COMPARISON OF AUTOMATICALLY GENERATED DEM OF TITHONIUM CHASMA WITH USGS INTERPOLATED CONTOUR DEM.

1) Background

Automated stereo-matching techniques capable of producing digital elevation models from stereo pairs of digital imagery have been developed at UCL over the past four years. We have recently begun to apply these to Viking Orbiter imagery.

We use an adaptive least squares algorithm to grow regions of matched points from user-supplied seed-points on stereo pairs of Viking Orbiter imagery (1,2,3). This provides typical coverage of 60% of the possible overlapping area being matched. The amount of coverage depends on there being sufficient surface texture to allow unique matches to be made. The resulting file of matched points can then be converted into set of geocoded elevation points, using camera modelling and stereo resection software which utilizes USGS-supplied camera position and orientation data. The geocoded elevation points can then be interpolated onto a regular map grid.

2) Example for Tithonium Chasma

A digital elevation model, with a resolution of 1/256° (ca 230m) for part of Tithonium Chasma was produced using the above method in 15 hours on a Sparc 1+ workstation. The images had resolutions of 108 m/pixel (057A45) and 78 m/pixel (64A22), with an overlapping area of about 80x80 km. The relative heights are known to an accuracy of ±70 m, although the absolute heights depend on the camera pointing accuracy, which is not the best possible for these two images. A photogrammetric block adjustment programme has recently been written at UCL which will allow the absolute accuracy to be improved.

The USGS DEM was produced by interpolating from 1km contours derived from manual photogrammetric techniques by the USGS Astrogeology Division. These data have a resolution of 1/64° (just over 900m), on a Sinusoidal Equal Area projection. One of us (TD) resampled this to a simple cylindrical projection at UCL, using bilinear interpolation to magnify the part of the DEM covering the same area.

Fig. 1 shows a comparison of the two DEMs. The higher resolution of the OU/UCL DEM reveals details such as the tributary canyon. This type of high resolution DEM can be produced directly from stereo images in a matter of hours with our current hardware capability. A measure of the quality of the matching process is available for each matched point, which can be translated through the derivation of the final DEM to give a measure of the accuracy of the height information.

The use of this automated technique will be extended to other areas of Mars, and eventually will provide a global DEM of Mars at 1/128°.

3) Interpretation

We have used our high resolution DEM to examine profiles of the chasma walls. These show the slopes on the north side to be approximately 30°, suggestive of talus slopes at the angle of repose. Along the base of this wall is a platform with a slope of 5°-7°, between 1.2 and 0.7 km above the chasma floor (fig. 2). This may be the result of slumping of debris partially fluidized by ground-ice lubrication. The platform may represent the level at which ground-ice occurs, producing the change in slope morphology. The platform is covered by a series of flows, with distinct lobate edges, some of which drape over the scarp to the chasma floor below. These are probably debris flow deposits.

We intend to stereo-match more parts of the western end of Vallis Marineris, and to use wall profiles to assess the mass-wasting processes in canyon formation.

References.

DEM OF TITHONIUM CHASMA. G. D. Thornhill et al.

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FIG. 1 Comparison of USGS DEM (left) with OU/UCL DEM (right).

FIG. 2 Image of Tithonium Chasma (64a22) showing platform and flow lobes.