ASSESSMENT OF TOPOGRAPHY OF PALEO TIGER STRIPES. C. S. J. Valdez[1], J. P. Kay[2], D. A. Patthoff[3], and P. Schenk[2], [1]University of Houston at Clear Lake [2] Lunar and Planetary Institute, USRA, Houston TX 77058, [3]Planetary Science Institute (ValdezC2757@UHCL.edu)

Introduction: The majority of the geologic activity on Saturn's moon Enceladus is focused within the South Polar Terrain (SPT), which consists of reworked and young tectonically disrupted terrain [1, 2]. The most notable features within the SPT are the long, linear, and sub-parallel fractures that are flanked by low ridges. These structures are known as the "Tiger Stripes" and are actively emitting plume material [1-3]. These features are approximately 130 km long and 2 km wide.

Work that measured the physical libration of Enceladus strong suggests that there is a global ocean that sits below the ice shell [4]. Additionally, three sets of Paleo Tiger Stripes have been identified [5]. This work was based on traditional crosscutting techniques and orientation calculations [5]. These Paleo Tiger Stripes are morphologically similar to the Tiger Stripes, are longer and wider than other fractures within the region, and can be connected by bisecting fractures [4]. Subsequent work that has leveraged the orientations of the Paleo Stripes and other fractures within the region and used numerical modeling (SatStressGUI), which calculates the tidal stresses, found that it is possible to form all sets within a minimum ~100,000 years [6]. This places a minimum benchmark on the total age of the observable major features.

The Tiger Stripes are the location of the highest regional temperatures (>180 K), but the entire SPT has an elevated heat flow as compared to the rest of the body (~75 K) [7, 8]. Work on crater relaxation has shown that Enceladus has sustained high heat flow, as high as 150 mW m^{-2} [9]. However, there is incomplete integration of this heat flow data and the sustained presence on tectonic features to see how support of the Paleo Stripes would change through time. Here we present topographic analyses that compares and contrasts the present topography of the previous identified Paleo-Tiger Stripes to assess the probability that any change can be attributed to relaxation. Over long timescales (absent other tectonic processes) we expect that that each each iteration of newer tiger stripe would be slightly more relaxed relative to the newer set.

a)

b)

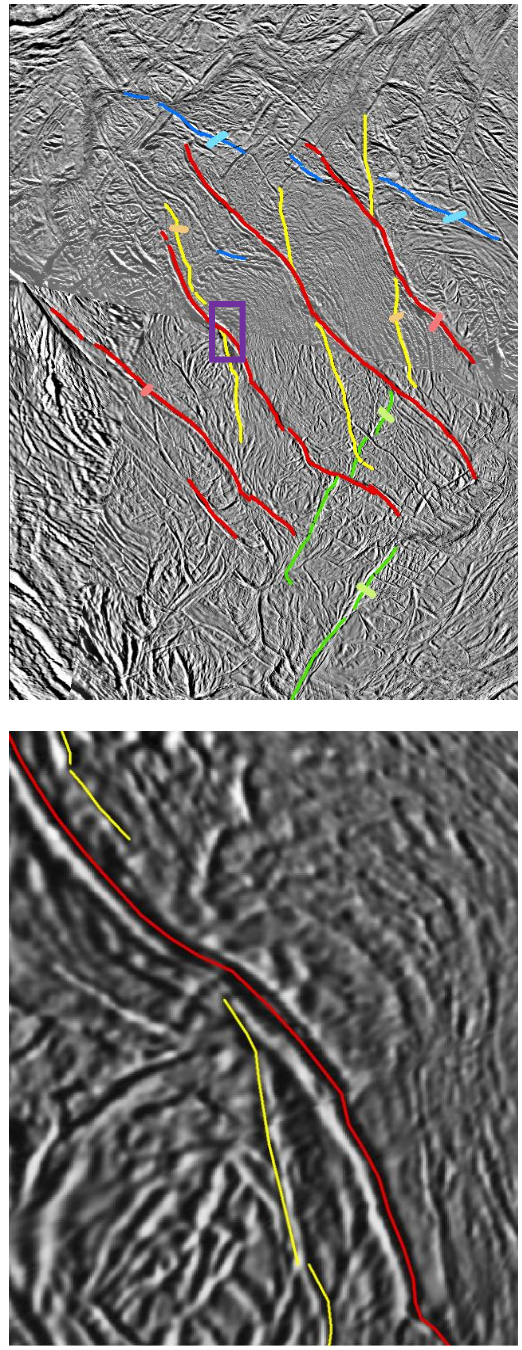

Figure 1: a) Paleo Tiger Stripes and the corresponding topographic profiles taken in Figure 2. Purple box indicates close up of crosscutting relationship. b) Image subset of set Tiger Stripe bisecting next oldest set.

