

A study on the chemical state of radiogenic osmium in molybdenite by sensitive fluorescence XAFS

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For the speciation of trace elements in rocks and minerals, fluorescence XAFS using energy-dispersive Ge detector has been often used. However, due to the upper count limit of the detector, high quality fluorescence XAFS for the trace elements cannot be obtained under intense scattering and/or fluorescence from other predominant elements in the samples. To deal with this problem, we developed a system for fluorescence XAFS using a bent crystal analyzer to selectively extract fluorescence x-rays of a target element, combined with an intense synchrotron radiation source, such as an undulator, which was applied to the speciation of trace Os in rocks and minerals.

In this paper, speciation of Os in molybdenite, often used as a suitable mineral for Re-Os dating, has been studied as an example of the application. Radiometric dating using various radioactive decay systems has been widely applied to various terrestrial and extraterrestrial materials. Although the information is closely related to chemical stabilities of parent and daughter nuclides and the reliability of the radiometric dating, there have been few investigations on the direct identification of the chemical state of the daughter nuclides. In this study, we chose ¹⁸⁷Re-¹⁸⁷Os system in molybdenite for the possible application of this idea, since initial abundance of Os in molybdenite is often negligible compared with radiogenic Os in old molybdenite minerals rich in Re. From XAFS spectra, we have investigated local structure of Re and Os in molybdenite from Onganja Mine in S. W. Africa (age: 530 million years). It was shown that bond length between Re and S and oxidation state of Re were identical to those of Mo in the mineral, which supports 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.

References

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