SPRING MOUNDS AT SIDI EL HANI SALINE ENVIRONMENT, EASTERN TUNISIA: TERRESTRIAL ANALOG FOR MARS. E. Essefi[1,2], G. Komatsu[3], A. G. Fairén[4], H. Ben Jmaa[5,6], F. Rekhiss[1,7], C. Yaich[1,2]; [1]National Engineering School of Sfax, Road of Soukra, km 4; [2]RU: Sedimentary Dynamics and Environment (DSE); hocinsefi@yahoo.fr; [3]International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy; [4]SETI Institute & NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035. [5]Faculty of Arts and Humanities of Sfax; [6]Laboratory of Geomorphologic Cartography of Fields, Environments, and Dynamics; [7]Laboratory of Water Energy and Environment.

Introduction: The saline environment of Sidi El Hani, located in eastern Tunisia **(Fig. 1)**, may be considered as a potential analog to Mars [1] due to the existence of specific geologic features on its surface. Included are spring mounds that have been hypothesized to exist also on Mars surface. At Sidi El Hani, spring mounds originate due to hydraulic pressure, which in turn is derived from groundwater convergence and/or tectonic fractures [1, 2]. On Mars, the features interpreted to be spring mounds may have originated from an over-pressured subsurface or tectonic alignment [3]. The aim of this work is to show that the development of spring mounds in the Sidi El Hani discharge playa is a slow and continuous process, following successive stages. Similarly, the early evolution stages of spring mounds on Mars might have followed an analogous sequential process, rather than a rapid construction.

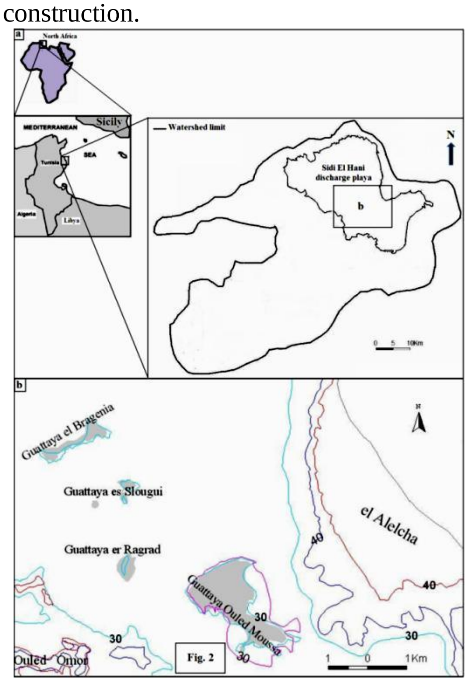

Fig.1. (a) Geographical location of the Sidi El Hani saline environment. (b) Locations of islets (Guattayas). The frame shows the locations of Fig. 2 and Figs. 3, 4, 5, 6.

Origin of spring mounds in the saline environment of Sidi El Hani: Along the saline environment of Sidi El Hani, spring mounds may be found in different stages, which we have named, in chronological order, *abortive*, *embryonic*, *child*, *mature* (adult), and *islet* (old) stages.

At the *abortive* stage **(Fig. 2)**, due to a weak hydraulic pressure, thousands of abortive spring mounds chaotically (randomly) form within the discharge playa. The majority of these spring mounds are aborted due to the absence of tectonic fractures, required to energize the hydraulic factor.

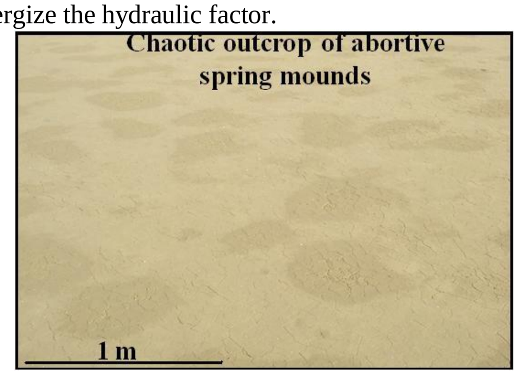

Fig. 2. *Abortive* stage of a spring mound; water convergence is stopped by an impermeable clayey layer.

At the *embryonic* stage **(Fig. 3)**, the tectonic activity enhances the formation of spring mounds along a preferential orientation.

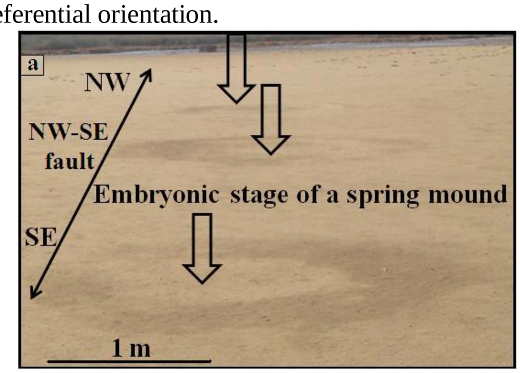

Fig. 3. *Embryonic* stage of spring mounds organized along a NW-SE fault.

At the core of this *embryo*, the precipitated travertine induces a reduction in sediment permeability. Consequently, water deviates toward the periphery **(Fig. 4)** and promotes the evolution of the *embryo* into a *child* spring mound.

