WATER ON THE RED PLANET

It's now a scientific fact...

By Henry M. Holden

Above: *Dark, narrow streaks on Martian slopes such as these at Hale Crater are inferred to be formed by seasonal flow of water on contemporary Mars. The streaks are roughly the length of a football field. These dark features on the slopes are called "recurring slope lineae" or RSL. Planetary scientists detected hydrated salts on these slopes at Hale Crater, corroborating the hypothesis that the streaks are formed by briny liquid water.* (Image: NASA/JPL-Caltech/Univ. of Arizona)

RECENT IMAGING using the Mars Reconnaissance Orbiter (MRO) detected signatures of hydrated minerals on slopes where mysterious streaks are seen.

These darkish streaks appear to ebb and flow over time. They darken and appear to flow down steep slopes during warm seasons, and then fade in cooler seasons. They appear in several locations on Mars when temperatures are above -10 degrees Fahrenheit (-23° Celsius), and disappear at colder times.

"It took multiple spacecraft over several years to solve this mystery, and now we know there is liquid water on the surface of this cold, desert planet," said Michael Meyer, lead scientist for NASA's Mars Exploration Programme at the agency's headquarters in Washington. "It seems that the more we study Mars, the more we learn how life could be supported and where there are resources to support life in the future."

"Our quest on Mars has been to 'follow the water,'" said John Grunsfeld, astronaut, and associate administrator of NASA's Science Mission Directorate, in Washington. "Scientists are searching for life in the universe, and now we have convincing science that validates what we've long suspected. This is a significant development, as it appears to confirm that water, albeit briny, is flowing today on the surface of Mars."

Some of the earliest missions to Mars revealed a planet with a watery past. Pictures beamed back to Earth from the Viking Project in the 1970s showed a surface crossed by dried-up rivers and plains once submerged beneath vast ancient lakes. Earlier this year, NASA unveiled evidence of an ocean that might have covered half of the planet's northern hemisphere in the distant past.

HYDRATED SALTS A CLUE

The new findings of hydrated salts on the slopes point to what that relationship may be to these dark features. The hydrated salts would lower the freezing point of a liquid brine, just as salt on roads here on Earth causes ice and snow to melt. Scientists say it is likely there is a shallow subsurface flow, with enough water leaking to the surface to explain the darkening.

But occasionally, Mars probes have found hints that the planet might still be wet. Nearly a decade ago, NASA's Mars Global Surveyor took pictures of what appeared to be water bursting through a gully wall and flowing around boulders and rocky debris. In 2011, the high-resolution camera on NASA's Mars Reconnaissance Orbiter captured what looked like little streams flowing down crater walls from late spring to early autumn. Not wanting to assume too much, mission scientists named the flows "recurring slope lineae" (RSL).

According to researchers, liquid water runs down canyons and crater walls over the summer months on Mars. This discovery raises the possibility of Mars being home to some form of life.

The trickles leave long, dark stains on the Martian terrain that can reach hundreds of metres downhill in the warmer months, before they dry up in the autumn as surface temperatures drop.

Images taken from the MRO show cliffs, and the steep walls of valleys and craters, streaked with summertime flows that, in the most active spots, combine to form intricate fan-like patterns.

Scientists are unsure from where the water comes. Speculation is it may rise up from underground ice or salty aquifers, or condense out of the thin Martian atmosphere.

"There is liquid water today on the surface of Mars," Meyer said. "Because of this, we suspect that it is at least possible to have a habitable environment today."

SOURCE OF HYDRATION?

The water flows could point NASA and other space agencies towards the most promising sites to find life on Mars, and to landing spots for future human missions where water can be collected from a natural supply.

"We found the hydrated salts only when the

Left: *Among the many discoveries by NASA's Mars Reconnaissance Orbiter are seasonal flows on some steep slopes.*

These flows have a set of characteristics consistent with shallow seeps of salty water.

This July 21, 2015, image shows examples of these flows on a slope within Coprates Chasma. The image covers an area of ground one-third of a mile (536 metres) wide.

