

Stratigraphic attenuation (Q) effects in heavy oilfield VSP data

Arnim B. Haase and Robert R. Stewart

ABSTRACT

As an extension of work on near-field Q-factor recovery we apply $Q(z)$ -inversion by forward modeling to VSP model data generated from Ross Lake well-logs applying a multi-interface Sommerfeld integral algorithm. An intrinsic $Q(z)$ model is derived from Ross Lake P-wave velocities by applying an empirical equation. When computing swept-Q forward models with the same Sommerfeld algorithm as is used for generating the VSP model data the sum of squared differences show minima at the correct intrinsic Q-values; velocities and densities are assumed to be known in these forward model computations. Applying a Golden-Section-Search algorithm for computational efficiency leads to a local-minimum problem at some depths which is solved by adding a local-minimum search extension. For this ideal noise free model situation intrinsic Q-factor recovery is very successful.

MOTIVATION

- For a more realistic stratigraphic Q investigation we introduce models with depth dependent Q-factors.
- Can intrinsic Q-factors be recovered by forward modelling?
- What difficulties are encountered when applying forward modelling to real VSP data?

CONCLUSIONS

- Intrinsic Q-factors can be recovered in the ideal model situation.
- Forward model matching to real VSP data is a work in progress.
- At this point of the investigation it is not clear what causes the data to model mismatch (velocity/density log errors or noise contamination of VSP data).

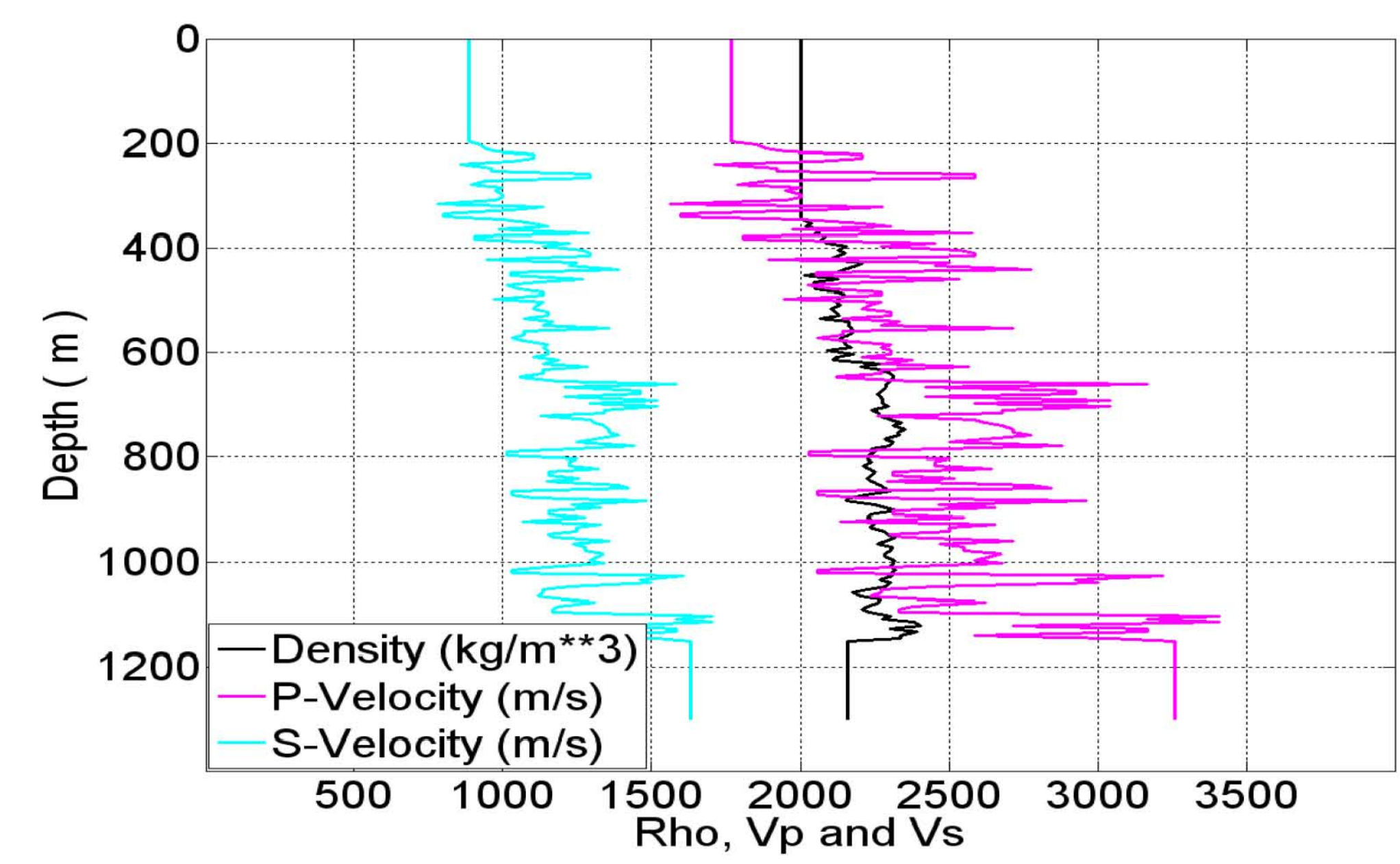


FIG. 1. Ross Lake velocities and density.

