E.L. 17/73

REPORT ON THE GEOLOGY, MINERALISATION AND EXPLORATION POTENTIAL OF THE BEACONSFIELD LICENCE AREA

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E.L. 17/73

BEACONSFIELD

REPORT ON THE GEOLOGY, MINERALIZATION AND EXPLORATION POTENTIAL OF THE LICENCE AREA

T.E. BATES

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FIGURE
Map showing Geology, E.L. 17/73, Beaconsfield.

VOLUME 2 = APPX 1 = Tasmania Gold Mine Dewatering Beaconsfield, Tasmania. Geophysical programme results.

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GEOLOGY

As a result of mapping of EL 17/73 few significant changes were recorded in the stratigraphy of the area. However some new opinions on the structure are presented.

Stratigraphy

The following new units were recorded when mapping the Beaconsfield area.

(i) A small dike or sill of fine grained dark green felty textured basic igneous rock containing some small ragged brown phenocrysts has been recorded near Eaglehawk Gully to the south of the licence. The rock is probably of basaltic composition. The age of the intrusion is unknown but it is most likely closely related to either the Jurassic dolerites or Tertiary basalts.

(ii) In the north western part of the licence a moderately well indurated relatively coarse conglomerate was recorded underlying semi-consolidated Tertiary quartz gravels. The fresh rock is rarely seen. Where visible it is a pale greenish grey colour, and contains from 40% to 75% clasts. Clasts range in size from 1.0 to 30 cm in diameter and are mostly sub-rounded to well rounded. Approximately 60% to 70% of clasts comprise a medium grained greenish grey well foliated to phyllitic quartz sericite sandstone. Approximately 20% - 30% of clasts are vein quartz. Remaining clasts are variable and include quartzite and some sub angular fragments of red and black cherty argillite. Some weathered exposures of the conglomerate include poorly exposed sandstone, and sticky white clays which are apparently derived from siltstone lenses.

The age of this unit is uncertain. It is older than all Tertiary beds in the area with the possible exception of the Deep Lead beds. The degree of induration shown in fresh outcrops indicate it could be considerably older than Tertiary, and perhaps as old as Lower Permian.

In addition to the new units described above some comments concerning other units mapped in the area by previous workers are in order.

In spite of a fairly thorough search of the area where the swampy lakes occur at the south end of the licence no significant limestone outcrops could be located. These lakes are reputed to be flooded limestone quarries, but their size makes this unlikely. It is assumed that the area was originally one of swamps and sink holes with small limestone outcrops which were quarried. This view is supported to some extent by Robertson, (1887).

Beds of supposed Cambrian age west of Cabbage Tree Hill consisting mostly of yellowish weathering phyllites and phyllitic sandstone are remarkably similar to rock exposed east of Cabbage Tree Hill near the crushing plant of Woodfield and French, and on the main road to Launceston. These eastern beds pass north into less weathered bluish to greenish grey slates and phyllites with minor sandstone that are similar to some of the Transition Beds seen in the drill core from drill holes B4 and A6. North of these eastern phyllities and slates old workers mapped a series of deeply weathered slates and sandstones with minor limestone in Beaconsfield to the east of Weld Street. These rocks are no longer exposed due to the town development. However unless a major fault occurs between the two areas, for which there is no evidence, the two areas are both likely to be part of the same sequence. On the accompanying map all these beds are assumed to be Cambrian.

Structure

The structure of the area is probably considerably more complex than indicated on the map, but due to the poor exposure over much of the area there is little evidence for this structural complexity. Examination of aerial photographs revealed 21 poorly defined lineaments. These possibly represent faults or large joint systems, however in general there is little geological evidence to support these lineaments as being genuine features Some in fact could be the result of extensive human activity in the area.

The area mapped can be divided into four structural units as follows:

i) The North East Area: This extends north east from Beaconsfield, occupying the area between Middle Arm and Beauty Point Road. Coastal outcrops are relatively good and indicate the area is covered with a conformable sequence of Permian sediments that dip north east generally between 10^{o} and 16^{o}. The lowest mapped Permian beds in the area are a dark calcareous mudstone. A mudstone of this nature is a most unusual type of sediment to occur as the lowest member of a transgressive marine sequence and a coarse sandstone or conglomerate would be expected. As no such sandstone or conglomerate has been recorded, a fault striking approximately north west is assumed to have down faulted the Permian to the north east and now forms the south west boundary of the area. Minor patches of thin semi-consolidated quartz gravels of Tertiary age overlie the Permian sediments.

ii) The North West Area: This area is situated north west of Pease Creek and a line joining it to the large dam at the head of Brandy Creek. Near the mouth of Pease Creek a north east striking fault is recorded that has apparently uplifted the Permian beds on the north west side at the coast by approximately 250 metres. This fault is inferred to follow the valley of Pease Creek under alluvial cover. Approximately on this bend some displacement of the contact between the Cabbage Tree Conglomerate and Transition Beds may occur.

Within the area that is north west of the inferred fault, a gently dipping indurated conglomerate outcrops at a number of places and is overlain by semi-consolidated quartz gravels of Tertiary age. Only one dip is recorded in the conglomerate and this indicates a gentle dip to the north west. The age of the conglomerate is unknown, but in view of its induration and its relationship to the inferred fault along Pease Creek it could be of Lower Permian age.

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iii) The Central Belt: This zone coincides with the topographic high of Cabbage Tree Hill and its extension north of Brandy Creek. The zone is bounded on the western side by a well defined fault along the lower western slopes of Cabbage Tree Hill separating the Cabbage Tree Conglomerate from Cambrian phyllites to the east. The eastern boundary is an inferred fault separating the Permian sediments from Cambrian rocks.

