PIT CHAINS ON ENCELADUS: AN EXPERIMENTAL TEST OF THE IMPACT OF FAULT GEOMETRY ON PIT CHAIN GROWTH.
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Introduction: Pit chains are linear troughs made up of circular to elliptical depressions [1] and are distinguishable from impact craters (which have raised crater rims), impact ejecta, or flow features [1,2]. They commonly tend to be cone or bowl shaped collapse depressions with circular to elliptical plan view shapes and, in some cases, exhibit flat floors [3] (Fig. 1). Often forming in parallel sets, pit chains are thought to be the result of unconsolidated regolith drainage into dilational normal faults within extensional tectonic settings [1,2]. Pit chains have been identified in many locations including Mars [1,4], Phobos [5], and Earth [6] (see review by [3]), and more recently have been identified in the outer solar system on Enceladus [2]. On Encladus specifically, pit chains are concentrated within the cratered terrains of Enceladus's Saturnian and anti-Saturnian hemispheres.

Pit chains may serve as an important tool for probing the distribution of regolith depths on the surface of Enceladus. It has been experimentally determined by [5] that a correlation exists between average pit spacing along a line of pits and the regolith thickness, independent of the angle of repose [5]. Additional experimental work on pit chains consider their formation along preexisting, unsegmented faults [1,5]. However, faults are typically segmented; therefore, it is important to understand pit chain formation as fault segments join together. If the correlation between pit spacing and regolith depth is to be used to estimate regolith depth across Enceladus's cratered terrains, the effect of the segmented nature of nascent faults on the regolith depth proxy must be constrained. Here we consider the effect of initial fault geometries on the relationship between pit formation, geometry, and regolith thickness.

Previous Experimental Models: The model set up by [1] to investigate the evolution of pit chains consisted of two base plates beneath two rigid wooden blocks overlain by two material layers. The rigid wooden blocks, in combination with a layer of cohesive silica powder, represented a vertical fault segment. This vertical fault segment is then linked to a 65° dip detachment fault. As the two baseplates begin to move apart, a tabular void is created along the vertical portion of the fault. The sandpack layer represents regolith with little cohesion and therefore drains into the created void.

Experiments by [5] established a very similar analog model to that of [1]. Rather then looking at the evolution of pit chain formation [1], the models of [5] were constructed to explain pit chain morphologies and geometric relations assuming pits formed due to regolith drainage into an underlying open fracture. The work of [5] used three different regolith materials: expanding vermiculite, no. 20 mesh silica sand, and glass spheres 0.7 mm in diameter. The study found a direct relationship between overlying regolith depth and pit chain spacing.

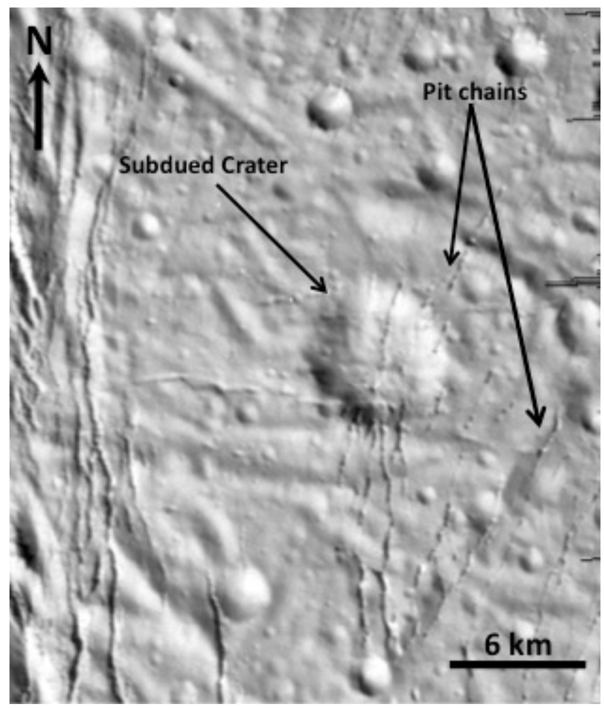

Fig. 1: Pit chains in cratered terrains on Enceladus. Centered at 5°N, 211°W. Image N1489050078.

