GULLY MORPHOLOGY IN HYDRATED DEPOSITS IN CANDOR MENSA. P. M. Grindrod[1,2], N. Warner[3], S. Gupta[3], [1]Earth Sciences, UCL, London, UK, [2]Centre for Planetary Sciences, UCL, London, UK, [3]Department of Earth Science & Engineering, Imperial College London, London, UK (p.grindrod@ucl.ac.uk).

Introduction: There is increasing evidence of groundwater-related formation of hydrated minerals in interior layered deposits (ILDs) on Mars [e.g. 1]. Here we investigate the nature of gully-like features observed in an ILD in Candor Mensa, which show similarities with features observed in many other ILDs in the wider Valles Marineris region.

Method: We used a HiRISE stereo pair to produce a high-resolution DEM, using the method of [2]. The stereo pair consists of the two images PSP_007166_1740 and PSP_007456_1740, giving a DEM centered at 5.928°S, 286.129°E. We used the freely available Integrated Software for Imagers and Spectrometers (ISIS) (http://isis.astrogeology.usgs.gov) to calibrate and process EDR files for ingestion into the commercial SOCET SET (http://www.socetset.com) software, in which a DEM with 1 m elevation posts (tied to MOLA data) was created. We had greater success with DEM creation using HiRISE images that had been processed with the recently introduced 'hiequal' routine in ISIS. We orthorectified each HiRISE image using the generated DEM, all of which were then imported into the commercial software package ArcGIS (http:// www.esri.com/software/arcgis). Using the method of [3], we estimate the vertical precision of the DEM to be ~0.2 m, although the steepness of some slopes in our DEM limits the precision in these locations to the 1 m postings [3].

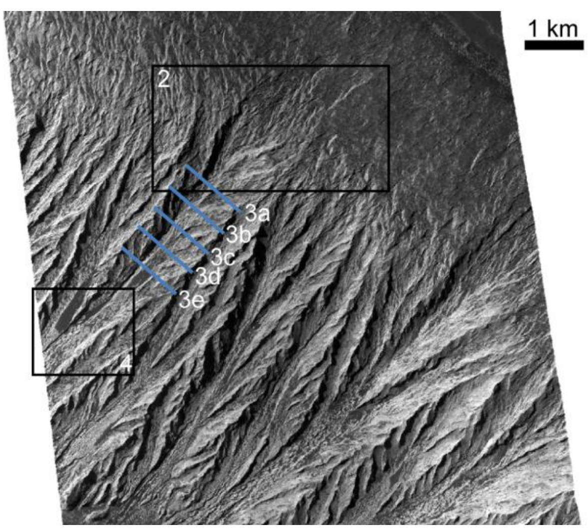

Figure 1. Part of the orthorectified HiRISE image (PSP_007166_1740) used in this study. Boxes and lines show the location of other figures and profiles respectively, covering the main gully used in this study.

Results: We estimate at least 15 gullies greater than about 2 km in length, many of which converge to a large single gully downslope. Most of these gullies begin at elevations between 1650 and 2300 m, in exposed light-toned material. We concentrate our analysis here on a single gully (Figure 1) typical of most in the study region, in order to demonstrate characteristic features from source to terminus.

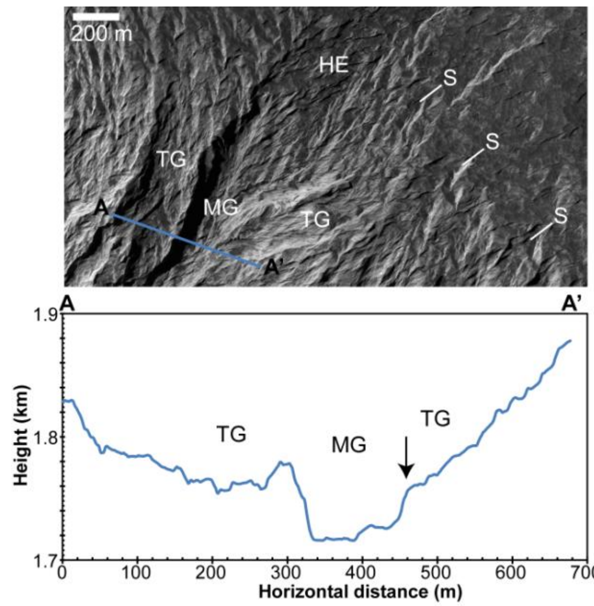

Figure 2. General source region of our study gully. Shown is a profile through the DEM from A to A' (arrow shows the edge of a truncated tributary gully), and the location of features described in the text: scallops (S), headward erosion zone (HE), tributary gullies (TG), main gully (MG).

Source region. Our study gully originates in a broad region ~1 km wide (Figure 2), where distinctive, usually V-shaped, scallops (approximately <100 m wide and 10 m deep) join together to form a preliminary or tributary gully of the order of 100 m wide. Several of these gullies are seen to join together near the source region to form a single dominant gully. In some cases the tributary gullies have been truncated by a primary gully. Significant headward erosion also seems to have occurred above the general source region, extending upslope by ~ 1 km.

Middle region. At least ten tributary gullies, about 70 – 120 m wide and 300 m long, flow away from ridge-lines towards, and are truncated by, the middle section of our study gully (Figure 3). The main gully shows evidence of multiple erosion episodes, with several increasingly-narrow gully edges visible. The smallest gully is about 30 m wide and 15 m deep, and shows signs of some infilling by a dark sand mantling material [1]. The floors of the tributary gullies have a distinctive texture, similar to the source region but with a higher density of scallops.

