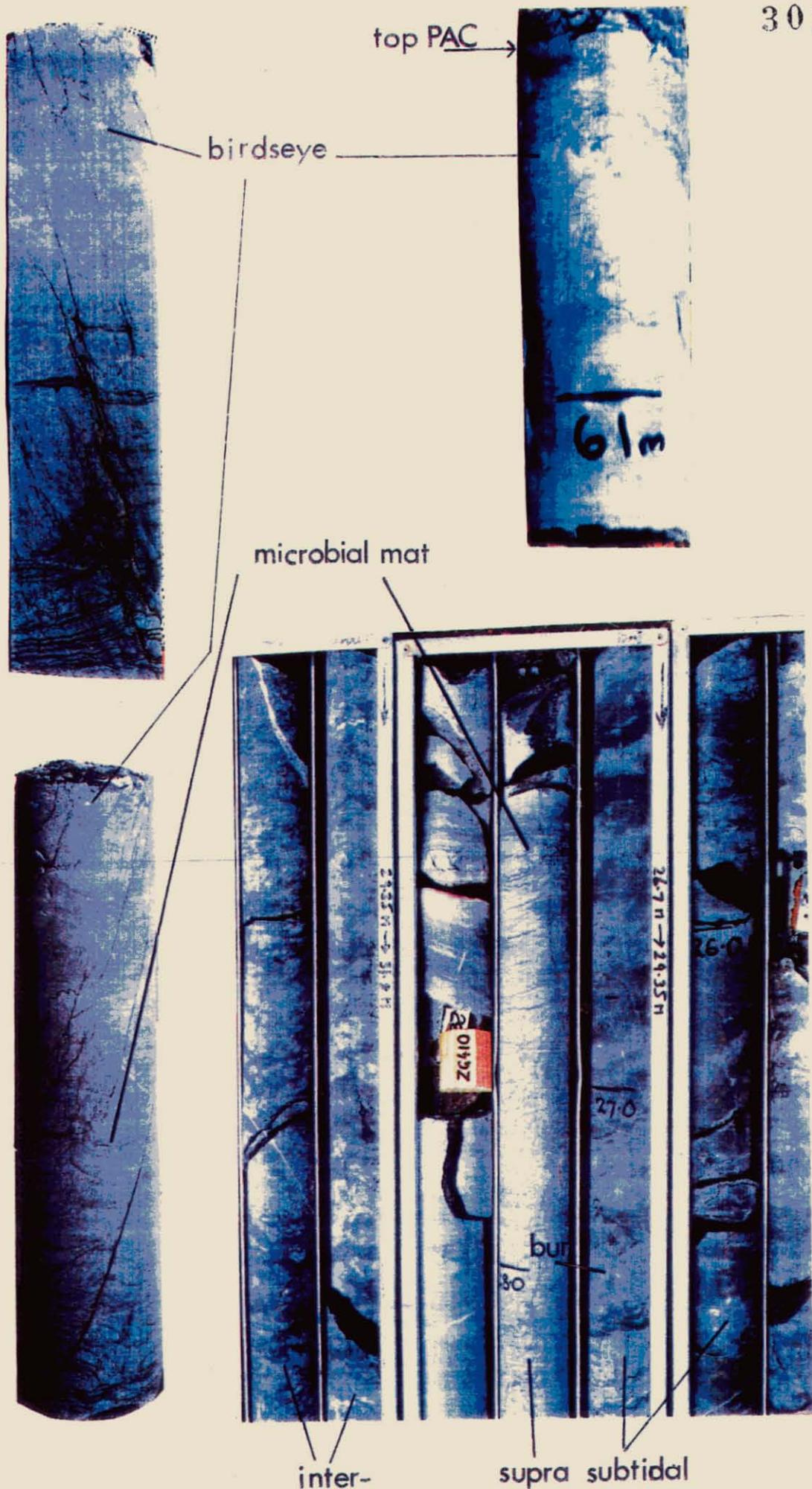


Plate 1 Typical PAC lithologies from ZG 410. Note darkening of limestone from shallow to deep. Core between 26.7m and 27m is typical subtidal alternation of argillaceous and micritic limestone and this lithology is typical of much of the Black Jacks Fm. but forms a small percentage of the Myrtle Fm. Boundary between Myrtle Fm and Black Jacks Fm is at 27.5m.

Ugbrook Formation (Burrett & Goede 1987, Burrett *et al.* 1989)

The siltstones of the upper part of the Moina Fm are succeeded by alternating thin micrites and shales with, in some cores, siltstones and sands (notably DB111). These centimetre-decimetre scale alternations are frequently bioturbated and often nodular (due to sedimentary boudinage). Pelloids and comminuted shells are very common. Asaphid trilobites are present but other identifiable fossils are rare. Several sections have developments of biocalcarenites and/or biosparites composed mainly of crinoidal debris. These sequences are very similar to the Ugbrook Fm in Mole Creek (Burrett *et al.* 1989; Appendix C) and, rather than erect a new name, I will use that term. This lithology is only a few metres thick in DB 110 (possibly 40m thick if a sideritised zone is included) and thickens towards Myrtle which also has a thick development of the crinoidal biospararenite member.

Myrtle Formation (new name)

The Myrtle Fm consists of between 40-170m of micrites, biomicrites, dolomitised micrites and minor calcarenites and shales deposited as upwardly shallowing tidal flat cycles known as Punctuated Aggradational Cycles (PACs). These were first recognised and used as a correlation tool by Calver (1977). Unfortunately, he did not publish and PACs have since been recognised worldwide as a useful correlation and palaeoenvironmental tool. The PAC concept is summarised in Appendix B and photographs of representative lithologies are shown on the attached photographs (Plate 1). Calver (1977) used PACs to correlate throughout the Florentine River Valley recognising 18 PACs in the Lower Limestone Member of the Benjamin Limestone. In the Florentine Valley, and in Zeehan, this correlateability is due to a basinwide or at least sub-basinwide response to changing sea level. PAC boundaries may therefore be regarded as essentially isochronous horizons. Fifteen PACs are recognised in the Myrtle Fm. and each section has most of them. The extent of faulting in ZG 403 is clear as only the first PAC is present.

Black Jacks Formation (new name)

The Myrtle Fm is succeeded by the Black Jacks Fm which consists of alternating micrites and shales with some biomicrites, calcarenites and calcisiltites. Two PACs occur in the Lower Black Jacks but are not present in every section. These are labelled BJ1 and BJ2 on Fig. 5. The Lords Member is a thin (1m-15m) siltstone-shale-sometime sandstone unit that is surprisingly variable on a kilometre scale for a unit that appears over most of western Tasmania from Precipitous Bluff on the south coast to the Florentine Valley to Zeehan to Mole Creek (Fig.2). The Lords Member equivalent at Mole Creek (the Mole Creek Fm) is discontinuous (see p.7 of Appendix C). A coarse, quartz sandstone occurs at the appropriate stratigraphic level in ZF 37 (Firewood Siding). The Lords Member is characterised, statewide, by a distinctive fauna consisting of abundant *Pliomerina* trilobites, strophomenid brachiopods (*Sowerbyites*) and the Tasmanian endemic ostracod *Dominina*.. The Lords Member lithology/fauna does not appear suddenly but is preceded by a gradual deepening of both biofacies and lithofacies.

The Upper Black Jacks Fm is completely dolomitised in some holes (ZR 104) and partially in others (DTM 84-6, DTB 84-1). Complete dolomitisation is unusual in the Gordon Group and increased porosity, including vuggy porosity, is evident in ZR 104 due to the 12% volume loss when calcite is replaced by dolomite. As dolomitised limestones are important petroleum reservoirs (and therefore porous for ore forming fluids) it might be useful to plot the distribution of dolomitisation within the Gordon Group at Zeehan (see Appendix A).

Where undolomitised, there is an abundant coral-stromatoporoid fauna, some of which is correlated to the widespread 'Den fauna'. A diverse trilobite-brachiopod-bryozoan fauna, which in previous studies has been called the 'Smelters fauna' (Zeehan Smelters fauna described by Pitt (1961) and mentioned by Banks and Burrett (1980), occurs below an 'upper peritidal member'. This 'upper peritidal member' occurs in ZF 37, DS 98, DTM 84-6 and DB 110 but is not obvious in ZM190.

PALAEOENVIRONMENTS

Most sections of the Gordon Group were deposited in predominantly very shallow subtidal to peritidal conditions on a mini-platform. due to a marine transgression from the south, west and east towards the Precambrian/Cambrian islands of the Tyennan and Rocky Cape regions (Fig. 3). Thick siliciclastic sandstone sequences, followed

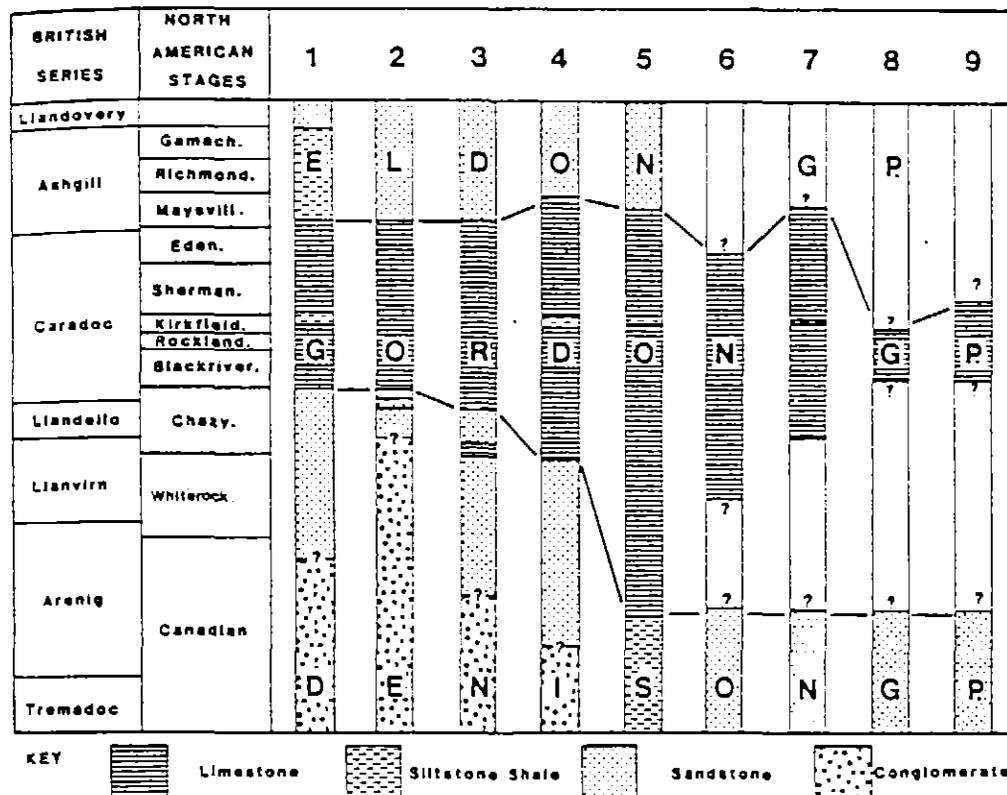


Fig.2. Simplified stratigraphic columns showing diachronous base of the Gordon Gp and of the Moina Fm. 1=Queenstown, 2=Vale of Belvoir, 3=Lower Gordon River, 4=Mole Creek, 5=Florentine Valley, 6=Ida Bay, 7=Precipitous Bluff, 8=Point Cecil, 9=Surprise Bay. (Burrett *et al.* 1984).

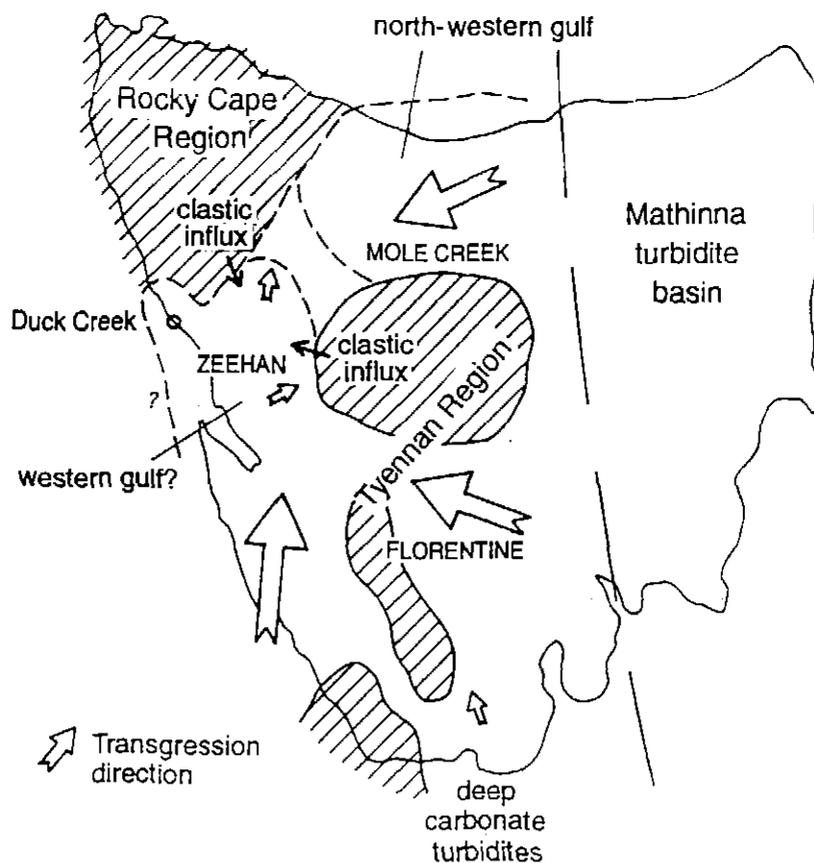


Fig.3. Generalised palaeogeography of the Tasmanian miniplatform in the Caradoc showing inferred directions of transgression. Dotted link between Tyennan and Rocky Cape regions may be an isthmus transgressed during Late Caradoc times.

by thick carbonate successions were gradually built up. This transgression started in the Tremadoc (in the Florentine Valley) and continued up to the Late Caradoc or even Early Ashgill (Figs.2-3). Probably much of the Tyennan and Rocky Cape regions were still emergent in the Late Ordovician (Ashgill). The timing of the transgression is mainly determined from conodont dates on the lowest Gordon Group carbonates with supplementary information from microfossils in the underlying Denison Group siliciclastics (Fig.2). In the north of the state, the transgression moved towards the Tyennan and Rocky Cape regions from the north and east possibly forming an east-west aligned gulf (Burrett 1978). In the west, the transgression was from the south towards the west and north. Very thin sequences of the Gordon Group are found at Duck Creek (just to the north of the Heemskirk Granite) and at Heazlewood River. It is possible that a similar gulf to the one in the northwest existed in the west of the state. The siliciclastic sands at the Lords level in the Firewood Siding hole (ZF 37) also suggest proximity to land. A solution to this palaeogeographic problem depends on studies on the Ordovician around Queenstown, outcrops south of Grieves and the poor limestone outcrops between Zeehan and the Vale of Belvoir and south of Firewood Siding.

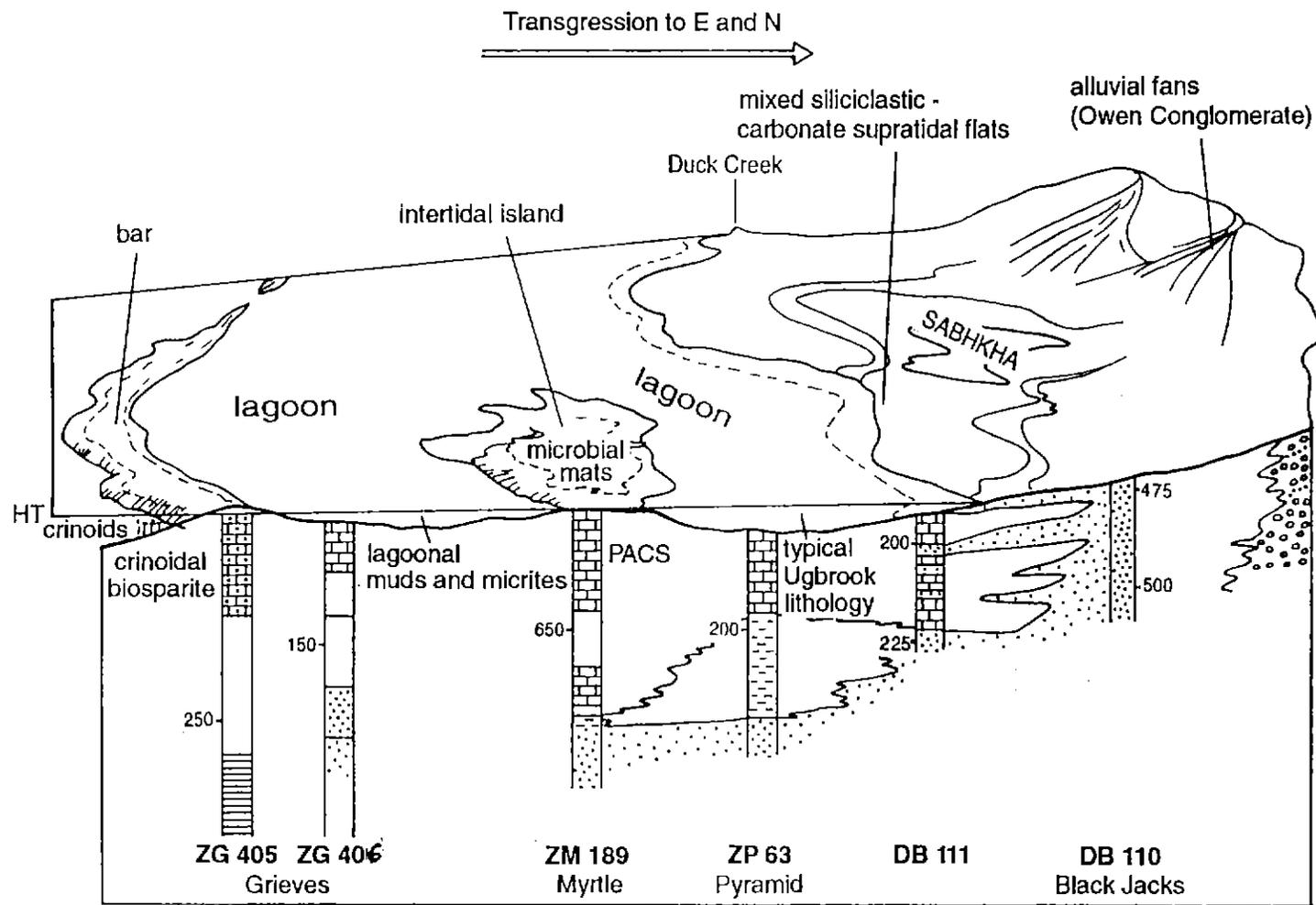


Fig. 4 Environmental reconstruction of the Zeehan area for early Ugbrook Fm times (about Early Caradoc) from the south of the area at Grieves to Black Jacks in the north. Shoreline is to the north (right) and east (behind the viewer). Not to scale. HT = normal high tide level. Numbers refer to down hole depth in m not stratigraphic thickness.

The Ugbrook Fm thins dramatically from DB111 to DB 110 and there is no suggestion that this is due to Devonian faulting. Unlike the other cores examined, the Ugbrook in DB 111 has several coarse siliciclastic interbeds as well as reddened tops to PACs in its basal part. The simplest explanation for this is that the (irregular) shoreline was between DB111 and DB 110 in early Ugbrook time (approximately mid-Caradoc or Blackriveran time) as shown in Fig.4, with clastic debris being derived from the Tyennan region to the east. This date, or a slightly younger one, also applies to the basal carbonates at Duck Creek and Heazlewood River. The typical Ugbrook micrites and pelloidal bioturbated shales were deposited in a lagoon formed behind (north of) a northerly or northeasterly migrating offshore carbonate bar with the minor PAC carbonates formed on intertidal islands within the lagoon (Fig.4). As the transgression continued, the carbonate bar moved from Grieves towards Myrtle during late Ugbrook time. Stabilisation occurred during Myrtle times (Upper Blackiveran) with the whole Zeehan area covered with waxing and waning PACs. Probably by that time, the shoreline (i.e. high supratidal limit) had moved north to Duck Creek and east onto the Tyennan region.

Deepening occurred after Myrtle Fm times, probably due either to the incapacity of the carbonate factory to keep-up with rising sea level or to an increased rate of basinal subsidence. Open subtidal sediments were deposited over the whole area with brief peritidal flat deposition (BJ 1 and BJ2) at Grieves, Myrtle (ZM189) and at Black Jacks (DB110).

The Myrtle core, ZM189, is unusual in that coarse grained carbonates including sparites, spararenites, calcarenites, biosparites are common through the section. This is presumably the consequence of the production of large bioclasts due to deposition further from the micrite producing tidal flats and due to the preponderance of a good subtidal fauna such as crinoids.

The Lords event appears to be isochronous across the whole Tasmanian miniplatform. It was a time of uplift in the Tyennan region leading to coarse quartzite conglomerates being deposited within the middle of the Benjamin Limestone Fm to the west of the Florentine Valley (in the Vale of Rasselas), a deepening in most sections but a shallowing in the deepwater Surprise Bay sequence (Burrett *et al.* 1984). The Lords event was clearly a significant but short lived epeirogenic episode during the mid-Trentonian (Late Caradoc). Normal shallow subtidal conditions resumed during the remainder of Black Jacks time except for a widespread peritidal interlude in late Black Jacks time (Late Trentonian/Early Ashgill). This upper peritidal interval is not found in the Upper Black Jacks Fm at Myrtle (ZM190) which again may suggest that Myrtle may have been in slightly deeper water. The upper peritidal member may correlate to a similar shallowing interlude recognised in the Overflow Creek Fm at Mole Creek.

CONCLUSIONS

The Gordon Group sequence at Zeehan, although starting later during the earliest Blackriveran rather than in the Chazyan, is similar to that at Mole Creek and dissimilar to that in the Florentine Valley. It lacks the oncolitic Standard Hill Fm but the fauna, lithofacies and interdigitation of the Ugbrook with the Moina is very similar. The Myrtle Fm has similarities with both the thicker Lower Limestone Member in the Florentine Valley and the Sassafras Creek Fm at Mole Creek. The generally subtidal Black Jacks Fm is, though, closer to that of the Upper Limestone Member of the Florentine Valley than to the dominantly peritidal Dogs Head and Overflow Creek Fms at Mole Creek.

Interdigitation of the Moina with the Ugbrook and a greatly thinned Ugbrook sequence at Black Jacks suggests that the Blackriveran (Early Caradoc) shoreline was at about the position of DB 110, moving eastwards onto the Tyennan region and northwards towards Duck Creek by the Late Blackriveran.

Identification of PACs or shallowing-upward sequences in the Myrtle Fm and in the Upper Black Jacks Fm allows correlation across the region.

There are several argillaceous horizons present in some sections and the identification of the Lords Member is helped by the identification of its characteristic fauna and by the lithofacies deepening prior to its deposition.

RECOMMENDATIONS

Chronostratigraphic correlations in the Zeehan area could be improved substantially by employing conodonts. Conodonts are rare in peritidal sections but this study has shown that there are sufficient subtidal intervals that would yield sufficient useable conodont elements per kilogram of core. If this was coupled with an intensive study of the macrofossils then very reliable chronostratigraphic correlations are possible. Conodonts also record the maximum temperature that they have experienced and, more importantly, are pitted in a characteristic manner by hydrothermal fluids. Such a study could define flowpaths of hydrothermal fluids.

There are sufficient drillholes to define the extent of any basin or basins by the use of isopachs. However, a complete palinspastic study is recommended that takes into account extension due to cleavage and stratigraphic loss due to tectostylolites as well as removing the effects of Devonian folding and thrusting.

The extent of pervasive dolomitisation in the Black Jacks Fm should be plotted. This might reveal a zone of enhanced porosity/ permeability within the Gordon Group into which hydrothermal fluids might have flowed (see Appendix A).

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Appendix A

Dolomitization and its control on porosity and reservoirs in the Trenton
Limestone
(from North, 1985 p.198-199).

Appendix B

Peritidal Carbonates from Walker and James Eds 1992. Facies Models.
Geological Association of Canada.

Appendix C

Lithostratigraphy at Mole Creek , Burrett et al. 1989.

RESERVOIR ROCKS

recrystallization, and most commonly of *dolomitization*. About 80 percent of all hydrocarbon reserves contained in carbonate reservoirs in North America are in essentially pure dolomites. This percentage is by no means representative of other regions of the world, and unquestionably reflects the number of North American carbonate reservoirs that are Paleozoic in age. In the Persian Gulf Basin, with the most prolific carbonate reservoirs in the world, the proportion of dolomite reservoirs is no more than 20 percent.

The replacement of CaCO_3 by dolomite involves a loss of volume of about 12.3 percent, and a consequent increase in porosity by that amount, if the replacement is molecule for molecule. It may not always be so, because volume for volume replacement is also possible. Yet it remains the case that in many fields having partially dolomitized carbonate reservoirs the oil is restricted entirely to the dolomitized portion. This portion is favorable because of *partial* dolomitization, preferentially of the finer-grained components of the limestone, and later leaching of the remaining calcitic parts which are more soluble. The most-quoted example of this phenomenon is the sprawling Lima-Indiana field south of the Great Lakes (Fig. 13.52). The oil is confined to porous dolomitic zones in the Ordovician Trenton Group where it passes over the axis of the broad, bifur-

cating Cincinnati Arch. Updip, porosity disappears in the unaltered limestone and only gas is recovered. Among the fields providing case histories for this book is the Jay field in Florida (Ch. 26), another example of restriction of oil to the dolomitized part of a carbonate formation. Up the dip, the undolomitized micritic limestone lacks porosity and is barren of oil. Most carbonate producing basins afford comparable examples.

An intriguing small example is provided by the Dover field, at the southwestern extremity of Ontario in Canada, like Lima-Indiana in the Ordovician Trenton Group. During the 1920s, articles on oil-bearing structures quoted Dover as an example of the rare synclinal trap. The syncline is controlled by an elongate fracture zone (Fig. 13.53) along which migrating waters have been able to dolomitize a considerable thickness of strata; the oil is restricted to the porous dolomite and therefore to the "syncline." The Albion-Scipio "trend", in Michigan's part of the same basin, is very similar and produces from the same formation (Fig. 13.52). From outside the normal concern of petroleum geologists comes the parallel case of Mississippi Valley-type lead-zinc deposits, in some of which it is established that the brines, derived from evaporite deposits, that deliver the metals also bring about dolomitization.

The selective nature of dolomitization extends to its

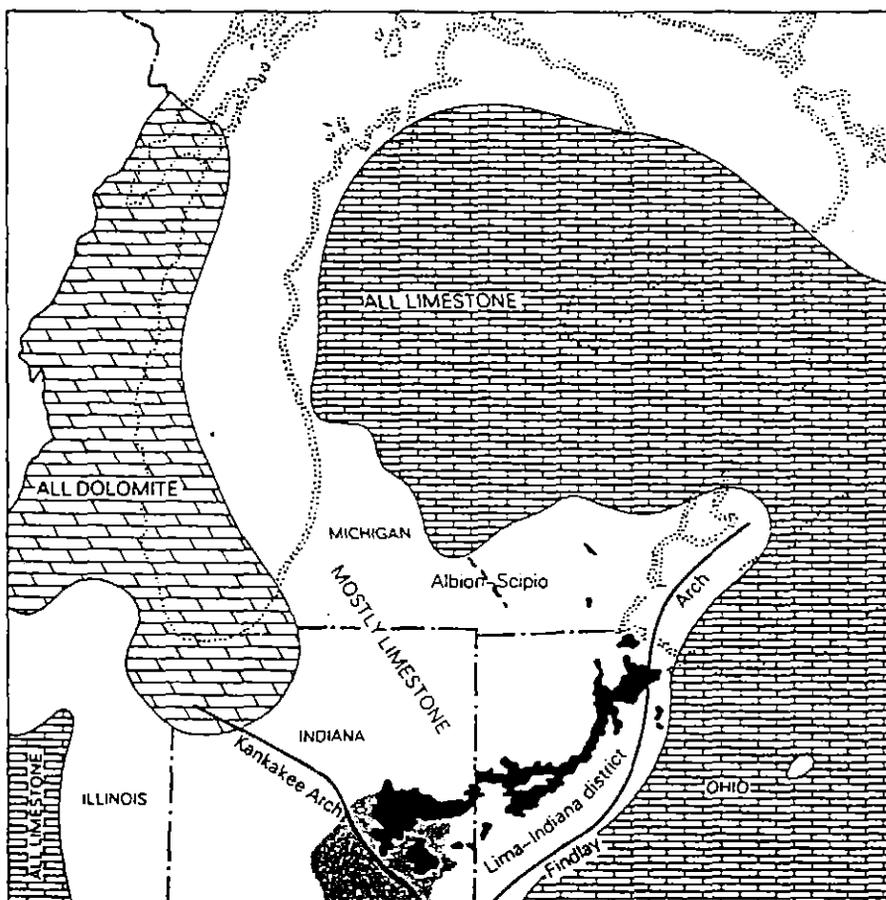


Figure 13.52 Michigan Basin in Middle Ordovician time, showing the Cincinnati Arch bifurcating into two arches as it crosses the basin from the south. The Trenton Group carbonates are dolomitized over the arches and along linear fracture zones; oil accumulations are restricted to the dolomitized portions. Dotted outlines on map delineate present Lakes Michigan and Huron. (After K. K. Landes, *Petroleum geology of the United States*, New York: Wiley-Interscience, 1970; and G. V. Cohee, US Geol. Survey Preliminary Chart no. 9, 1945.)

CARBONATE RESERVOIRS

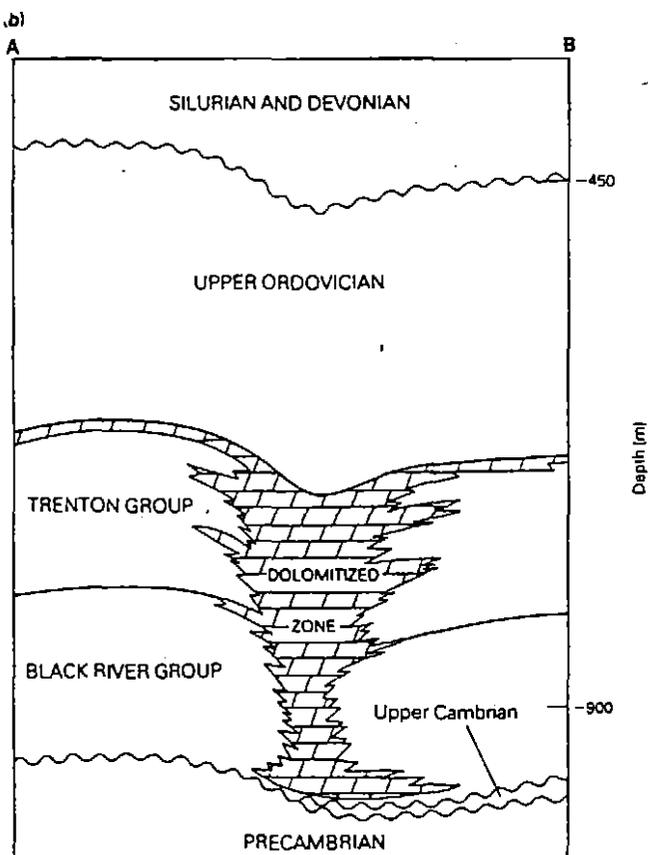
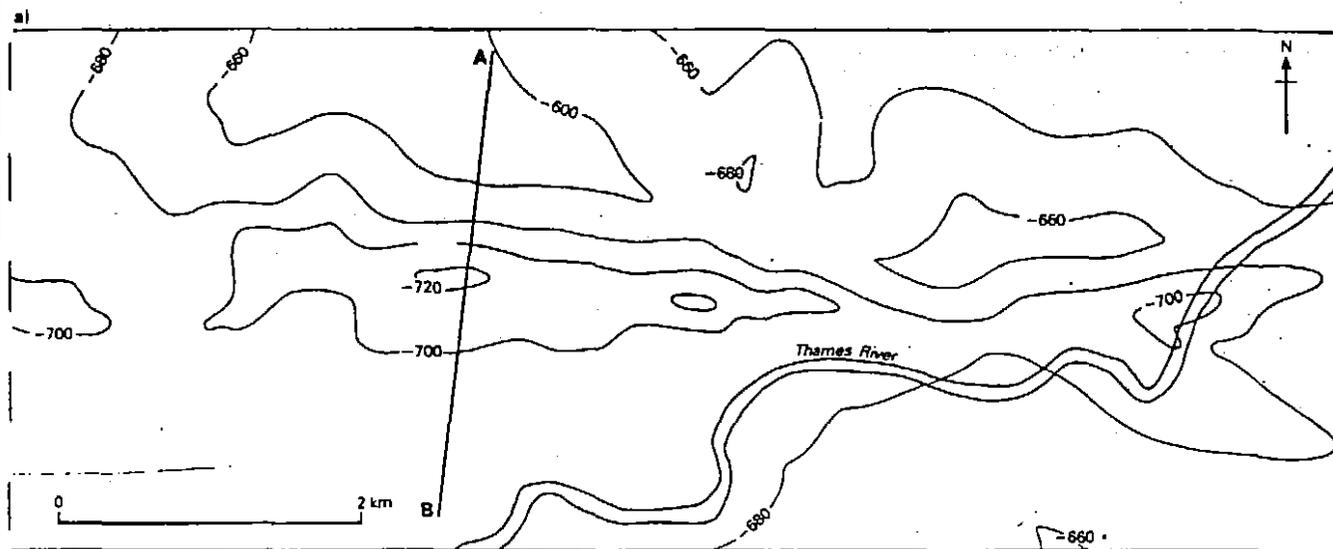


Figure 13.53 (a) Structure contours on the Ordovician Trenton Group (reservoir rock) in the Dover field, between Lakes Erie and Huron, southwestern Ontario, Canada. Contours at 20 m intervals below sea level. Note apparent synclinal structure. (b) Cross section along line A-B, to show dolomitized fracture zone creating a "pseudo-syncline." (From B. V. Sanford, Geol. Survey of Canada Paper 60-26: Fig. 10, 1961.)

effects on skeletal remains. Aragonite is much more easily dolomitized than is calcite, so shells of gastropods, cephalopods, and corals are dolomitized earlier than those of brachiopods, ostracodes, or echinoids. Well sorted crinoidal or shelly limestones are less dolomitized than surrounding rocks which contain less coarse material and more cement. Calcareous algae are easily dolomitized because high-magnesium calcite is deposited on them during their lives, and the algae themselves reduce sulfate which would otherwise inhibit

dolomitization (especially of calcite). The vast mats of algae in the shallow epicontinental seas of the great Paleozoic transgressions are undoubtedly a factor in the prevalence of Paleozoic dolomites. There is very little dolomite in the stratigraphic record since the early Cretaceous, especially in the Northern Hemisphere. This may be because the present oceans, originating at that time, have a distribution and orientation different from those of earlier oceans, and epicontinental seas in low latitudes are highly restricted.

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16. Peritidal Carbonates



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INTRODUCTION

Limestones and dolostones composed of calcareous sediment deposited in very shallow seawater and on muddy tidal flats are probably the most conspicuous carbonate facies in the rock record (Fig. 1). The term *peritidal* (from the Greek *peri*, meaning around or near, and *tidal*, relating to tides) was coined in passing by Folk (1973) and has proven a useful general name for the spectrum of nearshore and shoreline depositional environments and facies.

What distinguishes these rocks is their wide variety of features that can be compared directly with modern analogues, making them both easy to recognize in the field and important paleobathymetric indicators. The facies are generally arranged vertically in a *shallowing-upward sequence* (James, 1984), now referred to as a *shal-*

lowing-upward succession, in which marine sediments are overlain successively by muddy carbonates deposited in paleoenvironments subject to varying periods of exposure. This vertical stacking of peritidal and related facies is a valuable record of the dynamics of carbonate platform development, on both large and small scales. It hints at extrinsic factors such as relative sea level change and climate, and records the effect on periodically exposed sediment of biotic evolution through geologic time. Peritidal carbonates are also economically important because they host Pb and Zn deposits and frequently form hydrocarbon reservoirs.

In this chapter, we first summarize the tidal flat environment from a Recent standpoint. We then discuss how the record of carbonate tidal flats may have changed through time in re-

sponse to biological evolution and provide ancient examples of commonly encountered peritidal facies, with evidence for their interpretation. Finally, we outline how peritidal facies are preserved in the stratigraphic record, describe current hypotheses used to explain stratigraphic repetition and suggest how these facies can best be used in sequence stratigraphic analysis.

THE PERITIDAL ENVIRONMENT

The understanding of tidal flat carbonate rocks underwent a dramatic boost with the largely petroleum company-funded research on Holocene tidal flats during the 1950s and 1960s. This produced comprehensive studies on shallow water sedimentation of south Florida (Ginsburg, 1956; Gebelein, 1977; Enos and Perkins, 1979), Andros Island of the northern Bahamas (Hardie, 1977), Belize (Wantland and Pusey, 1975), the Arabian (Persian) Gulf (Purser, 1973), and Shark Bay, Western Australia (Logan *et al.*, 1970, 1974). Observations from these areas were quickly applied to ancient examples (e.g., Beales, 1958; Roehl, 1967; Matter, 1967; Laporte, 1967; Ginsburg, 1975; Schwarz, 1975), which ushered in the modern era of carbonate sedimentological thinking. These Holocene examples, together with more recently studied flats in the Caicos Islands (Wanless *et al.*, 1988) and southern Australia (Burne and Colwell, 1982; Belperio *et al.*, 1988) are fundamental reference points for the interpretation of carbonate rocks and illustrate the wide variety of potentially preservable peritidal environments. The carbonate tidal flat is an easily accessible area and students are encouraged to explore for themselves a modern example.

Three bathymetric zones are recognized in the nearshore setting: subtidal, intertidal and supratidal (Fig. 2).



Figure 1 Panorama of Cambrian shallow water limestones and dolostones, Dezaiko Range, east-central British Columbia. Distinctive "stripy" bedding of lower unit, to the right of the small ice field, is from peritidal facies of the Snake Indian Formation. The unit in the middle of the photograph is the Eldon Formation, consisting of locally dolomitized subtidal limestones, and the left side comprises peritidal limestones of the Lynx Group.

The subtidal zone is permanently submerged and ranges from low-energy, lagoonal environments to higher energy shoals. Semimonthly neap tides may briefly expose the shallowest portions. The intertidal, or littoral, zone lies between normal low- and high-tide levels and is therefore submerged on a diurnal or semidiurnal basis. It is generally dissected by subtidal creeks and dotted with brackish or saline ponds. The supratidal zone is above normal high tide, and is flooded only during storms and semimonthly spring tides. It may become evaporitic in semiarid and arid climates, and for these supratidal flats the Arabic word *sabkha* has been adopted by sedimentologists (Chapter 19).

The three-fold environmental subdivision is only an approximation, however, since tidal flats are often geographically complex, and tidal range can be modified by winds. While the environments are due to the variable submergence and emergence brought about by lunar tides, little sediment is transported onto the flats by the daily rise and fall in sea level. It is storms, which stir up the adjacent offshore sediments and drive sediment-laden waters up the tidal creeks and onto the flats, that result in sediment deposi-

tion. Even so, it is still the depositional environments, which are generated by daily lunar tides, that contain the distinctive sedimentary features that allow us to pinpoint facies so precisely. One approach to the analysis of environmental subdivision is to assign a specific, quantitative "exposure index" to lithologic features based on Holocene examples (see Hardie, 1977), but few ancient deposits have been described in this way (Smosna and Warshauer, 1981).

Marine coastlines can be separated into microtidal (<2 m), mesotidal (2-4 m) and macrotidal (>4 m) settings. Tidal range depends on basin shape and water depth. Strong tidal currents are generated when water is forced through relatively narrow straits or mouths of bays or over shallow shoals. Modern peritidal carbonate environments are exclusively microtidal. There is as yet no satisfactory way of judging ancient tidal range, but the scarcity of sedimentary structures formed by strong tidal currents suggests that most ancient carbonate peritidal settings were also microtidal.

Where do they form?

