Theory of the origin of terrestrial and lunar ores

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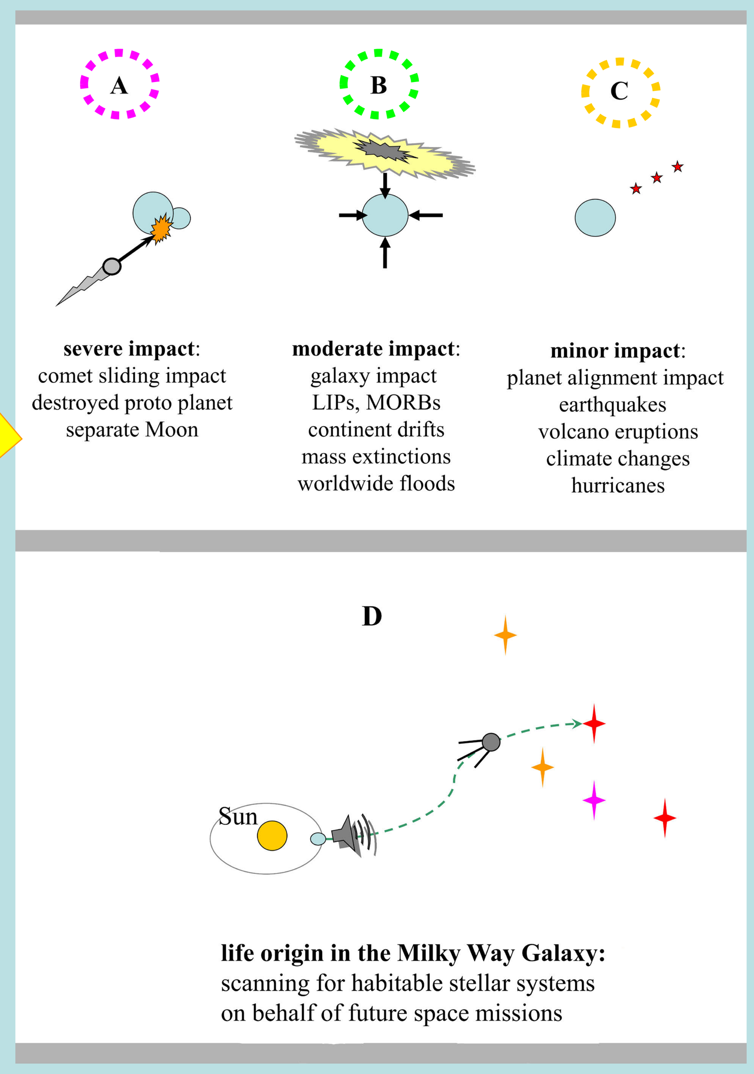


Figure 1. The scheme demonstrate severe (A), moderate (B) and minor (C) impacts to the Earth, please see details A – in (Safronov, 2016) and in this study (Safronov, 2023), B – (Safronov, 2020), and C – (Safronov 2022a) and (Safronov 2022b).

Abstract

In this study, the theory of ore formation on the Earth and the Moon was developed. It is shown that ore deposits on the Earth and the Moon were mainly formed simultaneously with the separation of the Moon from the protoplanet and the formation of the oldest continents. The formation of terrestrial ores occurred as a result of the release of intermediate and heavy chemical elements from the deep layers of the protoplanet and the subsequent process of adhesion them to old terrestrial geological faults. The time of terrestrial and lunar ores formations corresponds to the boundary between the Tonian and Cryogenian Periods (~ 720Ma). Lunar ore formation processes are different on the near and far sides. The farside side of the Moon is a single piece of the protoplanetary lithosphere, so ores there could be formed mainly due to the overflow of igneous rocks over the edge of the lunar continent. On the nearside, due to the rapid cooling, ores were formed in the area of navel-string during the drip-liquid separation of the Moon from the Earth. Due to the fact that the Moon separated at the first stage, the amount of water and methane on it is limited. In periods after the Cryogenian, volcanic, lava and sedimentary rocks on Earth could be enriched with intermediate elements due to the disruption of vertical stratification during galactic storms. To analyze this, a comparison of terrestrial volcanic and lunar pseudo–volcanic activity was carried out in the work.

