SEDIMENTARY VOLCANOES IN THE CROMMELIN CRATER AREA, MARS. M. Pondrelli[1], A. P. Rossi[2], G. G. Ori[1] and S. van Gasselt[3], [1]IRSPS, Università d'Annunzio, Pescara (Italy), (monica@irsps.unich.it), [2]ISSI, Bern (CH), [3]Freie Universität, Berlin (DE).

Introduction: Mound shaped morphologies are extremely common on the Martian surface and have been ascribed to very different geological processes such as volcanism, impact cratering, glacial, and periglacial. The possibility that sedimentary volcanism could have played a role in the formation of some of these features – in particular in Isidis Planitia - have been proposed already in Viking times [1, 2]. Thanks to higher resolution data coming from more recent missions, new evidences supporting the sedimentary volcanism hypothesis have been recently shown [3, 4, 5, 6, 7, 8].

Different possible processes responsible for the formation of different mound-like features have been discussed by [9].

We report here the discovery of possible sedimentary volcanoes located in many spots in the Crommelin crater surroundings (Fig. 1).

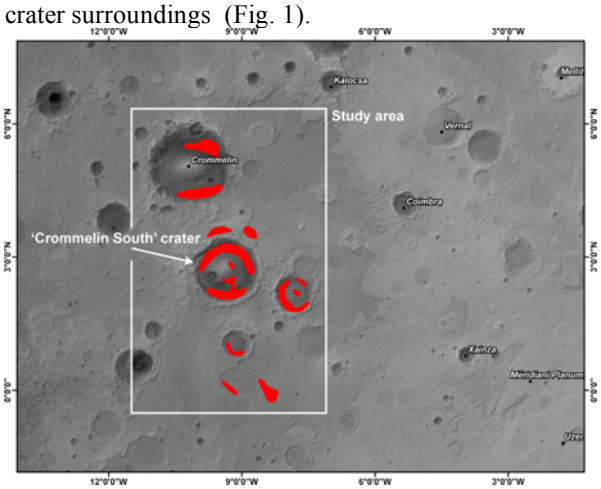

Fig. 1 - Location map of the study area. Areas with mounds occurrence are indicated in red.

Geological Setting: Conical mounds extend throughout a large area in correspondence of the Crommelin crater and its surroundings (bounding coordinates in decimal degrees: W=-12.12, E=-6.63, N=6.63, S=-1.48) (Fig. 1). We focus here on some examples from an unnamed crater located south of the Crommelin crater that we call informally 'Crommelin South' crater (Fig. 2).

The mounds are part of a stratigraphic succession starting with a substratum that consists of the Plateau Sequence (cratered unit) of Noachian age [10]. Equatorial Layered Deposits (ELD) crop out on top of the substratum forming bulges inside most of the craters, but also patches outside of the craters. The ELD consist of irregularly alternating dark and light tone deposits. The light layers show a festoon like layering, and are characterized by the extensive development of polygonal pattern. The mounds are locally associated with ELD and have been documented and mapped in the Crommelin South crater (Fig. 2).

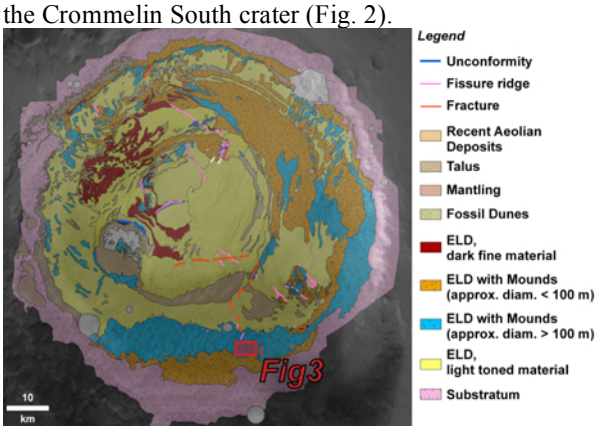

Fig. 2 - Schematic geologic map of the Crommelin South crater. The red box represents the location of Fig. 3.

Description: Fields of mounds are located preferentially along the outer floor and inner rim of the crater (Fig. 2) or are aligned along fractures. They include simple and coalescing complex mounds, both with and without central orifice (Fig. 3). Mapped candidate sedimentary volcanoes are distributed over an area with an altitude range between -2800 and -2600 m above aeroid, and with a slope of around 4 degrees over 5-km. Discovered mounds occupy a total area over a HiRISE scene of 5.9 km^2, representing about 10% of the total area imaged.

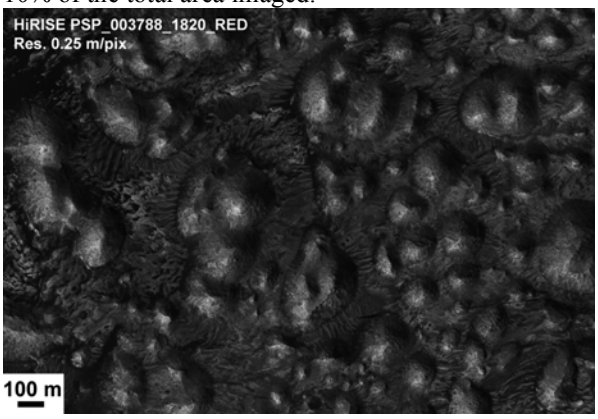

Fig. 3 – Field of mounds (see Fig. 2 for location).

