Department of Mines and Energy
South Australia

MVT LEAD-ZINC REVIEW

NORTHERN FLINDERS RANGES

DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

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MISSISSIPPI VALLEY TYPE LEAD-ZINC MINERALISATION NORTHERN FLINDERS RANGES, SOUTH AUSTRALIA

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Cover Photograph: View east of Heysen Range, Rawnsley Quartzite forms the rugged peaks of the range with Lower Cambrian sediments forming the lower hills in the foreground, Photo No. 39863 .

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A TECHNICAL REVIEW OF PREVIOUS EXPLORATION IN THE CONTEXT OF CAMBRIAN PALAEOGEOGRAPHY AND TERTIARY-RECENT WEATHERING

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MISSISSIPPI VALLEY TYPE LEAD-ZINC MINERALISATION NORTHERN FLINDERS RANGES, SOUTH AUSTRALIA

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Recent advances in the understanding of the Cambrian stratigraphy and its paleogeographic setting, in combination with a realistic mineralisation model, establishes that the southern Arrowie Basin platform margin could be host to a MVT province of significance.

Detailed field studies of primary lead-zinc sulphide mineralisation, within Lower Cambrian carbonates, confirm its MVT classification and establish its relationship to later Delamerian willemite zinc deposits. New concepts concerning aspects of the transport and emplacement mechanisms of MVT mineralisation are described.

An assessment of the impact of the Tertiary to Recent weathering history on MVT mineralisation in the Northern Flinders Ranges offers new opportunities for discoveries in areas previously discarded by explorers who were discouraged by dismal results from the testing of secondary dispersed geochemical signatures.

A comprehensive literature review of previous exploration was generated to identify possible features worthy of field investigation and provide intending explorers with a springboard data package for programme generation.

**** The unit name, Parara Limestone (Tepper 1879), as used in this report will be renamed the Mernmerna Formation (Dalgarno & Johnson 1962), throughout the Arrowie Basin as a result of a current review of Cambrian stratigraphy in South Australia (See Appendix 1.3).**

INTRODUCTION

The Northern Flinders Ranges cover a region of about 15,000 Km^2 that extends to the east and north from the town of Port Augusta which is located at the head of Spencer Gulf in south Australia.

Lead-zinc was actively sought and mined from this region during the late 1880's by pioneer prospectors. In 1962 B.P. Thomson reported that a significant proportion of lead-zinc mineralisation in the Northern Flinders Ranges occurred within the Lower Cambrian. (See Appendix 1.3 refs.) Later the mineralisation was described systematically by Johns (1972), after a period of relatively intense exploration by companies during the preceding decade: 1962-1972.

Early exploration consisted of broad based geochemical programmes with routine systematic follow up. Subsequent work has focused on the testing of mineralisation concepts utilizing the same techniques. To date only small sub-economic deposits have been located and a new mineralisation type recognised - willemite zinc deposits with one such deposit being an intermittent producer.

In 1989 the synthesis of a paleoenvironmental model of the Lower Cambrian by Gravestock was completed (See Appendix 1.3) and Curtis (see Appendix 2-REV 3GPD & 37PF) recognised that the detection of massive lead-zinc sulphide mineralisation might have eluded previous explorers due to concealment by Tertiary - Recent weathering geochemical processes.

This knowledge, which indicated that there was the potential for the emplacement of major **MVT** lead zinc deposits during the Lower Cambrian and that previous exploration field methodology may have hitherto been inadequate, justified reassessment of the region.

The early part of this report systematically examines the likely processes in the development of a **MVT** deposit, briefly describes the geological setting of the Lower Cambrian stratigraphy of the region, documents the geology & mineralisation of the Linda Prospect, and assesses the impact of Tertiary-Recent weathering.

The latter sections attempt to summarize the previous work and identify field features, which may be indicative of mineralisation, that warrant field investigation. Post 1972 open file exploration data (SADME ENV.'s) in concert with other pertinent published information were examined for this purpose.

Exploration data has been condensed on to summary sheets and compiled into a computer spreadsheet summary listing for quick referencing. (See Appendixes 2 & 3). Comments offered in the summary sheets are an amalgamation of those views expressed by previous explorers and the reviewer. However, since field authentication was not an option for the authors it is entirely the responsibility of readers to independently validate for themselves the information and ideas that are presented.

The style and layout adopted is designed to function as a convenient research reference guide and field handbook for exploration geologists working on the region.

MVT MODEL

Geological research on **MVT** deposits has been extensive since their recognition as a distinct class of deposit, circa 1930. However, despite major advances in knowledge during the period 1965 - 1985 some aspects of their origin remain controversial.

The salient features and the current understanding of these deposits are outlined briefly together with mention of generic aspects that appear to be absent from mainstream literature.

Characteristics of MVT Mineralisation

Research, by workers Beales & Jackson (1966), Beals & Onasik (1970) and Anderson & Mac Queen (1982), shows that whilst individual deposits may differ, 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.

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

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

- The host lithofacies may be of either fore-reef, back-reef or less commonly reefal bioherm facies, typical of platform carbonate deposit margins.

- Both primary and/or secondary structural/ hydrochemically induced porosity/permeability can be demonstrated to predate mineral deposition. Dolomitisation of the primary limestone is commonly associated.

- Mineralisation often postdates the filling of many primary voids by marine cements and clearly postdates the earliest stages of diagenesis.

- The deposits are invariably composed of galena and/or sphalerite with accessory pyrite and/or marcasite. Galena has a typically low silver content. Minor chalcopyrite is sometimes present. A gangue of dolomite, with accessory barite, fluorite, and quartz may be present. Late clay may be deposited in residual voids.

- Deposits were formed from hypersaline brines (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. Metals appear to have been transported as chloride complexes.

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

- MVT deposits occur antipathetically with respect to petroleum reservoirs, but traces of hydrocarbons have been noted as immiscible phases in fluid inclusions (kerogen) and residues (bituminous) from many deposits.

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

- Primary shales which typically carry 20-200 ppm Pb & 50-300 ppm Zn are considered to be a likely metal source, whereas primitive limestones with lower metal levels of 4-11 ppm Pb & 20-30 ppm Zn are a probable source of hydrocarbons and sulphur.

Origin of MVT Metals

Researchers used 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.

Pre-existing permeable foci 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 also been locally sourced from the sediments. Since shales contain abundant iron, any sulphur present is likely to be bound to it and therefore effectively immobilized. Carbonate sediments are relatively low in iron compared to their primary organic content (normally lost) and are thus a more likely sulphur source.

The mechanism of the sulphur delivery remains largely conjectural since it is unlikely to have been transported within the metal pregnant brine as mutually unstable phases to the site of deposition. A two fluid mixing model of deposition has been commonly proposed, but a universal and sustainable mechanism has been elusive. This one aspect has never been fully resolved and is considered further.

Ore Fluid Geochemistry

The petroleum residues present in some **MVT** deposits could be interpreted as the remnants of the inactive phases of hydrocarbons 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 substantial **MVT** provinces.

The MVT dewatering model clearly requires a focussed but open discharge plumbing system that would ensure full flushing of hydrocarbons from any **MVT** deposit site, consistent with the antipathetic occurrence of petroleum and **MVT** deposits in any one basin.

Hydrocarbons

Primitive hydrocarbons would be expected to be sourced predominantly (early diagenesis) from 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 hydrocarbon maturity index beyond that normally attributed to the depth of burial.

Generally, petroleum hydrocarbons are compositionally sulphur poor, but this does not preclude the existence of relatively abundant sulphur as dissolved H_2S with migrating hydrocarbons. The microbiological environment responsible for the primary breakdown of the organic matter leading to the generation of kerogens is quite clearly anoxic. Should a source of sulphate, such as evaporite beds be available, anaerobic bacteria would be expected to reduce the sulphur and co-generate H_2S along with the primary kerogens.

Petroleum residues, where the appropriate basin stratigraphy is present, are therefore a `pathfinder' indicating the possible past presence of H_2S, the most likely reductant for **MVT** deposit formation.

Mixing Model

A separate delivery/mixing type hypothesis fails because it demands sustained coincident and prolonged delivery of both components at a common unique site in open hydrologic conditions for the formation of a **MVT** deposit. The improbabilities of this concept, which requires relatively unique conditions, are incompatible with the uniform characteristics of the mineralisation and its widely distributed ubiquitous presence at many scales in many similar sedimentary basins. Common hydrodynamic transport with a triggering mechanism at the site of deposition is therefore the only viable type of model.

Brine Composition

Sverjensky (1981,1984) demonstrated that the evolution of model **MVT** type brines freshly expressed from sediments would involve Ca^{2+} & K^{+} ion exchanges with minerals such as K-feldspar and muscovite during their maturation enroute to depositional sites.

Based on a typical present day oil field brine composition with a TDS in the range of 100,000 to 250,000 ppm and in the order of 0.5 ppm H_2S, and a pH in the range 4 to 6, it was also demonstrated that similar brines are capable of maintaining 1 or more ppm of both Pb and Zn in solution at around 100°C.

It was further demonstrated that such a brine would first become supersaturated with respect to sphalerite during maturation and later with respect to both sphalerite and galena. The relatively low potassium content of high carbonate aquifers is much less likely to result in sphalerite supersaturation than is the case for siliceous arenite aquifers.

Since sphalerite supersaturation results in the dispersed loss of zinc from the aquifer brine and ultimately in galena rich mineralisation, association of zinc rich deposits with carbonate aquifers and lead rich deposits with siliceous arenite aquifers is predicted.

Paragenetic sequences with early dominance of sphalerite and later galena or galena deposition, together with sedimentary associations of Pb/Zn ratios, independently corroborate this geochemical thesis.

Ore Deposition Mechanism

While Sverjensky's model explains the aquifer transport geo-chemistry and paragenesis of deposits quite adequately, the triggering device that results in sustained deposition at ore sites is not identified.

Void space utilized by **MVT** mineralisation includes sedimentary breccias, fault breccias, and palaeokarstic apertures & breccias (which may have enhanced the former types). Given the shallow depths involved, both faults and palaeokarst systems offer potential unobstructed pathways for the discharge of aquifer waters.

In an open hydraulic system such locations must be low pressure `sinks' in the palaeoaquifer which become foci toward which fluids migrate. At such sites where the permeability is dramatically increased, the laminar flow regime is largely destroyed, and homogenization of the previously stratified fluids is inevitable. (See appendix 1)

Deep basin metal pregnant brines as envisaged carry maximum totally dissolved solids and are therefore relatively dense waters. Less mature, more locally derived, and less dense basin waters originating from near basin margin sediments, possibly containing primitive hydrocarbons and/or H_2S, would also be focussed to the same low pressure areas. It seems probable that, as the primitive hydrocarbon/H_2S content increases, the higher the partial pressure of dissolved gas phases and the more the aquifer fluid density would be reduced.

Providing migration by laminar flow is maintained in the aquifer system, any `light' waters are likely to remain separate (in the uppermost zones) from `heavy' deep basin brines (in the lowermost zones) by virtue of hydrodynamic density stratification (see Appendix 1) and thus geochemical destabilisation of dissolved metals by hydrocarbon related phases or H_2S is minimised.

Among changes to aquifer fluid at the low pressure focus, cooling due to hydrocarbon degassing and homogenisation are likely to be most significant. Slight cooling, reduction in the Eh, or increase in the pH, of a near saturated sphalerite/galena brine could result in supersaturation and deposition of sulphide coeval with active dissolution of the host carbonate.

While relatively cooled, the plume of upward migrating and egressing fluids could potentially operate as a weak convective pump and cause near surface waters to infiltrate into the system causing further hydrogeochemical changes.

The above model identifies almost ideal circumstances for sustained mineral deposition from a once stable hydro-geochemical regime by locally focussed changes in aquifer flow.

The model provides for the sustained coeval transport of metals in a reduced environment, in the proximity of excess reductant, over major distances and reflects the maturation path of the fluid, while adequately explaining the presence of hydrocarbon traces at ore sites and the paragenetic features previously ascribed to a mixing type origin. It is also consistent with the ubiquitous occurrence of trace **MVT** in sedimentary systems and dispenses with the requirement to invoke complex fluid delivery mechanisms.

Alteration

While dolomitisation is almost invariably associated with MVT deposits it is not essential and may arise from multiple independent causes.

Cyclic changes in sea level may result in the short term exposure of the shallower parts of a carbonate platform sequence. Solution weathering commonly results in karsting and the development of a thick dolomitic alteration. The less indurated the platform at the time of exposure the more porous the limestone and the more pervasive this dolomitisation is likely to be. It is in fact a deep weathering feature analogous to a soil duricrust. This `diagenetic' weathering process is likely to proceed much more rapidly than the normal diagenesis of similar lithologies below the water table. (Sedimentary Facies p8)

Such events are self evidently likely to mobilise elements as dissolved aqueous phases throughout the sediments of the platform margin with relatively little impact on deeper basin fluids. The rate of sediment diagenesis in the platform margin is therefore likely to be substantially higher than in the deeper basin.

Large bodies of former limestones, largely altered to dolomite, are commonplace in carbonate sequences. Alteration on this scale requires *enmasse* introduction of magnesium, probably mobilised in basin brines during diagenesis. **MVT** deposits do not seem to be associated with this type of widespread pervasive alteration.

Dolomitisation, often present as an alteration halo to **MVT** mineralisation within otherwise unaltered limestone host rocks, may be largely a reflection of the basin brine's passage through the **MVT** site and is therefore not necessarily evidence of palaeokarsting.

Recognition of specific styles of dolomitisation and their origin in limestones is therefore a potentially important **MVT** exploration indicator tool.

CAMBRIAN GEOLOGY

Cambrian deposition was generally concordant with a degree of disconformity upon Upper Proterozoic deposits, but unconformable onlap on to older basement units of cratonic terrains may have occurred at basin extremities.

In the Northern Flinders Ranges and its surrounds, the deposition of Cambrian sequences comprised the last phases of multi-cyclic sedimentation before the onset of the Delamerian Orogeny in South Australia (482-500 Ma. B.P.).

Subsequent uplift and erosion (mainly of Tertiary age) has resulted in the restriction of exposed Cambrian successions to isolated synclinal cusps whithin the Flinders Ranges. Elsewhere the Cambrian is mainly known from drill holes that penetrate later cover sequences.

The recorded extent of the Cambrian in northeastern South Australia is referred to as the Arrowie and Warburton Basins. However, the boundary of the Arrowie Basin shown on Figure 1 is a relic of tectonics and erosion with only indirect relevance to sedimentology.

Geological Setting

The Upper Proterozoic and subsequent Cambrian sequences were laid down in an elongate trough structure that probably began as a continental suture in an Archean basement block which separated into the Gawler Craton (west), the Curnamona Nucleus (east) and possibly a block (southeast) now fully concealed beneath the Murray Basin.

The suture of possible Lower Proterozoic age established a sustained rifting environment from Middle Proterozoic time, throughout the Upper Proterozoic, and into the Lower Cambrian. Periodic rejuvenation is reflected by the multi-cyclic sedimentation pattern and the great thickness of shallow marine sediments that accumulated. This tectonic setting has similarities with aucalogens elsewhere but has a distinctly different sedimentology.

Sedimentation during the Upper Proterozoic was predominantly of arenites, shales and carbonate facies with intercalated diamictites of glacigene origin. This thick accumulation was deposited in a relatively shallow marine setting with multiple marine transgressions and retractions that are comprehensively described in Preiss (1987). Shelf environments were present to the west and east of a deeper approximately N-S meridional zone, a pattern that was replicated during Cambrian time.

Detailed studies of the Cambrian stratigraphy have culminated in the development of a regional palaeofacies depositional model for South Australia.(Jenkins & Gravestock 1988, Gravestock 1989, 1991, & Appendix 1.3).

The main pertinent feature of the model is the inferred existence of the deep water Warburton Gulf (a protoform of the Cooper Basin) that extended north from the Wirrealpa Hill Hinge **(WHH)** Line, situated in the present position of the Northern Flinders Ranges, and an extensive shallow Flinders Sea to the south, during the Lower Cambrian. (Figure 2, **(WHH**=Platform Margin)

Stratigraphy

The Cambrian sequence is subdivided into the basal Hawker Group, Billy Creek Formation, Wirrealpa Limestone and Lake Frome Group. The sedimentology of this sequence indicates progressive long term regional shallowing with higher frequency transgression/regression cycles.

The stratigraphy within the inferred Warburton Gulf in the northern Arrowie Basin is thought to have been predominantly benthonic shales with some Parara Limestone carbonate facies in the trough/platform transition. (See Figures 2 & 3)

Taxonomic descriptions and palaoefacies reconstructions are briefly described in the following sections using diagrams from the published literature. A major excerpt from a new edition of "The Geology of South Australia"(in prep.), reproduced without diagrams as Appendix 1.3, is a comprehensive analysis of these topics.

Accordingly, the following sections are focussed on geological aspects pertinent to **MVT** mineralisation.

Sedimentary Sequence

Codes (C1.1/H etc.) in the following text relate to facies relations described on page 8.

Hawker Group (C1)

The Hawker Group embraces two sedimentary facies, a shallow marine basin edge platform environment with abundant biogenic forms typified by reefal deposits (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.

Uratanna Formation (C1.1/L)

The Uratanna Formation is a siltstone/shale sequence with minor limestone that includes distinct erosional channel fills in some localities. It is limited to the northern margin of the **WHH** in the Northern Flinders Ranges.

Parachilna Formation (C1.1/L)

The Parachilna Formation is widely distributed but is often thinned or restricted to probable palaeogeographic lows on the underlying basement. The unit is argillaceous sandstone with vertical worm burrows containing intercalated lenses of oolite and shale. Basal conglomerates are locally present. It is conformably overlain by the Wilkawillina Limestone.

Wilkawillina/Ajax Limestone (C1.1/T - C1.3/H)

The Wilkawillina/Ajax Limestone is of widespread occurrence and is often found in direct disconformable contact with the Upper Proterozoic Pound Subgroup. The northwestern extent of this unit is mapped on the Copley Sheet as the Ajax Limestone, elsewhere throughout its broad extent it is known as the Wilkawillina Limestone.

The unit is predominantly light to dark grey, massive, bedded biostromal/archaeocyathan 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.

Mottling due to abundant algal filaments, nodular limestones and localised intraformational breccias are known, but these features are frequently of local extent, there being no known regional marker beds.

The presence of phosphatic horizons has been recorded from several localities.

Parara Limestone (Mernmerna Formation) (C1.1/H - C1.3/T)

The unit is a dark grey flaggy and silty limestone with interbedded shales. It is widely distributed.

In the field it is readily distinguished from the underlying Wilkawillina Limestone by its thin bedded pattern. The contact between the two units is either gradational over about 10 to 15 metres 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 interbedded with 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 is dark blue grey calcareous siltstone with minor limestone.

Bendieuta Formation (C1.2/T-H)

This unit, a coarse grained sandstone with some trough crossbeds and lesser limestone is restricted to the Mt Chambers - Reaphook Hill region.

Bunkers Sandstone (C1.3/L)

This unit, a crossbedded sandstone with calcareous interbeds, is restricted to the Donkey Bore and western Balcoracana Synclines.

Oraparinna Shale (C1.3/T-H)

This unit, a green finely micaceous and carbonaceous fossiliferous siltstone, is widespread in the study area.

Moorowie Formation (C1.3/T-H)

This unit, a sequence of sandy limestones, siltstones, shales and massive flaggy limestones, with variable colour: indicative of deposition at or near an oxidation interface, is restricted to the northern portion of the Mt. Frome Syncline.

Narina Greywacke (C1.3/H)

This unit, an interbedded sequence of grey green interbedded calcareous siltstone and chloritic sandstone with some interbeds of cream/purple flaggy dolomite, is limited to the central north of the study area.

Billy Creek Formation (C2.1)

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

Wirrealpa Limestone (C2.2)

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

Lake Frome Group (C3)

The Lake Frome Group is composed 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 colour throughout, which coupled with the evidence of halite, implies a semi-terrestrial environment of deposition. Trilobite traces and minor carbonates are present at two levels, suggesting that possible marine incursions of short duration occurred.

Depositional Environments

Aspects of stratigraphy affecting aquifer permeability and potential **MVT** deposit sites are now considered.

Overview

Following early cycle arenite/lutite deposition (Uratanna & Parachilna Formations) widespread shallow marine carbonates were laid down (lower Wilkawillina Limestone).

Sedimentation was briefly interrupted by minor epeirogenic tectonic adjustments in the basement and a continent wide fall in sea level, which resulted in local emergence laterally to the east and west accompanied by deepening in the central north. (See Figures 4 & 5)

Coeval deposition of shallow shelf facies (upper Wilkawillina Limestone) and basin facies (Parara Limestone) carbonate units followed. (Figure 3). Initially deposits were conformable with the previous units, but progressive staged marine transgression reclaimed initially emergent areas, resulting in deposition on the widely recognisable Flinders Unconformity.

Additional disconformities and interdigitation of sedimentary facies types are evidence that tectonic adjustments continued to cause localised regression/transgression cycles.

The accumulation of cyclic shale and limestone sequences contributed to the progressive shallowing of the Cambrian basin. This finally resulted in the deposition of red-bed sequences with initial marine oxidizing conditions and later semi-terrestrial deposits (Billy Creek Formation and Lake Frome Group) with temporary facies controlled oxidising or reducing conditions (Wirrealpa Limestone).

Sedimentary Facies

The sedimentological facies history is illustrated in figures 4 and 5. Gravestock (in prep.) and Clarke (1990) have used palaeontological correlations to demonstrate that three very similar sedimentation cycles occurred during Hawker Group deposition (C1.1 ,C1.2, & C1.3).

At the beginning of the second C1.2 and third C1.3 cycles substantial regression led to exposure and erosion of parts of the sequence and the probable emergence of an archipelago or temporary land-bridge between the Arrowie and Stansbury Basins at the southern end of the study area.

Exposures in this type of setting favoured solution weathering and karstification of shelf carbonates due to falling water tables and the influx of meteoric water. While the chemistry of meteoric diagenesis, which resulted in widespread dolomitisation of platform carbonate, is not well understood, it is clear however, that diagenetic processes in the adjacent basin sediments were much slower.

During the following C1.2 transgression, as water tables rose to the surface a weakly phosphatic red algal coating developed on the palaeosurface (Flinders Unconformity) and many of the bedrock fissures were slowly filled in with multilayered carbonate cements. (See Appendix 1.3)

Given the likely physiography of the platform, large tracts of coast were probably covered by this coating, at near sea level where a small transgressive rise resulted in extensive drowning (analogous to the physiology of a sabkha-like setting). This event has been recognised in Cambrian platform successions of the Amadeus and Georgina Basins in the Northern Territory as well as elsewhere in SA within the Arrowie and Stansbury Basins.

Since the stratigraphy was flat lying throughout, the palaeosurface was not finally covered on the most elevated parts of the Central and Eastern shelves, until Billy Creek Formation deposition. The palaeosurface is diachronous over cycles C1.2 & C1.3 and recognised in the literature as the Flinders Unconformity although it is actually a disconformity. (See Figure 5).

In the western part of the trough, a clean C1.1/C1.2 break in sedimentation within the Ajax Limestone is not physically evident, but given the substantial evidence that a hiatus in deposition was widespread and an appropriate faunal break, within a uniform near shore shelly facies, has been recognised at Mt. Scott Range, a paraconformity is inferred. (See Gravestock, 1984, stratigraphic section N)

Parara Limestone

Where transgression was relatively rapid during cycle C1.1 the development of massive biohermal deposits was precluded and the muddy Parara Limestone facies was deposited directly on to the Flinders Unconformity over wide tracts of the platform.

The C1.2 & C1.3 cycles are recognised palaeontologically but have little or no lithological expression within the Parara Limestone in more basinal regions.

Wilkawillina Limestone

Less prominent disconformities recognised by Clarke (1990c) in the upper Wilkawillina Limestone in the Bunkers Graben are not so evident elsewhere, but are represented at Old Wirrealpa Mine. (See Figures 6 & 10a,b)

At the latter site, the C1.2/C1.3 boundary is diffuse in the exposure, but the change is marked by a pink oxidation zone and clear evidence of cavity enlargement by solution in the substrate. At the top of C1.3, small channel deposits within limestone a few metres below the contact with the Billy Creek Formation, indicate a brief influx of terrigenous material.

Dolomitisation and weak silicification at the top of C1.3 just below the Billy Creek Formation is considered to be diagenetic and unrelated to palaeoweathering.

Tuffs in this position and larger channel deposits are correlated with the `Kangarooian Movement'. Associated local regressions stimulated erosion that exposed Adelaidean units and released clastic detritus on to the platform.

Within the C1.3 cycle Clarke (1990c) recognises a further disconformity (K3) in the Bunkers Graben that is expressed as a sedimentary break with minor reddening of the substrate at Old Wirrealpa Mine. This break is not readily recognised beyond the limits of the Balcoracana, Narina and Donkey Bore Synclines.

Elsewhere, the oxidation characteristics of rocks mapped by Union Miniere at the Eric Prospect at Mt. Chambers, and the stratigraphic relationships mapped by BHP at Third Plain suggest that brief localised breaks in sedimentation were probably common on the shallower sections of the C1 platform.

In the Bunyeroo Syncline Morris (1986) also recognised a possible early palaeokarstic break below the Flinders Unconformity which he used to locally subdivide the lower Wilkawillina Limestone.

Depending on local conditions, each of these breaks had the potential to develop karst profiles. Gravestock (pers. comm.) suggests that such small deposition/exposure cycles were probably of 3 or less million years duration. This implies that the C1 sequence may have been deposited over a period of about 10 million years.

Phosphate Occurrences

It seems from the scant exploration data that phosphate is only present in the Narina/Donkey Bore region. While the stratigraphic position has not been field verified it seems that the distribution is generic and related to a shelf-break re-entrant formed during C1.2, extending back from the **WHH** into the present day location of the Balcoracana Syncline.

Since apatite deposition results from excess Ca^{++} due to depleted CO_3^{--} in restricted marine settings, ground/meteoric water influx from the adjacent terrain has a controlling influence. Both coastal drowning on transgression or desiccation during regression could reduce CO_3^{--} availability. In the latter situation, marine aquifer invasion could result in exchange of magnesium for calcium associated with meteoric diagenetic dolomitisation and increase the marine Ca^{++} concentration without appreciable changes in the CO_3^{--} availability.

It is therefore inferred that phosphate was probably deposited in C1.2 upper Wilkawillina Limestone at restricted localities not far above the basal Flinders Unconformity during the *L*owstand *P*hase in a near shore environment, and possibly although much less likely, at the top of the *H*ighstand *P*hase where the restricted re-entrant environment persisted.

Minor phosphate in the Flinders Unconformity red crust is consistent with Highstand Phase conditions. (See Appendix 1.3).

Sedimentological Instability

Each time such a new lowstand occurred, biohermal reefs of the previous highstand were vulnerable to physical breakdown along the platform margin and consequently shed materials by gravity creep, glide and turbidity flows of restricted extent.

Differential syntaphral settling of the competent reef limestone masses, built out over muds, which probably resulted in fracturing and localised gravity/slump induced faulting within the reef body also contributed to break-up.

James and Gravestock (1990) developed sedimentary models that reflect such processes during the development of the C1 sequence. They show a number of scenarios for the generation and maintenance of permeable pathways that could have been the focus for later basin dewatering fluids. (See Figure 7.)

Structure

Fundamental Fabric

The Adelaide Geosyncline comprises a late Precambrian/Cambrian multicyclic sequence that has 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 and commonly occur as fold core plumes or linear fault related bodies.

In the Flinders Ranges three prominent structural orientations can be recognised in this contorted maze. The primary structure is the north-south orientation of the main depositional trough which has been emphasised by Tertiary epeirogenic uplift expressed by present day relief. The other two prominent structural trends are generally NW-SE and SW-NE conjugate directions which are expressed as either faults or fold axes at different places along regional strike.

These directions are a subset of a fundamental fracture set that is commonly recognised to have influenced the distribution and character of geological units throughout the geological history of South Australia. Structures of this scale have the property of imparting inheritance into cover sequences by upward propagation during periods of regional stress. It follows that structures of this type which exhibit strong inheritance in the present post-folding regime had profound influence during pre-folding times.

It is thus no surprise that the cusp of the Platform Margin illustrated on Figures 2 & 14, (derived strictly from taxonomic geology), is roughly coincident with the intersection of the Norwest Fault (NW) and the Paralana Fault System (NE).

Sympathetic, less prominent structures of similar generalized orientation can be recognised crossing the fold belt, often refracted through diapiric features.

Influence on Sedimentation

Two well studied sites provide clear evidence that the platform sequences were affected by epeirogenesis along the main structural trends with coeval mobilisation of basement diapirs.

Along the Donkey Bore Ridge (NW), observations indicate that the lower Wilkawillina Limestone on-lapped the Wirrealpa Diapir, initially with a basal conglomeratic facies. Subsequently, uplift occurred with the result that large rafts and debris flows of older material were dumped on and incorporated into to later sediments. At one location, massive blocks of basal archaeocyathan limestone are perched like glacial erratics on the Flinders Unconformity.

A study of the Bunkers Graben shows systematic disharmonic fault displacements which are reflected in the detailed facies distribution that implies sustained subsidence. The graben is oriented NE and has its SW apex focussed toward the Oraparinna Diapir (Note the map presentation is an oblique cross sectional view).

This evidence suggests that, while sequence C1 was being deposited, episodic to creeping adjustments on basement structures occurred. Such movements were probably locally independent of the transgression/ regression cycles being more related to the general long term settling of the "geosynclinal" trough and isostatic adjustments to the changes of sea level and accumulating sediments.

Additional evidence points to active elevation of the Blinman-Oraparinna Dome during this period with probable terrestrial exposure of Adelaidean sequences during sequence C2 deposition.

The occurrence of mafic to intermediate pyroclastic volcanism late in C1.3 & early C2.1 is probably reflective of a tensional stress regime related to epeirogenesis.

This key evidence means that major joints and faults throughout the platform had little opportunity to atrophy and become impermeable through deposition of diagenetic minerals. In addition these instabilities would have favoured the disintegration of platform bioherms, paricularly where they had built outward over unstable muddy deposits.

Dewatering

At the close of C1 deposition the following was apparent:

- Either the Parara Limestone, or Oraparinna Shale overlay the lower Wilkawillina Limestone and were interdigitate with the Ajax/upper Wilkawillina Limestone.

- Meteoric related diagenesis of the Wilkawillina Limestone occurred far in advance of the lateral/covering units such that some relict and palaeokarstic secondary permeability was retained.

- The lateral/covering units, being well laminated silty carbonates with shaly interbeds, would have had relatively high lateral to vertical permeability ratios, resulting in their effectively being aquitards to any underlying permeable unit.

- Weak but sustained syntaphral and/or minor tectonic adjustments would have maintained fracture permeability within the Wilkawillina Limestone.

- A regional set of basement faults was active during C1 sequence deposition.

- All of the above features were present at the close of cycle C1 deposition and collectively would have directed waters egressing from the "Warburton Gulf" into and through the platform sequence. (See Figure 8).

The stratigraphic model developed by Gravestock is clearly in accord with the main regional and localised geological criteria identified by the **MVT** mineralisation model described in section 2.

MVT MINERALISATION

Linda Prospect

Following the discovery and delineation of weathering products of zinc and lead sulphides as well as minor fresh galena on the surface at B.H.P.'s Linda Prospect (Figure 9), a programme of percussion and diamond drilling was undertaken on and about the mineralisation. Diamond drill holes DLP1 and DLP2 encountered fresh sphalerite. This mineralisation is discussed in detail, as the textural relationships of the sulphides and carbonates illustrate the metallogenic processes quite clearly.

Weathered material from base metal prospects of this type elsewhere in the Flinders Ranges exhibits subtle textures analogous to those observed in weathered material at Linda. The Linda area is used as the type example for primary carbonate-hosted lead-zinc mineralisation in the Flinders Ranges.

Local Geology

The most striking geological feature of the area (Figure 10b) is a biohermal complex at the southeastern margin of the synsedimentary Bunkers Graben, the subsidence of which allowed the localised cyclic development of the bioherms and the accumulation of a reef-like complex. Development of the complex occurred from before the time of Early Cambrian Faunal Assemblage 2 of Daily (1956) to immediately before deposition of the overlying Billy Creek Formation. Most of the observed mineralisation here is localised in the area of the biohermal complex (Figure 9) in the upper Wilkawillina Limestone. Figures 10a & 10b show a stratigraphic facies interpretation of the graben from Clarke (1990b&c).

Lithologies encountered in the biohermal complex vary from calcilutite to calcirudite, and include ooid grainstones. Immediately to the southwest of the main mineralised area is an area of collapsed blocks of biohermal material up to several metres in size. Spaces between the blocks are filled with calcilutite, calcarenite, bioclastic material and fibrous calcite (early marine) cement, neomorphosed to sparry calcite in places. Fibrous calcite cement is also present as an early cavity fill in the other lithologies throughout the area.

Individual bioherms vary in length from 1 metre to over 10 metres and are up to 2 metres thick. They consist mainly of archaeocyaths bound together by the encrusting calcified microbiota *Renalcis* and *Epiphyton*. Further detail on such buildups is given in James & Gravestock (1990).

The biohermal complex was thus a reservoir of organic matter during early diagenesis.

Permeability

Within the biohermal complex, the average grainsize is coarse relative to the intertonguing finer grained deeper water facies of the more central graben sequence exposed several hundred metres to the southwest.

It is inferred that cross-stratal permeability within the basinal facies would have been low due to the presence of the very fine grained beds which acted as aquicludes. In contrast, cross stratal permeability within the biohermal complex was initially quite high.

This permeability was provided by well sorted units such as ooid grainstone, by spaces between collapsed blocks, by open cavities in biohermal material including the central cavities of archaeocyaths, and by shelter porosity beneath various types of clasts. Such primary porosity/permeability is visible in unmineralised Wilkawillina Limestone and its equivalents throughout the Flinders Ranges.

The early marine cementation referred to previously would have rapidly occluded much of this primary permeability, leaving only narrow fluid pathways. Fracture related permeability would have been maintained by local tectonic movement related to graben subsidence. Thus, some permeability was always present up to the time of mineralisation.

Diagenetic Dolomitisation

Mineralisation of this type throughout the Flinders Ranges is invariably associated with dolomitisation, but not all dolomitised areas are mineralised.

At Linda Prospect, dolomitisation is extensive in the area of the biohermal complex, and is easily recognized by its cream to yellow-brown colour. It is a microcrystalline diagenetic dolomite which replaces calcite rather than being a cavity filling dolomite cement. The dolomite appears to preferentially replace early marine calcite cements, which lined the majority of remaining pore spaces at the end of marine cementation.

The diagenetic dolomitisation is regarded as being due to chemical reactions at the fresh/saline water interface. The position of this interface would have varied through time due to the combination of local tectonic influences, varying input rates of meteoric water, and eustatic sea level changes. Such movement of the interface accounts for the apparently irregular distribution of the dolomite.

Depending on the exact mechanism of dolomitisation (Machel & Mountjoy, 1986), the permeability could have been increased by a volume change on conversion of calcite to dolomite.

All of the samples of diagenetic dolomite analyzed are disordered, containing up to 9% excess Ca, indicating formation at low (<150 +°C) temperatures.

Dolomitisation could have occurred at any time after early marine calcite cementation and before mineralisation. The diagenetic dolomite will be referred to as precursor dolomite for the remainder of this discussion.

Sulphide Paragenesis

It is clear from textural evidence that the zinc and lead sulphides replace precursor dolomite, and only appear to have infilled pre-existing open cavities. This illusion is produced by the sequential replacement of marine calcite cement by precursor dolomite followed by sulphides.

The following summary reaction is proposed as a mechanism for the replacement of dolomite by sphalerite (Jenkins, in prep.):

$$CaMg(CO_3)_2 + 2H_2S + 2Zn^{2+} \rightleftharpoons 2ZnS + 2H_2CO_3 + Ca^{2+} + Mg^{2+} \quad (1)$$

A similar reaction can be written for the replacement of dolomite by galena. H_2CO_3 is regarded as the most stable carbonate species in solution under the known conditions of mineralisation according to the data of Helgeson (1969).

It can be demonstrated that significant volume changes occur. In the case of sphalerite, the forward reaction would lead to a 25% reduction in the volume of solids (dolomite + sphalerite) present, and in the case of galena, a less significant 1.5% volume reduction (Jenkins, in prep.).

In addition, the H_2CO_3 produced by the forward reaction could have the potential to further dissolve calcite and dolomite. The amount of secondary corrosion of carbonates would be dependent on the two step dissociation of H_2CO_3 to produce free H^+. Controls on this dissociation are complex, and include P-T conditions.

However, some dissociation with consequent carbonate dissolution was bound to have occurred close to the sulphide mineralisation, and further dissociation and dissolution could be expected with changing conditions in the percolating fluids away from the mineralisation. In particular, dissolution of carbonates could be expected higher in the stratigraphy, with its exact position depending on the path of fluid flow towards the point of surface discharge of the groundwater.

This has profound implications for carbonate hosted lead-zinc deposits generally, and confirms theories put forward by Anderson (1983). Firstly, it indicates that a large amount of open space in host material is not a prerequisite for significant sulphide accumulation to occur, as the mineralizing process can be initiated in dolomitic host rock of relatively low permeability and generate its own open space as it proceeds.

Secondly, as the forward reaction depletes the precursor dolomite, the dissolution of surrounding calcite due to H_2CO_3 dissociation may buffer the mineralizing solution with respect to dolomite and permit sustained sulphide precipitation in the presence of petroleum and/or organic matter and/or H_2S, (reductants and sources of sulphur) provided that the fluid contains some Mg^{2+}. This effect is summarized by the following probable secondary reactions:

$$H^+ + HCO_3^- + CaCO_3 \rightleftharpoons Ca^{2+} + 2HCO_3^- \quad \text{(2)}$$

$$HS^- + HCO_3^- \rightleftharpoons H_2S + CO_3^{2-} \quad \text{(3)}$$

$$2CO_3^{2-} + Ca^{2+} + Mg^{2+} \rightleftharpoons CaMg(CO_3)_2 \quad \text{(4)}$$

Clearly, sulphide mineralisation due to reaction (1) could be terminated by a decrease in the supply of zinc or reduced sulphur, in which case the reaction could reverse, with precipitation of dolomite at the expense of sphalerite. Sulphide mineralisation dependent on the secondary reactions (2), (3) and (4) could be terminated by loss of Mg^{2+} from the system as well as by a decrease in availability of zinc and/or reduced sulphur.

Following the main episode of sulphide mineralisation at Linda Prospect, coarse euhedral dolomite was precipitated, replacing sulphides, and tending to occlude some of the permeability generated earlier due to an increase in the volume of solids present. This dolomite was precipitated in response to changes in the ratios of dissolved species in the percolating fluids, and represents a reversal of the dolomite/sulphide replacement reaction.

Towards the end of this episode of dolomite precipitation, as fluid composition approached that favouring sulphide precipitation, zincian dolomite rims were formed on some of the dolomite grains by cation substitution of Zn^{2+} in the dolomite lattice. The availability of reduced sulphur in the system may have been insufficient to produce sphalerite at this stage even though levels of zinc were high.

A short episode of sphalerite precipitation followed, after which subhedral dolomite was precipitated. The final stages of mineralisation (which do not appear to be a Delamerian overprint) involved precipitation of galena in fractures and coarse calcite-fine grained pyrite veining. The fractures in which galena was observed are less then several millimetres in thickness, and occasionally the galena is concentrated in stylolites. Veins of coarse calcite-fine grained pyrite, observed in drill core, are predominantly less than 1 mm in thickness, with pyrite making up less than 10% of the vein material.

The dissolution of carbonates in the host environment during sulphide precipitation is potentially sustainable, with the cavities formed growing much faster than they can be infilled with sulphide. The corrosive solution both at the mineralizing site and flowing through the system away from the mineralizing site has the ability to replicate all the solution features normally associated with near surface karstic processes due to percolation of meteoric waters. These features include sedimentary breccias and collapse structures.

Cyclic changes in the ratios of various dissolved species could lead to the sulphide-carbonate banding observed in many carbonate hosted lead-zinc deposits.

In the case of the samples obtained from Linda Prospect, the process appears to have terminated after two cycles of sphalerite precipitation. This has provided a record of the mechanism of initiation and perpetuation of mineralisation, which is usually not observed in major orebodies due to overprinting by the later stages of paragenesis.

Another aspect of the dolomite/sulphide replacement reaction is that it predicts the possibility of primary smithsonite deposition during the mineralizing process. The identity of the stable zinc bearing solid precipitated is due to ratios between, rather than absolute amounts of, the various species in solution (Jenkins, in prep.). While primary smithsonite undoubtedly produced by this mechanism has not been observed in the Flinders Ranges (although minor smithsonite has been observed at Puttapa), it may have been observed at the Narlarla deposits in Western Australia (Ringrose, 1989), but mistakenly regarded as a weathering product due to assumed chemical constraints.

Clay minerals related to the base metal paragenesis as described from other **MVT** deposits were not observed in the core samples examined.

No evidence of Delamerian overprinted willemite or sulphide mineralisation was observed.

Microprobe Geochemistry

Microprobe analyses were carried out on discrete carbonate, sphalerite and galena grains for substituent elements to study the effect of mineralizing solutions on carbonates and to characterize the sulphides. Results are presented here as percentages. Full analytical details are presented in Jenkins (in prep.).

The study compared carbonates from 10 metres away from mineralised outcrops with corresponding generations of carbonate from within a few centimetres of sulphides or their weathering products. The types of carbonate analyzed were: (neomorphosed) primary calcite, early marine fibrous calcite cement, sparry and blocky calcite, late vein calcite, precursor dolomite, euhedral dolomite replacing sphalerite, and coarse subhedral dolomite. Analyses were for Mg, Mn, Fe, Sr and Zn in calcite, and for Mn, Fe, Zn and Ca in dolomite. The results (excluding Ca in dolomite) are summarized in Table 1.

Statistically significant differences in carbonate chemistry were noted as follows :-

- Mg is depleted in fibrous calcite cement and in sparry and blocky calcite cement adjacent to mineralisation relative to elsewhere.
- Fe and Mn are enriched in fibrous calcite cement adjacent to mineralisation, and depleted in sparry and blocky calcite adjacent to mineralisation.
- Zn is enriched in sparry and blocky calcite adjacent to mineralisation.
- Zn levels are generally high but sporadic in precursor dolomite adjacent to mineralisation, and high in euhedral dolomite which replaces sphalerite.

Dispersion haloes within carbonates about the mineralisation are very narrow with respect to the elements analyzed. The most promising indicator element would appear to be Zn itself, particularly in dolomite.

Sphalerite was analyzed for a variety of trace elements. Average contents of substituent elements detected were Fe 0.17%, Cd 0.15%, Hg 0.08%, Se 0.06%, Bi 0.02%. Elements not detected were (detection limits in brackets) Ag (.02%), Co (.01%), Cu (.01%), Ga (.02%), Ge (.01%), In (.03%), Mn (.01%), Pb (.06%) and Sb (.01%).

Galena was also analyzed for substituent elements, but none were detected. Those analyzed were Ag (.02%), Bi (.05%), Sb (.02%) and Zn (.01%).

The substituent elements detected in sphalerite may be useful in rock chip and stream sediment sample analysis as indicators of sulphide mineralisation, but the extent of any dispersion halo involving them is indeterminate. A correlation between Cd and Zn has been recorded in rock chip samples from Manga and Llina Prospects by Morris (1986).

Weathering Products

At Linda Prospect, surface mineralisation occurs as irregular knobs and veinlets, up to 10cm in size, of smithsonite and hydrozincite with lesser cerussite and partly oxidized galena, in weathered carbonate with some silica. The zinc carbonates are clearly a weathering product; drill hole information shows that their abundance increases at the expense of sphalerite towards the surface. At the surface, smithsonite usually contains relict wisps and traces of its precursor sphalerite, only detectable by microscopy and electron imagery.

The observation that smithsonite replaces calcite along crystallographic planes (dolomite is relatively unaffected) clearly indicates remobilization of Zn in solution and can only be an effect of weathering, as fresh material is unaffected.

At surface, the precursor dolomite is strongly weathered, with much staining by manganese minerals whereas the syn- and post-mineralisation euhedral and subhedral dolomites are much less affected by weathering, and are easily recognized microscopically despite some discolouration.

The microtextures and relationships of sulphide weathering products to carbonates observable in weathered surface material correspond to those in fresh material from some depth, except in very porous material from which both primary and secondary carbonate and sulphide have been leached.

Research Options

Further work is required to define the distribution of Zn-rich dolomite in mineralised areas and to develop easy field techniques for detecting Zn substitution in dolomite.

Development of a simple field test to discriminate between the `weather prone' precursor and relatively `inert' **MVT** related dolomites could be valuable.

The extent of dispersion haloes of substituent elements detected in sphalerite needs to be defined around known mineralised areas.

Willemite Mineralisation

Willemite is recognised at a number of localities throughout the Northern Flinders Ranges, where in some instances a close spatial relationship to sulphide mineralisation is observed. This correlation has sometimes led to the assumption that anhydrous zinc silicate mineralisation is a secondary weathering product.

Field relations indicate that a hematitic alteration of a type not seen at sulphide only sites is invariably associated with willemite. Mineralisation is commonly veiniform and almost always related to (sometimes within) well defined structures, many of which are demonstrably of post/syn Delamerian orogenic age.

Willemite Deposition

Dana (1932) records that, unlike willemite, the hydrated zinc silicate, Hemimorphite, "calamine" $(ZnOH)_2SiO_3$ is widely reported from Mississippi Valley region of the USA and is invariably associated with carbonate hosted sulphide deposits. Furthermore, dehydration only occurs at > 350 °C and is hence unlikely even in an arid climate. Dana lists a multitude of complex hydrated zinc minerals and very few anhydrous species reflecting its well documented amphoteric chemistry and mobility in the natural environment. Given the above, the limited range of accessory minerals accompanying willemite in the Northern Flinders Ranges is at odds with a secondary weathering origin.

Puttapa is the best studied deposit. Muller (1972) described the geology and Grubb (1971) the mineralogy. Grubb inferred that hot saline solutions at temperatures above 250 °C were responsible for the deposition of this willemite. The observed hematitic alteration also suggests that at least weak oxidizing conditions also prevailed. Grubb's work is consistent with the information gleaned from Dana, and it is concluded that willemite found in the Northern Flinders Ranges is not a secondary weathering product of **MVT** or any other type of sulphide mineralisation.

The MVT-Willemite Association

The enigmatic close spatial relationships of **MVT** and willemite observed at some localities in the Northern Flinders Ranges is, however resolvable by the following model.

It is submitted that Delamerian neo-morphically driven fluids mobilised zinc from local sources (**MVT** mineralisation ?) and subsequently deposited willemite where oxidizing conditions prevailed. This thesis also implies that a second generation of epigenetic sulphide mineralisation may exist. Many of the small vein/fracture related lead zinc occurrences at similar structural sites in the Adelaidean basement and sometimes recorded in association with **MVT** in the Lower Cambrian, are possibly of this origin.

Given the pre-existence of **MVT** mineralisation focussed about fundamental structures it is inevitable that the distribution of late epigenetic Delamerian willemite mineralisation would tend to be biased to similar locations.

However, since the late neomorphic hydrological regime and fluid geochemistry is likely to be quite different to that of **MVT** deposition, some paragenetic overprinting on primary **MVT** mineralisation may have occurred but it may not be distinguishable where reducing conditions prevailed.

Field Observations

Using the data from Robertson (1988), Curtis (1989) examined the distribution of all lead-zinc mineralisation in the Northern Flinders Ranges. This rudimentary literature study not only confirmed the strong bias of lead-zinc mineralisation toward Lower Cambrian carbonate facies rocks (previously recognised by Johns (1972)), but also showed that the majority of such occurrences bore an affiliation with a **MVT** type genesis. Other types of mineralisation occur predominantly in Adelaidean and rarely in Cambrian units with a strong correlation with structures active during the Delamerian folding and/or diapir mobilisation.

Given the newly available reconstruction of the Cambrian stratigraphy, it has become clear that most of the primary regional criteria for the development of a **MVT** province existed during the Lower Cambrian and there were substantial indications that lead-zinc was mobile at that time. Importantly, the recognition of the Warburton Gulf not only fulfilled the major metal pregnant dewatering source requirement for the generation of economically significant deposits, but also provided the ability to predict flow path geometry through the adjacent platform, aspects hitherto beyond grasp.

The majority of exploration data collected over the last 20 or so years is largely of 1973 vintage, with a scatter of work during the mid 80's on the eastern half of the Parachilna 1:250,000 Sheet. This work has so far only outlined one willemite orebody at Puttapa. The majority of the work was focused on the geochemical techniques of stream, soil, and rock chip sampling, which often found strong anomalies that apparently failed to be indicators of substantial mineralisation.

The literature studied on this project indicates that the geochemical data were largely examined on an empirical statistical basis, followed up by field inspection, and occasionally geophysical survey and/or small drilling programmes, which were generally disappointing. Generally, company exploration, with important exceptions, placed relatively little emphasis on detailed host rock geology and even less on the geochemical impact of pre/post uplift weathering of the Northern Flinders Ranges.

BHP through its subsidiary, Dampier Mining Pty. Ltd. and Mines Exploration Pty. Ltd., (to a lesser extent) broke the historical empirical pattern by correlating mineralisation to palaeokarstic surfaces/stratigraphy and then exploring on that basis. In more recent time, Demis Pty. Ltd. was able to demonstrate the field application of concepts involving Cretaceous/Tertiary weathering profiles with encouraging results. (See reviews 36PD & 37PF, Appendix 3.2)

Stratigraphic Relations

BHP geologists focussed their attention on what was termed prepared ground, normally a relatively restricted zone ($\approx$ 1 m) of sparite filled cavities commonly located in the top of massive limestone beds. Occasionally these features were much thicker. Some were definitely associated with other palaeokarstic features such as the Flinders Unconformity.

Subsequently, Gravestock and others showed that the sparite was of marine diagenetic origin and largely unrelated to lead-zinc mineralising processes. The existence of the sparite merely indicates a pre-diagenetic solution or structurally induced porosity.

Jenkins (Sulphide Paragenesis P12 and in prep.) has been able to show that small residual relict porosity in such prepared ground can provide access to mineralising fluids, which may sequentially replace dolomite/sparite with sulphides. Where this process has gone to completion sulphide appears to have just occupied pre-existing cavities without the interim step. Later dolomite fills up any remaining voids in the host rock at the close of **MVT** paragenesis.

The close spatial position of the Adelaidean Pound Subgroup arenite sequence is such that these units may have been also involved in Cambrian age sediment dewatering but there is no known supporting evidence for this. In particular there is no clear zonal bias in the distribution of lead/zinc dominance related to Hawker Group stratigraphy that would otherwise be anticipated. Given the relative age difference and disconformable relationship it is probable that the permeability was considerably lower than that of sediments in similar structural position in other **MVT** provinces where such a involvement has been suggested. The basal Parachilna Formation is unlikely to have fullfilled a similar function due to its irregular distribution and lithology.

Since primary porosity of any kind in limestones is amenable to both early diagenetic sparite and later mineralisation it follows that **MVT** potential is not restricted to zones of palaeokarsting. Other geological situations such as intraformational debris flow or reef front marine talus breccias, clastically infilled deep fissures in biohermal reef complexes, and simple fault breccias are also potential **MVT** sites. (Callahan (1967) describes such features but inferred **MVT** mineralisation to be of syngenetic origin).

Since palaeokarsting provides a relatively extensive sheet like body of permeable ground, the latter modes are always likely to be of lower frequency in any one basin system. Examples of these less common **MVT** situations have been recently documented: from the Lennard Shelf, WA (Ringrose, 1989 - fault related) and Bleiberg-Kreuth, Austria (Cerny, 1989 - breccia related).

The Northern Flinders Ranges Lower Cambrian palaeogeographic model in combination with tectonic structure provides opportunities for nearly all **MVT** modes and has the in-built capacity to provide a predictive basis for mineralisation style.

It therefore follows that the spatial and sedimentological matching of **MVT** prone structure and facies scenarios, from the models, with empirical field data, is of critical exploration importance.

The following geological situations, either singly or in combination, are considered potential **MVT** deposit locations:

- Palaeokarst surfaces at **H**igh-**L**ow stand transitions within the Wilkawillina Limestone (C1 cycle); particularly where Northern Basin sediments (aquitard) are/were overlying.

- Facies boundaries, particularly where reef front talus and ramp breccias can be recognised; particular emphasis on the Wirrealpa Hill Hinge line and related platform re-entrants.

- Gravity or tectonically induced deep fissuring of reef masses with subsequent breccia infill.

- Syn-depositional and post-diagenetic fault breccias.

The first and last aspects are probably of greatest significance for field geologists because they are readily recognised; the former affecting the greatest rock volume and the latter being an integral part of the **MVT** fluid migration pathway.

Stratigraphic Age of Mineralisation

MVT mineralisation at Wirrealpa, Mt. Chambers, and in the Bunyeroo Syncline (Brachina area) occurs in the palaeokarst beneath the Flinders Unconformity within the lower Wilkawillina Limestone. In the northern part of the Bunyeroo syncline the Billy Creek Formation was deposited directly upon the Flinders Unconformity. Elsewhere at Linda the upper Wilkawillina Limestone is host to mineralisation. (See Figure 5)

This distribution implies that mineralisation was probably deposited during late C1.3 and/or early Billy Creek time. This period is also favoured by its coeval volcanism and inferred tectonic activity which point to a probable increase in terrestrial heat flux of regional extent. This would have given impetus to the dewatering of the Warburton Trough (and Gulf). A significantly later age is difficult to envisage because delayed dewatering/diagenesis of the sediments seems improbable. An earlier age is possible for only some of the mineralisation in the succession. Loss of section at the beginning of C2.1 is assumed to be minimal.

This is of economic significance, since it requires that the ore bearing fluids had to leak out through or around the periphery of the C1.3 Oraparinna Shale/Parara Limestone aquitard seal at its maximum extent. Both the Bunyeroo Syncline and Linda (southern Balcoracana Syncline) probably occur in close proximity to the spatial limits of C1.3 **H**ighstand. Similarly there is the possibility that the seal may not have fully covered the Oraparinna Dome or active high level diapirs such as at Wirrealpa for which the evidence is long gone. Major structures may have also been leakage sites.

While modelling of such leakage sites is beyond the direct scope of this report and the present day level of detailed stratigraphic knowledge, it is asserted that the mineralisation model implies that they are the most favoured locations for emplacement of **MVT** orebodies.

Mappable Signatures

Stratigraphic

Toward the base of the Lower Cambrian sequence the top and bottom boundaries of the Wilkawillina Limestone are easily recognised in the field.

Generally, the underlying Parachilna Formation is of relatively low competence and forms a self evident topographic low/saddle where it is present. Where it is either thin or absent, the underlying robust Pound Sub-group often sheds talus on to the basal Wilkawillina Limestone, obscuring the basal few metres of the Lower Cambrian. Where present, the Uratanna Formation does not seem to be affected to the same degree.

The upper contact is commonly marked by the change from massive to thinly laminated silty limestone of the Parara Formation that may present as massive hilly outcrops or large tracts of thinly mantled spiny fissile subcrop. Where the boundary coincides with the Flinders Unconformity, irregular undulations of up to 2m relief with local drape structures are commonly present and a thin zone of reddening may be observed from place to place. (See Appendix 1.2.) There is usually no diagnostic topographic contrast.

Within the Wilkawillina Limestone, which often presents as massive dark grey rock with zones and patches of variable pink-brown and/or buff colouration, significant stratigraphic boundaries have no universal easily recognisable signatures. Local stratigraphic features may only persist for a few kilometres of strike at a time. (See Morris 1986.)

It therefore follows that recognition of the major **C-LTH** cycles requires good quality mapping coupled with a sound working knowledge of carbonate facies types. Since the observable sequences are commonly incomplete, fitting to the regional facies model is essential and will only be possible in some cases by palaeontological means.

Mineralisation

Conventional (historic) assumptions that significant mineralisation will be visibly present as gossans or other outcrop may well be unfounded. On the balance, it can be forecast with some credibility that significant **MVT** mineralisation in the Northern Flinders Ranges may actually have little to no positive field expression on the following basis.

Since the Flinders Ranges consists of a partially dissected Tertiary horst block, it follows that some of the oxidation patterns and secondary oxide accumulations seen on present day exposures are actually exhumed tropical/sub-tropical Tertiary-Cretaceous palaeoweathering features. Uplift and climatic change supplanted this early chemical weathering with physical weathering processes by lowering of the water table and reduced precipitation. This was probably maximised during the dry desert conditions of the Pleistocene and remains current.

During the Cretaceous-Tertiary time, deep chemical weathering took place throughout much of Australia. In South Australia typical saprolitic profiles have been recorded from the margin of the Olary Block, and Eyre Peninsula. Remnant laterite, present in areas of lower relief, in the Southern Mt. Lofty Ranges provides reasonable justification for believing such processes also took place in the Northern Flinders Ranges.

As a result of this well established tropical regime there is ample evidence, from throughout Australia, for deeply penetrative oxidation of sulphide mineralisation, often well beyond that of nearby adjacent country rocks. For most sulphide ore body types, hosted within rocks of comparitvely low carbonate content, telltale gossans, acidic bleaching of the immediate host rock and/or supergene accumulations are well documented.

The weathered expression of high grade essentially bi-mineralic lead-zinc ore in >80 % grade carbonate rocks will differ significantly from these better known examples for the following reasons :--

- Since the pyrite/chalcopyrite content is low in **MVT** ores, in-situ massive residual iron oxide gossans are likely to be rare and only trace to small patchy iron oxide residues can therefore be anticipated.

- Since sulphuric acid is generated during weathering significant dissolution of the adjacent carbonate host rock must occur. A nett volume loss (sulphide + carbonate) with a clayey residue is therefore predictable. (See Figure 11)

- Since the foregoing indicates that lead-zinc sulphide would have been penetratively oxidised with significant metal loss and volume reduction it is further predicted that ore zones would have a negative to nil topographic expression. Where primary ore is of sheet like geometry collapse and gravitational closure of the structure could be anticipated. Cuestiform saddles, flat localised depressions or outcrop terminations, could therefore be indicative.

- It follows that `ore' might express at surface as extremely anomalous lead and zinc bearing clayey rubble to massive clay surrounded by a geochemical halo of primary and/or secondary genesis in the adjacent outcrop. Minor patchy masses to fragmentary clasts of iron/manganese oxides/jasper might be present where iron sulphides were present in the original ore.

It is immediately apparent that mineralisation of such expression could give strong stream and soil geochemical signatures but poor rock chip responses from the unweathered wallrock geochemical halo. Clearly such disappointing results could lead to premature termination of exploration activity.

Application of these principles at the Eric Prospect has led to the recognition of stratabound mineral-isation that is represented in the near surface by clays carrying up to 5 % Pb & 2,300 ppm. (See Figure 16).

Interpretation of Geochemistry

To discriminate such poorly expressed primary metal sources in an environment such as the Northern Flinders Ranges it is essential to first consider the chemistry of oxidizing zinc and lead sulphides in carbonate rocks, in both wet tropical and arid conditions, and then to model the redistribution processes and interpret the present day geochemical signatures.

Chemical Weathering Processes

Geochemistry of the Aqueous Environment
(Tropical weathering and present day water table)

Sphalerite and galena form smithsonite and cerussite under aqueous conditions in the presence of sufficient CO_2 according to the following:

$$ZnS\ (PbS) + H_2O + CO_{2\,(aq)} \rightleftarrows ZnCO_3\ (PbCO_3) + H_2S_{(aq)} \quad \_\_(5)$$

Under oxidising conditions in the presence of limestone, the following reactions will also occur:

$$H_2S_{(aq)} + 2O_{2\,(aq)} \rightleftarrows 2H^+ + SO_4^{2-} \quad \_\_(6)$$

$$2H^+ + SO_4^{2-} + CaCO_3 + H_2O \rightleftarrows CaSO_4.2H_2O + CO_{2\,(aq)} \quad \_\_(7)$$

It is apparent that the forward reactions will continue until all the sulphides and/or oxygen are completely exhausted, as CO_2 continues to be produced while sulphides are consumed, providing more CO_2 to drive reaction (5). Gypsum will also be produced.

Under reducing conditions, the extent of reaction (5) will be dependent on the relative concentrations of CO_2 and H_2S in the groundwater. High relative CO_2 will favour the formation of metal carbonates, while high relative H_2S will inhibit this and tend to preserve primary sulphides. As reactions (6) and (7) will be inhibited by reducing conditions, less metal carbonate will be produced than under oxidising conditions. In addition, gypsum will be absent.

The hydration of metal carbonates is mainly dependent on the partial pressure of CO_2 in the groundwaters with which they are in contact. The assemblages expected are, in order of increasing P_{CO2}:

hydrozincite + hydrocerussite ➢ hydrozincite + cerussite ➢ smithsonite + cerussite

Geochemistry of the Arid Environment
(Present day surface and upper vadose zone)

The change during Pleistocene time to an arid climate with very short periods of influx of meteoric waters caused changes in the geochemical weathering of exposed mineralisation.

Simple oxidation of sphalerite and galena (ignoring carbonates) proceeds according to the following reactions:

$$ZnS + 2O_2 \rightleftharpoons ZnSO_4 \text{ (zinkosite)} \quad \_\_(8)$$

$$PbS + 2O_2 \rightleftharpoons PbSO_4 \text{ (anglesite)} \quad \_\_(9)$$

Zinkosite is four orders of magnitude more soluble than anglesite. Under arid conditions, these two reactions as well as physical weathering would predominate at and near the surface where periodic drying occurs. Carbonates will only be involved in moist conditions.

Below the surface where dissolved CO_2 is present equation (5) will operate, dependent on CO_2 and H_2O supply.

Close to the surface much of the H_2S and CO_2 can diffuse away depending on soil cover and other factors, and reactions (6) and (7) have less effect.

Metal Redistribution in Saprolitic profiles

Since the present day lead/zinc distribution is the sum total of its weathering history, significant metal redistribution processes of the inferred Tertiary saprolitic soil profile are considered :-

- Leaching action in a saprolitic profile character-istically moves metals down toward the permanent water table but in an alkaline environment zinc is not so readily fixed due to its amphoteric character and is probably only weakly concentrated by this supergene process.

- Ordinarily in such profiles both iron, manganese and silica are hydrolysed into solution and re-deposited at particular levels, in the profile. Secondary iron (laterites) and silica (silcretes) may selectively or blanket replace original material.

  The product may vary in character from pisolitic to ocherous iron/manganese oxide/jasper masses. Selective replacement bodies of this type, not directly related to mineralisation, are commonly termed `false gossans'.

  Iron/manganese oxide accumulations located at the base of soil profiles on unmineralised limestones are probably due to the neutralisation of weakly acidic downward percolating meteoric waters from surface.

  It follows that in a saprolitic profile developed over mineralised parent rock iron/manganese oxides and other basic metal oxides and/or carbonates could accumulate at the base of the profile. The efficiency of this process in this tropical environment would be enhanced by the relative abundance of organic acids and relatively high meteoric flux.

- Since weathered mineralisation is likely to be clayey and of relatively low permeability, metals are unlikely to track down the ore zone. Instead, meteoric and vadose water could be expected to disperse metals down permeable pathways such as faults, joints, and other bedding plane discontinuities, to points of chemical fixation at the permanent water table.

  Collectively the above effects potentially result in the highly efficient and effective dispersion of weathering products away from a primary source with subsequent reconcentration at permeable and/or reactive sites in nearby country rock. (See Figure 12)

Saprolite Profile and Metal Residues

Subsequent denudation (of the saprolite profile) to bedrock results in the exposure of multiple residual geochemical concentrations of several types.

- Non robust secondary mineral accumulations such as soft secondary carbonates located within the soil profile and at its base will have generally left only traces in rock pores and fractures. Where such accumulations have only been exposed relatively recently, or were formerly quite large, local remnant masses and/or extensive low-medium strength superficial rock chip anomalies may persist today respectively.

- Massive iron/manganese oxide accumulations are relatively robust and will remain depending on their internal texture and capacity to `re-cement' prior to full exposure. Any co-deposited basic metal oxides will be retained. Notionally this ability is referred to as `scavenging'and results in strongly anomalous false gossans.

- Remnant in-situ oxidised primary mineralisation; rare strong apparently spurious spike anomalies due to clay `contamination' of rock chips or "sourceless" soil anomalies.

- Weak dispersed sub-profile secondary mineralisation in permeable footwall/ (hangingwall) rock units associated with inherent and or fracture porosity; example : base metal mineralisation in Pound Subgroup and also possibly on occasion the Parachilna Formation.

  In studies carried out by Morris (1986), the secondary anomalies are so obvious by virtue of size and/or magnitude, that primary anomalies are difficult to recognise. (See Figures 13 & 14)

  It is evident that where exploration is focussed on strong geochemical signatures without detailed consideration of the palaeoweathering environment and geological mapping there is a high probability that primary mineralisation could be overlooked.

Contemporary Geochemical Signatures

A contemporary weathering profile in limestone with sphalerite/galena mineralisation is anticipated to display the following effects and mineral assemblages:

Surface:

Dispersal of zinc through surface drainage and water table, retention of detrital galena and anglesite, minor conversion of sulphides to carbonates during wet periods; sphalerite, galena, zinkosite, anglesite, smithsonite/hydrozincite, cerussite.

Near surface subject to periodic drying:

Partial conversion of sulphides to carbonates, loss of CO_2 and H_2S during dry periods; sphalerite, galena, smithsonite/ hydrozincite, cerussite/hydrocerussite, zinkosite, anglesite.

Oxidising zone of aqueous regime:

Extensive conversion of sulphides to carbonates, precipitation of gypsum; smithsonite, cerussite, (sphalerite, galena).

Reducing zone of aqueous regime:

Partial conversion of sulphides to carbonates until all CO_2 consumed; sphalerite, galena, hydrozincite, hydrocerussite.

The above model illustrates the situations in which pre-existing products of Tertiary saprolitic weathering can be expected to remain stable, or otherwise be partially/ completely converted to other minerals or soluble products.

Given the high solubility of zinkosite relative to zinc carbonates, it is suspected that it is the main vehicle for the widespread dispersion of zinc in soils and drainage. The relatively low solubility of lead salts including anglesite will produce weaker and shorter lead dispersion trains.

The detailed sampling of Morris (1986) confirms that lead is likely to be the best near source indicator of primary mineralisation which can be further focussed using cadmium where it is sufficiently abundant. However these targets are small in the context of a first pass wide spaced sample density. (See Figure 14)

Similarly, zinc and/or copper in combination with iron/manganese appears to provide a broad base sample target, usable to loosely rank anomalous stratigraphic domains and helping to discriminate dispersed secondary geochemical accumulations from primary sources.

<u>Detrital Minerals in Regolith and Streams</u>

Detrital galena and willemite have been recorded from stream samples in the Northern Flinders Ranges.

General indications of the chemical behaviour of lead and zinc are that sphalerite should oxidise more readily than galena. Physical weathering will release exposed primary sulphides into the drainage system, followed by oxidation and dispersal of zinc, leaving detrital galena and anglesite. This accounts for reports of detrital galena without other sulphides in stream sediments of the Flinders Ranges.

Galena

Galena and possibly sphalerite are known to be present on exposed bedrock faces. Such grains and generally small veinlets are tightly bound with minimal weathering and often occur with slight upstanding relief.

