ELLIPTICAL CRATERS IN THAUMASIA, MARS: CONSEQUENCES ON FAULT BEHAVIOR P. Allemand[1], P. Allemand[1], D. Baratoux[2], M. Mondoux [(1,2)], [1]Laboratoire de Sciences de la Terre, Université Lyon 1 & ENS-Lyon, 2 rue R. Dubois, 69622 Villeurbanne cedex, France, [2]UMR 5562/CNRS/ Toulouse III University, Midi-Pyrenees Observatory, 14 Av. E. Belin, 31400 Toulouse, France, Baratoux@dtp.obs-mip.fr pascal.allemand@univ-lyon1.fr

Introduction: Thaumasia area is located south of the Tharsis dome. This 2000 km by 1000 km region is affected by an intense tectonics (both compressive and extensive) which has been mapped and studied these last years [1, 2, 3] from old Viking data and recent MGS and Mars Express data. This region has a key position to understand both Tharsis development and individual martian faults. The faults affect numerous impact craters. The purpose of this paper is to show relationships between the deformation produced by the faults and the ellipicity of impact craters as measured on HRSC (Mars Express data). Similar works on Viking images [4, 5] have been done in order to discuss the possible discrepancy between between extension measured by faults and extension estimated from impact craters.

Data set and data processing: The High-Resolution Stereo Camera, onboard Mars Express allows the derivation of orthorectified images of the surface of Mars at a resolution up to 12 meters/pixel. This data set is particularly adapted to high-precision geometric measurements of geological features. 5 nadir images orthorectified with HRSC DEM (486, 497, 508, 530, and 563) have been selected over the Thaumasia region. Rim of about 120 impact craters with diameters ranging from 2 to 66 km have been pointed manually. Geographic coordinates of these rim points have been fitted to an ellipse using a non-linear least squares method. The center, the semi-minor axis, the semi-major axis and the azimuth of the semi-major axis are determined as well as their associated uncertainties given residuals. We found errors of about 0.1 – 1% associated with the lengths of ellipse axis. Both faulted craters and fresh morphologies have been selected in order to compare and validate the results obtained on craters expected to be affected by the tectonic deformation.

Results and discussion:.120 craters have been investigated. For each, it has been measured the position, the size and orientation of the major (Fig. 1) and minor axis of the best fitting ellipse, the number of faults and their average orientation. The ratio between the difference of minor-axis length and the major-axis length (strain value if the crater is deformed) ranges from 0.02 to 0.25. Small craters not affected by faults present the extreme values. From the 120 craters, 31 are affected by more than one fault. The major axis of the ellipse which fits the crater (fig. 2) is perpendicular to faults within 10°. That demonstrates that deformation by fault is responsible for the crater ellipticity. Average residuals (deviations between ellipse fit and measured locations of the rim points) up to 10 – 20 pixels are common suggesting significant amount of erosion/degradation of some crater rims assuming perfect circular or elliptical shapes are initially produced by an impact. Examination of crater morphologies indicates that erosion, generally landslides (Fig. 3), have affected some craters in an asymmetric manner. These craters whose ellipticity may be attributed to erosional factors are not considered for tectonic purposes. Moreover, the shape of such craters departs significantly from a true elliptical shape.

The amount of displacement on extensive normal faults can be estimated from the difference between the major and minor axis of the 31 craters defined above. The ratio between difference in axis length and the number of faults (displacement per fault) (Fig. 4) has two kinds of values. For the 60% of craters, the displacements range from 100 to 250m. For the other, the displacement is more important with values ranging from 300 to 900m. Two observations can be made for these high displacement fault craters. Some of them are affected by superficial mass movements of the rim perpendicular to the faults. Some others are filled by lava or sedimentary products (Fig. 5). In that case, faults probably exist under the crater infilling. Sometimes, these faults are visible on the rim of the crater. In that case, the crater has undergone at least two episodes of deformation.

The amount of vertical displacement can be estimated from the range of horizontal displacement. If the extension faults have a dip of around 60°, the vertical displacement ranges from 100*tan60 to 200*tan60 that is 170 to 340 m. These values seem actually larger by at least 100m than the values measured on MOLA data.

References: [1] Dohm, J. M., and K. L. Tanaka (1999), Planet. Space Sci., 47, 411– 431.[2] Dohm, J. M., K. L. Tanaka, and T. M. Hare (2001), U.S. Geol. Suvr. Geol. Invest. Ser., Map I-2650. [3] Hauber, E and Kronberg P., (2005) vol. 110, E07003, doi: 10.1029/2005JE002407. [4] Thomas and Allemand (1993) Jour. Geophys. Res. Vol 98, 13,097-13,108 [5] Golombek, M.P., Tanaka, K.L., and Franklin, B.J. (1996), Jour. Geophys. Res, vol. 1001 E11, 26,119-26,130.

