CRATER-BASED SURFACE AGE DATING OF THE OSUGA VALLES REGION, MARS.

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Introduction: Osuga Valles is an outflow channel system carved by catastrophic discharges of groundwater [1, 21, 22, 23, 24]. To constrain the ages of surface terrains comprising Osuga Valles and associated features, we are mapping and statistically analyzing impact craters on these terrains. The density of impact craters on a planetary surface gives a statistical measure of the age of that surface. A higher crater density indicates an older age.

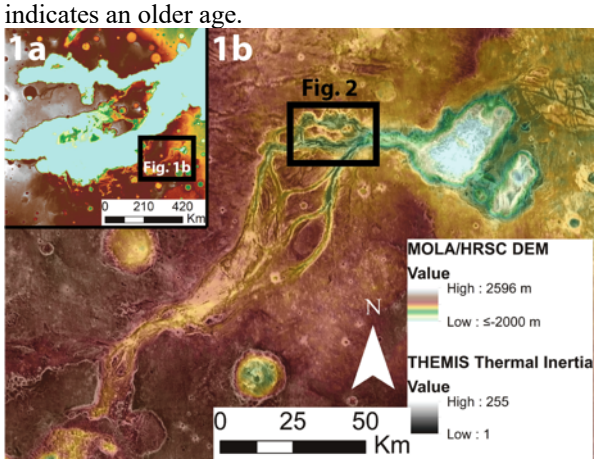

Figure 1. (a) Osuga Valles is near the eastern end of Valles Marineris on the southern highlands of Mars. (b) It is shown here in a MOLA+HRSC digital elevation model [2, 16, 17, 18, 19, 20] and layered with a THEMIS thermal inertia map to illuminate surface features [13, 14, 15.].

Mapping Methods: A Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) image mosaic [10] is the basemap for this project, covering our study area (Figure 1). We have so far mapped ~10000 craters in ArcMap 10.8, using the CraterTools plugin [8, 9] to digitize these mapped craters for statistical analysis. We qualitatively mapped potential secondary crater clusters and excluded them from our analysis.

Analysis Methods: We used the Craterstats2 program [3, 4, 5, 6, 7] for preliminary model age dating of mapped geologic units. We conducted randomness analyses on each geologic unit's craters, using the Mean Second Closest Neighbor Distance (M2CND) and Standard Deviation of Adjacent Area (SDAA) methods [5].

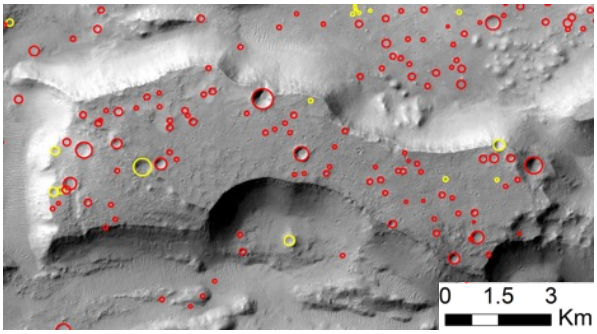

Figure 2. An example subset of the craters mapped for this ongoing study, displayed on an MRO CTX mosaic [10, 26]. Features mapped as red circles are impact craters, while features mapped as yellow circles are possible impact craters.

Preliminary Results: The crater model ages of the units within Osuga Valles that we have analyzed so far are younger than ~1.5 Ga, suggesting that Osuga Valles became active in the middle Amazonian period [11]. These findings are consistent with previous work on Mars outflow channel ages [25].

The channel beds and walls have younger model ages than do the streamlined forms within the channel. This is a natural result of channel formation, but may also be due to post-formation wall erosion and channel bed deposition. The terminal cavi (collapsed areas) of Osuga Valles have model ages suggesting that they are as young as or younger than the channels.

All such model surface ages have large non-modeled uncertainties, especially when calculated for relatively small surface areas like those in this study, and should be interpreted cautiously, ideally with the help of stratigraphic analysis. For example, stratigraphy indicates that the widespread geologic units surrounding Osuga Valles are Noachian to Hesperian in age [24]. Our crater statistics yielded an age of ~3.6 Ga for those units, confirming what stratigraphy tells us.

Future Work: We are counting craters on MRO High Resolution Imaging Science Experiment (HiRISE) images of selected portions of our study area, and we will quantitatively identify crater clusters with kernel density estimation.

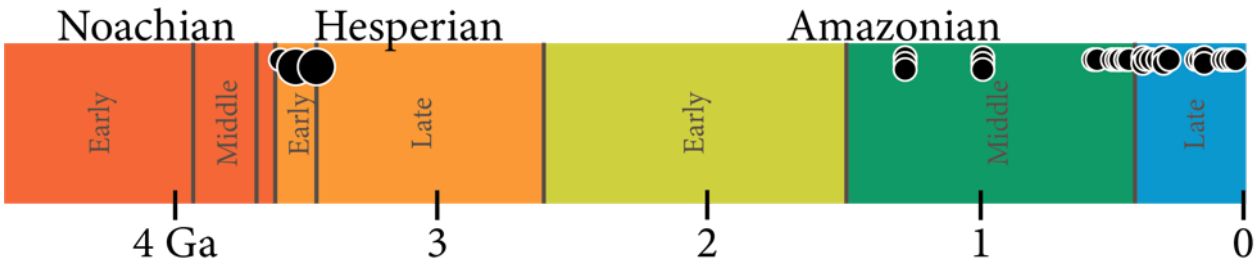

Figure 3. Martian geologic timescale based on averaged model ages from [11]. Each dot marks the model age of one surface in this study. Larger dots represent widespread surrounding units.

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Figure 4. Preliminary crater counting results mapped on an MRO CTX mosaic [10, 26]. Colors, from Fig. 3, represent the time periods in which units formed or were last resurfaced (via erosion or deposition) to a great enough depth to erase >100m diameter craters.