Mounds width ranges in average between 100 and 300 m of diameter, but it can be slightly larger when coalescence occurs. Their height can be estimated around few tens of meters at most (but complex ones are likely larger). Only one MOLA PEDR profiles (11445) covers the mounds imaged in high resolution:

individual mounds not resolvable, but their envelope is consistent with a height range of few tens of meters at most.

Some mounds display a central orifice (Fig. 4) while others not. In the area imaged by HiRISE PSP_003788_1820 more than 250 mounds, between simple and coalescing, have been mapped and about the 50% possess the orifice. Orifices have small sizes, with an average area of about 170 m^2. The ratio between orifice, when visible, and mound areas is almost always less than 1%.

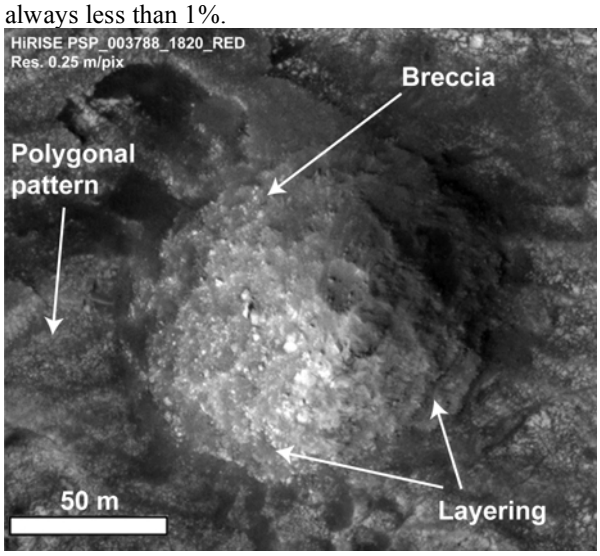

Fig. 4 – Simple mound showing a clearly expressed central orifice.

Mounds are layered with darker toned layers alternating with lighter toned ones (Fig. 5).

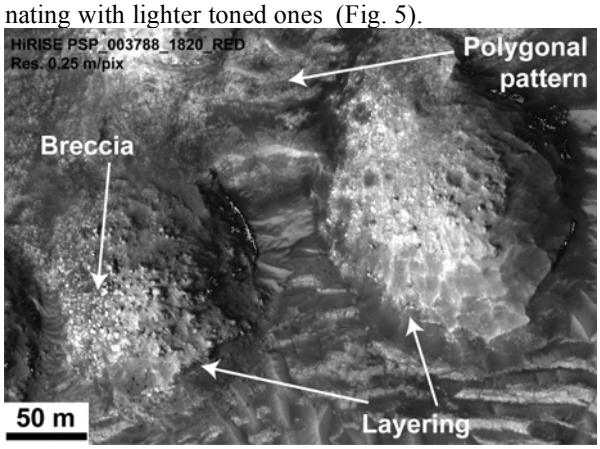

Fig. 5 – Mounds showing layering and breccia deposits. Example of preserved and not preserved orifice and variable erosion level.

The darker toned layers consist of finer material while the lighter toned ones consist of poorly sorted breccia either matrix or clast-supported (Figs. 4, 5). The mounds rest on top of the ELD layers and the material forming the breccia is identical to the one forming the light toned layers of the ELD, which allow to hypothesize that the breccia represents reworked bright ELD levels. The disruption of ELD lighter levels in polygons could have favored subsequent erosion and breccia formation.

Discussion: Mounds appear not to be remnants of a unit covering the present substrate. They consist in fact of different material (breccia layers are present only in correspondence of the mounds). Moreover, the presence of a central orifice is not consistent with a remnant unit. The central orifices could suggest a formation following cratering, but they occur in the topmost part of about the 50% of the mounds. Moreover, the filling of the crater is the same than the material of slope of the mound (Fig. 4) and they are of very similar size. It is unlikely the selective preservation of impact craters, only on the top of mounds and within the same size range.

The mound shape as well as the presence of an orifice could bear some resemblance with pingos, but layering, extensive brecciation and such a small extent (always on the order of 10% of the mound area) are strongly pointing against a pingo origin.

A volcanic origin also appears to be unlikely for the complete lack of unambiguous volcanic landforms and deposits associated, within the basin, such as lava flows or dykes. Moreover, the material forming the breccia seems identical to the ELD light toned layers one, and this is not consistent with a volcanic origin.

We propose that the mounds were formed as sedimentary volcanoes because of the general morphology, the distribution along fractures and the texture of the material. They would result from the emplacement of fluid-rich sediments moving upward due to overpressurization. Overpressure could have been related to endogenic processes or to overburden related to younger deposits (spring deposits? [11]).

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