FIELD INVESTIGATION OF THE DALANGTAN PLAYA IN WESTERN CHINA'S QAIDAM BASIN AS AN ANALOGUE TO POLYGONAL SURFACE STRUCTURES ON MARS. Y.N. Dang[1], L. Xiao[1,2], Y. Xu[1], J. Wang[1] and G. Komatsu[3]. [1]Space Science Institute, Lunar and Planetary Science Laboratory, Macau University of Science and Technology, Taipa, Macau (yanan_gis@163.com), [2]Planetary Science Institute, China University of Geosciences, Wuhan, 430074, P. R. China, [3]International Research School of Planetary Sciences, Universit à d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy.

Introduction: Polygonal Surface Structures (PSSs) have been found in ancient terrains on Mars [1-3], which were inferred to be playa geologic settings [3]. Detailed study of PSSs is a key to understanding of the conditions in which varieties of PSSs formed and shed light on understanding the ancient climate on Mars. Remote sensing reveals that many dried and undried playas in western China's Qaidam Basin (Fig. 1), where contains abundant PSS landforms of varying sizes and shapes, which we consider to be excellent analogues for Martian PSSs [4-9]. For this purpose, we carried out field work in the Dalangtan playa, a dried salt lake area in the northwestern Qaidam Basin, followed by laboratory analysis of collected samples.

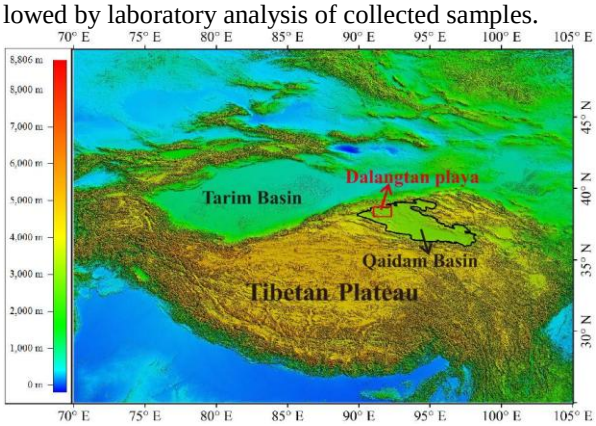

Fig. 1 The location of the Dalangtan playa, western China.

Data and Methods: Remote sensing data such as Google Earth images are utilized to study PSSs in the Qaidam Basin. We carried out the fieldwork during the summer seasons of 2015-2016 in the Dalangtan playa in order to obtain quantitative information of PSSs. We also collected a series of samples for laboratory XRD analysis of their composition. The PSSs in chloride-bearing materials region on Mars are examined using a set of HiRISE (High Resolution Imaging Science Equipment) images (25−32 cm/pixel) [10]. In addition, images from the Context (CTX) camera (6 m/pixel) [11] and the Mars Orbiter Camera (1.5−12 m/pixel) [12] are also used to facilitate our study.

Results: In general, the Dalangtan PSSs have a size range from centimeters to hundreds of meters in diameter, and most of them have raised rims. They display a variety of shapes such as triangle, quadrangle, and complex polygons, depending on their edge number and arrangement patterns. They tend to be topographically concentrated in relatively lower elevation areas.

In order to simplify the analysis of the complex polygonal system, the PSSs in the Dalangtan region are divided into three distinct types according to their sizes (Fig. 2a). The small-sized PSSs (< 10 m) are mainly distributed in the western Dalangtan playa with lower topography (Fig. 2b). The middle-sized PSSs (10–100 m) are usually irregular in shape, with discontinuous sinuous rims, which we think is the result of later erosion of the soil by activity owing to wind or water. The large-sized PSSs (> 100 m) appear to be concentrated in patches with discrete distribution. In contrast, larger PSSs are mainly located at higher topography, in particular for the largest PSSs at the outer edge of the playa.

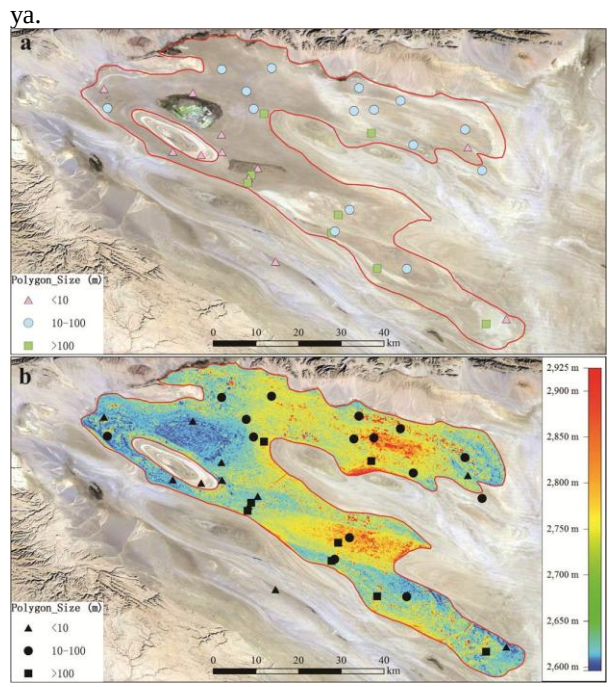

Fig. 2 (a) The distribution of three types of the PSSs (according to the sizes) in the Dalangtan playa. (b) The distribution of the three PSS types with an elevation map.

