**5-Day Seismic Imaging Short Course**

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**Course Objectives:** Learn the benefits and limitations of imaging methods (traveltime tomography, full waveform inversion (FWI), reverse time migration (RTM), least squares migration (LSM), and migration velocity analysis) for reconstructing earth structure from seismic data. Non-linear optimization methods are introduced, which include gradient type methods of Newton, steepest descent, conjugate gradient and Quasi-Newton. To provide better stability and performance, preconditioning, regularization, and multiscale methods are discussed. At the end of the course the participant will be able to assess which method might be best suited to solving their problem, and also understand its benefits and limitations. Participants will also use MATLAB programs for LSM, RTM, and FWI.

**Course Book:** Seismic Imaging by Gerard Schuster (to be published in 2014 by SEG).

**Day 1:** Overview of seismic inversion methods. Ill-posed problems. Optimization methods, objective function, gradient, Frechet derivative, Hessian. Iterative solution to linear and non-linear optimization problems: steepest descent, conjugate gradient, quasi-Newton methods, and line search. Regularization and preconditioning. Traveltime tomography method, case histories. Resolution analysis.

**Day 2:** Overdetermined and undetermined systems of equations, inconsistent equations, non-unique solutions, traveltime tomography case histories. Resolution analysis and assessment of solution reliability. Covariance matrix. Kirchhoff migration, and reverse time migration.

**Day 3:** Case histories for RTM, source illumination, smooth velocity model migration, generalized diffraction migration. Practical aspects of RTM, including aliasing, resolution limits, and eliminating artifacts. Wavepaths: Cigars, rabbit ears, and fat ellipses.

**Day 4:** Least squares migration. When it works and when it does not work. Estimating the source wavelet and the initial velocity model. LSM case histories, multisource LSM, and resolution analysis. Overdetermined and undetermined cases. Migration velocity analysis.

**Day 5:** Full waveform inversion. When it works and when it does not work. Estimating the source wavelet and the initial velocity model. Case histories. Resolution analysis. Tricks for getting FWI to work. Phase velocity inversion. Sparsity constraints. Future developments.