NEW STYLES OF MARTIAN VOLCANIC ACTIVITY REVEALED BY MARS ORBITER CAMERA IMAGES. P. J. Mouginis-Mark[1] and L. Wilson[1, 2], [1]Hawaii Institute Geophysics & Planetology, Univ. Hawaii, 2525 Correa Road Honolulu, HI 96822 (pmm@pgd.hawaii.edu), [2]Dept. Environmental Science, Lancaster University, Lancaster, Lancs., LA1 4YQ England (L.Wilson@Lancaster.ac.uk)

Introduction: Images from the Mars Orbiter Camera (MOC) are revealing more diversity in the styles of volcanism on Mars compared to observations made using Viking data [1, 2, 3]. Here we illustrate three new types of activity to aid further geomorphic mapping and the development of numerical models for Martian volcanic eruptions [4, 5].

Effusive Activity:

Pahoehoe Flows. The identification of the diversity of lava flow types is important because it provides information about the associated eruptions and subsurface structure of the volcano [4, 6-8]. For instance, based on fractal analysis of the edges of Martian lava flows [9], most are believed to be ‘a‘a flows. By analogy with Earth, these flows would have been emplaced at a high effusion rate (>~20 $m^3 s^{-1}$ [7]). We have identified one flow field on the SW flank of Alba Patera that appears to be a compound pahoehoe flow field (Fig. 1). The MOC coverage shows that this flow field is at least ~2 x 10 km in size. Individual flow lobes are ~20 x 60 m in size and there are hints of the presence of low ridges which may mark the locations of the sub-surface lava tubes that fed the flows.

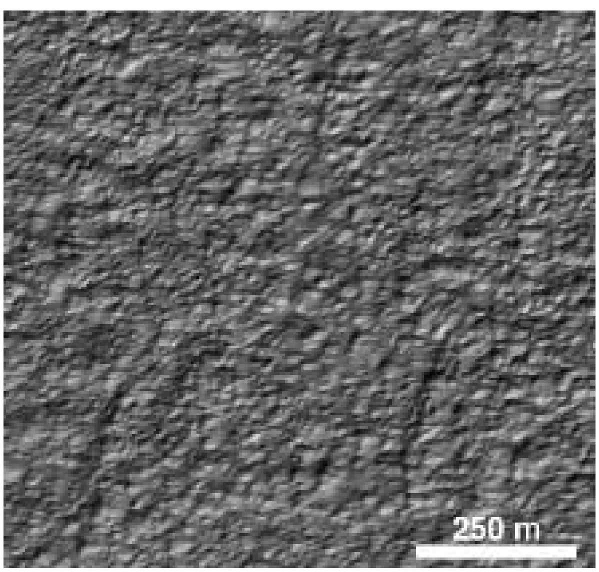

Fig. 1: Pahoehoe flow field on the SW flank of Alba Patera (39°N, 110°). Direction of flow is from top right to lower left. Illumination from right. MOC image 21004.

The existence of this pahoehoe flow field suggests that long-duration, low effusion rate eruptions (a few $m^3 s^{-1}$ based on terrestrial analogs [7]) may have occurred on Alba Patera, adding to the diversity of activity which has already been identified for this volcano [10].

Lava Lakes. Viking Orbiter images indicate that the caldera floors of the Martian volcanoes probably once had active lava lakes [11]. MOC data for the Elysium Mons caldera (Fig. 2) confirm this interpretation. Several raised, contiguous, ridges are comparable in size and morphology to Hawaiian lava lakes. These features are ~250 x 1,000 m in size, and typically have a raised rim ~30 m wide. The implication is that there was a volume of magma circulating within the caldera that was exposed to the atmosphere and directly linked to, and replenished by, a deeper magma source (into which some of the magma may have drained at the end of the eruption).

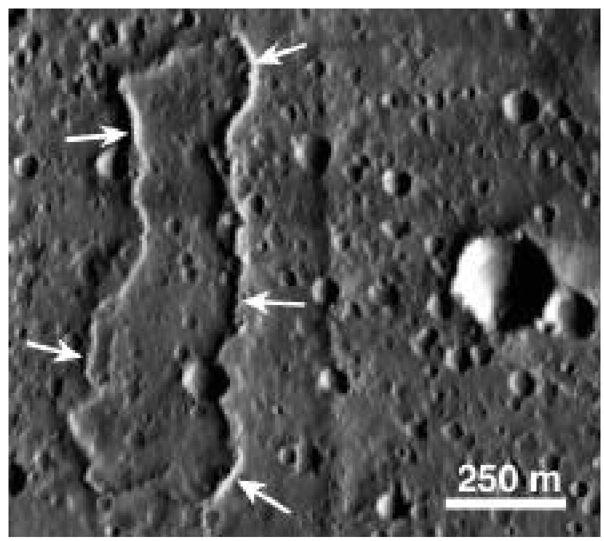

Fig. 2: Rim of a solidified lava lake (arrowed) within the Elysium Mons caldera. Illumination from right. MOC image 40303g.

Explosive Activity: Observations and numerical models have focused on large-scale explosive eruptions on Mars that may have produced the flank materials of volcanoes such as Hecates Tholus and Tyrrhena Patera [4, 12, 13]. MOC data reveal that more localized explosive eruptions also took place on Mars, producing channelized flows that strongly resemble pyroclastic flows on Earth.

Pyroclastic Flows. On Earth, both plinian ash fall and pyroclastic flow formation are mainly associated with silicic magmas, due to the greater water content and the propensity to fragment the magma on eruption. However, the lower Martian atmospheric pressure may encourage vigorous basaltic explosive eruptions to occur, and the lower Martian gravity and atmospheric pressure allow for greater dispersal and cooling of pyroclasts under some conditions [4, 5].

