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Inverted Metamorphic Field Gradient along a Neoarchean Suture Zone in Zanhuang Nappe System, North China Craton.

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Archean suture zones in the North China Craton preserve deeply eroded remnants of ancient plate boundaries formed by collision between oceanic arcs and continental fragments. In the Zanhuang region, Archean sutures crop out within a stacked fold–thrust nappe system derived from a forearc–oceanic setting. Structural restoration shows a stacked pile of allochthonous nappes overlying a para-autochthonous continental margin. The nappes and mélange are bounded by major ductile shear zones that merge downward into a décollement.

Metamorphic constraints reveal an inverted metamorphic field gradient across the décollement. The allochthon records peak conditions of 650–700 °C at 7–11 kbar, whereas the para-autochthon records 500–600 °C at 4–6 kbar. P–T conditions decrease sharply from ~700 °C/11 kbar to ~500 °C/4 kbar over ~1 km across strike, corresponding to an estimated depth contrast of nearly 20 km (Zhong et al., 2025 EPSL). This localized P–T discontinuity contrasts with the smooth thermal variation within the nappe pile, where no major internal P-T breaks are observed.

Distinct detrital zircon age spectra among individual nappes confirm stacking of discrete terranes. The absence of sharp internal P–T breaks suggests that nappe stacking within the fossil accretionary prism predates the main phase of collisional exhumation. In contrast, the localized P–T gap at the décollement is interpreted as the result of thrust-driven thermal advection during collision, whereas basal shear zones beneath individual nappes formed earlier during subduction–accretion through basal accretion or underplating along the plate interface.

These results provide quantitative constraints on the thermal architecture and stacking history of an Archean convergent margin, showing that thrust-driven thermal advection and discrete terrane stacking operated in ways comparable to Phanerozoic systems.