Origins of subsurface microorganisms:
Relating laboratory microcosm studies to a geologic time scale.

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This project was conducted as part of the Department of Energy's Deep Subsurface Science Program. It was part of a larger effort to determine the origins of subsurface microorganisms. Two hypotheses have been suggested for the origins of subsurface microorganisms: 1) microorganisms were deposited at the time of (or shortly after) geologic deposition of rocks and sediments (the in situ survival hypothesis), and 2) microorganisms have been transported from surface environments to subsurface rocks and sediments since the time of geologic deposition (transport hypothesis). These two hypotheses are not mutually exclusive. Depending on the geological setting, either one or both of these hypotheses may best explain microbial origins. Our project focused on the in situ survival hypothesis. We tested the hypothesis that microorganisms (individuals populations and communities) can survive long-term sequestration within subsurface sediments. Other objectives were to identify geologic conditions that favor long-term survival, identify physiological traits of microorganisms that favor long-term survival, and determine which groups of microorganisms are most likely to survive long-term sequestration in subsurface sediments. We tested this hypothesis using a combination of pure culture techniques in laboratory microcosms under controlled conditions and field experiments with buried subsurface sediments.

**Laboratory Microcosms**
Lab microcosm studies demonstrated the influence of sediment type and moisture conditions on long-term survival. Physiological responses to long-term starvation were determined. Results of this research have been published (Kieft et al., 1994, 1997, attached)

**Field studies**
Field studies were conducted in eastern Washington state. This effort focused on survival and transport of microorganisms under unsaturated conditions. Results of this work are in press (Kieft et al., 1999, in press, attached)

We also participated in a major field effort at Cerro Negro, New Mexico. Besides providing on-site microbiological expertise throughout the six-month drilling and sampling campaign, we conducted a geohydrological characterization of regional groundwater flow in the vicinity of Cerro Negro. The results of this work have been submitted for publication (Walvoord et al., submitted, attached)

**Other studies**
An unusual thermophilic, iron-reducing bacterium that appears to survive and grow in deep subsurface thermal environments was characterized. The results of this study have been submitted for publication (Kieft et al., submitted, attached)

Reviews of research from this project have been presented at several national meetings and international symposia. Proceedings papers from two of these symposia are attached.
Bibliography (New Mexico Tech):

Kieft, T. L., J. K. Fredrickson, T. C. Onstott, Y. A. Gorby, H. M. Kostandarithes, T. J. Bailey, D. W. Kennedy, S. W. Li, A. Plymale, C. M. Spadoni, and M. S. Gray. Dissimilatory reduction of Fe(III) and other electron acceptors by a *Thermus* isolate. Submitted to: *Applied and Environmental Microbiology*


Bibliography (UNLV):


Manuscripts Submitted


Abstracts


*Story, S., D. Haldeman and P. Amy. 1994. Comparisons of microbial communities from fracture water and rock at a 450 m depth in Rainier Mesa, Nevada Test Site. ASM National Meetings, Las Vegas, NV.


Arizona-Nevada Branch of the American Society for Microbiology meeting, Tucson, AZ. 1996. Took 10 students, presented four papers, one student won the outstanding poster award.

Arizona-Nevada Branch of the American Society for Microbiology meeting, Tucson, AZ. 1997. Took 5 students, presented three papers, outstanding undergraduate, outstanding poster and outstanding graduate awards.

* Signifies a published abstract

UNLV Students graduated during 1993-1996

Dr. Dana Haldeman
Dr. Beth Pitonzo
Ms. Sandra Story
Mr. Michael Staudaher