EPSC Abstracts
Vol. 7 EPSC2012-132-3 2012
European Planetary Science Congress 2012

Ancient fluid escape and related features in equatorial Arabia Terra (Mars)

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Abstract

Arabia Terra, in the equatorial region of Mars, is long-time studied area especially for the abundance of fluid related features. Detailed stratigraphic and morphological study of the succession exposed in the Crommelin and Firsoff craters evidenced the occurrences of flow structures and spring deposits that endorse the presence of fluids circulation in the Late Noachian. All the morphologies in these two proto-basins occur within the Equatorial Layered Deposits (ELDs).

1. Introduction

Martian layered spring deposits are of considerable interest for their supposed relationship with water and high potential of microbial signatures preservation. Their supposed fluid-related origin [1] makes the Equatorial Layered Deposits attractive targets for future missions with astrobiological purposes. In this study we report the occurrence of mounds fields and flow structures in Firsoff and Crommelin craters and summarize the result of a detailed study of the remote-sensing data sets available in this region.

2. Geological setting

The Crommelin and Firsoff impact craters are located in the equatorial southern lowlands of Arabia Terra respectively centered at 4,9° N – 349,5°E and 2,6°N – 350,8°E. The exhumed succession in the area begins with the Noachian *Cratered Unit* [2] unconformably overlapped by the ELDs [1, 3] on top of which mounds and spring structures always occur. Then the unit named *Hummocky Material* unconformably overlies the succession ending with the draping flood basalt (Hesperian*)* [2]. If the lower boundary is represented by the Noachian sequence the flood basalt represents the upper constrain for the ELDs, which are limited within the upper part of the Noachian [1]. The ELDs are composed by light rocks showing a polygonal pattern, described elsewhere on Mars [4], and is characterized by a high sinuosity of the strata that locally follows a concentric trend informally called "pool and rim" structures (Fig. 1A).

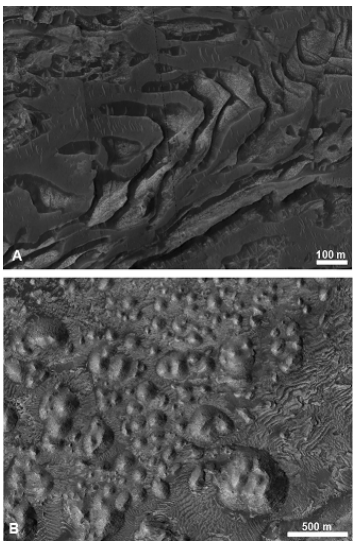

Figure 1. A) ELDs "pool and rim" pattern in the Crommelin crater (Hirise PSP_002021_1850). B) Mounds in the Firsoff crater (Hirise ESP_020679_1820).

3. Fluid related structures

In the studied area we considered as fluid-related morphologies the "flow channels" and the conical mounds. The spectacular "flow channel" in the Crommelin crater follow a radial pattern from the central bulge. The direction of the "flow channels" never coincides with the maximum dip of the bulge escarpment and evidences of landslides or debris flows are lacking. Each channel has symmetric levees and an u-shape morphology (Fig. 2) and terminates into the "pool and rim" structures. "Flow

channels" are lacking in the Firsoff crater which is characterized by abundant conical mounds. In the southern part of the crater the density of the buildups reaches the value of 20 mounds per square km (Fig. 1B). Most of the buildups have an asymmetrical shape and many of them have an orifice and sometimes fractures and dikes that branch out from the base. The apical orifice is a common characteristic for these Martian mounds and is attributed to combinations of volcanic and hydrothermal genetic factors [5]. Mound characterized by rounded apical orifice and interpreted as a spring mound were described within ELDs equivalent sediments in the Vernal Crater [6]. Starting from a detailed DEM, derived from HiRISE stereo data, it was inferred that the strata are significantly folded under the buildups and in the mounds neighborhoods. 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 and the mounds developed along kilometers long fractures and are connected with the "pool and rim" structures via veins and conduits that cut across the ELDs strata boundaries.

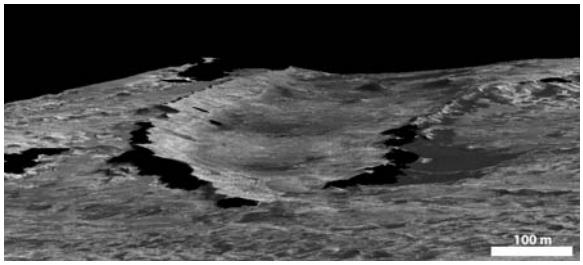

Figure 2. 3D view of a "flow channel" structure (HiRISE PSP_002021_1850).

4. Discussion

Imagines interpretations outlined a fluids circulation scenario in the Late Noachian Arabia Terra with the occurrence of "flow channels" and mounds in correspondence of layered strata with "pool and rims" structures, which resemble the terrestrial travertine pools. The "flow channels", connected with the "pool and rim" structures, could be preferential way for the superficial flow. Despite the conical mounds are in a different setting, their occurrences within the ELDs endorse the fluid escape scenario. Indeed, the mounds do not show internal horizontal stratification, this precludes their origin as simple erosional remnants. Furthermore a wind transport/erosion is excluded for the absence of alignment of the mounds with the main wind direction (yardangs). Hence 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. 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 be strongly related to seepage and fluid circulation.

Acknowledgements

This work 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).

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