# Geology and prospectivity of the Arthur Mobile Belt

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## INTRODUCTION

The Proterozoic rocks of northwest Tasmania are transected by a tectonic feature known as the Arthur Lineament which contains an assemblage of metasedimentary rocks and amphibolite called the Arthur Metamorphic Complex. The Arthur Mobile Belt encompasses the Arthur Lineament and the relatively unmetamorphosed rocks on either side. Rather than being strictly defined, the name of Arthur Mobile Belt is simply a term of convenience.

This paper briefly describes the setting of the Arthur Mobile Belt and outlines the styles of mineralisation which occur in it. More detailed discussion of these matters and a fuller citation of published work are given by Turner (1990). Work in preparation has been drawn on in compiling this paper. The work includes mapping and related studies by Turner, mineral determinations by Bottrill, rock chemistry by Crawford and Ar-Ar geochronology by Villa.

## STRATIGRAPHY AND DEPOSITIONAL SETTING

Successions comprising formations characterised by shallow-water quartz arenite, by siltstone or, subordinately, by dolomite underlie much of the Tyennan region (fig. 1), the Jubilee region and the region west of the Arthur Lineament which includes the Rocky Cape Group. These similar successions are the basement rocks in their respective regions and are probably of broadly similar age, perhaps in the vicinity of the c.1100 Ma depositional/provenance age determined for metapelite in the Tyennan region (Råheim and Compston, 1977).

Extending eastwards from inside the Arthur Lineament (fig. 1–3) is a sandy turbidite facies which includes the Burnie Formation and the correlated Oonah Formation, also the Badger Head Group. An approximate depositional age of c.725 Ma for the turbidite facies is provided by dolerite which was intruded whilst the sediments were still wet (Crook, 1979).

Successions of siliceous clastics, dolomite then basaltic volcanics at Smithton, Corinna and middle Pieman River (fig. 2–3) are thought to belong to the same tectonic episode (fig. 4) as the sandy turbidite facies. Shallow-water clastics resting on basement at Smithton appear to be equivalent to proximal turbidite fan deposits resting on basement at Corinna which, in turn, are regarded as lithological correlates of the sandy turbidite facies east of the Arthur Lineament where the basement is not exposed. This apparent transition from Smithton eastwards is interpreted as a passage from shelf to continental margin or basinal conditions (see also Gee, 1967). Subsequent structural disruption of the original transition has been considerable, particularly along zones such as the Arthur Lineament.

The basal beds at Smithton and Corinna pass conformably upwards into shallow-water dolomite, whilst at middle Pieman River (Brown, 1989) there are shallow-water clastics and stromatolitic dolomite in the succession overlying the sandy turbidite facies. In the latter locality the stratigraphic relationships are obscured by variations in the character of both early Palaeozoic and Devonian deformation and by the presence of disrupted, predominantly mudstone intervals which may represent large, low-angle faults (Findlay and Brown, 1992) and possibly, early decollement structures. The palinspastic reconstruction in Figure 4 assumes the presence of the latter and thus, that the shallow-water units at middle Pieman River are olistoliths. Alternatively, they may mark the emergence of the area occupied by the turbidite fan.

Basaltic volcanics with associated volcaniclastics and other, fine grained, sedimentary rocks occur above the dolomitic rocks in all three areas. The major, trace and REE chemistry of these basalts and of amphibolites in the Arthur Metamorphic Complex leave little doubt that they are rift tholeiites belonging to a period of stretching and rifting of the NW Tasmanian crust. Dolerite dykes which intrude the basement display, at least in part, similar chemistry to the tholeiites and are apparently a feature of the same extensional episode. Two dykes have been dated at about 600 Ma (Adams *et al.*, 1985). Thus, the Late Proterozoic shelf and margin phase in NW Tasmania appears to have had a duration of some 125 my from c.725 Ma to c.600 Ma.

