New Zealand Astrobiology Initiative - NZAI
Group of the Royal Astronomical Society of New Zealand
P O Box 3181, Wellington, New Zealand

NASA Spaceward Bound New Zealand 2015

Expedition Report
May 2015

Director:
Haritina Mogoşanu

Spaceward Bound New Zealand 2015 expedition logo

This design is based on two concepts of the Maori world view:

Takarangi: is the expanding heavens design depicted in the prow of ancient Waka that signifies humanity's celestial origin born at the beginning of the Universe.
Koru: represents growth and development, learning and teaching.

With the newly formed initiative of astrobiology supported by the Royal Astronomical Society of New Zealand, we acknowledge the unique indigenous traditional knowledge of Māori through our logo that relates to our development as human race and to life in the Universe.

Photo: H.Mogoşanu

Recently-drained hot spring pool at Waimangu Geothermal Valley, Taupo Volcanic Zone, New Zealand, SBNZ 2015

Coloured surface features are drying microbial mats that built up the knobby walls and floor when the pool was full, forming 'stromatolites', layered microbial-sedimentary structures that may be related to the earliest life on Earth. The white areas are dried silica that has deposited from hot-spring discharge of vent areas, preserving the microbial remains and indicative of a hydrothermal origin for this fossilized life. Hot spring "extreme environment" analogues such as these are relevant to studies of interpreted Martian siliceous hot spring deposits at the Home Plate site, Gusev Crater, explored by the Spirit rover.

NASA Spaceward Bound New Zealand 2015

Expedition Report

1. Executive Summary

In January 2015, the New Zealand Astrobiology Initiative (NZAI) organised an engaging, 6-day expedition for Kiwi educators and researchers, introducing them to the wonders of the Taupo Volcanic Zone in the central North Island. Partnering with NASA and incorporating speakers from all around the globe, Spaceward Bound New Zealand 2015 exposed its 50 participants to astrobiology research through a series of hands-on field trips and promoted New Zealand as a world-class site for astrobiology research.

What is Astrobiology?

Astrobiology is the study of life's potential in the Universe and the origin, evolution and history of life on Earth. It's an innovative and interdisciplinary subject that unites astronomy, biology, physics, chemistry, molecular biology, ecology, planetary science, geography, and geology to study "anything and everything about life on Earth in order to understand how life might arise and survive elsewhere in the Universe"[1].

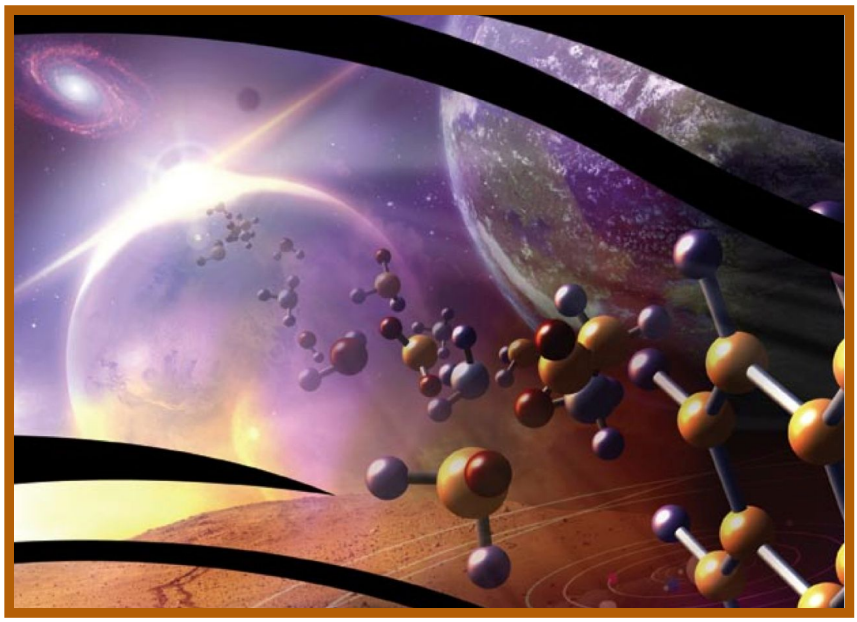


Photo credit: NASA

[1] History of Exobiology and Astrobiology at NASA

Spaceward Bound New Zealand 2015 team preparing to explore the Waimangu Geothermal Valley

What is Spaceward Bound?

Spaceward Bound is an inquiry-based astrobiology and educational Moon-Mars analogue science expedition organised in New Zealand by NZAI and partners. Spaceward Bound originated at NASA Ames Research Center in 2006. The primary mission of Spaceward Bound is to train the next generation of space explorers by teaming teachers and scientists to explore scientifically interesting but remote and extreme environments on Earth as analogues for human exploration of the Moon, Mars, and other planets: http://quest.nasa.gov/projects/spacewardbound.

Previous Spaceward Bound destinations have included the USA, Canada, Namibia, the United Arab Emirates, and Australia. New Spaceward Bound expeditions in India and Romania are in the planning stages.

New Zealand as an astrobiology field site

New Zealand features some of the best sites in the world to study astrobiology-related extreme environments. The geographical setup, dynamic and active geological setting, and the science capability of New Zealand support the study of astrobiology. Within its Taupo Volcanic Zone, New Zealand has unique extremophiles in the hot springs, and recent and current explosive volcanism. Other regions in the country include access to the K-Pg Boundary[2] (Marlborough Region) and the Dry Valleys of Antarctica. New Zealand is also a world-leader in biosecurity (essential to planetary protection) and has a rich cultural heritage derived from exploration, as Polynesians and Europeans arrived here guided by the stars. New Zealand's scientists encompass most of the required fields in astrobiology: microbiology, ecology, biosecurity, physics, astronomy, radio astronomy and geology. This represents an accessible yet rich knowledge base of local expertise.

[2] The Cretaceous–Paleogene (K–Pg) boundary, formerly known as the Cretaceous–Tertiary (K–T) boundary, is a geological signature, usually a thin clay-rich band, associated with the Cretaceous–Paleogene mass extinction event, which is considered to be the demise of the non-avian dinosaurs.

50 educators, scientists and researchers and students participated in Spaceward Bound New Zealand 2015

About the New Zealand Astrobiology Initiative (NZAI)

The New Zealand Astrobiology Initiative is a group dedicated to promoting astrobiology study in New Zealand and featuring New Zealand as an excellent astrobiology field site to the world. While New Zealand benefits from excellent sites and knowledge base, efforts had been scattered around the country without a centralized strategy for development until 2014 astrobiology. Astrobiology is an emerging field. It was formalized as a field of study in the 1960's, NASA established the National Astrobiology Institute as recently as 1998 (preceded by an earlier Exobiology program).

The Royal Astronomical Society voted in June 2014 for the establishment of the Astrobiology Group, also known as the New Zealand Astrobiology Initiative (NZAI), becoming the first organization within New Zealand to recognize astrobiology as its own discipline. By so doing, the RASNZ acknowledged the importance of astrobiology as a scientific discipline in the scientific and educational landscape of New Zealand. Astrobiology science, seeking to answer questions such as 'what is life?' and 'are we alone in the Universe?', can contribute to "the knowledge, skills, and values for successful citizens in the 21st century."[3]

NZAI started its activity in 2014 with an initial goal to identify astrobiology subject matter experts in New Zealand and seek the involvement of astrobiology experts from abroad. Spaceward Bound New Zealand 2015 brought together national and international astrobiologists, students and teachers in a pilot experiment, which assessed the knowledge gap and demand for astrobiology in New Zealand.

The future plans of NZAI are to connect and nurture a rich astrobiology network within New Zealand and create a hub for international researchers looking to pursue Astrobiology science in country. Educational products will include material and activity resources for secondary school teachers who are interested in including astrobiology as part of their curriculum streams and promote interest at tertiary levels, as well.

