Iterative Migration Velocity Analysis: extension to surface-related multiple reflections

Abstract

Active seismic experiments are commonly used to recover a model of the P-wave propagation velocity in the subsurface. “Migration Velocity Analysis” techniques aim at deriving a smooth background velocity model controlling the kinematics of wave propagation. First, a reflectivity image is obtained by “migration” of observed data using a first estimate of the background velocity. This image depends on an additional “subsurface-offset” parameter allowing to assess the quality of the background velocity model with a focusing criterion and to correct it. However classical migration techniques do not provide a sufficiently accurate reflectivity image, leading to inconsistent velocity updates. In particular they do not take into account multiple reflections, usually regarded as noise and removed from the data before processing. Multiple removal is however a difficult step, and additional information contained in multiples is discarded. In this thesis, we propose to determine the reflectivity model by iterative migration before subsequent velocity analysis, leading to a nested optimisation procedure. Iterative migration yields accurate reflectivity image and extends naturally to the case of multiples. One of its disadvantages is the associated increased computational cost. To limit the number of iterations in the inner loop, a preconditioner based on a pseudo-inverse of the modelling operator is introduced. Another difficulty is the instability of the velocity update obtained with very close successive reflectivity models. We propose a modified approach, valid in the presence of multiples, and discussed through applications on 2D synthetic data sets.

Keywords: Multiple reflections, Iterative migration, Velocity analysis, Inverse problems