Geophysical Exploration of the Shallow Sub-seabed (GESS)

RV Celtic Voyager

Cork – Cork

28th March to 13th April 2017

Andy Wheeler, Stefan Wenau, Siobhán Burke, Tim Daskevic, Nora Schultze, Zsuzsanna Tóth, Officers & Crew of the RV Celtic Explorer

Index

1 Executive Summary

xxx

2 Background

The GESS survey is a collaborative survey undertaken by researchers in iCRAG – The Irish Centre for Research in Applied Geosciences, University College Cork and the University of Bremen (Germany). The aim of the survey is to collect geophysical acoustic data in the Irish sector of the Irish Sea and the northern Celtic Sea. The data set will be primarily used to improve our knowledge on the nature and formation of recent seabed sediments that were influenced by the Irish Ice Sheet during the last glaciation and to create a 3D geological model and revise existing sub-seabed models of the seabed sediments in the Irish Sea and the northern Celtic Sea.

The GESS survey contributes to three iCRAG projects: QuSISS, AggrePOP and FLIPeR_Wick as introduced below.

The development of Irish offshore resources and infrastructure development are constrained by the properties of shallow sub-seabed units. Seabed raw materials are limited by the thickness of exploitable sedimentary units: a knowledge and overview which is lacking. The deployment of seabed infrastructure (pipelines, subsea facilities, jack-ups, static platforms, subsea development units, anchors, wind turbines, etc.) requires an understanding of sub-seabed stratigraphies and their geotechnical properties. Producing a stratigraphic model for the shallow sub-seabed around Ireland would enable constrained desktop evaluations for development at an early stage of planning, de-risking economic activities and improving efficiencies. Through the INFOMAR programme, Ireland has produced extensive multibeam seabed coverages for Irish coastal waters: near-continuous for the south and east coasts. In addition to the multibeam echosounder data, a significant amount of acoustic Pinger data has also been collected concurrently with additional lower frequency Sparker data acquired by the Marine Geology research group in UCC. Using the available seismo-acoustic data, the **QuSISS** project (Quaternary Seismostratigraphies of Irish Shelf Seas) for which this survey is dedicated aims at developing, for the first time, a Quaternary stratigraphic framework for the south coast of Ireland and for the Irish sector of the Irish Sea, complete with an inventory and a seismic database.

The QuSISS project collates existing shallow seismic data for the south coast of Ireland and for the Irish sector of the Irish Sea. All seismo-acoustic data is compiled within an IHS Kingdom (commercial seismic interpretation software) framework so that density of coverages and data gaps can be seen. The seismo-acoustic data if needed is processed to enhance the signal to noise ratio. Seismostratigraphic units and stratigraphic relationships are identified based on seismic sequence and seismic facies analysis. Analysis of the stratigraphical model is further enhanced by an interpretation of the successions in terms of the developmental history of Irish shelf seas. Unit geometries, spatial extents and the mapping of glacial features enables insights into the nature of glacial ice limits, glacial and glacial-marine incision and deposition, and the early Holocene transgression. At the southwesternmost (maritime) limit of the last European ice sheet, the British-Irish Ice Sheet (BIIS) was highly dynamic and responsive. Many challenges still exist in defining the limits and timing of ice advances and retreats on the Irish Shelf. Similarly, this study will also provide a framework to help define the history of the Irish Sea Ice Stream which played a significant role in the denudation of the BIIS.

This survey provides data filling in gaps in the seismic coverage of the south coast as well as providing a deeper penetration and resolution. A focus on the Dungarvan/Hook Head area has been taken to help provide insights into the ice sheet dynamics in this area where onland ice sheets meets the Irish Sea Ice Stream.

In addition, the GESS survey contributes to the **AggrePOP** project (Aggregate Potential in South Coast Offshore Palaeovalleys). This project delimits and quantifies (bed thickness and aggregate quality) marine aggregate resources off the south coast of Ireland that are principally confined to palaeovalley-fill seabed outcrops. Through acquisition of high resolution seismic data, new insights into palaeo-valley development, drainage patterns and cut-an-fill stratigraphies will also be defined advancing our understanding of Irish Quaternary landscape development.

The inland terrain of the south coast of Ireland was beyond, or near the edge of, ice sheets during the last (and earlier) glaciation(s). As such, deeply incised Tertiary river valleys have been repeatedly reactively by glacier meltwater flows draining from ice sheet and glacier fronts carrying water and sediment down system. Studies of on-land valley fills suggests the valleys were filled by high energy, braided river systems and contain significant deposits of sand and gravel channel and terraces fills. Much of these aggregate deposits have been extensively quarried near to major population centres servicing the construction industry in particular including for concrete.

During glacial periods, global sea levels are lowered as the expanded ice sheets stored water. During the last glaciation, sea level were around 150m lower than present and river systems beyond the ice sheets extended across the present shelf to the shelf break. As such, extensive palaeovalleys plugged with unextracted aggregate exist off the south coast of Ireland extending from existing (and abandoned) river systems onshore. Limited studies have been undertaken include the work of Gallagher (2002) and an industry consultancy report following mapping and surveying by the Chief Scientist. These studies reveal extensive systems principally cut into bedrock with surface aggregates exposed on the seabed or shallowly buried by recent, thin shelly hash and sand cover. Work by Dowling et al (1989) in Cork Harbour shows thick accumulation of gravels and sand deposited during multiple meltwater events from successive glaciations.

Sand and gravel aggregate deposits are a vital natural resource, providing essential raw materials to underpin societal needs for infrastructure and supply for the construction industry (Sutton et al., 2008). Marine aggregates have advantages over terrestrial supplies in that they are often cleaner and less prone to pyrite with improved calcium carbonate contents. Grains are often more rounded and hence more workable with reduce cement requirements. Marine aggregates offer significant benefits in terms of lower environmental cost compared to current land-based sources with reduced CO_2 emissions arising from both extraction and transport activities and reduced heavy goods vehicle (HGV) traffic volumes on the national, regional and local road networks. Also, marine aggregate post-extraction habitat recovery rates are significantly faster and permanent habitat modification significantly reduced in comparison to terrestrial extraction (Sutton et al., 2008). Marine aggregates are dredged allowing large-scale extraction. They can be screened on vessels and transported to local and international markets economically unlike terrestrial deposits than can only supply local marks due the prohibitive costs of road haulage.

During the last economic boom, the aggregate demand in 2005 was estimated by the Irish Concrete Federation (ICF) to be approximately 130 million tonnes, which translates to circa 30 tonnes per person per annum (approximately four times the EU average per capita demand). All of this demand was from local terrestrial sources with localise depletion of resource evident around several major population centres. Aggregates are finite non-replenishable resources, the local depletions will still be evident in the next construction boom. Despite a concerted effect to appraise offshore aggregate resources in the Irish Sea (IMAGIN project – Sutton et al., 2008), extraction was inhibited by a lack of adequate offshore licencing regulatory framework. Since then, considerable improvements have occurred in this respect.

In this context, it is timely to evaluate the aggregate potential off the south coast of Ireland, thereby extending the IMAGIN evaluations of the Irish Sea (Sutton et al., 2008), to place Ireland with identified resources to service the re-emergent construction industry.

The final project that this survey contributes to is the **FLIPeR_Wick** project (Formation of Littoral and Irish Placer Resources relating to the Wicklow Granite). Previously identified offshore heavy mineral, platinum and gold placer deposit sites onshore/offshore Wicklow, FLIPeR_Wick to ascertain mineral and elemental distributions/concentrations to development resource models. Understanding formation processes (source to sink) will also provide a pathway to identifying additional exploration priority targets.

Placer deposits form through density driven sorting of sediment and have proven to be highly lucrative and traditional sources of heavy mineral and metal resources especially gold, tin, uranium, REEs, diamonds and gemstones, amongst others. Many of these, at least historically, are from river and palaeo-beach settings, however, volumetrically offshore sandy and gravelly environments offer far greater mineral resource potential. A prerequisite for the formation of placer deposits is the erosion (sediment source) of dense mineral/metal bearing geological deposits (where the original concentrations need not be specifically high) and appropriate environmental (or palaeo-environmental) conditions able to effectively sort the sediment and generate concentrations of high density economic minerals. This effectively means that sediments need to be heavily reworked relative to the rate of sedimentation and burial.

Significant high value offshore mineral placer resources have been identified in many parts of the world e.g. offshore British Columbia and Nova Scotia (Canada), Alaska and Florida (USA), Australia and New Zealand, Brazil, Sierra Leone, Egypt, and India. As an example, offshore of Nome in Alaska, the total placer gold resources is estimated at 113,767 oz (with a cut-off grade of 1000 mg m^{-3}) with an average grade of 1.929 g m^{-3} (with a cut-off grade of 1000 mg m^{-3}) (Zhou *et al*., 2007). Exploration and extraction technologies are both basic and conventional making offshore placer extraction feasible.

The combination of metamorphic and igneous terrane adjacent to high energy coastlines offers a clear scenario for heavy mineral sand development in Ireland. In the 1980s, the Geological Survey of Ireland (Geoghegan *et al*., 1988; Sutton *et al*., 2001) revealed several offshore finds whilst heavy mineral sands on Irish beaches have been known since the last century (Figure 1). Geoghegan *et al*. (1988) noted finds offshore of Wicklow Head, Brittas Bay and Gorey in the southern Irish Sea, and offshore Falcarragh (Co. Donegal), Portacloy, Blacksod Bay and Achill Island (Co. Mayo) and Clogher Head (Co. Kerry) on the west coast.

In the 1980s, prospecting was undertaken on Wicklow/Wexford beaches with trenches dug. Offshore heavy minerals have also be noted (Geoghegan et al., 1988). Since this time, there have been major advances in the offshore exploration capabilities through technology developments. Systematic seabed mapping of Ireland offshore using groundtruthed multibeam echosounders and LIDAR has been undertaken through the Geological Survey of Ireland's INFOMAR programme providing valuable baseline data to this project. However, the crucial gap between the coast and INFOMAR coverage is where many placers may lie. Additional mapping in coastal waters will be necessary to supplement these data thereby also providing a valued-added product for INFOMAR linking the land to existing offshore coverages. Tellus soil and stream geochemical data are also available showing on-land elemental anomalies enabling links between offshore resources and river fluvial pathways. Anomalies near Wicklow Head (Pt), Courtown (Pt, Au) and Kilmacoe (Pt,Au) and their links offshore are of interest (Figure 2). This project, as well as the sister PhD programme (FLIPeR), provide a link, in fact explore the link, between two major national geological programmes (INFOMAR and Tellus).

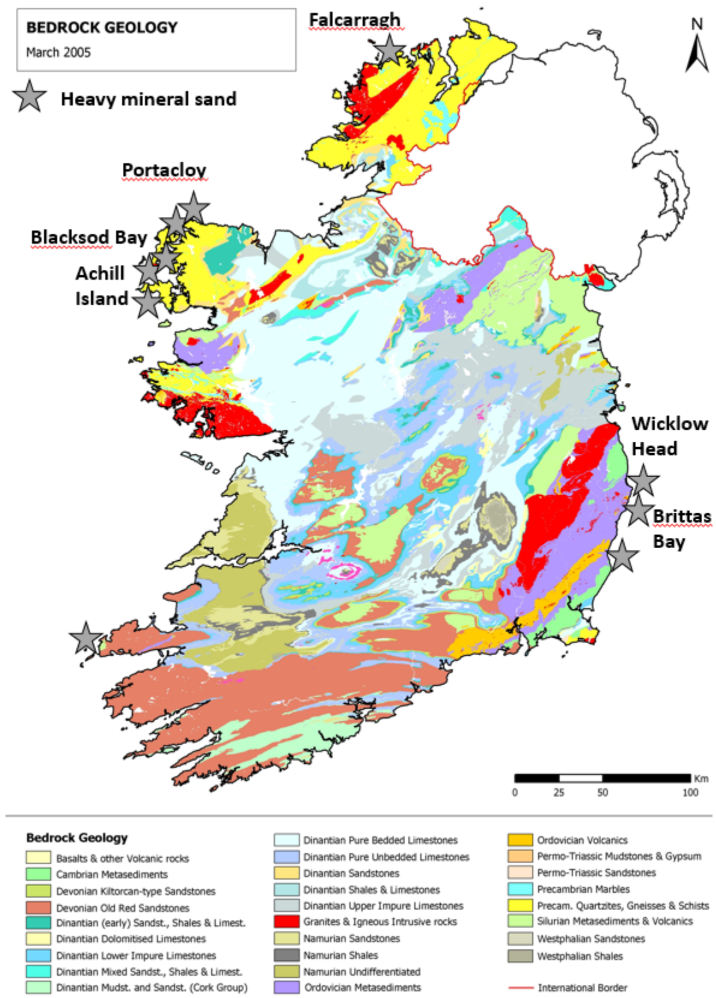


Figure 1. Geological map of Ireland showing potential heavy mineral sand prospects identified by Geoghegan et al. (1988).

Evaluating and developing economically viable offshore placers will enable Ireland to gain a strategic footing in the marine mining sector. This project will provide an updated assessment of littoral and offshore potential resources. A project such as this has not been carried out since the 1980s with what was then limited seabed mapping technology. A major focus of this project is to understand the placer formation process in Irish waters. In doing so, we will develop models to provide targeted contexts for more effective subsequent exploration approaches in this and other areas, both in Ireland and abroad.

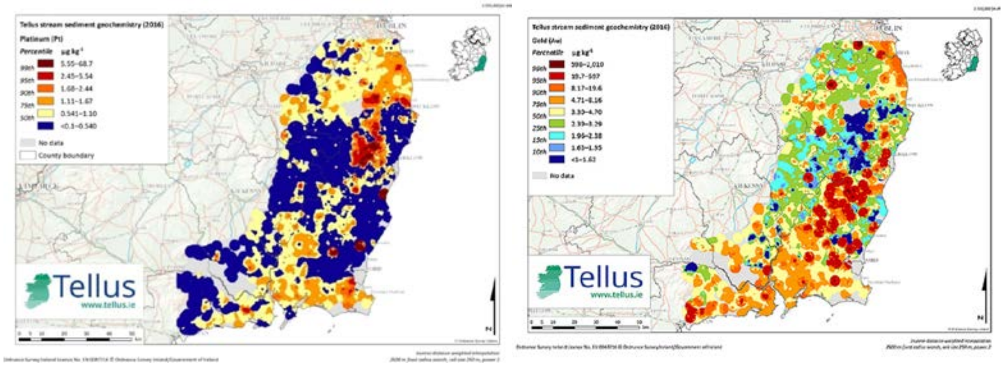


Figure 2. Platinum (left) and Gold (right) stream concentrations in the Wicklow-Wexford area. Source: www.tellus.ie

To serve the three project, GESS commenced an outline of work involving the acquisition of seismic data at three resolutions: a high resolution using the SES echosounder, an intermediate resolution using the sparker and a lower but deepest penetration survey using the GI airgun. The areas surveyed are shown below.

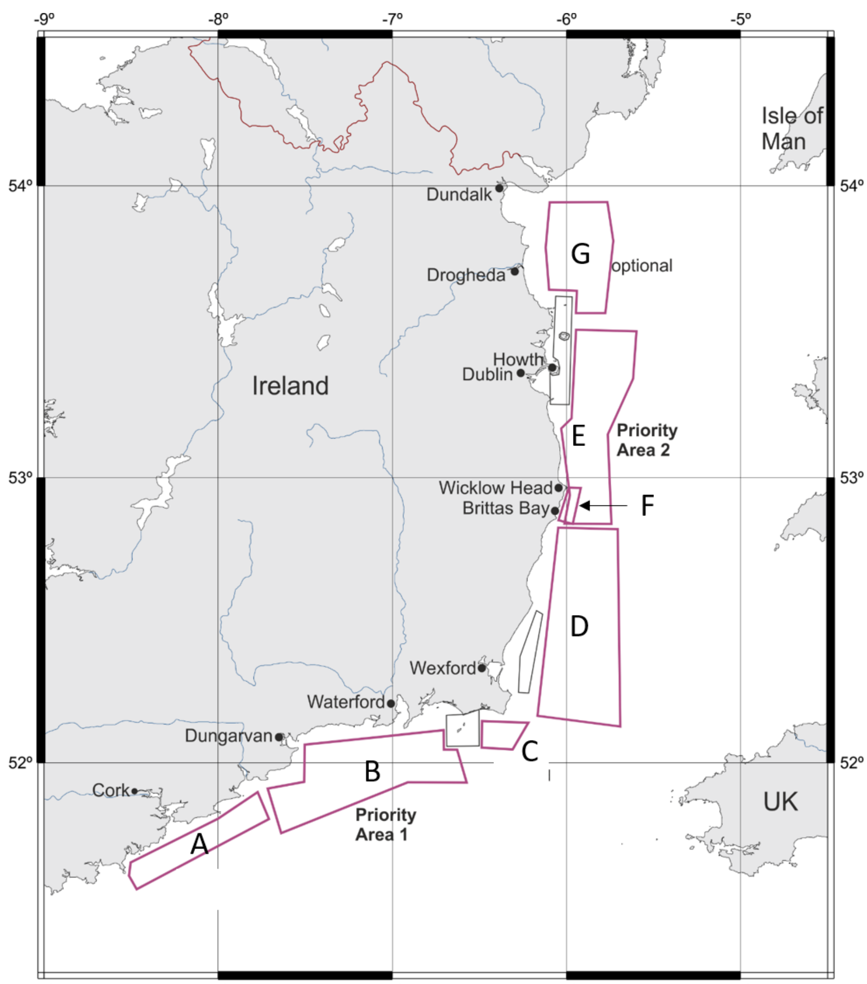


Figure 3: GESS areas of study

References

Dowling, L.A., Sejrup, H.P. & Coxon, P. (1989). Palynology, aminostratigraphy and U-series dating of marine Gortian interglacial sediments in Cork Harbour, southern Ireland. *Quaternary Science Reviews*, 17, 945-962,

Gallagher, C. (2002). The morphology and palaeohydrology of a submerged glaciofluvial channel emerging from Waterford Harbour onto the nearshore continental shelf of the Celtic Sea. *Irish Geography*, 35, 111-132.