A: Comet impact

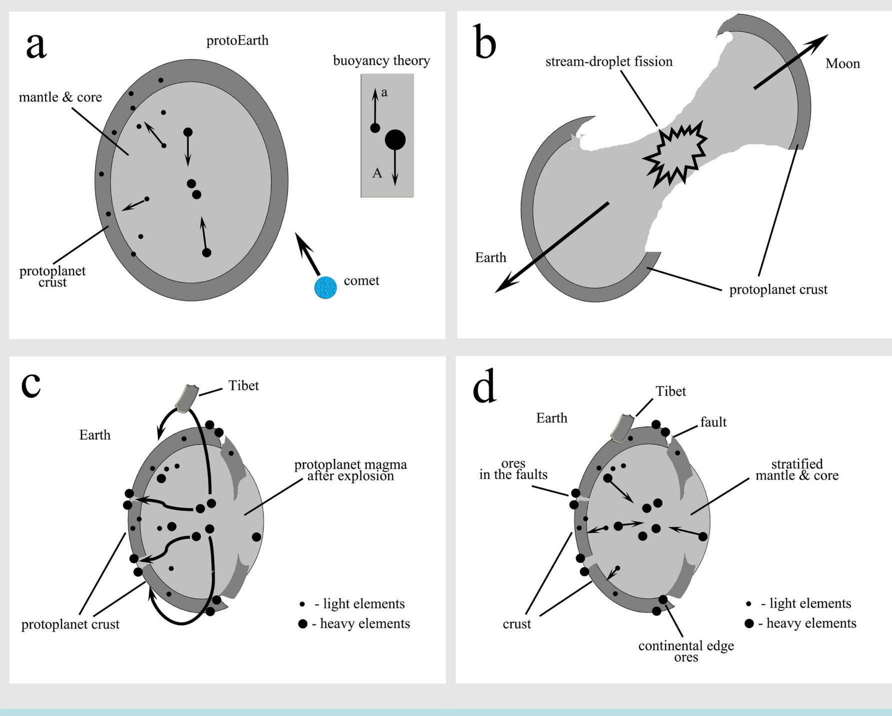


Figure 2. The scheme of ore formation on the Earth's surface after a collision with a comet is presented as a four-stage process. (a) – a comet hits a protoplanet at a sliding angle to its surface. (b) – thermal nuclear explosion after a collision with a comet. The formations of the Earth and the Moon are the result of the viscous stream-droplet separation process. (c) – the process of flow up of heavy elements from the deep layers of the planet. (d) – the origin of ores is the result of solidification of heavy elements in the old geological faults, as well as near the edges of the ancient monoblock continent. In all Figures (a)–(d), the pieces of protoplanetary crust are filled by dark gray, light gray color corresponds to the magmatic mass of the mantle-core. Additionally, the plate of Figure (a) illustrates the elemental buoyancy theory (EBT) in the form of a simple separation scheme.

