Integrated Ocean Drilling Program
Expedition 307 Scientific Prospectus

Modern Carbonate Mounds: Porcupine Drilling

Jean-Pierre Henriet
Co-Chief Scientist
Renard Centre of Marine Geology
Ghent University
Krijgslaan 281, S8
B-9000 Ghent
Belgium

Akihiro Kano
Co-Chief Scientist
Department of Earth and Planetary
Systems Science
Graduate School of Science
Hiroshima University
Kagamiyama 1-3-1
Higashi-hiroshima, 739-8526
Japan

Mitchell J. Malone
Expedition Project Manager
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA

PUBLISHER'S NOTES

Material in this publication may be copied without restraint for library, abstract service, educational, or personal research purposes; however, this source should be appropriately acknowledged.

Citation:
Henriet, J.-P., , Kano, A., Malone, M.J., and the Expedition 307 Project Team, 2005. Modern carbonate mounds: porcupine drilling. *IODP Sci. Prosp.,* 307. http://iodp.tamu.edu/publications/SP/307SP/307SP.PDF.

Distribution:
Electronic copies of this series may be obtained from the Integrated Ocean Drilling Program (IODP) Publication Services homepage on the World Wide Web at **iodp.tamu.edu/publications.**

This publication was prepared by the Integrated Ocean Drilling Program U.S. Implementing Organization (IODP-USIO): Joint Oceanographic Institutions, Inc., Lamont Doherty Earth Observatory of Columbia University, and Texas A&M University, as an account of work performed under the international Integrated Ocean Drilling Program, which is managed by IODP Management International (IODP-MI), Inc. Funding for the program is provided by the following agencies:

European Consortium for Ocean Research Drilling (ECORD)

Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan

Ministry of Science and Technology (MOST), People's Republic of China

U.S. National Science Foundation (NSF)

This IODP Scientific Prospectus is based on precruise Science Advisory Structure panel discussions and scientific input from the designated Co-Chief Scientists on behalf of the drilling proponents. During the course of the cruise, actual site operations may indicate to the Co-Chief Scientists and the Operations Superintendent that it would be scientifically or operationally advantageous to amend the plan detailed in this prospectus. It should be understood that any proposed changes to the science deliverables outlined in the plan presented here are contingent upon the approval of the IODP-USIO Science Services, TAMU, Deputy Director of Science Services in consultation with IODP-MI.

March 2005

ABSTRACT

During Integrated Ocean Drilling Program (IODP) Expedition 307, a downslope suite of three sites will be drilled on the eastern slope of Porcupine Seabight, west of Ireland. The sites are centered on Challenger mound (proposed Site PORC-03A), a 170 m high, partly buried carbonate mound in the Belgica mound province, topped by dead coldwater coral rubble.

The Belgica mound province belongs to the best documented carbonate mound provinces worldwide. Very high resolution seismic profiling, multibeam bathymetry, and side-scan sonar imaging have shed light on the stratigraphic, structural, and morphological setting. The mounds are rooting on a strongly erosive unconformity and are seated partly on an enigmatic sequence of sigmoidal units and partly on a semitransparent layer. Proposed Site PORC-02A will identify the semitransparent basement layer, proposed off-mound Site PORC-04A and the basal sequence of on-mound proposed site PORC-03A will identify the nature of the sigmoidal units. Both Sites PORC-02A and PORC-04A will constrain the age of the unconformity and the importance of the hiatus.

The on-mound Site PORC-03A will unveil the environmental record locked in a carbonate mound and shed light on the processes that may have controlled the genesis of the mound, in particular, testing the hypothesis of the possible role of fluid venting as trigger for mound growth and assessing the importance of environmental forcing factors. Particular attention will be paid to microbiological and biogeochemical processes in mound genesis and development.

SCHEDULE FOR EXPEDITION 307

Expedition 307 is based on a "light" or "slim" version of Integrated Ocean Drilling Program (IODP) drilling proposal number 573-Full2 (573-PRL5; summary available at **www.iodp-mi-sapporo.org/**). Following ranking by the IODP Scientific Advisory Structure, the expedition was scheduled by the IODP Operations Committee for the research vessel *JOIDES Resolution,* operating under contract with the U.S. Implementing Organization (USIO). The expedition is currently scheduled to begin in Dublin, Ireland, on 26 April 2005, departing after a 5 day port call (or when ready). The science party is scheduled to disembark the ship in Ponta Delgada, Azores (Portugal), on 16 May 2005, and the expedition officially concludes in Mobile, Alabama (USA), on 31 May 2005 (for the current detailed schedule, see **www.iodp.tamu.edu/scien-**

ceops). A total of 10 days will be available for the drilling, coring, and downhole measurements described in this report. Further details on the *JOIDES Resolution* can be found at **iodp.tamu.edu/publicinfo/drillship.html.**

INTRODUCTION

The carbonate mound build-up phenomenon, driven by microbial automicrite formation, is recognized to have been a prominent process throughout the Paleozoic. This process was generally believed to be extinct since the end of the Mesozoic. Fossil mounds are important reservoirs of oil and gas in a number of hydrocarbon provinces. In recent years, industrial efforts to explore deeper water environments have yielded increasing evidence of the existence of extended modern mound provinces, rich in deepwater corals, sponges, and other colonial invertebrates, along various continental margins of the world. Ocean Drilling Program (ODP) Leg 182 shed light on environmental controls on bryozoan mounds off South Australia (Feary, Hine, Malone, et al., 1999; James et al., 2000). In the Atlantic, mound provinces have been reported off southwest Brazil, Angola, Mauritania, Rockall Trough, and Norway, but the most intensively studied site is no doubt Porcupine Basin, southwest of Ireland, which in recent years has been the focus of more than 20 cruises, mobilizing the flagships of oceanography.

An overview of Porcupine Basin and the mound provinces is shown on Figure **F1.** Three different types of mound provinces are identified:

- Hovland mounds
- Magellan mounds
- Belgica mounds

Hovland Mounds

The first mound occurrences reported from industrial data on the northern slope of Porcupine Basin (Hovland et al., 1994) led to the unveiling of a complex setting with large multiphased contourite deposits and high-energy sediment fills, topped by a set of outcropping single mounds or elongated mound clusters up to 250 m high (Henriet et al., 1998; De Mol et al., 2002).

Magellan Mounds

The Hovland mounds are flanked to the north and west by a crescent-shaped, well-delineated province with a very high density of buried medium-sized mounds (1 mound/km^2; average height = 60–80 m). We estimate a total of more than 1500 buried mounds (Huvenne et al., 2003). Joint interpretations of high-resolution data (Henriet et al., 2001) and three-dimensional (3-D) industrial data (Huvenne et al., 2002) shed light on the presence of a past slope failure with large angular blocks, for a large part, underlying the mound cluster.

Belgica Mounds

On the eastern margin of Porcupine Basin, a 45 km long range of large mounds towers from a strongly erosive surface (Fig. F2). The mounds partly root on an enigmatic, locally very thick, acoustically rather transparent horizon of unknown age and composition (Henriet et al., 1998; Van Rooij et al., 2003) and partly on a layered sequence capped by a surprising set of short-wavelength, sigmoidal depositional units (De Mol et al., 2002; Van Rooij et al., 2003). The Belgica mounds province consists of 66 conical mounds (single or in elongated clusters) in water depths ranging from 550 to 1025 m.

The mounds are partly enclosed in an impressive set of contourites (Van Rooij et al., 2003). Mounds typically trap sediment on their upslope flank, which is consequently buried, while their seaward side is well exposed and forms a steep step in the bathymetry. Average slopes amount to 10°–15°. The largest mounds have a height of ~170 m.

In the deeper part of the Belgica mound province, an extremely "lively" mound was discovered in 1998 on base of a very diffuse surface acoustic response. This mound, known as Thérèse mound, was selected as a special target site to study processes involved in mound development within the European Union Fifth Framework (EU-F5) research projects GEOMOUND (The Mound Factory: Internal Controls), ECOMOUND (Environmental Controls on Mound Formation along the European Margin), and ACES (Atlantic Coral Ecosystem Study; Foubert et al., in press; De Mol et al., unpubl. data). Video imaging revealed that Thérèse mound, jointly with its closest neighbor Galway mound, might be one of the richest deepwater coral environments in the Porcupine Seabight (PSB), remarkably in the middle of otherwise barren mounds.

Shortened Expedition Approach

Although the original proposal 573-Full "Modern Carbonate Mounds: Porcupine Drilling" identified five prime scientific objectives (see below) that optimally could be addressed by drilling in the three mound provinces of Porcupine Basin, the slim version of the proposal (573-PRL5) addresses four of these major questions by focusing on three sites in the Belgica mound province (Fig. **F2, F3**). What will not be addressed is the hypothesis that fluid flow may genetically link both slope failures and mound growth. Indeed, the location of Porcupine mound provinces right above spectacular buried slope failures is limited to the Magellan and Hovland provinces. Another aspect of the original proposal that will not be addressed is the reason for the apparent difference in age and development between the Belgica and Hovland mound provinces, the latter already featuring significant hiatuses and hardgrounds in the first few meters. Finally, the reason for the peculiar development of the Magellan mound province, characterized by more than a thousand mounds of medium size (some 60–80 m), which did compete with sedimentation rather than featuring an initial fast growth phase prior to burial, will not be elucidated by drilling during Expedition 307.

BACKGROUND

Geological Setting

The Porcupine Seabight is an amphitheater-shaped embayment in the Atlantic Irish shelf, off the southwestern coast of Ireland. It is enclosed by four shallow platforms: Porcupine Bank and Porcupine Ridge on the western side, Slyne Ridge in the northeast, the Irish mainland shelf in the east, and the terraced Goban Spur in the south (Fig. **F1**). The only opening toward the Porcupine Abyssal Plain lies between Porcupine Bank and Goban Spur. Porcupine Seabight, which is the surface expression of the underlying deep sedimentary Porcupine Basin, is a failed rift of the proto-North Atlantic Ocean, which is filled with a 10 km thick series of Mesozoic and Tertiary sediments (Shannon, 1991). The basin evolution can be summarized in three major steps: a Paleozoic synrift phase, a predominantly Jurassic rifting episode, and a Late Cretaceous to Holocene thermal subsidence period.

Basin Development and Synrift Sedimentation

The basement of Porcupine Basin is composed of Precambrian and lower Paleozoic metamorphic rocks, forming continental crust of ~30 km thickness (Johnston et al., 2001). Because the greater part of the basin is located north of the main Variscan deformation front, it has known a lesser degree of metamorphism than time-equivalent rocks of southern basins. The prerift succession commences with probably Devonian clastic sediments, overlain with lower Carboniferous carbonates and clastics. The upper Carboniferous rocks feature deltaic to shallow-marine deposits with Westphalian coal-bearing sandstones and shales and possibly Stephanian redbed sandstones.

During a Permo–Triassic early rifting phase period, a first minor east–west regional extension regime is inferred by the development of a series of small rift basins (Shannon, 1991; Moore and Shannon, 1995). The lowest Mesozoic deposits are early rift-valley continental sediments, which can have a thickness of more than 2 km. During Permian times, predominantly fluvial and lacustrine sedimentation took place with nonmarine mixed clastic deposits and evaporites (Fig. **F4**). Triassic sediments contain nonmarine to marine facies (Ziegler, 1982; Shannon, 1991). The Early Jurassic (Lias) is characterized by a tectonic tranquil period and a relative sea level rise, resulting in a marine sedimentary environment (Shannon, 1991). Lower Jurassic deposits are not found over the entire basin but could comprise limestones and rare organic-rich shales with sandstones (Fig. **F4**).

Jurassic Rifting Phase

At the end of the Early Jurassic period, the middle Kimmerian rifting phase marked an increase of tectonic events in the Arctic, Atlantic, and Thetys rift systems. This major tectonic event was apparently accompanied by a renewed eustatic lowering of sea level and is likely responsible for erosion of a large part of the Triassic and Liassic deposits (Ziegler, 1982). Middle Jurassic fluvial claystones and minor sandstones might lie unconformably over earlier deposited strata and can be considered to be products of this major rifting episode. During the Late Jurassic, differential subsidence was responsible for the transition from a continental to a shallow-marine sedimentary environment in Porcupine Basin. Shallow-marine fans and scarp deposits were developed close to the basin margins, while in the center of the basin deepwater sand-rich mass flow deposits interdigitate with background hemipelagic sedimentation. These continuous series were topped by an unconformity of latest Jurassic age, a result of the late Kimmerian tectonic phase (Shannon, 1991).

Postrift Thermal Subsidence

At the start of the Cretaceous, the general structure of Porcupine Basin could be compared with a rift structure prior to breakup. Its specific failed rift structure has a typical steer's head profile (Moore and Shannon, 1991). The increased climatologic and plate tectonic reorganizations since the Paleogene also affected deepwater circulation and sedimentation within Porcupine Basin. Most of the postrift sediments are dominantly sandstones and shales, influenced by frequent sea level fluctuations. In contrast to the Celtic Sea basins, lower Paleocene deposits of Porcupine Basin underwent minimal inversion influence caused by the Alpine Orogeny (Shannon, 1991).

A major rifting pulse during the Early Cretaceous, referred to as late Kimmerian tectonism, was accompanied by a significant eustatic sea level fall and gave rise to a regional unconformity that is largely of submarine nature (Ziegler, 1982; Moore and Shannon, 1995). This undulatory unconformity marks the base of the Cretaceous, where marine strata onlap Jurassic sequences (Shannon, 1991). The contemporaneous Transition Sequence, however, is only found in some confined subbasins filled with clastic fans (Moore and Shannon, 1995). The Lower Cretaceous deposits (PK1) are northward-onlapping deep-sea sandstones and are still deposited on the wedge-shaped subbasins. The Albian PK2 sequence is affected by a minor rifting pulse of early actual North Atlantic seafloor spreading that started in the late Aptian (Shannon, 1991; Moore and Shannon, 1995). A local uplift of the basin margins produced a regressive period with an outer shelf deltaic sedimentation environment with locally sand rich deltas and associated beach complexes (McDonnell and Shannon, 2001). The onset of the Late Cretaceous (PK3) was characterized by a further relative sea level rise, featuring offshore sandstone bars, followed by a northward thinning and onlapping outer shelf to slope sequence of carbonates (chalk). Along the southwestern and southeastern margins of the basin, Moore and Shannon (1995) recognized the presence of biohermal reef buildups.

The transition from Upper Cretaceous to Lower Paleocene sedimentation is characterized by the high-amplitude reflector C40, marking the change from carbonate to clastic deposition (Shannon, 1992). In general, the Paleocene succession is more mud dominated, whereas the main coarse clastic input occurred in the middle Eocene to earliest late Eocene (McDonnell and Shannon, 2001). The Paleocene–Eocene is subdivided into five sequences (PT1–PT5) (Fig. **F4**). Within PT1 to PT4, every sequence is characterized by a southerly prograding complex deltaic event overlain by marine transgressive deposits (Moore and Shannon, 1992). The controls on the relative rises and falls in sea level are dominantly due to the North Atlantic plate tectonic regime. The upper Eocene is marked by a sea level rise with development of offshore bar sandstones (Naylor and Shannon, 1982). The upper Eocene sequence PT5 differs from previous sequences in a deep-marine mudstone facies (Moore and Shannon, 1992). A major basinwide unconformity developed in the latest Eocene to early Oligocene. This unconformity C30 marks the onset of deepwater sedimentation and establishment of regional contour-hugging bottom currents (McDonnell and Shannon, 2001).

During the late Paleogene and Neogene, a passive uplift of the Norwegian, British, and Irish landmasses was very important in shaping the present-day Atlantic margin. Although the origin of this uplift remains unclear, it probably resulted in enhancement of contour currents, causing local erosion and deposition and an increased probability of sedimentary slides and slumps. Therefore, overall Oligocene and Neogene sedimentation is characterized by along-slope transport and redepositional processes yielding contourite siltstones and mudstones and (hemi)pelagic deep marine sediments, caused by a combination of differential basin subsidence and regional sea level and paleoclimate changes. Eocene–Oligocene sediments are subdivided into three sequences (PT6–PT8) (Fig. **F4**). The base of the PT6 sequence is characterized by the high-amplitude continuous C30 reflector, while the top reflector is the erosive base Miocene C21 reflector. Within this Oligocene succession, a reworked Eocene microfauna has been described, suggesting shelfal incision or reworking by bottom currents. These Oligocene deposits are interpreted to be a sediment drift (Shannon, 1992). In sequence PT8, a slope-parallel sediment drift is described in the southeast part of the basin. The C20 reflector, which forms the lower boundary of PT8, is related to a relative sea level fall and is noticeably erosive in the south part of the basin (McDonnell and Shannon, 2001). This intensified scouring may be related to intensified bottom current activity elsewhere in the North Atlantic. The youngest unconformity mapped in Porcupine Basin is correlated with the Early Pliocene C10 event in the Rockall Basin. This event is considered to be a nucleation site for present-day coral banks (McDonnell and Shannon, 2001; De Mol et al., 2002).

