FLUVIAL STRATIGRAPHY AND REGIONAL VOLCANISM AT HYPANIS DELTA, MARS. J. B. Adler[1], J. F. Bell III[1], and T. N. Harrison[1] [1]Arizona State University School of Earth and Space Exploration, Tempe, AZ, 85282. (Jacob.B.Adler@asu.edu).

Introduction: The Hypanis fan-shaped deposit in Xanthe Terra has been interpreted by many to be a late Noachian aged delta along the dichotomy boundary [1-5]. The putative delta was a compelling candidate landing site for the future Mars 2020 and ExoMars rover missions as it was positioned at the edge of an open basin, could have been an ideal environment for biosignature formation, concentration, and preservation, and has accessible exposures of what could be delta bottomset beds [6]. We are working to solve the key questions raised by the community about Hypanis: Is the deposit an ancient delta, as opposed to an alluvial fan or mudflow? Was the ancient topography also an open basin, suggesting a large northern sea? and How does Hypanis fit into the regional geologic timeline and history of Mars?

Fluvial Timeline: Our stratigraphic study concluded that the main light-toned fan lobe was deposited first, and could have once been much larger due to identification of distal deposits over 150 km away (Fig. 1), which matched the expected morphology, thermal inertia, and albedo of the main lobe. What we interpret as an avulsion node then migrated north forming the northern lobe, which stratigraphically overlies the main lobe. Flow then migrated to the northeast braided (now expressed as inverted topography) channels, then to the east (also now inverted) channels. If Hypanis is an ancient delta, this sequence likely shows that deposition migrated basinward as water receded [2].

Geologic Context: The fluvial events mentioned above forming the deposits at the end of Hypanis Valles lie within a region characterized as transition morphology (early Hesperian transition unit eHt) [7]. The upstream catchment to the south is of late Noachian age (unit lNh), and the smooth volcanic/flood plains to the north contain large N-S trending wrinkle ridges, defining an age of Hesperian volcanism (unit eHt) [7]. Crater counts of the upstream catchment of Hypanis Valles reveal that the terrain is at least 3.6 Ga – late Noachian [8-9]. Thus, the fan shape deposit is of a distinct fluvial system from much earlier than catastrophic outflow and chaos terrain formation which occurred around 3.2 Ga [10].

Volcanic History: Volcanic features were mapped to the east [11] and mapping was recently updated to include the area surrounding Hypanis. This ongoing work reveals that regional episodic volcanism has persisted from before Hypanis to long after fluvial deposition and catastrophic erosion.

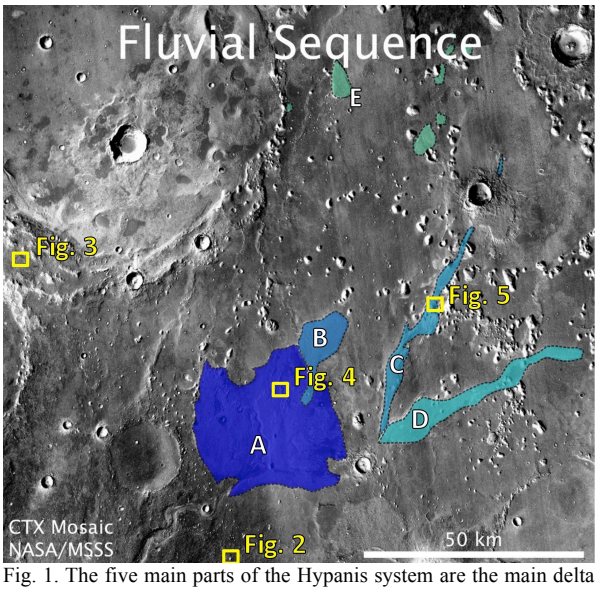

Fig. 1. The five main parts of the Hypanis system are the main delta lobe (A), northern lobe (B), NE inverted channel (C), E inverted channel (D), and the distal deposits (E). Locations of subsequent figures shown.

Our stratigraphic study found locations where a darker-toned unit (which retains small craters [12]) is exposed from underneath the main fan lobe by impacts, as well as locations where patches of a second dark-toned unit overly the northern lobe [2]. This suggests that plains style volcanism draped the terrain before the fan-shaped deposit was deposited, and again afterwards, but is now only found as patches after much erosion. The regional flooding and regional volcanism at Hypanis is consistent with the events presented in [10, 13].

