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Thursday, October 1, 2009

Mysterious moisture hints at extraterrestrial life

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- [A look back to the dawn](#)
- [Projecting the sweet smell of research](#)
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WILLIAM REVILLE

UNDER THE MICROSCOPE: ON SEPTEMBER 25th, the journal *Science* published two landmark papers on the presence of water on Mars and on the moon. There is now clear evidence that ice sheets extend beneath the Martian surface from the poles halfway to the equator, and most surprisingly, new data shows trace amounts of water distributed over the entire surface of the moon.

These discoveries have profound implications, not least for the possibility of life beyond our Earth. A key member of the team that discovered the widespread Martian ice sheet is Irishman Dr Shane Byrne from Co Louth, now working at the University of Arizona.

Ice on Mars is not surprising because scientists have known for several years that the Martian polar caps are made almost entirely of water ice (Byrne also played a critical role in this discovery). The surprise is that the sub-surface ice extends from the poles down to mid-latitudes. The findings were made by Nasa's Mars Reconnaissance Orbiter. Byrne is a member of the team that operates a high-resolution camera on the orbiter.

The Martian ice revealed itself as fresh bright material thrown up when meteorite impacts excavated craters on the planet. The ice sheet is about one-metre thick. "This ice is a relic of a more humid climate from perhaps just several thousand years ago," says Byrne. "We are talking about maybe a half million cubic kilometres of ice in total."

When Apollo astronauts visited the moon 40 years ago they found no evidence of water. Trace amounts of water were detected in rocks brought back to Earth, but it was assumed that this represented contamination from Earthly moisture. Many scientists suspect that water ice exists in the coldest lunar polar craters that are permanently shaded from the sun, where conditions are such that water ice, if present, could persist over geological time spans. However, the general consensus was that, otherwise, the moon is absolutely dry.

Chandrayaan-1 was India's first moon probe, launched in 2008. A Nasa-built detector on this probe measured wavelengths of light reflected from the surface of the moon indicating the chemical bond between hydrogen and oxygen – a sign of water and hydroxyl (a molecule of water is H-O-H and a hydroxyl is O-H). The water signal gets stronger towards the lunar poles. Nasa's Saturn-bound Cassini probe also detected this signal on its way past the moon in 1999, but the idea wasn't pursued.

Nasa's *Deep Impact* spacecraft closely approached the moon en route to its planned rendezvous with comet 103P/Hartley 2 in November 2010. It confirmed the water and hydroxyl signals detected by *Chandrayaan-1* and *Cassini*. It also observed the same regions at different times during the lunar day. When the sun's rays are strongest, at noon, the water signal is lowest. The signal is stronger in the morning – water molecules form and then dissipate, but the entire lunar surface is hydrated during at least some portion of the lunar day.

“The average amount of water reported (on the moon),” says Jim Green of Nasa, “is about a quart of water per ton of surface soil.” It is not clear yet how this water is formed, but scientists speculate that positively charged hydrogen ions in the solar wind interact with oxygen-rich minerals in the lunar soil to form water and hydroxyl molecules. It appears that layers of water a few molecules thick form each day on the surface in the morning, dissipate around noon and reform again in the cool evening.

These results are fascinating. We are conditioned to think that space is inhospitable towards life but the more we learn the more welcoming it seems. Simple molecules that could serve as precursors to the more complex molecules characteristic of life are widely distributed in space. And now we see that simple solar-driven cycles may be producing water on a widespread basis throughout the universe.

Access to water will be essential if humans are to live in space. We are largely made from water and need to drink copious amounts of water daily. Also, if a planet contained significant water this could provide a source of oxygen to breathe and hydrogen for rocket fuel. H₂O can be decomposed into oxygen (O₂) and hydrogen (H₂) by a simple process of electrolysis.

The moon may harbour significant quantities of water ice in its polar regions, deposited there by cometary impacts. This possibility will be tested on October 9th, when Nasa will crash a rocket into a permanently shaded moon crater blasting moon soil, and ice if it's there, up into the sunlight where it can be seen and analysed by the Lunar Reconnaissance Orbiter, the Hubble Space Telescope and Earth-based observations.

William Reville is associate professor of biochemistry and public awareness of science officer at University College Cork – understandingscience.ucc.ie

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