Seismic surface-wave dispersion profiling versus shear-wave refraction tomography on a granite-micaschists contact at Plœmeur hydrological observatory (France)

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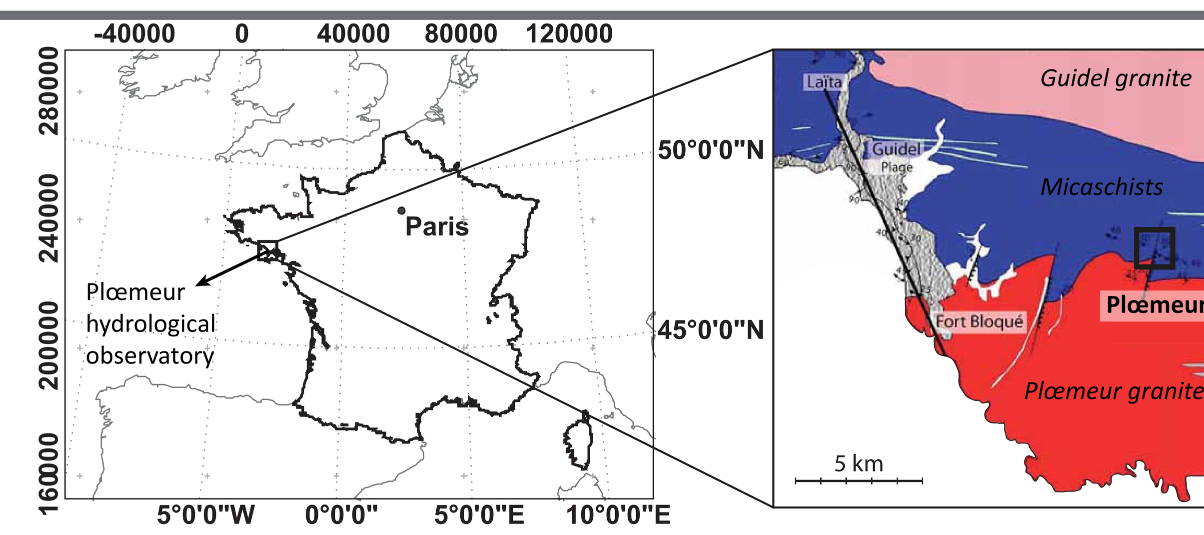
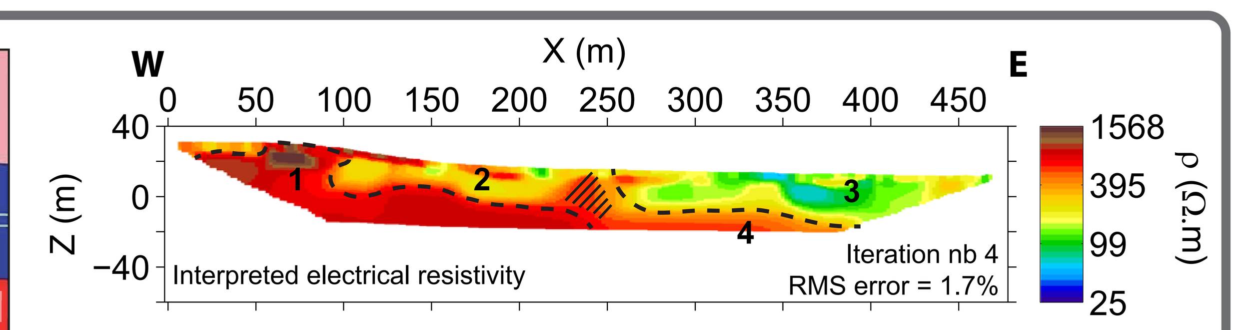
Despite generation and detection issues, shear (S-) wave-related techniques grow in popularity with the increase of multicomponent data acquisitions. Recent studies demonstrated that pressure (P-) wave reflection, P-wave refraction and surface-wave dispersion data could be simultaneously acquired for the characterization of the investigated medium (Konstantaki *et al.*, 2013). But refraction tomography and surface-wave dispersion inversion involve distinct characteristics of the wavefield and different assumptions about the medium. The methods thus provide results of different resolutions and investigation depths. We addressed these issues with a seismic survey conducted on a granite-micaschists contact at Plœmeur hydrological observatory (France). We performed simultaneous P-wave refraction tomography and surface-wave profiling, along with SH-wave refraction tomography, on a line intersecting the contact zone. S-wave velocities *(Vs)* obtained from both surface-wave profiling (Vs^{SWP}) and SH-wave refraction tomography (Vs^{TOMO}) show good agreement.

