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Interactions between the subducting slab and the mantle wedge during adakite petrogenesis: experimental constraints at 1.5-4.0 GPa

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Adakite magmatism in modern subduction zones is most often attributed to partial meltingof basaltic oceanic crust during prograde metamorphism and dehydration of the subductingslab of oceanic lithosphere, hence the term "slab melting" is almost synonymous with "adakite petrogenesis". Yet comprehensive constraints on the nature and impact of reactions between slab-derived melts (i.e., adakites) and peridotite in the overlying mantle wedge are lacking. In order to address this deficiency, we have begun a systematic experimental study of adakite melt-mantle peridotite interactions and their effects on the composition of "pristine" adakite melts, and on the mineralogic constitution of the mantle wedge, by considering the following variables, in descending priority: (1) temperature, (2) what we refer to as the "effective melt:rock ratio" (after Rapp et al., 1999), which in practical terms for the experiments, means the ratio of adakite melt to peridotite rock, (3), pressure, and (4) water content. A synthetic tonalite glass was first prepared from oxide and carbonate components; this glass was then spiked with a range of trace elements (e.g., U, Th, Pb, Ba, Sr, REEs, Y, Nb, Zr and Ni) at concentrations of 100-1000 ppm and hydrated with 9-10 wt% H2O in an internally-heated pressure vessel at 2.5 kbar and 900°C. This hydrated, trace element doped adakite glass was then mechanically mixed in variable proportions (\sim 20-60 wt% glass) with a natural depleted peridotite from the Kamchatka subarc mantle. Initial experiments have been conducted in a piston-cylinder apparatus at 1.6 GPa and temperatures ranging from $\sim 1050^{\circ}$ C to $\sim 1200^{\circ}$ C, using Au sample capsules at lower temperatures and Au80-Pd20 capsules at higher temperatures. Subsequent experiments will be conducted at 2.5-3.0 GPa and 3.5-4.0 GPa. Our preliminary results show that reaction between adakite melt and peridotite take the general form: melt1 (adakite) + olivine –> orthopyroxene +/- amphibole1 + melt2 (hybridized, mg-rich adakite). At melt:rock ratios less than 1:2, adakite melts are fully consumed in modal metasomatic reactions that form Mg-rich orthopyroxene and amphibole; at higher melt:rock ratios (up to 1:1), only small amounts of the initial adakite liquid remain after reaction with peridotite (again, in OPX- and amphibole-forming reactions), and the hybridized liquid retains relatively low Mg-numbers (0.20-0.30) at high SiO2 contents (> 70 wt%). It is only after the melt:rock ratio increases above 1:1 that substantial quantities of high Mg-number (> 0.60), intermediate SiO2 liquids (~58-60 wt%) exist in equilibrium with garnet websterite (garnet + orthopyroxene \pm clinopyroxene) reaction residues. In terms of their major element characteristics, these liquids resemble natural high-magnesian andesites possessing the adakite trace-element geochemical signature. Subsequent efforts will focus on the partitioning systematics of trace elements between minerals and melt in our experiments.