Reflectivity modeling for stratified anelastic media

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Summary

The reflectivity method is widely used for the computation of synthetic seismograms for layered media due to its capacity of modeling all kinds of wave propagation and attenuation for a given model with sufficient accuracy and relatively low computation cost. This paper gives a brief introduction of the reflectivity method, and then demonstrates that reflectivity method can give accurate and realistic modeling results for stratified anelastic media.

BASIC THEORY OF REFLECTIVITY MODELING

The reflectivity method is a wave-number or slowness integration method, which computes the response of a model in the frequency-wavenumber domain and automatically includes contributions from all possible rays within the reflecting zone.

In reflectivity modeling, the wavenumber or slowness integration is calculated by a matrix or propagator techniques, which mainly deals with the computation of the reflection and transmission coefficients for plane waves, incident on a plane surface or a stack of homogenous layers. The coefficients for an interface are given analytically according to the Zoeppritz equations, and those for a stack of layers are derived by a recursive algorithm.

NUMERICAL EXAMPLE

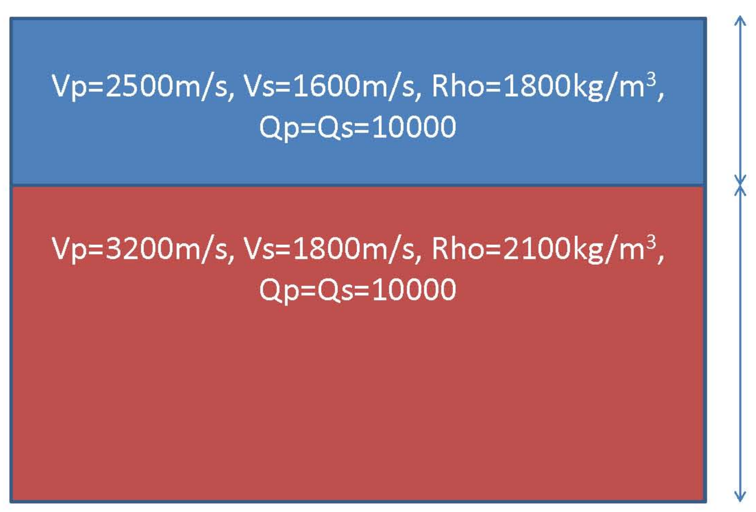

FIG. 1. A two layer earth model without attenuation.

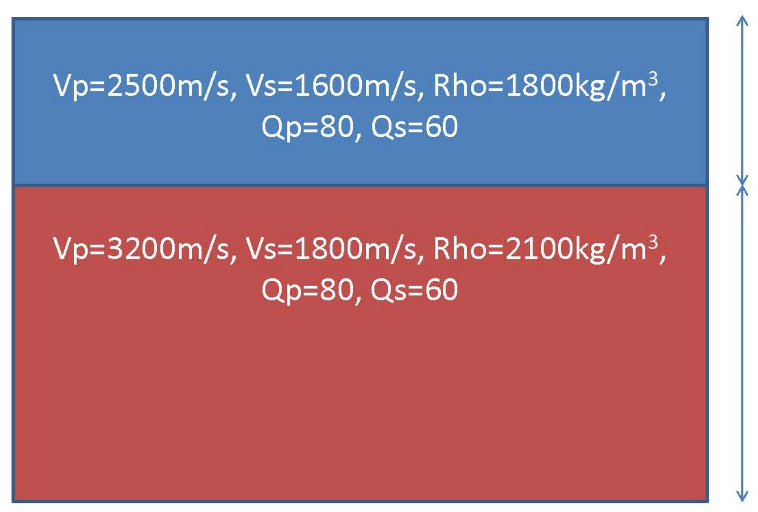

FIG. 2. A two layer earth model with attenuation.

