Streambed bugs eat gasoline pollutants

Microbes dwelling in the muck at the bottom of a stream can digest certain pollutants before they well up into the water, a new study finds.

Scientists have determined that microbes in sediment can dispose of methyl tertiarybutyl ether (MTBE) and tertiary-butyl alcohol (TBA). The two compounds are commonly added to gasoline to reduce vehicle emissions of carbon monoxide, an air pollutant. However, MTBE and TBA contaminate drinking water supplies in various ways, and the Environmental Protection Agency has classified MTBE as a possible human carcinogen.

The new finding should help environmental engineers more accurately assess the threat posed to streams by MTBE, says James E. Landmeyer. He, Paul M. Bradley, and Francis H. Chapelle, all of the U.S. Geological Survey in Columbia, S.C., report their findings in the June 1 ENVIRONMENTAL SCIENCE AND TECHNOLOGY.

"There has been considerable concern that this compound doesn't degrade," says Robert C. Borden of North Carolina State University in Raleigh. "If [the finding] turns out to be true, that would be very encouraging."

The USGS scientists looked at two sites in South Carolina where gasoline that contains MTBE had leaked from underground storage tanks. The researchers took sediment from nearby streambeds to their lab for testing.

They added radioactively labeled MTBE and TBA to the samples and traced the breakdown of the compounds into carbon dioxide. Over about 3 months, organisms—probably bacteria—in the sediment degraded up to 73 percent of the MTBE and 84 percent of the TBA. In contrast, if the scientists removed oxygen or heated the sediment to kill all the microbes, the pollutants remained intact.

Other groups have found bacteria that feed on MTBE in special environments, such as sewage sludge. "This study is the first to show that it happens in a natural system," Landmeyer says.

MTBE also enters the environment through gasoline spills and evaporation at the pump. The evaporated pollutant returns to Earth in rainwater, which soaks into the ground and eventually seeps up through streambeds.

"Bacteria in the groundwater don't have the correct digestive systems to degrade MTBE," Landmeyer notes, nor do they have access to oxygen. "But once MTBE reaches the stream, the bacteria just gobble it up." To microbes used to feeding on decaying leaves and such, MTBE "is just another organic compound to chew on," he says.

The evidence is convincing, but it's only part of the picture, comments Robert M. Cowan of Rutgers University in New Brunswick, N.J. A study of this duration, says Cowan, prompts a question: Is the rate of degradation fast enough to destroy pollutants as they flow through sediments in streams? "They haven't taken it to that point yet," he remarks.

The results, though encouraging, don't mean that people can rest easy about MTBE, Landmeyer cautions. Water in underground wells and rain that falls directly onto a stream won't benefit from this microbial filter. —*C. Wu*

Elderly show their emotional know-how

Scientists have documented a depressing list of memory and intellectual losses that mount as healthy adults advance into old age. A new study indicates, however, that when it comes to dealing with emotions, seniors rule.

From young adulthood to well past retirement age, positive emotions occur at a fairly constant rate, while the frequency of negative emotions declines markedly, a research team finds. Adults of all ages cite comparable intensities for the entire spectrum of emotions.

After bottoming out at around age 60, the amount of negative emotion experienced from day to day slowly rises, but it stays well below the peak level of people in their early 20s, reports psychologist Laura L. Carstensen of Stanford University, who directed the investigation.

Moreover, positive emotions linger longer, and negative ones make briefer intrusions as adults age, she says. Older people also tend to experience richer mixes of feelings, such as simultaneous anger at and affection for a close friend.

Carstensen described her investigation last week in Denver at the annual meeting of the American Psychological Society.

"These findings support growing evidence that older people regulate their emotional states better than younger people," the Stanford researcher holds.

An earlier study, for instance, found that elderly spouses display particular expertise at reining in negative emotions while discussing trouble spots in their marriages (SN: 9/13/97, p. 175).

Carstensen's team recruited 184 individuals ranging in age from 18 to 84 years. Each participant carried an electronic pager for a week. At 35 randomly chosen times during days and evenings, the researchers paged each one. Using a response sheet that listed 19 emotions, the volunteer described the nature and intensity of his or her current emotions. Participants mailed their sheets to the researchers daily.

