Project SEA-SEIS: Structure, evolution and seismicity of the Irish offshore

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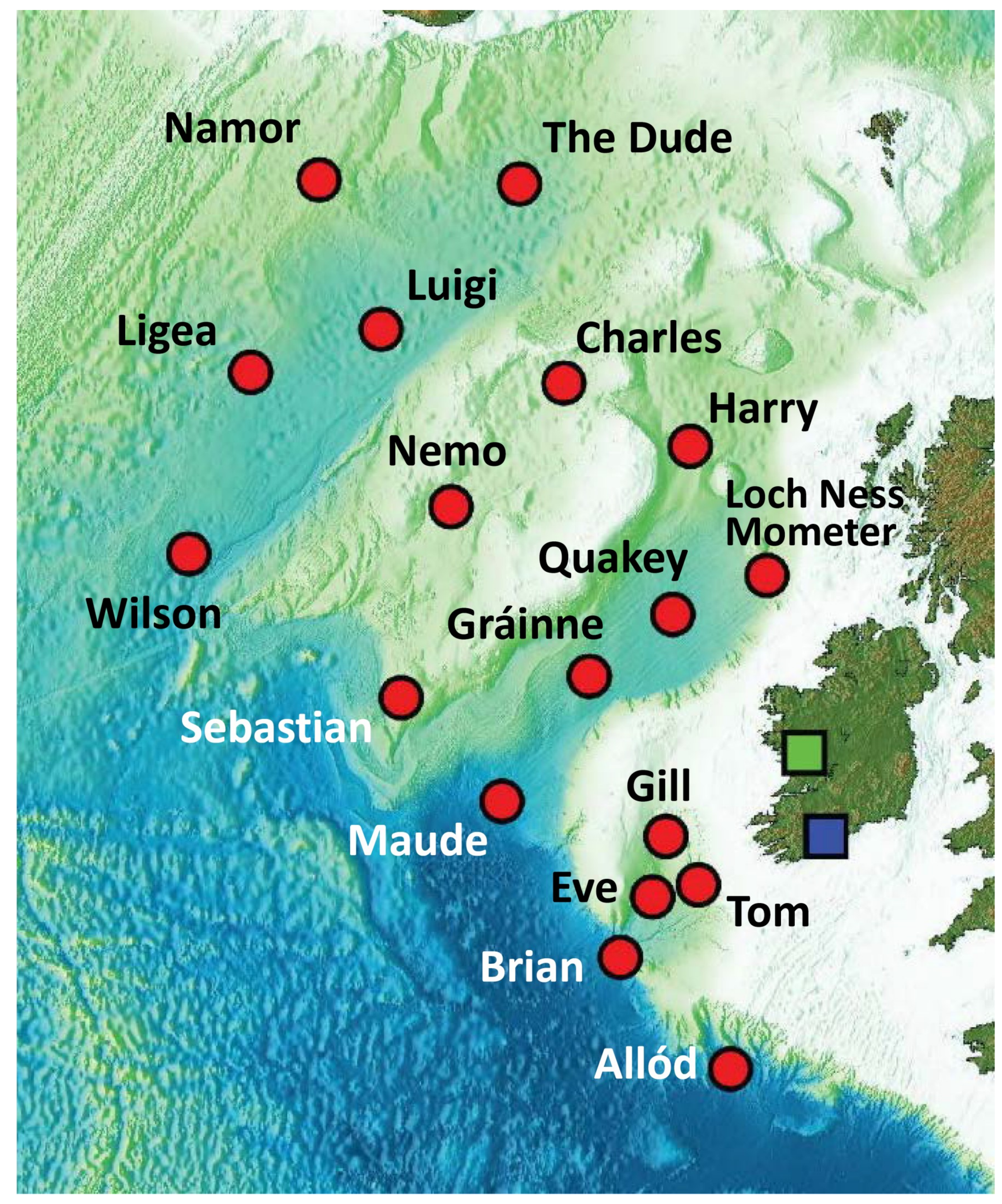
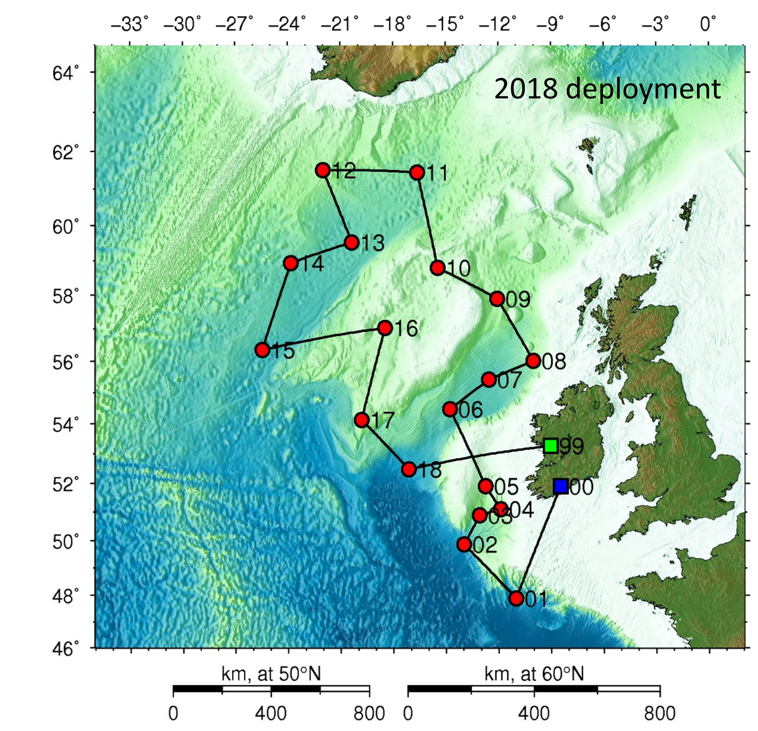
Ireland's largest sedimentary basins, hydrocarbon resources and natural hazards (offshore landslides) are in its vast offshore. The lack of broadband seismic sensors offshore has hindered our understanding of the deep mechanisms of the lithospheric hyper-extension that formed the basins, mechanisms of the Paleogene uplift and volcanism in and around Ireland (probably related to the enigmatic Iceland Hotspot activity, they affected the structural and thermal evolution of the basins), regional-scale structure and evolution of the area's crust and lithosphere, and its current deformation and seismicity. In the project SEA-SEIS, we have deployed 18 new, broadband, ocean-bottom seismometers provided by the newly established Insitu Marine Laboratory for Geosystems Research (iMARL) across the entire Ireland's offshore, with a few sensors also in the UK and Iceland waters. Seismic tomography with the new data will be performed using waveform inversions and ambient-noise and teleseismic cross-correlations. A new offshore earthquake catalogue will be obtained. Lithosphere-scale thermal evolution of the basins will be modelled. The project will yield important new information on regional geodynamics and energy resource development. All 18 OBSs have been deployed successfully from the Marine Institute's Celtic Explorer (17 September–5 October, 2018). The SEA-SEIS Expedition received broad media coverage and had a significant outreach component, reaching many hundreds of secondary and primary school students through competitions and ship-classroom video links.