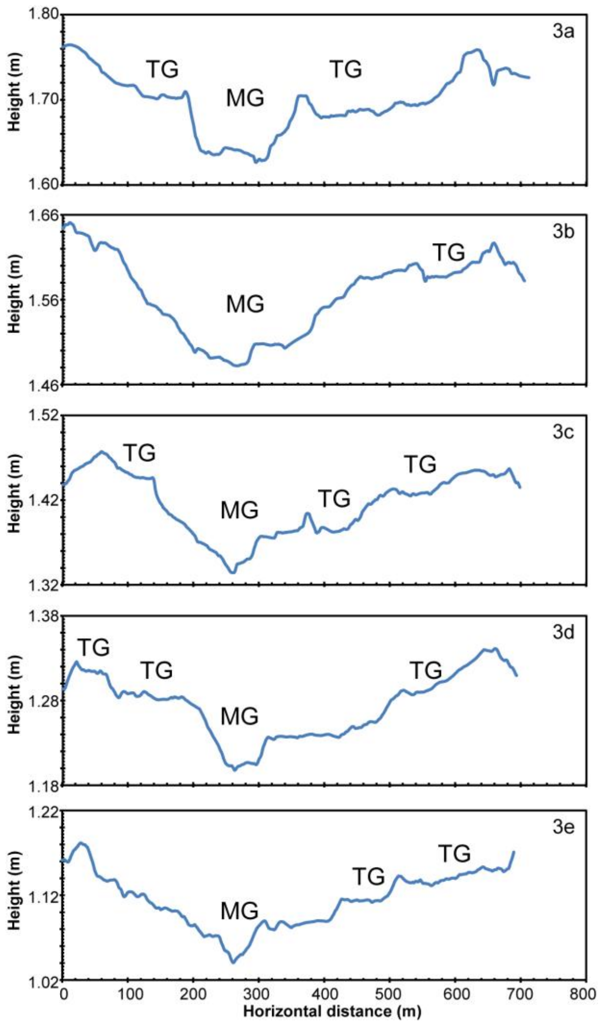

Figure 3. Profiles through the middle region of the main study gully (profiles 3a to 3e are progressively further downslope).

Terminal region. Towards the end of our study gully, it merges with an adjacent main gully of a similar width to form a large gulley with a floor about 375 m wide. Parts of the gully are dominated by small erosional scallops and dark sand mantling material (Figure 4). The scallops are visible in the DEM profile as individual depressions about 10 – 15 m deep. The large gully is separated from other main gullies by ridges approximately 100 m high, which also show evidence of tributary gully formation.

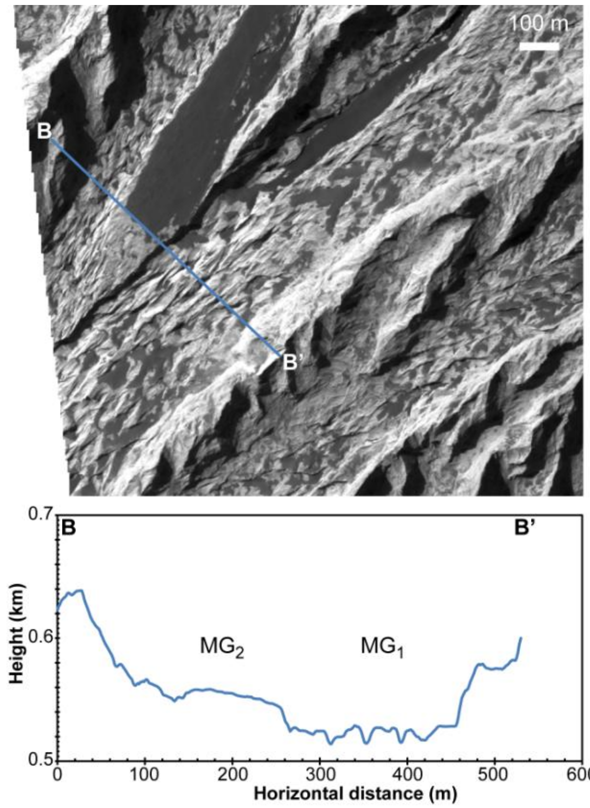

Figure 4. Terminal region of our study gully (MG_1), showing the convergence with another main gulley (MG_2), and the scalloped floor depressions in MG_1.

Discussion: CRISM observations have shown that the light-toned material in which the studied gullies occur contain the magnesium sulfate monohydrate kieserite ($MgSO_4 \bullet H_2O$), whereas the dark material at the base of the gully contains hematite [1]. Our observations of the gullies in this region fit well with a groundwater model of formation, either through catastrophic discharge of upwelling water and/or dehydration-related water release [1]. The scalloped source region and presence of primary gullies along the whole length of the main gullies indicate a broad region of water emergence. The multiple erosion surfaces indicate several different periods of gulley formation, and the distinctive erosional surface throughout the gulley length could possibly be indicative of karstic processes operating in this ILD, where chemical as well as physical erosion is responsible for gulley formation [e.g. 4,5].

References: [1] Murchie S. et al. (2009) *JGR, 114*, E00D05. [2] Kirk R. L. et al. (2008) *JGR, 113*, E00A24. [3] Okubo C. H. (2009) *Icarus, in press*. [4] Ford D. and Williams P. (2008) *Karst Hydrogeology and Geomorphology* (Wiley), pp. 562. [5] Baioni D. (2009) *Acta Carsologica*, 38, 9-18.