LOOKING FOR BURIED ICE RELICT OF GLACIAL ACTIVITY AT THE LOWER NW FLANK OF THE HECATES THOLUS VOLCANO ON MARS BY SHARAD DATA. M.A. de Pablo[1], R. Orosei[2], and J.D. Centeno[3]. [1]Dept. Geology, Geography and Environment. University of Alcalá, Madrid. Spain (miguelangel.depablo@uah.es), [2]Istituto di Radioastronomia, Istituto Nazionale di Astrofisica, Via Piero Gobetti 101, I-40129 Bologna, Italy (roberto.orosei@inaf.it), [3]Dept. Geodynamics. Faculty of Geological Sciences. Complutense University of Madrid, Spain (juande@ucm.es).

Introduction: Many Martian volcanoes show landforms related to ancient glacial activity on their flanks [1-10]. This glacial activity on thoe tropical volcanoes could be as recent as less than 1 Ma, during the last glacial age of Mars [11], [3], [11-14]. However, Hecates Tholus is the unique volcano at the Elysium province in which those features are visible, such as they were mapped and dated at its NW flank [12], [13], [15]. Flutes, roche moutonnees, erratic, moraines, eskers, crevasses, bergschrunds, arêtes, circus or hanging valleys where some of the features described in CTX and HiRISE images of the area (Fig. 1). Their presence reveals the existence of an extensive glacial activity until 450 ka [14]. However, ice has not been observed anywhere in the area on satellite images at any resolution, such as occurs on the Martian polar caps.

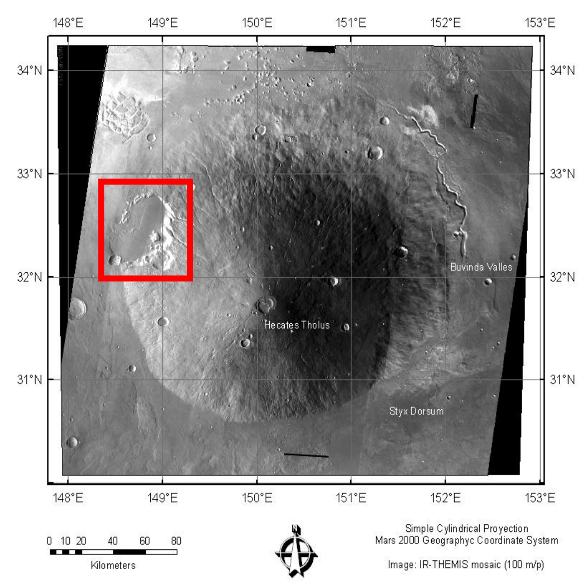

Fig. 1: Location map of the study area (red box) in the lower NW flank of the Hecates Tholus volcano.

This issue inspired us this question: How is it possible to have pristine glacial features without ice? Sublimation or dust/pyroclastic deposits could destroy or cover, respectively, some of those features, especially crevasses and bersgchrunds. Then, our working hypothesis is that the remanant ice from the last glacial events in the area [3], [12], [13], [15] still remains under the surface, partially covered by dust/pyroclastic deposits, as shallow as few meters. This hypothesis, moreover of the geomorphological cartography and the crater counting of the area, is based on the thermophysical models what propose that in this area ice lenses could exist in the at depths as shallow as 1 or 2 meters [16], [17].

In order to test this hypothesis we used data acquired by the SHARAD subsurface sounding radar on board NASA's Mars Reconnaissance Orbiter [18], already used to study the characteristics and properties of the Martian polar caps (e.g. [19], [20]). Here we briefly describe the data, methods and preliminary results of this study.

Data and methods: SHARAD works by transmitting radar pulses with a 10 MHz bandwidth at a central frequency of 20 MHz, which penetrate below the surface and are reflected by any dielectric discontinuity in the subsurface. Such discontinuities are caused by changes in composition (ice vs. rock) or in structure (lava flow vs. loose regolith), or both. Echoes are processed to obtain a vertical resolution of 15 m in free space (resolution in other media improves as the inverse of the square root of the relative dielectric permittivity), an horizontal resolution of 0.3-1 km along the ground track of the spacecraft (depending on processing), and of 3-6 km across-track (depending on surface roughness) [18].

