Noble gas compositions of the mantle-derived xenoliths from Cenozoic volcanic area in the Northeastern China

Sun Jinggui\(^1\), Aya Shimizu\(^1\), Hirochika Sumino\(^1\), Keisuke Nagao\(^1\), Chen Junqiang\(^2\) and Zhao Junking\(^2\)

\(^1\) Laboratory for Earthquake Chemistry, Graduate School of Science, University of Tokyo, Japan. \(^2\) College of Earth Science, Jilin University, Changchun, China

In this study we measured He-Ne-Ar isotopic compositions of fluid inclusions in minerals in the mantle-derived ultramafic xenoliths collected from Yitong and Jiaohe of typical Cenozoic volcanic areas, Jilin province of Northeastern (NE) China, to characterize the noble gases signature of subcontinental lithospheric mantle (SCLM) beneath the Xing’an Mongolian orogenic belt. The He, Ne and Ar isotopic compositions obtained by crushing olivine, orthopyroxene and clinopyroxene separates from the xenoliths showed wide variations indicating heterogeneous distributions of originally trapped and in situ produced radiogenic noble gases. The \(^3\)He/\(^4\)He ratios reported so far for mantle-derived xenoliths from Huinan, Baitoushan, and Longquan in the Jilin and Heilongjiang province situated on the NE China craton and east part of Mongolian orogenic belt are in the range of 6.1-9.2, 7.1-7.7 and 5.9-6.0 Ra (Ra is the atmospheric ratio of 1.4×10^{-6}), respectively [1, 2].

Based on the \(^3\)He/\(^4\)He ratios with Ne and Ar isotopic features, we can consider two different mantle sources for noble gases; one is similar to the MORB source (8±1 Ra) with values ranging from 7.8 to 9.2 Ra, and another is characterized by low \(^3\)He/\(^4\)He ratios ranging 5.0-6.1 Ra. The MORB-like source is, however, dominated by atmospheric noble gases with only a weak mantle signature such as slightly high \(^{20}\)Ne/\(^{22}\)Ne, \(^{21}\)Ne/\(^{22}\)Ne and \(^{40}\)Ar/\(^{36}\)Ar ratios. This is probably related to metasomatised upper mantle reservoirs caused by ancient subduction of oceanic plate beneath the continental margin of northeastern part of China. For the second reservoir with low \(^3\)He/\(^4\)He ratios, we suggest that the fluid in minerals from the xenoliths shows feature for the older SCLM. Considering the formed age of SCLM beneath NE China [3] and associated tectonic settings, radiogenic \(^{4}\)He and \(^{40}\)Ar accumulated in the older SCLM have decreased \(^3\)He/\(^4\)He and increased \(^{40}\)Ar/\(^{36}\)Ar ratios.

The noble gas data obtained in this work suggest that the SCLM beneath NE China is complex body on the geochemical structure with the evolution via multiple processes. Though noble gas data representing the older SCLM fluids in mantle-derived xenoliths, our noble gas study implies that the older SCLM underlying the NE China has been largely removed by underplating of basaltic magmatism and fluids, which associated with subduction of oceanic slab. This might have occurred in Xing’an Mongolian orogenic process or during the circum-Pacific process, or during both periods.

References