OCCURRENCE, DISTRIBUTION AND IMPLICATIONS OF MAFIC IGNEOUS BEDROCK THROUGHOUT THE UZBOI-LADON-MARGARITIFER FLUVIAL SYSTEM, MARS. M. D. Kraft[1], M. R. Salvatore[1], C. S. Edwards[2], and P. R. Christensen[1], [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, mdkraft@asu.edu; [2]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA.

Introduction: The Uzboi-Ladon-Morava (ULM) channel system forms one of the largest contiguous fluvial systems on Mars. The morphology of the ULM system has been well studied [1-4], but the composition of the crust in which this system of channels and basins formed has not been closely examined. Although olivine-rich bedrock exposures were previously identified along the stretch of the ULM system in a global survey of olivine bedrock [5], the relationship of these exposures to components of the ULM system were not formally recognized, and they have yet to be explored in any detail. For this study, we surveyed the ULM using Thermal Emission Imaging System (THEMIS) and Thermal Emission Spectrometer (TES) data in order to identify where olivine-rich bedrock occurs and to determine how the exposures relate to morphologic features of the channel system. The results have important implications for understanding how the ULM system operated and evolved.

Geologic setting: The ULM system extends from the northern rim of Argyre through the ancient plains of Margaritifer Terra into Margaritifer Chaos and Ares Vallis. The ULM is comprised of the ancient and infilled large impact features of Holden, Ladon and Margaritifer Basins, which are connected and, in some cases, throughcut by the large, incised channels of Uzboi, Ladon, Morava, and Margaritifer Valles **(Fig 1a)**. The channels were cut by overland flow of water and retain fluvial terraces in places [2,3]. Basins are thought to have been sites of ponding as well as sinks for sediment carried in the fluvial system, which appears to be corroborated by the presence of clay minerals detected in ULM basins [6]. The ULM is dotted by variably developed chaos terrains, which become more