Prior to the start of the EC-FP5 GEOMOUND and ECOMOUND projects studying cold and deepwater coral banks, little was known about the Quaternary evolution of the PSB. Recent sedimentation is mainly pelagic to hemipelagic, although (probably reworked) foraminiferal sands can be found on the upper slope of the eastern continental margin. The main sediment supply zone is probably located on the Irish and Celtic shelves, whereas input from Porcupine Bank seems to be rather limited (Rice et al., 1991). In contrast to the slopes of the Celtic and Armorican margins, which are characterized by a multitude of canyons and deep-sea fans, the east-west–oriented Gollum channels are the only major downslope sediment transfer system located on the southeastern margin of the seabight (Kenyon et al., 1978; Tudhope and Scoffin, 1995), which discharges directly onto the Porcupine Abyssal Plain. Rice et al. (1991) suggest that the present-day channels are inactive. According to Games (2001), the upper slope of the northern PSB bears predominantly north-south–trending ploughmarks on several levels within the Quaternary sedimentary succession. Smaller ploughmarks are also observed and interpreted as Quaternary abrasion of the continental shelf caused by floating ice grounding on the seabed. An abundance of pockmarks is also apparent on the seabed of this area. Within some of these Connemara pockmarks, an associated fauna of the coldwater coral *Lophelia* sp. has been observed (Games, 2001). Together with *Madrepora* sp., *Lophelia* sp. is found along the entire northwest European margin, manifested as coral patches to giant coral banks.

Seismic Studies/Site Survey Data

Studies carried out during the past 7 y under various EU Fourth and Fifth Framework programs (CORSAIRES [Coring Stable and Instable Realms in European Seas], ECOMOUND, GEOMOUND, and ACES), European Social Fund (ESF) programs (Euromargins project MoundForce) and national programs (GeNesis, etc.) have gathered substantial information from the area of interest, including box cores, long gravity cores, piston cores, high-resolution seismics (surface and deep towed), side-scan sonar at various frequencies and elevations over the seabed, surface multibeam coverage, and ultra-high-resolution swath bathymetry (using a remotely operated vehicle [ROV]) and video mosaicing (using ROV).

High-resolution seismic data (penetration = ~350 m; resolution = 1–2 m) have been acquired over the Belgica mound province (over a 1000 km^2 area). A very high resolution pseudo–3-D seismic grid over an area of 10 km^2 with a nominal line spacing of 180 m was shot over Thérèse mound. All proposed sites have been prepared by a minimum of a set of high-quality cross lines (Figs. F5, F6, F7, F8, F9, F10, F11, F12, F13, F14).

Side-scan sonar data have been acquired at various resolutions and elevations: deeptow 100 kHz side-scan sonar and 3.5 kHz profiler, resolution = 0.4 m (95 km^2 in the Belgica mound province), high-resolution Makanchi seismic array (MAK) data (Training Through Research [TTR] program), and full coverage of towed ocean bottom instrument (TOBI) side-scan sonar (30 kHz) (Figs. F15, F16).

A multibeam survey was completed in June 2000 (*Polarstern*) and the area was covered again by the Irish Seabed program (Fig. F2).

ROV *VICTOR* (Institut Francais de Recherche pour l'Exploration de la Mer [IFREMER]) was dedicated during two cruises (*Atalante* and *Polarstern*) to video surveying both Thérèse and Challenger mounds.

Previous subbottom sampling includes more than 40 gravity cores and piston cores in the Belgica mound province (penetration = 1.5–29 m), numerous box cores, and some television-controlled grab samples of ~1.5 ton.

SCIENTIFIC OBJECTIVES

External versus Internal Controls

The apparent coincidence between the occurrence of giant mound clusters and potential deeper-lying hydrocarbon deposits suggests a possible internal control from (mostly transient) fluxes of geofluids from deep geological reservoirs to the seabed. Sedimentary buildup might have been controlled by microbial communities, which also may have played an active role in the stabilization of the steep flanks and in the possible lithification of the (hitherto not yet sampled) mound core through automicrite formation.

On the other hand, these mounds are located on a margin that throughout the Neogene to Quaternary has repeatedly alternated between glacial and interglacial environments. There is also increasing evidence from results of the ACES, ECOMOUND, and GEOMOUND projects that the active mound provinces also occur in oceanographically distinct settings (De Mol et al., 2002; Foubert et al., in press; Van Rooij, 2004; Wheeler et al., in press). These mounds cluster in the highest salinity water and also bathymetrically coincide with the spread of the oxygen minimum zone along the deep continental margin (De Mol et al., 2002; Freiwald et al., 2004). In Porcupine Basin, these specific environmental conditions are provided by the northward flow of Mediterranean Outflow Water at intermediated depths (~700–900 m). Locally enhanced currents associated with mixing and interaction of watermasses featuring a density contrast may be at the origin of contrasting effects such as enhanced fluxes of potential nutrients and low sedimentation rates. Such observations consequently also argue for a complex but equally important external control.

In a way, a central hypothesis to be tested is to what extent mound provinces originate at the crossroads of fluxes of internal (trigger phase) and external (relay phase) origin (Henriet et al., 2002).

Of Mounds and Drifts

The thick drift sediment sheet embedding the mounds holds a high-resolution record of past fluctuations of watermasses and paleocurrents on this section of the North-Atlantic margin. Seismic records of exceptionally high resolution may allow the correlation of this record—once verified by drilling—to the mound growth phases. Correlation of the Porcupine drift record with ODP sites along the Atlantic margin opens perspectives of cross-basin comparisons. Corals within the drill cores will provide information on the paleoceanographic conditions, as already substantiated by the pre-IODP coring results (*Marion-Dufresne* preparatory coring). Variations in terrigeneous content and organic matter in drift sediments should allow us to trace terrestrial sources and shelf-to-slope sediment pathways. The association of mounds and drifts on this upper continental slope thus will also provide a unique paleoenvironmental record of the Atlantic margin.

Hypotheses to be Tested

The objectives of Expedition 307 can be summarized into four major hypotheses:

- Gas seeps act as a prime trigger for mound genesis—a case for geosphere–biosphere coupling.
- Mound “events” frame into a paleoenvironmental plot—prominent erosional surfaces reflect global oceanographic events.
- Mounds are high-resolution paleoenvironmental recorders.
- The Porcupine mounds are present-day analogs for Phanerozoic reef mounds and mud mounds.

1. Gas seeps act as a prime trigger for mound genesis—a case for geosphere–biosphere coupling.

Only drilling to the base of the mounds will allow verification of to what extent fluids may or may not have played a role in mound genesis and/or growth. The question of source rocks in the region and possible migration routes into the study area has been tackled by the teams of FZ Jülich and GFZ Potsdam, Germany. Two-dimensional basin modeling was used to evaluate the possible link between hydrocarbon leakage and mound growth (PetroMod version 8.0, IES GmbH Jülich). Seismic lines of industrial origin and six exploration wells were used for calibration of the burial and thermal history using vitrinite reflectance, bottom hole temperatures, and apatite fission track data. Modeling results indicate that Jurassic and older source rocks are mature to overmature throughout the basin. Cretaceous strata are immature to mature in the central part of the basin and immature on the flanks. The Tertiary sequence remains immature over the entire basin. Hydrocarbon generation started in Late Cretaceous times for the deepest sequences. Phase separation was modeled to occur during migration at depth ranges between 2000 and 4000 m. Upon phase separation, the migration of the free gas phase dominated over that of oil, such that gas is the main migrating fluid in the shallower intervals. Migration is mainly buoyancy driven and vertical. Only Aptian and Tertiary deltaic layers direct hydrocarbon flow out of the basin. The model predicts a potential focusing of gas migration toward the Belgica mounds area, where a pinchout of Cretaceous and Tertiary layers beneath the mound area is observed. The reconstruction shows that seeping gas may have been available for methanotrophic bacteria and related formation of hardgrounds since the Miocene.

During recent cruises that have studied mud volcanoes and mounds in the Gulf of Cadiz, gases, hydrates, and thick authigenic carbonate crusts were sampled associated with corals, clams, and pogonophores. In mid-2004, the *Marion-Dufresne* collected cores from juvenile mound sites off Morocco: full of corals from top to bottom, they were characterized by a strong H_2S signal and sulfidic mineralizations (Foubert et al., 2005). Analysis of very high resolution seismic data below the Belgica mounds (proposed Site PORC-03A) highlighted within the basal sigmoidal sequences acoustic anomalies (amplitude, instantaneous frequency, and polarity) (Figs. **F17, F18, F19**) possibly related to low quantities of gas. In light of ODP Leg 182 findings off Australia (Feary, Hine, Malone, et al., 1999), such mound/gas associations deserve attention. Gases and possible low molecular weight hydrocarbons in sediments and pore waters need to be analyzed. The carbon isotope signature ($^{12}C/^{13}C$) of the organic compounds, both in possible authigenic carbonates and in biological skeletal carbonate, may provide clues to hydrocarbon-derived components. Lithogenesis and possible authigenic carbonate formation will be studied through analysis of major, minor, and trace elements by X-ray diffraction (XRF) and laser ablation–inductively coupled plasma–mass spectroscopy (LA-ICP-MS) to provide a record of responses to external and internal controls of mound formation and growth. Subsamples for microbiological analysis will be aseptically obtained from whole-round core sections acquired from selected depths to test the hypothesis that methane-driven microbial activity catalyzes the formation and/or development of carbonate mounds.

Subsamples will be prepared to quantify total bacterial populations (direct microscopy) and their rates of activity (using ^{35}S- and ^{14}C-labeled compounds) and identify active bacterial populations. Extant bacterial populations will be characterized using classical microscopic methods (albeit adapted for deep biosphere sediments) as well as molecular genetic techniques (i.e., 16S ribosomal ribonucleic acid [rRNA]). Comparison with other deep-biosphere sites should help to evaluate whether bacterial populations that could potentially contribute to carbonate mound formation exist. This will be supplemented by shipboard initiation of enrichments and cultivations of important bacterial populations (most probable number [MPN] method). Bacterial phospholipid fatty acid (PLFA) biomarkers should provide complementary evidence of present and past bacterial populations. Furthermore, direct measurements of bacterial methanogenesis and sulfate reduction activity can be used to document ongoing bacterial activity that may be critical to mound formation through the formation of methane via methanogenesis and bicarbonate alkalinity through sulfate reduction. Samples will be taken for pore water analysis and solid-phase organic carbon analysis from the same whole-round cores as for microbiological analysis. Bacterial inputs to buried sedimentary organic carbon and their impact on deep organic matter maturation processes will be assessed, and the interplay between biological and geological processes in the formation of carbonate mounds can then be defined.

2. Mound "events" frame into a paleoenvironmental plot—prominent erosional surfaces reflect global oceanographic events.

Erosional surfaces are displayed on high-resolution seismic lines. Cores penetrating these unconformities have to be analyzed by means of high-resolution stratigraphy. The well-established nannoplankton and microplankton (planktonic foraminifers) biostratigraphy for the Neogene marine sections of the North Atlantic will support interpretations of unconformities. Oxygen isotope analysis on both planktonic and benthic foraminifers will be run to match isotope data with established orbitally tuned isotope stratigraphy. Absolute ages will be obtained from corals and foraminifers by applying ^{14}C accelerator mass spectrometry (AMS) and U/Th dating for the youngest sequences and ^{10}Be for the older strata. In addition to these tools, absolute ages will be determined on volcanic ashes that occur in the deeper part of the sections. Cores where sufficient biogenic calcite is continuously available will give access to $^{87}Sr/^{86}Sr$ stratigraphy. All these methods will provide necessary hints for tying the unconformities into a regional and global scheme of oceanographic events.

3. Mounds are high-resolution paleoenvironmental recorders.

To study paleoenvironmental variability a series of well-established proxies will be used. $\delta^{18}O$ analyses will be applied to foraminifers, corals, and other skeletal biota to reconstruct paleotemperatures. As this proxy is also influenced by evaporation/precipitation changes expressed as salinity, we shall run parallel Sr/Ca analyses from aragonitic skeletons to differentiate between temperature and salinity variations. In addition, we may run certain U/Ca analyses, which seem to be an appropriate indicator of paleotemperature as well. For the same reason, we shall use Mg/Ca ratios in calcitic foraminifers. $\delta^{13}C$ is a useful proxy to reconstruct paleoproductivity; however, it has been demonstrated that it also may indicate methane-derived carbon in carbonates. Therefore, we shall run Ba/Ca analyses to differentiate between productivity signals and methanogenesis. Paleoproductivity can also be determined via $\delta^{15}N$ in organic matter. Another important question focuses on the carbonate production of the mounds. This can be traced by bulk Sr analyses in combination with total organic carbon (TOC) and $CaCO_3$ determinations in the peri-mound cores. In addition to these geochemical proxies we shall apply classical methods like component analyses and grain size distribution. The sortable silt fraction (10–63 µm) can be used as a parameter for paleocurrent speed assessment. X-ray radiography will be used to observe delicate structures (ripples and cross stratification), hidden objects (dropstones and coral debris), or bioturbation (*Zoophycos* burrows) and will allow accurate positioning of subsamples. A promising tool is the application of fluorescence microscopy for organic matter petrography to differentiate between marine-derived material and terrestrial-derived material like leaves and tiny wood fragments. This, in combination with clay mineral analyses, will allow for a distinct differentiation of sediment sources between glacials and interglacials.

4. The Porcupine mounds are present-day analogs for Phanerozoic reef mounds and mud mounds.

Mounds are a fundamental and recurrent strategy of life from Precambrian times onward. The true dawn of carbonate mud mounds is in Cambrian times, in the early Paleozoic, when mounds suddenly feature a diversity in microbial and biodetrital fabrics with abundant mound-building calcified microbes, calcified coralline, and green algae and a variety of Paleozoic benthic invertebrates, which may have played an ancillary role in mound construction. In mid- to late Ordovician times, the dramatic rise of large skeletal metazoans such as stromatoporoids, corals (rugosa and tabulata), and bryozoans, as well as higher algae, paved the way for the strong development of reefs and typical stromatactoid mud mounds. Lower Devonian mounds (Gedinnian) in the Montagne Noire exhibit the most spectacular stromatactis fabrics, interpreted as the result of decaying microbial mats. Stratigraphically younger (Emsian) conical carbonate mounds (kess-kess) of the Moroccan Anti-Atlas are related to precipitation from hydrothermal fluids, some of which are inferred to be related to a light carbon source (hydrocarbon). Some of the most impressive of early Carboniferous bank aggregates, reaching up to 1 km in thickness, are those known as the Waulsortian. In full Mesozoic times, a decline in the abundance and diversity of microbial mounds is recorded from the Triassic to the Cretaceous. From the mid-Cretaceous onward, microbial fabrics are only known as components to metazoan framework reefs. Most Cenozoic mud mounds would be of biodetrital origin, although microbial components might have remained significant in deeper water. Drilling Challenger mound will not only allow framing this modern mound within this lineage but also will allow possible identification of the key actors in mound building. To study both skeletal and bacterial fabrics, thin sections of lithified and nonlithified parts of cores will be prepared for comparative studies. In addition, a detailed carbonate petrography shall be applied, including fluorescence microscopy and cathodoluminescence microscopy.

DRILLING STRATEGY

The three proposed sites (Fig. **F3**) jointly form a logic suite, representative of the Belgica mound province and relevant to a number of key scientific questions related to modern mound settings. This "Challenger" downslope transect addresses the key hypotheses regarding the paleoceanographic and stratigraphic significance of the mounds on the eastern slope of Porcupine Basin. The lower sequence of interest within the Belgica province is characterized by an alternation of parallel reflectors with relatively high amplitude, locally grading into a set of sigmoidal units. A thick package of drift deposits with rhythmic buildup onlaps the mound flanks.

Based on recommendations from EPSP on drilling site order, drilling will start on the off-mound Site PORC-04A, followed by the Challenger mound Site PORC-03A, and finalize with the stratigraphic drill site PORC-02A (Table **T1**). Drilling will help identify and date the major underlying sequences and unconformities and the mound-base. The proposed program includes using standard logging tools to determine downhole physical properties and hole-core correlation, as well as a zero-offset vertical seismic profile (VSP) at proposed Site PORC-03A.

Proposed Drill Sites

Site PORC-04A: Challenger Off-Mound Site

The pre-IODP coring exercise carried out with the *Marion-Dufresne* implied a systematic on-mound/off-mound comparison. This has already yielded exciting results, in particular in comparing the mode in which environmental signatures are being recorded, in comparing densities of corals, and in comparing relative rates of sedimentation (Foubert et al., 2003; Van Rooij, 2004). Proposed Site PORC-04A (Fig. **F11**) should provide valuable insight into the drape history of the mounds and the off-mound transportation of mound-related skeletal and nonskeletal grains. The flanking sediments contain mixed sedimentary signatures of both contouritic and turbiditic origin. Many horizons onlapping the mound flanks display enhanced amplitudes, which again might be of various origin (Figs. **F18, F19**). Cores acquired from the *Marion-Dufresne* at both Sites PORC-03A and PORC-04A document the full paleoceanographic record down to marine isotope Stages (MIS) 4–5. The MD01-2450 Calypso core (length = 11 m) taken off-mound close to the Challenger mound, moreover, features intriguing rhythmic deposits of sulfidic nature.

As noticed on the north-northwest–south-southeast seismic section crossing the site, penetrating the whole thickness of the sigmoidal units will allow us to groundtruth two different and overlying sigmoidal sequences. Below Thérèse mound, the 3-D migration patterns of such two different sigmoidal sequences have been elucidated by a pseudo–3-D seismic grid of very high resolution (Galanes-Alvarez, 2001).

Coring Strategy

Coring strategy for this site includes triple coring using the advanced piston corer (APC) or extended core barrel (XCB) (Table **T1**).

