Tectonic and geological framework of the North Australian Craton: Host to the world-class Proterozoic Carpentaria Zinc Belt

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The Proterozoic North Australian Craton (NAC) is one of the world's most richly mineralised provinces, hosting a diverse range of mineral deposits including significant VHMS, orthomagmatic Ni-Cu, rare-earth element and intrusion-related Sn-W-Mo deposits. The NAC also hosts world-class diamond, orogenic gold districts, unconformity-related uranium, IOCG and sediment-hosted Zn-Pb deposits. Including the Curnamona Province, an original part of the NAC, this craton contains three of the five largest global Zn-Pb deposits. The richness of this craton stems from tectonic events that assembled and then shaped the basement blocks and initiated overlying basins.

The NAC assembled mostly in the Paleoproterozoic as part of Nuna, with convergent margins to the northwest, south and east. Most assembly occurred before ~1800 Ma, with accretion of the Kimberley and Pine Creek provinces from the northwest onto the proto-NAC at 1865-1825 Ma, the accretion of the Aileron Province from the south before 1840 Ma, and the accretion Numil-Kowanyama-Abingdon Province from the east before 1850 Ma. After accretion of the Aileron Province, subduction likely continued along the southern margin until accretion of the Warumpi Province at ~1,640 Ma. The sutures produced by accretion of exotic blocks are recorded as major boundaries in seismic data and by gradients in Nd and Pb isotopic data, and are spatially associated with deposits, including VHMS and orogenic gold deposits, typically associated with convergent margins. It is likely that eastern NAC was contiguous with Laurentia, with separation later during Nuna and/or Rodinia break-up.

Many deposits in the eastern NAC are associated with north-trending rift and sag basins that commenced at ~1790 Ma. Rift-related mafic volcanics and red beds likely sourced Zn, Pb and Cu, and, in most cases, carbonaceous and dolomitic siltstone/shale units in the overlying sag basin trapped these metals. Mineralising events correspond to major changes in far-field stress, as indicated by deformation events and changes in the apparent polar-wander path. Although most Zn-Pb deposits conform to this model, several important deposits, including Broken Hill and Cannington, formed during rifting in deeper-water turbiditic successions, spatially and temporally associated with mafic magmatism.

The last major mineralising events in the NAC were 1590-1500 Ma IOCG event(s) associated with A-type magmatism just to the west with a major north-trending crustal boundary in the Cloncurry district. Subsequently, mineralisation in the NAC was sporadic, although the world-class Argyle diamond deposit formed at ~1190 Ma and Phanerozoic mineral systems have affected the very eastern part of the NAC.