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## 8 GEOLOGY OF THE TULLAH MINING FIELD

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### ABSTRACT

The area surrounding the North Mt Farrell and New North Mt Farrell Mines at Tullah was examined between March and May, 1963. The investigation was designed to assess the economic potential of the Farrell mining field, which has declined over recent years. Geological mapping of the underground levels of the New North Mt Farrell Mine was carried out using base plans made available by mining companies previously interested in the area. Surface mapping was virtually limited to creek sections due to extensive soil and talus cover, although a plane-table survey was carried out in an area of more extensive exposure adjacent to the North Mt Farrell Mine.

### INTRODUCTION

All data relevant to the North Mt Farrell Mine, which closed in 1932, has been extracted from previous reports as the mine workings are now inaccessible.

Tullah is situated approximately four and a half miles NE of Rosebery and consists of about 30 houses, an hotel, post office and store. It is connected to Rosebery by a sealed road about 9 miles in length, opened in 1962. Prior to this, access had been limited to the Emu Bay railway line from Burnie which passes some 3 miles west of Tullah. Five miles of two feet gauge railway, owned by the Farrell Mining Company, connected Tullah with Farrell Siding on the Emu Bay Line.

The North Mt Farrell and New North Mt Farrell Mines are connected by a two feet gauge tramway, and other mines in the area are generally accessible by 4-wheel drive vehicles.

The literature on the geology and mineral deposits of the Tullah district is not extensive. Twelvetrees (1901) examined the mines which were in active operation and described the open cut and adit workings above No. 4 adit level, North Mt Farrell Mine. The next visit to the area was by Waller (1904) and included an investigation of the North Mt Farrell lodes and the prospect of the Mackintosh Copper and Gold Mining Company N.L. in the immediate vicinity of the present New North Mt Farrell Mine. The area was later investigated by Ward (1908), Reid (1927) and Nye (1931).

Henderson (1945) also investigated the area in some detail and has been followed in recent years by Brooks (1962) and several large mining companies particularly interested in further development of the New North Mt Farrell Mine. Geophysical exploration of the area was carried out by the E.Z. Company in 1951 and by the Bureau of Mineral Resources in 1957. Electromagnetic and self-potential methods were employed during these surveys and several anomalies were defined.

