


Division of Mines and Mineral Resources — Report 1991/13

A proposal for an ion probe geochronology component in the National Mapping Accord project in Tasmania

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INTRODUCTION

This document is further to a proposal for an ion-probe geochronology project that was put to the Bureau of Mineral Resources last year (Turner, 12.10.1990; Hargreaves, 05.11.1990) and responds to the Bureau's reply (Falvey, 27.12.1990) by limiting the proposed geochronological work to the context of the existing National Mapping Accord project in Tasmania. For details of the existing project see the BMR document entitled *National Mapping Accord: Proposed Mineral Province Projects: Part E. Northern Tasmania*.

The geochronological programme proposed here is essential as background to the seismic profiling, which comprises the existing National Mapping Accord project in Tasmania. It also has a "stand alone" characteristic in that it is capable, in its own right, of generating information critical to a better understanding of mineralised early Palaeozoic and Precambrian rocks. Such a "stand alone" characteristic is desirable should the large amount of funds required for the seismic work not become available.

EXISTING PROJECT

The present Accord project essentially comprises three reflection seismic traverses (fig. 1) to be undertaken in 1993–1996. These traverses include:

- (1) a 350 km traverse near the north coast of Tasmania, to provide information on crustal structures (Arthur Lineament, Dundas/Dial Range Trough, Tamar Fracture System);
- (2) a 90 km-long traverse across central western Tasmania (Mount Read Volcanics, buried granite surfaces, fault channels for ore-bearing solutions, and the Arthur Lineament); and
- (3) a 100 km-long traverse from the Central Plateau to the east coast (coal-bearing Triassic and Permian rocks, the geometry of Jurassic dolerites and the Tamar Fracture System).

The results will be integrated with the known surface geology.

The objective of the project is to develop a better understanding of subsurface features with a view to improving mineral deposit modelling.

RELEVANCE OF PROJECT

The project is consistent with the major objectives of the National Mapping Accord in that it seeks to optimise the environment for mineral exploration and it will assist in addressing environmental and land use problems. Mineral deposit modelling is an integral component in mineral exploration. It is also an integral component in preparing Mineral Resource Potential Assessments of areas proposed for conservation and preservation.

LIMITATIONS

Reflection seismic profiling is a powerful technique for investigating subsurface rock boundaries of usually simple geometry in the vertical plane which includes the seismic line. Its application in the complicated geological terrane of northern and western Tasmania will doubtless provide potentially useful data. However, as the data relate to rock density and elastic moduli their more general geological meaning will be a matter for interpretation. In the proposed project this interpretation will be aided by direct geological input through core drilling to relatively shallow depth (about 1 km) and through the good quality geological maps which are available.

Although the surface geological mapping combined with the core drilling will provide direct geological input, these data are themselves the subject of interpretation. This is particularly so in terms of the stratigraphic relationships of the poorly-fossiliferous Precambrian to Cambrian rock units, and in terms of overall structural relationships in these rocks.

GEOCHRONOLOGY

The aim of the proposed geochronological work is to determine the ages of formation of volcanic and intrusive

rocks in the poorly fossiliferous and structurally complicated Precambrian to Cambrian successions in the vicinity of the seismic lines. It also aims to determine metamorphic ages.

The objective of this work is to improve the interpretation of the seismic data by better establishing stratigraphic relationships such as, for example, those between the various mafic, felsic and intermediate volcanic suites. Seismic interpretation should also be improved through a better understanding of the timing of metamorphism in features such as the Arthur Lineament and Tyennan region, and a better understanding of the relative ages of formation of geological units inside and outside these features. In the case of the Arthur Lineament recent K-Ar data imply a Late Cambrian age of metamorphism rather than the Precambrian age of previous interpretations. The significance of this result is considerable and confirmation is desirable.

EXISTING GEOCHRONOLOGICAL DATA

The existing geochronological data for the poorly fossiliferous Precambrian to Cambrian rocks in Tasmania are inadequate as a basis for correlation.

A large proportion of the available data are from multiply-deformed rocks. These data comprise either determinations of total rock K-Ar in sub-greenschist to greenschist, pelitic material, or mineral and total rock Rb-Sr in greenschist and higher grade rocks. Very varied ages have resulted, few of which are likely to reflect a single event. Ages in very low grade metasedimentary rocks may be influenced by both detrital minerals and new metamorphic minerals, whilst ages in higher grade rocks may be influenced by more than one episode of metamorphism.

A reduction in the variability of geochronological results should be achieved by concentrating on igneous and meta-igneous rocks and by focussing on single mineral rather than total rock determinations.

