Ireland Array

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Probing the crust and mantle beneath Ireland and North Atlantic

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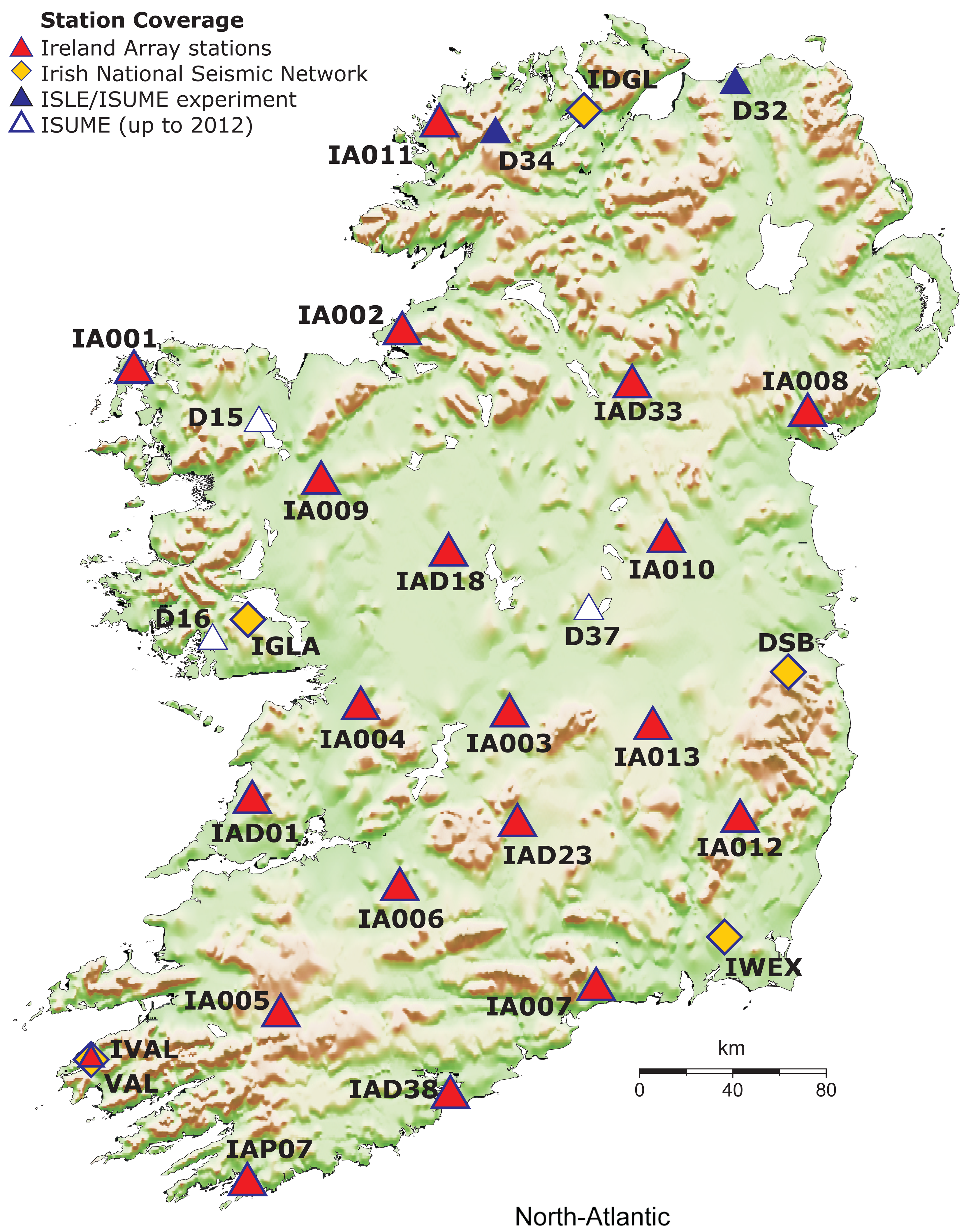
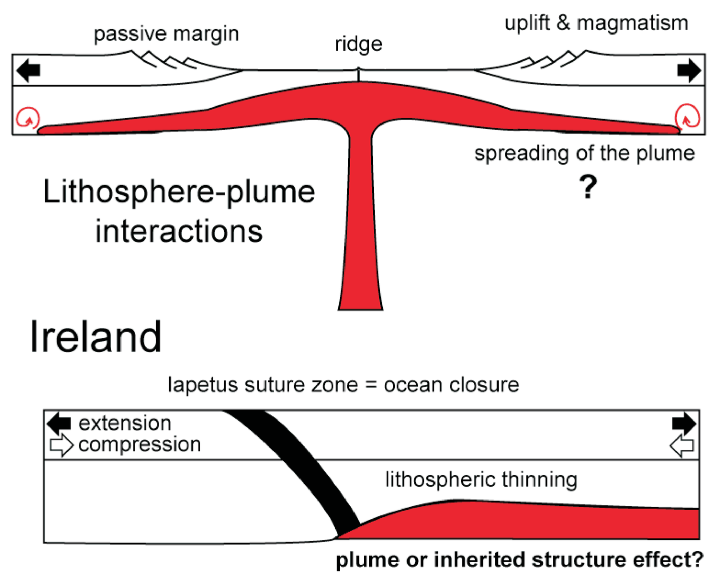
How did Ireland form? Where are the best places to look for geothermal energy? What do the deep structure and evolution of Ireland tell us of hydrocarbon deposit development? What is the distribution and origin of Ireland's micro-earthquakes? To help us answer these questions, a new array of broad-band seismic stations has been deployed across Ireland. A part of the array (its backbone component) is installed across the island for 5 years so as to probe the structure of the crust and lithosphere island-wide. Another part (the mobile component) is used for short-term, dense deployments, zooming in on local structure with particularly high resolution. The data from this state-of-the-art facility will be processed with novel geophysical methods and provide new insights into the evolution and natural resource potential of Ireland.

