Engineered collision spills new Moon secrets (w/ Video)

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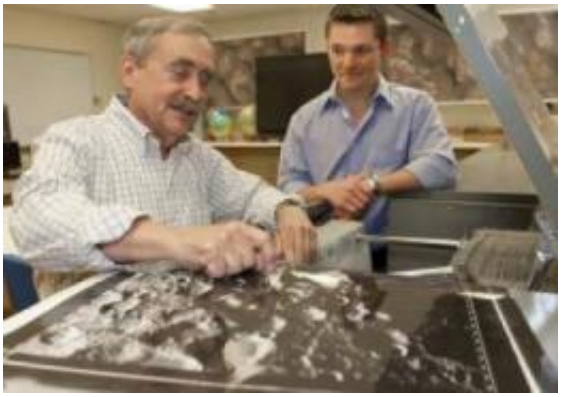

Peter Schultz and graduate student Brendan Hermalyn analyzed data from bits of the Moon's surface kicked up by a NASA-engineered collision. They found unexpected complexity -- and traces of silver. Credit: Mike Cohea/Brown University

Scientists led by Brown University are offering the first detailed explanation of the crater formed when a NASA rocket slammed into the Moon last fall and information about the composition of the lunar soil at the poles that never has been sampled. The findings are published in a set of papers in *Science* stemming from the successful NASA mission, called LCROSS for Lunar CRater Observing and Sensing Satellite.

Mission control at NASA Ames sent the emptied upper stage of a rocket crashing into the Cabeus crater near the Moon's south pole last October. A second spacecraft followed to analyze the ejected debris for signs of

water and other constituents of the super-chilled lunar landscape.

In one of the papers, Brown planetary geologist Peter Schultz and graduate student Brendan Hermalyn, along with NASA scientists, write that the cloud kicked up by the rocket's impact showed the Moon's soil and subsurface is more complex than believed: Not only did the lunar regolith — the soil — contain water, it also harbored other compounds, such as hydroxyl, carbon monoxide, carbon dioxide, ammonia, free sodium, and, in a surprise, silver.

Combined, the assortment of volatiles — the chemical elements weakly attached to regolith grains — gives scientists clues where they came from and how they got to the polar craters, many of which haven't seen sunlight for billions of years and are among the coldest spots in the solar system.

Schultz, lead author on the *Science* paper detailing the impact crater and the ejecta cloud, thinks many of the volatiles originated with the billions of years-long fusillade of comets, asteroids and meteoroids that have pummeled the Moon. He thinks an assortment of elements and compounds, deposited in the regolith all over the Moon, could have been quickly liberated by later small impacts or could have been heated by the sun, supplying them with energy to escape and move around until they reached the poles, where they became trapped beneath shadows of the frigid craters.

"This place looks like it's a treasure chest of elements, of compounds that have been released all over the Moon," Schultz said, "and they've been put in this bucket in the permanent shadows."

Schultz believes the variety of volatiles found in Cabeus crater's soil implies a kind of tug of war between what is being accumulated and what is being lost to the tenuous lunar atmosphere.

"There's a balance between delivery and removal," explained Schultz, who has been on the Brown faculty since 1984 and has been studying the Moon since the 1960s. "This suggests the delivery is winning. We're collecting material, not simply getting rid of it."

Astronauts sent as part of NASA's Apollo missions found trace amounts of silver, along with gold, on the near-side (Earth-facing side) of the Moon. The discovery of silver at Cabeus crater suggests that silver atoms throughout the moon migrated to the poles. Nevertheless, the concentration detected from Cabeus "doesn't mean we can go mining for it," Schultz said.

The crater formed by the rocket's impact within Cabeus produced a hole 70 to 100 feet in diameter and tossed up six-foot deep lunar material. The plume of debris kicked up by the impact reached more than a half-mile above the floor of Cabeus, high enough to rise into sunlight, where its properties could be measured for almost four minutes by a variety of spectroscopic instruments. The amount of ejecta measured was almost two tons, the scientists report. The scientists also noted there was a slight delay, lasting roughly one-third of a second, in the flash generated after the collision. This indicated to them that the surface struck may be different than the loose, almost crunchy surface trod by the Apollo astronauts.

"If it had been simply lunar dust, then it would have heated up immediately and brightened immediately," Schultz said. "But this didn't happen."

The scientists also noticed a one-half-mile, near-vertical column of ejecta still returning to the surface. Even better, the LCROSS spacecraft was able to observe the plume as it followed on the heels of the crashing rocket. Schultz and Hermalyn had observed such a plume when conducting crater-impact experiments using hollow spheres (that

mimicked the rocket that crashed into Cabeus) at the NASA Ames Vertical Gun Range in California before the LCROSS impact.

"This was not your ordinary impact," Hermalyn said. "So in order to understand what we were going to see (with LCROSS) and maybe what effects that would have on the results, we had to do all these different experiments."

Even though the mission has been judged a success, Schultz said it posed at least as many questions as it answered.

"There's this archive of billions of years (in the Moon's permanently shadowed craters)," Schultz said. "There could be clues there to our Earth's history, our solar system, our galaxy. And it's all just sitting there, this hidden history, just begging us to go back."

Provided by Brown University