

Near-field effects in VSP-based Q-estimation for an inhomogeneous model

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ABSTRACT

As a continuation of earlier near-field investigations into homogeneous situations we expand our analysis to an inhomogeneous example. We show that depth locations of so-called *wrap-around* points where spectral ratio method Q-estimates change from large negative values to large positive values are controlled by P-wave velocities and intrinsic Q-factors. A velocity-step model and Q-factors derived from these velocities by empirical equation are used to demonstrate near-field Q-factor recovery by inversion. Because VSP model data and forward models are computed with the same multi-interface Sommerfeld integral it is found that, in this noise-free situation where velocities and densities are assumed to be known exactly for the forward modelling step, Q-factors can be recovered exactly also. Even though this VSP model approach is a simplification in many respects it does include near-fields, far-fields and geometrical spreading in the analysis.

MOTIVATION

- Find a velocity model that causes multiple SRM Q wrap-arounds.
- What is the sensitivity of VSP model data to forward model difference with respect to intrinsic Q-factors?
- Can intrinsic near-field Q be recovered in an ideal model situation?

CONCLUSIONS

- Multiple SRM Q wrap-arounds can be generated by a simple velocity-step model.
- The sum of squared differences between forward model and VSP model data shows a minimum at the correct intrinsic Q-value.
- The sum of (un-squared) differences helps to find the parabolic range for a faster minimum search.

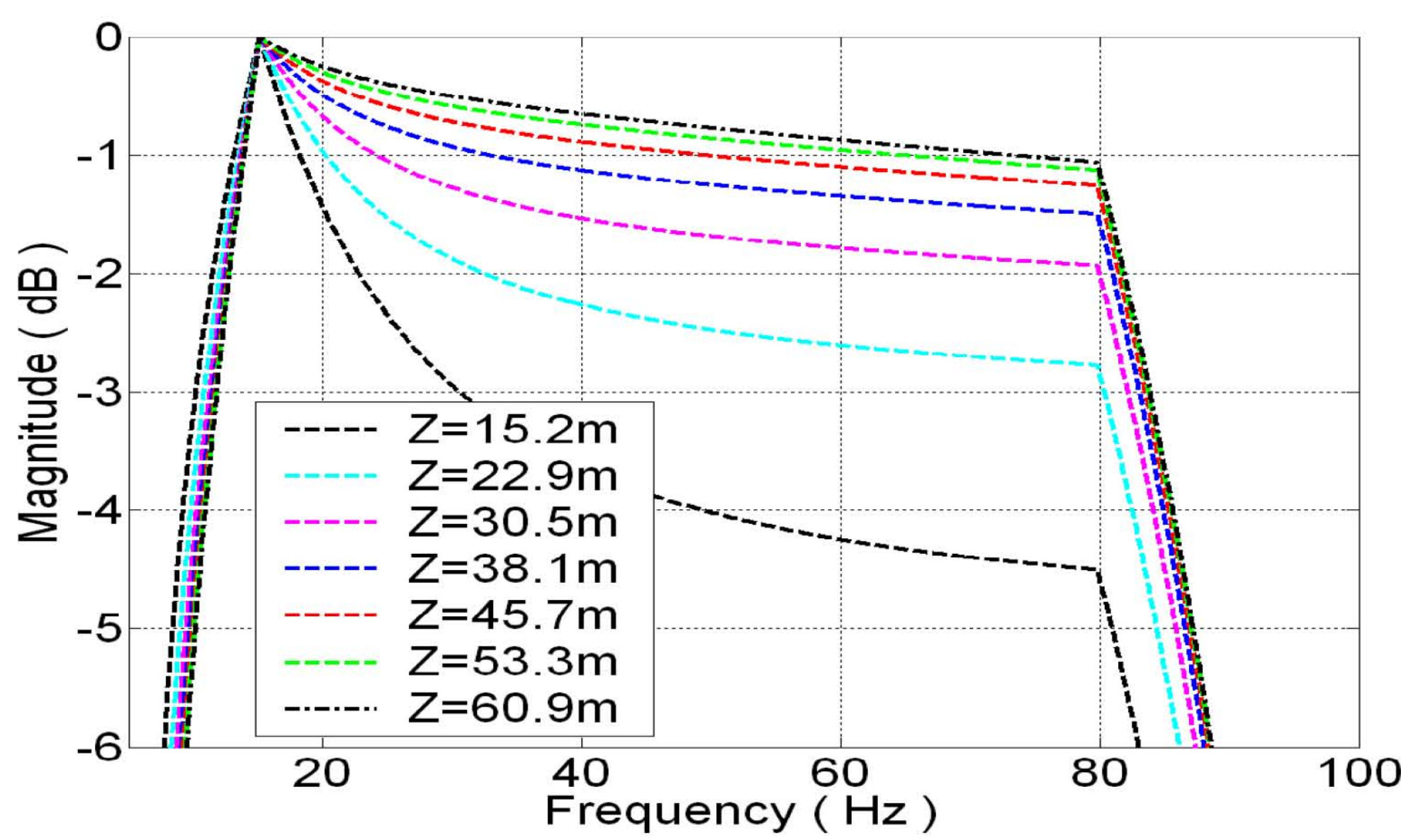


FIG. 2. Near-field log-magnitude spectra with all spectra equalized to their maximum amplitudes (zero dB scaling applied individually). The down going wave appears to gain high frequency strength.

