Venus: Another sign of a wet past

Did Venus once have an ocean? For decades, the question has been a major riddle in the study of a planet that is earthlike in such fundamental ways (size, mass, distance from the sun), yet so different in others (atmosphere, surface temperature). With only theory and indirect evidence to go on, researchers have struggled with two opposing possibilities: Either Venus was "born dry," or it was formed with a substantial water supply that was later lost in the growing heat.

The first direct clue was discovered late last year in data from one of the Pioneer Venus entry probes that descended through the planet's atmosphere in December of 1978. Analysis of formerly overlooked readings from the probe's neutral mass spectrometer provided scientists with the first measurements of the ratio of deuterium, or heavy hydrogen, to regular hydrogen in the atmosphere — a number that could be projected backward in time to indicate the amount of water that existed in the planet's early history (SN: 12/12/81, p. 372). The answer, report Thomas M. Donahue of the University of Michigan, John H. Hoffman of the University of Texas and colleagues: "Venus was wet."

Now there is another clue. And its message is the same.

This time the evidence comes not from an entry probe, but from the Pioneer Venus orbiter, which is still circling and studying the planet (though budget cuts may force it to be turned off late this year). Among its instruments is an ion mass spectrometer, capable of measuring the charged forms of both deuterium and hydrogen. And again the deuterium-to-hydrogen (D:H) ratio is the key.

When the solar system was being formed, a tiny fraction of the available hydrogen atoms consisted of deuterium atoms, with the same atomic number but twice the mass, which were incorporated along with the regular hydrogen into some water molecules. The waters of earth thus preserve that fraction, with about one ten-thousandth of their hydrogen atoms consisting of deuterium, a D:H ratio of 10^{-4} If Venus once had a lot of water that has since dissociated into its component atoms, however, the D:H ratio would be different, since most of the lightweight hydrogen would have escaped into space while a greater proportion of the heavier deuterium would have stayed behind, creating an enriched D:H ratio.

Donahue's group reports that the ratio measured from the probe data was 1.6 $(\pm 0.2) \times 10^{-2}$, more than 100 times as deuterium-rich as earth's. The measurement was obtained by comparing the number of molecules having an atomic mass of 18 (H_2O) with those of 19 (HDO). Identifying the tiny percentage of HDO in the water-poor Venus atmosphere would have been almost impossible except for the fact that during part of the probe's descent the sampling inlet of its neutral mass spectrometer became temporarily clogged with a drop of sulfuric acid from the clouds — a natural source of concentrated "Venus water."

The ion mass spectrometer aboard the orbiter measures ion concentrations at the top of the Venus atmosphere, including ions with an atomic mass of 1, which is hydrogen (H^+) or 2, which can be either molecular hydrogen (H_2^+) or deuterium (D^+). In a 1980 analysis of the data, Harry A. Taylor (the instrument's designer) and Richard E. Hartle of the NASA Goddard Space Flight Center, together with other colleagues, reported the presence of some mass-2 ions, but essentially assumed them to be H_2^+ rather than the telltale D^+. "We considered deuterium," says Hartle, "but I guess we were influenced by a then-prominent solar-system evolution model that said Venus never had water." Last year, however, Harvard's Michael B. McElroy and colleagues posed several problems with the H_2^+ interpretation, and suggested that the mass-2 measurement might indeed represent deuterium.

Thus prompted, Taylor and Hartle took another look, this time using only data gathered when the orbiter was low enough in the atmosphere for chemical effects to be undistorted by the dynamical effects that dominate the atmosphere's outer fringe. Down in that "chemical equilibrium region," says Hartle, the difference between D^+ and H_2^+ is easy to see, as is well-established from studies of earth's own atmospheric chemistry. For a 10-kilometer increase in altitude, he says, the D^+:H^+ ratio drops by about 10 percent, while the H_2^+:H^+ ratio drops by as much as 98 percent. Even before doing the analysis, Hartle recalls, "I told Harry, 'This is going to be a clearcut case.'" And indeed, the researchers found the ratio to drop by 8 to 15 percent — strong evidence of deuterium, yielding a D:H ratio of about 10^{-2}, similar to both McElroy's speculation and Donahue et al.'s measurement. This converts to less than one percent of the water in earth's oceans, but Donahue believes that additional deuterium would have been lost, and that far more water may well have been present. *—J. Eberhart*

Offspring tumor: A likely legacy?

Cancer strikes. One of the victim's parents works in industry and before the child's birth had come into contact with several harmful chemicals — some of which are known mutagens (substances that can alter the genetic material). Is there a link between the parent's exposure to mutagenic agents and the child's cancer? More specifically, can mutations in parental germ (sperm or egg) cells lead to heritable cancers? Taisei Nomura of Osaka University Medical School in Japan believes he has observed this phenomenon in mice, and his study — published in the April 8 NATURE — has caught the eyes of certain U.S. researchers.

Nomura's study involved first either exposing mice to X-ray radiation or injecting them with urethane ($CO[NH_2]OC_2H_5$) — a chemical used in the production of certain drugs, fungicides and pesticides. The radiation dose ranged from 36 to 504 rads (a person absorbs .030 rads from an average chest X-ray); the urethane dose ranged from 1 to 2 milligrams of the chemical per gram of mouse body weight. The treated mice then were mated to untreated mice. The results indicate that both radiation and urethane exposure significantly increased the number of tumors in the offspring. For example, of the 1,529 offspring of X-ray-treated male mice, 153 developed tumors within eight months after birth. Similar results were obtained with X-ray-treated females and urethane-treated parents of both sexes. By contrast, only 29 of 548 control progeny — mouse offspring of untreated parents — developed tumors.

While such data are striking, they "should be taken as just a preliminary indication," says Walderico Generosa, who is doing similar research at Oak Ridge National Laboratory in Tennessee. "The question is whether mutations induced in germ cells of parents increase the predisposition of their children to cancer," Generosa told SCIENCE NEWS, "and for several reasons, Nomura's study does not unequivocally answer that question." First, because 87 percent of the progeny tumors were in the lungs of the mice, the results may be due to a special property of the mouse strain used, Nomura himself admits. Another potential problem with the study, Generosa says, is that while the mutagenicity of radiation has been proved, the same is not true of urethane. If a researcher intends to show a link between a progeny cancer and a germ-line mutation, Generosa explains, then that researcher must be reasonably certain that a mutation did indeed occur; use of urethane does not give such an assurance.

Despite these possible flaws, Nomura's study is significant, Generosa says. It has encouraged researchers in the National Toxicology Program at Research Triangle Park, N.C., and scientists at Oak Ridge "to consider the importance of this particular research." In fact, Generosa says he recently began a study similar to, but more comprehensive than, Nomura's. Should the Oak Ridge study confirm what the Osaka University report suggests, then the findings will have "important implications," Generosa says, "for the evaluation of chemicals and X-rays in the environment." *—L. Garmon*