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An appraisal for EZ Co. of the Geophysical Surveys carried out in the Sterling Valley, Tullah and Farrell Electrolytic Zinc Co of Australasia Ltd*; Mitre Geophysist Bishop, J.R. EL1/62

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AN APPRAISAL

FOR

ELECTROLYTIC ZINC COMPANY OF ASIA LIMITED
West Coast Mines

OF

THE GEOPHYSICAL SURVEYS CARRIED OUT IN THE

STERLING VALLEY, TULLAH AND FARRELL AREAS

BY

DR. J.R. BISHOP

OPEN FILE

OCTOBER, 1980

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MINERAL EXPLORATION AND ENGINEERING CONSULTANTS

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- FIGURE 1. Scale 1:50,000 Location map of Sterling Valley, Tullah and part of Farrell areas. Major rock types and the extent of moraine cover are indicated.
- Scale 1:50,000 Maps of the Geophysical Grids and the coverage and location of anomalies are being prepared and will be added to this report when completed.

SUMMARY

The geophysical surveys that have been carried out over Sterling Valley, Tullah and Farrell areas are briefly described and their responses noted. Surveys that have been made over all or part of these areas are:

1. Aeromagnetics
2. Airborne radiometrics
3. Airborne electromagnetics
4. Ground magnetics
5. Self potential
6. Induced polarisation
7. Ground electromagnetics
8. Gravity.

That is, nearly all commonly-used geophysical methods have been tried over the area.

The present target of tin in association with pyrrhotite has meant that the aeromagnetic results have been of direct use in defining targets for further exploration. Several anomalies were found in favourable locations and these have been confirmed and further defined by ground magnetics which also detected a series of smaller anomalies.

The electric and electromagnetic methods have generally responded to the conductive black slates within the Farrell Slates. These are commonly pyrite-bearing and have been considered favourable horizons for economic mineralisation. However, these methods have not been successful in discriminating such mineralisation. (Possibly, of course, because of their absence in the areas covered; and indeed, in the opinion of the E.Z. Exploration Department, it is unlikely that a large base-metal deposit occurs in the region outside of the moraine covered areas.) And given the apparent variation in the conductivity of the black slates along their strike length, it is unlikely that even state of the art electrical methods (with the possible exception of complex resistivity) would discriminate between sulphides and black slates beneath the moraine material covering the area of interest. However, I.P. may be useful over magnetic targets in the search for tin.

The gravity data over the Tullah area has not been examined in detail, but drilled anomalies (with coincident anomalies from other methods) in the Sterling Valley have not been successful. Similarly the method was judged unsuccessful in the Farrell area. It is unlikely that gravity would be useful in the largely moraine covered area of the Tullah Grid. The radiometric data was not available at the time of writing.

It is thought that four separate sheets for each of the four maps covering the area will be needed for the compilation project on to 1:10,000 scale maps: one each for I.P. and magnetics showing both the coverage and anomalies. The former in line (coverage) and bar (anomaly) form, the latter in contour form. All other geophysical results can probably be drafted together; on to one map showing coverage and another indicating the positions of anomalies. The source of the data for the compilation is listed under Representation of Data at the back of this report.

INTRODUCTION

The Sterling Valley, extending north through the township of Tullah to the Mackintosh River is the site of many old workings and mineralised areas. The district has been extensively prospected, but, since a considerable part of the valley floor is covered by moraine, it may still be considered a prime exploration area. The emphasis has shifted away from the original base metal target (which was the expectation following the early lead, zinc, copper finds) to tin. Geophysics, particularly in the glacially covered areas, may be expected to play a major role in any exploration program.

GEOPHYSICAL GRIDS

There are many 'generations' of geophysical grids in the area and they have generally been under one of the following titles: The Sterling Valley Grid; The Tullah Grid or the Farrell Area. The Murchison River Grid is a recent exception which covers part of the Sterling Valley and Tullah Grids - the Murchison River being the boundary between these two grids. The division between the Tullah Grid and the Farrell Area is less clear, an arbitrary boundary is 5,378,000mN A.M.G..

The area under discussion is split into two Exploration Licences; E.L. 1/62 is a joint venture between Getty Oil Development and E.Z.; and E.L. 4/73 is a joint venture with the above two companies and Aberfoyle. The east-west boundary is some 500m south of the Murchison River.

GEOLOGY

A brief and simplified description of the geology and mineralisation is given below. A more detailed description is given in E.Z. report no. 133 (1980).

There are three distinct groups of rocks. The westernmost rocks are intermediate lavas, pyroclastics and small intrusives. They are locally called the Mt. Black Volcanics. In the centre are the Farrell Slates which consist of grey-wackes, siltstones and black shales. These grade eastwards into the massive lavas and pyroclastics of the third group, the Eastern Volcanics. The Farrell Slates strike north-north-east and dip steeply to the west. The (partly concealed) contact with the Mt. Black Volcanics is faulted. In the northern part of the area the slates are in contact with the overlying Ordovician Owen Conglomerate. A considerable proportion of the area is covered in glacial and fluvio-glacial alluvium.

MINERALISATION

At the southern end of the area of interest, the Sterling Valley Pb, Zn mine occurs and at the northern end the Farrell Pb mine, both within the Farrell Slates. There are various mineral occurrences and old mines (Pb, Zn, Cu, Ag, Sn) both within the Farrell Slates and the Eastern Volcanics (near the contact) between these two limits.

