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Astronomy

On the Primeval Ocean

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ABSTRACT. Taking into account the thermal dissipation of hydrogen from the atmosphere during all the time past from the Earth's origin, it is concluded that the level of the primeval ocean must have been 4 km higher than the contemporary one. Because of flooding of a considerable part of land, the tidal friction was essentially reduced, allowing us to explain the great age of the Moon. *© 2010 Bull. Georg. Natl. Acad. Sci.*

Key words: dissipation, hydrogen, age of the Moon.

1. Introduction

The investigation of the origin of the Moon is connected with the specific problem of paradox called nature. Because of the tidal friction in the system Earth-Moon, on the one hand, the day becomes longer and on the other, the lunar orbit is enlarging by 4 cm per year [1, 2].

The essence of the phenomenon is that the bulge (tidal wave) created in the ocean by the lunar and solar attraction and fixed relative to the Moon, because of diurnal rotation in every 12 hours strikes the Eastern bank of the land. This results in the braking of the earth and translation of part of the Earth's angular momentum to the orbital angular momentum of the Moon.

Hence, the value of the tidal friction strongly depends on the profile of continents' banks and their spreading along the meridian. Because of the specific form of the continents the contemporary value of tidal force is many times greater than the standard one, which would be the case in the absence of sea coast, if all the surface of the Earth was covered by water.

Assuming the constancy of the tidal dissipation factor θ during all the history of the Earth and the Moon, one can receive that no more than 2.8×10^9 years ago the Moon would be moving into the Roche limit which would provoke its breaking into small-sized bodies [3-7], which is in contradiction with the lunar age of 4.5×10^9 years, received by radioactive analysis of lunar soil [8, 9].

The discrepancy between the contemporary value of tidal friction and the lunar age may be avoided in two ways: we must assume that the sea coast of the continents had simpler form anciently, or the size of the land was significantly smaller than the contemporary one.

The present paper deals with the second version.

2. The dissipation of hydrogen from the Earth's atmosphere

The most important process which can influence the chemical composition of the terrestrial upper atmosphere is the thermal dissipation of gases.

The investigated gas is distributed in the atmosphere according to hydrostatic laws and its density varies with altitude by the barometric law, true for isothermal atmosphere:

$$n(h) = n(0)e^{-\frac{h}{H}}, \quad (1)$$

where the "altitude scale"

$$H = \frac{kT}{\mu m_0 g}(1 + \frac{h}{R_0}). \quad (2)$$

$n(h)$denotes the density of the atmosphere at the altitude h, k is Boltzmann's constant, T - absolute temperature, μ - middle molecular weight, R_0 - terrestrial radius, m_0 - the weight of hydrogen atom and g - Earth's surface gravity.

With altitude the density of the atmosphere falls; consequently the free run of atoms grows, finally becoming greater than the "altitude scale". In the greater altitude atoms move without collisions till they descend to more dense layers because of terrestrial gravitation, where the possibility arises of new collisions. In such distant layers of the atmosphere (exosphere) it is possible to neglect collisions between atoms.

In the exosphere part of molecules moving with the velocity not less than parabolic ("Maxwell's tail") have the chance of overcoming terrestrial gravity and beginning motion on an independent orbit in space. The number of atoms, infiltrated in such way, is proportional to the value of a solid angle, which is the sum of gaps between the atoms above the initial point of motion.

Thus, the atmosphere is like a "sieve" which classifies the atoms slipped out into space. In lower layers this "sieve" is so dense that the slipping of gas is practically impossible from there: the molecule moving in every direction till passing out of the atmosphere will impact any particle and will lose its initial velocity.

From the transitional layer, at some altitude, small areas of sky appear between atoms placed above and accordingly the chance arises for fast atoms to infiltrate the space which grows according to the rarefaction of matter with altitude.

The number of molecules lost in this way by a celestial body is usually calculated by the classic formula of Jeans [10]:

$$L = \frac{4\pi R_0 GM}{kT_c}\sqrt{\frac{mkT_c}{2\pi}}e^{\frac{-GmM}{kT_cR_0}}n_c, \qquad (3)$$

where R_0 is the radius of the celestial body, G - gravitational constant, T_c and n_c - temperature and density at the boundary of exosphere, m - mass of the molecule, M - mass of the celestial body.

For different models of the atmosphere there are several variants [11-15], slightly differing from [3].

In the case of terrestrial atmosphere the thermal dissipation is sensitive only for two lightest gases – hydrogen and helium.

As shown in [16], if the temperature of the highest layers of the atmosphere is 1000°C, all the hydrogen existing in the terrestrial atmosphere ($1.8\text{x}10^{14}$ G) must renew in 4 years, i. e. the Earth loses $4.5\text{x}10^{13}$ G hydrogen per year.

Hydrogen in terrestrial atmosphere generally occurs as a result of dissociation of steam by solar ultraviolet and X-ray radiation [16, 17], therefore the result of thermal dissipation of hydrogen is the reduction of a global resource of water by $4.5\text{x}10^{14}$ G per year.

With such pace of dissipation through the time of the Earth's existence, during $4.6\text{x}10^{9}$ years, the water's resource would be reduced by $2.1\text{x}10^{24}$ G.

Such quantity of water would cover the terrestrial surface by a 4 km-thickness layer.

Obviously, besides thermal dissipation, there are many factors for changing the quantity of hydrogen in the atmosphere (both growing and reducing), therefore the above given value must be considered as rough approach to the reality.

In spite of such uncertainty one can suppose that in the archaic epoch the level of ocean was significantly higher than the contemporary one and a great part of potential land was flooded.

Accordingly, at that time the θ coefficient for the Earth would be near its minimal (standard) value. Therefore the tidal friction in the past must have been significantly less than its contemporary value, which explains the paradox of lunar age.

ასტრონომია

პირველყოფილი ოკეანის შესახებ

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