Tasmanian exploration — the challenge and the opportunity

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INTRODUCTION

Tasmania is a mineral-rich province with an exciting diversity of geology and an array of mineral commodity types and ore deposit styles. Since the first significant discovery of tin at Mt Bischoff in 1871, twenty major mines have been established, giving rise to the growth of a strong and progressive mining industry over the past 120 years. Of these twenty major discoveries, nineteen were outcropping or subcropping deposits while only one (Hellyer) was a totally blind discovery. The potential for the presence of further blind deposits is considered to be excellent, however the application of best practice research and technology will be necessary for us to discover those hidden ore bodies which are necessary for the development of the mines of the future.

The development of best practice research and technology for the exploration industry involves:

- Highly trained geologists and geophysicists;
- Development and continual upgrading of the geological, geochemical and geophysical databases for the state;
- International standard research on the geological factors that control ore deposit location, and the criteria used to locate buried deposits;
- Cutting edge technology on the use of geochemical and geophysical techniques — both surface and down-hole;
- Application of computer technology to interpret large and complex data sets; especially Geographical Information Systems;
- Application of the best available drilling technology.

Tasmania is very well placed to achieve these best practice ideals, and because of the small area involved we have the capacity to focus this effort to gain the maximum result — major new ore discoveries. Currently we have a strong and active Department of Mines, a highly regarded National Key Centre at the University of Tasmania (CODES), and a technologically advanced (but small) exploration industry. Now is the time to build on our strategic advantages, and focus our attention to achieving excellence in mineral exploration — in terms of both practice and results.

THE EXCELLENT POTENTIAL FOR HIGH GRADE VHMS DEPOSITS

The grade advantage of Tasmanian deposits

In terms of tonnage and grade, the Tasmanian base metal massive sulphide deposits stand out as the best of their type in Australia, and rank amongst the best in the world (Large, 1992). A comparison of the average grade of Australian volcanic-hosted massive sulphides (VHMS) related to other lead-zinc types (Sedex and MVT) clearly indicates that their mean grade of 17.3% Pb + Zn is considerably better than Sedex (11.2% Pb + Zn) and MVT (8% Pb + Zn) mean grades (fig. 1). The comparison is even more favourable when the Tasmanian polymetallic deposits are shown to have an average grade of 21.1% Pb + Zn. In addition, the Tasmanian deposits are also significantly enriched in gold and silver, and form a pronounced high grade group when compared to all other Australian VHMS deposits (fig. 2).

Clusters of Deposits

World wide, massive sulphide deposits typically occur in clusters within a submarine volcanic belt. In the Mt Read Volcanics there are at least six clusters as listed below (passing north to south along the belt, fig. 3).

(1) Hellyer, Que River, Mt Charter

(2) Chester, Pinnacles, Browns Tunnel

(3) Rosebery, Koonya, Hercules, South Hercules

(4) Red Hills, Henty, CODES clasts

(5) Mt Lyell cluster — 11 separate deposits

(6) Wart Hill, Voyager 24

The clusters vary from two to seven kilometres in diameter and deposits may occur at one or a number of stratigraphic levels within each cluster. Only three of the six known clusters contain economic deposits, and each of these three clusters contains one large deposit and a number of smaller deposits. Based on the fact that each cluster represents a major submarine hydrothermal system, it is reasonable to conclude that excellent potential exists for the discovery of at least three further major deposits and a number of smaller deposits relating to the clusters. Based on the presence of a regular spacing to the clusters (e.g. Solomon, 1976), it is possible that a number of unidentified clusters occur elsewhere along the Mt Read Arc (e.g. Jukes–Darwin area, D'Aguilar Range, Cethana, Beulah).

Deep Exploration Potential for VHMS

The majority of exploration and discovery in the Mt Read Volcanics has occurred in the upper 300 metres. In the less well explored areas, such as Elliott Bay, D'Aguilar Range, and the far northern part of the belt, potential still remains for near surface (0–300 m) discoveries. In the central part of the belt (Hellyer to Mt Lyell) the next phase of exploration must target the deeper volcanic stratigraphy (300–1000 m) where excellent potential exists for new deposits. However, this phase of deep exploration will need to be guided by a better

