WIND-ERODED STRATIGRAPHY ON THE FLOOR OF A NOACHIAN IMPACT CRATER, NOACHIS TERRA, MARS.

R. P. Irwin III[1,2], J. J. Wray[3], T. A. Maxwell[1], S. C. Mest[2,4], and S. T. Hansen[3], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, MRC 315, 6th St. at Independence Ave. SW, Washington DC 20013, irwinr@si.edu, maxwellt@si.edu. [2]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson AZ 85719, mest@psi.edu. [3]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, 311 Ferst Drive, Atlanta GA 30332-0340, jwray@eas.gatech.edu, shansen6@gatech.edu. [4]Planetary Geodynamics Laboratory, Code 698, NASA Goddard Space Flight Center, Greenbelt MD 20771.

Introduction: Detailed stratigraphic and spectral studies of outcrops exposed in craters and other basins have significantly advanced the understanding of early Mars. Most studies have focused on high-relief sections exposed by aeolian deflation, such as those in Gale crater, Arabia Terra, and Valles Marineris [1–3]. Many flat-floored Noachian degraded craters also have wind-eroded strata, suggesting that they lack a cap rock of Gusev-type basalts [4,5]. This study focuses on the youngest materials exposed on the wind-eroded floor of an unnamed Noachian degraded crater in Noachis Terra, Mars. The crater is centered at 20.2ºS, 42.6ºE and is 52 km in diameter. A survey of imaging from 0–30ºS, 0–165ºE showed that wind-eroded crater floors are common in this region [6].

Data: The Mars Reconnaissance Orbiter (MRO) Context (CTX) camera provides the highest-resolution continuous imaging at 5 m/pixel. Higher-resolution discontinuous data include five MRO High Resolution Imaging Science Experiment (HiRISE) and 14 Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) images. The MGS Mars Orbiter Laser Altimeter (MOLA) 128 pixel/degree grid provides topographic data, and mineral detections are based on seven images from the MRO Compact Reconnaissance Imaging Spectrometer for Mars (CRISM).

Observations: Preliminary observations and interpretations are based on a study of the crater's geologic context, stratigraphy, and composition.

Geologic context. The crater is 52 km in diameter with a rim elevation of 2550–3150 m and a floor at 2000–2200 m. It is located on an elongated rise between a Hellas-circumferential graben to the NW and an intercrater plain to the SE (Fig. 1). Faulting related to Hellas did not modify the crater, which likely postdates the faults. The crater is topographically enclosed, with no large contributing valley network.

Crater stratigraphy. Based on its depth and diameter, the crater appears to be the oldest within ~100 km. Younger degraded and fresh craters have modified it. A fresh crater 11 km in diameter is located on the western rim, and its continuous and distal ejecta have armored the western side of the crater floor.

The crater floor has two sub-basins: one on the east-central side of the floor, and one in a vaguely circular 12-km depression (a possible highly degraded crater) on the southern side. The former received internal drainage from the north and east, whereas part of the southern wall drained to the latter (Fig. 2).

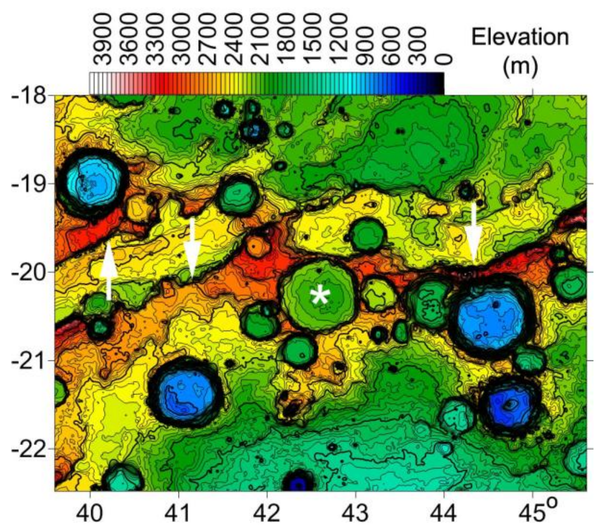

Figure 1. MOLA topography, 50 m interval, with subject crater (*) and Hellas-related fault scarps (arrows).

