were also excluded from our statistical analysis (see section 4), leaving only the morphologically "freshest" portions of the rim for geometric calculations. Furthermore, the third quartile statistics of the depths for Schwarzschild and Compton are still >1 km shallower than the *WZ*98 line (Figure 9a). Therefore, while reduction in rim elevation may be affecting the statistics, it is not enough to account for the substantially smaller depths that we measure.

[36] Third, the shallowing could be the result of differences in impact conditions and target properties. *Sori and Zuber* [2011] suggest that some basins could be shallower in the vicinity of South Pole-Aitken basin due to greater geothermal flux and increased viscous relaxation. Viscous relaxation of lunar impact basins has been suggested to be an effective shallowing mechanism for some older impact basins, with geographical differences in heat flux affecting the degree of this shallowing in these impact basins [*Solomon et al.*, 1982]. From our observations, we do not see any clear correlation between geography and the depth/diameter ratio of peak-ring basins or protobasins. Differences in the angle of impact and ruggedness of pre-existing topography could also affect the final basin depth. More oblique impacts can act to reduce the cratering efficiency (i.e., the ratio of the mass of excavated material to the mass of the impactor) of the impact event, which could account for the shallow depth of Compton compared to Antoniadi, Hausen, and complex craters of similar diameter [*Pike*, 1974]. However, no substantial offset or anomalies in the morphologies of central peak structures is observed in Compton or Schwarzschild (Table 6), which might be indicative of an oblique impact [*Schultz*, 1992a; *Schultz and Stickle*, 2011]. The fact that Compton impacted into the rim of the multi-ring basin, Humboldtianum, may have influenced its final topography; however, it is unclear if this would contribute to shallowing of the basin's depth.

[37] Finally, the depth-diameter trend in Figure 9a may be a direct result of the transition from complex craters to peak-ring basins. The depths and diameters of the protobasins, Antoniadi and Hausen, are comparable to those of complex craters on the Moon [*Pike*, 1974] (Figure 9a). Compton, however, plots at the tail-end of the apparent trend for peak-ring basins, with a depth/diameter ratio of 0.015. If Compton's shallow depth is not completely a product of post-impact modification, it may be reflecting a real result of the transition to peak-ring basins. This would be consistent with the comparably shallow depth of the smallest peak-ring basin, Schwarzschild, and could reflect a combination of non-proportional scaling of the excavation cavity geometry at large crater sizes, increased floor uplift, and an increase in listric faulting of the basin walls (see section 6). Unfortunately the lack of well-preserved protobasins and peak-ring basins within the transitional diameter range on the Moon does not permit an unambiguous interpretation of these observations.

[38] In summary, our plot of the depth-diameter relationship for protobasins and peak-ring basins reveals a possible steeper trend than previous measurements from *Williams and Zuber* [1998]. However, due to the limited number of preserved peak-ring basins and protobasins on the Moon, an unambiguous interpretation of this trend, especially at the smallest basin diameters, is difficult. What is more clear is the overall reduction in the depth/diameter ratio for peak-ring basins, compared with complex craters. This reduction in the depth/diameter ratio was observed by *Williams and Zuber* [1998] and is supported by our new data. Similar depth-diameter calculations for planetary bodies with a greater population of peak-ring basins and protobasins (e.g., Mercury; *Baker et al.*, 2011b) may help to resolve this ambiguity in the lunar depth-diameter trend.

5.2. Rim-Flank Height (h_{flank})

[39] The height of the rim flank is important for use in examining the amount of rim uplift, decay of ejecta with distance from the crater rim and for estimating the thickness of plains and mare material from buried impact craters [*Pike*, 1977; *Head*, 1982]. *Pike* [1977] defined relationships between rim-flank height (or his "rim height") and diameter for craters <15 km ($h_{\mathrm{flank}} = 0.036D_{\mathrm{r}}^{1.014}$) and >15 km ($h_{\mathrm{flank}} = 0.236D_{\mathrm{r}}^{0.399}$) on the Moon. He noted that the change in slope between the two trends indicated a transition from simple to complex craters, likely to be the result of the onset

Figure 9. Log-log plots of derived parameters (Table 4) for protobasins (dark gray squares, A = Antoniadi, Cm = Compton, H = Hausen), peak-ring basins (black circles), and the rings of Orientale basin (light gray diamonds, IR = Inner Rook, OR = Outer Rook, C = Cordillera). All parameters are plotted as a function of the rim-crest diameter, as reported by *Baker et al.* [2011a] (Table 1). Data points are median values and the errors bars are the interquartile range of the data set. The heavy dashed lines denote qualitative trends interpreted from the data. (a) Basin depth (*d*). The depth trend determined for lunar complex craters [*Pike*, 1974] is shown for reference. Also shown is the depth trend determined for lunar basins from *Williams and Zuber* [1998] (WZ98). Peak-ring basins and the protobasin, Compton, may form a steeper power law trend than determined by *Williams and Zuber* [1998]. The depths for the Inner Rook and Outer Rook rings of Orientale are shallower than extrapolation of the trend of *Williams and Zuber* [1998] and our new peak-ring basin measurements. The Cordillera ring is more in-line with the observed peak-ring basin trends. (b) Rim-flank height plotted with linear axes. The trend of rim-flank height determined for lunar complex craters is also given [*Pike*, 1977]. Points are very scattered, resulting from the difficulties in determining this parameter accurately. Negative values result from the target reference point being at a higher elevation than the rim-crest reference point. (c) Peak-ring height. Plotted are the trends for central peak heights in complex craters determined by *Hale and Grieve* [1982] (HG82) for small diameters and by *Pike* [1977] for larger complex craters. Peak-ring heights for peak-ring basins form a trend similar to central peak heights in small complex craters (HG82), although shifted toward larger rim-crest diameters. The plots for Orientale give the height of the equivalent of a "peak ring" for the Outer Rook ring (peak ring = Inner Rook ring) or the Cordillera ring (peak ring = Outer Rook ring). (d) Wall height generally increases with increasing rim-crest diameter, although the data are more scattered and could be consistent with a flatter trend. (e) Wall width increases in a well-defined manner with increasing rim-crest diameter. (f) Wall slope decreases with increasing rim-crest diameter, due to the increase in wall width without a proportional increase in wall height.