Transformation of continental lithosphere above the Afar plume: PGE and Re-Os isotopes in mantle xenoliths from Ethiopia

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We determined platinum-group element (PGE: Os, Ir, Ru, Pt, Pd) abundances and Re–Os isotope systematics for well-characterized mantle xenoliths hosted in Cenozoic basalts from the northwestern plateau (Gundeweyn area) and southern rift zone (Dillo and Megado areas) of Ethiopia in order to improve our understanding of the nature and timing of processes leading to the formation and transformation of subcontinental lithospheric mantle (SCLM) due to plume-lithosphere interaction beneath the East Africa rift. The whole-rock PGE concentrations are highly variable, with total PGE abundances ranging from 6.6 to 12.6 ppb for Gundeweyn, 11.5 to 23.3 ppb for Dillo, and 9.9 to 19.4 ppb for Megado xenoliths. Whole-rock $^{187}Os/^{188}Os$ vary from 0.1180 to 0.1287 for Gundeweyn, 0.1238 to 0.1410 for Dillo and 0.1165 to 0.1277 for Megado, compared to 0.130 for the Afar plume. The oldest Re-depletion ages are 1.45 Ga for Gundeweyn, 0.64 Ga for Dillo and 1.65 Ga for Megado.

PGE-$^{187}Os/^{188}Os$ systematics reveal interesting regional differences: Low PGE abundances in the plateau (Gundeweyn) reflect scavenging by early small-volume oxidizing melts, generated in the convecting mantle ahead of the arrival of the Afar plume. In contrast, percolation of late-stage silicate/basaltic melts associated with plume impingement and lithosphere thinning in the rift led to refertilization and sulfide precipitation, with replenishment of the PGE and convecting mantle-like $^{187}Os/^{188}Os$ at Dillo. Local enclaves of older, cryptically metasomatised mantle with unradiogenic Os (Megado) attest to the heterogeneous nature of melt-peridotite interaction at this stage. Overall highly depleted abundances of the compatible PGE are characteristic of SCLM affected by incipient rifting and percolation of oxidizing melts, here associated with the Afar plume focused beneath the East African rift, and may be precursors to advanced degrees of lithosphere destruction/transformation.