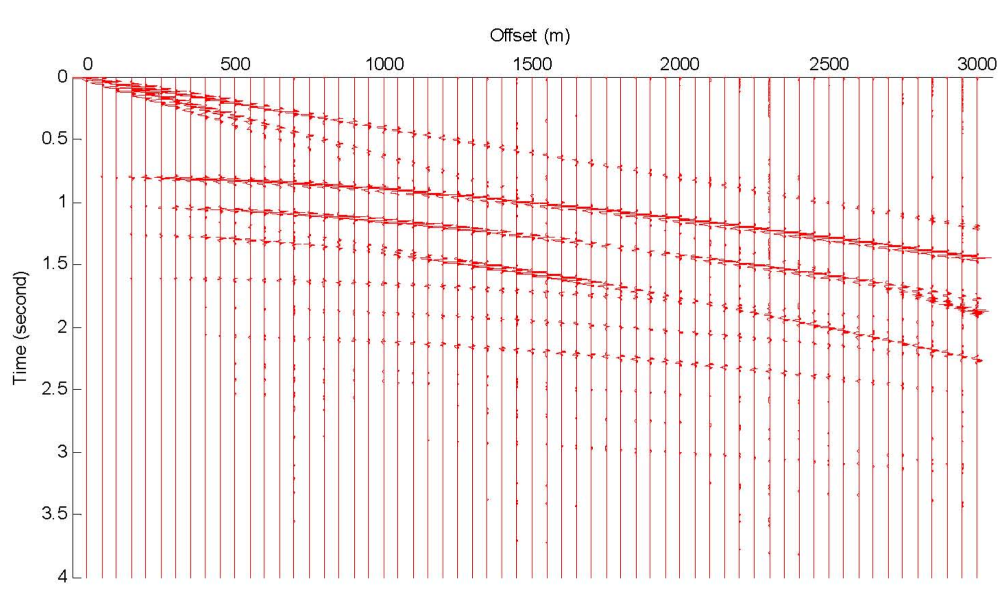

FIG. 3. Vertical component of P-SV waves for the two-layer model shown in figure 1.

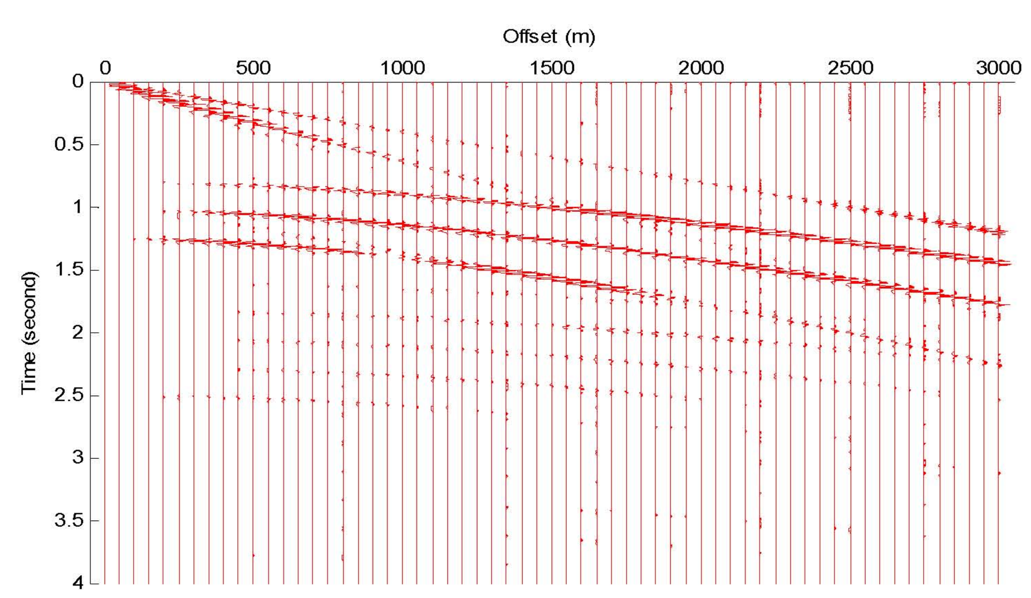

FIG. 4. Radial component of P-SV waves for the two-layer model shown in figure 1.

