DIP OF CHASM WALL FAULTS IN OPHIR CHASMA, VALLES MARINERIS, MARS.

F. Fueten[1], A. Robinson[1], R. Stesky[2], P. MacKinnon[1], E. Hauber[3], T. Zegers[4], and K. Gwinner[3], [1]Department of Earth Sciences, Brock University, St. Catharines, Ontario, Canada L2S 3A1 < ffueten@brocku.ca>; [2]Pangaea Scientific, Brockville, Ontario, Canada; [3]Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany; [4]Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands.

Introduction: Valles Marineris (VM) is thought to have achieved its current geometry as the result of a two-stage process [1,2]. Ancestral basins [3,1] formed prior to the opening of VM-related linear troughs. Faulting associated with the later VM opening [2] connected the basins and created the current geometry. The present width of the troughs is partially due to erosional processes which widened the existing structures [4,5]. Crustal stretching across VM has been estimated [6] to be 2 - 10% based on assumptions of the amount of tilting of fault blocks. The relative lack of rift-flank uplift across VM and MOLA topography-based modeling have been used to argue for bounding fault dips on the order of 40°-55° and fault depths of 60-75 km [5]. One feature used to recognize such normal faults are planar triangular facets, which truncate wall rock spurs [4, their fig. 7]. This study investigates the dip of such faults within Ophir Chasma (Fig 1A).

Methodology: High Resolution Stereo Camera (HRSC) [7] panchromatic orthoimages, obtained during orbit 0334 and 0360 (50 m/pixel) and corresponding digital elevation model (DEM) (100 m grid spacing) are the primary data set for this study. Fourteen Context Camera images (CTX) [8] were registered to the HRSC data. The attitudes of planar features were measured using the software Orion following the methodology discussed by Fueten et al. [9]. Attitudes of faults were measured in both the HRSC and CTX composite images by placing points on the outcrop surface and adjusting them until the best-fit plane was found.

Results and Discussion: Forty-three mostly triangular fault facets with dip ranges from 29.9° to 53° and a mean dip of 37.8° were measured using the CTX mosaic (Fig 1B). Due to the lower resolution of the HRSC images, only 21 faults segments could be measured within that data set. Their dip range of 30.6° to 48.6° and mean of 36.3° correspond well to the CTX data. By contrast, 53 randomly selected measurements of the slope of the walls with large slump scars have a mean dip of 31.2° while 49 random measurements of the slope along spur and gully walls indicate dips of 25.7°.

Measurements obtained in CTX and HRSC imagery are consistent for the fault facets and are steeper than that of other wall surfaces.

There is no correlation between the size of facet and the dip values (Fig 1C,D). Detailed views of the spur facet geometry (Fig1F, G) show no obvious evidence that the dip of the facets have been significantly modified by erosion.

The triangular fault facets expose wall rock which is unlikely to have been rotated. Several shallow rectangular facets were measured at the front of the large plateau (Fig 1B) which likely has been displaced downward. This plateau has an overall dip of 6° into the basin. Any rotation in this sense would steepen fault segments at the front of the plateau.

There is an active debate about initiation and reactivation of terrestrial low angle normal faults [e.g. 10] The Mohr-Coulomb criterion for fracture predicts that faults initiate with their plane at angles less than 45° to the maximum compressive stress, assumed to be near vertical for normal faults. Hence initiation and reactivation of normal faults with shallow dips is problematic.

However, if the initial stage of the basin forming event involved a localized uplift, thrust faults at relatively shallow dips could be initiated and then reactivated as normal faults during the later collapse phase. High fluid pressure during that phase may have facilitated motion, as is postulated for terrestrial low-angle normal faults [10].

Conclusions: The mean dip of normal faults in Ophir is approximately 36° - 38°. There is little evidence that this dip has been modified. We suggest that the shallow faults may have been initiated as thrust faults during an initial localized uplift phase of the basin formation and later reactivated as normal faults. More work on this problem is currently ongoing.

