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EXPLORATION LICENCE 30/87
KING RIVER, N.W. TASMANIA
REPORT FOR THE YEAR ENDED
15TH JANUARY, 1990

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and T. Whiting

December, 1989

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CONTENTS

FIGURES

003 LOCATION 546004

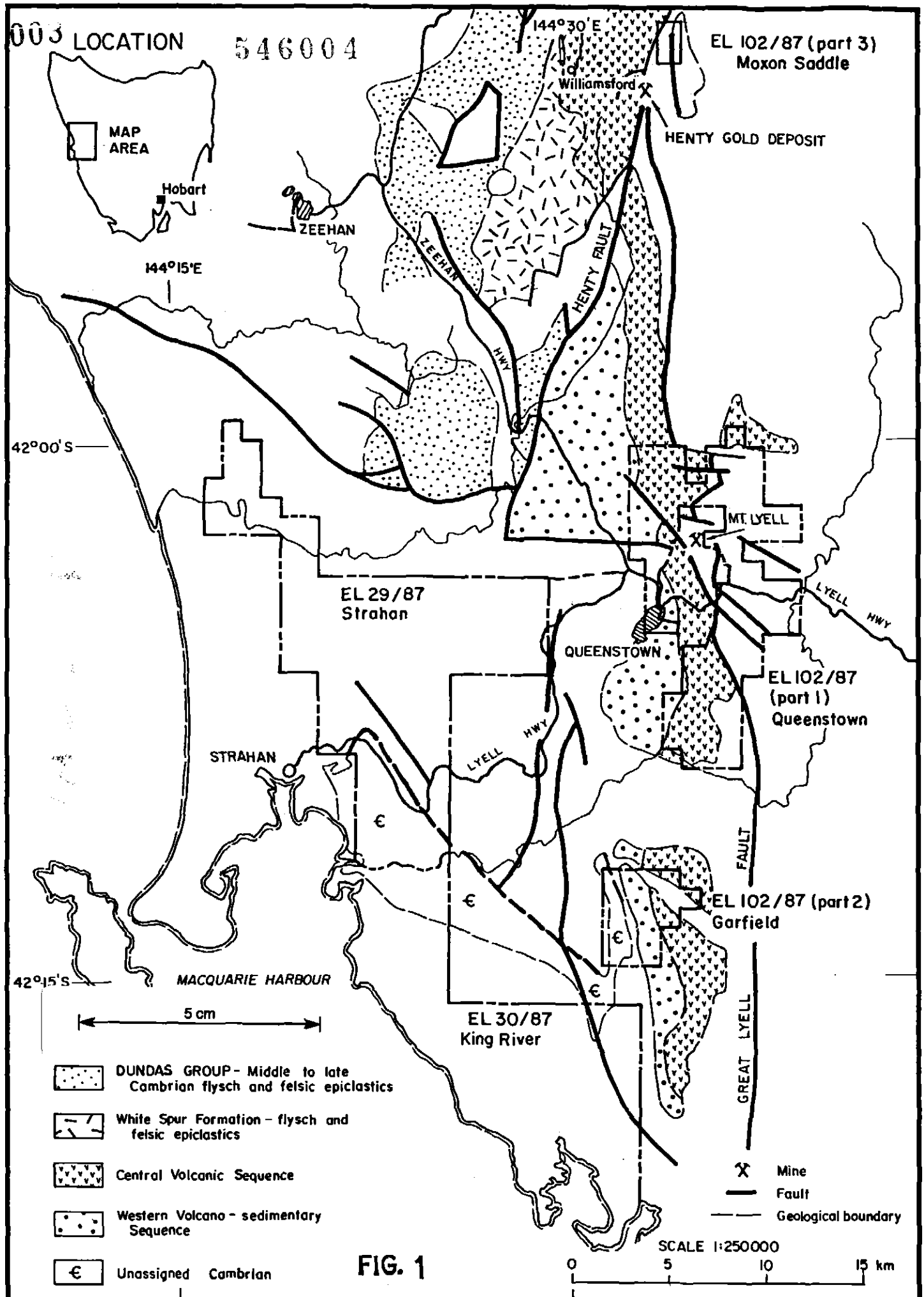

FIG. 1

Centre: Melbourne	THE BROKEN HILL PROPRIETARY CO. LTD.	Project Nº: 857
Date: 20·11·89	QUEENSTOWN REGION, TAS. EXPLORATION TENEMENTS & REGIONAL GEOLOGY	Drawing Nº: A4 3001

