WELL-PRESERVED ICE-RICH DEPOSITS ON MARS, IN THE SOUTHERN MIDLATITUDE REGION OF TERRA CIMMERIA. S. Adeli[1], E. Hauber[1], R. Jaumann[1,2], G. Michael[2], and P. Fawdon[3]. [1]Deutsches Zentrum fuer Luft- und Raumfahrt (DLR), Institute fuer Planetenforschung, Rutherfordstr. 2, 12489 Berlin, Germany (Solmaz.Adeli@dlr.de)., [2]Freie Universität Berlin, Institute of Geological Sciences, Malteserstr. 74-100, 12249 Berlin, Germany. [3]Birkbeck, University of London, Malet St, London WC1E 7HX.

Introduction: Evidence of shallow ground ice has been widely observed in the both mid-latitude regions of Mars [1, 2]. Its deposition has been hypothesized as the result of Mars' obliquity variations, which could cause significant changes in the seasonal cycles of ice deposition in the polar regions. When the obliquity exceeded 30°, water-ice would be partly removed from the polar regions and being transported to mid-latitdes regions, where a mantle of icy dust currently coveres the surface [3]. Although the obliquity variations are not predictable for periods more than 20 Ma ago [4], it is likely that the surface of Mars, during Amazonian, has been repeatedly undergone such climate changes leading to deposition and sublimation/evaporation of ice-rich material [e.g., 3, 5].

This study describes, for the first time, well-preserved glacial-like deposits in Terra Cimmeria, which are defined here as valley fill deposits (VFD) (Fig. 1). They are located on the floor of a valley system which bears a record of Amazonian-aged fluvial and glacial processes [6].

Morphological characteristics: Several deposits on the flat floors of S-N trending valleys south of Ariadnes Colles (34°S, 172°E) are characterized by (1) widths and lengths of a few kilometers, (2) convex-upward surface topography, and (3) pits and crevasses on their surfaces. The valley floors, the deposits, and the areas surrounding the deposits are partly covered by a thin (a few meters of thickness), smooth-textured mantle. This draping material shows characteristics similar to the latitude-dependent mantle (LDM) [7], such as a smooth surface, widespread and latitude dependent distribution, small thickness, and very few and small superposed fresh impact craters. The small diameters of fresh and undegraded impact craters imply a recent age [e.g., 8, 9].

The VFD have individual surface areas of a few km^2 to a few tens of km^2. In some cases they are located in the center of the valley floor, whereas in other cases they cover the entire width of the host valley, indicating their post-valley formation. The valley width could reach up to a few kilometers, in some areas. Using a HiRISE DEM, we observed that the VFD in the thickest part has a minimum thickness of ~30 meters. The LDM is also partly covering the VFD, and the surface of the VFD is outcropped where the LDM has been degraded or sublimated.

The surface of VFD shows only few impact craters, with diameters equal or smaller than ~700 m. Craters larger than 70 m are mostly degraded, their rims show almost no positive relief (at CTX resolution) and they have flat floors. Smaller modified craters have been observed, but there are also a few small fresh impact craters (smaller than 70 m in diameter) which do not show any modification of their rims and walls. On the surface of several VFD, we observed craters with a few hundred meters in diameter, bowl-shaped, and rimless, which have a flat floor. They have very similar characteristics to impact craters on LDA and LVF surfaces in mid-latitudes, which are termed ring-mold craters (RMC) by [10] and are thought to be a result of impacts into shallow buried ice.

Where higher resolution data are available, we can observe linear features, cracks, and crevasses on surface of VFD (Fig. 1-b & c). Fig. 1 shows two VFDs which completely cover their host valleys and display several crevasses at the surface as lateral or transverse crevasses. Transverse crevasses may indicate tensile stress caused by viscous flow of the deposit. In several cases, in front of the VFD margins, there is a zone up to 3 km of length, where the valley floors are rougher than further down the valley. We infer that this rough zone corresponds to sediment accumulation similar to morrain-like material in front of a glacier that moves down the valley. At the contact between the VFD and the valley walls, we observe several sublimation pits a few tens of meters wide and aligned along a preferential direction on the border of the VFD.

Absolute model age estimation: In order to understand the absolute model age (crater retention age) of the VFD, we analysed crater size-frequency distributions (CSFD) on CTX and HiRISE (where available) images using the method described in [11]. The data are plotted as a cumulative presentation of CSFD. The CSFD revealed at least one resurfacing events.

We suggest that the model age of the VFD surface is ~μ25 (±10) Ma, which corresponds to late Amazonian (the μ factor is a function representing the uncertainty of calibration of the chronology model [11]). The resurfacing event has roughly a recent age of

~µ3.4 (+2/-1) Ma corresponds to late emplacement(s) of a thin layer of dust, airfall, and/or ice-rich material (e.g., LDM) covering the VFD.

