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# Chang'E-1 orbiter discovers a lunar nearside volcano: YUTU Mountain

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**In the day time of the Moon surface, the strong illumination from high altitude and high albedo rate radical craters will introduce the illumination effect on observing the nearby low altitude, low albedo rate and shallow small slop rate area seriously, and even can "hide" the later area from the light. Based on the lunar global topography model obtained by Chang'E-1 mission, and by comparing with the lunar gravity model, a volcano named "YUTU Mountain" has been identified. It is a volcano with diameter of ~300 km and height of ~2 km located at (14°N, 308°E) in Oceanus Procellarum. Besides, the DEM of another volcano named "GUISHU Mountain" in the same area has been improved. This new discovery will benefit the study of lunar magmatism and volcanism evolution in the nearside of the Moon.**

Chang'E-1, lunar topography, volcano, YUTU Mountain

Since the first detection of lunar global topography by the Clementine mission[1,2], a long period of silence had elapsed before the two new laser altimeters aboard the Japanese lunar explorer Selenological and Engineering Explorer (SELENE//KAGUYA) and the Chinese lunar orbiter Chang'E-1 (CE-1) independently obtained the highly similar lunar global topographical maps that help improve basic parameters of the lunar form and shape with extremely high resolution and precision. These advanced instruments were named STM359_grid-02[3] and CLTM-s01[4], respectively. CE-1 also obtained lunar global image with a resolution of 120 m, which will help improve the studies of lunar craters[5].

Through frequency-domain (coherence and admittance) and spatial-domain analysis, our new maps are compared with the existing lunar global gravity models such as LP150Q[6] and SGM90d[7] to study the dichotomy and the subsurface structure of the Moon in detail. As shown in Figure 1, the lunar topography and gravity are found to be strongly coherent at the middle wavelengths (100—300 km). Although this is not revealed in the figure mainly because of poor resolution of the gravity model at higher frequencies, strong coherence should be expected at shorter wavelengths. Some researcher also used the method of seismic tomography to study the inner structure of the Moon[8].

Comparing the CLTM-s01[4] grid map (0.0625°× 0.0625°) with ULCN2005[9] and the Clementine image data (http://www.lpi.usra.edu/resource/mapcatalog/), we notice some new features at the middle and shorter wavelengths[10], from which we have identified a large volcano highland. This finding is also supported by the STM359_grid-02 model[3].

In the area of (0°N~30°N, 300°E~330°E) in the Oceanus Procellarum, two highlands are clearly shown in the western region (Figure 2). The one in the north

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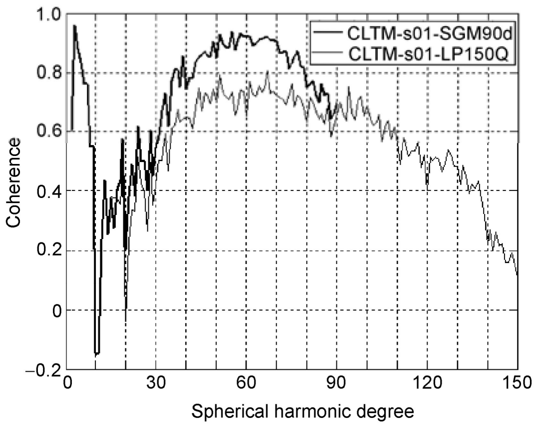


**Figure 1** Coherence between CLTM-s01 and gravity models LP150Q and SGM90D.

(25°N, 310°E) has a diameter of ~250 km and an altitude of ~3 km, which can be identified in the camera images from most missions. The radial impact craters, the Aristarchus and Herodotus, as well as the Vallia Schroteri are located in this area. The one in the south, inside the solid black circle of Figure 2, has a diameter of ~300 km and a height of ~2 km from the bottom of the basin, with its center located at (14°N, 308°E). Before they are officially recognized, we call the northern and southern highlands GUISHU and YUTU Mountains, named respectively after the cherry bay and the jade rabbit from an ancient Chinese legend. Both of them can also be clearly seen in STM359_grid-02.

In the early gravity data of the LP150Q model, evidence of positive gravity anomaly of ~250 mgal at the YUTU Mountain has been noticed (see Figure 2). However, its high altitude could not be seen either in the Clementine mission or in the CE-1 camera image. The Clementine laser data even missed it altogether. In the DEM of ULCN2005, the YUTU Mountain area shows a weak apophysis, or a flat gradient dome similar to the relief of a lunar mare. The LPI lunar map shows complicated relief characteristics (such as the radial line, the mountain, the crater, the valley and the rims) in the GUISHU Mountain area. However, in the YUTU Mountain vicinity that looks like a very simple geological area, only the Crater Marius and Rima Marius have been identified and named. Before the CE-1 and SELENE missions, we even guessed that there should be some hidden mass under the surface of this region.

