PRELIMINARY GEOLOGICAL INTERPRETATIONS AND A GEOLOGICAL MAP AT THE TIANWEN-1 LANDING SITE ON MARS.

Sheng Wan[1], Shangke Tian[1], Changqing Liu[1], Ping Liu[1], Yanqing Xin[1], Zongcheng Ling*, [1]Shandong Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, Institute of Space Sciences, Shandong University, Weihai Shandong 264209, China (zcling@sdu.edu.cn).

Introduction: Tianwen-1's rover Zhurong successfully touched down in the south of the Martian Utopia Planitia, on May 15, 2021, which represents the complete success of China's first Mars exploration mission. Using the new sub-meter-resolution images from the High Resolution Imaging Camera (HiRIC), the landing site location is refined to 109.925° E, 25.066° N at an elevation of −4,099.4 m [1]. Tianwen-1 landing region is almost covered by the Vastitas Boreals Formation (VBF), one of the largest units on Mars [2]. The long geological history and complex geological processes promote the diversification of geomorphic features, which also makes us focus on the relevant geomorphic interpretation around the traversed path of Zhurong. We employed the latest Mars-scientific data to identify the landform around Zhurong landing site, mapping the location of topographic features and finding their interaction patterns, with the intent to help recognize the geological context of the landing region and deepen our understanding of the geological evolution history of Utopia Planitia.

Methods: The data we used including the digital orthophoto map (0.7m/pixel) and digital elevation model (3.5m/pixel) of the landing region, which are generated from the HiRIC images taken by the Tianwen-1 orbiter [1]. MRO High Resolution Imaging Science Experiment (HiRISE, 0.3m/pixel) data and digital terrain model (1m/pixel) are combined to achieve accurate analysis. Based on the above data, we visually interpreted the images on the ArcGIS platform and drew the geological map of the landing region. Additionally, the location information extracted from the level 2 data of the Navigation and Terrain Camera (NaTeCams) on board the Zhurong rover, which can be used to determine the texture of Martian targets during the in-situ detections, and infer the approximate traversed path of the Zhurong rover.

Results: The elevation map clearly reflects the relative fluctuation of the surface before and after Zhurong's landing: before landing, the terrain is high in the east and low in the west; after landing, the terrain is low in the east and high in the west (Fig. 1a and b). The overall terrain of the landing region is relatively flat, and the steep areas are basically concentrated at the crater wall or the flank of TARs (Fig. 1c).

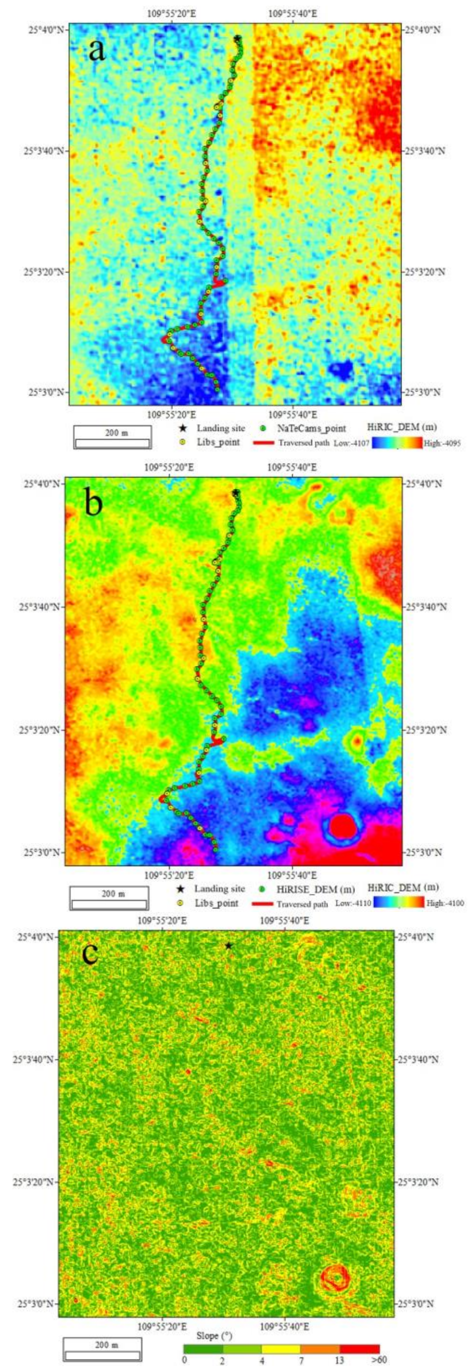

Fig. 1. Contexts around the Zhurong landing site. a) HiRIC topography data. b) HiRISE topography data. c) Slope map derived from HiRISE topography data. (The black star indicates the landing site of Zhurong, and the traversed path are mapped in a and b.)