B: Galaxy storm

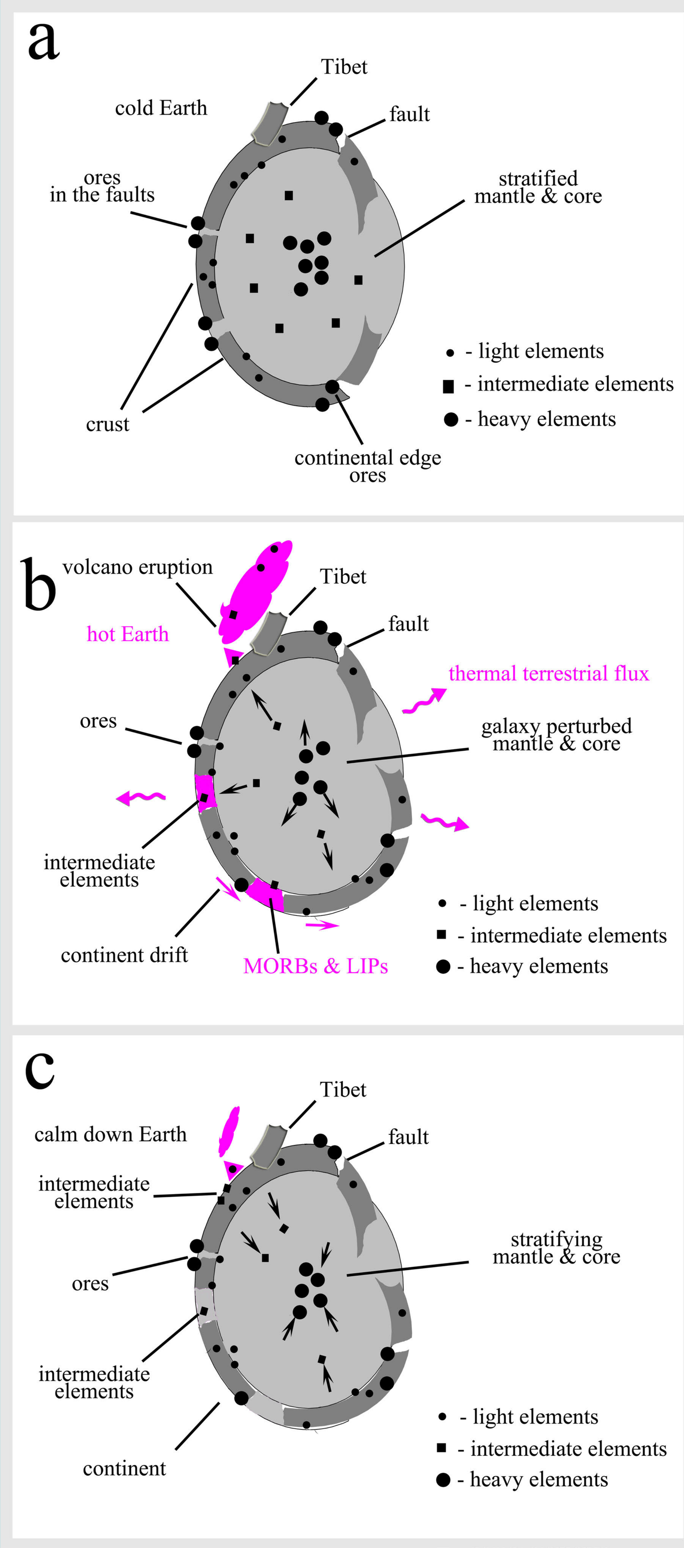


Figure 5. The process of enriching the Earth's lithosphere with chemical elements is presented. (a) – the stage of galaxy calm. The inner mantle-core terrestrial structure is stratified. (b) – the stage of galaxy storm. The internal structure of the Earth's mantle-core is perturbed, the Earth is hot, and the continents are drifting. Intermediate elements are lost in the sediments of the seabed and present in the MORBs and LIPs. (c) – the end of the galaxy storm. The internal structure of the Earth's mantle-core begins to stratify. The intermediate and heavy elements are lowered down.

The floating theory of elements

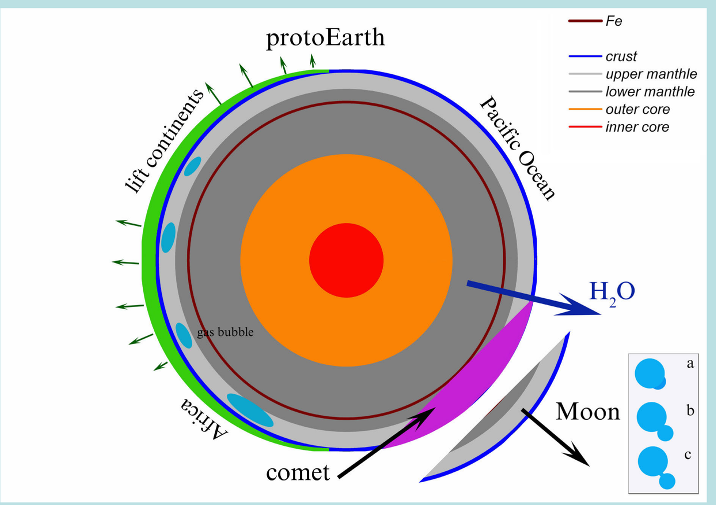


Figure 3. The comet impact, the CO_2 gas bubbles formation under a planet crust, the thermal expansion of the gas bubbles, the subsequent thermal nucleus explosion, the lifting continents and a Moon formation were shown in the general scheme. On the plate the drop hydrodynamic the Earth and the Moon separation process from the viscous magma of protoEarth is schematically displayed.