The present exploration target is for tin (cassiterite). The primary expected location being the contact between the Mt. Black Volcanics and the Farrell Slates. Drilling (STP 217 & MRP 212, see map A0-525-0081) has revealed occurrences of tin (maximum values of 1m and 2m of 0.5% Sn respectively) at or near the contact. The cassiterite is expected to occur in association with pyrrhotite and other sulphides.

Exploration in the 1980/81 field season will be concentrated in the vicinity of the Murchison River. The Murchison River Grid has been extended to the north and east to cover the Tullah Grid and drilling is planned between MRP 212 & STP 217. A magnetic survey has been carried out over the whole of the extended grid as well as for the northern part of the Sterling Valley Grid with a station spacing of 10m.

Exploration will be concentrated initially in areas that are covered by moraine, since it is considered likely that outcropping areas have already been prospected (at least surficially).

GEOPHYSICS

The geophysical coverage of the area (although geologically continuous) is discussed below in three sections, i.e. grid by grid, but conclusions and recommendations are made at the end encompassing all three areas.

STERLING VALLEY

Sterling Valley has been the site of several exploration programs and mostly, the same grid has been used. The grid is approximately 17° east of A.M.G. north and runs from south of the Sterling Valley mine into the Tullah area. However, this section will only be discussing surveys south of the Murchison River. The following geophysical surveys have been made over the Sterling Valley Grid. The extent of the coverage is mentioned in the description of the particular method.

1. Aeromagnetics
2. Airborne electromagnetics
3. Ground magnetics
4. Self potential
5. Induced polarisation
6. Ground electromagnetics
7. Gravity.

Aeromagnetics:

The survey was carried out by Geox in 1978. The line spacing was set at 250m with a terrain clearance of less than 200m. The results have been presented as contours on 1:10,000 scale maps. The contour interval is 10 γ . The majority of the area falls on maps AO-504-0008 and AO-504-0012 (E.Z. No's 7 & 8). The northern limit of the survey extended approximately 800m onto E.Z. maps 5 & 6.

The Farrell Slates are generally non-magnetic, as are the Mt. Black Volcanics in the immediate region. However, the Eastern Volcanics contain magnetite-bearing rhyolites and these are evident as linear, north-north-east bearing anomalies some 200 to 300m east of the Farrell Slates contact. A section over the Eastern Volcanics was not flown, but the magnetite-bearing sequence appears to be continuous from south of the Sterling Valley mine north to the Farrell mines area.

There are two closed magnetic highs on the Sterling Valley Grid. The more southerly anomaly is attributed to a mafic intrusion. This anomaly of about 110 γ is situated off the western end of line 2840N (5,373,000N; 383,800E). It is close to the Murchison Highway and magnetic mafic rocks outcrop on the road. The more northerly anomaly, centred on the western end of line 4280N (5,374,400N; 384,270E) has been drilled (STP 217) and is due to pyrrhotite (1m of 0.5% tin was intersected).

Indications of other highs from the aeromagnetic contours have been confirmed by ground magnetic surveys.

Airborne Electromagnetics:

The airborne electromagnetic (AEM) coverage of the Sterling Valley area was part of an extensive AEM survey of Western Tasmania by Adastr-Hunting for Rio Tinto in the late 1950's. The only data in E.Z.'s possession are the flight line positions with graded anomalies marked on. A one page report states that the contractor was Adastr-Hunting and that a helicopter and 'bird' were used. It is possible that the system was the Helicopter AEM system developed by Aero magnetics Surveys Ltd. - a Hunting affiliate. This method used a bird with coaxially mounted coils: in and out of phase components were recorded from a transmitted frequency of 4,000 Hz.

The survey shows several anomalies over the various areas flown (including 'major' anomalies over Colebrook Hill). Five flight lines were flown over the Sterling Valley area. The southern-most line was flown over the Sterling Valley Mine (and a small anomaly recorded). The remaining lines (north of the mine) were flown with (probably) a nominal flight line spacing of 4/5th of a mile (1200m). One of these lines recorded two small anomalies, one in the Eastern Volcanics (5,373,350N; 383,930E which was checked by circling of the helicopter) and another within the Farrell Slates (5,373,280N; 384,440E). Another line recorded a weak anomaly, possibly correlated with low altitude of the receiver, at (5,372,730N; 384,280E), also in the Farrell Slates.

Ground Magnetics

Several magnetic surveys have been conducted over the Sterling Valley Grid. The 1:10,000 scale E.Z. map showing the ground magnetics coverage (A0-525-0072) gives 50 γ contours of the January/February, 1980 survey which covered the Murchison River Grid and the Sterling Valley Grid south to 4040N with one more line 480m to the south (3560N). This survey did not go east of the baseline and had a 30m station spacing. Also indicated on this map are the major anomalies from a 1976/78 survey for Abminco. These are indicated by showing the 62,500 γ contour position. This Abminco survey covered the area from line 2600N to 4880N, and both sides of the baseline were surveyed. The width of the survey was a little greater than the width of the Farrell Slates. A Rio Tinto survey (1959) covered much the same area, but went further north to 5460N (48N on the old grid) and defined an anomaly not covered by any subsequent survey until the E.Z. October, 1980 survey which covered the northern part of the grid with 60m spaced lines and a 10m station spacing. The results of part of this survey have been discussed in a separate report (Bishop, 1980) and the rest of the data will be the subject of another report.