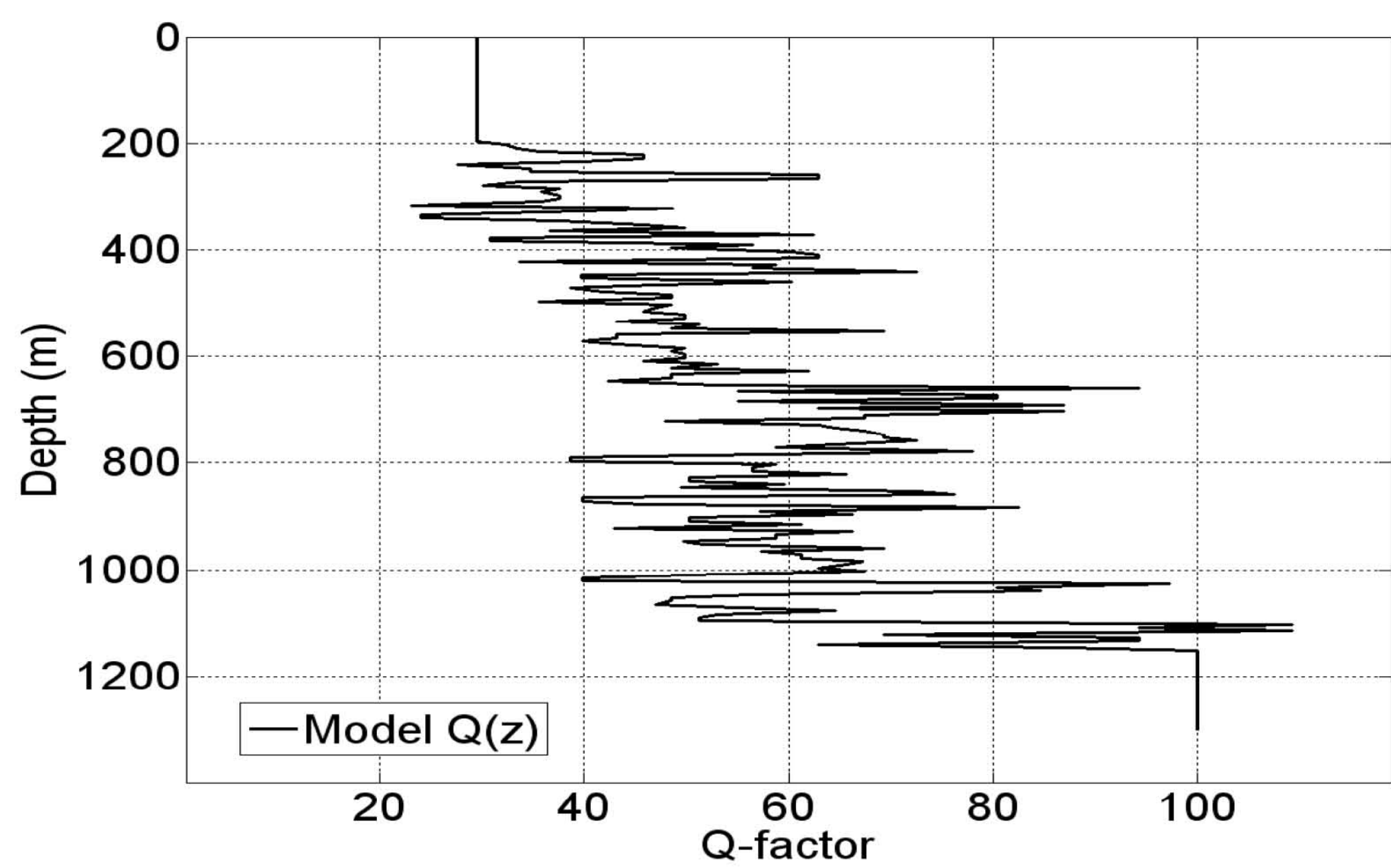


FIG. 2. Q-model generated from Ross Lake P-wave velocities using Waters's equation.