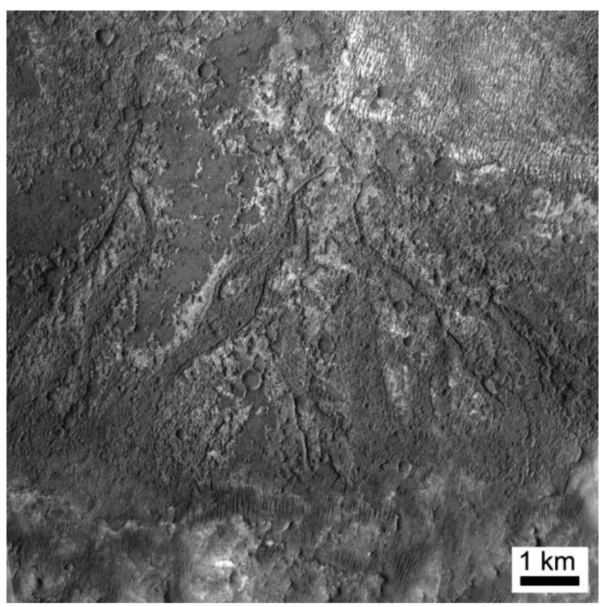

Figure 2. Sinuous ridges and exposed strata, southern sub-basin and crater wall (CTX image).

The floor contains at least three major geologic units. The oldest is a dark-toned, moderately etched unit that retains small craters. This unit outcrops at several locations west of the crater center.

Superimposed is a lighter-toned, deeply etched unit that outcrops mainly in the eastern half of the crater and in both sub-basins. Its morphological expression varies somewhat between the two sub-basins, with a smoother and more polygonally fractured appearance in the southern sub-basin. An outcrop showing a clear stratigraphic relationship between the two lighter-toned outcrops has not been identified, so they may have formed concurrently or could be distinct units. A small crater (1.2 km) just north of center excavated darker-toned ejecta, likely from a deeper layer, onto the lighter-toned materials.

The capping material is dark in tone and deeply etched. Outcrops occur over much of the western side of the crater floor and are discontinuous elsewhere. Some small craters appear to crosscut this unit and have been modified during its degradation. The susceptibility of this unit and the underlying lighter-toned materials to geologically recent aeolian deflation suggests that they are generally finer-grained.

Aeolian erosion of this capping unit or a member thereof has left dense, moderately etched sinuous ridges around the eastern and southern sides of the crater floor (Fig. 2). These possible inverted fluvial channels are branching and converge downslope. They head at the base of the crater wall and may represent drainage of much of the crater rim. The width of the ridges varies, suggesting poor lateral confinement or some lateral migration of the streams during deposition. The term sinuous ridge is favored [7], but sinuosity is low, and crater topography appears to mostly control the network planform. The sinuous ridges appear etched at high resolution and may lack very coarse particles, although they may be coarser or more strongly cemented than adjacent deflated areas. Possible earlier fluvial deposits associated with long-term crater degradation are not exposed on the floor.

Intercrater surface. The intercrater surface is rugged with low mesas and knobs, suggesting an aeolian mantle that has been mostly stripped. A possible relationship between the mantle and deposits in the crater is not clear. Some small craters on the intercrater surface crosscut and have been strongly modified by degradation and scarp retreat of the mantle, whereas others appear fresh. The small fresh craters either predate the mantle and have been exhumed, superimpose intact areas of the mantle, or post-date degradation of the mantle. Fluvial networks are relatively rare and weakly expressed outside the crater rim, which is typical for Noachis Terra [8].

Composition. Analysis of CRISM spectra suggests that the crater wall contains pyroxene-, Fe/Mg-smectite-, and Al-smectite-bearing rocks. The Al-smectite is only detected in combination with Fe/Mg-smectite, where they exhibit roughly equal spectral band depths (i.e., Al-smectite never dominates over Fe/Mg-smectite at decameter scales).

The lighter-toned material on the crater floor appears to be feldspar-rich. A minor hydrated component in these rocks could be a polyhydrated sulfate and/or possibly zeolite. The spectra do not directly constrain the type of feldspar. Detection relies on Fe^{2+} substituting for Ca^{2+}, so a Ca-rich plagioclase seems most likely, but even K-rich feldspars such as microcline can exhibit the observed broad band around 1.25 microns.

The darker-toned sinuous ridges are olivine-bearing, and some but not all of the dark-toned materials on the crater floor share this composition. The dark ejecta of the 1.2-km-diameter fresh crater just north of the crater center are interpreted as goethite-bearing.

Discussion: Interpretations of this stratigraphy are preliminary. The high position in the landscape limited exotic fluvial sediment supplies. Intercrater plains to the N and S have elevations similar to or lower than the crater floor, so the site should not have been a regional sink for groundwater. Deposits in the crater are likely derived from the rim or aeolian, aside from impact ejecta that has resurfaced part of the crater floor. Short transport distances (typically <5 km) from the crater rim to the sinuous ridges are consistent with relatively small discharges, small grain sizes, and weakly weathered sediment in the sinuous ridges.

These observations are most consistent with brief, late fluvial activity in a low-energy depositional setting, following a much longer period of weathering and crater degradation. The darker-toned capping layer appears stratigraphically consistent with the sinuous ridges and may also have a fluvial origin. The origin of the lighter-toned unit is less well constrained, but it may include feldspars derived from a mafic parent rock. Work is ongoing in the Noachis Terra region.

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