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Spaceward Bound Australia 2009 Expedition: June Progress Update

Introduction

This report is for the participants and parties interested in the Spaceward Bound Australia 2009 (SBA2009) expedition to the South Australian desert. Some parts of the report have been repeated from the previous 'April Update' for those new to the expedition.

Expedition Aim and Program

The Spaceward Bound Australian 2009 expedition is a 'Planetary and space science' expedition to Arkaroola and other remote locations in the South Australian desert involving scientists and teachers from the US and Australia. The expedition is a joint project between NASA Spaceward Bound located at NASA Ames and Spaceward Bound Australia an arm of 'Mars Society Australia'.

Expedition funding and support has been provided by NASA Spaceward Bound, CSIRO Space and Technology Division, Mars Society Australia, Australian National University, University of New South Wales, University of South Australia and the schools listed in the table 'Expedition Participant List'. In addition some individuals have made personal contributions. The expedition organisers wish to thank these institutions and people for their contributions support.

The expedition aim is in two parts:

- First, is to undertake field science supporting research into 'the evolution of life' in our solar system and to perform engineering trials of a field robot. Planetary scientists, geologists and engineers from the US and Australia are jointly participating in the expedition; and,

- Second, is to invite teachers and students from the US and Australia to participate and work together with the scientists undertaking practical field science. Teachers and students will have an opportunity for additional training and inspiration which, as part of the NASA Spaceward Bound program, will be passed on into school classrooms. Teachers will meet and work with scientists closely involved in recent space exploration missions to the Moon Mars and Titan.

Teachers have been undertaking 'on line' training from NASA Spaceward Bound education coordinator, Dr Liza Coe in preparation to work with the scientists on the expedition.

The SBA 2009 expedition will occur from the 9th to 16th July starting and finishing in Adelaide leading to the 9th Australian Mars Exploration Conference held on the following weekend on the18th & 19th July at the University of South Australia in Adelaide.

Table 1 lists the program as planned at in mid June. It covers the timing and places to be visited including Arkaroola, Marree and Reedy Springs, all located north of the Flinders Rangers in South Australia. A map of the region showing the locations is attached in the appendix. Expedition contacts and science activities are listed at the end of the report.

Table1: Program

Day	Activity	Travel Distance	Travel Time
Day 1, Thursday 9th July	Meet in Adelaide at: Mantra Hindmarsh Square 55-67 Hindmarsh Sq, Adelaide, SA 5000 Ph 61 8 8412 3333 hindmarsh.res@mantra.com.au Pick up vehicles		
Day 2, Friday 10th July	Travel from Adelaide to Arkaroola village Ph:61 8 8648 4848 res@arkaroola.com.au	659 kM	9 hrs 21 min
Day 3, Saturday 11th July	Science activities around Arkaroola Evening Presentations and/or astronomy	40 kM	
Day 4, Sunday 12th July	Science activities around Arkaroola Evening Presentations and/or astronomy	40 kM	
Day 5, Monday 13th July	Travel from Arkaroola to slightly north of Marree along the Birdsville track. Stay at Marree Hotel Railway Terrace Marree, South Australia, Marree, Australia, 5733 Ph 61 8 8675-8344	283 kM	5 hours
Day 6, Tuesday 14th July	Stay at Marree in Morning. Travel from Marree to Lyndhurst in afternoon. Stay at Lyndhurst Hotel-Motel: 3 Short Street, Lyndhurst, South Australia 5731 Ph 61 8 86757781 Lyndhurstpub@bigpond.com	230 kM	4hrs 40 min
Day 7, Wednesday 15th July	Travel from Lyndhurst to Reedy Springs Work at Reedy Springs to late afternoon Travel from Reedy Springs to Lyndhurst	300 kM	4 hours 30 min
Day 8, Thursday 16th July	Travel from Lyndhurst to Adelaide Stay at Mantra Hindmarsh Square	563 kM	7 hrs 40 min
		TOTAL 1965 kM	

The aim of the program is to set a loose plan that can be altered if science objectives change. Participants will note that there is considerable travel involved between the locations. An attempt has been made to maximize the time at the locations. Sleeping bags will not be required but individuals may wish to bring them. Some people may choose to camp overnight at Reedy Springs to collect night samples. Some tents will be provided in case this is required.

Participants have been issued documentation covering, 'Code of Conduct', 'Personal details form', 'Personnel equipment list' and 'a safety Information guide'.

