Deciphering Enceladus's Tectonic History: An Analog for the Pluto and Charon System. E.S. Martin and S.A. Kattenhorn, Department of Geological Sciences, University of Idaho, Moscow, ID 83844-3022, mart5652@vandals.uidaho.edu, simkat@uidaho.edu.

Introduction: Comparative planetology is a valuable tool when data resolution hinders analysis. In the case of Pluto and Charon, no detailed images of the surface exist; other icy bodies have been used to hint at what processes are or have occurred on the surface. Triton has been speculated to be a good analog for Pluto and Charon, but [1] suggest that a heating event caused by the capture of Triton by Neptune would have altered the surface enough to render it too dissimilar to Pluto and Charon. No icy satellite may ever truly serve as a direct analog for another; however, the techniques used to construct an understanding of an icy body's tectonic history are applicable to a variety of icy satellites. Here we present analog techniques used to understand the tectonic past of Saturn's moon Enceladus on both a local and global scale, in the event that a fracture history is found to exist on Pluto or Charon and needs to be deciphered.

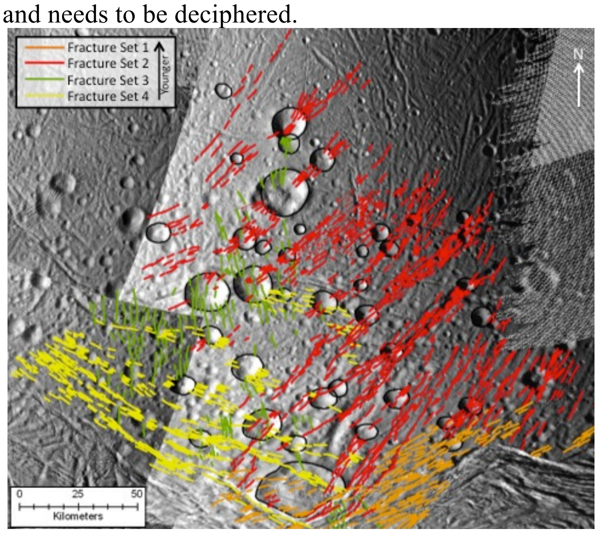

Figure 1: Fracture map of a region in the southern hemisphere of Enceladus, centered at -30° lat, 180° long.

Global Scale Fracture Patterns: Large-scale tectonic deformation in icy shells can manifest itself as fractures that form in response to stresses within an ice shell sourced from a variety of mechanisms [2]. Preserved fracture patterns can be used to identify the orientations and source of the stresses. [3] used global fracture patterns on Europa to suggest their formation by nonsynchronous rotation (NSR) of an ice shell above a global subsurface ocean. Similarly, work by [4] shows direct geologic evidence within the south polar terrain for the rotation of Enceladus's ice shell, suggesting NSR over a global ocean.

Enceladus's heavily fractured terrains show an extensive tectonic record, ostensibly related to global stress fields. Detailed fracture mapping of a small region of the cratered terrains has been completed using crosscutting relationships to determine relative ages of fractures that belong to regionally extensive sets (Fig. 1). We have identified four distinct fracture sets with different orientations showing a relative rotation of the stress field through time, perhaps related to NSR.

Small-Scale Tectonic Features: There are a variety of small-scale tectonic features found on Enceladus that aid in identification of tectonic processes and may be relevant to the Pluto-Charon system.

Pit chains: Pit chains are linear troughs made up of circular to elliptical depressions formed by the draining of regolith into a dilational space along an active high-angle normal fault or tension crack [5]. Pit chains have been identified on a variety of solar system bodies [6] and were recently identified by [7] on Enceladus, used to estimate depths of regolith mantled on the surface.

Strike-slip Faults: Strike-slip faults imply shear reactivation of cracks and have been identified on Europa [8], Ganymede [9], Enceladus [10], and Triton [11]. Their sense of slip can be identified from visible offsets or by using tailcrack patterns [12], which are indicative of the slip-to-dilation ratio and thus the stress conditions responsible for fault motions.

Crater-fracture interactions: Local perturbations to the regional stress fields can occur from a variety of mechanisms including fault tip stresses (e.g. tailcracks), diapiric uplift, and impact cratering. Enceladus shows crater induced fracture reorientation [13-16]. Characterizing the controls on a crater's ability to reorient fractures provides a better understanding of ice shell structure and localized heterogeneities within regional stress regimes.

Conclusions: Numerous techniques are used to illuminate Enceladus's tectonic history. These techniques may potentially be relevant to the Pluto-Charon system when surface images are ultimately received.

References: [1] Cruikshank et al. (1997), in *Pluto and Charon,* UA Press, 221-267. [2] Kattenhorn & Hurford (2009), in *Europa*, UA Press, 199-236. [3] Greenberg et al. (1998), *Icarus* 135, 64-78. [4] Patthoff & Kattenhorn (2010), *41ST LPSC* Abs. 2099. [5] Wyrick et al. (2004), *JGR* 109, E06005 [6] Wyrick et al. (2010), *41st LPSC* Abs. 1413. [7] Michaud et al. (2008), *39th LPSC* Abs. 1678. [8] Hoppa et al. (1999) *Icarus* 141, 287-298. [9] Pappalardo et al. (1998) *Icarus* 135, 276-302. [10] Smith-Konter & Pappalardo (2008) *Icarus* 198, 435-451. [11] Croft (1993), 24th LPSC Abs. 1176. [12] Kattenhorn (2004), *Icarus* 172, 582-602. [13] Barnash et al. (2006), *38th DPS Abs.* 24.06. [14] Bray et al. (2007), *38th LPSC Abs.* 1873. [15] Miller et al. (2007), *38th LPSC Abs.* 6007. [16] Martin & Kattenhorn (2011), 42nd *LPSC Abs.* 2666.