## METAMORPHISM AND DEFORMATION

High pressure, prograde metamorphic assemblages are locally preserved in the Arthur Lineament and in the higher grade parts of the Tyennan region. In the Arthur Lineament glaucophane/crossite in blueschist facies metabasite has compositional parameters that are consistent with crystallisation at about 700 MPa. The compositional parameters of the glaucophane/crossite closely match those of blue amphiboles in the Japanese Sambagawa metamorphic belt. On the basis of comparison with the Sambagawa Belt (Banno, 1986), hornblende-bearing metabasite assemblages in the Arthur Lineament are of rather higher grade than the blueschist assemblages. In the Tyennan region the highest grade rocks include eclogite which crystallised at 1520±105 MPa and 698±28°C (Goscombe, 1990, after Kamperman, 1984). Garnet amphibolite which is closely associated with the eclogite may reflect retrogression at high $P_{H_2O}$ (Råheim, 1976).

Prograde assemblages in the Arthur Lineament are strongly retrogressed to actinolitic assemblages which are syntectonic

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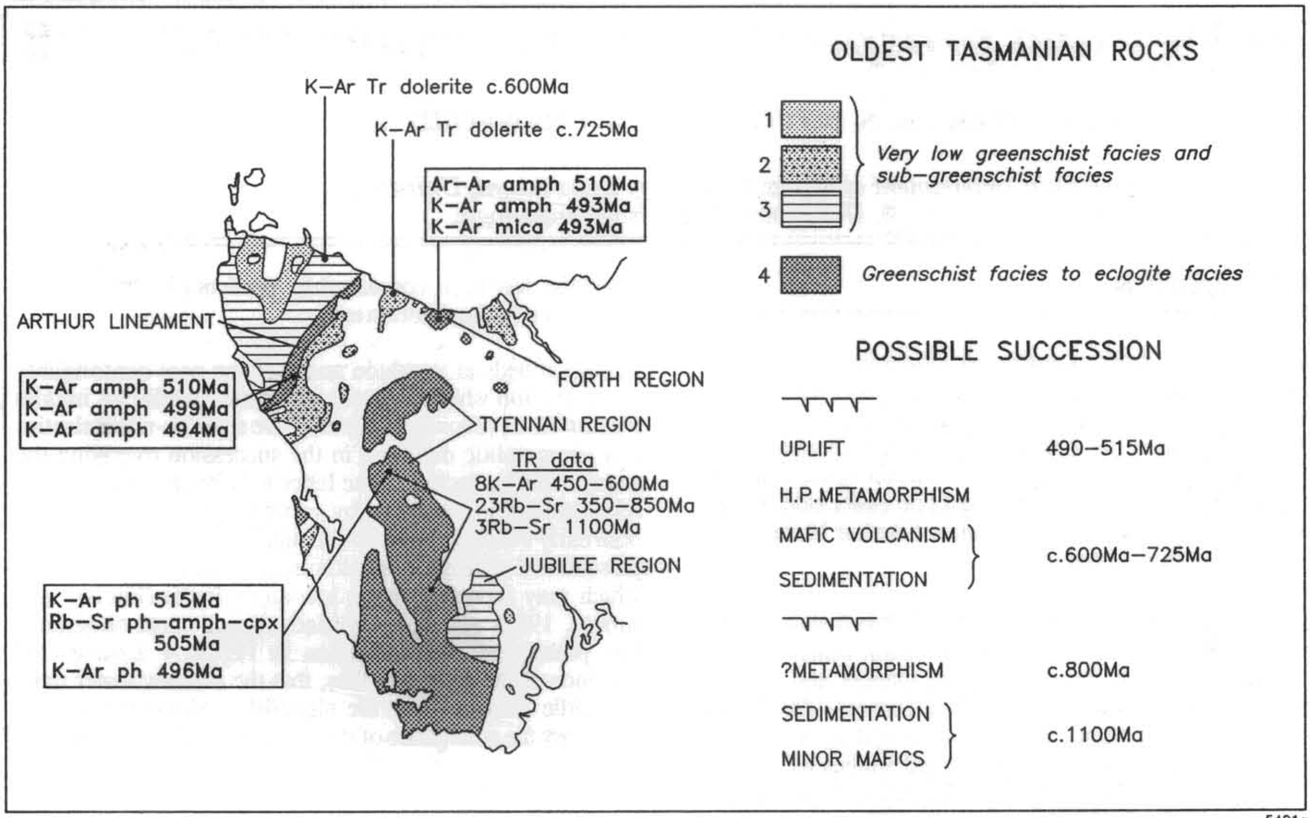