1 The Plœmeur hydrological observatory

is located at a contact between granite (West) and micaschists (East). Pumping wells are producing water at a rate of 10^6 m^3/year since 1991 (Ruelleu *et al.*, 2010).

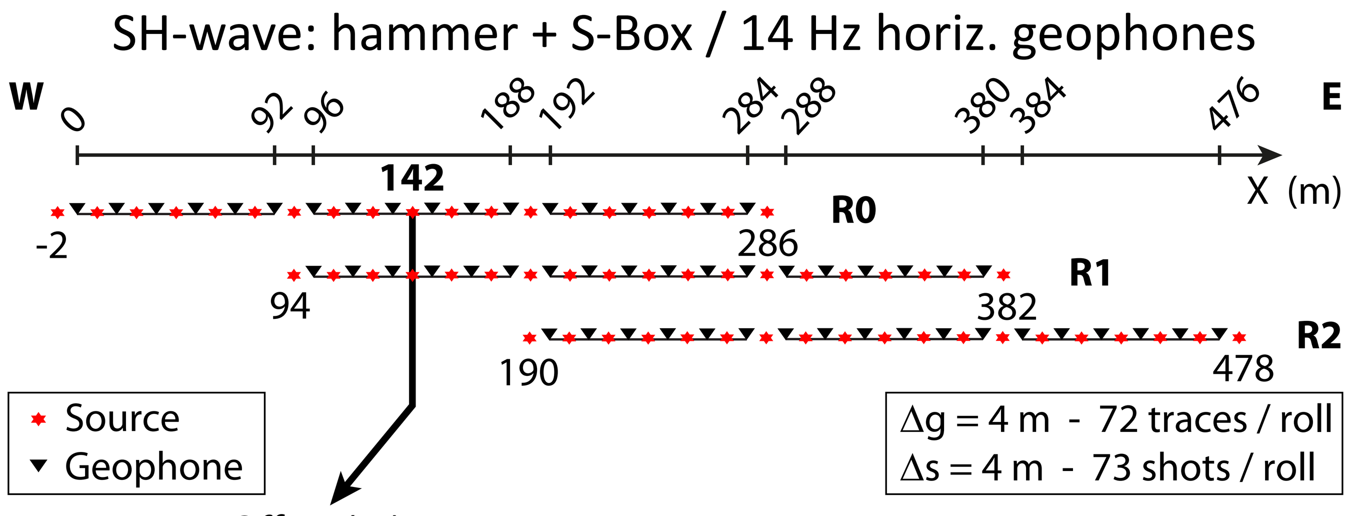


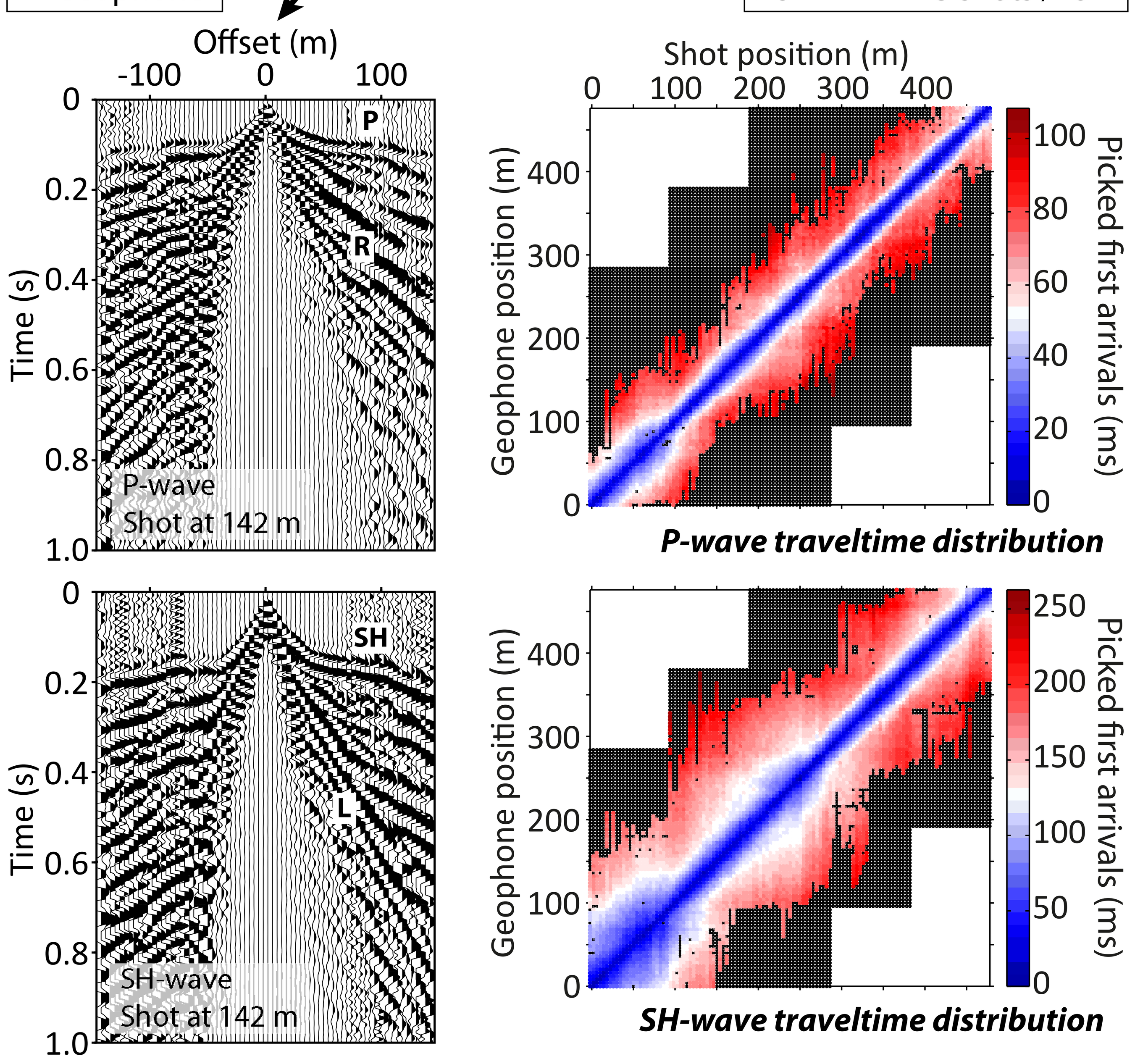


Interpreted limits for geological structures:
1- Granite
2- Weathered granite
3- Clays
4- Micaschists
Possible contact zone