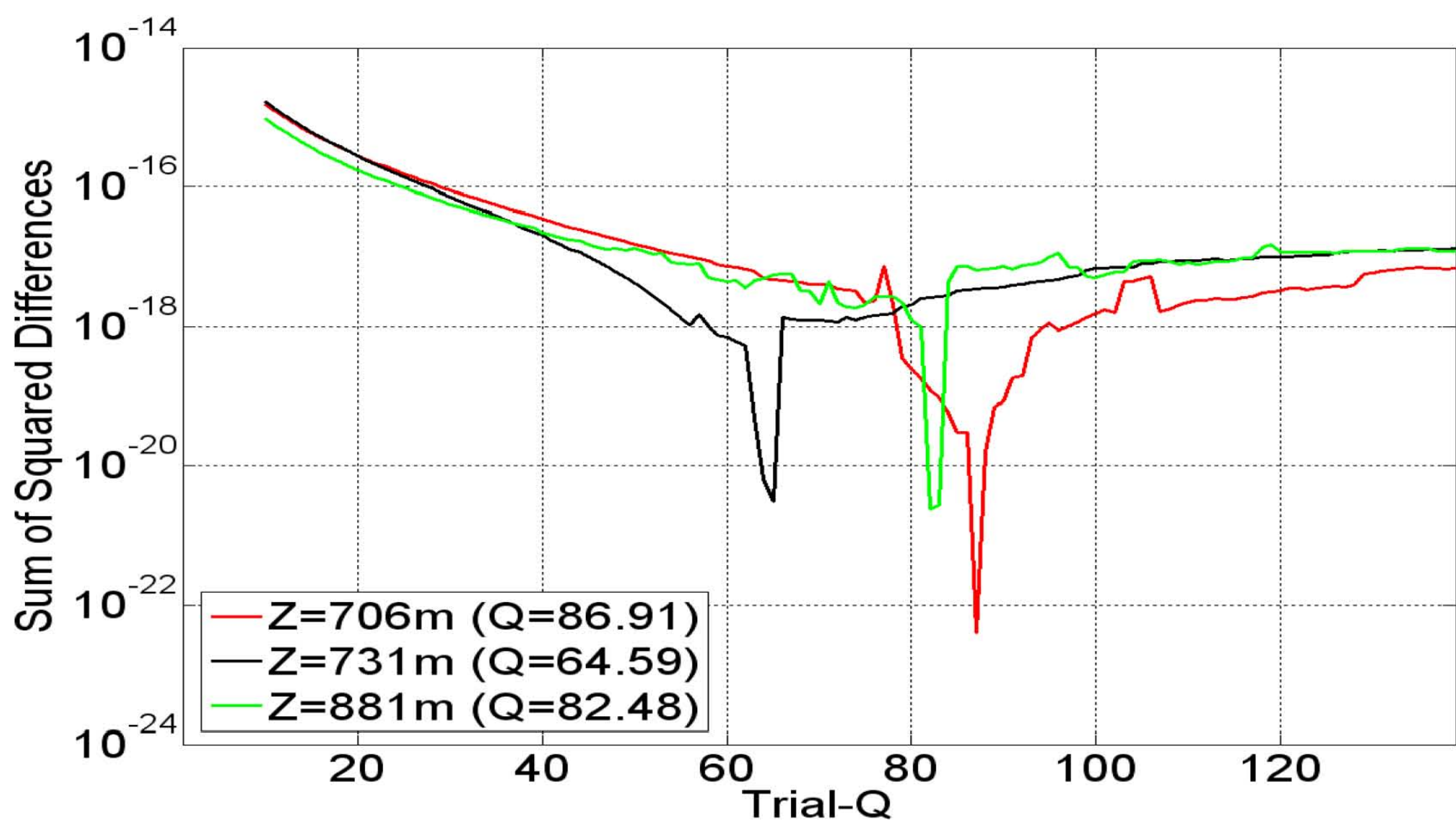


FIG. 3. Result of exhaustive Q search at selected depths.

