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EL 1515

WIRREALPA

PROGRESS AND TECHNICAL REPORTS TO LICENCE EXPIRY/SURRENDER FOR THE PERIOD 13/9/1988 TO 12/9/1989

Submitted by
Mining Corp. of Australia Ltd
1989

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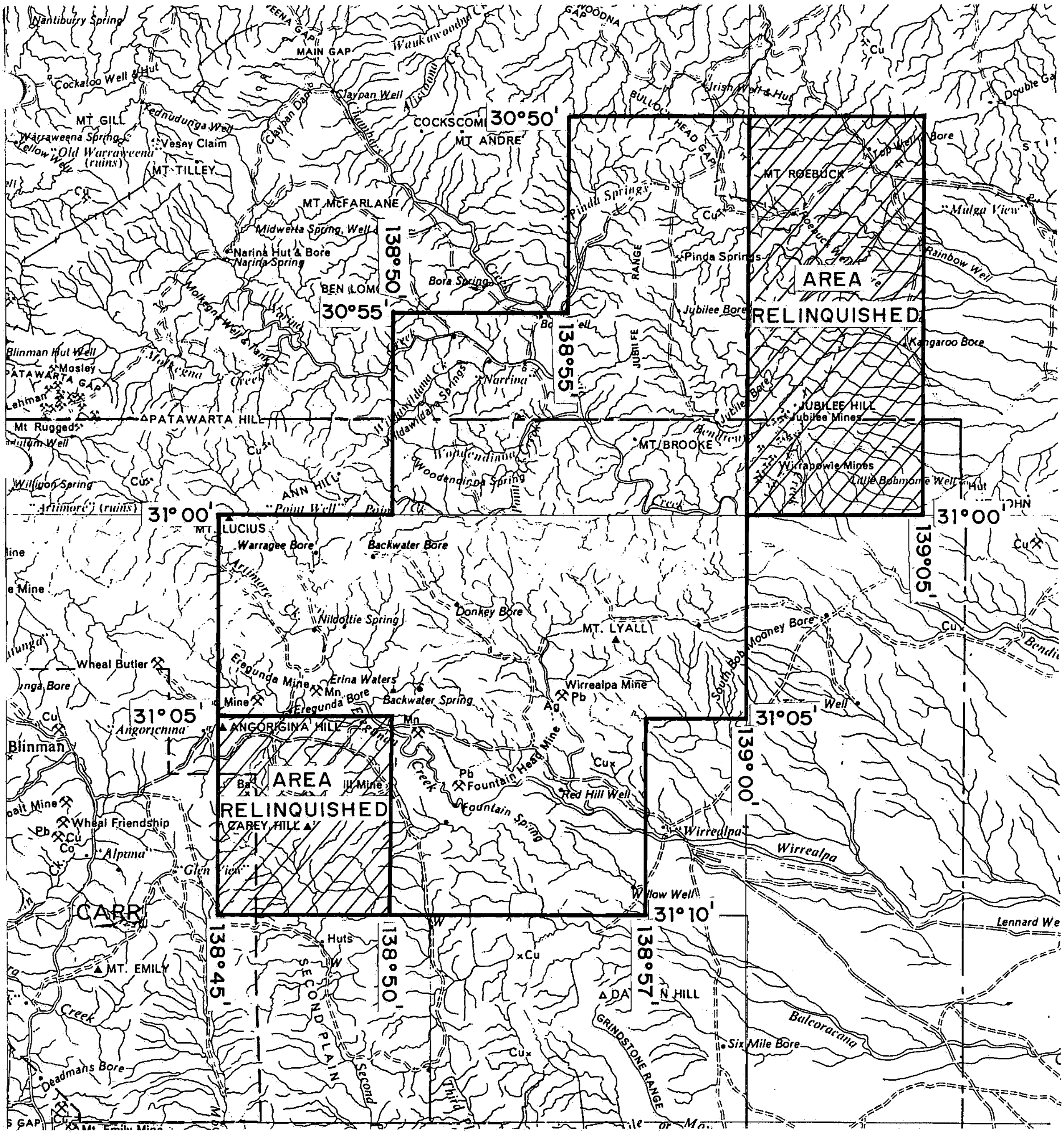
Government of South Australia
Primary Industries and Resources SA

SCHEDULE A



SCALE 1:250,000

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

EXPIRED

APPLICANT: DEMIS PTY. LTD.

DME 67/88 AREA: ~~764~~ 544 square kilometres (approx.)

1:250 000 PLANS: COPLEY, PARACHILNA

LOCALITY: WIRREALPA AREA – Approx. 20KM EAST of BLINMAN

DATE GRANTED: 13-9-88 DATE EXPIRED: ~~12-3-89~~ EL No: 1515

RED. Nº 14201 12.9.89

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TENEMENT: E.L. 1515 - Wirrealpa Area.

TENEMENT HOLDER: Demis Pty. Ltd. and Mining Corporation of Australia Ltd.

Oxford House Associates Pty. Ltd.

Mineral Exploration Consultants

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The Director General,
Department of Mines and Energy,
P.O. Box 151,
Eastwood. 5063.
South Australia.

2 February, 1989.

Dear Sir,

Exploration Licence 1515, Wirrealpa.

Report for the period ending 13 December, 1988.

Work Completed.

During the period information from previous exploration in the area was obtained and assessed. A number of conceptual models and exploration hypothesis were developed, and these were then checked by field reconnaissance. A report detailing the outcome of the work is being compiled by Mr. Lindsay Curtis of JLC Exploration Services. This report is presently being collated and will be supplied under separate cover when available.

Geology and Previous Exploration.

The Wirrealpa Exploration Licence is centred on the old Wirrealpa lead-silver mine and covers Precambrian (Adelaidean) Callana Group evaporites (in part diapiric), Umberatana and Wilpena Group sediments and Cambrian Hawker and Frome Group limestones and clastic sediments of the Adelaide Geosyncline. The rock unit of most interest is the Wilkawillina Limestone which is one of the major Lower Cambrian units in the Flinders Ranges. It is a massive or thickly bedded reef type limestone with abundant fossils.

Between 1967 and 1979, parts of the title application area were explored by Kennecott Exploration Ltd., Noranda Australia Ltd., North Flinders Mines Ltd, Australian Anglo American Ltd., and Asarco (Australia) Pty. Ltd. with the most recent work being done by Broken Hill Proprietary Company Limited (1979-1987) partly in joint venture with Esso Australia Ltd. (1984-1987).

BHP carried out a programme of mapping, stream sediment sampling, and rock chip traversing following up previously located stream sediment geochemical anomalies. Prospective targets were located at the Wirrealpa lead-silver mine, and along the western margin of the Wirrealpa Diapir at Donkey Bore, Wirrealpa Spring North, Wirrealpa Spring and Wirrealpa Spring South. In the Donkey Bore - Wirrealpa zone five kilometres of prospective karstified

Wilkawillina Limestone were defined adjacent to the limestone-diapir contact, and seventeen rock chip traverses were completed to locate the source of the stream sediment anomalies. Reconnaissance drilling was based on an evaluation of the surface geology and appears to have been carried out ahead of rock chip traverse sampling. The traverses, which averaged 30 metres in length, were rock chip sampled over each metre and assayed for copper, lead, zinc and silver.

Four traverses were made at Donkey Bore South. The best (T 3) returned 29 metres at 1.23% lead including a maximum assay of 7.8% lead. Three widely separated wagon holes were drilled at Donkey Bore to the north of the surface anomalies with negative results.

Nine rock chip traverses were made at Wirrealpa Spring North with the best result being T 9, 38m at 0.67% lead (maximum assay 9.7% lead). Two wagon holes and two deeper percussion holes were drilled at positions away from the surface lead anomalies and no positive results were obtained.

At the Wirrealpa Spring prospect surface rock chip sampling has outlined a zone reporting in excess of 1% lead on three traverses. The northernmost Traverse 13 reported 5 metres at 7.0% lead, Traverse 14 located 50 metres south along strike reported 17 metres at 13.6% lead, and Traverse 15 located a further 50 metres south along strike reported 11 metres at 6.4% lead. Average silver value for the above intersections is 9.9 g/t.

The BHP drilling in the vicinity of the prospect appears to have been carried out ahead of systematic surface sampling and was commenced some 20 metres south of Traverse 15 with holes PDP 5 and WD 19 which were both drilled to intersect the karst surface at depth. Hole WD 19 reported 5 metres at 1.9% lead between 44 and 49 metres, with a maximum value of 5.7% lead, confirming the down dip extension of the mineralised karst surface. A further 5 holes were drilled at irregular intervals over some 280 metres of strike south of hole WD 19. The area of Traverses 13, 14 and 15 which carries potential ore grade lead values at surface has not been tested by drilling.

At the Wirrealpa Spring South prospect surface rock chip sampling good grade lead mineralisation on two traverses 60 metres apart. The northernmost Traverse 16 reported 5 metres at 10.5% lead with 3.4 g/t silver, while Traverse 17 reported 10 metres at 3.7% lead containing an interval of 2 metres with 9.0% lead. No additional work appears to have been carried out at this prospect.

At Wirrealpa lead mine four wagon drill hole and one diamond drill hole were completed. Hole DWM 1 gave 6 metres 1.1% lead.

Exploration Potential.

As at Mount Chambers previous exploration in the Wirrealpa area has located significant lead-silver mineralisation associated with a karst surface developed within the Cambrian Wilkawillina Limestone. The mineralisation appears to be of the Mississippi Valley style.

Reconnaissance drilling followed by surface rock chip sampling has been carried out in areas which were apparently selected on the basis of favourable surface geology. This work delineated outcropping lead mineralisation at the Wirrealpa Spring and Wirrealpa Spring South prospects, and significant surface lead anomalies at the Donkey Bore South and Wirrealpa Spring North prospects. The strike extent of the Wilkawillina Limestone has been mapped and selected areas rock chipped to locate the above prospects, but the whole unit has not been systematically geochemically explored. In particular, several previously detected stream sediment anomalies associated with the mapped position of the Wilkawillina Limestone need to be followed up by mapping and geochemical sampling.

Proposed Programme.

Detailed mapping and geochemical sampling will be carried out over the known prospects to determine the dimensions, grade variation and geological controls on the mineralisation. The strike extent of the Wilkawillina Limestone will be systematically rock chip sampled, with particular attention being given to determining sources of the stream sediment anomalies located during the data assessment.

Expenditure to Date.

Invoices for the data assessment and field reconnaissance have not yet been received. The following schedule records only nominal expenditures associated with early data collection activities.

ITEM	AMOUNT
Geology, reporting	$ 850.00
Technical Assistant	$ 90.00
Vehicle costs	$ 85.00
Data acquisition, plans	$ 15.00
Running costs	$ 130.00
	$ 1,170.00

Yours faithfully,

R. G. Bluck.

WA:FQR019

WIRREALPA JOINT VENTURE
Exploration Licence 1515

QUARTERLY EXPLORATION REPORT
Period Ended 13 December 1988.

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Plympton Park, S.A. 5038
Telephone (08) 293 2994

J.L.Curtis.
22 January, 1989
W:QR0I9

ABSTRACT

A review of the literature and a brief field inspection of lead zinc mineralisation recorded in open file company reports indicates that MVT mineralisation is located in permeable Cambrian aged palaeokarst features which are an integral aspect of the stratigraphy in the vicinity of the Wirrealpa Diapir. Previous exploration has outlined a geological environment with potential to host substantial economic MVT mineral deposits.

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1 INTRODUCTION

Mineralization at Wirrealpa was first recognized by early prospectors who discovered the Wirrealpa Lead Mine which was developed in an archaeocyathid reef limestones in close proximity to inferred diapiric breccia.

The BHP Co. whilst exploring for Mississippi Valley Type (MVT) lead-zinc deposits throughout the Flinders Ranges carried out stream sediment and rock chip geochemical surveys, and diamond drilling which demonstrated that mineralization was more widespread in the vicinity of the Wirrealpa Diapir.

This report is a brief review of this work which has been undertaken to guide exploration planning.

2 LOCATION AND ACCESS

The Wirrealpa Exploration title covers an area of 1028 km2 in the vicinity of Mt. Brooke in the central eastern Flinders Ranges in South Australia approximately 450 km NNE of Port Augusta.

The region is accessible by either Hawker - Wilpena or Hawker - Parachilna - Blinman , the latter parts of each route being over unsealed road.

Parachilna 65 km to the west, across the ranges is the nearest station on the Port Augusta - Leigh Creek standard gauge railway line. (see figure 1)

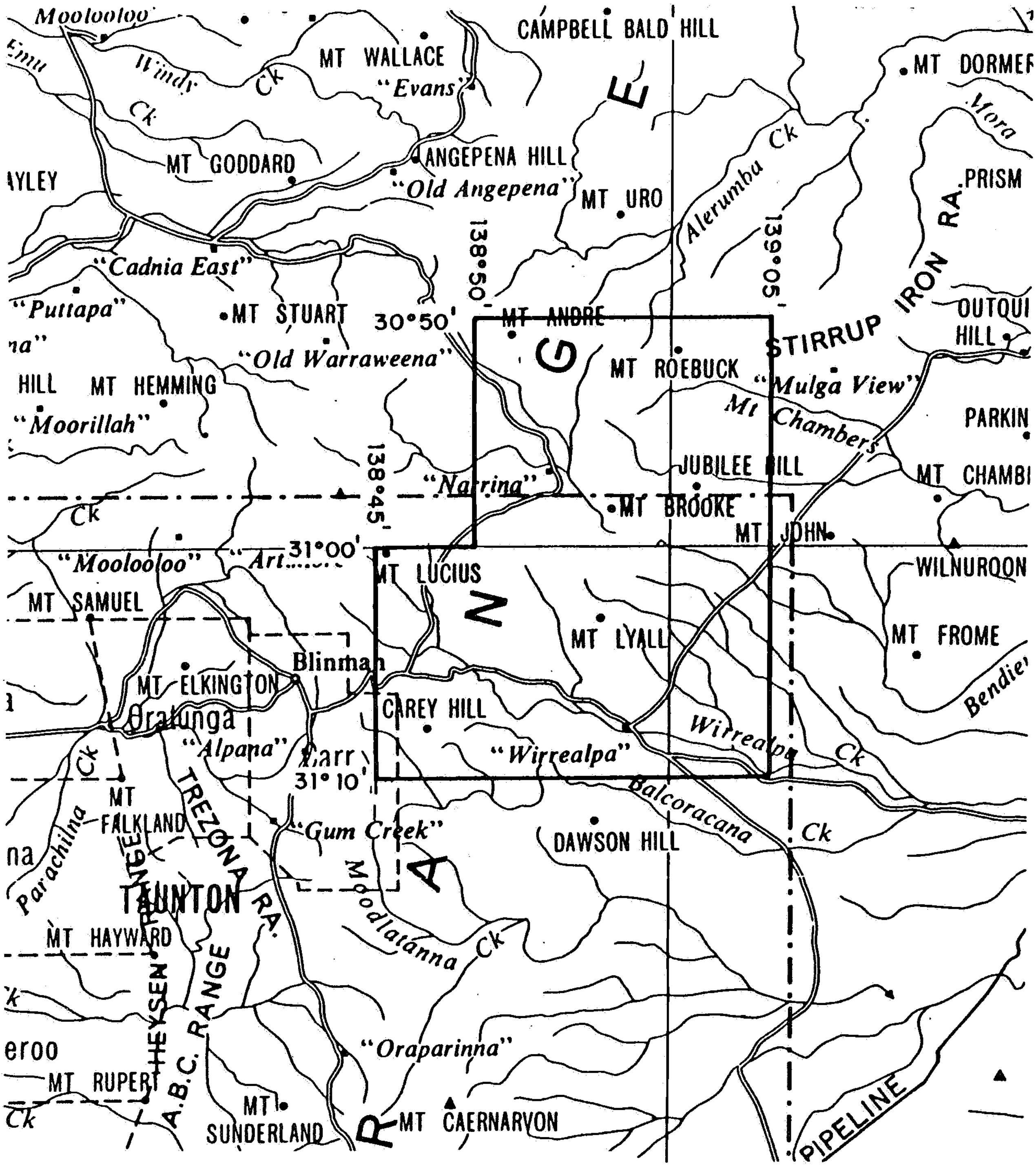
3 REGIONAL GEOLOGY

3.1 STRATIGRAPHY

The Finders Ranges comprises a late Precambrian geo-synclinal sequence overlain by Cambrian shelf facies carbonate deposits.

At a number of locations large bodies of complexly deformed rock disrupt the layered sequences. Such bodies have been ascribed to a diapiric emplacement origin.

All of these main stratigraphic subdivisions occur at Wirrealpa. This report focuses almost exclusively on the Wilkawillina and Parara Limestones of the Cambrian Hawker Group.



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LOCATION MAP EL No. 1515

FIGURE No. 1

Parachilna Formation

At Wirrealpa the Parachilna Formation is of restricted extent being confined to probable palaeogeographic lows at the base of the Cambrian succession. Mapping by the Geological Survey of S.A. describes this unit as argillaceous sandstones with vertical worm? burrows with intercalated lenses of oolite and shale. It is conformably overlain by the Willkawillina Limestone.

Wilkawillina Limestone

At Wirrealpa the Wilkawillina Limestone commonly forms the base of the Cambrian succession and lies disconformably upon the Upper Proterozoic Pound Quartzite or abuts the Wirrealpa Diapiric Dome.

It is typically a light to dark grey, massive, bedded, and biostromal archaeocyathid limestone which is creamy brown and/or mottled when dolomitised.

Bodies of breccia within the limestone have been inferred to be of karstic origin. Conglomeratic units intersected in drill holes and mapped by the Geological Survey of S.A. along the western side of the diapir are either basal rubble/fanglomerate deposits or highly attritioned diapiric breccias.

Detailed mapping by BHP in the Donkey Bore area has largely re-interpreted the Wirrealpa diapir in this vicinity to be a complex sheeted ? megga-breccia deposit at the base of the limestone. It is not clear from the mapping how free megga-clasts have been differentiated from the main diapir mass.

Along the western margin of the diapir the limestone is much thinner (<150m) than else where (~500m at the Wirrealpa Lead Mine) and appears to have been truncated by a palaeokarst surface upon which the overlying Parara Limestone was disconformably deposited.

Parara Limestone

The unit is described as a dark flaggy and silty limestone with interbedded shales

In the field it is readily distinguished from the conformably underlying Wilkawillina Limestone by its thin bedded pattern. The contact between the two units is gradational over about 10 to 15 meters of section.

3.2 STRUCTURE

The Precambrian and Cambrian rocks of the Flinders Ranges were extensively folded and faulted during the Delamarian Orogeny.

At Wirrealpa the regional structure is dominated by the presence of a major tectonic dome ,the Wirrealpa Diapir. This body is of complex shape comprising a globular mass in the south with a prominent NNW striking (Donkey Bore) ridge

The presence of diapir derived material in the conglomerate horizons within the covering limestones is cited as evidence for the preexistence of the dome as a basement high during early Cambrian deposition, (the diapiric origin for all such lithologies seems unlikely).

However the steep dips observed along the flanks of the diapir are almost completely attributable to Delamarian folding which generated a regional dome and basin structural pattern throughout the northern Flinders Ranges. The basins are elongate in a NNW direction ; consistent with the Donkey Bore ridge that occupies an anticlinal core which appears to be steeply overturned toward the east and possibly overthrust along the eastern margin of the diapir.

Geological Survey mapping identifies major east west faulting of Proterozoic basement in the east at Mt. Lyall that trends toward the vicinity of Wirrealpa Springs and in the west similarly oriented faults in Wilkawillina Limestone at the NW extremity of the main diapiric mass. Mapping of the diapir by BHP demonstrates continuity of this regional structure which is left laterally offset by N-S en-eschelon faulting in the vicinity of (Old) Wirrealpa Spring

BHP mapping of the diapir also identified an anticline to the north of the main diapir mass along an E-W axis within the Cambrian sequence that is truncated in the east by the above N-S fault along the diapir contact. Complex cross-folding is observed between the diapir and this anticlinal axis.

Westerly overthrusting of the main diapir body on to the Cambrian sequence with up to 1Km of translation is also interpreted by BHP mapping (Fountain Head Thrust). Such a displacement requires left lateral movement along the E-W boundary fault of the diapir, but there is no mapped evidence of substantial strike-slip. Locally near the NW apex of the main diapir mass the more basal members of the Cambrian succession are steeply overturned to the north suggesting steep overthrusting shear along the boundary fault may be dominant.

Syndepositinal faulting at the Wirrealpa Lead Mine has been inferred to possibly indicate active diapirism during sedimentation but the straight linear trace of the fault and the apparent drag of the limestone reef as mapped by BHP is regarded to be inconsistent with a pre-Delamarian age.

The obvious sympathetic relationships demonstrated between faulting and folding by BHP mapping indicates a common Delamarian age for both with much of the strain in the Cambrian rocks being ductile.

4 MINERALISATION

Mississippi Valley Type (MVT) lead zinc deposits occur in carbonate rock sequences where significant karstic porosity along basin margins or ridges has become the focus for metal bearing brines that have migrated laterally beneath extensive basin wide aquitards. The currently accepted model envisages that the brines deposit metals and further corrode the carbonate apertures when reduced by petroleum. Economic potential can only be assessed by examining the distribution of known mineralisation in respect of the model and the local geology.

There are two potentially economic targets to be considered. Firstly , near surface small cheaply exploited deposits and secondly very large multi-million tonne orebodies that can be exploited to depth. Potential for each of these categories is considered.

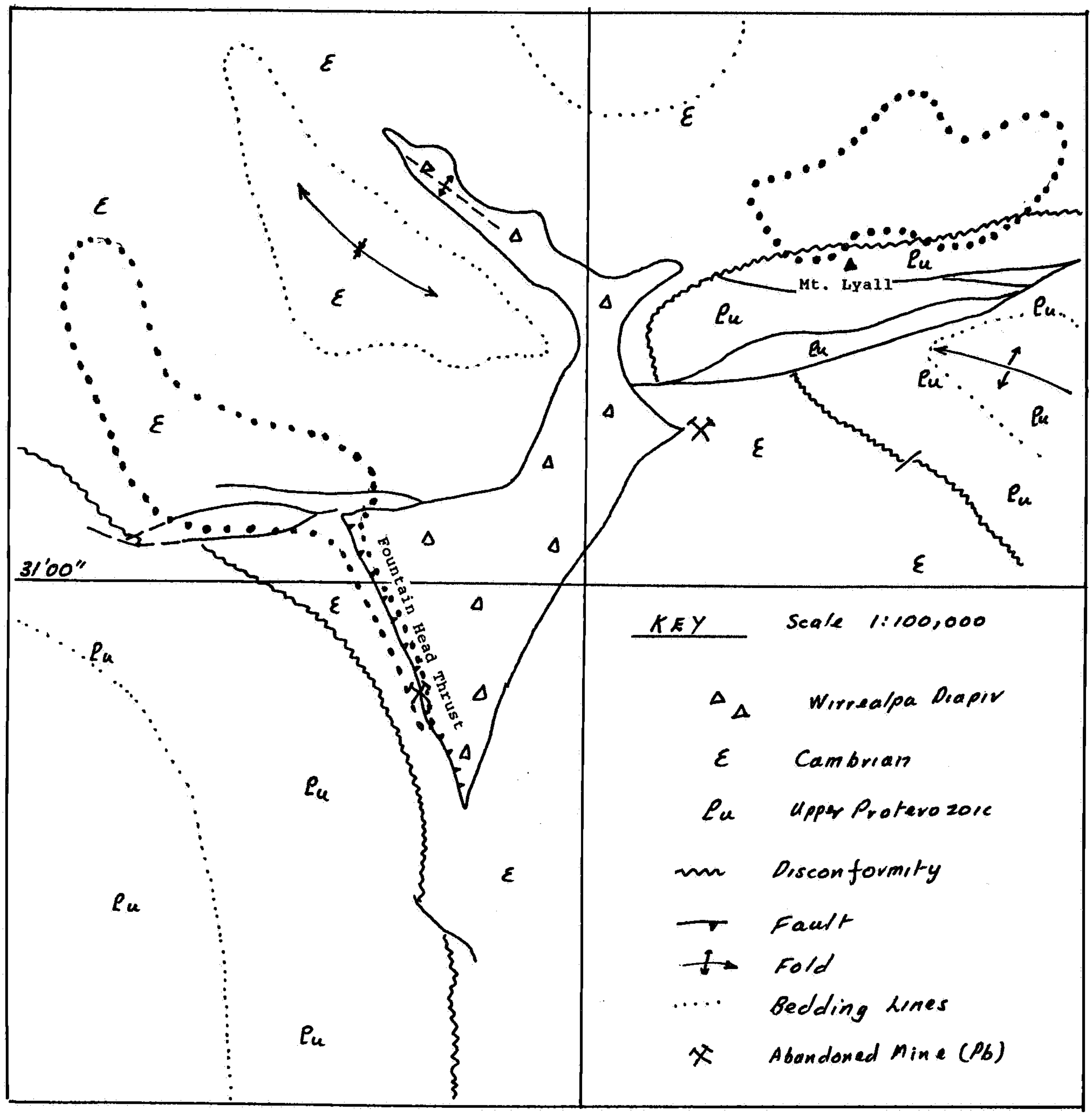
4.1 STREAM GEOCHEMISTRY

Stream sediment geochemical surveys were carried out by previous explorers and detailed up by BHP during their initial exploration programme.

The BHP exploration programme focussed on the Donkey Bore - Wirrealpa Spring trend and the Wirrealpa Lead Mine area. However two relatively large lead anomalies identified by ASARCO don`t appear to have been given further consideration.

One such region lies to the north of the Mt. Lyall basement dome to the east of Wirrealpa Spring and the other to the immediate west of the inferred `Fountain Head Thrust' along the western margin of the main body of the Wirrealpa Diapir. (see figure 2)

While these anomalies could be attributed to structure related epigenetic mineralisation at both localities ,the presence of palaeokarst related mineralisation within the Wilkawillina Limestone with a similar surface expression to that



Regional Lead Zinc Stream Anomaly

ASARCO REGIONAL STREAM SEDIMENT
GEOCHEMICAL ANOMALIES

FIGURE No. 2

of the Eric Prospect at Mt. Chambers to the east should not be discounted.

4.2 GEOLOGY

The primary porosity and permeability requirement for MVT deposits is dependent on the initial character of the carbonate sequence sedimentology and its early diagenetic history.

At Wirrealpa the Wilkawillina limestone is anomalous with respect to lead (zinc) mineralisation and fulfils MVT criteria.

BHP mapping indicates :--

* that the limestone on-lapped the Wirrealpa Diapir as a palaeogeographic high with near shore clastic facies deposits and some intercalated conglomerate units (basin margin).

* dolomitisation with breccias attributed to a karstic origin are exposed at surface and intersected by diamond drill holes (primary porosity/permeability).

* that locally,the top of the limestone is a palaeo-karstic surface sealed by the covering Parara Limestone (basin wide aquitard).

* that Delamarian folding has steepened stratigraphic dips , and enhanced porosity/permeability by faulting ensuring that a hydraulic gradient between the basin and its local margin was sustained (mobile basin brines).

* that substantial colonies of archaeocyathid corals and other fossil forms were present that must have given rise to organic residues within the basin capable of generating mobile petroleum (reduction agent).

* the presence of epigenetic veining with a pyrite-galena -barite-calcite-dolomite-siderite minerological association, typical of MVT mineral deposits, at several locations (metal source and appropriate P, T, Eh, & Ph conditions demonstrated).

...thereby satisfying the requisite geological criteria for the formation of a MVT deposit.

4.3 DRILLING

Four drilling campaigns have been undertaken in the Wirrealpa area (see figures 3 & 4)

BHP followed up systematic stream sediment geochemical anomalies and field geology by drilling four diamond drill holes in the vicinity of the Wirrealpa Lead Mine (WD 9 - 12) and three holes near Donkey Bore (WD 7,8,& 13). Later WD 14 & 15 were drilled nearby ,followed by holes WD 16,17,& 18 at Wirrealpa Spring North,and WD 19 at Wirrealpa Spring. Significant results are summarised in figure 5 & table 1.

Four short percussion drill holes (PDP1 - 4) were used to follow up the mineralisation observed in WD 19 at Wirrealpa Spring and much later another diamond drill hole ,DDB-1, was drilled at the same locality.

Two additional diamond drill holes (DWM 1A & 2) were sited at the Wirrealpa Lead Mine

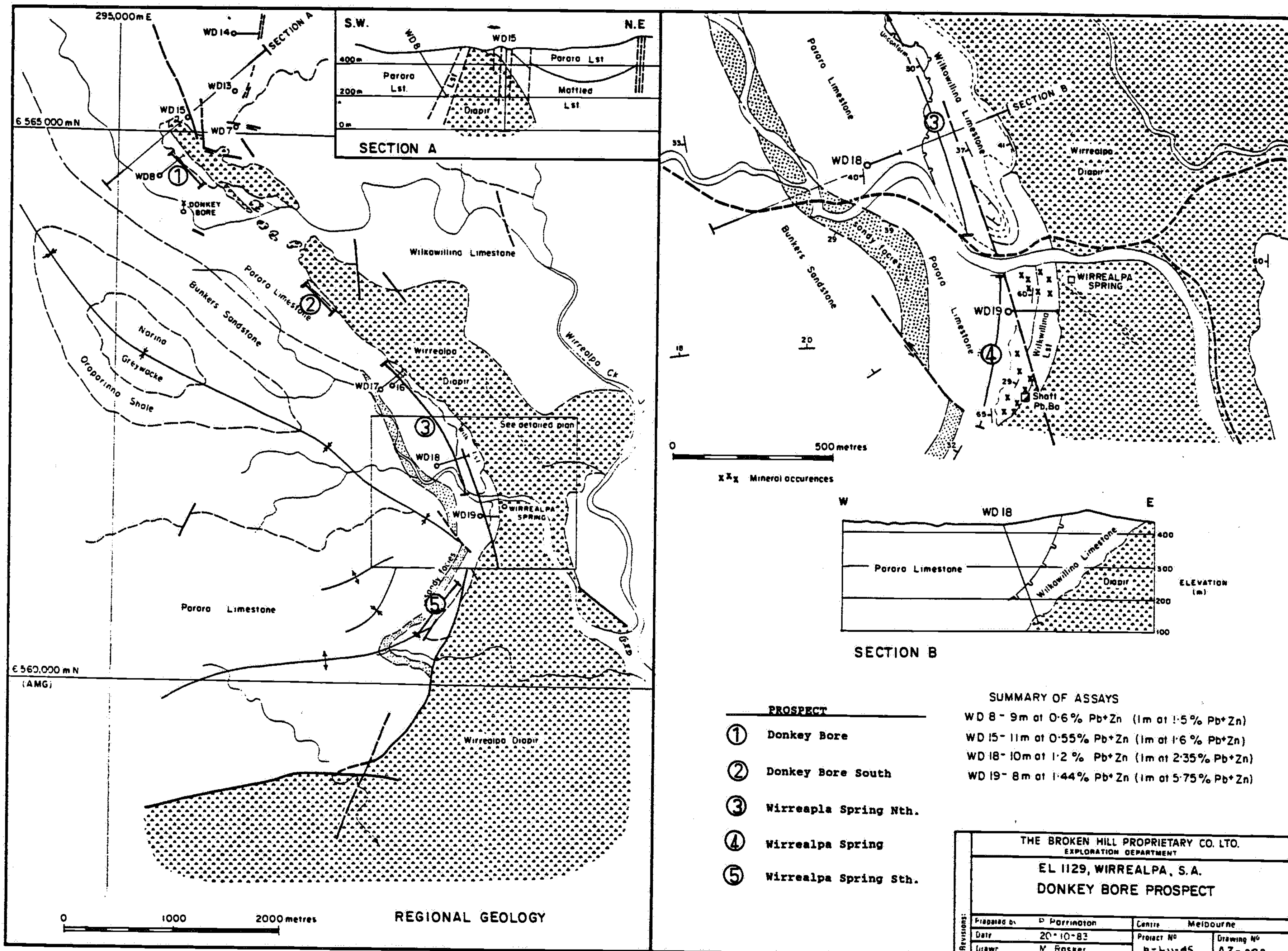
Generally the results of the follow up drilling are disappointing until it is realised that all the drilling was apparently planned without detailed surface mapping ,geochemical or geophysical targeting being employed. Secondarily little structural data was recorded from diamond cores in respect of predicting the orientation of mineralised features.

While it is acknowledged that economic intersections of mineralisation were not overlooked during sampling it is apparent that not all mineralisation was geochemically tested. However, significant +1.0 % Pb intersections appear to be related to intercalated breccia type rocks of probable karstic origin in WD 18 & 19 and tectonically induced porosity as fractures and styolites in WD 15 & 8 respectively.

The observation of mineralisation in drill holes and at the surface suggests that metals were mobile during late Delamarian time and the regional plumbing model for MVT deposits viable.

4.4 ROCK CHIP GEOCHEMISTRY

Subsequent to the completion of the WD series drilling systematic rock chip sampling across the Wilkawillina Limestone was undertaken at a number of localities along the western margin of the Wirrealpa Diapir between the Donkey Bore and South Wirrealpa Spring areas.

