CONDITIONS FOR RETENTION OF WATER ICE IN NEAR-EARTH OBJECTS.

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Introduction: Ice in main belt asteroids and Near-Earth Objects (NEOs) is of scientific and resource exploration interest [e.g., 1], but small airless bodies gradually lose their ice to space by outward diffusion. We use model calculations to quantify under what conditions water ice could last near the surface or in the deep interior of these bodies [2-4].

Results: Fine-grained material sometimes covers the surfaces of small bodies, such as 9P/Tempel 1 and Ceres. Such a layer can play a significant role for the preservation of subsurface ice, for two reasons: it acts as a diffusion barrier to water vapor and it increases the surface temperature amplitude and therefore enhances radiative cooling of the entire body [4]. Ceres still has ice extremely close to its surface [5], which suggests that impact-devolatilization was negligible.

We quantitatively estimate the time it takes a porous airless body to lose all of its interior ice. The average surface temperature, which is lower than the classical effective temperature, is representative of the body interior and hence an appropriate temperature to evaluate desiccation time scales. A bilobate structure emerges from the strong latitude dependence of desiccation rates. Cold polar regions can harbor subsurface ice, even when the body center does not.

For an NEO [6] to have retained ice in its interior, one of the following conditions has to be met: 1) a semi-major axis in the outer belt or beyond, 2) a mantle of very low thermal inertia, 3) a young physical age due to recent formation in the break-up of an ice-rich body, or 4) a stable and moderately small axis tilt that would maintain cold polar regions.

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