Logging Strategy

Logging at this site will include the triple combination (triple-combo) and Formation MicroScanner (FMS)-sonic tool strings to correlate core depth with hole depth and to gain information about physical properties.

Site PORC03A: Challenger Mound

Challenger mound can be imaged with very high resolution seismics, including its basal sequences (Figs. **F5, F13**), which is in contrast with many other mound sites in Porcupine (Hovland mounds) and Rockall basins, where energy is frequently scattered by the mound surface (hardgrounds). Hence, it is a prime target for linking seismic images with coring and logging information. Some polarity inversions may argue for residual patches of shallow gas below the mound, which might help to address the first hypothesis. The quality of the data has supported some level of attribute analysis (polarity, instantaneous frequency, etc.) (Figs. **F12, F13**). A time-to-depth conversion based on a compilation of velocity determinations in shallow subsurface sediments and on the flattening of a deeper horizon led to the depth model shown in Figure **F17.** A remarkable observation is the need to introduce a slightly higher velocity in the mound core (2000 m/s), which can argue for a beginning of lithification.

Coring Strategy

Coring at proposed Site PORC-03A (Table **T1**) may require the XCB, due to the higher degree of lithification and cementation (velocity pull-up on lower reflectors). Use of microbial contamination tracers will be necessary. Sampling has to be done carefully because this site may provide valuable insight into the microbially mediated early cementation. Samples for microbiological analysis will require the possibility to aseptically acquire whole-round core sections at selected depths for subsequent subsampling. Triple coring will be preferred, considering the risk of lower core recovery within a mound.

Logging Strategy

We propose triple combo and FMS-sonic tool string runs to correlate core depth with hole depth and to gain information about physical properties, as well as a zero-offset VSP (pending approval).

Site PORC02A: Upslope Challenger Site

Proposed Site PORC-02A, situated upslope Challenger mound (Figs. **F6, F14**), completes the Challenger slope transect (PORC-02A–PORC-03A–PORC-04A). It will primarily shed light on the enigmatic, rather transparent layer that underlies the southern part of the Belgica mound province and will refine dating of the basal unconformity below the mounds, as the sequence below the unconformity encompasses younger strata, including the quasi-transparent layer and some of its cover. The site is situated in water depths of ~650 m; it is proposed for a total penetration of 200 m.

Coring Strategy

At this site we propose double APC coring (Table **T1**).

Logging Strategy

We propose employing the triple combo and FMS-sonic tool strings to correlate core depth with hole depth and to gain information about physical properties.

LOGGING/DOWNHOLE MEASUREMENTS PLAN

Wireline Logging

Continuous downhole logging measurements will be critically important to the scientific objectives of Expedition 307, particularly because of the potential of low core recovery at proposed Site PORC-03A. The logging program will attempt to establish lithological boundaries, seismic integration, and stratigraphic and sedimentological data.

The operations plan for Expedition 307 includes downhole logging at all three proposed sites. The two standard IODP tool string configurations will be deployed at each site. The first run will be the triple combo tool string, which logs formation resistivity, density, porosity, natural gamma radiation, and borehole diameter, followed by the FMS-sonic tool string, which provides an oriented 360° resistivity image of the borehole wall and logs of formation acoustic velocity, natural gamma ray, and borehole diameter (pending approval). The well seismic tool (WST) will be run at proposed Site PORC-03A as a third tool string to conduct a zero-offset VSP (pending approval), which will also require the use of an air gun.

The standard sampling interval of the logging tools is 15 cm, with a typical vertical resolution of 40 cm. For higher vertical resolution, the FMS resistivity images allow subcentimeter resolution, and the Lamont Doherty Earth Observatory (LDEO) Multisensor Gamma Tool (MGT) (~15 cm vertical resolution) can be included in the triple combo tool string.

Combining sonic velocity and density logs will allow modeling of a synthetic seismic profile at each site. Moreover, the sonic logs will improve the depth to traveltime conversion and thus correlation of the holes with the seismic profiles. At proposed Site PORC-03A, the velocity structure inside the mound will be further constrained by the zero-offset VSP.

For core-logging correlation, density, resistivity, and natural gamma radiation logs can be matched to the equivalent core measurements made on the multisensor track

(MST). The logs will provide complete coverage in parts of the section that may not have full core recovery, which particularly may be the case at proposed Site PORC-03A, where limited core recovery is a possibility due to high coral density. This set of logs might thus reveal a more realistic stratigraphy of the internal buildup of the mound and the mound substrate (open-hole logs will be obtained below the position of the drill pipe, set at 50–80 meters below seafloor [mbsf]).

FMS resistivity images will be useful to identify the presence or absence of coral macrofossils, which will be visible in the images as resistive features in a conductive matrix. The strike and dip of inclined features (beds, fractures, etc.) are also provided by FMS data. Hardgrounds will probably be identified as hard, resistive layers with a high uranium natural gamma radiation signature.

SAMPLING STRATEGY

General

Shipboard and shore-based researchers should refer to the interim IODP Sample, Data, and Obligations policy posted on the Web at **iodp.org/data_samples.html.** This document outlines the policy for distributing IODP samples and data to research scientists, curators, and educators. The document also defines the obligations that sample and data recipients incur. Access to data and core sampling during Expedition 307, or within the 1 y moratorium, must be approved by the Sample Allocation Committee (SAC). The SAC (composed of Co-Chief Scientists, Staff Scientist, and IODP Curator on shore and curatorial representative on board ship) will work with the Shipboard Scientific Party to formulate a formal expedition-specific sampling plan for shipboard and postcruise sampling.

Shipboard scientists are expected to submit sample requests 2 months before the beginning of the expedition. Sample requests may be submitted at **iodp.tamu.edu/curation/samples.html.** Based on sample requests (shore based and shipboard), the SAC and Shipboard Scientific Party will prepare a working cruise sampling plan. This plan will be subject to modification depending upon the actual material recovered and collaborations that may evolve between scientists during the expedition. Modifications to the sampling plan during the expedition require the approval of the SAC.

All sample frequencies and sizes must be justified on a scientific basis and will depend on core recovery, the full spectrum of other requests, and the cruise objectives. Some redundancy of measurement is unavoidable, but minimizing the duplication of measurements among the shipboard party and identified shore-based collaborators will be a factor in evaluating sample requests.

Cruise-Specific Sampling Needs

The short duration of the operations, the expected high rate of core flow inherent to shallow-water operations, and the complex scientific objectives will in general not leave time for personal sampling on board. In addition, a significant amount of cores—mainly from proposed Site PORC-03—will remain unopened when X-ray imaging (subject to implementation) reveals the presence of coral fragments. Such cores will be cut in frozen state at the shore-based core repository.

Initial MST measurements will be carried out on whole-round core sections at medium resolution (5 cm) to keep pace with the core flow rate and ascertain a real-time control on core recovery and section coverage.

Two principal objectives of sampling during Expedition 307 will be to (1) obtain high-resolution interstitial water geochemical profiles to delineate microbial reaction zones and estimate potential zones of interstitial water flow; and (2) obtain corresponding samples for a variety of microbiological and biogeochemical analysis to be performed primarily in shore-based laboratories. Sampling strategies, core flow, and subsampling for shore-based laboratories will generally follow a modified scheme developed during ODP Leg 201.

Rapid analysis of key chemical species obtained from interstitial water samples in Hole A (i.e., sulfate and methane) will be important for establishing a sampling scheme for detailed microbiological analysis in Hole B. Cores identified for microbiology need to be handled rapidly and in a manner that prevents unnecessary warming and sediment oxidation. Core sections designated for microbiological sampling will be immediately removed to a temporary cooled core sampling laboratory, where the requisite number of whole-round cores will be removed and properly stored before the remainder of the core section is returned to the normal core flow pattern.

Because of time restrictions, the primary emphasis will be on cleanly obtaining whole-round cores for shore-based experimentation. To meet expedition objectives, these will include samples for deoxyribonucleic acid (DNA) and RNA based molecular microbial techniques, biomarkers, microbial activity measurements, and bacterial cultivation. These whole-round cores will be kept frozen at –80°C or anoxically stored and cooled at +4°C and shipped immediately from Ponta Delgada, Azores. Samples for quantification of total prokaryotes (acridine orange direct counts [AODC] and fluorescence in situ hybridization [FISH]) and further interstitial water chemistry for onboard processing will also be obtained. Radiochemical experiments will not be performed onboard ship during this expedition.

The second priority, subsequent to geochemical and microbiological studies, is preliminary definition of the sedimentologic and biostratigraphic framework by visual core description and targeted low-resolution sampling of age-diagnostic species. Sampling for high-resolution studies (such as stable isotope investigations) will be carried out after the cruise at a designated sampling party. Sampling of corals and associated macrofauna will also be restricted to the shore-based sampling party.

PRECRUISE WORKSHOP

Considering the short preparation time available for the cruise staffing and the very short transit time from port to the first drill site, the science party is invited to participate to a 2 day shore-based precruise workshop in Dublin, Ireland, on 26 and 27 April 2005 prior to boarding the ship. This workshop should be considered to be an inherent part of the expedition. The objectives of the workshop are as follows:

- general briefing on the science objectives;
- mutual presentation of the participants, their scientific expertise, and expectations;
- general overview of the programmed core flow and shipboard sampling scheme; and
- extensive opportunity for exchanging views in dedicated task groups for tuning shipboard actions and postcruise sampling and exploitation phases.

Introduction to shipboard activities will be completed by onboard briefings after embarkation. The main objective of the workshop is to help turn a community with varied backgrounds into a cohesive team, both toward shipboard and shore-based operations. Participants are requested to arrive on 25 April. Embarkation is scheduled in the later part of 27 April. Scientists are encouraged to bring a poster that adequately illustrates their research.

REFERENCES

De Mol, B., Van Rensbergen, P., Pillen, S., Van Herreweghe, K., Van Rooij, D., McDonnell, A., Huvenne, V., Ivanov, M., Swennen, R., and Henriet, J.-P., 2002. Large deep-water coral banks in the Porcupine Basin, southwest of Ireland. *Mar. Geol.,* 188(1–2):193–231.

Feary, D., Hine, A., Malone, M., and the Leg 182 Scientific Party, 1999. Cool-water 'reefs,' possible hydrogen sulphide/methane clathrates, and brine circulation—preliminary results of Leg 182 drilling in the Great Australian Bight. *JOIDES J.,* 25(2):4–7.

Foubert, A., Beck, T., Wheeler, A.J., Opderbecke, J., Grehan, A., Klages, M., Thiede, J., Henriet, J.-P., and the *Polarstern* ARK-XIX/3A Shipboard Party, in press. New view of the Belgica mounds, Porcupine Seabight, NE Atlantic: preliminary results from the *Polarstern* ARK-XIX/3a ROV cruise. *In* Freiwald, A., and Roberts, M. (Eds.), *Cold-Water Corals and Ecosystems.* New York (Springer-Verlag).

Foubert, A., Maignien, L., Beck, T., Depreiter, D., Blamart, D., and Henriet, J.-P., 2005. Pen Duick escarpment on the Moroccan margin: a new mound lab? [Intergovernmental Oceanographic Commission of UNESCO Training-through-Research programme: Geosphere-Biosphere Coupling Processes: The TTR Interdisciplinary Approach Towards Studies of the European and N. African Margins, Marrakech, Morocco, 1–5 February 2005].

Foubert, A., Van Rooij, D., Blamart, D., Henriet, J.-P., Jurkiw, A., and Kozachenko, M., 2004. A SE to NW piston core transect through Porcupine Seabight, SW of Ireland. *Proc. Int. Geol. Congr., 32nd*, 2:336–339, 1478. (Abstract)

Freiwald, A., Fosså, J.H., Grehan, A., Koslow, T., and Roberts, J.M., 2004. Cold-water coral reefs. UNEP/WCMC Report. *Biodiversity Ser.,* 22.

Galanes-Alvarez, H., 2001. A pseudo-3D very high resolution seismic study of the Thérèse Mound, Porcupine Basin, offshore SW Ireland [M.Sc. thesis]. Ghent Univ., Belgium.

Games, K.P., 2001. Evidence of shallow gas above the Connemara oil accumulation, Block 26/28, Porcupine Basin. *In* Shannon, P.M., Haughton, P., and Corcoran, D. (Eds.), *Petroleum Exploration of Ireland's Offshore Basins.* Geol. Soc. Spec. Publ., 188:361–373.

Henriet, J.-P., De Mol, B., Pillen, S., Vanneste, M., Van Rooij, D., Versteeg, W., Croker, P.F., Shannon, P., Unnithan, V., Bouriak, S., Chachkine, P., and the *Porcupine-Belgica* 97 Shipboard Party, 1998. Gas hydrate crystals may help build reefs. *Nature,* 391:648–649.

Henriet, J.-P., De Mol, B., Vanneste, M., Huvenne, V., Van Rooij, D., and the *Porcupine-Belgica* 97, 98, and 99 Shipboard Parties, 2001. Carbonate mounds and slope failures in the Porcupine Basin: a development model involving fluid venting. *In* Shannon, P.M., Haughton, P., and Corcoran, D. (Eds.), *Petroleum Exploration of Ireland's Offshore Basins*. Geol. Soc. Spec. Publ., 188:375–383.

Henriet, J.-P., Guidard, S., and the ODP Proposal 573 Team, 2002. Carbonate mounds as a possible example for microbial activity in geological processes. *In* Wefer, G., Billet, D., Hebbeln, D., Joergensen, B., and van Weering, Tj. (Eds.), *Ocean Margin Systems:* Heidelberg (Springer-Verlag), 439–455.

Hovland, M., Croker, P.F., and Martin, M., 1994. Fault-associated seabed mounds (carbonate knolls?) off western Ireland and north-west Australia. *Mar. Petrol. Geol.,* 11:232–246.

Huvenne, V.A., De Mol, B., and Henriet, J.-P., 2003. A 3D seismic study of the morphology and spatial distribution of buried mounds in the Porcupine Seabight. *Mar. Geol.,* 198:5–25.

Huvenne, V., Croker, P., and Henriet, J.-P., 2002. A refreshing 3D-view of an ancient sediment collapse and slope failure. *Terra Nova,* 14(1):33–40.

James, N.P., Feary, D.A., Surlyk, F., Simo, J.A.T., Betzler, C., Holbourn, A.E., Li, Q.Y., Matsuda, H., Machiyama, H., Brooks, G.R., Andres, M.S., Hine, A.C., Malone, M.J., and the ODP

Leg 182 Scientific Party, 2000. Quaternary bryozoan reef mounds in cool-water, upper slope environments: Great Australian Bight. *Geology,* 28(7):647–650.

Johnston, S., Doré, A.G., and Spencer, A.M., 2001. The Mesozoic evolution of the southern North Atlantic region and its relationship to basin development in the south Porcupine Basin, offshore Ireland. *In* Shannon, P.M., Haughton, P., and Corcoran, D. (Eds.), *Petroleum Exploration of Ireland's Offshore Basins.* Geol. Soc. Spec. Publ., 188:237–263.

Kenyon, N.H., Belderson, R.H., and Stride, A.H., 1978. Channels, canyons and slump folds between South-West Ireland and Spain. *Oceanol. Acta,* 1(3):369–380.

McDonnell, A., and Shannon, P.M., 2001. Comparative Tertiary stratigraphic evolution of the Porcupine and Rockall Basins. *In* Shannon, P.M., Haughton, P., and Corcoran, D. (Eds.), *Petroleum Exploration of Ireland's Offshore Basins.* Geol. Soc. Spec. Publ., 188:323–344.

Moore, J.G., and Shannon, P.M., 1995. The Cretaceous succession in the Porcupine Basin, offshore Ireland: facies distribution and hydrocarbon potential. *In* Croker, P.F., and Shannon, P.M. (Eds.), *The Petroleum Geology of Ireland's Offshore Basins.* Geol. Soc. Spec. Publ., 93:345–370.

Naylor, D., and Shannon, P.M., 1982. *Geology of Offshore Ireland and West Britain:* London (Graharn and Trotman).

Rice, A.L., Billet, D.S.M., Thurston, M.H., and Lampitt, R.S., 1991. The Institute of Oceanographic Sciences Biology programme in the Porcupine Seabight: background and general introduction. *J. Mar. Biol. Assoc. U. K.,* 71:281–310.

Shannon, P.M., 1991. The development of Irish offshore sedimentary basins. *J. Geol. Soc. (U. K.),* 148:181–189.

Tudhope, A.W., and Scoffin, T.P., 1995. Processes of sedimentation in Gollum Channel, Porcupine Seabight: submersible observations and sediment analyses. *Trans. R. Soc. Edinburgh: Earth Sci.,* 86:49–55.

Van Rooij, D., De Mol, B., Huvenne, V., Ivanov, M., and Henriet, J.-P., 2003. Seismic evidence of current-controlled sedimentation in the Belgica mound province, upper Porcupine slope, SW of Ireland. *Mar. Geol.,* 195(1–4):31–53.

Van Rooij, D., 2004. An integrated study of Quaternary sedimentary processes on the eastern slope of the Porcupine Seabight, SW of Ireland [Ph.D. dissert.]. Ghent Univ, Flanders, Belgium.

Wheeler, A.J., Kozachenko, M., Beyer, A., Foubert, A., Huvenne, V.A.I., Klages, M., Masson, D.G., Olu-Le Roy, K., and Thiede, J., in press. Sedimentary processes and carbonate mound morphology in the Belgica mound province, Porcupine Seabight, NE Atlantic. *In* Freiwald, A., and Roberts, M. (Eds.), *Cold-water Corals and Ecosystems.* Heidelberg (Springer-Verlag).

