

Determination of precise age corrected Sr-Nd-Pb-Hf isotope ratios of the clinopyroxene from Raivave OIB samples

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In Sr-Nd-Pb-Hf isotope analyses of whole rock samples, the leaching technique is used for removing the effect of secondary alteration and contamination from outside environments. Especially for the rock samples collected from sea area, the leaching is indispensable to eliminate the effect of seawater alteration. However, even if the strong leaching condition is applied, it is difficult to remove the altered components completely. In order to overcome this problem, clinopyroxene (CPX) was paid attention because of its early crystallization phase and its high resistibility against alteration. It is expected that the CPX preserve more primitive isotope signature than the leached whole rock samples. Using the CPX sample from ocean island basalt (OIB), Hanyu and Nakamura (2000) and Jackson et al. (2009) revealed the Sr and Nd isotope signature of OIB source mantle. Hanyu et al. (2011; 2014) also analyzed Sr and Nd isotopes as well as Pb and Hf isotopes of CPX to investigate the mantle end-members in the OIB samples from Polynesia and St. Helena.

Parent/daughter (P/D) ratios such as Rb/Sr, Sm/Nd, U/Pb, Th/Pb, and Lu/Hf were used for determining the age-corrected isotope ratios (initial ratios) of Sr, Nd, Pb, and Hf isotopes. The most suitable method for correction is using P/D ratios determined from the same CPX aliquot used for each of the isotope measurements. However, due to the limitation of the decomposition method used for the Pb isotope analysis in our laboratory, there was difficulty in determining the U/Pb and Th/Pb ratios from the CPX aliquot used for the Pb isotope. Therefore, Hanyu et al. (2011) determined the U/Pb and Th/Pb ratios from the whole rock U, Th, and Pb concentrations and partition coefficients, although the Rb/Sr, Sm/Nd, and Lu/Hf ratios were determined from the same CPX aliquot used for the Sr, Nd, and Hf isotope analyses. To overcome the uncertainty using partition coefficients, Hanyu et al. (2014) determined the U/Pb and Th/Pb ratios using the U, Th, and Pb concentrations of the CPX aliquot used for the Sr, Nd, and Hf isotope measurements, although the uncertainty of inhomogeneity in the CPX separates still remained.

In this study, we reexamined our analytical method, especially for the determination of U/Pb and Th/Pb of the CPX separates. We determined the Rb/Sr, Sm/Nd, and Lu/Hf ratios from the CPX aliquot used for the Sr, Nd, and Hf isotope measurements (Sr-Nd-Hf aliquot) and the U/Pb and Th/Pb ratios from the CPX aliquot used for the Pb isotope measurement (Pb aliquot) to determine the precise age-corrected Sr-Nd-Pb-Hf isotope ratios of the CPX sample from the Raivavae OIB samples. Comparisons between the Sr-Nd-Hf and Pb aliquots showed inhomogeneity in the U, Th, and Pb concentrations and revealed 0.34 and 0.88 of $\Delta U/Pb$ and $\Delta Th/Pb$, in maximum. These $\Delta U/Pb$ and $\Delta Th/Pb$ yielded 1052, 61, and 448 ppm in the $\Delta^{206}Pb/^{204}Pb$, $\Delta^{207}Pb/^{204}Pb$, and $\Delta^{208}Pb/^{204}Pb$ when the age correction used was 6 Ma. These $\Delta^{206}Pb/^{204}Pb$ and $\Delta^{208}Pb/^{204}Pb$ were beyond the analytical uncertainty of the standard samples. Therefore, using P/D ratios determined from the same CPX aliquot used for each of the isotope measurements is an important factor for the determination of precise age-corrected Sr-Nd-Pb-Hf isotope ratios of the Raivavae CPX sample.

Keywords: Sr-Nd-Pb-Hf isotopes, CPX, Raivavae, Age correction, P/D ratio