The Expedition Team

The expedition team scientists and teachers from the US and Australia as of the end of June 2009 numbers 29 people. We do not wish to have more than 30 people on the expedition. The participants, their affiliation, work and expedition roles are listed below in Table 2.

Table 2: The Expedition Participants

The US Science Team	**US Affiliation, work, expedition role and location**
Dr Chris McKay	NASA Ames: - NASA Spaceward Bound Principal & US Expedition Leader (CA)
Dr Jennifer Heldmann	NASA Ames:- NASA Spaceward Bound Coordinator (CA)
Dr Adrian Brown	Seti Institute: - Astrobiology and remote sensing (CA)
Dr Penny Boston	Dept of Earth & Environmental Science New Mexico Tech: - Geomicrobiologist (NM)
Shannon Rupert	University of New Mexico-- Ecologist (NM)
Elaine Bryant	San Jose State University:- PhD Student (CA)
Dave Bryant	San Jose State University:- Laboratory Technician (CA)
Mike Spilde	Univ of New Mexico:-Cave Research Scientist (NM)
Dr Rosalba Bonaccorsi	NASA Ames/ SETI institute:- astro-biologist (CA)
Jim Thompson	Affiliation not provided:-Cave Research Scientist (CA)
US Teachers	
Stephen Joyce	San Jose State University (CA)
Luther Richardson	Columbus High School (CA)
The Australian Science Team	**Australian Affiliation, work, expedition role and location**
Dr Vic Gostin	University of South Australia:- Geologist (retired) (SA)
Dr Paulo de Souza	CSIRO:- Physicist (TAS)
Dr Graham Mann	Murdoch University: - Robotics (WA)
Eriita Jones	Australian National University – PhD Student (ACT)
Reut Abramovich	Australian Centre for Astrobiology, University NSW - PhD Student (NSW)
Guy Murphy	MSA:- Author/architect historian (VIC), Expedition Media Coordinator
Australian Teachers	
Mark Gargano	St Joseph's School (WA) & SBA Teacher Coordinator
Joanne Berriman	Oatlands District High School (TAS)
Jane Dobson	Claremont College (TAS)
Liz Ryan	Campania District High School (TAS)
Nicolette Burraston	Armidale School (NSW)
Keith Treschman	Brisbane Girls Grammar School (Queensland)
Naomi Mathers	Victorian Space Science Education Centre:-Research Scientist & Curriculum Developer (VIC)
Expedition Support Staff	
David Willson	MSA:- Engineer/Australian SBA 2009 Expedition Leader (TAS):
David Cooper	MSA:- Pilot/Spaceward Bound Australia Coordinator & Expedition Safety Officer (WA):
Maureen Cooper	MSA: - Information manager/Expedition Principal Cook (WA)
Nina Stansfield	MSA: - Amateur Astronomer/Expedition Cook (WA)

Note that meals, managing the science equipment and the general organizing of the expedition will be provided by the expedition support staff from Mars Society Australia.

The Science Work

The scientist team has multidiscipline skills consisting of astro-biologists, Geomicrobiologist, geologists, physicists and engineers. The individual scientist research work is listed in table 3 at the end of this section.

The science work will include:

- The Comparison of soil microbial populations at sites between the various locations;
- A study of microbially colonized quartz;
- The examination of gullies and hydrological features at Reedy Springs; and,
- The trialling of a field robot from the Murdoch University's School of Information Technology. Refer to Figure 1 below.

The field robot, 'Mascot', a high-mobility hexapodal robot from Murdoch University's School of Information Technology is shown in Figure 1. It is designed as a low-cost teleoperated platform that can inspect and monitor remote industrial sites. The robot can navigate through rough terrain at speed and allows a remotely located operator to place sensors or view objects of interest.

Some 'teething' problems have occurred recently during preliminary trials and a main circuit board needed to be replaced. We expect these problems to be resolved for the expedition.

Field trials will include 'field shake down' trials, 'maintenance patrol' trials and testing it's use as a 'field aid' in conjunction with scientist and teacher activities. It usefulness for industrial work and to assist future manned and unmanned missions to the moon and Mars will be assessed.

