ANNUAL REPORT FOR
1974 FIELD SEASON,
E. L. 1011, ROBINSON RIVER, N. T.

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1. INTRODUCTION

Exploration Licence 1011 covers an area of 380 square kilometres (150 square miles) and is situated approximately 25 kilometres (16 miles) west of Robinson River Homestead near the Queensland/Northern Territory Border (Location (FIG. 1)). Access is via Borroloola and the Robinson River Road and then a 4-wheel drive track to the lease area and base camp.

The climate has been described as sub-humid (Slatyer and Christian, 1954) with a typically monsoonal rainfall thus restricting field investigation to the 'dry season'.

Exploration was largely carried out by a party of two geologists and two field assistants. Two geophysical operators undertook electromagnetic and induced polarization surveys in the early and late stages respectively of the field season.

2. PHYSIOGRAPHY

Most of the lease area lies within the physiography division known as the Gulf Fall (the area between the Bukalara Plateau and the Coastal Plain). The topography is hilly to undulating, some areas being strongly dissected by tributaries of the Foelsche River. Scarps commonly form the boundary between the Gulf Fall and the Bukalara Plateau in the North and West of the Exploration Licence.

3. PREVIOUS INVESTIGATIONS

(a) In 1961 the Bureau of Mineral Resources geologists mapped the area covered by the Robinson River Sheet, 1:250,000 series.

(b) Mt. Isa Mines held an A to P (No. 545) of 650 square miles in this area in 1956. Their report suggests the study was largely of a reconnaissance nature and that only very broad geological boundaries were mapped. The only mineral occurrence noted was haematite in 1/8" thick veins in sandstone. The A to P was
relinquished due to lack of discovery of other economic minerals even in small quantities.

(c) Australian Geophysical Pty. Ltd. held A to P 1334 from 1966 to 1968 inclusive. Although much of their work was carried out near Calvert Homestead, some time was spent mapping and gridding the areas of outcropping dolomites near the Foelsche River and Hopplestrap Creek. Malachite was noted in the base of the Karns Dolomites especially near Was Creek. Soil geochemistry, I.P., and E.M. were conducted on the coarse grid system. The only significant I.P. anomaly was located on the Hopplestrap Grid approximately 20km WNW of Robinson River Homestead. Subsequent drilling (DDH-HOL) intersected extensive pyrite veining and traces of chalcopyrite in the Aquarium Formation. A vertical drill hole (DDH-FOL) was sited on the Foelsche Grid to test the base of the Karns Dolomite. This failed to intersect significant mineralisation.

(d) Aberlous (a subsidiary of Metals Investment Holdings N.L.) held A to P 3083 from April 14, 1971 to April 14, 1972. Their summary report contains little information not available in the B.M.R. 1:250,000 Geological Series of the area.

Several companies have held leases in the vicinity of E.L. 1011. A list of reports is appended to this report.

4. STRATIGRAPHY

The stratigraphy is based largely on that outlined in the Robinson River 1:250,000 Geological Series.

Descriptions of rock units however are pertinent to the area of E.L. 1011 as are the subdivisions of the Karns Dolomite.

a. LOWER PROTEROZOIC

i. Aquarium Formation

This unit crops out within the lease as fine grained micaceous sandstones. In DDH-HOL (Australian Geophysical) it is
seen as sandstone of varying grain size and often glauconitic, inter-calated with fine grained green siltstones and shales.

ii. Settlement Creek Volcanics

A series of andesine basalts, andesine agglomerates and red-brown tuffaceous siltstones crop out in the eastern part of the lease. Weathering and oxidation of this unit is extensive. Fresh samples contain fine grained pyrite and celadonite filled amygdules are common in the andesite.

A strongly outcropping agglomerate occurs towards the top of the 100 metre thick succession.

iii. Wollogorang Formation

The main area of outcrop is located in the Woppitt Creek region. The unit is represented as low, well rounded scree covered hills or escarpments below sandstone cappings.

The lower half of the sequence is comprised of poorly bedded and wavy banded red and cream dolomites, dolomite breccias and dolomitic siltstone. Fine grained chalcopyrite has been observed in the recrystallized red dolomites.

Two prominent pseudo-algal or perlitic volcanic horizons occupy a central stratigraphic position in the Wollogorang Formation.

These consist of thin beds (up to 15cm) of chalcedonic silica and devitrified glass within a sequence of grey dolomites of similar structure. The structures are oblate semi-spheroids approximately 5cm in diameter. (Reference FR 106, 88 Report No. Misc./107, - A. W. G. Whittle & Associates).

A sequence of white uniform flaggy siltstones overlays the pseudo-algal horizon. A nodular dolomitic siltstone is present in this sequence but rarely as outcrop. Generally the bed is defined by a scree of highly oblate (axes: (a = b = 4c) spheroids.) Sphalerite and galena have been described from the nodular dolomite (Australian Geophysical Progress Report A to P 1343; 1966), near Calvert Homestead.
The Wollogorang Formation does not exceed 50 metres in thickness in this area and is assumed to be conformable on the Settlement Creek Volcanics. It may directly overlay the Aquarium Formation in the central west of the lease.

iv. Masterton Formation

This unit is common as rough bare hills and hillocks throughout much of the lease area. It commonly crops out as inliers in the MacArthur Group sediments, representing islands in the original basin.

The formation in this area is comprised of a red, commonly silicified quartz sandstone. Minor quantities of kaolin probably after feldspar are present (FR 9, FR 20, MEMO No. 616, Project No. 745/9008/6C, Robertson Research (Aust.) Pty. Ltd.). Well developed ripple marks and current bedding are a prominent feature.

This unit exhibits highly variable bedding inclinations. It is suggested that most of these are due to block movement of outcrop prior to MacArthur Group sedimentation. The effect produced is of an angular unconformity but is simply a severe erosional disconformity with the Karns Dolomite.

The Masterton Formation sandstone rests on both Settlement Creek Volcanics and Wollogorang Formation. The impurities in these basal sandstones suggest the Masterton Formation is disconformable in this area, being in part derived from the lower units?

Yates (1963) suggests a minimum thickness of 170 metres. Nowhere in this area has the top of the sequence been seen. Estimated thickness in this area is 30m.

b. LOWER PROTEROZOIC?

Karns Dolomite

The Karns Dolomite is the only representative of the MacArthur Group in this area. It has been subdivided into four main members and some lithological variations within these members.
i. Amazon Creek Dolomite (20 metres)

Outcrops are largely restricted to creek valleys which are often quite precipitous when cut into this unit.

The sequence is largely composed of red, cream and white dolomites, partly recrystallized and dolomitic silstones. A prominent dolomitic basal conglomerate is present. This commonly contains angular fragments of Masterton sandstone and less commonly Wollogorang Formation.

A well defined 2-3 metre thick, yellow vitric-lithic tuff occurs towards the base of this member. This tuff is also commonly found as a sub-aerial deposit on the Masterton sandstone occasionally associated with rhyolite. The tuff is largely composed of fragments of devitrified glass enclosed in cryptocrystalline and microcrystalline silica. Large euhedral limonite pseudomorphs after pyrite are common. In the more eastern and northern parts of the lease the tuff is commonly associated with siliceous rocks of the Always Creek Dolomite chert-volcanic type.

The Amazon Creek Dolomite disconformably overlays the Masterton Formation, Wollogorang Formation and Settlement Creek Volcanics. The sequence has a maximum observed thickness of 15 metres but is highly variable.

ii. Snake Hill Sandstone

This unit crops out extensively in the area on hill tops and subplateau positions. Where it directly overlies the Wollogorang Formation it forms the tops of escarpments.

This unit comprises a range of lithologies including sandy dolomites, sandy dolomite pebble conglomerate, dolomitic sandstone and sandstone. Generally the sandstone member only, crops out. It is a poorly sorted quartz sandstone with frequent leached pebble bands (possibly Wollogorang Formation Pebbles) except where the provenance is largely from the Masterton Sandstone when a coarse sandstone cobble and boulder conglomerate occurs as the basal unit of medium grained quartz sandstones. Occasionally very thin vitric tuffs are present within the sandstone and silicified oolitic dolomite
crops out occasionally. Small patches of siliceous cherty material are common in the sandstone horizon. Due to poor outcrop it is not possible to distinguish in situ silification from scree of the overlaying sediments.

The Snake Hill Sandstone is extremely widespread throughout the exploration license area. It has a severe abutment unconformity with the Masterton Sandstone but conformably overlies the Amazon Creek Dolomites. It has a maximum exposed thickness of 5 metres.

iii. Always Creek Dolomites

This sequence is restricted to the central north-south zone in the lease. It forms flat to gently undulating terrain, or low hillocks on the plateau. The upper part of the sequence produces a more hilly topography. Outcrop is generally quite rough with the more siliceous horizons forming extensive coarse scree and float.

The basal unit is a thin sandy dolomite pebble conglomerate overlain by red partly recrystallized dolomite with large domal structures (algal structures). This is overlain by a series of cream and pink dolomites and a prominent algal horizon. The algal horizon is comprised of closely packed columns of hemispherical shells of either dolomite or siliceous cherty material. The columns attain a maximum thickness of 3 metres. The 'chert-volcanic' horizon overlays and underlays the algal horizon and is composed of chalcedonic, cherty and quartzose rocks. The texture is often indicative of tuffaceous origin (A. W. G. Whittle's Report MISC/103, FR 81, 83-86) although some zones are essentially chert (MISC/103, A. W. G. Whittle, FR 70). Traces of malachite are common in this horizon.

The 'chert-volcanic' rocks are overlain by a series of finely laminated, slightly disrupted cream and grey dolomites, occasional thin chert bands and siltstone beds which become more significant further up the sequence.

The Always Creek Dolomites conformably overlay the Snake Hill Sandstone. Due to erosion and the severe abutment unconformity with the Deadfridge Dolomites the top of this sequence is not seen. Maximum observed thickness is 20 metres.
iv. Deadfridge Dolomites

This unit forms an extensive low-lying almost swampy terrain in the western half of the E.L. Except for a few hills in the north of the Was Creek Block, the succession is very poorly exposed. Four main divisions may be delineated.

(a) Basal dolomitíc, chert pebble conglomerate grading into;

(b) Well bedded, flaggy dololutite and occasionally iron rich beds with thin chert and siltstone beds.

(c) Red dololutite exposed as flaggy or smooth gently undulating beds.

The Deadfridge Dolomites disconformably overlay the Always Creek Dolomites and occasionally the Snake Hill Sandstone. The clastic component of the dolomites and lack of disruption generally are sufficient to distinguish them from the upper parts of the Always Creek Dolomites.

c. UPPER PROTEROZOIC

The Limmen Sandstone crops out on the western side of the Foelsche River and in the headwaters of the Wearyan River near the Calvert Fault.

It is a fine grained well sorted quartz sandstone. This unit is thought to be conformable on the Karns Dolomite - Deadfridge Dolomite (Robinson River 1:250,000 Geological Series, Y. R. Yates, et al).

d. CAMBRIAN

i. Bukalara Sandstone

This rock type crops out extensively as a reasonably thin plateau-forming veneer in the northern and western parts of the E.L.

Chert pebble conglomerates and chert breccias are common at the base of this sequence especially directly overlying the Deadfridge Dolomites in the north of the E.L. This suggests the
Bukalara Sandstone is disconformable although elsewhere the chert breccia is absent, e.g. at Eve's Fault. In general the unit is comprised of coarse grained friable poorly sorted quartz sandstone. Coarse jointing is common and has been noted in the underlaying red dololutite phase of the Deadridge Dolomites.

