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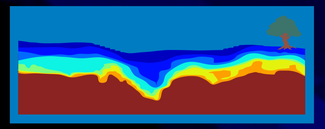

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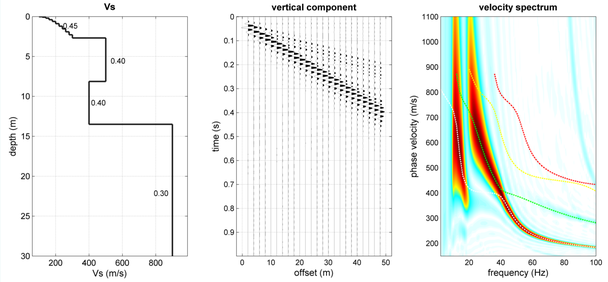
Optimizing the geotechnical exploration of vast areas via joint multi-component surface-wave velocity spectra analysis

1. What

Implementation of a *system* (acquisition and processing procedures) aimed at determining robust near-surface 2D shear-wave velocity (Vs) sections through the multi-component joint analysis of surface waves via *Full Velocity Spectra* (FVS) joint inversion.

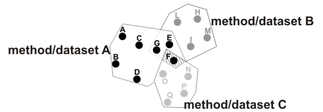
2. The problem

Understanding the velocity spectra can be extremely tricky (and sometimes even "impossible"). Consequence: **the analysis of single-component data does not ensure the determination of reliable V_S models** (in particular if standard *modal dispersion curve* anaysis is pursued – Dal Moro, 2014).

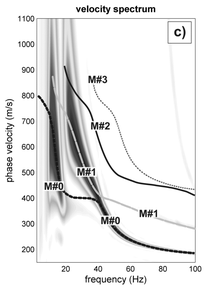


Synthetic dataset (vertical component of Rayleigh wave - ZVF): V_S model (indicated the Poisson moduli), the seismic traces and the phase-velocity spectrum.

Single-component analysis: ambiguities and pitfalls



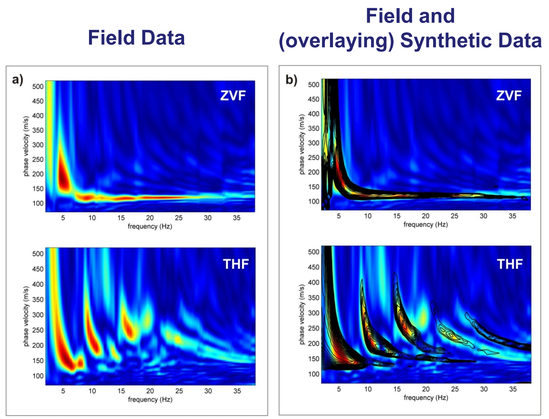
multi-component acquisition & analysis



The velocity spectrum explained in terms of modal dispersion curves: the continuity of the signal for frequencies higher than 20Hz is a misleading feature cause the signal acually pertains to two different modes.

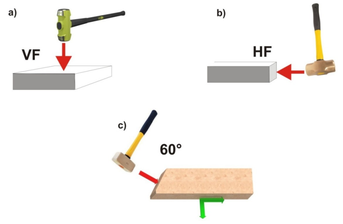
3. The approach: *Full Velocity Spectra* joint inversion

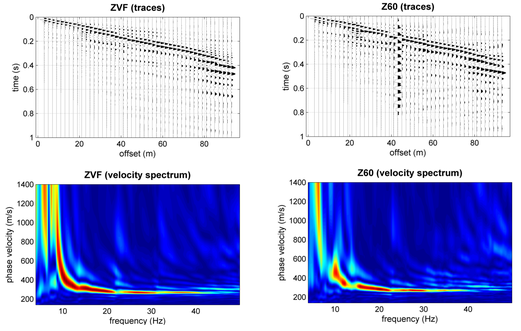
In the FVS approach, the velocity spectra are inverted in their totality (Dal Moro et al., 2015). The Figure reports the field velocity spectra of the vertical component of Rayleigh waves (ZVF) and Love waves (THF) [background colors] together, on the right column, with the velocity spectra of the model identified via joint FVS inversion [black contour lines]. The implemented FVS procedure is **highly automatized** (no dispersion interpretation/picking).



4. Optimizing field acquisition

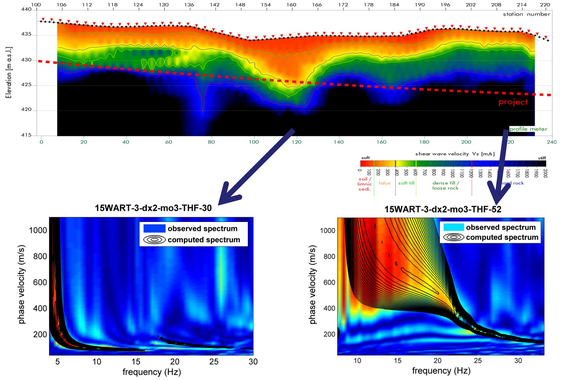
To optimize the simultaneous acquisition of multi-component data, we also tested a simple 60° wooden beam source and compared the velocity spectra of the ZVF and THF components (acquired while using the standard Vertical- and Horizontal-Force impact procedure) with the velocity spectra of the Z60 and T60 acquisitions. In the Figure the comparison between the ZVF and Z60 datasets.





5. A case study

We tested this **improved MASW approach** in the framework of a pipeline project in a complex geological situation with hard bedrock, basal till and a suspected channel filled with lacustrine sediments. It was assumed that the pipeline would cross the problematic channel and while drilling, problems may occur. To explore the subsurface conditions, a 250 m profile was acquired (Z60 + T60). The final shear wave velocity section clearly shows the expected channel, reaching a depth of about 10 m.



Two sample Love-wave shots

References

Multi-component Joint Analysis of Surface Waves **(Dal Moro G., Moura R.M., Moustafa S., 2015), *J. Appl. Geophysics* (in press)**

Surface Wave Analysis for Near Surface Applications **(Dal Moro G., 2014), *Elsevier,* ISBN 978-0-12-800770-9, 252pp**