Seismic velocities to characterize the soil-aquifer continuum on the Orgeval experimental basin (France)

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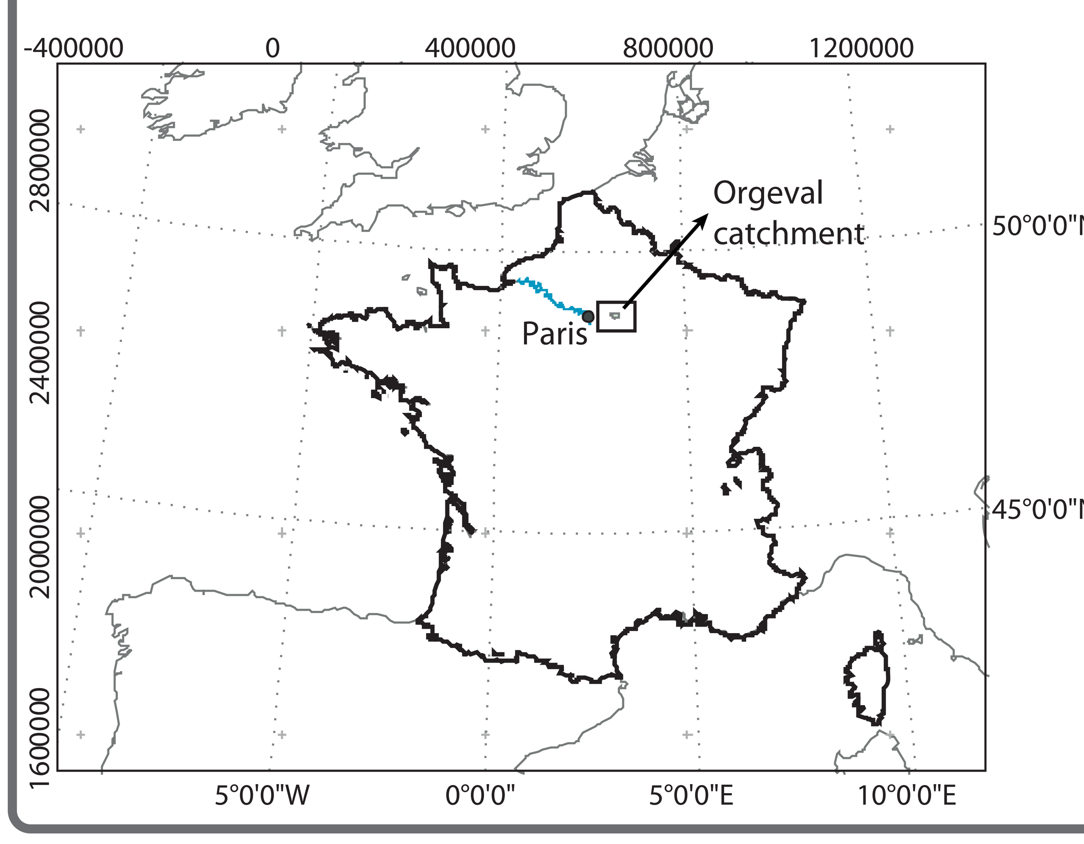
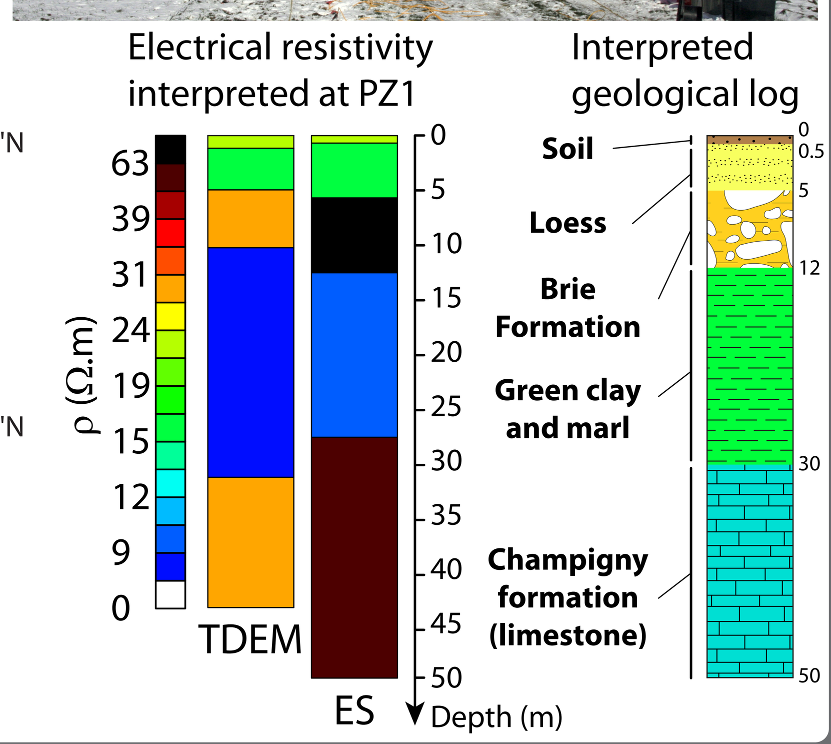
Among geophysical methods applied to hydrogeology, seismic prospecting is frequently confined to the characterization of aquifers geometry. The combined study of pressure (P-) and shear (SH-) wave velocities (respectively *Vp* and *Vs*) can however provide information about the aquifer parameters, as it is commonly done for most fluids in hydrocarbon exploration. This approach has recently been proposed in sandy aquifers with the estimation of *Vp/Vs* ratio (Konstantaki *et al.*, 2013). In order to address such issues in more complex aquifer systems (*e.g.* unconsolidated, heterogeneous or low-permeability media) we carried out P- and SH-wave seismic surveys along with surface-wave profiling on the Orgeval experimental basin (70 km east from Paris, France). P- and SH-wave first arrivals interpretation for tabular models provides 1D velocity structures in very good agreement with the stratification, while *Vp/Vs* ratios show a strong contrast at a depth consistent with the observed water table level.