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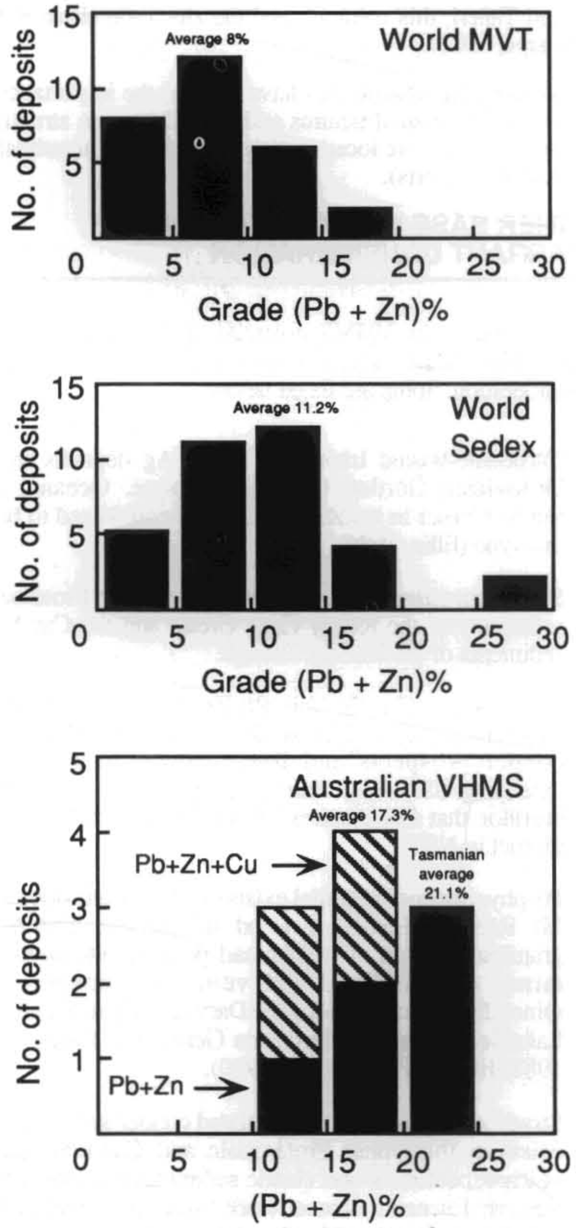

Figure 1

Comparison of grade histograms for Australian Pb-Zn VHMS deposits and world-wide MVT and Sedex deposits (data for MVT and Sedex deposits from Sangster, 1990). Note the high average grade of 21.1% for Tasmanian VHMS deposits.

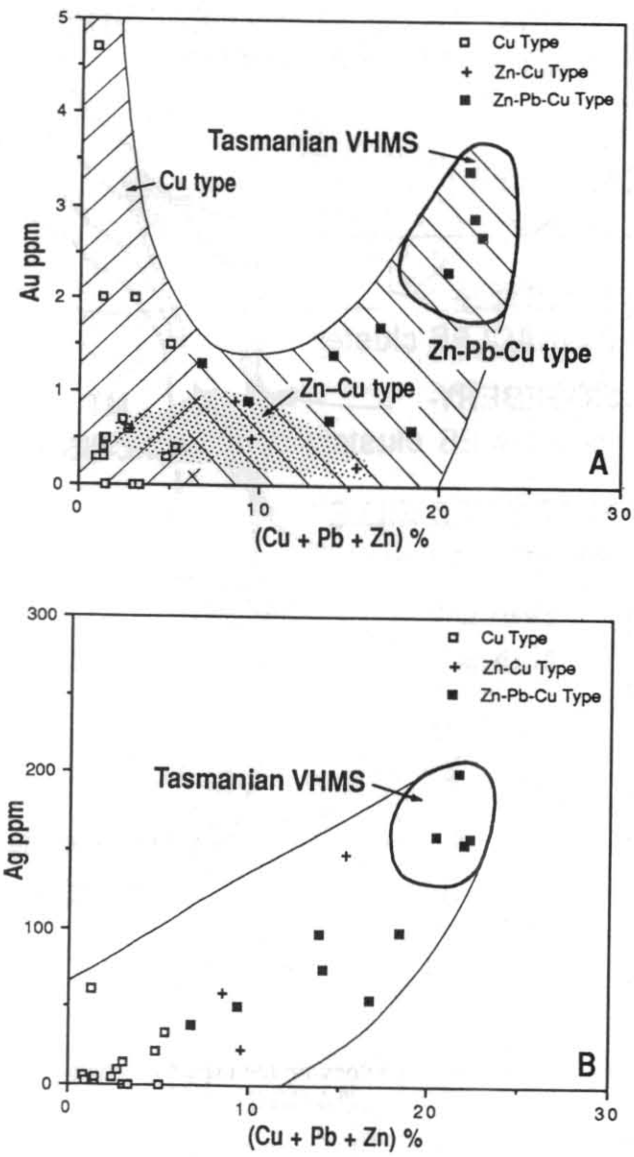

Figure 2

Variation in silver and gold with base metal (Cu+Pb+Zn) for Australian massive sulphide deposits. The Tasmanian polymetallic deposits are shown to have the best grade characteristics (modified from Large, 1992).

understanding of volcanic facies relationships, alteration geochemistry and down-hole geophysics. The integration of research with exploration, combining the experience and intellect of University, Department of Mines and company geoscientists will enhance the chances of discovery in this important phase.

Significance of recent research on exploration for VHMS

Research over the last five years into the volcanic rocks and deposits in western Tasmania has had a significant impact on the approach to mineral exploration. Much of this work has been published in a recent special issue of *Economic Geology* on Australian VHMS Deposits and their Volcanic Environment. Some of the important aspects of this and other research on the Tasmanian deposits are listed below.

