QUANTIFYING THE ENVIRONMENTAL RESPONSE TO DEGLACIATION IN MARTIAN CRATERS DURING THE LATE AMAZONIAN.

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Introduction: The mid-latitudes of Mars have experienced extensive patterns of glaciation throughout the Late Amazonian due to climate excursions, which are primarily driven by quasi-periodic fluctuations in orbital parameters, the most influential of which being obliquity [1,2]. These variations in axial tilt and eccentricity have led to in the repeated migration of glacial ice between the polar caps and the mid-latitudes [1,3,4] due to global shifts in the distribution and seasonal intensity of solar illumination [2]. During periods of glacial accumulation at the mid-latitudes, ground-ice becomes unstable at the polar caps, resulting in the removal of ice from the polar regions and its ensuing deposition in the mid-latitude regions [1,3,5]. Glacial deposits in the mid-latitudes are thought to have been stable up to ~5 Ma, where the mean obliquity of Mars was ~35°[2]. Between ~5 and ~2.5 Ma, the mean obliquity is modeled to have decreased from ~35° to ~25°, leading to the mid-latitudes transitioning into a period of glacial ablation [2,5]. The deglaciation process would have rapidly begun to erode and modify the previously glaciated environment as the glaciers retreated [5,6]. The transitional stage between glacial and interglacial periods is known as a paraglacial period and it is accompanied by a host of diagnostic geologic features on Earth [7,8] that have also been identified on the surface of Mars [5].

The paraglacial features of interest in this study include spatulate depressions, washboard terrain, polygonal terrain, and gullies (Fig. 1). Spatulate depressions are sharply rimmed depressions with hummocky floors that can be found near the bottom of the crater slope [5]. In craters at the mid-latitudes of Mars, they are often located on the pole-facing side of the crater, and they are interpreted to be formed via enhanced ice sublimation mechanisms at the base of the crater wall [3,8]. Washboard terrain denotes a cluster of parallel scarps that are perpendicular to the crater slope, which could have been created through debuttressing and ice crevassing [5]. The morphology of the polygonal terrain in the craters of this study are similar to sublimation polygons, which are indicative of the periodic thermal cycling of near-surface ice-rich material [1,5,10]. Gullies, argued to have a wide range of formation mechanisms, are likely to have formed primarily via water-assisted flow, although they may also be modified by dry and CO_2-assisted flow [5].

Aim of This Study: This work aims to draw comparisons between 5 unnamed craters near Terra Sirenum in the southern hemisphere (~160°W, 40°S) and 5 near Utopia Plantitia (~80°E, 40°N) in the northern hemisphere. The craters have previously been identified as containing paraglacial features by [3]. We mapped out the paraglacial features using Context Camera (CTX) [11] and HiRISE [12] observations of the specific craters and quantified the characteristics of each paraglacial feature along with conducting a spatial-proximity analysis between the various paraglacial features. By understanding the patterns between the extent of these paraglacial features in relation to their local environment, we hope to better understand the specific nature of deglaciation and paraglacial modification in recent Mars history.

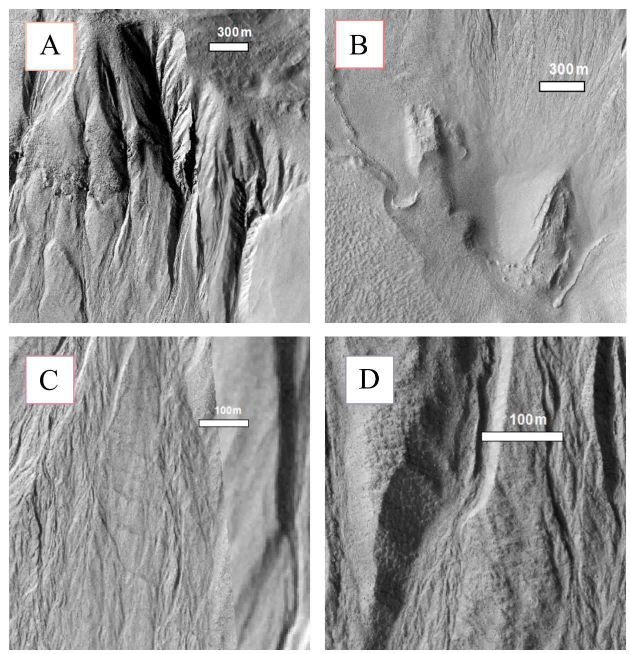

Figure 1: Paraglacial features in unnamed impact crater (18.2 km diameter, 161° W, 43.3° S) in eastern Newton basin. CTX image G05_0203342_1364_XI_43S161W. (A) Gullies. (B) Spatulate depressions. (C) Washboard terrain (D) Polygonal terrain.

Methodology: *Mapping.* To conduct our investigation, we used orthorectified 30 cm/pixel HiRISE and 6 m/pixel CTX observations of craters that have been previously determined to contain glacial deposits to map out these features in order to characterize the variability of paraglacial processes across the surface of Mars.