1 The Orgeval experimental basin

The Orgeval experimental basin drains a multi-layer aquifer system monitored by a network of piezometers. Tabular layers are delineated with Electrical Soundings (ES), Time Domain ElectroMagnetic (TDEM) soundings and wells (Mouhri *et al.*, 2013).



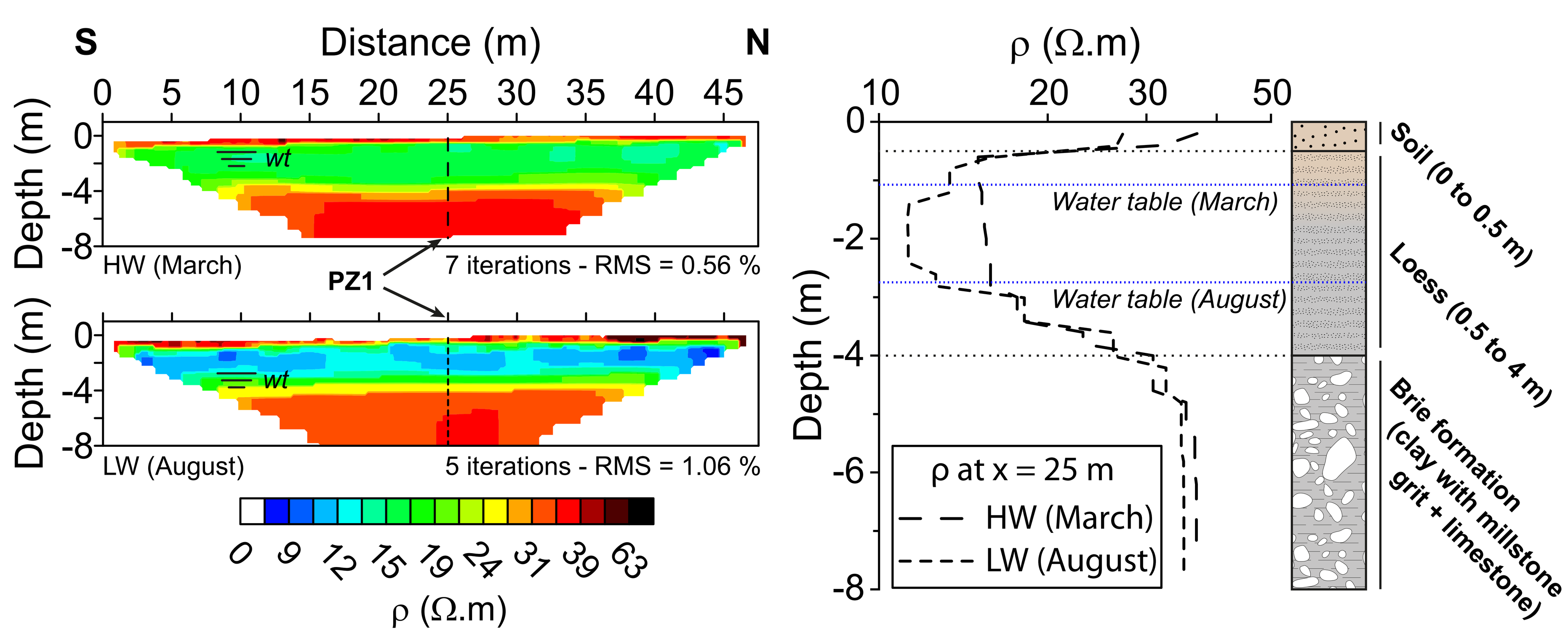


2 Electrical Resistivity Tomography

Wenner-Schlumberger – 96 electrodes – 0.5 m spacing

Measurements at High Water (March) and Low Water (August) periods

▹ *Tabular medium with low lateral variations*

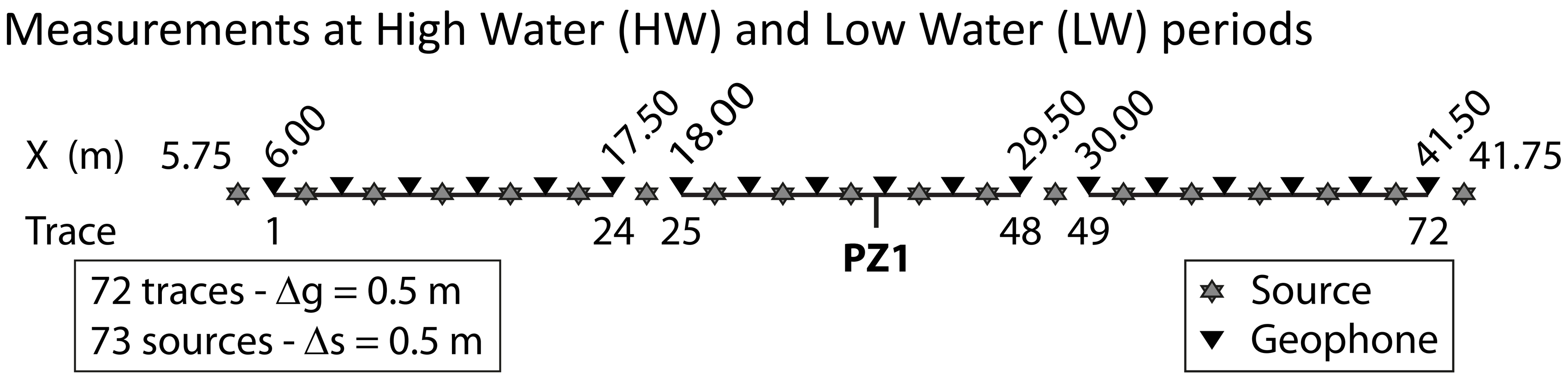


