GEOLOGY OF MIMAS?

Paul M. Schenk, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058 (schenk@lpi.usra.edu).

Introduction: Frozen lump of ice? Cratered wasteland? Wreck of the Death Star? No, Mimas maybe these things but the smallest of Saturn's classical mid-sized icy moons also sits just outside the main ring system, lies within the inner part of the E-ring centered on Enceladus, and deep within Saturn's radiation belts. It also occupies the same sequential place in the satellite system that Io does at Jupiter and is potentially involved in tidal interactions. With global topographic, high-resolution and color mapping now complete and the closest pass of Mimas in Feb. 2010 now a matter of public record, it seems appropriate to review what we know about this body, given its unique place in the Saturn system.

Mapping (Figure 1): Cassini imaging over roughly a dozen orbits has provided global mapping at ~400 m over >75% of the surface (except north of 70°, which will be covered during the extended orbits). Color mapping is also possible globally at similar resolutions at three principle wavelengths [(IR; 0.930 µm), Green (GRN; 0.568 µm), and Ultraviolet (UV; 0.338 µm)]. The combined observations also provide nearly global stereo viewing of Mimas and the construction of the first global topographic map of Mimas (as well as the other icy satellites [1]).

Tectonism: Voyager observed scattered linear to arcuate "grooves," V-shaped depressions [2], on Mimas (Fig. 2). A new map (Fig. 3) based on the global mosaics updates this earlier map, especially on the leading hemisphere. The groove pattern seems to show a preference for the centers of the leading and trailing hemispheres, with areas in between characterized by exceptionally rugged topography (Fig. 3). Such a symmetric pattern may be consistent with global despinning (or spin-up?) stresses [3].

Herschel: Herschel is by a factor of 3 the largest crater and dominates Mimas. The tectonic pattern in Fig. 3 could also be related to Herschel-induced global fracturing. Many but not all of the grooves trend radial to Herschel. Preliminary investigation of the morphology of the grooves suggests, however, that they may predate Herschel, which is very young and ha few supperposed craters. The area antipodal to Herschel does show reduced crater depths (Fig. 3) and could be consistent with seismic disruption of terrains in that region [e.g., 4]. High-resolution mapping at ~100 m shows talus deposits at the base of the 10-km high rimwall scarp of Herschel and lobate deposits on the floor indicative of slumping or impact melt (Fig. 4). A distinct annular deposit along the rim roughly 25-35 km wide and up to 500 m high is also evident in the stereo images.

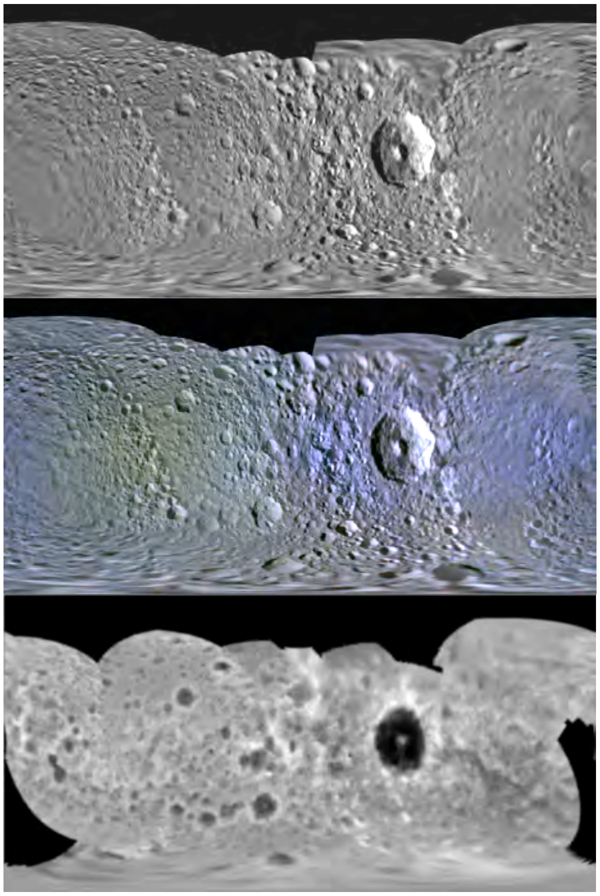

Figure 1. Global high-resolution (top), 3-color map (middle) and topographic maps (bottom) of Mimas. Herschel is large basin to center right. Orbit 126 mapping has not yet been added to these versions of the three maps. These data will enhance the global maps in the region centered on Herschel.

Resurfacing: Unlike Tethys or Dione, there are no distinct smooth plains on Mimas. Voyager mapping of crater densities suggested Mimas was not saturated [5] a possible indication of some type of crater erasure. However, the global topography of Mimas is surprisingly spheroidal (Fig. 1c) despite abundant large craters that must have struck it over time (and observed on Iapetus). This global topographic resetting has been cited as evidence that a global thermal event early in Mimantian history erased all record of ancient impacts large and small [1].

Exogenic Processes: Global color mapping [6] shows two distinct global patterns: an enhanced IR signature centered on the trailing hemisphere and a borad UV-enhanced signature along the equator of the leading hemisphere (Fig. 1b). IR mapping revealed a temperature pattern on the leading hemipshere very similar to the UV-band [7]. These patterns are seen on other satellites, especially Tethys, and have been attributed to accumulation of E-ring dust and MeV electron bombardment [6], respectively. High resolution color mapping shows that the boundary of the equatorial UV band is gradational over a distance of 35 km or so. There may be evidence of directionality in the formation of the UV band but mapping is still in progress. Dark ray craters are observed on the floor of Herschel as well.