We attempt here to provide a reason why the YUTU Mountain has always been hiding away from optical detectors. The slope rates for the YUTU on its west and east sides are only 1% and 2% respectively. In earlier archival images and the image obtained by the CE-1 camera (see Figure 2), it is found that, due to the special illumination effects in the day time[11], the strong illumination from two big nearby radial compact craters, the Aristarchus and the Kepler, is hiding the whole area of the YUTU Mountain with very low albedos and also part of the GUISHU Mountain, especially the sides with

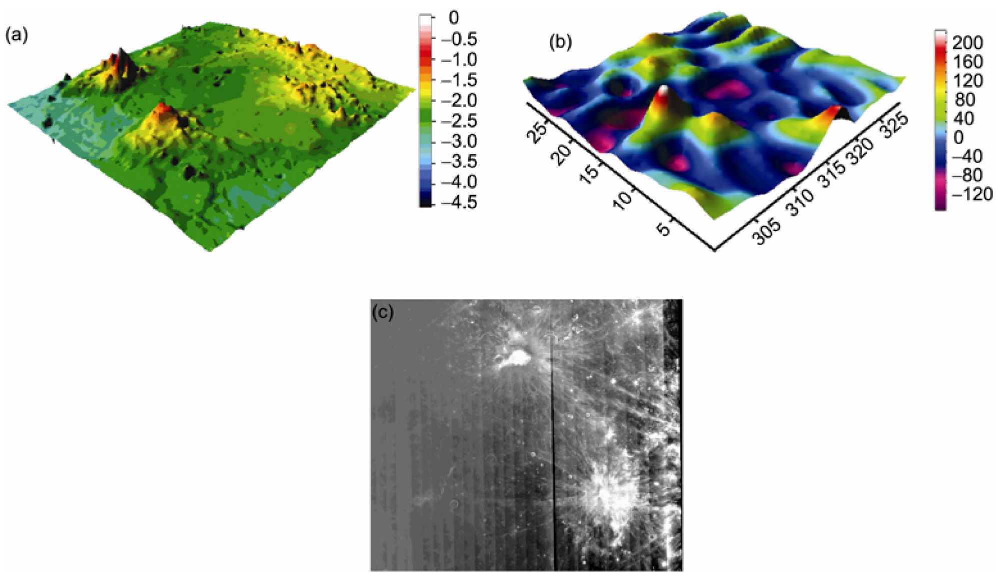


**Figure 2** Regional lunar topography, gravity anomaly, and images of GUISHU and YUTU provided by the CLTM-s01 (a), LP150Q (b) and CE-1 camera data (c).

gentle slopes. Neither polar orbital missions nor low-inclination missions can image the YUTU area as a result of severe limitations due to the strong illumination effects. Such effects may also come from the famous Copernicus Crater lying in the south-eastern direction some distance away. For this reason, even powerful optical telescopes on the Earth could not identify the YUTU Mountain in the long human history.

The two mountains are located in the igneous area of Oceanus Procellarum. Early studies indicated that the domes in various scales such as the YUTU and GUISHU Mountains in the lunar mares were believed to be volcanic shields[12,13]. At the south-west bottom of the YUTU Mountain, a relief that looks like flow fronts appears beside the Reiner Gamma near the impact crater Reiner and places surrounding the Mountain. As revealed by Figure 2, terrain and gravity have highly positive correlation at the YUTU Mountain; in contrast, highly negative correlation appears at the GUISHU Mountain and at locations such as (8°N, 308°E), (2°N, 317°E) and their neighborhoods. Either four mantle plumes may be implied under them, or the YUTU Mountain and the area surrounding (2°N, 317°E) may be standing on two separated channels that could have originated from the same plume. The strong positive and negative correlations between the terrain and gravity data may reveal the existence of some very complicated, alternating geological features lying in this area. The relationship between the topography and gravity in this area strongly supports the original idea of a shielded volcano.

The similar relief, gravity and optical characteristics of the GUISHU and YUTU Mountains imply that they may have similar origins and evolution histories. Their geological eras are probably before the Mare Imbrium but after the Oceanus Procellarum. The low crater density and volcanic relief of the YUTU may also imply a younger Lower-Imbrium Series. The topography and relief of this area is more complicated than our current knowledge could explain. The SELENE data with higher spatial resolution and data to be obtained from future missions may benefit further detailed investigation of this area.

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