Geoghegan, M., Gardiner, P.R.R., & Keary, R. (1989) Possibilities for commercial mineral deposits in the Irish Offshore Area. *Marine Mining*, 8, 267-282.

Sutton, G., Wheeler, AJ & O'Leary, E. (2001). *An assessment of the current status and RTDI requirements in respect of the development of Irish seabed resources*. Final Report to Marine Institute, Dublin. 242pp.

Zhou, W., Chen, G., Li H., Luo H. & Huang, S. (2007). GIS application in mineral resource analysis - a case study of offshore marine placer gold at Nome, Alaska. *Computers & Geosciences*, 33, 773-788.

3 Survey Rationale and Objectives

This survey has multiple objectives as set out below:

Objective 1: to collect shallow seismic data to revise and define the seismostratigraphic model for the nearshore Celtic and Irish Seas (Areas A, B, C, D, E & G).

Objective 2: to map the extent of palaeovalleys off the south coast and define the extent of potential offshore aggregates resources (Area A)

Objective 3: to collect seismic data pertinent to understanding the Pleistocene deglaciation of the Irish Sea Ice Stream, glacio-fluvial tunnel valley drainage networks and the Holocene transgression (Areas B & E).

Objective 4: to collect seismic, magnetic and sediment data off Wicklow Head/Brittas Bay to evaluate the resource potential of mineral sand (Area F).

To fulfil these objectives, the following keys tasks were undertaken:

Task 1 - *Collection of shallow seismic data for seismostratigraphic investigations*: we targeted identified data gaps in the shallow seismic coverage of the Irish and Celtic Sea to create a seamless coverage for these areas. In particular, the combination of seismic gear from the University of Bremen (micro-airgun and SES echosounder) in combination with the MI Sparker system was designed to generate high fidelity data with good ground penetration.

Task 2 - *Collection of shallow seismic data for deglacial history investigations*: using the combined University of Bremen and Marine Institute seismic gear, we collected a dense coverage of data on the mid-western Irish Sea tunnel valley and deeps area to improve our understanding of the Irish Sea Ice Stream retreat. In addition, off the Dungarvan/Hook area, dense coverage of seismic data gives an indication of the ice limits of both the Irish Sea Ice Stream and land-based ice sheets.

Task 3 - *Collection of shallow seismic, magnetometer and grab sample data for heavy mineral sands investigations*: A magnetometer survey was undertaken to identify magnetic mineral concentrations with the combined seismic system used to produce a dense coverage of a potential heavy mineral sands off of Wicklow Head/Brittas Bay to determine resource thickness and a resource map. Grab samples and magnetometer data will be used to target and constrain the resource for vibrocoring to provide sample for mineralogical and geochemical analysis.

4 Equipment

Research vessel - RV Celtic Voyager

The RV Celtic Voyager is a fully equipped research vessel 31.4m in length and a 4m draught: the smaller of the two research vessels. The vessel has wet, dry and chemical laboratories, which are permanently fitted with standard scientific equipment. She can accommodate 6-8 scientists depending on the survey and can stay at sea for a maximum of 14 consecutive days. The vessel facilitates the collection of fisheries, geophysical, oceanographic and environmental data and is also used to provide practical training for the next generation of marine scientists. The RV Celtic Voyager is equipped with a hull mounted EM2040 Multi-beam echosounder.

Figure 4: RV Celtic Voyager

Multichannel seismic system

Seismic source

A Sercel Mini Generator-Injector (GI) Air-Gun was used as a seismic source. The GI-Gun was used with volume reducers, bringing the volume of the two chambers to 0.1l each. The source was operated at 120 – 150 bar with air provided by a Sauer compressor with two pressure bottles acting as buffer. The frequency of the source lies between 100 – 300 Hz. The employment of a two-chamber air gun allows the efficient suppression of the oscillations of the produced air bubble, greatly improving the produced signal and the vertical resolution of the data. The penetration of the signal into the seafloor was usually below 300 ms due to the prevalent bedrock as well as coarse sediments encountered in the study area.

Seismic streamer

For data acquisition, a Teledyne 96-channel streamer was used. The first 32 channels have a distance of 1 m, channels 33 – 64 are spaced at 2 m and the last 32 channels are spaced at 4 m. The overall length of the streamer and towing gear was about 250m. The depth of the streamer was controlled by 4 birds which were set to hold a depth of 1.5 m.

Acquisition system

The source and the recording system are triggered using a custom trigger system. The GI-Gun and the Sparker were triggered alternatingly at a shot rate between 3 and 4 seconds. The data were recorded using the University of Bremen custom recording system Marine Multichannel Systems (MaMuCS) which includes Analog/Digital converters, data storage and visualization. Data were stored at 0.125 ms sampling rate at recording lengths between 1000 and 1500 ms. The ships' GPS was used for shot positioning. The layout of the source and streamer were documented relative to the GPS antenna for future data processing. The system includes the storage of so-called brutestacks, stacking some traces of each shot and storing them along with shot coordinates. These brutestacks were loaded into the IHS Kingdom seismic interpretation software for initial analysis and interpretation.

Figure 5: Sercel Mini Generator-Injector (GI) 0.1l Air-Gun

Figure 6: Teledyne 96-channel 250m streamer

SES-2000 Parametric Sub-bottom Profiler

The SES-2000 is a parametric sub-bottom profiler giving high resolution images of the shallow sub-surface. It operates at 100 kHz primary frequency with secondary adjustable frequencies of 5, 6, 8, 10, 12 and 15 kHz emitting at >236dB/uPa are 1m. It has a depth range of 1-400m water depth with an accuracy of 0.02 m + 0.02% of water depth at 100 kHz and 0.04 m + 0.02% of water depth at 10 kHz. The SES-2000 was pole mounted over the side of the vessel as shown on the picture below (pole is lower into the water and stropped during survey operations). Strumming on the pole was minimal at 5 knots.

Figure 7: The SES parametric sub-bottom profiler mounted on the over-side pole.

Geo-Source 400 sparker seismic system

The Geo-Source 400 sparker seismic system of the Marine Institute was used during the survey. This sparker seismic system consists of the Geo-Spark 6 kJ pulsed power supply which emits a pulse to the sparker source which is towed behind the vessel. The source comprises four electrode modules that are evenly spaced in a planar array. The return signal is picked up in Geo-Sense single channel hydrophone array. The system provides high resolution (<30cm) seismic profiles of the Shallow sub-bottom strata. The device achieves this level of accuracy due to its multi-tip array of sparker nodes, which are evenly spaced and set in-phase producing a very strong downward projection of acoustic energy. The system is designed to be towed on or just below the water-surface. High resolution seismic profiles of up to 300m depth can be imaged using the Geo-Spark 200 depending on the composition of the water column, sea conditions and the nature of the underlying geology.

Figure 8: The Sparker "box" and catamaran

SeaSPY/Explorer Magnetometer

The SeaSPY/Explorer is a highly sensitive total field magnetometer that detects magnetic variation in the marine substrate by detecting ferrous (Fe-rich) elements. Total field magnetometers measure the magnitude of the vector magnetic field i.e. vector components of the field in terms of declination (the angle between the horizontal component of the field vector and magnetic north) and the inclination (the angle between the field vector and the horizontal surface).

The SeaSPY/Explorer magnetometer overhauser sensor has the highest absolute accuracy of any magnetometer sensor available. It operates at an absolute accuracy of 0.1nT with a sensor sensitivity of 0.01nT and a counter sensitivity and resolution of 0.001nT. Its broad range makes it ideal for variation in sampling ranging from 18,000nT to 120,000nT. It has a sampling range of 4Hz — 0.1Hz and has a depth range of 1000m (1500psi), 3000m (5000psi), 6000m (9000psi) as standard. The housing comprises of 1⁄4" super strong fibreglass coated with a 'bumper' layer of polyurethane for extra shock absorption. A sensor located within the housing provides a visual queue and alarm sound if water penetrates the device if penetrated or damaged. The SeaSPY/Explorer is designed to be towed behind a vessel as the streamline design allows it to navigate through the water column seamlessly. The polyurethane coated tail with moulded fins acts as a bumber, while creating a stable towing platform.

BOB software is used on board to acquire and visualise data. Its geographical interface enables communication with the magnetometer with the ability to log and plot data in real time.

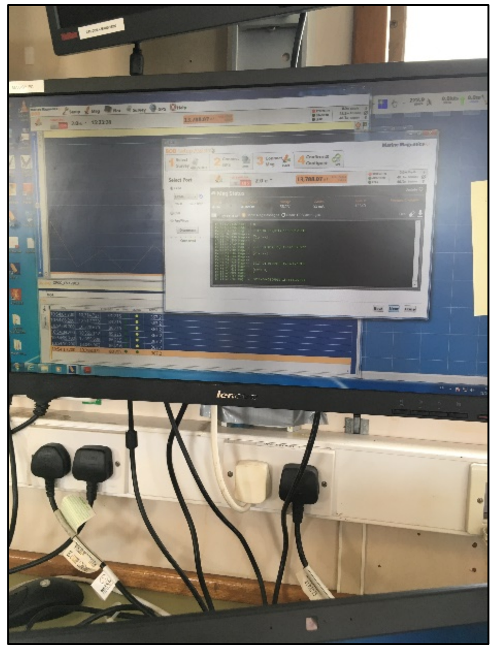


Figure 9: Total field magnetometer above deck (left) The SeaSpy/Explorer can be towed up to 50m behind the vessel. BOB software used for data acquisition and visualisation.

Simrad EM2040 Multibeam

The Kongsberg Simrad EM2040 High Resolution Multi-beam Echosounder (MBES) is a type of sonar used to map the seabed. It emits sound waves in a fanshape beneath the hull of a vessel and the time it takes for the sound wave to return from the seabed to the receiver is used to calculate depth. The system has the ability to map large areas at high speed without compromising data quality and produce high-resolution, calibrated acoustic-backscatter imagery. It is designed to operate in a range of water depths from 50 to approximately 1500m, giving a greater range and flexibility in sea bed mapping. The EM2040 has dual swath per ping that allows a doubling of survey speed and more efficient retrieval of data.

The EM2040 MBES holds four units, a transmit transducer, a receive transducer, a processing unit, and a workstation. The transducer has an angular coverage of 200º (±100º). This allows a coverage of 5.5 times water depth in comparison with a single receive transducer. Having a second receive transducer allows surveying to the water surface or up to 10 times water depth on flat bottoms. With this, The EM 2040 has a large operating bandwidth of 200 to 400 kHz which allows the system to have an output sample rate up to 58.8 kHz. 300 kHz is used for near bottom, 200 kHz for deeper waters, and 400 kHz for very high resolution inspection.

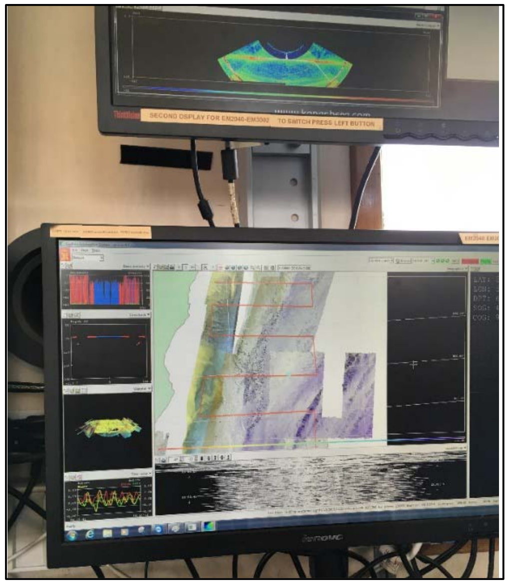


Figure 10: Multi-beam echosounder supported by Kongsberg SIS software

Shipek Grab sampler

The Shipek Grab sampler has a capacity of 3000ml and acquires samples using a single rotating jaw scoop. The grab covers an area of approximately 0.04 m2 on the seafloor and to a depth of approximately 10cm. The grab is deployed by a winch into the water column. When it reaches the seafloor an automatic trigger system is activated and the grab sampling compartment encloses a sample from the seafloor. The recovered sediment is trapped within the rotating drum in an undisturbed and unwashed state. The Shipek Grab can be used on slope of 20° or more.

Figure 11. Shipek sediment sampler

5 Technical Difficulties

All times in UTC (one hour earlier than summer time)

28th March 2017: *Wind southerly, force 3-6, slight becoming rough (Area A)*
Airgun and SES deployed at 06.30. Set-up teething problems and software did not initially recognise the trigger. Problem solved by 09.00. Set-up continued and the first line was started at 09.43.

29th March 2017: *Wind southerly. Force 6. Moderate to rough.*
Increasing winds eventually made the swell too big to collect data. Data recovery stopped at 00.50 when the significant wave height reached 2.3m with a following sea.

30th March 2017: *Rainy with low cloud and wind (Area D)*
There is an issue with the SES data and it is not clear if the data collected on the 28th-29th was recorded. It appears to be there and was displayed whilst collecting but would not translate into segy. Situation not resolved.

31st March 2017: *Wind* south-westerly*, F5, moderate sea (Area D)*
Survey lines shortened to avoid a large area of whelk pots. Airgun firing at 12.00 but data is not being recorded. Problem resolved at 12.33. All SES data so far is not recoding correctly and contains excessive noise. Data collected so far is not useable.

1st April 2017: *Wind south-westerly backing westerly, Force 5/6 becoming 3. Moderate to slight sea (Area B).*
SES not working properly.

2nd April 2017: *Wind northwesterly backing southerly. Force 4 dropping to 2 then 5. Moderate to slight to moderate sea (Area B).*
SES not working properly.

3rd April 2017: *Wind southerly. Force 6. Rough to moderate sea (Area B & D).*
Recover all gear at 09.00 as the swell reduced data quality beyond limits. Transited to Rosslare to drop off the Technician at 15.04 who had to leave the ship for personal reasons.
One of the air chambers stopped firing giving a weak signal on line **CV17013_54**. Line stopped at 23.01. Airgun recovered and faulty trigger cable repaired.
SES not working properly.

4th April 2017: *Wind north-westerly. Force 4 to 7 to 3. Moderate to slight sea* (Area D & F)
Airgun fixed by 00.31. Delay in manoeuvring vessel back onto line due to navigational hazards with a container ship.
SES not working properly.

5th April: *Wind north-westerly backing south-westerly and back to northerly. Force 5 dropping to 2. Moderate to calm seas.* (Areas D & E)
17.56 caught pot on airgun streamer at EOL **CV17013_69**. Pot towed and then released. Streamer recovered. No damage to streamer or birds. Airgun redeployed by 18.36.
SES not working properly.

6th April: *Wind variable. Force 4 falling to light airs. Slight to calm sea* (Area E)
On line **CV17013_85** it was spotted that the first bird was upside down. At the end of the line at 16.42, the streamer was partially recovered and the bird repositioned.
SES not working properly.

7th April: East of Bray Head, between East Kish and North Kish (Area E)
SES not working properly. It was noted that the SES had stopped recording at approx. 03.40 UTM and had not recorded since 18.40 UTM (6th April) as that is when the hard-drive was last changed. Gear started to be deployed at 15.10 UTC but there were technical difficulties deploying the pole initially. Once the gear was in the water, the trigger was initiated for the airgun at 15.45. The sparker was deployed last and had to be ramped up. It was triggered initially from the blue cable. The blue cable was swapped to the airgun trigger before ramping up began. The sparker was ramped up to 300 but didn't get any further because the airgun computer crashed. At approx. 16.05 the airgun system crashed and there was a smell of "buring". The sparker system was shut off immediately until the source of the problem was found.

The systems were powered off, both airgun and sparker. We looked for any possible trips in the switch board. It was decided by Chief scientists Zsusi that we would call for technical help from Gordon Fury. He advised us to look at the monitors and to try and switch screens to see if it helped as the monitor was displaying no signal connection. Siobhán spoke with Gordon and he advised to try look for an alternative VGA output or somewhere that the cable might be split. In the meantime, the screen returned and windows was working again. However, the screen was very dark and hard to read. Three other monitors were swapped in place and all displayed a dark violet colour. Gordon was out of ideas and suggested that we call the Coda helpline.

Siobhán called the coda helpline at approx. 18.00 UTC and was speaking to an operator/engineer called David. The technical support asked questions and thought it might be a problem with the graphics card. They suggested solutions such as looking for the system recovery DVD for Graphics Driver Restore, if this did not work it was suggested that the system may need to be repaired by Coda. This would involve sending the system back to Coda for an engineer to look at. The Coda technician (David) then said that he would discuss with his supervisor and call back. He never called back, story of my life.

After that, Gordon called back (18.41 UTC) and suggested swapping out the monitor and cable, this worked a little better but the screen was still violet. Zsuzsi discussed options with Gordon and it was decided to try and run the sparker through the coda with the dark screen. The crew were instructed to deploy the gear, once again. Siobhán and Zsuzsi set up the coda for sparker settings like in the beginning. It was then noticed that this would not work as the navigation system was no longer working. After consultation with all the scientists it was decided that all avenues were exhausted and that a technician on board was needed. Zsuzsi called Gordon and insisted we get assistance. He asked to see if the spare coda under the desk worked by plugging it into a monitor. It worked and it was decided to try and swap it out for the original coda. The set up the spare coda was complex; it would need a technician to set up.

Downstairs, in the wet lab, the computer had also crashed. It is unsure if it was a memory board problem or a problem with the graphics card. Stefan thinks it is definitely the motherboard because when a spare graphics card was swapped in place of the old and nothing changed. The mother board from another computer cannot be simply swapped out with that we have on board as it does not have the necessary slots. It was suggested that we try source a matching motherboard somewhere in Dublin city tomorrow 8th April.

At 20.30 UTC it was decided by the bridge (Philip and Adam) that we would dock in Dun Laoghaoire for the night. Gordon Fury confirmed that he would provide technical support and would arrive at approximately 23.00 UTC. At approx.23.30 UTC Gordon Furey arrived and looked at the systems. He decided it was best to return in the morning.

<u>8th April</u>: East of Bray Head, between East Kish and North Kish (Area E)
SES not working properly. The team assembled in the mess to make plans for the day. It was decided that Stefan, Nora and Siobhán would go to Dublin to get a motherboard for the PC that runs the Airgun. Zsuzsi, Tim and Niamh remained on the vessel to help Gordon work out the problems in the dry lab.