2 P- and SH-wave recorded seismograms

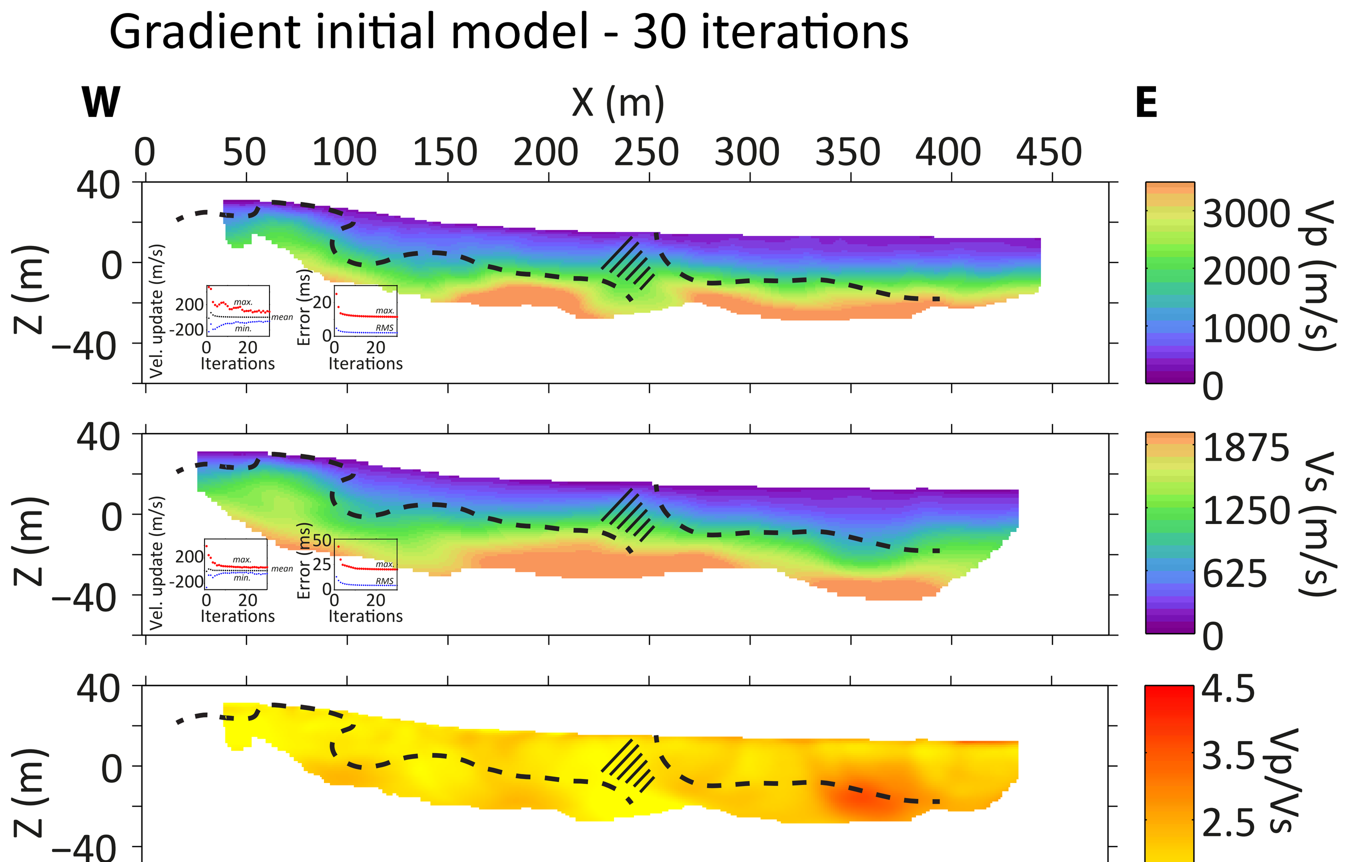
P-wave: hammer + steel plate / 14 Hz vert. geophones
SH-wave: hammer + S-Box / 14 Hz horiz. geophones