Carbonate sediment, generated mostly in the subtidal zone (the *carbonate*

factory), can be subsequently transported and molded into tidal flats by physical processes. In this sense, tidal flats are repositories of allochthonous sediment, and accrete as wedges along shorelines (e.g., Qatar, Shark Bay, Spencer Gulf), in the lee of rocky islands (e.g., northern Bahamas, Caicos, Belize), spits (e.g., Florida) and reefs and shoals (e.g., Trucial Coast), and as discrete islands and banks in shallow seas (Fig. 3). This last setting is inferred from ancient examples because modern shelves are comparatively narrow and not directly analogous to the broad epeiric seas that were common in the past.

For muddy tidal flats to form they must be protected from open ocean swells and such protection can be provided by a platform rim or in the case of a ramp or unrimmed platform, by nearshore carbonate sand shoals (Fig. 4). Muddy tidal flats do not, therefore, generally occur in the facies spectrum of high-energy, unrimmed platforms, except behind nearshore shoals or islands.

Holocene carbonate tidal flat environments

Shallow subtidal and lower intertidal

The shallow seafloor oceanward of modern tidal flats is generally a bio-

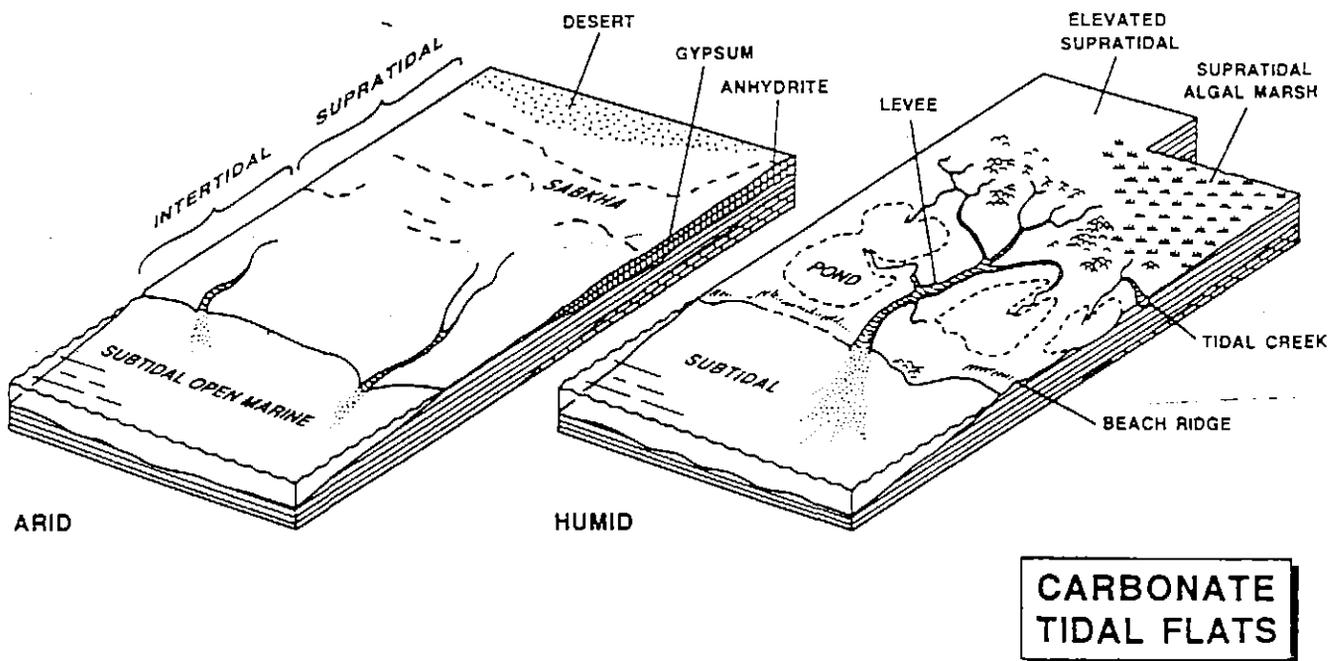


Figure 2 Block diagram showing the main morphological elements of a carbonate tidal flat. Left: a hypersaline tidal flat with few channels bordering a desert and developing evaporite deposits (based on modern Persian [Arabian] Gulf). Right: normal-marine tidal flat with many creeks, or channels, and ponds in a humid to sub-humid setting (based on modern Bahamas).

turbated and pelleted lime mud variably rich in shelly material from benthic organisms, and commonly supports a cover of sediment-stabilizing sea grasses (Chapter 15). Protective low-relief banks of cross-stratified oolitic or bioclastic sand are present in

some higher-energy nearshore areas where wave agitation is frequent.

In tranquil settings of normal salinity, the lowermost intertidal zone tends also to be a thoroughly bioturbated mixture of lime mud, pellets and bioclasts. This sediment is usually cov-

ered during low tide with an ephemeral microbial ("algal") slick that is the source of food for grazing organisms such as gastropods and worms. Crabs, shrimps, worms and fish are responsible for the bioturbation in the underlying sediment. Many low-energy flats are fronted by beaches of bioclastic sand winnowed from creeks and ponds or the adjacent seafloor during storms. Beach sands can be partially lithified by syndimentary cement composed of aragonite fibres or bladed and micritic high-Mg calcite, forming gently seaward-dipping layers of beachrock. Beachrock tends to be crumbly and easily eroded, and supports a hard-substrate biota of encrusting and boring invertebrates, plants and microbes.

Intertidal flats

Higher in the intertidal zone, microbial mat cover is more permanent, and forms thick, leathery carpets that can be locally shrunken, torn and folded over (Fig. 5). These exhibit various surface features such as pustules, blisters, wrinkles, crenulations or small, domical stromatolites. These mats are composed of a variety of filamentous and coccoid cyanobacteria ("blue-green algae") and bacteria, and are responsible for the millimetre-scale lamination exhibited by most of the sediment beneath them. The taxonomic makeup and surface appearance of such mats varies with degree of subaerial exposure and can be reflected in the microscopic nature of the underlying lamination. This type of lamination was called "algal" or "cryptalgal" before geologists became familiar with the detailed biological nature of the mats; "microbial" seems now to be the preferred adjective.

Ponds and creeks

Ponds containing brackish or hypersaline water are a common feature of the intertidal zone (Fig. 6), especially in more humid climates. These contain a restricted biota of microbial mats, foraminifera, gastropods, small bivalves, shrimps, ostracodes, and nematode and polychaete worms that is adapted to fluctuating salinity. This assemblage, living in a stressed environment, is typically one of high numbers of individuals but low species diversity, different from the immediate offshore

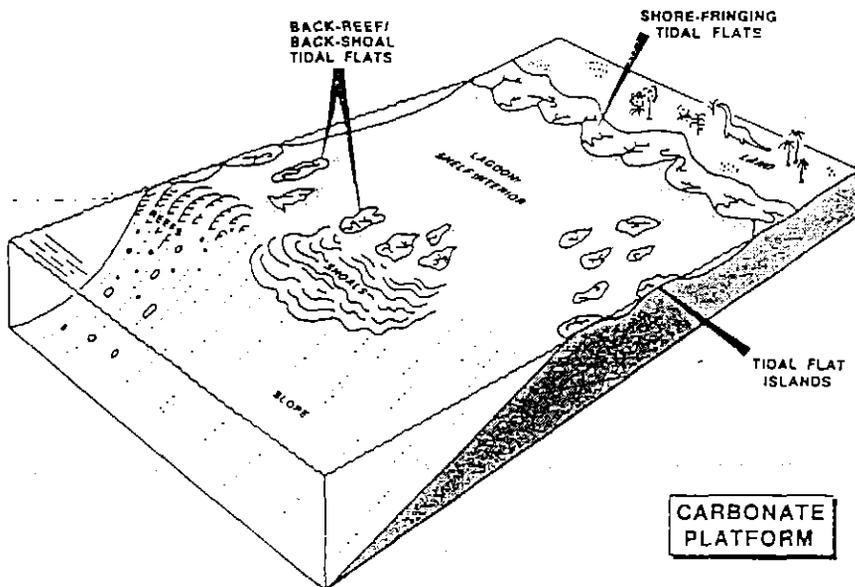


Figure 3 Block diagram of a carbonate platform, with basinward to left and landward to right, showing possible locations of tidal flats: in the lee of reefs and carbonate sand shoals, as islands, and as shoreline deposits.

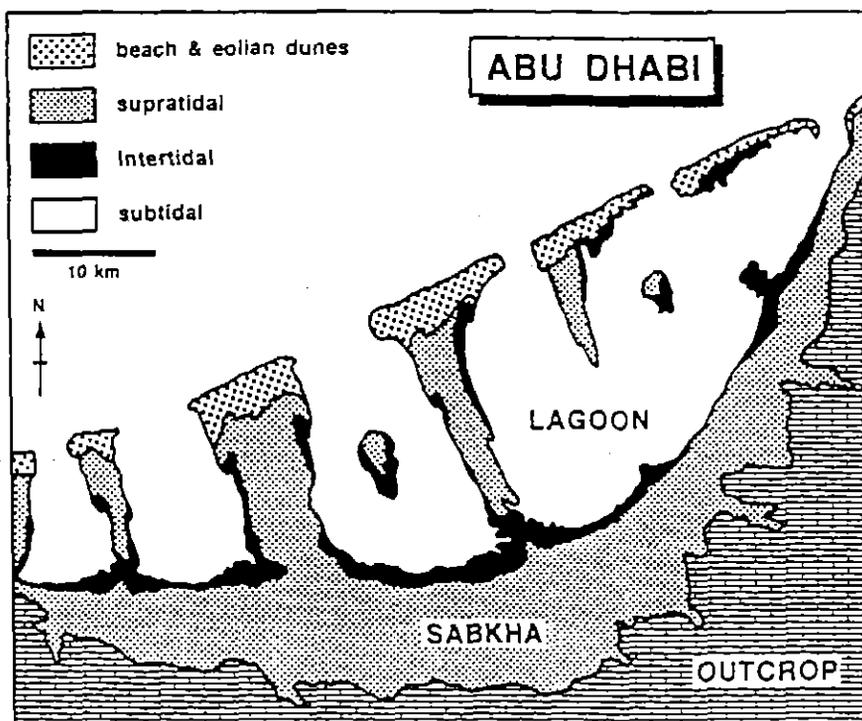


Figure 4 Simplified map of modern tidal flat areas near Abu Dhabi, Persian (Arabian) Gulf, based on Purser (1973).

5 cm

biota. Copses of mangroves are usually present, except in the most arid areas. Also characteristic of the intertidal zone are permanently submerged tidal creeks or channels that are the conduits for tidal flooding and draining (Fig. 6). Such tidal creeks (least common in arid settings) are up to several metres deep and tens of metres wide, and contain a basal lag of semilithified intraclasts eroded from the surrounding flats and flanking levees, and bars of bioclastic sand winnowed from the ponds. Supratidal levees protrude above high-tide level and are microbially laminated. Creeks migrate laterally, as they do in siliciclastic tidal flats, and leave behind a vertical succession of cross-stratified, intraclastic and bioclastic sand overlain in turn by bioturbated bioclastic and peloidal lime mud and microbially laminated sediment. The amount of lateral migration of creeks and the proportion of the internal facies mosaic of intertidal flats that is generated by such migration are not well understood, but studies of modern flats suggest that it may be considerable (Hardie, 1977).

Supratidal flats

Most of the sediment surface in the upper intertidal and supratidal zones is covered by microbial mats that are typically shrunken into desiccation polygons and commonly dislodged into chips or intraclasts. The laminated sediment beneath these mats is generally fine grained with occasional coarser intercalations that reflect deposition by exceptional storms and, in some regions, by winds blowing off the neighbouring land surface. Beds and nodules of anhydrite precipitate in these sediments in arid settings (Chapter 19). In many areas, the supratidal zone is the locus of widespread syndimentary cementation by microcrystalline aragonite, high-Mg calcite, or dolomite. This forms lithified pavements a few centimetres thick that are usually broken into intraclasts by forces exerted during crystal growth, groundwater pore pressure, or the roots of halophytic (salt-tolerant) plants such as grasses and mangroves. Evaporating sea spray can be responsible in some arid areas for fans and isopachous layers of fibrous aragonite that encrust stable substrates such as beachrock and shells, forming objects termed coniatolites.

Landward parts of the supratidal zone grade into eolian deposits, soils or freshwater marshes and lakes, or onlap bedrock surfaces, depending on the region's geography and climate. Marshes and lakes, which exist in the more humid areas and have fluctuating water chemistry, are characterized by microbial mats and stroma-

tolites; these are partially lithified by high-Mg calcite cement and calcification of organic substrates, and are interbedded with thin-bedded, locally bioturbated lime mud and bioclastic and peloidal carbonate sand deposited during storms. Much of the microbially laminated sediment shows fenestral fabric, i.e., the presence of millimetre-



Figure 5 Upper intertidal microbial mat mainly composed of filamentous cyanobacteria (*Microcoleus*) that has shrunken into desiccation polygons. Boca Jewfish, Bonaire; trowel is about 25 cm long.



Figure 6 Oblique aerial photograph of the tidal flats on the northeast coast of Andros Island, Bahamas, looking north. Offshore subtidal is to the left. The white areas along the channel edges are supratidal levees. The dark patches are intertidal microbial flats between the levees and around the periphery of the main subtidal ponds. The field of view is about 3 km across.

to centimetre-sized subhorizontal, sheet-like pores formed as voids bridged by microbial mats or as molds of degraded mats. Decimetre-scale tepee structures (Fig. 7), consisting of disrupted and overthrust crusts of lithified, tufa-like fenestral sediment giving an inverted V-shaped cross section, form in areas of groundwater discharge

(Kendall and Warren, 1987). These also contain complex generations of internal sediment and aragonite and high-Mg calcite cements.

Geological evolution of peritidal facies

Biological and environmental developments through geologic time have

exerted an important influence on the nature of carbonate tidal flats. This is manifest in several ways, via 1) the increase in diversity of carbonate-secreting organisms and consequent change in sediment type, 2) the evolution of bioturbating and herbivorous invertebrates, and 3) the evolution of angiosperms.

The subtidal carbonate factory was in its infancy during Precambrian time, when CaCO_3 was extracted from seawater by inorganic and microbial processes only. Peritidal strata during this phase in Earth's history are composed of ooids, intraclasts, stromatolites, supratidal tufas, and variable amounts of lime mud. Some subtidal units are entirely siliciclastic, and large-scale cyclicity of alternating calcareous and noncalcareous facies (e.g., Grotzinger, 1986; Bertrand-Sarfati and Moussine-Pouchkine, 1988) may have involved basin-wide, or greater, changes in carbonate saturation of seawater. The dramatic increase in skeleton-secreting and sediment-ingesting invertebrates beginning in Cambrian time meant that the carbonate factory changed in character and increased its output manyfold. New types of sedimentary particles appeared, in the form of abundant shells, fecal pellets, and carbonate mud from the breakdown of fragile skeletons and other biologically influenced precipitates. This no doubt changed the nature of tidal flats by causing increased mobility of the substrate, making it less and less likely to be cemented quickly or encrusted by stromatolite-forming microbial mats except in hypersaline areas (Pratt, 1982). It has been commonly held (Garrett, 1970) that grazing invertebrates such as gastropods caused intertidal stromatolites to become scarce after the Proterozoic, but the above sedimentary reasons rather than ecologic pressure seem likely to have been responsible for this decline.

Proterozoic tidal flat carbonates are distinctive too because, in comparison with other Precambrian carbonate facies and younger sediments, they were the preferred sites of diagenetic silica precipitation and formation of chert nodules (Maliva *et al.*, 1989). These cherts are important because they host the bulk of the Precambrian fossil record (Knoll *et al.*, 1991).

Bioturbation became a sediment-



Figure 7 The supratidal flat at Fisherman Bay, Spencer Gulf, southern Australia. The polygonal crusts are lithified and have been thrust into tepees by episodic groundwater resurgence. Crusts in the foreground are roughly 30 cm across.

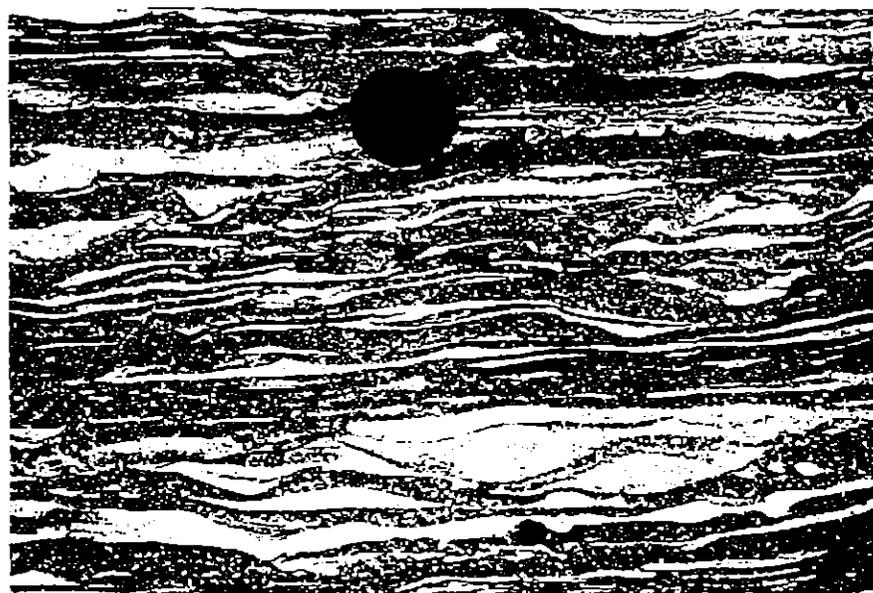


Figure 8 Outcrop of lenticular and wavy beds of wave-rippled peloidal grainstone (light coloured) in argillaceous dolostone (dark coloured), probably deposited in the lower intertidal zone. Petit Jardin Formation (Upper Cambrian), Port-au-Port Peninsula, western Newfoundland; lens cap is 6 cm across.

modifying process in Late Proterozoic time. Diversification of microbes, especially those involved in the breakdown of organic material, must have occurred in tandem with invertebrate diversification and the resulting appearance of new organic substances. The organic content and therefore the geotechnical properties of tidal flat sediments surely changed in the early Paleozoic. The effect of bioturbation seems to have increased dramatically after the late Paleozoic or earliest Mesozoic (Thayer, 1983; Bottjer and Ausich, 1986; Pratt, 1991). This was heralded by the evolution of a more diverse fauna including animals, such as certain shrimps and crabs, capable of burrowing as deeply as 1 m. Consequently, tidal bedding that would have been preserved in the Precambrian and early Paleozoic was commonly destroyed by infaunal activity, except in the upper intertidal and supratidal zones. Furthermore, intertidal to supratidal sedimentary and organosedimentary structures that escaped destruction were often subsequently bioturbated when buried by subtidal or lower intertidal sediments with an active deeply burrowing infauna.

Evolution of angiosperms since Cretaceous time has meant that the disruption of tidal flat sediments by halophytic plants has become a characteristic of Cenozoic deposits. In addition, shallow subtidal sea bottoms are especially well stabilized by the rhizomes (roots) of angiosperm sea grasses (*Thalassia*, *Posidonia*, *Cymodocea*). Such grasses also support a prolific encrusting biota that supplies fine-grained carbonate sediment to the factory. These carpets of sea grasses, however, are disrupted only by intense storms, causing "blowouts" (Wanless, 1981), and we suggest that pre-Cenozoic subtidal sediments, especially silt- and sand-sized particles, might have been more readily moved onto tidal flats than they are now, because they were not bound by these grasses. This is analogous to the suggestion that the post-Devonian presence of widespread terrestrial plant cover, with its stabilizing, soil-forming and weathering attributes, affected the subaerial sedimentary system of the Earth. It may partly explain why some early Paleozoic intertidal carbonates

look so much like siliciclastic counterparts from settings that lack significant seagrass communities.

Ancient peritidal carbonate facies

Environmental interpretation of peritidal limestones and dolostones is easily achieved in the broad sense,

especially when they contain features unequivocally of subaerial origin. However, some facies cannot be assigned confidently to a bathymetric position, and for these Walther's Law must be invoked. Furthermore, tidal processes involve such a variety of energy regimes, sediment sizes and climates that there may be a limit as to

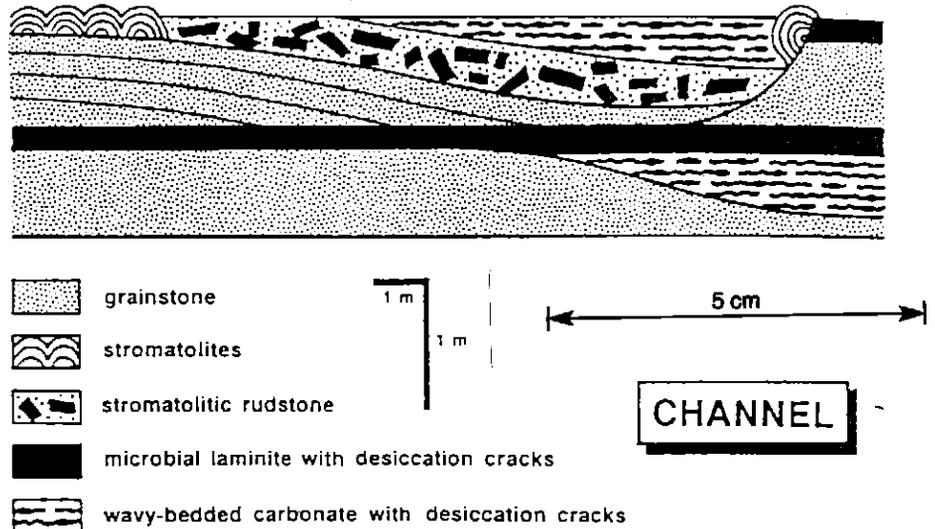


Figure 9 Simplified outcrop sketch of hypothetical channel or creek deposits cut into tidal flat facies, based on examples from the Waterfowl Formation (Upper Cambrian, Rocky Mountains, Alberta; Waters *et al.*, 1989) and Eibrook-Conococheague Formations (Middle and Upper Cambrian, Virginia; Koerschner and Read, 1989).

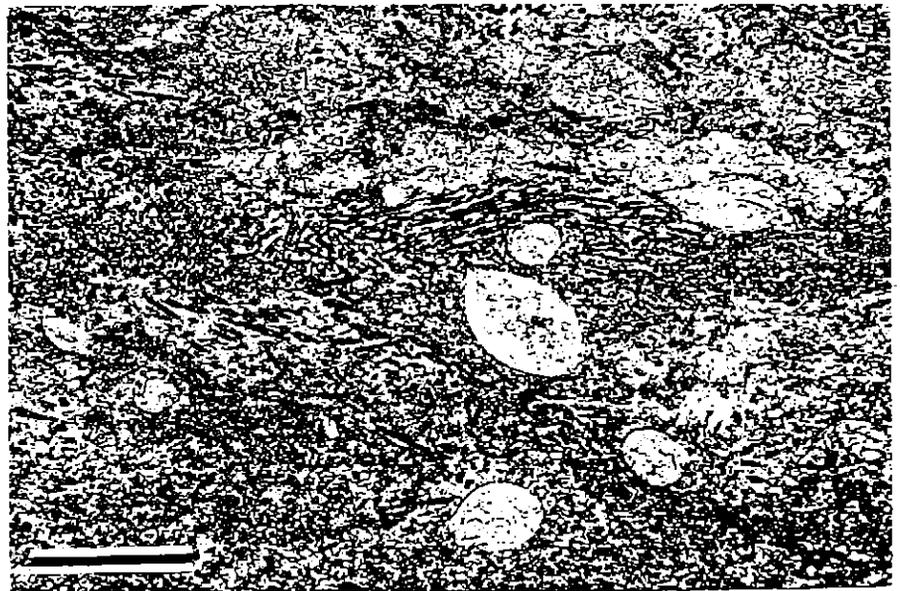


Figure 10 Thin section photomicrograph of limestone composed of loosely packed micrite, micrite peloids, articulated ostracode valves, and calcimicrobe (*Girvanella*) filaments with organic-rich walls. This sediment is interpreted to have been deposited in a tidal flat pond because of the low-diversity biota and the calcification of filamentous cyanobacterial thalli. Table Point Formation (Middle Ordovician), Port-au-Port Peninsula, western Newfoundland; scale bar is 1 mm.

how precise an interpretation one can make. The present level of detail is generally at the scale of units decametres to metres in thickness; few studies have gone down to the scale of individual beds and laminae.

Shallow subtidal and lowermost intertidal facies

Precambrian subtidal rocks are the most difficult to recognize, because the carbonate was produced by inorganic or microbially mediated precipitation, and there were no distinctive skeleton-

secreting organisms. Such subtidal facies tend to be variably siliciclastic, or frequently dolomitized lime mudstone with local oolitic, peloidal or intraclastic beds. Nearshore limestones of Phanerozoic age are fossiliferous, commonly bioturbated to some degree, and may exhibit patch reefs and oolites. Units of thinly interbedded bioturbated lime mudstone and wackestone and ripple or dune cross-laminated grainstone that are overlain by rocks exhibiting clearly supratidal facies are typical. Subtidal and lower intertidal

carbonates of Mesozoic and Cenozoic age are commonly thick bedded and totally bioturbated, reflecting the post-Paleozoic increase in the diversity and effect of the bioturbating fauna.

Intertidal flat facies

Wavy-, lenticular- and flaser-bedded peloidal lime mudstone or grainstone (calcsiltite) and dolomitized argillaceous lime mudstone (sometimes interbedded with small hemispheroidal stromatolites), arising from the alternation between slack water and sediment transport by both unidirectional currents and waves under lower flow regime, are particularly distinctive of Precambrian and lower Paleozoic sequences (Fig. 8). This facies is directly comparable to the tidal bedding in siliciclastic peritidal deposits, including those forming in many modern settings (see Reineck and Singh, 1980). The carbonate strata, however, commonly contain intraclastic horizons which are absent in siliciclastic counterparts. Phanerozoic intertidal facies frequently have bioclastic layers. Well-sorted coquinas were likely washed in from the subtidal zone by storms, whereas poorly sorted shelly deposits containing a low-diversity assemblage of gastropods or bivalves probably represent the in situ intertidal fauna. Laminae that appear laterally continuous, undulating and uniform in thickness, are typically intercalated in this facies, and record periods of stabilization or binding of the substrate by a microbial mat. This tidal bedding can be burrowed in Phanerozoic sequences, and in the lower Paleozoic the trace fossil fauna is dominated by a low-diversity assemblage of horizontal burrows and U-shaped forms like *Arenicoites* and *Diplocraterion*. As with subtidal deposits, post-Paleozoic intertidal sediments are likely to be thoroughly churned: bioturbated, poorly fossiliferous lime mudstone units may be interpreted as intertidal if other criteria, such as vertically juxtaposed beds with desiccation cracks, are evident.

Tidal creek facies

Rocks specifically interpreted as having accumulated in tidal creeks or channels piercing intertidal flats are relatively uncommon. The reasons for this are mainly 1) the rarity of laterally

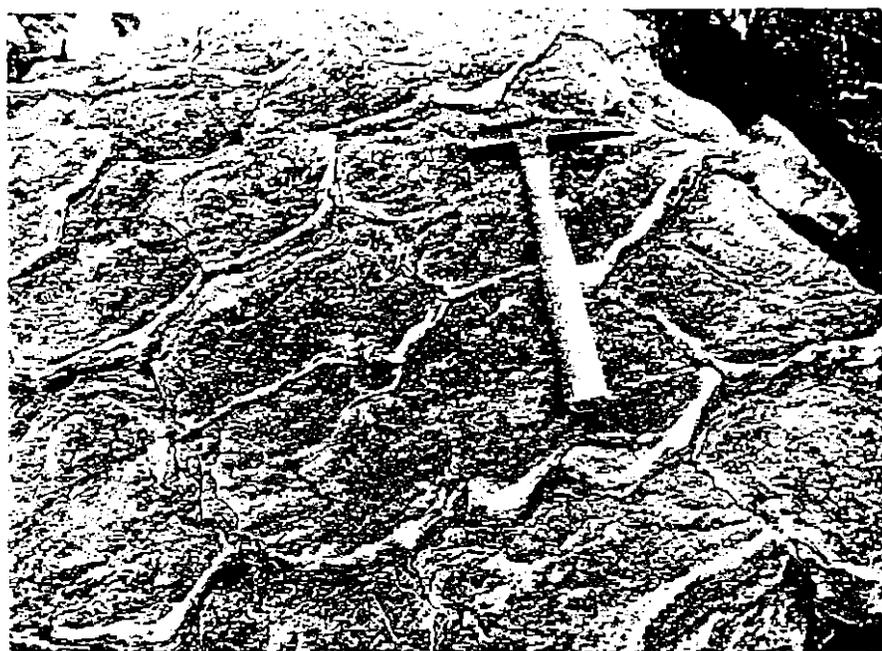


Figure 11 A bedding plane of desiccation-cracked polygons in which the edges of each polygon are curled up, probably because the original microbial mats shrivelled upon exposure. East Arm Formation, Upper Cambrian, Bonne Bay, western Newfoundland; hammer is 30 cm long.

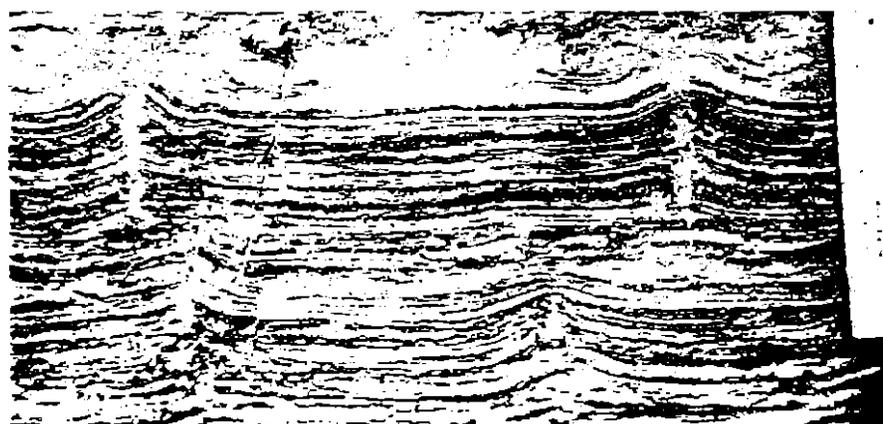


Figure 12 A cross section of desiccation cracks in microbially laminated peritidal dolomites; Providence Island Dolomite, Middle Ordovician, Lake Champlain, New York State.

extensive exposures that intersect the possible margins of channels once they stop migrating laterally, 2) the difficulty in distinguishing creek fills from regressive packages with a basal, higher-energy component that resulted from tidal flat progradation, 3) the similarity between bedforms and lateral-accretion bedding from bar migration in channels and inclined and tabular cross stratification from migrating offshore carbonate sand shoals, and 4) the difficulty in separating creeks in tidal flats from channels between adjacent offshore islands or shoals. The presence of flat-pebble and blocky intraclasts derived from the surrounding flats and levees, respectively, along with bipolar (herringbone) cross stratification typically exhibiting reactivation surfaces and *tidal bundles* (couplets of sandy and muddy laminae), seem to be diagnostic of creek or channel deposits (e.g., Pratt and James, 1986). Grainstone beds with erosional bases



Figure 13 Polished slab of clotted and peloidal lime mudstone showing microbial lamination and fenestral fabric of laminoid, millimetre- to centimetre-sized, cement-filled pores. This distinctive fabric probably formed in the upper intertidal or lower supratidal zone. Eldon Formation (Middle Cambrian), Exshaw, Alberta; scale bar is 1 cm.

and containing stromatolite or thrombolite mounds in some Proterozoic and Cambrian sequences are reasonably interpreted as channel deposits, (Koerschner and Read, 1989; Wright *et al.*, 1990). Waters *et al.* (1989) and Cloyd *et al.* (1990) have mapped Cambrian channels at least 10 m wide and 1 m deep with erosional bases, filled with lateral-accretion beds of individually graded, locally bipolar cross-laminated grainstone containing desiccation-cracked lime mud drapes and reactivation surfaces (Fig. 9). Care must be taken in late Proterozoic and early Paleozoic carbonates, however, to differentiate subaerial (desiccation) cracks and other cracks of submarine origin (Knoll and Swett, 1990; Cowan and James, 1992).

Beach facies

Beaches, which also have not been reported frequently from ancient tidal flat sequences, are characterized by seaward-dipping, low-angle laminae and thin beds of grainstone, often with hardgrounds exhibiting bored surfaces. This facies passes laterally to subtidal deposits in the seaward direction and tidal-bedded strata in the landward direction (e.g., Inden and

Moore, 1983; Waters *et al.*, 1989). Steeper shorelines, such as Tertiary and Quaternary examples from the Mediterranean and Red seas, are often overlapped by gravelly beds of well-rounded pebbles and large shells.

Pond facies

Recognition of schizohaline pond deposits on humid intertidal flats may be impossible in most rock sequences unless the ponds were particularly long-lived. In one example (Pratt, 1979), burrowed wackestone containing ostracodes and horizontal meshes of *Girvanella* filaments with organic-rich walls (Fig. 10) are intercalated within burrowed and microbially laminated lime mudstone and tidal-bedded dolostone and lime mudstone. The restricted biota of this deposit, the well-preserved microbial remains, and its lenticular geometry within a peritidal sequence argue against a normal-marine subtidal environment.

Supratidal facies

Microbially laminated limestone or dolostone, usually with desiccation cracks and coarser rippled layers, is a common peritidal rock type (Figs. 11, 12); such rocks, however, may be



Figure 14 Thin section photomicrograph of peloidal and clotted micrite containing bioclasts (mainly ostracodes and gastropods) and exhibiting fenestral fabric. Upper parts of the laminoid fenestral pores have pendant fringes of fibrous calcite cement (grey coloured) suggesting that this sediment was deposited in the upper intertidal zone and that the fibrous calcite precipitated as marine or mixed waters percolated through the pores during low tides. Table Point Formation (Middle Ordovician), western Newfoundland; scale bar is 1 mm.

upper intertidal or supratidal in origin. In older Phanerozoic sequences, a supratidal setting might be inferred if bioturbation is rare or absent, or there is evidence for prolonged subaerial exposure such as evaporites, karst horizons or paleosols. Intercalated within many microbially laminated rocks are intraclastic horizons, which are analogous to pavements of microbial mat chips or fragments of cemented crusts in modern supratidal environments. Fenestral lime mudstone and peloidal grainstone (Fig. 13) are common (Shinn, 1983b) and, by analogy with tidal flats of Florida and the Bahamas, were probably deposited in moist supratidal "algal marshes" or around ponds. This facies sometimes exhibits features, such as pendant fibrous cement (Fig. 14), brecciated crusts and tepees, pisolites and pores with geopetal sediment floors, suggestive of flushing by downward-percolating seawater and rainwater and upward-flushing by groundwaters in a subaerial environment. Precambrian supratidal deposits often contain digitate stromatolites, millimetres to centimetres in diameter, which have been interpreted as supratidal, tufa-like aragonite precipitates (e.g., Grotzinger, 1986). Post-depositional leaching of evaporites

causes collapse brecciation in supratidal facies.

THE PERITIDAL SHALLOWING-UPWARD SUCCESSION

Ancient peritidal carbonate lithofacies are characteristically organized stratigraphically into metre- to decametre-thick, shallowing-upward successions (Fig. 15) each with a basal subtidal unit, intermediate intertidal facies, and an upper supratidal unit with or without a terrestrial horizon on the top (James, 1984; Wright, 1984; Tucker and Wright, 1990). Contacts between the members are gradational or sharp and may show evidence of local synsedimentary scour. Walther's Law tells us that, if there are no major depositional breaks, we can reconstruct the ancient environmental mosaic by dealing out each facies like a deck of cards. There are departures from this ideal pattern, however, and it is not unusual to find the supratidal member overlain by intertidal facies, or components missing because of nondeposition or erosion.

Characteristics

The lithologic nature of the subtidal → intertidal → supratidal succession is variable, reflecting the broad spectrum

of intertidal and supratidal depositional environments, the dictates of biotic evolution and past changes in ocean chemistry. Such peritidal shallowing-upward successions can be subdivided into two types, low energy (Figs. 16, 17) and high energy (beach; Fig. 18), and both may show the effects of climate, such as thin beds of evaporites, especially anhydrite (Chapter 19).

In the simplest case, and referring only to the Phanerozoic, low-energy shallowing-upward successions have a burrow-mottled, variably argillaceous lime mudstone to wackestone or packstone lowest member, often with a basal bioclastic and intraclastic grainstone or rudstone as a transgressive lag on top of the pre-existing succession (Fig. 16). Patch reefs may be present in the subtidal member. The intertidal member exhibits thin-, lenticular- and wavy-bedded, variably bioturbated lime mudstone and bioclastic, peloidal and sometimes oolitic grainstone, locally with small domical stromatolites. This grades upward to an upper intertidal and supratidal member that is usually a microbially laminated, locally desiccation-cracked, slightly argillaceous lime mudstone frequently exhibiting fenestral fabric, with thin interbeds of intraclastic horizons and laminae of peloidal or bioclastic grainstone. If the sediments were laid down in an arid climate, nodular to wavy beds of anhydrite may displace and replace sediment of the intertidal and supratidal members (Fig. 16). Higher-energy cycles (Fig. 18) also have a bioturbated subtidal bioclastic basal member, but the intertidal component is made up of bioclastic and/or locally oolitic grainstones representing beach deposits. These may exhibit inclined- and cross-stratification and hardgrounds. The upper intertidal and supratidal units are generally desiccation-cracked microbial laminites.

Both kinds of shallowing-upward successions can have a capping horizon of marsh sediments, paleosol or calcrete. Successions may be separated from overlying units by a karst surface caused by subaerial weathering, or an erosion surface formed during the environmental shift responsible for the next succession. Supratidal sediments may show the diagenetic effects of groundwater dis-



Figure 15 A shallow pit excavated on the Holocene sabkha; Abu Dhabi, United Arab Emirates. The roughly 1 m of section is composed of light-hued subtidal sediment at the base, overlain in turn by conspicuous black intertidal microbial mats with desiccation cracks and light-coloured supratidal sediment and capped by eolian quartz-rich sands. Photo courtesy P. Scholte.

charge, such as tepees, cements and leaching of evaporites.

A warning! Tidal creek or channel fills can look suspiciously like shallowing-upward successions produced by tidal flat progradation (Fig. 18). Predictably, they should be composed of a basal intraclastic, peloidal and bioclastic grainstone lag or bar facies, overlain by thin-bedded and bioturbated lime mudstone and wackestone, and capped by microbially laminated lime mudstone, recording waning energy conditions as the creek is abandoned (e.g., Waters *et al.*, 1989; Cloyd *et al.*, 1990). Unless a channel margin or lateral-accretion bedding is exposed, or blocky intraclasts from margin collapse are present, these deposits could easily be misunderstood.

Geometry

To interpret how any particular peritidal shallowing-upward succession may have developed there must

be firm local and regional lateral control on the distribution of units; bed or event correlation must be demonstrable. Besides walking or tracing out individual beds, the lithologic features that may be widely correlatable in peritidal successions are subaerial exposure horizons (karst surfaces, collapse breccias and paleosols), evaporite beds and siliciclastic horizons resulting from sea level fall. We recognize two geometries. *Laterally continuous* metre-scale successions are widespread, possibly platform-wide, and correlatable. *Laterally discontinuous* metre-scale successions are local in extent and noncorrelatable and supratidal facies can be traced laterally into intertidal and/or subtidal facies over kilometre-scale distances.

Origin

An aspect of carbonate sedimentology that has become a maxim over the last decade, for Phanerozoic rocks at

least, is that healthy carbonate platforms, i.e., those not stressed by environmental conditions like cold water, hypersalinity, turbidity or nutrient poisoning that hinder organism growth, can produce enough carbonate sediment to aggrade, and commonly a surplus, causing progradation, while relative sea level rises (Schlager, 1981). Shallow water sediments thus overlie deeper water facies. Each shallowing-upward peritidal succession records the vertical and lateral accretion of a single tidal flat to a level just exceeding high-tide mark; if there was no subsidence or sea level change, the thickness of the intertidal-supratidal component might approximate the tidal range, but if there was any relative sea level change, the thickness is no indication of this at all.