The greatest thickness is exposed in the headwaters of the Foelsche River and is estimated to be 30 metres.

5. STRUCTURAL GEOLOGY

The lease is situated on the Western limb of a broad anticline with a north trending axis passing approximately through Robinson River Homestead (Robinson River 1:250,000 Geological series.)

The dips in the lease area are generally 5° - 10° to the west or south west. Local variations occur at the disconformities. Steeper and variable dips in the Masterton Formation have been previously explained. Some few slight flexures have been noted. Two are close to the interpreted Lineation FL5 (Fig. 6j) and a third close to Eve's Fault. They may thus be related to drag folds although they plunge northwards at between 300° and 330° which implies a lateral north-south stress and hence N-S trending lateral faults as opposed to the Calvert Fault - Eve's Fault trends of 300°. Thus they may be related to the stress field which produced the Lineation FL5.

The major regional fault trends are north-westerly and have been active in part at least up to the Cambrian.

The north-south trend appears to have ceased activity prior to deposition of the Deadridge Dolomites.

Further discussion on structure will be dealt with separately under each area.

6. WAS CREEK BLOCK

a. Introduction

The Was Creek Block is considered as that area immediately north and west of the Foelsche River and approximates to Plan Foelsche River Area, Sheet 1 (Fig. 6a). It essentially encompasses
the area of best development of the chert-volcanic horizon of the Always Creek Dolomites. It is also distinguished from the Amazon Block in that the grid lines run N-S (205° magnetic to 025° magnetic). This area is also the most intensively explored.

b. Stratigraphy

i. The stratigraphy from the Wollogorang Formation upwards, is present in this area. The major units are the Always Creek Dolomites and the Deadfridge Dolomites. In general, the lithologies are the same as described earlier. The variations are:

(a) A partly clastic agglomerate developed near the Capstan and Drum Prospects. This rock has obvious conglomerate characteristics including graded bedding but towards the Capstan Prospect the matrix is more chalcedonic, rock fragments are commonly volcanic shards and the quartz and grade material is less significant. Some copper oxy salts are present but most are thought to be due to secondary migration (A.W.G. Whittle's Report MISC/98, FR 47).

On petrographic evidence it is suggested that this source is close to a volcanic vent. However, the horizon itself is sub-horizontal. It may cover a volcanic vent of short duration.

(b) Calcrete or altered dolomite. This classification has been used for a variety of limestone rich, brecciated sheared or featureless rocks closely associated with dolomites. These rocks surely have a variety of origins from that of a standard calcrete to the end product of a shear zone in dolomite. It is not possible to distinguish the derivation of these rocks in the field and it may be that several agencies have acted.
(c) Massive cherty rocks are present in the Southwest of the block. These units are difficult to distinguish from the cherts of the lower Always Creek Dolomites. At this stage they are considered to be of purely chemical sedimentary origin and have been included in the sedimentary suite rather than with the chert-volcanics.

ii. DDH-FO1 drilled by Australian Geophysical Pty. Ltd. indicates a fairly rapid change in stratigraphy in this area. The hole was drilled vertically at the Always Creek Dolomite-Deadfridge Dolomites disconformity on co-ordinate 1268/125W (Wass Creek Grid). The significant variants are:

(a) The Always Creek Dolomites appear to be much thicker, nearly 40 metres and thus the Always Creek Basin was considerably deeper in this position than further to the east, (Fig. 12). Siltstones are much more prominent in the section although they may have been largely obscured by scree on the surface exposures. Except for the collar of the hole, the chert-volcanics are not visible in this section.

(b) Two interpretations are possible for the second part of this hole. The preference is for the last 43 metres to have intersected the Amazon Creek Dolomites, the last 10 metres representing a basal unit which may have developed on Settlement Creek Volcanics rather than the usual Masterton Formation disconformity and dolomitic quartz sandstone cobble conglomerate.

Alternatively this last section may represent the Wollogorang Formation. The disconformity would thus occur at 164' 6" (50 metres). The vitric-lithic tuff at 218' would have to be interpreted as the volcanic horizon in the Wollogorang Formation. The last 10 metres would be the basal section of the Wollogorang Formation.
c. Structural Geology

i. No definite faulting was located in this block by geological mapping. At 132W/161S a north-south fault has been inferred by the presence of calcrete, a distinctive creek pattern and distorted bedding. There is no evidence of substantial displacement on this fault thus it may be simply a tensional feature sympathetic to F11 (Fig. 6j) which is parallel.

Another inferred fault is present south west of the Capstan Prospect (111W/159S). It trends northwest as indicated by a foliation in 'calcrete' and appears to dip at 60° to the northeast. The fault is located in the Wollogorang Formation and does not appear to penetrate the Karns Dolomite.

At 130W/130S several narrow altered veinlets are present in the Deadridge Dolomite and trend at 060°. Elsewhere these have indicated faulting.

In the Further Hope area (122W/147S) narrow mineralized veins in dolomite trend 045° to 060°.

A unique slump? feature - a micro anticlinal system with sheared out? corresponding synclines - occurs in the northern parts of the block and is largely restricted to one horizon. The axis of this folding is approximately 070°.

ii. Basin Development

From geological mapping (Plan 6a) it is obvious that the hinge line for the general MacArthur Group (Karns Dolomite) sedimentation had a distinct north-east trend in this area. It is also apparent that the hinge or downwarping initiated in the east had migrated to the west quite distinctly by the end of the Lower Proterozoic Sedimentation. The basin development for Deadridge Dolomites has been quite severe as is exemplified by the steep disconformity and coarse basal conglomerate derived from the Always Creek Dolomites. The distinct difference in deformation between these dolomites also suggests a significant tectonic event occurred prior to Deadridge Dolomite deposition.
Thus it is suggested that during the era of MacArthur Group Sedimentation significant downwarping (faulting and folding) occurred along a northeast trending zone, a position which is now largely covered by Always Creek Dolomites. The final hinge position probably equates closely to the outcrop position of the disconformity between Always Creek and Deadfridge Dolomites. It also appears that the general northeast trend has been dislocated by sinistral cross faulting (Plan 6a).

d. Mineralization

i. Scattered traces of copper mineralization are common throughout the area. Minute grains of syngenetic chalcopyrite (A. W. G. Whittle's Report MISC/98, FR 22) are common in the lower part of the Always Creek Dolomites. Coarser grains of chalcopyrite occur in patches of recrystallized carbonate in dolomites just below the algal horizon. Malachite grains are very common in vughs and as discreet grains in the chert-volcanic suite of the Always Creek Dolomites. Sparse occurrences of chalcopyrite have been noted in the red dolomites of the Woolgorang Formation.

ii. Pyrite and limonite pseudomorphs are almost ubiquitous throughout the chert-volcanics of the Always Creek Dolomites and vitric-lithic tuff of the Amazon Creek Dolomites.

iii. The specific mineralized localities are:

(a) Capstan Prospect

This was the initial discovery in the area. It largely consists of scattered blebs and veinlets of malachite in very fine grained dolomites and algal dolomites. Disseminated chalcopyrite, chalcocite, and traces of bornite have also been described from this location. Malachite is also common in some of the chert-volcanic rocks. A small patch of limonite-malachite-chalcocite gossan is present below the algal horizon but no other field relationships are determinable.

(b) Drum Prospect

This deposit, although of small areal extent, is more consistent than the Capstan Deposit. A mineral assemblage of predominant malachite and chalcocite (with minor covellite and azurite)
occupy the interstices of a chert breccia, stratigraphically positioned immediately below a silicified (chalcedonic) vitric lithic tuff. In this area the mineralization appears to be strictly stratigraphically confined. Minor malachite has been observed in a nearby agglomerate (A. W. G. Whittle's Report MISC/98 FR 47) but is largely of secondary origin. Although the mineralized zone has not been delineated, the stratigraphic position is terminated by topographic dissection and an unconformity (Plan 6a).

(c) Further Hope

Several patches of copper oxysalt mineralization occur in an area of poor outcrop. Some sub-vertical veins of malachite and chalcocite are exposed in dolomite inliers in the chert-volcanic horizon. The veins trend at approximately 060°. Further patches of malachite and chalcocite occur in the chert-volcanics further to the north and in a highly gossanous sub-outcrop to the west. Large limonite cubes - pseudomorphs of pyrite are common in this area and are surely derived from the chert-volcanics.

(d) James Joy

The mineralization is very closely associated with the algal structures of the Always Creek Dolomites. Malachite and chalcocite commonly occupy layers in the algal structure alternating with siliceous or chalcedonic layers. Copper minerals are also common at the boundaries of the algal columns. Further irregular vein like mineralization is present in the underlying dolomites and algal dolomites. This mineralization is reasonably contiguous but is areally limited and probably stratigraphically confined.

iv. Other minor localities have been noted. They are similar to one of the four described above but usually represented by an isolated outcrop or very small area within the stratigraphic position.

e. Geochemistry

i. Grid lines 300 metres apart were constructed perpendicular
to the major air photo lineation in the area. Station spacings were 100 metres apart. Sampling was initially more detailed near the Capstan Prospect.

ii. Initial inspection of results allows an empirical deduction of anomalous zones. The halo around the anomalies also appears well defined. It was noted that values in excess of 900 ppm copper commonly related directly to high grade copper mineralization.

iii. Calculation of background and threshold was made for each rock type where possible. At this stage contouring does not employ these values due to the complexity of bimodal and trimodal populations and inherent contamination of samples near and especially downslope from rock boundaries. (Ref. A. Statistical Interpretation of Soil Sample Analyses, E. L. 1011, Northern Territory, R. Taylor and C. Persson, Appended). Threshold for the Always Creek Dolomites is considered to be approximately 350 ppm although indication of significant mineralization is considered to be higher.

iv. Two main controlling factors effect the geochemistry. A strong northeast trend to the geochemical anomaly suggests the mineralization may be controlled or originate from a similarly trending structure.

The northern part of the anomalous zone (Plan 6c) strictly outlines the outcrop of the mineralized horizon in the Always Creek Dolomites. It is probable, however, that the anomaly is in part terminated on the western side by a major structural feature.

The southern part of the anomaly (Plan 6c) also in part outlines the outcrop position of the chert-volcanics and exhibits a northeast trend. The agglomerate horizons and suspected volcanic vents form boundaries to the small basin enclosing the Capstan and Drum deposits and also form boundaries to the geochemical anomalies.

However, it is felt that in detail the geochemical anomaly is defined by outcropping chert-volcanics and stratigraphically adjacent rock types. The general northeast trend is surely a basin trend or hinge line active during deposition of the Always Creek Dolomites.
The dextral displacement of the northern and southern anomalies is well explained by sinistral movement along the major lineation interpreted from air photos (Plan 6j).

f. Geophysics

i. A C.E.M. survey was carried out during June, 1974. For details see report; 'An Interpretation of a Shoot-Back E.M. Survey, Robinson River, Northern Territory', by John L. Irvine.

In general the amplitude of anomalous zones was low. Little correlation exists between these anomalies and geological or induced polarization features. Zone C is approximately parallel to the I.P. anomaly 'Capstan' and is sub-parallel to the minor basin margins enclosing the Drum and Capstan Prospects.

