DIONE: THE EVIDENCE FOR ACTIVITY. B. J. Buratti[1], P. M. Schenk[2], K. Khurana[3], Jeffrey Moore[4]. [1]Jet Propulsion Laboratory California Inst. of Technology, 4800 Oak Grove Dr. 183-401, Pasadena, CA 91109, Bonnie.J.Buratti@jpl.nasa.gov. [2]Lunar and Planetary Inst., Houston, TX 77058. [3]Inst. Of Geophysics and Planetary Physics, University of California Los Angeles, Los Angeles, CA 90095. [4]NASA Ames Research Center, Moffett Field, CA 94035.

Introduction: The discovery of activity on Enceladus was one of the major high points of the *Cassini* mission. One important question is whether any of the other icy satellites of Saturn exhibit activity or have exhibited it in the past. Dione and Tethys are associated with the best evidence for activity, in the form of plasma transported from their surfaces affecting the magnetosphere of Saturn [1]. In addition, Dione exhibits a possible transient atmosphere [2, 3]; cryovolanic features; at least one rampart crater; and "tiger-stripe"-like features in its south polar region.

The evidence: Double peaked "butterfly" pitch-angle distributions representing both high and low energy electrons were found in Saturn's inner magnetosphere. A model of this distribution assuming a dipole magnetic field for Saturn shows that the two plasma streams originate separately from Dione and Tethys, forming plasma tori at the locations of their orbits [1]. (See [4] for another interpretation.)

An atmosphere was detected on Dione in *Cassini* Visual Infrared Mapping Spectrometer (VIMS) data obtained early in the Mission [2] and by the magnetometer [5]. Further analysis by the *Cassini* magnetometer suggests that the atmosphere is transient: Observations from a targeted flyby on October 11, 2005, show "weak field perturbation in the upstream region, indicative of a tenuous atmosphere around the satellite" [3]. During another close flyby on April 7, 2010, the signature was not seen. The most recent magnetometer data is consistent with a mass loading of 0.72 kg/s neutrals from Dione, about 0.6% of that from Enceladus.

Perhaps the most compelling evidence is given by the geomorphology of Dione. Figure 1 shows the southern polar region of Dione dominated by features that are similar to the "tiger stripes" on Enceladus, the active regions which are the center of geologic activity and from which the plumes originate. Figure 2 shows features which appear to be cryovolcanic [6], and which are located at the center of a vast, relatively crater-free plains region. These plains could represent either a large flow feature, or a region of ejecta from plumes originating in the central features. In either case, craters and other features would have been infilled.

Another feature evident in Figure 2 is a rampart, or pancake crater (marked by the red arrow), which consists of an ejecta blanket of fluidized flow. Additional craters in this hemisphere are possible pancake craters as well. These features are typically seen on Mars and are indicative of ice, possibly liquid or partially liquid, below the surface. In the Jovian system, pancake craters are quite common on Ganymede [7,8]. At the temperatures typical of the saturnian system, ice behaves like a rock in impact processes; a pancake crater suggests the subsurface of Dione is hotter than usual.

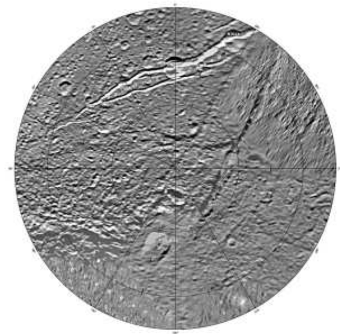

Figure 1: The south polar region of Dione, showing "tiger-stripe"-like features.

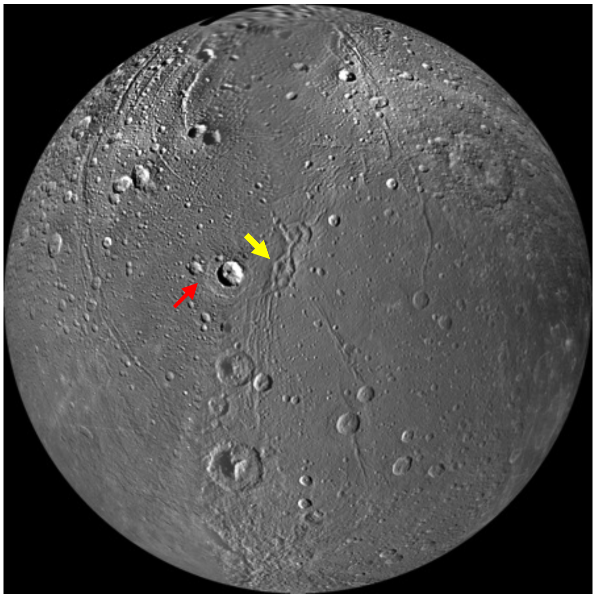

Figure 2: A *Cassini* image of Dione showing a putative cryovolcanic feature near the center (yellow arrow) surrounded by smooth plains. A rare rampart crater is marked by a red arrow.

Another method of seeking activity on a surface is to look for forward scattered radiation at very large solar phase angles. The plume of Enceladus is prominent at angles greater than ~150º, and the solar phase curve shows a large forward scattered peak. The phase curve of Dione shows no peak, down to a level of 1% of that of Enceladus [9].

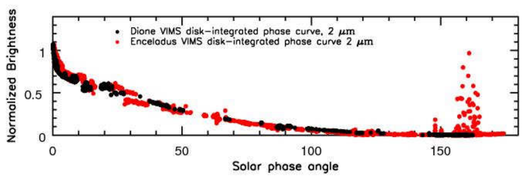

Figure 3: The integral solar phase curve of Dione based on *Cassini* Visual Infrared Mapping Spectrometer observations at 2.01 μm. For comparison the phase curve of Enceladus is shown, with the prominent forward-scattered peak. Based on [9].

Analysis of images of Dione obtained at large solar phase angles (Figure 4) also fail to show any plume activity.

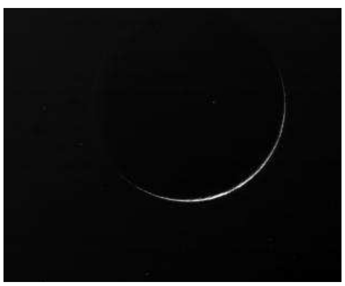

Figure 4: One of the many Cassini ISS observations of Dione at large solar phase angles. None of the images show evidence of a plume or an atmosphere.

Future work: The Cassini Solstice Mission (CSM), which is planned to last until 2017 (pending NASA approval), will continue observing Dione at large solar phase angles. In addition, stellar occultations by Dione to detect an atmosphere or any plume activity are currently in the timeline. During the proximal orbits prior to the termination of the mission, several more opportunities for stellar occultations exist.

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Ackowledgements: This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology under contract to the National Aeronautics and Space Administration.