The 2018 SEA-SEIS Expedition:

- **18** days in the North Atlantic
- **18** seismometers deployed at the seafloor
- **18** live ship-to-classroom video link-ups





The Real Map of Ireland

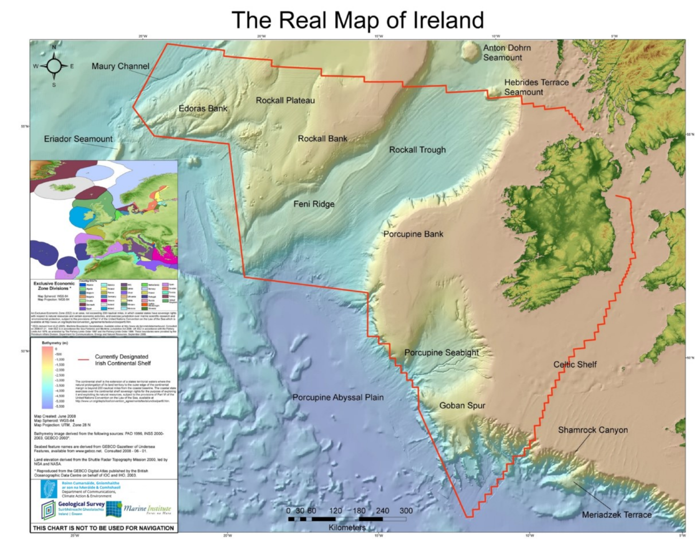
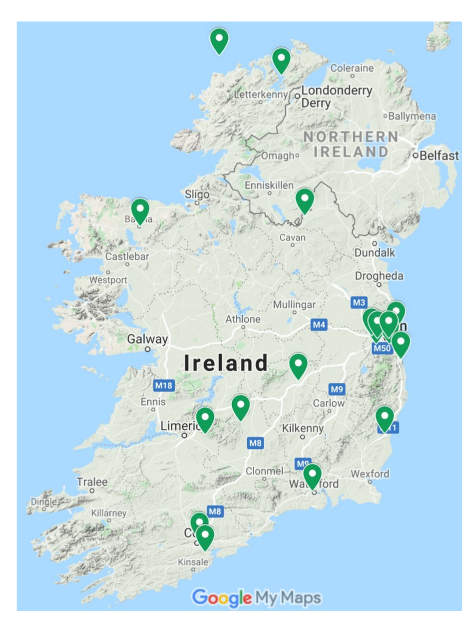


