REGIONAL GEOLOGIC MAPPING OF THE OXIA PLANUM LANDING SITE FOR THE EXOMARS MISSION.
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Introduction: The ExoMars mission will deploy a stationary surface platform and a rover in Oxia Planum (OP), a region at the transition between the heavily cratered highlands of Mars and the ancient and filled impact basin, Chryse Planitia. This site was selected [1] because (i) landing is technically feasible and (ii) exposed phyllosilicate-bearing rocks offer access to the early history of the planet, when Mars is thought to have been most habitable [e.g., 2,3]. The primary science goal of ExoMars is to analyze the geology and geochemistry of the local environment with the aim of identifying potential biosignatures [3]. While the fundamental geologic characteristics of the landing site have been investigated during its selection process [4], detailed geologic or morpho-stratigraphic mapping is still missing. To fill this knowledge gap, two complementary mapping approaches were initiated by the ExoMars RSOWG: (1) Local HiRISE-scale mapping of the landing ellipse(s) area will be performed as a joint effort of many individuals, each responsible for one or two 1×1 km boxes [5]. In a final reconciliation phase, the total number of 116 boxes will be assembled into a consistent map. (2) Regional mapping at ~CTX-scale [this study] will provide a more synoptic view of the wider landing site within OP, enabling the contextualization of the units within the stratigraphy of western Arabia Terra and Chryse Planitia, and a comparison to other sites with similar key geologic and physiographic characteristics. It is also expected that this map will serve as a geologic reference throughout the mission and subsequent data analysis.

Mapping Area and Datasets: The mapping area is located between 16.5°N and 19.5°N, and 334°E to 338°E. The geodetic reference is provided by the HRSC quadrangles MC11E and MC11W [6] which are tied to the global MOLA geodetic model. The data sets used for mapping include HRSC, THEMIS IR (day and night), CTX, and CaSSIS. Mapping scale in a GIS environment is 1:100,000, which will result in a final printable map at a scale of 1:1M. The mapping follows established and newly developed guidelines for planetary geologic mapping [7-10].

Preliminary Results: Mapping started in mid-October 2019 and results for selected units are shown in Fig. 1. Overall, the identified map units are very similar to those described by [4]: The spatially most widespread units are the phyllosilicate-bearing unit that is the prime ExoMars target (with distinctly enhanced THEMIS nighttime temperatures when compared to its surroundings), a dark resistant unit of possibly volcanic or sedimentary origin, and a mantling unit that was likely emplaced by eolian processes. Multiple channels of various morphology and degradation state (Fig. 2a) as well as sedimentary fan-shaped deposits (with low nighttime temperatures) imply a diverse and possibly long-lived history of surface runoff, perhaps accompanied or replaced by groundwater processes such as sapping (Fig. 2b and c). Inverted landforms (channels, impact craters) are the result of intense erosion. Additional mapped features include tectonic structures such as wrinkle ridges and lobate scarps (delineating a basin-like depression in the central mapping area), remnant erosional buttes in the northwestern portion of the mapping area (i.e. towards Chryse Planitia), craters and their ejecta blankets, and fields of eolian bedforms and secondary craters.

Comparison with Similar Site(s): The phyllosilicate-bearing rocks in Oxia Planum are part of a circum-Chryse «belt» of surface materials displaying spectral evidence of aqueous alteration [11]. If there is indeed such a geologically coherent «bathtube» ring, the phyllosilicates at OP may be the product of impact basin-related processes [4]. In that case, hypotheses related to the origin of OP phyllosilicates may also be tested in other circum-Chryse locations. To enable such tests, we selected a «reference» site in Xanthe Terra (~11±2°N/316.5±1°E) that exhibits several key characteristics of OP: Light-toned and fractured bedrock with a high nighttime temperature, nearby channels and sedimentary deposits (the Hypanis Valles and their terminal fans exhibiting low nighttime temperatures [12-13]), and erosional remnant buttes towards Chryse. The combination and spatial pattern of these features is very similar to OP and suggests that a similar geologic evolution may have shaped both areas.

Preliminary Conclusions: At the time of writing, the mapping is incomplete and only initial and limited conclusions can be drawn. Overall, the mapping confirms previous geologic analyses [4,14,15]. However, some features (e.g., contractional structures, channels, possible sapping landforms) need further attention as the may provide important constraints on the tectonic and aqueous evolution of the ExoMars landing area. A comparison to a distant, but very similar site in Xanthe Terra may enable testing of hypotheses raised by the geologic mapping of OP.

Acknowledgments: The data used in this study are available via the Planetary Data System (PDS) of NASA, the Planetary Science Archive (PSA) of ESA, and additional data repositories at DLR and the USGS.

References: [1] Loizeau, D. et al. (2019) *LPS L*, Abstract #2378. [2] Cockell, C.S. (2014) *Astrobiology, 14*, 182–203. [3] Vago, J. L. et al. (2017) *Astrobiology, 17*, 471–510. [4] Quantin-Nataf, C. et al., (2020) *Astrobiology (submitted)*. [5] Sefton-Nash, E. et al. (2020) *LPS LI*, this conference. [6] Gwinner, K. et al. (2016) *Planet. Space Sci., 126*, 93–138. [7] Skinner, J.A. (2017) *LPS XLVIII*, Abstract #2759. [8] Naß, A. et al. (2017) *EPSC Abstr., 11*, EPSC2017-627-1. [9] Hauber, E. et al. (2019) Planetary Geologic Mapping, in: H. Hargitai (ed.), *Planetary Cartography*, pp. 105–145, Springer. [10] Massironi, M. et al. (2018) *Geophys. Res. Abstr., 20*, EGU2018-18106. [11] Carter, J. et al. (2020) *manuscript in prep*. [12] Hauber, E. et al. (2009) *Planet. Space Sci., 57*, 944–957. [13] Fawdon, P. et al. (2018) *EPSL, 500*, 225–241. [14] Molina, A. et al. (2017) *Icarus, 293*, 27-44. [15] Garcia-Arnay, Á. et al. (2019) *LPS L*, Abstract #2149.