On one hand, remote sensing (and confirmed by field survey) shows that the small sized PSSs mainly take the form of regular shapes such as triangle and quadrangle (Fig. 3a), similar to their counterparts on Mars (Fig. 3b). Figure 3b shows numerous meter-sized polygonal cracks in northern circum-Hellas region.

They are interpreted to have formed in Fe/Mg smectite/chlorite mixed-layer sedimentary deposits, a geological environment of potentially lacustrine [13].

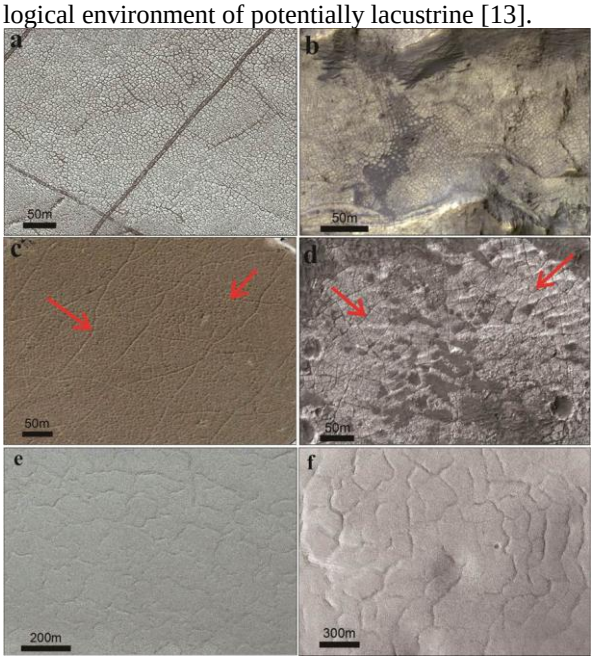

Fig. 3 Comparable polygons on Earth (a, c, and e) and Mars (b, d, and f).

Remote sensing observations, on the other hand, reveal the larger-sized PSS landforms that display similar size and pattern and coexist in dried Dalangtan Playa and in the polygonal terrain on Mars. In this case, the Dalangtan polygons (Fig. 3c) and the polygonal terrain on Mars (Fig. 3d) display and share the following two common characteristics: (1) they formed in the chloride-bearing deposits; (2) some of them are spatially arranged aligning a line. In addition, the large sized Dalangtan PSSs (> 100 m) (Fig. 3e) have the same structure as that of the similar size Martian polygons (Fig. 3f). The different orientation of their cracks may be controlled by regional topography and stress field state.

XRD analysis on the collected samples from the crusts of different PSSs suggest that: (1) commonly, most samples have a soil matrix with a significant halite (mostly > 40 wt%) and feldspar (~ 20 wt%) content, (2) illite and chlorite-dominated clay minerals are detected in nearly all middle to large sized PSSs region, (3) small sized PSSs have a relatively higher average halite contents than larger ones, and (4) the southeast-most Dalangtan region own a relatively higher content of gypsum than other sampling areas in the Dalangtan playa. These results suggest that composition of playa sediment is an important factor that controls the development of different types of PSSs. The variation of mineral assemblages of Dalangtan PSS samples indicates a diversity of sedimentary environments and climate fluctuations during the evolutionary periods of salt lakes in the Qaidam Basin.

Discussion and conclusions: The evaporates such as rock salt and gypsum deposited on the dry lake bed of Dalangtan playa are the hydrogenous sediments left behind by the evaporation of salty water. Desiccation polygons are commonly associated with chloride-bearing terrains which have a lacustrine/playa origin [3]. Though the desiccation-related processes are thought to account for the formation of PSSs in playas and endorheic (closed drainage) lakes on Earth, the possibility of the involvement of periglacial processes may not be excluded. Thermal contraction of sediments and ice at very low soil temperatures would occur with low air temperatures. Whether the periglacial processes have or have not involved in the formation of Dalangtan PSSs, it really depends on the climate history of the Dalangtan playa. The western area of the Qaidam Basin is a typical inland arid climate, characterized by cold weather, low rainfall and intensive evaporation [8]. Cracks formed early in the playa sediments provide pathways for material exchange between above- and below-ground. Under such conditions, periglacial processes may have involved in the early stage of the formation of Dalangtan PSSs.

PSSs in the Dalangtan playa are similar to their counterparts on Mars, especially those crater floor polygons and those occurred within the chloride and/or phyllosilicate terrains. The similarity in size and spatial pattern also reveals that the similar formation mechanism and environments would have been responsible for some PSS landforms in the Qaidam basin and some of those occurring on Mars.

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