Recording our shaking Earth

INTO THE PREMIER DIVISION

Tony Bazley talked to Thomas Blake of the Dublin Institute for Advanced Studies

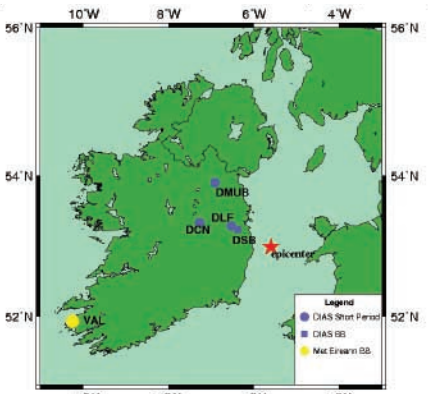
Ireland must have a complete and up-to-date network of earthquake recording stations, so we can safely design and build for the future.

You wake up in the morning and switch on the local news. There has been an earthquake a short distance off the Irish coast. — felt by light sleepers or late party-goers — from Roundwood in County Wicklow to Portmarnock in County Dublin. This happened on Wednesday 14th December last year and resulted in a minor cliff collapse on Killiney Beach in South Dublin. Just 2.8 magnitude, no-one hurt – not something to worry about? Or an alert to something more damaging around the corner?

Who tells us whether it was a genuine earthquake (seismic event) rather than a quarry blast or aircraft sonic boom? Who is studying Ireland's seismicity and seismic hazard potential? Just how safe are we in our beds in Ireland from one of nature's most devastating natural phenomena?

The answers come from a remarkably small group of experts within the Dublin Institute for Advanced Studies (DIAS). They operate highly sensitive motion-detectors (seismographs) set in the ground in parts of the country. This equipment records our earth-shaking events from local earthquakes and also from larger earthquakes around the world.

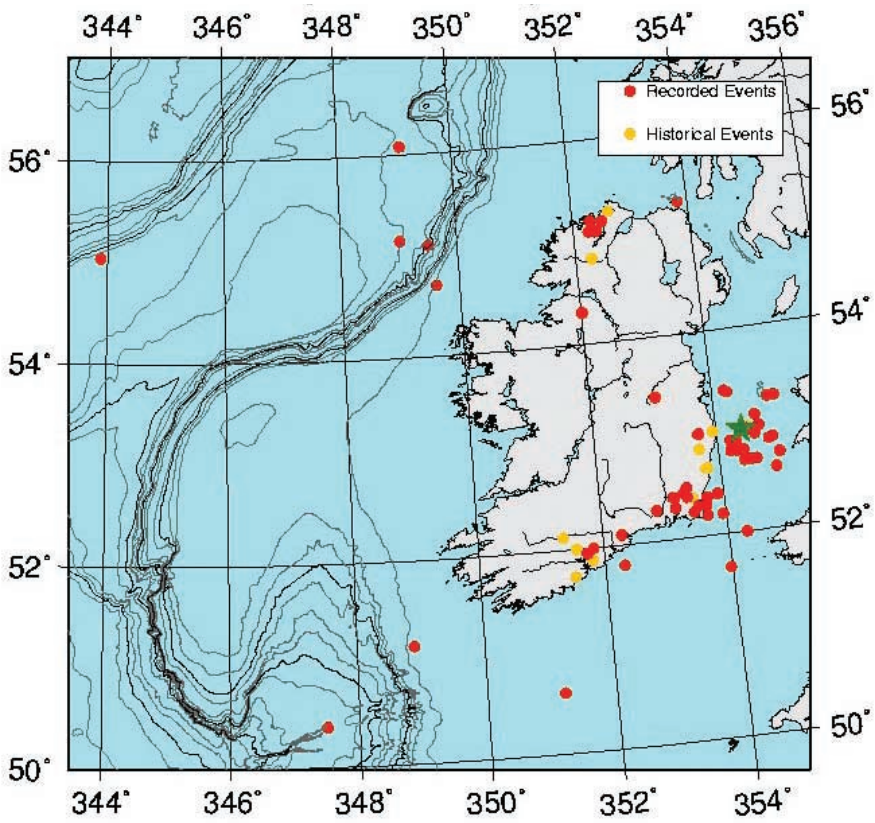
In the 'old days' an ink pen tracing on paper continually turning on a drum would have made the record of ground shaking. Now the tremors are recorded digitally on discs that are retrieved from each recording station every fortnight. So the system has been modernised – but only to an extent.



