MAPPING IN THE NORTHERN MARTIAN PLAINS: A renewed survey of the Acidalia Mensae and Colles regions

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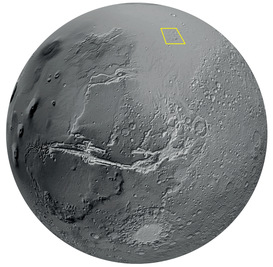
ABSTRACT.
Acidalia Mensae is an oblong field of tilted mesas roughly trending east-west, with Acidalia Colles encompassing a regime of knobby terrain trending northeast from the center of the mesa region. Each province extends for approximately 300km in their respective directions in the heart of the vast plains of Acidalia Planitia. As part of efforts in the 1980s targeting evidences for a putative northern Martian paleo-ocean – manifesting itself most notably in geologic maps of quadrangles in East Acidalia – the Acidalia Mensae region was selected and divided into three quadrangles ranging across 26.8°W to 36°W and 47.5°N to 52.5°N. The region was then mapped at a 1:1,000,000 scale using Canvas on a Viking base map. We present an updated draft of this document converted into ArcMap, including a completed fourth quadrangle that covers the bulk of the Acidalia Colles region. Previously mapped units have been updated according to the availability of new higher-resolution data – particularly, Thermal Emission Imaging System (THEMIS) Day Infrared (IR) data as a base map, paired with supporting Context Camera (CTX) and High Resolution Stereo Camera (HRSC) HRSC stamps extracted from the Mars Orbital Data Explorer repository. Geologic units and contacts for the mesa and knob regimes, interstitial alluvial units and the surrounding plains are comprehensively presented alongside lower-level features such as levels (hypothesized to be shorelines) and pitted cones (putative pingos). The project was mapped in a transverse Mercator projection. Upon minor revision, the map is to be submitted to the USGS for publication.



Mars Orbiter Laser Altimeter (MOLA) Global Hillshade topographic map, Mars orthographic projection. The mapping area is depicted in yellow.

ACKNOWLEDGEMENTS.

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REFERENCES CITED.

Carr, M. H. *The Surface of Mars*. New Haven: Yale University Press, 1981.

Kieffer, H. H. *Mars*. Tucson: U of Arizona, 1992.

Parker, T. J., Grant, J. A., and Franklin, B. J. "The Northern Plains." *Lakes on Mars* (2010): 249-73.

Parker, T. J., Gorsline, D. S., Saunders, R. S., Pieri D. C., and Schneeberger, D. M. "Coastal Geomorphology of the Martian Northern Plains." J. Geophys. Res. Journal of Geophysical Research 98.E6 (1993): 11061.

Rodriguez, J. A. P.; Fairén, A. G.; Tanaka, K. L.; Zarroca, M.; Linares, R.; Platz, T.; Komatsu, G.; Miyamoto, H.; Kargel, J.S.; Yan, J.; Gulick, V.; Higuchi, K.; Baker V. R.; and Glines, N. "Tsunami Waves Extensively Resurfaced the Shorelines of an Early Martian Ocean." Sci. Rep. Scientific Reports 6 (2016): 25106.

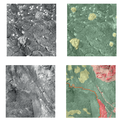
Salvatore, M. R., and Christensen, P. R. "On the Origin of the Vastitas Borealis Formation in Chryse and Acidalia Planitiae, Mars." J. Geophys. Res. Planets Journal of Geophysical Research: Planets 119.12 (2014): 2437-456.

Tanaka, K.L., Skinner, J.A., Jr., Dohm, J.M., Irwin, R.P., III, Kolb, E.J., Fortezzo, C.M., Platz, T., Michael, G.G., and Hare, T.M., 2014, Geologic map of Mars: U.S. Geological Survey Scientific Investigations Map 3292, scale 1:20,000,000, pamphlet 43

UNIT DESCRIPTIONS.

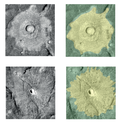
LOWLAND PLAINS UNIT

Grouping of all plains facies not covered by crater ejecta or alluvial deposits from the mesa or knobby terrains. Roughly corresponds to the "late Hesperian lowlands" of Tanaka (2014), or the "Vastitas Borealis Formation", as discussed in Salvatore (2014) and others.



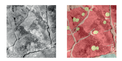
CRATER UNIT

All craters with distinct rims, mapped together with their associated morphologies. All craters whose basins and associated morphologies are collectively greater in size than 1km are mapped. Crater ejecta blankets, crater rays for fresh craters, and pedestal structures are present. One elliptical crater is mapped.



