

HOMESTAKE DUSEL AND SANFORD LABORATORY NEWSLETTER

Dear Homestake Collaboration,

Welcome to the February 2011 monthly newsletter for Homestake DUSEL and South Dakota's Sanford Laboratory. We gladly receive your input on news, links to news articles, upcoming workshops, conference notices, scientific updates, information concerning the Collaboration, employment opportunities, and other highlights relevant to our shared goal.

Important Dates

February 23: DUSEL Program Advisory Committee Meeting - Berkeley

February 25-26: AARM Collaboration meeting - Minneapolis

March 29-31: PDR Internal Review - Berkeley

April 13-15: Cosmogenic Activities and Backgrounds Workshop - Berkeley

FY11 to UC Berkeley to work with the SDSTA to maintain the site as the DOE worked on its assessments. The DUSEL Project is putting the finishing touches on the Preliminary Design Report (PDR). The DUSEL team is assembling alternative designs to be considered by the funding agencies as we look at options for the DOE stewardship of the facility. These plans are using the PDR as an "encyclopedia" for designing the laboratory. This report and the strong DUSEL design and engineering team is expediently assembling alternative facility design options including advanced cost and schedule estimates. The DUSEL design team continues to support LBNE as this collaboration advances the design of this project. The first draft of these alternative facility designs was presented to the DUSEL PAC on 23 February. The Project is encouraged by the cooperation and collaboration shown by the DOE and NSF in seeking solutions to the issues raised by the NSB in December. We look forward to refining the DUSEL design and continuing to discuss the exciting science opportunities enable by DUSEL to both the DOE and NSF in the coming months.

*Yours,
Kevin Lesko
Principal Investigator*

Dear DUSEL-supporters,

The past three months have been filled with news and events impacting DUSEL. In December, we learned that the National Science Board had declined to fund our Transition Proposal. This proposal was to: a) fund the design activities of the team between the completion of the Preliminary Design and start of Final Design, b) to install a selection of safety improvements focused on the early science activities at the 4850L, and c) to assure safe access so that the DUSEL design team would have the required access to the underground to advance the design and assessment activities. The termination of the NSF's efforts were summarized in the President's Budget, released 15 February. Also in the President's Budget we were pleased to see the Department of Energy proposed \$15M (\$10M from HEP and \$5M from NP) to maintain the viability of the site as DOE assessed options and alternatives to support their underground physics goals.

The DOE is establishing an expert review committee to advise them on DUSEL. The NRC panel continues to develop their report on DUSEL science for the NSF and DOE. Two weeks ago we were informed that the NSF was awarding up to \$4M in

Nuclear Astrophysics: DIANA - Part II



Figure 1: Design of DIANA accelerator laboratory

(Continued from January 2011 DUSEL Newsletter)
DIANA would build on the experience of the present LUNA facilities at Gran Sasso, but would provide much enhanced capabilities in terms of ion beam intensity (which would be more than one order of magnitude higher than in LUNA), ion species, and energy range. It would enable measurements of solar burning cross-sections at lower energies with higher precision, and enhance our knowledge of

more complex reaction mechanisms that occur during late stellar burning. The reactions associated with the nucleosynthesis of carbon and the neutron production for trans-iron nucleosynthesis have been identified as the most critical for simulating the nucleosynthesis of late stellar evolution and for understanding ignition conditions of novae and type I supernovae. In that spirit the projected scientific program at DIANA would complement and expand the existing low energy nuclear astrophysics programs at LUNA as well as US university facilities such as the Laboratory for Experimental Nuclear Astrophysics LENA (UNC) and the Nuclear Science Laboratory NSL (Notre Dame) and would provide unique research opportunities for the national and international nuclear astrophysics community.

