YOUNG WRINKLE RIDGES AROUND CHANG’E-3 LANDING SITE.  Y. Lu¹, Y. Z. Wu², ¹School of Geographic and Oceanographic Sciences, Nanjing University, Nanjing, 210023, China (yulu@smail.nju.edu.cn), ²Key Laboratory of Planetary Sciences, Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing, 210008, China.

Introduction: Recent studies found that there are a lot of young tectonic activities on the moon by means of Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) high resolution images, such as lobate scarps, wrinkle ridges and graben [1-6]. Lacking large superposing craters and crosscutting small fresh craters, these tectonics are widely accepted to belong to Copernican age (<1Ga) [1,7]. Additionally, the discovery of graben with depths as shallow as 1m indicates that they are less than ~50 Myr old according to the regolith infilling rates [3]. Moreover, based on the crater size and degradation method, [4] derives a maximum age (~40 Ma) of a small wrinkle ridge in Mare Frigoris using the model age of the smallest crater crosscut by this wrinkle ridge. This could be the youngest tectonic activity on the moon, indicating that the moon is probably still active today.

At 13:11:18 UTC on December 14 2013, the Chang’E-3 (CE-3) spacecraft landed in northern Mare Imbrium (44.1196° N, 19.5124° W, elevation = -2638.5 m [8]). From the images taken by the two cameras aboard the CE-3 spacecraft (the Panoramic Camera (PCAM) aboard the rover and the landing camera on the lander), we can clearly see that small wrinkle ridges (several meters long) passed the CE-3 landing site (Fig. 1) [9], while it’s hard to recognize them on correspondent LRO NAC images. So, we guess there are many small wrinkle ridges undiscovered before as limited by topographic resolution. In other words, wrinkle ridges are probably widely distributed.

When turning our gaze to the north of CE-3 landing site, we find that there are many young wrinkle ridges developing on top of a large wrinkle ridge (Fig. 2a). To figure out the formation ages of these young wrinkle ridges, we select several typical ones for study (Fig. 2).

Data and method: Using Integrated Software for Imagers and Spectrometers (ISIS), LRO NAC images (0.5-2m/pixel) [10] were calibrated and projected and then imported into ArcGIS. For every single wrinkle ridge, we used the buffered crater count (BCC) in the CraterTools [11] to count the buffered area and superposing craters [12,13]. Wrinkle ridges were described as polylines in ArcGIS, and craters only superposing the steep slope of wrinkle ridges were counted to make sure that these craters were formed after the formation of the wrinkle ridges. Using the BCC tool, we generated one buffer area (A) for the counting area according to the radius of every single superposing crater so that every crater made its own density contribution of 1/A to the population [13]. All the densities acquired above were exported into Craterstats [14] to derive the absolute model ages using Neukum’s production function and chronology function [15].

Fig. 1: Small wrinkle ridges pass the CE-3 landing site. (a) LRO NAC image M1144936321LE. (b) Image from CE-3 landing camera. (c) Yutu Panoramic Camera (PCAM) mosaic. Red arrows show possible ridges. As indicated by the red dashed arrow in (a), a shallow topographic low may separate the small ridges and the rim of the 450-m CE-3 crater.
Results: Since there are few craters superposing every wrinkle ridge, we applied the BCC method to 11 wrinkle ridges (Fig. 2a) on the north of the CE-3 landing site, and got our crater size-frequency distributions (CSFDs) (Fig. 3).

Just like the resurfacing process [13], the distribution plot is ladder shaped, which indicates that wrinkle ridges developed gradually. Secondly, consistent with recent studies, the youngest wrinkle ridge in our study is ~530 Myr old (Copernican age). Correspondingly, the oldest age (~2.63Ga) may belong to the largest wrinkle ridge, which is clearly identified, and the tectonic activities last a long time (almost 2Ga).

Discussion: The oldest age (~2.63Ga) also conforms with previous studies which inferred wrinkle ridges formed after the emplacement of mare basalts [7,17], since we derive a 3.49Ga of the upper unit (Fig. 2a) in our previous work [9]. It also proves the reliability of our results in some way. Compared to the traditional CSFD method, this BCC method is independent of special geological units, so it may be a good way to define the ages of linear tectons (eg., lobate scars, wrinkle ridges, valleys) [12,13].

Conclusion: The PCAM and landing camera aboard the CE-3 spacecraft detected several small wrinkle ridges which were undiscovered before, suggesting that wrinkle ridges may be widely distributed on the moon. Furthermore, the extensive distributions of young wrinkle ridges reflect a global compressional stress, which probably indicates that the Moon’s interior is cooling step by step [16]. The youngest wrinkle ridge (~530Ma) in our study further shows that maybe the moon is still active today.

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