CONSTRAINTS ON THE ORIGINS OF PLATY FLOWS ON MARS: MUD, LAVA, FROZEN SEA, OR…?

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Introduction: Recent Mars missions have revealed images and topography of enigmatic young-appearing (< tens of millions of years) geologic flows and surfaces that often appear to be the end product of material flowing downhill through topographically constrained channels into a closed basin [1-24]. These flows have surfaces characterized by plates and ridges at scales of hundreds of meters to several kilometers, and in some cases curving and grooved ridge systems on the flow surfaces indicative of flow directions [e.g. .2, 5, 6, 9, 11, 14, 15, 16-24]. The flows have been interpreted as both lava flows and as mud, water, or ice related flow features, and more recently as pack-ice-like landforms that are evidence for a currently frozen sea or lake [14, 15]. The flows in question are topographically fresh, appear relatively young in images in terms of dust cover and crater counts [e.g. 25], and are part of the major resurfacing units for extensive regions of Mars, (Cerberus, Elysium, Amazonis, etc…) [26]. They appear to be interleaved with channels of more obviously fluvial origins, and edifices and landforms of more clearly volcanic origins [21]. Understanding the origins of the platy and ridged flows is likely to be key in deciphering the recent (last few 100 m.y) geologic history of the Martian plains where they are found. So far, they have been studied by science teams assuming one perspective or another (e.g. volcanic, mud, or water- or ice-related) as a starting point, and often espousing viewpoints based on a small subset of the platy or ridged flows. This paper is a preliminary report from a larger collaboration, where we quantitatively and objectively are testing each proposed origin for the platy terrain with a mixed-expertise team (see acknowledgements) and the full range of available observed data and models, to determine if we can jointly propose a most probable geologic process(es) of origin. We expect the results to have major repercussions for recent Martian geologic history, supporting either significant water-related debris flow, lava flow, or the presence of a sea in recent Martian geologic history.

Approach: We are combining Image interpretation, flow modeling, and laboratory modeling with discussion and cross-comparisons of model results that focus primarily but not exclusively on the Athabasca and Marte Valles regions of the Cerberus Plains and the Kasei Valles region. For example, Figure 3 shows a MOC image of platy and platy-ridged flow textures annotated by R. Williams [pers. Comm.. 2005]. It is an example of initial image interpretation and superposition notes from the

Fig. 1. Arial photo of a lava channel within Craters of the Moon National Monument showing platy flow textures. Field of view is several hundred meters across.

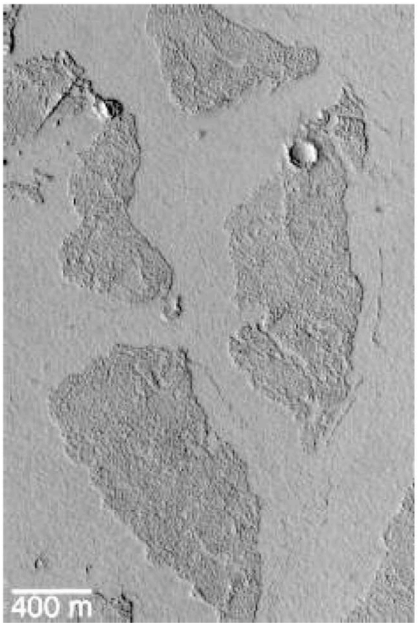

Fig. 2 . Image from MGS MOC Release No. MOC2-442, 4 August 2003 at 6.9°N, 177.2°E , showing platy surface texture of an area interpreted to be either lava flows or mud flows

perspective of the fluvial-like landforms community, and shows great diversity in platy surface textures and relative ages. See Figure 1 in Murray et al. [14] for an HRSC image of similar platy terrain near 5'N, 150°E, Mars and pack ice on Earth. The available data for platy martian terrains includes MOLA topography, and MOC, THEMIS, and HRSC images., and existing quantitative models for lava, water, mud and debris flows [e.g. 4, 7, 21, 24, 28], and we are re-running many of these models for selected platy flow examples for direct comparisons of results with expected lab and computational simulations and are collectively defining a series of observational tests for constraining likely origins.