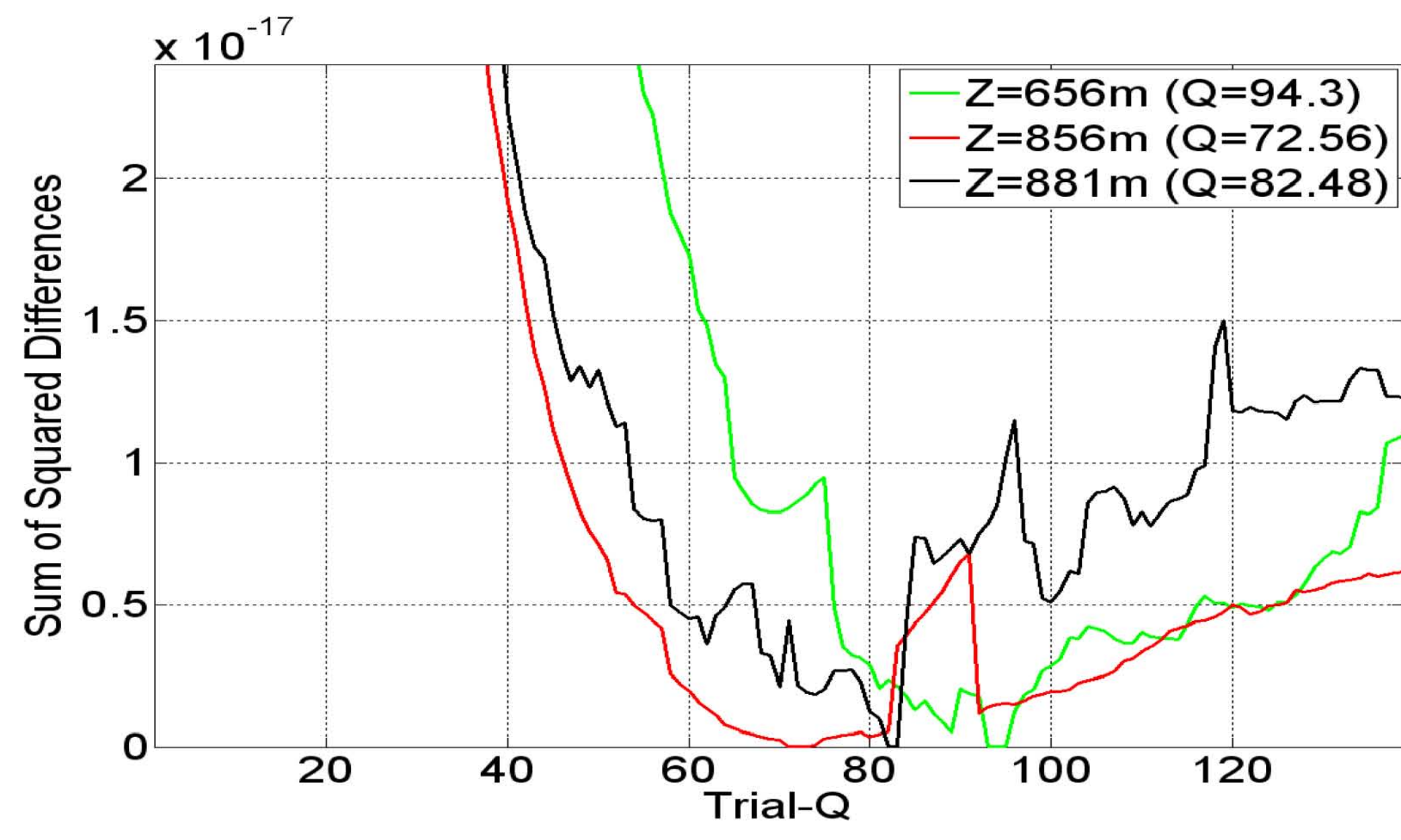


FIG. 5. Exhaustive Q search results at estimation error locations.

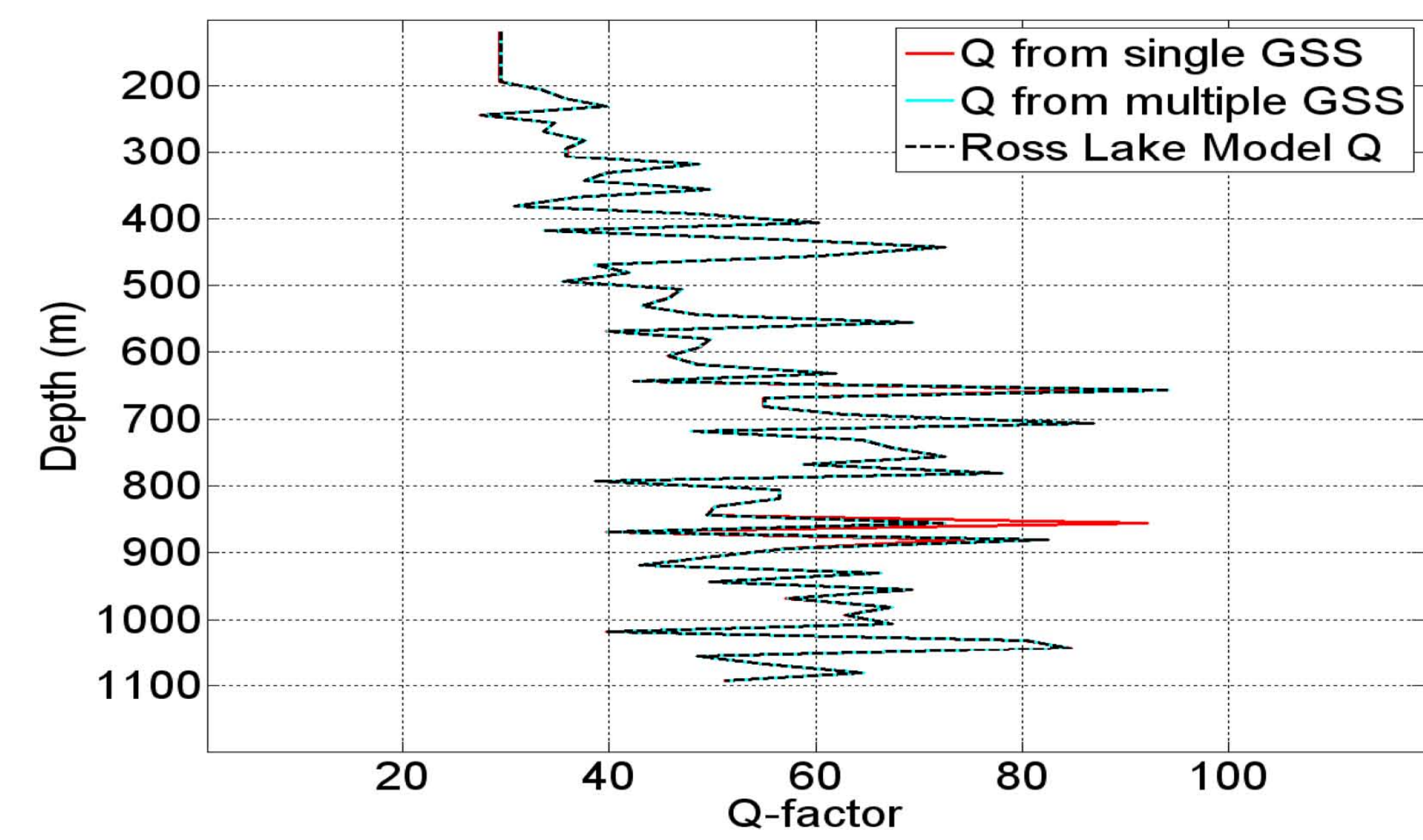


FIG. 6. Q versus depth from augmented Golden Section Search.