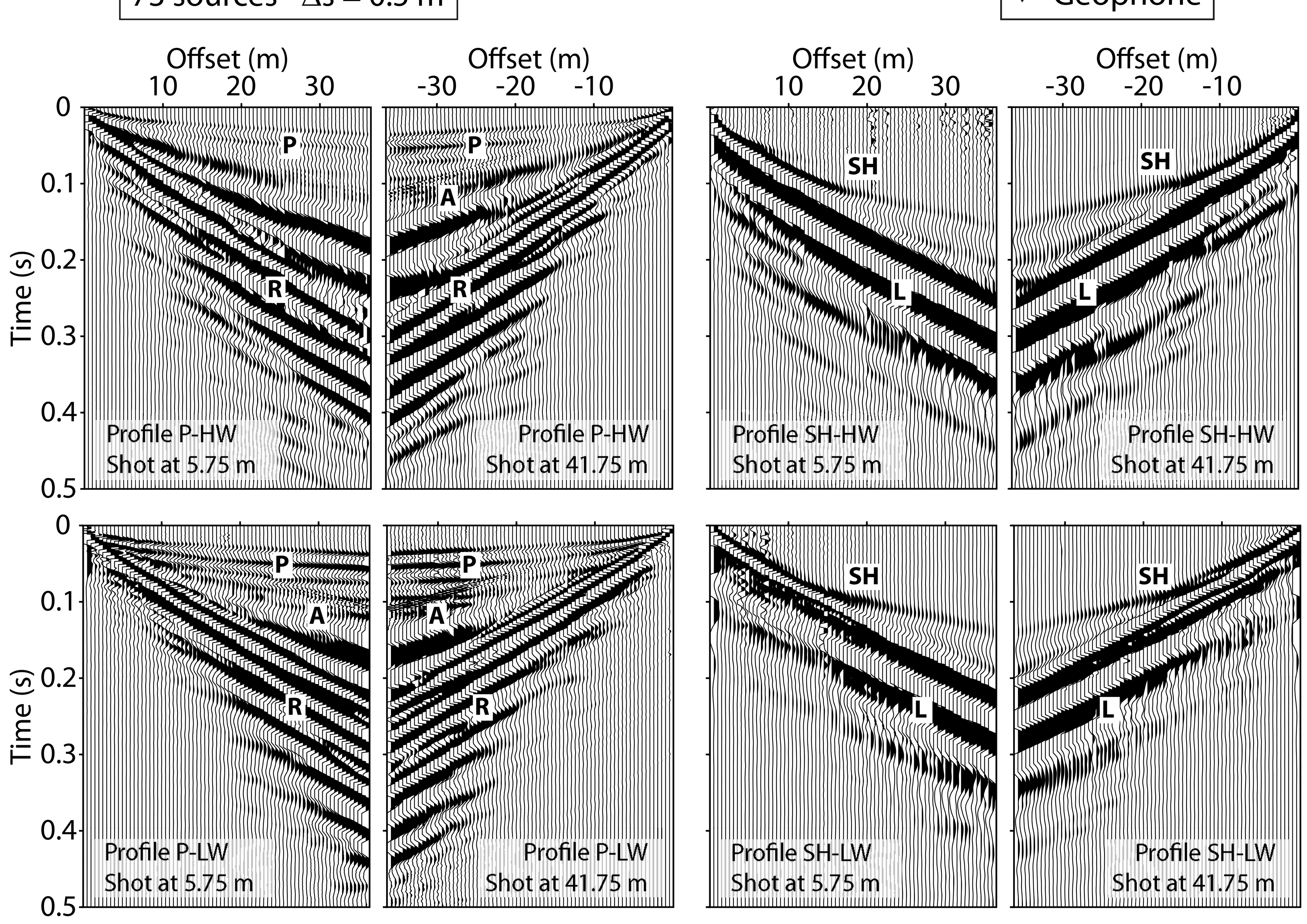
3 P- and SH-wave recorded seismograms

P-wave: sledgehammer + steel plate / 14 Hz vertical geophones

SH-wave: sledgehammer + S-Box / 14 Hz horizontal geophones

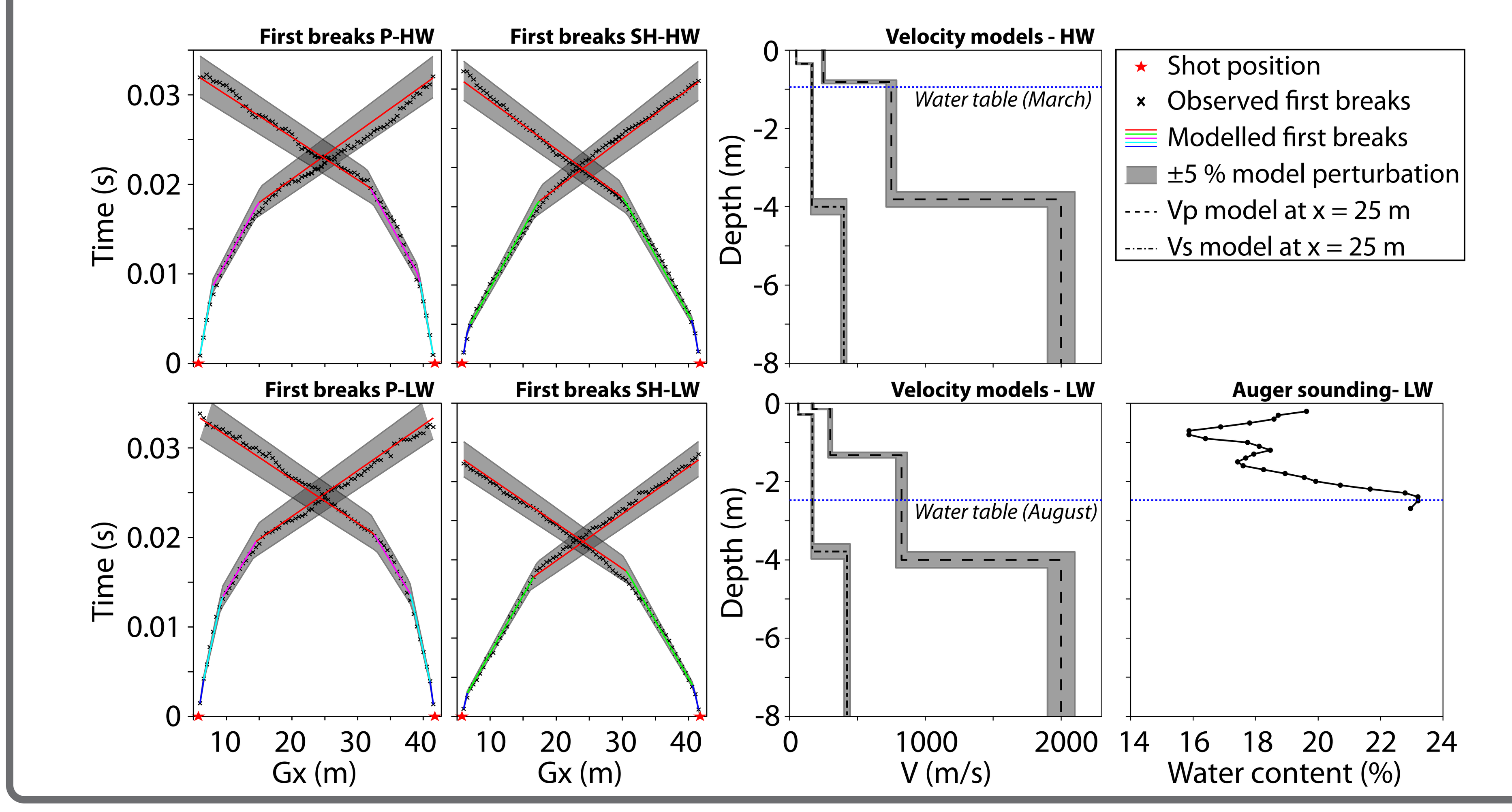
Measurements at High Water (HW) and Low Water (LW) periods