Since the expectation in the area is for cassiterite associated with pyrrhotite, magnetics is probably the most useful geophysical method and therefore the magnetic anomalies in the area are described below in some detail (from south to north).

- a) the delineation of the previously mentioned aeromagnetic high, interpreted as being due to mafic intrusion. This 600+ γ anomaly occurs on the western end of lines 2720N to 3080N.

- b) There are two anomalies which may be eastern extensions of the above mentioned mafic intrusion; one at 4670E, 2720N and one at 4740E, 3080N. The latter anomaly may be associated with the southern end of a weak I.P. anomaly.
- c) There is a broad high on the baseline (5000E) between lines 3200N and 3440N; there are coincident I.P. anomalies. The southern part of this anomaly has been drilled by DDH's STP 105, SV 2 and SV 3. The Cominco report (progress report on E.L. 4/73 for six months ending 6.3.76 by D.C. Simpson) suggests that SV 3 may have been drilled a little too shallow to have adequately tested the magnetic target.
- d) A narrow and intense anomaly (of about 500 γ) immediately to the east of the above anomaly occurs on line 3320N and 3440N. A very near surface cause is suggested. The Rio Tinto report by Boniwell (1959) shows this anomaly somewhat differently (it is at the eastern limit of that survey) and states that the anomaly correlates with a gravity high.
- e) On line 3800N at 5160E, there is a small isolated anomaly of 300 γ located between and along strike of two indicated mineral prospects (Fulford's or Turley's). Cu, Ag, Zn and Sn occurred at these workings and there is a coincident Sn geochem anomaly (500 ppm). According to Simpson's (1976) report the mineralisation is associated with thin qtz veins.
- f) On line 4280N there are a series of anomalies. The anomaly centred on 4650E was the target for STP 217. (Magnetic susceptibility logging of the hole suggests that the hole may not have intersected the magnetic target.) This anomaly extends from line 4160N to 4400N. The parameters of a magnetic dyke model by Getty Oil (the response of which approximates the anomaly) are a depth of 55m, dipping 45° to the west, centred below 4640E, 4280N. Its strike is 10° and for a susceptibility of 0.01, the thickness is 27m.
- g) At 5050E on line 4280N is centred a linear anomaly which extends from lines 4160N to 4400N. This anomaly coincides with I.P. anomalies that are thought to be due to black slates. A best fitting dyke model to this anomaly gave the following parameters. A depth of 30m and dipping vertically, centred below 5050E, 4280N. Its strike is approximately north-south and for a susceptibility of 0.05, thickness is 20m. An Abminco geochemical survey on line 4400N gave a tin value of 5000 ppm, but line 4280N was not sampled.

- h) There is a further, isolated anomaly on the eastern end of line 4280N and a shallow source is indicated. This anomaly is further discussed in the previously mentioned report on the October, 1980 magnetic survey.
- i) DDH STP 218 was drilled into a narrow magnetic high located at 4550E over lines 4400N and 4520N. The anomaly was coincident with an I.P. anomaly. Minor amounts of mineralisation were intersected.
- j) There are two highs on line 4760N; one at 4360E and a somewhat larger one at 4720E. I.P. was not carried out on this line, however, the 4720E anomaly is on strike with a possible I.P. anomaly on line 4640N. Further, this anomaly is close to the expected position of the contact between the western volcanics and the Farrell Slates (small anomalies such as those above may be more interesting if the mineralisation is more extensive than the pyrrhotite would suggest. Also a small equidimensional orebody of the order of 10^6 tonnes would have a diameter of perhaps less than 100m).
- k) The 1959 Rio Tinto survey delineated a 200γ anomaly on an extension of the baseline (5000E) of the Sterling Valley Grid, between 5330N and 5460N. This anomaly has been better defined by the October, 1980 survey.
- l) On lines 5,375,300N to 5,375,600N of the Murchison River Grid a narrow magnetic high is outlined on the eastern ends of these lines where they abutt the River.

Self Potential

Self potential was carried out over part of the Sterling Valley area on a separate, but apparently parallel grid (the grid was repositioned by Rio Tinto - see appendix to Boniwell, 1959). The survey extended from about 100m south of line 2600N to line 3560N and the work was centred over the present baseline (5000E). Several strong anomalies were recorded, the largest being over 500 millivolts between lines 3200N and 3320N, 15m west of the baseline. This is coincident with a gravity high and adjacent to a magnetic high. STP 105 passed through this zone and intersected several metres of black shale, but only minor amounts of sulphide mineralisation. The other SP anomalies are also close to the baseline. It is likely that all the SP anomalies from this (limited) survey are due to black shale.

Induced Polarisation:

The Sterling Valley Grid has been covered by McPhar dipole-dipole I.P. in 1960 and 1961, by Abminco in 1976 and by Scintrex dipole-dipole in 1979. The McPhar (1961) survey used 300ft (91m) dipoles on a line spacing of 400ft. The McPhar (1960) survey was over lines 12S and 20S and a 200ft dipole spacing was used. The results have been presented as pseudo-sections of resistivity ($\div 2\pi$ and ohm-ft, plotted as a mirror image) and metal factor. On many lines there are no metal factor values for several of the data points.

Nearly all lines show one well-defined anomaly. Anomalous resistivity values are generally very low (less than 10 ohm-m) but frequency effects are generally less than 10%. The persistency of the anomalous zone suggests a lithological cause - namely black slates within the Farrell Slates. Although the western side of the grid is covered by glacial till, most of the anomalies occur in uncovered sections and a more direct correlation of I.P. effect with rock unit could be made after more detailed mapping of the Farrell Slates.

