AN INVESTIGATION OF THE HYPOTHESES FOR FORMATION OF THE PLATY-RIDGED-POLYGONIZED TERRAIN IN ELYSIUM PLANITIA, MARS. Z. Yue [1], S. Gou [1], K. Di [1], H. Xie [2], H. Gong [1], and Y. Shao [1] [1] State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing 100101, China; [2] Department of Geological Sciences, University of Texas at San Antonio, San Antonio, TX 78249, USA

Introduction: The discovery of geologically young (late Amazonian age) Platy-Ridged-Polygonized (PRP) terrain in Elysium Planitia, Mars can be traced back to earlier geologic mapping with the Viking images [1, 2]. However, the origin of the PRP terrain is still debated (see reviews by [3]), and the debate is open-ended because it is closely related to the Mars climate in the recent geologic time. The main hypotheses include the pack ice [4], basalt lava ([5, 6, 7]), and muddy flow ([8, 9]).

In this work, we have collected 866 HiRISE images in the study area of Elysium Planitia from the mission phases of transition, primary science, and extended science prior to April 3, 2015. Among these images, we also find a pair of stereo images where the PRP terrain existed, which was used to generate the high resolution DEM data for further analysis..And we measured the height of the ridges of the PRP terrain for the first time (Fig. 1).

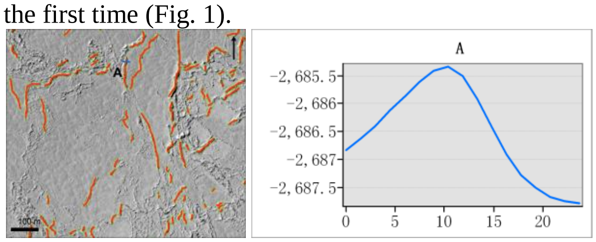

Fig.1 The identified ridges and the topography profiles examplified by one point. The height of the ridges is considered as the elevation difference between the crest and the lowest point.

Observations: Among the 866 HiRISE images in the Elysium Planitia, 328 of them have obvious features of the PRP terrain. In general, the PRP terrains are located in the regional depressions surrounded by the heavily impact-cratered terrains.

Fig.2 displays some typical detailed morphologies of the PRP terrain in this area. Fig.2A shows many circular or irregular ridges (indicated by arrows) can develop within the plates. Fig.2B shows that the plates appear ripple-like (labeled by R) where clasts were involved, while the polygons (labeled by PO) are embedded in circular or polygonal features. Fig.2C shows that the polygons display in long strips (labeled by PO), which is similar to the river netwrok. Fig.2D shows the PRP terrain lap against the topographic obstacles (exemplified by the arrows), indicating that the agent for the formation of the PRP terrain may have some fluidity.

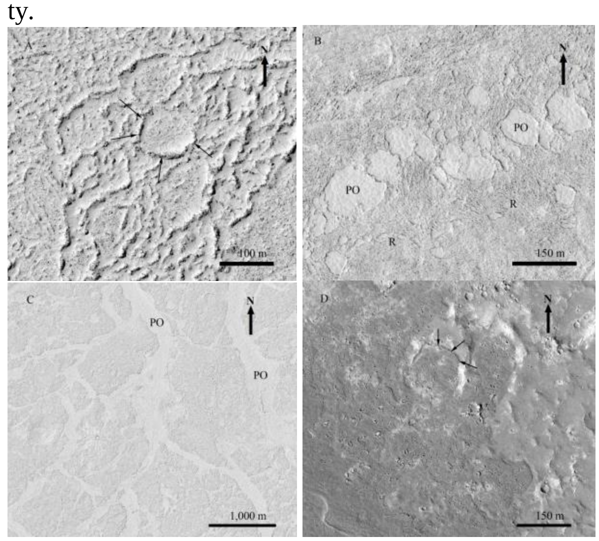

Fig.2. Different detailed morphologies of the PRP terrains in the study area. (A) Circular or irregular ridges developed in the plates (subset of HiRISE image TRA_000854_1855_RED.jp2); (B) Ripple-like plates with smooth polygons embedded therein (subset of HiRISE image ESP_011759_1850_RED.jp2); (C) Polygons displayed in long strips (subset of HiRISE image ESP_026475_1865_RED.jp2); and (D) Flows with rubbly surfaces filled in the shallow depressions (subset of HiRISE image ESP_012577_1815_RED.jp2).

To quantatively measure the typical heights of the ridges, we extracted 1326 ridges in this research. Fig.3 is the histogram of the height of the ridge, which shows that the majority of the height of the ridges ranges from 1.0 m to 1.8 m with the mean value of 1.7 m.

Discussion and Conclusion: From the observations to the detailed morphology, we find that it is difficult to interpret the PRP terrain with the pack ice hypothesis because the agents must have flowability.

The heights of the typical ridges in the PRP terrain are mostly less than 2.0 m, which makes it difficult to be explained by the lava flow. For example, in the field investigation in Laki flow field in Iceland by [10], the topographic ridges were found to be generally 5~15 m high.

