PRESS RELEASE

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Title:
Japan's MMX Martian Moon Probe is Unlikely to Bring Back Dangerous Martian Microbes

Subtitle:
A Japanese research team has assessed the probability that Martian microbes that might have contaminated Mars' moons would be returned to Earth by JAXA's Martian Moons eXploration (MMX) sample return mission.

Release summary:
Japan's Aerospace Exploration Agency (JAXA) plans to send the Martian Moons eXploration (MMX) mission to Mars' moons Phobos and Deimos. MMX would return samples to Earth in 2029, but before sending the spacecraft, researchers need to assess the likelihood such samples might be contaminated with Martian microbes. A team of researchers has now determined the probability is extremely low, and thus the samples to be returned by this mission are likely to be safe.

Full-text release:
Japan's Aerospace Exploration Agency (JAXA) plans to send the Martian Moons eXploration (MMX) mission to Mars' moons Phobos and Deimos. MMX would return samples to Earth in 2029, but before sending the spacecraft, researchers need to assess the likelihood such samples might be contaminated with Martian microbes. The research team, led by Prof. Kazuhisa Fujita (JAXA), Dr. Kosuke Kurosawa (Chiba Institute of Technology), and Drs. Hidenori Genda and Ryuki Hyodo (Earth-Life Science Institute, Tokyo Institute of Technology) in collaboration with the University of Tokyo and Tokyo University of Pharmacy and Life Sciences, has now determined the probability is extremely low, and thus the samples to be returned by this mission are likely to be safe.

When conducting space exploration, space agencies have to comply with a set of rules known as Planetary Protection Policy (PPP). However, until now there were no rules for Mars' moons Phobos and Deimos. The JAXA-led team jointly conducted scientific research to assess the microbial contamination of Mars' moons. A report on this research was accepted by the Panel on Planetary Protection of the Committee on Space Research (COSPAR) and was approved as a recommendation for the MMX mission by the 89th COSPAR Bureau in March 2019. This achievement is Japan's contribution to the international PPP maintained by COSPAR. The research was published in *Life Sciences in Space Research*.

COSPAR formulates and maintains a PPP as a reference standard for spacefaring nations and is in compliance with Article IX of the United Nations Outer Space Treaty. The goal of this policy is to avoid contamination of celestial bodies with organic matter and microorganisms from Earth, and to protect the Earth and its biosphere from potentially harmful extraterrestrial contaminants, including alien microorganisms. All planetary missions have to implement planetary protection measures of varying degrees of stringency - ranging from simple documentation to complete sterilization of entire flight systems.

MMX is currently being planned as a next-generation sample return mission, based on cutting-edge technologies for exploring small objects. Japan's last sample return mission, Hayabusa2, aims to return samples from the asteroid Ryugu, which most scientists feel is unlikely to host its own biology. However, MMX's target is Mars' moons Phobos and Deimos, which are very close to Mars. Despite the failure of landers or rovers to detect it so far, scientists still feel there is a reasonable chance there is currently life on Mars.

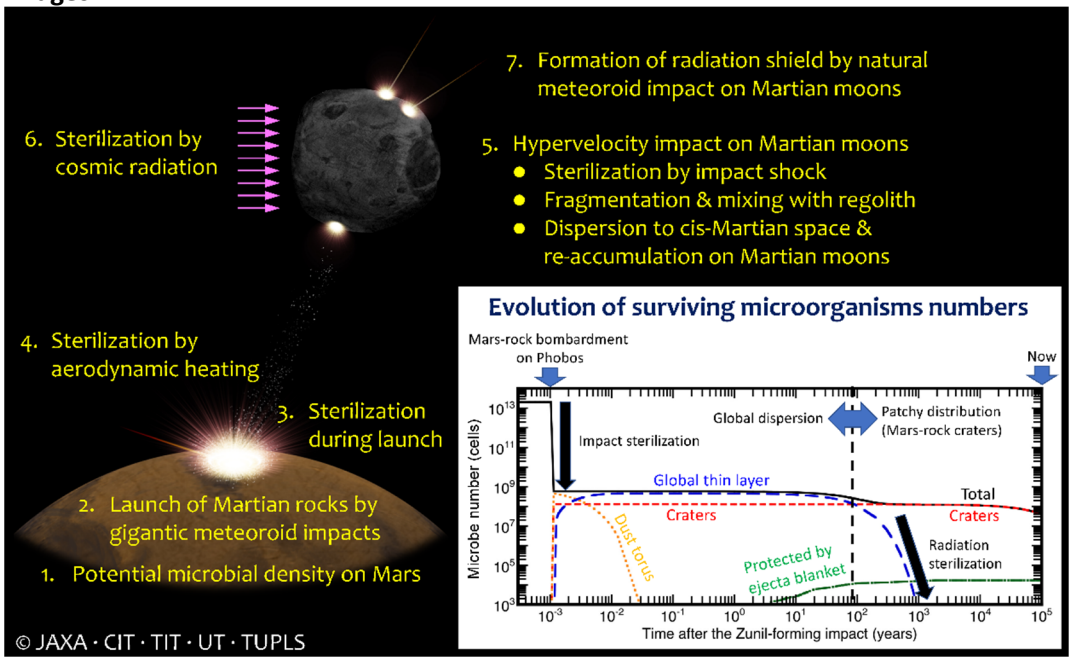
Since the existing COSPAR planetary protection policy did not cover the Martian moons, it was necessary to show that the probability of a single viable microorganism in samples returned by MMX is less than the internationally agreed upper limit. This limit, which is one in a million, would make the MMX mission compliant with the same level of PPP as Hayabusa2. The one-in-a-million value is an international standard for contamination risk, and is widely used in the water quality standards of the World Health Organization (WHO) and the quality standards of the US Food and Drug Administration (FDA).

