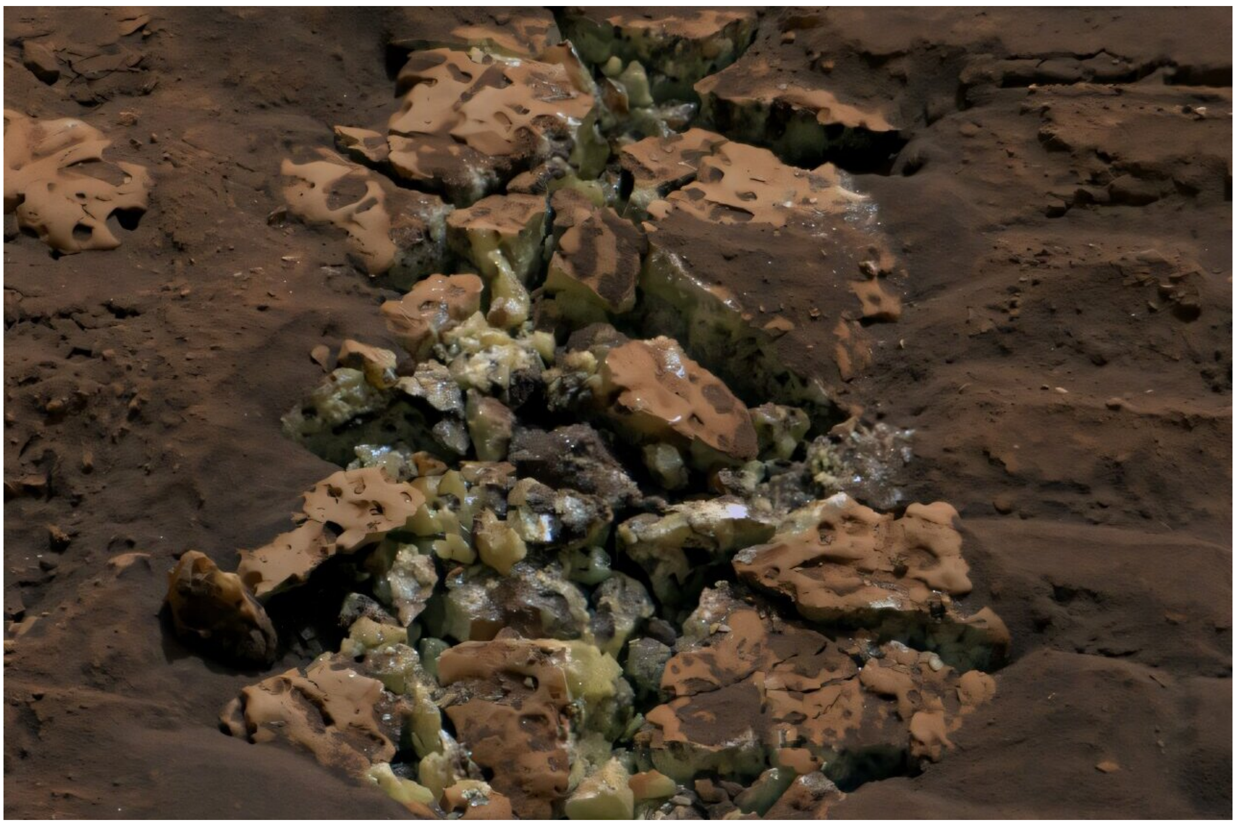
Ancient asteroid impact may explain Curiosity's first pure sulfur crystals on Mars

July 14 2026, by Sayan Tribedi



Curiosity's rover cameras captured these yellow sulfur crystals after the rover accidentally cracked the host rock. Credit: NASA/JPL-Caltech/MSSS.

The bright yellow sulfur crystals discovered by NASA's Curiosity rover have puzzled scientists because sulfur on Mars is normally associated with mineral formations, not elemental deposits.

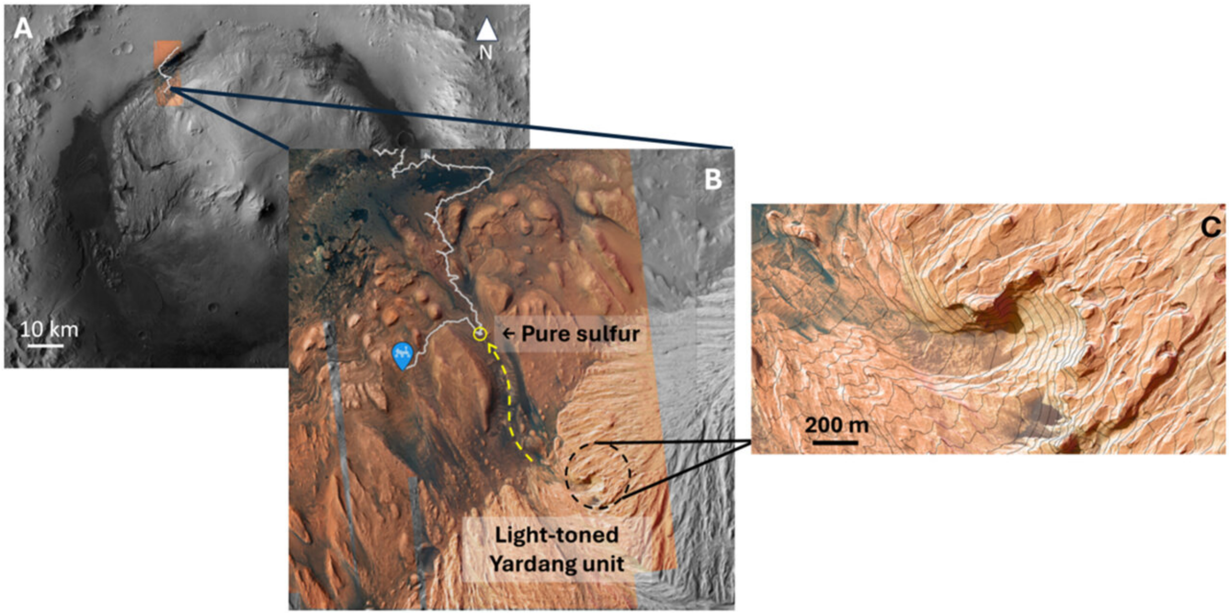
In early 2024, the Curiosity rover made an unexpected discovery: Its wheels had unintentionally split the surface of a rock, revealing glittering yellow crystals beneath it. Later lab tests showed that the crystals were pure elemental sulfur—a form of sulfur never seen on Mars before.

