Name: _____ Date: _____

The Rust That Remembers Water

Reading level 14 · 1335 words

Most books give the same short answer to why Mars is red: the iron in its rocks and dust has rusted. The answer is correct, and it is old; the ancient Egyptians already called the planet "the red one." But "rust" is a family name, not a single substance. Iron combines with oxygen to make several different minerals, and each one forms under its own conditions of heat, acidity and water. So the more interesting question is which rust colors Mars, and when it formed. In 2025 a team of scientists offered a new answer, and if they are right, the color of the planet is a record of water that vanished billions of years ago.

Up close, Mars is not especially red. Rover cameras show brown, gold and tan ground. What reddens the planet is the dust: grains so fine that winds lift them high into the air, where they tint the whole disk as seen from Earth. For decades the leading idea was that this dust got its color from anhydrous hematite, a kind of rust that holds no water. In that picture the rusting happened slowly and dryly, through ordinary weathering over the last three billion years or so, a long stretch of Martian history that geologists call the Amazonian period. A planet that rusted dry would tell us very little about its wet past.

The 2025 study was led by Adomas Valantinas, a researcher at Brown University and the University of Bern, and published in Nature Communications. It argued instead that the main rust in Martian dust is ferrihydrite. Ferrihydrite is poorly crystalline, meaning its atoms are only loosely ordered, and it holds water inside its structure. The team did not find it by digging. They compared the light reflected by Martian dust, measured from orbit and by rovers, with the light reflected by powders mixed in a laboratory. A very fine blend of ferrihydrite and ground basalt, a dark volcanic rock, mixed one part to two by weight, closely matched the dust seen from orbit. Adding a little sulfate, a kind of salt, made the match better still.

Ferrihydrite matters because of where it comes from. On Earth it forms quickly when dissolved iron meets oxygen in cool water that is close to neutral, neither strongly acidic nor strongly alkaline. If it gets warm, it turns into hematite, whose atoms sit in neat rows. If water stays around, it turns into another mineral, goethite. Its survival is therefore a kind of timestamp. The researchers also kept it for forty days under fake Martian conditions: ultraviolet light and a thin carbon dioxide atmosphere at about six millibars. It kept its structure and did not turn into any other mineral. That suggests the mineral formed long ago in cold water and has simply waited, unchanged, in the dust ever since.

The rest of the evidence for an ancient wet Mars is easier to see. Orbiters have photographed branching river valleys, deltas where those rivers dropped their sediment, and the flat floors of old lakes. Rocks on the surface contain minerals that form only in liquid water, and some

landforms suggest enormous floods roughly 3.5 billion years ago. Today none of that water flows. The air is now so thin that liquid water cannot last long on the surface, and much of the water that remains is ice, some of it hidden just under the ground near the poles. The puzzle, then, is not whether Mars was wet. It is how a planet loses rivers, lakes and a thick atmosphere, and where all of it went.

Part of the answer came from MAVEN, a NASA orbiter launched in 2013 to measure gas leaking off the top of the atmosphere. The culprit is the solar wind, a stream of charged particles that leaves the Sun at about a million miles an hour. As it sweeps past Mars, it makes an electric field that speeds up charged atoms in the upper air and flings them into space. MAVEN measured a loss of about 100 grams, roughly a quarter pound, every second. Bruce Jakosky, who led the mission, compared it to the theft of a few coins from a cash register every day: trivial at any moment, enormous over billions of years.

A quarter pound a second describes Mars today. To estimate the total loss over the planet's history, the team used argon, a noble gas that reacts with nothing and so cannot be locked away in rocks. The only way argon leaves Mars is by sputtering, in which particles carried by the solar wind slam into the upper atmosphere and knock atoms loose. Argon also comes in two forms, or isotopes, one lighter than the other. The lighter one escapes more easily, so the longer the leak runs, the more the remaining air is enriched in the heavy kind. By measuring that enrichment, MAVEN and the Curiosity rover together showed that about 65 percent of the argon that was ever in Mars's air has been lost to space.