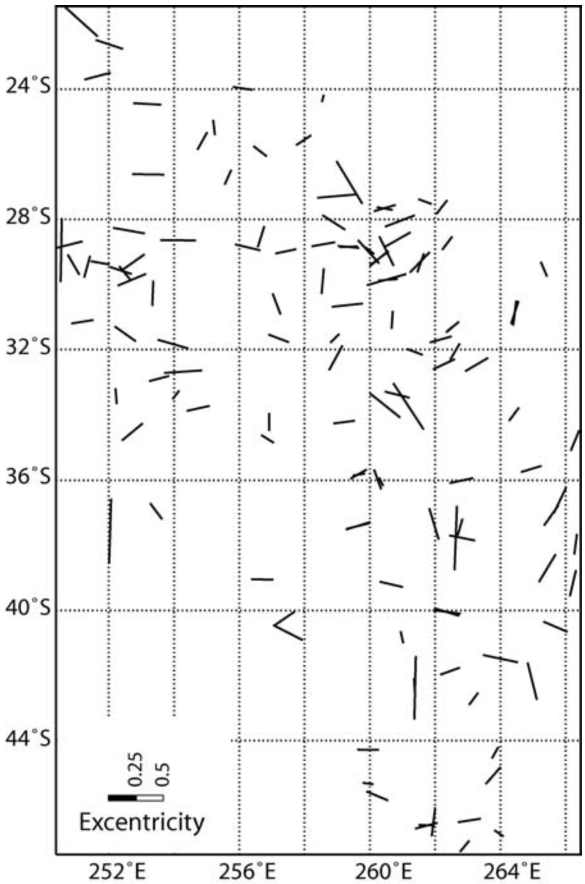

Figure 1: Eccentricity and orientation of major axis of 120 craters located in Thaumasia. The length of the axis reflects the difference between major and minor axis.

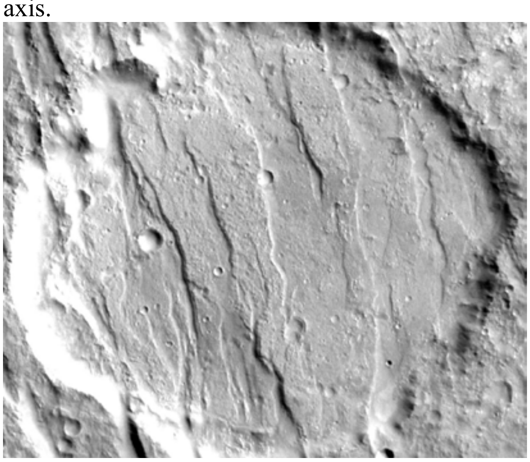

Figure 2: Crater located at 260.554°long and -29.860°lat, visible on HRSC image 508. The major axis is oriented N80 and is 27 km long.

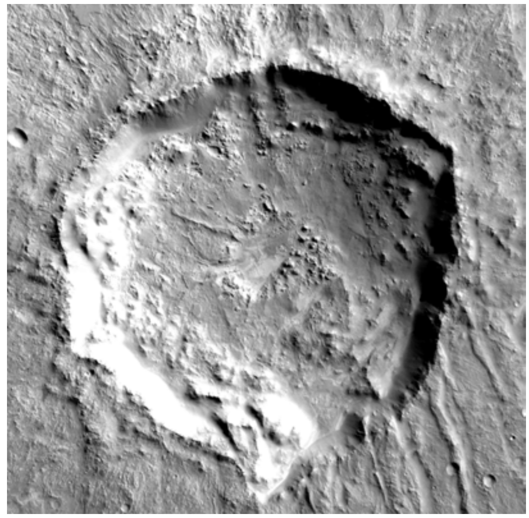

Figure 3: Elliptic crater non affected by faults but affected by superficial mass movements. Image HRSC 508. 260.683 long 31.092 lat**.**

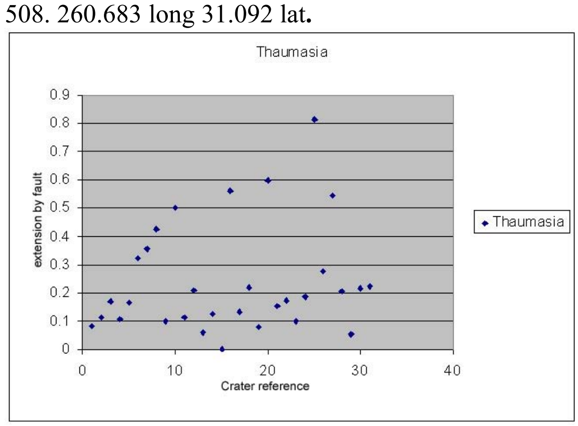

Figure 4: amount of extension by faults on the 31craters affected by more than one fault.

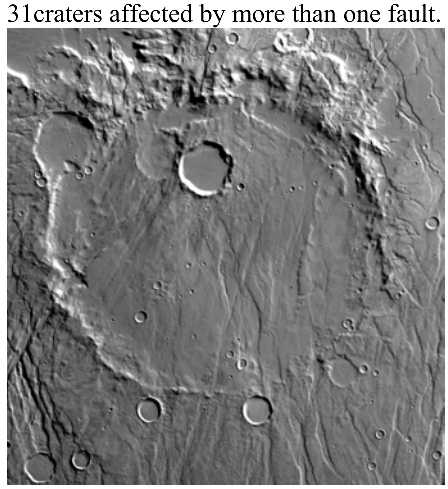

Figure 5: Crater located at 262.827°long and -37.775° lat, visible on HRSC image 497. Crater diameter is 45km. The crater is filled by lavas. Old deformation phases are visible on the South western part of the image.