**PALEOHYDRAULIC INVESTIGATION OF MARTIAN EQUATORIAL INVERTED CHANNELS IN A VOLATILE-ENRICHED GEOCHEMICAL PROVINCE.** R. Manogaran[1], J. S. Tubbs[1], A. Bates[1], E.B. Hughes[2], T. Ruj[3], and S. Karunatillake[1]. [1]Department of Geology and Geophysics, Louisiana State University, Baton Rouge, LA 70803 (rmanog1@lsu.edu), [2]Earth and Atmospheric Sciences Department, Georgia Institute of Technology, Atlanta, GA 30332, [3]Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA), 3-1-1 Yoshinodai, Sagamihara 252-5210, Kanagawa, Japan.

**Introduction:** Rivers on Mars are preserved as negative or positive relief branching networks broadly known as sinuous ridges, however, alternative terminologies have been used in the literature such as raised curvilinear structures or inverted channels [1]. These inverted channels are important features that have the potential to provide quantitative information on the ancient hydrology of the Martian surface [2]. They have been discovered in numerous areas on Mars such as the Aeolis Dorsa region and within Greater Meridiani Planum, specifically Miyamoto crater [3,4]. These two areas are the focus of this study (Fig. 1). These two regions are in the same chemically uniform province that is enriched in volatiles (H2O, Cl, and S) relative to the average Martian crust [5], and they are at a similar latitudinal zone (-3° to -5°), with a lateral separation of 150° of longitudinal distance.

Climatic conditions vary with latitude on Mars, and this phenomenon has been shown to have a significant impact on dominant geomorphic processes [6]. In addition, regional chemistry from elemental abundances measured by gamma ray spectroscopy (GRS) has been used to distinguish various processes underlying such geologic features [7]. Although the two regions of interest share a latitudinal zone and are geochemically consistent, it is unknown if they were affected by similar aqueous processes. These processes may have influenced the duration of fluvial deposition and flow intermittency, contributing to differences in geomorphology and channel bed induration. Hence, we aim to comparatively analyze the inverted channels' paleohydraulic geometry to further understand various paleohydraulic parameters. Estimates of these parameters will be used to calculate paleo-Froude numbers, paleoslopes, and flow velocities to provide new constraints on the flow and formation conditions of rivers on paleo-Mars. Through this interpretation, we will characterize the spatial variation of fluvial and post-fluvial processes in the Martian equatorial zone.

**Methods:** By using hydraulic geometry power-law equations scaled for Martian conditions [8], we will estimate hydraulic geometry parameters by first measuring the channels' widths in ArcGIS Pro from a more extensive dataset of Martian inverted channels. A combination of High Resolution Stereo Camera (HRSC) Digital Elevation Models (DEMs), Mars Reconnaissance Orbiter's High Resolution Imaging Science Experiment (HiRISE) images, and Mars Digital Image Model (MDIM) 2.1 were used.

Inverted channels were first identified by their morphology using HiRISE images overlain atop a base layer of HRSC DEMs and MDIM 2.1 to determine the positive relief of river features. The widths, perpendicular to the length of the inverted channels, were measured using Distance and Direction tools in ArcGIS Pro roughly every 5 to 10 km where sun-illumination or shading could be used to discern the edges. Where distinctions between edges of the inverted channels could not be confidently determined based on HiRISE images alone, we inspected topographic profiles of the sampled region from HRSC DEMs in the 3D view of ArcGIS Pro.

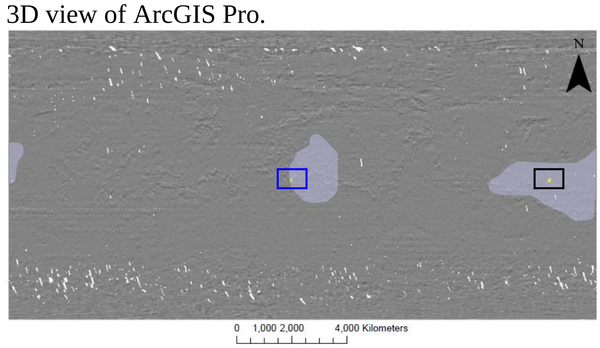


***Fig. 1*** *Mars Context Camera (CTX) Image Mosaic (5m/pixel) showing locations of inverted channels in Miyamoto crater (blue box) and Aeolis Dorsa (black box) in geochemical province C (purple-coded region) delineated by prior work [5]. Province C contains two geographic regions: Sinus Meridiani and the Medusae Fossae Formation (MFF) [5].*

