PROGRESS ON 1:5M GLOBAL GEOLOGIC MAP OF SATURN'S MOON DIONE. E. S. Martin[1], D. A. Patthoff[2], and M. R. Kirchoff[3] [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution (martines@si.edu), [2]Planetary Science Institute, [3]Southwest Research Institute).

Introduction: Dione is arguably the 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, 2, 3, 4, 5]. Interspersed with the heavily cratered terrains on the trailing hemisphere, Dione's wispy terrains 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 [8, 5].

The presence of a subsurface ocean (and possibly a habitable environment) at some point in Dione's geologic history identifies Dione as an ocean world endmember: an icy world that did not develop a current Enceladus or Europa-like level of activity but did have a period of significant activity. The development of a USGS Scientific Investigation Map (SIM) will lead to the better understanding of the timing of intense regional tectonism and possible volcanism. Our SIM creates the necessary framework for future comparative planetological studies for understanding the controls on the formation of ocean worlds.

So far, global geologic maps of Ganymede [9], Europa [10], Enceladus [11], Titan [12], and Triton [19] have been produced (or nearing completion) 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.

Previous Mapping Efforts: The first mapping efforts of Dione were produced using images obtained during the Voyager 1 and 2 flybys through the Saturn system [14, 15]. Dione was not completely imaged during these two flybys, but images showed the moon had experienced periods of geologic activity [1, 2]. [1] produced an early regional geologic map of Dione, interpreting cryovolcanic activity and recent tectonism. During Cassini, [8] utilized the Visible and Infrared Mapping Spectrometer (VIMS) to explore broad-brush geological terrain units. Now, with the most complete Cassini ISS image set available for Dione, our detailed mapping of geologic structures will result in the most complete geologic map product of Dione, and will focus on updating detailed crater analyses, tectonism, and evidence of cryovolcanism.

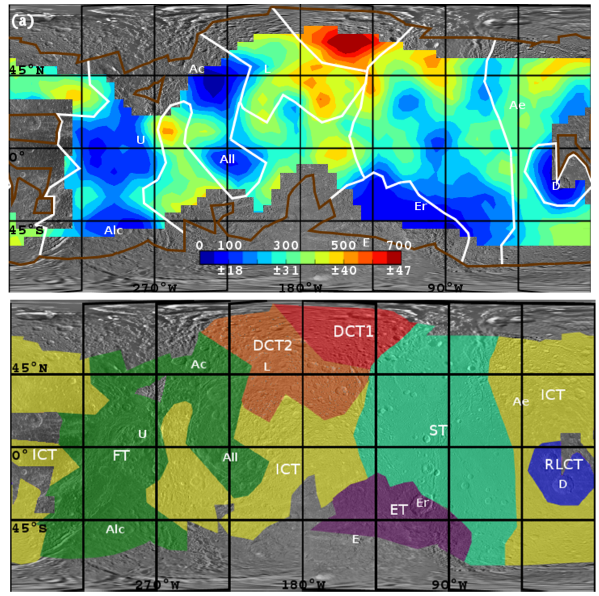

Figure 1: Figure 3a (top) and Figure 3b (bottom) from [5]. (top) Spatial crater density map of craters D> 4km. (bottom) Terrain units based on spatial crater density maps and surface morphology.

Crater Analysis. [5] used crater frequencies to identify near-global terrain units on Dione. This work focused on measuring crater location and diameters, and did not include mapping of crater materials or degradation classification.

Tectonism. Tectonic structures have so far been divided into stratigraphic categories broadly identified as ancient and recent and include morphological classifications including ridges, troughs, and scarps. Recent fractures are concentrated within Dione's wispy terrains. The tectonic stratigraphy is based on cross-cutting relationships among the features.

Cryovolcanic Features. Although Dione has not been observed to be currently volcanically active [16; 17], there is strong observational evidence to suggest that volcanism has played a role in modifying Dione's surface. The source of this volcanism is hypothesized to be a walled depression (Fig. 3) interpreted as a volcanic vent [4, 5]. Placing this feature into a global geologic context across Dione will help elucidate its relative and absolute model age with respect to the smooth terrains.

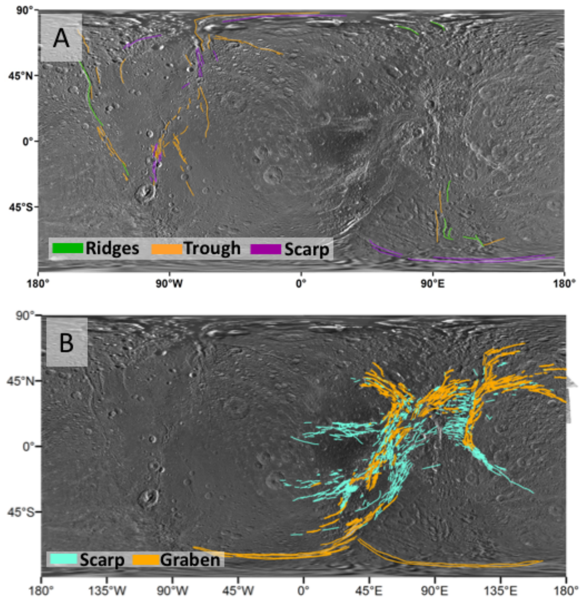

Figure 2: Preliminary mapping results from [6, 13]. Ancient fractures (A), recent fracturing in the wispy terrains (B).

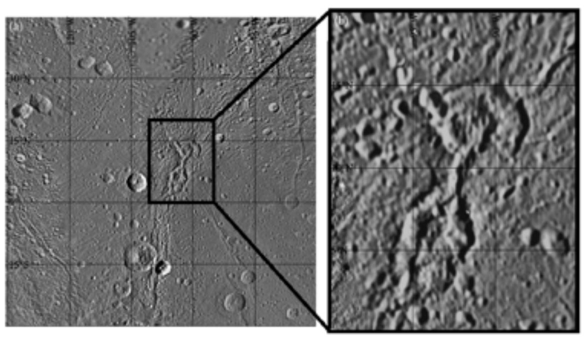

Figure 3: Figure 2 of [5] highlighting a feature interpreted as having a cryovolcanic origin.

Methodology and Approach: Comprehensive exploration of Dione's surface geology combines previous mapping efforts onto the updated Dione Cassini and Voyager Global Mosaic with an average resolution of 154 meters/pixel [20, 21]. Previous work that divided the surface of Dione into geologic units by [5] and [8] defined geologic units by crater density, surface morphology, and spectral properties. However, our work expands on those efforts by examining surface structures (ridges, troughs, evidence for volcanism, and impact craters) at a finer scale to define geologic units and develop a sequence of geologic events. Our work establishes a geologic history of Dione using both stratigraphic relationships among units to assess the relative ages as well as absolute model ages. While there are large error bars associated with absolute model ages, using both relative and absolute ages will help to establish the best assessment of stratigraphic order.

Discussion: Geologic mapping is one of the most fundamental ways in which to understand the history of a planetary body. In particular, the increasing interest in ocean worlds across the solar system as astrobiological targets necessitates the development of foundational data products from which to base future Dione and ocean world focused scientific investigations. Of the Saturnian moons, Dione has one of the most dynamic geologic histories preserved on its surface. The finale of the Cassini mission and the completed archiving of all Cassini data now available within the PDS means that the image data set for Dione is as complete as it can be until another encounter with a future mission.

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