

**MULTIPLE, DISTINCT, (GLACIO?)FLUVIAL PALEOCHANNELS THROUGHOUT THE WESTERN MEDUSAE FOSSAE FORMATION, MARS.** D.M. Burr<sup>1</sup>, R.M.E. Williams<sup>2</sup>, J. Nussbaumer<sup>3,4</sup>, and J.R. Zimbelman<sup>2</sup>, <sup>1</sup>SETI Institute, 515 N. Whisman Rd., Mt View, CA 94043, (dburr@seti.org), <sup>2</sup>CEPS/NASM MRC 315, Smithsonian Institution, Washington, D.C. 20013-7012 <sup>3</sup>University of Mainz, Germany, <sup>4</sup>University of Bergen, Norway.

**Introduction:** The Medusae Fossae Formation (MFF) is an extensive, wind-scoured deposit stretching from 130° to 240° E near Mars' equator [1,2]. The MFF is Amazonian in age [1], so fluvial processes inferred therein would imply the flow of water near Mars' equator in the geologically recent past. Here we present evidence of widespread, channelized, surficial water flow within the western MFF.

**Regional location:** We use 'western Medusae Fossae' (wMFF) to refer to the western most portion of the MFF as mapped by [1,2]. As such, the wMFF is comprised of that topographically elevated terrain extending from the dichotomy boundary northwestward into the western Cerberus plains (Fig. 1).

**Feature description:** A survey of THEMIS IR and VIS images of the wMFF through the 07/05 release reveals a few tens of examples (e.g., Fig. 1) of positive-relief landforms that appear curvilinear in plan view (e.g., Fig. 2). These raised curvilinear features (RCFs) can be characterized as follows:

*Dimensions.* Individual RCF's extend in length up to several tens of kilometers. The width of individual RCF's ranges from a minimum on the order of 10 meters (where visible in Mars Orbiter Camera imagery) up to a few kilometers. Shadow measurements show that these landforms stand up to a few ten's of meters above the surrounding terrain. Where RCF's form networks, the networks cover up to many hundreds of square kilometers.

*Sinuosity.* The RCF's in the wMFF display varying amounts of sinuosity. Some single RCF's are nearly straight for a few tens of kms. Other RCF's curve tightly into tens of consecutive ~180° turns within a similar distance (e.g., Fig. 2, D?). Still others are sharply angled (e.g., Fig. 2, E).

*Association/network appearance.* These RCF's can be found as single landforms. More commonly, they occur in networks, which have a range of morphologies (e.g., Fig. 2). These morphologies include a) dendritic, b) distributary fan-shaped, and c) having sub-parallel channel orientation. In a small number of cases, networks appear superposed, with finer-scale ridges on top of broader curvilinear landforms (e.g., Fig. 2, E).

**Interpretations:** Based on the similarity of both their individual curvilinear appearance and their network morphology to terrestrial fluvial landforms, we interpret the RCF's in the wMFF to represent fluvial

paleochannels formed by continually flowing water [cf. 3,4,5]. As such, they provide evidence of both fluvial sediment transport (in the form of the paleochannels) and the type of depositional environments (in the form of the network morphologies.)

**Age:** The MFF formed during the Amazonian epoch [1]. We infer the paleochannels likewise to be (at the oldest) Amazonian. In the context of the ongoing discovery of globally distributed fluvial paleochannels on Mars [e.g., 3,4,5], these wMFF landforms represent the youngest paleochannels yet observed.

**Stratigraphic context:** RCF's are found in multiple, distinct stratigraphic horizons. Although extended correlation of horizons in the MFF is not yet possible, superposition relationships within single THEMIS images suggest that RCF's are found in at least a few different strata (e.g., in Fig. 2, E appears superposed on F and possibly D; C may be superposed on A; and B is within a lower strata than that of either C or A). This suggests that the formation of these paleochannels was a time-transgressive process, occurring during multiple periods in this Amazonian-aged deposit.

**Geologic context:** In the THEMIS images surveyed to date, RCF's were found in 3 types of locations. A small proportion (~5%) of observed RCF's was associated with impact craters. These RCF's were found both on the near-crater ejecta and within the crater walls. A larger proportion (~40%) of RCF's are associated with elevational steps or scarps. These elevational steps tend to be curved; RCF's were largely absent from straight (tectonic?) scarps. For the remaining proportion of RCF's, no clear geologic association has been determined.

**Origins/formation mechanisms:** The variety of RCF morphologies and contexts suggests that they have a variety of origins. Possibilities include:

*Impact into volatiles.* Ground ice is a possible water source for those RCF's associated with impact craters. This is consistent with the interpretation of the MFF as an ice-rich dust deposit [6].

