Mars-Like places on Earth give new insights into rover data and conditions for life

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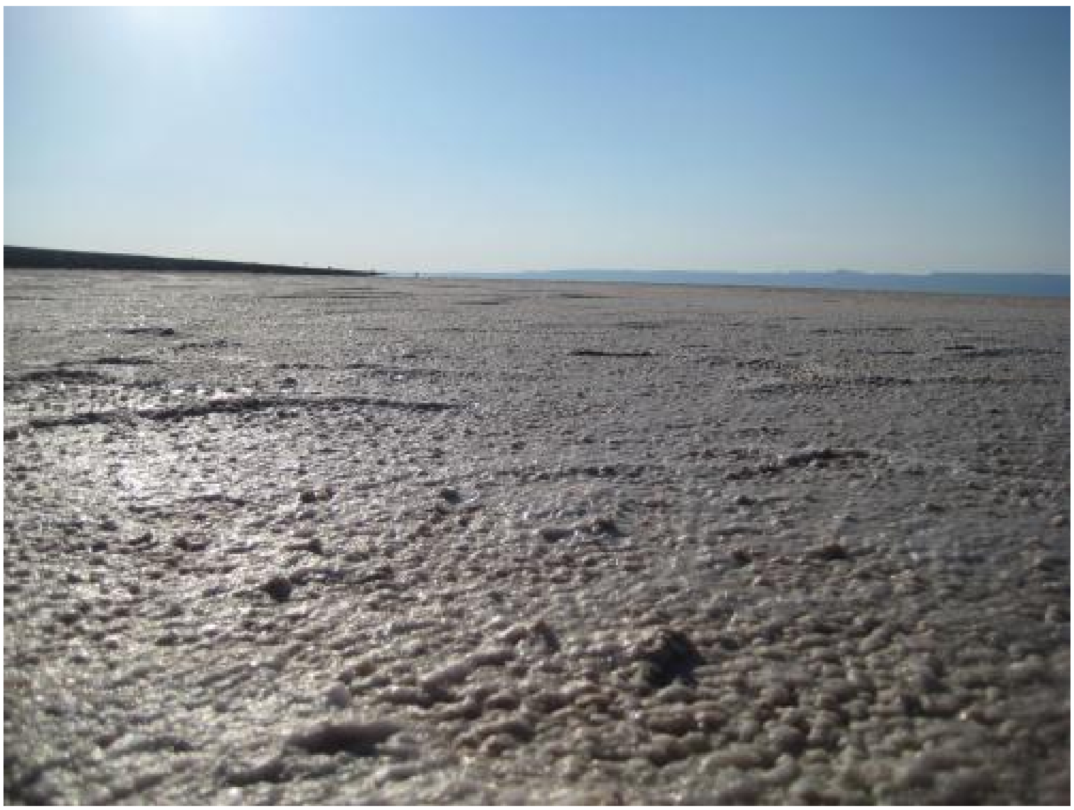


The salt pan at Chott el Jerid. Credit: Felipe Goméz/Europlanet

Life thrives on Planet Earth. In even the most inhospitable places – the freezing Antarctic permafrost, sun-baked saltpans in Tunisia or the corrosively acidic Rio Tinto in Spain – pockets of life can be found. Some of these locations have much in common with environments found on Mars, as discovered by orbiters and rovers exploring the surface.

Researchers from the Centro de Astrobiología (CAB) in Madrid have made a series of field trips to the most Mars-like places on Earth. Today, they presented some of their findings during a press conference at the European Planetary Science Congress in Madrid.

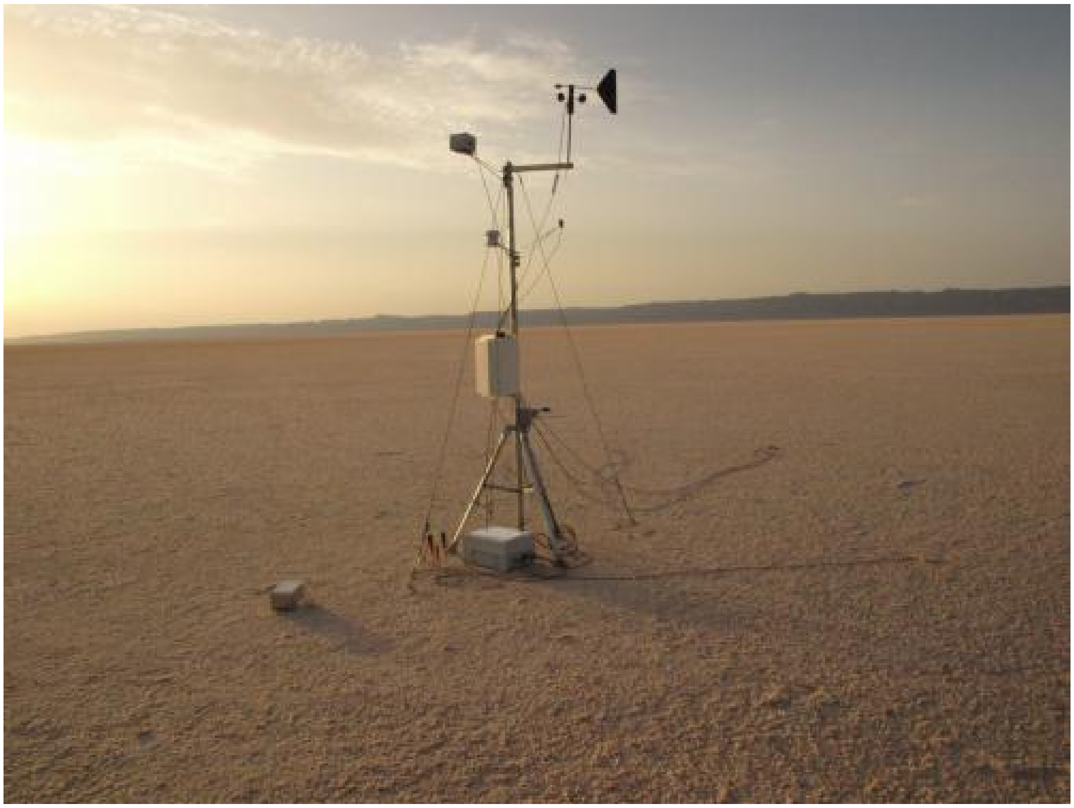
Dr Felipe Goméz, the project leader said, "The big questions are: what is life, how can we define it and what are the requirements for supporting life? To understand the results we receive back from missions like Curiosity, we need to have detailed knowledge of similar environments on Earth. Metabolic diversity on Earth is huge. In the field campaigns, we have studied ecosystems in situ and we have also brought samples back to the laboratory for further analysis. We have found a range of complex chemical processes that allow life to survive in unexpected places."

