BASIN-FORMING IMPACT EVENTS ON MERCURY: EFFECTS ON MELT PRODUCTION AND DEPTH OF THE SOURCE REGION

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Introduction and motivation: On the surface of Mercury six impact basins with a diameter larger than 500 km have been identified [1]. With a diameter d = 1550 km, Caloris is the largest one. Both the interior of Caloris and the surrounding regions are covered by volcanic plains [2], which postdate the basin formation [3]. In addition to Caloris, the other five basins are, in order of decreasing basin diameter, Matisse-Repin (d = 950 km), Sobkou (d = 770 km), b36 (d = 730 km), Rembrandt (d = 720 km), and Beethoven (d = 639 km) [1]. Within the rims of Sobkou, Beethoven, and Rembrandt, the surface is covered with smooth plains, volcanic in origin. The second largest basin, Matisse-Repin, and b36 do not show volcanic infillings. In this work we investigate to which degree large impact events on Mercury can modify the underlying mantle dynamics and how the presence of post-impact volcanism or the lack thereof can be related to the planet's interior properties.

Methods: We use the code GAIA [4] to simulate convection in the mantle of Mercury and treat impacts as instantaneous thermal perturbations in the interior by employing scaling laws [e.g., 5]. We focus on the long term effects that basin-forming events have on the interior dynamics of the mantle. Accordingly, we do not take into account shock-melt by assuming that the melt pond that forms as a consequence of the impact freezes in place. This choice is justified by the short timescale associated with the solidification of the melt pond compared to the convection timestep. We also do not model decompression melting induced by the sudden change of the pressure field following basin excavation [6,7]. Rather, we focus on the evolution of the convection and the associated melt production in the aftermath of the basin-forming event. When the temperature exceeds the solidus, we assume all the melt to be instantaneously extracted to the surface and we set the temperature at the local solidus. This choice is justified for Mercury since magmas in the interior of the planet are not expected to stall during ascent [8]. We keep track of the depth of the source region as melt from different depths might show different petrological signatures.

Goal and outlook: We revisit the work of Roberts and Barnouin [9], who investigated the effects of a Caloris event on the thermochemical evolution and volcanic production of Mercury. Their results, obtained assuming a pre-MESSENGER mission mantle thickness of 600 km, indicate that the volcanic plains observed both inside and outside the basin rim might be related to the effects of the impact on the mantle dynamics. We present simulations of the impacts that emplaced the largest observed basins on the surface of Mercury and test the effects on the post-impact volcanism of convective vigour, mantle fertility, impact location with respect to underlying convective planform, and initial mantle temperature.

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