

Geochemical studies of kimberlites and their constituent minerals from China and South Africa

C. TOYAMA¹, Y. MURAMATSU¹, H. KOJITANI¹,
J. YAMAMOTO², S. NAKAI³ AND I. KANEOKA³

¹Department of Chemistry, Gakushuin University, Japan
(chi-ki.blue_blue@hotmail.co.jp,
yasuyuki.muramatsu@gakushuin.ac.jp)

²Institute for Geothermal Sciences, Kyoto University, Japan

³Earthquake Research Institute, University of Tokyo, Japan

In order to understand chemical characteristics of kimberlites we have analyzed major and trace elements in 21 samples collected from South Africa and China (Shandong and Liaoning) by ICP-MS (inductively-coupled plasma mass spectrometry). The samples have been revealed to be enriched in such incompatible elements as light REEs, U and Th compared to other ultramafic rocks. Degree of partial melting was estimated by assuming that the kimberlite magma was produced from garnet lherzolite composition. The result has shown that the degree was considerably lower than 1% by using literature values of bulk distribution coefficients. A marked difference in the concentrations of heavy REEs between two Chinese regions suggests that their source materials might have been different, because Shandong samples are much depleted in heavy REE compared to Liaoning ones. The Th/U ratios in the kimberlite samples, particularly the Chinese ones, are much higher than those in MORBs. The I/Br ratios of samples from China have shown significantly lower values than those of South African samples.

Further, we have determined ⁸⁷Sr/⁸⁶Sr and ¹⁴³Nd/¹⁴⁴Nd isotope ratios in samples by MC-ICP-MS (multiple collector inductively-coupled plasma mass spectrometry). The results indicate that present kimberlites can be classified in two groups.

We have also carried out chemical analysis of separated minerals (olivine, serpentine and phlogopite) and matrix (residual of the mineral separation) of kimberlites. The results show that the REEs, U and Th concentrations in serpentine and phlogopite are relatively high. However, they are not sufficient enough to explain the high concentration of these elements in whole rocks. Hence it is inferred that the concentration of these elements in kimberlites would be controlled by minor minerals contained in the matrix. Analytical results by SEM-EDS (Scanning Electron Microscopy Energy Dispersive Spectroscopy) have shown that REEs are concentrated in perovskite and barite, and U in biotite and feldspar.

OH in zircon

DUSTIN TRAIL, JAY B. THOMAS AND E. BRUCE WATSON

Department of Earth & Environmental Sciences, Rensselaer
Polytechnic Institute, Troy, NY 12180, USA

Experiments were performed in simple SiO₂-H₂O-ZrO₂ melts in order to characterize the incorporation of hydrous species into zircon. Preliminary experiments from 1550-1650°C and 1.5-2.5 GPa produce OH concentrations (as H₂O) of 100 ppm or less, as determined by polarized FTIR spectra. Sharp, well-defined IR absorption bands at ~3180 and ~3400 cm⁻¹ are similar to natural zircons [1-3]. In the apparent absence of HOH bending modes, these are interpreted as evidence for OH stretching in the zircon lattice.

In order to gain some insight into the substitution mechanism(s) that support OH in zircon, we synthesized zircons with 1.7 wt% Lu₂O₃ under similar conditions. A ~3100 cm⁻¹ band was detected; if structurally OH, calculations suggest an order of magnitude increase in concentration. Although no ~3400 cm⁻¹ bands were observed in Lu-doped zircons, an overlapping ~3180 cm⁻¹ band may be present. Some zircons from this run product were heated to 1000°C for 64 hrs; this resulted in a decrease in the putative OH concentration by factor of three. In order to further explore whether this band is related to OH stretching, instead of lattice vibration combination modes in perfectly crystalline zircon [1], spectra were collected from two zircons grown by the flux method (i.e., in the absence of water). Pure and Dy-doped zircons were prepared in the same fashion as experimental run products, which also included grains that were heated to 1000°C for 2-3 days. None of these grains yielded identifiable peaks in the OH stretching region (i.e., >3000 cm⁻¹). These tests provide some confirmation that the ~3100cm⁻¹ band is related to structural water, and are not some feature of perfectly crystalline zircon or adsorbed molecular water.

Our measurements of kimberlitic zircon from Botswana, Tanzania, South Africa, and Brazil indicate OH contents of 15-40 ppm, and bands of ~3180 cm⁻¹ and ~3400 cm⁻¹, which corroborate past studies of kimberlitic zircon [1-3]. Experimental characterization of the parameters that control OH incorporation into zircon (e.g., P, T, [REE], a_{H2O}) will provide a new tool to constrain the formation environment of zircons.

[1] Woodhead *et al.* (1991) *Am. Min.*, **76**, 1533-1546.

[2] Nasdala *et al.* (2001) *Am. J of Science*, **301**, 831-857.

[3] Bell *et al.* (2004) *J. of Petrology* **45**, 1539-1564.