**Figure 1**

Distribution of Tasmania's oldest rocks. 1. Continental shelf and margin deposits with rift tholeiites near top – not all occurrences shown; 2. sandy turbidite facies; 3. quartzarenite, siltstone, minor dolomite; 4. Largely similar to 3 though protolith in high grade zones obscured.

Mineral ages from Turner and Crawford (in prep); McDougall and Leggo (1965); I. Villa – unpublished Ar-Ar; ph-amph-cpx age derived from 71–352 of Råheim and Compston (1977) and is approximate. Total rock data from Adams *et al.* (1985); Crook (1979); Råheim and Compston (1977).

with respect to the main deformation ($D_2$). In the Tyennan region the peak assemblages crystallised early in the main deformation phase ($D_2$) and display variable retrogression which may have occurred late in $D_2$, during $D_3$ and subsequently. In both the Arthur Lineament and the Tyennan region the climax of deformation was accompanied by mylonitisation. Also in both regions, and elsewhere in the Tasmanian Proterozoic, the regional transport direction associated with the main deformation was west over east.

The metamorphic and deformational similarities displayed by rocks in the Arthur Lineament and the Tyennan region are complemented by similar mineral ages (fig. 1) derived from hornblende amphibolite in the Arthur Lineament, garnet/hornblende amphibolite in the Forth region and eclogite in the Tyennan region. However, the relationship between these cooling or 'uplift' ages and the age of prograde metamorphism is a matter of some conjecture.

From the stratigraphic record it is clear that strong uplift and erosion of the Tyennan metamorphics occurred from the Middle Cambrian through to the earliest Ordovician (Corbett, 1990). This time range is generally consistent with the uplift indicated by the metamorphic mineral ages though the relationship between the fossil and radiometric time scales for the Cambrian is not particularly well established. The strong uplift of the Tyennan region probably reflects isostatic adjustment that would have quickly followed the deep burial that apparently generated the peak metamorphic assemblages. Thus, it seems likely that peak metamorphism occurred around the beginning of the Middle Cambrian or a little earlier.

There is some difficulty in reconciling the reconstruction of events based on the relatively precise dataset provided by the combined K-Ar, Ar-Ar and Rb-Sr mineral ages with total rock Rb-Sr data (Råheim and Compston, 1977) and total rock K-Ar data (Adams *et al.*, 1985) derived from the Tyennan region (fig. 1). The Rb-Sr data set comprises isochrons defined either by total rock and mineral (mainly phengite) pairs or total rocks and the resultant ages scatter very imprecisely from 350 to 1100 Ma. Interpretation of pre-520 Ma metamorphic events in this long time range was based on a preconception of what should be expected from the dataset and on an assumption that there was complete resetting of the total rock system by the inferred events at the localities sampled. It seems equally plausible to interpret the pre-520 Ma ages as representing partial resetting of the 1100 Ma depositional/provenance age thus reconciling the total rock Rb-Sr data with the mineral ages. Similarly, the K-Ar total rock data are imprecise and do not appear to mark complete resetting either.

