Statistical verification of teleseismic body-wave tomography robustness: features of the Vrancea subduction zone

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We present to approach to statistical analysis of earth models derived from observed data with the standard ACH method. The ACH method is one of the most robust seismic tomography techniques. It is used to invert teleseismic travel-time residuals for velocity variations beneath a receiver array. The teleseismic delay time data observed between 1992 and 1997 from the Romanian National Seismic Network, which is collected and digitally stored at the National Institute of Earth Physics (NIEP) in Bucharest, presents a new opportunity for the global understanding of the structure and processes within the lithosphere-asthenosphere system of the Vrancea zone situated at the southeastern Carpathian Arc. Although in some case the data are incomplete in terms of station distribution, the inversion method is still useful for pointing out some striking features. In spite of some problems arising from the data this approach of a currently developed computer algorithm, which is not a strict straightforward way of interpretation, gives additional information for resolving vertical structures, a well known weakness of tomographic inversions using ray methods.

It is more or less a trial and error method, but it uses the strategic advantages of genetic algorithms, which are crossover, mutation and transmission. Starting with an individual set of picked travel-times for each event, the program randomly generates a parental generation of models, each of them satisfying specific rules within given boundaries. The ACH program for the calculation of delay times is modified to allow the calculation of residuals for the picked travel-times, which are then used to evaluate each single model. This results in a ranking of the models. The best solutions survive in the next generation undisturbed, mutated or mixed with new randomly generated models by means of crossover and transmission. If a given level of matching will be reached, these certain models will be stored. Depending on the size of each model string, and therefore computational demands, it is usually sufficient to calculate several hundred generations to receive an useful amount of satisfying solutions for further statistical examinations. The set of models will split into classes with similar characteristics. This gives a major progress in discussions with scientists from various branches of the geosciences.