

INFOMAR supports TOSCA, a detailed geological and biological study of anomalous mountains, west of Ireland on the mid-Atlantic ridge.



Figure 1. The TOSCA team before departing Galway for the Mid-Atlantic Ridge

INFOMAR supports multidisciplinary marine research by working with marine researchers, sharing resources and expertise in seabed mapping. This is exemplified by the TOSCA geological and biological research survey that took place over May - June 2018 with the mission to studying the mid-Atlantic ridge, a complex area located 1,600km west of Ireland deep in the Atlantic Ocean.

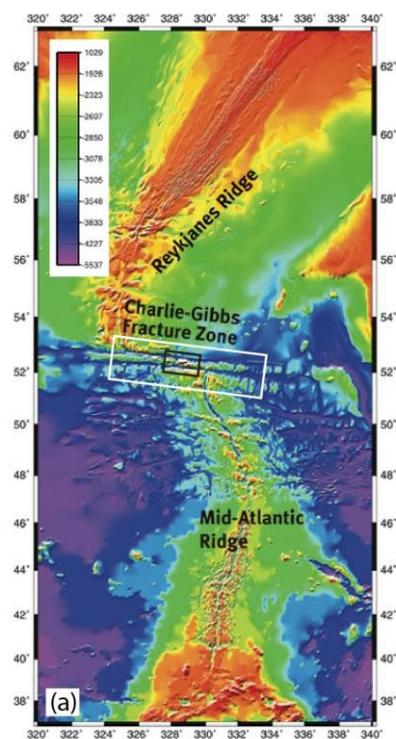
Tectonic Ocean Spreading at the Charlie-Gibbs Fracture Zone (TOSCA) was planned over 3 years by Aggie Georgiopoulou from the University College Dublin (UCD), Maria Judge (GSI) and Bramley Murton from National Oceanography Centre (NOC) in Southampton.

Thirteen scientists in total steamed 1,600km West from Galway to the site, a distance equal to a journey from Galway to Venice! On-board Ireland's largest Research Vessel (RV), the Celtic Explorer, was a full crew and equipment, taking up all of the vessel's deck space.



Figure 1. The RV Celtic Explorer at sea

During the month at sea, working 24 hours a day, seven days a week, marine surveying equipment including Ireland's marine robot, the Holland 1, was used to characterise an important part of our planet, called the **Charlie Gibbs fracture zone**.



The Charlie Gibbs fracture zone consists of two large scale cracks called fracture zones, visible on the seabed, that cross the Atlantic from Ireland to Newfoundland. These parallel cracks are 40 km apart on both the American and European tectonic plates and they continue to separate at about the rate your fingernails grow, from the centre of the Atlantic at the mid-Atlantic ridge. The cracks, or fracture zones, offset the mid-Atlantic ridge by 370km, and characterise a unique style of spreading between them that result in Alpine Scale Mountains, 4km high! That is four times larger than Ireland’s largest mountain Carrauntoohil. See below graphic illustrating this comparison.

