Multiple events in the Neo-Tethyan Oceanic upper mantle: Ru-Os-Ir alloys in the Luobusa and Dongqiao ophiolitic podiform chromitites, Tibet

Rendeng Shi[a,b], Xiachen Zhi[a], Suzanne Y. O'Reilly[c], William L. Griffin[c], Norman J. Pearson [c], Wenji Bai[d], Qingsong Fang[d], Olivier Alard[c], Ming Zhang[c]

[a)] *CAS Key Laboratory of Crust-Mantle Materials and Environments, School of Earth and Space Sciences, University of Science and Technology of China, Hefei, 230026, China*

[b)] *State Key Laboratory of Mineral Deposit Research, Nanjing University, Nanjing, 210093, China*

[c)] *GEMOC ARC National Key Centre, Department of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia*

[d)] *Institute of Geology, Chinese Academy of Geological Sciences, Beijing, 100037, China*

Ru-Os-Ir alloys were separated respectively from the Luobusa and Dongqiao ophiolitic podiform chromitites, Tibet and analysed for major and platinum group elements, and $^{187}Os/^{188}Os$ compositions (*in situ*) to trace the origin of the podiform chromitite deposits and estimate the Os isotopic composition of the sections of Mesozoic upper mantle. Individual alloy grains contain less than 5 wt% Ru and show limited major compositional variations. Most alloys can be subdivided into osmiridium and iridosmine on the basis of the IMA system of nomenclature. The $^{187}Re/^{188}Os$ ratios of the Ru-Os-Ir alloys are much lower than 0.001 and the $^{187}Os/^{188}Os$ ratios of individual grains are isotopically homogeneous at the 0.1% level of resolution. In the Luobusa ophiolite, the $^{187}Os/^{188}Os$ ratios of the entire suite of grains range from 0.12620 ± 4 to 0.12672 ± 6 (1σ), the average ratios for all grains (n=145) combined are 0.12645 ± 2 (1σ). Based on the Enstatite Chondritic Reservoir (ECR), the Re-depleted model ages (T_{RD}) of the Ru-Os-Ir alloys are from 197 to 270 Ma, consistent with the Neo-Tethyan Ocean opening between Permian and Triassic time, and also supported by the Sm-Nd age of 177 Ma for the gabbroic-diabasic dykes intruded in the chromitite and peridotites. In contrast, the $^{187}Os/^{188}Os$ values of the grains from the Dongqiao ophiolitic chromitite form two groups. Whole rock Re-Os data for the chromitite also fall into two groups; *Group I* $^{187}Os/^{188}Os$ ranges from 0.12616 ± 5 to 0.12664 ± 3 (1σ) and the T_{RD} of the alloys (using ECR) range from 208 to 276 Ma, a little older than the Luobusa ophiolite and consistent with the Neo-Tethyan Ocean opening time; *Group II* $^{187}Os/^{188}Os$ ranges from 0.12003 ± 5 to 0.12194 ± 3 (1σ) and the T_{RD} shows a wide range from 871 to 1139 Ma. Therefore, the Re-Os isotopic characteristics of the Ru-Os-Ir alloys from the Luobusa and Dongqiao ophiolites are consistent with the following: 1) both the Luobusa and Dongqiao ophiolitic podiform chromitites likely originated as a mantle melting residue in the late Permian to early Triassic time; 2) the Yarlung Zangbo and Bangong Lake Neo-Tethyan Oceans opened nearly simultaneously; 3) the $^{187}Os/^{188}Os$ value for this part of the Mesozoic upper mantle ranges from 0.12639 ± 4 to 0.12645 ± 2 (1σ); and 4) the mantle represented by Dongqiao ophiolite contains material with the geochemical signature of old lithopshere and may be relict ancient subcontinental lithospheric mantle from beneath the Rodinian continent.

Keywords: $^{187}Os/^{188}Os$ mantle composition; Ru-Os-Ir alloys; upper mantle; podiform chromitite; Luobusa ophiolite; Dongqiao ophiolite; Tibet

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