MULTIDISCIPLINARY HIGH ALTITUDE EXPEDITION IN THE PUNA DE ATACAMA : GEO & ENVIRONMENTAL SCIENCES AS A FIRST STEP TO DEFINE THE POTENTIAL OF THE OJOS DEL SALADO REGION AS A TERRESTRIAL ANALOGUE.

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Abstract : This study presents, through the description of the 2022 high-altitude campaign, the context of the organization of multidisciplinary scientific expeditions in the Puna de Atacama, near the Ojos del Salado volcano.

Introduction: The Puna de Atacama is a particular geographical area of the Central Andes, subset of the Puna ecoregion [1] and characterized by high-altitude volcanic landscapes whose high aridity and high ultraviolet radiation are potentially similar to the conditions that Mars may have experienced during its geological history [2].

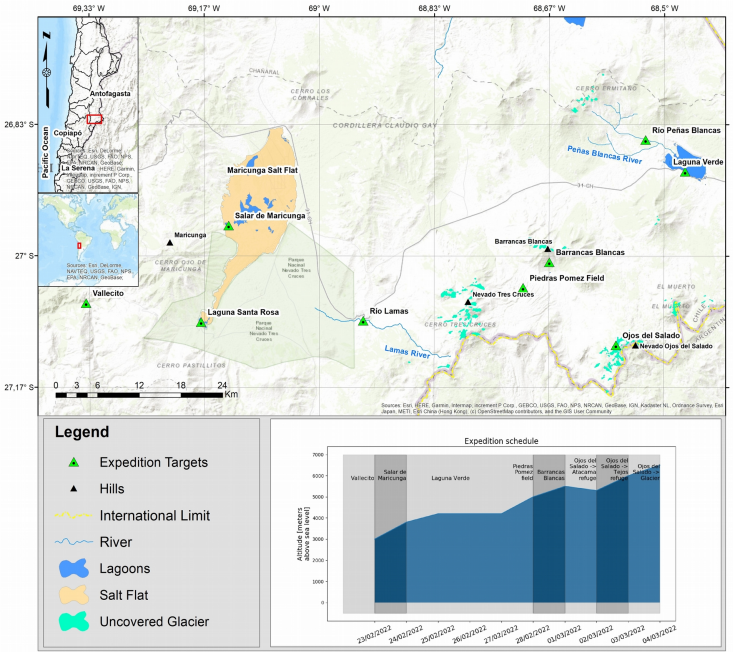

Figure 1 : Geographical area of interest and expedition schedule

Aware of the region's potential, the University of Atacama (UDA) has been trying since 2017 to federate multidisciplinary research around the use of the Puna de Atacama as a natural laboratory [3,4]. This project is partly based on the construction of a high-altitude laboratory, at 3800 meters above sea level (m.a.s.l) at the Salar de Maricunga site (26º92S / 69º08W -> Figure 1). After several postponements, this laboratory should be effective in 2022. Despite this delay, expeditions led by the Cryosphere and Water Laboratory (LICA) of UDA have been carried out every year since 2017. In addition to the initial protocols related to glacial and periglacial geophysics [5], other protocols have gradually been added to respond to the desire to develop a multidisciplinary scientific research center within the Puna de Atacama. An approach to optimize the time spent at high altitudes, requiring acclimatization stages, has been implemented in order to maximize data collection during these expeditions. The internal collaborations within UDA then gave way to international collaborations, in particular in order to go beyond the classic research framework of the UDA, which is oriented towards environment and geosciences. In this context, links were established with the EuroMoonMars program (EMM), a structure associated with the International Lunar Exploration Working Group (ILEWG) and specialized, among other issues, in the organization of analogue campaigns, in particular in Utah [6-12], Hawaii [13,14], Etna [15] and Iceland [16,17].

