

LOOKING FOR LIFE IN EXTREME ENVIRONMENTS ON EARTH AND BEYOND. PROFESSIONAL DEVELOPMENT WORKSHOP FOR EDUCATORS
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Introduction: Education and Public Outreach in the Department of Geological Sciences at Indiana University Bloomington is emerging as a diverse community of scientists, artists, educators, and representatives from the Indiana business sector who are working toward a common goal: to equip teachers with first-hand knowledge of field experiences, and to produce classroom materials based on current research.

The *Looking for Life in Extreme Environments* workshop for high school teachers, held at Indiana University Bloomington in July of 2009, was the first in a series of field study opportunities currently in development. The *Looking for Life* workshop is based on the research of faculty members in the Departments of Geological Sciences, Biology, and Astronomy, the School of Education, and the School of Public and Environmental Affairs at Indiana University Bloomington. We use lab exercises from *Exploring Deep-Subsurface Life. Earth Analogues for Possible Life on Mars: Lessons and Activities*, curricular materials that were produced and edited by Lisa Pratt and Ruth Droppo and published by NASA in 2008.

Exploring Deep-Subsurface Life is a workbook, a DVD (with closed-captioning), and a CD with the lessons in digital text format for adaptation to classroom needs and printing[1]. Each lesson includes the National Education Standards that apply to the materials. The workbook's lessons are written with three considerations: Life Domains, Cellular Metabolism, and Extreme Environments and Microbes. Students are challenged to build, draw, measure, discuss, and participate in laboratory processes and experiments that help them understand and describe microbes and their environments. A Capstone project challenges the students to research current NASA missions and write a grant proposal. The DVD is a collection of videotaped interviews with scientists in laboratories at Michigan State, Princeton, and Indiana University, who are working on water and gas samples they collected from deep gold mines in South Africa and the Canadian Arctic. The interviews, along with animated graphics, are compiled into four video pieces that support and complement the accompanying workbook lessons and activities, and offer students insight into the excitement of scientific discovery.

The Workshop: Teachers are invited from local area schools to the Indiana University Bloomington



Figure 1: Recruitment brochure from the 2009 Looking for Life teacher workshop

campus for a 4-day, hands-on series of training exercises and labs. Daily lectures focus on the scientific concepts contained in materials in the *Exploring Deep-Subsurface Life* Educator Guide; topics include The Environmental Envelope of Life on Earth, Life's 3 Domains on Earth, The Role of Membranes in Cells, Evidence of a Hydrological Cycle on Mars, Boundaries of Habitable Zones, and Current and Pending NASA/ESA Missions (Figure 1).

The workshop series offers background in microbial life, membrane composition, genetics, cellular metabolism, ion transfer in microbial communities, scientific processes and field techniques, and insight into remote field sites in the Canadian Arctic and Greenland.

The Summer 2009 Workshop: A total of 19 teachers traveled to Bloomington from middle and high schools in Indiana and Illinois, representing both minority and women educators. A subset of these teachers also attended a Bernard Harris ExxonMobil Summer Science Camp at Indiana University Bloomington.

The teachers received a stipend, housing, and a full set of materials to use in their curriculum development.

Faculty members from the IU Departments of Astronomy, Biology, and Geological Sciences gave two 1-hour lectures, followed by question-and-answer sessions. Lecture topics varied from “Water and Geomorphology on Mars” to Habitable Zones, Exoplanets, and “Radiolysis of Water as a Source of Biosustaining Energy.” Daily laboratories tied the lectures to the class materials with exercises on Sequestration of Methane in Icy Solids (Clathrates), Game Simulation of Metabolic Influence on Water Chemistry, and The Freezing Point of Martian Brines.



Figure 2: High school teacher Stacey Young describes her group's Astrobiology Mission Concept titled, “Detection of Surface and sub-Surface Sulfate Minerals and Water in Hellas Basin of Mars – MSWM Mars Sulfate/Water Mission” in the Capstone final presentations.

The Capstone project: Participants were asked to research current NASA and ESA missions and develop a mission concept for a grant proposal. Using a PowerPoint template from the NASA Mid-range Rover Science Analysis Group for the first step in a Mars Sample Return, teachers presented innovative ideas for robotic and human exploration of Mars and icy moons like Enceladus and Europa (Figure 2). Focus was on science objectives, investigation strategy, landing sites, and mission implementation.

Evaluation: Summative evaluations are used to measure the success of the workshops. Considered in the evaluations are teachers' use of the materials, number of copies handed out in workshops, and cost-effectiveness of the programs. These assessments provide information for evaluation of planning and construction of other projects.

Summer, 2009 workshop participants were handed questionnaires at the end of their presentations. Re-

views were mostly positive, with a few substantive criticisms that will be addressed in future workshops. The high school science teacher attendees were already making plans to use the materials in stand-alone units in their curricula, while middle school teachers found the materials too advanced for their classrooms, but thought the workshop experience was valuable.

Emerging Activities: Plans are in progress to expand the *Looking for Life* summer workshop to include studies at the Indiana University Geologic Field Station in Bozeman, Montana, acid mine drainage sites in the State of Indiana, and bacterial studies in Indiana dunes. To this end, we are exploring a partnership with the Thermal Biology Institute's Hot Science! Program at Montana State University and, at a later date, possible collaborations with Chabot Space and Science Center in Berkeley, California and the American Association of Petroleum Geologists in Tulsa, Oklahoma.

Reference:

- [1] Pratt, L.M. and Droppo, R. (2008) NASA product EG-2008-03-001-ARC.