Zone A in part coincides with weak I.P. anomalies but the trends in each case have been interpreted differently.

Zone D relates to the Drum Prospect and indicates it is little more than the mineralization seen at the surface.

The eastern end of Anomaly H corresponds closely to I.P. Anomaly H and occurs near the Deadridge disconformity.

Other anomalies are less distinct and without other supporting features are not considered worth pursuing.

ii. Geomagnetism

A magnetometer survey was completed over the north-south grid system. A Proton Precession instrument was used. Some difficulty was encountered due to magnetic storms and instrument malfunction. However, the data compiled and contoured is considered accurate to approximately 10 gammas. These final results were computer contoured in Tulsa and the results assessed by N. E. Goldstein (Inter-office letter Appendix 5 and Fig. 13). The most significant interpreted lineation trends northeast and has been designated 'A'. As mentioned, this coincides closely with the western edge of the geochemical anomaly. It also lies within the hinge zone of the basin development and is sub-parallel to the hinge line FL 3 (Fig. 6j).
It is difficult to relate lineament B to any geological features, however, it coincides with a major break in the resistivity at 120N-122N/90E-92E, (Fig. 8 c).

Magnetic highs RP-1 to RP-5 and RP-13 lay along a northeast trend almost exactly coincident with an ERTS photo lineament. These have been suggested as related to placer magnetic mineral deposits, however, little magnetic material has been found in the present creek bed. In addition the magnetic stations in the magnetic highs are topographically low and probably affected by the Settlement Creek Volcanics. These 'highs' may thus represent volcanic pipes or less oxidized andesites along a northeast lineament.

The trend interpreted through anomalies RP-12 and RP-11 and associated magnetic lows, coincides closely with the Poelsche Fault. The line of magnetic lows may represent a zone where the Masterton Sandstone was eroded prior to deposition of the MacArthur Group. Also the pronounced low RP-10 maybe sympathetic to the adjacent high. It is unlikely that the volcanic (Pte. - Fig. 6a) would have a lower susceptibility than the surrounding rocks especially since it is iron rich.

There is also a suggestion of a northeast trending lineament between magnetic highs RP-6 and RP-16. This corresponds to the suspected volcanic vents adjacent to the Drum and Capstan Prospects.

iii. Induced Polarization

An extensive I.P. survey was carried out during September and October. (Report on Geophysical Survey E.L. 1011, Robinson River, Northern Territory, by J. L. Irvine). Time domain equipment was used with an initial gradient array survey designed to cover the northeast trending geochemical anomaly and outcropping Always Creek Dolomites. It was anticipated that any feeder system (probable volcanic vents) to the chert-volcanic and algal horizons would be located using this technique. A possibility also existed for a thickening of the mineralized horizon in the southwest where the mineralized horizon was below outcrop level.
A new grid direction was established, based on the trend of the basin and geochemistry. In general the new grid co-ordinated well with the original soil sampling grid.

Following delineation of several anomalous zones, further detail was carried out employing 50 metre dipole-dipole spreads. Weak anomalies indicating a shallow source was obtained over the Drum, Capstan and James Joy Prospects. The data from the Drum Prospect is not complete and does not conclusively terminate the mineralization at depth.

All other I.P. anomalies are 25 metres deep or greater. Oxidation of sulphides is not expected to occur to this depth. Chalcopyrite is present in the Drum Deposit at the surface and minor chalcopyrite is present in the limonitic Wishing Well gossan. Thus it appears that no significant sulphide zone has been located within or extending into the Always Creek Dolomites.

However, mineralization has been noted both in the Amazon Creek Dolomites and the Wollogorang Formation. Extensive pyrite and trace chalcopyrite was logged in the Aquarium Formation Sandstones (DDH-H01 - Australia Geophysical Pty. Ltd. - Appendix II). The I.P. responses may represent mineralization in any of these horizons. Due to the following factors it is difficult to stratigraphically position the source of the I.P. anomaly.

a. Degree of error in depth determination of I.P. anomaly.

b. Irregular nature of the disconformity at the base of the MacArthur Group.

c. Uncertainty of the presence of Settlement Creek Volcanics below this area.

d. Rapid thickening of the Amazon Creek Dolomites and Always Creek Dolomites towards the west.

Allowing for these factors the following I.P. anomalies are considered:
(a) D-1 (Fig. 8d)

This clearly defined anomaly is spatially related to narrow irregular veins (bearing 055°N) of chalcocite and malachite. The depth interpreted from I.P. suggests that the source of the anomaly may be located within the Amazon Creek Dolomites. A strong resistivity high immediately west of the anomaly (Fig. 9) may indicate a narrow siliceous volcanic dyke—a channel for both the suspected mineralization and the outcropping mineralization.

(b) G-1 (Fig. 8c)

A well defined I.P. anomaly exists in this position. A resistivity contrast across the section (Fig. G-1) has distorted the chevron shape. The source has been interpreted to occur at 90.5E, approximately 25 metres deep. The electrical configuration coincides closely with an interpreted steep basin slope. The I.P. anomaly would lie close to the basement within the Amazon Dolomites and may be related to faulting along the basin hinge line or vulcanism associated with the yellow vitric lithic tuff (Pkv).

(c) B/C-1 (Fig. 8d)

This is the largest and strongest of the I.P. anomalies. The interpreted source is 50-100 metres wide and 25 metres deep. On the western side a high resistivity zone corresponds to a postulated fault. The I.P. anomaly lies in line with a lineament deduced from magnetics and geology and which passes close to the Drum and Capstan Deposits. The depth indication of this anomaly suggests it occurs within the Amazon Dolomites.

The other I.P. anomalies are not as significant as these three. A further evaluation will be made following 100 metre dipole-dipole traverses over anomalies E-1, C-2, C-3 and H, Drum and Capstan. Due to the sometimes poor correlation between gradient array and dipole-dipole it is considered that at least two dipole-dipole traverses be conducted over definite anomalies.
7. **AMAZON BLOCK**

a. Introduction

This area is essentially continuous with the Was Creek Block but is considered separately since during exploration it has been treated as a separate area largely as a result of extremely poor access.

The area under discussion is restricted to the south side of the Foelsche River and east of the river, south of 150S (Fig. 6b).

b. Stratigraphy

The stratigraphic sequence is similar to that described in the general section.

i. Settlement Creek Volcanics crop out in the extreme east of the area. The agglomerates have developed along Woppitt Creek and probably underlay purple and red tuffaceous siltstones. Outcrops of weathered andesites or andesine basalt occur just east of Woppitt Hill beside the creek and at the eastern end of line 162S.

ii. Wollogorang Formation

The Woppitt Creek area is the type locality for the description in the general section. Some difficulty is encountered in defining the base of the Wollogorang Formation. At this stage it is regarded as the lowest dolomitic lithologic unit.

iii. Masterton Formation

This red silicified sandstone is common throughout the Amazon Block, reflecting the lower stratigraphic sequence exposed in this block. An outcrop of Masterton Sandstone at the extreme east of line 162S overlies a thin sequence of Wollogorang Formation and then Settlement Creek Volcanic. The sandstone is poorly sorted purple and friable one indicative of
of derivation from the Settlement Creek Volcanics. Elsewhere the sandstone is as described previously.

iv. Amazon Creek Dolomites are common in this, their type locality. The Amazon Volcanic (vitric-lithic tuff) is wide spread in this area. At 188S/102W thin disrupted beds of vitric lithic tuff occur in the basal conglomerate of the Amazon Dolomites.

v. Snake Hill Sandstone has not been seen to have any dolomitic component in this area. Frequently it is difficult to distinguish from the Masterton Sandstone from which it appears to have been derived. Scattered outcrops of basal conglomerate are common overlaying the Masterton Sandstone. Much of the area southeast of the grid is of this type.

vi. Always Creek Dolomites are similar to those described from the Was Creek Block. Except in the south and west, it crops out as a thin veneer or small hillocks on the plateau level. Malachite and chalcopyrite are present in the chert-volcanic, algal horizon.

vii. The Deadridge Dolomites are as described in the general section and are restricted to the west and south of the area.

c. Structural Geology.

As for the Was Creek Block, very little evidence of faulting has been seen during mapping.

Air photo lineation FL4 (Fig. 7) coincides with the western edge of Amazon Creek Dolomite outcrop. The lineation thus may represent the western fault of a graben in which Amazon Creek Dolomites deposited. This lineation may be related to minor faulting trending 020° located at 191S/203W and 176S/205W.

The air photo lineation FL5 (Fig. 7) is continuous, from well into the Was Creek Block, to the south of the Amazon Block. No distinct features defining this fault have been located, however, some drag folding, silicification and calcrete development indicate the...
existence of a fault.

The southern continuation of Eve's Fault (Fig. 7) penetrates this area. The only indication of the fault is at 198S/205W where a chert breccia and small gossan crop out.

Some slight folding is present in the Wollogorang Formation west of Woppit Creek, but no general trends are apparent.

d. Mineralization

i. Pyrite and traces of copper sulphides are common throughout the chert-volcanics and algal horizon of the Always Creek Dolomites. Some flecks of chalcopyrite and pyrite have been seen in dolomites of the Wollogorang Formation and Amazon Creek Dolomites.

ii. Amazon Creek Volcanic

Large limonite pseudomorphs are ubiquitous in this unit. Traces of malachite are rare.

iii. Woppitt Hill Mineralization (156S/97W)

A very small quantity of limonite-malachite gossan float occurs in this position. It is close to a boundary between Masterton Sandstone and Wollogorang Formation (possible fault contact), but probably from within the pseudo-algal dolomites of the Wollogorang Formation. Sample FR 89 has been described as a mineralized silicified tuff. (Report MISC/103, A. W. G. Whittle, Appendix VI).

iv. Wishing Well Prospect (191S/104W)

This mineralization is distinct in that it is much more limonitic than the Was Creek Block mineralization.

It occurs as float and outcrop for a distance of about 50 metres. The gossan becomes less malachite rich towards both ends. A short gossan vein (sub-vertical?) trends 155°. The indication is that there may be a series of veins. Directly overlaying the mineralized zone is a bed of yellow vitric-lithic tuff. Further east the Dolomites are coarsely recrystallized and some alteration is present. Thus the area may be close to a vent from which the tuff was derived.
The area is situated at the southern end of lineation FL 4 (Fig. 7). A sinistral offset of the lineation is suspected due to apparent displacement of the Masterton Sandstone.

v. Chrysocolla has been noted in sandstone at 168S/208W. This may be related to lineation FL4. The copper minerals are found coating joint faces. Silicification is common in the sandstone as veining.

e. Geochemistry

The area can be divided into three geochemical regions.

i. The northern area around Amazon Creek consists primarily of isolated geochemical highs representing outcrops of either Always Creek chert-volcanic or Amazon Creek Volcanic. The notable exception is the Wishing Well Prospect and the spot-high at 196S/100W.

ii. The Woppitt Creek area consists of small isolated 'highs' representing Amazon Creek Volcanic and some large anomalous zones coinciding with the Wollogorang Formation. The source of these anomalous values is not known at this stage. There were insufficient samples taken for a statistical analysis but it is felt that 'background' may be quite high. It is noteworthy that lead and zinc values are significantly higher for the Wollogorang Formation.

iii. The southern area is very much like the Was Creek Block. No concentrated mineralization has been located in the area but the abundance of chert-volcanics is considered sufficient to explain most of the anomaly.

