THE FORMATION OF THE KILOMETER-SIZED FLOWS IN CHRYSE PLANITIA (MARS). P. Brož[1], E. Hauber[2], S. J. Conway[3], E. Luzzi[4], A. Mazzini[5], Axel Noblet[3], J. Jaroš[6], and Y. Markonis[6]. [1]Institute of Geophysics of the Czech Academy of Sciences, Boční II/1401, Prague, Czech Republic, petr.broz@ig.cas.cz, [2]Institute of Planetary Research, DLR, Berlin, Germany.[3] CNRS UMR-6112 LPG Nantes, France. [4]Department of Physics and Earth Sciences, Jacobs University Bremen, Germany. [5]Centre for Earth Evolution and Dynamics (CEED), University of Oslo, Norway. [6]Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Czech Republic.

Introduction: High-resolution images show the presence of kilometer-sized flows (KSFs) on Mars. Most of these features are observed in association with well-known volcanic centers, hence they have been interpreted as lava flows [e.g., 1,2]. However, some KSFs occur in regions where an association with magmatism is not obvious. Sedimentary volcanism, during which a mixture of water and sediment is extruded on the surface, has been proposed as an alternative mechanism to form some of the KSFs [e.g., 3-7]. A remarkable example of such KSF was reported by Komatsu et al. [6,8] at the southern margin of Chryse Planitia (*19.16°N; 322.71°E*) where an assemblage of landforms is possibly related to sedimentary volcanism [6,7]. Since then, thirty-five similar KSFs (e.g., Fig. 1a) have been reported in this region [7]. KSFs typically consist of three morphological elements: a) a central depression from which channel(s) originate(s), b) leveed channel(s), and c) a distal portion of the fading channel where the material is deposited forming terminal lobes. These lobes can have raised margins or no relief ultimately spreading radially [6]. Brož et al. [7] proposed that the KSFs are the result of low viscosity mud extrusions that propagate through laterally extensive networks of channels that gradually lose their transport energy. These initial studies were mainly based on Context Camera (CTX) images (~5-6 m/px, [9]) and HiRISE images (~30 cm/px; [10]), and lacked topographic resolution to fully support these hypotheses. Currently, six KSFs are covered by HiRISE stereo pairs enabling us to generate seven Digital Elevation Models (DEMs) with a ground sampling of 1-2 m/pix using established methods [11], and reveal additional insight about their origin.

Observations: We observe that all studied KSFs show a topographically well-defined "source" area with circular, semicircular or elongated map-view outline (Figs. 1, 2a). Three source areas are situated on relatively flat plains and are surrounded by ~hundred(s) of meter-wide elevated rims (Fig. 2a). The other three source areas are superposed on higher elevation and inclined pre-existing surfaces with smaller scale laterally extensive rims (see topographic profile in Fig. 1). The elevation difference between source area floors and the rims ranges from 10 to 20 m. The elevation of the source area floors is the same as that of the flat plains beyond the elevated margins on which KSFs are superposed. The margins of all studied source areas are breached on one side, enabling any extruded fluid to flow out. The HiRISE DEMs also reveal the presence of elevated mounds (<10 m high), or linear ridges (e.g. Fig. 1b), inside the three source areas superposed on the higher elevation, inclined surfaces. Our investigation also supports the observation of [6] that two distinct types of margins are present. One type is characterized by several meter-high scarps (Fig. 2a), whereas the other type shows a smooth topographical transition into the surroundings, and distinct albedo contrast on visible data (on Fig. 2b marked as bright units).

