

Kimberlites vs. OIB-Comparison as an indicator for the chemical state of Earth's deep interior

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In order to get the information on the chemical state of Earth's deep interior, it is the most direct way to get materials which reflect such conditions and it gives a significant constraint. Furthermore, it will give a lot of information on the material movements in the mantle through the subduction of slabs and interaction of materials at the core-mantle boundary. As such materials, we are using MORB (mid-ocean ridge basalt) and OIB (ocean island basalt) and many models about the chemical structure of the Earth's interior have been proposed based on their knowledges. In such cases, MORB magmas are regarded to represent

the upper mantle materials and OIB magmas the lower part than MORB magmas. Concerning OIB magmas, however, it is sometimes assumed that they represent those which are located as spots heterogeneously in the mantle.

In case of OIB magma sources, it has often been suggested that they are located from the core-mantle boundary based on information about the isotopic ratios of Hawaiian volcanic rocks and seismic tomography for example. In such a case, OIB is generally assumed to represent the conditions of the magma source. However, there are few trials to examine the validity of such assumption.

Through our study on fresh kimberlites from west Greenland, we have revealed that kimberlite magmas have a source similar to those of OIBs based on high $^3\text{He}/^4\text{He}$ ratios, implying that the source might be located in the lower mantle (Tachibana, Kaneoka, et al., 2003, 2006). It has been reported that Group I kimberlites, into which most kimberlites are grouped, show relatively uniform isotopic ratios close to Bulk Earth including Sr and Nd isotopes. This feature is quite different from those of OIBs which lie on a mixing line between the end-member of MORBs and Bulk Earth or crustal materials. Furthermore, kimberlites reflect the conditions of more reduced state compared to OIBs. Ir concentrations in volcanic rocks such as OIBs and MORBs are in the order of 0.1-0.001 ppb, whereas those in South African kimberlites are reported to be several ppb. In addition, PGE patterns normalized by those of C1 chondrite in MORBs and OIBs are much depleted in Os and Ir which are more siderophile compared to Pt. While those in kimberlites are almost flat. Based on isotopic ratios which include radiogenic isotopes, MORBs and OIBs show different magma sources and magma sources of kimberlites are similar to those of OIBs. On the other hand, PGE patterns of MORBs and OIBs are similar, but those of kimberlites are different. This clearly indicates that PGE patterns do not reflect those of magma sources, but are controlled by the interaction with environmental materials through which magmas ascend.

Since kimberlites transport diamonds to the surface without their decomposition, it has been inferred that kimberlite magmas are derived from the depth of more than 150 km through a lithosphere with a speed of several tens of km per hour. On the other hand, OIB magmas are inferred to ascend gradually through the mantle and dissolve the environmental materials to some extent. To carry PGEs without fractionation to the surface, existence of a phase, probably sulfides, is required. In practice, we have observed the occurrence of sulfides in kimberlites. In case of OIBs, if sulfides exist in their magma source originally, there is a possibility that Os and Ir are selectively depleted compared to Pt on their way to the surface affected by the oxidized environment in the upper part of the mantle. This explains why PGE patterns are similar between MORBs and OIBs. Accordingly, some elemental compositions in OIBs which are susceptible to the oxidation state of environments might have been changed from those of their magma source. Thus, it is conjectured that kimberlites would more directly reflect the chemical state of the lower mantle compared to OIBs.