Several drill holes intersect this line of I.P. anomalies (STP 101 & 105, SV 1 & 3). These holes intersected minor amounts of sulphide mineralisation. The Cominco I.P. survey was undertaken by Geoquest in April, 1976, the survey consisted of seven lines between 3320N and 4400N. On each line a 50m dipole-dipole spread was carried out with a 25m dipole-dipole follow-up over the anomalous area. Many of the spreads have 'N' at data points indicating 'noisy' (no reading), this was apparently due to very low resistivities.

As pointed out in Simpson's (1976) progress report on the Sterling Valley the survey for Abminco showed a broad zone of low resistivities (generally <100 ohm-m) on all lines within a high background (generally >500 ohm-m). Within the area of low resistivities there was an anomalous zone of very low values (<10 ohm-m). The zone was invariably at depth.

Simpson notes the correlation between magnetics and I.P. on lines 3320N and 3440N and comments that the Drill Hole STP 105 would have passed over the magnetic target (depth to top 130-150m): but no comment was made on any correlation between magnetics and I.P. on the northern line 'due to the distortion of (deep) magnetic anomalies by shallow anomalies'.

However, the strong magnetic anomaly centred at 5050E on line 4280N is smooth and undisturbed by surficial magnetic matter; but there is no corresponding I.P. anomaly. The zone of lowest resistivity is below 5200E which correlates with a strong (but noisy) magnetic anomaly (anomaly No. 4 of Bishop, 1980). The expected position of the contact between the Farrell Slates and the Eastern Volcanics is close to 5200E.

The Cominco survey covered the eastern section of the Farrell Slates up to the contact. Scintrex carried out a survey in 1979 for E.Z. over the western contact of the Farrell Slates in the Sterling Valley. The survey was a time domain dipole-dipole survey using 60m dipoles. On nearly all lines high chargeabilities occurred on the eastern edges of the lines and these have been ascribed to black slates within the Farrell Slates. Some anomalies were found near and west of the contact, within the Mt. Black Volcanics (for example the resistivity low, 10 ohm-m, on line 4280N, beneath 4650E). However, these anomalies were usually weak - in the above example, there is no corresponding well-defined zone of high chargeability.

Some generalisations may be made about the three rock types (Mt. Black Volcanics, Farrell Slates and Eastern Volcanics) in the Sterling Valley from the Scintrex and Geoquest I.P. surveys. The resistivity contrasts between the units varies; to the south the Mt. Black Volcanics are more resistive than the Slates, however, this distribution becomes blurred further north, possibly due to glacially-derived overburden. The chargeabilities, however, are consistently higher within the Slates. The Farrell Slates/Eastern Volcanics contact is not well covered by the Geoquest survey - the contact is near the edge of the surveyed lines: however, again the I.P. effects are higher in the Slates and the resistivities appear to be consistently higher in the Eastern Volcanics.

Ground Electromagnetics:

There appear to have been two ground electromagnetic surveys over the Sterling Valley Grid. Rio Tinto (RTAE) carried out a dip-angle survey (Boniwell 1959) over the grid. In 1974 McPhar carried out a vertical loop survey (using an SS15) for Asarco (see Barker, 1974). Both surveys defined conductors over long strike distances, however, there is considerable difference in the positioning of the conductors. The RTAE survey shows a conductor very close to the baseline north to line 4400N, where there is a shift to the east of some 100m. The Asarco

anomalies are generally 50 to 150m to the east of the RTAE anomalies. This discrepancy may be due to errors in converting data from one grid to another. But the problem has not been pursued since the anomalies are most probably due to conductive black slates. The E.M. conductors shown on the overlay 'showing summary of previous and proposed work' (map no. A0-526-0002) shows the Abminco compilation (as noted on the map).

Gravity:

RTAE carried out a gravity survey over the Sterling Valley Grid. The results are discussed by Boniwell (1959). Several small highs were detected including one on the base line from 3320N to 2720N coincident with the RTAE E.M. anomaly. However, several drill holes (STP 101 & 105, SV 2 & 3) have passed beneath this zone and no significant mineralisation was intersected. The other gravity highs in the northern part of the grid partially overlie E.M. or I.P. anomalies and have not been tested, however, the method does not appear to have defined any significant targets in the Sterling Valley area.

TULLAH AREA.

The following geophysical surveys have been conducted over the Tullah area. The extent of the coverage of each method is given in the discussion of the particular survey.

1. Aeromagnetics
2. Airborne electromagnetics
3. Ground magnetics
4. Self potential
5. Induced polarisation
6. Ground electromagnetics
7. Gravity

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Aeromagnetics:

The Tullah area is covered by the 1978 Geox survey described in the section on the Sterling Valley. The northern limit of this survey was approximately 800m north of the (arbitrary) boundary of the Tullah area (5,378,000N).

The division between the Sterling Valley and Tullah areas being one of finance rather than geology, the aeromagnetic response over the Tullah area is essentially a continuation of the Sterling Valley, namely a flat response over the Mt. Black Volcanics and Farrell Slates with isolated highs with a long linear anomaly over rhyolites within the Eastern Volcanics.

