CHEMICAL COMPOSITIONS OF SOILS AND ROCKS OBSERVED BY ZHURONG ROVER IN THE FIRST 300 SOLS. C.Q. Liu[1], Z.C. Ling[1*], P. Liu[1], E.B. Shi[1], Y.Q. Xin[1], and Z.C. Wu[1], [1]Shandong Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, School of Space Science and Physics, Institute of Space Sciences, Shandong University, Weihai 264209, China (zcling@sdu.edu.cn).

Introduction: Tianwen-1 is China's first Mars exploration mission, which has landed in Utopia Planitia and released the Zhurong rover. The landing site is within a Late Hesperian-aged deposit unit named Vastitas Boreals Formation (VBF) [1, 4-6]. VBF is one of the most widespread sedimentary units and covers most of the plains on the northern hemisphere of Mars (Figure 1). Some previous work inferred that VBF was deposited from an ancient ocean [6, 7], outflow channels from highland and lowland sources [5, 8], compaction and drainage activities [9, 10], or subsurface ice-related processes [1, 4, 11, 12]. While direct evidence of the VBF origin is still lacking, which could be further constrained by the new detections of the Zhurong rover.

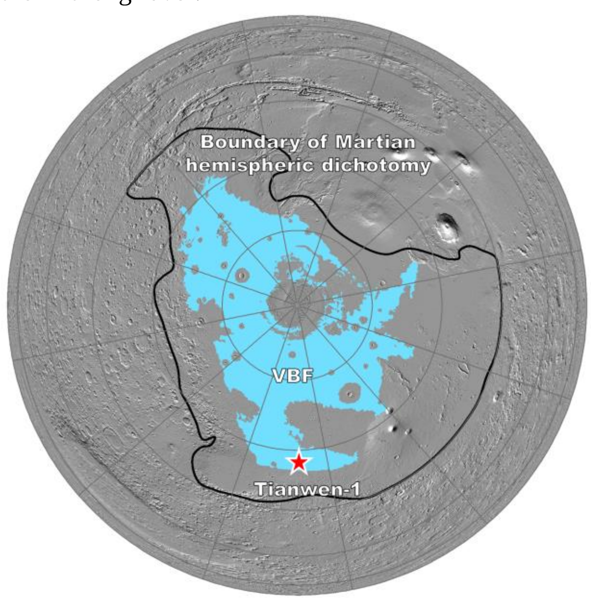

Figure 1 Distribution map of the VBF unit on the Northern Plains of Mars.

Zhurong rover carried a payload named Mars Surface Composition Detector (MarSCoDe), which can obtain chemical compositions, mineralogy information, and micro-morphology of Martian soils and rocks using Laser-Induced Breakdown Spectrometer (LIBS), Short-Wave Infrared Spectrometer, and Micro-Imaging Camera [13]. During the first 300 sols, 38 VBF-ZR targets have been detected by MarSCoDe (Figure 2), including 18 coarse-grained soils (exhibit clusters of ~ 6 mm in diameter), four fine-grained soils (< 150 μm), one induced soil, and 15 rocks.

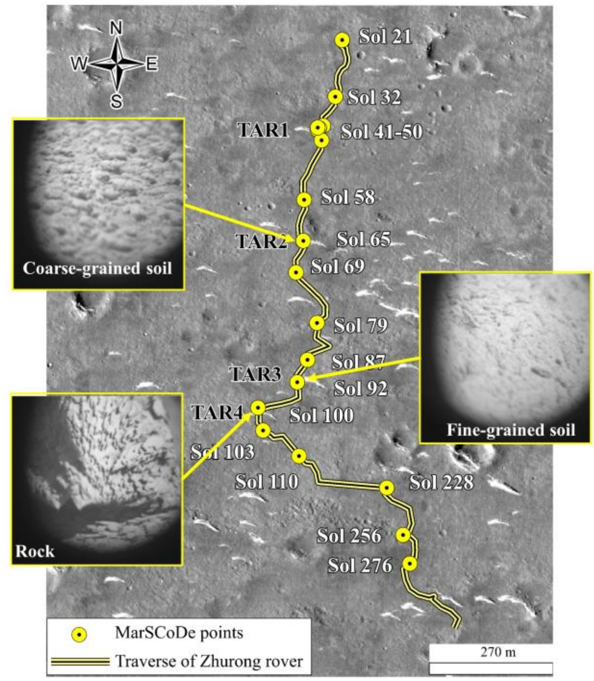

Figure 2 Traverse map of the Zhurong rover up to sol 300 overlain on the base image of High-Resolution Imaging Camera data, as well as the micro-images of coarse-grained soils, fine-grained soil, and a rock.

Results: Each LIBS spectrum is averaged from the signal excited by 60 laser shots. Emission lines of Si, Al, Fe, Mg, Ca, K, Na, O, H, and C are obtained from the LIBS spectra of VBF-ZR targets (Figure 3). The major element abundance of 22 among all targets is derived based on the multivariate model built using ChemCam-LIBS spectral database after cross-calibration between MarSCoDe-LIBS and ChemCam-LIBS systems [14]. Compositions of SiO_2, FeO_T, Al_2O_3, and CaO are selected in this work for further analysis (Figure 4).