Measurements. In order to characterize the extent of paraglaciation in each crater, we measured quantitative aspects of each of the paraglacial features in order to compare the trends of these measurements across different crater environments. Previous studies have deciphered large-scale trends in paraglaciation [3,5], and this analysis examines the spatial relationships of each paraglacial feature across a representative set of craters. We measured gully length, washboard terrain fracture distances, and short- and long-axis polygonal fracture distances in each crater (Fig. 2). Ongoing work is being done on conducting spatial analyses between each set of paraglacial features using tools within ArcGIS in order to further our understanding of the distribution of paraglacial features within glaciated craters on Mars. We also evaluated the distribution of paraglacial features as a function of crater wall aspect in order to further our understanding of patterns of ice accumulation within these craters.

Current Results and Discussion: We have completed the analysis of one mid-latitude crater in the southern hemisphere of Mars. The 67 washboard fractures identified had an average spacing of ~4 m. The highest concentration of gullies was found on the northern (pole-facing) wall of crater. The gullies averaged to ~3100 m in length, stretching from the alcoves on the rim of the crater down to the spatulate depressions on the crater floor. When examining the polygonal fractures found within the crater, the average short-axis length of each fracture was ~10 m, and the long-axis length was found to be ~25 m. A majority of the polygonal fractures found in this crater were located on gully channels, indicating the two features may be stratigraphically related. All of the paraglacial features examined in this study were clustered around the northern half of the crater, suggesting that ice accumulation (and in turn, ablation) was focused on the pole-facing side of the crater.

The same analysis of the remaining craters is underway. We are working on analyzing quantitative features within glaciated craters to identify trends in global paraglacial feature distribution and identify possible correlations with local setting, such as crater diameter or depth, and regional characteristics, such as latitude and elevation.

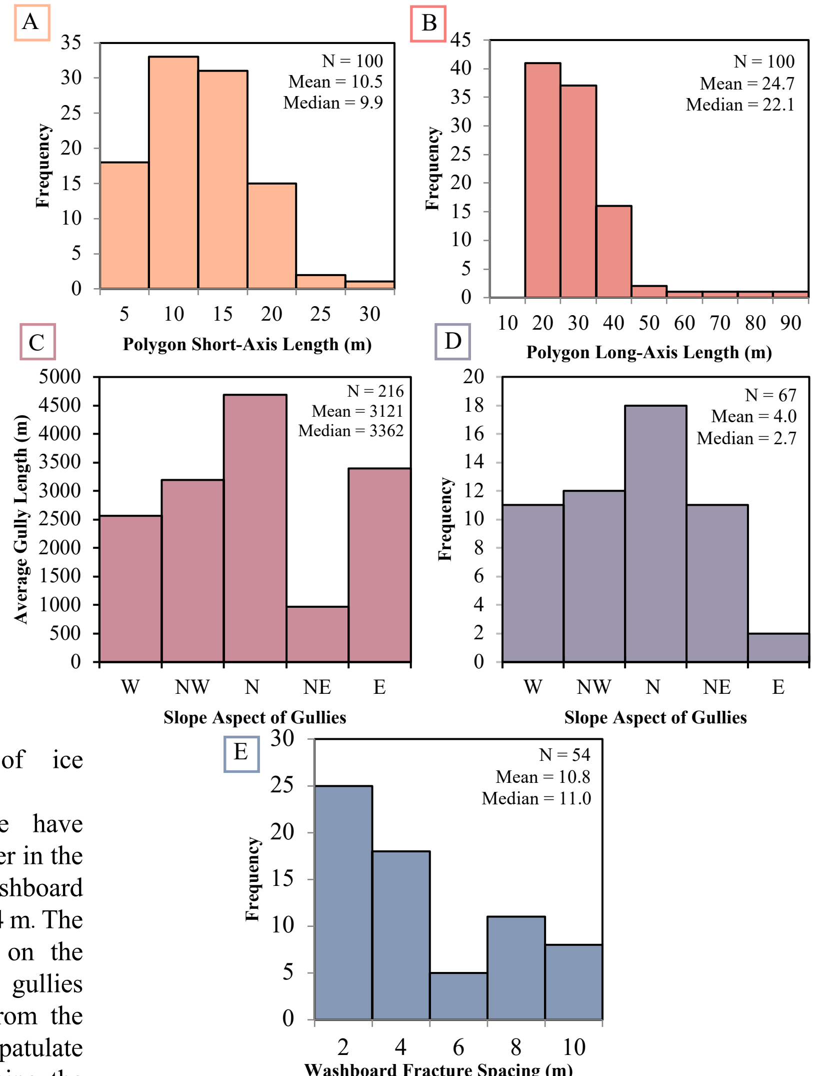

Figure 2: (A-B) Histogram of the length of polygonal fractures. (C-D) Average length and frequency of gullies based on geographic position in the crater. (E) Histogram of washboard terrain fracture spacing.

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