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Controversial New Idea Surfaces on Origin of Moon's Water

By [Clara Moskowitz](#)
Staff Writer
posted: 06 October 2009
10:00 am ET

Many experts were shocked by the recent discovery of water on the moon, which was long thought to be bone-dry.

But not everyone [was surprised](#).

Astrophysicist Arlin Crotts of Columbia University has been working for years on research that he says predicted this finding. In a paper he submitted recently to the Astrophysical Journal with his graduate student Cameron Hummels, Crotts hypothesizes the existence of widespread water on the lunar surface, and offers an idea for how it got there.

"I am predicting something that just happened, that nobody else was predicting," Crotts said. "I hope people recognize that this is a true prediction of the spatial distribution of water around the moon."

Until recently, many scientists thought the lunar surface was almost completely dry, and that [shadowed craters](#) near the poles offered the only chance for small stores of water. But [new data](#) from the NASA-built Moon Mineralogy Mapper (M3) on India's Chandrayaan-1 satellite, NASA's Cassini spacecraft and NASA's Deep Impact probe uncovered tantalizing evidence of water molecules all over the moon's surface. These findings were detailed in three papers in the Sept. 25 issue of the journal Science.

Some more details, especially about the possible water at the poles, are likely to come when [NASA's LCROSS impactor](#) slams into a crater on the moon's south pole Friday morning in search of signs of water.

Where did it come from?

The experts behind the new findings said they don't yet know the [source of this water](#). According to one hypothesis, charged hydrogen ions carried from the sun to the moon by the solar wind could combine with oxygen on the moon to form water molecules. Another idea is that the water is left over from comets that have impacted the moon.

"There are many models out there," said Roger Clark of the U.S. Geological Survey in Denver, who is a team member for the Cassini spacecraft and a co-investigator for Chandrayaan-1. "Probably to some degree they all are in play. It's too early to tell."

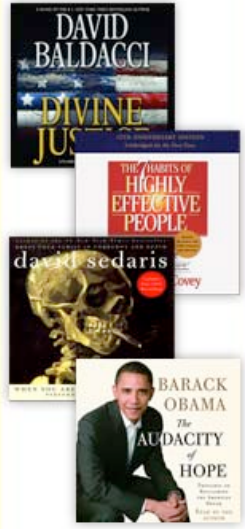
But Crotts has a different idea in mind.

Previous research has uncovered some water trapped in minerals deep inside the moon, Crotts said. According to his model, this water is likely to travel up through fissures to the lunar surface along with other gases that are escaping the pressure of the moon's dense interior.

"We now know that there's water in the interior," Crotts told SPACE.com. "There's no particular reason to think that it doesn't get out."

Buried water

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These images show a very young lunar crater on the side of the moon that faces away from Earth, as viewed by NASA's Moon Mineralogy Mapper on the Indian Space Research Organization's Chandrayaan-1 spacecraft. On the

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Surface water

One piece of evidence for interior water - a 2008 Nature study by Brown University's Alberto Saal and colleagues - identified water (between 260 and 745 parts per million, or ppm) in pebbles of hardened moon lava brought back by Apollo astronauts. Other work on similar samples by Francis McCubbin of the Carnegie Institution for Science in Washington D.C. also indicates the moon could harbor water beneath its surface.

While Crotts thinks those amounts are enough to produce the observed surface water, other experts are skeptical.

"I feel that it is highly unlikely that there are significant amounts of water remaining in the moon's interior at this time," said Darby Dyar of Mount Holyoke College in Massachusetts, who was a co-author on the recent Science papers announcing the surface water discovery. "The amounts of water found are at the parts per million level, and as such constitute only a very small amount of water as a resource."

Other scientists echo this thinking.

"The moon interior is believed to be very dry, with less water than what we observed on the surface," Olivier Groussin, a scientist at the Laboratoire d'Astrophysique de Marseille in France and another co-author on the Science papers, wrote in an e-mail. "Apollo samples indicate less than 50 ppm of water in the interior, while we detected about 1000 ppm on the surface."

Wet moon

However, Denton Ebel, curator of meteorites at the American Museum of Natural History in New York, said the trace amounts of interior moon water so far identified could be enough to produce the signature found at the surface.

