EVIDENCE FOR WIDESPREAD RESURFACING IN THE MARTIAN HIGHLANDS;
Robert A. Craddock and Ted A. Maxwell, Center for Earth and Planetary
Studies, National Air and Space Museum, Smithsonian Institution,
Washington, DC 20560

The southern cratered highlands of Mars contain a large population of
flat-floored, rimless craters which occur on a variety of Noachian
geologic materials. Previously these craters have been interpreted to
have formed by aeolian mantling [1] or flood volcanism [2]; however,
neither of these geologic processes accurately explains the observed
morphology or the crater statistics. Determining the distribution of the
flat-floored, rimless craters, the timing of the process responsible for
their formation, and the actual process involved in their formation is
important for understanding the geomorphic evolution of most of the
southern cratered hemisphere of Mars. Our initial investigation
concentrated on the analysis of the Amenthes and Tyrrenhena regions near the
dichotomy boundary [3,4,5]. Currently we have begun investigations into
other areas including Mare Australe, Eridania, Arabia, Noachis, and
Memnonia.

The geologic analysis of these regions was based on the published
1:15M geologic maps of Mars and was limited to two materials: the Noachian
 cratered unit (Npl; 6) and the Noachian dissected unit (Npld; 6).
Although flat-floored, rimless craters occur on other Noachian geologic
materials as well, the interpretations of these units [7,8,9] includes
resurfacing by processes we feel are separable from a larger, more
extensive process. The Noachian cratered unit (Npl) and the Noachian
dissected unit (Npld) are distinguished by the absence or presence of
ancient valley networks (i.e., runoff channels), respectively [6].
Together these units make up a bulk (~70%) of the surface area of the
southern cratered hemisphere.

The termination of the resurfacing event represented by the
cumulative size-frequency curves of superposed, fresh craters was not a
catastrophic, global event (Fig. 1). Resurfacing ceased during the late
Noachian to early Hesperian in the regions analyzed. In general,
resurfacing ceased in the Npld materials later than in the Npl
materials, suggesting that the ancient valley networks represent the late
stages or a change in the resurfacing process. These observations
 correlate well with other work suggesting that the ancient valley networks
ceased to form by the early Hesperian [6].

A proposed mechanism responsible for martian highland resurfacing
must be able to explain not only the morphology of the flat-floored,
rimless, craters, but also the timing of the process between regions and
the bendover in crater size-frequency distribution curves of highland
materials [e.g., 5] as well. Although a bulk of the cratered highlands
may be composed of volcanics [e.g., 10], volcanism does not produce
flat-floored, rimless craters except in very rare circumstances. Aeolian
erosion/deposition is also a very active process on Mars as evidenced by
the seasonal dust storms and a variety of landforms [e.g., 11]; however,
unlike what has been suggested by Wilhelms and Baldwin [1] aeolian fallout
would not only be deposited up to the rim crest of craters but on the rims
of craters as well. The result is not to produce a flat-floored, rimless
 crater, but to subdue the morphology of the crater. Volcanic and aeolian
resurfacing do not produce a bendover in the cumulative size-frequency
curves either. In both processes a crater is either buried, or it is not,
in which case it is still counted. We propose a fluvial process capable
of eroding the rims of the craters primarily from the outside, thus
reducing the apparent diameter of the craters. The eroded material is
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Craddock, R.A. and Maxwell, T.A.

redistributed, inundating the smaller craters before they are eroded completely. Such a complicated process not only explains the morphology of the flat-floored, rimless craters, but also the bendover in the cumulative size-frequency curves and potentially the timing of the process between regions.

Figure 1. Timing of resurfacing in the areas mentioned in text. N(5) ages represent the number of craters >5-km-diameter per million square kilometers. Solid lines represent age of material based on all craters. Dashed lines represent termination of resurfacing event based on fresh, superposed craters.


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