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

2022 fiscal year first call / second call / others (postponed FY2021 project)

5/29/2023

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

Name of the research project: *In situ* investigation of the C-O-H fluids behavior at the conditions of planetary interiors

Principal applicant: Nadezda Chertkova

Affiliated institution and department: Osaka University, Department of Earth and Space Science

Host at IPM

Name: Shigeru Yamashita

Affiliated institution and department: Institute for Planetary Materials, Division for Basic Planetary Materials Science

Collaborator

Name: Tadashi Kondo

Affiliated institution and department: Osaka University, Department of Earth and Space Science

Research report:

The purpose of proposed research was to provide insight into the phase equilibria in the C-O-H system at the conditions corresponding to the deep Earth and planetary interiors, with application of the novel *in situ* techniques for determination of fluids speciation directly at experimental conditions.

Experiments were carried out in the Mao-type symmetric and Bassett-type hydrothermal diamond anvil cells in the temperature range to 800 °C and in the pressure range to 3.7 GPa. Oxalic acid dihydrate was used in the experiments as a source of C-O-H fluid upon thermal decomposition. It was loaded into the sample chamber of diamond anvil cell together with the pressure sensor and oxygen buffer material. During experiments, the state of the sample was observed under the optical microscope and spectroscopic analysis was performed using combined FTIR and Raman system at IPM. After several stages of decomposition, a homogeneous C-O-H phase was seen in the sample chamber in the temperature interval from 400 °C to 800 °C, with the vibrational signals from CH_n, CO_2 and H_2O species recorded *in situ* in the infrared spectra. Upon quenching to room temperature, segregation of H_2O-rich phase from the fluid took place, accompanied by the precipitation of carbon-rich material.

Outcomes of this research include:

- Experimental procedure was established for the investigation of the C-O-H system in the broad *P-T* field, combining the Mao-type symmetric diamond anvil cell technique with the Bassett-type hydrothermal diamond anvil cell technique.
- Decomposition stages of oxalic acid dihydrate were described at various pressures with application of spectroscopic analysis for determination of decomposition products.
- Phase relationships were described in the temperature interval to 800 ˚C and pressure range to 3.7 GPa under controlled oxygen fugacity using *in situ* visual observations and combined infrared and Raman techniques.
- The change in fluid state, detected during quenching, shows that *in situ* analytical methods provide important data for modeling the behavior of C-O-H fluids at depth.
- Interim results of this research were presented at the Japan Geoscience Union Meeting 2022 (abstract SGC35-P02).