THE CHEMICAL COMPOSITION OF REGOLITH AT THE MOON'S SOUTH POLE, ACCORDING TO DATA OF LUNAR PROSPECTOR AND LUNAR RECONNAISSANCE ORBITER MISSIONS. S. G. Pugacheva and V. V. Shevchenko, Sternberg State Astronomical Institute, Moscow University, 13 Universitetsky pr., 119992 Moscow, Russia, pugach@sai.msu.ru.

Introduction: The article tells about the results of integrated study of the craters at the Moon's South Pole with permanently shadowed region of craters. The surface of the craters that are situated in the area of the Moon's South Pole is not exposed to the direct sun light and has extremely low temperature (below 90 K), which remains for billions of years. The estimated values of photometric parameters in visible and infrared spectral ranges show that the illumination conditions of pole craters create prerequisites for formation of considerable water ice fields in the cold traps of the craters. High content of hydrogen in the Moon's soil is proved by measurement made by KA Lunar Prospector (LP) and Lunar Reconnaissance Orbiter (LRO). The main target of research is to determine any indirect indicator of the hydrogen presence in the soil of the Moon's regulate. We have analyzed the ultimate chemical composition in the soil matter from 5 craters with the cold traps: in view of thorium-, ferric oxide- and hydrogen contents. As "candidates" for craters with cold traps in term of physical conditions of illumination and anomalously low surface temperatures there were selected the following craters: Cabeus (81.71°S, 305.47°E), Shackleton (89.63°S, 125.84°E), Faustini (87.13°S, 84.06°E), Shoemaker (88.00°S, 45.34°E), Haword (87.49°S, 358.12°E),

Hypsometric researches: The surface topography of the Moon's South Pole region shows the notable differences in the morphology and topography of the craters. The crater Cabeus is heavily destroyed; the wall of the crater is ill-defined; with regard to integrity class the crater belongs to class 4 of the craters with destroyed walls. Figure 1 shows the histogram of relief altitudinal distribution for 5 craters.

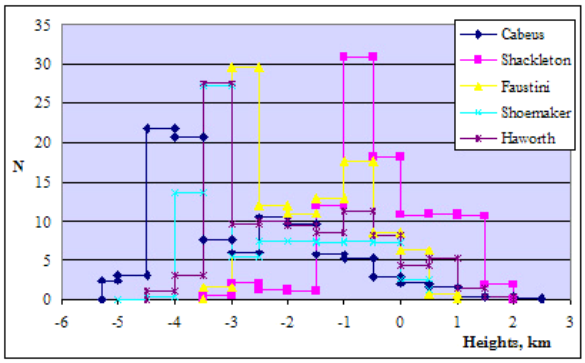

Fig.1. The histogram demonstrates the height distribution in the craters. The modes of the height distribution in the Cabeus, Shackleton, Faustini, Shoemaker and Haworth craters are –4.5, -0.70, -2.7, -3.5, -3.5 km, respectively. Regarding the altitudinal level the crater Cabeus is situated significantly lower than other craters with "cold traps".

The topographical boundaries of the craters were determined using the hypsometric relief map of the Moon's South Pole plotted on the basis of laser altimetry results KA Kaguya [1].

The abundances of the chemical elements: In order to make estimation of the chemical composition elements of the soil matter in the cold traps were used the measurements of Th, FeO and H contents by a spectrometer on KA LP [2, 3, 4]. The measurements of the ultimate soil composition have the spatial resolution of 0.5° x 0.5° that approximately coincides with a tetragon with 15 km side. The figures 2, 3, 4 represent the histograms of the elements distribution of the soil chemical composition in the craters with cold traps.

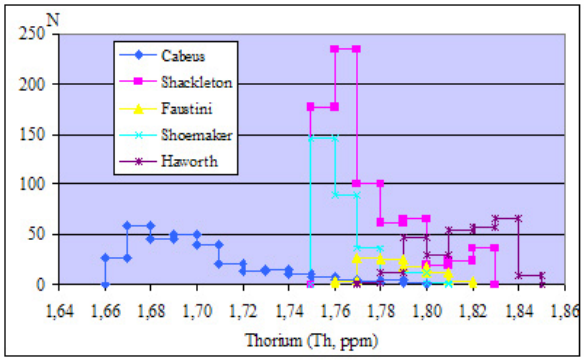

Fig. 2. The thorium (Th) distributions in the craters: Cabeus, Shackleton, Faustini, Shoemaker, Haworth.

The chemical composition of rocks in the area of Cabeus crater differs from the same of other craters. The most difference is observed in thorium and hydrogen contents. The concentration of FeO ferric oxide in the craters is approximately the same. Probably the low content of thorium in the area of the Cabeus crater is resulted from high irregularity of the surface microrelief. In our articles published in 2006, we resumed a regression dependency between thorium content in the Moon's soil samples and degree of irregularity of the surface micro-relief [5, 6].

The histogram in Figure 3 shows the distribution of the hydrogen content in the craters, plotted using the data from LP catalogue [2, 3]. According to figure 3

the general distribution of hydrogen in Cabers crater is of polymodal nature and can be divided into two marginal distributions that have form close to normal distribution. In this case, the first mode means 125 ppm, and the second mode of the hydrogen distribution is 170 ppm. The second mode of the hydrogen distribution matches with the northern shadowed border of Cabeus formation.