[3] http://www.minedu.govt.nz/


Field trips, SBNZ 2015

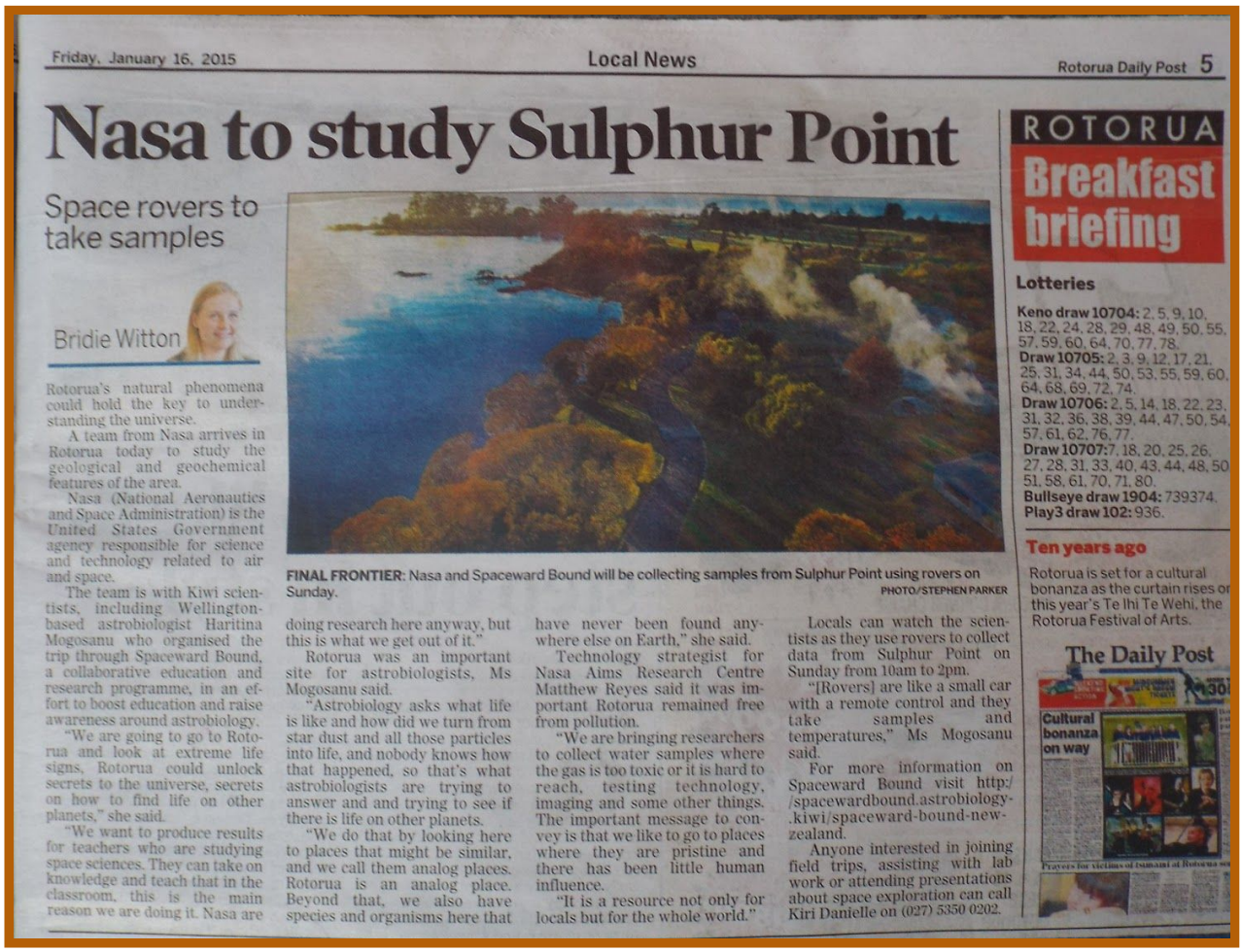
Synopsis: Spaceward Bound New Zealand consisted of 6 days of field trips, talks and keynote presentations by New Zealand university staff and graduate students and NASA scientists. It included inquiry-based field work, supported by local universities and experts from both within New Zealand and international organizations. Fifty scientists, educators, teachers and students attended Spaceward Bound New Zealand 2015. Visitors and locals also participated in various activities at the headquarters and at field sites at geothermal locations, the Tongariro volcanic crossing and the active volcano at White Island. A public event using a drone and rover attracted about 200 people and was held in Rotorua, a present-day geothermal field upon which a modern city has been built.

Lectures, SBNZ 2015

Deliverables: The expedition, besides being an excellent networking opportunity, promoted New Zealand as a significant astrobiology field research location, supporting the development of the New Zealand secondary schools education curriculum, but also encouraging university-level uptake of science related to astrobiology. Although astrobiology-related knowledge is taught in places as part of the Earth and Space Sciences Secondary Curriculum, until Spaceward Bound New Zealand 2015, there had been no national effort to integrate this field at educational and scientific research levels.

Project's webpage: http://spacewardbound.astrobiology.kiwi

Members of NZAI and KiwiSpace Foundation at the public event held at Sulphur Point in Rotorua, 2015



Friday, January 16, 2015 Local News Rotorua Daily Post 5

Nasa to study Sulphur Point

Space rovers to take samples

Bridie Witton

Rotorua's natural phenomena could hold the key to understanding the universe.

A team from Nasa arrives in Rotorua today to study the geological and geochemical features of the area.

Nasa (National Aeronautics and Space Administration) is the United States Government agency responsible for science and technology related to air and space.

The team is with Kiwi scientists, including Wellington-based astrobiologist Haritina Mogosanu who organised the trip through Spaceward Bound, a collaborative education and research programme, in an effort to boost education and raise awareness around astrobiology.

"We are going to go to Rotorua and look at extreme life signs, Rotorua could unlock secrets to the universe, secrets on how to find life on other planets," she said.

"We want to produce results for teachers who are studying space sciences. They can take on knowledge and teach that in the classroom, this is the main reason we are doing it. Nasa are doing research here anyway, but this is what we get out of it."

Rotorua was an important site for astrobiologists, Ms Mogosanu said.

"Astrobiology asks what life is like and how did we turn from star dust and all those particles into life, and nobody knows how that happened, so that's what astrobiologists are trying to answer and and trying to see if there is life on other planets.

"We do that by looking here to places that might be similar, and we call them analog places. Rotorua is an analog place. Beyond that, we also have species and organisms here that have never been found anywhere else on Earth," she said.

Technology strategist for Nasa Aims Research Centre Matthew Reyes said it was important Rotorua remained free from pollution.

"We are bringing researchers to collect water samples where the gas is too toxic or it is hard to reach, testing technology, imaging and some other things. The important message to convey is that we like to go to places where they are pristine and there has been little human influence.

"It is a resource not only for locals but for the whole world."

Locals can watch the scientists as they use rovers to collect data from Sulphur Point on Sunday from 10am to 2pm.

"[Rovers] are like a small car with a remote control and they take samples and temperatures," Ms Mogosanu said.

For more information on Spaceward Bound visit http://spacewardbound.astrobiology.kiwi/spaceward-bound-new-zealand.

Anyone interested in joining field trips, assisting with lab work or attending presentations about space exploration can call Kiri Danielle on (027) 5350 0202.

FINAL FRONTIER: Nasa and Spaceward Bound will be collecting samples from Sulphur Point using rovers on Sunday. PHOTO/STEPHEN PARKER

ROTORUA **Breakfast briefing**

Lotteries

Keno draw 10704: 2, 5, 9, 10, 18, 22, 24, 28, 29, 48, 49, 50, 55, 57, 59, 60, 64, 70, 77, 78.
Draw 10705: 2, 3, 9, 12, 17, 21, 25, 31, 34, 44, 50, 53, 55, 59, 60, 64, 68, 69, 72, 74.
Draw 10706: 2, 5, 14, 18, 22, 23, 31, 32, 36, 38, 39, 44, 47, 50, 54, 57, 61, 62, 76, 77.
Draw 10707: 7, 18, 20, 25, 26, 27, 28, 31, 33, 40, 43, 44, 48, 50 51, 58, 61, 70, 71, 80.
Bullseye draw 1904: 739374.
Play3 draw 102: 936.

Ten years ago

Rotorua is set for a cultural bonanza as the curtain rises on this year's Te Ihi Te Wehi, the Rotorua Festival of Arts.

The Daily Post

Cultural bonanza on way

Table of Contents

Sponsors

NZAI would like to thank the following organisations for their generous support, without which this project would not have been possible:

Platinum Sponsor

University of Auckland

Gold Sponsor

Institute for Applied Ecology, New Zealand, AUT

Silver sponsors

Blue Marble Space Institute of Science

Eagle Technology Group

GNS Science

Maori Tourism

Mars Society New Zealand

Partners

ESSE - Earth and Space Sciences..

KiwiSpace Foundation

Mars Society Australia

NASA Ames

Romanian Space Agency

SETI Institute

Acknowledgements

Many people have worked hard to make this expedition possible. We received a generous amount of help throughout the project. The programme was conceived through early conversations with Lucinda Offer and Chris McKay. Subsequent conversations with Jonathan Clarke and David Willson of Mars Society Australia helped crystallised the idea for Spaceward Bound in New Zealand. Jon Rask of NASA Ames helped to scout prospective field sites for this programme.

The author of this report wishes to thank Jen Blank for crafting the scope of activities and identifying key scientists to participate in this programme and coordinating the large team from NASA Ames who joined the expedition. Through many hours of iteration and discussion, we honed the scope of this programme together.

Professor Kathy Campbell from University of Auckland was the science lead of SBNZ, and shared her expertise of local hot spring field sites in the Rotorua area where she and her colleagues are conducting ongoing research.

Professor Steve Pointing from the Institute for Applied Ecology was the media liaison and shared his expertise of extremophiles.

Julian Thomson of GNS helped with the project planning and presented the geological history of the region.

Special thanks go to Joe Harawira Nga Potiki and Ngati Awa as Maori Adviser for Spaceward Bound, he introduced the author to the New Zealand Minister of Education Hekia Parata. Further, she introduced us to New Zealand Curriculum experts and promoted Spaceward Bound through the ‘Education Gazette’ and on New Zealand teachers websites.

Jessie Mckenzie from the Royal Society of New Zealand and Jenny Pollock from New Zealand Earth and Space Sciences provided advice on Earth and Space Sciences Curriculum.

Elf Eldridge brought amazing arduino robotics kits to share with the Spaceward Bound members and the general public in Rotorua.

Butch Bradley from Maori Tourism provided network support.

John Hershaw - President of RASNZ and RASNZ Council for supporting SBNZ 2015.
Simon Lowther, Glen Rowe and Gordon Hudson - the RASNZ project team.
Erik Vermaat and Ron Fisher, from the education section of RASNZ

Kiwispace and Mark Mackay supported the public event.

The US Consulate in Auckland promoted SBNZ through their networks.

Hoturoa Barclay-Kerr and Te Toki Voyaging Trust took the group on a waka trip in the Auckland harbour, commencing our Spaceward Bound expedition by emphasising the connection between Māori navigation and earth, sea and sky.

Jacob Haqq-Misra and Sanjoy Som from BMSIS helped with the website and promotion of SBNZ.

Katie Paul coordinated the operations at Te Takinga Marae and shared her laughter and humour while keeping things running smoothly.

Kiri Danielle provided onsite support and local media to the general public of Rotorua.

Mike Tana identified the venue for our Spaceward Bound expedition paving the way for this in future related endeavours.

Shanan Tana supported with the IT onsite.

Harry Keys, Neil Fawke and Wilma Howard from the Department of Conservation helped with permissions to visit sites.

