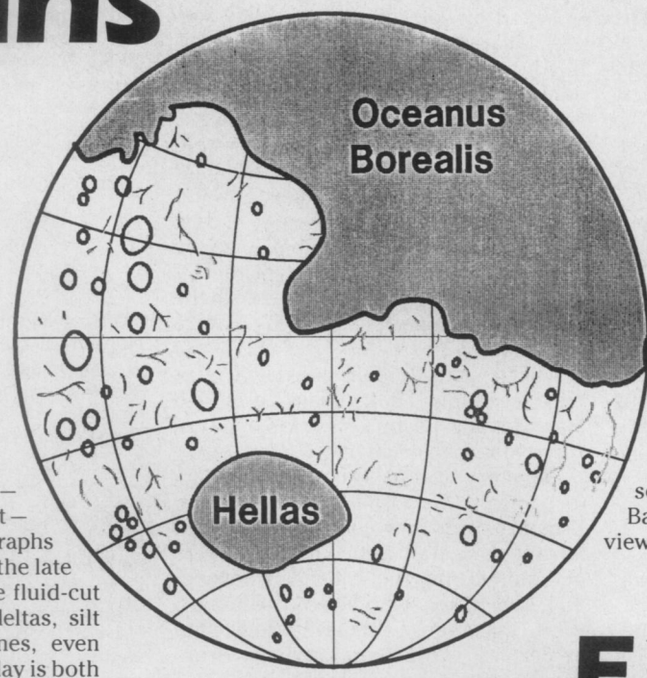
Episodic Oceans

The waning and waxing waters of Mars



An ancient ocean, Oceanus Borealis, may have covered the Martian northern hemisphere on repeated occasions, eroding valley networks in the planet's cratered uplands.

Baker et al.

By JONATHAN EBERHART

There is nothing new in suggesting that water — even vast quantities of it — once flowed on Mars. Photographs taken by the Viking orbiters in the late 1970s reveal what appear to be fluid-cut channels, floodplains, river deltas, silt deposits and eroded shorelines, even though the Martian climate today is both too cold and too dry for flowing water to exist. But researchers have now added a dramatic detail to the scenario of a wet Mars.

The conventional view of Martian water depicts it as a one-time phenomenon, which then disappeared forever. Planetary scientist Victor R. Baker and his colleagues propose a more complex scenario: an ocean that came and went more than once, prompting a succession of floods and droughts that markedly changed the planet's climate each time. They call the vanished sea Oceanus Borealis, and they suggest that its waters covered almost the entire northern hemisphere of Mars.

Oceanus Borealis emerges not from new findings but from existing data reevaluated by Baker, Robert G. Strom, Steven K. Croft, Virginia C. Gulick, Jeffrey S. Kargel and Goro Komatsu of the University of Arizona in Tucson. And, says Baker, it "has completely changed how we view Mars."

Indeed, he suggests, the implication of a waxing and waning ocean is almost as significant for that planet's history as the idea of plate tectonics has been for studies of Earth.

Geologists long viewed Earth's evolution in simple terms, Baker notes. But the emergence of the plate tectonics concept in the 1960s — providing a unifying theory to explain such seemingly disparate phenomena as mountain building, volcanism, giant earthquakes, the movements of continents and the continuous creation and destruction of the ocean floor — added a new dynamic to our understanding of the Earth. At several times in the long-ago past, the theory holds, giant land masses have split apart and their remnants have inched over the globe, only to rejoin several hundreds of million years later — and eventually to resume this dance of the continents.

"The planet has a cyclic life to it. . . . Mountains rise and fall, ocean basins open and close," Baker observes.

For Mars, the Arizona researchers propose another version of a planetary life cycle: an ocean and some isolated lakes that periodically come and go, producing a warmer, wetter atmosphere during their visits. These oceanic epochs — initiated by increased volcanic activity — interrupted long periods of cold, dry conditions resembling the Martian climate of today, they suggest.

"The cataclysmic ocean formation had an immediate climatic influence," asserts Baker in a summary written for last month's Lunar and Planetary Science Conference in Houston. "Both water (evaporated from the sea) and carbon dioxide (from the polar cap) are greenhouse gases. Just as human burning of fossil fuels is causing a global warming of Earth, so the Martian floods induced a cataclysmic warming. As Martian temperatures rose, other water, frozen in upland permafrost, was released to grow into lakes of the Oceanus Borealis."

"It's a view of Mars that isn't a series of still, static pictures," Baker told SCIENCE NEWS. "This is a view of constant flux and change."