8. DONALD YARD AREA

a. Geology

Most of the survey during the 1974 season occupied the
area to the north of the Was Creek Block on the western side of the Foelsche River.

The area contains an almost complete section of the stratigraphic column as mapped in the lease area. The stratigraphy thus conforms closely to that discussed in the general section.

b. Geochemistry

Two significant geochemical anomalies (copper) were noted in the area.

i. Approximately 1.3 km south-southwest of Donald Yard. This drainage area is derived from the lower (algal) horizons of the Always Creek Dolomites. It is also semi-contiguous with the geochemical trend outlined in the Was Creek Block. Although mapped faults and air photo interpreted lineations have been located both to the west and north of this area, no faulting can be directly related to this zone. The source of the anomaly is surely of similar type as that for the large geochemical anomalies of the Was Creek Block.

ii. Almost all of the drainage of Deep Creek approximately 5 km south-southwest of Donald Yard (south side of Foelsche River) contains anomalous copper values. No definite explanation can be given for this anomaly. The Creek dissects the Amazon Creek Dolomites. Scattered float and scree of the vitric lithic tuff (Pkv) and associated siliceous and cherty rocks are very common and is suggested as a source for the copper values.

c. Conclusion

Extension of the soil grid will be required to assess the likelihood of a Wishing Well type deposit in this anomalous zone as outlined by Deep Creek and adjacent Speedy Creek.

The main soil sample grid will also be extended northwards towards Donald Yard to fully close off the anomaly.
9. **AMAZON AREA**

This area was initially stream sediment sampled as part of the programme to locate further outcrop of the mineralized horizon as at the Drum and Capstan Deposits. It is immediately apparent that the lower stratigraphic units are predominantly exposed. The type section for the Amazon Creek Dolomites and Wollogorang Formation are in this area, as is the greatest thickness of the Masterton Formation.

All the significant anomalous areas were followed up by soil sampling and have been described under the Amazon Block heading. Two areas not detailed were (i) the western part, which consists of flat swampy ground over Deadridge Dolomites, the area is also geochemically unresponsive and (ii) the southern area. The topographically low positions are occupied by Always Creek Dolomites. Algal structures commonly crop out in Amazon Creek.

These algal structures are typical of the Always Creek Dolomites but are composed of deep red recrystallized dolomites rather than micritic grey and cream dolomites.

The Bukalara Sandstone commonly directly overlies this lower section of the Always Creek Dolomites and is generally a very siliceous coarse chert cobble conglomerate.

Although the favourable host horizon crops out in the area geochemical values are uniform and low and indicate a lack of mineralization. It is significant that this is associated with a lack of chert-volcanics.

Very little faulting has been interpreted in this area although a series of southwest trending faults head into the area.

The area is not considered worthy of further prospecting at this stage.

10. **CONCLUSIONS AND RECOMMENDATIONS**

a. Was Creek Block

i. The large geochemical anomaly is related directly
to mineralization in the chert-volcanic horizon of the Always Creek Dolomites. Subsequent exploration indicates that this stratigraphic horizon in this position has little potential. However, the area west of the Drum Deposit and west of I.P. Blocks B, C and D. requires further investigation. The chert-volcanic horizon would underlay the Deadfridge Dolomites in this position. Lineation FL 2 (Fig. 6j) cuts this area and further north forms the western edge of the geochemical anomaly and is associated with I.P. anomalies. It has not been shown conclusively that the geochemical dislocation (at approximately 150S) is a real geological feature although an air photo lineation is interpreted in this position. However, geological indications suggest a dextral movement in the basement whereas the geochemical displacement is sinistral. It is reasonable to suggest that the mineralized horizon extends under this area to the west of the Drum Prospect although, relating to data from DDH-F01, this is not conclusive. If the basin deepens as rapidly as is suggested by DDH-F01 then there exists a possibility of slumping, thickening and brecciation of the volcanic horizon providing a suitable host position for penecontemporaneous mineralization.

The most effective exploration method for this area would be gradient array induced polarization.

ii. Induced Polarization has indicated the presence of polarizable material at depth in the area. Of the anomalies obtained D-1, G-1 and B/C-1 are considered the most promising for reasons described previously. Inclined diamond drill holes are recommended for each of these positions. The final position being dependent on results of 100 metre dipole-dipole I.P. and parallel dipole-dipole traverses over the anomalous zones.

iii. A geological anomaly occurs at 149S/112W. Settlement Creek Volcanics crop out in a very high topographic position and apparently overlay the Wollogorang Formation. Despite the similarity petrographically with the Settlement Creek Volcanics, this may be an
outcrop of Gold Creek Volcanic (the commonly mineralized horizon at Redbank). If further detailed mapping cannot explain this area it may be useful to scrape a shallow costean across the boundary.

b. Amazon Block

i. The Wishing Well Prospect requires testing with dipole-dipole I.P. traverses. These should be extended to the small geochemical anomaly at 1968/100W.

ii. Induced Polarization is recommended for the area where lineation FL 4 and Eve's Fault intersect the geochemically anomalous area and also where gossan and siliceous breccia crop out at 1988/105W.

From geological mapping it is unlikely that the chert-volcanic horizon has any potential in this area. The geochemical anomaly may represent leakage from a more major deposit at depth, however further action should be delayed until drilling in the Was Creek Block provides further control of the geology.

iii. The geochemically anomalous zone near Woppitt Creek requires further geological study. Lithological sampling of the Wollogorang Formation for geochemical assays is required. Mechanical dispersion is a large factor in this area but it appears likely that an horizon with high background values of copper, lead and zinc is the source of the anomaly.

c. Donald Yard

Some follow up soil sampling and detailed mapping is required in the areas outlined as anomalous in stream sediment sampling. The area just east of the gridded area is of especial interest since it exposes the same stratigraphic position in which the Wishing Well Prospect is located.
d. Amazon Creek Area

Essentially the area of interest has been covered by subsequent soil sampling and geological mapping. Apart from minor extensions to the existing grid no further detailed study is considered necessary.

RGT/cah

BIBLIOGRAPHY


APPENDIX I

DDH-PO 1

LOCATION
Australian Geophysical Grid FA BL/62N Was Creek 126S/125W
(See plan; Foelsche River Area - Geology)

INTERVAL
DESCRIPTION

0' - 4'       Poor Recovery. Very broken core. Buff
coloured dolomite, green limestone and minor
chert and quartz.

4' - 14' 6"
Pink and cream dolomite and occasional chert.
Broken core.

14' 6" - 17' 6"
Cream siltstone - not dolomitic.

17' 6" - 18' 6"
Cream dolomite. Fractures at 0°.

18' 6" - 19' 6"
Cream slightly dolomitic fine grained
siltstone.

19' 6" - 24' 6"
Dark red, poorly bedded siltstone and some
green siltstone. Dolomite pebble conglomerate
bed at 27'. B. P. P. at 70°.

27' 6" - 34'
Pink and cream dolomite. Stylolytes at 90°.
Poorly defined bedding.

34' - 38'
Interbedded red and green siltstone. Green
siltstone is slightly dolomitic and some thin
dolomite beds are present. Bedding at 90°.

38' - 51' 6"
As above. Siltstones are slightly more
dolomitic. Two bands of vughy limestone.
B. P. P. at 90°.

51' 6" - 56'
Pink, partly recrystallized dolomite with
irregular large calcite veins. Stylolytes.

56' - 57'
Green dolomitic siltstone.

57' - 63'
Pink finely banded, fine grained dolomite.
Some coarse calcite development associated
with brecciation.

63' - 64'
Cream dolomitic siltstone.

64' - 73'
Pink, grey and white, fine grained dolomite.
Stylolytes. Some calcite patches and zones.

73' - 74' 6"
Dark grey mottled dolomite. Some development
of coarse grained calcite.
Dolomite, in part recrystallized and brecciated. Dolomite pebble conglomerate (3cm) at 75' and sandy dolomite pebble conglomerate at 77'. Pyrite in dolomite pebble conglomerate at 75'. Bedding 80°.

Dark grey and light grey finely banded dolomite. Frequent development of coarse grained calcite. Irregular wavy bands (algal structure?) associated with brecciation between 85' - 86'. Bright blue-green staining between 73' - 89'. Traces of Pyrite in zones of recrystallization.

Granular porous quartz - kaolin rock. Some pink and grey banded dolomite.

Medium grained and partly recrystallized pink and dark grey dolomites. Irregular to wavy indistinct banding. Some irregular coarse grained quartz-calcite development.

**Brecciation**

- **at 99'** below very fine grained dolomite.
- **at 102'** in association with vughs of calcite and quartz
- **at 108'** associated with recrystallized calcite and vughs
- **at 109'** associated with calcite veining (30cm)
- **at 116'** similar to a dolomite pebble conglomerate.

**Wavy bedding**

- **at 103' 80° - 20°**
- **at 115' 40° - 30°**
- Most bedding at 90°


125' - 127' Green weakly dolomitic siltstone with thin (1cm) sandy dolomite pebble conglomerate beds and dolomite beds.

127' - 127'6" Sandy siltaceous dolomite pebble conglomerate with some very irregular găluconitic fragments.

127'6" - 129'6" Fine grained well sorted sandstone with fine grained siltstone interbeds.
129.6' - 131'  Cream dolomitic siltstone with some sandy and dolomite beds.

131' - 132' "Greensand" type pebble conglomerate, containing occasional fine grained siliceous-dolomite fragments.

132' - 142' Fine grained white quartz sandstone and occasional greywackes. Minor green siltstone beds. Bedding 80°.

142' - 148' Predominant green siltstone with occasional dolomite and dolomitic sandstone beds. Bedding 80°.

148' - 153.6' Dolomitic sandstone and occasional green siltstone beds. Bedding 80°.

153.6' - 157.6' White sandstone and occasional green siltstone beds.

157.6' - 164.6' Pink and grey-green glauconitic sandstones commonly with pebbles of dolomite and green shale. Occasional green siltstone beds (2mm). Disrupted green siltstone beds at 164.6".

164.6' - 177.7' Pink, cream and off-white fine grained dolomites. Slight brecciation and disruption common especially at 173'. Bedding 85°. B.P.P. strong in green siltstone from 166.6' - 165.6". Fractures common at 0°.

177.6' - 197.6' Partly recrystallized banded pink dolomites. Some fine grained partly silicified dolomites (Chert)? Breccia zones common especially 180.6' - 181.6" where chlorite indicates a shear. Recrystallization common between 190'-193'. Fractures common at 0° - 10°. Bedding at 85°.

197.6' - 210' Pink banded and partly recrystallized dolomite and very fine grained cream partly silicified dolomite. Chert present from 200'-201' 203'-204' Brecciation at 203'.

210'-210.6" Brecciated weathered siliceous zone.

210.6' - 212' Purple - brown (weathered) dolomite with some dolomite pebble conglomerate beds.

212' - 217.6" Slightly oxidized pink mottled and banded dolomite.

217.6' - 237.6" Hard pink banded and mottled silicified dolomite with some fine grained cream dolomites and cherts.
Yellow vitric-lithic tuff at 218' (2cm) and 218'6" (2cm). Pyrite in shears at 227' (4cm). Probable green tuff with red vitric fragments from 226' - 228'6". Dolomite pebble conglomerate at 231'. Green siltstone from 225' - 226'. Bedding approx. 90°.

