Accurate LA-ICP-MS determination of HREE abundances in monazite

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Monazite is an useful geochrnonometer and its geochemical composition, especially rare earth element (REE), can provide clues to its genesis. The LA-ICP-MS technique has been widely used for REE analysis. However, determination of heavy-REE (HREE) abundances in monazite using LA-ICP-MS can be challenging, because of the interferences of light-REE (LREE) oxides on HREEs. The interferences are problematic especially for monazites in which HREEs are highly depleted. Accurate determination of HREE abundances in such monazites requires the correction for the oxide interferences. For solution ICP-MS analysis, the correction has been made by assuming a linear relation between Log (MO^+/M^+) and M–O bond energy [1]. It has been shown, however, that the assumption is invalid for LA-ICP-MS analysis [2].

In this study, we have investigated oxide production rates of REE, U and Th during LA-ICP-MS analysis using natural and synthetic REE phosphates as well as NIST SRM 610. Analyses were carried out at gas flow rates from 0.75 to 1.0 L min^{-1}. We found that ThO^+/Th^+ and UO^+/U^+ are identical between natural monazite and NIST SRM 610, indicating that the matrix effect is insignificant for the oxide production rates. We identified two distinct behaviors of oxide formation among the analyzed elements: MO^+/M^+ of Y, La, Ce, Pr, Nd, Gd, Tb, Th and U are sensitive to the changes in gas flow rates, whereas those of Sm, Eu, Dy, Ho, Er, Tm, Yb and Lu are relatively small and almost constant among variable gas flow rates. The distinct behaviors are attributed to the relative significance of oxide dissociation and ionization: the former group elements have M–O bond energies higher than M–O ionization energies. We conclude that the most accurate correction for the REE oxide interferences can be made by the directly measuring MO^+/M^+ of REEs using synthetic REE phosphates. We apllied this correction method to natural monazites and demonstrated its versatility.

[1] Aries et al. (2000) *Geostandard Newslett.* **24**. 19-31.

[2] Kent & Ungerer (2005) *J. Anal. Atom. Spectrom.* **20.** 1256-1262.