1. INTRODUCTION

Exploration Licence 30/87 (Fig. 1) was granted to New Holland Mining NL on 15th January, 1988 and currently comprises 127 km^2, most of which is within the South-West Conservation Area. Approximately half of the licence area has recently been nominated for World Heritage listing. BHP Minerals and New Holland Mining NL completed an option agreement in June 1989 and BHP Minerals has been responsible for exploration in the tenement since June.

Volcanogenic Zn-Pb massive sulphide is the main target type (ideally with grade-tonnage characteristics similar to those of the Hellyer deposit). A secondary target is Irish-type carbonate hosted mineralization in Ordovician Gordon Limestone which outcrops to the south of the area, near Kelly Basin, and which may occur within the southern portion of the licence. Structurally-hosted gold deposits are a tertiary target.

One of the prime considerations in developing exploration strategy is the inaccessiblity of the area, there being no vehicular access into EL30/87. It was originally intended to extend the stream sediment coverage of EL 29/87 ("Strahan") southwards into EL 30/87 in order to complete the first-stage assessment of the Cambrian sequence south of the King River. This would have required the cutting of approximately 12 km of gridlines and walking tracks and several helipads. Mines Department approval for this program had been obtained. Access would have been by helicopter and/or boat necessitating the establishment of a helicopter supported camp (estimated cost for camp and helicopter $25,000).

A change in strategy was occasioned by Geoterrex making available its "Geotem" system in December (for the first time in Australia). Geotem is an airborne TEM/magnetic/radiometric system which claims penetration depths of the order of 400 m. Given the flat topography and resistive nature of the sequence within EL's 29/87 and 30/87 it was decided to

abandon the planned stream sediment survey in favour of complete GEOTEM coverage. Not only would this method provide direct evidence of any relatively shallow conductive sulphide body, but it would also provide detailed aeromagnetic and radiometric coverage, at a cost comparable to, or somewhat less than, the stream sediment survey. A second advantage of this approach is minimisation of environmental impact.

2. SUMMARY OF EXPLORATION ACTIVITY IN YEAR 2

The main focus of this year's activity has been on the execution of a GEOTEM airborne EM survey, over the entire area of exposed Cambrian rocks. Owing to delays in the commissioning of the aircraft, planned for December, it has not been possible to commence the survey prior to the completion of this report. It is hoped that the survey will be carried out in early January.

Existing aeromagnetic data has been re-processed in order to establish the geometries of bodies causing prominent anomalies in EL 30/87 (and EL 29/87) and to establish depth to basement beneath the Tertiary cover in the south of the EL. A previous review of the aeromagnetic and gravity data commissioned by New Holland Mining has been critically assessed. A geological map of the tenement has been compiled, using existing Mines Department mapping, landsat and air photo interpretation and aeromagnetic data.

3. EXPLORATION ACTIVITY, YEAR 2

3.1 Evaluation of Previous Geophysical Data Interpretation

Existing gravity and aeromagnetic data covering EL 30/87 was reviewed by Leaman (1988). The gravity data is from the Mines Department "Tasgrav" and "Mt Read" databases. Data density is variable, with readings every km^2 over much of the Tertiary part of the EL, but very few readings from the area of exposed Cambrian rocks. There are areas as large as 10 km^2 with no readings, with most data collected along the old railway line along the King River. Clearly, the gravity

data would not be capable of reading much detail within the Cambrian. Aeromagnetic data are from Corbett et al. (1982).

In the northern part of the licence the main feature of the gravity field is due to the boundary between Cambrian and Tertiary rocks. Leaman (1988) infers that the margin of the Tertiary rocks south of Gravelly Creek is controlled by a NE-trending structure which "extends along the west face of the West Coast Range to Lynchford and Queenstown". This interpretation is inconsistent with the mapped geology of the region, however, and also with Leaman's (1988) own interpretation of the aeromagnetic data which (he concludes) reflects east-west directed displacement close to the basin margin! A dislocation in the gravity field west of Teepookana was interpreted to be due to a structure or lithology change sub-parallel to "the main Teepookana faulting". This corresponds to a small aeromagnetic anomaly.