In conclusion, it appears that in the Early–Middle Cambrian Tasmania was part of a collision zone in which very deep burial metamorphism was experienced by continental and

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epicontinental rocks which now form part of the Tyennan and Forth regions and the Arthur Lineament. At about this time an assemblage of rocks with 'oceanic' affinities made an appearance in the Tasmanian geological record (fig. 2). This assemblage which includes boninites, low titanium tholeiites and related ultramafics (Brown, 1989) may have been emplaced as a west-travelling allochthon (Berry and Crawford, 1988), or as part of an allochthon, fairly early in the orogenic episode. Subsequently the sense of structural transport (at ? deeper crustal levels) was west over east.

## MINERALISATION

Just as the Mount Read Volcanics and their associated polymetallic deposits compare with the setting and style of the Japanese Kuroko deposits, so too are there similarities between setting and mineralisation in the older Arthur Lineament and the Japanese Sambagawa Metamorphic Belt.

- Both the Arthur Lineament and the Sambagawa Belt are narrow, linear belts containing high pressure metamorphic assemblages.
- Compositional parameters of blue amphiboles from each terrain are remarkably similar.
- In each terrain the protolith succession comprises thick continentally derived, clastic sediments with rift-related basaltic volcanics.
- Mineralisation at the Alpine locality (fig. 2–3) in the Bowry Formation of the Arthur Lineament comprises pyrite-chalcopyrite with minor sphalerite, magnetite and hematite. Thus, this mineralisation is similar in composition as well as setting to the Besshi style deposits (Fox, 1984) of the Sambagawa Belt.

The Bowry Formation also contains:

- pyrite-magnetite lenses which include the ore bodies at the Savage River iron ore mine (Weatherstone, 1989).
- magnesite lenses (fig. 2–3) at Main Creek (Frost, 1982), Savage River mine (Frost and Matzat, 1984) and Arthur River-Lyons River (Dickson, 1990).
- gold in veins.

Gold also occurs in veins just east of the Bowry Formation and primary gold has been identified in residual soils overlying the Ahrberg Group (fig. 3; Khin Zaw *et al.*, this volume and poster).

Very pure, flour-like silica forms residual deposits over silicified dolomite in the Ahrberg Group near Corinna (fig. 2–3; Khin Zaw *et al.*, this volume and poster). Deposits of similar style are known within the Arthur Lineament where there are also residual deposits of ochre/umber at Main Creek (fig. 2).

Granite-related, vein and carbonate replacement deposits of tin and base metals (Collins and Williams, 1986) occur in rocks on either side of the Arthur Lineament whilst hard rock osmium-iridium-ruthenium alloys and gold (Brown, this volume) occur in ultramafic rocks to the east.

A small number of diamonds have been identified in placer deposits near Corinna.

