Establishing Baseline Seismicity of the Irish Frontier Basins:

Understanding seismic hazard and regional crustal structure offshore Ireland using new broadband seismometer arrays onshore

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Knowledge of baseline seismicity is important for evaluating the risks associated with hydrocarbon exploration and production and in monitoring any induced seismicity due to exploration and production activity west of Ireland. However, the natural baseline seismicity in the Irish Offshore is poorly known (Fig. 1). It has been difficult to map because of the lack of broadband seismic data, off- or on-shore. Such data have now become available on-shore, with multiple broadband seismic networks deployed across the island in the last few years (Fig. 2). The unprecedented new datasets offer new opportunities to (i) map and evaluate the baseline seismicity in the Irish Offshore and (ii) determine 3D crustal seismic-velocity structure across the region (relevant to basin evolution and hydrocarbon prospectivity).

Seismicity in and around Ireland is relatively low, and until recently Ireland has often been considered largely aseismic. This was due, however, to the absence of a dense digital network and an associated research programme aimed at detecting micro-earthquakes (below magnitude 3.0). In the last few years, multiple broadband seismic networks have been deployed across the island (Fig. 2). These have included the 20-station Ireland Array (Lebedev et al. 2013), 18-station Wave-Obs coastal array (Bean and co-workers, UCD), and 5 stations of the INSN (Blake and co-workers, DIAS). Preliminary analysis of the new data shows abundant, previously unknown micro-seismicity onshore, with entire earthquake sequences identified, for example, in Donegal (Lebedev et al. 2012).

Importantly, the occurrence of intermediate-size earthquakes off-shore, west of Ireland, indicates that this area is more seismically active than Ireland itself (Fig. 1). Events with magnitudes 4.0 and larger have occurred in the Rockall Trough, Porcupine Seabight, and, in 2012, 100 km off the coast of Co Mayo in the Slyne-Erris Trough (Figs. 1, 3). Based on well-known earthquake-size scaling laws, one can expect roughly 10 times more magnitude 3.0 earthquakes than magnitude 4.0 events, with 100 times more of magnitude 2.0s and 1000 more of magnitude 1.0s. A very small proportion of such smaller earthquakes has been mapped to date (Fig. 1).

An **environmental baseline study** aimed at establishing baseline seismicity of the Irish Frontier Basins can now be performed using the new data onshore. It will reveal areas with a high incidence of tectonic earthquakes. It should lead to the first, preliminary probabilistic seismic hazard maps for the offshore region, important in petroleum exploration and development planning.

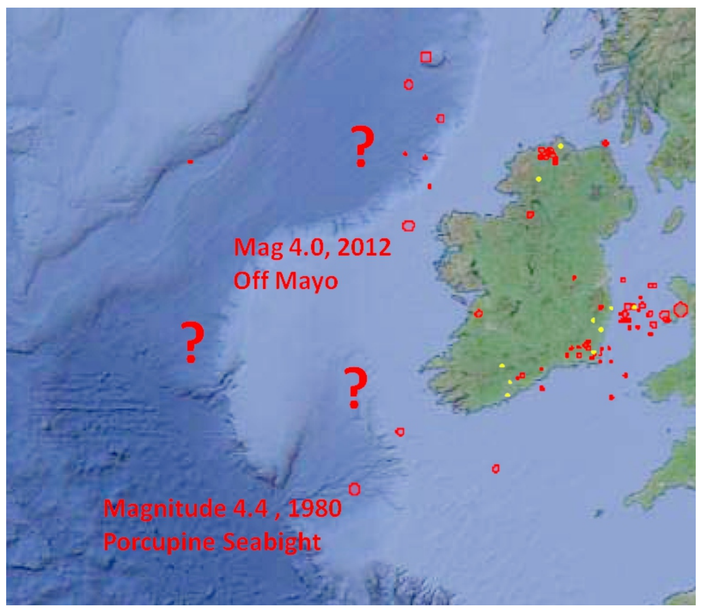

Figure 1. Known seismicity in and around Ireland (from DIAS Irish Seismicity website). Red circles indicate earth-quake epicentres, with circle sizes scaled with the event magnitude. Micro-seismicity to the west of Ireland is poorly known.