Interpretation and implication: The VFD have been observed on the floor of a valley system with traces of early to middle Amazonian fluvial activities [6] and our observations point to a post-valley formation for the VFD. The VFD is characterised by a convex-upward shape, transverse crevasses, sublimation pits, and association with moraine-like deposits. These characteristics, together with evidence of ring-mold craters, suggest that VFD are ice-rich deposits with a thickness of a few tens of meters. The late Amazonian model age of VFD (~µ25 Ma) points to their recent deposition, in addition to a very recent (~µ3.4 Ma) resurfacing event.

The accumulation of ice/snow at mid-latitude regions cannot be explained by the current climatic condition of Mars, as the atmosphere does not sustain snow/ice accumulation and surface ice is unstable at mid-latitudes [12]. Therefore, the glaciation and deposition of VFD should had taken place under different climatic conditions in the past. The stability of ice at the surface is sensitive to the insolation which varies with the obliquity cycle. During periods of high obliquity ice would be driven from the polar regions to be deposited at lower latitudes [3, 12]. The obliquity variation happened quasi-periodic [4] in the past, and Mars is currently in a relatively low obliquity phase of 25 degree. Therefore, the buried ice-rich deposits are currently undergo a degradation phase, which is evidenced, in our study, by degradation of LDM and presence of sublimation pits on VFD surface. Lastly, we conclude that the presence of ice-rich VFD underneath the young LDM is an evidence of an episodic and multi-event process of ice emplacement in the mid-latitude regions of Mars during the Amazonian Period.

References:

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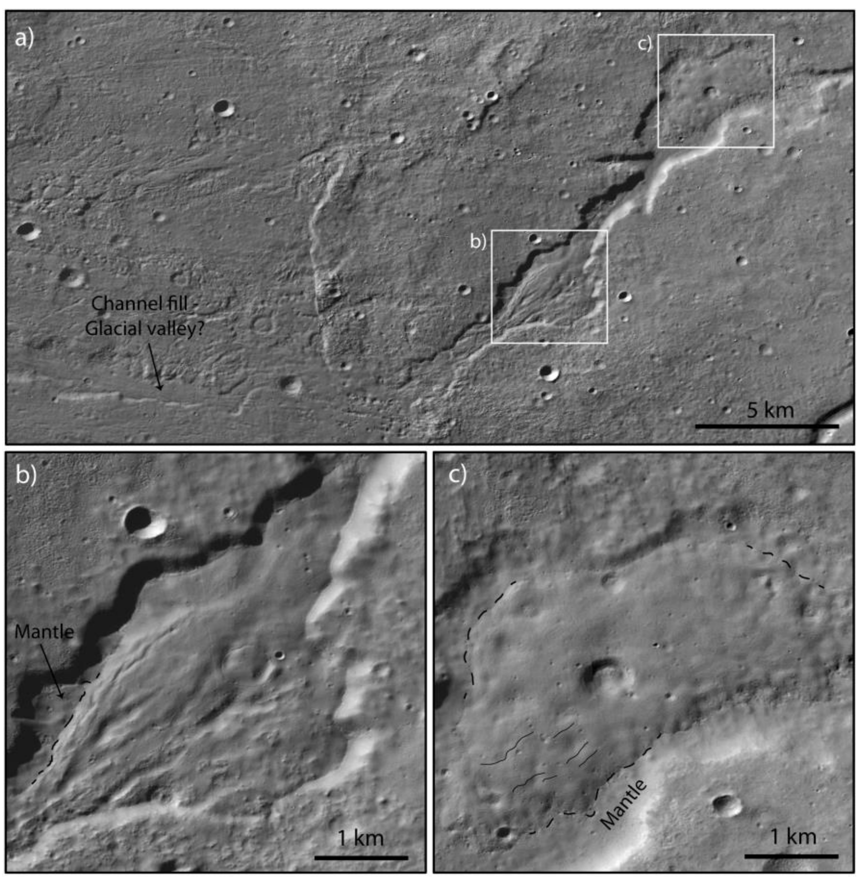

Fig. 1: a) Valley fill deposit (VFD) distribution on the floor of a fluvial system, located in Terra Cimmeria (CTX image B21_017798_1416). b) VFD with longitudinal crevasses. The dashed line represents the limit between the LDM (mantle) and VFD. Note the small unmodified and (relatively) fresh impact crater close to the NE border of VFD. c) VFD with a modified impact crater on its surface, probably a RMC. Solid lines highlight some crevasses.