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# Impactors Added to Lunar Reconnaissance Mission

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NASA's next mission to the Moon will not merely orbit the gray satellite, in will crash two vehicles into the lunar South Pole to hunt for water ice, the U.S. space agency announced April 10.

In addition to mapping the Moon to support astronaut missions expected to begin as soon as 2018, NASA's Lunar Reconnaissance Orbiter (LRO) mission also will aim a spent fuel stage and an impactor at a southern crater rich in hydrogen and, possibly, water ice.

"I think aggressively touching the Moon is an understatement," Scott Horowitz, NASA associate administrator for the Exploration Systems Mission Directorate, said during an April 10 press conference at NASA headquarters in Washington. "What this mission buys is an early attempt to know what some of the resources we're going to have ... we know for sure that for human exploration to succeed we're going to have to essentially live off the land."

Astronomers know that hydrogen exists in some form on the permanently shadowed crater floors along the Moon's polar regions from past lunar orbiters. The Pentagon's Clementine spacecraft hinted at water ice in a crater called Shackleton in 1994, while NASA's Lunar Prospector found unmistakable signs of hydrogen on the Moon's surface.

NASA hopes its LRO and accompanying lunar impactor mission will provide conclusive answers to questions about the presence of water ice on the Moon, most importantly whether it exists in forms that may prove useful for future astronauts. Under the space agency's exploration vision, a four-astronaut Moon mission is slated for no later than 2020.

Set to launch with LRO in October 2008, the $73 million Lunar Crater Observation and Sensing Satellite (LCROSS) is a bare-bones spacecraft designed to use cameras and spectrometers to watch its 2,000-kilogram upper stage slam into hydrogen-rich Shackleton Crater, mission managers said.

"It's got the mass of an SUV [sports utility vehicle] and we'll send it into the South Pole of the Moon," LCROSS project manager Daniel Andrews, of NASA's Ames Research Center, said of the rocket's spent upper stage, which will double as an impactor. "We will create a substantial plume [and] excavate some sample material, some of which we think will be water ice."

The 880-kilogram LCROSS probe will fly through the resulting plume and use its instruments to scan for water while taking photographs. Then, 15 minutes after the upper-stage booster's impact on the lunar surface, the "shepherding" satellite also will crash into the crater floor, Andrews said.

"We know that we can steer it sufficiently to sample another region of the crater," Andrews said, adding that smashing into

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the same place twice would likely not yield additional valuable data.

A network of ground-based observatories will monitor the impact and plume from Earth while LRO, India's Chandrayaan-1 lunar orbiter and other spacecraft will examine the Moon crash from their respective locations, LCROSS mission managers said.

Slamming probes into objects in the search for water is nothing new for NASA.

During the Deep Impact mission, the space agency crashed an impactor probe into the comet Tempel 1 July 4, 2005, while its parent flyby spacecraft and other space and ground-based observers looked on. NASA's Lunar Prospector orbiter also crashed into the Moon in July 1999, also in the hope of stirring up water ice, though researchers believe it may have hit at too shallow an angle to produce much in the way of science results.

"The models show that it kicked up a lot of material but mostly skidded on the surface," said Butler Hine, NASA's Robotic Lunar Exploration Program manager, of the earlier Moon crash.

Europe's Smart-1 orbiter -- currently circling the Moon -- also is expected to crash into the lunar surface later this year.

But LCROSS mission managers expect their primary impactor, which will weigh more and come in at a steeper angle than either Lunar Prospector or Smart-1 did, to create a crater 4.8 meters deep and about 30 meters wide as it crashes into the surface at a speed of about 9,000 kilometers per hour.

The impact is expected to kick up about 1,000 metric tons of lunar material, enough to fill 10 space shuttle payload bays to the brim, Andrews said, adding that the densest part of the plume could reach up to 64 kilometers above the lunar surface.

LCROSS was chosen after a brief competition among 19 contenders, each of which were restrained by a 1,000-kilogram spacecraft weight cap and a cost of no more than $80 million.

Although the competition was open only to NASA field centers, most if not all of the proposals featured industry involvement. Ames' industry partner on the LCROSS mission is Northrop Grumman Space Technology, Redondo Beach, Calif.

*Staff writer Brian Berger contributed to this article from Washington.*