

VOLCANIC OR FLUVIAL CHANNELS ON ASCRAEUS MONS: FOCUS ON THE SOURCE AREA OF SINUOUS CHANNELS ON THE SOUTHEAST RIFT APRON

Julia D. Signorella¹, A. P. de Wet¹, J. E. Bleacher², A. Collins³, Z. P. Schierl⁴, B. Schwans⁵. Department of Earth and Environment, Franklin & Marshall College, Lancaster, PA, 17603, ²Planetary Geodynamics Laboratory, Code 698, NASA GSFC, Greenbelt, MD, 20771. ³Department of Geology, College of Wooster, Wooster, OH, 44691, ⁴Department of Geology, Whitman College, Walla Walla, WA, 99362, ⁵Department of Geosciences, Trinity University, San Antonio, TX, 78212.

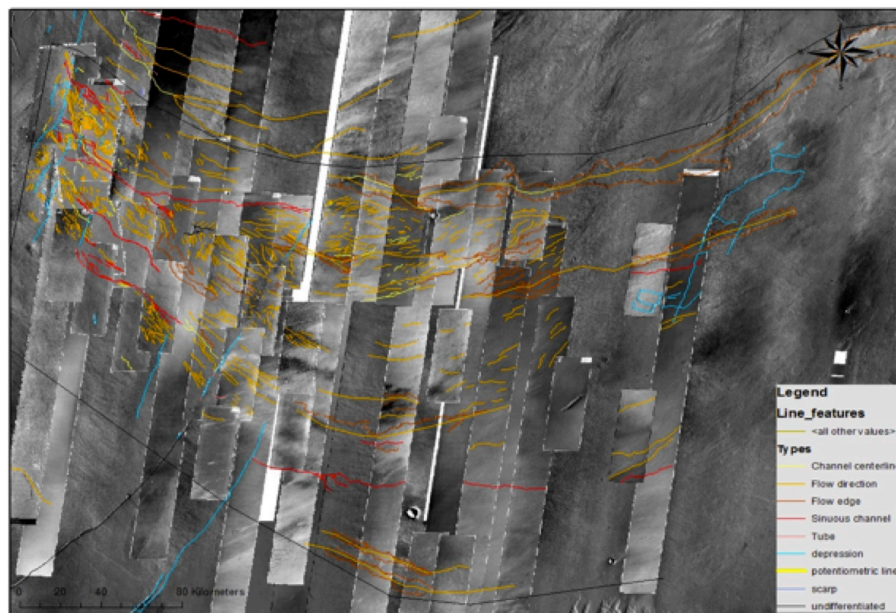


Figure 1: Mapped features in the southeast area of the south rift apron of Ascraeus Mons

Introduction: Deciphering the Mars water history is important to understanding the planet's geological evolution and whether it could have sustained life. Channel features on Mars, such as the features documented in Kasei Valles, are generally accepted as evidence for water flowing over the Mars surface in the past [1]. However, not all channels are the product of fluvial processes and many can be interpreted as having a volcanic origin [2]. This research involves studying channel features on the flanks of the Ascraeus Mons volcano, which is a part of the Tharsis province. Numerous sinuous channels exist on the rift apron of Ascraeus Mons and they have been interpreted as either fluvial [3] or volcanic [4,5]. The channels originate from pits and linear depressions and extend for many 100's of km downslope. Mapping the proximal to distal morphology of the complete channel and determining its relationship with other features on the apron provides evidence for the processes of formation and their relative temporal relationships. This study focused on sinuous channels located on the south-east part of the Ascraeus rift apron (Fig. 1).

Observations of possible analogous features on Hawai'i are used to provide insights into the processes of formation of the Mars features.

Methods: The study area is the southeast section of the south rift apron on Ascraeus Mons. Using ArcGIS, high-resolution (18 m) THEMIS visible images were geo-referenced onto a lower resolution THEMIS IR Day Mosaic of the study area and combined with other data including HiRISE and CTX images and MOLA topography. Initially the major morphological features in the area were examined and classified based on their characteristics such as size, shape, texture, and topography. We were able to identify and map topographic highs we interpret as volcanic vents, impact craters, pits, depressions (both linear and amphitheater-like), and tubes. We also identify surface lava flows and determine their flow directions. Several major sinuous channel systems were identified and these became the main focus of the study.

To understand which process, fluvial or volcanic, formed these channels, the source area on the rift apron, located in the northwest section of the mapping area, was mapped in detail. The relationship between vents, pits, depressions, channels, and flow features in the source area was particularly important in understanding how and where the channels formed and a relative time sequence for these features was determined based on crosscutting and superposition relationships (Fig 2).

