APPLICATION FOR THE CONSENT TO CONDUCT MARINE SCIENTIFIC RESEARCH IN AREAS UNDER NATIONAL JURISDICTION OF ICELAND

Date:

1. General information

1.1 Cruise name and/or number: CE15012 Deep-Links: Ecosystem Services of Deep-Sea Biotopes

1.2 **Sponsoring institution:**

Name: Marine Institute

Address: Rinville
Oranmore
Co. Galway
Ireland

Name of Chief Executive: Dr. Peter Heffernan

1.3 **Scientist in charge of the project:**

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1.4 **Scientist(s) from ICELAND involved in the planning of the project**

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2. Description of project (Attach additional pages as necessary)

2.1 Nature of objectives of the project:

Scientific objectives of research

Summary

We aim to assess the ecosystem services provided by three biotopes, hydrothermal vents, and bio-engineering cold-water corals and sponge gardens on mid-ocean ridges. We will investigate the role of hydrothermal vents, cold-water corals and sponge gardens in habitat diversification, biomass accumulation and biodiversity. We will relate these parameters to benthic-pelagic coupling, carbon sequestration and assess the potential of these biotopes in climate regulation and their importance for fisheries as breeding, nursery, refugia and feeding sites. Hydrothermal vent ecosystems, unlike both cold water-corals and sponges gardens, are fuelled primarily by chemosynthetic primary production and may act as ecosystem catalysts for biomass accretion. We will assess dispersal mechanisms of bio-available chemosynthetic derived energy in the wider ecosystem through the identification of biotope linkers such as invertebrates, vertebrates and microorganisms using the unique isotopic signatures found in hydrothermal chemosynthetic derived primary production. We will assess whether the proximity of hydrothermal vents, cold-water corals and sponge gardens result in synergy that leads to further increased biotope complexity, increased capacity for biomass accretion and biodiversity. These enhanced ecosystem services, through synergy effects, have the potential for greater carbon sequestration highlighting a previously unrecognised role of linked deep-sea biotopes in climate regulation. The principal geological question address what drives hydrothermal systems on oblique spreading ridges where magmatic flux is high and where the axial stress fields are oblique to the plate boundary. This knowledge is crucial to understanding the interplay between volcanism and tectonics, their effects on hydrothermal circulation, the transfer of mass and energy from the interior of the earth to the exterior and, ultimately, how this affects the ecosystem services provided by marine biotopes. As the world's most prominent and contiguous oblique spreading ridge, the Reykjanes Ridge provides the best natural laboratory to test these hypotheses.

The proposed study has eight scientific objectives:

I. A multidisciplinary characterisation of sponge gardens, cold-water coral reefs, hydrothermal vents and associated fauna along the Reykjanes Ridge from the Steinahóll and Njörður hydrothermal vent fields down to ~57°N (Appendix I, Figure 1).

II. Describe the ecosystem services provided by sponge gardens, cold-water coral reefs and hydrothermal vents relevant to commercially significant fisheries species (e.g. blue ling, red fish, blue whiting, mackerel etc.).

III. To identify biotope linkage mechanisms for the distribution of chemosynthetically derived labile organic carbon among deep-sea ecosystems (e.g. hydrothermal vents, sponge gardens and deep-water coral reefs).

IV. To advance understanding of cold-water coral reef and sponge garden development processes in sediment supply restricted settings, and thereby advance understanding of the control of sediment supply on reef attributes.

V. To assess the role of linked deep-water ecosystems for carbon sequestration and climate regulation.

VI. To establish the genetic connectivity among the biological communities along the Reykjanes Ridge and the wider North Atlantic in concert with international research groups (Horizon 2020, Blue Growth 1 – Improving the preservation and sustainable exploitation of Atlantic marine ecosystems).

VII. To appraise the effect of localised vent-associated seawater acidity on biomineralisation.

VIII. To understand the effects of underwater volcanism on hydrothermal activity and mass and energy are transferred from the interior of the earth to the exterior.

To this end we have devised a research programme targeting these three "biological hotspot" deep-sea ecosystems. Hydrothermal venting has been confirmed at Steinahóll and there is very strong evidence of hydrothermal vent activity elsewhere along the Reykjanes Ridge. While previous research cruises have only found strong indications of venting, they did not have access to the recent advances in technology for plume surveying (LSS and Eh sensor) that greatly enhances our capability to locate hydrothermal vents (e.g. previous Marine Institute funded expedition to the Moytirra vent field, CE11015). Sponge gardens and cold-water corals occur along the axis and both flanks of the Reykjanes Ridge, with possible depth zonation of reef-forming coral species in response to water mass structure. In addition, North Atlantic subpolar gyre (SPG) dynamics associated with changes in Atlantic Meridional Overturning Circulation (AMOC) affect coral and sponge occurrence and growth. Compared with Irish settings, the cold-water coral and sponge garden habitats on the Mid-Atlantic Ridge are relatively sediment starved.

