THE THERMAL STABILITY OF SOME VOLATILE SUBSTANCES IN THE MERCURY'S SOUTH POLE REGION.

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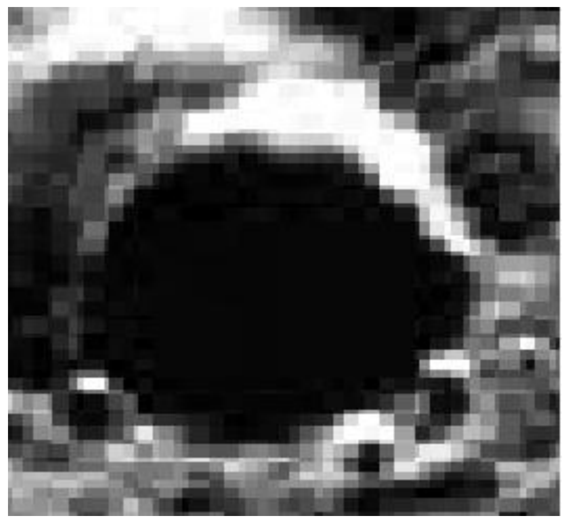
Introduction: Radar observations of the surface of Mercury had revealed areas with bright reflective properties in both polar regions of the planet [1]. The position of these areas coincided with position permanently shaded areas located in the relief depressions, such as impact craters. It is assumed that these areas may contain deposits of certain substances, including water ice, methane, carbon dioxide and other substances similar to those found in the Cabeus crater near the southern pole of the Moon [2]. The data obtained by the neutron spectrometer onboard MESSENGER probe confirmed these assumptions [3].

The most likely sources of volatile substances on the surface of atmosphereless bodies are impacts of asteroids, comets and meteorites. The possibility of the existence of such deposits is determined by their evaporation rate, which depends on the temperature. In this paper, we used data from [4] to calculate the thermal and lighting conditions in some craters that contain radar areas in the southern polar region of Mercury. We modeled the internal surface of host craters using 4 altitudinal profiles: latitudinal, longitudinal and two diagonal. These data allowed us to determine the depth, diameter of the flat bottom (if any), the slope of the walls, and height and diameter of the central rise for a number of host craters. These data were used by us to calculate the illumination conditions and the temperature regime in the craters, in the same way as we did in [5]. This allowed us to determine the area of permanently shaded areas in each crater and to investigate the stability of a number of volatile compounds such as H_2O, CO, CO_2, CH_3OH, CH_4, NH_3, H_2S, CH_2O, SO_2, C_2H_4, C_2H_6, C_2H_2 in these areas.

Unfortunately, not all host craters had the correct DEM data at the time of the research. For example, there is no good data for the crater Chao Meng-Fu, containing the largest in the southern polar region of Mercury radar bright area X. In addition, modeling in this way is possible if the inner surface of the crater is spherically symmetric. So this method turned out to be inapplicable, in particular, for the Petofi crater, who has an asymmetric internal structure and for some other host craters.



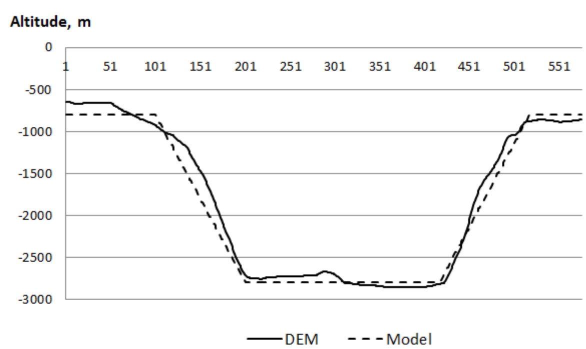


Figure 1. The image of the crater containing the radar-bright feature V3 from the MESSENGER probe (top) and the DEM data profiles and according to our model.

About 1,400 high-altitude profiles of 366 impact craters with a diameter of more than 10 km located in the southern polar region of Mercury were investigated. As a result, based on the DEM data, we created models of internal surface of 34 craters containing radar-bright areas. This approach is especially useful if there are no images of the internal structure of the host crater. This often happens for craters located in the polar regions of Mercury. In particular, there are yet no images of the inner surface of craters containing such radar bright features as V3, S3, Z3 and some other craters. In Fig. 1 shows the altitudinal profiles of a crater, which contains a radar bright feature V3 (85.2 ° S, 13.6 ° W).

To calculate the evaporation rate of volatile compounds, we used the data from [6]. In this paper we assumed that the substance can be considered stable against evaporation if its evaporation rate does not exceed 1 m for 1 billion years in a manner analogous to that [7]. We investigated the possibility of the existence of these compounds not only on the surface, but also in the subsurface layer of regolith in host craters. Figure 2 shows the temperatures at which volatiles remain stable with respect to evaporation, depending on the depth.

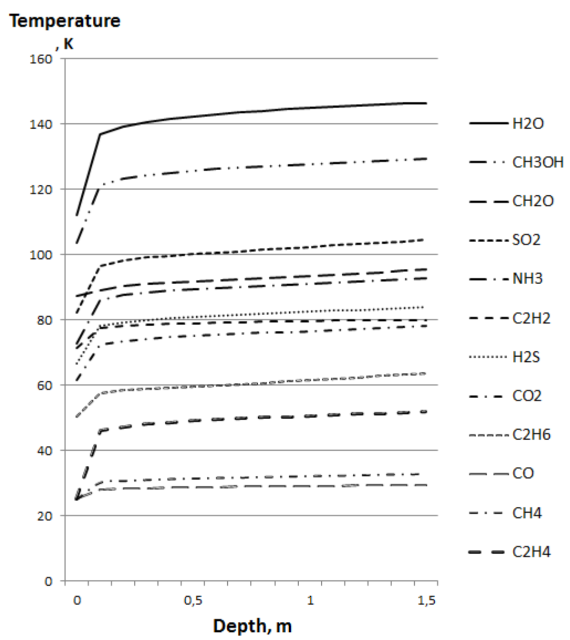


Figure 2. The temperatures at which the substances remain stable against evaporation, depending on the depth.

Our results show that compounds such as H2O, CH3OH, CH2O, SO2, CO2, NH3, H2S and C2H2, can exist during the billion years on the surface in permanently shaded areas of all the craters considered. But compounds such as C2H6, C2H4 and CH4 are more volatile and remain stable on the surface only in craters whose diameter exceeds 18 km. The thermal and reflected fluxes from illuminated crater walls in this case raise the temperature in the constantly shaded area during the day slightly. If the deposits of volatile compounds are under a layer of regolith, they can exist for a long time at higher temperatures (Fig. 2). According to our result, all the above compounds can exist in the presence of an insulating layer of regolith in all investigated craters.

References:

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