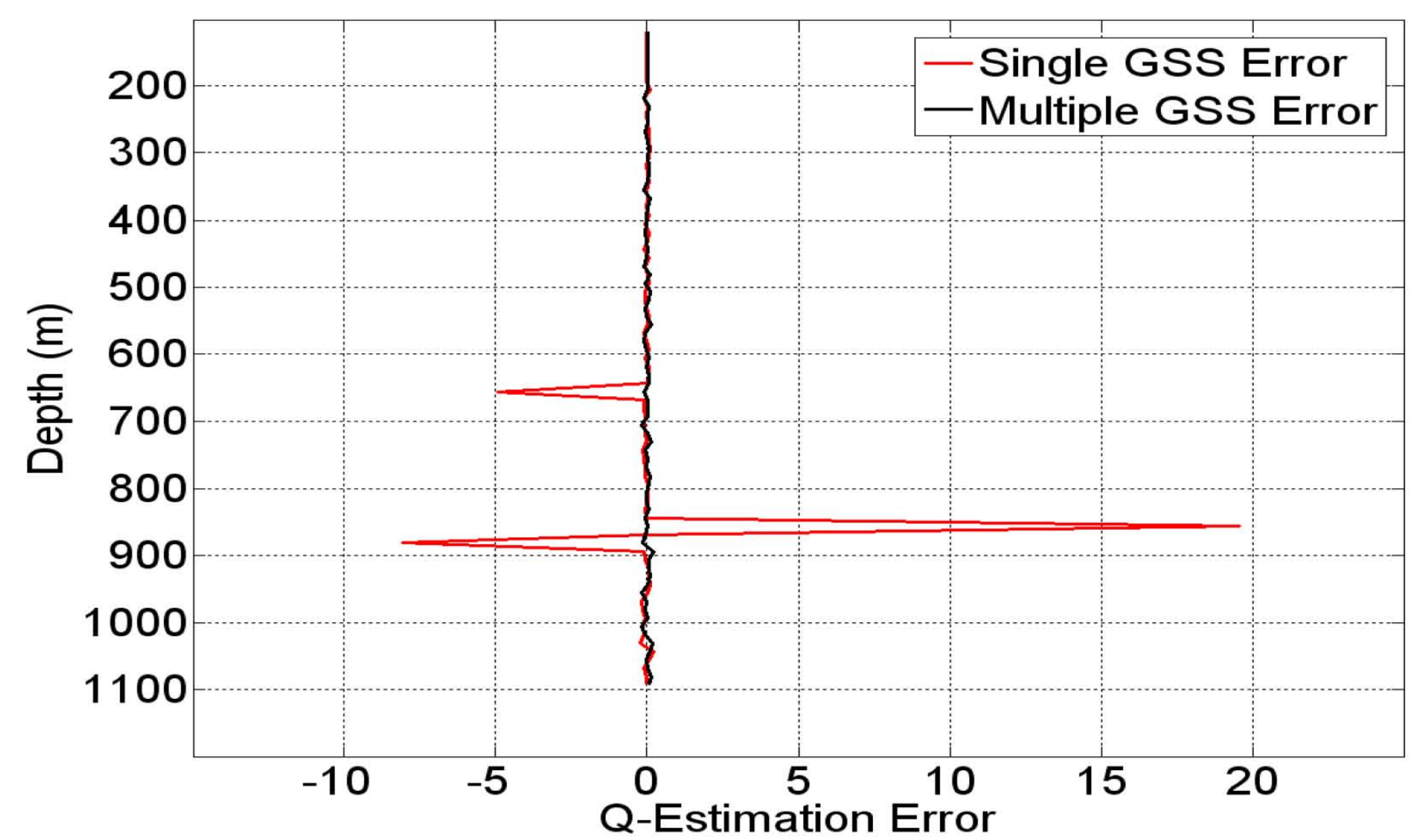


FIG. 7. Ross Lake Q-estimation error following Golden Section Search.

