

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

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

Name of the research project: Mercury Crustal Melting Experiments (MeCMeX)

Principal applicant: Arto Luttinen

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Collaborator

Name: Shigeru Yamashita

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Research report:

The main objective of our study is to define the compositional range of near-solidus ($f \leq 0.4$) crust-derived melts in the interior of planet Mercury. We use internally heated pressure vessel (IHPV) and electron probe micro analyzer (EPMA) to investigate the phase equilibria of S-free compositions and pressure conditions that correspond to typical Mercurial crustal compositions using compositions and p-conditions akin to those used in previous research (Namur and Charlier, 2017) but extend the runs to lower temperatures.

The research was carried out by Luttinen and Yamasahita at IPM in October–November 2024. We commenced the experimental work using a Fe-free simple analogue of Mercurial crustal composition (CaO–MgO–Al₂O₃–SiO₂–Na₂O system) as this approach renders oxygen fugacity buffering unnecessary. In an attempt to collect near-solidus melt into patches suitable for EPMA analysis, we ran some experiments using a layer of glassy carbon spheres above the starting material, but this approach turned out to be unsuccessful.

We ran a total of 12 experiments at 1 kbar for durations of 2 to 120 hours at temperatures of 1050, 1100, 1250, and 1300 °C. The runs included 2 tests (sintering of glass spheres, checking of IHPV pressure seal), 3 re-heatings after failed quenching, and time series at 1100 °C. We used the glass–crystal

ratio in the initial runs to decide the temperature steps and duration of the subsequent runs. Many of the near-solidus glasses record abundant gas bubbles despite the volatile-free starting material (absence of H₂O and CO₂ was confirmed using FTIR) probably due to trapping of air within extremely high-viscosity and notably SiO₂-rich melt. The experimental products are presently in Finland and the phase compositions are being determined using EPMA. A new proposal has been submitted to IPM to facilitate the completion of the project.