A 1:5M Global Geologic Map of Saturn's Moon Dione. E. S. Martin[1], D. A. Patthoff[2], M. R. Kirchoff[3] [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC (martines@si.edu), [2]Planetary Science Institute, [3]Southwest Research Institute, Boulder CO.

Introduction: Dione is arguably one of the most heavily tectonized icy satellites in the Saturnian system, behind only Enceladus and possibly Titan. Dione is also the one of the few Saturnian satellites to have terrains with strong evidence for cryovolcanism [e.g. 1-5]. Interspersed with the heavily cratered terrains on the trailing hemisphere, Dione's wispy terrains (Fig. 1) preserve evidence for a recent period of geological activity linked to the presence of a liquid ocean [6 & 7]. Meanwhile, the smooth plains on the leading hemisphere have undergone some geologic event, or events, that has removed much of the cratering record [5, 8]. However, no active plumes have been observed to-date, even in dedicated searches [9 & 10].

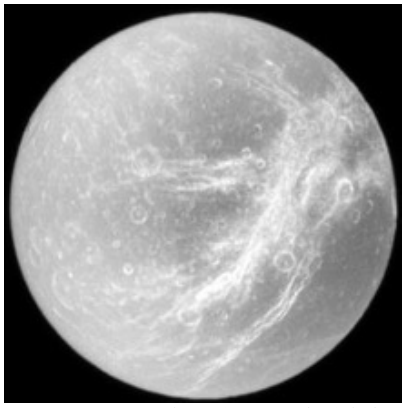

Figure 1: Saturn's moon Dione (D=1122km) is best known for its wispy terrains.

The presence of a subsurface ocean at some point in Dione's geologic history identifies Dione as an ocean world endmember: an icy world that did not develop Enceladus or Europa-like activity but could possesses, or possessed in the past, a liquid ocean deep below its icy exterior. Our development of a USGS SIM (Scientific Investigations Map) of Dione will result in a better understanding for the timing of intense regional tectonism and possible volcanism, creating a framework for future comparative planetological studies for understanding the controls on the formation of ocean worlds.

Background: The *Cassini* mission revealed that many of the mid-sized icy moons likely have, or recently had, global subsurface liquid water oceans. The expression of relatively recent geologic activity preserved on Dione's surface suggests it too was once in possession of a global ocean. The increasing interest in ocean worlds has targeted icy satellites as having high astrobiological potential. A comparative planetological approach is necessary to maximize the data return of outer solar system missions. Establishing a fundamental framework for Dione science starts with the completion of a global geologic map.

So far, global geologic maps of Ganymede [11], Europa [12], Enceladus [13], and Titan [14] have been produced and provide a broad perspective on ocean worlds. Dione is critical to advancing our understanding of the evolution of all icy ocean worlds and a global geologic map is a necessary tool to drive ocean world science forward. Our map will identify the global cratering, tectonic, and volcanic histories across Dione by producing a 1:5M USGS SIM. These efforts will provide a foundation for the ocean world community to complete detailed, process-based exploration of Dione's geologic history and facilitate comparative ocean worlds research.

Digital Formats: The proposed comprehensive exploration of Dione's surface geology will combine ongoing work including detailed tectonic analysis mapping with detailed crater analysis and ongoing exploration of Dione as a cryovolcanically active moon. We will use the most recent USGS global mosaic currently available on the PDS, produced primarily from Cassini ISS images, to synthesize and improve all existing analysis on Dione in an ArcGIS environment. We will define geologic units, linear features, and potential volcanic features, in accordance with USGS geologic mapping standards. We will use the resultant map of surface structures and geologic units to develop a possible sequence of geologic events resulting in an USGS SIM.

