Titan: No global ocean, maybe some seas

One of the more intriguing questions about the planets asks whether a hydrocarbon ocean covers Saturn's big moon Titan, which would then become the first liquid surface besides Earth's waters found anywhere in the solar system. After studying Titan by radar, a group of researchers has concluded that although no global Titanian ocean seems to exist, smaller seas remain a possibility.

Some scientists have suggested Titan may be covered with a layer of liquid methane and ethane more than a mile deep. But the radar results, indicating Titan has a far more varied surface than previously believed, rule out a hydrocarbon ocean blanketing the moon, says Duane O. Muhleman of the California Institute of Technology in Pasadena.

Muhleman et. al./Caltech

Picture of Titan combines radar echoes measured on three successive days, as reflected from three different sides of Saturn's biggest moon as it rotated. Because the radar beam was always aimed at Titan, Saturn's natural thermal glow produced the three smeared images at upper right, one from each day, as though the planet were orbiting Titan instead of vice versa.

On June 3, 4 and 5, Muhleman and graduate students Arie W. Grossman and Bryan Butler, together with Martin A. Slade of Jet Propulsion Laboratory in Pasadena, took part when NASA bounced a radar beam off Titan from the Deep Space Network tracking antenna in Goldstone, Calif. Listening to the beam's echo was a network of 27 electronically linked antennas near Socorro, N.M., collectively known as the Very Large Array. The experiment was possible because NASA has equipped the array to receive a radio frequency that Goldstone can transmit.

On the first and third days of the study, the radar echoes from Titan were so weak – about 2 to 4 percent – that the researchers could barely distinguish them from the background noise. A deep methane-and-ethane ocean of the type proposed for Titan would have very low reflectivity, and its smoothness would be likely to reduce the echo strength even more. However, Titan turns about 23° on its axis every 24 hours, exposing a different side to the radar beam each day, and the echo on the middle day was far too strong – 10 to 20 percent – to have come from such an oceanic surface. Instead, the group suggests, the echoes on the middle day are more like those from Venus.

"We concluded that these differences in reflectivity are real and that we were seeing evidence for surface variability," says Muhleman, who now calls Titan "the most interesting radar target in the solar system." In fact, the group concludes that the face of Titan is "at least as variable as the surface of Mars," some parts of which show reflectivity variations that are just as high. Muhleman notes that the weak Titan echoes could still have come from ethane oceans, although such an ocean "is certainly not 'universal,' and there may very well be some dry land."

Regardless of whether Titan has oceans, the Voyager 2 spacecraft found in 1980 that the pressure of the bottom of Titan's atmosphere is about 1.3 times Earth's, with a surface temperature of -290°F. Higher up, it appears to be warmer, but in the bottom 15 miles or so, some scientists suggest that methane and ethane rains may fall.

Next year, NASA hopes to nearly double the 360,000-watt power of the Goldstone transmitter, which could then produce more detailed radar returns. NASA and the European Space Agency hope to get a much closer look with the imaging radar of the planned Cassini mission, to be launched in 1995 to radar-map Saturn and Titan in 2002. *– J. Eberhart*

Psoralen's activity comes to the surface

A chemical found in celery, figs, limes and parsley has proven an effective treatment for years for psoriasis and, more recently, for a type of cancer known as cutaneous T-cell lymphona. Scientists have long thought that this ultraviolet-activated drug, called psoralen, worked solely by affecting DNA within cell nuclei. But about three years ago, chemical evidence began to suggest that psoralen also acts on several types of cell-surface molecules. Now researchers have added cell-membrane DNA to the list of psoralen targets, and other studies are revealing the importance of protein and lipid cell-surface molecules in the drug's therapeutic effect.

The new research brings scientists closer to developing more effective analogs of the drug to treat psoriasis and cancer, says photobiochemist Francis P. Gasparro of the Yale University School of Medicine. Gasparro and others described their findings last week at a photobiology symposium at Yale.

Physicians have tried to explain psoralen's success against psoriasis by its effect on nuclear DNA – the mechanism of many cancer drugs. This, they reasoned, could account for the chemical's ability to normalize the multiplication of overly productive epidermal cells, clearing up the scaly and often painful skin lesions of psoriasis. But "if the drug simply worked like classical cancer drugs by [affecting the nucleus], killing rapidly dividing cells, one would expect that all the cells in the epidermis would die," notes Yale's Richard L. Edelson.

Researchers have attempted to invoke the same nuclear explanation for psoralen's effectiveness in a cancer treatment known as photopheresis. But the theory behind photopheresis has been that it stimulates the immune system to recognize and attack lymphoma cells. Thus, it would seem "that the [cell] surface is involved because that's all the immune system sees," Gasparro says. Used in people with cutaneous T-cell lymphoma, this treatment involves removing samples of white blood cells, including T-lymphocytes, from a psoralen-treated patient, then exposing the cells to ultraviolet light and injecting them back into the patient (SN: 2/14/87, p.101).

Prompted by research from the early 1980s demonstrating that lymphocytes contain DNA bound to proteins on their surfaces, Gasparro, Edelson and their colleagues looked for a surface-DNA psoralen target on fresh human lymphocytes. They treated the cells with ultraviolet-activated psoralen and chemically disrupted their membranes. When they isolated the cells' membrane DNA, the group discovered that psoralen had bound to it. In a second experiment, they verified that such psoralen-DNA complexes also form in intact cells when they found that an antibody that specifically recognizes psoralen-DNA complexes binds to psoralen-treated cells but not to untreated cells.

At the meeting, a separate group presented evidence that psoralen's *main* site of action resides at a cell-membrane protein receptor. Jeffrey D. Laskin at the Robert Wood Johnson Medical School in Piscataway, N.J., suggests that when psoralen binds the receptor on diseased cells, it chemically normalizes a malfunctioning enzyme important in cell division. In studying this receptor, Laskin and his co-workers have developed some "striking new compounds" that show promise in human tissue culture as future drugs for leukemia as well as for psoriasis and other skin diseases.

Italian researchers say they have shown for the first time in living animals that cell-membrane fatty acids are also important psoralen targets. After applying psoralen to rat skin and separating the lipid, protein and nucleic acid components from epidermal cells, they found the most psoralen bound to the lipid fraction, reports Francesco M. Dall'Acqua of the University of Padova.

– I. Wickelgren