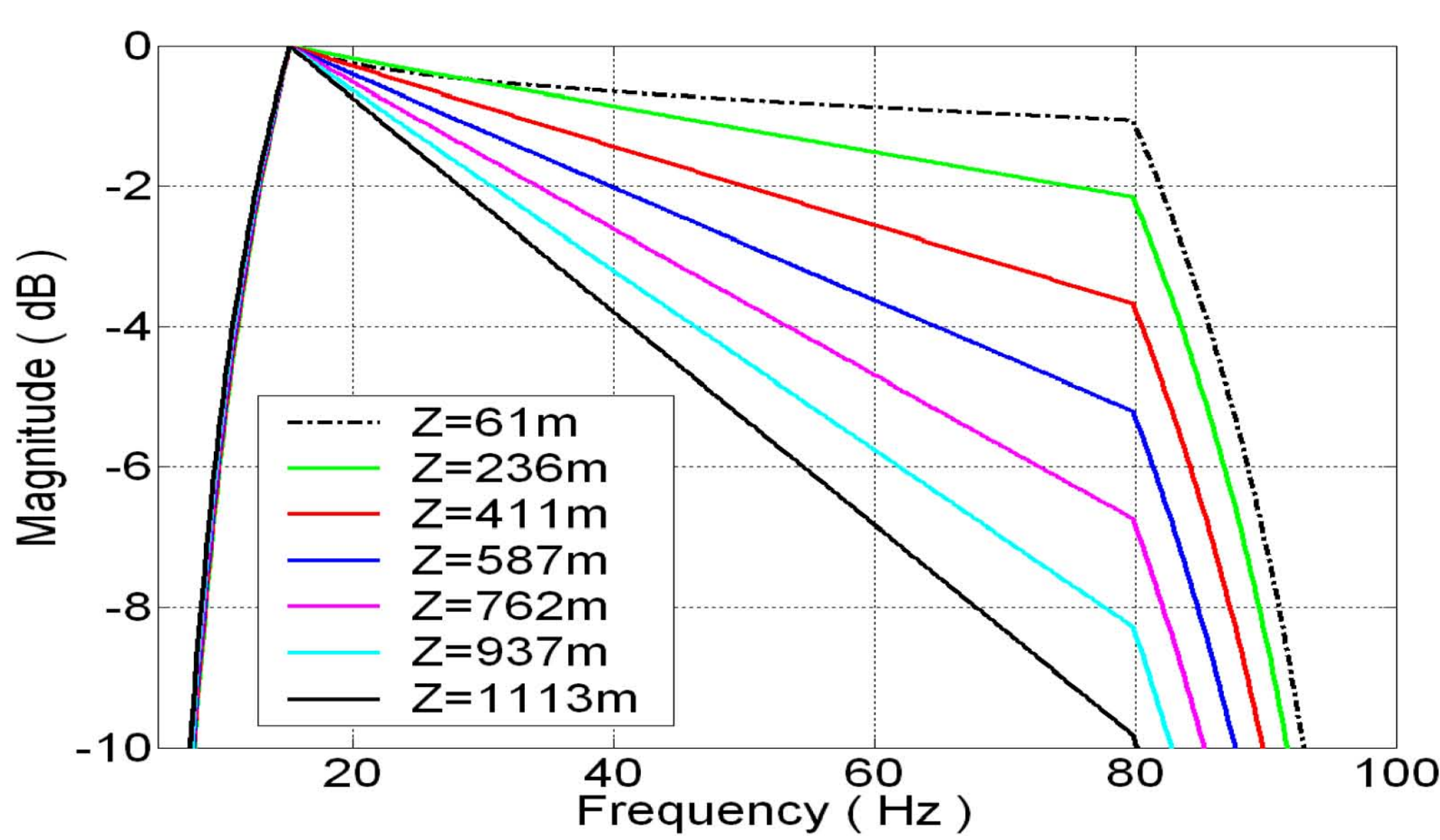


FIG. 3. Far-field log-magnitude spectra with zero dB scaling applied individually.