One particularly well-developed sinuous channel was traced from where it began at the source area on the rift apron to its farthest visible extent and any changes in its morphology were documented. The characteristics of the proximal, medial, and distal areas of the channel were studied using cross-sections and analysis based on topography and geomorphology.

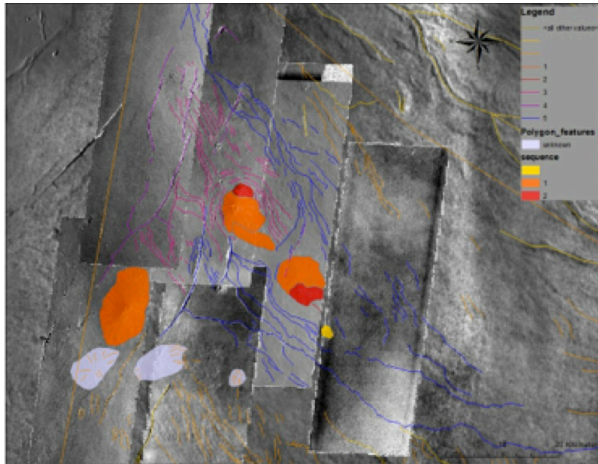


Figure 2: Temporal sequence of features based on crosscutting relationships

Results: Detailed mapping of the proximal sections of the main sinuous channels shows that these channels typically originate from the depression features on the rift apron. These channels have well-developed sinuous morphology in the proximal and medial sections but in the more distal parts they transition into dispersed, complex flows with what appear to be roofed over sections.

Two neighboring channels to the north and south of the one of the particularly well-developed sinuous channel, originating in the source area, appear to converge and cover the distal flow sections, so it is not possible to map its full extent (Fig 3). In this distal section of the channel, the flows coming from the channel appears to inflate, as a volcanic feature would [6].

Determining the relationships between the vents, depression, flows and sinuous channel features in the northwest corner of the study area helped to decipher if this relationship occurs in other areas of the south rift apron of Ascreaus, and therefore, determine if there is a pattern to how these features form. The relationships between the features also inform what process formed them. The superposition relationships mapped in the source area show the channels and lava flows have formed most recently and that the vents formed before them.

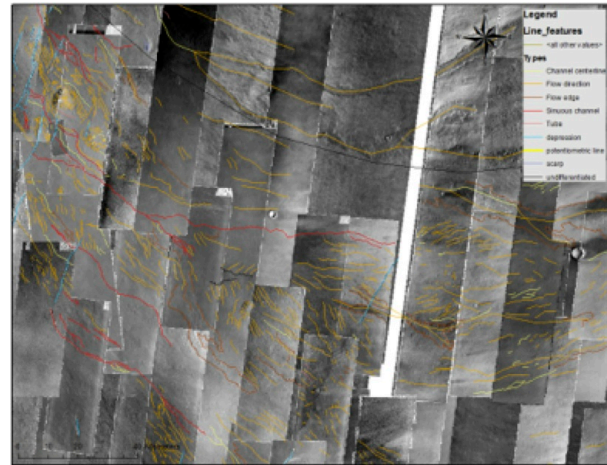


Figure 3: Major channel (northern most red line in central part of the image) originating from depressions in the source area in the northwest part of the study area

Discussion: The vents appear to be the youngest features in the area, but are not the source of significant long lava channels. The major channels formed prior to the vents and originate from linear, probably structurally controlled, depressions in the area. Identifying that the flows originate from depressions and not vents is important because it helps determine what process, fluvial or volcanic, forms the feature. Studying major channels from their proximal to distal sections also helps decipher which process formed the feature. The behavior of the major sinuous channel studied here implies a volcanic origin, as evidenced by the distal section where it inflates. As the sinuous channel feature originates from depression features instead of the vent features, questions arise. Is it most likely that mudflows or lava flows were emerging from the depressions on the flank of Ascreaus? Since our analysis of the sinuous channel suggests it has a volcanic origin, why does the most recent volcanic material that forms major flows coming from depressions without building topographic vents? Our current work is focused on this question.

Acknowledgements: Work supported by the Keck Geology Consortium and Franklin & Marshall College.

References:

- [1] Carr, M.H. (1996), *Water on Mars*, Oxford University Press.
- [2] Carr, M.H. (2006), *The Surface of Mars*, Cambridge University Press.
- [3] Murray et al. (2009) *EPSL*, doi:10.1016/j.epsl.2009.06.020.
- [4] Garry et al. (2007) *JGRE*, doi:10.1029/2006JE002803.
- [5] Bleacher et al., (2010) *LPSC*, #1612
- [6] Garry et al. (2009) *LPSC*, #1200