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Rapid recycling of S-type granites in accretionary orogens risks misidentification of sources

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The origin of S- and I-type granites in accretionary orogens remains contentious due to complex geochemical and isotopic signatures, challenging traditional granite classifications. We present new zircon U-Pb-Hf-O, quartz O isotope and whole-rock geochemical data from two-mica (S-type) and biotite (nominally I-type) granites in the Alataw Mountains, northwest China, showing both are derived from sediment-dominated protoliths. Zircon U-Pb dating indicates emplacement at 303-298 Ma, with differing inherited ages of 443–397 Ma and 1404–811 Ma. The two-mica granites were derived from metapelitic sources and are strongly peraluminous, while the biotite granites are metaluminous to weakly peraluminous with many "I-type" characteristics. Both types exhibit high SiO_2, low MgO, elevated zircon $\delta^{18}O$, high quartz $\delta^{18}O$ and high $D'^{17}O$ values consistent with sedimentary sources, but depleted εNd(t) and εHf(t) values that require a juvenile origin. Phase equilibrium modeling indicates that these granites formed through water-fluxed partial melting of variable Carboniferous sedimentary rocks (Fig.1). Thus, crustal melts appear juvenile and S-type granites appear to be I-type. Our findings highlight the critical role of rapid crustal recycling via sediment melting during the reworking of juvenile crust within arc-related accretionary orogens and suggest the need for caution when considering granite origins based on traditional typological classifications.

Fig. 1 Thermodynamic and trace element modeling