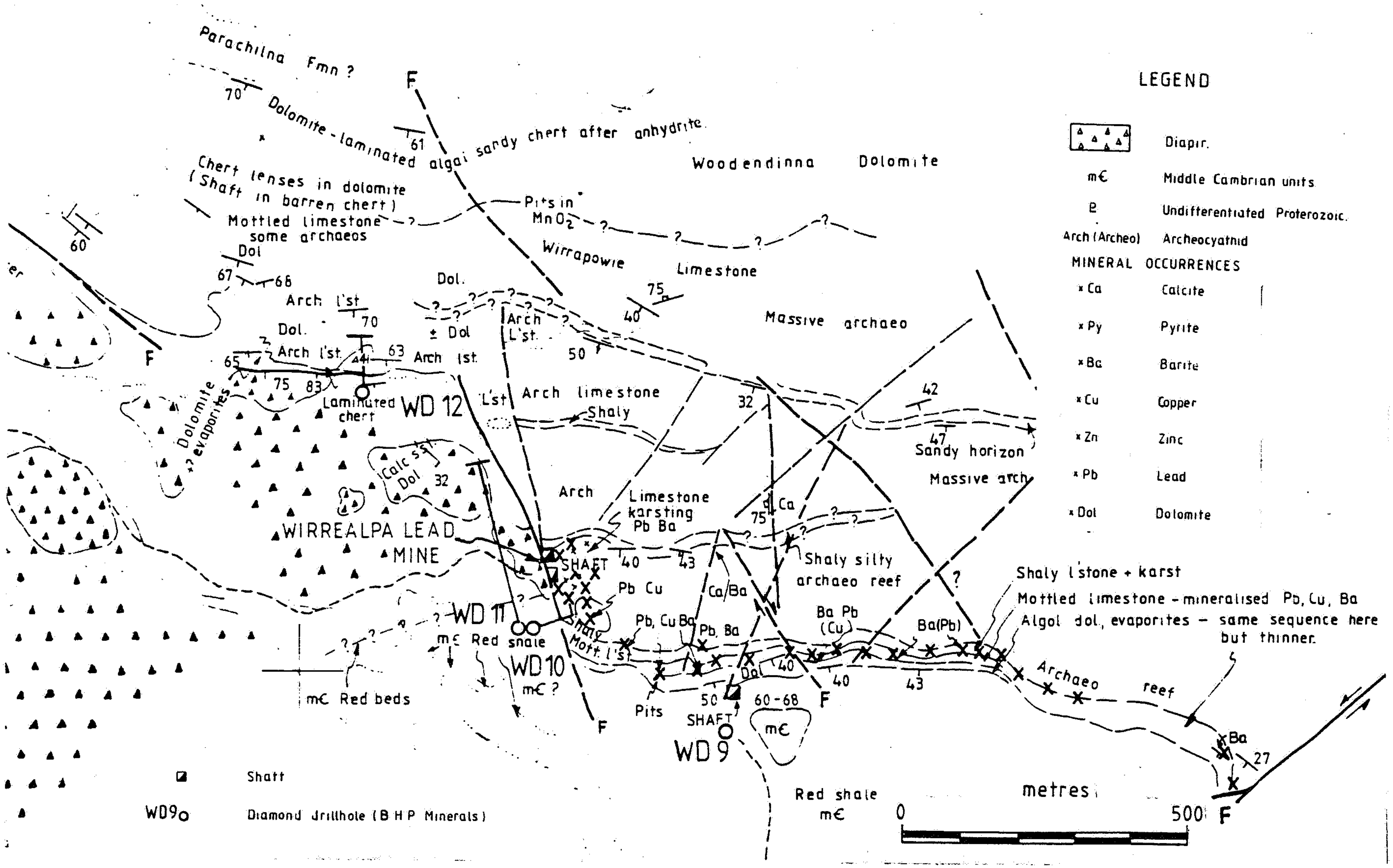


PROSPECT LOCATIONS

DONKEY BORE

WIRREALPA SPRING

FIGURE No. 3



DRILLING LOCATIONS

WIRREALPA LEAD MINE

FIGURE No. 4

HOLE N°	INTERVAL (m)	Pb + Zn
WD 7	332 - 336	0 26 %
	367 - 374	0 · 2 %
WD 8	270 - 271	0 5 %
	274 - 275	1 · 2 %
	276 - 277	0 6 %
	279 - 280	1 5 %
	280 - 281	0 · 7 %
	281 - 282	0 · 3 %
	282 - 283	0 2 %
	283 - 284	0 · 25 %
	284 - 285	0 4 %
	285 - 286	0 · 2 %
	286 - 287	1 · 3 %
	287 - 288	0 · 4 %
WD 15	10 - 11	1 · 6 %
	14 - 15	0 · 15%
	15 - 16	0 · 8 %
	16 - 17	1 . 0 %
	17 - 18	0 · 2 %
	20 - 21	0 · 4 %
	23 - 24	0 · 3 %
	24 - 25	0 · 3 %
	25 - 26	0 · 75 %
	36 - 37	0 · 3 %
	38 - 39	0 · 25 %
WD 18	223 - 224	0 1 %
	228 - 229	2 · 35 %
	229 - 230	1 16 %
	230 - 231	0 13 %
	231 - 232	0 · 5 %
	232 - 233	2 · 0 %
	233 - 234	1 13 %
	234 - 235	0 75 %
	235 - 236	0 · 17 %
	237 - 238	1 · 93 %
	238 - 239	1 74 %
	241 - 242	0 · 1 %
	245 - 246	0 · 6 %
	246 - 251	0 2 %
WD 19	42 - 43	0 5 %
	43 - 44	0 · 3 %
	44 - 45	5 · 75 %
	46 - 47	0 · 15 %
	47 - 48	1 4 %
	48 - 49	2 3 %
	49 - 50	0 35 %
	51 - 52	0 8 %
WD 10	108 - 109	0 7 % Cu

PRINCIPAL MINERALISED ZONES

WD SERIES DRILLING

FIGURE No. 5

TABLE No. 1 : DIAMOND DRILLING > 1.0 % Pb CUMULATED INTERSECTIONS

PROSPECT	DRILL HOLE	CUMULATED INTERSECTION
Donkey Bore	WD 7	<
	WD 8	3.0m @ 1.3 %
	WD 13&14	<
	WD 15	1.0m @ 1.6 %
Donkey Bore South	N D	
Wirreapla Spring Nth.	WD 16&17	N S
	WD 18	9.0m @ 1.25%
	PDP 6&7	<
Wirrealpa Spring	WD 19	5.0m @ 1.9 %
	PDP 1-4	<
	DDB 1	<
Wirrealpa Spring Sth.	N D	
Wirrealpa Lead Mine	WD 9-12	<
	DWM 1&2	<

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TABLE No. 2 : ROCK CHIP SAMPLING > 1.0 % Pb CUMULATED INTERVALS

PROSPECT	TRAVERSE	INTERVAL	DRILLING
Donkey Bore	19	2.0m @ 1.2 %	N D
	18	<	WD 8
Donkey Bore South	3	8.0m @ 3.7 %	N D
	1,2&4	<	N D
Wirreapla Spring Nth.	9	5.0m @ 3.15%	PDP 7
	5-8,10-12, & 20-21	<	WD 16 & 17
	22	<	WD 18
Wirrealpa Spring	13	11.0m @ 4.8 %	N D
	14	17.0m @ 13.8 %	N D
	15	11.0m @ 6.3 %	?WD 19
Wirrealpa Spring Sth.	16	8.0m @ 8.0 %	N D
	17	12.0m @ 3.6 %	N D
Wirrealpa Lead Mine	N S		

N D = not drilled   N S = not sampled   < = < 1.0 % Pb

Samples were collected at or over 1m intervals between the mapped boundaries of the limestone on traverses spaced 250 to 500 meters apart. The traverses illustrated on the BHP plans are diagramatic only and not true to scale and like the drilling programme there is no detailed supporting geological data. Accumulated intervals of > 1.0 % Pb are summarised in table 2.

While the distribution of the rock chip profiles does not completely cover the mapped mineralisation a study of the analytical profiles does reveal that mineralisation fluctuates in tenor quite abruptly between adjacent profiles and appears to have a tendency to maximise towards the top and base of the Wilkawillina Limestone

Anomalous traverses generally report above 1000 ppm for the complete limestone interval with zones of +1.0 % Pb in strong contrast to a background of commonly 100 ppm Pb and less. A geological explanation for such contrasts is not currently known but evidence of locally restricted porosity in the limestone might be anticipated.(see figure 6)

4.5 INTERPRETATION

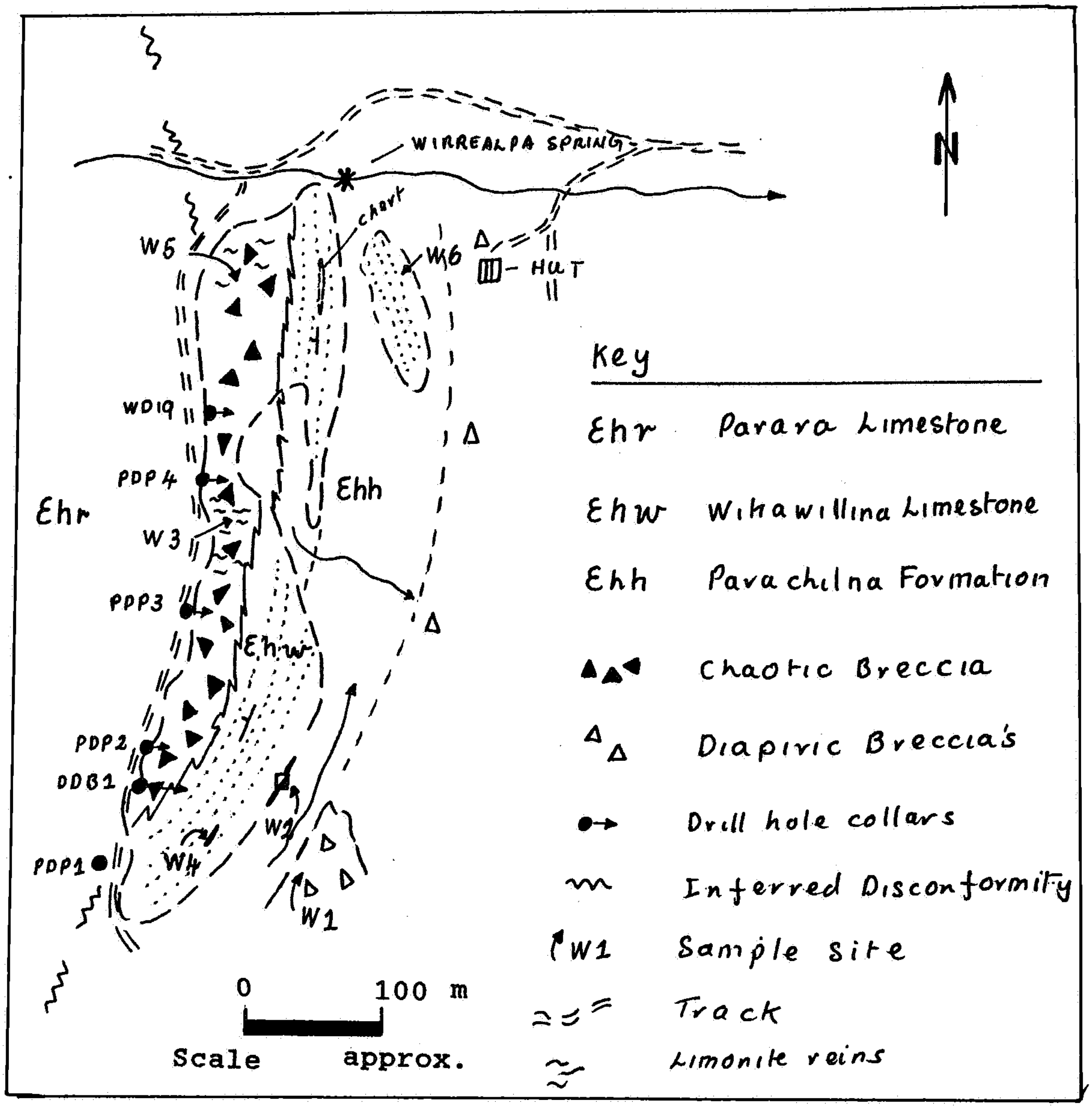
Lead mineralisation is widely distributed in the Wirrealpa region within the Wilkawillina Limestone. The following geological model has been constructed from the available data in order to focus attention on the disposition of potential ore bearing structures.

Geological Model

The Wirrealpa Diapiric Dome was probably a palaeo-island during the early Cambrian which was surrounded by a fossiliferous limestone reef built out from and upon a talus/fanglomerate like deposit (megga- breccia facies).

Oscillating sea levels led to the exposure of the reef deposit and the development of a palaeokarst surface that may have sloped westward (truncated section on the west side of the Wirrealpa Diapir). Dolomitisation of the at least the basal 150 to 200 m of the limestone was coeval with karsting.

Just prior to the deposition of later members of the Wilkawillina Limestone and/or the covering Parara Limestone caverns were probably filled with breccia and depressions on the palaeosurface with rubble deposits.



FIELD SKETCH PLAN

WIRREALPA SPRING

FIGURE No 6

Given the foregoing discussion on ore structure it is clear that significant mineralisation may well be quite readily over looked unless detailed assessment, including drilling, is undertaken on what might appear to be low priority anomalies.

Potential commercial exploration targets of two classes may be present, but intial field operations would not differ. One or more small bodies of > 10 % Pb , up to 1Mtonne in size at very shallow depths ,(< 50m) could be viably worked by open pit. A larger multi-Mtonne deposit would necessarily extend to depth down the dip of the strata and be developed as an underground operation.

The following programme of exploration work envisages parallel follow up of known mineralisation occurrences and regional evaluation of the Wilkawillina Limestone in areas not yet explored in detail, where the model is considered applicable.

5.2 PROGRAMME OF WORK

Preparatory Studies

The BHP regional mapping of the Wirrealpa region should be re drawn showing structure and stratigraphy on one base plan. A working version of this base should be used to show as near correctly as possible all the available geochemical evidence of mineralisation.

Re-logging of selected drill cores and chip sampling where warranted is considered desirable. Stratigraphic structure and the detailed aspects of mineralisation should be emphasised. Preparation of graphic/analytical data on a suitable scale for each hole is required. (Drill cores are currently stored by BHP at Whyalla.)

Detailed Follow-up

Drill collars should be field located , azimuth checked and detailed geological strip maps prepared to enable preparation of geological cross-sections. Surface geochemical sampling should also be carried out to test the continuity of mineralisation.

Rock chip sampling should be re-run in anomalous areas and gridded out once the mineralised zone has been identified. Geological mapping of the anomalous zone is very important if the mineralised zone is going to be traced to depth.

Where warranted geophysical surveys and drilling should be carried out.

Regional Assessment

De-watering of the subsequently accumulated Cambrian sequence was probably accelerated by the early stages of the Delamarian Orogeny which terminated sedimentation. Petroleum was possibly mobilised into the porous trap sites surrounding the dome, below the Parara Limestone aquitard.

Continued deformation lead to leakage around the Wirrealpa Dome and probably allowed influx of metal bearing basin brines which were reduced at sites of remnant or relict petroleum accumulation, resulting in MVT lead zinc mineralisation. Further leakage of brines around the Dome led to epigenetic vein mineralisation.

Economic Potential

The above geological model for the Wirrealpa region fits validly with the available data and clearly indicates that suitable geological conditions for the deposition of substantial MVT lead deposits probably occurred at the termination of Cambrian sedimentation and during the onset of Delamarian Orogenisis.

Clastic deposits of autochthonous rubble localised in surfacial and cavern drainage systems are considered to be potential ore structures.

Assuming the paleo-island/atoll model is correct it is reasonable to conjecture that both surfacial and subterranean drainage developed during falls in sea level would have a generally radial pattern.

Even with due allowance for Delamarian deformation ,potential ore structures of this type could be expected to be radially oriented with respect to the present day outline of the Wirrealpa Diapir.

It is therefore predicted that potential ore bearing structures would have very limited strike extent and possibly poor surface expression where significant weathering is present.

Furthermore the observable exposures may be the 'upstream' extremity of the palaeokarstic drainage system and hence potential ore structures may become better developed down the dip of the strata.

5 EXPLORATION STRATEGY

5.1 STRATEGY

Field reconnaissance of the ASARCO Fountain Head and Mt. Lyall stream sediment geochemical anomalies should be undertaken with a view to devising new exploration initiatives in these areas. Systematic geochemical rock chip /soil sampling and geological mapping would be a priority.

Rock chip sampling should be systematically extended in parallel with mapping along the Donkey Bore - Wirrealpa Spring trend to cover all outcropping Wilkawillina Limestone. Soil sampling in areas of poor out crop is mandatory, and may require shallow RAB drilling where transported overburden is evident. Routine geological mapping is also mandatory.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

* MVT lead mineralisation is present in the Wilkawillina Limestone at Wirrealpa
* Potential ore structures are likely to be radially oriented with respect to the Diapir margin , extending down the dip.
* The surface expression of mineralisation may be quite subtle.

6.2 RECOMMENDATIONS

* Exploration as outlined in the work proposal is recommended.

7 REFERENCES

ASARCO (Aust.) Pty. Ltd. 1978-79 . Open file reports on S M L No. 166 : Oraparrina and Wirrealpa Diapirs ,S.A.D.M.E. envelope No. 965 , (unpub.).

Broken Hill Proprietary Co. Ltd. 1979 - 82. Open file reports on E L Nos. 436/809 : Wirrealpa (E L No. 1138 : Mt. Frome) , S.A.D.M.E. envelope No. 3427, (unpub.).

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Mineral Exploration Consultants

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The Director General,
Department of Mines and Energy,
P.O. Box 151,
Eastwood. 5063.
South Australia.

21 July, 1989.

Attention Mr. I. Faulks.

Dear Sir,

Exploration Licence 1515, Wirrealpa.

~~Third~~ 2nd Quarterly Report for the period 13 December, 1988 to 13 March, 1989.

~~Fourth~~ 3rd Quarterly Report for the period 13 March, 1989 to 13 June, 1989.

Introduction.

Reporting for the above two periods has been consolidated into a single report consisting of this letter summarising the work completed and the expenditure incurred, and a separate technical report compiled by JLC Exploration Services (report attached, "The Regional Geological Setting of Cambrian MVT Mineralisation in SA").

Work completed.

Compilation of the data collected during field reconnaissance in the first quarter~~s~~ indicated that the potentially mineralised horizon was more extensively developed that previously reported. Accordingly, a review of the prevailing models for the formation of Mississippi Valley style lead-zinc deposits was carried out and considerable time spent in obtaining an understanding of the stratigraphy of the area. The data collected by earlier explorers was re-examined in the context of the models and stratigraphy, and targets for further field checking identified.

The "Aboriginal Heritage Act, 1989" was enacted during the fourth quarter of the title. Contact was made with the Flinders Ranges Consultative Committee and time spent in reviewing the legislation and deciding an appropriate course of action. Despite severe reservations by the Joint Venture partners it was decided to proceed with a limited field programme while investigating the attitude of the Consultative Committee.

Field programmes were scheduled to commence in June but were delayed by a combination of other work commitments, wet weather in the Flinders Ranges, and the uncertainties associated with the introduction of the "Aboriginal Heritage Act, 1989" discussed above. Work finally commenced in July, 1989.

Forward Programme.

Field work is being directed at examining the relationships between stratigraphy, structure and mineralisation discussed in the review report. Some mapping will be carried out in an attempt to place the previously drilled holes and rock chip traverses in their correct geological context, and a number of specific target areas will be tested for significant mineralisation by rock chip and soil sampling.

Expenditure.

The statement of expenditure does not take account of the following matters;

* discussion with SADME geologists to concerning the detailed stratigraphy of the area and its relationship to mineralisation,

* reviewing the Aboriginal Heritage Act and Regulations,

* discussion with various government agencies and the Consultative Committee concerning the interpretation and operation of the Act,

* discussion between the Joint Venture partners as to whether or not to proceed with exploration.

Geology	$ 3,646
Drafting and printing	$ 233
Reporting and administration	$ 485
	$ 4,364

Yours faithfully,

R. G. Bluck.

MC:s/tqr079
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1415

DEMIS - MCA JOINT VENTURE
Exploration Licences 1414 & 1515

THE REGIONAL GEOLOGICAL SETTING of CAMBRIAIN MVT MINERALISATION in SOUTH AUSTRALIA

JLC EXPLORATION SERVICES
3 Shelley Avenue,
Plympton Park, S.A. 5038
Telephone (08) 2932894

J.L.Curtis.
15 April 1989
MVT*REG

ABSTRACT

Consideration of the typical features of MVT SLZ deposits and an appraisal of the regional geology of the Northern Flinders Ranges of South Australia incorporating unpublished data on aspects of the Lower Cambrian biostratigraphy, facies relations ,and palaeodepositional environment indicates that all the geological conditions for the development of a major mineral province were present. Study of the metallogenic distribution confirms that an early basin dewatering plumbing system conveyed MVT mineralisation to many of the known prospects. Later rejuvenation during the Delamerian Orogeny deposited minor base metal and gold mineralisation in fault structures and diapiric bodies and also economically significant whillemite type zinc mineralisation as late MVT analogues. This study significantly upgrades the prospectivity of the region.

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**** LIST OF FIGURES ****

1 INTRODUCTION

This report sets out to describe the currently accepted geological model of Mississippi Valley Type (MVT) type lead zinc deposits and demonstrate its relevance to similar mineralisation in the Flinders Ranges of South Australia.

MVT style mineralisation has been long recognised to occur within Cambrian carbonates of the Hawker Group from the central north of the Adelaide Geosyncline. Mineral occurrences occur widely within the Wilkawillina Limestone at the base of the Group and therefore the prospectivity of this unit is the focus of the report.

The Flinders Ranges occur in an arid climatic zone that receives irregular rainfall. Weathering has caused many units to develop strong relief with aesthetic appeal. The climatic and visual aspects of the region have led to the development of environmental protection legislation. However there is provision for exploitation of resources "in the national/state interest".

Aboriginal Land/Sacred Site aspects are subject to current legislative review.

2 LOCATION AND ACCESS

The region with the greatest mineralisation potential occupies the Northern Flinders Ranges in South Australia, centred approximately 400 km NNE of Port Augusta.

Road access to the region is by either Hawker-Wilpena or Hawker-Parachilna-Blinman, the latter parts of each route being over unsealed surface.

To the west of the ranges is the Port Augusta-Leigh Creek standard gauge railway line. (see figure 1)

3 GEOLOGICAL MODEL

Geological research into MVT deposits has been controversial ever since their recognition as a distinct class of deposit. This section sets out to outline the salient features and the current understanding of these deposits.

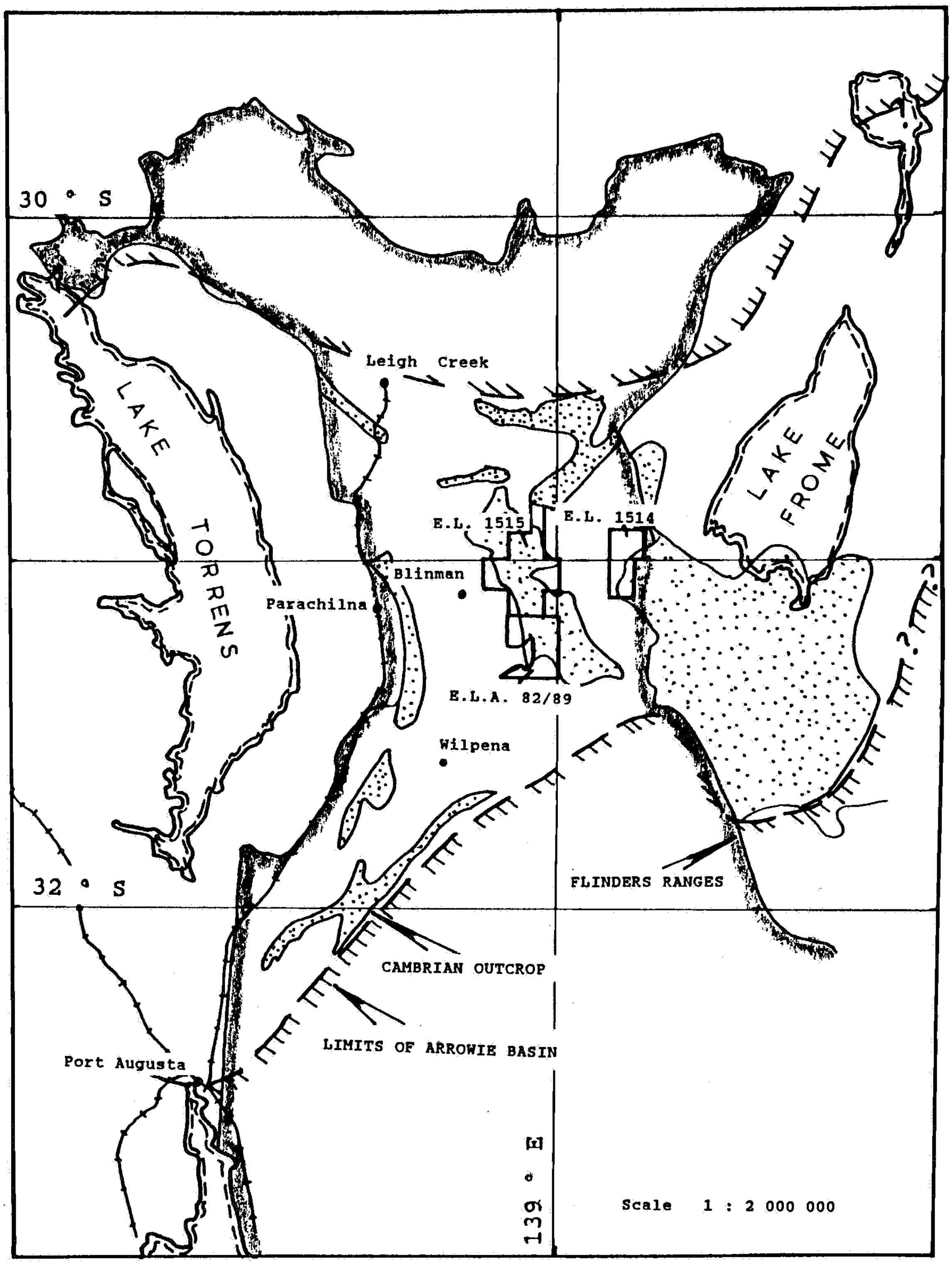


FIGURE No. 1 LOCATION DIAGRAM

3.1 OBSERVED FEATURES

Research by workers Beals and Anderson shows that whilst individual deposits may vary from each other there are many aspects that clearly indicate a common genetic origin :-

* MVT mineralisation is ubiquitous in carbonate sequences within most sedimentary basins of Proterozoic to Cretaceous age, with economically important deposits predominantly in Cambro-Ordovician and Carboniferous units.

* Within any one basin with substantial and widely distributed MVT mineralisation all deposits are remarkably similar.

* MVT deposits occur on basin margins or intrabasin domes/ridges where they formed at less than 1 km below surface.

* The host lithologies may be of either fore-reef, back-reef or less commonly reefal bioherm facies, typical of the platform margin.

* Structural/hydrochemically induced porosity and permeability can be demonstrated to predate mineral deposition. Dolomitisation of the primary limestone is commonly associated.

* Mineralisation often postdates the filling of many voids by marine cements.

* The deposits invariably are dominantly galena and/or sphalerite with accessory pyrite or marcasite. Galena has a typically low silver content and a gangue of barite and/or fluorite may be present. Copper as chalcopyrite is invariably very minor.

* Deposits were formed from hypersaline (4 X sea water) with an SG of about 1.1 at temperatures of 80 to 200%C, commonly 100 to 150%C which are not attributable to a local depth related thermal gradient.

* Thermal sources of igneous or metamorphic association appear to be absent.

* MVT deposits occur antipathetically with respect to petroleum reservoir but traces of hydrocarbons have been noted as immiscible phases in fluid inclusions and bitumen/kerogen residues recorded form many deposits.

* Isotopic data suggests that whilst a primary igneous or metamorphic source for Pb and S may be the case, a strong sedimentary/biogenic influence on the fractionation is commonly evident.

* Typical primary shales which carry 20-200 ppm Pb & 50-300 ppm Zn compared to 4-11 ppm Pb & 20-30 ppm Zn in primary limestones are considered to be a likely metal source.

3.2 INTERPRETATION

Researchers use the above observations to establish that lead and zinc chloride complexes in hypersaline brines at elevated temperatures migrate laterally to basin margin leakage sites from dewatering shales in the basin depocentres.

Prexisting permeable focii around the basin margin are a pre-requisite to the delivery of adequate metal inventories to deposit sites where sufficient reactive sulphur is available to cause reduction of the brine.

A strong biogenic influence observed in sulphur isotopic data is interpreted to mean that it has been also locally sourced from the sediments. Since shales contain abundant iron, any sulphur present is likely to be bound to it and therefore effectively immobilised. Carbonate sediments are relatively poor in iron compared to their primary organic content and are thus a more likely sulphur source.

The mechanism of the sulphur delivery is conjectural. Since it is unlikely to have been transported in the metal pregnant brine as unstable phase to the site of deposition a mixing fluid model of deposition has been proposed but the mechanism detail seems obscure in the literature.

3.3 ORE EMPLACEMENT

The petroleum residues found in deposits can be interpreted as the remnants of the non-active petroleum phases involved in the metal reduction. The existence of petroleum accumulations in some MVT provinces indicates that substantial mobilisation of hydrocarbons into the basin plumbing systems was probably common to all MVT provinces.

The MVT dewatering model clearly indicates a focused open discharge plumbing system that would ensure full flushing of hydrocarbons from any MVT deposit site.

Hydrocarbons would be expected to be sourced predominantly from shallow marine deposits near the basin margin where marine life flourished. Elevated temperatures due to the efflux of deeper basin brines could be expected to rapidly advance the primitive organic kerogens petroleum maturity index.

Separation of hydrocarbons and metal pregnant brines in the same plumbing system is readily achievable by virtue of salinity stratification. The deep basin metal pregnant brines as envisaged are very mature and carry maximum totally dissolved solids and are therefore very dense waters. Less mature more locally derived basin waters from near basin margin sediments would be expected to be of much lower density. Should these latter brines contain hydrocarbons their density would be lowered even more by comparison.

For example the hydrocarbon bearing fluids clearly might have an SG $<$ 1.0 whereas the MVT brines might have an SG $\simeq$ 1.1, a not an insignificant contrast.

Separation of otherwise mutually unstable phases in the same aquifer by this mechanism is conceivable over long periods of time providing migration by laminar flow parallels iso-density surfaces.

Disturbance of this regime in the cases where pressure loss, permeability conditions or a significant change in the migration path vector ,particularly steepening, is likely to destroy the stratification and result in fluid mixing.

A combination of lateral to upward migration with pressure loss associated with entry into a void could result in hydrocarbon degassing, attendant cooling, localised turbulent flow, and supersaturation of dissolved phases. Ideal circumstances for mineral deposition from a once stable hydrochemical regime by mixing.

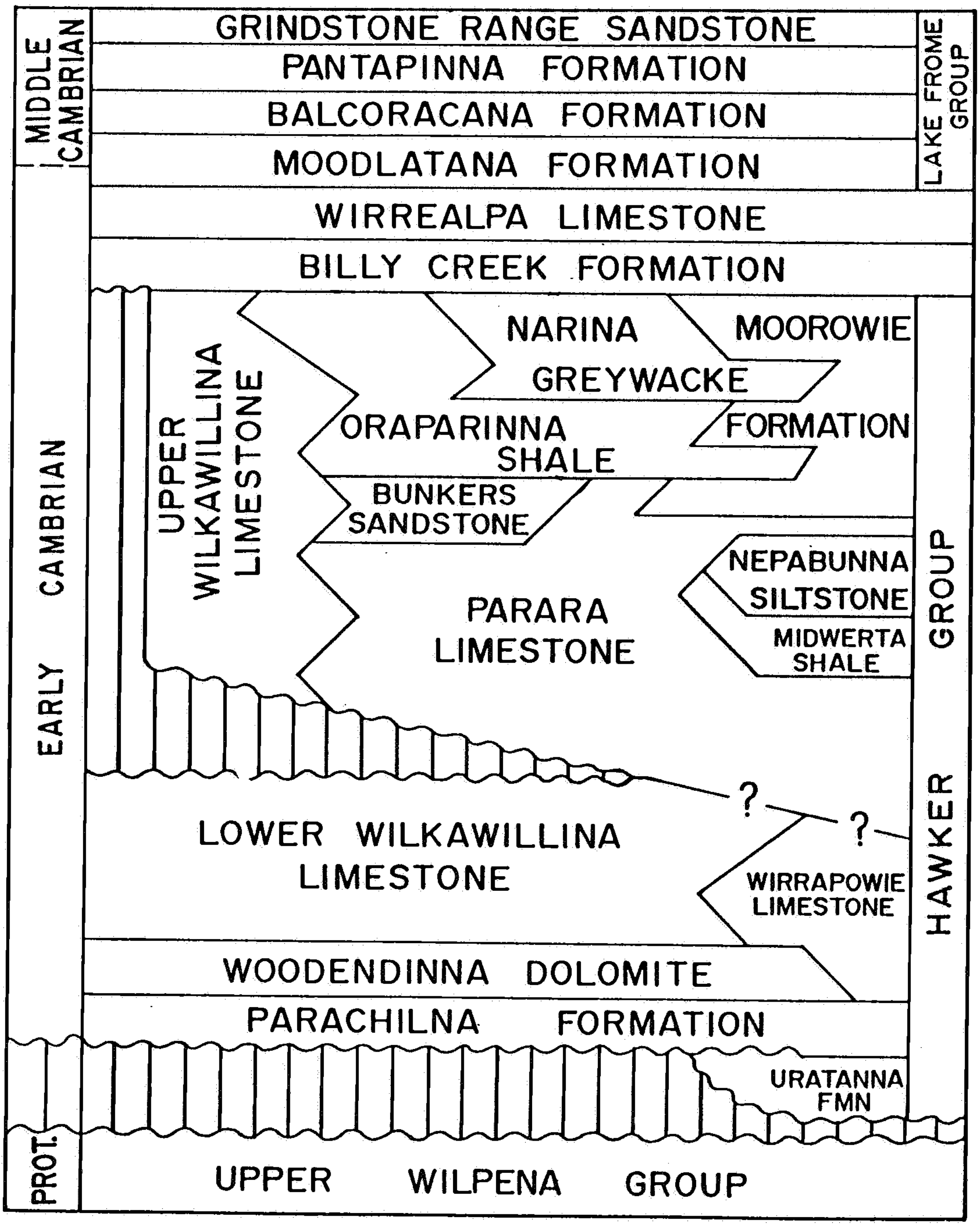
4 REGIONAL GEOLOGY

The Flinders Ranges comprises a late Precambrian geosynclinal sequence overlain by Cambrian shelf facies carbonate deposits that have been regionally folded into a dome and basin interference pattern.

At a number of locations large bodies of complexly deformed rock disrupt the layered sequences. Such bodies have been ascribed to a diapiric emplacement origin.

Cambrian carbonate sequences of the Arrowie Basin form the last cycles of shallow marine deposition in the northern parts of the Adelaide Geosyncline. Regional conformity with the underlying Pound Quartzite of the Wilpena Group is readily demonstrated.

CAMBRIAN STRATIGRAPHY
FLINDERS RANGES



Gravestock 1989

FIGURE No. 2 CAMBRIAN STRATIGRAPHY OF THE FLINDERS RANGES

These deposits were extensive and spread out laterally over the adjacent lower/middle Proterozoic basement margins of the aucalogen within which the Geosyncline developed. Only remnants of these units are preserved in fold keels resulting in some correlation uncertainty both locally and regionally.

4.1 STRATIGRAPHIC UNITS

The Cambrian sequence is subdivided into the basal Hawker Group, Billy Creek Formation, Wirrealpa Limestone and Lake Frome Group. (See figure 2)

HAWKER GROUP

The Hawker Group embraces two sedimentary facies, a shallow marine basin edge platform environment with abundant biogenic forms typified by reefal limestones (Wilkawillina/Ajax Limestones) and a deeper marine basinal environment with a significant clastic component (Parara Limestone, Midwerta Shale, Nepabunna Siltstone, Bunkers Sandstone, Moorowie Formation, Oraparinna Shale and Narina Greywacke.