Our work will consider previous broad-scale mapping efforts on Dione from both Voyager era images [1&2] and early Cassini images [5&8]. New images were acquired in the Cassini Solstice mission that were not available to earlier mapping efforts. [8]] focused primarily on the spectral properties of broad (not global) geomorphological units on a 1km/pixel basemap. Our global geologic map will have significantly higher mapping resolution (on a 154 m/pixel basemap) allowing for a robust stratigraphic framework for estimating the timing of geologic events not included in previous mapping efforts.

References: [1] Plescia (1983), *Icarus, 56,* 255-277. [2] Moore (1984), *Icarus, 59,* 205-220. [3] Burch et al. (2007), *Nature, 447,* 833-835. [4] Schenk & Moore (2009), 40th *LPSC,* Abs. No 2465 [5] Kirchoff & Schenk et al (2015), *Icarus, 256,* 78-89. [6] Martin et al. (2016), *GSA Annual. Met. Abs. Prog. 48, No. 48-12.* [7] Beuthe et al. (2016), *GRL 43,* 10,088-10,096. [8] Stephan et al. (2010), *Icarus, 206,* 631-652. [9] Buratti et al. (2011), *Icarus, 214,* 534-540. [10] Buratti et al. (2018), *GRL, 45.* [11] Patterson et al. (2010), *Icarus, 207,* 845-867. [12] Leonard et al, In press, Global Geologic Map of Europa. [13] Patterson et al. (2017) *3rd Planetary Data Workshop,* Abs. No 7117. [14] Lopes et al. (2020), *Nature Astronomy, 4,* 228-233.

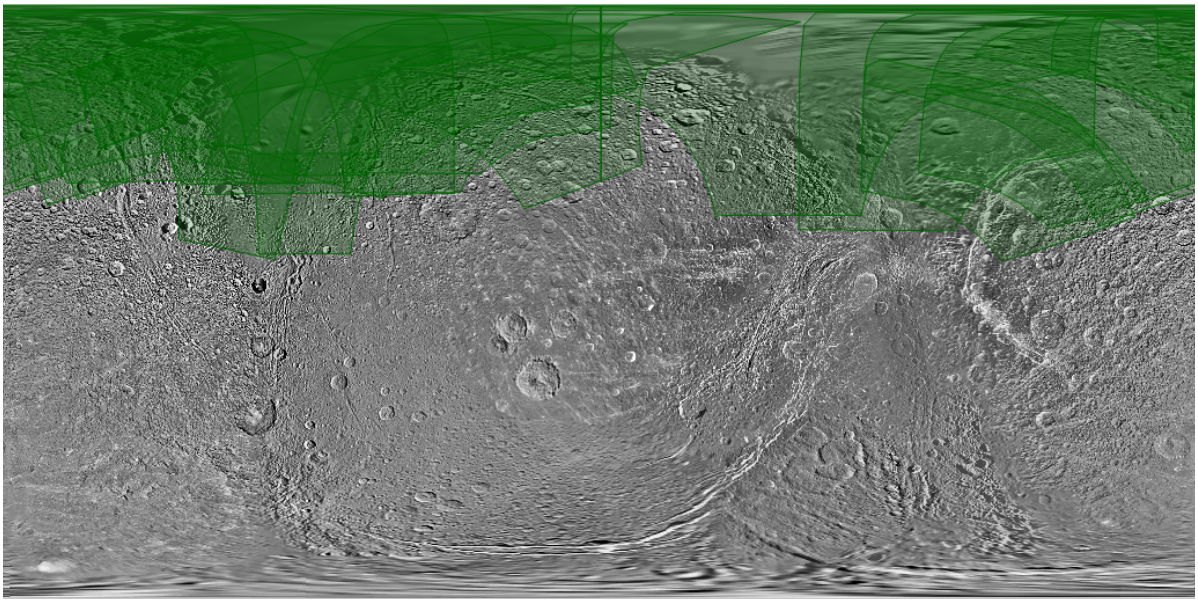

Figure 2: The Dione basemap that will be used for the SIM, overlain (green) by supplemental images to improve the coverage of the north polar regions.