Abstract. Five sinuous rilles occur in mare basalts in the Harbinger Mountains region of the Moon. Complete and accurate topographic data, now available for the first time, make possible a detailed topographic study of these rilles. Rille length ranges from 12 to 79 km and width from 0.8 to 4.8 km. Depth varies from 100 to 300 m and the rilles appear to become shallower to the north. The southern ends of the rilles are characterized by circular to elongate depressions that occur on a 30 km in diameter dome of probable volcanic origin. Longitudinal profiles show that the rille floors have a northward slope of less than one degree. This slope is consistent with the general slope of the surrounding mare surface. Structural studies indicate that slope rather than the regional structural pattern is the dominant factor controlling rille direction. Topographic data lend support to the theory that the rilles were formed as lava channels or tubes.

1. Introduction

Sinuous rilles have long puzzled lunar investigators. Cameron (1964) suggested that the rilles were formed by erosion by nuées ardentes. Urey (1967), Gilvarry (1968), and Lingenfelter et al. (1968) proposed that water was the erosive agent. However, considerations of morphology and Apollo mission data that demonstrated the absence of water on the Moon have refuted these theories (Head, 1976). Structural theories of rille formation include tensional fracturing (Quaide, 1965) and fluidization of the regolith by gases emitted from fractures (Schumm, 1970). Another possibility, that has gained wide acceptance, is that the rilles are lava channels or tubes (Oberbeck et al., 1969; Greeley, 1971a, b; and Howard et al., 1972). As an extension of this idea, Carr (1974) described a process of lava erosion by thermal incision within a lava channel. Hulme (1973) argued that thermal erosion may have been caused by turbulent lava flow.

These theories are based on photogeologic interpretations made without the benefit of the detailed and accurate topographic data that have recently become available. This paper summarizes the results of a study of selected rilles using the new data to see if more light can be shed on the problem of rille origin.

The five sinuous rilles studied in detail lie in the Harbinger Mountains region of the Moon. This region is in eastern Oceanus Procellarum within the area covered by LAC 39 (Aristarchus). The rilles were studied using Lunar Orbiter and Apollo Hasselblad, metric, and panoramic photographs as well as maps and profile data. The following maps were used: (1) the NASA Lunar Topographic Orthophotomap (LTO) of the Prinz Province (39A3) at 1 : 250000 scale; and (2) the NASA Lunar Topo-photomap of Rima Prinz at 1 : 50000 scale. Profile data along and across the rilles were supplied by the Defense Mapping Agency/Topographic Center on specially produced 1 : 50000 scale photomaps with ± 3 m vertical accuracy.

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