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Observatory of transfers in the Vadose Zone

Mohamed Azaroual, Arnaud Isch

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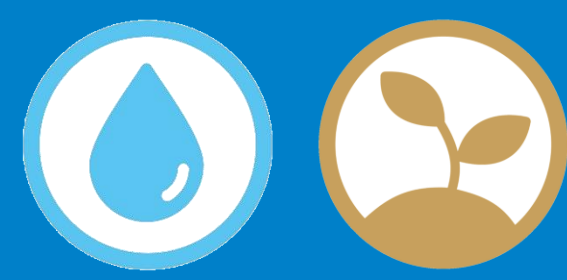
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O-ZNS is one of the 7 platforms of the **PIVOTS program** dedicated to the development of environmental engineering and metrology for activities with a high consumption of natural resources. Along the entire value chain, PIVOTS program brings together **public and private-sector actors in monitoring the quality of the environment** and the sustainable management of natural resources (soil, subsurface, surface water, groundwater, sediment, air).

The **O-ZNS platform** aims to understand and quantify the transfer processes in the Vadose Zone (VZ). The platform exceptionally large (well with a diameter of ~4m and a depth of ~20m) gives access to all ZNS column, from the ground surface to the Beauce aquifer and allows to:

- *in situ* and real-time monitoring of coupled physical, chemical, and biological processes
- the benchmarking of environmental monitoring techniques over the long term and the development of innovative technologies dedicated to the fine characterization of mass and heat transfers within ZNS
- the development of long term evolution logs and environmental databases



Materials and methods

A complete characterization of the initial state of the vadose zone of the site through the implementation of small boreholes and geophysical imaging prior drilling the O-ZNS well

- Geotechnical investigations: three core borehole and one pressuremeter test
- Surface and/or borehole geophysical imaging:
 - Gamma-ray, gamma-gamma and neutron logging
 - Electrical resistivity, radar and seismic tomography
 - Proton magnetic resonance spectroscopy
- Laboratory tests: characterizations carried out on a selection of samples representative of the lithologies of the vadose zone.



Geotechnical investigations



Geophysical imaging



Laboratory tests

- Information on the lithology and geology in place, clay levels, density, porosity and resistivity of the vadose zone materials
- Determination of the physical and mechanical properties of vadose zone samples

An unconventional triaxial system coupled to the multistep outflow method to determine the hydric properties

- Studies carried out under saturated and/or unsaturated conditions
- Consolidation of the sample to restore its natural pressure conditions
- Determination of physical and hydric properties of soil and sediment samples and limestone rocks (K_s , $K(h)$) and $\theta(h)$