Spaceward Bound was pioneered at NASA Ames part of the creative endeavours of Chris Mckay and Liza Coe and other from NASA Ames and we are proud to be part of this legacy.

Spaceward Bound New Zealand 2015 has been made possible through the efforts of the Royal Astronomical Society of New Zealand, the Education Section of the Royal Astronomical Society of New Zealand, the Australian Astrobiology Community, Blue Marble Space Institute of Science, the Institute for Applied Ecology, AUT, the Royal Society of New Zealand, the New Zealand Association of Science Educators, NASA Ames, NASA Astrobiology Institute (NAI), GNS Science - Te Pü Ao, Maori Tourism, University of Auckland's Faculty of Science, US Embassy to New Zealand and SAGANet.

Aims of the expedition

- to promote astrobiology to New Zealand teachers and students
- to promote New Zealand as a unique astrobiology world class site
- to offer unique Earth and space science investigation opportunity for teachers and senior students
- to develop communication and educational relationships with national and international science teams
- to engage in astrobiology hands-on investigations in the field, in New Zealand's active volcanic and geothermal landscapes

SBNZ Objectives

- Collaboration and networking of teachers with top space and geo-scientists from NASA and New Zealand
- Professional development in Earth and Space Sciences (ESS) and Nature of Science (NOS) curriculum streams.
- Encourage participation by emerging New Zealand scientists and secondary school teachers
- Be part of the international Spaceward Bound programme that qualifies teachers for other spaceward bound projects (these have taken place in United States of America, Australia, Antarctica, Namibia, the United Arab Emirates, the Arctic)
- investigate extreme geological and biological environmental analogues to conditions on other planets and earliest life on Earth
- experience technological challenges of human space exploration

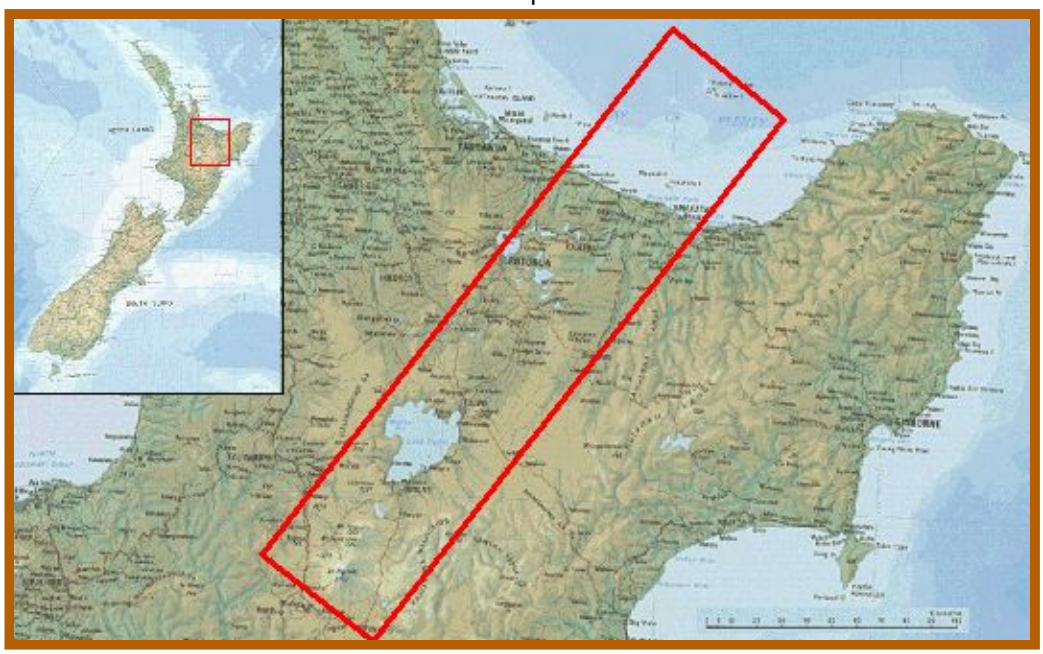
The unique and novel programme of the expedition is aligned with the New Zealand science curriculum and aimed at university students, secondary teachers and students from New Zealand schools. During Spaceward Bound New Zealand, teachers met and collaborated with New Zealand and NASA scientists. Research resulting from Spaceward Bound New Zealand will be published internationally. It is expected that new resources to support the New Zealand Earth and Space Sciences curriculum will be also produced.

By studying volcanic and geothermal terrains of the Taupo Volcanic Zone, the participants learned about processes that create these landscapes and possibly similar surface features on other planetary bodies. Complementary focus was on the significance of extremophile[4] habitats in guiding the search for life elsewhere in the solar system. The environments are considered as analogues for sites to search for extraterrestrial life in present and future planetary exploration missions.

[4] Extremophiles are life forms that live in "extreme" conditions of temperature, salinity, pH, nutrient availability

2. Overview of the programme

Spaceward Bound New Zealand 2015 (SBNZ 2015) is the first Spaceward Bound expedition held in New Zealand. The location was chosen in the Taupo Volcanic Zone in the North Island of New Zealand.



Map of the expedition locations, Taupo Volcanic Zone, New Zealand

The expedition took place from 15-22 January 2015.

The home base of the expedition was at Te Takinga Marae.
Te Takinga Marae is located at Mourea, Rotorua. Local tribe is Ngati Pikiao with Kaumatua Te Heru Tamati. Kaituna te awa, Rotoiti I kitea ai i Ihenga, Matawhaura te maunga. (Ngati Pikiao' river is Kaituna, Rotoiti that was gazed upon by Ihenga is the lake and Matawhaura is the mountain.)

The organiser of the expedition was the New Zealand Astrobiology Initiative (NZAI) with the generous support of sponsors and partners.

SBNZ 2015 Project team

Coordinator	**Haritina Mogoşanu**;
Science Lead	**Professor Kathy Campbell**, University of Auckland;
Media Coordinator	**Professor Steve Pointing**, Institute for Applied Ecology, AUT;
and project members	**Jen Blank, Lucinda Land, Julian Thomson, Elf Eldridge, Jonathan Clarke** and **David Wilson**
with support from	**Chris McKay**, team leader of the first Spaceward Bound; **Carol Stoker,** official NASA Ames Representative for SBNZ; **Jon Rask, Butch Bradley, Joe Harawira, Kiri Danielle** and **Shanan Tana**.

Activities summary

Thu 15 Jan	International participants who arrived in the morning met with the **Polynesian Maori navigators** at the Maritime Museum of Auckland and sailed aboard **Waka Hourua Haunui**.
Day 1 Fri 16 Jan	Media interviews of the science team - TV3 Auckland International guests travel to Rotorua, **Powhiri at Te Takinga Marae** Traditional welcome into ancestral house by Ngati Plkiao tribal elders at Mourea, Rotorua. Following the mihimihi (introductions), the group shared kai (food) with the local community. **Extremophiles on Earth:Travel to Kuirau Park** Field trip, observations of colours and temperatures in hot springs using probes
Day 2 Sat 17 Jan	**Extremophiles on Earth: Waimangu Volcanic Valley** Waimangu Volcanic Valley walk and observation of geothermal environments, extremophiles and biomarkers
Day 3 Sun 18 Jan	**Extremophiles on Earth: Arid Environments, Tongariro** Two groups: 1. Study of plant succession on several recent lava flows in the Mangatepopo Valley. 2. Climb via Tongariro Peak and the Red Crater to observe the volcanic landscapes, lava flows and craters. **Sulphur Point Open Day** Participants of SBNZ rover team supported a public event organised by SBNZ
Day 4 Mon 19 Jan	**Extremophiles on Earth: Parariki Stream (Rotokawa)**[5] Detailed observations of biomarkers in a silica terrace. Operation of rover to collect physical data of a hot springs. Operation of a DJI quadcopter to collect water samples from a hot spring.
Day 5 Tue 20 Jan	**Community Open Day** SBNZ participants created workstations for visitors Activities for kids - including making and shooting rockets, microscope observations, and other activities TV and printed media interviews
Day 6 Wed 21 Jan	**Final Day / Conclusions/** Ending presentations Panel / group discussions on education, Networking.

The trip to the White Island was cancelled due to rough seas (on 22 Jan 2015)

[5] Access to some sites in full complement was an issue, as Parariki stream had limited access for safety reasons.

Description of the work

A typical Spaceward Bound programme differs from other outreach programmes owing to its astrobiology field research component. This engages teachers and students to work alongside and with scientists in the field, and contribute to collection of real research data that can help make scientific discoveries. Hopefully SBNZ 2015 is the pilot expedition of many astrobiology expeditions to be held in New Zealand in the future.

By engaging with scientists from around the globe, and through the intent of publishing the results of the scientific research undertaken here, SBNZ 2015 also promoted New Zealand as an astrobiology analogue field site to the world of science.

Field trips

Site 1 & 2: Kuirau Park & Waimangu

The expedition examined the hydrothermal systems in the Kuirau Park/ Waimangu geothermal fields and extremophile habitats associated with them. The instructional staff focused on fossil hydrothermal systems as a possible site for a search for life on Mars and gathered samples for geological and biological analyses. The expedition used field instrumentation to characterise the chemistry and mineralogy of the rocks and the physical and chemical properties of the waters. Participants also were encouraged to make observations to try to determine how many types of geothermal features were present (e.g., acid, alkaline, mixed) and what the driving environmental factors in their formation could be.

Mid-temperature hot pool tufted cyanobacterial mat, SBNZ 2015
Kuirau Park, Rotorua, New Zealand
Photo: K. Campbell

Field trip to Kuirau Park, SBNZ 2015
Rotorua, New Zealand

Photo: J. Reilly

Frying Pan thermal lake
Waimangu Volcanic Valley, New Zealand

Site 3 and 4: Mangatepopo / Tongariro

The expedition visited Tongariro Plateau, which displays a range of basaltic- and intermediate-composition eruption products. Space exploration was used here as a hook to investigate the tenacity of life in hostile environments. The investigation was lead by Julian Thomson (GNS) and Katy Hodgson.