The northern basal escarpment of Olympus Mons is one area where we have identified possible examples of small pyroclastic flows (Fig. 3). The escarpment comprises several km-scale hummocks which appear to be composed of loose materials, as evidenced by the numerous low albedo talus shoots that can be found around the perimeter of the escarpment. At least 9 unusual individual flow features can be identified within the boundary of the escarpment (Fig. 3). These flows have a small range of dimensions, being typically <2 km long and ~60 m wide. Six of the flows have well-defined channels that have widths in the range of 26 – 59 m. Several additional flow "deltas" can also be identified ("B" in Fig. 3). These deltas are morphologically similar to examples seen at Mt. St. Helens [14] where multiple pyroclastic flows have been placed one on top of the other. Our interpretation of these Martian flows is that they are deposits from explosive eruptions that originated from two almost circular depressions just up-slope ("A" in Fig. 3). Given plausible assumptions about the rheology of the flows, their advance speeds would have been ~10 to 20 m/s and their travel times ~10 minutes. The volumes of the flows suggest that small-scale explosive volcanism occurred on the flanks of Olympus Mons, perhaps due to the intrusion of a dike into a volatile-rich substrate of the volcano [15].

References: [1] Carr M. et al. (1977) *JGR, 82,* 3985-4015. [2] Greeley R. and Spudis P. (1981) *Revs. Geophys., 19,* 31-41. [3] Mouginis-Mark P. et al. (1992) MARS, Univ. AZ Press, pp. 424-452. [4] Wilson L. and Head J. (1994) *Revs. Geophys., 32,* 221-263. [5] Fagents S. and Wilson L. (1996) *Icarus, 123,* 284–295. [6] Peterson D. and Tilling R. (1980) *J. Volcanol. Geotherm. Res., 7,* 271-293. [7] Rowland S. and Walker G. (1990) *Bull Volc., 52,* 615-628. [8] Lopes R. and Kilburn C. (1990) *JGR, 95,* 14383-14397. [9] Bruno B. et al. (1994). *Bull. Volc. 56,* 193-206. [10] Mouginis-Mark, P. et al. (1988) *Bull. Volc., 50, 361-379.* [11] Mouginis-Mark P. and Robinson M. (1992). *Bull. Volc. 54, 347-360.* [12] Mouginis-Mark P. et al. (1982) *JGR, 87,* 9890-9904. [13] Greeley R. and Crown D. (1990) *JGR, 95,* 7133-7149. [14] Rowley, P. et al. (1981). In: *U.S. Geol. Surv. Prof. Paper 1250,* pp. 489-512. [15] Wilson L. and Mouginis-Mark P. (1999) This volume.

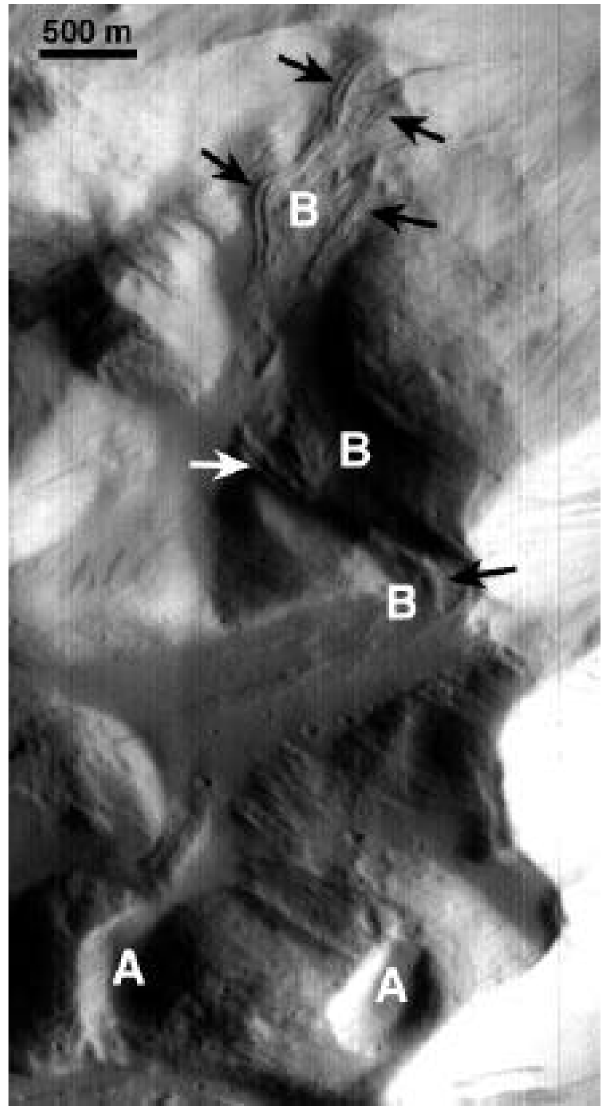

Fig. 3 Channelized flows (arrowed), interpreted to be pyroclastic flows, can be found at the lower elevations of the Olympus Mons escarpment at 22.5°N, 132.2°W. Direction of flow is towards the top of the image. Individual flows are typically ~60 m wide and ~2.0 km long. "A" denotes possible source craters. "B" identifies flow "deltas" where several individual flows appear to have come to rest on top of each other. Illumination is from the right. MOC image 46605g.

Acknowledgments: This work was supported by a grant from the Hawaii Space Grant Consortium, University of Hawaii.