The discovery was accompanied by many other sulfur-containing rocks nearby, raising questions about how sulfur, an element normally found in minerals on Mars, can appear in pure elemental deposits.

In a recent study, Luca Maggioni and colleagues, published in Icarus, suggest that millions of years ago, a meteor strike could have melted a sulfur layer, forming a molten sulfur pool that eventually transformed into the sulfur crystal deposit observed on Mars today.

Unraveling the Martian sulfur mystery

On Earth, elemental sulfur usually comes from volcanoes or hot springs. But there is no obvious volcanic source in Gale Crater, where Curiosity made its discovery, adding to the mystery of these Martian sulfur crystals.



This map of Gale Crater on Mars highlights the Curiosity rover's traverse (white line) and the precise location where the pure native sulfur deposit was found (yellow circle). Crucially, it also points to the proposed source: a distinct, breached crater (approximately 390 meters across) within the light-toned 'Yardang unit.' A dashed yellow line illustrates the hypothetical downhill flow path of molten sulfur from this impact site to where Curiosity made its discovery. Credit: Luca Maggioni et al, Impact-induced melting of materials with sparse thermodynamic data: The case of native sulfur on Mars, *Icarus* (2026). DOI: 10.1016/j.icarus.2026.117244

Scientists found one clue: a breach in the crater wall upslope, about 390 meters wide (about 1,280 feet). This collapsed pit, situated in the light-colored "yardang" rock unit, has the characteristics of an ancient impact crater.

One possibility is that melted material from this impact ran downhill and eventually formed the deposits Curiosity saw. This possibility could offer new insight into Mars' geological history.

Could a meteor melt Mars' sulfur?

To test the impact idea, Maggioni and colleagues ran computer simulations of asteroids slamming into sulfur-laden ground. They used the iSALE shock-physics code to model vertical impacts that would create an approximately 390 m crater (about 1,280 feet), matching the upland depression.

Because no high-pressure model exists for sulfur, the team approximated the bedrock as basalt with a small sulfur fraction. After each simulated hit, they calculated how much sulfur would melt and stay liquid inside the crater.

The results showed that only a modest pool of liquid sulfur remained unless the ground was extremely sulfur-rich. For example, assuming about 50% sulfur yields a crater pool of about 1.3×10^7 kg—about the same order of magnitude as the deposit Curiosity saw.

Curiosity's high-resolution color image shows part of Gale Crater, where scientists suspect an ancient impact may have created molten sulfur. Credit: NASA/JPL-Caltech/MSSS.

As one researcher notes, "Our model indicates that impacts can generate molten sulfur, but any substantial production requires significant sulfur enrichment within the target unit."

Molten sulfur flows surprisingly well—above about 115 °C (about 239 °F), it remains liquid up to about 219 °C (about 426 °F), and at those temperatures, the fluid is nearly as runny as water. A sulfur melt could plausibly pour downhill from the crater before freezing.

Simulations vs. reality: The limitations

Even so, there are major uncertainties. The model used vertical strikes and solid basalt (ignoring porosity) and did not simulate downstream sulfur flow. With no reliable high-pressure model, it treated sulfur as a minor basalt ingredient.

If the actual rock was far richer in sulfur or if an impact was glancing, the results could differ. Curiosity will soon visit the Yardang unit. As the team notes, arriving there "will provide a unique opportunity to test this impact-melting hypothesis."

Future work will test angled strikes and refine how sulfur is modeled at high pressures. For now, this impact scenario is one plausible explanation, but it gives researchers a concrete prediction to check with upcoming rover observations. If Curiosity confirms an ultra-sulfur-rich source rock in the Yardangs, the impact explanation would gain support.

If the meteor idea holds up, it offers a new way to interpret how Mars concentrates unusual minerals. The researchers emphasize that "this study establishes meteoritic impact as a viable mechanism to produce deposits of pure native sulfur from sulfur-bearing soils on Mars."

It's a reminder that rover observations, satellite mapping and simulations can together reveal the planet's dramatic past.

More information: Luca Maggioni et al, Impact-induced melting of materials with sparse thermodynamic data: The case of native sulfur on Mars, *Icarus* (2026). DOI: 10.1016/j.icarus.2026.117244

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