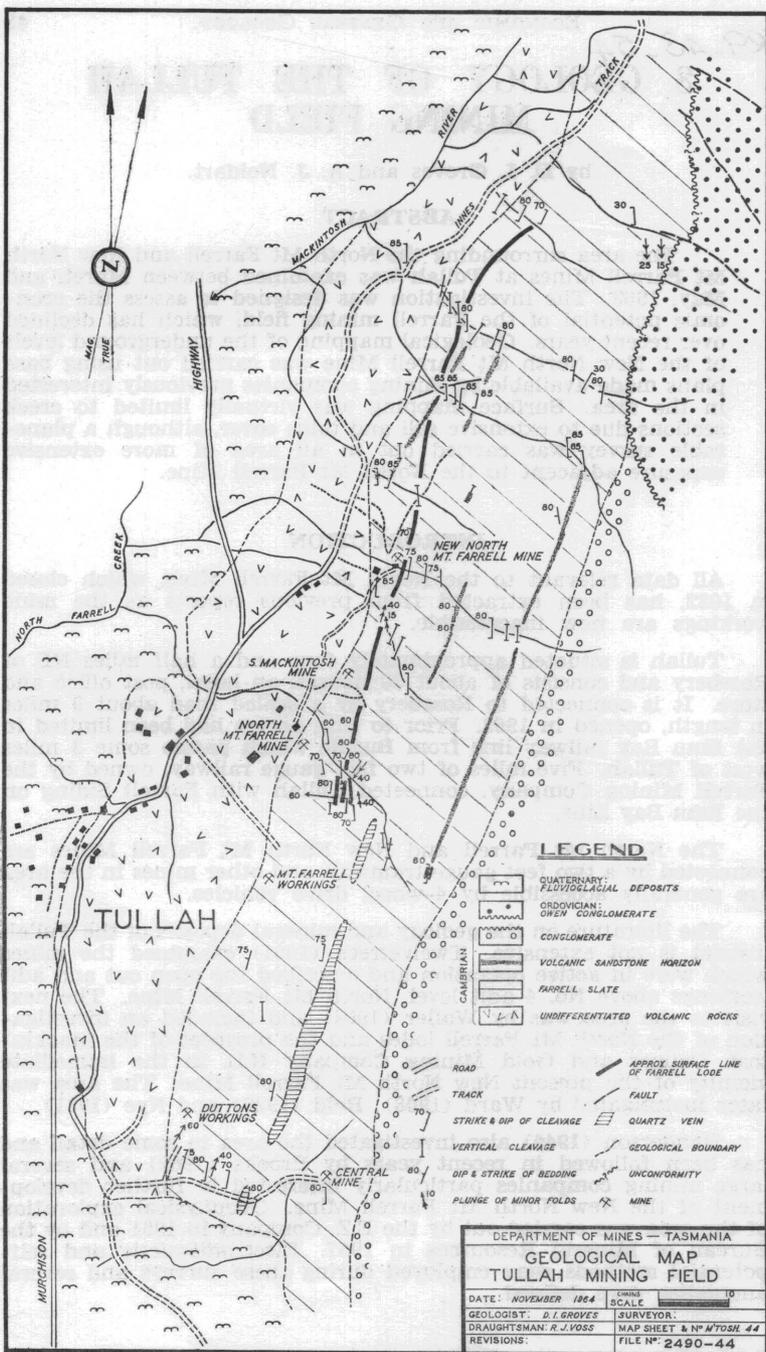
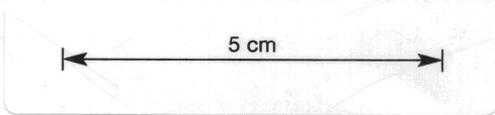


FIGURE 9.



A total of 27 surface diamond drill holes, totalling over 11,000 feet of drilling, have been put down in the area, the majority to the south of the New North Mt Farrell Mine. These failed to discover economic mineralization. Only 6 holes have been drilled north of the mine area, four of these intersecting a NNE-trending branch lode and two a N-trending line of lode, which in both instances were found to be uneconomic.

Several thousand feet of underground drilling has been done on the New North Mt Farrell Mine with a very limited amount of success.

A detailed history of mining in the Mt Farrell field was given by Henderson (1945), and only a brief description of the main features is given below.

Galena was first discovered on the North Mt Farrell leases in 1899 and mining was commenced by driving adits at successive levels on this lode. The North Mt Farrell Mine was worked on four adit and ten underground levels until its closure in 1932. The reason for closure is obscure, but it appears that it may have been due to a combination of low metal prices and poor management rather than poor values in the winzes below No. 10 level.

Following closure of the mine, the men were employed prospecting north of the Company's leases under Government Relief Fund subsidy. Early in March, 1933, a lode of galena, 6 inches wide, was discovered on the old abandoned Mackintosh Lease and a shaft was sunk on the lode in 1934. This was the beginning of the New North Mt Farrell Mine which has been working continuously since 1934. The main 3 compartment shaft was sunk to No. 7 level and an internal 2 compartment shaft sunk from this level to the No. 9 level. This is the present stage in development of the mine. Small reserves of ore workable without further development occur above Nos. 6, 7 and 9 levels.

### PHYSIOGRAPHY

The topography of the area is one of high relief, rising from 600 feet at Tullah to 2000 feet at the summit of Mt Farrell. The higher, rugged topography consists of ridges of resistant Owen Conglomerate while the area adjacent to the mines comprises rounded low hills covered with a secondary regrowth of bracken and low scrub. Small westerly flowing streams drain into the Mackintosh and Murchison Rivers which unite below Tullah to form the Pieman River, flowing westerly to the sea. The river valleys contain large deposits of fluvio-glacial material (up to 500 feet thick), suggesting extensive valley glaciations in the Pleistocene.