3 P- and SH-wave refraction tomography

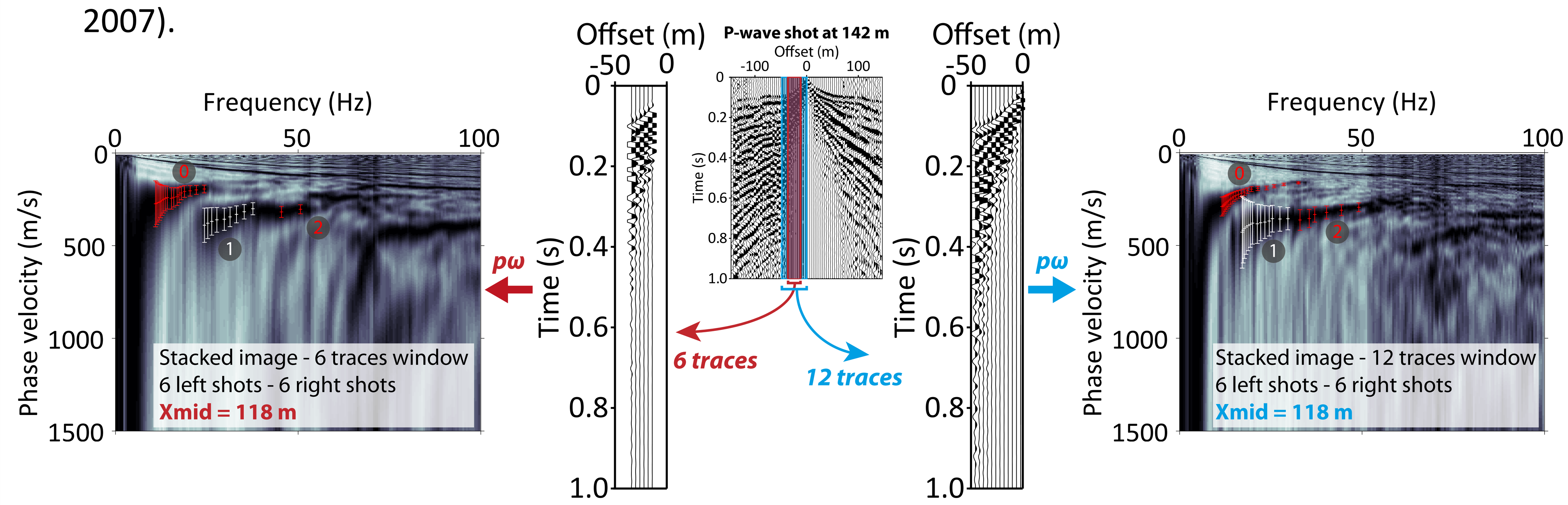
WET inversion (Schuster & Quintus-Bosz, 1993)
Gradient initial model - 30 iterations

