Geochemical evolution of sub-continental lithospheric mantle of Ethiopian plateau and rift zone

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Petrography based on detailed geochemical analyses were made on clinopyroxene (cpx) separates from spinel lherzolite and harzburgite xenoliths hosted in the Cenozoic basalts of Ethiopian Plateau (Gundweyn area) and rift zone (Dillo and Megado areas). The peridotites show fertile to refractory character in olivine Fo (87–91) and spinel Cr# (8–59). On a chondrite-normalized REE diagram, lherzolite cpxs show both LREE-depleted and -enriched patterns with higher HREE abundances than harzburgite cpxs that reveal LREE-enriched patterns. The degrees of LREE depletion and enrichment are similar to those of the Arabian cpxs, but different from those of abyssal peridotite cpxs. The $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ of the lherzolite cpxs range from 0.51285 to 0.51370 and 0.28289 to 0.28385, respectively. Some cpxs show higher $^{176}Hf/^{177}Hf$ than the DMM values. The Sm-Nd and Lu-Hf average model ages for LREE-depleted are 0.5 and 1.2 Ga for plateau cpx and 0.6 and 2.1 Ga for rift cpx, respectively. Back calculated Nd and Hf isotopic ratios using these model ages plot away from the field of MORB, indicating that these lherzolites could be produced by melt extraction from the asthenosphere during and/or before the Pan-African orogenic event. The peridotite compositional variations combined with pressure-temperature estimations show three layers of sub-continental lithospheric mantle (SCLM) that exist beneath the Ethiopian plateau and rift zone. From top to bottom these are accreted, modally metasomatized and modally-crypticallymetasomatized SCLM which are mainly made from fertile lherzolites with depleted Nd-Hf isotopic compostions, LREE-enriched lherzolites and refractory harzburgite, respectively. There is no much significant difference between the accreted and the metasomatized cpxs in $^{87}Sr/^{86}Sr$ ratios. This suggests that the metasomatic agents were mainly derived from asthenospheric mantle. Overall, mineralogical and isotopic compositions of peridotite xenoliths showed heterogeneity of the SCLM under Ethiopia. Such heterogeneity could be resulted from various degrees of melt extraction of the SCLM and then metasomatism by melts from asthenosphere.