### GENERAL GEOLOGY

The area under examination is portion of a larger area currently under examination by regional survey parties from the Department of Mines, and will be incorporated in the standard 1 mile: 1 inch publications of the Department, hence the general geology of the area is only briefly covered in this report.



A thick sequence of Cambrian rocks occurs in a westerly dipping belt along the western margin of the Farrell Range. There has been much controversy concerning the orientation of this succession, the majority of authors considering it overturned. Brooks (1962) reported overturning of sedimentary structures, current bedding and ripple marks near the Murchison River Bridge. No conclusive example of current bedding was found at this locality although features structurally similar to current bedding are present. These are apparently produced by modification of bedding by cleavage at an acute angle to bedding.

The Cambrian sequence is apparently intruded by the Murchison Granite, of Cambrian age, to the SE of Tullah and is unconformably overlain by Owen Conglomerate, of Ordovician age occurring to the east of the area under investigation. Both were fully described by Brooks (1962). Large boulders of Owen Conglomerate derived from the Farrell Range, form a surface blanket over the low hills behind Tullah township.

## STRATIGRAPHY

### CAMBRIAN BEDS

#### *Volcanic Suite*

The most westerly belt of rocks exposed at Tullah consists of soda-rich basic and intermediate volcanic rocks including lava, tuff and breccia.

They are equated to the Mt Read Volcanics, defined by Campana and King (1963) and include the "porphyroids" of early workers, the Mt Read Felsite (Twelvetrees and Petterd, 1899), the Massive Pyroclastics (Hall *et al.*, 1953), the Read-Rosebery Volcanics (Hills and Carey, 1949) and the Volcanic Assemblage (Campana *et al.*, 1958).

Briefly, the predominant rock types are sodic lavas comprising phenocrysts of pyroxene, feldspar, quartz and leucoxene in a fine groundmass of dominantly chlorite and sericite. Augite phenocrysts have ragged boundaries rimmed by secondary actinolite-tremolite and chlorite. The feldspar appears to be predominantly albite with a little oligoclase. In places the augite phenocrysts are altered to an aggregate of epidote grains enclosed in chlorite, and hornblende occurs rarely as a minor constituent. Some coarse grained aggregates of calcite, quartz and albite may represent amygdaloids.

#### *Farrell Slate*

Structurally underlying the volcanic rocks is a sequence of approximately 2000 feet of slate and volcanic sandstone, previously termed tuff and tuffaceous sandstone. These sediments have been termed the Farrell Slates (Hills, 1915), Farrell Slate series (Henderson, 1945), "bedded series" (Hall *et al.*, 1953), Slates and Breccias (Carey, 1953) and Tullah Slates (Solomon, 1958). They are reported to crop out over a distance of some 10 miles from the Stirling Mine to north of the Farrell Range, and contain the majority of the important ore deposits in the Farrell area.

The slate, which is predominant in this succession, is grey to black in colour and is finely laminated in places. It is composed of elongate, undulose quartz grains, in places severely crushed, in a fine grained matrix of sericite, chlorite and calcite. Small rock fragments and veinlets of calcite comprise the remainder of the rock, all constituents being commonly oriented parallel to the strong cleavage. Adjacent to the lode channels the slate is talcose due to alteration during mineralization.

The volcanic sandstone appears discontinuous along its strike and is probably made up of lenticular units up to 100 feet in width. Thin bands of alternating volcanic sandstone and slate are also common. The sandstone is green-grey, granular and contains irregular grains of quartz, albite, volcanic rock fragments, slate fragments and muscovite in a fine matrix. The rocks are characterized mainly by their granular texture.