237'6" - 251'
Red and pink banded and mottled dolomites. Partly silicified and recrystallized. Coarse grained calcite veins (3cm wide) are common.

251' - 256'
Pale pink and cream dolomite chert. Dolomite pebble conglomerate and green siltstone from 252'6" - 253'6". Pyrite on 20° fractured face.

256' - 261'
Pink to red banded and mottled dolomite. Fractures common at 0°.

261' - 266'
Fine grained cream dolomite. Some dolomite breccia bands and green siltstone at 265'.

266' - 267'
Cream siltstone Bedding 90°

267' - 273'
Banded mottled pink dolomite Breccia (10cm) at 268' Fractures at 0°.

273' - 276'
Cream siltstone

276' - 282'6"
Purple fissile mudstone B.P.P. 85° - 90°

282'6" - 286'
Cream mudstone with pebble beds towards 286'.

286' - 294'
Dark purple and green sandy pebble beds and siltstone. Pebbles of siltstone, dolomite and red silicified sandstone. Pyrite on fracture face associated with quartz and silicification of the sandstone.

294' - 305'
Dark purple siltstone with occasional coarse siltstone beds. Becoming very friable and fine grained with common quartz grains.

END OF HOLE
APPENDIX 2.

AUSTRALIAN GEOPHYSICAL DRILL HOLES
ROBINSON RIVER AREA.

DDH. H01

LOCATION
Hopplestrap Grid 00/32W.
150 metres E and 100 metres N of the first
Hopplestrap Creek crossing on the Old Salt Road.

Interval Description
0-5' Very fine grained weathered dolomite. Irregular bedding,
weak bedding plane parting. Very rare thin (3mm) apple
green chert bands.

5' - 7'
Poor Recovery. Thin zone of green siltstone conglomerate
containing angular plates of shale.

7' - 9'.
Very dirty purple sandstone. Massive but not siliceous.
C.F. Masterton Sandstone overlying Settlement Creek volcanics.

9' - 12'
Fissile green and red-brown siltstone. Some bands are
dolomitic.

12' - 13'
Quartz sandstone with dark green matrix. Very poorly sorted.

13' - 17'
Almost no recovery. Purple and green shales.

17' - 17'6''
Fine grained red dolomite, weathered.

17'6'' - 18'
Yellow and green vitric tuff. Some development of granular
quartz.

18' - 20'
Partly recrystallized red dolomite. Patches of pyrite
just below tuff and slightly brecciated dolomite.

20' - 21'
Similar to above. Rests angularly on Settlement Creek
Volcanics and contains large rounded pebbles of "andesite"
in a dolomitic matrix.

21' - 30'
Red (weathered) medium to fine grained basaltic rock.
Common large (2mm) chlorite amygdules.

30' - 39'6''
As above. Fewer amygdules. Prominent feldspar laths,
altered to red oxidized material.

39'6'' - 59'
As above. Some fine grained red fragments in intermediate
fine grained ground mass. Vitric-Lithic tuff?
Thin calcite veins common from 40' - 51'.

59' - 78'
Similar to above but slightly less weathered. Common
irregular thin calcite veins at angles of 0° - 20° to core
axis. Occasional thicket (2mm) calcite - amethyst veins
at 40° - 60°. A fine grained band (3cm) at 77' at 90°
with associated calcite vughs and parallel chloritic
bands indicates a shear.

78' - 98'
Slightly oxidized fine to medium grained chloritic igneous
rock with well developed feldspar laths. Some irregular
calcite veins with occasional chloritic development at the boundaries. Shears described in previous interval occur at 82', 86', 93', 98', and are all at 80° - 90°.

98' - 117'6"
"Andesite" ground mass is strongly chloritic with well developed feldspar laths. Occasional 2 - 3 mm chlorite-calcite veins at 70° - 90° and commonly containing patches of fine grained Pyrite. Narrow zones of fine grained material probably represent shears at 90°. Occasional irregular calcite veins at 0° - 30°.

117'6" - 134'
"Andesite". Some very irregular calcite veins between 120° and 123° with associated chloritic zones. Narrow (1mm) irregular calcite veins at 85° - 90° are frequent between 123° and 126°. "Andesite" becomes fine grained and less uniform towards 134°. Narrow band of green shale at 132°.

134' - 137'
Green spotted shale. Garnets (red) developed. Fissile. Cleavage at 80°.

137' - 141'
Purple and orange spotted shales.

141' - 157'6"
Red-purple and green shales. Highly fissile. Bedding Plane Parting (B.P.P.) 141' - 150' at 90° 150' - 157' at 80° Cleavage at 0° at 152'6"

157'6" - 175'
Red-brown fissile siltstone, B.P.P. 80° Cleavage 25° at 164° Occasional thin green shale beds. Some calcite flecking towards end of section.

175' - 198'
Beds of red-brown siltstone and green shale. Beds from 2cm to 10 cm thick. Green shale is more fissile. B.P.P. 80° Some irregular quartz-calcite veins.

198' - 210'6"
As above with increase of calcite flecking B.P.P. 70°

210'6" - 213'
Very contorted siltstone and shale, commonly orange or green. Very finely banded and in part brecciated.

213' - 271'6"

271'6" - 276'
Brecciated "Andesite". "Andesite" fragments are slightly finer grained than further up the section.

276' - 286'6"
Breccia Rounded to sub angular fragments of "Andesite" in a fine grained green to dark brown matrix. Rounded to angular fragments of shale in some beds indicate a breccia origin.

286'6" - 291'
Fine grained "Andesite". Sharp contact at 286'6". Fractures at 70°
Bright red oxidized sub-rounded fragments of "Andesite" in a fine grained matrix. Breccia.

Alternating fine grained dark brown siltstone and pale green siltstone. Green siltstone is invariably brecciated.


Dark red-brown siltstones and shales with beds up to 40cm thick, of green siltstone and cream and green dolomitic shales. Some sedimentary breccia zones generally confined to the lighter coloured beds. Bedding 70°.

Dark red brown siltstones and shales. Occasional beds of green and cream dolomitic pelites.

Development of red jasper common in bands of quartz-calcite and distributed throughout siltstone closely associated with irregular quartz-calcite veins. Similar to chert-volcanics of the Always Creek Dolomites. Fracture 80° Bedding 80° - 90°.

Similar to above with the appearance of massive fawn weakly dolomitic coarse grained siltstone and fine grained sandstone beds. Medium grained red sandstone from 360'-361'. Cleavage: - Very strong in green and shales at 85° - 90°.

As above except lutites and aremites are more frequent. Beds generally very thin (2-3cm). Sandstones are weakly dolomitic towards the end of the interval. Bedding 80° - 90°.

Similar to above with the appearance of bright green fine to medium grained glauconitic sandstone beds. Bedding 80° - 90°.

Red-brown, cream and green glauconitic sandstones. Thin (2cm) beds of brown and green shales. Bedding 80° - 85°. Sandstones are not dolomitic, and not all medium grained sandstones are glauconitic.

Similar to above. Thickness of shale beds increases up to 10cm. White clean sandstone is more common.

Predominantly red-brown and green shales. Occasional thin sandstone beds, more frequent towards 737'. Bedding 90°.
737' - 777'  
Green glauconitic sandstones and white sandstone, and green shale beds.  
Fractures in shale at 90°  
Bedding 90°

777' - 819'6"  
Massive white to pale green quartz sandstone. Some glauconite and green shale fragments.  
Pyrite, commonly fine grained, in sub vertical irregular fractures. Pyrite less frequent from 807' - 819'6''.

819'6" - 821'6"  
Red-pink sandstone with grains and blobs of chalco-pyrite and some pyrite.

821'6" - 858'  
Glaucnritic sandstone and green and brown micaceous shales.  
Traces of Pyrite  
Bedding 80°  
Fracture 90°

858' - 858'6"  
Red sandstone with traces of pyrite and minute grains of chalcopyrite.

858'6" - 885'  
Pure quartz sandstone, white or pink with well developed current bedding.  
Irregular fracture.

885' - 929'  
Purple and pink massive medium grained sandstone.  
Rare thin shale beds.  
Bedding 80°.

929' - 946'  
Pink mottled, weakly dolomitic sandstone. Occasional fracture at 0° - 20°.

END OF HOLE
INTRODUCTION

At the request of Mr. J. Cucvara, Chief Geologist for Australia-Cities Service, Inc., the author examined some C.E.M. data from the Robinson River N.T. area on behalf of Australia-Cities Service, Inc.

The target expected is a sulfide-enriched, dolomite horizon identified by geochemical methods. The C.E.M. method was utilized in an attempt to locate and identify a vertical system believed to be underlaying the horizontally-bedded, dolomite-bearing sulfides. The grid system was established on conclusions derived from aerial photography. Subsequent geochemical results would suggest that Geological and geochemical information were available but no complimentary geophysical information.

GEOLOGY

The geology of the area consists mainly of a series of flat-lying sediments with mineralisation known to occur in Upper Dolomites.

METHOD OF INTERPRETATION

Interpretation was based on the adaption of model studies presented by Crone Geophysics to the scale of the survey. As the coil separation was 100m and the reading interval was also 100m, detailed information of the recorded response was not available. However, several anomalies have been identified and plotted on the presented geological map. No magnetic results were available for interpretation.
DISCUSSION OF THE RESULTS

A general surface conductive zone was noted to exist from approximately 125S to at least 160S from east of traverse 112W to west of 127W. The results presented were collected by the horizontal mode but the data available for approximating the surface resistivity was not applicable as the theoretical work was presented in the vertical mode. However, it could be stated that the surface resistivity exceeds 100 ohm - metres, thus providing suitable conditions for electromagnetic methods.

ZONE "A"

This zone represents the strongest response recorded throughout the survey. The response recorded at 124W / 173.5S is of excellent quality for this survey. It is also one of the shallowest expected as models suggest less than 25 m depth of burial. The conductivity is good on traverse 124W and weakens to the west. Further investigation of this anomaly is highly recommended.

ZONE "B"

This is a much weaker zone striking E-W and of weak conductivity. The dip of this zone is expected to change from N dipping at the west end to south dipping at the east end.

ZONE "C & D"

These two separate zones are believed to form a single zone of response. They have a favourable NE strike similar to zone "A" and coincident to a geochemical anomaly at approximately 138S / 124-115W. It is especially favourable on traverse 117W / 156.5S where a medium frequency response is associated with known secondary copper mineralisation.
No dips have been indicated in the results but a questionable response on traverse 118W / 157.5S indicates a northerly dip. Further investigation of this zone for response is definitely warranted.

ZONE "D"

A very definite response from the low frequency was obtained at traverse 122W / 157S. From symmetry of the response plus the location of a possible response from the medium frequency, a southerly dip is expected. As no responses were noted on adjacent traverses, the strike length is very limited. As a short strike length exists, the conductivity of this zone is expected to exceed the best portion of zone "A". Massive malachite mineralisation is located near the interpreted conductor axis. Further work is warranted to explain the nature of the response.

ZONE "E"

This is another zone of limited strike length. The explanation for this zone can be explained geologically as it is directly associated with the unconformity at the top of the Tawallah sandstones.

ZONE "E & F"

These zones consist of two responses on traverses 115W. and one on traverse 115W which are closely related to Was Creek plus two responses on traverses 115W & 118W striking N.E. from the response on traverse 121W. This N.E. strike is highly favourable and it parallels zones "C" & "H" located further to the north. A large geochemical response is closely related to zones F, F₁, G & H as the zones approximate its edges. A fairly good quality conductor is expected.