Combined with remote sensing images (HiRIC) and pictures taken by NaTeCams, we have identified at least four geomorphic features: Transverse Aeolian Ridges (TARs), craters, rocky fields, and domes within the range of Zhurong traversed path (from May 2021 to October 2021) (Fig. 2). Around the traversed path of Zhurong, the impact landform and aeolian landform are the most common geologic features. Total 65 TARs were observed, whose overall direction was east-west, indicating the active direction of the wind. These TARs are divided into three categories: linear, beaded, and barchan, mostly barchan-shaped. They are irregularly arranged, and their profile has poor symmetry. A small fraction of TARs has been observed to have impact craters, suggesting that they have formed over a longer period and may TARs have been cemented or diagenetic. The craters in the study area are small in scale, with diameters ranging from a few meters to hundreds of meters. There are more boulders at the edge of some craters (Fig. 2b). For craters with a diameter greater than 20 m (n= 21), we have recognized the crater materials, which not only have more complex structure, but also have more obvious interaction with the surrounding geology. The rocky fields have small rocks and clasts with rough textures and different albedos [1]. Other distinct features are recognized as fine-grained, low roundness, pitted surfaces, flaky texture, grooves and etchings [3]. These rock targets around Tianwen-1 landing site with distinct textures reveal that the region has experienced a variety of geochemical and geophysical processes. Additionally, a suspected dome with apparent terrain relief was found, located at 109.931° E, 25.055° N, suggesting a possible regional volcanism.

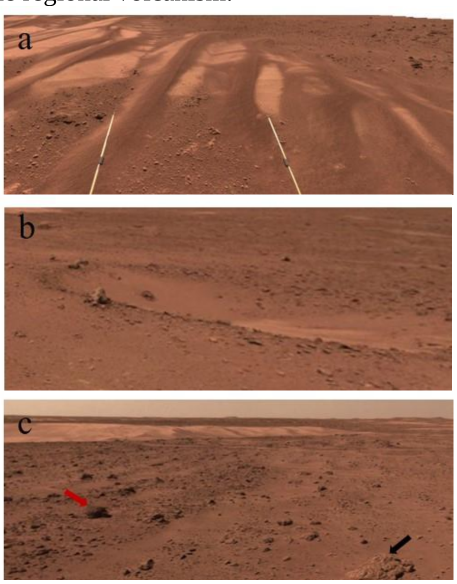

Fig. 2. The images of geomorphic features along the traversed path, taken by the NaTeCams on board the Zhurong rover. a) Barchan-like TAR. b) Craters. c) Rocky field, and arrows indicate characteristic stones.

A geological map at the Tianwen-1 landing site is produced and shown in Fig. 3. The proposed stratigraphy of the Zhurong landing region is divided into loose materials, rocky materials, VBF materials, volcanic ridged plains materials and basement [4].

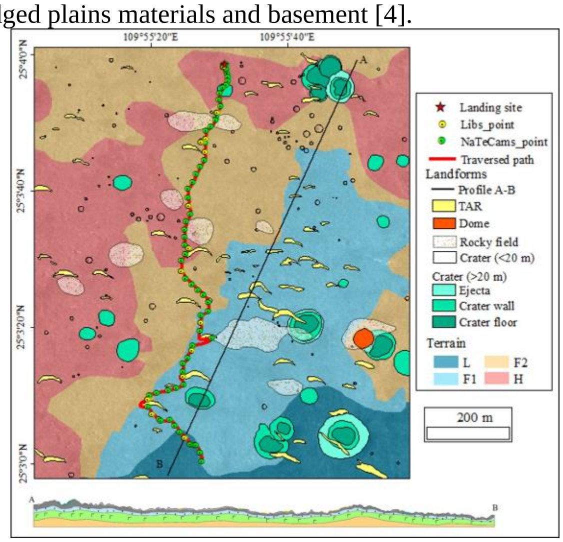

Fig. 3. Geological map (1:500) and proposed profile of the Tianwen-1 landing region.

On-going and Future Work: The flat terrain of the landing area provides the possibility for the exploration of Zhurong rover, and the abundant geological features can deepen our understanding of the geology of Utopia Planitia. We are also trying to refine the geological map combine with the images and spectral data taken by NaTeCams and MarSCode, etc.

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