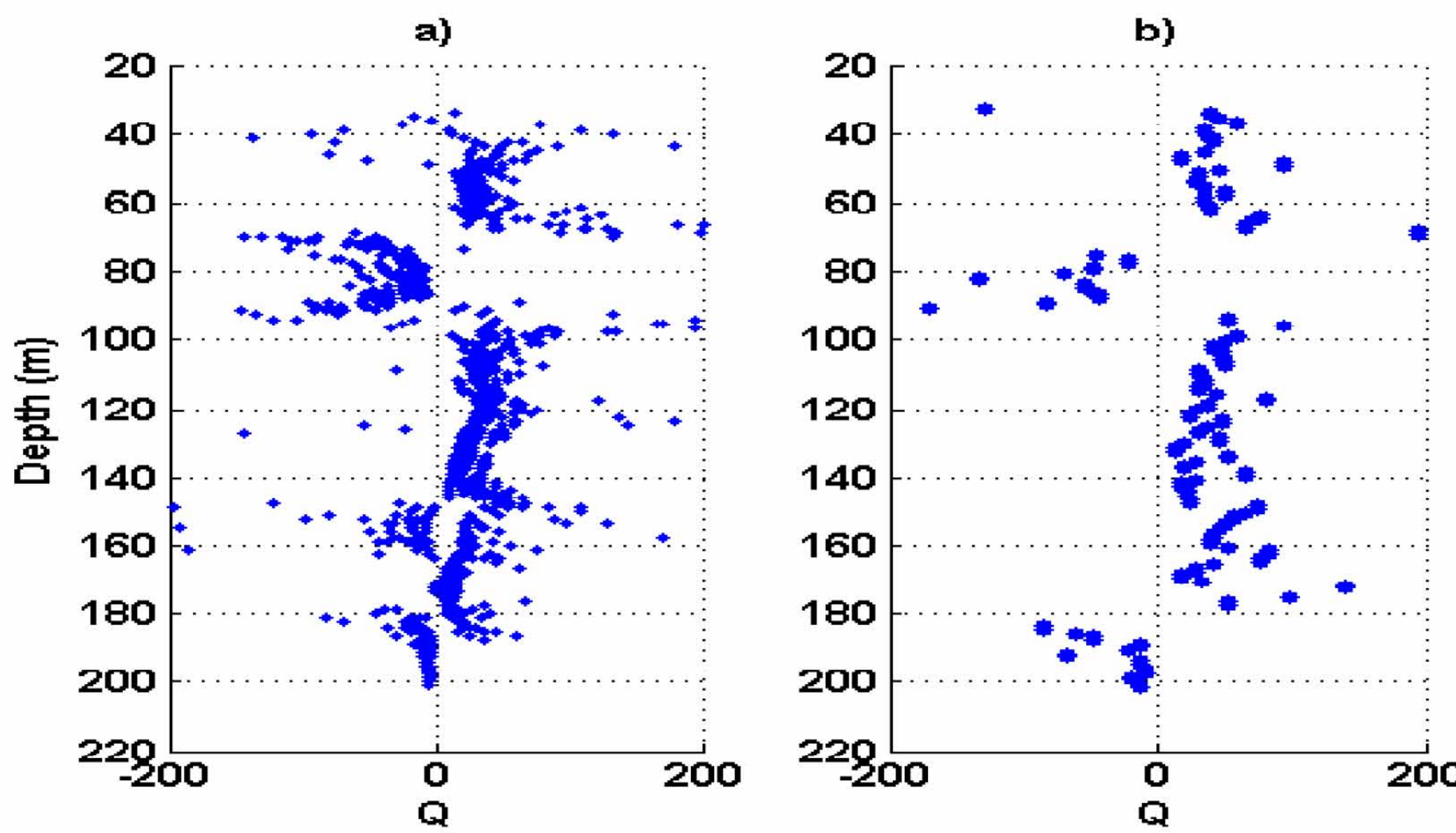


FIG. 6. Heavy oil sand Q-factors [Ortiz-Osornio and Schmitt, 2008: a) the traditional spectral ratio technique, and b) their inversion algorithm].

