Asymmetric magnetic anomalies over two young impact craters on Mercury

Valentina Galluzzi¹, Joana S. Oliveira²³, Jack Wright⁴, Lon L. Hood⁵, and David A. Rothery⁶

¹INAF, IAPS, Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy (valentina.galluzzi@inaf.it)
²ESA/ESTEC, SCI-S, Noordwijk, Netherlands
³CITEUC, Geophysical and Astronomical Observatory, University of Coimbra, Coimbra, Portugal
⁴School of Physical Sciences, The Open University, Milton Keynes, UK
⁵Lunar and Planetary Laboratory, University of Arizona, Tucson AZ, USA

In the last months of its mission, MESSENGER was able to obtain measurements at low altitude (< 120 km). This has made it possible to measure small magnetic field signals, probably of crustal origin (Johnson et al., 2015). Maps of the crust signatures at 40 km altitude were produced by Hood (2016) and Hood et al. (2018), showing that the strongest anomalies are about 14 nT in the Caloris basin. Some of the anomalies are associated with impact craters, and it has been demonstrated that this is not a coincidence (Hood et al., 2018). It is believed that these anomalies are the result of impactor materials rich in magnetic carriers (e.g., metallic iron) that were incorporated on the surface acquiring remanent magnetic fields during the cooling of the material. We intend to analyze whether the anomalies of the crustal field are related to geological characteristics by examining two Hermean craters in order to test this impactor hypothesis. Anomalies associated with Rustaveli and Stieglitz craters are slightly or totally asymmetric with respect to the crater center. The morphology and geological setting of these two fresh impact craters that still maintain a well-preserved ejecta blanket and visible secondary crater chains are investigated to constrain the overall impact dynamics. Both impact angles were likely > 40°. In both cases, slight asymmetries in the morphology and ejecta distribution show that the magnetic anomalies correlate well with the location of impact melt. For the large basin Rustaveli, the melt emplaced SE in the downrange direction, whereas in the case of the smaller crater Stieglitz, downrange direction remains uncertain; in one scenario the melt naturally migrated to the northern topographic lows away from a SW downrange direction, while in the other the downrange direction corresponds to the location of the melt to the north. Rustaveli is associated with a ~5 nT crustal magnetic anomaly centered close to the crater’s midpoint, although offset ~20 km east-southeast. This offset is somewhat consistent with the downrange direction implied by Rustaveli’s impact melt and crater chains distribution. For Stieglitz, all anomalies are offset from the crater’s center. An anomaly larger than 3 nT includes most of the ejecta melt locations towards southwest. The ejecta melt cluster to the north of the crater corresponds to an anomaly of ~5 nT, while the largest anomaly of ~7 nT is found further north and closely corresponds to the crater’s deepest chain, making the second scenario of a N downrange direction more realistic. For both craters, the melt likely recorded the prevailing magnetic field of Mercury after quenching. For Stieglitz, also
some solid impactor fragments likely contribute to the anomaly. Hence, both impactors brought magnetic carriers to the surface that could record the past magnetic field of Mercury.

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