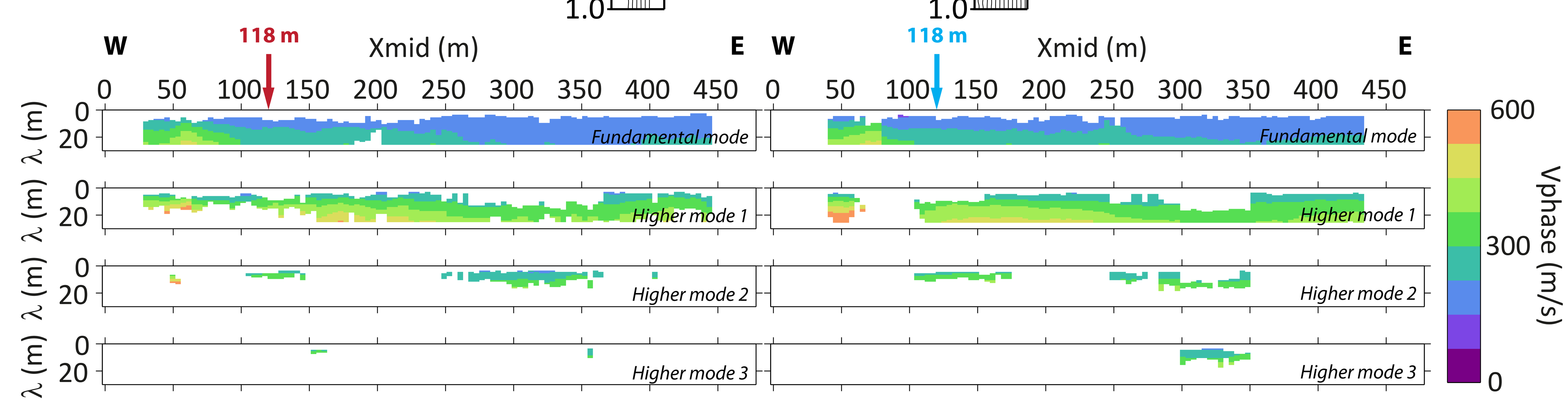


▹ *Good match with possible geological structures*
▹ *Vp anomaly => possible contact zone / Vs anomaly => clays*

4 Surface-wave profiling

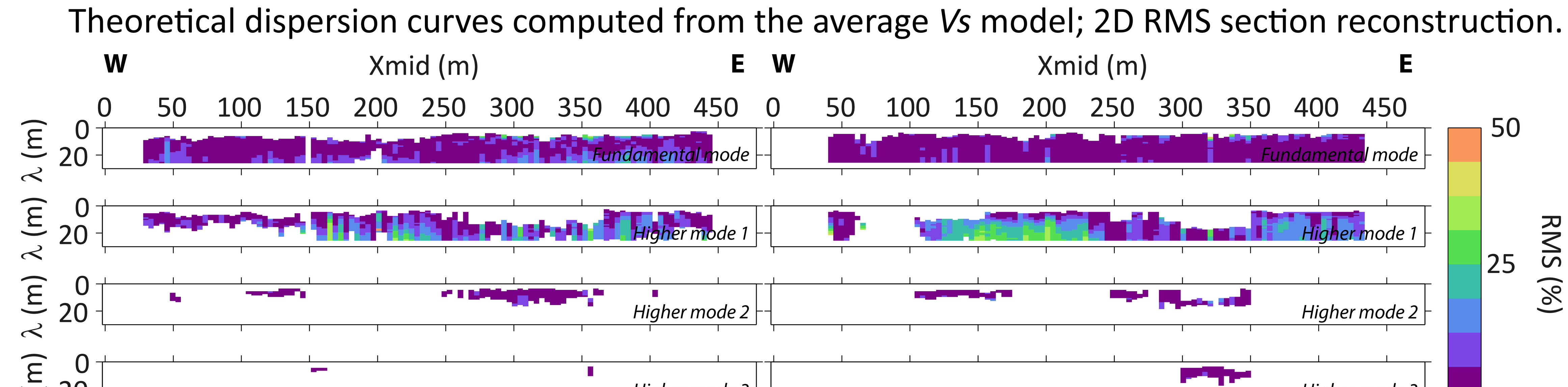
Dispersion extraction: offset moving window to narrow down lateral extent of dispersion measurements; stacking to improve signal/noise ratio and enhance higher modes (*e.g.* Neducza, 2007).