ION PROBE U-Pb TECHNIQUE

A more precise technique is required to improve on existing data. The ion probe U-Pb method treats single mineral grains and has a resolution of 25 micrometres. Thus, the method will provide results for single homogeneous grains of down to about 25 μm diameter as well as multiple results for zoned grains where the zones are 25 μm , or more, wide.

The main mineral of interest is zircon, and thus rocks of acid to intermediate composition are of particular interest. In basaltic rocks it may be possible to achieve a result from baddeleyite (ZrO_2), which is relatively uncommon and requires samples of some 10 kg weight to derive sufficient concentrate for analysis. Zoned zircons in metamorphic rocks should provide useful results if the outer (metamorphic) zones are sufficiently wide.

ROCKS OF POTENTIAL INTEREST

Precambrian to Cambrian rocks crop out along the North Coast reflection seismic traverse and along the Dundas traverse. The following is a list of rocks from these areas

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which may provide useful geochronological data. It is a fairly complete list and priority targets will be a matter for further discussion. Provisional priority has been assigned to the targets in bold type. An allowance of say, two additional samples should be made, as drilling on the Central Plateau traverse may provide further material from sequences below the Permo-Triassic which is suitable for dating.

A: North Coast Reflection Seismic Traverse

- (1) **Keratophyre in the Middle Arm structural unit — possible early Late Cambrian biostratigraphic control.**
- (2) **Beaconsfield ultramafic complex — in particular leucogabbro, rodingite, albitite.**
- (3) **Forth Metamorphic Complex — amphibolite.**
- (4) **Wilsonia Volcanics and Kerrison Volcanics (both in Cateena Group) — Middle Cambrian biostratigraphic control.**
- (5) **Lobster Creek Volcanics — intermediate to acid.**
- (6) **Motton Spilite.**
- (7) **Burnie Formation — spilite flows.**
- (8) **Burnie Formation — intrusive rocks including Cooee dolerite.**
- (9) **Arthur Metamorphic Complex — amphibolite near Arthur River.**
- (10) **Rocky Cape Group — intrusive rocks.**
- (11) **Smithton terrane — basaltic volcanics.**

B: Dundas Reflection Seismic Traverse

- (1) **Bernafai Volcanics, Tunnelrace Volcanics — metabasalt.**
- (2) **Timbs Group (Arthur Metamorphic Complex) — amphibolite, quartz-feldspar porphyry, felsic schist.**
- (3) **Oonah Formation (in Arthur Metamorphic Complex) — isoclinally folded gabbro at Reece Dam.**
- (4) **Oonah Formation (outside Arthur Metamorphic Complex) — alkali basalt/Montana Melaphyre.**
- (5) **Crimson Creek Formation — basalt.**
- (6) **Luina/Waratah association — basalt and andesite.**
- (7) **Heazlewood and Wilson River ultramafic complexes — tonalite and other intermediate to felsic rocks.**
- (8) **Murchison Granite.**

- (9) **Mt Black Volcanics — part of the Central Volcanics in the Mt Read Volcanics.**
- (10) **South Lake Porphyry — part of the Western Sequence in the Mt Read Volcanics.**
- (11) Que/Hellyer Volcanics — andesite and dacite with biostratigraphic control.
- (12) Southwell Subgroup — felsic lavas with biostratigraphic control.
- (13) Tyennan region — amphibolite at Cradle Mountain.
- (14) **Tyennan region — high grade rocks at Collingwood River/Lyell Highway including eclogite, amphibolite, gneiss, migmatite veinlets.**

Note 1:

To establish a control on the geochronological data it is desirable to carry out determinations on rocks whose biostratigraphic ages are known.

Note 2:

The Mount Read Volcanics form the most important mineralised succession in Tasmania. They are the subject of study by many workers and there is already ion probe geochronological work in progress by the University of Tasmania and the Australian National University. Consultation will ensure that undue repetition is avoided.

Note 3:

Rocks with mafic compositions are of uncertain potential but the importance of mafic volcanic successions in

correlation and tectonics is such that a special effort to achieve a result should be made. Relatively high values of trace zirconium should be a guide as to the potential usefulness of mafic rocks.

The relative ages of the compositionally similar Crimson Creek, Smithton, King Island, etc. basalts is of particular interest, as is the relative age of these 'continental' volcanic rocks to the 'oceanic' volcanic rocks in the Luina-Waratah succession.