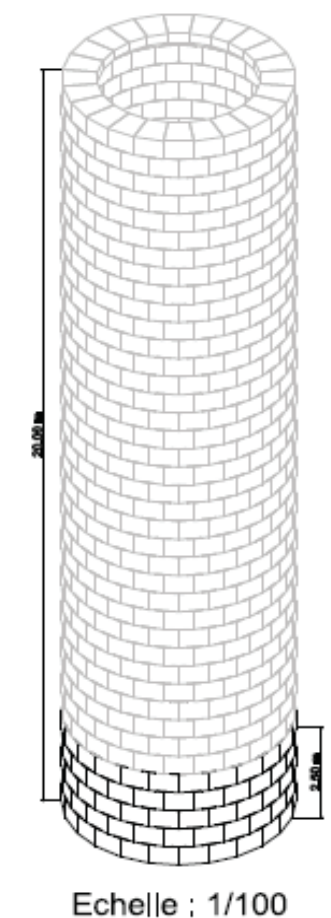
Unconventional triaxial system

Examples of operations and services

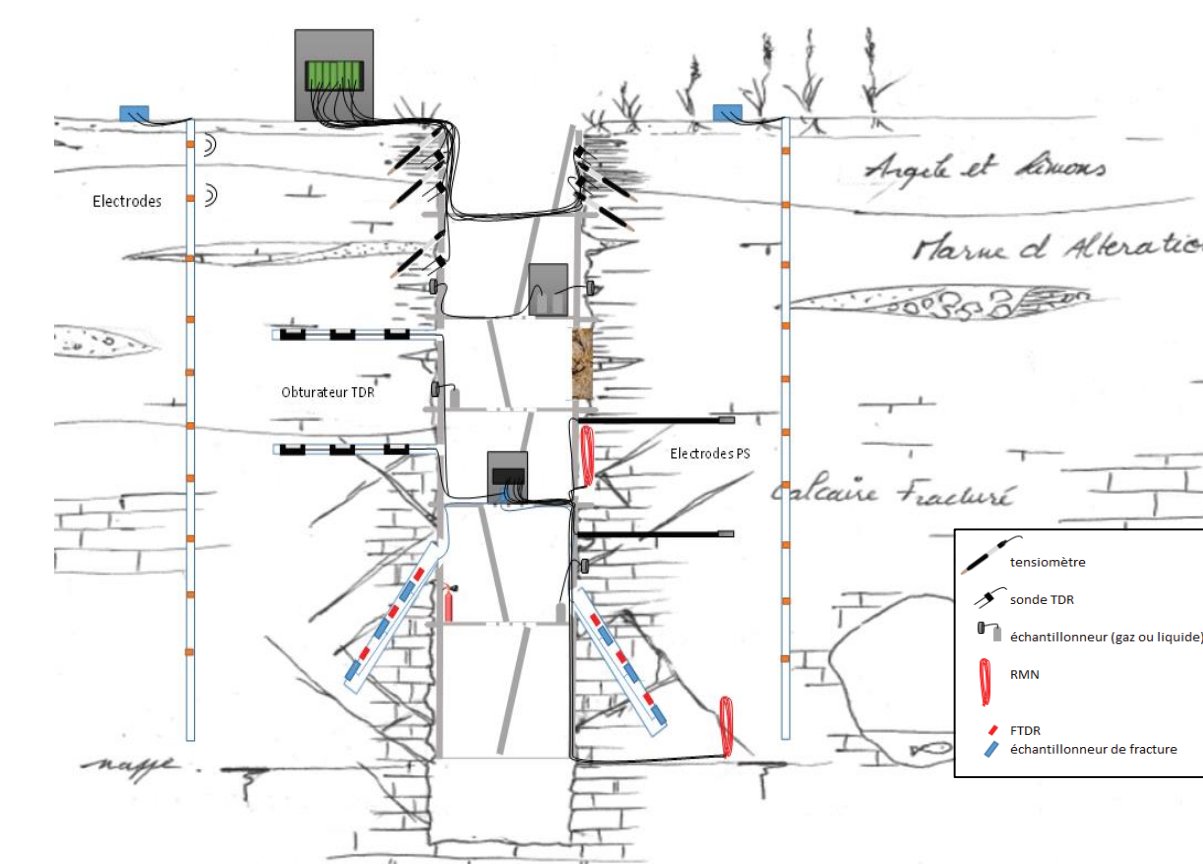
- **Implementation of commercialized sensors and/or innovative prototypes under development**
- **Tests of the performance** of environmental monitoring techniques **over the long term** (accuracy, time drift, loss of integrity, power consumption, etc.)
- **Couplings** between different relevant measurement and characterization techniques **to understand coupled critical phenomena**
- Development and/or validation of **multiphase reactive transport models helping environmental risks management** (storage/destocking of diffuse pollution, flooding risks, etc.) and the safe exploitation of underground resources

A well for access to the complete column of the VZ, equipped using innovative environmental monitoring techniques with relevant/adapted sampling levels

- Original and unique observatory with exceptional dimensions
- Allows to tackle scientific and technological challenges and locks linked to the well development
- Supporting the well by a circular limestone structure (durable, inactive chemically and non-magnetic)
- Sealing stones and filling voids between construction blocks are based on adapted materials for carbonate geology



Conceptual scheme of the support of the well
Echelle : 1/100



Conceptual scheme of the well instrumentation planned at t_0

- Instrumentation platforms arranged inside the well over the 20m depth
- Monitoring techniques: geophysics, physics, chemistry, thermal, micro-movements, microbiology sampling of water, gases, etc.
- Areas of interest already identified

- Addressing the innovation needs for the private and industrial developments
- Academic and industrial partnerships (internships, thesis, innovation support projects for the private sector, etc.)
- Provision of interoperable environmental databases
- Provide access to the exploitation of the well (experiments, tests of emerging technologies, performance tests of numerical models, etc.) by engineering and academic research actors
- Integrate national (OZCAR, etc.) and international (CZO, etc.) scientific observatories infrastructures