impactor properties and impact velocity and $d$ is a power law constant equal to 3.85. For the Moon, we take $c = 1.42 \times 10^{-4}$ and $d = 3.85$, which are appropriate to an anorthositic target composition, a chondritic impactor, and an impact velocity of 20 km/s (Cintala and Grieve, 1998). These values, however, do not account for the vaporized portion of the melt cavity, which, when factored into the calculations, can increase the total volume of the melt cavity by 20–30% from a melt only calculation (M.J. Cintala, personal communication, 2010). However, this should only produce about a 5–10% difference in modeled peak ring diameters, which is on the order of the uncertainty in our peak-ring diameter measurements and should not significantly affect our results. The values for the constants $\alpha$ and $\beta$ are dependent on the crater modification scaling relationships used to convert transient cavity diameters to final crater diameters. We use the constants of Croft (1985) [$\alpha = (D_{sc})^{0.15\pm0.04}$ and $\beta = 0.85 \pm 0.04$] and Holsapple (1993) [$\alpha = 0.980(D_{sc})^{0.079}$ and $\beta = 0.921$], which were derived largely from lunar and terrestrial data. Both of the scaling relationships for transient crater modification include a transition diameter from simple to complex craters ($D_{sc}$) appropriate to the Moon (19 km, Pike, 1988), which tailors the relationship to planetary-specific variables such as gravity and target strength. Holsapple (1993) also includes two relationships that account for the transient rim-crest diameter and the transient excavation diameter. We use the transient rim-crest diameter relationship for consistency with the melt volume power law of Grieve and Cintala (1992).

The power-law fit to lunar peak-ring basins (Fig. 4A and Table 2) follows the same form as Eq. (2), and the values for the constants $A$ and $p$ determined from this fit may be directly compared with the predicted values from the melt-cavity model (Table 2) (Baker et al., 2011). The power law fit to lunar peak-ring basins is very consistent with the model predictions. The modeled value for the constant $A$ in Eq. (4) ranges from 0.12 to 0.17 (mean = 0.14) using the Croft (1985) scaling and is 0.11 using the Holsapple (1993) scaling. These values fall within the uncertainty in $A$ values determined from the power-law fit to peak-ring basin data on the Moon (0.04–0.24) (Table 2). Modeled values for the slope of the power law trend, $p$, range from 1.04 to 1.14 using the Croft (1985) scaling and 1.18 using the Holsapple (1993) scaling, which nearly completely fall within the uncertainty of the $p$ values determined from lunar peak-ring basins (1.08–1.34) (Table 2). The consistency between the model predictions of a growing melt cavity and the power law fits to peak-ring basins on the Moon and also comparisons on Mercury (Fig. 4A) (Baker et al., 2011) (Table 2) support the first-order predictions of the nested melt-cavity model and suggest that impact melting and melt cavity formation exhibit important controls on the formation of impact basin rings.

Finally, while the apparent gravity dependence of the onset diameter for peak-ring basins (Fig. 6A) has generally favored a gravity-driven phenomenon for basin formation (e.g., Melosh, 1989), the nested melt-cavity model predicts that impact velocity should also be important in determining the onset of peak-ring basin morphologies. The onset diameters of peak-ring basins on the terrestrial planets do not appear to depend on mean impact velocity by itself (Fig. 6B), although a combination of gravitational acceleration and mean impact velocity provides an improved correlation with peak-ring basin onset diameter on the terrestrial planets (Fig. 6C and D). Thus, onset diameter is likely to be dependent on both gravitational acceleration and impact velocity. Under the nested melt-cavity model, gravity primarily determines the dimensions of the transient cavity and the final crater diameter, while kinetic energy and thus impact velocity largely determines the volume of melt that is produced during the impact event. Cintala and Grieve (Grieve and Cintala, 1992, 1997; Cintala and Grieve, 1994, 1998) have examined a variety of trends between crater dimensions and impact melting, suggesting that the ratio of the maximum depth of melting ($d_m$) to the depth of the transient cavity ($d_{tc}$) may be important in determining the onset of peak rings in basins. Cintala and Grieve (1998, their Fig. 7) observed that the depth of melting approaches the depth of the transient cavity with $d_m/d_{tc}$ ratios of 0.8–0.9 at the onset diameters for peak-ring basins on the Earth, Moon, and Venus. While the predicted depths of melting at these onset diameters do not meet or exceed the depths of the transient cavity ($d_m/d_{tc} \geqslant 1.0$), as emphasized in the general discussion of the onset of peak-ring basins in Grieve and Cintala (1997) and Cintala and Grieve (1998), sufficient depths of melting appear necessary for peak-ring basin formation. We used our calculated onset diameters (Table 1) and the plot of $d_m/d_{tc}$ ratio versus transient cavity diameter (Cintala and Grieve, 1998, their Fig. 10) to determine the $d_m/d_{tc}$ ratio predicted for the onset diameter of