In the southern part of the licence, a broad negative gravity feature was interpreted as due to the presence at shallow depths of Precambrian rocks of the Tyennan Block. This interpretation is again at odds with the published geology. Actually outcropping within this gravity low, according to Corbett et al (1988) are Cambrian rocks assigned to "Western Sequence". It seems far more likely that it is the presence of these rocks at shallow depth which gives rise to the anomaly. Leaman (1988) considered that the gravity data also provide evidence for presence of both NE and NW-trending faults, and for some irregularity in the thickness of Tertiary sediment. While a thickness of Tertiary sediment in excess of 600m was recognised, Leaman (1988) did not carry out systematic appraisal of the depth to basement throughout the basin.

The contoured aeromagnetic data yielded little information. Several prominent anomalies are located within the northern section of the licence. These were interpreted as being offset by three major east-west trending features, and were attributed to the presence of mafic rocks recognized at outcrop (Baillie and Corbett, 1985).

Leaman's (1988) overall assessment of the EL was not particularly encouraging. The geophysical data, he concluded, effectively precluded VMS mineralization (the Cambrian sequence correlates with the Crimson Creek or Mainwaring Groups) and granite-related mineralization (there are no granitoids). He suggested that inferred east-west trending offsets of magnetic anomalies could be targetted for further work, presumeably (although not stated) to test for structurally-hosted mineralization.

It is considered that Leaman's (1988) review adds little to our geological understanding of the region, and that the aeromagnetic data in particular has been underutilized. For example it is important to establish areas beneath the Tertiary cover, beneath which potentially prospective Cambrian rock subcrop at shallow depth. The aeromagnetic data of Corbett et al. (1982) was therefore image-processed in order to:-

- extract more detailed geological information than is apparent from contoured plots;
- quantify depth to basement beneath the Tertiary cover;
- provide constraints on the orientation and size of bodies causing the prominent anomalies to the north of the EL;
- offer a comparison with more detailed GEOTEM aeromagnetic coverage is the northern part of the licence area.

3.2 Aeromagnetic Data Interpretation

During 1981 the Tasmanian Mines Department flew an aeromagnetic survey over the West Coast of Tasmania. The specification for this survey were as follows:

Contractor: Geoex
Flight Line Spacing: 500m
FLight Line Orientation: East-West
Terrain Clearance: 135 m
Sample Interval: 40 m

It was felt that the aeromagnetic data could provide information regarding the structural complexity and depth to basement and perhaps ultimately clarify the relationship between the magnetic units south of and within EL 30/87 and the Mt Read Volcanics to the east. In order to achieve these aims it was necessary to reprocess aeromagnetic data so that problems due to the large dynamic range inherent in the entire data set could be overcome. This processing has enabled the enhancement of subtle magnetic features within the NW corner of the EL.

The interpretation of this data set has/will involve the following procedures:

1) Enhancement of the subset using image processing techniques
2) Identification of magnetic units
3) Interpretation of the geological character of the magnetic units
4) A detailed structural analysis
5) Interpretation of depth to basement by modelling of line data.

Images of a subset of this data, taken in the vicinity of EL 30/87, are included as Figs 2 to 4. Superimposed on these images are the boundaries of EL 30/87 and EL 29/87.

At this stage steps 1 and 2 have undergone a first pass interpretation with steps 3 and 4 currently in progress, as evidenced by the summary interpretation presented as an overlay to Figs 2 to 4. This interpretation is expected to be completed early in the new year.

Initial inspection reveals that south west of EL 30/87 highly magnetic NE-trending linear magnetic zones suddenly plunge to great depths immediately south of the licence, before being abruptly truncated within the licence. To the north of this truncation the regional trend becomes NW/SE, with anomalies due to bodies of depths of the order of a kilometre or more intermixed with quite near surface features. To the east of the licence it is apparent that the Mt Read Volcanics are abruptly truncated. Clearly EL 30/87 sits in a very complex structural zone.