Data are usually represented in the form of radargrams (Fig. 2), showing radar echoes acquired continuously during the movement of the spacecraft as grey-scale images, in which the horizontal dimension is distance along the ground track, the vertical dimension is the round trip time of the echo, and the brightness of the pixel is a function of the strength of the echo. The resulting image is a radar cross-section of the crust along the ground track of the spacecraft.

SHARAD transmits through a dipole, which has negligible directivity, with the consequence that the radar pulse illuminates the entire surface beneath the spacecraft and not only the near-nadir portion from which subsurface echoes are expected. The electromagnetic wave is thus scattered by any roughness of the surface. This means that areas of the surface that are not directly beneath the radar can scatter part of the incident radiation back towards it, and thus produce surface echoes that will reach the radar after the echo coming from nadir, which can mask, or be mistaken for, subsurface echoes. A numerical electromagnetic model of surface scattering [21] has thus been used to produce simulations of surface echoes using the MOLA topographic dataset [22], to validate the detection of subsurface interfaces in radargrams.

Results: Because of its small size, so far only a limited number of observations has been collected over the study area. An example of data is shown in Fig. 2, where it can be seen that a second echo past the surface appears when SHARAD flies over the NW flank of Hecates Tholus. Unfortunately, the same feature appears also in simulations of surface scattering, and is caused by the rim of the depression on which the study area is centered. Further observations have provided similar results, and no subsurface interface has been detected so far.

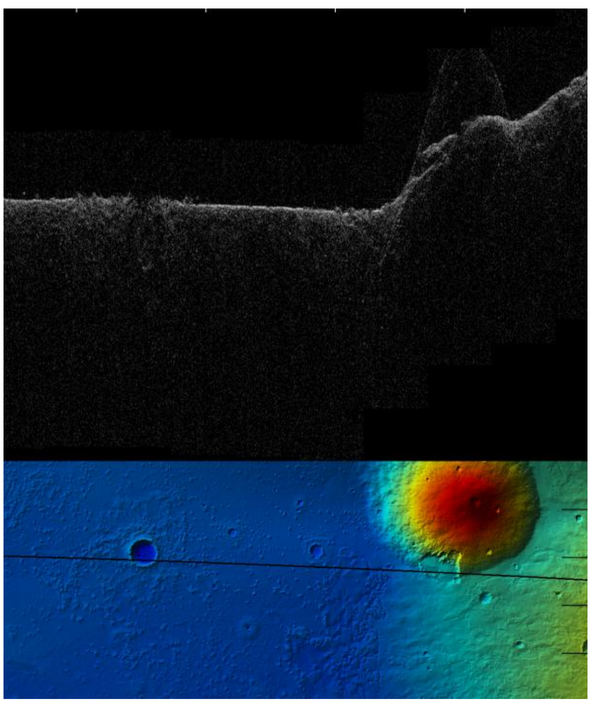

Fig. 2: detail of the radargram for orbit 13493 across the study area (top) and topographic map of the Hecates Tholus area showing the ground track of the spacecraft (bottom).

Conclusions: If ice was the main component of the mound filling the depression, then the mound itself should have been mostly transparent to radar pulses, and a clear detection of its bottom should have been possible. However, the lack of a suburface radar echo does not automatically rule out the presence of ice. For example, a very rough subsurface interface, such as caused by chaotic or collapsed terrain, would result in the diffuse scattering of radar signal that could weaken the backscattered echo below the threshold for detection.

Another factor potentially affecting detection is data porcessing: radar echoes are processed in such a way to enhance the signal coming from nadir, filtering out echoes arriving from different directions. The flanks of Hecates Tholus are tilted, however, and to get the strongest echo from any subsurface interface, echoes should be focused in a direction perpendicular to the flanks themselves, that is away from nadir. Until a more specialized processing can take place, a final result on the lack of detection of subsurfcace interfaces cannot then be ruled out.

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