A MULTISTAGE SEDIMENTARY HISTORY AT AEOLIS DORSA, MARS. K. L. Tobin and D. P. Quinn[2], [1]Department of Geosciences, University of Wisconsin – Madison, Madison, Wisconsin, USA (*kltobin@wisc.edu*), [2]Department of Geosciences, University of Wisconsin – Madison, Madison, Wisconsin, USA (*daven.quinn@wisc.edu*).

Introduction: The Noachian and Hesperian history of Mars includes abundant deposition from rivers and lakes [1, 2]. With its clear records of fluvial deposition and its low elevation in the northern plains of Mars, Aeolis Dorsa is a key locale for investigating this history. Previous work indicates the regional stratigraphy might record several phases of fluvial and lacustrine activity [3, 4]. These systems may correspond to several phases of a Noachian to Hesperian northern hemispheric oceans that have been proposed in other regional and global studies of Mars' early surface environment [e.g., 2, 5].

Here, we characterize a regional exposure of Aeolis Dorsa's early sedimentary sequence in order to determine the unknown origin of the lower unit described in [3] and the history of fluvial phases. Using interpretations from [3] and [4] as a base, we remapped the region at higher spatial and stratigraphic resolution using updated imagery and elevation models.

Background: Several imagery types were used in mapping. The CTX global mosaic produced by Caltech's Murray lab was used as a base map [7]. HiRISE images were used to gain a broad understanding of the area. Seven CTX and HiRISE digital elevation models (DEMs) and orthophotos were used as source data for measuring bedding planes. In addition, we used the CesiumJS (cesiumjs.org) digital globe to organize global and local DEMs into a single 3D base map. This helped develop our geologic interpretations.

Geologic Map: We focused on a region of Aeolis Dorsa that was dominated by the unstudied lower sedimentary units in previous mapping [3]. Kite et al. [3] mapped this region focusing on the Aeolis Dorsa fluvial deposits. We created a preliminary geologic map of this region that refines previous rock package descriptions based on geomorphologic and stratigraphic features [3] [Figure 1].

For Package 1, we separated the lower unit in [3] into two units (outcrop and plateau). The lower unit outcrop has a smooth hummocky structure with a likely sedimentary origin. The lower unit plateau has meter scale bedding and is overall more erosionally resistant, but it erodes into blocks near the plateau boundary. We incorporated basement material in [3] into our lower unit outcrop based on similar stratigraphic position and outcrop style. We mapped additional locations of the lower units and remapped the original boundaries from [3]. Exposures of lower units in the interior of craters were also grouped in this package.

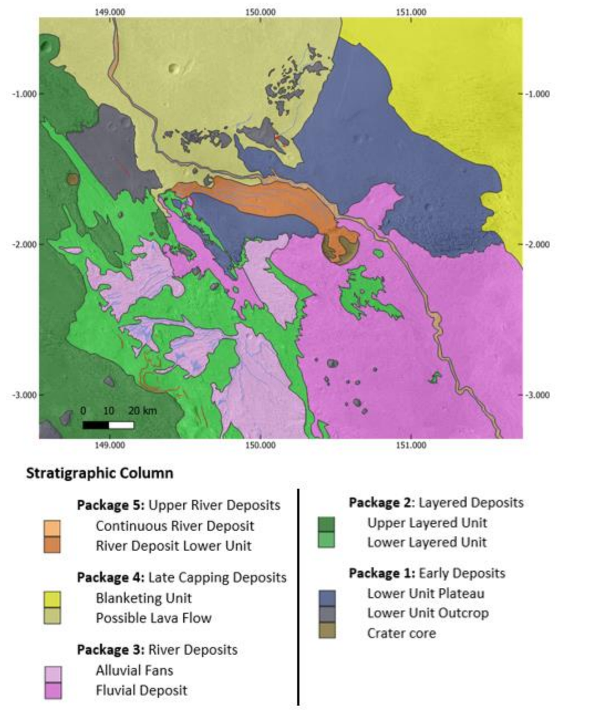

Figure 1: *Geologic map – section of Aeolis Dorsa. CTX mosaic background from [7]. Alluvial fans/rivers outlined in blue. Bedding plane measurements outlined in red. Rock packages ordered from youngest to oldest*.

Packages 2 and 3 represent the main sedimentary deposits of the Aeolis Dorsa sequence. Here, we split this sequence into two separate units based on the structure of sedimentary layering. Package 2 has a lower and upper layered deposit with no evidence of inverted fluvial channels. It is unknown if these components were deposited close together in time. The lower layered unit erodes into topographic steps of ~10 m thickness. This unit corresponds to the R-1 unit (Package II) of [3]. We mapped it separately because it underlies the fluvial units described in R-1 and lacks channels. The upper part of Package 2 corresponds to Aeolis Rise sedimentary deposits (no assigned package) in [3]. We speculate that two unconformities bound the upper layered unit (before and after deposition). However, more research is required.

