

NSF Report on USSA Workshop Life in Extreme Environments Workshop on Biotechnological Applications of Deep Subsurface Microbial Investigations

Workshop Goals

1. To familiarize the South African mining, government and academic communities with the results of our prior investigations of the microbial interactions with water and rock in the deep Au mines near Carletonville. To illustrate how collaborations between our research personnel and the South African universities, South African government agencies and South African mining managers facilitated attainment of the project's goals.
2. To explain the objectives of our new 5-year program, the technological challenges we face in meeting our sampling requirements and our proposed scientific plan to achieving these objectives. To seek new collaborations between our research personnel and the South African universities, South African government agencies and South African mining managers to attainment of the LSLIS project's goals.
3. To discuss the problems currently faced by the South African deep mining.
4. To determine where collaboration between our LExEn research project team and the mining companies can provide immediate short-term benefits to their mining efforts.
5. To develop educational and field-training programs or workshops for "previously disadvantaged persons" working for the mining companies that can be integrated with the field-training program for South African postgraduate students and international graduate students as part of the LExEn project.
6. To establish bridges between our LExEn research project and Any South African biotechnology development program or initiative.

Subsequent to the funding of this workshop, but just prior to the development of its agenda, two other issues arose that were addressed at this workshop. The first was whether our LExEn project was in compliance with the terms of the International Biodiversity Treaty. The second was how the popular press represented the South African mining environment in their reports of our LExEn activities.

Hosting Institute

Profs. D. Litthaur and E. vanHeerden of the Department of Microbiology and Biochemistry, University of the Orange Free State set the agenda, publicized it on their website and generously provided the venue, media support and numerous banquets and barbecues. Corporate sponsors included Merck and SA Brewery. They were the most gracious hosts we have ever experienced.

With assistance from

Rob Wilson, Turgis Technology (Pty. Ltd.), Johannesburg who diligently recruited the attendance of the South African mining community.

List of Attendees

A total of 85 South African participants registered for the USSA workshop. These included representatives from GoldFields, Evander and Beatrix mines, Billinton and several government and semi-government agencies, including NRF, SIMPROSS and WRI. Faculty and students from Univ. of Orange Free State, Univ. of Capetown, Univ. of the North, Witwatersrand University, and Rhodes University also attended. Their participation was supported in part by registration fees. Eight representatives of the Witwatersrand Long Term Site for Interdisciplinary Studies in Deep Microbiology, Drs. Onstott, Moser and Hall of Princeton University, Dr. Southam of Northern Arizona University, Dr. Phelps of Oak Ridge National Laboratory, Dr. Pfiffner of University of Tennessee, Dr. DeFlaun of Envirogen, Inc. New Jersey, Ms. Ward of the University of Toronto attended the workshop and the NSF International Program supported their travel. In addition, Dr. Wes Ward, Astrogeology branch chief for U.S. Geological Survey and Dr. Brendlyn Faison of Hampton University participated in the workshop. The former participation was

supported by U.S.G.S. and the latter was supported by the NSF International Program grant. Dr. Cowan of the Univ. of London, a biotechnologist of international standing, also participated and was supported by NSF International Program. For further details see www.uovs.ac.za/faculties/nat/mkboc/ or contact Dr. Esta vanHeerden at vHeerden@micro.nw.uovs.ac.za.

Agenda

Pre-conference Field Trip

Pre-conference field trip to Northam Pt. Mine was organized by Sue Webb of the Dept. of Geology, Witswatersrand University. Six conference attendees participated in this two-day field trip into one of the Bushveld Complex's most interesting mines. The mine is unique in several aspects, including its depth (down to 2 km below the surface), the amount of water (fresh meteoric water is ingressing along a major fracture zone crossing through the mine property), the temperature (the rock temperatures reach 70°C), and the hydrogeology (the fractures intersect a variety of rock types from anorthosite to dunite). Finally, the most intriguing aspect of the Northam mine in terms of its potential microbiological significance is the presence of isolated saline water pockets containing methane gas that are believed to be 1-2 billion years old. More information about the Northam mine can be found at our website <http://geoweb.princeton.edu/geomicrobio/samp/sindex.html>.



Field trip participants assembled at Northam security gate with mine gear awaiting the trek to cage. From left to right: James Hall (Princeton University), Marion Trudeaux (Univ. of Capetown), Sue Webb (Witswatersrand University), Susan Pfiffner (Univ. of Tennessee), Gordon Southam (Northern Arizona University), Duane Moser (Princeton University) and Northam representatives.



Susan Pfiffner and Sue Webb (who organized the field excursion) hamming it up in a stope with Duane Moser diligently pursuing samples in the background.



Duane Moser and James Hall collecting microbial and geochemical samples of water emanating from borehole and biofilm while Gordon Southam recuperates from jet lag.



Tommy Phelps (Oak Ridge National Laboratory) expostulating and pontificating (as usual) to Marion Trudeau as to the origin of the water emanating from the borehole behind him. James Hall and Duane Moser discuss sampling approaches with mine representative behind them.

