The Andean salt flats of Chile are well known for their vast natural beauty. Interspersed within their white salt crusts, small lakes, springs and creeks can be found alongside the unique microbial communities that inhabit them. Drs Cecilia Demergasso and Guillermo Chong along with a multidisciplinary research team from the Universidad Católica del Norte of Chile, are currently investigating the inhabitants of the rare acidic brine lakes found in Chile with the aim to understand the extreme populations due to the contrasting geological and environmental conditions. The acidic brine lakes are located in the high Andes (4000m above sea level) with a salinity of 28% – eight times saltier than average sea water. Flanked by the Cerro Bayo complex – a volcano found on the Chile-Argentina border – geochemical studies have suggested that the local acidity of the lakes (pH 2 – 4) may have arisen due to several reasons: the presence of volcanic native sulphur; the oxidation of sulphur releasing sulphuric acid, which seeped into the lakes; and a change in the buffering capacity of local rocks (the ability of the rocks to help maintain and control pH change in the system).

Demergasso and Chong were keen to find out whether microorganisms (known to play a relevant role in acid production by using sulphur as their energy source), such as the bacteria Acidithiobacillus thiooxidans, were contributing to the acidity of the system as similar microbes have been detected in other acidic environments such as hot springs and acid mine/rock drainage systems. To do this, several sampling expeditions from five zones across the Salar de Gorbea were carried out over a six-year period. Sediments and brine samples collected in the 2009 and 2011 campaigns were then selected for further analysis. Microbiological analysis was firstly carried out by extracting DNA from the brine and sediments samples. Then the DNA was subjected to Denaturing Gradient Gel Electrophoresis (DGGE) – a technique used in molecular microbial ecology to separate out different fragments of DNA – creating a fingerprint of a complex microbial community living within the samples. Recently, metagenomic analysis have been performed and phylogenetic analysis and bioinformatics tools were then used to determine the species found and characterize the functional content of the genes discovered. The combination of both a highly saline and acidic environment means that only the toughest and most resilient microorganisms can survive. The study of the ability of the microorganisms that inhabit and persist in this kind of saline ecosystem has prompted researchers at the terrain as a potential Mars analogue.

Demergasso and Chong’s research hopes to shine a light on the diverse microbial communities living within the acidic brine lakes to further improve our understanding of our planet’s unique microbial diversity, which could have wide-ranging implications on conservation and potential applications in Biotechnology. Microorganisms are usually grouped together according to their metabolic activity which enables the basic salt to survive (halophilic) or can grow under saline conditions (halotolerant) predominates, but analysis of sediment and water samples were taken from
A minor range of sulphur metabolising bacteria was also detected from other groups, including sequences related to Acidithiobacillus, Sulfoxbirillum and Lepotopirillum—chemolithotrophic microorganisms that produce energy by oxidation of sulphur.

Based on the metagenome analysis performed by Demergasso and Chong’s team, many of the organisms described were found to be potentially capable of carbon fixation and sulphur oxidation. Carbon fixation is a process whereby inorganic carbon (such as carbon dioxide) is converted to organic compounds, perhaps the most well-known example of organisms capable of carbon fixation are plants, which convert CO₂ into sugars using photosynthesis exclusively (autotrophs). Yet, in Demergasso and Chong’s team studies, they found that the genus, these are known as non-tuberculoid species and are found in an array of different ecosystems, including engineered and natural water systems, soils and even swamps. This is the first time that Mycobacterium has been found living in an acidic brine system carbon fixation capability appears to be a part of a macroscopic model that microbes in the acidic brine lakes exploit: their primary production is through the oxidation of reduced sulphur compounds, which allows them to efficiently conserve energy for fixing carbon if necessary. Demergasso and Chong have discovered a specialized microbiota supported by volcanic sulphur in a salty environment with low iron and organic matter content: a thiotrophic community.

**NON-TUBERCULOUS MYCOBACTERIA**

One of the most surprising findings from the analysis was the detection of Mycobacteria living in the acidic brine lakes. The most well-known species Mycobacterium tuberculosis and Mycobacterium leprae have been well studied due to the pathogenic role they play in causing the diseases tuberculosis and leprosy. Yet, there are many other less well-known species that belong to the genus, these species have been identified in the study of the acidic brine lakes. Mycobacterium sp. are organisms that belong to the group of acid-fast bacteria, which allows them to efficiently survive in environments with high acidity. Mycobacterium sp. are known for their ability to adapt and survive in a range of environments, from soils and even swamps. This is the first time that Mycobacterium has been found living in an acidic brine system carbon fixation capability appears to be a part of a macroscopic model that microbes in the acidic brine lakes exploit: their primary production is through the oxidation of reduced sulphur compounds, which allows them to efficiently conserve energy for fixing carbon if necessary. Demergasso and Chong have discovered a specialized microbiota supported by volcanic sulphur in a salty environment with low iron and organic matter content: a thiotrophic community.

**A MICROBIAL PLANET**

Microorganisms inhabit the earth long before animals and as such, their ability to adapt and survive in a range of different habitats has led to them being the most abundant organisms on the planet. Microorganisms involved in biogeochemical cycling make them important research subjects to help us understand how ecosystems respond to environmental change. By learning more about the microbiota that can survive in these extreme environments, Demergasso and Chong’s team hope that their data can be used to inform conservation which respects and protects our microbial planet.

**One of the most surprising findings was the detection of an abundant Mycobacteria population living in the acidic brine lakes.**

Dr Cecilia Demergasso and Guillermo Chong Diaz research aims to characterise the microbiota of an acidic brine lake in Chile to improve understanding of these complex environments.

**Research Objectives**

- Study the microbiota present in an acidic brine lake in Northern Chile.
- Characterise the microbial community in terms of their diversity, abundance, and activity.
- Understand the role of the microbiota in the biogeochemical cycling of sulphur and carbon.
- Analyse the impact of environmental factors on the microbiota.

**Personal Response**

**How can an understanding of acidic brine lakes inform conservation in the region?**

Salars and saline lakes are extremely fragile environments in the Andes framework. Over the last 20-30 years, they have been systematically explored for their industrial minerals (B, Li, K), but mostly for water extraction. This situation, in some cases, compromises its conservation and its flora, fauna and microbiota. However, there are some existing evaporitic deposits that are practically intact, like Salars with acid brines.

By using publications, describing Salars in terms of geology, microbiota and other characteristics, directly emphasise its importance as a landscape, its unique content in microorganisms, and its biochemical potential as well as its unique habitat worldwide.

**What effects do you think a changing climate may have on the unique lake systems?**

Salars and saline lakes ages are not measured in historical time but in geological time. These deposits have already suffered climate changes that can be observed in the size diminution of the original saline basen, paleo-costas, isolated terraces, and fossils of organic structures (stromatolites), indicating a previous development during a more humid climate.