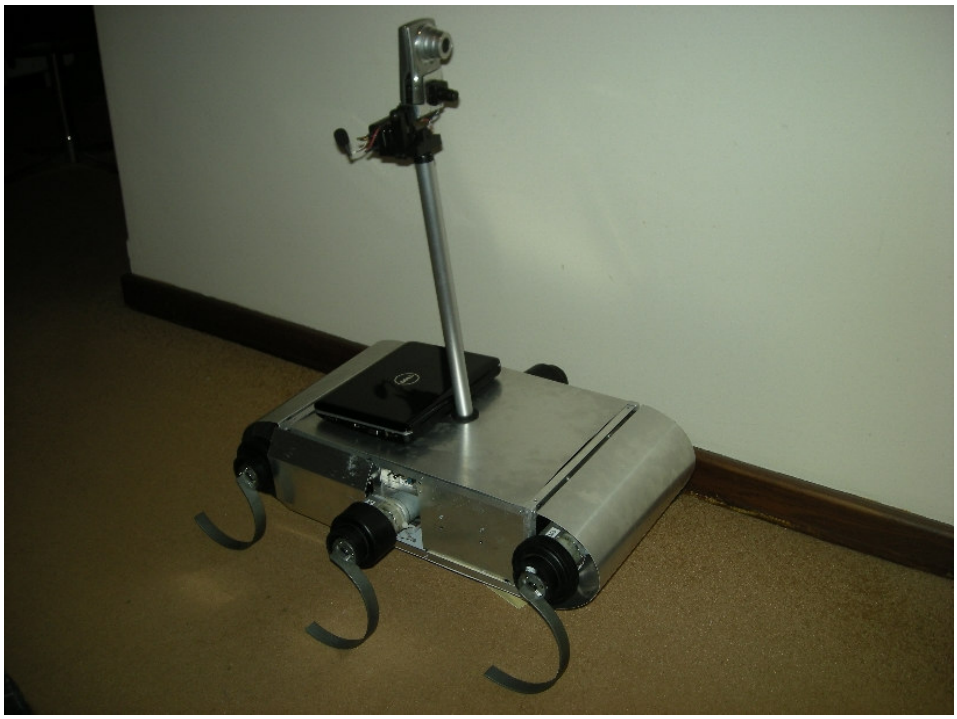


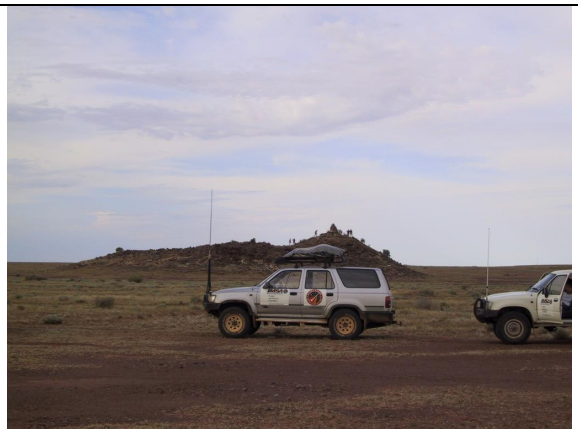
Figure 1: The Mascot Rover

Photographs of expedition locations and features that interest the scientists are shown below.

Arkaroola Region
Aerial view of the eastern margins of the Flinders Ranges and the Plain adjacent Lake Frome

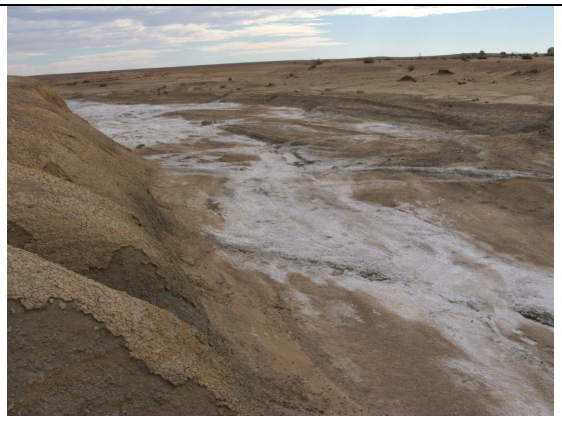
Arkaroola Region
Paralana Spring. Radioactive 70° spring with microbial communities suited to the hot radio active conditions. Such springs would be prime targets to look for life on mars and any martian life would require similar adaptations to a high radiation environment

Arkaroola Region View across the range front east of Arkaroola on alluvial fans. Similar locations are found on Mars.