(Image: NASA/JPL-Caltech/Univ. of Arizona)

Below: *Seasonal frost commonly forms at middle and high latitudes on Mars, much like winter snow on Earth.*

However, on Mars most frost is carbon dioxide (dry ice) rather than water ice.

This frost appears to cause surface activity, including flows in gullies.

This image, shows frost in gully alcoves in a crater on the Northern plains.

The frost highlights details of the alcoves, since it forms in different amounts depending on slopes and shadows as well as the type of material making up the ground.

(Image : NASA/JPL/University of Arizona)

seasonal features were widest, which suggests that either the dark streaks themselves or a process that forms them is the source of the hydration," said Lujendra Ojha, of the Georgia Institute of Technology in Atlanta, lead author of a report on these findings published by Nature Geoscience. "In either case, the detection of hydrated salts on these slopes means that water plays a vital role in the formation of these streaks."

Ojha first noticed these puzzling features as a University of Arizona undergraduate student in 2010, using images from the MRO's high resolution imaging science experiment (HiRISE). HiRISE observations now have documented recurring slope lineae at dozens of sites on Mars. The new study pairs HiRISE observations with mineral mapping by MRO's compact reconnaissance imaging spectrometer for Mars (CRISM).

The spectrometer observations show signatures of hydrated salts at multiple RSL locations, but only when the dark features were relatively wide. When the researchers looked at the same locations and RSL were not as extensive, they detected no hydrated salt.