- Completion of the Department of Mines mapping at 1:25 000 scale (Corbett, 1992) has revealed new stratigraphic relationships in the MRV.
- New theories have been developed on volcanic facies associations and correlations that relate to mineralisation (McPhie and Allen, 1992).
- Geochemical data on the volcanic rocks has enabled detailed grouping and correlations of different magma associations (Crawford *et al.*, 1992).
- A range of styles of VHMS mineralisation have been defined, which present different targets for exploration (e.g. Large, 1992; McGoldrick and Large, 1992, Khin Zaw and Large, 1992).
- Mineral zonation and alteration features of the Hellyer deposit have been detailed, which enables refinement of

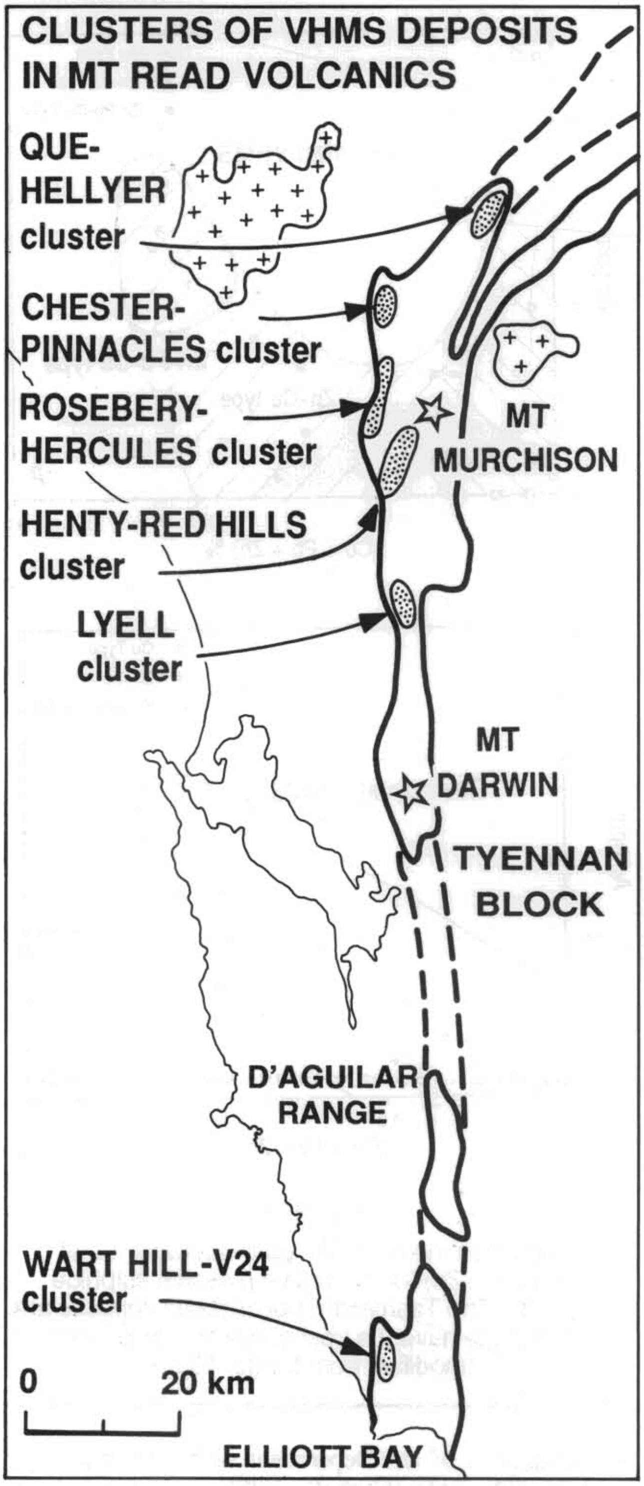

Figure 3

Known clusters of massive sulphide deposits in the Mount Read Volcanics.

exploration models (e.g. McArthur and Dronseika, 1990; Gemmell and Large, 1992).

- The relationship of gold and silver to base metals in VHMS deposits has been documented and related to deposit formation and zone refining (e.g. Huston *et al.*, 1992; Large *et al.*, 1989*b*).
- Geochemical and isotopic techniques have been applied to develop target selection criteria; e.g. Pb isotopes (Gulson *et al.*, 1987), oxygen and sulphur isotopes (Green and Taheri, this volume), and the zinc ratio (Huston and Large, 1987).
- Recent structural studies have defined the importance of early Cambrian structures and later Devonian structures in controlling ore location (Berry and Keele, unpublished AMIRA reports).

