



# Mineral Resources Tasmania

## REPORT 1993/27

### K-Ar geochronology in the Arthur Metamorphic Complex, Ahrberg Group and Oonah Formation, Corinna district

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#### INTRODUCTION

This report outlines the K-Ar geochronological work that was carried out following the mapping programme in the western part of the Corinna geological map quadrangle (Turner *et al.*, 1991). The principal aim of this report is to describe the work, its background, and to tabulate the results, although some interpretation is included.

Turner *et al.* (1992) also briefly interpret the Corinna geochronological data but some aspects of interpretation are more fully developed in Turner and Crawford (in prep). This latter work shows how new geological time scale data indicate that the Corinna dates, together with other similar Tasmanian dates, reflect an Early to Middle Cambrian event. This major tectono-metamorphic event corresponds to the earliest phase of the Delamerian Orogeny of South Australia, and to the apparently equivalent Ross Orogeny of North Victoria Land.

#### BACKGROUND

The older rocks in the Corinna Quadrangle have long been regarded as Proterozoic but there are different interpretations of the relative ages of the various units which make up the succession. Although there are no

known rocks from which the ages of formation can be determined using K-Ar dating, there are important implications for the relative ages of formation which derive from K-Ar metamorphic ages. To understand these implications it is necessary to examine conclusions arrived at by a number of workers who have been concerned with the Corinna rocks.

Of particular interest is the relative age of the metamorphic complex which extends east from the Lefroy Ridge fault (fig. 1). This complex includes the Timbs Group and part of the Oonah Formation. Spry (1964) called these rocks the Whyte Schist, and Gee (1967) identified them as being within the Arthur Lineament, a tectonic feature which extends right across northwest Tasmania. The term Arthur Metamorphic Complex (Turner, 1989) is correct stratigraphic nomenclature for the rocks within the Arthur Lineament.

Spry (1964) assigned an 'old' age to the Whyte Schist, suggesting that it was overlain with angular unconformity by the less metamorphosed rocks. However, Gee (1967) showed that the western boundary of the equivalent metamorphic rocks at the north coast is transitional, not unconformable, and the recently published Corinna