**Table A1**

Catalog of peak-ring basins on the Moon. Peak-ring basins are characterized by a single interior topographic ring or a discontinuous ring of peaks with no central peak.

| Number | Name[a] | Longitude[b] | Latitude | Rim crest (km) | Ring (km) | Ring/rim-crest ratio | Peak-ring arc (deg) | Confidence[c] | Pike and Spudis (1987)[d] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Schwarzschild | 120.09 | 70.36 | 207 | 71 | 0.35 | <180 | 1 | Protobasin |
| 2 | d'Alembert | 164.84 | 51.05 | 232 | 106 | 0.46 | <180 | 1 | Protobasin |
| 3 | Milne | 112.77 | −31.25 | 264 | 114 | 0.43 | >180 | 3 | Protobasin |
| 4 | Bailly | 291.20 | −67.18 | 299 | 130 | 0.43 | <180 | 3 | Protobasin |
| 5 | Poincaré | 163.15 | −57.32 | 312 | 175 | 0.56 | >180 | 3 | Peak-ring basin |
| 6 | Coulomb–Sarton* | 237.47 | 51.35 | 316 | 159 | 0.50 | >180 | 2 | Multi-ring basin |
| 7 | Planck | 135.09 | −57.39 | 321 | 160 | 0.50 | <180 | 1 | Peak-ring basin |
| 8 | Schrödinger | 133.53 | −74.90 | 326 | 150 | 0.46 | >180 | 3 | Peak-ring basin |
| 9 | Mendeleev | 141.14 | 5.44 | 331 | 144 | 0.44 | <180 | 2 | Protobasin |
| 10 | Birkhoff | 213.42 | 58.88 | 334 | 163 | 0.49 | <180 | 2 | Peak-ring basin |
| 11 | Lorentz | 263.00 | 34.30 | 351 | 173 | 0.49 | <180 | 2 | Peak-ring basin |
| 12 | Schiller–Zucchius* | 314.82 | −55.72 | 361 | 179 | 0.50 | >180 | 3 | Peak-ring basin |
| 13 | Korolev | 202.53 | −4.44 | 417 | 206 | 0.49 | <180 | 3 | Multi-ring basin |
| 14 | Moscoviense | 147.36 | 26.34 | 421 | 192 | 0.46 | >180 | 3 | Multi-ring basin |
| 15 | Grimaldi | 291.31 | −5.01 | 460 | 234 | 0.51 | >180 | 3 | Multi-ring basin |
| 16 | Apollo | 208.28 | −36.07 | 492 | 247 | 0.50 | >180 | 3 | Multi-ring basin |
| 17 | Freundlich–Sharonov* | 175.00 | 18.35 | 582 | 318 | 0.55 | >180 | 2 | Not classified |

[a] Names shown for basins are those approved by the IAU as of this writing (http://planetarynames.wr.usgs.gov). Names not approved by the IAU, but used by Pike and Spudis (1987) and Wilhelms et al. (1987), are denoted by an asterisk (*).

[b] Longitudes are positive eastward.

[c] Confidence levels are given for ring measurements (3 = highest and 1 = lowest).

[d] Basin classification of Pike and Spudis (1987).