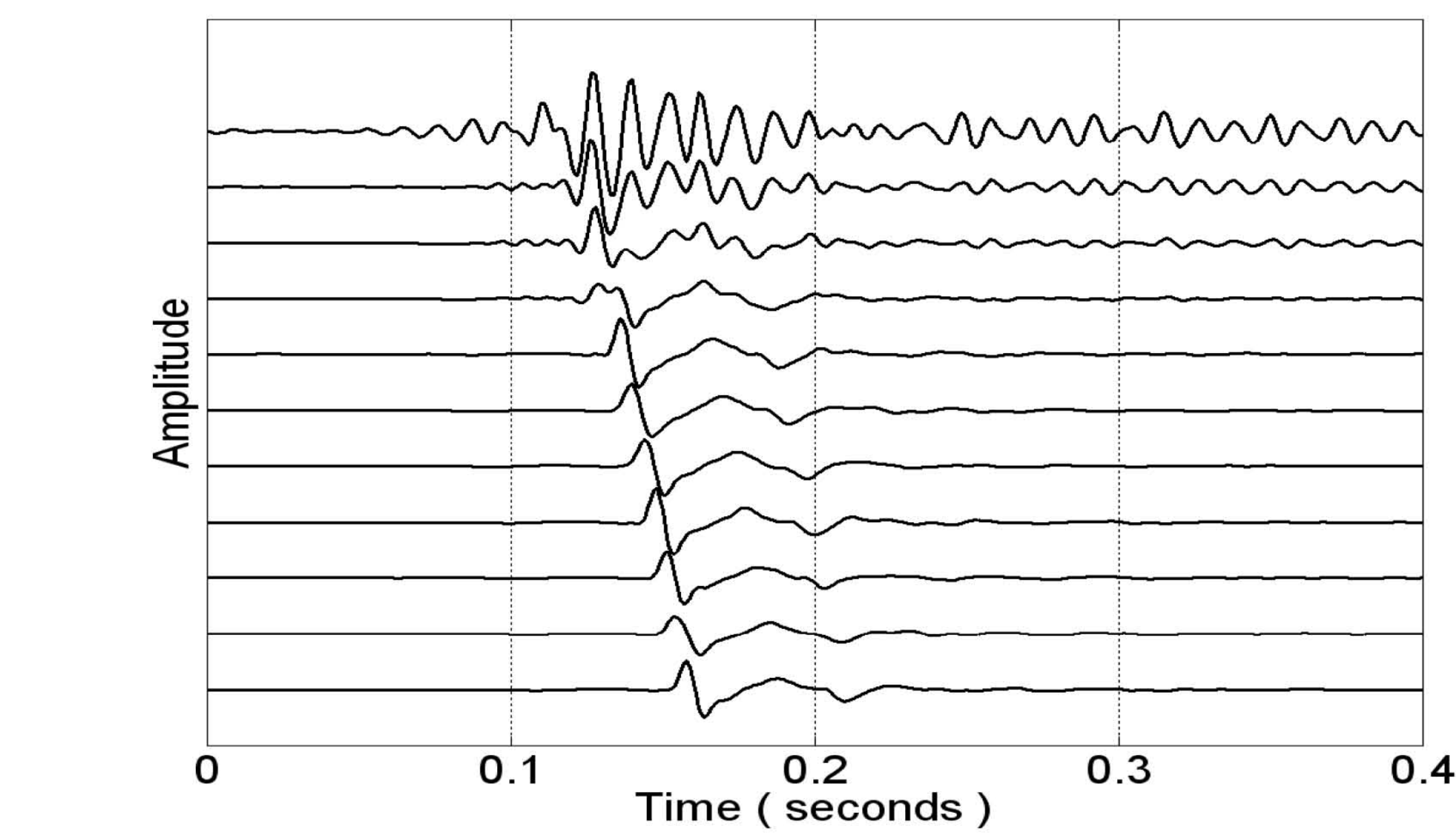


FIG. 9. Zero-offset VSP traces starting at Z=198m (depth step is 7.5m).