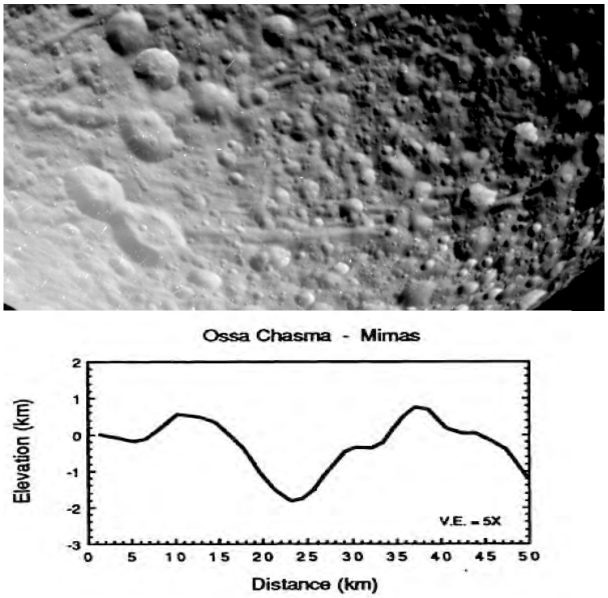

Figure 2. Cassini image of (top) and topographic profile (bottom) across Mimantian grooves.

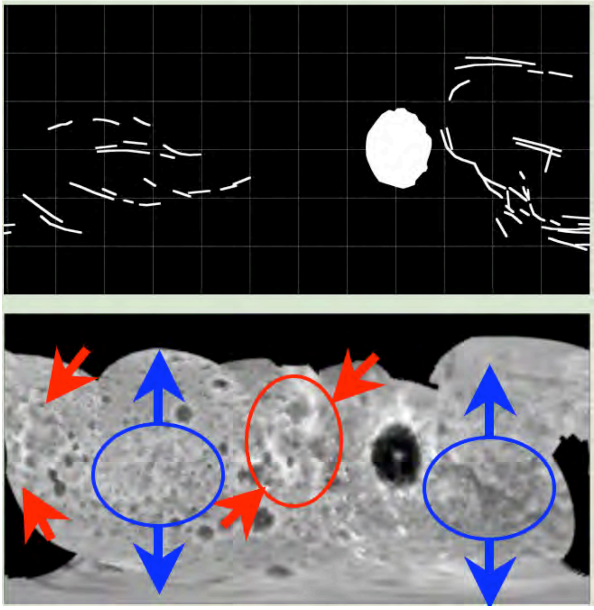

Figure 3: Global maps tectonic features (top) and topographic map (bottom) of Mimas. Red circles indicates areas of rugged relief (and possible compressional zones), blue circles areas of extension.

Blue area to left also indicates reduced crater depths in the region antipodal to Herschel.

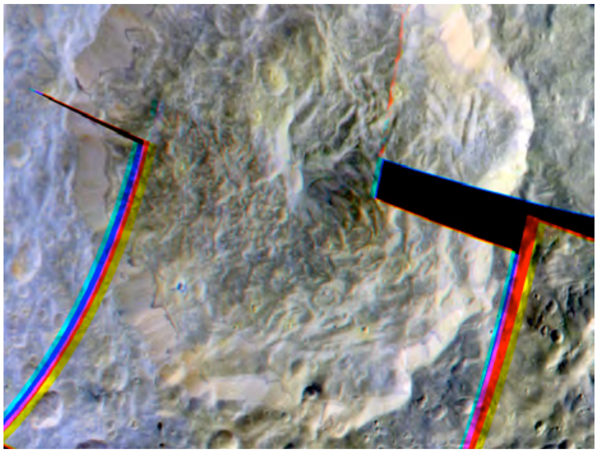

Figure 4. High resolution (100 m) 3-color mosaic of floor of Herschel impact crater.

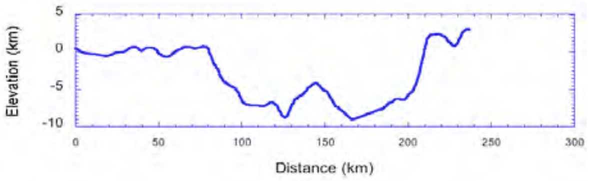

Figure 5. Topographic profile across Herschel.

Discussion: The geologic history of Mimas consists of several distinct phases. Early history appears to have been quite warm, leading to the wholesale resetting (or prevention of formation) of deep topography of the type seen on Iapetus. This created the triaxial spherical shape we see today. Heavy cratering and subsequent formation of a global tectonic grid followed. Whether the tectonism is related to Herschel or tides can be tested by comparison to stress patterns. Herschel impact was one of the most recent events, leading to formation of an annular ejecta deposit. Seismic disruption of the anitpodal region is possible. Ongoing processes include deposition of E-ring dust on the trailing hemisphere and alteration of the surface structure and thermal inertia by MeV electons along the equator on the leading hemipshere. Work continues.

References: [1] Schenk, P., (2010) *Bull. Am. Astron. Soc.*, 42, abst. 9.16; [2] Schenk, P., (1985) *Bull. Am. Astron. Soc.,* 17, 738; [3]Matsuyama, I., and F. Nimmo (2008); *Icarus*, 195, 459. [4] Moore, J., et al. (2004) *Icarus*, 171, 421; [5] Lissauer, S. Squyres, & W. Hartmann (1988) *J. Geophys. Res.,* 93, doi:10.1029/ JB093iB11, 13776; [6] Schenk, P., et al. (2010), *Icarus*, in press; [7] Spencer, J., et al. (2010) *Bull. Am. Astron. Soc.*, 42, abst. 1.07.