PERMANENTLY SHADOWED AREAS AT THE LUNAR POLES: NATURE AND POSSIBLE UNILIZATION. V.V.Shevchenko, E.A.Kozlova, Sternberg State Astronomical Institute, Moscow University, 13 Universitetsky pr., 119992 Moscow, Russia; e-mail: shev@sai.msu.ru
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The polar areas are the unique terrain on the Moon. The orbital plane of the Moon is inclined to the plane of the ecliptic at an angle 5.13 . The regression of the line of nodes of the Moon's orbit has amplitude of 9" in obliquity and varies over a period of 18.6 years. Taking account of these movements, the maximum altitude of the Sun above the celestial equator at midday is 1.53 . So, the Sun's disk rises a maximum of 1.78 above the horizon at the lunar poles. Therefore some topographic depressions near lunar poles may contain permanently shadow areas – cold traps. We calculated the areas of permanently shadowed regions according to minimum and maximum of the Sun's height above lunar horizon for each crater. The maximum permanently shadowed areas are located in the latitude zone from 70 - to 80 . The 12 craters near the North Pole and 3 craters near the South Pole permanently shadowed more than 30% and less than 50% during "the lunar summer". The number of craters containing permanently shadowed interior more than 80 % during 'the lunar summer' is 34 in the North Polar Region and 24 in the South Polar Region. Figure 1 shows the crater of diameter of 45 km (in center) near South Pole that has permanently shadowed interior on 50% during 'the lunar summer'.

The temperature inside cold traps (< 90 K) on polar regions is suitable for the presence of some volatile compounds (sulfur, carbon, hydrocarbons, hydrogen, and water ice). We estimate an amount of sulfur- and carbon-containing species delivered to lunar polar regions due to cometary impact.

In [1] had shown that effect of significant portion of the enhanced hydrogen near both lunar poles is corresponding to water ice deposits. For example, crater Peary in North Polar Region is demonstrating the enhanced hydrogen, especially in southeastern corner. According to our calculations, crater Peary is not contains the permanently shadow area. However, two small craters (diameter near 10 km) are lie in southeastern part of the Peary bottom. These craters contain the permanently shaded areas (about 20 km^2) and they could contain water ice deposits.

The concentrations of hydrogen are overlain a few small craters (<30 km in diameter) near the North Pole. According to our estimates the permanently shaded areas in these craters is about 50 km^2. The most enhanced hydrogen near North Pole is overlain the heavily cratered region near the crater Rozhdestvensky. There are many small craters, which could contain water ice deposits.

Hydrogen is enhanced in several craters from 10 km to 50 km in diameter near the South Pole. These craters contain the permanently shaded area about 50 km^2 and could contain water ice deposits too. The largest concentrations of hydrogen near the South Pole are overlay the crater Faustini, crater Cabeus, and Shoemaker, which contain about 100 km^2 of the permanently shaded area.

So, the largest terrain of the hydrogen content concentration is coinciding with area, which is permanently shaded during the period of 18.6 years.

In the future a polar region could be used for location of the lunar observatories or lunar bases. Habitat and facility conditions are easily kept constant inside a permanently shaded zone. Access from polar lunar orbiter is good because a spacecraft would pass overhead about every two hours. Cold trap volatiles may be available.

The polar regions ensure high quality astronomical opportunities because half of the sky is continuously visible from each pole. Inside cold trap it would not be hindrance from solar light. The cryogenic instrument can readily be operated there. Cryogenic telescope located in permanently shaded zone of crater bottom could view celestial objects for as long as desired in the observed half of the sky. Radio telescope located in the polar crater zone invisible from the Earth would be shielded from the radio noise of Earth. The most suitable for polar lunar observatory is crater Shoemaker. The crater lays in the depression that is permanently shaded zone. On other hand, about half of the crater bottom is invisible from the Earth (Figure 2).

Reference: [1] Feldman W.C. et al., (1998), *Science*, 281, p. 1496-1500.

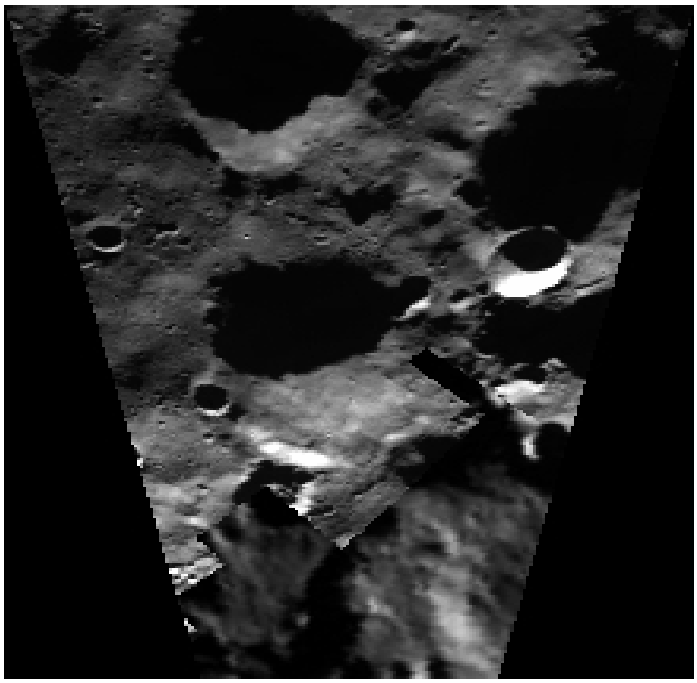

Fig. 1 shows the craters (in center) in South Polar region with interior permanently shadowed on 50% during “the lunar summer”.

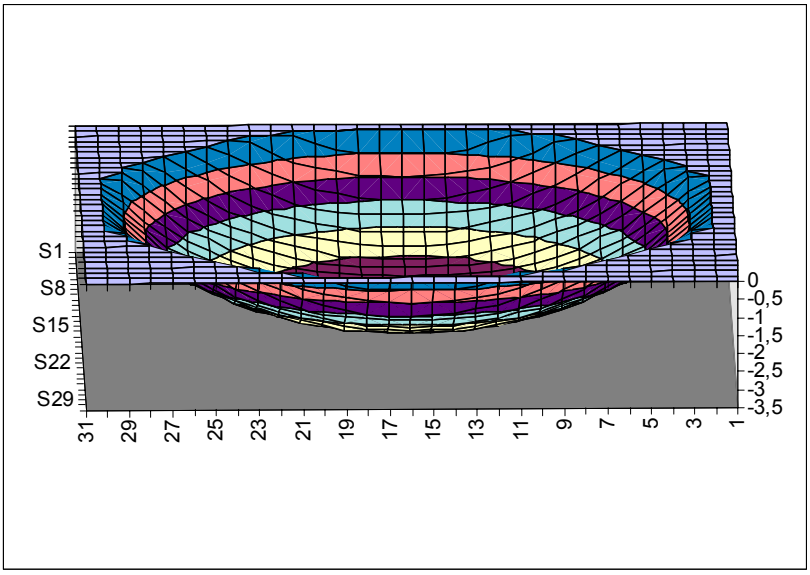

Fig. 2. Digital model of the crater Shoemaker. View from the Earth’s direction. About half of crater bottom is invisible from Earth.