The rocks within the zone generally dip north east at 40°- 60° in the case of Ordovician rocks, and more steeply with some folding indicated in the case of Cambrian Rocks. In the Brandy Creek area a small anticline is mapped in the Cabbage Tree Conglomerate.

Within this zone a significant north-north westerly striking fault has been mapped from old mine records and the work of old prospectors on the east side of Cabbage Tree Hill. This fault is the Main Cross Course of the Tasmania Mine. Further to the east a second significant fault is recorded at the eastern limits of the mine workings and in drill holes in the area. This fault was encountered at levels beneath the Deep Lead and seems to coincide with the contact between a dark fine grained limestone to the east and the Transition Beds to the west. Available evidence indicates that the intersection of the fault with the limestone horizon has created a zone of shattering along which a gorge was eroded. This gorge is now filled with alluvium and forms the Deep Lead. The Deep Lead has been traced by a gravity survey, (Howland-Rose 1964), from the southern edge of the mapped area to Brandy Creek. The extension of the Deep Lead north into the north western structural zone may possibly be defined by the weak photo lineaments 19 and 20.

The attitude of the fault that controls the position of the Deep Lead is of considerable importance to any proposal to develop the Tasmania Mine below 15 level. If the fault dips more steeply than the enclosing strata it will eventually cut the reef at depth and displace it.

In addition to the faults discussed, one other small fault with a similar trend has been recorded on M.L.5M/76. This fault has sub horizontal slickensides on the fault plane which may possibly indicate that all the north west and north north west striking faults have undergone some transcurrent movement. Several photo lineaments have a similar trend, and one of these, No.1, appears to control the emplacement of a basalt dyke.

A number of weak lineaments observed on the aerial photographs cut across the central zone. In general these strike between 025° and 050° and some are approximately parallel to the trend of the Tasmania Reef (045° - 050°). One of these lineaments, (11), could represent the extension of the Tasmania Reef across the fault controlling the Deep Lead. None of these lineaments can be related to any obvious displacement of the rocks in the area. However, on the north side of the lineament passing through the Brandy Creek area (15), the Cabbage Tree Conglomerate is folded into a small anticline, perhaps as the result of movement on this lineament.

Two other lineaments striking 085^{o} (12,13), cross Cabbage Tree Hill and the projection of these to the west coincides with a probable *south side west displacement of the major fault* between the Cabbage Tree Conglomerate and Cambrian beds.

iv) South West Area: The area is poorly exposed and consists of a basement of steeply dipping Cambrian phyllites in which some folding is indicated. Semi-consolidated quartz gravels of Tertiary age overlie much of the area. Two north east striking photo lineaments cut the area near Cabbage Tree Ridge. One of these passes right across the ridge but no displacement of beds is observed. In the far west one north west striking photo lineament (9) occurs.

Structural Control and Paragenesis of Mineralization in the Tasmania Reef.

At Beaconsfield known significant economic gold deposits are restricted to one vein, the Tasmania Reef, although numerous other small gold bearing veins of different orientation have been located.

The Tasmania Reef is well defined striking between 045^{o} and 050^{o} and dipping between 50^{o} and 60^{o} to the south east. Within the reef significant economic mineralization is restricted to the zone where the reef cuts the Transition Beds, a sequence of quartzite, quartz carbonate sandstone and some shale and grit.

Solomon (1969) indicates that the Tasmania Reef occupies a tensional fissure developed between two transcurrent faults or shears, and suggests that if this is so other fissures probably developed en echelon between the faults, and hence may host reefs similar to the Tasmania. Solomon's idea is sound and is supported to some extent by the nature of the reefs in the Moonlight cum Wonder and Brandy Creek workings. Reefs in these areas are generally thin, lensoidal and discontinuous, and represent the weak development of mineralization in tight fissures parallel to the main faults Recent mapping has located a west dipping, north north west striking fault exposed in a pit on ML 5M/76. This fault has sub-horizontal slickensides on its surface indicating that at least some transcurrent movement has taken place on faults with this strike.

At and near surface, the western end of the Tasmania Reef is cut by faults (ie the Main Cross Course), and the eastern end is obscured by the Deep Lead. Below No. 5 level, (715') the western end of the reef is clearly controlled by the contact between the Transition Beds and the underlying Cabbage Tree Conglomerate which dips about 50^{o} to 55^{o} to the north east. At the eastern end of the reef, control is exerted by the contact between the Transition Beds and an overlying dark limestone. Old mine records and reports indicate that the eastern end of the levels frequently passed into broken ground, pug, and/ or porous limestone before solid limestone was reached. These descriptions together with information from drill holes in this area indicate that this contact is probably faulted and hence control at the eastern end of the reef may not be entirely lithological as has previously been assumed. This situation is only likely to be resolved if and when development of the Tasmania Mine takes place below the 1500 foot level, in which case the nature of this eastern contact will be of considerable significance to future development.

The reef consists of white to bluish vein quartz, brown to cream carbonate and variable amounts of pyrite, arsenopyrite, chalcopyrite, galena, sphalerite and free gold. Petrographic and mineragraphic examination of four core samples was carried out by Lowder (1979). He notes a close relationship between the carbonate and sulphides and his observations together with examination of the core indicate that quartz mineralization predated the introduction of carbonate and sulphides. Deformation of the reef evidently continued throughout the period of deposition since as well as brecciation and recrystallization of the early quartz, carbonate and sulphides are also affected. Lowder considers that the textural relationships indicate early introduction of arsenopyrite closely followed by pyrite, both of which preceded much of the deformation. Later chalcopyrite commonly replaces pyrite along fractures as does galena. Galena also replaces chalcopyrite. The carbonate has been identified as mainly dolomite with minor calcite.