From the argon figure the team worked out how much carbon dioxide sputtering must also have removed, and concluded that most of the planet's carbon dioxide has been lost to space as well. That is a minimum, because other processes remove carbon dioxide too. Since carbon dioxide traps heat, losing it cooled the planet. The young Sun also produced far stronger ultraviolet light and solar wind than it does now, so the leak was probably much faster early on. One more clue sits in the crust. Mars has no global magnetic field today, yet parts of its southern rocks are strongly magnetized, leaving traces of a field that existed about four billion years ago.

If Mars was once wet, could it also have been alive? In July 2024 the Perseverance rover examined a rock nicknamed Cheyava Falls in an ancient river valley that once drained into Jezero Crater. The rock carried a pattern of spots the team called leopard spots, holding two iron minerals, vivianite and greigite. On Earth, vivianite is often found around decaying plant and animal matter, and some microbes make greigite. NASA calls the sample drilled from the rock, Sapphire Canyon, a potential biosignature: a feature that might come from life but needs more study. The same minerals can form without life, and the mission's project scientist stated the rule plainly: claims of past life on another world require extraordinary evidence.

Both the ferrihydrite result and the leopard spots end in the same place, with a sample that

has not yet reached Earth. Light measured from orbit can show which mineral fits best. It cannot show how hot the water was, or whether microbes helped shape it. Valantinas has said that samples brought back to Earth could supply the deciding evidence, because isotopes of iron, hydrogen and oxygen measured in a laboratory might reveal the water's temperature and source. Sapphire Canyon is also still on Mars, one of the rock cores Perseverance has collected. NASA's planned mission to bring those cores home was canceled in 2026. Nobody can yet say when, or whether, they will reach Earth. Meanwhile MAVEN has fallen silent after more than eleven years in orbit. Twin orbiters called ESCAPADE are due to reach Mars in September 2027 to keep studying how the solar wind strips its air.

So the red of Mars may be a kind of handwriting. If the study holds, the dust was rusted by cool water during a cold, wet time on early Mars, before most of its air was carried off into space by the Sun. The planet still shows that history every time it rises in the night sky as a bright red point of light. What nobody yet knows is how long that water lasted, whether anything ever lived in it, and whether the proof is sitting in a rock core on Mars right now. If you could bring back only one sample from Mars, which question would you want it to answer first?

Questions

1. Why does the 2025 study suggest that early Mars was cold and wet?

A. Ferrihydrite forms in cool water and would have changed if it had stayed warm
B. Rovers found frozen lakes on the surface
C. Hematite can only form in oceans

2. Why did MAVEN's team measure argon?

A. It is the main gas in the Martian air
B. It cannot hide in rocks, so only sputtering can remove it
C. It makes Mars look red

3. In the book, what does "anhydrous" mean?

A. Very old
B. Containing no water
C. Shaped like a crystal

4. What is a "potential biosignature"?

A. Proof that life existed
B. A sign that might come from life but needs more study
C. A rock made by robots

5. Why does the author call the red of Mars a kind of handwriting?

A. The dust may record the planet's watery history

B. Martians wrote on the rocks

C. The rovers draw on the ground

6. What would both the ferrihydrite question and the leopard spots need to be settled?

A. A bigger telescope on Earth

B. Samples brought back to Earth

C. Another dust storm

Words to know

ferrihydrite: water-holding rust

anhydrous: without water

isotopes: atom varieties

sputtering: knocking atoms loose

biosignature: possible life sign

Answer key: The Rust That Remembers Water

1. A. Ferrihydrite forms in cool water and would have changed if it had stayed warm
2. B. It cannot hide in rocks, so only sputtering can remove it
3. B. Containing no water
4. B. A sign that might come from life but needs more study
5. A. The dust may record the planet's watery history
6. B. Samples brought back to Earth