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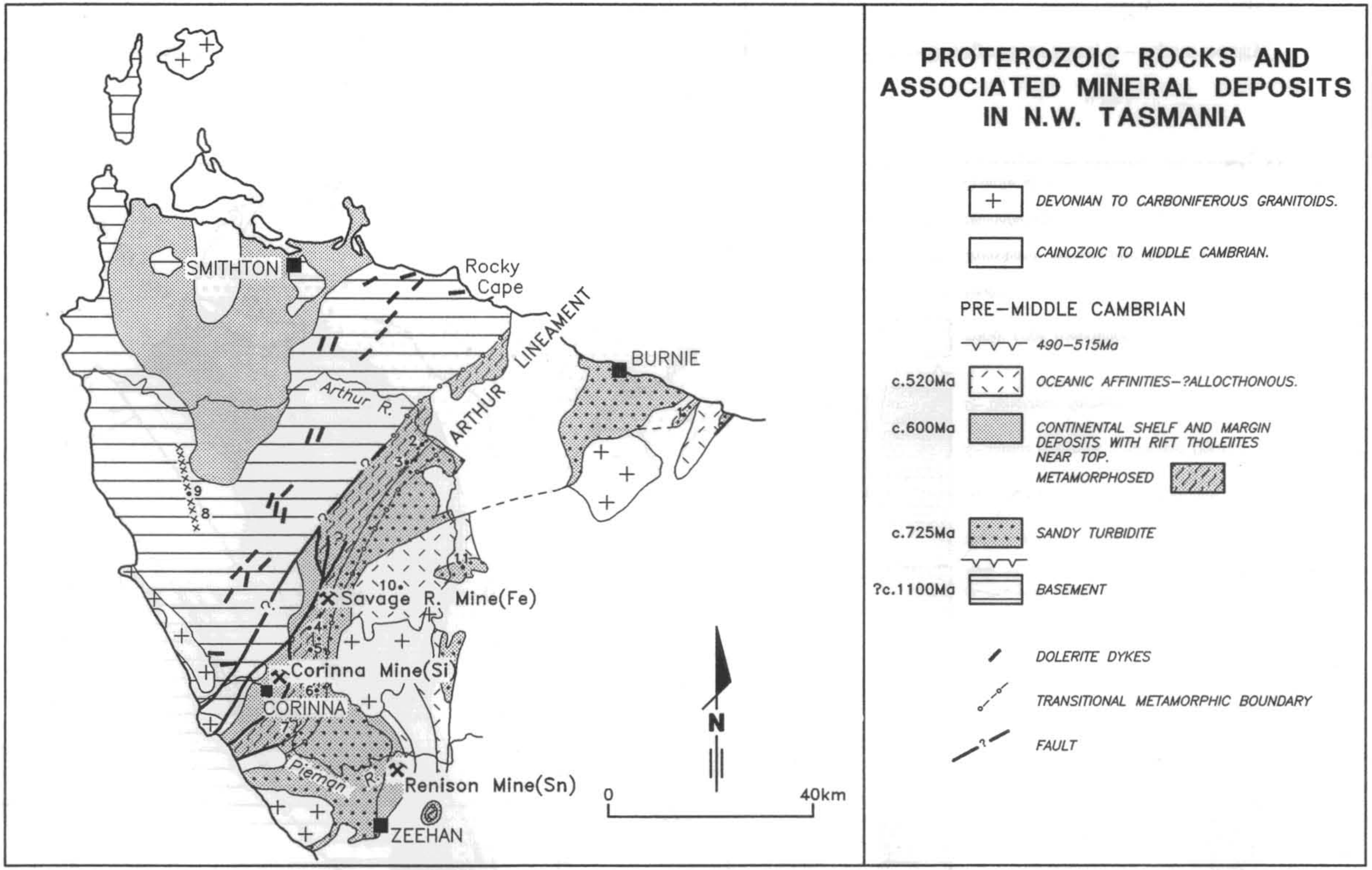


**Figure 2.** Proterozoic rocks and associated mineral deposits in N. W. Tasmania. Working mines are shown by mine symbols. Other deposits include mt-py-Cu at Keith River-Arthur River (3 to 2) and Alpine (7); mt-py at Long Plains South (5) and Rocky River (6); magnesite at Keith River-Arthur River, Lyons R (3), Savage River mine and Main Creek (4). Cp lodes occur in a quartz vein system (8) and tin occurs in veins at Balfour (9). Hm occurs at 1. Carbonate-replacement tin deposits occur at Cleveland (10) and Mt Bischoff (11). Silver-lead and zinc at Magnet between 10 and 11. Osmiridium in ultramafics in the ?allochthonous unit.