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In summary,it seems that the Tasmania Reef is a normal fissure vein in which mineralization fluids have filled open spaces and replaced wall rock in an open fissure. The early phase of mineralization was quartz rich. Deformation continued and later carbonate/sulphide-rich fluids penetrated fracture zones in the quartz and replaced quartz. There is strong evidence to indicate that the productive zone of the vein occurs in a particular, favourable host rock suite. The physical characteristics of this suite allowed the retention of an open fissure and the geochemical character probably facilitated ore deposition.

The source of the mineralizing fluids remains unknown. Three possible sources are considered.

i) Remobilization of metal ions, sulphur and gangue from country rock during metamorphic processes.

ii) Remobilization of metals and sulphur from pre-existing zones of enriched rock, perhaps syngenetic sulphide bearing horizons in sediments. The remobilization being caused by either metamorphic events, tectonic events, or the effects of igneous activity.

iii) Fluids arising from an unknown igneous source.

Either of the first two alternatives would provide greater scope for additional exploration than the third, as they are likely to affect a far greater area of country. However available evidence indicates that the third alternative is most likely.

The first alternative has been considered. However, because of the low grade of metamorphism displayed by rocks in this area it is not considered as a viable proposition. Pelitic rocks in the area are nowhere of higher rank than phyllites, fossils are found in the Transition Beds, quartzites not completely recrystallized, and calcareous rocks from the older sequences are all referred to as limestones rather than marble. All this suggests that metamorphic processes operating in the area were unlikely to result in the generation of mineralizing fluids.

The second alternative has been considered and examined in more detail. Early in the mapping of the area, common to abundant mineralization was noted in a horizon of fine black quartz conglomerate and grit near the base of the Cabbage Tree Conglomerate. Finely disseminated sulphides varied from sparse to abundant and were closely associated with a common to abundant green mineral thought to be malachite. As considerable gold mining and prospecting had been carried out along this zone, (the Moonlight cum Wonder, Brandy Creek and North Tasmania workings), it was thought that it may also carry some gold, and perhaps represented a low grade syngenetic copper/gold/uranium deposit. It was thought that this horizon may represent the source of sulphur and metals remobilized into the Tasmania Reef, or alternatively could in its own right represent a viable exploration target. Fifteen rock samples (AS1 to AS15) were collected from the zone and assayed for a variety of metals. Of these samples 12 returned gold values below 0.01 ppm, the other three values being 0.01, 0.04 and 0.59 ppm. Au. As the highest copper value obtained was 42 ppm. the green mineral was obviously not malachite. In view of the high chrome results obtained (190 to 10400 ppm) it is most likely the green mineral is a secondary chrome mineral derived from detrital

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chromite in the conglomerate. No significant lead, zinc, silver, uranium or arsenic values were obtained. In view of the disappointing analytical results obtained it is most unlikely that the horizon has contributed to the mineralization in the Tasmania Reef.

The third alternative is now considered most likely to provide the source of the mineralizing fluids. Only basalts and dolerites are known to occur in the immediate vicinity, however granitic rocks are common elsewhere in north eastern Tasmania. If an unexposed igneous body is the source of the mineralizing fluids, exploration potential of the area is likely to be restricted to the general vicinity of the intrusive or to the vicinity of any similar intrusive bodies.

Exploration Potential of the Beaconsfield Area.

The potential for finding further significant gold bearing reefs in the Beaconsfield area appears restricted to the search for fissures with the same trend as the Tasmania Reef. There is ample evidence to show that veins striking in a general north westerly direction do carry gold, but in all cases these veins are small,lensoidal in nature, and discontinuous, rarely containing significant quantities of economic mineralization. In view of these well established facts therecan be no point in examining structures with a north westerly strike.

Numerous cross cuts were constructed from the workings of the Tasmania Mine and other shafts in its vicinity in attempts to find repetitions of the Tasmania Reef. Some veins with similar dip and strike to the Tasmania Mine were located and, according to the opinions expressed in old records, did contain gold values (Cundy and Fawcett, 1914). However due to their small size and/or low grade these veins were not worked. One such vein south of the Tasmania Reef appears to warrant further investigation.

The North Tasmania mine is the only other group of workings in the area in which a reef striking in a north east direction was worked. An old newspaper report provided by Mr. H.G. Bleazard confirms this, but the high gold values reported in the article as being obtained from this reef were obviously not maintained as little subsequent work was carried out.

It is apparent that the only significant hard rock exploration targets in the exploration licence are those areas where there is evidence of cross-cutting structures with a general north easterly strike that may contain reefs. It can be assumed that such structures will only contain productive veins where they cut the Transition Beds, or beds with similar lithology. In view of the assumed origin of the mineralizing fluids as discussed in the previous section it is most likely that those fractures in proximity to the Tasmania Reef are more likely to contain significant mineralization than more distant fractures. Hence at this stage exploration should be confined to the existing Prospecting Licence.

The other significant exploration target in the area is the Deep Lead. Old records indicate that significant alluvial gold was found at various levels in the Deep Lead, in particular Robertson (1887) refers to the Ophir Shaft passing through thick auriferous wash between 100 and 160 feet below surface. Other reports suggest that other auriferous zones that yielded up to several ounces of gold per load were encountered in the lead. There is no record as to the size of the loads referred to, but as these had to be of manageable size rich material is indicated. It can be assumed that in addition to the Tasmania Mine other auriferous reefs in the area shed gold that has found its way into the Deep Lead. Hence the Deep Lead may well contain significant quantities of alluvial gold, particularly downstream from the Tasmania Mine.

Outline of Proposed Exploration Program and Discussion of Targets.

It is recommended that a two part exploration program be undertaken.

a) An examination of possible fractures with a similar trend to the Tasmania Reef as indicated by geological mapping and on aerial photographs.

b) An investigation by diamond drilling for a significant reef reputed to exist to the south of the Tasmania Reef.