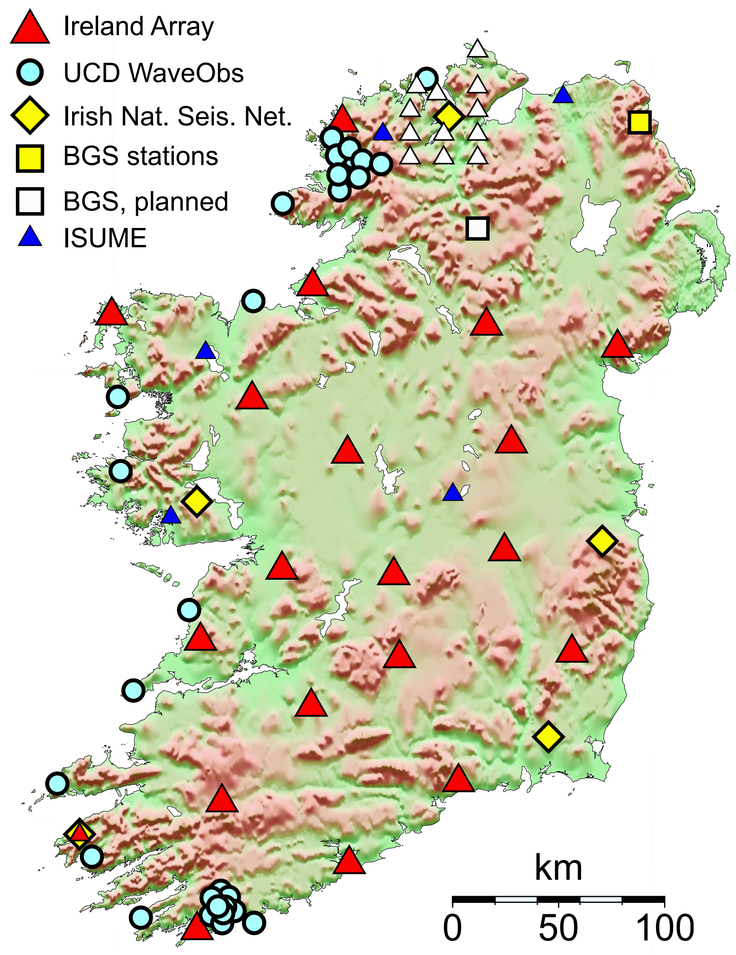

Figure 2. Broadband seismic stations in Ireland recording within the last 3 years. Coverage is par-ticularly dense across the west of the island, facilitating the study of seismicity and crustal structure off-shore.

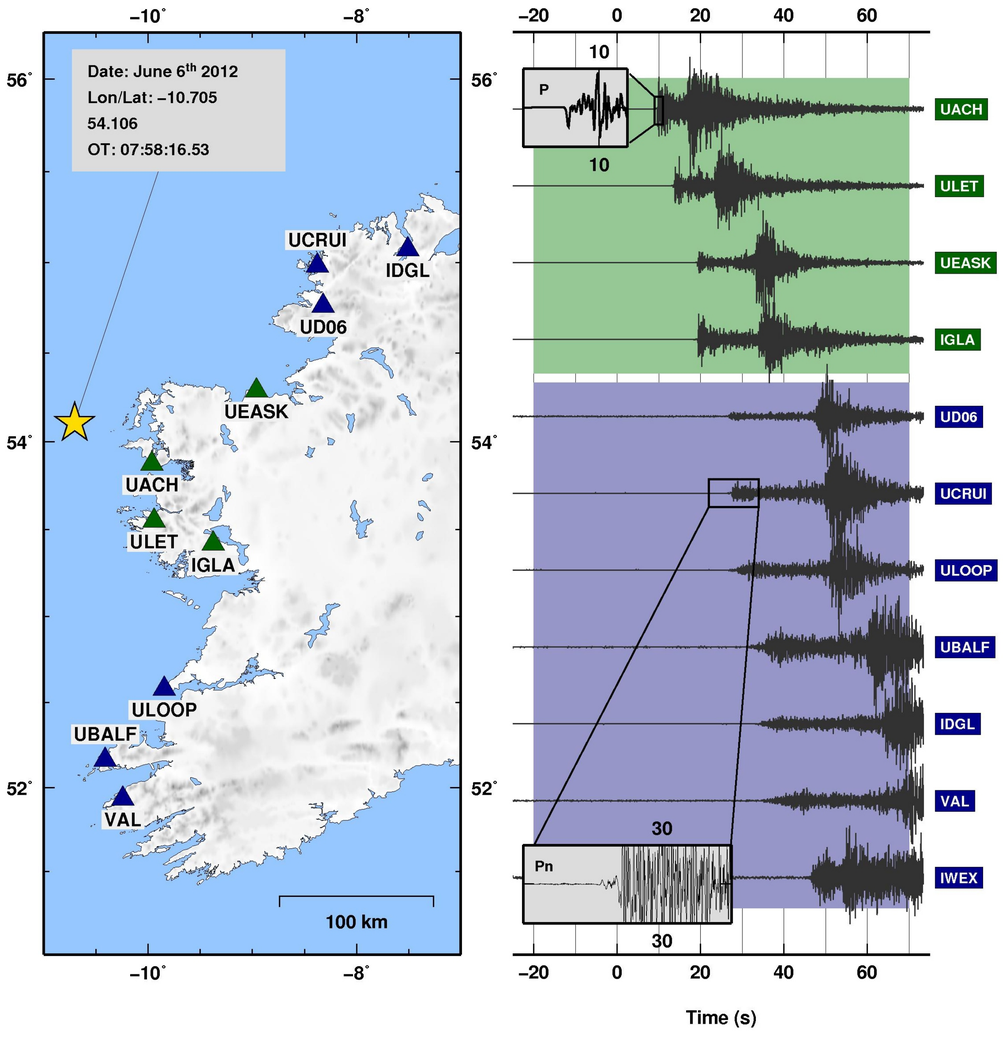

Figure 3. Recordings of the 2012 event off Mayo (Blake et al. 2012) at a few of the broadband stations in the west of Ireland. These vertical-component records were used to locate the earthquake. Top four traces (green background): P-wave arrival is clearly seen; bottom 7 (blue): Pn arrival is prominent. The signal-to-noise ratios are very high; a smaller aftershock has also been located. Smaller and more distant earthquakes can also be located using the data from the available broadband stations. For larger events, additional stations in Iceland, Britain and Iberia can be used to improve the azimuthal coverage. With the crustal models refined using these larger events, smaller earthquakes can be located using stations in Ireland, with polarisation and array analysis employed to enhance location accuracy (e.g., Piccinini et al. 2009).

References

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