References: [1] Lucchitta B. et al. (1994) *J. Geophy. Res. 99*, 3783-3798. [2] Schultz R. A. (1998) *Planet. Space Sci. 46*, 827-834. [3] Lucchitta B.K. and Bertolini M.L. (1990) *Lunar Planet. Sci. XX*, 590-591. [4] Peulvast J.-P. et al. (2001) *Geomorphology 37*, 329-352. [5] Schultz, R.A. and Lin, J. (2001) *J. Geophys. Res. 106(B8)*, 16549-16566. [6] Mège D. and Masson P. (1996) *Planet. Space Sci. 44*, 749-782. [7] Jaumann R. et al. (2007) *Planet. Space Sci. 55*, 928-952. [8] Malin M.C. et al. (2007) *J. Geophys. Res. 112*, CiteID E05S04, doi: 0.1029/2006JE002808. [9] Fueten F. et al. (2005) *Icarus 175*, 68-77. [10] Collettini C. and Sibson R.H. (2001) *Geology 29*, 927-930. doi: 10.1130/0091-7613(2001)029<0927:NFNF >2.0.CO;2

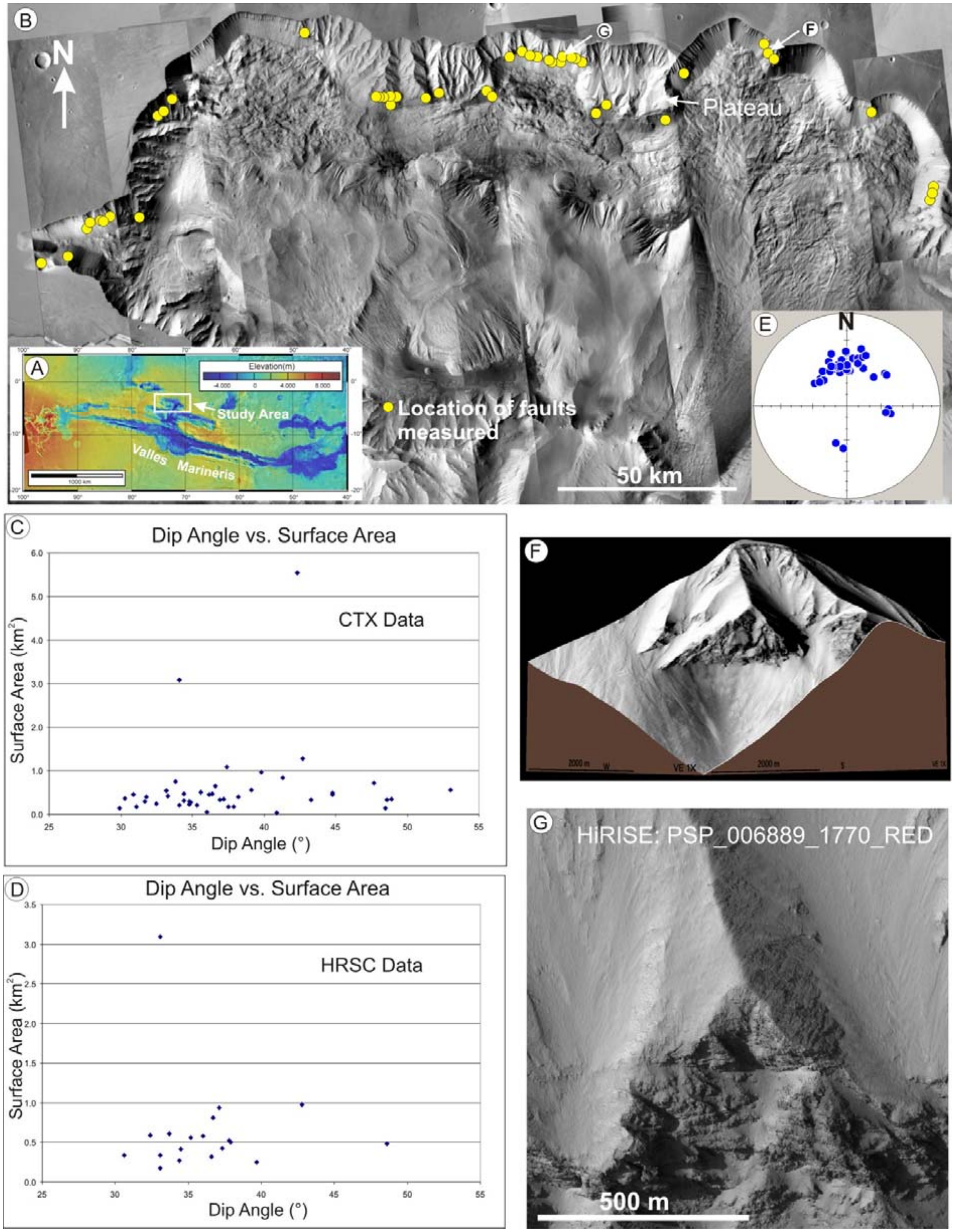

Figure 1: (A) location of Study area, (B) Location of CTX measurements, (C), Dip vs Size, CTX Data, (D) Dip vs Size, HRSC data, (E) Schmidt net of CTX data, (F) 3D view of spur, (G) HiRISE image of spur