It was discovered that the coda pc was not operational and the acquisition software was corrupted due to a power surge that damaged the equipment. Gordon tried to get the second coda pc running but it did not function. After that he switched back to the original coda box but swapped out the VGA cable as the output for the VGA was damaged (fried). He used the HDMI output for the output instead and it was possible to get the sparker running and logging data. Zsuzsi did point out that there was a lot of interference in the sparker data from the trip but it was decided that we would try and process it using the ships software.

As for the navigation, it could only be fixed after the coda acquisition software was reinstalled. The navigation is now running off the ships navigation and not the QUINSY as Gordon was not familiar with the QUINCY setup.

The airgun PC could not be fixed. The motherboard that was bought in Dublin was not suitable and it is unsure if that is even the problem.

At 16.05 UTC the vessel left Dun Laoghaire harbour to return to the last visited (north of east codling) area E to collect sparker data. The vessel arrived at area E, north of east codling and decided to resume seismics. Sparker was deployed into the water by Stefan while Zsuzsi and Siobhán ramped up the sparker and triggered it. The coda screen with the sparker profile was showing good data. The first line **CV17019_90** started to record at 18.47 UTC initially was recording with navigation. One hour later at 19.47 it was noticed that the navigation was no longer working. The GPS feed was down and would render data worthless without spatial reference. It was then noticed that the multi-beam navigation screen was also no longer working. Stefan tried to call Gordon Furey from the Marine Institute but they could not reach him. At 20.11 Niamh Connelly sent an email explaining the reoccurring problems.

Line **CV17013_90** was abandoned and stopped recording as it had no proper navigation record. The master log sheet continued to record lines but has to switch retrieving GPS data from the C Nav monitor that records in DMMS.

<u>9th April</u>: East of Dalkey Island, between Bennet Bank and Lambay Island (Area E)
SES not working properly. At 03.15 UTC Nora noticed that the sparker was not recording from line **CV17013_94** to **CV17013_99**. Recording recommenced from line **CV17013_100**. The record data button had not been checked after a technical problem with ships navigation at 00.30 UTC. Output for navigation had to be changed.

<u>10th April</u>: Wicklow Head to Brittas Bay, East of Rosslare (Area F/ D)
SES not working properly.

<u>11th April</u>: *Rosslare to line south of Dungarven area* (Area D/B)
SES not working properly. Airgun not working.

<u>12th April</u>: *offshore of Youghal* (Area A)
SES not working properly. Airgun not working.

6 Survey Narrative

All times in UTC (one hour earlier than summer time)

<u>27th March 2017</u>: Cork
Sunny with a fresh wind
Started mobilisation at 08.00 and was completed at 20.00.

<u>28th March 2017</u>: Roches Point to Offshore Youghal (Area A)
Wind southerly, force 3-6, slight becoming rough.
Vessel left the berth at 05.08 arriving at Roches Point at 06.35. Cetacean and seal observations commenced at 06.55 with gear deployment started at 06.55 and all in the water at 07.30 with airgun firing on 80 dB ramping up slowly over 20 minutes (airgun, SES, sparker). Test of equipment continued until 10.43 with the start of the first line in **Area A** (**CV17013_1**). Airgun and sparker both running alternately every two seconds and being recorded on the one multichannel hydrophone. Series of lines running across the palaeo-River Lee channel were collected in a dog-legged survey pattern (**CV17013_2** to **CV17013_18**). Multibeam was also collected on the final line (**CV17013_18**).

<u>29th March 2017</u>: Offshore Youghal to Waterford (Area A)
Wind southerly. Force 6. Moderate to rough
Line **CV17013_18** finished at 00.50 when wave conditions became too hard to work with. All gear was recovered on deck at 01.50 and proceed to transit to Waterford. Tied up at Waterford at 08.05 awaiting weather to improve.

<u>30th March 2017</u>: Tied up in Waterford
Rainy, with low cloud and wind
Remained tied up in Waterford due to the excessive swell off the south coast in and into the Irish Sea. Data processing was undertaken and improvements made to the GPS feed.

<u>31th March 2017</u>: Offshore Courtown (Area D)
Wind south-westerly, F5, moderate sea and overcast
Left Waterford at 04.07 and proceeded up the Irish Sea. Started MMO survey at 11.00. Started to deploy seismic gear at 11.30 off Courtown east of the Banks (**Area D**). MMO survey continuing. Air gun on at 12.00 and starting to turn onto line **CV17013_19.** Sparker being deployed 12.15. **CV17013_19** started at 12.52. Seismic data acquisition continued up till midnight with the completion of line **CV17013_22** at 23.01. All gear recovered on deck at 23.43 and transit to Area B commenced.

1st April 2017: Offshore Dungarvan to Tramore (Area B)
Wind south-westerly backing westerly, Force 5/6 becoming 3. Moderate to slight sea.
Arrived on station at 07.20 in **Area B** and started to deploy gear. MMO watch started 07.22. Airgun fired up at 07.58 and ramp up started. Commencing line **CV17013_23** at 08.20. Line **CV17013_25** finished at 13.01. A short N-S line (**CV17013_26**) was run with no sparker just to see if it was interfering with the airgun. It was not and the sparker was turned on again for the next time (**CV17013_27**) commencing at 14.17. Surveying continued all night with **CV17013_33** starting at 23.22.

2nd April: Offshore Dungarvan to Tramore (Area B)
Wind northwesterly backing southerly. Force 4 dropping to 2 then 5. Moderate to slight to moderate sea.
Continuation of **CV17013_33** and completion of set of lines at xxx with **CV17013_43**. A sparker airgun calibration line was run as a cross line in both directions (SE-NW and NW-SE). **CV17013_44** was with the sparker and magnetometer (SE-NW: started at 20.04) and **CV17013_45** with the airgun (NW-SE: started at xxx). The magnetometer was run as a test line.

3rd April: Offshore Dungarvan to Tramore (Area B) to Rosslare to Arklow Bank (Area D).
Wind southerly. Force 6. Rough to moderate sea.
Line **CV17013_45** finished at 00.26. Line **CV17013_46** (SOL 00.32) run as a connecting line between the Dungarvan to Tramore set of lines (**CV17013_23** to **CV17013_45**) and SE-NW trending lines tracing the palaeovalley of the River Suir (**CV17013_47** to **CV17013_51**). **CV17013_47** started at 00.45. Recovered gear at end of line **CV17013_51)** as swell made line untenable (09.00). Leave Area B and transit to Rosslare arriving at 15.04 to drop off technican. Start transit at 15.14 to **CV17013_53** further up the Irish Sea at the southern tip of the Arklow Bank (Area D). MMO survey started at 17.30. Sparker in water and on a 20 minutes slow start ramping up at 18.30. All gear in at 18.46. Line **CV17013_53** started at 19.16 (Area D) heading east.

4th April: Offshore Arklow Bank and Brittas Bay (Areas D & F).
Wind northwesterly. Force 4 to 7 to 3. Moderate to slight sea.
Line **CV17013_54** started at 01.43 (Area D) heading east as a continuation of **CV17013_54** following airgun downtime (see technical issues). Last line in Area D for today completed next to Arklow Bank (**CV17013_56**) at 07.49. All gear recovered by 08.32 and transit to Wicklow Head area (Area F). MMO survey starts at 08.45. Sparker turned on at 09.33. Magnetometer and sparker line off Arklow and Wicklow Head started at 09.49 (**CV17013_57**). This line is recorded as one long line covering all of Area F and consists of 3 parallel traces. A separate short W-E line (**CV17013_58**) as run (22.23-22.43) with magnetometer and sparker which is aligned with an airgun/sparker line on the east side of the India Bank. All gear recovered on deck at 22.50 and transit to line **CV17013_59** commenced.

5th April: offshore Arklow Bank and east (Area D & E).
Wind north-westerly backing south-westerly and back to northerly. Force 5 dropping to 2. Moderate to calm seas.
MMO survey started at 05.40 and gear put in water at 05.40. Sparker slow started at 06.20 with ramp up. Survey line **CV17013_59** started at 06.51. Survey line **CV17013_60** in Area E started at 10.16. Caught pot at 17.59 on line **CV17013_69** (EOL). Airgun recovered, checked and redeployed by 18.36. Sparker still going in the water. Line track resumed with new line **CV17013_70** at 19.02 and continued through the night.

6th April: offshore India and Codling Banks (Area E)
Wind variable. Force 4 falling to light airs. Slight to calm sea
Line **CV17013_72** started at 00.42 and continued on E-W transects with N-S connecting lines heading north all day.

7th April: East of Bray Head, close to North Kish (Area E)
Wind southerly. Force 3/4. Calm sea.
It was noted that the SES had stopped recording at approx. 03.40 UTM and had not recorded since 18.40 UTM (6th April) as that is when the hard-drive was last changed. Retrieved seismic gear between 06.00 and 06.40 (UTC) as normal. Stopped to port in Dun Laoghaire to let Andy disembark. Niamh Connelly joined the cruise at 09.00. The vessel left Dun Laoghaire at 13.00 to pick up the lines that had not been retrieved in the area. We reached the new line location just north of east codling bank. MMO survey started at 14.40 UTC. Gear deployment started at 15.10 UTC. Airgun and Sparker seismic systems were initiated at ~

8th April: East of Bray Head, between East Kish and North Kish (Area E)
Wind southerly. Force 2/3. Slight sea
MMO started survey at 17.05. Returned to the site north of east codling to resume seismic collection with just the sparker and SES. Problems with navigation delayed initial collection. Line **CV17013_94** to **CV17013_99** did not record as the system had to be rebooted and it was not noticed that the system was not recording. Recording resumed from line **CV17013_100** as normal. The sparker was displaying good data with clear profiles.

9th April: East of Dalkey Island, between Bennet Bank and Lambay Island (Area E)
Wind variable. Force 4/5. Slight sea
Series of long east-west and south-north lines. Recording from the sparker started at 03.55 UTC after technical difficulties moving North offshore of Bray Head towards Lambay Island.

10th April: Wicklow Head to Brittas Bay, East of Rosslare (Area F/ D)
Wind Variable. Force 3/4. Slight sea
At 8.00 UTC sparker was retrieved from the water to ensure a quicker mobilisation to the grab sampling site at Area F. Sampling with the Shipek Grab commenced at 09.00 UTC. Before sampling commenced it was noted that three targeted sites fell on within an SAC area so these sites were excluded from the plan. Grabs showed poor results, as hard bedrock in the area was prevalent. 17 samples were taken, 2 were unsuccessful **(CV17013_SPK_12 and CV17013_SPK_16)** retrieving little or no sediment after three grab attempts. Samples showed mostly sand with fragmented bioclasts. Last sample was retrieved at 3.30 UTC and the vessel moved back to Area D to resume collection of seismic lines from the sparker line **(CV17013_ 120)**

11th April: (Area D/B)
Wind north-westerly. Force 4/5. Slight sea
Seismic lines continued until the end of area D to the south where the sparker line **(CV17013_127)** was then retrieved so the vessel could transit to the next site more efficiently. Areas C and part of D were dropped to allow for more time at priority locations. Sparker was deployed at xxxx when the south-west side of *area B* was reached. Three long NE to SW lines were collected moving from north to south. The last line of the grid was omitted and a connecting line was collected between Areas B and A.

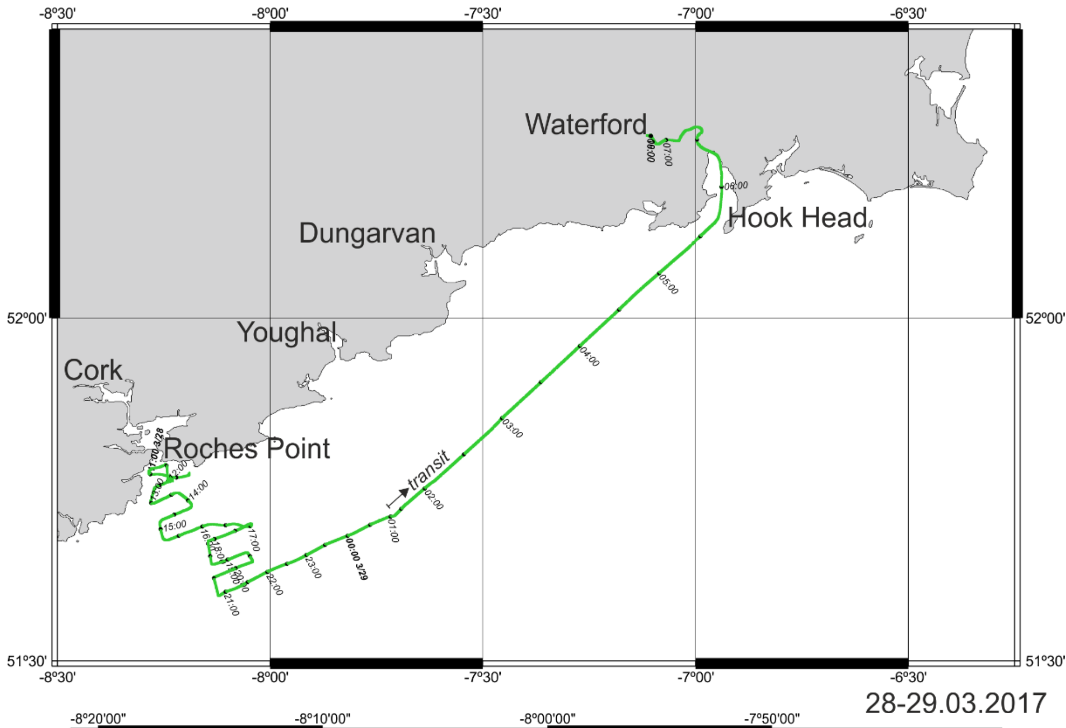
12th April: (Area B/A)
Wind westerly. Force 4. Slight sea
Series of short lines were collect using the sparker starting at approx. 06.00 UTC in order to complete *Area A* moving from south of the track lines to north. The sparker was retrieved from the water at 11.42 UTC, last line **(CV17013_147)** before the vessel started to transit back to Cork harbour.

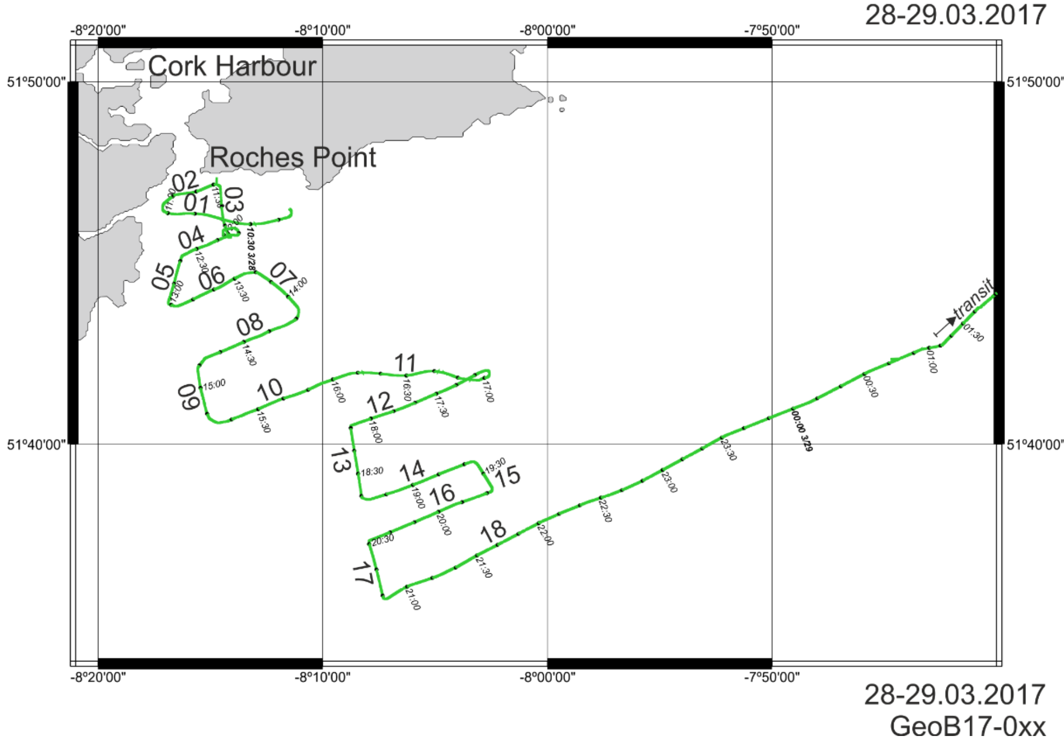
13th April: Cork Harbour

Demobilisation commenced at 0830.