Program A

It is proposed to conduct this program by carrying out a program of shallow auger and/or percussion drilling across possible fracture zones in an attempt to obtain for analysis, chip samples at any reefs in these zones. The program will be carried out in two stages. The first stage is essentially an orientation program and a series of holes will be drilled over the western extension of the Tasmania Reef to see if the technique will prove effective. At this stage two other targets will also be tested. The second phase will involve testing remaining targets with a similar trend, and possibly carrying out drilling in zones where vein quartz occurs if any of the samples collected from these areas in a previous survey return significant gold values.

A number of targets have been established for this program. With one exception these are based on the existence of weak photo lineaments of appropriate strike that cut the Transition Beds. From north to south, lineaments with this trend are 2,3,5,6,7,8,11,14,15,17. At this stage lineaments 2 and 3 can be disregarded as they are entirely in ground held by B.H.P., and lineamanets 7,8,11 and 17 can also be disregarded as they do not appear to cut Transition Beds.

This program is likely to be expensive due to various physical conditions existing in and controlling the extent of the exploration zone. These are as follows.

i) The presence of the Deep Lead beds overlying much of the Target Zone, i.e. the Transition Beds. As these beds are up to 400 feet thick, penetration by percussion or auger drilling is not practical.

ii) The narrow western edge of the Target Zone is generally covered by scree derived from Cabbage Tree Hill. In places the scree is quite deep, is often deeply weathered, and contains significant amounts of vein quartz some of which could be gold bearing.

iii) There is evidence for deep weathering in the area and oxidized zones have been noted in drill core at depths below 1000 feet. It is hence likely that significant geochemical values of metals other than gold will be leached from near surface rocks.

iv) The narrow width of veins, (1 to 5 metres) will require close spaced drill holes, probably about 10 metres.

Some geochemical analysis has been carried out on drill core from holes A6, A7, B4, B4B to see if a geochemical halo existed around the Tasmania Reef. In general the wall rock is devoid of metal values. However anomalous gold and to a lesser extent copper, zinc and arsenic was found close to the main reef where the wall rock contained quartz carbonate veining with or without sulphides. At distances greater than 10 metres from the main reef the fine quartz carbonate veins appeared barren. It seems that a narrow halo (up to 10 metres) of weakly mineralized fine quartz carbonate ± sulphide veins may occur on either the foot wall, the hanging wall or both.

v) Quartz fragments picked up in the weathered zone may be surface float. If these carry gold values spurious results could be obtained. It will hence be necessary to make sure the final sample from any hole is obtained from bed rock only.

The first phase of the program will test the technique on the western end of the Tasmania Reef. It will then test lineament 15 in the Brandy Creek area. Finally a line of holes will be drilled to test the area east of the North Tasmania Mine. The reef in this area is reputed to strike north east and in addition the area may be cut by a fault or fracture zone extending down Pease Creek.

The second phase of the program will test lineaments 5,6, and 14, and possibly also lineament 11 (possible extension of Tasmania Reef), and 7,8,9, and 10. In addition areas from which anomalous quartz has been collected will be tested and any additional work required in the Brandy Creek or North Tasmania area will be carried out.

<u>Program B</u>

This program involves some diamond drilling to look for a reef of significant size reputed to occur at deeper levels to the south of the Tasmania Mine.

Hudson (1923) reports that in 1887 a cross-cut was driven south at the 500' level and located a branch lode that yielded 10,000 oz. gold. The cross-cut was supposedly continued for a total distance of about 400 feet where a pyritic lode trending parallel to the main reef and 6 to 8 feet wide was cut. Due to gas emanating from it this lode was sealed up and not worked. Assays from this reef are reported by Hudson to have been between 10 and 15 dwt/ton.

Hudson further reports the intersection of a similar reef in the Bonanza Mine at a depth of about 1000 feet and assaying 11 dwts Au per ton. It is reported that the Bonanza company did not develop this reef as it occurred in a corner of their property and was only in their property over a very limited area. Various plans and sections held in the office of government geologist J.A. Noldart have pencilled notes on them indicating the presence of this reef in the Bonanza Shaft at a depth of 1056' and assaying 14 dwt Au/ton.

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It is considered likely that these two reefs are the same.

In 1969 the Tasmania Mines Department drilled hole B5 to a depth of 663 feet at an inclination of -75° towards Harts Shaft in an attempt to intersect this reef. The reef was not intersected, but between 373 and 440 feet no core could be recovered due to bad ground and no assaying was done of this section of the hole.

It seems most likely that the two reefs reported by Hudson are in fact the same reef. As there is no record of similar reefs being intersected by either Harts or Grubb shaft it is probable that the reef does not persist to the surface. It would hence seem logical to try to intersect this reef close to its position in the Bonanza Shaft and then follow it from there.

