MAARS ON MARS: POTENTIAL NICHES FOR EARLY MARTIAN LIFE. S. Rossato[1], M. Pajola[2], E. Baratti[3] [1]Geosciences Department, University of Padova, Via G. Gradenigo, 6, Padova, Italy - sandro.rossato@unipd.it, [2]NASA Ames Research Center, Moffett Field, CA 94035, USA - maurizio.pajola@nasa.gov, [3]School of Civil Engineering, Department DICAM, University of Bologna, Bologna, Italy - emanuele.baratti@unibo.it.

Introduction: Terrestrial maar-diatremes are small volcanoes characterized by craters whose floor lies below the pre-eruptive surface. They are surrounded by a tuff ejecta ring 2-5 km wide (Figure 1) that depends on the size of the maar itself and on the depth of the explosion forming them [1]. Maar-diatremes may form in response to the interaction between magma and underground/surface water, favoring explosions in otherwise quiet eruptions.

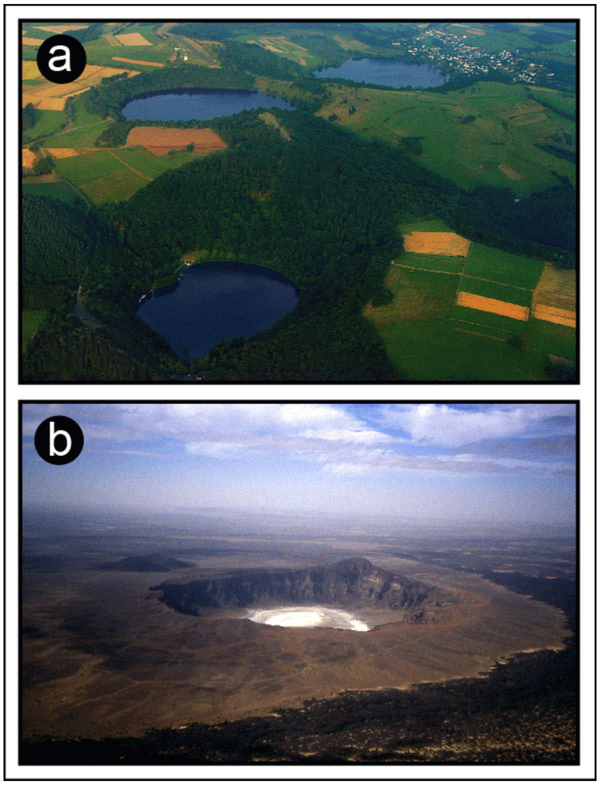

Figure 1: Terrestrial maars. (a) is a group of three maars filled with water in the Eifel region, Germany (rim-to-rim diameter ~0.5-1 km) ("Maare" by Martin Schildgen – Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons – https://commons.wikimedia.org/wiki/File:Maare.jpg#/media/File:Maare.jpg). (b) shows the Wabah maar, located in Saudi Arabia (rim-to-rim diameter ~2 km) (courtesy of Vic Camp, San Diego State University).

On Earth, the explosive eruptions that produce maar-diatremes can penetrate down to at least 2.2 km [2], bringing fragments of material originally located at different depths in the crust up to the surface, where it can be analyzed and sampled quite easily. After their genesis, many maar-diatreme structures host, or have hosted, long-lived lakes [3], due to their interaction with watery environments and to the elevation of the crater floor, often below the groundwater table. Post-eruptive lacustrine sediments hosting invaluable fossil records are commonly found inside the crater (e.g. the Messel pit UNESCO fossil site, Germany).

For such reasons, maars-diatremes constitute highly valuable sites for in situ investigations on Earth and planetary bodies as well, exposing subsurface rocks and being places which could preferentially preserve biomarkers.

Maars on Mars: on Mars examples of hydrovolcanism have been reported (e.g. [4]) but only in rare cases they have been ascribed to a maar-diatreme structure (e.g. in the Nephentes/Amenthes region, on the southern margin of Utopia Planitia). Maar-diatreme structures usually derive from multiple blasts that may alter the morphology of the landform, making their identification more difficult. On the contrary, those recently found in the Simud Vallis area (southern margin of Chryse Planitia; Figure 2; [5]) are morphologically very similar to some terrestrial analogs, presenting rounded to sub-rounded shapes and intact tuff rings with low inclination (<20°). Comparisons of the Simud Vallis maar-diatremes with laboratory experiments perfomed by [6], suggest that they originated from one, or at maximum two, blasts occurred at the optimal depth to maximize the size of the craters and the distinctiveness of the morphologies.

