THE YOUNG MARE BASALTS IN CHANG'E-5 MISSION LANDING REGION, NORTHERN OCEANUS PROCELLARUM. Yuqi Qian[1,2], Long Xiao[1], James W. Head[2], [1]Planetary Science Institute, School of Earth Sciences, China University of Geosciences, Wuhan, 430074, China (longxiao@cug.edu.cn), [2]Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, 02912, USA (james_head@brown.edu)

Introduction: The Chang'e-5 mission (CE-5) is China's first lunar sample return mission, which will collect ~2 kg of samples by drilling and collecting surface regolith samples [1, 2]. The northern Oceanus Procellarum region near Mons Rümker has been chosen as the landing and sampling region (Rümker region, 41-45°N, 49-69°W).

The northern Oceanus Procellarum is located in the Procellarum-KREEP-Terrain [3], characterized by elevated heat-producing elements [4], thin crust [5], and prolonged volcanism [6, 7] (<2.5 Ga, Fig. 1). This region was chosen on the basis of the occurrence of some of the youngest lunar mare basalts, which have not yet been sampled [1]. The geologic characteristics and scientific significance of the Rümker region were described in detail by [8], which devided the young mare basalts in the landing region into Em3 and Em4 (Fig. 2, left). Sampling these young mare basalts could profoundly improve our understandings of late lunar thermal evolution and constrain lunar impact history [8].

Late stage lunar volcanism occurred mainly in Oceanus Procellarum and Mare Imbrium [6] and produced unique high-Ti mare basalts [9]. The young high-Ti mare basalts in the western nearside are characterized by abundant olivine, which distinguishes them from old high-Ti mare basalts in the eastern nearside [10, 11]. Many critical questions related to the young mare basalts are as yet unanswered, including: 1) Heat sources for partial melting; is it related to the elevated PKT thorium anomaly? 2) Why are they Ti and olivine rich, and why does Ti content increase with time? 3) Are the basalts characterized by very high Th content similar to the soils, or are the soils preferentially enriched by lateral and vertical PKT terrain transport? Sampling and analyzing the CE-5 young mare basalts could definitely address and solve some of these issues. In order to properly interpret the laboratory analysis of the returned samples, the basic geological background and characteristics of the landing site and sample context need to be well understood. For this reason, we have undertaken a comprehensive study of the young mare basaltic units in the CE-5 mission landing region.

Methods: Multiple lunar remote sensing datasets are used for this research, including image data (CE-2 CCD, Kaguya TC, LROC NAC & WAC), multispectral/hyperspectral data (Kaguya MI, Chandrayaan-1 M^3), detrended data [12], etc. We focus on Em4 unit (Fig. 2) in this research, and sometimes we refer to it as the 'young basalt unit'.

Results and Discussion:

Geomorphology. The young basalt unit in the Rümker region is a smooth mare plain. The mean elevation is -2184 m, and the mean slope is 0.88° with a baseline length of ~ 180 m. Highland mountains (some are Imbrian Basin rings, Fig. 2, right, C), steep-sided domes (silica-rich, i.e., Mairan domes) are embayed by these young basalts. The Rima Sharp sinuous rille extends across the area, and four source vents closely associated with the rille are identified (Fig. 2, right, A, B). Numerous wrinkle ridges occur in the region, and most of them formed before the onset of Rima Sharp.

Rima Sharp is described as the longest sinuous rille on the Moon in the global catalog by [15]; [15] interpreted the rille to extend from north and the main branch length is 566 km. We find evidence that Rima Sharp is composed of two independent sinuous rilles; their channels were combined together by rille capture.

Composition. The young basalt unit in the Rümker region is richer in TiO_2 (6 wt. %, mean), FeO (17 wt.%, mean), and olivine than that of the Imbrian-aged mare basalts (Em3) [8]. Ejecta traced back to Harpulus Crater and Pythagoras Crater are low TiO_2, FeO highland materials.

