OVERVIEW OF POSSIBLE ICE-RELATED MORPHOLOGIES IN THE TRANSITION ZONE BETWEEN ELYSIUM AND UTOPIA BASIN, MARS. G. B. M. Pedersen[1] and J. W. Head III [2], [1]Dept. of Earth Sciences, Aarhus University, Denmark, gro.birkefeldt@geo.au.dk, [2]Dept. of Geological Sciences, Brown Univ., Providence, RI 02912, USA.

Introduction: The transition zone between Elysium and Utopia is a highly complex area, characterized by Galaxias Chaos along the northern boundary and huge outflow channels dominating the northwestern part. Several very enigmatic morphologies are observed including some very distinctive crater morphologies [1], having bipartite crater ejecta consisting of an inner pattern of breached folds close to the crater rim, while the ejecta further away seems smoother, bulging and slightly elevated. Moreover, ring mold-like craters (RMC) are observed in many areas [2] and thermally distinct craters have also been reported [3] and both have been related to existence of ice. Therefore we characterize the different types of craters distributed within the area, with special emphasis on the craters showing bipartite and excess ejecta [21, 22]. Moreover we evaluate their distribution and compile an overview in connection with other landforms, which have been ascribed to the presence of ice.

Background and Geologic Setting: Observations of landforms in the research area span from volcanic (lava flows, sills and dike emplacement [4-6]), outflow channels [5,7], glacial features such as eskers and thumbprint terrain [8], and ice-volcano interactions such as volcaniclastic flows, mega-lahars and subglacial volcanic edifices [3,5,9-16]. Several authors have found evidence for existence of H_2O in the region based on crater ejecta studies [17,21,22] and Mars Odyssey Neutron Spectrometer results [18]. Furthermore, the Vastitas Borealis Formation, which has been considered to be a residue from an H_2O-rich material deposited by huge floods, is situated in the study area near the proposed shoreline, contact 2 [19, 20]. Thus, using HiRISE, CTX, MOC and THEMIS data we here evaluate enigmatic morphologies investigating whether they can be explained by ice-related processes.

Observed Morphologies: Within the research area several different crater morphologies are observed. The biggest and most prominent craters are the craters having bipartite crater ejecta, which have a diameter up to 25 km. The unusual crater ejecta is divided into an inner ejecta facies consisting of breached folds and an outer ejecta facies, which is smooth, has a tongue-like outline and is slightly elevated with respect to the inner ejecta; different examples can be seen in Fig. 1. B-F. Especially Fig. 1E & F, shows the abrupt change in diameter, which seems to be closely related to the distance from the crater rim. Within the outer ejecta, circular knobby features are observed having similar characteristics to ring-mold craters, which have been related to impact into ice-rich material [2]. Other craters displying ring mold–like structure, can also be seen in Fig. 1G and are widely distributed throughout the region. They have concentric shells and are associated with a knobby textured unit. Furthermore, thermally distinct craters ae also observed [3] and their morphology bears a strong resemblance to RMCs. These phenomena are restricted to flow deposits and have been interpreted as ice-volcano interactions between a hot mudflow and ground ice [3], but may also be due to excavation of ice-rich material by impacts. Finally an edifice has been interpreted to be a möberg ridge (Fig. 1I) due to its characteristic surface and sharp crest parallel with other volcanic activity in the area [10]. A heavily modified ridge showing the same characteristics can be found further to the east (Fig. 1J).

Conclusions and Speculations: Unusual crater morphologies are observed throughout the transition zone between Elysium and Utopia including small scale ring mold-like craters, thermally distinct craters and craters with bipartite ejecta.

An hypothesis for explaining the morphology of the craters with the excess and bipartite ejecta [21, 22] could be related to an impact occurring when regional ice deposits existed in this area, and burial of the snow and ice by ejecta; the breached folds could be evidence of preferential volatile loss close to the impact itself. Further away from the crater rim crest the heating has not been sufficient for significant loss. This would result in ejecta covering ice and snow and retarding sublimation; later impacts would penetrate through the ejecta cover and excavate underlying protected ice, producing a ring-mold crater morphology. We are currently mapping the borad sdistribution of RMCs in this area and assessing the full range of candidate remenant ice deposits. SHARAD data may proivde tests for the presence of any remainng subsurface ice. These data will also permit better dating of these apparently very ice-rich deposits and an assessment of the timing of these ancient climates.