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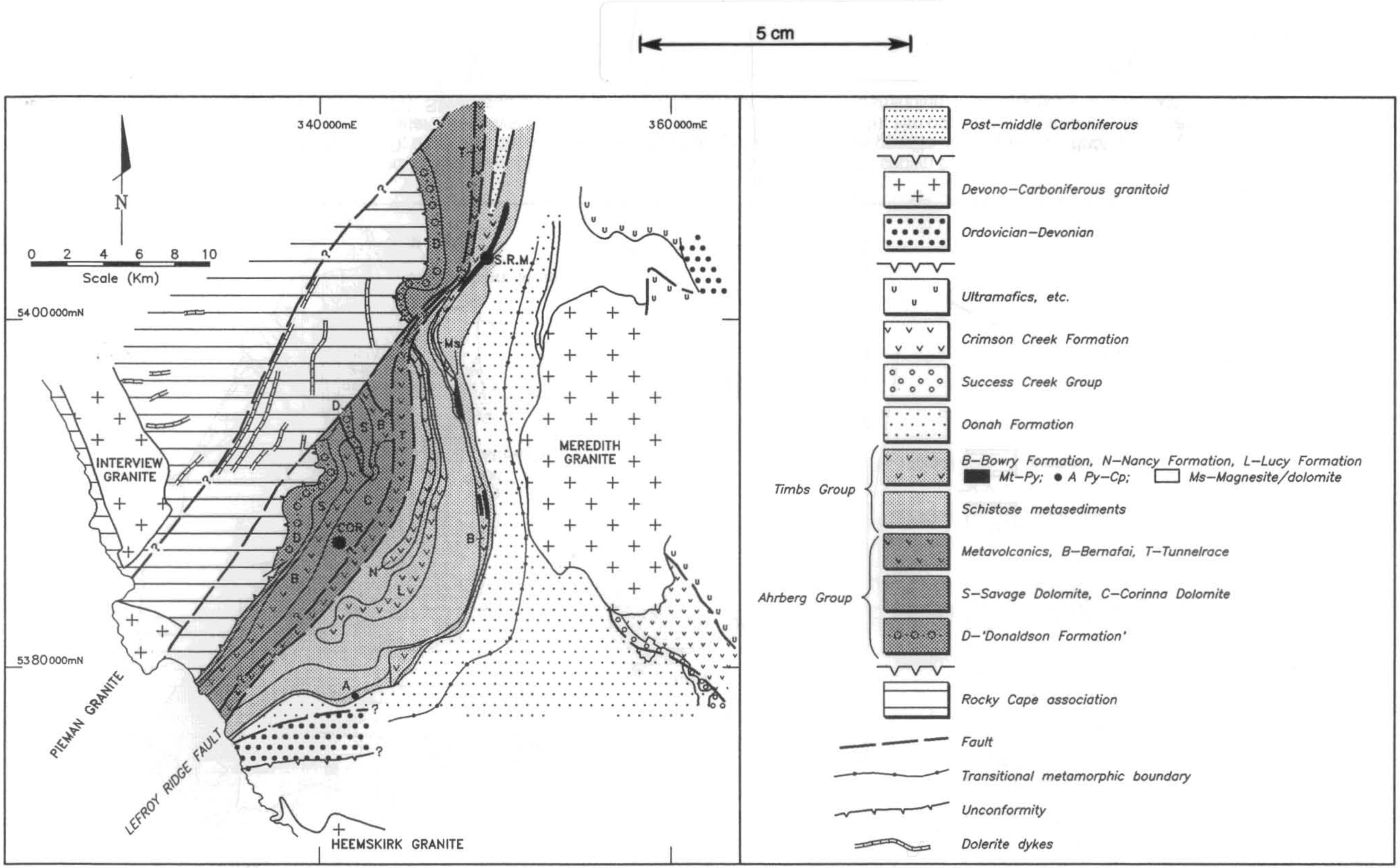


**Figure 3.**

Geology of the Corinna district after Turner *et al.*, 1991. COR – Corinna township; S.R.M. – Savage River Mine; A – Alpine locality.

