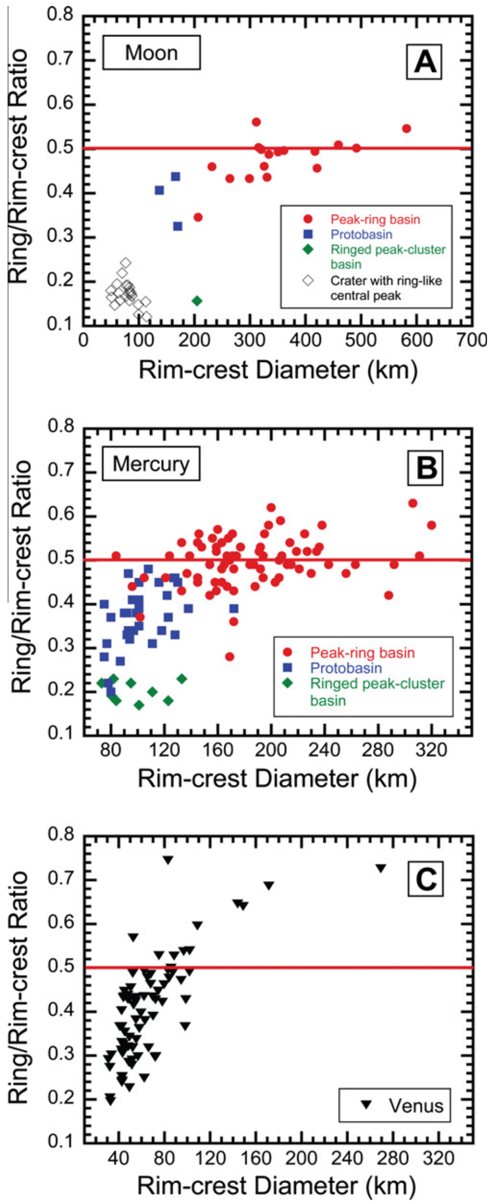

Fig. 5. Ring/rim-crest diameter ratios for peak-ring basins (red circles), protobasins (blue squares), and ringed peak-cluster basins (green diamonds) on the Moon (A), Mercury (B), and Venus (C). Basin data are from this study (the Moon, Tables A1–A3), Baker et al. (2011) (Mercury), and Alexopoulos and McKinnon (1994) (Venus). The 0.5 ratio line is drawn in each panel for reference. Also note the change in scale of the *x*-axis between the Moon (A) and Mercury (B) plots. Nonlinear, curved trends are observed for protobasins and peak-ring basins for each of the planets. The trend is steeper at smaller rim-crest diameters and then flattens to values of 0.5–0.6 for the Moon and Mercury (A and B) and to ~0.7 for Venus (C). The continuity between the ring/rim-crest ratios of protobasins and peak-ring basins suggest that they form a continuum of basin morphologies that is a direct result of the process of peak-ring basin formation. Ringed peak-cluster basins appear to diverge from the continuous trend shared by protobasins and peak-ring basins. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

0.33 to 0.44, with an arithmetic mean of 0.39. Since there are very few protobasins on the Moon, the lower rim-crest diameter end of the trend is not as well-defined as Mercury (Fig. 5B) and on Venus (Fig. 5C). The ring/rim-crest ratio (0.16) of the lunar ringed peak-cluster basin, Humboldt, is much smaller than protobasins and peak-ring basins of similar rim-crest diameter (Fig. 5A). This is consistent with similarly small (arithmetic mean = 0.20) ring/rim-crest ratios for ringed peak-cluster basins on Mercury (Baker et al., 2011), which appear distinct from the general continuum of ring/rim-crest ratios between protobasins and peak-ring basins. The ring/rim-crest ratios for craters with ring-like central peaks are also at very low values (range = 0.12–0.24 and arithmetic mean = 0.17) and are similar to the ratio of Humboldt, although they occur at much smaller rim-crest diameters.

6.3. Onset diameter of peak-ring basins

Comparisons of the onset diameter for peak-ring basins on the terrestrial planets have been complicated due to the lack of a standard method for calculating this metric. Some authors have compared only transitional diameter ranges, noting that the transitional diameters decrease from the Moon to Mercury and Mars (Wood and Head, 1976; Pike, 1988). Others have used the minimum diameter of the peak-ring basin populations on the terrestrial planets to define onset diameter, yielding a similar decreasing onset diameter ordering from the Moon (140 km) to Mercury (75 km), Mars (45 km), and Venus (40 km) (Pike, 1983; Alexopoulos and McKinnon, 1994). Our calculations for the onset diameter of peak-ring basins (Table 1) do not change this general ordering, but provide new values that are based on the most recent and complete basin catalogs of the terrestrial planets and that are statistical more robust compared with previous values. While the onset diameters for the Moon and Mercury are the most reliable due to relatively complete preservation of their crater populations, the onset diameters for Mars and Venus are more speculative due to the prevalence of erosional and resurfacing processes and effects of differing target properties (e.g., volatiles and temperature) on these planets. Mars' smaller onset diameter for peak-ring basins compared with Mercury, which has a similar gravitational acceleration, has traditionally been attributed to the effect of different target materials, including volatiles (e.g., Pike, 1988; Melosh, 1989; Alexopoulos and McKinnon, 1992). Mars is also anomalous in its large range of peak-ring basin diameters (52–442 km), suggesting that additional parameters other than gravity and impact velocity alone are influencing Mars' population of peak-ring basins. The surface of Venus has also been globally resurfaced either in a catastrophic manner or at a rate equal to the crater production rate, and thus preserves only a ~0.5 Ga crater retention age (Schaber et al., 1992). For these reasons, we exercise caution when interpreting the peak-ring basin and protobasin populations of Mars and Venus in context of the basin populations on the other planets. We also do not calculate an onset diameter for the Earth due to the obvious incompleteness of its impact basin record and the large uncertainties associated with interpreting highly eroded basin structures.

It has long been recognized that there is an inverse relationship between the onset diameter of peak-ring basins and the surface gravitational acceleration (g) of the planetary body (Pike, 1983, 1988; Melosh, 1989; Alexopoulos and McKinnon, 1992). This relationship has been used to suggest that the formation of peak rings is largely the result of a gravity-driven process. Gravity-induced collapse of the transient cavity has thus served as the foundation for many current models of peak-ring basin formation, including hydrodynamic collapse of an over-heightened central peak (Melosh, 1982, 1989; Collins et al., 2002). The dependence of peak-ring basin onset diameter on planetary impactor velocity has been more uncertain. Pike (1988) demonstrated that the geometric mean diameters of peak-ring basins do not correlate with the approach velocity of asteroids and short period comets (V_∞) on the terrestrial planets. An improved correlation was found when approach velocity was combined with g (i.e., g/V_∞), although g alone still provided the best correlation with the geometric mean diameter of peak-ring basins.