

NAI Annual Report 11/03 to 6/04 EPO and Science Update

Susan M. Pfiffner, Kim Davis, and Tommy Phelps
University of Tennessee
Oak Ridge National Laboratory

EPO Activities:

K-12 students: We held the second public demonstration for the Carnegie Institution in Washington Astrobiology interactive kiosk on the deep-sea vents. This activity was designed to introduce Astrobiology and the new IPTAI to the local and regional community of students, parent, and teachers. The event was held April 6-8 at the University of Tennessee, Knoxville during the Southern Appalachian Science and Engineering Fair. Posters and flyers were distributed. NASA educational research guides arrived at UTK and will be distributed to regional schools who participated in the science fair.

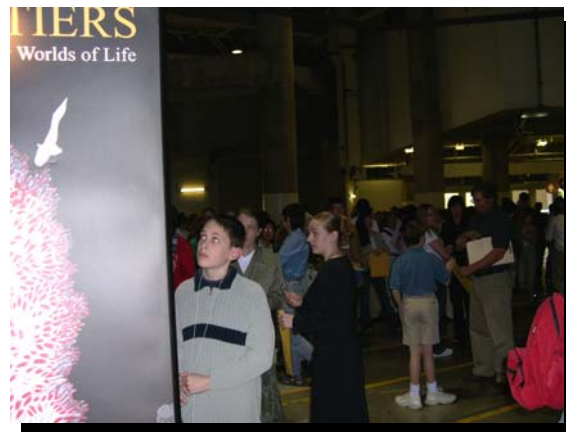


K-12 teachers: IPTAI funded three regional high school science teachers (Two women and one male, covering east Tennessee, Knoxville and Gate City, Virginia) to attend the Astrobiology Laboratory Institute for Instructors (ALI'I) at the University of Hawaii, Manoa. The workshop was held June 14 - 18, 2004 and was led by Mary Kadooka. In August the teachers will meet with Dr. Pfiffner to discuss the

various plans the teachers have for disseminating what they have learned to area schools.

Undergraduates: The University of Tennessee provided a seven-week Research Experience for Undergraduates (REU) Biogeochemical Education Experience in South Africa (BEE-SA). In 2003, seven undergraduate students each from the U.S. and South Africa interested in careers in Earth Sciences, Biological Sciences, Environmental Sciences, and Engineering participated. The international host institution is the University of Free State (UFS) in Bloemfontein, South Africa. The National Science Foundation, NASA, and the National Research Foundation of South Africa funded the REU. Students received a small stipend, housing and airfare for the REU.

The purposes of the REU are to engage students in interdisciplinary research, encourage students toward scientific careers and explore educational, research and biotechnological opportunities to expand the REU efforts. American students work side by side with South African students under the joint supervision of



U.S. and South African faculty, conducting interdisciplinary research on biogeochemical processes in South African gold mines. As part of the research program, students presented research results during laboratory progress meetings, at a science symposium concluding the REU, and in written manuscript format as a final report. During the REU, students had several opportunities for exploring science, educational, and technological collaborations as well as, for career development.

BEE-SA Team Research Projects:

1. Screening of clone libraries from Beatrix and Evander gold mines for enzymatic activity: Isolation and characterization of lipase
2. Exploring subsurface microbes using a molecular phylogenetic approach
3. The presence of functional genes in microbial communities of South African gold mines



Student comments:

1. The experience was amazing... It was one of those opportunities you can't pass up," Woodbury Bulletin, Woodbury, Minnesota 2003.
2. "No matter how new or engaging scientific research can be, the people who work with you are the ones that make the work enjoyable and worthwhile."
3. What did you like best about the REU? "the international nature – living, working, and doing science in another country"

REU BEE-SA 2004

The University of Tennessee administered a seven-week Research Experience for Undergraduates (REU) from June 11-August 2, 2004. The REU targeted minority undergraduate students who are interested in careers in Earth Sciences, Biological Sciences, Environmental Sciences, and Engineering. The international host institution is the University of Free State (UFS) in Bloemfontein, South Africa. Undergraduate students consist of ten U.S., seven S.A. and one Taiwanese. Of the U.S. students there were three males and seven females. Minorities represented are three African Americans (2 females, 1 male), one Native American (female), one Pacific-Islander and one Eurasian (female). Faculty Mentors from the U.S. included three long-term mentors (3-8 wks, Pfiffner, Kieft, Gihring) and three short term mentors (2 wk or less, Phelps, Onstott, DeFlaun). South African mentors: two females (van Heerden, Piater) for long term and two males (Nthangeni, Lithauer) for short term and 4 visiting lecturers. One Ph.D. student and one post-BS student from the U.S. participated as student mentors, with graduate students from the UFS assisting as needed.

