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Influence of parameterisation on inversion of surface wave dispersion curves and definition of a strategy of inversion.

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Inversion of surface wave dispersion curve is a non-unique problem which highly depends on the chosen parameterisation (number of layers, parameters to invert, velocity law). Using direct search techniques (like the neighbourhood algorithm), the number of parameters should be kept low so that the whole parameter space can be explored within a realistic computation time, but high enough to adequately fit the observed dispersion curve. Our objective is to define a robust strategy that can be applied blindly on any dispersion curve without prior information.

To address this problem, we first investigated the seismic data available at the 20 instrumental sites selected by the European program NERIES (Network of Research Infrastructures for European Seismology). Our aim was to define representative Vs profiles for geological structures with soil layers overlying bedrock. Most of these seismic profiles, measured by down-hole or cross-hole tests, exhibit only one or two seismic layers before reaching the bedrock. Vs in each layer usually shows a linear increase with depth. We selected two sites as synthetic references, respectively with 1 and 2 soft layers.

In the first step of the inversion, we start from the most simple parameterisation (one layer over a half space), and we increase progressively the number of layers, i.e. the number of parameters. When computing a sufficiently large number of models, we find that the minimum misfit versus the number of parameters systematically decreases to reach an asymptotic minimum value. This misfit decrease results from the increasing flexibility of the theoretical dispersion curves to fit the experimental data. Above a given number of parameters, no additional gain is obtained on the misfit with a free search. The depths of the main velocity contrasts and their corresponding uncertainties are derived from this optimum parameterisation. In a second step, we locally relax the rigidities of the schematic model parameterisation (e.g. intermediate layers, uniform layers replaced by gradients) to extensively investigate the non-uniqueness of the problem.

This strategy was applied on the synthetic references and allowed the correct Vs profiles to be retrieved with no prior information. It was also tested on the corresponding real cases where active seismics and ambient vibration methods were used to derive dispersion curves on a wide frequency range.