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Is there water on mars

Hydrolink

Is there water on Mars?

Written by:
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Italian Space Agency

Dr. Raffaele Mugnuolo joined Italian Space Agency on 1987, initially in space robotics development programme for ISS and planetary exploration applications. He was the ASI program manager for the Italian Sample Drill and Distribution system development, on board the Lander of the Rosetta Mission. Currently, he is the ASI program manager for the Italian scientific contribution to ExoMars Mission. In addition he is ASI responsible for the scientific participation to other solar system exploration missions, such as DAWN Mission, Venus Express and Bepi Colombo Mission.

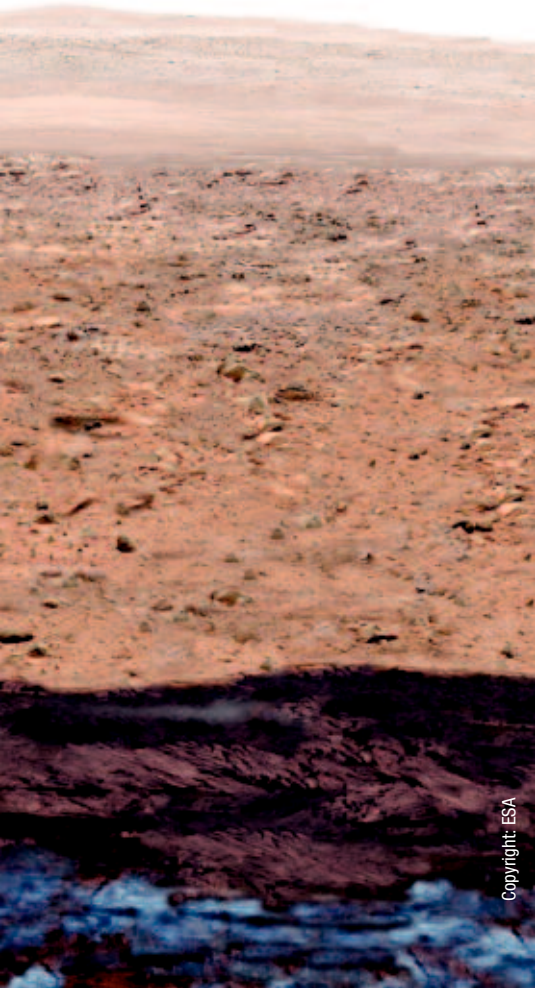
Exploring the red planet

Let's step back in to the past, to the end of 19th century. The *"canali"* (*channels*) observed by Giovanni Virginio Schiapparelli (an Italian Astronomer) referred to natural features on the Mars surface. A mistranslation of "*canali*" into *canals* gave rise to hypotheses and speculations about life on Mars. *Canals,* in fact, refers to artificial constructions, and this led many scientists to prove the existence of intelligent life on Mars.

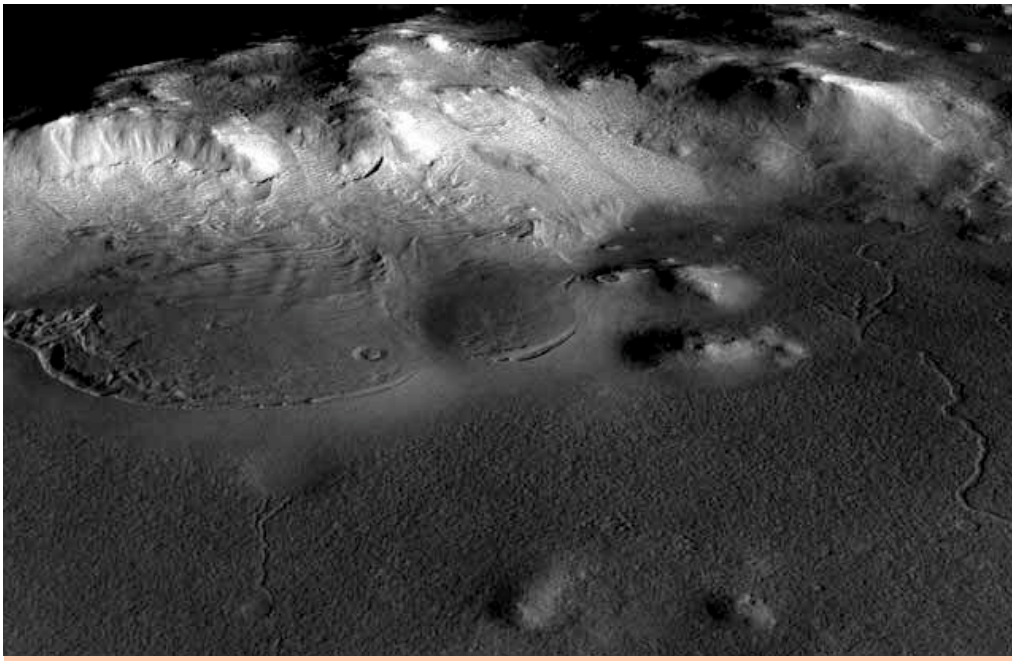
To determine wether life ever developed on Mars means to determine whether the Martian environment was ever suitable for life. On Earth, all forms of life need water to survive. It is likely, though not certain, that if life ever evolved on Mars, it did so in the presence of a long-standing supply of water.