7 Summary of Areas

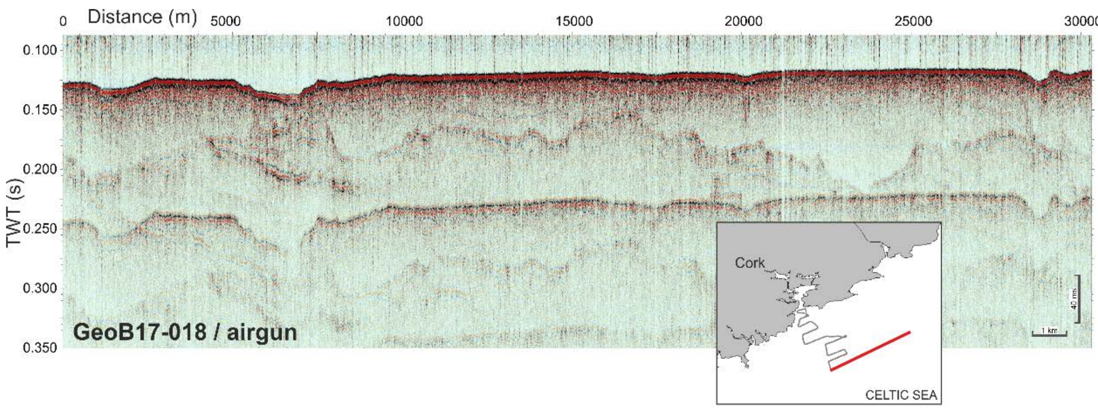
Area A: Roches Point to off Youghal





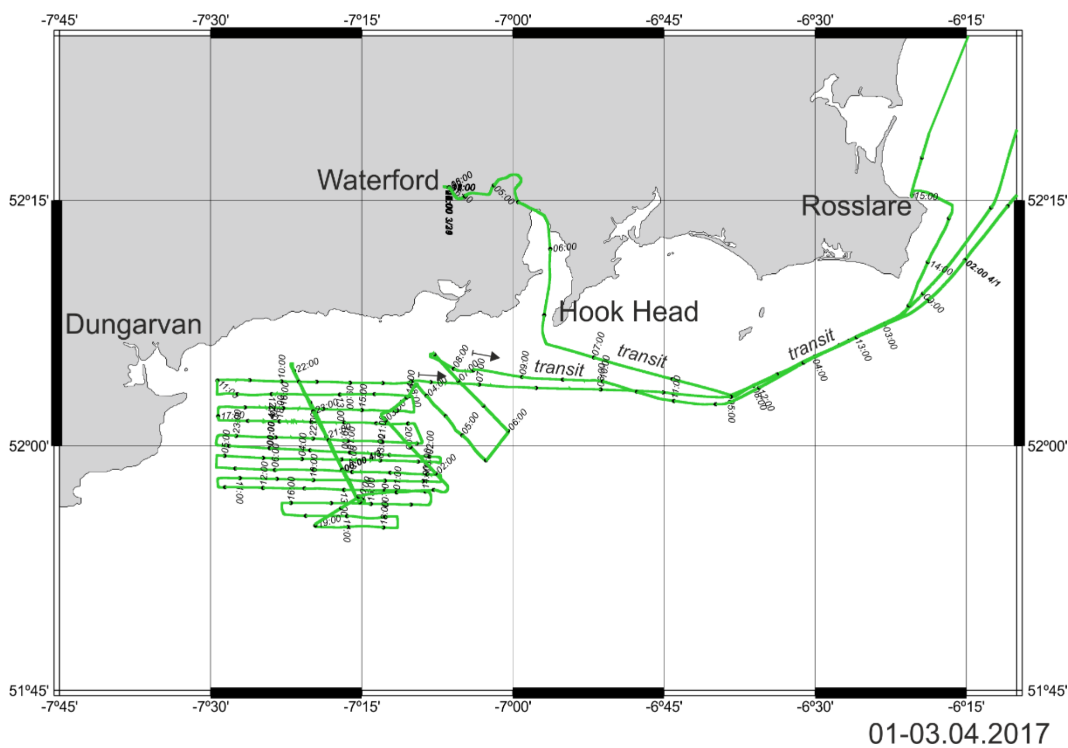
Missing: SPARKER DATA MAP, example

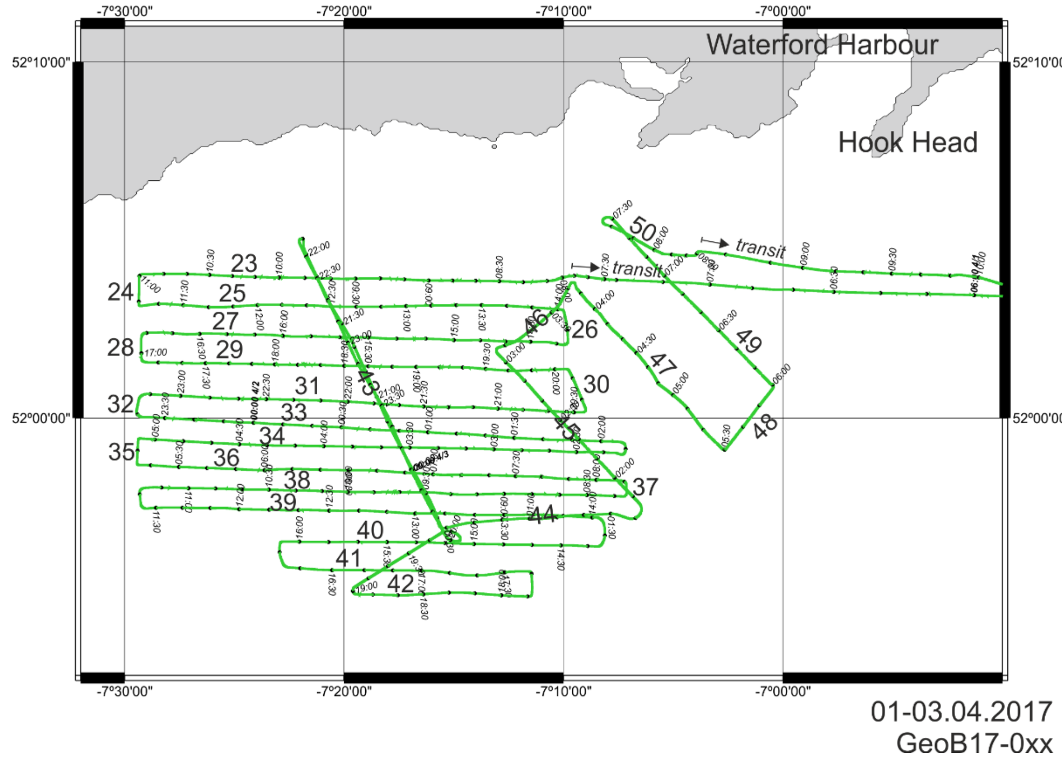
Channels that have a topographic expression on the INFOMAR multibeam bathymetry data were crossed with seismic lines. The airgun proved that these were channels with a sub-seabed expression. The rockhead was also clearly delimited as well as above rockhead seabed reflectors. The sparker system gave limited seabed penetration.

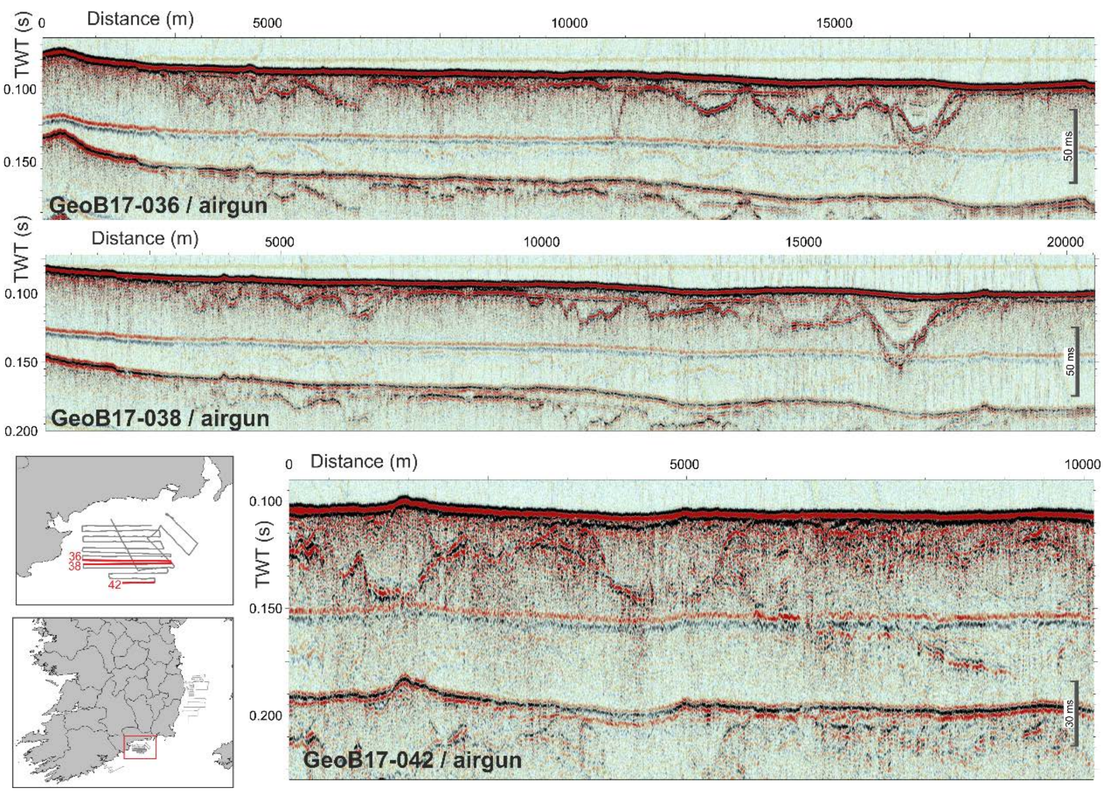


Area B: off Dungarvan to Hook Head

A series of lines were collected between Dungarvan and Hook Head that showed a layered stratigraphy above rockhead with a series of number of buried and emergent channels, moraines and eskers.







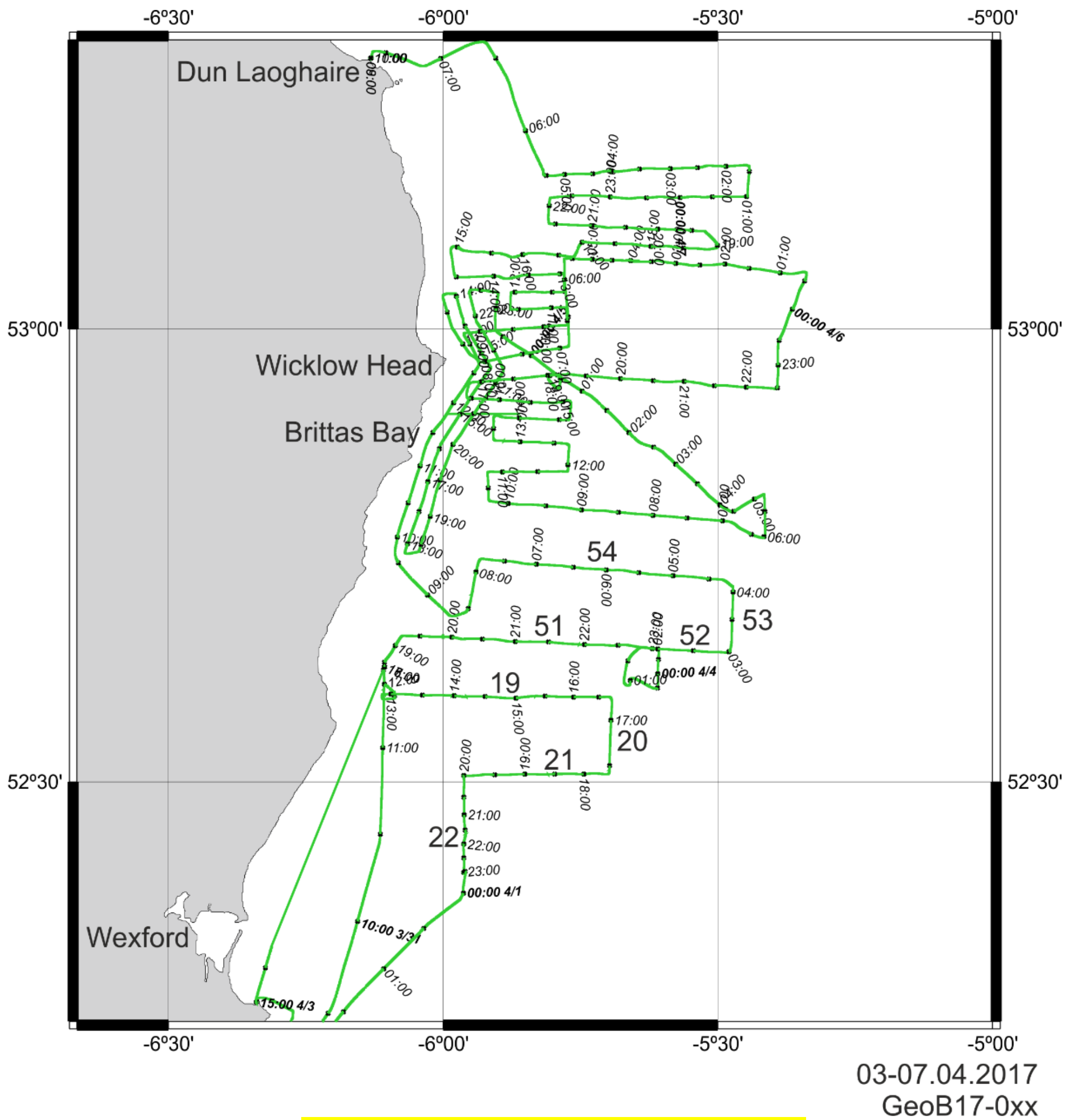
Missing: SPARKER DATA MAP, example

Area C: east of the Salties

Not surveyed due to time constraints.

Area D: off Rosslare to off Brittas Bay

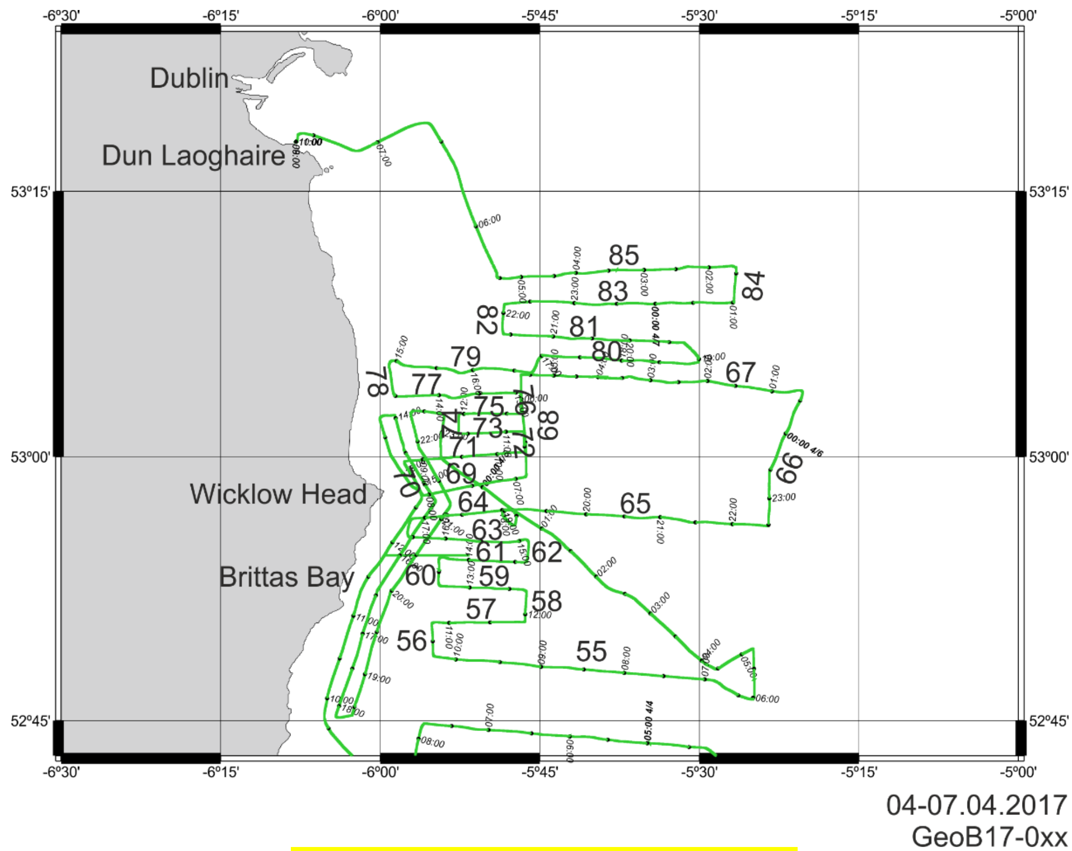
In this area, long east-west seismic lines were run to refine the stratigraphic model for the southern Irish Sea. Good penetration revealed a number of reflectors giving a good insight into the stratigraphy in this area.



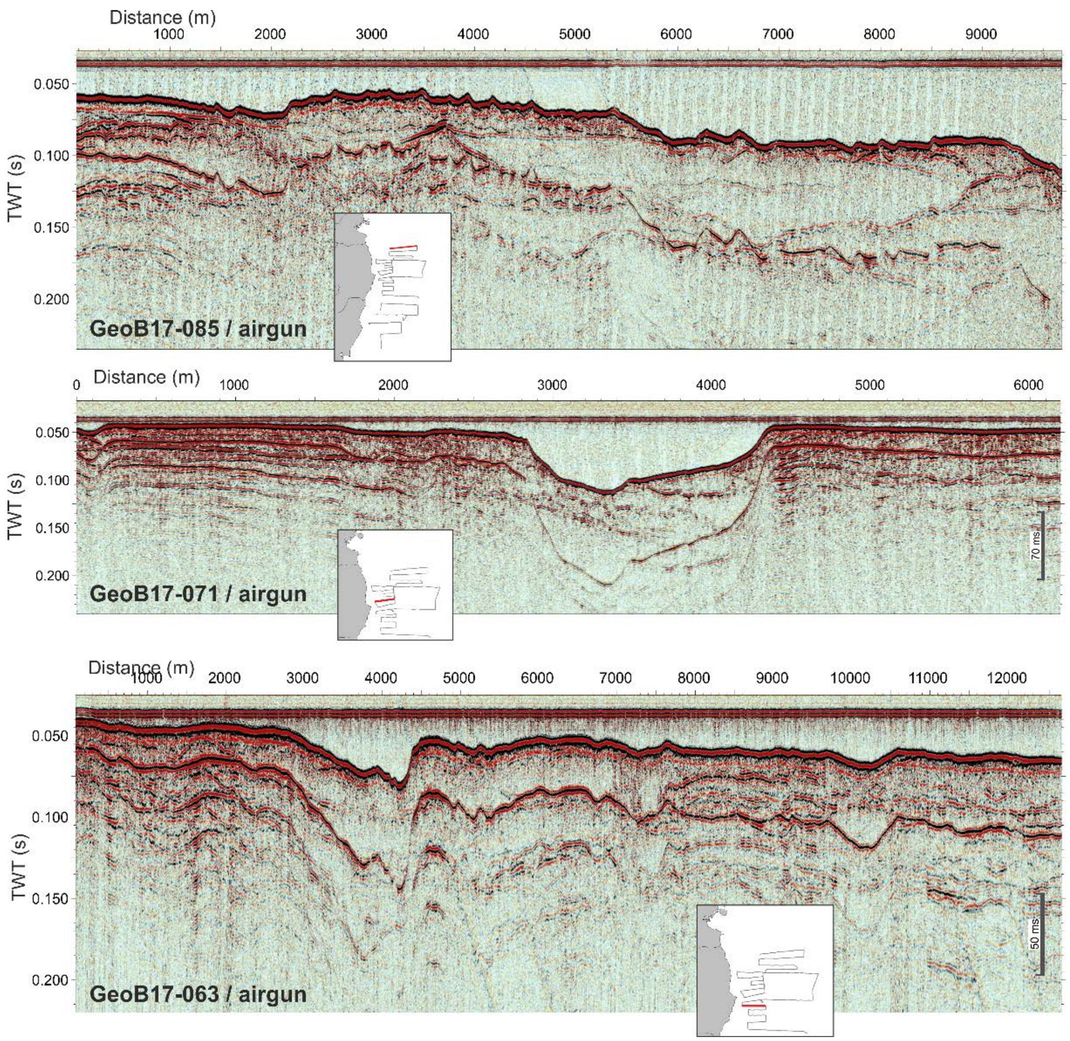
Missing: SPARKER DATA MAP, example

Area E: off Brittas Bay to off Lambay Island

The seismic tracks of this area were revised several times due to access, hazards (pots), SACs, technical difficulties and time constraints. The area was sampled in two sections, the south and the north. The southerly lines were sampled with both the airgun and sparker seismic systems. It comprised of a series of short parallel W-E lines close to Area F, east of Wicklow Head. The first long line to the north of the section was completed but the second line cut short due to transit to Dun Laoghaire for port. The northerly section was sampled with just the sparker and consisted of a series of W-E lines closely spaced. To western section of these lines were cut short due to pots in the area close to the coast.

