DEVELOPMENT OF AN UNUSUAL CRATER IN ARABIA TERRA, MARS H. Lahtela[1,2], C. Popa[2], J. Korteniemi[1], G. Di Achille[2], G. G. Ori[2], G. Neukum[3] and the HRSC Co-Invesigator Team. [1]Division of Astronomy, Dept. of Physical Sciences, P.O.Box 3000, 90014 University of Oulu, Finland (hlahtela@student.oulu.fi), [2]IRSPS, Universita d'Annunzio, Pescara, Italy, [3]Institute of Geosciences, Freie Universität Berlin, Germany.

Introduction: This still undergoing study discusses the characteristics and evolution of a crater located near the dichotomy boundary in Arabia Terra (36,0Nº/351,8Eº). The crater has a diameter of roughly 25 km and it has undergone several different evolutional phases, which have shaped its appearance (Fig. 1A). Three distinctive different terrain units characterize its floor; relatively smooth terrain, surface cracked by severe fissuring and a low albedo depression with a central bulge (Fig. 1B). Additionally, there are two fluvial channels entering the crater. Together all these units tell us about intense crater floor deformation. We suggest that this has been done by a mixture of aeolian, fluvial with possibly volcanic and lacustrine processes.

The Surroundings: The crater is located near the dichotomy boundary, in an area characterized both by the northern lowlands and the southern highlands. The origin of the boundary is still unknown, but various features speak on behalf of combined fluvial and volcanic deformation of the area [e.g. 1, 2]. There are numerous studies on the dissected crater-like features near the boundary [e.g. 1, 3], often associated with volcanism and hydrothermal environments inside craters. In the regional geologic map [2], made using Mariner 9 and Viking images, dark material inside this crater as well as in other locations was interpreted to be of aeolian origin. Same conclusion has been made also after studying the latest datasets [e.g. 4, 5, 6]. The crater itself is of Noachian age, and degraded, with no apparent rim or traceable ejecta field remnants.

The Water Environment: The crater's two inflow channels are quite small. Their short and stubby appearances indicate forming by sapping processes. However, there is a fresh impact crater (dash line in Fig. 1A), which superposes the eastern channel Its ejecta blanket may have covered the channel's connection to a much larger channel just a few km away. (black arrows in Fig. 1A show connections with possibly buried channel). However the amount of water entering the crater is still unclear and no crucial evidence of past lacustrine environment has been found.

Smooth floor: The western part of the crater is characterized by rather smooth and 'normal looking' floor material, i.e. sedimentary materials accumulated and partly eroded after the crater formation. Just next to the rims there are indications of mass wasting deposits on the floor surface.

Cracked terrain and the eastern depression: The inner crater floor has undergone intense fracturing (Fig. 1C). Especially the western part of the

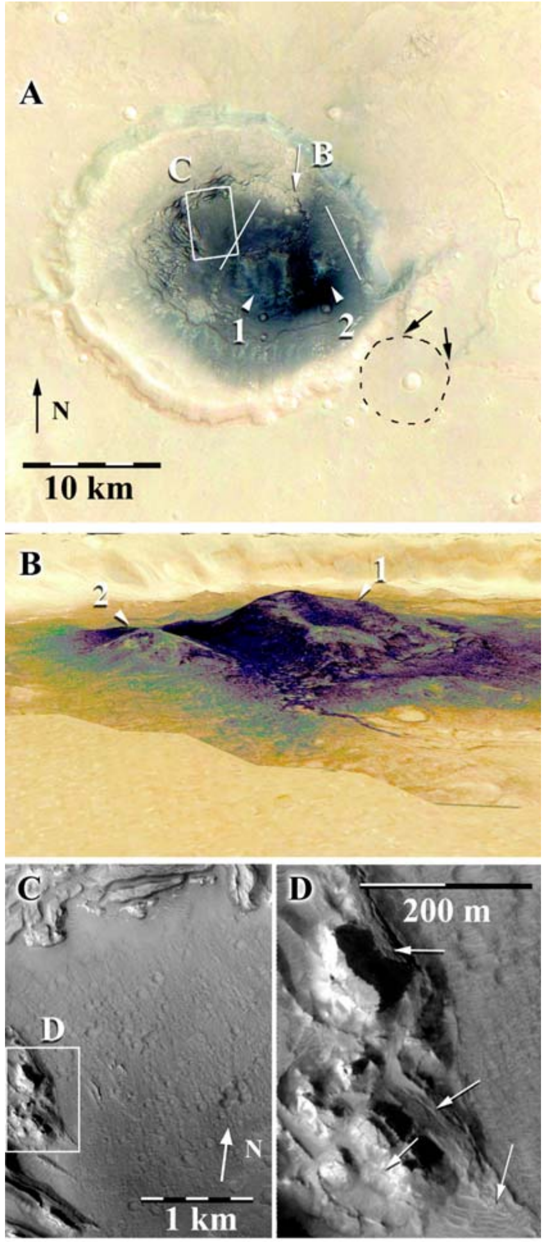

Figure 1: (A) Studied crater (A h1205) in Arabia Terra (HRSC orbit h1205 false-color image). Several processes have contributed to its evolution result is a crater with two inlet channels, low-albedo bulge (arrows 1&2, Fig. 1b) and partly dissect crater floor (rectangle in 1A, Fig. 1c). (B) A 3-D image of the dark bulge seen in the S-E part of the crater floor, clearly shows that it's composed of two separate peaks (arrows 1&2). The view is towards south (arrow B IN Fig. 1a). (C) The depression surrounding the bulge ends to partly fractured terrain (MOC M0403474). (D) Close-up shows layering (arrows) on the chaos remnants; the crater floor is apparently composed of layered sediments; layered sediments comprise the crater floor.

cracked terrain has a chaotic appearance, indicating collapse by very sudden removal of material from the subsurface. The central-eastern crater floor is about 50 m lower in elevation and significantly lower albedo than the smooth terrain. The contacts with the smooth crater floor reveal distinct layering (Fig. 1D).