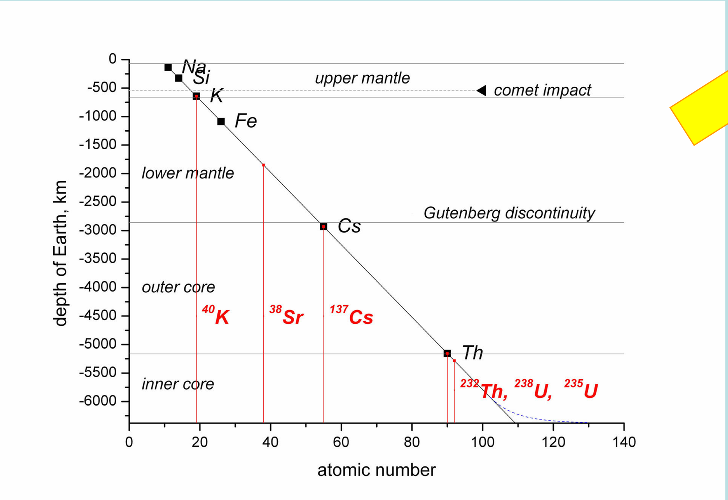


Figure 4. The linear dependence of the element sinking depth in the molten magma and the core from the element number was presented. The red lines show the basic fuel nuclear elements, such as ^{40}K, ^{232}Th, ^{235}U and ^{238}U.