#### *Conglomerate*

A lens of conglomerate occurs to the east of the slate and volcanic sandstone, reaching a maximum thickness of 500 feet to the east of Tullah and thinning rapidly towards the south. It is poorly sorted with an open framework and contains fragments of slate, quartz and feldspar porphyry, quartz and hematite in a fine matrix of sericitized and chloritized quartz and feldspar. It is unmineralized over its entire length.

#### QUATERNARY DEPOSITS

A sequence of gravel, sand and clay occupies the valley floors east and west of the Farrell Range. The gravel is generally unstratified but contains stratified beds of well sorted medium to coarse grained sand, fine to coarse silt and rare clay. They are probably fluvio-glacial deposits.

#### STRUCTURAL GEOLOGY

The structure of the Cambrian beds was examined in the field but the overall structure of the area is summarized from Brooks (1962).

The Farrell Range locally forms the core of the N-S trending West Coast Range-Dundas Anticlinorium with numerous related secondary folds (Hall and Solomon, 1962). The anticlinorium at Mt Farrell is asymmetrical with a steep easterly limb. To the east of the anticlinorium the Ordovician sequence is folded into a broad syncline forming part of the Sophia Synclinorium which is again asymmetrical with a steeper westerly limb.

East-west cross folds with general westerly plunge and smaller wavelength have been described by Brooks (1962) in the Owen Conglomerate. It is suggested that the sinuosity of the Cambrian contacts is also a result of possible E-W cross folding within the Cambrian beds. A concentric style of folding is dominant within the Owen Conglomerate. East-west to NW-SE faults of small movement are extremely common cutting the Owen Conglomerate and are reflected by movements of the sandstone marker horizon along the length of the Farrell Range. These faults appear to die out in the Cambrian succession and the movements may be taken up in less obvious deformation within the Cambrian beds.

The Cambrian rocks are extensively cleaved while the Owen Conglomerate is relatively less cleaved, probably due to greater competency. In places the cleavage or schistosity is so strong within the Cambrian beds that the rocks may be termed cataclasites. Pebbles of Cambrian rocks within the Lower Owen Conglomerate are cleaved, the cleavage being aligned parallel to that within the Cambrian rocks suggesting that the cleavage is post-Ordovician and probably a Tabberabberan structure. There is no direct evidence for pre-Ordovician folding although it is suggested by shallow residual dips in the Cambrian rocks upon unfolding of the Ordovician sequence (Brooks, 1962). Rose diagrams of cleavages from underground and the surface indicate the occurrence of two acutely transgressing cleavages, the predominant cleavage varying in strike from  $355^{\circ}$  to  $5^{\circ}$ M and the minor cleavage  $10^{\circ}$  to  $20^{\circ}$ M. Both cleavages generally dip steeply west throughout the area although vertical and easterly dipping examples occur. In the New North Mt Farrell Mine strong shear planes, in places carrying ore, are subparallel to cleavage and show strong analogies to cleavage plots on a rose diagram.

Variations between isoclinal and shallow concentric folds are common within the Farrell Slate. The axial planes of small folds exposed in the area generally subparallel cleavage, with a N-S trend. The folds generally plunge to the north at  $10^{\circ}$  to  $40^{\circ}$  although several plunge south at similar angles. Kink bands are common and strongly developed in places. More intense deformation appears to have occurred between the boundary of the slate and volcanic rocks and the main Farrell shear zone, some 250 to 450 feet to the east of the boundary. This is probably due to extensive relative movement between the two adjacent surfaces.

## ECONOMIC GEOLOGY

### Lode Deposits

The silver-lead deposits of the Tullah area occur almost entirely within the Farrell Slate over a distance of some two miles extending from the Murchison River N to the New North Mt Farrell Mine. The mines occur on two distinct lines of lode, the Farrell lode being the more important and the North Mt Farrell and New North Mt Farrell Mines the main producers from this lode.