The Bulge: The central area of the depression exhibits two separate prominent bulges. The western (Fig 1B, arrow 1) is clearly more massive: it rises 300 m above the depressed area floor and has a total volume of 6 km^3, while the smaller (Fig 1B, arrow 2) is 70 m high with a volume of 400 m^3. Even though the bulges lie in the depression, they clearly reach higher than all the rest of the crater floor.

The surface material of the bulge and the surrounding depression differs from surrounding materials both in composition and morphology. They have a very low albedo. The darkest part lies in the S-E part of the depression, from where the color diffuses outwards into brighter tones. The dark deposits on Mars are often connected with mafic/ultramafic dust/sand, most probably originating from volcanic sources [e.g. 7,8,9 and the references therein]. If the albedo would be caused by aeolian accumulation of this dust, it should follow the topography and cover mostly the lower parts of the crater. Instead, it covers the huge bulge with ease, indicating that it is closely linked to the characteristics of the bulge itself.

One hypothesis is that he bulge would be the central peak of the crater. However, for that purpose it is extremely large and situated quite far from the crater center for this to be a reasonable explanation.

Instead, we suggest that the bulge is of endogenic origin, built up by a volcanic plume coming near the surface. Volcanic extrusion would also help to understand the intense dissecting of the rest of the crater floor [see e.g. 1, 3, 10]. There have been also other studies from the near by areas concluding that there has been volcanic activity which have built small-scale edifices [e.g. 11].

Mineralogy: A mineralogical survey of the studied area will discriminate between the different units in the crater. Currently, three IR datasets are available: *1)* multispectral THEMIS high-res thermal infrared (TIR) (resolution ~100 m/pixel), *2)* hyperspectral low-res TES dataset (resolution 3x8 km/pixel; covering TIR part of spectra; suitable for mafic silicate mineral identification) and *3)* hyperspectral OMEGA dataset (300 m/pixel at periapsis, covering the near-IR part of the spectrum; suitable for evaporite mineral identification).

Unfortunately the datasets have some shortcomings. TES data has a too small pixel resolution, and it is thus not able to solve small-scale features. Additionally, the OMEGA data covering the target area has not been released to the public yet.

While examining TES spectra, only the usual clay mineral signatures could be proven. The presence of montmorillonite fit rather well to TES spectra. The results from current spectral datasets do not help solving such small scale features (Fig. 2).

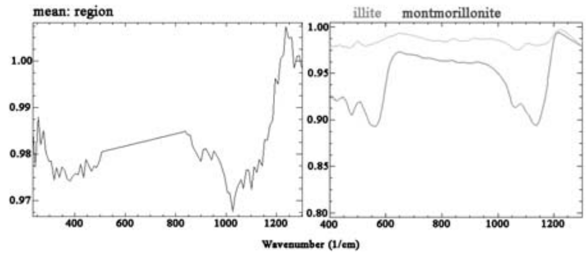

Figure 2: Spectral response of TES covering the target area (left) compared to laboratory spectra of illite and montmorilonite (right), two possible candidates for major components in the area. Of these montmorilonite fits better to TES result.

Conclusions: The hypothesis that the bulge is of volcanic origin, related to the endogenic activity of the dichotomy boundary area, seems plausible at this stage of studies. The fractured texture was probably formed due to the rising of the bulge and/or by the same forces, which caused it. There may have been volatile-rich sediments on the crater floor brought by the fluvial channels. Their sudden removal by heating and subsequent evaporation would easily account for the chaotic nature of the cracks.

Future studies: This study is still in its early phases. The major guidelines for the future research are more detailed analysis of the crater's characteristics with wider areal mapping to identify which of them are due to local phenomena and which part of large-scale the regional evolution. In addition, future higher resolution spectral image systems such as the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard the Mars Reconnaissance Orbiter (MRO) could solve the small-scale mineralogical characteristics of the terrain units and confirm or infirm out hypotheses.

Acknowledgements: We would like to recognize Vilho, Yrjö and Kalle Väisälä Foundation for funding and IRSPS for facilities for the research.

References: [1] Schultz, P.H. & D.L. Orphal (1978), *Meteoritics,* 13, 622-625. [2] Witbeck, N.E. & J.R.Jr Underwood (1984), *USGS* Misc. Inv. Geol. Map I-1614. [3] H.E. Newsom (2001), *LPSC* 32 #1402. [4] Fergason, R.L. & P.R. Christensen (2004), LPSC 35 #1710. [5] Wyatt, M.B. et al. (2003), LPSC 34 #2009. [6] Edgett, K.S. (2002) *JGR, 105,* 1623–1650. [7] Zimbelman, J.R. (1988) *NASA MEVTV*: Volc. On Mars, 19-21. [8] Edgett and Christensen (1994) *JGR*, 99, E1, 1997-2018. [9] Ruff, S.W. & P.R. Christensen (2002) *JGR*, 107 E12, 5127. [10] Wichman, R.W. & P.H. Schultz (1995) *JGR, 100,* 3233-3244. [11] Ferrand, W.H. Et al. (2005) *JGR, 110,* E05005.