3.3 Geotem Survey

The Geotem airborne time domain electromagentic system is a fully digital electromagnetic prospecting system mounted within a fixed wing aircraft. The transmitting coil consists of 3 turns of wire approximately 18 m in diameter which are mounted horizontally around the plane, attached to the wing tips and to brackets at the nose and tail of the plane. A current of approximately 600 amps is transmitted, giving a dipole moment of approximately 4.5×10^5 Am^2. The plane maintains a terrain clearance of approximately 120 m. The receiving coil measures the horizontal component of the magnetic field generated by electromagnetic responses in the ground. The receiving coil is towed in a bird at a terrain clearance of ca. 40 m, trailing the plane by ca. 105 m.

The Geotem system has made two major advances over the previously available INPUT system. The data is now acquired digitally and the user has some choice over the transmitting frequency and the width and positioning of the measured windows.

Digital acquisition allows much better separation of signal and noise, providing better resolution of real conductors. Analogue data were always greatly smoothed in a manner non-specific to the characteristics of the noise which could result in sharp spikes due to atmospheric noise being smoothed to appear as larger wavelength conductors.

The ability of the system to operate at two different frequencies with user specified windows allows the user to tailor the system to the particular geological environment. The system can operate at 125 Hz or 75 Hz. The higher frequency is most applicable in resistive terrains. At this frequency greater power is transmitted, and the data is stacked more frequently, providing a better signal to noise ratio. At this frequency the system measures out to approximately 3 ms which should be more than sufficient to detect strong conductors, whilst allowing better definition of the early time responses of poorer conductors. In conductive terrains the capacity of the 75 Hz frequency to allow measurements out to approximately 5.5 ms becomes very important. At earlier times the conductive overburden response would dominate any response from a bed rock conductor.

It is planned to fly a 125 Hz Geotem survey over the Cambrian sequence within EL 29/87 and EL 30/87 early in the new year. The boundary of the survey is illustrated in Fig. 5. The decision to base our exploration effort around this technique was made for the following reasons.

1) The electromagnetic technique is a direct base metal ore-body detection technique. The airborne electromagnetic method has been shows to be effective in detecting conductors at depths greater than 400 m. Importantly, the airborne method overcomes the coupling problems inherent in large ground fixed loop surveys.

2) In addition to gathering electromagnetic data the system can simultaneously acquire aeromagnetic and radiometric data. These two data sets, in conjunction with the electromagnetic dataset, will greatly enhance our understanding of the geology in a complex region with very limited outcrop.

Unfortunately the system is only available in a fixed wing aircraft which makes the Geotem technique inapplicable to large regions of Tasmania. However the region the proposed survey will cover is generally a very flat plateau, deeply incised in part by creeks and rivers. A study of the expected variations in effective penetration due to topographic variations was conducted using the known climbing and descending characteristics of the aircraft. The results of this study are presented in Fig. 5. It is clear that we expect very effective penetration over more than 75% of the licence. Hence Geotem appears very well suited to this particular exploration program.

3.4 Geological Overview

The geology of the licence area is shown on Figure 6, compiled from Tasmanian Mines Department mapping (summarised in Baillie and Corbett, 1985), airphoto interpretation, landsat imagery and re-processed aeromagnetic data (Section 3.2). The most significant additions are a structure parallel to, but west of the main Teepookana fault, defined by discontinuous airphoto lineaments and an aeromagnetic lineament, and a major WNW-ESE trending aeromagnetic lineament south of the King River. The latter corresponds to a mapped displacement at 37000mE, 532475mN.

Three Cambrian units are present, although contact relations are poorly exposed and thus overall stratigraphic relations are ambiguous, particularly in view of evidence of overturned bedding in Devonian rocks, north-cast of the Teepookana Fault. Outcropping to the west are basalts and andesites of the Pine Cove Creek Volcanics (informal name) which also has a restricted outcrop north of the King River. Several hundred metres of this unit is exposed up Gravelly Creek,

where a strong foliation is apparent. The unit apparently varies from andesite to basaltic composition, although both rocks are characterised by a feldspar, pyroxene and (devitrified) glass assemblage. Secondary phases include chlorite, sparry calcite, prehnite and pumpellyite.

