# Study determines the age of the Moon

**Analysis of the composition of samples collected by the Apollo Missions indicate that our natural satellite was formed 50 million years after the Solar System**

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Photo: NASA

More than 50 years ago, in July 20, 1969, the Apollo 11 Mission achieved its goal of taking astronauts to the Moon's surface. Neil Armstrong became, at that time, the first man to step on our natural satellite. Until 1972, five more crewed missions were sent to the celestial body, resulting in an extensive amount of scientific information and in 382 kilograms of soil and rocks samples brought to the Earth from the Moon. Even now, 47 years after the end of the Apollo Program, all this material is still being studied by scientists and producing new knowledge.

In an article published on the scientific journal Nature Geoscience in July, 2019, a group of researchers described how they were able to determine the age of the Moon from the analysis of these samples' composition. To reach the conclusion that our natural satellite was formed about 4,51 billion years ago – 50 million years after the Solar System and 30 million years after the Earth -, they checked for the presence of the chemical elements hafnium and tungsten in samples collected in different areas of the Moon by the Apollo Program in its different phases. Felipe Padilha Leitzke, a geologist from the Laboratory for Isotope Geology of UFRGS and who took part in the research team during his doctorate at the Bonn's University, Germany, explains that it was previously estimated that the Moon had emerged between 30 to 200 million years after the Solar System formation. "NASA gave us these samples because they would be measured with a much higher degree of accuracy than that carried out in the 70s. We made this analysis by isotopic dilution, which is a highly precise method. And to this degree of accuracy, we combined experimental data," Leitzke adds. The samples were then dissolved in acids to allow the proportion of the substances they are composed of to be measured. The scientists looked for specific variants (isotopes) of the analyzed elements: the hafnium-182 and the tungsten-182. These two isotopes compose a system of radioactive decay in which, after some time, the hafnium-182 tends to disintegrate itself and convert to tungsten-182. The half-life of this system is 9 million years long, which means that, after this period, half of the initial quantity of the hafnium-182 decays, whilst the quantity of tungsten-182 doubles. "Imagine that you have 100 atoms of hafnium-182 at the beginning. After a half-life, you will have 50 atoms of the father and 50 atoms of the son: 50 atoms of the hafnium-182 and 50 atoms of the tungsten-182. After two half-lives, it turns into 25 atoms of hafnium-182. Then, it turns into 12,5. And each time the quantity of the father decreases and the quantity of the son increases. We consider that after 8 or 9 half-lives the system will be extinct. You no longer have the father to produce the son because such a low quantity was left that it ceases being relevant," explains Leitzke.

The concentration of these isotopes in the samples is pretty low, about 10 micrograms per gram, or 0,00001% of the total of the composition. The analysis demands, therefore, high accuracy equipment. "In these samples, like in any land basalt, the biggest elements are calcium, magnesium, aluminum, silica, iron, titanium, and, sometimes, sodium and potassium, depending on the stone. But you can extract few information based on these bigger elements because they are so abundant, and it is not always easy to track these geological events based on such information. That is why we have so much interest not only in the isotopes but also in the trace elements, that would be those that are in concentrations smaller than a thousand micrograms per gram," clarifies Leitzke.

When checking how much of each element is present in the samples, the researchers developed scenario models of the Moon formation that permitted to estimate which was the initial quantity of the two isotopes and how much time was necessary to reach the actual level. This modeling works as a simulation that allows them to check if the proposed hypotheses make sense, covering all Moon's history since when it was all covered by a magma's ocean that, later, cooled down and originated different types of stones. "We cannot go back in time, right? So, we use a sample today, investigate the quantity of trace elements in that sample, and try to reproduce its entire formation process, since the beginning until nowadays," Leitzke reports.

According to the researcher, the study results meet the most accepted theory about the Moon formation, which says that a Mars-size celestial body would have collided with the Earth and expelled to the orbit the material that originated our natural satellite. "This is confirmed by a variety of studies that show the compositional resemblance between the Earth and the Moon," Lietzke highlights.

Studying the Moon is much like examining the past. As it has no atmosphere and is no longer tectonically active, it does not undergo processes of erosion or rework of the crust, which would allow it to preserve rocks and craters billions of years old. "Any sample of the lunar surface that you collect will have more than 3 billion years", emphasizes Leitzke. The internal dynamics of our planet, on the other hand, lead to a constant renewal of its rocks and have already erased much of the record of the beginning of its formation. Studying the Moon, then, could be an effective way to learn about the history of the Earth.

**Scientific paper**

THIEMENS, Maxwell M. et al. Early Moon formation inferred from hafnium–tungsten systematics. Nature Geoscience, 29 jul. 2019.

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