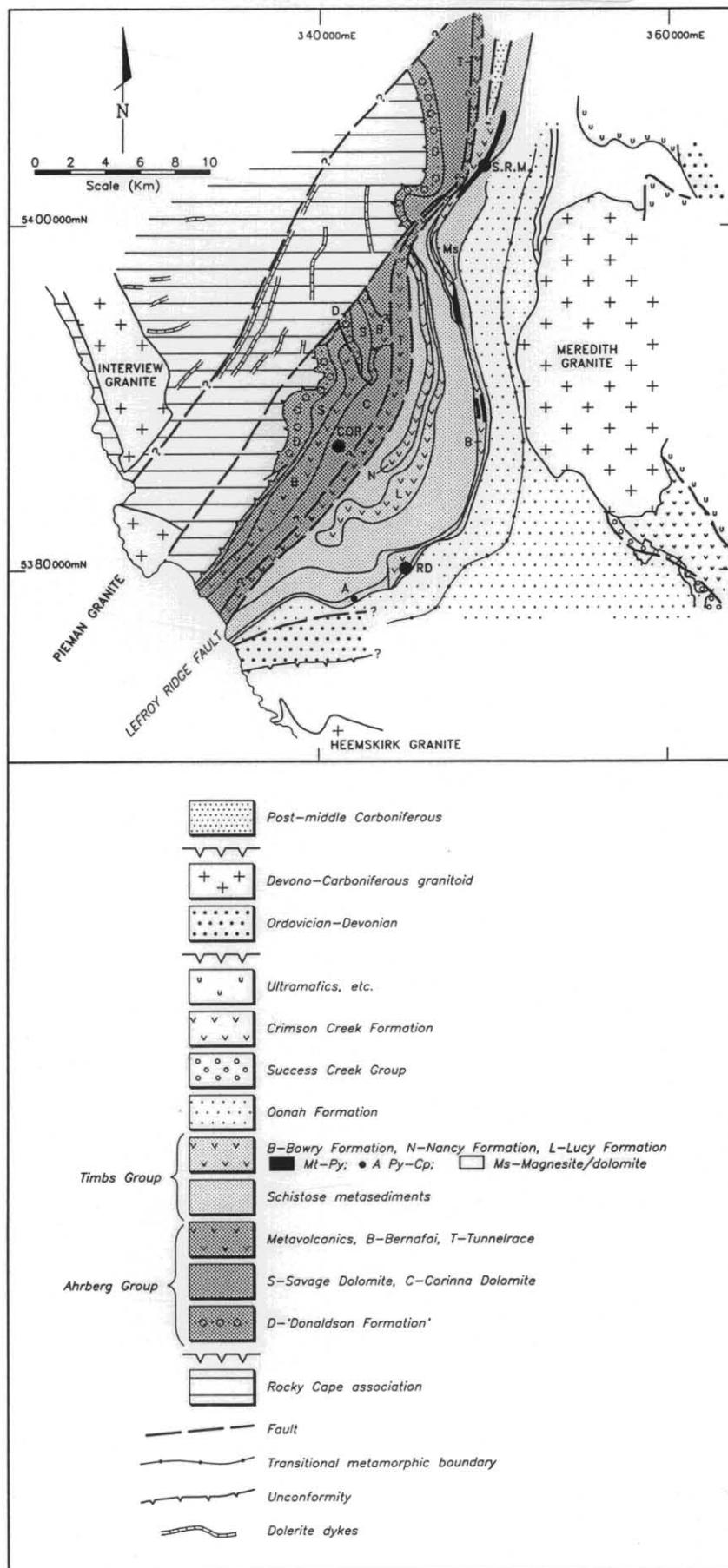


Figure 1.

Geology of the Corinna district. COR = Corinna; SRM = Savage River mine; A = Alpine locality; RD = Reece Dam. The Arthur Metamorphic Complex extends eastwards from the Lefroy Ridge fault to the transitional metamorphic boundary in the Oonah Formation.

mapping shows a similar transitional relationship for the eastern boundary (fig. 1). Thus, the Arthur Metamorphic Complex does not represent an older stratigraphic unit. Instead, it is a belt in which there is more intense development of the deformation and regional dynamic metamorphism than is evident in the adjacent, less metamorphosed Oonah Formation, Ahrberg Group and Rocky Cape association (fig. 1).

Tholeiitic basaltic rocks in the Arthur Metamorphic Complex, the Ahrberg Group, the Crimson Creek Formation (fig. 1) and the more distant Smithton Volcanics have similar major and trace element chemistry (Turner and Crawford, 1993), as well as similar rare earth element chemistry (Crawford, 1992). This close compositional similarity provides a basis for regional correlation, which is complemented by stratigraphic similarities. For example, the Ahrberg Group comprises a sequence of basal siliceous clastic rocks, dolomite, then basaltic volcanic rocks, which is broadly similar to the sequence of basal Forest Conglomerate, Black River Dolomite, then Smithton Volcanics that occurs near Smithton. The Smithton rocks have been recognised as correlates of the Success Creek Group and the basaltic Crimson Creek Formation (fig. 1) at middle Pieman River by other workers (e.g. Brown, 1986).

Although chemistry and stratigraphy support regional correlation of the various basaltic units in northwest Tasmania irrespective of their degree of metamorphism, other interpretations run counter to such correlation. Brown (1986) interprets a major structural break between the Oonah Formation and the overlying Success Creek Group/ Crimson Creek Formation. He identifies the break as being due to the Penguin Orogeny, that is, the event which produced the main structures and metamorphism in the Arthur Lineament and adjacent rocks (Gee, 1967). It clearly follows that the mafic rocks in the Arthur Metamorphic Complex and Ahrberg Group could not be correlates of basalt in the Crimson Creek Formation and Smithton Volcanics if they were deformed and metamorphosed by an orogenic event that was older than the Crimson Creek Formation and Smithton Volcanics.

For a general correlation of the basaltic rocks in the old successions in northwest Tasmania to be valid the metamorphism and associated deformation in the Arthur Metamorphic Complex must be younger than the Crimson Creek Formation and Smithton Volcanics. Unfortunately neither the Crimson Creek Formation nor the Smithton Volcanics has a known biostratigraphic age nor a directly measured isotopic age. The formations are older than Middle Cambrian fossiliferous rocks and are regarded as Late Proterozoic, an age which is indirectly supported by K-Ar whole rock ages of about 600 Ma (Adams *et al.*, 1985) for dolerite intrusions near Rocky Cape, which may be magmatically equivalent to the Smithton Volcanics (Crawford, 1992).

With the aim of determining the relative age of the metamorphism in the Arthur Metamorphic Complex and Ahrberg Group with respect to the Crimson Creek Formation and Smithton Volcanics, a series of six K-Ar determinations were carried out. Three determinations were made on amphibole separates derived from amphibolites in the Arthur Metamorphic Complex, whilst

another three determinations were made on whole-rock metabasalt samples from the Ahrberg Group. A separate K-Ar determination was made on detrital muscovite in the Oonah Formation. The objective of this determination was to establish the provenance age of distinctive mica-rich beds which make a sudden appearance near the top of the lower, sandy part of the Oonah Formation.