Cross-disciplinary field- and lab-based education is a major goal of the seven week research experience for undergraduates (REU): Biogeochemical Educational Experiences – South Africa, as well as international and cultural exchanges between U.S. and South African students. The research projects include characterizing microbial communities with molecular and biochemical techniques, utilizing geochemical and isotopic parameters to constrain nutrient cycling in groundwater, investigating extreme enzymes, and examining functional genes. Research team consists of four to five students with at least one student from each country and at least two of the disciplines represented.

During the REU, students collected biofilms and hot saline waters emanating from gas-rich boreholes in the mines and performed research within their respective projects under joint mentorship of U.S. and SA scientists. As part of the REU, each team presented oral progress reports to the other teams to provide communication skill development and to serve as a forum for data exchange. During these progress sessions, discussion on interpretation of data from the perspectives of the various disciplines was encouraged. Thus, students learned how their research contributed to the big picture of microbial

processes in the mines. Using the group research teams and the forums for discussion allowed the students to gain interdisciplinary knowledge and to expand thought processes and views of interdisciplinary research. <http://geomicro.utk.edu>

In preparation for the REU, advertisements or flyers were sent to Host Institutions with, HBCUs, Organizations (AGU [EOS], GSA, ASM), emails to several professors nation-wide; I gave departmental/guest seminars (OU, ETSU, FAMU on the research and the educational program).

Student applications included a transcript (1Yr Biol. and Chem required by NSF), letter of recommendation, statement of investigation, resume, and sometimes a phone interview. The student selection was made by a six member panel of US persons associated with the REU, the LExEn project or previous US/SA events. For evaluation we use a 15 point system, five for GPA and difficulty of coursework, five for letter of recommendation and five for the essay the student wrote. Deomgraphic and resume information provides insight in the selection process.

Pre-REU US preparation included health and safety forms, emergency contact, travel plans and insurance, mine access permission, parental or guardian notification/permission, and purchase of supplies. Meanwhile, pre-REU SA preparation included housing and transportation, agenda, meals, social/tour events, sampling trip to mines, laboratory preparation, and computer internet logistics.

REU Format:

Seven-week summer program with field sampling in the mines and laboratory research. Students work side by side with other students in research teams of 3-4 persons. Students ranked their top three choices for four research topics that were presented to them. Research teams were chosen based on student choices, their academic discipline, and their country. Each research team had at least one student from each country and at least two academic disciplines represented.

Research projects for 2004 include (1) cultivation of the *Desulfotomaculum*-like organisms, (2) limiting factors for growth/biomass in fissure waters, (3) proteomics- looking for enzymes of biotechnological significance (metal reducase, lipases), (4) examining community composition by 16S rDNA, functional genes and fluoesent in situ hybridization.

Each student has experienced one underground sampling trip and there are possibilities that some will get a second time underground as opportunities arise this summer. The underground sampling trips included Beatrix, Joel and Merrispriut mines. Besides laboratory research activities, two lecture sessions are held each week which covered various disciplines. (Orientation, safety, conduct, scientific ethics and intellectual property, field logistics, sampling trip preparation, on-site analyses and safety, site geology, fissure water geochemistry, stable isotopes, microbial characterization, cultivation, preservation, microscopy, molecular techniques (DNA, lipids, and protein), microbial diversity, metabolism, enzymatic processes.). To develop communication and data exchange skills, the



research teams will orally present their work at regularly scheduled laboratory progress meetings (a total of four in 2004). In these meetings, the REU participants discuss experimental design, research findings, data interpretation, and development of forward paths. Research projects are documented through a final group oral presentation to the REU community, UFS, and industry, and a final report is written in manuscript format.

Evaluation and Assessment of the REU:

(1) Biological science literacy survey (Pre- and Post-REU)

Addresses students' academic disciplines, years of study, gender, country, and experiences (last year's results indicated that an increased understanding of molecular theory was realized).

(2) Exit evaluation survey: last year's results listed below:

REU was enjoyable and enriching.

Interaction with students and mentors was a valuable learning experience.

Some felt less sure of themselves during sampling in the mines and giving oral presentations.

(3) Open-ended question evaluation of program: comments from last year listed below.

Wanted to know more about mentors and other students and research projects before the REU.

Learned about interdisciplinary scientific research and methodology.

Felt pressed for time when writing final report and preparing presentations.

Based on the comments from last year there have been changes to this year's format and scheduling.