It is the isolated magnetic highs in the Farrell Slates or Mt. Black Volcanics near the contact that are of particular interest and there is one such anomaly - over the inferred position of the contact - in the Tullah area. The coordinates of the maximum value (about 110 γ) are 5,376,320N 384,760E. The contours also suggest the presence of another high some 200 or 300m north of the river within the Farrell Slates. There is also likely to be a magnetic high (or highs) in the vicinity of the new part of the Tullah township (in the area around 5,377,900N; 384,800E).

There are several old mines on the western flanks of the linear magnetic high over the magnetite-bearing rhyolites within the Eastern Volcanics e.g. Murchison, North Murchison and Duttons Workings. Some of these are within the Farrell Slates, some within the Eastern Volcanics; most are close to the contact. There is one aeromagnetic anomaly, centred at 5,375,000N 385,900E which appears to be separate from the Eastern Volcanics magnetic zone: it is situated over the indicated position of the Farrell Slates/Eastern Volcanics contact.

The western-contact high has been located and better defined by the October, 1980 ground magnetic survey, however, the eastern contact anomaly is north of the area covered by this survey.

Airborne Electromagnetics:

The Rio Tinto survey described in the Sterling Valley section was flown over the Tullah-Farrell area. This area, which had the Murchison River as its southern and western boundaries and the foot of the Farrell Ranges as its eastern

boundary (Qwen Conglomerate), extended north to the Mackintosh River, thus taking in areas where strong ground E.M. (Turam) anomalies were defined in ground surveys over the Farrell area (Tate, 1958). These anomalies occurred in conductive black slates which persist along strike throughout the area (although covered in places by moraine). However, no anomalies were recorded by this RTAE survey in the Tullah or Farrell areas.

Ground Magnetism:

Prior to the October, 1980 survey the main magnetic coverage of the Tullah area was from an old survey (date unknown), the results of which are recorded as profiles on a scale of 1" = 100ft (the data is filed in the masonite-backed vertical files; No. 5 "Tullah, Farrell, Murchison and Sterling Valley Surface Geology"). The grid for this survey was best fitted to A.M.G. and thus there may be some inaccuracies in the transferred positions. An early 1980 magnetic survey of the Murchison River Grid covered the south west corner of the Tullah area and touched the edge of the aeromagnetic anomaly previously mentioned.

The 'old' magnetic survey covered an area from the northern side of the Murchison River almost to the 'Duttons Workings' at 5,377,850N. The survey lines generally crossed the expected locations of the contact between the Farrell Slates and the Mt. Black Volcanics and extended into the Farrell Slates but they usually did not cross the eastern contact of the slates. The northern limit of the survey is approximately also the northern limit of the glacial cover over the Farrell Slates. Station interval was 50ft and the line spacing varied between 200 and 500ft. The survey detected the edges of the interesting aeromagnetic anomaly, but did not define it.

Strong anomalies were detected on the north side of the Murchison River over the Green and Kings Pb, Ag workings at 5,375,500N 385,000E. There are associated SP anomalies with this area and further magnetic anomalies some 150m to the east.

A weaker anomaly was centred over the indicated position of the South Murchison Ag, Pb Mining Co's mine at 5,376,650N 385,300E. This anomaly extends along strike for some 650m. It is noted that the mine is shown some 200m in from the moraine boundary.

A strong magnetic anomaly is in close proximity to the Murchison Mine.

Other isolated anomalies occur, of which the following will be looked for in the results of the October, 1980 survey (at the time of writing, the results of this survey had only been examined for part of the Sterling Valley area):-

5,377,400N	385,570E
5,376,450N	385,420E
5,376,150N	385,420E
5,375,820N	385,030E

This early survey did not adequately test the area, however, it defined several areas of interest and also suggested (confirmed?) that there is some correlation between magnetics and mineral occurrence.

There will be a separate report dealing with the interpretation of the October, 1980 survey over the Tullah area.

Self Potential:

A self potential survey was apparently made over the area of the magnetic survey described above; with a few exceptions, the SP lines coincided with those of the magnetic survey. However, the SP survey appears to have had a typical station spacing of 25ft rather than 50ft.

Few anomalies were found. A strong anomaly was recorded in the vicinity of the Green and King's Workings on the Murchison River. The anomaly occurred on three lines over a distance of 140m. Weaker anomalies occurred 30 - 50m to the west and 60m north of the strong anomalies and these were also over three lines. With the exception of the line closest to the River, these SP anomalies are apparently situated within the area of glacial cover.

Strong anomalies occur on the two northernmost lines (out of, and on the edge of, the moraine). The anomalies parallel strike direction and are in the vicinity of several drill holes (e.g. MP 37, 38 and 43) which were placed to test old workings (not marked on the mineral occurrences maps). The anomalies are centred over 5,377,650N 385,500E.

A further anomaly occurs on the top northern line at 5,377,750N 385,700E and there are two more anomalies approximately 250m to the south (also on the edge of the moraine). None of these SP anomalies has a corresponding magnetic expression.

SP anomalies occurred on two lines over the Murchison Mine area, they are approximately 100m east of the magnetic anomaly (which has a smaller SP anomaly associated with it) previously mentioned as being associated with the Mine, but there is a small magnetic disturbance associated with these SP anomalies. DDH MP 32 may have been drilled into this anomaly (not the stated reason). This hole intersected minor amounts of sulphide mineralisation.

In summary no SP anomalies occurred well within the glacial alluvium, but strong anomalies did occur at the southern and northern limits; including the anomaly associated with the Murchison Mine all were within the Farrell Slates.

