

Report for the Joint Use/Research of the Institute for Planetary Materials, Okayama University for FY2024

2024 fiscal year second term (report on a visit to the IPM in March 2025)

05/25/2025

Category: ☒International Joint Research ☐General Joint Research ☐Joint Use of Facility
☐Workshop

Name of the research project: Lithium Isotope Records of Metamorphic Reactions

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Research report:

Since 2000, I have been involved in study of major and trace elements, and B and Li isotopes in metamorphic rocks, collaborating with Eizo Nakamura and other researchers in the Pheasant Memorial Laboratory. My work with Associate Professor Tak Kunihiro and Chief Supertechnician Tsutomu Ota recently resulted in the 2022 publication of a journal article in the journal *GEOSPHERE* (reference provided below). The paper in *GEOSPHERE* details our work on Li isotope behavior during the growth of ultrahigh-pressure metamorphic garnets in the Western European Alps in Italy. This recently published work focused only on garnets in metamorphosed sedimentary rocks in this region and a natural extension of the work is to

fully consider the major and trace element and Li (and O) isotope compositions of metamorphosed basaltic rocks in the same suite (exposed at Lago di Cignana and Monviso localities, NW Italy; see our study of some of these garnets in King et al., 2004; work conducted at the PML by my Ph.D. student Robbie King). Some Li data already exist for the metabasaltic garnets, resulting from my past visits to the PML. However, the dataset is incomplete and we will need to do additional work to fully investigate the metamorphic reactions that produced the garnets and, in particular, to consider the behavior of Li isotopes during the crystal growth.

The visit to the IPM/PML March 10–23, 2025, focused preliminary on O isotope analyses of the garnets previously analyzed for Li isotopes. A total of four garnets were analyzed (total of 60 analyses), along traverses defined by the spot locations for the previously-conducted Cameca 1280 Li isotope analyses. We are still working on determining the correction factors to account for matrix effects; however, it appears that there are subtle changes in O isotope composition from core to rim in the four garnets.

In this ongoing work, the hypotheses being tested include the following: (1) whether Li isotopes undergo fractionation during diffusion-limited delivery from the matrix to the growing garnets (and the relationship of this possible fractionation behavior to the delivery of trace elements such as Y and the HREE during the garnet crystal growth), and (2) whether O isotope compositions of the garnets can assist in determining whether the rock was open to infiltration by fluids from external sources during garnet growth, and (3) whether analyses of coexisting mineral phases in such rocks can yield information regarding mineral-mineral Li (and O) isotope fractionation factors. Finally, how does the growth history of the metabasaltic garnets compare with that of the garnets in nearby/adjacent metasedimentary rocks? For this latter question, we can compare our new results with those published in 2022 in our *GEOSPHERE* article (reference below).

Relevant References (we have not yet presented the new O isotope data at a scientific conference):

Bebout, G. E., Ota, T., Kunihiro, T., Carlson, W.D., and Nakamura, E., 2022, Lithium in garnet as a tracer of subduction zone metamorphic reactions: The record in UHP metapelites at Lago di Cignana, Italy, *Geosphere*.

King, R. L., Bebout, G. E., Kobayashi, K., Nakamura, E., and van der Klauw, S. N. G. C., 2004, Ultrahigh-pressure metabasaltic garnets as probes into deep subduction zone chemical cycling, *Geochemistry, Geophysics, and Geosystems*, Q12J14, doi:10.1029/2004GC000746, Dec., 2004.