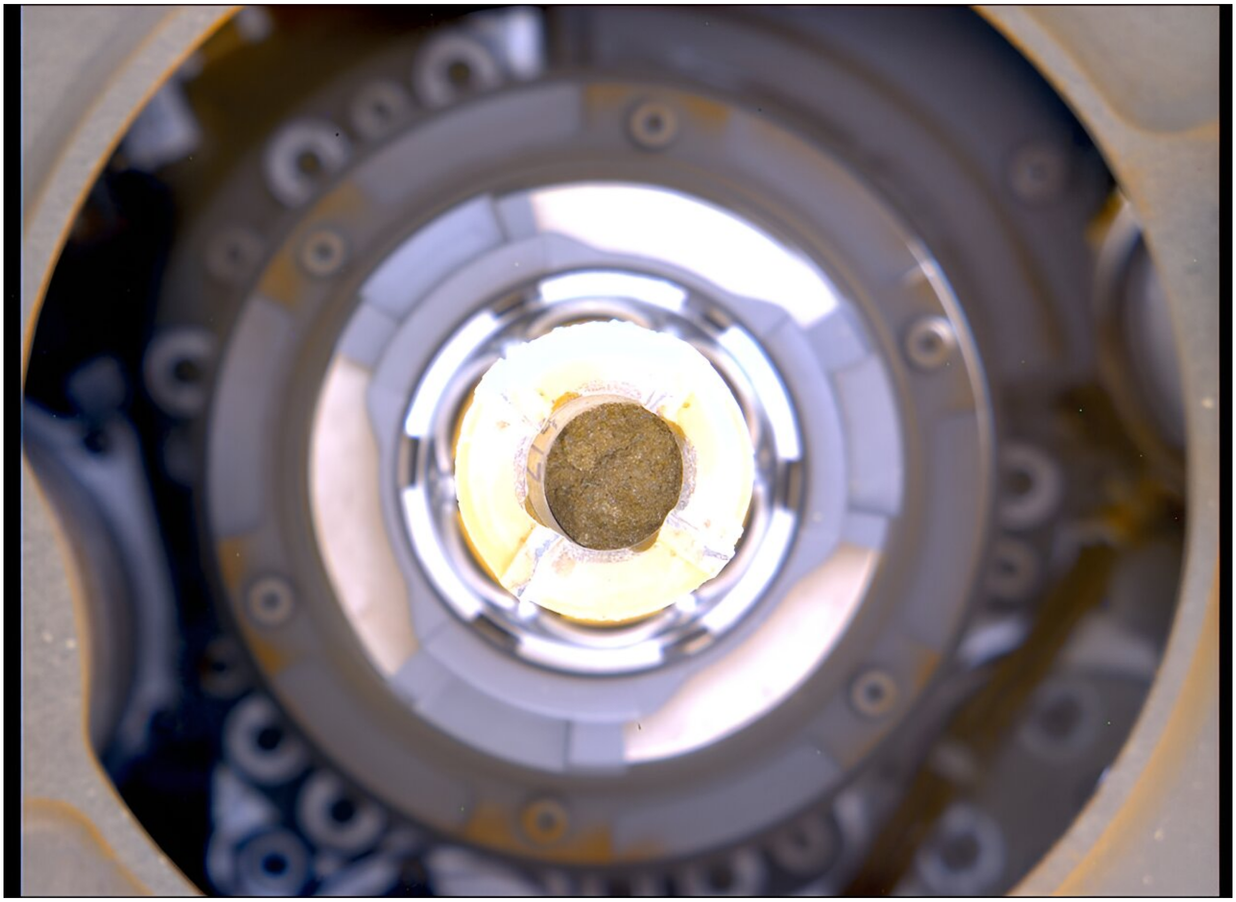
Why scientists are intrigued by air in NASA's Mars sample tubes

June 20 2024



This image shows the rock core from “Berea” inside inside the drill of NASA’s Perseverance Mars rover. Each core the rover takes is about the size of a piece of classroom chalk: 0.5 inches (13 millimeters) in diameter and 2.4 inches (60 millimeters) long. Credit: NASA/JPL-Caltech/ASU/MSSS

Atmospheric scientists get a little more excited with every rock core NASA's Perseverance Mars rover seals in its titanium sample tubes, which are being gathered for eventual delivery to Earth as part of the Mars Sample Return campaign. Twenty-four have been taken so far.