Origin of lunar ores

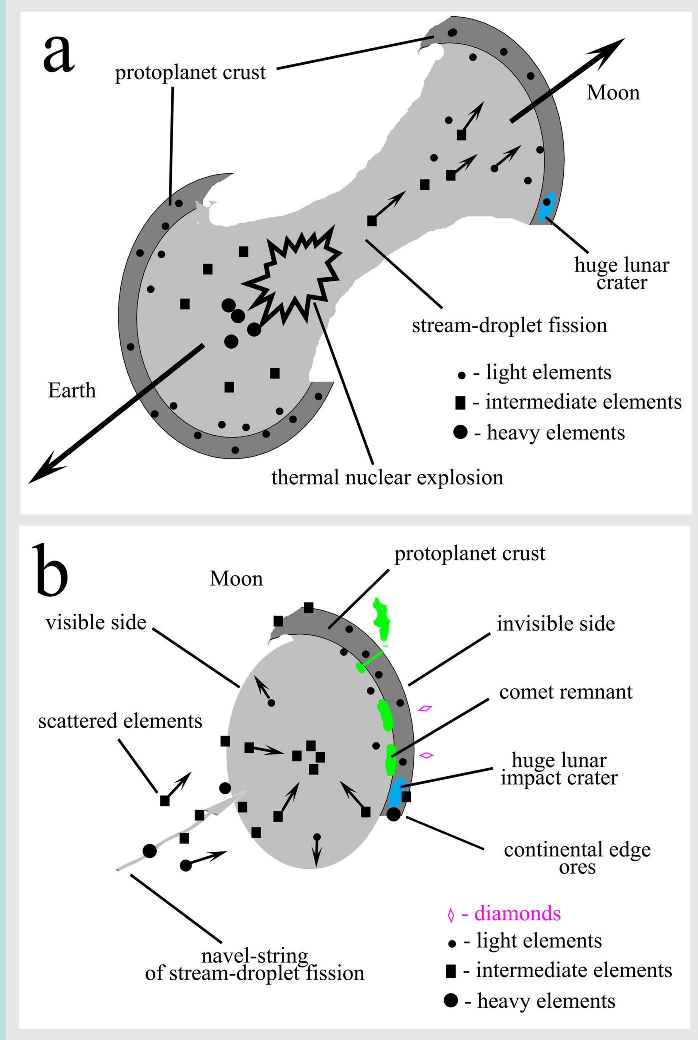