Over the past 4 years, the team has carried out field trips to Chott el Jerid, a salt pan in Tunisia, the Atacama desert in Chile, Rio Tinto in Southern Spain and Deception Island in Antarctica.

CHOTT EL JERID AND ATACAMA

Goméz and his colleagues visited Chott el Jerid salt pan 3 times between 2010 and 2012 and Atacama desert in 2010.

The team set up weather stations at a series of locations at each site. The weather stations measured surface and air temperatures, humidity, ultraviolet radiation levels, wind direction and velocity. The data collected from these field campaigns is comparable to the data now being collected by the Remote Meteorological Monitoring Station (REMS) carried by Curiosity, which was built by a team from CAB-INTA.



The weather station at Chott el Jerid. Credit: Felipe Goméz/Europlanet

"We studied measurements in different locations over several daily cycles. As well as the large-scale changes to all the parameters through the day, we observed a small rise in the surface temperature after dusk. We found that this is caused by water condensing on the surface and hydrating salts, which releases heat in an exothermic reaction. This is very interesting from the perspective of the REMS instrument on Curiosity – it gives us a way to follow when liquid water might be present on the surface," said Goméz. Cloud cover in the sky could also be tracked through fluctuations in measurements of the solar radiation and luminosity (ultraviolet flux variations). "The correlations we've found between these parameters and cloud cover means that we can use Mars orbiter measurements of cloud conditions to give us an indication of changes that are going on at the surface," said Goméz.

The team used probes to study the electrical properties of the soil. By studying changes in resistivity with depth, they were able to identify different materials underground and the water-content. By setting up criss-crossing 'transepts' of resistivity probes, the teams were able to build up a 3-dimensional picture of the structure of the subsurface.

They also drilled samples to a depth of 3.6 metres in Chott El Jerid and to 6 metres in Atacama. The core samples showed subsurface ecosystems of completely different kinds of bacteria from those found on the surface. The populations of bacteria found at the surface decreased with depth, but there was an increase in archaea, and also single-celled halophilic organisms that are able to oxidize metabolites under aerobic and anaerobic conditions. "In both Atacama and Chott El Jerid, we found ecosystems at a depth of a few metres that were completely isolated from the surface," said Goméz.

The surface of Chott El Jerid salt pan is very pure sodium chloride with traces of other salts. The team found small accumulations of organic matter inside the salt crystals. When they analysed the samples, they found that these were populations of halophilic, salt-loving bacteria that were dormant.

Goméz said, "This was a really exciting find. These condensed accumulations of halophilic bacteria could have been dormant for possibly hundreds of years. Back in the laboratory, we were able to rehydrate the samples and restore the bacteria to life."

Photosynthetic bacteria at Rio Tinto. Credit: Felipe Goméz

RIO TINTO

The Mars Exploration Rover, Opportunity, discovered jarosite on the surface of Mars. Jarosite is only synthesised in the presence of water and contains very high concentrations of metals, such as iron. The team studied outcrops of jarosite at Rio Tinto, areas that have extraordinarily high levels of acidity. Unexpectedly, they found photosynthetic bacteria growing between the layers in salt crusts. When they analysed the bacteria back in the laboratory, they made a further discovery: that iron appears to protect the bacteria from ultraviolet radiation.

Goméz explains, "We took two samples of the bacteria, one with iron present and one without and exposed them to high levels of ultraviolet radiation. For the sample without iron, nearly all the bacteria were destroyed. For the sample with iron present the population survived. There was a small increase due to toxic super-oxides being created, but the protective effect of ferric compounds was significant."

Their findings have implications for the development of life on the Earth: early in its formation, the Earth had no oxygen and its atmosphere would not have given the protection from ultraviolet radiation that it provides today.

"What the bacteria we found in Rio Tinto show is that the presence of ferric compounds can actually protect life. This could mean that life formed earlier on Earth than we thought. These effects are also relevant for the formation of life on the surface of Mars," says Goméz. The team also found that salt provides stable conditions that can allow life to survive in very hard environments.

"Within salts, the temperature and humidity are protected from fluctuations and the doses of ultraviolet radiation are very low," explained Goméz. "In the laboratory, we placed populations of different bacteria between layers of salt a few millimetres thick and exposed them to Martian conditions. Nearly 100% of deinoccocus radiodurans , a hardy type of bacteria survived being irradiated. But fascinatingly, about 40% of acidithiobacillus ferrooxidans – a very fragile variety of bacteria also survived when protected by a salt crust."

Provided by European Planetary Science Congress