Most of those samples consist of rock cores or regolith (broken rock and dust) that might reveal important information about the history of the planet and whether microbial life was present billions of years ago. But some scientists are just as thrilled at the prospect of studying the "headspace," or air in the extra room around the rocky material, in the tubes.

They want to learn more about the Martian atmosphere, which is composed mostly of carbon dioxide but could also include trace amounts of other gases that may have been around since the planet's formation.

"The air samples from Mars would tell us not just about the current climate and atmosphere, but how it's changed over time," said Brandi Carrier, a planetary scientist at NASA's Jet Propulsion Laboratory in Southern California. "It will help us understand how climates different from our own evolve."

The value of headspace

Among the samples that could be brought to Earth is one tube filled solely with gas deposited on the Martian surface as part of a sample depot. But far more of the gas in the rover's collection is within the headspace of rock samples. These are unique because the gas will be interacting with rocky material inside the tubes for years before the samples can be opened and analyzed in laboratories on Earth.

What scientists glean from them will lend insight into how much water vapor hovers near the Martian surface, one factor that determines why ice forms where it does on the planet and how Mars' water cycle has evolved over time.

Scientists also want a better understanding of trace gases in the air at Mars. Most scientifically tantalizing would be the detection of noble gases (such as neon, argon, and xenon), which are so nonreactive that they may have been around, unchanged in the atmosphere, since forming billions of years ago.

If captured, those gases could reveal whether Mars started with an atmosphere. (Ancient Mars had a much thicker atmosphere than it does today, but scientists aren't sure whether it was always there or whether it developed later). There are also big questions about how the planet's ancient atmosphere compared with early Earth's.

The headspace would additionally provide a chance to assess the size and toxicity of dust particles—information that will help future astronauts on Mars.

"The gas samples have a lot to offer Mars scientists," said Justin Simon, a geochemist at NASA's Johnson Space Center in Houston, who is part of a group of over a dozen international experts that helps decide which samples the rover should collect. "Even scientists who don't study Mars would be interested because it will shed light on how planets form and evolve."

A sealed tube containing a sample of the Martian surface collected by NASA's Perseverance Mars rover is seen here, after being deposited with other tubes in a "sample depot." Other filled sample tubes are stored within the rover. Credit: NASA/JPL-Caltech

Apollo's air samples

In 2021, a group of planetary researchers, including scientists from NASA, studied the air brought back from the moon in a steel container by Apollo 17 astronauts some 50 years earlier.

"People think of the moon as airless, but it has a very tenuous atmosphere that interacts with the lunar surface rocks over time," said Simon, who studies a variety of planetary samples at Johnson. "That includes noble gases leaking out of the moon's interior and collecting at the lunar surface."

The way Simon's team extracted the gas for study is similar to what could be done with Perseverance's air samples. First, they put the previously unopened container into an airtight enclosure. Then they pierced the steel with a needle to extract the gas into a cold trap—essentially a U-shaped pipe that extends into a liquid, like nitrogen, with a low freezing point. By changing the temperature of the liquid, scientists captured some of the gases with lower freezing points at the bottom of the cold trap.

"There's maybe 25 labs in the world that manipulate gas in this way," Simon said. Besides being used to study the origin of planetary materials, this approach can be applied to gases from hot springs and those emitted from the walls of active volcanoes, he added.

Of course, those sources provide much more gas than Perseverance has in its sample tubes. But if a single tube doesn't carry enough gas for a particular experiment, Mars scientists could combine gases from multiple tubes to get a larger aggregate sample—one more way the headspace offers a bonus opportunity for science.

Provided by NASA

Citation: Why scientists are intrigued by air in NASA's Mars sample tubes (2024, June 20) retrieved 25 June 2024 from https://phys.org/news/2024-06-scientists-intrigued-air-nasa-mars.html