AN UNUSUAL VOLCANIC CENTER IN WESTERN ELYSIUM PLANITIA, MARS.

Introduction: Detailed geological mapping of the Elysium Planitia region of Mars (200-230°W, 15-40°N) has recently identified a fourth volcanic center (in addition to Elysium Mons, and Hecates and Albor Tholli) within this area (1). Measuring approximately 260 x 480 km in extent, this center (informally called here the "Elysium Fossae Complex" or "EFC") is located 470 km west of Elysium Mons at 220°W, 26°N and is the source area for the channels comprising Elysium Fossae (Fig.1). Together with numerous sinuous channels, EFC comprises a complex series of vents, lava flows and domes. The purpose of this investigation is to document the existence of this volcanic center, to compare its morphology with that of the more familiar martian volcanoes (2,3), and to draw inferences about some of its eruption characteristics.

Morphology: Fig.2 illustrates the western portion of Elysium Planitia and the Elysium Fossae Complex. Prominent are several large sinuous channels with enlarged source craters. In several respects the EFC resembles the Aristarchus-Harbinger region of the Moon (4), in that the EFC vents are located in hummocky terrain, show no obvious structural control in their distribution, and are in close proximity to several dome-shaped features. Although less prominent than the lunar rilles due to the undulating nature of the surrounding topography, the martian sinuous channels (which measure up to 200 km in length and 5 km in width) transect a variety of hummocky terrains and extend in a westward direction toward Utopia Planitia. A few of these EFC channels display wide levees similar to those that flank the rille south of the lunar crater Euler (5), but no associated distal lava flows can be identified. At a resolution of about 150 meters per pixel, several domes with a crenulated texture can be identified (Fig.2). These domes are irregular in plan and possess a surface morphology that is reminiscent of terrestrial rhyolite domes (6).

Comparisons with other martian volcanoes: Although martian volcanoes illustrate a wide diversity in morphometry (7,8) and morphology (2,3,9), recognizable source areas of volcanic activity on Mars (i.e., excluding the buried vents that produced the plains volcanics in areas such as Lunae Planum and the cratered plateau materials of the southern highlands: ref. 10) are typically characterized by large constructs and multiple lava flows (e.g., refs. 3, 11). The Elysium Fossae Complex differs from other centers of volcanism on Mars in several respects:

1) There is no prominent volcanic construct or volcano/tectonic depression associated with the EFC source region that would be equivalent to shield volcanoes, patera or tholli on Mars (3).

2) The sinuous channels of the EFC are widely dispersed over an area measuring more than 100,000 km², indicating that large volumes of magma were erupted from an areally extensive source region. No lava flows are visible at the distal ends of these channels, however, so that morphometric measurements of channel geometry are required to determine their origin (1).
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Fig. 1: Morphological map of the Elysium Planitia area showing the locations of the major volcanoes, the Elysium Fossae Complex (represented by the Complex Vent Area) and the different terrain types identified in ref. 1. Regional geology mapped from Viking Orbiter images nos. 844A13-22, 844A37-46 and 846A13-22.

3) Several of the Elysium Fossae Complex channels have a morphometry which indicates that they were probably created by fluvial rather than volcanic processes (1,12). Thus, in addition to volcanic activity, this area may also have been modified by volcano/ground ice interactions.

4) Dome-shaped features within the Elysium Fossae Complex are morphologically different from possible martian cinder cones (7) and other landforms with proposed volcano/ground ice origins (13). Although lacking accompanying lava channels or flows, these domes are interpreted as volcanic features. Their size (20-30 km in diameter) and crenulated surface texture suggest that these domes were produced by low-volume and low-effusion rate eruptions rather than pyroclastic or phreatic activity.

Interpretations: The presence of numerous lava flows and sinuous channels indicates that the EFC is predominately a volcanic center. The diversity and unusual nature of the landforms, however, dictates a somewhat different mode of formation for this region in comparison to other volcanic features on Mars. One key attribute of the EFC which could aid in the interpretation of this region may be the morphology of the source craters associated with the sinuous...
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Fig. 2: Sinuous channels and domical terrain characterize western Elysium Planitia. Braided channels ("A"), crenulated domes ("B"), and enlarged source craters ("C") indicate that both high and low eruption rates probably occurred in this area, together with probably interactions between the erupted lava and ground ice within the surrounding terrain. Scale bar is 100 km, Viking Orbiter frame 844A41.

channels. These craters are comparable to the head craters of lunar sinuous rilles (4,14), which in turn are believed to be the products of turbulent motions within lava lakes. In cases such as these, the sinuous channel is interpreted to form by the thermal erosion of the country rock (15,16) as the lava lake overflowed and drained. The creation of the enlarged depression at the proximal end of each rille is attributed in the lunar case to a high eruption rate of volatile-poor magma (14). Thus it might be that the absence of a central volcanic construct within EFC is at least in part due to unusually high lava eruption rates (and hence areally extensive deposits; ref.17) in this area. The presence of the domes and fluvial channels, however, demonstrate that high eruption rates of volatile-poor lava can be only part of the explanation for the anomalous morphology of the EFC. Further analysis of vent distributions and sizes, together with morphometric measurements of the channels, are currently underway to help resolve some of the interrelationships between these different features.