Evaluating such a bold concept is difficult because scientists, lacking Martian rocks to date with isotope studies, do not know the actual age of anything on Mars. Some researchers, including Baker's colleague Strom, have set a rough historical timeline for Mars based on the number of meteorite craters on different parts of its surface. They assume that the number of large meteorites hitting the planet generally decreased as the solar system aged, a concept sometimes used to date structures on Earth's moon. For example, in Martian regions where fewer impact craters are visible, one might deduce that water once flowed, erasing some of the ancient craters as it "resurfaced" the terrain.

Strom and others have divided their Martian timeline into three stages. The first includes the heavy meteorite bombardment (documented on the moon from rocks brought back by Apollo astronauts) that ended about 3.8 billion years ago. The second stage spans a period lasting until perhaps 2 billion years ago, and the third extends from that time to the present.

Baker's team proposes that water has flowed during each of the three stages, not just in one massive deluge from which the planet has been drying out ever since, as simpler models seemed to suggest. "What really made us change our minds is essentially a crisis of thought," Baker says. "We realized that water has to be recycled in order to produce the features that we see on the planet. We can't make

the valleys we see unless we can reenergize the flow system to keep water moving through the valleys over time."

Intense periods of volcanism melted frozen water to begin each wet period, they suggest. Baker notes that for water to reach higher elevations, a heat source must evaporate it, enabling the water to move and fall as snow or rain. The landforms that seem to have been sculpted by flowing water in early Martian history occur in areas that show signs of possible volcanism, he says. The apparently more recent water-carved features are concentrated at Tharsis and Elysium, two high-elevation, volcanic-looking regions with channels that may have carried water to the surrounding plains.

Baker's group argues that the episodic oceans may have been hundreds of meters deep, and that evaporation from them may have led to rainfall, snow and flowing rivers over much of Mars, rusting the planet's iron-rich rocks and perhaps even assisting in an emergence of life forms, if any ever existed there.

Terrain apparently shaped by glaciers offers another hint of water on Mars. In a separate paper presented at the Houston meeting, Kargel and Strom assert that Oceanus Borealis "supplied the atmosphere with water vapor, which then was cold-trapped as snow or frost in the high elevations in the southern hemisphere." As the ocean's climatic perturbations warmed the planet, the ice sheet eventually melted, filling cratered regions with water that flowed northward, froze again and was remelted by volcanic activity, they suggest. This renewed flow could have refilled the giant ocean, Kargel and Strom note, "completing the cycle, possibly on a repeating basis."

Over time, Baker adds, Mars would have lost much of its water as solar ultraviolet light split molecules of water vapor, allowing the hydrogen to escape into space and the oxygen to oxidize the planet's surface. Today, most of the remaining water may lie frozen beneath the surface, with some locked up in polar ice caps, he says.

Will Oceanus Borealis one day return? "Yes, certainly," Baker says, provided Mars retains its potential for a future surge in volcanic activity.

Planetary scientists need far more data to confirm this vision of a wet Mars. Useful insights may come from U.S. and Soviet spacecraft scheduled for Mars missions during the 1990s and beyond. Still, says Baker, "we feel we have found a way to make sense out of what seemed to be perplexing problems of past environmental change on the planet." □

Letters continued from p.275

Is the reader forced to think in three dimensions because the language is fundamentally three-dimensional, and if so, is language three-dimensional because of some basic attribute of the brain, or because a Euclidian metaphor is an efficient way to describe the world of a nonspherical animal under the influence of gravity and of such small size that it sees Earth's surface as essentially a flat plane? How would a writer born in the weightless environment of space describe the positions of objects, and how would readers who had spent their lives in the environment organize their imaginary spaces?

Jeffrey Roseman
Director, Center for Health Risk Assessment & Disease Prevention
Associate Professor of Epidemiology
University of Alabama
Birmingham, Ala.

In their published report, psychologists Nancy Franklin and Barbara Tversky note that the pull of gravity may be one reason why imagined objects above and below a standing observer are remembered more easily than objects located on the observer's sides. — B. Bower

CORRECTION

In "Germanium speeds transistor" (SN: 3/31/90, p. 199), the fabrication process used for making the new transistors was misidentified as molecular beam epitaxy. The researchers actually used ultrahigh vacuum/chemical vapor deposition (UHV-CVD), a process invented by Bernard S. Meyerson of IBM's Thomas J. Watson Research Center in Yorktown Heights, N.Y.