The sample size was determined based on the 160 km diameter [4] of Miyamoto crater which was then used in the Aeolis Dorsa region at an approximately similar latitude to the Miyamoto crater. The significance of sampling both locations in similar latitudes is to ensure similar climate regimes, which could be a key driver of the planet's fluvial conditions. We chose the exact location of sample size in Aeolis Dorsa based on the abundance of inverted channels that are comparable in length scale to those in Miyamoto crater and those of intra-crater inverted fluvial features. We calculated all paleohydraulic parameters for the inverted channels using equations based on previous work [8]:

$$B = 3.13Q^{0.57} \qquad DF = 263.3B^{-0.87}$$

$$H = 0.29Q^{0.404} \qquad Slope = \frac{DF}{g_{Mars} \times 1000}$$

$$U = \frac{Q}{B \times H} \qquad Fr = \frac{U}{\sqrt{g_{Mars} \times H}}$$

Where B is the width (m), DF is the driving force ($kg/m^3s^2$), H is the depth (m), Q is the discharge ($m^3/s$), U is the velocity (m/s), slope is the channel slope calculated using $g_{Mars} = 3.71$, and Fr is the Froude number. Given the absence of flowing water on Mars at present, the predicted dependent variables refer to the parameters of channels on paleo-Mars when channels were active. We use the modified box-and-whisker plots to statistically compare the parameters between Aeolis Dorsa and Miyamoto crater. Each box spans the 25th–75th percentile of the data; horizontal lines in each box represent medians, and whiskers span the remaining data, except for outliers that are 1.5 times the distance of boxes

**Results and Discussion:** On average, channels in the Aeolis Dorsa region are twice as wide as those in Miyamoto crater, representing a three-fold higher average paleodischarge in the former region over the latter.

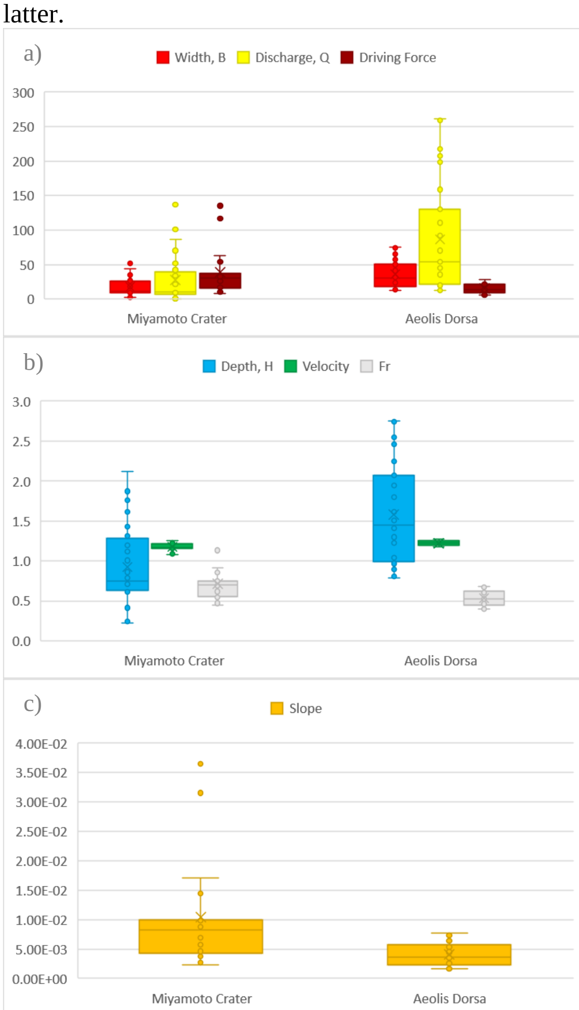


***Fig. 2** Box and whisker plots comparing different aspects of estimated hydraulic parameters in Aeolis Dorsa and Miyamoto Crater. Widths are the only independent variable used to predict other values. a) compares the width, discharge, and driving force, b) compares depth, velocity, and Froude number, and c) compares the paleoslope of the inverted channels in both regions.*

Channel width varies due to the tendency of water to flow faster on steeper slopes; as a result, the channels occupy smaller channel cross-sections [9]. From Fig. 2a, we see that Miyamoto crater's narrower inverted channels are most likely due to its steeper terrain as compared to the Aeolis Dorsa region. Based on Lane's balance [10], it is stated that when the amount of sediment is small, the discharge rate would increase, indicating that the flow energy required for transport, erosion, and incision processes has exceeded the maximum amount. We interpret that the Aeolis Dorsa region might have experienced an increase in discharge and velocity when there was a low sediment supply and when combined with its lower slope, the resulting channels were wider and deeper (Fig. 2b) as compared to the channels in the Miyamoto crater region. The DF or the erosive force of the flow [11] will be higher in steeper terrains (Fig. 2c) due to the influence of gravity, which we see in Fig. 2a where inverted channels in the steeper terrains of Miyamoto crater region have a greater driving force. Based on our Froude number calculations, we observe that inverted channels in both regions of Mars tend to be subcritical (Fr<1) but there is a small number of supercritical (Fr>1) flow features (Fig. 2b).

**Future work:** We will analyze the bulk crust composition and surficial age of the regions by delineating the study areas into several key regions based on the areal density of inverted channels, GRS-derived geochemical province map, and mapped geology of Mars. These delineated regions will be used to determine the relative ages of channels and to derive the mineralogy and geochemistry of the area. A more robust comparison of the channels and the surrounding environment will yield insight into the conditions under which the channels were formed and the history of flow conditions in the equatorial zone.

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