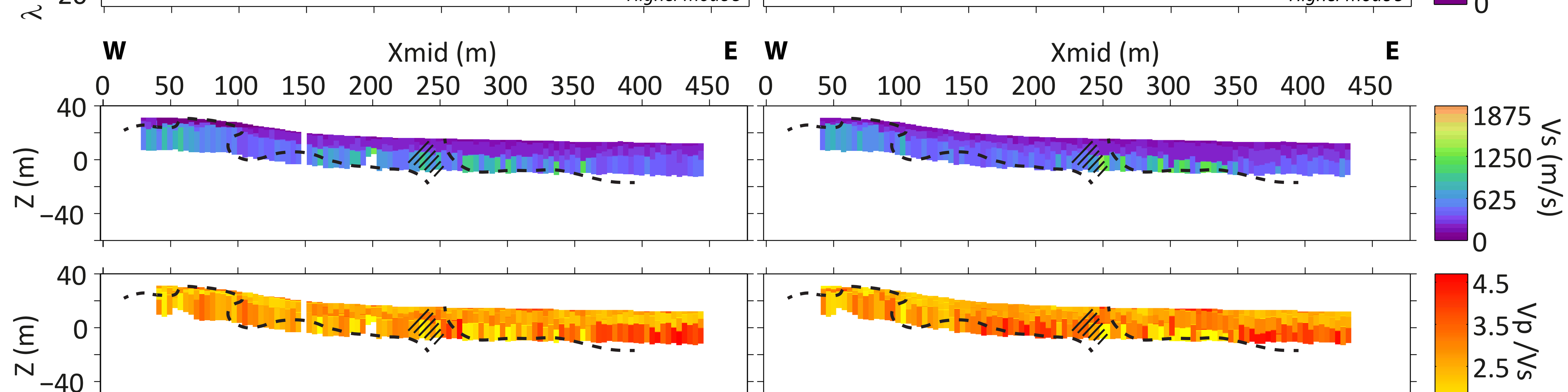




Dispersion inversion: 1D inversion using a Neighborhood Algorithm (Wathelet *et al.*, 2004) at each Xmid; average *Vs* model build from models fitting within the error bars; 2D Vs^{SWP} section reconstruction (Strobbia *et al.*, 2011) with no lateral constraint.

Theoretical dispersion curves computed from the average *Vs* model; 2D RMS section reconstruction.





▹ *Pseudo-2D section of RMS => a posteriori QC to select best window size (6 traces with lower RMS)*
▹ *No lateral contraint but continuous lateral variations of Vs^{SWP} with a 4-m window step*

5 Conclusions and perspectives

Very good match between *Vs* models from SW inversion and from refraction
Vs^{SWP} not limited by coverage => Vp/Vs^{SWP} enhance the clay/micashists zone

▹ *Compatibility issue between Vp^{TOMO} and Vs^{SWP} => retrieve Vp from guided waves*
▹ *Vp/Vs or Poisson's ratio => towards the characterization of the critical zone*

References
Konstantaki *et al.* (2013), *Near Surf. Geophys.*, **11**(4)
Neducza (2007), *Geophysics*, **72**(2)
Ruelleu *et al.* (2010), *J. of App. Geophys.*, **70**(2)
Schuster & Quintus-Bosz (1993), *Geophysics*, **58**(9)
Strobbia *et al.* (2011), *Near Surf. Geophys.*, **9**(6)
Wathelet *et al.* (2004), *Near Surf. Geophys.*, **2**(4)

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