Spatial Variation in Erosion Rates in Mars Equatorial Regions Inferred from Ejecta Retention of 1–3 Km Diameter Craters

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Introduction:

- Modification of impact craters has long been used to examine geomorphic forcing on Mars, and the spatial and temporal variability in resurfacing [1,2].
- As part of a broader study to understand crater degradation on Mars [3], we use CTX images and stereo-derived topography to characterize craters from the Robbins and Hynek catalog [4] quantitatively and qualitatively.
- For the study described here, we recorded whether craters had ejecta deposits with distinct tone or texture with respect to their surroundings in the global CTX mosaic [5].
- If the initial differences between crater ejecta deposits in different regions are minor, retention of crater ejecta is a proxy for the resurfacing rate because only relatively fresh craters retain their ejecta deposits.

Methodology/Analysis:

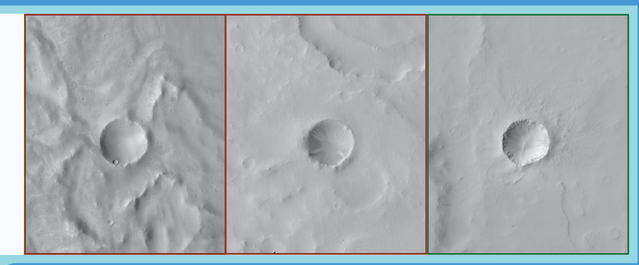
- Study area: equatorial Mars (-30°S to 30°N) convolved with the coverage of CTX stereo DTMs as of March 2019 (~20% of surface has coverage).
- The total number of 1-3 km craters examined and classified was 31,915.
- In 10°× 10° bins, we calculated the total number of craters and the number of craters that retained ejecta deposits. We also know the coverage area in each 10°× 10° bin. This allows calculation of the n(1-3 km) frequency of craters with and without ejecta. We can convert these to model ages.
- Removal of ejecta can either be due to erosion or gradation (burial).
- Based on the roughness on fresh craters' ejecta deposits, we estimate at least ~10 m of erosion or gradation is required to remove ejecta deposits.

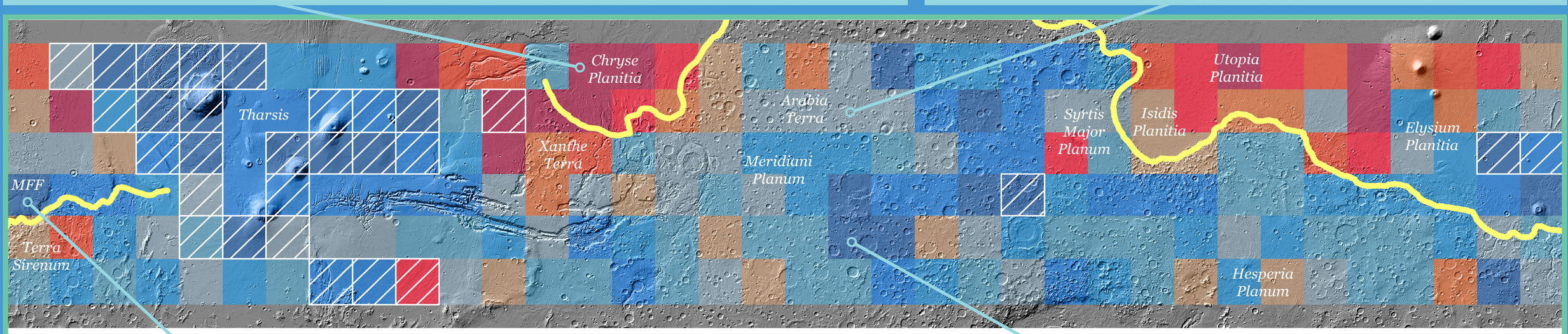
Takeaways:

- Across equatorial Mars, 9% of 1-3 km craters have ejecta deposits. The $n(1–3)_{ejecta}$ is 1.5×10^{-4} km^{-2}, equivalent to 390 Ma in the Neukum chronology [6].
- In other words, on average, only the 1–3 km craters formed since the Mid-Amazonian/Late Amazonian boundary retain their ejecta deposits [7].
- The average erosion or gradation rate for ejecta is thus 0.03–0.08 m/Myr.
- We see substantial spatial variation in impact ejecta retention; for example, northern lowlands' craters retain their ejecta much longer than those in the southern highlands.
- We favor an interpretation where this is a consequence of differences in long-term modification rates.

