

# First International ANDES-GEO Workshop

14-16 November 2018 in San Juan, Argentina

## State of the Art

ANDES (Agua Negra Deep experiment site) is an international initiative for the construction and operation of the first underground laboratory (1.750m below the surface) for particle physics in the southern hemisphere. It is located in the centre of the South American Andes on the border between Chile and Argentina (<http://andeslab.org/index.php>). The construction of the underground laboratory is an integral part of construction of two parallel tunnels from Argentina to Chile. Both tunnels allow a much easier flow of goods between the Atlantic (Brazil) and the Pacific Ocean (Chile). The construction of the tunnel tubes should be started in autumn 2018 or spring 2019. The Andes-project was initiated in 2011 in the field of particle physics. To maximize the scientific impact of the project, a strong interdisciplinary component of the project was required from the beginning. A geophysical and geo-scientific perspective (ANDES-GEO) was integrated into the science plan in June 2017 during the fourth ANDES-Workshops and since then the Andes-Coordination-Consortium strongly supports the ANDES-GEO-Initiative. To our knowledge, there is currently no comparable depth laboratory (1,750 m) in an active Orogeny and ANDES enable the unique research opportunity both in the geophysical-geo-scientific basic research as well as applied research (materials).

## Possible Aims

In the following, **Academic Committee Team** envisage three major experiments:

### **1) Permanent continuous observation of geophysical parameter**

Based on the long-term experience of the geophysical and geodetic observatory in the southern Black Forest (BFO), we propose to install dedicated geophysical and geodetic instruments, the entire range of the deformation frequency of static survey (mountain), growth, and self-oscillations of the earth ground times to local and regional events (earthquakes and tremor) covering the whole displacement spectrum from 0 Hz up to 100s Hz. The comparison of these new observations with current depth observatories, mainly in stable continental regions (e.g. BFO), will provide new insights and allow us to better understand, the physical and chemical processes during large earthquakes, mountain formation, subduction zone processes, and the associated hazards, including early warning.

### **2) Permanent determination of gas and fluid chemistry including isotope composition**

To characterize and quantify the gas and liquid chemistry that is generated by the orogenic processes and that influences the deformation process and can lead to the formation of mineral deposits, we will install devices to continuously monitor the fluid and gas chemistry and to measure their isotopic composition. The data obtained will be compared with the data from the geophysical instruments.

### **3) Laboratory for conducting experiments without influence of cosmic rays and spallation products**

The ANDES-Underground-Laboratory location of 1,750 meters below the earth's surface allows the investigation of crystallization processes in condensed matter without the influence of high-energy cosmic particles radiation and their spallation products. Such research on crystallization processes is not only of importance in the Geosciences, but also plays an important role in the materials science. At the same time, the researchers will perform similar crystallization experiments in Heidelberg and at the heavy ion accelerator facility FAIR of the Helmholtz Centre GSI Darmstadt. Glasmacher has a depth of experience in the application of accelerated ions for the modification of condensed matter under extreme conditions (pressure and temperature) at GSI, Darmstadt and with the construction of spectroscopic analytical equipment for experimental research at GSI.

In general, the ANDES-Underground-Laboratory provides the possibility of scientific experiments without the influence of the cosmic radiation and the spallation products in comparison to experiments under the influence of the cosmic radiation, GSI (DLR). Such experiments are potentially interesting for the fields of biology, medicine, and materials research.

The ANDES project driven by particle Physics is currently gaining momentum and is in its final stages to be approved by the Chilean and Argentinian governments. The ANDES-GEO initiative should be established, organized and coordinated by an ANDES-GEO-Consortium consisting of scientists from participating countries.

### **Background and Time Table**

Subduction zones are places where an oceanic plate is immersed in the earth's mantle. Processes that are related to the subduction are first order geoscientific processes that form and develop the surface of planet earth on a sustainable and long-term basis. The lithosphere above subduction zones are the places where large rich ore deposits form and extensive volcanic activity occur. In addition, these areas are home to the largest earthquake (90% of the energy release), as evidenced by the recent large and devastating events in Sumatra, Japan and Chile, and therefore represent a serious risk to human society. The South American subduction zone comprises the subduction of the oceanic plate (Nazca Plate) beneath the continental plate of South America and the location of the second highest mountain range on planet earth, the Andes. The construction of two road tunnels and the ANDES-Underground-Laboratory opens a complete transect with a limited 3-dimensional stretch through this active Orogeny, and allows insight into its recent and past processes. The suggested project will open a unique geological archive that allows studying fundamental geoscientific subduction-related processes of the present and past. In addition to the quantification of the long-term surface and rock uplift and erosion history, answers to questions of structure formation in igneous rocks, and metal accumulation (deposits) caused by gases and fluids are important and of economic relevance. Thus, the overall ANDES program provides the possibility to investigate the past subduction-related evolution, and allows comparing the long-term measurements in the underground laboratory, with palaeo-data. We envisage that the entire proposed research project would be conducted in three phases, and should be organized and directed by the ANDES-GEO-Consortium.

- 1) A preliminary phase (2019 - 2021), in which the first geophysical-geoscientific studies are performed at a surface transect following the direction of the tunnels and the location of the ANDES-Underground-Laboratory.
- 2) A second phase (2022 - 2024) partly parallel to the preliminary phase includes the accompanying investigations during the construction phase of the ANDES tunnels and the ANDES-Underground-Laboratory, and the installation and testing of the measuring instruments and experimental facilities for the long-term operating in the ANDES-Underground-Laboratory.
- 3) The main phase (2024 - open end) includes the long-term operation of measuring devices and the implementation of experiments under particularly outstanding conditions only in the depth laboratory is guaranteed. This main phase is an integral part of the planning phase of the depth laboratory and thus an important part of the long-term operation of the ANDES-Underground-Laboratory. For the first time, ANDES provides the opportunity to sustainably study long-term processes in an active subduction-orogeny in-situ and therefore, will provide a more accurate understanding of the associated deformation processes, the gas and fluid chemistry, and the response of the earth's crust.

**Rec. 1+2:**

Possible geoscientific research along a transect crossing the Andes in the area of the tunnel and the ANDES-Underground-Laboratory, during the preparatory phase might be (These research themes are only ideas and are not complete and should be discussed and enlarged during the proposed workshops):

The purpose of the **First International ANDES-GEO Workshop** is to discuss the establishment of a global ANDES Geoscience Consortium based on its potential research activities. Special emphasis will be laid in those first-phase experiments relevant to achieve this aim. Discussions will also encompass the coordination and financial support of the planned research activities. The above mentioned experiments are suggestions and can/should be enlarged.

**Topics**

1. Thermochronological investigations to quantify the long-term exhumation and erosion history of the Andes Orogeny;
2. Petrological-geochemical-geochronological (studies to characterize the Permian and Neogene geologic periods);
3. Magmatic rocks;
4. Tectonics (Analyses of tectonic features and quantification of the structural evolution);
5. Stress Field Measurements;
6. Seismicity and detection of possible tremor signals and slow slip events (Observing the background seismicity rate).
7. Acoustic Emissions (during the construction phase and in the subsequent years);
8. Geophysical experiments (seismology, geoelectrics, magnetotellurics, etc.);
9. Fluid and Gas Chemistry;
10. Physical Rock Parameters;
11. etc.

We will have two days (Wednesday and Thursday) of oral and poster presentations and intensive discussion. For Friday a field trip including the ANDES site (if snow permits) is organized. For further information and registration please visit: <https://andesgeo2018.com/>

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