The moon as solar system's Rosetta stone?

New research suggests that two distinct groups of objects battered the surface of the moon – and could give clues into the early days of Earth's solar system.

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The full moon is shown in the early morning southwestern sky as seen from Tigard, Ore., Aug. 25.

Don Ryan/AP

By Pete Spotts, Staff writer / September 16, 2010

New observations of the moon's heavily cratered surface have moved planetary scientists a step closer to solving a cosmic "what done it": What were the objects involved in the intense assault on the moon and other bodies in the inner solar system some 4 billion years ago, and where did they come from?

An analysis of lunar craters published in Thursday's issue of the journal Science strongly suggests that two distinct groups of objects punished the lunar surface during a period known as the "late heavy bombardment."

One group, made up mainly of larger objects, appears to have dominated the initial phase of that bombardment, which began about 4.1 billion years ago. Smaller objects appear to have taken over the pummeling process around 3.8 billion year ago, and have been at it ever since.

This contrasts with a competing theory that the objects ricocheting through the solar system had the same source and size mix throughout the solar system's history, but that the numbers available for smacking planets has dwindled with time.

And while the driving force behind the shift in impactors remain unclear, the ability to spot the change allows scientists to begin hunting for the sources of each group and figure out what sent them on their collision course with the inner planets, explains James Head III, a Brown University planetary scientist who led the team reporting the results.

The possibilities include "large projectiles being moved out of the asteroid belt by late-stage adjustments in the orbits of the gas giants" such as Jupiter and Saturn, he said during a press briefing Thursday. "Maybe there were other populations – asteroids in some cases or comets in others."

Indeed, Dr. Head says, the data from the Lunar Reconnaissance Orbiter (LRO) may be detailed enough to allow his team to tell from the impact craters themselves what kind of object struck the lunar surface. If that's the case, "we can start using these data to tell whether comets were more important early on" in the bombardment "or whether asteroids were more important," he says.

Researchers have noted that answering these questions can help answer questions about Earth's history – and the history of life on Earth – as well.

The third rock from the sun would have been subject to much the same pummeling the moon received. But the Earth is constantly recycling its crust through tectonic processes, which have erased much of the surface evidence of these ancient impacts.

Thus, the moon becomes what Head calls a Rosetta Stone for understanding conditions in the early solar system as well as conditions affecting the early Earth.

The paper is one of three appearing in the latest issue of Science in which researches have used the LRO to uncover a moon that is a more complicated object than scientists previously thought.

For instance, even a casual look at the moon with the naked eye suggests a surface with two broad types of rock. Scientists have identified the darker surfaces that make up the "seas" on the lunar surface as ancient volcanic basalts, similar to the material that wells up along ocean ridges on Earth and cools to form new crust. The lighter surface is made up largely of calcium-rich minerals.

But LRO has revealed at least four regions dominated by silicate-rich rock, similar to rocks astronauts returned during the Apollo missions. The regions appear either as broad volcanic domes where magma has oozed onto the surface, or in material ejected from craters carved by impacts. The silicates in the ejected material suggests the impactors uncovered subsurface formations of granite.

"If you were going to the moon and you wanted to dig someplace where you could mine some rocks and make some fancy lunar kitchen counter tops," these are the formations you'd look for, says Timothy Glotch, a planetary geologist at the State University of New York at Stony Brook and the lead author of the Science paper reporting the result.

For LRO, launched in June 2009, today marks a turning point. Its mission is shifting from one dominated by measurements to support further lunar explorations – hunting for potential landing spots or mapping the distribution of minerals human explorers could use to help live off the land – to answering scientific questions about Earth's companion.

"With these exquisite measurements we're able to make with LRO, we're seeing details that indicate that things are a bit more complicated and a lot more interesting" on the moon than many thought, says Michael Wargo, chief lunar scientist at NASA headquarters in Washington.