Crater Wall Failure and Original Excavated Diameter, R. A. De Hon, Department of Geography, Texas State University, San Marcos, TX 78666, dehon@txstate.edu

Introduction: Impact craters survive as a major landform on many planetary bodies. Cratered terrain makes up more than 80% of the lunar surface. Craters exhibit progressive morphological changes with increasing diameters. At the smallest sizes, craters are simple, bowl-shaped excavations at larger sizes, craters develop a complex morphology [1, 2, 3]. Wood and Anderson [3] describe this transition in five morphologic steps. Depth-to-diameter trends exhibit a major break as craters transition from bowl-shaped to flat-floored craters. Slightly different crater transitional diameters are found for mare and non-mare craters [3, 4].

Crater morphologic variations: Small lunar craters are a simple, bowl-shaped, excavations surrounded by a raised rim of ejecta. The rim-to-floor depth is about 1/5 of its diameter. Crater walls, lacking slumping, are smooth. Larger sizes the floor flattens, but the walls retain their smooth character. The floor diameter increases as crater diameter increases. As the diameter reaches 14-18 km the simple bowl shape transitions into craters with smooth walls and small flat floor. In this transitional class, the smooth floor increases in diameter as the crater diameter increases. At larger sizes (22-26 km), complex craters are formed with terraced walls and flat floors; and at still larger diameters complex craters develop central peaks (Fig. 1). Variation in transitional diameters is largely a function of the properties of the target materials [3, 4, 5, 6].

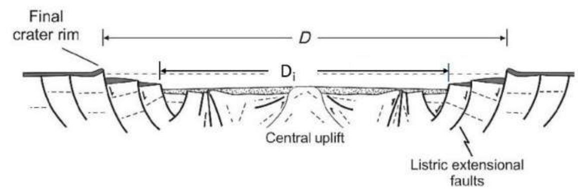

Figure 1. Complex crater morphology. D_i is the crater diameter measured at the inner terrace edge

Complex craters: Complex crater morphology results from instability of the crater walls and flattening of the floor by limits of vertical excavation and by rebound of the crater floor. These modifications result in a shallower slope in the depth/diameter scatter plots compared to that of simple craters. The diameter in depth-to-diameter plots (d/D) is the distance across the crater from rim crest to rim crest. In complex craters the diameter measurement ignores slumping within the craters that enlarges the diameter beyond the initial transient cavity. The pre-slump rim crest becomes a terrace on the crater wall.

To reconstruct the original crater diameter, measurements are taken across the crater for the inner-most terrace (D_i in Fig. 1). This measurement is slightly larger than the diameter of the floor. A correction is made for the horizontal displacement scarp face by movement along the slip surface. Rim slumping in complex craters ranges from a single, simple, floor encircling terrace to many literally discontinuous slump blocks and regolith flows. The preliminary data is compiled for 40 select, eumorphic craters (Copernican and Erastosthenian ages) on the earth-facing side of the
moon. The power function trend line for

d/D scatter plot (fig.) is $d = 0.945D^{0.328}$ with $R^2 = 0.459$. R^2 values for different trend lines—exponential (0.417), linear (0.444) or logarithmic (0.475)—are not significantly different.

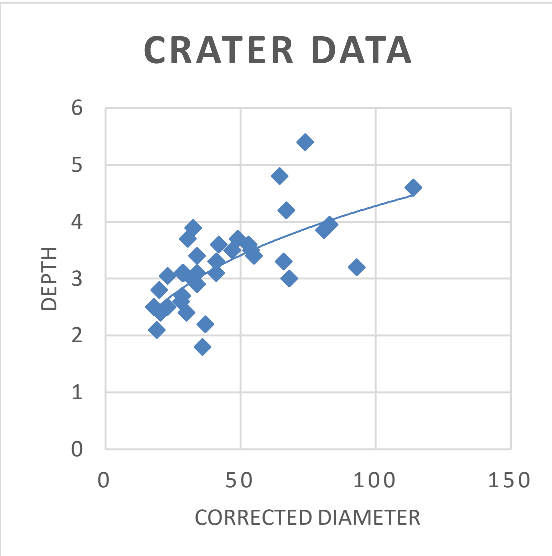

Figure 2. Scatter plot of Depth vs. Corrected Diameter. Trend line is power law best fit.

Significance: Formation of crater terracing by slumping is probably a rapid event occurring during collapse of the transient cavity. Attempts to identify internal scarps and horizontal displacements reveal complexity of crater wall structure beyond that of simple terraces created by slumping. Whether wall failure is by slump block or regolith flow depends on the properties of the target materials [7]. It is expected that continued study of walls of complex craters may provide some information about the characteristics of materials traversed by the crater.

References: [1] Pike, R.J. (1974) Geophys. Res. Letters 1, 291-294. [2] Wood, C. A. and L. Anderson (1978) LPSC IX, 3669-3689. [3] Kruger, T. and others (2018) AGU, 2667-2690. [4] Pike, R. J. (1980) Proc. LPSC XI, 2159-2189. [5] Cintala, M. J. (1977) PLSC VIII, 3409-3425. [6] Bray V.J. and others (2008) Meteoritic and Planet, Sci. 43(12)1979-1992. [7] USGS (2004) Fact sheet, 3072