"I think the amounts of water that are inferred for the lunar interior from the work of Alberto Saal and the work of Francis McCubbin, coupled with what we know about the lunar core, implies that degassing is a viable cause of the hydrogen signal that's observed," Ebel said in a phone interview.

"I think that [Crotts'] scenario of seepage - slow degassing - is consistent with the findings," Ebel said. "And I think it's more encouraging than the idea of hydrogen implantation by the solar wind. The bottom line is, he could turn out to be right."

Crotts's paper outlining his hypothesis has been submitted to an academic journal, and is in the process of being peer-reviewed before possible publication. Some scientists are waiting to reserve judgment until then.

"I am delighted that scientists have been thinking along these lines, but we must wait to see if it holds up to the test of peer review," said Jim Green, director of the Planetary Science Division of the Science Mission Directorate at NASA Headquarters in Washington, D.C., another co-author on the Science papers.

To get to the bottom of the issue, more data will be needed, scientists say.

In fact, the signature of water seen on the surface could easily result from a combination of multiple processes, Crotts said, adding that his explanation might only account for some of the water on the surface.

To find out for sure, more lunar expeditions will be required, Crotts said.

"We've got to have another polar orbiter mission, and it's got to have some instruments on it that study this question," he said.

- [Video - Water on the Moon: Hydrogen, Oxygen and Energy](#)
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left is an image showing brightness at shorter infrared wavelengths. On the right, the distribution of water-rich minerals (light blue) is shown around a small crater. Both water- and hydroxyl-rich materials were found to be associated with material ejected from the crater. Credits: ISRO/NASA/JPL-Caltech/USGS/Brown Univ.



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An illustration showing the stream of charged hydrogen ions carried from the sun to the moon by the solar wind. Scientists think this process might explain the possible presence of hydroxyl or water on the moon. Credit: University of Maryland/F. Merin/McREL



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Deep Impact observations of the northern polar regions. Left to right: Clementine basemap of the observed area; Brightness image generated from Deep Impact; Temperature map (in Kelvin); Map of the strength of the water signature. There are significant variations in the water signature across the lunar surface. While the strength of the water signatures is not correlated with terrain types (bright highland vs. dark maria), it is dependent on temperature. Credit: NASA/University of Maryland

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The discovery of hydrogen at the Moon's South Pole hints at ice in the deep shadowed craters. Credit: Thomas Lucas & Dave Bro
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topnotch wrote: posted 06 October 2009, 10:43 am ET

For all the money that will be re-spent studying the moon (including future moon bases, etc), we could go to Mars and back quite a few times and find all the water we would ever need to live there. Including planting vegetables, brick building for habitats, etc. There's probably uranium there for nuclear power on those cold Martian nights!

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Geoduck2 wrote: posted 06 October 2009, 10:52 am ET

"In fact, the signature of water seen on the surface could easily result from a combination of multiple processes, Crofts said"

There is a tendency for people to look for THE cause of something. In my experience there is almost never A cause. Whether it is an airplane crash, or the end of the dinosaurs, or global warming, or whatever, there are almost always multiple factors that come together to produce what we observe. The water on the moon is likely to be the same.

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IxSonicxI wrote: posted 06 October 2009, 10:53 am ET

There's uranium on the moon, we recently discovered this year. The moon's gravity is significantly less than the Earth's, and thus would be a very nice springboard for Martian landings. I find this particular paper to be a better representation of the situation with the water on the moon's surface. There's more to something than just the surface, afterall. Mars included.

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antigraviton wrote: posted 06 October 2009, 11:37 am ET

all these resources are on the moon, already shown in core samples.

It is entirely interesting to perceive that a destination 3 days away would cost more than a mission that is on average 70 times farther away (7 mnths x 30 avg days/mo divided by 3 days per trip = 70 equal one way trips) one way and has higher gravity necessitating larger and more powerful landing and taking off vehicles and still requires THE EXACT SAME facilities for human survival and workspace as the Moon does. Consider the Mars mission manpower at ALL levels, generating public interest for the bill, buying equipment and cutting contract deals, building all the vehicles and the life support, buying all the needed resources, testing EVERYTHING 1000% as FAILURE IS NOT AN OPTION, the vast millions in training all the RIGHT PEOPLE, the new radiation shielding methods, new toilet designs, new abort mission procedures tested, new self-supportive space methods of recycling human waste materials back into food and drink, paying the salaries of ALL the Earth supportive personnel including the scientists and engineers from the beginning of the mission to the end, creating a new method of handling all materials waste instead of simple ejection to space.