As adulthood progresses, a growing sense of having limited time left in life creates interest in promoting the emotional quality of established relationships, Carstensen theorizes. Younger people, who think of themselves as having lots of time yet to live, often sacrifice emotional depth to pursue a broad range of contacts and experiences, she proposes.

Still, young adults can also respond to a sense of having limited time, according to Carstensen. For instance, college seniors approaching graduation may spend their free time with their best friends rather than trying to make new acquaintances, as they had in past semesters.

However, this process operates most strongly in old age, Carstensen holds. In another study that she directed, only the elderly volunteers expressed a pronounced desire to develop close emotional ties to a wide variety of people.

"It's encouraging that older people are often doing well at emotional regulation despite their personal losses," comments Philip A. Cowan of the University of California, Berkeley. —*B. Bower*

Controversy simmers at atomic-waste site

Deep within the parched landscape of southwest Nevada, scientists are analyzing the geologic personality of an unassuming ridge called Yucca Mountain. At issue is whether the bald, elongated promontory has a stable character—steadfast enough to house the highly radioactive waste generated by nuclear power plants across the United States. The range must lock up this hot debris for the next 10,000 years.

During the past 15 years, hundreds of geologists have crawled over Yucca Mountain, making it the best-studied piece of real estate on the planet. Recently, however, a debate has erupted over some curious events discovered in the mountain's past that could signal an underlying restlessness in its constitution.

"The implications of this finding can be very serious for the [planned] repository," says Yuri V. Dublyansky, a Russian geologist studying Yucca mountain under contract with the state of Nevada, which opposes the repository.

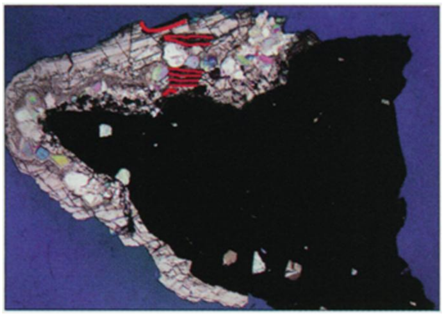
Scientists with the U.S. Geologic Survey counter that the unruly behavior was confined to Yucca Mountain's infancy, millions of years ago, and has no bearing on its current character. The Department of Energy (DOE), which oversees the investigation into Yucca Mountain, is now conducting an independent review of Dublyansky's controversial findings, hoping to resolve the scientific wrangling. The two sides discussed their work last week at a meeting of the American Geophysical Union in Boston.

Yucca Mountain is the only site currently under consideration as a repository for spent nuclear fuel. DOE began studying the ridge in the mid-1980s and had intended to open the facility by 1998. Although it has yet to finish assessing the site, DOE last December issued a report concluding that no "showstopper" had emerged in its studies to date.

The plans call for canisters of nuclear waste to reside in the mountain's heart, within rooms cut out of the volcanic rock formations 300 meters below the summit. This would keep the waste hundreds of meters above the water table, preventing the radioactive elements from leaking quickly into the groundwater.

The current debate centers on the history of water within the mountain. Dublyansky, a researcher at the Institute of Mineralogy and Petrology in Novosibirsk, Russia, claims that hot brines have surged upward in geologically recent times, reaching a level that would flood the repository.

Whelan



Calcite and opal coating this rock provide clues about Yucca Mountain's past.

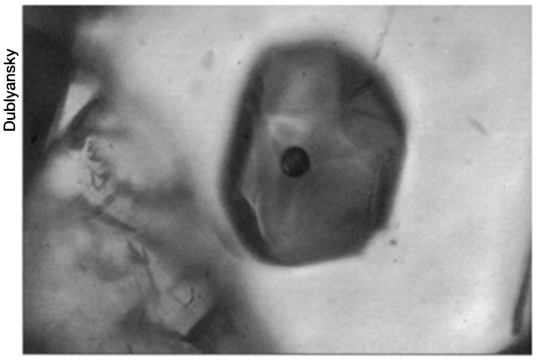
His evidence comes from microscopic pockets of water and air, or inclusions, within calcite growing along cracks and cavities. The inclusions serve as tiny thermometers, says Dublyansky. Heating them causes the fluid to expand and the air to dissolve. The point at which the bubbles disappear indicates the temperature of the fluids that formed the crust.

