Melting of felsic crust at mantle depth: implications for orogenic ultrapotassic magmatism

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We investigated the phase and melting relations in subducted felsic crust experimentally at pressures from 2.0 to 4.5 GPa and at temperatures from 675 to 1000 °C. The starting material was a slightly peraluminous metagranite from the Dora Maira Massif, Western Alps. Fluid-present experiments produced a dominant paragenesis of coesite/quartz–phengite–clinopyroxene–K-feldspar/K-cymrite ± garnet coexisting with a hydrous silicate melt/supercritical liquid at run conditions. Glass compositions range from granitic to quartz-syenitic. Alkalinity and K/Na increase with pressure and reach peralkaline compositions. Small amounts of allanite, apatite and zircon are present in many experimental runs. Trace element concentrations (LILE, HFSE, REE) of glasses were analysed by secondary ion mass spectrometry and show that solubility of accessory phases increases with increasing pressure, as melt compositions become more alkaline. Allanite strongly controls the LREE–Th budget and causes a high Th/La ratio of up to ~2 in coexisting melts. A high Th/La ratio is a typical feature of orogenic ultrapotassic rocks, such as the lamproites of the Alpine–Himalayan belt, for instance. These magmas originate from melting of lithospheric mantle during post-collisional extension that has been contaminated during a previous stage of subduction. We show that high-pressure silicate liquids released from subducted felsic material already have many major and trace element features typical for ultrapotassic rocks.