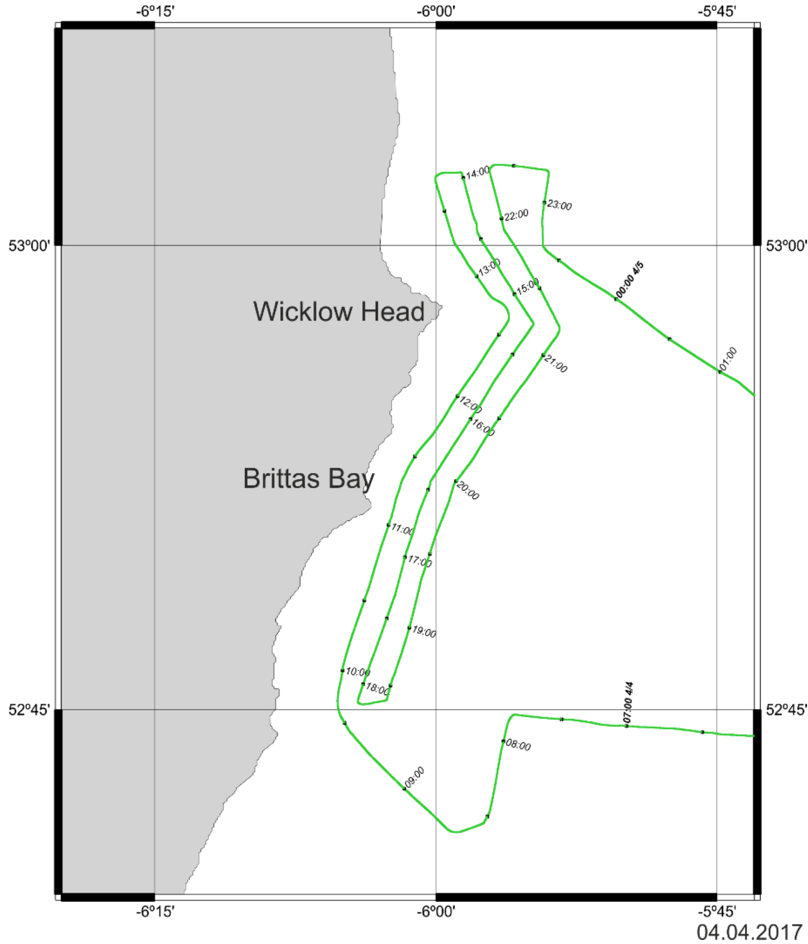


Missing: SPARKER DATA MAP, example



Area F: off Brittas Bay to off Wicklow Head

Three long and closely spaced (x m separation) lines of magnetometer and sparker seismics were run coast parallel from offshore Arklow to just north of Wicklow Head. These lines cover areas identified as heavy mineral sand finds with finds also present on the adjacent beaches. The sparker showed the thickness of surface units and several anomalies were obvious on the magnetics data. Sediment samples were taken to assess whether the anomalies relate to heavy mineral concentrations of other causes (e.g. bedrock signatures or metallic debris).



Missing: magnetic data map plus sampling sites

Area G: off Drogheda

Optional area not surveyed.

8 Weather Report

All times in UTC (one hour earlier than summer time) except on the maps

27th March 2017 – Tied up in Cork

Sunny, fresh winds

28th March 2017 – Roches Point to Offshore Youghal

11.00 Wind southerly. Force 3. Slight sea with a broad swell.
17.00 Wind southerly. Force 5/6. Moderate to rough sea. Good visibility.

29th March 2017: Offshore Youghal to Waterford (Area A)

05.00 Wind southerly. Force 6. Moderate to rough. Good visibility.

30th March 2017: Tied up in Waterford

Rainy with low cloud with some wind.

31st March 2017: Offshore Courtown (Area D)

11.00 Wind south-westerly. Force 5. Moderate sea. Mainly overcast.
17.00 Wind south-westerly. Force 5. Moderate sea. Good visibility.

1st April 2017: Offshore Dungarvan to Tramore (Area B)

05.00 Wind south-westerly. Force 5/6. Moderate sea. Good visibility.
11.00 Wind north-westerly. Force 3. Slight sea and swell. Light cloud, fine and clear.
17.00 Wind north-westerly. Force 4/5. Moderate sea. Good visibility.
23.00 Wind westerly. Force 3. Slight sea. Cloudy, fine and clear.

2nd April 2017: Offshore Dungarvan to Tramore (Area B)

03.00 Wind north-westerly. Force 4/5. Moderate sea. Good visibility.
07.00 Wind northerly. Force 2/3. Slight sea. Fine and clear with good visibility.
11.00 Wind variable. Force 2. Slight sea. Low swell. Fine and clear with good visibility.
15.00 Wind south-westerly. Force 4/5. Calm sea. Good visibility.
19.00 Wind southerly. Force 4. Slight sea and swell. Clear sky, fine with good visibility.
23.00 Wind southerly. Force 5. Slight/moderate sea. Low swell. Fine and clear with good visibility.

3rd April 2017: Offshore Dungarvan to Tramore (Area B) to Rosslare

03.00 Wind southerly. Force 6/7. Moderate to rough sea. Good visibility.
05.00 Wind southerly. Force 6. Moderate sea and swell. Overcast with good visibility.
11.00 Wind southerly. Force 6. Moderate sea and moderate swell. Overcast.

4th April 2017: Brittas Bay to Wicklow Head (Area F)

03.00 Wind north-westerly. Force 4/5. Moderate sea. Good visibility.

07.00 Wind north-westerly. Force 6/7. Moderate sea. Partly cloudy, good visibility.
11.00 Wind northerly. Force 3/4. Slight sea. Cloudy, fine and clear.
19.00 Wind north-westerly. Force 3/4. Slight sea and swell. Cloudy, fine with good visibility.

5th April 2017: Offshore Arklow to east (Area D & E)

03.00 Wind north-westerly. Force 4/5. Moderate sea. Good visibility.
07.00 Wind north-westerly. Force 3. Slight sea. Good visibility, partly cloudy, fine and overcast.
11.00 Wind north-north-west. Force 2. Slight sea. Cloudy, fine and clear.
15.00 Wind south-westerly. Force 3/4. Calm sea. Good visibility.
19.00 Light airs. Force 2. Calm sea with no swell. Overcast, good visibility.
23.00 Wind northerly. Force 2. Slight sea. Cloudy, fine and clear.

6th April 2017: offshore India and Codling Banks (Area E)

03.00 Wind north-westerly. Force 3/4. Calm sea. Good visibility.
07.00 Wind south-westerly. Force 2/3. Slight sea. Overcast with good visibility.
11.00 Wind north-north-west. Force 2. Slight sea. Cloudy, fine and clear.
15.00 Wind south-westerly. Force 3/4. Calm sea. Good visibility.
19.00 Light airs. Calm sea. Overcast with good visibility.
23.00 Light airs. Calm sea. Cloudy, fine and clear.

7th April 2017: offshore of Bray Head, close to North Kish (Area E)

04.08 Wind north-westerly. Force 3/
4. Calm sea. Good visibility.
16.00 Wind south-easterly. Force 2/3. Calm sea. Good visibility.
20.00 Wind southerly. Force2/3. Fine, clear and good visibility.

8th April 2017: offshore of Bray Head, between East Kish and North Kish (Area E)

20.00 Wind southerly. Force 2/3. Clear skies. Fine, slight gaze. Good visibility.
24.00 Wind southerly. Force2/3. Slight sea. Slight cloud. Fine and clear.

9th April 2017: East of Dalkey Island, between Bennet Bank and Lambay Island (Area E)

04.00 Wind southerly. Force 4/5. Calm sea, good visibility.
08.00 Wind north-easterly. Force 3/4. Slight sea, clear skies. Fine and slightly hazy. Good visibility throughout.
12.00 Wind west/north-westerly. Force1/2. Rippled sea. Light cloud, fine weather.
16.00 Wind south-westerly. Force4/5. Calm sea, good visibility.

10th April 2017: Offshore Wicklow Head to Brittas Bay/ East of Rosslare (Area F/D)

04.00 Wind westerly, Force 5/6. Moderate Sea. Good visibility.

08.00 North-westerly wind. Force 4/5, Slight sea and low swell. Good visibility.
16.00 Wind south-easterly. Force 3/4, clam sea. Good visibility.
24.00 Wind north to north-westerly. Force2/3. Slight sea. Light cloud, fine and clear.

11th April 2017: offshore of Rosslare to Dungarven area (Area D/B)

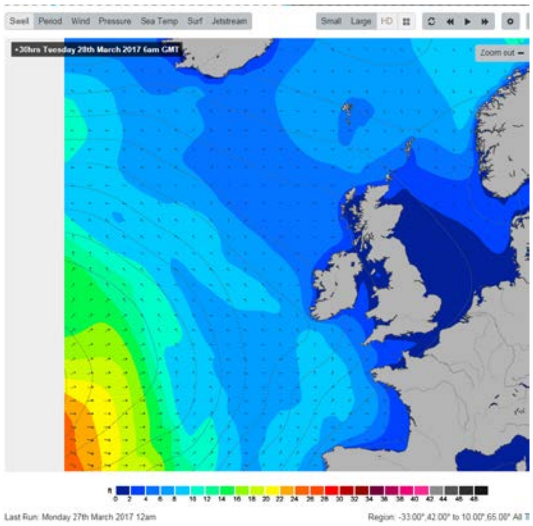
04.00 Wind North-westerly. Force 4/5. Calm sea. Good visibility.
08.00 Partly cloudy, fine and clear with good visibility throughout.
16.00 Wind south-westerly. Force 5/6. Moderate sea, slight swell.
20.00 Wind north-westerly. Very light pitching. Slight to moderate swell.
Force 3/ 4. Mostly cloudy, fine and clear. Good visibility throughout.
24.00 Wind north-westerly. Force 4. Slight sea. Light cloud and fine.

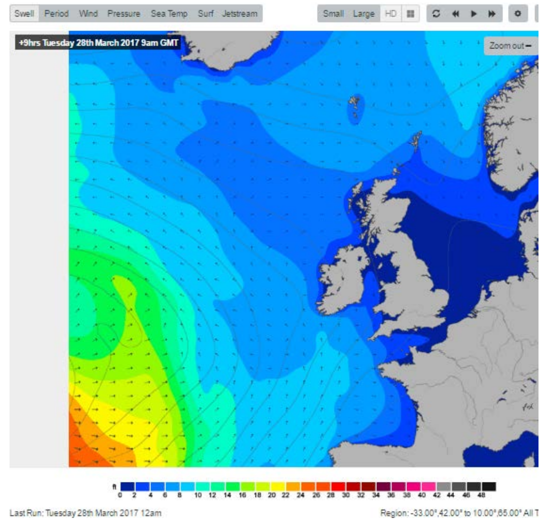
12th April 2017

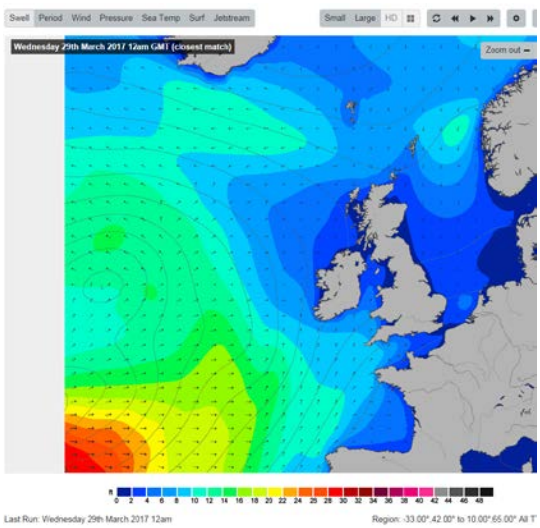
08.00 Wind westerly. Force 4. Very light pitching. Moderate sea and swell.
Overcast, fine and good visibility throughout.
12.00 Wind north-westerly. Force 4. Slight sea. Cloudy, fine and clear.

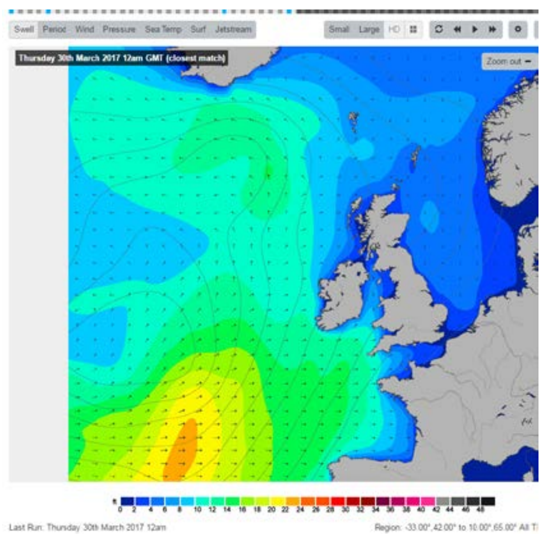
13th April 2017

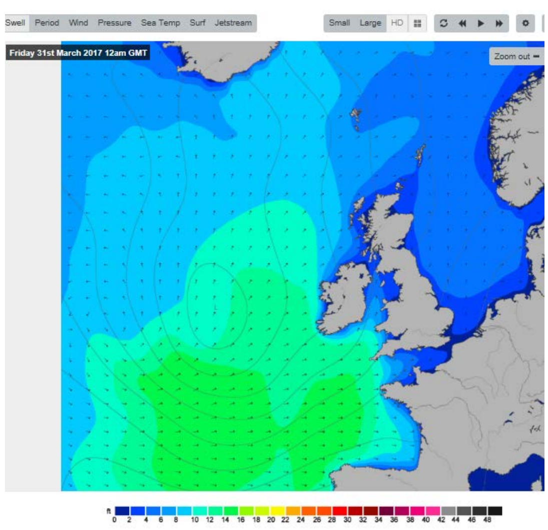
N/A

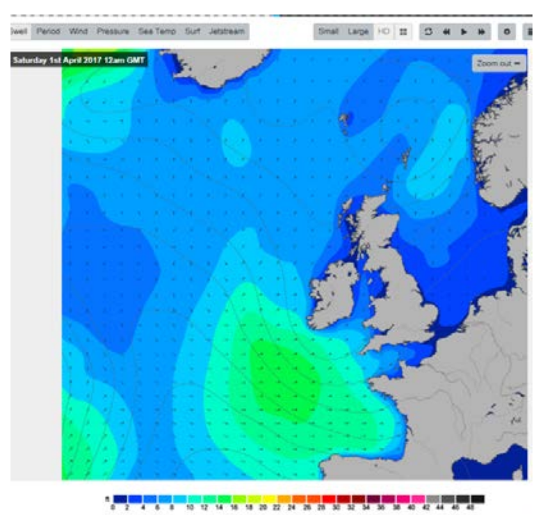

Swell Period Wind Pressure Sea Temp Surf Jetstream
Small Large HD
+30hrs Tuesday 28th March 2017 6am GMT
Zoom out
Last Run: Monday 27th March 2017 12am

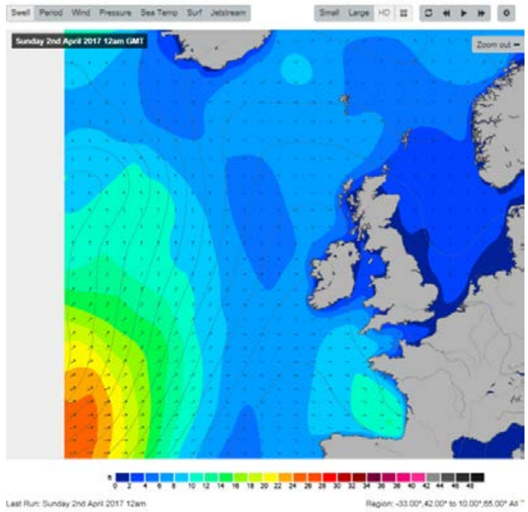

Swell Period Wind Pressure Sea Temp Surf Jetstream
Small Large HD
+9hrs Tuesday 28th March 2017 9am GMT
Zoom out
Last Run: Tuesday 28th March 2017 12am

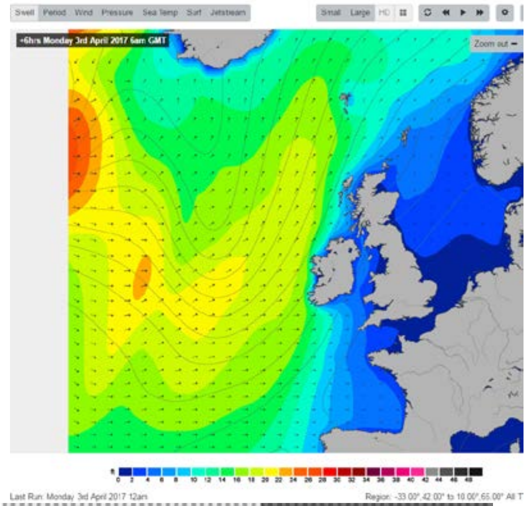

Swell Period Wind Pressure Sea Temp Surf Jetstream
Small Large HD
Wednesday 29th March 2017 12am GMT (closest match)
Zoom out
Last Run: Wednesday 29th March 2017 12am