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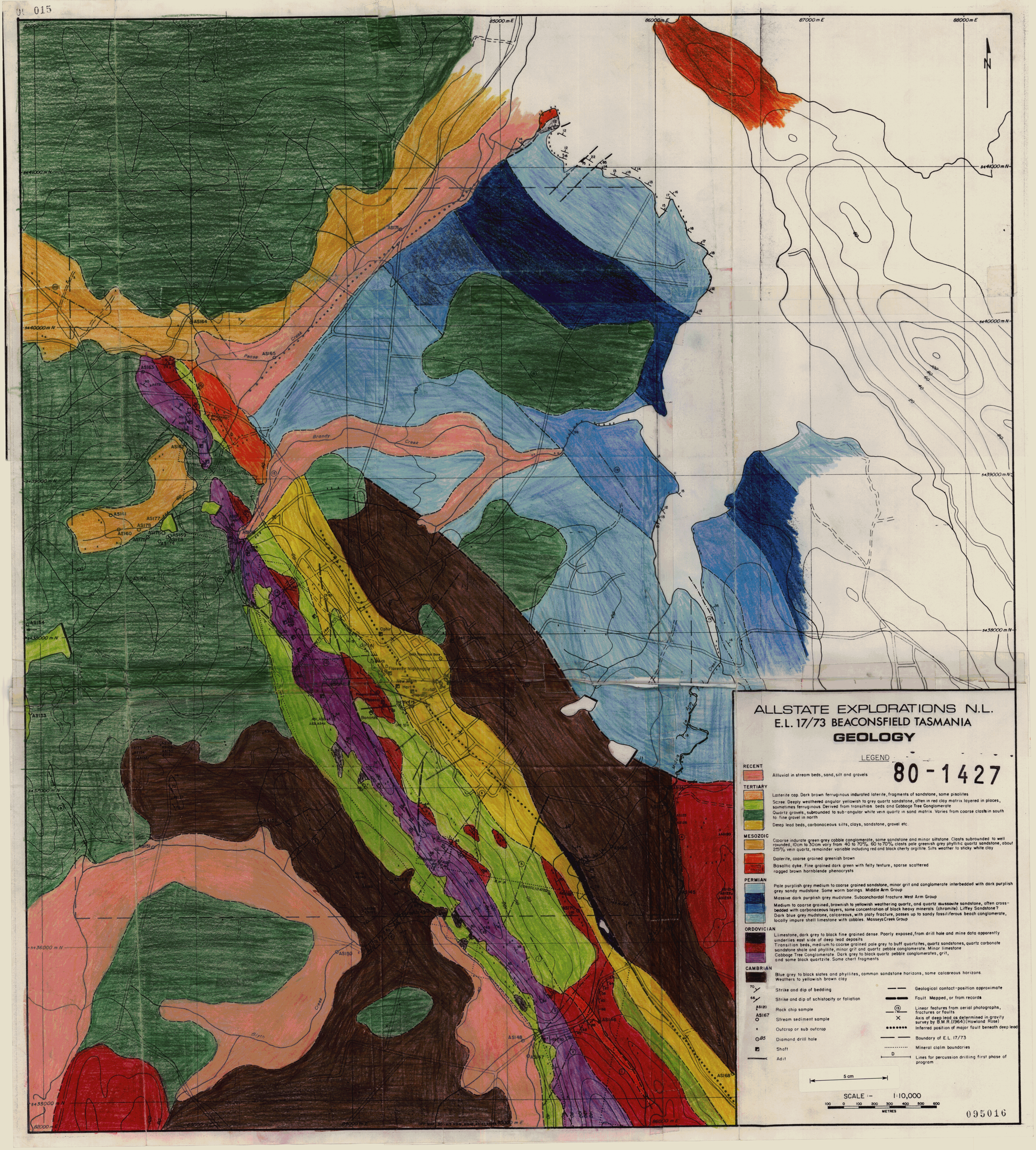

ALLSTATE EXPLORATIONS N.L.
E.L. 17/73 BEACONSFIELD TASMANIA
GEOLOGY
LEGEND
80-1427
RECENT
Alluvial in stream beds, sand, silt and gravels
TERTIARY
Laterite cap. Dark brown ferruginous indurated laterite, fragments of sandstone, some pisolites
Scree. Deeply weathered angular yellowish to grey quartz sandstone, often in red clay matrix layered in places, sometimes ferruginous. Derived from transition beds and Cabbage Tree Conglomerate
Quartz gravels, subrounded to sub-angular white vein quartz in sand matrix. Varies from coarse clasts in south to fine gravel in north
Deep lead beds, carbonaceous silts, clays, sandstone, gravel etc.
MESOZOIC
Coarse indurate green grey cobble conglomerate, some sandstone and minor siltstone. Clasts subrounded to well rounded, 10cm to 30cm vary from 40 to 70%. 60 to 70% clasts pale greenish grey phyllitic quartz sandstone, about 25% vein quartz, remainder variable including red and black cherty orgillite. Silts weather to sticky white clay
Dolerite, coarse grained greenish brown
Basaltic dyke. Fine grained dark green with felty texture, sparse scattered ragged brown hornblende phenocrysts
PERMIAN
Pale purplish grey medium to coarse grained sandstone, minor grit and conglomerate interbedded with dark purplish grey sandy mudstone. Some worm borings. Middle Arm Group
Massive dark purplish grey mudstone. Subconchordal fracture. West Arm Group
Medium to coarse grained, brownish to yellowish weathering quartz, and quartz muscovite sandstone, often cross-bedded with carbonaceous layers, some concentration of black heavy minerals (chromite). Liffey Sandstone?
Dark blue grey mudstone, calcareous, with platy fracture, passes up to sandy fossiliferous beach conglomerate, locally impure shell limestone with cobbles. Masseys Creek Group
ORDOVICIAN
Limestone, dark grey to black fine grained dense. Poorly exposed, from drill hole and mine data apparently underlies east side of deep lead deposits
Transition beds, medium to coarse grained pale grey to buff quartzites, quartz sandstones, quartz carbonate sandstone shale and phyllite, minor grit and quartz pebble conglomerate. Minor limestone
Cabbage Tree Conglomerate. Dark grey to black quartz pebble conglomerates, grit, and some black quartzite. Some chert fragments
CAMBRIAN
Blue grey to black slates and phyllites, common sandstone horizons, some calcareous horizons. Weathers to yellowish brown clay
Strike and dip of bedding
Strike and dip of schistocity or foliation
Rock chip sample
Stream sediment sample
Outcrop or sub outcrop
Diamond drill hole
Shaft
Adit
Geological contact-position approximate
Fault. Mapped, or from records
Linear features from aerial photographs, fractures or faults
Axis of deep lead as determined in gravity survey by B.M.R.(1964)(Howland Rose)
Inferred position of major fault beneath deep lead
Boundary of E.L. 17/73
Mineral claim boundaries
Lines for percussion drilling first phase of program
5 cm
SCALE :- 1:10,000
METRES
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AMAX MINERALS EXPLORATION (AUSTRALIA) INC.

