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A Coordinated Shock Recovery and TEM study: The Effects of Impact Pressures on Melt and npFe Production and Migration Behavior in Porous Materials.

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BepiColombo is a joint mission by ESA/JAXA scheduled for launch to Mercury in 10/2018. Onboard is a mid-infrared spectrometer (MERTIS-Mercury Radiometer and Thermal Infrared Spectrometer), which will map spectral features in the 7-14 μm range, with a spatial resolution of about 500 meters [1-4].The IRIS (Infrared and Raman for Inter-planetary Spectroscopy) laboratory at the Institut für Planetologie in Münster generates spectra for a database that will serve as a reference for the data, which will be obtained by MERTIS once it reaches its orbit around Mercury. These spectra will allow to determine the mineralogical composition of the planetary surface of Mercury via remote sensing. Mercury's surface experienced impact cratering at different scales (macro to micro impactors over an extended period of time). The tenuous exosphere and Mercury's magnetic field allow solar wind particles and micro impactors to reach its surface and hence, alter its mineralogical composition in a significant way over a given period of time. Most of these processes are referred to as 'space weathering' (see [5] and references therein). In order to investigate the effects of these processes in the MERTIS relevant mid-infrared range on a given mineralogical composition, terrestrial analog material is altered under laboratory conditions. Shock recovery, laser, and ion irradiation experiments have been used in combination with synthetic and natural analog material in the past to simulate the altering effects of (micro)meteorite and ion bombardment on atmosphere - free bodies. Yet, detailed TEM data from these experiments remain scarce. In a previous experiment, we used a pulsed IR laser to produce distinct melt layers on grain boundaries, which appear similar to agglutinate glasses containing npFe known from the lunar surface. The production of npFe in the melt layers affects the corresponding infrared spectra of these samples [6]. Melt layers and npFe production were investigated in the TEM. Here we report on a suite of classic shock recovery experiments, using the same analog material to investigate whether impact melt that is created during moderate shock conditions in porous material (estimated porosity $\sim$ 65%) will develop similar melt layers along grain boundaries as have been observed on material exposed to laser irradiation. TEM results from this experiment are compared to the laser irradiated samples (batch of sample material is identical) to see whether changes at nanoscale are comparable; at least where melt production – important for the formation of agglutinate glasses – is concerned. The question we try to address is: Are processes simulated by laser irradiation, e.g., melt formation with simultaneous production of npFe on grain boundaries by heat dissipation, and impact melt (sensu strictu) produced by shock recovery experiments comparable in terms of their production in npFe particles?
References: [1]Maturilli (2006) Planetary and Space Science 54 [2]Helbert and Maturilli (2009) Earth and Planetary Science Letters 285, [3]Benkhoff et al. (2010) Planetary and Space Science 58, [4]Hiesinger et al. (2010) Planetary and Space Science 58, [5]Domingue et al. (2014) Space Sci Rev 181, [6]Stojic et al. (2016) LPSC abstract #2332.