### SAMPLE SELECTION

Sample selection was done in collaboration with the geochronologist, Alan Webb of Amdel. Initially a batch of seven samples were forwarded to Amdel. These included (Table 1) three amphibolites from the Bowry Formation (fig. 1), three metabasalts from the Bernafai Volcanics, and a single sample from the gabbro at Reece Dam (Turner and Crawford, 1993). Only NC80 (Bowry Formation) was accepted, because it alone contained amphibole of sufficiently coarse grainsize to allow satisfactory mineral separation (Appendix 1).

Subsequently a batch of nine samples of amphibolite from the Bowry Formation were forwarded to Amdel. These represented the coarsest grain sizes found during mapping and included NC80. Altogether eleven samples of Bowry Formation amphibolite were evaluated and three were assessed as satisfactory for mineral separation. These three samples were NC77 from Main Creek near Savage River mine, NC80 from the Long Plains South ore zone, and NC478 from the Rocky River. Sample NC478 was collected close to the eastern edge of the Bowry Formation. Further field work would be beneficial in determining its exact relationship to the boundary.

The three samples of fine-grained metabasalt from the Bernafai Volcanics that were initially forwarded to Amdel were rejected on the basis that their grainsize would not allow satisfactory mineral separation. It was later decided to try the metabasalts as total rock K-Ar samples, although the geochronologist was not optimistic because of doubt about the argon retentivity of the metabasalts. For analytical purposes the geochronologist specified that samples be free of carbonate and preferably free of chlorite.

A further three samples of Bernafai Volcanics were forwarded to Amdel for evaluation along with two samples from the Tunnelrace Volcanics (fig. 1). The latter unit is probably a structural repetition of the Bernafai Volcanics but it is of slightly higher metamorphic grade (Turner and Crawford, 1993). Bernafai Volcanics samples NC506 and NC508 were selected for K-Ar work, together with NC384 from the Tunnelrace Volcanics. Thus, three metabasalt samples were selected for total rock K-Ar geochronology out of the eight samples that were evaluated.

A single K-Ar determination was made of material unrelated to the metabasalts and amphibolites. The sample comprised detrital muscovite derived from thin, distinctive mica-rich sandstone beds in the Oonah Formation. These distinctive beds occur near the top of the lower, sandy part of the Oonah Formation, below the muddy member designated Pom on the Corinna map. The beds are present below Pom in the Heazlewood River and Whyte River, and also on the Pieman Road where they occur 0.6-1 km west of the Stanley River, beneath an undelineated muddy section.

**TABLE 1**  
Samples evaluated for K-Ar dating

**Bowry Formation**

<i>Sample</i>	NC65	NC72	NC74	NC77*	NC80*	NC82
<i>AMG reference</i>	CQ494048	CQ494048	CQ494048	CQ497035	CP480955	CP480955
<i>Sample</i>	NC85	NC114	NC358	NC478*		
<i>AMG reference</i>	CP480955	CP474972	CP448795	CP484890		

**Bernafai Volcanics**

<i>Sample</i>	NC34	NC35	NC174	NC506*	NC507	NC508*
<i>AMG reference</i>	CP411905	CP411905	CP414906	CP417910	CP418909	CP414906

**Tunnelrace Volcanics**

<i>Sample</i>	NC382	NC384*
<i>AMG reference</i>	CP412865	CP412854

**Reece Dam gabbro**

<i>Sample</i>	NC8
<i>AMG reference</i>	CP446783

**Oonah Formation**

<i>Sample</i>	NC42*
<i>AMG reference</i>	CQ525005

\* Samples selected for analysis

Like the quartzose beds with relatively fine-grained muscovite that dominate the lower, sandy part of the Oonah Formation, the mica-rich beds are turbidite units. They contain abundant muscovite grains up to about 5 mm across along with biotite, chlorite, feldspar and abundant quartz. Their sudden appearance in the succession strongly suggests that they were derived from a newly uplifted provenance. A single provenance rather than multiple provenances seems likely, and the mineral assemblage in the sandstone is consistent with derivation from a granitic/metasedimentary terrain. The K-Ar age of the muscovite probably measures the age of uplift of the source rocks.

**RESULTS FOR AMPHIBOLE SEPARATES**

Similar ages were obtained for the three amphibole separates derived from NC77, NC80 and NC478 (Table 2). The spread of 16 million years between the oldest and youngest date is not a conclusive statistical difference (Webb, Appendix 2), and the results are thought to indicate metamorphic crystallisation at  $500 \pm 10$  Ma. However, because the textures and mineralogies of the three samples vary so as to suggest different stages of prograde and retrograde metamorphism, it may be that the K-Ar results should not be interpreted in terms of a single event.

