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The Hydrogeological Experimental Site of Poitiers University (France)

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Origin of the hydrogeological experimental site (HES)

In 1991, the French government decided to create a storage site for long-lived nuclear waste. After studying some thirty sites, three of them were selected for an underground laboratory: Bures (Meuse and Haute-Marne), Chasclan (Nord), and La Chapelle Bâton (Vienne). In the end, the Chapelle-Bâton site was not selected due to severe fracturing of the granite. However, the abandonment of this site enabled part of the Jurassic research program to be transferred to the *Le Deffend* site near Poitiers (Commune of Mignaloux Beauvoir) as part of the XIIth “Etat-Region” plan (CPER 2000-2006). The research objective, led by Gilles Porel and his team at the University of Poitiers, was initiated to experimentally test theories on fractured media in terms of flow, pollutant transport, and identification of hydrodynamic parameters (Bernard, 2005).

The Poitiers Hydrogeological Experimental Site (HES) was then developed next to a botanical garden of Poitiers University (Le Deffend). The site covers 33 hectares,

and a large meadow was used for drilling (Fig. 1). The HES is animated by the IC2MP/Hydrasa team (UMR CNRS 7285) as part of the National Network of Hydrogeological Sites (SNO H+) and the 'EAUX' programs of the former Poitou-Charentes region (CPER 2002-2006 and 2007-2013).



Figure 1 *Aerial view of the HES.*

HES description

The HES is situated in the middle of the Poitou threshold, in the watershed of the Clain river (Fig. 2). The plateau is above 125 m above sea level, and a little talweg crosses the site.

The first drilling campaign (2002) resulted in the completion of eight wells distributed over a wide area, intending to establish a protocol for positioning future boreholes. However, the heterogeneous nature of the formations encountered and the discharge rates observed by air-lift testing did not allow for the development of a drilling strategy based on lithology or fracturing. Consequently, a “five-spot” design was adopted for subsequent boreholes.

Widely used in the oil and gas industry to maximize reservoir recovery, the five-spot scheme enhances fluid circulation and reservoir drainage by positioning one central well surrounded by four additional wells located at the corners of a square. At the beginning of summer 2003, a second drilling campaign was initiated to install the experimental system, which was completed at the end of 2004. Following these three phases, the system now provides four distinct mesh sizes: i) 13 meshes with 70-m sides, ii) 5 meshes with 100-m sides, iii) 5 meshes with 140-m sides, and iv) 1 mesh with 210-m sides (Fig. 3).

At present, the experimental platform comprises 45 boreholes, including two vertical and two oblique cored holes. The vertical cores (C1 and C2) were drilled to investigate sedimentary heterogeneity and fracturing in the limestones, while the two oblique cores (C4 and C5) targeted potential fault zones (see location on Fig. 2).

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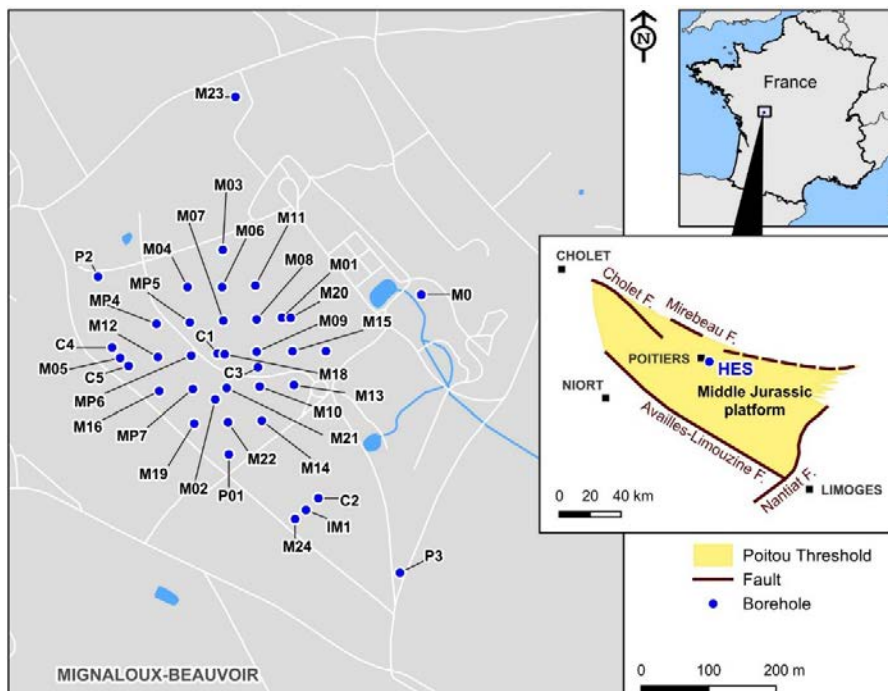


Figure 2 Location of HES boreholes.