All these parts of the Mars program would incur obvious phenomenal costs above any few satellite or rover missions to our local satellite we are just learning about.

I am still interested in how to grow crops on Mars in well below freezing temperatures in sand within a vacuum environment 1/1000th of the Earth's atmospheric pressure at the surface?

At what point in human space exploration did it become cheaper to visit and make use of another planet when we don't even make use of our own Moon that has similar Earth crust properties and same distance from the sun as Earth? IT WOULD BE WONDERFUL to be able to go to Mars and conquer it completely, but what if such a mission could be ENSURED by testing locally and building the ships needed in space from the Moon where they can be built and perfected and tested and launched from (instead of from Earth), allowing OTHER missions as well and not just Mars as world interest would be multiplied among nations and a lunar NASA could be headquartered there in the near future.

To embark on such an huge and frighteningly expensive undertaking as conquering Mars, we could likely build 3 moonbases with that money, allowing local business to flourish and have a reason in space...

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Mr_RSeay wrote: posted 06 October 2009, 11:51 am ET

To embark on such an huge and frighteningly expensive undertaking as conquering Mars, we could likely build 3 moonbases with that money, allowing local business to flourish and have a reason in space..."

Or could the Moon be the stepping stone to Mars. Of course it can. Columbus was looking for China and Japan. The pioneers followed the mountain men to California, Oregon, Washington. We don't or I don't worry about the Cash it'll will take. The "Will" will get humans to their dreams come true. Not the bank account.

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MasterSith wrote: posted 06 October 2009, 12:13 pm ET

Peer review, by people who probably don't like the idea. Yeah, that's always fair. lol.

Douglas Mallette
<http://thespaceadvocate.blogspot.com/>
Author: Turning Point
Available NOW @ www.lulu.com

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MasterSith wrote: posted 06 October 2009, 12:20 pm ET

antigraviton - Well said!

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Delphinus100 wrote: posted 06 October 2009, 12:24 pm ET

"For all the money that will be re-spent studying the moon (including future moon bases, etc), we could go to Mars and back quite a few times and find all the water we would ever need to live there. Including planting vegetables, brick building for habitats, etc."

Perhaps, perhaps not.

But it doesn't matter, unless Mars is all that you see. 'Either/or' is a false choice. The Moon, Mars and many other places are worthy of human presence and exploration. This isn't entirely about water/ice either, or we'd be sparing no expense to reach Europa or the rings of Saturn...

"There's probably uranium there for nuclear power on those cold Martian nights!"

Even if that's true, it takes a *major* mining and enrichment infrastructure to make it usable in reactors (and we do know there's at least some uranium on the Moon, but what I said is just as true there, too).

Water/ice, at least, is not nearly as hard to extract and is pretty much usable as is (with well known, off-shelf mineral filtration and/or distilling techniques, if needed).

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High_Evolutionary wrote: posted 06 October 2009, 12:41 pm ET

Friday can't come soon enough! The results will be interesting indeed. I had a theory as to the recent discovery of water on the moon. Could the water have come from the tails of comets in the last 30 years or so? It seems the way waters been discovered on the surface(not so much the poles) that it seems to have been sprinkled across the moons surface. It's a wild theory but it's been on my mind.

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ripvanwinkle wrote: posted 06 October 2009, 12:50 pm ET

It is indeed very interesting that water (ice) has been found on the moon and mars both. And we seem to have lots of great ideas for machinery that will extract water, oxygen, make rocket fuel, grow food, etc etc. But before we rush off to the moon or mars maybe we should take our clever ideas and machines and try to establish a self sustaining "outpost" here on earth, in one of our extreme high altitude climate regions, with people in space suits and sealed habitats and see how well that works first!

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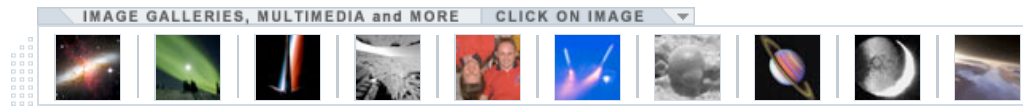
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