The Effect of Lateral Variation and Different Model Parameterization on the Surface Wave Dispersion Inversion

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Abstract

The traditional inversion of the surface wave dispersion curve is usually carried out with the linearized techniques to obtain S wave velocities in layers with fixed thicknesses. Nonlinear inversion methods, which can simultaneously invert for both thicknesses and S wave velocities, are becoming more popular. Since layer thicknesses are expected to vary along the path propagation, several synthetic tests were performed with a 1D model inversion using the average dispersion curve of an inhomogeneous propagation path. In the inversions, we used an improved genetic algorithm and several different model parameterizations (e.g., fixed or variable thickness, smoothing constraints, etc.). For approximately homogenous structure (i.e., little lateral variation), the main features of the average synthetic model can be retrieved for different model parameterizations. For strong lateral variations, however, the average dispersion curve can produce very different 1D inverted models depending on the parameterization. Artifacts, such as strong low velocity zones can be produced. Also, the 1D inverted models may differ significantly from the average properties of the inhomogeneous path, and wrong depths to interfaces may be inferred. For real data inversions, it is then suggested that various different model parameterizations should be tested. If the resulting models show consistent features, this probably indicates little lateral variation in the propagation path. On the other hand, if very different and unstable features are obtained in the 1D inversions, then strong lateral variation may be present in the propagation path, and the average 1D model may not represent average properties along the path. As an application, data from a small earthquake in the Parana basin, SE Brazil, was inverted to study the average basement depth.