GEOLOGICAL CHARACTERISTICS AND TARGETS OF HIGH SCIENTIFIC INTEREST IN THE ZHURONG LANDING REGION ON MARS. J. Zhao[1], Z. J. Xiao[1], J. Huang[1], J.W. Head[2], J. Wang[1], Y. Shi[1], B. Wu[3], L. Wang[1], and L. Xiao[1], [1]State Key Laboratory of Geological Processes and Mineral Resources, Planetary Science Institute, School of Earth Sciences, China University of Geosciences, Wuhan 430074, China (jnzhao@cug.edu.cn), [2] Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI 02912, USA, [3]Planetary Remote Sensing Laboratory, Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China.

Introduction: Tianwen-1 is China's first Mars exploration mission, which consists of an orbiter and a lander/rover composite. The lander and rover ("Zhurong") safely landed in southern Utopia Planitia on May 15, 2021. The scientific objectives of the rover include investigation of the surface composition, regolith characteristics, water ice distribution, magnetic field, and environment at the surface [1]. To better constrain the geological context of the landing area, we conducted detailed geological mapping and stratigraphical analysis in a 0.5°×0.5° region centered at 25.1°N, 109.9°E, and proposed several high scientific interest targets for further investigation.

Data and Methods: We used 128 ppd MOLA data, ~100 m/pixel THEMIS data, ~6 m/pixel CTX data, ~0.25 m/pixel HiRISE data for topographic and geomorphological analyses. We carried out crater size-frequency distribution (CSFD) measurements on the CTX global mosaics with ArcGIS plugin Cratertools, and analyzed the CSFD data with Craterstats2 [2].

Geological Background: The landing area is located in the southern part of Utopia Planitia (Fig.1a), belonging to a geological unit previously mapped as the Late Hesperian lowland unit (lHl; [3]). This unit is mainly composed of the Vastitas Borealis Formation (VBF) materials that have been interpreted as sediments of fluvial, lacustrine or marine in origin [4]. The study area has a higher topography in the south (Fig. 1b), and the elevation range in the study area is about 200 m, while the northward slope is ~0.25°. The nearest cone and largest impact crater are ~6.8 km and ~13.5 km away from the landing site, respectively.

Results: *Thermal physical properties.* The average DCI (Dust Cover Index; [5]) is 0.941 with a standard deviation 0.011, indicating that the surface of the study area is relatively dusty. THEMIS nighttime IR is a good proxy for thermal inertia, and we observed thermal inertia variation within the study area (Fig. 1c). Ejecta of impact craters show elevated thermal inertia; we named these as rocky ejecta craters (REC). Lower thermal inertia areas correspond to cones and some troughs which contain aeolian bedforms. An area of 600-meter by 600-meter centered at the landing site has a thermal inertia of 321–376 $JK^{-1}m^{-2}s^{-1/2}$ with a standard deviation of ~12 $JK^{-1}m^{-2}s^{-1/2}$.

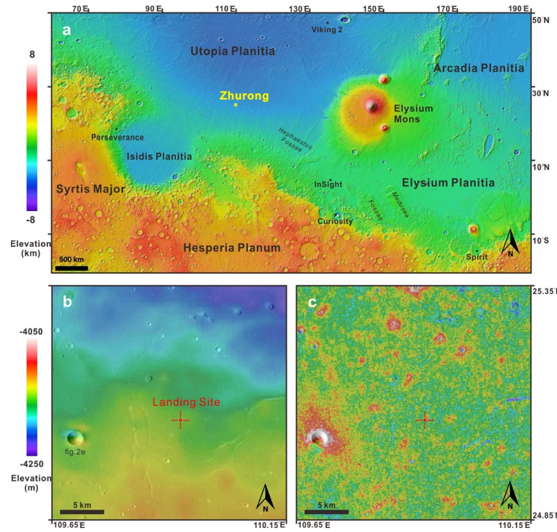

Fig. 1. (a) MOLA topographic map showing the location (yellow box) of (b) and (c). (b) Topography of the study area. (c) Color-coded THEMIS nighttime IR global mosaic over the CTX global mosaic.

Geomorphological features. A variety of landforms can be found in the study region. We identified over ten pitted cones (Fig. 2a), tens of giant troughs (Figs. 2b & 2c) and ridges (Fig. 2c), light-toned aeolian bedforms (Figs. 2a & 2b), and more than 400 impact craters (Fig. 2d).

There are some special craters in the study region. RECs are characterized by elevated nighttime temperature in the THEMIS nighttime mosaic (Fig. 1c). The rim crests of RECs usually appear sharp. The minimum diameter of RECs is 10 m. In addition, there are 40 craters with raised-rim pits on their equator-facing wall. The pits occurred on the upper portion of the walls in chains or clusters (Fig. 2d). These pits are unlikely to have formed by collapse but may be due to the energetic release of volatiles [6] or the sublimation of an ice-rich layer near the surface.

Absolute model ages. To better constrain the age of the landing region, we performed crater size-frequency distribution measurements in the central and eastern parts of the study region to minimize the influence of ejecta blankets, and we also excluded crater clusters and irregular craters that can be secondaries. The result shows that the estimated absolute model age of the region is 757±66 Ma, which is much younger than the previously estimated Late Hesperian age of the VBF unit [3], indicating the influence of local resurfacing processes (e.g., thin lava flows).