ZONES "G"

This zone is of particular interest as it would appear to
associated with a previously drilled diamond drill hole. No information on the drill hole is available, but the drill hole would appear to be collared in the footwall of the response. Further investigation of this zone is warranted.

ZONE "H"

This is on strike with zone G and could very easily be an extension of zone "G"? Well defined responses represent this zone. A possible extension of this zone occurs on traverse 115W / 119S. However, it is slightly off the expected strike and the character of the response is different.

ZONE "I"

This zone is somewhat unusual in that it is the only zone that has a definite N.W. strike. However, it is an interesting zone of response in that it has a strike similar to mapped fault and mapped shears. A northerly dip is expected.

DETAIL WORK

DH-1

A detail traverse was conducted across the drill hole. The transmitter was at 127W / 124.5S and the receiver traversed in a direction of 010° - 190°. A very weak response was noted but it is considered to be a very weak response.

CF-1

Another detail traverse was conducted with the transmitter located at 112W / 159.5S oriented at 060°-240°. A weak but well defined response was noted. It does not correlate well with the shoot-back results.

DF-1

Three traverses were completed from a transmitter location
at 118W/157S and traverses oriented 125°-295°. A very weak response was recognised and associated with the shoot-back results.

**TRAVERSE 275M**

A long traverse of shoot-back and broadside was completed commencing at 115W / 125S and bearing 275° mag. A comparison of the results with the standard traverses suggests that traverse 275M parallels the strike of the zones identified from the standard survey. Four zones of responses have been recognized. At 23.5W, a narrow zone has been noted by the low frequency and the medium frequency recognized a deeper zone at 23W. Another response at 17.5W, suggest a narrow zone at depth (50m). A wide flat-lying zone is located at 10-14W. The fourth zone is located at a depth of 50m at 8W. The quadrature results provide excellent correlation with the dip angle results. The broadside results have identified the wide zones at 12.5W and the zone at 8W.

**TRAVERSE 095M**

The E.M. results are rather featureless with the exception of the low frequency shoot-back results. A weak response at 3.5E may be due to a valid zone but the results generally suggest that the traverse paralleled the strike.

**TRAVERSE 270M**

Two weak responses have been recognized on this traverse. At 9.5W, the zone has been identified by both frequencies with the shoot-back mode and the broadside mode. A very weak zone exists at 5W. As this traverse was conducted in an area where no shoot-back was conducted on the grid, no comparison can be made.
## APPENDIX 4

List of Company Reports of Exploration in the Robinson River - Calvert Hills Area.

<table>
<thead>
<tr>
<th>Mines Dept. N.T. Catalogue No.</th>
<th>Title</th>
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<tr>
<td>CR 67/7</td>
<td>Progress Report A to P 1343 Calvert Hills Area 1967</td>
<td>Australian Geophysical</td>
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<td>CR 67/5</td>
<td>Progress Report A to P 1343 Calvert Hills 1966</td>
<td>Australian Geophysics</td>
</tr>
<tr>
<td>CR 71/136</td>
<td>Progress and Supplementary Report A to P 3239 Running Creek Area</td>
<td>Fisher and Royal</td>
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<td>Final Report Calvert A to P Geological Studies - Calvert Station</td>
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<td>Frome - B.H.P.</td>
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<td>Progress Report No. 1 A to P 511</td>
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</tr>
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<td>M.I.M.</td>
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<td>Redbank Exploratory Drilling A to P 655</td>
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<td>Final Report on Redbank</td>
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<tr>
<td>CR 73/84</td>
<td>Report No. 187 1972 (Redbank) Noranda E.L. 121</td>
<td>Noranda</td>
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<tr>
<td>CR 73/87</td>
<td>Report No. 188 1972 (Redbank) Noranda E.L. 122</td>
<td>Noranda</td>
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<td>CR 74/60</td>
<td>Report No. 219 1972 (Redbank) Noranda E.L. 124</td>
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<tr>
<td>CR 71/109</td>
<td>Final Report Mountain Home</td>
<td>Australian Geophysical</td>
</tr>
</tbody>
</table>
TO: Mr. D. H. Buchholz
FROM: N. E. Goldstein
SUBJECT: Ground Magnetometer Survey, Was Creek Block, Robinson River E.L. 1011

January 9, 1975

The total field magnetometer readings for the Was Creek Block, Robinson River were digitized and machine contoured at our computer facility in Tulsa. At my request they also calculated and plotted a residual map. Both maps are attached to this memorandum. The residual map is essentially a high-pass filtered version of the total field map and accentuates near-surface features. Contours near the edge of the residual map should be ignored.

I found two digitization errors and noted them in red pencil on the total field map. The errors do not alter the overall picture to any marked degree so I did not ask that these data points be corrected and the contour maps be re-drawn.

In general, the magnetic relief over most of the area is subdued, rather typical of a terrane composed mainly of limestones and sandstones at surface. However, there are a number of 100 to 200 gamma highs which appear to arise from near-surface causes. Many of these highs (RP-1 through RP-9) occur at or near the margin of the Poelsche River, whose west bank is shown by the purple line, traced from the geologic map of the same scale (1:10,000). These magnetic highs could be caused by local fluvial concentrations of titanomagnetite-or magnetite-bearing sands deposited along the drainage channel. The correlation seems so good between the river margin and the magnetic highs, that I am almost certain of this explanation for these anomalies.

Magnetic low RP-10 at 149N/112W has a small high to the north and could be due to a basalt in the Settlement Creek volcanics shown to outcrop nearby. This is the only outcrop of the Settlement Creek volcanics mapped in the area of the magnetometer survey, but the magnetics suggest that concealed volcanics extend north-westward along the line RP-10, -11, -12 of magnetic highs and lows.

The Masterton formation seems to be responsible for some of the low-amplitude magnetic highs. For example, RP-13, -14, and -15 correlate very well with small outcrop areas of the sandstone. Moreover, the broad magnetic highs RP-16, -17, -18, -19 and -20 in the southern part of the area all seem to correlate with outcrop of the Masterton formation. I think that a few susceptibility meter readings on this unit would show it to have sufficient susceptibility to produce the observed anomalies.
There is little correlation between the magnetic data and the IP-resistivity data. However, there is some interesting correlation between the magnetic data and the geochemistry that seems worthy of mention. Lineament "A" shown on the total field map is defined roughly by a line of magnetic highs 20 to 30 gammas in amplitude, trending east-westerly. It is not a particularly strong feature and I wanted to ignore it until I overlayed the geochemical anomaly map and observed that the elongate geochemical anomalies fall almost directly on the magnetic lineament. A more doubtful magnetic lineament "B" intersects lineament "A", extends toward RP-7 and it, too, seems to correlate well with an elongate geochemical anomaly.

Therefore, the ground magnetic data give subtle indications that the mineralization detected at surface could be structurally related. What the structural controls might be is a subject for further study, but certainly is an interesting aspect.

Again, I would like to point out the desirability of obtaining magnetic susceptibility measurements in areas where ground magnetometer surveys are conducted. These often can assist in the interpretation of the magnetic data, particularly where geologic maps are unavailable.

NEG/kd
cc: G. C. Riley
APPENDIX 6

The rock contains irregular cavities which are rimmed by pale-brown calcite and orthoamphibole. Some contain fine-grained quartz or, occasionally, feldspar, clear, carbonate.

II. Section Description:

Diagnosis: MEDIUM-GRAINED, QUARTZOSE SANDSTONE

This section description is a medium-grained, poorly-sorted, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, arenaceous, are...
2.14 SPECIMEN FR. 17:

Identification: SLIGHTLY SILICIFIED, PARTIALLY-RECRYSTALLIZED, EXTREMELY FINELY-CRYSTALLINE LIMESTONE (KICTIT)

Thin Section Description:

In thin section the specimen is an extremely finely crystalline, calcareous, sedimentary rock consisting essentially of cloudy carbonate. The latter exhibits partial recrystallization to clear, carbonate. Slight silicification has led to the development of irregular cavities rimmed by very fine-grained, chaledonic silica which contain medium to coarse-grained, clear, carbonate and discrete, subhedral/subhedral, grains of altered, opaque mineral.

Polished Section Description:

In polished section the opaque mineral phase consists of minor amounts of disseminated, hydrated iron oxides, in part goethite.

15 SPECIMEN FR. 20:

Identification: FINE TO MEDIUM-GRAINED, QUARTZOSE SANDSTONE

Thin Section Description:

In thin section the specimen is a fine to medium-grained, reasonably well-sorted, epiclastic, arenaceous, sedimentary rock consisting essentially of subrounded to angular, detrital quartz grains with minor amounts of siliceous cement which has developed in optical continuity with the original detrital quartz. The rock contains very minor to minor amounts of altered feldspar, chert, altered chloritic material, blue tourmaline, altered opaque mineral and zircon.

2.3 SPECIMEN FR. 24:

Identification: SANDY (ARENACEOUS), FINELY-CRYSTALLINE LIMESTONE (CALCAREMITE)

Thin Section Description:

In thin section the specimen is an arenaceous, finely-crystalline, calcareous, sedimentary rock which consists essentially of finely-crystalline, slightly-cloudy, carbonate with minor amounts of very fine-grained to coarse-grained, subrounded to angular, detrital, quartz grains. Irregular cavities in the rock are filled with fine to medium-grained, clear, carbonate or, in some instances, with extremely fine-grained cryptocrystalline silica. Trace to very minor amounts of brownish-yellow tourmaline, zircon and altered feldspar are also present in the rock.
Dolomite of extremely fine grain size constitutes the major facies. Oxidised pyrite, as well as pyrite and chalcopyrite of much finer grain size, are evenly dispersed through the dolomite.

There is no obvious lineation in the dolomite since all of the grains are equidimensional in form. Bedding is apparent by virtue of thin lobulate, and probably slump-structure intercalations of cherty dolomite. The fluting on the hand specimen was developed during weathering as a result of the hardness differences between these two facies. This fluting has the appearance of a lineation.

Extensive aggregates of spherulitic intergrowths of secondary silica i.e. chalcedony, are interlayered with microcrystalline malachite. Together, these enclose either fine grained euhedral intergrowths of quartz or quite coarsely crystallised calcite. The goethite boxwork from oxidised sulphides, and grains of unoxidised chalcopyrite are contained within the coarse calcite intergrowths.

The unaltered, and the oxidised pyrite and chalcopyrite granules within the dolomite itself, and to a lesser extent within the chert, have a grain size of 2-5 microns. They are commonly sited within the individual dolomite grains of 15-30 microns size, hence they are surely syngenetic in origin; and probably of simultaneous chemical or bacterial origin within the chemically deposited dolomite and chert.

The coarser chalcopyrite, and the oxidised pyrite which are contained within the coarser aggregates of euhedral quartz and calcite, would appear from the textures to be remobilised sulphides. Their mobilisation would also appear to have been concurrent with that of the relatively coarse euhedral quartz, and the very coarse grained carbonates. Since these as a group assemblage, are sited inside areas which were not completely filled by chaledonic silica, they all appear to have originated later than the chaledonic silica.
**II. 41. Sandy pyritic—slightly recrystallized dolomite.**

The dolomite is mainly a fine evenly granular aggregate of carbonates, amongst which there is about 0.1% minute pyrite granules of 3-10 microns size. Bedding is scarcely visible. There are small lobulate and avoided structures preserved in microcrystalline dolomite. These may be the pseudomorphs of organisms. In addition, there are sparse, randomly distributed elastic quartz grains.