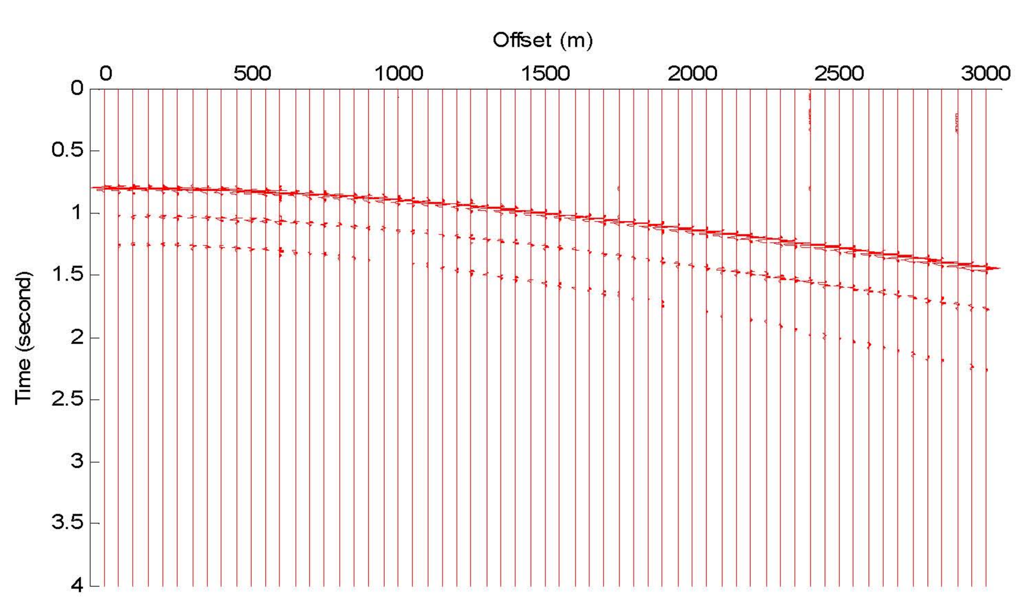

FIG. 5. Vertical components of primary reflection events for the earth model shown in figure 1.

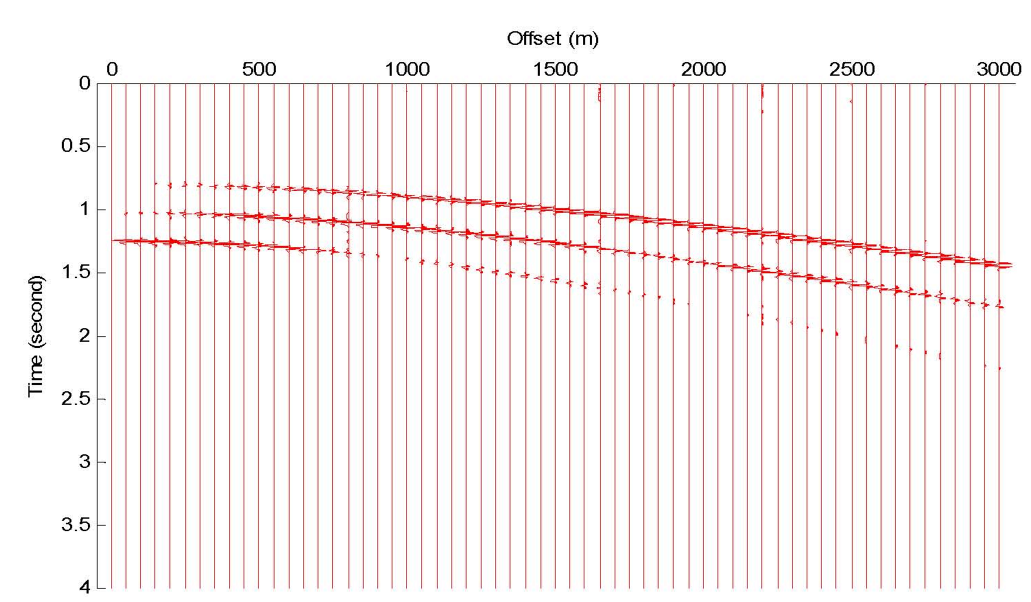

FIG. 6. Radial components of primary reflection events for the earth model shown in figure 1.