Fig. 1. Locations of the 18 broadband Ocean Bottom Seismometers (OBS), named by students from schools across Ireland. Right: Deployment survey ship track (17/09–05/10/2018). Bottom right: Ireland's offshore territory (The Real Map of Ireland.)

The 2018 SEA-SEIS Expedition

SEA-SEIS in Schools



Winning schools in the SEA-SEIS **Name-a-Seismometer competition**. Most of the winning classes also participated in one of our 18 **live ship-to-classroom video link-ups**.

The live ship-to-class video link-ups

Scoil Mhuire, Buncrana, Co. Donegal

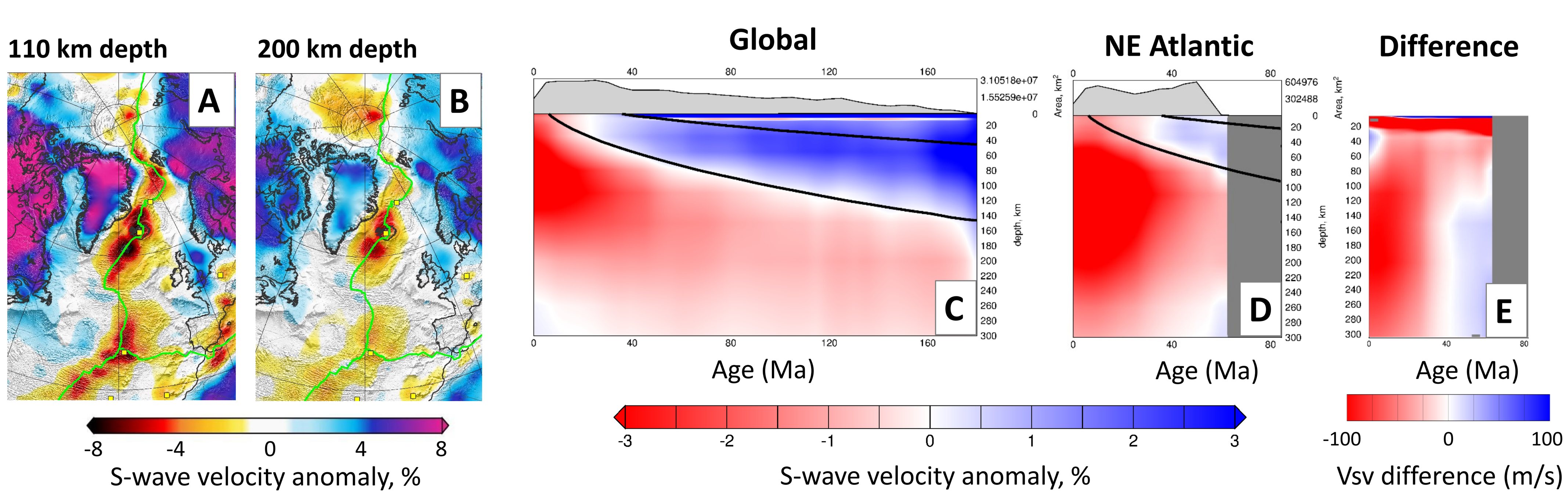
Gaelcholaiste Carrigaline, Co. Cork

Coláiste Phobail Cholmcille Tory Island, Co. Donegal

Kingswood Community College, Dublin

Largy College, Clones, Co Monaghan

Lycee Francais d'Irlande, Dublin

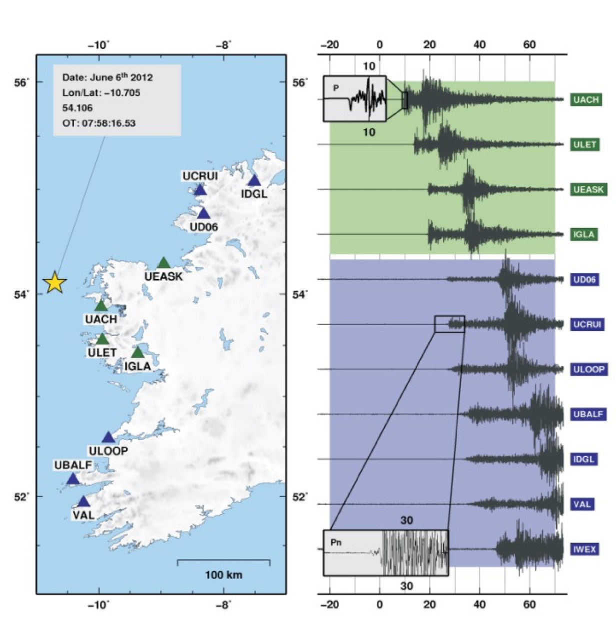


Structure and evolution of the North Atlantic

Fig. 2. Preliminary tomography of N Atlantic (Celli et al., IGRM 2017). **A**, **B**: map views at 110 and 200 km depths (ref. Vs: 4.39 and 4.45 km/s, respectively). **C**: Age-average Vs anomaly averaged over all oceans. **D**: Age-average Vs anomaly for NE Atlantic only (between Greenland on the west and Ireland, Britain and Norway on the east). **E**: Difference of the NE Atlantic and average oceans. The NE Atlantic lithosphere