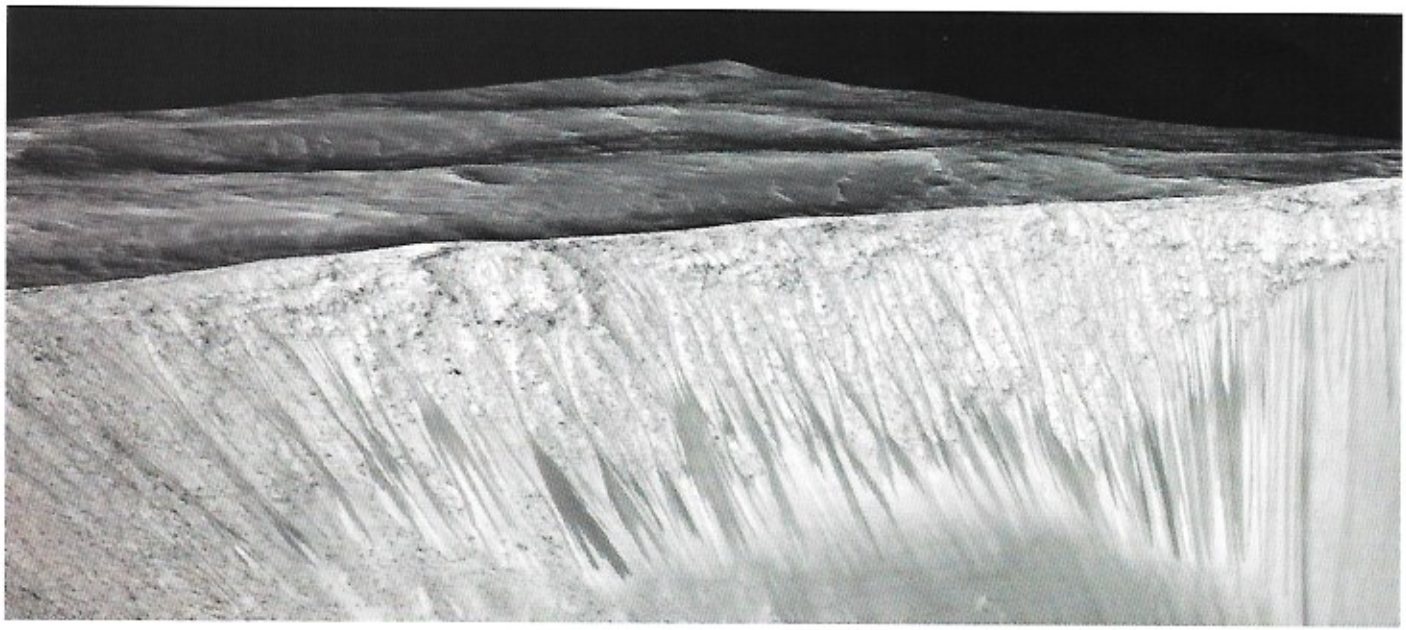
FUTURE ROCKET FUEL

Ojha and others interpret the phantom-like signatures as caused by hydrated minerals called perchlorates. Some perchlorates have been shown to keep liquids from freezing even when conditions are as cold as -94 degrees Fahrenheit (-70° Celsius). On Earth, naturally produced perchlorates are concentrated in deserts, and some types of perchlorates can be used as rocket propellant.

Seeing perchlorates is not new on Mars. NASA's Phoenix lander and Curiosity rover both found them in the planet's soil, and some scientists believe that the Viking missions in the 1970s measured signatures of these salts. However, this study of RSL-detected perchlorates, now in hydrated form, are found in different areas than those explored by the landers. This also is the first time perchlorates have been identified from orbit.

In the journal Nature Geosciences, the team describes how it found infra-red signatures for hydrated salts when the dark flows were present, but none before they had grown. The hydrated salts are a smoking gun for the presence of water at all four sites inspected: the Hale, Palikir and Horowitz craters, and a large canyon called Coprates Chasma.

"These may be the best places to search for extant life near the surface of Mars," said Alfred McEwen, a senior planetary geologist at the University of Arizona. "While it would be very important to find evidence of ancient life, it would be difficult to understand the biology.



Current life would be much more informative."

"The ability of MRO to observe for multiple Mars years and see the fine detail of these features has enabled findings such as these: first identifying the puzzling seasonal streaks and now making a big step towards explaining what they are," said Rich Zurek, MRO project scientist at NASA's Jet Propulsion Laboratory.

For Ojha, the new findings are more proof that the mysterious lines he first saw darkening Martian slopes as an undergraduate student five years ago are, indeed, present-day water.

"When most people talk about water on Mars, they're usually talking about ancient water or frozen water," he said. "Now we know there's more to the story. This is the first spectral detection that unambiguously supports our liquid water-formation hypotheses for RSL."

NEW CONCERNS

John Bridges, a professor of planetary science at the University of Leicester, said the study was interesting, but raises concerns for space agencies. The flows could be used to find water sources on Mars, making them prime spots to hunt for life, and to land future human missions.

"Agencies are required to do their maximum to avoid contaminating other planets with microbes from Earth, making wet areas the most difficult to visit," said Bridges. "This will give them lots to think about.

"For now, researchers are focused on learning where the water comes from. Porous rocks under the Martian surface might hold frozen water that melts in the summer months and seeps up to the surface.

"Another possibility," according to Bridges, "is that highly concentrated saline aquifers are dotted around beneath the surface, not as pools of water, but as saturated volumes of gritty rock. These could cause flows in some areas, but cannot easily explain water seeping down from the top of crater walls."

A third possibility, and one favoured by McEwen, is that salts on the Martian surface absorb water from the atmosphere until they have enough to run downhill. The process, known as deliquescence, is seen in the Atacama Desert, where the resulting damp patches are the only known place for microbes to live.

"It's a fascinating piece of work," Bridges said. "Our view of Mars is changing, and we'll be discussing this for a long time to come." →

Top: *Dark narrow streaks called recurring slope lineae emanating out of the walls of Garni crater. The dark streaks here are up to few hundred metres in length. They are hypothesized to be formed by flow of briny liquid water on Mars.* (Credits: NASA/JPL/University of Arizona)

Below: *The dark, narrow streaks flowing downhill on Mars at sites such as this portion of Horowitz Crater are inferred to be formed by seasonal flow of water on modern-day Mars. The streaks are roughly the length of a football field.* (Image: NASA/JPL-Caltech/Univ. of Arizona)