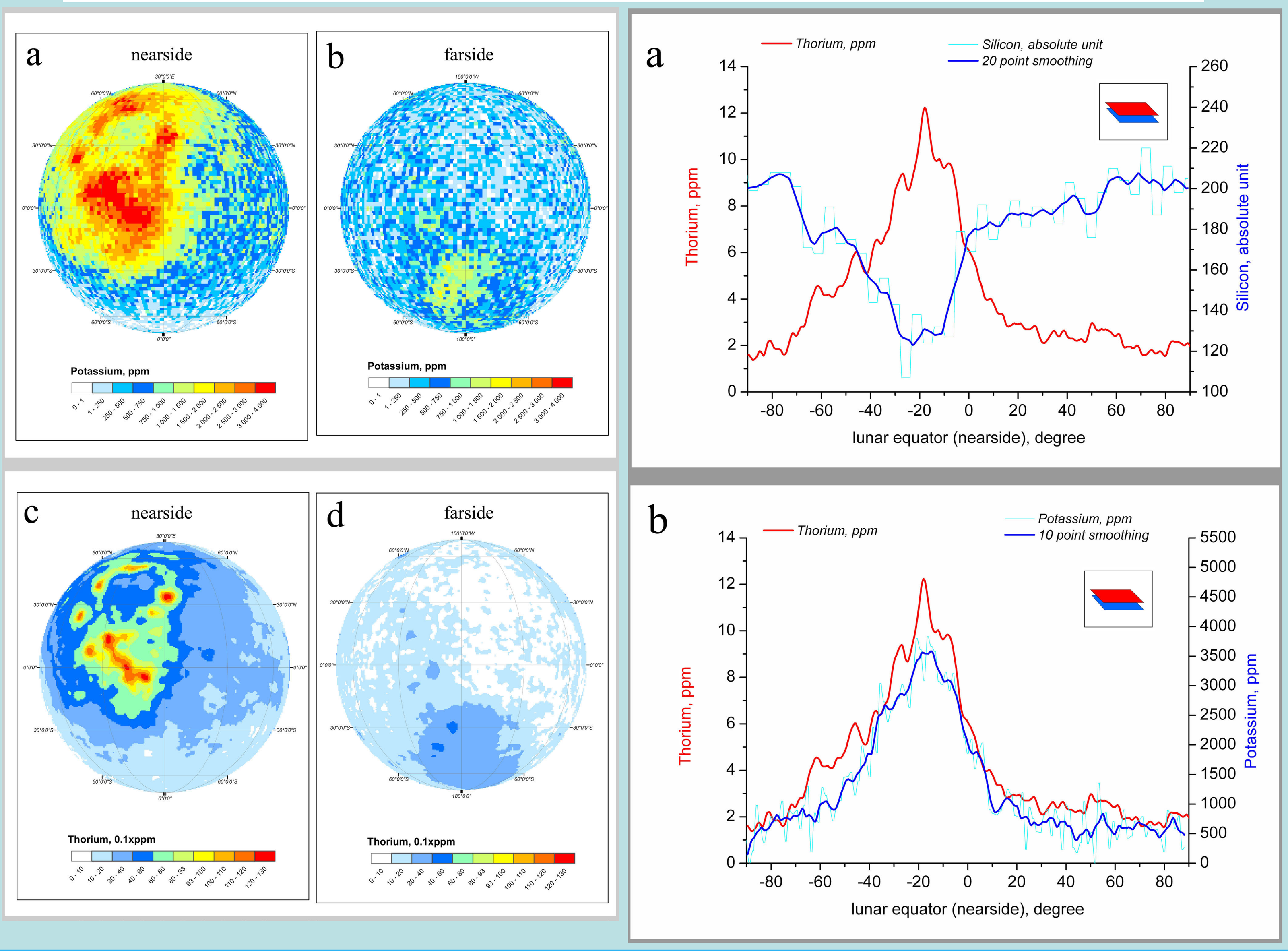
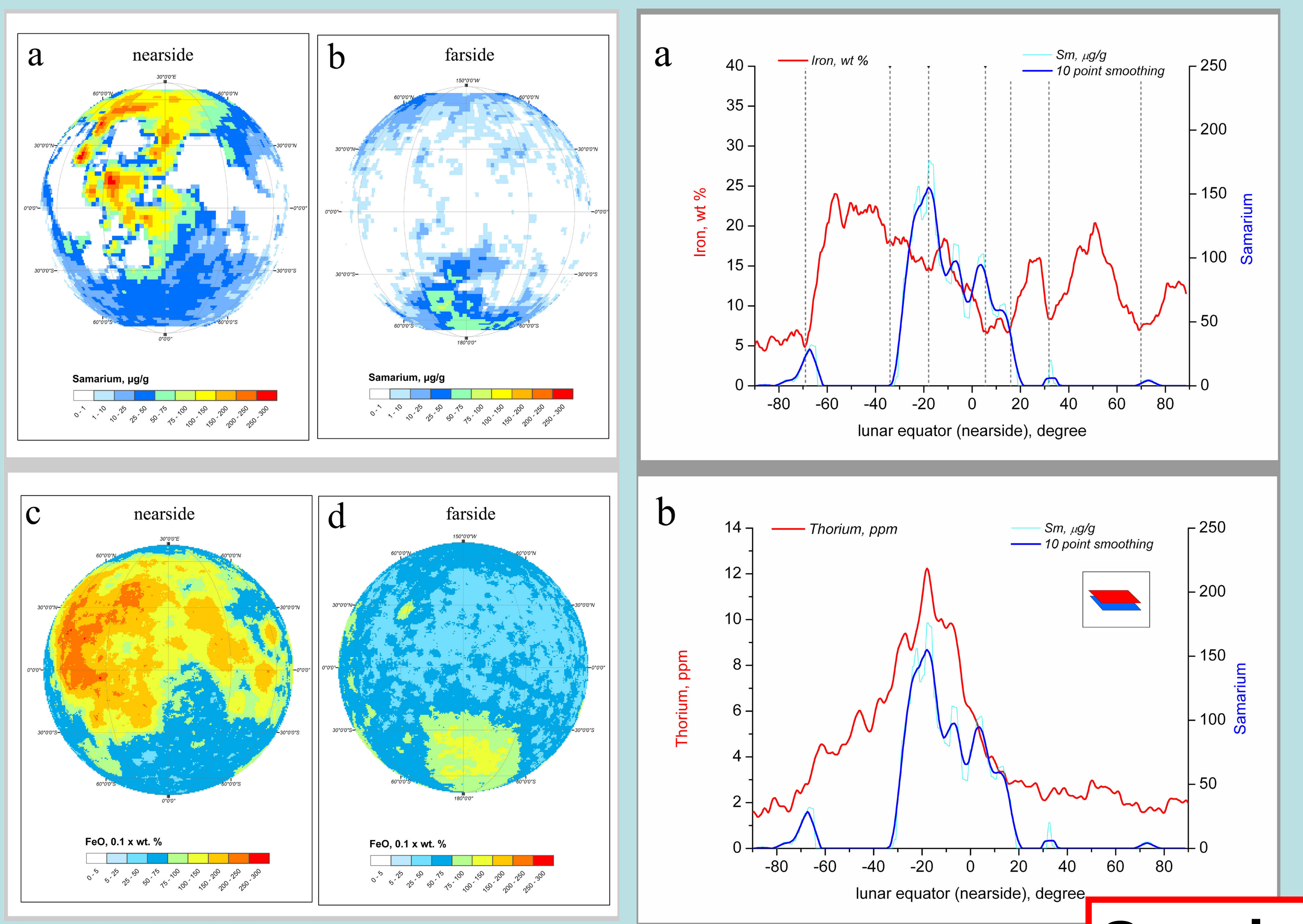