It is important to establish the stratigraphic affinity of these rocks. Aeromagnetic data suggests that they can be traced south of MacQuarie Harbour, into the Noddy Creek Volcanics (of White, 1975). Geochemical evidence (Crawford, 1987) suggests that rocks of the Noddy Creek are very similar to intrusives into the Central Volcanic Complex south of Queenstown near Mt Owen. It is tentatively concluded that:

1) Rocks of the Pine Cove Creek Volcanics are lateral equivalents of the Noddy Creek Volcanics;
2) They are therefore post Central Volcanic Complex in age and possible equivalents of the Dundas Group.

The exploration significance of this is that the mafic rocks could be of similar age (and genesis) to the Que-Hellyer sequence further north.

4. RESULTS AND CONCLUSIONS

Combined geological and geophysical assessment of EL 30/87 suggest that the Pine Cove Creek Volcanics are possible time-equivalents of the Que-Hellyer and Noddy Creek Volcanics and thus post-date the Central Volcanic Complex. Several additional structures have been delineated within the licence area. The major magnetic anomaly at the mouth of the King River is likely to be a ca. 1 km deep and of little economic significance.

A significant structural zone has been located close to 370000E 5320000N, in which a major NW-SE trending magnetic lineament abruptly truncates magnetic mafic volcanics. This is perhaps somewhat analogous to the Mt Lyell geometry.

An assessment of the prospectivity of the licence awaits completion of the proposed GEOTEM survey and evaluation of the depth of the Tertiary basin. If, however, the GEOTEM survey reveals any significant conductors worthy of follow-up a program will be carried out which involves:

- cutting of grids over the conductors at 200 m line spacing
- TEM (Sirotem) ground checking of airborne anomalies
- Rock-chip sampling and geological mapping. Rock chips will be analysed for base metals, As, Ba, Au and Ag and where appropriate major elements and rare earths
- petrography of rock chip samples.

Should this program outline a drill target, this will be drill-tested prior to the end of 1990. Depending on the location of the target, the rig will either be brought in by barge (e.g. from Strahan) or helicoptered in from Zeehan. Any drillholes will be logged using a TEM system and also by gamma-ray. An expenditure of the order of $150,000 is anticipated.

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8745

362000E
64000E
66000E
68000E
370000E
72000E
36000N
34000N
32000N
30000N
28000N
26000N
24000N
5322000N
STRAHAN
LYELL HWY
KING RIVER
EL 29/87
EL 30/87
MACQUARIE HARBOUR

EXPECTED GROUND PENETRATION

- Good depth penetration
- Moderate depth penetration
- Fair depth penetration
- Poor depth penetration

546016

89-3064

Scale 1:25000

0 500 1000 1500 2000 2500 metres

5 cm

BHP-Utah Minerals International
Asia Pacific Division - Exploration Department

EL 29/87, STRAHAN & EL 30/87, KING R, TAS
PROPOSED GEOTEM SURVEY
EXPECTED GROUND PENETRATION VARIATION DUE TO TOPOGRAPHIC RELIEF

Prepared: T. Whiting	Date: ~~July 89~~ Dec. 89	Centre: Melbourne
Drawn: M. Rosker	Project No.: B48/B49	Fig 5
Checked:	Drawing No.: AI-2384	

8746

362000E 64000E 66000E 68000E 370000E 72000E

36000N 34000N 32000N 31000N 30000N 29000N 28000N 26000N 24000N 5322000N

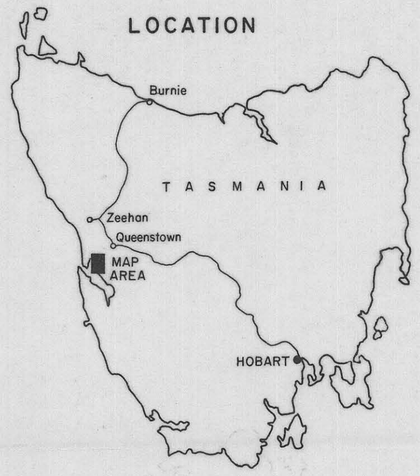
STRAHAN MACQUARIE HARBOUR

LYELL HIGHWAY TEEPOOKANA FAULT BLACKWOOD CK BEEHIVE CK KING RIVER GRAVELLY CK

EL 29/87 EL 30/87

Db Df Sa Og Ss Qa Ts P €sv €ss €pc

LOCATION



LEGEND

POST-CARBONIFEROUS COVER
- QUATERNARY — Qa — *Alluvium and dune sands*
- TERTIARY — Ts — *Mainly non-marine sandstones*
- PERMIAN — P — *Glacial sediments*

