CHARACTERIZATION OF THE DISTRIBUTARY FAN IN HOLDEN NE CRATER USING STEREO ANALYSIS. K. Lewis and O. Aharonson, California Institute of Technology, Division of Geological and Planetary Sciences, Pasadena, CA 91125, *klewis@gps.caltech.edu.*

Introduction: The recent discovery of a distributary fan in a large crater northeast of Holden by Malin and Edgett has been presented as evidence for persistent flow of water on Mars [1]. With at least three separate depositional lobes and a clearly layered structure, this feature is so far unique among sedimentary structures on Mars. This fan has been deposited by fluvial processes, and then subsequently eroded back from its original extent. This process has left behind an inverted topography, with the floors of former channels standing above the surrounding terrain. Several of the remnant channels in this formation appear to display meandering curves, which is the strongest evidence for a steady supply of water at this location. Further, persistent flow raises the possibility that this feature was, at one time, a lacustrine delta. In order to help characterize the Holden NE fan, we have used stereo analysis of MOC Narrow Angle images to derive topographical information about this site.

Procedure: For this study we have used high resolution Narrow Angle images from the Mars Orbiter Camera [2] on board the Mars Global Surveyor spacecraft [3]. These images have a maximum resolution of ~1.5 m/pixel and are taken in ~3 km wide frames. The combination of nadir-pointing images and images with ~18° emission angle allow stereo analysis of sites where such coverage exists.

Images are processed according to the following recipe (A. Ivanov, Pers. Comm., and [4]). Radiometric calibration of the images is performed using the Integrated Software for Imagers and Spectrometers (ISIS) software package. Calibrated images are rectified using VICAR tools and the MGS SPICE data and are adjusted manually for a final alignment.

When the stereo pair has been properly aligned, the VICAR program TRACKER3 is used to automatically search for tiepoints between the two images. Tiepoints are typically collected in a 2-pixel grid with respect to the reference image, and hundreds of thousands are generally collected for a given pair of MOC images. Elevation data is extracted for each tiepoint.

Once the elevation data has been collected, Digital Elevation Models (DEMs) are then constructed and analyzed in both GMT and MATLAB. If necessary, the data is filtered to remove noise resulting from incorrect tiepoint matching.

The final DEMs have a resolution of roughly 10 meters/pixel. The DEMs in the Holden NE region that have been used in this study are free of the jitter reported by Ivanov and Lorre [5] and Kirk et al. [6], and so have high vertical precision, with no need for filtering of elevation data.

Results: While there are several potential stereo pairs of the Holden NE fan, the pair of MOC images E14-01039 and E23-00003 proved most useful . These images cover the smallest of the three main depositional lobes of the fan, as well as the termination of some of the channels from the central lobe and some rough material which may be associated with the fan.

The DEM was derived from ~500,000 tiepoints. There were several areas where the topography was too smooth to correlate the images, resulting both in holes in the DEM, and in incorrectly matched points. Filtering was applied to eliminate many of the mismatched pixels within the DEM, but holes representing no elevation data remain in some places.

Initial analysis of this DEM has begun to reveal some of the characteristics of this portion of the fan. Slopes along the surface of the fan are calculated to be ~1.5-3°, steeper than the <0.35° reported by Malin and Edgett for the fan as a whole [1]. These higher observed slopes may be a consequence of the limited area observed. Slopes at the end of the fan, where layered outcrops are exposed, tend to be about 8-15°. However, slopes at the end of the fan likely have been altered by erosion to the point where they may not reflect information about the original depositional environment.

Summary: MOC Narrow angle stereo pairs were used to derive topography for a section of the depositional fan in Holden NE crater. Specifically, the stereo pair of E14-01039 and E23-00003 has been studied here. Analysis is ongoing for this and other stereo-derived DEMs to better characterize the fan in Holden NE crater. More work is required to fully understand the morphology revealed by these stereo images. This feature has the potential to provide an important window on the history of surface water on Mars. Improved topography offers a significant piece of information in the interpretation of the Holden NE fan.

References: [1] M. C. Malin and K. S. Edgett (2003) *Science* 302: 1931-1934. [2] M. C. Malin and K. S. Edgett (2001) *JGR* 106: 23,429-23,570 [3] A. L. Albee et al., *JGR.*, 106: 23,291-23,316 [4] A. Ivanov (2003) *LPS XXXIV*, Abstract #2084. [5] A. Ivanov and J. Lorre (2002) *LPS XXXIII*, Abstract #1845. [6] R. Kirk et al. (2002) *IAPRS XXXIV* (B4), 200 (CD-ROM).

