Peridotite xenoliths from the andesitic Avacha volcano, Kamchatka – Any signatures of subduction metasomatism?

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We report chemical data, Os- and Li-isotope ratios, PGE abundances and fO_2 estimates for peridotite xenoliths from the active Avacha volcano in southern Kamchatka peninsula, Russia. The rocks are large, fresh and homogeneous spinel harzburgites that contain accessory interstitial cpx and amphibole as well as highly variable amounts of fine-grained, second-generation orthopyroxene (opx). None of the samples have intrusive magmatic or metasomatic veins.

Major and trace element compositions were obtained for 17 peridotites. The whole-rocks contain 0.4-0.9% Al_2O_3, 0.5-0.9% CaO, ≤0.03% Na_2O, ≤0.01% K_2O; Mg# = 0.906-0.916. They are highly refractory rocks produced by high degrees of melt extraction, but their Mg# are lower than in many other (Ca,Al)-poor mantle peridotites. The Avacha xenoliths have low HREE and are depleted in LREE and MREE relative to HREE. The rocks show minor enrichments in Rb, Ba, U and Sr relative to adjacent REE but no significant Zr, Nb or Ti anomalies. Overall, they show no enrichment patterns considered typical of “subduction” metasomatism.

The rocks have 2.7 to 9.6 ppb Os; $^{187}Os/^{188}Os$ range from 0.1235 to 0.1319 and are positively correlated to Al contents. This “alumichron” is not likely to be related to ancient melt extraction. Rather, it may reflect a correlation between the amounts of slab-derived radiogenic Os and those of late-stage amphibole and pyroxenes added by percolating fluids. Li abundances in whole-rocks, olivine and opx range from 0.8 to 1.8 ppm, i.e. match estimates for melting residues. δ^7Li range from -2 to +4.7‰, with averages for olivine, opx and WR from +1.7 to +2.7‰, i.e. are within the range reported for oceanic basalts and “normal” mantle. $\Delta\log fO_2$ determined using measured Fe^{3+}/Fe^{2+} in spinels are FMQ +0.1 to +1.8.

Relatively high fO_2, Os abundances and $^{187}Os/^{188}Os$ in several Avacha peridotites might be related to enrichments by slab-derived fluids but these are decoupled from trace element and Li-isotope signatures, which show no or little evidence for metasomatism. The slab-derived fluids may be largely consumed by reaction with wall-rocks in the lower mantle wedge, with only small amounts of residual fluids occasionally reaching the shallow uppermost mantle sampled by the Avacha xenoliths.

Re-Os evidence for ancient mantle beneath the Ontong Java Plateau

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We have carried out a Re-Os isotope study of a suite of peridotite xenoliths from Malaita, Solomon Islands in order to better understand the nature and formation of oceanic lithosphere beneath the Early Cretaceous Ontong Java Plateau (OJP). Thermobarometric and petrochemical evidence reveal that the xenoliths represent virtually the entire section of subplateau lithospheric mantle (<120 km) which is stratified in compositional [1]. Os isotope data have been obtained for samples covering the whole range of *P-T* and depletion.

Whole-rock analyses of peridotites from the shallow part of the lithosphere (<95 km) yield an average $^{187}Os/^{188}Os$ ratio of 0.1247 (n=15) and a range from 0.1223 to 0.1272, illustrating an affinity with abyssal peridotites (whole-rock mean ~0.1246) [2]. This is consistent with previous Sm-Nd results indicating a recent (Jurassic) mid-oceanic ridge origin for the shallow lithosphere [3]. By contrast, the deep-seated peridotites (>95 km) show much greater variation in Os isotope composition that is correlated with differences in rock types: garnet lherzolites have limited $^{187}Os/^{188}Os$ variations (0.1244-0.1254); spinel harzburgites record unradiogenic $^{187}Os/^{188}Os$ ratios (0.1174-0.1196); Fe-rich garnet lherzolite from the deepest portion possesses the most unradiogenic ratio (0.1156). These unradiogenic ratios yield Proterozoic model T_{RD} ages of 1.2-1.8 Ga, demonstrating the existence of ancient mantle in the basal section of subplateau lithosphere.

There are several potential explanations for the diversity of ancient Os signatures found in these OJP peridotites. (i) Continental mantle was tectonically incorporated to the newly forming oceanic plateau, analogous to the scenario suggested for the Kerguelen plateau mantle [4]. (ii) The OJP lithosphere may be sampling the inherent isotopic variability of the oceanic mantle as represented by abyssal peridotites, which overlaps the range reported here (extending to $^{187}Os/^{188}Os$ as low as 0.110 in sulfide grains from abyssal peridotites [5]). (iii) The depleted Os isotope compositions may reflect recycled heterogeneity within the upwelling plume source, as suggested recently for Hawaii [6]. Option (iii) may best explain the absence of old continental materials around the OJP, the contrasting Os isotope ratios between shallow and deep lithosphere, and the presence of recycled pyroxenite of Proterozoic age in the basal lithosphere [7]. Thus, the OJP may have been generated by mantle plume consisting of a mix of ancient, depleted, recycled Proterozoic lithosphere.

References

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