Scientists identify mineral that destroys organic compounds, with implications for Mars Curiosity mission

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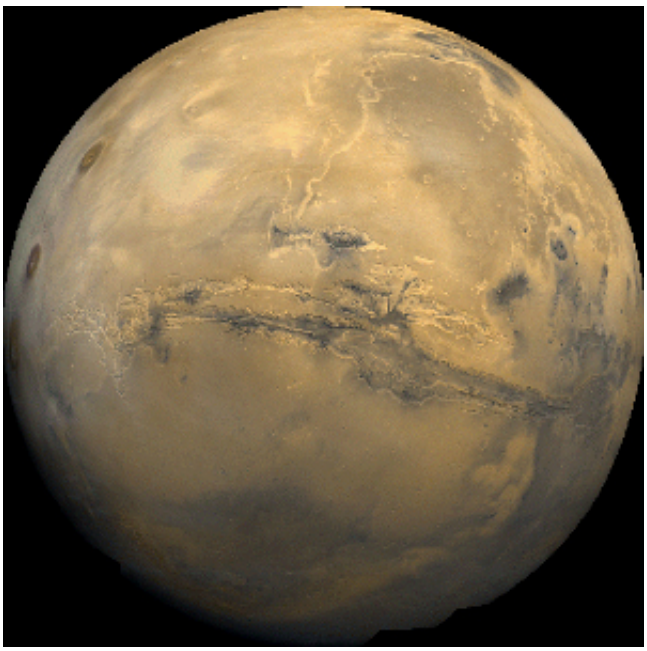

Valles Marineris, Mars. Credit: NASA

Scientists have discovered that the mineral jarosite breaks down organic compounds when it is flash-heated, with implications for Mars research.

Jarosite is an iron sulphate and it is one of several minerals that NASA's Curiosity Mission is searching for, as its presence could indicate ancient habitable environments, which may have once hosted life on the red

planet.

In a new study published today in the journal *Astrobiology*, researchers from Imperial College London and the Natural History Museum replicated a technique that one of the Curiosity Rover's on-board instruments is using to analyse soil samples, in its quest to find organic compounds. They tested a combination of jarosite and organic compounds. They discovered that the instrument's technique -which uses intense bursts of heat called flash-heating - broke down jarosite into sulphur dioxide and oxygen, with the oxygen then destroying the organic compounds, leaving no trace of it behind.

The concern is that if jarosite is present in soil samples that Curiosity analyses, researchers may not be able to detect it because both the jarosite and any organic compounds could be destroyed by the flash-heating process.

In 2014, Professor Mark Sephton, co-author of today's study, investigated the mineral perchlorate. This mineral also causes problems for flash-heating experiments as it breaks down to give off oxygen and chlorine gas, which in turn react with any organic compounds, breaking them down into carbon dioxide and water. Professor Sephton showed that though perchlorate was problematic, scientists could potentially use the carbon dioxide resulting from the experiment to detect the presence of organic compounds in the sample being analysed.

Professor Sephton, from the Department of Earth Science and Engineering at Imperial College London, said: "The destructive properties of some iron sulphates and perchlorate to organic matter may explain why current and previous missions have so far offered no conclusive evidence of organic matter preserved on Mars' surface. This is despite the fact that scientists have known from previous studies that organic compounds have been delivered to Mars via comets, meteorites

and interplanetary dust throughout its history."

To make Curiosity's search for signs of life more effective, the team are now exploring how Curiosity might be able to compensate for the impact of these minerals on the search for organic compounds. Their work could have important implications for both the Curiosity mission and also the upcoming European-led ExoMars 2018 Rover mission, which will be drilling for subsurface samples of the red planet and using the same flash-heating method to look for evidence of past or present alien life.

James Lewis, co-author of the study from the Department of Earth Science and Engineering at Imperial College London, added: "Our study is helping us to see that if jarosite is detected then it is clear that flash-heating experiments looking for organic compounds may not be completely successful. However, the problem is that jarosite is evidence of systems that might have supported life, so it is not a mineral that scientists can completely avoid in their analysis of soils on Mars. We hope our study will help scientists with interpreting Mars data and assist them to sift through the huge amount of excellent data that Curiosity is currently generating to find signs that Mars was once able to sustain life."

On Earth, iron sulphate minerals like jarosite form in the harsh acidic waters flowing out of sulphur rich rocks. Despite the adverse conditions, these waters are a habitat for bacteria that use these dissolved sulphate ions. This makes these minerals of great interest to scientists studying Mars, as their presence on the red planet provide evidence that acidic liquid water was present at the same time the minerals formed, which could have provided an environment favourable for harbouring ancient microbial Martian life.

On board Curiosity, the Sample Analysis at Mars (SAM) instrument

analyses soil samples for evidence of organic compounds by progressively heating samples up to around 1000 C, which releases gases. These gases can then be analysed by techniques called gas chromatography and mass spectrometry, which can identify molecules in the gas and see if any organic compounds are present. It is these SAM instrument experiments that the researchers behind today's study replicated with jarosite and organic compounds.

The researchers stress that not all sulphates break down to react with organic compounds. For example, those containing calcium and magnesium would not break down until extremely high temperatures were reached during the analysis, and therefore would not affect any organic compounds present.

The team suggest that if jarosite is found in samples on Mars, then it may be possible for Curiosity's SAM instrument to distinguish a spike in carbon dioxide level, which, as Professor Sephton has shown previously with perchlorate, would act as an indicator that organic material is present and being broken down by the heating process.

The next step will see the researchers using synthetic jarosite in their experiments, which will enable a cleaner decomposition process to occur when the mineral is flash-heated. This will allow for more precise quantitative measurements to be taken when the oxygen is being released. Ultimately, they hope this will enable more precise calculations to be carried out on Mars mineral samples to find ways in which Curiosity can identify the presence of these mineral to mitigate their impact on organic matter.

More information: "Sulfate minerals: a problem for the detection of organic compounds on Mars" published in the journal *Astrobiology* on Tuesday 17 February2015.

Provided by Imperial College London