appears to cool much slower than average, which may be related to the low velocities (by inference, high temperatures) in the asthenosphere in the vicinity of the mid-ocean ridge. The improved methodology in the proposed project (3D kernels) should enable improved resolution in deep upper mantle, revealing, we hope, the mechanisms and consequences of the hotspot-lithosphere interactions.

Seismicity offshore Ireland

Fig. 3. Recordings of the 2012 event off Mayo at a few of the land stations. 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. However, only one smaller aftershock has been detected. In the proposed project, smaller and more distant offshore earthquakes will be located using data from both offshore and land stations.



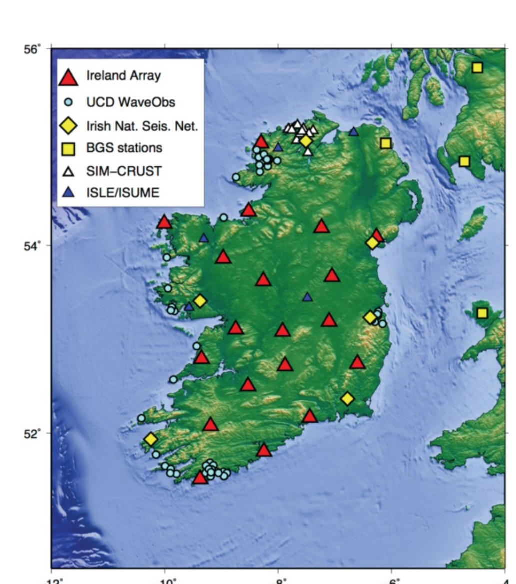


Fig. 4. Temporary and permanent broadband seismic networks onshore Ireland.

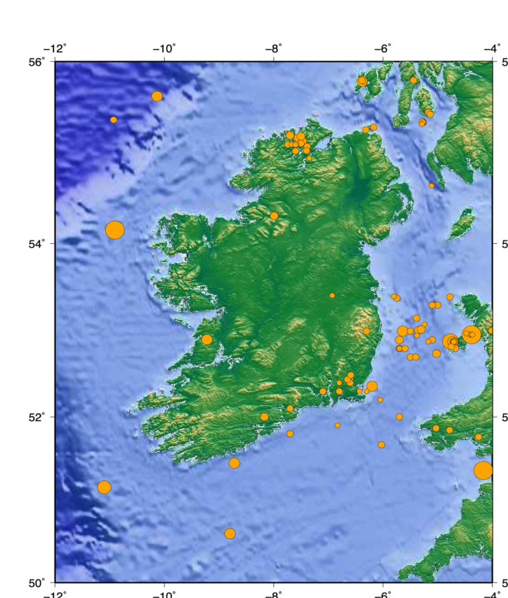


Fig. 5. Known seismicity in and around Ireland (from the INSN catalogue). Red circles indicate earthquake epicentres, with circle sizes scaled with the event magnitude. The largest Irish earthquakes are offshore.

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Acknowledgement

SEA-SEIS is co-funded by the Science Foundation Ireland, the Geological Survey of Ireland and the Marine Institute.