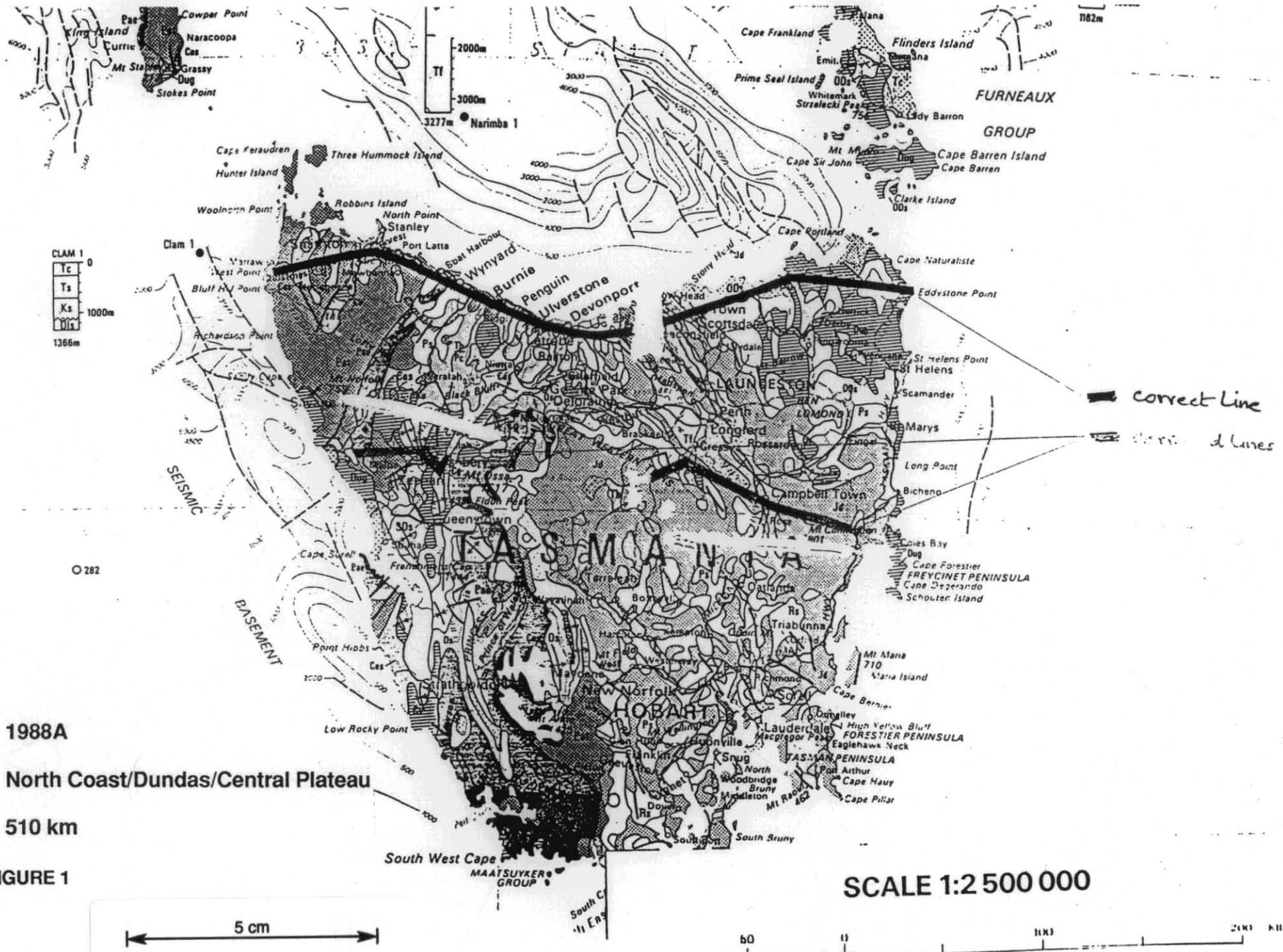
Note 4:

There have been previous geochronological studies of the Precambrian and Cambrian granitoids but no ion probe work. Success has been mixed, with some bodies giving only very approximate ages (e.g. Dove Granite) and other bodies showing evidence of substantial resetting (e.g. Cape Wickham and other western King Island granitoids).

Note 5:

The possibility of obtaining an age of emplacement from the meta-igneous rocks of the Forth and Tyennan regions is well worth pursuing as there are only two existing radiometric determinations (Rb-Sr, Pb-Pb) of premetamorphic events — both from metasedimentary rocks. Confirmation of the existing complicated Rb-Sr results for early metamorphic events by a different technique is also very desirable, although Ar-Ar work which is presently in progress may prove useful in this regard.

[29 July 1991]



1988A
 North Coast/Dundas/Central Plateau
 510 km

FIGURE 1

SCALE 1:2 500 000

5 cm

60 100 200 400

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