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Isotopic composition of lunar rocks is a key to Moon's origin understanding

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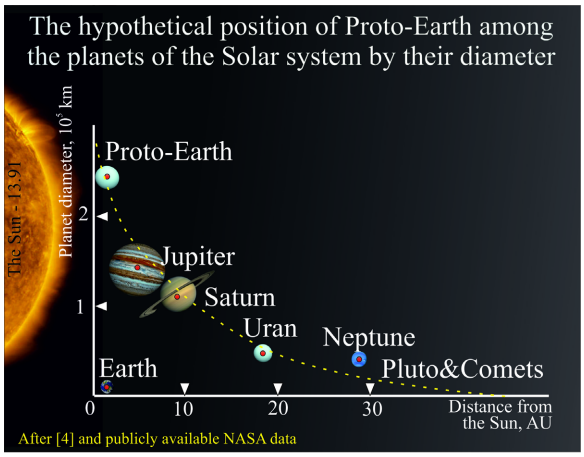
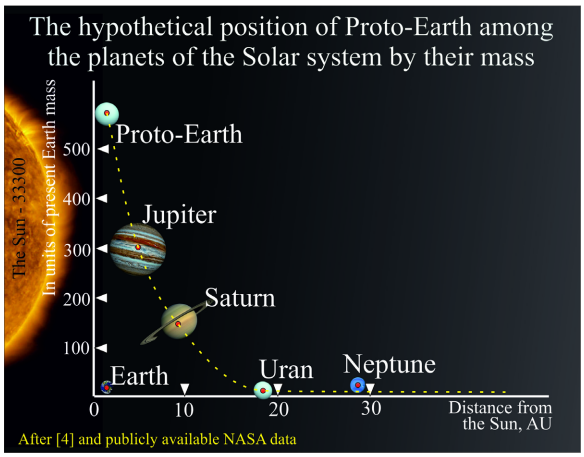
Generalization of recent data on the lunar rocks isotope geochemistry led us into the notion that widely accepted hypotheses of the Moon formation, such as impact [1] and evaporation [2] theories, are powerless to explain all the peculiarities of the isotopic signatures of the lunar rocks as well as the genesis of the Galilean moons.

It was found that silicon, oxygen and refractory metals isotopic composition of the lunar rocks is no different from terrestrial ones, indicating a single source of origin of both Earth's and Moon's substances. Simultaneously, the isotopic signature of the volatiles and rubidium, zinc, gallium, potassium, and iron in lunar rocks is fractionated considerably, showing heavier isotope enrichment than Earth's ones. The kinetic isotope effect, underlying this phenomenon, occurs during lava degassing when volatiles emits from the magma surface to the space vacuum. The reason for that lay in conditions of the crystallization of lunar rocks that deviate significantly from Earth's.

We consider the formation of the Moon following Darwin-Marakushev's fission theory. Proposed initially by George Darwin [3] the fission theory states that the Moon formed for the account of the separation of a piece of the Earth's substance by centrifugal force. However, as the total angular momentum of the present-day Earth-Moon system is insufficient to cause rotation instability even for liquid Earth, the hypothesis was rejected.

But a well-known Russian petrologist Aleksey Marakushev injected fresh momentum to the fission theory [4], hypothesizing that Proto-Earth mass was far beyond than now (Figure). In the view of his hypothesis, the Moon has been spun from proto-Earth, while a necessary impulse moment reached due to a proto-Earth's initial fluid veneer. This event dates to approximately 50 Ma from the moment of the Solar system formation and coincides with the beginning of the proto-Earth's core impulse segregation. Therefore, the future Moon was composed of relatively light silicate material, including some of Proto-Earth's mantle.





[1] Canup & Asphaug (2001), Nature, 412, 708–712.

[2] Galimov & Krivtsov (2012), Origin of the Moon.

[3] Darwin (1879), Phil. Trans. R. Soc., 170:1.

[4] Marakushev (1999), The Origin of Earth...