Fingerprinting Mineralization in the North Australia Craton During the Amalgamation and Breakup of the Nuna/Columbia Supercontinent

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The formation and preservation of many types of ore deposits has been temporally linked to the assembly and breakup of supercontinents. The late Paleoproterozoic to early Mesoproterozoic is a time of major metallogenesis in Australia and elsewhere, and may be linked to the assembly and breakup of the Nuna/Columbia Supercontinent. This study presents geochemical and isotopic data from Paleo- to early Mesoproterozoic sedimentary successions in northern Australia that complement existing regional stratigraphic correlations, and thereby reduce exploration risk.

A significant proportion of global orogenic gold mineralization occurred in the time interval 2100 to 1800 Ma. This corresponds with a time during which oceans are thought to have been relatively iron rich, and the sedimentary record is characterized by a major period of deposition of iron-rich sedimentary rocks, including banded iron formations. In northern Australia, orogenic gold deposits in the Tanami and Pine Creek provinces are hosted by anomalously iron rich marine mudstones deposited between ~1910 and 1800 Ma.

The ~1810 Ma Callie deposit in the Tanami Province, the largest gold deposit in northern Australia, is hosted by black, iron-rich mudstones of the Dead Bullock Formation, which contains ~275 t of gold. Black mudstones of the Koolpin Formation in the Pine Creek province have produced ~99 t of gold, including 17 t at the Cosmo Howley deposit. Effective exploration in the Tanami and Pine Creek provinces is severely hampered due to poor knowledge of potential stratigraphic correlations within and between regions. However, gold-bearing units in both provinces are characterized by high Cr/Th, low Th/Sc, and low $(La/Yb)_{PAAS}$, which together suggest that these rocks had a dominant mafic source. These characteristics can be used to identify stratigraphic units most favorable to host gold mineralization.

After 1800 Ma, and after the first global oxygenation event, the metallogeny of northern Australia changed significantly, possibly in response to geodynamic changes and the oxidation of the atmosphere and hydrosphere. Metallogenesis in the period between 1655 and 1575 Ma is characterized by oxidized fluid flow that produced zinc-lead deposits upon interaction with anoxic mudstones. During this time, most of the zinc-lead deposits that constitute the North Australian zinc belt formed.

Late Paleoproterozoic sedimentary basins across the Northern Australian zinc belt record a significant change in their neodymium isotope composition to more positive epsilon Nd values at ~1655 Ma. This isotopic change is interpreted to reflect increased mafic magmatism accompanying initial breakup of Nuna, and is recognized in the Mt. Isa, Georgetown, and Curnamona provinces and the Victoria River Basin, which together host the North Australian zinc belt. This change, which may reflect a buried or eroded eastern Proterozoic Australian source or an outboard Laurentian source, can be used to identify portions of the Paleoproterozoic stratigraphy with higher potential to host zinc-lead deposits.