Is there water and life on mars?

Life

Unlike Earth, since there are no oceans to obscure the planet Mars, its topography is now better explored and known than that of Earth (Australian Geographic 2003). It has the largest known volcano in the Solar System, Olympus Mons, three times as high as Mt Everest, arid the longest and deepest known canyon, Valles Marineris, 4000 km long and 10 km deep (Australian Geographic 2003).

Mars has no continental plate movement, so its surface isn't constantly reworked by mountain-building processes. As a result, much of the landscape is as it was billions of years ago (Australian Geographic 2003).

NASA researchers are taking lessons from the debate about life on Earth to Mars. Their future missions will incorporate cutting-edge biotechnology designed to detect individual molecules made by Martian organisms, either living or long dead (Zimmer 2005).

The search for life on Mars has become more urgent thanks in part to probes by the two rovers now roaming Mars' surface and another spaceship that is orbiting the planet. In recent months, they've made a series of astonishing discoveries that, once again, tempt scientists to believe that Mars harbors life or did so in the past. At a February conference in the Netherlands, an audience of Mars experts was surveyed about Martian life. Some 75 percent of the scientists said they thought life once existed there, and of them, 25 percent think that Mars harbors life today (Zimmer 2005).

The search for the fossil remains of primitive single-celled organisms like bacteria took off in 1953, when Stanley Tyler, an economic geologist at the University of Wisconsin, puzzled over some 2. 1 billion-year-old rocks he'd gathered in Ontario, Canada (Zimmer 2005). His glassy black rocks known as cherts were loaded with strange, microscopic filaments and hollow balls. Working withHarvardpaleobotonist Elso Barghoorn, Tyler proposed that the shapes were actually fossils, left behind by ancient life-forms such as algae. Before Tyler and Barghoorn's work, few fossils had been found that predated the Cambrian Period, which began about 540 million years ago (Zimmer 2005). Now the two scientists were positing that life was present much earlier in the 4. 55 billion-year history of the planet. How much further back it went remained for later scientists to discover (Zimmer 2005)?

In the next decades, paleontologists in Africa found 3 billion-year-old fossil traces of microscopic bacteria that had lived in massive marine reefs (Zimmer 2005). Bacteria can also form what are called biofilms, colonies that grow in thin layers over surfaces such as rocks and the ocean floor, and scientists have found solid evidence for biofilms dating back 3. 2 billion years (Zimmer 2005).

Fluvial Landforms geologic features putatively formed by water were identified in images of Mars taken by the Mariner and Viking spacecraft in the 1970s (Bell 2006). These landforms included enormous channels carved by catastrophic floods and large-scale valley networks somewhat reminiscent of river drainage systems on Earth. Over the past decade, images from the Mars Global Surveyor, which has been orbiting Mars since 1997, have revealed spectacular examples of extremely small and seemingly young gullies formed in the walls of some craters and canyons. These observations indicate the past presence of liquid water on the Martian surface or just below it but not necessarily for long periods (Bell 2006). The water from the catastrophic floods, for example, may have lasted only a few days or weeks on the surface before freezing, seeping back into the ground or evaporating.

Furthermore, the networks of river-like valleys shown in the Viking orbiter images do not have the same characteristics as terrestrial river valleys when seen at higher resolution (Bell 2006). The Martian valleys could have formed entirely from subsurface water flow and ground erosion a process known as sapping-rather than from water moving over the surface. The gullies observed in the Mars Global Surveyor's images may also be the result of water seeping underground below ice or from buriedsnowdeposits (Bell 2006). Although these features are stunning and dramatic indicators of water on Mars, they do not firmly prove that the Red Planet once had a warmer, wetter, more Earth-likeenvironmentwith long-lasting lakes and rivers.

In the past few years, however, new satellite images have provided much more convincing evidence that stable, Earthlike conditions prevailed on Mars for long periods (Bell 2006). One of the most exciting discoveries is a class of features that look like river deltas. The best and largest example, photographed by the Mars Global Surveyor, is at the end of a valley network that drains into Eberswalde Crater in a region southeast of the Valles Marineris canyon system (Bell 2006). This drainage system terminates in a 10-kilometer-wide, layered, fan-shaped landform characterized by meandering ridges that crosscut one another and show varying degrees of erosion. To many geologists, this feature has all the characteristics of a delta that formed at the end of a sediment-bearing river flowing into a shallow lake.