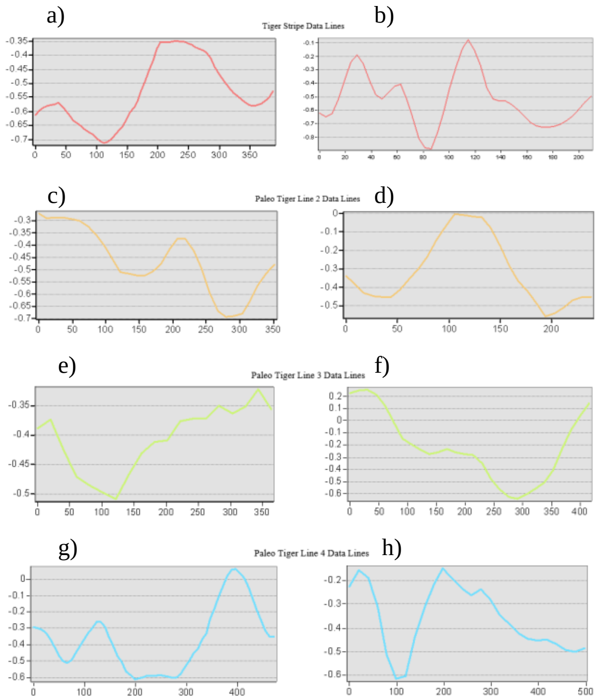

Figure 2: Analysis of Paleo Tiger Stripes at various, color coordinated locations on map

Data and Methods: Images of Enceladus and the SPT were captured by the Cassini Imaging Science Subsystem (ISS). The Integrated Software for Imager and Spectrometers (ISIS) was then used to process the images. Stereo images were used to create stereo-grammetric DEM's within the SPT and create a control network for Enceladus. ESRI's ArcGIS 10.3.1 was use with the Enceladus global basemap with a South Polar Projection. We used the 3D analysis extension to take the profiles.

Results: In our initial assessment we took two topographic profiles of the Tiger Stripes and the Paleo Tiger Stripes (Figure 1) and plotted the topography (Figure 2). The youngest set (shown in red) shows topographic relief of 350 m and 900 m (Figure 3a, 3b). The next oldest set (yellow) shows relief of 350m and 500 m (Figure 3c, 3d). Set 3 (teal) shows relief of 600 m and 400 m (Figure 3e, 3f). The oldest set (blue) has a relief of 100 m and 800 m (Figure 3g, 3h).

Discussion and Conclusions: We showed a series of profiles that have demonstrated an unclear trend on any noticeable variations within the different sets of Tiger Stripes. However, a larger systematic analysis is required and should lead to finer barriers. There also exists the possibility that the features have been tectonically re-worked to increase relief. Should the features be as young as has been speculated (< 100,000 years) the rate of NSR is so high, and thus the paleo tiger stripes are quite young. Therefore, the paleo tiger stripes have not had enough time to relax and some other method of degradation is dominating. Additionally, the paleo tiger stripes may have been taller (or shorter) during their initial formation which could lead to uncertainty in the amount of relaxation that has occurred. There also exists the possibility that the scale of the fracture sets does not lend to relaxation. Previous work on crater relaxation on Enceladus has found that relaxation in the highest heat flow models does not initiate until the diameter of the crater reaches ~4 km [8].

Future Work: We will take additional high-resolution profiles across the features to try to refine the size of the fractures. In addition to the we will incorporate new topographic data from both photoclinometry and shape from shading models. We also will incorporate finite element modeling to test the long term stability of the tiger stripes to determine the time scales under which relaxation would be expected to occur. We will also compare the topography of the paleo tiger stripes to the surrounding terrain to determine if other features have experienced any relaxation.

References: [1] Porco C.C. et al. (2006) Science 311, 1393 –1401. [2] Bland et al., (2015), Icarus 260 232-245. [3] Hansen et al., (2006) Science 311, 1422-1425. [4] Thomas et al., (2016), Icarus, 264, 37-47. [5] Patthoff D.A., and Kattenhorn S.A., (2011), GRL 38. L18201. [6] Patthoff et al., (2019) Icarus, 321, 445-457. [7] Spencer J.R. et al. (2006) Science, 311, 1401–1405. [8] Howett C.J.A. et al.(2011) JGR,116,E03003. [9] Bland et al., (2012), GRL 39, *doi:10.1029/2012GL052736.*