THE CRATERS SHOEMAKER AND FAUSTINI AS COLD TRAPS FOR VOLATILES

E. A. Kozlova[1], V. V. Shevchenko[1]. Sternberg State Astronomical Institute, 119899, Moscow, Russia

Introduction: In 1994, the "Clementine" spacecraft launched by NASA explored the Moon for 70 days. As a result, a radar experiment made it possible to discover areas with anomalous radar properties (Nozette et al., 1996). The "Lunar Prospector" spacecraft, launched by NASA toward the Moon in 1998, was equipped with a neutron spectrometer for detecting possible deposits of volatiles in the polar areas of the Moon. In the region of the south pole of the Moon, maximum hydrogen content was found in the areas coinciding with such craters as Faustini (87,2º S, 75,8º E, D = 45 km) – 160,3 ppm and Shoemaker (88º S, 38º E, D = 56 km) - 146 ppm, [2]. The average level of the contents of hydrogen for the Moon makes 50 ppm.

We computed the permanently shadowed areas and temperatures inside the craters for the variation of the position of the lunar pole of rotation with respect to the ecliptic pole with a period of 18.6 years. We estimate the total permanently shadowed area in the lunar northern polar region as 28260.2 km^2 [3]. The total permanently shadowed area in the region of the south pole of the Moon is smaller than in the region of its north pole and we estimate it as 22168.5 km^2. According to our results, the total permanently shadowed area in the polar craters of the Moon is equal to 50428.7 km^2, or 0.13% of the total area of the lunar surface [3].

For an estimation of temperature of a surface in a crater we took into account the direct solar flux coming to an illuminated element of the crater surface, the thermal flux from the interiors of the planet, the flux reflected from the illuminated surface of the crater, the secondary reflected light flux from element of the inner surface of the crater, the infrared flux incident onto crater surface element. We do not take into account the thermal flux from the adjacent elements of the crater; however, this flux can be ignored because of the low thermal conductivity of regolith on the Moon. In addition, we also ignore the effect of the solar wind, because it barely penetrates into permanently shadowed areas [4].

Water-ice deposits remain stable for a long time if the maximum temperature does not exceed 110 K. The temperature limit increases to 130--150 K in the presence of regolith [5]. And sulfuric compounds remain stable if the maximum temperature does not exceed 220K [5].

Crater Shoemaker (88º S, 38º E, D = 56 km) was found on the images received with the help of observatory Goldstone [6]. In view of position of the Earth above lunar horizon at the moment of radar-tracking measurements the structure of a crater has been constructed. Average depth of a crater has made 2,75 kms, an inclination of walls - 13º. The area of permanently shaded part of a crater makes 59 % from all area of a crater [3]. The diagram of distribution of the maximal temperatures in a crater shows, that in northern part of a crater there is an area where the temperature never exceeds 70 K. The average temperature of this area – 40 K Thus, this part of crater Shoemaker can be "a cold trap " for water ice or NH_3. In the central part of a crater the maximal temperatures reach at northern slope 100 K, and 140 K at southern. Average temperatures in this area do not exceed 50 K and 70 K accordingly. In such conditions in this part of a crater open deposits of water ice or deposit of water ice under a layer of regolith, and as connections of sulfur can be kept. The maximal temperatures in area of a southern slope of a crater exceed 180 K.

On images of area of South Pole of the Moon, received by observatory Goldstone [6] (fig. 1) as possible "cold trap", we have allocated crater Faustini (87,2º S, 75,8º E, D = 45 km). The maximal temperatures in northern part of a crater does not exceed 87 K, the average temperatures in this area change from 47 K up to 57 K. This area can be a cold trap for the deposits of the water ice which has been not covered with a layer of regolith. The maximal temperatures in a significant part of northern half of crater do not exceed 100K and can contain open deposits of water ice. The maximal temperatures inside south part of the crater Faustini do not exceed 200 K so connections of sulfur can contain in any part of a crater

We found that craters Shoemaker and Faustini containing permanently shadowed areas in which the temperature allows volatiles to remain stable for a long time coincide with the areas of high hydrogen content according to the "Lunar Prospector" data and can be "cold trap" for volatiles, including water ice.

References:

1. Nozette S et al. (1994) *The Clementine Mission to the Moon. Scientific Overview. Science*. V.266 p.1835-1839. 2. Feldman W.C. et al. (2001) *Evidence for water ice near the lunar poles. J. Geophys. Res.*, V. 106, p. 23231-23252. 3. Shevchenko V.V. et al. (2002) *Permanently shadowed areas at the lunar poles*. Abstract of 34-th Int. Microsimp. On Planetology, Moscow, #MS065. 4. Carruba, V. and Corradini, A., (1999) *Lunar Cold Traps: Effects of Double Shielding, Icarus*, p. 402--413. 5. Vasavada, A. R. et al. (1999) *Near-Surface Temperatures on Mercury and the Moon and the Stability of Polar Ice Deposits. Icarus,* V. 141, 179-193. 6. Margot J.L. et al. (1999) *Topography of the Lunar Poles from Radar interferometry: A Survey of Cold Trap Locations. Science*, V. 284, p. 1658 – 1660.

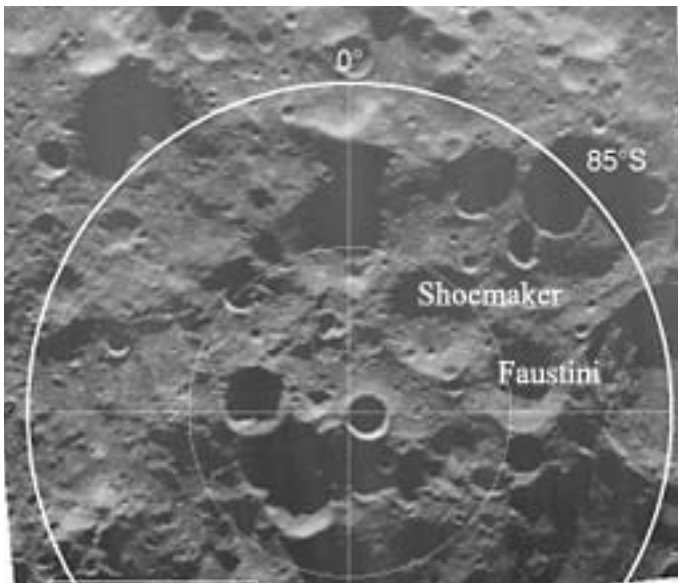

Figure 1. The radar image of lunar south pole region obtained with the 3.5 centimeter wavelength Goldstone Solar System.