Speciation of radiogenic Os in molybdenite

Yoshio Takahashi[1]; Katsuhiko Suzuki[2]

[1] Earth and Planetary Systems Sci., Hiroshima University; [2] IFREE, JAMSTEC

Radiometric dating using various radioactive decay systems has been widely applied to various terrestrial and extraterrestrial materials. In the dating, we can obtain the initial formation ages of rocks only if both parent and daughter elements have been retained in the rocks and minerals during the geological time scale. Before and after the radioactive decay, however, the chemical stabilities of the daughter is usually different from the parent element. Therefore, the retention behavior during geological time scale of the parent and daughter elements can change depending on the chemical characteristics of both elements if the samples have been subject to any alteration and weathering effects during the geological time scale. Strictly speaking, therefore, we need to investigate the local structures of parent and daughter elements in minerals for the precise dating of the minerals. However, there have been few investigations on the local structure of daughter elements.

In this study, we chose 187Re-187Os system in molybdenite for the possible application of this idea. It is well known that initial abundance of Os in molybdenite is often negligible compared with radiogenic Os in old molybdenite minerals rich in Re. Thus, Os in the molybdenite is ideal for studying the influence of radioactive decay on the local structure of daughter element. For this purpose, we employed X-ray absorption fine structure (XAFS) in this study, which may be exclusive method with enough sensitivity and high selectivity to target element. It is possible, however, that normal fluorescence XAFS using semiconductor (usually Ge) detector cannot give XAFS spectra of Os in molybdenite due to its very large Re/Os ratio. Rhenium is the element just before Os in the periodic table. For this reason, we have used crystal analyzer in Laue geometry to extract Os L-alpha emission before the detection by Ge detector (Takahashi et al., 2006).

From XANES and EXAFS spectra, we have investigated local structure of Re and Os in molybdenite (MoS2) from Onganja Mine in S. W. Africa (age: 530 million years). From the spectra, the local structure of Re, such as bond length between Re and S and oxidation state of Re, was identical to that of Mo in the mineral. This shows that Re can be enriched in the molybdenite. On the other hand, the local structure of radiogenic Os in the sample is different from that of Re or Mo in the sample, that is, Os-S bond length is shorter than Mo-S and Re-S bond lengths by more than 0.05 angstrom. In contrast, it was revealed that the structure is similar to that of Os in erlichmanite (OsS2). These results show that the local structure of Os in the molybdenite is decided primarily by the chemical characteristics of Os and the effect of the lattice of original site, where it was stable site for Re before radioactive decay, is less important. If we extend this knowledge to various radioactive decay systems, the present result suggests that the chemical behavior of the daughter atom can be different from the parent atom when the chemical characteristics of the parent and daughter elements are different.

Reference

Y. Takahashi, T. Uruga, H. Tanida, Y. Terada, S. Nakai, and H. Shimizu, Application of X-ray absorption near-edge structure (XANES) using bent crystal analyzer to the speciation of trace Os in iron meteorites, Anal. Chim. Acta, 558 (2006) 332-336.