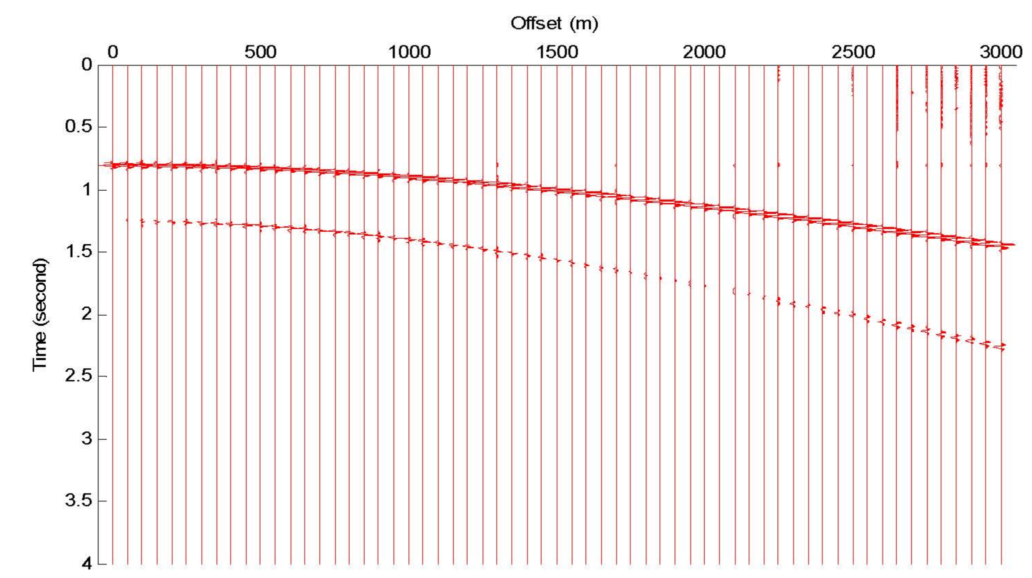

FIG. 7 Vertical components of the direct arrivals of a homogenous media with the physical parameters of the layer 1 shown in figure 1 and a point source at depth Z = 1995m.

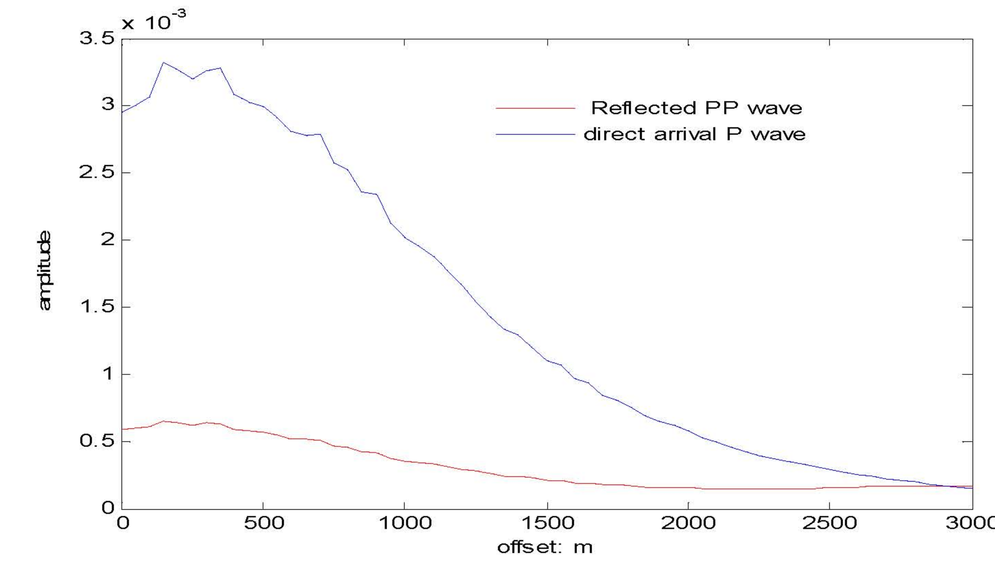

FIG. 8. Amplitudes of the direct P waves in figure 7 and reflected PP waves in figure 5.

