PRELIMINARY MEASUREMENT OF DEPTH-TO-DIAMETER RATIOS OF LUNAR CRATERS IN THE TRANSITION REGIME BETWEEN COMPLEX CRATERS AND MULTIRINGED BASINS. Michael M. Sori[1] and Maria T. Zuber[1], [1]Dept. of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambrdige, MA, 02139 (mms18@mit.edu).

Introduction: The new data received from the Lunar Orbiter Laser Altimeter (LOLA) instrument [1] aboard the Lunar Reconnaisance Orbiter spacecraft are providing the most spatially dense and accurate measurements of lunar topography to date. LOLA profiles are particularly well suited for the quantitative characterization impact structures, in order to elucidate the nature of the process of hypervelocity impact crater and basin formation and modification. In this study, LOLA data are used to characterize morphology and estimate the depth-to-diameter ratios of lunar impact craters in the transition regime between complex craters and multiringed basins.

Depth-Diameter Relationships of Lunar Craters and Basins: Impact craters and basins are the most pervasive distributed features of lunar topography. These structures follow a size-morphology sequence. From smallest to largest, this sequence is: microcraters, simple craters, complex craters, multiringed basins. In previous study, it was observed that transitions between these crater types are gradual [2]. The transition zone between complex craters and multiringed basins on the Moon occurs approximately for diameters in the range of 130 km to 280 km [3].

Simple lunar craters have a constant depth-diameter ratio of approximately 1/5, but this ratio changes in the transition zone between simple and complex craters [4]. But in the transition zone between complex craters and multiringed basins, the change of the depth-diameter ratio with increasing crater-basin size has not yet been systematically measured. An understanding of these ratios will allow investigation into both impact processes [2] and subsurface lunar structure [5].

The earliest accurate evaluations of the relationship between depth and diameter were done using terrestrially based shadow measurements in the 19th century [6] and later using telescopic measurements [4]. The Apollo program then added more accurate data via photographs and the 1:250,000 Lunar Topographic Orthophotomaps [4]. Dimensions of 280 lunar craters were compiled and published [7]. Most recently, the Clementine mission of 1994 provided yet more accurate topographic data with the Laser Image Detection and Ranging (LIDAR) system. The dimensions of large lunar craters were re-examined using Clementine data [5].

LOLA Observations: Now, LOLA and LRO have provided the most accurate and extensive topographic data ever taken for the Moon. LOLA provides both more highly-resolved data than Clementine and a more complete coverage of the lunar surface. This data can be used to accurately calculate depth-diameter ratios of craters in the desired transition range between complex craters and multiringed basins and compare them to results previously obtained. Other aspects such as wall, floor, central peak and ring structure can also be characterized quantatively.

LOLA [1] ranges to the surface with 5 beams, 10-12 m apart, distributed in an X-pattern, at a rate of 28 Hz. In the LO mapping orbit, the instrument has 5-m spots on the lunar surface spaced ~50 m along track. The range precision of the instrument is 10 cm and the radial accuracy using preliminary navigation orbits is a few tens of meters.

Procedure: In order to examine the depth-diameter ratios in the desired transition zone, the LOLA data has been used to study eleven impact features with diameters between 135 km and 277 km. These craters were chosen with the aid of the US Geological Survey Professional Paper 1348 [3]. The eleven craters and their diameters are listed below in Table 1.

Table 1: Craters Considered (with diameters)

Antoniadi	135 km
Compton	162 km
Petavius	177 km
Gauss	177 km
Humboldt	207 km
Landau	221 km
Campbell	225 km
Clavius	225 km
Schwarzschild	235 km
Milne	262 km
Gagarin	277 km

For each impact feature, altitude profiles were extracted from a topographic map provided by the LOLA science team [8] using a software program [9]. Accurate depths are estimated for each crater, so that depth may be plotted as a function of diameter for the eleven impact features.

Many data points are taken from each crater profile are averaged to get a result for the crater bottom's altitude. Only points corresponding to the crater bottom are considered; points corresponding to crater walls or peak rings are omitted. Furthermore, profile points that correspond to smaller "subcraters" from other direct impacts or ejecta are excluded. Eight such profiles are taken for each crater along different directions, and a final measurement for the altitude of the crater bottom is reached. This altitude is subtracted from the altitude of the crater rim to get a result for crater depth.