Tongariro Crossing, New Zealand, SBNZ 2015

Lichens growing on rocks, SBNZ 2015
Tongariro Crossing, New Zealand
Photo: H. Mogoşanu

Photo: H. Mogoșanu

A stop at a Mars analogue site, SBNZ 2015
Alpine Tongariro Crossing, New Zealand
This is a basin or crater filled with shallow, volcanic-derived sands and soils and weathered volcanic clasts that have eroded from the surrounding crater rim. Vegetation is sparse, in the form of low-profile surface lichen, or absent.

Photo: M. Smith

Participants to SBNZ 2015 investigate life in hostile environments
Alpine Tongariro Crossing, New Zealand

Site 5: Sulphur Point

Additionally there were opportunities to view and trial small science rovers and drones, and to learn about several challenges of exploration beyond Earth. One of such opportunities was the open day at Sulphur Point, Rotorua, run by Professor Steve Pointing, which had attendance of about 200 visitors and members of the public, and a group of KiwiSpace Foundation members.

Rover trials at Mars analogue sites during the public event organised at Sulphur Point by SBNZ 2015
Rotorua, New Zealand

Site 6: Parariki Stream

Parariki stream represents a great Mars analogue place due to the mixture of acid-sulphate-chloride in the spring, which is not common for a river bed. Mars also has river beds. The hot springs in silica at Home Plate site and the Martian silica are similar to those from Parariki Stream and an investigation was undertaken to discover what biomarkers are present in this environment, which might hold clues for similar processes on Mars. The Parariki stream investigation was lead by Professor Kathy Campbell.

Photo: J. Clarke

Rover and drone were used during SBNZ 2015 to collect samples from the Parariki stream
Rotokawa, New Zealand

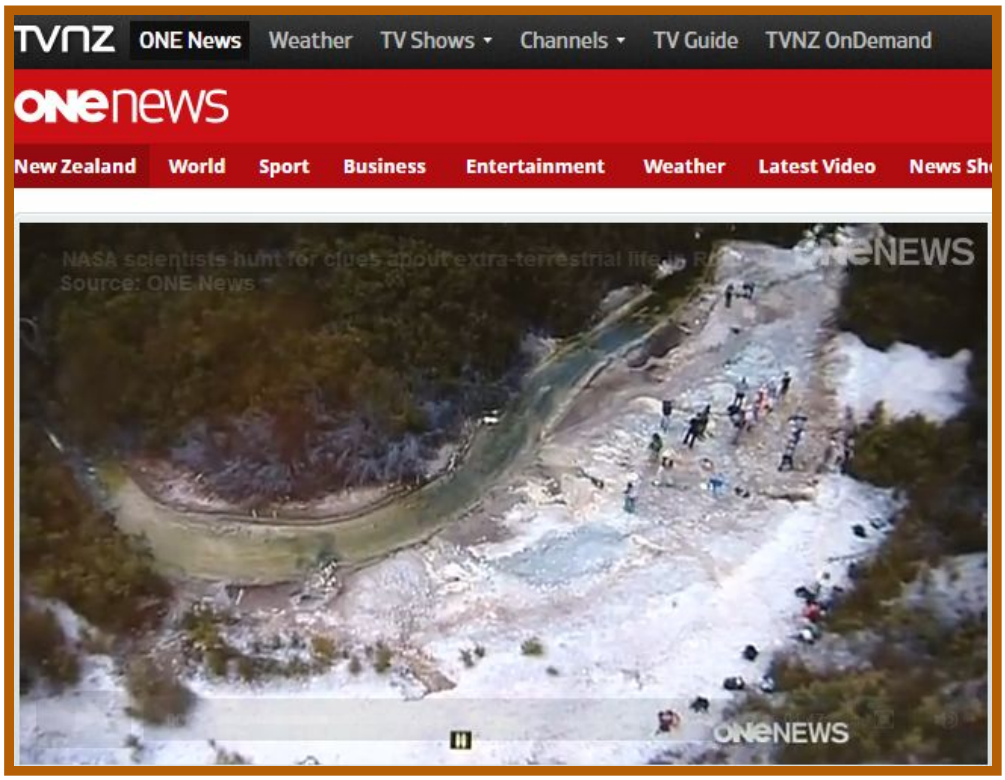
Samples were collected for microbial community analysis using genetic sequencing (lead by Parag Vaishampayan) and for geochemical analysis, total organic content, LAL and ATP activity (lead by Rosalba Bonaccorsi). David Willson and Carol Stoker collected samples to add to the reference library for the SOLID immunoassay instrument designed to search for evidence of life on Mars.

Photo: J. Clarke

Fumarole in an abandoned quarry near Nga Awa Purua geothermal power station, SBNZ 2015
The fumarole is discharging hot gases from which sulphur is condensing to form needle-like crystals. Sulphuric acid is also condensing from the gas, forming droplets at the end of some of the crystals.

Fumaroles on Mars (and elsewhere) could support life.
They bring heat, water, carbon, sulphur and other gases from the interior to the surface and thus provide essential elements, warmth, and energy gradients. They also help understand the process going on inside of a planet, including volatile cycling and loss, geothermal and magmatic processes and chemistry.

For human settlements, fumaroles could also point to useful geothermal energy and usable resources.



Drone image of the researchers investigating Parariki stream, Rotokawa, New Zealand

Photo: J. Clarke

Parag Vaishampayan collecting samples at Parariki Stream, SBNZ 2015
Parariki Stream, Rotokawa, New Zealand

Talks and practical work

Wherever possible talks were conducted in the field, with the local ecology and geology as visual aids.

Field trip stop at Hot Water Creek, SBNZ 2015
Group discussing photosynthesizing bacteria living in the thermal spring-fed stream, the silica precipitating on the mats and creek bottom, and the effects of seasonal storms and floods on the biosignatures left in the sedimentary deposits associated with the creek.
Waimangu Geothermal Valley, Taupo Volcanic Zone, New Zealand

Briefing before field trip, SBNZ 2015
Professor Pointing is drawing a diagram to show how the bright coloured cyanobacteria are distributed along the thermal gradient in the hot pools
Te Takinga, Mourea, New Zealand

Talks given over the week:

Carol Stoker	Mission Approaches to search for life on Mars
Eldar Noe	Water on Mars
David Willson	Space suit adventures
Haritina Mogoşanu	Biases and mindsets: what I learned from stargazing
Jen Blank	Results from the Mars Science Laboratory
Julian Thomson	Age appropriate science education
Kathy Campbell	Hydrothermal systems and early life on Earth (and Mars?)
Ken Silburn	The History of Science: Effects on the past on science invention
Lucinda Offer	Mars Analog Research Opportunities with The Mars Society
Rosalba Bonaccorsi	Science, Outreach, and Conservation in Death Valley/Timbisha Natl. Park: a Journey Into a Crater
Mark Gee	Astrophotography
Ron Fisher	Cosmodome stargazing
Shanan Tana	Maori Lore
Steve Pointing	Microbiology Research in Antarctica

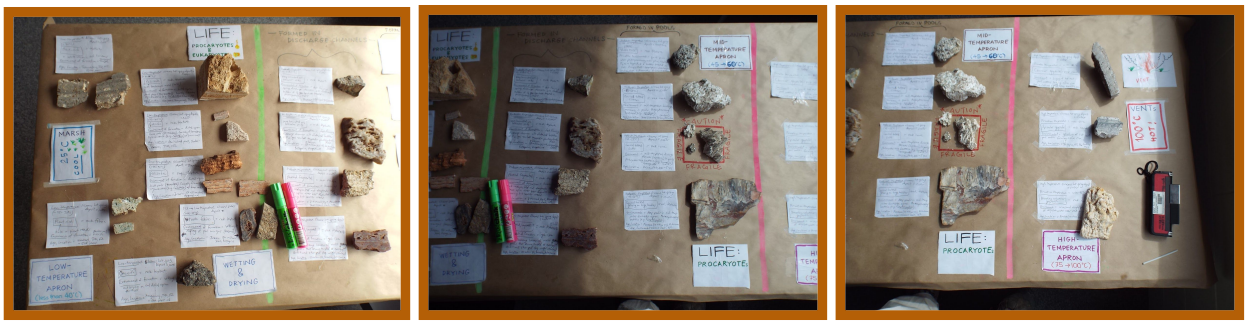
Multiple award-winning Astrophotographer of the Year 2013, Mark Gee
special guest of SBNZ, delivering a talk on Astrophotography

Activities at the Mourea - Te Takinga base:

Analysing geothermal rock collection	Kathy Campbell
Microscope observations	Steve Pointing
Cosmodome - learning the stars	Ron Fisher
Stargazing and telescope observations	Chris Monigatti, Ron Fisher & Haritina Mogoşanu
Dark sky drawing	Annalea Beattie
Robotics	Elf Eldridge

Geology and microbiology

The participants had the opportunity to observe and analyse the geothermal rock collection from University of Auckland Microscope observation. Microscopic examination of thin sections from AUT, industry and GNS collections have provided additional depth to the student and teacher investigations.



Geothermal rock collection from University of Auckland, SBNZ 2015
Exemplifying how rock textures are clues to paleoenvironmental conditions in hydrothermal settings, specifically siliceous hot springs from around the world.

Microscope bay, SBNZ 2015
(microscopes on loan from the Institute for Applied Ecology, AUT)

David Willson and students during a breakout session, SBNZ 2015

Putting astro back into astrobiology

During Spaceward Bound New Zealand, the participants had access to the inflatable portable planetarium Cosmodome and had the opportunity to learn about the New Zealand's night sky. Where possible, stargazing and telescope deep sky observations were held, stargazers learned how to orient by the stars and found out about Maori starlore.

