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# Towards a new tool to develop a 3-D shear-wave velocity model from converted waves

Leonardo Colavitti and György Hetényi

University of Lausanne, Institute of Earth Science, Faculty of Geosciences and Environment, Lausanne, Switzerland (leonardo.colavitti@unil.ch)

The main target of this work is to develop a new method in which we exploit converted waves to construct a fully 3-D shear-wave velocity model of the crust. A reliable 3-D model is very important in Earth sciences because geological structures may vary significantly in their lateral dimension. In particular, shear-waves provide valuable complementary information with respect to P-waves because they usually guarantee a much better correlation in terms of rock density and mechanical properties, reducing the interpretation ambiguities. Therefore, it is fundamental to develop a new technique to improve structural images and to describe different lithologies in the crust.

In this study we start from the analysis of receiver functions (RF, Langston, 1977), which are nowadays largely used for structural investigations based on passive seismic experiments, to map Earth discontinuities at depth. The RF technique is also commonly used to invert for velocity structure beneath single stations. Here, we plan to combine two strengths of RF method: shear-wave velocity inversion and dense arrays.

Starting from a simple 3-D forward model, synthetic RFs are obtained extracting the structure along a ray to match observed data. During the inversion, thanks to a dense stations network, we aim to build and develop a multi-layer crustal model for shear-wave velocity. The initial model should be chosen simple to make sure that the inversion process is not influenced by the constraints in terms of depth and velocity posed at the beginning.

The RFs inversion represents a complex problem because the amplitude and the arrival time of different phases depend in a non-linear way on the depth of interfaces and the characteristics of the velocity structure. The solution we envisage to manage the inversion problem is the stochastic Neighbourhood Algorithm (NA, Sambridge, 1999a, b), whose goal is to find an ensemble of models that sample the good data-fitting regions of a multidimensional parameter space. The ensemble of the resulting models will be interpreted by taking into account a priori information of the main tectonic units of the region investigated. Depending on the studied area, our method can accommodate, during the inversion procedure, independent and complementary geophysical data (gravity, active seismics, local earthquake tomography, ambient noise tomography, etc.) helping us to reduce the non-linearity of the RF inversion.

We propose to first apply and benchmark our method in the Central Alps, where a dense permanent network with well over a decade of high-quality data exists. In this region there is also a wealth of geophysical information at hand to test the inversion scheme's performance with and without complementary datasets to assess the results. Later, the 3-D shear-wave inversion method can be extended to the entire Alpine domain (e.g. contributing to AlpArray project) and applied to other geological contexts with a sufficiently dense network of broadband seismographs (e.g. USArray, Japan).