Such mineralisation from bedrock and within free incompletely weathered clasts from the C horizon palaeo-regolith, released, since early Pleistocene time, by physical processes has remained unoxidised due to the persistently dry conditions and entered the drainage.

The existence of the sulphide as free clasts at surface has been reported from the Brachina region. Survival of such free material is dependent on a general lack of gangue and probably enhanced by a fine granular structure.

Anglesite

Anglesite produced by oxidation of galena and physically eroded would, by virtue of its low solubility and similar physical properties, tend to be preserved in stream sediments close to its source. [Anglesite has yet to be recognised in stream sediments in the Flinders Ranges.]

Recognition of detrital galena and/or anglesite would imply that outcropping mineralisation is probably present nearby.

Willemite

The recognition of willemite is no surprise given its widely distributed occurrence and silicate composition. New explorers should be aware that appropriate chemical digestion techniques can be used to distinguish its presence in geochemical samples.

Geophysics

The performance of geophysical techniques in **MVT** exploration has not been researched. However there seems to have been a general body of opinion that electrical techniques seem to offer the best potential for success. Previous exploration (generally unsuccessful) has utilised Gravity & Magnetic data, and Self Potential, Induced Polarisation, and trial VLF, and AFMAG, surveys and more recently Sirotem.

The lack of general confidence with **MVT** exploration probably stems from historical experience in North America where ground conditions are somewhat different.

Local experience from Morris (1986), where IP and Sirotem signatures remain untested, suggests that there are likely to be many geophysical anomalies generated during surveys. Meaningful geophysical interpretation will therefore have to be cognisant of the interplay of weathering and the geometry of likely ore structures identified from mapping and geochemistry. (See Figure 14)

The utilisation of more sensitive electronics and computer processing/modelling of the data for these conventional techniques could be advantageous. Newer techniques such as Sirotem and CSAMT technologies might also prove successful. However, advancement in this area is hampered by the lack of a well documented deposit that can be used as a geophysical testbed. Perhaps the Eric Prospect could fulfil this role if more was known about it.

EXPLORATION

Exploration interest in the Northern Flinders Ranges dates from the early 1880's when small mines were opened up by pioneer prospectors. Such was the activity that, in 1905, the Government Geologist placed a mining reserve over the Bookartoo Ochre deposit to protect this traditional resource of the Aboriginal people.

This early impetus was short lived and activity was relatively minor until changes in analytical technology resulted in the widespread application of regional geochemical sampling throughout the Northern Flinders Ranges (Adelaidean & Cambrian units) during the decade 1962-72. These programmes by and large clearly delineated the main anomalous areas and confirmed the widespread occurrence of mineralisation in the basal Cambrian.

Since that time explorers have periodically carried out programmes predicated on a conceptual approach rather than the previously used empirical basis. While new mineral occurrences were found, economic deposits have remained elusive.

The lack of success in detecting even a modest subeconomic resource and the recent addition of environmental restraints have been discouraging for explorers. The underlying key element embodied in proposing any exploration activity is the implicit belief that the tract of land being considered is inherently prospective. The lack of successful exploration experience in the Northern Flinders Ranges during the last 30 years may have dampened the enthusiasm of some explorers and led to a general lowering of prospectivity perceptions.

The earlier portion of this report would appear to be at odds with such perceptions and would, in a `green pasture setting', give ample impetus to maintain exploration. Why has the information base been so unrewarding? It is now apparent that the lack of a stratigraphic framework and the absense of the palaeoweathering geochemical model may have blocked exploration success.

To assess the possibility, that features, potentially indicative of mineralisation, escaped the attention of previous explorers, and provide a quasi post-audit of previous exploration, systematic low intensity reviews of public domain exploration literature were undertaken.

<u>Review Procedure</u>

Initially exploration references were printout listed from the SAMREF database for individual 1:250,000 scale map sheets using the search codes lead, zinc, & Cambrian. Subsequently the search was re-run and full abstracts were `printed' to floppy disk with the search code broadened to copper/lead/zinc/base metals.

The files were then searched for lead and zinc independently and a list of references potentially relevant to Cambrian hosted lead-zinc was manually compiled. This listing was subsequently entered into spreadsheet format. (See Appendix 2.1).

Microfiche copies of the references were scanned to verify their relevance to **MVT** mineralisation. Pertinent geological descriptive information with an emphasis upon indications of unrecognized palaeokarstic or palaeoweathering features was noted.

It is acknowledged that because explorers were not particularly focussing on such aspects, the collection of such information was probably incidental and thus the degree of reliance/significance of such observations is difficult to assess without field verification. However a number of aspects that at least warrant consideration were identified.

The abstract information and manually collected notes were amalgamated into a suite of summaries presented in appendix 3. The comments thereon generally reflect opinions offered in the original material, together with reviewer input, on potentially relevant possibilities.

Johns (1972), Morris (1986), & Robertson (1988) were treated as independent resources and used to supplement/crosscheck the other data.

Appendix 2 is designed as an quick reference index for the reviews in appendix 3. The information is filed by 1:250,000 map sheet and location, coded by

Delamerian syncline cusp. (See Figure 15). Appendix 2.2 is provided to enable user manipulation by macro sorting and edit/up-date of the index itself.

The location data, prospect locations, and other features of **MVT** interest are presented on figures 18, 19, & 20.

Exploration Techniques

Geochemistry

A brief examination of appendix 2.1 shows that the most generally applied exploration technique has been stream sediment surveys, closely followed by soil and rock chip sampling.

These geochemical programmes appear to have been predicated on the assumption that economically significant mineralisation would give rise to strong anomalies and be self-evident from follow up field examination. They successfully delineated anomalous regions in the Lower Cambrian sequences and identified high background to weak mineralisation at a number of localities.

However application of statistical discrimination methods seems to have been strictly empirical without due consideration of the stratigraphic influences on the data set. Background levels for metals in individual units do not seem to have been correlated with soil or stream sediments.

Utilising a restricted data set from a distinctly anomalous terrain generates the dilemma of recognising only high `nugget effect' type spikes or secondary features within an anomaly, such as weathering effects. A broad based data set on the same basis may lead to indefinite results due to the mixing of statistically different populations. Ranking of geochemical anomalies without using other information to establish a balance between the two above cases is difficult.

Geological Mapping

The work of Gravestock and Clarke on the stratigraphy of the region (Section 3.2.2, Appendix 1.3) and Morris (1986, REV. 1PU, Appendix 3.2) indicates field mapping is likely to be a significant exploration tool.

Around 50 % of references contain field generated maps at scales of 1:5000 and 1:10,000 (approx.), but very few provide text descriptions of maps or stratigraphic features (an aspect that is also reflected in the SAMREF abstracts).

Target Assessment

Clearly, the value of correlating between geology and geochemistry has not always been appreciated and exploration potential was frequently assessed by early explorers on geochemistry alone.

Targets that were considered to be of merit were inevitably the strongest geochemical features but, given the aspects described on pages 19-21, this approach could with the benefit of hindsight be compared with the analogy of looking for iron ore without assessing the relevance of secondary laterite in the sample set.

The probability of selecting a primary **MVT** geochemical anomaly in the Northern Flinders Ranges, on stand alone empirical geochemical criteria, for detailed follow up must be relatively low. It follows that an early exploration success without systematic drilling of a very large percentage of all the encountered geochemical anomalies is improbable. It is therefore not surprising that the exploration success rate has been disappointing to date.

Reducing the odds in future programmes will of necessity require proper utilisation of geological mapping and a more sophisticated treatment of geochemical data. This could be possibly achieved using the current data set.

Innovative Changes

The first attempt to generate a workable geochemical data set for the region was initiated by CRAE who carried out a large stream sediment survey that is presented in SADME ENV. 975, REV. 8PG, This survey was post-audited by and extended by North Flinders Mines N.L. in SADME ENV. 1229, REV. 12PG.

One notable attempt to use geology as a targeting tool by BHP/Dampier Mining was partially successful. The focus of the work was palaeokarstic breaks in the stratigraphic record. This work which was geologically invaluable, is presented in SADME ENV.s 3427, REV. 29PDB & 3722, REV. 30PF, and led to a sustained BHP exploration presence in the region.

The encouragement of the stratigraphic approach adopted by BHP stimulated the SADME to examine the Lower Cambrian within the Flinders Ranges National Park. This work, (publicly available as SADME REPT. BK. No. 86/18. (Morris 1986), REV. 1PU), is a comprehensive documentation of geochemical and geological data that is adequate for anomaly classification and meaningful exploration targeting.

A minimum standard of workmanship similar to the integrated approach adopted by Morris is probably essential for future exploration to be successful. With the introduction in time of new exploration skills, such as the discrimination of alteration haloes, and more sophisticated geophysics, the chances of detecting primary **MVT** mineralisation will be much improved on a few years ago.

To illustrate the role of field mapping figures 16 and 17, originating from SADME ENV. 8071, REV. 37PF and ENV. 8072, REV. 36PD respectively have been included in this report.

The Eric Prospect as presented in figure 16 is an amalgamation of Union Minere, Electrolytic Zinc, and BHP/Dampier Mining data that has been re-interpreted. The evidence was recast on the basis of elementary field observations

1) The small `diapirs' mapped by BHP were stratabound without any deformation of the surrounding/enclosing Wilkawillina Limestone and are in fact siliceous karstic deposits.

2) Irregularities in the bedding patterns mapped by UM corresponded with colour changes that indicated cyclic interchange of reducing/ oxidising conditions during sedimentation. Probable sea level oscillation with near shore exposures resulted in disconformities within the sediments.

3) The most evident oxidation related break coincides with a trail of patchy secondary iron oxides and occupies a weak cuesta saddle in the southern part of the prospect.

4) Overlay of rock chip surveys by UM (north) and BHP drilling (south), shows that the strong lead-zinc anomaly in the north and the strongest mineralisation which occurs entirely within the saddle in the south, are one and the same feature, associated with the stratigraphic break.

5) It was concluded that the primary metal source was an east dipping surface within the stratigraphy that had not been previously recognised. Failure to consolidate the geology to the topography and drilling data had concealed the fact that drilling to the east had terminated in the hanging wall.

6) Furthermore the mineralisation `cropped out' as an erosively weak clayey material with up to ≈ 1 % combined metals with minor/trace of iron/manganese residues, enclosed by weak footwall/hanging wall mineralisation in massive limestone of up to 1000 ppm combined metals. Very low zinc values associated with high lead are considered to be the result of leaching and not a reflection of primary mineralisation.

At the Old Wirrealpa Spring location illustrated in figure 17 BHP had previously carried out rock chip sampling that indicated lead-zinc enrichment of the Wilkawillina Limestone just to the south of the creek and spring.

The map is original work, which recognised for the first time the likely field expression of palaeokarsts at Wirrealpa and confirmed the importance of `negative' type signatures, as previously recognised at Eric.

The main aspects of the map are:

1) The disconformable boundary between the Parara and Wilkawillina limestones is the Flinders Unconformity. Irregularities in this palaeosurface are clearly defined on the map and in the field various minor features are to be found from place to place.

2) The ovate structure in the upper middle of the map within the Wilkawillina Limestone is an obvious depression within a prominent limestone ridge.

   The depression has nearly black iron/ manganese massive/breccia rim deposits around the southern, eastern, and northern sides. It is occupied by gravelley yellow clayey soils with a weakly developed soil profile. The same feature is also a nearly treeless vegetational anomaly and reports moderately anomalous lead-zinc at surface.

3) Toward the southern end of the ridge outcrop continuity is broken but there is no depression. In this case the surface is a mixture of soil and rubbly ?sub-cropping honey coloured jaspery material. Some is banded and is very similar to parts of the small `diapirs' described from the Eric locality. Drill hole DDB 1 was collared from the west across the northern edge of this area in such a manner as to lead to the expectation that massive limestone below the Flinders Unconformity would be intersected within a very short drilling interval of about 5 m. However this was not the case and the pre-collar intersected weathered unconsolidated vuggy ground with manganese staining for an extra 15 m. The feature is clearly not superficial and was probably an infilled trough shaped depression on the`Flinders Palaeosurface' before the deposition of the overlying Parara Limestone.

Both of the latter features were probably solution palaeokarsts, the foremost remaining intact and the latter probably collapsed.

Other Methods

Exploration for **MVT** deposits in the past has used costeaning, drilling, and geophysics. The results of these methods are, in the first instance, primarily a reflection on initial target selection criteria. Inherently their ultimate effectiveness rests on the prior integration of geological and geochemical knowledge as discussed above.

In some instances systematic geophysical surveys have been run but without a geologically based ore model to work to, their effectiveness has to be in doubt. In such cases the data were probably also interpreted in isolation from geological input.

It is acknowledged however, that at Ediacara ENV. 1246, REV. 35CREA attempts were made to construct meaningful geophysical models but the physical nature of this deposit appears to be atypical of other locations and it would appear to be unwise to assume similarities at the present time.

Systematic induced polarisation surveys were also carried out by Morris (1986), but unfortunately circumstances have not allowed for follow up drilling, with the result that proper evaluation of the anomalies generated is not possible.

Regional Domains

Substantial erosion of the Adelaide Geosyncline has resulted in the restriction of the Cambrian sequence to major Delamerian fold cusps.

To facilitate geographic relativity to exploration work, each of these main structures has been assigned a name on figure 15 and all the references within Appendix 2 have been coded accordingly.
Names have been assigned to macro structures rather than individual fold axes perse. In most cases the feature is also present in the Adelaidean stratigraphy. Some names are from existing literature and others are new. However, where names have been previously assigned a limited spatial definition they have not been knowingly used.

Copley Sheet

Cadnia Syncline

The Cadnia Syncline is a 38 Km long EW (Mt Hack-Puttapa) synclinal trough with plunge reversals. The Cambrian sequence occurs in 4 separate elongate basins with a maximum width of about 3 Km. The eastern termination is named the Mt Hack Syncline.

Exploration reports have commonly focussed on the Black Range Springs and Sliding Rock mine areas.

In the Black Range Springs area the Flinders Unconformity has been recognised during mapping but its relevance to the distribution of mineralisation does not appear to have been considered by previous explorers.

Disseminated galena with associated sideritic alteration has been recorded from the Wilkawillina Limestone. Nearby, where zinc mineralisation is associated with hematitic alteration in both the limestone and an adjacent fault-bound diapiric breccia, willemite is inferred. This locality provides an opportunity for studying the relationship between **MVT** and later Delamerian willemite mineralisation.

Within a few kilometres of the Sliding Rock mine several iron/manganese oxide bodies with significantly elevated zinc concentrations were investigated by drilling but the results are of indeterminate significance due to limited analytical data. Close to the Sliding Rock mine is a stratabound zinc geochemical anomaly. The stratigraphic relationships of all these features warrant assessment.

The association of iron/manganese oxides with zinc enrichment at both Black Range Springs and Sliding Rock suggest that secondary palaeoweathering dispersion may have occurred.

Donkey Bore Syncline

The northern portion of the Donkey Bore Syncline, a NW trending syncline located in the middle south of the map sheet, has received little detailed field exploration beyond regional stream sediment surveys and regional mapping. Prominent geochemical anomalies (old criteria) appear to be absent or were regarded as `sourceless'.

Ediacara Syncline

The Ediacara Syncline, a small NS elliptical cusp located in the southwestern portion of the sheet, occurs as a Cambrian outlier on Adelaidean basement surrounded by Cretaceous-Quaternary deposits.

Exploration interest has been intensive and the structure has been systematically studied by drilling and geophysics. Mineralisation appears to be breccia related lead with little zinc. The breccias seem to be intra-formational in origin and probably represent debris sheets shed from the exposed coastal platforms to the SE (Flinders Unconformity).

However, Tertiary-Recent palaeoweathering effects, on what appears to be horst ridge, seem to have obscured some aspects of the primary geology. The absence of substantial zinc and an abundance of iron/manganese oxides are suggestive of supergene re-working of primary mineralisation.

A small resource has been defined but the work done to date implies that the major increase in tonnes/grade for commercial development is highly improbable within the precincts of the exposed basin.

Attempts to find additional resources to the south and north under shallow cover have so far been unsuccessful though this exploration option should be re-considered depending on the demonstration of a viable geophysical technology.

Aroona & Ajax Synclines

These two structures are located to the west of the Cadnia Syncline and are juxtaposed against the Norwest Fault and Beltana Diapir.

The Puttapa Willemite deposit, located in the Ajax Syncline adjacent to the Beltana Diapir, is the only recently worked zinc (lead) deposit in the Flinders Ranges. Mineralisation is clearly epigenetic and post Delamerian. There are no recorded indications of pre-cursor **MVT** mineralisation.

The Emu Prospect is located in the Aroona Syncline. Solution brecciation in the basal section of the middle unit of the Ajax Limestone may be of palaeokarstic origin. Siliceous hardground intersected under cover may be a silicified palaeokarst deposit within the Ajax Limestone. Strong zinc enrichment of iron/manganese oxides is indicative of Cretaceous-Tertiary palaeoweathering geochemical dispersion.

Given that movements of the Norwest Fault were probable during Cambrian sedimentation, the sedimentology is likely to locally reflect such events and the observed probable palaeokarst surface may be of restricted extent and unrelated to the Flinders Unconformity.

This locality near the inferred margin of the Cambrian platform in combination with its structural setting should be regarded as sedimentologically favorable for **MVT** mineralisation.

Narina Syncline

The Narina Syncline is oriented NW and parallels the Donkey Bore Syncline to the southwest. Exploration has been similar to that of the northern Donkey Bore Syncline, being mainly stream sediment surveys with minor follow up.

Several stream anomalies should be re-investigated from the stratigraphic perspective. Particular consideration of the area to the west of Mt. Brook and the phosphate occurrences near "Point Well" could be informative.

The recognition of detrital galena released into the drainage system from the underlying Adelaidean Bunyeroo Formation is worthy of investigation from a **MVT** standpoint and should be taken into account when stream sediment geochemistry is being assessed.

Nepabunna/Mt. Serle Synclines

The Nepabunna Syncline, located in the mid NE of the sheet, is a broad EW structural basin that includes several parallel fold axes. The southern-most axis extends from Italowie Gorge west to Mt. Jeffery. The western finger-like structure is otherwise named the Angepena Syncline.

In the west, stream sediment surveys led to the recognition of iron/manganese oxide associated metal enrichments that were discounted by previous explorers except for the minor occurrence of mineralisation at Castle Rock. While the influence of palaeoweathering on first order geochemical anomalies was clearly recognised by previous explorers, secondary anomalies potentially associated with favorable **MVT** sites do not seem to have been examined.

In the east, a 15 km long strike related stream sediment lead anomaly occurs to the west of Italowie Gorge. Iron/manganese oxides associated with a clay/silt band in the same general area carrying up to 3,500 ppm Zn have been reported and could potentially represent the weathered residue of mineralisation. Mineralisation in a biohermal reef has also been reported. Field inspections to establish the relationship of these features to local and regional stratigraphy is required.

In the central portion of the syncline is the Eveline Copper mine which appears to be fault related within the basal part of the Wilkawillina Limestone. Lead is more abundant than zinc in the ore but this is probably of little **MVT** relevance since it is likely to be of Delamerian age.

The Mt. Serle Syncline, now restricted to a localised graben inlier, was probably formerly part of the Nepabunna Syncline.

Here, an intraformational breccia with anomalous levels of copper and lead has been recognised in the Wilkawillina Limestone. Leaching associated with silicification and ferruginisation was also recorded. The breccias could be worthy of **MVT** related sedimentological study.

Red Range Syncline

The Red Range Syncline is located on the western flank of the Flinders Ranges in the central west of the sheet. Only the locally down faulted eastern limb is exposed. The bulk of the structure lies to the west below superficial cover.

Exploration has hitherto been restricted to exposed Ajax Limestone which is deeply weathered. Moderate geochemical concentrations of zinc are generally associated with iron/manganese oxides at surface where limited drill testing has never penetrated below the base of weathering.

At Puttapa Creek clays reported to carry up to 1 % Zn and 0.5 % Pb that could fit the **MVT** weathering expression model, resulted in the premature abandonment of drill holes. Such a setting should be thoroughly re-investigated.

This region is probably a suitable location for field investigations into the redistribution of lead-zinc during palaeoweathering, since remnants of the weathering profile remain.

Arrowie Syncline

The Arrowie Syncline is a broad EW structure located in the south eastern portion of the Copley Sheet.

Exploration has been generally focussed around the Moro Gorge area at the eastern end of the syncline where the relatively localised NS Balcanoona Anticline is located. Anomalous zinc concentrations have been recorded from iron/manganese `gossans' along the basal Wilkawillina Limestone and Parachilna Formation contact which is sometimes obscured by extensive scree cover.

Drilling of some features found weak and crumbly, deteriorated host rocks where sample recoveries were poor. Such zones may represent the weathering expression of mineralisation and need to be re-examined in that context. In other cases such small targets were selected that minor deviation from an assumed simple geometry could have resulted in intercept failure.

There appears to be a substantial interval of geochemically anomalous Parachilna Formation along the western side of the Balcanoona Anticline that has never been thoroughly investigated.

At Moro Gorge dip slopes with `lateritic' deposits up to 6 m thick carry up to 5000 ppm Zn. This geometry bears a similarity to the Eric prospect.

Given the evidence of weathering to depth and the presence of the anomalous iron/manganese oxide accumulations a thorough work-over of the historic data and a mapping programme to establish the stratigraphic relations of the features appears warranted. Particular attention to palaeokarstic surfaces is required.

Mt. Frome Syncline

See Parachilna Sheet.

Adelaidean Hosted LZ

Both the O'Donohue Castle Mine located in Skillogalee Limestone due west of "Wooltana" and the Patawarta Zinc Prospect in Bunyeroo Formation on the southwest flank of the Narina Syncline appear to have some aspects that may be genetically related to **MVT** mineralisation and therefore warrant followup.

Parachilna Sheet

Balcoracana Syncline & Bunkers Graben

The Balcoracana Syncline is a major structure located in the mid NW of the Parachilna Sheet. Tectonically it is the SE continuation of the Donkey Bore and Narina Synclines to the north of the Wirrealpa Diapir. This macro feature is probably the upward imprint of the Norwest Fault structure within the Delamerian fold belt.

The Bunkers Graben is a northeasterly trending pre-Delamerian palaeostructure which was active during Lower Cambrian deposition. It probably transected the "syncline" and influenced sedimentation at Mt. Chambers to the NE.

The area is largely concealed by Tertiary-Recent cover units of variable thickness. Limited drilling indicates that much of the cover conceals units of the Middle Cambrian sequence which overly the Hawker Group and the probability of finding economic **MVT** mineralisation is considered to be low. Exploration interest has therefore been focussed about the rim of the structure, particularly where the Hawker group is exposed around the NW of the structure adjacent to the Bunkers Range and in the north near Mt. Lyall.

Exploration has been based on stream sediment surveys followed up by rock chip surveys. These programmes led directly to the discovery of the Third Plain willemite and Linda **MVT** prospects. However, the "blind" application of statistical definitions to `anomalies' clearly inhibited the ability of early explorers to recognise empirically the relationship of mineralisation to stratigraphy. This delayed the detection of the Linda Prospect for an extended period (See page 18).

The Old Wirrealpa lead mine has also been investigated by explorers. The mineralisation seems to be related to the contact between the Wilkawillina Limestone and the adjacent Wirrealpa Diapir. While it is clear that the diapir pre-dates the Hawker Group, Delamerian induced disruption of the contact zone is likely and a clear cut case for a **MVT** origin cannot be made.

The Third Plain willemite prospect occurs in the Wilkawillina Limestone and is marked by a halo of pervasive hematitic alteration. Evidence of local precursor **MVT** mineralisation appears to be absent. Drilling indicates that the mineralisation is erratic which coupled with its small size makes the deposit sub-economic on a stand alone basis.

The literature reports geochemical anomalies associated with iron/manganese in the Mt. Lyall area which appear to be `sourceless'. Since the stratigraphic aspects do not appear to have been assessed mineralisation with a negative expression may have been overlooked. Followup is required.

Since the stratigraphy of the Wilkawillina Gorge area (Bunkers Graben) has been mapped in considerable detail by Clarke, an assessment of the available geochemical data could be an invaluable technical resource for explorers. (See Figures 9 & 10).
Since a major portion of this specific area lies within the Flinders National Park such work would have to be carried out on a research basis separate from normal exploration.

Narina Syncline

The southern continuation of the Narina Syncline from the Copley Sheet is located in the central north of the Parachilna Sheet.

Extensive mapping programmes by B. Daily and University students have used the southern portion of the Narina Syncline for stratigraphic analysis and palaeontological studies of the Lower Cambrian Hawker Group. These studies provided the foundation for the palaeofacies models developed for the entire province. The local interfingering of coastal conglomeratic facies sourced by the Wirrealpa Diapir and the Wilkawillina/Parara Limestone facies is well documented. (References on this work are incorporated into Appendix 1.3)

Exploration in the Narina Syncline has been mainly confined to stream sediment surveys. No significant prospects were identified but scout drilling was undertaken near "Narina" and due north of Mt. Lyall.

Regional mapping showed that the Flinders Unconformity was recognisable around the basin cup.

Donkey Bore Syncline

The Donkey Bore Syncline is located in the mid north of the Parachilna Sheet. It is separated from the adjacent Narina Syncline by the Donkey Bore Ridge, an anticline with a diapiric core zone.

The Donkey Bore Ridge is probably an upward imprint of the Norwest Fault structure that influenced both diapir injection and subsequent sedimentation.

The Flinders Unconformity is well exposed along the western side of the Donkey Bore Ridge where on-lap of Wilkawillina Limestone by Parara Limestone is clearly recognisable.

Stream sediment survey follow-up resulted in the detection of lead-zinc mineralisation along the Flinders Unconformity beneath the Parara Limestone. The surface indications were validated in the general sense by drilling, although optimum targeting did not occur.

Later work by this author applied the palaeo-weathering concepts described on pages 18-19 and recognised a number of features worthy of follow-up. (See Figure 17, Review 36PD, ENV. 8072)

Elsewhere to the south the Lower Hawker Group is truncated along the faulted contact with the Wirrealpa Diapir. In the west exploration has been less intense but some scout drilling has been undertaken near "Erina Waters". The Flinders Unconformity was mapped out around the structure.

Of potential interest from the stratigraphic standpoint is the Eregunda Graben in the SW of the syncline that has some gross similarities to the Bunkers Graben. Since this structure could be of Lower Cambrian age and may have some localised sedimentological facies features favorable to **MVT** deposition, a review of previous mapping and field inspection is desirable.

Mt. Frome Syncline

The Mt. Frome Syncline, oriented NS, is located in the upper mid NE of the Parachilna Sheet and extends on to the adjacent Copley Sheet to the immediate north. Only the western limb is exposed, the eastern portion being ?down faulted and concealed by Tertiary-Recent cover units. Stratigraphic subdivisions have not been published. Currently such data are in the uncollated form of University theses and exploration reports.

Local Stratigraphy

Mapping has subdivided the `Wilkawillina Limestone' as shown on the Parachilna Sheet into the Wilkawillina Limestone, Parara Formation, and the locally defined units, the Moorowie and Mt. Chambers Formations at the top of the succession.

The Wilkawillina Limestone overlies a thin band of Parachilna Formation and has been internally subdivided into upper and lower members in the neighborhood of the Mt. Chambers copper prospect where the upper/lower boundary matches the inferred palaeokarst break at the Eric prospect. (See page 24). Some investigators recognise the Woodendinna Dolomite member within the lower unit.

The Parara Limestone has also been subdivided into upper and lower units separated by the Bendieuta Formation.

The Mt. Chambers and Moorowie Formations are probably equivalent.

Exploration

Stream sediment surveys resulted in the recognition of new lead-zinc concentrations near the Mt. Chambers copper prospect and at Mt. Chambers Gorge (additional to the nearby abandoned Moorowie copper prospect).

Mineralisation at the Moorowie copper prospect appears to be controlled by strike faults which coincide with intraformational breccias. Silicification is present. The structural setting suggests possible metal mobilisation associated with the faults but the host rock is probably of sedimentary origin. Given that silicification is not necessarily hydrothermal, a definitive origin is unavailable. Precursor **MVT** mineralisation remobilised at a later time is possible.

To the north, a megabreccia at Mt. Chambers Gorge, detected during followup to stream sediment surveys, contains up to 7 % zinc. The lithology may be a fore-reef talus deposit and therefore should be regarded as a **MVT** host environment of significant potential. Field examination is therefore warranted.

To the south near the Mt. Chambers copper workings, extensive rock chip sampling programmes were used to follow up strong lead-zinc stream sediment signatures (4000 ppm Pb & 6000 ppm Zn). The early work was followed up by drilling that detected only weak to trace level mineralisation in the vicinity of the copper workings.

Subsequent reappraisal and more intense drainage sampling improved anomaly definition. An area of poor outcrop within the Wilkawillina Limestone became the focus of a drilling programme based on the model that this anomalous tract was the expression of a concealed palaoekarst feature described as a polje. The locality was named the Eric prospect. In the event the geochemical signature proved to be a superficial effect except along its eastern extremity where clays averaging around 1 % Pb with variable Zn up to 2300 ppm, were consistently encountered.

A second re-appraisal of these data established that the 1 % zone was the southern expression of mineralisation previously defined by rock chip geochemical signatures and initial drilling programmes. It was concluded that mineralisation was probably focussed along a nearly flat eastward dipping stratigraphic interface and the strong geochemical signature to the west was of secondary eluvial dispersion origin.

This re-interpretation of the data was precluded by the impression of an eastern boundary to mineralisation, that arose from shallow drilling, collared at an increased elevation which terminated above otherwise open mineralsiation within the eastern hanging wall. (See section 5.1, Innovative Changes, Page 24 & Figure 16)

Subsequent limited test drilling by SADME in the northern more accessible but less strongly mineralised section of the Eric prospect supports the proposed model (RB 91/101, REV. 38PF). More drilling is required.

<u>Reaphook Syncline</u>

The Reaphook Syncline, located close to the SW corner of the Balcoracana Syncline in the mid east of the sheet, is oriented NS and comprises two separate closures due to variable axial plunge. Similar to the Mt. Frome Syncline to the north, the eastern limb of this structure is concealed by Tertiary-Recent units.

In this area the Hawker Group is only represented by the Parachilna Formation and Wilkawillina Limestone below the overlying Billy Creek Formation. This contact is probably the local expression of the Flinders Unconformity reflecting the depositional hiatus on the Eastern Shelf recognised by Gravestock. (See figure 5).

Initial stream sediment surveys led to the recognition of vein mineralisation in the Wonoka Formation (Adelaidean) to the north and strata related secondary iron/manganese related zinc mineralisation in the Parachilna Formation and lowermost Wilkawillina Limestone in the south.

Detailed field work combined with drilling showed that while patches of high grade zinc phosphate (scholzite) are entirely superficial, modest sustained levels of zinc grading about 0.2 % are persistently present to depth and along strike within both the Parachilna Formation and Wilkawillina Limestone.

Evaluation of the prospective stratigraphic interval is hampered by scree and alluvial/eluvial cover, which may be in part a residual palaeosoil profile.

The mineralised zone appears to be related to the development of vugs and is accompanied by a brown dolomitic alteration. Depressions on the upper surface of the Wilkawillina Limestone infilled Billy Creek Formation (Flinders Unconformity) are probably associated palaeokarsts.

The report of residual pisolitic laterite, and the secondary mineralisation features (in particular the scholzite patches) suggest Tertiary saprolitic weathering has affected the present day exposures.

The weak zinc mineralisation in the Wilkawillina Limestone is both stronger and broader than the 1000 ppm halo recognisable at the Eric prospect. Given the comparatively steep dip (compared to Eric) the surface expression of a fully decomposed ore zone may be less than a metre wide at surface, and may remain unrecognised within the already defined 600 x 1200 m halo at the Reaphook Hill prospect.

A review of detailed field mapping and a field inspection seeking negatively expressed mineralised stratigraphic features is essential. Concurrent consideration of definitive palaeokarstic features should also be undertaken.

Detailed petrological study of the dolomitic alteration seeking to separate palaeokarstic, and **MVT** related dolomite, if successful would show that such aspects can be recognised even with superimposed Tertiary weathering affects.

<u>Bunyeroo Syncline</u>

The Bunyeroo Syncline is a strongly developed NS 35 km long fold along the western flank of the Flinders Ranges in the mid west of the map sheet. Only the eastern limb of the structure is exposed, the western limb being covered by Recent deposits.

The Parara Formation and Oraparinna Shale are very thin to absent and the Billy Creek Formation is commonly deposited directly upon the Wilkawillina Limestone at the Flinders Unconformity. In the south in the Bunyeroo-Brachina area the upper units of the Middle Cambrian sequence are also present.

Following stream sediment surveys widespread mineralisation was detected along much of the eastern limb. Progressively, more detailed geochemical surveys and investigations were undertaken by companies including drilling, until the Flinders Ranges National Park was declared.

Subsequently SADME carried out a thorough surface examination of the mineralisation and its expression within the lower Wilkawillina Limestone. Unfortunately some of the value of this effort cannot be fully realized until duplicate geological conditions are found where subsurface testing by drilling is permissible.

This work, reported by Morris (1986) is briefly summarised in review 1PU. Aspects of **MVT** exploration discussed on pages 17-21 use these data and since the area is effectively unavailable for exploration, no further detailed consideration is offered here.

<u>Mernmerna Syncline</u>

The Mernmerna Syncline, a major NNE-SSW oriented fold, is located in the SW of the map sheet. For the most part the Cambrian sequence lies concealed beneath superficial Recent deposits except for the northern closure in the vicinity of Mt. Aleck. In the northern part of the structure the Hawker Group is overlain by the Billy Creek Formation.

Early stream sediment surveys led to the recognition of a `gossan-like horizon in the basal Cambrian' in southern portion of the eastern limb. Subsequent work names the Vanessa prospect from the same general vicinity where mineralisation is fault related.

Regional mapping indicates that the Parara Limestone is relatively thin and that the Billy Creek Formation was deposited in the absence of the upper Hawker Group units as occurred in the southern Bunyeroo Syncline a few kilometres to the north. Although not documented, it is inferred that the Flinders Unconformity corresponds to the Parara/Wilkawillina contact.

Given the stratigraphic similarity and the multiple lead-zinc mineral occurrences of the nearby Bunyeroo Syncline, the Mernmerna area should be prospective and a detailed review of the geochemical data in combination with a new mapping programme could be productive.

<u>Kanyaka Syncline</u>

The Kanyaka Syncline, oriented NE-SW, is a simple fold with a 65 km long strike located in the mid south of the sheet that continues on to the Orroroo sheet to the south.

Stream sediment survey followups have noted lead-zinc enrichment associated with ocherous clays and/or iron/manganese oxide accumulations. It appears that little additional work has been undertaken.

Review of the data and field mapping to place the known geochemical anomalies into a proper stratigraphic context is required.

(See also Orroroo Sheet)

Yappala Syncline

The Yappala Syncline is a lesser fold co-joined to the Kanyaka Syncline, to the SW of Hawker, near the southern boundary of the map sheet.

Stream sediment surveys were undertaken without significant results.

Warrakimbo Syncline

The Warrakimbo Syncline is a small down faulted feature in the SW corner of the map sheet on the flank of the Flinders Ranges.

Stream sediment surveys indicate the presence of anomalous lead-zinc in the basal Wilkawillina Limestone/Parachilna Formatiion but no detailed follow-up appears to have been carried out.

Cotabena Syncline

The Cotabena Syncline, located to the west of the Mernmerna Syncline, is only recognised in the subsurface below Recent cover and consequently remains unexplored.

Orroroo Sheet

Mt. Ragless Syncline

The Mt. Ragless Syncline, located in the NW corner of the map sheet is a compound fold of arcuate outline. Much of the structure is concealed by Pleistocene-Recent deposits.

Stream sediment surveys indicated that the Lower Cambrian was regionally anomalous over a strike of 27 km. Followup work showed that the mineralisation was concentrated in the Parachilna Formation and basal 100m of the Wilkawillina Limestone where iron/manganese oxide bodies were commonly present.

Subsequent detailed exploration identified the old workings at Donnelly's/Comstock (iron oxide) and Mt. Arden & Radford Creek (copper) as potential lead-zinc prospects.

Costeaning, drilling and geophysical surveys were undertaken at these sites and just to the south of Mt. Ragless. High variability in the distribution of lead-zinc in the near surface and to depth as secondary minerals is evident. The near surface enrichment and superficial character of the iron/manganese deposits suggests substantial redistribution of metals during weathering processes.

Jasperoidal ironstones associated with drag folds, located in the core of the syncline, were found to contain appreciable zinc.

No detailed stratigraphic data appear to be available and the drill targeting seems to have been focussed on the superficial iron/manganese masses.

The geochemical information needs to be collated with detailed surface mapping because the open hole drilling is unlikely to have reliably sampled any thoroughly decomposed ore zone even if intersected. The significance of the geophysical survey results can only be addressed after such work.

Kanyaka Syncline

The Kanyaka Syncline is a major fold that extends a relatively short distance on to the map sheet from the Parachilna sheet to the north.

Stream sediment surveys identified the Kanyaka copper workings and environs as being lead-zinc anomalous but dispersion trains in streams were demonstrated to be short.

Detailed work using costeans and drilling showed that significant concentrations of zinc both accompanied the secondary copper minerals and occurred separately within the Parachilna Formation.

Similar low grade lead-zinc was also indicated 7 km to the north of the workings in Parachilna Formation.

Little attention was given to the Wilkawillina Limestone.

The geochemical data need to be reviewed as described for the nearby Mt. Ragless Syncline.

Stepping to Discovery

The regionally based assessment outlined above and detailed within the reviews of Appendix 3, coupled with the new ideas on **MVT** emplacement, local facies stratigraphy, palaeokarstification and the impacts of Cretaceous-Tertiary tropical and subsequent semi-arid weathering processes consistently point to justifying a systematic collation of existing data with new mapping wherever indications of mineralisation are present.

The Lower Cambrian regional stratigraphic model developed by Gravestock has limited implication for in-field geological mapping perse which should be assembling raw factual data, excepting that the nature of the information being sought should be relevant to it. The stratigraphic model could, however, be profoundly important in the ranking of areas and exploration targets.

This report demonstrates that **MVT** mineralisation processes were actively in place during the Lower Cambrian and the potential source and depositional criteria for significant deposits did occur.

Furthermore it examines and explains why exploration to date has not been capable of thoroughly testing the prospective environment and outlines some relatively simple and economic steps that can be taken to enhance our understanding and lead to discovery of a commercial **MVT** deposit in the Northern Flinders Ranges.

New initiatives designed to test the concepts presented and identify key indicators of **MVT** mineralisation such as alteration diagnosis would be invaluable.

Similarly a geophysical technique of proven reliability in this setting would be a useful adjunct.

CONCLUSIONS & RECOMMENDATIONS

Conclusions

- Stratigraphic modelling by Haslett (1975) and Gravestock recognises the existence of a deep northern basinal region which fulfils the requirement for a basin dewatering metal bearing brine source.

- Stratigraphic facies reconstructions by Gravestock and Clarke, when coupled with generally available data on structure, provide adequate opportunity for the focussing of potential **MVT** brines into favourable sites of emplacement.

- Detailed studies at Linda prospect by Jenkins unambiguously indicate **MVT** mineralisation did occur there and by extrapolation was a widespread event in the basal sequence probably just before the deposition of the Billy Creek Formation.

- There is a reasonable possibility that minor **MVT** mineralisation may have been introduced into underlying Adelaidean units such as the Wonoka Formation.

- a) Willemite is deposited from relatively warm geothermal brines and is unlikely to be a weathering product derived from sulphide oxidation.

  b) Willemite mineralisation and possible late sulphide remobilisation in **MVT** deposits occurred during the Delamerian orogeny.

- Detailed local and regional stratigraphic mapping designed to establish the facies and structural geometries of potential mineralisation pathways and ore entrapment sites is an essential step in assessing exploration potential.

- Tertiary palaeoweathering, that may have deflected historical exploration to focus on secondary dispersion signatures, needs to be considered at both the planning and assessment stages of field programmes, particularly in respect to physical and geochemical mapping.

- At the commencement of a new exploration initiative, a thorough work-over of historical geochemical data coupled with a field mapping programme to record stratigraphic facies settings and negative palaeoweathering features, supplemented by specific purpose sampling, is essential.

- Early validation of a geophysical method for detecting primary mineralisation in this region would be invaluable to explorers in this environmentally sensitive area of South Australia.

- Investigation into the development of a viable routine methodology for the typing of dolomite, to permit the identification of possible **MVT** mineralisation alteration haloes could result in an invaluable exploration tool.

Recommendations

- Future public domain support to encourage exploration should seek to identify a **MVT** test prospect for :-

  a) Validating the concepts put forward in this report.

  b) Establishing a geochemical evaluation strategy.

  c) Establishing a viable geophysical technique.

  d) Dolomite characterisation research.

- Explorers should revert to compiling detailed mapping and collating this information with previous geochemical data where available, as the first phase of any programme.

- Second phase exploration should seek to classify the geochemical signatures of all the anomalies detected and to validate these by appropriate field inspections and supplementary sampling.

- Third phase exploration should bring conventional exploration to bear upon those features most likely to represent primary mineralisation. (Small physical dimensions and low geochemical magnitudes may well be important.)

- Achademic investigations into the hydrological stratification of dissolved chemical phases in aquifers should be considered as there is potential for wider application of this concept to other sediment hosted ore types where basin fluids are believed to be genetically relevent.

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WILLEMITE MINERALISATION	JL CURTIS	GW JENKINS
PALAEOWEATHERING:		
Concepts	JL CURTIS	GW JENKINS
Geochemistry	GW JENKINS	JL CURTIS
EXPLORATION	JL CURTIS	
APPENDIX 1.1	JL CURTIS	
APPENDIX 1.2	GW JENKINS	
APPENDIX 1.3	D.I. GRAVESTOCK	
APPENDIX 2	JL CURTIS	
APPENDIX 3	JL CURTIS	GW JENKINS

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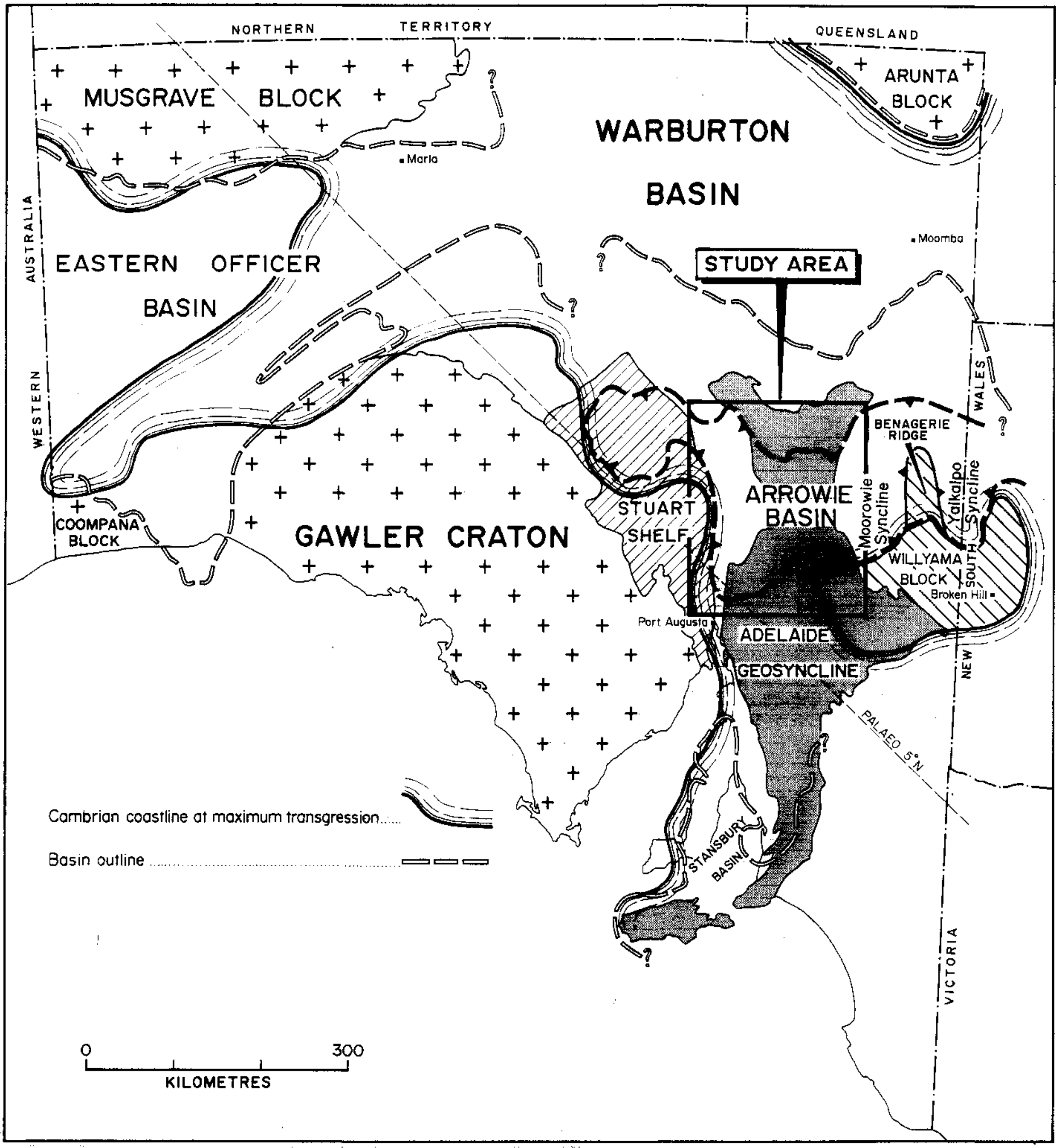
TABLE 1. SUMMARY OF CARBONATE ANALYSES-LINDA PROSPECT

Format: number of analyses / mean % ± std. dev.

Each analysis is the average of at least three points within 100um of each other within a grain, rounded to 3 decimal places. "nd" means not detected.

CARBONATE TYPE	Mg	Mn	Fe	Sr	Zn
Primary calcite, ≈ 10m from sulphides	7 .246±.068	7 .013±.009	7 nd	7 .018±.012	7 nd
Primary calcite, <9 cm from sulphides	15 .193±.065	13 .031±.019	13 nd	13 .015±.007	13 .011±.004
Early marine fibrous calcite, ≈ 10m from sulphides	4 .255±.087	4 nd	4 nd	4 .027±.014	4 nd
Early marine fibrous calcite, <9 cm from sulphides	6 .156±.021	6 .194±.160	6 .121±.063	6 .029±.010	6 nd
Sparry & blocky calcite, ≈ 10m from sulphides	3 .248±.031	3 .072±.016	3 .058±.026	3 .018±.006	3 nd
Sparry & blocky calcite, <9 cm from sulphides	9 .061±.042	9 nd	9 nd	9 nd	9 .077±.047
Late vein calcite, ≈ 10m from sulphides	9 .197±.043	9 .195±.080	9 .230±.134	9 .011±.004	9 .012±.006
Late vein calcite, <9 cm from sulphides	12 .172±.054	12 .107±.079	12 .107±.089	12 .017±.012	12 .023±.028
Host dolomite, ≈ 10m from sulphides	-	12 .153±.139	12 .463±.330	-	12 .015±.011
Host dolomite, <9 cm from sulphides	-	37 .120±.049	37 .345±.139	-	37 .045±.110
Euhedral dolomite replacing ZnS	-	10 .201±.149	10 .512±.428	-	10 .126±.106
Coarse subhedral dolomite		8 .311±.235	8 .137±.191	-	8 .022±.018
DETECTION LIMITS					
Calcite	.005	.010	.080	.017	.020
Dolomite	-	.014	.080	-	.020

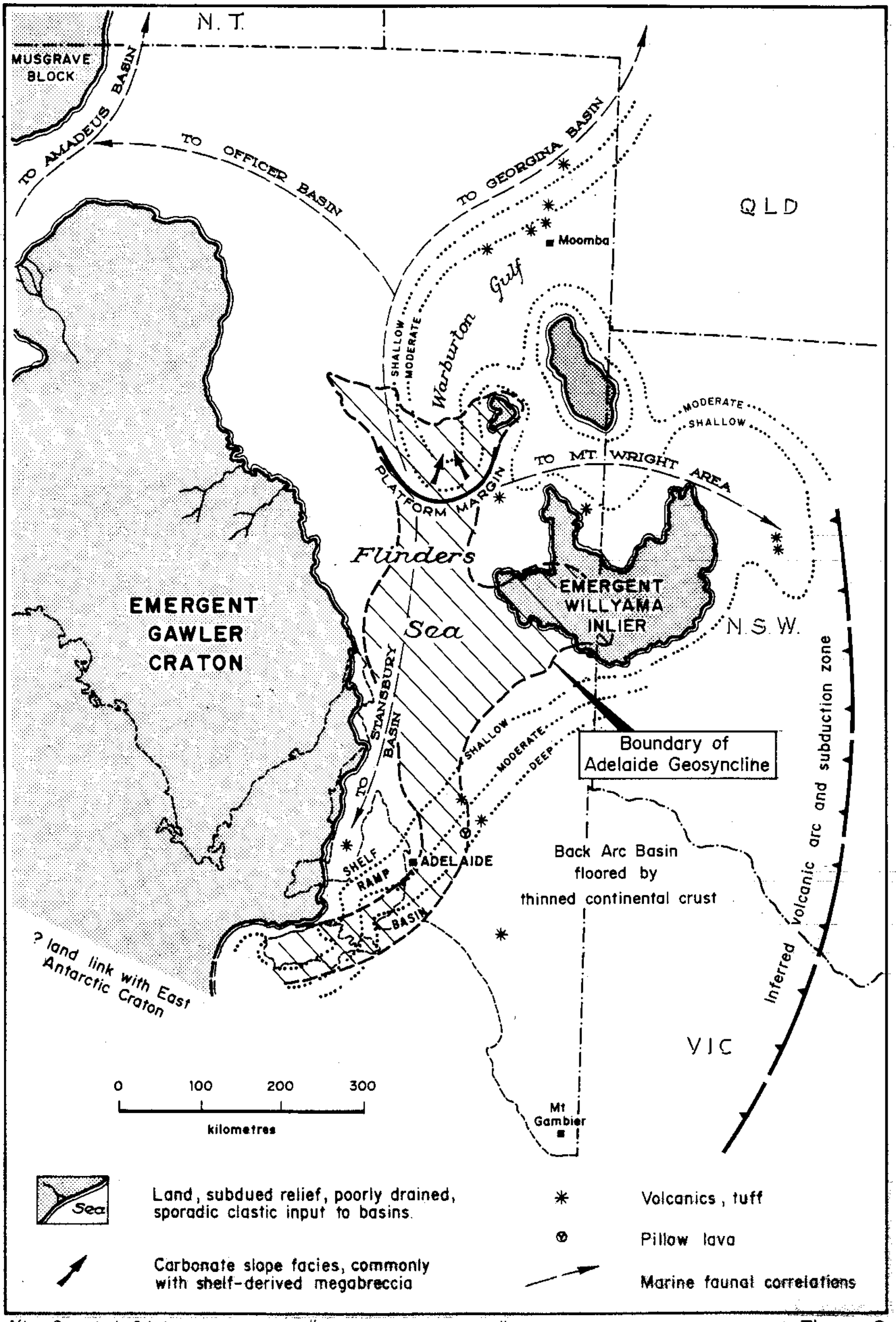


After Gravestock, D.I. in Parker, A.J. (1990) "Exploration Towards 2000"

Figure 1

MVT LEAD ZINC MINERALISATION – NORTHERN FLINDERS RANGES

CAMBRIAN PALAEO–SHORELINE AND REMNANT BASINS OF SOUTH AUSTRALIA

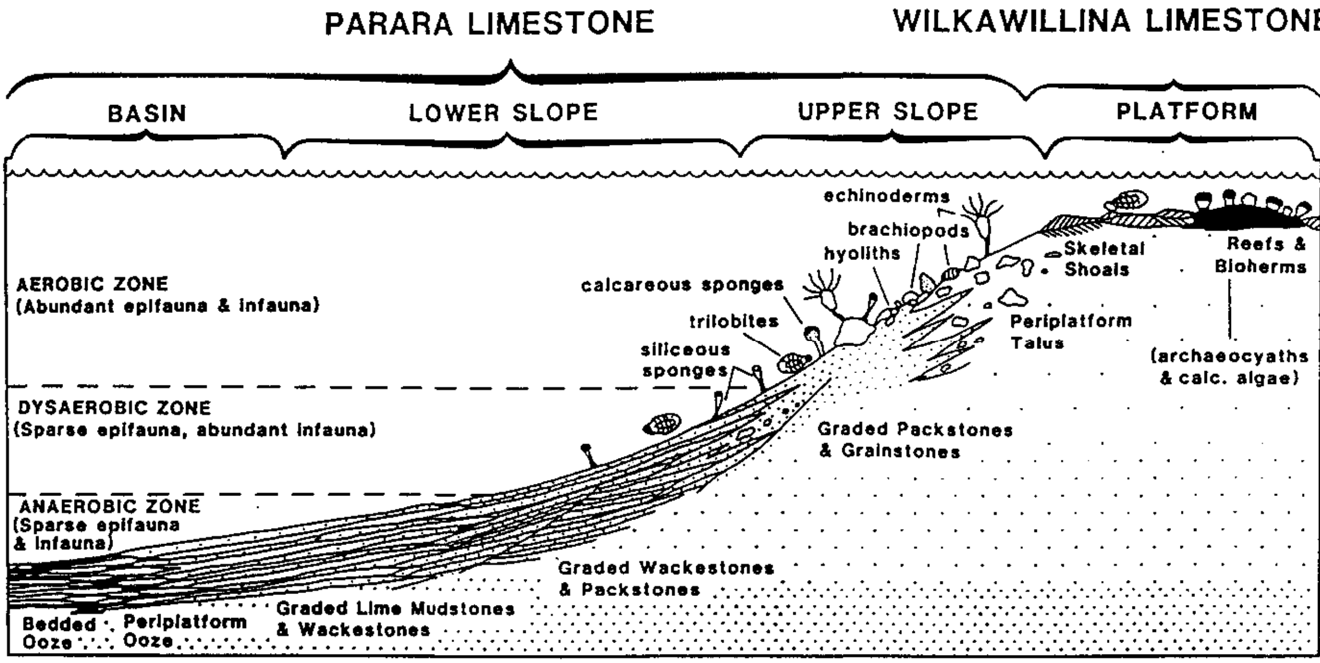


After Gravestock, D.I. in Parker, A.J. (1990) "Exploration Towards 2000"

Figure 2

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

PALAEO-BATHYMETRIC SKETCH OF THE LOWER CAMBRIAN EASTERN SOUTH AUSTRALIA

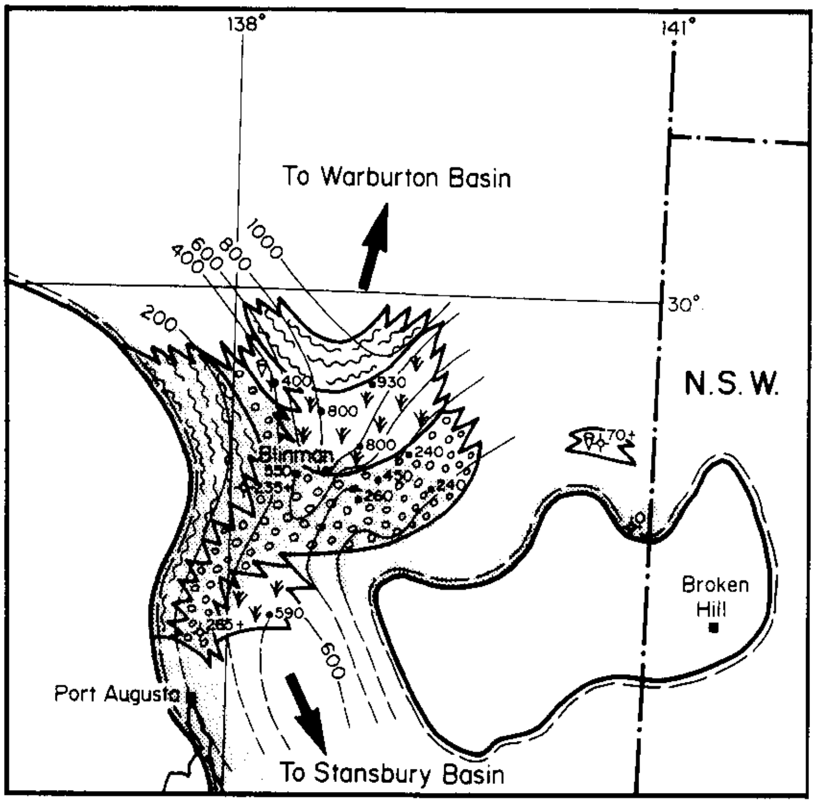


After Clarke, J.D.A. 1990b in Jago, J.B. and Moore, P.S.
GSA Special Publication 16

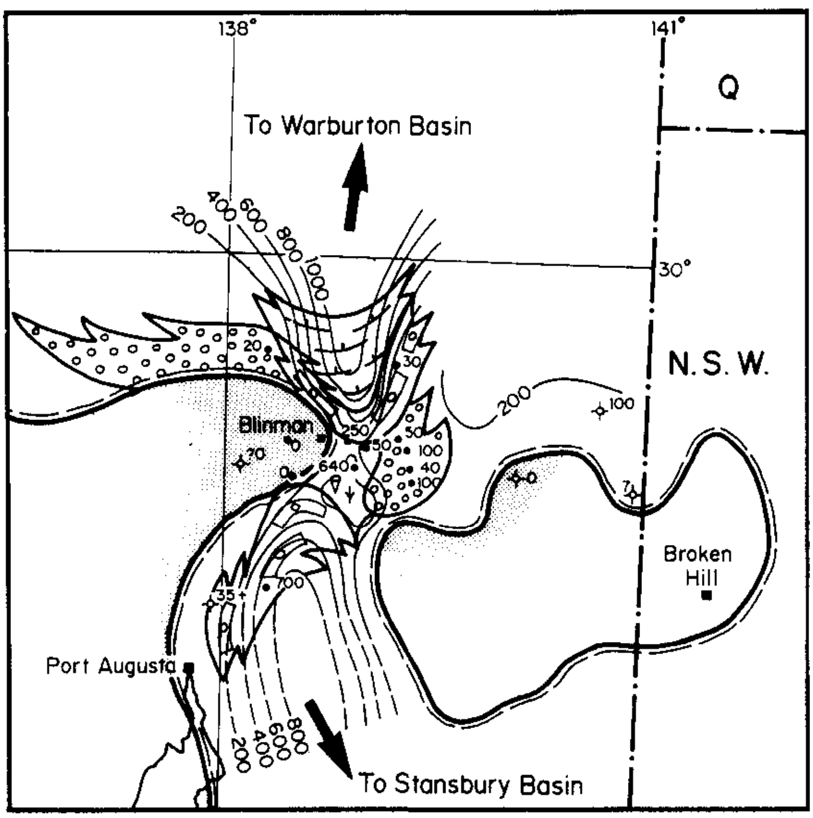
Figure 3

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

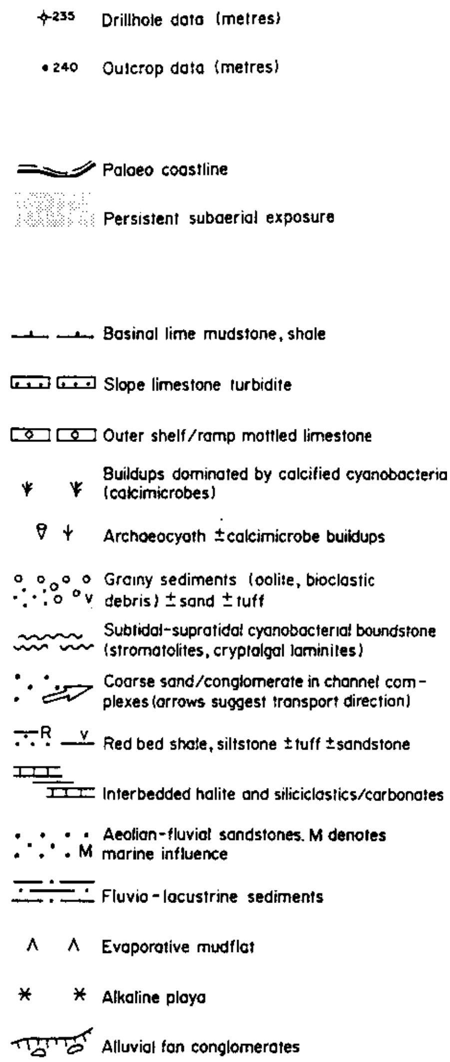
FACIES AND PALAEOECOLOGICAL RELATIONSHIPS OF THE WILKAWILLINA AND PARARA LIMESTONES

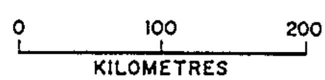


4A C1.1 sequence and following lowstand (grey shading)



4B C1.2 sequence transgressive deposits and exposed areas (grey shading)





Figures 4A & 4B

After Gravestock and Hibburt, 1991 APEA Journal

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

ARROWIE BASIN SEQUENCE RECONSTRUCTIONS

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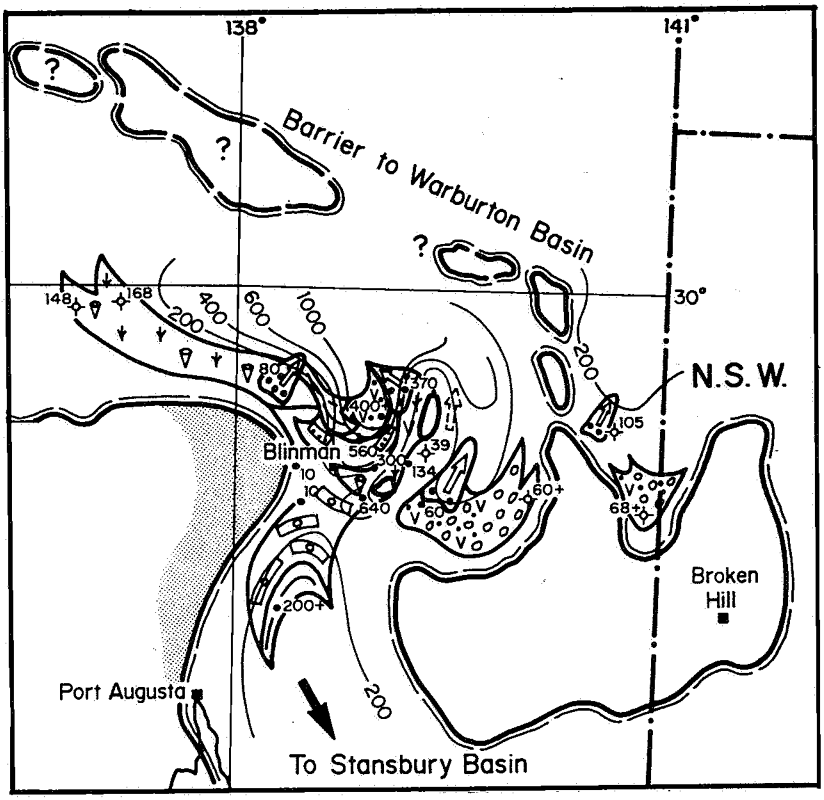
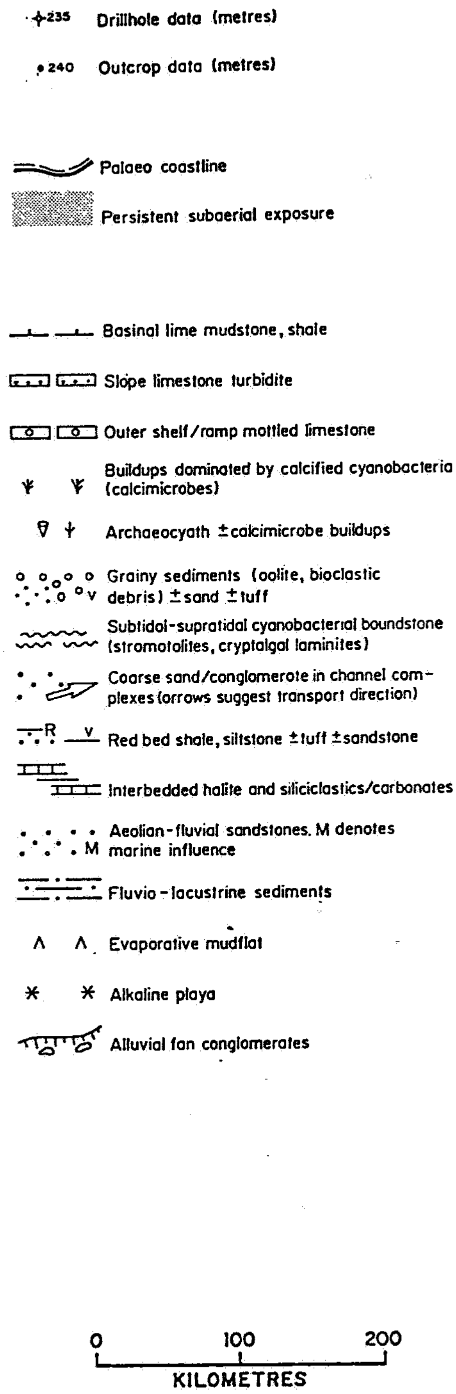
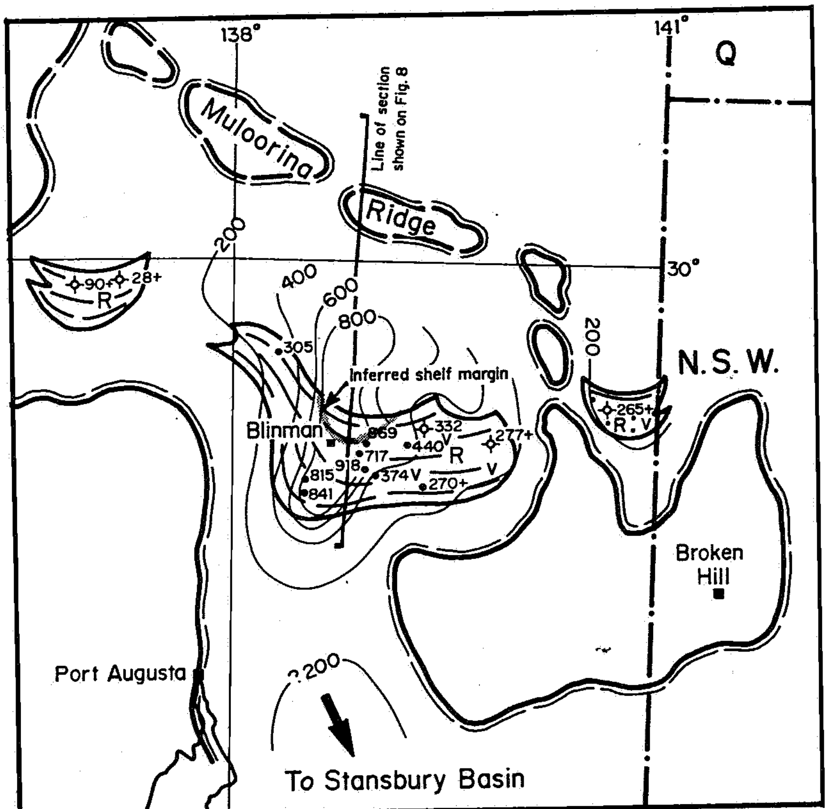


4C C1.2 sequence highstand and C1.3 sequence highstand tract deposits





4D C2.1 sequence, lacustrine marine barred environment

Figures 4C & 4D

After Gravestock and Hibburt, 1991 APEA Journal

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

ARROWIE BASIN SEQUENCE RECONSTRUCTIONS

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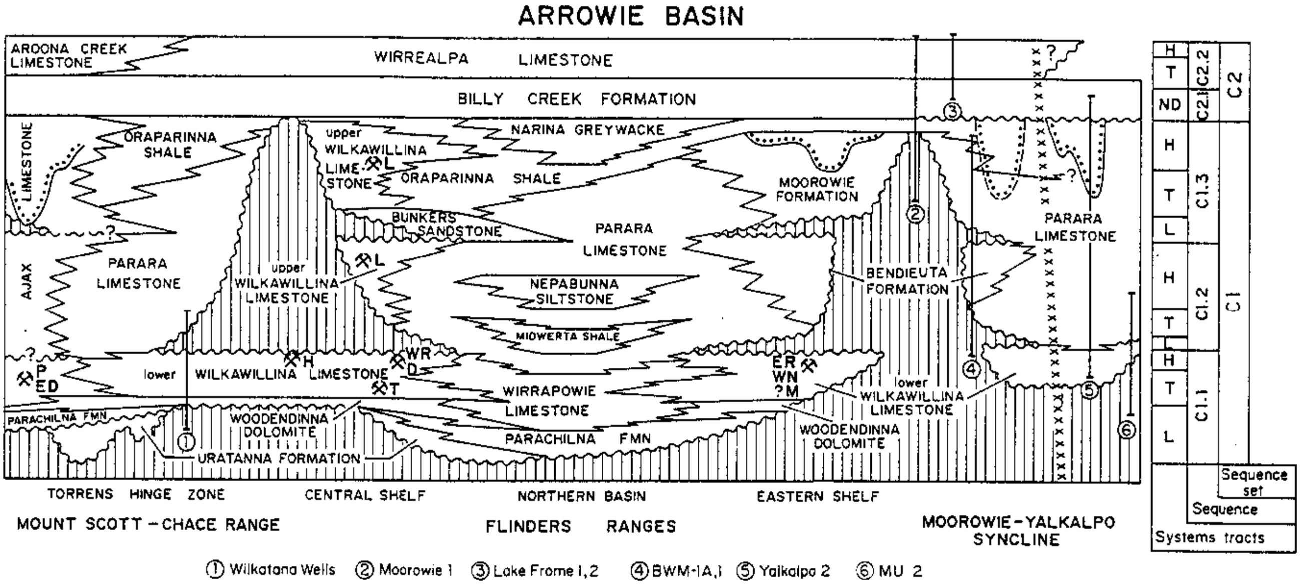


⚒ Mineralisation, Prospect or Mine

- P Puttapa
- ED Ediacara
- H Heysen Range / Brachina
- L Linda
- WR Wirrealpa
- D Donkey Bore
- T Third Plain
- ER Eric
- WN Wilnuroona
- M Moro

LEGEND

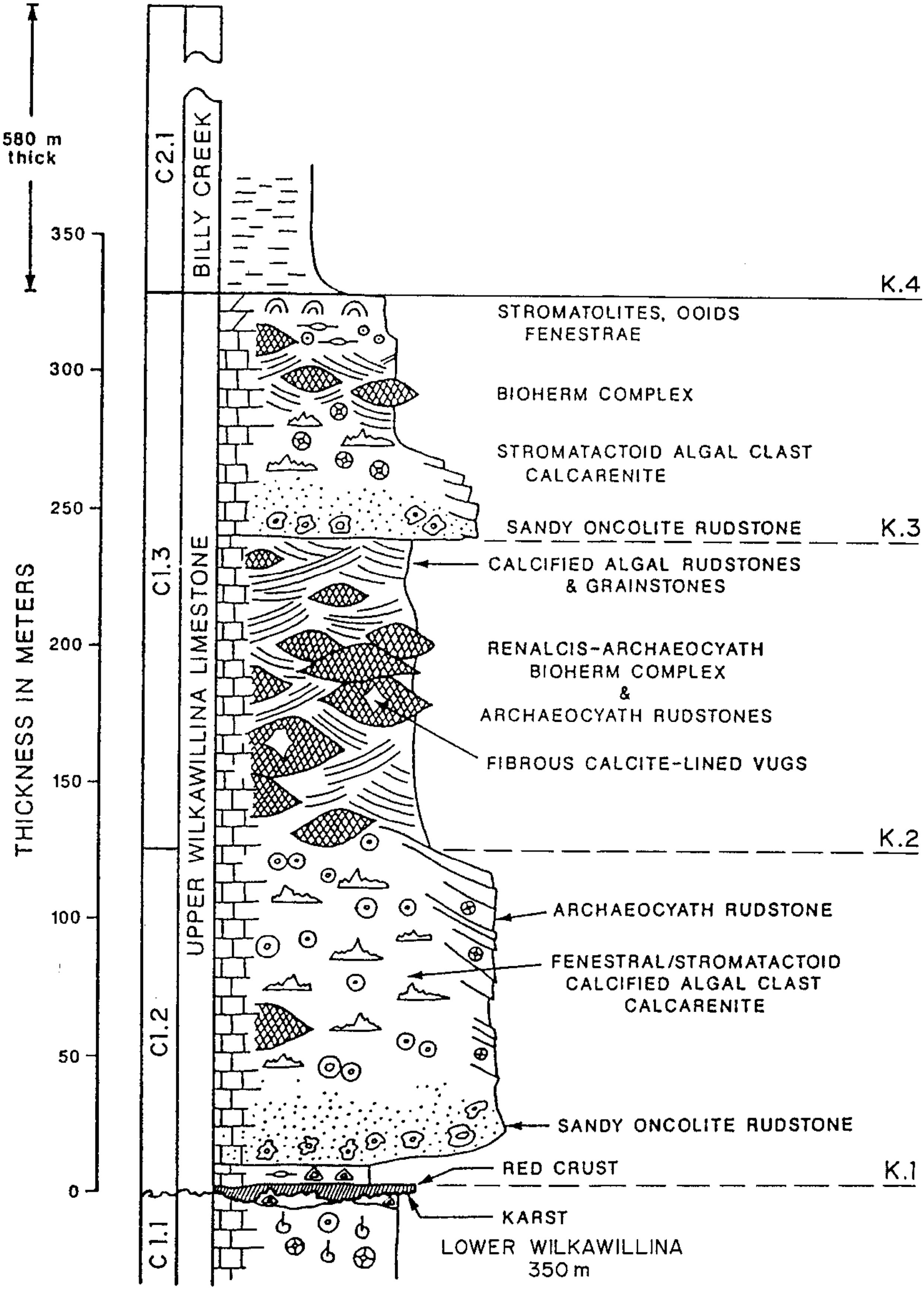
- L Lowstand
- T Transgressive
- H Highstand
- NM Non-marine or hinterland tract
- ND Not determined
- Channel

After Gravestock, D.I., 1991 APEA Journal

Figure 5

MVT LEAD ZINC MINERALISATION – NORTHERN FLINDERS RANGES

SEQUENCE STRATIGRAPHIC FRAMEWORK OF THE LOWER CAMBRIAN ARROWIE BASIN OF SOUTH AUSTRALIA



Note: For sequence C codes see figures 4 and 5
and for K codes figures 10(a) and 10(b).