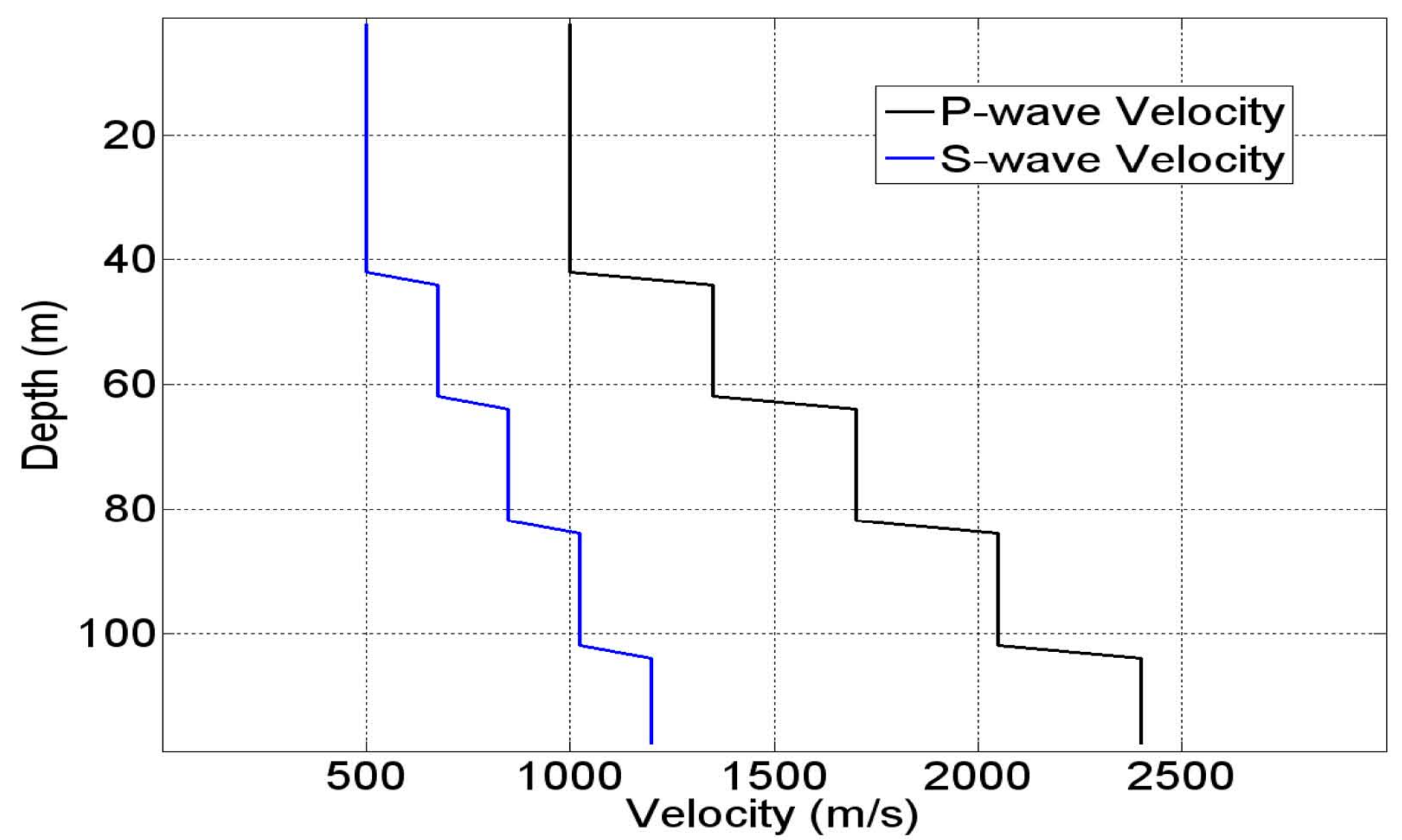


FIG. 8. Vp and Vs versus depth for stepped-velocity near-field VSP model.

