DOMINANT WAVELNEGTH OF SMALL-SCALE FOLDS BETWEEN ENCELADUS' SOUTH POLAR TIGER STRIPES. Lauren J. Preuss[1] and Amy C. Barr[2] [1]Department of Physics and Space Sciences, Florida Institute of Technology (150 W University Blvd. Melbourne FL 32901 lpreuss@my.fit.edu); [2]Department of Space Studies, Southwest Research Institute, Boulder, CO (1050 Walnut St. Suite 300 Boulder CO 80302).

Introduction: The south polar terrain of Enceladus is geologically active with plumes of water vapor, dust, and other material erupting from four linear features dubbed the "tiger stripes" [1,2,3,4]. The plumes are spatially associated with a region of high endogenic power output, with a total power output originally estimated from short-wavelength *Cassini* CIRS observations as 5.8 ± 1.9 GW [2]. Recent longer-wavelength observations suggest a power output of 13.6 ± 1.4 GW during the March 2008 flyby, and 17.5 (+2.1, -1.9) GW based on measurements during the October, 2008 flyby [5]. The SPT has few craters and none larger than 1 km, suggesting a < 0.5 Myr surface age [1].

In addition to a high heat flux, the SPT is a region of intense deformation. The area is bounded by cycloidal arcs running close to 55˚S latitude, with wedge-shaped regions of intense folding at their cusps [6,7] (see Figure 1). Initial mapping suggests that the south polar region is dominated by extensional tectonics with a component of right-lateral shear [6,7].

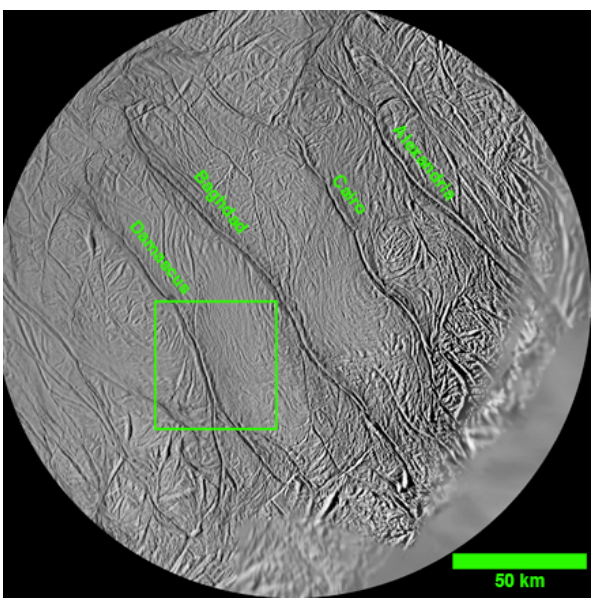

Figure 1. Polar stereographic mosaic of *Cassini* images of Enceladus' south pole, spanning 65˚S to 90˚S (*Cassini* PDS image SE_500K_90S_STEREO), showing the locations of Alexandria, Baghdad, and Damascus sulci, and the regions of intense deformation between the features. Approximate area of study is outlines by the green box.

South Polar Folds: The regions between the tiger stripes are characterized by closely spaced linear features, dubbed "funiscular" or "ropy" terrain [7]. High-resolution images of the region between Damascus and Baghdad sulci obtained in the August 11, 2008 and October 31, 2008 *Cassini* flybys reveal that the ropy terrain consists of many locally parallel features, interpreted to be folds [7] that follow the general direction of the tiger stripes.

Here, we report the results of a systematic study of the folding wavelength using Fourier transform methods [*cf.* 8].

Methods: *Topographic Analysis.* To constrain the wavelength of folding between Damascus and Baghdad sulci, we use high-resolution images to obtain profiles of brightness (expressed as data number, or DN). This method assumes that brightness corresponds with the topography, which is a safe assumption to make because the images were obtained at a high sun angle [8].

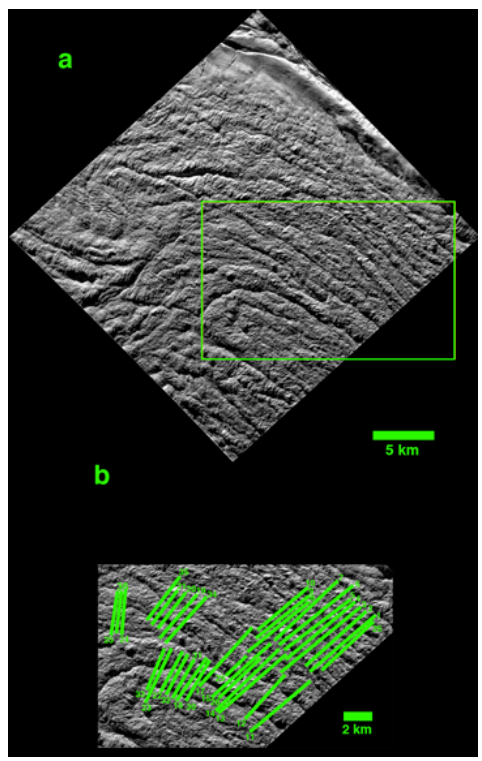

Figure 2. (a) Ropy area near Damascus/Baghdad sulci (Image N1597182533; Skeet Shoot #6). (b) Study area showing profile locations.