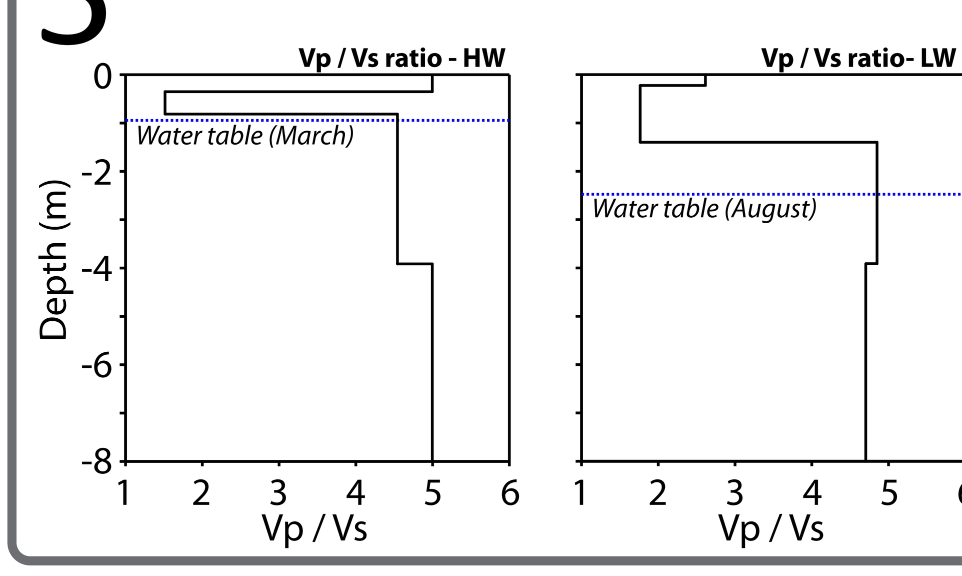


4 P- and SH-wave first arrival

P- and SH-wave first arrival are picked and interpreted as 2D models with tabular dipping layers.