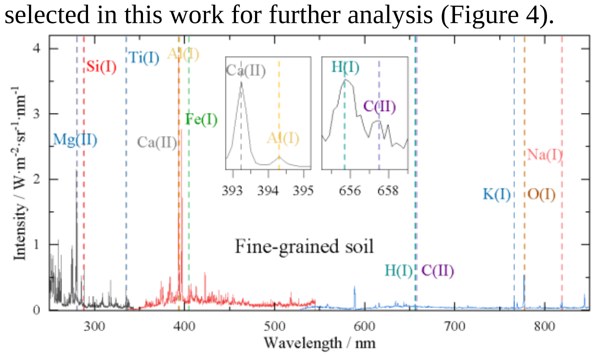

Figure 3 LIBS spectrum of the fine-grained soil.

Rocks. The compositional ranges of rocks are wider than soils, and the SiO_2 distribution exhibits three peaks, suggesting distinct origins of rocks. In other words, some rocks may be autochthonous but others are allochthonous. In addition, the covered Martian dust and the weathered layer will affect the compositions of these rocks.

Soils. The fine-grained soils (< 150 μm) have similar compositions to the Mars global dust (1.4 – 2.5 μm [15]) but with higher Al_2O_3 and lower CaO. The coarse-grained soils exhibit lower SiO_2 (48.1 wt.% vs. 48.9 wt.%) and higher CaO (13.3 wt.% vs. 12.9 wt.%) than fine-grained soils. These observations may be due to the contribution of local materials. Interestingly, the coarse-grained soils have wider compositional ranges than fine-grained soils, suggesting their inhomogeneous compositions due to different mixing proportions of local materials and dust.

On-going and Future Work: The accuracy of quantitative compositions can be further improved. We have prepared >300 standards and will collect their LIBS spectra using the MarSCoDe prototype. Improved compositional values can be extracted using the new model and will provide critical clues for the origin of VBF at the Tianwen-1 landing site.

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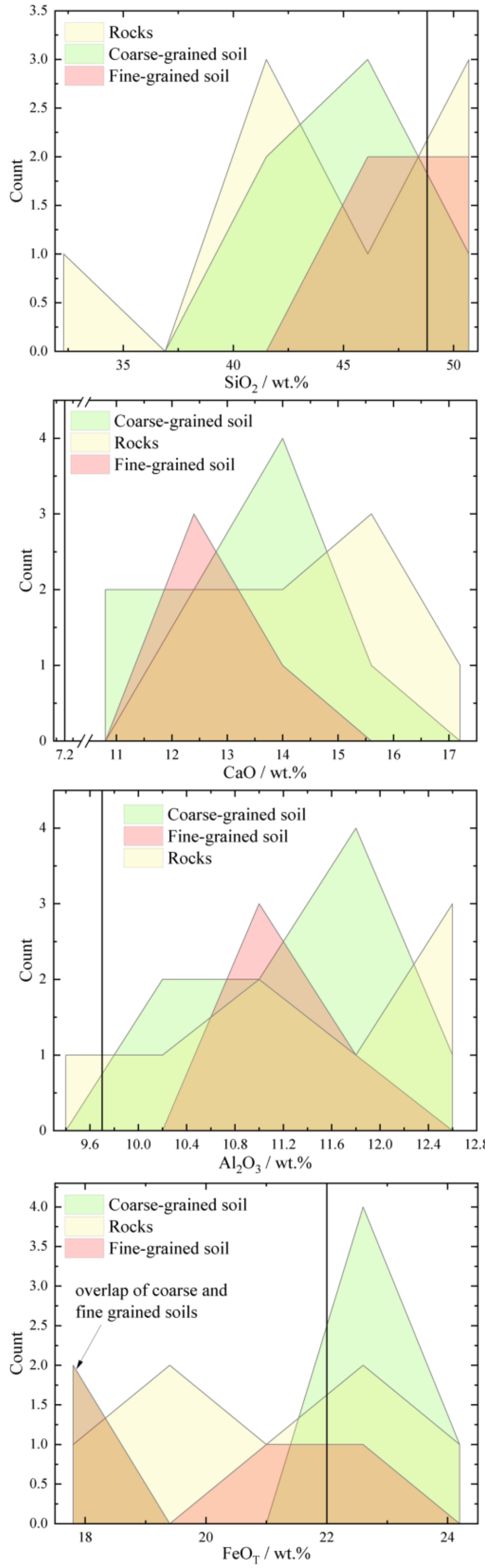

Figure 4 Composition count distributions of coarse-grained soils (green), fine-grained soils (red) and rocks (yellow). The black line represents compositions of eolian dust at Gale crater from Lasue et al. (2018) [15].