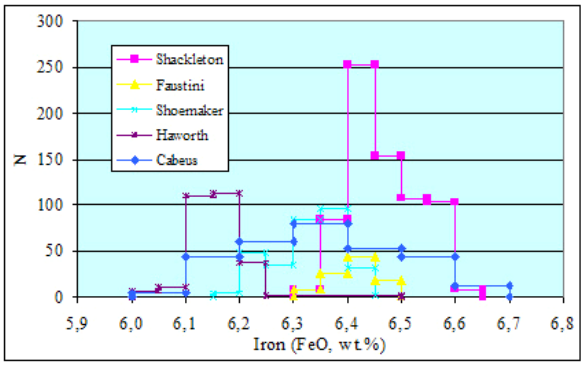

Fig. 3. The ferric oxide (FeO) distributions within the craters.

The shadowed area of the crater makes 8% of the total area. The neuron transmitters of KA LRO detected the hydrogen in the soil matter of craters, in the parcels with 5 km size [7, 8]. Different spatial resolutions of gamma-ray spectrometers, which KA LP and LRO were equipped with, make the comparison of the hydrogen measurement results in the craters difficult. Nevertheless, some comparative results were obtained and presented in the article.

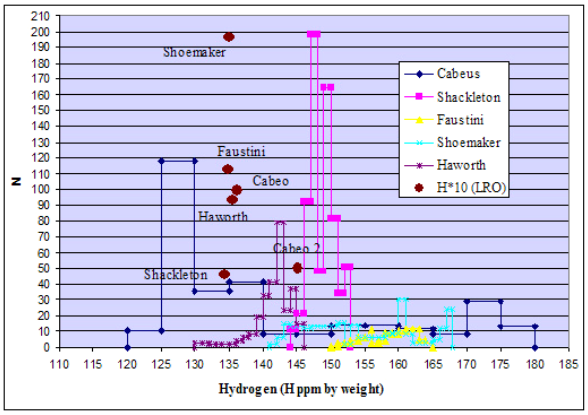

Fig. 4. The hydrogen (H) distribution within the craters.

Figure 4 shows the modes of the hydrogen distribution, using the measurements from KA LRO. On axis N the quantity pixels the hydrogen, measured LRO, were decreased twice.

The hydrogen measurement gaps between two spectrometers might be caused by time of lunar day and migration of hydrogen molecules into lower and cold surface areas under influence of the sunlight. As per one of the hypothesis, the water and hydroxyl may be the components of volcanic rock minerals of phosphates group.

Having analyzed the hydrogen measurement data made by two missions, one can conclude that the results obtained are consistent. We have compared the ultimate composition of the soil matters in the craters with “cold traps” in the Moon’s South Pole with regard to thorium, ferric oxide and hydrogen contents (Fig. 5).

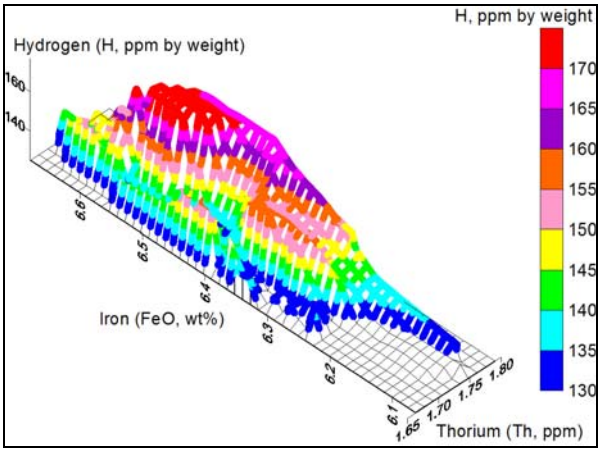

Fig. 5. The three-dimensional chart characterizing dependence of the hydrogen content on two parameters of thorium and ferric oxide in Cabeus crater.

Conclusions: The analysis of the results obtained confirms that the continental areas of the Moon’s South Pole are not homogenous. The variety of basalt types is resulted from the depth and melting temperature of any substance in accretion process. The changes in basalts composition are contributed with the meteoroid- and comet impacts that cause the substance melting and formation of various breccias. However, the American LRO orbital probe detected the hydrogen traces in the craters of the Moon’s South Pole, and LCROSS verified the presence of water in the area of Cabeus-2 crater. Probably, in the area of Cabeus-2 (83.78^{o}S, 338.96^{o}E) crater the relic type of porous surface with high irregularity of the surface microstructure has remained.

References: [1] http://spacespin.org/article.php/ [2] Lawrence, D. J. et al., (2002) *J. Geophys. Res., Ser. E,* vol. 107, no. 12, p. 5130. [3] Lawrence, D. J. et al., (1998) *Science*, vol. 281, 1484–1489. [4] http://pds-geosciences.wustl.edu/ [5] Shevchenko V. V. et al. (2003) *Proceedings of the International Lunar Conference*, 511-513. [6] Pugacheva S. G. and Shevchenko V. V. (2003) *LPS XXXI*, Abstract #1112. [7] Mitrofanov I. G. et al. (2008) *Astrobiology 8*, Issue 4, 793-804. [8] Ivatury V., McClanahan T.P. (2009) *LPS XXXX*, Abstract #1134.