Parachilna Formation

The Parachilna Formation is commonly of restricted extent being confined to probable palaeogeographic lows at the base of the Cambrian succession. Mapping by the Geological Survey of S.A. describes this unit as argillaceous sandstones with vertical worm? burrows with intercalated lenses of oolite and shale. It is conformably overlain by the Wilkawillina Limestone.

Wilkawillina Limestone

The Wilkawillina Limestone commonly forms the base of the Cambrian succession and often lies disconformably upon the Upper Proterozoic Pound Quartzite.

The unit is predominantly light to dark grey, massive, bedded and biostromal archaeocyathid limestones which are often creamy brown where dolomitised. Variants are often sufficiently distinct that they have been described as separate stratigraphic units. Notable are the Woodendinna Dolomite and Wirrapowie Limestone, the former being quite widely recognisable whereas the latter is clearly a restricted facies type. (See figure 3)

Mottled limestone is often recorded as distinct subunit. Its appearance is due to abundant algal filaments being preserved. It is thus a primary feature which occurs at a number of stratigraphic positions that can be locally used for mappable marker beds on occasion. Such units are not used for stratigraphic correlation.

Recent studies have led to the this unit being subdivided into upper and lower members. (see section 4.12)

Parara Limestone

The unit, described as a dark flaggy and silty limestone with interbedded shales, is widely distributed.

In the field it is readily distinguished from the underlaying Wilkawillina Limestone by its thin bedded pattern. The contact between the two units is either gradational over about 10 to 15 meters of section or quite sharp at an erosional surface where clastic debris and/or the presence of finely laminated silty deposits are likely to be observed.

The Midwerta Shale and Nepabunna Siltstone are members of the Parara Limestone being two prominent units recognised in the Arrowie Syncline. The former is typically grey green shale, sometimes calcareous with minor nodular limestone and the latter dark blue grey calcareous siltstone with minor limestone.

Bunkers Sandstone

This unit, described as a crossbedded sandstone with calcareous interbeds, is restricted to the Donkey Bore Syncline.

Oraparinna Shale

This unit, described as green finely micaceous and carbonaceous fossiliferous siltstone, is known from both the Donkey Bore and Arrowie Synclines.

Narinna Greywacke/Moorowie Formation

These units appear to be equivalent since they occupy the same stratigraphic slot if the Oraparinna Shale is considered to be absent at Moorowie.

The Greywacke is described as grey green interbedded calcareous siltstone and chloritic sandstone which may be coarse and gritty. Some interbeds of cream/purple flaggy dolomite may be present. Distribution is as for Oraparinna Shale.

The Moorowie Formation is described as sandy limestones, siltstones, shales and massive flaggy limestone of variable colour that suggests deposition at or near an oxidation interface.

BILLY CREEK FORMATION

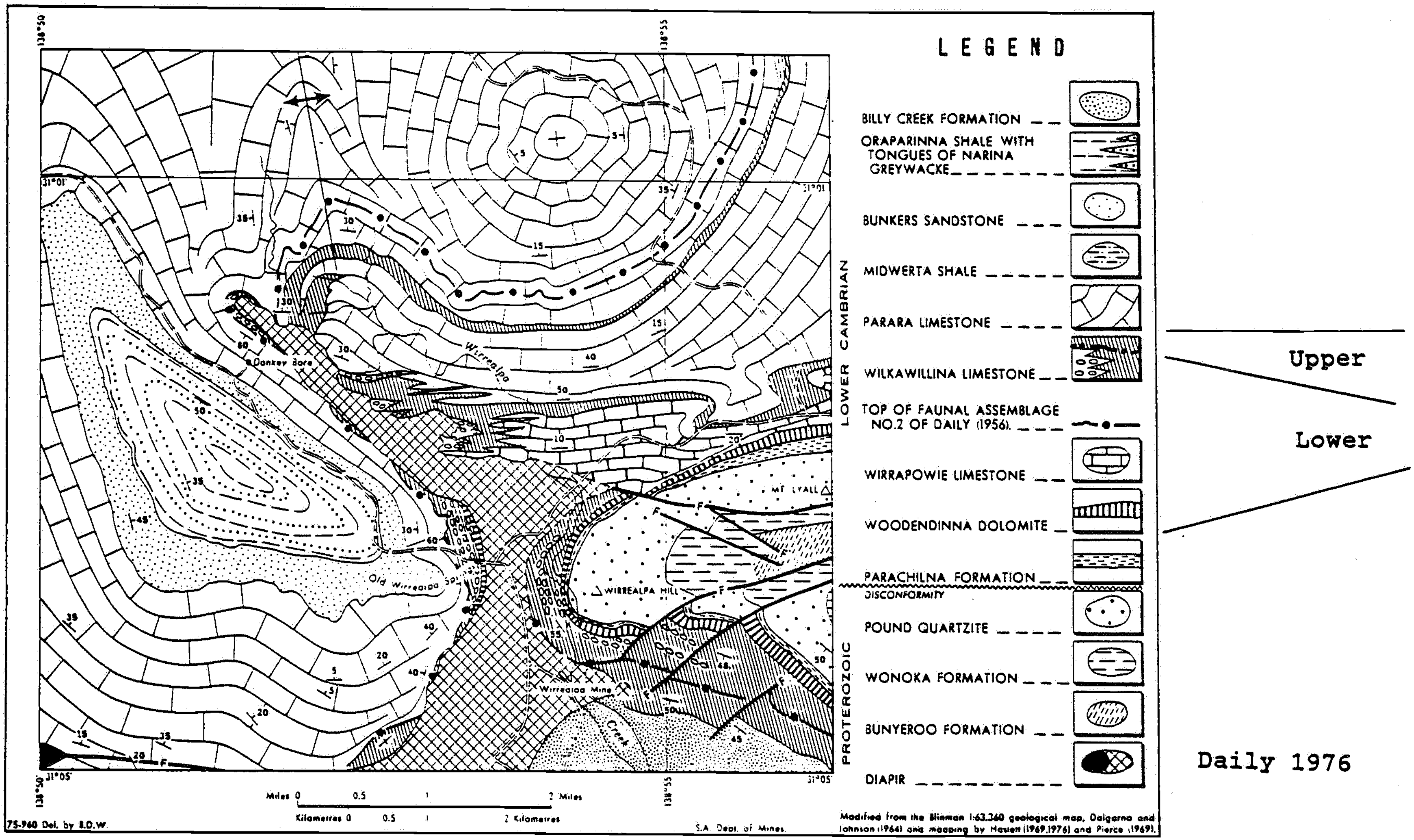


FIGURE No. 3

LOWER CAMBRIAN FACIES AT OLD-WIRREALPA

The Billy Creek Formation comprises a sequence of red brown micaceous sandstone and shales with halite pseudomorphs. Green/red shales and limestone at the base of the succession contain intercalated tuffs.

WIRREALPA LIMESTONE

The Wirrealpa Limestone is a grey, nodular and shaley fossiliferous limestone.

LAKE FROME GROUP

The Lake Frome Group is comprised of four units. They are the Moodlatana Formation (sandstone), Balcoracana Formation (siltstone), Pantapinna and Grindstone Range Sandstones (sandstones).

These units are predominantly of red brown to pinkish colours throughout which coupled with the evidence of halite implies a semi-terrestrial environment of deposition. Minor carbonates are present at two levels suggesting possible marine incursions of short duration occurred.

4.2 DEPOSITIONAL ENVIRONMENTS

The sedimentology described in the foregoing section is considered to indicate that following early cycle arenite deposition (Parachilna Formation) widespread shallow marine carbonates were laid down (Lower Wilkawillina Limestone).

Sedimentation was briefly interrupted by minor tectonic disturbance throughout the geosyncline, probably epirogenisis of deeply buried basement, which caused some portions of the Cambrian sea bed to become depressed and the local emergence of the earliest units. (See section 4.4)

Marine carbonate deposition then resumed. Both shallow shelf facies (Upper Wilkawillina Limestone) and basin facies limestone (Parara Limestone) were deposited coevally. Initially the basin deposits were conformable but later disconformable with respect to earlier deposits as marine transgression reclaimed some of the initially emergent areas. Simultaneously in more stable environments shallow carbonate deposition was sustained without significant interruption.

This interpretation adequately explains the existence of conformable succession, lateral interdigitation and simple disconformity/unconformity relationships that are observable between the Parara and Wilkawillina Limestones.

Shallowing of the Cambrian Basin from cyclic shale and limestone sedimentation finally resulted in the deposition of red bed sequences, initially marine oxidizing conditions and later semi-terrestrial deposits (Billy Creek Formation and Lake Frome Group) with temporary near reducing conditions (Wirrealpa Limestone).

Since the MVT model suggests that the foregoing aspects are likely to influence the location of ore, recent studies of the Hawker Group are described separately in Section 4.3.

4.3 SEDIMENTATION IN THE ARROWIE BASIN

The occurrence of MVT ore is profoundly influenced by the interplay of structure and stratigraphy along the shelf margin. In particular sedimentary facies and permeability paths are considered paramount in determining the site of ore.

4.3.1 REGIONAL ASPECTS

The sedimentology of the Arrowie Basin was studied extensively by B. Daily who authored a number of papers on aspects of the subject. (See appendix)

More recent biostratigraphic data assembled by D. Gravestock has resulted in the revision of the facies correlations between the Lower Cambrian units. This data when coupled with the release of petroleum exploration data on the early Middle Cambrian to Devonian Warburton Basin sequence, strongly suggests that deep water facies sediments of the Lower to early Middle Cambrian Arrowie sequence extend northward. (see figures 4 & 5)

Gravestock concludes that a major northward thickening Cambro-Devonian deposystem lies concealed beneath the Cooper Basin with its marginal facies in the northern Flinders Ranges. These deposits are believed to be thickest along the axial trend of the Cooper Basin and formerly extended south westward to an arcuate shelf margin at the latitude of Blinman. To the south east and west of this zone, the Warburton Trough (inferred), shelf facies sediments were predominant.

This places the MVT province associated with the Parara/Wilkawillina Limestone transition on the shelf margin of a major sedimentary system.

In this broad context the basal Hawker Group was deposited in response to localised tectonic adjustments along the shelf margin as were also the later oxide facies of the Hawker Group.

The cusp of the shelf margin was undoubtably determined by the disposition of deep structure since it lies at the generalised inter section of the "Norwest Fault" and the "Paralana Fault" fracture systems.

The coincidence of the these macro features with evidence of MVT mineralisation processes greatly enhanced the possibility of major deposits being present in the region.

4.3.2 SHELF MARGIN

Gravestock has revised the facies relations of the Wilkawillina Limestone utilizing biostratigraphic correlation. On this basis the Wilkawillina Limestone has been subdivided into upper and lower members at the biostratigraphic zone (2)/(3) boundary. Throughout all but the northwestern Flinders Ranges this boundary coincides with a hiatus in deposition. (See figure 4)

Minor tectonic adjustment resulted in sub-basins wherein deposition of the Parara Limestone as a lateral facies equivalent of the Upper Wilkawillina member subsequently took place.

Gravestock has used the distribution of biostratigraphic faunal assemblages in conjunction with the sedimentology of their respective occurrence to build up a palaeoenvironmental reconstruction of the shelf margin during Wilkawillina "time". (See figure 6)

The "partially exposed shelf", "reef rimmed platform margin" and to a lesser extent "bypass margin" environments clearly indicate situations where secondary dolomitisation and solution permeability (palaeokarsting) of the lower Wilkawillina Limestone might be anticipated.

Together with the marginal faults and the deposition of adjacent basin facies sediments these situations (above) offer substantial MVT potential.

Recognition of either of the (2)/(3), (2)/(4), or (2)/(5) faunal boundaries associated with a disconformity should therefore be regarded as encouraging. Locally restricted disconformable contacts without appreciable biostratigraphic contrast may have been due to only short periods of emergence and have consequently limited secondary porosity and lowered mineralisation opportunity. However close spaced stacking of such depositional hiatuses may offer considerable potential. (See figure 4)

The geological models proposed by Gravestock clearly imply that cemented fractures of multiple generation be they of tectonic faults, gravity slip planes or solution cavity origin will be present in any one setting. Clearly the classification of such features and the vein/cements within them are going to be of

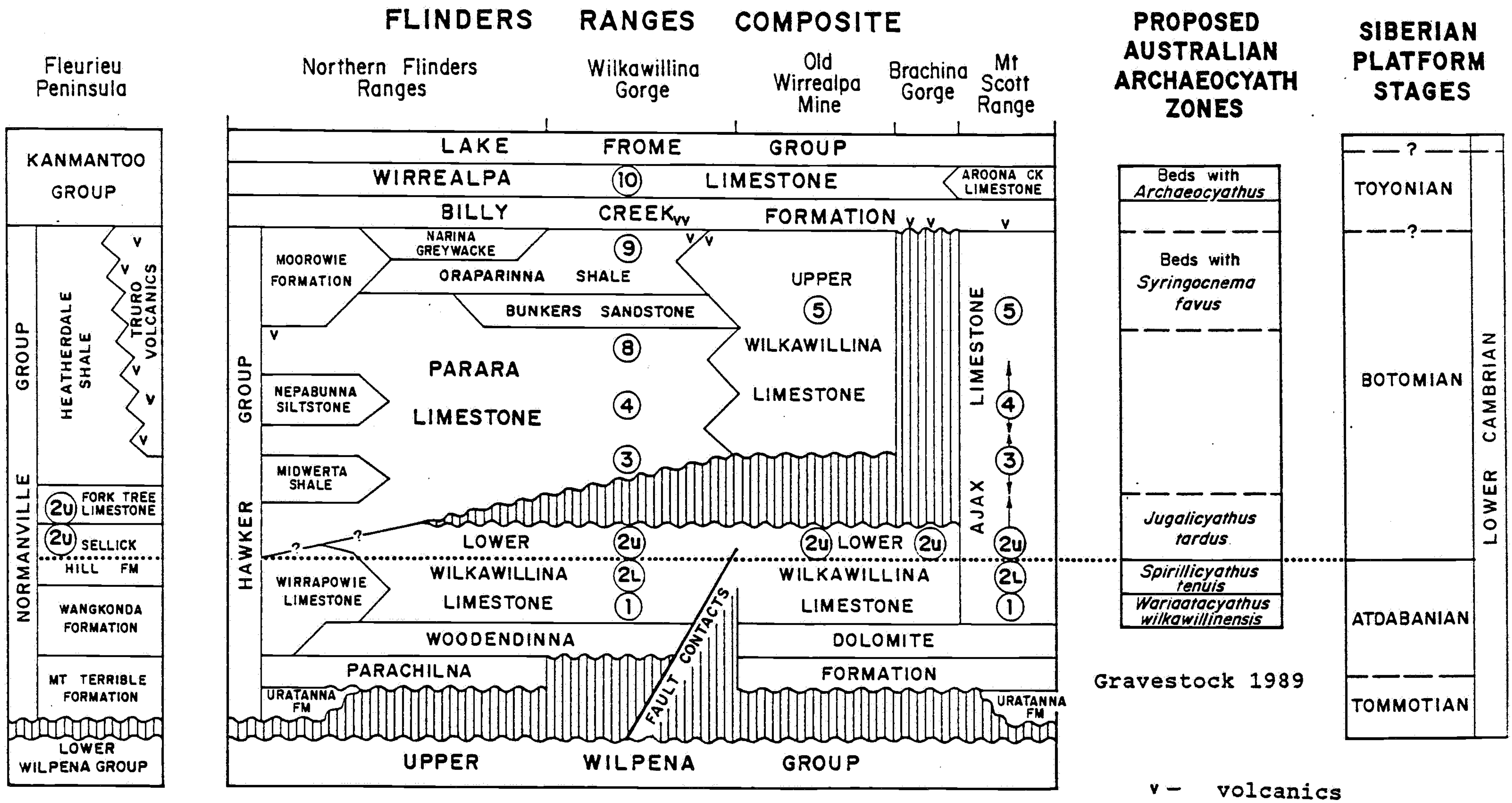
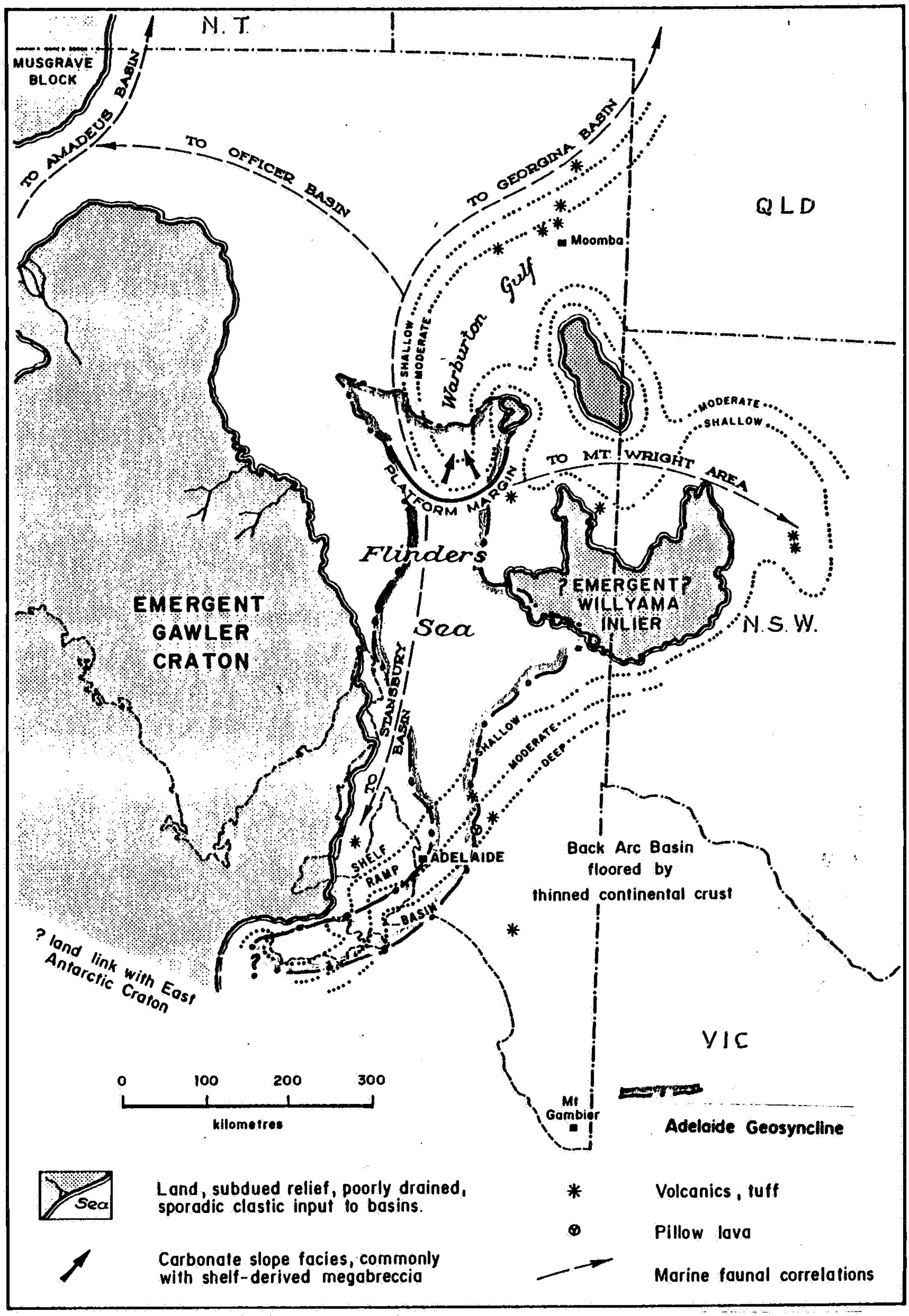


FIGURE No. 4

CAMBRIAN BIOSTRATIGRAPHIC ZONES OF THE FLINDES RANGES



NB. Emergence of easterly inliers was probably episodic.

Gravestock 1988

FIGURE No. 5

EARLY CAMBRIAN PALAEOGEOGRAPHY OF EASTERN SOUTH AUSTRALIA relevance to MVT exploration. Similarly the relations of these local features to macrofracturing of the region which determined the main dewatering hydrological regime is also important.

Gravestock's work serves to underline that the detailed geology is of considerable relevance to MVT exploration and deserves due attention in any exploration programme.

4.4 STRUCTURE

The Precambrian and Cambrian rocks of the Flinders Ranges were extensively folded and faulted during the Delamerian Orogeny. The earliest disturbance was named the Kangaroovian Movement by B. Daily who observed discontinuities in the stratigraphic record of Kangaroo Island.

Similar discontinuities recognised in the Wilkawillina Limestone facies in the Northern Flinders Ranges indicate that deformation during early Cambrian deposition occurred throughout the Adelaide Geosyncline. Structural and sedimentological evidence suggests that weak tectonic disturbance may have initiated Cambrian deposition and been periodically recurrent thereafter until the major mountain building event.

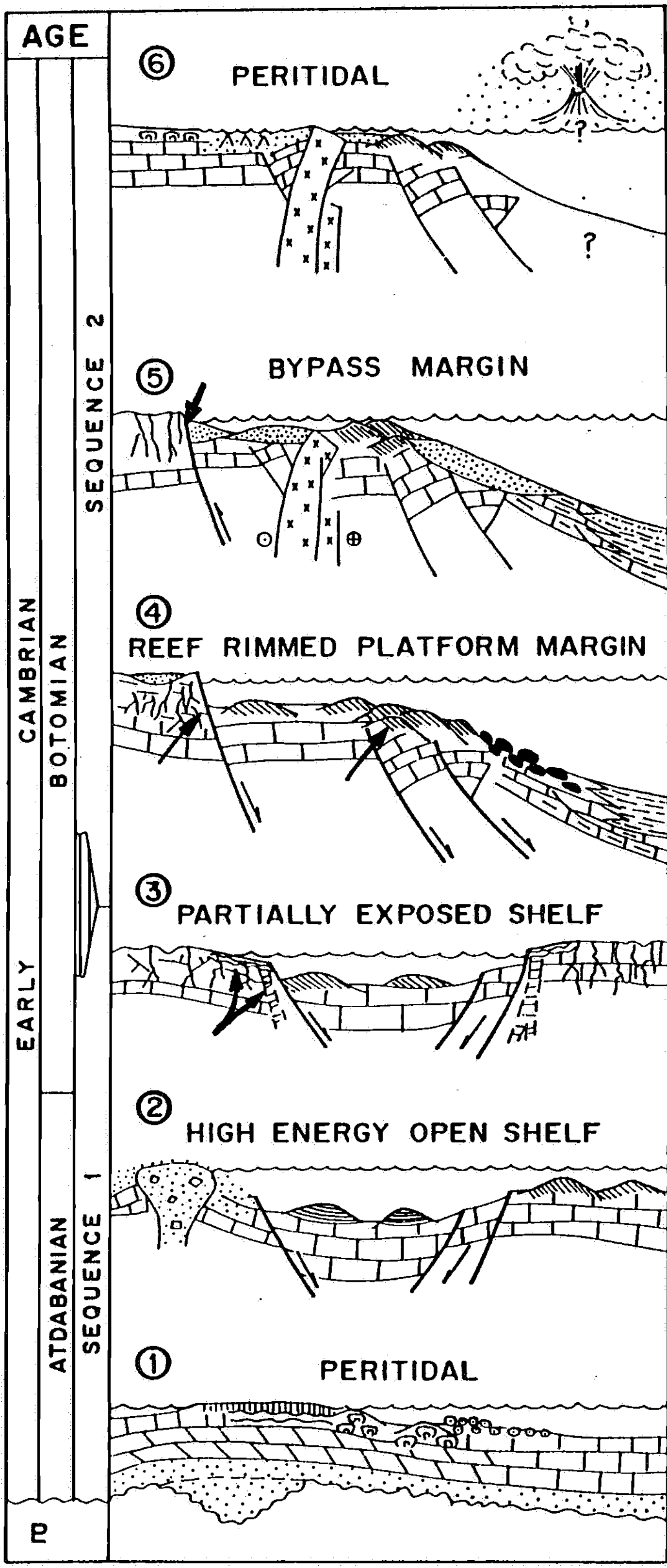
4.4.1 DEFORMATION AND SEDIMENTATION

Study of regional mapping clearly indicates both brittle and ductile response of Adelaidean and Cambrian sequences to stresses generated along deep basement features which are oriented in north west and north east directions.

The deformation style is one of complex interference folding with associated faulting and major piercment diapirs.

Displacements along major fault zones are commonly dissipated into ductile deformation where local flexures or the truncation of major folds occur. Faults frequently focus on to the diapiric bodies. Major breccias along faults that have a similar appearance to diapir bodies are also present.

While on brief inspection, it might appear that these tectonic features could have been due to a single tectonic upheaval, careful appraisal of the mapped stratigraphy unambiguously requires a progressive, if only episodic, tectonic evolution of the region concurrent with sedimentation and a later terminal tectonic event.



Environment	EVENT	SEDIMENTS
⑥ PERITIDAL	Apparent tectonic quiescence but volcanic activity (tuff). Shoaling upward sequence to eventual exposure landward of platform margin.	Billy Creek Formation (not shown) – partly exposed tidal flat redbeds – completes Sequence 2. Stromatolites, platy ? algal dolomite, evaporites e.g. top upper Wilkawillina, Ajax, Moorowie, Edeowie Limestone Calcmicrobe-dominated bioherms. Exposed basement e.g. Benagerie Ridge, Mt. Painter Inlier, Olary Inlier. Volcanic sources not yet located – possibly Mt. Wright (NSW), Gidgealpa, Truro.
⑤ BYPASS MARGIN	Compression. 'Kangaroolan Movements' Uplift of basement blocks. Siliciclastic input to basin via channels breaching margin. ? Sandy turbidites, submarine fan sands.	Erosional channels filled with 'buckshot' sands and sandy limestone breccia in upper Ajax Limestone (Mt. Scott Range), upper Wilkawillina Limestone (Old Wirealpa Mine, Ten Mile Creek) and upper Moorowie Formation (Moorowie Mine). Narina Greywacke may be downslope equivalent. Shelfoi sands (Bunkers Sandstone) may be local variant.
④ REEF RIMMED PLATFORM MARGIN	Extension. Differentiation of platform margin, megabreccias, persistent karst on structural highs, first tabulate corals	Platform margin reef complexes of archaeocyaths and calcmicrobes (*Renalcis, Epiphyton, Girvanella*) in upper Wilkawillina Limestone, Moorowie Formation. Slope megabreccias, slumps, turbidites in Moorowie Formation, Parara Limestone, Calc. shales (Oraparinna) in intra-shelf basins and possibly seaward of platform margin. Karst on exposed shelf carbonates e.g. North of Brachina Gorge, Ten Mile Creek.
③ PARTIALLY EXPOSED SHELF	Extension. Rapid exposure meteoric overprint, neptunian dykes, structural lows remain submerged, first trilobites.	Lower Wilkawillina Limestone, High energy skeletal sands subaerially exposed. Red laminated crusts, microstromatolites, collapse breccias. Fractures and fissures in active fault zones filled with marine cements and bioclastic debris. *Renalcis* and archaeocyath bioherms in persistently submerged areas.
② HIGH ENERGY OPEN SHELF	Extension. Intrashelf depressions, first archaeocyaths, sponges, calcified microbial communities.	*Renalcis* and *Epiphyton* – archaeocyath bioherms in x-bedded skeletal sands on shelf. Archaeocyaths + sponges + stromatactis in deeper water mounds in intrashelf depressions. Lithified mottled limestones, thrombolites. Pebbles shed from locally exposed diapirs e.g. Wirrealpa.
① PERITIDAL	Coastal onlap. Basal transgressive sands, locally channel – forming, stromatolites, cyanobacterial mats, ooid shoals.	Woodendinna Dolomite. Wirrapowie Limestone + basal Ajax + basal Wilkawillina Limestone. Stromatolites, cryptalgal laminites, ooids, mud-cracks, sand. Commonly dolomitised, chert nodules. Parachilna, Uratanna Formations. Transgressive sheet sands, burrowed shoreface sands, channels.

After James & Gravestock (in press)

➞ Sites favourable for MVT deposition

FIGURE No. 6 PALAEOENVIRONMENTS OF THE HAWKER GROUP

This aspect is well illustrated by the Wilkawillina Graben that developed as a fault bounded trough during the deposition of the Wilkawillina Limestone. (See figure 7)

Episodic movements resulted in an intricate biohermal reef complex developing along the southern side of the feature.

The boundary faults are intricately linked to the Oraparinna Diapir located in the axial zone of the north west trending the Blinman-Oraparinna Syncline.

The graben is essentially a parasitic feature of the major structure within which it is located namely, the common limb of the Oraparinna Anticline and Balcorcana Syncline.

Significant displacements in basement Adelaidean units and the syndepostional features in the Hawker Group fade upwards into sedimentary draping/ductile response in the overlying Lake Frome Group.

A similar interplay of sedimentary and tectonic processes has been recognized along the Donkey Bore-Wirrealpa Springs Anticline (diapir ridge) where complex facies relations exist. (See figure 3)

The evidence for periodic structural adjustments influencing sedimentology is therefore strong. Cyclic tectonic disturbance along the resulting confined zones of complex geology would also have ensured maintenance of permeable pathways for the egress of basin brines.

Fracture systems that were active during sedimentation are therefore to be regarded as the most likely conduits for conveying metal pregnant brines to MVT depositional sites. MVT deposits are therefore more likely to occur in proximity to such structural "trends" given the tendency to some of the regional faults to express ductilely.

4.4.2 METALLOGENIC DISTRIBUTION

If the metallogeny of the Northern Flinders Ranges is studied many occurrences of gold, copper, and lead-zinc within the Adelaidean and Cambrian successions are clearly associated with the main NW-NE fracture system. However, a major subset of lead-zinc occurrences are also clearly associated with the basal Cambrian. (See figure 8).

The density of lead-zinc occurrences falls off from north to south with the basal Cambrian subset scattered about the location of the inferred shelf margin. (see section 4.3.1)

Regional Fault Zone

potential target zone

PROSPECTS		
	M	MVT type
	W	Whillemite type
	U	unclassified

FIGURE No. 7

THE GEOLOGY OF THE WILKAWILLINA GRABEN

The Cambrian subset is also less clearly linked to major fractures which are now prominent because of the degree of deformation.

It is therefore probable that there are two generations of SLZ deposits.

A late suite of occurrences associated with epigenetic fluids mobilised during the major terminal phase of Delamerian folding is considered likely. Fluids of this generation would have been able to migrate relatively freely along the open plumbing system of the major fault/diapir network throughout the stratigraphic pile. Almost all of the copper and gold, and the late Precambrian hosted lead/zinc mineralisation appears to be of this type.

The Cambrian subset does not fit well with the late fluid model but rather better with a situation where permeabilities along regional, local, and stratigraphic boundaries were similar. An early basin dewatering model is consistent i.e. an MVT model.

Field observations by S.A.D.M.E. personnel whilst mapping the Brachina George region suggest that MVT mineralisation was related to second order SW-NE fractures which were active during and shortly after deposition.

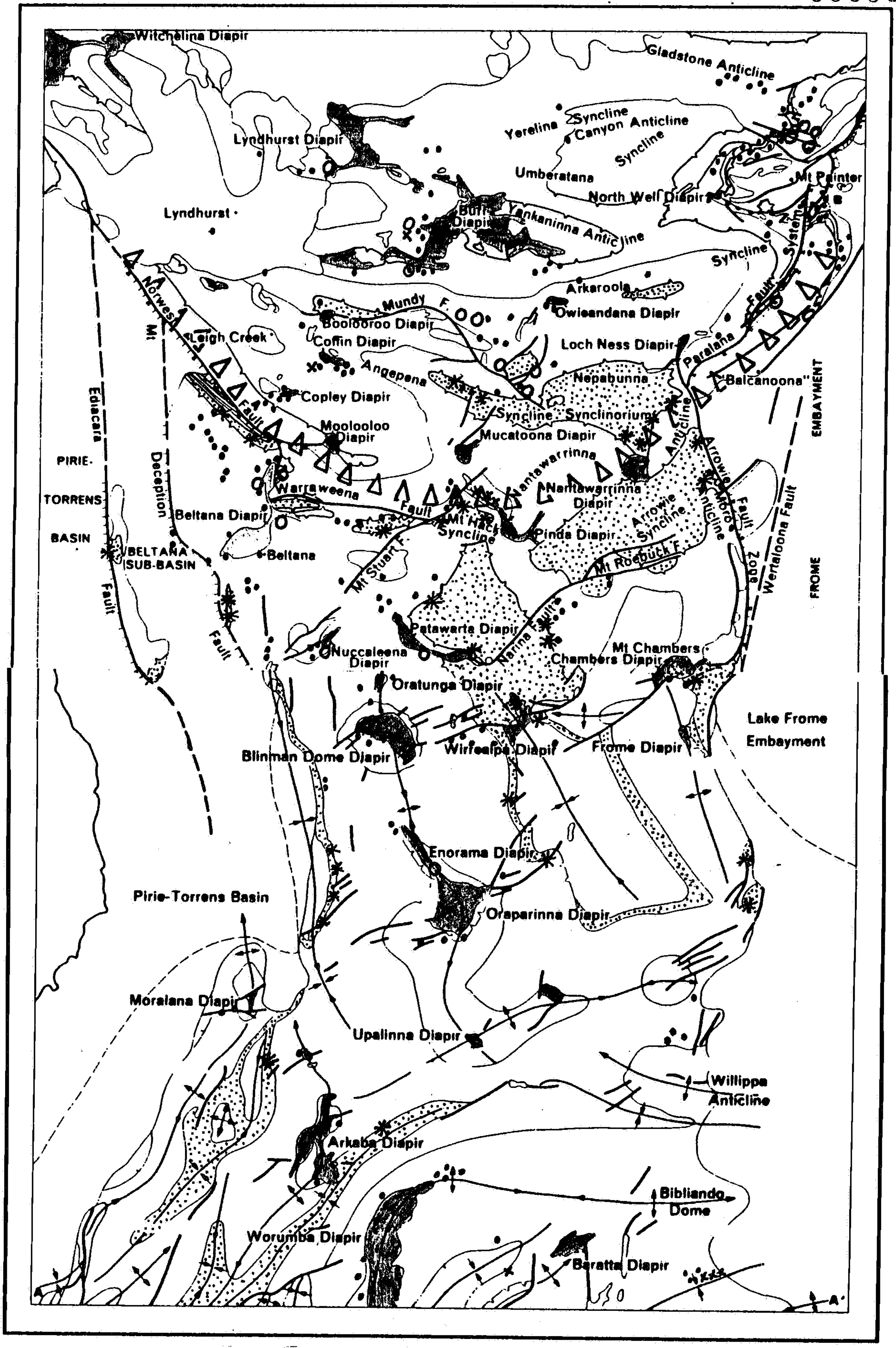
The field relations of whillemite zinc deposits in Lower Cambrian units, namely open fracture vein stockworks of late Delamerian? age, suggests they were deposited from the late fluids. The common trace element characteristics and sulphur isotopy of these and MVT deposits probably reflect a common parental source and fluid mobilisation path. (R. Horn , Pers. cóm.)