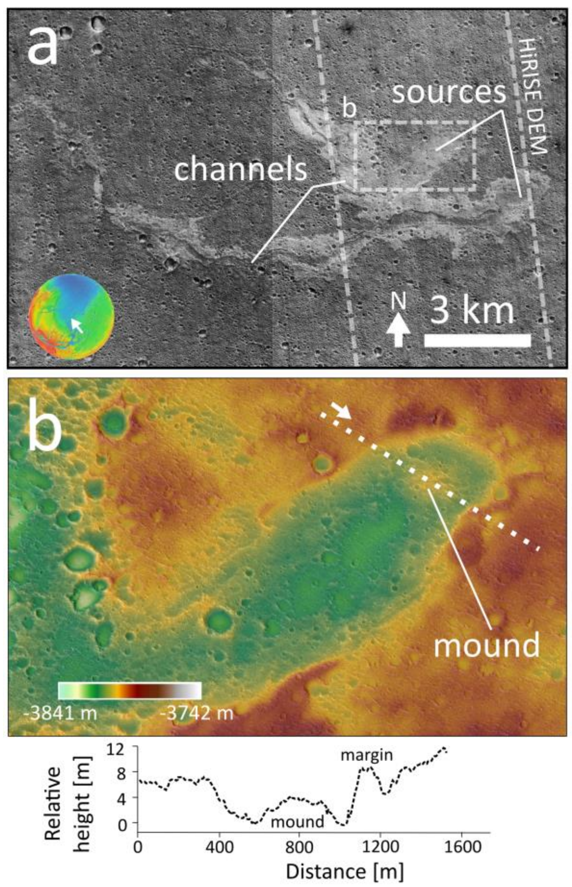

Figure 1: a) Example of studied KSF with position of HiRISE DEM marked. Base map: CTX mosaic centered at 20.22°N and 324.06°E. b) Topography of the source area with position of the central mound and cross-profile marked (HiRISE DEM). North is up. Bottom: topographic cross profile across the source area in b.

Discussion: Our observations support the previous notions of [6,7] that KSFs are aggradational, not degradational features formed by the transport of a liquid across the martian surface. The inclination of the surface as well as the shape of source areas are in agreement with the suggestion of [7] that liquid material has been released from the source areas. Since the elevation of the source area floors is the same as the surrounding plains, this suggests that the liquid medium forming KSFs was emplaced directly onto the preexisting surface. No signs of subsidence or explosive excavation were observed, which might be expected if these features were formed by volcanism [e.g., 12]. The mounds inside the source areas are not morphologically consistent with collapse of the rim of the source area, but could be the site where extruded material emerged at the surface. Therefore, we propose that these mounds are the surface expressions of the feeding conduits. It remains unclear whether they are the result of the ascent of more viscous material during the very late-stage of the eruption caused by the partial depletion of the water source. Alternatively, these mounds could have formed by the volume changes of the mud caused by the instability of water in the martian surface environment. This instability may lead to the formation of bubbles, their subsequent growth within the mud and the accompanied increase of viscosity [7,13].

The observations also reveal that the channel margins surrounding the channels are not continuous, but they are cut by channels joining the main channel to the bright units (Fig. 2b). No significant material accumulations in these areas of distinct brightness were observed, which we would expect in case of igneous eruptions (even in the case of very low viscosity lavas). This shows that the liquid medium was capable of a dual behavior; forming elevated margins and propagating into the surroundings without displaying defined topographical boundaries at the surface, but leaving a surficial expression by changing the brightness of the surface. We therefore propose a scenario that involves the release of water-rich sediments that were capable of modifying the surface, and spreading over a broad area. The fluid was capable of carrying sediments and depositing them and the flow was able to build from sediments margins (levees) around the channels. However, when water with sediments was spread over a wide area, the mixture froze and later the ice sublimated without leaving a detectable topographic expression, but instead changing the surface albedo.

Conclusions: Our study reveals that the morphology of KSFs in Chryse Planitia is consistent with the ascent and transport of low-viscosity mud across the surface during which the deposition of sediment caused the formation of leveed flow margins. The subsequent sublimation of ice removed substantial volume from the terminal parts of the flows. This supports the hypothesis proposed by [6,7] that these features are martian mud flows, formed as the result of subsurface sediment mobilization. These features represent a window into the martian subsurface and are an interesting target for in-situ investigation from a geological and astrobiological point of view [14].

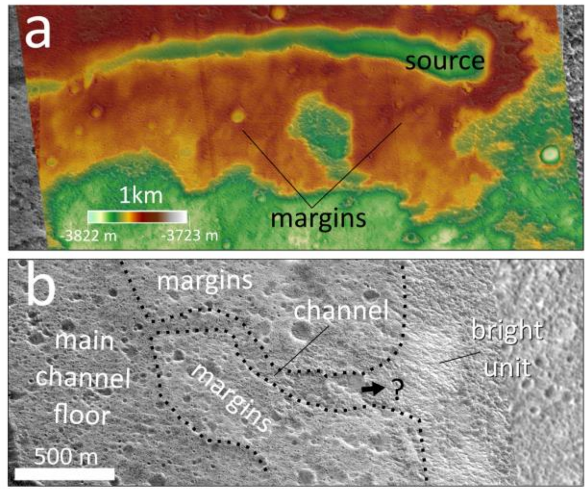

Fig. 2: Details of margins of two different KSFs in the area of interest. a) A source area superposed on relatively flat plain surrounded by km-wide margins, centered at 19.36°N, 323.96°E (HiRISE DEM). b) Channel transitioning into a bright unit towards East (HiRISE image centered at 19.11°N, 322.735°E. North is up in all images.

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