Ziegler, P.A., 1982. *Geological Atlas of Western and Central Europe:* Amsterdam (Shell International Petroleum).

Table T1. Expedition 307 operations plan and time estimates.

Site number	Location (lat., long.)	Seafloor depth (mbrf)	Operations description	Transit (days)	Drilling/ coring (days)	Wireline logging (days)
	Dublin, Ireland		Start of Expedition 307 (5 days)	In port		
			Transit ~300 nmi to Site PORC-04A @ 10.5 kt 28.6 h	1.2		
PORC-4A (Belgica mound)	51.37588°N, 11.73003°W	965	Hole A: APC to refusal @ ~75 mbsf, XCB to 112 mbsf, 4 temp. meas.		1.1	
			Wireline log with triple combo & FMS-sonic (12.0 h)			0.5
			Hole B: APC to refusal @ ~75 mbsf, XCB to 112 mbsf		0.5	
			Hole C: APC to refusal @ ~75 mbsf, XCB to 112 mbsf		0.6	
			Total days on site: 2.7			
			Transit ~0.5 nmi to Site PORC-03A @ 10.5 kt	0		
PORC-3A (Belgica mound)	51.38080°N, 11.71846°W	826	Hole A: APC to refusal @ ~75 mbsf, XCB to 220 mbsf, 4 temp. meas.		1.5	
			Wireline log with triple combo/FMS-sonic/VSP (WST) (18.0 h)			0.7
			Hole B: APC to refusal @ ~75 mbsf, XCB to 220 mbsf		1.0	
			Hole C: APC to refusal @ ~75 mbsf, XCB to 220 mbsf		1.1	
			Total days on site: 4.3			
			Transit ~7 nmi to Site PORC-02A @ 10.5 kt	0		
PORC-2A (Belgica mound)	51.43601°N, 11.55033°W	423	Hole A: APC to refusal @ ~75 mbsf, XCB to 200 mbsf, 4 temp. meas.		1.2	
			Wireline log with triple combo & FMS-sonic (11.25 h)			0.5
			Hole B: APC to refusal @ ~75 mbsf, XCB to 200 mbsf		1.0	
			Total days on site: 2.7			
			Transit ~1035 nmi to Ponta Delgado @ 10.5 kt 98.6 h	4.1		
	Ponta Delgada, Azores		Discharge Expedition 307 Science Party (1 day)	In port		
			Transit ~3525 nmi to Mobile @ 10.5 kt 335.7 h	14.0		
	Mobile, Alabama (USA)		End of Expedition 307	19.3	8.0	1.7
			Subtotal transit time:		19.3	
			Subtotal on site time:		9.7	
			Total operating days:		29.0	
			Total length of expedition including port call(s):		35.0	

Notes: Seafloor depth is prospectus water depth plus 11.0 m adjustment from waterline to rig floor (i.e., drillers depth). Advanced piston corer (APC) refusal depths are arbitrary. APC coring will proceed as deep as possible if justified by core quality/quantity. Use of the extended core barrel (XCB) will be dependent upon results of APC coring. Temperature measurements for formation gradient will be used primarily for hydrocarbon safety control. FMS = Formation MicroScanner, VSP = vertical seismic profile, WST = water sampling temperature probe.

Figure F1. Overview of Porcupine Basin (located west of Ireland), enclosed by four shallow platforms (Goban Spur, Porcupine Bank, Slyne Ridge and Irish Mainland Shelf [IMS]). The three main mound provinces (Belgica, Hovland and Magellan mound province) and drill areas (Fig. F3) are indicated.

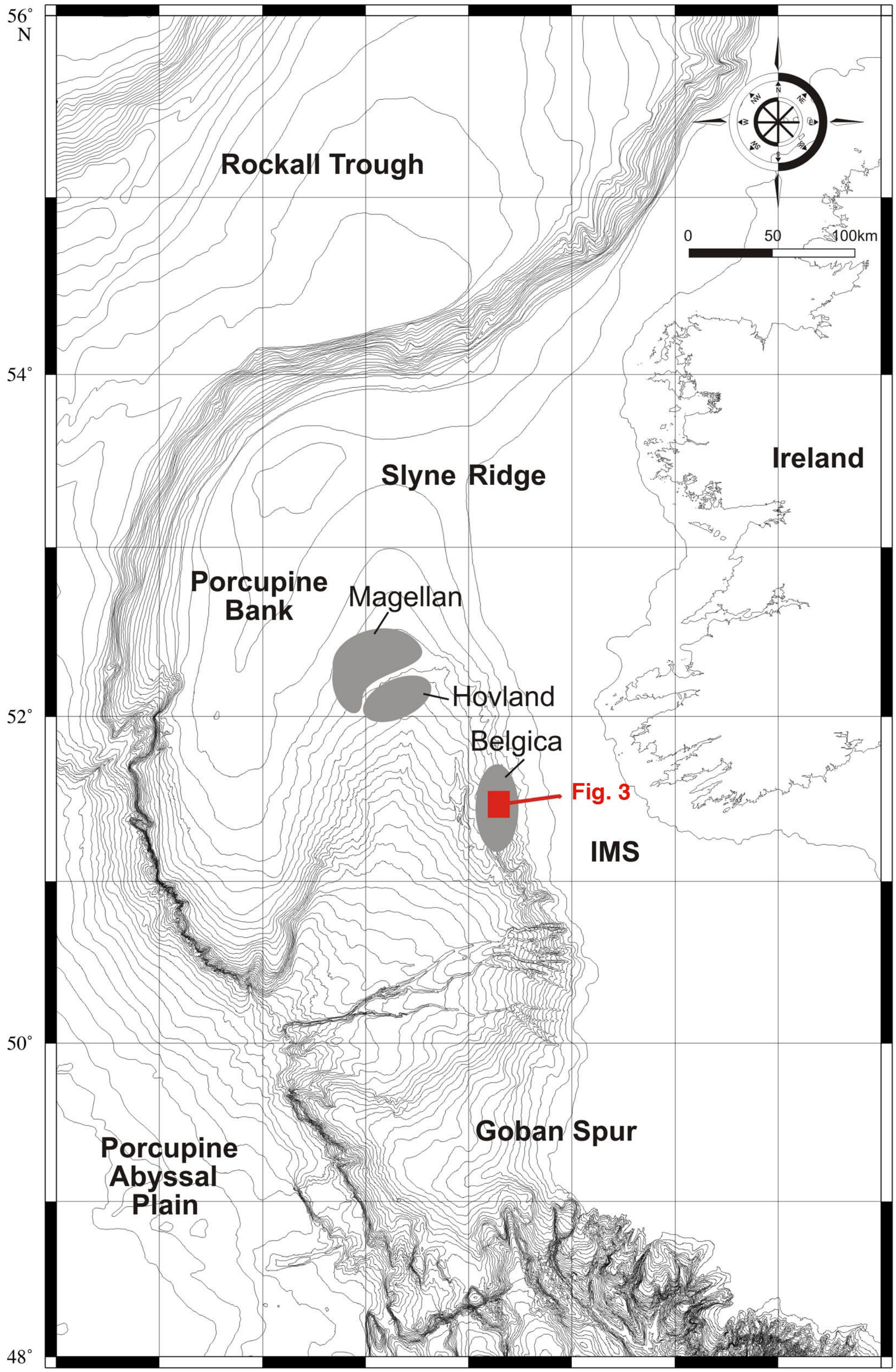


Figure F2. Digital terrain model from multibeam data, Belgica mound province (AWI Bremerhaven).

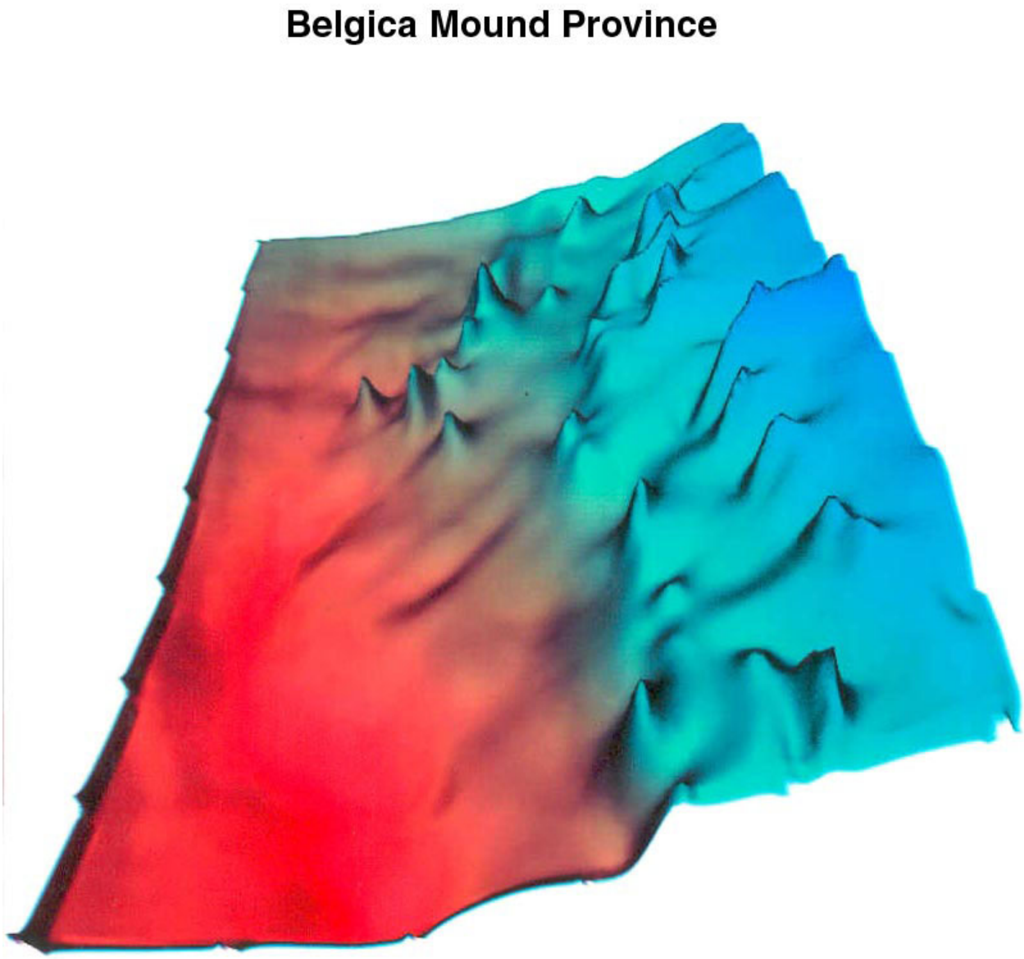


Figure F3. Overview of the three proposed drill sites, respectively PORC-02A, PORC-03A, and PORC-04A.

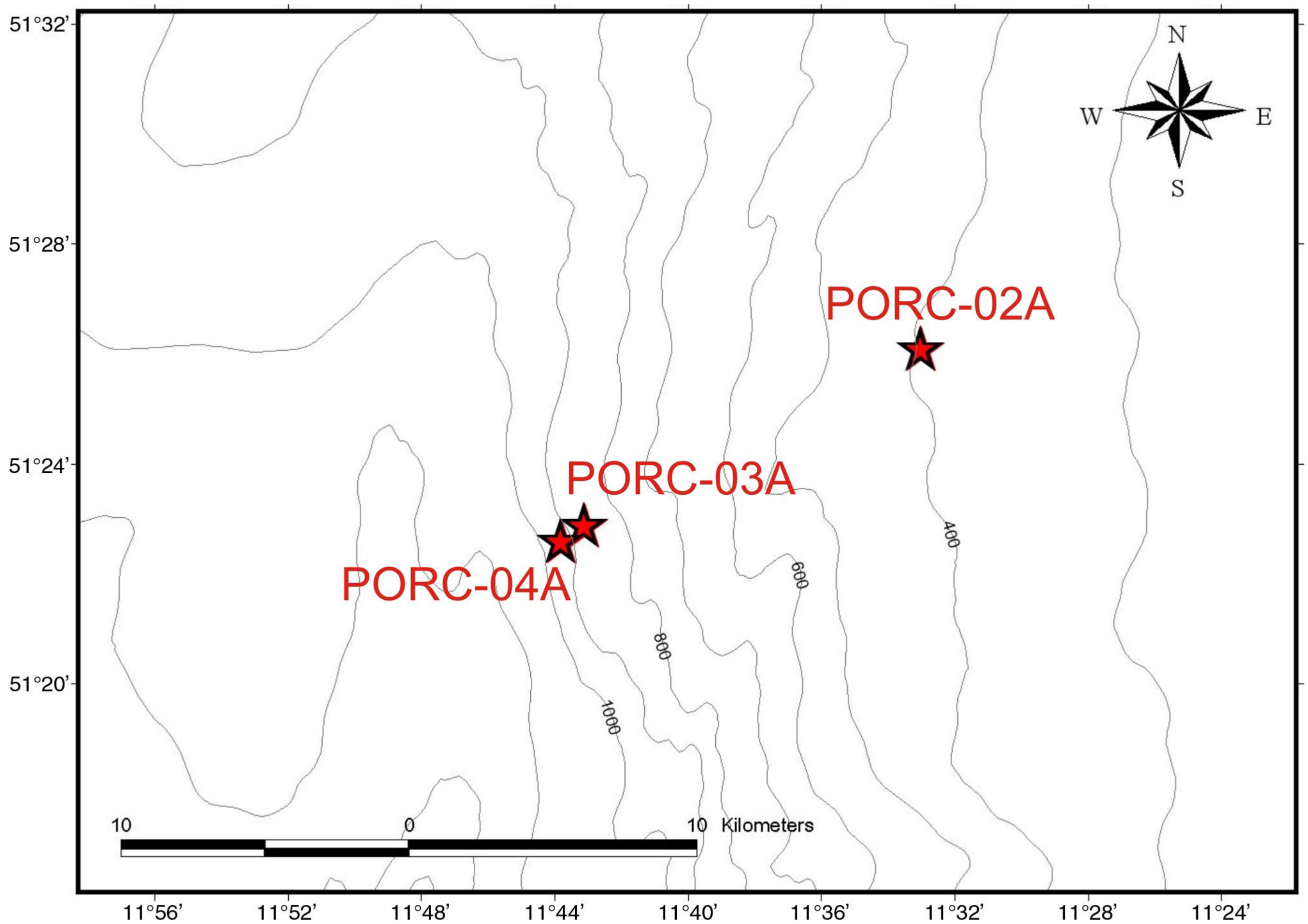


Figure F4. Generalized stratigraphy, tectonic history and relative sea level changes in the Porcupine Seabight after Ziegler (1982), Shannon (1991), Moore and Shannon (1995), and McDonnell and Shannon (2001) (Van Rooij, 2004).

