

Introduction

- A 2012 research initiative published a database of over 384,000 craters on Mars. Each data point includes the location, average depth, diameter, number of ejecta layer, and classification of crater (S. Robbins, 2012).
- Given that impact craters can signify the presence of fluvial deposits making these landscapes hospitable for humans in space-recent research seeks to classify craters as being more or less hospitable to human life.
- Recent studies suggest that craters have varied depths, peaks, and terraces-doing away with the previous understanding that craters were all the same shape. Complex ramparts (walls) have a larger surface area and can contain more water; the Reuyl Crater was observed to have frozen deposits of water within its rampart (wall) (S. Vijayan, 2020).

Martian Craters in Qualitative Analysis

Joseph Cohen, Wesleyan University, 2022 Applied Data Analysis, Professor Nazzaro



Methods

Sample

- This report analyzes an open source data set of 384,343 Martian craters with diameters equal to/greaten than one kilometer.
- The data was compiled by Stuart James Robbins in 2011 in fulfillment of a Doctorate of Philosophy at the University of Colorado, Boulder.

Measures

- The samples uses were Latitude, Longitude, Depth, Diameter, Frequency, and Morphology Ejecta 2.
- A subset of Morphology Ejecta 2 was made to signify if the outer-most later of a crater was classified as "hummock" (Hu) or "smooth (Sm).
- "Hummocky" craters have irregularly rounded hills and mounds and are often young. Contrary to the hummock is a "Smooth" crater, which is often bowl-shaped and rid of most surface tensions due to fluvial erosion (Y. Matsubara, 2017).

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- All quantitative values were rounded to one decimal point.
- Latitude was split into bins of 21 degrees each used to make a graph resembling Mars's surface. Regression models used in the study identified absolute values to calculate craters' average distance from the equator.

Research Questions

- Are there significant correlation(s) between the location of a crater on Mars and its defining characteristics?
- If certain trends are identifiable within the dataset, how might they order certain regions on Mars as more hospitable?

Results

- The frequency of craters on the surface of Mars is strongly negatively associated with the distance from the equator; more craters appear closest to the latitudinal line '0'. See Figure 1.
- Hummocky craters are 0.037%



Discussion

- The present findings suggest correlations between latitude and crater frequency, and latitude to hummock/smooth.
- Hummocky craters have larger surface areas that suggest a presence of water and ice beneath the Martian crust.

more likely to appear with each latitudinal degree away from the equator (P value < 2e-16), while Smooth craters are only 0.023% more likely to appear with each latitudinal degree away from the equator (P value < 2e-16).

- There is a weak significant relationship between the frequency of craters with Hummocky and Smooth outermost layers (Hu) and distance from the equator. See Figure 1 and 2.
- Despite most craters appearing closest to the equator, both Hummocky and Smooth craters are more likely to appear farther from the equator. This is likely due to the sparsity of craters

Figure 1. Geographic Frequency of All Craters on Mars.



Figure 3. Hummocky Crater (NASA)



Figure 1. Detail at equator.



Figure 4. Smooth Crater (NASA)



- Further research would be productive in which Hummocky craters have the largest diameters.
- Since water is thought to be beneath the surface of young hummocky craters, these craters would be most hospitable to human life in future space travel.
- It is likely that most craters appear at the equator because there is most surface area here. However, given that Mars's axis is at a 25% tilt (Earth is 23.5%), there may be a correlation between where fluvial deposits may be that mirror Earth's water deposits and gravitational fields (P. Mouginis, 2018.)
- More research would be beneficial to understanding the specific

towards the North and South Pole. At the equator most craters are uncategorizable.

> Figure 5. Probability of Hummock Classification of Outermost Ejecta Correlative to Distance from Equator, Craters on Mars.



Figure 6. Probability of <u>Smooth</u> Classification of Outermost Ejecta Correlative to Distance from Equator, Craters on Mars.

Longitude

ramparts and valleys that form around the surface of a crater. This would require better imaging technology that could provide threedimensional models for crater morphology.

Bibliography

A. Lagain1, 2. S. (2021). Mars Crater Database: A participative project for the classification of the morphological characteristics of large Martian craters.

Marchi, S. (2021). A new martian crater chronology: Implications for Jezero crater. The Astronomical Journal, *Volume 161, Issue 4, 797.*

Matsubara, Y. (2017). IMPACT CRATER DEPTH AND DIAMETER CHANGES ON NOACHIAN MARS. Lunar and Planetary Science.¹⁸⁰



Peter J. MOUGINIS-MARK1*, J. B. (2018). Determination of Mars crater geometric data: Insights from high-resolution digital elevation models. *Meteoritics & Planetary Science 53 Nr 4,* 726-740.

Vijayan, S. (2020). Evidence for Multiple Superposed Fluvial Deposits Within Reuyl Crater, Mars. JGR Planets.