"40Ar/39Ar age constraints on deformation and mineralization, Rosebery Zn-Pb-Cu and Mount Lyell Cu deposits, Tasmania, Australia"

C. Perkins
Department of Geology and Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200, Australia

Received: 5 October 1994/Accepted: 29 March 1995

Abstract. The 40Ar/39Ar dating of alteration muscovite from the Rosebery Zn-Pb-Cu and Mount Lyell Cu deposits, Tasmania, Australia, has determined a succession of deformation events which occurred from ~400–378 Ma, and comprises the Devonian Tabberabberan Orogeny. The dates from Rosebery range from ~400–390 Ma, are a minimum age for mineralization, indicate the time of deformation, and provide a maximum age limit for granitoid emplacement in the vicinity of the deposit. The ages from the Mount Lyell field range from ~400–378 Ma, are a minimum for mineralization, and date cleavage development. The North Lyell Cu mineralization, which was probably broadly coeval with deformation, may have formed at ~400 Ma. All pre-Devonian alteration micas in the Rosebery and Mount Lyell areas have been recrystallized or reset. The Tabberabberan deformation in western Tasmania was broadly contemporaneous with widespread crustal shortening in southeastern Australia, as established from the dating of alteration minerals associated with deformation-related precious and base metal deposits.

The late Middle Cambrian Mount Read Volcanics, Tasmania, Australia (Fig. 1), are richly mineralized with poly-metallic massive sulphide deposits, the three major systems being Rosebery (19.4 Mt, 16.2% Zn, 5.0% Pb, 0.7% Cu, 2.9 g/t Au, 155 g/t Ag; Large 1992), the Mount Lyell field (106.8 Mt total, with Cu grades ranging from 5.5% at North Lyell to 0.9% at Prince Lyell and Au ranging from 2.0 g/t at Lyell Blow to 0.3 g/t at Prince Lyell; Large 1992), and Hellyer (17 Mt, 13.0% Zn, 6.8% Pb, 0.3% Cu, 160 g/t Ag, 2.3 g/t Au; Gemmel and Large 1992). The smaller massive sulphide deposits of Hercules and Que River occur near Rosebery and Hellyer respectively (Fig. 1). The mineralization in the Mount Read Volcanics is widely considered to be of the volcanogenic massive sulphide style (e.g. Solomon 1989; Large 1992) and therefore broadly contemporaneous with the host late Middle Cambrian succession. A Devonian metamorphogenic origin has been considered, however, for Rosebery (Aerden 1991) or at least some mineralization in the Rosebery area (e.g. Solomon, Vokes and Walsh 1987, Green and Iliff 1989), and for North Lyell, one of the deposits in the Mount Lyell field (e.g. Arnold and Fitzgerald 1986; Solomon, Vokes and Walsh 1987; Arnold and Carswell 1990).

Geochronologic investigation of the Mount Read Volcanics and its ore deposits is important in unravelling the geological history of the sequence, and has implications for the genesis of the massive sulphide systems. As the volcanics are metamorphosed to lower greenschist facies (Corbett and Lees 1987), and the Rosebery and Mount Lyell deposits occur in moderately high strain zones, deformation is important in controlling the observed distribution of pre-existing Cambrian, as well as Devonian mineralization. The timing of the structures and cleavage development is therefore critical for a thorough understanding of the controls of mineralization.

Muscovite in altered volcanics associated with the Rosebery and Mount Lyell mineralization is strongly foliated, and the sulphides are largely recrystallized. Microstructural investigation of micas from Mount Lyell suggests that the muscovite grew under conditions of high fluid pressure during deformation, but relict alteration micas are also present, and have compositionally reequilibrated (recrystallized?) during the later deformation (Cox and Etheridge 1989; Cox 1979). The microstructure of micas in foliated volcanics at Rosebery is very similar to that of the Mount Lyell minerals, and largely consists of oriented grains which probably grew during the deformation, and a smaller number of randomly arranged crystals which are likely to be relict alteration. In this investigation, the 40Ar/39Ar dating of micas from both deposits was undertaken in an attempt to resolve the timing of deformation, and to determine whether relict alteration micas were completely recrystallized and reset by the Devonian activity.

Regional geology

The Lower Paleozoic rocks of western Tasmania are part of the southern portion of the Tasman Fold Belt System of eastern...
Australia. The late Middle Cambrian Mount Read Volcanics (502.6 ± 3.5 Ma; Perkins and Walshe 1993) comprise a 200-by-20 km belt (Fig. 1) of submarine rhyolite to basalt lavas, subvolcanic intrusions, and volcaniclastic rocks which were deposited in the eastern section of an elongate Cambrian volcano-sedimentary basin known as the Dundas Trough (Campana and King 1963) in western Tasmania. The trough is bounded by Precambrian rocks of the Tyennan Block to the east and the Rocky Cape Block to the west, and is overlain by the Upper Cambrian to Lower Ordovician siliciclastic Owen Conglomerate. The trough sequence may be considered in two parts, one lacking felsic volcanics and tied depositionaly to the Rocky Cape region, and the other comprising the Mount Read Volcanics and associated volcano-sedimentary sequences and attached to the Tyennan Region (Corbett and Lees 1987). The basal unit of the western succession, the Success Creek Group, is a shallow dolomite of latest Precambrian (Vendian) age, and is conformably overlain by the Crimson Creek Formation, which is composed of mafic greywacke, mudstone, tholeiitic basalt and chert (Corbett and Lees 1987). Mafic-ultramafic complexes occur within this unit and in the adjacent Dundas Group to the west of the Mount Read Volcanics, and may be largely overlain by the western volcano-sedimentary sequences of massive or graded volcaniclastic units, laminated mudstone, and sandstone (cf. Corbett 1989a; 1992). Further discussion of the geology of the volcanic succession may be found in Corbett (1989a; 1992) and Corbett and Lees (1987).

Geochemically, the Mount Read Volcanics largely comprise high-K calc-alkaline andesites and more evolved lavas, and minor strongly LREE-enriched shoshonitic basalts (Crawford and Berry 1991). The volcanics have undergone metamorphism up to lower greenschist facies, and contain quartz-sericite-chlorite-pumpellyite-epidote-actinolite bearing assemblages (Corbett and Lees 1987). Most of the Mount Read Volcanics are texturally and mineralogically well-preserved, but locally the rocks have been strongly overprinted by Devonian deformation, and are strongly cleaved and somewhat recrystallized (Corbett and Lees 1987). Widespread intrusion of...