ELEVATION DIFFERENCES ON THE FLOORS OF COMPLEX CRATERS: INSIGHTS INTO THE CRATER EVOLUTION PROCESSES Deepak Dhingra[1], James W. Head[2] and Carle M. Pieters[2], [1]Dept. of Physics, University of Idaho, Moscow, ID 83844 (Email: deepdpes@gmail.com), [2]Dept. of Earth, Environment and Planetary Sciences, 324 Brook Street, Box 1846, Providence, RI 02912.

Introduction: Crater floors, especially at large craters (i.e. complex craters and above), represent a chaotic landscape and are the product of continuous evolution during the cratering process. Starting with the compression of the material at the impact point and immediate vicinity, rapid expansion into a transient cavity is facilitated by the excavation and displacement of the material (along with melting). The floor region finally takes shape during the modification process wherein the displaced and melted material, that failed to escape, starts to accumulate on the crater floor as the crater units take form [e.g. 1, 2]. The formation of terraces, central peaks, peak rings and rings in complex craters and basins add further complexity to the crater floor terrain [e.g. 3, 4, 5]. Crater floors, therefore, represent a rich repository to study the details of the cratering event.

Here, we document elevation differences between large, coherent floor sections of complex craters and explore the likely geological scenarios which could have led to the observed differences in surface elevation. This effort represents part of an ongoing survey of complex craters aimed at understanding the dominant controls of the crater formation process under different geological settings.

Dataset and Methods: There are two primary datasets that have been used in this study: elevation data and panchromatic surface imagery. We have used digital elevation models (DEMs) derived from Lunar Orbiter Laser Altimeter (LOLA) instrument [6] which is onboard Lunar Reconnaissance Orbiter (LRO) spacecraft [7]. The DEMs have a resolution of 512 pixels per degree. The panchromatic imagery, used for obtaining the geologic context, is from Kaguya Terrain Camera (TC) [8] and has a spatial resolution of 10 m/pixel.

We have used the TC data of various craters to define the boundaries of the crater floors and subsequently used this spatial extent information to extract crater floor surface elevations from the available DEMs. The two datasets (crater floor DEM and panchromatic imagery) are then merged to explore the variation in floor elevations and the corresponding geologic context.

Observations: We note significant elevation differences on the crater floor and occurrence of large coherent floor sections having uniform elevation. The elevation differences could exceed 500 m, between the lowest and the highest elevations on the crater floors. In certain cases (e.g. Tycho crater, 85 km diameter), the floor sections are largely un-interrupted and the entire section has similar surface elevation (Figure 1). The elevation differences at Tycho were also noted by [9] based on radar observations.

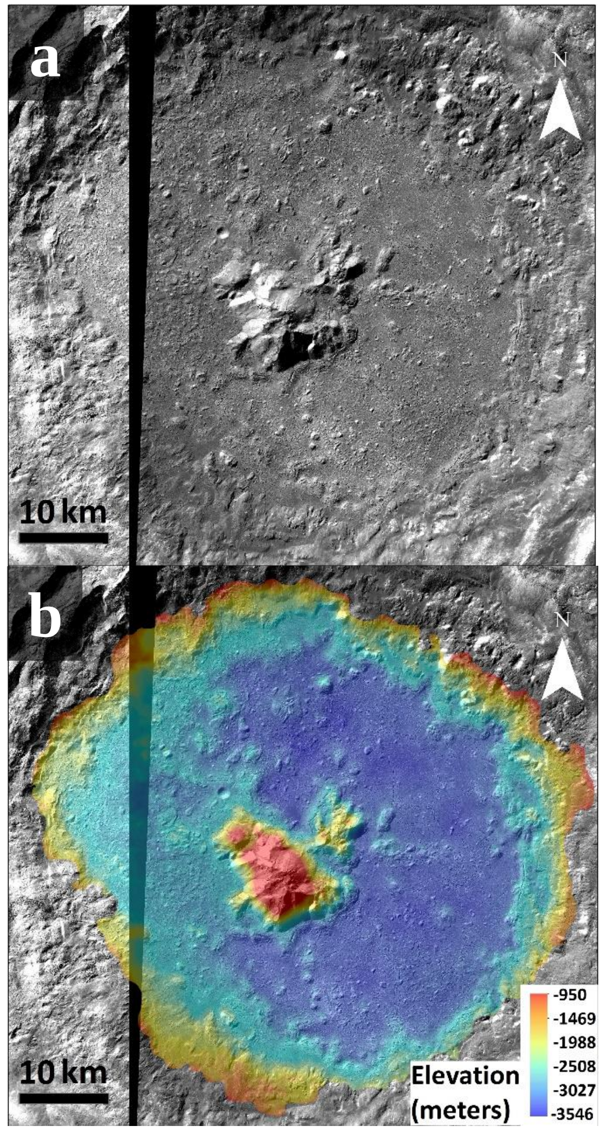

Figure 1 Coherent floor sections at different elevations at Tycho crater. (a) Kaguya TC image of Tycho. (b) Kaguya TC image overlain by LOLA derived DEM.

