Lunar rocks suggest meteorite shower

April 12 2006

Photo courtesy of NASA.

New age measurements of lunar rocks returned by the Apollo space missions have revealed that a surprising number of the rocks show signs of melting about 3.9 billion years ago, suggesting that the moon – and its nearby neighbor Earth – were bombarded by a series of large meteorites at that time.

The idea that meteorites have hammered the moon's surface isn't news to scientists. The lunar surface is pock-marked with large craters carved out by the impact of crashing asteroids and meteorites, said Robert Duncan, a professor and associate dean in the College of Oceanic and

Atmospheric Sciences at Oregon State University.

But the narrow range of the impact dates suggests to researchers that a large spike in meteorite activity took place during a 100-million year interval – possibly the result of collisions in the asteroid belt with comets coming from just beyond our solar system.

Results of the study are being published in Geochimica et Cosmochimica Acta, the journal of the international Meteoritical Society. Co-authors with Duncan are Marc Norman of the Australian National University and John Huard, also an oceanographer at OSU. The study was funded by NASA.

Tiny melted fragments from the lunar rocks were dated at the noble gas geochronology laboratory at Oregon State. Duncan and Huard were able to use radiometric dating techniques to determine when the rocks had melted after being struck by meteorites. What is particularly intriguing, Duncan says, is that this apparent spike in meteorite activity took place about 3.8 to 4 billion years ago – an era that roughly coincides with when scientists believe life first began on Earth, as evidenced by the fossil record of primitive one-cell bacteria.

It is possible that life was introduced to Earth from one of these meteorites, Duncan said. Or it could have developed spontaneously once the bombardment subsided, or developed beneath the ocean near life-nurturing hydrothermal vents. The lack of evidence on Earth makes the analysis of moon rocks much more compelling. The meteorite activity that bombarded the moon likely struck our planet as well.

"Unfortunately, we haven't found many very old rocks on Earth because of our planet's surface is constantly renewed by plate tectonics, coupled with erosion," Duncan said. "By comparison, the moon is dead, has no atmosphere and provides a record of meteorite bombardment that we

can only assume is similar to that on Earth."

When the solar system was formed, scientists say, it spun away from the sun like a huge, hot disk that subsequently condensed into planets. At least nine planets survived, sucking in loose space matter from around them. Those planets closer to the sun were more solid, while those farther away were comprised primarily of gases.

Over time, the space debris has lessened, either being gravitationally collected into the planets, or smashed into cosmic dust through collisions with other objects. The discovery of this apparent spike in meteorite activity suggests to the authors that a major event took place.

"We may have had a 10th and 11th planet that collided," Duncan said, "or it's possible that the outward migration of Neptune may have scattered comets and small planet bodies, inducing collisions in the asteroid belt. The close passing of a neighboring star could have had a similar effect."

Duncan and his colleagues examined about 50 different rock samples scooped up by astronauts on the Apollo missions. All but a few of them produced ages close to 3.9 billion years and they exhibited different chemical "fingerprints," indicating that they had melted from different meteorites and lunar surface rocks.

"The evidence is clear that there was repeated bombardment by meteorites," Duncan said.

When meteorites collide with the moon, the surface rock and the meteorites partially melt, and then turn to glass. After the glasses quenched, they slowly began to accumulate argon gas that scientists can measure and calculate from the known isotopic decay rate (from potassium) to determine age.

"The formation of glass from the melting is like starting a clock," Duncan said. "It resets the time for us to determine billions of years later."

Duncan and his colleagues say the intense bombardment ended about 3.85 billion years ago, and there has been a slowly declining pattern of meteorite activity since. Many of the prominent craters found on the moon date back to that era, including Imbrium, at 3.84 billion years; Serenitatis, 3.89 billion years; and Nectaris, 3.92 billion years.

Many of the moon's craters are 10 to 100 kilometers across and scientists say that meteorites of that size or larger may have struck the Earth in the past. Such meteorites impacts may have been responsible for the extinction of dinosaurs 65 million years ago, and a mass extinction that wiped out an estimated 75 percent of the Earth's plant and animal species 250 million years ago.

However, Duncan said, these mass extinctions could also be linked to climate, disease and volcanism – or a combination of such factors.

"It is clear that there was a spike of meteorite activity on the moon about 3.9 billion years ago, and that it lasted for roughly 100 million years," Duncan said. "The moon provides important information about the early history of our solar system that is missing from the Earth's geologic record."

Source: Oregon State University