A two-accelerator facility provides a broad range of experimental opportunities. A 500 keV high intensity machine will deliver milli-Ampere proton and alpha beams for studying the low-energy range of proton capture reactions of relevance for the CNO and NeNa cycles as well as alpha capture reactions associated with the pp-chains. The experimental results will improve substantially our understanding of neutrino production in stars. This is not only necessary for improved interpretation of the solar neutrino observations but might provide the key for extracting direct information about the solar core metallicity from the proposed measurement of CNO neutrino by the Sudbury Neutrino Observatory (SNO) and Borexino at Gran Sasso. The 3 MV accelerator is designed to deliver high intensity alpha and heavy ion beams to measure the low energy cross sections of alpha capture reactions of relevance for stellar helium burning. Particular interest is in the investigation of stellar neutron sources, since they are critical for the formation of heavy elements in stellar s-process environment. These results will provide key information in understanding the galactic chemical evolution of heavy elements, specifically since it will also help to extract from observations improved information about the r-process abundance distribution. Special neutron shielding has been developed and tested for these kinds of experiments. The 3 MV accelerator will also be the key instrument for testing nucleosynthesis reactions during the last phases of stellar evolution prior to core collapse, namely heavy ion fusion reactions. The low energy cross sections have been subject to intense debate and speculation over the last decade. DIANA would provide the definitive understanding of to the role of low-energy reactions in the overall nucleosynthesis scheme.

Hunting novel microbes

A research team led by Dr. Rajesh K. Sani of SDSMT has been collecting samples of microorganisms at the 4850 Level at Sanford Lab. The collections are part of microbiological research which has been ongoing for four and a half years. Assisting Professor Sani are microbiologist Dr. Gursharan Singh, CBE PhD candidates Aditya Bhalla and Rajneesh Jaswal, CBE MS candidate Laura M. Rodriguez, and undergraduate Anne Winkel from the Civil and Environmental Engineering Department, all of SDSMT.

Their main goal is the discovery, description, metabolic function, and cataloguing of unique microbes including archaea, as well as previously uncultured/unclassified microbes present in the extreme environments found in the Homestake mine. The site offers a unique opportunity for direct exploration of the deep biosphere environment for microbes. Using *PhyloChips* (Ribosomal RNA-targeted oligonucleotide microarrays) clone libraries, and various enrichment techniques, the group's microbial data (published and unpublished) collected over four years show that the mine harbors a significant microbial diversity including archaea, unclassified microbes, and unique organic polymer-degrading and fermentative bacteria - see Figure 2, and for more detail, the references listed on page 8.

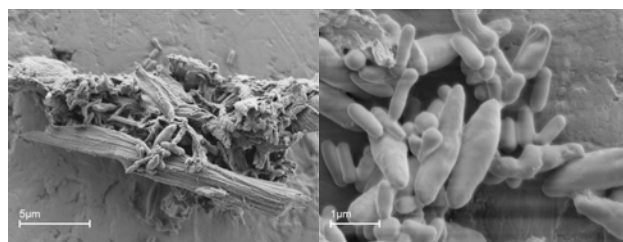


Figure 2: Whole cells of a DUSEL strain grown on cellulose as a source of carbon and energy – Scanned by students using electron microscope

A culture-independent molecular phylogenetic analysis using cloning and sequencing of 16S rRNA genes was carried out to study the prokaryotic diversity in two soil samples collected from the deep biosphere (1.34 km depth) at two sites--the Ross shaft and #6 Winze. Results indicated the existence of diverse microbial populations at both. Only 9% of total clones were related to known cultivable species. For the same soil samples, *PhyloChips* data revealed extensive bacterial diversity and detected the largest number of taxa in

Proteobacteria phylum followed by *Firmicutes* and *Actinobacteria*. The archaeal communities in the deep mine environments were less diverse; they belonged to phyla *Euryarchaeota* and *Crenarchaeota*. Interestingly, a total of 57 phylotypes could not be classified even at phylum level, representing a hitherto unidentified diversity in the deep biosphere.



Figure 3: PhD student Aditya Bhalla gathers a sample of organic material. SDSMT Assistant Professor Rajesh Sani looks on

These microbial data raise several fundamental questions. What uncultured/unclassified microbes are present in the rock fissures of DUSEL's deep biosphere? How do these indigenous microbes survive (generate energy) under extreme conditions including low nutrients, extreme temperature, pressure, pH, low oxygen concentrations, darkness, and toxic metals? How do microbes change the geology and chemistry in deep biosphere? What are syntrophic relationships among microbes? To address these questions, the research team recently visited DUSEL's 4850 level to collect soil, water, and sediment samples with the intent to isolate novel microorganisms. Sanford Lab Geologist Tom Trancynger and SDSMT graduate student Tessa Jones led them through the mines into isolated areas rarely visited. The group collected a total of eighteen samples currently being used for isolation of novel microbes.