1: Trillium 120pa seismometer.
2: Insulating Seismometer base.
3: Insulated Seismometer cover.
4: GPS antenna.
5: Taurus data logger.
6: 12v Battery.

Ireland Array is a major geophysical facility, producing abundant new seismic data. Multi-scale seismic imaging using the data will enhance our understanding of Ireland's deep structure and evolution. Ireland Array will underpin sustainable energy and minerals research by mapping the regional structure of Ireland's crust in detail; new insight into 3-D regional lithospheric structure and evolution will be of value for hydrocarbon research as well. Yet another target of Ireland Array is Ireland's microseismicity, poorly understood at present.

Ireland Array comprises two components. The first, backbone component includes 20 stations, distributed uniformly across Ireland, equipped with broad-band Trillium 120PA seismometers, and deployed for 5 years. The second, mobile component is for deployments as a dense array in specific locations. Ireland Array invites collaborations in Ireland and abroad and seeks to benefit the entire community.



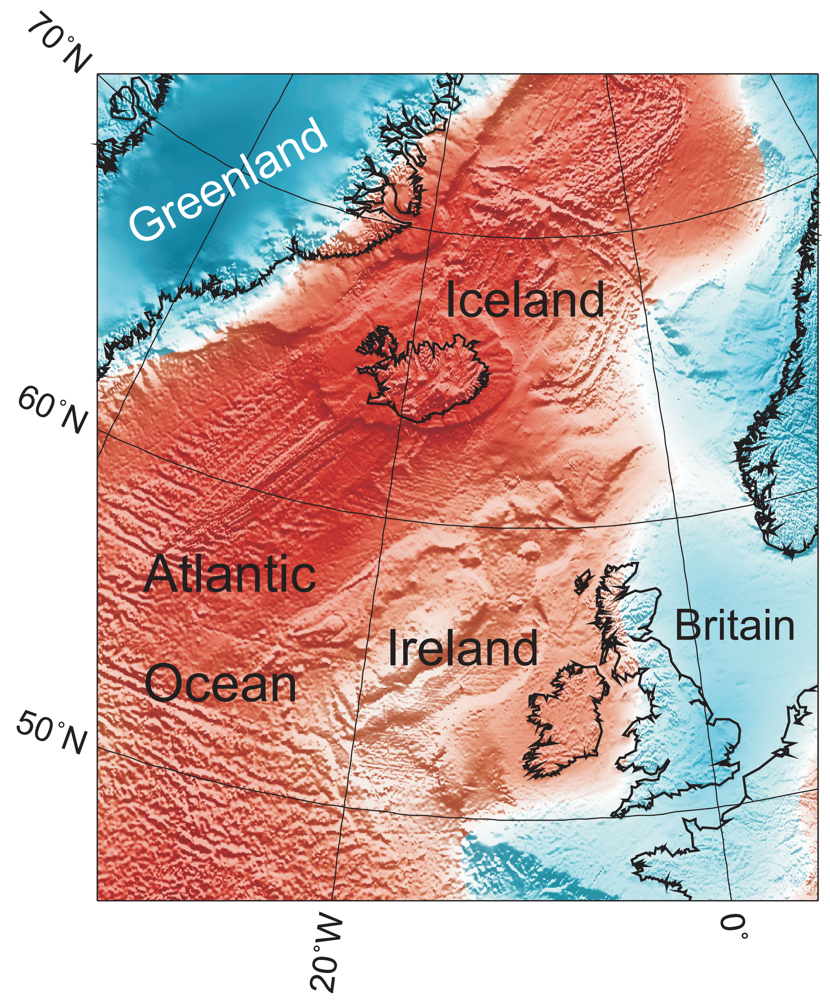


Hypotheses for deep causes of temporal and spatial temperature variations across Ireland. Top: heating of North Atlantic margins (Ireland) by hot asthenosphere spreading from the Iceland Plume, either continuously or in pulses. Bottom: hypothetical thinning of the lithosphere beneath northern Ireland, due to either inherited structure, or recent heating/thinning, or the heating with its effect influenced by the structure.