Conference Sessions

Two days of talks and discussions were held at the University of the Free State's conference center. Some of the conference expenses were supported by SA Brewery and Merck. The sessions were preceded by an icebreaker attended by the dean of the faculty of University of the Free State. The sessions focussed on three aspects:

1. LSLIS-Results of research to date from the LEXEN-supported deep microbiology project and the future plan for the Witwatersrand Long Term Site for Interdisciplinary Studies in Deep Microbiology (LSLIS). Presentations were made by Drs. Onstott and Moser (Princeton Univ.), Southam (Northern Arizona University), Pfiffner (Univ. of Tennessee), DeFlaun (Envirogen, Inc.), Ward (Univ. of Toronto).

Mars-Two presentations on the most recent scientific results on Mars, its ancient climate and the possibility of life were given by Dr. Ward (U.S. Geological Survey).

Biotechnology-Potential biotechnological spin-offs that could result from LSLIS research were discussed in presentations by Drs. Phelps (Oak Ridge National Laboratory) on organic remediation, DeFlaun (Envirogen, Inc.) on bioaugmentation and metal remediation, Faisson (North Hampton University) on microbial coal liquefaction, duPlessis (Billinton) on thermophilic bioleaching of ore, Cowan (Univ. of London) on bioenzyme exploitation for South Africa, Foster (Water Resource Institute) on the contaminant hydrology of the dolomite aquifer in proximity to the Au mines and Burton (Rhodes University) on a South African multi-institutional center for microbial biodiversity and biochemistry.

2. The Council on Biodiversity International Treaty was discussed and the current status of South African legislation with respect to the CBD was presented by Sean Klinkradt a representative of the law firm Bowman Gilfillan Inc., and expert on intellectual property rights. How the recommendations of the CBD could be implemented in the case of the LSLIS Witwatersrand Project was discussed and recommendations were made by Onstott on how best to proceed for LSLIS. One of the recommendations included the creation of a subsurface microbial culture collection within South Africa. The Dept. of Microbiology at the University of Orange Free State, which currently hosts a culture collection for yeast, has agreed to create and maintain just such a collection.
3. An undergraduate (honors level and above) exchange initiative was discussed. The discussion was preceded by presentations on the "High Flyer" program, an exchange program that was implemented for the NSF-funded Kaapvaal Project seismic project, by Prof. Marion Trudeau (Univ. of Capetown) and Sue Webb (Univ. of Witwatersrand). Dr. Esta vanHeerden of the University of Orange Free State agreed to act as the principal investigator for pursuing NRF funding of a similar type of program for the Witwatersrand Long Term Site with participation from the Univ. of the North, Witwatersrand University and Univ. of Capetown. Sue Pfiffner of the University of Tennessee agreed to act as the principal agitator in acquiring support for the counter part program in the United States. The need for secondary school teacher training workshops was also discussed in the context of this project and depending upon the success of the undergraduate mentoring efforts, this will be pursued.

Post-conference field trip

A post-conference field excursion and barbecue was held at the archeological site near Florisbad hot springs. Florisbad isotope and geochemical signatures bear a strong resemblance to those encountered in the fissure waters for the deep Au mines near Carletonville. Samples for the hot springs were collected from dissolved gas analyses, isotope and microbiology.

Conference Results

The workshop goals listed above were achieved plus the concerns regarding the compliance with the International Biodiversity have been addressed.

1. Prior results were communicated to a much larger group than we had anticipated.
2. New research collaborations were established.
 - a) Based upon the presentations at the conference, three new mines have agreed to cooperate with our project, Evander in the eastern Wits basin, Oryx in the southern Wits basin and the Northam Platinum mine in the Bushveld. Both Kloof and Driefontein have agreed to reopen access to our research group having resolved issues raised regarding the reporting of our activities by Discover magazine.
 - b) Collaborative agreements or Memos of Understanding between the LSLIS project and the University of Orange Free State and Witwatersrand University have been established initiated. The agreement with the University of Orange Free State has been signed. Both agreements have been forwarded to Sean Klinkradt for his information and advice. As legislation advances in the South African government on international biodiversity and as potential research spin-offs develop from LSLIS, we hope Sean will keep us apprised of the situation and will be able to offer his services in negotiating any CRADA's.
 - c) Representatives from SIMPROSS have offered the financial backing of research relevant to the microbial alteration of hazardous mine gases.
3. Presentations were made at the workshop concerning mining hazards and ore processing.
4. The workshop interactions have led to subsequent presentations by our research group to mining geologists and managers at Kloof and Evander who have expressed great interest in the measurement of combustible gases using the LSLIS supported field laboratory. SIMPROSS has shared their findings with our research group on combustible gases. Interested parties from Driefontein have approached our group about the biological remediation of uranium contaminated effluent.
5. The University of Orange Free State will be organizing a proposal to NRF for undergraduate exchange program. A committee led by Esta vanHeerden and composed of T.C. Onstott, Sue Pfiffner, Wes Ward and Brendlyn Faison has agreed to meet at the beginning of the year to develop these proposals.

6. A collaborative research proposal on biotransformation of aromatic monomers/oligomers with applications to the microbial liquefaction of coal has been drafted by Profs. Stephanie Barton of Rhodes University and Don Cowan of the University of London (soon to be at the University of the Western Cape) and includes Brendlyn Faisson of Hampton University.
7. The University of Orange Free State has agreed to include within its culture collection, current South African strains of bacteria isolated during previous research and currently archived at Florida State University and Portland State University and to include future strains and enrichments. Both David Balkwill and David Boone, the curators of these collections, have been contacted with regard to this and both have agreed to provide advice on the development of the South African culture collection and to ship to the University of Orange Free State existing South African deep mine strains.