Assessing the habitability of Mars using impact crater statistics

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Abstract

The goal of this ongoing project is to better understand exposure ages and organic preservation potential across Mars by analyzing the size-frequency distribution of impact craters at selected sites across the surface (Figure 1).

Introduction

Because Mars lacks a global magnetic field or protective ozone layer, its surface is unshielded to harsh radiation from space. This ionizing radiation breaks down any organic components in the soil at the martian surface on timescales of tens to hundreds of millions years (10–100 Ma). In planetary geology, we use the density of impact craters as a proxy for time: older surfaces tend to accumulate more craters. Using impact craters, we can assess the exposure age and therefore organic preservation potential of the Martian surface from orbit.

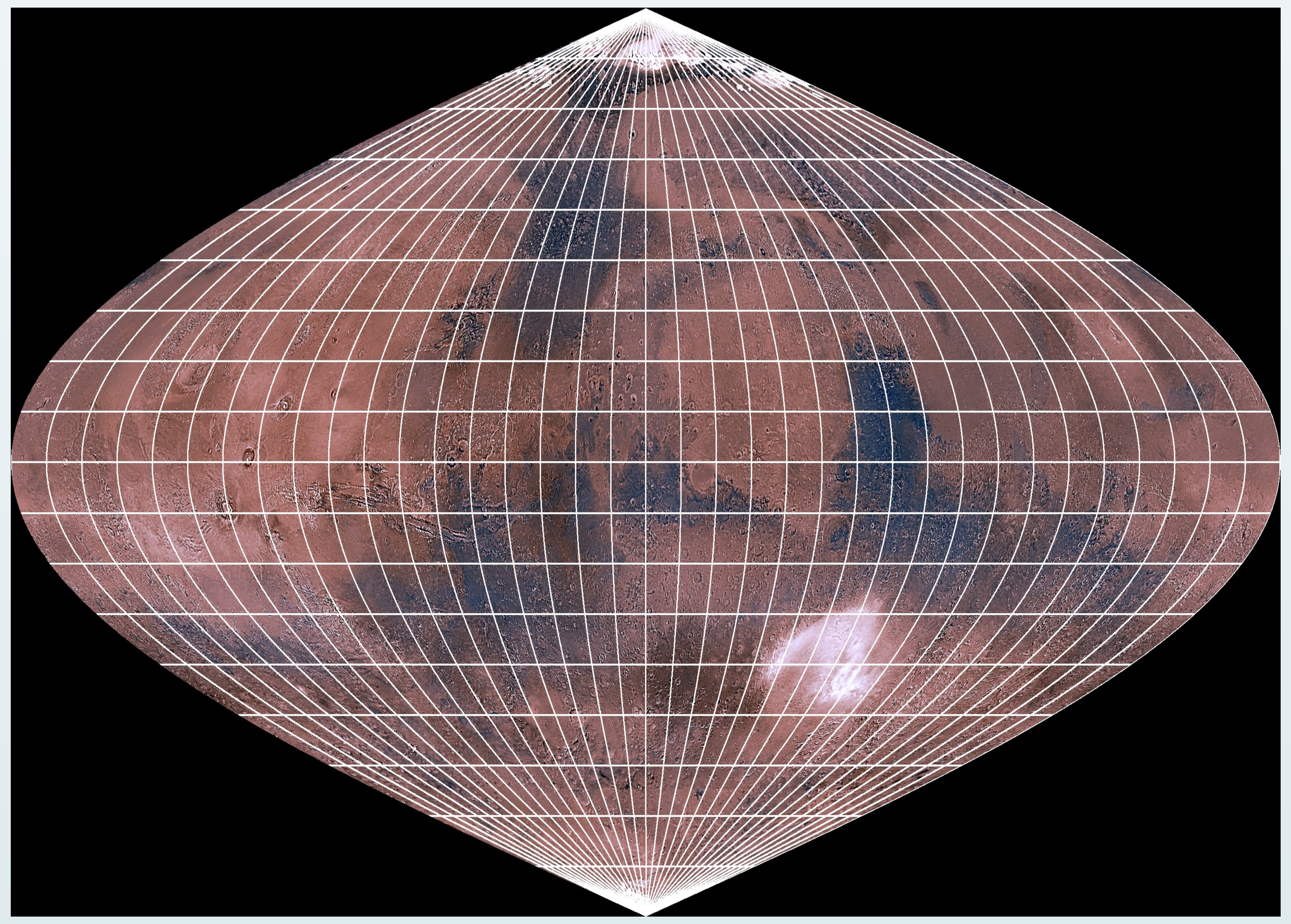
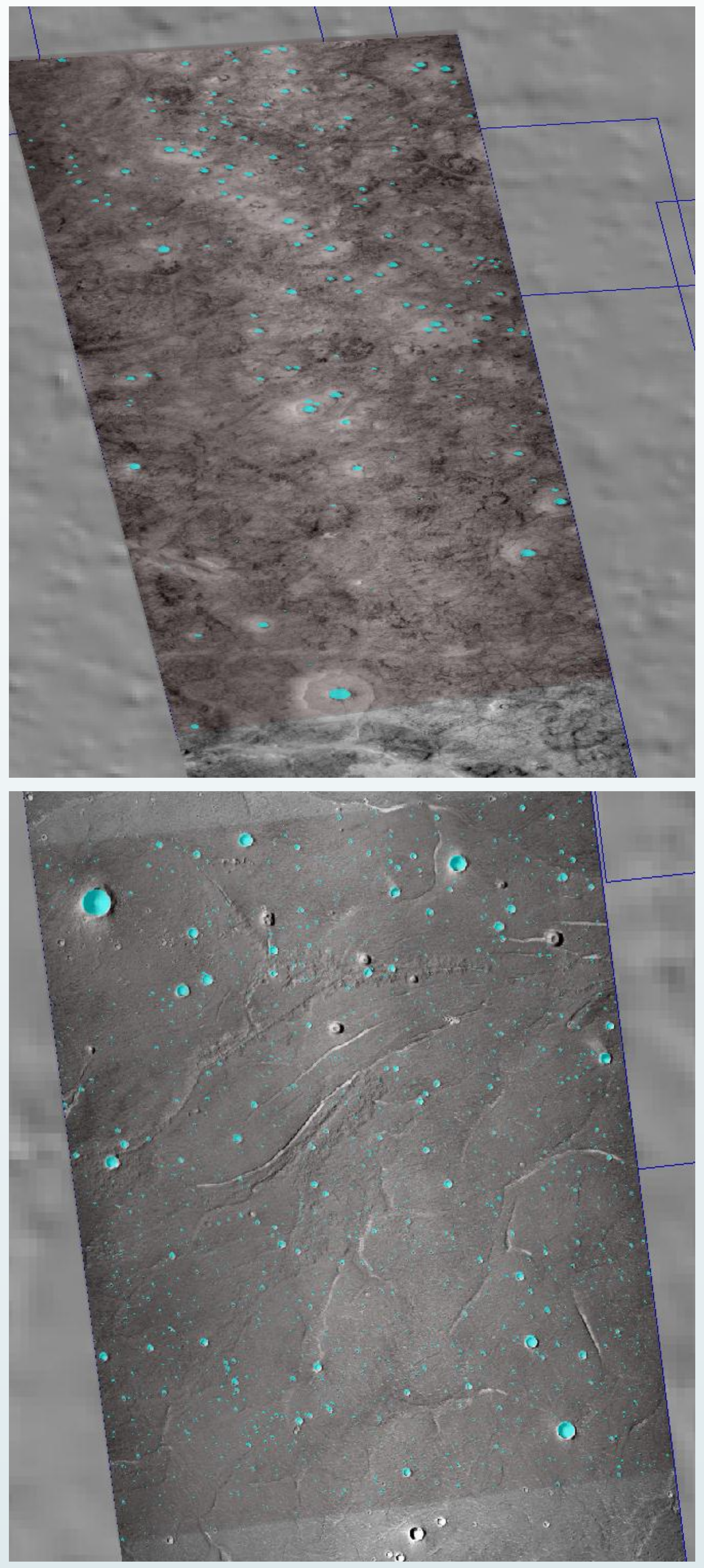


Figure 1: A grid of the areas on Mars where images were selected to count and analyze.