There are currently three models used to explain how a shallowing-upward succession forms 1) as a prograding wedge, 2) as a simultaneously

LOW ENERGY, PALEOZOIC

LOW ENERGY, EVAPORITIC

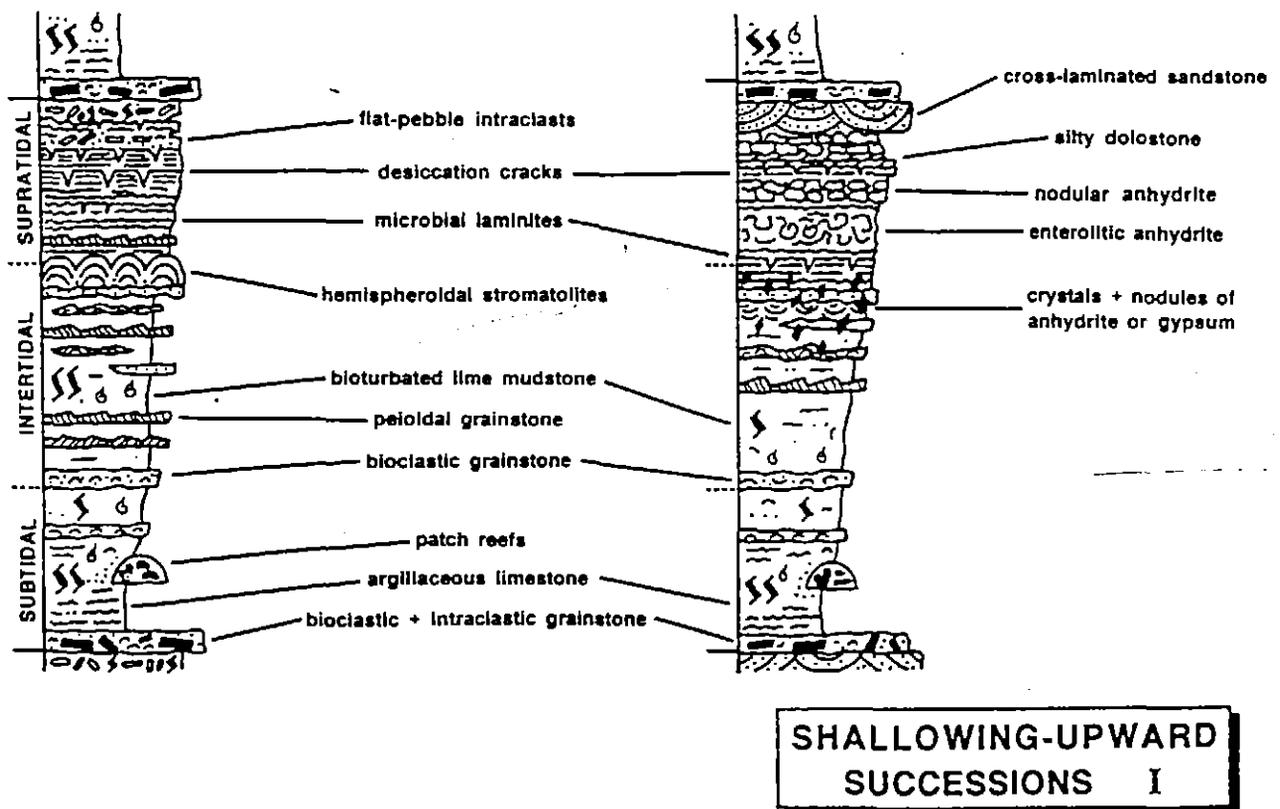


Figure 16 Hypothetical vertical profiles of individual low-energy, metre-scale, peritidal shallowing-upward successions. Left: from the lower Paleozoic; upper Paleozoic examples might exhibit calcretes at the top. Right: an evaporitic example (Chapter 19). No scale is implied, but each succession is typically 1-10 m thick.

aggrading sheet or, 3) as a mosaic of tidal flat islands (Fig. 19).

The prograding wedge

Holocene shallow-marine and peritidal environments are dynamic in that they shift geographically over geologically short periods of time in response to both local and regional changes in climate, prevailing wind direction, current pattern, and sediment supply. A single coastline, for example, may possess tidal flats that are accumulating and prograding, and tidal flats that are dormant or are eroding (e.g., Shinn *et al.*, 1969; Strasser and Davaud, 1986). Regardless, to generate a single, laterally extensive wedge that has peritidal, shallowing-upward attributes throughout, the tidal flat must prograde laterally from a nucleus. Such accretion can develop seaward from land, outward from islands, or shelfward from platform margin buildups and/or shoals. It must

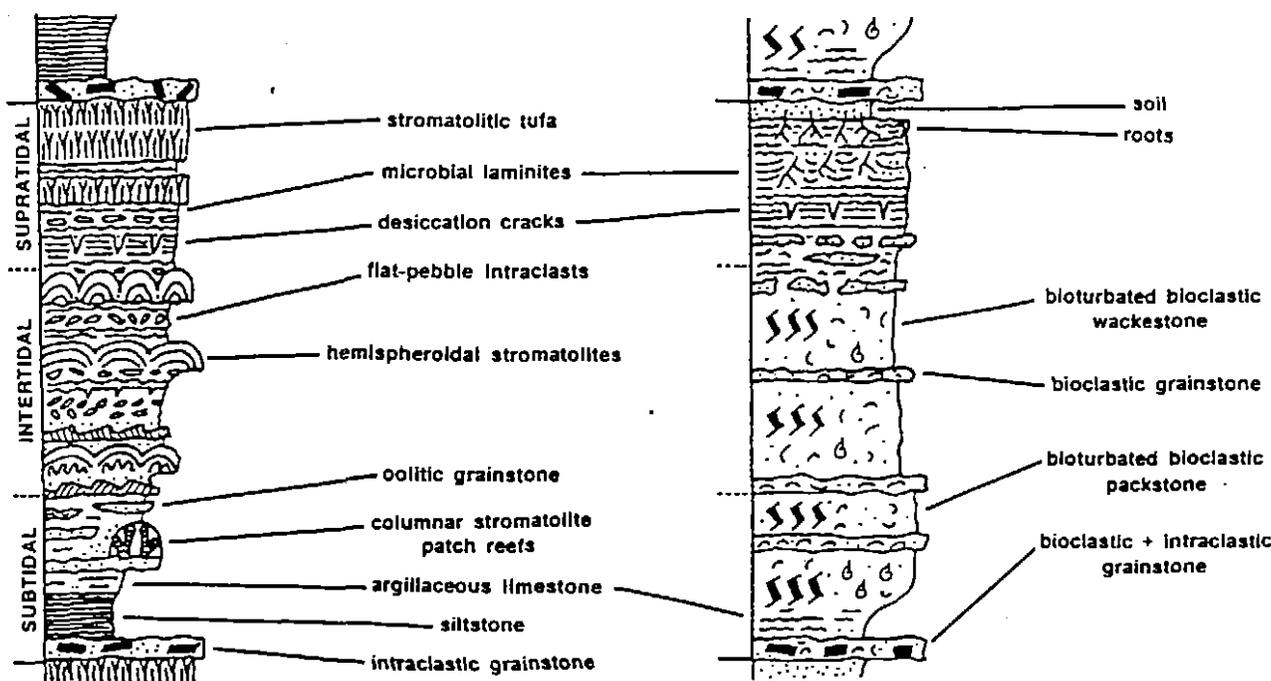
be stressed that deposition on the tidal flat is a physical process. Sediment generated on the platform is swept onto the flats by storms producing the gradually prograding tidal flat wedge. As such, the size and dynamics of the peritidal wedge are primarily a function of the health and nature of the source area (the subtidal carbonate factory) and the way in which sediment is redistributed on the platform (i.e., how much is transported to the flats, how much stays in place, how much is transported offshore into deep water).

The Holocene record of sea level change is one of rapid rise between 11 ka and 6 ka, followed by decelerated rise from 6 ka to the present. There are, unfortunately, few tidal flats that have been cored in enough detail to provide a good three-dimensional stratigraphic picture of deposition during this period. As a result of this small data base it is difficult to make generalizations. Nevertheless, at pres-

ent there appear to be two styles of progradation (Fig. 20), *simple offlap* and *staggered offlap* (Hardie and Shinn, 1986). Simple offlap is typified by the gradually prograding wedge along the southern coast of the Persian (Arabian) Gulf. Staggered offlap is characterized by the northern Bahamas tidal flats. In the latter case the tidal flat does not seem to have prograded but instead aggraded behind a protecting beach ridge. The vertical succession is mainly burrowed sediment, reflecting deposition in a variety of pond, channel and intertidal flat environments, capped by laminated upper intertidal to supratidal sediments. It is thought that tidal flat sedimentation began only when the offshore carbonate sand bar emerged to become a barrier. Once the flat aggraded to sea level, progradation took place by a series of jumps followed by back filling (Hardie, 1986). Such successions in the rock record should

LOW ENERGY, PRECAMBRIAN

LOW ENERGY, MESOZOIC



**SHALLOWING-UPWARD
SUCCESSIONS II**

Figure 17 Hypothetical vertical profiles of individual low-energy, metre-scale, peritidal shallowing-upward successions from the Precambrian (left) and Mesozoic (right). A comparison of these with the Paleozoic example in Figure 16 shows some of the lithologic changes exerted by biotic evolution through geologic time.

contain remnants of these barriers. The Abu Dhabi sabkha is reported to have buried barriers (Warren and Kendall, 1985) and may have also developed, in part, through staggered offlap.

For a wedge of tidal flat sediment to prograde from the strandline across an entire platform, accumulation of sediment must occur under relatively stable hydrographic conditions (i.e., sea level and climate) for the length of time represented by progradation. A rapid rise in sea level would flood the broad supratidal flat and halt progradation, whereas any fall in sea level would strand the tidal flat before transplatform progradation was complete.

This style of accumulation has been proposed to explain the extensive Cambro-Ordovician peritidal strata of the southern Appalachians (Hardie, 1986). Metre-scale peritidal shallowing-upward successions of this epeiric platform have been correlated (but not traced) for distances greater than 100

km parallel and perpendicular to depositional strike. Progradation at this scale, however, would produce vast areas of abandoned supratidal flats behind the prograding shoreline, far distant from the subtidal source of sediment and exposed to protracted subaerial diagenetic effects. Since constant and uniform subsidence would inundate this supratidal surface, progradation must have taken place while relative sea level was stationary or gradually falling. If progradation was simple offlap, then successions will be laterally continuous. If progradation was staggered offlap, successions will be discontinuous and separated by lenticular beach deposits.

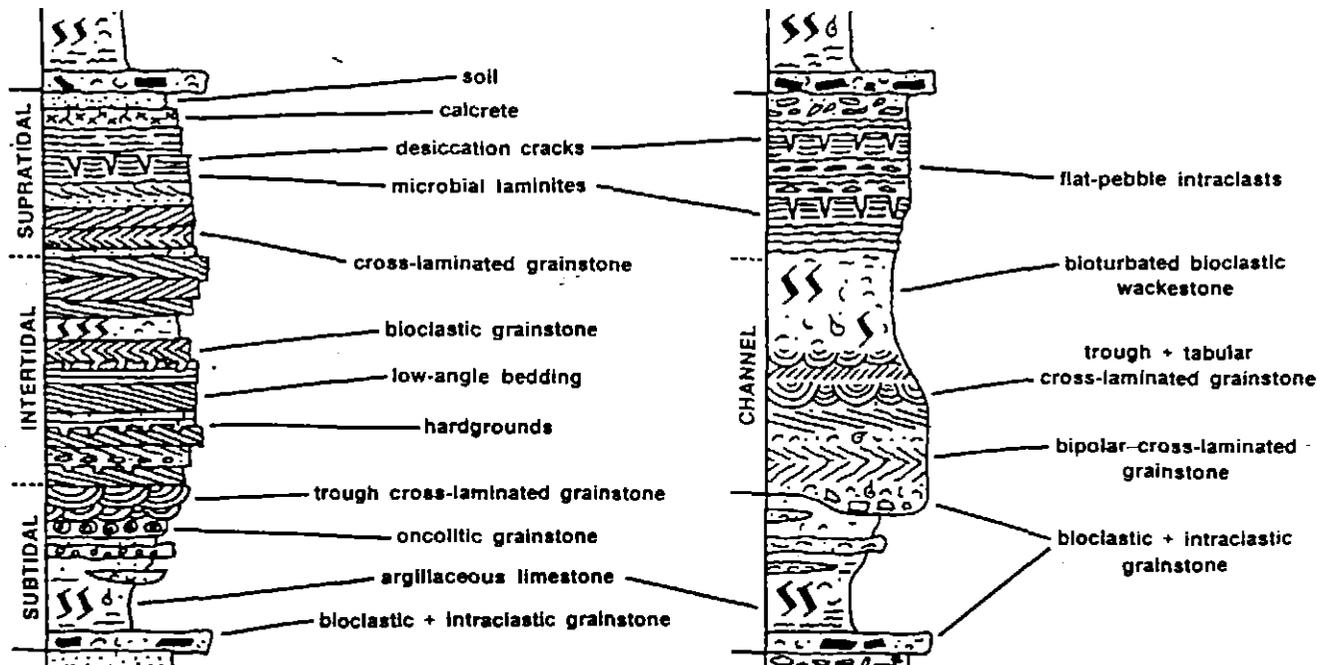
Simultaneously aggrading sheet

In this situation, continuous in situ carbonate sediment production results in aggradation of the seafloor steadily to sea level. The entire platform becomes intertidal and then supratidal, and can be completely exposed before

flooding and deposition of the next overlying succession (Fig. 19). There are no Holocene analogues for this process; it is derived entirely from interpretation of the rock record, and therefore is poorly constrained. Platform-wide peritidal exposure under these circumstances cannot be *intertidal* per se, because it is unlikely that tides could operate across such a vast horizontal distance all at once. Instead, alternating flooding and exposure would have to be induced through the movement of the sea surface by periodic storm surges or persistent winds. Such a style of *occasional* exposure and submergence may be difficult to distinguish in the rock record from true *intertidal* conditions. This hypothesis demands that at least some sediment be produced on the flats when the whole platform is in the intertidal-supratidal environment. Such accretion could predictably produce platform-wide, laterally continuous, metre-thick shallowing-upward successions, such

HIGH ENERGY (BEACH)

"HIGH" ENERGY (CHANNEL)



**SHALLOWING-UPWARD
SUCCESSIONS III**

Figure 18 Hypothetical vertical profiles of individual high-energy, metre-scale, peritidal shallowing-upward successions, from a setting characterized by beach development (left) and a tidal flat penetrated by channels or creeks (right).

as those inferred from Cambrian strata by Koerschner and Read (1989).

Tidal flat-islands

An alternative model has been postulated to explain shallowing-upward peritidal successions that are demonstrably laterally discontinuous (Pratt

and James, 1986). In this *tidal flat island* model deposition is envisioned as taking place on a platform dotted by a mosaic of exposed low-relief islands and intertidal banks separated by subtidal source areas (Fig. 19), with the whole complex shifting laterally and vertically through time in response to a

range of local and regional hydrographic conditions. Such islands are developed today in Florida Bay and illustrate two modes of Holocene accumulation, 1) physically deposited mud banks capped by prograding intertidal and supratidal sediments, and 2) entirely supratidal deposition of a coastal mud flat, later dissected by erosion (Enos and Perkins, 1979; Wanless and Tagett, 1989). These islands, however, have not migrated much during the relatively short period of Holocene flooding. If viable, this tidal flat island model severely limits the architectural predictability of ancient platforms, as the constituent facies, particularly the supratidal caps, are of inherently limited regional extent.

Asymmetry

Why is a metre-scale, peritidal shallowing-upward succession asymmetric? The characteristic asymmetry of a typical shallowing-upward succession, i.e., subtidal (A), intertidal (B) and supratidal (C) stacked in ABC → ABC *hemicycles* (Figs. 16, 17, 18), as opposed to full CBABC cycles, is generally attributed to problems with the source area during platform inundation. If the flooding which begins a succession were gradual, then the seafloor during initial submergence is thought to have been too wave swept and/or too shallow or restricted to produce much carbonate sediment. Thus there is a "lag time" or "lag depth" (Hardie, 1986) before the seafloor becomes deep enough to actively produce sediment that is subsequently moved onto the tidal flats. In some successions this time interval is represented by a coarse-grained "transgressive" facies at the base, whereas in others there is no obvious record of this hiatus in deposition. Alternatively, if flooding was rapid, then supratidal facies (C) would be rapidly drowned and intertidal facies (B) would not have time to accumulate.

PERITIDAL CYCLOSTRATIGRAPHY

The stratigraphic record of ancient peritidal carbonates tends to be one of persistent repetition of the basic metre-scale, shallowing-upward succession, imparting a characteristic *cyclic* or, more appropriately, *rhythmic* appearance to the strata. While Holocene tidal flats sometimes provide an analogue for the generation of one

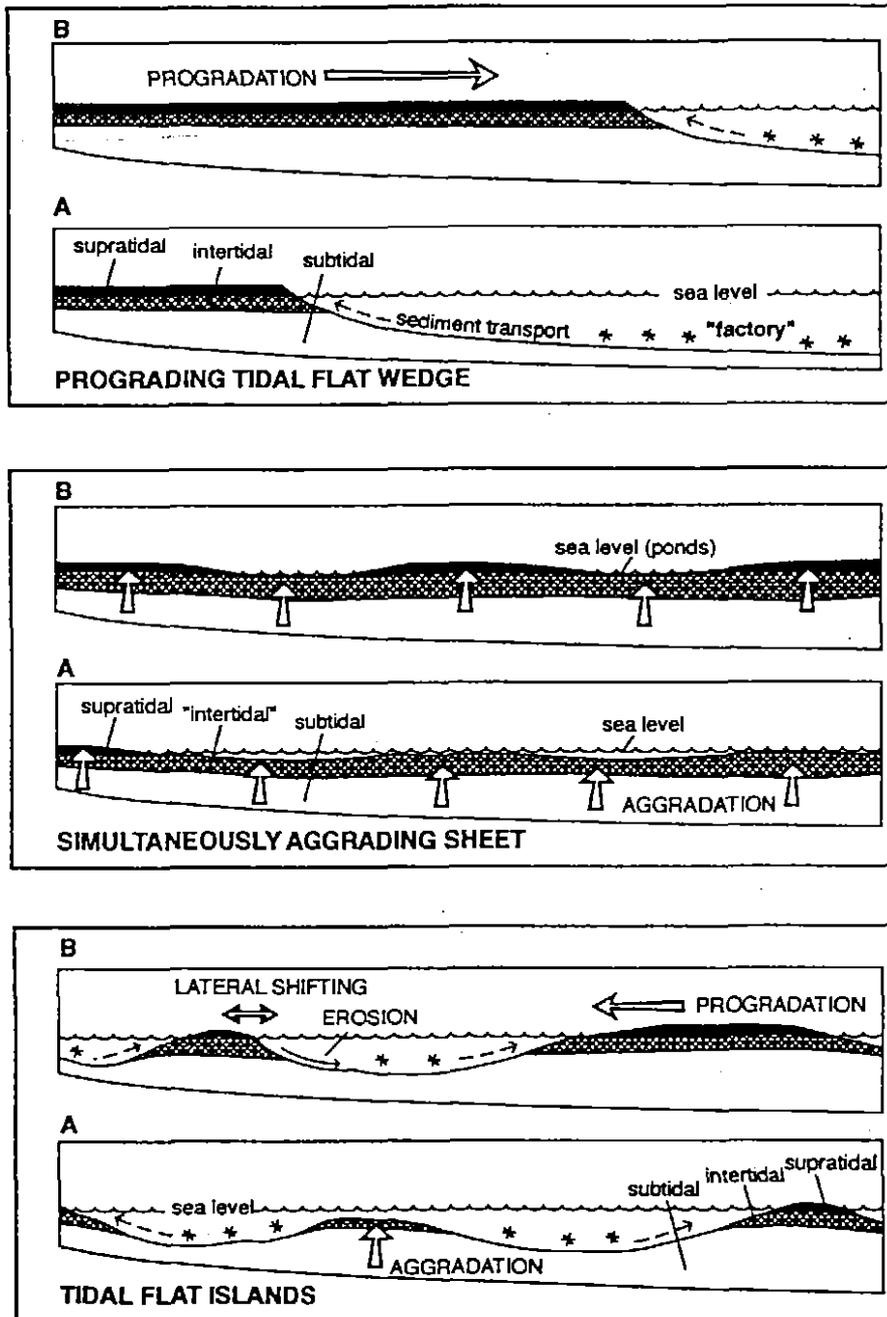


Figure 19 Diagrams illustrating various ways in which a metre-scale, peritidal, shallowing-upward succession can form. A prograding wedge is generated by sediment transported onto the tidal flat from the offshore carbonate factory. A simultaneously aggrading sheet accretes vertically to sea level and the whole platform becomes sequentially intertidal and then supratidal. Tidal flat islands nucleate and accrete by aggradation and progradation and shift in response to hydrographic forces.

shallowing-upward succession, the cause of stratigraphic repetition must be derived from the rock record. The Pleistocene history of climate and sea level change, although the most detailed and best understood of past epochs, has left a stratigraphic record of limited usefulness because sea level fluctuations were so large that they did not result in stacked metre-scale shallowing-upward successions. Consequently, there is currently much discussion as to what causes the rhythmic stacking into thick stratigraphic packages of ancient shallowing-upward successions. Debate has centred around the question of whether the new space made available for each successive shallowing-upward succession is the result of 1) recurring sea level changes (perhaps eustatic) at the same scale and temporal rhythm as the lithologic packaging; or 2) a high-frequency packaging mechanism *intrinsic* to processes of carbonate sedimentation which are superimposed on a low-frequency or irregular sea level rise. These are the *allocyclic* and *autocyclic* mechanisms, respectively, (see also Wilkinson, 1982). The two stacking mechanisms are not necessarily mutually exclusive, and it is uncertain at the moment whether or not evidence for either mechanism can be isolated in the rock record (Hardie *et al.*, 1991; Read *et al.*, 1991).

There is good evidence that a typical shallowing-upward succession was deposited within a time span of 10-100 k.y. (Algeo and Wilkinson, 1988). This is a scale of resolution beyond that provided by biostratigraphic methods. Much of the time represented by stacked shallowing-upward successions, however, is accounted for by hiatuses. Thus the time of deposition for a given tidal flat succession may be only a small fraction of the total apparent stratigraphic time; Wilkinson *et al.* (1991) have suggested as little as 3-30 per cent for some successions.

Autocyclicity

The driving force behind autocyclicity is the dynamics of sedimentation on the platform. Assuming optimum conditions, production rates for shallow-marine carbonate detritus could potentially provide enough sediment over a period of 10-100 k.y. to account

for tidal flat aggradation to sea level or progradation of many tens to perhaps hundreds of kilometres under essentially static sea level conditions on a gradient which experienced typical passive-margin rates of subsidence (see also Hardie and Shinn, 1986).

Progradation is inherently limited by the sediment budget of the carbonate platform. For example, in a model first proposed by Ginsburg (1971; see Bosellini and Hardie, 1973; Mossop, 1979), a tidal flat wedge is envisioned as prograding across a gently inclined, gradually subsiding platform under static or slowly changing sea level (Fig. 19). As progradation covers the platform, the subtidal source area for tidal flat sediments becomes increasingly smaller (and deeper). Eventually the source area is too small or too deep to provide sediment for the tidal flat, so sedimentation stops. If relative sea level continues to rise, however, soon the whole platform will once again be subtidal and, after a lag period, the carbonate factory will be robust enough for sediment production, and the cycle will begin again.

The meagre areal coverage of present-day tidal flats makes it difficult to envision a platform literally choking itself off through hundreds of kilometres worth of tidal flat progradation under steady-state sea level and subsidence conditions. Furthermore, it should be emphasized that interpreta-

tions of platform-wide progradation in ancient examples are usually based on correlation of strata assumed to be diachronous, not on continuous stratigraphic exposure.

Under conditions of platform-wide *aggradation* it is thought that, once flooded, a shallow platform could generate enough sediment in situ that the whole seafloor would inexorably build to sea level (Fig. 19). Fundamental to this hypothesis is the ability of the "intertidal" and "supratidal" environments to produce sediment. The next cycle would accrete once relative sea level rise had submerged the platform in water deep enough for subtidal sedimentation to begin again. Critics of this hypothesis argue that, in order for the sediment surface to intersect the air/water interface on a platform-wide scale, there must be a sea level fall (albeit minor — a metre or less?), because it is unlikely that the seafloor would everywhere build right up to sea level of its own accord. This model is based on examples where shallowing-upward successions are correlated on a regional scale and assumed to be synchronous deposits.

Tidal flat islands are in part aggradational and in part progradational and their location is thought to shift through time in response to changing hydrographic conditions (Fig. 19). During intervals of prolonged static sea level, or slow sea level rise, they would, like the

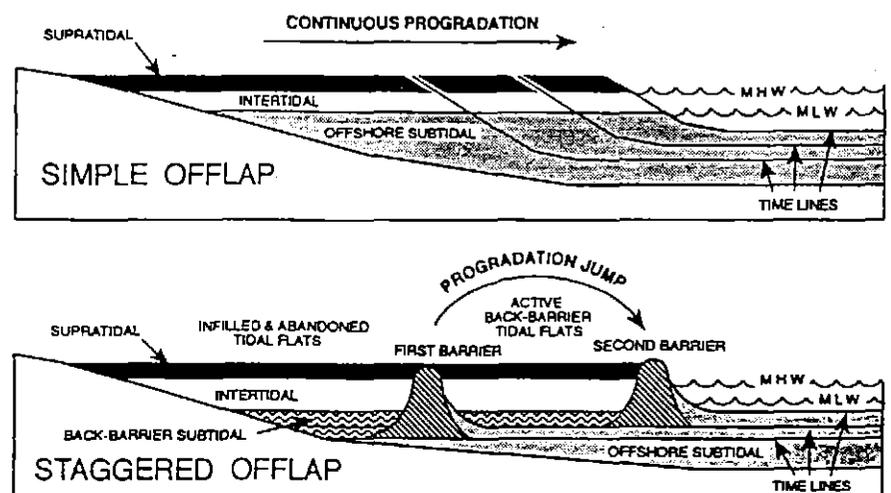


Figure 20 A diagram depicting two styles of tidal flat progradation envisioned from Holocene tidal flats. Simple offlap takes place by continuous progradation. Staggered offlap takes place by formation of an offshore bar which creates a leeward, protected setting in which tidal flat aggradation occurs. Once the flat builds to sea level it becomes dormant until another bar forms seaward and the process of backfilling begins again. Adapted from Hardie (1986).

prograding wedge, gradually choke off local source areas, eventually becoming dormant. For sedimentation to begin again after a period of local stasis and probably protracted exposure of supratidal flats, there must be creation of new accumulation space. Under conditions of more rapid long-term sea level rise, and continually renewed accumulation space, the islands would form a series of laterally discontinuous peritidal units.

These autocyclic models express a basic premise that pervades current thinking about peritidal carbonates. Persistent and ubiquitous stratigraphic repetition of the basic shallowing-upward succession seems to indicate that these systems are, at least in part, intrinsically self-governing.

Alloccyclicity

The extrinsic factors of subsidence and eustasy, which cause relative sea level change, have long been assumed to exert strong control on large-scale peritidal stratal patterns. High-frequency, low-amplitude sea level changes, the fourth- and fifth-order fluctuations of sequence stratigraphy (Chapter 2), are commonly invoked to drive the packaging of metre-scale, shallowing-upward peritidal successions (Grotzinger, 1986; Koerschner and Read, 1989; Read *et al.*, 1991). In this situation, a metre-scale rise in relative sea level provides a *window of opportunity*, in the sense of both time and accumula-

tion space, for the generation of a single shallowing-upward succession (Fig. 21). Deposition occurs while sea level is rising and at its apex, and is arrested by sea level fall.

Formation of the shallowing-upward succession in this window is envisioned in different ways by different workers. All three styles of accretion presented above are viable within this scheme (prograding wedge, Grotzinger, 1986; aggradation, Koerschner and Read, 1989; and tidal flat islands, Strasser, 1988). Extrinsically controlled metre-scale successions of many kinds, including peritidal, have also been called *punctuated aggradational cycles* (PACs; Goodwin *et al.*, 1986) or more recently *metre-scale allocycles* (Anderson and Goodwin, 1990). Such cycles are metre-scale units, bounded by surfaces of abrupt change to deeper or disjunct facies and comprising a suite of contemporaneous facies, all of which shallow upward. The peritidal portions of such cycles are thought to be aggradational, but there is no reason why they could not be progradational (either wedges or islands).

The most commonly postulated external controls to drive, or at least reset, the system at the end of each shallowing-upward succession are rhythmic eustatic change or jerky subsidence. While spasmodic subsidence with the required short frequency has been documented from seismically active areas and for passive margins where listric

faulting is common (e.g., Cisne, 1986; Hardie *et al.*, 1991), the importance of subsidence rate changes as a control on stratigraphic rhythmicity in peritidal shallowing-upward successions is unclear. Sudden base level drops have not been observed in modern passive margin platforms, and ancient epeiric settings, where much of the peritidal record is found, seem unlikely to have experienced metre-scale, high-frequency spasms of subsidence. Because there is currently no known frequency to such tectonism, it is difficult to use, and as yet impossible to model this mechanism as a universal control of stratigraphic rhythmicity. Nevertheless, the mechanism should not be dismissed as a potential control, especially in tectonically active regimes (e.g., Fischer, 1964; Knight *et al.*, 1991).

In the early to mid-1970s studies of DSDP sediment cores and relict coral reef terraces demonstrated that the Pleistocene record of eustatic change is one of superimposed orders of sea level variation (orders, in the sense of both magnitude and frequency; Chapter 2). Deep sea sediments were analyzed for oxygen isotopes (as proxy for glacial ice volume) and revealed a long-term (100 k.y.), 100 m-scale, asymmetric sea level oscillation. Pleistocene fossil reef data suggested that a shorter term (20 k.y.) sea level oscillation was superimposed on the longer term fluctuation. These various orders of eustatic change have been correlated to those predicted for icehouse glaciation driven by celestial mechanics, i.e., the Milankovitch rhythm (e.g., Fischer, 1986). It has been postulated that the stratigraphic rhythmicity apparent in ancient peritidal carbonates reflects a similar *composite eustasy* (Goldhammer *et al.*, 1987), both icehouse and greenhouse, of celestial origin. If astronomically forced composite eustasy is indeed the primary driver in the packaging of shallowing-upward successions, then presumably modulation of various orders of superimposed eustatic cycles could have provided potentially limitless rhythms to the stratigraphic record (Bova and Read, 1987; Koerschner and Read, 1989; Read *et al.*, 1991).

The common challenge to alloccyclicity is that extrinsic controls on peritidal sedimentation are neither demonstrable in, nor theoretically re-

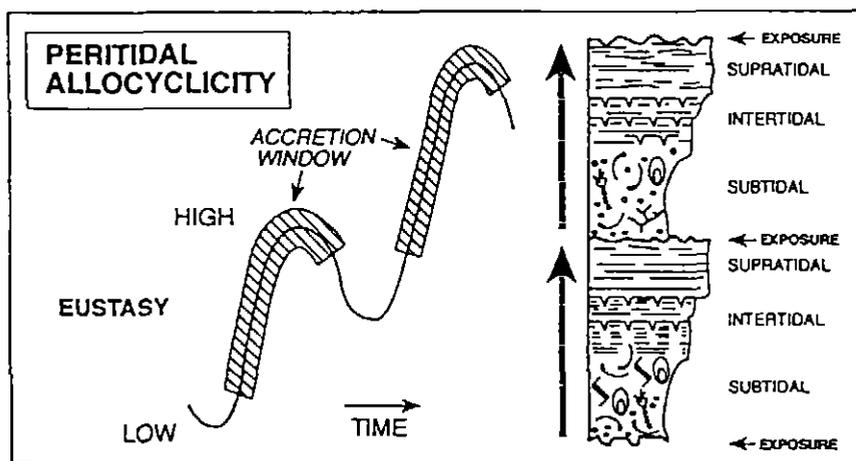


Figure 21 A diagram illustrating the relationship between fluctuating sea level and stacked metre-scale, peritidal, shallowing-upward successions. Sea level rise provides a window of opportunity for the succession to accrete as a prograding sheet or as tidal flat islands. Sea level fall terminates accretion and results in sub-aerial exposure.

quired to generate metre-scale shallowing-upward successions. It is hard, however, to imagine sea level remaining static for a long period of time, and therefore difficult, if not impossible, to dismiss some extrinsic control on succession development. Allocyclic, platform-wide event stratigraphy should not be underestimated, but its deterministic role in peritidal cyclostratigraphy is still uncertain.

The search for controls and rhythms

Significant effort has recently been devoted to unravelling the meaning of possible stratigraphic rhythms in stacked shallowing-upward successions by numerical analysis. Because peritidal carbonates are so sensitive to changes in climate and sea level, it was widely suspected (hoped?) that this rhythmicity might retain a causative signal of ancient climate and sea level fluctuations. If allocyclic eustatic control on stratal packaging is assumed, then reconstruction of the strata-generating sea level curve can be used as a tool to correlate and explain temporally correlative strata (Read and Goldhammer, 1988).

At the current level of understanding and data base, it is not possible to isolate unequivocal evidence in the rock record for either allocyclic or autocyclic control on most peritidal stratal patterns. Reasonable-looking, synthetic, one-dimensional stratigraphic sections can, however, be generated by varying the critical input parameters of cycle amplitude, duration and asymmetry, bathymetry for each facies, lag time (depth), type of sediment, sedimentation rate, regional and local subsidence, isostatic compensation, wave damping, tidal range, and platform slope and dimension (Grotzinger, 1986; Read *et al.*, 1986; Goldhammer *et al.*, 1987; Spencer and Demicco, 1989). These sections can then be compared to actual examples and eventually a match may be achieved. When similar modelling techniques are used to simulate two-dimensional (multisection) architecture it is often found that the time needed for a peritidal wedge to prograde across the platform is longer than that predicted by Milankovitch rhythms, and the wedges become *stranded*.

Techniques, such as relative time

series analysis and *Fischer plotting*, which made a good case for allocyclic forcing of some examples of platform carbonate rhythmicity, i.e., stratigraphic patterns attributable to rhythmic Milankovitch composite eustasy (Goldhammer *et al.*, 1987, 1990), cannot be used for the analysis of metre-scale *peritidal* shallowing-upward successions. Relative time series analysis to reveal the rhythms of sedimentation are invalid for progradational wedges, either local or platform-wide in extent, because such deposits are by nature diachronous, and thicknesses of resultant shallowing-upward successions vary with position on the regional gradient and/or platform topography. Fischer (1964) presented a graphic means of plotting time versus cumulative thickness for laterally continuous, stacked, peritidal shallowing-upward successions. Fischer plots have often been used in recent studies of cyclic strata because they are designed to reveal changes in accumulation space which deviate from that space generated solely by subsidence; these deviations are postulated to result from changes in sea level. However, interpretations of Fischer plots are essentially model driven. For them to be viable two assumptions must be satisfied: 1) each peritidal succession must have been deposited in the same amount of time as every other succession in the chain, and 2) there must be few, if any, missing tidal flat successions. The use of Fischer plots is therefore dubious for any peritidal successions which formed as prograding wedge-shaped tidal flats. It is likely that variations in both the tempo and magnitude of changes in accumulation space, however they are caused, account for stacks of shallowing-upward successions which vary in thickness. Whereas demonstration of allo- or autocyclic control of stratal patterns in stacked shallowing-upward successions appears out of reach at this time, more sophisticated models, particularly those which integrate peritidal rhythms with coeval subtidal and perhaps offplatform stratal patterns, hold promise.

PERITIDAL SEQUENCE STRATIGRAPHY

The concepts of sequence stratigraphy were developed in terrigenous

clastic successions and carbonates have only recently been analyzed in this fashion (Chapter 14). *Systematic* packaging of the basic metre-scale shallowing-upward succession is less common and seems less straightforward, or less well developed in carbonates compared to siliciclastics. This difference likely reflects the fundamental differences between carbonate and siliciclastic sediments generally. We have, therefore, avoided the term *parasequence* in this treatment of carbonate tidal flat deposits.

Peritidal deposits are not indicative of any particular systems tract because the controls on tidal flat development, such as climate, platform circulation, wind patterns and tidal range, vary with each platform's unique history and configuration. Nevertheless, tidal flat deposits are potentially useful in delineating sequences and their component systems tracts in two ways, 1) geographic position of the tidal flat on the platform may track long-term changes in sea level, and 2) changes in large-scale accumulation space, and thus sequences, can be recognized through analysis of stacking patterns (packaging) of shallowing-upward successions.

Tracking sea level

Tidal flats can be the first facies overlying a sequence boundary, deposited as the rate of relative sea level fall decreases and the sea slowly floods back across the platform. As third-order sea level fluctuates in response to long-term, large-amplitude driving forces, the location of the strandline on the platform will change. If conditions are favourable for their development, land-fringing tidal flat deposits will mark the position of coastal onlap through the third-order eustatic cycle (i.e., the "onlap-offlap" geometry of Hardie, 1986; Fig. 22). Sarg (1988) documented the utility of tidal flats at the outcrop scale in a sequence stratigraphic context for the Permian of New Mexico, where a sequence boundary and shelf-margin wedge systems tract were recognized in part by the downdip, basinward position of onlapping tidal flat deposits.

Stacking

The stratigraphic patterns of *laterally continuous*, metre-scale, shallowing-upward successions generated by pro-

grading tidal flat wedges, can be envisaged in the framework of long-term changes in relative sea level. Third-order sea level changes are thought to "modulate" the higher-frequency, fourth- and fifth-order sea level cycles represented by the tidal flat successions. This has two consequences.

Long-term, third-order fluctuations in sea level should carry the window of opportunity in which each individual metre-scale succession is formed back and forth across the platform. Depending upon the balance between different rates of subsidence, eustasy and sedimentation, the window will be geographically repositioned during each consecutive fourth or fifth-order change in relative sea level to result in backstepping, offlapping or stacking of peritidal shallowing-upward successions. Figure 22 illustrates, in a conceptual way, how this might work on an inclined shelf. If the rate of change of long-term relative sea level is *low*, the geographic position of successive windows should remain roughly the same. Thus, peritidal successions in lowstand (position 1) and early highstand (position 3) systems tracts will probably be stacked in one place and will be relatively thin because the rate of addition of new accumulation space

is low. If the rate of change is *high*, the window should be forced backward and forward across the shelf. This will likely result in either relatively thick, backstepped tidal flat successions (position 2 – transgressive systems tract) or relatively thin successions which offlap in a shingled fashion (position 4 – late highstand or early lowstand systems tracts). It must be stressed that the distance of progradation in each case will be specific to each peritidal package on each shelf.

Long-term sea level rise should accentuate short-term rises and suppress short-term falls; long-term falls in sea level will have the opposite effect. The relative proportions of subtidal, intertidal and supratidal facies in successive shallowing-upward successions may change systematically in response to this long-term modulation of short-term changes in accumulation space. This relationship is as yet hypothetical, and interpretations of such controls in ancient strata are necessarily model driven.

SUMMARY

Peritidal limestones and dolostones exhibit a large number of easily recognized sedimentary and biosedimentary structures. While some of these are in-

dividually equivocal bathymetric indicators (stromatolites or wave-rippled beds, for example, can form in subtidal areas), in most cases the features can be used collectively to make a firm environmental conclusion. A boon to interpreting ancient peritidal facies is the wealth of knowledge gained from modern settings. Very often a one-to-one lithologic comparison can be made, leading to a refined understanding of paleoenvironments and paleoclimates in individual cases. A *hierarchy of models* has been formulated that deals with successive levels of interpretation of peritidal carbonate strata.

These kinds of rocks fall into two main depositional systems, low-energy tidal flats and higher-energy beaches. The facies associations are fairly distinctive for each setting: this is the first tier of models to guide basic interpretations.

