New musings about old Martian puzzles

Anticipating the flood of data from a trio of spacecraft expected to begin their journey to Mars later this year, researchers have reconsidered some old puzzles about the Red Planet. Independent studies reported this week shed light on two long-standing Martian mysteries.

One of the mysteries concerns the Martian surface. Planetary scientists have compelling reasons for believing that the topmost layer of Martian soil contains substantial amounts of carbonates. These compounds are found in meteorites thought to have originated from ancient Mars. Moreover, many scientists suspect that the ancient Martian atmosphere contained much more carbon dioxide than it does now. Presumably, some of that carbon got incorporated as carbonates into Martian surface rock.

Despite these lines of indirect evidence, researchers over the years have failed to directly detect carbonates on the Red Planet. Now, Russian and German scientists say they have resolved the discrepancy.

Using a mercury lamp to mimic the effect of ultraviolet sunlight shining on Mars, the team found that carbonates decompose readily. The results suggest that the breakdown of calcium carbonate on Mars released carbon dioxide faster than the Martian atmosphere lost the gas.

Thus, the decomposition rate not only accounts for the apparent absence of carbonates on the Martian surface today but also indicates that surface carbonates represented an important source of atmospheric carbon dioxide in the past, assert the researchers. Lev M. Mukhin of the Embassy of the Russian Federation in Washington, D.C., and his colleagues describe their work in the Jan. 11 NATURE. The team suggests that to uncover carbonates, spacecraft may have to search several meters beneath the planet's dusty coating.

"A lot of people have looked for [carbonates] and not found them; this may be the explanation," notes Michael Carr of the U.S. Geological Survey in Menlo Park, Calif.

In another study, published in the Jan. 12 SCIENCE, scientists reexamine 1970s spacecraft data in an attempt to understand why the southern hemisphere of Mars appears more heavily cratered than the northern half. Some researchers have suggested that a massive body slammed into the northern hemisphere, altering its surface and creating a bowl-shaped depression.

In the new report, David E. Smith of NASA's Goddard Space Flight Center in Greenbelt, Md., and Maria T. Zuber of the Massachusetts Institute of Technology contend that if an asteroid did indeed strike the northern hemisphere, it didn't leave behind a depression.

Scientists had inferred the bowl-shaped scar from comparisons of topographic maps with old gravity maps that assumed a relatively uniform distribution of mass inside Mars. But when Smith and Zuber recently reanalyzed data on the radius of the northern and southern hemispheres, based on radio transmissions from the Mariner 9 and Viking craft, they found a surprise. The center of mass of Mars differs from its geometric center by about 3 kilometers—presumably because matter inside Mars has a lumpy distribution.

Taking this offset into account, Smith and Zuber find that the inferred depression vanishes. Earth-based radar studies support their finding, which leaves unexplained the difference in cratering between north and south. Smith and Zuber also report that elevations at the north pole are about 6 km lower than at the south, a finding that has implications for the Martian climate. — *R. Cowen*

Philip James, Steven Lee/NASA

Mars imaged by the Hubble Space Telescope.

Metal-tainted trout operating on overload

Some fish living in water contaminated with metals have efficient means of surviving the dirty environment. They both excrete the pollutants and store them in fat. However, new studies suggest a downside to this acclimation. The results also call into question previous laboratory findings that low-level metal contamination makes fish more tolerant of bigger doses.

Depending on the quality of water where brown trout (*Salmo trutta*) live, tissues involved in a fish's response to stress vary markedly in appearance, says David O. Norris of the University of Colorado at Boulder. Tissues of fish living in water contaminated with metals show signs of chronic stress, presumably due to the pollution. Moreover, these fish respond poorly to additional pollution and to the stress of confinement, he said in an interview this week.

The studies "have expanded the range at which [pollutants] have deleterious effects," says Cliff H. Summers of the University of South Dakota in Vermillion. "This work was particularly good."

Norris and his colleagues examined brown trout from three stretches of the Eagle River in Colorado to see if they show the hormonal changes typical of a chronically stressed fish. Under stress, fish release corticotropin-releasing hormone (CRH), which triggers the pituitary gland to produce more corticotropin. That hormone, in turn, causes the kidney to increase its release of cortisol, another hormone.

The fish came from one site that had no cadmium or zinc contamination from mining effluent and two sites contaminated to different extents. Fish from the polluted water had high concentrations of the metals in their tissues.

The fish that had lived in the contaminated water appeared to have thicker kidney tissues, more kidney cells, and more nerve cells responsive to CRH—all signs that the animals had suffered chronic stress, Norris says. He reported these results Dec. 28 at the American Society of Zoology meeting in Washington, D.C.

To find out whether the metals, rather than other factors, cause these changes, the team plans to expose uncontaminated fish to metals and then monitor their response to stress.

In another recent study, the scientists examined how brown trout from Eagle River and Clear Creek, also in Colorado, respond to the acute stress of being captured. They measured the concentration of cortisol in the fish's blood 10 minutes after capture and 1 to 3 hours later.

Compared to the fish in cleaner water, the contaminated animals' cortisol increased much more slowly in response to the confinement, he says. The team is now analyzing its data on the fish's other physiological responses to the stress of confinement.

In an earlier, unpublished study, Norris' colleague John D. Woodling of the Colorado Division of Wildlife in Denver examined how fish handle additional pollution. He put brown trout in cages for 96 hours in an area so poisoned by mining effluent that no fish lived there. Fish that had resided in water with mining effluent survived only 28 hours, while residents of cleaner waters survived almost 48 hours, Woodling says.

These studies hold a message for good-hearted anglers who toss their catch back after hooking them. Make sure to fish in clean water, because the stress of getting caught may be too much for contaminated fish, Norris warns. — *T. Adler*