Early Permian I-S-A-type granite trinity from central Inner Mongolia, North China: Sequential melting model and tectonic implication

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The granitic suites from sequential partial melting are rarely documented on Earth and their geneses harbor a key to ascertaining critical geodynamic controls on continental crustal formation and differentiation. This zircon U-Pb dating and geochemical study documents three contrasting early Permian granite suites from Erenhot of central Inner Mongolia, eastern Central Asian Orogenic Belt (CAOB) and reveals a rare occurrence of I-S-A-type granite trinity derived from sequential partial melting of distinct protoliths. The ca. 280 Ma Gancihuduge (GCG) suite shows a calc-alkaline I-type character, with initial $^{87}Sr/^{86}Sr$ ratios of 0.7035 to 0.7039, $\varepsilon_{Nd}(t)$ of +1.87 to +4.70, zircon $\varepsilon_{Hf}(t)$ of +8.0 to +13.2 and $\delta^{18}O$ from 7.4 to 8.7‰. These features are consistent with partial melts of newly underplated meta-basaltic to -andesitic protoliths. The ca. 276 Ma Cailiwusu (CLS) suite is magnesian and peraluminous, with initial $^{87}Sr/^{86}Sr$ ratios of 0.7036 to 0.7040, $\varepsilon_{Nd}(t)$ of +1.9 to +2.4, zircon $\varepsilon_{Hf}(t)$ of +6.5 to +12.1 and $\delta^{18}O$ from 9.7 to 10.9‰. Its petrographic and geochemical characters point to an affinity with S-type magmas and originate from partial melting of meta-greywacke protoliths. By contrast, the ca. 279 Ma Kunduleng (KDL) suite exhibits an A-type magmatic affinity, with typical enrichment in alkalis, Ga, Zr, Nb and Y, depletion in Sr and P, $\varepsilon_{Nd}(t)$ of +2.39 to +3.55, zircon $\varepsilon_{Hf}(t)$ from +8.3 to +12.3 and $\delta^{18}O$ values from 6.8 to 7.5‰. These features suggest that they stem from high-temperature fusion of refractory charnockitic protoliths. Apart from representing the firstly-recognized occurrence of I-S-A type granite association within the same melting zone, the Erenhot granite suites could not only serve as a temporal marker for monitoring post-thickening extension and mantle upwelling in the aftermath of a retreating subduction zone, but also present spatial magmatic proxy for tracing crustal formation and differentiation within back-arc basin environments in the CAOB.