We will compare the site morphology, community structure, biodiversity and population genetic parameters of organisms at vents, coral reefs, sponge gardens and associated fauna on the ridge. ROV-based hard sampling will target material for taxonomic voucher specimens, biodiversity studies, and food web analyses. In addition, samples will be collected for genetic connectivity studies. These samples will support and provide leverage for UCD's involvement in the Horizon 2020, Blue Growth 1 – Improving the preservation and sustainable exploitation of Atlantic marine ecosystems.

We will investigate areas of recent underwater volcanism and compare them to other volcanic terrains that are of various ages and have varying amounts of sediment cover. Young volcanic rocks react chemically with the water column and release nutrients and other chemicals that can affect sessile biota (especially micro-organisms). They also provide a range of macro-habitats depending on the eruption style, varying from tabular sheet flows with little topographic variation to scoriatious and pillowed lavas with highly rugose surfaces. In addition, we will study the effect of localised vent-associated acidification on biomineralisation.

Our findings will be contextualised with previously described vent/coral/sponge communities in the North Atlantic and fulfil a priority research objective identified by the international Census of Marine Life Chemosynthetic Ecosystems (ChEss) programme. The overarching objectives are to highlight ecosystem services provided by deep-sea ecosystems such as primary production (chemosynthetic), biomass accretion leading to carbon sequestration, which may have a potential climate regulatory role. On a sea-scape level ecosystem services must consider biotope synergies and the linkage among them. We will, therefore, investigate the role of chemosynthetic primary production (at hydrothermal vents) as a labile organic carbon source supporting growth at cold-water corals and sponge gardens – essential fisheries (Task 8) habitats. The role of deep-sea corals and sponge gardens in the life history of commercial fisheries stocks is recognized but poorly studied. In order to improve our understanding of the ecosystem services provided by sponge gardens and cold water coral reefs for pelagic and mesopelagic fisheries (e.g. blue whiting, redfish and orange roughy), we aim to characterize fish diversity and relative abundances along the Mid- Atlantic Ridge.

We will during our campaign use the RV Celtic Explorer and ROV Holland I, a highly efficient sampling platform for addressing first-order questions at deep-sea biotopes. Our programme uses cutting-edge marine technology to contribute to key objectives in biodiversity and Earth system science themes, including exploring ecosystems to discover novel biodiversity, increasing knowledge of how ocean circulation influences ecosystems, and determining how the properties of the Earth's interior influence its surface environment. In addition, the samples we expect to obtain will provide resources for the wider marine biotechnology community and for the study of volcanic hosted massive sulphide deposits.

2.2 Relevant previous or future research cruises:

2014. SeepC cruise to Gulf of Mexico methane seeps. Genetics consultant. June 5 – 14 on the RV Atlantis and the DSV Alvin.

2013. SeepC cruise to Atalante mud volcano's chemosynthetic ecosystem. Genetics consultant. June 1 – 7 on the RV Atlantis and the ROV Jason.

2011. VENTuRE cruise to 45°N to the Mid-Atlantic Ridge hydrothermal vent system. Genetics team leader. July 14 to August 4 on the RV Celtic Explorer and the ROV Holland I.

2.3 Previously published research data relating to the project:

Thaler AD, Plouviez S, Saleu W, Alei F, Jacobson A, Boyle EA, Schultz TF, Carlsson J, Van Dover CL. 2014. Comparative population structure of two deep-sea hydrothermal-vent-associated decapods (Chorocaris sp. 2 and Munidopsis lauensis) from southwestern Pacific back-arc basins. PLOS One, 9: e101345

Collins PC, Croot P, Carlsson J, Colaço A, Grehan A, Hyeong K, Kennedy R, Mohn C, Smith S, Yamamoto H, Rowden A. 2013. A primer for the Environmental Impact Assessment of mining at seafloor massive sulfide deposits. Marine Policy, 42:198-209.

Collins PC, Kennedy R, Copley J, Boschen R, Forde J, Flemming N, Ju SJ, Lindsay D, Marsh L, Nye V, Patterson A, Watanabe H, Yamamoto H, Carlsson J, Thaler AD. 2013. Ventbase: Developing a consensus among stakeholders in the deep-sea regarding environmental impact assessment for deep-sea mining. Marine Policy, 42: 334-336.

