THE FLUVIAL AND WATER-RICH HISTORY OF NORTHERN XANTHE TERRA: A REFERENCE FOR THE EXOMARS LANDING SITE. T. Frueh[1, 2], E. Hauber[2], S. Adeli[2], D. Tirsch[2], A. Nass[2], H. Hiesinger[1], and L. Pauw[1], 1Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str.10, 48149 Münster, Germany, (thomas.frueh@uni-muenster.de), 2Institute of Planetary Research, German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin, Germany.

Introduction: As part of ESA´s ExoMars mission, Rosalind Franklin will be the first European-built and -landed Mars rover. It is planned to land the rover in the Oxia Planum (OP) region, located near the Chryse Planitia (CP) margin in western Arabia Terra [1,2]. This landing site has been specifically chosen for its ancient age, evidence for the sustained presence of water, the presence of layered deposits, and the potential for biosignature preservation [2].

We aim to understand if the geological setting and history in OP are unique or if they are representative of Mars on a regional scale at the Chryse Planitia margin. To achieve this goal, we chose a study area in northern Xanthe Terra (XT) and compare it to our map of OP [12]. Specifically, the fluvial history [3-5], the presence of phyllosilicates [6-9], and the abundance of remnant mounds that might be indicative of widespread erosional processes [10,11] suggest a potentially shared history. Here, we present our geomorphological map and the stratigraphy of the fluvial and water-rich history of northern Xanthe Terra.

Data and Methods: This map is a geomorphological map, which has been made with the intent to be comparable with our OP map [12]. Thus, we set the mapping scale at 1:100,000 and used CTX image data as the mapping base. We used THEMIS nighttime and daytime images, as well as HRSC, MOLA DTMs, and HiRISE data if available. The mapping took place in ArcGIS 10.5.1 and ArcGIS Pro.

Units and Interpretation: Our map can be seen in Figure 1. In the following section, we will shortly describe and interpret the most relevant units, sorted from most ancient to most recent.

mNh – Mid-Noachian Highland Unit. The Mid-Noachian Highland unit is the southernmost unit of our study area. The surface is heavily cratered in contrast to other units. Several ancient and heavily degraded craters and crater chains are present. The morphological degradation of those craters and stratigraphic interpretation of previous studies [13,14] imply a mid-Noachian age. The fluvial history is recorded by the presence of several (hundreds of meters wide) channels and one inverted channel.

HNlp & HNdp – Light-toned and Dark-toned Plains. Both units are present in the central southern mapping area. The darker plains are stratigraphically lower than the light-toned plains and are exposed as geological windows. The unit eroded to a flat level; therefore, it is difficult to characterize the morphology. The albedo is lower than that of the light-toned plains. The unit exhibits periodic bedrock ridges and sandy ripples, which suggest later wind erosion uncovered both units. A polygonization, which shows a preferred northwestern orientation at some places, is observable. The light-toned plains are finely layered, partly covered by sandy material, and also show a polygonization. Both units exhibit a spectral signal for hydrous phyllosilicates [6], indicating liquid water's past presence [6-9]. Fluvial channels are present but have been infilled and inverted, which highlights the fluvial activity during their deposition. Fine-layered sedimentary phyllosilicate-bearing units are also present in OP [7-9].

lNh/eHt – Ridged Plains. The ridged plains have medium albedo and are the most widespread unit in our mapping area. They are coarsely layered and different layers are exposed throughout our area. The ridged plains cover the highland unit and the light- and dark-toned plains. The ridged plains exhibit several wrinkle ridges and also lobate scarps. The wrinkle ridge number and size increase significantly north of our study area. The widespread nature, the medium albedo, the coarse layering, and the existence of wrinkle ridges suggest a volcanic history. Fluvial channels are only present in the southeastern study area close to Shalbatana Vallis and might have a shared origin with the latter. Next to Shalbatana Vallis, post-dating fluvial activity is expressed by the deltaic deposits of the Hypanis fan. A widespread and layered volcanic plain unit is also present in OP [12].

HNms & AHNmd – Mesas and Mounds. Two types of remnant mounds are present in northern Xanthe Terra, i.e., small fine-grained rounded mounds and large flat-toped mesas. Both get more abundant and larger towards the north and are aligned with ancient crater rims. We postulate differing ages for both features. Mesas are a remnant of a unit, which had covered at least some parts of this region in the past. Their formation might be similar to the fracturing, collapsing, and erosion of the highland boundary in eastern Chryse Planitia. Some Mesas are embedded by the ridged plains and, thus, are at least older than the uppermost layers of the ridged plains (late Noachian age). Mounds are postulated to be strongly eroded mesas

[10], which might be true for some of them. However, we observe mounds superposing Mesas. It was also argued that mounds superpose the Hypanis Fan deposits [4,5]. Thus, we propose that some of the mounds have a Hesperian age. Mounds and mesas are, while being less abundant, also present in OP [11].

Hdf – Delta and Fan Deposits. The most prominent features are the two Hypanis Fan arms in the northwestern study area. Those finely layered deposits are argued to be of deltaic origin [3-5]. Hence, they are evidence of the fluvial and water-rich activity during the Hesperian. OP also exhibits delta-like fan deposits [7,12].

AHct – Collapsed and Chaotic Terrain. The eastern margin of our study area exhibits several rimless collapse features. Shalbatana Vallis is partly collapsed. The ridged plains east of Shalbatana Vallis show circular and elongated collapse holes, often associated with tectonic features or craters. Further east, the individual collapse features build connected networks.

