Subterranean oceans on Saturn's moon Titan

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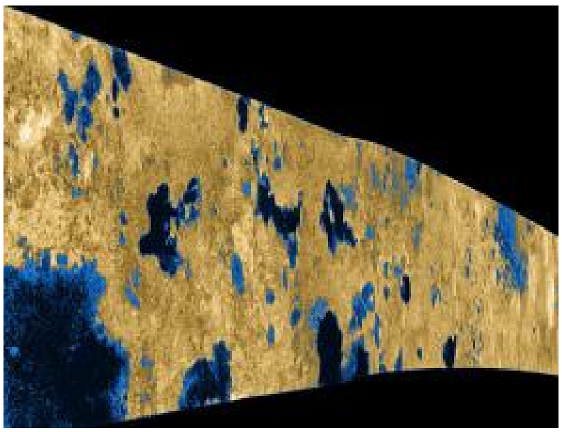

A radar image of some of the lakes of hydrocarbons spread across one of the poles of Titan, the largest of Saturn’s moons. Colors have been altered to accentuate the topographic features. Photo courtesy of NASA/JPL and the Cassini Project Office

(PhysOrg.com) -- Saturn's largest moon, Titan, may have a subterranean ocean of hydrocarbons and some topsy-turvy topography in which the summits of its mountains lie lower than its average surface elevation, according to new research.

Titan is also more squashed in its overall shape—like a rubber ball pressed down by a foot—than researchers had expected, said Howard Zebker, a Stanford geophysicist and electrical engineer involved in the work. The new findings may help explain the presence of large lakes of hydrocarbons at both of Titan's poles, which have been puzzling researchers since being discovered in 2007.

"Since the poles are squished in with respect to the equator, if there is a hydrocarbon 'water table' that is more or less spherical in shape, then the poles would be closer down to that water table and depressions at the poles would fill up with liquid," Zebker said. The shape of the water table would be controlled by the gravitational field of Titan, which is still not fully understood.

Hydrocarbons are the only materials on Titan's surface that would remain liquid at minus180 degrees Celsius, the average temperature of the moon's surface. Any water would be frozen, making it plausible that instead of groundwater, Titan would have the equivalent in hydrocarbons.

The research will be published in a paper in *Science* and can now be read on the magazine's website.

Zebker, the lead author, and a group of colleagues have been making radar measurements of Titan's surface over the last four years using an instrument aboard the Cassini spacecraft, which is orbiting Saturn. Whenever Cassini passes close enough, they sweep beams of cloud-penetrating radar through Titan's thick atmosphere and across the surface. Using the radar data, they can calculate the surface elevations along the tracks of the sweep.

Combining more than 40 tracks across the surface, the researchers were able to calculate the three-dimensional shape of Titan.

Zebker said that there were theoretical reasons to expect that Titan was not a perfect sphere, but instead probably slightly oblate, or flattened, due to the centrifugal force from its rotation while orbiting Saturn. But the degree to which Titan is flattened exceeds what would be expected, based upon how close it is to Saturn and its roughly 16-day orbit.

It also turns out that Titan is not flattened uniformly. By way of analogy, if you were to put your foot on a rubber ball and press down, the ball would bulge out equally on all sides in the directions perpendicular to the downward force from your foot.

But the bulge of Titan is asymmetrical. The longest axis is oriented so that it points toward Saturn, a result of tidal forces from the planet. The shortest axis runs through the poles. And the other axis, oriented in the direction in which Titan orbits Saturn, is intermediate in length.

"While some asymmetry is expected from Saturn's gravitational pull, there is obviously something going on that causes Titan to have a different shape than expected," Zebker said.

There are several possible explanations for Titan's deformity. It might be that when the shape of the moon was determined, it was in an orbit closer to Saturn. "Another is that there are active geophysical processes occurring inside Titan that further distort the shape," Zebker said. "There are probably many other explanations as well, but we don't have enough information from this one experiment to be able to distinguish those."

Active geophysical processes might help account for another of Titan's oddities.

Zebker said that if you look at images of the surface of Titan, you see surface features that look every bit like mountains on Earth but don't have the high elevations compared to the plains stretching out around them.

"One of the really surprising finds that we have from this, is that the largest apparent continent is lower than the average elevation on Titan, as opposed to higher than the average elevation, as we have on the Earth," Zebker said.

"My favorite explanation is that the material that forms the mountains is simply more dense than the material surrounding them," he said. That would result in the mountains pushing down the surrounding crust, effectively putting the mountains in a basin of their own creation.

On Earth, the situation is the reverse: The crust that lies under the oceans is denser than the material that makes up the continental crust, where mountain ranges are built up.

"The things that we would expect to exist on the surface of Titan would either be solid hydrocarbon materials, essentially frozen ethane and methane, and that is fairly light, and then frozen water ice, which is denser," Zebker said. "If the mountains are composed of water ice and the plain features in between are composed of these solid hydrocarbons, that could lead to this kind of a situation."

Zebker said that research currently being conducted by other scientists to decipher the gravity field of Titan should help resolve some of the questions raised by his team's latest work. But he's holding off making any predictions.

"All of it surprises me because you never know what you are going to see," he said.

Source: Stanford University (news : web)

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