Structural geology, tectonics and gold mineralisation of the southern Anakie Inlier

David G. Wood

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Statement of authorship

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of the authors knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text.

David G. Wood
August 2, 2007

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Abstract

The Late Neoproterozoic-Early Palaeozoic geology of northeast Australia is not well known, and is restricted to studies of relatively small basement inliers in Queensland. The Anakie Inlier is one such area. Basement rocks of the Anakie Inlier comprise the Anakie Metamorphic Group, and provide a window into crust that potentially underlies a significant area of northeast Australia. A ductile flat-lying foliation is the dominant structural feature of the Anakie Metamorphic Group, and both extensional and shortening processes have previously been interpreted for its formation. A combination of structural, metamorphic, $^{40}Ar/^{39}Ar$ thermochronologic and SHRIMP U-Pb geochronologic studies were used to elucidate the nature of the flat-lying foliation, as well as provide tectonic constraints for the Late Neoproterozoic-Early Palaeozoic evolution of northeast Australia.

Detailed structural mapping and microstructural analysis revealed a more complex deformation history than previously interpreted. A minimum of 6 distinct deformation events are interpreted, up from a previous total of 3. Early deformation of the Anakie Metamorphic Group is characterised by upright isoclinal folding coeval with mid-amphibolite facies metamorphism, which is overprinted by recumbent folding and a flat-lying foliation synchronous with (retrograde) greenschist facies metamorphism. The formation of shear bands, stretching mineral lineations and asymmetric folding during flat-lying foliation development indicates a component of simple shear during deformation. The contrast of upright folding followed by low angle shearing is interpreted to reflect a switch between shortening and extensional deformation. Younger deformation formed variably trending uprights folds that reoriented the flat-lying foliation, and resulted in complex outcrop patterns.

The age of early deformation of the Anakie Metamorphic Group is constrained to between *ca* 510-483 Ma from detrital zircon ages in a previous study, and from $^{40}Ar/^{39}Ar$ ages in this study. SHRIMP U-Pb analysis undertaken constrains the age of younger upright deformation to

between *ca* 443-392 Ma, based on cross-sutting relationships between intrusives and structures in the metamorphic rocks. A U-Pb age of 443.3 ± 6.2 Ma is interpreted to represent the absolute age of a regional (D4) deformation event.

Gold in the Anakie Inlier occurs in a variety of settings. In the Clermont region, gold can be divided into two broad groups, the first is structurally controlled lode gold mostly in the Bathampton Metamorphics, the second is gold in a basal conglomerate horizon of Permian basins. Structurally controlled gold occurs in shear zones along the limbs of the Oaky Creek Antiform, and is concentrated at the intersection of the shear zones with areas of younger intense deformation. The earliest known gold mineralisation occurs in structures that are dated at 443.3 ± 6.2 Ma. Gold in Permian conglomerate is enigmatic, and occurs as palaeoplacer nuggets and hydrothermal related deposits in close proximity to each other. Gold is concentrated in, and adjacent to, fractures that cut the unconformity between Permian sediments and the underlying Anakie Metamorphic Group. A model of fluid mixing along the unconformity interface best explains the presence of concentrated gold in this setting.

Correlations between the Anakie Metamorphic Group and equivalent metamorphic rocks elsewhere in Queensland indicate that the Late Neoproterozoic - Early Palaeozoic evolution of northeast Australia was dominated by extensional tectonics, punctuated by short-lived episodes of lithospheric shortening.

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