Stargazing at Te Takinga Marae, SBNZ 2015
Southern Cross and the two pointers, Alpha and Beta Centauri can be observed above Te Takinga Marae. Alpha Centauri is Earth's closest neighbouring solar system. ('The fish and flounder in the frying pan' asterism) January 2015

A Dark Skies awareness drawing project was designed to challenge participants to think about different ways of interpreting knowledge.

As light emitting above the horizon scatters dust or water particles into our atmosphere, it impedes vision and inhibits astronomy. The sky is often too bright to see the stars and urban light pollution changes our perception of the night, disrupts nocturnal environments and wastes energy.

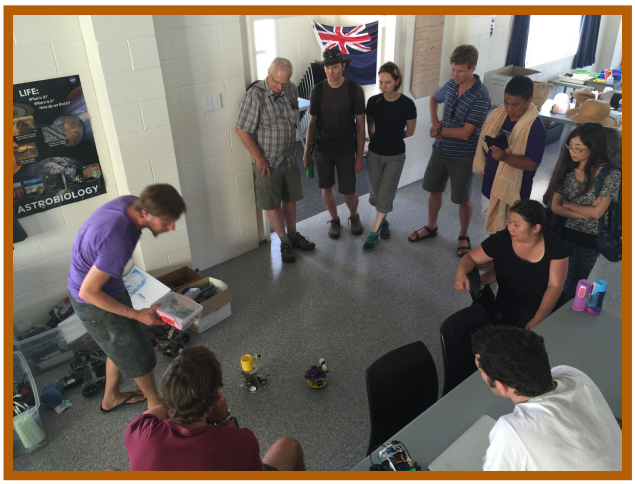
Participants' drawings of the SBNZ night sky, SBNZ 2015,
Te Takinga Marae, New Zealand

The Dark Skies Project emphasised qualitative observation of the sky via the first hand experience of drawing as a different way of understanding the night sky and the role light pollution plays in our visibility of stars and in our ecosystems.

Robotics

A robotics workshop was held over the course of two days where participants had the opportunity to participate in hands-on robotic activities.

Elf Eldridge, Victoria University of Wellington, SBNZ 2015
provided a brief introduction to robotics course for the students using arduino, VEX and 3D modelling software



Educational deliveries:

Eighteen out of the fifty participants in Spaceward Bound New Zealand identified themselves as teachers and educators.

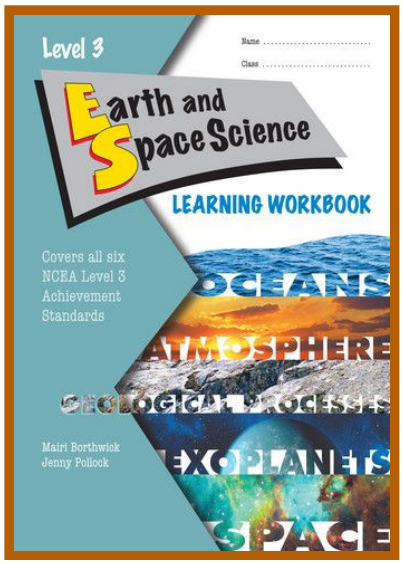
Education workshop - SBNZ 2015 Mourea, Te Takinga

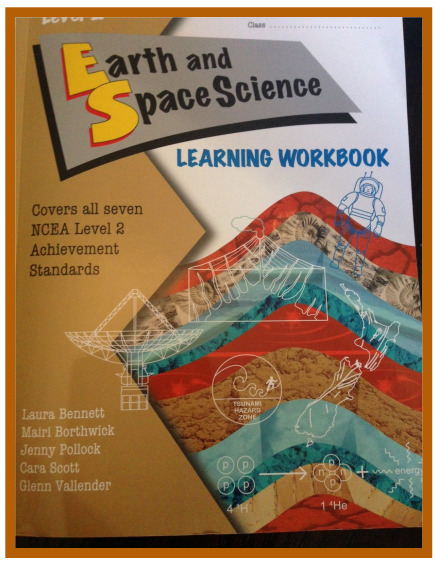
An education workshop was held at the Mourea Te Takinga base, during which discussions have been held about the ways in which Spaceward Bound can enhance the New Zealand secondary schools resource pool. The emphasis went on 'Earth and Space Sciences[6]' and 'Nature of Science' curriculum streams.

The results of the workshop are to be corroborated in a different report, which will also be made available.

Spaceward Bound New Zealand expedition and follow-up aims to

- increase teacher awareness of, and exposure to astrobiology so that they understand the value of, and are better equipped to provide a science context in curriculum;
- provide relevant materials and resources to teachers from New Zealand for use in the classroom that assist students to understand their learning in a "real world" situation.





Earth and Space Sciences New Zealand workbooks
Level 3 (published in 2015), Level 2 (published in 2014), which includes astrobiology examples

[6] "*Earth and space science (ESS) connects systems by exploring the interconnections between the land, ocean, atmosphere, and life of our planet. These include the cycles of water, carbon, rock, and other materials that continuously shape, influence, and sustain Earth and its inhabitants. ESS also explores the cyclical interactions between the Earth system and the Sun and Moon*. [...] *ESS explores the solar system and beyond; Planet Earth is dynamically linked with the solar system and the wider universe. ESS investigates the structure and composition of these systems and develops understanding of the vast distances and times involved.*" *(TKI Senior Secondary)*

While New Zealand benefits from excellent field sites and knowledge base, until 2014, astrobiology efforts had been scattered around the country without a centralized strategy for development. However, efforts have been made to bring astrobiology to the classroom. These efforts include lessons on geology and extreme life in the 'Earth and Space Science' NCEA workbooks.

The L3 ESS workbook, published in 2015, has a section on Astronomy and Space topics for one of the Level 3 Earth and Space Science standards called "Investigate an aspect of Astronomy". The section gives a range of ideas for suitable topics and hints on how to go about researching them and writing a report. Students could be assessed in Astrobiology by using this standard.

The work undertaken during Spaceward Bound New Zealand addressed the following subjects: astrobiology, geology, biology, planetary protection, astronomy, robotics and GIS.

Spaceward Bound New Zealand aims to produce supplementary resources for teachers from the learnings of the expedition, which will be made available online and that could be used in conjunction with these workbooks.

Outreach and further resources

The website of the expedition is http://spacewardbound.astrobiology.kiwi supported by the Blue Marble Institute for Space - SAGANET

Using ArcGIS Online, Esri's cloud mapping technology, interactive web maps will be created documenting Spaceward Bound field trip activities such as experiment sites, field trip routes and points of interest. These interactive web maps will showcase field trip photos, experiment findings and other relevant information via pop-ups and will provide a communication mechanism enabling other interested parties to follow field trip activities and explore the various environments studied.

The information is available for schools free of charge.

3. Media Coverage

Spaceward Bound benefited from extended media coverage.

Professor Steve Pointing coordinated the media efforts during the expedition.

Media releases

2014-11-19 New Zealand	NASA Planetary Scientists Come to New Zealand
2015-01-11 Australia	Australian Robots Aid Search Life on Mars - New Zealand

Spaceward Bound New Zealand in the press

Apr 2014 New Zealand Science Teacher article:	Training the next generation of space explorers
2014 August, NASA Ames, seminar by Haritina Mogoşanu:	Astrobiology in New Zealand and Spaceward Bound
2015, January 12, Times.co.nz – article:	Student reaches for the stars: Sarah Childs, Larraine Barton (teacher)
2015 January, Manurewa High School news – article	Spaceward Bound, Solinna Toul, Justin Walker, Daniel Blakeborough

2015 January, SETI Institute's dedicated site for Spaceward Bound New Zealand: article	An expedition through New Zealand with Rosalba Bonaccorsi
2015 January, SETI Institute Blog	Join Researcher Rosalba Bonaccorsi on her Spaceward Bound Expedition on the North Island of New Zealand (16-21 January 2015)
2015 January, 3 News video link	NASA Spaceward Bound in NZ NASA's hunt for alien life reaches New Zealand  Jennifer Blank of NASA Ames being interviewed on 3 News
2015 January NZ Herald, articles	Nasa to study Sulphur Point (16 Jan) Roving robots collect data for Nasa (19 Jan) Hot springs could solve mystery of life on Mars (16 Jan) 
2015 January, Professor Steve Pointing's blog: Pointing at Science	Spaceward Bound "T minus 1 day" Spaceward Bound "T minus 2 days" Spaceward Bound Captain's Log

	Testing the NASA drone
2015 January, Radio New Zealand, radio	Afternoons – Spaceward Bound
2015 January 20, TVNZ – National News	Video link NASA scientists hunt for extraterrestrial life in Rotorua  
2015 January 21, Newstalk ZB,	NASA program grows in popularity
2015 January, Tangatawhenua.com	NASA scientists help tamariki learn more about space exploration

	
2015 February, Julian's blog	NASA comes to Rotorua
2015 March, University of Auckland	Spaceward Bound New Zealand

The expedition was also supported with Twitter feeds #SBNZ and #SBNZ2015 and Facebook postings.

4. SBNZ 2015 Outcomes

Spaceward Bound 2015, as a New Zealand national event aimed to raise awareness about the importance of astrobiology in New Zealand and to internationally promote New Zealand as an excellent field site for the study of it.

SBNZ 2015 benefited from support by universities, such as University of Auckland, AUT (through the Institute for Applied Ecology New Zealand), and other organisations and communities, which recognized the importance of astrobiology within the science landscape of New Zealand. This sustained effort resulted in a high media profile before and during the expedition and in it is hoped that will help kick-start the New Zealand astrobiology community.