Marree Region
Small mesa in stony desert north of Maree – a very martian landscape

Marree Region
Region covering up to 40 km North East Marree
The driest region in Australia with microbial communities suited to extreme dry conditions.



Reedy Springs
Microbial communities in gullies with possible acid seepage
Similar locations occur on Mars.

Education

For the SBA2009 educators, please refer to the website;
http://quest.nasa.gov/projects/spacewardbound/australia2009/info.html

The email updates are now all listed on the website, so that you may refer to them at any time. For scientists, this will give you an idea about some of the background work that has been examined by teachers at this stage as preparation and for general understanding.

Also, to identify some of the areas of operation, also examine the images on;
http://quest.nasa.gov/projects/spacewardbound/australia2009/images.html

This will give you a perspective on what some of the readings are referring too and a general picture of some of the locations.

Also, for all participants, there are a number (over 15) readings that have been placed at;
http://quest.nasa.gov/projects/spacewardbound/resources.html#australia

Use these and refer to them as required, these cover analogue studies, the Arkaroola region itself, geology, astrobiology and various techniques associated with field studies. Also, there is healthy reference list relating to other Spaceward Bound activities that may also be relevant to particular areas of study that will be occurring on SBA2009.

The Swine Influenza

The swine flu is present in Australia with several thousand people diagnosed and 5 deaths to date.

International participants may be inspected with infrared cameras upon entry to Australia. If 'flu like' symptoms are measured you may be quarantined until a proper diagnosis has been undertaken.
If this occurs please call David Willson on 0418 558 129.

Media

The expedition will be visited by the media. 'Essential Media and Entertainment', located in Sydney is producing a six part documentary series for National Geographic, titled 'Space Traveler: the astronaut's guide to leaving Earth'.

The series will present an engaging synthesis of our growing understanding of planetary science, presented in the guise of an inter-planetary travelogue sweeping through the Solar System from Mercury to the Kuiper Belt. They will also be filming on behalf of the ABC's 'Catalyst' program.

There will most likely be some requests for brief telephone interviews with expeditioners from the print media and radio. It would be most appreciated if people provided time for these interviews. We will aim to schedule these according to convenience and peoples availability.

Discussions are still in progress as to the planning of this film work. Our expedition media coordinator is Guy Murphy and can be contacted on 0416794688

Contact Information

If you require further information on the expedition, NASA Spaceward Bound or Spaceward Bound Australia please contact:

For Australian enquiries please contact:

Australian Expedition Leader	David Willson	David.willson@au.tenovagroup.com
Spaceward Bound Australia Coordinator	David Cooper	mdghobby@vianet.net.au
Spaceward Bound Australia Teacher Coordinator	Mark Gargano	Gargano.mark@cathednet.wa.edu.au
Spaceward Bound Australia Science Coordinator	Dr Jon Clarke	Jon.Clarke@ga.gov.au

For US enquiries please contact:

US Expedition Leader & NASA Spaceward Bound Principle	Dr Chris Mckay	cmckay@mail.arc.nasa.gov
NASA Spaceward Bound Coordinator	Dr Jennifer Heldmann	Jennifer.L.Heldmann@nasa.gov
NASA Spaceward Bound teacher coordinator	Dr Liza Coe	Liza.coe@nasa.gov

Details of the expedition and personal CVs of the participants can be found on the NASA Spaceward Bound website http://quest.nasa.gov/projects/spacewardbound/australia2009/info.html.

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Table 3: Scientist Expedition Research Work