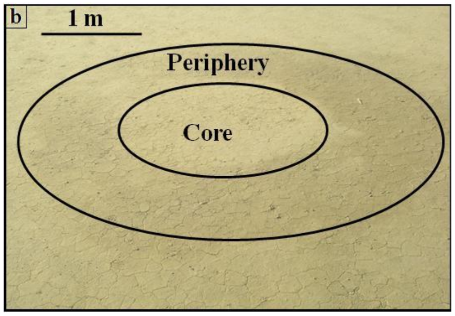

Fig. 4. As travertine precipitates in the core, water migrates towards the periphery.

At the *child* stage **(Fig. 5)**, simultaneous deposition of evaporites and eolian sediment is observed. Evaporitic minerals precipitate from the salty water outpouring from aquifers, while eolian sediments come from eolian deposits within the hydrological watershed of the Mechertate-Chrita-Sidi El Hani system [4]. These sediments are subsequently attached to the growing spring due to the humidity imposed by the nearby aquifer and the capillary fringe.

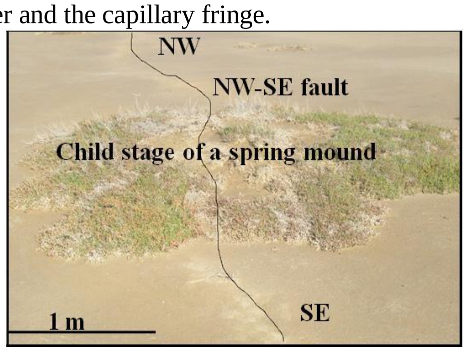

Fig. 5. *Child* stage of a spring mound is enhanced by a NW-SE fault.

At the *mature* stage **(Fig. 6)**, the spring mound is covered with eolian sediments, acting as an obstacle and collecting more eolian sediments. At this stage, the exogenous factor (eolian deposition) starts to counterbalance the endogenous factor (evaporite precipitation), hence allowing the development of halophyte vegetations.

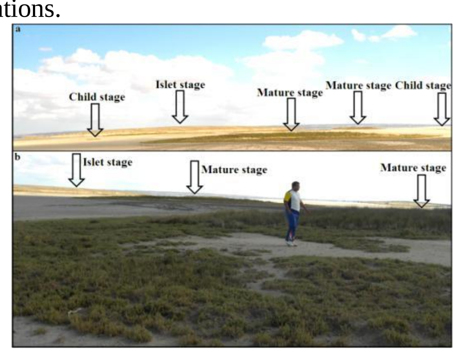

Fig. 6. *Child*, *mature* and *islet* stages of spring mounds.

At the *islet* stage, eolian deposition dominates the system, and the salty soil is completely buried. During field expeditions, we noticed that the fertile soil of these islets ('Guattaya') produces wheat. The inten- sive eolian sedimentation increases their sizes toward their current forms as distinctive bodies within the Sidi El Hani saline environment. All these islets are organ- ized along a NW-SE orientation (Fig. 1b).

Implications for martian studies: The formation of putative spring mounds on Mars may be originated by upward-water outpouring in an over-pressured subsurface [3]. A slow and continuous development, similar to that at Sidi El Hani, appears as a reasonable explanation for the origin of spring mounds on Mars [3], especially in the case of absence of geomorphologic evidence of paleo-channels **(Fig. 7)**. This possibility is reinforced by the fact that big conical features (possibly mature spring mounds) on Mars (e.g., Arabia Terra) [3] are aligned along preferential orientations, allowing them to reach a developed stage, and small conical features (possibly at the spring mound stages of embryo or child) are randomly distributed **(Fig. 7)**. These situations are compatible with what we observe at Sidi El Hani.

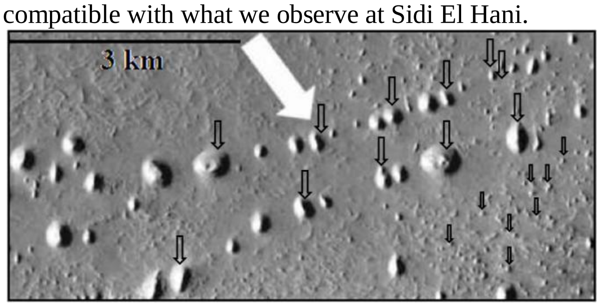

Fig. 7. Alignment of big conical features (big arrows) and chaotic distribution of small conical features (small arrows) in Arabia Terra, Mars [3; reinterpreted].

Conclusions and perspectives: The development of spring mounds within the saline environment of Sidi El Hani is a slow and continuous process, occurring along different stages. Similarly, the formation of some putative spring mounds on Mars may be explained by the same processes. We are currently working [e.g., 2] in relating the genesis of martian spring mounds and other features interpreted to be mud volcanoes with the tectonic activity and the hydrologic context of eastern Tunisia.

References: [1] Essefi, E. (2009) Master thesis. [2] Essefi, E., et al. work in progress. [3] Allen, C. C., and Oehler, D. Z. (2008) *Astrobiology*, *8*, doi: 10.1089/ast.2008.0239. [4] Ben Jmaa, H. (2008) Ph. D. thesis.