SPACEWARD BOUND NAMIBIA - FACT SHEET
EXTREMOPHILES AND THE SEARCH FOR LIFE ON MARS

Scientists are fascinated by the unknown. They want to explore new territories and tackle unanswered questions. That is why many scientists are captivated by the search for extraterrestrial life. Spaceward Bound is a NASA-led programme that is working towards this goal - but in this programme the search starts right here on Earth.

Spaceward Bound expedition members seek out the driest places on Earth that are usually also very hot or extremely cold. Here they look for and study extremophiles - microscopic life forms that eke out an existence in the soils, clays or rocks in these harsh surroundings. The lessons that the scientists learn here will ultimately help us to search for life on other planets or moons. It helps to understand the types of organisms that are able to cling to life in extreme conditions, as well as where they occur and how to find them.

Spaceward Bound expedition members have been to the cold deserts of the Arctic and Antarctica, to the hot Atacama Desert in Chile and the Mojave Desert in California. Some have also studied the deserts of central Australia and Western China, while others have been doing work in remote parts of Tibet and Kazakhstan. In April 2010, a group of about 20 researchers came to the gravel plains of the Namib Desert.

"When we come to a desert such as the Namib, we look for the typical things that we know are prerequisites for life," says Dr Charles Cockell, a researcher at the Centre for Earth, Planetary, Space and Astronomical Research at the Open University, UK. "We look for places where there is or has been transient liquid water, we look for energy sources from sunlight or rocks (some microbes are able to 'breathe' the iron in rocks in the same way that we breathe oxygen) and we look for the availability of nutrients - organic carbon or minerals," he describes. "Generally, where there are rocks, there is life."

For many years, scientists thought that the dry valleys of Antarctica were completely lifeless because they could not find any traces of life in the soil. Then they discovered that the sandstone rocks harboured life in the form of endoliths - bacteria that live inside tiny pores in the rocks. Therefore scientistsneed to know where to look for the most extreme forms of life and how to collect and preserve these samples. As part of the Spaceward Bound team, NASA engineers work side by side with biologists to observe how they take soil, clay and rock samples. This will help NASA to design the best possible robotic equipment that will increase thechances of finding past or present life elsewhere in space.

For now, the Spaceward Bound scientists focus on Mars as one of the most likely places to find extraterrestrial life. "Mars and Earth had very similar beginnings," explains Dr Henry Sun, a microbial ecologist who works at the Desert Research Institute at the University of Nevada in the USA. "So, if life evolved on Earth, you have to wonder, did the same thing not happen on Mars too?" Scientists are particularly interested in the permafrost below the Martian surface that could possibly harbour endolith communities.

Astrobiology is the study of the possibility of life on other planets or moons. On Earth, astrobiologists focus on organisms that live under extreme conditions, because these organisms may serve as examples of what could be found on other planets. Studying these organisms may provide clues to evolution, adaption and the possibility of extraterrestrial life

Extremophiles (literally "extreme-loving") are microscopic organisms that are adapted to thrive in very harsh environmental conditions that would be inhospitable to most other forms of life. Such extreme conditions also exist on other planets - that is why astrobiologists are so interested in studying these organisms.

Thermophiles can grow and thrive at high temperatures, for example in hot springs, volcanic geysers and hydrothermal vents on the deep ocean floor. They are also found in South Africa's deep gold mines. Psychrophyles require cold to thrive and are found in glaciers, sea ice and icy soils.

Acidophiles live in very acidic (low pH) conditions, such as acidic hot springs and acid mine drainage.

Alkaliphiles grows best at a high pH, for example in soda lakes.

Halophiles are able to grow under high salt concentrations, for example in saline springs and salterns.

Xerophiles can grow at very low water activity and may be found in sand deserts, ice deserts and salt flats.

Organisms that grow only under high pressure, for example on the ocean floor, are called **piezophiles**.

Rocks often harbour microscopic life forms, because the rocks offer protection against UV radiation from the sun. **Hypoliths** grow under rocks, **chasmoliths** grow in the cracks in rocks, and **endoliths** live in the tiny pores inside rocks.

MESSAGES FROM THE SPACEWARD BOUND: NAMIBIA MISSION

Scientists, especially those who are involved in the search for life away from Earth, are very aware of how special and rare our home planet is in the universe. The fact that we have not yet found life anywhere else makes it even more important to protect the rich diversity of life on Earth. Here are some thoughts from Spaceward Bound expedition members:

Pristine natural environments are precious and need to be protected. (Professor Don Cowan, University of the Western Cape)

Life is the most important thing we have on this planet. We are looking for life all over our solar system and eventually we will seek it all over the universe. We have life in abundance on Earth, but we don't value it enough. Respect for life is so important, especially in the fragile desert ecosystems where life barely hangs on. (Wanda Davis, NASA Ames Research Centre, California, USA)

Finding life outside our planet will be one of the most important scientific discoveries ever and it will change our perspective of ourselves. (Dr Alfonso Davilla, NASA Ames Research Centre, California, USA)

People explore and will never stop exploring. One day we will be able to answer questions about life on Mars and we may even go to Mars ourselves. That is also the spirit of Spaceward Bound. (Dr Henry Sun, Desert Research Institute, University of Nevada, USA)

Interested in studying extremophiles at postgraduate level? Visit the web site of the Institute for Microbial Biotechnology and Metagenomics at the University of the Western Cape – see http://imbm.co.za

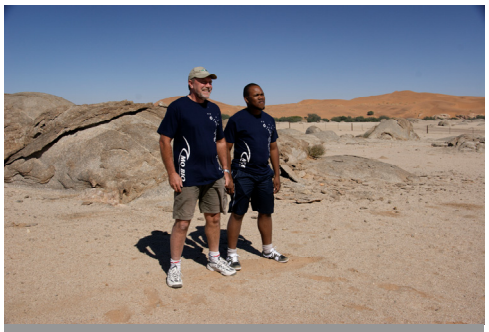
NRF National Research Foundation | SAASTA South African Agency for Science and Technology Advancement

UNIVERSITY of the WESTERN CAPE

NASA

The Gobabeb Research and Training Centre, about 120 km from Walvis Bay.

At Gobabeb, three Namib ecosystems meet: the majestic red sand dunes, the ephemeral Kuiseb River and the vast gravel plains.



Ready to take on the Namib: Professor Don Cowan from the University of the Western Cape and doctoral student Thulani Peter.

Green and extreme, but not quite Martians. Scientists on Spaceward Bound: Namibia investigate how the greenish colonies of cyanobacteria are able to survive in the extreme desert environment, to help them plan how and where to look for life on Mars. These bacteria that grow on the underside of rocks are called hypoliths.

Life in the extreme: About 25 scientists, students, teachers and journalists from around the globe joined Spaceward Bound: Namibia in April 2010 to explore and document living organisms that are able to survive at the edge of life in this desert environment. The knowledge and experience gained on this trip will feed into future expeditions to search for life on Mars.