Geophysical Research Abstracts
Vol. 20, EGU2018-13162-3, 2018
EGU General Assembly 2018

2D adjoint-state full-waveform inversion of band-limited multichannel seismic data in the Alboran basin (SE Iberia)

Claudia Gras Andreu (1), Valentí Sallarès (1), Daniel Dagnino (1), Clara Estela Jiménez-Tejero (1), Adrià Meléndez (1), and César R. Ranero (2)

(1) Barcelona Center for Subsurface Imaging, Institute of Marine Sciences ICM, Ciències del Mar, CSIC, Barcelona, Spain (clgrasan8@alumnes.ub.edu), (2) Barcelona Center for Subsurface Imaging, Institute of Marine Sciences ICM, ICREA at CSIC, Barcelona, Spain

Here we present a high-resolution P-wave velocity model of the sedimentary cover and the uppermost basement until ∼3 km depth obtained by applying adjoint-state full-waveform inversion (FWI) to a Multichannel Seismic (MCS) data set acquired with a 6 km-long streamer of 480 channels. The MCS profile was acquired in the Alboran Sea (SE Iberia), in the framework of the TOPOMED-2011 experiment. The inherent non-linearity of FWI for short-offset, band-limited seismic data as this one, was circumvented by using a reference velocity model obtained by travel-time tomography. Given the water depth in excess of ∼2 km and the short acquisition offset, refractions are not visible as first arrivals in the original shot gathers. To solve this issue, we applied a data processing/modelling sequence consisting of three steps: (1) data re-datuming (i.e. downward continuation, DC) by back-propagation of the recorded seismograms to the seafloor using a numerical solver of the wave equation; (2) joint refraction (first arrival) and reflection (top of basement) travel-time tomography of the DC shot/receiver gathers; and (3) FWI of the original shot gathers using the model obtained by travel-time tomography as initial reference.

FWI is performed using specific data and gradient preconditioning techniques to concentrate model updates in the regions where the gradient is more reliable. A multi-scale strategy adding low to high frequencies sequentially is followed to reduce the risk of converging to a local minimum and add details progressively to the model. The source wavelet is also inverted and updated in each inversion step. We show that FWI provides reliable and accurate results starting at frequencies as high as ∼6 Hz, because the initial model has the low wavenumber information needed to avoid cycle-skypping.

The final velocity model shows a number of geologically meaningful details that cannot be identified in the initial model. For instance, a volcano-like structure is observed in the central part of the profile, also a strong velocity contrast that accurately follows the shape and geometry of the top of the basement, and steeply dipping anomalies that correspond to normal faults can be seen at the flanks of the basin. In addition, a 200-300 m thick, high-velocity layer embedded within the sediments that likely correspond to salt deposited during the Messinian crises is clearly imaged. The two-way-time transformed velocity model has an excellent match with time-migrated MCS image: velocity changes nicely follow major reflectivity contrasts and fault locations, which further validates the inversion result. The results confirm that the combination of DC and joint refraction and reflection travel-time inversion provides models that are accurate enough to apply FWI to relatively short offset streamer data starting at realistic field data frequencies.