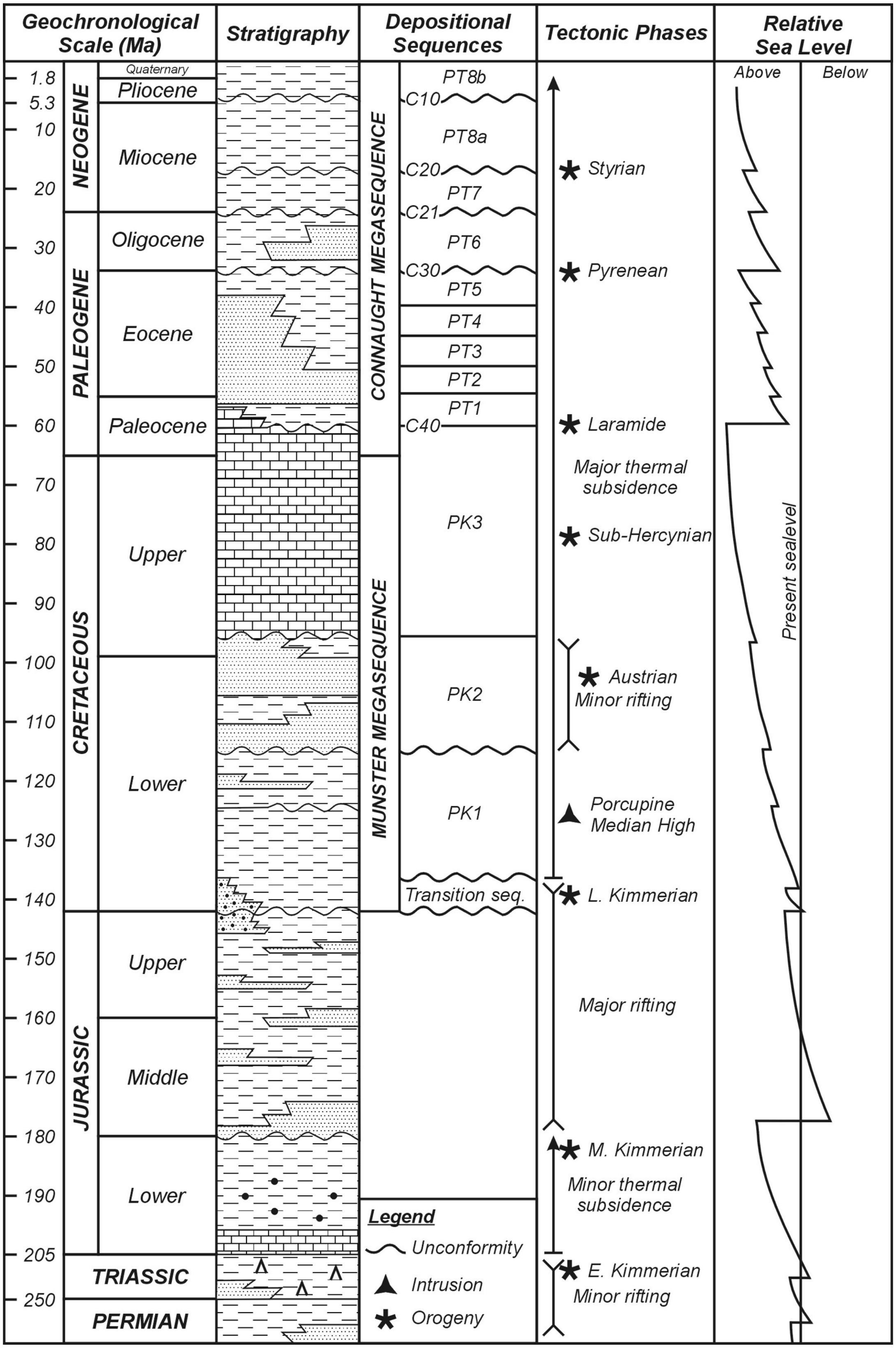


Figure F5. Downslope seismic profile P010516 over proposed Site PORC-03A

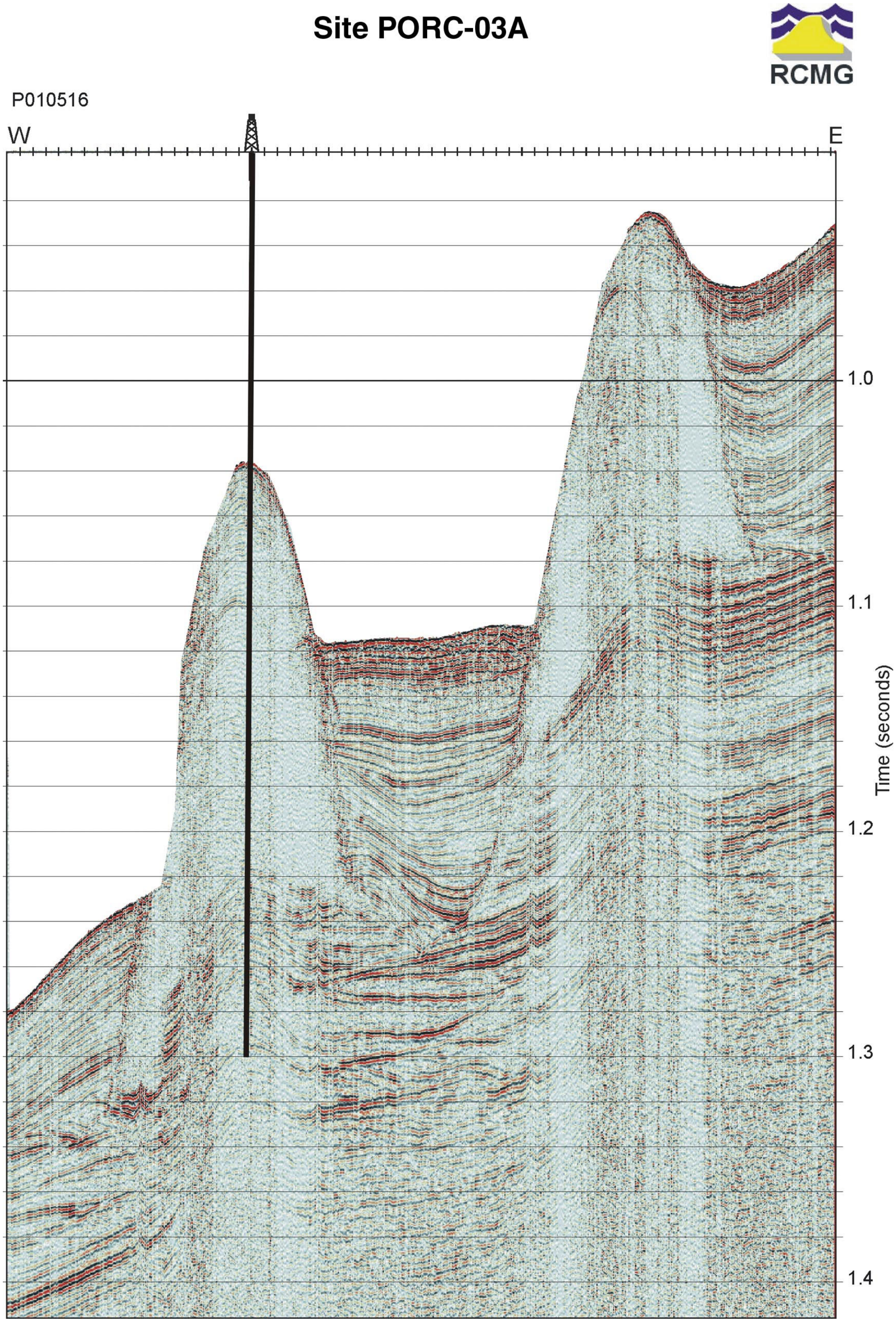


Figure F6. Downslope seismic profile P010517 over proposed Site PORC-02A

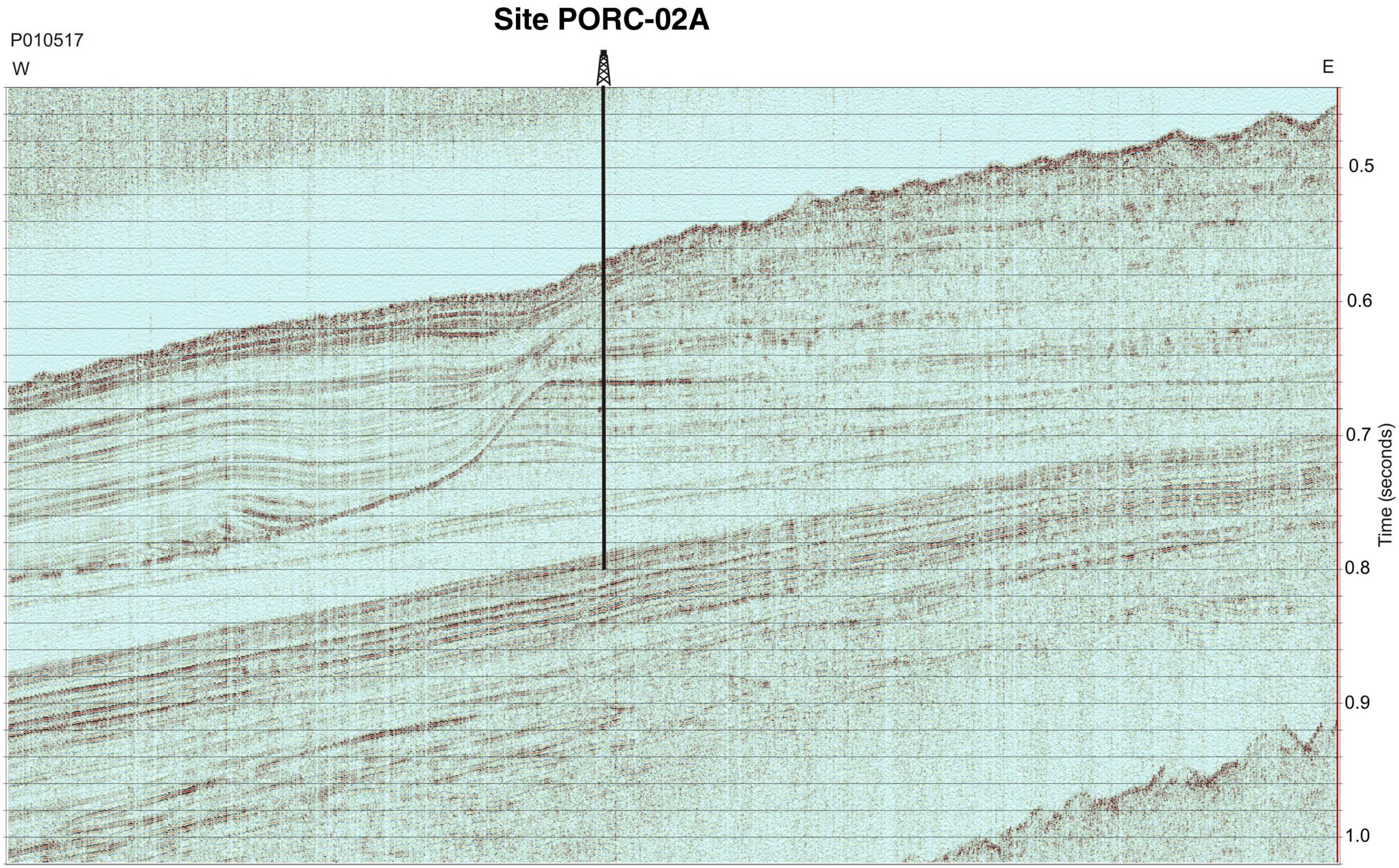


Figure F7. Downslope seismic profile P010515 over proposed Site PORC-04A

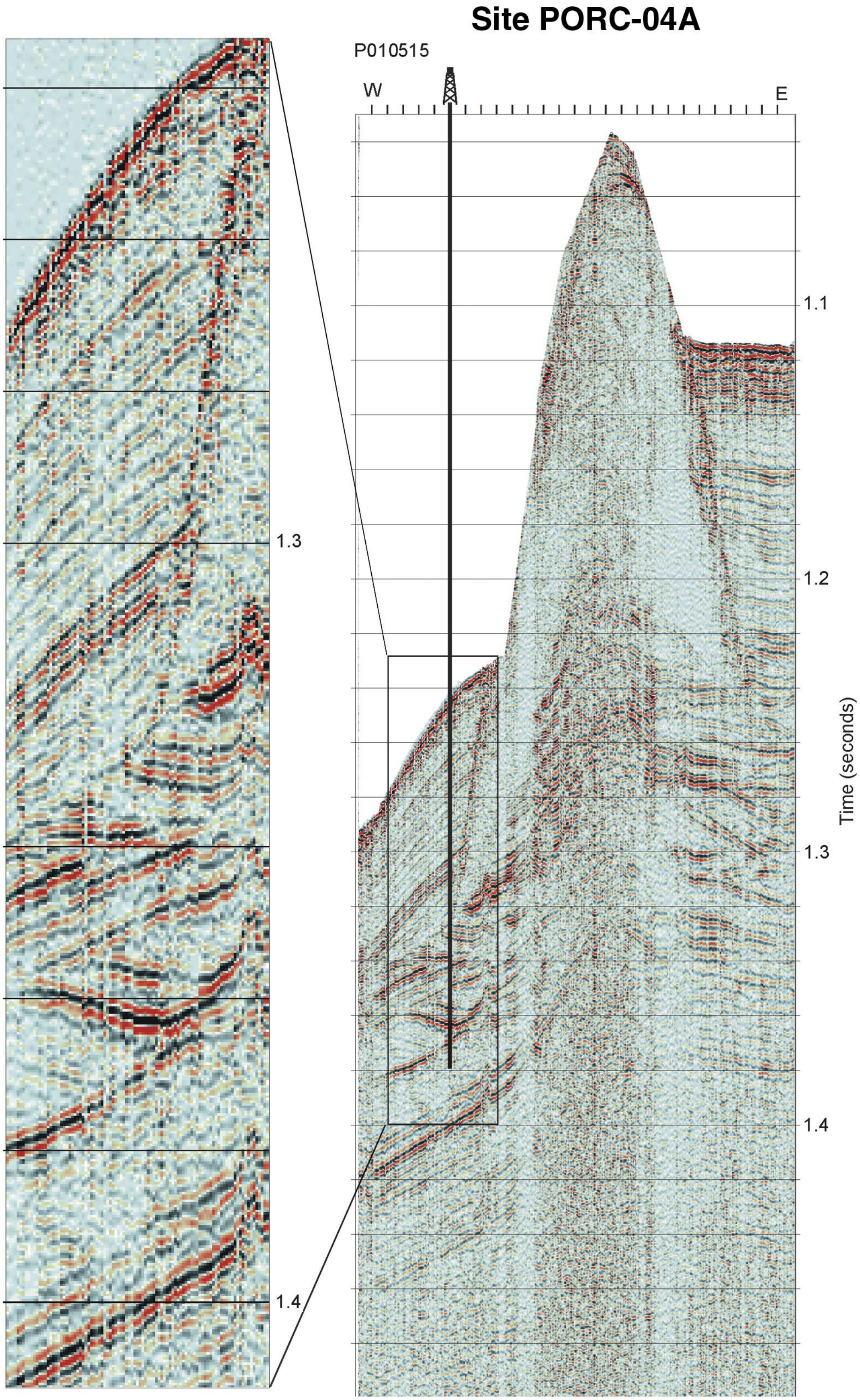


Figure F8. Challenger mound in the Belgica mound province.

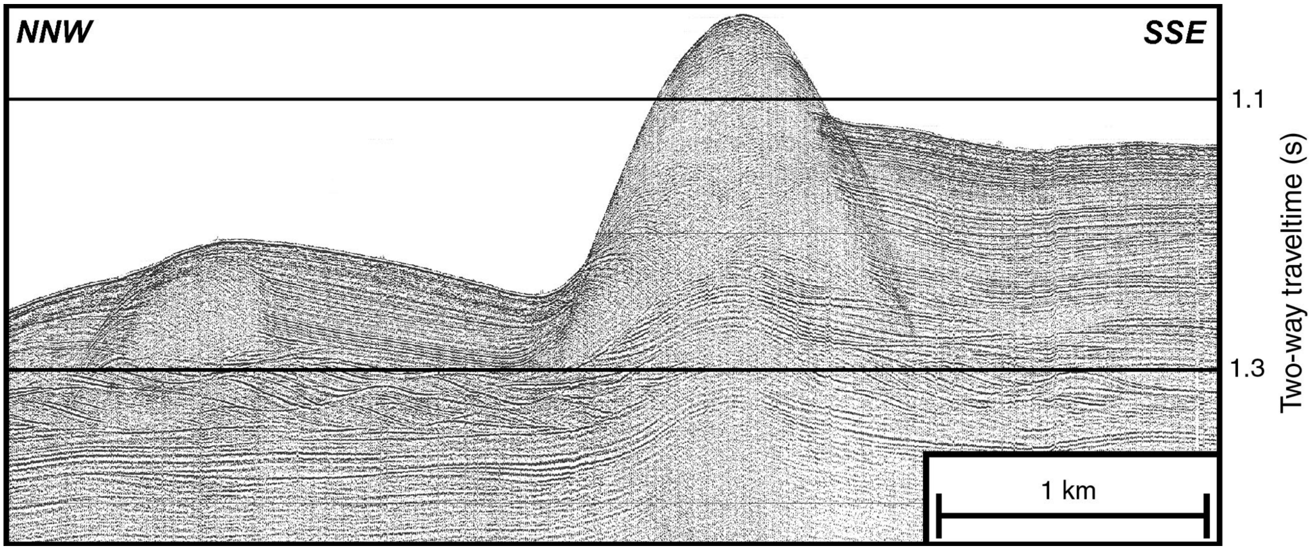


Figure F9. Seismic track map over proposed Sites PORC-03A and PORC-04A, with positioning of the pre-IODP *Marion Dufresne* cores.

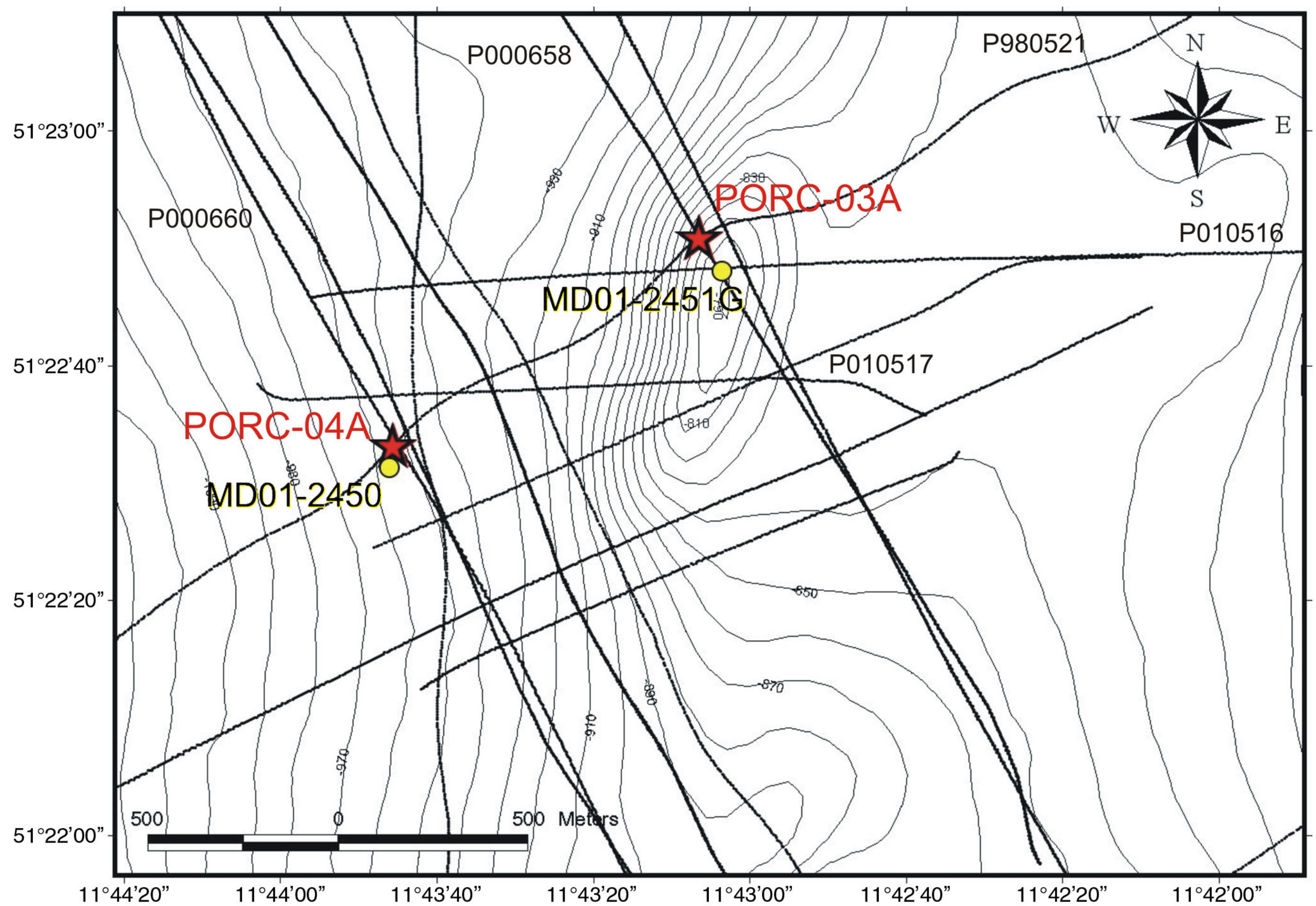


Figure F10. Seismic track map over proposed Site PORC-02A.