The vertical record of peritidal facies commonly shows a trend from subtidal limestone through intertidal sediments to supratidal deposits, at a metre scale, as tidal flats aggrade to sea level and prograde laterally. Peritidal models are therefore shown as shallowing-upward successions as a reminder of these dynamic processes.

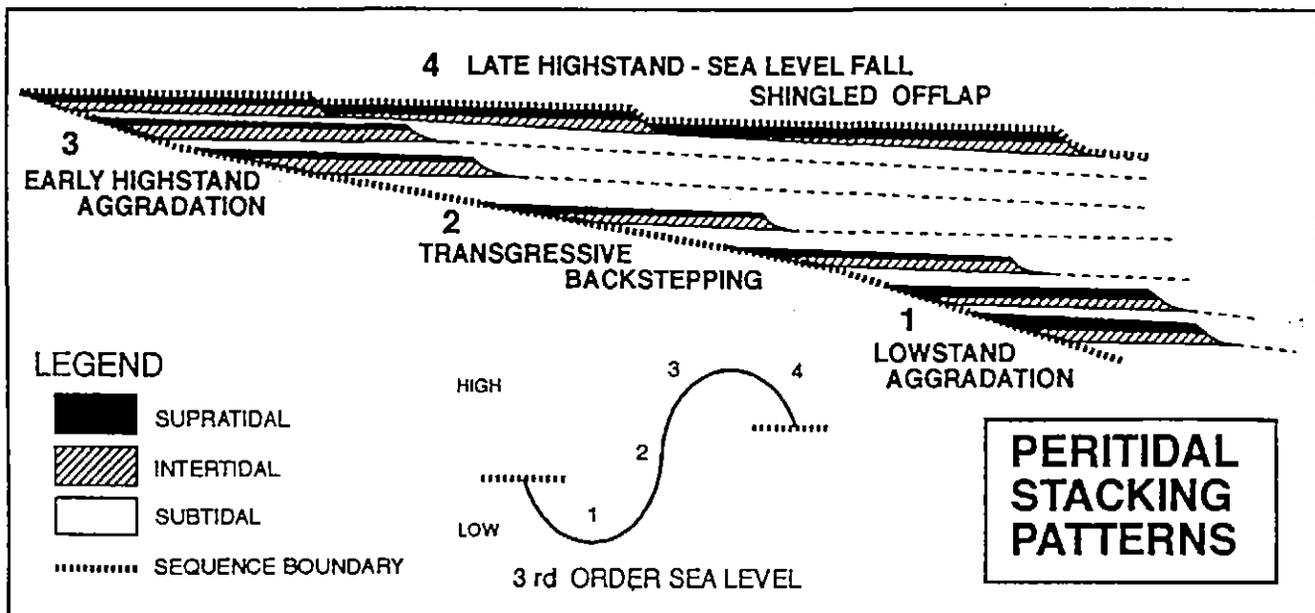


Figure 22 A diagram illustrating the hypothetical stratigraphy of metre-scale, peritidal, successions between two sequence boundaries. Each succession formed by progradation which took place in the window of opportunity produced by short-term fourth- and fifth-order fluctuations in relative sea level during a long-term, third-order rise and fall of sea level. Slow, third-order, sea level-controlled movement of the strandline will dictate where tidal flats develop on the shelf. The balance between sea level changes, sedimentation, and subsidence will dictate how successive tidal flats will stack, backstep or offlap.

These models, as predictors, point to departures from the norm and other irregularities that might have important implications regarding intrinsic or extrinsic controls on deposition. They also provide a framework within which the diagenesis of the sediment can be tracked.

Peritidal carbonates occur repetitively in stratigraphic sequences, often in a seemingly regular, or cyclic, fashion. There is much debate about whether these metre-scale, shallowing-upward successions are platform-wide responses to allogenic forces such as spasmodic subsidence or episodic eustasy, or whether they represent localized tidal flat shorelines and islands shaped by autogenic, i.e., hydrographic, controls. Sedimentologists have their work cut out for them by these models; we are now charged with the job of deciding, if possible, which one best explains our own successions, or if a new approach is necessary. It is an exciting field of research, one that weds careful and precise field observations with increasingly sophisticated numerical modelling.

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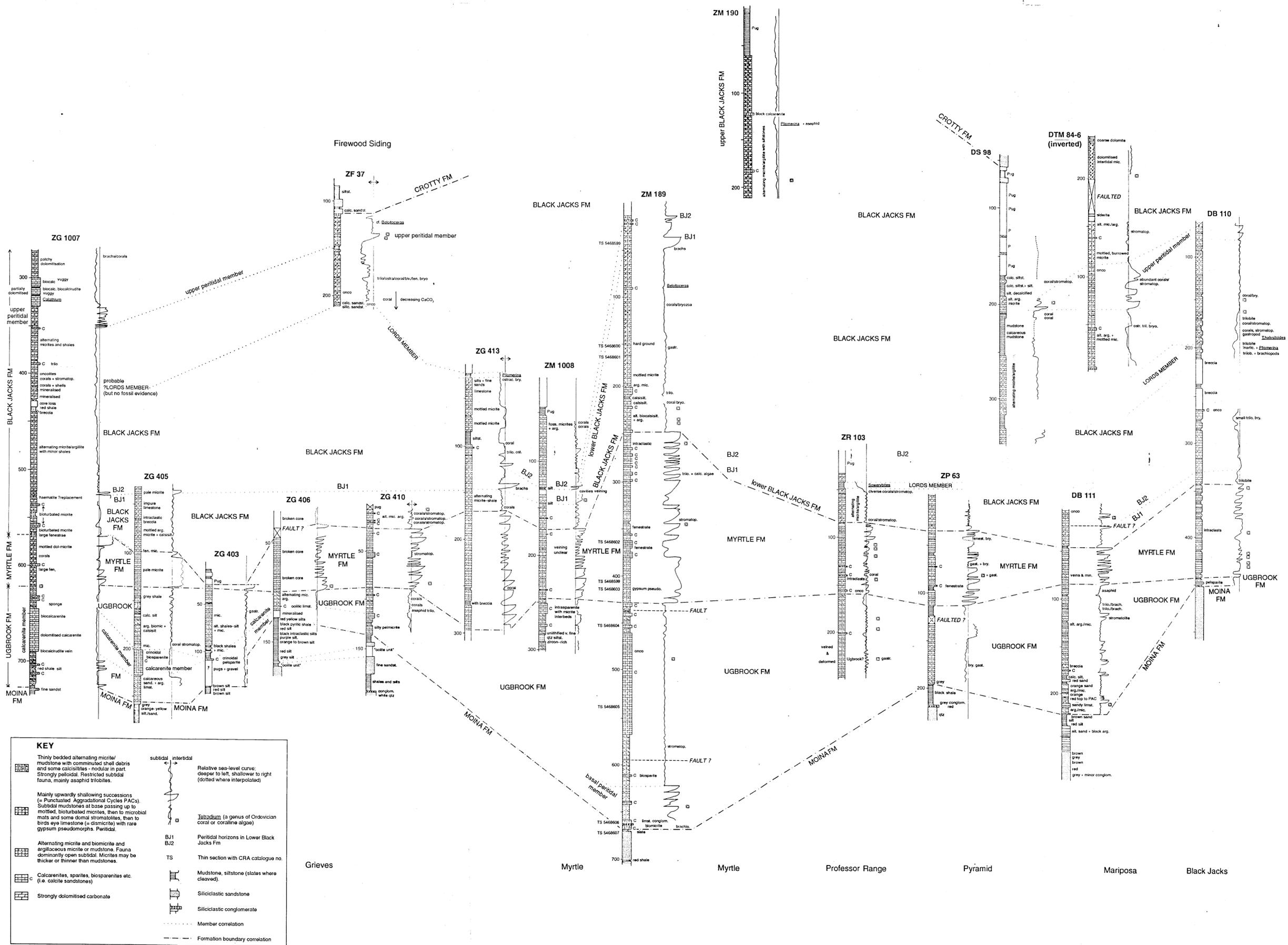
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Appendix XV

Zinc Mineralisation in the Gordon Limestone

Zinc Mineralisation of the Gordon Limestone

CRAE's exploration and research activities directed at locating carbonate-hosted Zn-Pb mineralisation within Gordon Limestone at Zeehan have led to a number of mineralisation styles being recognised. The following discussion is a synthesis of CRAE's current level of knowledge, gained from work throughout the Zeehan area.

CRAE's exploration activities in the Zeehan area have indicated that Zn-Pb mineralisation within the Gordon Limestone may be pre-Devonian in age, and therefore unrelated to the Tabberabberan Orogeny. On this basis, it is possible that carbonate-hosted Zn-Pb mineralisation may be more widespread than that presently under evaluation at Zeehan.

The Gordon Limestone originally occupied a large area, deposited at the close of a major period of tectonic activity that produced the metal-rich Mount Read Volcanics. During and immediately before carbonate deposition the tectonic regime was still unstable, evidenced by rapid changes in stratigraphic thickness of Ordovician strata. Hydrothermal systems may have continued to emit metals into this system, focused by basement irregularities and syn-sedimentary faults. Basin-bounding syn-sedimentary faults in the Zeehan area are WNW-trending, and include the Firewood Siding Fault on the SW side, and Professor Range and Balstrup Faults on the NE side.

The present Gordon Limestone exposure is a vestige of Devonian deformation. Ordovician mineralisation may have a distribution totally independent of the well-documented Devonian systems.

Five targets are recognised for the carbonate-hosted Zn mineralisation in Gordon Limestone at Zeehan, subdivided by the stratigraphic interval in which they are hosted (Figure):-

- stratabound at the lower limestone-sandstone contact
- stratabound at the upper limestone-quartzite contact
- stratabound within a sub-unit in the middle of the limestone sequence
- structurally controlled discordant mineralisation
- surficial "clay-hosted" accumulations developed above primary mineralisation.

Stratabound at the lower limestone-sandstone contact

Mineralisation at Grieves and Mariposa falls into this category. Alteration located at Blackjacks, Pyramid and Professor Range may also belong to this deposit type.

This position is characterised by carbonaceous and/or ferruginous clays resting on the Moina Sandstone, in turn overlain by a massive siderite zone. The siderite zone passes stratigraphically upward either gradationally or abruptly into unaltered and unmineralised limestone. The clay layer may be up to 50m thick and the siderite zone up to 25m thick. Both may contain Zn mineralisation up to several percent. The clay and siderite zone are laterally quite uniform and it may be that the mineralisation is actually stratiform.

Mineralisation of this style has an alteration halo that is both visually and geochemically distinct. This halo, characterised by vuggy, broken or massive recrystallised Fe-carbonate and Fe-rich clays, may extend laterally hundreds of metres beyond the main Zn mineralisation, and thus present a considerably larger target than the mineralised core. Lateral alteration geochemistry is reflected by Fe-Mn-As-Zn. Stratigraphy above the mineralised core is a weaker halo of elevated Zn (\pm As).

Ore mineralogy, based on work at Grieves, is complex with a mixture of zincian siderite and minor sphalerite in the siderite zone, and a Zn-clay with minor to moderate amounts of sphalerite in the clay zone. It is not known whether this is a regional characteristic of this position. It could be possible that the complex clay mineralogy is a supergene weathering process acting on an original sphalerite-pyrite mineralised black shale. The siderite may be capping the sulphide systems, preserved in its primary form due to its low porosity and permeability.

The stratiform character, replacive style of alteration/mineralisation, intense Fe-Mn alteration, and reasonably predictable geometry suggest similarities to Navan or Reocin.

Stratabound at the upper limestone-quartzite contact

Low-grade but widely anomalous zones from Firewood Siding, Grieves, Professor Range, Sunny Corner, and Mariposa are examples of this type.

Upper zone mineralisation occurs near the contact between the limestone and overlying Crotty Quartzite. Mineralisation is not closely bound to the upper quartzite contact, but may "wander" up to 100m stratigraphically below the contact.

Mineralisation appears characterised by widespread but low-level Zn in the 0.1% to 2% Zn range. None of the prospects tested has revealed a higher-grade core, although given the limited drilling it is entirely possible high-grade cores may exist. Limited mineralogy suggests all Zn to be as sphalerite.

Aircore drilling shows the mineralised zones to be comprised of clays and decomposed carbonate. Rare fresher material is usually a granular recrystallised dolomite, and can be ferroan. Intense siderite alteration is absent. A detailed geochemical study of the alteration has not been completed.

The upper zone style may be occurring within karstic structures formed by Ordovician weathering before deposition of the Crotty Quartzite. This setting is analogous to Bleiberg or Cracow-Silesia.

Stratabound in a middle sub-unit of the limestone sequence

Currently two occurrences fall into this grouping, Grieves middle zone, and Oceana. Apart from their stratigraphic concurrence, these two deposits may not share many other similarities.

The mineralised middle sub-unit is equidistant from the upper and lower contacts, although facies variations may affect the location at other prospects. Mineralisation is breccia hosted, and in the case of Grieves has a linear aspect. For Grieves there is very little indication of proximity to mineralisation as there is virtually no alteration outside the breccia zone itself.

Mineralogy at Grieves is a mixture of zincian siderite and sphalerite. Oceana is dominated by galena with subordinate (?) sphalerite. There is also intense siderite alteration at Oceana, presumably containing Zn?

Zinc grades at both prospects are high, locally forming massive sulphide.

There has been insufficient work completed at Grieves middle zone to suggest any controlling mechanisms.

Structurally controlled discordant mineralisation

Most mineralisation in the Zeehan area is structurally controlled. Mineralisation at the historic Mariposa mine, and at Myrtle belong to this type. Possibly some of the mineralisation at Oceana is also structurally controlled.

Structurally controlled mineralisation may occur at any stratigraphic level. It appears to be late-stage filling of brittle fractures. Alteration of wall-rocks is absent, and the gangue to mineralisation may be pure calcite. Mineralisation within the structures is patchily distributed. Ore minerals are coarse-grained sulphides.

Devonian deformation is the likely cause of the fracturing and mineralisation. Potential deposit size is small, although the presence of discordant mineralisation may indicate a nearby stratabound source. Late-stage structurally controlled deposits *per se* are not currently considered a valid CRAE target.

Surficial "clay-hosted" accumulations developed above primary mineralisation

Surficial Zn accumulations within decomposed carbonate was CRAE's original target for carbonate exploration in Zeehan. All currently tested prospects were selected due to the presence of known surficial mineralisation.

It has now been conclusively demonstrated that the surficial mineralisation occupies the surface trace of underlying stratabound mineralisation. Geometry of the surficial deposits are therefore dependent on the shape and extent of this underlying mineralisation. Depth extent of the Zn-rich clays and decomposed carbonates averages 10m to 20m, but have been reported to be over 100m at Oceana.

A thin layer of decomposed carbonate exists over large areas of limestone, but this layer only thickens and becomes substantially Zn-rich as "basement" mineralisation is approached. Areas of +0.1% Zn in the clay layer are regionally extensive, indicating substantial dispersions from the primary zone. Clay thickness and Zn grade may be useful vectors toward primary zones. Geochemically inert peat and gravels up to 5m thick obscure the clays and limestone over virtually the entire trace of the Gordon Limestone.

Zinc ore mineralogy is dominantly to exclusively sphalerite.

Because of their restriction to the surface zone, the potential size of the surficial deposit is somewhat limited. They are probably unlikely to be a CRA target in themselves. Their main attraction is their usefulness as an indicator of the underlying primary mineralisation. If a large primary deposit suitable to CRAE's requirements can be identified, then the surficial deposits would possible be an easy way to generate short-term cash-flow whilst the major deposit was being developed.

Zinc-rich clay deposits overlying primary carbonate mineralisation have been described at Tynagh and Silvermines.

R.G.Parkinson

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Appendix XVI

**“Zonation within Mineralisation Phases Around the Heemskirk Granite,
Zeehan Tasmania” by Kim Ely (Honours Project)**

**Zonation within mineralisation phases
around the Heemskirk Granite,
Zeehan, Tasmania**

Kim Ely

31 October 1996

Honours thesis submitted as part of the
B.Sc. (Hons) degree in the School of Earth Sciences,
The University of Melbourne

I certify that this work
contains less than 15,000 words.

Kim Ely

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ABSTRACT

The Zeehan lead-zinc mineral field has been cited as being zoned around the Heemskirk Granite. This zonation is primarily manifested in the change of gangue mineralogy, from pyrite to siderite dominated. However, the relationship of limestone-hosted deposits distal to the granite has been disputed. Several authors have suggested that the deposits of the Gordon Limestone have their origins in an Ordovician mineralisation event, and therefore are not part of the zoned mineral field. Siderite occurs in three main positions within the stratigraphy of the Gordon Limestone, but is not restricted to these zones. The position of siderite appears to be fault controlled. Four types of siderite are recognised in the limestone-hosted deposits. However, all types of siderite are chemically and paragenetically very similar. Galena and sphalerite post-dates the siderite. The variation of the chemistry of siderite sampled from nine locations illustrates a zonation to the south-east of the Heemskirk Granite. This zonation, reflected in both elemental and isotopic composition, overprints regional folding. Siderite crystallisation post-dates Tabberabberan deformation and since mineralisation post-dates siderite, it is therefore younger than Middle Devonian. Thus siderite, and associated mineralisation in the Gordon Limestone, near Zeehan, does not have an Ordovician origin. The limestone-hosted lead-zinc deposits are part of the siderite zone of the zoned mineral field. Mineralisation is most likely related to the intrusion of the Heemskirk Granite in the Late Devonian to Early Carboniferous.

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1. INTRODUCTION

1.1 Overview of the Zeehan mineral field

Around the turn of the century, Zeehan was a boom town on the west coast of Tasmania. Around fifty mines of various size and prosperity were worked for lead, zinc, silver and tin. A total production of 200,000 tons of lead, 27,000,000 ounces of silver and 2,700 tons of zinc were extracted (Both & Williams, 1968a). Sporadic workings continued until 1960, when the Oceana Mine closed.

Mineralisation is contained within folded and faulted Proterozoic to Devonian sediments east of the Heemskirk Granite, and occurs as both fissure veins and replacement of carbonate (King & Blissett, 1968). Classification of the ore types and paragenesis of the mineral deposits culminated in a description of mineral zoning in the Zeehan field by Both and Williams (1968b). The area was modelled as a hydrothermal mineral field zoned around the cassiterite-bearing Heemskirk Granite (Figure 1).

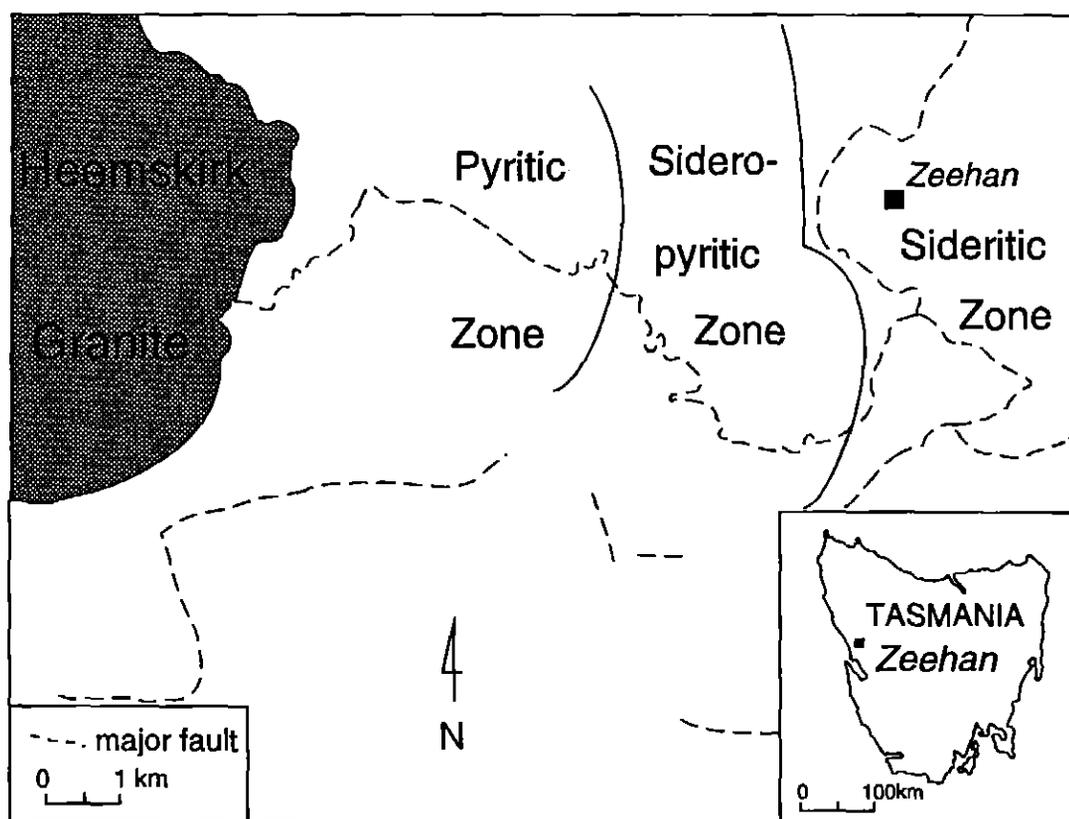


Figure 1. Mineralogical zoning of the Zeehan mineral field (modified from Both & Williams, 1968b) and location.

5 cm

This west to east zoning is characterised by changes in gangue mineralogy, from pyrite to siderite dominated.

Carbonate-hosted deposits distal to the granite, such as the Oceana Mine, are included in the siderite zone described Both and Williams (1968b). However, it was concluded by Taylor and Mathison (1990), that the Oceana deposit is not a member of the zoned mineral field. Their preferred model of genesis for the Oceana deposit was that of a stratiform deposit formed by syndiagenetic replacement of carbonate mud, therefore indicating a period of mineralisation during the Ordovician, prior to the intrusion of the Heemskirk granite. Taylor (1989) also reported syngenetic mineralisation at other sites within the Gordon Limestone. Peace (1995) concluded that the syngenetic model of mineralisation of the Oceana deposit is not supported and that its formation was related to the intrusion of the Heemskirk Granite in the Late Devonian to Early Carboniferous.

1.2 Aims

The major objective of this project is to document the characteristics of siderite from several locations in the Gordon Limestone. The geographic relationship of the siderite at these locations will be studied in order to determine if the mineralisation in the Gordon Limestone is related to the zoned Zeehan mineral field or has its origins in an Ordovician mineralisation event. The aims are:

- to define a stratigraphy of the Gordon Limestone near Zeehan;
- to document the characteristics of mineralisation and siderite phases, including their relationships to the stratigraphy;
- to compare the characteristics of siderite from a variety of locations within the Gordon Limestone and document their relationships, and;
- to contribute to the understanding of the origin of the mineralisation and its relationship to the zoned Zeehan mineral field.

These aims will be achieved by:

- logging of drill core of the Gordon Limestone;
- documentation of the characteristics of the Mariposa deposit, including paragenesis and the relationships of siderite with other ore phase minerals and the host rock;
- examination of the petrology of siderite from several prospects;
- analysis of oxygen and carbon isotopic composition of siderite samples, and;
- analysis of major and trace elements in siderite.

1.3 Field work

This study is based on logs and samples of diamond drill core held by CRA Exploration in Zeehan, and Pasmenco Exploration in Tullah. Core from the Mariposa, Blackjacks, Austral and Oceana prospects, from within the Gordon Limestone, was logged and sampled. In addition, siderite was sampled from five other prospects (Figure 2).

LOCALITY	DRILL HOLE NAME	AMG (ZONE 55) COORDINATES
Mariposa	DTM 84-2*	673591
	DTM 84-9*	674588
Blackjacks	DD95DB110*	665605
	DD95DB111*	666606
	DD96DB112*	661605
Austral	OP5*	602591
	OP6*	603590
Oceana	OP2*	601572
Grieves Siding	DD95ZG405	648498
	DD95ZG410	642490
	DD96ZG416	646494
Sunny Corner	DD96DS101	633570
Stonehenge	DD95ZS31	598594
Baura	DD95ZB1	627475
	DD95ZB2	627474
King Billy	DD96ZK123	712519

Figure 2. Drill holes sampled. Holes indicated by * were logged.

These prospects are located between 1.5 and 13.5 km from Zeehan, with most sites to the south and east (Figure 3). Samples were assigned numbers consisting of a three digit abbreviation of the drill hole name, followed by the depth of the base of the sample in metres, to one decimal place.

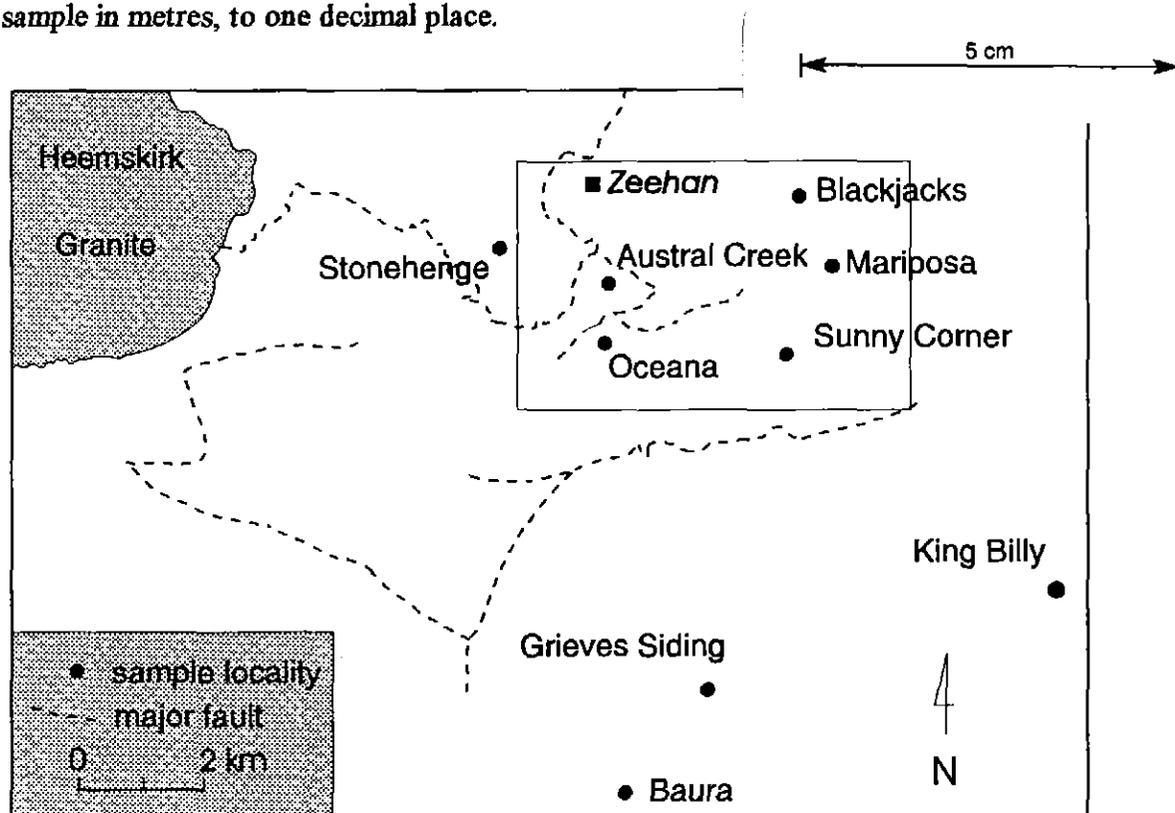


Figure 3. Location of study sites. The geology of the boxed area, with specific drill hole locations, is illustrated in Figure 5.

Drill core was logged to establish the stratigraphy, and the nature of siderite and mineralisation. Core was logged at a scale of 1:500, using the classification of Dunham (1962). Limestone was classified as mudstone, wackestone, packstone or grainstone. The presence of fossils, lamination, veining, mineralisation, siderite alteration and core condition were all noted. The presence of dolomite was detected by etching the core with 10% HCl. In drafting of the logs, the bedding to core axis angles were used to calculate true bedding thickness.

In the Zeehan area, the Gordon Limestone is situated in valleys between ridges of sandstone and quartzite. It is deeply weathered and is often covered with gravels. Outcrop is rare, of poor quality and of little value to the current study.

2. GEOLOGY OF THE ZEEHAN AREA

The geology of the Zeehan district is dominated by folded and faulted marine sediments of upper Proterozoic and Palaeozoic age, and a Late Devonian granite intrusion, which is known as the Heemskirk granite. The sediments are found within the Zeehan-Mt Pearce Synclinorium (Both & Williams, 1968a after Solomon, 1965). The granite was emplaced in a parallel anticline structure to the west (Both & Williams, 1968a).

2.1 Stratigraphy

Oonah Formation

The late Precambrian Oonah Formation, a clastic unit of variable composition (Turner, 1989), forms the base of the sedimentary sequence seen in the Zeehan area (Figure 4). The lower section of the Oonah Formation consists of muscovitic quartz sandstone interbedded with quartz wacke and mudstone, and is interpreted as a distal turbidite facies (Turner, 1989). This is overlain by carbonate, sandstone, conglomerate and volcanoclastic lithic wacke interbedded with laminated siltstone and mudstone. Basaltic lavas are also present in the upper part of the sequence. Mineralisation in the Oonah Formation is hosted within dolomicrite, sideritised evaporite, chert and pyritic shale (Anderson, 1989).

Success Creek Group and Crimson Creek Formation

The overlying Success Creek Group consists of basaltic lavas and thin beds of dolomitic limestone interbedded with similar sediments to those of the Oonah Formation. Deposited in the early Cambrian, this group has a conformable, but transitional boundary with the Oonah Formation (Both & Williams, 1968a). The Cambrian Crimson Creek Formation conformably overlies the Success Creek phase, although the relationship is not certain due to poor outcrop and the similarities between the two units (Both & Williams, 1968a). The Crimson Creek Formation consists of a grey mudstone turbidite sequence with basalt flows (Corbett & Turner, 1989).

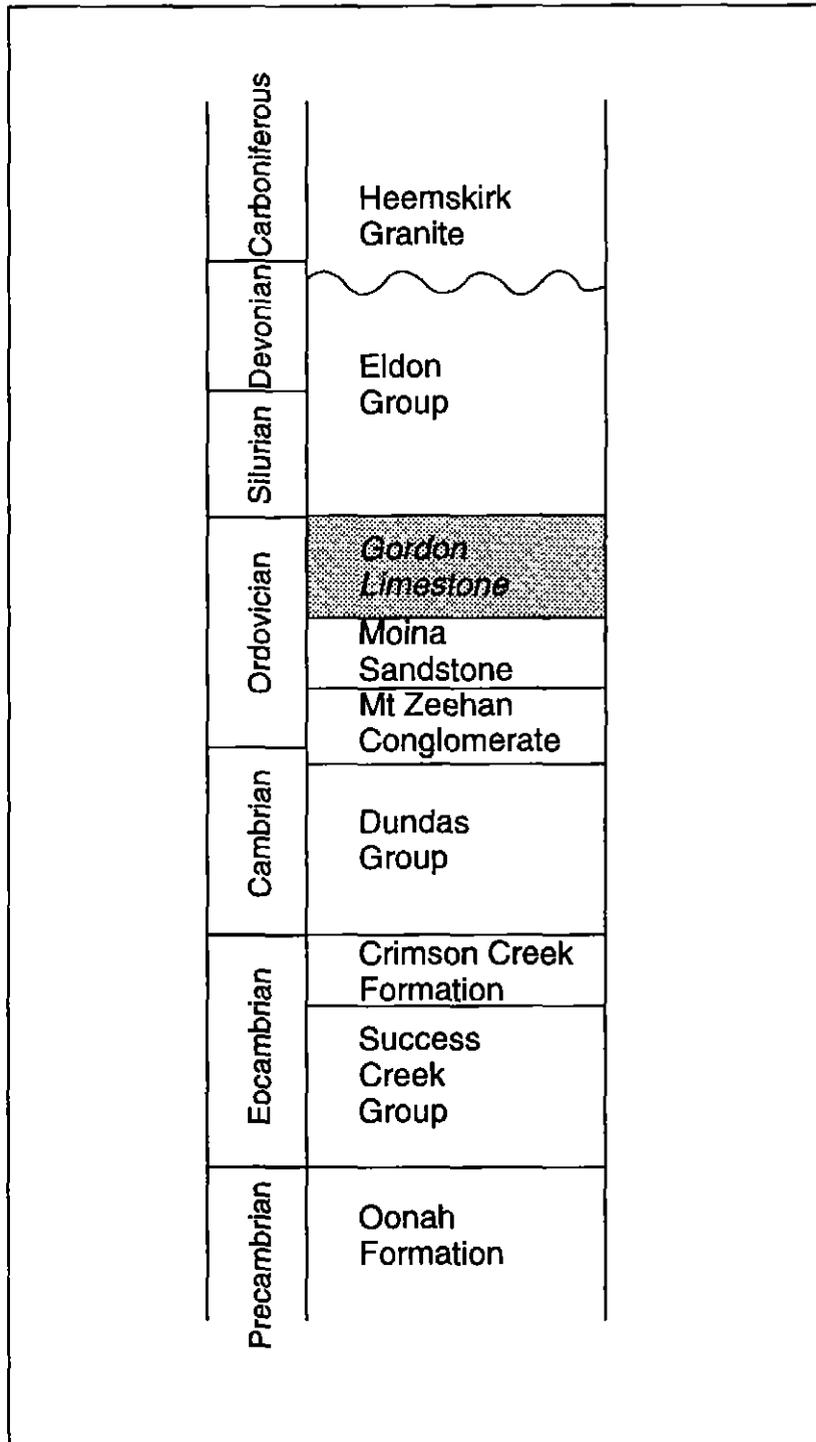


Figure 4. Stratigraphic sequence at Zeehan (after Brown *et al.*, 1994).

Dundas Group

The Dundas Group crops out to the east of the field area (Figure 5). The group consists of an interbedded sequence of quartz sandstones and pebble to boulder conglomerates deposited in the Cambrian.

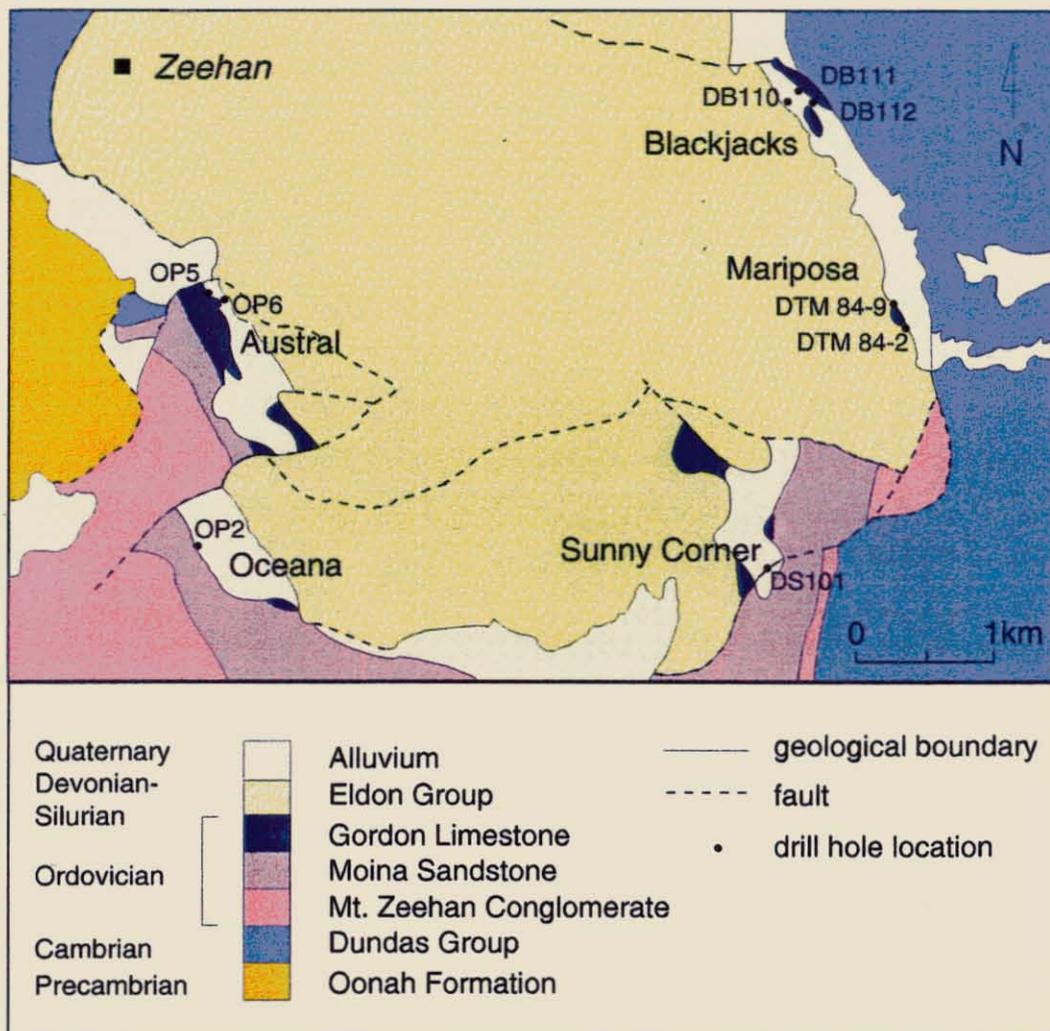


Figure 5. Geology of major study sites (after Brown *et al.*, 1994), with drill hole locations.

5 cm

Mt Zeehan Conglomerate

Ordovician sediments have been brought into contact with the Cambrian sequence by faulting (Both & Williams, 1968a). The Ordovician Mt. Zeehan Conglomerate is thought to represent abrupt environment change in the area resulting from the late Cambrian Jukesian Orogeny (Both & Williams, 1968a). It consists of a massive to bedded purple conglomerate with minor interbedded sandstone and siltstone.

Moina Sandstone

Conformably overlying the Mt. Zeehan Conglomerate, the Moina Sandstone fines up from a pebbly base. The Moina Sandstone consists of pale grey to pink sandstone and contains tubicular trace fossils towards the top of the sequence. The Gordon Limestone conformably overlies the Moina Sandstone (Both & Williams, 1968a).

In the Blackjacks area, the Moina sandstone varies from pale grey to white quartzite. The quartzite is of varying coarseness and moderate sorting and forms a well bedded sequence that fines upward. The nature of the contact with the overlying Gordon Limestone is uncertain as it is not well preserved in drill core. Poor core recovery and the presence of clays at the contact may indicate that the contact of the Moina Sandstone with the Gordon Limestone is locally faulted.

Gordon Limestone

The Gordon Limestone is a thinly bedded series of nodular micrite, biomicrite and calcareous mudstone. It is dominantly dark grey in colour, with some lighter micritic and fossiliferous intervals. The Gordon Limestone represents high intertidal to subtidal environments of deposition (Taylor & Mathison, 1990). The Gordon Limestone is the focus of this field study, and its characteristics are described and discussed in more detail in Chapter 3.

Eldon Group

The Ordovician sequence is succeeded by the Silurian to Lower Devonian Eldon Group. The Silurian sequences consist of the Crotty Quartzite, Amber Slate, Keel Quartzite and Austral Creek Siltstone. This is succeeded by the Lower Devonian Florence Quartzite and Bell Shale (Both & Williams, 1968a).

In the Oceana and Austral areas, the Crotty Quartzite is white to pale grey, fine grained and well sorted. At Oceana, there is also an interval of a fine conglomerate of grit and pebbles.

Sedimentation ceased with onset of the middle Devonian Tabberabberan Orogeny, which resulted in the major fold and fault structures observed in the Zeehan area (Both & Williams, 1968a).

Heemskirk Granite

The intrusion of the Heemskirk Granite postdated the Tabberabberan Orogeny (Williams, 1974) and has been dated at 354 Ma (Heier & Brooks, 1966). The Heemskirk granite body consists of two granite types, referred to as the red and white granites (Heier & Brooks, 1966). Both granites are comprised of quartz, K-feldspar, plagioclase, biotite and tourmaline. The red granite includes accessory hornblende, magnetite, sphene and allanite, while the white granite contains monazite, cassiterite and muscovite (McClenaghan, 1989). The white granite forms the dominant part of the outcrop. Tin mineralisation in the southern area of the granite is related to emplacement of the white granite (Green, 1990). Cassiterite is concentrated in greisen veins and areas of irregular alteration located in fracture zones within the red granite (Collins *et al.* 1989).