5 Conclusions



- Lithology well delineated with ERT and refraction seismic
- *Vp/Vs* consistent with water table level (especially at High Water)
  - ▹ *Influence of the non-saturated to saturated transition zone on wave propagation?*
  - ▹ *Alternative to SH-wave acquisition?*

6 To go further... surface-wave dispersion inversion

Dispersion extracted from P-wave records at both HW and LW periods

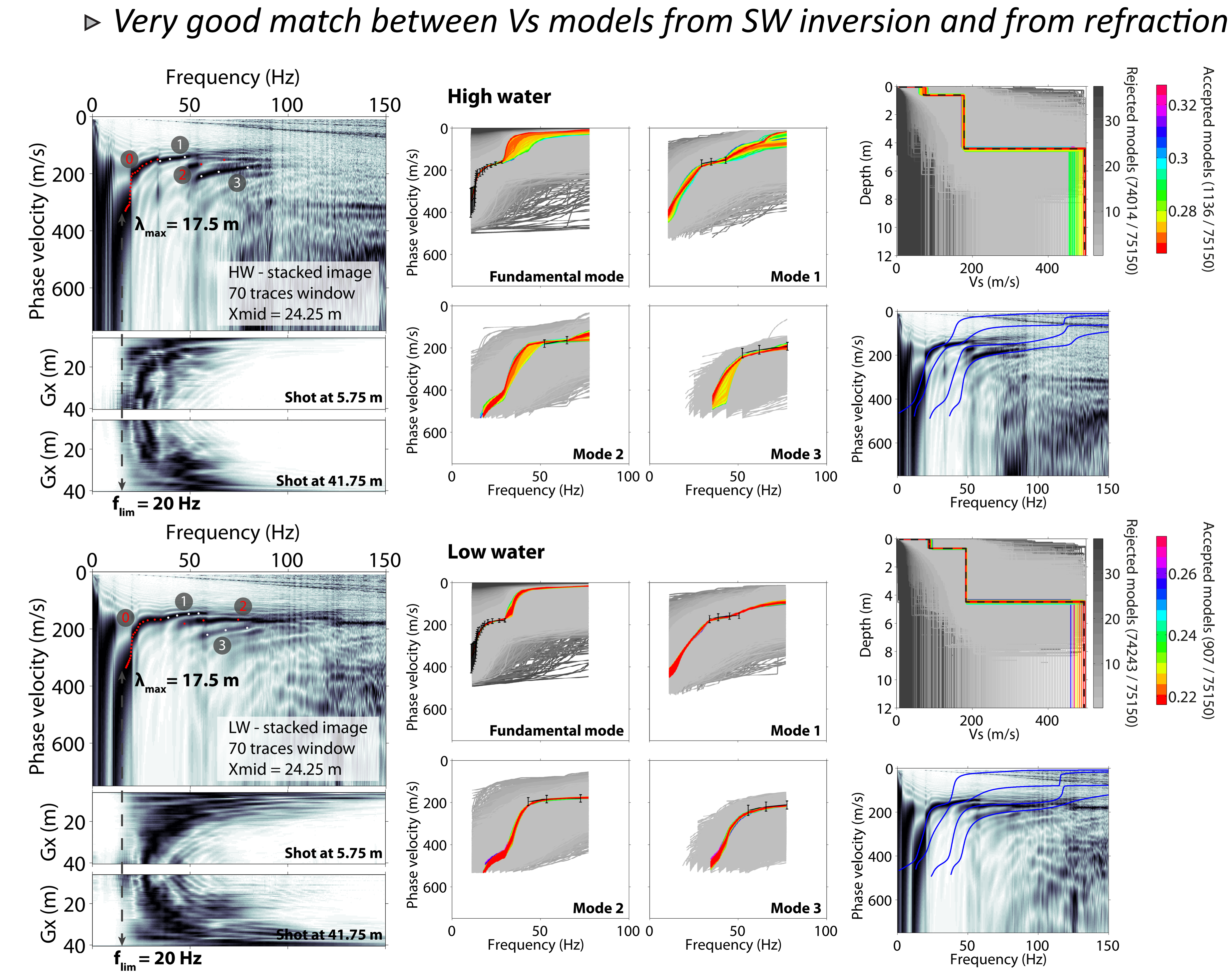
4 propagation modes identified and picked

1D inversion using a Neighborhood Algorithm (Wathelet *et al.*, 2004)

Average *Vs* model build from models fitting within the error bars

Theoretical dispersion curves computed from the average *Vs* model

▹ *Very good match between Vs models from SW inversion and from refraction*



7 Perspectives

Laboratory study of the transition zone by combining analogue modelling and ultrasonic techniques on water saturated porous media

Retrieving **2D** *Vp/Vs* with a single acquisition setup (P-wave source + vertical geophones) → **Meet me this afternoon (ID: NS43A-1784)**

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References

Konstantaki *et al.* (2013), *Near Surf. Geophys.*, **11**(4)
Mouhri *et al.* (2013), *J. of Hydrology*, **504**
Wathelet *et al.* (2004), *Near Surf. Geophys.*, **2**(4)