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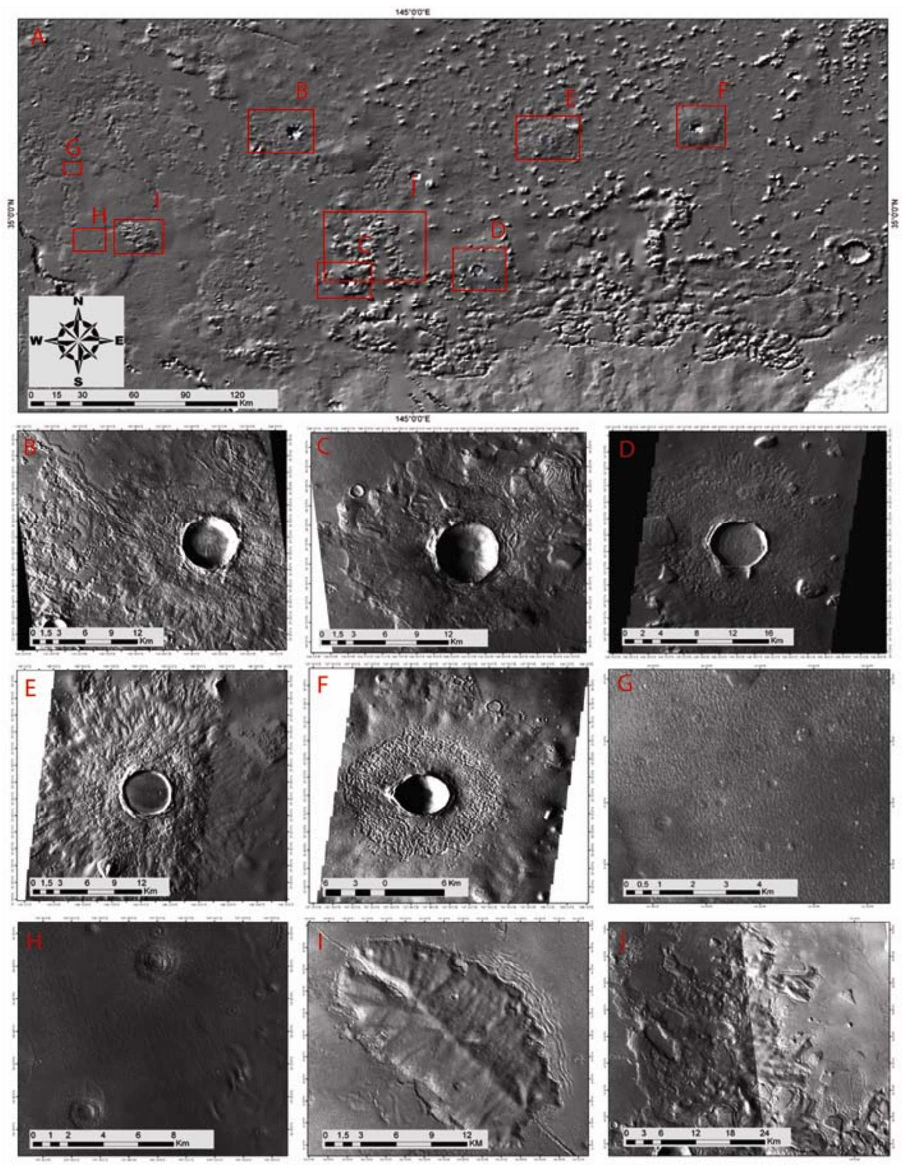

Figure 1. The transition zone between the northern part of the Elysium Rise and the Utopia Basin with Galaxias Chaos as the southern boundary. The red boxes show the locations of plausible ice-related morphologies. A) A THEMIS-mosaic providing an overview of some of the morphologies investigated. B-F) Craters sharing similar morphologic characteristics having unusual crater ejecta, divided into an inner ejecta consisting of breached folds and an outer ejecta, which is smooth, has a tongue-like outline, and is slightly elevated with respect to the inner ejecta. E and F are the best examples; B-D are modified in different ways, showing either breached folds or bulging elevated outer ejecta. G) Ring mold-like crater morphologies emplaced in a knobby unit. H) Thermally distinct craters. I) Ridge interpreted to be a möberg ridge by [10] J) A possible möberg ridge, which has been heavily modified. This deposit has similar characteristics as I) having a smooth undulating surface with a distinct edge and a crest lying parallel to a fracture southeast of the image.