After James, N.P. and Gravestock, D.I., 1990. Sedimentology 37 pp 455-480

Figure 6

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

DETAILED STRATIGRAPHIC SEQUENCES AT THE OLD WIRREALPA MINE

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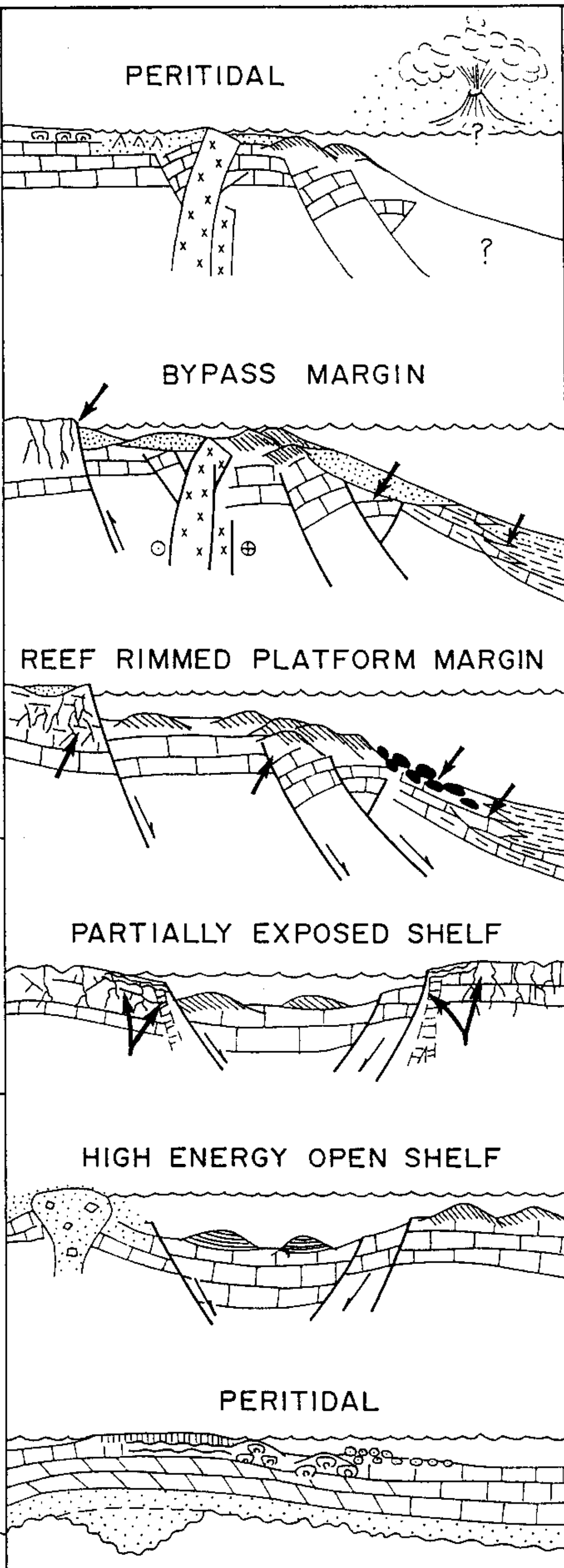

AGE			Setting	EVENT	SEDIMENTS
CAMBRIAN EARLY	BOTOMIAN	C1.3 – C2	PERITIDAL	Apparent tectonic quiescence but volcanic activity (tuff). Shoaling upward sequence to eventual exposure landward of platform margin.	Billy Creek Formation (not shown) – partly exposed tidal flat redbeds – completes Sequence 2. 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.
		C1.3	BYPASS MARGIN	Compression 'Kangarooian 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 Wirrealpa Mine, Ten Mile Creek) and upper Moorowie Formation (Moorowie Mine). Narina Greywacke may be downslope equivalent. Shelfal sands (Bunkers Sandstone) may be local variant.
			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 intrashelf basins and possibly seaward of platform margin. Karst on exposed shelf carbonates e.g. North of Brachina Gorge, Ten Mile Creek.
		C1.1 – C1.2	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.
	ATDABANIAN	C1.1	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.
			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, mudcracks, sand. Commonly dolomitised, chert nodules. Parachilna, Uratanna Formations. Transgressive sheet sands, burrowed shoreface sands, channels.
Ꞓ					

After James & Gravestock

↙ Sites favourable for MVT deposition

Figure 7

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

THE PALAEOENVIRONMENT OF POTENTIAL MVT DEPOSITS IN THE HAWKER GROUP

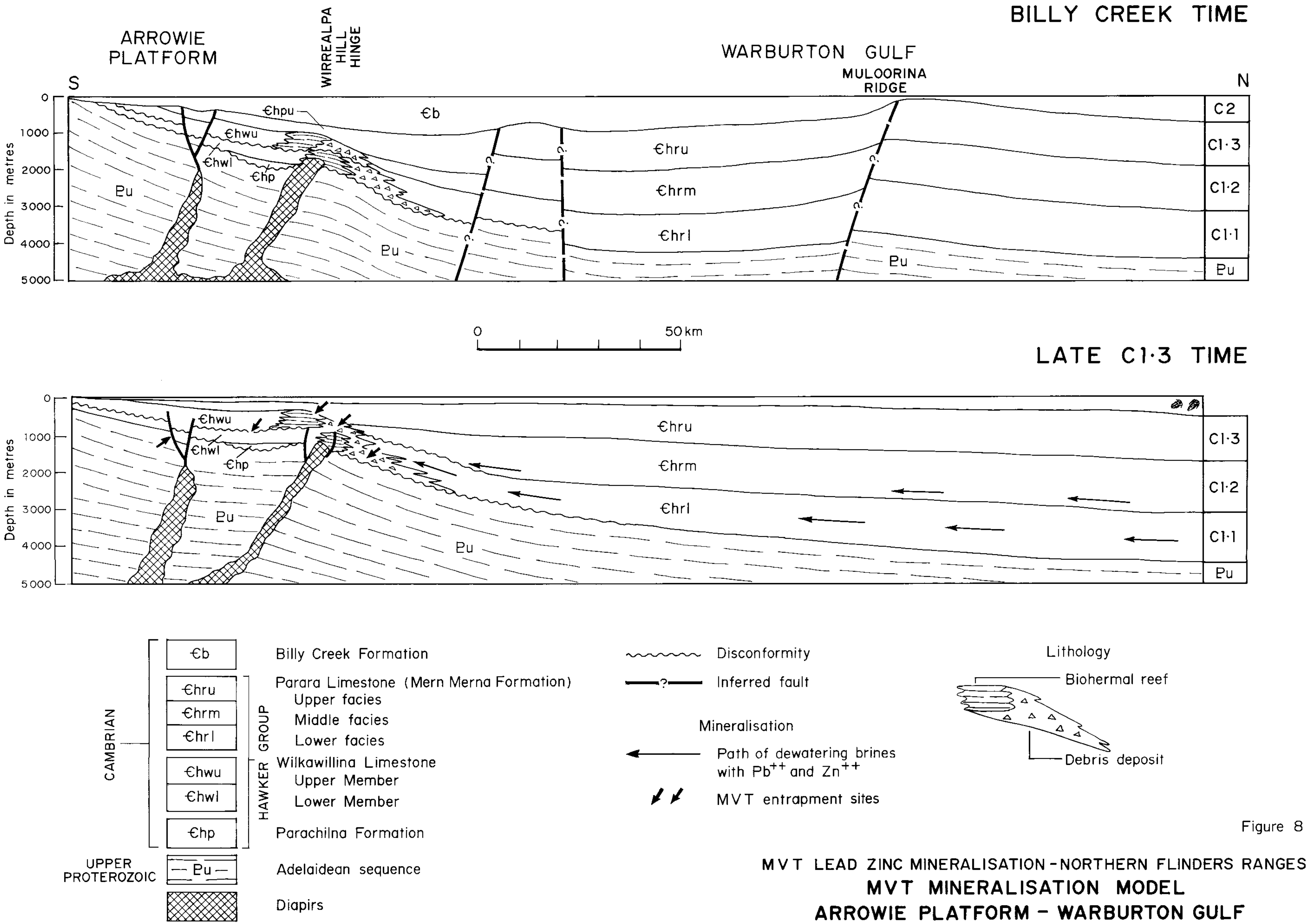

Figure 8

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

MVT MINERALISATION MODEL

ARROWIE PLATFORM – WARBURTON GULF

Compiled by J.L.Curtis

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91-488

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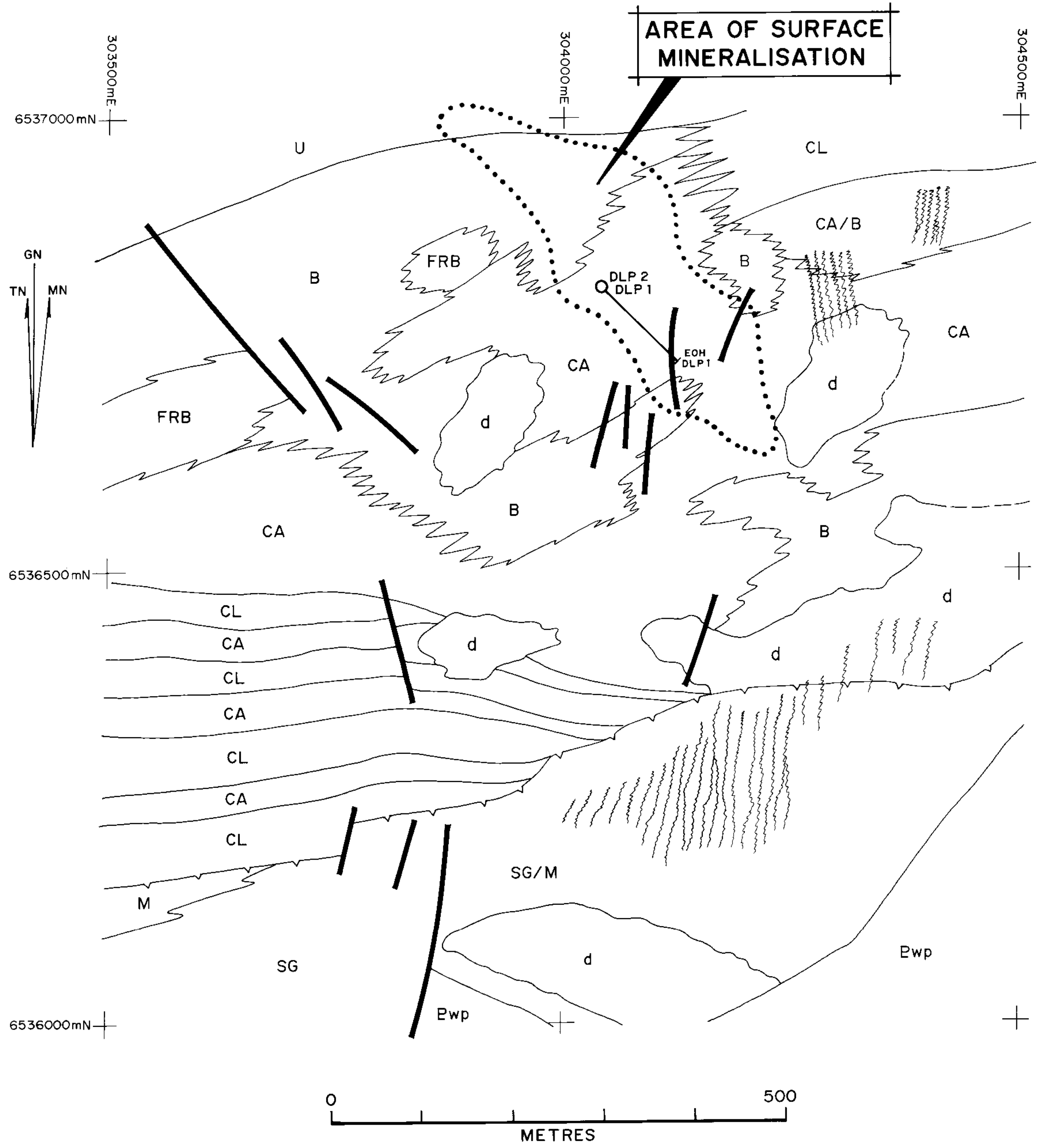

CAMBRIAN
- U — Undifferentiated Cambrian
- d — Dolomitisation intense enough to completely obscure primary structure
- CA — Calcarenite
- CL — Calcilutite
- B — Biohermal material
- FRB — Fore reef breccia
- SG — Skeletal grainstone
- M — Mottled limestone

PRE-CAMBRIAN
- Ꞓwp — Pound Subgroup

- Fault
- Palaeovertical fissures (possible neptunian dykes)
- Diamond drillhole

Notes: Average strike and dip of Cambrian sediments in map area 080°/75°N. Local variations not shown.
Original mapping by M. Roche (1984), with modifications and additions by G. Jenkins (1991).
Base for mapping S.A. Dept of Lands aerial photo 2679/040 enlarged to 1:5000. No correction for photographic distortion.

Compiled by G. Jenkins

Figure 9

MVT LEAD ZINC MINERALISATION
NORTHERN FLINDERS RANGES

LINDA PROSPECT
GEOLOGY AND MINERALISATION

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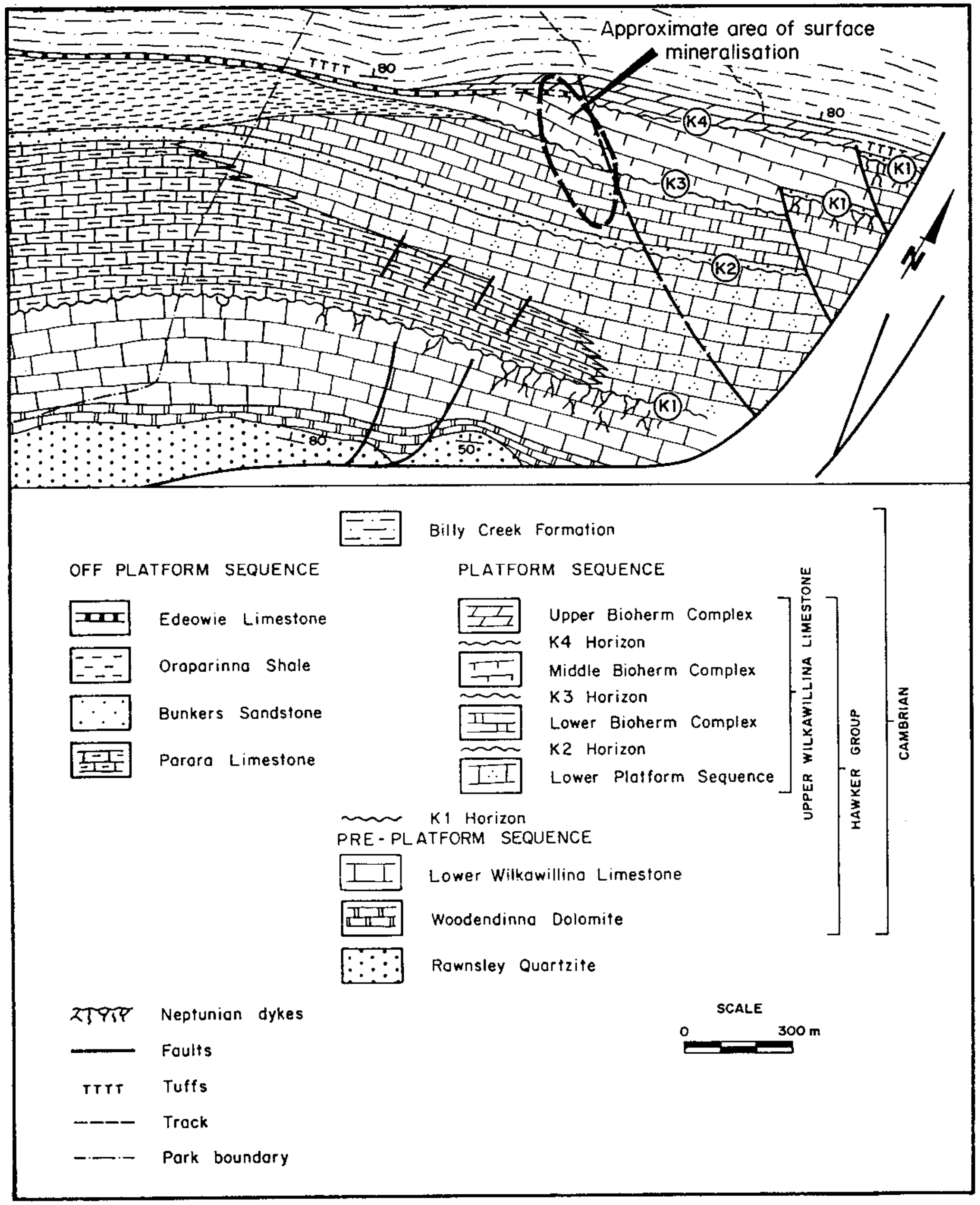
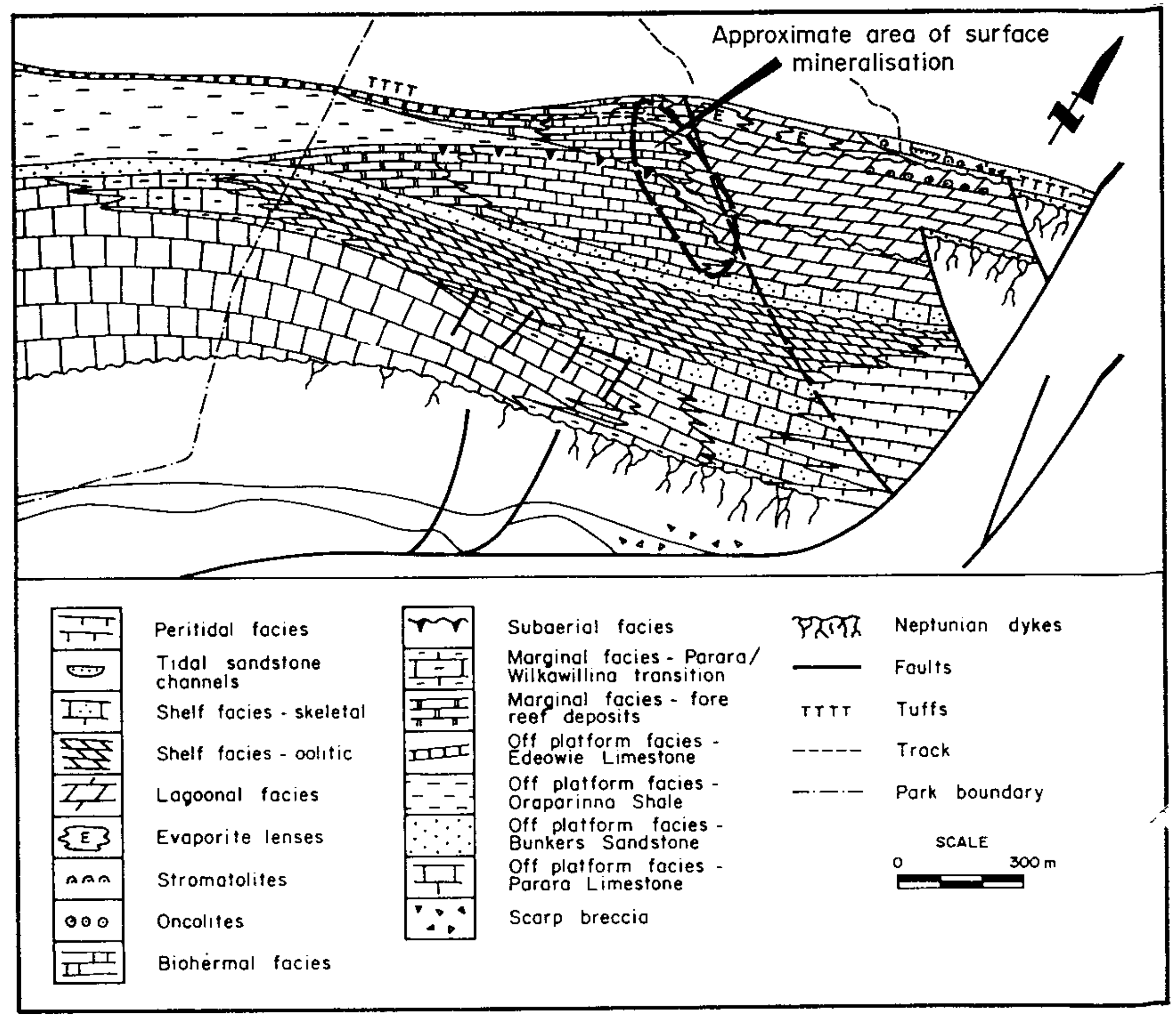
Department of Mines and Energy - South Australia



10(a) The stratigraphic setting of the Linda Prospect. Bunkers Graben



10(b) The sedimentary facies setting of the Linda Prospect. Bunkers Graben

Figure 10

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

STRATIGRAPHIC AND SEDIMENTARY FACIES SETTINGS OF THE LINDA PROSPECT

Department of Mines and Energy - South Australia

(Adapted from Clarke J.D.A., 1990(c))

91-490

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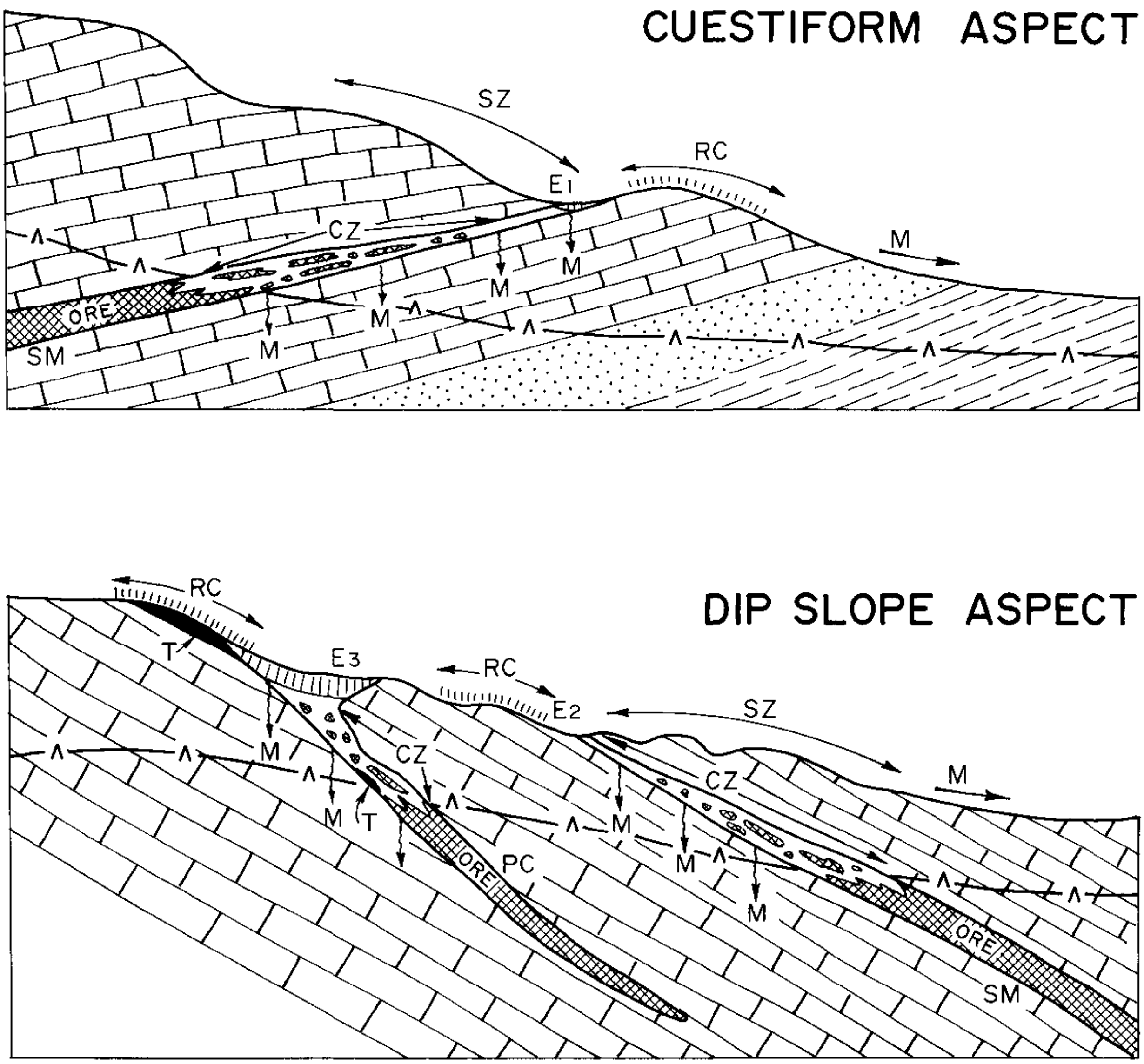


Compiled by J.L.Curtis

SM....Sheet model

PC.....Palaeokarst model

E1-3...Yellow clays with anomalous metal contents, accessory Fe oxides/jaspers

E1......Clay/scree filled saddle

E2.....Thin interbedded clay

E3.....Circular-ovate depression with clay/scree-soil profile

T......."Travertine" jaspers

RC.....Rock chip geochemical anomalies

CZ.....Collapsed ore zone, yellow clay and limestone breccia

SZ....Sag zone in hanging wall, slightly flattened dips

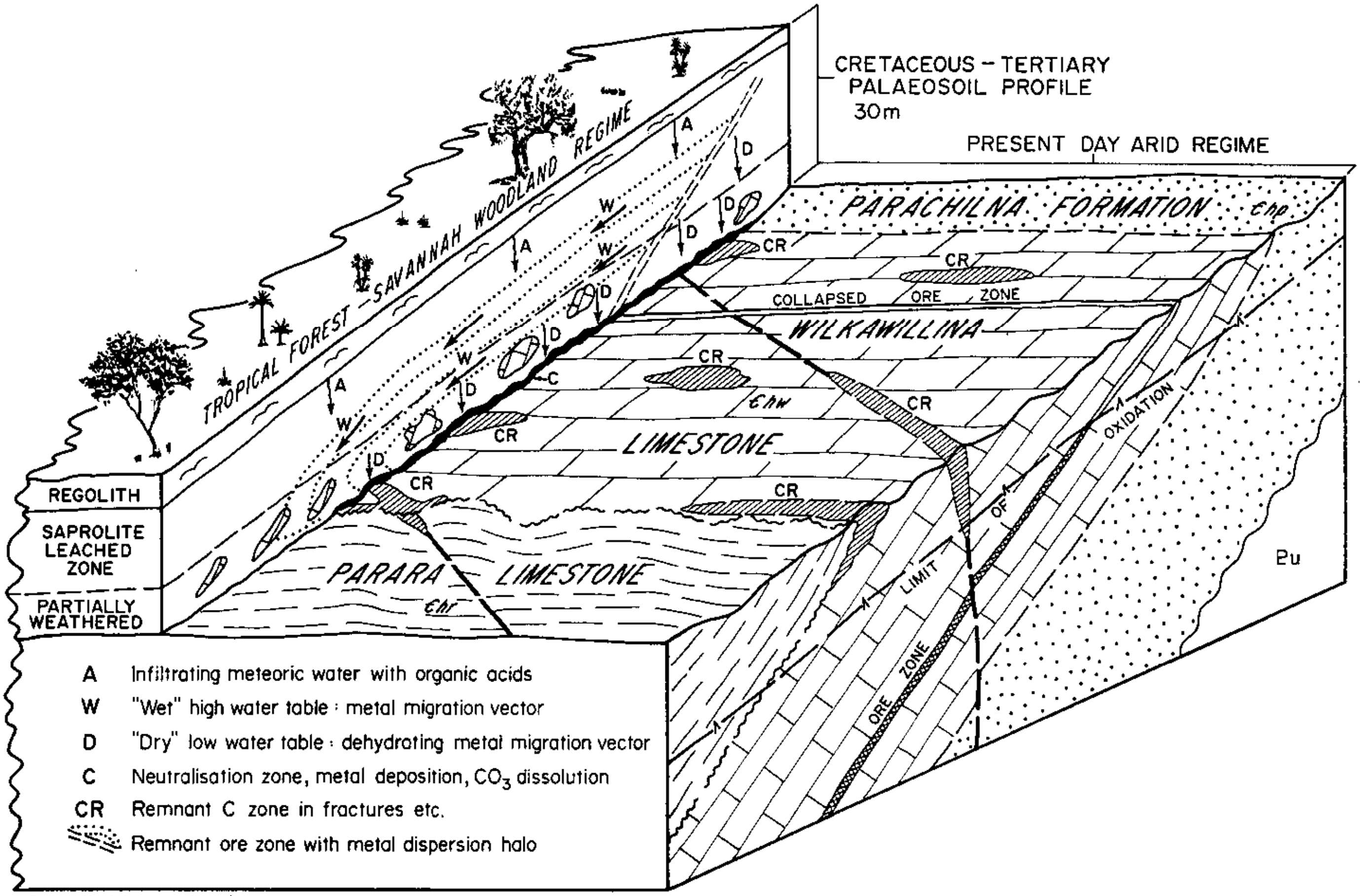
M......Migration path of secondary mineralisation

—Λ—....Limit of oxidation

Figure 11

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

SURFACE EXPRESSION MODEL

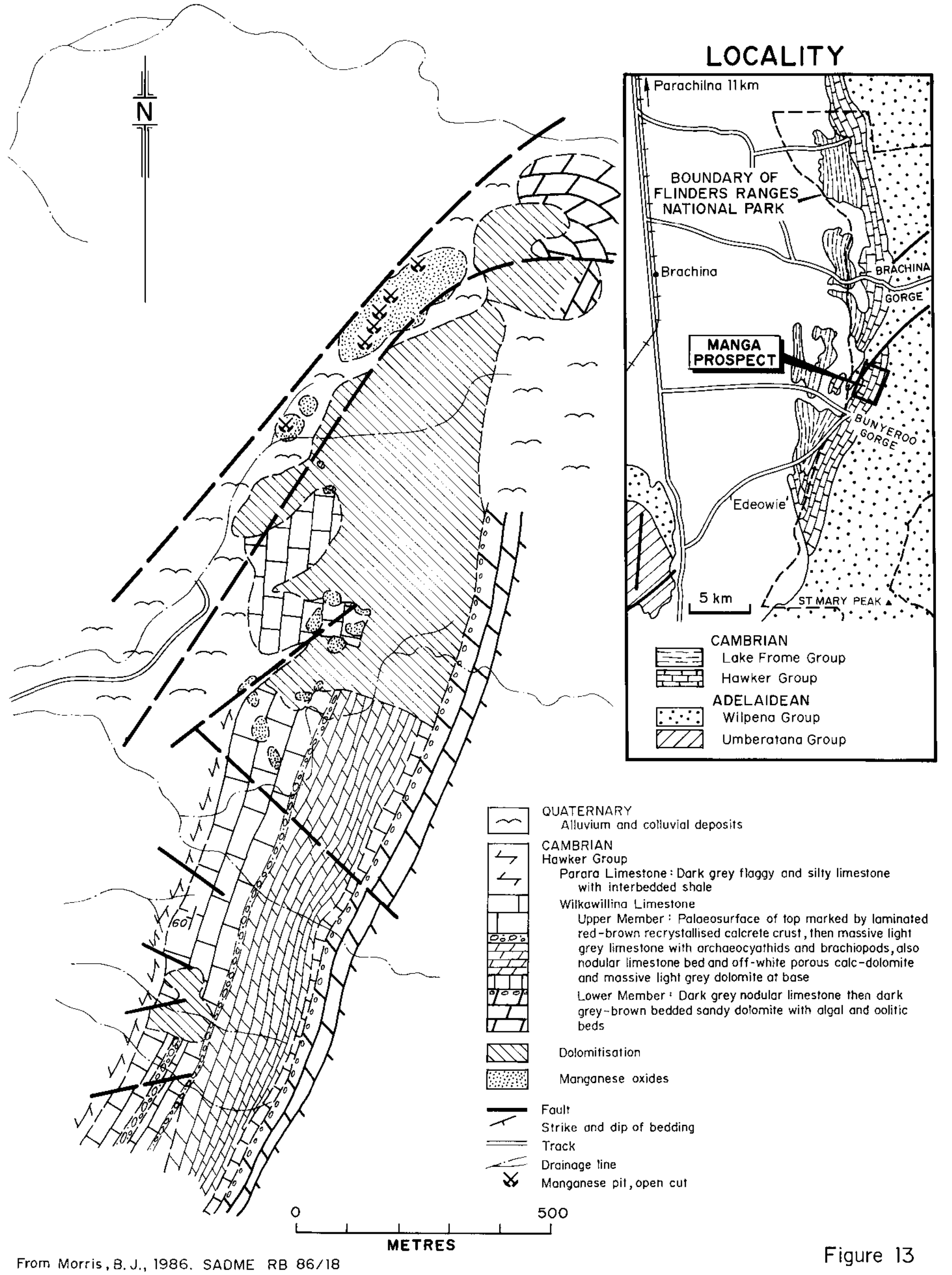


Compiled by J.L.Curtis

Figure 12

MVT LEAD ZINC MINERALISATION – NORTHERN FLINDERS RANGES

SECONDARY MINERALISATION AND PALAEOWEATHERING OF LIMESTONES IN THE NORTHERN FLINDERS RANGES

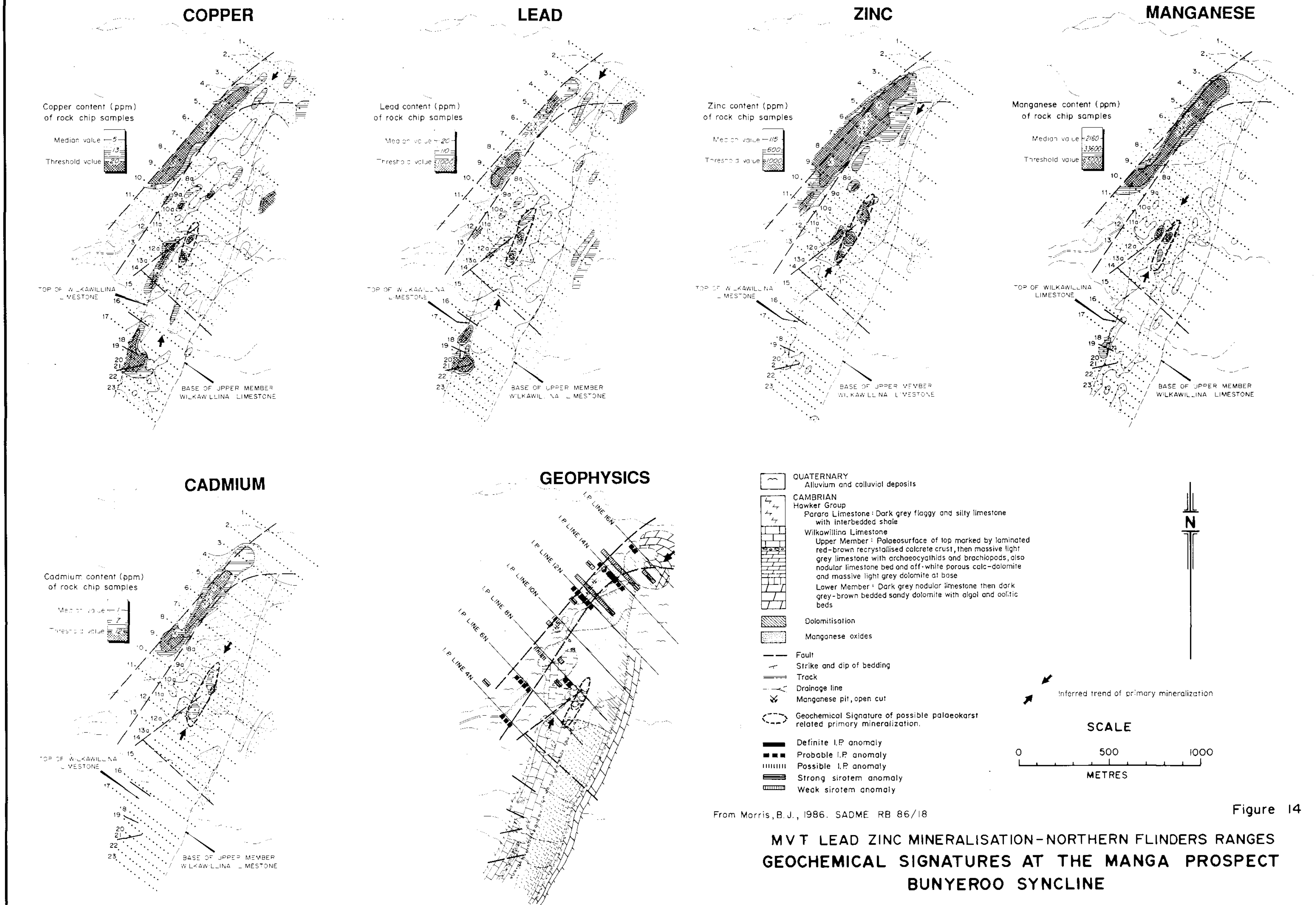


From Morris, B. J., 1986. SADME RB 86/18

Figure 13

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

GEOLOGICAL SKETCH OF THE MANGA PROSPECT BUNYEROO SYNCLINE



From Morris, B.J., 1986. SADME RB 86/18

Figure 14

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES
GEOCHEMICAL SIGNATURES AT THE MANGA PROSPECT
BUNYEROO SYNCLINE

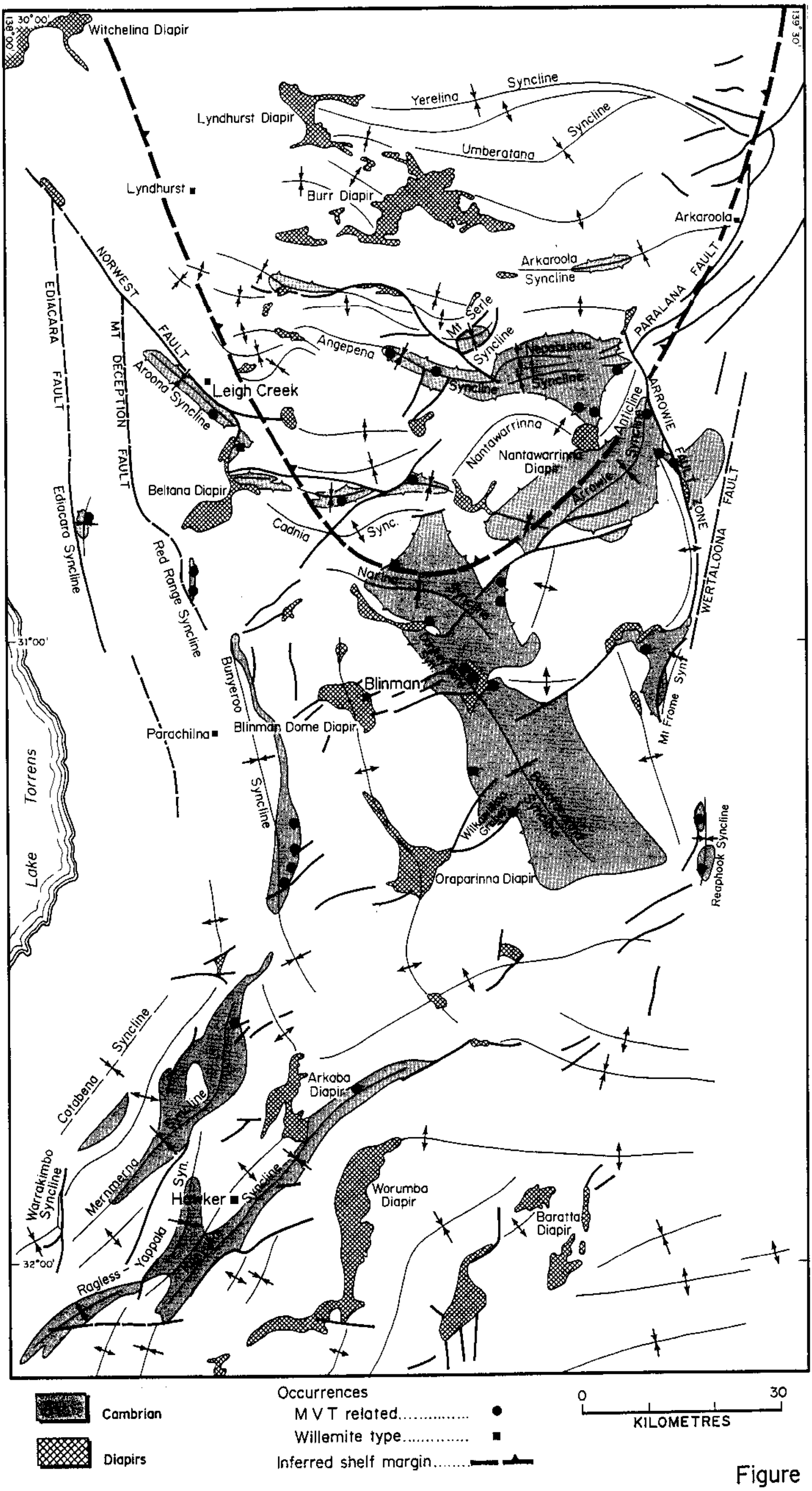


Figure 15

MVT LEAD ZINC MINERALISATION - NORTHERN FLINDERS RANGES

STRUCTURAL REMNANTS OF THE ARROWIE BASIN

Modified from Curtis (1989)

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APPENDIXES

MVT-LZ EXPLORATION

NORTHERN FLINDERS RANGES

November 1991

APPENDIX 1.1

HYDRODYNAMIC STRATIFICATION AND MVT MINERALISATION

Since this phenomenon is seldom if ever addressed within metallic mineral deposit literature and probably has little impact upon the genesis of most economic deposits, a brief synopsis follows.

Ions in solution are clearly mobilised by thermal kinetic energy and weak temporary bonding to neighbouring entities. Such factors lead to the dispersion of soluble species throughout the aqueous body. The higher the temperature the more effective the dispersion.

While the above is fully acknowledged, it is also clear that each ion/molecule in a fluid is gravitationally attracted downwards by its mass. On a laboratory scale this is quite insignificant, but not so for tall aqueous columns.

In any column of mobile particulate components subject to agitation, the system of particles will attempt to reach its lowest gravitational potential energy which corresponds to its greatest packing density. This is readily demonstrated visually by sand, which tends to expel its coarsest fraction upwards to permit maximum packing toward the base.

Observations of real aquifers provide clear evidence that ionic species dispersion is not uniform but depth biased over aqueous columns as short as 30 m. The most graphic evidence for the phenomenon is clearly petroleum, which accumulates as an independent phase at the very top of an aquifer. The phenomenon is also very apparent with gases especially on the mega scale of the atmosphere.

Within an aquifer, the overall salinity of soluble species increases with depth. This 'stratification' is sufficiently pronounced that the significant variation in the concentration of individual common chemical species such as SO_4^{2-} can be measured.

The phenomenon is actually sufficient to justify the practice of modifying the natural hydrochemistry of formation waters surrounding uranium deposits (preconditioning) by commonly injecting unmodified water from the upper parts of the same aquifer in advance of initiating solution mining.

It is therefore proposed here that a single aquifer can carry mutually unstable chemically soluble phases at relatively low concentrations (if their gravitational characteristics are appropriate), concurrently under laminar flow conditions.

The chemical incompatibility of H_2S (pressure soluble gas) and base metal cations Cu^{2+}, Pb^{2+}, & Zn^{2+} (high density low hydration ions) would fit the model criteria. The work of Sverjensky (1984) complements this hypothesis because it allows for the dispersion of these phases up to a level such that premature precipitation does not take place prior to arrival at an ore site with an increase of the nett metal inventory being carried.

The stratification concept provides for the movement of mutually unstable quantities of metals and reductant through the focussing zone at a basin margin until permeability conditions ensure mixing and consequent sulphide deposition.

Widely distributed mixing environments around a basin margin would predictably lead to small scale sub-economic scattered mineralisation, but strongly developed focussing mechanisms are essential for significant mineral deposits to develop.

This concept is solely a conceptual hypothesis that has yet to be thoroughly tested by rigorous application of phase chemistry thermodynamics and the physics of groundwater.

APPENDIX 1.2

THE FLINDERS UNCONFORMITY RED CRUST

A red coloured crusty deposit, up to 20 cm thick, is draped over the palaeotopography of the Flinders Unconformity.

Mineralogy

It consists of alternating layers up to 2 mm thick of very fine grained red impure carbonate and 0.1 mm grainsized white sparry and marine fibrous calcite. While most of the sparry calcite layers are parallel to bedding, they frequently anastomose, and occasionally crosscut the other material.

The red layers consist mainly of very fine grained calcite with clay minerals, iron oxides and phosphate minerals. Very infrequently, titanium minerals of assumed detrital origin are present.

Occasionally, the phosphates occur as discrete fragments less than 1mm in size, suggesting that they may have originated as phosphatic fossils rather than by chemical precipitation. In other places, the phosphates occur in irregular layers with cuspate boundaries or as irregular patches, again less than 1mm in size; these layers and patches may have been precipitated chemically.

Palaeontology

Small microbial structures (microstromatolites) are abundant in the red layers. These occur in four forms. The first and most abundant form consists of columnar digitate microstromatolites up to 0.2 mm. wide and 0.5 mm. high, with calcite cement filling spaces between the columns. The second form consists of hemispherical domes up to 2 mm. in size, sometimes with similar domed structures growing on top of them. The third form consists of solitary domed structures up to 1 mm. in size, containing a large amount of sparry calcite relative to microbial-bound material. The fourth form, which may be a poorly developed version of the first, consists simply of subhorizontal wavy layers of microbial-bound material separated by layers of calcite cement.

The abundant black material visible microscopically in some microbial structures is organic matter, and not manganese oxide.

Origin

The very low content of manganese, and the fact that phosphate occurs either as probable fossil fragments or disseminated traces and patches, imply that the structures are not due to chemical precipitation of manganese or phosphate, but are of organic origin. However, some layered areas of phosphate with cuspate edges are probably of chemical origin, and appear to fill spaces between microbial structures.

APPENDIX 1.3

GEOLOGY OF SOUTH AUSTRALIA

PART CHAPTER 7

ARROWIE BASIN

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NOTE: No figures from the original text are included in this appendix.

EARLY CAMBRIAN

INTRODUCTION

Cambrian and Ordovician sediments were deposited in tropical latitudes in two distinct settings. One was situated in present-day eastern South Australia on the palaeo-Pacific margin of Gondwana, while the other setting to the west was in shallow epeiric seaways which extended hundreds of kilometres into the supercontinent. The contrast between these settings is reflected by the nature, distribution and thickness of sedimentary facies which form the basis for discussing the eastern and western regions separately.

The western region embraces the South Australian portion of the Officer and western Warburton Basins. The latter is very poorly known but appears to span the transition from epeiric to more fully marine conditions. The eastern region comprises relatively thin, little-deformed strata on the Stuart and Spencer Shelves, the thicker folded Cambrian in the Arrowie and Stansbury Basins, and the Cambro-Ordovician of the eastern Warburton Basin. Biostratigraphic correlation between the eastern and western regions is poor. However, the available data combined with sequence stratigraphic interpretations, provide a means of integrating Cambrian geology in the context of major depositional sequence sets (supersequences) and higher order sequences. The integration of Ordovician strata into a similar framework must await the acquisition of new data.

EARLY PALAEOZOIC OF THE EASTERN REGION

Three major Cambrian depositional sequence sets (ε 1, ε 2, ε 3) are preserved in the Stansbury and Arrowie Basins. A fourth (ε 4/O1), possibly extending into the Ordovician, is suggested for the eastern Warburton Basin and may also include a suite of mafic igneous rocks beneath the Tertiary Murray Basin.

Sequence sets vary in thickness from less than 400 m to more than 1800 m and some sets can be subdivided into sequences *sensu* Vail (1987). Each sequence comprises:

- a basal suite of relatively shallow water sediments (lowstand deposits), conformable to disconformable on the underlying sequence,
- an upward deepening succession (transgressive deposits), sometimes with evidence of slope instability and turbidity current deposition,
- deeper water, relatively organic-rich, laminated lime mud or shale (maximum highstand starved sediments), and
- either an upward shallowing succession (late highstand deposits) or a sharp conformable to disconformable (erosional) contact with relatively shallow marine sediments of the overlying sequence.

The transgressive-regressive sediment packages which comprise each sequence are best preserved in shelf margin and deeper basinal settings. Sediments on the shelf proper exhibit rapid facies changes in response to the combined effects of tectonism, eustasy and sediment supply. Disconformities, which may be frequent on the shelf, diminish or disappear in a basinward direction.

Three sequences, designated Ɛ 1.1, Ɛ 1.2 and Ɛ 1.3 (Fig. 7.2) can be distinguished in sequence set 1. They are composed of shelf and shelf margin slope or ramp carbonates, shallow water and deeper water siliciclastics. Systems tracts can be identified in each sequence, and are described for the Arrowie and Stansbury Basins below.

Two sequences (Ɛ 2.1, Ɛ 2.2) are recognised locally in sequence set Ɛ 2, but there is too little information at this stage to subdivide sets Ɛ 3 and Ɛ 4/01 meaningfully.

CORRELATION

Sequence sets Ɛ 1 and Ɛ 2 are Early Cambrian, set Ɛ 3 is late Early to late Middle Cambrian, while set Ɛ 4/01 ranges from the late Middle Cambrian to possibly Early Ordovician. No formal stage subdivisions have been proposed for the Australian Early Cambrian, thus the Siberian Platform stage scheme of Rozanov and Sokolov (1984) is used here. The Ordian Stage (Opik, 1968) is considered by Zhang and Jell (1987) to correlate with the Chinese Lungwangmiaoan Stage which is late Early and not Middle Cambrian in age. The Siberian Platform equivalent of the Ordian is the Toyonian Stage (Rozanov and Sokolov, 1984).

Daily (1972, 1976a) considered the basal formations of the South Australian Cambrian to correlate with the Tommotian Stage. He had earlier (Daily, 1956) assigned archaeocyaths, trilobites and other shelly fossils in overlying formations to 12 Faunal Assemblages. Gravestock's (1984) study of archaeocyaths led to subdivision of Faunal Assemblage 2 into upper and lower parts. He correlated Faunal Assemblages 1 and 2 with the middle and upper Atdabanian. Recent work on Yorke Peninsula has shown that the Atdabanian - Botomian boundary may be in the lower part of the Parara Limestone where it is conformable on the Kulpara Formation (Jell *et al.*, 1990; Zhuravlev and Gravestock, in prep.). Trilobites and numerous shelly fossils collected from levels corresponding with Daily's assemblages have been recently described (Bengtson *et al.*, 1990). Trilobite zones are particularly useful in deeper marine facies where archaeocyaths are virtually absent (Jell, *in* Bengtson *et al.*, 1990), and archaeocyathan zones are most suited to shelf or reef facies (Zhuravlev and Gravestock, in prep.).

Middle Botomian archaeocyaths occur in the upper parts of the Parara, **Wilkawillina** and **Ajax Limestones**, in the Moorowie Formation and lower **Oraparinna Shale**, (Walter, 1967; Kruse, 1982; Gravestock, 1984; Lafuste *et al.*, 1991; Zhuravlev and Gravestock, in prep.). With cessation of hitherto prolonged and widespread carbonate deposition at the top of set Ɛ 1, biostratigraphic correlation becomes restricted to a few key trilobite-bearing units in the Arrowie and Stansbury Basins, and to a problematic succession on the north coast of Kangaroo Island. In metamorphosed sections in the eastern Stansbury Basin, lithostratigraphic correlation is used. It relies on the position within the younger depositional cycles of shallowing-upward or deepening-upward facies suites and on selected marker beds (Gatehouse *et al.*, 1990b).

The lower and upper boundaries of the Toyonian are tentatively placed within the **Wirrealpa Limestone** and **Moodlatana Formation** respectively based on the presence of the trilobite *Onaraspis rubra* (= *Anadoxides*) in the latter (Jell, 1983a, Jell in Bengtson *et al.*, 1990). Correlation of the Wirrealpa Limestone with the Toyonian is also supported by other skeletal fossils (Kruse, 1991; Brock and Cooper, in press). A late Middle Cambrian age is reported for uppermost **Balcoracana Formation** based on a single effaced agnostid trilobite cf. *Leiopyge* (Daily and Forbes, 1969; Daily, 1976 b). Lack of other diagnostic fossils in these redbeds precludes assignment of Middle Cambrian stages. The latter, where shown, refer strictly to the eastern Warburton Basin, where carbonate and shale contain trilobites which permit correlation with Australian Middle and Late Cambrian stages. No stages are assigned to the Ordovician strata whose facies relationships are poorly known in this region.

ARROWIE BASIN

INTRODUCTION

Cambrian sedimentary rocks up to 4 km thick crop out in the Flinders Ranges which separate flat-lying to gently folded Cambrian strata at depth to the east and west. These sediments were assigned by Wopfner (1972) to the Arrowie Basin, the western limit of which was placed at the Torrens Hinge Zone. However, Youngs and Moorcroft (1982) included thin, flat-lying Cambrian sediments on the Stuart Shelf. Their concept of the basin embraces three tectono-sedimentary regimes: the stable Stuart Shelf, mobile Adelaide Geosyncline and sub-stable Curnamona Craton. This extended region is adopted here as the Arrowie Basin.

There was depositional continuity during the Cambrian between the Arrowie and Stansbury Basins and with the Gnalta Shelf in western New South Wales (Daily, 1956; Wopfner, 1966, 1972; Cook, 1982). Seaways also extended via the Warburton Basin into the Officer, Amadeus and Georgina Basins, and south to Antarctica.

The subsurface region (Torrens Hinge Zone) between the Flinders Ranges and Stuart Shelf is virtually unexplored. There have been no geophysical surveys of note, and apart from a number of closely spaced shallow, petroleum exploration wells drilled by Santos near Wilkatana, only 4 other drillholes have penetrated the Cambrian succession in the western region. East of the ranges, drillholes are widely spaced, but several geophysical surveys have outlined the Cambrian at depth (Callen, 1981; Adams, 1987; Santos, 1988). The succession deepens gently northward in the Moorowie and Yalkalpo 'Synclines', more correctly termed 'depressions' since they contain thick, unfolded strata. The depressions occur to the west and east respectively of the Benagerie Ridge, comprising a suite of Mesoproterozoic volcanics and sediments. The Moorowie 'Syncline' is bisected by a northerly trending wrench fault complex, subparallel to the Benagerie Ridge, and referred to as the Poontana Fracture Zone (Adams, 1987; Poontana Structure of Coats *et al.*, 1969; Callen, 1981). The Moorowie 'Syncline' coincides loosely with Freeman's (1966) 'Lake Frome Gravity Depression' but it is terminated to the north by shallow basement which links the Benagerie Ridge and Mount Painter Inlier.

Mineral resources summarised by Johns (1968), include Cambrian-hosted zinc, lead and silver, and low-grade copper and manganese have been mined in the past. Since the 1957 Wilkatana drilling programme which resulted in oil 'shows' in Early Cambrian limestone (Wopfner, 1970), petroleum exploration has focused on the 12 300 km^2 Moorowie 'Syncline'. Beyond minor traces of oil and gas, no significant discoveries have been made.

Early Cambrian limestone on the Stuart Shelf has been investigated for lead, zinc and copper, but no economic prospects have been discovered, apart from copper mined at the turn of the century near the northern margin of Lake Torrens (Thomson, 1965; Johns, 1968, 1972). Opal workings in bleached Cambrian shale near Yarra Wurta Cliff have produced only potch (Barnes and Scott, 1979).

DEPOSITIONAL SETTING AND STRATIGRAPHY

Fossil discoveries in the early part of the century (Etheridge, 1905, 1919; Howchin, 1907, 1922; Taylor, 1910) were followed by systematic description of the Cambrian in the Flinders Ranges (Segnit, 1939; Mawson, 1939; Daily, 1956; Dalgarno, 1964). Richly fossiliferous carbonates of the Hawker Group (Dalgarno, 1964) yielded archaeocyaths of exceptional variety which resulted in several monographs (Taylor, 1910; Bedford, R. and W.R., 1934, 1936; Bedford, R. and J., 1936, 1937, 1939; Debrenne, 1969, 1970, 1973, 1974a,b), but these fossils have been studied in stratigraphic order only comparatively recently (Walter, 1967; Gravestock, 1984). Daily's (1956) biostratigraphic correlation based on faunal assemblages in the carbonates has been greatly improved by detailed description of trilobites and shelly fossils (Bengtson *et al.*, 1990).

The Arrowie Basin was viewed by Wopfner (1969) and others as a central mobile zone of deeper water deposits flanked to the east and west by shallow marine sediments on the stable Stuart Shelf and Curnamona Craton. In an important departure, Haslett (1975) pointed out that deeper water facies predominated north of a hinge-line connecting the Blinman, Wirrealpa and Chambers Diapirs. Following Haslett's example, Gravestock

(1988) suggested a more arcuate hinge curving north into the Warburton Basin. In the Flinders Ranges it follows a line between the Lyndhurst, Beltana, Wirrealpa and Chambers Diapirs and is named the Wirrealpa Hill Hinge (WHH) in this work.

Deeper water sediments probably extended north beyond the present Arrowie Basin limit (Muloorina Ridge) to the Warburton Basin and south to the Stansbury Basin. The palaeoslopes inferred from incised canyons in the Wilpena Group (Coats, 1964; von der Borch *et al.*, 1982; Gehling, 1983) support this model and suggest that the saddle-shaped geometry of the Arrowie Basin was inherited from an older configuration (Gravestock and Hibburt, 1991).

SEQUENCE SET Ɛ 1

Three depositional sequences Ɛ 1.1 to Ɛ 1.3 constitute this set. The lowest sequence, Ɛ 1.1, was not deposited on the Stuart Shelf but is of substantial thickness north of the WHH and comprises both siliciclastic and carbonate sediments. With further work, it may be necessary to replace it with two sequences.

SEQUENCE Ɛ 1.1 STRATIGRAPHY AND ENVIRONMENTS OF DEPOSITION

The base of sequence Ɛ 1.1 is the Precambrian-Cambrian boundary. The base of the Cambrian is disconformable on Pound Subgroup at many localities in the Flinders Ranges, but in others, it is marked only by a change in the degree of silica cementation and by the first appearance of Cambrian trace fossils, including *Diplocraterion* burrows which sometimes penetrate the uppermost beds of the underlying sequence. The Precambrian-Cambrian boundary in the Arrowie Basin discussed by Daily (1972, 1976a,b) and Gauld (1976), has long been a topic of intense international debate as an event of global significance. Mount (1990) suggested that the boundary as presently mapped in the Mount Scott Range coincides with a sharp facies change but with no major stratigraphic break. He surmised further that the base of the Cambrian may be in the upper Rawnsley Quartzite. Nedin and Jenkins (1991) argued for a break at the base of the Uratanna Formation and McDonald and Mount (1991) agreed that this sequence boundary marks the base of the Cambrian in the northern Flinders Ranges.

Sequence Ɛ 1.1 facies span shoreline shallow marine shelf and ramp deposits (*sensu* Ahr, 1973). Local subsidence created intra-shelf depressions but there was no pronounced shelf/slope break. Sequence 1 of James and Gravestock (1990) corresponds to Sequence Ɛ 1.1 which is represented by the **Uratanna Formation** (Daily, 1973) and the lower Hawker Group (Dalgarno, 1964).