Permian tillites occur in the Zeehan region, overlying a Permian unconformity surface. Further faulting is attributed to post-Permian block faulting (Both & Williams, 1968a).

2.2 Mineralisation

Mineralisation generally occurs in fissure veins that are steeply dipping and have been identified as two sets, generally striking north north-west or north north-east. Ore bodies are commonly lenticular or irregular in shape. The strike length of veins is up to a few hundred metres and their depth is usually constrained to a maximum of 100-150 metres (Williams *et al.*, 1989). Veins may be up to five metres wide, but are generally less than 30 cm in width. Within the Gordon Limestone, stratiform mineralisation has also been described (eg. Taylor & Mathison, 1990). Ore consists of galena and sphalerite, with minor chalcopyrite, arsenopyrite, pyrrhotite and tetrahedrite. Gangue minerals include pyrite, siderite and quartz.

2.3 Mineral zonation

The variation between deposits occurs within the assemblages of ore and gangue minerals, and their chemistry. Waller (1904) first recognised three different ore types in the field; the Pyritic Formation, the Sideritic Formation and the Stannite Formation. Ore types intermediate between Pyritic and Sideritic types were also noted. Further work by Twelvetrees and Ward (1910) resulted in the recognition of a geographic zoning of ore types around the Heemskirk Granite. The zoning and paragenetic relationships of the ore minerals were modified and further defined by Both and Williams (1968b).

Both and Williams (1968b) defined a sequence of four zones from west to east based largely on gangue mineralogy. A cassiterite rich zone is adjacent to, and within the granite. The remaining three zones show a transition from pyrite to siderite rich assemblages. The four zones are;

- 1) Cassiterite Zone - includes tin mineralisation within and adjacent to the Heemskirk granite;
- 2) Pyritic Zone - pyrite is the dominant gangue mineral, siderite is rare or absent;
- 3) Intermediate (Sidero-pyritic) Zone - siderite increases to similar abundance as pyrite in this zone. Lead sulphosalt minerals are present, and high silver grades have been related to the presence of tetrahedrite;

- 4) Sideritic Zone - siderite increases in abundance to become the dominant gangue mineral. Pyrite becomes rare.

Although these zones have been defined, it is stressed that the changes are transitional, and boundaries of zones quite arbitrary. Mineralogical and chemical changes that occur across the zones from west to east include;

- a decrease in the abundance of pyrite;
- an increase in siderite abundance, from rare or absent near the granite contact in the west, to dominant in eastern deposits;
- an increase in the abundance of galena;
- a decrease in the amount of sphalerite;
- a decrease in the FeS content of sphalerite, and;
- a rapid decrease in the concentration of MnS in sphalerite towards the east.

The zones are thought to be a result of progressive changes in the physical and chemical environment of ore deposition as fluids migrated upward and outward away from the granite (Both & Williams, 1968b). A 300°C isotherm defined by the transition from manganiferous to non-manganiferous sphalerite lies just within the pyrite zone boundary (Williams, 1974). With the appearance of siderite, an abrupt decrease in MnS content of sphalerite occurs, this is thought to be due to the MnS preferentially partitioning into siderite rather than sphalerite. A general decrease in the FeS content of sphalerite occurs away from the granite.

It was first suggested by Both *et al.* (1969) that the increase in the abundance of siderite in the eastern part of the Zeehan mineral field could be partly due to the fluids passing through limestone or dolomite in the eastern area. Solomon and Groves (1994) reasoned that the increase in siderite abundance could be due to increased $f\text{CO}_2$ of the ore fluid due to dissolution of limestone, or by the mixing of ore fluids with CO_2 rich groundwater. The outer parts of the field are likely to have been mineralised through the action of separate groundwater circulation systems heated by the intrusion, rather than the original magmatic fluids (Solomon & Groves, 1994).

3. STRATIGRAPHY OF THE GORDON LIMESTONE

3.1 General stratigraphy

During core logging, carbonates were classed as one of six lithologies; mudstone, dolomite-rich mudstone, wackestone, packstone, grainstone and laminated mudstone. Other classifications used were dolomite, siderite and breccia. Descriptions of these units from field observations follow, in Sections 3.2 and 3.4. The stratigraphy of the logged drill core was correlated using the broad stratigraphic sequence, smaller packages of units and specific marker beds (e.g. an onkoid rich layer). The logs and correlation are illustrated in Enclosure 1. The correlation resulted in the compilation of a complete stratigraphic section through the Gordon Limestone, from the Crotty Quartzite through to the Moina Sandstone, of approximately 400 m (Figure 6).

The base of the Gordon Limestone consists of mudstone through to grainstone interbedded with laminated mudstone units containing fenestrae. Thin layers of rounded quartz grains also occur. The sequence fines up and the upper half of the stratigraphy is dominated by mudstone with thin wackestone and packstone layers. Near the upper contact with the Crotty Quartzite the limestone has been extensively dolomitised. Siderite alteration tends to occur most commonly in three zones, although intervals of siderite do occur throughout the sequence. The three main siderite zones are positioned near the contacts of the limestone with the Moina Sandstone and Crotty Quartzite, and in a central zone associated with quartz rich beds.

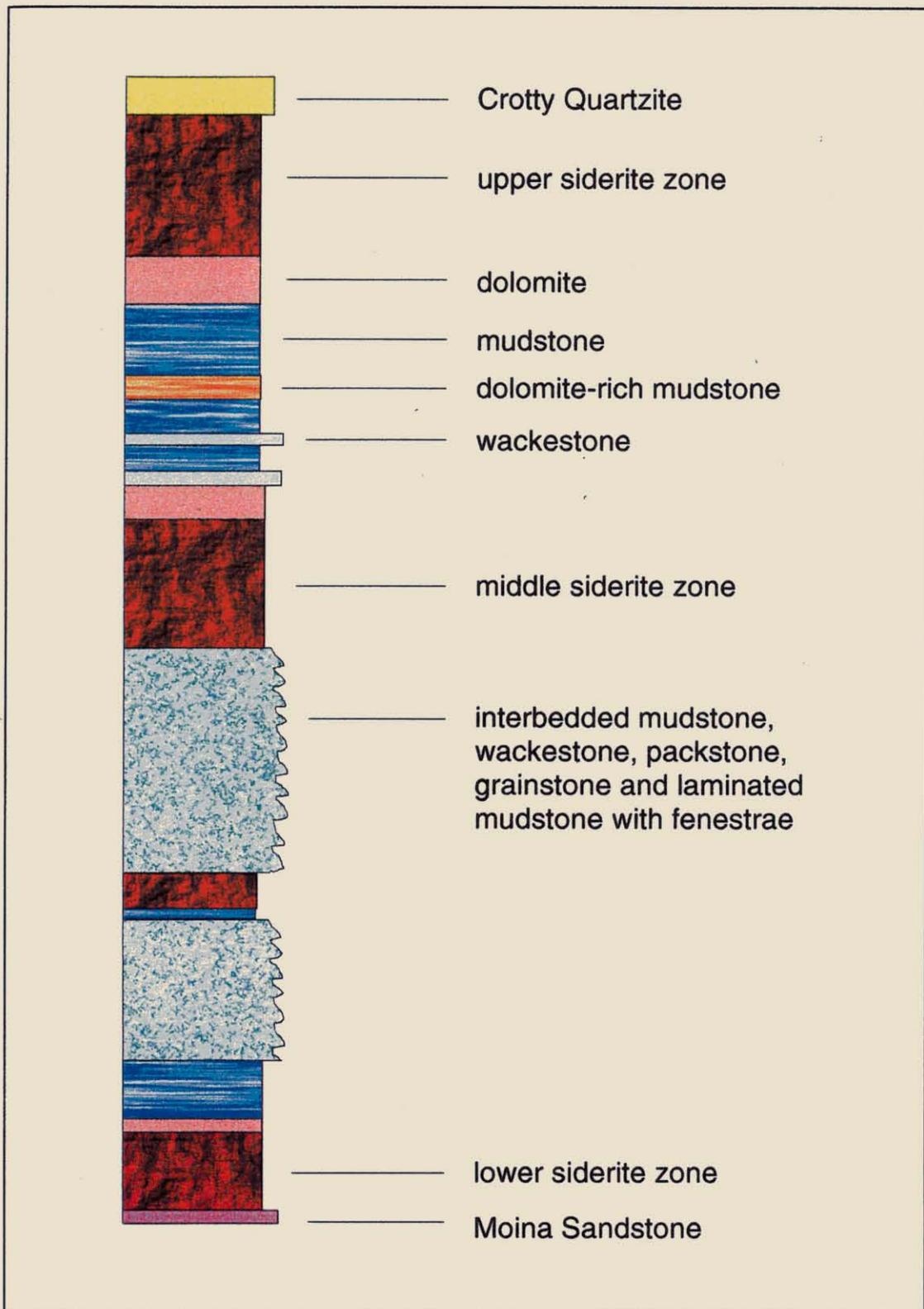


Figure 6. Generalised stratigraphy of the Gordon Limestone near Zeehan.

3.2 Lithologies within the Gordon Limestone

Mudstone

The upper section of the Gordon Limestone is dominated by fine-grained carbonate mudstone. The high content of clay and organic matter in the mudstone has resulted in a dark grey colour being dominant. The mudstone is often nodular or has bands or blotches of clay or dolomite-rich material. The nodules or bands often have stylolites forming their margins. Extensive bioturbation has occurred and burrows are evident. Sections may lighten up sequence from dark to medium grey. Fossils are scattered throughout the rock. Fossils include brachiopods and gastropods (up to 40 mm), onkoids (10 mm), bryozoa fragments (up to 8 mm) and corals, including tabulate coral colonies (up to 15 cm in diameter). Shelly debris and ooids are also common. Fine fossils and fragments are concentrated in muddy bands or solution seams. The mudstone is interbedded with wackestone and packstone layers up to 4 cm thick. Burrows and fossil moulds are *sometimes* filled with sparry calcite cement. Calcite veining occurs throughout, varying from rare to common.

Dolomite-rich mudstone

The dolomite-rich mudstone is a medium to dark grey micritic limestone with no bioclasts. Dolomite-rich mudstone is mottled with irregular dolomitised patches and bedding parallel dolomitisation (Figure 7). Anastomosing mud seams and limestone nodules with interstitial dolomite also occur. Fine calcite veining is common.

Wackestone

Wackestone units consist of interbedded fossiliferous, burrowed and muddy layers (Figure 8). The fauna includes corals up to 11 cm in diameter, onkoids, gastropods, brachiopods, bryozoa and fine shelly debris (less than 3 mm). Porosity within fossils is often filled with sparry calcite cement. The matrix is composed of medium-dark grey, fine grained micrite and often has a mottled appearance. Concentrations of fine fossil fragments occur with organic matter and clay in irregular seams.

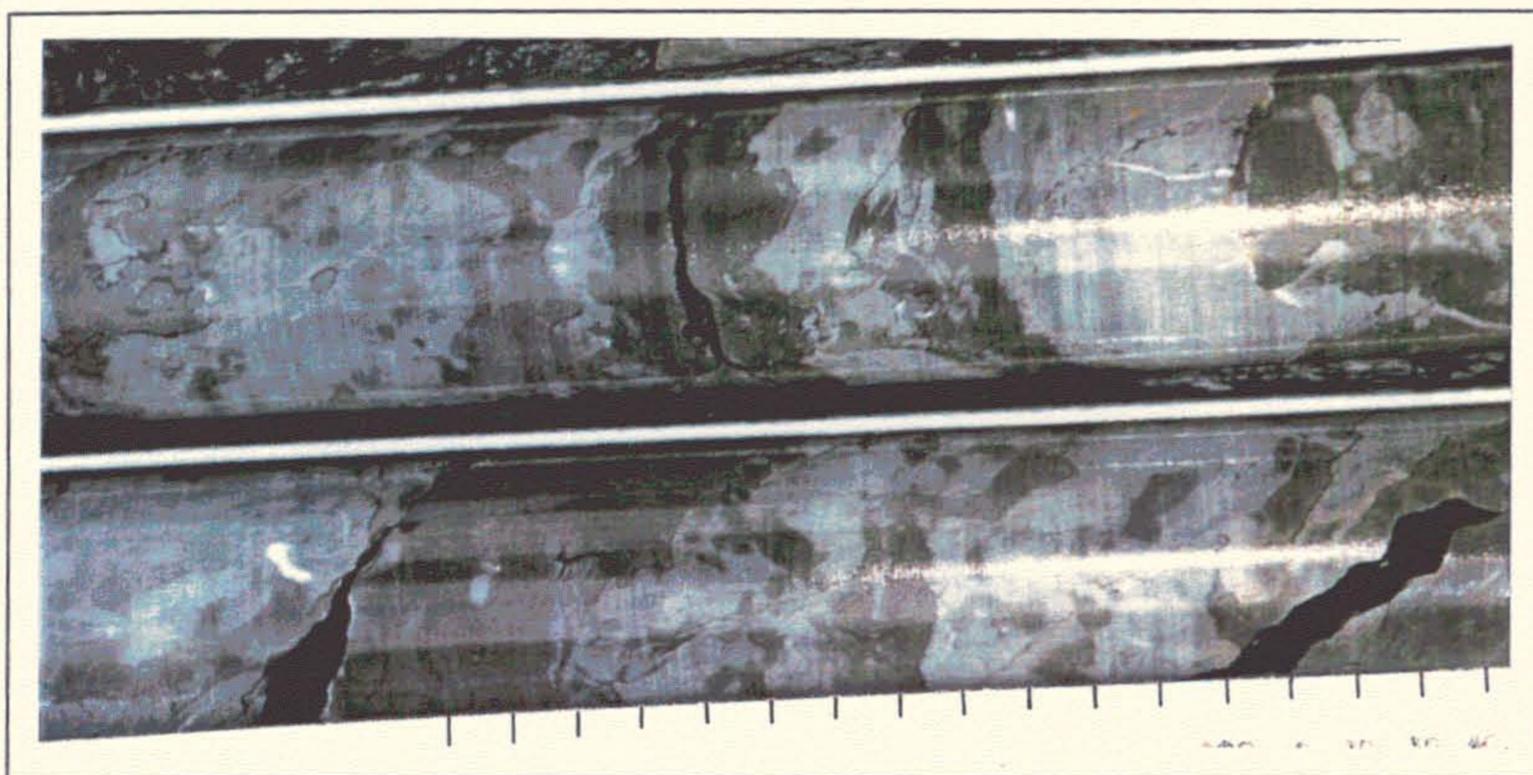
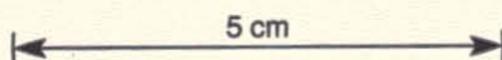


Figure 7. Mudstone with patchy and bedding parallel dolomitisation. Scale is in centimetres. DDH DB110.



Figure 8. Wackestone of bryozoa and brachiopods in dark grey micritic matrix. Scale bar is in centimetres. Sample 1104066.



Packstone

This lithology is comprised of closely packed fossils in a micrite matrix. Clasts include corals (up to 8 cm), gastropods (up to 4 cm), nautiloid and brachiopod fossils, ooids, onkoids and fossil fragments. Calcite fossil moulds and burrowing also occur. Shelly fauna is often poorly preserved. Patchy dolomitisation and dolomite bands are present. The matrix is pale grey, clean micrite.

Grainstone

Grainstone varies from single to mixed fossil assemblages and often includes fine, moderately sorted and rounded quartz grains. The fauna includes corals up to 20 cm in diameter, onkoids up to 15 mm, ooids and fossil fragments. Grainstone units are generally about 2 metres thick, but may be up to 25 metres. Grainstone occurs in the lower and central part of the stratigraphy. In the lower section, grainstone beds are often associated with sequences that include laminated mudstone layers.

Laminated mudstone

Laminated mudstone consists of clean, light grey micrite. Laminations are formed by 5 mm graded units or fine seams of clay-rich limestone. Laminated mudstone may grade to massive, pale grey micrite. Fossils are not present, but lamination may be disturbed by burrowing.

Laminated mudstone may contain horizontal layers of fenestral porosity. The fenestrae are filled with sparry calcite cement (Figure 9). This unit often forms the top of lightening upwards cycles with a transitional boundary from dark grey mudstone. The upper contacts are often sharply defined and may be scoured. Both horizontal and vertical fenestrae may also occur in poorly laminated or massive light grey micrite.

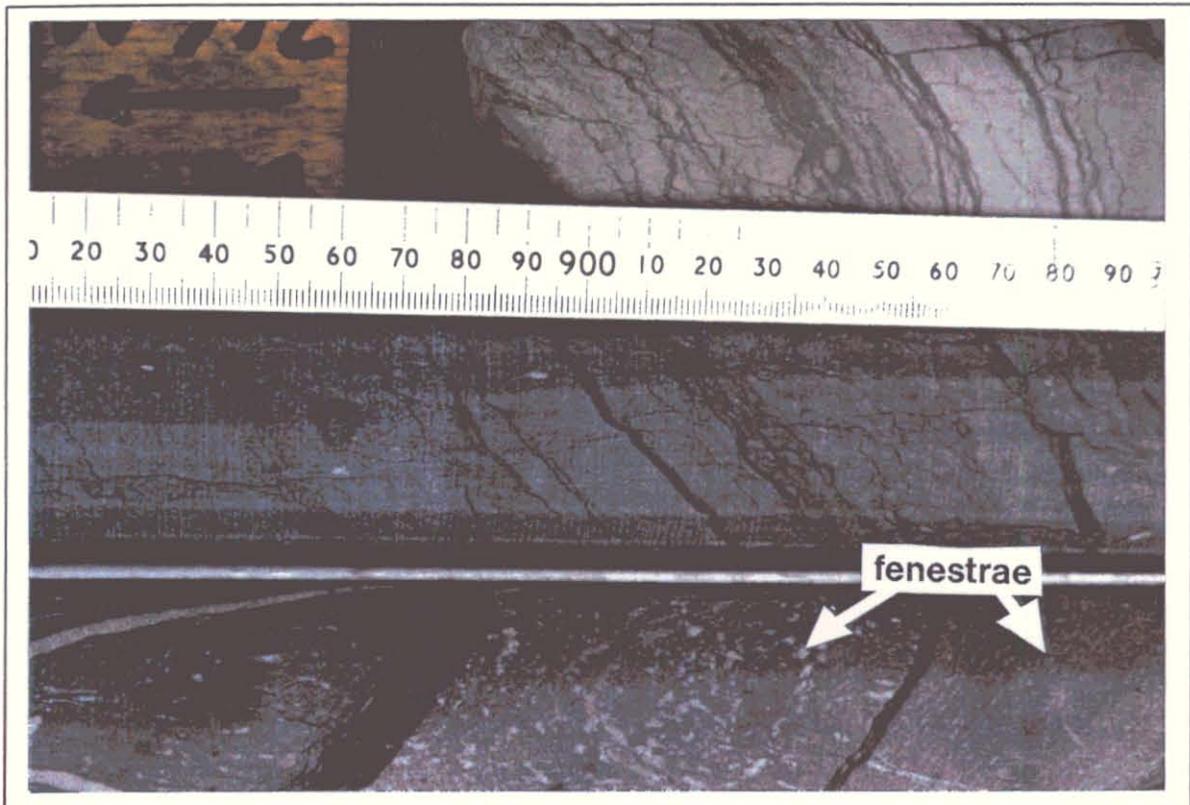


Figure 9. Laminated mudstone, fenestrae in massive micrite and fine laminated fenestrae. Scale in millimetres. DDH DB110.

5 cm

3.3 Environments of deposition

The sequence of Gordon Limestone in the Zeehan area was deposited in a low energy, shallow marine environment, that became deeper towards the top of the sequence.

Cyclic lithological relationships are seen in the lower section of the limestone. These 2-5 metre thick cycles commonly consist of, from base to top, intraclastic packstone, bioclastic grainstone, clay-rich mudstone, ooid grainstone, burrowed mudstone and laminated mudstone with fenestral fabrics (Figure 10). These cycles are similar to the peritidal, shallowing upwards succession described by Pratt *et al.* (1992), and provide convincing evidence for a shallow water origin.

The pale grey laminated mudstone units with fenestrae represent the development of algal mats. Fenestral fabrics most commonly indicate shallow intertidal or supratidal conditions (Pratt *et al.* 1992). The cycles may represent small variations in depth

from intertidal to very shallow intertidal or supratidal in low energy conditions (Pratt *et al.* 1992).

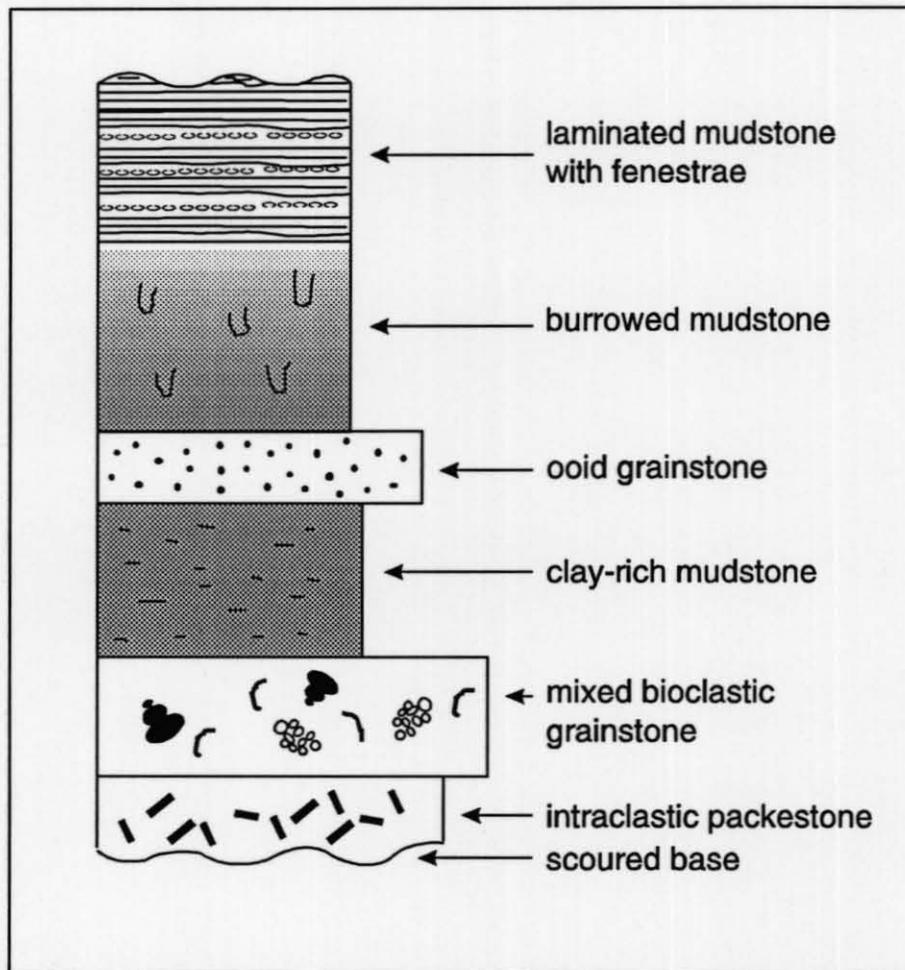


Figure 10. Schematic representation of a shallowing upwards cycle as seen in the lower section of the Gordon Limestone. Cycles may be 2-5 metres thick.

The upper part of the Gordon Limestone is dominated by mudstone with minor interbedded wackestone and packstone. The mudstone is dark in colour and contains a large amount of clay and organic matter. The fine grained nature of this sequence indicates deposition in a low energy environment (Greensmith, 1989). The lack of intertidal features, such as fenestrae, in the upper part of the Gordon Limestone may indicate a deepening water depth towards the top of the sequence.

3.4 Alteration

Change due to diagenetic and deformational processes has occurred in the Gordon Limestone since deposition. Dolomitisation, precipitation of siderite and brecciation are some of the major processes that have occurred.

Dolomite

Much of the mudstone throughout the sequence is partially dolomitised. The uppermost section of the Gordon Limestone is extensively dolomitised, up to 100 m below the contact with the Crotty Quartzite. Complete dolomitisation occurs near the upper contact with the Crotty Quartzite. The dolomitised limestone is medium grey to black in colour and may have a massive or crystalline appearance. Dolomite veins 1-40 mm thick are common throughout dolomitised limestone. Dolomite veins 1-40 mm thick are common throughout dolomitised limestone. Partial dolomitisation of mudstone has resulted in dolomitised bedding parallel bands or irregular blotches (Figure 7). Complete dolomitisation of grainstone has occurred with preservation of original textures (Figure 11). Vughs containing quartz and pyrite crystals, and rare interstitial pyrite are associated with complete dolomitisation.

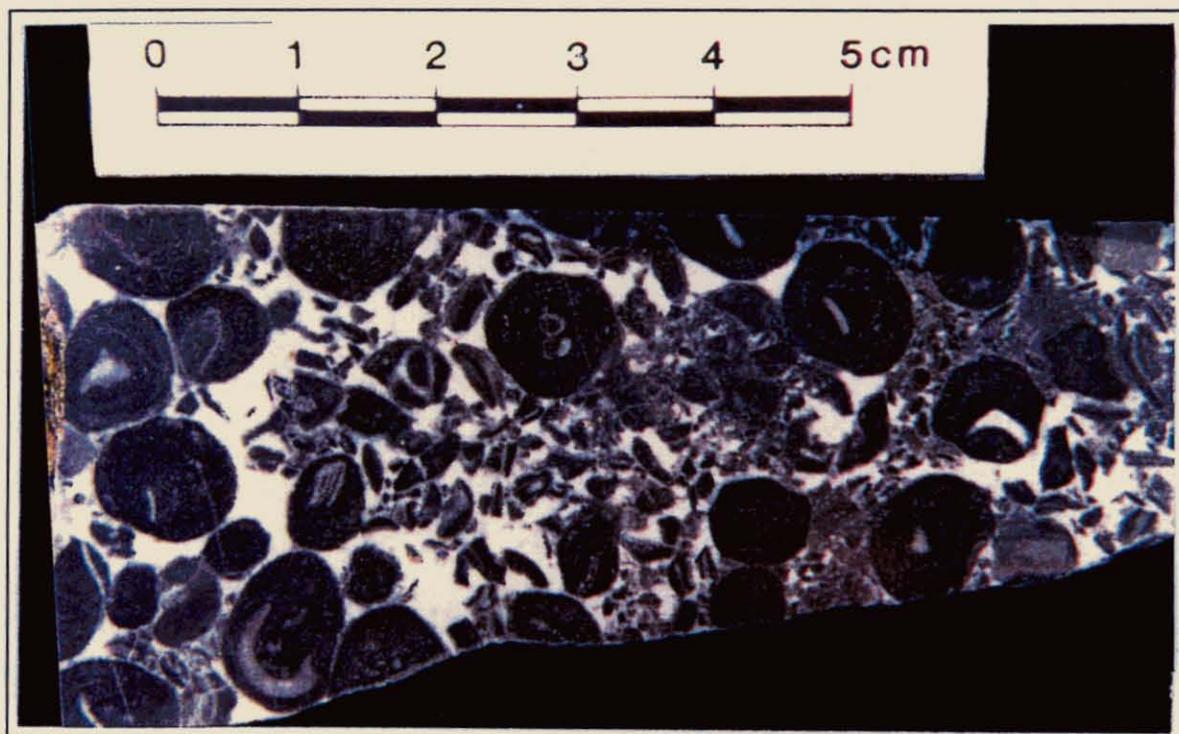


Figure 11. Completely dolomitised onkoid grainstone. Scale bar is in centimetres. Sample 8420772.

5 cm

Siderite is the major gangue mineral associated with galena and sphalerite mineralisation at Mariposa, Oceana and Austral. Siderite occurs, with or without mineralisation, at all of the study prospects. Siderite occurs as cements or as massive replacement of limestone. In drill core, siderite zones are often weathered and preserved only as small (10 cm) remnant pieces within extensive clays, poorly recovered core and dolomitised limestone chips. In well preserved mineralised sections from the Oceana deposit, siderite forms an alteration halo around sulphide mineralisation. At Oceana, the contacts of the siderite with the host limestone are distinct, showing cross cutting relationships with diagenetic features (Peace, 1995). Siderite zones are up to ten metres thick.

Replacement siderite

Replacement siderite is fine-medium crystalline and massive. Fresh surfaces are dark bronze-grey. More weathered siderite may be dark brown, bronze grey or orange brown. Siderite commonly contains cracks and irregular cavities. It is generally massive, but may have a roughly laminated or brecciated appearance (Figure 12).

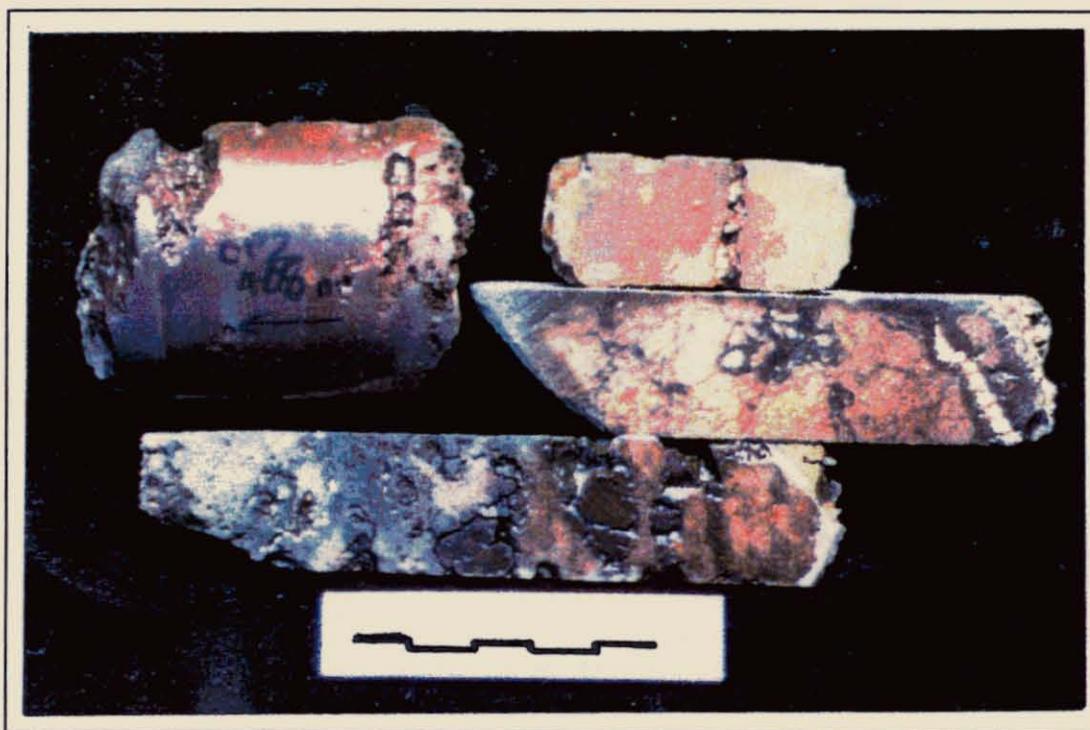


Figure 12. Samples of replacement siderite from the Blackjacks and Oceana prospects. Scale bar is in centimetres.

5 cm

The brecciated type of siderite usually has irregular clasts of less than 10 mm and is matrix supported. On close inspection, the edges of clasts are often gradational and not well defined. Examination of thin sections indicates that this type of "breccia" is actually a result of patchy dolomitisation. Zones of replacement siderite occur within partially dolomitised mudstone or grainstone, however contacts with the host rock are not preserved. The associated grainstone is often rich in quartz clasts.

Siderite cements

Fine to coarsely crystalline siderite cements occur in veins, cavities and as cements in breccias. The cement is cream coloured on fresh surfaces and weathers to bright orange. Siderite zones are associated with extensive calcite veining in both the siderite zones and host rock.

Brecciation

Minor sections of breccia with varying characteristics are present within the sequence. Brecciation is often associated with dolomitisation and calcite veining. Clast and matrix composition varies, often within a small distance. Breccia may consist of subrounded calcite clasts in dolomite matrix, angular to rounded dolomite clasts in calcite cement or clasts supported in a network of fine calcite veining. Mineralisation is present within some breccias. Clasts in the mineralised breccias include host carbonate, vein calcite, sphalerite and galena. Clasts are angular and their size varies from millimetres to several centimetres. The mineralised breccias may be cement supported with calcite being the major cement type, or have a matrix of fine calcite and siderite (Figure 13).

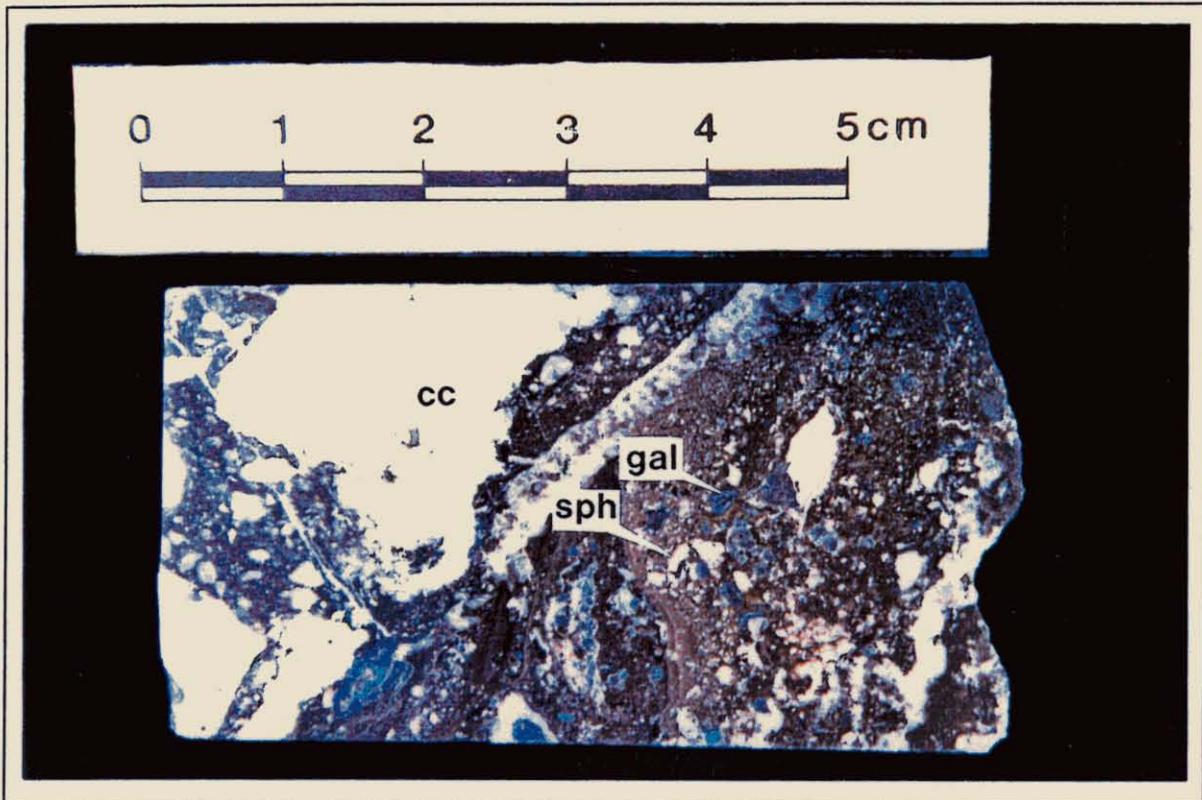
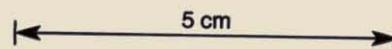


Figure 13. Mineralised breccia. The dominant clast type is calcite (cc), with some galena (gal) and sphalerite (sph) clasts. The matrix consists of fine siderite and calcite. Scale bar is in centimetres. Sample 8421367.



3.5 Correlation and faulting

The somewhat monotonous nature of the Gordon Limestone made correlation difficult. Few beds had distinctive characteristics that enabled them to be traced between localities. This resulted in the stratigraphy being correlated using the general stratigraphic sequence, rather than using individual marker beds, with only a few exceptions. Siderite zones were not correlated in the field as this would have involved the assumption that they are of stratiform nature.

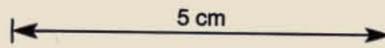
Extensive veining and slickenside striations throughout the sections logged suggest that faulting has occurred in the Gordon Limestone. Furthermore, faulting was also observed in Moina Sandstone outcrop adjacent to the contact with the Gordon Limestone. Therefore, it is likely that extensive faulting has occurred in the Gordon Limestone, resulting in loss and repetition of stratigraphy. Combined with deep

weathering and sections of poorly preserved, broken core and clay (Figure 14), the effects of faulting contributed to problems in correlation.

However, by logging drill holes containing the upper and lower contacts of the Gordon Limestone and correlation of several marker beds and sequence packages, the stratigraphy of the Gordon Limestone in the Zeehan area was able to be constrained.



Figure 14. Example of poor preservation of drill core. Clipboard, for scale, is 34 cm long.



4. MINERAL PHASES

4.1 Siderite

Siderite has been identified as the major gangue mineral of the galena and sphalerite deposits within the siderite zone (Both and Williams, 1968a), including limestone-hosted deposits, such as Oceana (Peace, 1995). The occurrence of siderite varies from finely crystalline replacement to coarsely crystalline cements. Several different types of siderite are distinguished in thin section. The five different types are distinguished by variations in texture, grain size and colour. However, a chemical variation between the types cannot be distinguished. Siderite chemistry is more characteristic of location, rather than of different siderite types.

Type 1

Type 1 siderite is very finely crystalline (< 0.1 mm) and yellow-brown. It has a granular or needle-like texture (Figure 15). This type of siderite replaces the host rock, destroying most original textures. Quartz clasts and small dolomite crystals may be preserved. The small dolomite crystals among a matrix of finely crystalline siderite may be due to the siderite having preferentially replaced calcite over dolomite. Type 1 siderite occurs at the Baura, Blackjacks, Grieves Siding and Sunny Corner prospects.

Type 2

The second type of siderite is buff brown and has poorly defined crystal boundaries (Figure 16). Under high magnification, sweeping extinction is evident in anhedral to subhedral crystals. Crystals (0.1-0.3 mm) may be outlined by dark brown or black, fine-grained organic matter. These outlines may contain finer (less than 0.1 mm),

5 cm

301234

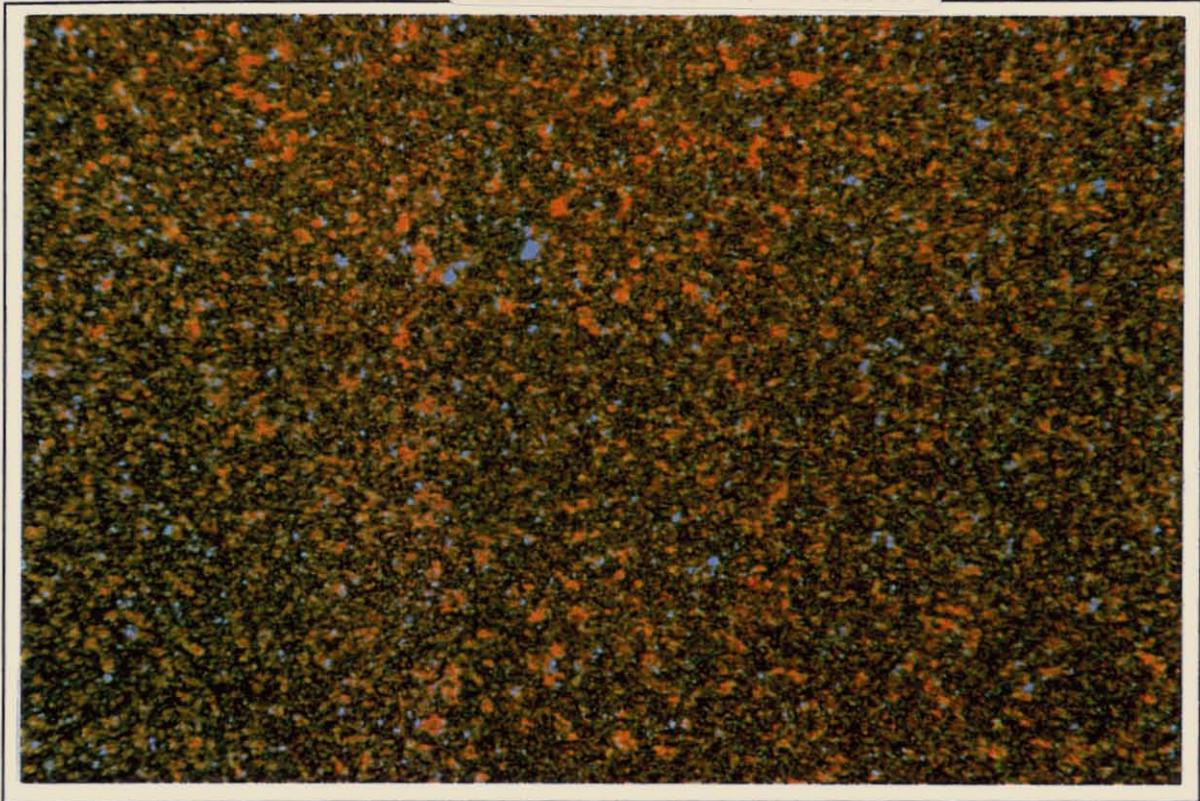


Figure 15. Photomicrograph of fine grained replacement siderite (type 1). PPL (plane polarised light). Width of view is 3 mm. Sample ZB10202.

