Arizona State U. geologists suggest Mars feature linked to meteorites, not evaporated lakes (Forwarded)

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ASU geologists suggest Mars feature linked to meteorites, not evaporated lakes

Geologic features at the Opportunity landing site on Mars were formed not by a lake that evaporated but by constant strikes from meteorites, say two Arizona State University geologists.

The site where the Mars Exploration Rover Opportunity landed has sediments and layered structures that are thought to be formed by the evaporation of an acidic salty sea. The prevailing thought is that when this Martian sea existed it may have supported life forms and thus would be a prime site to explore for fossils.

However, ASU geologists L. Paul Knauth and Donald Burt, who along with Kenneth Wohletz of Los Alamos National Laboratory, say that base surges resulting from massive explosions caused by meteorite strikes offer a simpler and more consistent explanation for the rock formations and sediment layers found at the Opportunity site. The researchers published their findings in the current issue of Nature.

The research could impact where and how scientists continue their exploration of Mars in search for past life forms.

Impact surges "present a simple alternative explanation involving deposition from a ground-hugging turbulent flow of rock fragments, salts, sulfides, brines and ice produced by a meteorite impact," the three state in their article "Impact Origin of Sediments at the Opportunity Landing Site on Mars."

"Subsequent weathering by inter-granular water films can account for all of the features observed without invoking shallow seas, lakes or near surface aquifers," they add. "Layered sequences observed elsewhere on heavily cratered Mars and attributed to wind, water or volcanism may well have formed similarly."

When the Opportunity lander touched down on the Meridiani Planum in January 2004, it began a very important period in planetary exploration. The rover has operated for nearly two years -- when it was designed to operate for 90 days -- and has returned many breathtaking images of the Martian surface, as well as measurements of the surrounding geologic features and chemistry.

Researchers on the Mars Exploration Rover team feel these observations of this site point to an area once drenched in water, providing an environment that could have supported life. The body of water gradually evaporated away, due to the thin Mars atmosphere, leaving high concentrations of salt behind and several telltale mineral deposits and geologic formations. Because the observed signs point to an area that once was a lake, or large body of water, it would be a good choice to further explore the Meridiani Planum for fossils or other relics of previous life forms.

But to Knauth, Burt and Wohletz the geologic features at the Opportunity landing site can also be explained as being artifacts of a meteorite strike rather than a one-time lakebed.

"When a meteorite hits there is a tremendous blast, like a nuclear explosion," Knauth says. "On a planet with an atmosphere, around the base you get a turbulent ground-hugging cloud of debris that goes out and makes a sedimentary deposit. You get deposits that can go up to almost 100 kilometers from big volcanoes. A big [meteorite] impact can provide deposits over tens of thousands of square kilometers.

"Mars is cratered from one end to the other. All of these should have made base surges," Knauth says.

Upon examining the evidence, the researchers believe the sediments and structures at the Opportunity landing site are more likely caused by a base surge than an evaporated lake. Some of the questions concerning the observed sediments include a mixing of evaporative salts, textures of the sediments and the existence of small spheroid concretions at the landing site.

"The mixed chemistry of the salts is all wrong at the Opportunity site," Burt says. "If it were a large lake that slowly evaporated, then the salt deposits would be more uniform going from least soluble (calcium sulfate, jarosite) to most soluble (halides and Magnesium-sulfate).

"With evaporated deposits you would not get what you are seeing chemically or mineralogically on Mars," Burt adds. "At the Mars site, they have their most soluble salts mixed with the least soluble salts. On Earth, the least soluble evaporates first (like a bathtub ring) and the most soluble last, but in this deposit it is a complete mix."

The researchers explained that from orbital imagery it seems clear that Mars had a "warm-wet" interval very early in its history when there was water briefly on its surface. Most of the water escaped from the planet leaving behind brine that seeped into the rubble created from the early large meteorite impacts, the so-called "megaregolith."

When the planet froze, salts formed in the subsurface along with ice and residual brine. All of this would then be "excavated," basically thrown all together in subsequent impact events, the researchers say.

A specific sedimentary feature called festoon cross bedding, is one which scientists first examining the Mars evidence said was proof of flowing water in the area. Knauth, Burt and Wohletz say it also is a common structure resulting from base surges.

Knauth uses illustrations from structures found in Kilbourne Hole, New Mexico, and compares them to images taken of Martian strata. While these features can be explained as being caused by flowing water, the researchers write: "Cross bedding and other sedimentary structures form in base surges as they slow down and allow suspended particles to be pushed along the surface and worked into layers and cross beds."

"These features," Knauth says, "are quite common in base surges." In fact, such cross bedded sand deposits up to 1 meter think have been found at nuclear test sites in the western U.S. and are common around volcanic blasts. Co-author Wohletz, an expert on base surges, proposed early on that cross bedded deposits should be common on Mars.

One particularly interesting feature found at the Opportunity landing site are little spheroid like concretions, or globules, of material. Initially, scientists believed they were artifacts of water interacting with the ground as it moves through the rocks. But in order to make as many spheroids as they found, it would take large amounts of groundwater to be present and "these things need to grow within rock. We didn't see any evidence of this," says Knauth, who has been studying concretions on Earth for 35 years.

"They were absolutely perfect little spheres," he says. "These turn out to be abundant in base surges. They form like little hailstones. They are the same shape, the same size and the same uniform distribution, which concretions don't have."

Knauth explains that there is plenty of evidence of past water on Mars and that there is a fair likelihood that some forms of life may have existed on the Red Planet. But if the team's theory is correct, and the surface features of Meridiani Planum were caused by meteorite strikes and not a large lake, then the scientists need to be more creative in where they focus the next steps of their exploration for evidence of life forms, Knauth says.

Knauth says clues may lie in Martian rocks.

"If we know anything about Mars it is that it has been pounded unmercifully by meteorites," he adds. "We just need to live with it and take advantage of it. Meteorites are excavators, they throw rock around all over the planet and I think some of those are juicy astrobiological targets."

He says most every rock on Mars is cracked and if there was microbial life on the planet, microorganisms could be picked up by the wind and driven to different parts of the landscape. They eventually could lodge in the cracks of rocks and have calcium carbonate and other salts entomb them."

He adds that one of the meteorites from Mars has such carbonate in cracks and possibly contains evidence of past life. Cracks filled with the white material have been imaged repeatedly by the rovers on Mars, but the current instrumentation cannot analyze them.

"If we want to find evidence of past life on Mars we need to look at these cracks," Knauth explains. "If there were microbes blowing around these rocks, they could settle and become entombed in these little fills.

"Forget trying to find fossils in situ in apparent lake or ocean beds, that stuff probably is long gone, being pulverized by later impacts," he adds. "Instead we may have to look at these little films and fractures."
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