EGU24-4874, updated on 11 Oct 2024
https://doi.org/10.5194/egusphere-egu24-4874
EGU General Assembly 2024

Earth structure from P-wave coda autocorrelation using particle swarm optimization

Jinju Zhou[1,2] and Hrvoje Tkalčić[2]
[1]School of Resources and Geosciences, China University of Mining and Technology, Xuzhou, China (zhoujj@cumt.edu.cn)
[2]Research School of Earth Sciences, The Australian National University, Canberra, Australia (hrvoje.tkalcic@anu.edu.au)

Teleseismic P-wave coda autocorrelation has been increasingly applied to subsurface structure detection and has shown potential for inverting subsurface velocity models. However, it has yet to be extensively investigated in terms of inversion and practical field data application strategy and initial model dependence. Compared with the receiver function, teleseismic P-wave coda autocorrelation can be used to invert the subsurface velocity model using only single-component data. This will significantly improve the application areas and reduce the costs of passive source seismology methods. Here, we propose a new inversion scheme for teleseismic P-wave coda autocorrelation based on the particle swarm optimization.

The teleseismic P-wave coda autocorrelations are binned according to the ray parameters and then stacked to construct the observed waveforms. Our featured method, the particle swarm optimization, is then used to find the velocity model that minimizes the fitting error to the observed waveforms. It is a global optimization algorithm that simulates the feeding of a natural population. Each particle in the population has two parameters: position and velocity. The optimization space is a multi-dimensional space comprising various stratum thicknesses and velocities. Thus, a particle's position in the optimization space represents a set of parameters for the subsurface velocity distribution. We assume that the maximum number of layers within the crust above the mantle (a homogeneous half-space) is 10. The thickness of each layer ranges from 0 to 10 km, and if the thickness of a layer is 0 km, this corresponds to a reduction of one layer. The method thus allows the number of layers within the crust to be obtained by inversion without a priori information. Together with the P-wave velocity of each layer (including the mantle), the optimization space is 21-dimensional.

While we still assume horizontal layers, our method is capable of inverting a wide range of crustal models, including those containing surface sedimentary layers, upper crustal low-velocity layers, and lower crustal low-velocity layers, among others. Notably, the method does not require prior knowledge of the number of layers in the model, making it highly robust. Furthermore, field data tests demonstrate the method's potential for practical application.