We need to consider conservation efforts on Mars, say researchers

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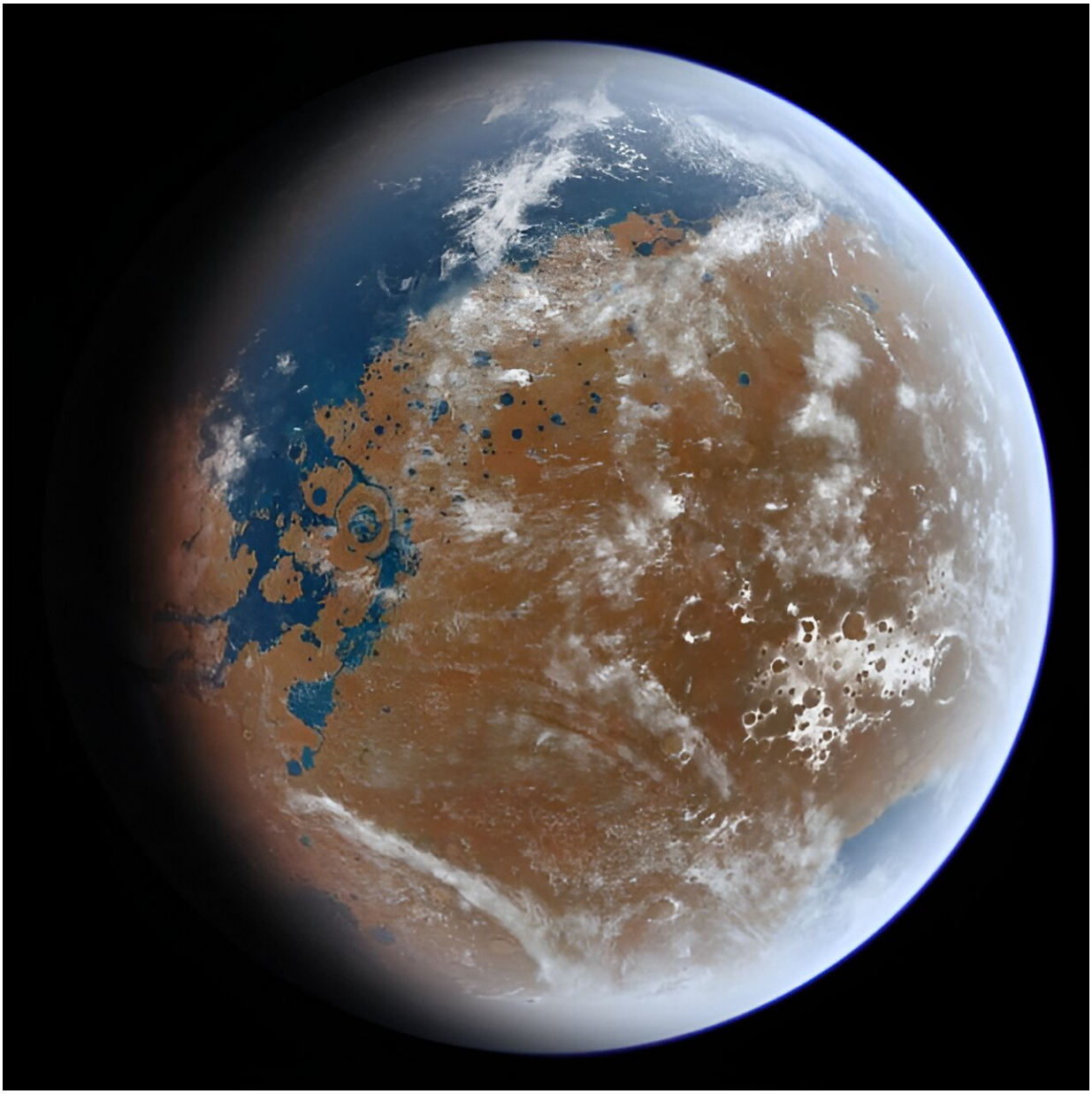

Artist's impression of Mars during the Noachian Era. Credit: Ittiz/Wikipedia Commons

Astrobiology is the field of science that studies the origins, evolution, distribution, and future of life in the universe. In practice, this means sending robotic missions beyond Earth to analyze the atmospheres, surfaces, and chemistry of extraterrestrial worlds.

At present, all of our astrobiology missions are focused on Mars, as it is considered the most Earth-like environment beyond our planet. While several missions will be destined for the outer solar system to investigate "Ocean Worlds" for evidence of life (Europa, Ganymede, Titan, and Enceladus), our efforts to find life beyond Earth will remain predominantly on Mars.

If and when these efforts succeed, it will have drastic implications for future missions to Mars. Not only will great care need to be taken to protect Martian life from contamination by Earth organisms, but precautions must be taken to prevent the same from happening to Earth (aka Planetary Protection).

In a recent study, a team from the University of New South Wales (UNSW) in Sydney, Australia, recommends that legal or normative frameworks be adopted now to ensure that future missions do not threaten sites where evidence of life (past or present) might be found.