OTHER BASE METAL STYLES WHICH WARRANT CONSIDERATION

In addition to the VHMS potential of Tasmania there are other base metal styles which are worthy of serious consideration. Some are listed below;

- Carbonate-hosted Irish-style Pb-Zn-Ag deposits in the Ordovician Gordon Group Limestone. Oceania and Sunny Corner in the Zeehan area are considered to be of this type (Ellis, 1984).
- Stratiform sediment-hosted Pb-Zn-Ag within Proterozoic sediments of the Rocky Cape Group and the Cambrian sediments of the Dundas Trough.
- Cobar-style Cu-Au and Pb-Zn-Ag in the Norfolk structural corridor of the Rocky Cape Group. A series of copper prospects and linear magnetic anomalies extending SSE from Balfour occur within a structural corridor that has features of similarity with the Cobar district in NSW.
- Porphyry copper potential exists on the eastern side of the Mt Read Volcanics related to the late Cambrian granitoids. Areas of widespread potassic alteration and minor disseminated and vein style copper-gold mineralisation occur along the Darwin Ridge and between Lake Selina and the Murchison Gorge (e.g. Eastoe *et al.* 1987; Hunns, 1987; Doyle, 1990).
- Stratiform copper and shear-related copper-gold potential exists in the Upper Proterozoic and Cambrian mafic volcanic, dolomite and clastic sedimentary sequences of western Tasmania. Recent work (Stolz and Large, 1992) has shown that the rift-related tholeiitic volcanic rocks have anomalously high backgrounds in copper and gold, and therefore provide an excellent source for these metals. The carbonate and clastic sequences overlying these basalts (Smithton basalts, Crimson Creek basalts, Mainwaring Group basalts) hold potential for sediment-hosted stratiform copper deposits.
- Besshi-type copper deposits within the Arthur Mobile Belt associated with the amphibolite-schist sequence of the Bowry Formation (Turner *et al.*, this volume).

WORLD CLASS TIN AND TUNGSTEN DEPOSITS

Tasmania is the major tin-tungsten province of Australia with a range of deposit styles, including greisens, sheeted veins, skarns and massive sulphide stratabound replacements (fig. 4). Both the stratabound replacement tin deposits (e.g. Renison Bell, Mt Bischoff and Cleveland) and the tungsten skarns (King Island) are world class in terms of tonnes and grade. Although the commercial interest in tungsten deposits has declined drastically in the last ten years and the outlook remains bleak, there has been a recent surge in the tin price which indicates the need for a revaluation of the tin potential of the state.

