Lunar Polar Ice - A Reappraisal, T. Svitek and B. C. Murray, Dept. of Planetary Science, Caltech, Pasadena, Calif. 91125.

Recently there has been a significant renewal of interest in the old question of lunar polar ice (1). This is related to several proposals, at JPL and elsewhere, for a quick and cheap mission - a precursor for the Lunar Polar Orbiter. Therefore we have developed an updated model for the lunar polar ice based on the most realistic scenario and utilizing the new insights not available at the time of the previous studies.

Our principal conclusion is that existence of lunar polar ice is still likely, albeit at smaller extent than was proposed before (2). The sputtering by energetic particles (3) may be important loss mechanism but does not completely eliminate the possibility of existence of lunar polar ice.

First of all, it is necessary to point out that the supply of volatile material is probably much smaller than previously expected. The Moon, as recently as 2-3 By ago, had a high obliquity (2 and 4). Based on properties of megaregolith, this could deplete any primordial volatiles to a depth of several hundred meters.

We expect that the primary source which could produce any sizeable lunar polar ice deposits is from impacts of large water-rich bodies (comets). Then the water has to be transported in vapor phase from an original arbitrary location on the lunar surface to permanently shadowed areas near the lunar poles.

The critical part for this study was a reappraisal of the transport efficiency. Our model suggests that this efficiency could be much lower than previously expected (maybe as low as 10^{-3}). This would produce deposits of equivalent thickness on the order of one millimeter distributed within the top meter of a soil. This is still a non-trivial amount considering the surface of permanently shadowed areas (about 0.5 % of the total surface).

There are several reasons for the reduction of transport efficiency. First, during a temporary stay on a cold night side surface there is a very high chance for water molecules to be sputtered by energetic magnetospheric particles from the geotail. Therefore, we believe that only impacts at high latitudes will contribute non-negligible amounts of water to polar ice deposits.

The transport has to be faster, or at least on the order of the photodissociation time of water molecule. The amount of water deposited by a random walk process is an exponentially diminishing function of ratio of transport time over photodissociation time. Therefore, we have attempted to revise the transport rates, and come to the conclusion that there will be a significant loss from photodissociation (primarily near polar regions).

Also, as was pointed out in (2), the chemical absorption can become a non-equilibrium process, and thus prolong residence time of volatiles on the surface for much longer than expected from purely vapor pressure arguments. Our rough analysis showed that this is likely to play a non-negligible role and also decrease the transport efficiency.

On the other hand, it was suggested in (3) that the sputtering by energetic particles will completely prevent any accumulation of water ice at the lunar polar region. However, the regolith overturn will probably play an important role in shielding the ice deposited.

References:

(1) K. Watson, B. C. Murray and H. Brown, JGR, **66**, 3033, 1961.
(2) J. R. Arnold, JGR, **84**, 5659, 1981.
(3) L. J. Lanzerotti, W. L. Brown and R. E. Johnson, JGR, **86**, 3449, 1981
(4) W. R. Ward, Science, **189**, 377, 1974.