

Along-axis crustal structure of the Porcupine Basin from seismic refraction data modelling

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The Porcupine Basin is a tongue-shaped offshore basin SW of Ireland that formed during the opening of the North Atlantic Ocean. Its history of development involved several rifting and subsidence phases during the Late Paleozoic and Cenozoic, with a particular major rift phase occurring in Late Jurassic–Early Cretaceous times. Previous work, focused on subsidence analysis, showed that stretching factors (β) in the northern part of the basin are < 1.5 and increase significantly southwards, where they were estimated to be > 6 . However, recent studies based on seismic reflection and refraction profiles concluded that β in places along the basin axis were significantly higher, and suggested the presence of major crustal faulting and uppermost mantle serpentinization in the basin. Constraining β and the processes related to the formation of the basin will provide insights into aspects such as the tectonic response to lithospheric extension and the thermal evolution of the basin. Here we present the tomography results of five wide-angle seismic (WAS) profiles acquired across and along the basin axis. We used a travel time inversion method to model the WAS data and obtain P-wave velocity (V_p) models of the crust and uppermost mantle, together with the geometry of the main geological interfaces along each of these lines. Coincident seismic reflection profiles to each WAS line were also used to integrate the tectonic structure with the V_p model. These results improved constraints on the location of the base of the crust and allow to estimate maximum β (β_{max}) along each profile. The analysis shows that β_{max} values in the northern part of the basin are 5–6 times larger than estimates based on subsidence analysis. Towards the south, β_{max} increases up to 10, but then rapidly decreases to 3.3 southwards. These values are well within the range of crustal extension at which the crust becomes entirely brittle at magma-poor margins allowing the formation of major crustal faulting and serpentinization of the mantle. In agreement with this observation, V_p values of the mantle are lower than those expected for a non-altered mantle (i.e. ~ 8 km/s) supporting mantle serpentinization. The outcome of this study reveals the complexity of the crustal structure of the Porcupine Basin and demonstrates the importance and value of this type of analysis in understanding rift systems. This project is funded by the Irish Shelf Petroleum Studies Group (ISPSG) of the Irish Petroleum Infrastructure Programme Group 4.