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# Processes producing the large-scale magnetic field of Mercury

M. Purucker (1), C. Johnson (2,11), B. Anderson (3), H. Korth (3), R. Winslow (2), J. Nicholas (1), J. Head (4), S. Solomon (5), M. Zuber (6), J. Slavin (7), I. Alexeev (8), R. Phillips (9), and D. Paige (10)

(1) NASA, Geodynamics Lab, Greenbelt, MD, 20771, United States (michael.e.purucker@nasa.gov), (2) Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, BC, V6T 1Z4, Canada, (3) The John Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA, (4) Department of Geological Sciences, Brown University, Providence, RI 02912, USA, (5) Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC 20015, USA, (6) Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, (7) Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, MI 48109, (8) Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow 119991, Russia, (9) Planetary Science Directorate, Southwest Research Institute, Boulder, CO 80302, USA, (10) Department of Earth and Space Sciences, University of California, Los Angeles, CA, 90095, USA, (11) Planetary Science Institute, Tucson, AZ 85719, USA

Observations of Mercury's magnetic field by the MESSENGER spacecraft now include repeated orbital coverage in both magnetic local time and body-fixed longitude of near-surface magnetic fields from mid to high northern latitudes, observations of the magnetic equator at altitudes of approximately 1000 km, and three flybys at low latitude. Both flyby and orbital observations include time in the solar wind and inbound and outbound transits through the magnetopause on each pass. From this set of observations, Mercury's magnetic field can be described as an offset but axially centered weak dipole immersed in the solar wind. The large-scale magnetospheric fields include magnetopause and cross-tail currents and magnetic fields associated with the open field lines of the magnetospheric cusp regions. At a slightly smaller scale are magnetic fields associated with plasma enhancements, possible closure current systems, and crustal fields. A permanently trapped particle population does not exist in Mercury's present magnetic field, and electrons do not execute complete drift paths around the planet. Among the candidate processes to produce the large-scale internal magnetic fields of Mercury are a core dynamo, remanent crustal fields, and induced fields. We find evidence for crustal magnetization at high northern latitudes in an area that corresponds closely to the northern smooth plains, an extensive unit emplaced by flood volcanism more recently than 3.8 Ga. Required magnetizations are in excess of 1 A/m for a 15-km layer thickness and would be in a direction opposite to that of the present main field. Such a crustal field would be a product of thermal remanent magnetization acquired at a time when Mercury's magnetic field was stronger than, and opposite in polarity to, the modern field. The inferred magnetization decreases with geomagnetic latitude, as would be expected from a dipolar inducing field and from the latitudinal dependence on insolation. We interpret the crustal magnetic signature as originating from the extrusive volcanic rocks, and their associated intrusive roots, of the northern plains.