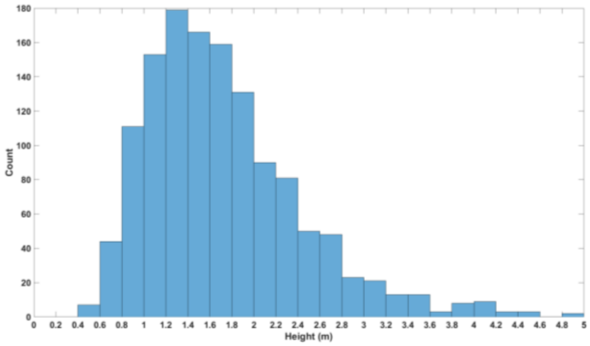

Fig.3. Statistics of the height of ridges.

In addition, the detailed observation to the microtopography also supports that the agent for the formation of the PRP terrain could not be the lava flow. Fig.4 shows a trace is that cut through the previous ridges, indicating that the trace is formed after the polygons. According to the topography data, some material must have moved from the east to west. Since there is no obvious source, the agents for the trace should be the same with that of the PRP terrain. Under martian conditions in recent geologic history, only water ice in the surficial material has the possibility to be melt and flow.

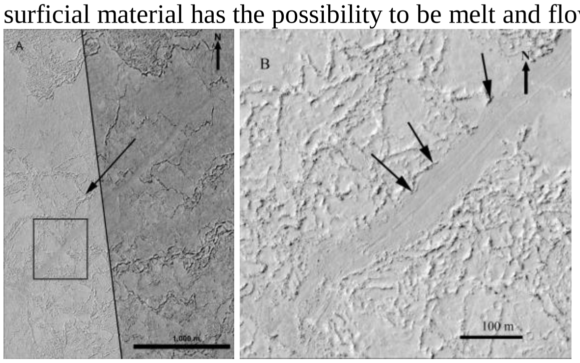

Fig.4. The preexisting ridges exemplified by the arrows were destroyed by the track of the late flow. The image (A) is a mosaic of HiRISE image ESP_018036_1880_RED.jp2 (left to the line) and CTX of B10_013368_1876_XN_07N210W.jp2 (right to the line). The arrow in (A) indicates the move direction of the trace, while the arrows in (B) indicate the previous polygons are destroyed by the track later.

It is interesting to note that similar situation was found in terrestrial surface. Fig.5 (the image is from GF2 satellite, which has the resolution of 1.0m) is from Xinjiang Province, China, where the environments are currently very arid and cold. There are several traces flowing through the area, which are formed when only a small amount of water existed within a short time. This demonstrates that the muddy flow can have the potential to form the PRP terrains, given that Mars had experienced temporary warm conditions within recent past. As a result, our research supports that the PRP terrain was formed by the muddy flow.

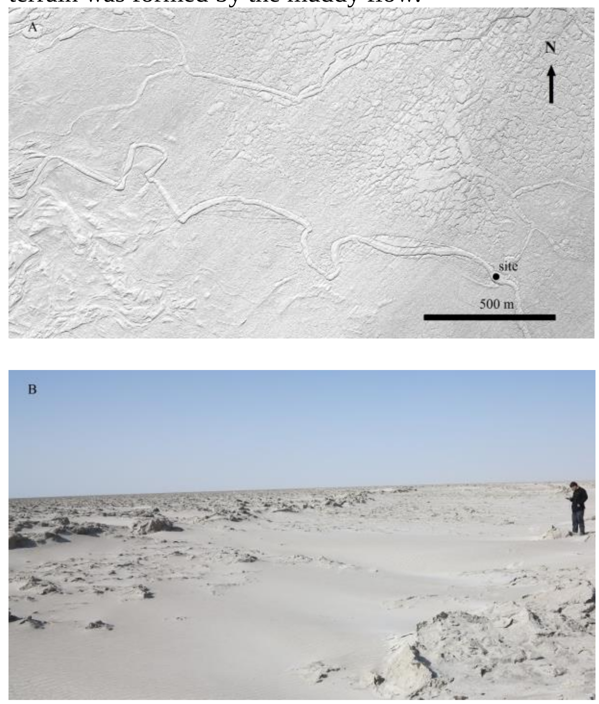

Fig.5 Similar landforms in Xinjiang Province, China. (A) The GF2 image (ID: 1878208) shows the polygons and traces which are very similar to that in Mars. (B) The picture taken in the site in (A) and the camera points to north west.

Acknowledgment: The authors wish to acknowledge the HiRISE, MOLA, and HRSC science teams for making the observation data available. This research was supported by the National Natural Science Foundation of China (Grant No. 41472303) and free exploring and talent youth project of State Key Laboratory of Remote Sensing Science (Grant No. 16RC-07).

References: [1] Tanaka, (1986) *JGR*, *91*, E139–E158. [2] Mouginis-Mark, P. J., et al. (1984) *Earth Moon Planets 30*, 149-173. [3] Page, D.P. (2010). *Planet Space Sci..*, *58*, 1406–1413. [4] Murray J. B., et al. (2005). *Nature*, *434*, 352–355. [5] Plescia, J. B. (1990) *Icarus*, *88*, 465–490. [6] Keszthelyi L. P., et al. (2000) *Icarus*, *205*, 211-229. [7] Jaeger, W. L., et al. (2007) *Science*, *317*, 1709–1711. [8] Rice J. W., et al. (2002) LPSC XXXIII, abstract #2026. [9] Page D. P., et al. (2009) *Icarus*, *203*, 376–389. [10] Keszthelyi L. et al. (2004) *Geochem Geophy Geosy*, *5*, Q11014.