A CLASSIFICATION AND CHARACTERIZATION SCHEME FOR TECTONIC STRUCTURES ON ENCELADUS. Amanda L. Nahm[1] and Simon A. Kattenhorn[1], [1]Department of Geological Sciences, University of Idaho, Moscow, ID 83844, nahm@uidaho.edu and simkat@uidaho.edu.

Introduction: The ice shell of Enceladus has experienced widespread and diverse tectonic deformation. The diversity of structures visible on the surface attests to a complicated and perhaps long-lived tectonic history. Currently, no fundamental classification scheme based on morphology and formation mechanisms exists for the tectonic structures on Enceladus, as does for Europa [1], which limits analysis and discussion of tectonic structures and the regional and global tectonic history. Characterization and classification of structures based on their formation mechanisms allows for the stress states (orientation, magnitude, and sense) responsible for their formation to be inferred. Thus, characterizing and classifying structures on Enceladus is a major first step in understanding its tectonic history. Here, we present our global classification scheme for tectonic structures on Enceladus.

Data: The base map used for our structure classification was the global Imaging Science Subsystem (ISS) mosaic obtained from CICLOPS (110 mpp; [2]) released in April 2013. Individual ISS images (resolution varying from ~20 mpp to ~200 mpp) were utilized for detailed morphological description where images were available and appropriate.

Structure Classification Classes: The structures observed on the surface have been divided into five broad classes based on morphology: *trough*, *scarp*, *chasmata*, *ridge*, and *lineated band*. Several of the classes have subclasses of structures representing the range in morphology observed for that class. Representative images for each class and subclass are shown in Figure 1.

Troughs: A *trough* is defined as a ridgeless fracture with a measurable width, forming a linear to curvilinear indentation at the surface of the ice shell [1]. Older structures crosscut by troughs display horizontal separation across the trough and experience no observed lateral offsets or other trough-induced modification. This is the most abundant class of structures on the surface of Enceladus and accordingly displays the most diverse morphologic range. This class is divided into several subclasses. *Pit chains* are linear arrangements of circular to elliptical depressions (i.e., pits) [3, 4] that lack an elevated rim, ejecta, or flow deposits, and occur in parallel, sometimes sinuous, sets. They can be comprised of individual pits, partially merged pits, or fully merged pits. *En echelon troughs* are closely spaced, subparallel to parallel, linear depressions that overlap or have a staggered arrangement. These troughs may be left- or right-stepping.

Scarps: *Scarps* are defined as prominent cliffs with an abrupt change in elevation perpendicular to strike as determined in imagery, topography, or both. Three subclasses make up this classification. *Arcuate scarps* are defined as curved scarps with subdued, rounded crests. Troughs end abruptly at the scarp crest. An elevation change across the scarp is inferred based on shadows. *Sinuous scarp complexes* are defined as tabular groupings of parallel, sinuous crenulations with a sharp bounding scarp. Widths of the complexes vary, but are on the order of ~10s km. Limited topographic data reveals a prominent outer scarp with an abrupt step down to lower elevations. *Linear scarps* are described as long (>100s km), approximately straight cliffs. They appear in imagery as narrow (~100s m), single dark stripes with sharp edges and appear in topography as sharp breaks in elevation. The most prominent example, which is located in the northern trailing hemisphere, shows higher elevations on the west and lower elevations on the east. Its associated topography [5] gives a relief of 572 ± 124 m.

Chasmata: *Chasmata* are defined as deep, elongate, steep-sided depressions; the singular form is chasma [6]. This class is divided into two subclasses. *Narrow chasmata* are narrow (~0.8 – ~3 km), deep, subparallel to parallel linear depressions with flat floors that extend for 10s to 100s of km. Rims are often irregular or scalloped. *Wide chasmata* are wide (~4 – ~35 km), deep, curvilinear depressions that extend up to 100s of km north from protuberances in the south polar dichotomy. The floors of the chasmata are flat with irregular crenulations parallel to the walls. The chasmata are widest in the south and narrow northward.

Ridges: *Ridges* are defined as any approximately linear, topographically high (relative to surroundings) structure on the surface of Enceladus. This class is divided into four subclasses. *Single ridges* are raised, approximately linear structures that appear in imagery as single, wide, bright stripes alongside narrower dark stripes (shadows). Irregular, depressed crenulations with varying depths and widths are present along the crests. The most prominent examples are located in the trailing hemisphere. Topography [5] shows these single ridges are several hundred meters high. *Double ridges* are prominent linear to curvilinear depressions that are ~130 km long, 2 km wide, and with a 500 m deep central depression, flanked by 100 m high topographic edifices [e.g., 7]. Double ridges within the South Polar Terrain (SPT) and with observed jet activity are known colloquially as “tiger stripes" [e.g., 8]. *Subdued double ridges* are linear depressions with subdued double ridge morphology. They range from 10s to 100s of meters in width and from 10s of meters to 10s of kilometers in length [9]. Currently, both double ridges and subdued double ridges have only been identified within the SPT, but may exist elsewhere on Enceladus. *Corrugated ridges* consist of sets of parallel ridges with rounded crests oriented approximately concentrically to the SPT dichotomy. The ridge sets also are observed in protuberances from the SPT dichotomy (in the form of triangular wedges) and within wide chasmata, but are not parallel to the wedge boundaries.

