

Adapting research towards monitoring the key phenomena during operation and retrievability phase : The example of seismic tomography

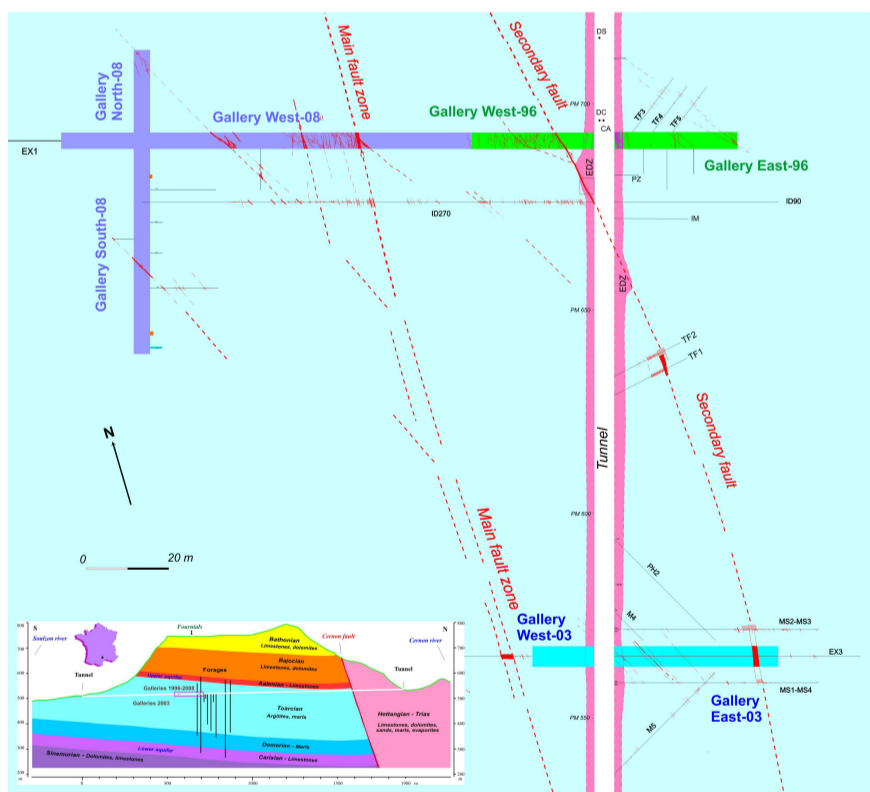
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Seismic surveys linked with safety assessment

Fluid transfers along tectonic structures or along fractures related to the gallery excavations (EDZ) may change confining properties of argillaceous rocks and are therefore important parameters for the safety assessment of deep nuclear waste repositories. The seismic tomography is a non destructive method that can be conducted during the operation and retrievability phase to detect discontinuities at depth.

Geological setting and gallery facilities of Tournemire Experimental Platform (TEP)

The tectonic strike-slip faults with small vertical offsets that affect the argillaceous formation in the TEP can be difficult to detect from the surface, as showed 3D seismic experiments. The old tunnel and the galleries that cross these faults provide a favorable configuration to assess the capacities and limits of seismic methods for the tectonic fault detection and EDZ evolution.



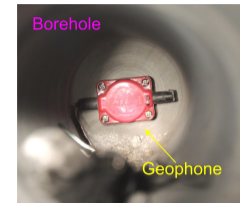
Structural simplified map of the central area of the TEP (Cabrera, 2013) with the seismic tomography area located between the tunnel and the galleries .

Seismic tomography between underground galleries

The acquisition layout extended over the tunnel and the galleries West-08 and South-08 (Bretaudeau et al., 2013), where several boreholes were excavated to compare tomography results with *in-situ* geological information. 116 geophones (40 Hz) were emplaced horizontally into the rock along the galleries and tunnel walls. The source was a hammer and a total of 23780 traces were analyzed.

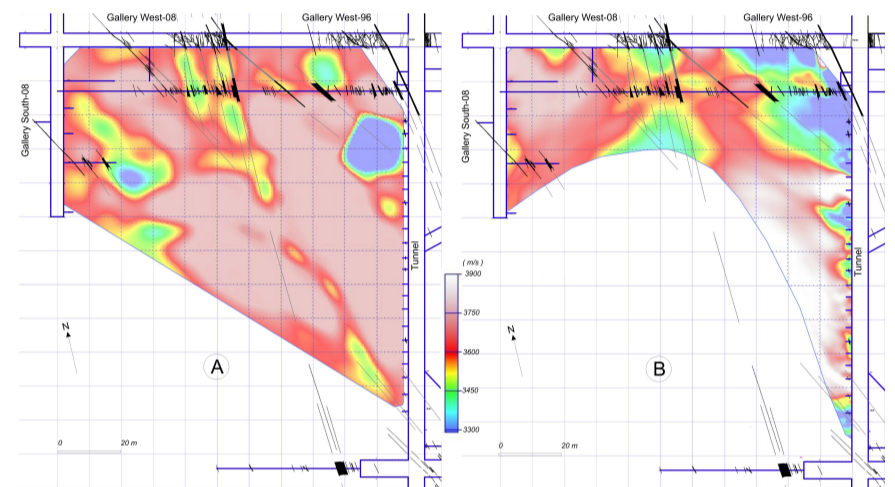


Geophones line along the gallery wall (West-08 gallery)



Geophone in borehole (Tunnel acquisition)

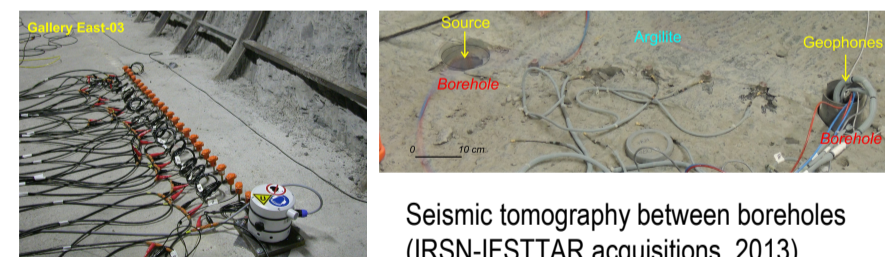
The first-arrival travelttime tomography and the full waveform inversion methods were applied. Inversion of the field data gives a velocity map in agreement with the fault zone and the local faults identified in the galleries and boreholes.



Velocity (P wave) maps obtained from the experimental data with (A) seismic full waveform inversion and (B) travel time tomography (Bretaudeau et al. , 2013).

Seismic tomography in the EDZ

The EDZs of different galleries were investigated with seismic tomography between boreholes or with seismic profiles located on the gallery walls and floors. The first inversion results give velocity profiles of P and S waves in agreement with the EDZ borehole mapping.



Seismic tomography between boreholes (IRSN-IFSTTAR acquisitions, 2013)

Seismic profile - S wave source

Other seismic methods are tested in the TEP, like seismic noise recordings or seismic anisotropy measurements. Furthermore, a seismic survey between the surface and the underground galleries was conducted in July 2013 in order to investigate the fractured zones in the limestone layer located above the argillaceous medium.

Geophysical research programs conducted in the TEP (IFSTTAR, Mines ParisTech and IPGS collaborations) show the potential of the seismic monitoring during the operational and retrievability phases of deep waste repositories.