Attitude determination of geological layers using HRSC data and Orion software. F. Fueten[1], R. Stesky[2], P. MacKinnon[1], T.Zegers[3], E. Hauber[4], B. Foing[3], R. Pischel[3], K. Gwinner[4], F. Scholten[4], G. Neukum[5] and the HRSC Co-Investigator Team. [1]Department of Earth Sciences, Brock University, St. Catharines, Ontario, Canada L2S 3A1 (FFueten@Brocku.ca), [2]Pangaea Scientific, Brockville, Ontario, Canada,[3]ESTEC, ESA, Noordwijk, The Netherlands, [4]Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany, [5]Remote Sensing of the Earth and Planets, Freie Universitäet, Berlin, Germany

Introduction: Previous work [6, 2] has demonstrated that MOLA and wide angle MOC data can be combined in Orion software to determine attitudes of large scale layering within the chasmta walls of Valles Marineris. Individual layers, between 7.7 km and 83.8 km in lateral extent, were found to have statistically consistent orientations. Layer attitudes indicated largely shallow dips into the canyon and were interpreted to record the collapse that produced the early ancestral basins [2]. Unfortunately the resolution of the MOLA 1/128° x 1/128° topographic grid file (463 m/pixel) limited the scale of layering that could be investigated. While many more detailed layers are visible in narrow angle images, most narrow angle MOC images only span about 10 DEM pixels, which makes it impossible to obtain quality attitudinal data from them.

HRSC Data sample: The availability of HRSC data which couples high-resolution imagery with digital elevation data allows for the examination of geological layering on the scale of 1 to 2 km. It is thus possible to investigate a much wider range of geological problems. As an example, we present measurements from a small interior layered deposit (ILD) which had been the focus of a previous study [5]. ILDs have been the object of considerable study [e.g. 3,4,6] as the nature of their origin has major implications for the formation of Valles Marineris. In 2004 Lucchitta combined MOC imagery and MOLA topography to present attitudinal measurements of several layers visible around the ILD. Lucchitta [5] concluded the layers generally dip outwards and concluded that the geometry was consistent with layering surrounding a volcanic cone. Our work with HRSC data confirms the general attitudes determined by Lucchitta [5] and, in addition, is able to provide more measurements with finer resolution.

Structural Analysis: HRSC data images a semicircular feature on the NE flank of the ILD (Fig. 1), approximately 12km by 8km in extent and displaying good internal layering suitable for analysis with Orion. Similar, though smaller, whorl-shaped enigmatic features within Candor Chasma have been modelled as diapirs or are suggested to be due to permafrost [1]. While some layers can be traced around the entire feature, analysis with Orion suggests that layers in the NE and SW quadrants show good planarity. Curvature apparent in the imagery in these regions is produced by gully–shaped topography intersecting north-easterly dipping planes in the NE and SW quadrants. The dip of the plane in the NE quadrant is approximately 20°NE, while that in the SW quadrant is approximately 7°NE (Fig.1 d). However, the apparent curvature of the layers in the NW and SE quadrant of this feature cannot be explained in this fashion. Analysis indicates that no single rectiplanar feature can fit this outcrop trace. Rather, the layering itself is non-planar, adding to the topographic sectional effect. We infer this feature to be an asymmetrical open fold with a NW-SE trending fold axis and limb dips of approximately 20° and 7° to the NE. The origin of the fold is most likely the result of draping over an existing topgraphical feature.

Capping the ILD is a single layer of considerable extent. Analysis of this layer indicates that it is essentially planar and dips approximately 6°SW (Fig 1c). Hence the SW fold limb (dipping 7°NE) is unconformably overlain by a planar layer dipping approximately 6°SW.

Conclusion: The accurate determination of layer attitudes facilitates a true understanding of the three-dimensional geometry of the geology and places valuable constraints on the interpretation of features of Martian geology. While the origin of the fold and unconformity and their geological implications are debatable, possible models must account for this geometry. Use of Orion with HRSC data will constrain the interpretation of geological features on Mars as it enables the determination of the attutides of smaller scales.

References: [1] Beyer R. A. et al. (2000) *LPS XXXI*, Abstract #2022. [2] Fueten F. et al. (2005) *Icarus* in press. [3] Hauber E. et al. (2004) Eos Trans. AGU, 85*(47), Fall Meet. Suppl., Abstract* V33C-1471. [4] Komatsua G. et al. (2004) *Planetary and Space Science* 52 (2004) 167 – 187. [5] Lucchitta B.K. (2004) *LPS XXXV*, Abstract # 1881. [6] Lucchitta B.K. et al. (1992) *Mars* 453-492. [6] MacKinnon P. et al. (2004) *LPSXXXV*, Abstract # 1127.