Therefore, during the last decades Mars exploration programmes (Mars Global Surveyor, 2001 Mars Odyssey) have addressed the search for evidence of life in areas where liquid water was once stable, and below the surface where it still might exist today. Recent data suggest that liquid water may exist deep below the Martian surface as well as the ice water is present at the Martian poles. Further analysis of the great amount of data available will allow scientists to confirm those results.

Currently, an attention is focused on the ExoMars joint ESA/NASA Programme. ExoMars (Exo-biology on Mars) is in advanced design status and consists of two distinct missions. The first named "Trace Gas Orbiter Mission, will launched in 2016 and will carry also a demonstration lander. The Orbiter will conduct a survey of trace gases in the Mars atmosphere, in order to understand the nature of subsurface sources that produce gases, such as methane. The second mission, named ExoMars 2018, will be launched in 2018 (arriving in Mars 8 months later) and will release a rover vehicle on the Mars surface, equipped with several subsystems and scientific instruments selected to analyse the surface and sub-surface (up to 2 meters deep) samples. The rover will also collect and seal samples in canisters for future possible sample return mission.



ESA's ExoMars Rover provides key mission capabilities: surface mobility, subsurface drilling and automatic sample collection, processing, and distribution to instruments. It hosts a suite of instruments, known as the Pasteur payload, dedicated to exobiology and geochemistry research.
Depicts: ESA's ExoMars Rover



In this perspective view looking at the inside rim of Lyot Crater on Mars, a broad lobate debris apron (left) (thought to be a debris-covered glacier) is found amongst water-carved channels. The authors argue that these ice-rich units underwent melting in the relatively high-pressure environment provided by Lyot Crater, the deepest point in the northern hemisphere of Mars.

CREDIT: NASA/JPL/GSFC/Malin Space Science Systems

Follow the water

The exploration strategy adopted by NASA, and consequently by all the Agencies involved in Mars Exploration activities, can be summarised in the term "Follow the water". This approach begins with an understanding of the Mars environment in terms of soil and atmosphere features and its evolution. During the last decade, missions to Mars were mainly aimed at observing sub-surface water reserves, ice at the polar caps and particular soil samples related to presence of water in the past. Geological and climate evolution are the key topics to be investigated.

Fly-by missions

Missions to Mars during the 60's, were essentially fly-by missions, aimed at remote observation of the planet surface. The mariner missions belong to this class. In particular the Mars surface images from the Mariner-4 mission in 1965, analysed with other environment conditions (pressure, temperature, magnetic field) depicted a well defined scenario: there is no liquid water on the surface of mars.

These first results lead scientists to look for indirect evidence of water presence in the past. This means to perform observation by mean of orbiters and surface vehicles, equipped with instrumentation designed to detect soil sample features amenable to water presence.

Orbiter missions

Missions such as Mariner 8 and 9, and the Mars Reconnaissance Orbiter, are missions capable to insert of placing a satellite into Mars orbit in order to perform long term remote observations to detect water presence on the surface and sub-surface.

The Mars Express mission launched by ESA on 2003, had the objective of detecting the presence of sub-surface water presence. Its scientific payload included MARSIS *(the Mars Advanced Radar for Subsurface and Ionosphere Sounding)* developed in a NASA-ASI cooperation (by Prof. G. Picardi from "Università La Sapienza – Rome" as the Principal Investigator; and J. Plaut from NASA/JPL and R. Orosei from INAF). This sounding radar detected the ice deep under Martian surface (up to 5 Km). Moreover, the PFS *(Planetary Fourier Spectrometer)* on Mars Express detected the presence of ice on Mars polar cap (Prof. V. Formisano from INAF/IFSI is the Principal Investigator).

Instruments such as MARSIS and PFS revealed the presence of minerals related to water presence in a remote epoch.

Lander & Rover missions

Viking 1 and 2, Pathfinder, Polar Lander, Mars Exploration Rovers, Phoenix Mars Lander, are part of the missions that have released landers and rovers on the Mars surface to perform *in-situ* environment analysis. Phoenix Mars Lander, equipped with a set of instruments like a chemistry lab, detected water in sub-surface samples, which vaporized after their exposure to the air for some days.

