Scientists sift through lunar dirt for record of early Earth's rocks

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In this 1992 photo from the Galileo spacecraft, the surface of the moon is marked with craters from impacts, but isn't weathered. Many particles on the moon's surface can last billions of years undisturbed. Credit: NASA/JPL/USGS

Hidden in the particles of moon dirt brought back by astronauts more than fifty years ago, secrets of ancient Earth lie in wait.

A team of scientists are examining crushed rocks brought back from the moon by Apollo astronauts for evidence of minerals that might have been formed in the presence of water to better understand the early formation of Earth. They presented the preliminary results of their work last month at the 2017 American Geophysical Union Fall Meeting in New Orleans.

Planetary scientist Sarah Crites and instrumentationalist Casey Honniball are part of a team of researchers from the Hawaii Institute for Geophysics and Planetology and the Japan Aerospace Exploration Agency who are exploring lunar regolith. Lunar regolith is the layer of dust, dirt, and broken rock scattered across the surface of the moon; the researchers are examining millions of individual particles of material, searching for fragments that might have long ago been blasted off Earth's surface and preserved in the pristinely still environment of the moon.

"It's a record of Earth's surface geology that could go back billions of years," said Marc Fries, a Raman spectroscopist who now works as Astromaterials curator at NASA's Johnson Space Center who was not involved with the research.

Scientists know little about the surface of Earth billions of years ago. Crites, Honniball, and the team are relying on ancient collisions—asteroids and other space debris plummeting to the planet's surface and blasting rock all the way to the moon—to provide raw material like clay from Earth's surface among the more common basalt and olivine formed on the moon itself. They also rely on the moon's surface, which experiences very little weathering, volcanic activity, and movement.

"If you drop a rock on the moon, it's just going to stay there for the most part," Crites said. "We still have rocks on the lunar surface from when the moon was formed."

By the end of the Apollo missions, astronauts had brought a total of 842 pounds of lunar rock, core samples, pebbles, sand and dust from the moon's surface to Earth. The researchers are using the material to try to detect particles of ancient Earth, asteroids, and anything else that might have landed on the moon over the last several billion years.

Carefully tapping sieved lunar samples into a thin layer, the researchers have been scanning the particles beneath three different hyperspectral imagers. These devices reflect wavelengths of light off of each captured pixel of the scanned material, giving the researchers a precise chart of wavelengths of light reflected or absorbed by minerals and other particles, Honniball said. While the receptors in human eyes can only see three colors, the hyperspectral equipment samples hundreds of different wavelengths.

The plots of reflection and absorption for each pixel of their images reveal something about the chemical makeup of lunar dirt. Crites is specifically looking for water, or the evidence of its presence when the particles were formed, making those particles "hydrated minerals."

Basalt, pyroxene and olivine are all igneous rocks and were probably formed on the moon itself, but clay and mica, among others, can only form near water. The researchers' procedure for sorting the moon rocks should pinpoint hydrated minerals that couldn't have developed on the dry surface of the moon, Honniball said.

So far, four particles have stood out as likely candidates. On their next scan, the team plans to remove those pieces of material and analyze them further, looking for chemical composition and structure that might confirm their origin and even their age.

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