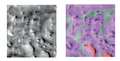
MESA UNIT

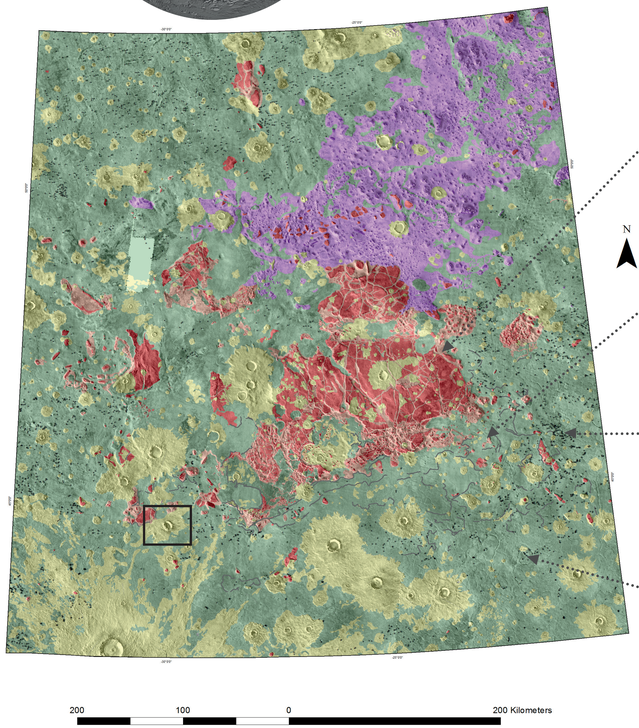
Flat-topped structures with abrupt escarpments protruding from the plains unit, often in the scale of kilometers to tens of kilometers across. Sometimes Cross-cut by canyons. Highly variable albedo. Lighter hue indicates interstitial alluvial unit.



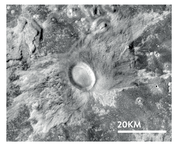
KNOBBY UNIT

Structures with rounded tops ranging from four kilometers to the subkilometer range – not all knobs in the subkilometer range are documented here. Tend to occur in groups but can stand isolated. Occasionally draped by sediments, reducing contrast. Lighter hue indicates interstitial alluvial unit.



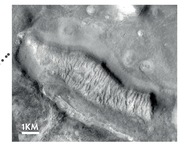


MORPHOLOGY.

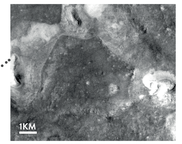


Elliptical crater
A single large elliptical crater was observed on THEMIS and CTX data in the southwestern portion of the map. Such craters, as summarized in the Impact Cratering Record chapter from Kieffer (1992), are thought to form from very low-angle impacts and has been hypothesized as progenitors of the SNC meteorites.

The image is indicated by a black box in the map's southwestern quadrant.

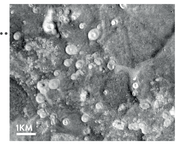


Fluvial Rills
These structures (termed rills) have been previously associated with the Ismenius Level, the second-highest regionally-extensive bench observed in Deuteronilus Mensae, and are hypothesized to be a remnant of a catastrophic flooding event (Parker et al, 2010). Such structures have been most notably discussed in press as tsunamis in Rodriguez *et al* (2015). However, the image above was the only such structure discovered in the area.



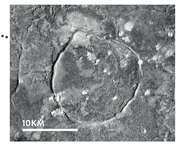
Levels (putative paleoshorelines)
The presence of putative shorelines of a regional ocean was the reason why this region was initially selected for mapWping, and were found nearly exclusively off the southern scarps of the main mesa province of Acidalia Mensae. The four regional- scale benches summarized by Parker et al (2010) in Deuteronilus Mensae – Arabia, Ismenius, Deuteronilus, and Acidalia – show elements of distinct interplain morphologies, which they discuss in detail. The image above indicates an apparent lobate flow upsurging over what is either the Acidalia or Deuteronilus Level.

On the map presented here, the putative shorelines are not yet classified by level. They are represented as thick grey lines on the map.



Pitted cones (putative pingos)
Scattered across the breadth of the plains unit are subkilometer- wide cones and are often characterized by central pits. These cones tend to be smooth in shape and strikingly bright in albedo. Parker et al (2015) evokes these cones as diagnostic features for terrains between and below the Acidalia and Deuteronilus Levels, which include the mottled plains unit described by Carr (1981). Salvatore and Christensen (2015) support the idea that these structures are mud volcanoes.

The icon depicted here indicates the object's symbology on the map.



Polygonal fracturing (putative "circular" graben)
The above image, taken from CTX, shows a very salient example of circular valley structures that prevail across the plains to the south of Acidalia Mensae. These structures have been interpreted as circular graben by Salvatore and Christensen (2015) in other regions of the Vastitas Borealis Formation, and have an indistinct stress field.