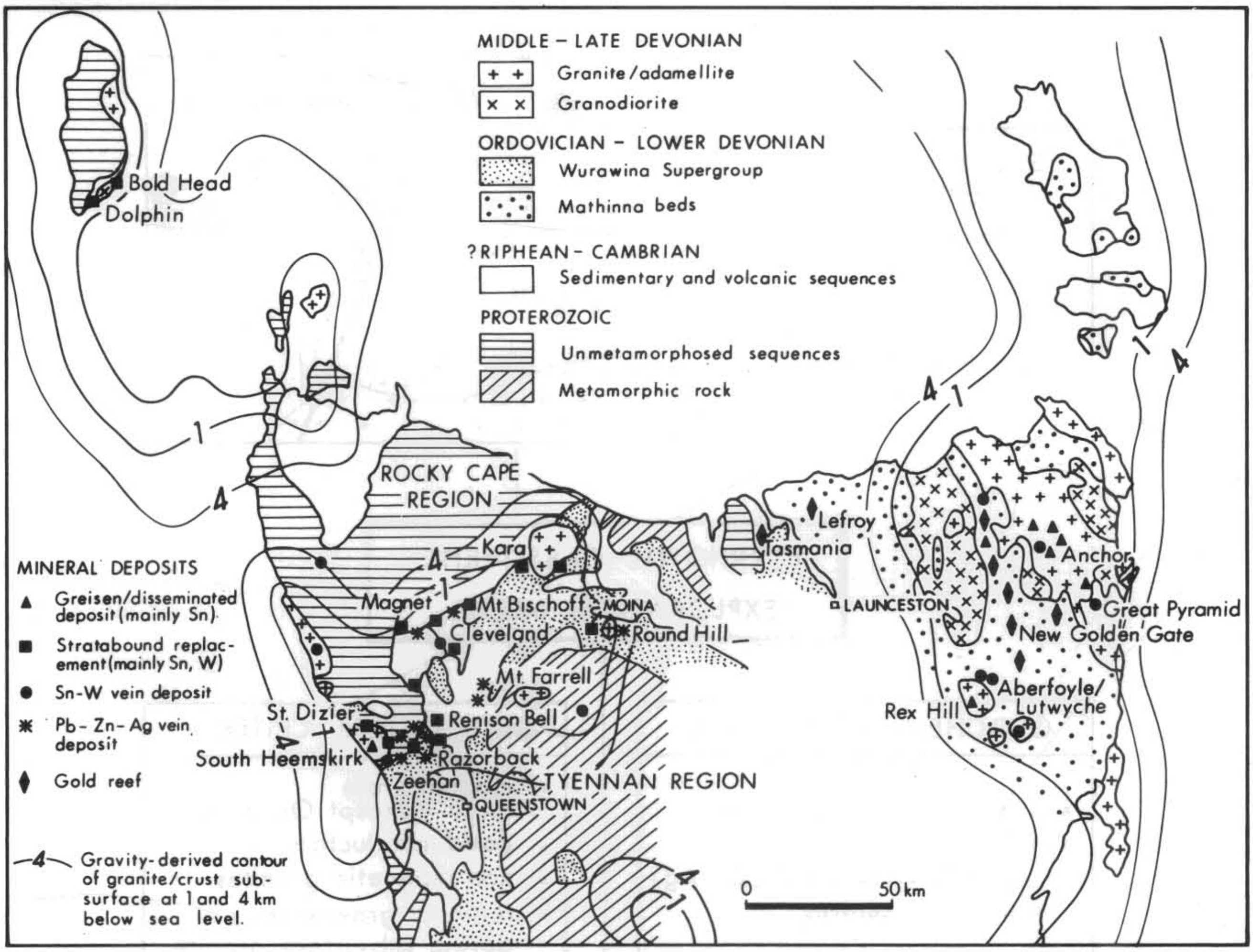

Figure 4

Location of tin, tungsten and related base metal vein deposits in northern Tasmania (from Collins *et al.*, 1989).

Potential for Stratabound Replacement Tin Deposits

Research into the massive pyrrhotite replacement deposits at Mt Bischoff, Cleveland and Renison Bell has shown that the deposits formed by the interaction of Devonian magmatic fluids with certain reactive carbonate horizons within the Dundas Trough sequences (Patterson *et al.*, 1981; Collins *et al.*, 1989; Kitto, this volume). Definition of the subsurface shape of the Devonian granite complex in western Tasmania and its relationship to the distribution of favourable carbonate stratigraphy are therefore key elements in the development of an exploration model (Large *et al.*, 1989*a* and fig. 5). Recent studies by Leaman and Richardson (1989) and Archer (1989) have used the comprehensive gravity database of western Tasmania to interpret the shape of the surface of the Devonian granite complex and relate this to the distribution of known tin deposits.

The incorporation of this gravity data on the granite surface, with structural studies to determine the magmatic fluid plumbing system, and stratigraphic studies to locate favourable host carbonate stratigraphy has recently led to the development of a very powerful exploration focus for this style of mineralisation. Because this data has gradually accumulated over the past decade during a period of little exploration activity for tin (compared with gold and base metals), the potential for new tin discoveries has reached a peak.

The best potential is considered to exist along the northeast-trending gravity low (i.e. subsurface granite ridge) extending from the Heemskirk Granite to Granite Tor. The major deposits at Renison and Queen Hill occur on this structure, along with many minor occurrences (fig. 6). Other target areas include:

- magnetic anomalies to the north of the Heemskirk Granite;
- along the NE-trending structure through Cleveland, Mt Bischoff and Kara;
- in the Dial Range Trough, where granite is interpreted at depth, and minor copper and tin prospects are known.

CONCLUSION

The future of the mining industry in Tasmania depends on the competitiveness of our current mines on the world market, coupled with our ability to discover new mines at the rate of about one every five years (Large, 1987). Given that the mineral potential of the State remains very high, other factors affecting the discovery of new mines are:

- the level of exploration activity by industry;
- the level of research into new exploration models and new exploration techniques;

