New research provokes more questions about the origin of the moon

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Moon. Photo courtesy of NASA

(PhysOrg.com) -- It's beguiled watchers since before records were kept, and today still, it fills poets with pensive musings, and scientists with enchanting questions. Where did the moon come from, and how did it get there? The prevailing view is that a planet named Theia entered out solar system and banged into our planet with sufficient force to push some of the molten material from our planet into orbit. Over time, that material coalesced to form the moon. Now, new research from geophysical scientist Junjun Zhang and colleagues, suggests that such thinking might be wrong. In their paper published in *Nature Geoscience*, they find that in comparing titanium isotopes from both the moon and the Earth, that the match is too close to support the theory that the moon could have been made partly of material from another planet.

Scientists had already found that oxygen isotopes from the Earth's mantle and the moon were nearly identical, but that wasn't enough to put a dent in the theory that a collision with Theia had created the moon because oxygen isotopes from the Earth could have mixed with isotopes from the mass of molten material circling the planet after impact. Now, though, because titanium isotopes are not nearly so easily exchanged, it's difficult to theorize that the same sort of mixing could have occurred.

Most scientists agree that if a planet had smacked into Earth and the moon came about as a result, than the moon ought to be made of some of that other planet as well. Some say the laws of physics suggest it would be somewhere in the neighborhood of forty percent. If that's the case, why don't studies of rocks brought back by the Apollo missions show evidence of this other planet?

Some suggest the moon didn't come about as a result of an impact at all, but from parts of the Earth being flung into orbit due to a faster spin than we now have. Unfortunately, there is no evidence thus far to support the notion that the Earth ever spun that fast. Others suggest that perhaps it wasn't a planet that struck the Earth but an object made of ice, which would have evaporated leaving no evidence behind that it caused a huge chunk of the Earth to be knocked into orbit.

And some, despite the new evidence, still cling to the belief that it could have been Theia, if Theia were made of nearly the exact same stuff as the Earth, meaning the isotopes would be the same. The odds for that are pretty slim, but not impossible. Hopefully new research will one day provide us with a definitive answer. Until that day though, it seems we will all have to just keep on musing.

More information: The proto-Earth as a significant source of lunar material, *Nature Geoscience* (2012) doi:10.1038/ngeo1429

Abstract
A giant impact between the proto-Earth and a Mars-sized impactor named Theia is the favoured scenario for the formation of the Moon. Oxygen isotopic compositions have been found to be identical between terrestrial and lunar samples, which is inconsistent with numerical models estimating that more than 40% of the Moon-forming disk material was derived from Theia. However, it remains uncertain whether more refractory elements, such as titanium, show the same degree of isotope homogeneity as oxygen in the Earth–Moon system. Here we present 50Ti/47Ti ratios in lunar samples measured by mass spectrometry. After correcting for secondary effects associated with cosmic-ray exposure at the lunar surface using samarium and gadolinium isotope systematics, we find that the 50Ti/47Ti ratio of the Moon is identical to that of the Earth within about four parts per million, which is only 1/150 of the isotopic range documented in meteorites. The isotopic homogeneity of this highly refractory element suggests that lunar material was derived from the proto-Earth mantle, an origin that could be explained by efficient impact ejection, by an exchange of material between the Earth's magma ocean and the protolunar disk, or by fission from a rapidly rotating post-impact Earth.

Press release