MARTIAN FLOOR-FRACTURED CRATERS VS. CRATERS WITH IRREGULAR DEPRESSIONS. J. Korteniemi[1], M. Aittola[1], H. Lahtela[1], T. Öhman[2] and J. Raitala[1], [1]Dept. of Physical Sciences, P.O. Box 3000, FI-90014 University of Oulu, Finland, <jarmo.korteniemi@oulu.fi>, [2] Geosciences, Univ. of Oulu, Finland.

Introduction: Mars has ~43000 recognized >5 km impact craters [1,2]. They exhibit a wide range of interior morphologies, e.g. central peaks, multiple rings [3,4], central pits [5-7], flat floors, fractured floors (henceforth "FFs", Figs. 1a and c) [8-11] and irregular pits and depressions ("IDs", Fig. 1d) [10-14].

The central pits occur in 28% of all craters [7] and are intimately connected to the special volatile conditions at the time of crater formation [5,6]. The floor filling and flattening as well as the creation of FFs and IDs are caused by processes, which only use the impact structure as an easy access outlet [e.g. 8,9,11].

This study categorizes some of the post-impact crater floor deformations, and is intended to provide preliminary means to begin recognizing the processes, which take advantage of the impact crater structure. Our aim is to get in touch with deep-lain and otherwise undetectable processes, which tell of the special subsurface environment(s) in various places on Mars.

Floor-fractured craters: Several FF-craters were identified on the Moon [8] and Mars [8,9], exhibiting radial/concentric cracks cutting the impact structure floor. Additional nine were recognized on Venus [15] as well as two possible candidates on Earth [16,17].

Distribution: On Mars, the FFCs (Fig. 2 (yellow)) occur in Arabia Terra near the dichotomy boundary, and at the mouth of outflow channels in the Xanthe - Margaritifer Terrae region [8,10]. The boundary region chaotic terrains are closely linked to ancient water removal (and magma interactions with ice) [18].

Origin: The FF formation has been attributed to laccolith intrusions [e.g. 8,9] rather than viscous relaxation [19,20]. In the intrusion model magmatic injections penetrate into the deeply fractured underneath the crater. A small magma chamber is created below the crater, the crater floor swells and begins to crack, with tilting and rising surface blocks. On Mars the fracturing can be more intense than on the Moon, probably enhanced by heating, expansion and removal of volatiles [9]. This creates chaotic crater floors often connected to outflow channels (Figs. 1b, 2 (red)), seen as a clear continuation from the FFCs [21].

Irregular pits: ID-craters (Fig. 2 (blue)) occur in specific places on Mars [9-12]. ID size is mostly small compared to the crater, and they have often layered walls, revealing the sedimentary origin of the surrounding materials. Some ID walls are straight, either 1) radial/concentric to the parent crater, or 2) parallel to each other within a cluster of ID-craters [22]. This may indicate that there is some crater-related or even regional control over the ID formation.

Distribution: ID-craters (Fig. 2 (blue)) occur in two dense clusters on Mars, 1) on Arabia Terra and 2) in the Hellas-Argyre region. There is no major difference between the two population morphologies. At least the Arabia population is closely linked to FFs: They occur in the same regions but at their outskirts. They may also gradually exhibit more and more FF features whilst coming closer to the central region.

Preliminary ongoing studies with HRSC data have also revealed the existence of a few FF-craters in the Hellas region [23]. This is the first time FFs were found away from the dichotomy or areas of strong tectonic deformations, and may reveal that there is a connection between the Hellas region IDs and FFs.

Conclusions: Arabia Terra craters with chaotic interiors, FFs and IDs are located in similar areas and gradually transform into each other. This indicates that the processes forming them are similar, and the transformations may be due to the changing process intensity, or e.g. the covering sediment load thickness.

The second distinct cluster of IDs, and the newly found FF-craters in the Hellas-Argyre region hint also towards a similar deformation source. This is perhaps further an indication of analogous characteristics of the subsurface and/or surface processes between the dichotomy boundary and Hellas-Argyre region.

At this stage, it appears that the IDs are probably pre-stages of FFs. At the very least they tip off some of the primal regional properties of the subsurface.

Open questions and future work: The process(es) creating crater floor depressions are still rather ambiguous, and further research is needed. What controls the formation of irregular pits? How do the Hellas and Argyre basins effect the local subsurface? Case studies and closer analysis of the relationships between depressions in smaller example regions are required.

The catalogue of Martian crater floor depressions will be put available online from the Univ. of Oulu planetology group website during spring 2006 [http://www.oulu.fi/astronomy/planetology/].

