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Morphology and depth of reflectors from 2D non-linear inversion of Common Depth Point seismic data

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We developed a 2D non linear method for the inversion of reflected/converted traveltimes, based on waveform coherence, to obtain the location and morphology of seismic reflectors by using Common Depth Point (CDP) seismic reflection data. The method is specifically designed for geophysical investigations in complex geological environments where the presence of heterogeneous structures makes the standard velocity analysis difficult and degrading the quality of migrated images. The method is based on the travel time computation in a lateral heterogeneous medium, and it employs a scheme of non-linear optimisation for the determination of the interface parameters. The computation of reflection/conversion traveltimes is done by using the Podvin & Lecomte finite-difference solver of the eikonal equation, assuming an a priori known background velocity model and using the Fermat's principle. The reflector is described by a cubic-spline function whose control points are equally spaced in the horizontal direction. For the search of the optimal interface model we use a multi-scale approach and a global optimization technique (Genetic Algorithm) which search for the minimum of an objective function in the whole parameters space (i.e. vertical coordinates of spline nodes). We used two types of objective functions. The first one is a L2 norm, defined as the sum of the squared differences between observed and computed traveltimes. The second one is based on the lateral waveform coherence (semblance) of the reflected/converted arrival. During the initial stages of inversion we use the arrival times of the reflection phase to retrieve the interface model defined by a small numbers of parameters. In the successive steps the inversion is based on optimization of the semblance value determined along the calculated travel time curves. We present an application of the developed technique to synthetic CDP sections simulating the acquisition of reflection data in a complex volcanic structure.