Kauhako Crater and Channel, Kalaupapa, Molokai, Hawaii: A Terrestrial Analog to Lunar Sinuous Rilles. Cassandra R. Coombs and Bernard Ray Hawke, Planetary Geosciences Division, Hawaii Institute of Geophysics, Honolulu, HI, 96822

Previous work done on lava tubes and channels associated with recent and historic lava flows in Hawaii has shown that the terrestrial features are similar in many ways to the sinuous rilles found on the lunar surface (e.g.:1,2). As part of a larger study of the nature and origin of lunar sinuous rilles, and because of the current inaccessibility of the Moon for field work, we have studied the Kauhako Channel/Tube system on the Kalaupapa Peninsula of Molokai, Hawaii, a volcanic complex that has many of the characteristics of lunar sinuous rilles and appears to be a viable analog. In this study we investigated the basic processes responsible for the formation of the Kauhako conduit system and related it to the formation of lunar sinuous rilles. Here the geology, morphology, and volcanic history of Kauhako Crater and Channels are presented. Various data sets used during the course of the study include: field, topographic, photographic, and sample.

Recent photo- and map reconnaissance of the crater and channel has shown that morphologically, Kauhako Crater/Channel is very similar to many lunar sinuous rilles .[3] Both the Kauhako and lunar channels studied formed as a result of basaltic volcanism, have deep source craters, exhibit some degree of tube formation, follow sinuous paths, and show evidence of some thermal erosion in their formational histories.

Kalaupapa is a 10 km^2 lava shield volcano that rises to 135 m above sea level at Pu'u 'Uao (Peacemaker Hill). The Kalaupapa shield is capped by Kauhako Crater, measuring 500 m wide by 650 m in diameter with a rim elevation of 135 m. The crater forms a funnel-like pit with one circum-crater terrace and a lake in the bottom. A second, smaller pit about 22 m wide by 10 m deep is located on the northeastern part of the crater terrace, near the mouth of the lava channel. A sinuous lava channel/tube extends northward from the northeast side of Kauhako crater. This discontinuous channel is 1.0 km long, up to 30 m deep, and varies in width from 100 m to 150 m. Tumuli, formed by the squeeze-up of magma form an underlying tube system, extends the line of the channel another 1.3 km to the N-NE.

The walls of the crater and main channel/tube system are composed of two stratigraphic units; one a composite of relatively thick and massive flow units, and the other a composite of very thin flow units. Many blocks of the thin layered "rim" material were found on the channel floor, suggesting that the lava once formed a shelf or crust that once extended across the channel.A second prominent tube system extends N-NW from an elbow in Kauhako Channel to the eastern coast of the peninsula. The lava tube is discontinuous along its trend but eight skylights were found in the field, six of which allowed entrance into the lava tube.

A second, previously unknown, source vent was identified during this field study. This second vent is located near the base of the pali bounding the S side of the peninsula, 1.4 km southwest of Kauhako Crater. That this cone is associated with the Kauhako eruption has not been firmly established. However, the two vents are aligned along the same trend as the Koko fissure and other alignments associated with the rejuvenation-stage volcanism on Oahu.[4]

An analogy may be drawn between the Kauhako Crater/Channel/Tube system, lunar sinuous rilles (e.g., Rima Mozart) and other lava channel systems on the Big Island of Hawaii. These analogous systems include: the currently active Kupaianaha vent on Kilauea; the Mauna Ulu crater, tubes and channels; Thurston lava tube; Makapu'u lava tube, and the Whittington lava tube. Both the Whittington and Makapu'u lava tubes show evidence of thermal erosive activity in their formational histories. At least four stages of infilling and cross-cutting are evident in the Makapu'u tube, suggesting that thermal erosion was at least partly responsible for its formation. Evidence for thermal erosion in terrestrial lava tubes is difficult to establish, however, the Whittington lava tube provides excellent evidence that thermal erosion played an important role in its formation. Several tree molds were identified at the base of two older, successive lava flows adjacent to the tube, which are separated by a thin, weathered paleosol. The presence of these features indicates that some time interval occurred between the eruption and deposition of the two flows to allow the trees

to grow and the soil layer to accumulate. The lava tube cuts through both of these lava flows. While it may be argued that the lava followed a pre-existing fault plane or stream channel, no evidence was found in the field for the pre-existence of either feature.