Lowstand deposits

The Uratanna Formation disconformably overlies Rawnsley Quartzite as erosional channel fill up to 100 m thick southwest and west of the WHH. It comprises mudclast-rich medium-grained to pebbly quartz sandstone with local evidence of channel reoccupation (Hull, 1973). More widespread green siltstone and shale with thin, mudcracked sandstone and limestone interbeds, comprise middle and upper members up to 500 m thick north of the WHH (Coats, 1973; Gauld, 1976), although only 16 m of the upper member are present in the eastern Nepabunna Syncline (Mann, 1981). *Phycodes, Skolithos, Planolites, Rusophycus* and *Didymaulichnus* are representative trace fossils (Daily, 1972a, 1976c; Gauld, 1976). An upward deepening marine succession from initially fluvial conditions has been interpreted by McDonald and Mount (1991), who also recorded the first 'shelly' fossil *Sabellidites cambriensis.*

Where Uratanna Formation is absent, siliciclastics of the Parachilna Formation (Dalgarno, 1962) disconformably overlie Rawnsley Quartzite and, in the absence of both units, younger carbonates onlap elevated Pound Subgroup locally, south of the WHH (e.g. Wilkawillina Gorge). Nowhere do carbonates rest directly on Uratanna Formation. The Parachilna Formation is widespread; it has been recorded in Wilkatana boreholes in the southwestern Arrowie Basin (Thomson, 1962) and has a maximum known thickness of 570 m in the Nepabunna Syncline (Mann, 1981), where its upper part may belong in the transgressive systems tract. There is evidence of minor erosion between the Uratanna and Parachilna Formations (Daily, 1973; Hull, 1973; Gauld, 1976).

The **Parachilna Formation** is an upward-fining suite of sandstone and siltstone with minor carbonate interbeds (Ford, 1971; Gauld, 1976). 'Pipe rock' typifies basal units due to numerous U-shaped dwelling burrows of *Diplocraterion*. Ripple marks, thin brown shale laminae and desiccation cracks are common in the lower, bioturbated beds. Upper, fine-grained units lack mudcracks north of the WHH where shallow subtidal conditions prevailed. Sandy *Diplocraterion*-burrowed units were deposited in low to moderate energy environments. Other trace fossils and a single mould of the gastropod *Bemella* have been recorded (Daily, 1976b,c). Ford (1971) has suggested the Stuart Shelf Adelaidean as a source of Parachilna Formation clastics.

The Ajax and Wilkawillina Limestones (Daily, 1956) conformably overlie Parachilna Formation south of the WHH, commencing a phase of extensive carbonate sedimentation. Basal beds 25 to 100 m thick, are stromatolitic and oolitic with stringers of coarse-grained quartz sand. The first archaeocyaths occur at Wilkawillina Gorge (Faunal Assemblage 1) in bioclastic packstone, and in small bioherms with *Renalcis.* The equivalent Ajax Limestone is dolomitised but also comprises skeletal packstone with associated oolite.

Stromatolites, oolite, mud-cracked dolomitic shale and abundant quartz sand interbeds comprise the laterally equivalent **Woodendinna Dolomite** (Haslett, 1975). Lithoclast gravel trains occur near the Wirrealpa Diapir, which was active at this time. The Woodendinna Dolomite, which is usually 90 to 180 m thick, exceeds 400 m in actively subsiding grabens (e.g. Erina Waters), but thins to zero north of the WHH. Sediments were deposited on subtidal to subaerially exposed mud flats and formed ooid shoals on the marine shelf.

Transgressive deposits

The basal transgressive surface of the overlying systems tract can be recognised locally. It coincides with the base of a mottled member of the Wilkawillina Limestone at Moro Gorge, and at the type locality (Hideaway Well Member of Clarke, 1986a) south of the WHH. Submarine erosion is evident at Wilkawillina Gorge where the transgression is found within upper Faunal Assemblage 1. Archaeocyaths indicate a mid-to late Atdabanian age (Gravestock, 1984). To the north, transgression coincides with the base of the **Wirrapowie Limestone** (Haslett, 1976a), and is possibly in the upper Parachilna Formation in the Nepabunna Syncline.

The Woodendinna Dolomite is overlain north of the WHH by dark grey, laminated lime mudstone with thin tongues of cross-bedded oolite, and numerous stromatolite, thrombolite and *Renalcis*-archaeocyath bioherms of the Wirrapowie Limestone (Haslett, 1975, 1976a,b). Storm breccias are common but mudcracks and siliciclastics are rare. This formation overlies Parachilna Formation erosively in the Puttapa Syncline (Hull, 1973, his 'Beltana Dolomite') and with apparent conformity in the Nepabunna Syncline (Mann, 1981) beyond the northern depositional limit of the Woodendinna Dolomite. In the vicinity of the hinge zone, Wirrapowie and Wilkawillina Limestones intertongue, while the Wilkawillina and Ajax Limestones dominate on the shallow shelf. However, Wirrapowie Limestone also occurs in deeper water regions of the southwest Arrowie Basin to the exclusion of other shelf carbonates..

The lower Ajax and Wilkawillina Limestone (Hideaway Well Member) transgressive deposits are lime mudstone, wackestone and isolated archaeocyath-*Renalcis* bioherms. Deeper water archaeocyath-sponge buildups are flanked by mottled lime mudstone in intra-shelf depressions (James and Gravestock, 1990). These buildups contain the world's oldest encrusting lithistid sponges (Reitner, 1991). In northern synclines the transgressive deposits also include archaeocyath-calcimicrobe bioherm complexes of the Wirrapowie Limestone and basal **Mernmerna Formation** (Haslett, 1975; Mann, 1981). The name Mernmerna Formation (Dalgarno and Johnson, 1962) replaces Parara Limestone in the Arrowie Basin, the Parara now being restricted to the western Stansbury Basin (Gravestock and Alexander, in prep.). The archaeocyaths are from Lower Faunal Assemblage 2 and are late Atdabanian in age (Gravestock, 1984). It is worth noting that the conformable basal Parara Limestone on southern Yorke Peninsula is also in Lower Faunal Assemblage 2 and marks the transgressive phase of sequence Є 1.1 in that region.

Highstand deposits

In the vicinity of the WHH, highstand deposits are high energy bioclastic grainstones of the Ajax and Wilkawillina Limestones. Archaeocyaths and other shelly fossils, including the oldest Australian trilobites (Upper Faunal Assemblage 2) are in these beds. Bioherms up to few tens of metres across form isolated buildups within the grainstones. Small bioherms in the Mount Scott Range are dominated by *Epiphyton* (James and Gravestock, 1990). Further south, however (Chace Range, Mernmerna), mottled *Renalcis*-rich bioherms coalesce to form mound complexes (Toteff, 1971, his 'Chace Formation').

At Old Wirrealpa Spring and along the Bunkers Range, fault activity produced deep fractures which penetrated the lithified grainstones for 100 m or more, and were filled with marine fibrous calcite cement, fossil debris (usually *Micrina* sclerites) and quartz sand (Haslett, 1969; Pierce, 1969; Daily, 1976b; Clarke, 1986b, 1990b; James and Gravestock, 1990).

North of the WHH (Wirrealpa Hill, Puttapa Syncline, eastern Arrowie Syncline) thin tongues of archaeocyathan bioclastic 'hash' were transported into deeper water from the adjacent carbonate shelf where high energy conditions prevailed. Deeper water conditions appear to have been rapidly established in the Yalkalpo 'Syncline' during early highstand. In Yalkalpo-2 drillcore, muddy archaeocyath bioherms with minor calcimicrobes are enclosed in rhythmically alternating nodular wackestone and black laminated lime mud. Sequence Ɛ 1.1 has not yet been drilled in the Moorowie Syncline where the same deeper water conditions are assumed to have been present. Both synclines probably formed a single embayment at this time since the Benagerie Ridge had not formed a barrier to sedimentation.

SEQUENCE Ɛ 1.2 STRATIGRAPHY AND ENVIRONMENTS OF DEPOSITION

The carbonate ramp of sequence Ɛ 1.1 evolved rapidly into distinct shelf, slope and basinal settings during the time represented by sequence Ɛ 1.2. The WHH more or less separated the shelf from slope and basinal carbonates further north. However, there are exceptions where the shelf-break was south of the WHH (Donkey Bore Syncline, Wilkawillina Gorge) suggesting the formation of local embayments.

Platform carbonates were grouped by James and Gravestock (1990) into a single sequence, but Clarke (1990b) has recognised two (sequences Ɛ 1.2 and Ɛ 1.3 herein). His 'lower platform sequence' corresponds to sequence Ɛ 1.2 described below.

Lowstand deposits

South of the WHH, much of the lower Wilkawillina Limestone was exposed as sea-level fall outstripped subsidence in all but a few localities. Bioclastic calcarenites with high sedimentation rate were particularly affected in a broad swathe from the Heysen Range to Reaphook Hill. The Stuart Shelf was still not covered at this stage. Exposure is recorded as far east as Mu-2 drillhole in the southern Yalkalpo Syncline, and carbonates presumed to have been deposited marginally to the Torrens Hinge Zone would have been affected as well.

Limestone at the disconformity is solution sculptured. Penetrating the limestone at depths ranging from centimetres to tens of metres, solution-enlarged fractures, karst collapse breccias and possible calcrete profiles are variably developed (Daily, 1976b; Clarke, 1986a,c; Horn and Morris, 1988). The surface is capped by a conspicuous red crust, up to 10 cm thick, composed of haematite-rich laminae which in places form small, digitate stromatolites (Haslett, 1969; Clarke, 1986a, 1988). These grew on the hard limy substrate which, in Mu-2 drillcore, is within a few centimetres of the disconformably underlying Precambrian Brachina Formation. Adelaidean strata are likely to have been exposed locally in the southern part of the Curnamona Craton at this time.

During the hiatus there was little or no siliciclastic influx into the Arrowie Basin. Lowstand deposits are thus virtually non-existent but, at Old Wirrealpa Spring, several large blocks of lower Wilkawillina Limestone rest on the disconformity surface and probably represent scarp debris (Haslett, 1976a).

The lower Wilkawillina Limestone is overlain disconformably by either lower Mernmerna Formation or upper Wilkawillina Limestone immediately south of the WHH (Flinders Unconformity of James and Gravestock, 1990). A break in the fossil record is evident here as on northern Yorke Peninsula. From Reaphook Hill almost to Mount Frome, the lower Wilkawillina Limestone is overlain disconformably by the **Bendieuta Formation** of sequence Ɛ 1.2 (Gravestock and Wigglesworth, in prep.).

A much longer break is evident between Bunyeroo Gorge and Parachilna Gorge, and at Balcoracana Creek, where the **Edeowie Limestone Member** of the Oraparinna Shale (Moore, 1979a) onlaps exposed lower Wilkawillina Limestone. In such regions, the carbonate shelf remained exposed to meteoric diagenesis while sequences Ɛ 1.2 and Ɛ 1.3 were being deposited elsewhere.

Transgressive deposits

A thin wedge of Wilkawillina Limestone, known only from Wirrealpa Mine and Wilkawillina Gorge (Second Plain Creek Member of Clarke, 1986c), is the first transgressive deposit above the red crust and represents initial drowning of the shelf (J. L. Curtis, 1991, pers. comm.). The unit comprises grey laminated lime mudstone up to 74 m thick, with thin bioclastic 'hash' beds and phosphate-coated omission surfaces. Large calcite-filled irregular fenestrae are common at Wirrealpa Mine. The depositional setting was initially shallow subtidal, deepening upward rapidly, with evidence of unstable slope conditions in upper beds at Wilkawillina Gorge.

Transgressive deposits on the carbonate shelf are condensed (10-20 m) sections in the mid-Ajax and Wilkawillina Limestones. Sediments are red glauconitic (Ajax) and grey (Wilkawillina), thinly bedded, abundantly fossiliferous packstone and wackestone. Fossils are mainly small molluscs, hyoliths, brachiopods and *Chancelloria*, with less abundant archaeocyaths and trilobites of the *Abadiella huoi* and *Pararaia tatei* zones (Jell in Bengtson *et al.*, 1990). Localised thicker Ajax Limestone in the Mount Scott range is grey, sparsely fossiliferous wackestone.

Proximal slope carbonates (lower Parara Limestone) intertongue with adjacent platform bioherm complexes at Ten Mile Creek (Clarke, 1988, 1990a,). Distal slope carbonates onlap the sequence boundary at Wilkawillina Gorge, in Donkey Bore Syncline, and between Mount Chambers and Mount Frome. South of the WHH along the Heysen Range, condensed Mernmerna Formation partly onlaps the carbonate shelf.

In contrast, the lower Mernmerna Formation conformably overlies *Renalcis*-rich bioherms or mottled Wirrapowie Limestone at Mernmerna, near Mount Aleck and in the Chace Range. There is insufficient information at these localities to distinguish transgressive and highstand facies at present. In this part of the Arrowie Basin, the Mernmerna Formation is unusually thick (up to 600 m), and is suggested by Gravestock and Hibburt (1991) to indicate a palaeoslope towards the southeast (i.e. towards the Stansbury Basin). Dalgarno (1964) also recognised a depocentre in this region.

Flaggy lower Mernmerna Formation, 300-650 m thick north of the WHH and at Wilkawillina Gorge (Six Mile Bore and part of the Linns Springs Member of Clarke, 1986b), comprises turbidite couplets of lime silt and mud. Intraformational slumping is common; debris flows, peloid grain flows and platform-derived lithoclasts are rare. Trilobites in these slope carbonates are from the *Abadiella huoi* and *Pararaia tatei* Zones (including Daily's (1956) Assemblages 3 and 4); sponge spicules and echinoderm plates are common (Clarke, 1990a). Lower Mernmerna Formation turbidites in the northern synclines (Angepena, Nepabunna, Arrowie) conformably overlie Wirrapowie Limestone and intertongue with the **Midwerta Shale** and **Nepabunna Siltstone** (Leeson, 1967; Coats, 1973; Mann, 1981). These latter units are green-grey to black, argillaceous, pyritic, manganiferous limestones which comprise the deepest water sediments of sequence Є 1.2. Fossils are rare but Mann (1981) has reported *Thambetolepis* (Faunal Assemblage 3?) from immediately below Midwerta Shale.

There is no evidence of shoaling at the sequence Є 1.1 upper boundary in the Yalkalpo Syncline. The Mernmerna Formation, 97 m thick in Yalkalpo 2, comprises nodular wackestone alternating with black laminated lime mud, representing a dysaerobic outer shelf environment. Upward increase in the proportion of lime mud may indicate passage from transgressive to early highstand conditions in this region.

Highstand deposits

Early highstand deposits of sequence Ɛ 1.2 are thought to have spread to the Stuart Shelf for the first time. Alternatively, Cowley (1990) considered basal units to represent part of sequence Ɛ 1.1. The base of the Cambrian on the Stuart Shelf is locally disconformable but is regionally a low-angle unconformity. Due to slight tilting and erosion of the Adelaidean succession, the Cambrian **Andamooka Limestone** (Johns, 1968) rests on Yarloo Shale in the north, then on successively older members of the Tent Hill Formation. Basal beds of the Andamooka Limestone are fine to coarse-grained, locally bouldery siliciclastics and carbonates which pass up rapidly into widespread ooid grainstones.

The upper Ajax and upper Wilkawillina Limestone around the WHH are shallow marine shelf deposits. At Wirrealpa Mine, sandy oncolite rudstone is overlain by quartz sand-rich archaeocyath floatstone with bedding-parallel and solution-enlarged stromatactoid cavities (James and Gravestock, 1990). At Ten Mile Creek ooid grainstone is common (Clarke, 1990c). In the eastern Flinders Ranges, highstand shelf deposits are represented by the Bendieuta Formation which conformably overlies lower Mernmerna Formation between Mount Frome and Mount Chambers Mine (Wigglesworth, 1970; Hatcher, 1970; Mount, 1970), but disconformably overlies lower Wilkawillina Limestone at Reaphook Hill to the south (Gehling, 1971, his 'Reaphook Limestone'). The Bendieuta Formation, up to 238 m thick, is planar to trough cross-bedded, coarse-grained, sparingly fossiliferous quartz sandstone, ooid-peloid grainstone and fenestral limestone deposited in a shallow subtidal setting.

Fossiliferous ooid-peloid packstone of the Bendieuta Formation comprises the basal 16 m of the Cambrian succession in the southern Moorowie Syncline (BWM1A-1 drillhole). In the Yalkalpo Syncline, muddy nodular Mernmerna Formation indicates continued deeper marine conditions. Several thin tuff bands occur in Yalkalpo 2 drillcore.

The middle Mernmerna Formation at Wilkawillina Gorge (Third Plain Creek Member of Clarke, 1986b), in Donkey Bore Syncline and north of the WHH, differs in detail from the transgressive lower Mernmerna Formation beneath. The background facies is still dark grey laminated lime silt and mud, but grain flow deposits are common. These consist chiefly of ooids, calcified microbe peloids, abraded fossils and well rounded coarse to very coarse-grained quartz sand. Intraformational slumps are frequent on the northward deepening palaeoslope and blocks of lithified platform limestone boulders up to 15 m across occur in the Donkey Bore Syncline. The transported boulders are composed of ooid grainstone and masses of *Renalcis*-archaeocyath 'reef rock'. The particulate allochthonous debris contains archaeocyaths contemporaneous with those on the platform. The

Pararaia bunyerooensis Zone occurs in upper levels of the middle Mernmerna Formation at Wilkawillina Gorge (Jell *in* Bengtson *et al.*, 1990).

Sandy debris beds and clasts up to 5 cm in size persist as far north as the Arrowie Syncline. This widespread appearance of allochthonous shelf debris reflects northward progradation of the carbonate shelf during gradual sea-level fall.

SEQUENCE Є 1.3 STRATIGRAPHY AND ENVIRONMENTS OF DEPOSITION

The WHH and local embayments continued to mark the carbonate shelf edge. However, unlike its predecessors, sequence Є 1.3 was deposited during an epoch of pronounced tectonic activity accompanied by increasing volcanism, which affected mainly the late highstand deposits. Sequence Є 1.3 corresponds to upper Sequence 2 of James and Gravestock (1990) and Clarke's (1990c) upper platform sequence.

Lowstand deposits

A second phase of subaerial exposure marks the sequence boundary on the carbonate shelf. Associated diagenetic effects are difficult to distinguish from older and younger phases of exposure which are superimposed at several localities. However, solution enlargement of stromatactis-like cavities probably occurred at this time in the Mount Scott Range and at Wirrealpa Mine. Ooid grainstone is truncated by an iron oxide stained karst horizon at Ten Mile Creek (Clarke's, 1990c, K2 horizon), while reddened pisolites at the top of the Bendieuta Formation at Reaphook Hill probably formed by subaerial weathering during the Є 1.3 lowstand (Gehling, 1971). Dolomitisation has obscured the sequence boundary within the Andamooka Limestone on the Stuart Shelf.

Carbonate supply was effectively starved on the shelf but, in contrast to the sequence Є 1.2 lowstand, quartz sand was transported over the shelf edge and extended basinward as far north as the Arrowie Syncline. Clarke (1990b) first recognised the lowstand nature of the **Bunkers Sandstone** (Daily, 1956), which thins from 200 m adjacent to the shelf at Wilkawillina Gorge to 15 m in the Arrowie Syncline.

The basal Bunkers Sandstone is flat to ripple laminated, silty, fine-grained quartz sandstone which overlies the Mernmerna Formation with a sharp, locally disconformable contact. The overlying unit, restricted to Wilkawillina Gorge and comprising the main part of the formation, is planar to trough cross-bedded quartz sandstone. Flat to cross-bedded silty, fine-grained sandstone predominates in the Donkey Bore and Arrowie Synclines. Trace fossils occur at several levels but body fossils are extremely rare. Bipolar current directions at Wilkawillina Gorge are interpreted by Clarke (1990b) to result from tidal circulation in an embayment opening to the north.

The **Curdlawidny Siltstone Member** of the Andamooka Limestone crops out near 'Parakylia' on the Stuart Shelf (Cowley, 1990). It is proposed tentatively here as a lowstand correlative of Bunkers Sandstone but could alternatively be a late highstand deposit of sequence Є 1.2. The member is up to 22 m thick, comprising planar and ripple-bedded siltstone and fine-grained sandstone, locally with shale clasts and mudcracks; lower parts of the unit are dolomitic. Boundary relationships with the enclosing Andamooka Limestone are not clear.

Transgressive deposits

Transgressive deposits on the Stuart Shelf are best displayed by the Andamooka Limestone in SCYW1a drillcore. These comprise peritidal oolite, stromatolites and shallow subtidal *Renalcis* boundstone, a middle succession of burrowed fossil wackestone, and upper levels comprising buildups of fenestral spiculitic wackestone with archaeocyaths and calcareous sponge-like organisms (James and Gravestock, 1990).

Platform carbonate of the upper Wilkawillina Limestone bordering the WHH is composed of archaeocyath-calcimicrobe buildups. These occur both as small isolated bioherms less than 1 m across and as coalescing bioherm complexes (reefs) up to hundreds of metres in length and tens of metres thick. The relative abundance of calcimicrobes (*Renalcis*, *Epiphyton*, *Girvanella*) and archaeocyaths depends on the location of buildups on the shelf and the energy of the environment (James and Gravestock, 1990). Archaeocyaths from Wirrealpa Mine, Ten Mile Creek (Clarke's, 1990c 'lower bioherm complex') and the classic Ajax Mine locality flourished at this time.

The Ajax and Wirrealpa Mine reefs were of the flat-topped 'keep-up' type (terminology of Kendall and Schlager, 1981) and were not covered by deeper water deposits. The lower bioherm complex at Ten Mile Creek was a rimmed 'catch-up' type backed by a lagoon (Clarke, 1990c) and is interesting because its retreating rim managed to build to sea-level. A series of 'reddened pockets' on the reef top represents Clarke's (1990c) K3 karst horizon. The thickness of this reef, 181 m, provides an estimate of maximum water depth attained during transgression. True water depth, taking subsidence into account, was probably much less; Clarke suggests somewhat less than 100 m.

Prior to growth of this reef at Ten Mile Creek, however, silty and calcareous facies of the upper Bunkers Sandstone lapped on to karsted sequence Є 1.2 grainstone. Sandy limestone breccia, channels near Wirrealpa Mine (Haslett, 1969), and sedimentary dykes along the Bunkers Range (Pierce, 1969), all formed during lowstand, were preserved beneath onlapping upper Bunkers or beneath reef sediments as sea level rose.

With continued transgression, the lower Oraparinna Shale (Daily, 1956) was deposited conformably on Bunkers Sandstone at Ten Mile Creek. To the north (Bunkers Range), it overstepped Bunkers Sandstone and lapped on to the lower Mernmerna Formation of sequence Є 1.2 (Dalgarno, 1964). To the southeast at Ten Mile

Creek, the lower bioherm complex gradually retreated, but kept up with transgressing Oraparinna Shale, though little sediment was transported off-reef. Trilobites of the *Pararaia janeae* Zone occur in the Oraparinna Shale (Jell *in* Bengtson *et al.*, 1990). The lower Oraparinna Shale is khaki, sparingly fossiliferous and silty, with common limestone concretions. It is thickest at Wilkawillina Gorge (≈ 200 m) but thins rapidly away from that locality.

The upper Mernmerna Formation is the main transgressive unit beyond the shelf edge. Thickness varies from 190 m in Donkey Bore Syncline to 700 m or more in the Arrowie Syncline, although some of the latter may be a highstand deposit. The upper Mernmerna Formation overlies Bunkers Sandstone conformably in these regions, but intertongues with, and is replaced by Oraparinna Shale at Wilkawillina Gorge.

The growing reef at Wirrealpa Mine supplied the adjacent slope intermittently with bioclastic debris. This occurs as planar to cross-bedded calcarenite and rudstone, often with well rounded coarse-grained quartz sand. Such beds are numerous in the upper Mernmerna Formation but are rarely more than 0.4 m thick, and contrast with the background muddy limestone deposits.

In the eastern Flinders Ranges, the upper Mernmerna Formation, up to 60 m thick, onlaps Bendieuta Formation from north to south with a sharp basal contact (Hatcher, 1970; Mount, 1970; Wigglesworth, 1970), but did not reach Reaphook Hill (Gehling, 1971). The unit is fossiliferous dark grey, flaggy to mottled argillaceous limestone with common coarse-grained quartz sand and occasional dolomitised pebbles near the base.

In the Moorowie and Yalkalpo Synclines, drillcores from BWM1A-1, Yalkalpo-2 and Mu-2 all have sharp boundaries marked by conglomerate or cut-and-fill structures, interpreted here as submarine erosion surfaces at the boundary between sequences Ɛ 1.2 and Ɛ 1.3. The uppermost 68 m of Cambrian core in Mu-2, 27 m in BWM1A-1, and a mere 6 m remnant in Yalkalpo 2, comprise the transgressive Mernmerna of sequence Ɛ 1.3. Sediments are nodular lime mudstone, siliceous shale and thin oolite interbedded in all 3 drillholes with green tuffaceous sediments 0.05 to 0.15 m thick. In BWM1A-1, a further 19 m of ripple-laminated shale with thin calcarenite cross-beds may represent transgressive or highstand deposits of the Oraparinna Shale.

<u>Highstand deposits</u>

A final phase of reef growth around the WHH, followed by widespread regression ending carbonate sedimentation, resulted from this highstand. Contemporaneous tectonic activity and volcanism have left a distinctive stratigraphic record which is discussed separately below.

The upper Andamooka Limestone on the Stuart Shelf was initially shallow marine to supratidal, fenestral, mudcracked and bioclastic limestone overlain by bioherms which crop out on the north shore of Lake Torrens as low, flat-topped 'biscuits' 10 to 80 m diameter. The bioherms are a complex intergrowth of *Renalcis* and *Botomaella* with rare, dwarfed archaeocyaths and thrombolite-like clotted fabric (James and Gravestock, 1990). They are overlain sharply by buff, dolomitised stromatolites at the top of the Andamooka Limestone.

In the Mount Scott Range, 60 m of dolomitised, peritidal, platy algal boundstone and stromatolites of the upper Ajax Limestone overlie syntectonic breccia and conglomerate (see below). The corresponding section at the Ajax Mine has been overthrust and altered to dolomite which hosts the Beltana willemite orebodies (Horn, 1975). Mineralised black shale intersected beneath the main orebody may be a tongue of Oraparinna Shale. The top 90 m of Wilkawillina Limestone at Wirrealpa Mine are oolite, fenestral limestone, a solitary bioherm of Andamooka type, and 10-20 m of buff, dolomitised stromatolites identical to those in the uppermost Andamooka and Ajax Limestones (James and Gravestock, 1990).

Small (1-2 m) buildups, surrounded by Oraparinna Shale, grew at Ten Mile Creek during the transgressive maximum between the lower and middle bioherm complexes. They are rich in archaeocyaths (Walter, 1967) and contain rare specimens of the oldest known tabulate corals (Lafuste *et al.*, 1988). Clarke's (1990c) middle and upper bioherm complexes at Ten Mile Creek on the platform margin prograded over Oraparinna Shale and were backed by quiet-water lagoonal wackestone and lime mudstone, the latter with evaporite pseudomorphs.

The Moorowie Formation (Mount, 1970) records a new phase of reef growth in the eastern Flinders Ranges at this time. Outcrops between Mount Frome and Chambers Gorge form a prograding facies complex of nearshore shale and siltstone, shelf margin oolite and reef limestone, all breached by high energy erosional channels. Transported reef blocks which occur near Moorowie Mine were constructed by tabulate corals, archaeocyaths and calcimicrobes of late Middle Botomian age (Lafuste *et al.*, 1991).

Early highstand carbonates of the uppermost Mernmerna Formation underlie the Moorowie Formation and overlie transgressive, flaggy, silty limestone at Chambers Gorge. Slump-folded, graded, silty limestone with abundant platform megaclasts up to 20 m across typifies these highstand slope sediments (Mount, 1970). A peloidal limestone immediately beneath may represent the basinward limit of Bendieuta Formation shelf-edge shoals which were rapidly drowned at maximum transgression and finally covered by debris from the advancing platform. A 60 cm thick tuff bed has been preserved in the slope setting (Mount, 1970).

Beyond the platform margin, the Mernmerna Formation is replaced by calcareous upper Oraparinna Shale which becomes less limy and increasingly silty north of the WHH. The youngest unit in this region is **Narina Greywacke** (Dalgarno, 1964) which is 540 m thick at its type locality. Nowhere is its contact with overlying units seen in outcrop due to faulting, and no subsurface occurrences are known. The Narina Greywacke intertongues with the Oraparinna Shale on decimetre scale over a passage of 100 m and comprises khaki, flat to ripple-laminated, silty to medium-grained feldspathic sandstone. Several distinct olive-green units contain coarse-grained quartz phenocrysts reworked from crystal tuff. Volcanic wacke was originally described by Chebotarev (1959), and Coats (*in* Dalgarno, 1964) mapped a tuff near Angepena. Much of the detrital material in the Narina Greywacke is volcaniclastic. One coarse-grained tuffaceous bed at the type section contains several angular chips of peloid and archaeocyathan limestone, clearly derived from the carbonate shelf. Basal bedding contacts in the Narina Greywacke are sharp and erosional, or loaded into finer-grained material beneath. Reworked shale clasts, limestone chips and coarse, well rounded quartz granules appear sporadically, but carbonate interbeds are rare. The shallow marine environment was one of moderate energy, interrupted at times by high energy influxes of terrigenous and volcaniclastic detritus.

The calcareous upper Oraparinna Shale is widespread south and southwest of the WHH, where the Narina Greywacke was not deposited, but is very thin (<20 m) or even absent in the Bunkers Range and near Brachina Gorge.

The Edeowie Limestone Member of the Oraparinna Shale is a thin marker horizon of platy carbonate south of the WHH (Dalgarno and Johnson, 1962; Moore, 1979a). Outcrops further north have been eroded to lower stratigraphic levels, thus the original extent of the member is unknown. The Member overlies silty, calcareous beds of the Oraparinna Shale with a sharp, conformable contact, except at Brachina Gorge and Balcoracana Creek where it disconformably overlies the lower Wilkawillina Limestone of sequence Є 1.1. Facies ascribable to the Member also occur above channel-fill deposits (described below) which were thus formed prior to final regression.

The Edeowie Limestone Member comprises planar to wavy laminated, platy dolomite mudstone with peloidal, sandy limestone and tuff beds (Moore, 1979a). At Ten Mile Creek, the Member is overlain by Clarke's (1990c) upper bioherm complex and passes laterally into stromatolites and lime mudstone with evaporite pseudomorphs. Evaporite replacement is also evident in lenticular carbonate (?)collapse breccia at Bunyeroo Gorge, and as 'palisade' structures in the upper Moorowie Formation ('Book Limestone' ascribed by Mount [1970] to the Billy Creek Formation). The only drillhole to intersect uppermost sequence Є 1.3 in the Moorowie Syncline is Moorowie-1 (Elliott, 1984). In this well, 31 m of sandy dolomitic limestone are overlain by 7 m of anhydrite which Gravestock and Hibburt (1991) correlate with the Edeowie Limestone Member.

Volcaniclastic and syntectonic deposits

The first of two recognizable phases of tectonism, which represent the Kangarooian Movements (Daily and Forbes, 1969), affected upper sequence Є 1.3 prior to deposition of the Edeowie Limestone Member and its carbonate-evaporite lateral equivalents. Fault reactivation along the Torrens Hinge Zone, and uplift of the eastern

Willyama Inlier and Benagerie Ridge, caused locally severe erosion of platform carbonates. Erosion products were transported towards the platform margin and re-deposited either as channel fill or as upward-fining conglomerate beds. Well rounded granules of quartz sand, released in large volume by tectonic activity, promoted further erosion and formed the matrix of channel breccias or lenticular to tabular sandstone cross-beds.

In the Mount Scott Range, channels in the upper Ajax Limestone cut down to levels containing the trilobite *Abadiella huoi* and were disconformably overlain by amalgamated conglomerate beds up to 9 m thick. Outcrops and drillhole intersections at Wirrealpa Mine comprise 'trough-fill' in the upper Wilkawillina Limestone (Roche, 1986; Gravestock, unpublished data). At Ten Mile Creek, cross-bedded sandstone and channel breccia occur in Clarke's (1990c) upper bioherm complex. From Mount Frome northward to Moorowie Mine, the Moorowie Formation contains breccia beds and lenses of sandy (quartz granule) limestone (Hatcher, 1970; Mount, 1970; Wiggleworth, 1970).

Volcanic activity is recorded in off-shelf environments by tuff in the upper Mernmerna Formation and volcaniclastic debris in the Narina Greywacke shortly before the erosional episode outlined above. On the carbonate shelf at Ten Mile Creek, bright olive green, partly reworked ash fall tuff up to 2 m thick crops out several metres below the uppermost exposure of Wilkawillina Limestone. The tuff has a welded fabric of exquisitely preserved (undevitrified) glass shards, infilled vesicles and feldspar laths. Attempts to obtain an age of crystallisation from zircons have so far yielded only an imprecise age of 564±61 Ma (Fanning, 1987).

The best evidence of contemporaneous volcanic and tectonic activity is found at Reaphook Hill in the **Coads Hill Member**, assigned by Moore (1980) to the Billy Creek Formation. The Coads Hill Member is correlated here with upper Oraparinna Shale because unit H of Moore (1980) is a facies equivalent of the Edeowie Limestone Member, and because the Coads Hill Member is also represented in Yalkalpo-2 drillcore beneath the Billy Creek Formation. The basal Coads Hill Member at northern Reaphook Hill is a conglomerate 6 m thick with cobbles of eroded Bendieuta Formation in a very coarse-grained quartz sand matrix. Elsewhere at Reaphook Hill, conglomerate is absent and feldspathic sandstone disconformably overlies calcrete-capped Bendieuta Formation (Gehling, 1971; Moore, 1980). The Coads Hill Member below unit H is ripple-laminated sandstone, siltstone, shale, burrow-mottled limestone and stromatolites. Shallow marine to intertidal, muddy alluvial plain and poorly oxygenated lagoon environments are represented in complex succession (Moore, 1980).

Unit H is nodular limestone with shaly to stromatolitic lower and upper beds, desiccation cracks and halite imprints. Trilobites (*Balcoracania dailyi*) are uncommon in unit H and abundant in units G and J (Moore, 1980). Of particular note are the dozen or more tuff bands 0.05 to 1.4 m thick in the southward thickening (140-200 m) Coads Hill Member.

Similar facies variation is found in Yalkalpo-2 drillcore but in a shallow subtidal setting. An unknown thickness of upper Mernmerna Formation has been removed by erosion, leaving a thin remnant beneath a scour surface. Clasts in the overlying conglomerate are platform limestone in quartz-feldspar granule and red volcanic porphyry matrix. Succeeding lithologies are silty to granule sandstone, burrowed fenestral mudstone, nodular oncolite limestone and oolite; all riddled with tuff beds 0.05 to 0.3 m thick. Porphyry granules which persist several metres above the base of Billy Creek Formation imply erosion of newly exposed Benagerie Ridge.

Channels have been identified seismically in the Hawker Group at depth in the Moorowie Syncline (Adams, 1987). They form a complex up to 4 km wide and appear to head north from an origin near Reaphook Hill. Although not yet drilled, they are attributed here to the same erosional events represented by the basal Coads Hill Member and other units beneath the Edeowie Limestone Member in the Flinders Ranges.

The Edeowie Limestone Member and equivalent evaporitic facies are thin but widespread, representing a return to tectonically quiescent conditions. Although the first phase of the Kangarooian Movements was short-lived in the Arrowie Basin, volcanic activity continued, since tuff beds occur in the Edeowie Limestone Member (Moore, 1979a), lower Billy Creek Formation (Dalgarno, 1964; Moore, 1979b, 1980) and Yarrawurta Shale on the Stuart Shelf (Daily, 1976b). The most intense extrusive volcanism suggested by tuff bed frequency and distribution, is recorded in the eastern Flinders Ranges in upper sequence Ɛ 1.3 (late Botomian), and most likely correlates with eruptive phases of the Truro Volcanics in the Stansbury Basin to the south.

SEQUENCE SET Ɛ 2

Two depositional sequences (Ɛ 2.1, 2.2) are distinguished in set Ɛ 2 (Fig. 7.2). The base of sequence Ɛ 2.1 at the top of Hawker Group marks a regional lowstand, but with tectonic overprint. The boundary marks a significant event on the eastern seaboard of the Gawler Craton related to changes in the rate and direction of extension associated with partial dismemberment of the Gondwana Supercontinent.

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APPENDIX 1.4

UNCOMMON Pb & Zn MINERALS - NORTHERN FLINDERS RANGES

NAME	COMPOSITION
Scholzite	$CaZn_2(PO_4)_2.2H_2O$
Smithsonite	$ZnCO_3$
Cerussite	$PbCO_3$
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$
Aurichalcite	$2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$
Rosasite	$(Cu,Zn)CO_3.(Cu,Zn)(OH)_2$
Hemimorphite (Calamine)	$(ZnOH)_2.\ SiO_3$
Willemite	$(Zn,Fe)_2SiO_4$
Hedyphane	$Pb_5(AsO_4)_3Cl$
Vanadinite	$Pb_5(VO_4)_3Cl$
Finnematite	$Pb_5(AsO_3)_3CL$
Cesarolite	$Pb(OH)_2.3MnO_2$
Chalcophanite	$(Mn,Zn)(OH)_2.2MnO_2$
Coronadite	$PbMnO_4.?H_2O$
Celestite	$SrSO_4$
Bronchantite	$CuSO_4.3Cu(OH)_2$
Anglesite	$PbSO_4$
Zinkosite	$ZnS0_4$
Polysphaerite (Pyromorphite)	$(PbCl)Pb_4(P0_4)_3$

DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

Volume 2
(Appendices 2 and 3)

REPORT BOOK 91/102

MISSISSIPPI VALLEY TYPE LEAD-ZINC MINERALISATION NORTHERN FLINDERS RANGES, SOUTH AUSTRALIA

J L Curtis[1]

G W Jenkins[2]

Mineral Resources Division

with contributions from

D I Gravestock[3]

Oil Gas and Coal Division

DECEMBER 1991 DME 404/89

Cover Photograph: View east of Heysen Range, Rawnsley Quartzite forms the rugged peaks of the range with Lower Cambrian sediments forming the lower hills in the foreground, Photo No. 39863 .

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[1] Senior consultant geologist

[2] Contract geologist

[3] Senior petroleum geologist

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VOLUME 2

2

2.1	Exploration Data Listings
2.2	Computer Diskette (1.4 Kbyte 3.5")

FILE NAME	CONTENTS
AMVTREPT.WP	Report MVT LZ Northern Flinders Ranges
MVTAPPDX.WP	Short Appendixes - MVT LZ Northern Flinders Ranges
ARRSTRAT.WP	Cambrian Stratigraphy - Arrowie Basin
MVTDATL.WK1	Macro Sortable Exploration Data Listing
COPREV.WP	Exploration Reviews - Copley Sheet
PARAREV.WP	Exploration Reviews - Parachilna Sheet
ORROREV.WP	Exploration Reviews - Orroroo Sheet

APPENDIX NO	TOPIC
3	
3.1	Exploration Reviews - Copley Sheet
3.2	Exploration Reviews - Parachilna Sheet
3.3	Exploration Reviews - Orroroo Sheet

APPENDIX 2.1

EXPLORATION DATA LISTINGS

- Sorted by SADME ***Envelope*** Number (sequential)
- Sorted by ***Review*** Number (Appendixes 3.1-3.3)
- Sorted by ***Regional Location*** (See Figure 15)

- Spreadsheet Instructions.

******** DATABASE INFORMATION & INSTRUCTIONS ********

MACRO DRIVERS FOR DATA LISTING

****

MACRO	FUNCTION
ALT-C	Displays the COPLEY data listing (also 'HOME').
ALT-P	Displays the PARACHILNA data listing.
ALT-O	Displays the ORROROO data listing.
ALT-E	Sorts listing by SADME ENVELOPE number.
ALT-S	Sorts listing by SAMREF catalogue number.
ALT-T	Sorts listing by SML & EL TITLE number.
ALT-R	Sorts listing by AG number, RB 88/41.
ALT-V	Sorts listing by REVIEW number, (this report).
ALT-L	Sorts listing by STRUCTURAL LOCATION.
ALT-H	Displays a description of the Listing's structure.
ALT-M	Displays this page.
ALT-D	Prints the entire data listing (See note). (setup: compressed print on wide paper)
ALT-G	Sorts listing by geophysics method

MVT DATA LISTING - EXPLANATORY NOTES

****

GENERAL

There are thirteen data fields to each record. The nature of each is desribed in the following notes. The macros sort using these parameters.

REVIEW NUMBER

The review number has three components:

The first is the consecutive listing number of descriptions concanted from SAMREF, RB 88/41 , RI 37, and scanning of the literature presented as part of this study.

The second is a simple code designating the 1:250,000 map sheet

The third is up to three codes that correlate with the regional synclinal structures (Tectonic Domain) to which the reference relates.

CODE	REGIONAL STRUCTURE	SHEET
G	General references.	
A	Aroona Syncline	COPLEY
B	Balcoracanna Syncline	PARACHILNA
B	Wilkawillina Graben	PARACHILNA
C	Cadnia(-Mt. Hack) Syncline	COPLEY
D	Donkey Bore Syncline	PARACHILNA
E	Ediacara Syncline	COPLEY
F	Mt. Frome Syncline	PARACHILNA
H	Reaphook Syncline	PARACHILNA
J	Ajax Syncline	COPLEY
K	Kanyaka(-Druid) Syncline	PARACHILNA
L	Mt. Ragless Syncline	ORROROO
M	Mernmerna Syncline	PARACHILNA
N	Narina Syncline	COPLEY
O	Cotabena Syncline	PARACHILNA
O	Warrakimbo Syncline	PARACHILNA
P	Nepabunna(Angepena) Syncline	COPLEY
R	Red Range Syncline	COPLEY
S	Mt. Serle Syncline	COPLEY
U	Bunyeroo Syncline	PARACHILNA
W	Arrowie Syncline	COPLEY
Y	Yappala Syncline	PARACHILNA
XD	Mt. Deception Anticline	COPLEY
XA	Arkaroola Syncline	COPLEY

These codes are used for the location sort macro.

RB 88/41 'AG' NUMBER

This code/number is a sequential number in SADME report book 88/41 which addresses the distribution of lead & zinc mineralisation in the Adelaide Geosyncline. (AG prefix)

RECORD NUMBER

A once only record that was generated by the SAMREF data output that was used for this project. It is retained as a hidden column in the sheet for back track referencing. (deletion will affect the macros)

SAMREF NUMBER

Unique catalogue number identification within the SAMREF database

ENVELOPE NUMBER

The file number whithin which the reference is actually stored by the SADME library system. (Data is available as microfische or hard copy.)

TENNEMENT NUMBER

This is the exploration title number under which the exlporation work was carried out. Up until 1973 Special Mining Leases were issued, and subsequently Exploration Licences. (SML & EL respectively)

DATE/YEAR

YEAR of or following title expiry when data was accessioned into the public domain. (usually SAMREF)

SADME PUBLICATION

Publication used in the study as a source of information (other than RB 88/41).

REGIONAL LOCATION

The general geographical locality cited whithin the reference.

TECTONIC DOMAIN

The main tectonic entity(ies) that is(are) the focus(ii) of the reference. This classification was created in this report to correlate references on a geo-tetonic basis to avoid diverse locational data. It is encoded within the REVIEW NUMBER (see above list).

STRATIGAPHIC UNITS

A listing of the main LOWER CAMBRIAN stratigraphic units that are the focus of this report. (There are however, some exceptions.)

EXPLORATION MODES

Primary methods of exploration and activities undertaken and described in the reference.

COMMENT

Cross-referencing information and other reevent data.

GEOPHYSICS (Codes)

AM	Aeromagnetic	IP	Induced Polarisation
DL	Down hole logging	RA	Radiometric
EM	Elecromagnetic	RE	Resistivity
GR	Gravity	SE	Seismic
GM	Ground magnetic	SI	Sirotem
X	None	SP	Self Potential

****

PRINTING

Before printing it is recommended that either :---

GEOPHYSICS (Cols. Y, Z, AA-AC) or COMMENT (Col. X) be hidden.

HIDE /WCH (Point Range)
UNHIDE /WCD (Point Range)

HIDDEN COLUMN

Column "J" is hidden in the worksheet and is available for data entry such as user library index information.

UPDATING THE SPREADSHEET

This sheet is designed for user up-dating. Entries should be made at the bottom of the appropriate sheet listing and the range name (sheet name) modified in the usual way.

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REVIEW NUMBER	RB 88/41 NUMBER	SHEET /FILE	PAGE No.	SAMREF NUMBER	ENVELOPE NUMBER	TENEMENT SML No.	EL No	DATE YEAR	SADME PUBLIC'N	REGIONAL LOCATION	TECTONIC DOMAIN	STRATIGRAPHIC UNITS	EXPLORATION MODES	COMMENT	GEOPHYSICS
0 G	AG 69	COPLEY		1002220	0	-	-	1972	RI 37	Northern Flinders Ranges	Arrowie Basin	Lower Cambrian	Tech. Rev. BMetals, Lwr. Camb. N.Fl.Ra.	SEE RB 67/12	X
0 G		COPLEY		1002035	0	-	-	1967	RB 88/41	Northern Flinders Ranges	Adelaide Geosyncline	Adelaidean & Lower- Middle Cambrian	Tech. Review - Lead-Zinc Mineralisation	AG XX refer	X
5 CE		COPLEY	8	4901	534	77	-	1962	RI 37	Ediacara	Ediacara Syncline	Ajax Ls.	Drilling		X
1 CW	AG 47	COPLEY	1	1002494	564	91	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.	SEE ENV 638,	X
37 CJC		COPLEY	59	4907	623	113	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sediment geochemistry	SEE ENV 732	X
1 CW		COPLEY	1	1002191	638	89	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Drilling	SEE ENV 564,	X
37 CJC		COPLEY	59	4913	664	113	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sediment geochemistry	SEE ENV 732	X
39 CW		COPLEY	62	4914	672	124	-	1966	RI 37	Ironstone Bore	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.		X
39 CW		COPLEY	62	4915	673	128	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
1 CW		COPLEY	1	1002262	695	127	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.	SEE ENV 564,	X
1 CW		COPLEY	1	1002192	695	127	-	1967	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
1 CW	AG 47	COPLEY	1	1002192	695	91	-	1967		Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
39 CW		COPLEY	62	1002287	721	128	-	1967	RI 37	Ironstone Bore	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
37 CJC		COPLEY	59	1002275	732	136	-	1967	RI 37	Puttapa	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	1002275	732	113	-	1967	RI 37	Puttapa	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	1002275	732	142	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.	SEE ENV 623	X
37 CJC		COPLEY	59	1002219	733	113	-	1966	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
5 CE	AG 28	COPLEY	8	1002215	740	77	-	1967	RI 37	Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
5 CE		COPLEY	8	1002215	740	144	-	1967	RI 37	Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
5 CE		COPLEY	8	1002216	740	77	-	1962		Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
38 CW		COPLEY	61	1002211	778	54	-	1963	RI 37	Balcanoo. (Moro, Wertaloona)	Arrowie Syncline	Parachilna Formation	Rock Chip Geochemistry		X
40 CE	AG 28	COPLEY	63	1000256	892	177	-	1968		Ediacara	Ediacara Syncline	Parachilna Fmn, Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
40 CE	AG 28	COPLEY	63	1000258	892	177	-	1968		Ediacara	Ediacara Syncline	Parachilna Fmn, Ajax Limestone	Geophysical Interpretation	SEE ENV. 695	IP
2 CC	AG 33	COPLEY	4	1000262	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
2 CC	AG 33	COPLEY	4	1000260	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
2 CC	AG 33	COPLEY	4	1000261	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
4 CP	AG 43	COPLEY	7	1004792	937	184	-	1969		Mc Kinlay Ck, Italowie Gorge	Nepabunna Syncline	Pclna.Fmn, Wilk.& Par. Ls, Nepabunna Slt.	Stream. Sed.,	INCLUDES SML	X
3 CC	AG 32	COPLEY	6	1001018	961	178	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Rock Chip Geochemistry	SEE ENV 1130	X
41 C G	AG 44	COPLEY	65	1000268	975	202	-	1968		Aroona, Arrowie, Marina,	Balcoracana, Kanyaka Synclines	Basal Cambrian	Regional Stream Sed. Geochemistry Survey	SEE ENV 1229	X
13 CP		COPLEY	19	1003090	1104	217	-	1969		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
13 CP	AG 45	COPLEY	19	1003089	1104	217	-	1970		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Geophysics	SEE ENV 997,	RA
34 CP		COPLEY	54	1003072	1106	259	-	1969		Mt. McKinlay Ck.	Nepabunna Syncline	Wilkawillina Ls.	Stm. Sed. Foll-up, soil & lat. Geochem.		X
34 CP		COPLEY	54	1003073	1106	259	-	1969		Mt. McKinlay Ck.	Nepabunna Syncline	Wilkawillina Ls.	Stm. Sed. Foll-up, soil & lat. Geochem.		X
6 CC		COPLEY	10	1003025	1129	312	-	1969		Mt. Bayley	Cadnia Syncline	Ajax Limestone	Stream Sed. Geochemistry		X
7 CC	AG 32	COPLEY	11	1004701	1130	283	-	1969		Sliding Rock	Cadnia Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Rock Chip & Soil Geohemistry, Mapping	SEE ENV 961,	X
8 CE	AG 28	COPLEY	12	1002869	1160	309	-	1970		Ediacara	Ediacara Syncline	Ajax Limestone	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002858	1162	170	-	1970		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002857	1162	170	-	1969		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002856	1162	170	-	1969		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
10 CM	AG 42	COPLEY	15	1002774	1194	321	-	1970		Jubilee Range	Marina Syncline	Upper Prot. Wonaka Fmn.-Will./Ga. Veins	Stream Sed. Geochemistry		X
11 CXA	AG 22	COPLEY	17	1003967	1226	294	-	1971		Wooltana	Arkaroola Syncline	Skillogalee Dolomite		Adelaidean	X
12 CW		COPLEY	18	1003973	1227	293	-	1971		Moro Springs	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip Geochem.		X
35 CREA	AG 28	COPLEY	55	1002760	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Seismic Survey		SE
35 CREA	AG 28	COPLEY	55	1002756	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics, Mapping, Soil Geoch. & Drill	SEE ENV. 183	EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002756	1246	353	-	1972		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics, Mapping, Soil Geoch. & Drill	SEE ENV. 183	EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002755	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics-AFMAG Survey (Electromag.)	SEE ENV. 183	EM
35 CREA	AG 28	COPLEY	55	1002759	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Review of methods.		EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002758	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Gravity Survey		GR
35 CREA		COPLEY	55	1002757	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Mapping, Soil Geoch. & Drill.		X
43 CW		COPLEY	67	1002770	1253	338	-	1970		Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.		Not MVT rele	X
42 CC		COPLEY	66	1002641	1289	359	-	1970		Angepena	Cadnia Syncline	Parachilna Fmn. & Ajax Limestone	Stean sed, Soil & Rock geochemistry		X

29-Jan-92

REVIEW NUMBER	RB 88/41 NUMBER	SHEET /FILE	PAGE No.	SAMREF NUMBER	ENVELOPE NUMBER	TENEMENT SML No.	EL No	DATE YEAR	SADME PUBLC'N	REGIONAL LOCATION	TECTONIC DOMAIN	STRATIGRAPHIC UNITS	EXPLORATION MODES	COMMENT	GEOPHYSICS
42 CC		COPLEY	66	1002640	1289	359	-	1970		Angepena	Cadnia Syncline	Parachilna Fmn. & Ajax Limestone	Geophysics-IP survey.		IP
36 CSP		COPLEY	58	1002623	1324	386	-	1972		Mt. Serle	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Diamond Drilling		X
36 CSP		COPLEY	58	1002619	1324	386	-	1970		Mt. Serle	Mt. Serle, Nepabunna Sync.	Marina Grywk. & Lr. Cambrian	Geophysics - Magnetic Survey		GM
36 CSP		COPLEY	58	1002622	1324	386	-	1970		Mt. Serle	Mt. Serle, Nepabunna Sync.	Marina Grywk. & Lr. Cambrian	Geophysics - IP Survey		IP
13 CF	AG 45	COPLEY	19	1002259	1390	217	-	1971		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
14 CSP	AG 37	COPLEY	22	1002651	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002653	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002654	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002650	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002652	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
15 CSC	AG 34	COPLEY	24	1001975	1585	536	-	1972		Mt. Serle-Slid.Rk, Waraweena	Mt. Serle, Cadina Synclines	Parachilna Fmn. & Ajax Ls.	Soil & Rock Chip Geochemistry, Geophys.	SEE ENV 961,	EM
15 CSC	AG 34	COPLEY	24	1001974	1585	536	-	1972		Mt. Serle-Sliding Rock	Mt. Serle, Cadina Synclines	Parachilna Fmn. & Ajax Ls.	Soil & Rock Chip Geochemistry, Geophys.	SEE ENV 961,	EM
16 CWB	AG 47	COPLEY	26	1004209	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 36	COPLEY	26	1004208	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 36	COPLEY	26	1004210	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 47	COPLEY	26	1004206	1638	557	-	1972	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
17 CM		COPLEY	29	1003	1653	519	-	1971		Mt. Hack	Marina Syncline	Lower Cambrian	Stream Sed. Geochemistry		X
18 CAMD		COPLEY	30	1000330	1693	585	-	1971		Beltana (Mt. Deception Ra.)	Mt. Deception Anticline	Wonaka & Bunyeroo Fmns.	Stream Sed., Rock Chip, Geochemistry	?Not MVT rel	X
19 CR	AG 46	COPLEY	31	767	1701	525	-	1971		Red Range (Beltana)	Red Range Syncline	Ajax Limestone	Stream Sed. & Rock Cbip Geochemistry		X
20 CC		COPLEY	32	1015397	1785	609	-	1972		Mt. Bayley	Cadnia Syncline (west)	Ajax Limestone	Stream Sed. Geochemistry		X
21 CE	AG 28	COPLEY	33	1015400	1835	637	-	1972		Ediacara	Ediacara Syncline	Parachilna Fmn. & Ajax Ls.	Drilling & Geochemistry		X
22 CS	AG 37	COPLEY	34	1001604	2081	708	-	1973		Mt. Serle	Mt. Serle Syncline	Wilkawillina Ls.	Soil Geochemistry	SEE ENV 2314	X
23 CE	AG 28	COPLEY	36	1001335	2254	-	46	1975		Ediacara	Ediacara Syncline	Ajax Limestone	Drilling		X
23 CE	AG 28	COPLEY	36	1001336	2254	-	46	1973		Ediacara	Ediacara Syncline	Ajax Limestone	Drilling		X
24 CS	AG 37	COPLEY	37	1000447	2314	-	96	1976		Mt. Serle	Mt. Serle Syncline	Wilkawillina Ls.	Stream Sed. & Soil Geochemistry	SEE ENV 2081	X
25 CW	AG 47	COPLEY	38	1001945	2317	-	78	1975		Moro Gorge	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Drilling & geoghemistry	SEE ENV 564,	IP
26 CC	AG 34	COPLEY	40	1014843	2341	-	72	1974		Sld. Rck., Blk. R. Spg., War	Cadnia Syncline	Wilkawillina/Ajax Ls.	Mapping, Soil geochemistry & Drilling	SEE ENV 961,	IPEM
27 CW		COPLEY	42	1001710	2379	-	107	1974		Mt. Roebuck	Arrowie Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Stream Sed. & Soil Geochemistry		GM
28 CM		COPLEY	43	1011948	3539	-	482	1981		Wirlpa., Mt.Hack, Patwta. Hl	Marina Syncline	Wilkawillina (Wirrap. Mem.) & Parara Ls.	Stream Sed. Geochemistry & Mapping		X
29 CWP	AG 48	COPLEY	44	2030	3641	-	526	1971		Angepena, & Moro Gorge	Arrowie, Nepabunna Syncline	Nepabunna Slt., & Parara Ls.	Mapping, Drilling & RChip Geochemistry	SEE ENV 937,	IP
29 CWP	AG 48	COPLEY	44	2030	3641	-	934	1971		Mt. Roberts, Alerumbera,	Arrowie, Nepabunna Syncline	Parachilna Fmn., Wilkawillina Ls.,	Mapping, Drilling & RChip Geochemistry	SEE ENV 937,	IP
44 CF	AG 56	COPLEY	68	3524	3722	-	1138	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
44 CF	AG 56	COPLEY	68	3524	3722	-	807	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
44 CF	AG 56	COPLEY	68	3524	3722	-	538	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 CC		COPLEY	46	1011649	3735	-	563	1980		Sliding Rock	Cadnia Syncline	Parachilna Fmn. & Wilkawillina Ls.	Map., Strm.Sed.& RChip.S., Gphys., Drill.		GMGR
30 CC		COPLEY	46	1011648	3735	-	563	1981		Sliding Rock	Cadnia Syncline	Parachilna Fmn. & Wilkawillina Ls.	Map., Strm.Sed.& RChip.S., Gphys., Drill.		GMGR
29 CWP		COPLEY	44	1013038	4323	-	526	1981		SEE ENV 3641 (above)	Arrowie, Nepabunna Syncline		Final Report-interpretive, Geophys.	SEE ENV 937,	IP
31 CD	AG 50	COPLEY	48	2243	4449	-	894	1986		Ann Hill	Donkey Bore Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Photogeol interpretation, no field wk.		X
31 CD	AG 50	COPLEY	48	2243	4449	-	1188	1986		Ann Hill	Donkey Bore Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Photogeol interpretation, no field wk.	SEE ENV 2379	X
32 CJA	AG 29	COPLEY	49	3410	4942	-	1039	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG110	COPLEY	49	3410	4942	-	1039	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG 29	COPLEY	49	3410	4942	-	1269	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG110	COPLEY	49	3410	4942	-	1269	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
33 CPSW	AG 49	COPLEY	52	1815	5647	-	1235	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
33 CPSW	AG 38	COPLEY	52	2250	6651	-	1235	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
33 CPSW	AG 49	COPLEY	52	2251	6759	-	1345	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X

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38 PFB		PARACHILNA	74	5552	0	-	-	1991	RB 91/101	Mt. Chambers -Wirrealpa	Mt. Frome & Balcoracana Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Drilling	SEE ENV. 807	X
0 G	AG 69	PARACHILNA		1002220	0	-	-	1972	RI 37	Northern Flinders Ranges	Arrowie Basin	Lower Cambrian	Tech. Rev. BMetals, Lwr. Camb. N.Fl.Ra.	SEE RB 67/12	X
0 G		PARACHILNA		3557	0	-	-	1967	RB 88/041	Northern Flinders Ranges	Adelaide Geosyncline	Adelaidean & Lower- Middle Cambrian	Tech. Review - Lead-Zinc Mineralisation	AG XX refer	X
1 PU		PARACHILNA	1	1404	0.1	-	-	1986	RB 86/022	Nthn Flind Ra National Park	Bunyeroo Syncline	Parachilna Fmn. & Wilkawillina Ls.	Lead Zinc Exploration		REIP
1 PU	AG 53	PARACHILNA	1	1457	0.1	-	-	1986	RB 86/018	Nthn Flind Ra National Park	Bunyeroo Syncline	Parachilna Fmn. & Wilkawillina Ls.	Lead Zinc Exploration		X
4 PYK	AG 74	PARACHILNA	17	1002292	600	94	-	1966	RI 37	Willochra (Mt. Arden)	Yappala, Kanyaka Synclines	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., Soil, & RChip Geochem, Mapp.	SEE ENV 641,	X
2 PH	AG 58	PARACHILNA	12	1002234	601	95	-	1966	RI 37	Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping & Strm. Sed. RChip Geochemistry		IPSP
24 PU		PARACHILNA	49	4912	660	115	-	1966	RI 37	Lake Torrens	Bunyeroo Syncline	Wilkawillina & Parara Ls.	Silt, Soil, RChip Geoch. & Geophys.	SEE ENV 2356	AMIP
3 PMDF		PARACHILNA	15	1002303	671	123	-	1967	RI 37	Mts. Lyall & Frome, Wirrlpa	Narina, BBore, Mt. Frome Syn	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., Rock Chip Geochem & Mapping		X
5 PB		PARACHILNA	19	4914	672	124	-	1967	RI 37	Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV. 722	X
5 PB		PARACHILNA	19	1002285	722	124	-	1967	RI 37	Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV. 672	X
2 PH		PARACHILNA	12	1002210	742	137	-	1967	RI 37	Emu Bore/Reaphook Hill	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., Rchip., Mapp., Cost. & Drill.		IPSP
2 PH		PARACHILNA	12	1002210	742	138	-	1968	RI 37	Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., RChip., Mapp., Cost. & Drill.		IPSP
6 PB	AG 60	PARACHILNA	20	1001676	800	143	-	1967	RI 37	Third Plain	Balcoracana Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Costeaning, & Drilling, Reserve	INCLUDES MC	X
6 PB	AG 60	PARACHILNA	20	1001675	800	143	-	1967	RI 37	Third Plain	Balcoracana Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Costeaning, & Drilling, Reserves		X
2 PH	AG 58	PARACHILNA	12	1001615	863	137	-	1968	RI 37	Emu Bore/Reaphook Hill	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., RChip., Mapp., Cost. & Drill.		IPSP
7 PB	AG 59	PARACHILNA	22	1001593	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
7 PB	AG 59	PARACHILNA	22	1001594	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
7 PB	AG 59	PARACHILNA	22	1001595	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
8 P G		PARACHILNA	24	1000268	975	202	-	1968		Aroona, Arrowie, Narina, Balcoracana, Kanyaka Synclines		Basal Cambrian	Regional Stream Sed. Geochemistry Survey	SEE ENV 1229	X
9 PP		PARACHILNA	25	1000617	997	217	-	1969		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	SEE ENV 1104	RA
9 PP		PARACHILNA	25	1000616	997	217	-	1969		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	SEE ENV 1104	RA
9 PP		PARACHILNA	25	1003089	1104	217	-	1970		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	INCL 217A, E	RA
9 PP		PARACHILNA	25	1003090	1104	217	-	1969		Mt. John - Mt. Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
10 PB	AG 61	PARACHILNA	28	1003956	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
10 PB	AG 61	PARACHILNA	28	1003957	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
10 PB	AG 61	PARACHILNA	28	1003954	1146	290	-	1971		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
10 PB	AG 61	PARACHILNA	28	1003955	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
11 PMU	AG 52	PARACHILNA	30	1002876	1157	302	-	1971		Torns: Mts. Aleck & Hayward	Mernmerna & Bunyeroo Syncs.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip follow-up Geoch.	SEE SML. 576	X
12 P G		PARACHILNA	31	1003977	1229	290	-	1970		Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003977	1229	292	-	1970	RB 81/119	Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003978	1229	292	-	1971	RB 81/119	Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003977	1229	293	-	1970		Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
13 PYK		PARACHILNA	33	1002767	1258	323	-	1970		Hawker	Yappala, Kanyaka Synclines.	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping & Stream Sed. Geochemistry	SEE ENV. 137	X
14 PH		PARACHILNA	34	1002355	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002370	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002349	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002372	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002371	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
15 PK		PARACHILNA	36	1002353	1378	371	-	1970		Hawker	Kanyaka Syncline	Wilkawillina, Parara Ls., Oraparinna Shl	Stream Sed. Geochemistry.		X
9 PP	AG 45	PARACHILNA	25	1002259	1390	217	-	1971		Moorowie - Mt. Chambers	Mt. Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Rock Chip Geochem. & Drilling	11PF=13CF	RA
16 PK		PARACHILNA	37	1004757	1531	500	-	1971		Hawker	Kanyaka Syncline	Wilkawillina, Parara Ls., Oraparinna Shl	Stream Sed. Geochemistry.		X
17 PDB	AG 63	PARACHILNA	38	1004188	1548	397	-	1972		Ten Mile Creek	Donkey Bore, Balcoracana Syn	Wilkawillina Ls.	Stream Sed. & Rock Chip follow-up Geoch.	SEE ENV. 163	X
18 PDB		PARACHILNA	40	1004206	1638	557	-	1972	RB 81/119	Norwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
18 PDB		PARACHILNA	40	1004208	1638	557	-	1971	RB 81/119	Norwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Percussion Drilling Patawarta Zinc Pros.		X
18 PDB		PARACHILNA	40	1004209	1638	557	-	1971	RB 81/119	Norwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip follow-up Geoch.		X
19 PP		PARACHILNA	43	1000282	1657	548	-	1971		Moorowie - Mt. Chambers	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Mapping & Sampling		X
20 PUM	AG 52	PARACHILNA	44	1000334	1660	576	-	1971		Mt. Hayward	Bunyeroo Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Mapping, Drilling	SEE ENV. 302	X
20 PM		PARACHILNA	44	1000331	1674	583	-	1971		Mt Aleck	Mernmerna Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Mapping, Drilling	SEE ENV. 302	X
21 PK		PARACHILNA	46	1004184	1677	500	-	1971		Hawker	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.	SEE ENV. 153	X
21 PK		PARACHILNA	46	1004184	1677	582	-	1971		Druid Range	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.		X

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31 PH		PARACHILNA	61	1014685	4602	-	725	1981		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping.		X
33 PM		PARACHILNA	66	1015035	4794	-	727	1982		Mt. Alek	Mernmerna Syncline	Wilkawillina & Parara Ls.	Stream Sed.		X
33 PM		PARACHILNA	66	321	5326	-	1084	1984		Mt. Alek, Arkaba	Mernmerna Syncline	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
34 PB		PARACHILNA	68	2583	6536	-	1310	1986		Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls. (concealed)	No signifcant work reported.		X
31 PDHB		PARACHILNA	61	3435	6958	-	1085	1986		Reaphook Hill	Reaphook Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry & Mapping		X
35 PB		PARACHILNA	69	3564	8002	-	1432	1986		Buffalo Dam	Balcoracana Syncline	Wilkawillina Ls & Frome Gp.	Photo-interpretation		X
37 PF		PARACHILNA	72	5082	8071	-	1514	1988		Mt. Chambers	Mt. Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	R.Chip Geochemistry & Mapping		X
37 PF		PARACHILNA	72	5083	8071	-	1515	1988		Wirrealpa	Mt. Frome, Balcoracanna, Syn.	Parachilna Fm., Wilkawillina & Parara Ls.	Regional Appraisal		X
37 PF		PARACHILNA	72	5083	8071	-	1514	1988		Mt. Chambers	Mt. Frome, Balcoracanna, Syn.	Parachilna Fm., Wilkawillina & Parara Ls.	Regional Appraisal		X
36 PD	AG 57	PARACHILNA	70	4858	8072	-	1515	1989		Wirrealpa	Donkey Bore Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Min. Model, RChip, Soil, Geoch. Mapping		X

