How the Earth got its moon is a long debated question. The giant impact theory – which states that the Moon formed from the collision between the early Earth and a rocky body called Theia – has become the front runner among the explanations. But the details around how this happened are blurry and there are many observations that scientists are still struggling to explain.

Now a new study, published in Nature Geoscience, has shed light on what actually happened by solving one of the biggest mysteries surrounding the
One explanation is that Theia and the early Earth must have had an identical composition to start with. That seems unlikely because every documented planetary body in our solar system has their own
unique composition, with slight differences reflecting the distance from the sun where a body formed.

Another explanation is that the mixing of the two bodies was much more thorough than anticipated, leaving a less clear signature of Theia in the Moon. But that is also unlikely, as it would require a much larger impact than the one that actually took place.

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**Digging deep**

The new study resolves this dilemma by showing that the Earth and the Moon aren’t as similar as previously thought. The researchers looked with very high precision at the distribution of isotopes of the element oxygen in rocks returned from the Moon by the Apollo astronauts. In chemistry, any element’s atomic nucleus is made up of particles known as protons and neutrons; isotopes of an element have the same number of protons in the nucleus as the regular version, but different numbers of neutrons. In this case, oxygen’s isotope, O-18, which has eight protons and ten neutrons, is slightly heavier than the much more common than O-16, with its eight protons and eight neutrons.

The study shows that there is a small difference between the Earth and the Moon in their oxygen isotope composition – their profiles aren’t identical after all. What is more, the difference increases when you look at rocks from the Moon’s mantle, which is a layer below the surface or crust – having more lighter oxygen isotopes than the Earth. This is important. The crust is where mixed debris would have ended up, whereas the deep interior would have more bits of Theia.

So Theia and Earth weren’t identical, and the Moon and the Earth aren’t identical either. But the results also teach us a bit more about Theia itself.

Because of gravity, one may expect slightly more of the heavier isotopes closer to the Sun. Compared to Earth, Theia must have had more of the lighter oxygen isotopes, which suggests that it would have formed further away from the Sun than the Earth.

With the results from this study the giant impact theory has crossed another hurdle in explaining the formation of our Moon, and we have learned a little more about Theia itself on the way.
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