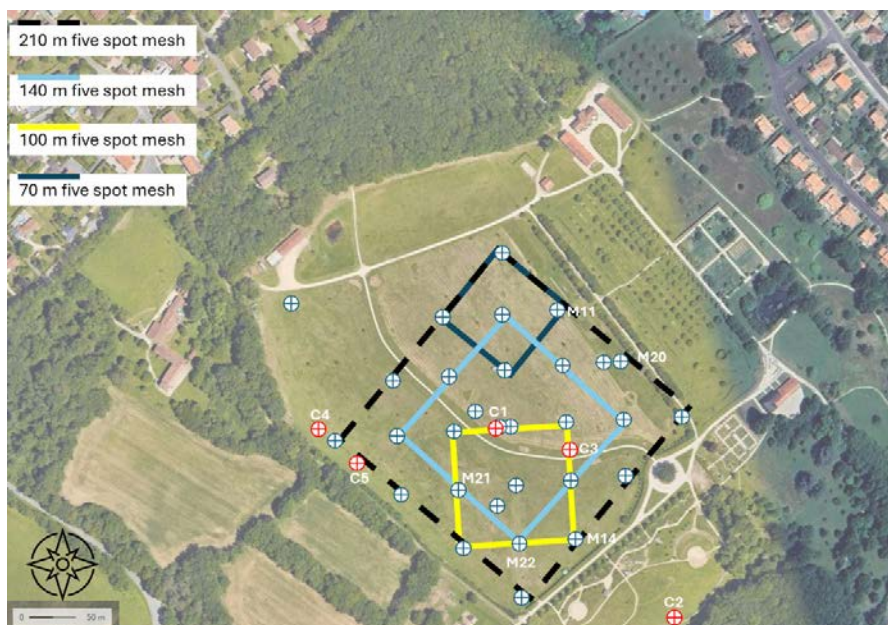


Figure 3 Mesh size distribution of the defend HES.

The HES boreholes are either left uncased or fitted with casings screened across the full thickness of the Supra-Toarcian aquifer. As a result, the piezometric level recorded in the boreholes reflects an average hydraulic head over the aquifer's thickness. Under natural conditions, piezometric levels range between 20 and 25 m below the ground surface. Drilling consistently revealed dry clayey limestones down to about 30 m, confirming that the Dogger aquifer is confined beneath this low-permeability formation. Two additional boreholes (C2 and IM1, each ~160 m deep) were drilled into the crystalline basement to monitor hydraulic heads in the Infra Toarcian aquifer during hydraulic testing in the other wells. No pressure disturbances were ever detected in the Infra-Toarcian aquifer, demonstrating that they are effectively isolated from the Supra-Toarcian aquifer by the Toarcian marls (Porel, 2024).

Scientific studies

Since 2002, investigations carried out on the HES have resulted in the collection of a large amount of data concerning the Supra-Toarcian aquifer (Mari and Porel, 2024). These data, now archived in the H+ database (<http://hplus.ore.fr/poitiers/donnees-poitiers>), concern:

- the geological structure of the reservoir: stratigraphy/lithology on two core drillings, 3D seismic imaging of the reservoir, Vertical seismic profiles (VSP), Full waveform acoustic logging, Gamma ray logs, acoustic imaging, high-resolution camera, and optical televiewers acquisition (OPTV);
- petrophysical properties of carbonate rocks: laboratory porosity and permeability measurements on core samples;
- flow structure in boreholes: heat-pulse flowmetry, cross-flow logs; temperature-conductivity logs;
- groundwater dynamics under “natural” and/or forced flow conditions: pumping tests and slug tests;
- transport dynamics (non-reactive) in forced flow: Radially convergent tracer tests (RCT).

HES is currently used for the training in hydrogeology and geophysics of young professionals and students coming from universities and high schools. HES is used to study the vadose zone, and data collected since 2002 could be useful to study the impact of climate change on groundwater.

The site gives universities and private companies the opportunity to conduct in situ tests and research projects, for example, the “Karst'ogène” project of CPGF HORIZON.

References

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