Epicentre of December 14th 2005 earthquake, shown by red star.

In fact Ireland is unique amongst its European partners in not having a nationally funded regional network of recording stations reporting back in "real-time" and analysed automatically at a national data centre. Despite the antiquated infrastructure DIAS continues to supply essential seismic data to the State, to the International Seismological Commission and to its EU partners. It cannot continue to work in line with these European and other international partners without a significant injection of capital spending on modern comparable systems such as those used throughout the EU and in all First World countries around the globe. Is being unique in this way a claim to fame Ireland wants or should allow? Does it matter if it remains in a lower division? Let's look at some of the facts.

The DIAS network is currently made up of just four active recording stations in the eastern part of the country, one south of Dublin in the Dublin mountains (operated in association with GFZ Potsdam,



Irish earthquakes 1980 to 2006.

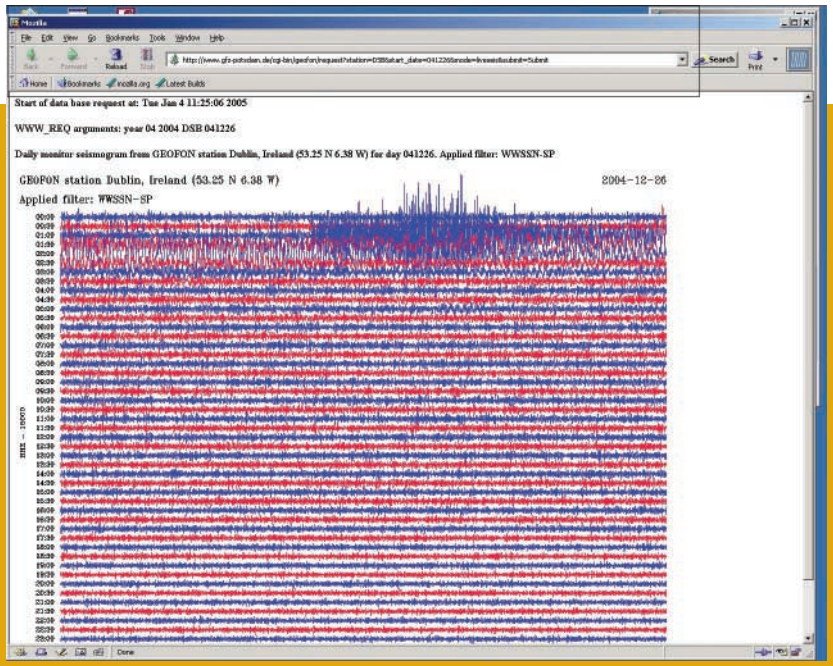
Germany) and three to the north and west of Dublin. These operate continuously, every day of the year. The Irish Meteorological Service operates another station near Valentia in County Kerry. Then there are two stations in Northern Ireland (north and south of Belfast) operated by the Seismic Monitoring Service of the British Geological Survey (BGS). There is close cooperation between DIAS and the BGS.

The seven stations in Ireland compare with over 140 stations in Britain - there are even 2 on the Isle of Man. The types of recorders also vary and in Britain we learn that the system is currently being upgraded. Currently, we are operating in the second division

Contrary to popular belief, seismic events occur each year in and around Ireland. Most are so small they are only picked up by the sensitive recording instruments and are not 'felt' by people. There are two distinctive areas of activity. These are the southeast and the northwest of the country. Some of the events occur offshore and are felt here, like the 14th December incident mentioned at the start of this article. The offshore earthquakes tend to be linked to fault structures in the Irish Sea Basin that cause the tremors in North Wales. The Donegal tremors can be linked to rock structures (or should we say fractures) that come through the Highlands of Scotland where there are regular minor earthquakes. There are also events off Ireland's west coast in our national territory beneath the waters of the Atlantic Ocean. However, the poor quality of the sensors in the State means that we have no information of low level seismicity (up to events about the size of the 14th December one), which is a serious handicap to potential hydrocarbon exploitation of the region.