Sample NC478 is an unusually coarse-grained amphibolite from the Rocky River. The amphibole in the sample is blue-green in colour and its maximum extinction angle of about  $30^\circ$  is indicative of hornblende. Individual amphibole grains range up to 7 mm across and are randomly oriented. They are poikiloblastic and are contained in a fine-grained matrix of granoblastic plagioclase. Patches of sphene are present in the amphibolite but there is negligible opaque mineral.

The amphibole grains in NC478 are fractured and rotated along irregular shear zones that cut through the rock, and there is chlorite alteration of the amphibole in the vicinity

of these shears. Apart from effects related to these late shears, the assemblage in NC478 seems to be prograde and is texturally comparable with little-altered prograde crossite amphibolite west of Reece Dam (Turner and Bottrill, 1993). Thus, the K-Ar result for NC478 seems to be dating prograde hornblende with good analytical accuracy ( $\pm 4$  Ma) but unknown geological accuracy. The geological accuracy may have been impaired by the late shearing.

Sample NC77 from Main Creek near the Savage River mine also contains relatively coarse grains of blue-green amphibole in a fine-grained matrix. However, the grains only range up to 2 mm across rather than the 7 mm of NC478. Extinction angles of  $20-28^\circ$  indicate that the coarse amphibole includes hornblende. Fine-grained amphibole in the matrix may be actinolite. Other minerals in the matrix are epidote, albite and minor chlorite. Relatively large patches of sphene are common, and there is a little anhedral pyrite.

There is a distinct alignment of sphene in NC77 but the coarse amphibole grains are fairly randomly oriented. Texturally the coarse amphibole grains appear to be prograde, and thus the K-Ar result is probably measuring this stage of metamorphism. Electron microprobe evaluation of the amphibole in NC77 would provide a better guide as to the relative amounts of prograde hornblende and retrograde actinolite than is provided by extinction angle measurements.

Sample NC80 from Long Plains South is texturally different to the other samples. It is a strongly foliated, fine-grained amphibolite which contains large, irregular patches and veins of epidote. The amphibole in NC80 has the same blue-green colour that is evident in the other samples but all measurements of extinction angle were under  $20^\circ$ , thus indicating actinolite. The amphibole grains are uniformly small and display strong preferred

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TABLE 2

K-Ar ages of samples from the western part of the Corinna 1:50 000 geological map quadrangle

<i>Formation</i>	<i>Sample No.</i>	<i>Sample Type</i>	<i>AMG</i>	<i>Age (Ma)</i>
Bowry Formation	NC77	amphibole	CQ497035	510 ± 4
Bowry Formation	NC80	amphibole	CP480955	499 ± 10
Bowry Formation	NC478	amphibole	CP484890	494 ± 5
Tunnelrace Volcanics	NC384	total rock	CP412854	450 ± 7
Bernafai Volcanics	NC506	total rock	CP417910	325 ± 4
Bernafai Volcanics	NC508	total rock	CP414906	246 ± 9
Oonah Formation	NC42	muscovite (detrital)	CQ525005	708 ± 6

orientation. Other minerals include epidote, albite and sphene. There is little chlorite and negligible opaque mineral.

Texturally the foliated amphibolite from Long Plains South appears to have undergone complete syntectonic retrogression. Similar foliated actinolite amphibolites near Reece Dam have undergone retrogression from apparently unfoliated, crossite amphibolite (Turner and Bottrill, 1993). Thus, the K-Ar result for NC80 probably dates the retrograde stage of metamorphism, again with good analytical accuracy ( $\pm 10$  Ma) and unknown geological accuracy.

### RESULTS FOR TOTAL ROCK METABASALTS

All three metabasalt samples are fine grained and consist mainly of actinolite, epidote, albite and sphene. Sample NC384 from the Tunnelrace Volcanics is less strongly foliated than the other two samples and retains a recognisably porphyritic texture. Sparse, large laths represent pre-existing pyroxene phenocrysts which are now altered to actinolite, whilst felsic patches of granular epidote and albite probably represent pre-existing plagioclase phenocrysts.

In the Bernafai Volcanics samples NC506 and NC508 the small actinolite prisms and laths are very strongly aligned. Common, irregularly-shaped patches of sphene are also aligned, as are scattered felsic patches of epidote, albite and minor chlorite which are probably recrystallised plagioclase phenocrysts. Tiny, subhedral to anhedral grains of opaque mineral are associated with the patches of sphene in restricted zones in NC506 and throughout NC508.

Results for the three metabasalt samples (Table 2) are disappointing in their total lack of agreement. Webb (Appendix 3) notes that potassium in NC508 is so low as to make the K-Ar result geologically meaningless. The low age for NC506 is possibly attributable to the sample having come from a zone in which crenulation cleavage of inferred Devonian age is developed in adjacent sediments. However, there is no evidence of this late deformation actually within NC506. Sample NC384 gave a result which approaches the Early Palaeozoic ages obtained from the Bowry Formation amphiboles but the discrepancy is quite large.

