Nature study explains mystery of Mars icecaps

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An interdisciplinary team of scientists thinks it has an answer to a long-standing mystery of why the permanent icecap on Mars' South Pole is offset from the pole itself. Simply put, it's colder and stormier in that hemisphere.
But that is only part of the equation, scientists say, and new understanding about Mars' climate and its polar regions may suggest clues to finding water in the planet's equatorial zone - where it would be easier to land a spacecraft - and opening the door to future exploration and the search for life.
They reported their findings in the journal Nature (May 11, 2005).

Jeffrey Barnes, a professor of atmospheric sciences at Oregon State University and one of the authors of the study, said the permanent icecaps on Mars' poles are quite different. The icecap on the northern pole is much larger - about the size of Greenland - and comprised primarily of water ice.

"The South Pole, however, is a strange animal," Barnes said. "The cap is made up mostly of carbon dioxide ice - or dry ice - which is the main component of the Martian atmosphere. The southern icecap is much smaller, about a 10th the size of that at the northern pole, and it is all on one side of the pole. The other side of the pole contains a much larger area known as 'the Cryptic Region,' which is made up of seasonal ice in the winter but has low albedo, or reflectivity.

"And no one has been able to figure out why there is this peculiar

distribution of ice deposits."

The scientists were able to use images from the Mars Global Surveyor, temperature information, and climate models to develop a new theory.

"We basically think the Cryptic Region is a sheet of incredibly clear ice," Barnes said. "The reason for the low reflectivity is that the ground beneath the ice shows up right through it."

Other scientists in the study included lead author Anthony Colaprete, of the NASA Ames Research Center; Robert M. Haberle and Jeffery L. Hollingsworth, NASA Ames and San Jose State University; and Hugh H. Kieffer and Timothy N. Titus, the U.S. Geological Survey.

The southern pole's permanent icecap is in the western hemisphere, which is stormy during Martian winters and receives a lot of snowfall that comes in the form of carbon dioxide (C02) particles. These are very bright and highly reflective, creating a visible permanent icecap as well as much more extensive seasonal deposits.

The eastern hemisphere is comparatively warmer and rarely has storms. The scientists believe that instead of falling in the form of snow, the CO2 from the Mars atmosphere condenses right on the ground and forms slab ice, which is clear. They think the slab is about one meter deep.

C02 ice requires much colder temperatures - down to minus-125 degrees centigrade - than does the water ice at the northern pole.

Snow falling in just one hemisphere of the southern pole can be explained by Mars' asymmetrical climate in the south, Barnes said. The planet's topography is severe, and the different features strongly affect climate just as they do on Earth.

Mars has the highest volcano system in the solar system - the 85,000-foot high Olympus Mons and others of nearly that height. The southern hemisphere also is home to the Valles Marineris Canyon, which is six to seven kilometers deep and the length of the United States. The Hellas Basin is even deeper, at 10 kilometers, or more than six miles.

"The planet has huge volcanoes and mountains that extend from well north of the equator to the southern hemisphere, and two gigantic basins in the south," Barnes said. "The wind blowing over these topographic features sets up large-scale patterns that have a profound impact on the climate. Mars has weather systems much like the Earth, with traveling high- and low-pressure systems, and warm and cold fronts."

Barnes said there is evidence that the C02 ice in the permanent south cap is eroding, raising the possibility of global climate change. The area of the icecap has not shrunk, but features within it are diminishing and the depth may be decreasing as well, he said.

Disappearance of the southern CO2 icecap could indicate a very significant change in Mars' climate, pointed out Barnes, whose research specialty is the Martian atmosphere. Scientists think the icecaps are relatively young because they lack craters. They also say that Mars probably has a volatile climatic history, triggered by changes in the tilt of its axis and its pattern of orbit around the sun.

"Scientists think that the ice ages on Earth were triggered by small changes in the tilt of the Earth's axis and its orbit - over tens and hundreds of thousands of years," Barnes said. "Mars has undergone similar changes, but much, much larger. Earth tilts at about 23 degrees and Mars has about a 25-degree tilt. But in its past, Mars has tilted as much as 60 degrees and as little as zero degrees.

"Its orbital pattern changed dramatically, too," he added. "That would

have a major impact on temperatures, climate, and icecaps."

During these major changes, Mars may have had enormous seasonal icecaps that extended nearly to its equator - or the permanent polar icecaps may have completely melted away. Learning more about the pattern of ice formation and melting may lead scientists to find deposits of water ice close to the equator, where it is easier to land and operate spacecraft than in the forbidding polar zones.

Water, of course, is the most essential ingredient for life, Barnes pointed out.

"Some of the biggest deposits of water ice may actually be in lower latitudes, close to the surface, covered in dust," he said. "We've taken a step toward a better understanding of where the water may be through learning more about the polar icecaps and the climate system. But there is a great deal that we don't know about the polar icecaps and climate changes on Mars. We have a lot of work yet to do, much of which will need to be highly interdisciplinary in nature, as this study was."

Source: Oregon State University

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