

**Geophysical Monograph 144**

---

# The Subseafloor Biosphere at Mid-Ocean Ridges

**William S.D. Wilcock  
Edward F. DeLong  
Deborah S. Kelley  
John A. Baross  
S. Craig Cary**  
*Editors*

 American Geophysical Union  
Washington, DC 2004

## Introduction

### The Subsurface Biosphere at Mid-Ocean Ridges: Issues and Challenges

*John A. Baross, William S. D. Wilcock, Deborah S. Kelley, Edward F. DeLong, S. Craig Cary*.....1

## Physical Limits to Subsurface Life

### The Upper Temperature Limit for Life Based on Hyperthermophile Culture Experiments and Field Observations

*James F. Holden and Roy M. Daniel*.....13

### The Stability of Biomolecules and the Implications for Life at High Temperatures

*Roy M. Daniel, James F. Holden, Jolanda Truter, Don A. Cowan, and Renate van Eckert*.....25

### On the Edge of a Deep Biosphere: Real Animals in Extreme Environments

*James J. Childress, Charles R. Fisher, Horst Felbeck, and Peter Girguis*.....41

## The Subseafloor Environment at Mid-Ocean Ridges

### Geophysical Constraints on the Subseafloor Environment Near Mid-Ocean Ridges

*William S. D. Wilcock and Andrew T. Fisher*.....51

### Diking, Event Plumes, and the Subsurface Biosphere at Mid-Ocean Ridge

*Robert W. Embley and John E. Lupton*.....75

### Fluid Flow and Fluid-Rock Interaction Within Ocean Crust: Reconciling Geochemical, Geological, and Geophysical Observations

*Wolfgang Bach, Susan E. Humphris, and Andrew T. Fisher*.....99

### Serpentinization of Oceanic Peridotites: Implications for Geochemical Cycles and Biological Activity

*Gretchen L. Früh-Green, James A. D. Connolly, Alessio Plas, Deborah S. Kelley, and Bernard Grobety*.....119

### Environmental Conditions Within Active Seafloor Vent Structures: Sensitivity to Vent Fluid Composition and Fluid Flow

*Margaret Kingston Tivey*.....137

## Energy Sources and Physiological Diversity

### Geochemical Energy Sources That Support the Subsurface Biosphere

*Everett L. Shock and Melanie E. Holland*.....153

### Volatiles in Submarine Environments: Food for Life

*Deborah S. Kelley, Marvin D. Lilley, and Gretchen L. Früh-Green*.....167

### Activation of Diatomic and Triatomic Molecules for the Synthesis of Organic Compounds: Metal Catalysis at the Subseafloor Biosphere

*George W. Luther, III*.....191

<b>Potential Importance of Dissimilatory Fe(III)-Reducing Microorganisms in Hot Sedimentary Environments</b> <i>Kazem Kashefi, Dawn. E. Holmes, Derek R. Lovley, and Jason M. Tor</i> .....	199
<b>Significance of Polysaccharides in Microbial Physiology and the Ecology of Hydrothermal Vent Environments</b> <i>Marybeth A. Pysz, Clemente I. Montero, Swapnil R. Chhabra, Robert M. Kelly, and Kristina D. Rinker</i> .....	213
<b>Environmental Dynamics and Variability</b>	
<b>Detection of and Response to Mid-Ocean Ridge Magmatic Events: Implications for the Subsurface Biosphere</b> <i>James P. Cowen, Edward T. Baker, and Robert W. Embley</i> .....	227
<b>Diffuse Flow Hydrothermal Fluids From 9°50'N East Pacific Rise: Origin, Evolution and Biogeochemical Controls</b> <i>Karen L. Von Damm and Marvin D. Lilley</i> .....	245
<b>Mixing, Reaction and Microbial Activity in the Sub-seafloor Revealed by Temporal and Spatial Variation in Diffuse Flow Vents at Axial Volcano</b> <i>David A. Butterfield, Kevin K. Roe, Marvin D. Lilley, Julie A. Huber, John A. Baross, Robert W. Embley, and Gary J. Massoth</i> .....	269
<b>Illuminating Subseafloor Ecosystems Using Microbial Tracers</b> <i>Melanie E. Holland, John A. Baross, and James F. Holden</i> .....	291
<b>Sedimented Ridges as a Laboratory for Exploring the Subsurface Biosphere</b> <i>Robert A. Zierenberg and Melanie E. Holland</i> .....	305
<b>Global Distribution and Comparisons</b>	
<b>The Ocean Crust as a Bioreactor</b> <i>Hubert Staudigel, Bradley Tebo, Art Yayanos, Harald Furnes, Katie Kelley, Terry Plank, and Karlis Muehlenbachs</i> .....	325
<b>Diversity of Life at the Geothermal Subsurface-Surface Interface: The Yellowstone Example</b> <i>John. R. Spear and Norman R. Pace</i> .....	343
<b>Unifying Principles of the Deep Terrestrial and Deep Marine Biospheres</b> <i>Frederick S. Colwell and Richard P. Smith</i> .....	355
<b>Distribution of Unusual Archaea in Subsurface Biosphere</b> <i>Ken Takai, Fumio Inagaki, and Koki Horikoshi</i> .....	369
<b>Future Directions</b>	
<b>Studying the Deep Subsurface Biosphere: Emerging Technologies and Applications</b> <i>S. Craig Cary, Barbara J. Campbell, and Edward F. DeLong</i> .....	383