The expedition organized at the beginning of 2021 [18] allowed a first interaction between LICA and EMM, mainly in the form of remote support. In early 2022, EMM collaborators will physically participate in the high-altitude campaign by setting up their own

protocol. This 2022 expedition will take place from 21st of February to 5th of March 2022 (with 10 days spent at high altitude) in the geographical area of the Ojos del Salado (27º11S / 68º54W → Figure 1), the highest active volcano on Earth (6893 m.a.s.l) and a potential Martian analogue [19]. The scientific work will be carried out using a mobile laboratory (Figure 2) over an altitude gradient ranging from 3800 to 6500 m.a.s.l.

Figure 2 : LICA Mobile Laboratory

Figure 1 shows the geographical area of interest and the expedition schedule. Table 1 summarizes the different protocols that will be implemented, focusing mainly on geophysics, geochemistry, astrobiology and human physiology in extreme environments.

PROTOCOL DESCRIPTION	ALTITUDE RANGE	AREAS OF INTEREST
1 : Recovery of shallow soil temperature and air temperature sensors for climatic monitoring .	*4500 – 6500 m.a.s.l*	*Ojos del Salado*
2 : Geophysical characterization of glacial & periglacial environment	*5000 – 5500 m.a.s.l*	*Barrancas Blancas glacier and Piedras Pomez field*
3 : Geophysical and geochemical measurement of hydrothermal complex	*4300 m.a.s.l*	*Laguna Verde*
4 : Biosignature characterization of extremophiles	*3800 – 5000 m.a.s.l*	*Laguna Santa Rosa, Salar de Maricunga, Rio Lamas, Rio Peñas Blancas, Laguna Verde, Piedras Pomez field*
5 : Meteorite research and micrometeorite flux characterization	*3800 – 6000 m.a.s.l*	*Northern part of Salar de Maricunga (meteorites) / Area to be defined for the collection of reference surfaces in the context of micrometeorite research*
6 : Geochemical study of the magmatic history of the area	*3000 – 6000 m.a.s.l*	*Laguna Santa Rosa, Salar de Maricunga, Rio Lamas, Rio Peñas Blancas, Laguna Verde, Piedras Pomez field, Ojos del Salado*
7 : Human adaptation to harsh environment	*0 – 6000 m.a.s.l*	*Entire expedition*
8 : Geophysical study of the magma chamber activity	*4200 – 5300 m.a.s.l*	*Laguna Verde, Piedras Pomez field, Ojos del Salado*
9 : Atmosphere UV transparency measurement to test for potential astronomical observations	*0 – 6000 m.a.s.l*	*Copiapó, Laguna Santa Rosa, Salar de Maricunga, Rio Lamas, Rio Peñas Blancas, Laguna Verde, Piedras Pomez field, Ojos del Salado*
10 : Genomics study of extreme organisms naturally adapted to live in higher cadmium and arsenic concentration	*3800 – 5500 m.a.s.l*	*Copiapó, Laguna Santa Rosa, Salar de Maricunga, Rio Lamas, Rio Peñas Blancas, Laguna Verde, Piedras Pomez field, Ojos del Salado*

Table 1 : Scientific protocols implemented on the field, in green, main protocols / in orange, secondary protocols / in yellow, pilot studies.

About twenty people, equally divided between local researchers and EMM collaborators, will take part in this expedition, with the additional involvement of a remote support team based in Europe and responsible for facilitating exchanges between the field and the outside world. The field team will include geologists, geophysicists, astronomers, microbiologists, astrobiologists, doctors and an artist, who will not only be in charge of communication operations, but will also capture snapshots of the expedition.

This first international and multidisciplinary expedition of this kind led by UDA through LICA, should be repeated annually, in particular with the EuroMoonMars program in order to develop the analogue terrestrial and space exploration research lines relating to the very specific environmental characteristic of the highest part of the Puna de Atacama in the Ojos del Salado region.

Acknowledgments: The authors are grateful to the Directorate for Innovation, Developement and Transfert of the University of Atacama (DIDET), the Secretariat of the Convention on Biological Diversity of the United Nation, Earth Space Innovation (ESI), MoonMars Foundation and all partners and institutions involved in this project aiming at the enhancement of the Puna de Atacama region.

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