

**REMOTE NATURAL LABORATORY IN A SUBMARINE VOLCANO-HYDROTHERMAL SYSTEM:  
FIBER-OPTIC TELEPRESENCE IN THE DEEP SEA** J. R. Delaney, School of Oceanography, University of  
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Entirely new approaches to understanding the complexity, the power, and the vagaries of many interactive processes operating in the global ocean, are arising from the rapid implementation and use of submarine cabled networks that now provide unprecedented electrical power and communications bandwidth to a variety of sophisticated robot-sensor systems distributed throughout selected subsea environments. From an Astrobiology perspective there now exist operating, interactive submarine natural laboratories linking land-based users to a highly active volcano-hydrothermal systems on the Juan de Fuca Ridge off the coast of Washington-Oregon. One entire system, constructed within the NSF Ocean Observatory Initiative, is designed to operate for several decades, providing a growing number of science- and education-oriented users with real-time access to physical, chemical, and biological processes interacting with one another at Axial Volcano, hundreds of kilometers from land. Partly triggered by the advent of a growing number of these cabled research systems, oceanographers are poised to benefit, in the coming decade, from a host of **emergent** technologies largely developed by investment from communities external to ocean sciences. Important developments include: robotics, biotechnology, cloud computing, *in situ* chemical and genomic sensors, extraction of novel biochemical materials, digital imaging, nanotechnology, serious gaming, new visualization technologies, computational simulations and data assimilation, seismic-acoustic tomography, and universal access to the Internet. Far more powerful than any one of these emerging technologies will be the **convergence** of the ensemble when applied to the objective of understanding the innate complexity of the many ecosystems within our global ocean system. As these rapidly evolving capabilities are integrated into more sophisticated, remote, interactive operations, a new era of pervasive human telepresence throughout entire volumes of our once “inaccessible” global ocean will be realized. The use of such capabilities to develop, test, and employ novel approaches to enhance our understanding of deep sea microbial communities supported by volcano-hydrothermal systems here on earth may have the potential to inform strategies eventually adopted to send remote sensor-robotic packages beyond earth in the quest to establish presence of viable colonies of living organisms on other water-worlds.