Spatially separate deposition of sulphide and whillemite from late fluids, reflecting Eh? Ph, T, P, and fugacity conditions is to be expected. Sites of early fluid sulphide MVT mineralisation may also have been favourable for late fluid whillemite, but direct local derivation of whillemite from nearby sulphide mineralisation is considered less probable.

Because of common source and similar emplacement mechanisms whillemite and MVT mineralisation are of virtually equal regional metallogenic significance.

The metallogenic distribution of MVT mineralisation supports the conclusion that regional conditions at the southern extremity of the Warburton Trough were such that a significant MVT plumbing system functioned during dewatering of the Hawker Group..

TECTONIC SKETCH



PROSPECT TYPE (inferred)

Cambrian Sediments	o late fluid : fracture type	● Copper	ΔΔ Inferred Shelf Margin
Diapir	✱ early fluid: MVT type	✱ Gold	0 — 50km

FIGURE No. 8 METALLOGENY OF THE FLINDERS RANGES

5 ECONOMIC POTENTIAL

The crossover of the Norwest and Paralana Fault systems ,centred on the Wirrealpa Diapir ,being also on the southerly cuspate terminus of the Warburton Trough is the most prospective region for MVT deposits.

It is inferred that the Wirrealpa Diapir is a manifestation of the Norwest structure which as expressed by the Fountain Head Thrust, the Donkey Bore-Wirrealpa Springs facies transition, and the long axes of the Ben Lomond and Donkey Bore Synclines. Similarly the Mt. Lyall-Mt Falkland, Mt. Emily, Dawson Hill and Mt. Frome Fault zones are an expression of the Paralana structural zone.

MVT mineralisation along the Donkey Bore-Wirrealpa trend at the Wirrealpa mine, Linda and Eric Prospects and the Third Plain whillemite deposit lie in close proximity to the above structural features where they intersect the Wilkawillina Limestone. Similarly the Mt. Emily zone influenced MVT mineralisation near Mt. Hayward and another NE fault zone (Iron Knob-Reaphook Hill Lineament) relates to whillemite mineralisation at Reaphook Hill.

Three structurally favourable locations for MVT mineralisation along the Wilkawillina Limestone are predicted by the model. Two of these locations lie within EL 1515 ,being at the northern and southern ends of a Pound Quartzite outcrop that extends from the neighbourhood of Ti-Tree Well south easterly to Wirrealpa Creek. The third is located within EL 1514 almost due north of Mt. Frome in an analogous situation to the nearby Eric Prospect. (See figure 7)

Of the presently known prospects listed above ,those with structural and stratigraphic features described in the preceding sections should be considered to have high prospectivity. Those currently under title .Eric in EL 1515 ,Donkey bore Old Wirrealpa trend in EL 1514 and Linda in ELA 82/89 are therefore rated highly.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

* Palaeogeographic reconstruction of the Lower Cambrian depositional environment confirms that sedimentary, hydrological, and structural features were favourable for the formation of MVT deposits during dewatering.

* Metallogenic evidence indicates that an early basin dewatering event was responsible for the deposition of known MVT type mineralisation in the Wilkawillina Limestone.

* The economic prospectivity of the region is enhanced and the currently held exploration ground is very favourably located.

* Additional potentially favourable and accessible exploration locations have been identified.

* Rejuvenation of the plumbing system late in the Delamerian Orogeny resulted in the deposition of Whillemite Zinc deposits at similar geological sites.

6.2 RECOMMENDATIONS

* Exploration for MVT type deposits should be focused on localities where the interplay of regional structure and sedimentary processes have generated suitable MVT entrapment sites.

* Evidence for features such as lateral facies changes, palaeokarsted disconformity surfaces, and growth faulting in proximity to the inferred position of the Warburton Trough margin should be sought during exploration.

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DEMIS - MCA JOINT VENTURE
Exploration Licence 1515

WIRREALPA, S.A.

EXPLORATION REPORT

Periods Ended 13 June & Sept. 1989.

J.L.Curtis.
30 September 1989
W1RR:QRJU89

ABSTRACT

Field studies confirm that MVT mineralisation along the Donkey Bore - Old Wirrealpa Spring trend is associated with permeable Cambrian aged palaeokarst features. Mapping has identified the possible surface expressions of potentially mineralised palaeocaverns at a number of locations and a zone of goethite-jasper gossans in the basal Parara Limestone adjacent to possibly altered Wilkawillina Limestone at Donkey Bore Plain. Sampling of both soils and rock indicates that lead and zinc are the predominant metals in the south and north respectively. Generally the levels of lead and zinc anticipated at surface from BHP data were not attained by the sampling techniques employed in the current work.

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1 INTRODUCTION

Mineralization at Wirrealpa was first recognized by early prospectors who discovered and developed the Wirrealpa Lead Mine. This deposit is hosted by archaeocyathid reef limestones in close proximity to inferred diapiric breccia.

The BHP Co. whilst exploring for Mississippi Valley Type (MVT) lead-zinc deposits throughout the Flinders Ranges carried out stream sediment and rock chip geochemical surveys, and diamond drilling which demonstrated that this style of mineralization was relatively widespread in the vicinity of the Wirrealpa Diapir.

This report is a brief summary of a short field programme which sought to verify previous exploration information and attempt to relate the known mineralisation to geological surface features.

2 LOCATION AND ACCESS

The Wirrealpa Exploration title covers an area of 1028 km2 in the vicinity of Mt. Brooke in the central eastern Flinders Ranges of South Australia, approximately 450 km NNE of Port Augusta.

The region is accessible by either Hawker - Wilpena or Hawker - Parachilna - Blinman, the latter parts of each route being over unsealed road.

Parachilna 65 km to the west, across the ranges is the nearest station on the Port Augusta - Leigh Creek standard gauge railway line. (see figure 1)

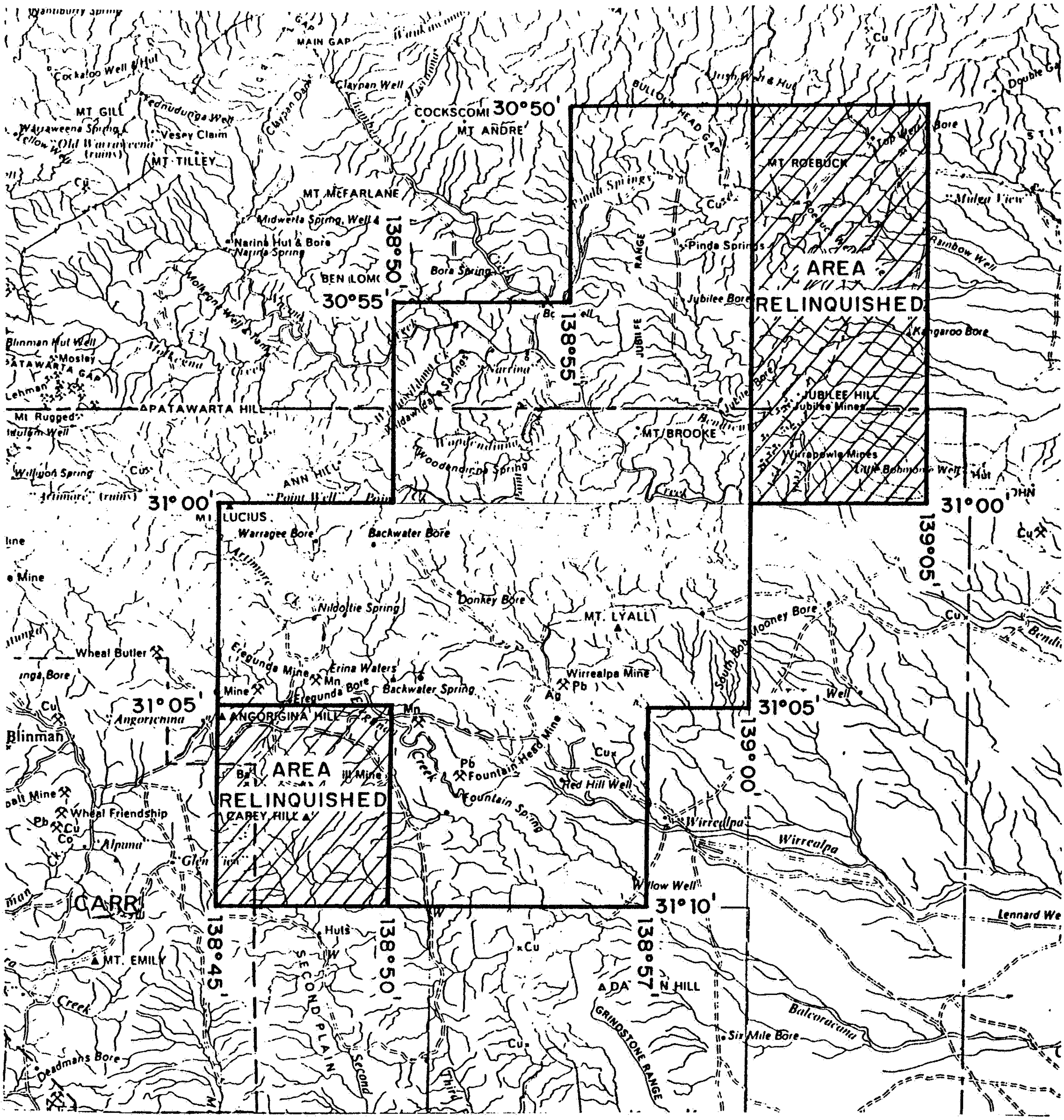
3 REGIONAL GEOLOGY

3.1 STRATIGRAPHY

The Finders Ranges comprises a late Precambrian geo-synclinal sequence overlain by Cambrian shelf facies carbonate deposits.

At a number of locations large bodies of complexly deformed rock disrupt the layered sequences. Such bodies have been ascribed to a diapiric emplacement origin.

All of these main stratigraphic subdivisions occur at Wirrealpa. This report focuses almost exclusively on the Wilkawillina and Parara Limestones of the Cambrian Hawker Group.



Scale 1 : 250,000

LOCATION MAP EL No. 1515

FIGURE No. 1

Parachilna Formation

At Wirrealpa the Parachilna Formation is of restricted extent being confined to probable palaeogeographic lows at the base of the Cambrian succession. Mapping by the Geological Survey of S.A. describes this unit as argillaceous sandstones with vertical worm? burrows that contain intercalated lenses of oolite and shale.

Field observations at Old Wirrealpa Spring indicate, that a buff weathering and relatively soft laminated limestone/dolomite unit with sporadically occurring lenses of quartzite towards the top, is probably this unit. Previous workers have also considered this unit to be the overlying Woodendinna Dolomite or the underlying Wonoka/Pound Quartzite of the Wilpena Group.

It is conformably overlain by the Willkawillina Limestone.

Wilkawillina Limestone

At Wirrealpa the Wilkawillina Limestone was subdivided by B. Daily into a number of sub-units designed to reflect the facies of deposition.(Curtis 1989 b)

It (broard definition) commonly forms the base of the Cambrian succession and lies disconformably upon the Upper Proterozoic Pound Quartzite or abuts the Wirrealpa Diapiric Dome.

It is typically a light to dark grey, massive, bedded, and biostromal archaeocyathid or stromatolite mottled limestone which may dark to creamy brown due to dolomitisation.

Conglomeratic units intersected in drill holes and mapped by the Geological Survey of S.A. and BHP along the western side of the diapir are either basal rubble/fanglomerate deposits or highly attritioned diapiric breccias. There appear to be two generations of conglomerate, a basal bouldery polymictic type with a very high proportion of greenstone, large megga-clasts of which occur in the overlying conglomeratic limestone

At Old Wirrealpa Spring an intra-formational meggabreccia incorporates large clasts of a conglomeratic limestone that is typical of the immediately underlying units. The angularity and the large size of some clasts suggests a talus type of origin.

The upper surface of the limestone is quite irregular with a typical palaeokarst morphology over which the Parara Limestone was draped. Discrete bodies of breccia within the limestone and at the contact have been inferred to be of karstic origin.

The stratigraphy of the limestone along the SW side of the Donkey Bore Ridge indicates that periodic marine regression took place during deposition.

Parara Limestone

The unit is described as a dark flaggy and silty limestone with interbedded shales

In the field it is readily distinguished from the conformably underlying Wilkawillina Limestone by its thin bedded pattern that imparts a fissility on weathering and the occurrence of thin (<1.0 m) silty calcarenite beds. The contact between the two units may be gradational over about 10 to 15 meters of section where conformable but quite sharp along the palaeokarst surface.

3.2 STRUCTURE

The Precambrian and Cambrian rocks of the Flinders Ranges were extensively folded and faulted during the Delamarian Orogeny.

At Wirrealpa the regional structure is dominated by the presence of a major tectonic dome ,the Wirrealpa Diapir. This body is of complex shape comprising a globular mass in the south with a prominent NNW striking (Donkey Bore) ridge

Field mapping demonstrates wrap around continuity of the Wirrealpa Limestone at the nose of the Donkey Bore Ridge in conformity with the Parara Limestone confirming its genesis as a tight anticlinal core, which is paralleled by more open folds to the north east.

Geological Survey mapping identifies major east west faulting of Proterozoic basement in the east, at Mt. Lyall, that trends toward the vicinity of Wirrealpa Springs and in the west similarly oriented faults in Wilkawillina Limestone at the NW extremity of the main diapiric mass. Mapping of the diapir by BHP demonstrates continuity of this regional structure which is left laterally offset by N-S en-eschelon faulting in the vicinity of (Old) Wirrealpa Spring

Field mapping ground truth does not diagnostically confirm many of the geological contacts mapped by BHP as fault structures. Indeed many such contacts involving Cambrian units are consistent with palaeosurface features.

4 EXPLORATION SUMMARY

Mississippi Valley Type (MVT) lead zinc deposits occur in carbonate rock sequences where significant focused permeability paths and trap sites were present along basin margins or intra-basin ridges during basin de-watering.

Field work was predicated on the review work and regional assessment (Curtis 1989 a & b) and sought to examine the distribution of known mineralisation in respect of the MVT model and local geology.(see tables 1 & 2)

The work was carried out exclusively along the south west side of the Donkey Bore Ridge. Field inspections sought to identify and sample features that might relate to mineralisation.

Mapping was undertaken at variable precision, varying from detailed mapping at Old Wirrealpa Spring to rough field sketching further north. These areas are identified on Plate 1

Base drawings were compiled from 1;10,000 scaled colour airborne photographs and fitted enlargements of portions of the Wirrealpa 1:50,000 scale topographic sheet. Geological data was compiled from field observations and open file BHP company reports.

During the course of compilation it was noted that many of the drill holes on BHP plans were plotted to full length in the horizontal position rather than projected to surface as has been done in this report.

TABLE No. 1 : DIAMOND DRILLING > 1.0 % Pb CUMULATED INTERSECTIONS

PROSPECT	DRILL HOLE	CUMULATED INTERSECTION
Donkey Bore North	WD 7	<
	WD 8	3.0m @ 1.3 %
	WD 13&14	<
	WD 15	1.0m @ 1.6 %
Donkey Bore South	N D	
Wirreapla Spring Nth.	WD 16&17	N S
	WD 18	9.0m @ 1.25%
	PDP 6&7	<
Wirrealpa Spring	WD 19	5.0m @ 1.9 %
	PDP 1-4	<
	DDB 1	<
Wirrealpa Spring Sth.	N D	
Wirrealpa Lead Mine	WD 9-12	<
	DWM 1&2	<

****

TABLE No. 2 : ROCK CHIP SAMPLING > 1.0 % Pb CUMULATED INTERVALS

PROSPECT	TRAVERSE	INTERVAL	DRILLING
Donkey Bore North	19	2.0m @ 1.2 %	N D
	18	<	WD 8
Donkey Bore South	3	8.0m @ 3.7 %	N D
	1,2&4	<	N D
Wirreapla Spring Nth.	9	5.0m @ 3.15%	PDP 7
	5-8,10-12, & 20-21	<	WD 16 & 17
	22	<	WD 18
Wirrealpa Spring	13	11.0m @ 4.8 %	N D
	14	17.0m @ 13.8 %	N D
	15	11.0m @ 6.3 %	?WD 19
Wirrealpa Spring Sth.	16	8.0m @ 8.0 %	N D
	17	12.0m @ 3.6 %	N D
Wirrealpa Lead Mine	N S		

N D = not drilled   N S = not sampled   < = < 1.0 % Pb

4.1 OLD WIRREALPA SPRING

The region to the south west of Old Wirrealpa Hut was grid mapped along a 600 m strike ridge of Wilkawillina Limestone. Compass and hipchain lines were placed at 50 m intervals with 25 m spaced reference points.

A map was generated from the field grid and topographic contours over laid from an enlargement of the published Wirrealpa 1:50,000 sheet. (See plate 2)

STRATIGRAPHY

The work clearly disclosed the presence of contorted carbonate rocks of probable Proterozoic age in the east which are overlain disconformably on the west by the Cambrian Parachilna Formation (see sect 3.1). The actual contact is fully concealed beneath soil & scree.

The Parachilna Formation is conformably (locally) overlain by the Wilkawillina Limestone (actual contact also concealed).

The basal Wilkawillina Limestone comprises a greyish to brown weathering unit with dark brown weathering conglomeratic horizons, lenses and pebble stringers. In the north this unit has experienced local slump type deformation and appears to be overlain disconformably by a massive grey limestone with local shadowy outlines of intraclasts. This latter unit passes upwards into a megabreccia that has large (> 1 cu. m.) and small intraclasts of the brown conglomeratic limestone similar to the basal interbeds.

The distinctive megabreccia thins to the south. It is overlain by a massive grey limestone bed in the north that becomes brown weathering to the south.

The palaeokarstic contact with the overlying Parara Limestone is readily recognised due to lithological contrast, drape structures in the Parara Limestone and zoned carbonate fracture cementation in the top of the Wilkawillina Limestone. Pink to orangy-pink hematitic algal rinds and/or staining is sometimes observed just below the contact.

PALAEOKARST DEPOSITS

Two palaeokarst features were recognised. At the southern end of the massive limestone ridge, a 40 x 35 m region of honey-yellow, banded and silicified travertine rubble in a yellow clay matrix, considered to be diagnostic of a palaeo-cavern, was mapped.

An ovate depression in the centre of the ridge axis 150 m south west of the hut is also considered to be a palaeokarst. Measuring 100 x 75 m in extent, it has a steep rim wall with local ironstone/manganese deposits at both southern and northern ends. While there is no travertinous rubble, the amphitheatre shape, discordant manganiferous rim bodies and the ferrugenous/yellow clay and scree deposits are very suggestive of a palaeocavern. The feature is quite prominent on airborne photographs due to the vegetation being almost solely grasses.

The field relations of a small travertine occurrence to the immediate south of the ridge are obscure.

GEOCHEMISTRY

The northern palaeocavern was soil sampled and a rock chip traverse was run across the Wilkawillina Limestone to duplicate BHP traverses 13,14, & 15.(See table 2, appendix 1 & plate 2).

The rock chip values obtained by BHP were not substantiated. The lead and zinc values being generally less than 100 ppm. with the strongest response associated with the basal conglomeratic unit.

However soils from the inferred palaeokarst depression were substantially anomalous by comparison. Both lead and zinc are sympathetically enriched towards the west of the feature, the maximum values being 940 and 340 ppm. respectively.

Sampling of the gossans reversed the dominance of lead over zinc seen for the soils. Of particular relevance is the observation that when a gravelly channel sample (WR89/167) from the bank of a drainage rill is compared with the nearby soil samples (WR89/148-9) the zinc level is much higher indicating that the surface soils may be significantly zinc depleted. Thus where thick regolith is present, samples collected from depths of 0.3 to 0.5 m may be more geochemically significant.

DRILLING

The relationship of nearby drill holes WD-19 & PDP's 4 & 5 and the inferred palaeokarst was examined by constructing cross sections (see plate 4).

It is quite apparent that the mineralisation sampled in WD-19 is unlikely to be directly related to the inferred palaeokarst. The sampled zone is probably typical of the yellow ochre clastic veining/staining seen in the upper most parts of the Wilkawillina Limestone (marked Fev on plate 2). The log of WD-19 records brecciation, calcrete fill, and pyrite, with oxidation toward the base in the 114.0 to 146.1 m interval. This zone, which may be a down dip expression of the inferred palaeokarst, was unsampled by BHP.

PDP 5 appears to be too short to have tested the inferred palaeokarst whereas PDP 4 may have, if there is any plunge of the feature to the south. Neither hole intersected significant mineralisation nor penetrated the full thickness of the Wilkawillina Limestone

Cross sections were also constructed for PDP's 2 & 3 and DDB-1. These reconstructions show that it is unlikely that PDP's 2 & 3 would have tested the full thickness of the Wilkawillina Limestone. The log of hole DDB-1 does not record the travertine deposit but the length of the precollar implies that a substantial zone of rubbly material was present from surface down to 20 m. The sudden thickening of the weathering profile at this locality is out of character suggesting a fundamental localised change in the nature of the geology of the Parara/Wilkawillina contact.

The log infers that the full 20 m precollar was weathered Parara Limestone. However, surface mapping suggests that the Parara probably accounts for only the upper 7 m and the remainder of the interval, vuggy, weathered, and manganese stained limestone material, is possibly the northern margin of the karst fill deposit. Clay filled vugs recorded from the first cores below the precollar may be related.

The log also records a clayey breccia zone between 70 & 80 m. The position of this breccia is such that if it were the subsurface expression of the traverine deposit then the palaeokarst was originally a steeply plunging funnel or pipe that is now nearly vertical. In the absence of direct geological evidence the cross section has been drawn suggesting that the two features are independent.

The stratigraphic position of the gossan upon which the shaft was sunk is similar to that of the lower breccia and therefore a structural origin for the lower breccia cannot be wholly discounted since there appears to be no directly related palaeokarstic feature at surface.

The collar of PDP-1 could not be field verified and since drill hole plots on BHP drawings were found to be incompatible with field observations a satisfactory overlay is not possible and it is not shown on plate 1.

4.2 WD 18 AREA

The collar of WD-18 diamond drill hole was located and a hipchain and compass profile run for 450 m to the north east. Investigation of the stratigraphy in the vicinity revealed aspects not evident to the south of Spring Creek.

The area was examined by strip mapping along the approximate section line of WD-18 and supplemented by rough photo mapping. All the data was sketched on to an enlargement of the 1:50,000 scale published Wirrealpa sheet. (See plate 3)

STRATIGRAPHY

The Parara Limestone is of typical appearance. The underlying Wilkawillina Limestone is typically grey and massive where it is unaltered.

The Parara/Wilkawillina palaeosurface is quite irregular and seems to be characterised by large detached blocks of Wilkawillina Limestone around which the Parara Limestone has been deposited. Where significantly discordant bedding relations are observable such blocks are readily identified. One such block has mapped dimensions of about 60 x 20 m (marked on plate 3 by the code Ehwgr) is probably a fallen coastal stack.

The Meggabreccia unit of the Wilkawillina Limestone (mapped to the south) appears to have pinched out at WD-18. However the presence of large laminated carbonate cemented fractures in the uppermost conglomeratic horizon may correlate with the time break associated with the derivation of the breccia rubble.

The basal intervals of the Wilkawillina Limestone are a confusing array of outcrops where massive light grey limestone envelopes large and small, sometimes partially fragmented dark brown blocks (up to at least 5 m in diameter) of polymictic bouldery conglomerate. The conglomerate includes boulders of up to 50 cm. in diameter and contains a high proportion of greenstone.

The brown conglomeratic limestone seems to be a gradational upward development of this basal zone, probably reflecting increasing degradation of the polymictic conglomerate.

The rounded nature of the greenstone clasts is probably a function exfoliate palaeoweathering and not stream transport since other clasts are quite angular. A talus origin for the conglomerate blocks is considered probable, perhaps a shore line cliff environment. Steep slopes on the north east side of these exposures comprise a scree of greenstone rubble that has been mapped (Ehc on plate 1) as basal conglomerate to the Wilkawillina Limestone, consistent with a local source in the adjacent diapir.

Previous workers have apparently not distinguished between conglomeratic limestone in the base of the Wilkawillina Limestone and the underlying polymictic conglomerate unit. The relationship of the Parachilna Formation to the polymictic conglomerate was not investigated and hence remains unclear. However, since the relationships do indicate that a disconformity probably exists at the top of the polymictic conglomerate, it might be a variant of the Parachilna Formation.

ALTERATION

A most obvious feature is a 50 m thick zone of moderately strong pink hematitic alteration within the Wirrealpa Limestone which occurs 10 to 15 m below the Parara contact and has a strike extent of about 300 m.

The origin of the hematisation is unclear but there is a strong possibility that it is a localised palaeo-weathering feature associated with the Parara/Wilkawillina disconformity.

PALAEOKARST

About half way along the hematitic zone the otherwise bold rocky terrain is contrasted by a small grassy scree plain about 60 m in diameter. The scree is mixed with yellow clayey soil, and consists solely of limestone fragments a few cms. in diameter. While there is no evidence of travertine or iron/manganese oxide rubble, the morphology and stratigraphic position is strongly suggestive that this may be the surface expression of the mineralised palaeocavern intersected by WD-18. (see table 1)

GEOCHEMISTRY

To assess the mineralisation potential a soil sample traverse with a 10 m spacing was placed over the inferred palaeokarst expression and a suite of rock chip samples were taken across the hematised zone 110 m to the NW .

The rock chip profile returned background levels of lead and zinc of less than 40 and 20 ppm. whereas the soil samples from the inferred palaeokarst returned anomalous lead and zinc values of up to 300 and 200 ppm respectively.(See Appendix 2)

Since the near tenfold enrichment is most unlikely to be a weathering phenomenon a primary concentration is probable. These anomalous results are similar to the levels recorded from the soils at nearby Old Wirrealpa Spring and also correlate with a similar physiographic and vegetational anomaly.

DRILLING

A composite cross section was constructed from the field map and the log of WD-18. Consideration of the hematitic alteration zone and the lithological data suggests that the Parara/Wilkawillina contact was incorrectly assigned by previous workers to the top of the conglomeratic unit at 210 m instead of the top of the hematitic alteration zone at 131 m.

This stratigraphic reassignment is consistent with the observed dips and out crop distribution.(See plate 5) It also correlates the surface palaeokarst feature and the palaeocavern intersected by WD-18 with the conglomeratic unit of the Wilkawillina Limestone indicating a similar stratigraphic control to Old Wirrealpa Spring.

Since the palaeocavern is located 200 m to the west of and at 190 m RL , 225 m below the inferred palaeokarst feature at about 415 m RL , a single pipe like cavern plunging down the dip at 48 degrees for 300 m is a valid interpretation.

Comparison of the geochemistry from WD-18 with the surface data demonstrates similar metal levels in the host limestone (rock chips V's 200-215 m) and the palaeokarst (soils V's cavern geochmical halo : 217-227 m). (See appendix 4) The geochemical data therefore supports the proposed interpretation.

Since sub-economic mineralisation was intersected by WD-18 within the palaeocavern, localised areas of low relief, almost devoid of vegetation within tracts of outcropping limestones should be regarded as potentially mineralised palaeokarsts.

4.3 BHP GEOCHEMICAL TRAVERSE 3

BHP rock chip traverse 3 was located by measuring south easterly along the outcrop of the Wikawillina Limestone from the margin of Donkey Bore Plain.

Nearby a similar 35 m thick interval was mapped and sampled by rock chipping over 5 m intervals. (See figure 2 & plate 1)

GEOLOGY

At this location the Wilkawillina and Parara Limestones are of typical appearance. The morphology of the Parara/Wilkawillina palaeosurface is quite irregular with well developed drape structures in the Parara Limestone near the contact.

BHP traverse 3 is somewhat diagonal to strike due to the morphology of the massive outcrop of uniform grey limestone. Vector components in both horizontal and vertical directions affect the true thickness representation of the profile (probably less than 20 m). Examination of the locality also reveals that the full thickness of the Wilkawillina Limestone was untested.

A set of black veins approximately 1 cm. thick that occur in the upper-most portion of the outcrop have been vigorously sampled in the past and give a strong yellow precipitate with KI solution after HNO_3 acid attack. Fresh galena was obtained from previously broken rock confirming the results of the BHP sampling.

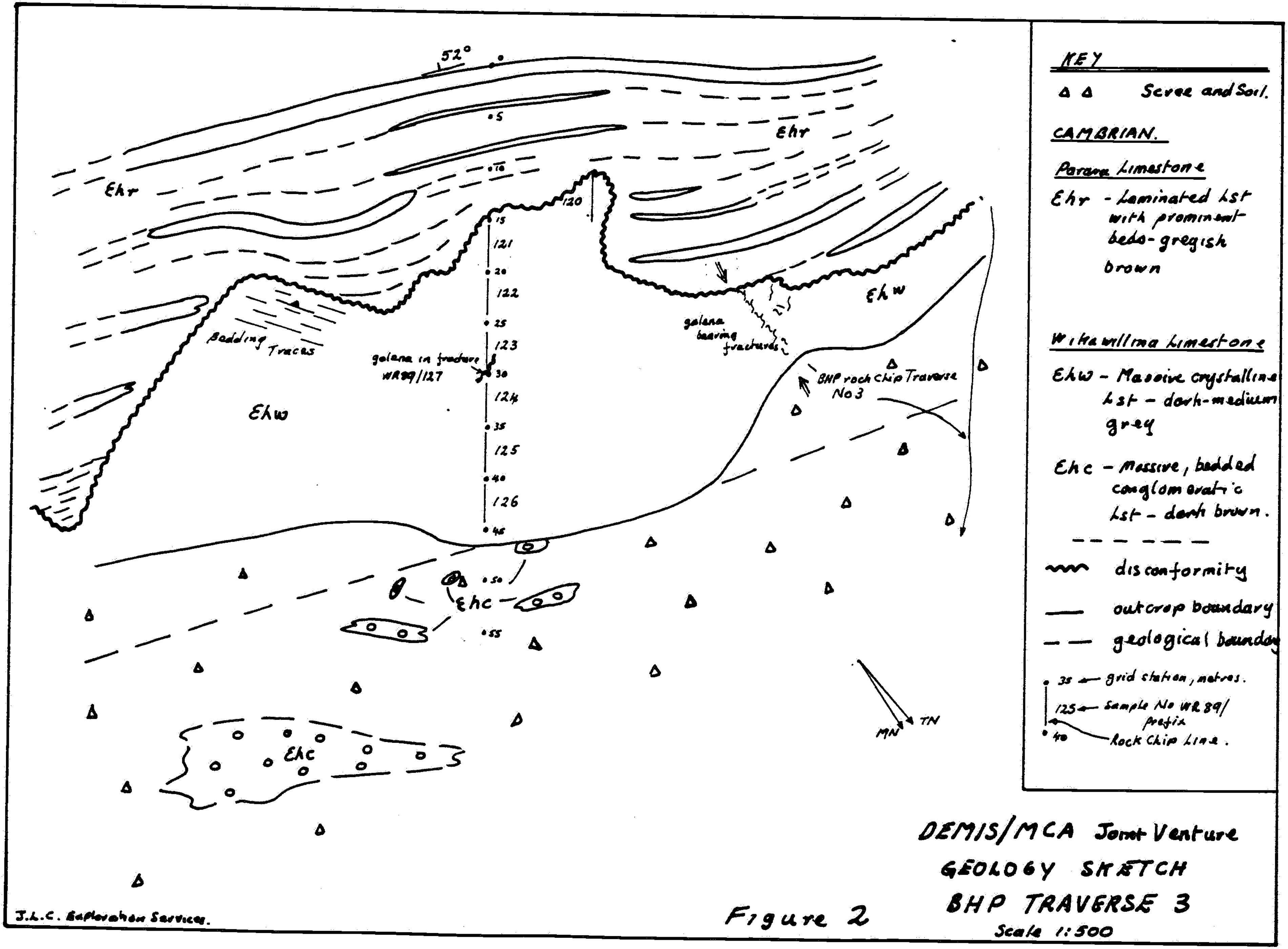


Figure 2

DEMIS/MCA Joint Venture
GEOLOGY SKETCH
BHP TRAVERSE 3
Scale 1:500

A parallel traverse, about 50 m to south east, was sampled and mapped over a more uniform terrain where a full section from the Parara/Wilkawillina contact to the top of the conglomeratic limestone is exposed.

Midway along the new traverse, fresh galena was discovered in a narrow joint which cut the sampling profile at an acute angle. This observation highlights the risk of sampling bias due to the limitation that chippings of massive exposures are frequently derived from fractures sub-parallel to the traverse.

The style of mineralisation indicates porosity was restricted to near vertical fractures of post diagenetic age in the Wilkawillina Limestone.

GEOCHEMISTRY

The rock chip profile returned strongly anomalous lead and weakly anomalous zinc values. The strongest values were associated with the visible sulphide veining but lower than those recorded from the BHP traverse.(See table 2, & Appendix 3) One sample was apparently depleted in zinc and slightly enriched with copper.

The metal values are significantly stronger than those recorded from similar limestone lithologies at Old Wirrealpa Spring and WD-18 indicating a regionally high geochemical back-ground may be present. Additional sampling of the overlying Parara and underlying conglomeratic unit may be of exploration interest.

4.4 DONKEY BORE PLAIN - SOUTH

At Donkey Bore Plain, field inspection identified a persistent NW trend of ferrugenous float. At the south eastern end of the plain a number of geological features of potential economic significance were recognised, mapped, and systematically sampled. (See figure 3 & plate 1)

GEOLOGY

A prominent NW trending outcrop of massive grey Wilkawillina Limestone terminates abruptly at the southeastern extremity of Donkey Bore Plain. The adjacent overlying Parara Limestone and underlying conglomeratic limestone continue to the NW for some distance before also merging into the plain.

The stratigraphic position of the Wilkawillina Limestone is devoid of outcrop, consisting entirely of scree derived from the Parara Limestone mixed with yellow clays. A lithological change in the Wilkawillina Limestone is inferred.