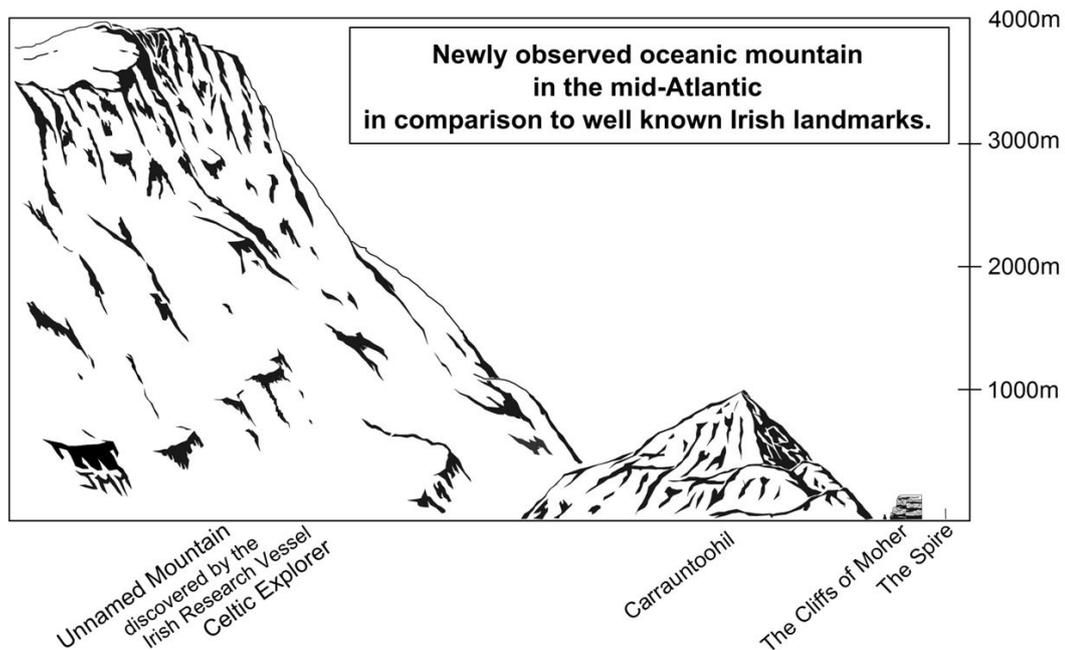


Figure 3. 4km high mountains under water in comparison to well-known Irish landmarks

Studying the seabed here, we learn a lot about the geological mechanisms the Earth uses to continue evolving. These mechanisms produce large scale earthquakes and landslides, both at sea and on land. Rocks exposed by these mechanisms can produce metals in great abundance and contribute energy to life in the deep sea.

- **Seafloor Mapping**

The first task was to map the seafloor using sound emitted from a multibeam echosounder. Echosounders were used to measure the depth of the ocean floor allowing the scientists to gain a greater understanding of the shape of the ocean floor. This provides the scientist with the locations to launch the Remotely Operated underwater Vehicle (ROV), the Holland 1, for video surveys of both the geology and biology. The RV Celtic Explorer was fitted with the same multibeam system used on INFOMAR surveys as it was ideal for mapping the dramatic relief of the 4km high mountains. This system was set up and operated by INFOMAR staff and the sampling tools, accessories and software used to process the data and create maps for geological interpretation were coordinated by INFOMAR staff for the duration of the survey.

- ***Seismic Geophysics Survey***

The TOSCA Survey carried out seismic reflection geophysics surveys and acquired sub-bottom acoustic profiles to understand the sediment cover infilling the trough and seafloor morphology. This survey allowed the scientists a greater insight into the sediments below the seafloor. These offered an understanding into sediment distribution and gave the scientists a better idea of locations to core and sample the sediments. The seismic gear was launched on two occasions for a total of two days. Images obtained from this survey gave the team a 2D time-slice in direction of travel through the subsurface determining the structural information about the sediments forming the present and ancient seabeds.

- ***ROV Holland 1 Dive and Sampling***

Multiple ROV dives were completed where video data of the seafloor geology and biology was acquired along with sample collection. The multibeam echosounder mounted on the ROV also allowed for mapping of the seafloor at a much higher resolution (5m) compared to using a similar multibeam mounted to the ship's hull. Over the course of the TOSCA project, the ROV collected approximately 4,600 images, 67 hours of HD video and a total of 3.3Tb of data. The aim of the dives was to gain a greater understanding as to why species occur where they do determined by the environmental conditions such as the terrain (depth, slope, aspect, roughness of terrain). TOSCA scientists identified over 200 biological species during the ROV dives. Additionally, samples and specimens were collected and the morphology of the samples was examined in greater detail on board the ship and will continue to be examined by the partner agencies.

Having returned with a wealth of rock and biological samples as well as video and geophysical datasets, scientists from the nine participating agencies will continue working to produce and circulate ground breaking results. This research will detail the mode of spreading at this location on the Mid Atlantic Ridge. The final results will detail the mechanisms that form and erode the 4km high mountains. Further details about the chemical interactions of the rocks and biological habitat will complete the Earth systems approach to our study, ultimately resulting in bettering our understanding for this key area in the Atlantic.

The success of such a high profile scientific research expedition to one of the most remote parts of the world shows that Ireland has the capacity to contribute to global leading edge marine research.



Figure 4. Marine Geologists Maria Judge and Isobel Yeo working on board the RV Celtic Explorer from the operating desk of the marine robot ROV Holland 1

The nine research agencies involved were the Geological Survey Ireland, University College Dublin, National Oceanography Centre, Marine Institute Ireland, Queens University Belfast, Memorial University and Marine Institute Newfoundland, Canada National University of Athens, Greece, Christian-Albrechts Kiel University, Germany. The expedition was funded by National Development Plan, Irish National Research Vessels Ship-Time Programme, Deutsche Forschungsgemeinschaft, the INFOMAR programme and the Atlantic Ocean Research Alliance.

Link to further project information:

<https://www.gsi.ie/en-ie/events-and-news/news/Pages/TOSCA-expedition-sets-sail-for-the-mid-Atlantic.aspx>