Acknowledgement
We thank those who have assisted us in establishing Ireland Array, the local Teagasc officers, Met Eireann staff and the landowners who have agreed to host an Ireland Array station.

Deep structure and evolution of Ireland

The Irish landmass was formed in the Caledonian Orogeny, and the associated closure of the Iapetus Ocean is recorded in the NE–SW structural trends that dominate the tectonic set-up of Ireland today (Chew & Stillman 2009; Holland & Sanders 2009). Anisotropic seismic tomography shows that the NE–SW oriented fabrics penetrate the entire crust (Polat et al. 2012). Today, Ireland sits at a margin of the northern Atlantic Ocean. Cenozoic thermal evolution of Ireland may have been linked to the activity of a hot upwelling from the deep mantle, the Iceland Plume (White and Lovell, 1997). Large-scale seismic imaging (e.g., Schaeffer & Lebedev 2013) shows that Ireland is distinctly different from the parts of Europe to the east of it: it seems to have a thinner lithosphere and is underlain by a hot asthenosphere of the North Atlantic affinity. Lithosphere-asthenosphere interactions and small-scale convection in the mantle may also be influenced by poorly known deep lithospheric heterogeneity, created during Ireland's formation. Ireland Array stations are now probing the subsurface beneath Ireland and northern Atlantic and will enable high-resolution seismic imaging of the lithosphere and asthenosphere beneath them.



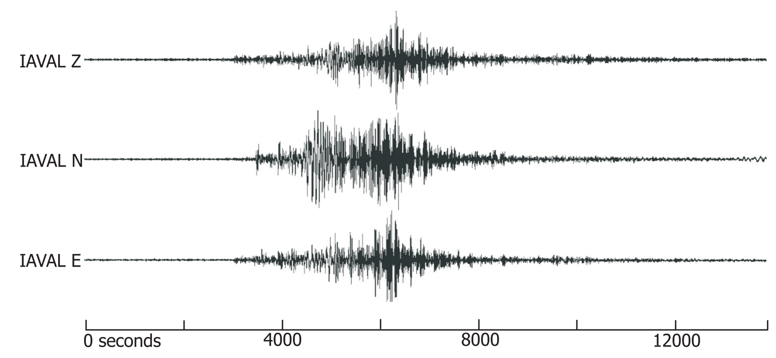
Map view of the mantle at 110-km depth (Schaeffer & Lebedev 2013). Topography is super-imposed as shading. Relatively low shear speeds (red) indicate relatively high temperatures. The warm North Atlantic asthenosphere (hottest below Iceland) appears to extend to beneath Ireland and northwestern Britain.

Ireland Array Deployment

Examples of recorded seismic signal

A Large Distant Earthquake

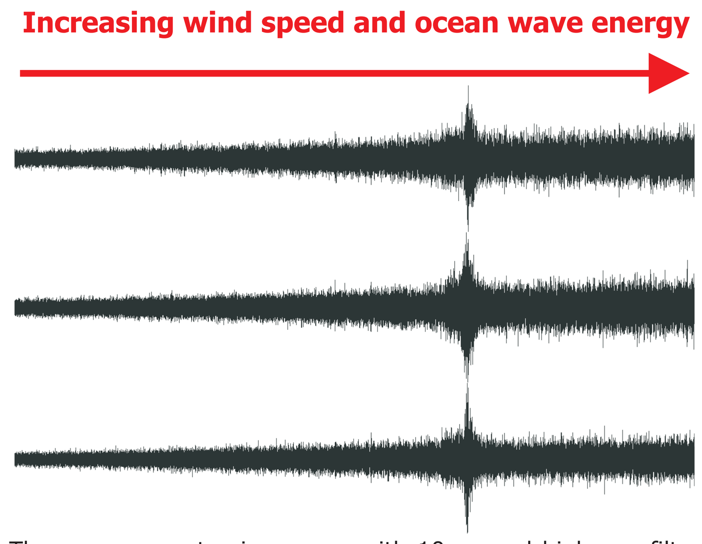
Three-component seismogram from station IAVAL with the recording of the magnitude 7.5 earthquake in the Kepulauan Mentawai region, Indonesia (25th October, 2010, 14:42:25). 10-second lowpass filter was applied (periods below 10 s removed).



Ambient noise: seismic waves from ocean waves

Weather reports, Valentia Observatory

	Date	Rainfall (mm)	Max Temp (°C)	Min Temp (°C)	Grass Min Temp (°C)	Mean Wind Speed (knots)	Gusts (if >= 34 knots)	Sunshine (hours)
Day before: **quiet**	24/10/2010	0	11.6	2.2	-3.1	3.8		8.7
Day of the seismogram: **weather changing**	25/10/2010	13.8	14.3	8	4.1	13.2		0
Day after: **very windy**	26/10/2010	19.4	16	12.4	10	13.6	41	0



Three-component seismogram with 10 second highpass filter (periods longer than 10 seconds removed) showing 24hrs of data at IAVAL on 25th October 2010. The arrow indicates the increase in wind speed and seismic wave energy during this day.

References

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