NEW GEOLOGIC MAP OF THE LQ-18 (GRIMALDI) QUADRANGLE ON THE MOON. Jianzhong Liu[1,3], Ke Zhang[1,2,3], Li Zhang[1], Jingwen Liu[1,2,3], Congzhe Wu[4], Pengju Sun[1,2,3], Shengbo Chen[4], Tianqi Lu[4], Zongcheng Ling[5], Jian Chen[5], Xiaozhong Ding[6], Kunying Han[6], Kejuan Xu[6], Jianping Chen[7], Xiang Wang[7], Ziyuan Ouyang[1], [1]Center for Lunar and Planetary Science, Institute of Geochemistry, Chinese Academy of Sciences, 99 Lincheng West Road, Guiyang 550051, China, Email: liujianzhong@mail.gyig.ac.cn. [2]University of Chinese Academy of Sciences, Beijing 100049, China. [3]Center for Excellence in Comparative Planetology, Chinese Academy of Sciences, Hefei 230031, China. [4]Jilin University, 2199 Jianshe Street, Changchun 130000, China. [5]Shandong University (Weihai), 180 Wenhua West Road, Weihai 264209. [6]Institute of Geology, Chinese Academy of Geological Sciences, 26 Baiwanzhuang Road, Beijing 100037, China. [7]University of Geosciences (Beijing), Xueyuan Road 29, Beijing, 100083, China.

Introduction: Lunar geologic maps are an integration of the morphology, lithology, chronostratigraphy, tectonism, and volcanism of the Moon. China's lunar exploration project has achieved historic breakthroughs (CE-1, CE-2, CE-3, CE-4). Chinese lunar geologic mapping program on a scale of 1:2.5M is nearing completion[1, 2]. We had completed geologic map of LQ-18 (Grimaldi).

Study area: Grimaldi (LQ-18) map is in the range of 90°W ~ 45°W, 0°~ 30°S, which is located in the mid and low latitudes of the southern hemisphere on the front of the moon. Mercator projection is used. The scale is 1:2,500,000. The area is about 1.25 million km^2. The elevation ranges from -4,161 to 4,697.5 m, and the average elevation is -242.1 m (Figure 1).

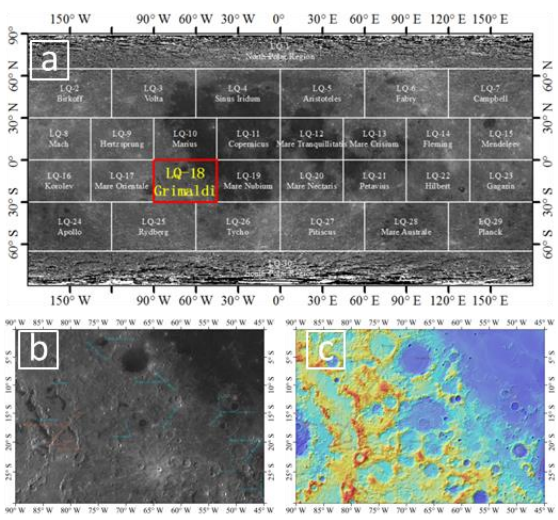

Figure. 1 (a) Geologic map of the moon, nomenclature and numbering, and the location of LQ-18 on the lunar surface is marked with a red outline. The background is the Chang'e-1 CCD image mosaic. (b) photographic map of the Grimaldi (LQ-18). (c) Topographic map of the Grimaldi (LQ-18).

Data and Method: This mapping program mainly relies on data from Chinese lunar exploration missions, including CE-1 images (120 m/px), CE-2 images (50 m/px), imaging interferometer spectral data (200 m/px), X-ray and Gamma-ray Spectroscopy (5°×5°) data of CE-1. Data from other countries' missions (e.g. Lunar Reconnaissance Orbiter , Chandrayaan-1, Clementine) are used to complement these data. The software tool, ESRI ArcMap, is used to compile the LQ-18.

Result and Discussion: Considering lunar geologic/geodynamic processes and history, we use a new lunar chronology subdivision in this geologic map, three Eons (Neolunarisian/NL, Paleolunarisian/PL and Eolunarisian/EL) and six periods (Magma oceanian/MO, Aitkenian/A, Necterian/N, Imbrian/I1&I2, Eratothenian/E and Copemican/C)[3, 4].

Impact crater materials: According to the craters formation mechanism, crater materials characteristics and the distribution characteristics, impact craters are divided into five categories (as shown in table 1), and the typical crater materials are divided into five units (as shown in table 2). In the Grimaldi (LQ-18) geologic map, there are 172 craters with diameters greater than 10 km, 22 craters with age among them. Due to the variety in the size and age of the craters, the subunits of crater materials in some craters are incomplete. In addition, it should be noted that except for the Copernican age, the crater materials of other periods could not recognize discontinuous ejecta materials any more.