Rover vehicles offer surface mobility and this opened new wide exploration scenarios to scientists, interacting with them from Earth. For ex-

ample, we can look for particular rocks and select them from Earth before undertaking sample analysis.

The Mars Exloration Rover mission, for example, released two rovers on the Mars surface. Both rovers operated from 2004 up to 2010. In particular, *Spirit* detected trace of carbonate in soil samples: this is an evidence that water and carbon dioxide interacted, in the past.

The next step

The future of Mars exploration missions will be aimed at returning Mars samples back to Earth and to investigate the sub-surface looking for the presence of water.

Mars sample return missions represents the natural step forward the exploration of Mars in order to have available Mars soil and atmosphere samples in a laboratory on Earth.

Exploring the deep Mars sub-surface could help scientists to better understand the geology of the planet, as well as to look for water presence that could answer the main question: was Mars ever a suitable habitat for life?

Italian contribution to Mars Exploration

Italy is strongly involved in Mars Exploration activities since 1990. The Italian Space Agency (ASI) supportted participation in Mars Missions in terms of both scientific and engineering contributions. Currently, Italy is one of the major contributors to the ExoMars mission. Firms involved include Thales Alenia Space, Kayser Italia, and Selex Galileo. The scientific community involved in Mars Exploration Programme includes INAF (National Institute for Astro-Physics) with several university departments, University of Rome "La Sapienza", International Research School for Planetary Science, University of Padua/CISAS and several department from the National Council of Research.

Lava likely made river-like channel on Mars

"Whether channels on Mars were formed by water or by lava has been debated for years and the outcome is thought to influence the likelihood of finding life there"

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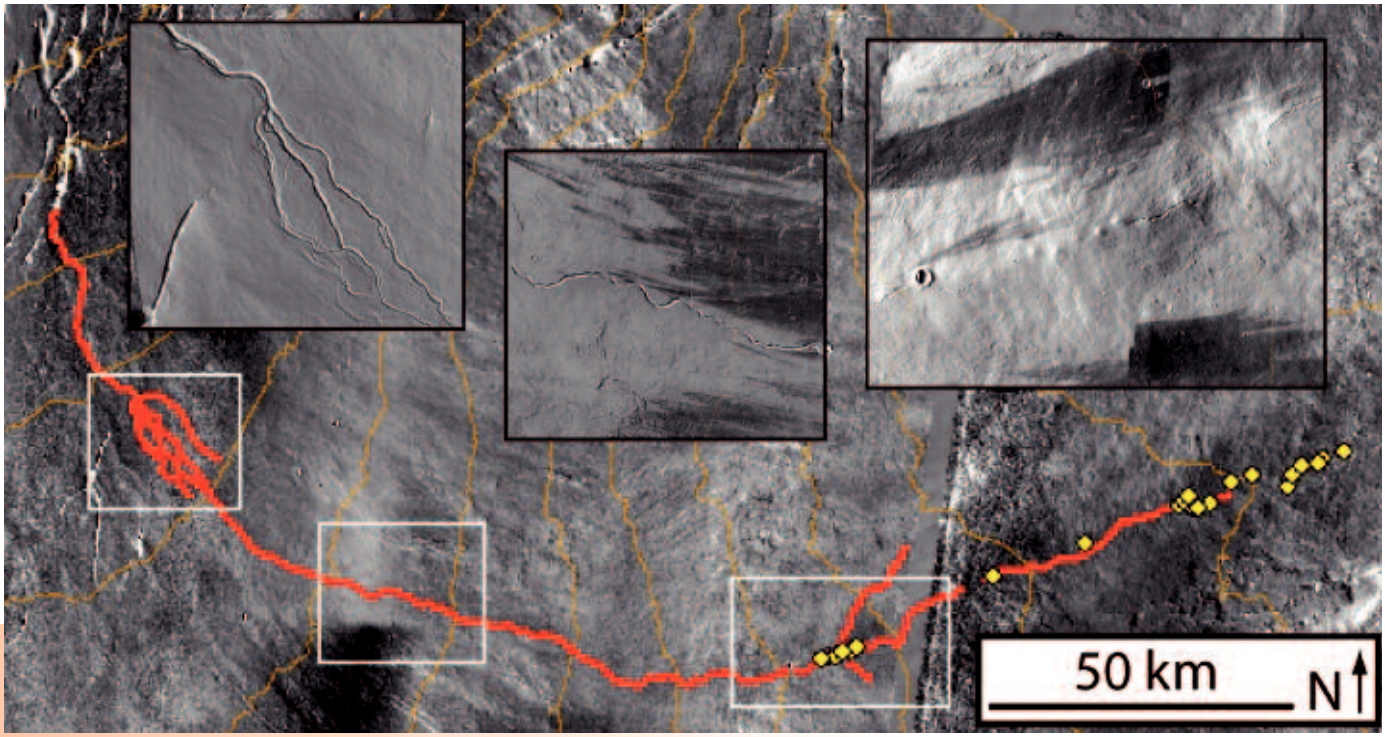
Dr. Elizabeth Zubritsky is a science writer working for ADNET Systems at NASA's Goddard Space Flight Center in Greenbelt, Maryland. An engineer and molecular biologist by training, her love of words led to her study journalism, as well. She has written and edited news about analytical chemistry, lab-on-a-chip systems, proteomics, and environmental science. At Goddard she specializes in planetary science, which ties together the elements of her wide-ranging background.

