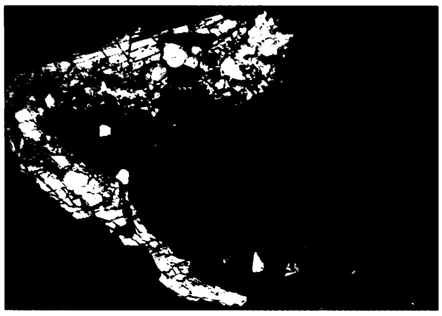
can Geophysical Union in Boston.

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*