Exploring the moon today to learn more about Earth's youth billions of years ago

July 8 2015, by Augusto Carballido

What can what's on the moon tell us about our home planet? Credit: NASA , CC BY

The surface of the Earth preserves little or no information about its distant past. Constant tectonic activity has recycled Earth's crust and shifted landmasses. Rainfall, wind, ice and snow have weathered away surface features over billions of years. Most of the craters formed by the impacts of asteroids and comets have been erased from the geologic record, with just over 100 known craters remaining on the continents.

But there is a place that we can go to learn more about the past of our own planet: the moon. In sharp contrast to Earth's surface, that of the moon is covered with thousands of craters of all sizes, many of them produced *shortly* after the moon was born. The moon doesn't have the winds, rivers or plate tectonics capable of erasing these marks of ancient impacts.

For that reason, the surface of the moon is like a window into the early history of our solar system. By studying the chemical composition of rocks and soil on our natural satellite, we could obtain a glimpse of the Earth's own geological infancy – including the emergence of life.

Way back when

The Earth formed 4.54 billion years ago, after ancient asteroids known as planetesimals piled up into a single, planet-sized body as they orbited the sun. Scientists think the moon formed roughly 70 million years later, when a planet about the size of Mars collided with the young Earth. With the aid of sophisticated computer models, experts have shown that this huge collision created a donut-shaped envelope of molten rock and hot gas around the Earth. By calculating how this scorching disk would lose its heat, they've deduced that the moon condensed from all this hot material in less than 100 years.

Fast forward some 500 million years. Around this time, the giant planets Jupiter, Saturn, Uranus and Neptune likely underwent a rearrangement of their orbits around the sun, as a result of complex gravitational interactions with myriad planetesimals. This rearrangement sent many asteroids on a collision course with Earth. When they crashed into our planet, their impacts launched terrestrial fragments into Earth's orbit. A very exciting possibility is that some of those Earth rocks might have landed on the moon.

Artist’s concept of the kind of planetary smash-up that likely created the moon. Credit: NASA/JPL-Caltech, CC BY

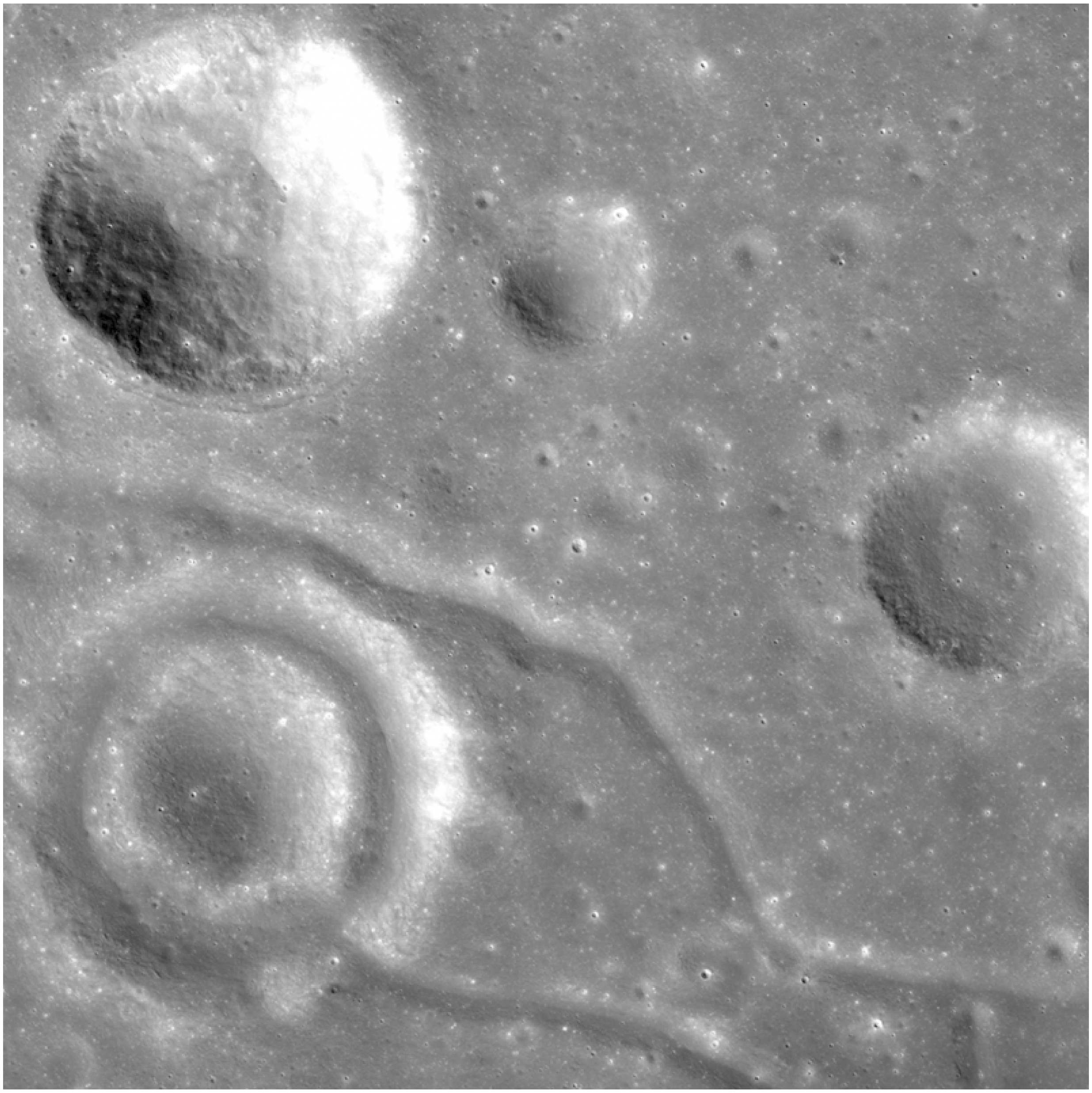
If those pieces of Earth did make it to the moon, they're probably still lying somewhere on the lunar surface. Some studies predict a large concentration of impacts near the moon's poles. In some regions, there may be as much as a golf cart's mass worth of terrestrial material spread over an area equivalent to 140 soccer fields. Whether this mass is in the form of rocks or tiny dust particles depends on, among other things, how hard Earth's fragments hit the lunar ground.