Martian organisms may have been transported to Phobos and Deimos by rocks ejected from Mars' surface during giant meteorite impacts over the past 5 million years. It is virtually certain that Martian surface material is transported to its moons, as several Martian rocks blasted into space by ancient giant meteorite impacts have been found on Earth. Rocks ejected more recently from Mars may contain extant Martian microorganisms and these could have been transported to the Martian moons.

The team examined Mars' surface history over the past 5 million years and compared it to sterilization data for terrestrial microorganisms. They showed that microorganisms on Mars' moons, if they came from Mars' surface, would have to have been transported there very recently, and thus would have to originate from a 10 km-sized crater called Zunil, which formed ~100,000 years ago. Other craters over 10 km in diameter on Mars are much older than Zunil, and microorganisms transported from these craters would already have been sterilized by intense cosmic radiation.

The team investigated the fraction of Mars rocks coming to the Martian moons compared to the entire amount of Martian rocks ejected in the Zunil-forming impact event, and the three-dimensional distribution of Martian materials accumulated on the moons. The evolution of the surviving microorganisms in the space radiation environments was then calculated. Based on these results, the team demonstrated that samples collected by MMX are 99% likely to not contain a single viable microorganism below the one-in-a-million threshold, even after including the various uncertainties in the input parameters that were taken into account. Based on this study, the MMX mission is now classified as being at the same PPP level as Hayabusa2, and samples collected by the MMX mission are likely safe to bring back to Earth.

Images:



A schematic diagram of the time sequence from the Zunil-forming impact event to the present, and processes

related to the number of surviving microorganisms considered in the study. The team estimated the number of potentially living microorganisms on present-day Mars based on the number of microbes at analog sites in Antarctica. The team conducted a series of 3D impact simulations to reproduce the Zunil-forming impact event and calculated the orbital evolution of each ejecta particle near Mars. This calculation provides the total transported mass of Mars rocks to the Martian moons. The team also considered the sterilization of microorganisms due to collisions with the moons. The figure inset shows the number of surviving microorganisms on Phobos over time. Finally, the team calculated the probability that living microorganisms might be collected from returned Martian moon samples.
Credit: JAXA

Reference:

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More information

Tokyo Institute of Technology (Tokyo Tech) stands at the forefront of research and higher education as the leading university for science and technology in Japan. Tokyo Tech researchers excel in fields ranging from materials science to biology, computer science, and physics. Founded in 1881, Tokyo Tech hosts over 10,000 undergraduate and graduate students per year, who develop into scientific leaders and some of the most sought-after engineers in industry. Embodying the Japanese philosophy of "monotsukuri," meaning "technical ingenuity and innovation," the Tokyo Tech community strives to contribute to society through high-impact research.

The Earth-Life Science Institute (ELSI) is one of Japan's ambitious World Premiere International research centers, whose aim is to achieve progress in broadly inter-disciplinary scientific areas by inspiring the world's greatest minds to come to Japan and collaborate on the most challenging scientific problems. ELSI's primary aim is to address the origin and co-evolution of the Earth and life.

The World Premier International Research Center Initiative (WPI) was launched in 2007 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) to help build globally visible research centers in Japan. These institutes promote high research standards and outstanding research environments that attract frontline researchers from around the world. These centers are highly autonomous, allowing them to revolutionize conventional modes of research operation and administration in Japan.

The Japan Aerospace Exploration Agency (JAXA) was born through the merger of three institutions, namely the Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL) and the National Space Development Agency of Japan (NASDA). It was designated as a core performance agency to support the Japanese government's overall aerospace development and utilization. JAXA, therefore, can conduct integrated operations from basic research and development, to utilization.