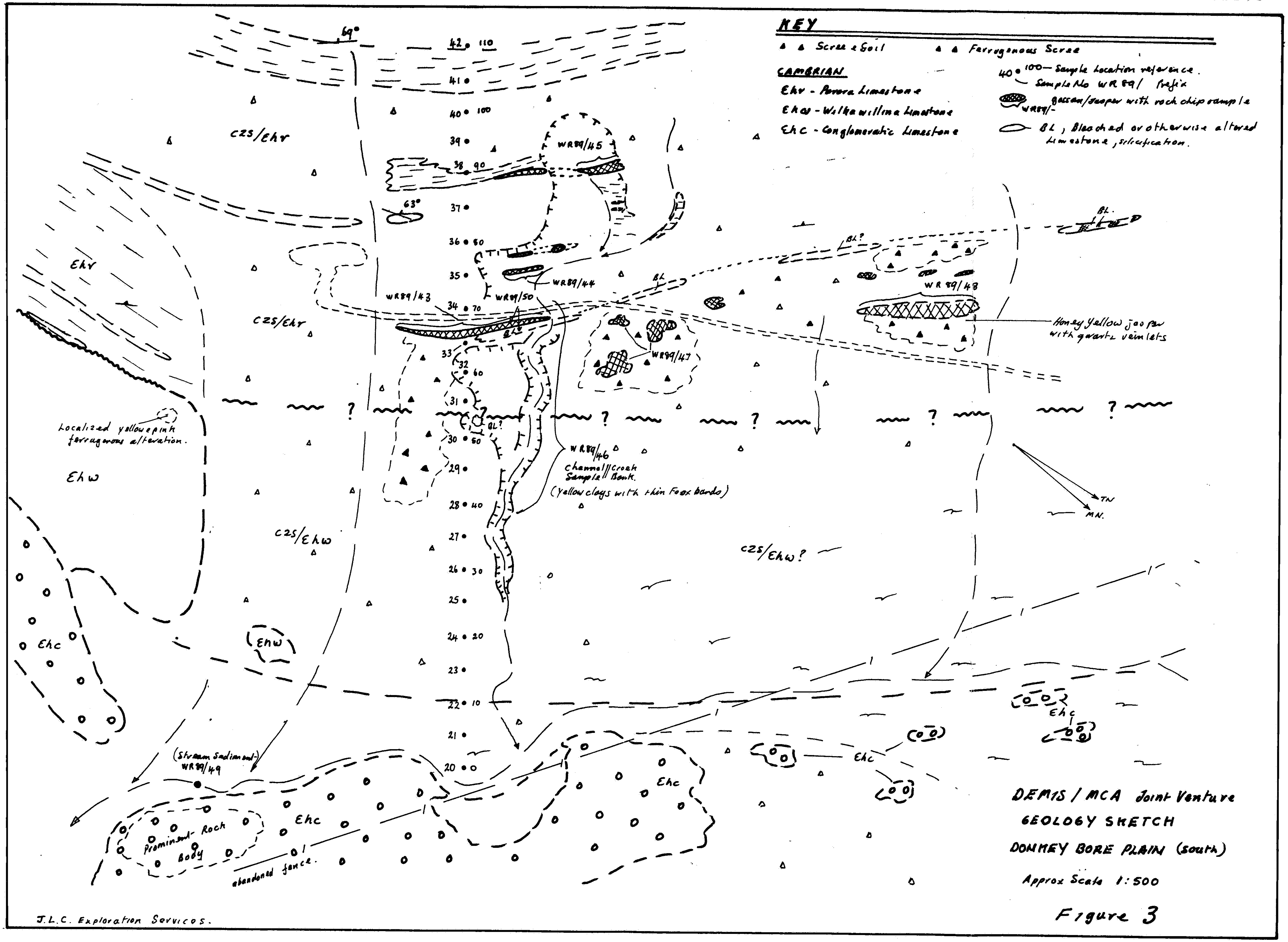

KEY
Scree & Soil
Ferruginous Scree
CAMBRIAN
Ɛhr - Parara Limestone
Ɛhw - Wilkawillina Limestone
Ɛhc - Conglomeratic Limestone
40 • 100 — Sample Location reference.
Sample No WR 89/ Prefix
gossan/jasper with rock chip sample WR89/-
BL, Bleached or otherwise altered Limestone, silicification.
CZS/Ɛhr
Ɛhr
Ɛhw
CZS/Ɛhw
CZS/Ɛhw?
Ɛhc
Ɛhw
WR89/45
WR89/44
WR89/43
WR89/50
WR89/47
WR 89/48
WR89/46
Channel/Creek Sample Bank.
(Yellow clays with thin Feox bands)
Honey Yellow jasper with quartz veinlets
Localized yellow pink ferruginous alteration.
(Stream Sediment) WR89/49
Prominent Rock Body
abandoned fence.
TN
MN.
DEMIS / MCA Joint Venture
GEOLOGY SKETCH
DONNEY BORE PLAIN (south)
Approx Scale 1:500
J.L.C. Exploration Services.

Figure 3

Within the basal 30 m of the Parara Limestone bedding concordant gossanous bodies, with dimensions of up to 0.5 x 20 m, are present. Their usual surface expression is an area of scattered rubbly of black to dark orange-brown limonitic-geothitic material. Young drainage scours have exposed thin root zones of massive red/orange-brown gossan. The gossans are of spongy appearance but have no recognisable boxwork patterns.

The presence of sheeted areas of ironstone float along the same trend to the north west suggest that similar, though concealed bodies may be present in the shallow sub-surface.

ALTERATION

Adjacent to the most prominent body, the Parara Limestone is bleached white and silicified with a spotty black mottling such as might be expected as a result of acid attack. A primary sulphide origin for the gossans is therefore inferred.

The sympathetic occurrence of the gossans corresponding to the 'disappearance' of the Wilkawillina Limestone suggests that the alteration associated with the gossans may have affected the Limestone. Given the different physical characteristics of the Parara and Wilkawillina Limestones, and the relatively small mass of iron oxides, it is unlikely that the acids sourced from the gossans were sufficient to account for the missing Wilkawillina outcrop.

The alteration causing the negative expression of the Wilkawillina might therefore be palaeokarstic and/or due to acids generated by oxidation of MVT mineralisation.

GEOCHEMISTRY

To test for MVT mineralisation a programme of - 20 # soil samples at 5 m spacings were run across the gossanous zone , a channel sample from the bank of the scour channel, a drainage sample, and rock chipping of prominent ironstone/gossan areas/bodies was undertaken.

The analytical results indicated that a 10 fold lead and 5 fold zinc soil anomaly was focused in the uppermost 30 m of the 'Wilkawillina Limestone'. Sporadic high zinc values also occur in the basal Parara Limestone. Since the channel sample generally reflects the main anomalous zone which it straddles and was collected 0.3 to 0.4 m below the surface the metal enrichment in the soil samples is not due to superficial physical down slope dispersion. (See appendix 3)

Rock chips from the gossans returned up to 9700 ppm. Zn with highly variable lead. The gossans are clearly zinc rich with the zinc rich soils possibly representing a primary halo.

The stream sediment sample returned a very strong geochemical response compared to the soils given the dilution by material from beyond the immediate vicinity. This lone sample could be construed to indicate that a stronger metal source still lies undetected nearby. Given the abundance of clay in the vicinity it seems unlikely that the sample had a disproportionate gossan content in the fine fraction.

The strong metal enrichment at this locality warrants follow-up.

4.5 DONKEY BORE PLAIN

In the centre of Donkey Bore Plain about 500 m to the north west of the previously described locality is a region of extensive sheeted ferrugenous float with subcropping jaspers. To test these features soil and rock chip sampling was undertaken.

GEOLOGY

Of all stratigraphic units, only the extent of the Parara Limestone may be recognised by its' diagnostic subcrop pattern reliably.

Subcrops of the underlying Wilkawillina Limestone , conglomeratic limestone and possible Parachilna Formation are sparse. The weak exposures suggest that these units are about 20, 15 and 5 to 10 m wide respectively.(See figure 4 & plate 1)

The inferred Wilkawillina Limestone has been altered to a buff colour and is associated with minor honey yellow travertine. The conglomeratic limestone is similarly altered being recognisable solely by its lumpy texture. It would be easy to assume that the alteration was a weathering feature except that fresh massive banded dark grey crenulated (slumping?) limestone (Parachilna Formation?) also occurs nearby.

Within the limits of the Parara Limestone irregularly distributed black to yellow-brown, fine grained, and strike bound jaspery bodies are present. They are expressed as semi-continuous patches of massive material and strings of subcrop up to 20 m long.

They are clearly analogues of the gossans to the south east and the source of the float. The few exposed patches of limestone associated with them appear to have been affected by a blotchy bleaching type of alteration.

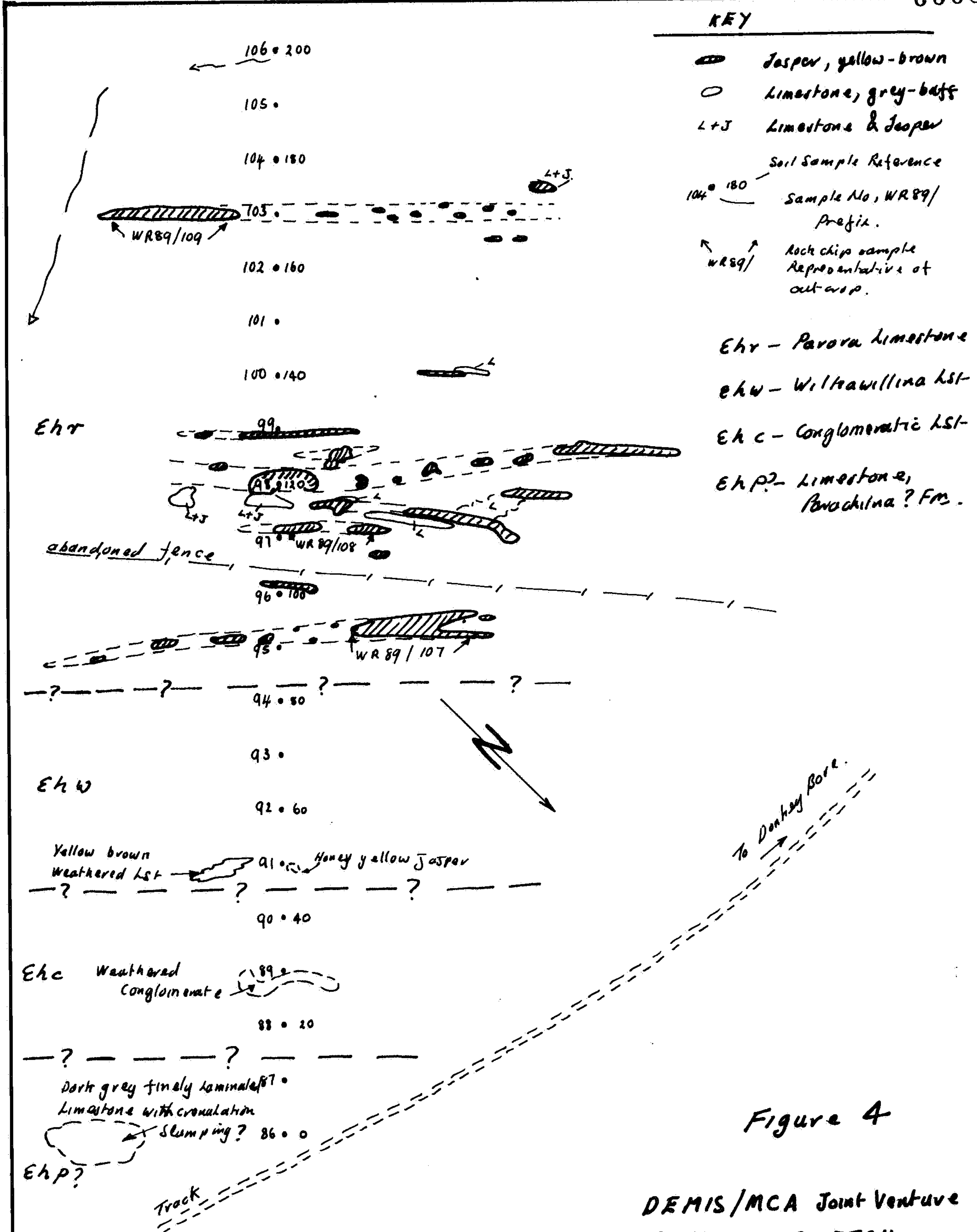


Figure 4

DEMIS/MCA Joint Venture
GEOLOGY SKETCH
DONKEY BORE PLAIN

Scale 1: 1000

GEOCHEMISTRY

The atypical surface expression of the units, the extent of the jasper bodies, the existence of the travertine and probable alteration of the host rocks, are suggestive of possible karst related MVT mineralisation. A profile of - 20 # soil samples at 10 m spacing was laid across the zone and randomly selected jaspers were rock chip sampled to test the proposition.

The soil samples showed that a 50 m wide zone of modest zinc enrichment with background lead occurs in the uppermost Wilkawillina Limestone and the basal Parara Limestone.

The three rock chip samples returned zinc values in excess of 1000 ppm. from the same zone. The metal concentration in the soils is therefore likely to be derived from the jaspers although the highest soils are located away from the main cluster of jaspers.

4.6 DONKEY BORE PLAIN - NORTH

About 500 m to the north west of the jasper occurrences the Wilkawillina Limestone and adjacent units are emergent from the Wirrealpa Creek flood plain. This locality was investigated because the geological situation has similarities with Donkey Bore Plain South. (See figure 5 & plate 1)

GEOLOGY

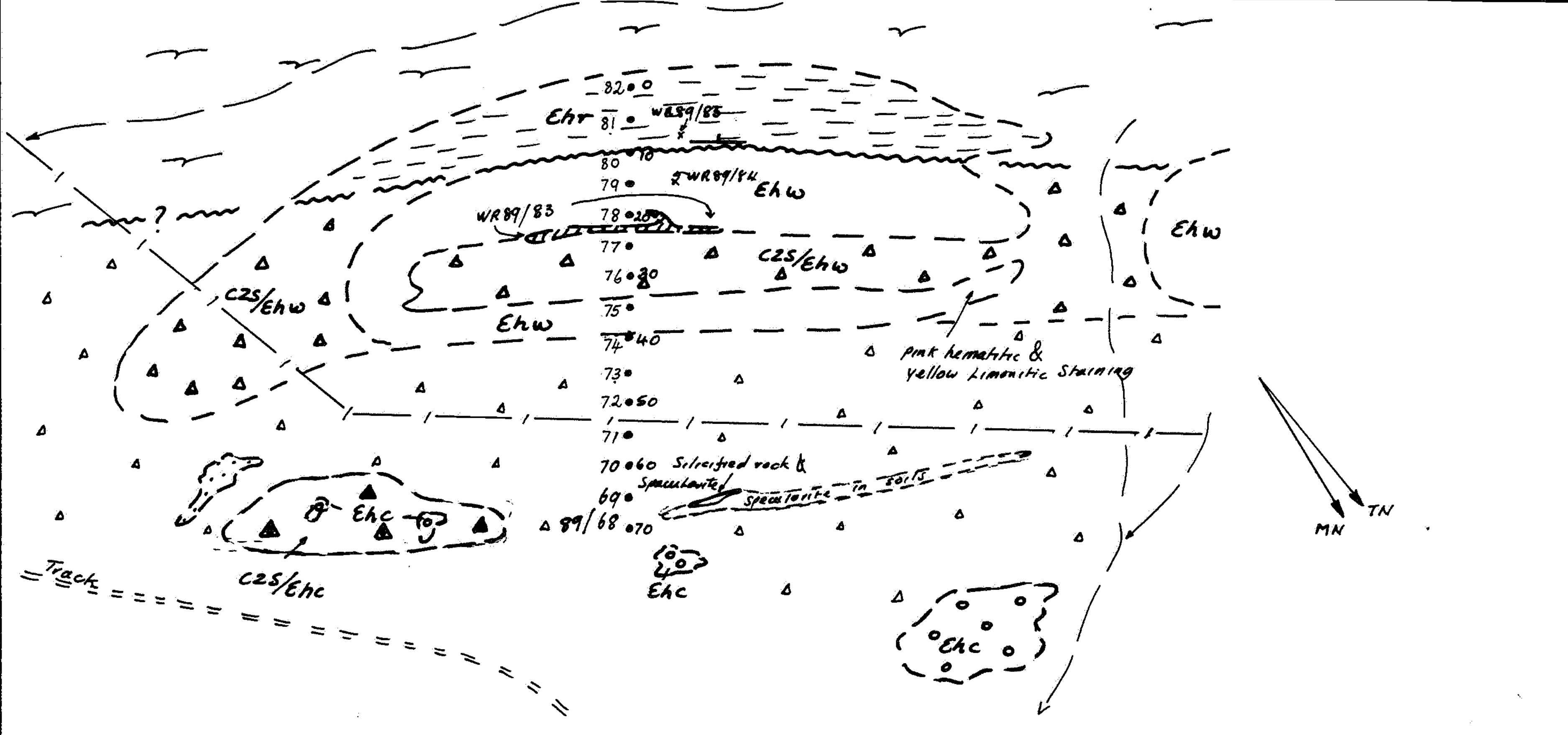
The uppermost 30 m of the Wilkawillina Limestone and basal few meters of the Parara Limestone are exposed on a low ridge. On the north east a gentle 30 m wide scree slope extends to poor subcrops of the conglomeratic limestone. Lithologies are typical.

A modest amount of black to brown ironstone in the scree appears to be derived from the top of the ridge where a thin and narrow band of gossanous jasper occurs. Minor yellow-brown staining was also observed on the NE corner of the ridge.

GEOCHEMISTRY

A profile of - 20 # soil samples spaced at 5 m intervals was laid out across the Wilkawillina Limestone and adjacent scree zone.

A modest zinc anomaly with a pronounced northeasterly down-slope dispersion tail is evident along with a very much weaker similar lead response.(See appendix 3) The coincidence of the peak values with the jaspery gossan and the distribution of



KEY

△ △	Scree/soil
~	Alluvium.
(gossan symbol)	Jaspery gossan

CAMBRIAN.

- Ehr — Parara Limestone - Laminated, Silty.
- Ehw — Wilhawillina Limestone
- ▲ C2S/Ehw — Subcropping Wilhawillina Limestone
- Ehc — Conglomeratic Limestone
- ▲ C2S/Ehc — Subcropping Conglomeratic Limestone.

Sample Sites:

76• 30 ← Location reference
↖ Soil Sample WR89/- Number Prefix

- ~~~ disconformity
- — — geological boundary
- ⟶ drainage.

J.L.C. Exploration Services.

DEMIS/MCA Joint Venture
GEOLOGY SKETCH
DONKEY BORE PLAIN (NTH)
Scale 1:1000
Figure 5

ferrugenous scree implies that the ironstone is the sole metal source. A rock chip sample of the jasper returned 5700 ppm. Zn supporting this opinion.

An attempt was made to locate previously identified mineralisation on BHP traverse 19, 180 m to the NW. (see table 2) However, while rock chip sampling marks were recognised in the locality mineralisation was not visually identified. Hematisation observed along the Parara/Wilkawillina contact was systematically spot sampled because of its similarity with the WD-18 area. Of the two samples, each representing a 4 m wide zone along 25 m of strike only the northern most which returned 2150, 250, & 370 ppm. of Zn, Pb, & Cu respectively, was significantly anomalous. These values being much less than those recorded by BHP.

4.7 WD 15 AREA

At WD-15 a possible palaeocavern similar to that inferred at Old Wirrealpa Spring was recognised and investigated.

GEOLOGY

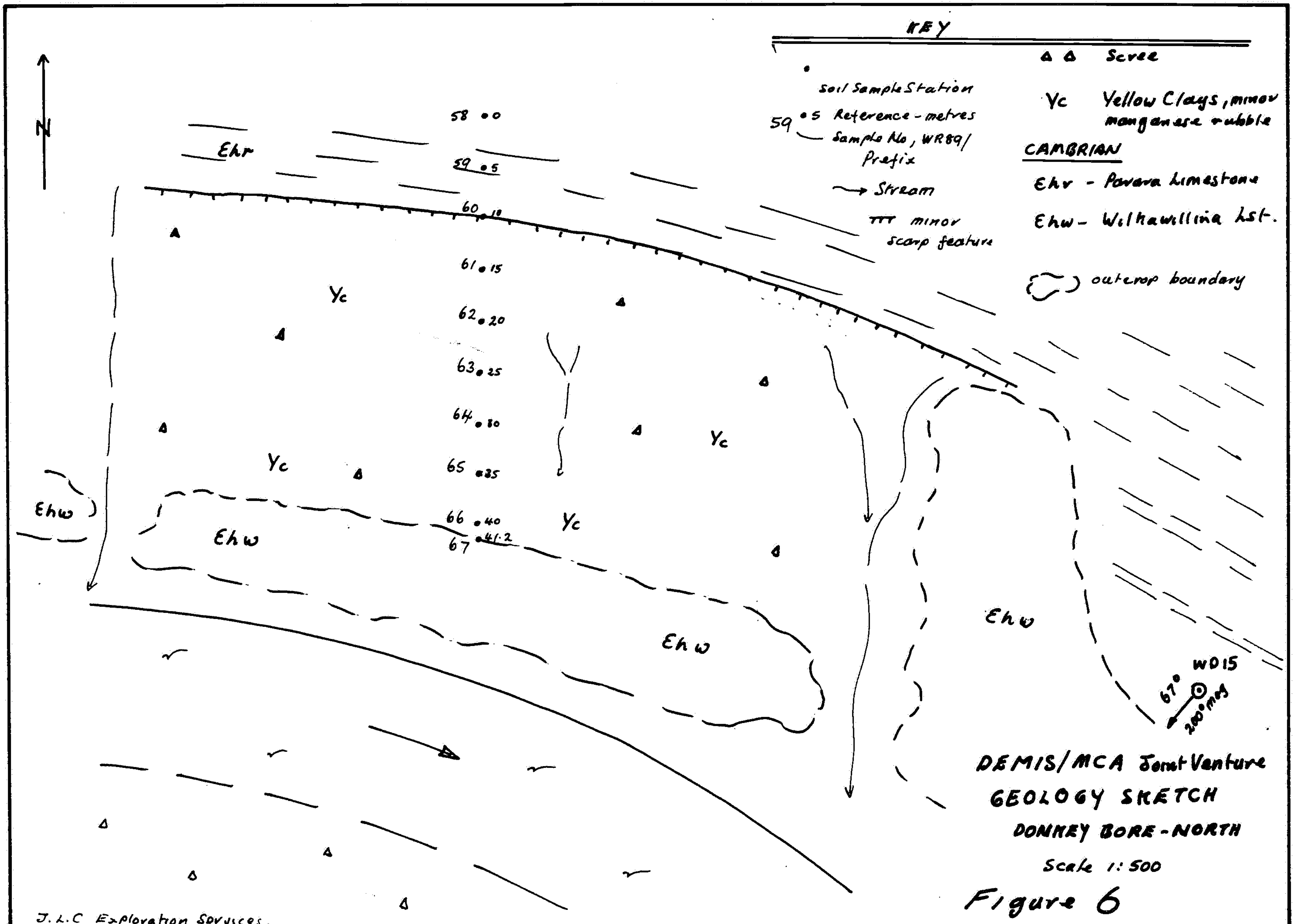
The Wilkawillina Limestone can be traced by semi-continuous outcrop to wrap around the nose of the Donkey Bore Anticline in general conformity with the overlying Parara Limestone. WD-15 is collared on the north east corner of the fold nose where a local embayment in the Parara/Wilkawillina disconformity is present. Dips are close to vertical. (See figure 6 & plate 1)

The WD-15 collar is located in Parara Limestone approximately 10 m above the underlying Wilkawillina Limestone. There is little surface expression of the mineralisation intersected just below the Parara/Wilkawillina contact in the drill hole.

A few meters west of the collar the Wilkawillina Limestone outcrop reduces abruptly from 40 to 10 m in width and the overlying Parara Limestone trends along strike undeviated as if the full thickness of Wilkawillina Limestone were present.

The resulting feature is a slightly depressed area, of about 50 x 30 m, which slopes gently towards the south from a sharp 1 m step down at the Parara Limestone outcrop along its northern flank. Yellow clays and Parara Limestone scree with trace amounts black ironstone float occupy this treeless zone.

Similarities between other inferred palaeocavern deposits and the mineralisation and oxidation features intersected in WD-15 suggests that it might also be a mineralised palaeocavern deposit.



DEMIS/MCA Joint Venture

GEOLOGY SKETCH

DONKEY BORE - NORTH

Scale 1: 500

Figure 6

GEOCHEMISTRY

To test the hypothesis a short 5 m spaced -20 # soil sampling profile was run across the zone.

The results identify a strong zinc anomaly which grows in strength down-slope, from the boundary of the Parara Limestone to the outcrop of the Wilkawillina Limestone. The full 30 m width of the topographic feature averages more than 500 ppm. zinc. A weak lead response follows the same pattern.(See appendix 3)

Examination of WD-15 assay results clearly indicates that strongly anomalous concentrations of zinc were intersected over the 10 to 40 m interval with the strongest mineralisation between 10 and 18 m. (See appendix 4)

It is clear that the soil anomaly corresponds to the mineralised zone in WD-15 and the zinc to lead abundance as recorded by the soil samples is reflecting the metal distribution of primary mineralisation.

There is thus a strong probability that the physiographic feature is a mineralised palaeocavern deposit similar to those inferred at Old Wirrealpa Spring and WD-18.

Given the strength of the soil anomaly, mineralisation in WD-15 may be the lateral traces of formerly stronger mineralisation in the inferred palaeocavern, now substantially leached by weathering.

4.8 WD 7 AREA

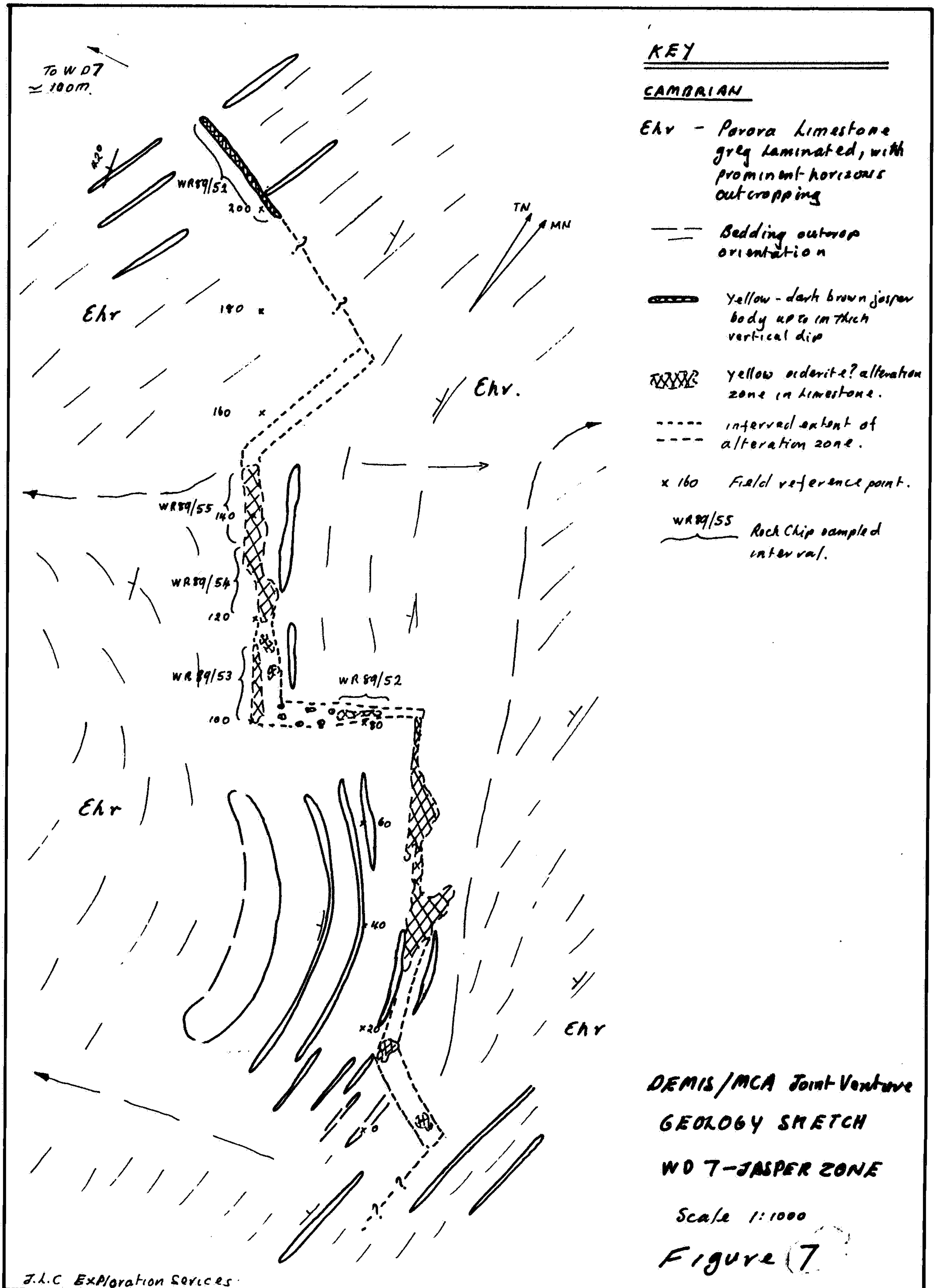
Whilst identifying the collar of WD-7 during field orientation, a siliceous jasper crosscutting Parara Limestone was encountered a short distance to the east near the top of the adjacent hill. (See plate 1 & figure 7)

From this vantage point, to the south east yellow-brown alteration zones appear to transgress the grey limestone beds . Closer inspection revealed that both bedding parallel and cross cutting alteration trends constitute a single zone which is probably linked in the sub-surface to the hilltop jasper body.

The alteration is expressed solely as a colour change suggesting that siderisation has taken place along a fracture path.

GEOCHEMISTRY

Since the alteration was clearly epigenetic and possibly genetically related to the features on the Donkey Bore Plain both it and the jasper were sampled by rock chipping.



DEMIS/MCA Joint Venture
GEOLOGY SKETCH
WD 7-JASPER ZONE
Scale 1:1000
Figure 7

The jasper is strongly enriched in zinc but all the other samples reported relatively low metal contents. (See appendix 3)

The high zinc confirms a genetic link between the epigenetic jasper and the zinc enrichment observed elsewhere in the Donkey Bore region.

4.9 OTHER LOCATIONS

During the course of field work a number of other sites were visited but no substantive work was undertaken save for observing the geological setting. (See pate 1)

WD-8 AREA

This drill hole collar was visited and found to be discharging a substantial flow of water. The ridge of outcropping Wilkawillina Limestone to the north east was visited but no signs of alteration or other evidence of mineralisation was noted.

Beyond the ridge in the core of the Donkey Bore Anticline a small window of complexly deformed phyllite was observed below the conglomeratic limestone.

WD-16/17 AREA

These drill collars were visited and the collars found to be 190 m apart with WD-16 about 63 m from the Wilkawillina Limestone outcrop and WD-17 collar in the alluvial plain of 'Spring Creek'.

The Wilkawillina limestone was typically grey and massive on this section and indistinct from elsewhere except for abundant masses of white carbonate apparently filling karstic voids possibly up to a metre in diameter. A scree including partially disintergrating carbonate rhombs is characteristic.

PDP-6/7 AREA

The collars of these holes were readily found . The Wilkawillina Limestone was the same as elsewhere in appearance. Mineralisation previously identified by BHP rock chip traverse 9 near PDP-7 was not successfully identified.

TRAVERSE 16/17 AREA

Mineralisation on the Parara/Wlikawillina contact was successfully identified at one location, possibly BHP traverse 17. Galena is visible on some fractures approximately parallel to the bedding direction over an area of about a square metre.

The contact was traced to the north for about 450 m without finding any further mineralisation. Study of the geology led to the conclusion that the Wilkawillina Limestone is probably thinner than recorded by previous workers and lies directly on the Parachilna Formation rather than fault bound Wilpena Group.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

* MVT mineralisation along the Donkey Bore Trend occurs in post diagenetic apertures within the Wilkawillina Limestone and basal Parara Limestone.

* Mineralisation is/occurs in minor joints and cross-fractures and palaeocavern deposits within the Wirrealpa Limestone, and bedding plane partings within the Parara Limestone.

* Generally mineralisation appears to be lead rich in the Old Wirrealpa Spring region and zinc rich in the Donkey Bore region but this aspect could be a fortuitous result of the sampling density.

* Mineralisation at surface is often quite subtly expressed and difficult to recognise.

* The disparities between BHP sampling and the current results cannot be readily explained at present.

* The greatest economic potential would appear to occur when a palaeocavern retained significant void space subsequent to Parara Limestone deposition.

* Massive sulphide deposition could take place within the palaeocavern or sag partings in its' roof.

* Future exploration should be directed at locating such geological situations which can be anticipated to present as weakly expressed depressions and/or areas of low relief due to attack of the host limestones by acid derived from the oxidation of mineralisation.

5.2 RECOMMENDATIONS

* Systematic sampling of all the potential palaeocavern fill deposits characterised by the described relief features with associated yellow clays ± ferrugenous/manganiferous material, and/or ± travertine/jasper should be undertaken.

* Exploration should be directed at locating potential palaeocavern deposits throughout the title.

* Systematic exploration of the Donkey Bore region is recommended.

* Systematic re-logging and sampling of previous BHP diamond drill holes should be undertaken

6 REFERENCES

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Broken Hill Proprietary Co. Ltd. 1979 - 82. Open file reports on E L Nos. 436/809 : Wirrealpa (E L No. 1138 : Mt. Frome) , S.A.D.M.E. envelope No. 3427, (unpub.)

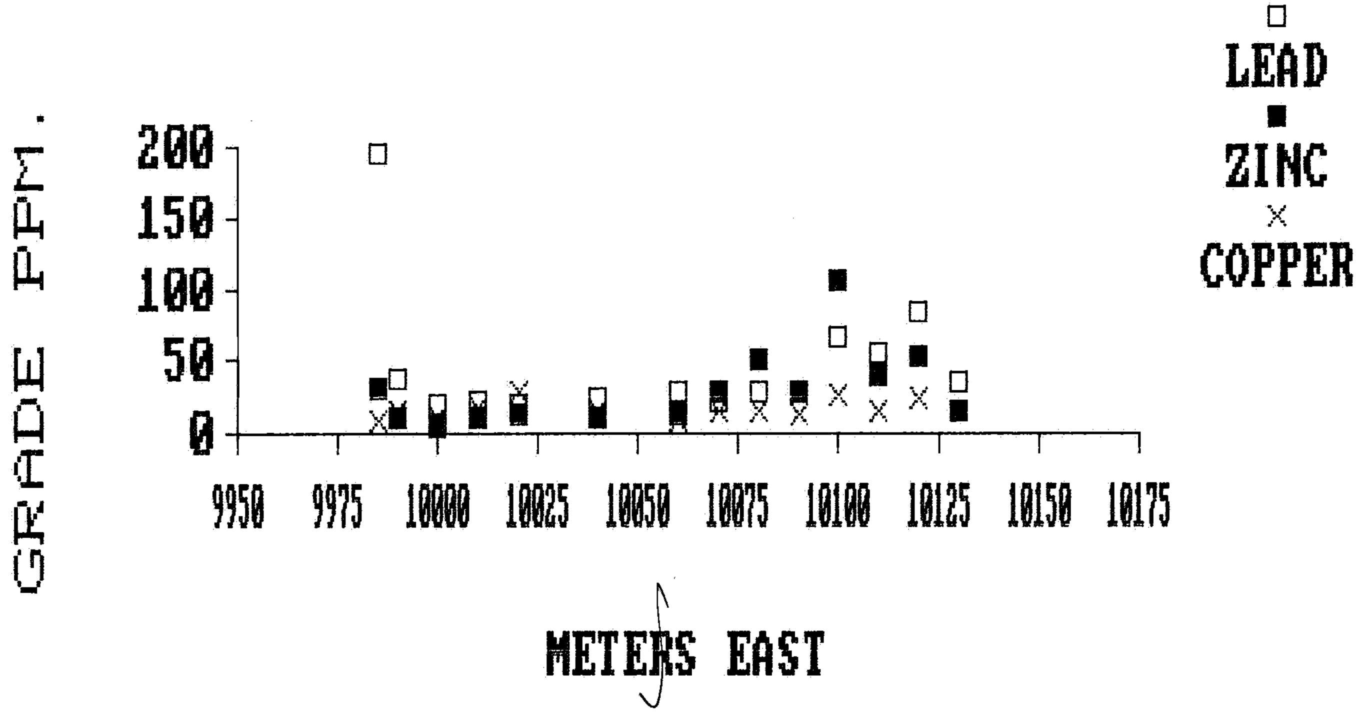
Curtis J. L. 1989 a. Wirrealpa Joint Venture, Exploration Licence 1515, Quarterly Exploration Report, Period Ended 13 December 1988.

Curtis J. L. 1989 b. Demis- MCA Joint Venture, Exploration Licences 1514 & 1515, The Regional Geological Setting of Cambrian MVT Mineralisation in South Australia.

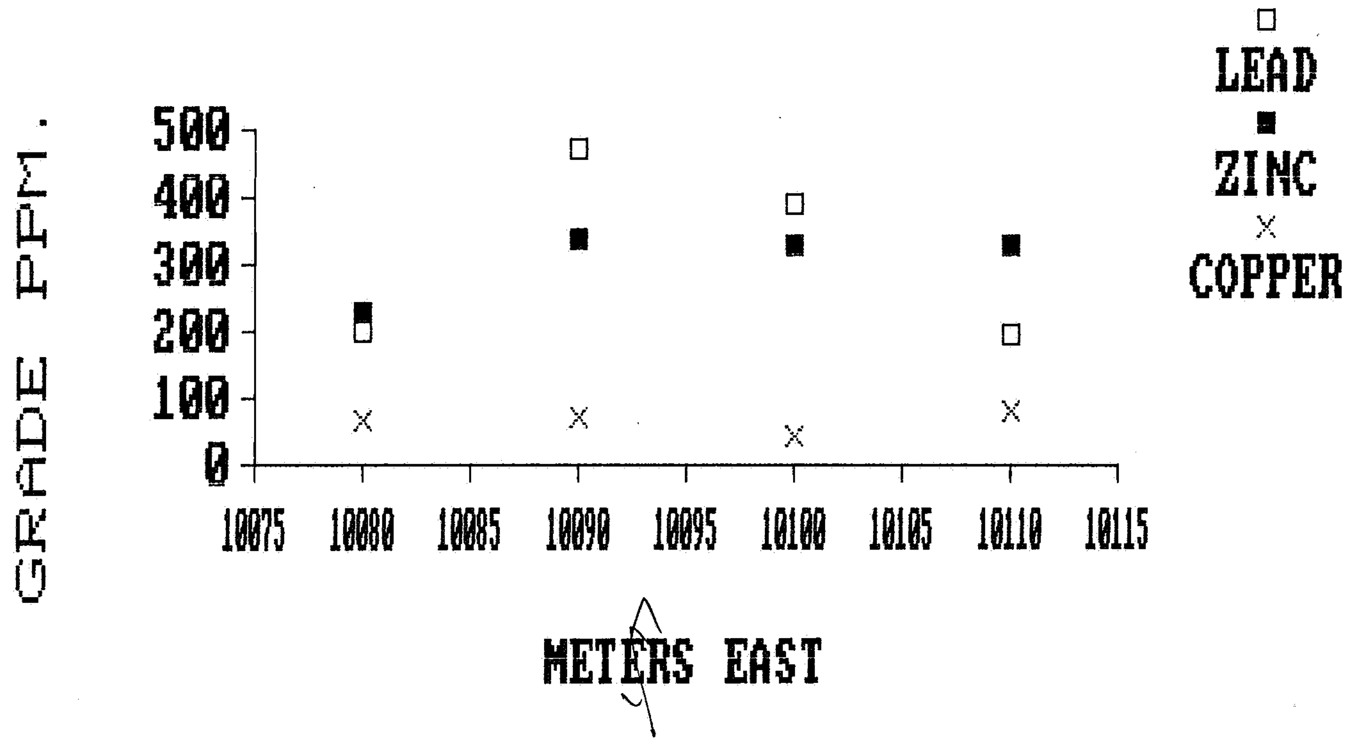
APPENDIX 1

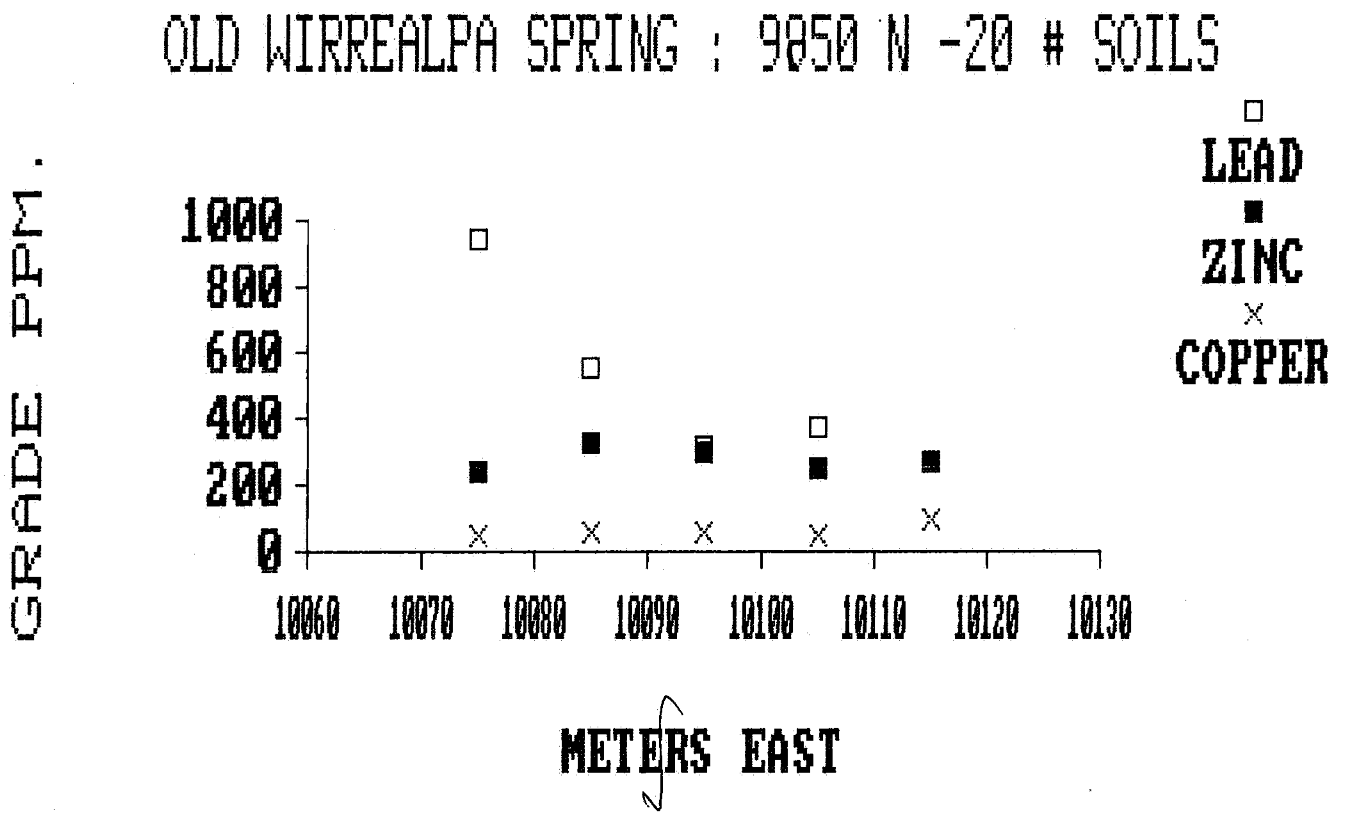
OLD WIRREALPA SPRING GEOCHEMISTRY

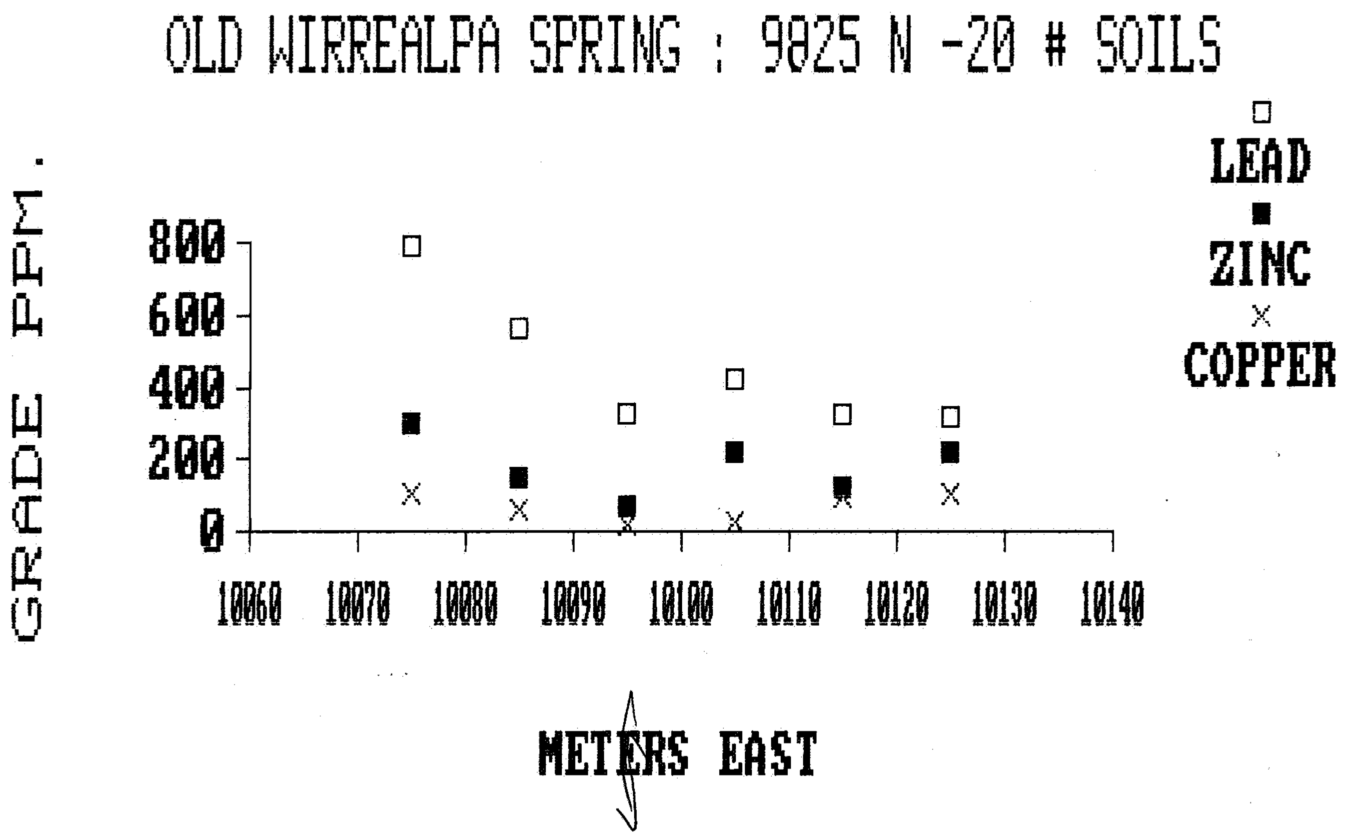
OLD WIRREALPA SPRING : 9850 N ROCK CHIP



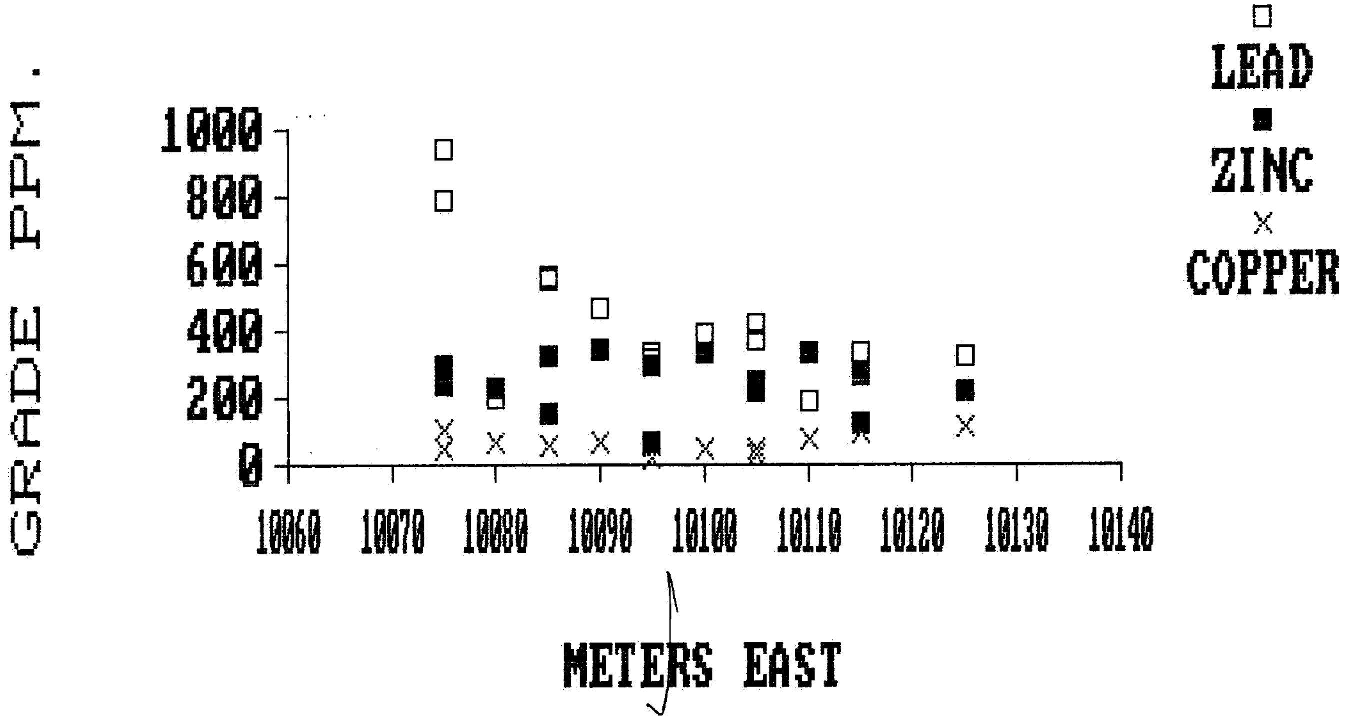
OLD WIRREALPA SPRING : 9875 N -20 # SOILS



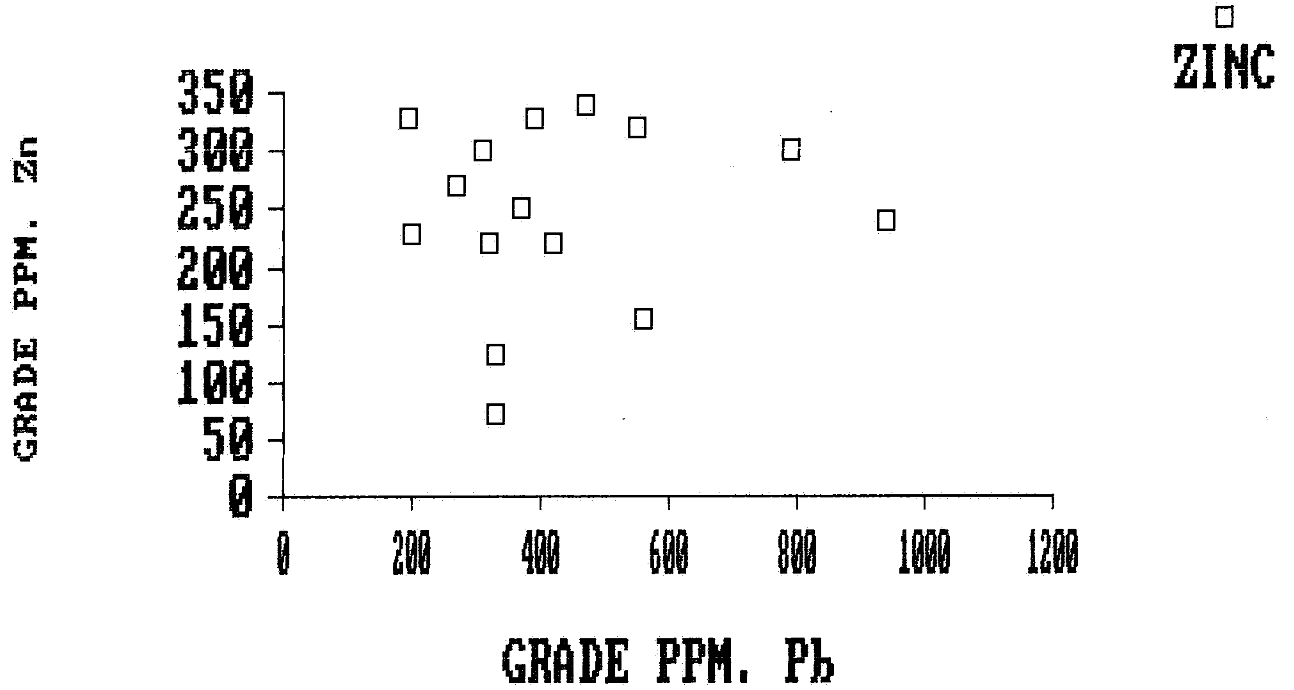

OLD WIRREALPA SPRING : 9850 N -20 # SOILS
GRADE PPM.
1000
800
600
400
200
0
10060
10070
10080
10090
10100
10110
10120
10130
METERS EAST
LEAD
ZINC
COPPER


OLD WIRREALPA SPRING : 9825 N -20 # SOILS
GRADE PPM.
800
600
400
200
0
10060
10070
10080
10090
10100
10110
10120
10130
10140
METERS EAST
LEAD
ZINC
COPPER

OLD WIRREALPA SPRING : COMB. -20 # SOILS



OLD WIRREALPA SPRING : Pb-Zn CORR.

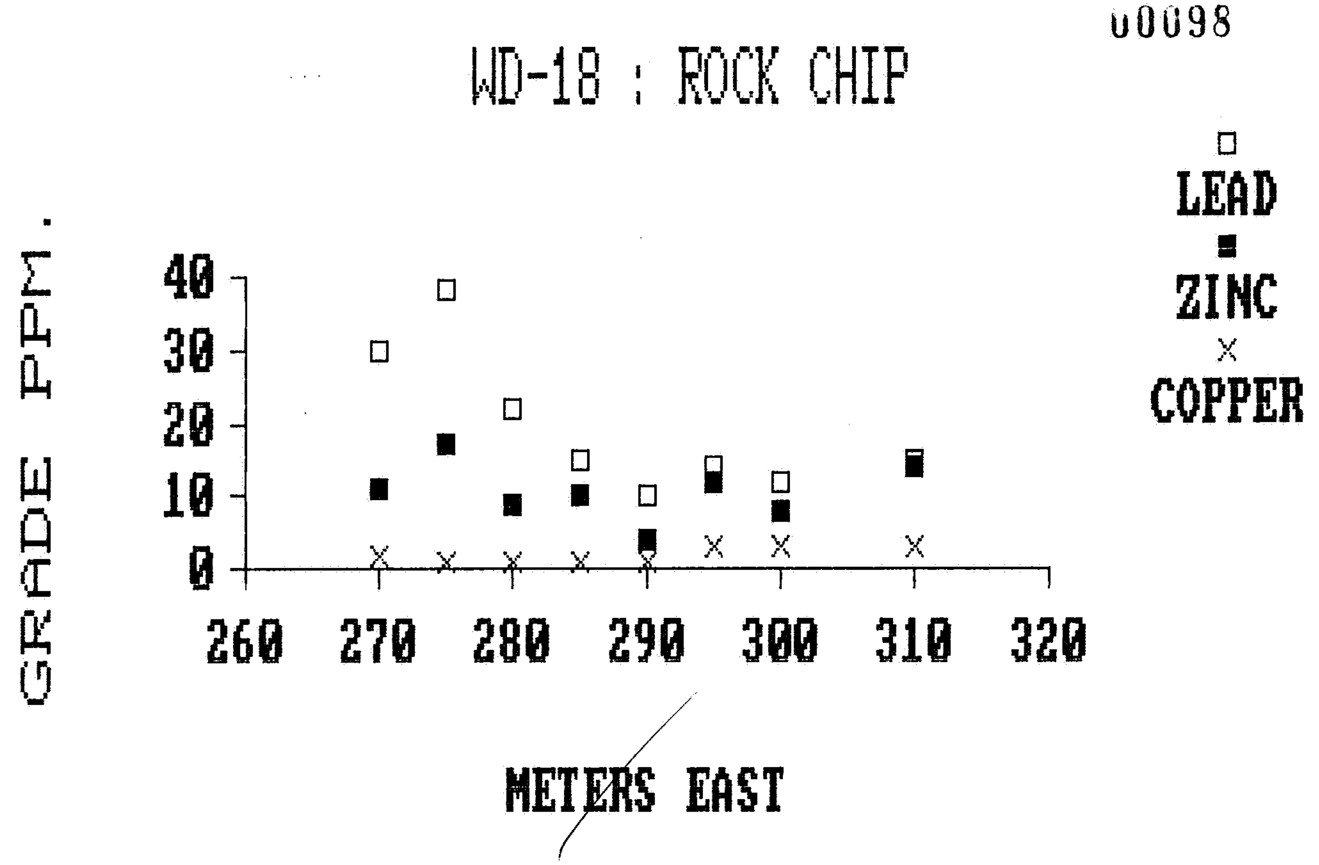


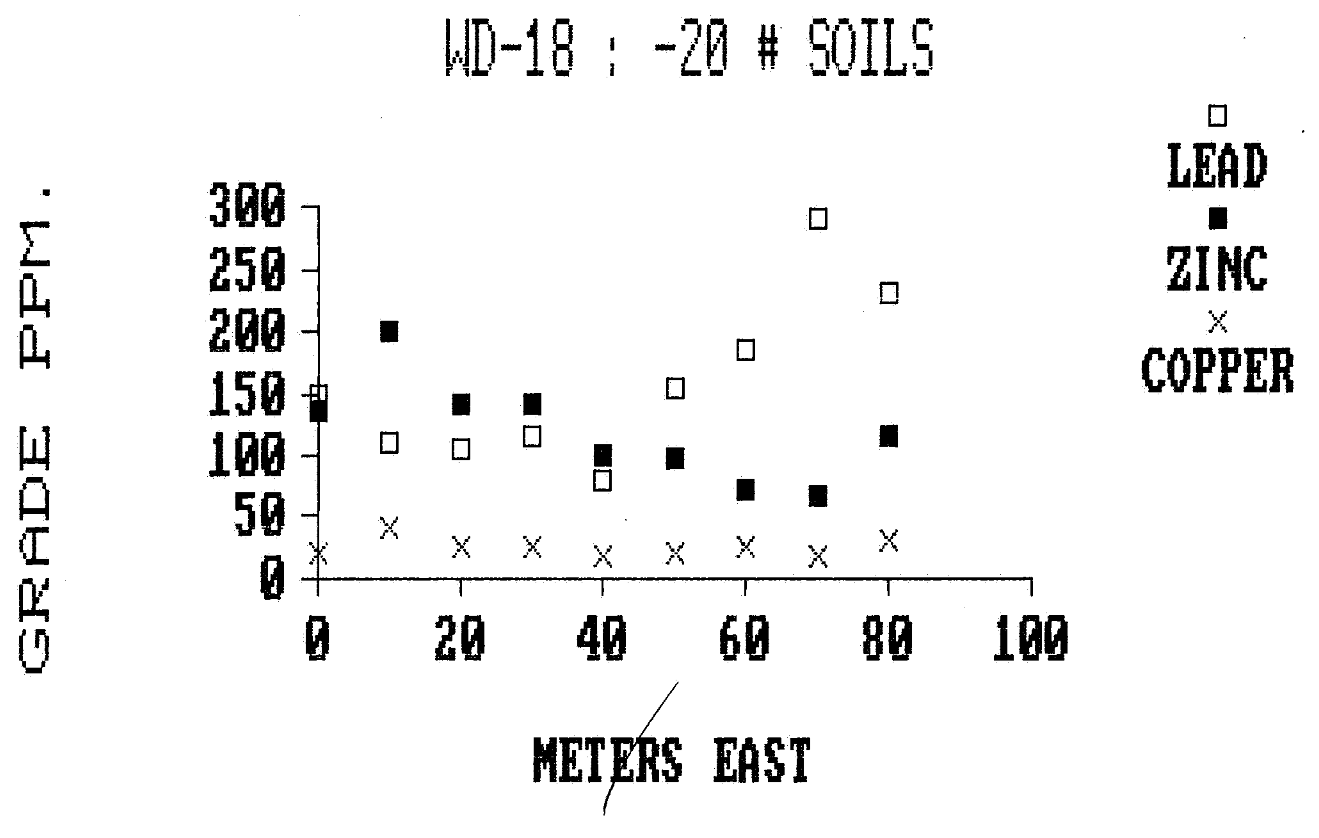
OLD WIRREALPA SPRING GEOCHEMICAL ANALYSES

REFERENCE m	LEAD	ZINC	COPPER	NUMBER	LITH. CODE	SAMPLE SPECIFICATIONS.
9985	195	32	10	WD89/ 6	Ehwg	LOCATION : OLD WIRREALPA SPRING
9990	38	12	15	7	Ehwbb	PROFILE AZ. : GRID EAST
10000	20	6	12	8	"	REFERENCE : LINE 9950 N
10010	22	11	19	9	Ehwgb	SAMPLE TYPE : ROCK CHIP PROFILE
10020	20	14	28	10	"	
10040	25	11	16	11	"	
10060	28	13	9	12	Ehwbc	
10070	22	30	16	13	"	
10080	28	50	16	14	"	
10090	28	28	14	15	"	
10100	66	105	26	16	"	
10110	55	40	16	17	Ehwb	
10120	84	54	24	18	"	
10130	35	15	15	19	"	
10075	790	300	105	WD89/146	"	LOCATION : OLD WIRREALPA SPRING
10085	560	155	60	147	"	PROFILE AZ. : GRID EAST
10095	330	70	18	148	"	REFERENCE : LINE 9825 N
10105	420	220	30	149	"	SAMPLE TYPE : SOIL - 20 #
10115	330	125	100	150	"	
10125	320	220	110	151	"	
10080	200	230	65	WD89/152	"	LOCATION : OLD WIRREALPA SPRING
10090	470	340	70	153	"	PROFILE AZ. : GRID EAST
10100	390	330	44	154	"	REFERENCE : LINE 9875 N
10110	195	330	80	155	"	SAMPLE TYPE : SOIL - 20 #
10075	940	240	48	WD89/156	"	LOCATION : OLD WIRREALPA SPRING
10085	550	320	60	157	"	PROFILE AZ. : GRID EAST
10095	310	300	54	158	"	REFERENCE : LINE 9850 N
10105	370	250	44	159	"	SAMPLE TYPE : SOIL - 20 #
10115	270	270	92	160	"	
9820N 10130E	660	820	470	WD89/161	Fe gossan	LOCATION : OLD WIRREALPA SPRING
9790N 10120E	830	1560	98	162	Mn/Fe goss.?	PROFILE AZ. :
9880N 10175E	46	540	120	163	Fe gossan	REFERENCE : SEE MAP
9760N 10160E	150	85	125	164	Fe gossan	SAMPLE TYPE : ROCK CHIP
9860N 10120E	270	1060	52	165	Fero.-Lst.	
9755N 10090E	2300	1450	72	166	Fe gossan	
9820N 10100E	480	530	58	167	yell. clay	

APPENDIX 2

WD 18 AREA GEOCHEMISTRY


WD-18 : ROCK CHIP
LEAD
ZINC
COPPER
GRADE PPM.
40
30
20
10
0
260
270
280
290
300
310
320
METERS EAST


WD-18 : -20 # SOILS
LEAD
ZINC
COPPER
GRADE PPM.
300
250
200
150
100
50
0
0
20
40
60
80
100
METERS EAST

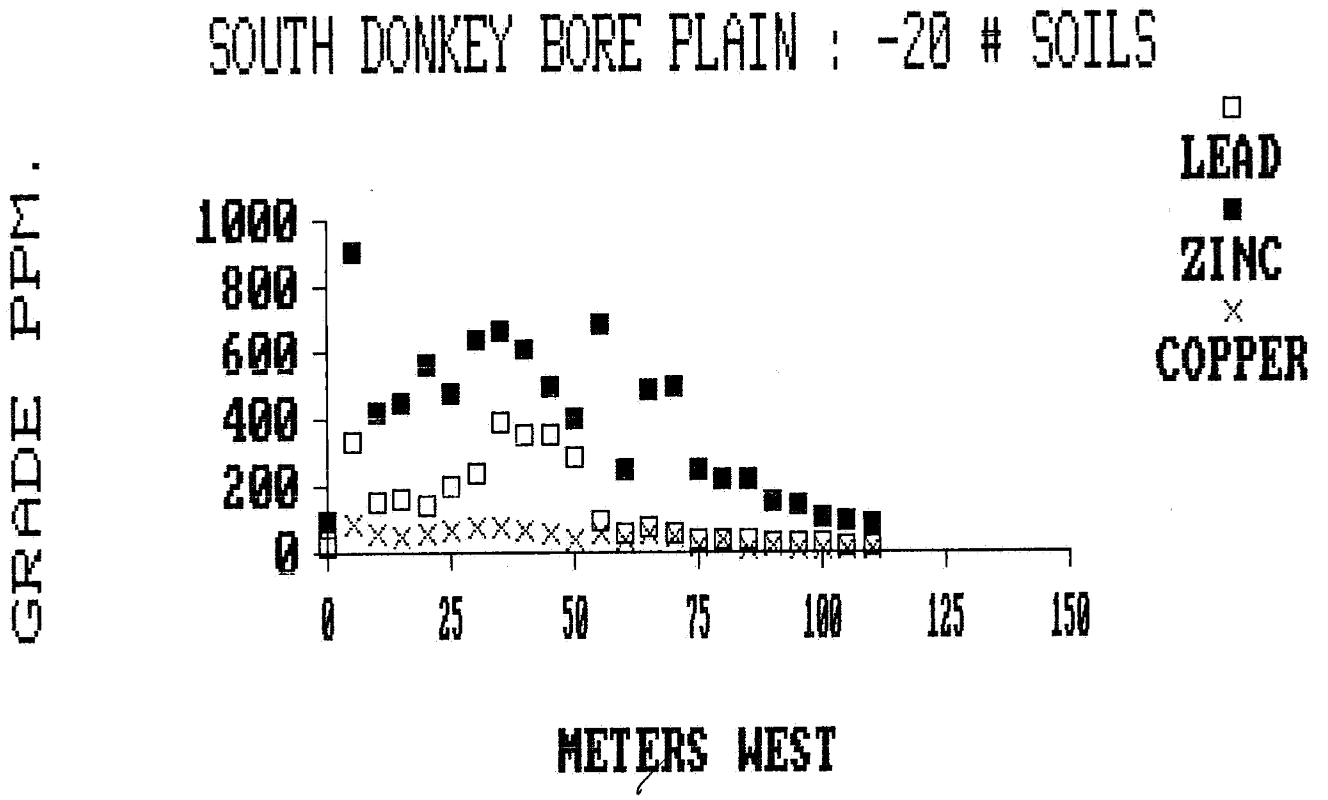
WD-18 AREA GEOCHEMICAL ANALYSES

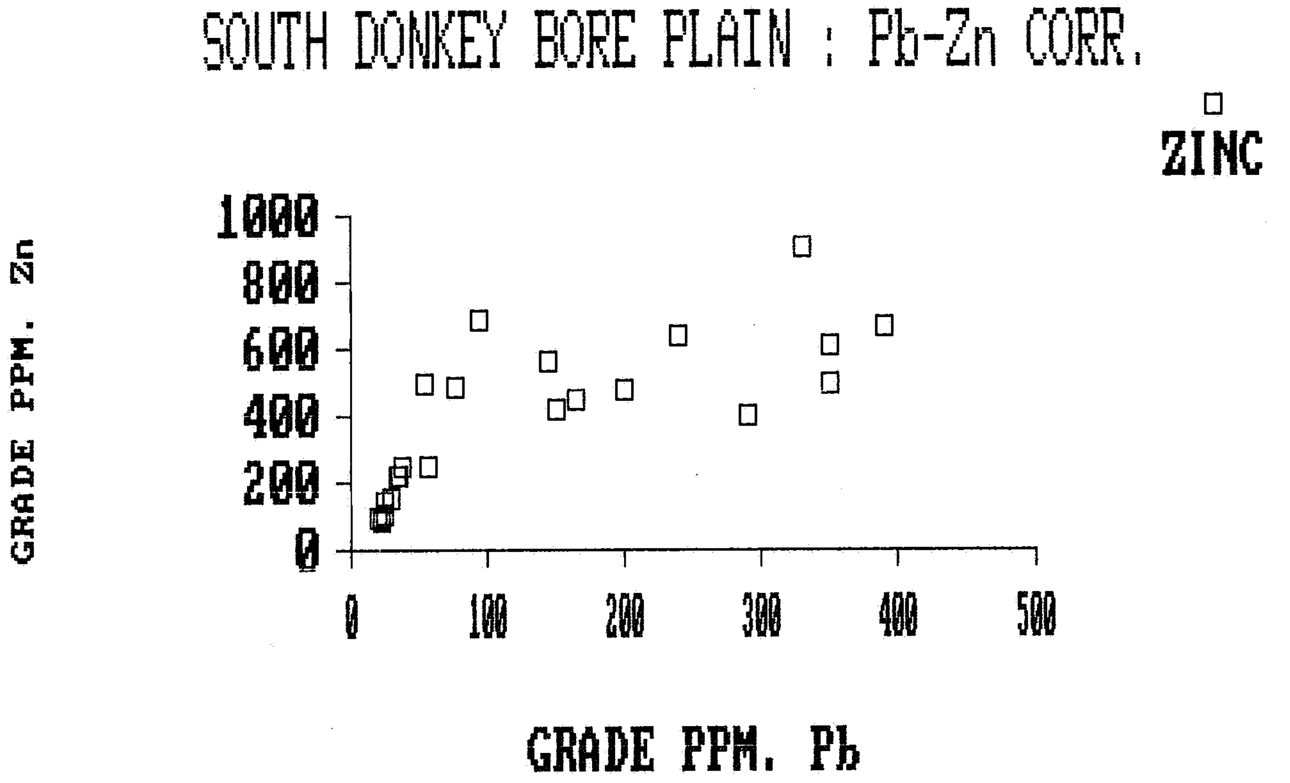
REFERENCE	LEAD	ZINC	COPPER	NUMBER	LITH. CODE	SAMPLE SPECIFICATIONS.
270	30	11	2	WD89/138	Ehwg	LOCATION : WD-18 AREA
275	38	17	1	139	"	PROFILE AZ. : 48 DEG MAG
280	22	9	1	140	"	REFERENCE : WD-18 PROFILE, EASTINGS
285	15	10	1	141	Ehwp	SAMPLE TYPE : ROCK CHIP PROFILE
290	10	4	1	142	"	
295	14	12	3	143	"	
300	12	8	3	144	Ehwpc	
310	15	14	3	145	"	

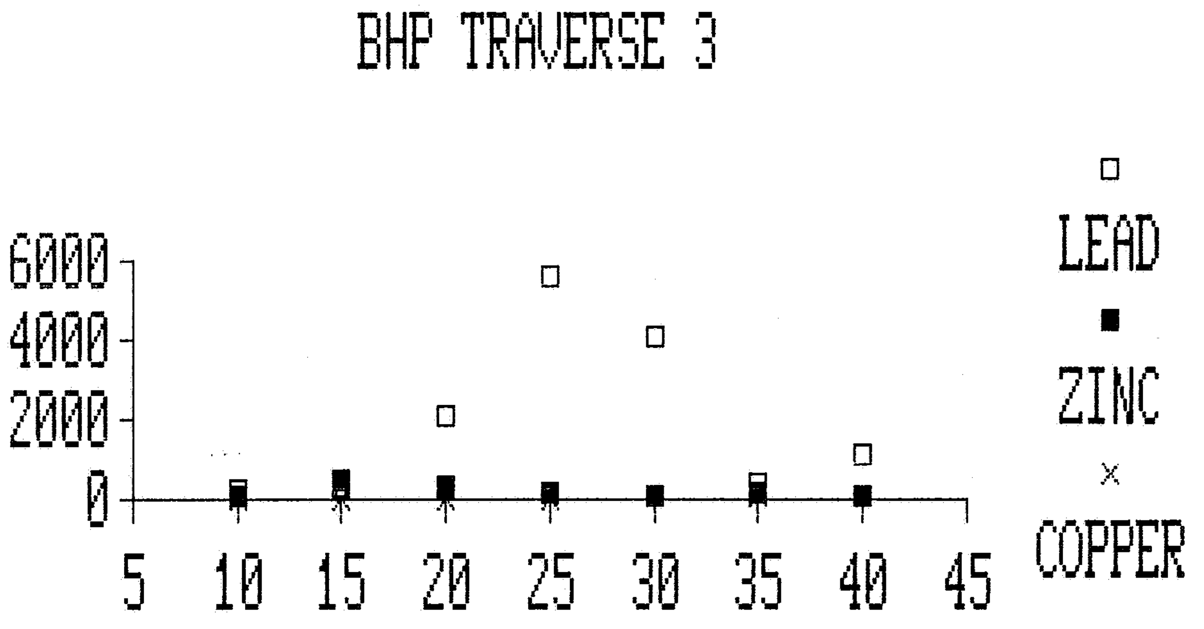
