VOLCANIC OR FLUVIAL: COMPARISON OF AN ASCRAEUS MONS, MARS, BRAIDED AND SINUOUS CHANNEL WITH FEATURES OF THE 1859 MAUNA LOA FLOW AND MARE IMBRIUM FLOWS

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Introduction: The observations of sinuous channels on the Moon and Mars led to debates over their formation either as a result of fluvial or volcanic processes. Apollo samples showed that fluvial processes did not form channels on the Moon [1] However, the acquisition of new martian data seems to heighten the debate for some sinuous channels. This debate demonstrates the similar characteristics of fluvial and volcanic channels and their products [2]. Here we present a detailed study of one braided and sinuous channel on the southwest rift apron of Ascraeus Mons and compare its morphology with those of similar features on the 1859 Mauna Loa lava flow, Hawai'i and features within Mare Imbrium on the Moon. We show that while the proximal and medial parts of this channel show features that are analogous to fluvial channels, these parts also share similarities with volcanic features. The distal section of the channel is clearly volcanic, which strongly suggests that the entire feature is volcanic in origin.

Background & Approach: The development of the Tharsis Montes includes main flank formation followed by rift zone activity [3] but the relationship between the two is not entirely clear. It is suggested that these two episodes represent a magmatic continuum [4], two temporally unique but spatially overlapping magmatic events [5], and a magmatic event (main flanks) followed by hydrothermal and fluvial activity (rift aprons) [6]. We use a combination of MOLA (gridded data product), THEMIS, HRSC, and CTX data to examine a channel on Ascraeus Mons that is suggested to represent fluvial activity. We conducted field work on the 1859 Mauna Loa lava flow, Hawai'i (Fig. 1), using a Trimble R8 Differential GPS with vertical and horizontal accuracies of 2-4 and 1-2 cm respectively. We also compare this feature with Apollo metric images of Mare Imbrium (Fig. 2). The lunar and terrestrial comparisons are used to provide insight into the formation of the martian channel.

Results: *Ascraeus Mons:* This channel is suggested to result from fluvial erosion [5-8]. It originates from a NE trending fissure with a possible relationship to a larger rille to the North. The fissure does not display a topographic "cap" typical of nearby small volcanic vents. The channel and is traceable for >270 km and we observe unique morphologies along the proximal, medial, and distal sections of the flow (Fig. 3).

The proximal section extends ~60 km from the fissure and displays braided and hanging channels, terraced channel walls, no levees, "streamlined" islands, and flow margins that are difficult to detect or are embayed by younger materials. The medial section extends from 60-170 km. Here the channel is composed of one sinuous trench that also lacks clear levees. Generally the this section of channel is surrounded by a smooth surface but sometimes shows minor leveed channels leading away from the main channel, probably due to overflow. Flow margins are difficult to determine and are sometimes embayed by younger materials. The distal section extends from 170 to >270 km and displays a significantly different morphology. At 170 km the slope decreases from 0.7-1º towards the fissure to 0.3-0.6º. Here, the channel is located along the axis of a ridge that exceeds 40 m in height. In some locations the channel roofed over. Furthermore, rootless vents are located along the axis of the ridge. These rootless vents display topographic "caps" up to 1 km in diameter and radiating flows some extending for several kilometers.

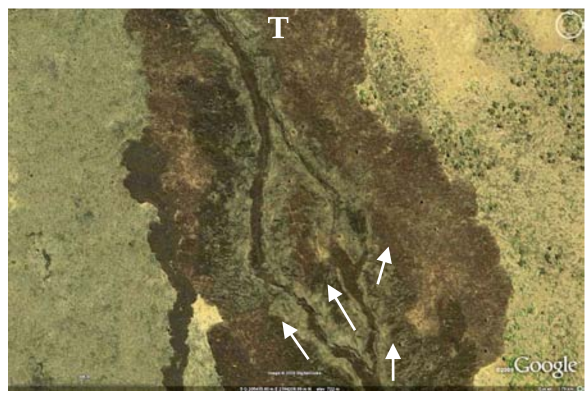

Figure 1. An island constructed in the 1859 Mauna Loa lava flow showing a single channel that bifurcates into three channels (white arrows), terraced walls (T) and the complex relationships between 'a'ā and pāhoehoe flows, all of which are part of the same eruption.