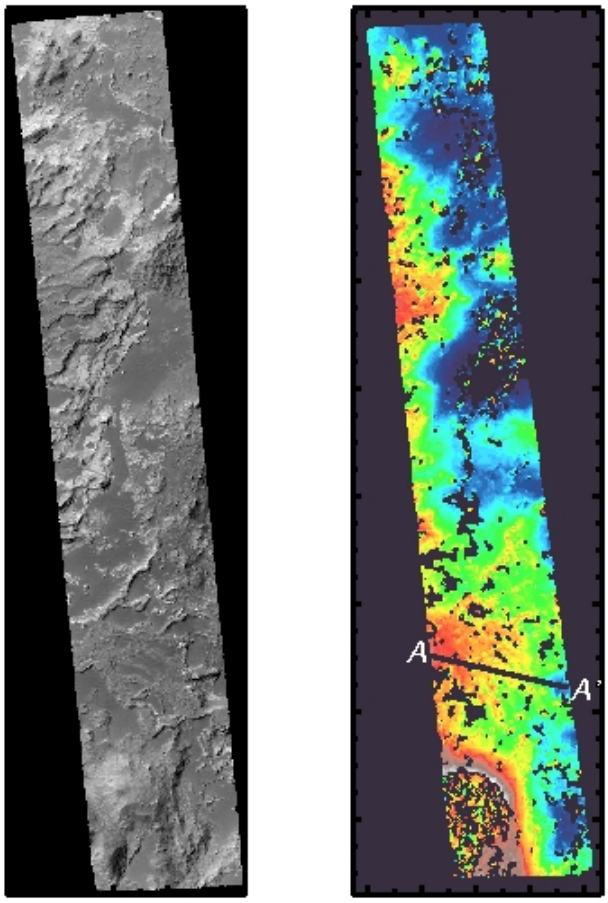

Figure 1: A portion of MOC Narrow Angle Image E23-00003 along with the DEM generated from this image and E14-01039. Profile A-A' is along the length of one of the depositional lobes of the fan in Holden NE crater. Also present in the DEM are the termina ends of channels from an adjacent lobe of the fan. Gaps in the DEM result from incomplete tiepoint correlation of the images.

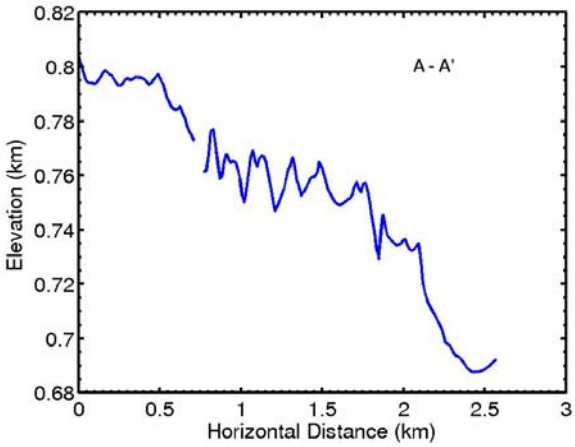

Figure 2: Profile along A-A' as shown in Figure 1. The relation between the low slope of the fan surface and the higher slopes of the fan front are clear in this plot. The total relief along this profile is about 110 meters, about 50 meters of which is expressed in the final drop off in the layered front of the fan. Note the vertical exaggeration of ~20:1.

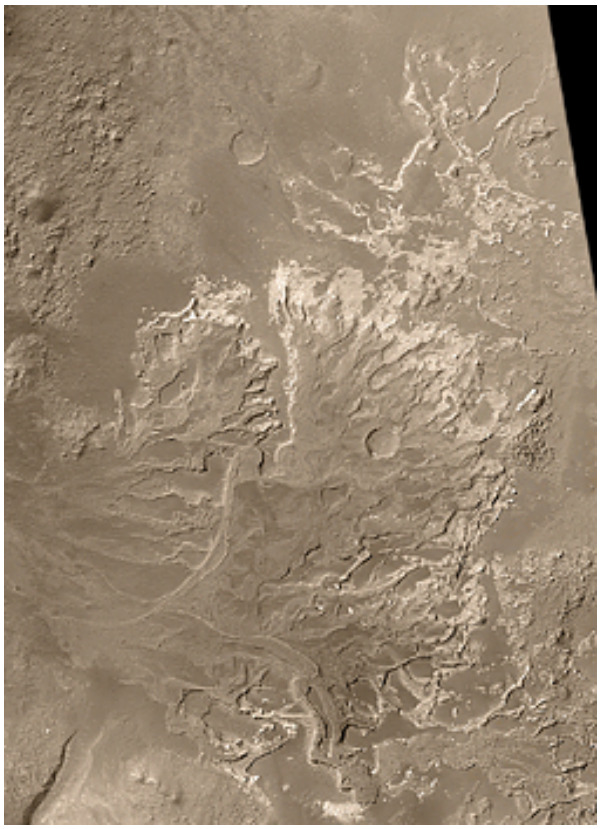

Figure 3: View of the entire fan in Holden NE crater. This paper mainly analyzes the lobe in the lower right corner of the image. Image credit: NASA/JPL/Malin Space Science Systems.