A network of recording machines in various places on the Earth's surface allow the origin (epicentre) and depth (focus) of earthquakes to be determined; the rock structures causing them are usually obscure and require a lot of research. There is still much to learn before the reasons for an earthquake at a particular place or time are understood. Only then will prediction of future events become a possibility.

Earthquakes in Ireland are generally of low magnitude – 0.5 to 2.0 on the Richter Scale although magnitudes of up to 5.4 are known to have



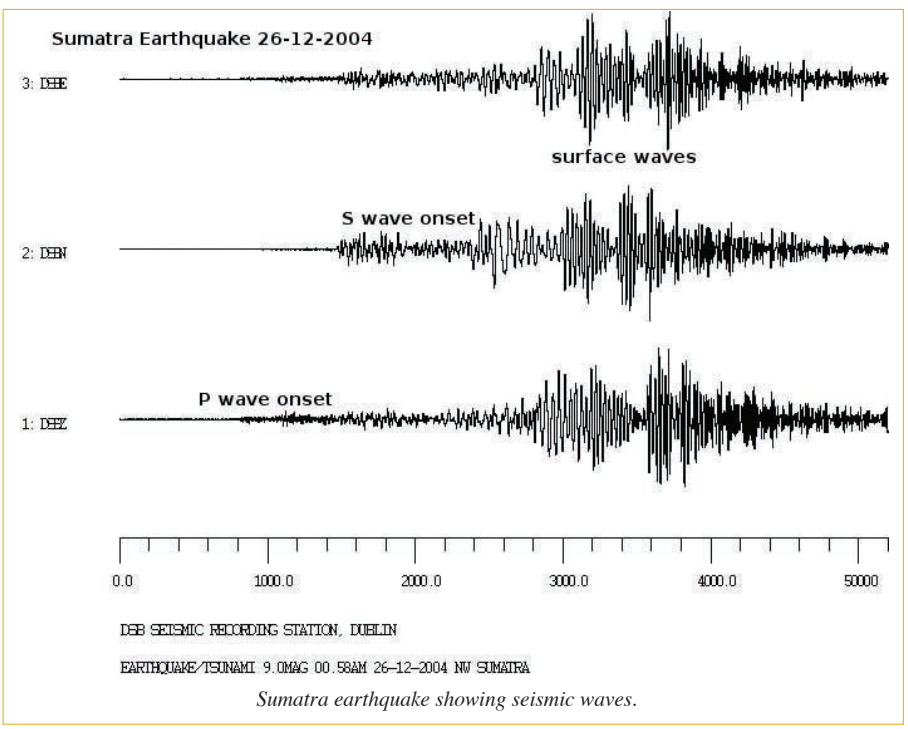
Actual Dublin recording of the Sumatra earthquake, Boxing Day 2004.

occurred since recordings began – there could have been larger events prior to 1962 when the Valentia station started operating. They are mostly shallow events, usually 10-20km down. In fact the low magnitude and frequency of events in Ireland compared with Britain is surprising. Could it be that our lack of recording sites means we are missing things?

You might well ask if a network of recording stations is needed if the shocks are so small they usually cannot be felt? People have not been killed and buildings have not collapsed — yet.

Around the world it is estimated that there are on average over 8,000 events in the 'minor to very minor' range (1 to 3 magnitude) each day. In the 'moderate' range (5-5.9 range) about 800 events per year and in the 'great' range just 1 per year. The Sumatra earthquake of 26th December 2004 that caused the devastating tsunami is one of the latter.