Figure 6. The scheme illustrates the process of formation of lunar ores. (a) – thermal nuclear explosion of a protoplanet after a collision with a comet. The Moon was created as a result of the viscous liquid-droplet separation from a piece of crust and the magmatic mass of a protoplanet. (b) – the stage of cooling of the Moon and the formation of lunar ores. The huge lunar comet impact crater is filled by blue sport; the gaseous comet remnants under the crust are green; diamond deposits are shown by violet rhombuses, and the lunar volcano spews a gas plume which is also drawn in green as some comet remnants.

The lunar distributions of K, Th and Si



The lunar distributions of Fe, Sm and Th



C: Galaxy calm

The terrestrial and lunar volcanic eruptions

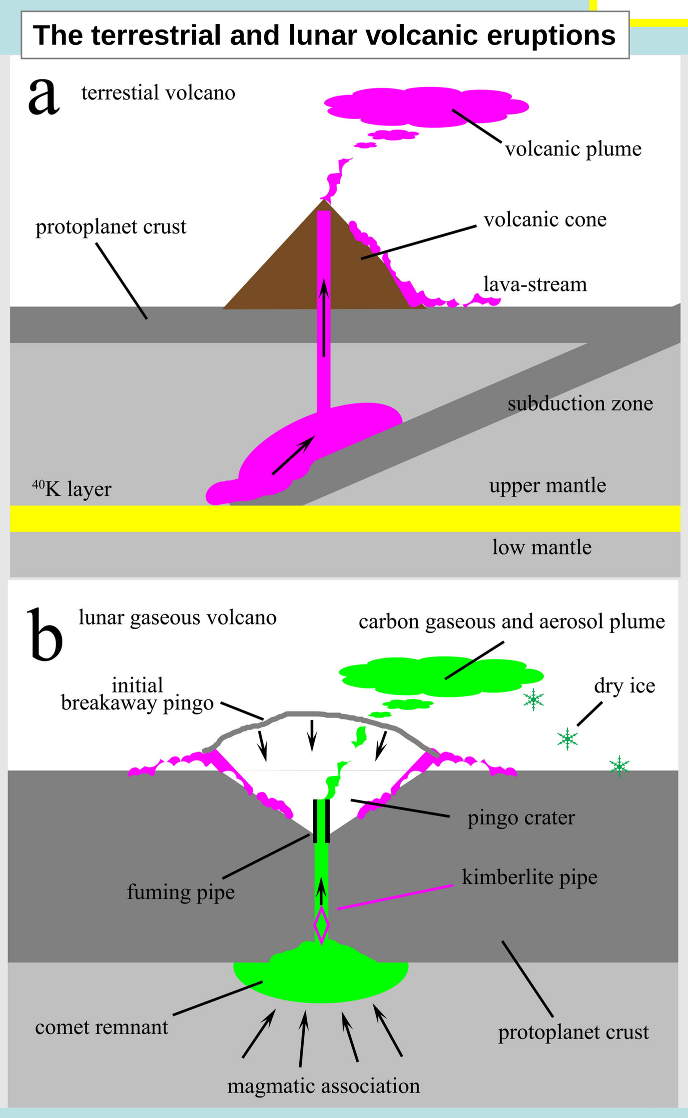


Figure 7. The comparison of volcanic processes occurring on the Earth and the Moon is highlighted. (a) – the scheme illustrates the formation of a typical volcanic cone on Earth during the processes of crust melting in the subduction zone. (b) – the formation of a reverse lunar volcanic cone on the far side of the Moon during the eruption of the remnants of a comet trapped under the crust of the lunar continent. A lunar volcanic crater might have an explosive feature with the synthesis of a kimberlitic pipe and diamonds, or a smoking feature with the formation of a typical prominent fuming-pipe (usually a central peak) in the center of the lunar collapsed pingo crater.

