Astronomy

Watery clues from Martian valleys . . .

Did it ever rain on Mars? Recent climate models have suggested that the ancient Martian atmosphere couldn't have held enough carbon dioxide to warm the planet and permit rainfall. A new analysis supports that view, although it doesn't rule out the possibility that snow once fell on the Red Planet.

Virginia C. Gulick and Victor R. Baker of the University of Arizona in Tucson compared the nature of valleys — features carved by water erosion over hundreds of thousands of years — on Earth and Mars. The geologists considered two types of valleys: sapping valleys and runoff valleys. Sapping valleys typically form when groundwater rises to the surface, eating away support rock at the base of a cliff and eventually carving a trough. Runoff valleys are sculpted by the flow of surface water, possibly rainwater.

On Earth, the researchers note, sapping valleys and runoff valleys occur near one another. On Mars, however, runoff valleys don't seem to accompany the sapping valleys in the ancient terrain of the southern highlands. Moreover, the Martian sapping valleys tend to cluster together, with vast expanses of uneroded surface between them.

Gulick and Baker say the clustering of sapping valleys and the apparent lack of runoff features suggest that Mars produced its valley networks by localized release of heat from its interior. The heat release would not have been uniform across the Martian surface, they add, since not all areas on the planet have valleys. Global rainfall would have produced a broader, less concentrated pattern of valleys and would have led to runoff valleys large enough to have been detected by the Viking craft, says Gulick.

The new findings, she notes, don't exclude the possibility that snow once fell on Mars. If snow did exist, it might have served to replenish the vast supplies of underground water.

Gulick and Baker presented their findings at the Lunar and Planetary Science Conference, held in Houston in mid-March.

. . . and channels

While an internal heat source may have helped create Martian valleys, external forces may have triggered the formation of the planet's long, sinuous channels, suggested other researchers at last month's conference.

According to this model, when asteroids slammed into Mars billions of years ago, they may have created intense shock waves that spread out around the planet. These waves would have exerted tremendous pressure on underlying, porous rock and the water held by these rocks. That water pressure would have eventually cracked the planet's frozen crust. Once the underground water emerged, the combination of gravity and erosion would have acted to cut the channels.

The scientists proposing this scenario — Ivett A. Leyva of the California Institute of Technology in Pasadena and Stephen M. Clifford of the Lunar and Planetary Institute in Houston — note that the number of craters points to numerous "Marsquakes" triggered by impacts. In addition, geologic evidence indicates that the ancient Martian crust contained lots of water.

Leyva and Clifford say they took their cue from the effects of a 1964 earthquake in Alaska, which created geysers and a rush of other watery uprisings as distant as 400 kilometers from its epicenter. The quake also significantly altered levels of well water as far away as Perry, Fla., 5,500 kilometers from the site.

On Mars, a shock wave powerful enough to globally compress submerged water could be generated by an asteroid big enough to form a crater at least 1,000 kilometers in diameter, Leyva and Clifford calculate. Such pressure might crack frozen ground several kilometers thick, resulting in a catastrophic discharge of underground water deposits, they say.

Going with the flow

The controversy continues to ebb and flow over whether Mars once had a shallow ocean. Peter Mouginis-Mark, a geologist at the University of Hawaii in Honolulu, now suggests that ancient oceans might explain several puzzling volcanic landforms on the planet's northern plains.

He proposes, for example, that oceans could have sculpted the unusual, cliff-like escarpments of two volcanoes on Mars: Olympus Mons and Apollinaris Patera. Each of these volcanoes, he notes, lies adjacent to a shoreline of a Martian sea postulated by several other researchers. In addition, each volcano's base has an elevation of less than 2 kilometers above the surrounding terrain — the lowest elevations of any volcanic bases known on Mars. The low elevations may have allowed relatively shallow oceans to eat away at the bases of these volcanoes. Thus, Mouginis-Mark suggests, ocean waves pounding the shores and eroding the flanks of the volcanoes could have shaped the escarpments.

He also invokes an aquatic explanation for the volcanic deposits that form a ring around Olympus Mons. Gravity alone can't readily account for this huge ring, he says, because material that rolled down Olympus Mons probably wouldn't travel so far from the volcano. But if part of the volcano's base were submerged in an ocean at one time, subsequent eruptions of lava would result in the buildup of a submerged, weakly supporting foundation prone to underwater landslides. When the ancient Martian ocean receded, a wide ring of volcanic material might well have remained.

A Martian sea might also account for a series of smooth, wind-eroded deposits of low-density material in the region known as Amazonis Planitia, he adds. A combination of wind and wave action from an ancient ocean might have deposited pumice — a porous, low-density rock that floats in the water — along the shoreline, Mouginis-Mark notes.

"Such ideas seem outlandish," he acknowledges, "but they represent the first consistent explanation for [all] these features." He presented his model at the Lunar and Planetary Science Conference.

Space station redesign

Under presidential order last month, NASA began a drastic redesign of Space Station Freedom aimed at halving development, transportation, and operating costs for the Earth-orbiting outpost. Without design revisions, the station would cost $118 billion to operate over its 30-year lifetime, according to estimates by the General Accounting Office. Marty Kress, deputy director of the space station project, says this figure includes $16.9 billion for development costs and $14 billion for costs including construction and transport of the station's various components by space shuttle. NASA has already spent more than $8.5 billion on the station.

To cut costs, the space agency is considering a station with a lifetime of just 10 to 15 years, NASA Administrator Daniel Goldin said at a press conference last month. A scaled-down version might also require only half of the 17 to 20 shuttle flights originally envisioned to transport parts. Goldin said maintaining a full-time crew on the space station remains a priority for his agency, but he indicated that this is now a goal rather than a requirement. Kress notes that some scientists might be unhappy with a space station inhabited only sporadically by humans, since this could defeat studies aimed at understanding the biological effects of long-term exposure to the space environment.

NASA has until June 1 to develop its new version of the space station, now scheduled for launch in 1997. As of April 1, the agency had yet to fill all the positions on the panel appointed to develop the redesign plans.