Jianghai Xia, Richard Miller, Julian Ivanov, and Shelby Peterie (2011) Estimation of Near-Surface Quality Factors by Constrained Inversion of Rayleigh-Wave Attenuation Coefficients. Symposium on the Application of Geophysics to Engineering and Environmental Problems 2011: pp. 132-132.

Quality factors of near-surface materials are as important as velocities of the materials in many applications. High-frequency (≥ 2 Hz) surface-wave data are generally inverted to determine near-surface shear (S)-wave velocities, in which only phase information of surface-wave data is utilized. Amplitude information of high-frequency surface-wave data can be used to determine quality factors of near-surface materials. Given S-wave velocity, compressional (P)-wave velocity, and Rayleigh-wave phase velocities, it is feasible to solve for S-wave quality factor $Q_S$ and P-wave quality factor $Q_P$ (for some specific velocity models) by inverting high-frequency Rayleigh-wave attenuation coefficients in a layered earth model down to 30 meters below the ground surface in many settings. Amplitude is an exponential function of attenuation coefficients. When calculating attenuation coefficients from changes in amplitude, this nonlinear nature would result in that small variations in amplitude cause huge changes in attenuation coefficients, which suggests data (attenuation coefficients) normally possess large errors that eventually transfer to a model (quality factors). Therefore, constraints (*a priori* information) on models become necessary. Because an inversion system of this problem itself is unstable, a regularization parameter must be introduced into an inversion algorithm to stabilize inversion procedure. These characteristics of the inversion problem lead us to solve a constrained and regularized linear system. Usually, a set of models that meet the constraints can be obtained by solving the system. Based on the linear nature of the inversion system, we can pick a smooth model as a solution of the inversion using the *L*-curve method, which is a trade-off solution between data misfit and model length. Several real-world examples demonstrate importance of constraints in finding acceptable quality factors from real data.