YOUNG FANS IN AN EQUATORIAL CRATER IN XANTHE TERRA, MARS. R. M. E. Williams, K. S. Edgett, and M. C. Malin, Malin Space Science Systems, P.O. Box 910148, San Diego, CA 92191-0148, USA.

Introduction: In recent years, the Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) investigation has largely focused on NASA's Mars Exploration Program "Follow the Water" theme. We report here on MOC narrow angle (NA) images obtained in 2003 following observations from 1999 that show a specific, un-named, ~60 km-diameter impact crater at an equatorial latitude (7.6^{o}N, 33.0^{o}W) that exhibits well-preserved landforms similar in planimetric form and morphology to alluvial fans of arid environments such as the Mojave Desert of southern California. The principal question is whether these fans represent the products of water and gravity-driven alluvial sedimentation. The landforms in the Xanthe Terra crater are unique among MOC images of martian impact craters, with the exception of some features in middle latitude Hale Crater and its central peak (35.9°S, 36.6°W). The purpose of this paper is to present an initial, brief description of these landforms and explore their implications.

Observations: The ~60 km diameter crater is located between Simud and Tiu Valles in Xanthe Terra (Fig. 1). The crater has a distinct rim, terraced walls, ejecta deposit, and central peak. The crater is superposed on the Tiu/Simud channel floor, indicating its youth relative to the time when these two channels formed (i.e., Amazonian).

The most striking attribute of the crater in Xanthe is the presence of landforms that resemble desert alluvial fans. Fan-shaped deposits occur on both interior and a few exterior crater walls and terraces with radii typically ~500 m (Fig. 2). The fans broaden downslope and exhibit radiating, branching distributary channels, some of which are braided. The fans often coalesce to form a broad apron of material resembling a terrestrial bajada. Channels on the fans are lighter-toned than the fan surfaces. Relict or abandoned fan surfaces occur where a subsequent channel has cross-cut an existing fan surface (Fig. 2). These cross-cutting relationships suggest fan formation was episodic. A few fans have small (<200 m) impact craters on them, indicating that while they are young landforms, they did not form recent enough to be craterless.

Some of the channels display branching networks proximal to the fan (Fig. 3). The channel networks display a third-order topology using Horton's ordering scheme. First-order tributaries of the channels that feed the fans extend to the crest of local topographic highs. Locally, the density of channels (total channel length per area of network) is extremely high (preliminary value >500 km^{-1}), comparable to terrestrial values for much larger-scale rivers in humid environments with highly erodable substrates. In areas of high channel density, channels are visible to the resolution limit of the MOC NA images.

Discussion: The fan landforms in the Xanthe Terra crater are, among >55,000 MOC NA images, unique. Landforms on the walls and central peak of Hale Crater share some of the attributes of the Xanthe crater fans, but Hale also shows mid-latitude gullies, similar to those found throughout middle and polar latitude depressions; thus, the suite of landforms within Hale differs from what is found in the Xanthe Terra crater. Part of our working hypothesis is that the crater in Xanthe represents one of the youngest large impact craters on Mars (Hale, too, may be relatively young). It is young enough that landforms created shortly after impact, and perhaps associated only with that impact, have been preserved. Other martian craters of similar size and larger have been subjected to greater degrees of degradation, including filling, burial, and exhumation.

How did the fan-like forms develop? As this is a work-in-progress, additional MOC targeting of the crater, its ejecta and neighboring fresh craters is being undertaken to document the relevant geomorphic and age relationships. We are investigating several hypotheses of fan formation: (1) channelized, dry mass movement; (2) surface runoff related to transient groundwater release or precipitation during and shortly after the impact event; (3) later surface runoff unrelated to the impact event. The high degree of dissection indicated by the distal channel density and the topographically-controlled bifurcating pattern of channels headward of the fan and on the fan surface argues for a surface-constrained fluid erosional process. Either atmospheric or groundwater fed surface runoff could produce the observed relationships but a groundwater source is inconsistent with first-order tributaries heading at local topographic highs. Further, groundwater seepage would be expected to have formed collapse features and alcoves above the channel heads, features that are not observed. Surface runoff could be generated directly from rainfall or indirectly from snowmelt (although the collecting area for snowmelt appears to be quite small). Given that these fans are uniquely confined to this specific crater, local as opposed to regional, climate-induced processes are likely responsible. For example, volatiles sequestered in the ground may have been liberated during the impact event. These volatiles may have precipitated back onto the crater, resulting in the surface runoff and erosion. While some evidence suggests multiple episodes of fan formation, it is possible different networks and fans developed sequentially over a relatively short event. In any case, the unique occurrence indicates a unique origin.

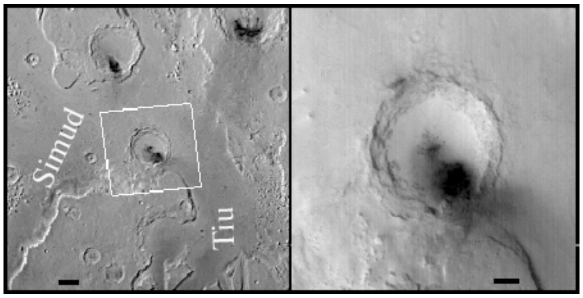

Figure 1: (Left) Regional view of crater centered at 7.6°N, 33.0°W. Scale bar is 25 km. White box corresponds to context image R07-01505 (Right). Scale bar is 10 km.

Figure 2: (Below) Portion of MOC image R07-01504 near 7.9°N, 32.9°W. Coalesced fans on the west wall of the crater. Light-toned channel (white arrows) cross-cuts relict fan (black arrow). Image is 2.2 km wide; illumination is from upper left.

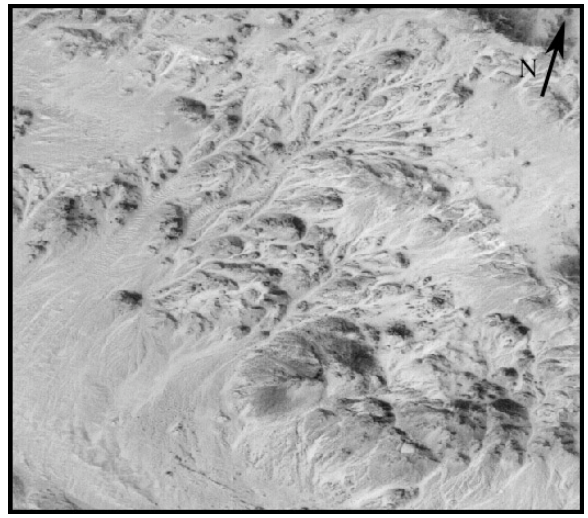

Figure 3: Portion of MOC image R08-01657 on eastern crater wall near 7.9°N, 33.0°W. Branched networks are at least a Horton third order system of channels. Channel density is extremely high over small areas with channels visible down to the resolution limit. Channels extend to regional topographic highs. Locally, this is the most densely dissected region on Mars yet observed. Image is 2 km wide; illumination from lower left.