The eclogite mantle reservoir: $^{176}Hf/^{177}Hf$, Nb/Ta and Zr/Hf of rutile

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Some eclogitic xenoliths may represent recycled material, and thus may provide information on subduction components in the mantle. Such mantle rock types are also subject to modification by mantle fluid processes. We analysed Hf isotopic and trace-element compositions of eclogitic rutile by LAM MC ICPMS and ICPMS to obtain new constraints.

Zr/Hf in rutile (n=11) varies from 19.6 to 61.9 (mean: 40.1) and Nb/Ta from 10.3 to 39.5 (mean: 23.7; chondrite: 34.3 and 19.9, respectively, Münker et al., 2003). $^{176}Hf/^{177}Hf$ in single samples is extremely variable (within-sample ε_{Hf} variation in ten samples averages 84), due to low Lu/Hf in rutile and partial isotopic equilibrium with high-Lu/Hf garnet. Mean $^{176}Hf/^{177}Hf$ broadly correlate with whole-rock Lu/Hf.

Zr/Hf and Nb/Ta in rutile are weakly anti-correlated (r^2 = 0.37) and 8 of 11 samples have Nb/Ta > 20, contrary to the positive correlation and subchondritic Nb/Ta observed for samples from the major terrestrial reservoirs (Münker et al., 2003). Subchondritic Nb/Ta is associated with high long-term whole-rock Lu/Hf and $^{176}Hf/^{177}Hf$ ascribed to rutile+garnet-controlled melt depletion (Schmidt et al., 2004). Super-chondritic Nb/Ta, low $^{176}Hf/^{177}Hf$ and variable Zr/Hf are associated with whole-rock HFSE abundances >> potential crustal protoliths. The enriching agent may be representative of a metasomatised, high-Nb/Ta subcontinental lithospheric mantle component as seafloor weathering and subduction-related processes are not expected to entail HFSE addition.

References

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Depth of andesitic magma storage beneath Mt. Mazama from melt inclusions and experimental petrology

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Crystal-rich andesitic scoriae erupted after rhyodacitic pumice during the ~7700 calendar year B.P. eruption of Mt. Mazama, Crater Lake, OR, are characterized by their distinct modal mineralogy and Sr concentration in plagioclase, amphibole and matrix glass. Climactic andesite includes: high-Sr scoria (modal hbl > cpx + opx), later erupted low-Sr scoria (modal cpx + opx > hbl), and olivine + pyroxene-rich scoria the most mafic material erupted. Total dissolved H_2O in homogenized, olivine- and pyroxene-hosted andesitic melt inclusions (MI) measured by FTIR, range from 2.4 wt.% to 6.3 wt.%. High-Sr MI (>1270 ppm) contain from 3.4 to 6.3 wt.% H_2O. Pre-eruptive temperatures calculated for high-Sr MI range from 936°C to 992°C (liquid thermometer of Sisson and Grove 1993) and overlap new temperatures from touching ilmenite-titanomagnetite pairs (890°C to 945°C using QUILF) in high-Sr scoria. Dissolution of 6.3 wt.% H_2O in high-Sr andesitic melt requires ~2.3 to 2.4 kbars total pressure at 950°C to 975°C equivalent to 9-11 km depth, with final storage at ~6 km.

Water-saturated experiments were conducted at 2-2.3 kbars between 950°C to 990°C ($logfO_2$ from NNO+1 to NNO+2) on representative high-Sr and low-Sr compositions. Amphibole identical in composition to that in natural samples is stable in water-saturated high-Sr andesitic melts at 950°C to 975°C, and up to 950°C in low-Sr melts. Olivine composition in 975°C experiments (Fo80) matches that of host olivines containing high-Sr MI. Glass compositions in 950°C to 975°C experiments closely match those of MI's.

Reference

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