Table 1. Statistics of crater's types

Crater type \ Era	Copernican	Eratosthenian	Late Imbrian	Early Imbrian	Nectarian	Aitkenian	Total
Blow crater	0	0	0	0	0	0	0
Smooth floor crater	1	0	0	0	0	0	1
Hummocky floor crater	0	0	0	0	7	0	7
Terrance crater	0	2	3	0	6	0	11
Central peak crater	0	1	2	0	0	0	3

Table 2. Statistics of craters' subunit materials

Crater type \ Era	Copernican	Eratosthenian	Late Imbrian	Early Imbrian	Nectarian	Aitkenian	Undivided age	Total
Central peak materials	0	1	2	0	4	0	1	10
Floor materials	1	3	7	1	8	4	1	24
Wall materials	1	3	7	1	10	16	1	45
Continuous ejecta	1	3	7	1	8	5	1	31
Discontinuous ejecta	1	0	0	0	0	0	0	2

Large basin formation: There are five basins in this map. Orientale basin formed in Imbrian and are widely distributed in central and western part in this

quadrangle. In the lower right corner of the map is Humorum basin in Necterian, which occupies only a quarter of the total area of Humorum basin. Grimaldi basin, Cruger-Sirsalis basin, Flamsteed-Billy basin are belong to Aitkenian. Only little partially Flamsteed-Billy basin wall and rim are preserved due to the filling of the volcanic basalt. Due to the destruction of late geological processes, most of basins remain only partially formation units.

Rock type: Ferroan anorthosite accounts for about 90% of the area of the whole map. The mare basalt is distributed in a small amount, accounting for about 8% of the area of the map, and mainly located in the floor of Humorum basin at the northeast corner of the map. Intermediate-Ti mare basalt and High-Ti mare basalt are mainly distributed at the bottom of the PKT ocean, and Ultralow-Ti mare basalt is mainly distributed in the southern part of the Humorum Basin. According to the model age obtained from the crater frequency size distribution, the PKT basalt formed about 3.4 billion years ago[5, 6]. Non-Mare Basalts are mainly Ferroan anorthosite (FA), Magnesian anorthosite (MA) and KREEP rock. FA is distributed in all areas except the PKT Basin. MA is scattered in the east. Ferroan norite is distributed slightly in the rim formation of Humorum basin.

Structure: The structures are relatively developed and there are many types of structures in LQ-18 map. The lunar graben is the linear structure with the most abundant and widely distributed. Lunar graben is widely distributed in the middle and east of the map. The other main feature is the ridge, mainly in the distribution of the PKT. The other part is the crater floor fracture, mainly distributed in Mare Orientale basin.

Table 3. Statistics of structure types in Grimaldi (LQ-18) geologic map

	Endogenic process							Exogenic process	
Linear Structures	Subsurface fracture	Surface fracture	Lunar graben	Wrinkle ridge	Rille	Crater-Floor fracture	Lobate scarp	Impact fault	Crater chain
number	0	17	131	447	14	485	0	23	0
Circular Structures	Dome	Volcano	Mascon					Basin	Crater
Number	1	20	1					5	172

Conclusion: Based on the above results, the geologic map of LQ-18 (Grimaldi) was shown in Figure 2.

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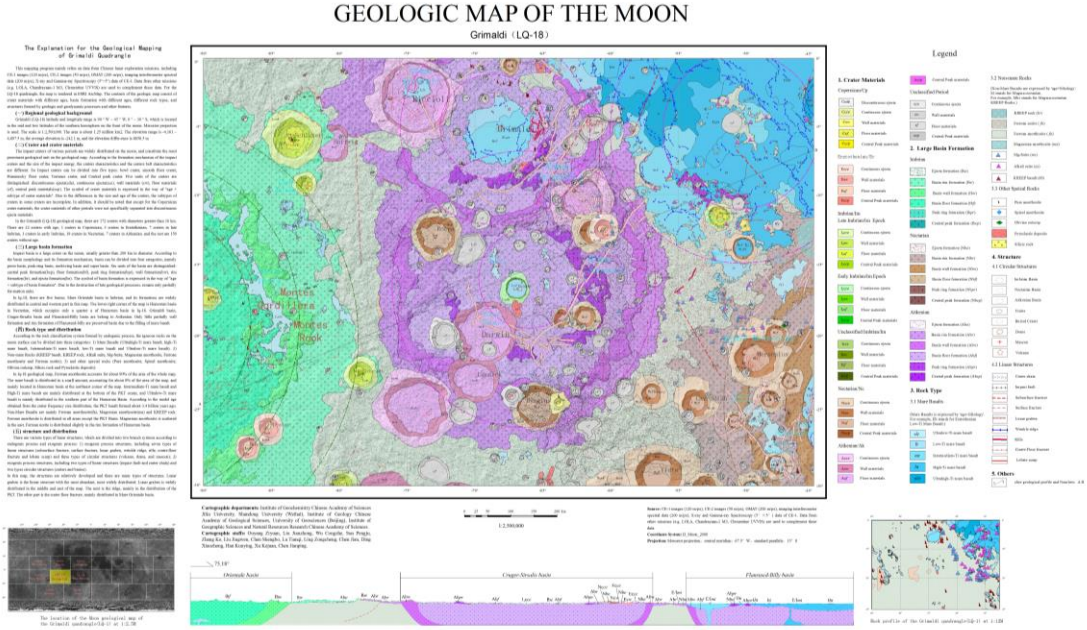

Figure. 1 Geological map of the LQ-18 (Grimaldi) quadrangle