Radio study finds drier Martian atmosphere

There's dry and then there's *dry.*

Although researchers have known that the atmosphere of Mars contains very little water vapor, a newly reported study shows that in December 1990 the Martian atmosphere contained the smallest concentration of water vapor ever recorded for the Red Planet. Indeed, if all the vapor then present in the atmosphere had condensed on the planet's surface, it would have formed an ocean only 3 micrometers deep – too shallow to cover even the thickness of a human hair.

The study marks the first time researchers have used a ground-based instrument – in this case, the Very Large Array radiotelescope near Socorro, N.M. – to measure the thermal radio emissions of water in a planetary atmosphere other than Earth's. Previous surveys, both in space and on the ground, have relied on an entirely different technique to measure the concentration of Martian water vapor.

Past surveys, notes study coauthor R. Todd Clancy of the University of Colorado at Boulder, employed near-infrared detectors that record how much sunlight the vapor absorbs. In particular, infrared instruments aboard the Viking spacecraft in the mid-1970s found twice as much water vapor during the same Martian season, early northern spring, as the 1990 study; a 1988 infrared study from the ground revealed four times as much water vapor. Clancy and his colleagues, Arie W. Grossman of the University of Maryland in College Park and Duane O. Muhleman of the California Institute of Technology in Pasadena, report their work in the November ICARUS.

Bruce M. Jakosky, also at the University of Colorado, cautions that scientists have not yet rigorously compared the infrared absorption and radio-emission methods. But if the apparent variation in water vapor proves accurate, he says, it suggests that the concentration of water in the atmosphere varies as much from year to year on Mars as it does from season to season.

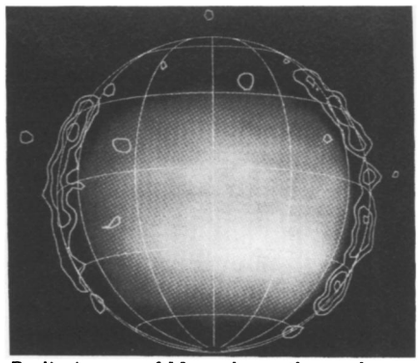
Water may have played a key role in etching the rugged face of the Red Planet, and it remains an influence on climate. But planetary scientists, says Jakosky, have begun to realize that they "don't have a sense of what the typical behavior of water vapor is in the present epoch on Mars and how much variation there can be. The extremes of water vapor that have been measured – if they're real – are telling us that our previous understanding is not the whole story, that here's a year that has less water than we thought was possible."

Clancy adds that the views of Mars gathered by the two Viking craft, and earlier by Mariner 9, may not reflect the general status of water vapor on the planet. Each of these missions made observations during and soon after Martian dust storms, which probably warmed the planet. Such warming could melt some of the ice on the surface, temporarily boosting the amount of water vapor in the atmosphere. Jakosky notes that water stored in the planet's frozen polar caps, as well as ice mixed in with surface soil, could influence the amount of water in the atmosphere.

Clancy says his team's radio study, though restricted to detecting vapor above the limb, or edge, of the planet, has an advantage over infrared measurements: It recorded the density of water vapor at different altitudes above the Martian surface. The team found that the density of water vapor was nearly constant up to 50 kilometers above the surface.

This finding suggests that Mars' windy atmosphere may transport water between middle and low latitudes, he says. Jakosky adds that he looks forward to further observations that can indicate whether water density remains uniform from year to year. A greater density at lower depths, he notes, could force more water vapor into the soil.

Clancy's team plans to examine water vapor concurrently with other studies using a detector aboard the Mars Observer, which is expected to reach Mars in 1994 (SN: 9/19/92, p.181). *– R. Cowen*



Clancy *et al.*

Radio image of Mars shows thermal emissions from water vapor (white contours) on both the morning (left) and evening (right) limbs of the planet.

Better traces of whale pedigree discovered

Many paleontologists believe that *Pakicetus*, a carnivorous mammal that flourished 50 million years ago, helped bridge the evolutionary gap between whales and their land-dwelling ancestors.

Now, fossils uncovered in Pakistan provide the best evidence to date that *Pakicetus* teetered on the midpoint of this radical evolutionary change, pursuing its meals in the water but spending significant time on dry land.

Arguments for this theory hinge on whether *Pakicetus* had the hearing of a land-dwelling or a marine mammal. Newly recovered jaw and middle-ear bones strongly indicate that *Pakicetus* was not well adapted for underwater hearing, says paleontologist Hans Thewissen of Duke University School of Medicine in Durham, N.C. Thewissen discussed the new *Pakicetus* fossils and their implications at last week's meeting of the Society of Vertebrate Paleontology in Toronto, Canada.

"I think for the first time there is what you could call a missing link – if there is such a thing as a missing link – between the hearing mechanism of the marine mammal and the terrestrial mammal," he says.

Thewissen and paleontologist S. Taseer Hussain of Howard University College of Medicine in Washington, D.C., unearthed the fossils in the Kala Chitta Hills of the Punjab region of Pakistan. Researchers found the first remains of such creatures at the same site more than a decade ago. The deposits, called the Kuldana Formation, have also yielded fossilized ancestors of sea cows.

According to a widely accepted theory, whales have large fat pads in their jaws that channel sound vibrations to each ear. These fat pads and other adaptations give cetaceans – members of an order that includes whales, dolphins, and porpoises – their directional hearing.

A decade ago, paleontologist Philip D. Gingerich at the University of Michigan in Ann Arbor first described *Pakicetus.* Based on a reconstruction of the creature's skull, Gingerich determined that *Pakicetus* did not seem to have the necessary equipment for underwater hearing. Also, the whale ancestor's remains were found with those of land mammals. This evidence suggested that *Pakicetus* had an amphibious life-style.

The new fossils strongly confirm Gingerich's theory. They show that *Pakicetus* had very narrow channels in the back of its jaw, making it quite unable to accommodate the large fat pads characteristic of cetaceans, explains Thewissen. The structure of the middle-ear bones – the first recovered for *Pakicetus* – are also decidedly uncetacean, Thewissen notes.

Gingerich says the ear bones provide especially strong evidence for *Pakicetus'* transitional status in cetacean evolution. "It's another important characteristic that shows this thing is really intermediate," he explains.

Although the new fossils clarify *Pakicetus'* place in the evolution of whales from land-dwelling mammals, they don't tell the whole story. As Thewissen notes, "Every missing link makes two more – one above it and one below it."

– D. Pendick