We use images N1597182533 and N1597182568, known as Skeet Shoot (SS) images #6 and #7 from the August 11, 2008 flyby and N1604167003 (SS #3),

N1604167059 (SS #5), and N1604167158 (SS #8) from the October 31, 2008 flyby. Radiometric calibration was performed using CISSCAL [9] and imported into ISIS 3.1.20 [10]. The images were re-projected into a polar stereographic projection, necessary because they were obtained close to Encleadus' south pole. Because the planet-spacecraft distance is small, the projection does not significantly alter the geometry of the features.

We obtained a total of 160 profiles of brightness as a function of distance. Fourier transform methods were used to determine the dominant wavelength of folding in each profile. Figure 2 shows the locations of profiles in N1597182533 (SS #6). Figure 3 shows a sample topographic profile and its Fourier transform.

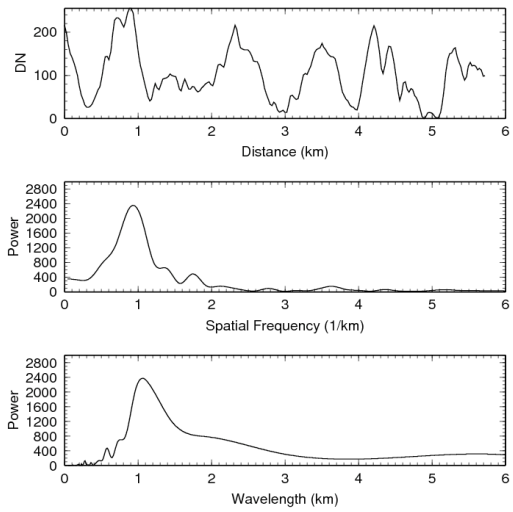

Figure 3. Example of a Discrete Fourier Transform (DFT) across folded terrain near Damascus sulcus in Enceladus' south polar terrain. (top) Profile of DN versus distance extracted across profile 6 in the Skeet Shoot #6 image shown in Figure 2. (middle) DFT of the top DN profile, showing peak power at a spatial frequency of 0.87 km^{-1}. (bottom) Inverse of the DFT showing the corresponding dominant wavelength, 1.15 km.

Results: Figure 4 shows a histogram of folding wavelengths among all images used in the study. We find a dominant wavelength of folding of 1.1 ± 0.4 km across all parts of the folded terrain. Because the dominant wavelength of folding can hint at conditions of fold formation [e.g., 11, 12, 13, 14], our future work on this topic will focus on interpretation of the fold wavelength to deduce the thermal and mechanical structure of Enceladus' ice shell at the time of fold formation.

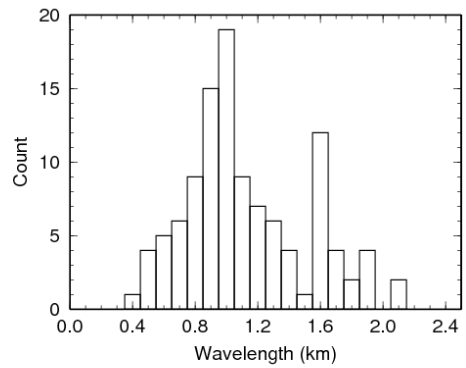

Figure 4. Histogram of the dominant wavelength of folding in the Damascus/Baghdad region in Enceladus' south polar terrain. We find a dominant wavelength of 1.1±0.4 km.

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References: [1] Porco, C. G., et al. *Science, 311*, 1393-1401, 2006; [2] Spencer, J. R. et al., *Science* 311, 1401-1405, 2006; [3] Waite, J. H., et al., *Science* 311, 1419-1422, 2006; [4] Spitale, J. N. and C. C. Porco, *Nature* 449, 695-697, 2006; [5] Spencer, J. R. et al., *AGU Joint Assembly Meeting Abstracts*, no. 2120, 2009; [6] Helfenstein, P. et al., (2006) *LPSC XXXVII* #2182; [7] Spencer, J. R. et al., in *Saturn from Cassini-Huygens*, p. 683-724, Springer, New York, 2009; [8] Patel et al. (1999) *J. Geophys. Res., 104*, 24,057-24,074. [9] Porco, C. C., et al., CO-CAL-ISSNA/ISSWA-2-EDR-V1.0, COISS_0011. NASA PDS, 2005; [10] Anderson, J. A., et al., *LPSC* XXXV, abs. no. 2039, 2004; [11] Fink, J., and R. C. Fletcher (1978) *J. Volcanol. Geotherm. Res., 4*, 151-170. [12] Fink, J. (1980) *Geology, 8,* 250-254. [13] Fletcher, R. C., and B. Hallet (1983) *J. Geophys. Res., 88*, 7457-7466. [14] Dombard, A. J. and W. B. McKinnon, *J. Struct. Geol.* 28, 2259-2269, 2006.