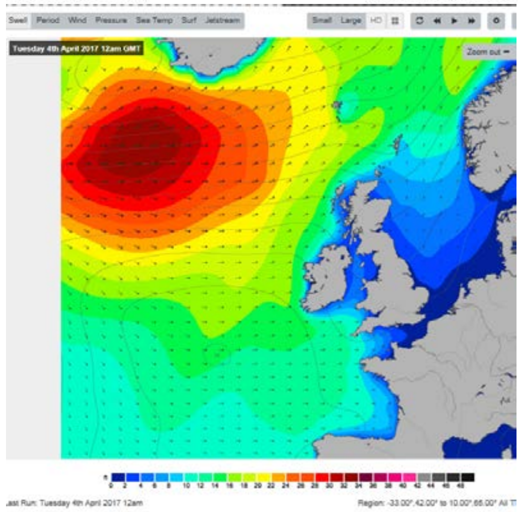

Swell Period Wind Pressure Sea Temp Surf Jetstream
Small Large HD
Thursday 30th March 2017 12am GMT (closest match)
Zoom out
Last Run: Thursday 30th March 2017 12am

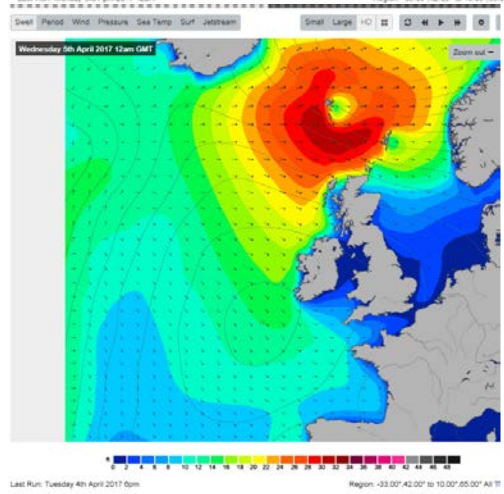

Swell Period Wind Pressure Sea Temp Surf Jetstream
Small Large HD
Friday 31st March 2017 12am GMT
Zoom out
ast Run: Friday 31st March 2017 12am

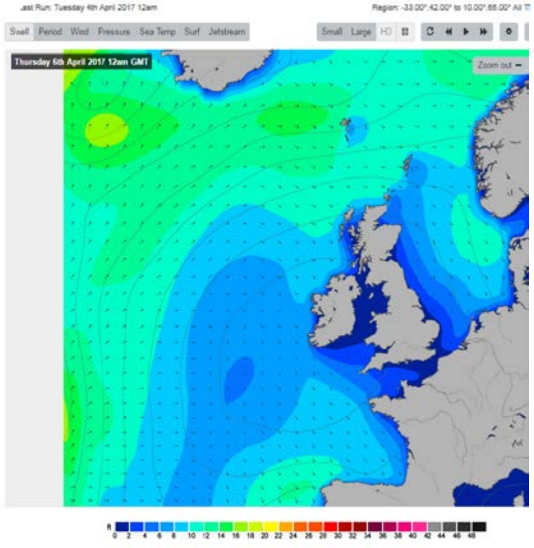

Period Wind Pressure Sea Temp Surf Jetstream
Small Large HD
Saturday 1st April 2017 12am GMT
Zoom out

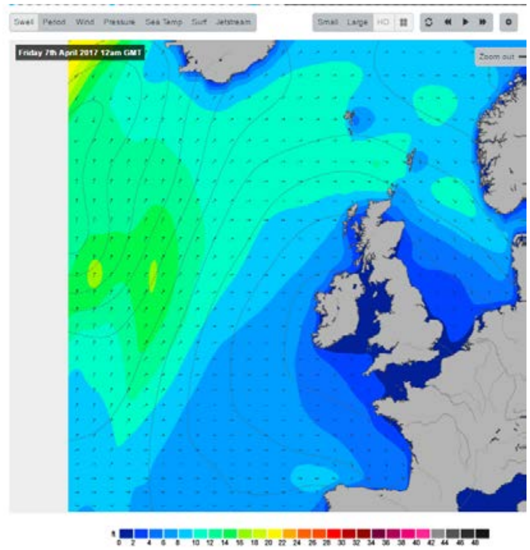

Sunday 2nd April 2017 12am GMT
Last Run: Sunday 2nd April 2017 12am
Region: -33.00°,42.00° to 10.00°,65.00°

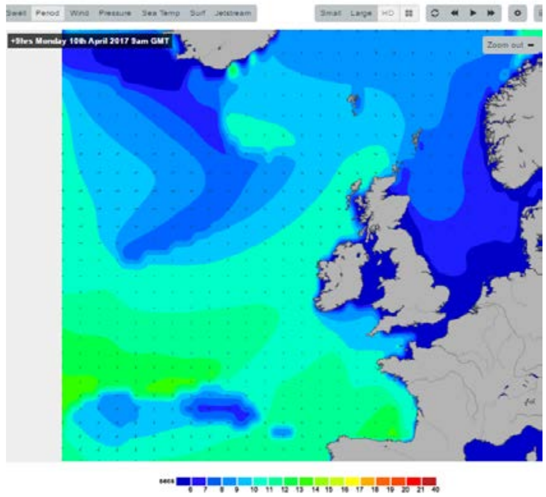

+6hrs Monday 3rd April 2017 6am GMT
Last Run: Monday 3rd April 2017 12am
Region: -33.00°,42.00° to 10.00°,65.00°

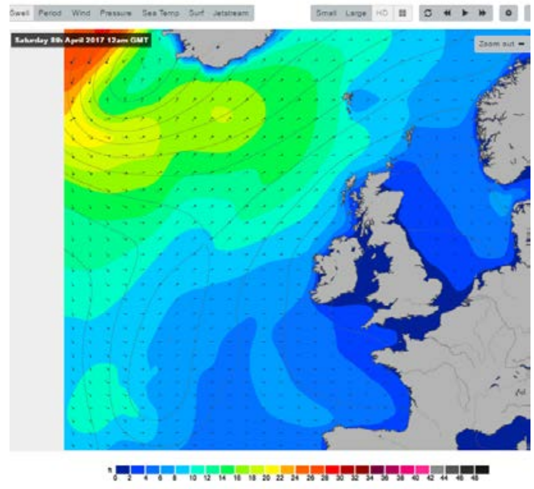

Tuesday 4th April 2017 12am GMT
Last Run: Tuesday 4th April 2017 12am
Region: -33.00°,42.00° to 10.00°,65.00°

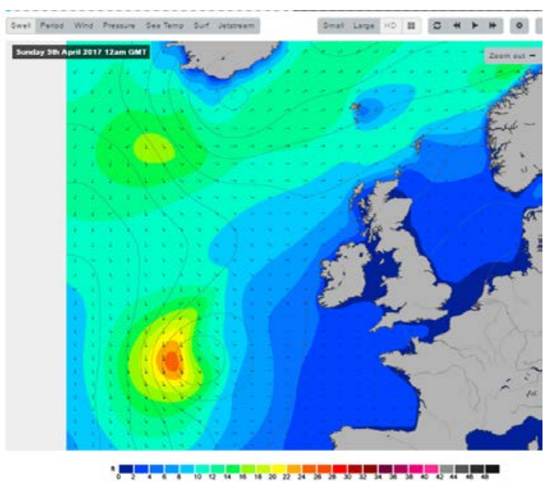

Wednesday 5th April 2017 12am GMT
Last Run: Tuesday 4th April 2017 6pm
Long Range Last Run: Tuesday 4th April 2017 6pm
Region: -33.00°,42.00° to 10.00°,65.00°

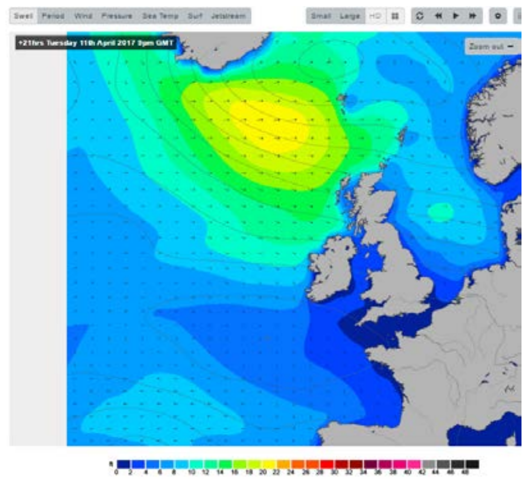

Thursday 6th April 2017 12am GMT
Last Run: Wednesday 5th April 2017 6pm
Region: -33.00°,42.00° to 10.00°,65.00°

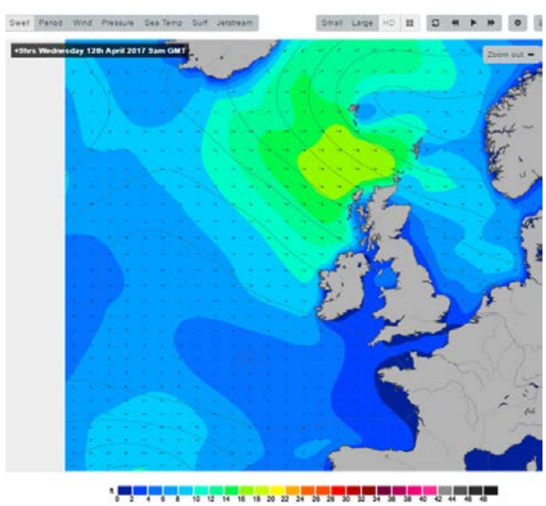

Friday 7th April 2017 12am GMT


Swell
Period
Wind
Pressure
Sea Temp
Surf
Jetstream
Small
Large
HD
+9hrs Monday 10th April 2017 9am GMT
Zoom out


Swell
Period
Wind
Pressure
Sea Temp
Surf
Jetstream
Small
Large
HD
Saturday 8th April 2017 12am GMT
Zoom out


Swell
Period
Wind
Pressure
Sea Temp
Surf
Jetstream
Small
Large
HD
Sunday 9th April 2017 12am GMT
Zoom out


Swell
Period
Wind
Pressure
Sea Temp
Surf
Jetstream
Small
Large
HD
+21hrs Tuesday 11th April 2017 9pm GMT
Zoom out


Swell
Period
Wind
Pressure
Sea Temp
Surf
Jetstream
Small
Large
HD
+9hrs Wednesday 12th April 2017 9am GMT
Zoom out

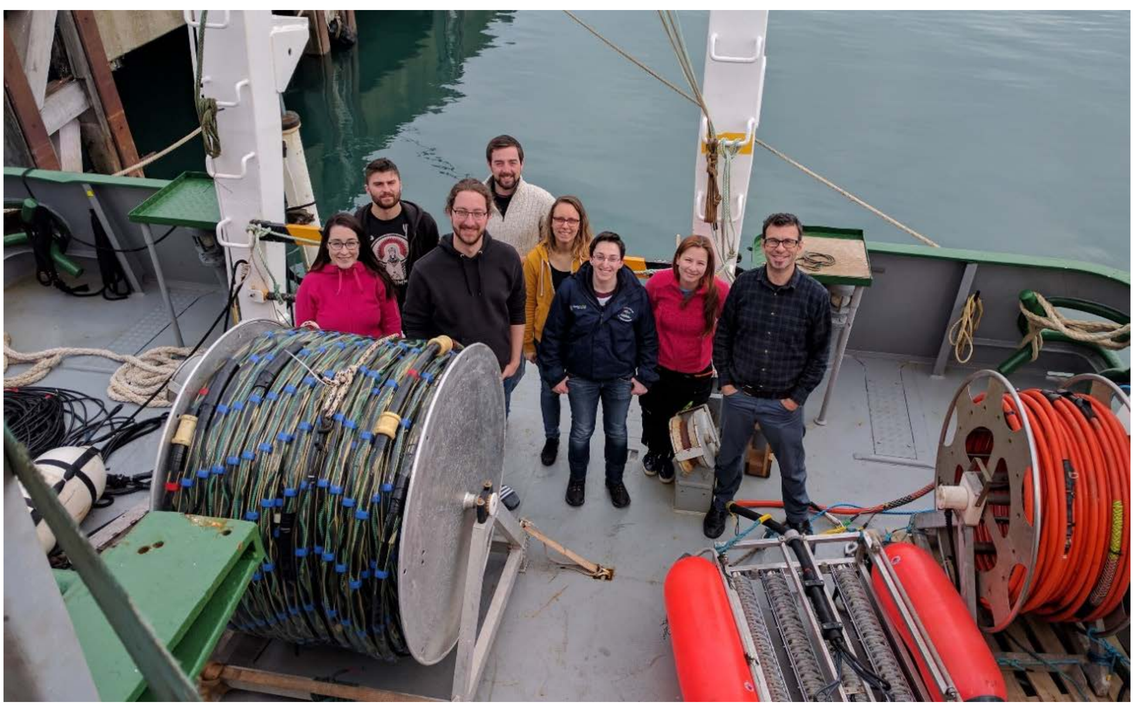
Sin é

Appendices

Appendix I

Personnel

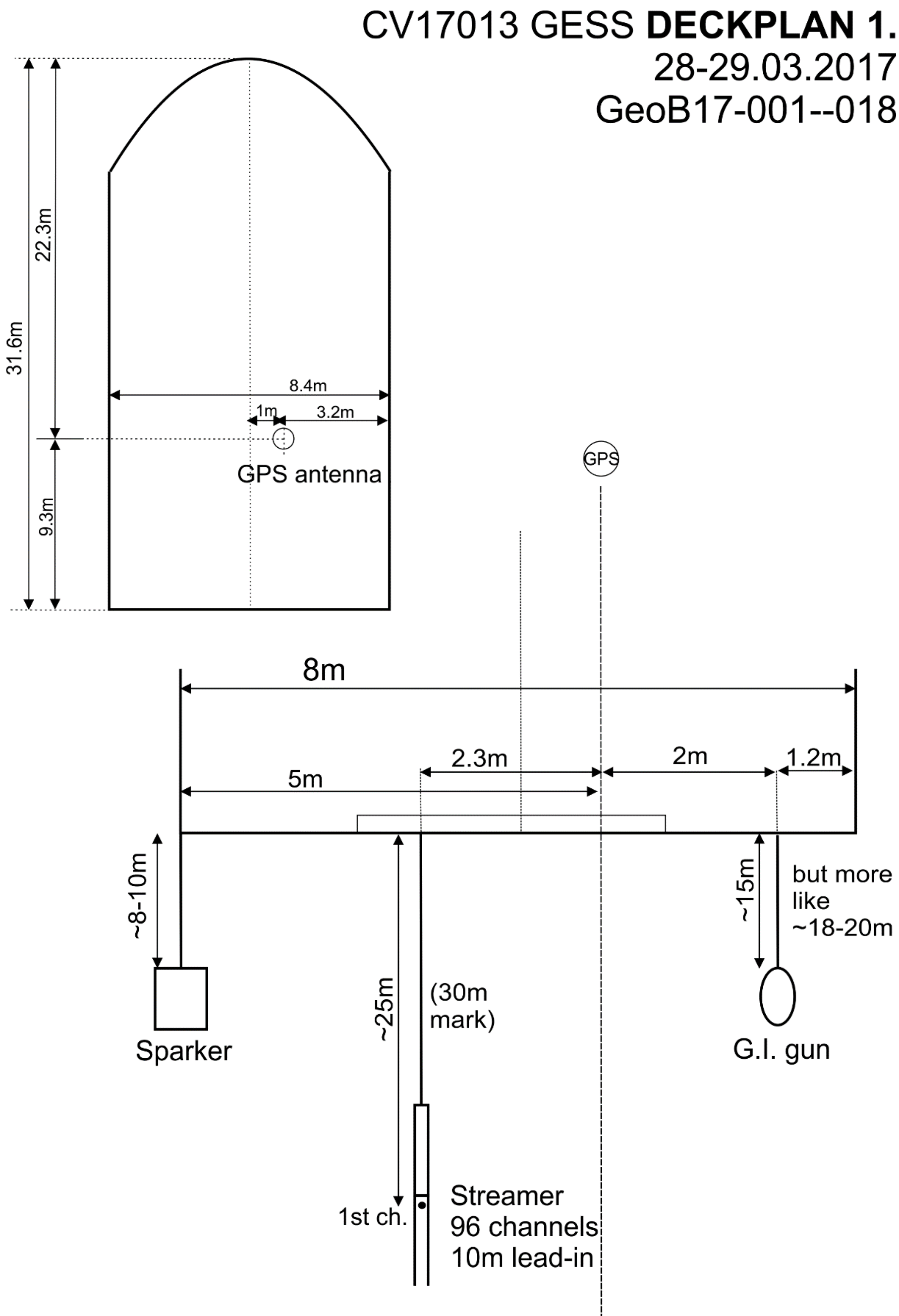
Ship's crew	Scientific Party
Phillip Baugh Captain	Prof. Andy Wheeler Chief Scientist (UCC)
Jason White Chief Engineer	Dr. Stefan Wenau Head of the Geophysical Team (UB)
Adam O'Rahilly Chief Officer	Dr. Zsuzsanna Tóth Geophysicist (UCC)
Diarmuid Seoighe 2nd Mate	Nora Schultze Geophysicist (UB)
Tommy Grealy Boson	Tim Daskevic Geophysicist (UB)
Tommy Byrne Boatman	Siobhán Burke Geologist (UCC)
David Guggisberg Technician	Darren Craig MMO (Freelance)
Ollie Murphy Cook	Niamh Connolly Geologist (ex-UCC)