Two profiles for the smallest impact feature studied, Antoniadi, are given in Figs. 1 and 2. An image of the Antoniadi, with the tracks for these profiles, is given in Fig. 3. Antoniadi has approximate coordinates 188 E, 70 degrees S, and a diameter of 135 km. Its size places it at the lower bound of the transition phase from complex crater to multiringed basin.

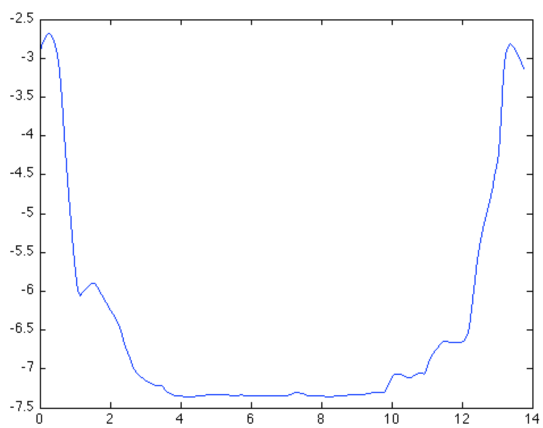

Fig. 1. Profile of Antoniadi, in the latitudinal direction. Units are in degrees (x-axis) and kilometers (y-axis)

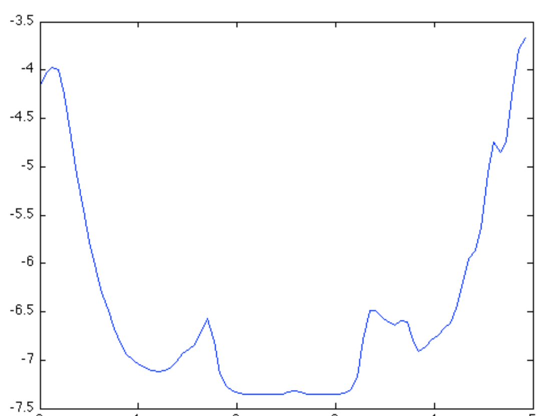

Fig. 2. Profile of Antoniadi, in the longitudinal direction. Units are in degrees (*x*-axis) and kilometers (*y*-axis)

For the latitudinal profile of Antoniadi (Fig. 2), points between x=4 and x=8.5 are considered, and for the longitudinal profile (Figure 3), points between x=2 and x=3 are considered. These two profiles give altitudes for crater bottoms as -7.3427 km and -7.3488 km, respectively. Six more profiles are taken in different directions through the crater and also used to calculate the altitude of the crater bottom.

Similar profiles are taken for each of the eleven craters listed in Table 1.

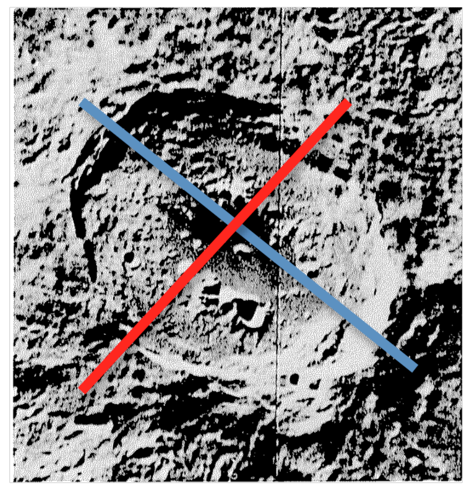

Fig. 2. The crater Antoniadi, with lines correspoding to the latitudinal profile track (blue) and longitudinal profile track (red).

Discussion: The analysis continues to accumulate measurements for comparison to a previous Clementine analysis [5] and to extend the analysis to include other quantitative aspects of crater morphology. Results will be used to better understand the process of wall collapse due to the loss of strength with increasing impact energy [2].

References: [1] Smith D. E. et al. (2009) *Space Sci. Rev.*, in press. [2] Melosh, H.J. (1989), *Impact Cratering, A Geologic Process*, Oxford University Press, New York. [3] Williams, D.E. (1987) *U.S. Geol. Surv. Prof. Pap. 1348.* [4] Pike, R.J. (1974), *Geophys. Res. Lett.*, **1** 291. [5] Williams, K.K. and M.T. Zuber (1996), *Lunar and Planetary Science*, **27** 1441. [6] Baldwin, R.B. (1963), *The Measure of the Moon,* Univ. Chicago Press, Chicago. [7] Pike, R.J. (1976), *The Moon,* **15** 463. [8] Smith D. E. et al. (2009) this issue. [9] Luis J. F. (2007). *Computers & Geosciences,* **33** 31-41.