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POTENTIAL IMPLICATIONS OF A COMMON ORIGIN FOR OUTFLOW SYSTEMS ON VENUS, MARS, AND THE MOON. D. W. Leverington, Department of Geosciences, Texas Tech University, Lubbock, TX 79409.

Introduction: Among the landform types common to Venus, Mars, and the Moon are large channel systems formed by voluminous fluid flows from the subsurface. These channels head abruptly at topographic lows or ridged plains and extend downslope for distances of tens to thousands of kilometers. Lunar systems are relatively small, with channel widths of less than 10 km and lengths of less than 100 km [1]. The largest of the Venusian and Martian outflow systems have widths of tens of kilometers and lengths of thousands of kilometers, and are typically characterized by complexly anastamosing reaches and large streamlined landforms [2,3].

Hypothesized Origins of Outflow Systems: The outflow systems of Venus and the Moon are generally believed to have formed through extrusive igneous processes in the absence of water [1,2], although alternative aqueous interpretations have also been proposed [4]. Igneous interpretations are based in part upon the widespread association of channel systems with volcanic landscapes and flows [1,2], the apparent anhydrous nature of associated geological materials [5,6], the likely long-term instability of water at the surfaces of Venus and the Moon [1,5], and the absence of landforms suggestive of past wet conditions.

The Hesperian outflow systems of Mars are widely believed to have formed through aqueous outbursts from large aquifers maintained under pressure by an ice-rich cryosphere [3,7]. Aqueous interpretations are consistent with morphological similarities between these channels and those of terrestrial diluvial systems [3], the confirmed presence of water ice at high latitudes [8], and the hypothesized development of older (Noachian) valley networks by aqueous processes [9]. However, Martian outflow channels have also been hypothesized as non-aqueous volcanic systems [10,11] on the basis of the strong association of channels with volcanic landforms and flows, the notable similarities between the morphological characteristics of Martian systems and those of Venusian and lunar systems, and the consistency between formation mechanisms and recognized igneous processes. This perspective is not widely accepted, but can account for channel properties more simply than alternative models. Aqueous models are potentially inconsistent with channel properties (e.g., heads of large systems are at elevations at which piezometric pressure in hypothesized aquifers should have approached minimums), and lack satisfactory analog processes for development of large catastrophic outbursts from the subsurface.

Potential Implications of Hypothesized Igneous Origins: The past existence of Martian oceans and the past occurrence of associated climate shifts have been inferred primarily on the basis of aqueous interpretations of the Martian outflow channels [12-14]. A non-aqueous volcanic origin for the outflow systems of Mars would greatly undermine the feasibility of these inferences.

If the outflow systems of Venus, Mars, and the Moon developed through common volcanic processes, might analogous systems have developed early in the history of the Earth? The poor preservation of early terrestrial crust [15], combined with variations in the inner solar system with regard to volatile abundance, crustal thickness, degree of differentiation, thermal history, and activity of plate tectonics [16,17], limits such an inference to the realm of speculation. Although early mantle temperatures were high [18] and mantle processes likely had the capacity to drive periodic resurfacing events [19], the formation of terrestrial outflow systems could have been inhibited by widespread water cover [18] and by the operation of early plate tectonic processes [20].

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