Induced Polarisation:

A dipole-dipole frequency domain I.P. survey was conducted over the Tullah area by McPhar in 1961. Line separation was between 300m and 450m and the dipole length was 91m (300ft), i.e. it was a reconnaissance survey. The grid was an extension of the Sterling Valley Grid and thus the baseline closely paralleled the local strike direction (nor-nor-east). The survey extended over 1720m, the southernmost line being approximately 300m north of the Murchison River. The results were presented, as pseudo-sections of apparent resistivity ($\rho_a/2\pi$ ohm-ft) and metal factor. The frequency effects (resistivity x metal factor \div 1000) have since been superimposed over the metal factor profiles. Scale is 1" to 300ft. The line locations and (previously interpreted) anomalies are shown on the 1:10,000 scale maps A0-525-0057 and A0-525-0024.

The north-east corner of the Murchison River Grid covers part of the southern portion of the Tullah area and this grid has been covered by gradient array I.P. (Scintrex, 1979). Chargeability contours are shown on a 1:10,000 scale map (A0-525-0024; E.Z. Map Area 7). Resistivity as well as chargeability contours are shown on the 1:5,000 scale maps A0-504-0073 and A0-504-0069 respectively.

The chargeability contours show two distinct areas; the highly chargeable Farrell Slates and the lowly chargeable Mt. Black Volcanics. (The location of the contact is confirmed from outcrop within the Murchison River.)

The results of the 1961 McPhar survey are poor and suspect. There are several missing values from the metal factor pseudo-sections (the low resistivities encountered in the Abminco survey of the Sterling Valley?) and most of the profiles show horizontal layering which suggest that the effects may be largely due to

the glacial overburden (known thickness of nearly 90m). Except for the southernmost lines, the pseudo-sections show a resistivity low at depth near the centre of the spread with corresponding high metal factors, and if there is any validity to the results, the resistivity lows/metal factor highs are due to black slates known to occur within the Farrell Slates.

In summary, the Tullah area may be considered essentially unsurveyed by I.P. except for that part covered by the Murchison River Grid. Any I.P. survey would be expected to 'map' the Farrell Slates or at least certain units within the slates.

The bedrock topography undoubtedly varies considerably beneath the glacial cover. It would therefore be advisable for 2 or 3 electrical soundings (measuring the I.P. effect as well as resistivity) to be carried out prior to any electric or electromagnetic survey over the area.

Ground Electromagnetics:

I have found no information on ground electromagnetics surveys carried out over the Tullah area; however, a supplementary memorandum from McPhar (dated 27th April, 1961) stated "only electromagnetic results are available on the Tullah Grid....". The results of such a survey might be of interest for helping to define the Mt. Black Volcanics/Farrell Slates contact.

(Addendum: an RTAE plan titled 'Plan of Tullah area em Profiles' is being sought)

Gravity:

Gravity surveys were conducted over parts of the Tullah area. The results were presented as profiles on the same grid (then called the Murchison Mine Grid) as the magnetic and self potential data. The profiles have not been examined or transferred to A.M.G. and so no comments are made apart from noting the presence of a strong regional gradient - values increasing to the west. However, it seems likely that if, as expected, the bedrock topography is irregular beneath the glacial cover; then the gravity results would reflect these variations and perhaps be dominated by them. But the data does show some anomalies and results in the vicinity of drill hole targets (based on other criteria) would be worth examining if interesting intersections were obtained. That is, I consider it unlikely that the gravity method would define a drill hole target that was not suggested by some other geophysical method. However, it is possible that the method could be used

to define areas of concentrated (massive) mineralisation within the belt of conductive black slates. (This was tried, without success, in the Farrell area, but it was pointed out that the very narrow width of the orebody made it impossible to detect by gravity surveys, unless it was at very shallow depths.)

THE FARRELL AREA

The following geophysical surveys have been conducted over the Farrell area. The extent of the coverage of each method is given in the discussion of the particular survey:

1. Aeromagnetics
2. Airborne radiometrics
3. Airborne electromagnetics
4. Ground magnetics
5. Self potential
6. Induced polarisation
7. Ground electromagnetics
8. Gravity.

Aeromagnetics:

The Farrell Area is covered by a Scintrex, 1973 aeromagnetic survey. This survey apparently had a flight line spacing of 200m with a flight height of 250ft (76m). The data has been presented as 10 γ contours on a 1:10,000 scale map.

The map shows the four Farrell Mines (Mt. Farrell, North Mt. Farrell, Farrell Mackintosh and New North Mt. Farrell), all on the western edge of the Farrell Slates, are in an area of fairly gentle magnetic gradient. The magnetic rhyolites of the Eastern Volcanics appear to have stopped east of the southernmost mine (the Mt. Farrell Mine) and the gradient flattens rapidly northwards.

There is a small isolated magnetic high 350m west of the Mt. Farrell Mine and a much larger high 500m west of the Farrell Mackintosh Mine. These anomalies are in the Mt. Black Volcanics and would therefore probably not be of interest for Farrell-type orebodies, but may be of interest if the Sterling Valley-Tullah tin concentration hypothesis proves encouraging.

There are three more mines/old workings mapped north of the Farrell area all on or near the Mackintosh River. The Farrell Blocks and Metropolitan Mines are some 2000m north of the four previously mentioned 'Farrell Mines', and Lynch's Section (Ag) is a further 1000m upstream. There is an isolated magnetic high some 700m west of Farrell Blocks workings - again west of the Farrell Slates.