The Sumatra earthquake was recorded by the Dublin recording



Sumatra earthquake showing seismic waves.

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How many of our offices and factories were built with quakes, however minor, in mind?

station and the seismogram is a good example of the nature of the different seismic waves that travel through the Earth. The Primary (P) wave is observed first, followed by the slower Secondary or Shear (S) wave. The difference in time of arrival in the two waves allows DIAS to measure the distance of the earthquake from the recording station. Finally, the surface waves arrive. The latter are seen on all earthquakes but arrive at almost the same time as the S waves for local earthquakes that come from a depth of less than 5km. In engineering terms it is the S - wave component that poses the greatest threat to buildings, although the longer-period and larger amplitude surface waves also are a danger to infrastructure. All these waves travel at different rates through different sorts of rock so a study of arrival times from different places can tell us new things about the rocks and rock structures that lie at depth beneath and off-shore Ireland.

Two terms that are important in talking about earthquakes are intensity and magnitude. Intensity is a measure of ground shaking estimated from its observed effects. It will vary from place to place depending on how near you are to the origin (epicentre) of the earthquake. It will usually be greatest close to the epicentre and less as you move away. For example, the 1984 earthquake on the North Wales coast caused minor damage to a few chimneys and walls near the epicentre but in mid-Wales (Aberystwyth) about 60km south it just caused leaves on plants to rustle and produced a sound like a lorry passing. Intensity can vary from I - not felt (only detected by instruments) - to XII - catastrophic (everything destroyed).

Magnitude is a measure of the size of an earthquake and the scale is logarithmic – which means for every increase of 1 on the scale the ground moves 10 times more. This is the Richter Scale and the one usually reported on newscasts. The amount of damage and loss of life for an earthquake of similar size will be far greater in poorer countries, where buildings are not designed to withstand movement, than in the richer nations – assuming of course that the richer nation has had an appropriate national building code in place that considers earthquake risk, which Ireland doesn't.

This brings us back to the dangers at home. Ireland, historically, hasn't suffered a really damaging major earthquake in our collective memory. It has seen the effects of more distant earthquakes, such as the 1st November 1755 event that destroyed Lisbon and that generated a tsunami wave that caused damage on Ireland's south and west coasts. There is no reason why there should be large earthquakes within its national border because, like Britain, it lies on a relatively passive continental margin. Even so, it is not immediately obvious why it appears to be seismically quieter than Britain, such a short distance away. Perhaps it will, itself, one day suffer an event like the 1984 North Wales earthquake – 5.4 magnitude – or even a little bigger. Are the high-rise buildings now being planned and built designed to withstand such a shaking? Are our dams, some quite old, designed so they do not fail and cause flooding? What magnitude earthquake should we be designing for? If toxic substances are being buried anywhere could the chambers be split open by ground movement? Are our chemical factories designed so they wouldn't be caused to leak? Might landslides be triggered? And finally, should we be joining the network being set up by UNESCO to give an early tsunami warning in the NE Atlantic? We know there have been tsunamis that have hit the Irish coast in the past. Michael Williams of the Department of Earth & Ocean Sciences, NUI Galway, graphically described one at Kilmore Quay in Wexford in Issue 11 of the ES2k magazine. The question must also be addressed what would be the seismic risk and likely damage for a large population centre such as Dublin had the 1984 event occurred at a shallower depth of say 10km?

Such events in Ireland will be rare but as our knowledge and technology improves, so we will get better at determining truly safe levels of design and be able to provide better early warning systems. Our greatest threat is indeed ourselves - our own complacency whereas in reality we should get no comfort from our deep lack of knowledge of Ireland's seismicity and seismic hazard. Accordingly, it is good to see the Royal Irish Academy Committee for Geosciences supporting the proposal to upgrade and extend the seismic network being operated by DIAS in Ireland. We hope the financial support, not huge in modern terms, can be found and that in Northern Ireland a similar network will be installed.

Let's move up to the Premier Division.

SPIN

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and for British earthquakes look up www.bgs.ac.uk/education/earthquakes .