DEVONIAN
- Db — *Interbedded sandstone and mudstone ('Bell Shale')*
- Df — *Fine sandstone ('Florence Quartzite')*

SILURIAN — Sa — *Mudstone, minor sandstone*

ORDOVICIAN — Og — *Gordon Limestone*

CAMIRIAN
- €ss — *Turbidite sandstone and siltstone*
- €sv — *Possible volcaniclastic debris flow deposits (65%) and laminated siltstone with micaceous sandst. (35%)*
- €pc — *Pine Cove Creek Volcanics Cleaved basalts and pyroxene andesites. Rare siltstone*

Lithological boundary

Fault, mapped and inferred from aerial photographs and landsat imagery.

Airphoto/Landsat lineament (no evidence of displacement)

Aeromagnetic lineament

Major anticlinal/synclinal axis

Dip and strike of bedding

Dip and strike of dominant foliation

Exploration grid, pegged every 25 m (200m interval shown)

546017

89-3064

Scale 1:25000

0 500 1000 1500 2000 2500 metres

5 cm

BHP-Utah Minerals International
Asia Pacific Division - Exploration Department

EL 29/87, STRAHAN & EL 30/87, KING R, TAS

GEOLOGY & LOCATION OF EXPLORATION GRID

Prepared: A. Wilde	Date: Dec 89	Centre: Melbourne
Drawn: M. Rosker	Project No.: B48/B49	Fig 6
Checked: A. Wilde	Drawing No.: AI-2346	

5360000N +

+

PRELIMINARY MAGNETIC INTERPRETATION
(work to date of this report)

KEY

magnetic unit

inferred fault

Major fault zone (inferred)

Unconformity, marking increased depth of magnetic unit

5300 000N +

+

50 000E

90 000E

546019

BHP-UTAH MINERALS INTL.
EL 29/87 EL 30/87 TASMANIA

TOTAL MAGNETIC INTENSITY
SK55 1:1000000 PROJ=AMG ZONE=55

SN. 1369

5 cm

546019

BHP-UTAH MINERALS INTL.
EL 29/87 EL 30/87 TASMANIA

TOTAL MAGNETIC INTENSITY
SK55 1:1000000 PROJ=AMG ZONE=55

5 cm

SN. 1369

546018
89-3064 8741

5360000N-
5350000N-
5340000N-
5330000N-
5320000N-
5310000N-
5300000N-

500000E
600000E
700000E
800000E

PRELIMINARY MAGNETIC INTERPRETATION
(work to date of this report)

KEY

magnetic unit

inferred fault

Major fault zone (inferred)