Such tests suggest that the fluid temperatures ranged from 35° to 80°C, says Dublyansky. The only possible source of such hot water, he says, lies deeper in the crust. Earthquakes or other geologic instability must have forced the warm water upward hundreds of meters, and such events have occurred repeatedly to build up the calcite layers, he claims.

The USGS researchers dispute Dublyansky's conclusions. They have studied the calcite and other crusts by analyzing the ratio of two different oxygen isotopes in the minerals. They have also dated the deposits using the radioactive decay of natural uranium in the minerals.

The isotopic thermometers, they say, record high temperatures only early in the history of the Yucca Mountain rocks, which formed during eruptions more than 10 million years ago. The layers created by such hot fluids "were likely deposited shortly after the cessation of volcanic activity in the region," says James B. Paces of the USGS in Denver.

Dublyansky



A dark inclusion with a small air bubble.

Paces and his colleagues contend that the crusts grew from rainwater percolating down through the mountain, rather than from upwelling hot fluids. They note that mineral crusts appear only on the bottom face of sloping cracks and not on the upper face or on the roofs of cavities. Below the current water table, mineral growths coat all surfaces of fractures and cavities, Paces says.

"We feel very comfortable with the conclusions that we've drawn," says Joseph F. Whelan of the USGS. "But the potential consequences of Dublyansky's hypotheses are serious enough that it definitely needs to be resolved." Dublyanksy, the USGS, and the University of Nevada are now conducting independent tests on inclusions to assess Yucca Mountain's true nature. *— R. Monastersky*

Besieged tadpoles send chemical alert

Tadpoles have a stinky way of warning each other to hunker down when a predator looms, according to a new study.

Like many aquatic species, tadpoles use their keen olfactory sense to identify danger, locate good food, and recognize family. Scientists also know that the amphibians, when captured, send out chemical distress signals. Now, researchers have learned that tadpoles that are merely harassed also release such distress signals. The new findings show that the signal's chemistry includes ammonium.

"This is something that, in my opinion, it's amazing people haven't discovered earlier," comments Lee B. Kats of Pepperdine University in Malibu, Calif.

In the recent study, Joseph M. Kiesecker of Yale University and his colleagues put two groups of tadpoles of red-legged frogs in an aquarium partitioned by a screen that blocked visual and acoustic communication between the groups. Water, however, flowed freely through the partition.

When a wooden heron stalked the tadpoles in one compartment, those on the other side slowed down, moved away from the divider, and ducked under a shelter, the researchers report in the June Animal Behaviour. Undisturbed tadpoles did not elicit these defensive behaviors in their neighbors. The researchers conclude that the beleaguered tadpoles released a chemical signal that penetrated the screen.

"If [such signaling] is a common occurrence, which I think it is, it may be an effective way that prey animals can avoid predation," says Kiesecker.

Several other water-dwelling animals, including crayfish, hermit crabs, and a fish called the Iowa darter, also release a chemical distress signal. Researchers have speculated that the agent carrying such signals may be ammonium, a foul-smelling compound that is the animals' chief metabolic waste.

In further work, which bolsters that idea, Kiesecker's group observed that disturbed tadpoles release more ammonium than undisturbed tadpoles do. What's more, when the researchers added ammonium to an aquarium, tadpoles displayed the same defensive behaviors seen in the earlier experiment.

"More and more, we're becoming aware that tadpoles are sensitive to very, very subtle chemical cues in the environment," says Richard J. Wassersug of Dalhousie University in Halifax, Nova Scotia. The importance of the new study, he adds, is that it asked the question, "What are the chemicals?"

Kiesecker

Tadpoles of the red-legged frog send chemical signals when disturbed by a predator.

Kats says that Kiesecker's findings illustrate the animals' sensory sophistication, although he notes that the tadpoles' ability to release signals does not mean the creatures are acting with intention. "Just in the process of being stressed, their metabolism changes and they release ammonium, and then those nearby can pick that up," he says.

The researchers haven't yet investigated whether different aquatic species share the same chemical language, whether ammonium combines with other chemicals to send more complex messages, or if signals vary depending on the environment.

"Those are all really, really interesting questions," Kiesecker says, "but at this point, they're all the great unknown." *—S. Carpenter*