Experiment Model: Our initial experiment aims to understand the effect of initial segmented fault geometries on the evolution of pit chains. Pit chains will form along fault segments, but as dilation continues and segments begin to merge, will the pits simply get larger, thus maintaining their average spacing, or will new pits nucleate and change the average pit spacing?

These initial questions will be answered by first attempting to replicate the observed pit chain formation and evolution as seen by [1,5] with our new experimental set up model (Fig. 2). Our analog model construction differs slightly from [1] and [5] because we will be using a pure dilational fault fracture with no sense of normal motion along the fault. Future experiments will study the temporal evolution of fault populations under moderately oblique and highly oblique distributed extension.

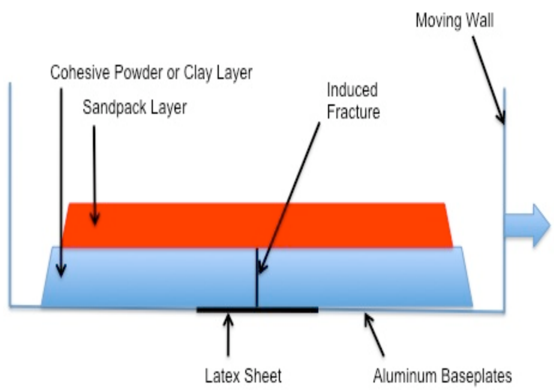

Fig. 2: Initial model setup. Cohesive powder or clay layer represents a material layer similar to a structural crust. The sandpack material layer represents our overlying regolith.

Our proposed experimental set up consists of a latex sheet, at the base of our cohesive material layer, that is connected to one fixed and one moving baseplate. The latex sheet is used to help create a fault population within our cohesive layer later in our experiments. [1] and [5] did not use a base latex layer in their experiment setups. Above our latex sheet and aluminum baseplates will be two material layers. The cohesive powder or clay layer is used to represent a material layer that can support steep slopes in hopes of maintaining our dilational fault tabular void throughout our experiment. We will experimentally determine which material is better (cohesive powder, clay, or both) for the purpose of our study. The sandpack layer will represent our unconsolidated regolith. A fracture will be induced in the clay or cohesive powder before the experiment takes place to ensure dilation initiates at this locality and in a controlled geometry. As dilation increases, material from the sandpack layer should progressively drain into our induced fracture. This early experiment will involve perpendicular motion of the moving wall in relation to our induced fracture. The experiment aims to build upon work by [1] and [5] by incorporating more complex fracture geometries and growth patterns.

Further experiments will be expanded by involving moderately oblique and highly oblique distributed extension. Similar experiments were performed by [7] when considering the effect of oblique extension on fault populations in a clay layer. Our experiment will differ by incorporating a layer of sandpack material above the clay or cohesive powder. This sandpack layer will represent the regolith on Enceladus. By ultimately incorporating oblique extension in our experiment we hope to induce fault populations in an en echelon pattern within our cohesive powder or clay layer. Our regolith layer should then drain into these fault populations. This will allow us to observe the impact of fault segmentation on pit chain spacing and geometry.

Discussion: Our modified experimental set up of pure dilation and a variety of fault geometiries will allow us to to determine if segmented fault systems result in larger or more numerous pits. We hope to experimentally compare the different pit chain geometries associated with a simple linear dilational fracture (similar to Ferrill et al. [1]) and in an en echelon fault pattern. With further experimentation we would also like to see if regolith properties such as cohesion effects the pit chain geometries and spacing associated with an en echelon fault pattern.

References: [1] Ferrill D. A. and Wyrick D. Y., *GSA Today,* 4-12, 2004; [2] Michaud et al. (2008) *39th LPSC* Abs. #1678. [3] Wyrick et al., *Journal Geophysics Research*, 20, 2004; [4] Wyrick et al. (2011) *42th LPSC* Abs. #1536; [5] Horstman K. C. and Melosh H. J., *JGR,* 12433-12441, 1989; [6] Ferrill D. A. and Wyrick D. Y., *GSA,* 133-142, 2011; [7] Schlische et al., *Journal of Structural Geology*, 910-925, 2009.