Geophysical Research Abstracts
Vol. 18, EGU2016-8339, 2016
EGU General Assembly 2016

Visco-elastic full waveform inversion of controlled seismic data from the San Andreas Fault Observatory at Depth

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We apply visco-elastic full waveform inversion (FWI) to a 50-km-long controlled-source refraction/reflection seismic survey at the San Andreas Fault (SAF) to obtain high resolution P-wave and S-wave velocity models for the SAF Observatory at Depth (SAFOD) drill site near Parkfield. The profile consists of 63 explosive sources and a fixed spread of 912 3-component receivers.

Traveltime models from Ryberg et al. (2012) and Hole et al. (2006) are used to derive velocity starting models for FWI. Attenuation is estimated from Qp and Qs t*-tomography models after Bennington et al. (2008). Density is estimated from P-wave velocity using Gardner's (1974) relation.

Preprocessing includes the muting of noisy traces, the estimation of spatio-temporal weighting factors to exclude Rayleigh waves, which otherwise mask the comparatively low-amplitude body wave signals, and a 3D-to-2D-conversion, which is carried out separately for P- and S-waves and their coda. The separation of P- and S-wave arrivals is based on travel-time and polarization analysis.

The forward-modeling is based on a time-domain visco-elastic FD-algorithm of Robertsson et al. (1996). Topography is considered using the image method. The inversion is performed in the frequency-domain using the multi-scale approach. As a first step, we derived individual source wavelets for the different shots at the low frequencies (2-6 Hz).

The project is funded by the German Research Foundation (DFG) and is part of the International Continental scientific Drilling Programme (ICDP).