REFERENCE	LEAD	ZINC	COPPER	NUMBER	LITH. CODE	SAMPLE SPECIFICATIONS.
0	150	135	20	WD89/129	Czsa	LOCATION : WD-18 AREA
10	110	200	40	130	"	PROFILE AZ. : NNE
20	105	140	25	131	"	REFERENCE : POSSIBLE KARST, EASTINGS
30	115	140	26	132	"	SAMPLE TYPE : - 20 # SOILS
40	80	100	17	133	"	
50	155	96	20	134	"	
60	185	72	24	135	"	
70	290	66	17	136	"	
80	230	115	30	137	"	

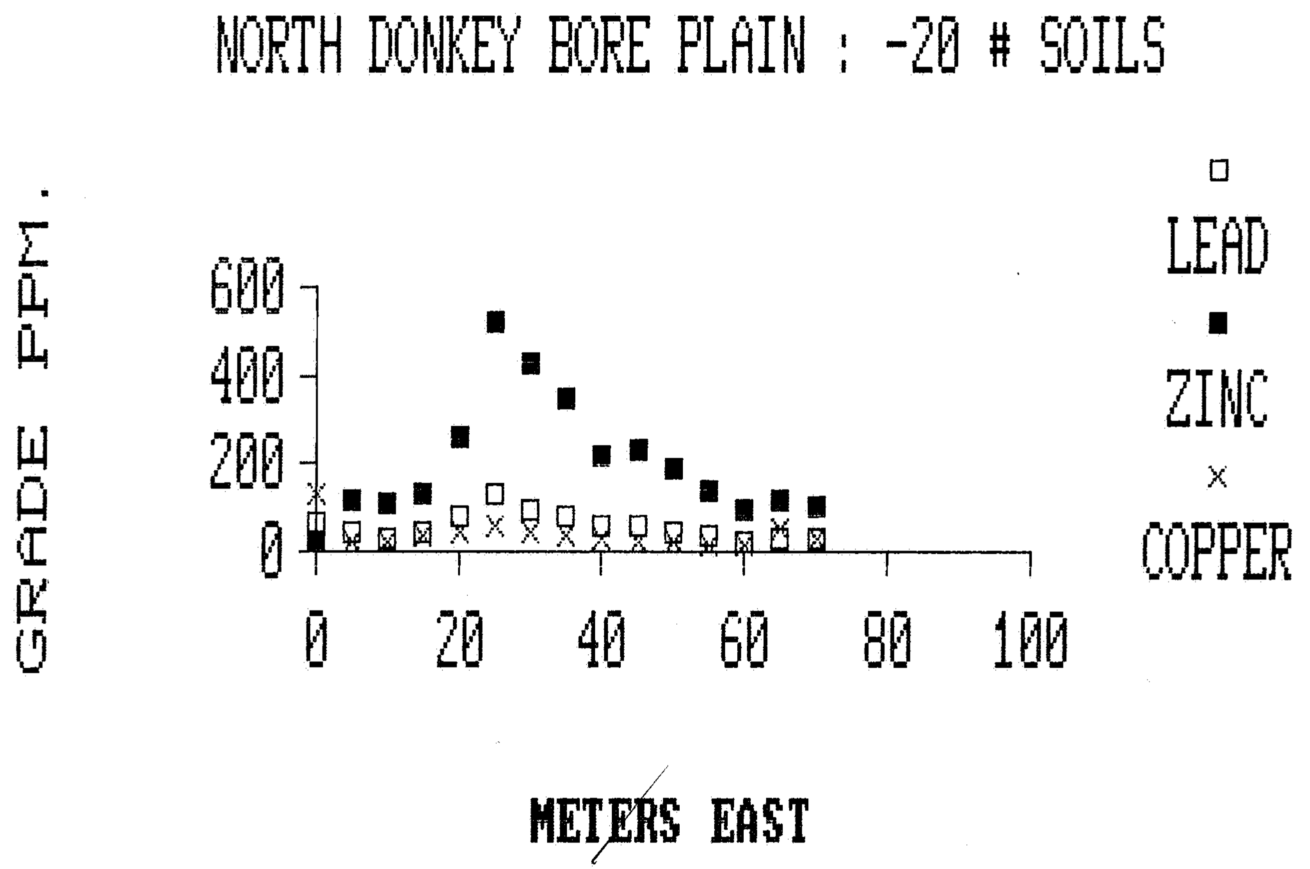
APPENDIX 3

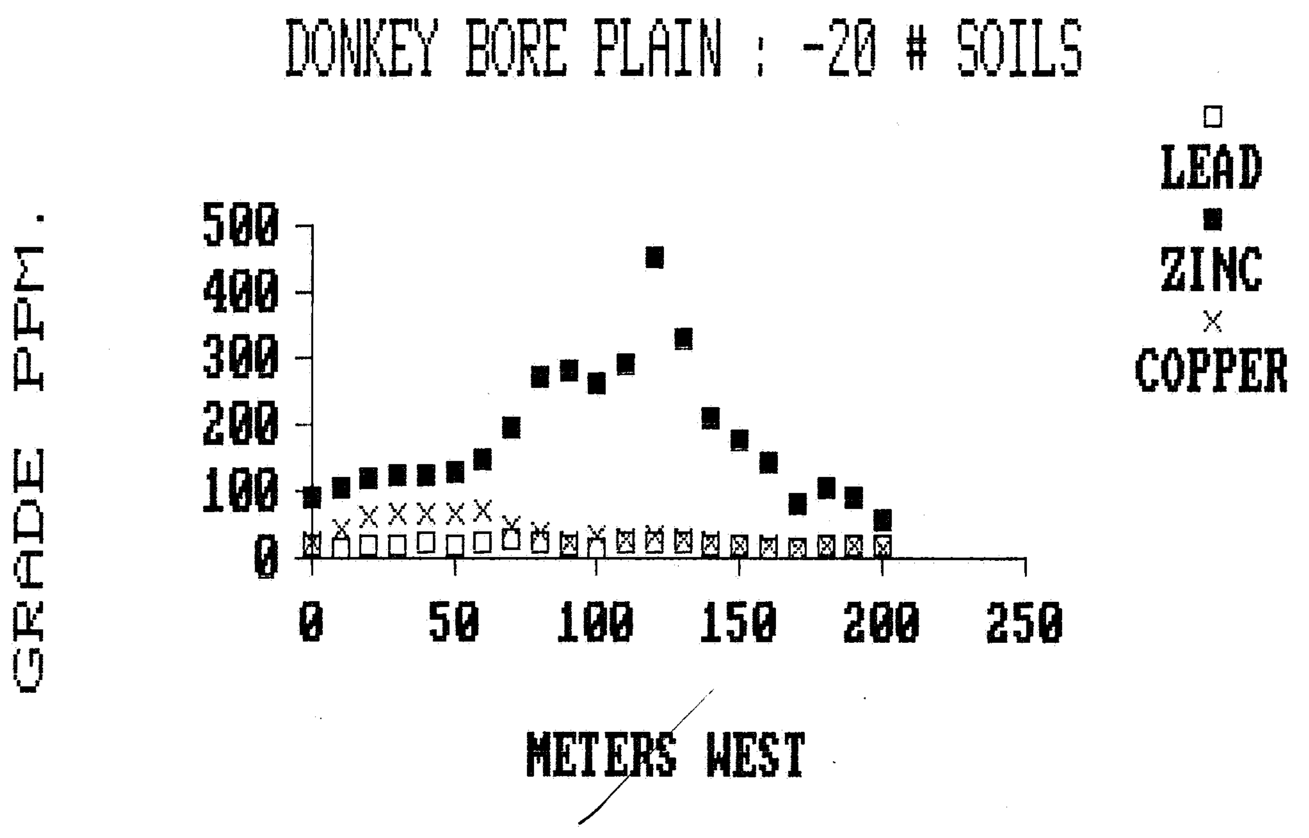
DONKEY BORE GEOCHEMISTRY

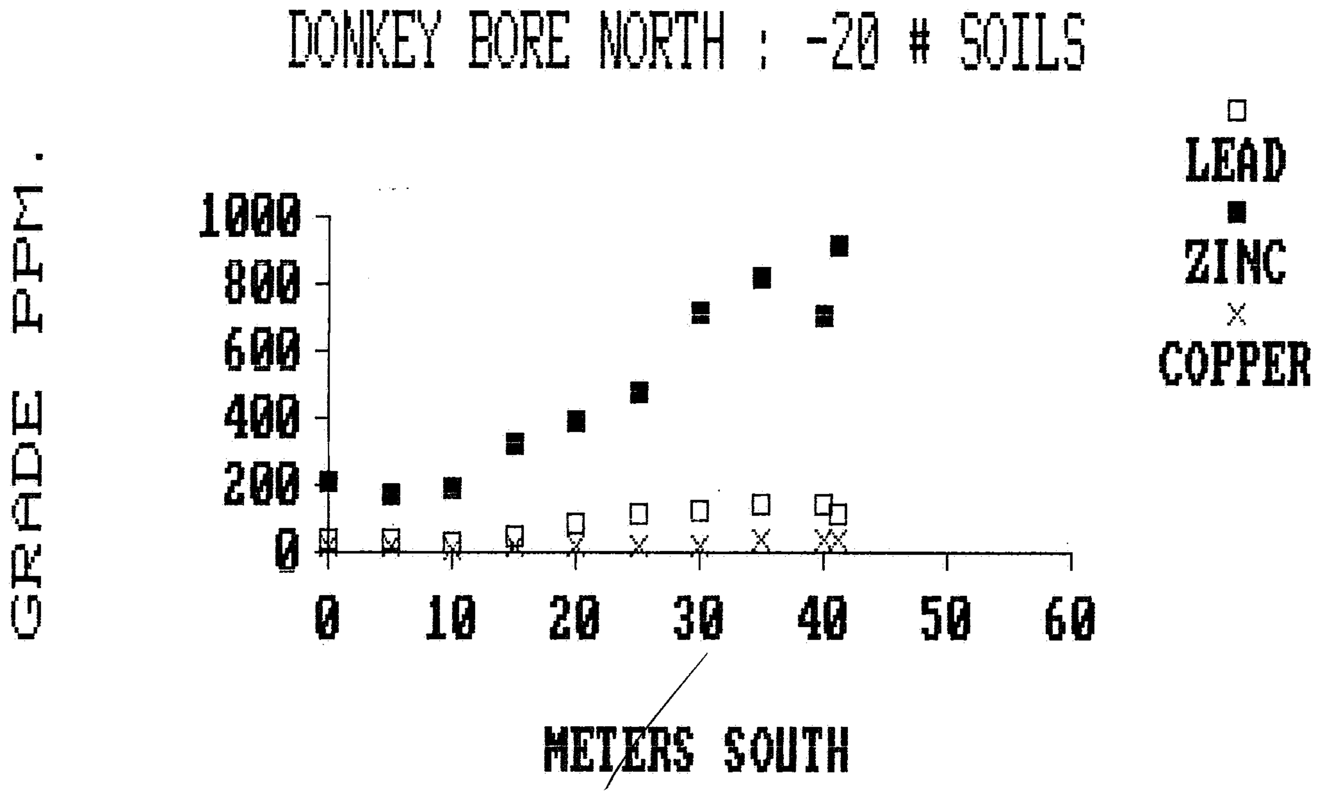

SOUTH DONKEY BORE PLAIN : -20 # SOILS
LEAD
ZINC
COPPER
GRADE PPM.
1000
800
600
400
200
0
0
25
50
75
100
125
150
METERS WEST


SOUTH DONKEY BORE PLAIN : Pb-Zn CORR.
ZINC
GRADE PPM. Zn
1000
800
600
400
200
0
0
100
200
300
400
500
GRADE PPM. Pb


BHP TRAVERSE 3
6000
4000
2000
0
5
10
15
20
25
30
35
40
45
LEAD
ZINC
COPPER


NORTH DONKEY BORE PLAIN : -20 # SOILS
GRADE PPM.
600
400
200
0
0
20
40
60
80
100
LEAD
ZINC
COPPER
METERS EAST


DONKEY BORE PLAIN : -20 # SOILS
LEAD
ZINC
COPPER
GRADE PPM.
500
400
300
200
100
0
0
50
100
150
200
250
METERS WEST


DONKEY BORE NORTH : -20 # SOILS
LEAD
ZINC
COPPER
GRADE PPM.
1000
800
600
400
200
0
0
10
20
30
40
50
60
METERS SOUTH

DONKEY BORE GEOCHEMICAL ANALYSES

REFERENCE	LEAD	ZINC	COPPER	NUMBER	LITH. CODE	SAMPLE SPECIFICATIONS.
10	250	130	10	WR89/120	Ehwg	LOCATION : BHP traverse 3
15	340	470	26	121	"	PROFILE AZ. : Northeast
20	2050	360	52	122	"	REFERENCE : Eastings
25	5600	210	34	123	"	SAMPLE TYPE : Rock Chip Profile
30	4050	72	115	124	"	
35	430	165	86	125	"	
40	1140	135	85	126	"	
0	22	100	82	WD89/ 20	Ehc	LOCATION : SOUTH DONKEY BORE PLAIN
5	330	900	86	21	"	PROFILE AZ. : SOUTH WEST
10	150	420	54	22	"	REFERENCE : WESTINGS
15	165	450	52	23	Czs/Ehw	SAMPLE TYPE : - 20 # SOILS
20	145	560	55	24	"	
25	200	480	68	25	"	
30	240	640	75	26	"	
35	390	670	80	27	"	
40	350	610	66	28	"	
45	350	500	54	29	"	
50	290	400	40	30	"	
55	94	690	62	31	Czs/Ehr	
60	56	250	38	32	"	
65	76	490	54	33	"	
70	54	500	52	34	"	
75	38	250	16	35	"	
80	35	220	35	36	"	
85	34	220	13	37	"	
90	30	155	15	38	"	
95	25	140	10	39	"	
100	25	105	10	40	"	
105	20	96	11	41	"	
110	22	82	12	42	"	
	58	3700	220	WD89/ 43	gossan	LOCATION : SOUTH DONKEY BORE PLAIN
	44	3350	175	44	"	PROFILE AZ. :
	26	9700	14	45	"	REFERENCE : SEE MAP
	2650	4950	195	47	"	SAMPLE TYPE : ROCK CHIP
	600	1280	125	48	"	
	290	500	40	WD89/ 46		LOCATION : SOUTH DONKEY BORE PLAIN
						PROFILE AZ. : PARALLEL TO SOIL PROFILE
						REFERENCE : SEE MAP
						SAMPLE TYPE : CHANNEL ALONG MINOR DRAINAGE

DONKEY BORE GEOCHEMICAL ANALYSES

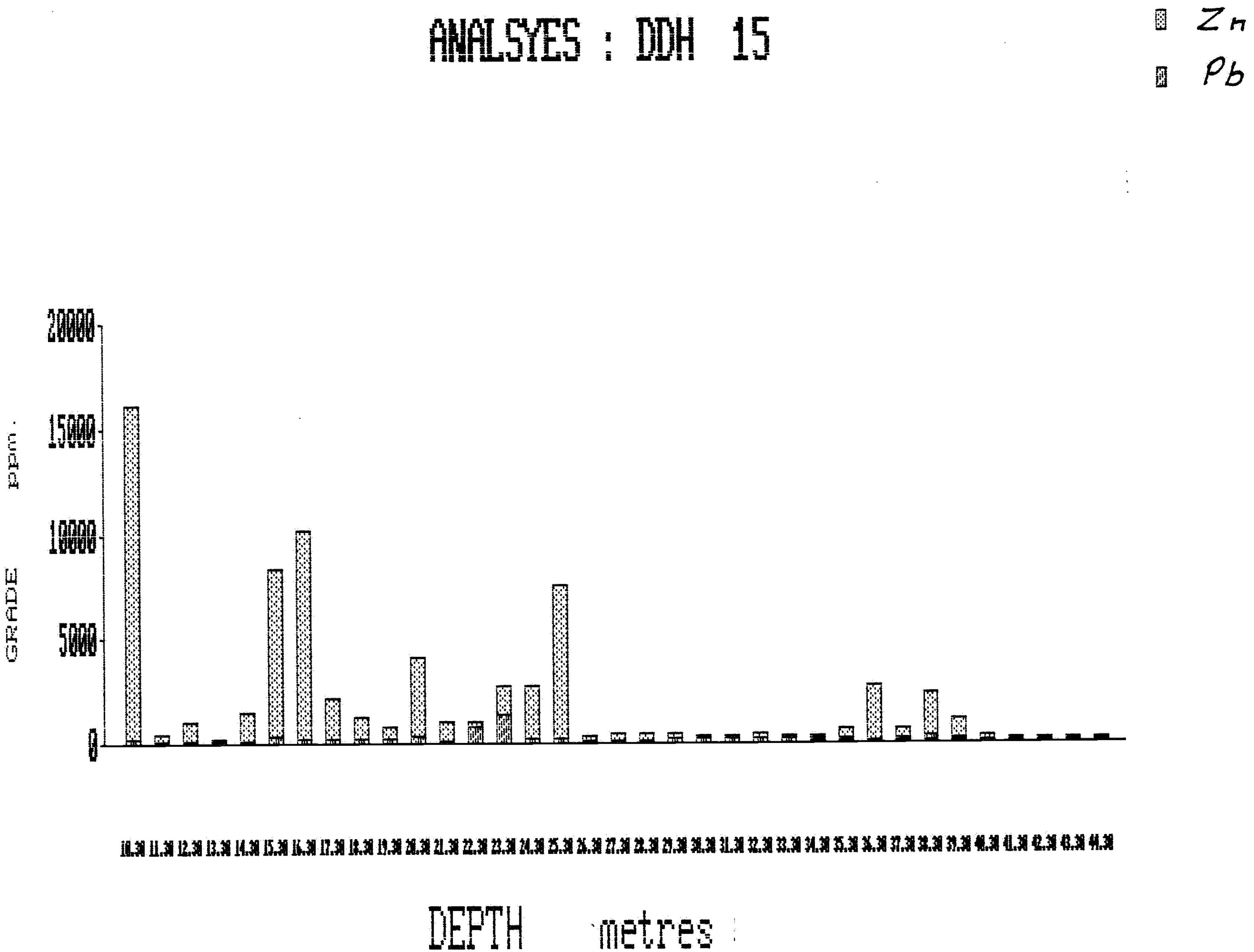
REFERENCE	LEAD	ZINC	COPPER	NUMBER	LITH. CODE	SAMPLE SPECIFICATIONS.
	450	1060	98	WD89/ 49		LOCATION : SOUTH DONKEY BORE PLAIN
						PROFILE AZ. :
						REFERENCE : SEE MAP
						SAMPLE TYPE : - 20 # STREAM SEDIMENT
0	18	90	26	WD89/ 86	?	LOCATION : DONKEY BORE PLAIN
10	14	105	42	87	?	PROFILE AZ. : SOUTH WEST
20	18	120	62	88	?	REFERENCE : WESTINGS
30	18	125	65	89	Czs/Ehc	SAMPLE TYPE : - 20 # SOILS
40	22	125	66	90	"	
50	20	130	65	91	Czs/Ehw	
60	22	150	70	92	"	
70	28	195	50	93	"	
80	24	270	40	94	"	
90	18	280	25	95	"	
100	16	260	32	96	Czs/Ehr	
110	22	290	30	97	"	
120	22	450	32	98	"	
130	22	330	28	99	"	
140	20	210	22	100	"	
150	20	175	19	101	"	
160	15	145	18	102	"	
170	14	82	16	103	"	
180	18	105	17	104	"	
190	18	92	17	105	"	
200	18	56	16	106	"	
	32	2800	135	WD89/107	Fe jasper	LOCATION : DONKEY BORE PLAIN
	22	4250	165	108	"	PROFILE AZ. : SOUTH WEST
	16	1400	12	109	"	REFERENCE : SEE MAP
						SAMPLE TYPE : ROCK CHIP SAMPLES
70	30	100	26	WD89/ 68	Ehc	LOCATION : NORTH DONKEY BORE PLAIN
65	30	115	50	69	"	PROFILE AZ. : SOUTH WEST
60	22	95	17	70	"	REFERENCE : WESTINGS
55	32	135	16	71	Ehw	SAMPLE TYPE : - 20 # SOILS
50	44	185	20	72	"	
45	58	230	24	73	"	
40	54	220	25	74	"	
35	82	350	35	75	"	
30	96	430	42	76	"	
25	130	520	56	77	"	
20	78	260	42	78	"	
15	46	130	32	79	"	
10	28	110	18	80	"	
5	42	115	19	81	Ehr	
0	64	19	130	82	"	

DONKEY BORE GEOCHEMICAL ANALYSES

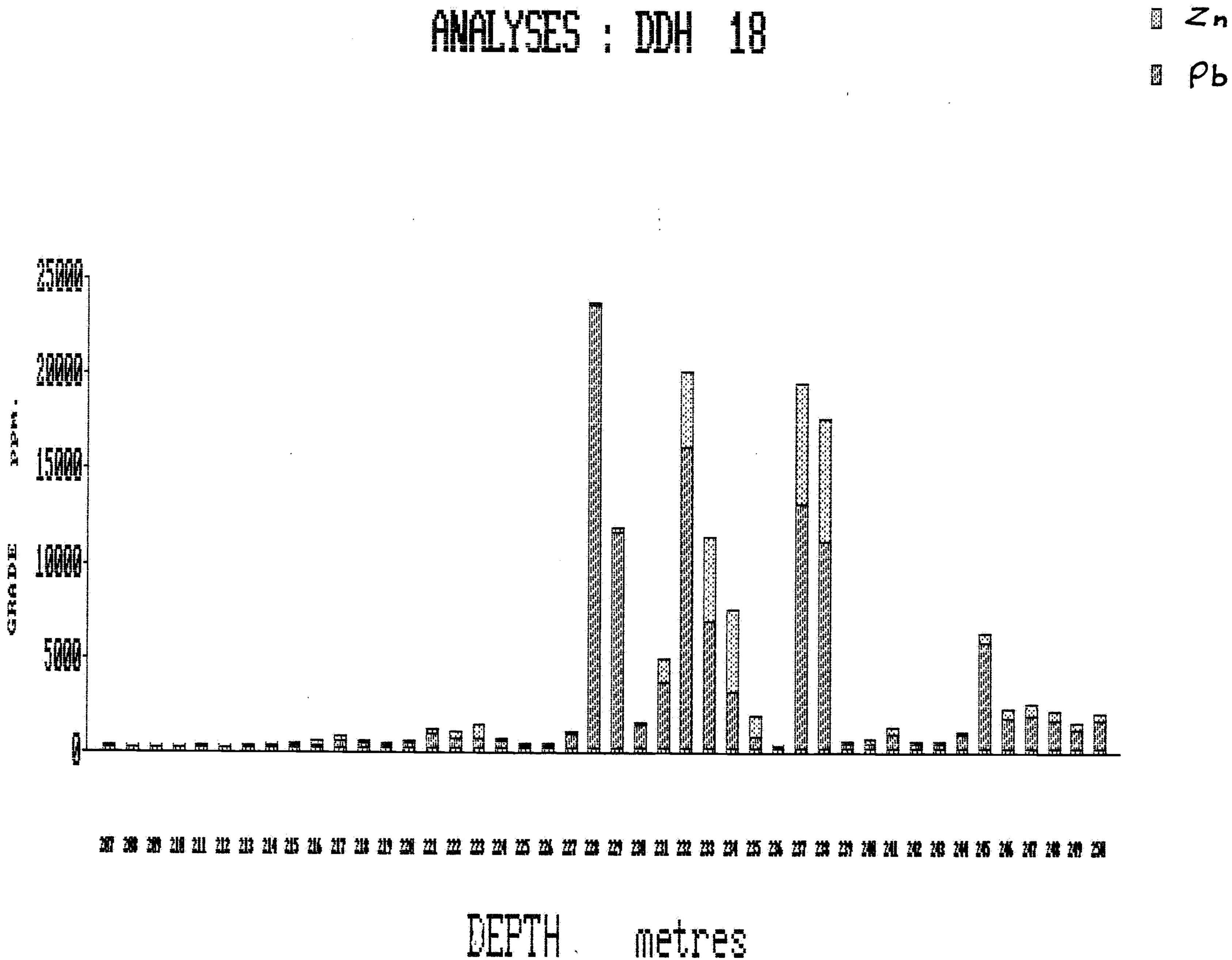
REFERENCE	LEAD	ZINC	COPPER	NUMBER	LITH. CODE	SAMPLE SPECIFICATIONS.
	480	5700	155	WD89/ 83	jasper	LOCATION : NORTH DONKEY BORE PLAIN
						PROFILE AZ. :
						REFERENCE : SEE MAP
						SAMPLE TYPE : ROCK CHIP
	250	2150	370	WD89/ 56	Ehw	LOCATION : BHP TRAVERSE 19
	25	145	15	57		PROFILE AZ. :
						REFERENCE :
						SAMPLE TYPE : ROCK CHIP
0	40	210	18	WD89/ 58	Ehr	LOCATION : DONKEY BORE NORTH
5	34	175	16	59	"	PROFILE AZ. : SOUTH
10	32	190	12	60	"	REFERENCE : SOUTHINGS
15	46	320	18	61	Yell. clay	SAMPLE TYPE : - 20 # SOILS
20	84	390	15	62	"	
25	110	480	16	63	"	
30	120	710	20	64	"	
35	140	820	38	65	"	
40	145	700	36	66	"	
41.20	115	910	40	67	"	
200	98	5000	8	WD89/ 51	Fe jasper	LOCATION : WD-7 AREA
80	15	62	3	52	Yell. Lst	PROFILE AZ. : NORTH
100	18	175	1	53	"	REFERENCE : NORTHINGS
120	18	230	1	54	"	SAMPLE TYPE : ROCK CHIP
140	12	94	1	55	"	

APPENDIX 4

WD 15 & WD 18 ANALYSES (BHP)


ANALSYES : DDH 15
Zn
Pb
GRADE ppm.
20000
15000
10000
5000
0
10.30
11.30
12.30
13.30
14.30
15.30
16.30
17.30
18.30
19.30
20.30
21.30
22.30
23.30
24.30
25.30
26.30
27.30
28.30
29.30
30.30
31.30
32.30
33.30
34.30
35.30
36.30
37.30
38.30
39.30
40.30
41.30
42.30
43.30
44.30
DEPTH metres

ANALYSES : DDH 18



SELECTED ANALYSES : BHP WIRREALPA DIAMOND DRILLING

WD - 15 ANALYSES

DEPTH m FROM	TO	ASSAYS ppm. Pb	Zn
10.30	11.30	155	16000
11.30	12.30	35	400
12.30	13.30	40	1000
13.30	14.30	25	110
14.30	15.30	65	1400
15.30	16.30	350	8000
16.30	17.30	135	10000
17.30	18.30	150	2000
18.30	19.30	240	1000
19.30	20.30	130	600
20.30	21.30	275	3800
21.30	22.30	100	900
22.30	23.30	750	210
23.30	24.30	1350	1350
24.30	25.30	165	2550
25.30	26.30	150	7400
26.30	27.30	40	200
27.30	28.30	45	350
28.30	29.30	110	330
29.30	30.30	155	220
30.30	31.30	160	120
31.30	32.30	120	115
32.30	33.30	210	190
33.30	34.30	180	140
34.30	35.30	140	195
35.30	36.30	120	470
36.30	37.30	110	2600
37.30	38.30	195	420
38.30	39.30	300	2100
39.30	40.30	210	900
40.30	41.30	95	210
41.30	42.30	60	60
42.30	43.30	95	70
43.30	44.30	75	140
44.30	45.30	65	70

WD - 18 ANALSES

207	208	35	50
208	209	25	20
209	210	15	10

SELECTED ANALYSES : BHP WIRREALPA DIAMOND DRILLING

210	211	25	15
211	212	25	40
212	213	20	20
213	214	25	55
214	215	50	55
215	216	80	110
216	217	145	155
217	218	320	330
218	219	195	210
219	220	65	115
220	221	260	75
221	222	685	245
222	223	520	280
223	224	485	715
224	225	325	205
225	226	155	40
226	227	150	115
227	228	670	125
228	229	23500	55
229	230	11500	155
230	231	1200	80
231	232	3450	1300
232	233	16000	3950
233	234	6650	4600
234	235	2950	4400
235	236	635	1050
236	237	45	25
237	238	13000	6350
238	239	11000	6450
239	240	255	129
240	241	245	191
241	242	745	285
242	243	235	95
243	244	220	120
244	245	675	105
245	246	5550	505
246	247	1600	470
247	248	1750	550
248	249	1450	555
249	250	945	330
250	251	1450	320

APPENDIX 5

ANALYTICAL REPORT (COMLABS)

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

305 South Road, Mile End South, South Australia, 5031
Telephone: (08) 43 5722 Fax: (08) 234 0321 Telex: LABCOM AA89323

Mr. Russell Bluck
Oxford House Associates
Suite 8
3 Mount Barker Road
STIRLING
SA 5152 AUSTRALIA

Job Number: 9AD1335

Your Reference:
Number of Samples: 191
Extra Samples : 0

Date Received: 04-AUG-1989
Date Reported: 18-AUG-1989

This report comprises a cover sheet and pages 1 to 9

This report relates specifically to the samples tested in so far as that the samples as supplied are truly representative of the sample source. Please address any enquiries to Mr. Trevor Francis.

Approved Signature:

for

Dr. John Kikkert
General Manager - Adelaide.
CLASSIC COMLABS LTD

Report Analyte Codes:
N.A. - Not Analysed.
L.N.R. - Listed But Not Received.
I.S. - Insuffient Sample for Analysis.

Distribution Codes:
CC - Carbon Copy
EM - Electronic Media
MM - Magnetic Media

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

SAMPLE	Cu	Pb	Zn	
WR88/001	15	8	12	OLD WIRRCALPA SPRING See Renous Wirrealpa Report.
WR88/002	28	110	230	
WR88/003	86	4350	2050	
WR88/004	15	92	220	
WR88/005	62	1020	1040	
WR89/006	10	195	32	OLD WIRRCALPA SPRING ROCK CHIP.
WR89/007	15	38	12	
WR89/008	12	20	6	
WR89/009	19	22	11	
WR89/010	28	20	14	
WR89/011	16	25	11	
WR89/012	9	28	13	
WR89/013	16	22	30	
WR89/014	16	28	50	
WR89/015	14	28	28	
WR89/016	26	66	105	
WR89/017	16	55	40	
WR89/018	24	84	54	
WR89/019	15	35	15	
WR89/043	220	58	3700	SOUTH DONKE BORE PLAIN ROCK CHIP:— OUTCROPS
WR89/044	175	44	3350	
WR89/045	14	26	9700	
WR89/046	40	290	500	CHANNEL SAMPLE
WR89/047	195	2650	4950	
WR89/048	125	600	1280	
UNITS	ppm	ppm	ppm	
SCHEME	AAS1	AAS1	AAS1	

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

SAMPLE	Cu	Pb	Zn	
WR89/050	125	40	2900	
WR89/051	8	98	5000	WD-7 AREA ROCK CHIP.
WR89/052	3	15	62	
WR89/053	<2	18	175	
WR89/054	<2	18	230	
WR89/055	<2	12	94	
WR89/056	370	250	2150	BHP TRAVERSE 19 ROCK CHIP.
WR89/057	15	25	145	
WR89/120	10	250	130	BHP TRAVERSE 3 ROCK CHIP.
WR89/121	26	340	470	
WR89/122	52	2050	360	
WR89/123	34	5600	210	
WR89/124	115	4050	72	
WR89/125	86	430	165	
WR89/126	85	1140	135	
WR89/138	2	30	11	WD-18 TRAVERSE ROCK CHIP.
WR89/139	<2	38	17	
WR89/140	<2	22	9	
WR89/141	<2	15	10	
WR89/142	<2	10	4	
WR89/143	3	14	12	
WR89/144	3	12	8	
WR89/145	3	15	14	
WR89/161	470	660	820	OLD WIRREALPA SPRING OUTCROP: ROCK CHIP.
WR89/162	98	830	1560	
UNITS	ppm	ppm	ppm	
SCHEME	AAS1	AAS1	AAS1	
UPPER SCHEME		AAS4		

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

SAMPLE	Cu	Pb	Zn	
WR89/163	120	46	540	OLD WIRRALPA SPRING (cont'd).
WR89/164	125	150	85	
WR89/165	52	270	1060	
WR89/166	72	2300	1450	
WR89/167	58	480	530	
WR89/107	135	32	2800	DONKEY BORE PLAIN OUTCROP : ROCK CHIP
WR89/108	165	22	4250	
WR89/109	12	16	1400	
WR89/113	7	800	6100	DAWSON HILL. LICENCE.
WR89/114	4	1260	3100	
WR89/115	9	1600	5800	
WR89/116	50	1640	30.3%	
WR89/117	65	1860	13.7%	
WR89/118	11	5600	49.4%	
WR89/083	155	480	5700	DONKEY BORE PLAIN NORTH. ROCK CHIP.
WR89/020	82	22	100	SOUTH DONKEY BORE PLAIN -20# SOILS.
WR89/021	86	330	900	
WR89/022	54	150	420	
WR89/023	52	165	450	
WR89/024	55	145	560	
WR89/025	68	200	480	
WR89/026	75	240	640	
WR89/027	80	390	670	
WR89/028	66	350	610	
WR89/029	54	350	500	
UNITS	ppm	ppm	ppm	
SCHEME	AAS1	AAS1	AAS1	
UPPER SCHEME		AAS4	AAS1C	

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

SAMPLE	Cu	Pb	Zn	
WR89/030	40	290	400	DONKEY BORE PLAIN STH (cont'd)
WR89/031	62	94	690	
WR89/032	38	56	250	
WR89/033	54	76	490	
WR89/034	52	54	500	
WR89/035	16	38	250	
WR89/036	22	35	220	
WR89/037	13	34	220	
WR89/038	15	30	155	
WR89/039	10	25	140	
WR89/040	10	25	105	
WR89/041	11	20	96	
WR89/042	12	22	82	
WR89/049	98	450	1060	DONKEY BORE PLAIN STH STREAM SED
WR89/058	18	40	210	DONKEY BORE NORTH. -20# SOILS.
WR89/059	16	34	175	
WR89/060	12	32	190	
WR89/061	18	46	320	
WR89/062	15	84	390	
WR89/063	16	110	480	
WR89/064	20	120	710	
WR89/065	38	140	820	
WR89/066	36	145	700	
WR89/067	40	115	910	
WR89/068	26	30	100	NORTH DONKEY BORE PLAIN -20 # SOILS.
UNITS	ppm	ppm	ppm	
SCHEME	AAS1	AAS1	AAS1	

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

DONKEY BORE PLAIN NTH (-20 # SOILS cont'd)

SAMPLE	Cu	Pb	Zn
WR89/069	50	30	115
WR89/070	17	22	95
WR89/071	16	32	135
WR89/072	20	44	185
WR89/073	24	58	230
WR89/074	25	54	220
WR89/075	35	82	350
WR89/076	42	96	430
WR89/077	56	130	520
WR89/078	42	78	260
WR89/079	32	46	130
WR89/080	18	28	110
WR89/081	19	42	115
WR89/082	19	64	130
WR89/086	26	18	90
WR89/087	42	14	105
WR89/088	62	18	120
WR89/089	65	18	125
WR89/090	66	22	125
WR89/091	65	20	130
WR89/092	70	22	150
WR89/093	50	28	195
WR89/094	40	24	270
WR89/095	25	18	280
WR89/096	32	16	260
UNITS	ppm	ppm	ppm
SCHEME	AAS1	AAS1	AAS1

DONKEY BORE PLAIN -20 # SOILS.

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

SAMPLE	Cu	Pb	Zn	
WR89/097	30	22	290	DONNEY BORE PLAIN (-20# SOILS cont'd)
WR89/098	32	22	450	
WR89/099	28	22	330	
WR89/100	22	20	210	
WR89/101	19	20	175	
WR89/102	18	15	145	
WR89/103	16	14	82	
WR89/104	17	18	105	
WR89/105	17	18	92	
WR89/106	16	18	56	
WR89/129	20	150	135	WD-18 AREA. -20# SOILS.
WR89/130	40	110	200	
WR89/131	25	105	140	
WR89/132	26	115	140	
WR89/133	17	80	100	
WR89/134	20	155	96	
WR89/135	24	185	72	
WR89/136	17	290	66	
WR89/137	30	230	115	
WR89/146	105	790	300	OLD WIRRERLPA SPRING -20# SOILS.
WR89/147	60	560	155	
WR89/148	18	330	70	
WR89/149	30	420	220	
WR89/150	100	330	125	
WR89/151	110	320	220	
UNITS	ppm	ppm	ppm	
SCHEME	AAS1	AAS1	AAS1	

Job: 9AD1335

ANALYTICAL REPORT

OLD WIRREALPA SPRINGS (-20# SOILS cont'd)

SAMPLE	Cu	Pb	Zn
WR89/152	65	200	230
WR89/153	70	470	340
WR89/154	44	390	330
WR89/155	80	195	330
WR89/156	48	940	240
WR89/157	60	550	320
WR89/158	54	310	300
WR89/159	44	370	250
WR89/160	92	270	270
WR88/004 A	17	80	210
WR89/046 A	34	240	470