Patchesy recrystallisation to coarser grain size, and the formation of relatively coarse grained carbonate veins, indicate that the incipient mobilisation of the carbonate has begun. There are however, no other modifications to the rock.

**II. 42. Malachite—limonite—quartz—impregnated vitric—lithic tuff.**

The copper oxysalts and limonite are contained in the open spaces amongst fragments of grey and reddish brown flow-structured glassy rhyolite, smaller amounts of chert, and sparse fragments of fine grained sandstone. The devitrified rhyolite displays flow structure and extensive fracturing; and many have incorporated elastic sand grains. Dolomite and copper carbonates are contained in the fractures.

All of the open space in the tuff, as well as the fractures within individual fragments contain crustiform banded deposits of fine grained quartz, banded deposits of microcrystalline malachite, and colloform goethite. There are only trace amounts of chalcocite within some of the larger malachite intergrowths. Boxwork from former sulphides is absent.

The distribution of malachite and limonite is not related to the areas of contrastingly coarser silica, as in other samples. Such coarser quartz is present in some open space zones, but it is associated with a relatively small amount of the copper oxysalt. The bulk of microcrystalline malachite, and most of the coarser grained malachite exist together in compact masses in the largest of
the inter-fragmentary zones where they enclose the finest of the glassy rhyolite, short and elastic quartz grains.

The separate locations of copper oxysalts and coarser euhedral quartz; the presence of malachite in fractures in the larger rock fragments; and the general absence of chalcedony relics and sulphide boxwork, together indicate that much of the malachite moved into this rock from an adjacent source.

End of mineralized zone.


The large lighter coloured fragments of fine grained evenly granular dolomite are encrusted by secondary microcrystalline calcite which is of darker colour. This material is calcrete of surface water origin; and it encloses numerous residual weathered fragments of quartz and dolomite.

FR 49. Arcoseous-pebble dolomite.

This is essentially a dolomite facies since dolomite is the major component. The fine grained chemically precipitated dolomite was formed in an environment where elastic angular and rounded quartz grains, as well as larger fragments of ferruginised pyritic-sedepathic quartzite, and fragments of obsidian, were being concurrently deposited. The quartz grains and rock fragments together constitute about 40% of the dolomite.

The large grain size range, the irregular sorting, and the angular shapes of the elastic components indicate rapid deposition close inshore.


Large proportions of crustiform banded brownish microcrystalline chalcedony are present in the rock. In many areas the deposits of chalcedony appear to have formed within and around nuclei of hollow
The report describes from 4 thin sections, 4 samples which were submitted by Mr. X. Taylor. Comparisons are made with former samples XMC, XMC.

The view is still maintained that these apparent algal structures are in fact facsimiles created by combinations of porritic ring and pyroclitic structures in glassy acid volcanics. Consequently, the conclusion is that algal dolomites were not silicified; but that highly silicous vitreous acid volcanics were carbonatized (dolomitized) and concurrently mineralized.

XMC and XMC. Abnormal structures.

The essential difference between XMC and XMC is, that the former sample was more completely carbonatized and silicified. Because of this, and the subsequent preferential solution of the carbonates on weathered surfaces; the silicified portions persist in relief and therefore provide a much better expression of a pseudomorphous structure, than is the case with XMC.

The porritic ring structure is visible with more difficulty in the case of XMC. It is outlined in part by the separate dolomite and silica replacement zones; but in particular by the persistent unreplace parts of the original volcanic glass. Those thin curvaceous residual shells consist mainly of completely isotropic glass which encloses some cryptocrystalline anisotropic material, mica-like of muscovite and of opaque minerals. These three latter components are expressions of partial devitrification of the main mass of isotropic obsidian.

The porritic ring structures of XMC are characteristic of glassy acid lavas in respect to their shapes and inter-relationships with each other. These structures are quite distinct from algal structures, e.g. they lack septa and other cell-like forms. Furthermore,
The partly devitrified isotropic volcanic glass is in itself, proof of the origin of these structures; while the progressive deuteric replacements by carbonates and colloidal silica of probable exhalative fumarolic origin, constitute phenomena often found in volcanic regions.

**FM07. Bubble algal structures.**

The structures revealed by this rock are not considered to be algal forms. These structures are thought to be the result of a combination of porphyric rings and spherulites, both of which are common characteristics of glassy acid volcanics.

This rock was strongly, but incompletely carbonized along the ring structures, with the formation of ring-oriented strings of granules of minute sulphides. Where carbonization was incomplete, there remain thin curvaceous shells of partly devitrified volcanic glass containing microlites and oxidized opaque mineral granules, as in the case of FM06, FM08.

It would appear unlikely that FM07 is an algal dolomite lying below the horizon typified by FM06, 8S; or that those volcanics silicified an algal dolomite. FM07 is surely indicative of the continuation of the obsidian sequence; and again, deuteric carbonatization appears to have reached significantly high levels in the lower part of this sequence.

**FM08. Obsidian stone bubble or lithophysae.**

This sample is considered to be an unusually large example of a stone bubble or obsidian lithophysae which may have formed during a submarine volcanic effusion. It is not considered to be representative of an algal or similar organic form.

The structure is strictly concentric. It consists of some continuous shells of partly devitrified glass; and of other shells which were partly disrupted; and which are therefore discontinuous. Between successive shells there are thin zones of microcrystalline
PA.70. Silicified brecciated tuffaceous pyritic chert.

The rock is quite distinctly laminated; and at various intervals it displays what is probably interformational brecciation. A large proportion of the rock is microcrystalline silica with a characteristic chert texture. All of this displays lamination by virtue of rapidly fluctuating proportions of enclosed stratiform minute opaque minerals. These opaque minerals are minute grains of limonite which formed by the oxidation of pyrite of less than 5 microns size. At irregular intervals there are goethite replicas of larger euhedral authigenic pyrites of 0.1 mm size.

PA.71. Accretionary quartz-pyrolusite.

Although the rock has a somewhat layered structure the texture within the banding is spherulitic. The spherulitic aggregates are intergrowths of fine grained euhedral quartz and pyrolusite. These minerals were progressively deposited, presumably from solutions at ambient temperatures, in an environment allowing uninhibited growth.

The textures and the euhedral habits of the components suggest growth either in open space, or in an aqueous medium.

PA.72. Silicified vitric tuff.

The rock consists mainly crustiform banded microcrystalline and fine grained silica which formed as numerous closely spaced spherical, ovoidal and wavy layered masses. Together these enclosed shredded and smaller shard-like fragments of isotropic or devitrified brownish volcanic glass. The latter constituted a porous vitric tuff within which the silica was deposited.

PA.73. Slump-brecciated "nisolitic" dolomite.

The peculiar structure of the dolomite was the result of pre-consolidation slump; while the initial texture was the result of the progressive deposition of the carbonates around silt-size sand grains.
silica was trapped in the zones between the shells of rapidly chilled lava. These shells were fragmented in many places, and the silica also formed in the transverse fractures.

Limonite is the oxidation product of both fine grained pyrite, and the ferromagnesian component of the glass. Both pretoxed pyrite and oxidised pyrite is contained also by the deuter ic silica in amongst the shells of volcanic material. Chalcopyrite or its oxidised products were not detected.

FR 81. Intercalated chert and vitric lava : vitric sinter.

From the nature of this laminated rock, it is postulated that the "chert" may not be a normal chemical precipitate from a marine environment, but rather, microcrystalline silica of primary origin, deposited from colloidal suspension in volcanic fluids. Associated with it are discontinuous layers of fine grained subhedral granular quartz.

The rock consists of sequences of the cherty material with fairly continuous irregularly shaped flow-like layers of dark coloured cryptocrystalline, and in part isotropic glassy lava. This material is fragmentary in some lamellae and dispersed amongst the chert.

The coarser subhedral quartz intergrowths appear to have occupied open space, the immediate linings of which are chalcedonic and crustiform banded.

FR 82. Missing.

FR 85. Vitric sinter : mineralised.

There is a general similarity with FR 81. The siliceous rock does not exhibit normal chert characteristics; and amongst the dominant medium of banded microcrystalline and coarser subhedral quartz, there is a large proportion of vitric volcanic material.

Aggregates of malachite occupy the central areas of cavities which were filled also by subhedral granular quartz. These cavities
were possibly the sites of gases trapped within the sinter deposit.

The silica embodies goethite replicas of pyrite grains of less than 0.1 mm size, as well as preserved minute pyrite granules of less than 0.005 mm size. Chalcopyrite was formerly present; and the malachite was developed from this.

\[34\] Silicified (sintered) vitric angularite.

The characteristics of chert are not apparent in this rock. There are large light coloured fragments of contorted variably devitrified glass which embodies flow lines. These fragments are extensively replaced by both microcrystalline and subhedral granular quartz which exhibits crustiform banding.

The darker brown areas of the sample contain large proportions of goethite which developed from pyrite. Some of the pyrite was irregularly scattered, and some was in crustiform banded distribution amongst xenomorphic granular intergrowths of quartz of fluctuating grain sizes. All of this is surely a deposit of primary quartz and pyrite, and it is a type of pyritic siliceous sinter which formed around the vitric material.

\[35\] Silicified (sintered) vitric tuff.

This rock displays irregular, wavy and discontinuous stratification which is an expression of the distribution of contorted and shredded fragments of devitrified glassy lava.

Some 50% of the rock bulk is occupied by microcrystalline and subhedral granular quartz, as well as radiating spherulitic intergrowths of chalcedony. These components filled open space, and in part replaced the vitric lava. All of this would appear to be primary silica of the sinter type.

\[36\] Silicified vitric tuff.

All of the silica in this rock displays crustiform banded structure;
and in most cases the silica is formed around shard-like shredded fragments of glassy volcanic material. These fragments are immediately enclosed by microcrystalline silica, and then successively by radiating growths of chalcedonic silica. The final open space contains fine-grained subhedral granular quartz. However, the final fillings were not always complete, hence there remain some "weathered irregular holes". These holes are not due to weathering, but are incompletely filled space between adjacent deposits of silica.

**Fig 87.** Volcanic ash-lomite : mineralized.

The brown oxidised rock consists mainly of an assortment of irregularly shaped volcanic rock fragments of several cm maximum size. Amongst these, there are 1-2% randomly sited rounded quartz grains.

The rock fragments are extensively oxidised porphyritic glassy or microcrystalline lavas which contain no quartz, but only small phenocrysts of plagioclase and highly altered amphiboles. The dark coloured groundmasses of these fragments are obviously iron-rich, and strongly limonitic. The composition of these fragments cannot be determined optically, but they are either andesitic or basaltic, and more probably basaltic.

Evidence of mineralisation does not appear in the hand specimen, but in the polished section thin quartz veins which embody numerous minute unoxidized grains of chalcopyrite, are readily visible. The veins are widespread amongst the fragments, and they contain fully protected chalcopyrite of 5-25 micron size. There is no pyrite. This is surely mineralisation of a deuteric origin inherent at the volcanic source.

**Fig 88.** Carbonatised perlitic volcanic glass.

The structure is not of an algal type. The irregularly shaped ring-like structures are the expressions of perlite structure in volcanic material which is in part isotropic, and in part devitrified.
Large amounts of microcrystalline carbonates were dispersed along the ring structures; and they were sometimes highly concentrated at the nucleus of a given set of perlitic rings. Veinlets of carbonates followed along some rings, and cut through others.

