Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

SFI-GSI Investigator's Programme

2015: Developing geochronology by LA-ICPMS imaging: applications of U-Pb calcite dating in raw materials research
Dr David Chew, Trinity College Dublin

Co-funded with EPA

Lay abstract: Calcite is the major rock-forming mineral in limestones, and is a common mineral in veins in zinc and lead ore systems such as the world-class Irish Zn-Pb mineral province. Calcite is also a common in mineral in sedimentary basins, where it fills the porosity in hydrocarbon reservoirs. This proposal will develop a new image-based approach to dating calcite by the U-Pb method, using a laser-ablation system coupled to a mass spectrometer. Isotopic dating of calcite has important industrial applications and permits dating of carbonate rocks from key time periods in the ancient geological record, before the appearance of hard-bodied fossils.

Scientific abstract: Calcite is a common mineral in both ore systems (in carbonate veins or cements) and in petroleum systems (as a diagenetic phase destroying porosity in hydrocarbon reservoirs). Isotopic dating of calcite therefore has important industrial applications, such as constraining the timing of mineralization in the world-class Irish Zn-Pb mineral province. Isotopic dating of calcite also facilitates direct dating of carbonates for key time intervals in Earth history, particularly those associated with ancient climatic changes that are poorly constrained due to the absence of hard-bodied fossils. Present approaches to U-Pb dating of calcite suffer from large age uncertainties due to low U concentrations and/or high amounts of initial Pb. This proposal (backed up by a comprehensive pilot study on limestones, dolomites and vein calcite) demonstrates that an LA-ICPMS rastering approach can often circumvent these limitations. The generation of U/Pb image maps facilitates identification of high and low U/Pb portions of the rastered area, which can be sub-sampled to yield a sufficient spread on isochrons to yield U-Pb calcite age uncertainties as low as ±1%. These U/Pb image maps can be precisely overlain over other images (other LA-ICPMS elemental maps, photomicrographs or SEM-CL images) to spatially link age information to calcite paragenesis.

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2016: Structure, evolution and seismic hazard of the Irish offshore: An investigation using the first broadband, ocean-bottom seismometer deployment offshore Ireland
Prof. Sergei Lebedev, Dublin Institute for Advanced Studies

Co-funded with Marine Institute

Lay abstract: 90% of Ireland's territory is offshore. This underwater territory contains vast natural resources but also hazards: Ireland's offshore earthquakes are its largest and can trigger undersea landslides, causing tsunamis. In this project we will deploy, for the first time, an array of ocean-bottom, broadband seismometers offshore Ireland. Together with dense existing arrays onshore, the array will cover the entire Irish territory. The unique new data will yield important insights into basin-evolution processes, the origins of the volcanism that formed the Giant's Causeway and other geological landmarks, the offshore-seismicity distribution and hazard, and the development of conventional and geothermal energy resources.

Scientific abstract: Ireland's largest sedimentary basins, hydrocarbon resources and natural hazards (offshore landslides) are in its vast offshore. The lack of broadband seismic sensors offshore has hindered our understanding of the deep mechanisms of the lithospheric hyper-extension that formed the basins, mechanisms of the Paleogene uplift and volcanism in and around Ireland (probably related to the enigmatic Iceland Hotspot activity, they affected the structural and thermal evolution of the basins), regional-scale structure and evolution of the area's crust and lithosphere, and its current deformation and seismicity. In this project, we will take advantage of the exciting opportunity presented by the establishment of the SFI-funded Insitu Marine Laboratory for Geosystems Research and deploy 18 new, broadband, ocean-bottom seismometers across Ireland's offshore. Surface-wave array tomography will be performed using broadband phase velocity measurements, obtained with ambient-noise and teleseismic cross-correlations and waveform inversions. Waveform tomography of Ireland and NE Atlantic will be performed using 3D waveform sensitivity kernels and the new NAGTEC model of the NE-Atlantic crust. An offshore earthquake catalogue and probabilistic hazard estimates will be obtained. Lithosphere-scale thermal evolution of the basins will be modeled. The project will yield important new information on regional geodynamics and conventional and geothermal energy resource development.

