

NEW OBSERVATIONS OF MARTIAN OUTFLOW CHANNEL FLOOD DEPOSITS. J. W. Rice¹ and V. R. Baker², ¹Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719 (rice@psi.edu) ²Dept of Hydrology and Water Resources, Harshbarger Bldg Rm 122, PO Box 210011, University of Arizona, Tucson, AZ 85721.

Introduction: During the past forty years numerous scenarios have been proposed for the creation of the Martian outflow channels ranging from mega floods, volcanic dikes followed by groundwater release, lava flows, debris flows, glaciers, and explosive carbon dioxide outgassing. Today most workers favor water as the major outflow channel forming medium, however considerable uncertainty remains about the amounts of water and sediment involved (e.g., sediment-charged floods or water-rich debris flows). It should be noted that this result is based primarily on the presence of a suite of erosional landforms (cataracts, longitudinal grooves, streamlined hills).

To date no clear Martian flood deposits, bed forms or deltas have been identified associated with the outflow channels. However, here we present for the first time new observations that these heretofore enigmatic deposits and bedforms have been located. Our preliminary photogeologic analysis of the high resolution images indicates that these channels contain a rich inventory of both erosional and depositional landforms. HiRISE imagery of the Martian outflow channels does show morphological differences, albeit subtle in most cases, between the channel floors and the surrounding regions unaffected by the floods. More detailed mapping of depositional bedforms on Mars will provide additional constraints on the surface hydraulics, erosion and sedimentary processes.

Methods: Most of the diagnostic clues used to identify the largest terrestrial catastrophic floods in the Channeled Scabland and Iceland are based on landform assemblages and associations [1,2,3]. These clues also depend on geologic context and often require the preponderance of observational data to properly identify flood features. Our extensive experience in field geology investigations of large scale floods in both the Channeled Scabland and Iceland indicate that no one feature or landform can be used to properly identify paleofloods.

This same methodology (landform assemblages and associations) is used in our analysis the Martian outflow channels. We use the hierarchical classification scheme developed by Baker [1, 2] to search for and describe Martian macroform and mesoform landforms. Macroforms are scale controlled by channel width and some examples are streamlined hills, rock benches, pendant bars, and expansion bars. Catastrophic floods also produce mesoforms which are scale controlled by channel depth. Mesoforms include large scale transverse ripples, boulder bars, inner channels, cataracts,

and longitudinal grooves.

Observations: The most obvious morphologic signature associated with the unconfined outwash regions (basin ward of channel mouths) of the outflow channels is a rippled texture on the plains [Figs. 1 and 2].

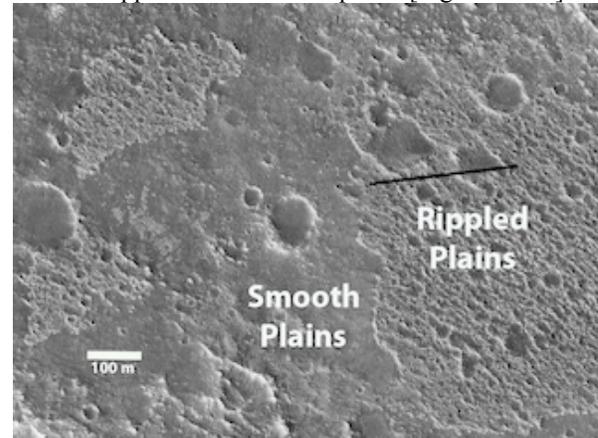


Figure 1. Regional HiRISE view illustrates relationship of rippled plains overlying smoother plains. The rippled plains form a relatively thin deposit that is being stripped away in places revealing lower smoother plains unaffected by the floods. More detailed mapping of depositional bedforms on Mars will provide additional constraints on the surface hydraulics, erosion and sedimentary processes.