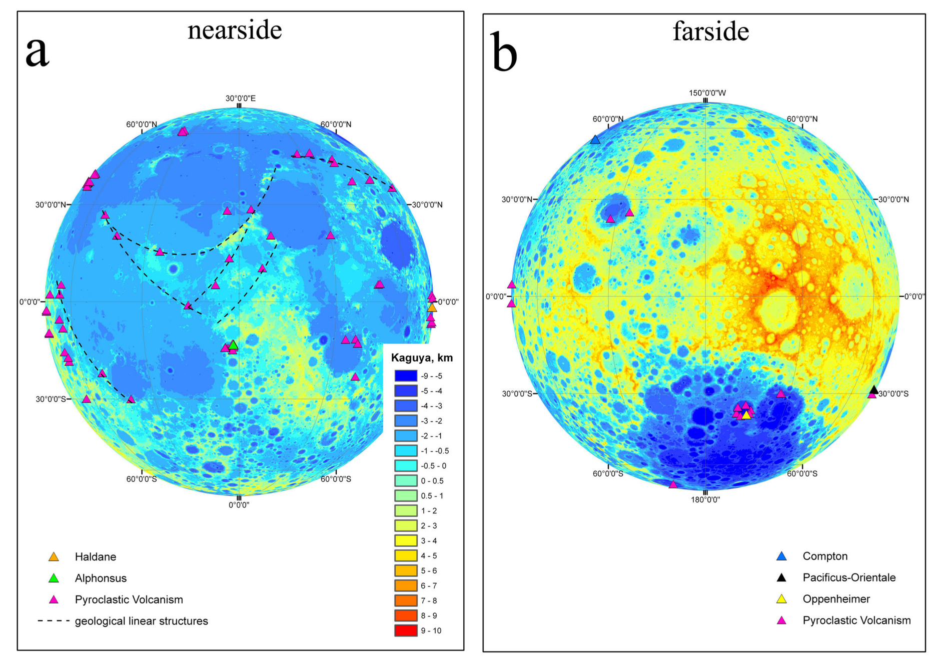
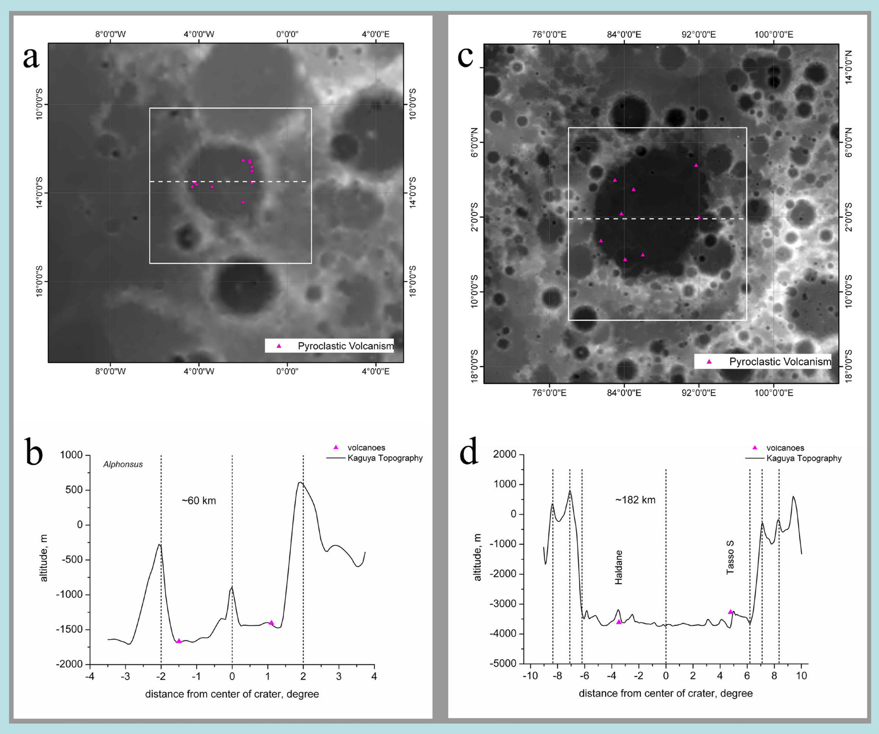


Figure 8. Figure 12. The topography of Kaguya on the near (a) and far (b) sides of the Moon is presented. Pyroclastic deposits are recorded along the geological linear structures (grey dash lines), as well as at the bottom of some crates (see margin triangles). Additionally, the craters Alphonsus, Haldane–Tasso S, Compton, and Oppenheimer, mentioned in the text of the manuscript, are marked with colored triangles.

Example of lunar pseudo-volcanic eruptions

Figure 13. The craters Alphonsus and Haldane – Tasso with the spatial distribution of pyroclastic volcanic depositions are shown in Figure (a) and (c). Cross-sections of the topography of Kaguya in the area of the craters Alphonsus and Haldane – Tasso (white dashed lines) are shown in Figures (b) and (d). The crater Alphonsus has a peak in the center, while the Haldane – Tasso crater system has a flat basin in the center of the crater.



Conclusions

Table 1. The localization and qualitative comparison of the formation of ores, water, methane and diamonds at different stages of the evolution of the Moon-Earth system are presented.

Period	Creation	Earth		Moon	
		southern hemisphere	north hemisphere	nearside	farside
comet impact	ores (intermediate and heavy elements)	oldest faults		more, scattering	less, in craters
	diamonds	more, large size	less, small size	none	probably
	water	none	yes	slightly	slightly
	methane and oil	none	yes	slightly	slightly
galaxy storm	ores (intermediate elements)	MORBs, LIPs		none	
galaxy calm	light elements, mainly sulphide	volcanic lavas and ashes		none	

Two paths of carbon dioxide realizes

$$CO_2 \to CO \to C \to diamonds \qquad (1)$$

$$CO_2 + H \to C - O - H \to CH_4 + H_2O \to ... \to OH - CH_4 - OH \to ... \to life \qquad (2)$$

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