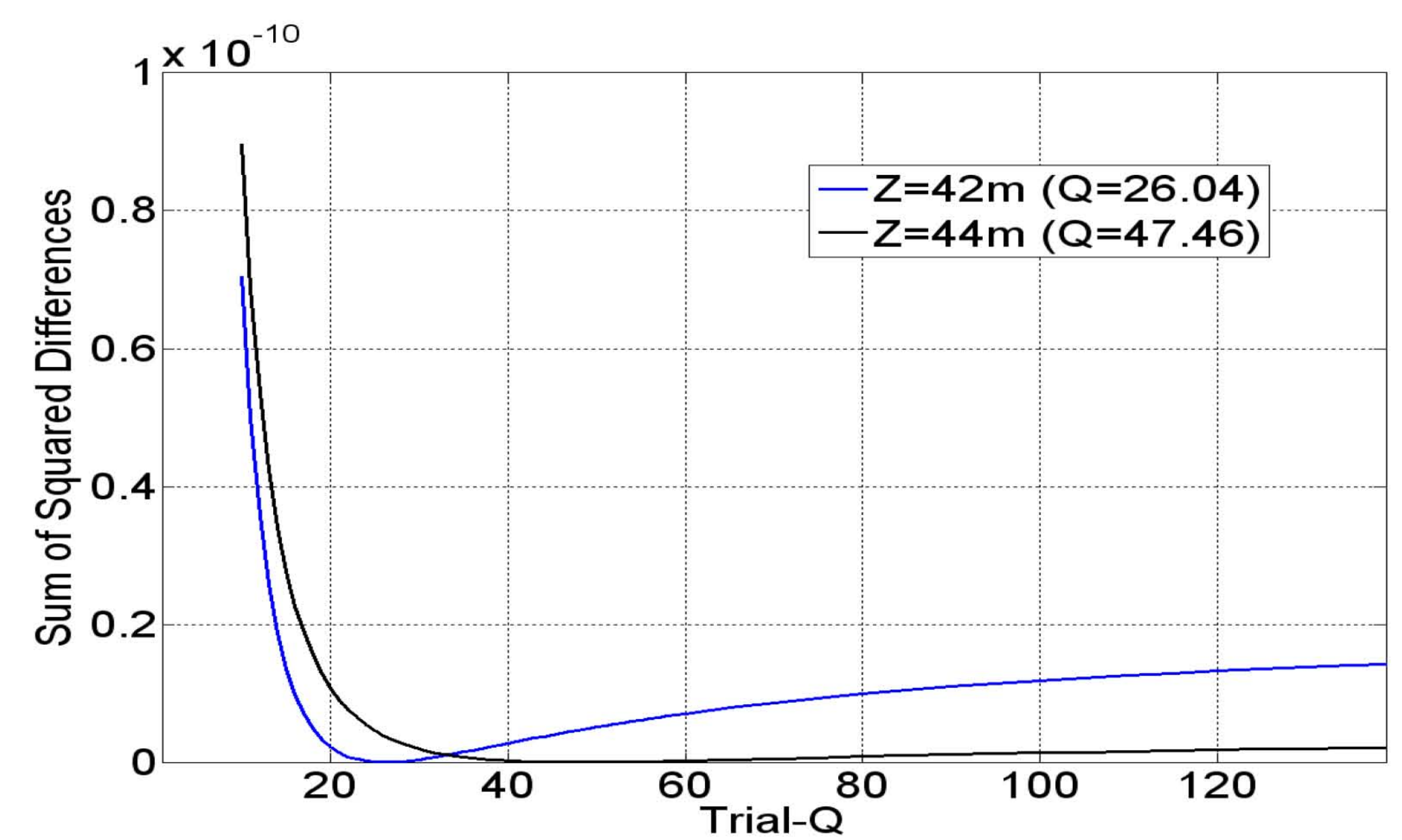


FIG. 11a. Sum of squared differences between data and forward model (linear scale).

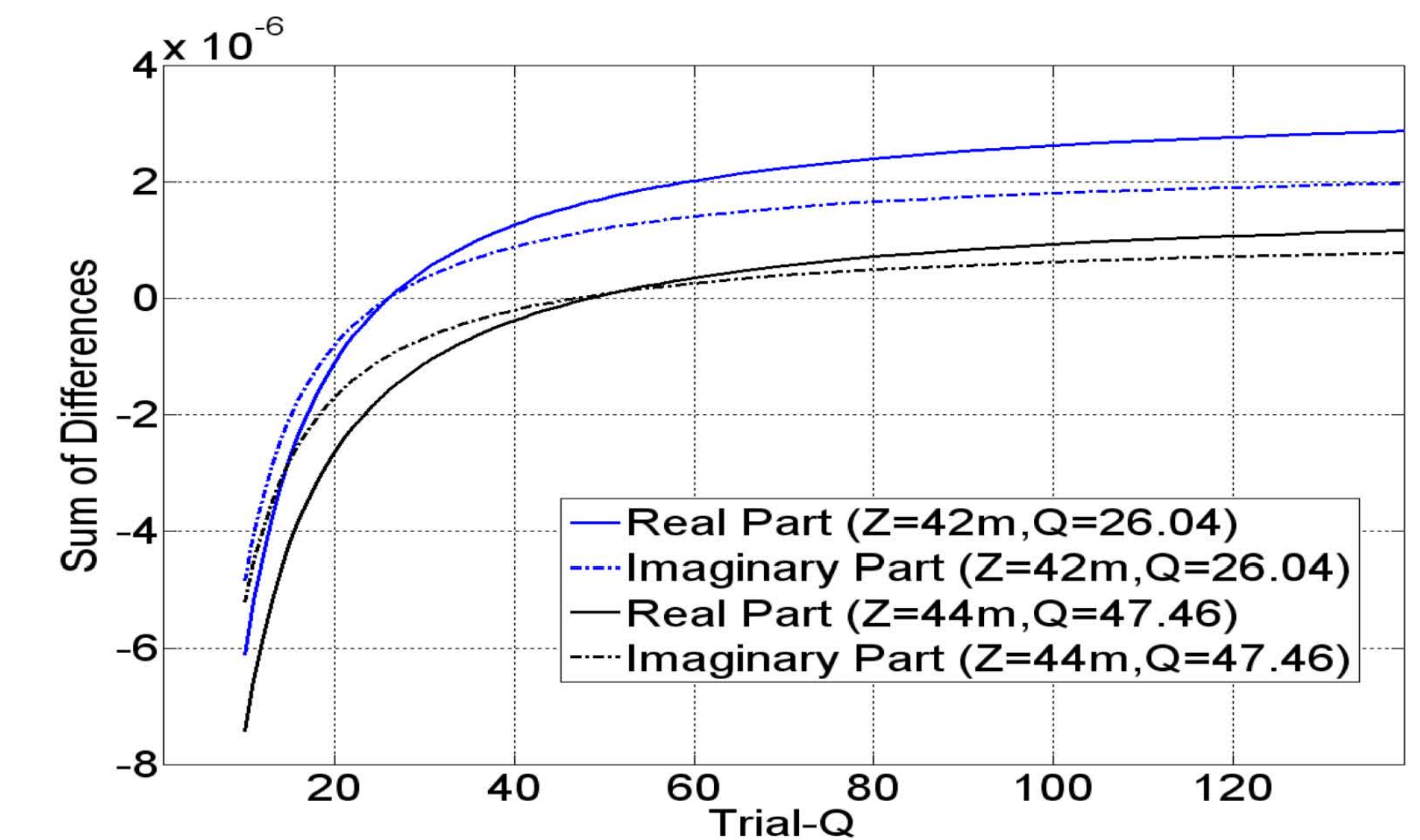


FIG. 12. Sum of differences between data and forward model.

