# LUNAR CRATER PEAK AND PEAK-RING VOLUMES FROM THE LROC GLOBAL LUNAR DTM 100

V. J. Bray*[1], C. Atwood-Stone[1] and A. S. McEwen[1]. [1]Lunar and Planetary Lab., University of Arizona, Tucson, AZ 85721, USA. *vjbray@lpl.arizona.edu

**Introduction:** The transition from central peak craters, to peak-ring basins, to multi-ring basins has been an important area of lunar cratering studies for decades. Many different theories have been suggested to explain the transition from peak to peak-ring basins on terrestrial bodies [1,2,3 and many more!]. These theories have been constructed using terrestrial structural data, theory, hydrocode simulations, and most commonly on the basis of crater morphology catalogs. The trends in central feature (CF) diameter with growing crater rim diameter (D) have been used to support multiple theories. Estimates of the volume and heights of these features are less common [4] and could prove important for testing different theories.

**Model Predictions:** For peak-ring formation via the downward and outward collapse of a large transient central uplift [e.g. 1], peak heights and volumes should increase until the peak to peak-ring transition (PRT), CF height should decrease at the transition. In a simplified model, the volume of material comprising the CF should scale linearly (relative peak volume should be conserved across the PRT). Models in which the peak-ring is created due to the collision of collapsing peak and rim material [e.g. 2] also predict a decrease in peak height at the PRT. CF volume would increase at the PRT as the incoming rim material adds to the peak volume. A third hypothesis suggested by [3] is the nested melt cavity model. This model would predict that as crater size increases less of the central uplift protrudes through a growing melt-sheet thickness. This would lead to a decrease in peak heights and volumes *before* the PRT. At the PRT the amount of melt in the crater cavity is large enough to prevent surface expression of the central uplift, instead only the uplifted periphery of the melt cavity remains topographically prominent, and the uplifted volume is expected to be relatively small [5]. In this abstract we present volume and height measurement of the central features of lunar complex craters, protobasins, and peak-ring basins.

**Method:** Each crater used in this work and its surrounding area were cropped from the Global Lunar DTM 100 [6]. For collection of CF volumes, the cropped DTM of each crater was entered

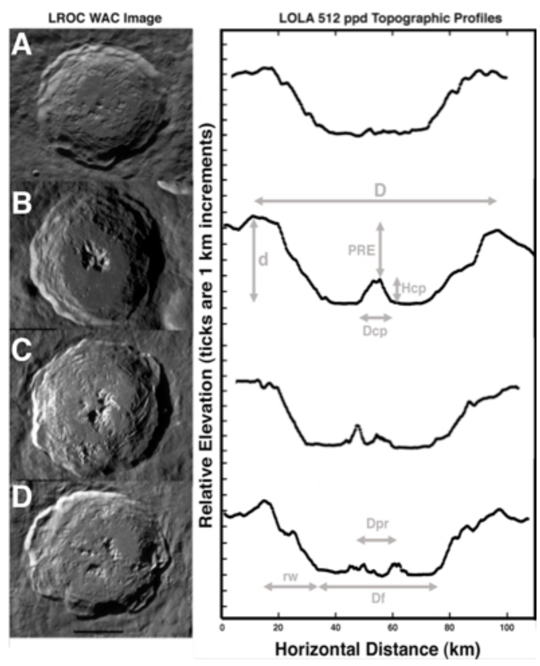


**Figure 1:** Images and topographic profiles of the four morphological types noted in this work: A) Dispersed peak, B) Peak, C) Ring of Peaks (and D) Peak-ring. Measurements taken in this work are marked onto the topographic profiles in gray. Crater diameter (D), depth (d), floor diameter (Df), rimwall width (rw), central peak diameter (Dcp), height (Hcp), peak-ring diameter (Dpr), and the distance from peak or peak-ring tip to average rim elevation (PRE).

into ArcMap (www.esri.com). The extent of the peak or peak-ring was defined by image and DTM.The crater floor surrounding the peak/peak-ring was used to define a sloped base to the feature, rather than assuming a flat plain. The volume was then computed above this sloped plain. Crater dimensions were measured from profiles extracted from the DTM *(e.g. Figure 1).* As CF height can be decreased by later infill and degradation of topography, peak-rim elevation (PRE) was measured - the averaged crater rim elevation to the highest point on the central feature.