This research on unique deep biosphere geomicrobial systems will provide novel microbes (possibly with industrial potential, including lignocellulose degradation, biohydrogen production, and metal bioremediation) and improve our current fundamental understanding of complex subsurface biogeochemical interactions in deep biosphere microbes. Another impact of this research is the education of university and elementary school level students on metabolic functions of novel microbes present in the unique environments of DUSEL.

A number of similar research projects are under way at Sanford Lab. In December 2010, a South Dakota

School of Mines team presented a paper at the American Geophysical Union in San Francisco, which included a look at a form of life called DUSELR13, described as a "thermophilic cellulose-degrading deep gold mine strain."

DuRA Survey and DuRA Charter

The DUSEL Research Association Executive Committee (DuREC) is conducting a survey among members of DUSEL.org to see if they wish to become voting members of the DUSEL Research Association (DuRA). (You may have already received your request.) Membership in DuRA is open by request; all are welcome. Given the research-specific focus of DuRA, emails regarding DuRA business may not be of interest to all and this underlies the upcoming membership request from DuRA. The request will come in the form of a brief survey. Responding to the survey will automatically establish membership. For more info on the DuRA survey:

<https://spreadsheets.google.com/viewform?formkey=dEZyUWhNQTJEB2RDMFFTdU15YTB0UHc6MQ>

DuRA Charter: http://www.dusel.org/PDFs/dura-docs/DuRA_charter_20101202.pdf



On January 18-23, 2011, a workshop on *New Horizons for International Investigations into Carbon Cycling in the Deep Crustal Biosphere*, sponsored by the Alfred P. Sloan Foundation took place at the University of Free State, Bloemfontein, South Africa. Over 50 participants from around the world attended to view 27 presentations, followed by discussions in breakout sessions.

Biology Department Chair Tom Kieft, University of New Mexico, presented an overview of research opportunities at DUSEL. Other breakouts identified 26 areas of possible collaboration, including a proposal for a network of deep terrestrial biosphere research (NISO: Network for Inner Space Observatories) aligned with potential activities at DUSEL.

To view a photo album of the event:

<http://www.princeton.edu/southafrica/workshop-photos/>

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DUSEL IN THE NEWS



Figure 4: Daryl "KC" Russell and Connie Giroux

Native Sun News: *Black Hills laboratory seeks tribal collaboration*, by Talli Nauman

LEAD, SOUTH DAKOTA — If the ancestors here were told that Black Hills gold would one day offer a way for their people to become recognized world leaders in knowledge of the universe, it has not been remembered. But the forging of the former Homestake mine into a Deep Underground Science and Engineering Laboratory (DUSEL) provides just that opportunity, according to members of DUSEL-Sanford Lab Cultural Advisory Committee.

"We're giving encouragement for Native American students to access the project for internships and studies in science that is going to allow them to advance their education and occupations," says DUSEL Cultural and Diversity Coordinator Daryl "KC" Russell, a member of the committee and the Lower Brule Sioux Tribe.

To read more: <http://64.38.12.138/News/2011/000267.asp>

To read more DUSEL news items:

Black Hills Pioneer: *NSF approves \$4M for Lab* (February 17); *Public excited about DUSEL science education* (Wendy Pitlick, February 3)

South Dakota Public Broadcasting: February 17 edition of *Dakota Middy* included speaker Bill Roggenthen, co-principal investigator of the DUSEL project. Subject: Operation of DUSEL has been transferred from the National Science Foundation to the Department of Energy. <http://bit.ly/Roggenthen>
Physics Today: *DUSEL budgets*, February 18; <http://bit.ly/PhysTodaybudget>

Columbus Dispatch: *Scientists go deep underground to search for elusive dark matter* (Spencer Hunt, January 23)

Rapid City Journal: *Christen appointed to Science & Tech Authority* (February 4)

Evz.ro: *DUSEL mention in Romanian news, Capcane pentru materia întunecată* (January 30)

DUSELwatch.com: *Noem says lab funding a top priority; DUSEL education survey shows higher interest in public science education; Lab crews finish 4850 excavation* (Wendy Pitlick)

www.sanfordlab.org - Check out "Twitter updates" in lower left hand column

SANFORD UNDERGROUND LABORATORY AT HOMESTAKE

Representative Noem visits 4850 Level

On January 31, newly elected US House of Representatives member Kristi Noem toured the 4850 Level, visiting the MAJORANA cleanroom and the Davis campus at Sanford Lab. She represents South Dakota's At-large district. Noem was a state legislator for four years prior to her current post.



