Lunar floor-fractured craters: constraining the timing of intrusion formation within the lunar volcanic history.

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Abstract. Lunar floor-fractured craters (FFCs) are a class of 170 lunar craters characterized by shallow, fractured floors and associated morphologic features such as moats, mare deposits, and pyroclastic deposits. These craters are formed by stalling of a dike beneath the crater, and subsequent sill formation which uplifts and deforms the overlying crater floor. The geographic distribution of FFCs indicates that they preferentially form near the edges of lunar basins, although a subset of the FFC population is located in highland areas. The nature of FFC intrusions is an important factor to the understanding of the intrusive volcanic history of the Moon. Dating of these intrusions may offer additional insight into the chronology and associated mode (i.e. intrusive vs. extrusive) of lunar volcanism. Here, we investigate the timing of FFC formation and compare to the ages of extrusive lunar volcanic features. The stratigraphic ages of the FFC host craters span from the pre-Nectarian through the Eratosthenian. The majority of the host craters are Nectarian to Imbrian in age. There are six FFCs whose interiors have been partially embayed by mare deposits following their intrusion events; these mare deposits are Imbrian in age. Host crater age places an older bound on the intrusion age for a given intrusive event, and the few examples of post-deformation mare embayment place a younger bound on intrusion age. Plotting the spatial distribution of the host crater ages reveals a link between ages of mare basalt deposits (via crater size-frequency distributions) and the host crater ages of regional FFC clusters. For example, there are several FFCs surrounding the Nectaris basin, all of which have a Nectarian host crater age. No stratigraphically younger craters around Nectaris have been deformed by the intrusive volcanic processes affecting FFCs; however, a paucity of younger craters adjacent to the basin edge means the intrusive activity cannot be constrained to the Nectarian. Indeed, the general lack of Nectarian-aged mare deposits combined with the Imbrian-aged crater degradation surface ages in Nectaris suggest that the FFC intrusions surrounding Nectaris formed during the Imbrian period. Many of the FFC host craters on the western edge of Oceanus Procellarum are Imbrian in age, as are the mare units located in that region. This correspondence between regional mare basalt ages and FFC host crater ages suggests that the intrusions which formed FFCs were emplaced during the main phase of extrusive volcanism on the Moon. Additionally, tectonic deformation associated with basin mare filling and loading shows close spatial correlation to FFC locations. Models of basin flexure have postulated that the extensional regime present in peripheral basin regions should be favorable to dike ascent, consistent with the suggestion that some FFCs are the surface manifestation of dikes propagated in response to basin filling and flexure.