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

March/13/2025

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

Name of the research project: Elasticity measurements at Planetary Interior Conditions (EPIC)

Principal applicant: Niccolo Satta

Affiliated institution and department: Institute for Mineralogy, University of Muenster

Collaborator

Name: Takayuki Ishii

Affiliated institution and department: IPM

Research report:

The EPIC project aimed to provide novel experimental constraints to infer the thermo-physical state of the Earth's mantle. Its experimental outcomes will have a significant impact on our ability to interpret seismological observations. In FY-2024, EPIC focused on deep recycling of water by studying the elastic and plastic properties of oxyhydroxides - the primary hydrogen carriers in the lower mantle – within a pressure (P), temperature (T), and composition (C) space relevant to Earth's mantle. The applicant secured beamtime at the Extreme Conditions Beamline P02.2, DESY synchrotron (Hamburg, Germany), and employed a unique radial x-ray diffraction setup available only at P02.2. This approach enabled the quantification of plastic deformation strength and development of crystallographic-preferred orientation in oxyhydroxide solid solutions under extreme *P-T* conditions of planetary interiors. This study provides us with a new perspective on the seismic signatures of hydrous lithologies recycled at depth. Additionally, the experiments managed to overcome previous technical limitations, achieving record-breaking *P-T* conditions and paving the way for additional studies, such as the plasticity of major lower-mantle minerals. The research is currently the subject of an abstract submitted for the EMPG 19th conference (June 2025, France) and will be part of a manuscript integrating experimental mineral physics and seismology to describe deep geodynamical processes. Furthermore, EPIC has led to a manuscript on the effect of cation substitution on the elastic properties of oxyhydroxide solid solutions. This study relies on Brillouin spectroscopy and X-ray diffraction experiments, and is currently under review in Physics and Chemistry of Minerals (Springer). This work has the potential to impact mineralogy, Earth sciences, and planetary sciences significantly.

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