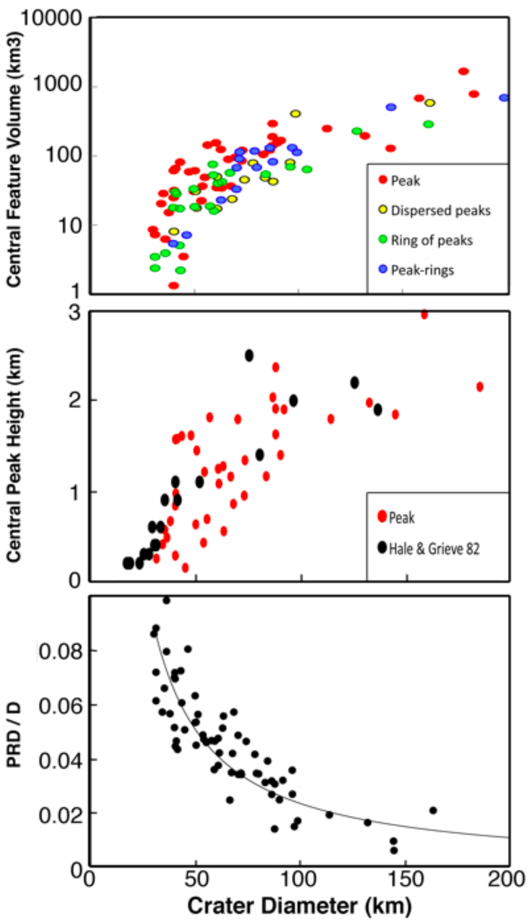


**Figure 2:** Crater dimensions relative to crater rim-to-rim diameter. Top) Central feature volume. Middle) Central peak height from this work and from Hale and Grieve, 1982. Bottom) Peak-to-rim elevation normalized to crater diameter.

**Results and Discussion:** Figure 2A shows that volume of CFs in lunar craters increases as crater diameter increases, with a relative decrease in volume at crater diameters of ~ 60 km. Analysis of the separate crater-types shows that changes in the CF volume are ***not*** simply associated with the transition from central peak to peak-ring morphology, as each crater type shows the same trend. A lack of increase in CF volume does not support the formation of peak-rings via the collision of collapsing rim and peak material. Also, lack of a more pronounced decrease in CF volume for peak rings does not support the nested melt cavity model as envisioned by [Head 2010]. More complex investigation of these peak-ring formation mechanisms requires the incorporation of crater cavity volumes.

Figure 2B shows that peak heights (as measured from the crater floor) decrease at crater diameters of ~ 60 - 100 km, as predicted by all theories assessed in this work. However, Figure 2C shows a smooth decreasing trend in PRE/D with increasing crater size (Figure 2C)., with no similar statistically significant inflection at crater diameters of 60 – 100 km. This suggests that the decreased slope in peak height vs D at crater diameters of ~ 60km is due to increased crater infill, not necessarily the collapse of the central feature itself.

The conclusions presented here are based on simplified predictions of peak-ring formation models. The role of impact melt sheet volume and other factors that may obscure some CF volume are to be incorporated.

**References:** [1] Baldwin (1981) LPSC 12:275-288. [2] Collins et al. (2002) Icarus 157:24-33. [3] Grieve and Cintala, (1992) Meteoritics 27:526-538. [4] Hale and Grieve (1982) JGR 87:A65-A76. [5] Head (2010), GRL 37:L02203. [6] Scholten et al., JGR, in press.