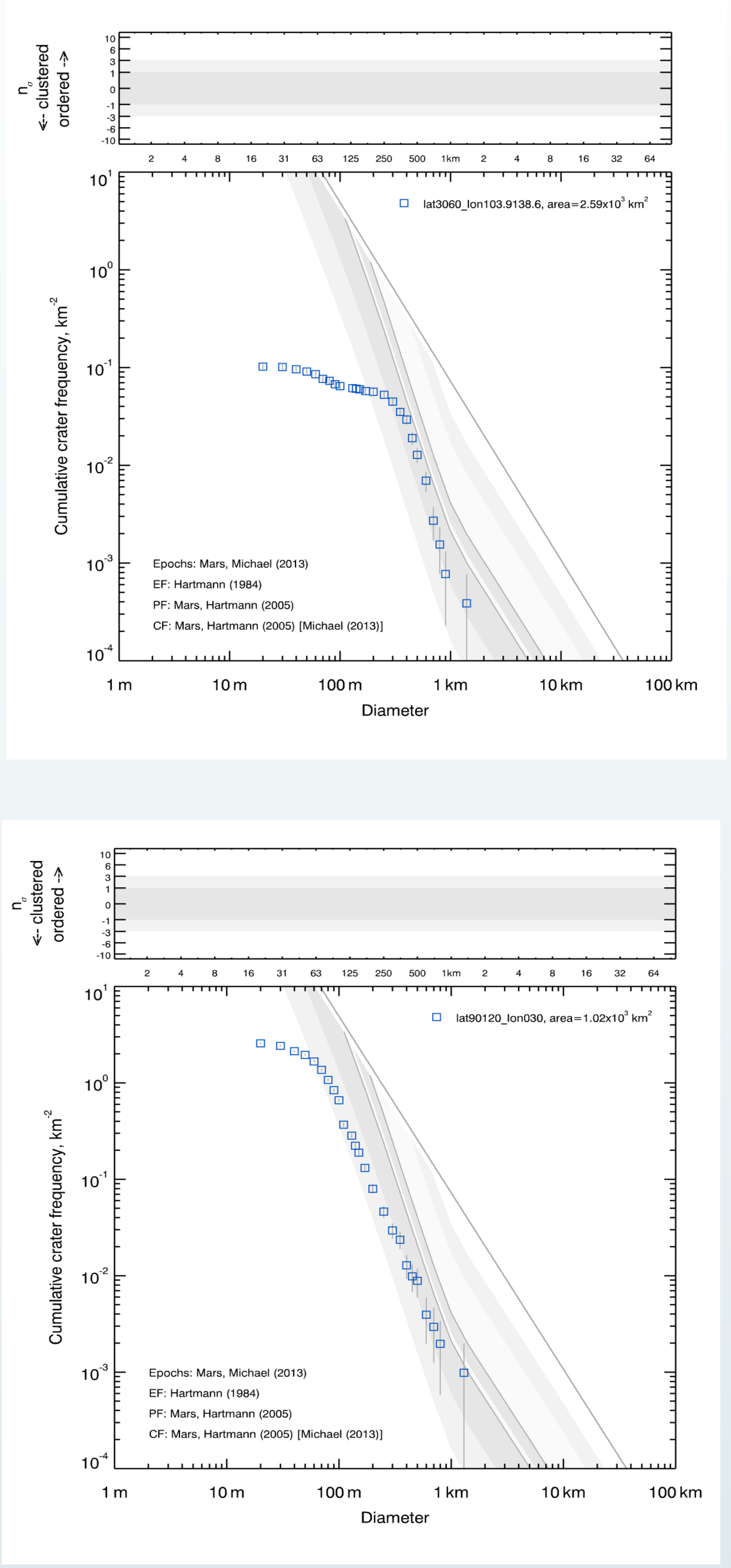
Methodology

For this project, we used JMARS, a GIS program developed by ASU's Mars Space Flight Facility [*Christensen et al.,* 2009], to examine CTX (Context Camera) images of Mars in a gridded array over Mars (Figure 1) so that we can document the density of craters between 100 m and 1 km in diameter, which are the most susceptible to erosion.