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1 OKYL	AG 74	ORROROO	1	1002292	600	94	-	1967	RI 37	Willochra - Mt. Arden	Kanyaka, Yappla, Mt. Ragless	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip Geochemistry		IPSP
2 OL	AG 68	ORROROO	3	4910	641	108	-	1967	RI 37	Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.	SEE ENV 642,	IPSP
3 OL		ORROROO	5	1002230	642	109	-	1967	RI 37	Radford Creek	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St sed,Soil,Rchip,Cost,Drill,Mapp, Gphy.	SEE ENV 641,	IPSP
4 OK	AG 75	ORROROO	7	4911	643	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill	SEE ENV 641,	IPSP
2 OL	AG 68	ORROROO	3	1002194	684	108	-	1966	RI 37	Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.	SEE ENV 641,	IPSP
3 OL	AG 74	ORROROO	5	1003886	685	109	-	1966	RI 37	Radford Creek	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St sed,Soil,Rchip,Cost,Drill,Mapp, Gphy.		IPSP
4 OK		ORROROO	7	1002190	686	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill		IPSP
4 OK	AG 75	ORROROO	7	1002261	686	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill		IPSP
5 OK	AG 76	ORROROO	9	1002604	1306	313	-	1970		Kanyaka	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp,Strm Sed, Soil, RChip Gchm. & Gphy.		GMGR
5 OK	AG 76	ORROROO	9	1002605	1306	313	-	1970		Kanyaka	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp,Strm Sed, Soil, RChip Gchm. & Gphy.		GMGR
6 OL	AG 73	ORROROO	10	1004191	1466	709	-	1972		Mt. Arden/Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.		GM
6 OL	AG 73	ORROROO	10	1004191	1466	455	-	1972		Mt. Arden/Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.		GM
7 OYK	AG 70	ORROROO	12	1001779	1698	584	-	1971		Kanyaka	Yappala, Kanyaka Synclines	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.		X
8 OL	AG 71	ORROROO	13	1002446	2750	-	242	1976		Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Soil Geochemisry, & Geophysics		SI
8 OL	AG 71	ORROROO	13	1002445	2750	-	242	1976		Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Soil Geochemisry, & Geophysics		SI
9 OL	AG 72	ORROROO	14	1004001	2958	-	273	1977		Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp, Soil/RChip Gchm, Geophys., & Drill		IP

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22 PYK	AG 70	PARACHILNA	47	1001779	1698	584	-	1971		Kanyaka	Yappala, Kanyaka Synclines	Parachilna Fm., Wilkawillina Ls.	Stream Sed. Geochemistry.		X
23 PO		PARACHILNA	48	1000322	1749	611	-	1971		Warrakimbo	Warrakimbo Syncline	Lower Cambrian Ls.	Stream Sed. Geochemistry.	Extreme SW s	AMGM
24 PU	AG 51	PARACHILNA	49	1001711	2356	115	-	1966		Lake Torrens	Bunyeroo Syncline	Wilkawillina & Parara Ls.	Silt, Soil, RChip Geoch. & Geophys.	SEE ENV. 235	AMIP
25 PUO		PARACHILNA	51	1001714	2359	131	-	1969	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip, Geoch. Geophys	INCLUDES 131	IPAMGR
25 PUO	AG 51	PARACHILNA	51	1001712	2359	131	-	1969	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip, Geoch. Geophys	ALSO SML 130	IPAMGR
25 PUO		PARACHILNA	51	1001716	2359	131	-	1968	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Geophyics report	INCLUDES 131	X
26 PF		PARACHILNA	53	1014844	2373	-	103	1974		Mt. Frome	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Rock Chip Geochem. & Drilling		X
27 PDB		PARACHILNA	54	1004585	2986	-	299	1977		Wirrealpa	Dnky Br., Narina, Balc., Syn	Wilkawillina Ls.	Stream Sed. Orientation, Rock Sampling		X
28 PB		PARACHILNA	55	1006153	3305	-	367	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
28 PB		PARACHILNA	55	1006153	3305	-	366	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
28 PB		PARACHILNA	55	1006153	3305	-	368	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
29 PDB		PARACHILNA	56	4377	3427	-	1129	1985		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1138	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	1084	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	1129	1987		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	4377	3427	-	1085	1985		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 695	DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	894	1987		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	934	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3519	3427	-	436	1987		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1080	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	809	1987		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	894	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	4377	3427	-	1138	1985		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1085	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	1129	1983		Wirrealpa	Dnky Br., Narina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
30 PF		PARACHILNA	59	3520	3722	-	1084	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1080	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1129	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	934	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	538	1987		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 PF		PARACHILNA	59	3520	3722	-	1138	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1085	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	1138	1987		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	807	1987		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 PF		PARACHILNA	59	3520	3722	-	894	1983		Mts. Frn. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
31 PDNB		PARACHILNA	61	3520	3968	-	1085	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDNB		PARACHILNA	61	4377	3968	-	1138	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDNB		PARACHILNA	61	3520	3968	-	1138	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDNB	AG 62	PARACHILNA	61	4376	3968	-	725	1987		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDNB		PARACHILNA	61	3520	3968	-	934	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDNB		PARACHILNA	61	3520	3968	-	894	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDNB		PARACHILNA	61	4377	3968	-	1085	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDNB	AG 62	PARACHILNA	61	4376	3968	-	1085	1987		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 695	X
31 PDNB		PARACHILNA	61	3520	3968	-	1080	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDNB		PARACHILNA	61	4377	3968	-	1129	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDNB		PARACHILNA	61	3524	3968	-	1084	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDNB		PARACHILNA	61	3520	3968	-	1129	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
32 PU	AG 54	PARACHILNA	64	2241	3969	-	1080	1986		Commodore	Bunyeroo Syncline	Wilkawillina Ls.	Stream Sed., Rock Chip, Mapping, Drill.		DL
32 PU	AG 54	PARACHILNA	64	2241	3969	-	726	1986		Commodore	Bunyeroo Syncline	Wilkawillina Ls.	Stream Sed., Rock Chip, Mapping, Drill.		DL
33 PMK	AG 55	PARACHILNA	66	2242	3970	-	1084	1986		Mts. Alek, Arkaba, Druid Ra.	Mernmerna, Kanyaka Syncs.	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
33 PMK	AG 55	PARACHILNA	66	2242	3970	-	727	1986		Mts. Alek, Arkaba, Druid Ra.	Mernmerna, Kanyaka Syncs.	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X

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0 G	AG 69	COPLEY		1002220	0	-	-	1972	RI 37	Northern Flinders Ranges	Arrowie Basin	Lower Cambrian	Tech. Rev. BMetals, Lwr. Camb. N.Fl.Ra.	SEE RB 67/12	X
0 G		COPLEY		1002035	0	-	-	1967	RB 88/41	Northern Flinders Ranges	Adelaide Geosyncline	Adelaidean & Lower- Middle Cambrian	Tech. Review - Lead-Zinc Mineralisation	AG XX refer	X
1 CW		COPLEY	1	1002191	638	89	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Drilling	SEE ENV 564,	X
1 CW		COPLEY	1	1002192	695	127	-	1967	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
1 CW	AG 47	COPLEY	1	1002192	695	91	-	1967		Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
1 CW	AG 47	COPLEY	1	1002494	564	91	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.	SEE ENV 638,	X
1 CW		COPLEY	1	1002262	695	127	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.	SEE ENV 564,	X
2 CC	AG 33	COPLEY	4	1000262	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
2 CC	AG 33	COPLEY	4	1000260	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
2 CC	AG 33	COPLEY	4	1000261	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
3 CC	AG 32	COPLEY	6	1001018	961	178	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Rock Chip Geochemistry	SEE ENV 1130	X
4 CP	AG 43	COPLEY	7	1004792	937	184	-	1969		Mc Kinlay Ck, Italowie Gorge	Nepabunna Syncline	Pclna.Fmn, Wilk.& Par. Ls, Nepabunna Slt.	Stream. Sed.,	INCLUDES SML	X
5 CE		COPLEY	8	4901	534	77	-	1962	RI 37	Ediacara	Ediacara Syncline	Ajax Ls.	Drilling		X
5 CE		COPLEY	8	1002215	740	144	-	1967	RI 37	Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
5 CE	AG 28	COPLEY	8	1002215	740	77	-	1967	RI 37	Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
5 CE		COPLEY	8	1002216	740	77	-	1962		Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
6 CC		COPLEY	10	1003025	1129	312	-	1969		Mt. Bayley	Cadnia Syncline	Ajax Limestone	Stream Sed. Geochemistry		X
7 CC	AG 32	COPLEY	11	1004701	1130	283	-	1969		Sliding Rock	Cadnia Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Rock Chip & Soil Geohemistry, Mapping	SEE ENV 961,	X
8 CE	AG 28	COPLEY	12	1002869	1160	309	-	1970		Ediacara	Ediacara Syncline	Ajax Limestone	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002857	1162	170	-	1969		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002858	1162	170	-	1970		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002856	1162	170	-	1969		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
10 CM	AG 42	COPLEY	15	1002774	1194	321	-	1970		Jubilee Range	Marina Syncline	Upper Prot. Wonaka Fmn.-Will./Ga. Veins	Stream Sed. Geochemistry		X
11 CXA	AG 22	COPLEY	17	1003967	1226	294	-	1971		Wooltana	Arkaroola Syncline	Skillogalee Dolomite		Adelaidean	X
12 CW		COPLEY	18	1003973	1227	293	-	1971		Moro Springs	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip Geochem.		X
13 CF	AG 45	COPLEY	19	1002259	1390	217	-	1971		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
13 CF	AG 45	COPLEY	19	1003089	1104	217	-	1970		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Geophysics	SEE ENV 997,	RA
13 CF		COPLEY	19	1003090	1104	217	-	1969		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
14 CSP	AG 37	COPLEY	22	1002652	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002654	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002653	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002650	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002651	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
15 CSC	AG 34	COPLEY	24	1001975	1585	536	-	1972		Mt. Serle-Slid.Rk, Waraveena	Mt. Serle, Cadina Synclines	Parachilna Fmn. & Ajax Ls.	Soil & Rock Chip Geochemistry, Geophys.	SEE ENV 961,	EM
15 CSC	AG 34	COPLEY	24	1001974	1585	536	-	1972		Mt. Serle-Sliding Rock	Mt. Serle, Cadina Synclines	Parachilna Fmn. & Ajax Ls.	Soil & Rock Chip Geochemistry, Geophys.	SEE ENV 961,	EM
16 CWB	AG 36	COPLEY	26	1004210	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 47	COPLEY	26	1004206	1638	557	-	1972	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 36	COPLEY	26	1004208	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 47	COPLEY	26	1004209	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
17 CM		COPLEY	29	1003	1653	519	-	1971		Mt. Hack	Marina Syncline	Lower Cambrian	Stream Sed. Geochemistry		X
18 CAXD		COPLEY	30	1000330	1693	585	-	1971		Beltana (Mt. Deception Ra.)	Mt. Deception Anticline	Wonaka & Bunyeroo Fmns.	Stream Sed., Rock Chip, Geochemistry	?Not MVT rel	X
19 CR	AG 46	COPLEY	31	767	1701	525	-	1971		Red Range (Beltana)	Red Range Syncline	Ajax Limestone	Stream Sed. & Rock Chip Geochemistry		X
20 CC		COPLEY	32	1015397	1785	609	-	1972		Mt. Bayley	Cadnia Syncline (west)	Ajax Limestone	Stream Sed. Geochemistry		X
21 CE	AG 28	COPLEY	33	1015400	1835	637	-	1972		Ediacara	Ediacara Syncline	Parachilna Fmn. & Ajax Ls.	Drilling & Geochemistry		X
22 CS	AG 37	COPLEY	34	1001604	2081	708	-	1973		Mt. Serle	Mt. Serle Syncline	Wilkawillina Ls.	Soil Geochemistry	SEE ENV 2314	X
23 CE	AG 28	COPLEY	36	1001336	2254	-	46	1973		Ediacara	Ediacara Syncline	Ajax Limestone	Drilling		X
23 CE	AG 28	COPLEY	36	1001335	2254	-	46	1975		Ediacara	Ediacara Syncline	Ajax Limestone	Drilling		X
24 CS	AG 37	COPLEY	37	1000447	2314	-	96	1976		Mt. Serle	Mt. Serle Syncline	Wilkawillina Ls.	Stream Sed. & Soil Geochemistry	SEE ENV 2081	X
25 CW	AG 47	COPLEY	38	1001945	2317	-	78	1975		Moro Gorge	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Drilling & geoghemistry	SEE ENV 564,	IP
26 CC	AG 34	COPLEY	40	1014843	2341	-	72	1974		Sld. Rck., Blk. R. Spg., War	Cadnia Syncline	Wilkawillina/Ajax Ls.	Mapping, Soil geochemistry & Drilling	SEE ENV 961,	IPEM
27 CW		COPLEY	42	1001710	2379	-	107	1974		Mt. Roebuck	Arrowie Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Stream Sed. & Soil Geochemistry		GM

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28 CM		COPLEY	43	1011948	3539	-	482	1981		Wirlpa., Mt.Mack, Patwta. El	Marina Syncline	Wilkawillina (Wirrap. Mem.) & Parara Ls.	Stream Sed. Geochemistry & Mapping		X
29 CWP	AG 48	COPLEY	44	2030	3641	-	526	1971		Angepena, & Moro Gorge	Arrowie, Nepabunna Syncline	Nepabunna Slt., & Parara Ls.	Mapping, Drilling & RChip Geochemistry	SEE ENV 937,	IP
29 CWP		COPLEY	44	1013038	4323	-	526	1981		SEE ENV 3641 (above)	Arrowie, Nepabunna Syncline		Final Report-interpretive, Geophys.	SEE ENV 937,	IP
29 CWP	AG 48	COPLEY	44	2030	3641	-	934	1971		Mt. Roberts, Alerumbera,	Arrowie, Nepabunna Syncline	Parachilna Fmn., Wilkawillina Ls.,	Mapping, Drilling & RChip Geochemistry	SEE ENV 937,	IP
30 CC		COPLEY	46	1011649	3735	-	563	1980		Sliding Rock	Cadnia Syncline	Parachilna Fmn. & Wilkawillina Ls.	Map., Strm.Sed.& RChip.S., Gphys., Drill.		GMGR
30 CC		COPLEY	46	1011648	3735	-	563	1981		Sliding Rock	Cadnia Syncline	Parachilna Fmn. & Wilkawillina Ls.	Map., Strm.Sed.& RChip.S., Gphys., Drill.		GMGR
31 CD	AG 50	COPLEY	48	2243	4449	-	894	1986		Ann Hill	Donkey Bore Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Photogeol interpretation, no field wk.		X
31 CD	AG 50	COPLEY	48	2243	4449	-	1188	1986		Ann Hill	Donkey Bore Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Photogeol interpretation, no field wk.	SEE ENV 2379	X
32 CJA	AG 29	COPLEY	49	3410	4942	-	1039	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG 29	COPLEY	49	3410	4942	-	1269	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG110	COPLEY	49	3410	4942	-	1269	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG110	COPLEY	49	3410	4942	-	1039	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
33 CPSW	AG 38	COPLEY	52	2250	6651	-	1235	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
33 CPSW	AG 49	COPLEY	52	1815	5647	-	1235	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
33 CPSW	AG 49	COPLEY	52	2251	6759	-	1345	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
34 CP		COPLEY	54	1003073	1106	259	-	1969		Mt. McKinlay Ck.	Nepabunna Syncline	Wilkawillina Ls.	Stm. Sed. Foll-up, soil & lat. Geochem.		X
34 CP		COPLEY	54	1003072	1106	259	-	1969		Mt. McKinlay Ck.	Nepabunna Syncline	Wilkawillina Ls.	Stm. Sed. Foll-up, soil & lat. Geochem.		X
35 CREA	AG 28	COPLEY	55	1002756	1246	353	-	1972		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics, Mapping, Soil Geoch. & Drill	SEE ENV. 183	EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002758	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Gravity Survey		GR
35 CREA	AG 28	COPLEY	55	1002759	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Review of methods.		EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002756	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics, Mapping, Soil Geoch. & Drill	SEE ENV. 183	EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002755	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics-APMAG Survey (Electromag.)	SEE ENV. 183	EM
35 CREA	AG 28	COPLEY	55	1002760	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Seismic Survey		SE
35 CREA		COPLEY	55	1002757	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Mapping, Soil Geoch. & Drill.		X
36 CSP		COPLEY	58	1002623	1324	386	-	1972		Mt. Serle	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Diamond Drilling		X
36 CSP		COPLEY	58	1002622	1324	386	-	1970		Mt. Serle	Mt. Serle, Nepabunna Sync.	Marina Grywk. & Lr. Cambrian	Geophysics - IP Survey		IP
36 CSP		COPLEY	58	1002619	1324	386	-	1970		Mt. Serle	Mt. Serle, Nepabunna Sync.	Marina Grywk. & Lr. Cambrian	Geophysics - Magnetic Survey		GM
37 CJC		COPLEY	59	4907	623	113	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sediment geochemistry	SEE ENV 732	X
37 CJC		COPLEY	59	4913	664	113	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sediment geochemistry	SEE ENV 732	X
37 CJC		COPLEY	59	1002219	733	113	-	1966	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	1002275	732	142	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.	SEE ENV 623	X
37 CJC		COPLEY	59	1002275	732	113	-	1967	RI 37	Puttapa	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	1002275	732	136	-	1967	RI 37	Puttapa	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
38 CW		COPLEY	61	1002211	778	54	-	1963	RI 37	Balcanoo. (Moro, Wertaloona)	Arrowie Syncline	Parachilna Formation	Rock Chip Geochemistry		X
39 CW		COPLEY	62	4915	673	128	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.. Drill.	SEE ENV 564,	X
39 CW		COPLEY	62	4914	672	124	-	1966	RI 37	Ironstone Bore	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.		X
39 CW		COPLEY	62	1002287	721	128	-	1967	RI 37	Ironstone Bore	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
40 CB	AG 28	COPLEY	63	1000256	892	177	-	1968		Ediacara	Ediacara Syncline	Parachilna Fmn, Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
40 CB	AG 28	COPLEY	63	1000258	892	177	-	1968		Ediacara	Ediacara Syncline	Parachilna Fmn, Ajax Limestone	Geophysical Interpretation	SEE ENV. 695	IP
41 C G	AG 44	COPLEY	65	1000268	975	202	-	1968		Aroona, Arrowie, Marina, Balcoracana, Kanyaka Synclines		Basal Cambrian	Regional Stream Sed. Geochemistry Survey	SEE ENV 1229	X
42 CC		COPLEY	66	1002640	1289	359	-	1970		Angepena	Cadnia Syncline	Parachilna Fmn. & Ajax Limestone	Geophysics-IP survey.		IP
42 CC		COPLEY	66	1002641	1289	359	-	1970		Angepena	Cadnia Syncline	Parachilna Fmn. & Ajax Limestone	Steam sed, Soil & Rock geochemistry		X
43 CW		COPLEY	67	1002770	1253	338	-	1970		Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.		Not MVT rele	X
44 CF	AG 56	COPLEY	68	3524	3722	-	538	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
44 CF	AG 56	COPLEY	68	3524	3722	-	807	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
44 CF	AG 56	COPLEY	68	3524	3722	-	1138	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X

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0 G		PARACHILNA		3557	0	-	-	1967	RB 88/041	Northern Flinders Ranges	Adelaide Geosyncline	Adelaidean & Lower- Middle Cambrian	Tech. Review - Lead-Zinc Mineralisation	AG XX refer	X
0 G	AG 69	PARACHILNA		1002220	0	-	-	1972	RI 37	Northern Flinders Ranges	Arrowie Basin	Lower Cambrian	Tech. Rev. BMetals, Lwr. Camb. N.Fl.Ra.	SEE RB 67/12	X
1 PU	AG 53	PARACHILNA	1	1457	0.1	-	-	1986	RB 86/018	Nthn Flind Ra National Park	Bunyeroo Syncline	Parachilna Fmn. & Wilkawillina Ls.	Lead Zinc Exploration		X
1 PU		PARACHILNA	1	1404	0.1	-	-	1986	RB 86/022	Nthn Flind Ra National Park	Bunyeroo Syncline	Parachilna Fmn. & Wilkawillina Ls.	Lead Zinc Exploration		RBIP
2 PH		PARACHILNA	12	1002210	742	138	-	1968	RI 37	Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., RChip., Mapp., Cost. & Drill.		IPSP
2 PH		PARACHILNA	12	1002210	742	137	-	1967	RI 37	Emu Bore/Reaphook Hill	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., Rchip., Mapp., Cost. & Drill.		IPSP
2 PH	AG 58	PARACHILNA	12	1002234	601	95	-	1966	RI 37	Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping & Strm. Sed. RChip Geochemistry		IPSP
2 PH	AG 58	PARACHILNA	12	1001615	863	137	-	1968	RI 37	Emu Bore/Reaphook Hill	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., RChip., Mapp., Cost. & Drill.		IPSP
3 PNDF		PARACHILNA	15	1002303	671	123	-	1967	RI 37	Mts. Lyall & Frome, Wirrlpa	Narina, DBore, Mt. Frome Syn	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., Rock Chip Geochem & Mapping		X
4 PYK	AG 74	PARACHILNA	17	1002292	600	94	-	1966	RI 37	Willochra (Mt. Arden)	Yappala, Kanyaka Synclines	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., Soil, & RChip Geochem, Mapp.	SEE ENV 641,	X
5 PB		PARACHILNA	19	4914	672	124	-	1967	RI 37	Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV. 722	X
5 PB		PARACHILNA	19	1002285	722	124	-	1967	RI 37	Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV. 672	X
6 PB	AG 60	PARACHILNA	20	1001675	800	143	-	1967	RI 37	Third Plain	Balcoracana Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Costeaning, & Drilling, Reserves		X
6 PB	AG 60	PARACHILNA	20	1001676	800	143	-	1967	RI 37	Third Plain	Balcoracana Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Costeaning, & Drilling, Reserve	INCLUDES MC	X
7 PB	AG 59	PARACHILNA	22	1001595	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
7 PB	AG 59	PARACHILNA	22	1001594	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
7 PB	AG 59	PARACHILNA	22	1001593	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
8 P G		PARACHILNA	24	1000268	975	202	-	1968		Aroona, Arrowie, Narina, Balcoracana, Kanyaka Synclines		Basal Cambrian	Regional Stream Sed. Geochemistry Survey	SEE ENV 1229	X
9 PF		PARACHILNA	25	1000616	997	217	-	1969		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	SEE ENV 1104	RA
9 PF		PARACHILNA	25	1003090	1104	217	-	1969		Mt. John - Mt. Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
9 PF		PARACHILNA	25	1000617	997	217	-	1969		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	SEE ENV 1104	RA
9 PF	AG 45	PARACHILNA	25	1002259	1390	217	-	1971		Moorowie - Mt. Chambers	Mt. Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Rock Chip Geochem. & Drilling	11PF=13CF	RA
9 PF		PARACHILNA	25	1003089	1104	217	-	1970		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	INCL 217A, B	RA
10 PB	AG 61	PARACHILNA	28	1003955	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
10 PB	AG 61	PARACHILNA	28	1003954	1146	290	-	1971		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
10 PB	AG 61	PARACHILNA	28	1003957	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
10 PB	AG 61	PARACHILNA	28	1003956	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
11 PMU	AG 52	PARACHILNA	30	1002876	1157	302	-	1971		Torns: Mts. Aleck & Hayward	Mernmerna & Bunyeroo Syncs.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip follow-up Geoch.	SEE SML. 576	X
12 P G		PARACHILNA	31	1003978	1229	292	-	1971	RB 81/119	Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003977	1229	290	-	1970		Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003977	1229	292	-	1970	RB 81/119	Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003977	1229	293	-	1970		Asses. CRA Reg. Stream Sed.	SEE ENV 975, SML 202	Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
13 PYK		PARACHILNA	33	1002767	1258	323	-	1970		Hawker	Yappala, Kanyaka Synclines.	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping & Stream Sed. Geochemistry	SEE ENV. 137	X
14 PH		PARACHILNA	34	1002355	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002349	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002370	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002371	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002372	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
15 PK		PARACHILNA	36	1002353	1378	371	-	1970		Hawker	Kanyaka Syncline	Wilkawillina, Parara Ls., Oraparinna Shl	Stream Sed. Geochemistry.		X
16 PK		PARACHILNA	37	1004757	1531	500	-	1971		Hawker	Kanyaka Syncline	Wilkawillina, Parara Ls., Oraparinna Shl	Stream Sed. Geochemistry.		X
17 PDB	AG 63	PARACHILNA	38	1004188	1548	397	-	1972		Ten Mile Creek	Donkey Bore, Balcoracana Syn	Wilkawillina Ls.	Stream Sed. & Rock Chip follow-up Geoch.	SEE ENV. 163	X
18 PDB		PARACHILNA	40	1004209	1638	557	-	1971	RB 81/119	Morwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip follow-up Geoch.		X
18 PDB		PARACHILNA	40	1004208	1638	557	-	1971	RB 81/119	Morwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Percussion Drilling Patawarta Zinc Pros.		X
18 PDB		PARACHILNA	40	1004206	1638	557	-	1972	RB 81/119	Morwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
19 PF		PARACHILNA	43	1000282	1657	548	-	1971		Moorowie - Mt. Chambers	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Mapping & Sampling		X
20 PUM	AG 52	PARACHILNA	44	1000334	1660	576	-	1971		Mt. Hayward	Bunyeroo Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Mapping, Drilling	SEE ENV. 302	X
20 PM		PARACHILNA	44	1000331	1674	583	-	1971		Mt Aleck	Mernmerna Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Mapping, Drilling	SEE ENV. 302	X
21 PK		PARACHILNA	46	1004184	1677	500	-	1971		Hawker	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.	SEE ENV. 153	X
21 PK		PARACHILNA	46	1004184	1677	582	-	1971		Druid Range	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.		X
22 PYK	AG 70	PARACHILNA	47	1001779	1698	584	-	1971		Kanyaka	Yappala, Kanyaka Synclines	Parachilna Fm., Wilkawillina Ls.	Stream Sed. Geochemistry.		X
23 PO		PARACHILNA	48	1000322	1749	611	-	1971		Warrakimbo	Warrakimbo Syncline	Lower Cambrian Ls.	Stream Sed. Geochemistry.	Extreme SW s	AMGM

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24 PU		PARACHILNA	49	4912	660	115	-	1966	RI 37	Lake Torrens	Bunyeroo Syncline	Wilkawillina & Parara Ls.	Silt, Soil, RChip Geoch. & Geophys.	SEE ENV 2356	AMIP
24 PU	AG 51	PARACHILNA	49	1001711	2356	115	-	1966		Lake Torrens	Bunyeroo Syncline	Wilkawillina & Parara Ls.	Silt, Soil, RChip Geoch. & Geophys.	SEE ENV. 235	AMIP
25 PUO		PARACHILNA	51	1001716	2359	131	-	1968	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Geophyics report	INCLUDES 131	X
25 PUO		PARACHILNA	51	1001714	2359	131	-	1969	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip, Geoch. Geophys	INCLUDES 131	IPAMGR
25 PUO	AG 51	PARACHILNA	51	1001712	2359	131	-	1969	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip, Geoch. Geophys	ALSO SML 130	IPAMGR
26 PF		PARACHILNA	53	1014844	2373	-	103	1974		Mt. Frome	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Rock Chip Geochem. & Drilling		X
27 PDB		PARACHILNA	54	1004585	2986	-	299	1977		Wirrealpa	Dnky Br., Marina, Balc., Syn	Wilkawillina Ls.	Stream Sed. Orientation, Rock Sampling		X
28 PB		PARACHILNA	55	1006153	3305	-	368	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
28 PB		PARACHILNA	55	1006153	3305	-	367	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
28 PB		PARACHILNA	55	1006153	3305	-	366	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	1129	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3519	3427	-	436	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	4377	3427	-	1129	1985		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1080	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	1084	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	809	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	4377	3427	-	1085	1985		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 695	DL
29 PDB		PARACHILNA	56	3520	3427	-	894	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	934	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	4377	3427	-	1138	1985		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1129	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	1138	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	894	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1085	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
30 PF	AG 56	PARACHILNA	59	3524	3722	-	1138	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 PF		PARACHILNA	59	3520	3722	-	1138	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	894	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1085	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1129	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1084	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	538	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 PF		PARACHILNA	59	3520	3722	-	934	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF		PARACHILNA	59	3520	3722	-	1080	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	807	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
31 PDHB		PARACHILNA	61	3520	3968	-	1080	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB	AG 62	PARACHILNA	61	4376	3968	-	1085	1987		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 695	X
31 PDHB		PARACHILNA	61	3520	3968	-	1085	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	3435	6958	-	1085	1986		Reaphook Hill	Reaphook Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry & Mapping		X
31 PDHB		PARACHILNA	61	3520	3968	-	1138	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	4377	3968	-	1129	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	3520	3968	-	934	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	3524	3968	-	1084	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	4377	3968	-	1085	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	3520	3968	-	1129	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB	AG 62	PARACHILNA	61	4376	3968	-	725	1987		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	4377	3968	-	1138	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	3520	3968	-	894	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PH		PARACHILNA	61	1014685	4602	-	725	1981		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping.		X
32 PU	AG 54	PARACHILNA	64	2241	3969	-	726	1986		Commodore	Bunyeroo Syncline	Wilkawillina Ls.	Stream Sed., Rock Chip, Mapping, Drill.		DL
32 PU	AG 54	PARACHILNA	64	2241	3969	-	1080	1986		Commodore	Bunyeroo Syncline	Wilkawillina Ls.	Stream Sed., Rock Chip, Mapping, Drill.		DL
33 PMK	AG 55	PARACHILNA	66	2242	3970	-	1084	1986		Mts. Alek, Arkaba, Druid Ra.	Mernmerna, Kanyaka Syncs.	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X

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33 PM		PARACHILNA	66	321	5326	-	1084	1984		Mt. Alek, Arkaba	Mernmerna Syncline	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
33 PM		PARACHILNA	66	1015035	4794	-	727	1982		Mt. Alek	Mernmerna Syncline	Wilkawillina & Parara Ls.	Stream Sed.		X
33 PMK	AG 55	PARACHILNA	66	2242	3970	-	727	1986		Mts. Alek, Arkaba, Druid Ra.	Mernmerna, Kanyaka Syncs.	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
34 PB		PARACHILNA	68	2583	6536	-	1310	1986		Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls. (concealed)	No signifcant work reported.		X
35 PB		PARACHILNA	69	3564	8002	-	1432	1986		Buffalo Dam	Balcoracana Syncline	Wilkawillina Ls & Frome Gp.	Photo-interpretation		X
36 PD	AG 57	PARACHILNA	70	4858	8072	-	1515	1989		Wirrealpa	Donkey Bore Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Min. Model, RChip, Soil, Geoch. Mapping		X
37 PF		PARACHILNA	72	5083	8071	-	1515	1988		Wirrealpa	Mt. Frome, Balcoracanna, Syn.	Parachilna Fm., Wilkawillina & Parara Ls.	Regional Appraisal		X
37 PF		PARACHILNA	72	5082	8071	-	1514	1988		Mt. Chambers	Mt. Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	R.Chip Geochemistry & Mapping		X
37 PF		PARACHILNA	72	5083	8071	-	1514	1988		Mt. Chambers	Mt. Frome, Balcoracanna, Syn.	Parachilna Fm., Wilkawillina & Parara Ls.	Regional Appraisal		X
38 PFB		PARACHILNA	74	5552	0	-	-	1991	RB 91/101	Mt. Chambers -Wirrealpa	Mt. Frome & Balcoracana Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Drilling	SEE ENV. 807	X

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1 OKYL	AG 74	ORROROO	1	1002292	600	94	-	1967	RI 37	Willochra - Mt. Arden	Kanyaka, Yappla, Mt. Ragless	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip Geochemistry		IPSP
2 OL	AG 68	ORROROO	3	4910	641	108	-	1967	RI 37	Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.	SEE ENV 642,	IPSP
2 OL	AG 68	ORROROO	3	1002194	684	108	-	1966	RI 37	Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.	SEE ENV 641,	IPSP
3 OL		ORROROO	5	1002230	642	109	-	1967	RI 37	Radford Creek	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St sed,Soil,Rchip,Cost,Drill,Mapp, Gphy.	SEE ENV 641,	IPSP
3 OL	AG 74	ORROROO	5	1003886	685	109	-	1966	RI 37	Radford Creek	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St sed,Soil,Rchip,Cost,Drill,Mapp, Gphy.		IPSP
4 OK		ORROROO	7	1002190	686	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill		IPSP
4 OK	AG 75	ORROROO	7	4911	643	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill	SEE ENV 641,	IPSP
4 OK	AG 75	ORROROO	7	1002261	686	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill		IPSP
5 OK	AG 76	ORROROO	9	1002604	1306	313	-	1970		Kanyaka	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp,Strm Sed, Soil, RChip Gchm. & Gphy.		GMGR
5 OK	AG 76	ORROROO	9	1002605	1306	313	-	1970		Kanyaka	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp,Strm Sed, Soil, RChip Gchm. & Gphy.		GMGR
6 OL	AG 73	ORROROO	10	1004191	1466	455	-	1972		Mt. Arden/Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.		GM
6 OL	AG 73	ORROROO	10	1004191	1466	709	-	1972		Mt. Arden/Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.		GM
7 OYK	AG 70	ORROROO	12	1001779	1698	584	-	1971		Kanyaka	Yappala, Kanyaka Synclines	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.		X
8 OL	AG 71	ORROROO	13	1002446	2750	-	242	1976		Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Soil Geochemisry, & Geophysics		SI
8 OL	AG 71	ORROROO	13	1002445	2750	-	242	1976		Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Soil Geochemisry, & Geophysics		SI
9 OL	AG 72	ORROROO	14	1004001	2958	-	273	1977		Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp, Soil/RChip Gchm, Geophys., & Drill		IP

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0 G	AG 69	COPLEY		1002220	0	-	-	1972	RI 37	Northern Flinders Ranges	Arrowie Basin	Lower Cambrian	Tech. Rev. BMetals, Lwr. Camb. N.Fl.Ra.	SEE RB 67/12	X
0 G		COPLEY		1002035	0	-	-	1967	RB 88/41	Northern Flinders Ranges	Adelaide Geosyncline	Adelaidean & Lower- Middle Cambrian	Tech. Review - Lead-Zinc Mineralisation	AG XX refer	X
41 C G	AG 44	COPLEY	65	1000268	975	202	-	1968		Aroona, Arrowie, Marina, Balcoracana, Kanyaka Synclines		Basal Cambrian	Regional Stream Sed. Geochemistry Survey	SEE ENV 1229	X
18 CAXD		COPLEY	30	1000330	1693	585	-	1971		Beltana (Mt. Deception Ra.)	Mt. Deception Anticline	Wonaka & Bunyeroo Fmns.	Stream Sed., Rock Chip, Geochemistry	?Not MVT rel	X
7 CC	AG 32	COPLEY	11	1004701	1130	283	-	1969		Sliding Rock	Cadnia Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Rock Chip & Soil Geohemistry, Mapping	SEE ENV 961,	X
26 CC	AG 34	COPLEY	40	1014843	2341	-	72	1974		Sld. Rck., Blk. R. Spg., War	Cadnia Syncline	Wilkawillina/Ajax Ls.	Mapping, Soil geochemistry & Drilling	SEE ENV 961,	IPEM
42 CC		COPLEY	66	1002641	1289	359	-	1970		Angepena	Cadnia Syncline	Parachilna Fmn. & Ajax Limestone	Steam sed, Soil & Rock geochemistry		X
30 CC		COPLEY	46	1011648	3735	-	563	1981		Sliding Rock	Cadnia Syncline	Parachilna Fmn. & Wilkawillina Ls.	Map., Strm.Sed.& RChip.S., Gphys., Drill.		GMGR
2 CC	AG 33	COPLEY	4	1000261	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
30 CC		COPLEY	46	1011649	3735	-	563	1980		Sliding Rock	Cadnia Syncline	Parachilna Fmn. & Wilkawillina Ls.	Map., Strm.Sed.& RChip.S., Gphys., Drill.		GMGR
2 CC	AG 33	COPLEY	4	1000260	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
3 CC	AG 32	COPLEY	6	1001018	961	178	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Rock Chip Geochemistry	SEE ENV 1130	X
6 CC		COPLEY	10	1003025	1129	312	-	1969		Mt. Bayley	Cadnia Syncline	Ajax Limestone	Stream Sed. Geochemistry		X
2 CC	AG 33	COPLEY	4	1000262	928	171	-	1969		Sliding Rock	Cadnia Syncline	Hawkwer Gp. (Ajax/Wilkawillina Ls.)	Stream Sed. & Soil Geochemistry		AM
42 CC		COPLEY	66	1002640	1289	359	-	1970		Angepena	Cadnia Syncline	Parachilna Fmn. & Ajax Limestone	Geophysics-IP survey.		IP
20 CC		COPLEY	32	1015397	1785	609	-	1972		Mt. Bayley	Cadnia Syncline (west)	Ajax Limestone	Stream Sed. Geochemistry		X
31 CD	AG 50	COPLEY	48	2243	4449	-	1188	1986		Ann Hill	Donkey Bore Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Photogeol interpretation, no field wk.	SEE ENV 2379	X
31 CD	AG 50	COPLEY	48	2243	4449	-	894	1986		Ann Hill	Donkey Bore Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Photogeol interpretation, no field wk.		X
21 CE	AG 28	COPLEY	33	1015400	1835	637	-	1972		Ediacara	Ediacara Syncline	Parachilna Fmn. & Ajax Ls.	Drilling & Geochemistry		X
40 CE	AG 28	COPLEY	63	1000256	892	177	-	1968		Ediacara	Ediacara Syncline	Parachilna Fmn, Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
5 CE		COPLEY	8	4901	534	77	-	1962	RI 37	Ediacara	Ediacara Syncline	Ajax Ls.	Drilling		X
5 CE		COPLEY	8	1002216	740	77	-	1962		Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
40 CE	AG 28	COPLEY	63	1000258	892	177	-	1968		Ediacara	Ediacara Syncline	Parachilna Fmn, Ajax Limestone	Geophysical Interpretation	SEE ENV. 695	IP
5 CE		COPLEY	8	1002215	740	144	-	1967	RI 37	Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
23 CE	AG 28	COPLEY	36	1001335	2254	-	46	1975		Ediacara	Ediacara Syncline	Ajax Limestone	Drilling		X
23 CE	AG 28	COPLEY	36	1001336	2254	-	46	1973		Ediacara	Ediacara Syncline	Ajax Limestone	Drilling		X
8 CE	AG 28	COPLEY	12	1002869	1160	309	-	1970		Ediacara	Ediacara Syncline	Ajax Limestone	Stream Sed. Geochemistry		X
5 CE	AG 28	COPLEY	8	1002215	740	77	-	1967	RI 37	Ediacara	Ediacara Syncline	Ajax Limestone	Drill, Struct. Intp., Res. Rev.		X
13 CF	AG 45	COPLEY	19	1003089	1104	217	-	1970		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Geophysics	SEE ENV 997,	RA
44 CF	AG 56	COPLEY	68	3524	3722	-	538	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
44 CF	AG 56	COPLEY	68	3524	3722	-	807	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
13 CF		COPLEY	19	1003090	1104	217	-	1969		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
13 CF	AG 45	COPLEY	19	1002259	1390	217	-	1971		Moorowie, Mts.John-Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
44 CF	AG 56	COPLEY	68	3524	3722	-	1138	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
32 CJA	AG 29	COPLEY	49	3410	4942	-	1269	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG 29	COPLEY	49	3410	4942	-	1039	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG110	COPLEY	49	3410	4942	-	1039	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
32 CJA	AG110	COPLEY	49	3410	4942	-	1269	1987		Puttapa	Ajax, Aroona Syncline	Ajax Limestone	Strat. Mapping, RChip Goechem. & Drill.	INCLUDES ML	IP
37 CJC		COPLEY	59	4913	664	113	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sediment geochemistry	SEE ENV 732	X
37 CJC		COPLEY	59	1002275	732	142	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.	SEE ENV 623	X
37 CJC		COPLEY	59	1002219	733	113	-	1966	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	1002275	732	113	-	1967	RI 37	Puttapa	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	1002275	732	136	-	1967	RI 37	Puttapa	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sed., RChip, Mapp.		X
37 CJC		COPLEY	59	4907	623	113	-	1967	RI 37	Beltana	Ajax & Cadnia Synclines	Ajax Ls. & Parachilna Formation	Stream Sediment geochemistry	SEE ENV 732	X
10 CM	AG 42	COPLEY	15	1002774	1194	321	-	1970		Jubilee Range	Marina Syncline	Upper Prot. Wonaka Fmn.-Will./Ga. Veins	Stream Sed. Geochemistry		X
28 CM		COPLEY	43	1011948	3539	-	482	1981		Wirlpa., Mt.Hack, Patwta. Hl	Marina Syncline	Wilkawillina (Wirrap. Mem.) & Parara Ls.	Stream Sed. Geochemistry & Mapping		X
17 CM		COPLEY	29	1003	1653	519	-	1971		Mt. Hack	Marina Syncline	Lower Cambrian	Stream Sed. Geochemistry		X
4 CP	AG 43	COPLEY	7	1004792	937	184	-	1969		Mc Kinlay Ck, Italowie Gorge	Nepabunna Syncline	Pclna.Fmn, Wilk.& Par. Ls, Nepabunna Slt.	Stream. Sed.,	INCLUDES SML	X
34 CP		COPLEY	54	1003073	1106	259	-	1969		Mt. McKinlay Ck.	Nepabunna Syncline	Wilkawillina Ls.	Stm. Sed. Foll-up, soil & lat. Geochem.		X
34 CP		COPLEY	54	1003072	1106	259	-	1969		Mt. McKinlay Ck.	Nepabunna Syncline	Wilkawillina Ls.	Stm. Sed. Foll-up, soil & lat. Geochem.		X
33 CPSW	AG 49	COPLEY	52	1815	5647	-	1235	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X

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33 CPSW	AG 38	COPLEY	52	2250	6651	-	1235	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
33 CPSW	AG 49	COPLEY	52	2251	6759	-	1345	1986		Mt. Uro (Angepena)	Cad.,Mt.Srle.,Arr.,Nep.Syncl.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
9 CR	AG 46	COPLEY	13	1002857	1162	170	-	1969		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002858	1162	170	-	1970		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
9 CR	AG 46	COPLEY	13	1002856	1162	170	-	1969		Beltana-Red Range	Red Range Syncline	Ajax/Wilkawillina Ls.	Stream Sed. Geochemistry		X
19 CR	AG 46	COPLEY	31	767	1701	525	-	1971		Red Range (Beltana)	Red Range Syncline	Ajax Limestone	Stream Sed. & Rock Chip Geochemistry		X
35 CREA	AG 28	COPLEY	55	1002756	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics, Mapping, Soil Geoch. & Drill	SEE ENV. 183	EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002758	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Gravity Survey		GR
35 CREA		COPLEY	55	1002757	1246	353	-	1971		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Mapping, Soil Geoch. & Drill.		X
35 CREA	AG 28	COPLEY	55	1002760	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Seismic Survey		SE
35 CREA	AG 28	COPLEY	55	1002755	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics-AFMAG Survey (Electromag.)	SEE ENV. 183	EM
35 CREA	AG 28	COPLEY	55	1002759	1246	353	-	1970		Beltana, Ediacara, Aroona	Red Ra., Ediac., Aroona Syn	Ajax Ls.	Geophysics-Review of methods.		EMIPSEGRGM
35 CREA	AG 28	COPLEY	55	1002756	1246	353	-	1972		Beltana, Ediacara, Aroona	Red Ra, Ediacara, Aroona Syn	Ajax Ls.	Geophysics, Mapping, Soil Geoch. & Drill	SEE ENV. 183	EMIPSEGRGM
22 CS	AG 37	COPLEY	34	1001604	2081	708	-	1973		Mt. Serle	Mt. Serle Syncline	Wilkawillina Ls.	Soil Geochemistry	SEE ENV 2314	X
24 CS	AG 37	COPLEY	37	1000447	2314	-	96	1976		Mt. Serle	Mt. Serle Syncline	Wilkawillina Ls.	Stream Sed. & Soil Geochemistry	SEE ENV 2081	X
15 CSC	AG 34	COPLEY	24	1001975	1585	536	-	1972		Mt. Serle-Slid.Rk, Waraweena	Mt. Serle, Cadina Synclines	Parachilna Fmn. & Ajax Ls.	Soil & Rock Chip Geochemistry, Geophys.	SEE ENV 961,	EM
15 CSC	AG 34	COPLEY	24	1001974	1585	536	-	1972		Mt. Serle-Sliding Rock	Mt. Serle, Cadina Synclines	Parachilna Fmn. & Ajax Ls.	Soil & Rock Chip Geochemistry, Geophys.	SEE ENV 961,	EM
14 CSP	AG 37	COPLEY	22	1002653	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002652	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
36 CSP		COPLEY	58	1002619	1324	386	-	1970		Mt. Serle	Mt. Serle, Nepabunna Sync.	Marina Grywk. & Lr. Cambrian	Geophysics - Magnetic Survey		GM
14 CSP	AG 37	COPLEY	22	1002650	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
36 CSP		COPLEY	58	1002623	1324	386	-	1972		Mt. Serle	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Diamond Drilling		X
14 CSP	AG 37	COPLEY	22	1002651	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
14 CSP	AG 37	COPLEY	22	1002654	1481	422	-	1972		Mt. Serle-Castle Rock	Mt. Serle, Nepabunna Syncl.	Marina Grywk. & Lr. Cambrian	Petrology & Stream Sed. Geochemistry	SEE ENV 2081	X
36 CSP		COPLEY	58	1002622	1324	386	-	1970		Mt. Serle	Mt. Serle, Nepabunna Sync.	Marina Grywk. & Lr. Cambrian	Geophysics - IP Survey		IP
25 CW	AG 47	COPLEY	38	1001945	2317	-	78	1975		Moro Gorge	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Drilling & geoghemistry	SEE ENV 564,	IP
39 CW		COPLEY	62	4914	672	124	-	1966	RI 37	Ironstone Bore	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.		X
39 CW		COPLEY	62	4915	673	128	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
43 CW		COPLEY	67	1002770	1253	338	-	1970		Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.		Not MVT rele	X
1 CW	AG 47	COPLEY	1	1002494	564	91	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.	SEE ENV 638,	X
27 CW		COPLEY	42	1001710	2379	-	107	1974		Mt. Roebuck	Arrowie Syncline	? Parachilna Fmn. & ? Wilkawillina Ls.	Stream Sed. & Soil Geochemistry		GM
1 CW	AG 47	COPLEY	1	1002192	695	91	-	1967		Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
12 CW		COPLEY	18	1003973	1227	293	-	1971		Moro Springs	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip Geochem.		X
1 CW		COPLEY	1	1002192	695	127	-	1967	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
38 CW		COPLEY	61	1002211	778	54	-	1963	RI 37	Balcanoo. (Moro, Wertaloona)	Arrowie Syncline	Parachilna Formation	Rock Chip Geochemistry		X
1 CW		COPLEY	1	1002262	695	127	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp.	SEE ENV 564,	X
39 CW		COPLEY	62	1002287	721	128	-	1967	RI 37	Ironstone Bore	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., RChip, Mapp., Drill.	SEE ENV 564,	X
1 CW		COPLEY	1	1002191	638	89	-	1966	RI 37	Balcanoona (Moro)	Arrowie Syncline	Parachilna Fmn. & Wilkawillina Ls.	Drilling	SEE ENV 564,	X
16 CWB	AG 47	COPLEY	26	1004209	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 36	COPLEY	26	1004208	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 47	COPLEY	26	1004206	1638	557	-	1972	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
16 CWB	AG 36	COPLEY	26	1004210	1638	557	-	1971	RB 81/119	Third Pln, Linda, Moro Gorge	Arrowie, Balcoracanna Syncl.	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed. Geochemistry-Field Follow up		X
29 CWP	AG 48	COPLEY	44	2030	3641	-	934	1971		Mt. Roberts, Alerumbera,	Arrowie, Nepabunna Syncline	Parachilna Fmn., Wilkawillina Ls.,	Mapping, Drilling & RChip Geochemistry	SEE ENV 937,	IP
29 CWP	AG 48	COPLEY	44	2030	3641	-	526	1971		Angepena, & Moro Gorge	Arrowie, Nepabunna Syncline	Nepabunna Slt., & Parara Ls.	Mapping, Drilling & RChip Geochemistry	SEE ENV 937,	IP
29 CWP		COPLEY	44	1013038	4323	-	526	1981		SEE ENV 3641 (above)	Arrowie, Nepabunna Syncline		Final Report-interpretive, Geophys.	SEE ENV 937,	IP
11 CXA	AG 22	COPLEY	17	1003967	1226	294	-	1971		Wooltana	Arkaroola Syncline	Skillogalee Dolomite		Adelaidean	X

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12 P G		PARACHILNA	31	1003977	1229	293	-	1970		Asses. CRA Reg. Stream Sed. SEE ENV 975, SML 202		Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003978	1229	292	-	1971	RB 81/119	Asses. CRA Reg. Stream Sed. SEE ENV 975, SML 202		Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
8 P G		PARACHILNA	24	1000268	975	202	-	1968		Aroona, Arrowie, Marina, Balcoracana, Kanyaka Synclines		Basal Cambrian	Regional Stream Sed. Geochemistry Survey	SEE ENV 1229	X
12 P G		PARACHILNA	31	1003977	1229	290	-	1970		Asses. CRA Reg. Stream Sed. SEE ENV 975, SML 202		Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
12 P G		PARACHILNA	31	1003977	1229	292	-	1970	RB 81/119	Asses. CRA Reg. Stream Sed. SEE ENV 975, SML 202		Basal Cambrian	Stream Sed. assess / Field follow-up	SEE ENV. 975	X
0 G	AG 69	PARACHILNA		1002220	0	-	-	1972	RI 37	Northern Flinders Ranges	Arrowie Basin	Lower Cambrian	Tech. Rev. BMetals, Lwr. Camb. N.Fl.Ra.	SEE RB 67/12	X
0 G		PARACHILNA		3557	0	-	-	1967	RB 88/041	Northern Flinders Ranges	Adelaide Geosyncline	Adelaidean & Lower- Middle Cambrian	Tech. Review - Lead-Zinc Mineralisation	AG XX refer	X
35 PB		PARACHILNA	69	3564	8002	-	1432	1986		Buffalo Dam	Balcoracana Syncline	Wilkawillina Ls & Frome Gp.	Photo-interpretation		X
10 PB	AG 61	PARACHILNA	28	1003957	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
28 PB		PARACHILNA	55	1006153	3305	-	366	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
10 PB	AG 61	PARACHILNA	28	1003955	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
28 PB		PARACHILNA	55	1006153	3305	-	367	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
5 PB		PARACHILNA	19	1002285	722	124	-	1967	RI 37	Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV. 672	X
28 PB		PARACHILNA	55	1006153	3305	-	368	1978		Wertaloona, Coffins Bore	Balcoracana Syncline	Lake Frome Group	Mapping, RChip, Soil, Geochem, Drilling		GMGR
6 PB	AG 60	PARACHILNA	20	1001675	800	143	-	1967	RI 37	Third Plain	Balcoracana Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Costeaning, & Drilling, Reserves		X
34 PB		PARACHILNA	68	2583	6536	-	1310	1986		Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls. (concealed)	No signifcant work reported.		X
7 PB	AG 59	PARACHILNA	22	1001593	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
7 PB	AG 59	PARACHILNA	22	1001594	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
5 PB		PARACHILNA	19	4914	672	124	-	1967	RI 37	Mt. Mantell	Balcoracana Syncline	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV. 722	X
6 PB	AG 60	PARACHILNA	20	1001676	800	143	-	1967	RI 37	Third Plain	Balcoracana Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Costeaning, & Drilling, Reserve	INCLUDES MC	X
10 PB	AG 61	PARACHILNA	28	1003954	1146	290	-	1971		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
7 PB	AG 59	PARACHILNA	22	1001595	965	166	-	1969		Orraparinna	Bunkers Graben, Balcor. Sync.	Wilkawillina Ls.	Stream Sed. Geochemistry	SEE ENV 3427	AM
10 PB	AG 61	PARACHILNA	28	1003956	1146	290	-	1970		Mt. Lyall - Third Plain	Balcoracana Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stm. Sed. Fol-up, Mapp. & Geoch. & Drill.		RA
36 PD	AG 57	PARACHILNA	70	4858	8072	-	1515	1989		Wirrealpa	Donkey Bore Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Min. Model, RChip, Soil, Geoch. Mapping		X
18 PDB		PARACHILNA	40	1004209	1638	557	-	1971	RB 81/119	Norwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip follow-up Geoch.		X
29 PDB		PARACHILNA	56	4377	3427	-	1138	1985		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	1129	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
27 PDB		PARACHILNA	54	1004585	2986	-	299	1977		Wirrealpa	Dnky Br., Marina, Balc., Syn	Wilkawillina Ls.	Stream Sed. Orientation, Rock Sampling		X
29 PDB		PARACHILNA	56	4377	3427	-	1129	1985		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	894	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	4377	3427	-	1085	1985		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 695	DL
29 PDB		PARACHILNA	56	3519	3427	-	436	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB	AG 57	PARACHILNA	56	3519	3427	-	809	1987		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling		DL
29 PDB		PARACHILNA	56	3520	3427	-	1084	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	1080	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	1138	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
17 PDB	AG 63	PARACHILNA	38	1004188	1548	397	-	1972		Ten Mile Creek	Donkey Bore, Balcoracana Syn	Wilkawillina Ls.	Stream Sed. & Rock Chip follow-up Geoch.	SEE ENV. 163	X
29 PDB		PARACHILNA	56	3520	3427	-	1085	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
18 PDB		PARACHILNA	40	1004206	1638	557	-	1972	RB 81/119	Norwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Geochemistry		X
29 PDB		PARACHILNA	56	3520	3427	-	1129	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	894	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
29 PDB		PARACHILNA	56	3520	3427	-	934	1983		Wirrealpa	Dnky Br., Marina, Balc., Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Survey, Rock Chip & Drilling	SEE ENV. 372	DL
18 PDB		PARACHILNA	40	1004208	1638	557	-	1971	RB 81/119	Norwie.Gg., Third.Pl, Linda	Donkey Bore, Balcoracana Syn	Wilkawillina & Parara Ls.	Percussion Drilling Patawarta Zinc Pros.		X
31 PDHB		PARACHILNA	61	3520	3968	-	1129	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	3520	3968	-	1138	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	3520	3968	-	934	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	3520	3968	-	894	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDHB		PARACHILNA	61	4377	3968	-	1138	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	3435	6958	-	1085	1986		Reaphook Hill	Reaphook Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry & Mapping		X
31 PDHB		PARACHILNA	61	4377	3968	-	1129	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDHB		PARACHILNA	61	3524	3968	-	1084	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X

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31 PDBB		PARACHILNA	61	3520	3968	-	1085	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDBB		PARACHILNA	61	3520	3968	-	1080	1983		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
31 PDBB	AG 62	PARACHILNA	61	4376	3968	-	725	1987		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.		X
31 PDBB	AG 62	PARACHILNA	61	4376	3968	-	1085	1987		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 695	X
31 PDBB		PARACHILNA	61	4377	3968	-	1085	1985		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Rock Chip, Mapping, Drill.	SEE ENV. 342	X
26 PF		PARACHILNA	53	1014844	2373	-	103	1974		Mt. Frome	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Rock Chip Geochem. & Drilling		X
30 PF		PARACHILNA	59	3520	3722	-	1129	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
19 PF		PARACHILNA	43	1000282	1657	548	-	1971		Moorowie - Mt. Chambers	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Mapping & Sampling		X
30 PF		PARACHILNA	59	3520	3722	-	894	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	1138	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
37 PF		PARACHILNA	72	5083	8071	-	1515	1988		Wirrealpa	Mt. Frome, Balcoracanna, Syn.	Parachilna Fm., Wilkawillina & Parara Ls.	Regional Appraisal		X
30 PF		PARACHILNA	59	3520	3722	-	934	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
37 PF		PARACHILNA	72	5082	8071	-	1514	1988		Mt. Chambers	Mt. Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	R.Chip Geochemistry & Mapping		X
30 PF		PARACHILNA	59	3520	3722	-	1080	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
9 PF		PARACHILNA	25	1000616	997	217	-	1969		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	SEE ENV 1104	RA
30 PF	AG 56	PARACHILNA	59	3524	3722	-	807	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
9 PF		PARACHILNA	25	1003089	1104	217	-	1970		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	INCL 217A, E	RA
30 PF		PARACHILNA	59	3520	3722	-	1084	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
37 PF		PARACHILNA	72	5083	8071	-	1514	1988		Mt. Chambers	Mt. Frome, Balcoracanna, Syn.	Parachilna Fm., Wilkawillina & Parara Ls.	Regional Appraisal		X
30 PF	AG 56	PARACHILNA	59	3524	3722	-	538	1987		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.		X
30 PF		PARACHILNA	59	3520	3722	-	1085	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
9 PF		PARACHILNA	25	1003090	1104	217	-	1969		Mt. John - Mt. Chambers	Mt Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip Gechm., Drilling	SEE ENV 997,	RA
9 PF		PARACHILNA	25	1000617	997	217	-	1969		Mt. John - Mt. Chambers	Mt. Frome Syncline	Wilkawillina , Parara, & Beuindetta Lsts.	Radiom. Svy, Strm. Sed. Geoch. & Mapping	SEE ENV 1104	RA
9 PF	AG 45	PARACHILNA	25	1002259	1390	217	-	1971		Moorowie - Mt. Chambers	Mt. Frome Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Rock Chip Geochem. & Drilling	11PF=13CF	RA
30 PF		PARACHILNA	59	3520	3722	-	1138	1983		Mts. Frm. & Chmbs, Moorowie	Mt. Frome Syncline	Wilkawillina & Parara Ls.	Jack Hammer Geochem, Geophys.	SEE ENV. 342	X
38 PFB		PARACHILNA	74	5552	0	-	-	1991	RB 91/101	Mt. Chambers -Wirrealpa	Mt. Frome & Balcoracana Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Drilling	SEE ENV. 807	X
31 PH		PARACHILNA	61	1014685	4602	-	725	1981		Wrlpa, Thd.Pl, Linda, Rep.H	Dnky Br., Balc., Reaphk. Syn	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping.		X
14 PH		PARACHILNA	34	1002355	1363	.339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
2 PH	AG 58	PARACHILNA	12	1001615	863	137	-	1968	RI 37	Emu Bore/Reaphook Hill	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., RChip., Mapp., Cost. & Drill.		IPSP
14 PH		PARACHILNA	34	1002370	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
2 PH		PARACHILNA	12	1002210	742	138	-	1968	RI 37	Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., RChip., Mapp., Cost. & Drill.		IPSP
14 PH		PARACHILNA	34	1002371	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
14 PH		PARACHILNA	34	1002372	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
2 PH		PARACHILNA	12	1002210	742	137	-	1967	RI 37	Emu Bore/Reaphook Hill	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., Rchip., Mapp., Cost. & Drill.		IPSP
14 PH		PARACHILNA	34	1002349	1363	339	-	1971		Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping, Rock Chip Sampling		X
2 PH	AG 58	PARACHILNA	12	1002234	601	95	-	1966	RI 37	Reaphook Hill/Emu Bore	Reaphook Syncline	Parachilna Fmn. & Wilkawillina Ls.	Mapping & Strm. Sed. RChip Geochemistry		IPSP
15 PK		PARACHILNA	36	1002353	1378	371	-	1970		Hawker	Kanyaka Syncline	Wilkawillina, Parara Ls., Oraparinna Shl	Stream Sed. Geochemistry.		X
21 PK		PARACHILNA	46	1004184	1677	582	-	1971		Druid Range	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.		X
16 PK		PARACHILNA	37	1004757	1531	500	-	1971		Hawker	Kanyaka Syncline	Wilkawillina, Parara Ls., Oraparinna Shl	Stream Sed. Geochemistry.		X
21 PK		PARACHILNA	46	1004184	1677	500	-	1971		Hawker	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.	SEE ENV. 153	X
20 PM		PARACHILNA	44	1000331	1674	583	-	1971		Mt Aleck	Mernmerna Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Mapping, Drilling	SEE ENV. 302	X
33 PM		PARACHILNA	66	321	5326	-	1084	1984		Mt. Alek, Arkaba	Mernmerna Syncline	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
33 PM		PARACHILNA	66	1015035	4794	-	727	1982		Mt. Alek	Mernmerna Syncline	Wilkawillina & Parara Ls.	Stream Sed.		X
33 PMK	AG 55	PARACHILNA	66	2242	3970	-	1084	1986		Mts. Alek, Arkaba, Druid Ra.	Mernmerna, Kanyaka Syncs.	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
33 PMK	AG 55	PARACHILNA	66	2242	3970	-	727	1986		Mts. Alek, Arkaba, Druid Ra.	Mernmerna, Kanyaka Syncs.	Wilkawillina & Parara Ls.	Stream Sed., Soil, Rock Chip, Geochem.		X
11 PMU	AG 52	PARACHILNA	30	1002876	1157	302	-	1971		Torns: Mts. Aleck & Hayward	Mernmerna & Bunyeroo Syncs.	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. & Rock Chip follow-up Geoch.	SEE SML. 576	X
3 PMDF		PARACHILNA	15	1002303	671	123	-	1967	RI 37	Mts. Lyall & Frome, Wirrlpa	Marina, DBore, Mt. Frome Syn	Parachilna Fmn. & Wilkawillina Ls.	Stream Sed., Rock Chip Geochem & Mapping		X
23 PO		PARACHILNA	48	1000322	1749	611	-	1971		Warrakimbo	Warrakimbo Syncline	Lower Cambrian Ls.	Stream Sed. Geochemistry.	Extreme SW	sAMGN
1 PU		PARACHILNA	1	1404	0.1	-	-	1986	RB 86/022	Nthn Flind Ra National Park	Bunyeroo Syncline	Parachilna Fmn. & Wilkawillina Ls.	Lead Zinc Exploration		REIP
24 PU		PARACHILNA	49	4912	660	115	-	1966	RI 37	Lake Torrens	Bunyeroo Syncline	Wilkawillina & Parara Ls.	Silt, Soil, RChip Geoch. & Geophys.	SEE ENV 2356	AMIP
32 PU	AG 54	PARACHILNA	64	2241	3969	-	726	1986		Commodore	Bunyeroo Syncline	Wilkawillina Ls.	Stream Sed., Rock Chip, Mapping, Drill.		DL

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1 PU	AG 53	PARACHILNA	1	1457	0.1	-	-	1986	RB 86/018	Nthn Flind Ra National Park	Bunyeroo Syncline	Parachilna Fmn. & Wilkawillina Ls.	Lead Zinc Exploration		X
24 PU	AG 51	PARACHILNA	49	1001711	2356	115	-	1966		Lake Torrens	Bunyeroo Syncline	Wilkawillina & Parara Ls.	Silt, Soil, RChip Geoch. & Geophys.	SEE ENV. 235	AMIP
32 PU	AG 54	PARACHILNA	64	2241	3969	-	1080	1986		Commodore	Bunyeroo Syncline	Wilkawillina Ls.	Stream Sed., Rock Chip, Mapping, Drill.		DL
20 PUM	AG 52	PARACHILNA	44	1000334	1660	576	-	1971		Mt. Hayward	Bunyeroo Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Mapping, Drilling	SEE ENV. 302	X
25 PUO		PARACHILNA	51	1001716	2359	131	-	1968	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Geophyics report	INCLUDES 131	X
25 PUO	AG 51	PARACHILNA	51	1001712	2359	131	-	1969	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip, Geoch. Geophys	ALSO SML 130	IPAMGR
25 PUO		PARACHILNA	51	1001714	2359	131	-	1969	RI 37	Lake Torrens	Bunyeroo & Cotabena Synclines	Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip, Geoch. Geophys	INCLUDES 131	IPAMGR
13 PYK		PARACHILNA	33	1002767	1258	323	-	1970		Hawker	Yappala, Kanyaka Synclines.	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping & Stream Sed. Geochemistry	SEE ENV. 137	X
22 PYK	AG 70	PARACHILNA	47	1001779	1698	584	-	1971		Kanyaka	Yappala, Kanyaka Synclines	Parachilna Fm., Wilkawillina Ls.	Stream Sed. Geochemistry.		X
4 PYK	AG 74	PARACHILNA	17	1002292	600	94	-	1966	RI 37	Willochra (Mt. Arden)	Yappala, Kanyaka Synclines	Parachilna Fmn. & Wilkawillina Ls.	Strm Sed., Soil, & RChip Geochem, Mapp.	SEE ENV 641,	X

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4 OK	AG 75	ORROROO	7	1002261	686	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill		IPSP
5 OK	AG 76	ORROROO	9	1002605	1306	313	-	1970		Kanyaka	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp,Strm Sed, Soil, RChip Gchm. & Gphy.		GMGR
5 OK	AG 76	ORROROO	9	1002604	1306	313	-	1970		Kanyaka	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp,Strm Sed, Soil, RChip Gchm. & Gphy.		GMGR
4 OK		ORROROO	7	1002190	686	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill		IPSP
4 OK	AG 75	ORROROO	7	4911	643	110	-	1967	RI 37	Kanyaka Mines	Kanyaka Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St Sed,RChip,Grab Smp, Cost, Gphy, Drill	SEE ENV 641,	IPSP
1 OKYL	AG 74	ORROROO	1	1002292	600	94	-	1967	RI 37	Willochra - Mt. Arden	Kanyaka, Yappla, Mt. Ragless	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed., Soil, RChip Geochemistry		IPSP
2 OL	AG 68	ORROROO	3	1002194	684	108	-	1966	RI 37	Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.	SEE ENV 641,	IPSP
6 OL	AG 73	ORROROO	10	1004191	1466	709	-	1972		Mt. Arden/Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.		GM
2 OL	AG 68	ORROROO	3	4910	641	108	-	1967	RI 37	Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.	SEE ENV 642,	IPSP
9 OL	AG 72	ORROROO	14	1004001	2958	-	273	1977		Mt. Arden-Comstock	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapp, Soil/RChip Gchm, Geophys., & Drill		IP
8 OL	AG 71	ORROROO	13	1002446	2750	-	242	1976		Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Soil Geochemisry, & Geophysics		SI
6 OL	AG 73	ORROROO	10	1004191	1466	455	-	1972		Mt. Arden/Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Map Strm sed, RChip, Cost, Drill & Gphy.		GM
3 OL		ORROROO	5	1002230	642	109	-	1967	RI 37	Radford Creek	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St sed,Soil,Rchip,Cost,Drill,Mapp, Gphy.	SEE ENV 641,	IPSP
3 OL	AG 74	ORROROO	5	1003886	685	109	-	1966	RI 37	Radford Creek	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	St sed,Soil,Rchip,Cost,Drill,Mapp, Gphy.		IPSP
8 OL	AG 71	ORRORDO	13	1002445	2750	-	242	1976		Ragless Range	Mt. Ragless Syncline	Parachilna Fm., Wilkawillina & Parara Ls.	Mapping, Soil Geochemisry, & Geophysics		SI
7 OYK	AG 70	ORROROO	12	1001779	1698	584	-	1971		Kanyaka	Yappala, Kanyaka Synclines	Parachilna Fm., Wilkawillina & Parara Ls.	Stream Sed. Geochemistry.		X

APPENDIX 2.2

COMPUTER DISKETTE (1.4 Kbyte 3.5")

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AMVTREPT.WP	REPORT MVT LZ NORTHEN FLINDERS RANGES	
MVTAPPDX.WP	SHORT APPENDIXES - MVT LZ N.F.Ra.	AP 1
ARRSTRAT.WP	CAMBRIAN STRATIGRAPHY - ARROWIE BASIN	AP 1.3
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APPENDIX 3.1

MVT-LZ EXPLORATION REVIEWS

COPLEY SHEET

NORTHERN FLINDERS RANGES

November 1991

Page Nos. in data listing.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 1CW & AG 47

ENVELOPE No. : 564,638 & 695

LOCATION : BALCANOONA

SAMREF CAT. Nos. : 1002191, 1002192, 1002262, 1002494.

TITLE : SMLs 91, 89 & 127.

SHEET : SH5409 COPLEY; 6736.

RECORDS/REPORTS :—

#1002191.
Kennecott Explorations (Australia) Pty. Ltd., (Lennon, I.G., 1966), Balcanoona Examination, South Australia. Special report on SML 89, August 1965- July 1966. SML 89, South Australia. (ENV 638).

