Gold Mineralisation in the Adelaide Fold Belt

PhD thesis submitted by

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Declaration

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Abstract

This project provides an up to date study of the various types and occurrences of gold-(base metal) mineralisation in the Adelaide Fold Belt, South Australia. The Adelaide Fold Belt comprises Neoproterozoic to Cambrian sediments and igneous rocks and Mesoproterozoic basement inliers deformed and metamorphosed during the Delamerian Orogeny between 520 Ma and 490 Ma. A number of small primary gold-(base metal) mineralisations are known in the Fold Belt which have produced about 250,000 oz of gold since the middle of the 19th century. This study investigates the geological setting, the mineralogy, geochemistry, fluid characteristics, stable and radiogenic isotopes as well as the timing of these mineralisation in relation to the Delamerian Orogeny. Gold mineralisation in the Adelaide Fold Belt are dominantly sediment-hosted, structurally controlled mineralisation in host-rocks that underwent greenschist- to amphibolite facies metamorphism during the Delamerian Orogeny. The majority of mineralisations is hosted by a restricted section of the Neoproterozoic Adelaidean strata, the lower Umberatana Group. Gold in the investigated mineralisation is usually associated with base metals (Cu and, or Pb-Zn-Cd-Ag). Fluid inclusion studies show that mineralising fluids have moderate to high salinities. Fluid inclusion studies were combined with Titanium in Quartz geothermobarometry resulting in a T-P range of ore formation from 300°C to 450°C and 1.5 kbar to 5 kbar. Oxygen isotopes of hydrothermal quartz (+13.3‰ to +19.9‰) and carbonate (+10.8‰ to +30.6‰) indicate an metamorphic origin of fluids. Carbon isotopes of hydrothermal carbonate range from -10.2‰ to +1.4‰ and may be a result of a mixing of carbon from sedimentary carbonate and C_organic. Sulphur isotope values in the investigated mineralisation range from -0.53‰ to +0.43‰ with the majority of values close to crustal average, indicating that most Zn from the source could be mobilised and that no fractionation took place between source and mineralisation. Pb isotopes of galena of the Woodside and Baratta mineral field are anomalous radiogenic and could represent a source within the Basement or the Adelaidean strata. Sr-isotopes of vein carbonate range from 0.710 to 0.719 and support a Sr source within the central to lower Adelaidean. Direct dating of mineralisation and the relationship of mineralisation to Delamerian igneous rocks show that mineralisation formed post-peak metamorphism in the extensional late stage of the Delamerian Orogeny or later. Most mineralisation have shown no links to magmatic activity. The general geological, structural and T-P characteristics support a classification of the investigated mineralisation as orogenic gold mineralisation but fluid chemistry and the base metal content of the mineralisation are unusual for these type of deposits. Some deposits in the central part of the Adelaide Fold Belt (Nackara Arc) also have characteristics of Telfer-style mineralisation.
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