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

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Kimberlite is an igneous rock originated from deep mantle. Compared to ordinary ultramafic rocks, kimberlite is rich in volatile components such as water and carbon dioxide. 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 (e.g., Sumino et al., 2006).

The halogen elements (chlorine, bromine, iodine) have high aqueous fluid-silicate melt partition coefficients (Bureau et al., 2000). Thus, they (especially iodine) are enriched in pore fluid and have distinct elemental ratios in seawater, pore fluid, sediment, oceanic crust and mantle. Moreover, these elements are used as good tracers for pore-fluid subduction (e.g., Fehn et al., 2003; Muramatsu et al., 2007). Recently, halogens are revealed to be one of the reliable tracers for water cycling in subduction zones (Sumino et al., 2010). In this study, we analyzed concentrations of Cl, Br, and I in kimberlites and mantle-derived xenoliths from six localities to investigate the halogen characteristics and their origins in the kimberlite source regions.

Samples analyzed are 35 kimberlites collected from South Africa, China, Greenland, Brazil, Russia and Canada, and 4 xenoliths collected from South Africa and Russia. For the Cl, Br and I determination, we used the pyrohydrolysis method (Muramatsu et al., 2008) combined with ICP-MS and ion chromatography.

The result shows that the kimberlite samples are classified into two groups with respect to I/Br ratios. The first group (Group S) shows high I/Br ratios (about 1 x 10^{-1}), which are distinctively observed in the kimberlites from South Africa, Greenland, Canada and Brazil. The xenolith from South Africa is also classified into the Group S. In addition, the I/Br ratios of the Group S are fairly similar to that of CI chondrite (I/Br ratio: about 1 x 10^{-1}, Anders and Ebihara, 1982). This suggests that these kimberlites preserve the characteristics of halogens in the mantle from which the kimberlite magmas formed. On the other hand, the other group (Group C) composed of Chinese and Russian kimberlite samples shows markedly low I/Br ratios (about 6 x 10^{-3}). Similar low I/Br ratios have been observed in fluid inclusions in eclogites derived from seawater-altered oceanic crust (Svensen et al., 2001) and in seawater associated with halite precipitation (Zherebtsova and Volkova, 1996). This suggests 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 raito, South Africa, China, Russia