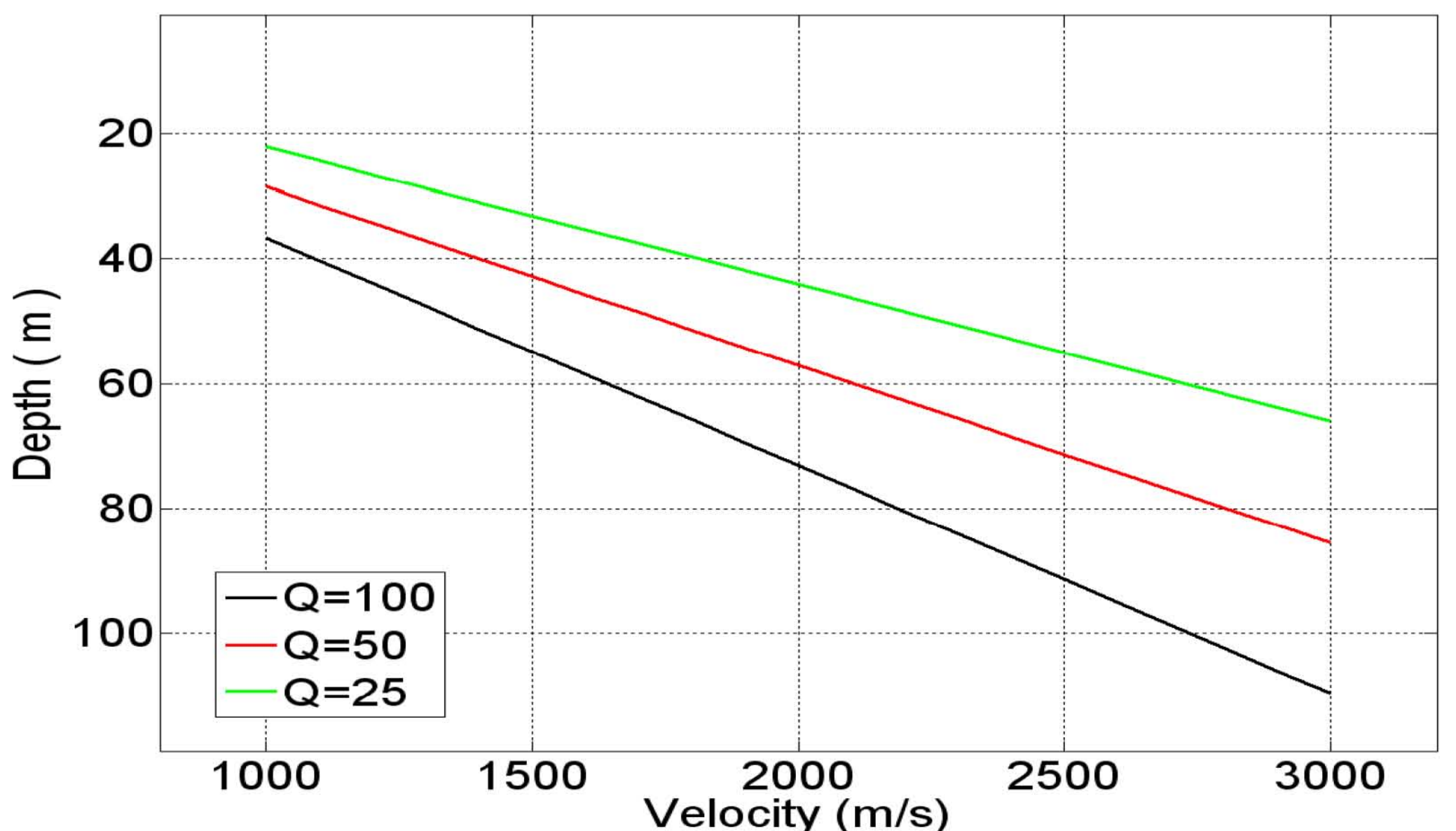


FIG. 7. Wrap-around depth as function of velocity and Q-factor.