Stratigraphy. The Em4 unit is the youngest unit in the region. It covers all pre-existing units, including Em3, and Imbrian-aged low-Ti mare basalts; it embays pre-existing hills, domes, and crater rims. Large craters can penetrate through the overlaying high-Ti young basalts and excavate old low-Ti basalts (Fig. 2, right, D). On the basis of the crater excavation technique [13], the average thickness of the young basalt unit is estimated to be ~40 m; together with its area, we estimate its total volume to be 1521 km^3. This value is within the estimation of [14] (30-60 m), using crater size frequency distribution measurements. The Em3 unit, however, is underneath Em4 and is also Ti-rich, suggesting that 1521 km^3 is the upper limit of Em4 volume. This volume is near the range of volumes that appear typical for lunar basaltic eruptions 10^2-10^3 km^3 [16].

Source. A source vent for the young high-Ti basalts is unclear. We are investigating three possible scenarios: 1) eruption occurred through a dike(s), with the source vent buried by later erupting parts of the flow unit; 2) eruption occurred through Rima Sharp, which has several apparent source-vent-like features at both ends of the rille; 3) The young flow unit is composed of more than one flow, sourced from different vents. We are currently utilizing these data to model rille vent features [17] and compare these prediction to the nature and structure of the rille and associated parts of the flow unit.

References: [1] Li C. et al. (2019) *Science*, *365*, 238-239. [2] Wang Q. and Xiao L. (2017) *LEAG*, Abstract #5092. [3] Jolliff B. L. et al. (2000) *JGR*, *105 (E2)*, 4197-4216. [4] Prettyman T. H. et al. (2006) *JGR*, *111*, E12007. [5] Wieczorek M. A. et al. (2013) *Science*, *339*, 671-675. [6] Hiesinger H. et al. (2011) *GSA Special Paper*, *477*, 1-51. [7] Morota T. et al. (2011) *EPSL*, *302*, 255-266. [8] Qian Y. et al. (2018) *JGR-Planets*, *123*, 1407-1430. [9] Pieters C. M. (1978) *9th LPSC*, 2825-2849. [10] Staid M. et al. (2011) *JGR*, *116*, E00G10. [11] Zhang X. et al. (2016) *JGR-Planets*, *121*, 2063-2080. [12] Kreslavsky M. A. et al. (2017) *Icarus*, *283*, 138-145. [13] Chen Y. et al. (2018) *JGR-Planets*, *123*, 630-645. [14] Hiesinger H. et al. (2002) *GRL*, *29 (8)*, 1248. [15] Hurwitz D. M. et al. (2013) PSS, *79-80*, 1-38. [16] Head, J. W. and Wilson, L. (2017) *Icarus*, *283*, 176-223. [17] Wilson, L. and Head, J. W. (2020) *51st LPSC*.

