The Hypanis fluvial deltaic system in Xanthe Terra: a candidate ExoMars 2018 Rover landing site

Conference or Workshop Item

THE HYPANIS FLUVIAL DELTAIC SYSTEM IN XANTHE TERRA: A CANDIDATE EXOMARS 2018 ROVER LANDING SITE

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Introduction: The search for life on Mars is a cornerstone of international solar system exploration. In 2018, the European Space agency will launch the ExoMars Rover to further this goal. The key science objectives of the ExoMars Rover are to: 1) search for signs of past and present life on Mars; 2) investigate the water/geochemical environment as a function of depth in the shallow subsurface; and 3) characterize the surface environment. ExoMars will drill into the sub-surface to look for indicators of past life using a variety of complementary techniques, including assessment of morphology (potential fossil organisms), mineralogy (past environments) and a search for organic molecules and their chirality (biomarkers).

The choice of landing site is vital if the objectives are to be met. The landing site must: (i) be ancient (≥3.6 Ga); (ii) show abundant morphological and mineral evidence for long-term, or frequently recurring, aqueous activity; (iii) include numerous sedimentary outcrops that (iv) are distributed over the landing region (the typical Rover traverse range is a few km, but ellipse size is ~104 by 19 km). Various engineering constraints also apply, including: (i) latitude limited to 5º S to 25º N; (ii) maximum altitude of the landing site 2 km below Mars's datum; and (iii) few steep slopes within the ellipse.

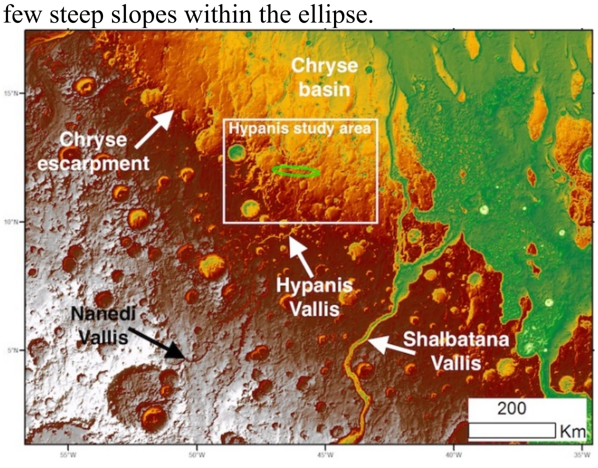

***Figure 1:** MOLA 128ppd colorized shaded relief showing location of Hypanis study area (white box) and nominal 2018 landing ellipse (green). Color stretch is -5212 m to 1920 m relative to MOLA datum.*

In 2014, two international workshops were held to discuss potential landing sites. The outcome of these workshops was a shortlist of four possible sites: Aram Dorsum, Hypanis Delta, Mawrth Vallis, and Oxia Planum. Our group proposed the Hypanis and Aram Dorsum sites and led the scientific presentations about these sites at the workshops. Here, we present the science case for Hypanis – the case for Aram Dorsum is made in a sister-abstract [1].

Overview: The Hypanis landing site in northern Xanthe Terra is situated on the dichotomy boundary (Fig. 1). Our study area includes fluvio-deltaic deposits at the termini of Sabrina Vallis and Hypanis Vallis. Mapped Sabrina terminal deposits are constrained to within the buried crater, Magong. The Hypanis deltaic system is more extensive, with multiple depositional lobes extending to the north and east (Fig. 4).

Significant aeolian modification has occurred since delta formation, with crater counts on both Sabrina [5] and Hypanis [7] delta units revealing crater-retention ages of < 100 Ma, supported by the presence of ubiquitous aeolian features and suggesting recent exhumation from overburden. The large crater population classifies the study area as mid to late Noachian terrain [5, 7].

Geologic mapping: Geologic mapping within the study area was performed using HiRISE, CTX and THEMIS coverage, including 13 stereo-derived HiRISE DEMs.

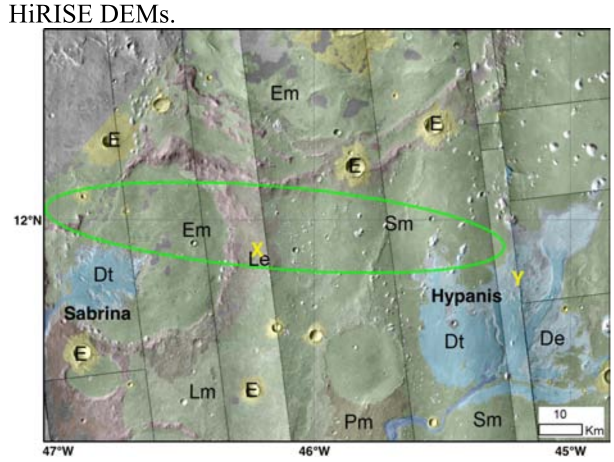

***Figure 2:** Geologic map of Hypanis study area overlaid on CTX. Geologic units are labeled. Deltaic units are shades of blue. The nominal 104 x 19 km 2018 landing ellipse is bright green. Pertinent CRISM observations are marked with yellow 'X' and 'Y'.*

Closely spaced transverse aeolian ridges (TARs) on top of units De and Dt (Fig. 2) prevent landing directly on upper delta material, because TAR morphology (Fig. 3) produces adverse slopes unsuitable for EDL and rover locomotion. The nominal 2018 ellipse therefore is positioned so as to avoid landing directly on the upper delta units. Instead, smooth plains units, Sm and Em and related unit Le (interpreted as a mantling of Sm onto ancient crater ejecta) are less hazardous, and occupy a significant areal fraction of the ellipse (Figs. 2 and 4). These may also be compelling science targets if formed in low energy depositional environments caused by delta activity. Here we expect the finest grain sizes would have been deposited and any potential biosignatures would be concentrated.