Figures 2 & 3: Examples of crater counts completed in area Latitude 30-60 degrees, Longitude 103.9-138.6 degrees (Scale: 87 km x 30 km) (Top); Latitude 0-30 degrees, Longitude 90-120 (Scale: 36.15 km x 28.04 km) (Bottom)

The data for the collected craters is then analyzed on CraterStats, a crater counting analysis software by the Freie Universitat Berlin [*Michael,* 2013], where we document the transition diameter between erosion and production (the rollover diameter).



Figures 4 & 5: Cumulative frequency curves for Figures 2 & 3.

Acknowledgments

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Results

Preliminary results [*Thomson,* 2018] indicate that at high latitudes greater than about ±45° N and S, fewer small diameter craters are present than at regions closer to the equator, indicating more active erosion. This latitudinal pattern is consistent with other observed surface parameters, such as the depth to diameter ratio of 3-5 km diameter craters [*Robbins and Hynek*, 2012] and the surface roughness measured in MOLA (Mars Orbital Laser Altimeter) profiles [*Kreslavsky and Head*, 2000].

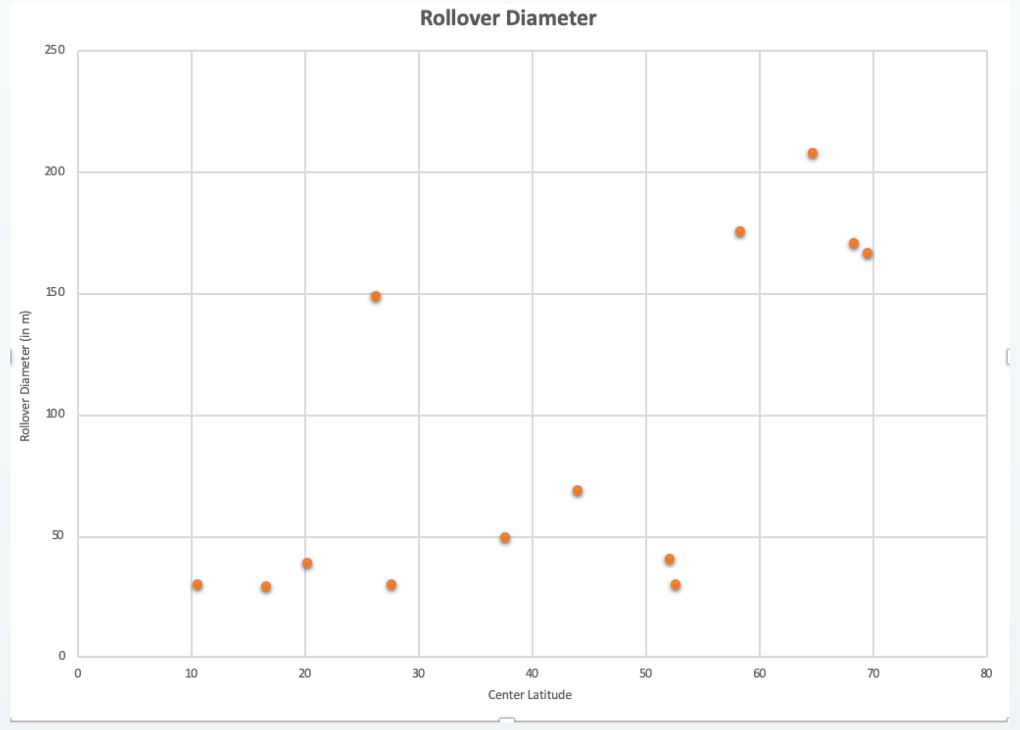

Figure 6: The plot of rollover diameters by center latitude documented from collected crater counts.

Conclusion

While work on this project is ongoing, with support from the UT Office of Undergrad Research in summer 2019, preliminary results are promising and consistent with previous studies where fewer smaller craters are observed in higher latitudes. Hopefully, these results will continue to be replicated as the project progresses and more craters are documented.

Citations

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