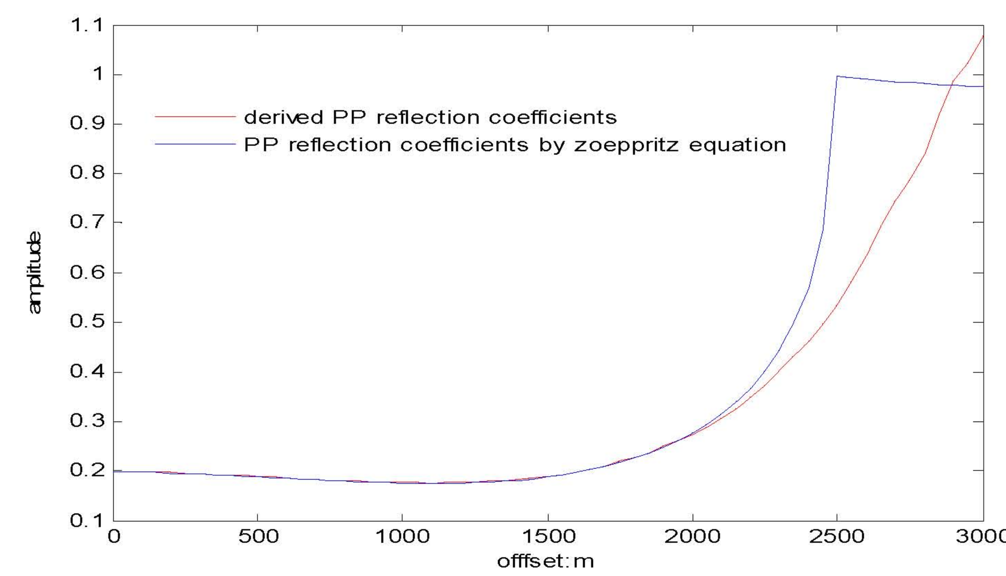

FIG. 9 . Derived reflection coefficients (from figure 8) for the PP waves shown in figure 5.

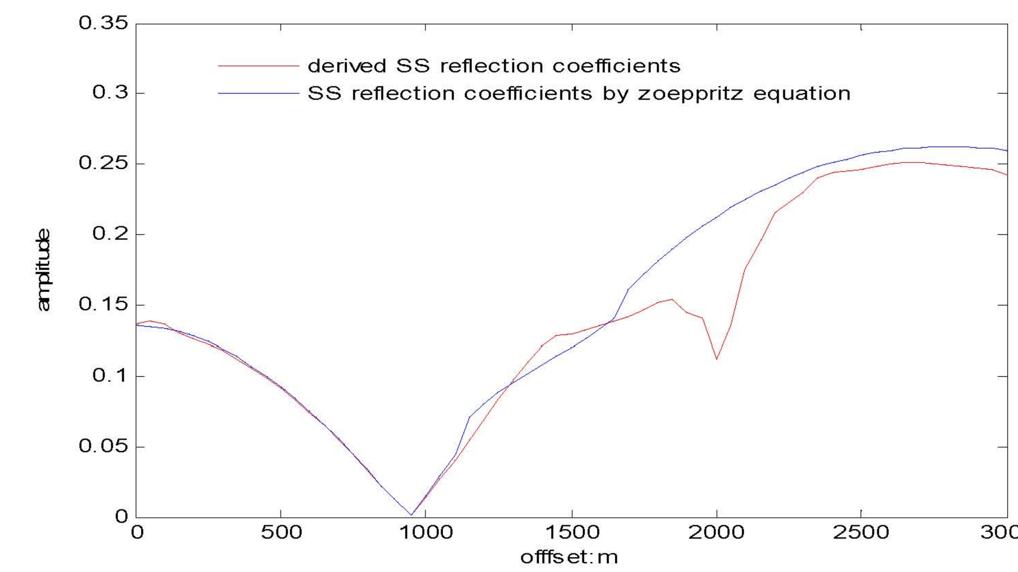

FIG. 10. Derived reflection coefficients for the SS waves shown in figure 5.

