

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

2022 fiscal year second term (report on a visit to the IPM in March 2023)

22/05/2023

**Category:** International Joint Research

**Name of the research project:** Weathering and Metasomatism: Earth and Mars

**Principal applicant:** Gray E. Bebout

**Affiliated institution and department:** Lehigh University, Department of Earth and  
Environmental Sciences

**Collaborators:** Katsura Kobayashi, Tak Kunihiro, Tsutomu Ota, Ryoji Tanaka,  
Christian Potiszil, and Eizo Nakamura

**Affiliated institution and department:** Pheasant Memorial Laboratory, IPM

## **Research report:**

My visit to the IPM in March 2023, was to re-initiate collaborations with scientists in the Pheasant Memorial Laboratory, after more than three years of COVID. My last visit to the IPM had been in December 2019, just before the onset of the pandemic. During this 2023 visit, I conferred extensively with all collaborators in the PML and discussed in detail strategies for biogeochemical and microtextural study of samples of altered volcanic glasses and amygdule-filling zeolite and phyllosilicate phases. Of highest priority in this study is the identification of biogeochemical and microtextural signatures that could together constitute a compelling biosignature in Mars altered basaltic glasses and amygdule-filling minerals.

Based on our discussions during my visit in March 2023, it appears the continued collaborative work will initially involve analysis of excellent samples previously obtained by my former Ph.D. student Matthew Nikitzuk, some of which he studied when he visited the PML in recent years. Some obvious work to extend includes that on altered volcanic glasses from Antarctica and Iceland (and several other localities), adding to what Matthew Nikitzuk was able to accomplish while in Misasa. During the next visit (likely in January 2024), we would in part work with Christian Potiszil to determine feasibility of using instruments in the Organic chemistry lab to identify and characterize organic compounds present in the materials, likely beginning with relatively coarse-grained amygdule-filling

minerals analyzed by Matthew Nikitzuk at Lehigh University for their N concentrations and isotope compositions (see the references below). Another possibility will be to conduct a fieldtrip in Iceland, possibly in summer 2024, to obtain additional samples.

Based on discussions during and after my March 2023 visit, it appears that we would use the following laboratories and instruments during a visit beginning in early January 2024. I would plan to visit with my Lehigh University Ph.D. student Juan Felipe Bustos Moreno, who is fully trained in my stable isotope chemistry laboratory.

Petrographic microscopes

Scanning electron microscopes

Transmission electron microscope

Cameca 5f and 1280 SIMS

Orbitrap system (and other instruments in the Organic chemistry laboratory)

Mass spectrometers in the Stable isotope lab (O, H, and C isotope analyses)

The first sample collected by Perseverance was an altered basalt(!), as NASA recently announced, and thus there will be added interest in developing a regimen/protocol for analytical work on such materials. For support of the further planned laboratory work, we would submit a later proposal for joint research (Second Term 2023), as this work would likely be conducted in January 2024.

#### **Relevant recent publications:**

Nikitzuk, M. P., Bebout, G. E., Geiger, C. A., Ota, T., Kunihiro, T., Mustard, J. F., Halldórsson, S. A., and Eizo Nakamura, 2022, Nitrogen incorporation in potassic and micro- and meso-porous minerals: Potential biogeochemical records and targets for Mars sampling, *Astrobiology*.

Nikitzuk, M. P., Bebout, G. E., Ota, T., Kunihiro, T., Mustard, J. F., Flemming, R. L., Tanaka, R., Halldórsson, S. A., and Nakamura, E., 2022, Nitrogenous altered volcanic glasses as targets for Mars sample return: Examples from Antarctica and Iceland, *Journal of Geophysical Research-Planets*.