

The Exploration of Mercury by MESSENGER

LOUISE M. PROCKTER¹, SEAN C. SOLOMON² and RALPH L. McNUTT Jr.¹

¹*Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, United States.*

²*Carnegie Institution of Washington, Washington, DC, United States.*

The MERcury Surface, Space ENvironment, GEOchemistry, and Ranging (MESSENGER) spacecraft, developed under NASA's Discovery Program, is the first space probe to visit the planet Mercury in more than 30 years. MESSENGER flew by the innermost planet twice in 2008 and once last fall. The flybys confirmed that Mercury's internal magnetic field is dominantly dipolar, with a vector moment closely aligned with the spin axis. MESSENGER detected magnesium in Mercury's exosphere, demonstrated that Mercury's anti-sunward neutral tail contains multiple species, and revealed that the distributions of sodium, calcium, and magnesium in the exosphere and tail vary differently with latitude, time of day, and Mercury's position in orbit, signatures of multiple source processes. MESSENGER's laser altimeter showed that the equatorial topographic relief of Mercury exceeds 5 km and documented the form of numerous impact craters and fault scarps. MESSENGER images provided evidence for widespread volcanism, and candidate sites for volcanic centers were identified. In addition, newly imaged lobate scarps and other tectonic landforms support the hypothesis that Mercury contracted globally in response to interior cooling. The ~1500-km-diameter Caloris basin, viewed in its entirety for the first time by MESSENGER, was the focus for concentrations of volcanic centers, some with evidence of pyroclastic deposits, and widespread contractional and extensional deformation; smooth plains interior and exterior to the basin are demonstrably younger than the basin-forming event. A ~290-km-diameter basin contains interior plains that are among the youngest volcanic material on the planet. The nearly global observations of Mercury surface units distinguishable by color and composition enforce the significance of the largely volcanic smooth plains, which occupy ~40% of the surface area, and of low-reflectance material, occupying ~15% of the surface area and located primarily in deposits excavated by impact, consistent with having originated at depth. Reflectance spectra show no evidence for FeO in surface silicates, and reflectance and color imaging observations support earlier inferences that Mercury's surface material consists dominantly of iron-poor, calcium-magnesium silicates with an admixture of spectrally neutral opaque minerals. In support of the hypothesis that those opaque minerals are iron-titanium oxides, MESSENGER's neutron spectrometer showed that the surface abundance of iron

plus titanium is comparable to that of some lunar mare regions. MESSENGER's three flybys revealed that Mercury's magnetosphere is more dynamic and responsive to imposed solar wind conditions than that of any other solar system body. MESSENGER is now on course for insertion into orbit about Mercury in March 2011, and one Earth-year of orbital observations is planned for the remainder of the nominal mission.