A summary of these outcomes is presented below:

Works presented at international conferences

Two posters have been accepted at the Astrobiology Science Conference 2015:

- NASA's Spaceward Bound New Zealand: The Inaugural Expedition, in the Taupo Volcanic Zone, N. Island, 2015
- Advancing Astrobiology Curriculum via Teacher-Scientist Collaboration in the Taupo Volcanic Zone

New Zealand Astrobiology Community Portal development

New Zealand astrobiology community can now benefit from information which is kept up to date and includes relevant data about New Zealand. This portal can be found at: www.astrobiology.kiwi. Spaceward Bound New Zealand 2015 helped generate content for it.

A newsletter is also available as part of the outreach efforts.

Secondary education

SBNZ 2015 is aiming to provide lesson elements tailored to New Zealand geography and geology. These will be available via http://edu.rasnz.org.nz/, the education portal for astronomy and space sciences of New Zealand

Teachers and students have been exposed during SBNZ 2015 to considerable knowledge of the potential further study of the subjects and the ability to transfer that information to others, including lesson plans/elements for use in the classroom

This course can also be used to meet to meet the requirements of ESS teacher training and certificates will be provided on request.

Tertiary education

The development of a collaborative tertiary level programme for studying astrobiology is being considered by New Zealand astrobiology community champions.

Science & research

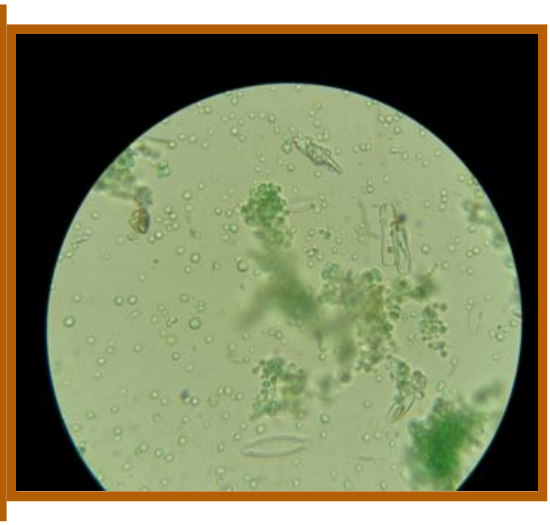
Samples collected during Spaceward Bound New Zealand 2015 have been successfully returned to NASA Ames and JPL.

Photo: R. Bonaccorsi

Detail of sampled facies from the sinter system, SBNZ 2015

During the Spaceward Bound Expedition, Dr. Rosalba Bonaccorsi of SETI institute and NASA Ames, in collaboration with Dr. Carol Stoker and David Willson (NASA Ames) performed science-driven activities and involved local teachers, high school students as well as the local Maori community.

Dr. Bonaccorsi sampling high density colonized sinters and simultaneous spectral acquired by Junior Rover, SBNZ 2015



Microscope image of diatoms and cyanobacterial micro-organisms from a water sample assayed with LAL, SBNZ 2015.

Under the guidance of Kathy Campbell (University of Auckland) they sampled a variety of locations from the Parariki Stream hot springs and sinter for assay with the Lymulus Amebocite Lysate to quantify the “Lipid A” biomarker.

Dr. Bonaccorsi science objectives were to determine the first-order distribution of gram negative-like biomass, as a dominant component of the Parariki Spring. This extreme setting represents a suitable analogue system for habitability/habitation studies supporting the exploration and search for life on Mars,

our Solar System, as well as future exoplanetary surfaces. To address this goal they also performed Astrobiology-Technology trials involving drones and rovers to scout, acquire in situ data, and sampling.

A supplementary report will follow and will be available on request.

The collection was coordinated with other researchers from JPL and the Blue Marble Institute (etc).

A full next-generation sequencing study is underway at JPL by Dr. Parag Vaishampayan and his PhD student and will result in a complete inventory of the microbial community in the spring. Dr. Vaishampayan' PhD student will look at "Microbial community structure of Acid-Sulphate-chloride springs at Parariki stream, New Zealand".

Dr Vaishampayan group at JPL has developed a molecular approach to selectively detect viable microbial population from a low-biomass environmental samples. He will use the 'Next Generation Sequencing' (NGS) approach to study the microbial diversity of these unique samples. He will also perform ATP and qPCR assays to determine bio-burden of these samples. He and his student will apply advanced bioinformatics and statistical techniques to decipher microbial community profiles in sub-samples collected from this location. They hypothesise that a variety of extremophiles could exist in this samples based on the unique nature of these samples (low pH, high temperature, high sulphate and chloride contents).

Sampling with Junior Rover (in collaboration with Steve Hobbs, Mars Society of Australia), SBNZ 2015
Parariki, New Zealand

5. Participants

The expedition had fifty participants. They included research scientists, professors, graduate and undergraduate students and teachers from five countries: New Zealand, Australia, United States, Romania and Kazakhstan. Their affiliations and roles are listed in table below.

Whilst this is the first Spaceward Bound expedition in New Zealand, a number of participants have attended previous expeditions.

Name	Affiliation	Country	Role
Bryan Drake	University of Auckland / Drake Geoscience Ltd	New Zealand	Research Scientist
Laura Ward	Plant and Food Research	New Zealand	Research Scientist
Parag Vaishampayan	NASA-JPL	United States	Research Scientist
Steven Hobbs (SB Alumni)	UNSW	Australia	Research Scientist
Virgiliu Pop	Romanian Space Agency	Romania	Research Scientist
Eldar Noe	NASA Ames	United States	Research Scientist / Mars
Jen Blank (SB Alumni)	NASA Ames & Blue Marble Space IS	United States	Research Scientist / Organiser
Jonathan Clarke (SB Alumni)	Mars Society Australia	Australia	Research Scientist / Organiser
Haritina Mogoşanu	New Zealand Astrobiology Initiative (NZAI)	New Zealand	Research Scientist / Organiser / Coordinator
Martin J. Van Kranendonk	Australian Centre for Astrobiology	Australia	Research Scientist / Professor
Steve Pointing (SB Alumni)	AUT	New Zealand	Research Scientist / Professor/ Organiser / Media Coordinator
Kathy Campbell	University of Auckland	New Zealand	Research Scientist / Professor/ Organiser/ Science Lead
David Willson (SB Alumni)	NASA Ames	United States	Research Scientist/ Engineer
Sanjoy Som	NASA Ames & BMS Institute of Science	United States	Research Scientist/ Flight Engineer
Carol Stoker (SB Alumni)	NASA Ames	United States	Research Scientist/ NASA Official Representative
Rosalba Bonaccorsi (SB Alumni)	NASA Ames and SETI Institute	United States	Research Scientist/ SETI Official Representative
Anna-Thea Littek	Havelock North High NZ	New Zealand	Student
Daniel Blakeborough	Manurewa High School	New Zealand	Student
James Railey		New Zealand	Student
James Swan	University of Canterbury	New Zealand	Student

Justin Walker	Manurewa High School	New Zealand	Student
Laura Penrose	Nayland College	New Zealand	Student
Melissa Smith	Hamilton Fraser High School	New Zealand	Student
Sarah Childs	Pakuranga College	New Zealand	Student
Solinna Toul	Manurewa High School	New Zealand	Student
Carly Gott (SB Alumni)	UC Riverside	United States	Student (graduate)
Chris Kennell	UNSW	Australia	Student (graduate)
Courtney Bright	UNSW	Australia	Student (graduate)
Cristiana Paraschiv	Mars Society Australia	Australia	Student (graduate)
Siddharth Pandey	Manurewa High School	Australia	Student (graduate)
Tremayne Kaseman	UNSW	Australia	Student (graduate)
Scott Perl (SB Alumni)	Manurewa High School	United States	Student (graduate) / Research Scientist
Astrid Mueller	Science Alive!	New Zealand	Educator
Katie Sopher		United States	Educator
Ron Fisher	Cosmodome NZ & RASNZ Education Group	New Zealand	Educator
Beth Anders	Mars Society NZ	New Zealand	Educator (Early Childhood)
Annalea Beattie	Mars Society Australia	Australia	Educator / Artist
Julian Thomson	GNS Science, Lower Hutt	New Zealand	Educator / Geoscience Education / Organiser
Trevor Anders	Mars Society NZ	New Zealand	Educator / Retired Engineer
Matthew Reyes (SB Alumni)	Exploration Solutions / NASA Ames	United States	Educator / Technologist
Audra Phelps (SB Alumni)	Almaty International School	Kazakhstan	Teacher
Chris Monigatti	Tawa College	New Zealand	Teacher
Katy Hodgson	Western Heights High School Rotorua	New Zealand	Teacher
Kirsty Farrant	Newlands College	New Zealand	Teacher
Larraine Barton	Pakuranga College	New Zealand	Teacher
Matt Parkes	Ao Tawhiti Unlimited Discovery	New Zealand	Teacher
Nicola Fahey	Mars Society/Mars One	New Zealand	Teacher (Early Education)
Ken Silburn (SB Alumni)	Mars Society Australia	Australia	Teacher / Educator
Kiri Danielle		New Zealand	Teacher / Organiser
Lucinda Offer (SB Alumni)	Marsonauts, Inc., Mars Society USA	United Kingdom	Teacher's Lead

Guest speakers and visitors:

- **Hon. Steve Chadwick** - Mayor of Rotorua addressed the Spaceward Bound participants at the Mourea Te Takinga base and welcomed the expedition to the region of Rotorua
- **Mark Gee** - Multiple award winning and Astrophotographer of the Year 2013, delivered a lecture on Astrophotography
- **Elf Eldridge** - Victoria University - Rover Competition - undertaking a two day workshop with participants of Spaceward Bound and public.
- **Mark Mackay and members of KiwiSpace Foundation**: Around 15 people travelled down from Auckland as part of a KiwiSpace-organised Meetup event, to attend the robotics field day and meet some of the personnel from NASA.
- **Katie Sleeman** - US Consulate, Education Section, took part in the Pararíki Stream research trip.

