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キンバーライト中の揮発性元素：深部マントル起源の可能性を示す指標
Volatiles in kimberlites:an indicator of possible deep mantle origin

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Kimberlites are well known to bear diamonds and their magmas are regarded to have been derived from a depth of at least more than 150km. They are found only in old continental areas and the exposed areas at the surface are quite limited to a diameter of less than 2km in most cases. Although their distributions are quite sparse, they have quite unique characteristics in their chemical and isotope compositions.

In spite of ultrabasic properties, they bear abundant volatiles such as H2O, CO2, halogens, sulfur and they also contain relatively abundant LIL elements. On the other hand, they show more abundant concentrations of Os and Ir compared to those of other kinds of lavas such as MORBs (mid-oceanic ridge basalts) and OIBs (oceanic island basalts). Their magmas are generally regarded to have been produced in relatively less oxidized environments compared to MORBs, OIBs and IABs (island arc basalts). Hence, it is a quite significant issue to clarify the origin of volatiles in kimberlite magmas, which might be related to the chemical circumstances of deep mantle.

Based on Sr-Nd isotope systematics, kimberlites are classified in two groups (Smith, 1983). In the 87Sr/86Sr-143Nd/144Nd diagram, Group I kimberlites are relatively concentrated in an area which is close to the Bulk Earth value. In contrast, Group II kimberlites are located in an area of typical enriched character and widely scattered. Most kimberlies are regarded to belong to Group I. Since Group II kimberlite magmas show the effect of recycled materials with an enriched character, volatiles in Group II kimberlites might have been also affected from them.

On the other hand, distribution of data of Group I kimberlites on the Sr-Nd isotope diagram implies that the magma source of Group I kimberlites is less fractionated from the assumed Bulk Earth material than those of MORBs. Further, Ne isotopes in kimberlites from Russia indicates that its magma source is similar to those of OIBs isotopically and different from those of MORBs (Sumino et al. 2006). Noble gas signatures of OIBs indicate the occurrence primordial components in the OIB source (e.g.Kaneoka, 2008). The magma source of MORBs has been generally assigned to be located in the upper mantle, while those of OIBs are located at a deeper part than those of MORBs. These signatures suggest that volatiles in Group I kimberlites would probably reflect those of the deep mantle. In effect, some diamonds are regarded to have been derived from the upper part of the lower mantle. Thus, at least Group I kimberlites might contain volatiles including carbon of the lower mantle origin which has not always been recycled.

Further, kimberlite magmas are conjectured to have been erupted directly from a magma reservoir located below the thick continental lithosphere within a few hours so that captured diamonds might not be decomposed during the rise of a kimberlite magma. Hence, it is inferred that chemical contamination for a kimberlite magma might be less compred to that for a OIB magma which would take much longer time to be transported to the surface from a magam reservoir. If so, Group I kimberlites might keep more primary information on the chemical state of the lower mantle compared to OIBs.

References
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