**DISPLACEMENT-LENGTH RELATIONSHIPS OF NORMAL FAULTS ON MARS: NEW OBSERVATIONS WITH MOLA AND HRSC.** E. Hauber[1] , E. Charalambakis[1], K. Gwinner[1], M. Grott[1], M. Knapmeyer[1], K.-D. Matz[1], M. Wählisch[1], [1]Institute of Planetary Research, German Aerospace Center (DLR), Ruth-erfordstr. 2, 12489 Berlin, Germany (Ernst.Hauber@dlr.de).

**Introduction:** The geometric properties of planetary fault populations can provide useful information on fractured rock bodies [e.g., 1]. However, so far only few data sets of the relationships between fault length and displacement have been measured for extraterrestrial faults [2], partly due to the limited number of reliable topographic datasets.

Here we use MOLA altimetry data [3] and HRSC images [4] to obtain one or more displacement values for a given (normal) fault. This method allows us not only to measure the maximum displacement, but also to analyze the displacement distribution along the trace of a single fault. We compare our results to previous measurements on Mars and on Earth, and discuss the implications for further interpretation

**Data and Methods:** We selected a fault population on the western Ophir Planum plateau in the Valles Marineris region for our preliminary analysis. This is an unnamed set of relatively complex, Late Hesperian-aged grabens between eastern Candor Chasma in the north and Coprates Chasma in the south (Fig. 1) [5]. It has characteristics that make it particularly useful for measurements with MOLA data: It has a fault trend which runs approximately WNW-ESE, which is ±perpendicular to single topographic MOLA profiles. This is important, since we measure fault offsets only at the location of MOLA tracks to avoid interpolation effects and to make use of the highest possible MOLA resolution. Another advantage is that the faults are relatively isolated, i.e. they do not cut major older fractures, and in turn are not cut and modified by younger fault populations (both would make the measurements much more complicated). We plot the single MOLA profiles on high-resolution HRSC images (12-20 m/pixel; mosaicked with a resolution of 50 m/pixel), and identify fault traces on the images. Fault lengths are measured in the images, and offsets across faults are measured in MOLA profiles (due to the distance between single MOLA tracks in E-W direction of typically a few km at the equator, we can obtain several offset measurements for a single fault only if the fault length is more than a few km; Fig. 2). With these measurements, we can plot the lengths of faults vs. their maximum displacements (Fig. 3), as well as the offset distribution along single faults (Fig. 4). Usually, fault planes dipping 60° are assumed for Mars [e.g., 6], and even shallower dips for fault planes have been found in western Candor Chasma [7]. We apply a correction for 60°-dipping faults in our displacement-length plot (Fig. 3) for better comparison to other data sets [2]. Since the basic pattern of displacements along faults is not affected by such a correction, we present our preliminary assessments of displacement distributions (Fig. 4) assuming vertical fault planes, i.e. the measured topographic offset corresponds to the displacement on the fault plane. We also did not consider fault linkage in this preliminary analysis, since we plan to use higher-resolution HRSC-derived topography to analyze the offset distribution at relay ramps in the next step (see also Results).

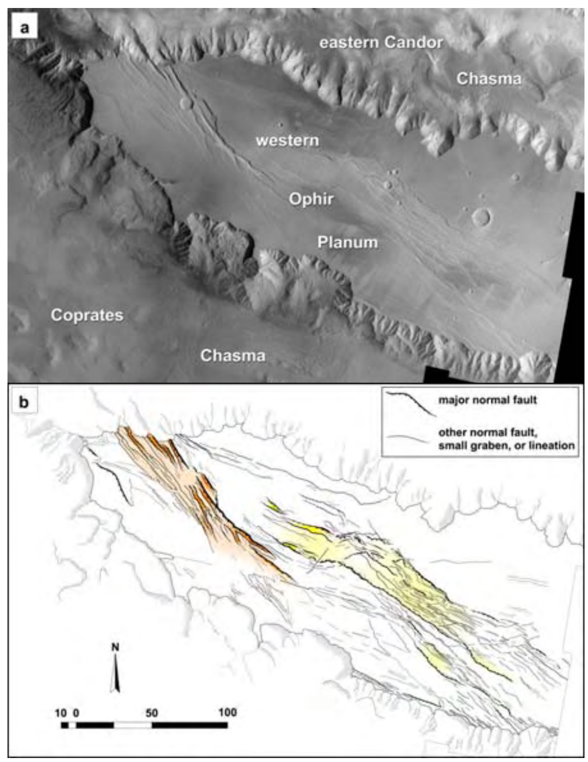


**Fig. 1.** Study area in Ophir Planum, centered at ~9.6°S and ~292.5°E. (a) Viking Orbiter image mosaic with physiographic features labeled. (b) Tectonic sketch map. The *en echelon* configuration of the two main fault sets (see [5]) is indicated by different color shading. We measured 145 faults in the "yellow" fault set.

**Results:** We measured 145 faults of the southeastern Ophir Planum fault array (marked in yellow in Fig. 1b). For each fault, the fault length and one or more offset (throw) measurements were obtained in an interactive, IDL-based software tool (Fig. 2).

*Displacement-Length Relationship.* The distribution of maximum displacements ($D_{max}$) vs. fault length ($L$) appears to be similar to previous measurements [6] from the northeastern branch of the Tempe Terra rift [8] (Fig. 3). However, a tendency for slightly shorter fault lengths than those obtained by [6] can be observed. This might be due to the fact that we measured separate fault segments, since fault lengths increase in relation to the maximum offset if linkage is considered [9]. We expect that D/L values will shift towards lower D/L ratios if we consider fault linkage in the next step.

