Abstract. Numerous lunar craters (206 examples, mean diameter = 40km) contain pronounced floor rilles (fractures) and evidence for volcanic processes. Seven morphologic classes have been defined according to floor depth and the appearance of the floor, wall, and rim zones. Such craters containing central peaks exhibit peak heights (approximately 1km) comparable to those within well-preserved impact craters but exhibit smaller rim-peak elevation differences (generally 0–1.5km) than those (2.4km) within impact craters. In addition, the morphology, spatial distribution, and floor elevation data reveal a probable genetic association with the maria and suggest that a large number of floor-fractured craters represent pre-mare impact craters whose floors have been lifted tectonically and modified volcanically during the epochs of mare flooding. Floor uplift is envisioned as floating on an intruded sill, and estimates of the buoyed floor thickness are consistent with the inferred depth of brecciation beneath impact craters, a zone interpreted as a trap for the intruding magma. The derived model of crater modification accounts for (1) the large differences in affected crater size and age; (2) the small peak-rim elevation differences; (3) remnant central peaks within mare-flooded craters and ringed plains; (4) ridged and flat-topped rim profiles of heavily modified craters and ringed plains; and (5) the absence of positive gravity anomalies in most floor-fractured craters and some large mare-filled craters. One of the seven morphologic classes, however, displays a significantly smaller mean size, larger distances from the maria, and distinctive morphology relative to the other six classes. The distinctive morphology is attributed, in part, to the relatively small size of the affected crater, but certain members of this class represent a style of volcanism unrelated to the maria - perhaps triggered by the last major basin-forming impacts.

1. Introduction

The present study presents the morphology and interpretation of floor-fractured craters on the lunar near and far sides. The observational data for such craters will be examined first, including their classification, distribution (spatial and size), and floor, peak, and rim elevations relative to the maria. These data contribute to a reconstructed history of crater modification, which is illustrated by two selected examples. Lastly, the significance of floor-fractured craters is considered.

2. Classification and Distribution
Craters can be described by the characteristic morphologies of the floor, wall, and rim zones. This zonal approach permits comparison of different craters without assigning a crater type, which is a result of the different premutations of these zones,
and thus preserves an important distinction between crater origin and crater modification. Floor-fractured craters represent a floor type that is based on the presence of a single parameter, large floor rilles, and that is associated with wall and rim zones of widely different morphologies. Three parameters can be used in describing such crater floors: fracture pattern; floor depth; floor type. Floor fractures generally do not extend beyond the wall/rim boundary and occur in concentric, radial, and polygonal patterns. Additionally, a characteristic form of concentric fractures occurs as a boundary between the floor and wall, a configuration that produces a moatlike appearance.

The second parameter, floor depth, is largely independent of fracture pattern. As will be discussed below, floor depths range from very shallow (above adjacent units outside the crater) to deep (comparable to the depth of Copernicus).

The third parameter, floor type, is more qualitative. If the formation or development of the crater floor unit is independent of a period of floor fracturing, then it is clear that a wide variety of floor types with fracturing can, and does, occur. The following descriptions of floor types combine the three parameters.

Class I (fractured-floor impact craters) resembles Copernicus in its overall morphology: deep floor, central peak complex, extensive wall slumps, and well-preserved hummocky ejecta blanket (Figure 1a). However, concentric, radial, and/or polygonal fracture patterns cross the floor, and dark mantle deposits commonly surround elongate pits which occur along fractures near the floor-wall boundary. Emplacement of marelike units, which occur in a few examples, postdates the period of floor fracturing. The central peak complex is typically a system of annular peaks, a crescent-shaped peak, or central peak with a summit pit. Although these craters typically are near the shallow maria, two examples (Compton; unnamed near +73°, 165°E) occur deep in the lunar highlands. Where a stratigraphic relation to the maria exists, crater formation predates at least the last stages of local mare emplacement. Examples include Atlas, Einstein A, Schlüter, Cardanus, Petavius, Humboldt, and Lavoisier E.

Class II (shallow, fractured hummocky floor) is characterized by a shallow, hummocky floor bounded by abrupt wall scarps (Figure 1b). The hummocky floor is comprised, in part, of old wall slumps, and interior to this debris in several examples is a polygonally fractured plains region surrounded by concentric fractures. As in Class I, central peaks occur, but less frequently, and five exhibit central depressions. In contrast to Class I, dark-haloed craters and mantling deposits are uncommon. A full range of rim morphologies is displayed; from hummocky Copernicus-like ejecta facies to diffuse or nonexistent blankets. Where a preserved ejecta blanket exists, the rim may be raised. Severed, or ‘perched’, craters, commonly occur along the scalloped rim. Craters with this morphology occur immediately adjacent to or within the mare plains and predate mare emplacement. Examples are Encke, Davy, Briggs, and Vitello.

Fig. 1. Examples of classes of floor-fractured craters as described in the text. Class I: Atlas (LO IV-74-H2, H3); diameter, 85 km. Class II: Encke (LO IV-138-H1); diameter, 28 km. Class III: Gassendi (LO IV-143-H2); diameter 110 km. Class IV A: unnamed (LO I-115-H1, H2); diameter, 28 km. Class IV B: Gaudibert (LO IV-72-H3, H2); diameter, 36 km. Class V: Repsold (LO IV-189-H3); diameter, 110 km. Class VI: Pitatus (LO IV-119-H3); diameter, 110 km.