MISSION NEEDS MAPS: TOWARDS A GLOBAL AGE FOR MARS AND THE MOON AT ULTIMATE RESOLUTION

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SUM UP

By using the most complete Martian crater database *[1]*, we built a Crater Detection Algorithm (CDA) trained on THEMIS imagery (100m/px) → see *[2] for details.*

1. **In this study, we retrained and applied the CDA over the Murray Lab global CTX mosaic (5m/px) *[3]* in the aim to use the detection for model ages derivation.**
2. **We cleaned the detection from secondary impact craters using a cluster analysis.**
3. **We also applied the algorithm using HiRISE imagery (25cm/px) covering an area within the Jezero crater and obtain a comparable model age from already published results.**
4. **Same outcomes are expected for the Moon for which a model is currently being trained. Our technique can be used to create an age map at ultimate resolution and guide future in-situ investigations on Mars and on the Moon.**

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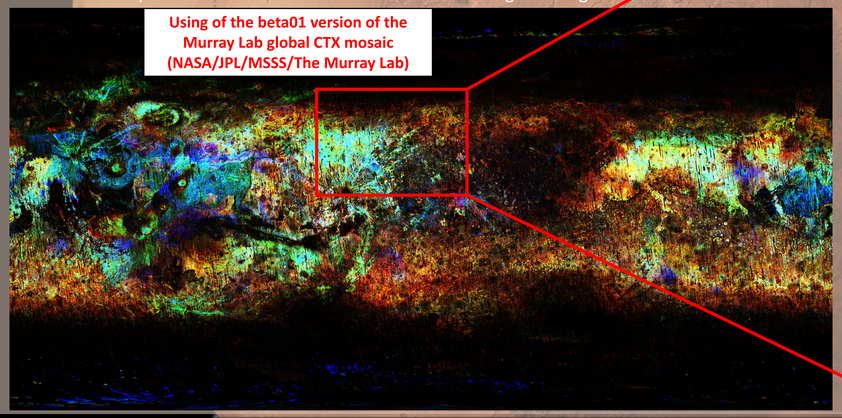
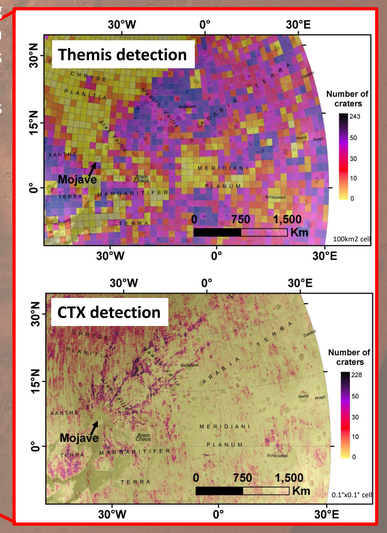
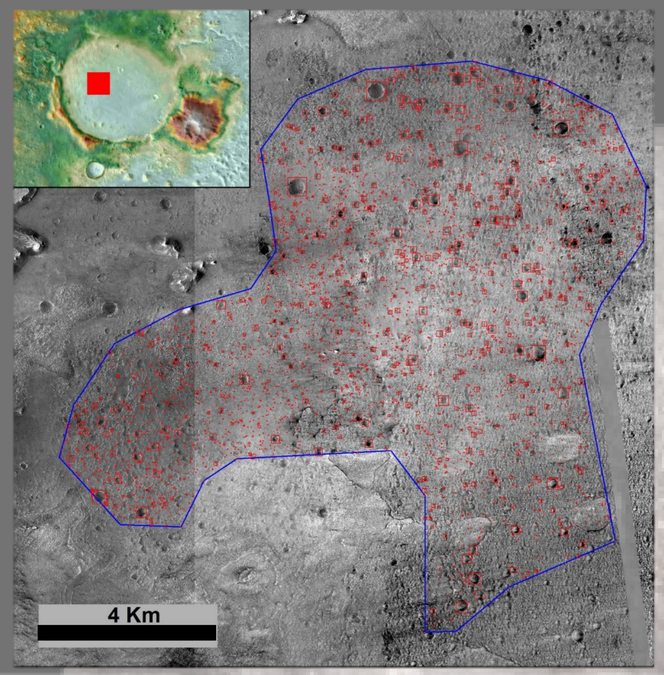
1. AUTOMATIC CRATER DETECTIONS ON THE CTX MOSAIC

- We used the beta 01 version of the global CTX mosaic from the Murray Lab (5m/px) [3] to detect smaller craters on Mars. The cratering density map below show the results over entire planet. Colors are based on diameter (blue: 25m<D<150m, green : 150m<D<300m, red : D>300m). In total, **~95 millions of craters larger than 25m** have been detected. We estimate our crater database complete for D>100m. High cratering density rays visible at the west and the center of the map correspond respectively to the secondary crater rays of Tooting and Mojave crater.
- The close-up at the right show a cratering density map of the Mojave region at low resolution (top) using craters detected on THEMIS imagery, >1km in diameter. The bottom figure show a high resolution cratering density map using detection on CTX images (>25m in diameter) where the rays of secondaries are visible.
- The detection of circular secondary craters by the CDA allow the identification of the youngest craters formed on the planet but need to be removed from a counting for an age-derivation.