Appendix II

Station List

Appendix III
DECKPLANS



CV17013 Grab sample logsheet

Station No	Date	Time (UTC)	Depth (m)	LAT		LON		LAT DD	LON DD	Note
CV17013_SPK01	10.04.17	14:02	16.5	52	53.2753	6	0.7886	52.8879217	6.01314333	
CV17013_SPK02	10.04.17	13:41	15.1	52	55.0111	5	58.987	52.9168517	5.98311667	
CV17013_SPK03	10.04.17	12:42	14.5	52	56.7374	5	56.966	52.9456233	5.94943333	
CV17013_SPK04	10.04.17									SAC
CV17013_SPK05	10.04.17									SAC
CV17013_SPK06	10.04.17	10:49	21.9	53	59.7868	5	58.7132	53.9964467	5.97855333	
CV17013_SPK07	10.04.17	10:17	16.3	53	2.1793	5	58.6823	53.0363217	5.97803833	
CV17013_SPK08	10.04.17	09:59	21.5	53	0.7601	5	57.8568	53.0126683	5.96428	
CV17013_SPK09	10.04.17									SAC
CV17013_SPK10	10.04.17	11:17	**71.05**	52	58.3615	5	55.7899	52.9726917	5.92983167	*
CV17013_SPK11	10.04.17	11:43	**70.95**	52	57.4959	5	54.7538	52.958265	5.91256333	*
CV17013_SPK12	10.04.17	11:29	**70.97**	52	57.277	5	55.1455	52.9546167	5.91909167	* unsuccessful
CV17013_SPK13	10.04.17	12:54	18.7	52	55.8636	5	56.3729	52.93106	5.93954833	
CV17013_SPK14	10.04.17	13:28	16	52	54.6737	5	58.0792	52.9112283	5.96798667	
CV17013_SPK15	10.04.17	13:11	25.1	52	54.1215	5	56.5667	52.902025	5.94277833	
CV17013_SPK16	10.04.17	12:16	**70.8**	52	56.5124	5	53.9966	52.9418733	5.89994333	* unsuccessful
CV17013_SPK17	10.04.17	12:01	**70.78**	52	57.2851	5	53.5973	52.9547517	5.89328833	*
CV17013_SPK18	10.04.17	09:41	19.6	53	0.16	5	56.0056	53.0026667	5.93342667	
CV17013_SPK19	10.04.17	09:32	17	53	0.54	5	56.24	53.009	5.93733333	coordinates not recorded
CV17013_SPK20	10.04.17	09:09	18.1	53	2.5823	5	55.5167	53.0430383	5.92527833	west from planned station

*all water depths that are ~70 m are probably wrong

CV17013 Masterlog

Station Number	GeoB No	SOL/EOL	Date	Time (UTC)	Lat DD	Long DD	Depth (m)	AirGun	SES	Sparker	MBES	Note
Area A												**Area A: R. Lee Palaeovalley**
CV17013_1	GeoB17_001	SOL	28.03.17	10.43	51.771173	-8.24683		x		x		Airgun firing at 120 bars every 2 secs. Speed 4 kts
		EOL	28.03.18	11.00	51.77364	-8.28426		x		x		
CV17013_2	GeoB17_002	SOL	28.03.19	11.05	51.77829	-8.28246		x		x		Most northerly line
		EOL	28.03.20	11.27	51.7855802	-8.249507		x		x		Siobhan
CV17013_3	GeoB17_003	SOL	28.03.21	11.35	51.77909	-8.242011		x		x		N-S line over rock west of channel
		EOL	28.03.22	11.59	51.76231	-8.23823		x		x		Some turning at the end
CV17013_4	GeoB17_004	SOL	28.03.23	12.13	51.76277	-8.23632		x		x		W-E across channel
		EOL	28.03.24	12.35	51.7543	-8.268		x		x		
CV17013_5	GeoB17_005	SOL	28.03.25	12.38	51.75205	-8.27191		x	x	x		N-S line over rock east of channel
		EOL	28.03.26	12.58	51.73173	-8.28133		x	x	x		
CV17013_6	GeoB17_006	SOL	28.03.27	13.03	51.7305	-8.2728		x	x	x		E-W line across channel
		EOL	28.03.28	13.35	51.74535	-8.2227		x	x	x		
CV17013_7	GeoB17_007	SOL	28.03.29	13.41	51.7452	-8.214		x	x	x		N-S line over rock
		EOL	28.03.30	14.06	51.7279	-8.1844		x	x	x		
CV17013_8	GeoB17_008	SOL	28.03.31	14.11	51.7232	-8.1889		x	x	x		W-E line over channel
		EOL	28.03.32	14.45	51.70632	-8.25377	40.0	x	x	x		
CV17013_9	GeoB17_009	SOL	28.03.33	14.52	51.7003	-8.2592	36.5	x	x	x		N-S line over rock west of channel
		EOL	28.03.34	15.12	51.678	-8.2495	48.6	x	x	x		
CV17013_10	GeoB17_010	SOL	28.03.35	15.16	51.6766	-8.2429	49.2	x	x	x		W-E line across the cahnnel
		EOL	28.03.36	16.03	51.69827	-8.15031	58.9	x	x	x		
CV17013_11	GeoB17_011	SOL	28.03.37	16.08	51.6994	-8.14274	61.2	x	x	x		NW-SE line
		EOL	28.03.38	16.52	51.696713	-8.060563	71.0	x	x	x		ship went slightly off line (<100m) but returned to line
CV17013_12	GeoB17_012	SOL	28.03.39	17.14	51.696126	-8.06119	72.5	x	x	x		W-E line
		EOL	28.03.40	18.07	51.6754	-8.14449	71.2	x	x	x		
CV17013_13	GeoB17_013	SOL	28.03.41	18.10	51.6732	-8.1456	71.9	x	x	x		N-S line
		EOL	28.03.42	18.40	51.64197	-8.1371	78.5	x	x	x		
CV17013_14	GeoB17_014	SOL	28.03.43	18.44	51.6414	-8.13	78.6	x	x	x		W-E line
		EOL	28.03.44	19.21	51.6584	-8.0567	80.5	x	x	x		
CV17013_15	GeoB17_015	SOL	28.03.45	19.25	51.6575	-8.052	81.4	x	x	x		N-S line short
		EOL	28.03.46	19.36	51.6467	-8.0409	82.5	x	x	x		
CV17013_16	GeoB17_016	SOL	28.03.47	19.39	51.6446	-8.0427	82.2	x	x	x		E-W line with channel
		EOL	28.03.48	20.28	51.6221	-8.1322	81.2	x	x	x		
CV17013_17	GeoB17_017	SOL	28.03.49	20.29	51.6207	-8.132	80.8	x	x	x		N-S line short
		EOL	28.03.50	20.50	51.5958	-8.1215	86.4	x	x	x		
CV17013_18	GeoB17_018	SOL	28.03.51	20.52	51.5956	-8.1180	86.6	x	x	x	x	E-W line long
		EOL	29.03.17	0.50	51.7091	-7.7260	77.9	x	x	x	x	

Area D												**Area D: offshore Courtown**
CV17013_19	GeoB17_019	SOL	31.03.17	12.52	52.5973	-6.1074	29.6	x	x	x		E-W line
		EOL	31.03.17	16.43	52.5942	-5.9663		x	x	x		
CV17013_20	GeoB17_020	SOL	31.03.17	16.47	52.5889	-5.6927		x	x	x		
		EOL	31.03.17	17.34	52.5105	-5.6976		x	x	x		
CV17013_21	GeoB17_021	SOL	31.03.17	17.37	52.5087	-5.7033	74	x	x	x		E-W line
		EOL	31.03.17	19.59	52.5068	-5.9632	69.2	x	x	x		
CV17013_22	GeoB17_022	SOL	31.03.17	20.02	52.5048	-5.9625	70.8	x	x	x		N-S line
		EOL	31.03.17	23.01	52.3984	-5.9625	76.9	x	x	x		
Area B												**Area B: Durgarvan to Hook Head**
CV17013_23	GeoB17_023	SOL	01.04.17	8.20	52.0637	-7.2004	44.9	x	x	x		E-W line
		EOL	01.04.17	10.58	52.0674	-7.4859	27.4	x	x	x		
CV17013_24	GeoB17_024	SOL	01.04.17	11.01	52.0646	-7.489	27.5	x	x	x		N-S line
		EOL	01.04.17	11.11	52.0525	-7.4878	29.6	x	x	x		
CV17013_25	GeoB17_025	SOL	01.04.17	11.14	52.0527	-7.4836	30.5	x	x	x		E-W line
		EOL	01.04.17	13.01	52.0503	-7.1666	44.6	x	x	x		
CV17013_26	GeoB17_026	SOL	01.04.17	13.03	52.04843	-7.1657	45.01	x	x			N-S line. No sparker
		EOL	01.04.17	14.14	52.0359	-7.1632	48.5	x	x	x		
CV17013_27	GeoB17_027	SOL	01.04.17	14.17	52.0342	-7.1672	48.9	x	x	x		E-W line
		EOL	01.04.17	16.49	52.0398	-7.4848	33.9	x	x	x		
CV17013_28	GeoB17_028	SOL	01.04.17	16.54	52.0361	-7.4874	34.4	x	x	x		N-S line
		EOL	01.04.17	17.02	52.0271	-7.4863	36.8	x	x	x		
CV17013_29	GeoB17_029	SOL	01.04.17	17.06	52.0263	-7.4797	38.1	x	x	x		E-W line
		EOL	01.04.17	20.06	52.0225	-7.1627	54.7	x	x	x		
CV17013_30	GeoB17_030	SOL	01.04.17	20.07	52.0211	-7.1614	55.1	x	x	x		N-S line
		EOL	01.04.17	20.24	52.0036	-7.1498	58.5	x	x	x		
CV17013_31	GeoB17_031	SOL	01.04.17	20.29	52.0026	-7.1586	59.1	x	x	x		E-W line
		EOL	01.04.17	23.10	52.0112	-7.4822	42.2	x	x	x		
CV17013_32	GeoB17_032	SOL	01.04.17	23.14	52.0084	-7.4892	41.5	x	x	x		N-S line
		EOL	01.04.17	23.18	52.0031	-7.4909	41	x	x	x		
CV17013_33	GeoB17_033	SOL	01.04.17	23.22	52.0004	-7.4852	42.5	x	x	x		W-E line
		EOL	02.04.17	1.05	51.9888	-7.1245	55.7	x	x	x		
CV17013_34	GeoB17_034	SOL	02.04.17	1.15	51.9837	-7.1287	54.8	x	x	x		E-W line (note no N-S connector)
		EOL	02.04.17	5.05	51.9903	-7.4887	40.6	x	x	x		
CV17013_35	GeoB17_035	SOL	02.04.17	5.06	51.9885	-7.4898	41.1	x	x	x		N-S line
		EOL	02.04.17	5.14	51.9785	-7.4903	43.9	x	x	x		
CV17013_36	GeoB17_036	SOL	02.04.17	5.15	51.9779	-7.4881	43.5	x	x	x		E-W line
		EOL	02.04.17	8.07	51.9707	-7.1234	60.8	x	x	x		
CV17013_37	GeoB17_037	SOL	02.04.17	8.11	51.8678	-7.1188	61.7	x	x	x		N-S line
		EOL	02.04.17	8.14	51.9645	-7.1188	62.6	x	x	x		
CV17013_38	GeoB17_038	SOL	02.04.17	8.16	51.9632	-7.122	63.3	x	x	x		E-W line
		EOL	02.04.17	11.15	51.9673	-7.4836	49.3	x	x	x		
CV17013_39	no entry	SOL	02.04.17	11.19	51.964	-7.4883	48.9	x	x	x		N-S line
		EOL	02.04.17	11.24	51.9589	-7.4872	51.1	x	x	x		

Area B (cont)												
CV17013_40	GeoB17_039	SOL	02.04.17	11.26	51.9575	-7.4824	51.8	x	x	x		W-E line
		EOL	02.04.17	14.01	51.9531	-7.14	63.3	x	x	x		
CV17013_41	GeoB17_040	SOL	02.04.17	14.16	51.9397	-7.1423	68.6	x	x	x		E-W line (note no N-S connector)
		EOL	02.04.17	15.06	51.9415	-7.3816	57.1	x	x	x		
CV17013_42	GeoB17_041	SOL	02.04.17	16.17	51.9297	-7.3731	59.7	x	x	x		W-E line (note no N-S connector)
		EOL	02.04.17	17.28	51.9271	-7.1909	68.9	x	x	x		
CV17013_43	GeoB17_042	SOL	02.04.17	17.50	51.9162	-7.1955	68.5	x	x	x		W-E line
		EOL	02.04.17	18.54	51.9171	-7.3205	66.9	x	x	x		
CV17013_44	no entry	SOL	02.04.17	20.04	51.9464	-7.258	63.8			x		SE-NW line sparker calibration line
		EOL	02.04.17	21.59	52.0765	-7.362	40.2			x		
CV17013_45	GeoB17_043	SOL	02.04.17	22.14	52.0812	-7.3658	40.2	x	x	x		Re run of line 44 in opposite direction
		EOL	03.04.17	0.26	51.9493	-7.2606	61.8	x	x	x		
CV17013_46	GeoB17_044	SOL	03.04.17	0.32	51.9494	-7.2494	62.7	x	x	x		W-E line
		EOL	03.04.17	1.34	51.9539	-7.1224	64.6	x	x	x		
CV17013_47	GeoB17_045	SOL	03.04.17	1.45	51.9592	-7.1084	62.9	x	x	x		SE-NW line
		EOL	03.04.17	3.04	51.0301	-7.2168	49.6	x	x	x		
CV17013_48	GeoB17_046	SOL	03.04.17	3.14	51.0364	-7.2012	48.7	x	x	x		SW-NE line
		EOL	03.04.17	3.37	52.0578	-7.1654	40.9	x	x	x		
CV17013_49	GeoB17_047	SOL	03.04.17	3.46	52.0604	-7.1563	39.7	x	x	x		NW-SE line (note wide turn due to conditions)
		EOL	03.04.17	5.29	51.9852	-7.045	58.4	x	x	x		
CV17013_50	GeoB17_048	SOL	03.04.17	5.30	51.9863	-7.041	58.2	x	x	x		SW-NE line
		EOL	03.04.17	5.58	52.0148	-7.0071	53.7	x	x	x		
Area D												**Area D: off Arklow Bank**
CV17013_51	GeoB17_049	SOL	03.04.17	5.59	52.0166	-7.0107	53.5	x	x	x		SE-NW line
		EOL	03.04.17	7.28	52.0921	-7.1281	33.2	x	x	x		
CV17013_52	GeoB17_050	SOL	03.04.17	7.43	52.0879	-7.124		x	x	x		
		EOL	03.04.17	19.16	52.662	-6.0672	29.1					
CV17013_53	GeoB17_051	SOL	03.04.17	19.16	52.662	-6.0672	29.1	x	x	x		W-E line
		EOL	03.04.17	23.01	52.6478	-5.6146	86.7	x	x	x		Line broke airgun failure
CV17013_54	GeoB17_052	SOL	04.04.17	1.43	52.6484	-5.6425	77.9	x	x	x		New line following on from above
		EOL	04.04.17	2.57	52.6433	-5.4837	73.6	x	x	x		
CV17013_55	GeoB17_053	SOL	04.04.17	3.02	52.6481	-5.4766	74.1	x	x	x		S-N line
		EOL	04.04.17	4.06	52.7166	-5.4731	77.8	x	x	x		
CV17013_56	GeoB17_054	SOL	04.04.17	4.21	52.7244	-5.4977	76.1	x	x	x		E-W lline (long turn)
		EOL	04.04.17	7.49	52.7471	-5.9314	41.8	x	x	x		

Area F												**Area F: Brittas Bay to Wicklow Head**
CV17013_57	no entry	SOL	04.04.17	9.49	52.7596	-6.0866	20.8			x		S-N line
		turn	04.04.17	12.45	52.96972	-5.94406	25.6			x		back on line, SE-NW
		turn	04.04.17	13.53	53.0392	-5.9791	15.7			x		short line, w-e
		turn	04.04.17	13.57	53.0382	-5.97658	15.3			x		N_S line
		turn	04.04.17	15.14	52.95698	-5.9142	15.4			x		N-S line after bend, ERROR message on maggy. Had to restart
		turn	04.04.17	18.08	52.75351	-6.06814	25.3			x		short W-E line
		turn	04.04.17	18.24	52.75685	-6.04298	30.4			x		S-N line
		turn	04.04.17	21.12	52.573	-5.534	28.3			x		SE-NW line
		turn	04.04.17	21.54	53.008	-5.939	16.9			x		S-NNW line
	no entry	EOL	04.04.17	22.18	53.0398	-5.9522	15.1			x		EOL
CV17013_58	no entry	SOL	04.04.17	22.23	53.0433	-5.9454	32.7			x		W-E line
		EOL	04.04.17	22.43	53.0407	-5.903	44			x		
Area D												**Area D: off Arklow Bank**
CV17013_59	GeoB17_055	SOL	05.04.17	6.51	53.7884	-5.482	79.6	x	x	x		E-W line
		EOL	05.04.17	10.14	52.8109	-5.9144	38.8	x	x	x		
Area E												**Area F: off Arklow Bank to Lambay Island**
CV17013_60	GeoB17_056	SOL	05.04.17	10.16	52.8127	-5.9169	43.1	x	x	x		S-N line
		EOL	05.04.17	10.45	52.8423	-5.919	27.9	x	x	x		
CV17013_61	GeoB17_057	SOL	05.04.17	10.50	52.8433	-5.9106	28.2	x	x	x		W-E line
		EOL	05.04.17	11.53	52.8435	-5.7747	58	x	x	x		
CV17013_62	GeoB17_058	SOL	05.04.17	11.56	52.8459	-5.7725	57.4	x	x	x		S-N line
		EOL	05.04.17	12.14	52.8711	-5.7706	45.1	x	x	x		
CV17013_63	GeoB17_059	SOL	05.04.17	12.28	52.8743	-5.7763	46.7	X	X	X		E-W line
		EOL	05.04.17	13.19	52.8774	-5.9027	33.7	x	x	x		
CV17013_64	GeoB17_060	SOL	05.04.17	13.24	52.8824	-5.9088	39.5	x	x	x		S-N line
		EOL	05.04.17	13.35	52.8986	-5.9077	39.7	x	x	x		
CV17013_65	GeoB17_061	SOL	05.04.17	13.40	52.9049	-5.9042	35.5	x	x	x		W-E line
		EOL	05.04.17	14.36	52.9	-5.7731	41.2	x	x	x		
CV17013_66	GeoB17_062	SOL	05.04.17	14.38	52.9028	-5.7695	44.7	x	x	x		S-N line
		EOL	05.04.17	14.47	52.9167	-5.7671	37.2	x	x	x		
CV17013_67	GeoB17_063	SOL	05.04.17	14.54	52.9218	-5.7737		x	x	x		E-W line
		EOL	05.04.17	16.32	52.9242	-5.9538		x	x	x		
CV17013_68	no entered	SOL	05.04.17	16.34	52.924	-5.9538	14.6	x	x	x		S-N line
		EOL	05.04.17	16.49	52.9418	-5.9427	15.8	x	x	x		
CV17013_69	GeoB17_064	SOL	05.04.17	16.52	52.9419	-5.9412	16.1	x	x	x		W-E (long)
		EOL	05.04.17	17.59	52.9494	-5.8089	29.4	x	x	x		caught pot
CV17013_70	GeoB17_065	SOL	05.04.17	19.02	52.9296	-5.8001	32.1	x	x	x		W-E line (cont)
		EOL	05.04.17	22.28	52.9346	-5.3922	77.4	x	x	x		
CV17013_71	GeoB17_066	SOL	05.04.17	22.30	52.9359	-5.3917	77.5	x	x	x		S-N line
		EOL	06.04.17	5.37	53.0611	-5.3381	89.6	x	x	x		
CV17013_72	GeoB17_067	SOL	06.04.17	5.42	53.0626	-5.3471	93.3	x	x	x		E-W line (long)
		EOL	06.04.17	5.40	53.0772	-5.7788	17.9	x	x	x		

