A stratigraphic and structural reconstruction of a complex terrane in an Archean large igneous province: the Redeemer-Raroonga mine corridor, Agnew, Eastern Goldfields, Western Australia

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The Au-mineralised Redeemer-Waroonga mine corridor, situated near Agnew within the Kalgoorlie Terrane of the Eastern Goldfields, Yilgarn Craton, is part of a 2.7 Ga large igneous province (LIP). The stratigraphy has experienced at least one regional deformation event and been metamorphosed to greenschist facies. We examined 46 diamond drill holes spread evenly along the 15 km mine corridor to unravel the structure and stratigraphy in relation to the evolution of the LIP. We begin with the early stages of mafic and ultramafic magmatism, continue with the generation of felsic magmas and resultant uplift, erosion and sedimentation, and end with the later deformation and mineralising events.

The basal sequence is a 3 km thick package of mafic and ultramafic rocks and thin mudstones. The paleo-environment was subaqueous and distal to any major landmass, as judged from the thin mudstone beds, pillowed basalts and komatiites. The paucity of sediments also suggests that there were no significant time breaks between volcanic events, suggesting rapid emplacement, as expected from mantle-derived melts generated from one mantle plume. Unconformably overlying this is the sediment-dominated succession, which consists of a generally upward fining sequence of conglomerates, pebbly sandstones, sandstones, siltstones and mudstones. Thick beds of cross-bedded sandstone suggest that the paleo-environment was dominantly subaerial, although less common turbidites indicate that at least some of the stratigraphy was subaqueous and below wave base. There are several significant stratigraphic changes along strike, including: 1) the lithofacies underlying the sediment-dominated succession varies between basalt, dolerite and komatiite, 2) the conglomerate thickness ranges from 2 to 200 m, and 3) there are several thin intervals of basalt, komatiite and highly deformed equivalents, within the sediment-dominated succession. Based on lithofacies variations and geochemistry of lithic clasts, we show how the mafic-ultramafic succession was uplifted and tilted by diapiric felsic plutons (approximately 2665 Ma), which were sourced from crustal melts generated from plume-derived magmas. The thin ultramafic and mafic intervals within the sediment-dominated succession are located in the Waroonga Shear, a major regional structure and indicate that structural duplication plays a major role in the stratigraphy. Thus, it is difficult to assess whether lithofacies thickness changes have any depositional significance.

Gold is hosted in most of the sedimentary lithofacies and occurs along the Waroonga shear zone, thus lithology does not appear to be a first-order control on mineralisation. Recent teleseismic studies indicate that deep crustal structures link with the Waroonga Shear, providing a pathway for Au-bearing fluids. This research has application to reconstructions of complex volcano-sedimentary successions within LIPs where there is limited material for study.