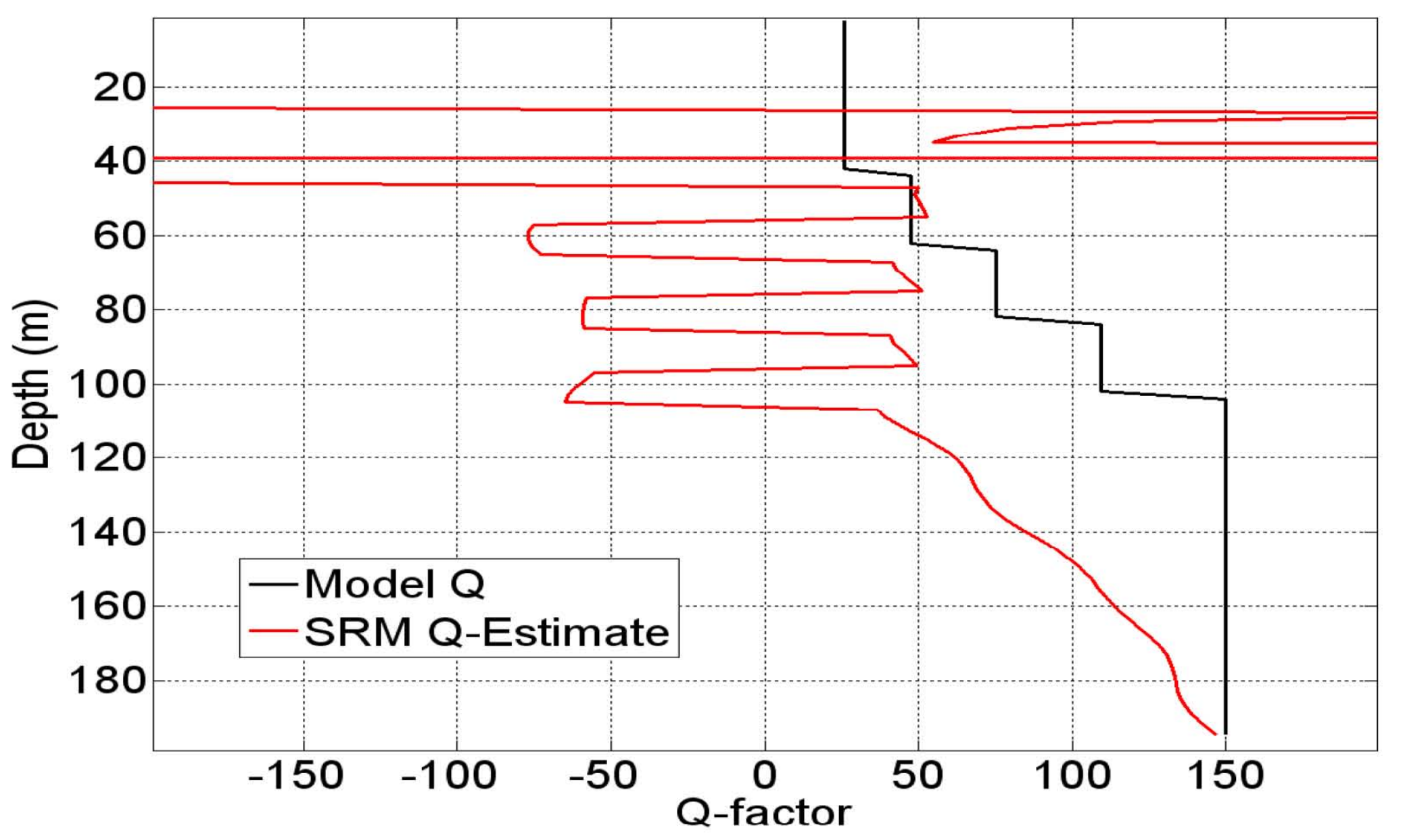


FIG. 9. Spectral ratio method (SRM) Q-estimate compared to stepped velocity model Q.