Scientist	Affiliation and Contact Details	Science Activity Description
US Scientists		
Dr Chris McKay	Astro-biologist, NASA Ames Research Center chris.mckay@nasa.gov	Studies of life in extreme environments. In particular the survival of cyanobacteria under translucent desert stones. We will map the percent of translucent stone colonized over the moisture transect to compare with similar work from the Atacama and the Mojave deserts. Connection of desert landscapes to Mars with particular emphasis on Astrobiology.
Dr Jennifer Heldmann	Planetary Scientist, NASA Ames Research Center jennifer.heldmann@nasa.gov	The past and present distribution of water on Mars in all three states is of prime interest to researchers interested in the history of the martian environment, the past and present possibility of life, and the availability of resources for human exploration. A useful method for improving our understanding of martian hydrologic systems is to study analog systems on Earth that occur in Mars-like environments. The Arkaroola region in Australia is recognized as a valid Mars analog given the diversity of sites that provide useful analogs for martian rocks, environments, and processes. There are a number of permanent or semi-permanent water sources in the Arkaroola area that will be studied as Mars analogs. These springs or waterholes include radioactive hot springs, weakly radioactive cold springs, warm springs, and pools in creek beds. The physical and environmental conditions sustaining these water sources in the arid Arkaroola region will be investigated.
Dr Penny Boston	Microbiologist Associate Professor of Cave and Karst Science Dept of Earth & Environmental Science New Mexico Tech pboston@nmt.edu	Studies of microbial life in extreme environments. Survival of microbe in subsurface environments. Biomineralization by microbes and the traces they leave behind as possible indicators of past life on Mars.
Mike Spilde	Manager, Microprobe/SEM Laboratories Institute of Meteoritics University of New Mexico Albuquerque	My primary field of study is mineralogy, with an emphasis on microbeam techniques (SEM, TEM, electron microprobe, and X-ray microprobe). My research is focused in several areas: 1) The use subsurface terrestrial environments (particularly caves and lava tubes) as analogies to the subsurface of Mars in the search for life, 2) The study of biogenic minerals, particularly manganese oxides, and

		3) Cave geology and mineralogy
Elaine Bryant	Soil microbiologist, San Jose State University Elaine P. Bryant epbryant@earthlink.net	The project will identify how bacterial and Archaeal communities in the top 7-8 cm of soil change due to the availability of liquid water. My previous research has focused on a precipitation transect through the Mojave Desert, encompassing a precipitation gradient from 23cm annual precipitation to 9 cm annual precipitation. I used two culture techniques and two molecular techniques to compare microbial communities from 7 sampling sites in order to alleviate shortcomings of the individual techniques. I intend to inoculate viable count plates, which should quantify the culturable microorganisms at sample sites, and will be inoculating Biolog sole-carbon-source microplates. The Biolog plates offer communities of bacteria 95 different carbon sources. The pattern of usage at the different sample sites is indicative of the physiological characteristics of the bacteria at those sites. The microbial communities can be compared using multivariate analysis. The project will also extract DNA from the microbial communities in order to create clone libraries for sequence and identification purposes and to perform Denaturing Gradient Gel Electrophoresis. DGGE allows a side-by-side comparison of the taxonomically distinct organisms at each site. This presents a snapshot of organisms which are located at many or all sites, as well as indicating more selective organisms located at only one site.
Shannon Rupert	Ecologist University of New Mexico, Department of Biology srupert@unm.edu	Ecology, carbon cycling, and nutrient dynamics in extreme environments on Earth that are analogs for Mars. Place-based education. Springs and waterholes on Arkaroola and Wooltana were investigated in 2004 as part of Expedition Two. At that time, streams had not flowed in seven years. Streams flowed again for the first time in 2009. Study sites will be revisited and water quality and vegetation characterized. A new investigation will look at microbial ecology in subsurface environments. Place-based education looks at local cultural heritage and incorporates traditional ecological and scientific knowledge in science studies. This has mainly been done at the K-12 level, but my work incorporates place-based education at the college level. Scientists and teachers will be invited to interact with local experts while we are in the field.
Dr Adrian Brown	Planetary Scientist, SETI Institute, NASA Ames Research Center abrown@seti.org	Multispectral and hyperspectral instruments such as TES, THEMIS, CRISM, and OMEGA are essential tools in the mapping of the surface mineralogy of Mars. My planned SBA research activities will revolve around remote sensing of Arkaroola using the HyMap airborne hyperspectral dataset and demonstrations to the teachers who are present. The resulting data will be linked to the results from the CRISM dataset on Mars.
Dr Rosalba Bonaccorsi	Astro-biologist, NASA Ames Research Center/ SETI Institute rosalba.bonaccorsi-1@nasa.gov	I plan to identify mars analogs for MSL11 landing sites candidates, and test hypotheses on preservation of organics/ total/viable and Gram negative biomass in clay minerals deposits vs. hematite-rich materials/ironstones. These objectives will be addressed by using ATP luminometry and LAL (Lymulus Amebocite Lysate) assays in the field. We will also test feasibility/potential of applying these assays under extreme field conditions. Data obtained from SBA09 will be compared with ATP, LAL and CN data obtained from other desert/Mediterranean regions (Rio Tinto, Atacama, Death Valley, and the California coast).