Hon. Steve Chadwick - Mayor of Rotorua and Haritina Mogoşanu, SBNZ 2015
Te Takinga Marae, Mourea

Elf Eldridge (Victoria University Wellington),
Lillian Pak (Hutt City Libraries) and Members of KiwiSpace Foundation, SBNZ 2015

6. Budget

	Expenditures	Revenue
Teachers & Students Fees		9,830.40
UoA Sponsorship		10,000.00
AUT Sponsorship		5,000.00
Mars Society NZ		100.00
Transportation/ Travel	4,237.87	
Accomodation	4,679.00	
Food	11,535.72	
Stationery and Attendees Packs	1,097.14	
Administration	271.72	
Miscellaneous	400.96	
Field Equipment	534.67	
Venue Admission Fees	2,160.00	
	24,617.08	24,930.40
Net Revenue/(Loss)	13.32	

Letters of support for Spaceward Bound New Zealand

Rosalba Bonaccorsi, Research Scientist, SETI Institute/NASA Ames Research Center Space Science & Astrobiology Division, The SETI Institute the Carl Sagan Center for the Study of Life in the Universe.

The SETI Institute's Education and Public Outreach programs share the excitement of searching for life in the universe with people of all ages. As human beings we all share a common curiosity about our place in the universe: Where did we come from? Are we alone in the vast ocean of stars and galaxies?

The SETI Institute is proud to collaborate and support the Spaceward Bound, New Zealand, this year by sharing with the Kiwi enthusiasts the fascinating research that will be conducted during a 5-day expedition. Astrobiologists and New Zealand teachers and students will work together. The goal is to elevate public awareness about planetary analog research taking place on Earth, and its associated missions in space (such as Mars Science Laboratory and the upcoming Mars 2020 Missions).

As a part of the SETI Institute, the Carl Sagan Center for the Study of Life in the Universe team has scientists engaged in a wide variety of interdisciplinary investigations: from studies of extreme setting on Earth, where we can learn more about how life began and how its many diverse forms have survived and evolved, to observing and modeling the precursors of life in our Solar System and beyond into the outer space.

The Center for SETI Research conducts scientific experiments that search for extraterrestrial intelligence by seeking the signature of distant technologies in the electromagnetic spectrum. Research is conducted with the Allen Telescope Array at Hat Creek Radio Observatory in Northern California.

Kathleen A. Campbell, Professor, Geology – School of Environment, University of Auckland

University of Auckland is proud to be the science lead for the first Spaceward Bound expedition in New Zealand. We are engaging to make the most of the special environment NZ has to offer, and steer towards new fields or methods of research when opportunities or needs arise.

From projects seeking habitable planets orbiting stars in the Milky Way to understanding how life arose on planets such as Earth and Mars in the first few billion years following their formation, University of Auckland scientists and students cannot aim too high nor stretch too far.

Spaceward Bound New Zealand with its exploratory science approach has the recipe to make particular use of New Zealand's special attributes of being at the frontiers of scientific exploration: Fields such as geothermal energy, extreme life, Antarctic research, marine biology, Polynesian migration, climate science, southern astronomy, phylogeography and biosecurity protecting a unique biota are obvious possibilities, situated as we are astride an active plate tectonic boundary in the Southwest Pacific in the Southern Hemisphere.

Mars Society Australia has had a long-standing partnership with people in New Zealand sharing our vision of exploring Mars and other planets in the Solar System.

Jonathan Clarke President and Research Director, Mars Society Australia

These have included the Kiwi Mars and Tas Mars expeditions to MDRS and shared experiences at space conferences in Australia. All Australian that will be participating in the expedition look forward to working with Spaceward Bound New Zealand and the data and contacts that it will create.

Kiri Danielle

The public open day at Sulphur point had major coverage in the local paper, making the front page. The day provided an excellent opportunity for the public to get up close and personal with inspirational scientists and technology, an opportunity considered by many who attended as a 'once in a lifetime chance to meet some of the brightest minds on the planet'. University students

also drove for many hours to be present and meet people they considered heroes of the scientific community.

The children who attended clearly enjoyed themselves and after speaking with them, I know many left with memories and inspiration that will last a life time.

I personally witnessed networks created and received wonderful feedback from members of the public, particularly parents who were delighted to seeing their children's eyes wide and shining as they were handed the remotes to some of the robots on display.
This program was an invaluable step towards creating a more involved and inspired space loving community in New Zealand.

Chris McKay, NASA Scientist, team leader of the first Spaceward Bound Expedition

Spaceward Bound was conceived at NASA Ames in 2006 with support from NASA HQ. The first Spaceward Bound trip was to the hyper-arid core of the Atacama Desert and involved teachers from the US and from Chile.

The teachers liked being in the middle of a real, and evolving, science activity. The scientists appreciated the interest and help from the teachers. The model has been revived many times since that first Atacama trip and I am delighted to support the Spaceward Bound expedition in New Zealand in 2015 and look forward to assisting with similar expeditions in New Zealand in the future.

The core of the concept was to involve middle school and high school math and science teachers in real astrobiology field work: doing real work, collecting real samples, participating in the discussion and analysis and planning for the next days work.

Mark Mackay, KiwiSpace Foundation

KiwiSpace is a volunteer organisation dedicated to promoting opportunities for New Zealanders to work and participate in space projects. We are delighted to support the Spaceward Bound expedition for 2015, and look forward to assisting with similar events in the future.

KiwiSpace Foundation is especially proud of our team member Haritina Mogoşanu and her team for undertaking this project, and the formation of the New Zealand Astrobiology Initiative. This builds on past analogue missions to the Mars Desert Research Station in Utah — KiwiMars (2012), TasMars (2013) and WSW MDRS (2013) — and it's fantastic to see this in New Zealand, extending the reach to more Kiwi educators and young professionals.

Duncan Morrison, Captain Haunui Waka Hourua (double hulled Polynesian voyaging canoe)

Tena koutou katoa-Greetings to all,

There was an obvious correlation made between the voyages of the Polynesian ancestors on missions of discovery and astro-exploration today.

The use of celestial knowledge was fundamental to survival, as was the practical ability to live in a confined space with limited resources for periods of time.

It was a great delight to have the NASA group out sailing with us on the waka for the afternoon. Wonderful to make the connection and spend some time learning of their very interesting work.
Our guests seemed to appreciate the realities of ocean voyaging as a direct reflection of what would be dealt with albeit in a very different context in spacebound missions.
Selecting crew and managing relationships onboard is/was a very important part of the voyaging process,

and awareness of the crew dynamic and the pressures that long periods of isolation, lack of space, privacy and personal freedom put on a crew is at the heart of a successful voyage.
It was wonderful to share some of the very large body of knowledge that has been accumulated in voyaging culture both through the Navigator tradition and land based life over many generation.
The depth of knowledge of the master Navigators, Maori/Polynesian people and other indigenous cultures around the world is beginning to be recognized by science as being a valid reference library built on centuries of observation.
It was wonderful to meet a group of curious, open-minded individuals willing to engage in a way that for a long time has been beyond the scope of the 'scientific world'.
We look forward to future meetings.
Nga mihi ki a koutou

Steve Pointing, Professor, Director, Institute for Applied Ecology New Zealand, AUT University

AUT researchers have a long association with astrobiology research and NASA. We are therefore very excited to be able to help support the first ever Spaceward Bound expedition in New Zealand. We look forward to meeting participants in Taupo in January, for a very special astrobiology experience.

Julian Thomson, Education and Outreach, GNS Science

GNS Science strongly values initiatives that help New Zealanders to engage in and appreciate scientific adventure and discovery.
We are enthusiastic about the Spaceward Bound initiative in Rotorua in 2015 and look forward to participating in this exciting week of exploration.

Pania Tyson-Nathan, Chief Executive NZ Māori Tourism

We are proud to be supporting the mission of Spaceward Bound New Zealand, as NASA explores the geological features of Rotorua in particular – a place that has incredible cultural and historical significance to Māori and the tourism sector.

NZ Māori Tourism works collaboratively for the collective interests of the Māori tourism sector. We promote Māori tourism as the strategic point of difference for Aotearoa New Zealand, and assist the development of our country's brand internationally.

Annex

SBNZ 2015 Survey results

We are very grateful for all the feedback received, which will be incorporated in the design of future expeditions like Spaceward Bound in New Zealand. The survey was anonymous, below are all the replies received to the first 3 questions:

- What was your most important personal benefit from participating in SBNZ?
- What were 3 significant things you learned during SBNZ?
- What are 3 elements or activities of SBNZ that you found most enjoyable, effective or useful?

What was your most important personal benefit from participating in SBNZ?

"I met wonderful people who share my passion. That is huge."

"Being around like minded people which just cemented my passion for space and made my dreams a reality."

"Collaborating with fellow scientists and sharing research interests."

"I enjoyed meeting and talking to the wide range of people involved, who shared their knowledge and enthusiasm."

"Meeting with the students and scientists, both NASA and NZ/AUS, and talking about their work, making links and contacts. Seeing how extreme environments in NZ link closely with the astrobiological research community."

"Networking and working alongside practicing scientists."

"I had two: Helping to start-up links between scientists and teachers in NZ via Astrobiology Networking with scientists and educators, which will be leading on to projects and programmes."

"Meeting a variety of people interested in space and astrobiology."

"Meeting people of varying ages that shared similar interest as me, as well as people sharing their knowledge with everyone else that participated."

"Seeing hot spring deposits with world experts, meeting scientist colleagues, forging a connection between the ACA and Astrobiology NZ! Meeting the host woman of the Marae, who was an absolute inspiration! I could have talked with her for days."

"Meet other NASA and University researchers. Interact with students and teachers. Work on amazing extreme environmental sites. cultural exchange."