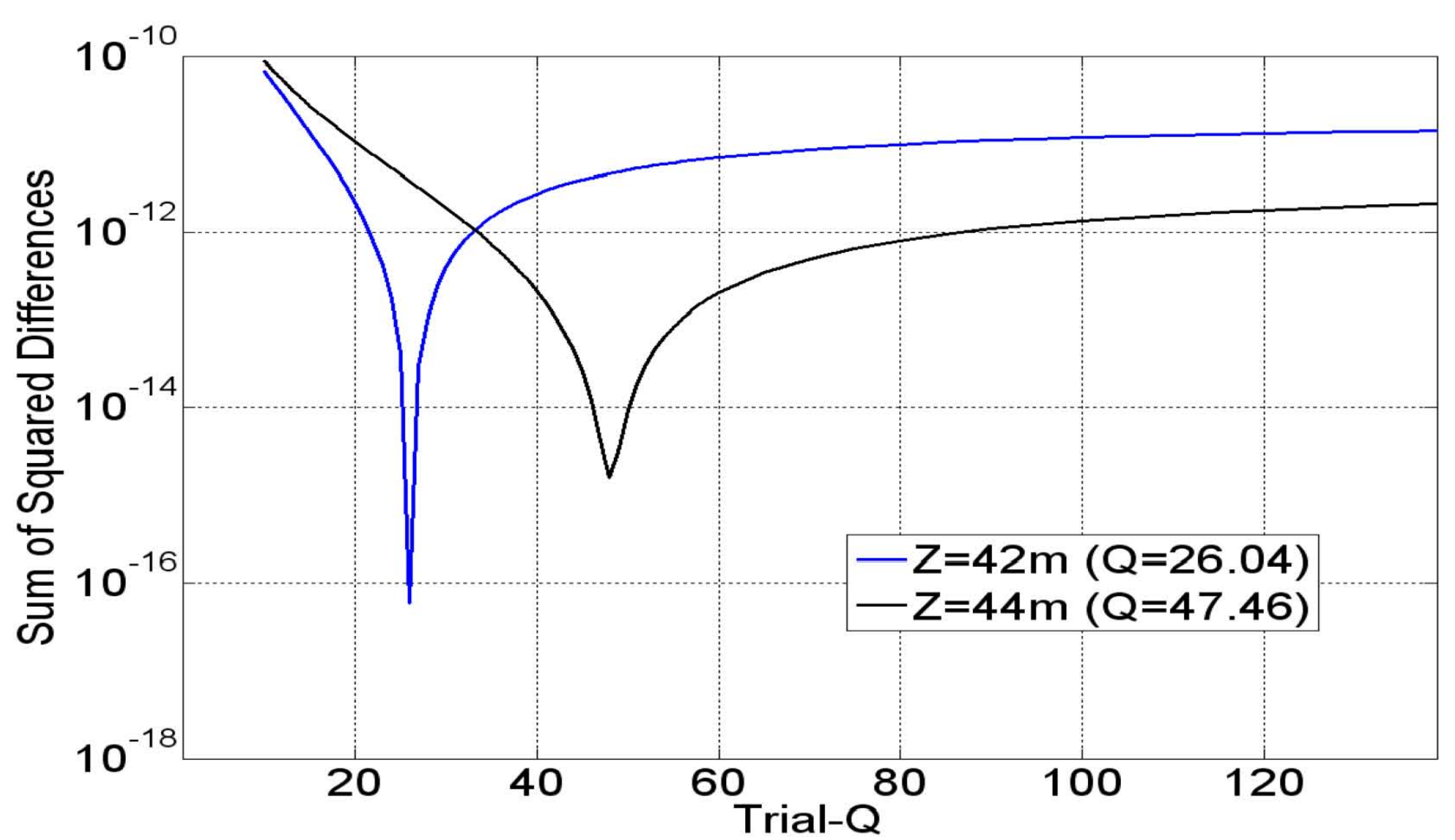


FIG. 11b. Sum of squared differences between data and forward model (log scale).

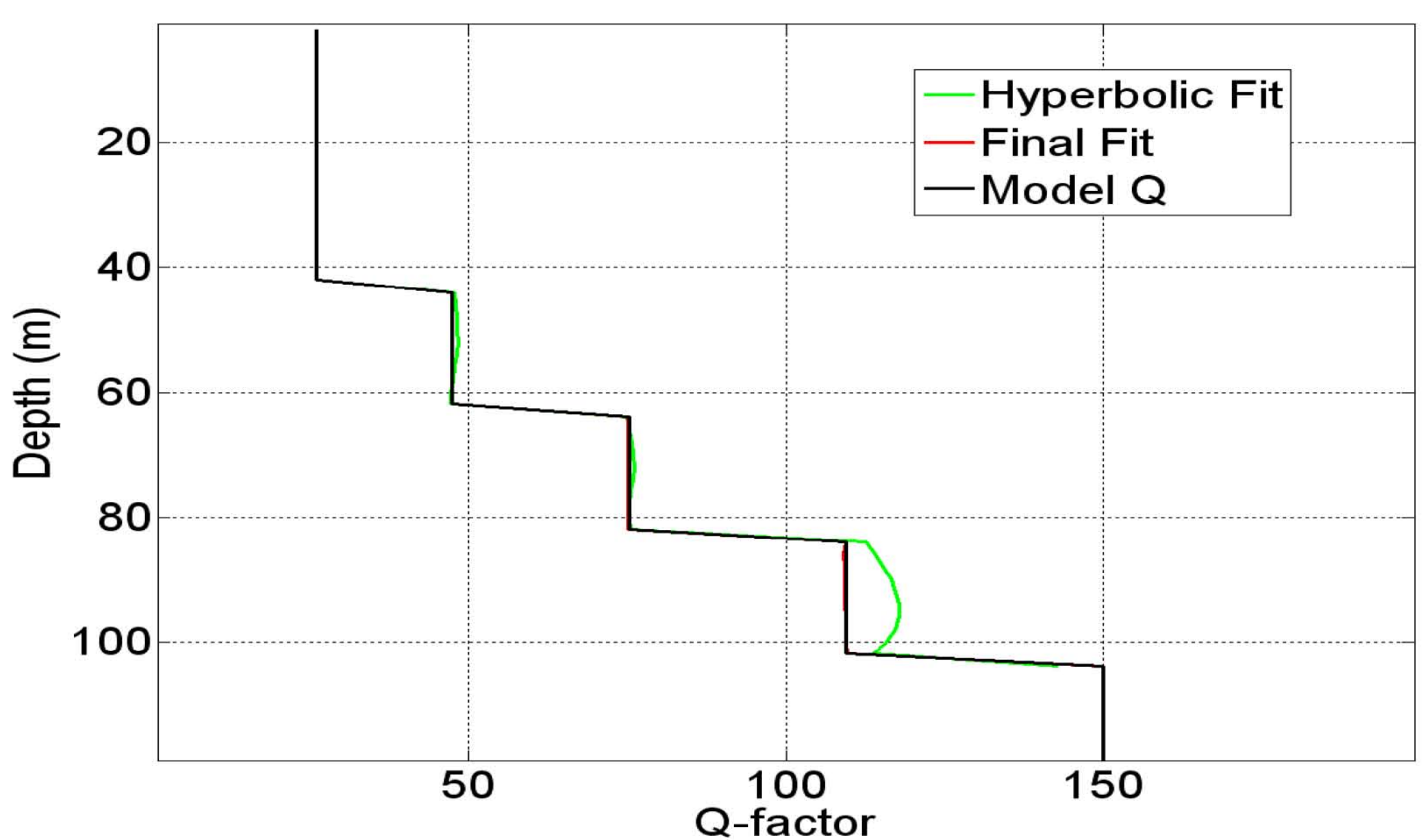


FIG. 13. Q versus depth for stepped-velocity near-field VSP model.