Area E (cont)												
CV17013_73	GeoB17_068	SOL	06.04.17	5.42	53.0762	-5.7795	17.8	x	x	x		N-S line
		EOL	06.04.17	6.51	52.981	-5.7729	25.2	x	x	x		
CV17013_74	GeoB17_069	SOL	06.04.17	6.54	52.9804	-5.7762	25.1	x	x	x		E-W line
		EOL	06.04.17	8.02	52.9635	-5.9311	23.1	x	x	x		
CV17013_75	GeoB17_070	SOL	06.04.17	8.05	52.965	-5.9352	23.5	x	x	x		S_N line
		EOL	06.04.17	8.44	52.9943	-5.9624	17.4	x	x	x		
CV17013_76	GeoB17_071	SOL	06.04.17	8.47	52.996	-5.9576	23.2	x	x	x		W-E line
		EOL	06.04.17	10.22	53.0045	-5.7735	20.5	x	x	x		
CV17013_77	GeoB17_072	SOL	06.04.17	10.24	53.0054	-5.773	20.1	x	x	x		S-N line
		EOL	06.04.17	10.46	53.0234	-5.02356	19.2	x	x	x		
CV17013_78	GeoB17_073	SOL	06.04.17	10.51	53.0238	-5.7846	18.7	x	x	x		E-W line
		EOL	06.04.17	11.36	53.0218	-5.876	15.7	x	x	x		
CV17013_79	GeoB17_074	SOL	06.04.17	11.39	53.0231	-5.8772	17.8	x	x	x		S-N line
		EOL	06.04.17	11.56	53.0401	-5.8761	33	x	x	x		
CV17013_80	GeoB17_075	SOL	06.04.17	11.58	53.0406	-5.8728	34.2	x	x	x		W-E line
		EOL	06.04.17	12.38	53.0407	-5.7814	17.9	x	x	x		
CV17013_81	GeoB17_076	SOL	06.04.17	12.41	53.0424	-5.7792	17.1	x	x	x		S-N line
		EOL	06.04.17	12.55	53.0602	-5.7806	17.6	x	x	x		
CV17013_82	GeoB17_077	SOL	06.04.17	12.57	53.0615	-5.7837	16.9	x	x	x		W-E line
		EOL	06.04.17	14.29	53.057	-5.9745	22.4	x	x	x		
CV17013_83	GeoB17_078	SOL	06.04.17	14.31	53.0595	-5.9791	23.9	x	x	x		S-N
		EOL	06.04.17	14.50	53.0854	-5.9863	23.4	x	x	x		
CV17013_84	GeoB17_079	SOL	06.04.17	15.10	53.0856	-5.95411	29.8	x	x	x		W-E line
		EOL	06.04.17	16.42	53.07928	-5.7632	15.2	x	x	x		stopped to check streamer. Bird upside down on water.
CV17013_85	GeoB17_080	SOL	06.04.17	16.58	53.09491	-5.7473	14.3	x	x	x		W-E line
		EOL	06.04.17	18.57	53.0897	-5.5011	84.4	x	x	x		
CV17013_86	GeoB17_081	SOL	06.04.17	19.01	53.0948	-5.503	87.2	x	x	x		S-N line
		EOL	06.04.17	19.17	53.1076	-5.5245	85.3	x	x	x		
CV17013_87	GeoB17_082	SOL	06.04.17	19.19	53.1077	-5.5285	85.2	x	x	x		E-W line
		EOL	06.04.17	21.33	53.1156	-5.8048	15.2	x	x	x		
CV17013_88	GeoB17_083	SOL	06.04.17	21.36	53.1172	-5.8076	14.2	x	x	x		S-N line
		EOL	06.04.17	22.09	53.1436	-5.8051	12.6	x	x	x		
CV17013_89		SOL	06.04.17	22.12	53.1443	-5.8006	13.1	x	x	x		W-E line
		EOL	06.04.17	5.09	53.1682	-5.76	31.1	x	x	x		
CV17013_90		SOL	08.04.17	18.47	53.1918451	-5.8030035	70.2		x	x		W-E Line
		EOL	08.04.17	19.47	53.192389	5.7896424	70.55		x	x		**stopped recording line at 19.47, no navigation coda**
CV17013_91		SOL	08.04.17	20.27	53.2022	-5.6216	70.78		X	X		S-N line
		EOL	08.04.17	20.44	53.21681667	5.616877778	70.91		x	x		switched to degrees, minutes, seconds
CV17013_92		SOL	08.04.17	20.47	53.21681111	5.616922222	70.9		x	x		E-W line
		./	08.04.17	21.27	53.21668889	5.716811111	71.06		x	x		stopped recording line, restart record 10 mion later
		EOL	08.04.17	22.10	53.20016389	5.155555556	72.2		x	x		
CV17013_93		SOL	08.04.17	22.12	53.20016389	5.816722222	72.2		x	x		S-N line
		EOL	08.04.17	22.29	53.21685278	5.833333333	71.14		x	x		

Area E (cont)												
CV17013_94		SOL	08.04.17	22.31	53.21687778	5.816905556	71.12		x	x		W-E line
		EOL	08.04.17	23.32	53.23349444	5.700066667	70.7		x	**x**		**Stopped recording, problem with ship electronics,**
												changed output and plug of Sparker
CV17013_95		SOL	09.04.17	0.04	53.23346944	5.700236111	70.5		x	**x**		W-E Line picking up where stopped at the last line
		EOL	09.04.17	0.28	53.23358889	5.650222222	70.2		x	**x**		
CV17013_96		SOL	09.04.17	0.29	53.23359722	5.650194444	70.24		x	**x**		S-N Line
		EOL	09.04.17	0.42	53.25018611	5.650177778	70.02		x	**x**		
CV17013_97		SOL	09.04.17	0.45	53.25021389	5.650227778	70.08		x	**x**		E-W Line
		EOL	09.04.17	2.16	53.25021944	5.850083333	69.09		x	**x**		
CV17013_98		SOL	09.04.17	2.18	53.25024167	5.850147222	69.07		x	**x**		S-N Line
		EOL	09.04.17	2.35	53.26693056	5.866688889	68.89		x	**x**		
CV17013_99		SOL	09.04.17	2.38	53.28335833	5.850247222	68.84		x	**x**		W-E Line
				3.20	0	0						no data recorded before 3.39
			09.04.17	3.45	53.26690494	5.700209722	68.68		x	x		recording started
		EOL	09.04.17	3.50	53.26689842	5.683598444	68.64		x	x		
CV17013_100		SOL	09.04.17	3.55	53.28335908	5.683460611	68.67		x	x		S-N Line, 5 kts
		EOL	09.04.17	4.13	53.30008514	5.666765722	68.71		x	x		
CV17013_101		SOL	09.04.17	4.14	53.30010458	5.666817639	68.7		x	x		E-W
		EOL	09.04.17	6.08	53.30024594	5.916877	69.7		x	x		
CV17013_102		SOL	09.04.17	6.12	53.31671294	5.933352278	69.87		x	x		S-N
		EOL	09.04.17	6.30	53.33351161	5.933408333	70.11		x	x		
CV17013_103		SOL	09.04.17	6.50	53.33345164	5.900102861	70.15		x	x		W-E
		EOL	09.04.17	9.25	53.31676667	5.600108333	71.28		x	x		
CV17013_104		SOL	09.04.17	9.27	53.31680278	5.600083333	71.35		x	x		S-N line
		EOL	09.04.17	9.46	53.33358611	5.616775	71.43		x	x		
CV17013_105		SOL	09.04.17		0	0			x	x		E-W line, SOL not recorded
		EOL	09.04.17	12.18	53.35020711	5.916733639	69		x	x		
CV17013_106		SOL	09.04.17	12.19	53.35021825	5.916749694	70		x	x		S-N line
		EOL	09.04.17	12.44	53.38334414	5.916733528	70.4		x	x		
CV17013_107		SOL	09.04.17	12.46	53.38336025	5.916686444	70.3		x	x		W-E line
		EOL	09.04.17	14.55	53.36667289	5.616813028	68.2		x	x		software restarted during turn
CV17013_108		SOL	09.04.17	14.57	53.36669189	5.616792361	68.3		x	x		S-N restarting software
				15.01	53.36674253	5.616849444	68.2		x	x		start recording
		EOL	09.04.17	15.25	53.38346111	5.63356725	68.1		x	x		
CV17013_109		SOL	09.04.17	15.26	53.38345956	5.633588694	68.1		x	x		E-W line
		EOL	09.04.17	17.34	53.56679531	5.916776444	68.9		x	x		
CV17013_110		SOL	09.04.17	17.39	53.40022231	5.91679925	68.9		x	x		N-S line
		EOL	09.04.17	17.54	53.41691919	5.9167855	69.2		x	x		
CV17013_111		SOL	09.04.17	17.58	53.13111111	5.916676889	69.2		x	x		W-E line
		EOL	09.04.17	20.07	53.40010556	5.633369444	70.6		x	x		stop recording
CV17013_112		SOL	09.04.17	20.12	53.40021044	5.616943556	70.73		x	x		S-N line
		EOL	09.04.17	20.32	53.433447	5.616806583	71.01		x	x		
CV17013_113		SOL	09.04.17	20.34	53.43347911	5.616847944	70.96		x	x		E-W line
		EOL	09.04.17	22.32	53.45001328	5.866943139	71.74		x	x		

Area E (cont)												
CV17013_114		SOL	09.04.17	22.34	53.45004103	5.883357278	71.72		x	x		S-N line
		EOL	09.04.17	22.49	53.46674453	5.866924556	71.79		x	x		
CV17013_115		SOL	09.04.17	22.51	53.46676153	5.866842722	71.75		x	x		W-E line
		EOL	10.04.17	0.31	53.45011033	5.633430806	70.8		x	x		
CV17013_116		SOL	10.04.17	0.34	53.4501345	5.633376472	70.8		x	x		S-N line
		EOL	10.04.17	1.03	53.48338122	5.616799	70.5		x	x		
CV17013_117		SOL	10.04.17	1.07	53.483406	5.616920583	70.4		x	x		E-W line
		EOL	10.04.17	3.14	53.50004767	5.916710722	68.87		x	x		
CV17013_118		SOL	10.04.17	3.22	53.48356711	5.933415667	68.88		x	x		N-S line
		EOL	10.04.17	6.14	53.25012417	5.950057389	69.29		x	x		
CV17013_119		SOL	10.04.17	6.15	53.25011181	5.950069528	69.27		x	x		NE-SW
		EOL	10.04.17	7.19	53.00206389	6.000423139	70.2		x	x		
Area D												
CV17013_120		SOL	10.04.17	18.40	52.00414953	5.004257583	95.5		x	x		W-E line
		EOL	10.04.17	23.26	52.38360019	5.00957175	77.53		x	x		
CV17013_121		SOL	10.04.17	23.29	52.38357547	5.950123972	78.14		x	x		N-S Line
		EOL	11.04.17	0.09	52.33343967	5.950109306	80.9		x	x		
CV17013_122		SOL	11.04.17	0.12	52.33338239	5.950162944	82.14		x	x		E-W Line
		EOL	11.04.17	1.34	52.33341522	6.133475444	50.6		x	x		
CV17013_123		SOL	11.04.17	1.37	52.33333539	6.133531806	50.77		x	x		N-S Line
		EOL	11.04.17	2.02	52.28353378	6.150127694	36.9		x	x		
CV17013_124		SOL	11.04.17	2.06	52.28345494	6.150088833	35.95		x	x		W-E Line
		EOL	11.04.17	5.18	52.26679544	5.683471083	69.53		x	x		
CV17013_125		SOL	11.04.17	5.22	52.26672353	5.683378444	69.55		x	x		N-S line
		EOL	11.04.17		0	0			x	x		
CV17013_126		SOL	11.04.17		0	0			x	x		E-W line
		EOL	11.04.17	7.12	52.15018681	5.71677725	96.5		x	x		
CV17013_127		SOL	11.04.17	7.15	52.15017858	5.716846222	97.9		x	x		W-E line
		EOL	11.04.17	11.13	52.00175506	6.001755667	69.6		x	x		
Area B												
CV17013_128		SOL	11.04.17	16.06	52.93360606	7.216797278	64.8		x	x		NE-SW line
		EOL	11.04.17	19.30	52.93360606	7.633529917	67.1		x	x		
CV17013_129		SOL	11.04.17	19.33	52.83339161	7.6335175	68.6		x	x		N-S line
		EOL	11.04.17	19.46	52.81694183	7.633364528	71.72		x	x		
CV17013_130		SOL	11.04.17	19.49	51.81667897	7.616915361	71.72		x	x		SW-NE line
		EOL	11.04.17	23.58	51.81668419	7.183381278	68.66		x	x		
CV17013_131		SOL	12.04.17	0.01	51.9168615	7.1669105	68.7		x	x		N-S line
		EOL	12.04.17	0.20	51.91684503	7.150226722	68.6		x	x		
CV17013_132		SOL	12.04.17	0.22	51.90009103	7.150259611	68.5		x	x		NE-SW line
		EOL	12.04.17	4.04	51.90004469	7.600087111	71.64		x	x		(Depth recorded wrong)

Area A												
CV17013_133		SOL	12.04.17	4.56	51.78347681	7.683576694	**72.01**		x	x		(Depth recorded wrong) NE-SW line
		EOL	12.04.17	5.28	51.73349122	7.750277694	**72.47**		x	x		(Depth recorded wrong)
CV17013_134		SOL	12.04.17	5.30	51.7168175	7.750051389	**72.17**		x	x		(Depth recorded wrong) SE-NW line
		EOL	12.04.17	5.44	51.71683867	7.783390444	**72.7**		x	x		(Depth recorded wrong)
CV17013_135		SOL	12.04.17	5.45	51.73357669	7.783347417	**72.4**		x	x		(Depth recorded wrong) SW-NE line
		EOL	12.04.17	6.38	51.73360433	7.650009389	**72.42**		x	x		(Depth recorded wrong)
CV17013_136		SOL	12.04.17	6.41	51.76691317	7.633604778	**72.33**		x	x		(Depth recorded wrong) SE-NW line
		EOL	12.04.17	6.56	51.78336078	7.650207139	72.71		x	x		
CV17013_137		SOL	12.04.17	7.00	51.80005069	7.666721111	72.7		x	x		NE-SW line
		EOL	12.04.17	8.10	51.80007631	7.783543444	68.8		x	x		
CV17013_138		SOL	12.04.17	8.13	51.76683336	7.800002222	67.7		x	x		SE-NW line
		EOL	12.04.17	8.36	51.76687639	7.800121111	52.7		x	x		
CV17013_139		SOL	12.04.17	8.41	51.80013764	7.783580278	52.2		x	x		SW-NE line
		EOL	12.04.17	9.10	51.80019392	7.7334295	55.6		x	x		
CV17013_140		SOL	12.04.17	9.13	51.81688247	7.733435028	55.8		x	x		SE-NW line
		EOL	12.04.17	9.42	51.81692347	7.766758639	38.2		x	x		
CV17013_141		SOL	12.04.17	9.46	51.85011917	7.766897028	34.3		x	x		SE-NW line
		EOL	12.04.17	9.59	51.85008725	7.800086417	27.9		x	x		
CV17013_142		SOL	12.04.17	10.02	51.83358617	7.800127778	31.1		x	x		SE-NW line
		EOL	12.04.17	10.17	51.85000611	7.800239139	22.8		x	x		
CV17013_143		SOL	12.04.17	10.28	51.86669239	7.783498861	30.15		x	x		SW-NE line
		EOL	12.04.17	10.38	51.866791	7.766764417	30.89		x	x		
CV17013_144		SOL	12.04.17	10.39	51.86687608	7.766768556	27.6		x	x		SE-NW line
		EOL	12.04.17	11.05	51.86689522	7.8000755	15.4		x	x		
CV17013_145		SOL	12.04.17	11.06	51.90009906	7.800107528	15.2		x	x		NE-SW line
		EOL	12.04.17	11.19	51.90010203	7.833371972	12.3		x	x		
CV17013_146		SOL	12.04.17	11.20	51.90001161	7.83339325	11		x	x		S-N line
		EOL	12.04.17	11.25	51.90001575	7.833431472	9.4		x	x		
CV17013_147		SOL	12.04.17	11.29	51.9001	7.833374556	11.9		x	x		W-E line
		EOL	12.04.17	11.42	51.90017667	7.800121972	12.5		x	x		

Appendix IV

Marine mammal observer report