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Martian craters point to large climate change

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Craters on the surface of Mars may hold the key to discovering patterns of drastic climate change in the planet's recent history, a Brown-led research team found recently.

Seth Kadish GS, a graduate student in the Department of Geological Sciences, and Professor of Geological Sciences James Head presented their findings Sept. 24 at the European Planetary Science Congress in Munster, Germany. Nadine Barlow of Northern Arizona University, with whom Kadish started his work as an undergraduate, and David Marchant of Boston University also contributed to the research.

Evidence has long been scarce for researchers trying to document climate changes on Mars, but Kadish said the group's research on craters has provided signs that the planet has undergone "extreme climate change" in the last 100 million years - including an ice age.

Mars is a planet with an obliquity - or a tilt on its axis - that varies much more than the Earth's. Earth's obliquity rests at a relatively constant 23.5 degrees, stabilized by the gravitational pull of the moon. Mars' obliquity, however, has varied from approximately 25 degrees to at least 60 degrees within the past 100,000 years, changes that severely impact the planet's climate.

Even the comparatively mild fluctuations of Earth's axis have triggered ice ages and other significant shifts, leading scientists to believe that Mars' climate fluctuations must have been even more dramatic. For example, while global warming debates on Earth have focused on slowly melting ice caps, scientists believe that at times when Mars' poles pointed directly at the sun, ice caps there sublimated - evaporated directly into gas - and dispersed across the face of the planet.

Even such drastic changes are undone by the cyclical axis fluctuations as sublimated ice retracts back to the poles, leaving little evidence on the surface that anything ever changed.

But Kadish and Head's research may have uncovered a current physical marker of the variations, they said - pedestal craters, geological features unique to the planet that get their name from the 10- to 100-foot-tall mounds the indentations sit on.

A normal crater is formed when a meteorite or other projectile strikes a planet's surface. But a pedestal crater is formed when the impact hits an elevated surface, like a plateau. That surface, Kadish suspects, was a mixture of ice and dust that would have covered the planet during an ice age.

Now, while the ice has receded, sites where pedestal craters formed have preserved the ice underneath it, Kadish believes, because debris from the impact would settle into a hardened layer of armor protecting the ice.

At the edges of some pedestals, where the armor begins to taper off, Kadish and his fellow researchers found tiny pits near the pedestal's base. The material in the pits appears to have sublimated, Kadish said, which suggests it was in fact ice, since dust would have eroded.

These "marginal pits" are critical to the theory of climate change on Mars, Kadish and Head said. They are the "window into (what lies) below the pedestals," Head said.

Next, Kadish plans to determine more conclusively what lies underneath the craters by using radar to penetrate their surface. The amount of ice underneath the pedestals will reveal a great deal of information on Mars' history of climate change.

Head, who teaches GEOL 0050: "Mars, Moon and the Earth," said the work has immediate relevance, calling it "cutting-edge research that goes right into an intro course" and noting that he will incorporate the findings into his class this semester.

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