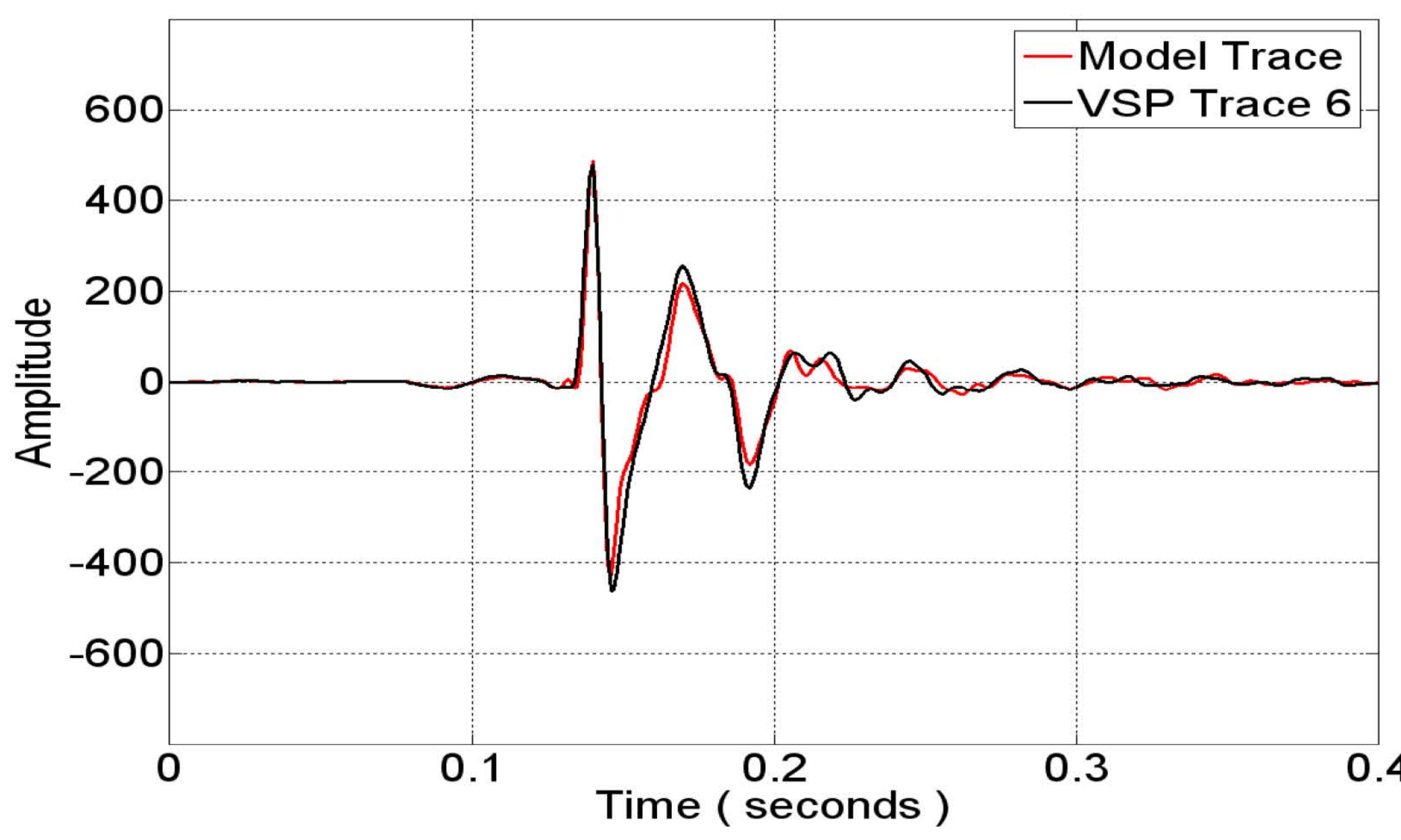


FIG. 10. VSP trace number 6 (black) and model trace (red) derived from trace number 5.