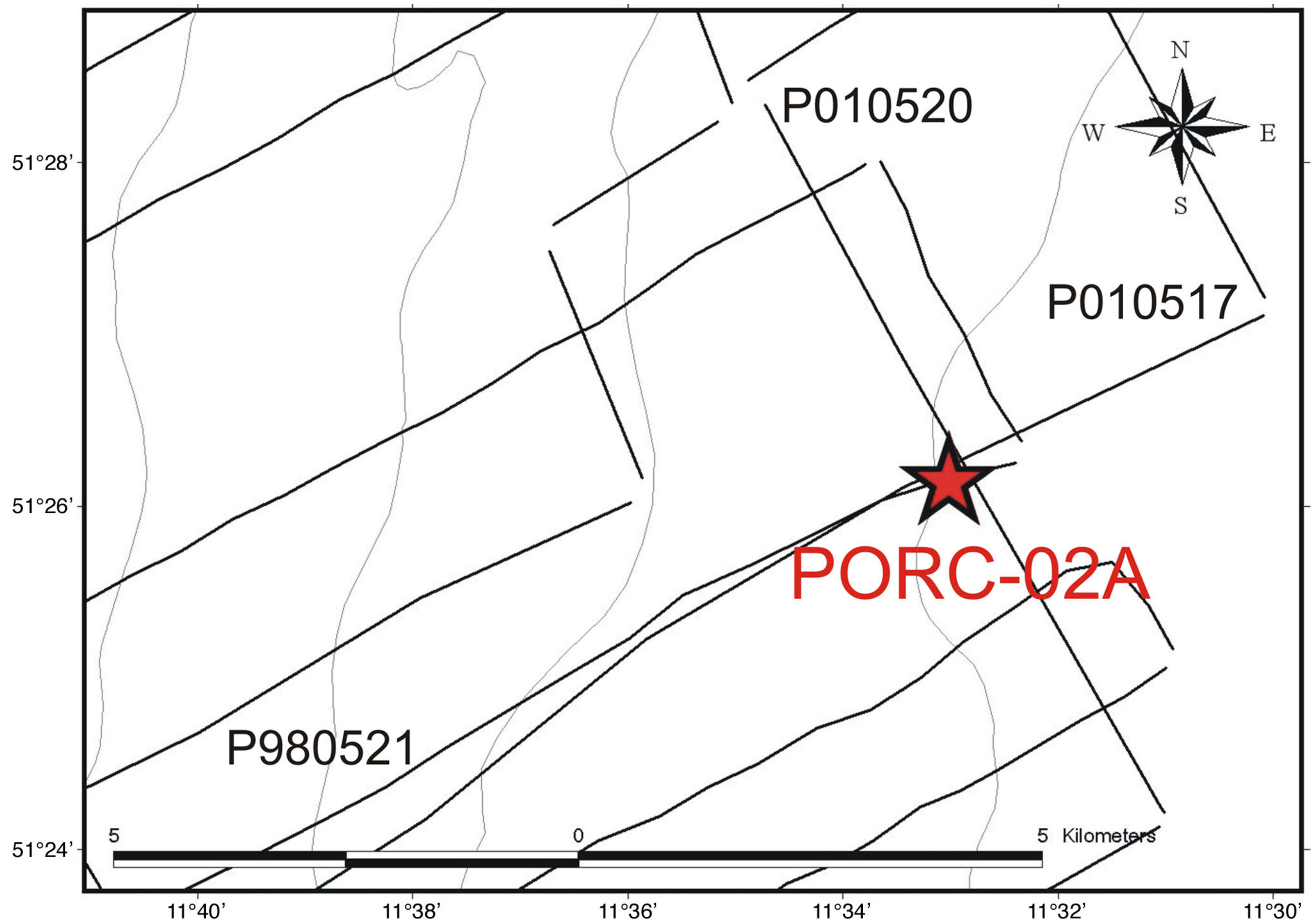


Figure F11. Slope-parallel seismic line P000660 through proposed Site PORC-04A with enlarged inset of sigmoidal units featuring high-amplitude reflections.

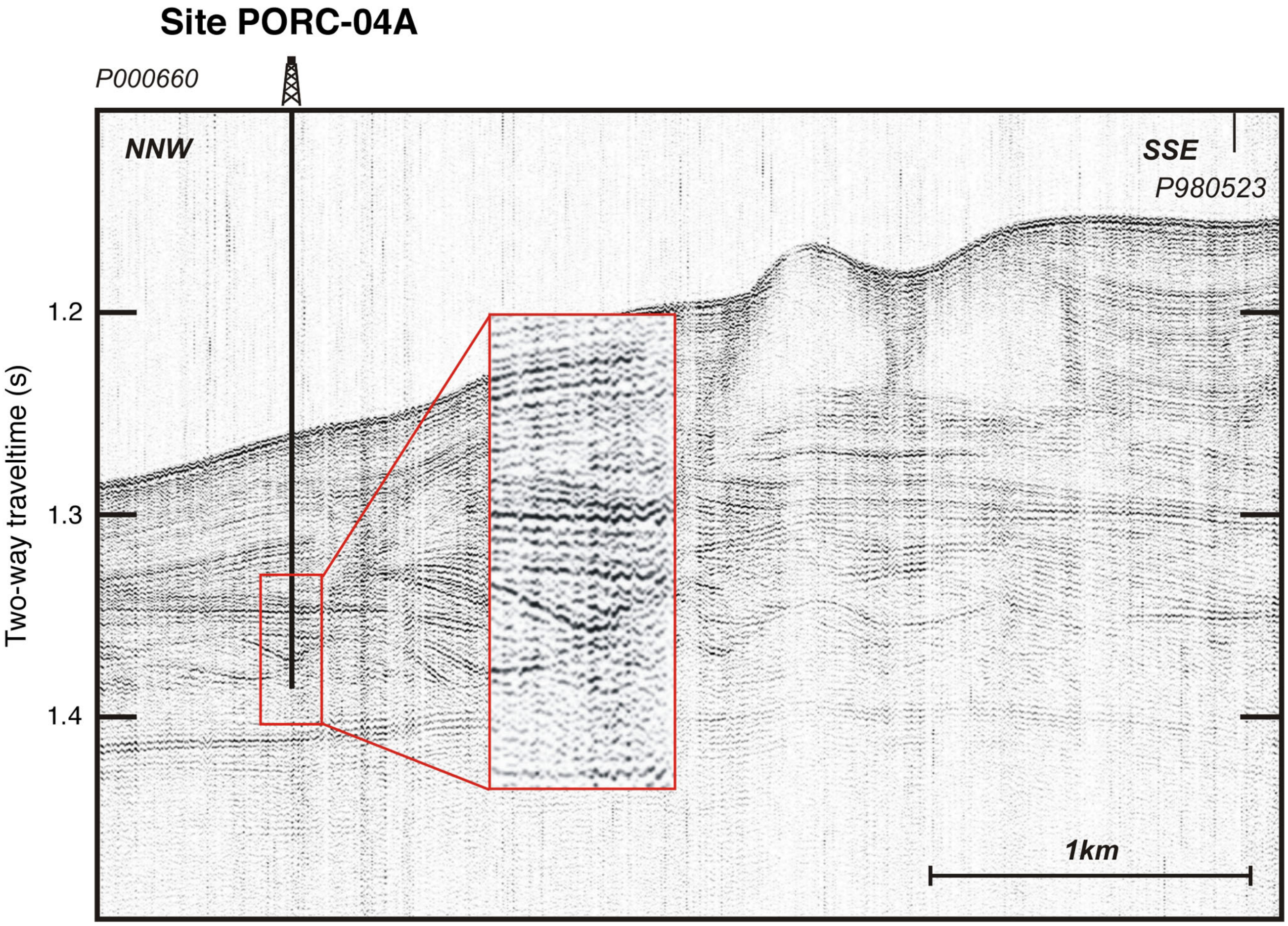


Figure F12. Downslope seismic line P980521 crossing proposed Sites PORC-03A and PORC-04A.

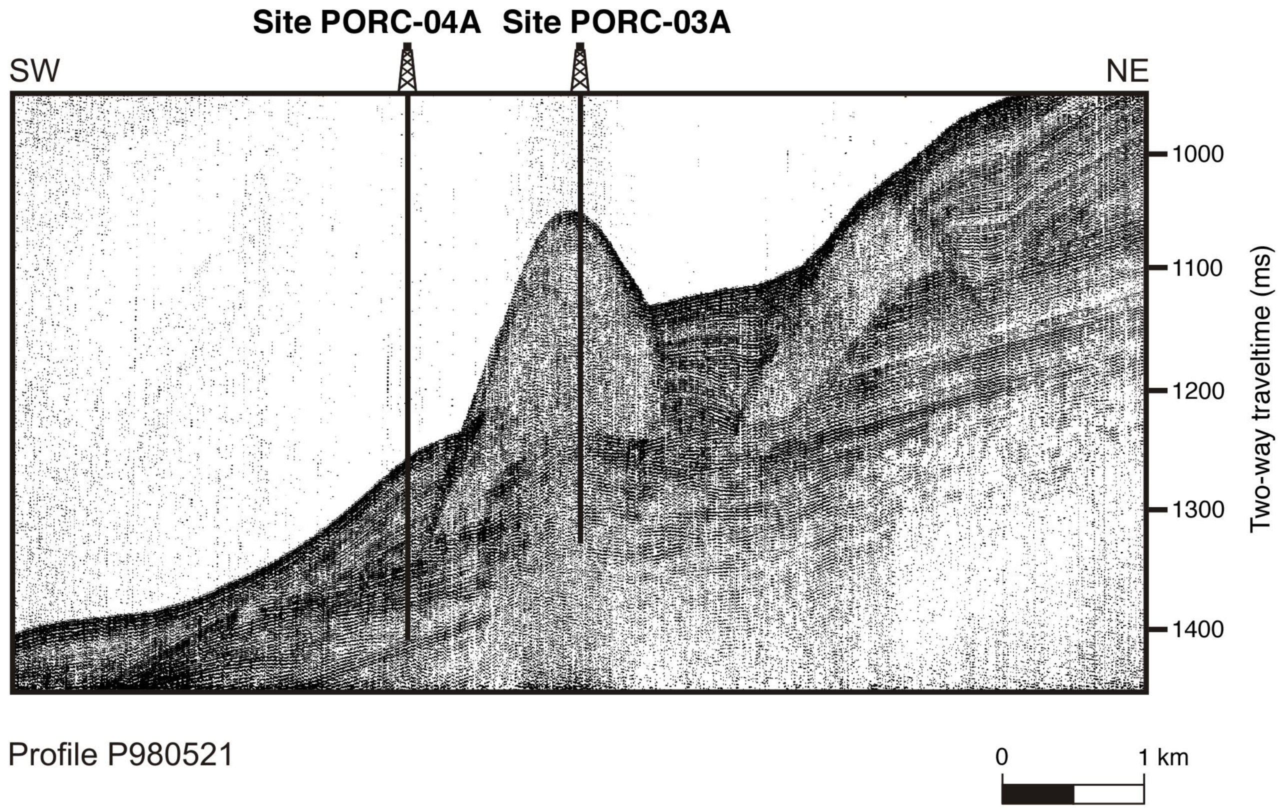


Figure F13. Slope-parallel seismic profile P000658 over proposed Site PORC-03A.

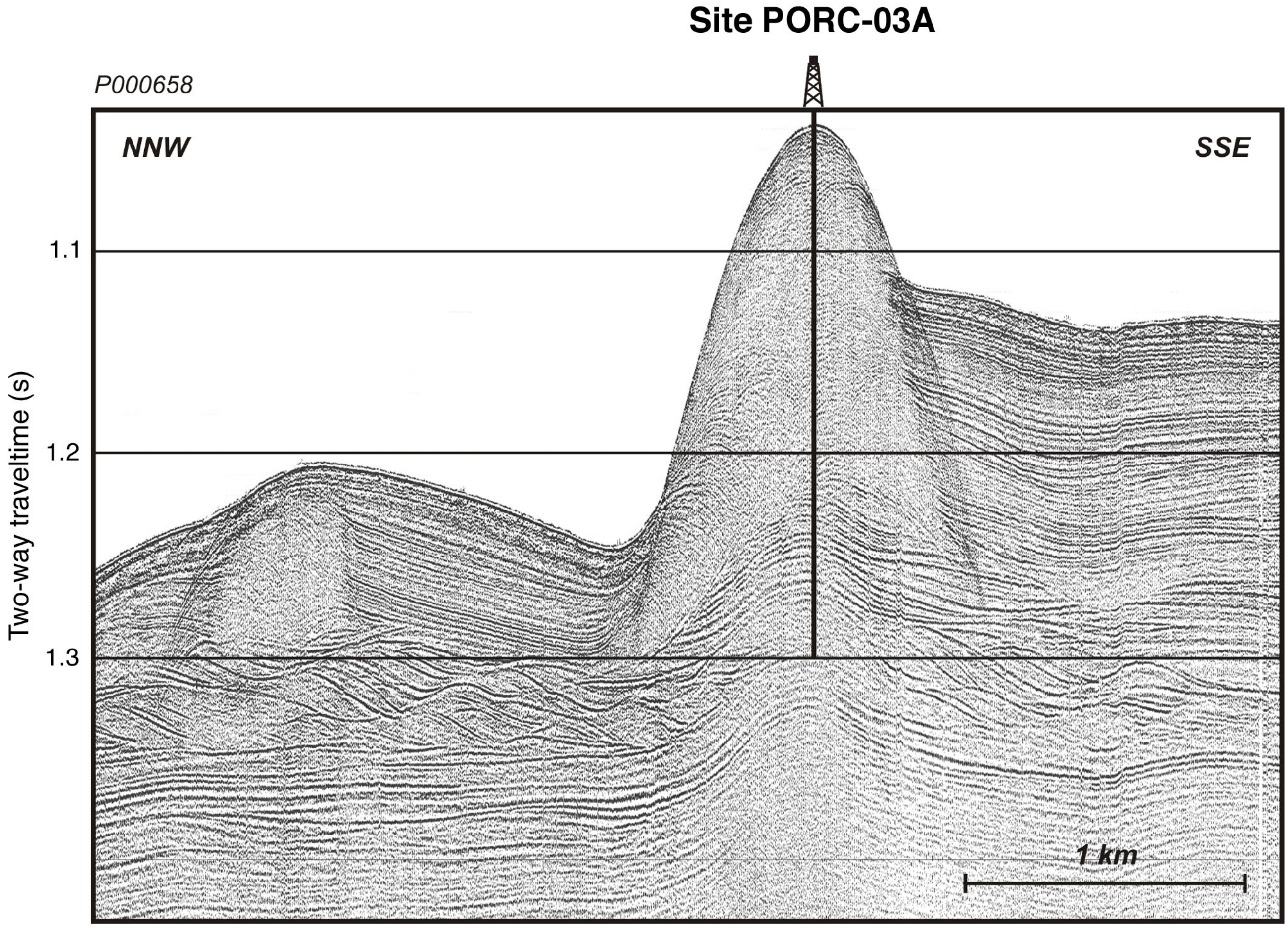


Figure F14. Slope-parallel line P010520 through proposed Site PORC-02A.