"Getting to meet and interact with people who were as passionately interested in Astrobiology as I was, and learning more about extremophiles."

"Getting to meet some real NASA researchers and get a sense of the reality behind the work they do. I appreciated the time and space that the camping marae style provided. This gave time to interact with everyone in a comfortable way."

"Having the opportunity to meet others."

"Working alongside scientists to really see what kind of career I am hoping to achieve."

"Knowing that I assisted in inspiring younger people to pursue science majors."

"I learned a lot of cool stuff and I was inspired to do more science things."

"Participating in field work and learning through hands-on experience."

"It was fantastic to meet other teachers who are passionate about teaching astrobiology."

"Networking, to find like-minded people and to interact with them and come away with more contacts. I felt that I was successful in achieving that goal."

"New ideas and inspiration."

"Meeting local people, sharing the local culture, seeing amazing sites."

"Meeting and working with interesting people, experiencing the Marae and locations."

"The ability to interact with enthusiastic students and identify ways to communicate and get them informed about my field of expertise."

"Being able to meet some wonderful people that have similar interests and thought patterns. It was also great being able to meet scientists from around the world and hear them talk about their areas of study."

"Getting to talk to real life scientists that have the same or similar interests to me that I was able to discuss with them. It was also very helpful because I was able learn more about the subjects that I was thinking of studying at University."

"Meeting the NZ researchers, teachers, students and Mars Society members."

"Interacting with NASA Scientists hard at work at 3AM in the morning."

"Networking with amazing scientists, teachers and local experts. Sharing knowledge and passion for science."

"Meeting interesting people that I'll hopefully have contact with in future."

What were 3 significant things you learned during SBNZ?

"1. What it feels like to belong to something very special 2. People are very keen to help if asked 3. We can have SB in NZ."

"Everything. Its hard to specify just 3 things"

"1) The workings of an XRD machine and how the mineral database compares analyzed samples to reference data. 2) Details on how the biotic matter observed in the hot springs obtains energy and nutrients from their environment. 3) Bring headphones with proper music when sleeping in giant shared space :)"

"Firstly, the topography of Lake Rotoiti, Okere Falls, etc - very interesting to visit this area. Secondly, although I have visited the thermal areas previously, it was very interesting to have a more detailed explanation of the extremophiles living in the hot water, particular in terms of how the colours of the archaea and bacteria etc can be an indication of the temperature of the water. Thirdly, it was very interesting to learn about the proposed 2020 Mars robotic landing missions from the scientists putting together a proposal for NASA."

"About some of NZ's extreme environments About the gradation in temperature with distance from a hot spring and how the cyanobacteria population changes About some of the sampling techniques currently being used on Mars and some planned for the next mission(s)."

"Fieldwork Astrobiology Use of technology."

"Teachers in NZ need curriculum materials in Earth and Space Sciences. Drones are very useful research tools. The public is interested in Astrobiology."

"1. Extremophiles! What they look like, how they are preserved in rock, and what makes a good extremophile habitat. 2. Maori culture, introductory, but more than I knew before. 3. Sleeping in a giant room with many other people is a good way to spread germs."

"- I learnt about varying forms of technology used to sample matter at atomic levels (ie the x-ray spectroscopy machine), and how this is important for the future of space exploration. - Studying organisms on earth is a vital

process if we are to continue searching for life elsewhere in the universe. - That I'd like to pursue a career in Astrobiology ;)"

"1) Silicification of microbial mats on hot spring outflow creeks and their piling up during flood events as mat chip breccias. Love it! This applies to my own research on very old rocks 2) the size of sinter terrace deposits, for e.g. at Champagne Springs 3) the chemistry of hot spring deposits: alkaline vs acidic."

"Microbial ecology of thermal springs of New Zealand Geology of these sites Maori culture."

"That it is planned to return to Mars to search for life specifically and that has not been done for some time. That many of NASA's employees are contractors working on specific tasks I have a greater appreciation for NZ's extreme environments and geography - particularly lava flows."

"About the Maori. About astrobiology. About New Zealand"

"1. How each branch of science may be different, they can all be used in unison to really understand the topic of study. 2. There are many more roles in interplanetary studies than I had realised. 3. There is huge potential to make links with extremophiles and space science with the education system."

"That tectonic activity is causing NZ to continue to grow. --I learned how Maori story telling can be linked to the teachings of science --Discovered the glorious array of minerals being released via geothermal events."

"Hot Spring Ecology Habitability of Mars Science is even more cool than i thought it was."

"Three significant things I learned about during SBNZ were hot spring ecology, lava flows and cosmology."

"Better understanding of the microbiology of hot pools and thermal waters Better understanding of the microbiology of Antarctica Learnt a lot about the use of analogous environments for the study of astrobiology."

"1. The wealth of knowledge that can be shared among a group of people. 2. Where some significant sites are for looking at extreme life. 3. That you don't need to "dumb down" for even our high school students - the teaching was well within their grasp."

"Linking biology and geology; some nice applications of science on rovers; soft funding sucks."

"Maori navigation and the philosophy associated with it. The beauty of the southern sky. The value of NZ in astrobiology research."

"About why people think it is good to look closely at microbial life forms and life on Mars. Learning more about specific areas with hot springs and geothermal activity in the Taupo Volcanic Zone. How kids can get so excited about rockets and stars."

"1) That extremophiles have colored sunblock 2) I learned a lot about Maori culture and personality 3) Differences between sulfur-rich and sodium-rich springs. 4) Never to sleep in the same room as 40 other people who have just themselves been in airplanes with 100 other people. Chances of someone bringing some contagious disease are huge."

"1) The temperature significance of the colour zonation of hot spring biofilms. 2) The history of the Tarawera volcano 3) The catastrophic floods from Lake Tarawera"

"Do what you enjoy because you never know where it might take you Science is awesome Learn and do more of what I enjoy and meet people. Don't be afraid to go an talk to people (I'm a little bit shy sometimes)"

"Maori people are amongst the warmest people in the world. Scientists hardly get any sleep. Cyanobacteria is awesome."

"1. How volcanoes and hot springs are related. 2. Methods for field work 3. Ideas for bringing fieldwork to a classroom"

"1. That the colours around hot springs are sometimes caused by bacteria, rather than just different elements. 2. A bit about Maori culture 3. Can't actually think of anything else."

What are 3 elements or activities of SBNZ that you found most enjoyable, effective or useful?

"1. the interactions with people 2. the lectures 3. the practical demonstrations"

"Star gazing - where people were pointing out different objects Group work - Working with people who had different angles coming in to a problem"

"1) Field trips 2) Reference material and papers 3) Subject matter experts present on trip."

"a. Visit to Waimangu thermal area b. Lectures by NASA scientists c. Astronomical viewing"

"The trip to the thermal reserve on Saturday. I was not able to go on any of the others, either by accident or design. The time to just sit and talk with the students and scientists The talks"

"Networking with science teachers and educators; being in a different country; visiting volcanic landscapes"

"Team research at Parariki Stream. Getting the group to make observations on the first afternoon at Kuirau Park and applying this as a curriculum tool for any aspect of science. Tables set up in the camp to show students, teachers and other scientists aspects of research the scientists are doing globally."

"Networking Field expeditions. Getting to chat w/ experts about their subjects."

"The inclusion of both scientists and students meant that every activity was interesting, as we all learned things from one another. The field activities (ie the valley walk) allowed for us to experience events first hand, and learn about them as they occurred. I think the talks were very important as they put the whole trip into perspective."

"Visit to Champagne Springs Tongariro Crossing Walking through hot spring deposits with Katherine."

"Being on a marae with locals so that we could enjoy and relax amongst the geeky stuff. Conquering the big mountain even if it hurt. Julien's talk on science educating."

"Drawing at night; science trips; mixing with community"

"Workshops at the marae, field work, listening to the experts."

"Mark Gee's talk was awe inspiring -The planetarium was amazing as I had never before been in one nor have I previously been able to identify constellations. This new information made me feel more connected to my universe. -Carol Stoker's talk was a great way to pull all the previous topics together."

"The field work and hands on experience. Star Gazing/Planetarium. Learning stuff from all the scientists."

"Being able to talk to and socialise with real scientists, field work and presentations/demonstrations."

"Staying at the Marae. Really enjoyed visiting Waimangu Volcanic Valley as a whole group. Great to have experts present to explain what we were looking at Enjoyed the evening talks from experts"

"Tongariro. The abundance of life and what is represented going by the age of the lava flow. Rovers. The work that goes into designing/making them. How geothermal areas are readily available to most New Zealanders yet most of us don't realize it."

"Field trips collaboration with other teachers to develop resources access to specialist knowledge."

"Free evenings, natural conversations at a very nice locality Visit to great sites (Tongariro, Waimangu, soda lakes) Science day with kids."

Conversations, networking and getting to know people experiencing the environment The planetarium

"1) In-house demonstrations and discussions 2) The field trips were remarkably informative 3) Having a robotics workshop was very enjoyable."

"1) The welcome at the meeting house. 2) Waimangu geothermal area 3) Paraki boiling acid stream 4) Hospitality from the local community."

"In the evenings, talking to people, and hearing their presentations or talks. Being out in the field talking about stuff because I can associate what I'm seeing with what we are talking about. Being divided into groups to come up with ideas was also pretty good. I would do more of that because it was creating conversation and we were able to explore our ideas and work on them with the scientists and learn."

"Eating and sleeping together with scientists, exploring a geologically historic environment, glow worms!!"

"1. The first day, learning about hot springs and using the temperature probes/laser. 2. Staying at the Marae, particularly when Shanan and Katie took us out. 3. The planetarium was really cool."

"1. Field work at Parariki stream 2. Discussions with fellow teachers 3. Analysis of data with scientists."

Photo: M. Gee