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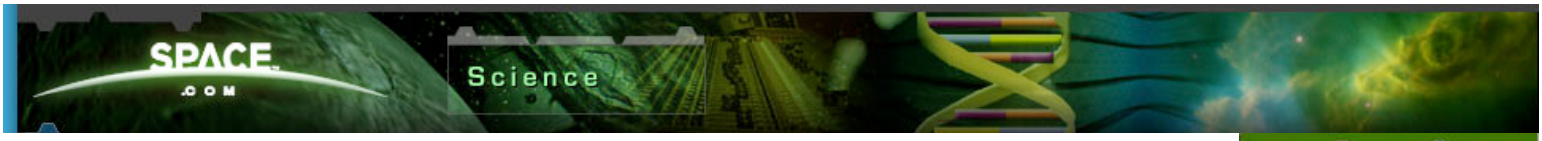

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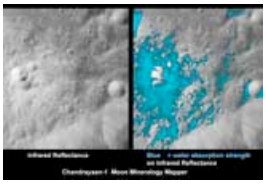

Moon Water: A Game-Changing Discovery

By Andrea Thompson
Senior Writer
posted: 24 September 2009
02:24 pm ET

This story was updated at 3:00 p.m. ET

The discovery of widespread but small amounts water on the surface of the moon, announced yesterday, stands as one of the most surprising findings in planetary science.

Three spacecraft picked up the signature of water, not just in the frigid polar craters where it has long been suspected to exist, but all over the lunar surface, which was previously thought to be bone dry.

"Widespread water has been detected on the surface of the moon," said planetary geologist Carle Pieters of Brown University in Rhode Island, who led one of the studies detailing the findings.

While the findings, detailed in the Sept. 25 issue of the journal Science, don't mean there are pools of liquid water sitting on the moon, it does mean that there is — entirely unexpectedly — water potentially tied up or mixed in the minerals that make up the lunar dirt.

"What we're detecting is completely unexpected," Pieters said. "The moon continues to surprise us."

The moon dirt would be akin to soil from an arid environment like Arizona — it wouldn't feel wet to the touch, but there's certainly water bound up in it, Pieters told SPACE.com.

This discovery may well revolutionize our understanding of the nature of the moon's surface, experts say, and it has geologists eager to go back to the moon and dig up some lunar dirt.

"I rank this as a game changer for lunar science," said University of Colorado astrophysicist Jack Burns, chair of the science committee for the NASA Advisory Council. Burns was not involved in the new findings. "In my mind this is possibly the most significant discovery about the moon since the Apollo era."

Surprising findings

Samples of lunar rocks brought back to Earth by Apollo astronauts had never shown any signs of water, leading scientists to presume that the moon was bone dry, except for possible pockets of water ice in permanently shadowed craters at the moon's south pole.

But the new observations, from the NASA-built Moon Mineralogy Mapper (M3) on India's Chandrayaan-1 satellite, NASA's Cassini spacecraft and NASA's Deep Impact probe call into question 40 years of assumptions on the make-up of the lunar surface.

"If it stands, then that really changes our understanding of the lunar surface," said Ray Arvidson, a planetary scientist at Washington University in Saint Louis who also was

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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/E. Medin/MoRE

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not involved in the new studies.

"Really, the moon is much more than a gray body in orbit around the Earth," said Rob Green, of NASA's Jet Propulsion Laboratory in Pasadena, Calif., and the project instrument scientist for M3.

All three spacecraft detected the spectral signature of water (the wavelengths of light that it reflects) across the lunar surface. The signal, or fingerprint of water, was strongest at the lunar poles. The signal also varied in strength depending on the time of day, with the most robust signals coming early in the morning and the lowest at midday.

"The entire surface of the moon will be hydrated during at least part of the lunar day," said Jessica Sunshine, of the University of Maryland and the deputy principal investigator for NASA's Deep Impact extended mission and co-investigator for M3.

The detection from Chandrayaan came first and took the team members by surprise; they first thought it was error in the data that would have to be calibrated for. But no matter what errors they accounted for, the signal still showed up. The data from Cassini and Deep Impact clinched the discovery.

"The rest is history now. It is completely conclusive," Pieters, the principal investigator for M3, said.

The signal actually indicates the presence of both water molecules and hydroxyl — an oxygen atom and hydrogen atom bonded together, or essentially water missing one of its hydrogens. Hydroxyl is more reactive than water. What minerals bear the hydroxyl isn't clear, though examples of hydroxyl-bearing minerals on Earth are the various clays.

How much of each type of molecule exist on the surface can't be determined from the data, but suffice it to say the lunar soil couldn't be called wet.

"Even the driest deserts on the Earth have more water than are at the poles and surfaces, as we've presented here, of the moon," said Jim Green, director of the Planetary Science Division of the Science Mission Directorate at NASA Headquarters in Washington, D.C.

The exact form that the water takes on the lunar surface isn't clear with the data the scientists have, either, though they have several ideas: The water could be mixed in to the lunar surface or could be a part of altered minerals present in the lunar dirt.

"We do not know precisely," Pieters said.

It also remains a mystery how the water and hydroxyl formed, though some of the scientists who made the discovery suggest it could be from the interaction of the solar wind with the lunar surface.

Polar water

The findings come just as NASA's Lunar Reconnaissance Orbiter and LCROSS impactor are set to explore the the lunar south pole craters looking for water ice.

"Much to our surprise, we found [water] elsewhere," Pieters said.

