Geophysical Research Abstracts
Vol. 14, EGU2012-9925-3, 2012
EGU General Assembly 2012

INVITED Effusive and Explosive Volcanism on Mercury from MESSENGER Orbital Observations

J.W. Head III (1), S.C. Solomon (2), C.I. Fassett (3), S.L. Murchie (4), L.M. Prockter (4), D.T. Blewett (4), B.W. Denevi (4), T.R. Watters (5), R.G. Strom (6), C.R. Chapman (7), J.J. Gillis-Davis (8), M.T. Zuber (9), D.E. Smith (9), J. Oberst (10), K. Gwinner (10), C.M. Ernst (4), L.R. Ostrach (11), P.K. Byrne (2), C. Klimczak (13), and Z. Xiao (12)

(1) Brown University, Geological Sciences, Providence, RI 02912 United States (james_head@brown.edu, +1 401 863-2526), (2) Department of Terrestial Magnetism, Carnegie Institute of Washington, Washington, DC 20015 United States, (3) Department of Astronomy, Mount Holyoke College, South Hadley, MA 01075 United States, (4) The Johns Hopkins Universitiy Applied Physics Laboratory, Laurel, MD 20723 United States, (5) Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560 United States, (6) Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721 United States, (7) Southwest Research Institute, Boulder, CO 80302 United States, (8) Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, Honolulu, HI 96822 United States, (9) Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02129 United States, (10) German Aerospace Center, Institute of Planetary Research, Berlin, 12489 Germany , (11) School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287 United States, (12) China University of Geosciences, Wuhan, Hubei, 430074 P.R. China, (13) Carnegie Institute of Washington, Washington, DC 20015 United States

Observations from the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft, after one Earth year in orbit about Mercury, have provided new insights into the nature of volcanic activity on the innermost planet and shown that volcanic characteristics on Mercury differ from those on other terrestrial planetary bodies. MESSENGER observations reveal no evidence for large shield volcanoes like those on Earth, Mars, and Venus, and small numbers of low shield-like constructs, pit craters, and candidate calderas. No evidence has been discerned for extensive centers of volcanism as seen on Mars (e.g., Tharsis, Elysium) or Venus (e.g., Beta and Atla Regiones), or less well-developed ones as seen on the Moon (e.g., Marius and Rumker Hills). Nor has evidence been seen for any Venus-like coronae or related annular deformational features displaying associated volcanism. Only one radial graben structure (Pantheon Fossae), centrally located in the Caloris basin, has been documented. Observations of Mercury to date also reveal no evidence for several types of volcanic features (cones, leveed flows, or widespread sinuous rilles). Instead, we see evidence on Mercury for extensive flooding of the surface to form regional smooth plains that appear to be very extensive lava sheet flows, and intercrater plains (found between large, old impact craters) that may also have been formed by volcanic eruptions. Smooth volcanic plains filling the interior of the Caloris basin show generally uniform ages and spectral characteristics and are up to several kilometers thick. Exterior plains of volcanic origin have similar to slightly younger ages. Contiguous plains at northern high latitudes cover $\sim$6% of the surface of Mercury, have surface ages and spectral properties that show no resolvable variation, and have no locatable source regions. The general characteristics of the plains deposits and features on Mercury strongly suggest that they were emplaced by flood-lava-style eruptions rather than collections of narrow, leveed flows typical of small dike-emplacement events and more limited-volume surface eruptions. In summary, effusive volcanic deposits on Mercury appear to be characterized predominantly by: (1) deep magma sources of large volume, (2) little very shallow crustal storage of magma, and (3) high-volume eruption rates of lava and correspondingly voluminous outpourings that produced long and wide lava flows that covered extensive areas. These observations are consistent with theoretical predictions of vertically extensive and wide dikes penetrating through the lithosphere and crust. Deposits of pyroclastic origin and associated source depressions are globally distributed. The dimensions of individual pyroclastic deposits around vents signal the involvement of substantial amounts of magmatic volatiles in the eruptions. Observations by the suite of instruments on the ESA/JAXA BepiColombo spacecraft will markedly improve our knowledge of volcanism on Mercury.