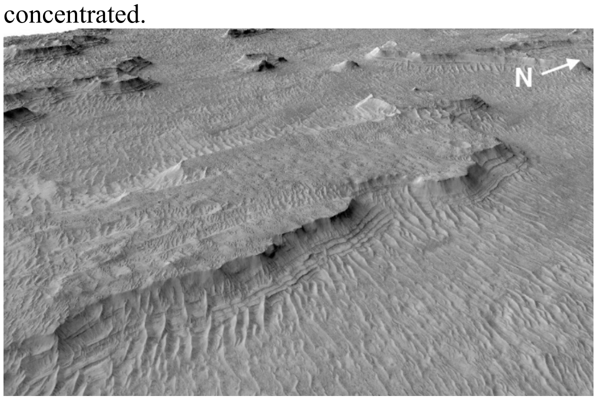

Figure 3: *Perspective view of HiRISE 1m DEM at ~45.2°W, 11.7°N (observations ESP_21577_1920 & ESP_22434_1920). Note fine-scale layering and extensive erosion of upper delta units.*

Hyperspectral analysis: The footprints of two full-resolution short (FRS) CRISM observations lie within the study area. FRS0003157E ('Y' in Fig. 2) shows a 1.9 μm hydration signature that spatially aligns with exposed strata in eroded deltaic sediments, indicating putative hydrated minerals in discrete layers (Fig. 3). A spectral unit in FRS0003134F ('X' in Fig. 2) is defined by the combined presence of the 1.9 μm absorption plus a strong 2.3 μm dropoff in reflectance, indicative of the presence of Fe/Mg-phyllosilicates [3,4]. Both spectral signatures spatially correspond to fractured areas within polygonally ridged terrain. The unit is between, but not immediately adjacent to, the Sabrina or Hypanis deltas, perhaps indicating that extensive ancient fluvial activity has influenced mineralogy throughout the landing ellipse. CRISM coverage of the Sabrina Vallis delta deposits in Magong crater also indicates a weak Fe/Mg-phyllosilicate signature that is consistent with the presence of nontronite, verminculite or saponite in delta sediments [5].

Relevance to ExoMars Science Goals: The Hypanis landing site displays clear evidence for the long-lived action of water in the Noachian.

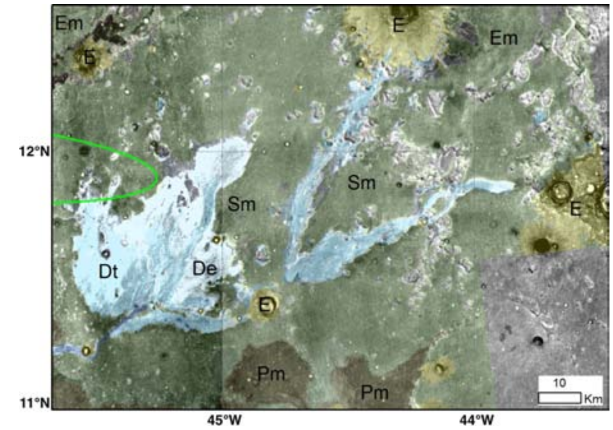

Figure 4: *East of landing ellipse – geologic map overlain on THEMIS nighttime brightness temperature (brighter equates to lower thermal inertia, characteristic of delta top material). Multiple exhumed and eroded lobes in the Hypanis delta are remnants of an extensive ancient avulsing system that was the result of sustained aqueous activity.*

This is supported by the interpretation that the total northward flow, including that through a now degraded channel connecting Nanedi Vallis to Hypanis Vallis, removed and deposited ~850 km^3 of material, of which the Hypanis deposits are estimated to comprise ~150 km^3 [6]. While upper delta units present an EDL hazard and traversability obstacle, the most rewarding science target may lie in the Sm, Em and Le units, which are pervasive throughout the ellipse. Sm and Le exhibit fine-scale layering and the presence of phyllosilicates. Low-energy depositional environments that formed or influenced delta-proximal exposures of these units may have concentrated any potential biosignatures transported from the upstream Hypanis-Nanedi fluvial system. Crucially, there is growing geological and mineralogical evidence that the Hypanis delta was extensive and that habitable environments may have been prevalent over almost the entire landing ellipse. Recent exhumation of this formation could imply its protection from the surface environment for much of Mars' history, resulting in a high preservation potential for any biomarkers emplaced in the Hypanis-Sabrina delta system.

References: [1] Balme, M. *et al.,* (2015, this volume), *LPS XLVI,* Abstract #1321. [2] Gupta, S. et al., (2014), ExoMars 2018 First Landing Site Selection Workshop (LSS WS#1), ESAC, Spain. [3] Pelkey, S. M. et al. (2007) *J. Geophys. Res., 112*, E08S14. [4] Viviano-Beck, C. E. et al. (2014), *J. Geophys. Res. Plan.* 119, p. 1403-1431. [5] Platz, T. et al., (2014) First Mars 2020 Landing Site Workshop, Crystal City, VA, USA. [6] Hauber, E. et al., (2009), *Plan. Space Sci.* 57, p. 944-957. [7] Werner, S. (2014) *Pers. Comm.*