ON THE NUCLEAR CHAIN REACTIONS IN THE EARTH'S OUTER LIQUID CORE

V. F. Anisichkin

Lavrentyev Institute of Hydrodynamics of the Siberian Branch of the RAS, Novosibirsk, Russia

Quasi-stationary reactions. The main source of heat in the Earth's interior is the spontaneous decay of radioactive elements. An increase in the flow of heat to the surface can be caused by the nuclear chain reactions. A layer of actinides near a critical thickness can be formed as a result of the deposition of high-melting high-density particles of uranium and thorium oxides from the molten outer core to the solid inner core of the Earth [1]. The upward currents of mass and heat arising during nuclear chain reactions in the Earth's outer liquid core warm up the overlying layers. With the warming of the Earth's crust and the bottom of the oceans, due to the decomposition of gas hydrates, the greenhouse gas methane enters the atmosphere. With the heating of the atmosphere and oceans due to positive feedbacks, more and more water vapor and carbon dioxide dissolved in the water of the oceans enter the atmosphere. Climate warming is accelerating.

With the dispersion of the active layer in the thermal convective flows, the stopping of nuclear reactions and a decrease in the heat flow from the interior occures, the methane content in the atmosphere decreases. More and more carbon dioxide is dissolved in the cooling water of the oceans. A cold snap is coming. Actinide particles begin to settle again on the Earth's inner core with parallel reproduction of easily fissionable isotopes [2]. The duration of climatic cycles is determined mainly by the time of sedimentation of actinide particles. Simulation of the process with critical size of uranium dioxide particles and viscosity of the core from 10^2 Pa s to 10^9 Pa s leads to a cycle duration of about 130 thousand years, which consistent with the data on climate change over the past 400,000 years obtained from ice cores in Antarctica [3] (Fig. 1).

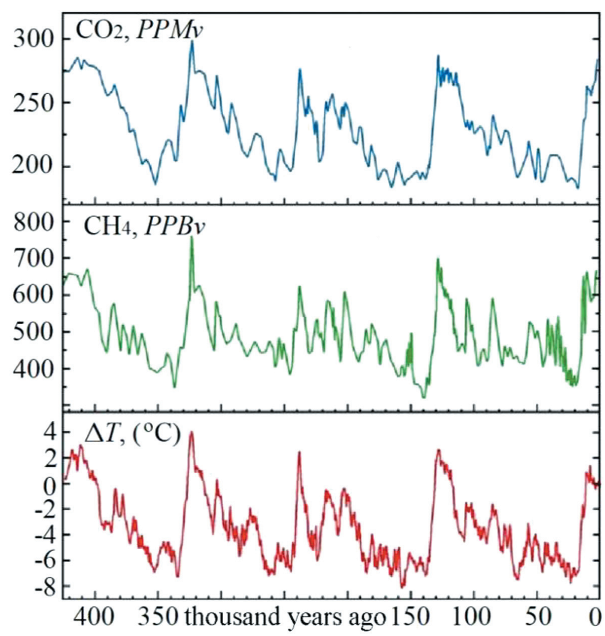

Fig. 1. Cyclic changes in concentration of CO2 and CH4 in the atmosphere, and temperature [3]

To start nuclear chain reactions, it is enough to form a layer of actinides of critical thickness, without the sedimentation of all fissile material on the Earth's solid inner core. But the gradual "burnout" of actinides requires more and more complete sedimentation of actinide particles. Therefore, the duration of cycles should increase over time. From Fig. 1 it shows that over the past hundred thousands of years, the duration of climatic cycles has increased from approximately 80 to 120 thousand years. Before 1.2 million years climate change occurred twice as often, this can be explained by the alternating operation of two "georeactors". Changes in the level of insolation – the amount of heat coming from the Sun, Milankovitch cycles, the duration of which is relatively constant in the considered time range, do not explain so sharp variability.

Explosive reactions. The most popular theories of co-accretion, capture, and "megaimpact" have difficulty in explaining the origin and elemental and isotopic composition of the Moon. An explosive nuclear reaction in the deep interiors of the planet and ejection of part of its outer layers into orbit with the formation of a satellite makes it possible to explain the differences in the elemental, but similarity of the isotopic composition of the Moon and the Earth [4]. At the same time, the explosion could have been initiated by the forced deposition of suspended actinide particles in the shock wave from the fall of the asteroid [4].

In case of ejection of a small point mass, it either moves away from the planet at a speed greater than the second cosmic velocity, or returns due to the closure of orbits in the gravitational field. However, the interactions of large masses of ejected fragments can lead to an exchange of energy and angular momentum, so that as a result, some of the matter can remains in orbit. In addition, the gravitational influence of other planets can lead far ejected bodies from a closed orbit.

The size, structure, composition, and daily rotation rate of the proto-Earth, and other parameters of the simulated process, as they were billions of years ago, cannot be chosen definitively. Therefore, it is impractical to carry out detailed calculations of the results of the explosion in the interiors of the planet. The purpose of the work is to show the main thing on the basis of computer modeling of the mechanical component of the process – the fundamental possibility of explosive formation of a large satellite near an Earth-like planet.

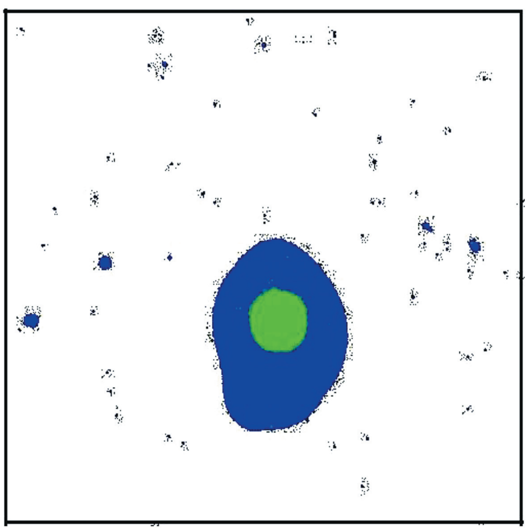

Fig. 2. Result of explosive formation modeling of the planet's satellites

The problem of numerical simulation of the explosive formation of the planet's satellite was solved in a two-dimensional formulation by the method of molecular dynamics with a number of particles of about 10^5. The role of atoms was played by bodies of asteroid size of about 100 km, interacting according to Newton's law. The properties of matter in the compact state were determined by the short-range Lennard-Jones potential. In this case, the mass of the nucleus particles was assumed to be 3 times greater than the mass of the outer particles. The rotation of the planet was set so that the speed on the surface of the planet was close to the first cosmic velocity.

The results of modeling confirm the realism of the explosive origin of the Moon [5] (Fig. 2).

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