Near-Surface Temperatures on Mercury and the Moon and the Stability of Polar Ice Deposits

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Icarus **141**, 179-193 (1999)

It has been suspected over the past half-century that water ice is stable in permanently shadowed areas near the poles of Mercury and the Moon. In the last decade, radar observations of these two bodies (and neutron spectrometer measurements from the Moon) have been made which suggest the presence of ice and hydrogen. While the observations have not been uniquely explained by water ice, the authors of this paper decided to model the near-surface temperature environments of Mercury and the Moon, and determine if water, if present, could survive there for substantial periods of time. They then compared their results to the observations.

The specific environments which were modeled on both bodies were flat surfaces (open areas) and the insides of craters at varying latitudes and longitudes. The effect of regolith cover of ice deposits was also considered. The thermal model used in this project approximated the Mercurian and lunar regolith as two separate layers with different thermal properties.

Craters were approximated by a grid of 32 x 32 surface elements. A thermal finite element analysis taking into account scattering of sunlight and thermal radiation from each element (reflected/emitted from crater walls, floor, etc.) was performed to determine minimum, maximum, and average temperatures for each surface element over the course of a year. 110 K was accepted as a reasonable maximum temperature at which water ice could survive (not sublimate quickly).

It was concluded that: 1) Unshaded surface water ice deposits (i.e. polar caps) are not possible on the Moon or Mercury. 2) Unshaded, buried water ice is stable within 2º latitude of the lunar poles. 3) Ice deposits in permanently shadowed portions of craters are stable as far as 10º and 13º latitude from the poles of Mercury and the Moon, respectively. 4) Observed locations of water ice on the Moon and Mercury are consistent with the predicted temperatures given that some of the deposits are covered with several centimeters of insulating regolith.

Other Articles:

"Lunar Ice: Adsorbed Water on Subsurface Polar Dust" by Cocks *et al*. Icarus **160**, 386-397 (2002)

"A Search for Water Ice at the Lunar Poles with Clementine Images" by McConnochie *et al*. Icarus **156**, 335-351 (2002)