The ore bodies occur in a series of fissure veins in shear zones acutely transgressing bedding in the host rocks. The main lodes consist of semi-tabular bodies distributed along two major lode channels with subsidiary branch lodes. In the New North Mt Farrell Mine the ore occurs in two subparallel fissures about 100 feet apart, although the footwall lode is filled in most sections by barren quartz. In the North Mt Farrell Mine the ore occurred in a single N-S trending lode at depth, although several branch lodes were present in the upper levels. Mineralization along the shear zone is not continuous, and is intensified locally at the intersection of main and branching lodes. In the shear zones in the New North Mt Farrell Mine the ore is generally found in lenticular shoots less than 200 feet in length and 3 to 4 feet in width. The ore bodies occur in both slate and volcanic sandstone although the lodes in the sandstone appear wider and more continuous than those in the slate. This is probably due to the sandstone lenses acting as the competent horizons within the succession, shearing producing con-

tinuous discrete fractures in these horizons in contrast to a series of small anastomosing fractures in the slate. Infilling of such fractures has generally produced a more convenient ore body for mining undertakings in the sandstone than in the slate, although the ore grade is similar. The average dip of the main ore bodies in the field is  $60^{\circ}$ - $65^{\circ}$  to the west with a general individual plunge to the SW, the plunge length being a minimum of 400 feet.

The lodes comprise generally coarse-grained aggregates of argentiferous galena, sphalerite, pyrite, marcasite and chalcopyrite with minor tetrahedrite, jamesonite, ruby silver and argentite in a quartz and siderite gangue. Coarse-grained galena aggregates occur in places as narrow veins along each wall of the lode and rarely veins of predominantly coarse galena occur up to 13 feet wide over a limited extent. In general the lodes have a distinct footwall but small veinlets of quartz and galena penetrate the country rock on the hangingwall side and smears of galena are common on joint surfaces. Little alteration of the wall rocks has occurred although finely disseminated pyrite is common in the host rocks adjacent to the lodes. The main gangue mineral in the mine is sphalerite, the content varying considerably. It was reported on some levels to have occupied the major portion of the ore channel.

#### MINE WORKINGS

##### *North Mt Farrell Mine*

The lodes at the North Mt Farrell Mine have been worked from four adit levels and ten underground levels. An internal three compartment shaft connects No. 4 adit level and all levels to No. 9 level and a three compartment shaft connects Nos. 8 and 10 levels to the surface. The surface shaft was sunk just prior to closure of the mine.

The No. 3 lode is the principal of four lodes worked in the North Mt Farrell Mine and is considered by most authors to be a continuation of the quartz-footwall lode of the New North Mt Farrell Mine. It strikes approximately magnetic north and dips  $60^{\circ}$ W, the ore shoot pitching about  $70^{\circ}$ S. It has been continuously stoped from the surface to No. 10 level south. The latter proved uneconomic but may not be a true indication of ore grade as the ore shoots are reported to be patchy. The average width of the lode on No. 10 level was 4 feet.

Apart from the main lode, three branch lodes have been worked in the North Mt Farrell Mine, the deepest joining No. 3 lode at No. 6 level. No. 1 lode strikes at  $35^{\circ}$ M and dips  $60^{\circ}$ W and has been driven on at No. 3 and No. 4 adit levels and No. 1 level. Ward (1908) reported an overall lode width of 35 feet on No. 4 adit level with a payable length of 240 feet. No. 2 lode strikes  $17^{\circ}$ M and dips  $50^{\circ}$ W from No. 4 adit level to No. 2 level and then  $85^{\circ}$ W to No. 6 level where it joins No. 3 with a south pitching intersection. The lode has been stoped to the surface from No. 2 adit level over a length of 750 feet, from No. 3 to No. 2 adit levels over a length of 400 feet and between Nos. 4 and 3 adit levels over a length of 250 feet. No. 2A lode strikes  $10^{\circ}$ M and dips  $75^{\circ}$ W with stoping between Nos. 3 and 1 levels.

