Evaluation of small-sized mounds formation mechanisms in China's Zhurong landing region. Yu Lin, Jiannan Zhao and Le Wang, Jun Huang, Liang Zhang, Long Xiao, (China University of Geosciences, Wuhan, China. didalinyu@cug.edu.cn).

Introduction: Tianwen-1 is China's first independent Mars exploration mission. The rover "Zhurong" landed in the southern Utopia Planitia where various landforms such as impact craters, pitted cones, troughs, and aeolian features are present [1-5].

In this study, we identified ~1300 small-sized mounds in the Zhurong landing region, 655 of which developed pits on the flanks. They are different from mounds previously identified on Mars [6-8]. We have carried out a detailed identification and morphological investigation of the small-sized mounds in the landing area to reveal their origin and development.

Observations: Based on the High Resolution Imaging Camera (HiRIC) images, we identified ~1300 small-sized mounds within the study area, which can be classified into three types: Type I are small-sized mounds with relatively smooth surfaces (Figure 1a); Type II have pits at the base of the small-sized mounds (Figure 1b); Type Ⅲ have pits on their flanks and the pits are higher in elevation than the surrounding plains (Figure 1c). The mounds are clustered and likely to be bedrock features covered with loose materials. We found the linear relationship between diameters and heights of the small-sized mounds.

The pits are irregular in shape and concentrated on the northeast (NE) side of the mounds (Figures 1b and 1c). Most of their bottoms show similar roughness to the surrounding area, but some of them have a slightly higher albedo than their surroundings. The bottoms of the pits at the base of the small-sized mounds are slightly lower than the surrounding plains (Figure 1b). Pits on the flanks of the small-sized mounds are elevated (Figure 1c).

Discussion: According to the morphological characteristics of the small-sized mounds, possible origins of them are accretion (as mud volcanos), deflation (as ring-mold craters or pedestal craters), or inflation (as pingos or lava domes). As some small-sized mounds expose the underlying rocky materials and some pits show small humps that may be underlying rocky materials, we propose a two-layer structural model for the mounds. The upper layer is dominated by loose materials and the lower layer is dominated by the subsurface rocky materials.

We have successively ruled out mud volcanoes, ring-mold craters (RMCs), and pingos as the origin of the mounds. (1) The interior of the small-sized mounds is rocky, while the mud volcano is mainly composed of less resistant sediments [9]. (2) The pits of RMCs appear around the central peaks [10], but the pits of the small-sized mounds only appear on the NE side. (3) The interior of pingos is mainly composed of sediments and ice cores [11, 12], but the small-sized mounds are made of rocky materials.

We can't completely rule out the pedestal crater origin for some of the mounds. It is possible that a welding process of the surface during impact helps preserve underlying ice to produce pedestal craters like the small-sized mound. However, we believe that the origin of the mounds is lava domes. The small-sized mounds are similar to the subaqueous cryptodomes or possible blister-type lava domes (Figure 2a, 2b, 2c and

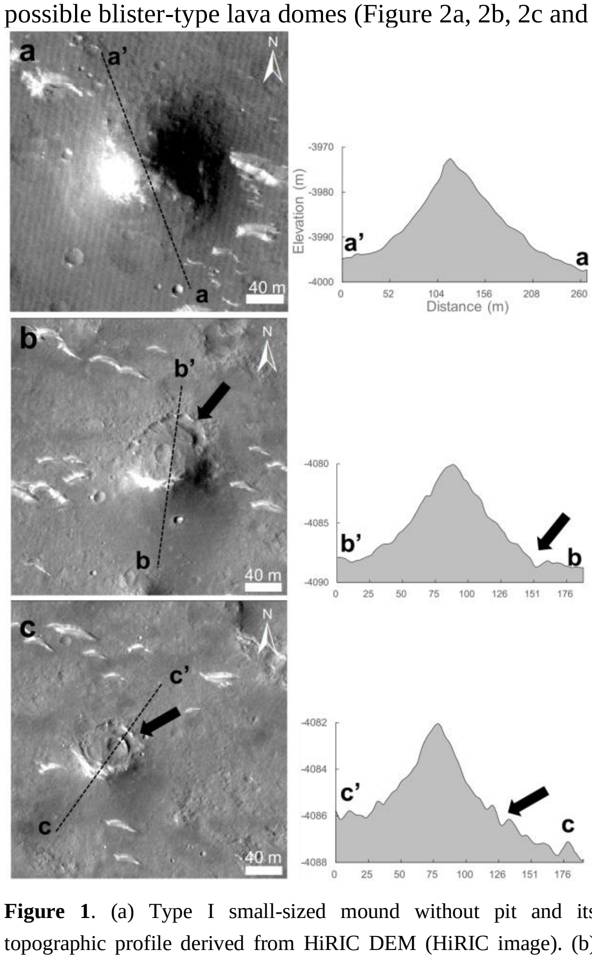

Figure 1. (a) Type I small-sized mound without pit and its topographic profile derived from HiRIC DEM (HiRIC image). (b) Type II small-sized mound with a pit at the base and its topographic profile. Black arrows indicate the location of the pit (ESP_069731_2055). (c) Type III small-sized mound with a pit on its flank and its topographic profile. Black arrows indicate the pit (ESP_069731_2055).

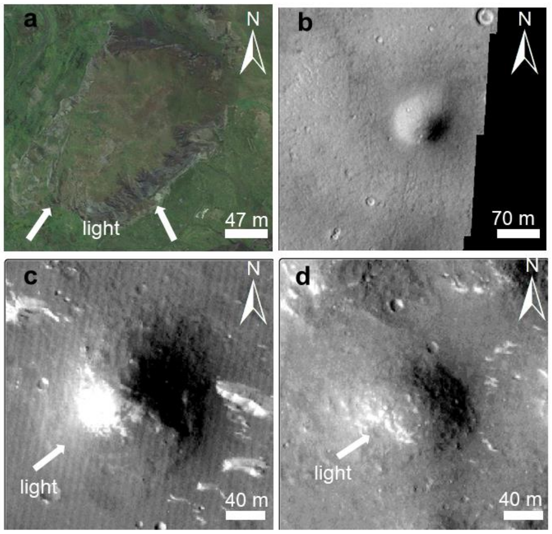

Figure 2. Lava domes on Earth, and possible lava domes near the Elysium Mons, and the small-sized mounds in the landing zone. (a) A subaqueous cryptodome in Japan (Landsat image) [14]. (b) A possible blister-type dome on Mars, in which the magma pushes up the overlying material, leaving no ring around it and making it more circular (THEMIS V10417013). (c, d) The presence of type I small-sized mounds in the landing zone, with a smooth surface and no ring of material surrounding it (HiRIC image).

2d) [13, 14]. Zhao et al. (2021) found a large number of possible lower rocks at the bottom of the crater and the surface of the ejecta blankets in the landing zone [5]. This is similar to the rock parts we found at the bottoms of the pits. And a variety of ridges distributed in the landing zone are interpreted as igneous dikes or ridge-like lava tubes [5, 15, 16].

The pits associated with the small-sized mounds are caused by volatiles in the surface layer, and we interpret them to be sublimation origin.

Conclusions: We proposed that the small-sized mounds are most likely to be lava domes in origin. The associated pits are mainly formed by volatile sublimation and may be affected by slope, local topography, and time of sunlight illumination. These mounds are interesting targets for the Zhurong rover to explore in situ to reveal the geological evolution of the southern Utopia Planitia.

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