However, in other cases (e.g. Jackson crater, 71 km diameter), the largely coherent floor sections are locally interrupted, sometimes leading to significant differences in elevation (Figure 2) within the floor section. In this context, Copernicus crater (96 km diameter) also provides an interesting floor surface elevation setting. Based on our earlier work [10], we documented a large, depressed floor region in the north-central part of the crater floor. However, in addition to this coherent unit at lower elevation, there is a small depressed region in the southern part of the floor region that shares the same elevation characteristics (as the northern depressed region). The two regions are separated by a large cluster of central

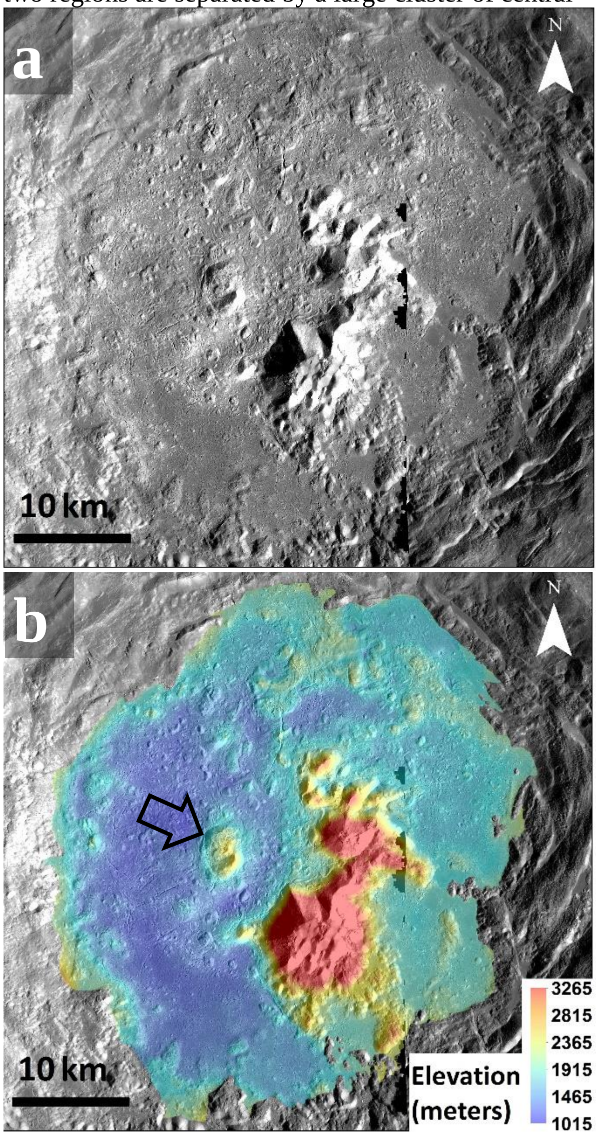

Figure 2 Coherent floor sections at different elevations at Jackson crater. (a) Kaguya TC image of Jackson. (b) Kaguya TC image overlain by LOLA derived DEM. Notice the high elevation unit (marked by arrow) located within the low elevation unit (deep blue color).

peaks. It is not clear at the moment whether the two regions have any genetic linkage (i.e. whether the two depressed regions originally formed a single coherent floor unit) but it represents an interesting example of an interrupted low elevation floor section.

Discussion and Implications: The observed elevation differences between coherent sections of the crater floors at various craters and their intrinsic peculiarities likely represent different crater evolution pathways that were guided by various controlling parameters. These observations therefore represent an important database to understand the evolution of the crater floors during the cratering process. It is also interesting to note that the three craters described above, are located in geographically different regions of the Moon and therefore do not represent a local anomaly.

Several geological scenarios are plausible and may have caused the observed differences in floor elevation within a crater: a) differential subsidence of the floor during cooling of the melt column [e.g. 11], b) collapse of a wall section that could pile up material on the adjacent crater floor [e.g. 9, 12] and cause floor elevation differences, c) role of impact conditions including impact direction, impact angle, pre-impact topography [e.g. 12] and d) structural failure of the floor section along a major plane of weakness.

The elevated western floor section of Tycho could have formed by the collapse of the south-western wall section and is consistent with previous work [12, 13]. However, a late stage structural failure of the crater floor is also a plausible based on our recent geological mapping of the crater floor [14]. The cause for floor elevation differences at Jackson is less obvious. High elevation eastern crater floor aligns with the wide south-eastern wall suggesting wall collapse as the likely cause. However, the striking smoothness of the crater floor adjacent to the south-eastern wall and the lack of any rough debris (resulting from wall collapse) makes it difficult to confirm wall collapse as the cause of observed floor elevation differences. Analysis of additional craters will provide further insights into the evolutionary controls of the crater floors.

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