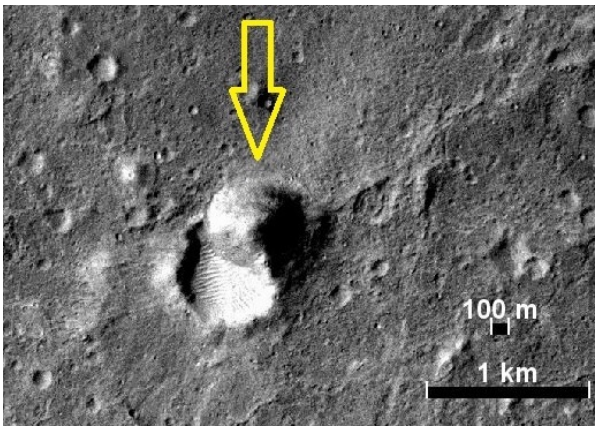

Fig. 2. Cone (volcanic?) overlies impact crater in the plains unit south of Hypanis, implying this feature postdates the formation of the plains and the major erosion of the plains.

Additional volcanic features include cinder cones which overly the plains/floor unit (*e.g.*, Fig. 2) and breached cones classified as hydrovolcanic tuff cones [14]. The interaction between episodic volcanism and past water or ice in the region could be an important factor contributing to the morphologies we see in the Hypanis region.

Fractured Terrain: Polygonal fractures are found in patches within the floor/plains unit surrounding the layered fan deposit [2]. We've also found patches of this polygonal terrain near the Lederberg crater rim (Fig. 3) with matching orbital mineralogic signatures of Fe/Mg smectite clays from high-resolution CRISM images [15]. This may point to desiccation (mudcracking) as the source of these features, as opposed to cooling of a volcanic unit. If this is so, the wide distribution of this terrain throughout the region could further indicate that water was once widespread in southern Chryse Planitia. Additionally, it is possible that the many layers visible in HiRISE images [16] of Lederberg rim show not only underlying crater strata, but also post-crater aqueous sedimentary materials.

Orthogonal fractures are also found in the plains/floor unit and are abnormally linear (Fig. 5). We do not know the origin of these enigmatic features, but hypothesize that they could be related to cooling of a volcanic unit, desiccation of a sedimentary unit, or uplift after mass removal.

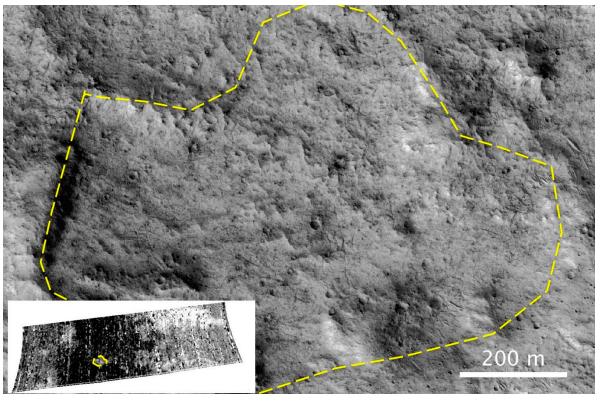

Fig. 3. Signature of 2.3μm band depth (Fe/Mg clay) aligns with a topographic depression with a polygonally fractured floor near Lederberg Rim. [CRISM FRS0003F079 HiRISE ESP_047805_1925].

Topography: Its topographic location, without a clear local closed basin, may imply that Hypanis was a delta at the edge of a large northern sea. We are conducting a survey of sedimentary bed strike and dip distribution to determine if long slope profiles and detailed stratigraphic columns reveal the history of accommodation space. We utilized HiRISE and CTX DTMs [17] to measure fluvial and stratigraphic quantities, a CTX 5 m/pixel mosaic basemap (USGS), and THEMIS day/night IR images [18]. We determine map unit stratigraphy (relative ages) from superposition and cross cutting relationships supported in our 3D models.


Fig. 4. Cliff and bench exposures in the wall of Hypanis record over 30 thin sedimentary strata.

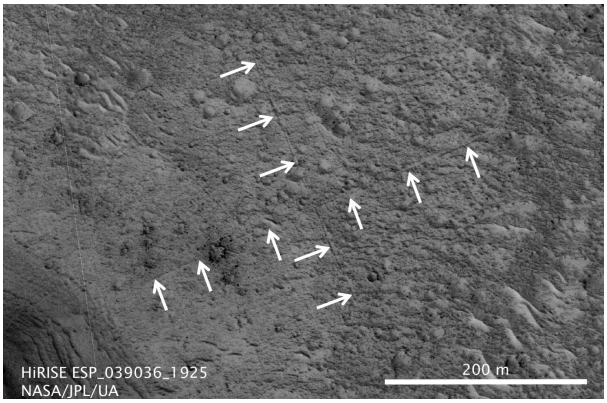

Fig. 5. Orthogonal fractures in plains unique to areas near fan layers are abnormally straight and could possibly be related to cooling of a volcanic unit, desiccation of a sedimentary unit, or uplift due to removed mass.

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