Chemistry

Minding those microbial mineral-makers

If a mineral shows up unexpectedly or disappears too readily from its environment, then it's a good bet that some bacteria are to blame. That's the message of two new reports examining chemical cycles in marine environments.

While studying the Black Sea in 1988, U.S. researchers were puzzled by the paucity of sulfur compounds known to be intermediate products in the cycling of this element from sulfate to hydrogen sulfide in salt water. They discovered that a versatile bacterium, *Shewanella putrefaciens,* that thrives in both oxygen-rich and oxygen-poor water actually uses these intermediates to help break down organic material. This species can take advantage of many oxidants, such as oxygen, manganese, or iron, in water. But unlike most bacteria, which also use sulfate, this one relied on the intermediates, Karen A. Perry of the University of Delaware's College of Marine Studies in Lewes and her colleagues report in the Feb. 5 SCIENCE.

"Apparently, there's significant microbiological control of sulfur speciation," says chemist George W. Luther III, a Delaware collaborator. "It's not just chemical."

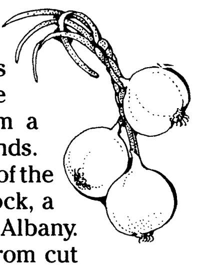
Other scientists investigating the anomalous buildup of an iron carbonate mineral called siderite also fingered versatile bacteria as the cause. Siderite nodules typically form where bacteria are producing methane, not where bacteria use sulfate to decompose organic material into carbon dioxide, says Derek R. Lovley, a microbiologist at the U.S. Geological Survey in Reston, Va. However, he and his colleagues discovered that, if given the opportunity, several of these so-called sulfate-reducing bacteria will instead use iron oxide to accept electrons generated in the decay process. Lovley and his colleagues describe their findings in the Feb. 4 NATURE.

"It shows a whole new class of microorganisms that might be involved in metal reduction," Lovley says. "There's a lot of unexpected things that microorganisms are doing."

Metal-reducing microbes are also proving capable of removing uranium from contaminated water, he adds.

Microbial mineral-makers can come from diverse backgrounds. For example, comparisons of RNA from ribosomes of various bacteria that orient via magnetic fields (SN: 5/16/92, p.330) reveal that this ability evolved more than once in these microbes. Most of these "magnetotactic" bacteria make iron oxide. But those that make iron sulfide particles come from a different twig on the evolutionary tree, according to Edward F. DeLong of the University of California, Santa Barbara. In the Feb. 5 SCIENCE, he and his colleagues report that these microbes come from two subdivisions of Proteobacteria, even though they solved the need to orient in similar ways. The use of iron oxide or iron sulfide may have evolved because of the sediment types readily at hand, they suggest.

Flavor makeup of onion, garlic revised



Leeks, shallots, scallions, chives, onions, and garlic impart zest to many a bland dish. Scientists had thought that this zest, as well as the tears and bad breath these substances can cause, results in part from a variety of polysulfide and thiophene compounds. But those compounds may be only an artifact of the analysis of flavor components, says Eric Block, a chemist at the State University of New York at Albany. Many of the gaseous substances released from cut garlic and onions break down at room temperature and higher, he points out in an upcoming letter to the JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY. Block has developed ways to analyze flavor components at temperatures close to 0°C. He finds that a different class of sulfur-based substances, called thiosulfinates, really provide the strong flavors.

Environment

Janet Raloff reports from Anchorage, Alaska, at the Exxon Valdez *Oil Spill Symposium*

Native Alaskans eschew this oily diet

Oil spilled from the *Exxon Valdez* supertanker fouled beaches and waters that have provided food and other vital resources to native peoples for the past 7,000 years. At the time of the spill, the diets of residents in 15 remote villages in the area of the spill still depended heavily on harvests of a diverse combination of marine mammals, fish, shellfish, birds, land mammals, and wild plants. Indeed, per capita consumption of subsistence foods by the more than 2,000 individuals – mainly Alutiiq – averaged between 200 and 500 pounds annually in these communities, reports James Fall of Alaska's Department of Fish and Game in Anchorage. By comparison, he notes, each year the average U.S. *family* purchases 220 pounds of meat, fish, and poultry.

After the spill, however, subsistence harvests of wildlife plummeted in the 10 villages that had witnessed the most visible and prolonged oil impacts. Surveys of 403 households revealed fear of toxic contamination as a major reason.

The resulting dietary shift threatened both the nutrition and economy of individuals in these villages – accessible only by air or water – and the cultural fabric of their society, Fall says. Subsistence hunting, gathering, and fishing "are usually cooperative family activities, during which young people learn the skills and values needed to survive," he explains.

Realizing that, health officials began advising villagers they could safely eat foods that didn't smell or taste of crude oil. But that recommendation "was generally received with skepticism and disbelief," Fall recalls. Moreover, an Oil Spill Health Task Force – made up of officials from state and federal agencies, Exxon, and associations representing the affected communities – rapidly discovered that there were no data on the extent to which subsistence foods were contaminated by *Exxon Valdez* oil or the risks such tainting might pose.

National Oceanic and Atmospheric Administration researchers tested tissue from 309 fish, 1,080 shellfish, 19 ducks, 16 deer, 33 harbor seals, and 10 sea lions and found elevated levels of several aromatic chemicals characteristic of oil contamination in many of the samples. But outside experts enlisted to evaluate the health risks of such tainting concluded that except for shellfish, the highest concentrations of the oil contaminants observed were "well below those considered to be of concern for human health," Fall says. And even the shellfish could be eaten if collected from sites without obvious oil. Though the task force transmitted these findings to the native communities last June – more than three years after the spill – Fall says that many villagers remain wary of the food's safety.

Oil still musseling into food chain

The more volatile – and generally toxic – constituents of crude oil tend to evaporate out of petroleum quickly. As oil continues to "weather," it turns progressively tarrier, eventually becoming biologically inert. Surprisingly, some of the *Exxon Valdez* oil appears to have escaped weathering by hiding out beneath mussel beds, reports Charles H. Peterson of the University of North Carolina at Chapel Hill. More important, he reports, oil "is leaking into those mussels."

The effective protection afforded by these bivalve communities suggests that this unweathered oil is "likely to persist for a long time," he says, permitting the shellfish to accumulate high concentrations of hydrocarbons. The mussels themselves do not appear to be suffering, he notes, but their contamination may prove toxic to humans and others. Indeed, he speculates, this contamination may explain why some key mussel consumers – such as otters, harlequin ducks, and certain shore birds – continue to suffer unabated oil-related reproductive difficulties despite low concentrations of petroleum in their water and on their home beaches.