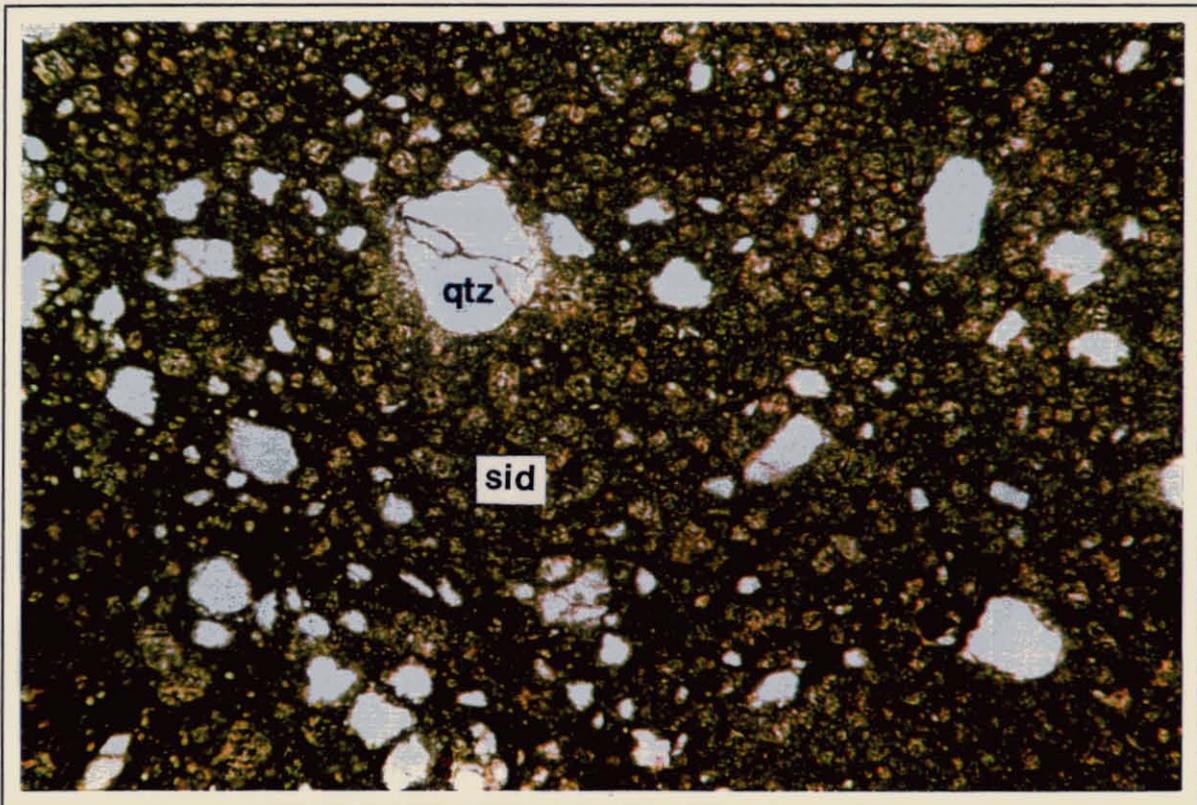


Figure 16. Photomicrograph of type 2 siderite (sid) with quartz grains (qtz). PPL. Width of view is 4 mm. Sample 1230833.

5 cm

recrystallised siderite or the centre of the crystals may be weathered out. Type 2 siderite is also often associated with quartz grains, having replaced the surrounding limestone. It may have gradational contacts with type 1 siderite. In cleaved samples, patches of siderite may truncate the cleavage. This type of siderite occurs at the King Billy, Blackjacks, Grieves Siding and Mariposa prospects.

Type 3

Type 3 siderite is colourless to yellow, with clear, inclusion-free crystals. Crystals are blocky and vary in size from less than 0.1 to 0.2 mm. Type 3 siderite occurs in veins, patches and associated with quartz grains. Crystals often have sweeping extinction.

Veins containing type 3 siderite cements terminate to points at both ends and are thin (0.2-1.0 mm wide). They may be up to 10 mm long. The veins contain fine (0.05-0.1 mm) crystalline siderite. Veins may not be completely filled with siderite. The presence of porosity in the centre of the veins and the lensoidal shape of the veins indicates that they may be the result of shrinkage. Aggregates of this siderite are also associated with the veins. Very fine siderite veins also occur in cleavage plane cracks in dolomite crystals.

Crystals of replacement siderite up to 0.2 mm across occur around quartz grains and in cracks within the grains (Figure 17). Type 3 siderite occurs at the Blackjacks, Grieves Siding and Sunny Corner prospects.

Type 4

Coarsely crystalline, colourless siderite cements are associated with galena and sphalerite. This siderite, and mineralisation, may be hosted within cavities or breccias. Type 4 siderite occurs at the Mariposa prospect.

Subhedral to euhedral crystals of clear siderite with few inclusions grow into cavities. The centres of these cavities contain sphalerite, galena or ankerite. These cavities are often elongate and have formed within buff type 2 siderite (Figure 18).



Figure 17. Photomicrograph of type 3 siderite (sid) within and around a fractured quartz grain (qtz). Width of view is 8 mm. Sample 1100635.

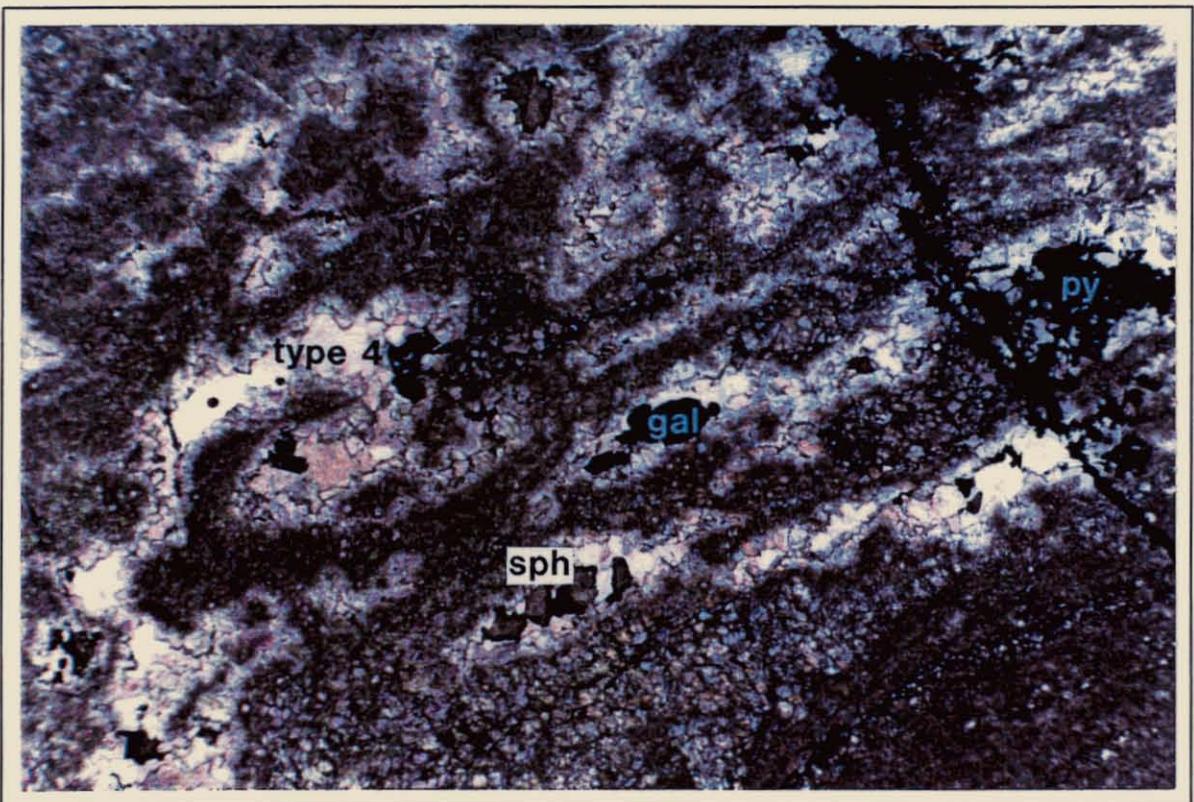


Figure 18. Photomicrograph of type 4 siderite in cavities within type 2 siderite. Sphalerite and galena are in the centre of cavities. Irregular pyrite (py) vein cross cuts cavities. PPL. Width of view is 8.5 mm. Sample 8421325.

Strongly zoned, curved siderite crystals are found growing around clasts in breccias (Figure 19). These long crystals often have very strong sweeping extinction.

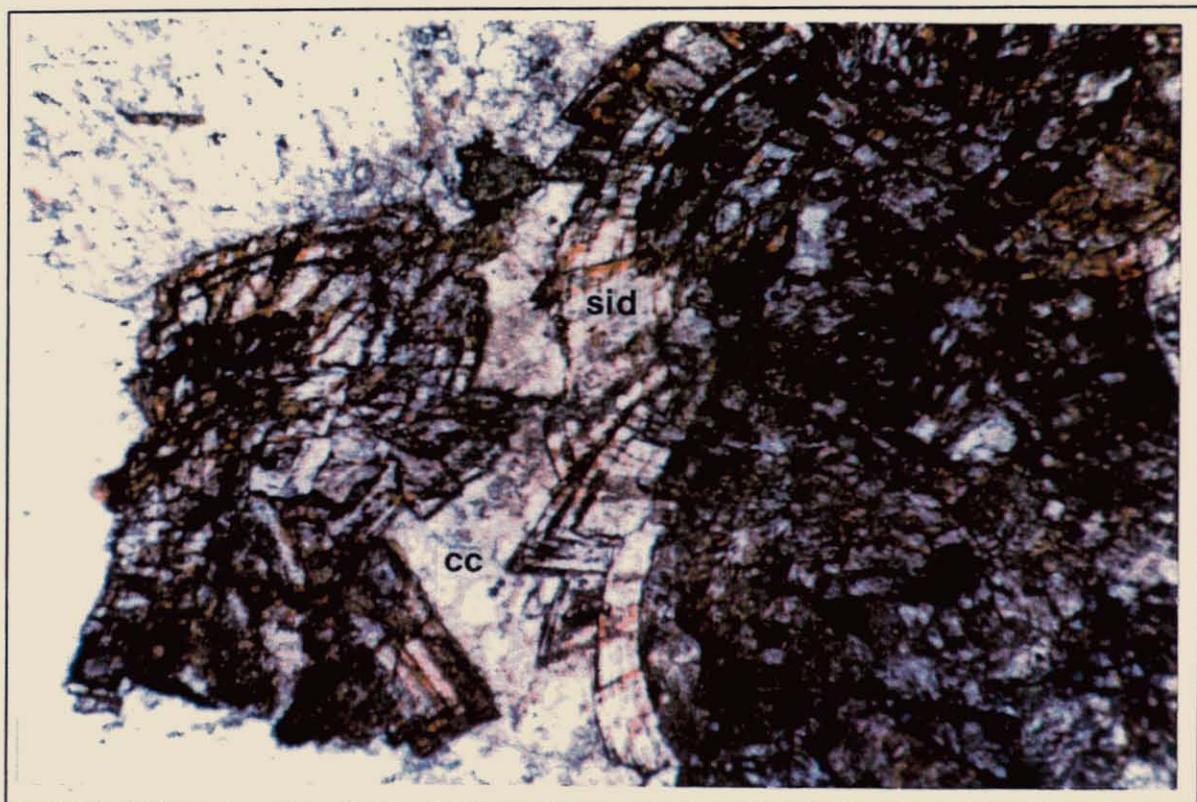


Figure 19. Photomicrograph of curved siderite crystals (sid) in a breccia. Clasts are cemented by calcite (cc). PPL. Width of view is 2 mm. Sample 8421503.

5 cm

Type 5

Siderite from the Stonehenge prospect is hosted within a fine-grained, quartz-rich rock. The siderite is different to all of the limestone-hosted siderite. The Stonehenge siderite is colourless and forms large (up to 4 mm) tabular crystals.

4.2 Dolomite

Partial dolomitisation

Extensive dolomitisation has occurred throughout the sequence. Much of the mudstone, and matrix of packstone and wackestone has small (0.1 mm), buff to colourless euhedral dolomite rhombs scattered throughout. Under cathodoluminescence, these rhombs have distinctive red luminescent cores with non-luminescent rims. Areas containing this kind of dolomite are often bounded by stylolites. Where cleavage exists, individual dolomite rhombs may be truncated by the cleavage. This type of dolomite also occurs in the siderite zones.

Pervasive replacement dolomitisation and dolomite cements

In the upper part of the stratigraphy, at the *Mariposa* and *Austral* prospects, complete dolomitisation of limestone has occurred. Dolomite that has replaced micrite is fine-grained (0.1-0.2 mm), whereas dolomite that has replaced bioclasts is coarser (0.2-0.5 mm). The crystals are anhedral and colourless, but inclusions in the more finely crystalline dolomite may give it a brown colour. Complete dolomitisation most commonly results in massive, textureless dolostone, but depositional fabric has been preserved in some sections (Figure 11). Coarsely crystalline (up to 2 mm), subhedral to euhedral, zoned cements in between clasts indicate crystallisation during burial diagenesis (Figure 20).

4.3 Ankerite

Ankerite occurs as final stage cavity fill associated with galena and sphalerite. Colourless crystals are large and fill the remaining cavity space (up to 1 mm). Ankerite also occurs in thin cross-cutting fractures. These 0.5-1 mm wide veins contain very fine-grained fault gouge and broken crystals.

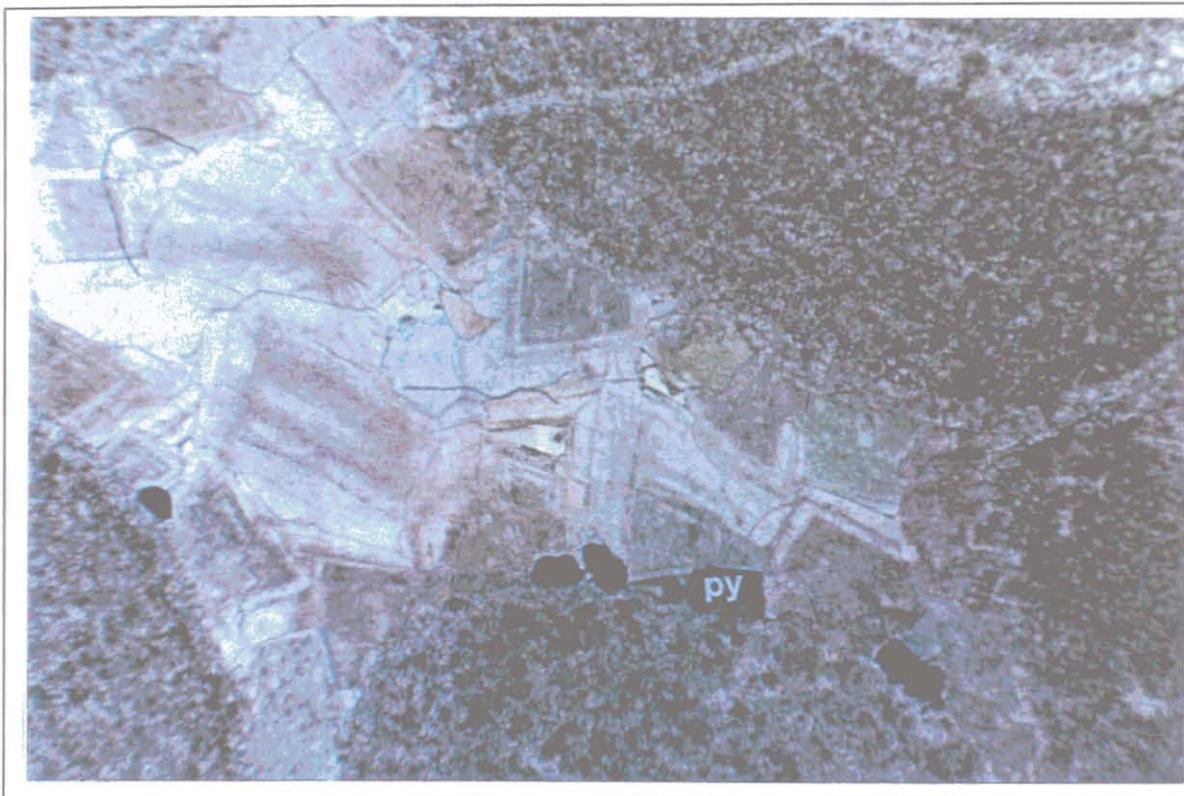


Figure 20. Photomicrograph of coarse zoned dolomite cements and pyrite (py) within dolomitised grainstone. PPL. Width of view is 8.5 mm. Sample 8420772.

|----- 5 cm -----|

4.4 Pyrite

Pyrite occurs in several different forms. Clusters of subhedral to euhedral pyrite up to 1 mm across are scattered throughout dolomite cements (Figure 20). Clusters of pyrite and quartz also line cavities in completely dolomitised rock.

Pyrite also occurs as highly irregular veins that cross cut siderite and cavity-fill sulphides. The pyrite invades cavities and follows fine fractures (Figure 21).

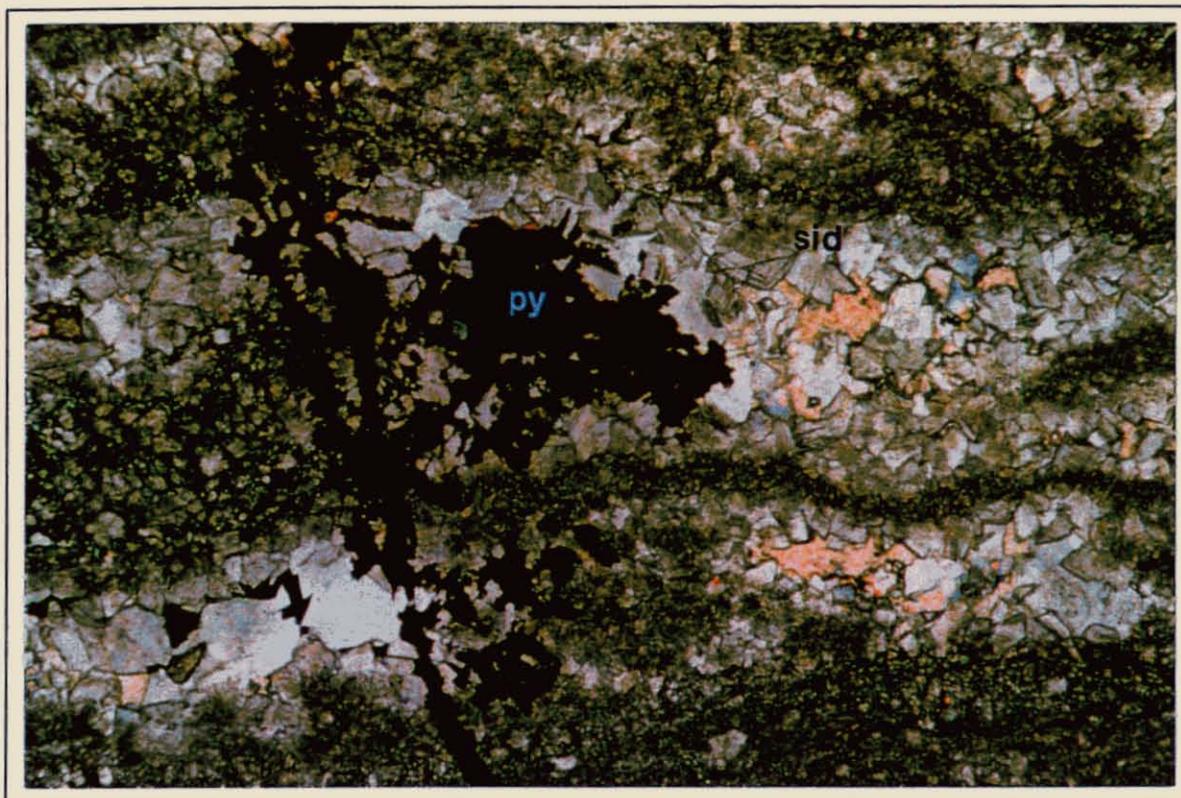


Figure 21. Photomicrograph of pyrite filled fracture and cavity (py) within siderite (sid). PPL. Width of view is 4.8 mm. Sample 8421325.

← 5 cm →

4.5 Base metal sulphide minerals

Galena and sphalerite mineralisation occurs at the Mariposa prospect. The zones of mineralisation are hosted in siderite zones up to 10 m thick, or as discrete faults. Mineralisation may be hosted within breccias or cavities in siderite (as described in Section 5.1, see Figure 18).

Galena

Small amounts of galena occur within siderite in cavities and within siderite or calcite in breccias. The galena crystals are small, with a maximum size of 1.5 mm. Galena is often closely associated with sphalerite.

Sphalerite

Sphalerite occurs as cavity-fill and disseminated within breccias. The sphalerite is olive-green in thin section. In breccias, sphalerite may be intergrown with siderite or have grown around rounded clasts of calcite and fault gouge. Sphalerite blebs measure up to 0.5 mm across and sphalerite intergrowths are up to 3 mm across.

Mineralised breccias

At Mariposa, mineralisation is contained within breccias. Clasts include sphalerite and galena, dolomitised host limestone, calcite crystal fragments and siderite crystal clusters. The clasts are poorly sorted and vary in size up to 10 mm, in thin section. The clasts occur as angular crystal fragments or rounded aggregates of intergrown minerals (Figure 22). Breccias may be cemented by coarsely crystalline calcite or have a fine brown matrix of calcite and siderite. This matrix may include graded internal sediments. Calcite crystal fragments are the dominant clast type in matrix supported breccias. Areas of twinned vein calcite contain fault gouge.

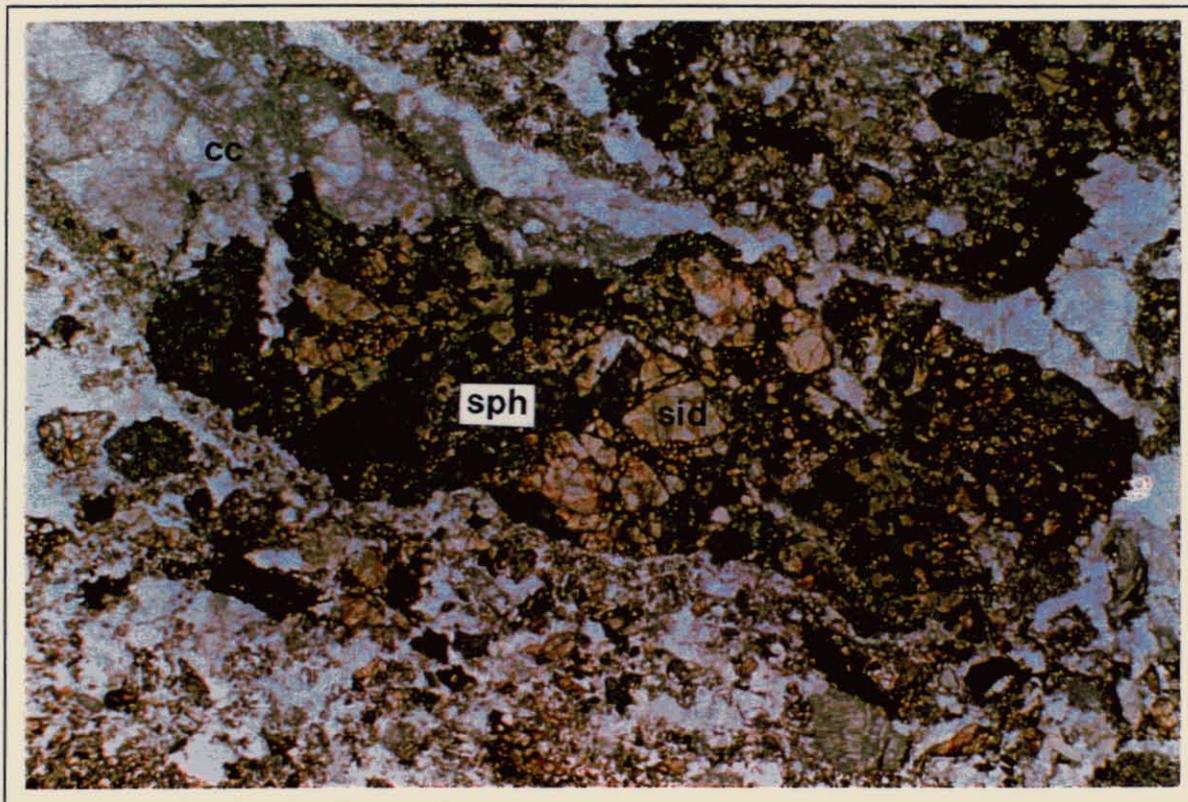


Figure 22. Photomicrograph of clast of sphalerite (sph) intergrown with siderite (sid) within breccia at Mariposa. Also note calcite clasts (cc) within fault gouge (upper left-hand corner). PPL. Width of view is 8.5 mm. Sample 8421367.

5. ANALYTICAL TECHNIQUES AND RESULTS

5.1 Thin sections

Twenty nine thin sections were made by the author for petrographic study. Twenty of these sections were polished for reflected light work and electron microprobe analysis. Refer to Appendix A for descriptions of thin sections.

5.2 X-ray diffraction

X-ray diffraction (XRD) was used to identify the mineralogy of selected samples. A small amount of powdered sample was obtained using a dentists drill, spread onto a glass slide with water and dried. The samples were analysed in the School of Earth Sciences, University of Melbourne, using the Siemens X-ray Diffractometer. Results are presented in Appendix B.

5.3 Stable Isotopes

Siderite from each sampling locality and from the upper, central and lower zones was analysed for oxygen and carbon isotopic composition. Finely powdered samples were collected using a dentists drill or a small mortar and pestle for analysis in the School of Earth Sciences, Monash University. Siderite samples of 7-9 mg were reacted with 103% H_3PO_4 at 50°C for 18 hours in sealed vessels, a modification of the technique of McCrea (1950). Isotopic ratios of the exsolved CO_2 gas were measured on a Finnigan MAT 252 mass spectrometer. Values of $\delta^{18}O$ and $\delta^{13}C$ are reported relative to Standard Mean Ocean Water (SMOW) and Pee Dee Belemnite (PDB) respectively. Oxygen values were corrected using a fractionation factor of 10.46‰ (Rosenbaum & Sheppard, 1986). Oxygen values were converted from SMOW to PDB by the equation

$$\delta^{18}O \text{ PDB} = \delta^{18}O \text{ SMOW} \times 0.97002 - 29.98$$

to enable results to be plotted against each other. Data is presented in Appendix C.

The oxygen isotopic composition of siderite varies from 15.94 to 28.85 ‰ SMOW. The carbon isotopic composition of the samples is also quite variable, from -12.85 to 1.09‰ PDB. A weak inverse correlation exists between $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ (Figure 23).

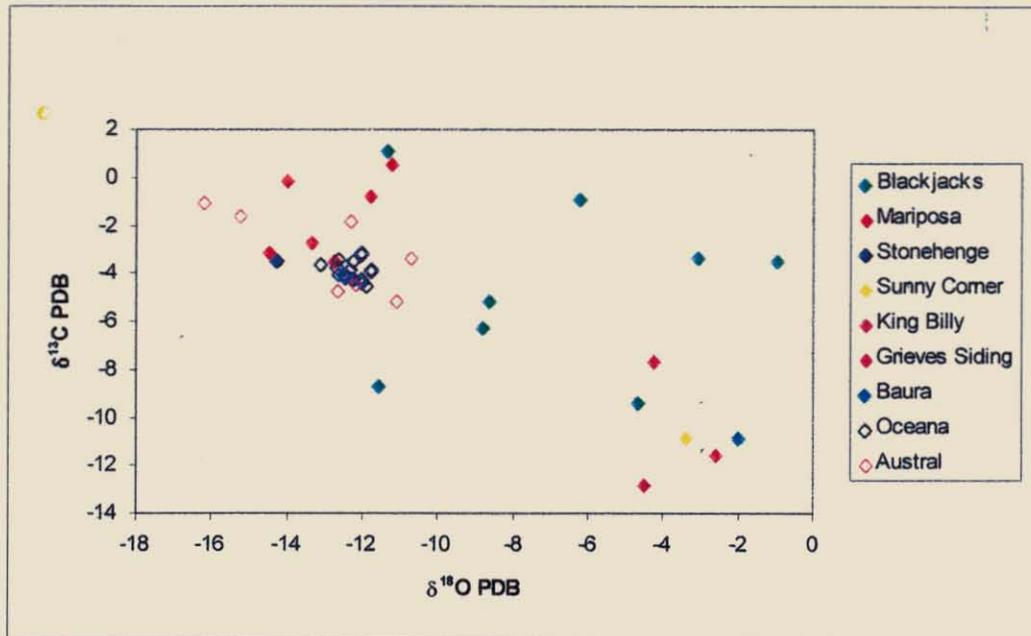


Figure 23. The oxygen and carbon isotopic composition of siderite samples. Data for Oceana and Austral prospects from Peace (1995).

The variation between prospects of oxygen isotopic composition of siderite can be illustrated by plotting average values on a plan map (Figure 24). The $\delta^{18}\text{O}$ values become less negative to the south-east of the sampling area. The $\delta^{13}\text{C}$ values also become less negative to the south-east, however the variation is less consistent than that seen in $\delta^{18}\text{O}$.

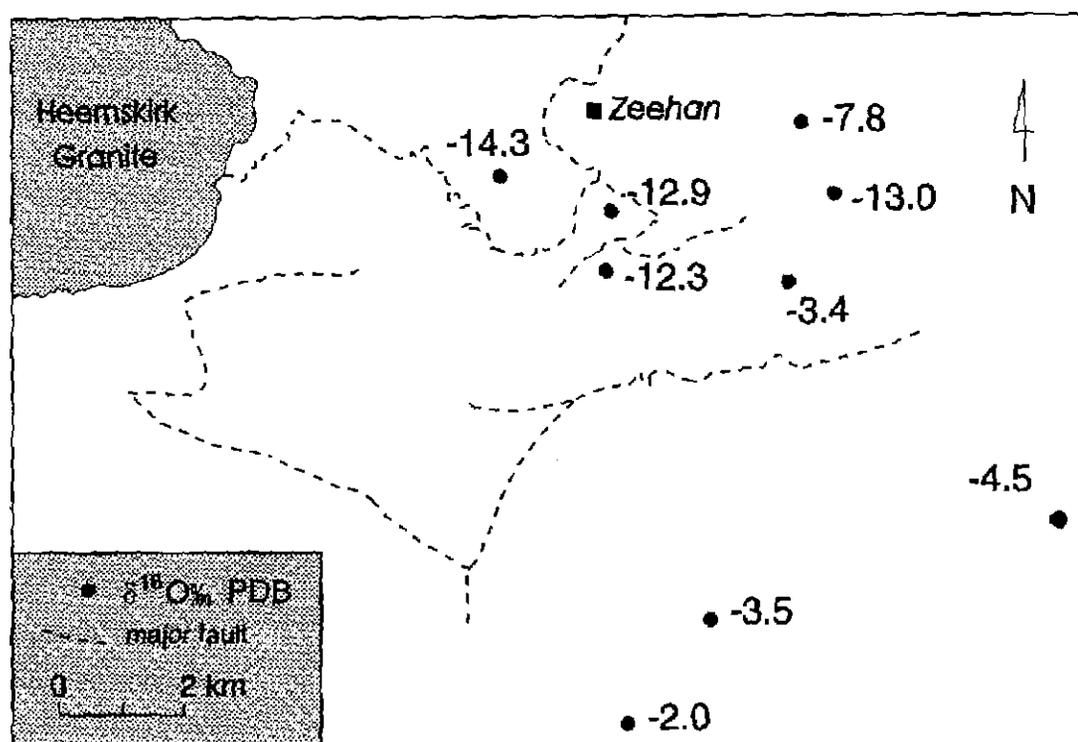


Figure 24. Oxygen isotopic composition of siderite. Data from current study and Peace (1995).

5 cm

5.4 Electron microprobe

The chemical compositions of carbonate phases were analysed using the Cameca SX-50 electron microprobe under standard operating conditions, in the School of Earth Sciences, University of Melbourne. Twelve thin sections were carbon coated in preparation for analysis. Samples were analysed for Ca, Mg, Mn, Fe, Sr, Zn, Pb and Ba. Results are presented as weight percent carbonates in Appendix D. Siderite samples from all prospects, including from the upper, central and lower siderite zones were analysed to establish chemical variation of different siderite types, and variation between geographic position. Dolomite and ankerite phases from several prospects were also analysed.

Variability in the chemical composition of siderite can be quite large. Siderite (endmember FeCO_3) forms complete solid solutions between rhodochrosite (MnCO_3) and magnesite (MgCO_3) through the substitution of Mn^{2+} or Mg^{2+} for Fe^{2+} . Substitutions of up to 15% calcium have also been reported (Deer *et al.*, 1992). The

chemistry of siderite from the prospects studied exhibits a large range of compositions. In the Gordon Limestone hosted samples, the composition varies from 57-95 wt% FeCO_3 , with substitutions of manganese and minor calcium. Most samples contain less than 7% Ca, but several samples from Grieves Siding contain up to 20% Ca. Siderite from Mariposa is particularly manganese-rich, containing 24-32 wt% MnCO_3 , and thus may be classed as mangano-siderite. Siderite from the Stonehenge prospect, which is hosted within Proterozoic sediments, is of the magnesium-rich variety, pistomesite (Chang *et al.*, 1996), and contains up to 33 wt% MgCO_3 .

Siderite chemistry is generally quite constant at any particular prospect, but varies markedly between prospects. The variation in siderite chemistry can be illustrated on a Fe-Mg-Mn triangle diagram (Figure 25).

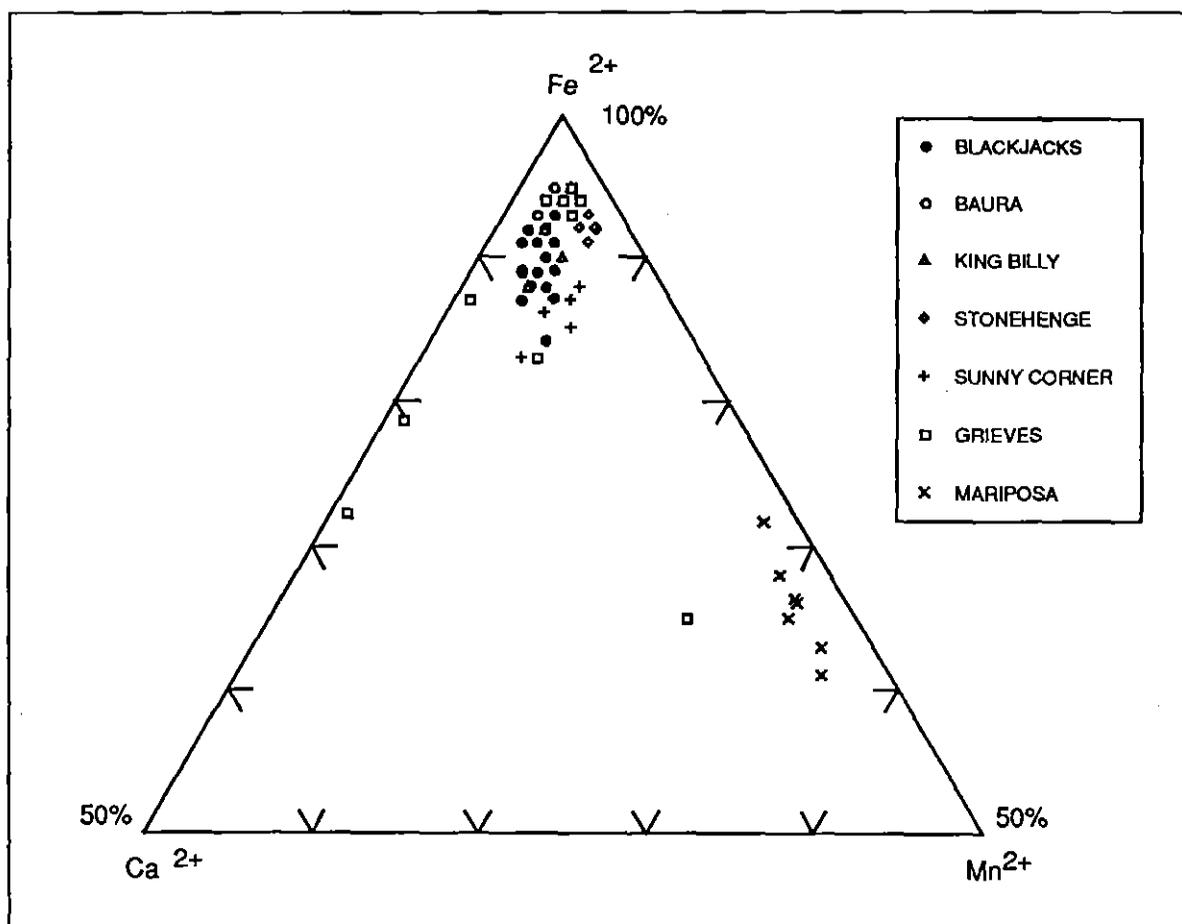


Figure 25. Siderite chemistry with respect to Fe, Mg and Mn.

The variation of siderite compositions across the field can be illustrated with the change in average wt% FeCO_3 between locations (Figure 26).

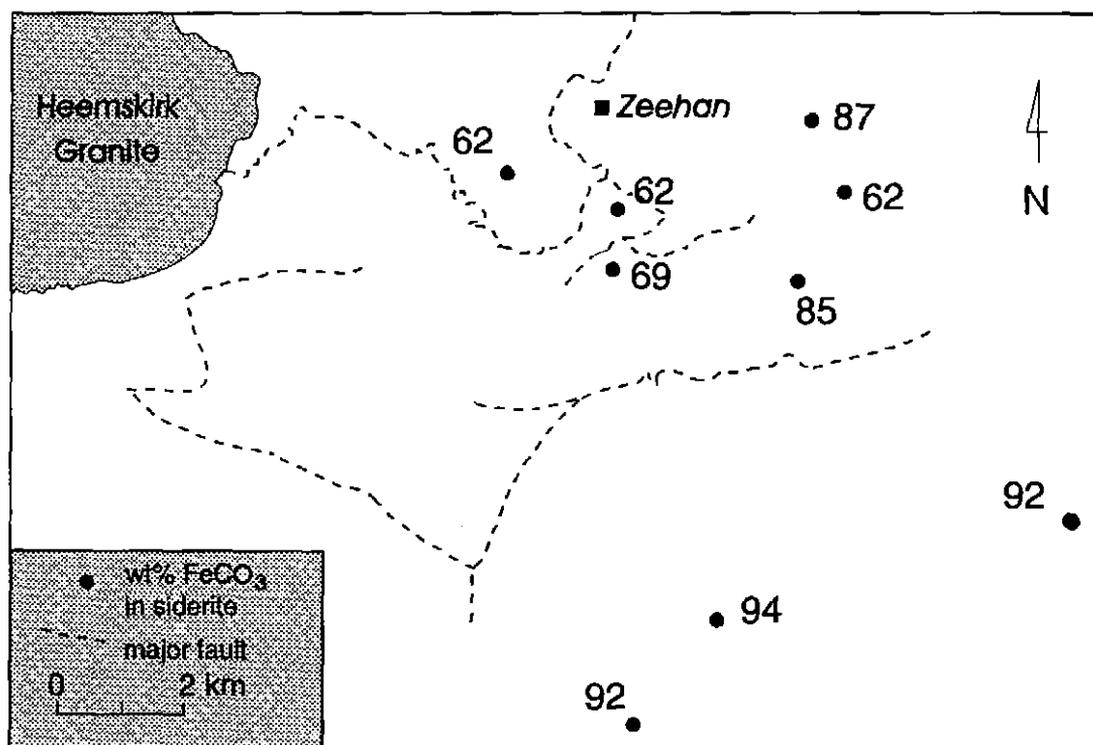


Figure 26. Variation of wt% FeCO_3 contained in siderite. Data from current study and Peace (1995).