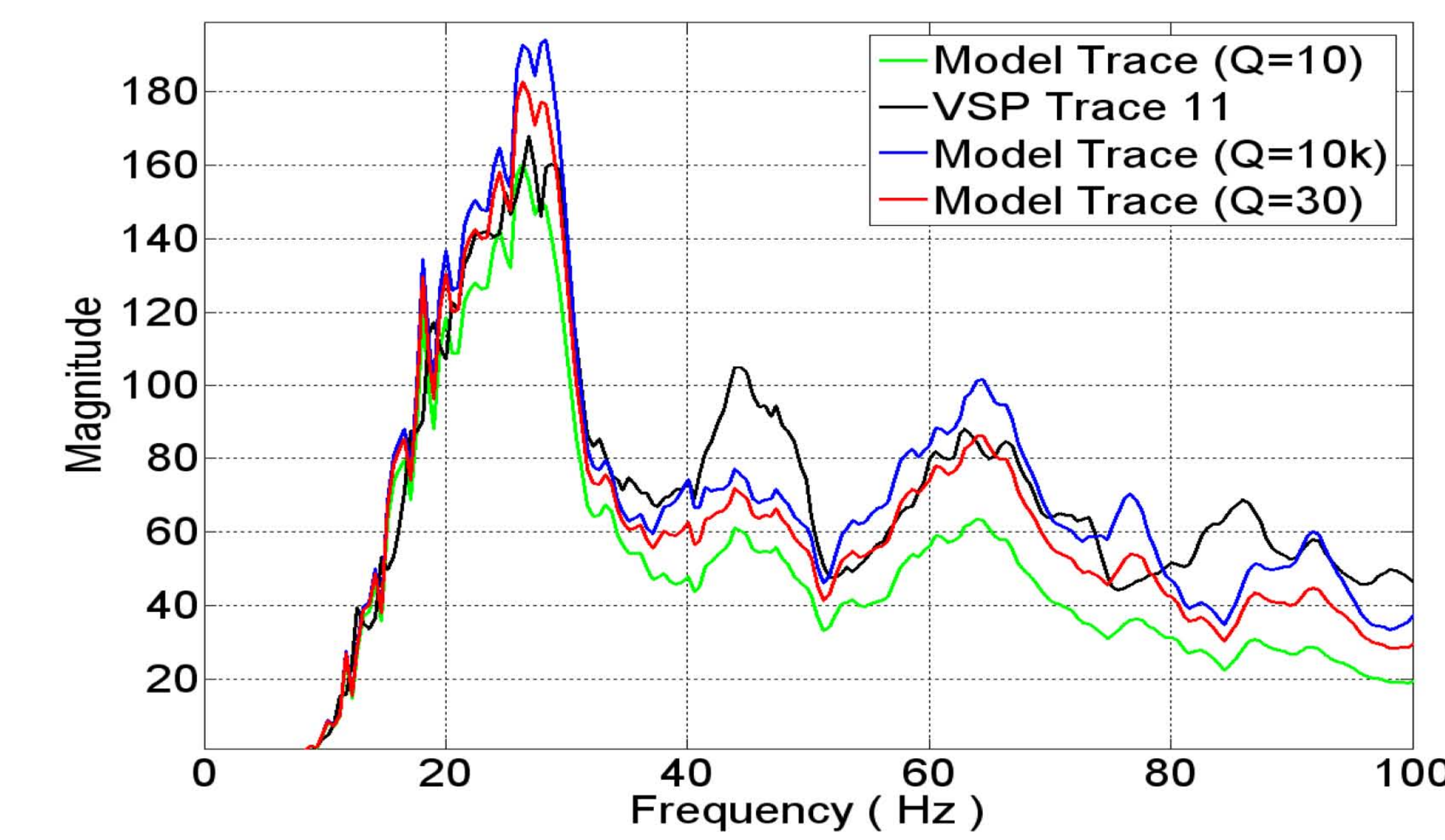


FIG. 11. Spectrum of VSP trace number 11 and model trace spectra derived from VSP trace number 5 for a range of Q-factors.

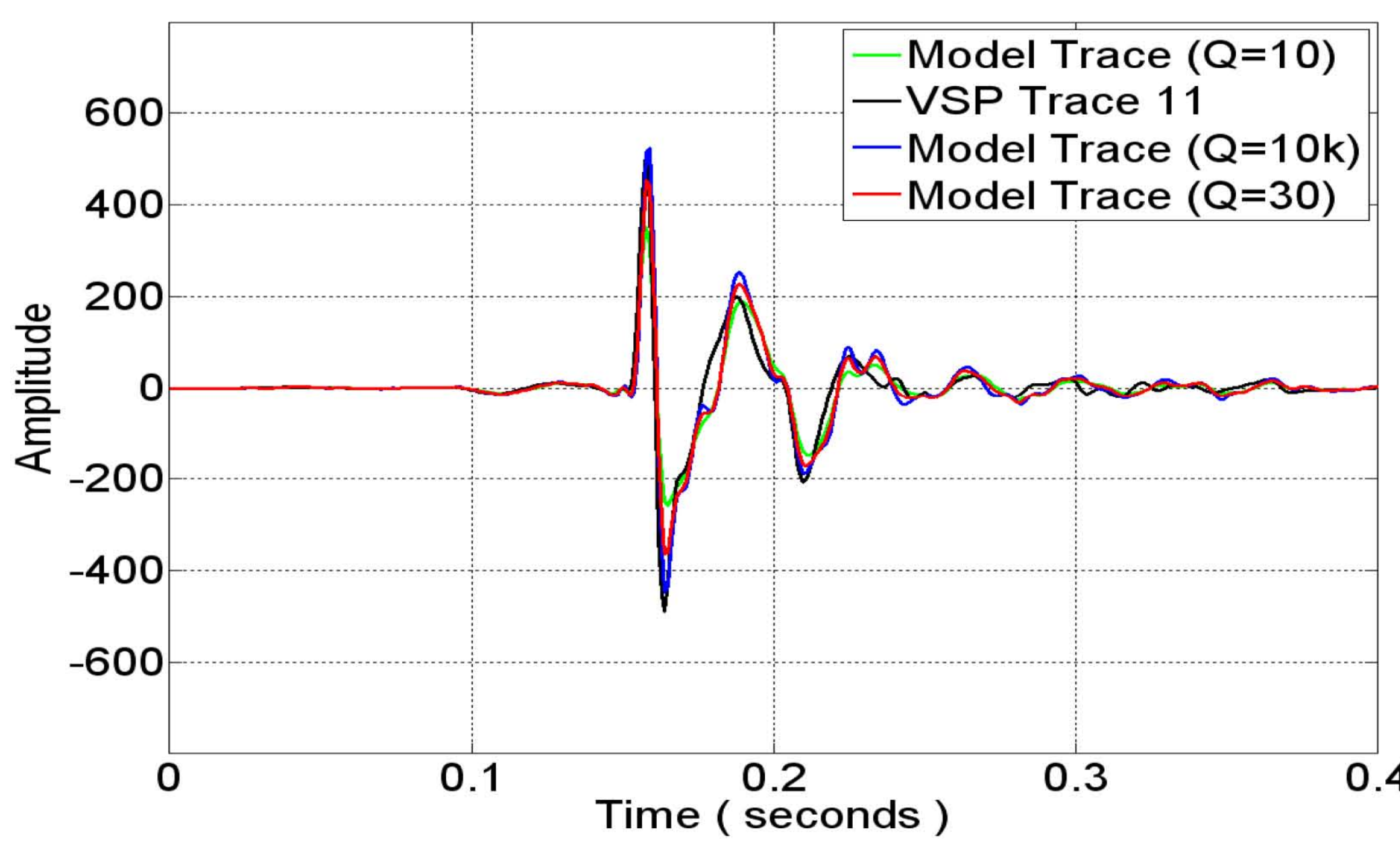


FIG. 12. VSP trace number 11 (black) and model traces derived from trace number 5 for a range of Q-factors.