Flowing lava can carve or build paths very much like the riverbeds and canyons etched by water, and this probably explains at least one of the meandering channels on the surface of Mars. These results were presented this morning at the 41st Lunar and Planetary Science Conference by Jacob Bleacher at NASA's Goddard Space Flight Center, Greenbelt, Md. Whether channels on Mars were formed by water or by lava has been debated for years, and the outcome is thought to influence the likelihood of finding life there.

"To understand if life, as we know it, ever existed on Mars, we need to understand where water is or was," says Bleacher. Geologists think the water currently on the surface of Mars is either held in the soil or takes the form of ice at the planet's north and south poles. But some researchers contend that water flowed or pooled on the surface sometime in the past; water in this form is thought to increase the chance of some form of past or present life.

One of the lines of support for the idea that water once flowed on Mars comes from images that reveal details resembling the erosion of soil by water: terracing of channel walls, formation of small islands in a channel, hanging channels that dead-end and braided channels that branch off and then reconnect to the main branch. "These are thought to be clear evidence of fluvial [water-based] erosion on Mars," Bleacher says. Lava is generally not thought to be able to create such finely crafted features.

Bleacher and his colleagues carried out a careful study of a single channel on the southwest flank of Mars' Ascraeus Mons, one of the three Tharsis Montes volcanoes. The researchers relied on detailed images from three cameras: the Thermal Emission Imaging System (THEMIS), the Context Imager (CTX) and the High/Super Resolution Stereo Color (HRSC) imager, as well as earlier data from the Mars Orbiter Laser Altimeter (MOLA). From these images, the team pieced together more than



Details from the Ascraeus channel (red), meandering across the surface of Mars. The insets in the black boxes show close-ups of some of the structures that lava can form: (left) branched channels, (middle) a snaking channel and (right) rootless vents; the rootless vents are also marked by yellow spots on the main image. Credit: Jacob Bleacher, NASA Goddard Space Flight Center

270 kilometers (~168 miles) of the channel.

At the source of the channel, the visual clues seem to point to water. But at the channel's other end, an area not clearly seen before, Bleacher and colleagues, including Andy de Wet of Franklin & Marshall College, Lancaster, Penn., found a ridge that appears to have lava flows coming out of it. In some areas, "the channel is actually roofed over, as if it were a lava tube, and lined up along this, we see several rootless vents," or openings where lava is forced out of the tube and creates small structures, he explains. These types of features don't form in water-carved channels, he notes.

Bleacher argues that having one end of the channel formed by water and the other end by lava is an "exotic" combination. More likely, he says, the entire channel was formed by lava.

Evidence that lava can produce finely detailed features came from a survey by Bleacher, along with W. Brent Garry and Jim Zimbelman of the Smithsonian Institution in Washington, of the 51-kilometer (32 mile) lava flow from the 1859 eruption of Mauna Loa on Hawaii. Their main focus was an island nearly a kilometer long in the middle of the channel.

"We found terraced walls on the insides of these channels, channels that go out and just disappear, channels that cut back into the main one, and vertical walls 9 meters (~29 feet) high," Bleacher says. "So, right here, in something that we know was formed only by flowing lava, we found most of the features that were considered to be diagnostic of water-carved channels on Mars."

Further evidence came from the examination of a detailed image of the Mare Imbrium, a dark patch on the moon that is actually a large crater filled with ancient lava rock. Here, too, the researchers found channels with terraced walls and branching secondary channels.

Bleacher says the team's conclusions do not rule out the possibility of flowing water on Mars, nor of the existence of other channels carved by water. Even so, he adds, the findings have implications for the geological evolution of this volcanic region of Mars and could ultimately change our ideas about water's role in the geological evolution of Mars.

Philip Christensen of Arizona State University is the principal investigator for the THEMIS instrument on the Mars Odyssey orbiter, and Mike Malin of Malin Space Science Systems is the principal investigator for the CTX instrument aboard the Mars Reconnaissance Orbiter. Both missions are managed by NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif. MOLA was aboard the Mars Global Surveyor, built by JPL.

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