ANCIENT FLUID ESCAPE AND CONICAL MOUND FIELDS IN FIRSOFF CRATER, ARABIA TERRA (MARS).
F. Franchi[1], A. P. Rossi[2], M. Pondrelli[3], R. Barbieri[1], Dipartimento di Scienze della Terra e Geologico Ambientali, Università di Bologna, via Zamboni 67, 40129 Bologna, Italy (fulvio.franchi2@unibo.it). [2]Jacobs University, Bremen, Germany. [3]IRSPS, Università D'Annunzio, Pescara, Italy.

Introduction: Martian conical mounds within potential spring deposits are of considerable interest for their supposed relationship with water and high potential of microbial signatures preservation. These characteristics make Martian mounds attractive targets for future missions with astrobiological purposes.

In this study we report the occurrence of a mounds field in the southern Arabia Terra (Fig. 1) and present data from the Firsoff crater and its neighborhood where the mounds are exposed within the Equatorial Layered Deposits (ELDs). For these mounds, with a supposed hydrothermal-related origin [1], a geomorphological mapping has been performed on the remote sensing dataset.

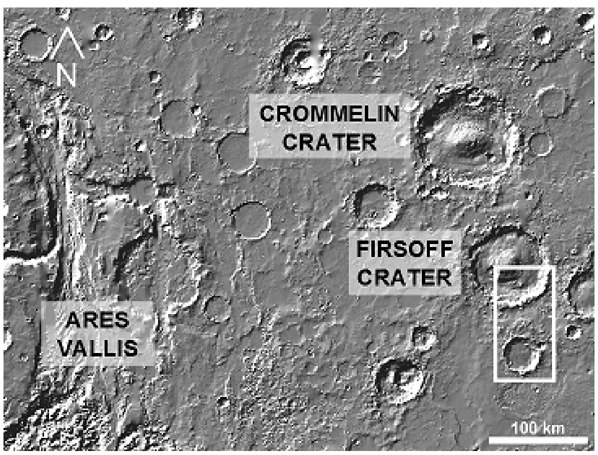

Figure 1. *Map of the studied area (MOLA based shaded relief). In the white box the study area with mounds fields within the ELDs.*

Geological Setting: The Firsoff impact crater is located in the equatorial southern highlands of Arabia Terra centered at 2.6°N – 350.8°E.

The exhumed succession in the Firsoff area begins with the *Noachian Cratered Unit* [2]. These mainly volcanoclastic deposits are non-conformably overlapped by the ELDs [1, 3, 4] on top of which mounds and spring structures always occur. Then the unit named *Hummocky Material* unconformably overlies the succession ending in a draping flood basalt (*Hesperian)* [2]. If the lower boundary is represented by the Noachian Plateau Sequence the flood basalt represents the upper constrain for the ELDs, which are limited within the upper part of the Noachian [1]. The upper Noachian ELDs unit, composed by light rocks showing a polygonal pattern described elsewhere on Mars [5], is characterized by a high sinuosity of the strata that locally follows a concentric trend informally called "pool and rim" structures (Fig. 2A).

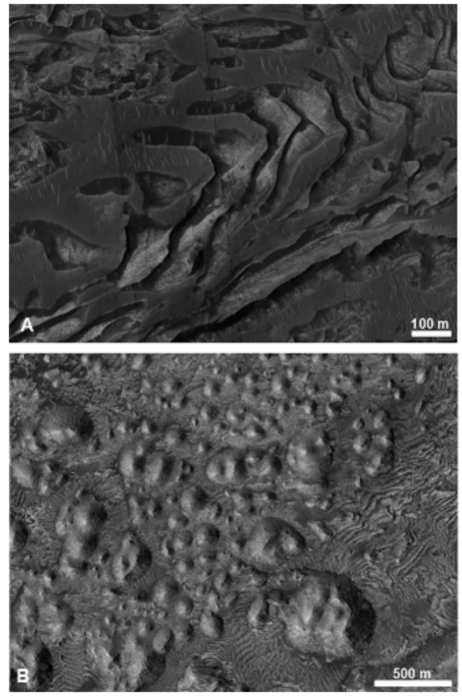

Figure 2. *A) ELDs strata showing the typical "pool and rim" pattern in the Crommelin crater (Hirise PSP_002021_1850). B) Mound field in the southeastern sector of the Firsoff crater (Hirise ESP_020679_1820).*

Firsoff crater mounds. In the southern part of the Firsoff crater the density of the buildups, in width ranging from 500 meters to 20 meters, reaches the value of 20 mounds per square km (Fig. 2B).

Most of the buildups have an asymmetrical shape, with the down-slope flank that is always steeper than the up-slope one. Many of these mounds have an orifice and sometimes fractures and dikes that branch out from the buildups (Fig. 3A). The apical orifice is a common characteristic for these Martian mounds and is attributed to combinations of volcanic and hydrothermal genetic factors [6]. A mound characterized by rounded apical orifice and interpreted as a spring mound was described within ELDs equivalent sediments in the Vernal Crater, 300 km from Crommelin crater [7].