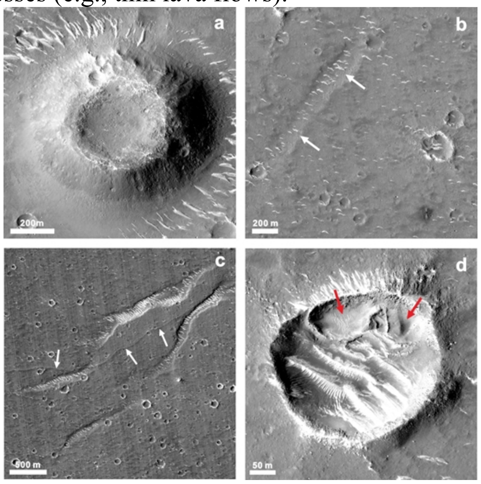

Fig. 2. Geomorphic features in the landing region. (a) A pitted cone with aeolian bedforms around it. (b) A polygonal trough. (c) Ridges and troughs. (d) An impact crater with raised-rim pits.

High Scientific Interest Targets: We proposed that the pitted cones, pitted-wall craters, aeolian bedforms, polygonal troughs, and ridges are high-value targets to be further investigated. A pitted cone may have possible origins including cinder cone, rootless cone, mud volcano, etc. Deciphering their origin could help understand the source and property of surface materials, and estimate the existence of an ancient ocean and habitable environment. Detection of a pitted-wall crater could provide insights into the subsurface water-ice/CO_2 ice distribution. Young aeolian landforms can reveal the direction of the recent prevailing wind and the wind direction changes. In addition, detection of their composition may help shed light on the origin of light-toned bedforms. Giant polygonal troughs are pervasively distributed in Utopia Planitia and could be related to the activity of volatiles. Understanding their origin may provide clues to the volatile evolution of the region. Ridges in the study region may be related to volcanic or glacial activities, and detailed investigation can help determine the resurfacing characteristics of the study region in the Amazonian period.

Stratigraphical and Geological Evolution: Based on the results above, we made a geological map of the Zhurong landing region (Fig. 3a) and proposed a five-layer stratigraphical model for the study area (Fig. 3b): The top layer A consists of relatively loose materials, which appear relatively smooth in high resolution visible images and show relatively low night-time temperatures at night. The materials of layer A are interpreted to contain water ice and/or carbon dioxide ice, which are suggested by widely distributed pitted-wall craters (Fig. 2d). Layer B beneath layer A is made of coarser and more rocky materials, identified on the basis of the rocks and boulders in the ejecta of RECs with elevated nighttime temperatures. The thickness of layer A is up to ~48 m based on the diameters of RECs. Layer C is composed of materials of VBF, which is a thin sedimentary unit with an estimated minimum average thickness of ~100 m [7]. Layer D is the Early Hesperian volcanic ridged plains, and its thickness is estimated to be ~800–1000 m [7]. The bottom (Layer E) is the Noachian-aged basement [8].

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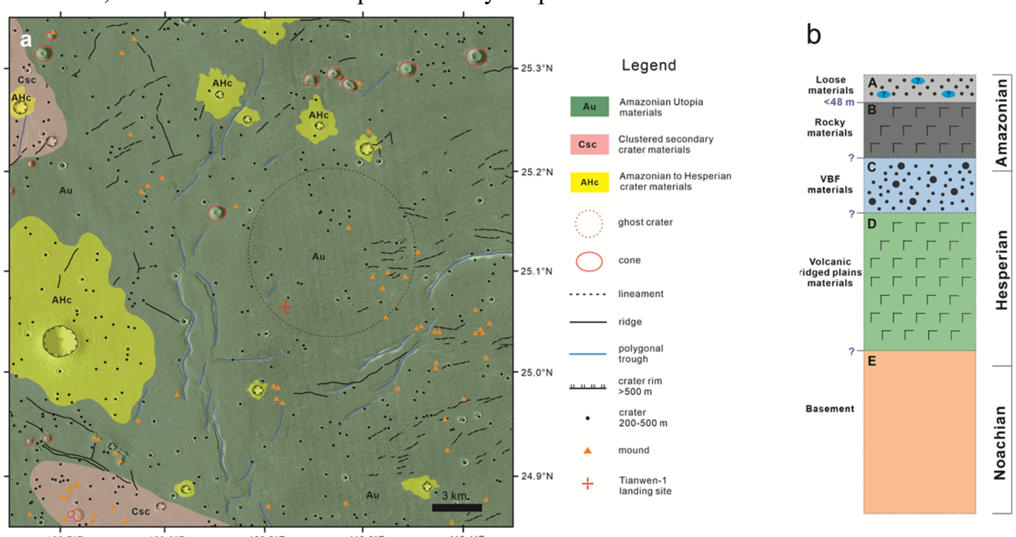

Fig. 3. Geological map (a) and the stratigraphy (b) of the Zhurong landing region.