

Is Mars cheating about its ice? J. Helbert¹ and J. Benkhoff^{1,2}, ¹Institute for Planetary Research, German Aerospace Center DLR, (Rutherfordstr. 2, Berlin-Adlershof, Germany, joern.helbert@dlr.de), Research and Scientific Support Department, ESTEC, (Keplerlaan1, 2201AZ Noordwijk ZH, The Netherlands).

Introduction: While Mars has been considered for a long time a dry place, this view has changed in recent years. This started mainly after the MOC imagery showed features like the gullies and morphological features which can be associated with glacial activity. Now the notion was discussed that at least small amounts of water or ice had been present in the recent past on Mars. Still, the common notion was that Mars today is a dry place. With the excellent dataset of the Gamma and Neutron spectrometer (GRS and HEND) on board of Mars Odyssey this view had to be corrected. The instrument detected water abundance of at least 8wt% in the equatorial regions of Mars and this water is found within the first 2m below the surface, the penetration depth of the instrument.

Water on Mars: There are three main explanations for this observed amount of water which are not mutually exclusive. Some of the water measured is most likely adsorbed water. While it is still unclear how much water the Martian soil can adsorb, this mechanism can not explain the high abundances measured in some place. We might see highly hydrated minerals. Some of the suggested minerals are indeed capable of holding large quantities of water. The last and maybe most exciting possibility are near surface ice deposits. However if it is ice, the question is, how did it survive close to the surface under the hyper-arid conditions we encounter on present day Mars. And how much ice is there really on present day Mars?

Ice on Mars: Until today we have seen ice only at the polar caps and only this year did we get the first direct measurements of ice abundances by the PFS and OMEGA instrument on Mars Express. We do not have any direct evidence for ice at lower latitudes. From the GRS and HEND measurements we know that the polar caps extend under the surface much further than previously expected. One might assume therefore that near surface ice deposits we see at low latitudes are literally only the tip of an iceberg and the Mars might have a global ice reservoir in shallow depths. If this would be the case, Mars would be a wet planet which is just temporarily frozen. Another less dramatic scenario is the assumption that ice deposits at low latitudes are remnants of the last Martian ice age. The change in the obliquity of Mars can lead to a redistribution of ice across the planet. So maybe we observe today a transition state, in which we only see the dwindling remains of equatorial glaciers. If the ice within the top 2m has survived until today, this would however imply that

these regions have been covered by large amounts of ice during the last ice age. Both ice related scenarios would imply that Mars has, or at least had in the very recent past, large quantities of ice on or close to the surface.

Enrichment of ice: While working on model calculations for the stability of ice on Mars today we discovered a possible third scenario. Most models used to study the stability of ice in the Martian soil assume a homogenous soil with constant thermo-physical properties with depth. Furthermore most of the models do not actually model the water vapor transport in the subsurface, but instead using an equilibrium approach and derive the depth of the ice table based on the subsurface temperatures. With the Berlin Mars near Surface Thermal model we have worked on a different approach. The model actually models how the ice table would move over time, including a detailed treatment of the diffusive processes and the energy transport.

We have studied cases where the soil consists of layer with very different thermo-physical properties. One of the scenarios we have looked at is a low thermal conductivity dust layer on top of a sand layer with a significantly higher thermal conductivity. Such configurations can be found for example in the Terra Arabia region. For this case we observed the formation of an ice lens at the boundary between the material, effectively closing the pore space and significantly reducing downward diffusion. This leads to an actual enrichment of ice within the top layer. Depending on the thickness of the dust layer and the parameters used we can get an enrichment of a factor of 2 or more in the first 2m below the surface.

Conclusions: We will discuss the implications of such a scenario on our understanding of ice on Mars. The ice enriched layer might in a sense fool the GRS and HEND instrument and it might show a morphological behavior very similar to a rock glacier. The process of enriching the ice significantly slows the movement of the ice table to greater depth and can therefore stabilize ice over several thousands of years close to the surface.

This means we might indeed see today the remains of the last Martian ice ages, but the amount of ice moved across the planet can be significantly smaller than previously thought. Furthermore some of the “young” glacial feature we see today would have been formed not during, but after the last ice age and might even exist until today.