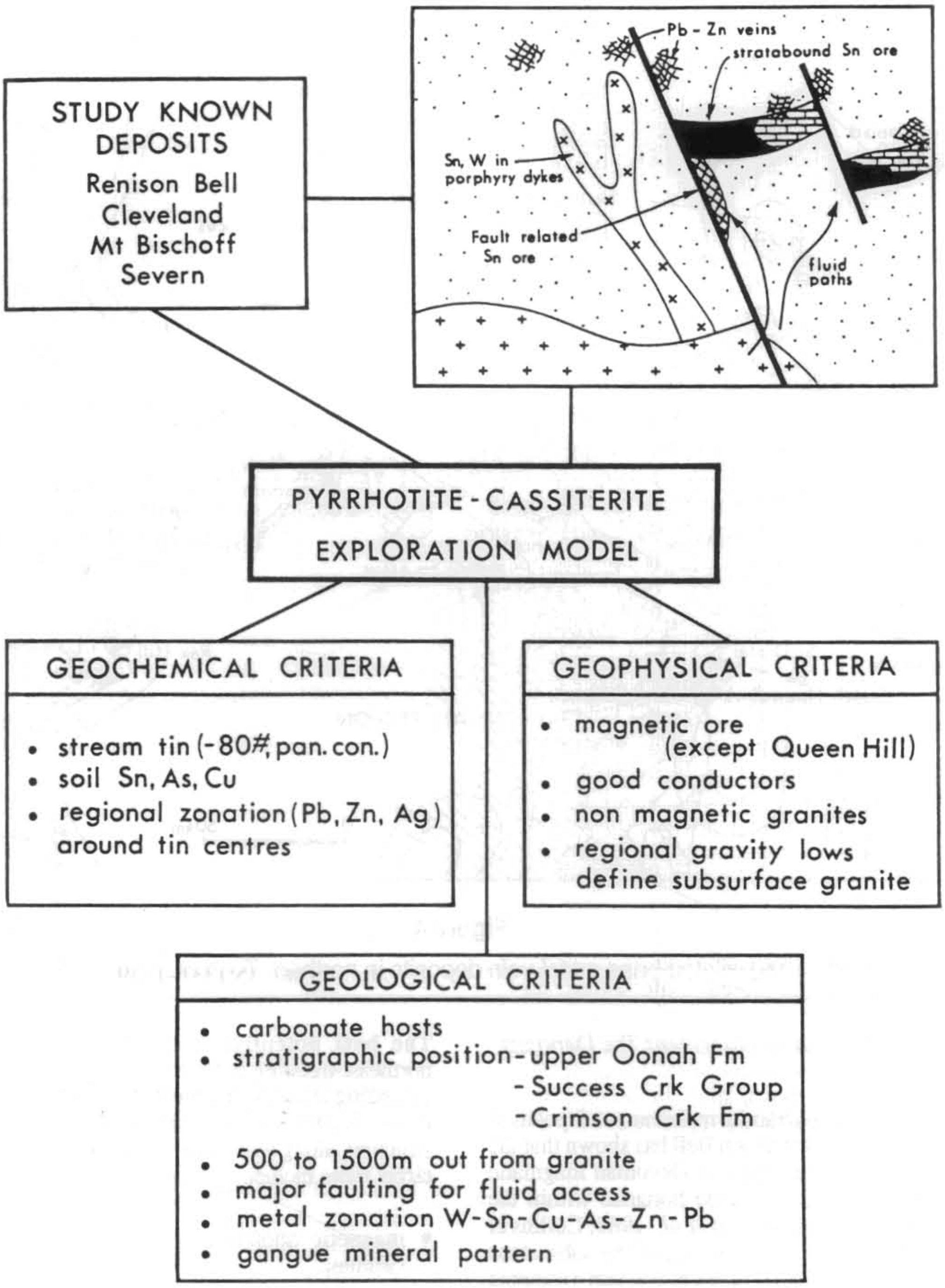

Figure 5

Exploration model for pyrrhotite-cassiterite replacement deposits, western Tasmania (from Large *et al.*, 1989).

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NOTE: Figure 6 (a-c) is located in pocket at the rear of this Bulletin.