References: [1] Berman, D.C., & W.K. Hartmann (2002) Icarus, 159, 1-17. [2]Burr, D.M., et al. (2004) Icarus 171, 68-83. [3] Burr, D.M., et al. (2002), Icarus 159, 53-73. [4] Burr, D.M., et al. (2002) LPSC XXXIII, Abstr.#1047. [5] Burr, D.M., et al., (2002) GRL 29, 13-1. [6] de Pablo, M. A., Fair, & A. G., Marquez, A (2004) 35th COSPAR Sci. Assem. 425. [7] Fagents, S.A. & Baloga, S.M., (2003) LPSC XXXIV Abstr.#1788. [8] Fuller, E.R. & J.W. Head, (2002), JGR 107, 10.1029/2002JE001842. [9] Gregg, T.K.P. & S.E.H. Sakimoto (2000) LPSC XXXI #1758. [9] Head, J.W., M.A. Kreslavsky, & S. Pratt, (2002) JGR 107, DOI 10.1029/2000JE001445. [10] Keszthelyi, L., A.S. McEwen, & Th. Thordarson (2000) JGR 105, 15,027-15,050. [11] Keszthelyi, L., Burr, D.M., McEwen, A.S, (2004) 2004, LPSC XXXV Abstr.#1657. [12] Manga, M, (2004), GRL 31, L02702. [13] McEwen, A., et al., (2002) AGU, Mtng. 2002, Abstr.#P11B-09. [14] Murray, J.B., et al. (2005) Nature 434, 352-356. [15] Murray, J.B., ., et al. (2005) LPSC Abstr.#1741. [16] Rice, J.W et al, (2003) LPSC XXXIV, Abstr.#2091. [17] Rice, J.W., et al, (2002) LPSC XXXIII Abstr.#2026. [18] Rice, J. W. et al, (2002), AGU Mtng. Abstr. [19] Russell, P.S. & J.W. Head, (2003) JGR 108(E6) ,CiteID 5064, DOI 10.1029 [20] Sakimoto, et al. (2001) AGU, Mtng. Abstr.#P22A-0537. [21] Sakimoto, S.E.H. & Gregg, T.K.P. (2004) LPSC XXXIV Abstr.# 1851. [22] Tanaka, K.L., et al. (2003) JGR 108, 20-1. [23] Williams, R. M. E., & M. C. Malin, (2004) JGR 109 10.1029/2003JE002178. [24] Williams, R.M., & R.J.Phillips, M.C. Malin, (2000) GRL 27(7) 1073. [25] Hartmann, W.K. & D.C. Berman, (2000) JGR 105 15,011-026. [26] Tanaka, K.L., (1986) JGR 91, E139-158.[28] Glaze et al.,(2003) Icarus 165 26-33.

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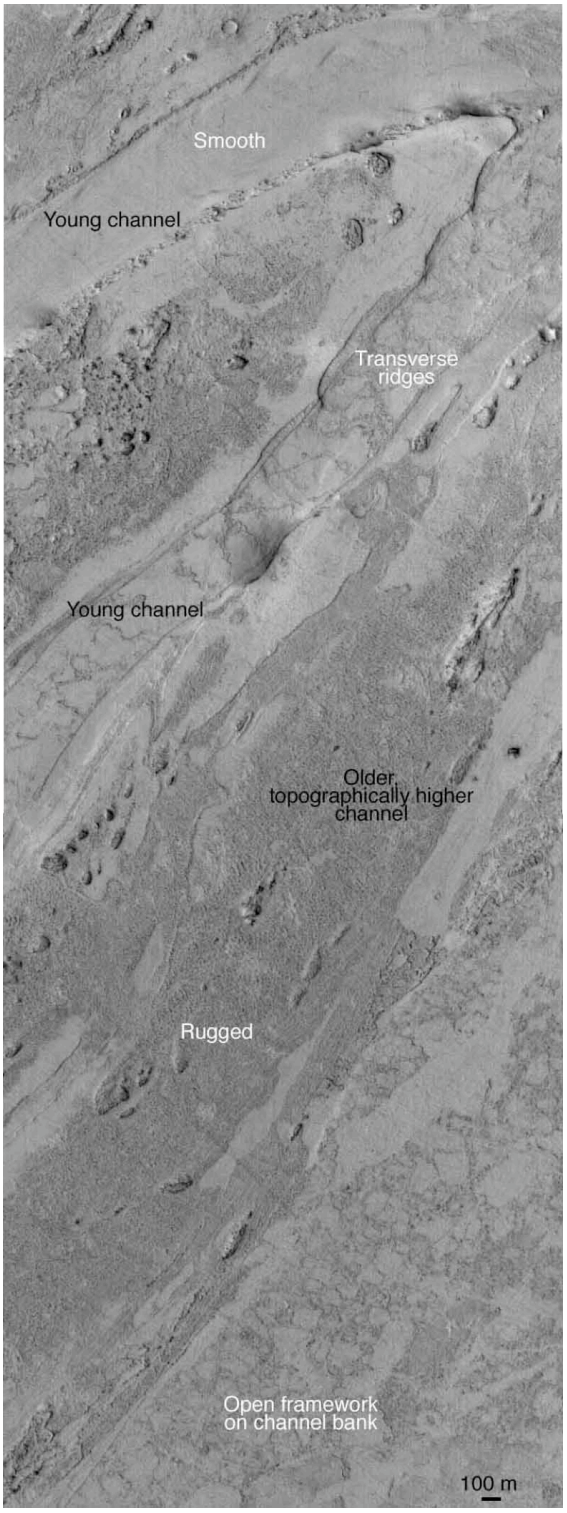

Fig. 3 Labeled MOC image courtesy of R. Williams showing several Cerberus Region channels with smooth, platy, and ridged textures.