#1002192
Kennecott Explorations (Australia) Pty Ltd. (Brooks, C.C., and Lennon, I.G.) 1967. Progress reports Balcanoona, SML 127, South Australia. (ENV. 695).

#1002262.
Milnes, A.R., and Loos, M., 1966. Report on mapping of The Eastern Limb of the Balcanoona Anticline, SML 127, South Australia. (ENV. 695)

#1002494.
Kennecott Explorations (Australia) Pty. Ltd. (Brooks, C.C., and Clema, J.M.) 1966. Balcanoona Examination, South Australia, Progress report for 1965 and Special report on SML 91, September, 1965 - August 1966, SML 91, South Australia. (ENV 564).

GEOLOGY :

Adelaidean : Nuccaleena Formation, Bunyeroo Formation, Wonoka Formation, Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones, Wirrealpa Limestone.

Structure : Balcanoona Syncline, Balcanoona Anticline, Arrowie Syncline.

MINERALISATION :

Moorowie & Balcanoona Copper Mines; Moro Central Prospect. Malachite, Azurite, Chalcocite, Gossans, Psilomelane, Goethite, Jarosite, Smithsonite, Cobalt? wad; associated with strike faults? and brecciation of limestone along easterly dipping limb of north plunging anticline; some jaspers.

EXPLORATION :

Mapping : Geological.

Geochemistry : Pits (excavations); Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Silver, Cobalt, Mercury, Multielement scans.

Geophysics : Electrical surveys; Frequency domain IP; SP surveys.

Drilling : Diamond drilling (6 holes).

COMMENTS :

Stream sediment survey identified several anomalous areas, particularly concentrated on the northerly plunging nose of the Balcanoona Anticline (Mt. Roberts). Values above 100 & 200 ppm for Pb & Zn with maxima of 1180 & 2250 ppm were considered anomalous and were backed up by soil & rock chip sampling.

Elevated lead and zinc in the Wilkawillina Limestone was found to be concentrated with iron/manganese 'gossans' with up to 0.4% Zn & up to 0.1% Pb being recorded in the Moro area.

Diamond drilling that appears to have been based on weak geophysical signatures however was regarded as disappointing. Four of the holes were sited to test the Wilkawillina Limestone/ Parachilna Formation contact.

The subsurface to gossanous material was drilled and found to be physically weak and crumbly. The recoveries were poor and there is thus some possibility that the core losses may have been due to leached and weathered ground after mineralisation.

The cross sections (figs 25 & 26 RI 37) show that the gossan targets were small in relation to the geometry of the drill holes. It follows therefore that if the target features do not follow exactly down dip drill intersection was uncertain.

The inferred superficial character (previous investigators) of the gossans is thus not absolutely proven by the drilling although the presence of major mineralisation at shallow depth in close proximity to the drill holes appears unlikely.

Given the level of zinc present and the uncertainty over the geological significance of the drilling further technical investigation of the gossanous zone is warranted.

Chip sampling on the western side of the Balcanoona Anticline led to the discovery of a 10 m interval of Parachilna Formation with up to 1500 ppm Zn that was never fully investigated. This warrants further consideration.

See ENV 2317 & 3641 for later investigations.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 2CC & AG33

SAMREF CAT. Nos. : 1000260, 1000261, 1000262.

ENVELOPE No. : 928

TITLE : SML 1718

LOCATION : SLIDING ROCK, ANGEPENA

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1000260.
Mt. Isa Mines. (Carpentaria Exploration Co. Pty. Ltd.) 1969. Copper at Mucatoona, South Australia, SML171, South Australia.

#1000261.
Mt. Isa Mines. (Carpentaria Exploration Co. Pty. Ltd.) (Severne, S.B.) 1969. Drilling report Angepena, Mucatoona, SML 171, South Australia.

#1000262.
Mt. Isa Mines. (Carpentaria Exploration Co. Pty. Ltd.) (Smith, W.D.) 1969. Progress reports Angepena, South Australia, SML171, South Australia.

GEOLOGY :

Adelaidean : Ulupa Siltstone, ABC Quartzite, Bunyeroo & Wonoka Formations, Pound Subgroup.

Palaeozoic : Hawker Group.

Structure : Cadnia Syncline.

MINERALISATION :

Pyrite; Malachite; Gold.

EXPLORATION :

Geochemistry : Soil sampling; Stream sediment sampling; Rock (chip) sampling; Copper, Lead, Zinc, Nickel, Cobalt, Silver.

Geophysics : Aeromagnetic ?interpretation.

Drilling : Percussion drilling.

COMMENTS :

One anomalous stream sediment sample recorded from Hawker Group, probably not materially significant, (p. 032 in Envelope) Pb 340 ppm, Zn 800 ppm backed up by soils with maxima of 2000 ppm Zn.
See ENV. 1227, 1638 & 2317.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 3CC & AG32

SAMREF CAT. Nos. : 1001018.

ENVELOPE No. : 961

TITLE : SML 178

LOCATION : SLIDING ROCK

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1001018.
Electrolytic Zinc Co. of A/Asia Ltd. (Pratten, R.D.) 1969. Progress reports Sliding Rock, SML178, South Australia.

GEOLOGY :

Palaeozoic : Early Cambrian, Parara Limestone, Oraparinna Shale.

Structure : Cadnia Syncline.

MINERALISATION :

Sliding Rock Mine.

EXPLORATION :

Mapping : Geological, at Black Range Spring.

Geochemistry : Rock chip sampling; Stream sediment sampling; Soil sampling; Copper, Lead, Zinc.

COMMENTS :

Geochemical anomaly at Black Range Springs detected.
Note review 7CC ENV. No. 1130, SML 283.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 4CP & AG32 SAMREF CAT. Nos. : 1004792

ENVELOPE No. : 937 TITLE : SML 184

LOCATION : ANGEPENA, Mt. McKINLAY Ck. SHEET : SH5409 COPLEY; 6636; 6736.

RECORDS/REPORTS :—

#1004792.
Electrolytic Zinc Co. of A/Asia Ltd. (Muller, D.W., and Pratten, R.D.) 1969. Progress and final reports SML 184 and SML 184A Angepena area, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones, Nepabunna Siltstone.

Structure : Nepabunna Syncline.

MINERALISATION :

Castle Rock Prospect.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment sampling; Rock (chip) sampling; Copper, Lead, Zinc.

COMMENTS :

Castle Rock Prospect in the western end of the Syncline was discovered by the stream sediment survey but does not appear to be of significance. Other anomalies were discounted as being due to iron oxide (after pyrite) scavenging. However the iron oxides may be relict MVT gossans and should be re-inspected in the field.

An anomalous zone 15 km long with lead values commonly exceeding 300 ppm and maximum Pb 1700 & Zn 380 ppm associated with Wilkawillina Limestone SW from Italowie Gorge should be examined from the stratigraphic aspect in the field.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 5CE & AG28

SAMREF CAT. Nos. : 1002215, 1002216, 0004901.

ENVELOPE No. : (534) 740

TITLE : SML 77 & 144

LOCATION : EDIACARA

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

Broadhurst, E. 1947. Ediacara silver-lead field. *Min. Rev., Adelaide* 84: PP 87-107.

Nixon, L. G. B., 1963. The Ediacara mineral field. *Proc. Australas. Inst. Min. Metall., 206: PP 93-102*

Nixon, L. G. B., 1964. Ediacara silver-lead-copper mineral field. *Min. Rev., Adelaide* 116: PP 5-9.

Nixon, L. G. B., 1967. Ediacara mineral field. Summary report. *Min. Rev., Adelaide* 120: PP 17-24.

#1002215
C.R.A. Exploration Pty. Ltd. (McQueen, A.F.) 1967. Notes on results of drilling of the Ediacara Structure, SML 144, South Australia. (ENV.(534)/ 740)

#1002216.
C.R.A. Exploration Pty. Ltd. (Carruthers, D.S., and Mackenzie, D.H.) 1962. The Ediacara Mineral Field, SML 77, South Australia. (ENV. (534)/ 740)

[NOTE: Reports SML 77, ENV. 534, 0004901 transferred to ENV. 740.]

GEOLOGY :

Palaeozoic : Ajax Limestone.

Structure : Ediacara Syncline.

MINERALISATION :

Greenwood, Southern, Morish & Black Eagle Workings; Southeastern & Southwestern gossans.
Galena; Cerussite; Psilomelane: Lead, Zinc & Copper.

EXPLORATION :

Mapping : Geological (plans & sections).

Geochemistry : Drill core analyses: Lead, Silver, Nickel, Cobalt, Copper, Zinc.

Drilling : Diamond drilling (35 SADME & 11 CRAE holes).

Other : Structural interpretation and resource estimation.

COMMENTS :

The lowermost sandy crossbedded unit (15-140 m) of the Ajax Limestone contains a well bedded subunit with breccia sheets that are commonly manganiferous with associated primary lead mineralisation.

The middle laminated algal dolomite unit (35 m) also contains breccias. The near basal breccia is siliceous, iron/manganese stained and the most persistent. As for the lower unit manganese staining throughout the unit is associated with lead mineralisation.

The uppermost massive dolomite unit (up to 35 m) with archaeocyaths contains minor breccias and is only weakly mineralised.

Recognition of these exposed units in drill cores is difficult.

The clastic dolomite described is probably debris arising from platform emergence nearby and indicates probable proximity to the Flinders Unconformity.

The breccia character of the SW gossans may well be palaeokarstic in origin and deserves field inspection from a generic viewpoint.

Drilling indicates that breccias exposed at surface do not persist to depth.

Nixon noted that mineralisation was focussed at two levels, about 15 m apart & straddling the common boundary of the lowermost and middle Ajax units within diverse lithological facies. He also inferred that the mineralisation was possibly syndepositional and influenced by depositional structures with post lithification mobilisation & recrystallisation.

A resource consisting of a lower body of about 17 M tonnes @ 1.23 % Pb & an upper body of about 17 M tonnes @ 0.84% Pb without appreciable zinc is present. (McQueen 1967)

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 6CC

ENVELOPE No. : 1129

LOCATION : Mt. BAYLEY

SAMREF CAT. Nos. : 1003025

TITLE : SML 312

SHEET : SH5409 COPLEY; 6536; 6636.

RECORDS/REPORTS :—

#1003025.
Electrolytic Zinc Co of A/Asia Ltd. (Muller, D.W.) 1969. Final report on SML 312 Mt. Bayley, 8th October 1969. SML 312, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material).

Palaeozoic : Ajax Limestone.

Structure : Cadnia Syncline.

MINERALISATION :

Not recorded.

EXPLORATION :

Geochemistry : Stream Sediment Sampling; Copper, Lead, Zinc.

COMMENTS :

No anomalous base metal values were obtained from streams draining Ajax Limestone. Diapiric material showed no signs of mineralisation.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 7CC & AG32
SAMREF CAT. Nos. : 1004701.

ENVELOPE No. : 1130
TITLE : SML 283

LOCATION : SLIDING ROCK
SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1004701.
Electrolytic Zinc Co of Australasia Ltd. (Muller, D.W.) 1969. Report no.1 for 6 months ended 30th September 1969 - final report SML 283, Sliding Rock. SML 283, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, (Woodendinna Dolomite), Wilkawillina & Parara Limestones, Oraparinna Shale.

Structure : Cadnia Syncline.

MINERALISATION :

Not reported.

EXPLORATION :

Mapping : Geological, showed interdigitative relationships between the Parara Limestone and algal facies Wilkawillina Limestone with a dolomite marker bed. At Black Range Springs the Parara/- Wilkawillina boundary appears to be disconformable with ferruginous residues of indeterminate character.

Geochemistry : Rock Chip sampling: Lead, Zinc.

COMMENTS :

The high background zinc recorded at Black Range Springs and Warraweena attributed to iron oxide adsorption. (see also ENV 1585)

Given the probability that the disconformity at Black Range Springs is possibly the Flinders Unconformity, the ferruginous matter might be related to **MVT** along the interface. The dolomite marker in the Wilkawillina is suggestive of an emergence effect associated with the Flinders Unconformity.

Field inspection is clearly warranted.
Note review 3CC ENV. No. 961, SML 178.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 8CE & AG28

SAMREF CAT. Nos. : 1002869

ENVELOPE No. : 1160

TITLE : SML 309

LOCATION : EDIACARA

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1002869.
Electrolytic Zinc Co of Australasia Ltd. (Muller, D.W.) 1969. Progress and Final reports. SML 309, South Australia.

GEOLOGY :

Palaeozoic : Ajax Limestone.

Structure : Ediacara Syncline.

MINERALISATION :

Not discussed..

EXPLORATION :

Geochemistry : Stream Sediment sampling: Copper, Lead, & Zinc.

COMMENTS :

Nine lead and eight zinc anomalies were detected.

Zinc anomalies were generally associated with iron/manganese oxide and inferred to be due to scavenging & adsorption. One occurrence of up to 2% Zn in haematised pink dolomite was detected.

One lead anomaly was observed to be caused by detrital galena, a cause attributed to four other anomalies. A further two anomalies were attributed to un-natural lead sources.

The focus of the programme was Beltana Type willemite mineralisation. The 2% Zn in pink dolomite is probably of this type, contrary to the opinions expressed in this envelope.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 9CR & AG46 SAMREF CAT. Nos. : 1002856, 1002857, 1002858.

ENVELOPE No. : 1162 (927) TITLE : SML 170

LOCATION : BELTANA-RED Ra. SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1002856.
Carpentaria Exploration Co. Pty Ltd. (Smith, W.D.) 1969. Progress reports Beltana SML 170 SA. SML 170, South Australia.

#1002857.
Carpentaria Exploration Co. Pty Ltd. (Smith, W.D.) 1969. Remarks concerning the Beltana complex and reply to comments by Leeson. SML 170, South Australia.

#1002858.
Carpentaria Exploration Co. Pty Ltd. (Fairburn, W.A.) 1970. Rotary percussion drilling - Beltana, SML 170, South Australia.

[Note: contents of ENV. 927 have been transferred to ENV. 1162.]

GEOLOGY :

Adelaidean : Callanna Group (diapiric material).

Palaeozoic : Ajax/Wilkawillina Limestone.

Structure : Red Range Syncline, eastern limb truncated by fault to west.

MINERALISATION :

Red Range mine; Iron Blow mine; Puttapa zinc deposit; Harveys Return mine; Black Feather mine; Enterprise mine.

EXPLORATION :

Mapping : Structural geology.

Geochemistry : Stream Sediment & Soil sampling; Copper, Lead, Zinc, Silver.

Drilling : Rotary.

COMMENTS :

The field work was split between the Beltana Diapir and Cambrian base metal search. Indications of copper and lead-zinc were followed up by drilling.

Puttapa Ck.

Iron oxides in the basal Ajax Limestone anomalous with respect to copper were drilled but holes were frequently abandoned prematurely due to "clays". Up to 1% Zn & 0.5% Pb was recorded.

Red Range

Within a 3km semi-continuous strike zone of anomalous soils associated with limonitic basal Ajax Limestone, two holes targeted on iron/manganese oxides detected Zn of 450 to 5200 ppm and Pb of 240 to 12000 ppm just above the underlying Parachilna Formation.
See p. 047 ENV. 1162.

The observations suggest that **MVT** mineralising processes were active in this area. The clays at Puttapa Ck. might well be the residue of oxidising **MVT** and this site therefore warrants close examination.

Since drilling appears not to have penetrated beyond the zone of weathering at both localities testing remains inadequate.

No attempt appears to have been made to consider the potential of a geological repetition beneath shallow Tertiary/Quaternary cover to the west of Red Range.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 10CN & AG42(a)

SAMREF CAT. Nos. : 1002774

ENVELOPE No. : 1194

TITLE : SML 321

LOCATION : JUBILEE Ra.

SHEET : SH5409 COPLEY; 6636; 6736.

RECORDS/REPORTS :—

#1002774.
Noranda Australia Ltd. (Dunlop, A.C., Dunlop, C.P. & Thomas, A.) 12970. Progress and final reports, SML 321 Jubilee Range. SML 321, South Australia.

GEOLOGY :

Adelaidean : Bunyeroo Formation (Wearing Dolomite Member), Wonoka Formation.

Palaeozoic : Not specified.

Structure : Narina Syncline.

MINERALISATION :

Pinda Springs Mine; Jubilee Mine; Wirrapowie Mine.
Galena; Willemite; Chalcocite; Chalcopyrite; Malachite; Azurite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment sampling; Copper, Lead, Zinc.

COMMENTS :

An east dipping dolomite is transgressed by a N-S oriented fault at Pinda Springs (ML 5076). In the northerly sector of the fault a gossan has been excavated by a pit within a khaki shale band. The gossan is after galena and has an associated narrow willemite vein.

This occurrence appears to be in the Bunyeroo Formation which together with the overlying Wonoka Formation constitutes the latest Adelaidean carbonate sequence which developed in a progressively shallowing marine environment. This sequence is separated by one unit, the Pound Subgroup, from the overlying Lower Cambrian sequence.

This small occurrence is probably associated genetically with the nearby basal Cambrian postulated **MVT** mineralisation. It also illustrates the thesis that epigenetic willemite is probably mineralisation remobilised during Delamerian orogenesis.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 11CXA & AG22(a)

SAMREF CAT. Nos. : 1003967.

ENVELOPE No. : 1226

TITLE : SML 294

LOCATION : WOOLTANA

SHEET : SH5409 COPLEY; 6737.

RECORDS/REPORTS :—

#1003967.
North Flinders Mines NL (Donovan, P.R., Jones, W.R.R., Wilson, R.B., Pontifex, I.R., Webb, J.E., Garman, M.R.W., & Carthew, S.) 1971. Progress & final reports, SML 294, South Australia.

[NOTE: Reports SML 294, 1003966, 1003968-72 of low **MVT** interest.]

GEOLOGY :

Adelaidean : Wooltana Volcanics, Blue Mine Conglomerate, Skillogalee Dolomite.

Structure : Arkaroola Syncline.

MINERALISATION :

O'Donoghue's Castle Mine, McLeashes Copper Prospect.
Malachite; Azurite; Chalcopyrite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream Sediment and Rock Chip sampling. Copper, Lead, Zinc.

Geophysics : IP surveys.

Drilling : Copper Prospects only.

COMMENTS :

Dolomite observed near the O'Donoghue's Castle Mine, in this reference attributed to the Skillogalee Dolomite, bears a striking resemblance to the Cambrian Ajax Limestone elsewhere.

The occurrence of stream sediment anomalies over 10km of strike backed up with rock chip sampling that returned up to 2100 ppm Pb & 4500 ppm Zn suggests Adelaidean carbonates could be a viable **MVT** exploration target. ENV. 1226 PP 042.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 12CW

SAMREF CAT. Nos. : 1003973

ENVELOPE No. : 1227

TITLE : SML 293, (290, 292)

LOCATION : MORO SPRINGS

SHEET : SH5409 COPLEY; 6636; 6736.

RECORDS/REPORTS :—

#1003973.
North Flinders Mines NL (Wilson, R.B., Donovan, P.R., and Garman, M.R.W.) 1971. Progress and final reports SML 293, Moro Springs area Nov 1969-Jan 1971. SML 293, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Arrowie Syncline.

MINERALISATION :

Not reported.

EXPLORATION :

Geochemistry : Stream sediment sampling; Rock (chip) sampling; Copper, Lead, Zinc.

COMMENTS :

A stream sediment anomaly along the western side of the Stirrup Iron Range 2km SW of Moro Springs & south of the road, that returned values of up to 5700 ppm Pb & 1800 ppm Zn rock chips appears to be derived from the Middle-Lower Wilkawillina Limestone.

At Moro Springs, zinc appears to be associated with iron/manganese oxides. About 0.8 km south of Moro Springs rock chipping returned up to 0.5% Pb.

Both the above situations could be **MVT** but field mapping is required to assess the potential.

Cu-Pb-Zn mineralisation at Bullock Head Gap appears to be fault related and is probably not **MVT**.

Stream sediment coverage appears to be duplicated in ENV. 1638, plans 1638/1-5 to 1638/1-7 inclusive.

REVIEW No. : 13CF/9PF & AG 45 SAMREF CAT. Nos. : 1000616, 1000617, 1002259, 1003025, 1003089, 1003090.

ENVELOPE No. : 997, 1104, 1390 TITLE : SML 217, 217A, 217B.

LOCATION : MOOROWIE, Mts. JOHN & CHAMBERS. SHEET : SH5413 PARACHILNA; 6735. SH5409 COPLEY; 6736.

RECORDS/REPORTS :—

#1000616.
Electrolytic Zinc Co. of A/Asia Ltd. & Newmont Pty Ltd., (Muller, D.W., Garman, M., and Wilson, R.B.) 1969. Final report on SML 217, Flinders Ranges, SML 217 South Australia, ENV. 997.

#1000617.
Electrolytic Zinc Co. of A/Asia Ltd., 1969, Final Report, Mt. Chambers Project, SML 217B, SML 217, South Australia. ENV. 997.

#1002259.
Electrolytic Zinc Co. of A/Asia Ltd., 1971, Progress reports, Arrowie-Wirrealpa area & Mt. Chambers, SML 217B, 217, South Australia. ENV. 1390.

#1003025.
Electrolytic Zinc Co. of A/Asia Ltd., (Wilson, R.B., and Tulp, T.) 1969, Report on SML 217A Flinders Ranges SA for the period 15th January 1969 to 15th July 1969, SML 217A, South Australia, ENV. 1104.

#1003089.
Electrolytic Zinc Co. of A/Asia Ltd., (Muller, D.W.) 1970. Progress reports SML 217A, 217 Flinders Ranges, SA. SML 217, 217A, 217B, South Australia. ENV. 1104.

[Reference 1003090, SML 217A, 1969 concerns uranium exploration only.]

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Wilpena Group.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Mt. Frome Syncline.

MINERALISATION :

Mt. John Prospect, Moorowie Copper Mine; Mount Chambers Prospect. Galena; Aurichalcite; Rosasite; Malachite.

EXPLORATION :

Mapping : Geological, Stratigraphic.

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Multielement scans.

Geophysics : Radiometric surveys.

Drilling : One diamond hole at Mt. Chambers Prospect but mislocated. Auger drilling.

COMMENTS :

Programme focussed on uranium exploration and diapir related mineralisation in addition to carbonate LZ. LZ work arose from the follow-up of radionuclide accumulations in secondary iron oxides which also had a Pb-Zn signature. (LZ exploration is addressed from page 055 in ENV 1104).

New outcrops of Wilkawillina Limestone (strongly deformed) were detected. (pp 057 ENV 1104).

The stream sediment programme is described from PP 070 ENV 1104 onwards. Seven areas of lead zinc enrichment associated with iron/manganese oxides and brecciated limestone were initially regarded as inconsequential.

However near Moorowie/Mt. Chambers Gorge stream sediments peaked at 2,300 ppm Zn and were backed up by rock chip sampling of limestone megabreccia which returned up to 7.2% Zn and 430 ppm Pb. Secondary Cu up to 0.5%. But the nature of the breccia mineralisation is unclear as this locality is both close to the Moorowie Mine and diapiric breccias.

At Mt. Chambers descriptions of the lithologies are suggestive of a frontal biohermal reef (pp 077 ENV 1104).

Similarly nearby to the Mt. Chambers Prospect stream sediments sampling outlined a strongly anomalous area of 3 km^2 with peak values of 6,000 ppm Pb & 500 ppm Zn that was backed up by rock chip sampling that returned up to 6,500 ppm Pb & 1,300 ppm Zn from massive Wilkawillina Limestone.

The association of **MVT** deposits and breccias of both sedimentary and structural origin is well documented. The anomalous breccias in the Mt. Chambers Gorge area therefore warrant careful examination to establish their genesis before their **MVT** potential/significance can be determined.

Rock Chip sampling at Mt. Chambers led to the diamond drilling but the first hole was mislocated by 300m. The accuracy of location of samples and anomalies was criticised by Union Miniere several years later when they explored the area.

See later ENV. Nos. 1657, 2373, 3722, & 8071.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 14CSP & AG37   SAMREF CAT. Nos. : 1002650, 1002651, 1002652, 1002653, 1002654.

ENVELOPE No. : 1481   TITLE : SML 422

LOCATION : Mt. SERLE-CASTLE ROCK   SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1002650.
Fox Mining and Exploration Pty. Ltd. & Australian Aquitaine Petroleum Pty. Ltd. (Ognar, S., Elliott, P., and Hutch, D.) 1972. Progress and final reports SML 422 North Flinders Ranges. SML 422, South Australia.

#1002651.
Fox Mining and Exploration Pty. Ltd. & Australian Aquitaine Petroleum Pty. Ltd. (Mutch, D., Ognar, S., and Elliott, P.) 1972. Routine stream sediment sampling & local followup geological investigations. Annexure 2 to final report SML 422, South Australia.

#1002652.
Australian Aquitaine Petroleum Pty. Ltd. (Elliott, P., and Ognar, S.) 1972. Examination of Narina Greywacke near Angepena Homestead annex 3 in final report SML 422, South Australia.

#1002653.
Fox Mining and Exploration Pty. Ltd. & Australian Aquitaine Petroleum Pty. Ltd. (Mutch, D., Ognar, S., and Elliott, P.) 1972. Rock Chip sampling of ferruginous zones, Balcanoona Formation and followup diamond drilling, BF P1 and BF P2. Annexure 1 to final report SML 422, South Australia.

#1002654.
Fox Mining and Exploration Pty. Ltd. (McPhar Geophysics Pty. Ltd., and Donovan, P.R.) 1971. Stream sediment reconnaissance survey Angepena area, SML 422, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Balcanoona Formation.

Palaeozoic : Parachilna Formation, Narina Greywacke.

Structure : Mt. Serle & Nepabunna Synclines.

MINERALISATION :

Eveline, Nevada, White Virgin Mines.

EXPLORATION :

Geochemistry : Stream sediment sampling; Copper, Lead, Zinc, Cobalt, Nickel, Mercury.

Drilling : Diamond drilling of Balcanoona Formation only.

Petrology : Mineral descriptions.

COMMENTS :

Two stream sediment anomalies recognised in the basal Cambrian with the Narina Greywacke being more anomalous. At Eveline Mine Pb & Zn are above 200 ppm.where the primary source reports up to 1.5% Cu, 3.3% Pb & 3.2% Zn.

The Narina Greywacke is probably anomalous due to goethitic grains and "devils dice" after primary pyrite.

Stream Sediment samples in the Mt. Serle Syncline and west of Angepena in the Nepabunna Syncline exceeding 50 ppm Pb, and/or 100 ppm Zn may be anomalous and warrant review.

The Balcanoona Formation has sedimentological similarities to the Lower Cambrian and follow-up to a 800 ppm Pb rock chip sample returned only low values from soils and rock chips.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 15CSC & AG34 SAMREF CAT. Nos. : 1001974,1001975

ENVELOPE No. : 1585 TITLE : SML 536

LOCATION : Mt. SERLE, SLIDING ROCK, & WARRAWEENA SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1001974.
Endeavour Oil Co. NL (Nixon, L.G.- Nixon & Associates) 1972. Progress reports for SML 536 Warraweena area, Flinders Ranges, South Australia.

#1001975.
Endeavour Oil Co. NL (Donaldson, R.C.) 1972. Report on reconnaissance drilling September 1972 SML 536, Warraweena, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Mt. Serle & Nepabunna Synclines.

MINERALISATION :

Sliding Rock Mine; Green Rock Mine.
Native copper; Malachite; Cuprite; Chalcocite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment sampling; Rock (chip) sampling; Soil sampling; Copper, Lead, Zinc, Silver, Cobalt.

Geophysics : VLF EM surveys.

Drilling : Percussion drilling.

COMMENTS :

Several ironstone 'cappings' were found to be anomalous with respect to Pb & Zn.

The ironstone about 1.5 km NW of the Sliding Rock Mine has up to 2,000 ppm Zn with 270 ppm Co. When drilled (PDSL 1) only clay was encountered below about 25 m with poor to nil sample return and the upper portion of the hole was not assayed. This zone has no other surface expression and does not appear to be weathered Parachilna Formation as none was mapped in the vicinity. There is thus a distinct possibility that it is a weathered palaeokarstic feature, and possibly weathered **MVT** mineralisation.

Two other ironstones one 1.5 km SE of Warraweena and the other 1.5 km ESE of the Sliding Rock mine contain in excess of 1000 ppm Zn, with variable lead and copper.

At Warraweena West Bore an ironstone was drilled (PSDL 6) but the hole was abandoned without penetrating through the target and no analytical work was carried out.

Up sequence of the Sliding Rock mine and extending to the SW (0.8 km) is a discernable zinc anomaly with a weaker lead signature (max. 1500 ppm Pb & 450 ppm Zn). The sedimentological and stratigraphic significance of this feature are not described.
2
The Black Range Springs anomaly is also investigated (see ENV. 1130) and presented in map 1585-4. The drainage anomaly persists for over 2 km along strike at a threshold of 100 ppm Zn against a background of 50 ppm Zn & 40 ppm Pb.

The Green Rock Mine appears to be gossanous quartz lodes in the Brachina Formation and of little **MVT** relevance.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 16CWB/18PDB & AG36,47
ENVELOPE No. : 1638

LOCATION : THIRD PLAIN, MORO, LINDA, NARINA, MT. ROEBUCK.

SAMREF CAT. Nos. : 1004206, 1004208 1004209.
TITLE : SML 557 (292 & 293)

SHEET : SH5409 COPLEY; 6736,6636. SH5413 PARACHILNA; 6536.

RECORDS/REPORTS :—

#1004206.
North Flinders Mines Ltd. (Wilson, R.B., Read, R.E., Cartew, S.J., Fidler, R.W., and Donovan, P.R.) 1972., Progress reports SML 557 Blinman - Wirrealpa area, (Includes Regional Geochemistry Survey Reports by McPhar),. SML 557, South Australia.

#1004208.
North Flinders Mines Ltd. (Read, R.E.) 1971. Report on rotary percussion drilling Patawarta Zinc Prospect, SML 557, South Australia.

#1004209.
North Flinders Mines Ltd. (Read, R., and Carthew, S.J.) 1971. Geological report on the Patawarta Diapir by Read. Follow up of stream sediment geochemical anomalies by Carthew, SML 557, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Umberatana Group, Wilpena Group.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Arrowie, Balcoracana, Narina Synclines.

MINERALISATION :

Patawarta Zinc Prospect, Wepowie, Mt. Mary, Lady Lehman, Lady Lennon, Mt. Rugged, Warioota, Oratunga, Ivy Queen, Ladder, Mosley's Copper, Wheal Butler Mines (Adelaidean), Third Plain willemite prospect (Cambrian), Henry's Range, Orange Tree prospects.
Polysphaerite (Wepowie); Galena; Sphalerite; Gold; Chalcopyrite; Chalcocite; Malachite; Azurite; Phosphate; Haematite; Siderite; Gossans.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream Sediment & Rock Chip sampling; Zinc, Lead, Copper & Multielement scans.

Drilling : Percussion drilling at Patawarta.

COMMENTS :

Patawarta (west limb of Narina Syncl.) & Wepowie/Mt. Mary Mines (Oraparinna Antcl.).

The focus of the work identified by SAMREF is the Patawarta Zinc Prospect in Adelaidean Bunyeroo Formation . Together with the overlying Wonoka Formation the Bunyeroo Formation constitutes the latest Adelaidean carbonate sequence which is separated by one unit, the Pound Subgroup, from the overlying Lower Cambrian units.

The prospect is marked by a 1.5 km long stratabound gossan of unclear genesis. The gossan contains low-iron sphalerite. Given its stratigraphic proximity to the Lower Cambrian, a field inspection to assess possible **MVT** affinities is warranted.

The mines of the Oraparinna Anticline are hosted by Adelaidean sediments and diapiric breccias and are not **MVT** relevant.

Moro George & Spring:

Ferruginous material 5 to 6 m thick on a dipslope surface has up to 5000 ppm Pb with anomalous zinc over a strike of 400 m was detected. The zone is close to the Wilkawillina Parara/Limestone interface. The origin of the ferruginous deposit was not self- evident a the time of mapping but there is a strong possibility that the horizon/surface could be the palaeokarsted Flinders Unconformity with a **MVT** signature.

Narina Syncline:

Stream sediment sampling along the eastern limb to the west of Mt. Brooke revealed that a 4 km long anomalous zone with up to 1700 ppm Zn, is present in the Wilkawillina Limestone (pp. 122, 196). Anomalous zinc values occur along Wirrapowie Creek, and were tentatively attributed to a "duricrust". Further investigation is needed.

At a location 3 km east of "Point Well" on the western limb of the syncline, manganiferous phosphatic rock near the Wilkawillina/Parara Limestone interface associated with possible karstic features has up to 1700 ppm Zn and 17% P_2O_5 (pp. 032, 079, & see ENV. 4449).

Anomalous zinc was found to be associated with manganiferous outcrops in Wilkawillina Limestone 6 to 7 km SE of "Narina".

Arrowie Syncline:

Stream sediment Zn anomalies to the north of River Bluff and at Bullock Head Gap were also considered to be sourced in the Wilkawillina Limestone (p. 122). However the Brachina Formation at Bullock Head Gap was also found to carry elevated Cu, PB, & Zn. The Rivers Bluff anomaly was accompanied by elevated levels of copper but no lead.

Third Plain: (Parachilna Sheet)

Zinc anomalies located 1 km north of the Wilkawillina Gorge were found to correlate with Willemite in the stream load but no source area with the characteristic haematite alteration was recognised.

Re-mapping indicated that thrust faults mapped by previous workers could not be substantiated.

Wilkawillina George (adjacent to Linda Prospect, Parachilna Sheet):

Four NE trending anomalous zones were inferred from stream sediment sampling within an area of about 8 km^2 over Wilkawillina Limestone in the Bunkers Graben. Anomalous results are supported by up to 500 ppm Zn in soils. Faulting was suspected to be responsible for the pattern (p. 086).

It seems that arbitrary statistical methods resulting from the restrictive data set appear to have failed to take into account the regional average background for Pb & Zn of 80 ppm, and consequently have not declared anomalous results at the 200 ppm level. Using a lower threshold shows a strong stratigraphic bias for the results.

The ridge and spur sampling was restricted in its scope to the anomalous creeks and thus was also incapable of recognising the stratigraphic correlation. The Linda prospect therefore remained undetected.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 17CN

SAMREF CAT. Nos. : 0001003.

ENVELOPE No. : 1653

TITLE : SML 519

LOCATION : Mt. HACK

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#0001003.
Westgate Drilling Co. Pty. Ltd. (McPhar Geophysics Pty. Ltd., Donovan, P.R., Dandy, B.C., and Fidler, R.W.) 1971. Mount Hack. Progress reports from June to September 1971, SML 519, South Australia.

GEOLOGY :

Adelaidean : Bunyeroo Formation.

Palaeozoic : Lower Cambrian.

Structure : Narina Syncline.

MINERALISATION :

Pinda Creek Deposit (?Adelaidean).
Malachite; Chalcopyrite; Sphalerite; Galena.

EXPLORATION :

Geochemistry : Stream Sediment and Rock Chip sampling; Copper, Lead, Zinc, Bismuth.

COMMENTS :

Focus of the programme was copper in Adelaidean lithologies but coverage did include tracts of Lower Cambrian rocks.

Anomalous lead and zinc was encountered in the Bunyeroo Formation north of Waukawoodna Ck.

A weak third order stream sediment anomaly was located on Lower Cambrian lithologies south of Warraweena Gap. However, there is a possibility of the source being iron/manganese oxides within faults at Warraweena Gap.

Of technical significance is the recognition of unoxidised galena floaters up to 2cm in diameter being shed from veining in the Bunyeroo Formation.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 18CAXD

SAMREF CAT. Nos. : 1000330

ENVELOPE No. : 1693

TITLE : SML 585

LOCATION : BELTANA
(Mt. DECEPTION Ra.)

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1000330.
Exoil NL & Transoil NL (Youles, I.P.) 1971. SML 585 Beltana progress and final reports, SML 585, South Australia.

GEOLOGY :

Adelaidean : Bunyeroo Formation.

Palaeozoic : Ajax Limestone.

Structure : Mt. Deception Anticline-Aroona Syncline.

MINERALISATION :

Not described.

EXPLORATION :

Geochemistry : Stream sediment & Rock Chip sampling: Copper, Lead, Zinc.

Drilling : Percussion drilling of Bunyeroo Formation.

COMMENTS :

The focus of the programme was the Bunyeroo Formation, in which stratabound galena and sphalerite were observed. While a syngenetic origin was proposed, given the stratigraphic position, an association with **MVT** deposition is possible. See ENV. 1638 & 1653.

A secondary ?supergene origin is also a possability.

Stream sediment coverage over the adjacent Cambrian sequence was not undertaken. See ENV. 1246.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 19CR & AG46 SAMREF CAT. Nos. : 0000767.

ENVELOPE No. : 1701 TITLE : SML 525 (170)

LOCATION : RED RANGE (BELTANA) SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#0000767.
Carpentaria Exploration Co Pty Ltd. (Okill, R.) 1971. Beltana. Progress reports from 17.6.71 to 17.12.71, SML 525, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Pound Subgroup.

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Red Range Syncline.

MINERALISATION :

(Adelaidean) Copper Queen; Iron Blow; Black Feather; Harvey's Return; Enterprise; Beltana.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment, soil, & rock chip sampling.

Drilling : One percussion drill hole.

COMMENTS :

Deeply weathered Ajax Limestone was observed in both the northern and southern parts of the area to be associated with abundant iron/manganese oxide and anomalous lead and zinc with a high degree of variability. The data were inferred to be solely a result of a weathering concentration mechanism.

Mean values of Pb:Zn 45:100, 72:180, 120:620 in Stream Sed., Soil, & Rock Chip sampling were observed. Max. for Stream sed 750:370 & Rock Chip 1500:80,000 were recorded.

The weathering features could easily be the strongly weathered expression of in-situ **MVT** mineralisation and warrant re-evaluation.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 20CC

SAMREF CAT. Nos. : 1015397.

ENVELOPE No. : 1785

TITLE : SML 609

LOCATION : Mt. BAYLEY

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1015397.
Australian Aquitaine Petroleum Pty. Ltd. (Blangy, B., and Cambrell, R.) 1972. SML 609, Mt Bayley mine, Progress & final reports from 22-10-71 to June 1972. SML 609, South Australia.

GEOLOGY :

Adelaidean : Wonoka Formation, Bunyeroo Formation.

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Cadnia Syncline.

MINERALISATION :

Mount Bayley Mine.
Chalcopyrite; Pyrite; Malachite; Barite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment, Soil, & Rock Chip sampling; Copper, Lead, Zinc.

Petrology : Mineral descriptions.

COMMENTS :

Only minor zinc geochemical anomalies were detected in sandy zones within limestones around the westerly closure of the Cadnia Syncline. (See ENV. 961).

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 21CE & AG 28

SAMREF CAT. Nos. : 1015400.

ENVELOPE No. : 1835

TITLE : SML 637

LOCATION : EDIACARA

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1015400.
Carpentaria Exploration Co. Pty. Ltd. (R. Okill) 1972. Ediacara Progress Reports, SML 637, South Australia.

GEOLOGY :

Palaeozoic : Ajax Limestone.

Structure : Ediacara Syncline.

MINERALISATIÓN :

Lead and zinc; Barite; Malachite; Chalcocite.

EXPLORATION :

Geochemistry : Stream sediment & rock chip sampling; Copper, Lead, Zinc; Heavy mineral separation.

Drilling : Percussion drilling.

COMMENTS :

Programme was seeking repetitions/extensions of Ediacara host environment along the Ediacara Fault beyond previously known mineralisation. Anomalous geochemical results indicated a correlation between LZ and barium.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 22CS & AG37

ENVELOPE No. : 2081

LOCATION : Mt. SERLE

SAMREF CAT. Nos. : 1001604

TITLE : SML 708

SHEET : SH5409 COPLEY; 6636

RECORDS/REPORTS :—

#1001604.
Fox Mining & Exploration Pty. Ltd. & Australian Aquitaine Petroleum Pty. Ltd. (Artru, P., Ognar, S., & Blangy, B.) 1973. Progress & final reports SML 708, Period May 1972-May 1973, Mt.Serle-Angepena, (formerly SML 422), South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Tapley Hill (Tindelpina Shale Member), Balcanoona, Brachina, Bunyeroo Formations.

Palaeozoic : Uratanna & Parachilna Formations, Wilkawillina Limestone.

Structure : Mt. Serle Syncline.

MINERALISATION :

Eveline Copper Mine; Ead Mine; Mount Serle ?Mine; Angepena ?Mine; Constitution Hill Silver-Lead Mine; Nevada Mine.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment, soil & rock chip sampling; Copper, Lead, Zinc.

COMMENTS :

Lower Cambrian sequence generally regarded as anomalous but values were generally low for both lead & zinc. Five anomalous areas were identified but only three (1, 2 & 4) are high in zinc with weaker lead signatures. Areas 1 & 2 appear to be associated with iron oxide (concretionary & joint planes respectively). Area 4 appears to be willemite associated with fault structures.

Only area 1 appears to be of possible **MVT** significance; however, no major dolomitisation was observed.

Mineralisation at both the Nevada and Constitution Hill mines occurs as epigenetic galena-calcite veins in Wonoka & Balcanoona Formation dolomite. It is probably of little **MVT** significance.

REVIEW No. : 23CE & AG28

SAMREF CAT. Nos. : 1001335, 1001336.

ENVELOPE No. : 2254

TITLE : EL 46.

LOCATION : EDIACARA

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :——

#1001336.
Carpentaria Exploration Co. Pty. Ltd. (Mt. Isa Mines) 1973. Metallurgical investigation of "Cu-Pb-Ba Ore", EL 46, South Australia.

#1001335.
Carpentaria Exploration Co. Pty. Ltd. (Mt. Isa Mines) 1975. Progress and final reports Exploration Licence No. 46 "Ediacara" S.A., EL 46, South Australia.

GEOLOGY :

Adelaidean : Wonoka Formation, Pound Subgroup.

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Ediacara Syncline.

MINERALISATION :

Black Eagle Mine; Moorish Workings; Greenwood Workings.
Malachite; Barite; Galena; Anglesite; Cerussite.

EXPLORATION :

Mapping : Geological Interpretation.

Geochemistry : Drill core analyses; Copper, Lead, Zinc, Silver.

Drilling : Percussion & Diamond drilling.

Metallurgy : Laboratory Flotation & Panning testwork & assays; Lead, Copper, Manganese, Barium, Iron, Sulphur.

COMMENTS :

Mineralisation is associated with limestone breccias for which a post leaching collapse origin is proposed but a primary **MVT** breccia origin overprinted by weathering cannot be discounted. Such a primary breccia could be sedimentological or cogenerative with **MVT** processes.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 24CS & AG37 SAMREF CAT. Nos. : 1000447.

ENVELOPE No. : 2314 TITLE : EL 96

LOCATION : Mt. SERLE SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1000447.
Aquitaine Australia Minerals Pty. Ltd. & Fox Mining & Exploration Pty. Ltd., (Ognar, S. & Blangy, B.) 1976. Progress and final reports Mount Serle, S.A.. (formerly SML 708), EL 96, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina Limestone;

Structure : Mt. Serle Syncline.

MINERALISATION :

Eveline Copper Mine.

EXPLORATION :

Mapping : Geological.

Geochemistry : Soil sampling: Copper, Lead & Zinc.

COMMENTS :

Intraformational breccia recognised within the Wilkawillina Limestone and found to be anomalous with respect to copper and lead.

The Eveline Mine, close to the Cambrian/Adelaidean boundary, has a lead association with weaker zinc.

Silicification and ferruginisation in the limestones is observed to be associated with leaching to depth.

This latter aspect would be expected from the weathering of in-situ lead-zinc mineralisation such as **MVT**. The intraformational breccia could be of sedimentological relevance to assessing **MVT** potential and should be better described.

REVIEW No. : 25CW & AG47

SAMREF CAT. Nos. : 1001945.

ENVELOPE No. : 2317

TITLE : EL 78

LOCATION : MORO GORGE

SHEET : SH5409 COPLEY; 6736.

RECORDS/REPORTS :—

#1001945.
Carpentaria Exploration Co. Pty. Ltd. (Mt Isa Mines), 1975. Progress and final reports, EL 78, Moro Gorge, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone (?Woodendinna Dolomite).

Structure : Balcanoona Anticline, Arrowie Syncline.

MINERALISATION :

Azurite; Chalcopyrite.

EXPLORATION :

Mapping : Geological, structural.

Geochemistry : Rock Chip & Soil sampling; Drill core analyses; Copper, Lead, Zinc, Silver, Mercury.

Geophysics : Electrical IP surveys; Dipole Dipole array, Pole Dipole array, & Gradient array.

Drilling : Diamond & Percussion drilling.

COMMENTS :

Percussion drill holes (5) only analysed for copper. Diamond hole (twin to PDH M2) was generally anomalous with respect to Zn below 14 m, commonly > 1000 and up to 2000 ppm Zn being recorded from variably weathered Wilkawillina Limestone.

Below 3m of surface rubble down to 12m brown clay with minor iron/manganese oxides reported up to 5000 ppm of both Cu & Zn. In the narrow 12 to 14m interval a zone of dolomite and yellow clay with dolomite clasts reported up to 9500 ppm Zn.

The upper 3 to 14m of the DDH could be the weathered expression of **MVT** mineralisation and warrants re-evaluation. The best rock chip anomalies: up to 1300 ppm Pb & 1.25 % Zn, were not drilled.

REVIEW No. : 26CC & AG34

SAMREF CAT. Nos. : 1014843.

ENVELOPE No. : 2341

TITLE : EL 72

LOCATION : SLIDING ROCK-
BLACK RANGE SPRINGS

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1014843.
Endeavour Oil Company N.L. (Woolf, D.L., and Nixon, L.G.B.), 1974. EL 72 Warraweena S.A., Progress Reports & Completion report on Drilling at Black Range Springs Zn Prospect. EL 72, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina Limestone.

Structure : Cadnia Syncline.

MINERALISATION :

Not covered.

EXPLORATION :

Mapping : Stratigraphic, geological.

Geochemistry : Stream sediment & Rock Chip sampling; Diamond drill core analyses; Copper, Lead, Zinc, Manganese.

Geophysics : IP Electrical & VLF EM surveys.

Drilling : Diamond drilling.

COMMENTS :

Focussed on the Black Range Springs prospect.

The local stratigraphy of the Wilkawillina Limestone which faces north at 70° to 88° striking at 245° comprises a major basal bioherm, followed by beds of oolite, crossbedded calcarenite, cherty lenses, wavy bedded ?stromatolitic limestone and capped by intraformational breccia. The blue-grey limestone sequence is truncated cleanly against the diapir on the west.

Where rock chip samples returned from 1000 to 20,000 ppm Zn in association with visible siderite ?alteration disseminated galena crystals were identified.

Elsewhere in the uppermost 100m of section adjacent to the diapir haematised limestone carries up to 2% Zn & 1200 ppm Pb at surface. This anomaly is transgressive into the adjacent diapir which is also silicified and haematised. Drilling (BRD2) returned up to 1.6% Zn & 680 ppm Pb. Willemite mineralisation is inferred. The field evidence is believed to indicate the source of zinc was primarily in the limestones and subsequently remobilised into the diapir.

Black Range Springs is one of the few localities where probable **MVT** sulphide mineralisation can be demonstrated to be the precursor to epigenetic willemite mineralisation that was mobilised during the late stages of Delamerian orogenesis in the Flinders Ranges.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 27CW

SAMREF CAT. Nos. : 1001710.

ENVELOPE No. : 2379

TITLE : EL 107.

LOCATION : Mt. ROEBUCK

SHEET : SH5409 COPLEY; 6636,6637.

RECORDS/REPORTS :—

#1001710.
Australian Anglo American Ltd. (Hoyle, M.W.H., Kernick, R.J. & Lay, R.E.) 1974. Progress and final reports Mt. Roebuck, EL 107, South Australia.

GEOLOGY :

Adelaidean : Tapley Hill (Tindelpina Shale Member), Fortress Hill, Elatina, Nuccaleena, & Brachina Formations, ABC Range Quartzite, Bunyeroo & Wonoka Formations, Pound Subgroup.

Palaeozoic : Lower Cambrian.

Structure : Arrowie Syncline, Arrowie Fault.

MINERALISATION :

Not considered.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment , Soil & Rock Chip sampling; Copper, Lead, Zinc, Barium, Manganese, Cobalt, Nickel, Arsenic, Silver.

Geophysics : Ground magnetic surveys.

Petrology : Microscopic descriptions.

COMMENTS :

Three stream sediment anomalies with a strong lead signature were detected over Wilkawillina Limestone.

'Basal arkose' is reported to be associated with algal limestones and ironstones. This unit is suspected to be Parachilna Formation transitional to Wilkawillina Limestone. The metallogenic significance of the ironstones is unclear and warrants field checking.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 28CN

SAMREF CAT. Nos. : 1011948

ENVELOPE No. : 3539

TITLE : EL 482.

LOCATION : WIRREALPA NORTH, PATAWARTA HILL & Mt. TILLEY

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1011948.
Dampier Mining Company Ltd. (BHP) 1981. EL 482, Wirrealpa North, Progress & Final reports, EL 482, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation, Wilkawillina Limestone (Wirrapowie Limestone Member), Parara Limestone.

Structure : Narina Syncline, Narina fault.

MINERALISATION :

Not discussed.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment sampling; Rock Chip sampling. Copper, Lead, Zinc, Cobalt, Nickel, Chromium, Arsenic, Antimony, Barium, Silver, Gold, Tin, Tungsten, Uranium, Niobium, Diamonds.

COMMENTS :

The Wilkawillina Limestone is largely represented by its Wirrapowie Member. A 10m thick zone with anomalous levels lead and zinc was detected close to the overlying Parara Limestone. The mineralisation seemed to favour calcarenite beds but was considered economically insignificant.

Economics aside this occurrence could be worthy of investigation from the generic aspect.

Since stratigraphic position is probably proximal to the Flinders Unconformity there is a possibility that subtly expressed non-outcropping palaeokarst related **MVT** is likely to have been overlooked in the same stratigraphic position. Further field investigations are therefore warranted.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

<u>REVIEW No.</u> : 29CWP & AG48 <u>SAMREF CAT. Nos.</u> : 0002030, 1013038.

<u>ENVELOPE No.</u> : 3641, 4323 <u>TITLE</u> : EL 526, 934.

<u>LOCATION</u> : ANGEPENA & MORO GORGE <u>SHEET</u> : SH5409 COPLEY; 6636; 6736.

<u>RECORDS/REPORTS</u> :—

#0002030.
Dampier Mining Co Ltd, BHP Minerals Ltd, and Esso Australia Ltd. (Vivian, B.J., Jarvis, D.M., Taylor, R.J., and Mann, S.T.) 1971. Angepena, Mount Roberts. Progress and final reports from 12.9.79 to 15.11.86. EL 934 and EL 526, South Australia.

#1013038.
Dampier Mining Co Ltd, (BHP) 1981. Exploration Licence 526 Angepena, Relinquishment report, EL 526, South Australia.

<u>GEOLOGY</u> :

Adelaidean : Wonoka Formation.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone, Parara Limestone.

Structure : Arrowie Syncline, Nepabunna Syncline.

<u>MINERALISATION</u> :

Moro Gorge.
Galena, Hydrozincite, Sphalerite, Willemite.

<u>EXPLORATION</u> :

Mapping : Regional and detailed geological mapping.

Geochemistry : Stream sediment and Rock Chip sampling; Cu, Pb, Zn, Ni, Co, Fe, Mn, Ag, Cr, Sn, W, U, Nb, Diamonds.

Geophysics : Induced Polarization surveys.

Drilling : 7 diamond & 4 ?percussion drill holes, some targeted on IP signatures.

Petrology : Identification of minerals which might affect IP results.

<u>COMMENTS</u> :

Arrowie Syncline - Moro Gorge.

Mineralisation intersected in 7 diamond drill holes (best result of 1m @ 2.35% Zn & 0.4% Pb in MD3) occurs in mottled algal reefal limestone facies and appears to be associated with an unconformity surface, which could be the Flinders Unconformity. "Black muds" reported from MD7 (294.9-298m) may be intercalated black shales or possibly a palaeokarstic deposit.

Correlation of the drilled mineralisation with surface geochemistry is warranted.

Nepabunna Syncline.

Mapping revealed a zone of irregular iron/manganese oxides in the upper Parachilna Formation adjacent to the overlying Wilkawillina Limestone. This feature could be of genetic significance because some portions of the Parachilna Formation may have been aquifers for **MVT** brines.

Six km SW of Italowie Gap anomalous base metals were detected in stream sediment samples and found to relate to iron/manganese oxides associated with yellow clay/siltstones within the Wilkawillina Limestone. Stream sediment samples of 135 to 150 ppm Zn were backed up by rock chip samples that returned up to 3500ppm Zn.

This anomalous zone was probably inferred to be a weathered "pyritic black shale" band that has scavenged base metals. However weathered **MVT** mineralisation could also leave such material as a residue if the host limestone was the least bit silty. A field inspection to examine this possibility is therefore warranted.

ENV. 934 is a compilation of previous stream sediment surveys with some follow-up work. Illustrative of the significance of early stream sediment surveys is a detailed follow-up of a single point anomaly of 200 ppm that was upgraded with detailed infill to 900 ppm Pb/Zn. This clearly indicates that geochemical dispersion trains can be quite short and interpretation of old geochemical data should be done with care and not be solely based on statistical parameters.

This detailed work also resulted in the recognition of a mineralised Biohermal Reef but it appears that this favourable **MVT** host environment was not explored further and therefore merits field inspection.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 30CC

SAMREF CAT. Nos. : 1011648, 1011649.

ENVELOPE No. : 3735

TITLE : EL 563

LOCATION : SLIDING ROCK, ANGEPENA

SHEET : SH5409 COPLEY;

RECORDS/REPORTS :—

#1011648.
Amoco Minerals Australia Co. (Miller, G.C., and Harley, R.A.) 1981. Progress & final reports, 5/1/80-5/6/81, EL 563, Sliding Rock, South Australia.

#1011649.
Amoco Minerals Australia Co. (Henderson, R.J., O'Callaghan, M., Geoex Pty. Ltd.) 1980. Combined Gravity and Magnetic Survey conducted near Copley, S.A., EL 563, South Australia.

GEOLOGY :

Adelaidean : Tapley Hill, Amberoona, & Balcanoona Formations.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Cadnia Syncline (Mt. Hack Syncline).

MINERALISATION :

Sliding Rock Mine; Angepena Goldfield.

EXPLORATION :

Mapping : Geophysics; Geological.

Geochemistry : Stream sediment, Soil, & Rock Chip sampling; Gold, Copper, Lead, Zinc, Manganese, Barium, Silver, Cobalt, Molybdenum, Mercury, Arsenic, Nickel, Uranium.

Geophysics : Gravity surveys; Ground magnetic surveys.

Drilling : Rotary drilling.

Petrology : Minerological Descriptions.

COMMENTS :

An ironstone with anomalous Zn located 1.5km east of Puttapa Spring associated with algal dolomite may be a palaeokarst related deposit and therefore warrants a field inspection.

A stream sediment anomaly detected previously by EZ Co. was traced to Parachilna Formation & Wilkawillina Limestones in the eastern extremity of the Cadnia Syncline near Mt. Hack where rock chip samples returned 1750 & 420 ppm Zn respectively.

Since the nature of the ironstone is unclear and its stratigraphic position is considered favourable for **MVT** mineralisation a field inspection is warranted.

The large ironstone blow described in the envelope appears to be derived from a precursor pyrite body and is not considered to be **MVT** related. It was the focus of Gold exploration by Amoco.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 31CD & AG50

ENVELOPE No. : 4449

LOCATION : ANN HILL

SAMREF CAT. Nos. : 0002243.

TITLE : EL 894, 1188

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#0002243.
BHP Minerals Ltd, and Esso Australia Pty. Ltd.(Johnson, S.A., Jarvis, P.M., and Taylor, R.J.) 1986. Ann Hill. Progress and final reports from 28.9.81 to 26.7.86, EL 1188 and EL 894, South Australia.

GEOLOGY :

Palaeozoic : Lower Cambrian.

Structure : Donkey Bore Syncline.

MINERALISATION :

No discussion.

EXPLORATION :

Mapping : Photogeological interpretation.

COMMENTS :

Very little field work was undertaken during tenure of the licences, and no technical results apart from photogeological interpretation were presented. Proper investigation of the Cambrian limestones may be warranted.

REVIEW No. : 32CJA & AG110 SAMREF CAT. Nos. : 0003410.

ENVELOPE No. : 4942 TITLE : EL (1039), 1269; ML 4369

LOCATION : PUTTAPA SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#0003410.
Electrolytic Zinc Co of Australasia Ltd. (Schmidt, B.L., Golding, L.Y., Miller, D., Milovanovic, J., Circosta, G., and Taylor, S.) 1987. EL 1269 (formerly EL1039), Beltana mine area. Progress and final reports from 12.12.82 to 8.12.87. EL 1269, EL 1039 and ML 4369, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Copley Quartzite, Brachina Formation, ABC Range Quartzite, Bunyeroo Formation, Wonoka Formation, Pound Subgroup.

Palaeozoic : Uratanna Formation, Parachilna Formation, Ajax Limestone, Billy Creek Formation, Aroona Creek Limestone, Moodlatana Formation.

Structure : Ajax & Aroona Synclines.

MINERALISATION :

Beltana Zinc Mine; Ajax Copper Mine; Copper King Mine; Ochre King Mine; Aroona, Emu, Moolooloo, & Aristotle willemite prospects.

EXPLORATION :

Mapping : Geological, Detailed stratigraphy.

Geochemistry : Stream sediment & rock chip sampling; Pb, Zn, Cu, As, Fe, Mn, Ba, Co, Ni, Ag, Au, W, Sn, Mo; Sampling of previous drilling.

Geophysics : IP surveys.

Drilling : RAB and percussion drilling (165 holes).

COMMENTS :

Ajax Syncline - Puttapa willemite mineralisation.

The Ajax Limestone is subdividable into two units.

The lower unit of yellowish to buff dolomite is variably laminated & crossbedded towards the top and relatively poorly bedded toward the base. Calcarenite to silty facies predominate with some mud-chip conglomerates, and oolitic horizons. Chalcedony is present near the base.

The upper unit is a white-grey-pink archaeocyathan limestone with a thin red to grey thinly bedded and laminar limestone marker facies at the top. This uppermost facies may be stratigraphically close to the Parara Limestone transition/boundary. Where locally dolomitised glauconite is also present.

The upper/lower boundary may be a palaeokarsted disconformity surface. The pink and white colouration is probably an alteration effect.

Iron oxide deposits are present at high topographic points such as Ajax South and Ochre King where a lateritic origin is considered likely.

The willemite mineralisation which is located between sandstone (FW) and brecciated limestone (HW) is thought to been derived from primary sulphides in shaly horizons by a "secondary concentration process".

The lower dolomitic member of the Ajax Limestone is zinc enriched relative to the upper unit. The significance of this observation is unclear since the white/pink alteration is a typical association of willemite mineralisation elsewhere in the region. There would be an expectation that such alteration would be accompanied by an increase in zinc levels but the opposite occurs here at Puttapa unless only acid soluble zinc was analysed.

The Puttapa mineralisation is accompanied by minor copper and barium enrichment.

Aroona Syncline - Emu Prospect.

The Ajax Limestone is subdividable into three members.

The lower unit is light grey to buff at the base but otherwise generally grey in colour. Laminated dolostones, stromatolitic, cryptalgal, oolitic, shaly & massive calcarenite facies are present.

The middle unit is an archeocyathan limestone with a diverse fauna. A discrete basal zone that is "dolomitised and 'solution brecciated' with a very irregular upper surface" that is overlain red and white shales & limestones. The upper portion of the unit is massive archeocyathan limestone with a less diverse fauna.

The upper unit is a buff birdseye, silty, to laminated dolomite that is partially disconformable on the middle unit.

At Emu surface soils returned up to 1000 ppm Zn and at shallow depths 1 to 2 % Zn over the middle unit. Iron oxides from the same environment also yielded up to 1% Zn.

Of particular interest is the detection of a tough siliceous zone uncovered by drilling. At the time of drilling it was assumed that a patch of Tertiary silcrete had been located. However given the dolomitisation, the irregularity of the basal dolomite in the middle member and the 'solution brecciation' a strong case for a palaeokarsted disconformity is evident. It would not be out of keeping if the 'silcrete' turned out to be a silicified palaeokarst fill deposit.

The proximity of the hinge point of the North West Fault and the likely unstable tectonic setting during Cambrian carbonate deposition is likely to account for the relative lithological diversity observed and resulted in several periods of platform emergence.

The Emu area and Aroona Syncline generally therefore have many of the ideal precursor conditions for significant **MVT** mineralisation. Since weak mineralisation has been already been located further investigative work is justified.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 33CPSWC & AG49

SAMREF CAT. Nos. : 0001815, 0002251, 0002250.

ENVELOPE No. : 5647,(6651) 6759

TITLE : EL 1235, 1345

LOCATION : ANGEPENA

SHEET : SH5409 COPLEY; 6636,6736.

RECORDS/REPORTS :—

#0001815.
Electrolytic Zinc Co. of A/Asia Ltd. (Circosta, G. & Schmidt, B.L.) 1986. Progress reports & addendum relinquishment report, EL 1235, Angepena area, South Australia, 29/7/84 to 29/10/86. EL 1235, South Australia. (ENV 5647, (6651))

#0002251.
Electrolytic Zinc Co. of A/Asia Ltd. (Schmidt, B.L.) 1986. EL 1345, Mucatoona area, Flinders Ranges, South Australia. First & final quarterly report for period ended October 29, 1986. EL 1345, South Australia. (ENV 6759)

[NOTE: Contents ENV 6651, 0002250 transferred to ENV. 5647.]

GEOLOGY :

Adelaidean : Umberatana Group, Wilpena Group.

Palaeozoic : Hawker Group.

Structure : Cadnia, Arrowie, Nepabunna, Angepena & Mt.Serle Synclines.

MINERALISATION :

Mucatoona Mines; Lady Millicent Mine; Old Angepena Homestead Prospect; Angepena Goldfield.

EXPLORATION :

Mapping : Limited geological mapping.

Geochemistry : Stream Sediment & Rock Chip Sampling; Zn, Pb, Cu, As, Fe, Mn, Co, Ni, Ba, Sb, Bi, Au, Ag, Sn, W, Mo, V, Nb, Se, Y, La, Ce.

COMMENTS :

Programme sought to follow-up on minor geochemical anomalies, with emphasis on faulted calcareous lithologies of Adelaidean and Cambrian age. Further work is warranted in the Cambrian sequences in the eastern part of EL 1235, but was not possible during EL tenure due to the land titles being in the process of transfer to the local Aboriginal community.

It was noted that Sedex mineralisation might not have been detected in past surveys with the philosophies and methods used.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

<u>REVIEW No.</u> : 34CP

<u>SAMREF CAT. Nos.</u> : 100372, 1003073

<u>ENVELOPE No.</u> : 1106

<u>TITLE</u> : SML 259

<u>LOCATION</u> : Mt. McKINLAY CK.

<u>SHEET</u> : SH5409 COPLEY; 6736.

<u>RECORDS/REPORTS</u> :—

#1003072.
CRA Exploration Pty. Ltd. (Hughes, F.E.) 1969., Examination of Geochemical Lead Anomaly, Mt. Mckinlay Creek, Balcanoona area, SML 259, South Australia.

#100373.
CRA Exploration Pty. Ltd. (Kostlin, E.C.) 1969., Geochemical Drainage Sampling in SML 259, South Australia.

<u>GEOLOGY</u> :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Nepabunna Syncline.

<u>MINERALISATION</u> :

Not discussed.

<u>EXPLORATION</u> :

Geochemistry : Stream sediment & Soil sampling; Rock Chip sampling; "Laterite"; Zinc, Lead, Copper, Nickel, Cobalt, Silver.

Petrology: Microscopic descriptions.

<u>COMMENTS</u> :

"Lateritic" iron/manganese oxide deposits near the Parachilna/Wilkawillina contact were assumed to have accumulated up to 500 ppm Zn by geochemical scavenging. Some lead-zinc correlations observed in stream sediment results were problematical, and caution was advised in the interpretation of lead results.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 35CREA & AG28

SAMREF CAT. Nos. : 1002755, 1002756, 1002757, 1002758, 1002759, 1002760, 1003256.

ENVELOPE No. : 0243, 1246

TITLE : SML 353

LOCATION : EDIACARA, BELTANA AROONA.

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1002755.
Carpentaria Exploration Co Pty Ltd. (McPhar Geophysics Pty Ltd, Burnside, E.) 1970. Report on AFMAG Tests, Northern Flinders Ranges SML 353, South Australia.

#1002756.
Carpentaria Exploration Co Pty Ltd. (Binks, P.J., and Dwyer, E.A.) 1971, Progress and Final reports Lake Torrens Plains, 1970-1971, SML 353, South Australia.

#1002757.
Carpentaria Exploration Co Pty Ltd., (Okill, R.) 1971, Progress Report to Aug.1971 and Final Report on Drilling Results at Ediacara, SML 353, South Australia.

#1002758.
Carpentaria Exploration Co Pty Ltd., (Loveless, A.) 1971, Lake Torrens Gravity Survey (Preliminary) Report and Addendum to Report. SML 353, South Australia.

#1002759.
Carpentaria Exploration Co Pty Ltd., (Shalley, M.J.) 1970, Review of Past Geophysical Surveys in the Ediacara mineral field and assessment of future geophysical requirements for Torrens Hinge Zone. SML 353, South Australia.

#1002760.
Carpentaria Exploration Co Pty Ltd., (Geosurveys of Australia Ltd, Yakunin, A., and Michail, N.) 1970, Final Report, Beltana Refraction Seismic Survey, SML 353, South Australia.

#1003256.
Carpentaria Exploration Co Pty Ltd. (Binks, P.J.) 1972, Late Cainozoic Uplift of the Ediacara Range, SML 353, South Australia. (Published; Aus. I. M. M. Proceedings, vol. 243, pp: 47-5, ENV. 2243.)

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Ediacara, Aroona, Synclines, Mesozoic Faulting.

MINERALISATION :

Greenwood Workings; Morish Workings; Black Eagle Mine; Southeast Gossans; Beltana Mine-southern workings.

Ediacara resources: two stratabound bodies, 12Mt. @ 0.84% Pb, & 17Mt. @ 1.23% Pb.

Cesarolite; Coronadite; Galena; Cerussite; Barite; Covellite; Tetrahedrite; Chalcopyrite.

EXPLORATION :

Mapping : Geological mapping.

Geochemistry : Ground water, Stream sediment, Soil, & Rock Chip sampling; Drill cutting analysis; Copper, Lead, Zinc, Silver, Cobalt, Nickel, Manganese, Mercury; Electron microprobe analysis.

Geophysics : EM surveys; AFMAG; IP surveys; Gravity surveys; Ground Magnetic surveys; Seismic refraction surveys.

Drilling : Rotary percussion.

Petrology: Microscopic descriptions.

COMMENTS :

In the Aroona area (NW Fault) the Ideyaka soil anomaly was found to be due to a veined breccia zone.

