



GeoPro Hamburg

PORCUPINE WARRP SURVEY

A Preliminary Discussion of the Data

prepared for the

Porcupine Studies Group

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Introductory Remarks

In May 2002 GeoPro-Hamburg performed a Wide Aperture Reflection Refraction Profiling (WARRP) survey on behalf of the Porcupine Studies Group, in order to establish the crustal structure of the Porcupine Basin and the adjacent Highs. As described in the Survey Report, sixty five Ocean Bottom Seismographs (OBS) were deployed. Sixty one positions produced good quality data that will be used in the modelling process. In the following we will briefly describe some qualitative observations derived from the common receiver gathers (CRG) based on the vertical geophone recordings and we will present a starting model for the inversion and two-point ray-tracing process.

Geological Considerations and Aim of the Project

The Porcupine developed during the Mesozoic era as a consequence of multiple continental rifting episodes. The sedimentary -fill consists mainly of Mesozoic and Tertiary sequences and has been mapped in great detail by conventional vertical seismic profiling. The stratigraphy is well constrained by exploration wells (Shannon et al., 1995). Information on the crustal structure and type of the Porcupine Basin and the Porcupine High hardly exists and previous experiments (Makris et al., 1988) provided simple crustal models, mainly restricted to the eastern flank of the Basin and the transition from the Basin to the Atlantic oceanic crust. The present experiment therefore was designed with the intention to obtain seismic data that could yield information on the crustal structure and the velocity behaviour of the crust and upper mantle in the Basin and the neighbouring Highs.

The Data and Preliminary Modelling

The discussion will be restricted mainly to crustal properties and the delineation of first order discontinuities within the crust, rather than the sedimentary sequences, their geometry and velocity behaviour.

As can be seen in sections 1 and 5 which are placed on the shallower part of the Porcupine High (see Appendix), a PmP reflection from the crust/mantle boundary can be easily identified in offsets of 70 to 80 Kms. This means that the crustal thickness exceeds 26 to 28 Kms (depending on the velocity structure of the overlaying sequences). In offsets between 60 to 70 Kms a second reflection PiP_2 is also easily recognized which is generated from an intercrustal reflector at a short distance (5 to 8 Kms) above the Moho. At offsets between 35 to 45 Kms one can recognize a further reflection denoted as PiP_1 which is generated from an intercrustal reflector that can be located at a depth of 12 to 15 Kms. Of course in several sections one can easily recognize the base of the sedimentary Basin from another reflection which is close-by to the OBS location. This reflection is of very variable offset depending on the thickness of the sedimentary sequence.

The existence of two intercrustal reflections and the crustal thickness mapped below the Porcupine High are of very similar structure to the crust mapped by Jacob et al. (1985) for the onshore Ireland. It is also similar to that mapped further to the north by Jacob et al. (1995) where they have also demonstrated that the offshore continental areas of Ireland have a crustal type very similar to that mapped below Ireland. Only in the deeper parts of the strongly stretched Rockall Trough the crust is modified and thinned and only one intracrustal reflector was identified. The same seems to be the case in the deeper part of the Porcupine Basin. O'Reilly and Readman presented in 2002 a density model of the northern

part of the Porcupine Basin where they introduced a very thinned continental crust and a differentiated upper mantle intruding to very shallow depths below the central part of the Porcupine Basin.

The seismic data produced during the present experiment will provide conclusive evidence on the true situation of the mantle structure. Gravity alone cannot provide undisputable models.

In the attached computations we inverted selected data by a first break tomography and run a first test of 2-point ray-tracing. The results demonstrate the validity of the assumptions discussed above on a purely qualitative basis. We did not elaborate a precise fit between observed and calculated travel-times, since the precise geometry and structure of the sediments has not been evaluated. These preliminary results are all documented in the Appendix.

Proposal for Further Work

The qualitative inspection of the data has shown that the seismic information collected across the northern part of the Porcupine Basin can resolve the crustal and sedimentary structures. The steps to be followed should be:

- 1) a tomographic linear and non-linear inversion,
- 2) 2-point kinematic and dynamic ray-tracing in order to finalize the seismic structure,
- 3) synthetic computations by finite difference techniques in order to optimize the synthetic amplitude computations,
- 4) application of migration techniques using the wide-angle reflections in order to reconstruct the tectonic structure of the basement and correlate the results with the major tectonic lineaments.

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APPENDIX