Figure 5: Visiting the 4850 Level: Rep. Kristi Noem in center. Visitors to the 4850 ride from the Ross Shaft to the Davis Campus in a newly refurbished covered personnel car

This was Noem's first visit to Homestake. She was joined by Qusi Al-Haj, West River director for Senator John Thune, and Darrell Shoemaker, who holds the same position with Senator Tim Johnson, Beth Hollatz and Jordan Stoick of Noem's staff, and SDSTA Board Chairman Casey Petersen. SDSTA Executive Director Ron Wheeler and several others from Sanford Lab also participated in the tour. Noem's lab visit was part of a general South Dakota tour which also included a discussion on mountain

pine beetle infestation with Black Hills National Forest officials, loggers, and local government officials, and a meeting with Ellsworth Task Force officials.

Noem stated that she plans to work hard to make sure the lab receives the necessary funds to continue operation.

4850 Level Progress

At the end of January, shotcrete applications began on the 4850 Level. This spray-on form of concrete will be applied more than 3 inches thick to the rock walls of the Davis and Transition Caverns. Contractors from Shotcrete Technology are working with Sanford Lab infrastructure technicians and crews from CAI Construction.



Figure 6: CAI supervisor Jim Norris and Ramiro Hernandez of Shotcrete Technology inspect batch plant in Transition Cavern. The jib crane was recycled from Homestake's wash rack at the surface level

A rotating jib crane (Figure 6) lifts 2,000-pound bags of dry shotcrete, which are deposited into a hopper (tan box in figure 6). An auger moves the shotcrete from the hopper through a mixer, where water is added, and then to a pump which delivers wet shotcrete into a 2-inch hose that feeds shotcrete to a robotic arm mounted on the bucket of a LHD loader. A compressor (silver box) delivers compressed air to the robotic arm. Shotcrete and air are forced through a nozzle that sprays even layers of shotcrete onto the rock.

Later in 2011, the LUX dark-matter detector will be installed in the Davis Cavern. The MAJORANA neutrino experiment will be in the Transition Cavern.

Bushing change

On January 27, Facilities Tech Kevin Becker coordinated the changing of a bushing or sleeve bearing on a Ross Hoist drum, assisted by 15 technicians. Each of four sections of the bushing weighs 575 pounds. The team used five different

lever-hoists to maneuver them into place. The hoist will not operate without bushings. The process, which can take up to 48 hours, was completed in 12 hours.



Figure 7: Facilities Tech Buddy Lester and Jeff Essink guide a section of the bearing into place

EDUCATION AND OUTREACH

Early Programming

K-12 Education: Peggy Norris gave a talk to EduTube, a technology education group in the Winnipeg, Manitoba area, utilizing the high-definition video system. Demonstrating that science education is taking advantage of our increasingly flat world, the talk was the final segment in a three-part presentation to the group that included the Superintendent of Ware County School District in southern Georgia and an educator and technology expert from a school district outside of Atlanta. The presentation on the plans for the Sanford Science Education Center was an example of how content providers could work through partnerships that utilize technology to deliver educational messages in an effective way.

The new video equipment has seen increasing use to both provide and receive content:

Providing content: On January 21, geologist Tom Trancynger spoke to a class of fifth graders at Mt. Vernon Elementary School in Hall County, Georgia about mining gold and geology in general, showing them different samples of rocks and minerals during the presentation, and answering many questions.



Figure 8: A student from Georgia asks Tom Trancynger (reflected in monitor) a question about gold

Receiving content: On January 28, the Yates Education Building hosted over 50 sixth graders from the Lead-Deadwood Middle School for a live video-lecture with Senior Research Scientist David Gottfried of the Nanotechnology Research Center at Georgia Tech. Broadcasting from a clean room in his laboratory, the scientist led the students in two chemistry experiments and talked about the work he does and the future of nanotechnology. Sanford Lab Cyberinfrastructure Engineer Warren Matthews (his daughter is pictured below) organized the science seminar, with help from Julie Dahl of Black Hills State University and middle school teacher Deborah Thorpe.