WR89/121 A	25	330	460
WR89/142 A	3	6	2
WR89/161 A	410	690	790
WR89/030 A	48	280	380
WR89/049 A	105	460	1050
WR89/090 A	65	24	130
WR89/132 A	30	94	160
WR89/152 A	65	185	230
UNITS	ppm	ppm	ppm
SCHEME	AAS1	AAS1	AAS1

"LABORATORY REPLICATE ANALYSES!"

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

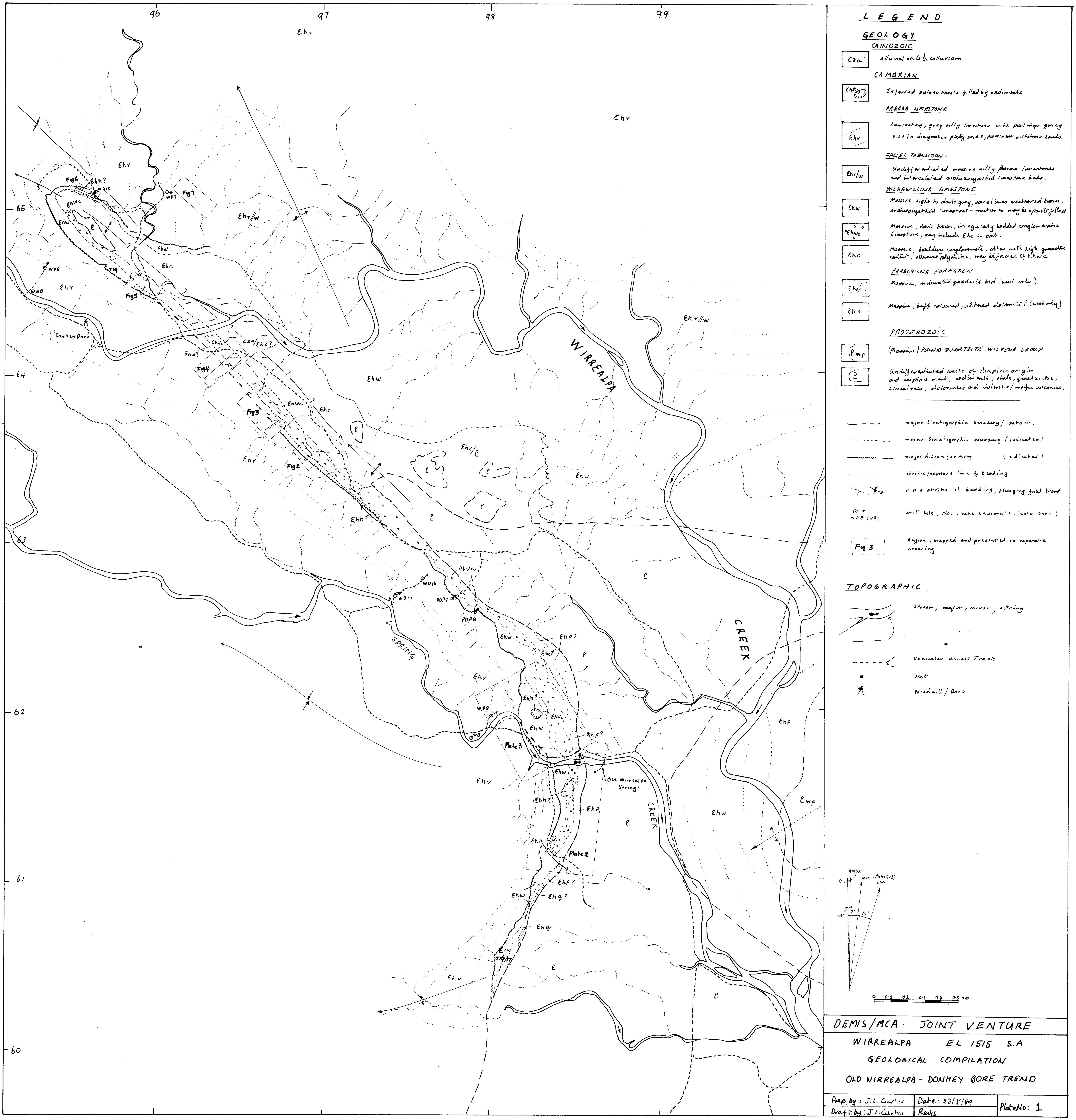
SAMPLE	As
WR89/043	<50
WR89/044	<50
WR89/045	50
WR89/046	<50
WR89/047	150
WR89/048	50
WR89/050	50
WR89/051	150
WR89/052	<50
WR89/053	<50
WR89/054	50
WR89/055	50
WR89/046 A	50
UNITS	ppm
SCHEME	AAS2

CLASSIC COMLABS LTD
Analytical Laboratories (INC. IN W.A.)

Job: 9AD1335

ANALYTICAL REPORT

SAMPLE	Zn
WR89/107	3300
WR89/108	4600
WR89/109	2300
WR89/113	6800
WR89/114	3300
WR89/115	5400
WR89/116	36.5%
WR89/117	15.6%
WR89/118	51.0%
UNITS	ppm
SCHEME	AAS4


LEGEND
GEOLOGY
CAINOZOIC
Cza alluvial soils & colluvium.
CAMBRIAN
Ehk Inferred palaeo karsts filled by sediments
PARARA LIMESTONE
Ehr Laminated, grey silty limestone with partings giving rise to diagnostic platy scree, prominent siltstone bands.
FACIES TRANSITION:
Ehr/w Undifferentiated massive silty Parara limestones and intercalated archaeocyathid limestone beds.
WILKAWILLINA LIMESTONE
Ehw Massive light to dark grey, sometimes weathered brown, archaeocyathid limestone - fractures may be sparite filled
Ehwc Massive, dark brown, irregularly bedded conglomeratic Limestone, may include Ehc in part.
Ehc Massive, bouldery conglomerate, often with high greenstone content, otherwise polymictic, may be facies of Ehwc
PARACHILNA FORMATION
Ehq Massive, indurated quartzite bed (west only)
Ehp Massive, buff coloured, altered dolomite? (west only)
PROTEROZOIC
Pwp (Massive) POUND QUARTZITE, WILPENA GROUP
P Undifferentiated units of diapiric origin and emplacement, sediments, shale, quartzite, Limestones, dolomites and dolerite/mafic volcanics.
major Stratigraphic boundary/contact.
minor Stratigraphic boundary (indicated)
major disconformity (indicated)
strike/exposure line of bedding
dip & strike of bedding, plunging fold trend.
WD8 (WB) drill hole, No:, rake & azimuth. (water bore)
Fig 3 Region; mapped and presented in separate drawing
TOPOGRAPHIC
Stream, major, minor, spring
Vehicular access Track.
Hut
Windmill / Bore.
WIRREALPA
CREEK
SPRING
Old Wirrealpa Spring
Donkey Bore
Fig 2
Fig 3
Fig 4
Fig 5
Fig 6
Fig 7
Plate 2
Plate 3
96
97
98
99
65
64
63
62
61
60
0 0.1 0.2 0.3 0.4 0.5 Km
DEMIS/MCA JOINT VENTURE
WIRREALPA EL 1515 S.A
GEOLOGICAL COMPILATION
OLD WIRREALPA - DONKEY BORE TREND
Prep. by: J.L. Curtis
Date: 23/8/89
Plate No: 1
Draft. by: J.L. Curtis
Revs.

8072-1

LEGEND

GEOLOGY

CAINOZOIC

- Qa — QUATERNARY - alluvium, sand, gravel.
- CZa — alluvial soils & colluvium
- CZs — soils & scree/talus
- CZYc — yellow clays & scree

CAMBRIAN

- Ehwk — Karstic deposits, travertine (▲ - rubble & scree)

PARARA LIMESTONE

- Ehr — Laminated, grey silty limestone with partings, giving a characteristic platey scree, local competent silty horizons.

WILKAWILLINA LIMESTONE

- Ehwg — Massive light to dark grey, thick bedded limestone. Fractures & joints in upper part of unit may be filled with multi layered sparitic calcite. Archaeocyathids in some places.
- Ehwb — Massive 'brown' weathering to varying degree but otherwise similar to Ehwg
- Ehwbc — Massive, thick bedded, dark brown conglomeratic limestone, lenses of light grey limestone sometimes interbedded, particularly in North.
- Ehwbb — Massive grey limestone with large & small clasts of both grey limestone and dark brown conglomeratic limestone. Clasts angular, disoriented, up to 1m or more in maximum dimension.

PARACHILNA FORMATION.

- EhPl — Massive yellow-brown/fawn laminated limestone, altered, recrystallized appearance, possibly dolomitic
- Ehpq / Ehpc — Thin beds and lenses of porous quartzite/conglomerate

PROTEROZOIC

- Pl — Undifferentiated, altered and recrystallized limestones of yellow-buff colour.

- Fev — Yellow limonitic fracture fill/veining, sometimes with clastic components - probably sediment filled joints, later infused with sulphide and oxidized to limonite during weathering.
- gosson/ferruginous alteration (intense)
- geological boundary, indicate, inferred.
- inferred fault.
- dip/strike of bedding
- major disconformity/palaeosurface, karsted.
- drill hole with azimuth and dip, hole no:, projection crossection reference marks
- Sample; soil, rock chip area, linear, sample designation (WR89/50)

TOPOGRAPHIC

- Stream - major, flow direction, spring
- " minor, "
- steep slope. — vehicle track
- fence — derelict fence

GEOLOGICAL NOTES

1. Large pieces of honey yellow, banded travertine - Ehwk
2. Coherent outcrop of honey yellow travertine Ehwk

3a. Yellow clayey soil and scree possibly concealing Ehwk

3b. Yellow clayey soil and scree with, possibly subcropping, honey yellow travertine

3c. Similar to 3a but with substantial ferruginous float.

4. Small pods of jaspery gosson
5. Sedimentary breccia, small body, similar to but discrete from Ehwbb
6. Large >1m diam blocks of Ehwbb may be subcrop, cavern roof?
7. Poorly outcropping area, Fev alteration/staining present
8. Possible cross bedding in Ehwbc
9. Poor outcrop, much scree
10. Siliceous/sugary quartzite, iron-porous matrix - stratigraphic affin uncertain, probably local high or a raft of parachilna formation
11. Small mound of travertine (honey yellow) rubble - probably in situ
12. Upright sheet of manganiferous ironstone, partially destroyed by down hill creep to north. (blue-black colour, massive)
13. Apparently flat lying (platey fractures) manganiferous ironstone similar to 12
14. Yellow clays and silts, minor sandy deposits with ironstone, gentle westerly dip exposed in drainage slot.
15. Red-brown-dark brown, porous gossanous ironstone - probably affected and partially dismembered by NW soil creep.

16 & 17. Very ferruginous Ehwbc, of altered appearance.

18. Shaft, >10m? deep, sunk on near vertical gossan with remnant sulphides, surface expression strongly affected by down hill creep to east, gossan/vein set inferred in subsurface as shown.
19. Small pit, mullock pile contains few scattered ironstone and quartz fragments - fully excavated
20. Small lens of light grey fine grained chert, bedded.

DEMIS-MCA JOINT VENTURE

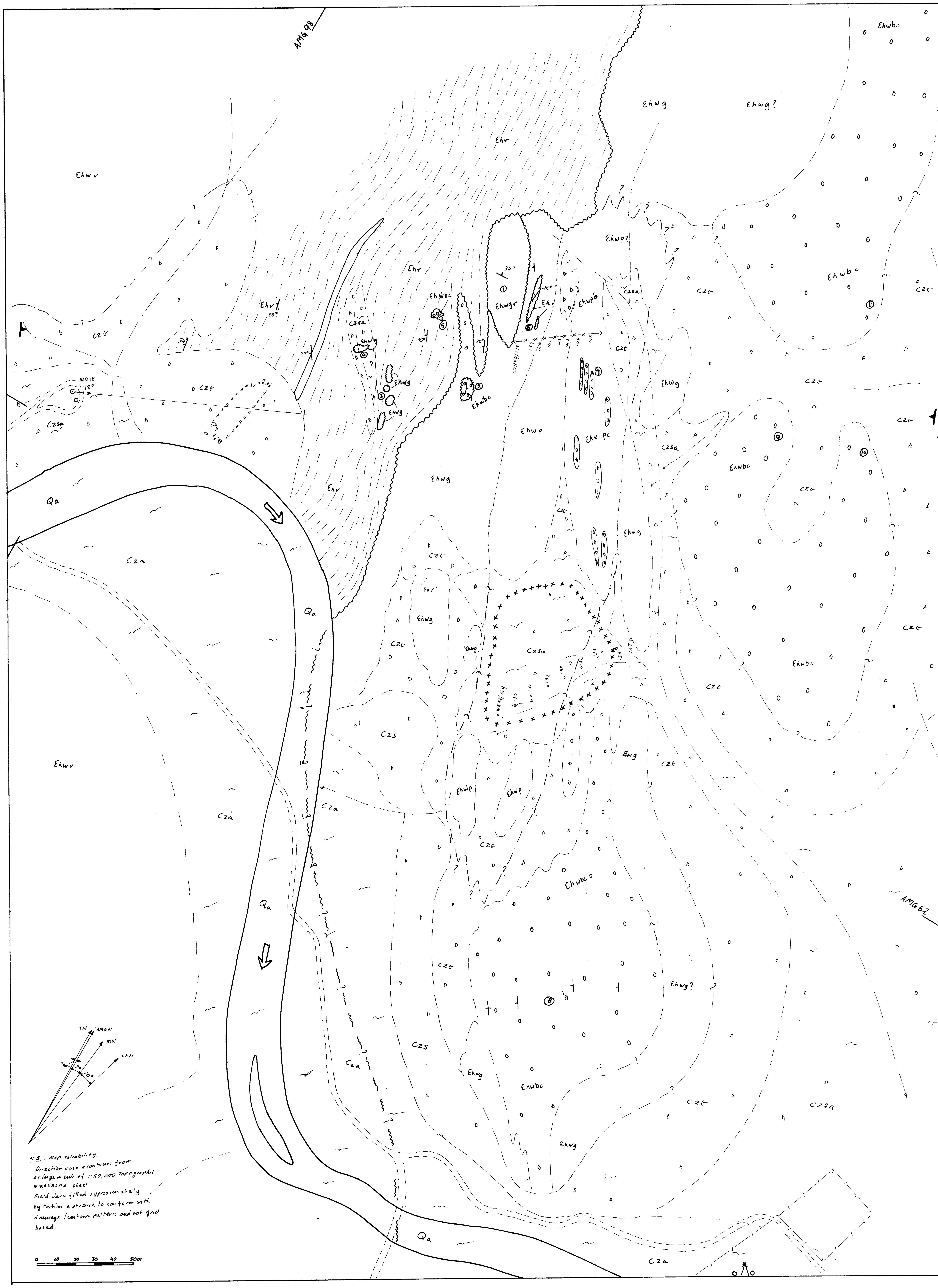
WIRREALPA E.L. 1515 S.A.

GEOLOGY MAP

OLD WIRREALPA SPRING

Prep by J.L. Curtis	Date 18/8/89	Plate No: 2
Draft by J.L. Curtis	Revis	

8072-2



LEGEND

GEOLOGY

CAINOZOIC

- Qa — QUATERNARY – alluvium, sand, gravel
- Cza — alluvial soils & colluvium
- Czsa — soil & scree, alluvial/elluvial
- Czs — Scree & soil.
- Czt — Talus – scree with subcrop

CAMBRIAN

- Ehwk — Karstic deposits, travertine – (▲ breccia)

PARARA LIMESTONE

- Ehr — Laminated, grey silty limestone with partings giving a diagnostic platey scree, locally competent silty horizons.

WILKAWILLINA LIMESTONE

- Ehwg — Massive light to dark grey, thick bedded limestone. Fractures & joints in upper part of unit may be filled with multi layered sparitic calcite
- Ehwgr — Massive grey limestone with a high proportion of Archaeocyathid coral skeletons, Large megaclast, – collapsed pillow block?
- Ehwbc — Massive, thick bedded, dark brown conglomeratic limestone,
- Ehwp — Massive light pink limestone; Appears to be hematized Ehwg
- Ehwpc — Massive Ehwp with blocks and intercalated beds of conglomerate
- Ehwpb — Small body of intraformational limestone breccia

- Fev — Yellow limonitic staining possibly due to oxidized sulphide
- Outline of possible palaeokarst – stratabound
- Cavern? now filled with Ehwk (See WD18 section) at surface, at depth.
- Regional disconformity / palaeokarstic surface.
- Limit of pink (hematitic) alteration / oxidation possibly related to inferred palaeokarst.
- Geological boundary
- Dip & Strike of bedding (32)
- Projection line for crossection.
- Soil, rock chip sample. (WR89/50)

TOPOGRAPHIC

- Stream, major
- Stream, minor
- Vehicle track.
- Fence
- Windmill & Tank

GEOLOGICAL NOTES.

1. Large block of Archaeocyathid Limestone, rests discordantly upon massive limestone. The contact dips to the SW and has characteristic red brown oxidation features typical of the Parara/Wilkawillina palaeokarst surface. The dip and strike of the block are such that if the palaeosurface was rotated back to horizontal, the dip of the block would be nearly vertical. A fallen pedestle/pillar origin is therefore inferred
2. Conglomerate block of similar origin?

3 & 4. Blocks of limestone may be either basement protrusions or free megga clasts as for ①

5. This block of conglomerate appears to be superficial
6. West dipping bodies of Parara limestone adhering to east side of hill top indicate that ① was a significant tor-like feature on the palaeosurface.
7. Conglomerate appears to have been partly lithified coherent rock before diagenisis was complete, may be transported entity
8. limestone/conglomerate cap dips westerly, relatively flat lying causing beds to appear on both sides of hill top generating false "fold pattern" on photographs. Vertical dips at "contour pinch" indicate monoclinal flexure is probably present.

9, 10, 11. Flat & shallow dipping grey limestone with large partly dismembered clasts of conglomeratic rock (with boulder size clasts) and beds?/slabs? of conglomerate suggests that conglomerate of two generations may exist. Mafics feature prominently in the conglomerates relations with ⑦ & ⑧ are obscure.

DEMIS / MCA JOINT VENTURE

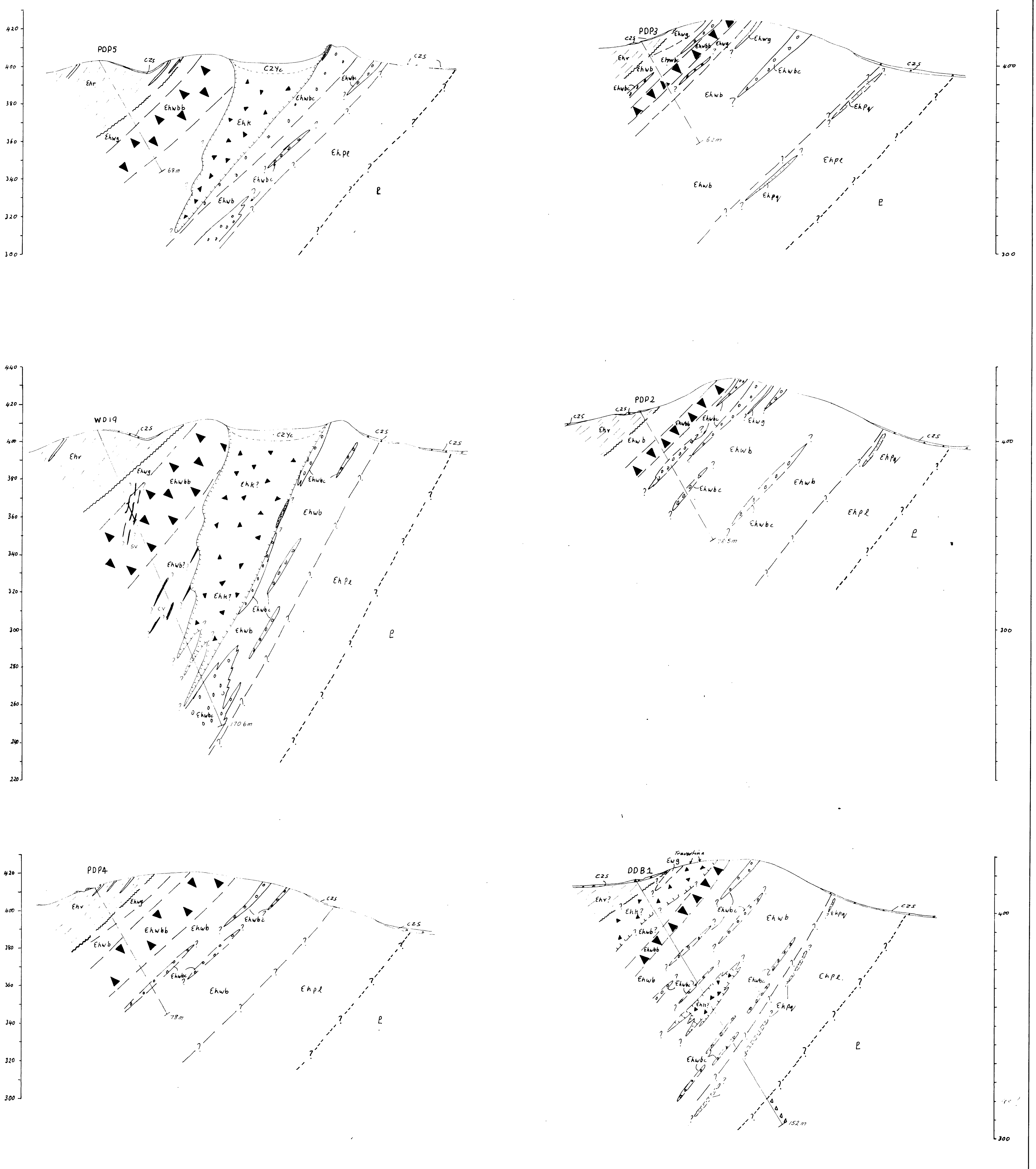
WIRREALPA E.L. 1515 S.A.

GEOLOGY SKETCH MAP.

OLD WIRREALPA SPRING – WD18 REGION.

Prep by J.L. Curtis	Date: 22/8/89	Plate No: 3
Draft by J.L. Curtis	Rev'n	

8072-3



Key

Geological codes & symbols as for Plate No 2.

Additional Codes & Symbols.

SV — Sulphide veins, galena in WD19.

CV — Calcite vein and vug fillings

Inferred extent of palaeokarst aperture.

Mineralized interval.

Notes.

Geological logs PDP4, percussion holes unavailable.

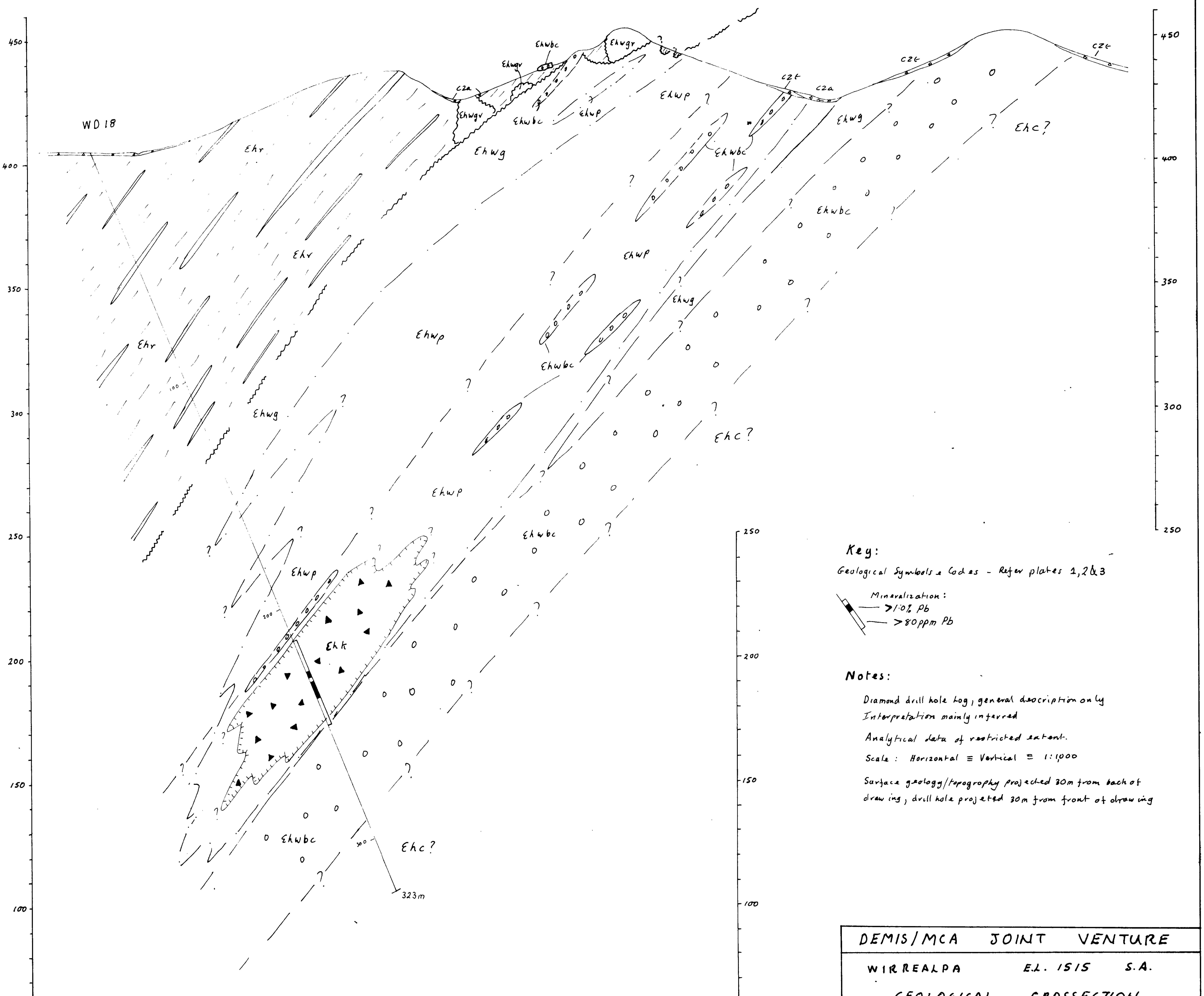
Geological logs WD19, DDB1, diamond holes, general descriptions only.

Assay data not spatially located PDP holes. and of restricted extent in diamond drill holes.

Scale Horizontal = Vertical. 1:1,000

DEMIS-MCA JOINT VENTURE		
WIRREALPA EL 1515 S.A. GEOLOGICAL CROSS SECTIONS OLD WIRREALPA SPRING		
Prep. by: J.L. Curtis	Date: 24/8/89	Plate No. 4
Draft. by: J.L. Curtis	Revis.:	

8072-4



Key:

Geological Symbols & Codes - Refer plates 1, 2 & 3

Mineralization:
- >1.0% Pb
- >80ppm Pb

Notes:

Diamond drill hole log, general description only

Interpretation mainly inferred

Analytical data of restricted extent.

Scale: Horizontal ≡ Vertical ≡ 1:1000

Surface geology/topography projected 30m from back of drawing, drill hole projected 30m from front of drawing

DEMIS/MCA JOINT VENTURE		
WIRREALPA E.L. 1515 S.A.		
GEOLOGICAL CROSSECTION WD18 AREA		
Prep by: J.L. Curtis	Date: 24/8/89	Plate No 5
Draft by: J.L. Curtis	Revis:	

8072-5

Oxford House Associates Pty. Ltd.
Mineral Exploration Consultants

Principal
Russel Bluck, B.Sc.,M.Sc.

u0123

The Director General,
Department of Mines and Energy.
P.O. Box 151,
Eastwood. 5063.
South Australia.

6 November, 1989.

Attention Mr. W. Newton.

Dear Sir,

Exploration Licence 1515, Wirrealpa.

Fourth Quarterly Report for the period 13 June, 1989 to ~~13~~ 12 September, 1989.

Introduction.

A field programme was carried out in the area to verify previous exploration information and relate the known mineralisation to the stratigraphy and specific surface features. The title lapsed on ~~13~~ 12 September, 1989, and an application has been lodged for a new title to incorporate the Wirrealpa and Mount Chambers prospects within a single Exploration Licence.

Work Completed.

Following a comprehensive review of the previous exploration data a field programme was undertaken to verify the existing data and confirm the validity of the exploration models which have been developed. Work was concentrated on the setting of mineralisation in the Cambrian limestones between Donkey Bore and Wirrealpa Springs, and on the re-sampling of previous BHP rock chip traverses. The results of the programme are presented in the attached report by J. L. Curtis.

Expenditure.

ITEM	PREVIOUS QUARTER	FOURTH QUARTER	TOTAL
Geology	$ 6,646	$ 5,577	$12,223
Technical Assistant	$ 90	$ 1,099	$ 1,189
Vehicle costs	$ 165	$ 819	$ 984
Data acquisition, plans	$ 40	$ 195	$ 235
Drafting	$ 377	-	$ 377
Running costs	$ 130	$ 538	$ 668
Reporting and admin.	$ 1,972	$ 1,028	$ 3,000
total	$ 9,420 ?	$ 9,256	$18,676

Yours faithfully,

R. G. Bluck.