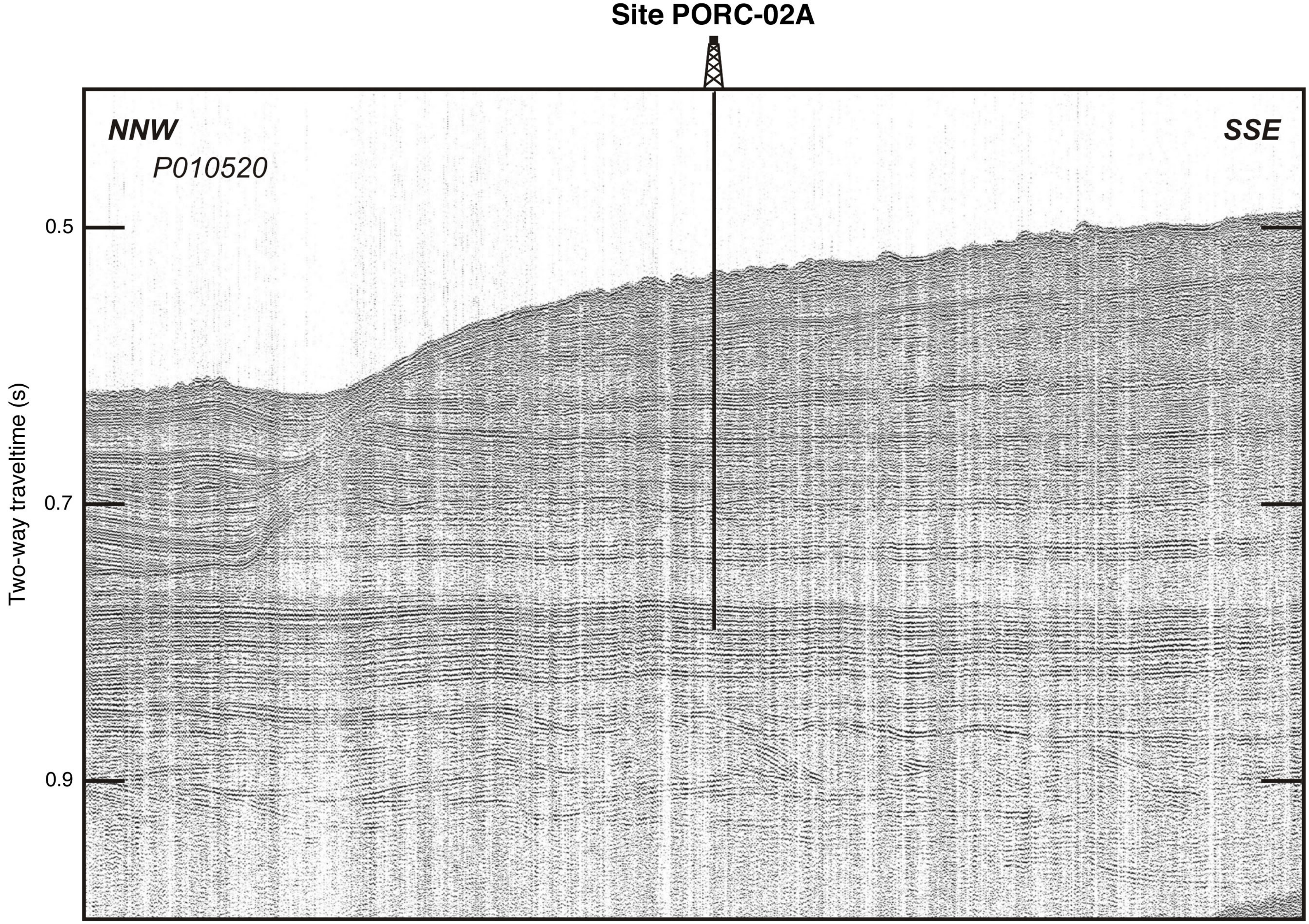


Figure F15. Positioning of the pre-IODP *Marion-Dufresne* cores at proposed Sites PORC-03A and PORC-04A on TOBI side-scan sonar imagery and seismic profile.

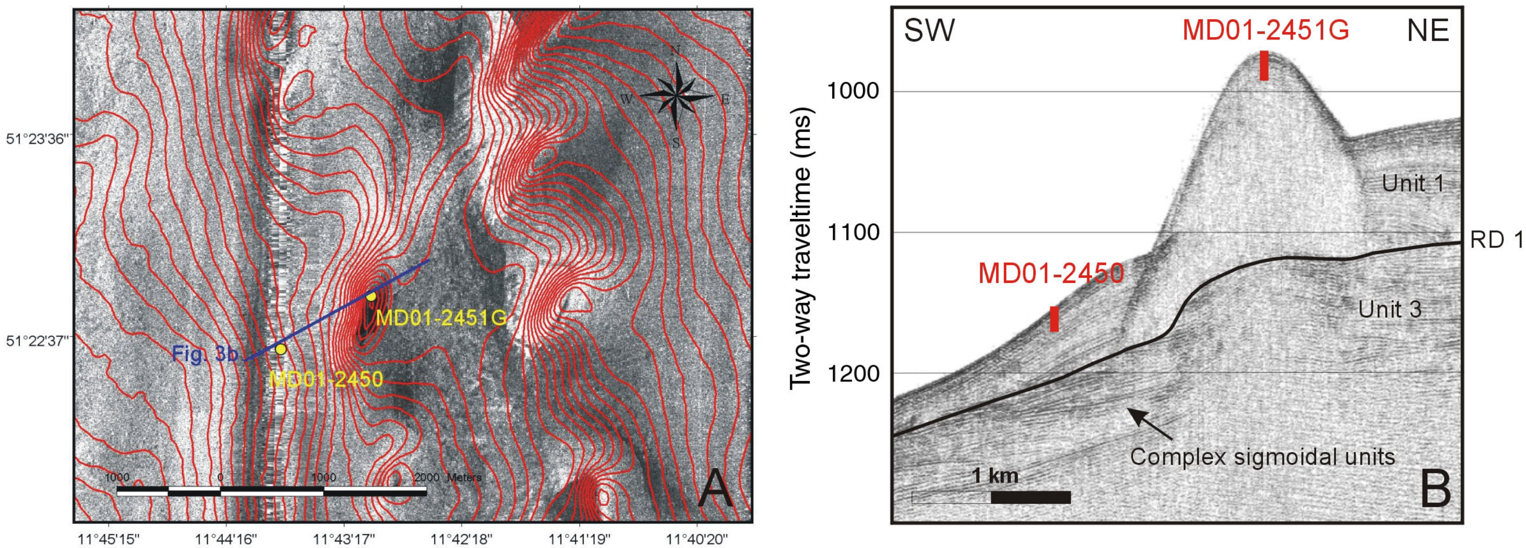


Figure F16. ROV videotrack/TOBI side-scan sonar map with facies interpretation over Challenger mound. Imagery corresponds respectively with a lost fishing net, dead coral debris and dropstones on a sandy seabed.

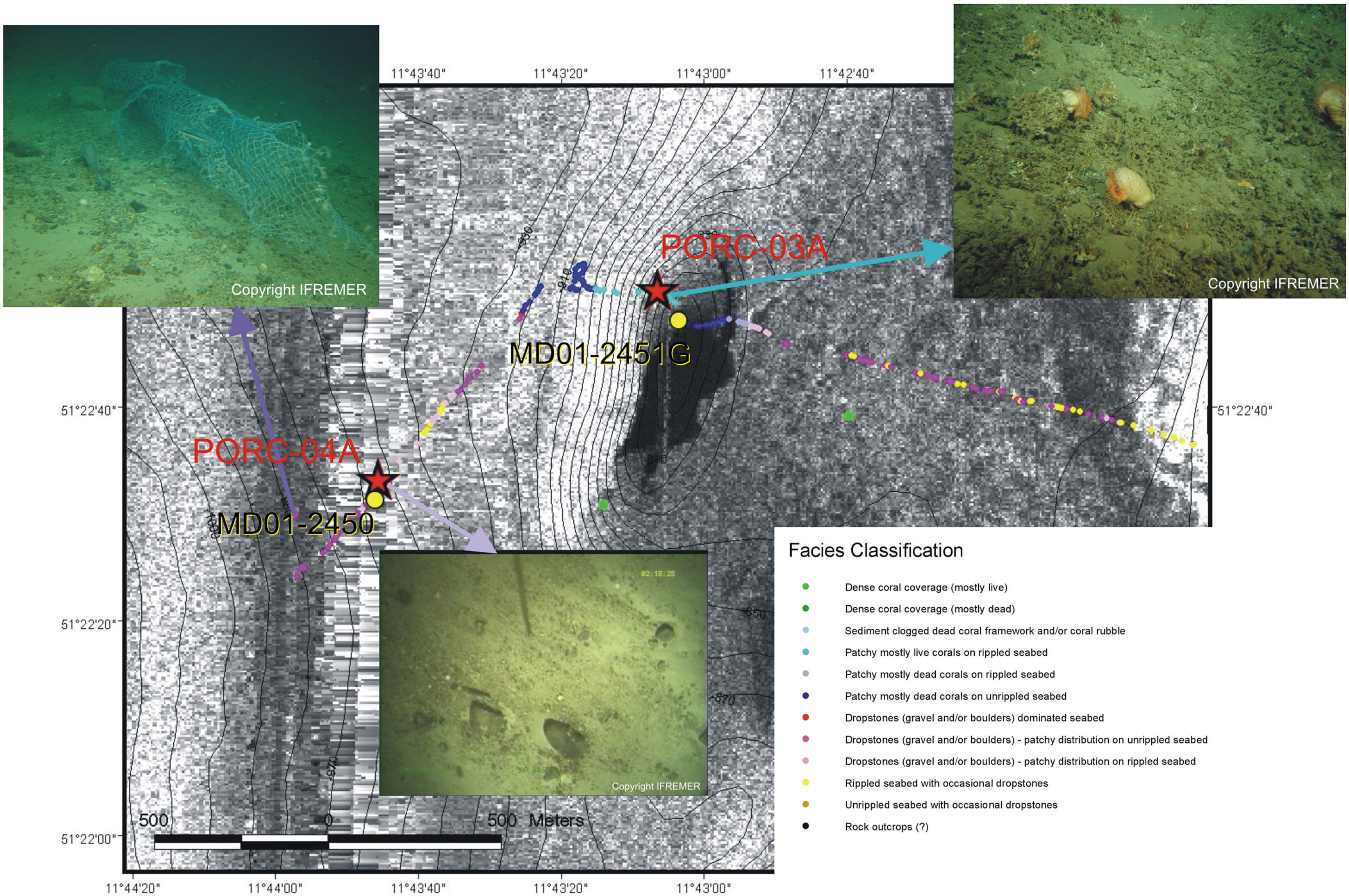


Figure F17. Apparent polarity display of Challenger mound.

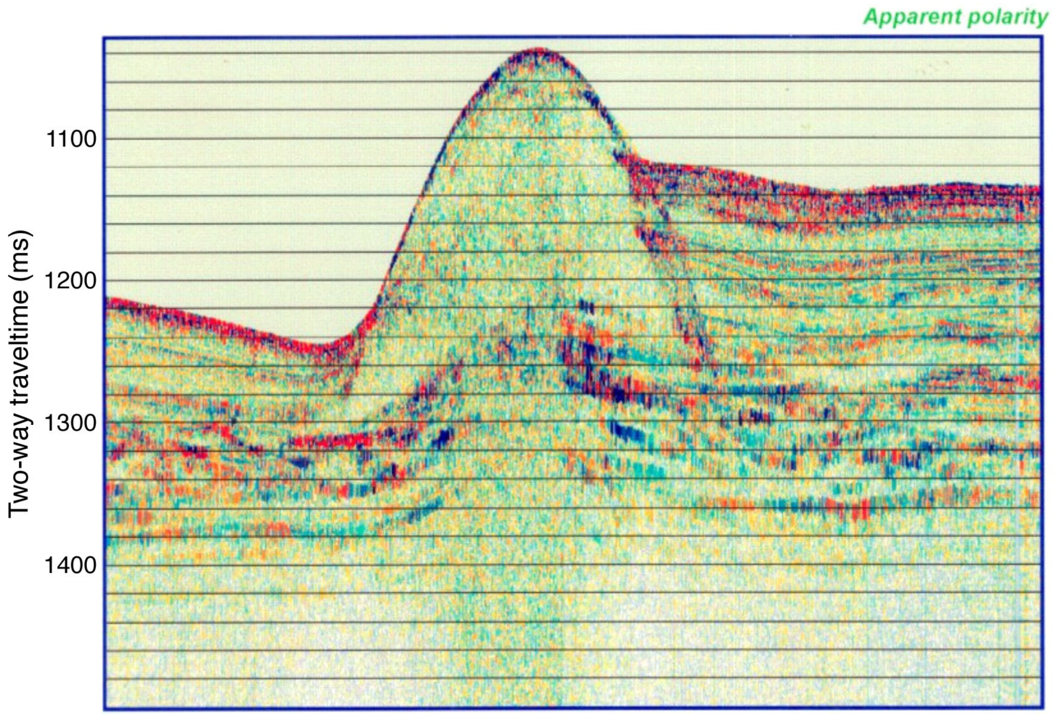


Figure F18. Instantaneous frequency display below Challenger mound (blue = lower frequencies).

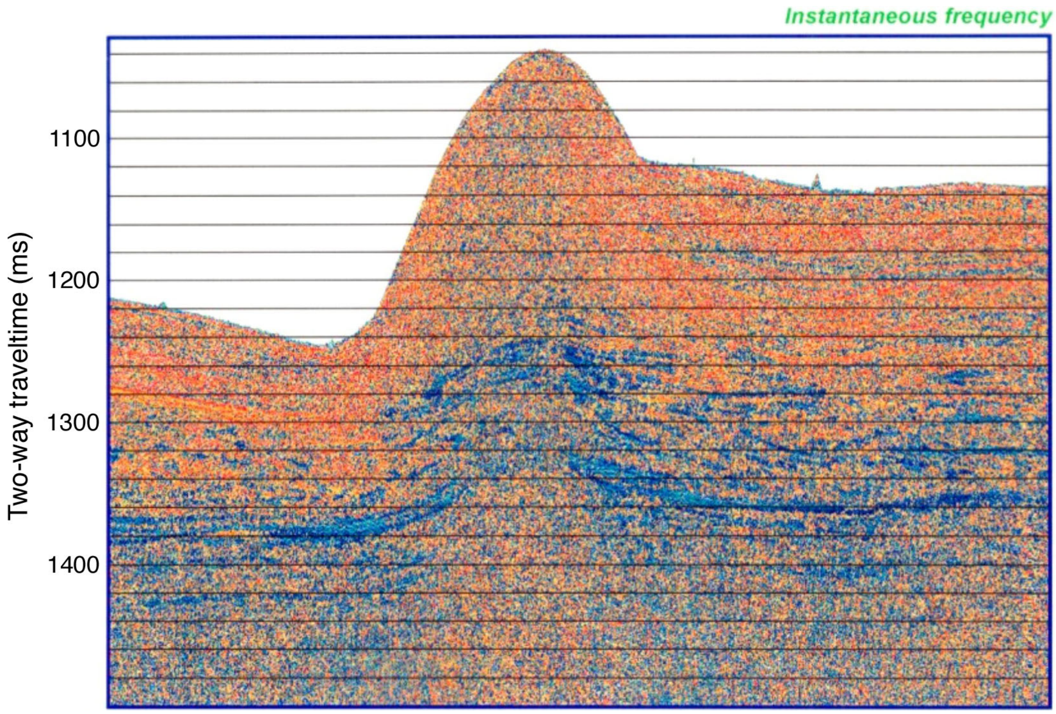
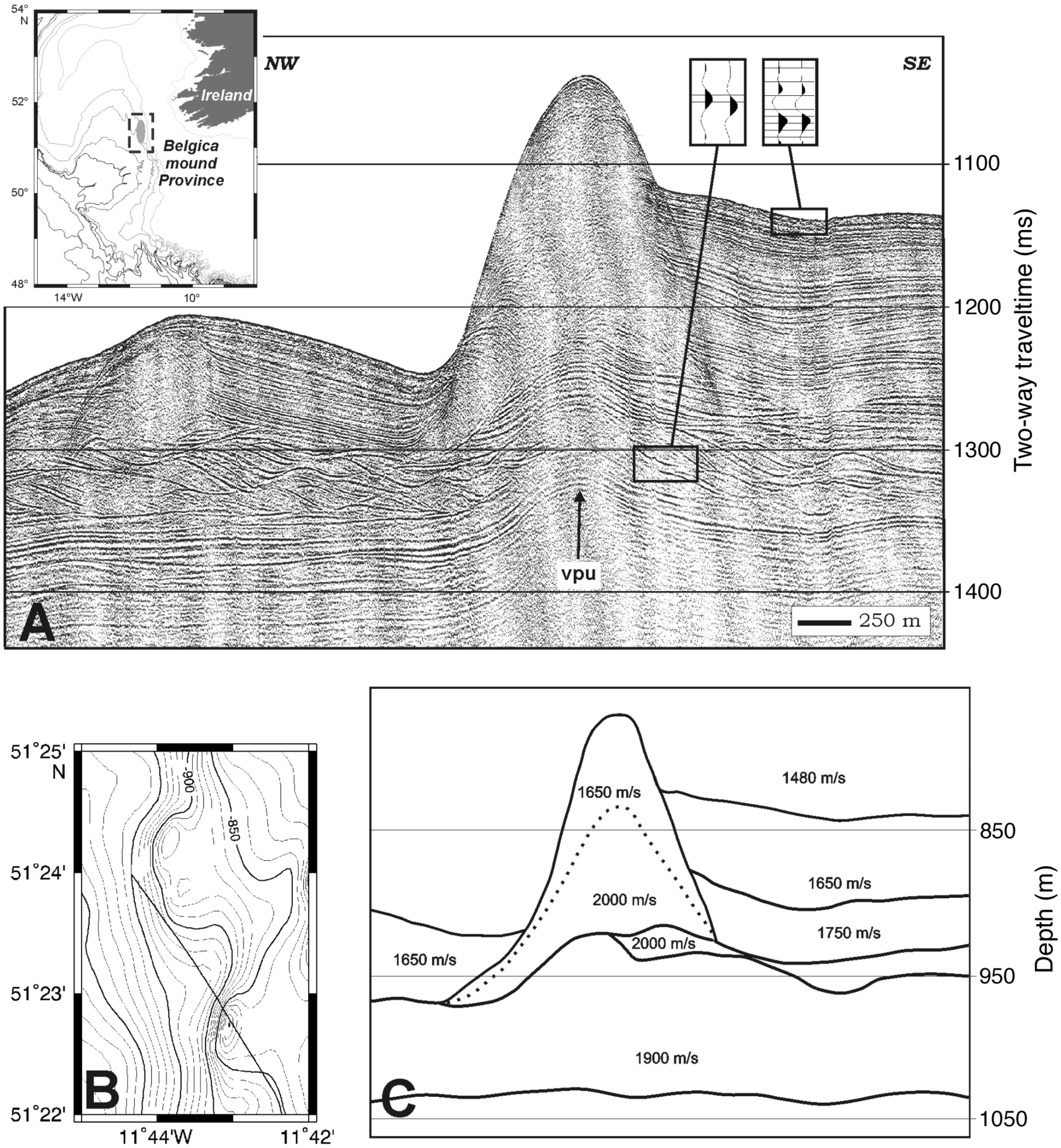


Figure F19. Velocity model and time-to-depth conversion for the section of Figure F8.



