



## **Outflow channels with deltaic deposits on Mars: Evidence for fluvial flows rather than volcanic flows**

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Outflow channels are broad fluvial landforms formed by catastrophic flows with typical braided pattern. A controversy exists about their origin as aqueous flows because recent works have observed volcanic processes creating similar landforms, for example on Mercury. One caveat of the aqueous flows hypothesis is the lack of deltaic deposits that should be associated with deposition of transported material. Postflow filling can hide these deltas subsequently, but this should not be the case for 100% of outflow activity. We show from a newly found series of outflow that some outflow channels can display features typical of aqueous deposits. A connected series of outflow channels in the Ismenius Lacus quadrangle are identified for the first time and characterized using High Resolution Stereo Camera images of Mars Express and Context camera images of Mars Reconnaissance Orbiter. These channels, which stretch over >400 km south to north and join the northern plains, were identified from braided channels, scour/groove marks, poorly sinuous valleys and depositional landforms. Discharge rates were estimated to 0.1 to  $5 \times 10^6$  m<sup>3</sup> s<sup>-1</sup> from analysis of Mars Observer Laser Altimeter topographic data. Pathways of channels segments were extracted from topography showing a unique source at a breached crater rim, suggesting overflow from ponded depressions. A series of delta fans are observed inside depressions along the channel pathways. The presence of these deltas formed in former transient bodies of water is a compelling argument for formation of this outflow channel system by fluvial flows. The similarity of these flows with other outflow channels on Mars proves that volcanically-related outflows cannot explain all channels observed on Mars. In addition, this study also shows that catastrophic floods are able to create fan deltas in transient lakes, a distinct context than usually involved for such landforms.