Background information 1:

What is the geological composition of the Earth and the Moon and what does this tell us about the formation of the Moon?

4.5 billion years ago, the Earth collided with the protoplanet Theia, a planet with two to three times the mass of Mars. Theia hit the Earth off-center and destroyed itself in the process. The individual parts of the protoplanet either fused with the Earth, such as the iron core of the impactor, which migrated to the Earth's core, making it disproportionately large for the mass and size of the Earth today, or they landed with parts of the Earth in Earth's orbit. The hot ejected rocks in Earth's orbit then formed the Earth's satellite, our moon, after 100 years. According to experiments and models, the heavy minerals sank down from the melt and formed the mantle, while the lighter ones formed the lunar crust. After 10,000 years, today's compression of the Moon was formed (see Fig. 1). This development can be deduced from the moon rocks of the Apollo missions and is the most common theory on the formation of the Moon. The lunar rock is very similar to the Earth's mantle rock. Only the highly volatile elements are not or hardly to be found on the Moon, as the majority probably evaporated during accretion or due to the enormous gravitational force of the Earth in the initial stage. A total of 400 kg of moon rock was brought to Earth and analyzed by the Apollo missions.

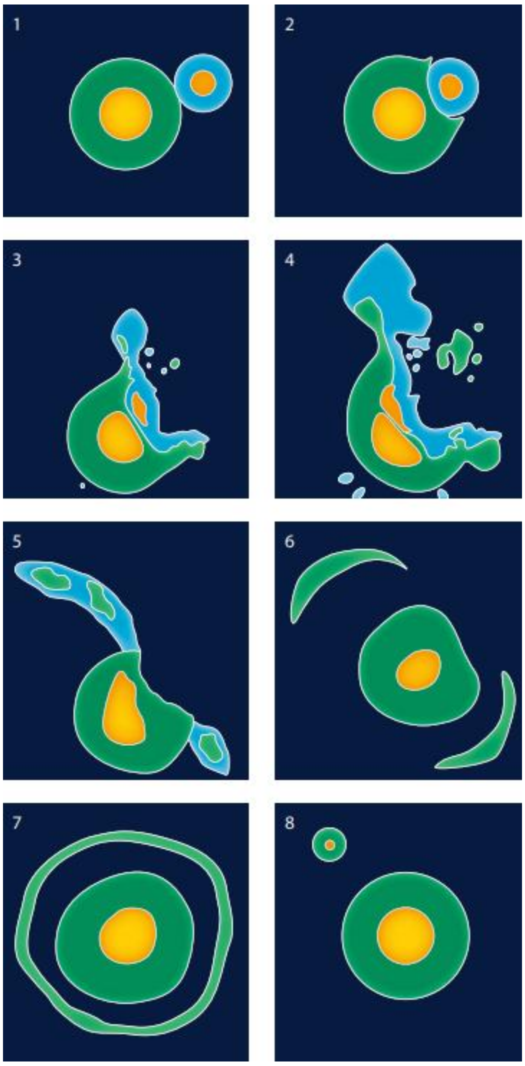

Figure 1: Formation of the Moon

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One major difference between the Moon and the Earth is that the Moon contains less iron than the Earth, as it has no or only a very small iron core. The heavy iron core is also the reason for the much higher density of the Earth. Otherwise, there seems to be a clear similarity between the rock of the Moon and the Earth's mantle rock. This is particularly evident in the most common elements: silicon, aluminum, iron, magnesium and calcium. The Moon also has the same density as the Earth's mantle. Differences exist in particular with regard to the volatile components, as the Moon is depleted in alkalis, water and volatile trace elements. In addition to the history of the Moon's formation, the lack of an atmosphere and the constant cosmic influence and heat are responsible for this.

The Moon no longer exhibits the constant alternation of endogenous and exogenous processes that prevail on Earth, even though these were caused by volcanism, for example. The traces of former lunar volcanism can still be seen today in the form of grooves (formerly thin lava) and craters. The end of volcanic activity on the Moon cannot be clearly determined. It is estimated that activity lasted until around 2 billion years ago. However, a study published 2019 in the journal "Nature Geoscience" describes that the Moon may be more geologically active than previously assumed. Seismic activity was measured, which manifests itself in the form of so-called moonquakes. It is highly likely that tension in the lunar crust, which had built up due to global contraction and tidal forces, was released near the fracture zones. Overall, however, it can be said that the tectonic processes of the Earth and the Moon are not comparable and, above all, have significantly different dimensions.

