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Systematic differences of I/Br ratios in kimberlites related to their origin

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Kimberlite is an igneous rock originated from deep mantle. Compared to common ultramafic rocks, kimberlites are rich in volatile components such as water and carbon dioxide. Because kimberlites are known to contain diamonds, it has been generally thought that their magma sources are located at a depth of more than 150km (e.g., Dawson, 1980). In addition, studies on the noble gas isotopes in kimberlites showed that kimberlite magmas have similar noble gas characteristics to those of ocean island basalts (OIBs; e.g., Sumino et al., 2006). Based on noble gas isotopic compositions of mid-ocean ridge basalts (MORBs) and OIBs, primordial noble gases still remain in the Earth's interior (e.g., Craig and Lupton, 1976; Kaneoka et al., 1978). Therefore, primordial components of other volatile elements including halogens might also be retained in the Earth's interior and be found out by analyzing kimberlites. In this study, we analyzed concentrations of Cl, Br, and I in kimberlites from six regions to investigate the characteristics and their origins.

Samples analyzed are 34 kimberlites collected from South Africa, China, Greenland, Brazil, Russia and Canada. For the Cl, Br and I determination, we used the pyrohydrolysis method combined with ICP-MS (Muramatsu and Wedepohl, 1998) and ion chromatography.

The I/Br ratios of kimberlite samples were classified into two groups. The first group (Group S) showed high I/Br ratios (about 1 x 10^{-1}), which are distinctively observed in the kimberlites from South Africa, Greenland, Canada and Brazil. The I/Br ratios of Group S are fairly similar to that of CI chondrite (I/Br ratio: about 1 x 10^{-1}, Anders and Ebihara, 1982), suggesting these kimberlites preserve the characteristics of halogens in the mantle from which the kimberlite magmas formed. In contrast to this, a group (Group C) composed of Chinese and Russian kimberlite samples showed markedly low I/Br ratios (about 6 x 10^{-3}). Similar low I/Br ratios have been observed in fluid inclusions in eclogite derived from seawater-altered oceanic crust (Svensen et al., 2001) and in seawater associated with halite precipitation (Zherebtsova and Volkova, 1996), suggesting an involvement of seawater-derived halogens having low I/Br ratios in the source regions of the Group C kimberlites.

Keywords: kimberlite, halogen, I/Br ratio, South Africa, China, Russia