What the new observations are seeing is "water in a different mode on the surface altogether," she added, as the polar crater water ice is thought to be in solid clumps on the surface, while the newly detected water is attached to surface minerals.

More water could also be stuck underneath the surface as strong water signals were found in fresh craters, but not in the area around them, suggesting they might have churned up water-rich dirt.

The new findings, though, could help explain how the water ice got to the lunar poles. The fluctuating signals seen throughout the day could indicate that the water is migrating across the surface toward colder, higher latitudes and eventually the poles.

"If the water molecules are as mobile as we think they are — even a fraction of them — they provide a mechanism for getting water to those permanently shadowed craters," Pieters said.

When water is heated, it evaporates and moves off the surface, but gravity can snatch it back down. If the water molecules aren't swept away by the solar wind or some other force, they could be re-deposited in a different spot. If that spot is colder, they're more likely to stick longer, so slowly, the water would tend to move from warmer to colder spots, in this case, the lunar poles.

This type of migration is actually seen on other bodies in the solar system including Jupiter's moon Ganymede and Saturn's moon Iapetus.

Maryland/P. Merrill/McREL

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 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.

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

This schematic shows the daytime cycle of hydration, loss, and rehydration on the lunar surface. In the morning, when the moon is cold, it contains water and hydroxyl (OH). One theory holds that the water and hydroxyl are, in part, formed from hydrogen ions in the solar wind. By local noon, when the moon is at its warmest, some water and hydroxyl are lost. By evening, when it is colder, the surface returns to a state equal to that seen in the morning. Thus, regardless of location or terrain type, the entire surface of the moon is hydrated during some part of the lunar day. Credit: University of Maryland/O. Groussin/McRE.

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"So we see this kind of migration on other bodies, so it's just a surprise to see it working on the moon," said Roger Clark, of the U.S. Geological Survey in Denver and a team member for the Cassini spacecraft and a co-investigator for Chandrayaan-1.

But whether the signals actually show moving water or just water being created and destroyed daily can't be determined with the current data and would take a dedicated orbiter to tease apart, Pieters said. There is still a lot that isn't understood about the interaction between the lunar surface and the vacuum surrounding it.

"There's a lot of unknowns that we need to work out," Sunshine said.

"We need to go back obviously," Pieters said.

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netdragon wrote: posted 24 September 2009, 2:34 pm ET

I think if we build a colony near the polar water, we should build it underground. E.g. we should only remain on the surface long enough to actually build the underground habitat. For one thing, deep enough underground will shelter us from some of the cosmic rays, micrometeorites, etc. Additionally, I imagine there are some existing caverns and caves, especially where there's been water. It's always nice when geology did the building/tunneling for us.

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Geoduck2 wrote: posted 24 September 2009, 2:39 pm ET

I've been watching the news conference on NASATV.

I took a couple of things out of it.

First the AVERAGE is very low, but there are spots where the concentration is much higher. Tablespoons per ton is not going to be useful, but that is an average over large areas. There are spots where it's a quart or more per ton on the surface
Second some crater ejecta shows a lot of water.This implies to me that it is not a surface skin of H2O & HO. There must be layers below that are very rich that are getting excavated by the impacts.
Third, They said that this process could work on any rocky object even Mercury.

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SpaceJeff wrote: posted 24 September 2009, 2:56 pm ET

Well, this is another reason we should return to the Moon, and spend some time there, before we try to send humans to Mars. If we can master the techniques necessary to recover these small amounts of water on the Moon, we will be in a better position to do so when we reach Mars, which appears to have substantially more water located underground and near the poles compared to the Moon.

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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

- **Video Show - Getting Back to Luna: Why the Moon?**

Why go back to the moon? Who's going, how will they get there, and what will they do when they arrive? Credit: Thomas Lucas & Dave Brody

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Watch NASA's LRO and LCROSS lunar probes fly to the moon in this mission animation. Credit: NASA/GSFC

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Schlurry wrote: posted 24 September 2009, 3:02 pm ET

At last, the first step of a long road to finding life.

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Evil_Judai wrote: posted 24 September 2009, 3:36 pm ET

This is incredible. This really changes everything.

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Kud_Dukan wrote: posted 24 September 2009, 3:36 pm ET

If you think about it, this has a rather large implication for our understanding of planets in general. We though we would never find widespread water (even small amounts) anywhere on the Moon with the exception of the poles. Now it seems to be all over the place (again, in small amounts, but it's still there). That means that the chances of finding water on any given (rocky) planet, both within our solar system and in others, just got a lot better.

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djmerkone wrote: posted 24 September 2009, 3:37 pm ET

I call first dibbs on a public pool in the south pole.

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GalacticBunny wrote: posted 24 September 2009, 4:07 pm ET

Wow. This will have a huge impact on the location of possible moon basis. It could also have an impact in speeding up or at least making sure Nasa returns to the moon. Very Cool.

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Aneyo wrote: posted 24 September 2009, 4:13 pm ET

The Indian scientists had much a hand in this and I am not hearing a shout out to them. Wake up people; together we stand , divided we fall. Another lesson missed- peoples of the world unite!

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Aneyo wrote: posted 24 September 2009, 4:13 pm ET

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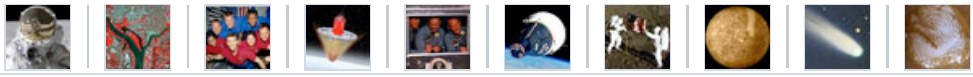

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