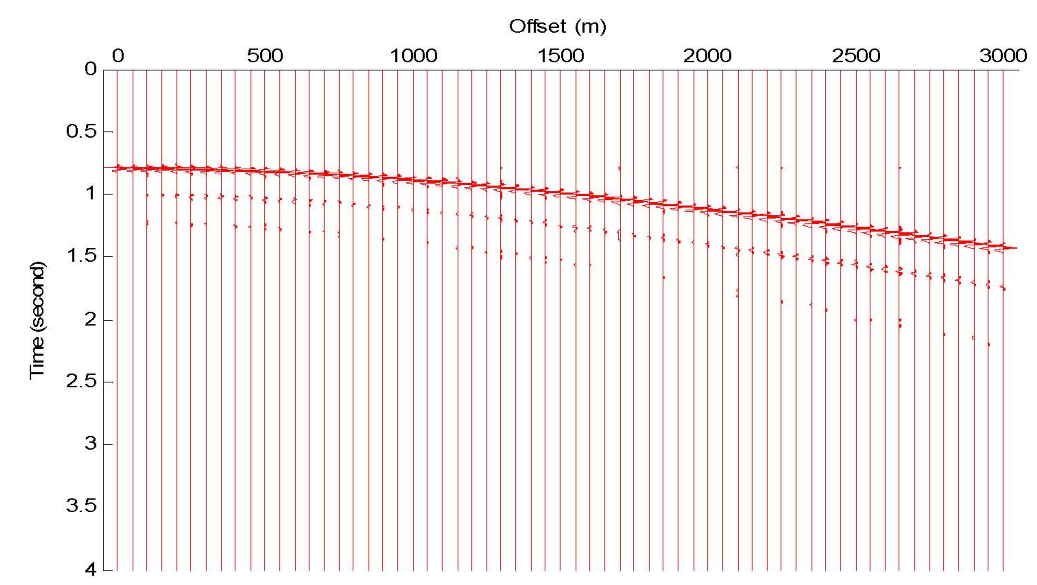

FIG. 11 . Vertical components of primary reflection events (with attenuation) for the earth model shown in figure 2.

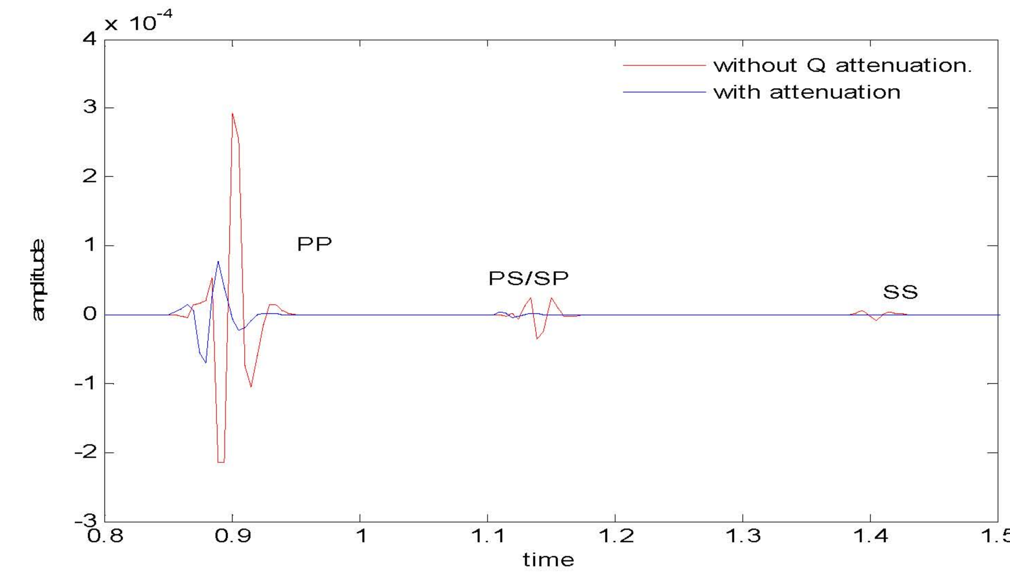

FIG. 12. Comparison of the trace with an offset of 1000m shown in figure 5 (without attenuation) and figure 11 (with attenuation).