Further evidence of an Earth-like climate in Mars's past comes from high-resolution images, taken by the MarsOdysseyand Global Surveyor orbiters, of the small-scale valley networks on the plateaus and walls of the Valles Marineris canyon system. Unlike previously identified valley networks that seem to have formed largely from subsurface flow, these newly found networks have characteristics that are consistent with their formation by rainfall or snowmelt and surface runoff. For example, the networks are arranged in dense, branching patterns, and the lengths and widths of the valleys increase from their sources to their mouths. Moreover, the sources are located along the ridge crests, suggesting that the landscape was molded by precipitation and runoff. Indeed, these landforms provide the best evidence to date that it may have rained on Mars.

A more exploratory possibility is that these runoff features arose relatively recently, perhaps one billion to 1. 5 billion years after Mars formed. To estimate the ages of Martian landforms, researchers count the number of impact craters on the feature the more impacts the region has endured, the older it is. This dating method, however, has many uncertainties; it can be difficult to distinguish betweenprimary and secondaryimpact craters and volcanic calderas, and erosion has destroyed the evidence of craters in some regions (Bell 2006). Still, if these surface runoff valleys do turn out to be relatively young, Mars may have had an Earth-like climate for as much as a third of the planet's history and perhaps longer if even younger valleys are eventually identified.

Yet another piece of evidence supporting persistent liquid water on Mars is theobservationof truly enormous amounts of erosion and sedimentation in many parts of the planet. Making calculations based on new orbital imaging data, researchers have determined that the rate at which sediments were deposited and eroded in the first billion years of the planet's history may have been about a million times as high as the present-day rate (Bell 2006).

But what process could have transported the massive amount of sediment needed to bury almost everything in the Gale Crater region? (Bell 2006) Scientists believe flowing water offers the best explanation. Studies of erosion and sedimentation rates on Earth suggest that wind could have moved some of the Martian sediment in the past (just as it is doing today, albeit at a very slow pace). No viable wind-based scenario, however, can explain the rapid transport of millions of cubic kilometers of material across large fractions of the planet's surface, which apparently occurred repeatedly during Mars's early history. Flowing water, though, has routinely moved gargantuan amounts of sediment on Earth and could have done so on the Red Planet as well.

In addition scrutinizing the shape of Martian landforms, scientists have searched for hints of liquid water in the composition of the planet's minerals (Bell 2006). One of the reasons why researchers had long believed that Mars never enjoyed an extensive period of warm and wet climate is that much of the surface not covered by wind-borne dust appears to be composed of material that is largely unweathered pristine volcanic minerals such as olivine and pyroxene. If water had flowed over the surface for a long time, the argument went, it would have chemically altered and weathered the volcanic minerals, creating clays or other oxidized, hydrated phases (minerals that incorporate water molecules or hydroxide ions in their crystal structure).

The emerging paradigm is that Mars had an extensive watery past: puddles or ponds or lakes or seas (or all of them) existing for long periods and exposed to what must have been a thicker, warmer atmosphere. During the first billion or so years of Martian history, the Red Planet was a much more Earth-like place, probably hospitable to the formation and evolution of life as currently known. The Martian environment began to change, however, as sulfur built up, the waters became acidic and the planet's geologic activity waned (Bell 2006). Clays gave way to sulfates as the acid rain (of sorts) continued to alter the volcanic rocks and break down any carbonates that may have formed earlier. Over time, the atmosphere thinned out; perhaps it was lost to space when the planet's magnetic field shut off, or maybe it was blown off by catastrophic impacts or sequestered somehow in the crust. Mars eventually became the cold, arid planet recognized today.

This new view of Mars is not yet universally accepted, however. Key questions remain unanswered (Bell 2006): How long did the waters flow in the Eberswalde delta; for decades or millennia? Where are all the sediments that appear to have been eroded from Meridiani Planum and places such as Gale Crater? And were they eroded by water or wind or something else? What is the global abundance of clay minerals on Mars, and were they ever major components of the planet's crust? And, most vexing, where are the carbonates that should have formed in the warm, wet, carbon dioxide-rich environment but have not yet been observed anywhere on Mars, not even in the older terrains where clays have been detected? Acidic water could have destroyed the bulk of the carbonates but surely not all of them!

Perhaps the most important question of all is: Did water or life ever exist on Mars, and if so, was it able to evolve as the environment changed so dramatically to the present-day climate? (Bell 2006) The answer depends in large part on how long the Earth-like conditions lasted. What can be deduced is that the past decade of discoveries on Mars may be only a small taste of an even more exciting century of robotic and eventually human exploration.

References

Australian Geographic, (2003) Life on Mars. 08161658, Jul-Sep2003, Issue 71

Bell, J., (2006) The Red Planet's Watery Past. Scientific American, 00368733, Dec2006, Vol. 295, Issue 6

Zimmer, C., (2005) Life on Mars? Smithsonian, 00377333, May2005, Vol. 36, Issue 2