THE UCL IUS-TITHONIUM CHASMA DIGITAL ELEVATION MODEL. A. C. Cook[1], T. Day[2], and J-P. Muller[3], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Washington D.C. 20560. Email: tcook@ceps.nasm.edu, [2]timday@bottlenose.demon.uk, [3]Department of Geomatics, University College London, Gower Street, London WC1E 6BT, UK Email: jpmuller@ge.ucl.ac.uk.

Introduction: We re-examine a previously unpublished digital elevation model (DEM) of a ~105,000km^2 area (figure 1) of Tithonium and Ius Chasma area, produced by the EXODUS (Extra-terrestrial Orbital DEMs for Understanding Surfaces) project at University College London (1990-1993) using an almost fully automated digital stereo matcher from the UCL 3D image maker software package. Other results of the Exodus project have included a study of Ma'adim Vallis [1], and the grooves on Phobos [2].

Method: 38 stereo pairs (43 images) of the area were chosen according to a set of rules [3]. The selected images were then down loaded from CDROM, uncompressed, underwent reseau detection, noise and reseau removal, and were finally geometrically de-calibrated to remove vidcon distortion [4].

Photogrammetry. The majority of the images had poorly known camera orientations (±0.25°). However five low resolution reference images had been used in the USGS control network [5], so their camera positions and orientations were reliable. These images also covered a large area. For the remaining high resolution images a local secondary network of 90 control points was established by identifying at least three land-marks in each, which were also visible in the reference images. By feeding the reference pair pixel coordinates of these points through a stereo intersection camera model, the longitudes, latitudes and heights of the local control points could be determined. Once these were established, a photogrammetric block adjustment was performed for each of the high resolution stereo pairs in order to refine their camera positions and orientations.

Stereo matching. Three or more common points in each stereo pair were selected manually. These acted as seed points for the stereo matcher and also helped to define the affine transform between images so that the image patch in the right image could approximate for the effects of foreshortening due to stereo look angles. All stereo pairs were then automatically stereo matched using a patch-based adaptive least-squares correlation matcher utilizing a control strategy based upon region-growing. The stereo matching program, "Gotcha" [6], makes use of the Gruen-Otto-Chau matcher algorithm and used a patch radius of 10 pixels.

DTM generation. The matched coordinates for each stereo pair were then fed through a stereo intersection camera model (using updated camera positions and orientations) to produce a large set of longitude, latitude, height points, or a digital terrain model (DTM).

DEM generation. The DTMs contained points of different density, height accuracy, and quality of match. Krig interpolation was used to blend these results together into a rasterized grid DEM in a simple cylindrical map projection.

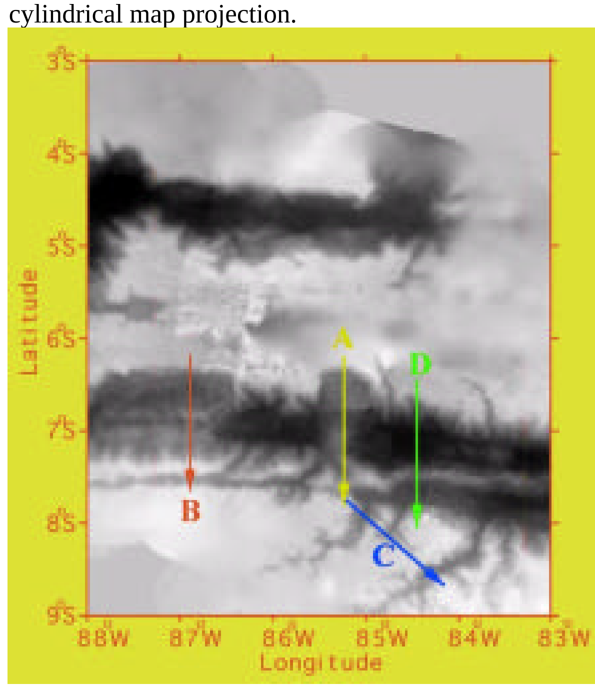

Figure 1 Grey-scale DEM of Ius (lower) and Tithonium (upper) chasma. Black is low, white is high.

Ortho-image mosaic. The DEM was utilized to produce an ortho-rectified map projected image with the effects of topography removed. A low resolution color ortho-image was generated by combining violet and red filter images together and blended with high resolution black and white ortho-images using the Hue-Saturation-Intensity transform.

Visulization. Perspective projection terrain renderings and a video were generated using the UCL Dynamic Visualization toolkit software originally developed for terrestrial global change [7], which allows Z-buffer texture-mapping as well as ray-tracing to be 3D composited at multiple resolutions. The flight-path was defined using a Wavefront commercial software package on an SGI workstation with 1.75x height exaggeration. Simulated martian haze (linear attenuation) with red, green, and blue intensities of 0.76, 0.24, and 0.08, was added. This left the immediate foreground clear of fog in order to show up the ortho-image detail.

