Could Martian atmospheric samples teach us more about the red planet than surface samples?

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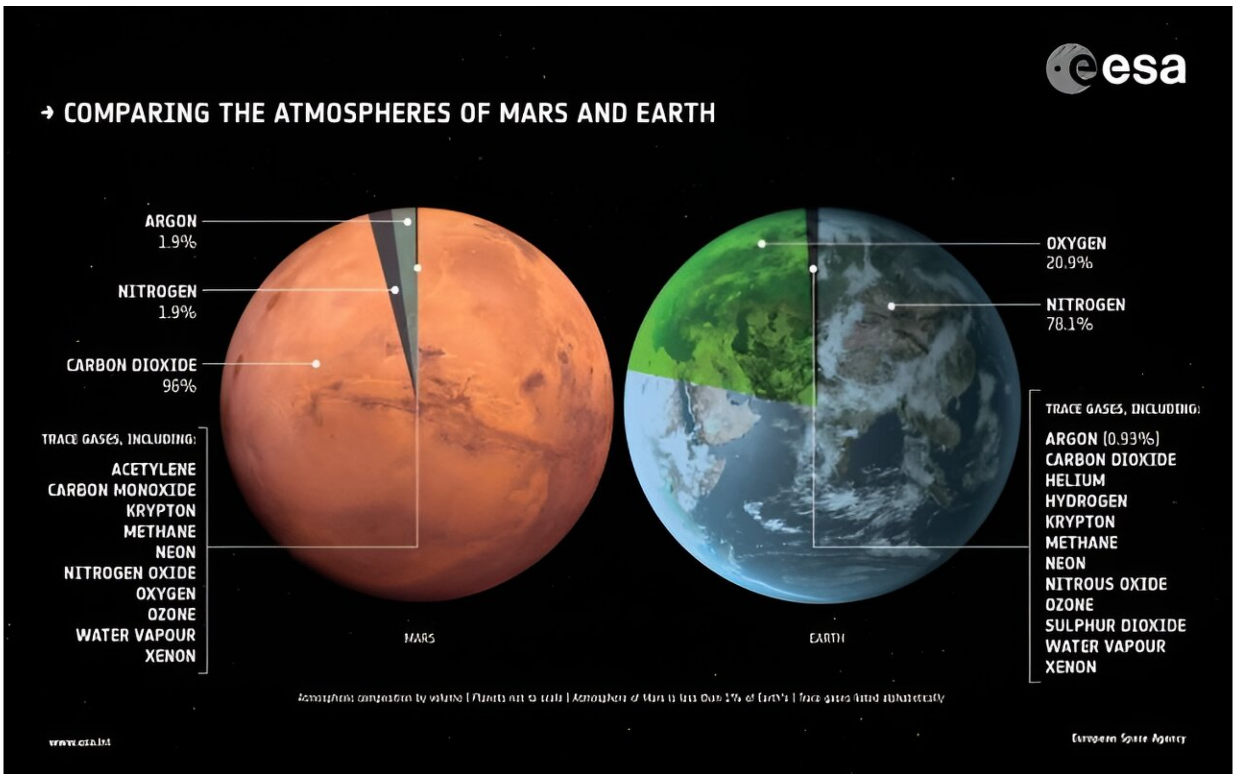

Credit: European Space Agency

NASA is actively working to return surface samples from Mars in the next few years, which they hope will help us better understand whether ancient life once existed on the red planet's surface billions of years ago.

But what about atmospheric samples? Could these provide scientists with better information pertaining to the history of Mars?

This is what a recent study presented at the 55th Lunar and Planetary Science Conference hopes to address as a team of international researchers investigated the significance of returning atmospheric samples from Mars and how these could teach us about the formation and evolution of the red planet.

Here, Universe Today discusses this research with the study's lead author, Dr. Edward Young, who is a professor in the Department of Earth, Planetary, and Space Sciences at UCLA, and study co-author, Dr. Timothy Swindle, who is a Professor Emeritus in the Lunar & Planetary Laboratory at the University of Arizona, regarding the motivation behind the study, how atmospheric samples would be obtained, current or proposed missions, follow-up studies, and whether they think life ever existed on the red planet. Therefore, what was the motivation for the study?

Dr. Young tells Universe Today, "We learn a lot about the origin of a planet from its atmosphere as well as its rocks. In particular, isotope ratios of certain elements can constrain the processes leading to the formation of the planet."

Dr. Swindle follows this with, "There are two basic types of motivation. One is that we're planning on bringing all these rock samples, and we're going to be interested in knowing how they've interacted with the atmosphere, but we can't figure that out without knowing the composition of the atmosphere in detail.

"So, we need an atmospheric sample to know what the rocks might have been exchanging elements and isotopes with. But we'd also like to have a sample of the Martian atmosphere to answer some basic questions about processes that have occurred, or are occurring, on Mars.