Field evidence and rock chemistry (Turner and Crawford, 1993) support arguments that metamorphism in the Ahrberg Group is of the same age as metamorphism in the Arthur Metamorphic Complex. Therefore, the discrepancy

between the Bowry Formation amphibole dates and the Tunnelrace Volcanics total rock date is unlikely to reflect a real age difference, and is probably attributable to poor argon retentivity in the total rock system, one of the geochronologist's initial concerns.

### RESULTS FOR DETRITAL MUSCOVITE SEPARATE

A good result was achieved with the NC42 muscovite concentrate derived from the sample of Oonah Formation sandstone. An excellent mineral separation was achieved, and the potassium analysis for the concentrate is very close to the potassium content of pure muscovite (Webb, Appendix 4). The resultant K-Ar date has good analytical accuracy (Table 2).

### DISCUSSION AND CONCLUSIONS

The three amphibole separates derived from amphibolites in the Bowry Formation of the Arthur Metamorphic Complex give similar K-Ar ages of  $494 \pm 5$  Ma,  $499 \pm 10$  Ma, and  $510 \pm 4$  Ma. The statistical difference in the ages is not conclusive, and the three ages may be interpreted as representing a single metamorphic event of  $500 \pm 10$  Ma. However, variations in texture and mineralogy suggest that prograde and retrograde rocks are included in the samples. Thus the K-Ar determinations may be measuring different stages in a fairly short metamorphic episode, not necessarily with the same geological accuracy in each case.

Sample NC478 ( $494 \pm 5$  Ma) appears to be an essentially prograde amphibolite, whilst NC80 ( $499 \pm 10$  Ma) appears to be retrograde and NC77 ( $510 \pm 4$  Ma) may be partially retrogressed. Simple extinction angle measurements indicate that amphibole in NC478 is hornblende, hornblende and possibly actinolite in NC77, and actinolite in NC80. Microprobe studies are needed to confirm these identifications because more complicated assemblages of amphiboles have been identified in microprobe studies of other amphibolites in the Bowry Formation (Turner and Bottrill, 1993).

Unfortunately the K-Ar total rock determinations for metabasalts in the Ahrberg Group appear to be of almost no value because of poor argon retentivity in the total rock system. Only the  $450 \pm 7$  Ma result for NC384 approaches the ages obtained from the Bowry Formation amphibole separates. The poor result from the total rocks in this study raises serious doubts about other total rock K-Ar ages in Tasmania (e.g. Adams *et al.*, 1985) and elsewhere.

According to the time scale of Harland *et al.* (1990) the Cambro-Ordovician boundary is at 510 Ma. Thus, the Bowry Formation amphibole results may suggest that metamorphism and deformation in the Arthur Metamorphic Complex occurred late in the Cambrian. However, the Cambrian part of the geological time scale is the subject of major reappraisal (e.g. Compston *et al.*, 1992), and isotopic ages of around 510 Ma or a little older may relate to a biostratigraphic level as low as the Early-Middle Cambrian boundary. Consequently, the Bowry Formation amphiboles may have been formed in a tectonothermal event marking the earliest phase of the Delamerian Orogeny (Turner and Crawford, in prep.).

Irrespective of whether the Bowry Formation amphibole ages represent the Cambro-Ordovician boundary or the Early-Middle Cambrian boundary, they indicate that the metamorphism and deformation (Penguin Orogeny) in the Arthur Metamorphic Complex is younger than the Late Proterozoic Crimson Creek Formation and the Smithton Volcanics. They are thus consistent with the young relative age of metamorphism as indicated by correlations between the metamorphosed Ahrberg Group/Arthur Metamorphic Complex and the relatively unmetamorphosed Smithton and middle Pieman River successions based on rock chemistry and stratigraphy. The K-Ar ages are contrary to the interpretation which puts the Penguin Orogeny between the Oonah Formation and the Success Creek Group/Crimson Creek Formation.

There is clearly a need to reappraise the arguments for locating the Penguin Orogeny at the boundary between the Oonah Formation and the Success Creek Group/Crimson Creek Formation. It may be that structural changes which have been thought to occur across stratigraphic boundaries in the Zeehan and middle Pieman River area actually occur across faults. For example, structure west of the extension of the Federal-Bassett Fault at middle Pieman River is more complicated due to the presence of a phase of easterly-trending Devonian folds which is not present east of the fault. Other faults in the area, such as the Tenth Legion Fault (Findlay and Brown, 1992), may have juxtaposed rocks with more profound structural differences but not necessarily different ages of structure.

