Hot springs microbes hold key to dating sedimentary rocks, researchers say

January 22 2008

Scientists studying microbial communities and the growth of sedimentary rock at Mammoth Hot Springs in Yellowstone National Park have made a surprising discovery about the geological record of life and the environment.

Their discovery could affect how certain sequences of sedimentary rock are dated, and how scientists might search for evidence of life on other planets.

"We found microbes change the rate at which calcium carbonate precipitates, and that rate controls the chemistry and shape of calcium carbonate crystals," said Bruce Fouke, a professor of geology and of molecular and cellular biology at the University of Illinois.

In fact, the precipitation rate can more than double when microbes are present, Fouke and his colleagues report in a paper accepted for publication in the *Geological Society of America Bulletin*.

The researchers' findings imply changes in calcium carbonate mineralization rates in the rock record may have resulted from changes in local microbial biomass concentrations throughout geologic history.

A form of sedimentary rock, calcium carbonate is the most abundant mineral precipitated on the surface of Earth, and a great recorder of life.

"As calcium carbonate is deposited, it leaves a chemical fingerprint of the animals and environment, the plants and bacteria that were there," said Fouke, who also is affiliated with the university's Institute for Genomic Biology.

The extent to which microorganisms influence calcium carbonate precipitation has been one of the most controversial issues in the field of carbonate sedimentology and geochemistry. Separating biologically precipitated calcium carbonate from non-biologically precipitated calcium carbonate is difficult.

Fouke's research team has spent 10 years quantifying the physical, chemical and biological aspects of the hot springs environment. The last step in deciphering the calcium carbonate record was performing an elaborate field experiment, which drew water from a hot springs vent and compared deposition rates with and without microbes being present.

"Angel Terrace at Mammoth Hot Springs in Yellowstone National Park is an ideal, natural laboratory because of the high precipitation rates and the abundance of microbes," Fouke said. "Calcium carbonate grows so fast – millimeters per day – we can examine the interaction between microorganisms and the calcium-carbonate precipitation process."

The researchers found that the rate of precipitation drops drastically – sometimes by more than half – when microbes are not present.

"So one of the fingerprints of calcium carbonate deposition that will tell us for sure if there were microbes present at the time it formed is the rate at which it formed," Fouke said. "And, within the environmental and ecological context of the rock being studied, we can now use chemistry to fingerprint the precipitation rate."

In a second paper, to appear in the *Journal of Sedimentary Research*, Fouke and colleagues show how the calcium carbonate record in a spring's primary flow path can be used to reconstruct the pH, temperature and flux of ancient hot springs environments. The researchers also show how patterns in calcium carbonate crystallization can be used to differentiate signatures of life from those caused by environmental change.

"This means we can go into the rock record, on Earth or other planets, and determine if calcium carbonate deposits were associated with microbial life," Fouke said.

Source: University of Illinois at Urbana-Champaign