Isotopic compositions of noble gas and carbon in the Archean carbonatites from the Sillinjärvi mine, central Finland

TAKUYA MATSUMOTO[1] , TERUYUKI MARUOKA[2], JUN-ICHI MATSUDA[1], GEN SHIMODA[3], KOSHI YAMAMOTO[4], TOMOAKI MORISHITA[5] & SHOJI ARAI[5]

[1] Department of Earth and Space Scicence, Osaka University, Japan ; matsumoto@ess.sci.osaka-u.ac.jp
[2] Tsukuba University, Japan
[3] Geological Survey of Japan
[4] Nagoya University, Japan
[5] Kanazawa University, Japan

In order to obtain noble gas isotope composition of the Archean mantle, we have analyzed noble gases in mineral separates from Archean cabonatities collected in the Sillinjärvi carbonatite complex which is located in eastern Finland close to the city of Kuopio. The carbonatite within the Siilinjärvi complex occurs as a central tabular 600-700 m wide body of calcite and dolomite-bearing phlogopite rocks running the length of calcite- and dolomite-bearing phlogopite rocks running the length of the complex surrounded by a fenite margin. Majority of rock type in this complex is phlogopite-rich rocks. Typical modal composition is: 65% phlogopite, 20% carbonates (with a 4:1 calcite: dolomite ratio, 5% richterite and 10% apatite (with other relatively minor accessory minerals include narite, strontianite, monazite, pyrochlore, baddeleyite, ilmetnite, magnetite, pyrite etc…). A concordant zircon U-Pb age of 2609 ± 6 Ma (Lukkarinen et al., 2003) shows that Siilinjärvi is one of the oldest carbonatites in the world. However, their ultimate origin, whether they are from mantle or from crust, is still an open question. We collected samples from the bottom of the currently active mining pit in 2003. Thus, the samples are only recently excavated, ensuring that these samples are less susceptible to the air-addition by alteration and to the augmentation of cosmogenically produced isotopes (such as He-3 and Ne-21). We analyzed full set of noble gas isotopes from mineral separates (apatite, phlogopite, richterite, carbonates and magnetites) by stepped crushing or by the stepped heating gas extraction. Noble gases released by crushing appeared to be highly enriched in radiogenic isotopes. In addition to noble gases, some of the samples (apatite and carbonates) are subjected to the carbon isotope analysis as well. The range of $\delta^{13}C$ values are consistent with their mantle origin, but apparent absence of mantle-derived noble gas might indicate they had been affected by some secondary processes which modified or masked the inherited noble gas signatures of these samples.