Results: At the time the DEM (figure 1) was produced the USGS post-Viking Orbiter coordinate system, with a 6.1mb topographic datum [8], was used. Longitudes maybe offset by 10-20km, latitudes by a smaller amount, and elevations by >1km or tilted [9]. Nevertheless the DEM, with 0.46 x 0.46km pixels is an improvement in many areas over the pre-MGS digital USGS DEM [10]. The latter had been interpolated from 1000m contours, so much of the intervening terrain was poorly portrayed, and very occasionally digitized contours were mistakenly assigned wrong heights. In our DEM the low texture areas between valleys suffer poor matching from the correlation-based stereo matcher and hence result in topographic noise. Sometimes the control points used had a larger uncertainty than elsewhere, hence tile-like offsets can be seen e.g. north of B in figure 1. Relative height accuracy within DEM tiles appears to be better than ±100 m, although absolute height uncertainty maybe ~±1km [9,10]. A topographic range of 9 km was found in the region studied. A ~1° up-hill slope (N to S) can be seen in the general DEM, but it is possible this is related to the USGS topographic datum [8,9]. A ~1.5 km thick landslide feature is visible in the DEM on the mid-section of the north wall of Ius Chasma with a series of three E-W 200-300 m high ridges (figure 2 left side of curve A).

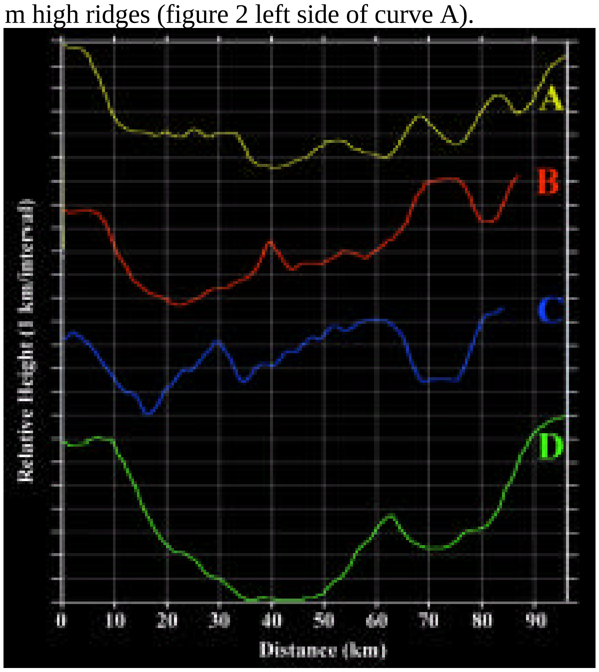

Figure 2 Four profiles through the DEM in figure 1.

A video was created of a flight around Ius and Tithonium chasma: 1) aerial view S-N over Ius and Tithonium Chasma, 2) flight west along Tithonium Chasma, 3) turn south into Ius Chasma, 4) turn east over (86.1°-88.0°W, 5.4°S-8.2°S), 5) east along Ius Chasma, 6) turn to view the strata on the north rim of Ius Chasma, 7) turn south to enter a sapping valley channel (effective height at +20km over 83.6°-85.5°W, 7.3°-9°S), 8) aerial view, looking north over the sapping valley (figure 3).

Conclusions: Our stereo derived DEM contains topography which was not recorded between the contours used to produce the pre-MGS digital USGS DEM [10]. It is likely that the expected inter-orbit spacing of the Mars Global Surveyor MOLA tracks will be comparable to the typical spatial resolution (defined by patch size) of Viking Orbiter derived DEMs. Therefore in future it makes no sense to derive DEMs unless the patch size of the DEM is less than the expected MOLA track spacing. Because there are no publicly available MOLA profiles for the study area, at the time of writing, it is impossible to make any comparisons. However the MOLA orbit 35 profile, [9] further to the east, does at least show a similar height range and valley side slopes. Our DEM is available over the internet at the following web sites: http://www.ge.ucl.ac.uk/isprs-etm/ and its mirror site at http://wwwflag.wr.usgs.gov/USGSFlag/Space/Isprs/index.html/

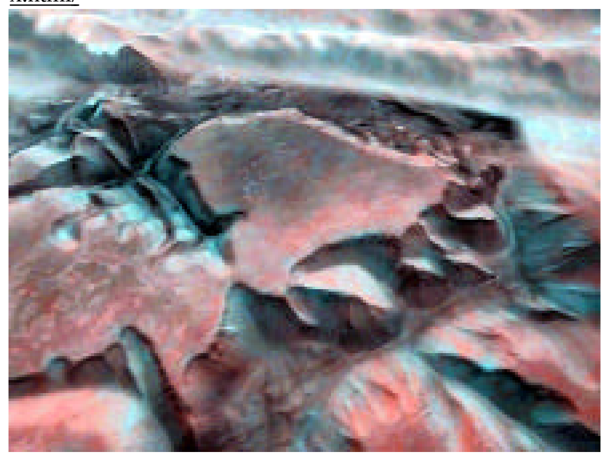

Figure 3 Simulated view above a sapping valley system in SE corner of the DEM in Figure 1.

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