80-1427 V2

TASMANIA GOLD MINE DEWATERING

BEACONSFIELD, TASMANIA

GEOPHYSICAL PROGRAMME RESULTS

Australian Groundwater Consultants Pty Ltd

Janaury 1980
Job No. 572/1 A

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018 1. INTRODUCTION

Amax Minerals Exploration (Aust) Inc. is the operator in a joint venture agreement between Amax and Allstate Exploration N.L. to reopen the Tasmania Gold Mine at Beaconsfield and explore for deeper ore reserves from within the existing workings. This operation will require the workings to be dewatered.

Allstate commissioned a hydrogeological appraisal of the problems related to reopening the mine by Australian Groundwater Consultants Pty Ltd (AGC). In their report, the consultants identified the problem of subsidence possibly in or close to the town area as a possible consequence of rapid dewatering and recommended a programme of geophysical studies to both assess the extent and areas which could be affected by this problem and also to locate sites where drilling of dewatering wells might be advisable in order to mitigate the problem.

The geophysical survey was carried out in the Beaconsfield area from 3rd-18th December, 1979 by the staff of AGC and the traverses completed are shown on Locality Plan, Figure 1. —not available

The specific aim of the programme was to map the extent and depth of the alluvial deep lead through the town, and to identify the nature of the bedrock which underlies it particularly with reference to identifying cavernous limestones which are believed to represent the catalyst for subsidence.

2. GEOPHYSICAL METHODS

The relatively steep dipping nature of the bedrock and the deep narrow profile of the "deep lead" was such that the aims of the programme seemed likely to be difficult to achieve. These problems were further compounded by the town itself which both restricted access and which limited the use of some techniques.

The techniques considered likely to yield results were seismic refraction and electrical resistivity.

Seismic refraction surveys measure the sound carrying properties of rocks and subsurface sediments. Using a theoretical layered model for the earth, various rock categories can be identified and their distributions calculated along traverses and by correlation from traverse to traverse. Given a basic knowledge of the geology derived from drill holes and old mining records, seismic results can be interpreted in terms of rock types and characteristics.

Electrical resistivity surveys consist of injecting commutated Direct Current into the ground via steel electrodes with the electrical potentials set up by the current being measured at other electrodes. The potential measuring electrodes are non-polarizing Cu/$CuSO_4$ porous pots. The measured value of apparent resistivity can be related to the electrical properties of the rocks and the distribution of electrodes. By varying the electrode configuration, different values of apparent resistivity may be measured at varying depths and then interpreted by using type curves from the field plots. These are called Vertical Electrical Soundings (VES).

Three electrode configurations were used in the survey :-

(a) Schlumberger Gradient Array Traversing
(b) Dipole-Dipole Traversing
(c) Schlumberger Vertical Electrical Sounding (VES)

Since it seemed likely that the use of seismic refraction surveys in the town might be limited by danger to people, property and services, the programme sought to develop a correlation between seismic refraction surveys and electrical resistivity surveys in open country south of the town.

The uncertainties involved in geophysical techniques due to the theoretical model considerations are significant. The uncertainty in depth estimate from seismic data is about ±10%. From VES data, the uncertainty is ±20 to 30% for depth estimates.

3. PROGRAMME LOGISTICS

The area of the survey included parts of the town of Beaconsfield, requiring selection of the survey lines to cause minimum disruption to the local populace. Co-operation from the police was obtained and special precautions observed included deep drilling of the seismic shot-holes to avoid blow-out, and return of unused explosive to the supplier each day.

Survey lines were pegged oblique to the expected strike, in order to extend the length of the traverse crossing the various bedrock formations along each line. A total of four lines were surveyed. and are shown on Figure 1.

These were -	Line 1	- Seismic refraction	990m
		- Electrical Resistivity	990m
	2	- Seismic Refraction	330m
		- Electrical Resistivity	780m
	3	- Seismic refraction	660m
		- Electrical Resistivity	900m
		- Dipole Dipole	150m
	4	- Seismic Refraction	0m
		- Electrical Resistivity	600m
	TOTAL	- Seismic Refraction	1980m
		- Electrical Resistivity	3420m
TOTAL			5400m

3.1 Seismic Refraction

The seismic refraction survey undertaken used a Nimbus Model ES1210 seismograph. A 330m spread using 12 geophones, each at 30m. intervals was used with seven shots per spread.

Shots were fired using Nobel AN60 as the explosive using seismic detonators with shot holes having an average depth of 3m. The shot holes were drilled by H. Stacpoole & Co. from Launceston using a small power auger rig.

Seismic data reduction and analysis used the Reciprocal method via programmes run on a T.I. 59 programmable calculator.

3.2 Resistivity

The resistivity equipment employed used a Haber 450V and 600V portable transmitter and Comark Millivoltmeters as the receiver, which is capable of reading to .001 μV.

Over three thousand meters of Schlumberger electrode configuration traversing was carried out using a current electrode spacing of 450m and potential electrode spacing of 15m measured across the centre one third. An overlap between traverses of 15m was used. In addition, three vertical electrical soundings were carried out and 150m of double dipole traversing was undertaken.

The double dipole traversing was undertaken to determine its suitability in this environment compared with Schlumberger traversing.

3.3 Progress of Work

In general, the local townspeople were extremely helpful. The police assisted considerably in clearing areas and in controlling traffic on the West Tamar highway in particular. Progress was however much slower than anticipated.