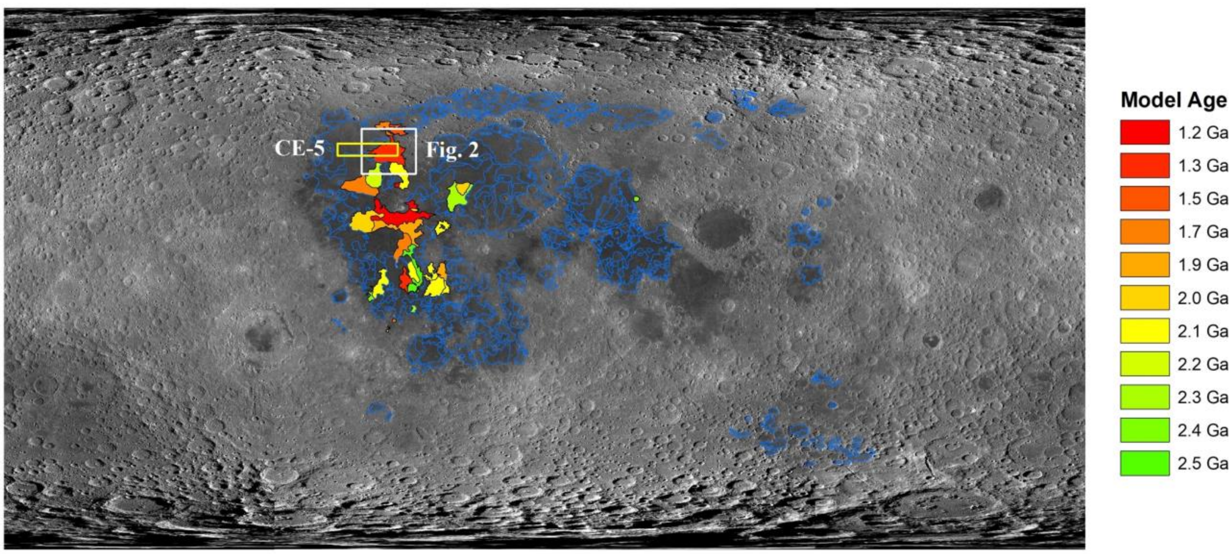

Figure 1: Locations of CE-5 landing region (yellow box, 41-45°N, 49-69°W) and young mare units on the Moon [6].

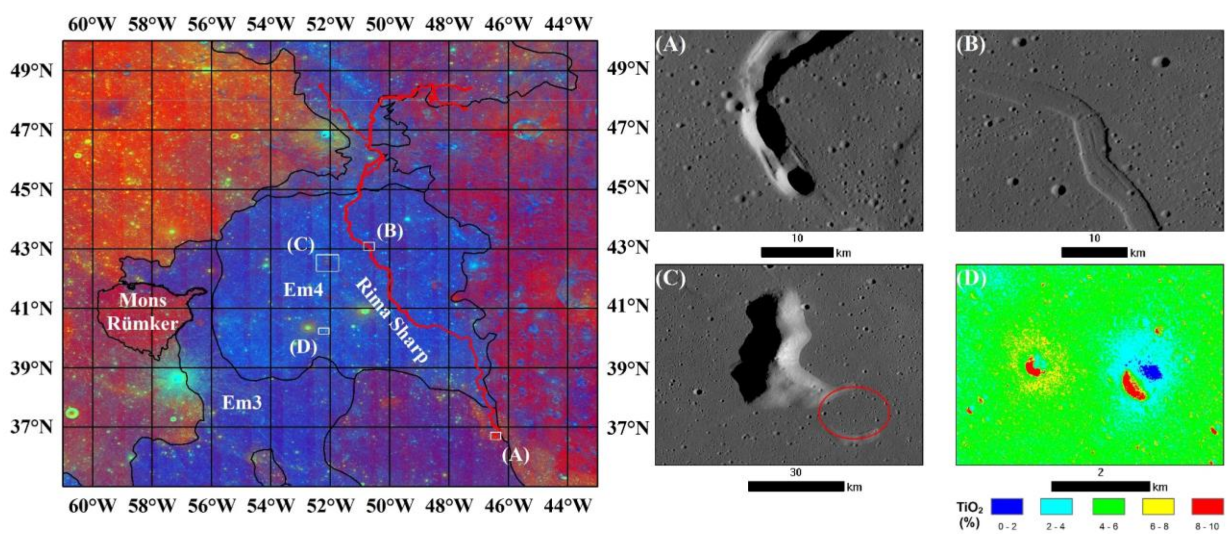

Figure 2 (Left): Young mare units (Em3, Em4) in the CE-5 landing region. The basemap is a Kaguya MI color composite map. **(Right):** (A) South vents of Rima Sharp; (B) The channel of Rima Sharp; (C) Highland mountains and a buried crater (red circle) surrounded by young basalts; (D) A nonpenetrating crater (yellow ejecta) and a penetrating crater (blue ejecta).