Unconformity, marking increased depth of magnetic unit

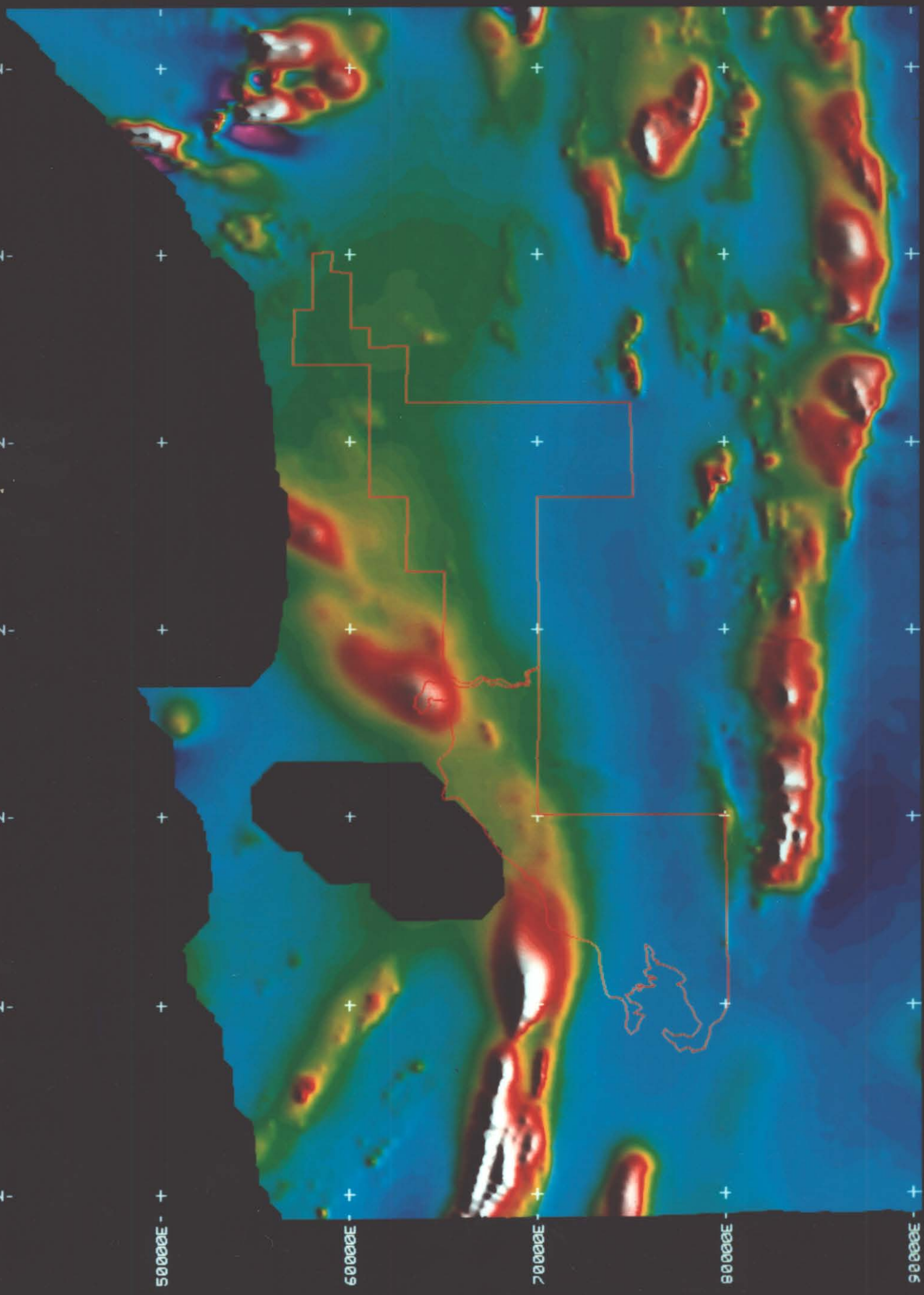
546020

BHP-UTAH MINERALS INTL.
EL 29/87 EL 30/87 TASMANIA

TMI DRAPED OVER HORIZONTAL DERIVATIVE
PLHEQ STRETCH
SK55 1:1000000 PROJ=AMG ZONE=55

SN. 1371

5 cm



546020

BHP-UTAH MINERALS INTL.
EL 29/87 EL 30/87 TASMANIA

TMI DRAPED OVER HORIZONTAL DERIVATIVE
PLHEQ STRETCH
SK55 1:1000000 PROJ=AMG ZONE=55

SN. 1371

5 cm

546018
89-3064 8741

5360000N
5350000N
5340000N
5330000N
5320000N
5310000N
5300000N

500000E
600000E
700000E
800000E
900000E

PRELIMINARY MAGNETIC INTERPRETATION
(work to date of this report)

KEY

magnetic units

inferred fault

Major fault zone (inferred)