Two verbal complaints were received by the crew, both associated with "blow-out" shot holes on Line 1 to the south of the town area. These were dealt with by :-

- Employing a laborer to backfill the holes after the survey ended
- Deep drilling of shothole in Dally's paddock where hay making was in progress, in order to minimize ground disturbance

On completion of the programme the crew believed that the town people and land holders no longer had any real cause for complaint.

4. PROGRAMME RESULTS AND INTERPRETATION

The results of the seismic refraction and electrical resistivity surveys are shown on Figures 2 and 3 and are related to the mapped and interpretated geology on Figure 4.

4.1 Deep Lead

The full width of the deep lead is traversed by both seismic refraction and electrical resistivity on traverse 1 and by electrical resistivity only on traverse 4. The eastern margin is delineated on traverse 2 and 3 with marginal depths being shown by VES on traverse 2 and by the seismic refraction on traverse 3.

On traverse 1 the seismic velocity within the deep lead varies from $1500ms^{-1}$ in the centre to $1800ms^{-1}$ at the edges. The same marginal sequence velocity as recorded on line 3. This distribution of velocities is not uncommon in buried valleys in S.E. Australia and represents partial erosion and redeposition of sediments, with the older sediments being more consolidated and frequently partly lateritized compared with the younger alluvium.

The seismic profiles on traverse 1 indicate the deep lead to have a variable bottom profile which is steep to the west and less steep to the east and a maximum depth of about 100-115m. This is confirmed by VES A. The marginal depth on line 3B is only of the order of 65m and this depth is confirmed by VES C on the margin of the lead on traverse 2.

The resistivity results over the deep lead as seen on the traverses show generally uniform apparent resistivities across the lead, but the absolute values tend to be higher to the south and more variable (line 1) than they are to the north through line 2-4 where they range generally between 60 and 110 Ωm.

True resistivities for the alluvial sediments in the deep lead are demonstrated on VES A&C at between 60 and 110 Ωm. This value could only be interpreted as a sequence varying from being predominantly clean sands (VES A at 330m Line 1) to an interbedded sequence of clays and sands (VES C Line 2B) but with all aquifer formations saturated with low salinity waters.

The results are consistent with the general resistivity traversing results which showed higher resistivities to the south.

In every case, the apparent resistivity over the deep lead are uniform and lower than those of the surrounding bedrock, hence clear delineation of the margins of the deep lead are possible using this technique with the delineated edge of the lead being at a depth between 20 and 30m beneath ground level.

4.2 Weathered Bedrock

Outside the deep lead area, a two-layered sequence of weathered bedrock (seismic velocity, 1650-3000m) over bedrock(3300-7500m/sec) is often seen. On line 1 the 2400ms^{-1} layer is consistent and indicates fairly strong rock. The 1650ms^{-1} layer seen on lines 2 and 3 probably represents claystones and would be of low strength.

This weathered bedrock layer is clearly distinguished from the marginal alluvium by having substantially higher apparent resistivities. Its relationship to the bedrock sequence known to exist in the area is not understood.

4.3 Bedrock

The Cabbage Tree Conglomerate/Transition Bed sequence is lithologically well known in the area as is the presence of the limestones to the east. Structure within the bedrock and its control on the bedrock type distributions is poorly known due to its being masked by the deep lead. Some drill hole data is available as are some sections derived from mapping in the original mine workings, these do not however extend far enough to permit detailed plotting of the bedrock type or a distribution of the limestones in particular which would explain the subsidences which occurred during the operating life of the mine.

Cavernous limestones are interpreted to exist in the bedrock sequence traversed by lines 1 and 2. On these lines seismic velocities of 7500ms^{-1} were accompanied by a loss of signal interpreted to result from velocity inversion from caverns. High velocities of 6900 ms^{-1} are seen on traverse line 3, but no loss of signal is found. This velocity group to the east of the deep lead is also interpreted to be limestone but while evidence exist of a faulted margin on both lines 2 and 3, there is no evidence of caverns in either the seismic or resistivity results on line 3.

North of traverse line 2 no evidence of cavernous limestones exists at all near the deep lead. On traverse line 3 however a very low velocity (1200ms^{-1}) "weathered bedrock" unit occurs at a site beneath the old mine dam where subsidence was previously recorded. It is noted from Montgomery's section that remnants of limestone were included caught in fault zones, this zone may be one of these and its northerly extension seems likely to have caused the sharp changes in resistivity recorded near the eastern edge of the lead on traverse line 4. The velocity of this unit is very low, but loss of signal would not be recorded here because it is not overlain by a higher velocity layer.

The general bedrock velocities excluding the sequence interpreted to be limestones fall in the range of 4700-5500m^{-1} and are composite velocities of the layered dipping sequence which tend to show values towards the highest available velocity in the sequence. Individual bed velocities do not appear because of the short length of any particular bed in the sequence traversed.

Anomalous in this bedrock profile is a bedrock velocity group having substantially lower velocity around 3300ms^{-1}. This group occurs directly beneath the deep lead on traverse line 1 and on the margin of the deep lead on traverse line 1 and on the margin of the deep lead on traverse line 3. The density of housing precluded seismic traversing further west on traverse line 2 and for the same reason traverse line 4 has no seismic refraction survey along its length. Significantly this zone of low velocities and the ultra low intermediate velocities (1200ms^{-1}) recorded on traverse 3 take in the old mine dam where subsidence has been recorded in the past. In addition, this zone coincides closely with a thrust fault zone postulated by Noldart.

line 2?