Figure 9: Left: Sixth grade students crowd around the video screen to ask questions of a scientist in Georgia. Right: Kathryn Matthews and Riley Lundquist experiment with dilution techniques

On January 23, Peggy Norris traveled to Cankdeska Cikana Community College in Fort Totten, North Dakota to give a workshop on radiation, its effects and uses for a monthly 'Science Sunday' program run by the college for high school students from the Spirit Lake Reservation. Thirteen students from Grades 9-12 participated. On the way back, she stopped at Timber Lake High School on the Standing Rock Reservation in northwestern South Dakota, where Norris spoke to several science classes about Sanford Lab, plans for DUSEL, and future opportunities for students.

On January 28, Peggy Norris and SDSMT Assistant Professor Xinhua Bai gave a joint multimedia presentation about dark matter at the Journey Museum in Rapid City, as part of the *Final Frontier Friday* public program. The presentation combined slide show and flat-screen planetarium shows; it was well received.

On February 4-5, Peggy was a featured speaker at the South Dakota Science Teachers Association (another SDSTA!) in Huron. She presented status talks on planning for the Sanford Center for Science Education and DUSEL as well as talks on specific

educational program opportunities, featuring waste water treatment and modern physics curriculum.

ENVIRONMENT, HEALTH & SAFETY



Winter Safety

What to do if you are stopped or stalled in snow:

- Stay in your car. This will decrease your risk of frostbite or hypothermia and increase your chances of being rescued.
- Run your engine for heat about once an hour or every half hour in extreme cold. Make sure your exhaust pipe is clear to prevent carbon monoxide from getting into the car.
- Leave one window slightly open.
- Hang bright markers on your antenna or windows and keep the interior dome light turned on.
- Limit your sleep to short naps. **Stay warm!**



For info on Lead, South Dakota road and weather conditions: Call (605) 722-0002

Safety pages on Sanford Lab website: www.sanfordlab.org - Use the left hand menu to open individual pages

UPCOMING EVENTS AND ANNOUNCEMENTS

Workshops

Cosmogenic Activities and Backgrounds Workshop, Lawrence Berkeley National Laboratory, April 13-15, 2011. This DUSEL-sponsored workshop will explore key experimental measurements and theoretical models of cosmogenic activity and backgrounds, discuss the challenges in interpreting the data and matching models to experiment, and lay out a roadmap for future experimental activities and modeling efforts. The workshop scope includes neutron spallation and subsequent interactions, isotope production, electromagnetic and hadronic showering, muon-incident interactions and propagation, and other related topics.

<https://docs.sanfordlab.org/docushare/dsweb/View/Wiki-141/HomePage>

Fourth IUPAP International Conference on Women in Physics, Stellenbosch, South Africa, April 5-8, 2011. Conference goals: provide an opportunity to view and analyze current status of and progress in promoting women in physics in each country and internationally; provide an arena for women in physics to share their scientific accomplishments and create international scientific collaborations; and build capacity in each participating country to design and implement changes to improve the participation and advancement of women in physics.

For more info: <http://www.uswip.org/>

12th International Conference on Topics in Astroparticle and Underground Physics, Münchner Künstlerhaus (Munich House of Artists), Munich, Germany, September 5-9, 2011. Topics covered by the conference: Cosmology and particle physics, Dark matter and its detection, Neutrino physics and astrophysics, Gravitational waves, High-energy astrophysics and cosmic rays.

For more info: <http://taup2011.mpp.mpg.de/>

Third International Workshop on Baryon and Lepton Number Violation (BLV-2011), Gatlinburg (Edgewater Hotel), Great Smoky Mountains, Tennessee, September 22-24, 2011. The Workshop purpose is to discuss state of the art of B,L, and B-L violation search, stimulate experimental and theoretical developments in this area, and attract new and young researchers to this field. Other topics will include: proton decay, n-nbar transformations, MAJORANA neutrinos and their role in physics beyond the standard model and in Cosmology.