These are very probably primary deuteritic carbonates, and they may relate in origin to the zones of oxidized opaque minerals along some of the rings. The opaque minerals are mainly goethite replicas of minute pyrite grains, but there are also traces of chalcocite from oxidized chalcopyrite.

PR 89. Seesaw mineralized acid tuff.

The mineralization, which is expressed in goethite from oxidized pyrite, and in small amounts of malachite, was partly conformable, and partly transgressive within the laminated tuff. This material is not dolomitic.

The tuff is built up of sequences of cryptocrystalline part vitric materials which are interlayered with lamellae composed of very fine grained quartz, sericite and opaque mineral granules. These aggregates were pervasively silicified.

The masses of goethite with enclosed malachite are not associated with vein quartz. All of this goethite displays sulphide boxwork, much of which expresses the structure of closely packed cuboctahedra of pyrite. At irregular intervals there are small quadrangular structures from oxidized chalcopyrite grains of less than 0.2 mm size. The malachite exists close to these chalcopyrite boxworks.

The mineralization thus appears to be an indigenous feature of the tuff; and it was probably of syngenetic origin with it.

PR 90. Permuminised-silicified weathered sandstone cutaron.

The ironstone embodies a great abundance of rounded and irregularly shaped quartz, martitized magnetite, ilmenite and zircon grains of sand-grade size, as well as fragments of composite sandstone made
AUSTRALIA-CITIES SERVICE, INC.  
INTER-OFFICE LETTER  

APPENDIX 7  

TO:  D. H. BUCHHOLZ/J. CUCVARA,  
FROM:  R. G. Taylor/C. C. Persson,  
SUBJECT: STATISTICAL ANALYSIS - GEOCHEMICAL  
SAMPLES - ROBINSON RIVER, NORTHERN  
TERRITORY, E.L. 1011, 1974  

1. INTRODUCTION  

Exploration of E. L. 1011 in 1974 produced  
2,543 soil samples from the Foelsche River area (assayed for  
Cu, Pb, Zn). Stream sediment samples were collected throughout  
much of the lease. They totalled 404.  

2. SAMPLING TECHNIQUES  

For the bulk of the soil sampling two grids  
were employed. Nearly half the samples were collected at 100  
metre stations on 300 metres spaced lines. The other half were  
collected at 100 metre stations on 200 metre spaced lines. Note  
that the grid directions are at right angles. In the Was Creek  
area some detailed sampling was undertaken (Fig. 6c). This was  
largely over anomalous or suspected mineralized areas.  

The total population is not a random or  
statistical sample.  

3. STATISTICAL TECHNIQUES  

By simple comparison of the geochemical plans  
with geological plans it was possible to attribute a geological  
unit to each assay point and hence assay value. Of necessity  
some interpretation has arisen but in general the unit assigned  
to the assay point will directly underlay the point. By this  
technique it is assumed that the soil sampled is derived from the  
underlaying rock. This is obviously not valid. Mechanical dis-  
persion is common throughout much of the area and hence many of  
the samples will contain soil from the overlaying geological units.  
In general no fluvial or aeolian soils are considered in the analysis  
since these are assigned to the alluvial group. The following  
table outlines the lithological division of the assay values. 

.../2
<table>
<thead>
<tr>
<th>ROCK TYPE</th>
<th>SOIL SAMPLE GROUP</th>
<th>GROUP SYMBOL</th>
<th>No. OF SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deadridge Dolomites</td>
<td>Pkd</td>
<td>D</td>
<td>321</td>
</tr>
<tr>
<td>Always Creek Dolomites</td>
<td>Pka</td>
<td>A</td>
<td>791</td>
</tr>
<tr>
<td>Snake Hill Sandstone</td>
<td>Pks</td>
<td>S</td>
<td>424</td>
</tr>
<tr>
<td>Amazon Creek Dolomites</td>
<td>Pkz</td>
<td>Z</td>
<td>118</td>
</tr>
<tr>
<td>Masterton Sandstone</td>
<td>Ptn</td>
<td>M</td>
<td>112</td>
</tr>
<tr>
<td>Wollogorang Formation</td>
<td>Pto</td>
<td>W</td>
<td>59</td>
</tr>
<tr>
<td>Settlement Creek Volcanics</td>
<td>Pte</td>
<td>P</td>
<td>19</td>
</tr>
<tr>
<td>Bukalara Sandstone</td>
<td>Elb</td>
<td>B</td>
<td>90</td>
</tr>
</tbody>
</table>

Some slight discrepancy is present due to the speed with which the assessment was made. However, it is not sufficient to effect the overall results.

Assays were grouped into 10 ppm intervals. Histograms were then constructed for each lithological unit and a cut off point chosen above which the population was considered anomalous. This cut off point is not always obvious.

Threshold was calculated from these values using:

\[
\text{Threshold} = \text{Mean} + 2 \times (\text{Std. Deviation})
\]

\[
\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}
\]

In addition to this technique cumulative frequency was plotted on log probability paper for each rock type using all values. Any inflection point should represent a deviation from a normal distribution and indicate either the anomalous zone or poly modal populations. Threshold was considered the point of inflection.

The results are tabulated below:

<table>
<thead>
<tr>
<th>ROCK TYPE</th>
<th>Threshold (Arithmetical)</th>
<th>Threshold (Graphical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deadridge Dolomite</td>
<td>70</td>
<td>190 (98% Population)</td>
</tr>
<tr>
<td>Always Creek Dolomite</td>
<td>165</td>
<td>340</td>
</tr>
</tbody>
</table>
4. INTERPRETATION OF GRAPHS

a. Always Creek Dolomite

This appears to be a trimodal population.

i. The upper part of the Always Creek Dolomites. (Less than 35 ppm).

ii. The chert-volcanic horizon and algal horizon which is commonly weakly mineralized with possible syngenetic chalcopryite in the dolomites. (Greater than 35 ppm and less than 340 ppm).

iii. From 190 ppm to 500 ppm appears to be a zone of mixing.

iv. The mineralized population is considered to be reflected by values greater than 340 ppm and hence this is regarded as the threshold value.

b. The Snake Hill Sandstone (Pks) appears to be trimodal. The low value population is based on one point and cannot be explained. The other inflection at 185ppm probably represents the zone of contamination from the Always Creek Dolomites by mechanical dispersion.

c. Amazon Creek Dolomite

This is a distinctive bimodal population defined by the low value dolomites (less than 76 ppm). The second population relates to the vitric-lithic tuff (Amazon Volcanic). A threshold value of 600 ppm relates to a 98% population position.

d. Masterton Sandstone

A distinct dislocation between 20 and 30 ppm suggests an unusually large group of samples over these values. The normal distribution pattern is not followed. The inflection point at 90 ppm probably represents the zone of contamination from the Always Creek Dolomites and Amazon Volcanics.
5. STREAM SEDIMENT SAMPLES

A similar technique was used for these samples as for the soil sample analysis. Threshold was calculated in the same way with a 'cut-off' being selected from a histogram. The calculated values are tabulated below:

<table>
<thead>
<tr>
<th>Area</th>
<th>Element</th>
<th>'Cut-off'</th>
<th>Threshold</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon</td>
<td>Cu</td>
<td>150 ppm</td>
<td>109</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Pb</td>
<td>50</td>
<td>35</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Zn</td>
<td>55</td>
<td>55</td>
<td>25</td>
</tr>
<tr>
<td>Donald Yard</td>
<td>Insufficient Samples</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cumulative frequency was plotted against copper assay values. The curve indicates a definite trimodal population with thresholds at 35 ppm and 180 ppm. These populations are thought to represent:

a. Amazon Dolomites (<35 ppm)
b. Amazon Volcanics (<180 ppm)
c. Always Creek Dolomites and mineralized population (>180 ppm)

10. CONCLUSION

This analysis has been made using a largely empirical attitude. It is felt that a comparison between this and a strictly statistical analysis would be of value. It has not been possible to treat each value individually which may alter the final data in such relatively small population.

RGT:CCP/cah
EL1011 ROBINSON RIVER - N.T.
Deadfridge Dolomite (Soil)

Log$_{10}$ ppm Cu $\sim$ Cumulative % frequency
(probability scale)
EL 1011: ROBINSON RIVER - N.T.
Snake Hill Sandstone (Soil)

Log\(_{10}\) ppm Cu  Cumulative % frequency
(probability scale)
EL 1011 ROBINSON RIVER - N.T.
Always Creek Dolomite (Soil)
Log₁₀ ppm Cu, ~ Cumulative % frequency
(probability scale)
EL 1011  ROBINSON' RIVER- N.T.
Amazon Creek  Dolomite  (Soil)
$\log_{10}$ ppm  Cu  Cumulative % frequency

76 ppm
EL.10II  ROBINSON RIVER - N.T.
Masterton Sandstone (Soil)

Log\(_{10}\) ppm Cu  ~  Cumulative % frequency
LEGEND

QUATERNARY

LOWER CAMBRIAN

UPPER (?) PROTEROZOIC

LOWER (?) PROTEROZOIC

LOWER PROTEROZOIC

McArthur Group

Karns Dolomite

Always Creek Dolomite

Snake Hill Sandstone

Amazon Creek Dolomite

Masterton Formation

Wollogorang Formation

Settlement Ck Volcanics

Roper Group

Bukalara Sandstone

Limmen Sandstone

Deadfridge Dolomite

Altersation or calcrete in dolomite

Alluvium

Medium to coarse grained sandstone, chert pebble & chert cobble conglomerate

Massive fine to medium grained quartz sandstone and micaceous siltstone

Red massive dololutite

Red and cream dolomites w strong bedding plane parting

Glaucanitic siltstone, chert and oolitic chert, dolomitic siltstone and "greensand"

Grey and fawn, flaggy dolomites and chert interbeds

Basal dolomitic chert-pebble, conglomerate.

Laminated grey and pink dolomite, interbedded cherts and siltstones

Silicified sediments and volcanics

Dolomite and silicified algal structures

Basal dolomitic pebble conglomerate

White medium to coarse grained poorly sorted quartz sandstone and dolomitic sandstone

Red sandstone cobble conglomerate

Red, white and cream dolomite, dolomite siltstone and occasional thin vitric-lithic tuff beds

Yellow vitric-lithic tuff and rhyolite

Dolomitic red sandstone, pebble conglomerate, lenses of medium grained quartz sandstone

Red medium grained silicified sandstone

Red and cream dolomite overlain by dolomitic siltstones and white fissile siltstone

Perlitic volcanics

Andesine basalt, agglomerate and fissile purple and red siltstone
Pkd  Grey & fawn, floggy dolomite & chert interbeds

Pka  Laminated grey & pink dolomite & interbedded cherts

Pks  White medium to coarse grained poorly sorted quartz sandstone & dolomitic sandstone

Pkn  Red white & cream dolomite, dolomitic siltstone & occasional thin vitric tuff beds

Pkn  Red medium grained silicified sandstone

Pre  Red & cream dolomite overlain by dolomitic siltstones & white fissile siltstone

FIGURE 12

FOELSCHERIVER AREA E.L. 1011 N.T.
PLAN AND INTERPRETED SECTION NEAR AUSTRALIAN GEOPHYSICAL DIAMOND DRILL HOLE DDM F01