It is concluded from detailed consideration of the geology, hydrology and structure, that the low velocity material (3300ms^{-1} and 1200ms^{-1}) represents the thrust fault zone which is both crushed and possible metamorphosed. The subsidence in the old mine dam and the ultra-low seismic velocities which occur on traverse 3 indicate that at some locations, the thrust fault zones include slivers of limestone which are cavernous when they are adjacent to the deep lead. Elsewhere however, this zone is considered to represent a hydrological barrier.

No relationship is believed to exist between the thrust fault zone and the cavernous limestones to the south. Faults interpreted on traverse 1 and 2 correlate closely with mapped faults in the bedrock as shown on Figure 4 .
It is believed that the main mass of cavernous faults lies to the south of the NNE striking fault shown on Figure 4.

The limestones interpreted to occur at depth on traverse 3 are not thought to be necessarily related to the limestones intersected on the south side of the fault on traverse 1 and 2. They are non-cavernous and it seems probable that the occurrence of limestones in the sequence becomes more frequent up the sequence and certainly the effect of the thrust fault makes the establishment of any stratigraphical relationship on present data quite meaningless.

5. HYDROLOGICAL SIGNIFICANCE OF THE RESULTS

5.1 General

It is apparent that wherever limestones occur adjacent to the deep lead valley they are cavernous, but their distribution on the east side appears to be limited to slivers along the thrust fault and a broad area extending north-east from the limestone pits adjacent to a cross fault.

Limestone which is porous and probably cavernous was intersected in the East Tasmania Bore and in Mines Department holes B4 north of line 3. This may be a source of problem.

Other limestones may occur at depth beneath the deep lead adjacent to the mine workings as were shown by Montgomery on his section (see previous report). No evidence of large extents of limestones adjacent to the deep lead at shallow depths is apparent through the town except as mentioned near hole B4.

It seems probable that the fault shown by Montgomery underlying the lead does exist, but that it is not major in terms of hydrology. The thrust fault zone represented by the low seismic velocity bedrock is interpreted to be the major hydrological barrier to groundwater flows between the bedrock around the old East Tasmania Mine and the Tasmania Mine. The loss of hydraulic conductivity across this zone presumeably results from mylonization and metamorphism of the rock mass in the zone.

The probable lack of hydraulic continuity in the thrust fault zone east of the lead and its relation across the N.E. fault from the limestone, results in the path of hydraulic continuity from the limestone to the bedrock in the Tasmania mine area on line 1 being via the adjacent deep lead sediments.

This route explains the extent of landslips which accompanied the 1906 inflow of the creek to the pit, as is evidenced by contemporary photographs. It also explains why the limestones intersected in the mine workings were not a major source of water and why the main source of water is from the west and from the workings where the less competent sandstone sequence predominates and where strike oriented faults exist.

Additional seismic refraction surveys across the full width of the mine would undoubtedly delineate further faults in bedrock, but such a survey would be severely limited by the housing in the area, and would necessitate deep charge setting and significant drilling costs and might still incur substantial damage claims.

5.2 Specific

The purpose of the survey was to delineate areas of risk with respect to subsidence occurring as dewatering of the bedrock underdrains shallow alluvial zones overlying weak rock, generally cavernous limestone.

It is clear that the major area of concern is parallel to the thrust faulting, particularly as follows :- .

Traverse line	1	500-600m
	2A	150-300m
	3	100-180m
	4	450-550m possible

It should be noted that these chainages are only under the town on lines 2,3 and 4. Another area of concern may be close to hole B4.

6. HYDROLOGICAL TESTING PROGRAMME

As recommended in the report to Allstate and as has been approved by Amax as the joint venture manager, a programme of hydrological evaluation of the deep lead is to be carried out.

The programme consists of drilling one test production well and three observation wells at locations where deep lead dewatering will be critical in order to minimize the risk of subsidence in the town area.

Based on the results obtained in the programme, it is proposed to move to the evaluation programme by drawing up specification to undertake the following programme :-

1. Drill site 1 as a pilot hole to approx. 100m at 135m chainage on traverse line 3B.
2. Sample and geophysically log the well then move to site 2 and drill a second pilot hole to 100m sampling and logging as before. Site 2 will be located at 35m on traverse line 3B.
3. Dependent on the results of the logs, drill one additional observation well 40m NW of Site 2. This hole will be similarly logged and sampled.
4. After drilling and assessment of the well at site 2 is completed, order screens of a size and aperture as is appropriate for completing site 1 and 3 as an observation well, and site 2 as a test production well.
5. Ream all holes as necessary and construct them in the appropriate manner, developing them to a high level of hydraulic efficiency.
6. Run a test pump into the test production well at site 2 after first running a flow meter logging device.
7. Undertake pumping tests with water level and water quality monitoring so as to permit both individual aquifer transmissivity evaluations and assessments of the probable dewatering pumpage which will be necessary to achieve given rates of dewatering in the deep lead adjacent to the critical subsidence areas.

On completion of this project the first deep lead dewatering well will be established along with one water level monitoring well at a critical location, in this case, adjacent to one of the schools.

7. CONCLUSIONS

The electrical resistivity and seismic refraction survey undertaken at Beaconsfield though limited in its coverage by the town itself, has provided data which is interpreted to show that the only areas with a significant risk of subsidence during dewatering occurs adjacent to the eastern margin of the deep lead and largely along a thrust fault, and well south of the town, where limestones exist at shallow depth.

It seems probable that significant danger of subsidence in the town is limited to areas where limestone slivers are included in the thrust fault plane.

No data has emerged from the study which in anyway alters the dewatering rate estimates made in the report to Allstates, but the hydrological controls in the area and their relations to past occurrences are now more clearly understood and hence, the risks involved in rapid dewatering are also better understood.

8. RECOMMENDATIONS

This report represents one report on one facet of an overall study. No recommendations are made, except that the programme proceed in the manner already approved.

Australian Groundwater Consultants
Pty Ltd

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