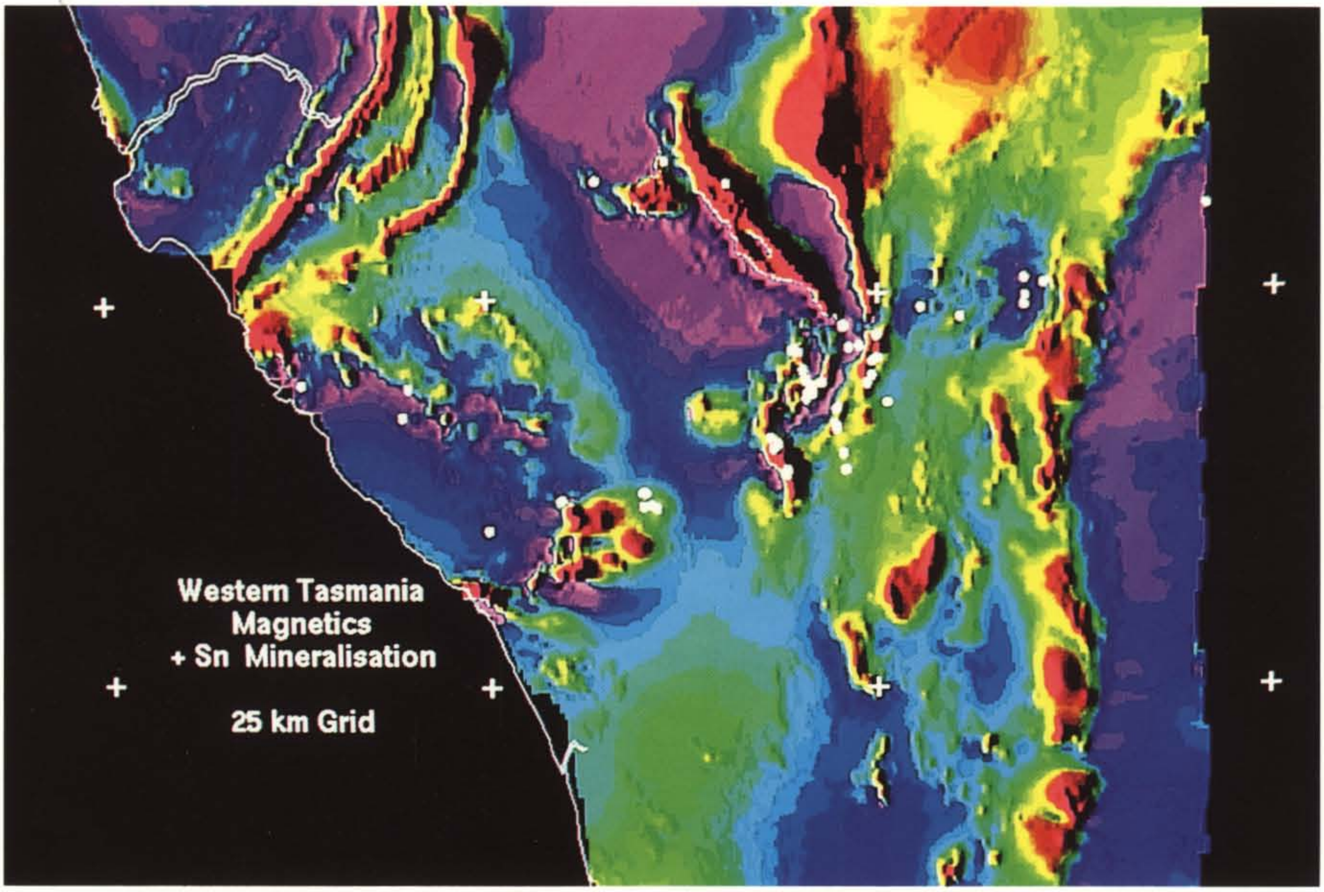

Figure 6*a*.

Western Tasmania — Magnetics and tin mineralisation

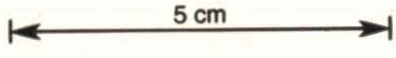

Figure 6.

(R. R. LARGE — *Tasmanian exploration — the challenge and the opportunity*)

A comparison of magnetics, residual gravity, geology and tin deposit locations for central western Tasmania. Note the concentration of tin deposits across the gravity low feature (granite ridge) extending from Heemskirk Granite to Granite Tor. Processed magnetics is from the Department of Mines, 1981 survey. Processed gravity is from the Department of Mines Mt Read database. Tin deposits locations are from MIRLOCH. Refer to Large (this volume) for the discussion of tin potential in western Tasmania, relative to this figure.

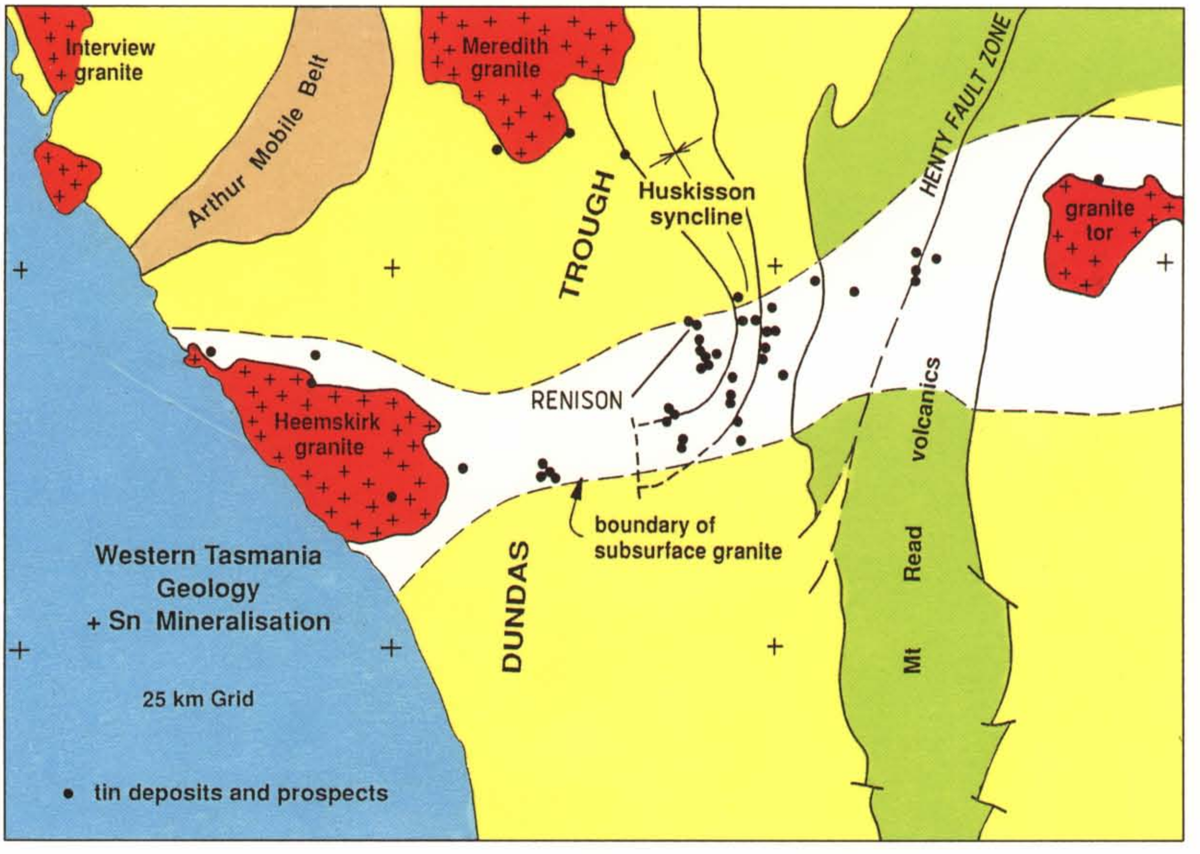

Figure 6*b*.