*Inversion of rainfed fluvial channels.* Fluvial channel inversion has been hypothesized for intra-crater and other RCF's elsewhere on Mars [4,5,7]. In the wMFF, fluvial channel formation would be consistent with hypothesized rainfall induced by local volcanism [cf. 8]. After formation from rainfall, the channel may have been inverted through induration

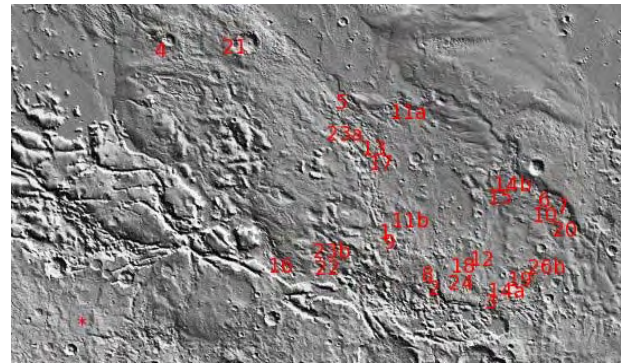
of the channel floor by armoring and/or cementation, and the subsequent erosion of the less resistant surrounding terrain. [see 9 for details on channel inversion]

*Inversion of glaciofluvial channels.* Alternatively, channel formation could have resulted from the flow of glacial meltwater. Meltwater commonly produces pro- or subglacial channels; after glacial retreat, inversion of the glaciofluvial channel can occur as outlined above [see 9 for details]. This possibility is consistent with the interpretation of other geologic features in the wMFF as formed by glacial processes [10,11].

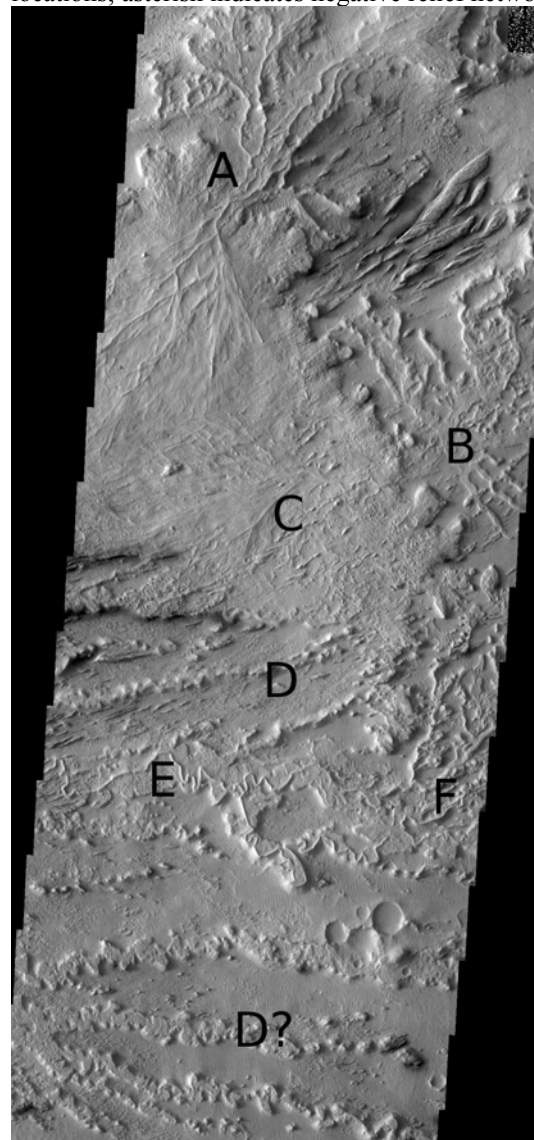
*Eskers.* Eskers have been hypothesized for RCF's elsewhere on Mars, e.g., on the northern plains [12], and in southern impact basins [e.g., Argyre; 13]. A result of sub-glacial fluvial processes, eskers form from meltwater streams flowing within sub-glacial ice-walled tunnels. The stream deposits sediment (in certain locations) within the sub-glacial tunnel; glacial retreat reveals a discontinuous, positive-relief, curvilinear ridge. As with the idea of inverted glaciofluvial channels, an esker interpretation would be consistent with suggested local glaciation [10,11].

**Summary:** At least a few tens of RCF's or RCF networks are found throughout the wMFF. In comparison, mapping of the eastern MFF to date has not revealed any similar landforms. These RCF's are interpreted as having formed through channelized, surficial water flow. These landforms have a variety of morphologies and are scattered throughout the wMFF at a variety of geologic locations and strata. Thus, they likely formed through a variety of mechanisms, including impact, rainfed fluvial, and pro- or sub-glaciofluvial processes.

**References:** [1] Scott D.H. and Tanaka K.L. (1982) *JGR* 87, 1179-1190. [2] Bradley B.A. et al. (2002) *JGR* 107(E8), 10.1029/2001JE001537. [3] Williams R.M.E. and Edgett K.S. (2005) *LPS XXXVI*, 1099. [4] Malin M.C. and Edgett K.S. (2003) *Science* 302, 1931-1934. [5] Moore J. et al (2003) *GRL* 30(24),10.1029/2003GL019002. [6] Head J.W. III and Ghatan G. (2004) *LPS XXXV*, 1635. [7] Williams et al. (2005) *LPS XXXVI*, 1173. [8] Plescia J. (1993) *Icarus* 104, 20-32. [9] Pain C.F. and Ollier C.D. (1995) *Geomorph.* 12, 151-165. [10] Nussbaumer J. (2003) *6th Mars*, 3018. [11] Nussbaumer J. (2005) *LPS XXXVI*, 1949. [12] Kargel J.S. and Strom R.G. (1992) *Geology* 20, 3-7. [13] Baker V.R. (2001) *Nature* 412, 228-236.



**Fig. 1:** MOLA relief context image ( $1^{\circ}\text{N}$ – $9^{\circ}\text{S}$ ,  $140^{\circ}$ – $157^{\circ}\text{E}$ ) of most of the wMFF. Numbers indicate RCF locations; asterisk indicates negative relief network.



**Fig. 2:** Subset of THEMIS vis image V05875001, showing multiple RCF networks (A through F) with varying morphologies and stragrapic levels.