GEOLOGY AND SCIENCE VALUE OF THE RÜMKER REGION IN NORTHERN PROCELLARUM: CANDIDATE SAMPLE RETURN AREA OF THE CHANG'E-5 LUNAR MISSION. Y. Qian[1], L. Xiao[1], J. Zhao[1], S. Zhao[1], J. W. Head[2], J. Flahaut[3], M. Martinot[4, 5], H. Hiesinger[6], G. Wang[7] and J. Huang[1], [1]Planet. Sci. Inst., China Univ. of Geosci., Wuhan, 430074, China, (yuqi_qian@cug.edu.cn), [2]Dep. Earth, Env. & Planet. Sci., Brown Univ., Providence, 02912, USA, [3]IRAP, CNRS/UMR 5277, Univ. Paul Sabatier, Toulouse, 31400, France, [4]Fac. of Sci., VU Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands, [5]Univ. Lyon 1, ENS-Lyon, CNRS, UMR 5276 LGL-TPE, F-69622, Villeurbanne, France, [6]Inst. für Planetologie, Westfälische Wilhelms-Univ. Münster, Münster, 48149, Germany, [7]Beijing Spacecrafts, China Acad. of Space Tech., Beijing, 100089, China.

Introduction: The Chang'E-5 mission, China's first lunar sample return mission, is scheduled to launch in 2019 and is designed to bring back up to 2 kg of lunar samples from the lunar surface [1]. The candidate landing region is designated between 41-45°N in latitude and 49-69°W in longitude within northern Oceanus Procellarum, and is named hereafter the Rümker region [1]. Early geologic mapping [2] showed that Mons Rümker was the most prominent feature in this area and that it was embayed by Imbrian and Eratosthenian-aged mare basalts. Three spectrally homogeneous mare units were subdivided by Hiesinger et al. (2003) using spectral data [3], and their model ages were acquired (P9, 3.47 Ga; P10, 3.44 Ga; P58, 1.33 Ga). More detailed work recently focused on Mons Rümker and its geologic history [4]. However, the geology of other parts of the landing area is still poorly understood and there is no synthesis of the science of the entire Rümker region. Therefore, the purpose of this study is to produce a large-scale regional geologic map and to summarize the nature of the geologic units in the area to support the Chang'E-5 mission.

Data: The latest high-resolution image data were used to analyze the geomorphologic features in the region, including SELENE TC Morning Map data (10 m/pixel) and LRO WAC/NAC data. FeO and TiO_2 abundances were obtained from SELENE Multiband Imager data (MI, 20 m/pixel) [5]. A false-color map constructed from MI data, with parameters sensitive to composition and maturity [6], is also used to track variations in composition. Reflectance spectra from the Moon Mineralogy Mapper (M3) instrument, acquired during the optical period OP2C (280 m/pixel with 85 channels spanning from 430 nm to 3000 nm [7]), were mosaicked in order to study the mineralogical composition. The spectral study was performed on the M3 continuum-removed spectra obtained with the method used in [8].

Results: *Topography and geomorphology.* The Rümker region is located in the smooth plains in northern Oceanus Procellarum (Fig. 1) [9, 10], the average altitude is -1300 m and most of the region has a slope smaller than 2°. A variety of landforms that can be identified in this region. Mons Rümker is a circular volcanic complex that is ~70 km in diameter and ~500 m higher than the surrounding mare surface [10]. In addition to the domes developed in the Mons Rümker, a small dome centered at 49.85W, 43.68N, ~3 km in diameter and 170 m higher than the surrounding mare surface, is surrounded by mare basalts in the eastern landing region.

The Rümker region is covered by numbers of mare ridges, and it is clear that large and long ridges are more common in the western part of the landing region. Rima Sharp, ~1 km in width and 20-50 m in depth, is a sinuous rille in the east part of the landing region. At the bottom of Rima Sharp, some lava channels can be seen [11].

In the eastern part of Rümker region, there are many massifs that resemble the Alpes Formation [12]. They are generally variable in size and shape, and are surrounded by mare basalts.

Composition and mineralogy. The rock and mineral types are regionally different in the Rümker region. The eastern unit has a relatively higher FeO (16-18 wt.%) and TiO_2 (6-7 wt.%) content with higher albedo, while in the western part, FeO (14-17 wt.%) and TiO_2 (1-2 wt.%) abundances are lower. In addition, the western part is orange red in false-color map, which indicates this part is covered by low-Ti basalts with high maturity, and the eastern part is high titanium basalts with bluish violet color [6].