In the Simud Vallis area splosh craters indicate the presence of ancient groundwater/ice. In addition, the presence of mud volcanoes, chaos terrains and straight fluvial channels suggests that tectonic and volcanic activity likely have been a relevant factor in the evolution of the area, at least soon before its abandonment (i.e. 3.18–3.34 Ga ago). Therefore, local maars may have hosted closed (or partially closed, since one of those seems to be connected with fluvial features; Figure 2a; [5]) basins, where interaction with volcanic materials/gasses was present when the volcanic activity connected with the maars and/or the mud volcanoes were still ongoing. Sediments deposited during this phase are likely to be still preserved, due to their elevation and to the protection of the tuff rings, and most probably can still be present inside the maar craters.

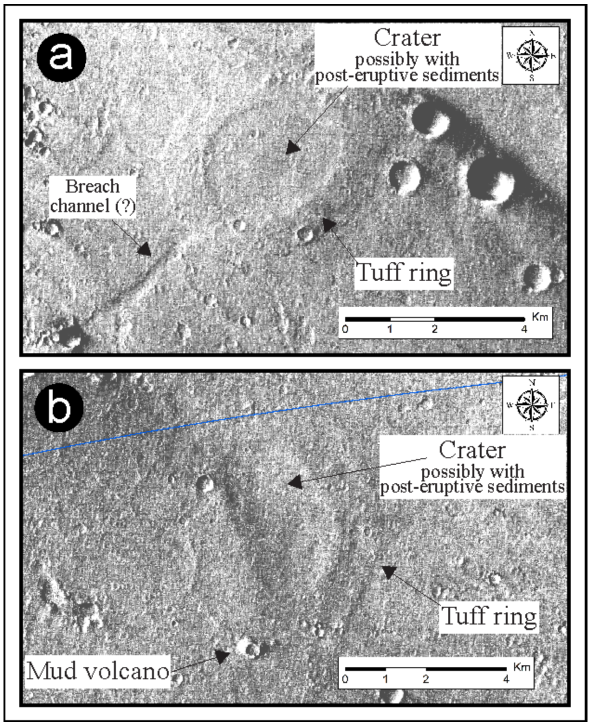

Figure 2: Two close-ups (stretched HRSC image H2024_0001_ND3) of the Simud Vallis maars are presented. It is possible to appreciate the high similarity with terrestrial (Fig. 1) maars.

The Simud Vallis as potential landing site: an evaluation of the Simud Vallis area as potential landing site for the ESA ExoMars 2020 (104 x 19 km landing ellipse) and NASA Mars 2020 (25 x 20 km to 13 x 7 km landing areas) missions was presented [5]. To date, this site is no longer considered one of the final choices for both missions; nevertheless, it can be of great interest for future rover and human in situ exploration.

This area completely fulfill ExoMars 2020 and Mars 2020 engineering constraints (see [5] for a detailed analysis of all parameters). Moreover, in this area a long term interaction between fluvial, volcanic, and tectonic processes took place, therefore representing an highly valuable place for on-site investigation of many aspects of Mars ancient evolution. Beyond maars, multiple secondary targets are located in all landing ellipses, in case the rovers will settle beyond the nominal traveling distance from the maars structures.

Given the peculiarity of this site, this area has been inserted as one of the first targets of interest foreseen for the first year of the ExoMars CaSSIS mission. The possibility to derive CaSSIS Digital Elevation Models with a spatial resolution of 10 m, will be of utmost importance to better define the morphologies and to measure quantitative parameters of the discussed maar-diatremes.

References: [1] Lorenz, V. (2003). *Geolines, 15*, 72-83. [2] Valentine, G.A. (2012). *Journal of Volcanology and Geothermal Research*, *223-224*, 47-63. [3] White, J.D.L., Ross, P.S. (2011). *Journal of Volcanology and Geothermal Research*, *201 (1-4)*, 1-29. [4] Keszthelyi, L.P., Jaeger, W.L., Dundas, C.M., Martínez-Alonso, S., McEwen, A.S., Milazzo, M.P. (2010). *Icarus*, *205*, 211-229. [5] Pajola, M., Rossato, S., Baratti, E., Mangili, C., Mancarella, F., McBride, K., Coradini, M. (2016). *Icarus*, *268*, 355-381. [6] Graettinger, A.H., Valentine, G.A., Sonder, I., Ross, P.-S., White, J.D.L., Taddeucci, J. (2014). *Geochemistry, Geophysics, Geosystems, 15 (3)*, 740-764.