Airborne Radiometrics:

The Scintrex, 1973 aeromagnetic survey apparently also recorded radiometric data from four 5" crystals using a G.D.S.A. differential spectrometer. However, E.Z. has no known record of this survey. Presumably copies can be obtained from Scintrex.

Airborne Electromagnetics:

As previously mentioned, the RTAE 1956 helicopter-borne electromagnetic survey included the Farrell Mines in its coverage of the Tullah area. No anomalies were detected and the results are discussed under the Tullah area. But it is mentioned again here that several very strong ground E.M. (Turam) anomalies were detected in the Farrell area.

Ground Magnetics:

Geophysical consultant, L.A. Richardson, wrote in 1950, "The question of whether any magnetic mineralisation is associated with the Tullah ore zones has not yet been closely investigated". The position does not appear to have changed since then. Richardson made a few magnetic measurements between the "1st and 2nd Creeks" and the results apparently may have helped to define the strike direction. Tate (B.M.R. record 1958, No. 35) wrote that the magnetic method was tested but no results were given or comments made.

In view of the response of electrical systems to the black slates in the area, it is possible that magnetics could be a useful tool for discriminating the more mineralised sections of the slates.

Self Potential:

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A considerable amount of self potential has been carried out in the area. L.A. Richardson (1950) supervised a large survey which covered a strike length of some 1800m; its southern limit being just north of the New North Mt. Farrell Mine. Some strong anomalies were recorded. A few are shown as being upto 80m west of the Farrell Slates contact; but it is most likely that all the SP anomalies are due to Black Shales within the Farrell Slates and that the contact is therefore west of its indicated position. Tate (1958) carried out an SP survey in the vicinity of the Farrell Mines in conjunction with an E.M. survey and obtained coincident anomalous zones.

Not all SP anomalies have been checked against drill holes to verify that the anomalies have been investigated. This will be best carried out when compilation of drill holes and geophysical anomalies (at 1:10,000 scale) has been completed.

Induced Polarisation:

Four lines of I.P. were conducted by McPhar in 1970 over mining lease 11257 north of the New North Mt. Farrell Mine. The lines crossed a previously detected E.M. conductor/SP zone (discussed above) and obtained anomalous results which strengthened to the north. McPhar also interpreted a possible anomaly on the eastern end of two of the lines. Drill holes through the main anomaly intersected black slates with pyrite. This appears to be the only record of I.P. carried out in the Farrell area.

Ground Electromagnetics:

Tate (1958) conducted a survey near the Farrell mines using SP and the Turam E.M. system. An anomalous zone was found north of the New North Mt. Farrell Mine - part of this zone was covered by the I.P. described above. Two other zones were found to the east of the mine. The more northerly one, 'C', was classified as weak and Tate considered it too poor for further investigation (the only results given are profiles and contours of phase - amplitudes of field strength ratios are not presented). However, the anomaly is quite pronounced and is, by itself, a definite anomaly.

Indication 'B', the more southerly anomaly, is well pronounced and Tate stated that it is "probably that marked by Henderson (1945) on his plan as the Central Farrell Lode". As with SP anomalies, these results can best be checked when the 1:10,000 scale compilation of drill holes and geophysical anomalies is completed.

Gravity:

Four lines of gravity observations were carried out by L.A. Richardson in 1950. The results are not presented in his report but it is likely that they are in E.Z.'s possession (a file containing copies of material sent to Richardson includes some gravity data. It has not been examined in detail). No anomalies were found and Richardson pointed out that Farrell-type lodes - very narrow, near vertical, tabular bodies would only produce measureable effects if at or very near the surface.

CONCLUSIONS.

The aeromagnetics has served as a coarse and partial aid to geologic mapping, but more particularly it has defined targets for follow-up exploration.

The results of the airborne electromagnetics were most surprising over the Tullah and Farrell areas, particularly so since the method had defined anomalies on all other areas surveyed. Equipment malfunction is suspected. It is expected that any subsequent AEM survey over this area would respond to the black slates within the Farrell Slates. The anomalies from the survey over the Sterling Valley area are interpreted as being due to conductive black slates within the Farrell Slates, except for the anomaly within the Eastern Volcanics which may be worth investigating.

The magnetometer is the most useful tool for work on the present hypothesis of cassiterite associated with pyrrhotite. Several targets have been defined in the zone of interest. It has not yet been established whether magnetics would be of any assistance in finding a Farrell type orebody, that is a base-metal deposit of massive sulphides, probably narrow and steeply dipping within conductive slates.

The self potential method responds to the conductive black slates and variation in anomaly strength along strike apparently reflects change in host conductivity rather than sulphide content. The method is not expected to give meaningful results over glacially covered areas.

Induced polarisation surveys have shown that the contact between the Mt. Black Volcanics and the Farrell Slates can be determined, though with what certainty when the contact is under some tens of metres of glacial cover, is not known. It is quite likely that I.P. would not discriminate sulphides from the large background values within the Farrell Slates.

Similarly electromagnetic surveys (now severely hampered in the Sterling Valley area by a power line running down the baseline) would be expected to define black slates and probably not be able to discriminate variations in this response from sulphide concentrations.

