Noble gas study of kimberlites from West and South Greenland

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Introduction

About the source materials of kimberlites, which are known to transport diamonds to the surface, there have been several hypotheses such as the asthenosphere, the lower part of the upper mantle, the lower mantle, etc.. Further, it has been reported that kimberlites are divided into two groups based on the Sr-Nd isotopic systematics. Group 1 kimberlites are located at an area close to the 'bulk-Earth' in the Sr-Nd isotope diagram, whereas Group 2 kimberlites located in a field where enriched mantle components are assigned.

Although Group 1 kimberlites resemble OIBs in the Sr-Nd isotopic systematics, it is not certain whether the source of Group 1 kimberlites is related to that of a mantle plume or not. Because such Sr-Nd isotopic systematics can be also explained by the mixing of MORB and crustal components. Noble gas isotopic study could reveal whether their source materials resemble OIBs or not because OIBs has higher 3He/4He ratios than those of MORBs and other volcanic rocks.

So far, noble gas studies of kimberlites have been rarely performed because most kimberlites have been severely weathered and altered, so that such kimberlites are not suitable for getting noble gas information. We have performed the noble gas study of kimberlites by using extremely fresh kimberlites.

Samples and experimental methods

Samples used for noble gas study were collected from South and West Greenland. 2 samples are from Pyramidefjeld, South Greenland, erupted around 200Ma, and 5 are from Sarfartoq West Greenland, erupted around 600Ma.

These kimberlites are very fresh and include fresh large olivine crystals (more than 0.5mm). Olivines were hand pickked and after acid treatment of olivine crystals, noble gas isotopes were investigated by degassing with the crushing method. The crushing effiency in each sample was around 30%.

Results and discussion

All samples generally show high He concentrations and relatively low Xe. Most samples from West Greenland show 3He/4He ratios higher than those of MORBs. The sample (W_GR_kim_9) shows the highest value of 26.6+-1.04 R/Ra. On the other hand, samples from South Greenland (S_GR_a,b) show 3He/4He ratios of 4.8-9.7 RA. West and South Greenland samples have 40Ar/36Ar ratios of 886-11500 and W_GR_kim_9 shows the lowest 40Ar/36Ar ratio. South Greenland samples and samples with lower 3He/4He ratio from West Greenland show high 40Ar concentrations. Excess 129Xe compared with the atmospheric Xe has also been remarkably observed for four West Greenland samples.

The high 3He/4He ratio of 26.6 R/Ra follows the trend as Hawaiian volcanos or Iceland samples which show the 3He/4He ratios as high as 30-40 R/Ra, implying that its source could be similar to those of OIBs. Although some samples show relatively low 3He/4He, they are accompanied with high 40Ar concentrations. It is supposed that these kimberlites might contain radiogenic components, which cause the degression of their 3He/4He ratios.

It is intended to investegate present samples further by degassing with the heating method.