3-D gravity inversion using a constrained probabilistic method: Applications to crustal-scale models of rifted continental margins, offshore Newfoundland, eastern Canada

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Gravity techniques have been widely used as an exploration tool for oil and mining exploration. With the availability of airborne, marine, and satellite data, gravity methods have been extended to recognize salt dome provinces, overthrusts, foothill belts, and underexplored basins (Nabighian et al., 2005). Since the crust-mantle interface (the Moho) is also a prominent density gradient, gravity data have a role in understanding the geometry of the Moho and/or density variations from the crust to upper mantle, especially where no further information is available, or seismic data are sparse, or seismic imaging of the lower crust is poor.

In this study, we present a method for stable 3-D inversion of gravity data to study crustal-scale structures based on a probabilistic frame with constraints from bathymetry, sedimentary basin thickness, and sparse Moho depths. Using the proposed method, model structures with sharp boundaries can be obtained while the existing boundary information and sparse seismic constraints are honoured. Application of the method to crustal-scale models of rifted margins, eastern Canada (Figure 1) shows that the interpolated seismic depths to Moho and the Moho proxy from the inversion show a good match. Moreover, in some locations, our inversion results (Figure 2) show an improved agreement with the results from new seismic surveys that were not incorporated as constraints into the inversion. The method provides an effective regional tool for bridging between existing sparse deep seismic constraints and producing geologically reasonable density models at the crustal-scale.

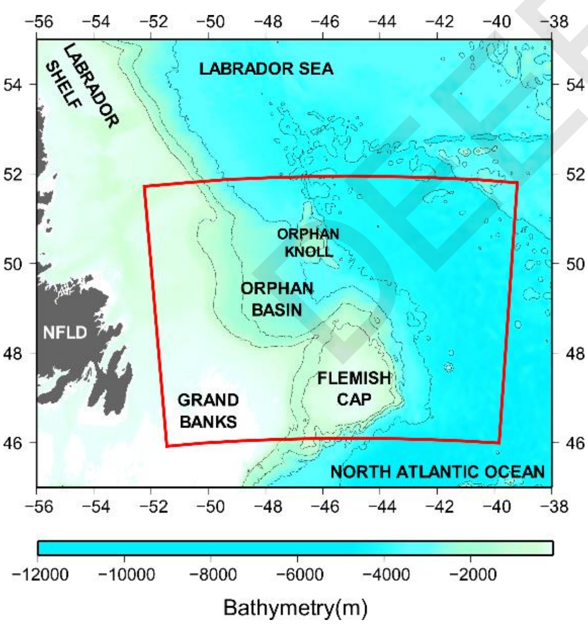

Figure 1. Bathymetric map of offshore Newfoundland (NFLD), eastern Canada. The red polygon shows the location of the study region and the key bathymetric structures of the margin are labelled.

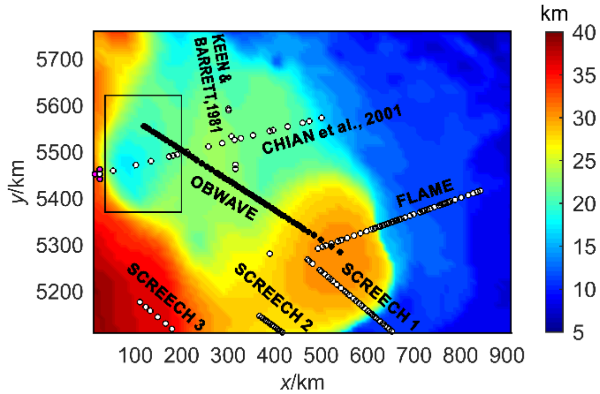

Figure 2. Moho depths from the density anomaly Moho-proxy from the 3-D gravity inversion in this study. The white points show the seismic survey lines which were incorporated directly into the inversion as constraints and the black points show the seismic survey line which were deliberately not used as constraints but were used to gauge the quality of the inversion results.

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