5 cm

Most siderite samples have a low zinc content (less than 0.25 wt% ZnCO_3). However, there are exceptions, with over 1 wt% ZnCO_3 in several siderite samples. Dolomite and ankerite phases have elevated zinc, relative to most siderite samples, containing up to 0.7 wt% ZnCO_3 .

6. PARAGENETIC SEQUENCE

The Gordon Limestone in the Zeehan area underwent deformation, resulting in folding and faulting, during the mid-Devonian Tabberabberan Orogeny. With the exception of minor post-Permian block faulting, this is the only major period of deformation that has been experienced by the Gordon Limestone (Both & Williams, 1968a). Structures that resulted from the Tabberabberan Orogeny are therefore useful markers in determining paragenetic sequence. Events that have resulted in textural or mineralogical changes in the Gordon Limestone are classified in the following sections as pre-Tabberabberan, Tabberabberan or post-Tabberabberan features.

6.1 Pre-Tabberabberan features

Pre-Tabberabberan events may have occurred from deposition of the Gordon Limestone in the Ordovician, until the onset of the Tabberabberan Orogeny. Burial diagenesis processes were dominant during that time, resulting in dolomitisation and the formation of stylolites and solution seams.

Primary porosity within fossils, such as gastropods, is often filled with calcite cement. No siderite or base metal sulphide minerals were observed to exist in primary porosity.

Partial dolomitisation has resulted in small dolomite rhombs occurring in bedding parallel bands and irregular patches, often in mudstone. These areas of dolomitisation are often bounded by stylolites, and therefore pre-date some stylolites. The extensive dolomitisation at the top of the sequence is likely to be due to burial diagenesis. This is indicated by coarsely crystalline dolomite cements, which are typical of burial dolomitisation, and the broad regional extent of the dolomitisation.

Concentrations of dark, fine-grained insoluble material form stylolites and solution seams that are subparallel to bedding. Stylolites are thin (1-2 mm), have sutured boundaries and amplitudes up to 3 cm. Solution seams up to 3 cm thick have smooth, sometimes wispy boundaries. Solution seams may contain concentrations of fine fossil fragments, commonly bryozoa.

6.2 Tabberabberan features

The Tabberabberan Orogeny resulted in folding and faulting of the Gordon Limestone (Both & Williams, 1968a). Throughout the sections sampled, the extent of effects due to deformation varies.

Cleavage has developed to varying degrees and is not present in all samples. Cleavage is best developed in clay-rich lithologies. Solution cleavage has developed as thin, parallel solution seams of dark insoluble material and may form thin parallel or anastomosing planes or be concentrated in wider seams. These seams may cross cut diagenetic solution seams, stylolites and dolomite. Flattening of bioclasts in grainstone is also observed.

Quartz grains within the limestone often have fibrous calcite strain shadows (Figure 27). These strain shadows form parallel to the surrounding solution cleavage, with the fibrous calcite crystals also oriented parallel to the cleavage. Fibrous calcite is also present in cracks within the more elongate (less well rounded) quartz grains. These partings within the quartz grains are perpendicular to the cleavage and appear to be microboudinage-type structures. Both of these structures are interpreted as being the result of Tabberabberan deformation. The fibrous calcite is not overprinted by the small dolomite rhombs in the matrix, supporting the interpretation that the dolomite is pre-Tabberabberan.

6.3 Post-Tabberabberan features

Clear, yellow siderite (type 3) is also associated with quartz. Siderite occurs both within cracks in large quartz grains and in shadows around the grains, occupying zones in the same position, relative to cleavage, as the calcite strain shadows (Figure 28). However, unlike the calcite strain shadows, this siderite is blocky, not fibrous, and crystals display no preferred orientation. This suggests that the siderite shadows are not a deformational feature, but that the siderite has replaced the fibrous calcite crystallised during the Tabberabberan deformation. This strongly suggests that precipitation of siderite was post-deformational, therefore, post-Tabberabberan.

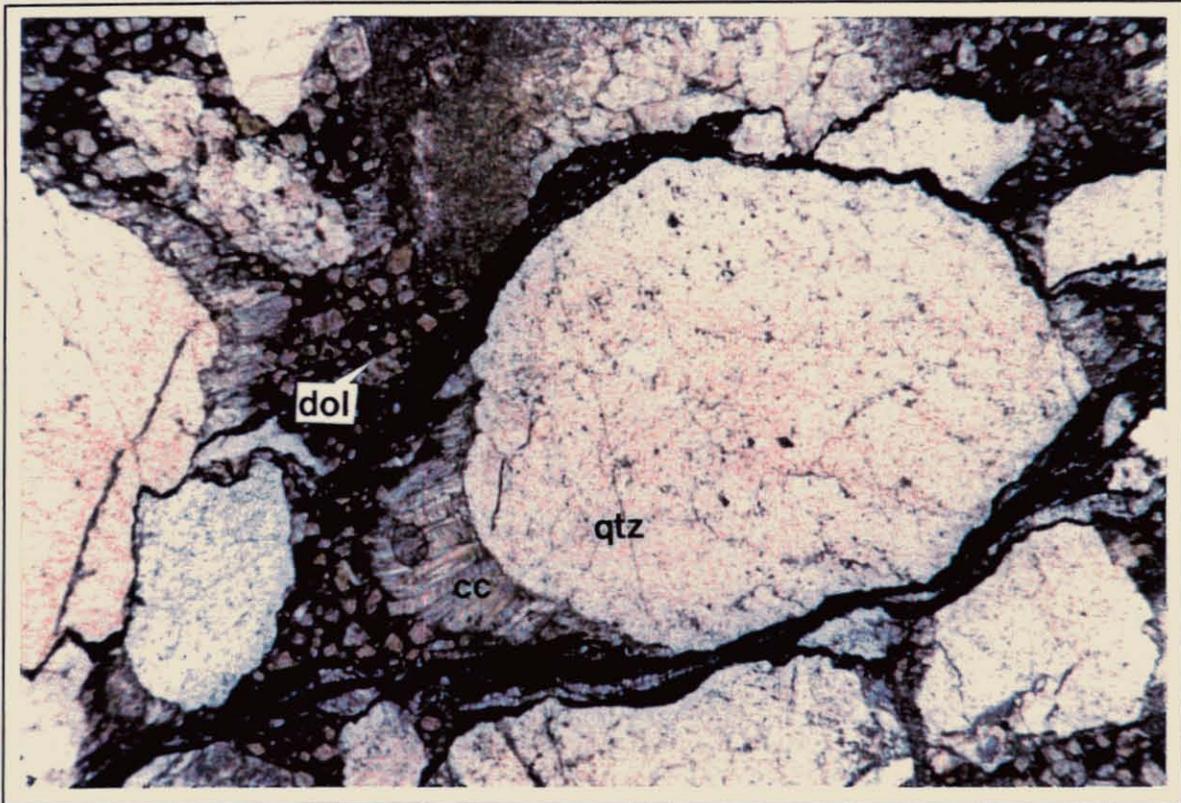


Figure 27. Photomicrograph of calcite strain shadows (cc) around quartz clast (qtz). Small dolomite crystals (dol) are in the surrounding matrix. PPL. Width of view is 6 mm. Sample 1104347.

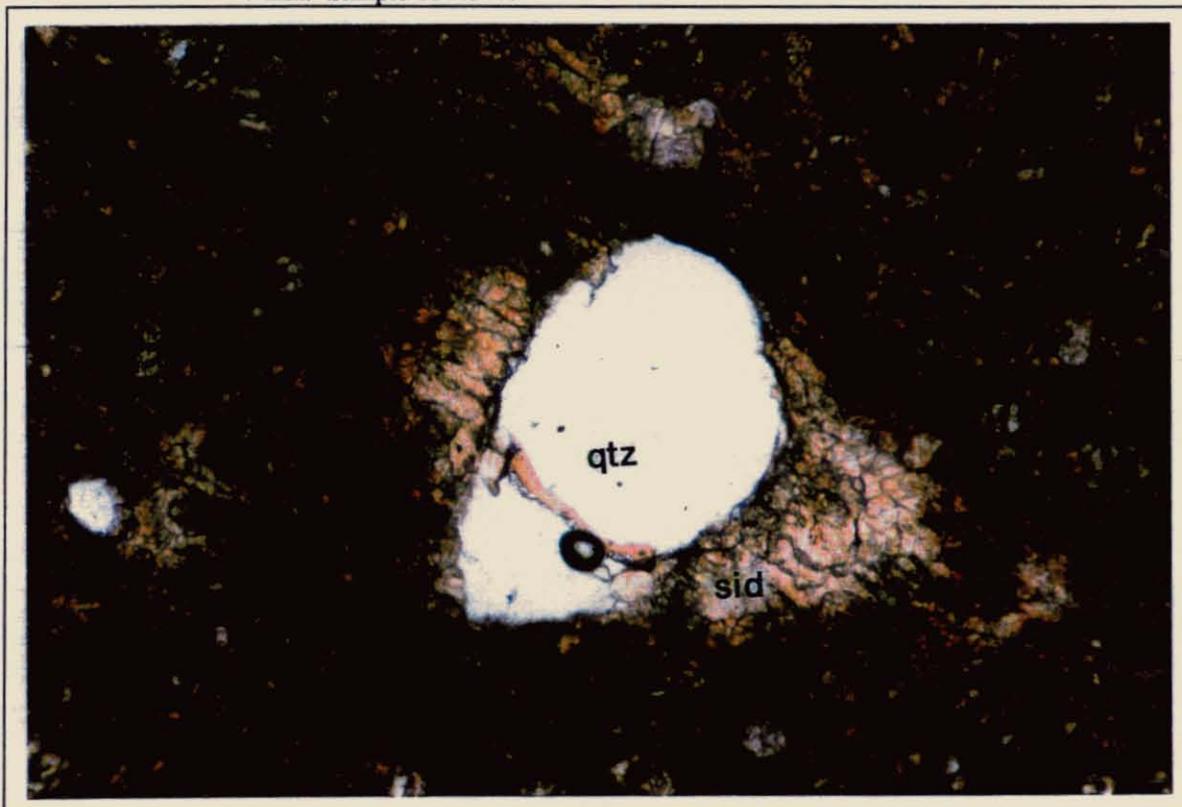


Figure 28. Photomicrograph of replacement siderite (sid) in strain shadow around quartz (qtz). PPL. Width of view is 1.5 mm. Sample 1100635.

5 cm

Type 3 siderite is also seen in thin, lense-shaped veins. These veins cross cut diagenetic dolomite and solution cleavage, again indicating post-Tabberabberan crystallisation of siderite (Figure 29).

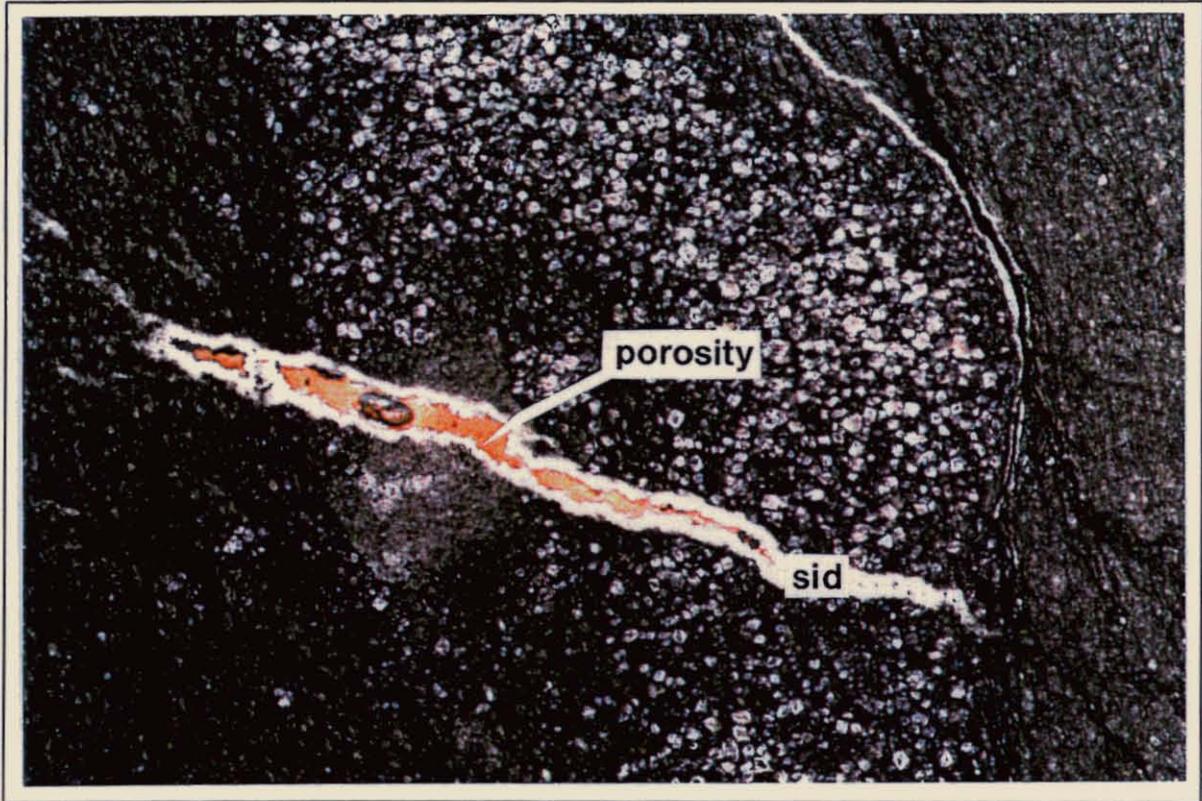
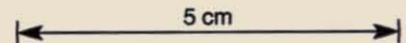


Figure 29. Photomicrograph of siderite (sid) filled fracture cross cutting solution cleavage. Remaining porosity in the centre of the fracture has been filled with glue. PPL. Width of view is 5.5 mm. Sample 1013664.



The matrix surrounding the quartz grains consists of fine-grained siderite (type 1). The lack of difference in chemistry between different siderite types within the one sample indicates that they have precipitated from fluids of the same chemistry, most likely at the same time. The form that siderite adopts is a function of the material it is replacing, rather than the types of siderite being indicative of separate events. The existence of pre-Tabberabberan dolomite within this fine siderite matrix suggests that the siderite may have preferentially replaced calcite over dolomite. Textures suggesting this relationship are seen within the replacement type siderites (type 1 and type 2).

Siderite also occurs as cements within cavities and breccias. Siderite cements (type 4) occur in cavities within type 2 replacement siderite, indicating that the cements were

precipitated later than the replacement siderite. However, the similarities in chemistry between the two phases suggests that the timing difference between the two may be marginal.

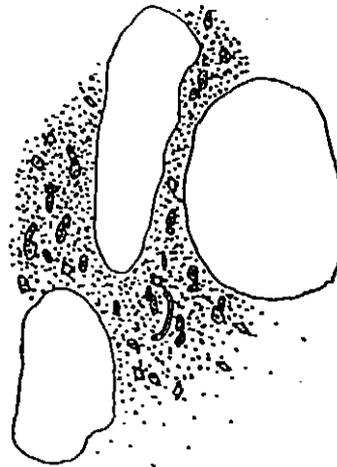
Both galena and sphalerite are found in the centre of siderite lined cavities, therefore these phases post-date the siderite (Figure 18). Sphalerite and galena appear to be contemporaneous phases within both cavities and breccias. Although the timing relationship between cavity fill and breccia mineralisation is not known, there is no evidence to suggest two separate phases of mineralisation. Sphalerite from both types of mineralisation is very similar in appearance. Therefore it is suggested that sphalerite and galena were precipitated simultaneously in cavities and breccias.

Ankerite occurs in the centre of cavities within siderite and as fine cross cutting veins. Both of these modes of occurrence suggest that ankerite is a paragenetically late mineral phase, possibly contemporaneous with galena and sphalerite. The calcite that cements breccias containing galena and sphalerite is the latest recognised mineral phase.

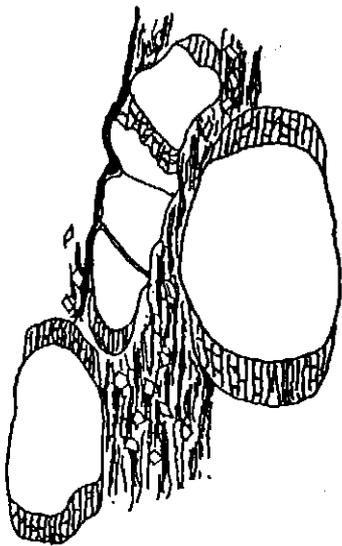
6.4 Summary

Features within the Gordon Limestone strongly suggest that crystallisation of siderite and base metal sulphide minerals occurred after the Mid-Devonian Tabberabberan Orogeny. The replacement of strain shadows around quartz grains by siderite is one of the features that supports this timing (Figure 30).

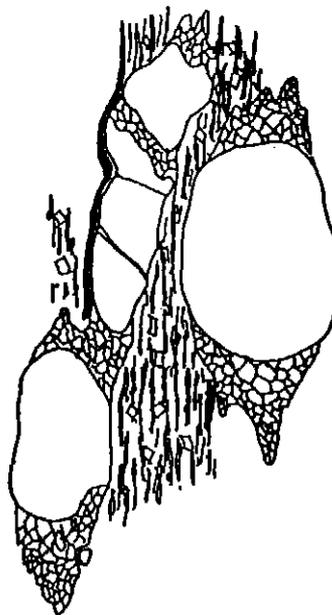
Pre-Tabberabberan
Rounded quartz grains
and diagenetic dolomite in
clay-rich micritic matrix.



Tabberabberan
Deformation results in formation
of solution cleavage and fibrous
calcite strain fringes.



Post-Tabberabberan
Calcite replaced by siderite.
Coarsely crystalline siderite forms
around quartz grains. Fine siderite
has replaced micrite matrix.



0 1 2mm
Scale 1:10

Figure 30. Sketch of the development of siderite shadows around quartz grains.

5 cm

7. DISCUSSION

7.1 Zonation

Chemical zonation

The variation in the isotopic composition of siderite from different localities illustrates a zonation away from the Heemskirk Granite. When average isotopic compositions of siderites are plotted in plan section, a trend of heavier values to the south east is evident (Figure 24).

The variation of chemical composition of siderite also reflects this zonation, with siderite becoming increasingly iron-rich further south-east of the granite. The relationship between the oxygen isotopic composition and the chemical composition of siderites from the outer part of the Zeehan mineral field correlates well (Figure 31). When FeCO_3 is plotted against $\delta^{18}\text{O}$ for each locality a linear relationship is seen.

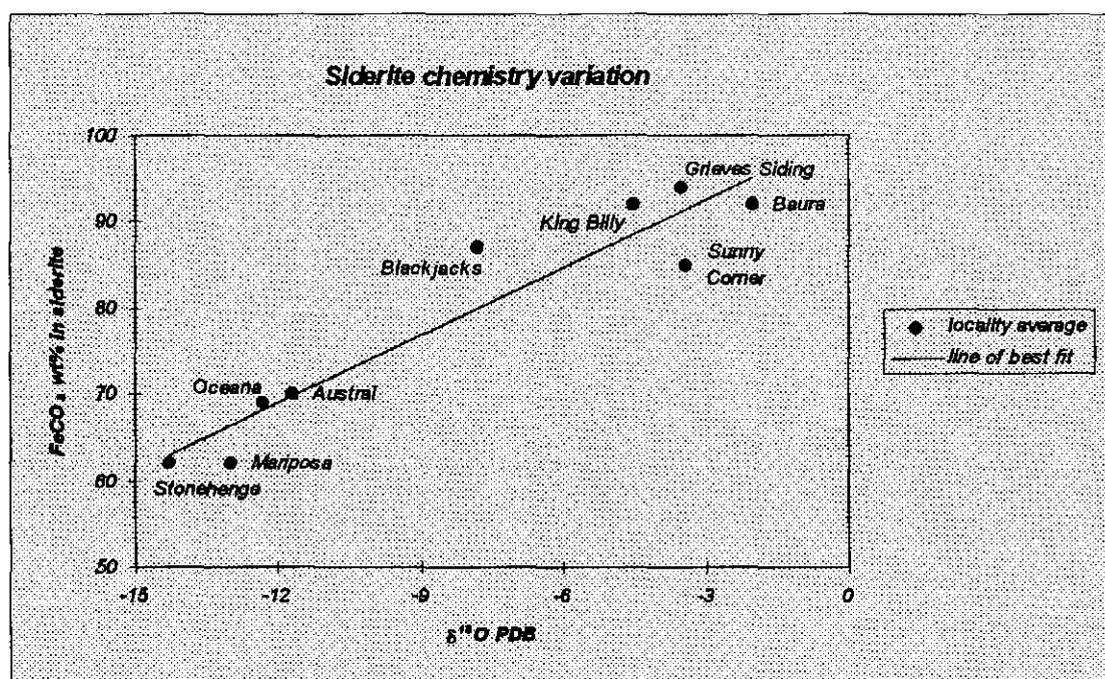


Figure 31. $\delta^{18}\text{O}$ versus wt% FeCO_3 of siderite. Data from current study and Peace (1995).

The positive correlation of these parameters indicates that the siderite at each of the separate sites is chemically related. This suggests that the precipitation of siderite at each site was not independent.

It could be argued that the distribution of siderite compositions falls into two groups, rather than being a linear trend. However, the distribution of sample locations must be taken into account (Figure 3). Sample sites are limited by the location of available diamond drill core, and these locations are not distributed evenly with respect to distance from the Heemskirk Granite.

Crystal Size Zonation

The crystal size of siderite appears to decrease to the south-east. This can be illustrated with the occurrence of coarse cement and replacement siderite at Mariposa (Figure 18) compared to very fine-grained replacement at Baura (Figure 15). However, sampling from all localities was not sufficiently extensive to statistically verify this trend.

7.2 Development of zonation

Williams (1974) proposed that the decreasing FeS content of sphalerite to the east of the Heemskirk Granite was due to the decreasing temperature of crystallisation. Collins and Williams (1986) also supported that the west to east zoning was due to the thermal environment. An isotherm defined by the transition from manganiferous to non-manganiferous sphalerite lies just within the pyrite zone, parallelling the zonation (Williams, 1974). The chemical and crystal size zonation of the limestone-hosted deposits distal to the granite could also be the result of decreasing temperature away from the granite. Alternatively, the zonation may have resulted from the chemical development of mineralising fluids as they moved away from the granite. Solomon and Groves (1994) suggested siderite precipitation was due to an increase in $f\text{CO}_2$ of the mineralising fluids. This change in chemistry of mineralising fluids resulted from the dissolution of limestone or mixing of fluids with CO_2 -rich groundwater.

The outer deposits of the Zeehan mineral field may be the result of circulating heated groundwater, rather than primary magmatic fluids (Solomon & Groves, 1994). Given the size of the area studied, it seems very unlikely that the more distal deposits, such as the Baura prospect (located 14 km south-east of the granite), are the result of

fluids exsolved from the Heemskirk Granite. Therefore, it seems most likely that the zonation is the result of the decreasing temperature influence, rather than the development of a magmatic fluid as it moved away from the granite intrusion.

Both and Williams (1968b) proposed that the zonation developed to the east of the Heemskirk Granite. However, when this zonation model is extended further from the granite, to include more deposits of the Gordon Limestone, the zonation takes on a south-east trend. Although this trend may be the product of the location of the sampling sites of this study, the south-east trend is supported by the subsurface position of the Heemskirk Granite. Based on their interpretation of gravity and magnetic geophysical data, Leaman and Richardson (1989), propose that the Heemskirk Granite has an underground expression trending east north-east. This inferred shape is consistent with the proposed zonation to the south-east of the granite outcrop.

It is proposed that the chemical zonation seen in siderite from within the Gordon Limestone is consistent with the zonation in gangue mineralogy seen closer to the Heemskirk Granite. The zonation illustrated by the variation of siderite chemistry includes a siderite sample from the Stonehenge prospect, which is located within the sidero-pyritic zone described by Both and Williams (1968b). This serves to illustrate the continuity of the zonation across the lithology change from clastic sediment to limestone. The zonation and chemical relationships between localities in the outer part of the Zeehan mineral field illustrate that siderites from the different prospects have a related chemistry, thus a related genesis. The overprinting of Tabberabberan deformation features, including regional folding and faulting, by this chemical zonation suggests that the crystallisation of the siderite post-dates the deformation. This overprinting indicates that pre-Tabberabberan mineralisation of the carbonate-hosted deposits of the Zeehan mineral field is unlikely.

7.3 Stratigraphic and fault control

The presence of mineralisation in fault breccias from Mariposa indicates the association of mineralisation with faulting. The mineralisation at Mariposa does not appear to be stratabound.

Siderite occurs at the upper and lower contacts of the limestone with sandstone. These contacts, which may be locally faulted, provide both a permeability barrier and conduit for fluids within the Gordon Limestone. The contacts seem to be controlling structures of the upper and lower zones. The middle zone may be favourable because of increased porosity in grainstone and quartz rich rocks when compared to the surrounding limestone. This may indicate that the stratigraphic position of siderite is influenced by host rock permeability. Alternatively, the quartz-rich carbonates may have behaved in a more brittle manner during deformation, resulting in more intense faulting and fracturing, hence a preferred zone for mineralisation. Jack (1961) interpreted the mineralisation of the Oceana deposit, which is situated in the central siderite zone, to be occupying a zone of intense shearing. It was concluded that these structures were pre-ore, and had acted as favourable conduits for the mineralising fluids (Jack, 1961).

7.4 Siderite chemistry

Siderite chemistry does not vary significantly between the upper, central and lower zones. The range of compositions, represented by weight percentage FeCO_3 , for each zone is illustrated in Figure 32. The central and central-lower zones are each represented by only one sample, limiting the range of compositions.

The lack of distinction between the chemistry of the three siderite zones indicates that their formation is likely to be due to the same event. Consistent chemistry of different siderite types within a sample indicates that all of the siderite in that sample is of the same generation, i.e. both coarse and finely crystalline siderite. The chemical homogeneity across siderite types suggests that only one event of siderite crystallisation has occurred.

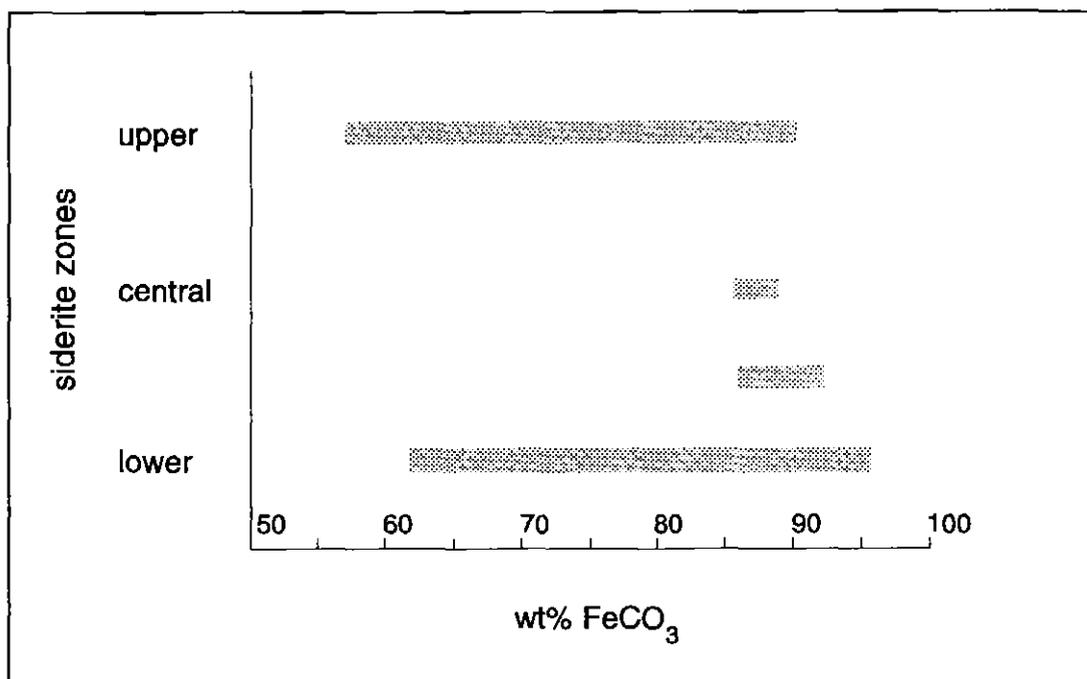


Figure 32. The range of wt% FeCO₃ for each siderite zone. A sample from between the central and lower zones is also represented.

7.5 Paragenesis

It may be concluded from paragenetic studies that siderite post-dates Tabberabberan cleavage development. This is demonstrated by replacement of calcite strain fringes by siderite, lack of preservation of cleavage in massive siderite and siderite veins cross-cutting cleavage. The occurrence of type 4 siderite in cavities within type 2 siderite indicates that type 4 appears to be marginally later, paragenetically. However, no cross-cutting or overprinting relationships that would imply more than one event of siderite crystallisation are seen between siderite types. This suggests that precipitation of siderite, both replacement and coarser forms, post-dates cleavage formation during the Tabberabberan Orogeny. The presence of galena and sphalerite in the centre of cavities within siderite implies that the base metal sulphides post-date the siderite. Therefore, mineralisation also post-dates the Tabberabberan Orogeny.

8. CONCLUSIONS

As a result of handspecimen and thin section study, major and trace element chemical analysis and stable isotope analysis, the following conclusions can be made from this study.

- The stratigraphy of the Gordon Limestone has been defined. However, the effects of faulting prevents detailed correlation on a single bed scale. Three main siderite zones are recognised in the stratigraphy. However, siderite is not entirely restricted to these zones. The position of the siderite zones appears to be associated with the contacts of the limestone with quartzite and to faulting within the limestone.
- Five types of siderite have been recognised, based on texture, grain size and colour. However, chemical variation does not occur between the siderite types occurring at a single locality. Physical relationships between the siderite types suggest that all of the siderite types are paragenetically similar.
- Both the elemental and isotopic chemistries of siderite display systematic variation to the south-east, away from the Heemskirk Granite. This trend is illustrated in both siderite from the Stonehenge prospect, which is located within the sideropyritic zone, and limestone-hosted siderite samples from the siderite zone. The zonation may be the result of decreased temperature away from the Heemskirk Granite.
- Galena and sphalerite from Mariposa are hosted within breccias or small siderite-lined cavities. Mineralisation does not appear to be stratabound.
- Siderite post-dates Tabberabberan deformation features. Mineralisation post-dates siderite, and therefore the mineralisation is younger than Middle Devonian.

In summary, the zonation, timing and apparent structural control of siderite within the Gordon Limestone suggests that the siderite and associated mineralisation is related to the intrusion of the Heemskirk Granite in the Late Devonian-Early Carboniferous, and does not have its origins in an Ordovician mineralisation event.

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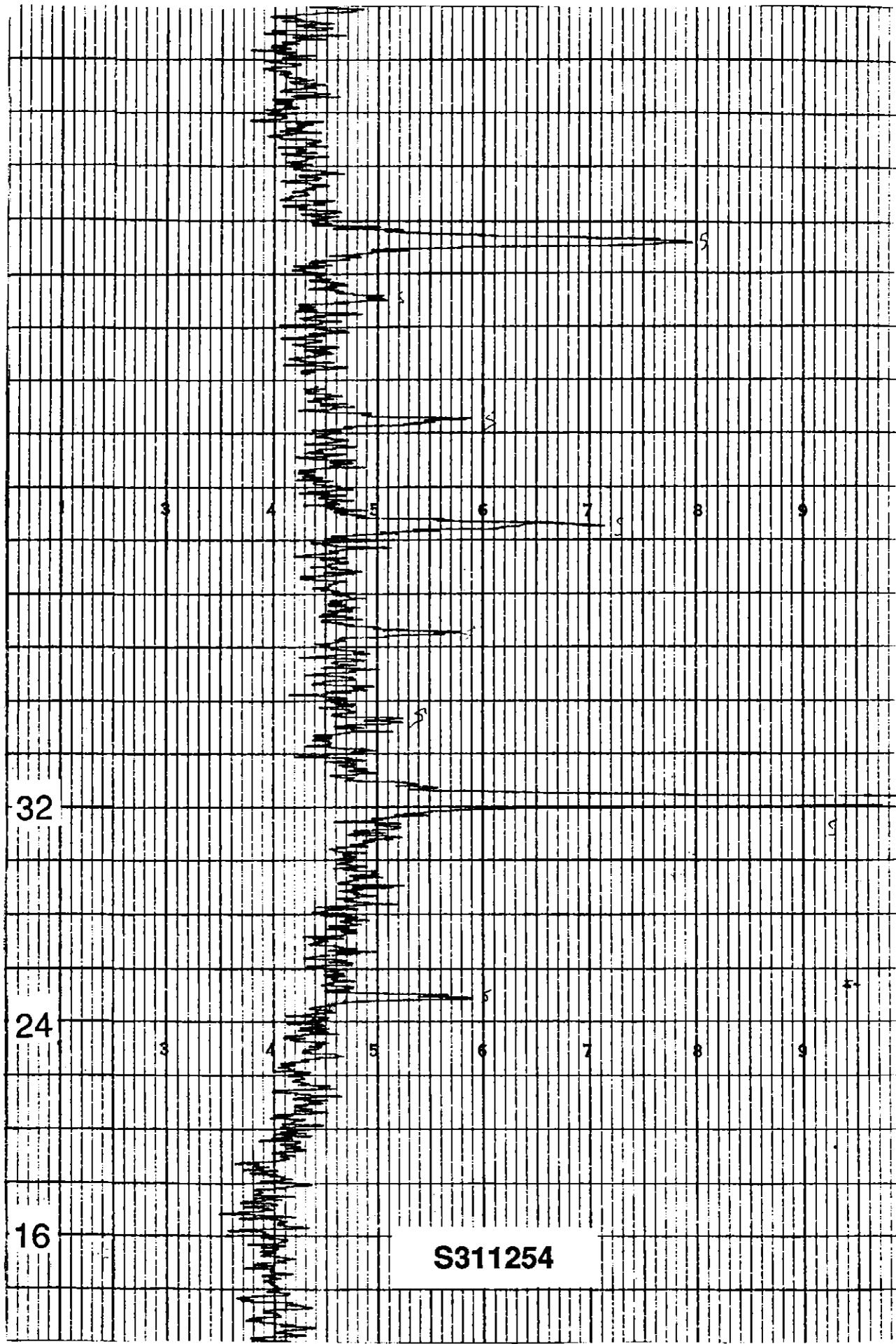
APPENDIX A: THIN SECTION DESCRIPTIONS

Appendix A:			Abbreviations used	
Thin section descriptions			<i>qtz - quartz; dol - dolomite; py - pyrite; xtal - crystal; o.m. - organic matter</i>	
			<i>var. - variable; v. - very; conc. - concentrated; xcutting - cross cutting</i>	
Sample Number 9685/...	Location AMG (Zone 55) coordinates	DDH	Depth (m)	Description
1100635	Blackjacks 665605	DB110	63.5	<i>siderite - laminated, red-brown, cleaved, clear subhedral siderite overgrowing yellow subhedral siderite in uncleaved zones; siderite filled cavities and veins crosscutting cleavage; qtz - < 0.2 mm rounded grains with siderite veining</i>
1100905	Blackjacks 665605	DB110	90.5	<i>siderite - finely crystalline, yellow-brown; weak foliation defined by fine, dark solution cleavage planes; colourless, finely crystalline veins, 1-2 mm, no preferred orientation; vein - large (< 1 mm), blocky calcite cement, overgrowing yellow siderite</i>
1102568a	Blackjacks 665605	DB110	256.8	<i>grainstone of assorted fossil fragments with large areas of calcite cement fines up to wackstone; ~10% qtz grains</i>
1102568b	Blackjacks 665605	DB110	256.8	<i>wackestone has sharp contact with mudstone; mudstone - cleaved, dolomite overgrowing cleavage; sharp stylolite contact with lighter mudstone, increased dolomite up hole to complete recrystallisation</i>
1103114	Blackjacks 665605	DB110	311.4	<i>grainstone - 4 mm brachiopods, 15 mm corals; mudstone, cleaved, dolomite overgrowing cleavage; gradual boundary, no dolomite in grainstone</i>
1103580	Blackjacks 665605	DB110	358.0	<i>qtz sandstone; qtz - moderately sorted, 0.1-0.5 mm, larger grains rounded, smaller grains subangular; matrix - micrite; rextallised dol. rhombs; sparry calcite cement, forms pressure shadows on qtz grains; interstitial o.m.; rare rounded micrite clasts</i>
1103665	Blackjacks 665605	DB110	366.5	<i>interbedded wackestone and dolomitic mudstone; wackestone - fossil moulds (up to 10 mm) of sparry calcite cement, micrite matrix; zones of fine (0.1 mm) dolomite bounded by stylolites</i>
1103829	Blackjacks 665605	DB110	382.9	<i>quartz sandstone - grains 0.1-0.3 mm, subrounded to angular, black organic matter matrix, calcite cement; transitional contact with peloidal limestone, 0.4 mm clasts, long axes aligned with foliation; elongate, wispy clasts of mudstone, 8 mm long</i>
1104347	Blackjacks 665605	DB110	434.7	<i>quartz sandstone with matrix of micrite, sparry calcite cement and later, brown dolomite, euhedral rhombs; quartz - rounded to irregular, 2 mm, undulose extinction, pressure shadows</i>
1104770	Blackjacks 665605	DB110	477.0	<i>clear, fine siderite laths in brown v.v. fine groundmass; very porous; quartz (chalcedony) grains with radiating extinction</i>