The so-called dichotomy or asymmetrical appearance of the Moon is particularly striking. The Moon has a lunar crust that is much thicker on the side facing away from the Earth than on the side facing the Earth. The reason for this lies in the early phase of the Moon's formation. After the Moon had formed into a celestial body, the distance to the Earth was still much smaller at around 40,000 to 45,000 kilometers than it is today (380,000 kilometers on average). Due to the much greater gravitational influence of the Earth on the Moon, it was extremely hot and surrounded by molten lava. It is scientifically assumed that the lava moved towards the side facing away from the Earth due to centrifugal force and solidified there. For this reason, the lunar crust facing away from the Earth is said to be thicker. However, this is only one of the possible explanations. The Moon also has a center of mass that does not correspond to the geometric center. Even then, the moon's orbit was quickly synchronized with the Earth due to the gravitational influence of the Earth, which caused the Moon to always have an Earth-facing side and a side facing away from the Earth. As a result, plateaus, so-called (bright) terra regions, have formed on the side facing away from the Earth and (dark) mare/maria on the side facing away from the Earth (see Fig. 2). Terra areas are very densely covered with craters of various

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sizes, while mare plains are poorer in craters. The plateaus consist mainly of anorthosite and breccias. Overall, the highlands thus document the intensive bombardment by asteroids and meteorites. The impact rate of which was much higher than today, especially in the early phase of formation. The mare plains are usually much lower than the neighboring terra regions. All mare areas are of volcanic origin. They are younger than the highlands and consist of basalts (volcanic rocks) because lava has filled the basins formed by asteroids and comet impacts. They therefore document the volcanically active phase of the Moon.

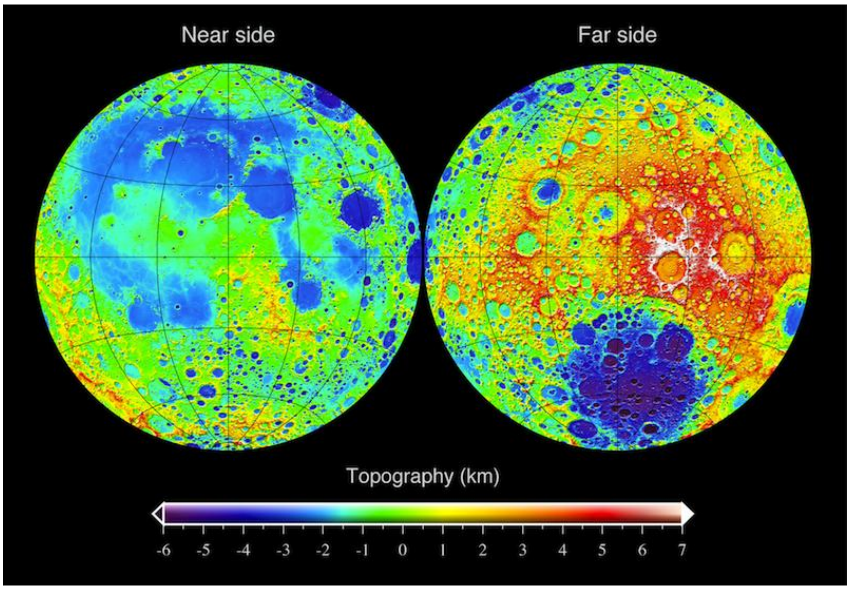

Figure 2: Elevation map of the Moon

Due to the lack of a lunar atmosphere, the surface of the Moon, in contrast to the Earth, is practically permanently exposed to any external influences without protection. This has resulted in numerous craters on the lunar surface. Impacts of small and large bodies from space hit the lunar surface unfiltered at cosmic speeds. But extreme forces also act from the Sun towards the Moon. This is atomic particle radiation, which consists of approximately 90% protons and approximately 10% helium ions. The main quantity is made up of particles from the constant solar wind, but also partly from the periodically occurring solar flares.

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