

Report for the Joint Use/Research of the Institute for Planetary Materials, Okayama University for FY2023

May/14/2024

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

Name of the research project: Nitrogen biogeochemical signature in Mars sample-return targets

Principal applicant: Juan Felipe Bustos Moreno

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Department

Collaborator

Name: Christian Potiszil

Affiliated institution and department: Institute for Planetary Materials Pheasant Memorial
Laboratory

Research report:

The purpose of the visit during January 2024 was to follow up on work previously conducted by a collaboration between the PML and Lehigh (Matthew Nickitzuk) working on altered glasses and related minerals from Iceland and Antarctica as Mars analogs in the pursue of establishing a Nitrogen (N) biosignature in these materials. The follow up work consisted of adding organic chemistry analyses with the goal of investigating the possible presence of biotic organic compounds.

The expected outcome of this continuing project is to find a compelling N biogeochemical signature in these materials that would serve for the development of a protocol for the analyses of returned altered volcanic glasses from Mars.

Thus far the progress of the ongoing research includes:

- 1) Raman spectroscopy: an initial exploratory study was undertaken to assess whether it was possible to observe any organic signatures in the altered glass samples. This was done for existing polished samples and non-cleaned (for organics) polished slabs.

- 2) Sample preparation: Samples were prepared for Raman spectroscopy work, using an ultra-microtome for the creation of a clean polished surface, and for SEM work, in order to produce a carbon (C) element map. The C element maps was undertaken to identify spots where organic matter could be present and thus allow for possible organic sites to be analyzed with Raman. Additionally, new whole-rock powders were produced for 2 samples (Antarctica and Iceland) for the organic geochemistry work following protocols used in the organic geochemistry laboratory.
- 3) Gas chromatography-mass spectrometry: Samples were prepared for soluble organic matter biomarkers measurements. This is ongoing work to be continued in a following visit during the fall 2024.
- 4) Stable isotope geochemistry: partial CNOH concentrations and isotopic values were measured for alteration products relevant for Mars exploration (zeolites, clay minerals, sulfates, and silica) and for mineral separates obtained from Antarctica and Iceland altered glasses at the Stable Isotope Laboratory with Ryoji Tanaka. These samples correspond to the samples previously analyzed by Nikitczuk et al. (2022a,b).

In summary, the presence of organic compounds in these materials was confirmed but further analyses will corroborate the type of organic compounds. Furthermore, given the success of the research project, the proposed research will expand on further characterizing the organic compounds in these materials with new techniques involving the Orbitrap fusion system working with Dr. Potiszil and in new materials (zeolites and clays from Icelandic amygdules). Additionally, the source of organics in relation to their textural components (glass, palagonite, and cement) will be evaluated. CNOH work will be completed in the remaining samples and new Icelandic amygdule samples.