1859 Mauna Loa Flow: The 51-km-long 1859 Flow originates from a fissure along Mauna Loa's NW flank and is an example of a "paired" (both 'a'ā and pāhoehoe) lava flow [9]. We collected DGPS data at an elevation of 730 m across one of two several hundred meter long islands (Fig. 1). Here, the channel either diverted around a pre-existing obstacle or an obstruction within the channel, building vertical walls up to 9 m in height above the current channel floor. The complicated emplacement history along this channel section, including an initial 'a'ā stage partially covered by pāhoehoe overflows from the channel, results in an appearance of terraced channel walls and diffuse flow margins. These relationships are typical of those described in the proximal section of the Ascraeus channel.

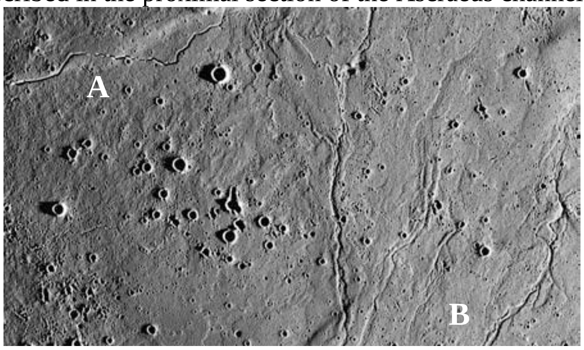

Figure 2. Mare Imbrium flows showing both single sinuous (A) and braided (B) channels.

Mare Imbrium: Apollo image AS15-M-1702 displays phase III Mare Imbrium flows west and northwest of Euler crater [10] (Fig. 2). In this image, one channel displays a sinuous trench similar in morphology to the medial section of the Ascraeus channel, while an adjacent channel displays branching and hanging channels that are similar in appearance to the proximal section.

Discussion & Conclusions: Visual inspection of the Ascraeus channel's proximal section shows braided and hanging channels, terraced walls, and streamlined islands all of which have led many, including the first author of this abstract, to suggest an origin involving fluvial activity. However, new image data have enabled a complete view of the channel, including its distal portions, which display a topographic ridge, well defined flow margins, roofed channel sections, and rootless vents. We suggest that these features are indicative of a volcanic origin for the distal portion of this channel.

The conclusion that the distal portion of this channel is of volcanic origin leads one to question the origin of the entire feature. All three sections show smooth transitions that suggest they are part of one continuous feature. The proximal section displays characteristics suggestive of fluvial activity. As such it is possible that this channel has experienced a mixed fluvial-volcanic history or that proximal volcanic features were mistaken as fluvial. Faced with these two scenarios we examined features of known volcanic origin on the Moon and the Earth for similarities with the Ascraeus proximal section. We observed branching and hanging channels, islands, and terraced channel walls in known volcanic terrains. Together, our observations indicate that the distal section displays volcanic features and that the proximal section displays features that could also form in volcanic settings. Additionally we see no evidence for younger modification of this feature by fluvial processes. Therefore we conclude that this feature was formed by volcanic processes only, followed by partial embayment of its margins by younger materials. This interpreted origin agrees with that for a similar lava channel described on the SW rift apron which also has a rille-like proximal section [11].

Although we conclude that the origin of this feature involved volcanic processes, this inference does not preclude the possibility of fluvial activity in this region. It does, however, emphasize the importance of detailed studies of the full extent of individual features and mapping campaigns based on new martian data.

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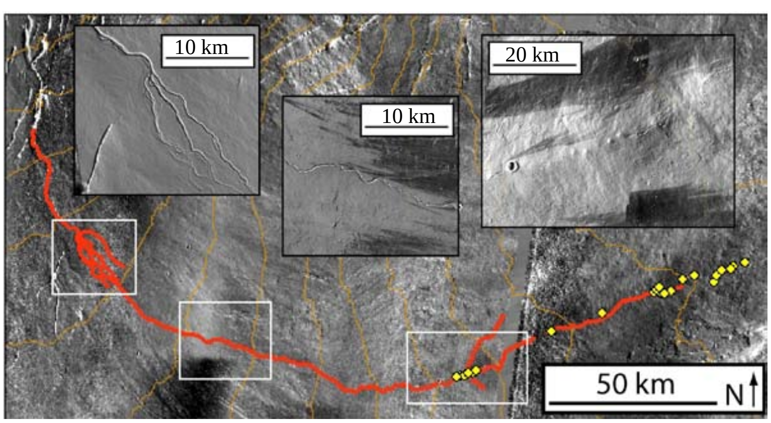

Figure 3. The Ascraeus channel (red line) and associated rootless vents (yellow dots). White boxes outline examples from the proximal (P07_003897_1855), medial (P18_008169_1857), and distal (V13721014) sections. 250 m contours also show the emergence of a topographic ridge in the distal section.