

BOLIVIA EXPEDITION

2005 High Lakes Expedition: An Astrobiological Trek Across the Altiplano

Dr. Nathalie Cabrol, a planetary geologist working with the NASA Ames Research Center and SETI (Search for Extraterrestrial Intelligence) Institute, carried Wings WorldQuest Flag #1 on a trek to the top of two volcanoes in the Andes and across the Altiplano. She and her team were searching for clues as to whether or not the lakes of Mars might ever have sustained living organisms.

Nathalie and her co-principal investigator, Dr. Edmond Grin, have led three previous expeditions to the highest lakes on earth, where the conditions are analogous to those of ancient Martian lakes – low oxygen, intense UV (ultraviolet) radiation, and an atmospheric pressure roughly half of that at sea level.



Dr. Nathalie Cabrol holds Wings WorldQuest Flag #1 with her expedition's guide, science team, and porters at the summit of Poquentica in the Andes.

The Mars Underwater Project team investigated the underwater ecosystem of the summit lake of Licancabur volcano (5,916 meters) during 2002–2004. In October 2005, Nathalie and her team would try to reach the summits of both Licancabur and Poquentica (5,850 meters) volcanoes in 10 days – a challenging ambition made all the more risky due to unusually harsh weather.

CONDUCTING SCIENCE OF THE EXTREMES

Because they planned to be working and diving at altitudes of 20,000 feet, Nathalie and the team spent their initial days in Bolivia training, acclimatizing, and coping with sustained winds of over 100 kilometers per hour.



WHO

Dr. Nathalie Cabrol

WHAT

Exploring two of the highest mountain lakes in the Andes

WHERE

Licancabur and Poquentica volcanoes, Bolivia, South America

WHY

To assess the potential for life on Mars, Cabrol finds out if and how life survives and can adapt to extreme environments

The work began at the base of Licancabur, one of the three sacred mountains of the “triangle of fire” of the Incas, whose civilization was flourishing some 500 years ago.

Although the team planned high-altitude dives, the bitter cold, high wind, and frozen lakes made it impossible. During a break in the harsh weather, Nathalie and her team ascended to the volcano crater in record time, climbing 200 vertical meters per hour. They worked quickly to collect ice, mud, permafrost, and other samples; to retrieve the previous year's meteorological data; and to set up a new data recording station. The collected ice will be used to ascertain how spores, pollen, and other airborne material contribute to the sediment of high-altitude lakes.



The 800-kilometer trek across the Altiplano began and ended at two volcanoes – Licancabur and Poquentica.

2005 EXPEDITION GOALS

- To map geology and morphology; to establish the bathymetry of high-altitude lakes
- To study geophysical environment; to chart temperature variations, humidity, pressure, and UV flux
- To characterize and to understand physical extremes (cold, UV, salt, wind, aridity, and low atmospheric pressure) and their influences on microbial life.

Experience the Journey on the Web:

Read Nathalie's expedition log at:
www.eventscope.org/highlakes



Nathalie holds Wings WorldQuest Flag #1 at the summit of Licancabur volcano on November 4, 2005, after a record ascent time of 3.5 hours from mid-camp.

**CROSSING THE ALTIPLANO:
 A JOURNEY TO ANOTHER PLANET**

On the way to the second volcano, Nathalie's group covered more than 800 kilometers, most of the distance off-road. Typically they found themselves in total isolation in an incredible landscape.

The team stopped to sample evaporating lakes and geothermal centers located at altitudes between 4,000 and 4,800 meters – Laguna Blanca, Laguna Verde, Thermales, Sol de Mañana, Laguna Colorada, and an unnamed hydrothermal spring.

At Laguna Verde, no surface life was visible around the lake, but as soon as rocks were overturned, layers of pigmented colonies of microbial organisms were revealed. Across the Altiplano, the team stopped at the Salar de Uyuni, a 12,000-square-kilometer salt lake with bubbling springs and orange streams containing living algae and other microorganisms.

At the foot of Poquentica, the team saw pink lichen, dunes, lava flows, canyons, and thousands of llamas, alpacas, and vicuñas. After a five-hour climb up 40-degree slopes of gravel and sand, the team reached the summit, and the porters set up camp. With only limited time at the top, and battling fatigue, the team collected samples, installed the monitoring equipment, and explored the mostly frozen lake. The next day's descent was quick, only 55 minutes, since the team simply ran down the slopes, kicking up dust, happy with what they had accomplished.

EXPEDITION RESULTS

Nathalie considers a highlight of her 2005 work to be the discovery that the Licancabur permafrost is as rich as it is in microbial life. Life in high-altitude lakes appears to be diverse and abundant, and it utilizes both biological and physical protections.

Another highlight of the expedition is the 12 months of data retrieved from the Licancabur meteorological station. The team also completed its geological transect across the entire paleostratigraphy of Laguna Verde.

The NASA Astrobiology Institute provided most of the funding for the 2005 expedition, supplemented by funding from the Wings WorldQuest Foundation.

ABOUT DR. NATHALIE CABROL

Dr. Nathalie Cabrol, a planetary geologist, works with the NASA Ames Research Center to analyze images and data from the Mars missions. She looks for evidence of water in order to discover whether Mars either has been, or still could be, habitable by living organisms. She has led rover field experiments and helped to determine the landing sites for recent Mars Expeditions.

Nathalie is also a principal investigator with the SETI Institute and hopes to find evidence of life beyond earth. Nathalie was the recipient of the 2005 Wings WorldQuest Women of Discovery Award for Air & Space.

EXPEDITION SCIENCE TEAM

Principal Investigator:

Dr. Nathalie Cabrol, NASA Ames/SETI

Co-Principal Investigator:

Dr. Edmond Grin, NASA Ames/SETI

Logistics:

Victor Gaete (UCN Chile), Rob Morris (SETI), Cristian Tambley (CHEP Chile)

Education/Outreach:

Michèle Cabrol (French Mars Society)
 Peter Coppin (CMU/Eventscope)

Emergency Medicine:

Dr. Ross Donaldson

Science Specialists:

Andrew Hock, UCLA/NASA Ames (Geophysics)
 Dr. Lynn Rothschild, NASA Ames (Microbiology)

Research Assistants:

Melissa Rice, Dana Rogoff, Clayton Woosley



Anchoring the meteorological equipment in the permafrost at the summit of Poquentica



At Salar de Uyuni, the team extracts halite crystals, some of them containing halophiles, which are microbial organisms that thrive in extremely salty environments.