Not only are structural interpretations in the Zeehan-Pieman River area challenged by the Corinna results but so also are interpretations of the unconformity at the base of the Smithton succession. Baillie (1989) attributed this unconformity to the Penguin Orogeny but the Corinna work places the Penguin Orogeny higher in the Smithton succession, above the Smithton Volcanics. The Corinna work substantiates an earlier structural analysis at Black River near Smithton, which found that Penguin Orogeny structures transgress the unconformity at the base of the Smithton succession (Gee, 1967).

The K-Ar age of  $708 \pm 6$  Ma for the Oonah Formation detrital muscovite is indistinguishable from a K-Ar age of  $724 \pm 16$  Ma for granite on King Island (McDougall and Leggo, 1965). It is also indistinguishable from the total rock K-Ar age of  $725 \pm 35$  Ma for the Cooee Dolerite (Crook, 1979). This latter age is interpreted as the approximate depositional age of the Burnie Formation and (by correlation) of the Oonah Formation. Thus, the King Island or equivalent Proterozoic granites were being

uplifted at the same time as the Burnie/Oonah Formation turbidite pile was forming. Further, the matching detrital muscovite age in the Oonah Formation provides strong evidence that the granites broke surface to become part of the provenance of the turbidite pile late in the period of sedimentation.

## REFERENCES

- ADAMS, C. J.; BLACK, L. P.; CORBETT, K. D.; GREEN, G. R. 1985. Reconnaissance isotopic studies bearing on the tectonothermal history of Early Palaeozoic and Late Proterozoic sequences in western Tasmania. *Australian Journal of Earth Sciences*. 32:7-36.
- BAILLIE, P. W. 1989. Forest Conglomerate and Quartzite, in: BROWN, A. V. (comp.) Geological atlas 1:50 000 series. Sheet 21 (7916S). Smithton. *Explanatory Report Geological Survey Tasmania*. 20-21.
- BROWN, A. V. 1986. Geology of the Dundas-Mt Lindsay-Mt Youngbuck region. *Bulletin Geological Survey Tasmania*. 62.
- COMPSTON, W.; WILLIAMS, I. S.; KIRSCKVINK, J. L.; ZHANG, Z.; MA, G. 1992. Zircon U-Pb ages for the Early Cambrian time-scale. *Journal Geological Society of London*. 149:171-184.
- CRAWFORD, A. J. 1992. Geochemistry and implications of mafic metavolcanics in the Corinna-Savage River area, in: TURNER, N. J. (ed.). Corinna 1:50 000 Geological Map. Field guide to selected rock exposures. *Report Department of Mines Tasmania*. 1992/06.
- CROOK, K. A. W. 1979. Tectonic implications of some field relations of the Adelaidean Cooee Dolerite, Tasmania. *Journal Geological Society of Australia*. 26:353-361.
- FINDLAY, R. H.; BROWN, A. V. 1992. The 10th Legion Thrust, Zeehan District: Distribution, interpretation, and regional and economic significance. *Report Division of Mines and Mineral Resources Tasmania*. 1992/02.
- GEE, R. D. 1967. The Proterozoic rocks of the Rocky Cape anticline, in: *The Geology of Western Tasmania — A Symposium*. University of Tasmania: Hobart.
- HARLAND, W. B.; ARMSTRONG, R. L.; COX, A. V.; CRAIG, L. E.; SMITH, A. G.; SMITH, D. G. 1990. *A geologic time scale, 1989*. Cambridge University Press.
- MCDUGALL, I.; LEGGO, P. J. 1965. Isotopic age determination on granitic rocks from Tasmania. *Journal Geological Society of Australia*. 12:295-332.
- SPRY, A. H. 1964. Precambrian rocks of Tasmania, Part VI, the Zeehan-Corinna area. *Papers and Proceedings Royal Society of Tasmania*. 98:23-48.
- TURNER, N. J. 1989. Precambrian, in: BURRETT, C. F.; MARTIN, E. L. (ed.). *Geology and mineral resources of Tasmania. Special Publication Geological Society of Australia*. 15:5-46.
- TURNER, N. J.; BOTTRILL, R. S. 1993. Blue amphibole in the Proterozoic to Cambrian Arthur Metamorphic Complex, northwest Tasmania. *Report Mineral Resources Tasmania*. 1993/26.
- TURNER, N. J.; BOTTRILL, R. S.; CRAWFORD, A. J.; VILLA, I. 1992. Geology and prospectivity of the Arthur Mobile Belt. *Bulletin Geological Survey Tasmania*. 70:227-233.
- TURNER, N. J.; BROWN, A. V.; MCCLENAGHAN, M. P.; SOETRISNO, I. 1991. Geological Atlas 1:50 000 Series. Sheet 43 (7914N). Corinna. *Department of Resources and Energy, Tasmania*.
- TURNER, N. J.; CRAWFORD, A. J. 1993. General features and chemical analyses of mafic and other rocks, Corinna geological map quadrangle. *Report Mineral Resources Tasmania*. 1993/23.

