Rutile stability and rutile/melt HFSE partitioning during partial melting of hydrous basalt: Implications for Adakite/TTG genesis *

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Synthesis experiments were conducted on a natural basalt (with 2 or 5 wt.% H_2O added) at 1.0-2.5 GPa and 900-1100°C, to investigate the stability field of rutile and rutile/melt HFSE partitioning during partial melting of hydrous basalt. The basalt chosen has TiO_2 content close to average N-MORB. 100 ppm of Ta, Nb, Hf, Zr etc. were added to the starting composition in order to improve analytical precision with the LAM-ICP-MS and the electron microprobe.

Rutile occurs in the partial melting field of hydrated basalt at pressures higher than approximate 1.5 GPa, depending on H_2O content and bulk composition (especially TiO_2 and K_2O). Its stability increases with increasing pressure and decreasing temperature. H_2O helps produce a more mafic melt and so results in dissolution of rutile and shrinkage of the P-T field of rutile crystallization.

The rutile/melt partitioning results confirm previous observations (Green and Pearson, 1987; Jenner et al., 1993; Foley et al., 2000; Schmidt et al., 2004), including that rutile is a dominant carrier for Nb and Ta, and that rutile favours Ta over Nb with D_{Nb} always lower than D_{Ta} for each rutile/melt pair. In addition our experiments demonstrate that both D_{Nb} and D_{Ta} decrease with increasing H_2O content but increase with decreasing temperature.

Rutile is a necessary residual phase during the generation of modern adakite and Archean tonalite-trondhjemite-granodiorite (TTG) magmas to account for the negative Nb-Ta anomaly in these magmas. The depth for TTG production via melting of subducted oceanic crust must be more than 45 - 50km based on the approximate 1.5 GPa minimum-pressure for rutile appearance. Rutile fractionates Nb from Ta and will result in slightly higher Nb/Ta in coexisting liquids. Archean TTG magmas with subchondritic Nb/Ta must, therefore, have been derived from low Nb/Ta source regions unless alternative magmatic processes have lowered the Nb/Ta ratio. Also rutile-bearing residues should display lower Nb/Ta after TTG liquids are extracted. Hence, the present data do not support the view that subducted rutile-bearing eclogitic oceanic crust is a superchondritic Nb/Ta reservoir on Earth.

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