Lineated Bands: *Lineated bands* are defined as tabular features characterized by sharp boundaries and a fine lineated interior texture parallel to the feature boundaries. The interior lineations are non-continuous along their length and appear knobby in some places, giving the appearance of crenulated crests.

Discussion: Previous studies of tectonics on Enceladus have primarily focused on the "tiger stripes," structures around or within the SPT, and on more broad-brush characterization of tectonic terrains [e.g., 10, 11]. Here, we focus on the identification and classification of individual local-scale structures.

While our presented classification scheme is based on morphology alone, some interpretation of the formation mechanisms of the identified structure classes has been made. At this time, we have preliminary inferences regarding the formation for a subset of these classes.

- *En echelon troughs* are interpreted to be the result of lateral shear along an underlying fracture in the ice shell, oriented parallel to the en echelon array [e.g., 12].
- *Linear scarps* are interpreted as large, single normal faults.
- We assume that *pit chains* form in regolith above a dilating normal fault [13]. An evolutionary sequence is inferred based on morphology: Individual pits form initially due to small fault displacement. Pits coalesce into partially merged pits and finally into fully merged pits as displacement on the subjacent fault accumulates [13–15].
- *Chasmata* are interpreted to be normal fault graben. A *narrow chasma* is a series of distributed individual graben, while a *wide chasma* is the result of accumulation of more normal fault displacement than in the narrow chasmata and thus accommodates a larger amount of extension.
- *Corrugated ridges* and *single ridges* may be the result of compression, forming folds and/or thrust faults [e.g., 16].

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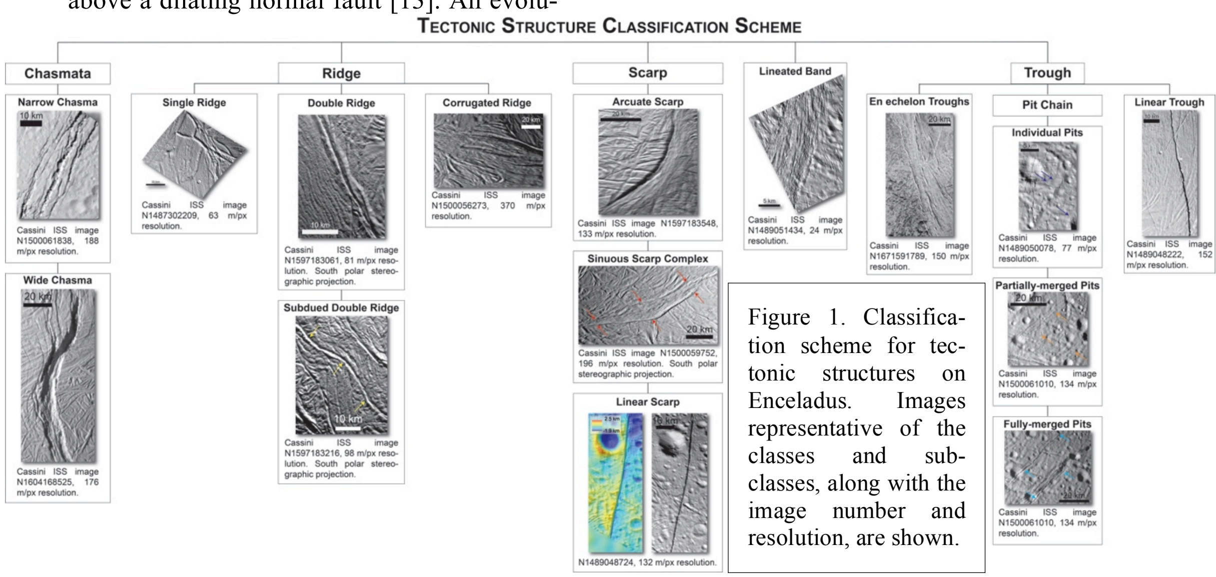

Figure 1. Classification scheme for tectonic structures on Enceladus. Images representative of the classes and subclasses, along with the image number and resolution, are shown.