Chyrse Planitia:
~50% of craters retain ejecta.
$n(1\text{-}3\ km)_{ejecta}$: 5.6×10^{-4}
Ejecta retention period: 2.1-2.3 Ga
Ejecta erosion rates: 0.004 m/Myr
Slow ejecta destruction/erosion

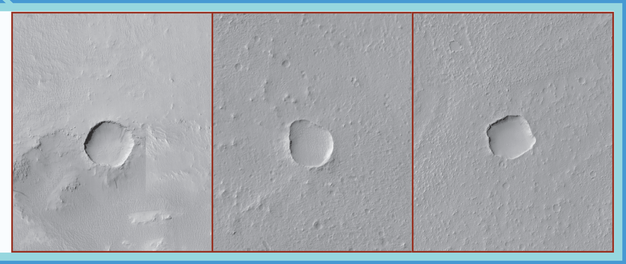
Arabia Terra:
~8-10% of craters retain ejecta.
$n(1\text{-}3\ km)_{ejecta}$: 1.6×10^{-4}
Ejecta retention period: ~400 Ma
Ejecta erosion rates: 0.02 m/Myr
Typical ejecta destruction/erosion



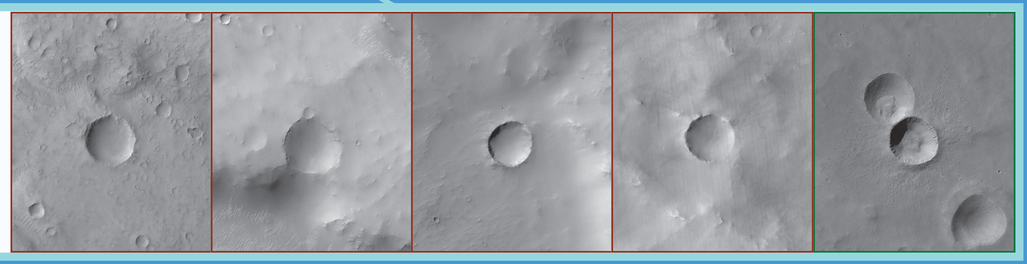


n(1-3 km) density/age for craters *with ejecta* in the study area.

Medusae Fossae Formation:
~5% of craters retain ejecta.
$n(1\text{-}3\ km)_{ejecta}$: 3.7×10^{-5}
Ejecta retention period: ~100 Ma
Ejecta erosion rates: 0.1 m/Myr
Fast ejecta destruction/erosion



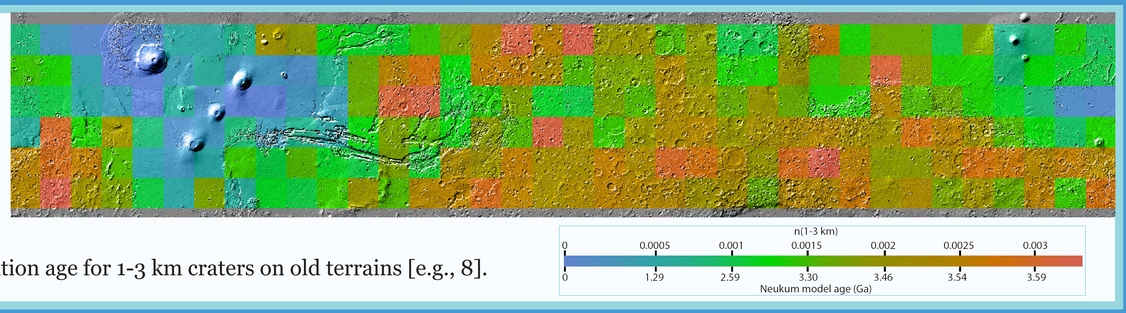
East Noachis Terra
~1.5% of craters retain ejecta.
$n(1\text{-}3\ km)_{ejecta}$: 3.6×10^{-5}
Ejecta retention period: ~90 Ma
Ejecta erosion rates: 0.1 m/Myr
Fast ejecta destruction/erosion



n(1-3 km) retention age / crater density for all impact craters [4] in the study area (excluding secondaries).

Some young regions have too few craters to reliably assess ejecta retention.

Note retention age ≠ formation age for 1-3 km craters on old terrains [e.g., 8].



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