

Extreme crustal fractionation in a Proterozoic chemical hotspot

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The distribution of mineral systems is heterogeneous over space and time, reflecting transient element enrichment within Earth's evolving crust. Australian Proterozoic rocks host some of the world's largest ore deposits, including the Broken Hill Pb-Zn-Ag deposit within the Curnamona Province, and the Olympic Dam Cu-U-Au-Ag super-deposit, within the Gawler Craton, offering key insights into crustal preconditioning for mineralization. New feldspar and whole-rock Pb isotopic data, and complementary apatite geochronology, support a common source for Mesoproterozoic magmatism in the Curnamona Province and Gawler Craton and hence a genetic link between their world-class ore deposits. Exceptionally radiogenic Pb isotope ratios in the Curnamona Province indicate extreme crustal fractionation, likely driven by a positive feedback scenario where crustal anatexis produced melts strongly enriched in heat-producing, incompatible elements, which in turn prolonged anatectic conditions through radiogenic heat production. The resulting granitic rocks may have acted as important metal sources for certain ore deposits, while more generally fostering metal enrichment by providing a persistent heat source for hydrothermal systems. This chemical hotspot may have been triggered by the combination of insulating thickened crust and gravitational destabilization following the assembly of the Nuna supercontinent.