Wheeler AJ, Murton B, Copley J, Lim A, Carlsson J, Collins P, Dorschel B, Green D, Judge M, Nye V, Benzie J, Antoniacomi A, Coughlan M, Morris K. 2013. Moytirra: discovery of the first known

deep-sea hydrothermal vent field on the slow-spreading Mid-Atlantic Ridge north of the Azores. Geochemistry Geophysics Geosystems. 14: 4170-4184.
Carlsson J, Shephard S, Coughlan J, Trueman CN, Rogan E & Cross TF. 2011. Fine-scale population structure in a deep-sea teleost (Orange roughy, Hoplostethus atlanticus). Deep-Sea Research Part I. 58: 627-636.
Schultz TF, Hsing P-Y, Eng A, Zelnio KA, Thaler AD, Carlsson J & Van Dover CL. 2011. Characterization of 18 polymorphic microsatellite loci from Bathymodiolus manusensis (Bivalvia, Mytilidae) from deep-sea hydrothermal vents. Conservation Genetics Resources. 3: 25-27.
Thaler AD, Zelnio K, Saleu W, Schultz TF, Carlsson J, Cunningham C, Vrijenhoek R & Van Dover CL. 2011. The effects of spatial scale on the population dynamics of Ifremeria nautilei, a hydrothermal vent endemic gastropod from the southwest Pacific. BMC Evolutionary Biology. 11: 372.
Thaler AD, Zelnio K, Jones R, Carlsson J, Van Dover C &, Schultz TF. 2010. Characterization of 12 polymorphic microsatellite loci in Ifremeria nautilei, a chemoautotrophic gastropod from deep-sea hydrothermal vents. Conservation Genetics Resources. 2: 101-103.
Zelnio KA, Thaler AD, Jones Re, Saleu W, Schultz TH, Van Dover CL & Carlsson J. 2010. Characterization of nine polymorphic microsatellite loci in Chorocaris sp. (Crustacea, Caridea, Alvinocarididae) from deep-sea hydrothermal vents. Conservation Genetics Resources. 2: 222-226.

3. Methods and means to be used

3.1 Particulars of vessel

Name: Celtic Explorer
Nationality: Irish

Owner: Marine Institute

Overall length: 65.5m
Maximum draught: 5.7m
Net tonnage: 727
Propulsion: 2 x 1530 KW, 1000Rpm, 1 x 1020 KW, 1000 Rpm
Cruising speed: 10 Kts
Call sign: EI GB
Method and capability of communication –
Vsat Satellite Broadband
Imarsat –c
HF
VHF
Mini –M

Name of master: Antony Hobin/Denis Rowan
Number of crew:
Number of scientists on board: 15

3.2 Aircraft or other craft to be used in the project: N

3.3 Particulars of methods and scientific instruments

Types of samples and data	Methods to be used	Instruments to be used
Benthic fauna	Suction and manipulators, dredge	ROV and rock dredge
Plankton and larvae	Multinet	Multinet
Water samples	Water samples for biol. analyses	CTD
Mesopelagic fish	Small ring net	Small ring net

3.4 Indicate whether harmful substances will be used: Yes
Ethanol 100% molecular grade
Formalin

3.5 Indicate whether drilling will be carried out: No

3.6 Indicate whether explosives will be used No

4. Installations and equipment

Details of installations and equipment (dates of laying, servicing, recovery, exact locations and depth): No installations

5. Geographical areas

5.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude): Reykjanes Ridge Southwest of Iceland (see Fig below). Vent site 1 is located ~N59° W29°. Steinaholl is located at N63° W24°. As weather contingency, we plan to operate North of Iceland on shallow vents in the Eyjafjörður area (~N66° W18°) and around the Kolbeinsey Ridge, between N66° and 68° and W22°to 16°.

5.2 Attach chart(s) at an appropriate scale showing the geographical areas of the intended work and, as far as practicable, the positions of intended stations, the tracks of survey lines, and the locations of installations and equipment.