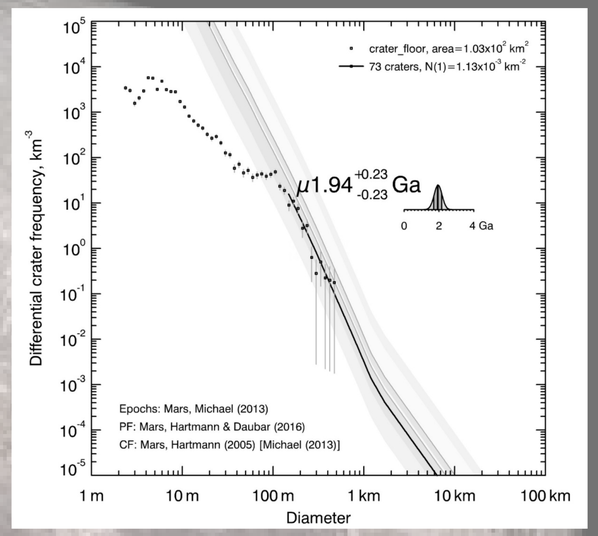




3. APPLICATION TO THE ULTIMATE RESOLUTION : JEZERO CRATER



We used the craters detected on the HiRISE mosaic [3] over the Jezero crater floor to derive an age of the dark-toned unit. For this we used CraterStats II [5], the Hartmann's (2005) chronology system [6] and the Poisson fitting technique [7]. Using craters > 200m we obtain a model age equal to 1.9±0.23 Gy. This is very close to the ages already reported by [8]: 2.6±0.5 Gy and 2.2±0.7 Gy and [9]: 1.6 Gy.



2. SECONDARY CRATERS IDENTIFICATION / AGE-DATING FROM THE DETECTIONS ON CTX IMAGES

Automatic identification of secondary crater clusters on the Arandas crater ejecta blanket and validation for surface model age derivation.

a: Delineation of the counting area for ejecta blankets. Footprints of poor quality CTX images were removed from the counting area.

b: Density map of craters detected on the ejecta blanket using the CTX mosaic [3], showing clusters of secondaries on the southeast part of the blanket.

c: Size-Frequency Distribution of the Voronoi polygon associated to the detection (red) compared to those produced by 1000 crater population randomly distributed over an area of the same size than the counting area.

d: Voronoi polygons from the considered crater population.

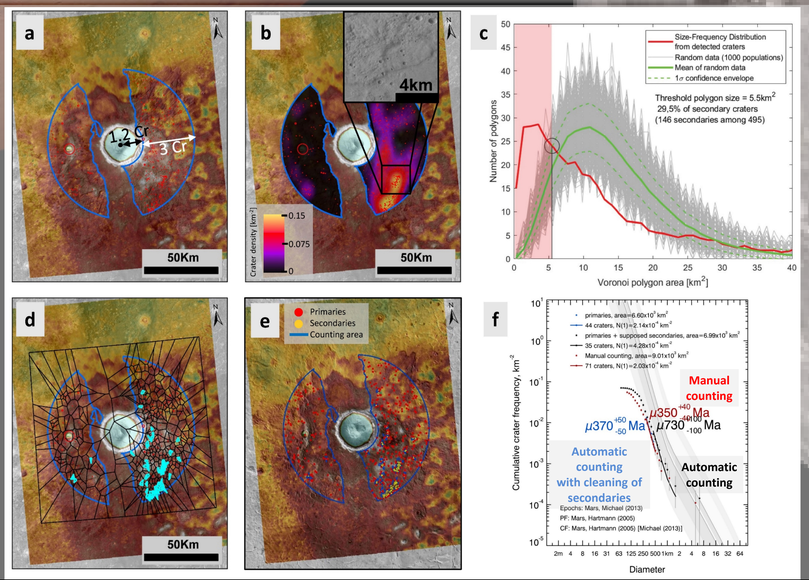
Polygons whom the size is under the threshold defined in fig c are displayed in blue.

e: The final counting area is displayed in blue, where Voronoi polygons associated to secondaries (yellow) have been removed.

f: Model age derivation according to the entire crater population (in black) and the primary detected population (in blue), compared to a manual counting (red, [4]).

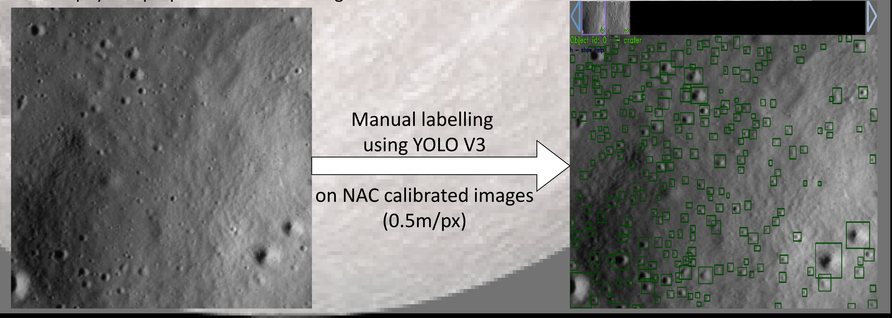
Age derivation have been performed using CraterStats II [5] and the chronology system from [6].

Using our CDA, the detected impact crater population allow an age derivation undistinguishable from manual count when filtered using our cluster analysis algorithm.



4. CURRENT WORK ON THE MOON AND PERSPECTIVES

- We are currently retraining our model in the aim to detect small craters on the Moon.
- We are using NAC calibrated images (0.5m/px) and YOLO V3 for manual labelling.
- We expect to detect impact craters as small as 2m in diameter and having a complete crater database for D>10m.
- Billions of detection are expected and will then be used for age dating of the surface at an ultimate resolution.
- Among other aims, the identification of crater sources having formed most of small secondary impact craters on the surface of the Moon is expected. They will be then analysed in details and will allow to identify processes controlling the ejection of debris during an impact event and help in the understanding of secondary craters formation mechanisms.
- This crater database will allow to help the identification and characterization of future mission landing site in terms of physical properties and surface age.



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