

Sulfur in the Earth's deep interior and the related circumstances

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Sulfur (S) changes its electric charge depending on the redox state of the surrounding circumstance. However, if it exists abundantly, it reduces the oxygen fugacity. Hence, it is not always easy to identify its chemical form in the Earth's interior. For example, S in a magma might change its chemical state from the site of its genesis during the transport of the magma to the surface. Furthermore, S reacts with the surrounding metals resulting in forming ores. In such a case, S is retained in the Earth's interior and we cannot observe its existence on the surface. This may lead us to estimate its amount less than what really exists. It is generally conjectured that the amount of S in the mantle and crust is depleted compared to that expected from meteorites and the depleted S might be retained in the core. However, we have not enough information about the amount of S, especially in the lower mantle.

It has been revealed that the $^3\text{He}/^4\text{He}$ in kimberlites from southwestern Greenland show higher values of MORBs, suggesting its source to be similar to those of OIBs. This indicates a possibility that the source of kimberlite magmas might be originated from the lower mantle. It is enriched in kimberlites with more than two orders of magnitude compared to those in MORBs and OIBs. Furthermore, PGE patterns of kimberlites normalized to C1 chondrites are not so fractionated as those of MORBs and OIBs. It is generally considered that kimberlite magmas are enriched in incompatible elements due to the small degree of partial melting, but it cannot explain such characteristics of PGEs in kimberlites, since PGEs are chalcophile elements and remained in the residual phase during the partial melting. Hence, there should be some carrier of PGEs in kimberlite magmas and sulfide is the most likely candidate. In practice, we can observe sulfides in kimberlites with EPMA examination. Fractionation of PGEs in MORBs and OIBs might occur during the genesis and transport of magmas to the surface and S might be lost during the processes. On the other hand, it is expected that PGEs in kimberlite magmas might be transported to the surface without losing S due to the rapid upwelling of the magma. This implies that S might be relatively enriched in S at the place where kimberlite magmas are originated. If the magma source of kimberlites exists in the lower mantle as suggested above, this indicates a possibility that S in the lower mantle may be more abundant than that in the upper mantle and the former has more reduced state than the latter.