At Ediacara, research demonstrated that the mineralisation was primary galena with accessory tetrahedrite, chalcopyrite, & pyrite located within the breccia matrix. It was also concluded that the Ediacara deposit was located in a recently (perhaps Pleistocene/Quaternary) uplifted horst block that had been affected by deeply penetrative late Mesozoic and early Tertiary weathering. Some of the observable features were therefore attributed to Mesozoic/Tertiary weathering processes.

Since later weathering is a resumption and a continuation of previous palaeokarstic weathering processes, overprinting of earlier events is likely to obscure them completely. Therefore there is probably no clear way of establishing if Cambrian palaeokarsting was present at Ediacara.

However many of the features such as the cavernous nature of the ground, the 'canyon like' filled features (p 134) and iron/manganese silcrete breccias that approximated the position of the mineralised zone (p 136) are possibly palaeokarstic.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 36CSP

SAMREF CAT. Nos. : 1002619, 1002622, 1002623.

ENVELOPE No. : 1324

TITLE : SML 386

LOCATION : MT. SERLE

SHEET : SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1002619.
Vidic, V., Kristoff, S.M., Walters, K.A., & Shelley, E. (Iredale, J., Austral Exploration Services Pty. Ltd.) 1970, Report on Magnetic Survey in the Mt. Serle area. SML 386, South Australia.

#1002622.
Vidic, V., Kristoff, S.M., Walters, K.A., & Shelley, E. (Webb, J.E., Austral Exploration Services Pty. Ltd.) 1970. Report on induced polarization survey at Mt. Serle, SML 386, South Australia.

#1002623.
Vidic, V., Kristoff, S.M., Walters, K.A., & Shelley, E., 1972. Progress report SML 386 Mt. Serle area, South Australia.

GEOLOGY :

Not discussed.

MINERALISATION :

Malachite.

EXPLORATION :

Geochemistry : Drill core analysis: Copper, Zinc, Nickel, Cobalt, Lead, & Multielement scan.

Geophysics : Electrical surveys; IP surveys; Ground magnetic surveys;

Drilling : Diamond drilling (1 hole).

COMMENTS

The project appears to have concentrated purely on follow-up of geophysical anomalies, with little or no geological control. "Outcropping mineralisation" is mentioned in the geophysical report, but there is no geological information in the rest of the envelope. Consequently, the significance of the information with respect to MVT mineralisation is unknown.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 37CJC

SAMREF CAT. Nos. : 1002219, 1002275, 0004907, 0004913.

ENVELOPE No. : 733, 732, (623), & (624).

TITLE : 113, 136 & 142.

LOCATION : PUTTAPA, BELTANA MT BAYLEY, ANGEPENA, NUCCALEENA

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1002219.
Anaconda Australia Ltd. (Whitehead, S., 1966)., Report on Beltana Concession, SML 113, South Australia.

#1002275.
Anaconda Australia Ltd. (Whitehead, S., 1966)., Report on Beltana Concessions, SML 113, SML 136 & SML 142, South Australia.

[NOTE: Reports ENVs. 623, 624; 0004907, 0004913 now in ENV 733.]

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Tapley Hill Formation (Tindelpina Shale Member), Bunyeroo Formation.

Palaeozoic :Parachilna Formation, Ajax Limestone.

Structure : Ajax Synclinorium, Cadnia Syncline; Fault Zone with diapiric breccias.

MINERALISATION :

Puttapa Zinc Deposit; Mucatoona Mines; Nuccaleena Mine; Mt. Bayley Mine; Ajax Copper Mine; Copper King Mine.
Willemite; Hedyphane; Vanadinite; Finnemanite; Coronadite; Hemimorphite; Malachite; Azurite; Chalcopyrite; Phosphate.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream Sediment & Rock Chip Sampling; Copper, lead, & Zinc.

COMMENTS :

Mapping showed that the 4.5 km long Puttapa Stream sediment anomaly (up to 760 ppm Zn, 217 ppm Pb) was due to lead and zinc in the Ajax Limestone. Rock Chip samples associated with haematised (pink) manganiferous dolomite of the Ajax Limestone returned up to 2000 ppm Zn and 170 ppm Pb.

Within the anomalous zone an area of about 300 x 100 m^2 was found to contain masses of white willemite as massive, banded and crystalline forms with other lead minerals that assayed up to 52% Zn & 46% Pb. The mineralisation has a strong arsenic signature.

Subsequently Electrolytic Zinc Ltd. established that a resource of lm tonnes @ 40% Zn was present.

The mineralisation is focussed along the easterly boundary faults of the northern lobe of the Beltana Diapir. The field relations are somewhat suggestive of an unconformable relationship between the Parachilna Formation and the diapir but the fairly intricate folding and complex faulting together with the lack of field evidence for precursor sulphides suggests the mineralisation is epigenetic and of Delamerian age. Only indirect linkage with **MVT** is possible.

Field mapping to the north & east of the Puttapa Zinc deposit of the Ajax Limestone shows several extensive ironstone bodies of which two host minor copper mineralisation. Given their stratigraphic relations and the minimal geological data, it is possible that these features may be of palaeokarstic origin.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 38CW

SAMREF CAT. Nos. : 1002211.

ENVELOPE No. : 778

TITLE : SML 54

LOCATION : MORO

SHEET : SH5409 COPLEY; 6736.

RECORDS/REPORTS :—

#1002211.
C.R.A. Exploration Pty. Ltd. (MacKenzie, D.H. & MacNamara, P.M.) 1963. Report on Wertaloona Special mining lease, SML 54, South Australia.

GEOLOGY :

Adelaidean : Wonoka Formation, Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Balcanoona Anticline, Arrowie Syncline.

MINERALISATION :

Moro Central Prospect.
Malachite, Azurite, Chalcocite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Rock Chip Sampling; Copper.

COMMENTS :

The Parachilna Formation/Wilkawillina Limestone contact zone in this area is reported to be generally obscured by masses of ironstone and scree. Since the focus of the programme was copper mineralisation which was self evident as abundant malachite staining, these features and the nearby fault gossans were probably not examined in much detail. Later explorers may have also presumed them to be of little consequence. Given their stratigraphic position, a field inspection seeking to determine if any hitherto unrecognised palaeokarstic features are present should be carried out along and above the contact zone. See ENV 695, 39CW.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 39CW

SAMREF CAT. Nos. : 1002287, 0004912, 0004915.

ENVELOPE No. : 721 (673)

TITLE : SML 128.

LOCATION : IRONSTONE BORE

SHEET : SH5409 COPLEY, 6736.

RECORDS/REPORTS :—

#1002287.
Kennecott Explorations (Australia) Pty Ltd., (Brooks, C.C., and Clema, J.M.) 1967., Progress and final reports on Ironstone Bore, SML 128, South Australia.

[Contents of ENV. 673, 0004912, 0004915 ?tansferred to ENV. 721.]

GEOLOGY :

Adelaidean : Bunyeroo Formation (Wearing Dolomite Member), Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Nepabunna Syncline, Arrowie Syncline.

MINERALISATION :

Malachite; Chalcocite.

EXPLORATION :

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc.

COMMENTS :

Results appear to have been disappointing. There are no geological details given in RI 37. The **MVT** significance of this exploration is unassessed.

Seven stream sediment samples above 100ppm Zn were recorded but were not considered anomalous in view of the presumed high background levels in the Wilkawillina Limestone.

REVIEW No. : 40CE & AG28

SAMREF CAT. Nos. : 1000256, 1000258.

ENVELOPE No. : 892

TITLE : SML 177

LOCATION : EDIACARA

SHEET : SH5409 COPLEY; 6536.

RECORDS/REPORTS :—

#1000256.
Trans Australian Explorations Pty. Ltd., 1968., Progress and final reports Ediacara Mineral Field, SML 177, South Australia.

#1000258.
Trans Australian Explorations Pty. Ltd. (McPhar Geophysics Pty. Ltd., Eadie, E.N.) 1968. Induced Polarization survey (SADME) of the Ediacara Mineral Field - A reinterpretation, SML 177, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Ediacara Syncline.

MINERALISATION :

Black Eagle Mine; Greenwood Workings; Morish Workings.
Galena; Malachite; Chalcopyrite; Pyrite; Barite; Cerussite.

EXPLORATION :

Mapping : Geological; Drill core Examination.

Geochemistry : Drill core analysis; Copper, Lead, Silver.

Geophysics : Geophysical (re-) interpretation; IP surveys.

COMMENTS :

The work consisted of reviewing previous surveys, geological mapping, reinterpretation of IP surveys, several new check IP surveys, and examination and analysis of existing drill core.

The mineralisation was recognised as "galena in MVT deposits" in the basal 100m of the dolomites, presumably on the basis of previous work by Nixon. Check IP surveys showed known anomalies to be valid but of lesser magnitude than previously interpreted. Results were not considered encouraging enough to justify further drilling of the anomalies. It was noted that an IP anomaly occurs above each place where barite was located.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 41CG/8PG SAMREF CAT. Nos. : 1000268

ENVELOPE No. : 975 TITLE : SML 202

LOCATION : REGIONAL SHEET : SH5413 PARACHILNA;

AROONA, ARROWIE, NARINA, BALCORACANA, KANYAKA, AREAS.

RECORDS/REPORTS :—

#1000268.
CRA Exploration Pty. Ltd., (McQueen, A.F.) 1968. SML 202, Flinders Ranges, South Australia. Geochemical Prospecting for Metallic Mineral Deposits, SML 202, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Lower Cambrian synclinal basins.

MINERALISATION :

Not discussed.

EXPLORATION :

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Silver, & Cobalt.

COMMENTS :

Entirely documentation of data organised by geographic region.

Area	Region
A	Aroona Syncline.
B	Arrowie Syncline.
C	Wirrealpa/Narina Syncline.
D	Kanyaka (north) Syncline.
E	Mernmerna/Kanyaka (south) Synclines.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 42CC

SAMREF CAT. Nos. : 1002640, 1002641.

ENVELOPE No. : 1289

TITLE : SML 359

LOCATION : MUCATOONA

SHEET : SH5409 COPLEY;

RECORDS/REPORTS :—

#1002640.
Carpentaria Exploration Co Pty Ltd. (Shalley, M.J.) 1970. Angepena IP survey, SML 359, South Australia.

#1002641.
Carpentaria Exploration Co Pty Ltd. (Pflaum, B.R., and Smith, W.D.) 1970. Progress and final reports Angepena, SML 359, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Ajax Limestone.

Structure : Cadnia Syncline.

MINERALISATION :

Smithsonite? in veinlets, Ironstone (Adelaidean hosted).

EXPLORATION :

Mapping :

Geochemistry : Stream, Soil, and Rock geochemistry, Copper; Lead; Zinc; Silver; Gold; Sulphur; Multielement analysis;.

Geophysics : Induced Polarisation & Resistivity (Ironstone).

Drilling : Diamond & percussion Drilling of Adelaidean hosted ironstone.

COMMENTS :

Zinc carbonate veins in Ajax Limestone were observed but not followed up with further work. Field examination is suggested.
Veins could be of Delamarian age.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 43CW

SAMREF CAT. Nos. : 1002770.

ENVELOPE No. : 1253

TITLE : SML 338

LOCATION : BALCANOONA, MORO

SHEET : SH5409 COPLEY;

RECORDS/REPORTS :—

#1002770.
Poseidon NL (Donovan, P.R., McPhar Geophysics Pty. Ltd.) 1970. Stream sediment surveys, Balcanoona area, SML 138, South Australia.

GEOLOGY :

Adelaidean : Umberatana Group, Wilpena Group.

Palaeozoic : Hawker Group.

Structure : Balcanoona Anticline & Arrowie Syncline.

MINERALISATION :

Malachite; Azurite.

EXPLORATION :

Geochemistry : Stream sediment surveys; Copper, Lead, Zinc.

COMMENTS :

The survey was primarily concerned with exploration for copper. Some of the areas surveyed drain Hawker Group lithologies, but no anomalous lead-zinc results were recorded.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 44CF/30PF & AG56

SAMREF CAT. Nos. : 0003520, 0003524, 0001665.

ENVELOPE No. : 3722

TITLE : EL 538, 807, 894, 934, 1080, 1084, 1085, 1129 & 1138.

LOCATION : MOOROWIE, Mts. CHAMBERS & FROME.

SHEET : SH5413 PARACHILNA; 6735.

RECORDS/REPORTS :—

#0003520.
BHP Minerals Ltd. (Roche, M.T., Parrington, P.J., and Blain, C.F.) 1983, Exploration for carbonate-hosted base metals in the Flinders Ranges, South Australia. EL 934, EL 894, EL 1080, EL1084, EL1085, EL 1129, & EL 1138, South Australia. Envelopes, 3427, 3722 & 3968.

#0003524.
Dampier Mining Co Ltd (BHP Minerals Ltd), and Esso Australia Ltd., (Vivian, B.J., and Mann, S.T.) 1987, Mount Frome, Progress reports & Surrender report from 25.10.79 to 25.2.88, EL 538, EL 807 and EL 1138, South Australia.

[NOTE: Report EL 807, 0001665, ENV. 5016, minor **MVT** interest.]

GEOLOGY :

Adelaidean : Callanna Group (diapiric material, Wonoka Formation, Pound Subgroup.

Palaeozoic : Wilkawillina/ Moorowie Limestone, Parara Limestone.

Structure : Mt. Frome Syncline.

MINERALISATION :

Moorowie copper mine, Wilnuroona & Eric lead zinc prospects.
Galena; Cerussite; Sphalerite; Smithsonite; Hydrozincite; Malachite; Azurite; Fluorite.

EXPLORATION :

Mapping : Regional and detailed geological mapping, & Photo-interpretation.

Geochemistry : Stream sediment, Rock Chip, Jack Hammer & Channel sampling; Drill sample analysis; Copper, Lead, Zinc, Silver, Manganese, Iron, Magnesium, Calcium, Cadmium, Cobalt, Gold, Arsenic.

Geophysics : IP surveys at Moro Gorge and Moorowie. Downhole gamma surveys DDF3,4,5.

Drilling : RAB/Percussion drilling (152 holes); Diamond drilling (10 holes).

COMMENTS :

Mt. Chambers Prospect. (Parachilna Sheet)

This programme followed-up previous work by EZ and UM (ENV. 997, 1104, 1390 & 2373 resp.) in the vicinity of the Mt. Chambers Copper Mine.

In this locality the Wilkawillina Limestone and overlying Parara Limestone dip have a shallow easterly dip. Mapping identified a number of beds with sparite filled cavities upon their upper surfaces that appear to carry anomalous levels of zinc.

In the same region small patches of diapir were mapped but later work demonstrates that these have a different origin.

A small alluvial/eluvial plain in an outcrop embayment west of the Union Miniere rock chip anomaly was found to have a strong soil and stream lead-zinc signature. This area was extensively drilled on the basis that it was a palaeokarst of some magnitude but the results were disappointing. Mineralisation was proven to be strongest in the east around the edge of the outcrop and the new occurrence was named Eric.

Further east, just below the Parara Limestone at Wilnuroona a small body of dark grey 300m^2 carbonate breccia of indeterminate origin grading 7.5% Pb+Zn with significant silver was drilled at grid A. Nearby weak mineralisation was detected at grid B in the sparitic top of a massive limestone bed.

See ENV. 8071 & 3968 for follow-up exploration.

Moorowie Prospect.

The Moorowie Prospect is a combined copper & lead-zinc occurrence hosted by Lower Cambrian carbonate sedimentary breccias in close proximity to diapiric breccias on the west and relatively active faults to the east.

In this context it bears some parallels with the Wirrealpa Lead Mine and may represent remobilised **MVT** mineralisation.

APPENDIX 3.2

MVT-LZ EXPLORATION REVIEWS
PARACHILNA SHEET
NORTHERN FLINDERS RANGES

November 1991

Page Nos. in data listing.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 1PU & AG53

SAMREF CAT. Nos. : 0001404, 0001457.

ENVELOPE No. : RB 86/018, &
RB 86/022

TITLE : DME. 141/83.

LOCATION : HEYSEN RANGE
(FLINDERS RANGES NATIONAL PARK)

SHEET : SH5413 PARACHILNA; 6535.

RECORDS/REPORTS :—

#0001404.
Horn, C.M., and Morris, B.J., 1986. Base metal exploration Flinders Ranges National Park - July 1983 to February 1986 - summary report. SADME Report Book, 86/022.

#0001457.
Morris, B.J., 1986. Base Metal Exploration, Flinders Ranges National Park, Final Report, Stages 1 and 2, SADME Report Book, 86/018.

Horn, C.M., and Morris, B.J., 1988. Base-metal exploration in the Flinders Ranges National Park, Mineral Resources Review, South Australia, 156, p: 51-56. Compiled from RB 86/022.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Hawker Group, Lake Frome Group.

Structure : Bunyeroo Syncline.

MINERALISATION :

Mineralogy:

Willemite; Galena; Malachite; Chalcocite; Smithsonite; & Hydrozincite.

Alteration :

Dolomitization & Silicification.

Prospects :

Southern, Camp, Manga, Llina, Hayward, Concert, Willa (Bookartoo Ochre deposit) and Northern (Galena Creek prospect).

EXPLORATION :

Mapping : Regional and detailed geological mapping.

Geochemistry : Stream sediment (826), & detailed rock-chip (2550), and soil (108) sampling : Cu; Pb; Zn; Mn; Cd; As; Hg; Co; Ni; Ag; Mo; Fe; Sn; Au; Ca; Mg; SiO_2; Orientation Survey.

Geophysics : IP and Sirotem surveys.

Petrology : 288 detailed thin section descriptions.

Costeaning & Drilling: None.

COMMENTS-GENERAL :

The Project

The Flinders Ranges National Park **MVT** investigation was undertaken over previously disclosed mineralisation to expand the technical data set available to explorers elsewhere in the Flinders Ranges.

Primary Results

The investigation disclosed lead/zinc mineralisation as open - space fillings, in the upper part of the Wilkawillina Limestone. Mineralisation is associated with dolomitization, facies changes, and karstic features. The latter were developed at palaeosurfaces at the top of the Wilkawillina Limestone and a possible unconformity lower in the sequence.

Stage 1 exploration, comprising regional geological mapping and geochemical surveys, resulted in the delineation of eight prospective areas showing features characteristic of **MVT** deposits.

Stage 2 exploration, comprising detailed geochemistry, geological mapping and geophysical surveys showed that Southern, Manga, Concert and Willa prospects have the most potential for **MVT** mineralisation.

The work clearly indicates that company exploration in the same geological environment elsewhere in the Flinders Ranges is warranted.

Stratigraphy

The westerly dipping Wilkawillina Limestone that hosts the mineralisation is readily subdivided into two units and is laterally equivalent to the Ajax Limestone referred to on the Copley sheet to the immediate north. [Note that the upper and lower members refer only to this project, and do not correspond to the later subdivisions Upper and Lower Wilkawillina Limestone used in the main text of this MVT-LZ data package and elsewhere.]

The lower member **(WLM)** (Woodendinna Dolomite equivalent?) is a 100m thick bedded dark grey-brown crystalline sandy and oolitic dolomite with 5m of nodular limestone a the very top in the Bunyeroo Gorge vicinity.

The upper member **(WUM)** is subdivided into a basal 100m thick calc-dolomite unit (WUM1) (an altered limestone) with solution collapse breccias at the top which may represent an palaeo-karsted unconformity. The overlying unit WUM2 , composed of medium grey nodules set in buff to mauve limestone matrix, is up to 30m thick. The uppermost unit (WUM3) comprises massive weakly to strongly fossiliferous limestone of variable off white-grey-pink colour with a localised facies change to nodular limestone in the vicinity of Bunyeroo Gorge similar to the top of the underlying member.

The uppermost surface of WUM3 has been palaeokarsted and is characterised by red brown calcareous microbial rind/crust that infills crevices and cavities on an undulating contact surface (relief of 2m) with the overlying unit and with localised macro structures that may represent palaeocaverns.

Geochemistry

Studies of stream sediment data indicated 3 generic sources of Pb & Zn which appear to be moderately well correlated. Two populations of Fe/Mn were also indicated. A much lower correlation between both Pb & Zn and Mn was also noted.

These observations indicate finesse is required to interpret geochemical results and a simple empirical approach is unlikely to permit the viable ranking of anomalies.

Rock chip sampling showed that zinc enrichment is commonly associated with either one or more of dolomite, pink haematite alteration and Mn/Fe gossan.

Geophysics

IP and Sirotem surveys were carried out at selected localities but the lack of follow-up drilling means their significance is largely speculative. Practical determination of diagnostic geophysical characteristics of primary **MVT** mineralisation in this environment is therefore unavailable. The significance of the anomalies identified during the project work is unknown and therefore no opinions are offered in this review.

COMMENTS-PROSPECTS :

Southern

The locality is transected by several NE to ENE oriented faults with variable displacement.

Mineralisation is visually evident as several smithsonite /hydrozincite occurrences in the top of WUM2, a porous calc-dolomite, and as medium to weak geochemical signatures. Some small patches of manganese/iron oxide were also recorded near the top of WUM2.

The strongest base metal geochemical results indicate an oblique cross-stratigraphic trend with the broader and most anomalous area occurring to the west ?beneath the WLM and trending on to the WUM to the south. A weaker more stratabound relationship to the WUM is also apparent for lead, whereas zinc seems to have been concentrated along some of the faults and the upper surface of the WUM.

Manganese is concentrated at the top of WUM/basal Parara Limestone and has only a weaker locational correlation to the main base metal signature.

The correlation of manganese and zinc with the WUM/Parara contact and zinc with faulting seems to imply significant influence of recent permeability may be influential, and by implication, groundwater remobilisation. The transgressive nature of the strongest base metal signature and its coincidence about a focus of intersecting faults may reflect the existence of a palaeo-watertable which could be examined simply by comparing sample elevations.

Given the westerly dip of the sediments, it is probable that the main base metal and manganese concentrations have resulted from the concentrating effects of palaeoweathering and watertable adjustments. Vertically downward mobilisation from now removed WUM along faults into the underlying units and down the west dipping WUM/Parara contact seems probable.

The weaker stratabound lead and even more tentative cadmium signature in the WUM is therefore probably the ?leached remnants of primary mineralisation.

No palaeokarst structures of significant size are recorded.

Camp

This locality is affected by a NE oriented fault pair with a conjugate fault, all with very minor displacements.

There are no mapped visible mineral occurrences. Several patches of manganese/iron oxides in localised depressions are inferred to be palaoekarst sites. One is located in the upper portion of WLM, two in basal WUM3 and two in upper WUM3. The conjugate fault appears to have influenced the orientation of one of the masses.

Base metal mineralisation delimited by geochemistry is focussed along three trends, the WLM/WUM, WUM2/3 and WUM/Parara contacts. Lead is the clearest discriminator of the zonation.

The lower WLM zone is strongly expressed in lead and weakly by zinc and copper. The middle WUM2/3 zone is weak but persistent in lead but stronger though displaced down section in both copper and zinc correlating with manganese, to merge with the lower zone. Strong spikes occur in the lead/copper-zinc overlap. The uppermost zone is strongly expressed by all metals and slightly transgressive on to the Parara limestone toward the south, and has a strong manganese association.

The upper zone is probably a weathering enhancement. The lower manganese-copper-zinc to the middle zone probably also represents down section dispersion by weathering and ground water. The middle zone lead and the lower zone may represent primary mineralisation associated with palaeokarsting.

Sampling data of the inferred palaeokarst sites is not reported.

Manga

This locality is significantly affected by a major NE fault that effectively displaces the Cambrian section 3 km sinistrally. Drag folding is apparent, and the Cambrian is brought into juxtaposition with the underlying Pound Subgroup to the north. Minor faulting is also present in both parallel and conjugate directions.

There are no mapped base metal mineral occurrences. However, significant masses of manganese/iron oxides and a large area of pervasive dolomitic alteration (1000 X 450 metres where lithological features are unrecognisable) are focussed about the main NE fault. Several of the more southerly manganese oxide masses located just below the palaeosurface at the top of the Wilkawillina Limestone clearly occupy circular solution cavities up to 30 metres in diameter.

Mineralisation detected by geochemical sampling is generally anomalous, though erratically distributed throughout and adjacent to the main zone of strong dolomitic alteration. With one exception, there is poor direct correlation between copper, lead and zinc.

This anomaly is strike oriented and located at the base of WUM3, near the southern margin of the main alteration zone, and closely associated with palaeokarstic manganese patches and a locally high cadmium signature.

A separate isolated much smaller dolomitized area of WUM3, located 500m south of the main zone, is distinctly anomalous with respect to copper and lead with weak zinc enrichment and moderate manganese.

The most prominent anomaly is clearly associated with the manganese body located within the main fault zone. This body is strongly anomalous with respect to all the metals, with lead being the least concentrated. Previous exploratory drilling showed the body to narrow at depth without underlying massive sulphides or appreciable increases in average metal content. A secondary origin was inferred. (See 'grid A' ENV. 2359/REV. 28PU)

Regional mapping and sampling indicates that mineralisation and associated dolomitic alteration is also present to the west within the northern offset of the Wilkawillina Limestone some distance away from the main fault which is concealed beneath alluvium.

The strong Cu-Pb-Zn-Cd metal signature associated with massive dolomitic alteration associated with faulting would be of considerable interest to explorers if it were located on the Lennard Shelf of WA.

The crux of the significance of this locality lies in the generic age of the faulting and the associated dolomitisation. While **MVT** deposits would have had to have formed before Delamerian folding, this does not preclude later fault movements that may have facilitated the formation of the main manganese body in relatively recent geological time during the weathering of nearby primary **MVT** mineralisation.

Such primary mineralisation may still be present at the other anomalous sites in WUM3 discussed above. Using the example of the Lennard Shelf, the westerly extension of the main offsetting fault would be a prime **MVT** exploration target.

Llina

This locality lies on the northern side of a major E-W dextral fault which controls the location of the nearby Brachina Gorge. Parallel subsidiary faults are present together with other minor NNE and NE faults.

A substantial raft of internally dislocated and partially brecciated Wilkawillina Limestone occurs out of stratigraphic context in the overlying Billy Creek Formation in the SW. The Wilkawillina Section is complete, with a relatively wide exposure of WUM3 massive light grey limestone at the top of the sequence.

The Billy Creek Formation has been deposited directly on to the upper palaeosurface of the Wilkawillina Limestone, indicating onlap beyond the maximum extent of the Parara Limestone. Mapping disclosed that the palaeo-crusting is discontinuous, indicating possible minor erosion prior to Billy Creek deposition.

There is no mappable evidence of **MVT** mineralisation, but geochemical data indicates that low level copper and lead are widespread. Zinc and manganese are generally correlated and restricted to the basal WUM1 calc-dolomite and WUM3/Billy Creek contact. The lower zone also has a strong cadmium signature. Despite the smudgy nature of the lead signature a similar bias to the Zn-Mn is also present. These spatial observations are also evident in the numerical statistics.

Given the observations made for the other prospect localities, it seems probable that the Zn-Mn anomaly has been dispersed down the stratigraphic section. This means that remnant primary mineralisation may be present at the both the base and top of WUM3.

Hayward

At this locality minor NE faulting and a full section of Wilkawillina Limestone are present. Billy Creek Formation has been deposited directly on the nearly continuous uppermost palaeosurface crusting, since the Parara Limestone is absent.

Two depressions 50 to 100m across in the lower middle part of the massive light grey limestone of WUM3, and a scree covered indentation along the WUM3/Billy Creek contact, may be palaeokarsts.
The lower two features contain exposures of iron/manganese, laminar calcrete and coarse calcite crystals. Small pockets of these minerals are also present elsewhere.

Mineralisation is only evident from geochemistry. Two discrete trends appear to be present. Copper, lead and zinc seem to trend both within the WUM3 about 100m from the palaeosurface and at the palaeosurface itself. A broad manganese signature encompasses both zones.

One line clearly transects one of the inferred palaeokarsts where a localised Pb-Zn-Cd-As-Mn anomaly is recorded. Similarly, the inferred palaeokarst at the top of the WUM3 is anomalous with respect to Cu-Zn-As where Pb and Mn are conspicuously low.

The obvious focus of manganese about the WUM3/Billy Creek contact and its generally dispersed nature suggest secondary supergene processes have been active.

Concert

This locality is characterised by a natural amphitheatre about 200m in diameter at its upper extremity. Positioned just below the WUM3/Billy Creek Formation contact within otherwise massive archaeocyathan limestone, a palaeokarstic origin is inferred. An elongate body of breccia with a haematitic matrix trends NE up the slope of the depression. The floor is littered with coarse scree.

Soil sampling indicates generally increasing lead and zinc toward the centre of the feature except to the NE in relative proximity to the breccia in the wall which is probably part of the original fill.

The structure would be an ideal research site were it not for the National Park. A similar structure if found could be usefully sampled by costean, and deeper drilling to establish geochemical criteria for exploration purposes.

Willa-Northern

The *Bookartoo Ochre deposit*, *Toondana Prospect* (EZ, ENV. 1157, 13PMU) and *Galena Creek Prospect* (MEPL ENV 843/2359, 28PMU) referred to in previous literature are portions of this area.

The *Willa* and *Northern* localities lie to the south and north of a NE sinistral fault offset with a lateral displacement of about 1000m.

Bookartoo Ochre deposit

This 8.091 ha site within the Willa locality was reserved for Aboriginal People by the Assistant Government Geologist in 1905 and later transferred to the Aboriginal Lands Trust in 1979.

The ochre is of friable character and hosted by a hard band of haematite with minor calcite. The ochre contains mercury and is believed to have be a weathering product of pyrite with accessory sphalerite. Minor willemite has also been recorded.

The mercury and the haematite/zinc silicate association suggests that the mineralisation could be genetically related to the Puttapa type willemite mineralisation.

Willa

This locality is nested by NNE to NE faulting. The Wilkawillina Limestone is complete and capped by the Billy Creek Formation. The uppermost palaeosurface crust is intermittently preserved.

Bodies of red-brown haematitic ochre are focussed along the WUM2 nodular limestone unit with the largest being about 1 km long and up to 100m wide within which the Bookartoo Ochre working is situated. The ochres contain coarse crystalline calcite.

The main body is centred on a breccia with clasts derived from the overlying unit. A solution collapse origin is inferred.

Smaller similar bodies and localised patches of calcite, manganese, willemite, hydrozincite, galena, chalcocite, and malachite are also recorded from WUM3.

Some of the breccia/ochre bodies are clearly fault related, as are galena bearing quartz veins in upper WUM3 at the SW plunging nose of a fold in the SW of the locality.

Mineralisation depicted by geochemistry is generally erratic in detail, but consistent trends along the WUM2/3 contact and in upper WUM3 are evident.
The lower zone is clearly related to the genesis of the ochres in WUM2, and the upper zone to the palaeosurface and the minor mineralisation just below.

One particular zone, with anomalous Cu-Pb-Zn-Mn-As and weak Cd about 100m down section from a cluster of willemite occurrences just below the palaeosurface in the middle of the locality, has no mapped expression.

The patchy nature of the geochemical signatures clearly indicates secondary mobilisation of metals consistent with the recognition of secondary/supergene minerals at the surface. However, the presence of the willemite/haematite/mercury, quartz/galena associations and post folding fault related ochreous breccias suggest that Delamerian epigenetic fluids have migrated through the locality and have overprinted any primary **MVT** features.

Northern (Galena Creek)

The locality is transected by the major fault to the south previously described, and a similar NE fault with 600m of sinistral displacement also diagonally bisects the area. In the SW, a strike fault causes repetition of WUM3. Other minor subparallel faults are also present. A complete section of the Wilkawillina Limestone is present, with the uppermost palaeosurface crust irregularly preserved at the base of the overlying Billy Creek Formation.

Two small fault related ochre patches are present within the WLM in the SE and another is located in WUM3, as is also a 0.42 ha breccia centred on the WUM2/3 contact in the central north of the area. The breccia, comprising sub-angular limestone clasts up to 30 cms in diameter set in a fine grained yellow brown carbonate matrix, is attributed to a solution collapse origin.

Visible willemite is present in two of the ochre patches and also in association with hydrozincite and blebby galena just below the palaeosurface to the east of the repeated succession.

At the 'Galena Creek' workings located just below the palaoesurface further north, 130m of 1m wide trenches have been excavated to recover coarse crystalline galena from a strata parallel quartz/calcite vein of similar thickness.

Geochemical data is similarly erratic to that observed at Willa to the south. The trend associated with the upper portion of WUM3 is sustained and notably repeated reliably with the stratigraphy.

In the SE of the locality, a narrow base metal arsenic anomalous zone is focussed about the WLM/WUM contact. To the north of the collapse breccia is a strong lead with relatively weak but persistent Cu-Zn-Mn-As association, which is open to the north beyond the study area. Unlike the palaeosurface related anomaly, no mineralisation has been mapped in the position of these latter geochemical features.

COMMENTS-SUMMARY

Although the National Park investigation was not carried to its full exploration cycle, it remains the most comprehensive investigation into this geological environment within the Northern Flinders Ranges.

It clearly shows:-

* that epigenetic Delamerian mineralisation probably follows the trail of early **MVT** mineralisation.

* that faulting has a bearing on the occurrence of **MVT** mineralisation.

* that mineralisation is influenced by stratabound porosity including palaeokarsting.

* that the effects of Cretaceous/Tertiary and subsequent weathering/water table profiles need to be considered carefully in the interpretation of geochemical data.
  Redistribution of metals clearly has the effect of dispersal, generating larger physical targets, but in so doing can generate secondary accumulations that become prominent 'geochemical red herrings'.

The widely spaced occurrence of mineralisation and the recognition of one significant dolomitization halo is disparate. Dolomitic alteration is characteristic of **MVT** formation. Therefore it is either fully endemic to the investigated area or has not been clearly discriminated. Dolomite of at least two generations should be present, primary dolomite of palaeokarstic origin, and later dolomite associated with **MVT**. A third generation related to Delamerian fluid mobilisation is also probable.

Further investigation of the field geochemical anomalies that are apparently without mappable expression could be fruitful in this regard, since they appear to be free of Delamerian haematisation /dolomitisation. Collation of thin section descriptions with geochemical and hand specimen lithology could also be pertinent in this regard.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 2PH & AG58

SAMREF CAT. Nos. : 1001615, 1002210, 1002234.

ENVELOPE No. : 601, 742, 863

TITLE : SML 95, 137, & 138

LOCATION : REAPHOOK HILL & EMU BORE

SHEET : SH5413 PARACHILNA; 6735.

RECORDS/REPORTS :—

#1001615.
Kennecott Explorations (Australia) Pty Ltd., (McNeil, R.D.) 1967. Final report on Reaphook Hill, SML 137 (formerly SML 95), South Australia. (ENV. 863)

#1002210.
Kennecott Explorations (Australia) Pty Ltd., (Loos, M., Milnes, A.R., and Preiss, W.V.) 1967. The Geology of the Reaphook Hill area, South Australia. SML 137, 138, South Australia. (ENV. 742)

#1002234.
Kennecott Explorations (Australia) Pty. Ltd., (McNeil, R.D.) 1966. Progress and final reports on SML 95, Reaphook Hill, South Australia. (ENV. 601)

[NOTE: RI37 incorrectly refers to ENV 843; this should be ENV 863.]

GEOLOGY :

Adelaidean : Bunyeroo & Wonoka Formations; Pound Subgroup.

Palaeozoic : Parachilna Formation; Wilkawillina Limestone; Billy Creek Formation.

Structure : Reaphook Syncline.

MINERALISATION :

Galena; Celestite; Scholzite; Chalcophanite; Manganese minerals; Goethite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream Sediment & Rock Chip sampling; Zinc, Lead, Copper, & Multielement scans.

Geophysics : Electrical surveys; IP & SP surveys.

Drilling : Rotary, 2 holes; Diamond, 5 holes.

COMMENTS :

At Emu Bore, indications of mineralisation in the basal Cambrian were not considered encouraging, since stream anomalies were traced to galena/calcite veins in the underlying Wonoka Formation. The main focus of work was therefore Reaphook Hill.

At Reaphook Hill lead-zinc mineralisation is generally restricted to the basal portion of the otherwise massive blue grey Wilkawillina Limestone, where it is typically brown to buff coloured with iron/manganese oxide staining and dolomitisation. Exposures are often poorly developed.

Visible secondary lead/zinc minerals are associated with the iron/manganese oxides. Small pockets of mineralisation with up to 2-4% Zn within the Wilkawillina Limestone give rise to stream sediment anomalies of over 100 ppm Zn with elevated lead.

Detailed work outlined stratabound mineralisation in one area of area about 1.2 X 0.6 km^2 of +1% Zn where rock chip sample intervals returned up to 4.1% over 20m widths.

Drilling indicated apparent surface enrichment over a 600 m wide horizon within the Wilkawillina Limestone that averages just 0.2 % Zn.

Residual gravel deposits arising from in-situ degradation of the Parachilna Formation lead to poor outcrop.

Drilling showed that neither of the three scholzite outcrops of up to 27% Zn within the Parachilna Formation persists to depth but the formation does carry a high Zn background of around 0.2 % Zn.

Small basin like structures are present on the uppermost surface of the Wilkawillina Limestone are apparently infilled by Billy Creek Formation.

The brown/buff colouration associated with mineralisation is probably a combination of recent weathering and primary dolomitic alteration. The depressions at the top of the Wilkawillina Limestone are probably sink holes and direct evidence of Palaeokarsting that probably affected the full limestone interval and later influenced mineralisation. Some of the mapped stratigraphic features could be palaeokarstic in origin but this is not totally clear.

The mineralisation levels reported by drilling would be compatible with what might be expected in the geochemical halo associated with a significant deposit. The data suggests that the whole of Reaphook Syncline is a target rather than the manifestation of a very strong localised geochemical anomaly that probably has its primary genesis in the weathering cycle that was facilitated by complex local faulting.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 3PNDF

SAMREF CAT. Nos. : 1002303

ENVELOPE No. : 671

TITLE : SML 123

LOCATION : Mts. LYALL, FROME, & CHAMBERS.

SHEET : SH5413 PARACHILNA; 6735,6736.

RECORDS/REPORTS :—

#1002303.
Kennecott Explorations (Australia) Pty Ltd. (Besley, R.E., Farrel, B., Reed, J., & Clema, J.E.) 1967. Progress and final reports on SML 123 Mt. Frome, Flinders Ranges, SML 123, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material); Wilpena Group.

Palaeozoic : Parachilna Formation; Wilkawillina & Parara Limestones; Billy Creek Formation.

Structure : Narina, Donkey Bore & Mt. Frome Synclines.

MINERALISATION :

Wirrealpa Mine; Mt. Chambers Mine.
Malachite; Galena; Barite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Multielement scans.

COMMENTS :

In the Wirrealpa-Mt. Lyall region iron/manganese accumulations were identified near the base of the Wilkawillina Limestone (broad sense) but found to have low base metal contents. Follow up rock chip sampling of stream sediment anomalies of up to 300 ppm Zn & 160 ppm Pb failed to disclose significant mineralisation.

In the Mt. Chambers Mine area rock chip sampling which followed up a significant stream sediment anomaly, returned up to 200 ppm Pb & 1000 ppm Zn. Small iron/manganese accumulations scattered throughout the area were found to have generally low base metal contents with an isolated exception of 200 ppm Pb & 2,500 ppm Zn.

See ENV. 2986, 3427, & 8072.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 4PYKL/1OKYL & AG74 SAMREF CAT. Nos. : 1002292.

ENVELOPE No. : 600 TITLE : SML 94

LOCATION : WILLOCHRA- Mt. ARDEN

SHEET : SH5413 PARACHILNA; 6534. SH5401 ORROROO; 6533.

RECORDS/REPORTS :---

#1002292.
Kennecott Explorations (Australia) Pty Ltd, (McNeil, R.D.) 1966. Progress report (1.12.65 - 31.5.65) Willochra, SML 94, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation; Wilkawillina & Parara Limestones.

Structure : Kanyaka, Yappala, & Mt. Ragless Synclines.

MINERALISATION :

Copper, Lead & Zinc, Mount Arden mine & Kanyaka Copper mine.

EXPLORATION :

Geochemistry : Stream sediment Soil & Rock chip sampling; Copper, Lead, Zinc, Cobalt, Multielement scans.

COMMENTS :

Stream sediment surveys carried out on the Parachilna Sheet portion of the title did not lead to significant exploration results.

An extensive anomalous zone was detected in drainages along the contact of the largely scree covered Parachilna Formation and the basal Wilkawillina limestone in the Mt. Arden-Comstock and Radford Creek areas.

At Radford Ck. a 1000 ppm stream sample was backed up by soils with more than 0.5% Pb & Zn. Rock Chip samples where obtainable, supported the soil results with similar levels of lead and zinc and lesser contents of copper and cobalt. The host rock appears to be manganiferous dolomite.

The mineralisation is clearly stratabound and related to dolomitisation of parent limestone but direct confirmation of **MVT** is not available.

Geochemical signatures were considered sufficiently significant to justify on-going exploration in the Radford Creek, Mt. Arden-Comstock & Kanyaka Mine areas. See ENV's 642, & 648.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 5PB

SAMREF CAT. Nos. : 1002210, 0004914.

ENVELOPE No. : 722 (672)

TITLE : SML 124

LOCATION : Mt. MANTELL

SHEET : SH5413 PARACHILNA; 6735, 6635

RECORDS/REPORTS :—

#1002210.
Kennecott Explorations (Australia) Pty Ltd. (Clema, J.M.) 1967. Progress and final report on SML 124 Mt. Mantell. SML 124, South Australia.

[NOTE: Contents of ENV. 672, 0004914 transferred to ENV. 722.]

GEOLOGY :

Palaeozoic : Lower Cambrian Hawker Group & Middle Cambrian.

Structure : Balcoracana Syncline

MINERALISATION :

None reported.

EXPLORATION :

Geochemistry : Stream sediment sampling; Copper, Lead, & Zinc.

COMMENTS :

No significant results. Strong dilution of stream sediments from superficial Tertiary/Quaternary deposits may have suppressed detection of basement metal sources.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 6PB & AG60

SAMREF CAT. Nos. : 1001675, 1001676.

ENVELOPE No. : 800

TITLE : SML 143, MC 5158.

LOCATION : THIRD PLAIN

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1001675.
Kennecott Explorations (Australia) Pty Ltd., (Besley, R.E.) 1967. Final report on Third Plain, Flinders Ranges S.A., SML 143, South Australia.

#1001676.
Kennecott Explorations (Australia) Pty Ltd., (Besley, R.E.) 1968. Report on Evaluation of Zinc Mineralisation at Third Plain, Central Flinders Ranges, MC 5158, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation; Wilkawillina Limestone.

Structure : Balcoracana Syncline (western); Transverse faulting.

MINERALISATION :

Third Plain prospect.

Willemite; Smithsonite; Resource estimation.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment Rock Chip sampling; Zinc & Multielement scans.

Costeaning : Sampled & mapped.

Drilling : Percussion drilling, 23 holes.

COMMENTS :

Stratigraphy:

At Third Plain the Wilkawillina Limestone is relatively thin, being in a zone of stratigraphic thinning during the Lower Cambrian, probably reflecting progressive upwarp of the Adelaidean basement to the west along the axis of the Oraparinna Dome.

Two marker horizons are present, the lower is characterised by a total absence of fossils and the upper by an abundance of archaeocyaths and brachiopods. The Limestone rests on sandy deposits which appear to be terrestrial regolith or eluvium that are clearly a correlate of the Parachilna Formation.

During drilling sandy units (?calcarenite), oolitic horizons, and siltstones of uncertain stratigraphic significance were intersected since they are not known from outcrop. A near shore palaoeslope interdigitate facies sequence would be consistent.

Mineralisation:

Mineralisation was recognised on progressive followup to 400 ppm Zn stream sediment anomalies. Outcropping willemite covering patches as big as 45 x 12 m^2 were found within a region of haematitic pink dolomitic alteration within the Wilkawillina Limestone.

The mineralisation presents a surface geochemical signature over an area of 300 x 120 m^2 of greater than 1000 ppm Zn with elevated Pb and As. Some correlation between lead, arsenic, and manganese oxides is also evident. Willemite occurs in both massive and dispersed configuration, as radiating spherulitic aggregates or colloform banded masses.

An exposure of zinc rich goethite was found to be a superficial feature overlying anomalous goethitic clays that extended to at least 10m depth.

Costeans showed that the mineralisation is distributed very irregularly and surface/subsurface correlation is generally poor.

REVIEW No. : 7PB & AG59

SAMREF CAT. Nos. : 1001593, 1001594, 1001595.

ENVELOPE No. : 965

TITLE : SML 166, 167

LOCATION : ORAPARINNA, WIRREALPA, THIRD PLAIN, & BUNKERS GRABEN

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1001593.
Asarco (Aust.) Pty. Ltd., (Allchurch, P.D.) 1969. Special mining lease 166 (North), Mineral Exploration Progress Report, January 1969, SML166, South Australia.

#1001594.
Asarco (Aust.) Pty. Ltd., (Allchurch, P.D.) 1968. Special mining lease 166 (South) Oraparinna Prospects, Drilling Report, November 1968 and Core Analyses, SML 166, South Australia.

#1001595.
Asarco (Aust.) Pty. Ltd., (Hosking, A.J.) 1968. Special mining lease 166 (South), Geological Investigations, Progress Report to 30 Nov 1968, SML 166, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Wilpena Group.

Palaeozoic : Wilkawillina Limestone.

Structure : Oraparinna, Enorama, Wirrealpa, Upalinna, Yadnapunda Diapirs; Balcoracana Syncline, Bunkers Graben.

MINERALISATION :

Loves Mine; Appealinna Mine; Kibble Hill Mine; Wirrealpa Mine; Fountain Head Mine; Eregunda Mine.
Chalcopyrite; Bornite; Chalcocite; Digenite; Covellite; Willemite; Limonite; Malachite; Azurite; Barite; Crocidolite; Siderite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Nickel, Cobalt & multielement scans.
Geophysics : Aeromagnetic compilation map.

Costeaning : Mapped & sampled.

Drilling : Diapir mineralisation only. Diamond and percussion drilling.

Petrology: Sample descriptions.

COMMENTS :

Exploration focussed on Adelaidean Diapir mineralisation. However the stream sediment survey overlapped on to the Lower Cambrian and some low order anomalies (> 100 ppm Zn) were detected in the east of the title over Wilkawillina Limestone, in the Wirrealpa, Third Plain and Wilkawillina Gorge areas. Ref. pp. 064, 066/067 in ENV 965.

The Wilkawillina Limestone was recognised as containing "syngenetic lead-zinc".

REVIEW No. : 8PG/41CG SAMREF CAT. Nos. : 1000268

ENVELOPE No. : 975 TITLE : SML 202

LOCATION : REGIONAL SHEET : SH5413 PARACHILNA;

AROONA, ARROWIE, NARINA, BALCORACANA, KANYAKA, AREAS.

RECORDS/REPORTS :—

#1000268.
CRA Exploration Pty. Ltd., (McQueen, A.F.) 1968. SML 202, Flinders Ranges, South Australia. Geochemical Prospecting for Metallic Mineral Deposits, SML 202, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Lower Cambrian synclinal basins.

MINERALISATION :

Not discussed.

EXPLORATION :

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Silver, & Cobalt.

COMMENTS :

Entirely documentation of data organised by geographic region.

Area	Region
A	Aroona Syncline.
B	Arrowie Syncline.
C	Wirrealpa/Narina Syncline.
D	Kanyaka (north) Syncline.
E	Mernmerna/Kanyaka (south) Synclines.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 9PF/13CF & AG 45

ENVELOPE No. : 997, 1104, 1390

LOCATION : MOOROWIE, Mts. JOHN & CHAMBERS.

SAMREF CAT. Nos. : 1000616, 1000617, 1002259, 1003025, 1003089.

TITLE : SML 217, 217A, 217B.

SHEET : SH5413 PARACHILNA; 6735. SH5409 COPLEY; 6736.

RECORDS/REPORTS :—

#1000616.
Electrolytic Zinc Co. of A/Asia Ltd. & Newmont Pty Ltd., (Muller, D.W., Garman, M., and Wilson, R.B.) 1969. Final report on SML 217, Flinders Ranges, SML 217 South Australia, ENV. 997.

#1000617.
Electrolytic Zinc Co. of A/Asia Ltd., 1969, Final Report, Mt. Chambers Project, SML 217B, SML 217, South Australia. ENV. 997.

#1002259.
Electrolytic Zinc Co. of A/Asia Ltd., 1971, Progress reports, Arrowie-Wirrealpa area & Mt. Chambers, SML 217B, 217, South Australia. ENV. 1390.

#1003025.
Electrolytic Zinc Co. of A/Asia Ltd., (Wilson, R.B., and Tulp, T.) 1969, Report on SML 217A Flinders Ranges SA for the period 15th January 1969 to 15th July 1969, SML 217A, South Australia, ENV. 1104.

#1003089.
Electrolytic Zinc Co. of A/Asia Ltd., (Muller, D.W.) 1970. Progress reports SML 217A, 217 Flinders Ranges, SA. SML 217, 217A, 217B, South Australia. ENV. 1104.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Wilpena Group.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Mt. Frome Syncline.

MINERALISATION :

Mt. John Prospect, Moorowie Copper Mine; Mount Chambers Prospect. Galena; Aurichalcite; Rosasite; Malachite.

EXPLORATION :

Mapping : Geological, Stratigraphic.

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, & Zinc, Multielement scan.

Geophysics : Radiometric surveys.

Drilling : One diamond hole at Mt. Chambers Prospect but mislocated. Auger drilling.

COMMENTS :

Programme focussed on uranium exploration and diapir related mineralisation in addition to carbonate LZ. LZ work arose from the follow-up of radionuclide accumulations in secondary iron oxides which also had a Pb-Zn signature. (LZ exploration is addressed from page 055 in ENV 1104).

New outcrops of Wilkawillina Limestone (strongly deformed) were detected. (pp 057 ENV 1104).

The stream sediment programme is described from PP 070 ENV 1104 onwards. Seven areas of lead zinc enrichment associated with iron/manganese oxides and brecciated limestone were initially regarded as inconsequential.

However near Moorowie/Mt. Chambers Gorge stream sediments peaked at 2,300 ppm Zn and were backed up by rock chip sampling of limestone megabreccia which returned up to 7.2% Zn and 430 ppm Pb. Secondary Cu up to 0.5%. But the nature of the breccia mineralisation is unclear as this locality is both close to the Moorowie Mine and diapiric breccias.

At Mt. Chambers descriptions of the lithologies are suggestive of a frontal biohermal reef (pp 077 ENV 1104).

Similarly nearby to the Mt. Chambers Prospect stream sediments sampling outlined a strongly anomalous area of 3 km^2 with peak values of 6,000 ppm Pb & 500 ppm Zn that was backed up by rock chip sampling that returned up to 6,500 ppm Pb & 1,300 ppm Zn from massive Wilkawillina Limestone.

The association of **MVT** deposits and breccias of both sedimentary and structural origin is well documented. The anomalous breccias in the Mt. Chambers Gorge area therefore warrant careful examination to establish their genesis before their **MVT** potential/significance can be determined.

Rock Chip sampling at Mt. Chambers led to the diamond drilling but the first hole was mislocated by 300m. The accuracy sample and anomaly locations was criticised by Union Miniere, several years later, when they explored the area.

See later ENV. Nos. 1657, 2373, 3722, & 8071.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 10PB & AG61

ENVELOPE No. : 1146

LOCATION : Mt. LYALL - THIRD PLAIN, MORO.

SAMREF CAT. Nos. : 1003954, 1003955, 1003956, 1003957.

TITLE : SML 290, 293, 297

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1003954.
North Flinders Mines N.L. (Wilson, R.B., and Donovan, P.R.) 1971. Progress and final reports SML 290, Wirrealpa area, SA. Nov 1969-Jan 1971,. SML 290, South Australia.

#1003955.
North Flinders Mines N.L. (Wilson, R.B., and Rees, B.) 1970. Report on a Rotary-Percussion Drilling Programme, Third Plain Willemite Prospect, June - Nov, 1970, SML 290, South Australia.

#1003956.
North Flinders Mines N.L. (Rees, B.) 1970. Report on a Preliminary Rotary-Percussion Drilling Programme, Erina Waters Phosphate Prospect, SML 290, South Australia.

#1003957.
North Flinders Mines N.L. (Watts, Griffis & McOuat (Australia) Pty. Ltd., Garman, M.R.W.) 1970. Report on Investigations of SML 290, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Wilpena Group.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone, Parara Limestone, Lake Frome Group.

Structure : Balcoracana Syncline (west), Wirrealpa Diapir.

MINERALISATION :

Third Plain Willemite Prospect, Wirrealpa Mine, Fountain Head Mine, Eregunda Mine, Erina Waters Phosphate Prospect (Cambrian), Ango Mine, Parabarana Copper Prospect (Adelaidean).
Willemite; Smithsonite; Galena; Rhodocrosite; Siderite.

Third Plain resource estimated at 50,000 tons @ 15-20% Zn contained in a body oriented at > 60°.

EXPLORATION :

Mapping : Geological; Drill logs.

Geochemistry : Stream sediment, Soil, & Rock Chip sampling; Electron microprobe analysis; Drill hole analyses ; Copper, Lead, Zinc & Arsenic.

Geophysics : Radiometric surveys for phosphate exploration.

Drilling : Percussion drilling.

COMMENTS :

Extensive details of the follow-up to both previous and current stream sediment surveys are given. Field reconnaissance seems to have been quite thorough.

Association of geochemical anomalies with the Wilkawillina/Parara contact and/or yellow brown alteration and iron/manganese oxides is recurrent. Soil & Rock Chip sampling at least a dozen such sites indicates zinc is commonly present at concentrations of 0.1 to 0.3 %, with substantially less lead.

Zinc and manganese carbonates in addition to willemite were encountered during drilling. Their significance should be investigated.

Lithological data is suggestive of stratigraphic control and associations of sedimentary disconformities and/or breccias in some instances. Given recent knowledge (accompanying report) that implies that much of the Wilkawillina/Parara interface is demonstrably a palaeokarsted disconformity surface, the above anomalies are worthy of re-investigation.

Of palaeoenvironmental significance is the association of both sedimentary phosphate (commonly over 10% P_2O_5) and anomalous zinc up to 1000 ppm. Up to 0.5% adsorbed zinc is reported to be commonly found in other known phosphate deposits.

REVIEW No. : 11PMU & AG52

SAMREF CAT. Nos. : 1002876

ENVELOPE No. : 1157

TITLE : SML 302, 576, 583

LOCATION : TORRENS - Mts. ALECK & HAYWARD.

SHEET : SH5413 PARACHILNA; 6534,6535.

RECORDS/REPORTS :—

#1002876.
Electrolytic Zinc of A/Asia Ltd. (Muller, D.W.) 1971. Progress reports SML 302, Torrens, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina Limestone.

Structure : Mernmerna & Bunyeroo Synclines.

MINERALISATION :

Toondana Prospect.
Willemite; Malachite; Chalcocite; Chalcopyrite; Galena.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, & Zinc.

Drilling : Diamond drilling, 4 holes (see ENV. 1660).

COMMENTS :

The Toondana Prospect, situated in the Flinders Ranges National Park near Mt. Hayward, is hosted by a bed of archaeocyathan limestone. Mineralisation consists of small willemite bodies accompanied by galena and minor copper mineralisation. Rock chip sampling gave up to 11% Zn over 21.5m and drilling up to 31% Zn over 1.2m. A supergene enrichment origin was proposed. See RB 67/122.

At Mt. Aleck, anomalous lead zinc occurs at the base of the Cambrian sequence.

See ENV. 1660 for additional information on Mts. Aleck & Hayward.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 12PG

SAMREF CAT. Nos. : 1003977, 1003978.

ENVELOPE No. : 1229

TITLE : SMLs. 290, 292, 293

LOCATION : PARACHILNA, MORO

SHEET : SH5413 PARACHILNA; 6536; 6636; 6535; 6635.

RECORDS/REPORTS :

#1003977.
North Flinders Mines N.L. (Garman, M.R.W., Watts, Griffis & McOuat (Aust.) Pty. Ltd.) 1970. Reports on Investigation of Stream Sediment Geochemical Anomalies in SML's 290, 292 and 293. SML 292, South Australia.

#1003978.
North Flinders Mines N.L. (Wilson, R.B., Donovan, P.R., & Fidler, R.W.) 1971. Progress and final reports SML 292, Nilpena SA. Nov 1969-Jan 1971. SML 292, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Umberatana Group, Wilpena Group.

Palaeozoic : Parachilna Formation; Ajax Limestone.

Structure : Arrowie Syncline

MINERALISATION :

Nuccaleena Mines; Warioota Mine; Lady Lehman Mine; Wheal Butler Mine; Ladder Mine; Oratunga Mine; Mt. Mary Mine; Mt. Elkington Mine; Wepowie Mine (Adelaidean).
Willemite; Malachite.

EXPLORATION :

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Cobalt & P_2O_5; pH.

COMMENTS :

This project area was probably established to extend the assessment of Lower Cambrian data throughout the Northern Flinders Ranges that was began with SML 290 ENV 1146. The study of previous surveys suggested that sample densities were somewhat less than ideal and frequently the surveys had been restricted too much to the lower-most Cambrian. The regional survey by CRAE SML 202, ENV. 975 was particularly criticised.

A number of anomalous stream sediment and rock chipped sample sites are documented with geological data which suggests follow-up is warranted. Such sites are associated with the Parachilna/ Wilkawillina/Parara boundaries and have ferruginisation haematite/goethite ± dolomite associated.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 13PYK

ENVELOPE No. : 1258

LOCATION : HAWKER

SAMREF CAT. Nos. : 1002767.

TITLE : SML 323

SHEET : SH5413 PARACHILNA;

RECORDS/REPORTS :—

#1002767.
Exoil N.L. and Transoil N.L., (Youles, I.P., Benbow, D.C., and Lopes, D.) 1970. Progress Reports, SML 323, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Yappala & Kanyaka Synclines.

MINERALISATION :

Willemite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment, Rock chip sampling; Copper, Lead, Zinc, Silver, Bismuth, Arsenic, Antimony, & Multielement scan.

Drilling : Percussion.

COMMENTS :

Follow-up of stream sediment sampling resulted in the examination of an 11 km long 15 m wide NE striking iron/manganese zone with minor base metals and silver, which proved to be a residual weathering cap on ferruginous shales.

There appeared to be no anomalous features associated with Cambrian carbonates.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 14PH

ENVELOPE No. : 1363

LOCATION : REAPHOOK HILL

SAMREF CAT. Nos. : 1002349, 1002355, 1002370, 1002371, 1002372.

TITLE : SML 339

SHEET : SH5413 PARACHILNA; 6734.

RECORDS/REPORTS :—

#1002349.
Delhi International Oil Corporation. (Rees, B.V.L., Cundill Myers & Associates Pty. Ltd.) 1971. Report on Preliminary Geochemical Investigations in the Reaphook Hill area, SML 339, South Australia.

#1002355.
Dobbyn Mines Pty Ltd, 1971. Progress reports on SML 339 Reaphook Hill, South Australia.

#1002370.
Delhi International Oil Corporation. (Caunt, F.M.) 1971. A Preliminary Report on the Geology of the Kempes Bore area, Eastern Flinders Ranges, SML 339, South Australia.

#1002371.
Dobbyn Mines Pty Ltd. (Gabriel, C.) 1971. Summary of the Geology of the Emu Bore area, SML 339, South Australia.

#1002372.
Delhi International Oil Corporation. (Gehling, J.G.) 1971. The Geology of the Upper Proterozoic and Lower Cambrian of the Reaphook Hill area, Eastern Flinders Ranges, SML 339, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Brachina Formation, Bunyeroo Formation, Wonoka Formation, Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone, Billy Creek Formation.

Structure : Reaphook Syncline.

MINERALISATION :

Malachite.

EXPLORATION :

Mapping : Geological, Structural, Photogeology, Palaeontology.

Geochemistry : Rock Chip sampling; Manganese; Phosphate; Zinc; Copper; Multielement scans.

COMMENTS :

Throughout the Reaphook hill area the prospective zone at the base of the Wilkawillina Limestone and the underlying Parachilna formation is obscured by alluvium.

This prospective zone consists of a 100m thick unit of variegated and dolomitised limestone which is sometimes vuggy. Patches of iron/manganese oxide concentration up to 150m in diameter and/or ferruginised scree and rubble are sometimes also present. (pp 085)

A vuggy horizon about 300 m above the base of the Wilkawillina Limestone may be mineralised.

Areas of alluvium could well conceal mineralisation that is expressed less strongly in nearby outcrop and therefore warrant systematic exploration.

The presence of the dolomitisation and some development of vugs may be a result of Cambrian palaeokarsting but the evidence is ambiguous since the presence of pisolitic calcrete on the Reaphook Plateau suggests the zone of mineralisation could have been affected by Mesozoic/Tertiary weathering that may have caused the development of vugs and overprinted primary alteration to some degree. However major dolomitisation is most likely to be diagenetic and/or alteration associated with the mineralisation.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 15PK

ENVELOPE No. : 1378

LOCATION : HAWKER

SAMREF CAT. Nos. : 1002353.

TITLE : SML 371

SHEET : SH5413 PARACHILNA; 6534.6634.

RECORDS/REPORTS :——

#1002353.
Exoil N.L. & Transoil N.L. (Hillwood, E.R., - Minoil Services Pty Ltd) 1970. Report on SML 371, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina, & Parara Limestones, Oraparinna Shale

Structure : Kanyaka Syncline.

MINERALISATION :

Not discussed.

EXPLORATION :

Geochemistry : Stream sediment & Rock Chip sampling; Zinc, Copper, Lead, & Silver.

COMMENTS :

Anomalous stream sediment samples do not seem to have been fully explained in geological terms. Comparison with earlier geochemical programmes to determine if any new metal sources exist is warranted.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 16PK

ENVELOPE No. : 1531

LOCATION : HAWKER

SAMREF CAT. Nos. : 1004757.

TITLE : SML 500.

SHEET : SH5413 PARACHILNA; 6534,6634.

RECORDS/REPORTS :—

#1004757.
Electrolytic Zinc Co. of A/Asia Ltd. (Schmidt, B.L.) 1971. Progress & summary reports 5/11/70-5/8/71, SML 500 Hawker, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material).

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Kanyaka Syncline, Arkaba Diapir.

MINERALISATION :

Goethite; Malachite; Galena; Crocidolite.

EXPLORATION :

Geochemistry : Stream sediment sampling; Copper, Lead, & Zinc.

COMMENTS :

Zinc-lead anomalies were attributed to scavenging by iron- and clay-rich weathering products of Parara Limestone and Parachilna Formation. However, the possibility that these represent palaeokarst fill should be investigated.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 17PDB & AG63

SAMREF CAT. Nos. : 1004188

ENVELOPE No. : 1548

TITLE : SML 397

LOCATION : TEN MILE CK.

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1004188.
Austral Pacific Mining. (Fidler, R.W., and Donovan, P.R.) 1972. Geochemical-Geological Investigations Parachilna area, SML 397 Flinders Ranges, 1971-1972, SML 397, South Australia.

GEOLOGY :

Adelaidean : Etina Formation.

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Donkey Bore & Balcoracana Synclines.

MINERALISATION :

Willemite; Galena; Malachite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment & Rock Chip sampling; Copper, Lead, & Zinc; Heavy mineral separation: willemite; X-ray diffraction; Electron microprobe analysis.

COMMENTS :

The stratigraphic relations of some Lead (minor Zn) stream anomalies are unclear. Several appear to be spurious since they occur on alluvial plains, but release of lead from formerly reduced Tertiary muds or some such origin is possible.

Some Zinc (minor Pb) anomalies located in the south of the area, in the vicinity of Leslies Dam (20km SW of Mt. Mantell), are sourced in the Adelaidean Etina Formation and are not of **MVT** interest.

Elsewhere Zinc stream anomalies are sourced in the Wilkawillina Limestone. Heavy mineral concentrates prepared from some anomalous stream samples contained detectable willemite.

Follow-up rock chip sampling at some locations showed that haematised Wilkawillina Limestone can contain wp to 10 x normal background Zinc concentrations. Willemite would be a suspected mineral form where pervasive alteration was present. Haematisation associated with the Flinders unconformity is a separate primary diagenetic feature. The documentation does not make this distinction.

The follow-up work lead to the inference that lead mineralisation in the Wilkawillina Gorge area was related to fissuring in the Wilkawillina Limestone where high lead and zinc values were attributed to adsorption by manganese oxides.

Stratigraphic and lithofacies correlation of these anomalies is warranted.

Lower Cambrian limestones in the Ten Mile Creek area (near Linda Prospect) were recognised as mineralised, although the exact nature of the mineralisation was not determined. The occurrences of lead marked on the geological map appear to be to the southwest of Linda Prospect in the more basinal facies of the limestones. Linda Prospect itself was not recognised.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 18PDB/16CWB AG36,47
SAMREF CAT. Nos. : 1004206, 1004208, 1004209.
ENVELOPE No. : 1638
TITLE : SML 557 (290, 292 & 293)

LOCATION : THIRD PLAIN, MORO, LINDA, NARINA, MT. ROEBUCK.
SHEET : SH5413 PARACHILNA; 6635. SH5409 COPLEY; 6636.

RECORDS/REPORTS :—

#1004206.
North Flinders Mines Ltd. (Wilson, R.B., Read, R.E., Cartew, S.J., Fidler, R.W., and Donovan, P.R.) 1972., Progress reports SML 557 Blinman - Wirrealpa area, (Includes Regional Geochemistry Survey Reports by McPhar), SML 557, South Australia.

#1004208.
North Flinders Mines Ltd. (Read, R.E.) 1971. Report on rotary percussion drilling Patawarta Zinc Prospect, SML 557, South Australia.

#1004209.
North Flinders Mines Ltd. (Read, R., and Carthew, S.J.) 1971. Geological report on the Patawarta Diapir by Read. Follow up of stream sediment geochemical anomalies by Carthew, SML 557, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Umberatana Group, Wilpena Group.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Arrowie, Balcoracana, Narina Synclines.

MINERALISATION :

Patawarta Zinc Prospect, Wepowie, Mt. Mary, Lady Lehman, Lady Lennon, Mt. Rugged, Warioota, Oratunga, Ivy Queen, Ladder, Mosley's Copper, Wheal Butler Mines (Adelaidean), Third Plain willemite prospect (Cambrian), Henry's Range, Orange Tree prospects.
Polysphaerite (Wepowie); Galena; Sphalerite; Gold; Chalcopyrite; Chalcocite; Malachite; Azurite; Phosphate; Haematite; Siderite; Gossans.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream Sediment & Rock Chip sampling. Zinc, Lead, Copper & Multielement scans.

Drilling : Percussion drilling at Patawarta.

Petrology: Minerological descriptions.

COMMENTS :

Patawarta (west limb of Narina Syncl.) & Wepowie/Mt. Mary Mines (Oraparinna Antcl.).

The focus of the work identified by SAMREF is the Patawarta Zinc Prospect in Adelaidean Bunyeroo Formation . Together with the overlying Wonoka Formation the Bunyeroo Formation constitutes the latest Adelaidean carbonate sequence which is separated by one unit, the Pound Subgroup, from the overlying Lower Cambrian units.

The prospect is marked by a 1.5 km long stratabound gossan of unclear genesis. The gossan contains low-iron sphalerite. Given its stratigraphic proximity to the Lower Cambrian, a field inspection to assess possible **MVT** affinities is warranted.