Several models have been developed for the formation of lunar sinuous rilles in conjunction with thermal erosion.[5,6,7,8,9] In this study we adapted Hulme's[5] model for thermal erosion of a lunar sinuous rille for use under terrestrial conditions to model the thermal erosion rate for the Kauhako system. Briefly, the Kauhako eruption was monogenetic, lasted for a period of just over 33 days and erupted a maximum volume of 2.2 km^3 at a rate of 7.8 m^2s^{-1}. Thermal erosion aided in the downcutting of this channel at a rate of 10.5 μms^{-1}.

The morphology and eruptive history of this volcano make it a good analog to lunar sinuous rilles (i.e.: Rima Mozart). Morphologically, the Rima Mozart and Kauhako lava channels are very similar (Fig. 1). Their channel floors are hummocky, their paths are sinuous and they begin at deep source craters. Volcanologically, the two are similar also. Both were carved out of basaltic material, were associated with a pyroclastic eruptive phase, and exhibit evidence that some degree of thermal erosion was involved in their formation.

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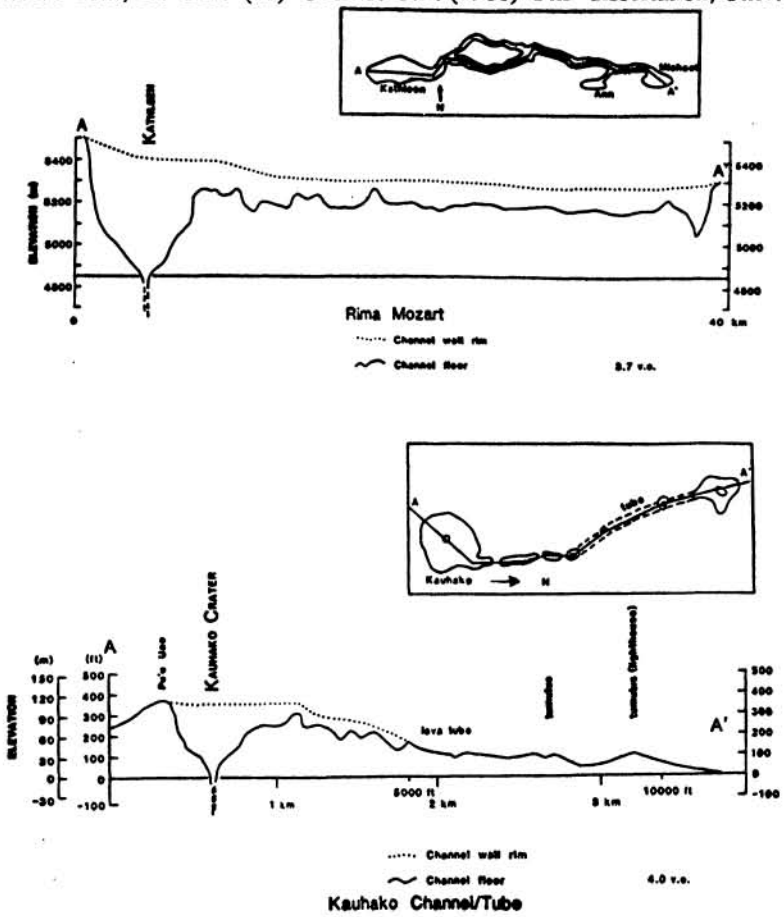

Figure 1: Comparative cross-sections of Rima Mozart and Kauhako Crater/Channel showing the morphologic similarity between the two volcanic complexes. (after Coombs, 1988).[10]