Package 3 consists of fluvial and alluvial fan deposits. We combined some parts of the R-1 unit (Package II) and the fan shaped deposits (Package III) of [3] to form a unit that contains all clear inverted channel deposits in the Aeolis Dorsa stratigraphy. At several locations, sediment from the river deposits transitions laterally into alluvial fans [see Figure 1], forming a continuous section of material that suggests laterally resolved, time-equivalent deposition. This package varies regionally in thickness and certain sections have windows into Package 1 and 2.

Package 4 consists of late capping deposits. We speculate that the first unit in this package is a fractured lava flow. This material was mapped as R-1 (Package II) in [3] and the lava flow mapped in [3] is roughly 200 km north of this spot. A few channels inscribed atop the south end of this unit indicate late fluvial action. There is also an unconformity between the lower outcropped unit and the lava flow. The blanketing unit consists of thinly bedded sedimentary material, which matches the description in [3]. This material was mapped as yardang forming layered deposits (Package IV) in [3].

Package 5 consists of a relatively young, isolated river deposit and a crater outflow deposit. The continuous river deposit was noted in [3] as R-1 (Package II). We placed it into a later package since it cross cuts other packages that were likely deposited after Package 3. A late phase of fluvial action, not noted in [3], created a large surficial deposit in the central area of the map and eroded a section of the lower unit plateau. We speculate that this feature was created by rapid fluvial erosion from an overflowing crater lake, with paleoflow from east to west. An alluvial fan is seen at the mouth of the channel. This likely occurred well after deposition of the main Aeolis Dorsa stratigraphy due to relations with other units. Such outflow events are typical of the Hesperian Period [8].

Bedding Orientation Measurements: Alongside mapping, we have begun collecting traces of bedding planes to measure the dip and dip direction of sedimentary deposits. Bedding planes are collected atop HiRISE orthophotos and regional-scale imagery, and elevations are extracted from DEMs. Four DEMs have been evaluated thus far. For planar measurement, we use the methods and software of [6] to provide reliable error boundaries [Figure 2]. Over 250 measurements have been collected thus far, with more anticipated as this work continues. Error distributions will assist us in filtering and cleaning the orientation dataset for publication. These measurements will be integrated with models of fluvial deposition to help illuminate depositional history.

Few bedding orientations are available for evaluation in Package 1. Package 3 has not been closely studied yet due to complex channel morphologies being the dominant outcrop style. Package 2 has bedding orientations suggestive of flat to slightly northward dips, and the late capping units are nearly flat. More work is needed to illuminate systematic changes and track them across the study area.

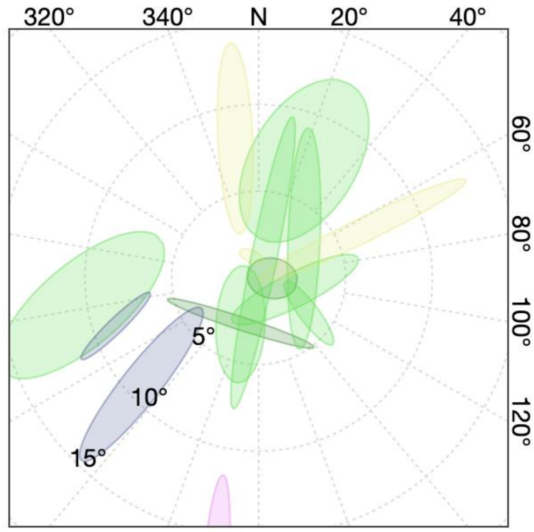

Figure 2: *Upper-hemisphere projection of errors to preliminary bedding orientations measured. Colors correspond to mapped packages in Figure 1; dip magnitude is shown on the radial axis. Key sedimentary packages in Aeolis Dorsa appear to dip slightly to the north, aligned with the regional topographic gradient.*

At least two, and possibly three phases of separable fluvial action occurred in Aeolis Dorsa. The lowest sedimentary unit's formation mechanism remains uncertain. The middle units represent a well-developed lacustrine to fluvial system characterized by [3, 4]. The latest phase is represented by small-scale fluvial systems. Each of these phases is separated by periods of erosion. As research continues, we plan to expand the mapped region and collect additional accurate bedding orientation for the dataset. This will allow us to understand the extent of the fluvial systems, the origin of the lower units, and possibly provide evidence of several phases of deposition relating to episodic Noachian to Hesperian northern hemispheric oceans.

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