From mine plans of the North Mt Farrell Mine it appears probable that enrichment occurred at the intersection of main and branching lodes, a feature consistent with smaller-scale enrichment in the New North Mt Farrell Mine. The ore grade determined from tonnages given by Drew (1957) averaged 11.5 per cent lead and 11.5 oz per ton of silver, figures from the Department of Mines indicating an average of 9 per cent lead and 9 oz of silver per ton between 1922 and 1927.

#### *New North Mt Farrell Mine*

The New North Mt Farrell lode has been worked from 9 underground levels, to approximately the same depth as the North Mt Farrell workings. A main three compartment shaft extends from the surface to No. 7 level and an internal two compartment shaft between Nos. 7 and 9 levels. The main lode, striking  $0^{\circ}$  to  $10^{\circ}$ M and dipping  $65^{\circ}$  to  $80^{\circ}$  W comprises three main ore shoots which although patchy contain abundant argentiferous galena in places. Most of the lead produced has been obtained from this lode although two additional lodes have been productive.

The most extensive ore shoot, with a maximum level length of some 400 feet and plunge length of 700 feet, was located on the north side of the main shaft. The ore shoot had a relatively consistent level length between Nos. 1 and 5 levels and an average width of 4 to 5 feet. Below No. 5 level the ore shoot has a maximum level length of 90 feet, beneath the most northern section of the shoot in the higher levels, and an average width of about 2 feet. The balance of the lode north of the shaft appears barren below No. 5 level apart from a small shoot of ore stoped close to the main shaft on No. 7 level. The most productive sector of the ore shoot occurred between Nos. 1 and 2 levels, where the lode width was up to 45 feet for a length of some 20 feet at the intersection of main and branch lodes. The overall plunge of the ore shoot is about  $75^{\circ}$ S.

Two further ore shoots are situated to the south of the main shaft. The uppermost shoot has been stoped from the surface to No. 7 level over a plunge length of some 1100 feet, with a maximum level length of 340 feet. The average width of the shoot is about 2 to 3 feet and the plunge  $35^{\circ}$  to the south. This ore shoot has not been worked on Nos. 8 and 9 levels because extensive driving is required to intersect the shoot which is pitching away from the shaft with depth. The third shoot has been stoped adjacent to the shaft on the southern side from above No. 5 level to No. 8 level, and partially stoped between Nos. 8 and 9 levels. The shoot plunges steeply south and has been stoped over a plunge length of 450 feet and a maximum level length of 280 feet.

The quartz-footwall lode subparallels the main lode and dips at  $45^{\circ}$ W between the surface and No. 4 level, steepening to  $75^{\circ}$ W to No. 9 level. It comprises predominantly barren quartz, although three discrete ore shoots have been stoped to a maximum height of 30 feet over a stope length of 150 feet on various levels. A single branch lode has been stoped between Nos. 3 and 4 levels over a level length of about 300 feet.

The ore grade in the New North Mt Farrell Mine has averaged 9 to 12 per cent lead and approximately 1 oz silver to each 1 per cent of lead. Ore grade in 1956 approximated 12 per cent lead and 14 oz silver per ton (Drew, 1957) and in 1963 was about 10.4 per cent lead and 11 oz silver per ton. The ore treated generally averages 1 to 2 per cent zinc, care being taken to exclude excessive sphalerite from the treatment plant. The ore grades are very similar to those for the North Mt Farrell Mine.

#### GEOPHYSICAL EXPLORATION

The Electrolytic Zinc Company conducted a self-potential survey to the north of the New North Mt Farrell Mine (Richardson, 1951). An anomaly indicated at mine grid co-ordinates 3000 N-4000 N and 1400 E-1500 E, was tested by drill holes MP 86 and MP 87 but only pyritic slate was intersected in the projected lode position.

In 1957, officers of the Bureau of Mineral Resources carried out an electro-magnetic geophysical survey over the field. Three indications were obtained as a result of the survey, indication "A" being interpreted by the authors as the most significant (Fig. 10). The relationship between this indication and the four holes drilled by the Department of Mines in 1947 are shown in Fig. 10.