*Displacement Distribution along Faults.* The displacement distribution along some of the selected faults has a more or less symmetrical pattern (Fig. 4). However, in many other cases the distribution is distinctly asymmetrical, an effect that is also observed for slip distributions at earthquakes on Earth [10]. We will analyze relay ramps in detail to determine if asymmetric distributions are an effect of fault segmentation.

**References:** [1] Schultz, R. A. (1999) *JSG, 21,* 985-993. [2] Schultz, R. A. et al. (2006) *JSG, 28,* 2182-2193. [3] Zuber, M. T. et al. (1992) *JGR, 97,* 7781-7797. [4] Neukum, G. et al. (2004) *ESA SP-1240*, 17-35. [5] Schultz, R. A. (1989) *JGR, 96,* 22,777-22,792. [6] Wilkins, S. J. et al. (2002) *GRL, 29,* 1884, doi: 10.1029/2002GL015391. [7] Fueten, F. et al. (2007) *this conference*. [8] Hauber, E. and Kronberg, P. (2001) *JGR, 106,* 20,587-20,602. [9] Dawers, N. H. and Anders, M. H. (1995) *JSG, 17,* 607-614. [10] Manighetti, I. et al. (2005) *JGR, 110,* B05302, doi: 10.1029/2004JB003174. [11] Schlische, R. W. et al. (1996) *Geology, 24,* 683-686.

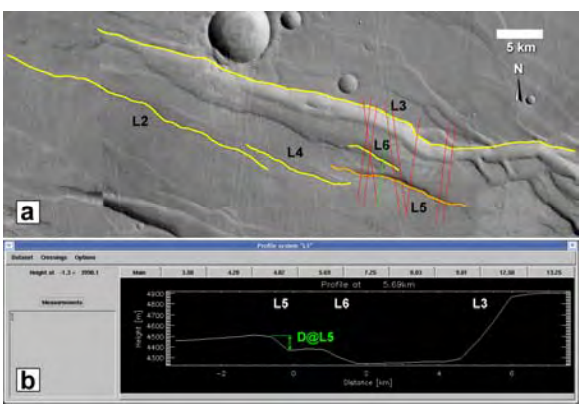


**Fig. 2.** Measurement technique. (a) HRSC image mosaic (50 m/pixel) and location of MOLA tracks (white dotted lines). Selected faults are marked with yellow lines and labeled (e.g., "L2"). Fault "L5" is selected (orange), and cross-sections used for offset measurements are marked in red. The active cross-section (see Fig 2b) is marked in green. (b) Screenshot of interactive measurement window (IDL). The cross-section marked in green in Fig. 2a is shown, and the offset at fault "L5" is indicated.

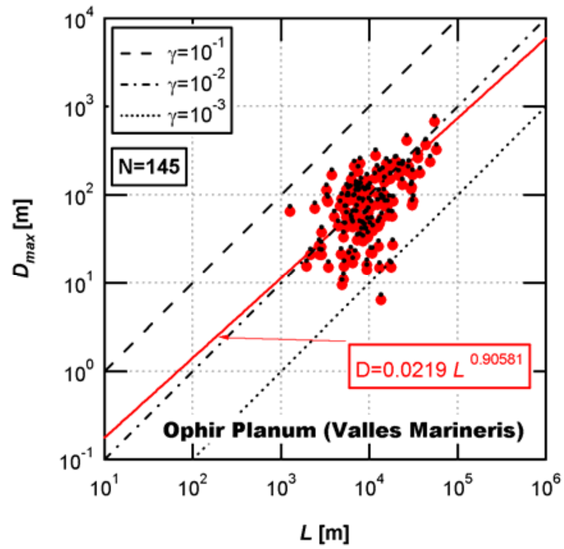


**Fig. 3.** D/L values for 145 normal faults on Ophir Planum. Red dots mark topographic offset, small black dots mark displacement on fault plane after correction for 60°-dipping fault planes. The data show a relatively large scatter, but are comparable to data from terrestrial faults ($\gamma = \sim 1\text{-}5 \times 10^{-2}$; [2]; see also [11], where $D_{max} = 0.03 * L^{1.06}$).

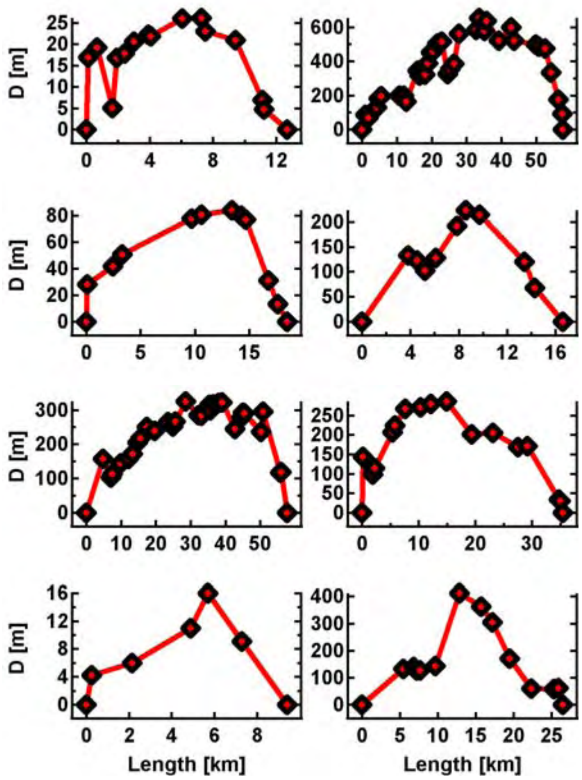


**Fig. 4.** Examples of observable displacement $D$ (=throw) along normal faults in Ophir Planum, assuming vertical faults. The offset at the beginning and end of each fault was assumed to be zero. Fault linkage is not considered, i.e. only isolated fault segments are shown.