Preliminary Results of Geologic and Remote Sensing Studies of Rima Mozart

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The nature and origin of lunar sinuous rilles have long been the subject of major controversy. Lunar sinuous rilles typically occur on mare surfaces, though a few cross highland terrains. Suggested origins for sinuous rilles vary widely: 1) erosion by nuees ardentes (Cameron, 1964), 2) fluvial erosion (Urey, 1967; Gilvarry, 1968; Lingenfelter *et al.*, 1968; Schubert *et al.*, 1970), 3) tectonic features of tensional origin (Quaide, 1965) 4) formation as lava tubes and channels during lava emplacement (Kuiper *et al.*, 1966, Greeley, 1971, Oberbeck *et al.*, 1969) or, during the draining of a lava lake (Howard *et al.*, 1972), 5) incision of channels by thermal erosion and/or turbulent flow through the channels (Carr, 1974; Hulme, 1973).

It is very unlikely that nuees ardentes would form the smooth sinuous channels on the lunar surface. On the Earth they form hummocky channels and dunes, not smooth curvy channels. Though a morphologic similarity to terrestrial fluvial features has been noted (Urey, 1967; Gilvarry, 1968, Lingenfelter *et al.*, 1968), a fluvial origin for lunar rilles has long been discounted due to the anhydrous nature of the returned lunar samples (e.g. Taylor, 1975). The similarity of certain lunar rilles to terrestrial channels of fluvial origin merely suggests an origin by fluid flow, though water is not necessarily the erosive agent (Oberbeck *et al.*, 1971). Terrestrial lava tubes and channels often originate at vent craters or depressions associated with regional tectonic features such as faults, fissures, or fracture systems that often form concentric to calderas (Greeley, 1971). Similarly, many lunar sinuous rilles are located in areas of structural weakness and often tend to follow pre-existing structural trends. However, the presence of elongate "head" craters, levees, and the fact that lunar sinuous rilles may extend for large distances without offset or mirror images on either side helps negate an origin soley by extensional tectonics.

Lunar sinuous rilles are also similar to terrestrial lava channels and collapsed lava tubes in that they commonly originate at irregular shaped "head" craters, trend down-slope, are discontinuous in areas (tube formation and/or collapse?), taper out at distal ends, and may form distributaries. Thermal erosion and turbulent flow may help explain the extent of lunar sinuous rilles, but it can not explain the formation of meanders that are commonly associated with lunar rilles.

In order to better understand the processes responsible for the formation of lunar sinuous rilles, we have conducted a study of Rima Mozart using a variety of geologic, photographic, and remote sensing data. The apparent source of this rille is located in a highlands unit of known composition (i.e., KREEP basalt; Hawke and Head, 1978; Spudis, 1978; Spudis and Hawke, 1986) and it was hypothesized that thermal and mechanical erosion played an important role in the formation of Rima Mozart. Excellent photographic, topographic, multispectral, and radar data exist for this rille. The purpose of this paper is to present the preliminary results of an analysis of this data.

Rima Mozart is a 40 km-long lunar sinuous rille located near the SE rim of Imbrium basin (25°21"N, 359°03"W). It is situated about 100 km southwest of the Apollo 15 landing site. It is 250 - 500 m deep and is incised into the volcanically derived KREEP basalts of the Apennine Bench Formation and dark mare basalts surrounding the rille (Figure 1).

Photographic data indicates the presence of two volcanic source vents for Rima Mozart. Now girdled by dark mare-type material, these vents appear to have formed in the underlying Apennine Bench Formation (Figure 1). The primary source vent, Kathleen, is an elongate crater (5 x 3 km) in the Apennine Bench Formation. From Kathleen, Rima Mozart follows a dominant NW/SE structural trend (Swann, 1986) until terminating 30 km to the east. About 10 km from the termination of Rima Mozart the second elongate (2 x 1 km) source vent, Ann, is joined to the main channel by a secondary rille. Evidence of spatter surrounding Ann strongly supports the volcanic origin of this feature. At the distal end of Rima Mozart, the rille terminates at Michael, a possible "sink" crater. The crater Michael may be connected to the NE-trending Rima Bradley, to the southeast, through a conduit and/or underground plumbing system marked by a collapse feature , Patricia. This possible extension of Rima Mozart joins Rima Bradley at a NW/SE angle, reflecting the dominant structural trend of the region.

We suggest that Rima Mozart, like many other lunar sinuous rilles, is most likely formed by a combination of events. Rima Mozart does follow a pre-existing, dominant, NW/SE structural trend suggesting the influence of structural features on the rille, however, the tectonic influence is not the sole source for the formation of the rille, as suggested by the presence of two volcanic source vents and spatter present around Ann. We suggest that the rille formation began with an explosive eruption at Kathleen which later calmed down to a pulsating, high volume, low-viscosity lava flow. The rapid effusion rate of the magma as well as its high temperature and turbid nature helped carve the sinuous rille into the fractured and structurally weak Apennine Bench Formation underneath. Similar eruptions and subsequent flows were also created at Ann and joined to the main channel by a NE-trending secondary rille. Rapid and turbulent lava flows continued to form Rima Mozart through a distributary system of channels and/or tubes that paralleled the underlying, pre-existing structure of the Apennine Bench Formation until reaching the terminus at Michael.

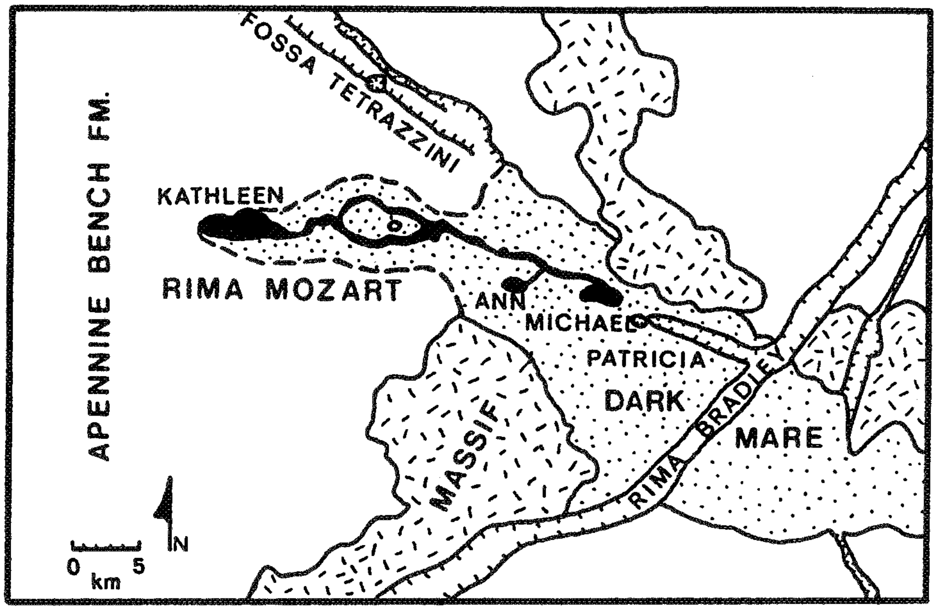

FIGURE 1: A sketch map of the Rima Mozart region showing the locations of the two surce vents, Kathleen and Ann, and the "sink" crater, Michael.

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