#### DRILLING PROSPECTS

##### *Known Ore Bodies*

In the New North Mt Farrell Mine comparatively short ore bodies (80-100 feet length) stoped above No. 9 level continue underfoot and should prove economic under normal mine development programmes. However, the driving of deeper levels is not practical in the existing mine due to a poorly positioned main shaft and an inadequate internal shaft. The gently plunging ore shoot south of the main shaft has not been investigated below No. 7 level although it appears to extend underfoot. This is again directly attributable to the position of the main shaft, extensive driving being required on the lower levels to intersect the ore shoot. Testing to sufficient depth to warrant sinking a new shaft to the west of the present main shaft would entail intersection depths of about 1600-1700 feet. Under these conditions deep drilling is not recommended on the New North Mt Farrell lodes at this stage.

In the North Mt Farrell Mine the lodes are generally larger (100 and 300 feet lengths) than in the operating mine and should continue below No. 10 level. Stoping has been carried out above an intermediate level below No. 10 level (south) with only moderate success, but further exploration should not be abandoned on this basis as the lodes are reported to have been patchy throughout the mine. Economic considerations involved in reopening the mine would probably be consistent with drilling intersections at a depth of about 1500-1600 feet vertical. The main shaft connecting the surface with Nos. 8 and 10 levels is admirably placed for working any existing ore shoots below No. 10 level.

### *Hidden Ore Bodies*

The even distribution of ore-bodies along the shear zones at Tullah suggests a possible repetitive pattern extending from the Murchison Mine northerly to the New North Mt Farrell Mine. Further, an apparent progressive depth of ore body burial can be postulated from south to north, from root systems in the south to buried ore bodies in the north. This suggests the possible occurrence of buried deposits northerly of the present mine. Based on the separation of known lodes in the field such an ore body could be expected to occur at approximately the position of the S.P. anomaly at mine grid co-ordinates 3000-4000 feet N, 1400-1500 feet E.

The electromagnetic (Turam) anomaly designated indication "A" (Tate, 1958) is consistent with the normal branching lode pattern observed underground at the New North Mt Farrell Mine and on a large scale at the North Mt Farrell Mine. It is suggested that the main lode continues to the north parallel to indication "A" and that the previously drilled "estimated Farrell lode" is probably a subsidiary branch lode of the normal pattern.

### RECOMMENDATIONS

The Farrell lode has been extensively drilled from the North Mt Farrell Mine south to Duttons Workings (Fig. 9) with little success. The E.Z. Co. have drilled 9 holes near Duttons Workings and four holes at the Murchison Mine while the Farrell Mining Co. have drilled 13 holes between the North Mt Farrell Mine and Duttons Workings. Only six holes have been drilled north of the New North Mt Farrell Mine, none of which has tested Turam indication "A", which may represent the main Farrell lode, at depth. E.Z. Co. drilling to test the detected S.P. anomaly north of the existing mine has been confined to shallow depths.

1. The following diamond drilling programme is recommended in the Tullah field as a basis for any future extended programme:—

- (a) The Bureau of Mineral Resources Turam anomaly, indication "A", be tested by a minimum of two drill holes to a depth of approximately 500 feet down dip. The initial proposed drill hole is shown in Fig. 10.
- (b) The S.P. anomaly indicated at mine grid co-ordinates 3000-4000 feet N, 1400-1500 feet E be tested by two drill holes to a depth of approximately 500 feet vertical. This drilling programme to succeed (a) above.

2. Future consideration should also be given to the following prospective drilling targets:—

- (a) Testing at a depth of approximately 1300-1500 feet (vertical) for any downward extension of the southern ore body in the North Farrell Mine.
- (b) Testing for a possible confluence of the North Mt Farrell and New North Mt Farrell ore bodies at depth as suggested by plunge data of the two ore bodies.

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