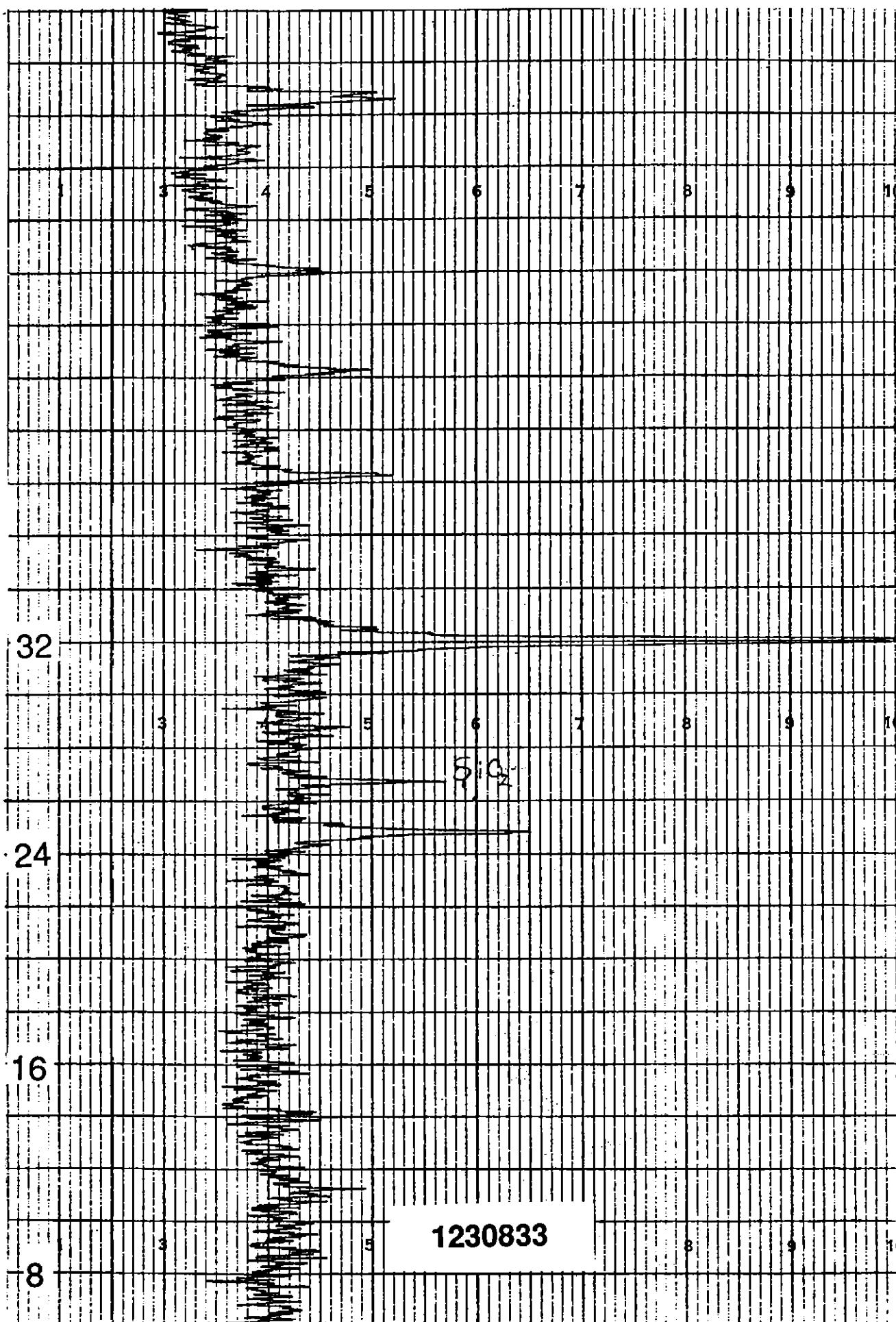
1110186	Blackjacks 666606	DB111	18.6	packstone - fossil moulds up to 5 mm filled with sparry calcite cement, ooid matrix; mudstone - extensive dol. replacement overprinting cleavage; extent of dol. bounded by stylolites; qtz conc. in stylolites, rounded to subangular, poorly sorted, 0.1-1 mm
1111651	Blackjacks 666606	DB111	165.1	quartz sandstone - quartz rounded, generally 0.1-0.2 mm, up to 4 mm, with calcite strain shadows; matrix - fine FeO, opaques, calcite cement; vein - 15mm, coarse, blocky calcite, cross cutting
1111934	Blackjacks 666606	DB111	193.4	siderite - pale yellow-brown, v. finely crystalline, pale cavity fill with interconnecting veins (shrinkage features?); siderite fill shrinkage cracks/veins across rextallised dol clast, small sub-anhedral dol xtals, some with fine siderite veins
1112263	Blackjacks 666606	DB111	226.3	siderite - yellow, sub-anhedral, var. xtal size, o.m. xtal outlines; dolomite - ~80%, sub-euhedral rhomb, 0.2 mm, patches of almost complete dol overgrowth with v. fine siderite veining in dol cleavage planes; siderite filled shrinkage crack
8420772	Mariposa 673591	DTM 84-2	77.2	Onkoid grainstone, completely dolomitised; dol. brown, cement xtals up to 2 mm; onkoids up to 15 mm diameter; abundant interstitial, subhedral py, up to 1 mm;
8421126	Mariposa 673591	DTM 84-2	112.6	ooid grainstone overgrown by euhedral brown dolomite, concentrated o.m. around areas of dolomite, large twinned calcite xtal containing clasts of grainstone replaced by dol rhombs; two generations of dol veining, second with small py cubes in centre
8421325	Mariposa 673591	DTM 84-2	132.5	siderite - finely xtalline, brown, with poor xtal definition surrounding pale cavity fill with sweeping extinction; cavities often parallel and elongate; sphalerite and galena in centre of cavities, py in cavities and as cross cutting veins
8421367	Mariposa 673591	DTM 84-2	136.7	breccia of calcite, siderite, sphalerite and galena in fine, brown matrix and sparry calcite cement; siderite - grey-brown, small xtals, poor extinction; stylolites
8421503	Mariposa 673591	DTM 84-2	150.3	Interlocking, subhedral, twinned calcite infilling between finer xtalline siderite with galena (<1 mm) and sphalerite (<1 mm) blebs; surrounded by cavity fill siderite, clear, zoned, curved xtals with sweeping extinction; some clasts of dol. mudstone
8490850	Mariposa 674588	DTM 84-9	85.0	wackestone of corals and bryozoa in dolomite matrix; 15 mm seams of dark organic matter with some dolomite crystals (0.1 mm); cross cutting stylolites
8491658	Mariposa 674588	DTM 84-9	165.8	packstone with stylolite bounded dark dolomite rich zones with rare fossils; foliation strong in dark bands; corals (20 mm); onkoids (8 mm); dense concentrations of thin solution seams around some fossils
OP23558	Oceana 601572	OP2	355.8	qtz sandstone - rounded to irregular grains, poorly sorted, sparry calcite cement; some coral fragments < 6 mm with stylolite edges; brown dol vein with stylolites along margins

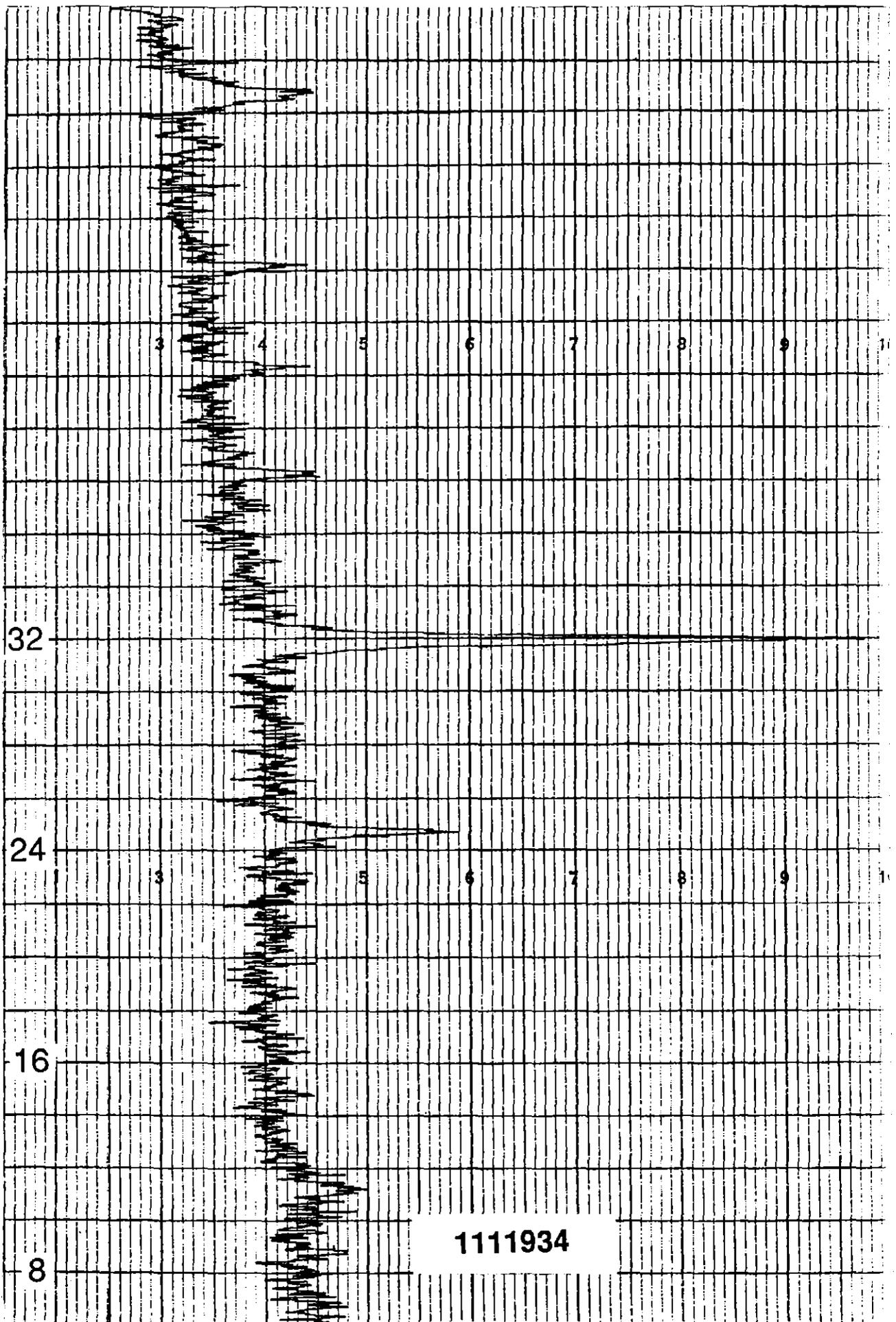
S311254	Stonehenge 598594	ZS31	125.4	siderite - clear anhedral xtals growing among remnants of fine grained, qtz rich host rock; large laths (up to 5 mm); irregular py clusters, late siderite and ankerite veins
1013664	Sunny Corner 633570	101	366.4	fine pale buff-grey siderite, cleaved; later 0.1 mm euhedral dolomite overgrowing, ~50%; dolomitised areas bounded by stylolites/cleavage planes; late stage shrinkage cracks with pale siderite cross-cutting cleavage
1230833	King Billy 712519	123	83.3	siderite - sub-anhedral xtals, less distinct xtal shape in dark areas, zones of different xtal size, occurs as fine veins through qtz; qtz - rounded or being overgrown, < 0.5 mm
4050527	Grieves Siding 648498	405	52.7	siderite - pale grey-brown, subhedral with organic matter xtal outlines, 0.2 mm, in areas of cavity fill and interconnecting veins xtals < 1 mm, seam of dark organic matter with rounded clusters of siderite; rare 0.1 mm qtz grains; porous
4101774	Grieves Siding 642490	410	177.4	siderite - pale grey-brown, organic matter outlines 0.01-0.02 mm, finely recrystalline inside outline; porous
ZB10202	Baura 627475	ZB1	20.2	siderite - massive, v. fine grained, < 10 μ m, yellow-brown; qtz, 10 μ m, ~5%

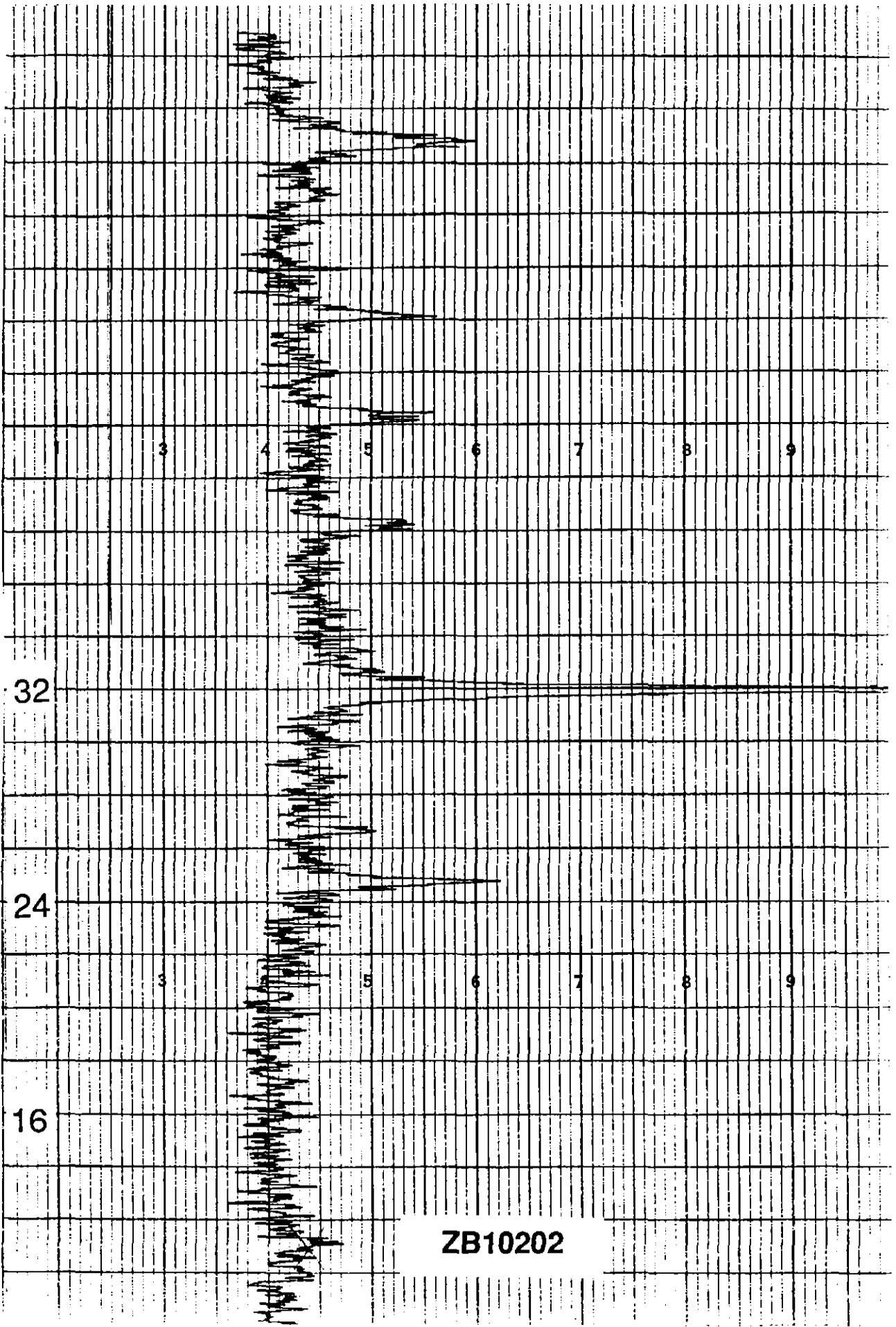
APPENDIX B: XRD SPECTRA

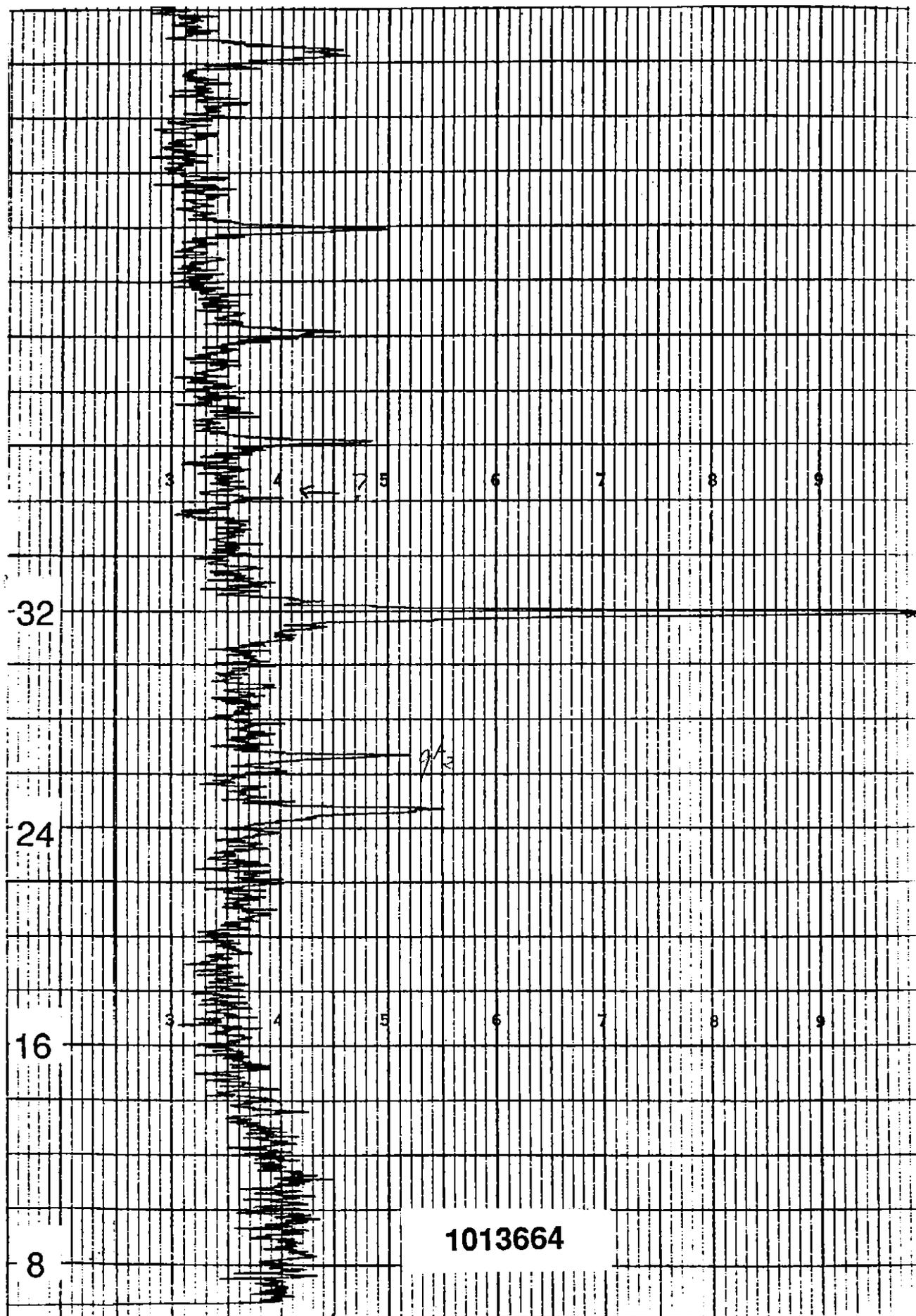


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1013664

APPENDIX C: STABLE ISOTOPE DATA

Appendix C:

Oxygen and Carbon Isotope Data

Sample number	Location	Depth (m)	$\delta^{18}\text{O}$ SMOW	$\delta^{18}\text{O}$ PDB	$\delta^{13}\text{C}$ PDB
9685/...					
1100635	Blackjacks	63.5	18.97	-11.58	-8.68
1102375	Blackjacks	237.5	19.21	-11.35	1.09
1103525	Blackjacks	352.5	24.49	-6.22	-0.89
1104691	Blackjacks	469.1	29.93	-0.95	-3.53
1111057	Blackjacks	57.0	26.09	-4.67	-9.44
1111934	Blackjacks	193.4	27.75	-3.06	-3.37
1112420	Blackjacks	242.0	21.99	-8.65	-5.14
1112592	Blackjacks	259.2	21.82	-8.81	-6.26
8421325	Mariposa	132.5	15.94	-14.52	-3.12
8421411	Mariposa	141.1	17.11	-13.38	-2.75
8421707	Mariposa	170.7	16.43	-14.04	-0.18
8490296	Mariposa	29.6	18.73	-11.81	-0.75
8490392	Mariposa	39.2	17.73	-12.78	-3.48
8491016	Mariposa	101.6	19.27	-11.29	0.54
4050527	Grieves Siding	52.7	28.2	-2.63	-11.54
4101774	Grieves Siding	177.4	26.49	-4.28	-7.66
1013664	Sunny Corner	366.4	27.38	-3.42	-10.9
S311254	Stonehenge	125.4	16.17	-14.29	-3.49
ZB10202	Baura	20.2	28.85	-1.99	-10.88
1230833	King Billy	83.3	26.23	-4.54	-12.85

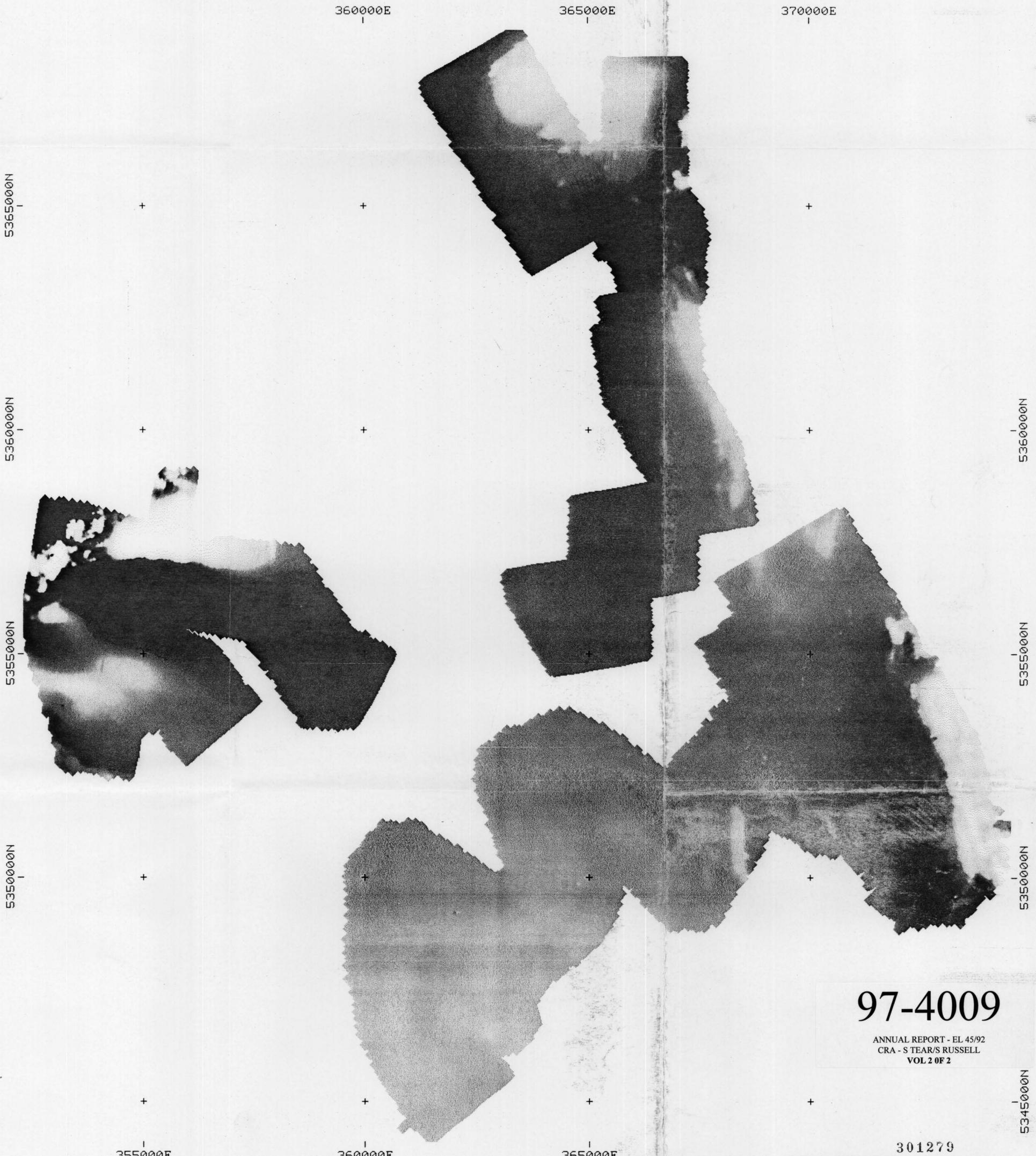
APPENDIX D: MICROPROBE DATA

Sample Number	Location	Phase	weight % as carbonate							Total
			Mg	Sr	Ca	Mn	Fe	Zn	Pb	
9683/...										
1104770	Blackjacks	SIDERITE	0.29	0	3.64	3.16	90.26	0	0.03	97.38
1104770	Blackjacks	SIDERITE	0.32	0.02	3.36	2.7	91.98	0.01	0.02	98.42
1104770	Blackjacks	SIDERITE	0.36	0.03	3.63	2.66	91.06	0	0	97.75
1104770	Blackjacks	SIDERITE	0.69	0	7.22	6.45	81.63	0	0.02	96.01
1104770	Blackjacks	SIDERITE	0.64	0	5.43	4.72	86.08	0.24	0	97.1
1111934	Blackjacks	SIDERITE	0.49	0	2.63	3.02	92.1	0.21	0.19	98.65
1111934	Blackjacks	SIDERITE	0.57	0	2.76	3.03	92.4	0.21	0.04	99
1111934	Blackjacks	Fe DOLOMITE	36.12	0	56.45	1.46	3.9	0.71	0.08	98.72
1111934	Blackjacks	Fe DOLOMITE	35.61	0	55.96	1.21	4.37	0.78	0.02	97.96
1111934	Blackjacks	SIDERITE	0.32	0	4.28	3.22	90.02	0	0	97.85
1111934	Blackjacks	SIDERITE	0.71	0	6.95	3.28	86.65	0.07	0.03	97.7
1111934	Blackjacks	SIDERITE	0.85	0	5.52	3.88	86.64	0.26	0.1	97.25
1112263	Blackjacks	SIDERITE	0.81	0.01	5.34	1.91	86.81	0.06	0.09	95.02
1112263	Blackjacks	SIDERITE	0.61	0	5.18	2.26	88.97	0	0	97.02
1112263	Blackjacks	DOLOMITE	38.89	0.08	60.68	0.06	0.14	0.14	0	99.99
1112263	Blackjacks	DOLOMITE	39.32	0.13	60.58	0.03	0.44	0.07	0	100.56
1112263	Blackjacks	SIDERITE	0.71	0	4.21	3.21	88.74	0.15	0.04	97.05
1112263	Blackjacks	SIDERITE	0.91	0	5.85	3.23	86.17	0.12	0	96.27
1112263	Blackjacks	SIDERITE	0.64	0	5	2.1	86.83	0	0.05	94.62
1112263	Blackjacks	SIDERITE	0.85	0.04	6.8	3.5	85.33	0	0.04	96.56
1112263	Blackjacks	SIDERITE	0.97	0.05	7.56	3.61	85.07	0.15	0.04	97.45
8421325	Mariposa	ANKERITE	18.95	0	57.53	5.19	17.32	0.63	0	99.63
8421325	Mariposa	CALCITE	0.53	0.04	95.02	3.17	1.54	0.13	0	100.43
8421325	Mariposa	Mn SIDERITE	4.12	0.06	2.26	27.95	65.11	0.12	0.01	99.62
8421325	Mariposa	Mn SIDERITE	3.86	0	2.87	29.85	63.84	0.06	0.02	100.5
8421325	Mariposa	Mn SIDERITE	5.29	0.01	2.41	28.81	63.55	0	0.01	100.07
8421325	Mariposa	ANKERITE	17.34	0.03	56.7	8.31	18.39	0.52	0.05	101.34
8421325	Mariposa	Mn SIDERITE	6.23	0.01	2.1	29.05	61.7	0.07	0.05	99.21

Sample Number			weight % as carbonate							
9683/...	Location	Phase	Mg	Sr	Ca	Mn	Fe	Zn	Pb	Total
8421325	Mariposa	Mn SIDERITE	7.17	0	3.03	32.22	57.15	0.17	0.01	99.74
8421325	Mariposa	Mn SIDERITE	7.19	0	2.42	31.72	57.83	0	0.12	99.27
8421325	Mariposa	DOLOMITE	41.67	0.01	56.11	0.12	1.07	0	0	98.98
8421325	Mariposa	DOLOMITE	39.85	0.05	57.28	0.61	1.47	0.04	0	99.3
8421325	Mariposa	Mn SIDERITE	7.17	0.02	3.11	28.36	60.16	0.35	0	99.18
8421325	Mariposa	ANKERITE	17.58	0.03	58.3	6.7	17.55	0.22	0.02	100.4
8421325	Mariposa	Mn SIDERITE	5.34	0.02	1.9	24.4	66.82	0.14	0	98.61
8421325	Mariposa	Mn SIDERITE	5.45	0.11	2.24	27.44	63.88	0.14	0.12	99.37
S311254	Stonehenge	Mg SIDERITE	33.22	0	1.54	3.93	60.18	0	0	98.87
S311254	Stonehenge	Mg SIDERITE	32.04	0.02	1.35	3.66	63.05	0.03	0.07	100.2
S311254	Stonehenge	ANKERITE	30	0	51.6	3.82	14.22	0.08	0	99.72
S311254	Stonehenge	ANKERITE	29.88	0	41.71	5.88	20.85	0.06	0	98.38
S311254	Stonehenge	Mg SIDERITE	32.77	0	1.37	3.47	62.02	0	0.04	99.67
S311254	Stonehenge	Mg SIDERITE	31.13	0	1.29	3.76	62.32	0.03	0	98.53
S311254	Stonehenge	Mg SIDERITE	32.24	0	0.82	3.6	62.3	0.06	0	99.01
S311254	Stonehenge	Mg SIDERITE	30.68	0	0.94	3.83	64.21	0	0	99.66
1013664	Sunny Corner	DOLOMITE	35.7	0.05	62.99	0	0.28	0	0.02	99.04
1013664	Sunny Corner	DOLOMITE	36.99	0.05	61.58	0.08	0.55	0.04	0.03	99.33
1013664	Sunny Corner	SIDERITE	0.54	0	5.43	7.18	83.74	0.11	0.03	97.03
1013664	Sunny Corner	SIDERITE	1.96	0	9.44	5.34	78.77	0	0.04	95.55
1013664	Sunny Corner	SIDERITE	0.49	0.05	4.1	6.92	87.5	0	0	99.07
1013664	Sunny Corner	SIDERITE	0.51	0	3.71	6.73	87.44	0	0	98.4
1013664	Sunny Corner	DOLOMITE	34.42	0	58.34	0.1	5.72	0.09	0.03	98.71
1013664	Sunny Corner	SIDERITE	0.49	0.04	6.41	5.51	84.66	0.02	0.01	97.13
1013664	Sunny Corner	SIDERITE	0.42	0	4.82	6.62	85.95	0.19	0	98
1013664	Sunny Corner	SIDERITE	0.51	0	6.04	5.95	87.55	0	0.02	100.07
4050527	Grieves Siding	Ca SIDERITE	10.56	0	15.71	1.16	69.03	0.08	0	96.53
4050527	Grieves Siding	Ca SIDERITE	6.46	0	9.65	0.83	80.62	0	0	97.55

Sample Number	Location	Phase	weight % as carbonate								
			Mg	Sr	Ca	Mn	Fe	Zn	Pb	Total	
9683/...											
4050527	Grieves Siding	Ca SIDERITE	13.5	0	20.02	0.72	63.02	0	0	97.26	
4050527	Grieves Siding	SIDERITE	0.5	0	3.4	1.46	95.49	0.07	0.02	100.95	
4050527	Grieves Siding	Mn SIDERITE	3.21	0	8.45	24.14	62	2.41	0.15	100.37	
4050527	Grieves Siding	Mn SIDERITE	1.36	0	8.8	6.32	82.46	0	0.1	99.03	
ZB10202	Baura	SIDERITE	0.56	0	2.47	1.94	92.48	0	0	97.45	
ZB10202	Baura	SIDERITE	0.47	0	2.62	2.12	91.17	0	0.04	96.41	
ZB10202	Baura	SIDERITE	0.46	0	4.11	1.99	92.14	0	0.02	98.72	
ZB10202	Baura	SIDERITE	0.85	0	2.21	2.49	94.03	0	0.09	99.67	
			Mg	Sr	Pb	Ca	Ba	Mn	Fe	Zn	Total
1100635	Blackjacks	SIDERITE	0.58	0.06	0	5.19	0.02	3.97	88.98	0	98.8
1100635	Blackjacks	SIDERITE	0.52	0	0.04	6	0	3.5	88.51	0	98.57
1100635	Blackjacks	DOLOMITE	36.91	0.26	0	62.53	0.22	0.1	1.62	0	101.65
1100635	Blackjacks	DOLOMITE	36.61	0.17	0.05	59.71	0.07	0	3.01	0	99.62
1100635	Blackjacks	Ca SIDERITE	0.6	0.01	0.04	6.19	0.05	2.87	86.97	0.48	97.22
1100635	Blackjacks	SIDERITE	0.84	0	0.05	7.04	0.22	3.81	88	0.12	100.07
1100635	Blackjacks	SIDERITE	0.59	0	0.09	6.58	0	3.58	88.03	0	98.87
1100635	Blackjacks	SIDERITE	0.53	0	0.09	4.61	0	4.58	90.17	0.09	100.07
1100635	Blackjacks	SIDERITE	0.43	0	0.04	5.7	0	4.11	89.48	0	99.76
1100635	Blackjacks	SIDERITE	0.7	0	0.01	5.18	0	3.16	87.55	1.03	97.62
1100635	Blackjacks	SIDERITE	0.66	0	0.03	6.33	0	2.36	86.69	1.18	97.24
8421126	Mariposa	ANKERITE	28.01	0.07	0	54.8	0.02	0.29	14.76	0	97.95
8421126	Mariposa	ANKERITE	28.53	0	0	55.42	0	0.31	15.15	0.03	99.45
8421126	Mariposa	DOLOMITE	40.49	0	0	56.08	0	0.07	1.24	0.01	97.88
8421126	Mariposa	DOLOMITE	40.48	0.04	0	57.7	0.09	0.05	0.54	0.09	98.99
8421126	Mariposa	ANKERITE	26.02	0.01	0	54.19	0.1	1.09	17.96	0	99.37
8421126	Mariposa	ANKERITE	24.22	0.05	0.14	56.33	0	1.23	18.38	0.01	100.36
8421126	Mariposa	DOLOMITE	40.98	0.03	0	57.63	0.01	0.06	0.64	0.1	99.46
8421126	Mariposa	ANKERITE	30.01	0.04	0	56.76	0.02	0.61	11.08	0.01	98.53

Sample Number	Location	Phase	weight % as carbonate								
			Mg	Sr	Pb	Ca	Ba	Mn	Fe	Zn	Total
9683/...	King Billy	SIDERITE	0.26	0	0.07	1.64	0	2.91	95.14	0	100.02
1230833	King Billy	SIDERITE	0.33	0.03	0.02	1.76	0	2.63	94.2	0.02	98.98
1230833	King Billy	SIDERITE	0.59	0	0	3.79	0	4.67	89.18	0	98.23
1230833	King Billy	SIDERITE	0.25	0	0.07	4.24	0	2.88	93.14	0	100.59
1230833	King Billy	SIDERITE	0.41	0	0.04	2.46	0.05	2.63	94.81	0	100.41
1230833	King Billy	SIDERITE	3.59	0.06	0.02	7.29	0	3.52	85.97	0.15	100.62
4101774	Grievess Siding	SIDERITE	0.84	0	0	2.09	0.05	3.35	94.48	0	100.81
4101774	Grievess Siding	SIDERITE	0.88	0	0	1.93	0.09	3.48	94.59	0	100.97
4101774	Grievess Siding	SIDERITE	1.15	0	0.08	1.2	0.08	2.82	95.79	0	101.12
4101774	Grievess Siding	SIDERITE	1.82	0	0.05	2.38	0.12	2.98	92.88	0.22	100.45
4101774	Grievess Siding	SIDERITE	1.23	0	0.01	1.34	0	2.83	94.47	0.15	100.04
4101774	Grievess Siding	SIDERITE	1.66	0.02	0.03	1.81	0	3.59	92.01	0.01	99.13



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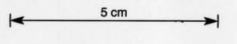
CRAE AIRBORNE MAGNETIC SURVEY, ZEEHAN AREA
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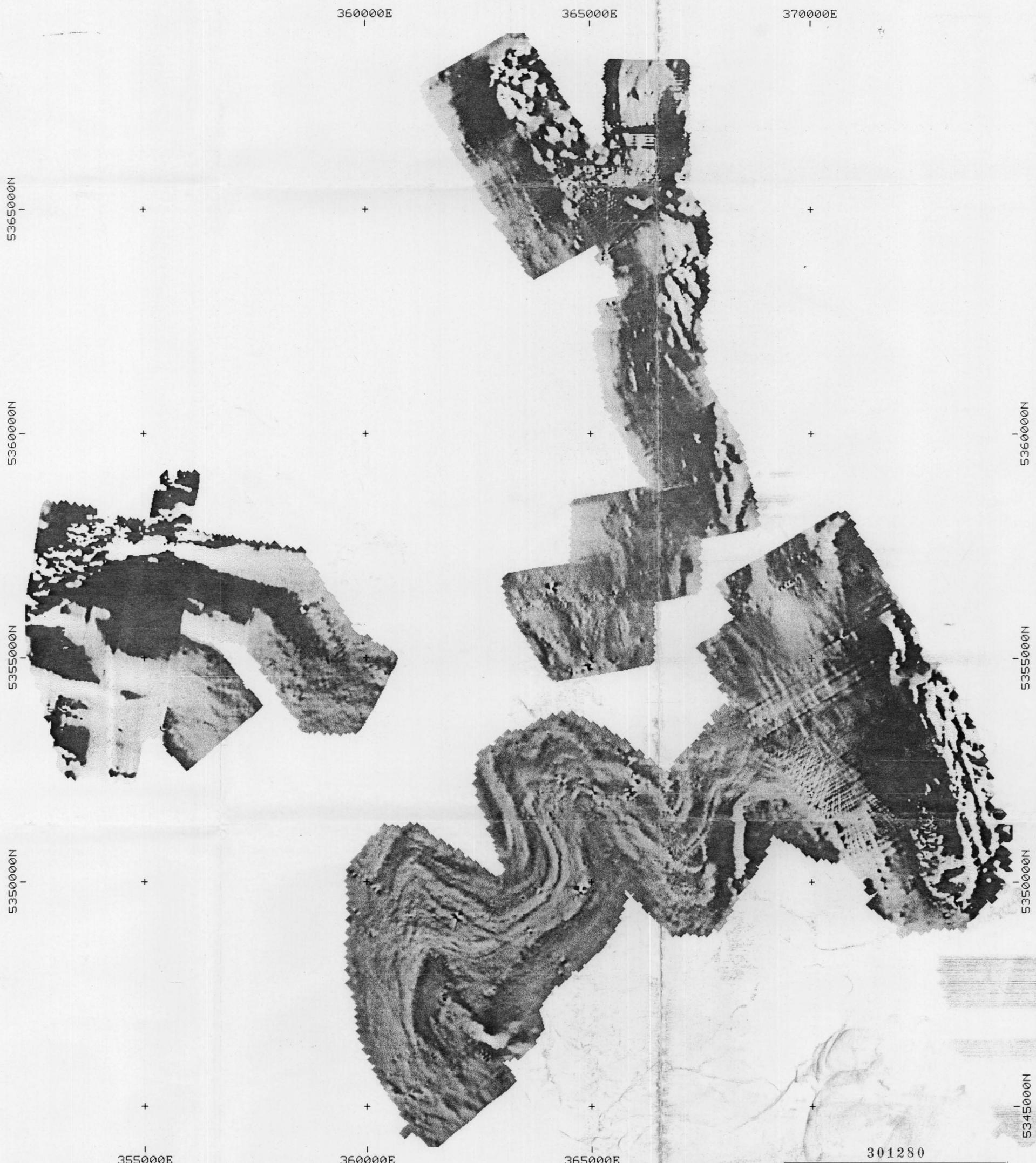


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CRA EXPLORATION PTY. LIMITED	
Zeehan Helirrag Survey	
Total Magnetic Intensity Map	
Author: John Tesselaar	Reference: SK55-05
Drawn: John Tesselaar	File Name:
Date: July 1998	Report No: 22222
Scale: 1:50,000	Plan No: Tv1026





CRAE AIRBORNE MAGNETIC SURVEY, ZEEHAN AREA
 VERTICAL DERIVATIVE (GEOSOFT GRID)
 CRAE SURVEY NUMBER I27M AMG PROJECTION ZONE 55 DATUM AGD 66
 CELL SIZE 20M RESAMPLED TO 10M PLOT NO QIP0497 1:50,000

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CRA EXPLORATION PTY. LIMITED	
Zeehan Helimag Survey	
Vertical Derivative Map	
Author: John Tesselaar	Reference: SK55-05
Drawn: John Tesselaar	File Name:
Date: July 1996	Report No: 22222
Scale: 1:50,000	Plan No: Tv1027



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