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Observatory of transfers in the Vadose Zone

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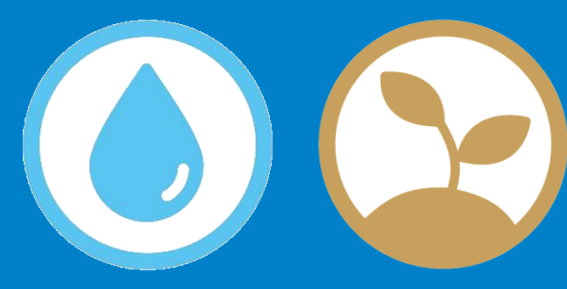
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O-ZNS is one of the 7 platforms of the **PIVOTS program** dedicated to the development of environmental engineering and metrology for activities with a high consumption of natural resources. Along the entire value chain, PIVOTS program brings together **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

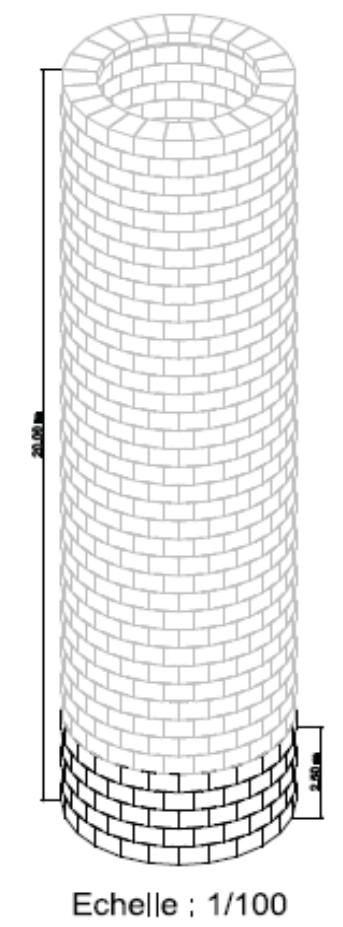


Laboratory tests

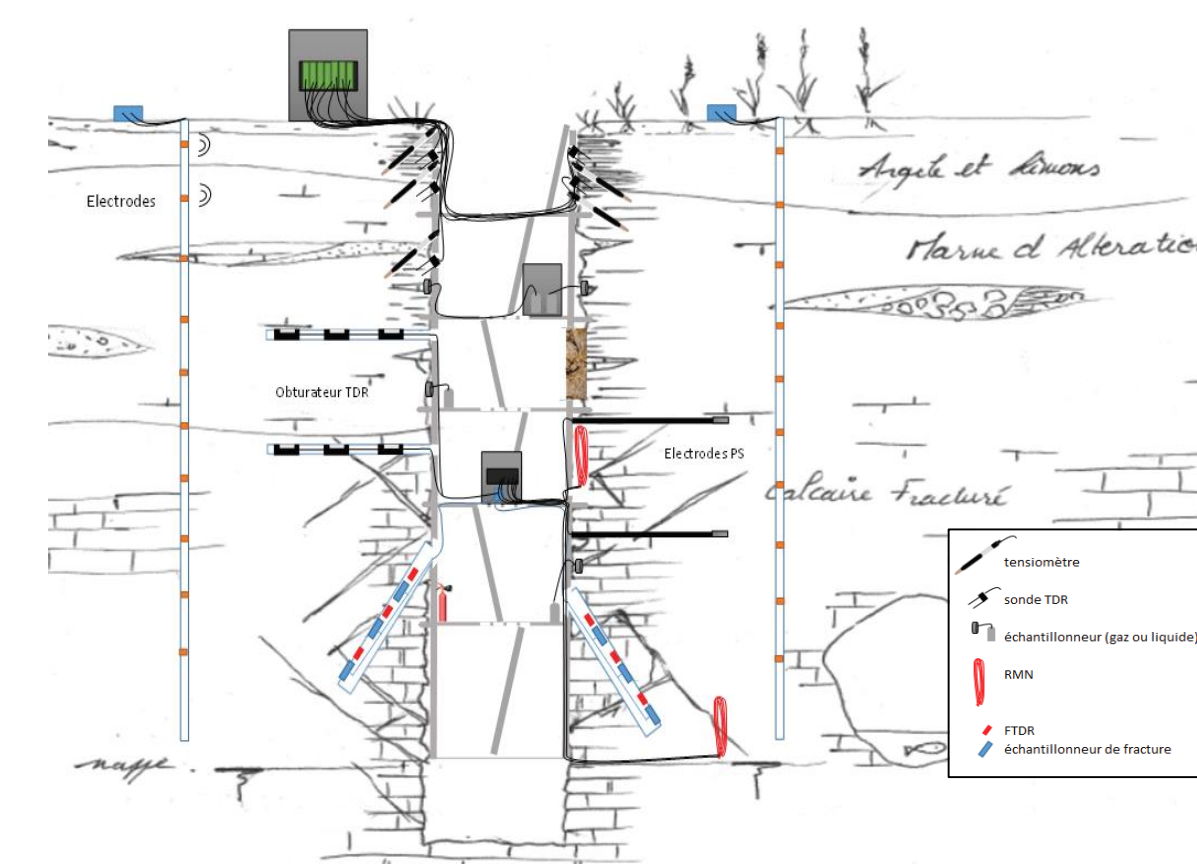
- Information on the lithology and geology in place, clay levels, density, porosity and resistivity of the vadose zone materials
- Determination of the physical and mechanical properties of vadose zone samples

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



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

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

- 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

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



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