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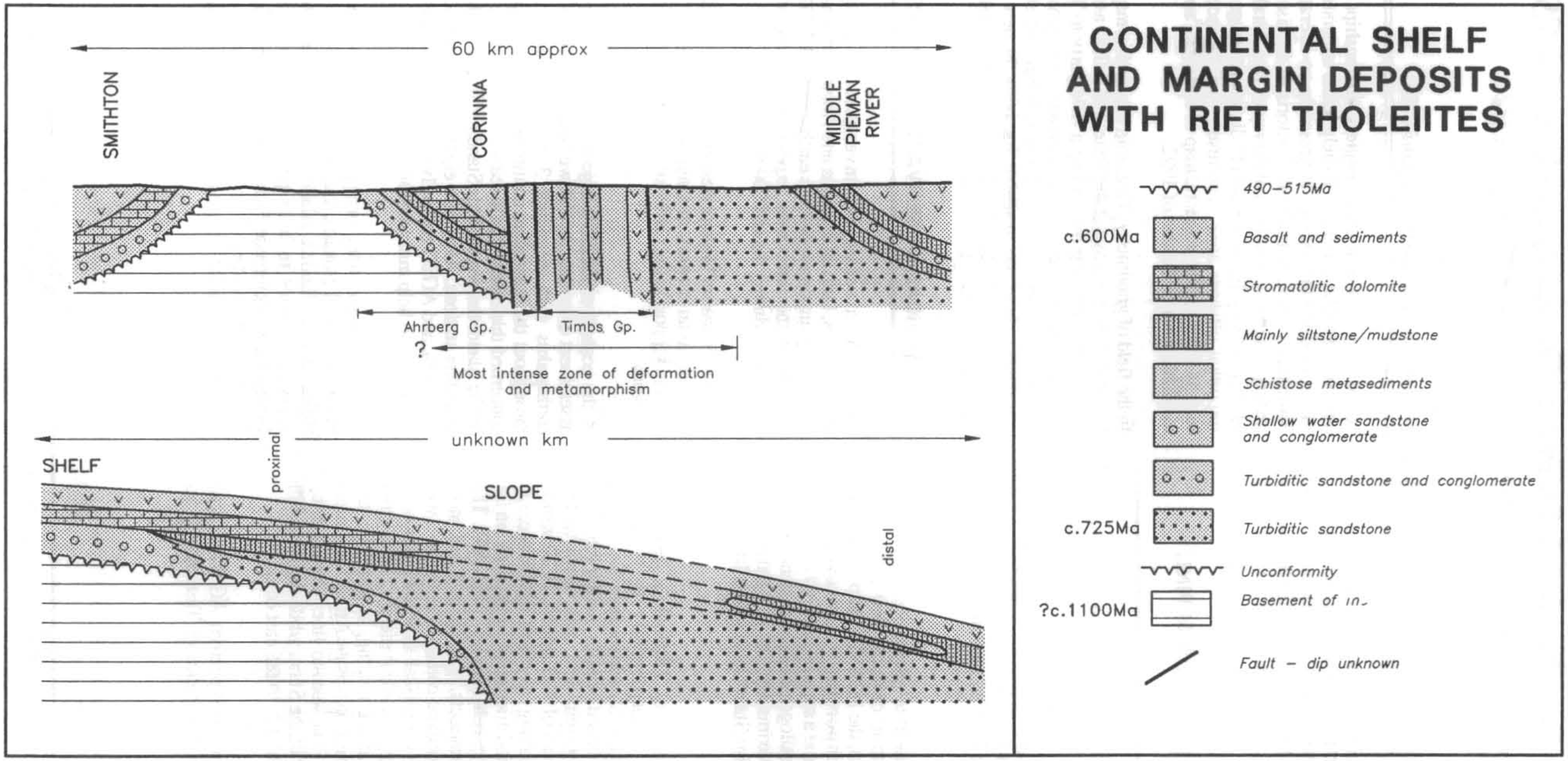


**Figure 4**

Above — much simplified composite cross section designed to illustrate stratigraphy. It includes the eastern edge of the Smithton synclinorium then is off-set in order to pass through Corinna to Middle Pieman River.

Below — palinspastic reconstruction of the inferred continental shelf and margin – see text for discussion.

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