This process seems to be ongoing and might be evidence of a volatile-rich subsurface.

Conclusion: XT exhibits several signs of a water-rich and fluvial history, including channels, hydrous phyllosilicates, fan and delta deposits, as well as collapsed features. Several of the features and units have analogous counterparts in OP, which makes XT a suitable reference site and allows further comparison.

References: [1] Vago, J. L. et al. (2015), *Sol. Syst. Res., 49,* 538–542. [2] Bridges, J. C. et al. (2018), *LPS XLIX,* #2177. [3] Hauber, E. et al. (2009), *Planet. Space Sci., 57,* 944–957. [4] Fawdon et al. (2018), *EPSL, 500,* 225–241. [5] Adler, J. B. et al. (2019), *Icarus, 319,* 885–908. [6] Carter, J. et al. (2019), *Ninth Int. Conf. Mars,* #6175. [7] Quantin-Nataf, C. et al. (2021), *Astrobiol., 21,* 994-1013. [8] Mandon et al. (2021), *Astrobiol., 21,* 464-580. [9] Brossier et al. (2022), *Icarus,* 386. [10] McNeil, J. et al. (2021), *J. Geophys. Res Planets, 126*. [11] McNeil et al. (2022), *JGR Planets, 127*. [12] Hauber, E. et al. (2021), *LPSC, 52,* #1947. [13] Adler et al. (2022), *JGR*, 127. [14] Tanaka et al. (2014*), Geol. Surv. Scie. In., 3292*

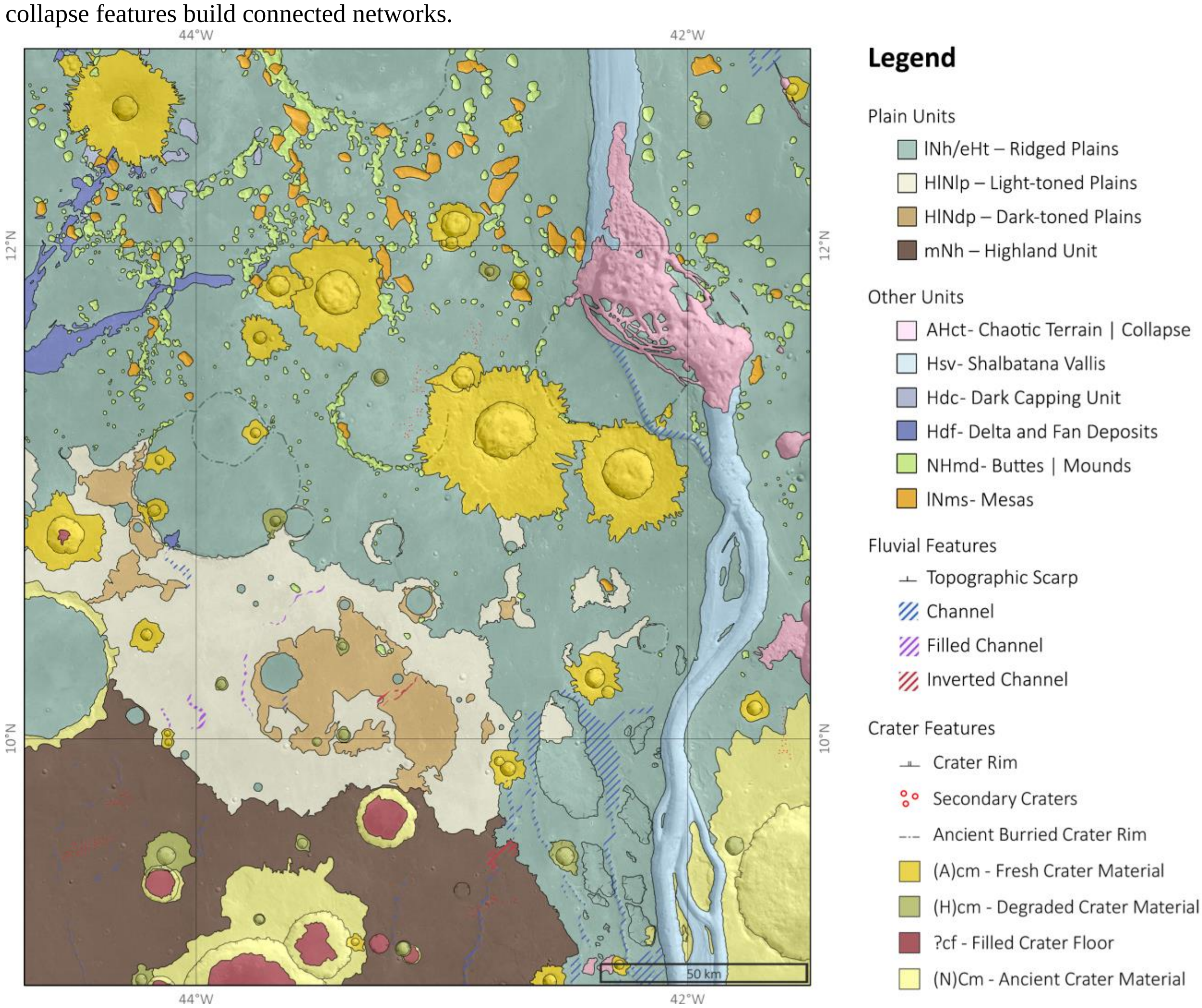

Figure 1*. Geomorphological map of northern Xanthe Terra. The age of the Crater Features is not yet fully defined.*