Australian Scientists		
Dr Graham Mann	Roboticist, Murdoch University WA. g.mann@murdoch.edu.au	An experimental hexapodal field robot is being made available for Mars Society experiments at SBA2009. Designed as a low-cost teleoperated platform for inspection and monitoring of remote industrial sites, the Mascot robot allows an operator to move remote vision cameras and other sensors after navigating through very rough terrain at speed. Firstly, the robot will be test-operated on a variety of terrains, including sand, rocks, and different kinds of floors. Measurements of the speed, reliability and repeatability will be taken under tough field conditions, as will observations of the performance, wear and dust effects on the robot. A simple HCI evaluation of the system's teleoperation unit will also be carried out. Secondly, if performing satisfactorily, the system will be put through a number of simulated maintenance patrols, during which the robot will be teleoperated between a number of fixed stations to take digital photographs of critical equipment. The quality of these photographs for maintenance purposes will be judged later by engineers. Thirdly, the opportunity to ask experienced field scientists about potentially new uses, useful sensor or actuator capabilities or control features of the robot should not be missed.
Dr Paulo de Souza	Physicist CSIRO Tasmanian ICT Centre Research Director Paulo.Desouza@csiro.au	Remote characterisation of the mineralogy and chemistry of the Martian surface is a key role for unmanned exploration. It will also be a requirement for both hand-held and laboratory-based instrumentation on manned missions. Techniques include laser-induced breakdown spectroscopy (LIBS), X-ray diffraction, X-ray fluorescence (XRF), infrared spectroscopy, and Mossbauer spectroscopy. In this project there will be laboratory characterization of samples collected by geologists in the field using different techniques such as XRF, LIBS, and Mossbauer spectroscopy and instruction of students and teachers into their use and significance on the Earth and Mars
Dr Vic Gostin	Geologist (ret) Geology & Geophysics, Adelaide University	Search for Ancient Life. The search for water and for the presence of life, is one of the leading aims of planetary exploration. Investigation of the sedimentary record, including any preserved fossils, is key to understanding the evolution of planetary environments. Therefore it is imperative to distinguish actual fossils from inorganic structures such as those formed by chemical precipitation, physical deformation, or worm-like curved mudcracks. Arkaroola has excellent outcrops of Precambrian limestones and organic-rich shales that have preserved stromatolites and sponge-like fossils, as well as microfossils. Some of these will be examined in the field. In addition, other specimens of reputed fossils and pseudo-fossils will be available as a comparison. The question of biogenic vs non-biogenic origins continues to be a hot research topic, and is most relevant to the exploration of the Martian environment.
Eriita Jones	Planetary Science PhD student, Mount Stromlo Observatory, ANU Canberra eriita@mso.anu.edu.au	Potential groundwater discharge sites have been identified on Mars and are a plausible explanation for a range of surface features. To investigate features in the desert at Arkaroola that form from subsurface seepage and surface runoff and are visually similar (in morphology, not in scale) to features seen on the Martian surface. By understanding the controls on the formation of these features insight can be gained into whether the same mechanisms could have been involved in forming the 'visually analogous' features on Mars.

Reut Abramovich	Microbiology PhD student, Australian Centre for Astrobiology, University of NSW reut.sorek@gmail.com	(1) Radon and hot spring water, microbial mats and adjacent soil will be sampled at every site. We aim to carry out a culture-independent survey of archaeal, cyanobacterial and bacterial 16S rRNA, nifH genes and mRNA. This extensive study will allow us to estimate microbial diversity and identify diazotrophs (bacteria capable of fixing atmospheric nitrogen) which are an important niche in microbial communities and critical for nitrogen global productivity. We aim to sample multiple sites, at variable depths and times of day/night, to ensure that we obtain a comprehensive description of the bacterial diversity and gene expression. We would then compare microbial communities between sites in order to highlight common bacteria in this unique area and ascertain, if possible, their ecological roles. (2) I will also survey on Behalf of Carol Oliver participating teachers at various points over the next two years, beginning with pre and post field trip surveys to gather initial data on the learning and attitudes towards science research. During the field trip we will hold several focus group meetings with the teachers. We will then subsequently send questionnaires to the teachers to understand what in-class practices they have changed as a result of the field trip and the impact on their students. Several publications will be forthcoming – one on the field trip experience, and the other on the impact in the classroom over the next two years. We expect the data to influence future efforts in bringing teachers and researchers together on scientific field trips.

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APPENDIX

Reference Maps