The inverse problem of seismic velocities

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Abstract

Waveform (output least squares) inversion of seismic reflection data can reconstruct remarkably detailed models of subsurface structure, and take into account essentially any physics of seismic wave propagation that can be modeled. However the waveform inversion objective has many spurious local minima, hence convergence of descent methods (mandatory because of problem size) to useful Earth models requires accurate initial estimates of long-scale velocity structure. Accordingly, the seismic industry has developed a collection of apparently unrelated *migration velocity analysis* methods, capable of correcting substantially erroneous initial estimates of Earth structure. Appropriate choice of objective turns migration velocity analysis into an optimization problem, for which Newton-like methods exhibit little tendency to stagnate at nonglobal minima. The main theme of this talk is the intimate relation between these two approaches to seismic velocity estimateion: migration velocity analysis is a solution method for a *partially linearized* waveform inversion problem, based on *extension* of the underlying mapping from Earth structure to data.