The mines of the Oraparinna Anticline are hosted by Adelaidean sediments and diapiric breccias and are not **MVT** relevant.

Moro George & Spring: (Copley Sheet)

Ferruginous material 5 to 6 m thick on a dipslope surface has up to 5000 ppm Pb with anomalous zinc over a strike of 400 m was detected. The zone is close to the Wilkawillina Parara/Limestone interface. The origin of the ferruginous deposit was not self- evident a the time of mapping but there is a strong possibility that the horizon/surface could be the palaeokarsted Flinders Unconformity with a **MVT** signature.

Narina Syncline:

Stream sediment sampling along the eastern limb to the west of Mt. Brooke revealed that a 4 km long anomalous zone with up to 1700 ppm Zn, is present in the Wilkawillina Limestone (pp. 122, 196). Anomalous zinc values occur along Wirrapowie Creek, and were tentatively attributed to a "duricrust". Further investigation is needed.

At a location 3 km east of "Point Well" on the western limb of the syncline, manganiferous phosphatic rock near the Wilkawillina/Parara Limestone interface associated with possible karstic features has up to 1700 ppm Zn and 17% P_2O_5 (pp. 032, 079, & see ENV. 4449).

Anomalous zinc was found to be associated with manganiferous outcrops in Wilkawillina Limestone 6 to 7 km SE of "Narina".

Arrowie Syncline. (Copley Sheet)

Stream sediment Zn anomalies to the north of River Bluff and at Bullock Head Gap were also considered to be sourced in the Wilkawillina Limestone (p. 122). However the Brachina Formation at Bullock Head Gap was also found to carry elevated Cu, PB, & Zn.

The Rivers Bluff anomaly was accompanied by elevated levels of copper but no lead.

Third Plain:

Zinc anomalies located 1 km north of the Wilkawillina Gorge were found to correlate with Willemite in the stream load but no source area with the characteristic haematite alteration was recognised.

Re-mapping indicated that thrust faults mapped by previous workers could not be substantiated.

Wilkawillina George (adjacent to Linda Prospect):

Four NE trending anomalous zones were inferred from stream sediment sampling within an area of about 8 km^2 over Wilkawillina Limestone in the Bunkers Graben. Anomalous results are supported by up to 500 ppm Zn in soils. Faulting was suspected to be responsible for the pattern (p. 086).

It seems that arbitrary statistical methods resulting from the restrictive data set appear to have failed to take into account the regional average background for Pb & Zn of 80 ppm, and consequently have not declared anomalous results at the 200 ppm level. Using a lower threshold shows a strong stratigraphic bias for the results.

The ridge and spur sampling was restricted in its scope to the anomalous creeks and thus was also incapable of recognising the stratigraphic correlation. The Linda prospect therefore remained undetected.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 19PF

ENVELOPE No. : 1657

LOCATION : MOOROWIE
SH5409 COPLEY; 6536.

SAMREF CAT. Nos. : 1000282.

TITLE : SML 548

SHEET : SH5413 PARACHILNA; 6535;

RECORDS/REPORTS :—

#1000282.
North Flinders Mines Ltd., (Wilson, R.B.) 1971., Mt. Chambers Gorge, Final Report,. SML 548, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Mt. Frome Syncline.

MINERALISATION :

Moorowie mine.

EXPLORATION :

Geochemistry : Rock chip sampling; Copper, Zinc, & Lead.

COMMENTS :

'Hydrothermal' mineralisation along the Moorowie Fault was the main focus od the work done including a Student Honours thesis which concluded that hydrothermal fluids had selectively replaced non-dolomitic blocks in the megabreccias with siliceous masses.

Such a genesis is somewhat questionable since siliceous replacements are known to exist well away from faults elsewhere such as near the Eric Prospect to the immediate south. A late in situ silicification of palaeokarstic deposits cannot be ruled out.
Examination of the internal structure of the siliceous bodies at Moorowie is therefore of generic importance to **MVT** understanding in the area since there is a reasonable probability that the precursor Moorowie Fault may have been an **MVT** brine conduit facilitating mineralisation in the adjacent sediments.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 20PM,PU & AG52

SAMREF CAT. Nos. : 1000331, 1000334.

ENVELOPE No. : 1660, 1674

TITLE : SML 576,583

LOCATION : Mts. HAYWARD & ALECK

SHEET : SH5413 PARACHILNA; 6535,6635. & 6534.

RECORDS/REPORTS :—

#1000331.
Electrolytic Zinc Co of A/Asia Ltd. 1971. Progress Reports Mt. Aleck, SML583, South Australia.

#1000334.
Electrolytic Zinc Co of A/Asia Ltd. (R.A. Horn), 1972. Progress Reports, SML 576 Mt. Hayward and SML 583 Mt. Aleck., South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Mernmerna & Bunyeroo Synclines.

MINERALISATION :

Toondana Prospect.
Willemite; Chalcocite; Malachite.

EXPLORATION :

Mapping : Geological & Photogeological.

Geochemistry : Stream sediment sampling; Heavy mineral separation; Electron microprobe; Lead & Zinc.

Drilling : Diamond drilling (4 holes-Mt. Hayward).

COMMENTS :

In the Mt. Aleck area (SML 583), anomalously high zinc and lead levels occur in streams draining Lower Cambrian limestone. The lead-zinc source was apparently attributed to plumbian/zincian wad.

In the Mt. Hayward area (SML 576), diamond drill holes were sited to test outcropping willemite. However, drilling was limited to lightweight equipment due to the area being in a National Park. Comparison with the willemite from Third Plain implied different origins for the two prospects. "Earthy ocherous material" intersected in DDH T1 may represent palaeokarst fill.
See ENV. 1157.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 21PK

SAMREF CAT. Nos. : 1004184

ENVELOPE No. : 1677

TITLE : SML 500, 582.

LOCATION : DRUID RANGE

SHEET : SH5413 PARACHILNA; 6634.

RECORDS/REPORTS :—

#1004184.
Electrolytic Zinc Co. of A/Asia Ltd., 1971., Progress report SML's 500 and 582 Hawker and Druid Range, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones, Oraparinna Shale.

Structure : Kanyaka Syncline.

MINERALISATION :

Not discussed.

EXPLORATION :

Geochemistry : Stream sediment sampling; Copper, Lead & Zinc.

COMMENTS :

Stream sediment follow-up resulted in the recognition of elevated base metal levels in the Parachilna Formation. Ochreous clays were notably enriched with respect to lead and zinc.

Galena mineralisation was also found in the Parara Formation south of the Arkaba Diapir.

The stratigraphic relationships of the mineralisation warrant description and interpretation.

See ENV. 1531.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 22PYK/70YK & AG70

ENVELOPE No. : 1698

LOCATION : KANYAKA

SAMREF CAT. Nos. : 1001779.

TITLE : SML 584.

SHEET : SH5413 PARACHILNA; 6533,6534.

RECORDS/REPORTS :—

#1001779.
Electrolytic Zinc Co. of A/Asia Ltd., (Horn, R.A.) 1971. Progress reports SML 584 Kanyaka, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation.

Structure : Yappala & Kanyaka Synclines.

MINERALISATION :

Kanyaka mine.

EXPLORATION :

Geochemistry : Stream sediment sampling; Copper, Lead, & Zinc.

COMMENTS :

Geochemical surveys indicated that anomalies related to the Parachilna Formation show elevated lead and zinc to levels of about 7x regional background.

Some elevation of lead and zinc is also found to be associated with a crush zone in the southeast of the area 4km to the west of Kanyaka Hill.

Lithostratigraphic documentation of the geochemical enrichments is warranted.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 23PO

ENVELOPE No. : 1749

LOCATION : WARRAKIMBO

SAMREF CAT. Nos. : 1000322.

TITLE : SML 611

SHEET : SH5413 PARACHILNA; 6534.

RECORDS/REPORTS :—

#1000322.
Electrolytic Zinc Co. of A/Asia Ltd., 1971, SML 611 Warrakimbo, Final Report, South Australia.

GEOLOGY :

Adelaidean : ?Callanna Group (diapiric material), Umberatana Group.

Palaeozoic : Hawker Group.

Structure : Warrakimbo Syncline.

MINERALISATION :

In diapiric material: Specularite, Malachite, Magnetite.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment sampling; Copper, Lead & Zinc.

Geophysics : Ground and Aeromagnetic surveys.

COMMENTS :

Anomalous lead and zinc found in the basal limestone but lithostratigraphic details were not reported. There is some possibility that the mineralisation may have been influenced by the faulting.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 24PU & AG51

ENVELOPE No. : 660, 2356

LOCATION : LAKE TORRENS

SAMREF CAT. Nos. : 1001711, 0004912.

TITLE : SML 115.

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1001711.
Mines Exploration Pty. Ltd., (Roberts, J.B.) 1966., Technical Report at Expiration of SML 115, Lake Torrens area, South Australia.

[NOTE: Contents of ENV. 660, 0004912 have been transferred to ENVs. 2356, 2358, 2359.]

GEOLOGY :

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Mernmerna & Bunyeroo Synclines.

MINERALISATION :

Galena, Sphalerite, Gossan.

EXPLORATION :

Mapping : Stratigraphic mapping of drill hole cores and in the field.

Geochemistry : Stream sediment & Rock Chip sampling;Hand Auger sampling; Drill core analysis; Copper, Lead, & Zinc.

Geophysics : IP surveys, ground magnetics.

Drilling : Petro-exploration wells: Wilkatana 1, 2, & 3.

COMMENTS :

Programme focussed on Lower Cambrian sequences in petroleum cores from the Torrens region and demonstrated the westerly extent of the Arrowie Basin under Tertiary cover. The work also demonstrated that the elevated base metal signature of the Lower Cambrian was ubiquitous.

Exploration along the western margin of the Flinders Ranges from north of Parachilna Gorge south to Mt. Aleck led to the recognition of lead-zinc mineralisation about 10 km north of Brachina Gorge.

Mineralisation was found both in veins and as disseminations in breccias. Galena was found as floaters in one stream and could therefore be anticipated to show up in the finer heavy mineral fraction of the stream sediment from this area.

IP electrical surveys were carried out on suspected mineralisation but the results were far from ideal.

Gossans were found to carry up to 1% or more of Zn but proved disappointing when further tested, becoming dubbed 'false gossans'.

The 'false' perception arises from the assumption that gossans are strictly in-situ pseudomorphic in character. However, the weathering process generates acid which is immediately neutralised by the carbonate host through its dissolution, and the void thus generated is then available for occupation by weathering residues.

Since these processes are a function of oxidation and require moisture, they are most active at the water table. Maximum gossan development occurs at that position when it is stable for a prolonged period.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 25PUO & AG51

ENVELOPE No. : 843,854,895, 2356,& **2359**

LOCATION : LAKE TORRENS

SAMREF CAT. Nos. : **1001712**, 1001714, **1001716.**

TITLE : SML (115, 129, 130, 130A), **131, & 131A.**

SHEET : SH5413 PARACHILNA; 6534; 6535; 6635.

RECORDS/REPORTS :—

#1001712.
Mines Exploration Pty. Ltd., (Roberts, J.B.) 1969. Progress and Final Reports SML 131 and 131A Lake Torrens area, South Australia. ENV. 2359 (Roberts J.B., 1968b,c,f& h, ENV. 843,854,& 895 : RI37)

#1001714.
Mines Exploration Pty. Ltd., (Roberts, J.B.) 1969. Progress and Final reports Lake Torrens area, SML's 129, 130, 130A, 131 & 131A, South Australia. ENV. 2356

#1001716.
Mines Exploration Pty. Ltd., (Webb, J.E., and Bishop, J.R.) 1968. Report on Geophysical Surveys in the Parachilna area, SML131, South Australia. ENV. 2359

GEOLOGY :

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Bunyeroo Syncline; Pirie-Torrens Basin; Cotabena Syncline.

MINERALISATION :

Galena; Pyrite; Manganese; Gossans.

EXPLORATION :

Mapping : Geological

Geochemistry : Stream sediment (3,300), Rock Chip (320) & Soil sampling; Drill core analysis; Lead, Zinc, Copper, & Silver.
Geophysics : Electrical surveys; IP surveys; Ground magnetic surveys; Magnetic & Gravity interpretation.

Drilling : Diamond Drilling, 5 holes.
Petrology: Minerological descriptions.

COMMENTS :

Persistent though weak mineralisation was found to be associated with several oolitic/algal limestone units in the Bunyeroo Syncline.

Individual basal dolomitic horizons up to 1.2m x 250m with both veinlet and/or disseminated galena, sphalerite, pyrite, ?chalcopyrite and their oxidation products, haematite, limonite, anglesite, cerussite and copper carbonates were found.

Higher in the sequence minor fracture fill galena was also noted in massive archaeocyathan limestone which also hosts what appear to be secondary gossans.

Six localities were examined. These were named Galena Creek and Grids A to E. The latter work focussed on two 'gossans' in the lower Wilkawillina Limestone.

Gossan (grid) A, 1100m x 60m, was found to comprise two pyrolusite forms that were pseudomorphic after rhombic carbonate that formed in an inferred fault zone between the Wilkawillina Limestone and Pound Subgroup. At surface it was shown to contain up to 1.0% Zn and 0.4 oz/ton Ag, drilling indicated these grades are generally maintained to at least 150m depth where the body was demonstrably thinned. The mineralisation was inferred to be secondary, due to scavenging by iron/manganese oxides.

Gossan (grid) B was similar but with lower lead content and only up to 1000 ppm Zn.

Nearby, a horizon with gossanous zones (B-NE) was found to contain up to 1,100 ppm Pb & 8,700 ppm Zn.

SEE SADME RB 86/18 for followup exploration.

REVIEW No. : 26PF

ENVELOPE No. : 2373

LOCATION : Mt. FROME

SAMREF CAT. Nos. : 1014844.

TITLE : EL 103.

SHEET : SH5413 PARACHILNA; 6735.

RECORDS/REPORTS :—

#1014844.
Union Miniere (Aust.) Pty. Ltd., (Ikstrums, J., and Garman, M.R.W.) 1974,. EL 103 Mount Frome, Progress & Final reports from 14-12-73 to 4-9-74. EL 103, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Mt. Frome Syncline.

MINERALISATION :

Mount Chambers Copper-Lead Prospect.

EXPLORATION :

Mapping : Geological.

Geochemistry : Rock Chip sampling; Copper, Lead, & Zinc.

Drilling : Percussion drilling (18 holes).

COMMENTS :

Rock chip geochemistry in the Mt. Chambers Mine area delimited a zone of anomalous copper, lead and zinc. The anomaly, which was closed to the NE and open to the south, was tested by drilling and the results were considered discouraging.

In spite of the excellent mapping and the possibility of mineralisation extending down dip to the east being recognised, the Flinders Unconformity remained unrecognised and the Eric Prospect undiscovered.

"Epigenetic" dolomitisation was noted in the anomalous area.

REVIEW No. : 27PDB

ENVELOPE No. : 2986

LOCATION : WIRREALPA

SAMREF CAT. Nos. : 1004585.

TITLE : EL 299.

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1004585.
Carpentaria Exploration Co Pty Ltd. (Simpson, P.G.) 1977. Progress and Final Reports 22/4/77-17/10/77, EL 299, Wirrealpa, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material).

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Donkey Bore, Narina, & Balcoracana Synclines.

MINERALISATION :

Galena.

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment & Rock Chip sampling; Lead, Zinc, Copper, Silver, Barium, Iron, Sulphur & Fluorine.

COMMENTS :

Geochemical orientation surveys were carried out in the vicinity of previously known mineralisation. Palaeokarstic features were recognised from P. Haslett's work on the same area.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 28PB

SAMREF CAT. Nos. : 1006163.

ENVELOPE No. : 3305

TITLE : EL'S 368, (366,367)

LOCATION : COFFINS BORE, (WERTALOONA & BUNYEROO)

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#1006163.
Western Mining Corporation Pty. Ltd., 1978. Terminal Report Exploration Licences: 366 (Wertaloona), 367 (Bunyeroo) and 368 (Coffins Bore), South Australia.

GEOLOGY :

Palaeozoic : Lake Frome Group:- Moodlatana & Balcoracana Formations, Pantapinna Sandstone, Grindstone Range Sandstone.

Structure : Balcoracana Syncline.

MINERALISATION :

Weak thin stratiform copper at Moodlatana/Balcoracana Formation contact in Bunyeroo EL 367.
Malachite; Chalcocite; Bornite.

EXPLORATION :

Mapping : Regional geological.

Geochemistry : Soil & rock chip sampling; Drill sample analysis; Copper, Lead, Zinc, Cobalt, Nickel, Uranium.

Geophysics : Gravity surveys; Ground magnetic surveys.

Drilling : Percussion drilling (2 holes).

COMMENTS :

The program unsuccessfully sought economic copper mineralisation in dolomitic lithologies at the Moodlatana/Balcoracana Formation contact. It appears to have little relevance to exploration for MVT mineralisation.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 29PDB & AG57

SAMREF CAT. Nos. : 0003519, 0003520, 0004377.

ENVELOPE No. : 3427

TITLE : EL's 436, 809, 934, 1085, 1129 & 1138

LOCATION : WIRREALPA

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#0003519.
Dampier Mining Co Ltd, BHP Minerals Ltd, and Esso Australia Ltd. (Vivian, B.J., Roche, M.T., and Mann, S.T.) 1987. Wirrealpa Progress Reports from 29.11.79 to 27.12.87, EL 436, EL 809, EL 894 and EL 1129, South Australia.

#0003520.
BHP Minerals Ltd. (Roche, M.T., Parrington, P.J., and Blain, C.F.) 1983, Exploration for carbonate-hosted base metals in the Flinders Ranges, South Australia. EL 934, EL 894, EL 1080, EL1084, EL1085, EL 1129, & EL 1138, South Australia. ENV 3427, 3722 & 3968.

#0004377.
BHP Minerals Ltd, and Esso Australia Ltd (Roche, M.T.), 1985. Flinders Ranges Joint Venture Drilling Programmes: EL 1085, EL 1129 and EL 1138, South Australia. ENV 3968 & 3427.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Wonoka Formation.
Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Narina & Donkey Bore Synclines.

MINERALISATION :

Wirrealpa silver lead mine; Donkey Bore Prospect; unnamed occurrences. Galena, Hydrozincite, Smithsonite.

EXPLORATION :

Mapping : Regional and detailed geological mapping, (1:10,000 scale).

Geochemistry : Stream sediment & Rock Chip sampling; Drill core analysis; Copper, Lead, Zinc, Silver, Tin, Arsenic, Nickel, Cobalt, Cadmium, Molybdenum, Iron, Manganese, Gold, Calcium, Magnesium, Silica.

Geophysics : Borehole Radioactivity, Resistivity, & SP logs.

Drilling : Diamond drilling, 22 holes; Reverse circulation, 7 holes.

COMMENTS :

The palaeokarsting of the Wilkawillina Limestone prior to the deposition of the overlying Parara Limestone is evident from the mapping. Correlation between the palaeokarsted environment and the mineralisation is confirmed by geochemical sampling.

The Wilkawillina Limestone was found to be subdividable on a lithofacies basis. Archaeocyathan limestone, calcilutite and calcarenite are the predominant facies types that can be shown to have substantial lateral continuity. Breccias and conglomeratic beds are locally important in the vicinity of the Wirrealpa Diapir.

Locally to the south of the Wirrealpa mine chert nodules with an endolithic texture believed to be fibrous felted pseudomorphic replacement of anhydrite were observed in the top of the Wilkawillina Limestone. Together with the observation of some textural similarities of the Woodendinna Dolomite to the halite bearing Myrtle Shale of the Mc Arthur Basin NT, suggests that a coastal marine/sabkha environment may have existed during palaeokarsting.

Mineralisation is found to occur as archaeocyath replacements and in veins. The veins are now known to be in part pre-mineralisation marine cements of sparry calcite which is frequently banded. The first stage of mineralisation seems to have been d2eposition of barite and calcite, which is later followed by galena, chalcopyrite, sphalerite, and more barite. Accessory siderite, dolomite, and pyrite were also observed.

Drilling demonstrated the widespread occurrence of weak mineralisation but the records show that much of the rock chip geochemistry was carried out after drilling and target optimisation had not been possible. Best intersection WD 18, 10m @ 1.2% Zn.

The mineral suite and the geological setting fit the **MVT** deposit model quite well. See ENV. 8072 for follow-up exploration.

In close proximity to the diapir, significant mineralisation is present at the Wirrealpa Lead Mine and minor trace mineralisation along the Eregunda Fault. In both these situations there is a strong possibility of former **MVT** mineralisation being remobilised and redeposited with the addition of gold without significant relocation.

Of unknown significance is the recording of lead-zinc mineralisation (best interval: 18m @ 3.4% Pb+Zn) at Ti-Tree Gorge Well within the Adelaidean Wonoka Formation.

REVIEW No. : 30PF/44CF & AG56
ENVELOPE No. : 3722

LOCATION : MOOROWIE, Mts. CHAMBERS & FROME.

SAMREF CAT. Nos. : 0003520, 0003524.

TITLE : EL 538, 807, 894, 934, 1080, 1084, 1085, 1129 & 1138.
SHEET : SH5413 PARACHILNA; 6735.

RECORDS/REPORTS :—

#0003520.
BHP Minerals Ltd. (Roche, M.T., Parrington, P.J., and Blain, C.F.) 1983, Exploration for carbonate-hosted base metals in the Flinders Ranges, South Australia. EL 934, EL 894, EL 1080, EL1084, EL1085, EL 1129, & EL 1138, South Australia. Envelopes, 3427, 3722 & 3968.

#0003524.
Dampier Mining Co Ltd (BHP Minerals Ltd), and Esso Australia Ltd., (Vivian, B.J., and Mann, S.T.) 1987, Mount Frome, Progress reports & Surrender report from 25.10.79 to 25.2.88, EL 538, EL 807 and EL 1138, South Australia.

[NOTE: Report EL 807, 0001665, ENV. 5016, minor **MVT** interest.]

GEOLOGY :

Adelaidean : Callanna Group (diapiric material, Wonoka Formation, Pound Subgroup.

Palaeozoic : Wilkawillina/ Moorowie Limestone, Parara Limestone.

Structure : Mt. Frome Syncline.

MINERALISATION :

Moorowie copper mine, Wilnuroona & Eric lead zinc prospects.
Galena; Cerussite; Sphalerite; Smithsonite; Hydrozincite; Malachite; Azurite; Fluorite.

EXPLORATION :

Mapping : Regional and detailed geological mapping, & Photo-interpretation.

Geochemistry : Stream sediment, Rock Chip, Jack Hammer & Channel sampling; Drill sample analysis; Copper, Lead, Zinc, Silver, Manganese, Iron, Magnesium, Calcium, Cadmium, Cobalt, Gold, Arsenic.

Geophysics : IP surveys at Moro Gorge and Moorowie. Downhole gamma surveys DDF3,4,5.

Drilling : RAB/Percussion drilling (152 holes); Diamond drilling (10 holes).

COMMENTS :

Mt. Chambers Prospect (Eric/Wilnuroona).

This programme followed-up previous work by EZ and UM (ENV. 997, 1104, 1390 & 2373 resp.) in the vicinity of the Mt. Chambers Copper Mine.

In this locality the Wilkawillina Limestone and overlying Parara Limestone dip have a shallow easterly dip. Mapping identified a number of beds with sparite filled cavities upon their upper surfaces that appear to carry anomalous levels of zinc.

In the same region small patches of diapir were mapped but later work demonstrates that these have a different origin.

A small alluvial/eluvial plain in an outcrop embayment west of the Union Miniere rock chip anomaly was found to have a strong soil and stream lead-zinc signature of 6000 ppm Zn & 4000 ppm Pb. This area was extensively drilled on the basis that it was a palaeokarst of some magnitude but the results were disappointing. Mineralisation was proven to be strongest (≤2300 ppm Zn & 1-5 % Pb) in the east around the edge of the outcrop and the new occurrence was named Eric.

Further east, just below the Parara Limestone at Wilnuroona a small body of dark grey 300m^2 carbonate breccia of indeterminate origin grading 7.5% Pb+Zn with significant silver was drilled at grid A. Nearby weak mineralisation was detected at grid B in the sparitic top of a massive limestone bed.

See ENV. 8071 & 3968 for follow-up exploration.

Moorowie Prospect. (Copley Sheet)

The Moorowie Prospect is a combined copper & lead-zinc occurrence hosted by Lower Cambrian carbonate sedimentary breccias in close proximity to diapiric breccias on the west and relatively active faults to the east.

In this context it bears some parallels with the Wirrealpa Lead Mine and may represent remobilised **MVT** mineralisation.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 31PDHB(F) & 31PH AG62

SAMREF CAT. Nos. : 0003435, 0003520, 0004376, 0004377, 1014685.

ENVELOPE No. : 3968, 6958

TITLE : EL 725, 894, 934, 1080, 1084, 1085, 1129, 1138.

LOCATION : WIRREALPA, THIRD PLAIN, LINDA, Mt. CHAMBERS & REAPHOOK HILL

SHEET : SH5413 PARACHILNA; 6635,6735.

RECORDS/REPORTS :—

#0003435.
BHP Minerals Ltd, 1986, Reaphook Hill, Partial Relinquishment report, from 20.9.82 to 18.11.86, EL 1085, South Australia. Envelope 6958.

#0003520.
BHP Minerals Ltd. (Roche, M.T., Parrington, P.J., and Blain, C.F.) 1983, Exploration for carbonate-hosted base metals in the Flinders Ranges, South Australia. EL 934, EL 894, EL 1080, EL1084, EL1085, EL 1129, & EL 1138, South Australia. Envelopes, 3427, 3722 & 3968.

#0004376.
Dampier Mining Co Ltd. (BHP Minerals Ltd), and Esso Australia Ltd. (Vivian, B.J., Mann, S.T. & Roche, M.T.) 1987. Reaphook Hill. Progress reports from 22.10.79 to 18.11.87. EL 725 and EL 1085, South Australia. Envelope 3968.

#0004377.
BHP Minerals Ltd, and Esso Australia Ltd, 1985. Flinders Ranges Joint Venture Drilling Programmes: EL 1085, EL 1129 and EL 1138, South Australia. Envelopes, 3968 & 3427.

#1014685.
BHP Minerals Ltd, 1981, Reaphook Hill, Partial Relinquishment report, EL 725, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Hawker Group.

Structure : Balcoracana, Reaphook, Narina, Donkey Bore & Mt. Frome Synclines; Bunkers Graben.

MINERALISATION :

Linda, Third Plain, Eric, Wilnuroona & Reaphook Hill prospects.
Sphalerite; Galena; Hydrozincite; Willemite; Smithsonite; Fluorite.

EXPLORATION :

Mapping : Regional geological mapping (1:20,000), & Photogeology.

Geochemistry : Stream sediment, Rock Chip and Soil sampling; Drill sample analysis.

Pb; Zn; Cu; Co; Ni; Ag; Sn; Cr; W; U; Nb; Cd; Fe; Mn; Sn; As; & Mo.

Drilling : Reverse Circulation, Diamond.

COMMENTS :

The main foci of exploration were the Linda, Eric and Wilnuroona Prospects. Reaphook Hill and Third Plain are of lesser significance.

Linda Prospect.

The prospect is located adjacent to the southeastern boundary fault of the Bunkers Graben within the Wilkawillina Limestone.

The limestone host at Linda comprises two stacked biohermal reef systems which grew in response to progressive subsidence during sedimentation. Movement on the adjacent boundary fault resulted in the cyclic fracturing and fissuring of the reef complex.

The main lithofacies are: archaeocyath-rich biohermal limestones, inter-reef calcarenites, interbedded massive calcarenites and thin calcilutites.

The succession was periodically emergent such that it became karsted and partially dolomitised to a significant degree.

At surface the mineralisation is very irregular with small patches up to a few metres in diameter with up to 20% Zn+Pb. Detailed mapping shows that the sulphides occur as fracture-fill and disseminated blebs over a stratigraphic interval of about 400 metres.

Drilling, which was not sited in the optimum locations because of access constraints, returned grades of 1 to 4% over generally short intervals, high grades being usually restricted to intervals of about a metre.

Mineralogical studies revealed that two types of sphalerite, yellow (early) and red (late) were present, a normal characteristic of **MVT** deposits. The following simplified paragenetic sequence was proposed:

Cal → Ga → Cal → Sp(y) → Sp(r) → Cal+Dol

[NB. Sequence revised on microscopic evidence in main text of this data package.]

Eric Prospect

Percussion drilling showed a 1200 X 400 metres lead-rich anomalous zone. Diamond drilling (DEP3) showed average 3.6% Pb over 20 metres.

Karst features are extensive in and about the mineralised area. Whether the mineralisation is related to primary processes or is the result of colluvial fill of Tertiary to Recent karst was not determined, and warrants investigation.

Wilnuroona Prospect

Percussion drilling gave encouraging results including 2 metres of 7.45% Pb, 6.15% Zn. Brecciation and irregular assay results were attributed to extensive karsting and collapse. The area should be investigated further. Unfortunately, there are discrepancies in the plotted positions of the grids relative to AMG.

Third Plain

Drilling at Third Plain sought to test the hypothesis that primary sulphide underlay the willemite mineralisation, but was unsuccessful and not fully effective.

Wirrealpa

Drilling designed to follow up the previous rock chip programme only encountered weak mineralisation.

Reaphook Hill (relinquished area)

Follow-up of anomalous stream samples in the 'Reef' locality by rock chip sampling gave disappointing results. Mapping revealed several disconformities in the stratigraphic succession but aspects pertaining to the presence of palaeokarsting were not recorded.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 32PU & AG54

SAMREF CAT. Nos. : 0002241.

ENVELOPE No. : 3969

TITLE : EL 726, 1080

LOCATION : COMMODORE

SHEET : SH5413 PARACHILNA; 6535.

RECORDS/REPORTS :—

#0002241.
BHP Minerals Ltd, and Esso Exploration and Production Australia Inc. (Taylor, R.J., Jarvis, D.M., Mann, S.T., and Vivian, B.J.) 1986. Commodore. Progress and Final Reports from 22.9.80 to 21.10.86,. EL 1080 and EL 726, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Wilkawillina Limestone.

Structure : Bunyeroo Syncline.

MINERALISATION :

Galena.

EXPLORATION :

Mapping : Photointerpretation; Geological.

Geochemistry : Stream sediment, Soil, & Rock Chip sampling; Cu; Pb; Zn; Ni; Co; Ag; Cr; Sn; W; U; & Nb; Heavy mineral sampling.

Geophysics : Down hole gamma, resistivity, SP surveys.

Drilling : Percussion (Tertiary lignite).

COMMENTS :

Mapping and rock chip sampling examined mineralisation at Galena Creek and Tea Cosy Creek, but the work at the latter location was never completed.

Drilling to the east of the ranges indicates that up to 100m of Tertiary cover could be present over the western limb of the Bunyeroo Syncline in a graben.

Scree was found to cover some portions of the Lower Cambrian succession and therefore some parts of the area were not fully explored.

Galena Creek.

Five grids were set up and sampled. Mineralisation was observed in both rock pores and veinlets to be galena, sometimes as discrete cubes.

A strong correlation between breccia zones with calcite veins, dolomitisation and palaeokarstic features with mineralisation was noted.

A dolomitic limestone unit was found to carry up to 4,400 ppm Zn & 1,900 ppm Pb but the best results of 42.0% Zn & 5.0% Pb were located at the top of the palaeokarsted Wilkawillina Limestone.

Stream sediment sampling showed that the -80#, sieve fraction often reported anomalies with sources located several 100's of metres upstream. This clearly has implications for follow-up field procedures.

Tea Cosy Creek.

Mapping revealed the presence of a biohermal reef complex that was possibly a source for a stream sediment anomaly but detailed field appraisal was not undertaken.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 33PM/PMK & AG55

ENVELOPE No. : 3970,4794, & 5326.

LOCATION : Mt. ALECK, ARKABA, CHACE & DRUID Ra's.

SAMREF CAT. Nos. : 0000321, 0002242, 1013038.

TITLE : EL 727, 1084.

SHEET : SH5413 PARACHILNA; 6534, 6634.

RECORDS/REPORTS :—

#0000321.
BHP Minerals Ltd, 1984, Mount Aleck, Partial relinquishment report, EL 1084, South Australia. ENV. 5326.

#0002242.
BHP Minerals Ltd, and Esso Exploration and Production Australia Inc. (Mann, S.T., Jarvis, D.M. & Roche, M.T.) 1986, Hawker - Mount Aleck, Progress and Final Reports from 22.9.80 to 18.9.86, EL 1084 and EL 727, South Australia. ENV. 3970.

#1013038.
BHP Minerals Ltd, 1982, Mount Aleck, Partial Relinquishment Report, September,1982, EL 727, South Australia. ENV. 4794.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material), Wilpena Group.

Palaeozoic : Wilkawillina & Parara Limestones.

Structure : Mernmerna & Kanyaka Synclines.

MINERALISATION :

Vanessa Prospect (East limb, Mernmerna Syncline).

EXPLORATION :

Mapping : Geological.

Geochemistry : Stream sediment, rock chip & soil sampling; Copper, Lead, Zinc, Nickel, Cobalt, Chromium, Silver, Tin, Tungsten, Uranium & Niobium.

Costeaning : Moomba - Stony Point pipeline trench was sampled.

COMMENTS :

The Vanessa Prospect was examined and inferred to be fault (?axial plane) related mineralisation with a copper-barium association of little **MVT** relevance. Extensive scree cover is present.

Anomalous stream samples from the Druid-Chace ranges were not followed up. Three mineral occurrences noted.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 34PB

SAMREF CAT. Nos. : 0002583.

ENVELOPE No. : 6536

TITLE : EL 1310

LOCATION : Mt. MANTELL

SHEET : SH5413 PARACHILNA; 6734,6735.

RECORDS/REPORTS :—

#0002583.
BHP Minerals Ltd., (Jarvis, D.M. & Taylor, R.J.) 1986, Mount Mantell. Progress and Final Reports for the period 1.12.85 to 2.9.86, EL 1310, South Australia.

GEOLOGY :

Palaeozoic : Wilkawillina Limestone.

Structure : Balcoracana Syncline.

MINERALISATION :

Not discussed.

EXPLORATION :

No technical data.

COMMENTS :

Project intention was to explore for lead-zinc mineralisation in the Wilkawillina Limestone in areas where it is concealed by Tertiary and recent deposits.

REVIEW No. : 35PB

ENVELOPE No. : 8002

LOCATION : BUFFALO DAM

SAMREF CAT. Nos. : 0003564.

TITLE : EL 1432

SHEET : SH5413 PARACHILNA; 6735.

RECORDS/REPORTS :—

#0003564.
BHP Minerals Ltd, 1988, Buffalo Dam, First and Final Report, from 25.12.87 to 25.2.88, EL 1432, South Australia.

GEOLOGY :

Palaeozoic : Wilkawilina Limestone & Frome Group.

Structure : Balcoracana Syncline.

MINERALISATION :

Not disclosed.

EXPLORATION :

No technical data.

COMMENTS :

No field work was carried out due to the fact that hypothetical target depth would exceed economic viability.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 36PD

SAMREF CAT. Nos. : 0004858, 0005082.

ENVELOPE No. : 8072

TITLE : EL 1515 (1514).

LOCATION : WIRREALPA

SHEET : SH5413 PARACHILNA; 6635.

RECORDS/REPORTS :—

#0004858.
Demis Pty Ltd, and Mining Corporation of Australia Ltd., (Bluck, R.G., and Curtis, J.L.) 1989, Wirrealpa, Progress reports from 13.12.88 to 13.9.89, EL 1515, South Australia.

#0005082.
Demis Pty Ltd, and Mining Corporation of Australia Ltd., (JLC Exploration Services; Curtis, J.L.) 1989, The Regional Geological Setting of Cambrian **MVT** Mineralisation in South Australia, EL 1514 & EL 1515, South Australia.

GEOLOGY :

Adelaidean : Callanna Group (diapiric material).

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Donkey Bore Syncline.

MINERALISATION :

Donkey Bore prospect.

EXPLORATION :

Mapping : Geological.

Geochemistry : Rock Chip & Soil sampling; Zn; As; Cu; Pb;

COMMENTS :

Mapping led to the delineation of palaeokarstic features not previously recognised within the Wilkawillina Limestone, beneath the Flinders Unconformity,which carry anomalous levels of zinc and lead.

These palaeokarst features are negative with respect to bold upstanding limestone outcrops and present as flat areas of rubble/scree with a bright yellow clay matrix with some trace to minor amounts of iron/manganese chippings and/or stainings on nearby massive outcrops.

Rock chip geochemical lead-zinc anomalies in Wilkawillina Limestone previously reported by BHP were not duplicated successfully at Old Wirrealpa Spring.

NORTHERN FLINDERS RANGES MVT-SLZ REVIEW

REVIEW No. : 37PF

SAMREF CAT. Nos. : 0005082, 0005083.

ENVELOPE No. : 8071

TITLE : EL 1514.

LOCATION : Mt. CHAMBERS

SHEET : SH5401 PARACHILNA; 6735.

RECORDS/REPORTS :—

#0005082.
Demis Pty Ltd, and Mining Corporation of Australia Ltd., (Bluck, R.G., and Curtis, J.L.) 1989, Mt. Chambers, Progress reports for the period 13/9/88-13/9/89, EL 1514, South Australia.

#0005083.
Demis Pty Ltd, and Mining Corporation of Australia Ltd., (JLC Exploration Services; Curtis, J.L.) 1989, The Regional Geological Setting of Cambrian **MVT** Mineralisation in South Australia, EL 1514 & EL 1515, South Australia.

GEOLOGY :

Adelaidean : Pound Sub-group

Palaeozoic : Parachilna Formation & Wilkawillina Limestone.

Structure : Mt. Frome Syncline.

MINERALISATION :

Galena, Jasper/Gossan ; Eric & Wilnuroona prospects.

EXPLORATION :

Mapping : Compilation of previous and field mapping.

Geochemistry : Rock chip sampling, Copper, Lead, Zinc, Silver, Arsenic & Gold.

Drilling : Review of previous drilling.

COMMENTS :

A thorough reassessment and synthesis of previous geological mapping, geochemistry and drilling data at the Eric Prospect showed that observed mineralisation is probably the weathered expression of, a primary east dipping-sheet like body, located along a palaeosurface that appears to have been palaeokarsted.

Jaspery bodies and rubble patches previously interpreted to be of diapiric origin were field inspected and re-interpreted to be residual palaeocavern deposits.

The disparity between the very strong stream sample anomalies and the weak zinc signature of the mineralized zone suggests very strong leaching of zinc has occurred.

NORTHERN FLINDERS RANGES MVT-SLZ REVIEW

REVIEW No. : 38PFB

ENVELOPE No. :

LOCATION : WIRREALPA & Mt. CHAMBERS

SAMREF CAT. Nos. :0005552.

TITLE : DME 404/89

SHEET : SH5401 PARACHILNA; 6735.

RECORDS/REPORTS :—

#0005552.
Newton A.W. 1991. Lead-Zinc Drilling Investigations, 1989, Wirrealpa Area, SA. SADME Rept. Bk. No. 91/101.

GEOLOGY :

Adelaidean : Pound Sub-group.

Palaeozoic : Parachilna Formation: Wilkawillina & Parara Limestones.

Structure : Mt. Frome & Balcoracana Synclines.

MINERALISATION :

Eric Prospect.

EXPLORATION :

Geochemistry : Analyses of drill cuttings. Copper, Lead, Zinc, & Silver.

Drilling : 3 Percussion and 28 RAB/mud drill holes.

COMMENTS :

The programme sought to test mineralisation models proposed as a result exploration by Demis Pty. Ltd. at Eric and within the Bunkers Graben structure in the eastern Balcoracana Syncline.

The work at Eric confirmed the postulated east dipping sheet like geometry for the mineralisation. Grades and weathered material similar to previous occasions were intersected.

The more regional work was targetted on Wilkawillina Limestone thought to lie at shallow depth beneath Tertiary-Recent cover. The deeper than anticipated cover (50 m or more) resulted in only one hole successfully sampling the Wilkawillina Limestone. The posulated model remains un-tesed. See 36PD & 37PF (ENV. 8072, 8071 resp.).

APPENDIX 3.3

MVT-LZ EXPLORATION REVIEWS

ORRORCOO SHEET

NORTHERN FLINDERS RANGES

November 1991

Page Nos. in data listing.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 1OKYL/4PL & AG74

ENVELOPE No. : 600

LOCATION : WILLOCHRA- Mt. ARDEN

SAMREF CAT. Nos. : 1002292.

TITLE : SML 94

SHEET : SH5401 ORROROO; 6533. SH5413 PARACHILNA; 6534.

RECORDS/REPORTS :—

#1002292.
Kennecott Explorations (Australia) Pty. Ltd., (McNeil, R.D.), 1966. Progress report Willochra, SML 94, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Kanyaka, Yappala, & Mt. Ragless Synclines.

MINERALISATION :

Mount Arden Mine; Kanyaka Copper Mine.
Copper, Lead, Zinc.

EXPLORATION :

Geochemistry : Stream Sediment, Soil & Rock Chip Sampling; Copper, Lead, Zinc, Cobalt.

COMMENTS :

An extensive anomalous zone was detected in drainages along the contact of the largely scree covered Parachilna Formation and the basal Wilkawillina limestone in the Mt. Arden-Comstock and Radford Creek areas.

At Radford Ck. a 1000 ppm stream sample was backed up by soils with more than 0.5% Pb & Zn. Rock Chip samples where obtainable, supported the soil results with similar levels of lead and zinc and lesser contents of copper and cobalt. The host rock appears to be manganiferous dolomite.

The mineralisation is clearly stratabound and related to dolomitisation of parent limestone but direct confirmation of **MVT** is not available.

Geochemical signatures were considered sufficiently significant to justify on-going exploration in the Radford Creek, Mt. Arden-Comstock & Kanyaka Mine areas. See ENV's 642, & 648.

NB. This summary also appears as 4PL.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 2OL & AG68 SAMREF CAT. Nos. : 1002194, 0004910.

ENVELOPE No. : (641), 684 TITLE : SML 108

LOCATION : Mt. ARDEN - COMSTOCK SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1002194
Kennecott Explorations (Australia) Pty. Ltd., 1966, (Mc Neil, R.D.), Progress and final reports on Mt.Arden, SML 108, South Australia.

[NOTE: Contents of ENV. 641, 0004910, transferred to ENV. 684.]

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Mt. Ragless Syncline.

MINERALISATION :

Mount Arden Mine; Comstock Mine.
Chalcophanite; Limonite; Manganese; Iron.

EXPLORATION :

Mapping : Geological mapping.

Geochemistry : Stream sediment & Rock Chip sampling; Heavy mineral separations; Copper, Lead, Zinc, Cobalt, Nickel, Manganese, Multielement scans.

Geophysics : Electrical surveys; SP surveys; IP surveys.

Costeaning : Bulldozer Trenching.

Drilling : Rotary drilling.

COMMENTS :

A prominent 27 km long stream sediment anomaly, strongest along the west flank of the Ragless Range where up to 1740 ppm Zn was recorded. The anomaly was traced to a 6-15 m zone straddling the Parachilna Formation/Wilkawillina Limestone interface.

Mineralisation seems to be generally focussed within the Parachilna Formation and associated with ironstone bodies that commonly exceed 100m in diameter. It also occurs in the basal 100m of Wilkawillina Limestone.

Geophysics did not detect the presence of any metal concentrations, although a weak IP anomaly was detected between 1800W and 2400W on line S.P.8 in the lower part of the Wilkawillina Limestone, and was correlated with surface zinc mineralisation. Low order anomalies were attributed to depth extensions of surface mineralisation.

Zinc up to several thousand ppm (max. 3.5 % Zn) over intervals as wide as 30 m was recorded from trenches cut across iron/manganese bodies/zones along the western limb of the Ragless Range.

Follow-up drilling in the same area disclosed similar but relatively lower levels of zinc concentrations (max. 1 % Zn) in the subsurface within both the overlying basal Wilkawillina Limestone and the Parachilna Formation.

Chalcophanite mineralisation was demonstrated to be present over a strike of about 10km in both units without significant lead or copper.

Since the target zone is partially obscured by scree from the neighbouring Pound Subgroup, detailed mapping of the stratigraphic relationships and the ironstone bodies has probably not been undertaken.

The primary origin of the mineralisation and its relationship to stratigraphy are unclear but it is probable that iron manganese scavenging in the weathering profile has resulted in localised upgrading.

An examination of the field relationships and the internal structure of the ironstones may give some clues. The possibility that drill holes were sampling the leached/bleached zone of a palaeoweathering profile does not appear to have been considered.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 3OL & AG74

SAMREF CAT. Nos. : 1002230, 1003886.

ENVELOPE No. : 642, 685

TITLE : SML **109**, 94

LOCATION : RADFORD CREEK

SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1002230.
Kennecott Explorations (Australia) Pty Ltd. (McNeil, R.D.) 1967. Final report on Radford Creek, (formerly part SML 94), SML 109, South Australia. ENV. 642.

#1003886.
Kennecott Explorations (Australia) Pty Ltd. (McNeil, R.D.) 1966. Progress report on the Radford Creek Area (for 3 months 1/9/66 to 1/12/66), SML 109, South Australia. ENV. 685.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Mt. Ragless Syncline.

MINERALISATION :

Chalcophanite; Cerussite; Pyrolusite.

EXPLORATION :

Mapping : Geological mapping.

Geochemistry : Stream sediment, Soil, & Rock Chip sampling; Copper, Lead, Zinc, Manganese, Silver, Germanium, Multielement analysis.

Geophysics : Electrical surveys; SP surveys; IP surveys.

Costeaning : Trenching.

Drilling : Rotary drilling.

COMMENTS :

The mineralisation at Radford Creek is hosted by a down faulted block of Cambrian sediments juxtaposed against older units on three sides. The exposure measures approximately 3 x 1.5 Km^2.

Strong lead and zinc in stream sediments up to 1000 & 700 ppm respectively were backed up by the discovery of soils that yielded up to 4,800 and 2650 ppm respectively. The metal source was traced to iron/manganese oxides within the Parachilna Formation that assayed up to 3.8 and 1.15 % lead and zinc.

Trenches revealed substantial widths with metal values of several thousand ppm. Notably the superficial enrichment of lead with respect to zinc was reversed with depth.

Drilling revealed that the near surface grades rapidly diminished with depth to 0.3 % or less for both lead and zinc. Cerussite was recognised from drill holes.

Geophysics did not detect any significant metal concentrations.

Detailed stratigraphic relationships between the iron/manganese bodies and the sediments are not documented. The primary origin of the metals is also unclear.

The configuration of high lead at surface giving way to strong zinc within a few metres in the soil profile above a much less anomalous weathered bedrock is probably a Tertiary/Cretaceous weathering phenomena. It remains to be determined as to whether or not the lower subsurface metal values are leaching zone residues or merely the insitu oxidation of weak mineralisation.

The near surface geochemical partitioning shows that either of lead or zinc may indicate the presence of the other although it may be only a minor primary component itself.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 40K & AG75

SAMREF CAT. Nos. : 1002261, 1002190, 0004911.

ENVELOPE No. : (643), 686

TITLE : SML 110

LOCATION : KANYAKA

SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1002190.
Kennecott Explorations (Australia) Pty Ltd., (McNeil, R.D.), 1967. Progress and Final reports on the Kanyaka area., SML 110, South Australia.

#1002261.
Kennecott Explorations (Australia) Pty Ltd. (Milnes, A.R., and Preiss, W.V.), 1967. The Geology of the Kanyaka area,. SML 110, South Australia.

[NOTE: Contents of ENV. 643, 0004911, transferred to ENV 686.]

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones, Oraparinna Shale.

Structure : Kanyaka Syncline.

MINERALISATION :

Kanyaka Mine.
Azurite; Malachite; Bronchantite; Chalcopyrite; Sphalerite; Galena; Pyrite; Marcasite; Covellite; Bornite; Chalcocite; Chalcophanite; Digenite; Neodigenite; Cuprite.

EXPLORATION :

Mapping : Structural geology; Geological mapping.

Geochemistry : Grab sample; Stream sediment & Rock Chip sampling; Copper, Lead, Zinc, Cobalt, Nickel, Manganese, Multielement scans.

Geophysics : Electrical surveys; IP surveys; SP surveys.

EXPLORATION (Cont'd)

Costeaning : Trenching (7).

Drilling : Rotary drilling (11 holes).

Petrology : Microscopic descriptions.

COMMENTS :

Dark colouration reported in the uppermost Wilkawillina Limestone may be due to oxidation of a palaeosurface that existed prior to Parara Deposition.

Study by McNeil of stream sediment results in the vicinity of the Kanyaka Mine indicated that geochemical dispersion trains were short and therefore other anomalies detected in the area were separately sourced.

Grab sampling indicated that zinc averaged 0.56 % in old reject copper ore grading 1.43 % Cu, at the Kanyaka Mine workings.

Costeans at the same locality indicated that anomalous lead and zinc were sometimes present without appreciable copper.

Subsequent drilling showed that in the subsurface the Parachilna Formation is modestly enriched in copper up to 1000 ppm, rarely to 5000 ppm compared to a greater relative abundance of zinc in both the Parachilna Formation and the basal Wilkawillina Limestone commonly exceeding 1000 ppm Zn.

The strongest zinc recorded, 3.3m @ 2.75% is associated with an intercalated dolomite unit in the upper Parachilna Formation

Costeans cut into the Parachilna Formation up to 7 Km to the north of the mine in the western limb of the Kanyaka Syncline returned modestly anomalous lead and zinc with low copper. Since the focus of exploration was copper these indications were not pursued.

The Kanyaka Mine example adds to observations concerning surface geochemical signatures discussed in the previous review. In this latter case the strong superficial copper anomaly masks the weak zinc mineralisation at depth. It was noted in R.I.37 that zinc minerals were absent from the surface to 100 feet depth in drill samples. This reflects the significance of groundwater leaching in the redistribution of zinc.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 5OK & AG76

SAMREF CAT. Nos. : 1002604, 1002605.

ENVELOPE No. : 1306

TITLE : SML 313

LOCATION : KANYAKA

SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1002604.
Cyprus Mines Corp., (Austin Anderson (Australia) Pty. Ltd.) 1970. Appraisal on Stage 1, mineral exploration of the Kanyaka Prospect and half yearly report on SML 313 Kanyaka, South Australia.

#1002605.
Cyprus Mines Corp., (Johnson, B.T.) 1970., Evaluation of surface magnetic survey , Kanyaka Mineral Prospect, SML 313, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones

Structure : Kanyaka Syncline.

MINERALISATION :

Kanyaka Mine; Malachite; Azurite.

EXPLORATION :

Mapping : Geological mapping.

Geochemistry : Stream sediment, Soil & Rock Chip sampling; Grab sampling; Copper, Lead, Zinc, & Multielement analysis.

Geophysics : Ground magnetic surveys; Electrical surveys; IP surveys - Dipole dipole array.

COMMENTS :

Localised ironstones along the Parara/Wilkawillina contact and 'embayment structures' with strong geochemical expression may be palaeokarstic in origin.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 6OL & AG73

SAMREF CAT. Nos. : 1004191.

ENVELOPE No. : 1466

TITLE : SML 455, 709

LOCATION : Mt. ARDEN - RAGLESS RANGE

SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1004191.
Utah Development Co. (Rowlands, N.J.) 1972. Progress and final reports Mt. Arden SML's 455 and 709, South Australia.

GEOLOGY :

Adelaidean : Bunyeroo Formation, Wonoka Formation, Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones, Oraparinna Shale.

Structure : Ragless Range Syncline.

MINERALISATION :

Mount Arden & Comstock mines.
Jasper; Malachite; Azurite.

EXPLORATION :

Mapping : Geological mapping; Stratigraphy; Structural geology;

Geochemistry : Stream sediment, Soil, & Rock Chip sampling; Multielement analysis, Copper, Lead, Zinc, Cobalt, Nickel, Silver, Arsenic.

Geophysics : Ground magnetic surveys; Vertical magnetic intensity.

Costeaning : Trenching; Channel Samples.

Drilling : Auger, Rotary, & Diamond drilling.

COMMENTS :

As found previously strong stream sediment zinc results were backed up by rock chip, auger, & costean results in the vicinity of the Mt. Arden Mine. Strong copper with lesser lead were also recorded.
The sole diamond drill hole, AMD-1, intersected similar copper but lower levels of lead and zinc.

Jasperoids were noted to occur associated with drag folds along the core of the Ragless Syncline and commonly assay 1-2 % Zn.
They also occur along the Parara/Wilkawillina contact.
Field study of the jasperoids is warranted.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 7OYK/22PYK & AG70

ENVELOPE No. : 1698

LOCATION : KANYAKA

SAMREF CAT. Nos. : 1001779

TITLE : SML 584.

SHEET : SH5413 PARACHILNA; 6533,6534.

RECORDS/REPORTS :—

#1001779.
Electrolytic Zinc Co. of A/Asia Ltd., (Horn, R.A.) 1971. Progress reports SML 584 Kanyaka, South Australia.

GEOLOGY :

Palaeozoic : Parachilna Formation.

Structure : Yappala & Kanyaka Synclines.

MINERALISATION :

Kanyaka mine.

EXPLORATION :

Geochemistry : Stream sediment sampling; Copper, Lead, & Zinc.

COMMENTS :

Geochemical surveys indicated that anomalies related to the Parachilna Formation show elevated lead and zinc to levels of about 7x regional background.

Some elevation of lead and zinc is also found to be associated with a crush zone in the southeast of the area 4km to the west of Kanyaka Hill.

Lithostratigraphic documentation of the geochemical enrichments is warranted.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 8OL & AG71

SAMREF CAT. Nos. : 1002445, 1002446.

ENVELOPE No. : 2750

TITLE : EL 242

LOCATION : RAGLESS RANGE

SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1002445.
Amoco Minerals Australia Co., (Bennett, G.R.), 1976, Progress and final report, Ragless Range: - Buckaringa project, EL 242, South Australia.

#1002446.
Amoco Minerals Australia Co., (Geoquest Pty. Ltd.), 1976, Electrical Resistivity Survey, Buckaringa prospect, Quorn, EL 242, South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina & Parara Limestones.

Structure : Ragless Range Syncline.

MINERALISATION :

Not discussed.

EXPLORATION :

Mapping : Geological mapping.

Geochemistry : Soil sampling; Copper, Lead, Zinc, Silver.

Geophysics : Electrical surveys; Resistivity sounding: Schlumberger array; Pole multidipole (equatorial) array; Resistivity profiling: Dipole dipole array.

Costeaning : Trenching.

COMMENTS :

Soil sampling programme based on previous explorers. Near surface scavenging by iron/manganese considered probable. Best results 1750 ppm Pb, 4000 ppm Zn with a trace of Cu.
Resistivity surveys did not identify any discrete targets.

NORTHERN FLINDERS RANGES MVT-LZ REVIEW

REVIEW No. : 90L & AG72 SAMREF CAT. Nos. : 1004001.

ENVELOPE No. : 2958 TITLE : EL 273

LOCATION : COMSTOCK-
Mt. ARDEN SHEET : SH5401 ORROROO; 6533

RECORDS/REPORTS :—

#1004001.
Amoco Minerals Australia Co., (Johnson, J.) 1977. Final report EL 273 South Australia.

GEOLOGY :

Adelaidean : Pound Subgroup.

Palaeozoic : Parachilna Formation, Wilkawillina Limestone.

Structure : Mt. Ragless Syncline.

MINERALISATION :

Comstock Mine.

EXPLORATION :

Mapping : Geological mapping.

Geochemistry : Soil & Rock Chip sampling; Copper, Lead, Zinc, Manganese, Arsenic, Silver, Antimony, Tin, Gold.

Geophysics : Ground magnetic surveys; IP surveys: Dipole dipole array;

Drilling : Diamond drilling.

Petrology: Microscopic descriptions.

COMMENTS :

Exploration concentrated on the Parachilna Formation.

Drilling failed to intersect economic mineralisation. However, a narrow zone of high zinc values was interpreted petrologically as probable zincian dolomite. This is significant in terms of MVT genesis; zincian dolomite occurs at Linda Prospect [see main text of this review].

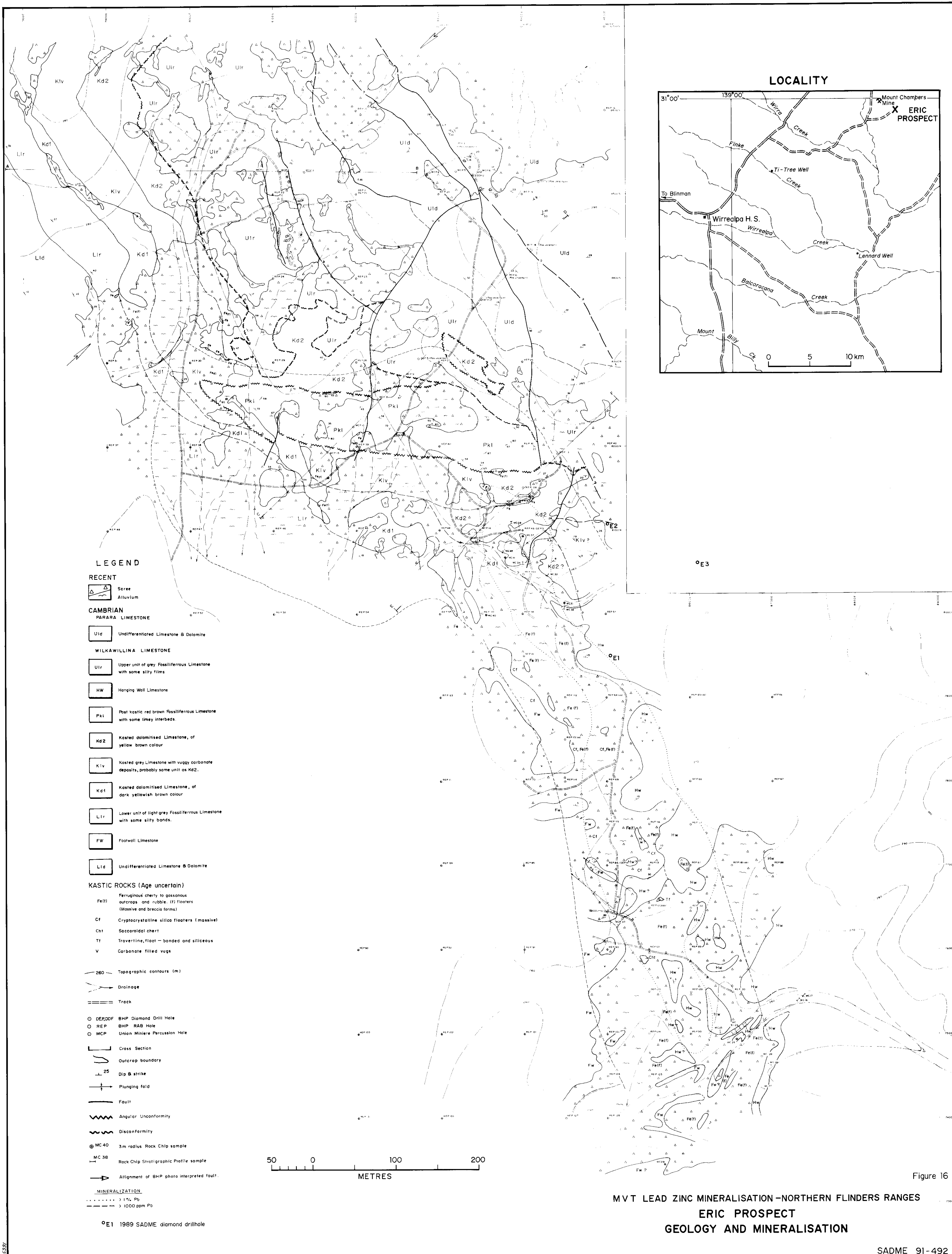


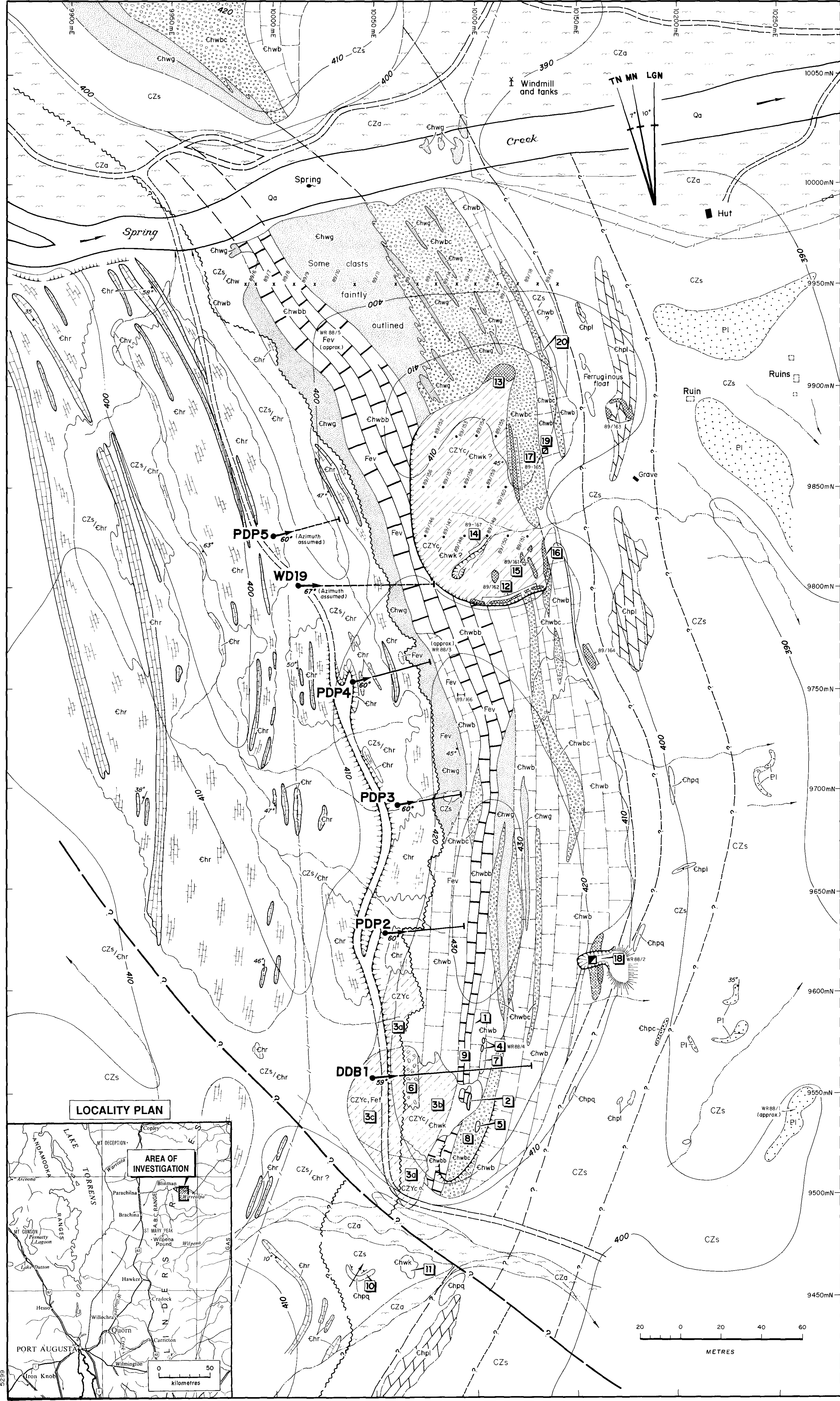
Figure 16

MVT LEAD ZINC MINERALISATION – NORTHERN FLINDERS RANGES

ERIC PROSPECT

GEOLOGY AND MINERALISATION

SADME 91-492



LEGEND

CAINOZOIC

Symbol	Description
Qa	QUATERNARY - alluvium, sand and gravel
CZa	Alluvial soils and colluvium
CZs	Soils and scree/talus
CZYc, Fef	Yellow clays and scree, ferruginous floaters.

CAMBRIAN

Symbol	Description
Єhwk	Karstic deposits, travertine (includes rubble and scree)
Єhr	**PARARA LIMESTONE:** Laminated, grey silty limestone with partings, giving a *characteristic* platey scree, local competent silty horizons
Єhwg	**WILKAWILLINA LIMESTONE:** Massive light to dark grey, thick bedded limestone. Fractures and joints in upper part of unit may be filled with multi-layered sparitic calcite. Archaeocyathids in some places.
Єhwb	Massive 'brown' weathering to varying degree but other wise similar to Єhwg
Єhwbc	Massive, thick bedded, dark brown conglomeratic limestone, lenses of light grey limestone, sometimes interbedded, particularly in north.
Єhwbb	Massive grey limestone with large and small clasts of both *grey limestone and dark brown conglomeratic* limestone. Clasts angular, disoriented, up to over 1m in maximum dimension.
Єhpl	**PARACHILNA FORMATION:** Massive yellow-brown/fawn laminated limestone, altered, recrystallised appearance, possibly dolomitic
Єhpq / Єhpc	Thin beds and lenses of porous quartzite/conglomerate

PROTEROZOIC

Symbol	Description
Pl	Undifferentiated, altered and recrystallised limestones of yellow-buff colour.
Fev	Yellow limonitic fracture fill/veining, sometimes with clastic components - probably sediment *filled*. Joints, *later infused* with sulphide and oxidised to limonite during weathering.
	Gossan/ferruginous alteration (intense)
	Geological boundary, indicated, inferred.
	Inferred fault
	Dip/strike of bedding
	Major disconformity/palaeo surface, karsted.
	Drill hole with azimuth and dip, hole no, projection crossection reference marks, location of PDP1 not verified.
	Sample: soil, rock chip area, linear, sample *designation*

TOPOGRAPHIC

Symbol	Description
	Stream-major, flow direction, spring
	Stream, minor
	Steep slope
	Vehicle track
	Fence
420	Topographic contour, 10m interval

GEOLOGICAL NOTES

No.	Note
1	Large pieces of honey yellow, banded *travertine* - Єhwk
2	Coherent outcrop of honey yellow travertine - Єhwk
3a	Yellow clayey soil and scree possibly concealing Єhwk
3b	Yellow clayey soil and scree with, possibly outcropping, honey yellow travertine Єhwk.
3c	Similar to **3a** but with substantial *ferruginous float*
4	Small pods of jaspery gossan
5	Sedimentary breccia, small body similar to but discrete from Єhwb
6	Large >1m diam blocks of Єhwbb may be outcrop, cavern roof?
7	Poorly outcropping area, Fev alteration/staining present
8	Possible cross-bedding in Єhwbc
9	Poor outcrop, much scree
10	Siliceous/sugary quartzite, iron-porous matrix, stratigraphic affinities 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	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, probably *ferrugi nised* soil profile.
15	Red-brown/dark brown, porous gossanous ironstone, probably affected and partially dismembered by NW soil creep.
16 17	Very ferruginous Єhwbc, 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 subsutace 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.

MVT LEAD- ZINC MINERALISATION
NORTHERN FLINDERS RANGES

OLD WIRREALPA SPRING GEOLOGICAL PLAN

Figure 17
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COPLEY

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

Figure 18
MVT LOCATIONS COPLEY SHEET

PARACHILNA

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

Figure 19

MVT LOCATIONS PARACHILNA SHEET

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ORROROO

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

Figure 20

MVT LOCATIONS ORROROO SHEET

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