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**APPENDIX 1**  
**Amdel Report G8473/90**

**Sample evaluation**

*by A. W. Webb*

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**EVALUATION OF SUITABILITY OF 7 ROCKS  
FOR K-Ar GEOCHRONOLOGY**

**1. INTRODUCTION**

Seven thin sections of metavolcanic rocks from the Bernafai Volcanics and Bowry Formation were received from Mr N. J. Turner, Tasmanian Department of Resources & Energy, with a request to evaluate the suitability of the rocks for K-Ar geochronology.

**2. EVALUATION**

NC34 is a fragmental metavolcanic dominated by secondary minerals: epidote, carbonate, chlorite and needle-like amphibole. Only the amphibole could be used for dating the metamorphism, but it is too fine-grained to permit efficient mineral separation.

NC35 is more homogeneous than NC34 but contains similar alteration products, and the fine grain size would prevent mineral separation.

NC174 is similar to NC35 and is not suitable for dating.

NC80 is the coarsest grained sample of the 6 metavolcanics and contains abundant pale blue-green amphibole. It may be possible to obtain an acceptable mineral separate from this sample.

NC82 is finer grained than NC80 and is unlikely to yield a suitable mineral concentrate.

NC85 is coarser than NC82 and in addition to amphibole, there is olive green mica, closely intergrown with the amphibole. Mineral separation would be difficult.

NC8 contains coarse, slightly strained but fresh pyroxene. However, pyroxene from gabbros and metamorphosed rocks may contain extraneous <sup>40</sup>Ar and frequently give anomalously old ages. This sample is therefore not recommended for dating.

APPENDIX 2  
Amdel Report G8514/90

**K-Ar results for amphibole separates  
NC77, NC80, NC478**

*by A. W. Webb*

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**GEOCHRONOLOGY OF 3 METAMORPHIC ROCKS**

**1. INTRODUCTION**

Following examination of thin sections of rocks from the Bernafai Volcanics and Bowry Formation and the evaluation of their suitability for K-Ar geochronology (Amdel Report G 8473/90), further samples were received from Mr N. Turner, Tasmanian Department of Resources & Energy, for K-Ar dating.

**2. EVALUATION**

Three samples, NC77, NC80 and NC478, contain amphibole that is sufficiently coarse grained to permit effective mineral separations to be made. All 3 rocks are composed of amphibole, epidote, chlorite, felsic minerals and altered Ti minerals, which are present in varying proportions. NC80 has the best developed metamorphic foliation and mineralogy in comparison with NC77, where amphibole occurs as large grains up to 1 mm size (? replacing primary pyroxene) as well as smaller and more prismatic grains of more obvious metamorphic origin. NC478 is much coarser grained and partially preserves a primary gabbroic texture and the large amphibole grains show evidence of strong deformation. Regardless of the form of amphibole in these 3 rocks, all exhibit the same

pale green to blue-green pleochroism. K-Ar dating of these amphiboles is likely to indicate the time of metamorphic recrystallisation of the minerals.

Abundant epidote and chlorite are closely intergrown with the amphiboles and proved to be difficult to eliminate totally from the amphibole concentrates. Approximately 5% of epidote is present in samples NC77 and 478 and up to 10% in NC80. The effect of the epidote impurity on the K-Ar age is not known but is expected to be insignificant.

**3. RESULT**

Duplicate analyses for K were made by AAS. The K level was lowest in NC80 and the error in the determination is the cause of the greater error (2%) in the calculated age.

The K and radiogenic Ar analyses, with the calculated K-Ar ages are given in Table 1. Although there is a spread of 16 Ma between the oldest and youngest date, the statistical difference is not conclusive and the results are interpreted as indicating an age of metamorphic recrystallisation at  $500 \pm 10$  Ma i.e. early Ordovician. A larger number of samples would need to be analysed if greater refinement in these results is required.

**Table 1**  
Potassium-argon analyses

Sample	%K <sup>#</sup>	<sup>40</sup> Ar*(× 10 <sup>-10</sup> moles/g)	<sup>40</sup> Ar*/ <sup>40</sup> Ar <sub>Total</sub>	Age†
NC77 Hornblende	0.1214 0.1215	1.2411	0.876	510 ± 4
NC80 Hornblende	0.0922 0.0930	0.92232	0.813	499 ± 10
NC478 Hornblende	0.1996 0.2001	1.9698	0.871	494 ± 5

\* Denotes radiogenic <sup>40</sup>Ar

Age in Ma with error limits given for the analytical uncertainty at one standard deviation

Constants :

<sup>40</sup> K	=	0.01167 atom %
λ <sub>β</sub>	=	4.962 × 10 <sup>-10</sup> y <sup>-1</sup>
λ <sub>ε</sub>	=	0.581 × 10 <sup>-10</sup> y <sup>-1</sup>

