Osmium isotopic compositions of mantle xenoliths in east China: Implications for continental lithospheric mantle beneath China

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Geochemical and isotopic data on mantle peridotite xenoliths provide key constraints on the evolution of lithospheric mantle beneath the thick continental crust. Especially, Os isotopes could give us information on the age of continental roots (Peason, 1999) and genetic relation of the lithosperic mantle to the ovelying continental crust. The continental crust was possibly formed by extraction from primitive upper mantle to form both the lithospheric mantle and the continental crust. Here we report both Re and Os abundance and Os isotopic compositions of 13 peridotite xenoliths collected from Cenozoic continental basalts which are widely distributed in eastern China, where they form an important part of the circum-Pacific volcanic belt.

The samples were analyzed using the method of Suzuki and Tatsumi with some modification. Rhenium and Os abundance obtained for the xenolith samples range from 30 to 350 ppt and from 600 to 4750 ppt, respectively. The 187Os/188Os ratios of these samples range from 0.1140 to 0.1391. The xenoliths except for garnet lherzolites form positive correlation in 187Os/188Os ratio vs. Al2O3 space. The Al2O3 content is one of the depletion factor for peridotite. The Al2O3 and 187Os/188Os data for these samples were regressed. The trend was extrapolated up to a fertile composition Al2O3 content of 4.2% (w/w). Results show intercepts of 187Os/188Os at the fertile Al2O3 composition is 0.1300, which is in the range of the 187Os/188Os ratio of the global primitive upper mantle (0.1296 +/- 0.008, Meisel et al., 2001). A similar value (0.1301) is reported for the most fertile Vitim samples (Pearson et al., 1998). The 187Os/188Os ratio obtained in this study likely represents the 187Os/188Os ratio of the lithospheric mantle beneath China.

Proterozoic model depletion ages ranging from 1.8 Ga (San Quintin) to 1.3 Ga (southwestern United States) were proposed for the sub-continental lithospheric mantle (SCLM) sources of these xenolith suites on the basis of the Re depletion model age of the y-axis intercept in the Al2O3 vs. 187Os/188Os diagram (Meisel et al., 2001). On the basis of the same type of model age calculation, the y-axis intercepts in the Al2O3 and 187Os/188Os space of the xenoliths from eastern China is 0.1144, which results in the Re depletion age of 1.9 Ga. This y-axis intercept can most easily be explained by melt depletion events of most spinel-bearing mantle xenolith systems. The depletion ages obtained by Meisel et al. (2001) and in this study range from 1.9 Ga to 1.3 Ga. The intense melt depletion and formation of SCLM recorded in these suites could be the consequence of an important continental crust–forming period that occurred globally while the Earth was still sufficiently hot, which may be inconsistent with some estimates of continental crust growth. According to Nagler and Kramers (1998), most of the continental crust (ca. 70%) were formed before 2.0 Ga, whereas the Al2O3 and 187Os/188Os regression ages indicate that a significant amount of SCLM was formed after 2.0 Ga, as pointed out by Meisel et al. (2001). If it is assumed that the SCLM Os model ages are accurate, then the continental crust may have served as an anchor for the later-forming SCLM. This implies that the continental crust and the underlying SCLM are complementary neither in chemical composition nor in age.

No distinct correlation can be seen in the 187Re/188Os vs. 187Os/188Os diagram (isochron) of the xenoliths, implying that Re was lost or added in later alteration stage, indicating open system behavior of Re. Alternatively, these xenoliths posses no age-relationship one another.