For more info: <http://www.phys.utk.edu/blv2011/>

DuRA Events

Presentations that may be of interest to DuRA members are scheduled in the following meetings:

2011 SME Annual Meeting & Exhibit, Denver, Colorado, February 27-March 2, 2011. <http://www.smenet.org/public/Core/Events/eventdetails.aspx?iKey=AME2011&TemplateType=A>

Symposium on Experiments on the Cosmic Frontier: Astrophysical Studies of Matter, Energy, Space and Time, Fermilab, Batavia, Illinois, March 23-26, 2011. <http://astro.fnal.gov/events/Conferences/cosmic/Home.html>

2011 APS April Meeting, Anaheim, California, April 30-May 3, 2011.

<http://www.aps.org/meetings/april/index.cfm>

45th U.S. Rock Mechanics/Geomechanics Symposium with sessions on Geology and Geophysics, Mining Engineering, DUSEL Rock Mechanics, Civil Engineering, and underground construction, San Francisco, CA, June 26-29, 2011. <http://www.armasymposium.org/>

2011 XXV International Union of Geodesy and Geophysics (IUGG) General Assembly, workshops and business meetings, Melbourne, Australia, June 28-July 8, 2011. <http://www.iugg2011.com/>

Meeting of the Division of Particles and Fields of APS, Brown University, Providence, RI, August 9-13, 2011. <http://www.hep.brown.edu/~DPF2011/>

12th International Congress on Rock Mechanics, with workshop WS-5 on Networks of underground research laboratories for international disciplinary innovations, Beijing, China, October 17-21, 2011. <http://www.isrm2011.com/page.asp?id=100>

Please send information regarding upcoming meetings of interest or presentations from DuRA members, as well as other related events to Steve Elliott (elliotts@lanl.gov) or Duane Moser (Duane.Moser@dri.edu).



JOBS

Visiting Assistant Professor, Dept. of Physics, Univ. of South Dakota. Candidate will participate in 2010 DUSEL Research Center (CUBED) activities and in the planned DUSEL experiments. Apply at: <https://yourfuture.sdbor.edu> or submit materials to Chair of Physics Search Committee, Dept. of Earth Science & Physics, University of South Dakota, 414 East Clark, Vermillion, SD 57069 or to physics@usd.edu.

Senior Tenured Faculty, Physics Dept., Temple University, in all areas of Astrophysics particularly experimental/observational. Applicants must have his/her own high-quality research program with substantial research funding, and teaching

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experience. To apply, send CV, pubs list, research plan, current grant support, statement of teaching philosophy and 5 references, or for more info: <http://www.temple.edu/physics/news/positions.html> or Search Committee, Dept. of Physics, Temple University, 1900 N 13th Street, Philadelphia, PA 19122-6082.

Postdoctoral Fellow with PhD in Microbiology or Geology to work on NSF PIRE-funded project with focus on microbial community structure and diversity, biogeography, genomics and related research in China, Tengchong Geothermal Field, Yunnan Province. To apply send CV and research statement, or for more info: Dr Hailiang Dong, Dept of Geology, Miami University, Oxford, OH 45056, or dongh@muohio.edu.

Postdoctoral Position, UC Santa Barbara, Particle Detector Development, Dept. of Physics. Lead detector R&D program, building ultra-high-resolution particle detectors for future neutrino and dark matter detectors. Assist KATRIN neutrino experiment and at UCSB Nanofabrication Facility. Contact: bmonreal@physics.ucsb.edu, Professor Ben Monreal or <http://hep.ucsb.edu/>

Postdoctoral Position, Syracuse University, Direct Dark Matter Detection. Experimental particle astrophysics group working with Cryogenic Dark Matter Search (SuperCDMS), AARM, and DEAP/CLEAN. Further info: <http://cdms.syr.edu/> Apply: <https://www.sujobopps.com/> (Job # 026971)

Assistant Physicist, Brookhaven National Laboratory Physics Dept., Electronic Detector Group (5900). Required Ph.D. in physics with emphasis on experimental particle or nuclear physics. participate in group activities including LBNE, DUSEL in South Dakota and Daya Bay reactor neutrino experiment in China. Appointment start date: March 1, 2011 under direction of S. Kettell. <http://www.bnl.gov/hr/careers/> - Job ID # 15570.

Newsletter Editor: Melissa Barclay

Contributors: Kevin Lesko, Bill Harlan (Sanford Lab); Michael Wiescher (Nuclear Astrophysics: DIANA-Part II); Rajesh K. Sani (Hunting novel microbes); Steve Elliott, Derek Elsworth, Joe Wang (DuRA News); Tullis Onstott, Duane Moser (New Horizons for International Investigations into Carbon Cycling in the Deep Crustal Biosphere); Peggy Norris, Ben Sayler (Education and Outreach).

Photo Credits: Fig. 1: Matthaues Leitner; Fig. 2: SDSMT students; Figs. 3-7,9: Matt Kapust; Fig. 8: Bill Harlan.

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