Mission to Mars moon could be a sample-return twofer, study says

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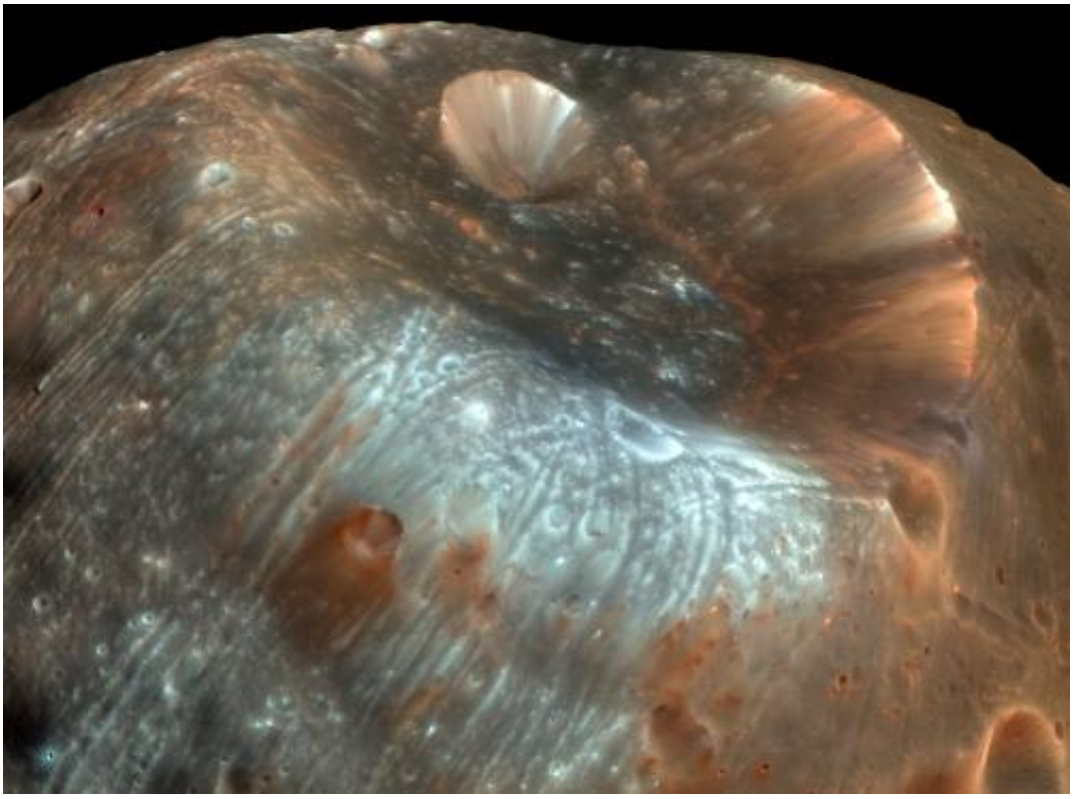

The Martian moon Phobos has accumulated dust and debris from the surface of Mars, knocked into its orbital path by projectiles colliding with the planet. A sample-return mission to Phobos would thus return material both from Phobos and from Mars. Credit: NASA

The study helps to confirm the idea that the surface of Phobos contains tons of dust, soil, and rock blown off the Martian surface by large

projectile impacts. Phobos' orbital path plows through occasional plumes of Martian debris, meaning the tiny moon has been gathering Martian castoffs for millions of years. That means a sample-return mission planned by the Russian space agency could sample two celestial bodies for the price of one.

"The mission is scheduled to be flown early in the next decade, so the question is not academic," said James Head, professor of geological sciences and an author on the study. "This work shows that samples from Mars can indeed be found in the soil of Phobos, and how their concentration might change with depth. That will be critical in the design of the drills other equipment."

The research appears in the latest issue of *Space and Planetary Science*.

The Russian mission will be the space agency's second attempt to return a sample from Phobos. Head was a participating scientist on the first try, which launched in 2011, but an engine failure felled the spacecraft before it could leave Earth orbit. The next attempt is scheduled to launch in 2020 or shortly thereafter.

This new research grew out of preparation for the original mission, which would still be en route to Phobos had it not encountered problems. Scientists had long assumed Phobos likely contained Martian bits, but Russian mission planners wanted to know just how much might be there and where it might be found. They turned to Head and Ken Ramsley, a visiting researcher in Brown's planetary geosciences group.

To answer those questions, Ramsley and Head started with a model based on our own Moon to estimate how much of Phobos' regolith (loose rock and dust on the surface) would come from projectiles. They then used gravitational and orbital data to determine what proportion of that projectile material came from Mars.

"When an impactor hits Mars, only a certain of proportion of ejecta will have enough velocity to reach the altitude of Phobos, and Phobos' orbital path intersects only a certain proportion of that," Ramsley said. "So we can crunch those numbers and find out what proportion of material on the surface of Phobos comes from Mars."

According to those calculations, the regolith on Phobos should contain Martian material at a rate of about 250 parts per million. The Martian bits should be distributed fairly evenly across the surface, mostly in the upper layers of regolith, the researchers showed.

"Only recently—in the last several 100 million years or so—has Phobos orbited so close to Mars," Ramsley said. "In the distant past it orbited much higher up. So that's why you're going to see probably 10 to 100 times higher concentration in the upper regolith as opposed to deeper down."

And while 250 parts per million doesn't sound like a lot, the possibility of returning even a little Martian material to Earth gets planetary scientists excited. It's a nice bonus for a mission primarily aimed at learning more about Phobos, a mysterious little rock in its own right.

Scientists are still not sure where it came from. Is it a chunk of Mars that was knocked off by an impact early in Martian history, or is it an asteroid snared in Mars's orbit? There are also questions about whether its interior might hold significant amounts of water.

"Phobos has really low density," Head said. "Is that low density due to ice in its interior or is it due to Phobos being completely fragmented, like a loose rubble pile? We don't know."

If all goes well, the upcoming Russian mission will help solve some of those mysteries about Phobos. And we might learn a good deal about

Mars in the process.

More information: The study appears in the newly published October issue of *Planetary and Space Science*. The proofs originally appeared online on September 20, 2013.

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