Adakite-like potassic magmatism and crust-mantle interaction in a postcollisional setting: An experimental study of melting beneath the Tibetan Plateau

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Adakite-like potassic rocks are widespread in postcollisional settings where they provide potential insights into deep crustal processes that include partial melting, lower crustal flow and thickening, plateau uplift, and the creation of porphyry copper deposits. Although substantial progress has been made in characterizing the geochemical and geophysical features of postcollisional adakite-like potassic rocks, their genesis remains controversial. Here we report direct experimental evidence for the origins of these rocks with partial melting experiments on: (1) a garnet amphibolite, and (2) the same garnet amphibolite mixed with 20 wt. % of a primitive Tibetan shoshonite. The experiments were conducted at 1.5-2.0 GPa and 800-1000 °C. The partial melts of garnet amphibolite have high Sr/Y and are calc-alkalic but lack the enrichments in potassium and other strongly incompatible elements (Rb, Ba, Th, U) that are characteristic of Tibetan adakite-like rocks. In contrast, all characteristic features of the natural adakite-like rocks are convincingly reproduced by the hybrid experiments. This includes negative inflections for Nb, Ta and Ti on mantle-normalized plots which are inherited from source materials rather than the effects of rutile in melting residues. The input of mantle-derived alkaline melt to a crustal source can be argued to provide not only the high concentrations of incompatible elements characteristic of silicic and K_2O-rich adakite-like magmas, but also the heat necessary for crustal melting. Our experimental results demonstrate that, in the case of the Tibetan Plateau at least, the production of adakite-like potassic rocks in postcollisional settings can be best explained by such a model.