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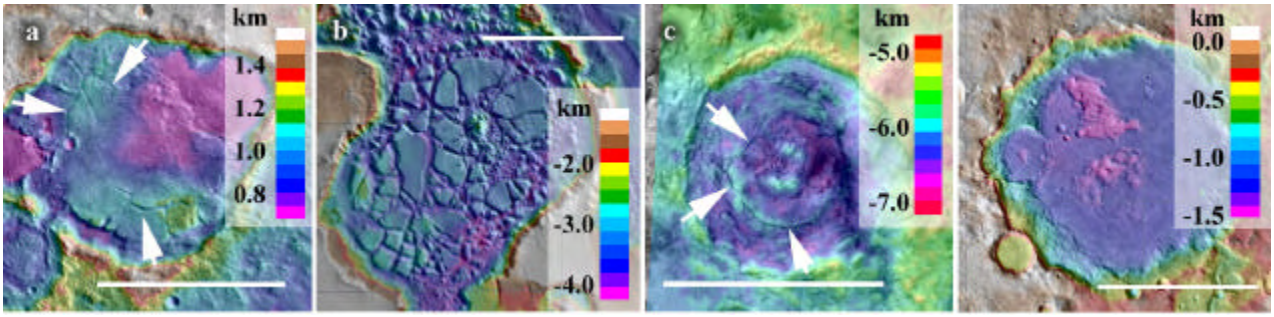

Figure 1. Crater floor depression examples. a. Crater (16.0°N/56.2°E) with a fractured floor. b. Chaotically fractured craters (2.8°N/331.4°E). c. Fractured floor crater on the Hellas basin floor (-36.7°N/81.3°E; HRSC orbit 47; modified from [23]). d. Typical crater with irregular depressions (20.8°N/39.0°E). Scale bars are 50 km long. In a and c the fractures (arrows) occur on elevated parts of the floor. Figs. a,b and d from Viking MDIM2. MOLA DTM color overlay.

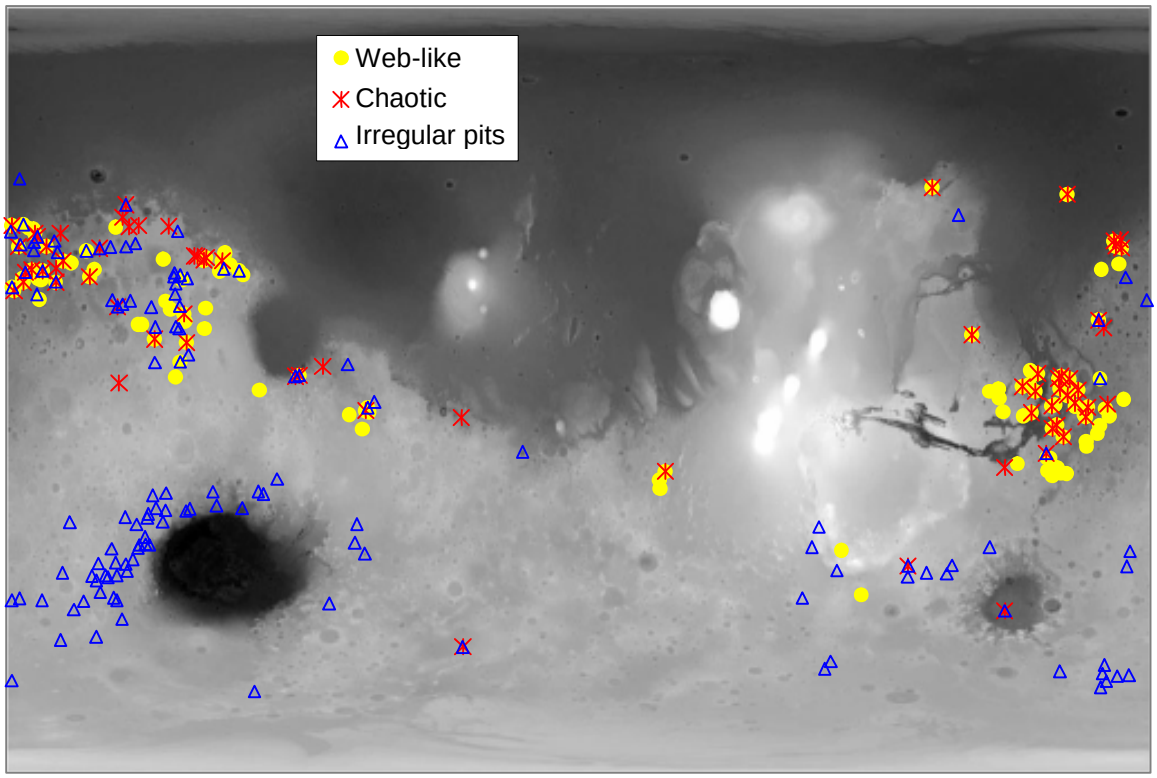

Figure 2. Distribution of impact crater floors with 1) web-like radial and/or concentric fracture patterns (yellow), 2) well-developed fractures causing chaotic terrains (red) and 3) irregular depressions (blue). All coincide in Arabia Terra, with the web- and chaotic floored craters additionally occupying Xanthe-Margaritifer Terrae region. The irregular depressions form a regional cluster aroung Hellas and Argyre basins, which is separate from all others.