Microcomets as a Possible Source of the Surface Layer of Hydroxyl and Water on the Moon

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Abstract

According to the results of spectral measurements of spacecraft Cassini, Chsndrsyan-1 (Moon Mineralogy Mapper) and Deep Impact [1,2,3], water and hydroxyl are ubiquitous on the lunar surface, including the equatorial region. In addition, quadrupole mass spectrometer, CHACE Chandrayaan-1 showed the presence of water in the exosphere of the moon [4]. This is a direct proof of the existence of the migration of volatiles [5].

These facts mean that surface processes of water and hydroxyl replenishment (especially in the equatorial regions) is happening just at present time. Thus, it is necessary to assume the existence of permanent water sources.

As source of water formation on the surface is the influence of solar wind protons [6]. At the same time, as shown by laboratory experiments with proton irradiation of solar energy spectrum of the sample, similar to the moon, the amount of water formed is negligible or non-existent [7]. In addition, our study based on data from apparatus Lunar Prospector showed lower content of hydrogen in marine areas, where under the influence of the solar wind is expected a significant amoun of water formed by the reaction like [6]:

$$2H^{+} + FeO = Fe^{0} + H_2O \qquad (1).$$

Thus, to explain the continued presence of in the exosphere of the moon to be offered another source. Thus, in order to explain the constant presence of OH/H_2O in the exosphere of the Moon, we must assume an additional new source. Such a source may be microcomets.

Microcomets are comet like objects with a diameter of about 10 m. and density 0.01-0.1 g/cm^3. Although the presence of microcomets in the immediate vicinity of the Earth is experimental and visual evidenced, the existence of such objects is still in doubt. But now, having evidence of the being of water in the equatorial areas of the moon and the movement of water in the lunar exosphere, we maybe have direct confirmation of their existence.

Frank and Sigwarth [8] believe that the flow microcomets on the lunar surface is ~ $1.2 \cdot 10^{-19} cm^{-2} s^{-1}$. From this data they tell that fall rate of comets on the Moon is about $0.7 \min^{-1}$, which corresponds to 370 000 impacts per year. But, such a huge number of comets, for some reason, almost not recorded at the Apollo seismometers. Therefore, a more realistic estimation of the frequency of microcomets fall on the Moon is about n~100 collisions per year. We estimated how much time it would take microcomets to deliver on the Moon amount of water, observed at the both poles. Putting ice deposits about $m_{ice} = 2 \cdot 10^{9} t$ [9], we calculate the time accumulation of water like:

$$t_{trap} = m_{ice} / m_w \approx 125 \text{ my} \qquad (2),$$

where m_w - mass of water remaining on the surface after impacts of microcomets per year. It's calculated by the equation:

$$m_w = n m_k c_{H_2O} c_{mat} (1 - c_{ph}) = 1.6 \text{ t/y} \qquad (3),$$

where $m_k = 2 \cdot 10^7 g$ -mass of microcomet [8]; $c_{H_2O} \approx 0.2$ - concentration of water in minicomets [10]; $c_{mat} \approx 0.1$ - mass fraction of the comet material remaining in the gravity of the Moon [11]; c_{ph} =0.96 -part of the water which has undergone photodissociation [5].

We got a very realistic time estimates of water storage ~ 125 million years. For comparison, the accumulation of ice time, resulting Vondrak and Crider [5] of assumptions about the formation of water from the solar wind and the calculation of the migration is about 83 million years. Thus, we have another very likely source of water on the moon, which really explains the data from space missions, showing the presence of water in the equatorial region and the exosphere of the Moon.

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