The study was led by Clare Fletcher, a Ph.D. student with the Australian Center for Astrobiology (ACA) and Earth and Sustainability Science Research Center at UNSW. She was joined by Professor Martin Van Kranendonk, a researcher with the ACA and the head of the School of Earth and Planetary Sciences at Curtin University, and Professor Carol

Oliver of the School of Biological, Earth & Environmental Sciences at UNSW.

Their research paper, "Exogeoconservation of Mars," was published on April 21 in *Space Policy*.

The search for life on Mars can be traced to the late 19th and early 20th centuries when Percival Lowell made extensive observations from his observatory in Flagstaff, Arizona. Inspired by Schiaparelli's illustrations of the Martian surface (which featured linear features he called "canali"), Lowell recorded what he also believed were canals and spent many years searching for other indications of infrastructure and an advanced civilization. During the ensuing decades, observatories worldwide observed Mars closely, looking for indications of life and similarities with Earth.

However, it was not until the Space Age that the first robotic probes flew past Mars, gathering data directly from its atmosphere and taking close-up images of the surface. These revealed a planet with a thin atmosphere composed predominantly of carbon dioxide and a frigid surface that did not appear hospitable to life.

However, it was the Viking 1 and 2 missions, which landed on Mars in 1976, that forever dispelled the myth of a Martian civilization. But as Fletcher told Universe Today via email, the possibility of extant life has not been completely abandoned:

"It's my personal belief that it is unlikely we will find evidence of extant (current) life on Mars, as opposed to evidence of past life on Mars. If we were to find extant life on Mars that could be proven to be endemic to Mars and not contamination from Earth, some think it might be found underground in lava tubes, for example, and some think the ice caps or any possible source of liquid water might be suitable places."

Ironically, it was the same missions that discredited the notion of there being life on Mars that revealed evidence that water once flowed on its surface. Thanks to the many orbiter, lander, and rover missions sent to Mars since the turn of the century, scientists theorize that this period coincided with the Noachian Era (ca. 4.1–3.7 billion years ago).

According to the most recent fossilized evidence, it was also during this period that life first appeared on Earth (in the form of single-celled bacteria).

Our current astrobiology efforts on behalf of NASA and other space agencies are focused on Mars precisely for this reason: to determine if life emerged on Mars billions of years ago and whether or not it co-evolved with life on Earth.

This includes the proposed Mars Sample Return (MSR) mission that will retrieve the drill samples obtained by the Perseverance rover in the Jezero Crater and return them to Earth for analysis. In addition, NASA and China plan to send crewed missions to Mars by 2040 and 2033 (respectively), including astrobiology studies.

These activities could threaten the very abodes where evidence of past life could be found or (worse) still exists. "Human activities might threaten sites like this in part due to possible microbial contamination," said Fletcher.

"Evidence of life (past and extant) also has greater scientific value when in its paleoenvironmental context, so any human activities that might damage the evidence of life and/or its surrounding environmental context pose a risk. This could be something innocuous, like debris falling in the wrong spot, or something more serious, like driving over possibly significant outcrops with a rover."

Conservation measures must be developed and implemented before additional missions are sent to Mars. Given humanity's impact on Earth's natural environment and our attempts to mitigate this through conservation efforts.

In particular, there have been numerous cases where scientific studies were conducted without regard for the heritage value of the site and where damage was done because of a lack of proper measures. These lessons, says Fletcher, could inform future scientific efforts on Mars:

"It's important that we learn from what has been considered 'damaging' on Earth and take this into consideration when exploring Mars. If a site is damaged beyond being able to be studied in the future, then we limit what can actually be learned from a site.

"When considering Mars missions cost billions of dollars and are to meet specific scientific goals, limiting the information being learned from a site is incredibly detrimental.

"My recommendations are that of my paper: interdisciplinary cooperation, drawing on experience and knowledge from Earth, creating norms and a code of practice (part of my Ph.D. work), and working towards creating legislation for these issues."

The need for exogeoconservation is paramount at this juncture. In addition to Mars, multiple astrobiology missions will travel to the outer solar system this decade to search for evidence of life on icy moons like Europa, Ganymede, Titan, and Enceladus.

This includes the ESA's JUpiter ICy moons Explorer (JUICE) mission, currently en route to Ganymede, and NASA's Europa Clipper and Dragonfly missions that will launch for Europa and Titan in October 2024 and 2028 (respectively).

Therefore, the ability to search for extant or past life without damaging its natural environment is an ethical and scientific necessity.

"I hope this paper is very much a starting point for anyone working in Mars science and exploration, as well as anyone thinking about space policy and exogeoconservation," said Fletcher. "My goal was to start drawing attention to these issues, and that way start a generation of researchers and practitioners focused on exogeoconservation of Mars."

More information: Clare Fletcher et al, Exogeoconservation of Mars, *Space Policy* (2024). DOI: 10.1016/j.spacepol.2024.101627

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