Seismic Interpretation Validation at Deep-Water Rifted Margins Using Structural-Stratigraphic Modeling

Júlia Gómez-Romeu[1], Nick J. Kusznir[1], Gianreto Manatschal[2], and Alan M. Roberts[3]

[1]Earth, Ocean and Ecological Sciences, University of Liverpool, Liverpool, United Kingdom.
[2]IPGS-EOST, Université de Strasbourg, Strasbourg, France.
[3]Badley Geoscience, Spilsby, United Kingdom.

ABSTRACT

Exploration at deep-water continental rifted margins presents substantial scientific and technical challenges for the hydrocarbon industry. It is important to understand the transition from thinned continental crust to oceanic crust, the distribution of pre-, syn- and post-breakup sedimentary sequences and their depositional environment and heat-flow. Most of this information is dependent on the interpretation of seismic reflection data. We present and apply a new methodology for the validation of seismic interpretation at deep-water rifted margins using forward structural and stratigraphic modelling. We use a kinematic forward model (RIFTER) of continental lithosphere stretching and thinning leading to continental breakup. Lithosphere extension is achieved by extensional faulting in the upper crust and distributed deformation in the lower crust and mantle. RIFTER incorporates the flexural isostatic response to extensional faulting, crustal thinning, lithosphere thermal loads, sedimentation and erosion. The model predicts the structural and stratigraphic consequences of recursive sequential faulting and sedimentation. Inputs for the kinematic forward model derived from seismic reflection interpretation are fault locations and extensions and sedimentary sequence thicknesses and geometries. We test and calibrate the predictions of the forward structural and stratigraphic model and hence the seismic reflection interpretation, against observed breakup paleo-bathymetry and crustal basement thickness. The target data used to constrain model predictions consists of two components: (i) gravity anomaly inversion is used to determine Moho depth, crustal basement thickness and continental lithosphere thinning and (ii) reverse post-rift subsidence modelling consisting of flexural backstripping, decompaction and reverse post-rift thermal subsidence modelling is used to give paleo-bathymetry at breakup time. We apply and test the RIFTER structural and stratigraphic model and its quantitative calibration workflow using interpreted seismic reflection data on the Iberia-Newfoundland conjugate rifted continental margins. Additional outputs from the calibrated model are the predictions of paleo-bathymetry evolution (depositional environment) and heat flow history.