There are several examples in the geophysical literature where the gravity method has been successful in such discrimination. However, the sulphide body, in order to be detected by gravity, must be massive and have significant width, as well as length and depth. This apparently has not been the case here. Also the usefulness of the method would be further downgraded over areas of glacial cover with an uneven (and unknown) bedrock topography.

RECOMMENDATIONS.

The area of immediate interest is the contact zone between the Mt. Black Volcanics and the Farrell Slates. Specific targets near this zone will be magnetic highs hopefully representing pyrrhotite bodies with significant associated tin.

The Farrell Slates western boundary is hidden by glacials over a distance of approximately 2200m in the Tullah area. The I.P. survey over the Murchison River Grid reduced the distance by some 500m. Before further defining this contact, the aeromagnetic anomaly near the inferred contact will most likely be drilled, thus reducing the distance over which the position of the contact is unknown to approximately 1600m.

If it is desired to locate this contact then the following methods might be considered:

- i) Resistivity profiling: The resistivity results from the Murchison River Grid I.P. survey show a large contrast when crossing the contact. A resistivity survey would be considerably cheaper (and probably quicker) than an I.P. survey, but of course the valuable frequency effect/chargeability information would not be obtained.
- ii) Seismic survey: It is very likely that there is a significant difference in the seismic velocities of the Mt. Black Volcanics and the Farrell Slates. (If the H.E.C. cannot give this information a test survey would quickly provide it.) Given the contrast in velocities, a seismic survey would provide the most precise geophysical method of locating the contact.

There are two other considerations, regarding seismic surveys;

1. The thickness of glacial cover (and hence bedrock topography) would be well defined by seismic survey, and
2. Any sulphides in appreciable concentrations (?) may be indicated by a drop in velocity.

Given the nature of the expected target, it is likely that magnetics is the primary geophysical method with possibly I.P. being used for confirmation and perhaps definition.

Representation of Data.

The surveys discussed in this report need to be included in the overall compilation of geophysical surveys over the E.Z. exploration licences and joint ventures. This compilation is being done at scales of 1:10,000 and 1:50,000.

The aeromagnetic data has already been compiled on 1:10,000 scale maps in contour form.

The airborne electromagnetic data is largely an unknown quantity, nevertheless it is suggested that the areas covered be shown on a sheet titled 'coverage of geophysical methods' and to show the anomalies on a sheet titled 'geophysical

anomalies'. There would need to be a standardisation of symbols within the AEM survey; differently coloured symbols have been used on different sheets for the same classification of anomaly. Separate symbols should be used for each AEM survey.

The ground magnetics data should be represented as contoured data at 1:10,000 scale on its own map - the one map would serve to show area covered and position of anomalies.

The October, 1980 survey over the Tullah area can be taken to supercede the previous 'old' survey where it overlies it. Where it does not, lines can be used to indicate coverage, with bars to indicate anomalies - on the same map as the contours. Similarly for the Sterling Valley area. The October, 1980 survey can be used with a break between it and the 1976/78 Abminco survey covering the southern portion of the Sterling Valley. The Jan/Feb, 1980 survey data will be needed for the north-western part of the Grid.

The self potential data would be included with those methods not requiring their own separate maps (i.e. all methods other than magnetics and I.P.). For such methods, one sheet would be needed for coverage and one to show anomalies. The SP surveys to be included are those for:- Rio Tinto (Boniwell, 1959); the B.M.R. survey (Tate, 1958); and that by Richardson (1950); plus a considerable amount of data shown as profiles in the vertical file No. 5 (the coverage and anomalies have been roughly plotted onto a working map of the area which has had the Tullah Grid drafted over it).

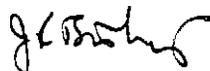
The job could perhaps be best done by a draftsman marking on to the 1:10,000 map the coverage and then the marking on of the anomalous regions by myself.

Like the magnetic data, I.P. coverage and anomalies could be represented on the one map. Nearly all of the data to date has been dipole-dipole and should be represented as lines indicating coverage with bars for anomalies. There are, however, some lines with upto four surveys over them. But all data should be included - even that from the 1961 survey over the Tullah-Sterling Valley area since comparisons can be most instructive. Surveys to be included are the McPhar, 1960 and 1961 surveys; the Cominco, 1976 survey (incompletely drawn on the present 1:10,000 I.P. compilation map); a Scintrex, 1979 survey plus the McPhar, 1961 survey over the Farrell Area.

The ground electromagnetic surveys for:- Rio Tinto (Boniwell, 1959); for Abminco (McPhar, 1974) and the B.M.R. survey over the Farrell area (Tate, 1958), would go on the coverage and anomalies maps in much the same fashion as the AEM data, though classification of anomalies is perhaps not as important as correlations from line to line and previously defined anomalies are probably satisfactory for the E.M. surveys over this area.

The gravity survey of the Tullah area has not been properly examined and some time and effort would be needed for proper identification (and interpretation) of anomalies. As argued in that section, it is considered that this would not be worthwhile at the moment, although it is likely that the data is of good quality. Therefore coverage only of gravity over the Tullah area should be shown with a note to say that some gravity has also been carried out in the Farrell area by Richardson (1950) - but no anomalies were found. In the Sterling Valley area, the anomalies from the Rio Tinto survey can be shown.

Thus it is likely that four different sheets will be needed for each of the four maps which comprise the area: one each for magnetics and I.P., showing both coverage and anomalies, and two for all other methods; one for coverage, and the other for anomalies.



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24TH OCTOBER, 1980.

JRB/amd

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