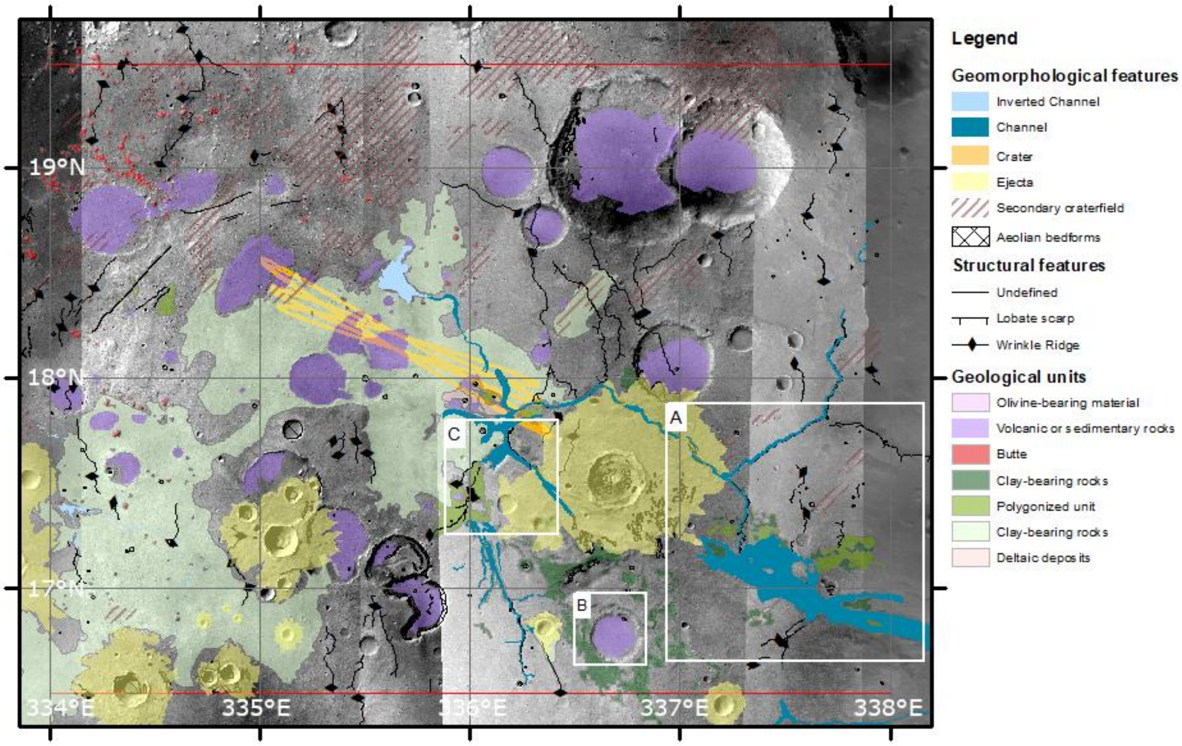

Figure 1. Selected geological units and geomorphological features (note that mapping is still in progress at the time of writing (01/2020) - this is a preliminary version). Red box marks boundary of mapping area. Note landing ellipses and locations of Fig 2.

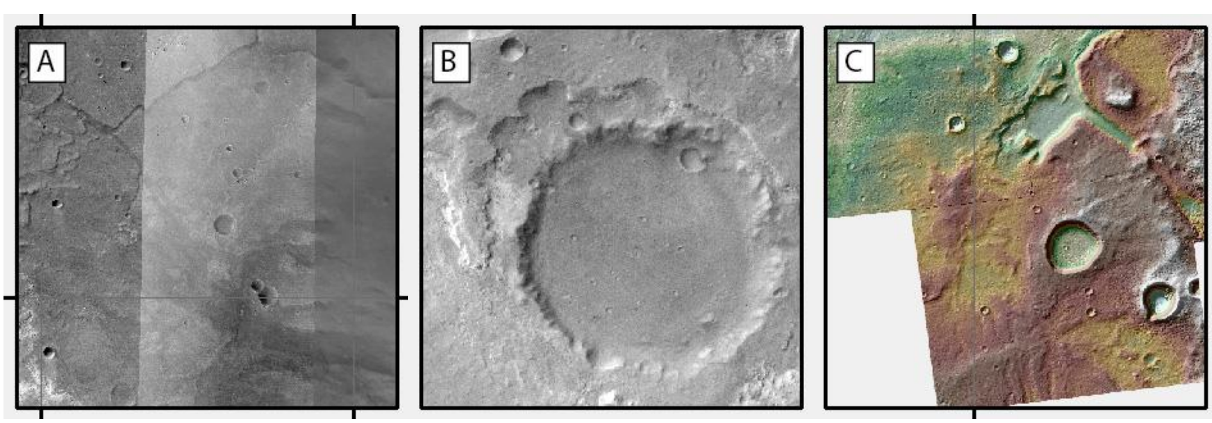

Figure 2. Geomorphological details. (a) Paleo-outflow channel (dark, lower part of image) and narrow, deeply incised channel (upper part) as part of the Coogoon Valles system [14]. The morphological diversity suggests different types of runoff, possibly at different times in geologic history. (b) Amphitheatre-like alcoves northwest of an impact crater may have been formed by sapping (erosion by groundwater seepage). (c) Steep headward scarp at box canyon-like depression (upper central part of image). The scarp may have retreated along a pre-existing shallow topographic depression (center of image), and may indicate sapping.