Unconformity marking increased depth of magnetic unit

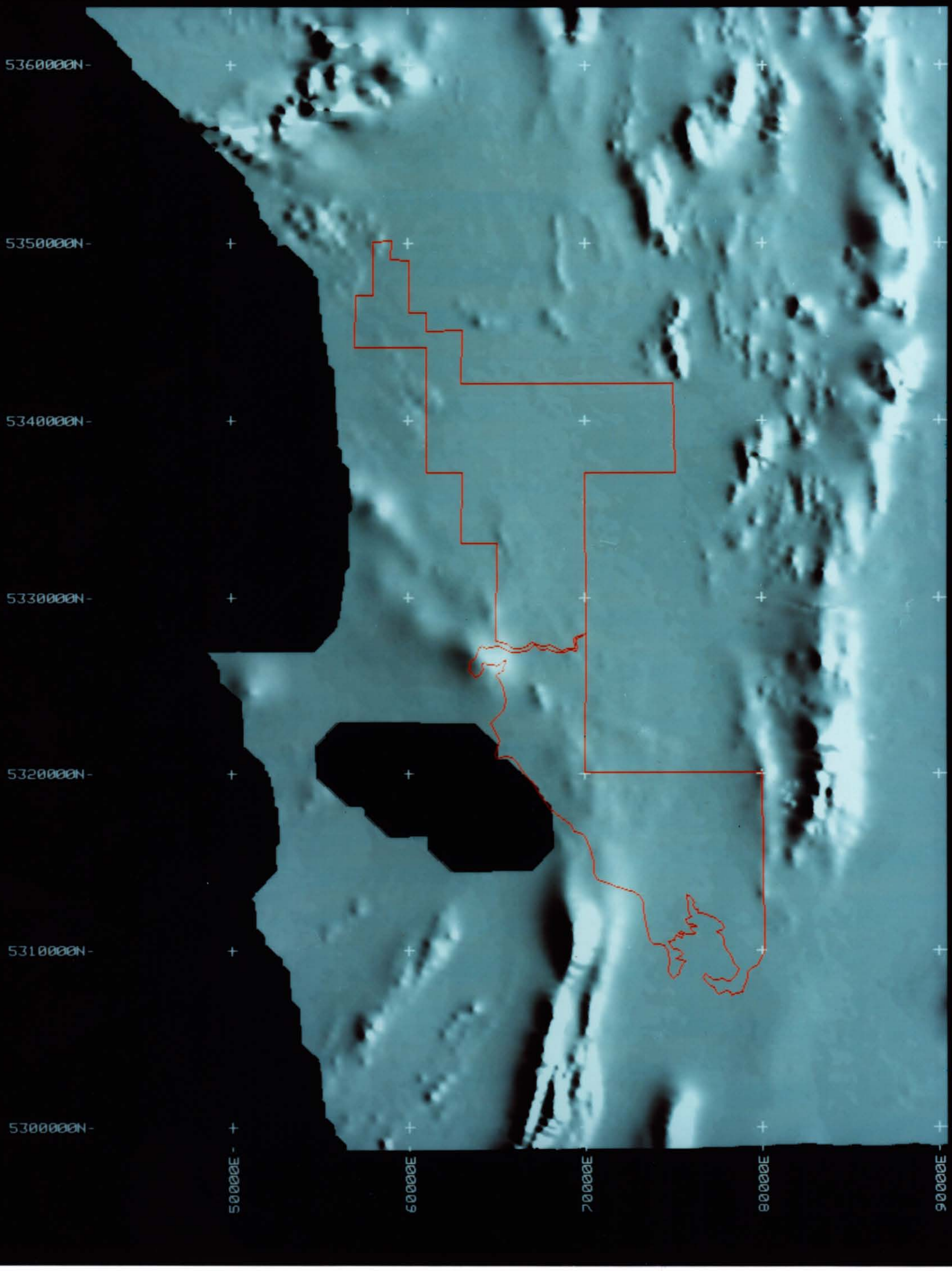
546021

BHP-UTAH MINERALS INTL.
EL 29/87 EL 30/87 TASMANIA

HORIZONTAL DERIVATIVE
PLHEQ STRETCH
SK55 1:1000000 PROJ=AMG ZONE=55

SN. 1370

5 cm



546021.

BHP-UTAH MINERALS INTL.
EL 29/87 EL 30/87 TASMANIA

HORIZONTAL DERIVATIVE
PLHEQ STRETCH
SK55 1:1000000 PROJ=AMG ZONE=55

SN. 1370

5 cm

546018
89-3064 8741

5360000N
5350000N
5340000N
5330000N
5320000N
5310000N
5300000N

50000E
60000E
70000E
80000E
90000E

PRELIMINARY MAGNETIC INTERPRETATION
(work to date of this report)

KEY

magnetic unit

inferred fault

Major fault zone (inferred)

Unconformity, marking increased depth of magnetic unit