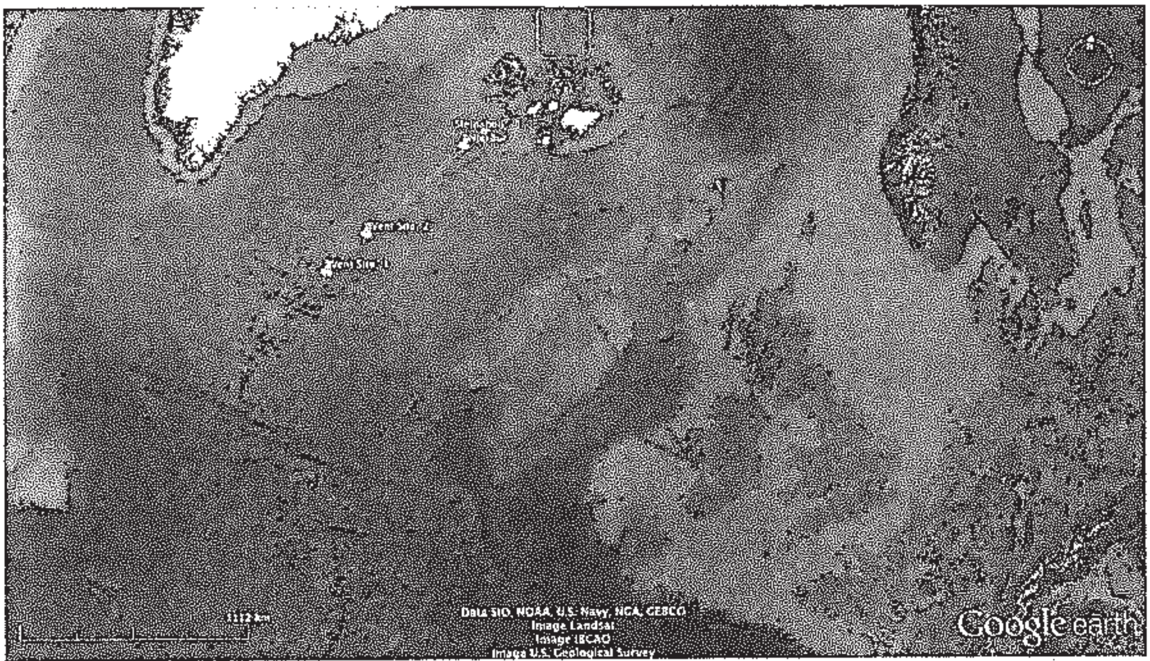

Figure. Route and map of survey area. Expedition leaves from Galway to Steinahóll and Njörður hydrothermal vent fields and transit to vent field 1 at ~57-59°N. The read box indicates the Eyjafjörður area (N66° W18°) and the green box indicates the Kolbeinsey Ridge (N66° and 68° and W22°to 16°).

6. Dates

6.1 Expected dates of first entry into final departure from research area of the research vessel: Leave Galway Oct 23 with 4-5 days transit to research area and 4-5 transit days back to Galway.

6.2 Indicate if multiple entry is expected:

7. Port calls

7.1 Dates and names of intended ports of calls in ICELAND:

No port calls are expected, however, due to potential bad weather a port call to Reykjavik cannot be excluded.

7.2 Any special logistical at ports of call:

7.3 Names/ Address / Telephone of shipping agent (if available)

8. Participation

8.1 Extent to which ICELAND will be enable to participate to be represented in research project:

8.2 Proposed dates and ports for embarkation / disembarkation:

None are planned

9. Access to data, samples and research results

9.1 Expected dates of submission to ICELAND preliminary reports which should include the expected dates of submission of the final results:

MAY 2016

9.2 Proposed means for access by ICELAND to data and samples:

Electronic access and shared hard sample repository

9.3 Proposed means to provide ICELAND with assessment of data, samples and research results or provide assistance in their assessment or interpretation:

Electronic access to all documents and co-authorship when deemed appropriate

9.4 Proposed means of making research results internationally available:

WE AIM TO PUBLISH FINDINGS IN PEER REVIEWED INTERNATIONAL SCIENTIFIC JOURNALS AND PRESENT FINDINGS AT INTERNATIONAL CONFERENCES. IN ADDITION, A FILM CREW FROM BBC WILL USE THE MATERIAL FOR A DOCUMENTARY FILM. FINALLY, WE EXPECTED THAT THE PRESS WILL SHOW AN INTEREST IN THESE ACTIVITIES AND WE PLAN TO DISSEMINATE OUR FINDING FOR LAY AUDIENCES THROUGH THE PRESS/

10. Scientific Equipment

We do not plan to use Icelandic equipment

COMPLETE THE FOLLOWING TABLE-
SEPARATE PAGE FOR EACH COSTAL STATE:

INDICATE YES OR NO

LIST SCIENTIFIC WORK BY FUNCTION Eg: MAGNETOMETRY:				DISTANCE FROM COAST

GRAVITY DIVING SEISMICS BATHYMETRY SEABED SAMPLING TRAWLING ECHO SOUNDING WATER SAMPLING U/W TV MOORED INSTRUMENTS TRAWLING ECHO SOUNDING WATER SAMPLING	Water column includin g sedimen t samplin g of the Seabed Yes	Fisheri es researc h within fishing limits Yes	Research concerni ng the natural resource s of the continen tal shelf or its physical character i-stics Yes	Within 12nms Yes	Between 12-200nms Yes	(Continental shelf work only) Beyond 200nm but within the continental margin Yes
WATER SAMPLING	Yes	Yes	Yes	Yes	Yes	Yes
PROFILING INSTRUMENTS	Yes	Yes	Yes	Yes	Yes	Yes
ABOVE WATER OPTICS AND PHOTOGRAPHY	No	No	No	No	No	No

(On behalf of the Principle Scientist)

Dated --------------------------