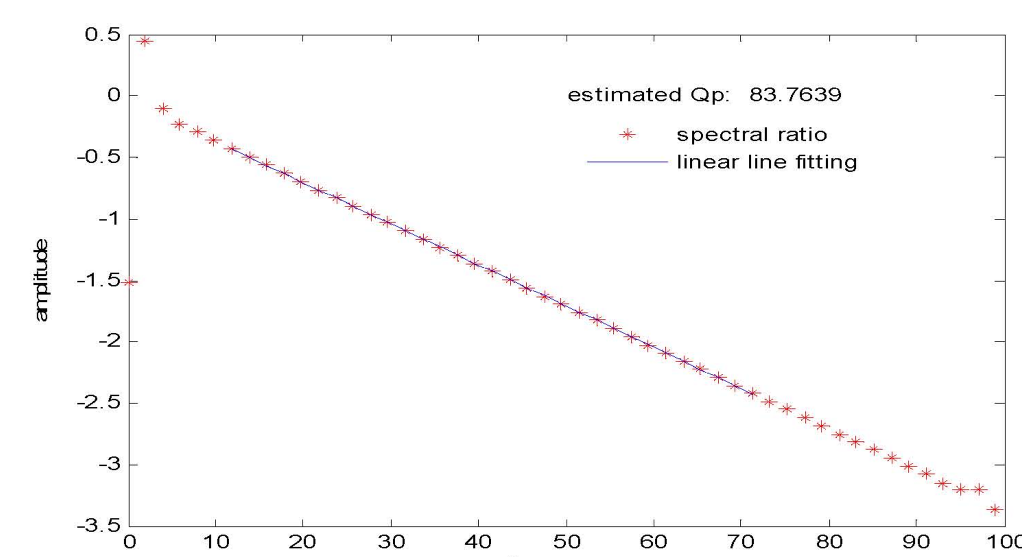

FIG. 13 . Q_p estimation for the earth model shown in figure 2, using spectral ratio method for the PP events shown in figure 12.

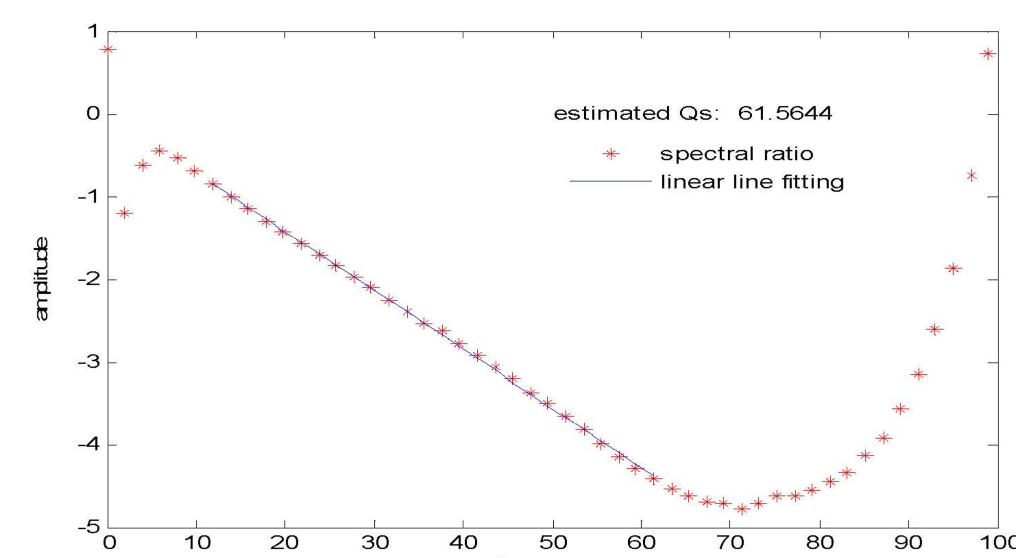

FIG. 14. Q_s estimation for the earth model shown in figure 2, using spectral ratio method for the SS events shown in figure 12.

Conclusion

The reflectivity method is very useful for the seismic modeling of stratified media. It can model all kinds of waves and address the geometric spreading and Q attenuation properly, which makes the modeling result realistic and gives sufficient information for layered earth model.