Western Tasmania — Geology and tin mineralisation

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8/9

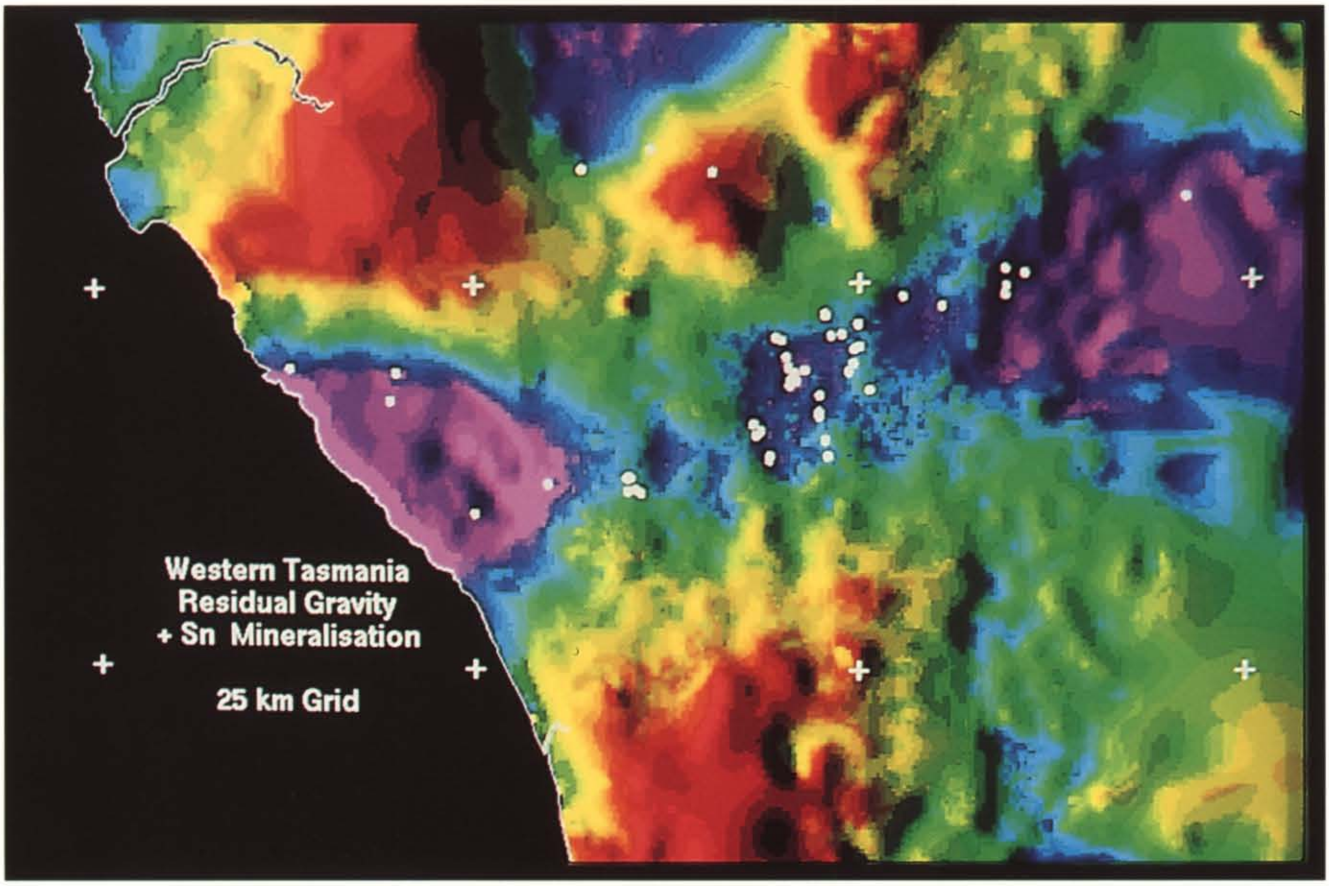

Figure 6*c*.

Western Tasmania — Residual gravuty and tin mineralisation

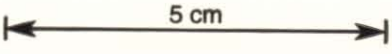

Figure 6.
(R. R. LARGE — *Tasmanian exploration — the challenge and the opportunity*)

 9/9

- the quantity and quality of geological, geochemical and geophysical databases provided by the Government;
- access to land with mineral potential.

The challenge for explorers and Governments is to maintain these factors in a favourable balance which enables us to grasp the opportunity and make new discoveries.

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