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2016: Mapping, Modelling and Monitoring Key Processes and Controls on Cold-water Coral Habitats in Submarine Canyons (MMMonKey_Pro)

Prof. Andrew Wheeler, University College Dublin

Co-funded with Marine Institute

Lay abstract: Submarine canyons in the deep ocean are rich environments supporting fisheries and oil reservoirs although often closed for conservation. One such canyon, the Irish Porcupine Bank Canyon (PBC) supports deep-water coral reefs and is studied here as an example of others. We use advanced robotic technology and novel 3D visualisation tools to

explore and monitor the PBC defining seabed processes that dictate where corals occur and their sensitivity to climate change and fisheries/oil industry impacts. Recommendations for sustainable responsible fisheries and hydrocarbon activity and for effective management during climate change will be defined to the benefit of society.

Scientific abstract: Submarine canyons are dynamic environments that support diverse biological communities including fisheries. Recent work on the Irish Porcupine Bank Canyon (PBC), a natural laboratory isolated from terrigenous input, has revealed extensive speciose, high biomass cold-water coral (CWC) structural habitats. This “big science” project uses Irish state-of-the-art and new innovative marine exploration and analysis technologies to explore and monitor the PBC-CWC habitats and relate to ocean-climate environmental dynamics. The project will employ ROV-based multibeam bathymetry and novel 3D photogrammetric approaches for geostatistical analysis and habitat characterisation. Monitoring of canyon hydrodynamic and sedimentary processes, core and coral-morphotype analysis will reveal the process thresholds defining coral sub-habitats’ limits, in space and time, and allow predictive CWC, and habitat sensitivity, models to assist marine spatial planning. By assessing the magnitude of existing anthropogenic impacts within the constraints of the sensitivity model, recommendations can be extrapolated from the data for sustainable, responsible intervention in these habitats for fisheries and hydrocarbon exploration. Likewise, process thresholds will reveal the potential impact-response from climate change facilitating knowledge-based recommendations for effective management. This project adds to Irish seabed mapping capacity, develops a critical mass to generate large consortia, building further capacity and relationships with industrial (hydrocarbon)/international partners.

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2017: Integrating multidisciplinary geoscientific data into forecasting models to monitor and predict coastal change: Proof of concept in Dublin Bay.

Prof. Brian Kelleher, Dublin City University

Co-funded with Marine Institute

Lay abstract: Coastal zones are threatened by forces such as climate change and sea-level rise that combine to drive increasingly intense storms, flooding, and erosion. Assessment and prediction of coastal vulnerability can only be achieved by systematic and sustained monitoring of physical, chemical and biological processes that occur in coastal zones. The objective of our project is a coordinated program of coastal observations that will be used to validate, calibrate and extract as much information as possible from satellite environmental data. We will integrate these datasets to generate forecasting models that can be used to predict environmental change and inform future planning.

Scientific abstract: Satellite-based environmental data is an important asset that can provide cost effective and timely information for mapping, monitoring, and managing coastal

environments. It is therefore a major tool that we can use to address societal challenges such as coastal flooding, port security or marine pollution. A primary objective of our project is a coordinated program of coastal ocean observations that will be used to validate, calibrate and extract as much information as possible from satellite earth observation data. We will integrate these datasets to generate models that can be used to predict environmental change. These models will contribute to future planning in a diversity of areas such as coastal mapping, flooding prediction, marine habitats and fisheries, climate change, environmental protection and policy. The project aims to provide experimental proof-of-concept in Dublin Bay that can be extrapolated to a range of environments. All data and models produced will be made publicly available. The project is multi-disciplinary and will integrate mathematical modelling, remote and in-situ sensing, physical and chemical oceanography and seabed mapping. Implementation will be accomplished using a suite of open source tools such as satellite data and validated with comprehensive ground-truthing of water and sediment chemical, biological and physical properties.

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