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Elevated zinc and germanium levels bolster evidence for habitable environments on Mars

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This view from the Mast Camera (Mastcam) on NASA's Curiosity Mars rover shows a site with a network of prominent mineral veins below a cap rock ridge on lower Mount Sharp. The APXS instrument on Curiosity discovered unusual material in these veins that has the highest germanium concentrations found in Gale Crater. Credit: NASA

New data gathered by the Mars Curiosity rover indicates a potential history of hydrothermal activity at Gale Crater on the red planet, broadening the variety of habitable conditions once present there, scientists report in a new study.

Researchers found concentrations of the elements zinc and germanium to be 10 to 100 times greater in sedimentary rocks in Gale Crater compared to the typical Martian crust.

Zinc and germanium tend to be enriched together in high temperature fluids and often occur together on Earth in hydrothermal deposits containing sulfur. The elevated concentrations of zinc and germanium in Gale Crater can potentially be explained by hydrothermal activity that occurred in the region, according to Jeff Berger, a geologist at the University of Guelph, in Ontario, Canada and lead author of the new study published in *Journal of Geophysical Research*: Planets, a journal of the American Geophysical Union.

Extreme thermal environments on Earth are home to a diverse array of microbial life adapted to these conditions, and these organisms may have been some of the first to evolve on Earth.

Evidence of possible hydrothermal activity has been found by other Mars rovers in other locations on the red planet and in Martian meteorite samples. Researchers have used computer simulations, laboratory experiments and investigation of hydrothermal sites on Earth to try to understand potential past hydrothermal activity on Mars.

Now with potential evidence for hydrothermal conditions once present inside or near Gale Crater, Curiosity's mission takes another step toward determining if there were favorable environmental conditions for microbial life on Mars, according to the study's authors. Hydrothermal deposits are more likely to preserve evidence of microbial life or its precursors, according to Berger.

"You have heat and chemical gradients … conditions favorable for the genesis and persistence life," Berger said.

The new measurements come from the Alpha Particle X-Ray Spectrometer (APXS) on the Curiosity rover, which is exploring Mount Sharp in Gale Crater, the rover's landing site.

Gale Crater formed 3.5 to 3.8 billion years ago from a meteor impact early in Mars's history. Over a period of several hundred million years after the impact, the crater was filled in with 1 to 2 kilometers (0.6 to 1.25 miles) of sediment from its rim. Previous research has shown evidence that this process of filling Gale Crater with sediment was associated with a lake and streams that probably existed intermittently for thousands to millions of years.

The rock record at Gale crater is fundamental for determining if Mars had environmental conditions favorable for microbial life, according to NASA. The new research illuminates what may have happened before and after the formation of the lake, according to Ashwin Vasavada, Curiosity mission project scientist at the NASA Jet Propulsion Laboratory in Pasadena, California, who was not a part of the new study.

In the new study, researchers used data from the Mars Science Laboratory APXS mounted on Curiosity's robotic arm to measure 16 major, minor and trace elements in the rocks at Gale Crater, including zinc, in addition to the Chemistry and Mineralogy instrument in the rover's body, which analyzes samples from its drill and scoop.

At concentrations that have been estimated for the average Martian crust, germanium is below the detection limit of the APXS instrument and scientists did not expect to see it. So when the data was analyzed for elements beyond the main 16 elements, the researchers were surprised to find germanium, like zinc, is at concentrations up to 100 times higher than in the average Martian meteorite, and even 300 times higher in one vein, Berger said. The new study is the first to include APXS measurements of germanium during the rover's first 1,360 sols, according to the study's authors. A sol is a Martian day, which is 24 hours and 39 minutes long.

Germanium tends to follow silicon in the rocks on Mars, in a predictable ratio of germanium to silicon. The new study found germanium in Martian rocks that was not in its typical relationship with silicon and did not show the standard germanium-silicon ratio.

The presence of zinc and germanium clustered together in such high concentrations points to the potential for hydrothermal activity, according to the study's authors. These elements have an affinity for each other in minerals that solidify out of high temperature fluids and often occur together on Earth in hydrothermal deposits containing sulfur.

If the target region on Mars had sufficient water when Gale Crater was formed by a meteor impact, the energy of the impact could have heated the crust and caused the fluids to circulate in a hydrothermal system, which could have concentrated zinc and germanium, according to Berger. The elements could also have been concentrated by volcanic and impact activity that occurred before Gale Crater was formed. These enriched sediments could have then been carried by water, wind, and gravity to Gale Crater, he said.

The potential presence of hydrothermal systems during Mars' ancient history adds to a "whole variety of conditions that might all fall under the umbrella of being habitable," Vasavada said.

More information: Jeff A. Berger et al. Zinc and germanium in the sedimentary rocks of Gale Crater on Mars indicate hydrothermal enrichment followed by diagenetic fractionation, *Journal of Geophysical Research: Planets* (2017). DOI: 10.1002/2017JE005290

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