Starting from a detailed DEM, derived from HiRISE stereo data [e.g. 8], it was inferred that the strata are significantly folded under the buildups and in the mounds neighborhoods (Fig. 3B). Where the inner facies of the mounds are exposed it is clear that the ELDs strata form an anticline sometimes draping the positive morphology.

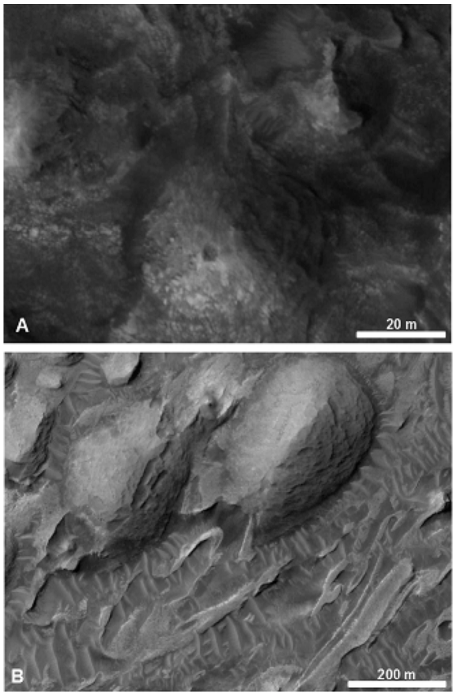

Figure 3. *A) Mound settled on top of a fracture or vein showing a well rounded apical hole (Hirise PSP_003788_1820). B) Folded strata below a mound south of Firsoff crater (Hirise ESP_016776_1810).*

The exceptional exposition of the strata in the crater south of Firsoff permits the reconstruction of the mutual relationship between ELDs and mounds. In this crater the mounds alignment seems to be more influenced by the local tectonics than in the Firsoff crater. The mounds developed along kilometers long fractures (Fig. 4A) are connected with the “pool and rim” structures via veins and conduits that cut across the ELDs strata boundaries (Fig. 4B).

Discussion: The analysis indicates that the Firsoff mounds do not show internal horizontal stratification, this precludes their origin as simple erosional remnants. After having excluded a weathering related origin, as well as a wind transport/erosion for the absence of alignment of the mounds with the main wind direction (yardangs), we consider fluids seepage and associated deposition as a viable genetic mechanism. The pervasive veins and fractures that cut across the ELDs could have acted as a main way for fluids seepage. As shown in figure 4B, there is a clear relationship between mounds buildups, “pool and rim” structures and fractures. Furthermore, the folded strata under the buildups may have been affected by radial cleavages able to create many preferential ways for the fluids circulation.

Approaching the problem from another point of view, is it likely that the abrupt shape of these mounds may have preserved only by early cementation processes. As observed on Earth, the early lithification and pristine cementation can strongly related to seepage and fluid circulation.

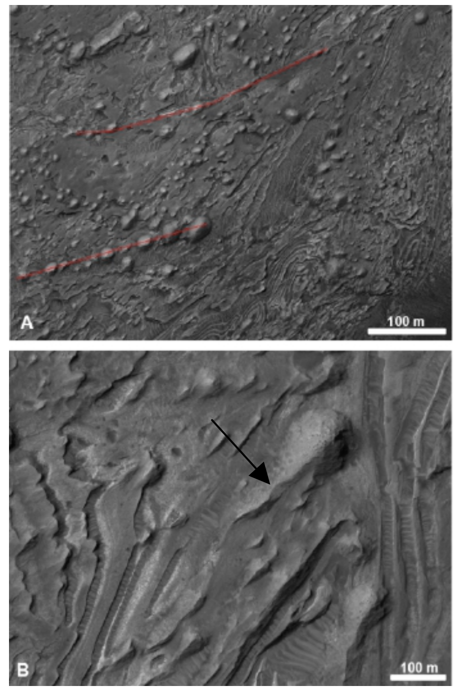

Figure 4. *A) Southern sector of the crater south of Firsoff. Red lines mark two major faults on top of which mounds developed. B) Solitary mound linked with the ELDs “pool and rim” structures by a fracture (black arrow). (Hirise ESP_016776_1810)*

Acknowledgements: This research is part of FF PhD project financially supported by the MIUR-PRIN program “Comparative geomicrobiology of the mounds in the Moroccan Sahara: implications for Mars astrobiology” (to RB).

References: [1] Pondrelli M. et al. (2011), *EPSL* 304 (3-4), 511-519. [2] Scott D. and Tanaka K. (1986) *US Geol. Surv. Misc. Invest. Ser.*, Map I-1802-A. [3] Hynek B. M. et al. (2002) *JGR.* 107, 11–18. [4] Malin M. and Edgett K. (2000) *Science* 290, 1927. [5] Levy J. et al. (2009). *JGR,*114, E01007. [6] Farrand W.H.(2005), *JGR* 110 doi:10.1029/2004JE002297. [7] Allen C. C. Oehler D. Z. (2008), *Astrobiology* 8 (6), 1093–1112. [8] Moratto, Z. et al. (2010) XVI LPSC, #2364