New Evidence of Ancient Sea on Venus

Born in the same part of the solar system as our own planet, Venus has a mass, chemical composition, and size similar to Earth's. But the planet known as Earth's twin differs in at least one important respect. Venus is as dry as a bone. So could the two planets truly have a common origin?

A new analysis of spacecraft data suggests that in the distant past, Venus was all wet. The planet may have had an ocean as deep as 25 meters, according to a reexamination of data gathered by the Pioneer Venus satellite, which burned up in the Venusian atmosphere last fall after a 14-year mission (SN: 10/17/92, p.263). The ocean on Venus might have lasted long enough—about a billion years—to support primitive life, says Thomas M. Donahue of the University of Michigan in Ann Arbor. He reported the findings last week at a press conference in Pasadena, Calif.

Donahue and his colleagues base their report on the chemical evidence that water molecules leave behind when they split apart and leave the atmosphere of a planet. This chemical signature comes from the abundance of two atoms—hydrogen and its less abundant isotope deuterium, which has twice hydrogen's mass. From 1978 through 1980, Pioneer Venus recorded the ratio of deuterium to hydrogen in the planet's upper atmosphere.

The craft's early measurements revealed that this deuterium-to-hydrogen ratio is at least 150 times greater on Venus than in any other known place in the solar system. That unusual ratio presumably came about over billions of years during which atmospheric conditions on Venus prompted ionized hydrogen to escape, while gravity kept the heavier deuterium on the planet. Thus, Venus once had at least 150 times as much hydrogen as it does now. And since hydrogen readily bonds with oxygen to produce water, this suggests that Venus once had a minimum of 150 times as much water as it does now.

Those early data would make any ocean on the young Venus only 0.5 meter deep, notes Donahue. But in reexamining the data, two of his collaborators — Richard E. Hartle and Joseph M. Grebowsky of NASA's Goddard Space Flight Center in Greenbelt, Md. — calculated that deuterium on Venus might exit more easily, compared with hydrogen, than estimated.

If Donahue's team is correct, then Venus once had much more deuterium than previously calculated. This means that the planet must also have had more hydrogen in the past, in order to come up with the ratio of deuterium to hydrogen measured by Pioneer Venus. In fact, Donahue says, hydrogen was about 3.5 times more abundant than believed. And since more hydrogen implies more water, he asserts that Venus may once have had an ocean 8 to 25 meters deep. "The data indicate that Venus was a pretty wet planet," he says.

Donahue cautions that Venus' early water supply might have been steam, not liquid. But scientists generally believe that the sun's luminosity was 30 percent lower several billion years ago, and it may have been cool enough on Venus to permit an ocean. Later on, as carbon dioxide and other greenhouse gases — including water vapor itself — rapidly accumulated in the planet's atmosphere, the surface heated up and the proposed ocean disappeared.

A comparison of data collected by Pioneer Venus during its first few and last few years in orbit shows that the Venusian ionosphere is much lower and less dense when the sun is near a minimum in its 11-year sunspot cycle, Donahue notes. This indicates that if Venus had an ocean, it probably did not exist beyond the first billion or so years of the planet's existence, he says.

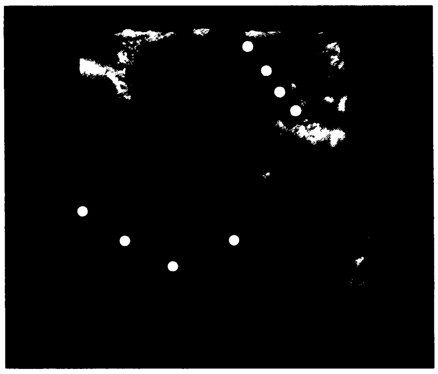
Climate modeler James Kasting of Pennsylvania State University in University Park says the new analysis hasn't yet convinced him that Venus once had a deep ocean. "It's not clear to me that we are understanding all the processes important for hydrogen escape; it's messier than we used to think," Kasting says.

Victor R. Baker of the University of Arizona in Tucson, who has proposed that Mars once harbored an ocean, says the Venus findings support the view that all of the inner solar system planets were formed from the collision of similar material and once had an abundance of water.

—R. Cowen

Cretaceous die-offs: A tale of two comets?

Hot on the trail of a prehistoric killer, geologists have used the chemical equivalent of fingerprints to exonerate one suspect while shoring up the case against another in Earth's greatest murder mystery—the mass extinction that ended the Cretaceous period and wiped out the last living dinosaurs.



Sharpton

Gravity data from Chicxulub show the buried crater. White dots indicate proposed outer rim, which would make the crater nearly 300 km across.

At the Lunar and Planetary Science Conference in Houston last month, several teams of researchers reported on studies concerning two impact craters that date to the boundary between the Cretaceous (K) and Tertiary (T) periods 65 million years ago. Analysis of a crater buried near Manson, Iowa, suggests that the impact there left no widespread trace in the sediments of the time and therefore did not cause any of the global havoc. Instead, mounting evidence links the Chicxulub crater beneath Mexico's Yucatán Peninsula with the K-T catastrophe.

"I think people who have been supporters of Manson have realized that Manson is probably not responsible for virtually anything we see in the K-T boundary sediments and that everything is fitting into place for Chicxulub," says Joel D. Blum of Dartmouth College in Hanover, N.H.

Scientists first raised the idea of K-T impacts in 1979, after finding a thin layer of clay containing high concentrations of the element iridium in 65-million-year-old sediments. Because iridium is much more abundant in comets and asteroids than in Earth's crust, the scientists proposed that the clay layer represents the fallout from a thick dust cloud created when an extraterrestrial body walloped Earth at the end of the Cretaceous.

Further impact evidence came when researchers studying the K-T boundary sediments found slivers of quartz bearing fractures created by a severe shock wave. The K-T sediments also yielded pieces of "tektite" glass, which forms when an impact sends up a spray of molten rock droplets that solidify as they fall.

When geologists went searching for the crater left after the K-T crash, they focused first on the Manson structure. At 35 kilometers wide, Manson is one of the biggest impact craters on Earth, though most scientists have considered it too puny to account for the amount of iridium present in K-T boundary sediments. In the last two years, geologists have drilled into the Manson crater to obtain samples that would resolve its age and relationship with the K-T event.