SITE SUMMARIES

Site: PORC-04A

Priority:	Primary
Position:	51°22.553′N, 11°43.802′W
Water depth (m):	954
Target drilling depth (mbsf):	112
Approved maximum penetration (mbsf):	112
Survey coverage:	• P980521 (SP 2000) (Fig. **F12**) • P000660 (SP 0900) (Fig. **F11**) • P010515 (SP 0222) (Fig. **F7**) • P010528 (SP 3246) • Track map (Fig. **F9**) • Porcupine-Belgica 1998, 2000, and 2001 high-resolution seismic grid • TTR7-AT-ORAT8 3.5 kHz and side-scan sonar • TOBI 30 kHz mosaic side-scan sonar (Figs. **F15, F16**) • Polarstern ANT-XVII/4 swath bathymetry (Fig. **F15**) • ROV-Videotransect (Fig. **F16**) • Core MD01-2450 (September 2001)
Objectives:	Onlapping drift body, partly draping the lower part of the carbonate mound. It bears information on the amount of carbonate being shed off the mound production area. The drift body is in close relation to an active channel system. Below follows a series of sigmoidally shaped sedimentary bodies of internally alternating high- and low-amplitude layers.
Drilling program:	Triple-APC to refusal
Logging program:	Triple combo, FMS-sonic
Nature of rock anticipated:	Silty clay and nannofossil- and microfossil-bearing ooze with intercalation of sandy and terrigeneous material, including mound-derived micrite and calcareous debris

SITE SUMMARIES (CONTINUED)

Site: PORC-03A

Priority:	Primary
Position:	51°22.848′N, 11°43.108′W
Water depth (m):	815
Target drilling depth (mbsf):	220
Approved maximum penetration (mbsf):	220
Survey coverage:	• P980521 (SP 1850) (Fig. **F12**) • P000658 (SP 0750) (Figs. **F13, F17, F18**) • P000617 (SP 1520) • P980525 (SP 0360) • P010516 (SP 0172) (Fig. **F5**) • Track map (Fig. **F9**) • Porcupine-Belgica 1998, 2000, and 2001 high-resolution seismic grid • TTR7-AT-ORAT8 3.5 kHz and side-scan sonar • TOBI 30 kHz mosaic side-scan sonar (Figs. **F15, F16**) • Polarstern ANT-XVII/4 swath bathymetry (Fig. **F15**) • ROV-Videotransect (Fig. **F16**) • Core MD01-2451G (September 2001)
Objectives:	Carbonate mound sitting on a gently inclined flank overlying an erosional surface. This site may provide insight into deeper biosphere, the mound formation, and microbial mediated early diagenetic cementation.
Drilling program:	Triple-APC or XCB to refusal
Logging program:	Triple combo, FMS-sonic, zero-offset VSP (pending approval)
Nature of rock anticipated:	Carbonate mud mound, lithified micritic carbonate with skeletal grains up to 5 cm diameter forming a typical floatstone and wacke- to packstone fabric

SITE SUMMARIES (CONTINUED)

Site: PORC-02A

Priority:	Primary
Position:	51°26.161′N, 11°33.020′W
Water depth (m):	412
Target drilling depth (mbsf):	200
Approved maximum penetration (mbsf):	200
Survey coverage:	• P980521 (SP 0100) • P010517 (SP 1565) (Fig. **F6**) • P010520 (SP 0740) (Fig. **F14**) • Track map (Fig. **F10**) • Porcupine-Belgica 1998 and 2001 high-resolution seismic grid • TTR7-AT-ORAT8 3.5 kHz • Core MD99-2327 (September 1999)
Objectives:	Carbonate mound sitting on a gently inclined flank overlying an erosional surface. This site may provide insight into deeper biosphere, the mound formation, and microbial mediated early diagenetic cementation.
Drilling program:	Double-APC or XCB to refusal
Logging program:	Triple combo, FMS-sonic
Nature of rock anticipated:	Silty clay and nannofossil- and microfossil-bearing ooze with intercalations of sandy and terrigeneous material, possibly diagenetic carbonate

SCIENTIFIC PARTICIPANTS

Co-Chief Scientist
Timothy Ferdelman
Department of Biogeochemistry
Max-Planck-Institute of Marine Microbiology
Celsiusstrasse 1
Bremen 28359
Germany
tferdelm@mpi-bremen.de
Work: (32) 9-264-4585
Fax: (32) 9-264-4967

Co-Chief Scientist
Akihiro Kano
Department of Earth and Planetary Systems Science
Graduate School of Science
Hiroshima University
Kagamiyama 1-3-1
Higashi-hiroshima, 739-8526
Japan
kano@geol.sci.hiroshima-u.ac.jp
Work: (81) 82-424-6583
Fax: (81) 82-424-0735

Staff Scientist
Trevor Williams
Lamont-Doherty Earth Observatory
Columbia University
Borehole Research Group
PO Box 1000, 61 Route 9W
Palisades NY 10964
USA
trevor@ldeo.columbia.edu
Work: (914) 365-8626
Fax: (914) 365-3182

Logging Staff Scientist
Philippe Gaillot
Center for Deep Earth Exploration (CDEX)
Japan Marine Science and Technology Center
Yokohama Institute for Earth Sciences
3173-25 Showa-machi, Kanazawa-ku
Yokohama, Kanagawa 236-0001
Japan
gaillotp@jamstec.go.jp
Work: (81) 45-778-5818
Fax: (81) 45-778-5704

Inorganic Geochemist
Tracy D. Frank
Geosciences Department
University of Nebraska, Lincoln
214 Bessey Hall
Lincoln NE 68588-0340
USA
tfrank2@unl.edu
Work: (402) 472-9799
Fax: (402) 472-4917

Inorganic Geochemist
Jamshid J. Gharib
Department of Geology and Geophysics/SOEST
University of Hawaii at Manoa
1680 East West Rd.
Honolulu HI 96822
USA
gharib@hawaii.edu
Work: (808) 956-8558
Fax: (808) 956-5512

Inorganic Geochemist
Saburo Sakai
Institute for Frontier Research on Earth Evolution
Japan Marine Science and Technology Center
2-15 Natsushima-cho
Yokosuka 237-0061
Japan
saburos@jamstec.go.jp
Work: (81) 46-867-9784
Fax: (81) 46-867-9775

Microbiologist
Barry A. Cragg
Department of Earth Sciences
Cardiff University
Main Building, Park Place
Cardiff, Wales CF10 3YE
United Kingdom
b.cragg@earth.cardiff.ac.uk
Work: (44) 29-2087-4928
Fax: (44) 29-2087-4326

Microbiologist/Geochemist
Kai Mangelsdorf
Organic Geochemistry and Hydrocarbon Systems
Geo Forschungs Zentrum Potsdam
Department 4.3, Telegrafenberg B423
Potsdam 14473
Germany
k.mangelsdorf@gfz-potsdam.de
Work: (49) 331 288 1785
Fax: (49) 331 288 1782

Microbiologist
Vladimir A. Samarkin
Department of Marine Sciences
University of Georgia
220 Marine Sciences Bldg.
Athens GA 30601
USA
samarkin@uga.edu
Work: (706) 353-0593
Fax: (706) 542-5888

Microbiologist/Geochemist
Arthur J. Spivack
Graduate School of Oceanography
University of Rhode Island
Marine Geology
Bay Campus, South Ferry Road
Narragansett RI 02882
USA
spivack@gso.uri.edu
Work: (401) 874-6200
Fax: (401) 874-6811

Organic Geochemist
Philippe Léonide
Centre de Sédimentologie-Paléontologie
Université de Provence
CNRS Research Unit FRE 2761
3, Place Victor Hugo, case 67
Marseille, Cedex 03 13331
France
leonide@up.univ-mrs.fr
Work: (33) 4 91 10 6208
Fax: (33) 4 91 10 8523

Paleomagnetist
Anneleen Foubert
Renard Centre of Marine Geology
Universiteit Gent
Geology and Soil Sciences
Krijgslaan 281-S8
Gent 9000
Belguim
anneleen.Foubert@UGent.be
Work: (32) 9264 4591
Fax: (32) 9264 4967

Paleomagnetist
Yuji Fuwa
Department of Earth Sciences
Toyama University
Gofuju 3190
Toyama 930
Japan
s011426@ems.toyama-u.ac.jp
Work: (81) 076-445-6649
Fax: (81) 076-445-6549

Paleontologist (Foraminifer)
Kohei Abe
Graduate School of Science and Technology
Kumamoto University
2-39-1 Kurokami
Kumamoto 860-8555
Japan
abe@es.sci.kumamoto-u.ac.jp
Work: (81) 96-342-3421
Fax: (81) 96-342-3411

Paleontologist (Nannofossil)
Emily L. Browning
4019 Sumner Street
Lincoln NE 68506
USA
ebrowning3@hotmail.com
Work: (251) 554-7756

Physical Properties Specialist
Akiko Tanaka (Nakano)
Institute of Geology and Geoinformation
Geological Survey of Japan, AIST
Tsukuba Central 7
1-1-1 Higashi
Tsukuba, Ibaraki 305-8567
Japan
akiko-tanaka@aist.go.jp
Work: (81) 29-861-3962
Fax: (81) 29-861-3609

Sedimentologist
Miriam S. Andres
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami FL 33149
USA
mandres@rsmas.miami.edu
Work: (305) 421-4683
Fax: (305) 421-4632

Sedimentologist
Morten Bjerager
Geologisk Institut
University of Copenhagen
Oster Voldgade 10
Copenhagen 1350
Denmark
mortenb@geol.ku.dk
Work: (45) 3532 2401
Fax: (45) 3314 8322

Sedimentologist
Jay M. Gregg
Geological Sciences & Engineering
University of Missouri-Rolla
125 McNutt Hall
1870 Miner Circle
Rolla MO 65409
USA
greggjay@umr.edu
Work: (573) 241-4664
Fax: (573) 341-6935

Sedimentologist
Xianghui Li
Department of Earth Sciences
Chengdu University of Technology
#1, Er'xianqiao Dongsanlu
Chengdu, Sichuan 610059
China
lixh@cdut.edu.cn
Work: (86) 28-84079527
Fax: (86) 28-84075588

Sedimentologist
Ivana Novosel
Department of Earth Sciences
Rice University
6100 Main Street, MS-126
Houston TX 77005-1892
USA
novosel@rice.edu
Work: (713) 348-4135
Fax: (713) 348-5214

Sedimentologist
Keiichi Sasaki
Department of Cultural Properties and Heritages
Kanazawa Gakuin University
10 Sue-machi
Kanazawa, Ishikawa 920-1392
Japan
sasak1@kanazawa-gu.ac.jp
Work: (81) 76-229-8859
Fax: (81) 76-229-8718

Sedimentologist
Chizuru Takashima
Earth and Planetary Systems Science
Hiroshima University
Kagamiyama 1-3-1
Higashi, Hiroshima 739-8526
Japan
tksmcdr@hiroshima-u.ac.jp
Work: (81) 824-24-6583
Fax: (81) 824-24-0735

Sedimentologist
Juergen Titschack
Institut für Paläontologie
Universität Erlangen-Nürnberg
Loewenichstrasse 28
Erlangen 91054
Germany
juergen.titschack@pal.uni-erlangen.de
Work: (49) 9131 852 4756
Fax: (49) 9131 852 2690

Stratigraphic Correlator
Ben De Mol
GRC Geociències Marines
Universitat de Barcelona
Campus de Pedralbes
Barcelona 08028
Spain
bendemol@ub.edu
Work: (34) 93 403 4641
Fax: (34) 93 402 1340

Stratigraphic Correlator
Veerle Ann Ida Huvenne
Challenger Division for Seafloor Processes
Southampton Oceanography Centre
Waterfront Campus
European Way
Southampton, England SO14 3ZH
United Kingdom
vaih@soc.soton.ac.uk
Work: (44) 23 8059 6263
Fax: (44) 23 8059 6554

Science Observer
Boris Dorschel
Department of Geology
University College Cork
Donovan's Road
Cork
Ireland
dorschel@uni-bremen.de

Science Observer
Xavier Monteys
Marine Department
Geological Survey of Ireland
Beggars Bush, Haddington Road
Dublin D4
Ireland
xavier.monteys@gsi.ie
Work: (353) 1604 1466
Fax: (353) 1604 1436

Schlumberger Engineer
Javier Espinosa
Schlumberger Offshore Services
369 Tristar Drive
Webster TX 77598
USA
jespinosa@webster.oilfield.slb.com
Work: (281) 480-2000

Operations Superintendent
Derryl Schroeder
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
schroeder@iodp.tamu.edu
Work: (979) 845-8481
Fax: (979) 845-2308

Laboratory Officer
Roy T. Davis
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
davis@iodp.tamu.edu
Work: (979) 845-2367
Fax: (979) 845-0876

Assistant Laboratory Officer
Lisa K. Crowder
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
crowder@iodp.tamu.edu
Work: (979) 845-7716
Fax: (979) 845-2308

Assistant Laboratory Officer
Chieh Peng
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
peng@iodp.tamu.edu
Work: (979) 845-0879
Fax: (979) 845-0876

Yeoperson
Kristin Hillis
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
hillis@iodp.tamu.edu
Work: (979) 845-2673
Fax: (979) 845-0876

Imaging Specialist
William Crawford
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
crawford@iodp.tamu.edu
Work: (979) 862-7757
Fax: (979) 458-1617

Marine Curatorial Specialist
Paula Weiss
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
pweiss@qwest.net
Work: (979) 845-3602
Fax: (979) 845-0876

Marine Laboratory Specialist: Chemistry
Dennis Graham
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
graham@iodp.tamu.edu
Work: (979) 845-3602
Fax: (979) 845-0876

Marine Laboratory Specialist: Chemistry
Robert M. Wheatley
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
wheatley@iodp.tamu.edu
Work: (979) 458-1067
Fax: (979) 845-0876

Marine Laboratory Specialist: Core
Kazuho Fujine
Center for Deep Earth Exploration (CDEX)
Japan Marine Science and Technology Center
Yokohama Institute for Earth Science
3173-25 Showa-machi, Kanazawa-ku
Yokohama, Kanazawa 236-0001
Japan
fujinek@jamstec.go.jp
Work: (81) 45-778-5816
Fax: (81) 45-778-5704

Marine Laboratory Specialist: Downhole Tools
Andrew P. Baker
Joint Oceanographic Institutions Inc.
1201 New York, NW, Suite 400
Washington, DC 20005
USA
abaker@joiscience.org
Work: (202) 787-1634

Marine Laboratory Specialist: Paleomagnetism
Klayton Curtis
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
Work: (979) 845-3602

Marine Laboratory Specialist: Physical Properties
Bradley Weymer
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
Work: (979) 845-3602

Marine Laboratory Specialist: Underway Geophysics
Denise Hudson
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
hudson_d@iodp.tamu.edu
Work: (979) 458-1067
Fax: (979) 845-0876

Marine Laboratory Specialist: X-Ray
Eric Jackson
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
geocrust@yahoo.com
Work: (979) 845-3602
Fax: (979) 845-0876

Marine Instrumentation Specialist
Jan Jurie Kotze
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
kotzejj@megaweb.co.za
Work: (979) 845-3602
Fax: (979) 845-0876

Marine Instrumentation Specialist
Pieter Pretorius
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
pretorius@iodp.tamu.edu
Work: (979) 845-3602
Fax: (979) 845-0876

Marine Computer Specialist
Margaret Hastedt
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
hastedt@iodp.tamu.edu
Work: (979) 862-2315
Fax: (979) 458-1617

Marine Computer Specialist
David Morley
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
morley@iodp.tamu.edu
Work: (979) 862-4847
Fax: (979) 458-1617

Applications Developer
David Fackler
Integrated Ocean Drilling Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
fackler@iodp.tamu.edu
Work: (979) 845-1918
Fax: (979) 845-2308