**APPENDIX 3**  
**Amdel Report G8534/90**

# K-Ar results for total rocks NC384, NC506, NC508

by A. W. WEBB

## K-Ar GEOCHRONOLOGY OF 3 METAMORPHIC ROCKS

### 1. INTRODUCTION

Five rock samples were received from Mr N. Turner, Department of Resources and Energy, with a request to carry out K-Ar age determinations on the 3 most suitable samples. Thin sections of some of these rocks had been examined previously, and sections were prepared and examined for 3 new samples. Three samples were selected for dating. These were all fresh and fine grained. Sample NC384 appears to have some relict primary grains of pyroxene, replaced by amphibole, while the other samples have a more dominant metamorphic texture. They are all composed of amphibole, epidote, chlorite and felsic minerals. Cloudy, amorphous leucoxene is also present in NC506. It was expected that K-Ar total rock dating of these samples would give an indication of the age of metamorphic recrystallisation.

### 2. RESULTS

The K and Ar analyses and calculated K-Ar ages are given in Table 1. There is a large scatter in the ages which seems

unlikely to be due to responses to separate geological events. The sample giving the oldest age (NC384) was the one which appeared to retain some relict primary grains while the other samples, from the Bernafai Volcanics, were totally recrystallised. The abnormally low K content of sample NC508 suggests that the sample is chemically anomalous and that the result has no geological significance.

When considered in conjunction with the 3 hornblende dates of 494–510 Ma from the same district (Amdel report G 8514/90) it would appear that the non-amphibole mineral phases in the present samples do not have as high an argon retentivity as amphibole.

The total rock samples therefore, have responded to some later tectonic stimulus to give a scatter of K-Ar ages, whereas the hornblende dates could be regarded as a recrystallisation and cooling age.

**Table 1**  
Potassium-argon analyses

Sample	%K <sup>#</sup>	<sup>40</sup> Ar* (× 10 <sup>-10</sup> moles/g)	<sup>40</sup> Ar*/ <sup>40</sup> Ar <sub>Total</sub>	Age†
NC384	0.2853	2.5301	0.980	450 ± 7
Total rock	0.2852			
NC506	0.1440	0.8908	0.945	325 ± 4
Total rock	0.1446			
NC508	0.0571	0.2604	0.788	246 ± 9
Total rock	0.0567			

\* Denotes radiogenic <sup>40</sup>Ar

† Age in Ma with error limits given for the analytical uncertainty at one standard deviation

Constants :

$$^{40}\text{K} = 0.01167 \text{ atom } \%$$

$$\lambda_{\beta} = 4.962 \times 10^{-10} \text{ y}^{-1}$$

$$\lambda_{\epsilon} = 0.581 \times 10^{-10} \text{ y}^{-1}$$

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APPENDIX 4  
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# K-Ar results for muscovite separate NC42

by A. W. Webb

## K-Ar DATING OF DETRITAL MUSCOVITE

### 1. INTRODUCTION

One rock sample (NC42) and thin section were received from Mr N. J. Turner, Tasmanian Department of Mines, with a request to separate and date, by the K-Ar method, the detrital muscovite in the sample.

separation produced a high quality muscovite concentrate free from biotite, chlorite and sericite. The sample was analysed for K and radiogenic argon.

### 2. PROCEDURE

The rock contained both detrital muscovite, mainly as large (greater than 0.070 mm) flakes and secondary fine grained sericite, presumably replacing plagioclase. Lesser amounts of detrital biotite and chlorite were also present. Mineral

### 3. RESULTS

The K and Ar analyses and calculated K-Ar age are listed in Table 1. The simple interpretation of this result as a provenance age relies on the muscovite all being derived from the one source. If more than one rock unit contributed to the detrital mica, the result is a mixed age with possibly no significance other than that the sediment must be younger than 708 Ma.

Table 1  
Potassium-argon analyses

Sample	%K <sup>#</sup>	<sup>40</sup> Ar*(× 10 <sup>-10</sup> moles/g)	<sup>40</sup> Ar*/ <sup>40</sup> Ar <sub>Total</sub>	Age†
NC42	8.084	121.80	0.994	708 ± 6
Muscovite	8.105			

# The mean K value is used in the age calculation

\* Denotes radiogenic <sup>40</sup>Ar

† Age in Ma with error limits given for the analytical uncertainty at one standard deviation

Constants :

<sup>40</sup>K = 0.01167 atom %

λ<sub>β</sub> = 4.962 × 10<sup>-10</sup> y<sup>-1</sup>

λ<sub>ε</sub> = 0.581 × 10<sup>-10</sup> y<sup>-1</sup>