Messages from Earth on the moon

Regardless of their size, terrestrial remnants could contain invaluable information about our planet's early years. For example, those terrestrial meteorites may hold a record of the chemical composition of the Earth's ancient mantle, the hot layer of rock between the crust and the core. Learning about the composition of the Earth billions of years ago would allow us to make comparisons with our present-day planet. With more historical data, we could infer how a habitable planet evolves over time, which would enable us to understand extrasolar planetary systems.

And since we're talking about habitability, consider this: if there are terrestrial meteorites on the moon, they could potentially give us details about the conditions on Earth right before, or even during, the emergence of life. Stuff to look for on the rock samples blasted off Earth would be organic carbon, minerals gathered by microorganisms, or maybe even fossilized microbes.

Evidence of Earth's enigmatic past may also be found on the moon in a more subtle way. Some researchers have suggested that ancient atmospheric gases from Earth could be trapped in the lunar soil. Right around the time when the young Earth and moon were heavily bombarded by asteroids, the moon was half as close to the Earth as it is now. It's therefore possible that Earth's atmosphere came into contact with the lunar surface.



A 10-km-wide view of the moon's Lavoisier Crater. Credit: NASA/GSFC/Arizona State University, CC BY

To search for traces of earthly gases on the moon, the proponents of this idea suggest using well-known experimental techniques to detect the presence of helium, nitrogen and oxygen in lunar grains. The idea would be to measure how much of their various isotopes – the differing flavors of an element based on how many neutrons they have in the atomic nucleus – are present. Since the number of neutrons in isotopes changes at known rates, it's possible to measure how much of one isotope there is in a grain in relation to its "parent" isotope. That would tell you how long those particular elements have been attached to the grains. If it turns out that the isotopes have been there for at least four billion years, there's a good chance they came from Earth.

Detecting four-billion-year-old terrestrial oxygen on the moon would be another way to learn about the appearance of life, since atmospheric oxygen would probably have been produced by ancient photosynthetic organisms. Moreover, finding equally old nitrogen could mean that the early Earth did not have a magnetic field as it does today, because electrically charged nitrogen atoms from Earth's atmosphere would not be capable of reaching the moon had there been a magnetic field.

Does the moon hold some of the early Earth's secrets? Credit: NASA/Bill Ingalls, CC BY

We are still a long way from obtaining a clear understanding of our home planet. But the possibility of lunar exploration by private ventures, in addition to that carried out by national space agencies, raises the prospects of mind-blowing discoveries that can shed light on Earth's mysteries.

We may well end up repeating the words of Apollo 8 astronaut Bill Anders: "We came all this way to explore the moon, and the most important thing is that we discovered the Earth."

Source: The Conversation

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