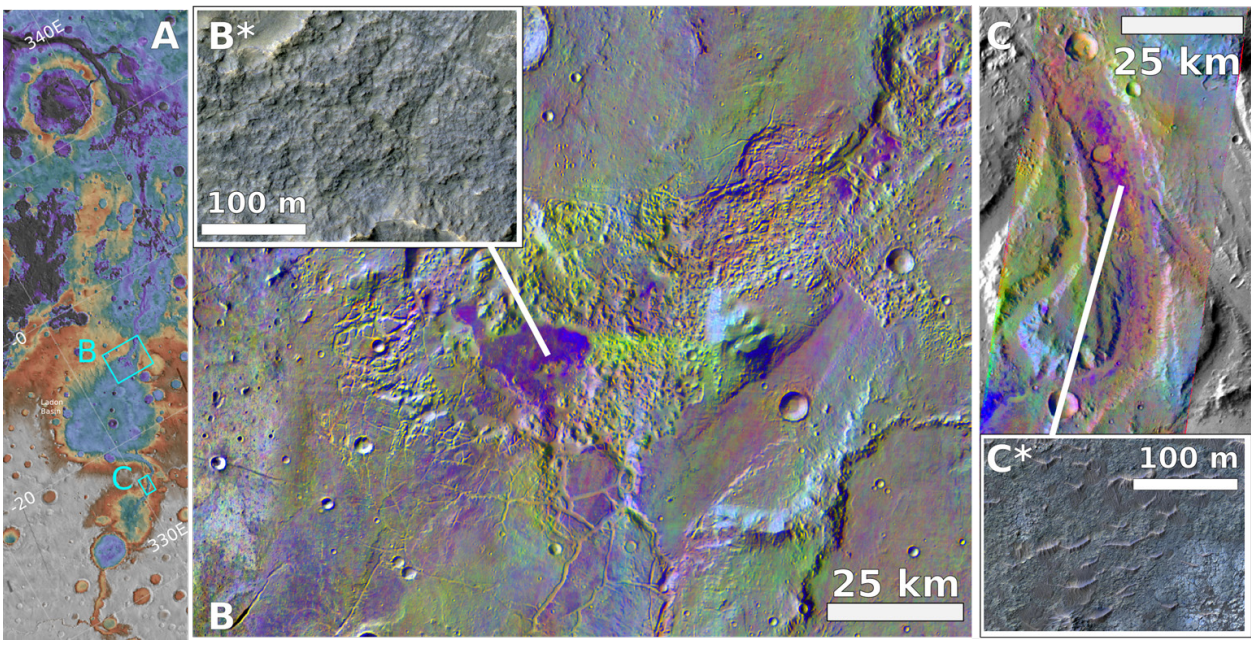

Figure 1. (a) Regional view of the Uzboi-Ladon-Morava fluvial system shown as MOLA topography overlain on THEMIS daytime-IR; (b) THEMIS DCS image of bands 8-7-5 for region B in (a) showing olivine-rich units in purple and bluish tones, which are associated with chaos terrains in northern Ladon Basin and the mouth of Morava Vallis; inset image shows fractured bedrock associated with large olivine-rich unit (HiRISE ESP_015946_1620); (c) THEMIS DCS image of bands 8-7-5 for region C in (a) showing olivine-rich outcrops associated with fluvial terraces in Ladon Vallis; inset (c*) shows high-resolution view of fractured olivine-rich bedrock outcrops, which are overlaid by darker-toned drift material (HiRISE image ESP_016579_1575).

prominent toward the northern portion of the system. The southern portion of the fluvial system is superposed by Holden and Eberswalde Craters, which host some of the best preserved fluvial deposits recognized on Mars [7,8].

Observations: Olivine-rich materials occur throughout the ULM system. They are recognized as purple tones in THEMIS decorrelation stretch (DCS) images of bands 8, 7 and 5, due to the low emissivity of olivine in band 7. Olivine-rich materials have high nighttime temperatures (relatively high thermal inertia), as well as bright-toned and fractured surfaces in high-resolution images. The observations indicate that these are exposures of olivine-rich bedrock, and that they are similar to olivine-rich mafic bedrock observed in other locations on Mars [5,9].

Olivine-rich bedrock occurs in three general places in the ULM system: (1) basin floors, (2) channel terraces, and (3) in chaos blocks.

Olivine-rich bedrocks comprises large portions of the floors of Holden Basin and Ladon Basin. In these locations, the olivine-rich materials form extensive units. While the units are disrupted by local structures or, in the case of Holden Basin, partly covered by ejecta from Holden Crater, they are generally flat-lying and contiguous exposures, which lack signs of having been eroded by fluvial activity.

Basin floors grade to chaos terrain in the northern portions of both Holden and Ladon Basins, where the basins are breached by down-stream channels (Ladon Vallis and Morava Vallis, respectively). Blocks of chaos commonly show olivine enrichment in THEMIS DCS images. A gradation from basin floor to chaos is best exhibited where Ladon Basin connects with Morava Vallis, in which case it appears that the bedrock on the basin floor has been undercut and partly collapsed to form large olivine-capped blocks of chaos at the mouth of Morava Vallis **(Fig 1b)**.

Lastly, olivine-rich bedrock is found in channels in Uzboi and Ladon Valles, where it is observed near the channel bottoms and is generally associated with previously identified fluvial terraces [2] **(Fig 1c)**.

Discussion: The mafic bedrock units have important implications for how the ULM fluvial system evolved. For example, the large exposures of olivine-rich material in Holden and Ladon Basins indicate that igneous processes may have played a more extensive role in filling basins than is presently recognized [10].

Olivine bedrock may have controlled fluvial development of the ULM, forming resistant layer(s) that resulted in benches and terraces in channels. This is consistent with the suggestion that competent bedrock layers inhibit fluvial down cutting in places like Ares Vallis [11]. Similarly, olivine bedrock may have played an important role in chaos development, by forming a competent upper layer that was preserved during the collapse associated with chaos formation. Furthermore, the olivine bedrock may have contributed to the formation of chaos by acting as an aquaclude that trapped subsurface water or ice that was later debauched catastrophically.

The olivine-rich unit(s) identified throughout the ULM are most likely igneous rocks, although it is uncertain exactly how they formed, whether they are genetically related from place to place, or how volumetrically important they are. Olivine-bearing bedrock units might be layered throughout the upper crust, representing processes that occurred during much of the Noachian. If so, the layered olivine-rich bedrock may have been instrumental in how the fluvial system operated and developed. If, instead, the olivine bedrock represents a single material or event, it could provide an excellent stratigraphic marker that can be used to determine the timing of fluvial events in Margaritifer Terra. We are pursuing localized studies to determine the nature of the olivine-rich bedrock, its stratigraphic relationships and the timing of its formation [12]. Understanding how olivine-rich bedrock formed is important for determining its role in the geologic evolution of the ULM.

Outstanding Questions: Many outstanding questions remain, including: What is the origin of olivine-exposures? Do they exposures represent one large or several isolated olivine-rich units? How are these materials related to those observed in the circum-Chryse chaos terrains and outflow channels?

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