ESTIMATING NEAR-SURFACE VELOCITIES AND QUALITY FACTORS BY VISCOELASTIC WAVEFORM INVERSION

Yudi Pan[1], Lingli Gao[2], and Thomas Bohlen[1]
1 Geophysical Institute, Karlsruhe Institute of Technology (KIT), Germany
2 Institute of Applied and Numerical Mathematics, Karlsruhe Institute of Technology (KIT), Germany

The reconstruction of near-surface structures by using shallow-seismic wavefields plays an important role in geophysical and geotechnical site investigation. The dispersion-curve-based surface-wave method has been proven as an efficient way to estimate near-surface S-wave velocity. However, this method fails to work when strong lateral heterogeneity exists. By directly fitting the observed data, full-waveform inversion (FWI) has the potential of imaging heterogeneous models with high resolution. In shallow-seismic FWI, the earth model is usually assumed as elastic and the intrinsic attenuation of seismic wavefields is neglected.

In this paper, we perform viscoelastic FWI on shallow-seismic wavefields and invert for quality factor and velocity models simultaneously. Numerical models are used to investigate the crosstalk between Qs and Vs models in viscoelastic FWI. We compare the inversion results of multi-parameter viscoelastic FWI to the conventional mono-parameter FWI in which the viscosity effect is neglected. Synthetic results (Figure 1) show that it is important to consider the viscosity effect in shallow-seismic FWI. We apply viscoelastic FWI to a real-world data acquired in Rheinstetten, Germany. We compare our inversion result to a GPR profile, which proves a fairly high accuracy of the models estimated by viscoelastic FWI.

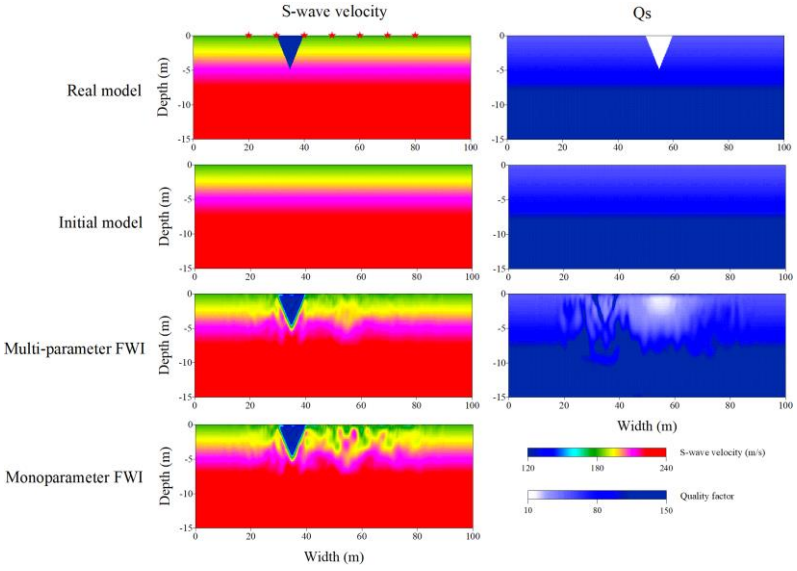

Figure 1. A synthetic example. The true models (first row) are used to investigate the crosstalk between Vs (left column) and Qs (right column). The red stars represent the source locations, and 61 receivers are distributed along the free surface with an equidistant spacing of 1 m from the first source to the last one. We use the 1-D background model as initial models (second row). The third row represents Vs and Qs models estimated by multi-parameter viscoelastic inversion (Vs and Qs simultaneously). The fourth row is the Vs model estimated by the conventional mono-parameter inversion (Vs only).