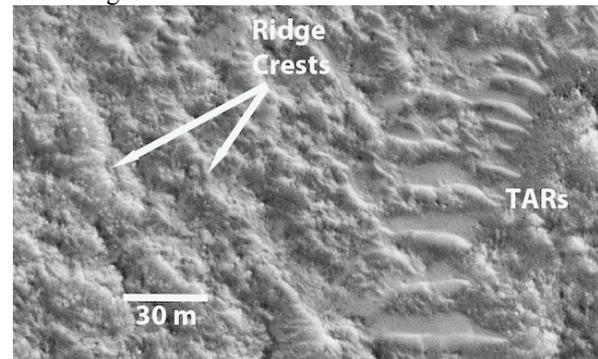


Figure 2. Rippled Plains north of Ares Vallis showing generally straight ridges running from upper left to lower right with orientations transverse to inferred flood flow direction. On the right side of this image Transverse Aeolian Ridges (TARs) are visible. Note how the transverse ridges differ morphologically from the TARs.

This ripple-like texture lies transverse to flow direction. This texture is commonly observed in regions affected by the Ares and Tiu Valles floods in Chryse/Acidalia Planitia. Malin and Edgett [4] noted that the outflow channel surfaces in Chryse and Acida-

lia Planitia were typically pitted and had a rippled texture. They were not really certain what to make of this texture in terms of flood processes. Here we propose that this rippled texture is the morphologic signature of fluvial bedforms (antidunes or transverse ribs) of the last floods to flow through these regions of Chryse/Acidalia Planitia.

We have conducted some preliminary quantitative studies of a mesoscale bedforms (ridges), observed on the rippled plains near the mouth of the Tiu Valles outwash region in Chryse Planitia. We propose that features are antidunes/transverse ribs based on the morphometric analysis. We measured these features and found that the average wavelength, is 53.6 m. The equations developed by [9] were then applied to these features in order to calculate and help constrain the velocity, depth and Froude number of the floods. The following results were obtained by using these equations: mean velocity of 6 m/s; flow depths ranging from a minimum of 5.5 m to a maximum of 19 m; and Froude numbers ranging from 0.7 to 1.3, which is the range associated with antidune flow. The features measured here were most likely deposited during the last floods through this region. This would be analogous to the catastrophic floods responsible for the Channeled Scabland, which undergo an abrupt cessation of flood discharge which results in the preservation of many of the mesoforms.

We have also observed large sub-rounded boulder deposits (bedload) located on the floors of some outflow channels where they empty into the Chryse basin (Fig. 3). Some of these boulders are up to 15 m across and display corner knicks or chips which we interpret to be perussion marks created during flood transport.

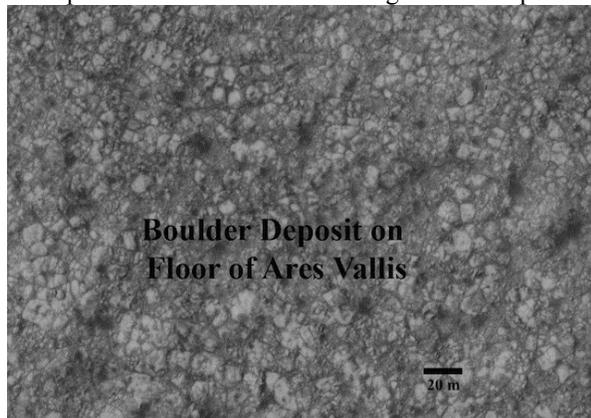


Figure 3. Large boulder field found on the floor of Ares Vallis.

Conclusions: This information will allow us to reconstruct the paleoflood depths and velocities for the outwash plains of Chryse/Acidalia Planitia. This information when combined with our future hydraulic modeling task for the five outflow channels in our

MDAP funded research will provide new data on the nature and dynamics of these Martian paleofloods.

Some of the most important issues involving the formation of fluvial landforms on Mars relate to the water source, which mechanisms and processes combined to modify the surface, and the ultimate fate of the water and sediment after transport into depositional sinks. These results will enable us to more fully understand the role water played in the origin and evolution of the outflow channels and aid in reconstructing the global hydrologic cycle of Mars.

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