M^3 data shows that the Rümker region is dominated by pyroxene. The signature of other common lunar minerals such as olivine or plagioclase is not clear. Spectra of the area show that the pyroxene in the western part is intermediate in composition (such as pigeonite), and more high calcium in the eastern part consistent with augite and/or diopside.

Compared to the surrounding mare basalts, Mons Rümker is characterized by low TiO_2 (~2 wt.%) and FeO (~15 wt.%), and by a weak pyroxene absorption in M^3 data, which is likely indicative of a less mafic composition.

Geologic units. According to the spectroscopic observations, the mare basalts in the area can be readily subdivided into 6 geologic units (Fig. 2) numbered as R1 to R6; R7 is outside the landing region. The model ages of these geologic units were acquired using the

TC Morning Map data; standard CFSD methods, yielded ages shown in Table 1.

Results show that the western part (R1, R2, R4) of the Rümker region is much older than the eastern part (R5). R1, R2 and R4 have Imbrian ages and R3, R5, R6, R7 have Eratosthenian ages. R5 has an absolute model age of 1.21 Ga, which is the youngest geologic unit in this region, and is nearly the youngest mare unit on the Moon [13].

Craters in this region can be classified into Copernican, Eratosthenian, and Imbrian-aged craters by albedo, optical maturity and their morphology. In addition to the mare materials and crater materials, the massifs in the eastern mare can also be classified into a geologic unit that has a different composition and origin. We constructed a 1:250 000 geologic map of all geologic units and features.

Table 1. The absolute model ages of the geologic units in Rümker region.

Region	Model Age (Ga)	Stratigraphy
R1	$3.39^{+0.02}_{-0.02}$	Im2
R2	$3.42^{+0.02}_{-0.02}$	Im1
R3	$1.51^{+0.07}_{-0.07}$	Em3
R4	$3.16^{+0.06}_{-0.09}$	Im3
R5	$1.21^{+0.03}_{-0.03}$	Em4
R6	$2.30^{+0.10}_{-0.10}$	Em1
R7	$2.13^{+0.13}_{-0.13}$	Em2

Discussion: *Regional geologic evolution history.*

1. Oceanus Procellarum has been hypothesized to have formed due to a giant impact [14]. Ejecta of the Imbrium basin formed massifs in the eastern mare [12], and Iridum basin impact formed lineated terrain in the northern parts of Mons Rümker [4];

2. Rümker plateau materials erupted and formed units IR1 (3.71 Ga), IR2 (3.58 Ga), IR3 (3.51 Ga) [4];

3. An Imbrian low-Ti volcanic eruption embayed the western part of the Rümker region and formed Im1, Im2, Im3;

4. Eratosthenian high-Ti maria basalts (Em1, Em2, Em3) formed and superposed the older maria;

Proposed landing site. We propose the young high-Ti basalts as a preferred landing site. The possible lunar samples from this region could answer many fundamental questions. For example, 1) the radiometric age of the young basalt could be compared with the CSFD ages to help constraint the impact cratering flux history of the Moon and other planets, 2) the mineralogy and geochemistry could provide information on mantle properties and thermal state at this time and further constrain the lunar thermal history; 3) volatile components in glass and pyroclastic rocks could provide direct clues of mantle properties; 4) Th distribution and contents could tell us about the role of Th in late-stage mare basalt petrogenesis, etc.

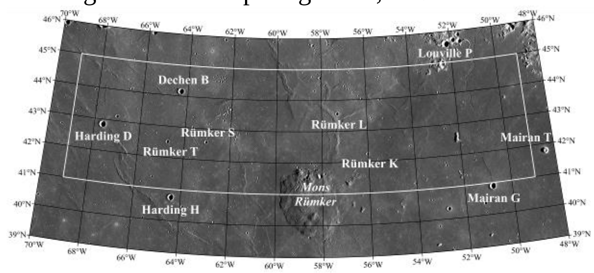

Figure 1. TC Morning Map of Rümker region (Lambert Conformal Conic Projection).

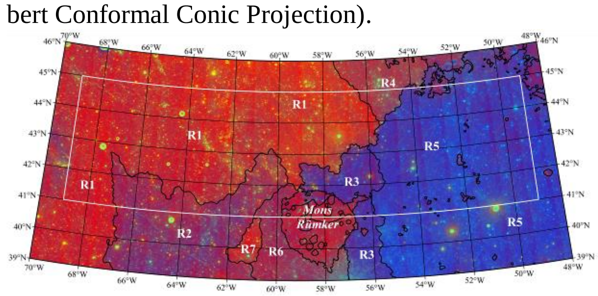

Figure 2. False-color map derived from SELENE MI data (Lambert Conformal Conic Projection). Red=750 nm/415 nm, Blue=750 nm/950 nm, Green=415 nm/750 nm.

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