"For example, Martian meteorites contain trapped atmospheric noble gases, like krypton and xenon. But it appears that there are at least two different 'atmospheric' components in those meteorites."

For the study, the researchers proposed several benefits of returning a Mars atmospheric sample to Earth, including atmospheric samples being among the NASA Perseverance (Percy) rover sample tubes, gaining insight into potential solar gar within the Martian interior, evolutionary trends in atmospheric compositions, nitrogen cycling, and sources of methane on Mars.

For the Percy atmospheric sample, also known as Sample No.1 "Roubion," the study notes how this sample was obtained after Percy tried to collect a rock core sample but ended up collecting atmospheric gases instead.

Additionally, the study proposes the lack of leakage the sample tube will experience while awaiting its return to Earth and the gases present within the sample are ideal for analysis once returned to Earth, as well. But aside from the Percy rover sample, how else could a Martian atmosphere sample be obtained?

"At least two other ideas for collecting a sample of Martian atmosphere have been suggested," Dr. Swindle tells Universe Today. "One is to fly a spacecraft through the Martian atmosphere, collect a sample as it goes through, then return it to Earth. The other is to have a sample return cannister (it doesn't have to be any bigger than a Perseverance tube) that has valves and a (Martian) air compressor.

"You could land it on the surface of Mars, open the valve to the atmosphere, turn on the compressor, and get a sample that has hundreds or thousands of times as much Martian atmosphere as a volume that is just sealed without compression, as Perseverance has done, and hopefully will do again."

Dr. Swindle and Dr. Young both mention the Sample Collection for Investigation of Mars (SCIM) mission, which was proposed in 2002 by a team of NASA and academic researchers with the goal of collecting atmospheric samples at an altitude of 40 kilometers (25 miles) above the Martian surface and return them to Earth for further analysis.

While SCIM was selected as a semi-finalist for the 2007 Mars Scout Program, it was unfortunately not selected for further development, and both Dr. Young and Dr. Swindle tell Universe Today there are currently no atmospheric sample missions being planned aside from the Percy rover sample.

Therefore, what follow-up studies from this research are currently underway or being planned?

Dr. Swindle and Dr. Young both mention how efforts are being made to collect small quantities of atmospheric gas due to the small size of the sample tubes, with Dr. Swindle telling Universe Today, "A big set of questions right now is how good a sealed Perseverance tube would be at containing an atmospheric sample. How good is the seal? Might the tube spring a leak on a hard landing? Would some molecules in the Martian atmosphere stick to the coatings of the tubes?

"There's been some activity on all of these questions, and so far, the answers have all been good—it looks like those Perseverance tubes may do well, even though they weren't really designed with atmospheric sampling in mind."

As noted, the purpose of obtaining and returning an atmospheric sample from Mars could help scientists better understand the formation and evolution of the red planet. While present-day Mars is a very cold and dry world with an atmosphere that is a fraction of the Earth's atmosphere, with liquid water being unable to exist on the surface, along with no active volcanism, as well.

However, significant evidence obtained from landers, rovers, and orbiters over the last several decades point to a much different Mars billions of years ago after it first formed. This included an active interior that produced a magnetic field that shielded the surface from harmful solar and cosmic radiation, a much thicker atmosphere being replenished from active volcanism, and flowing liquid water, all of which potentially led to the existence of some forms of life on the surface.

However, given Mars' small size (half of Earth), this means its internal heat cooled off much faster (possibly over millions of years), resulting in volcanism becoming inactive and the dissipation of the magnetic field the interior activity was driving, the latter of which led to harmful solar and cosmic radiation stripping the atmosphere, with the surface liquid water evaporating to space along with it.

Therefore, do Dr. Young and Dr. Swindle believe life ever existed on Mars, and will we ever find it?

Dr. Young tells Universe Today, "I really don't know. I think microbial life sometime in the past, or even now, is a reasonable hypothesis but we don't have enough information."

Dr. Swindle also echoes his uncertainty whether life ever existed on Mars, but elaborates by telling Universe Today, "If there hasn't, why did life start so early on Earth, but didn't start on Mars, which had a similar climate at the time. If there has been, how similar is it to life on Earth? Since Earth and Mars are always exchanging rocks because of impacts, is life on Earth related to life on Mars?

"If it has existed, it will be tough to find. But an atmospheric sample could help. For instance, there seems to be methane in the Martian atmosphere. Most, but not all, of the methane in Earth's atmosphere is biological, and analyzing the relative ratios of the isotopes of carbon or hydrogen is one of the best ways to figure that out."

More information: The importance of Martian atmosphere sample return. www.hou.usra.edu/meetings/lpsc2024/pdf/2620.pdf

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