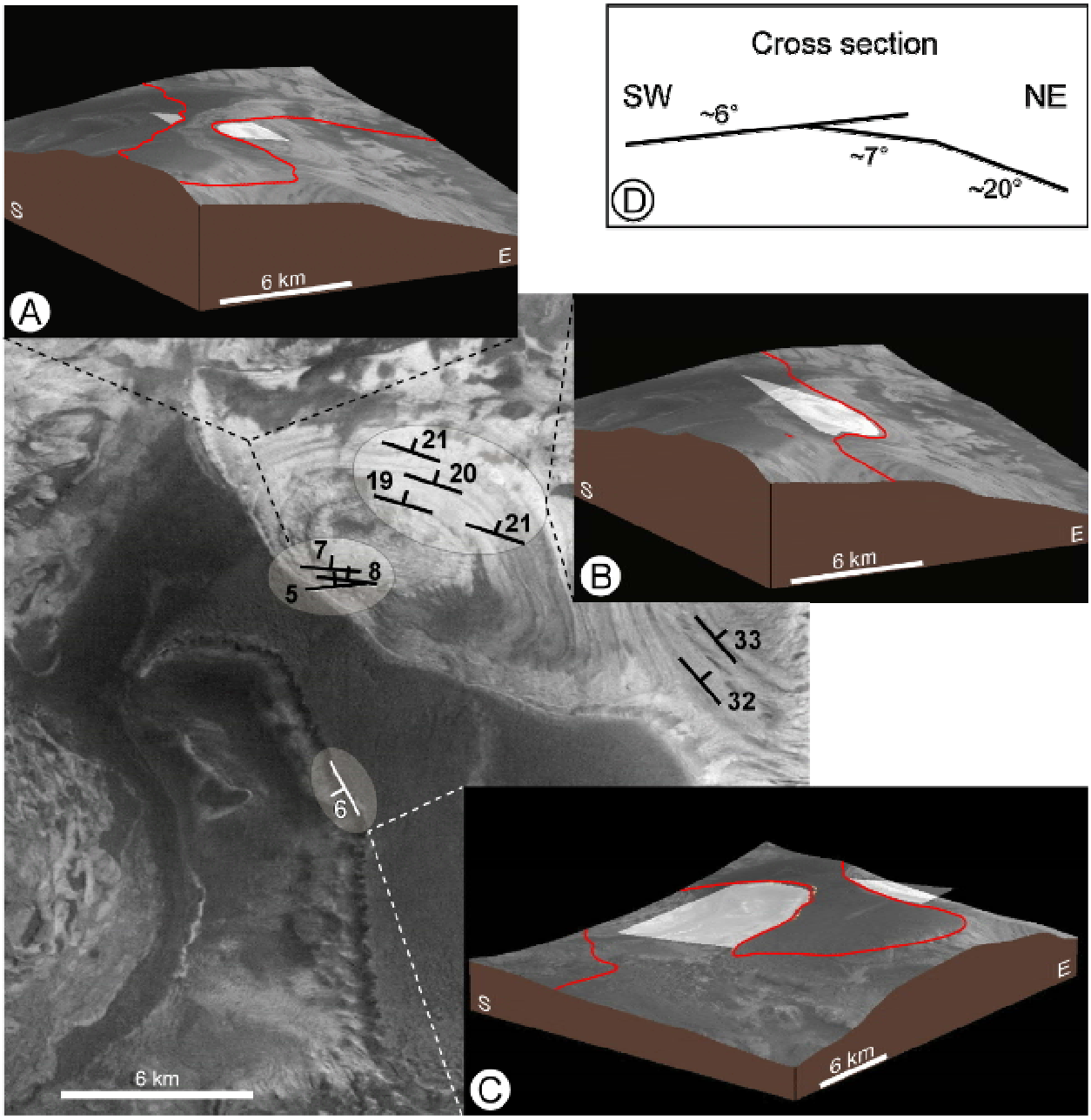

Figure 1. Central Image: Portion of HRSC image containing ILD. Location of the ILD is approximately 75°E/6.5°S, in the western part of the Candor Chasma. Attitudes of layers measured are indicated using standard strike/dip symbols. We show only a few of the symbols for clarity. Insets A, B and C illustrate the orientation of layering in three regions of the image, with no vertical exaggeration. In these insets the translucent plane indicates the orientation of the plane above the ground level. The dashed red line is the outcrop trace of the plane. Inset A: Planar layers in the SW quadrant of the semi-circular with average dips of 7° to the NE. Inset B: Planar layers in the NE quadrant with average dips of 20° to the NE. Inset C: Planar layer capping the ILD. Its dip is 6° to the SW indicating an angular unconformity. Inset D: A 2D schematic cross-section along a SW to NE direction, indicating the angular relationships of the structure.