2018 ASPIRE WHITE PAPER FOR THE EXPLORATION OF THE CHARLIE-GIBBS FRACTURE ZONE, CENTRAL ATLANTIC

CONTACT INFORMATION

Aggeliki Georgiopoulou (marine geology, sedimentology and geophysics), University College Dublin, Ireland, aggie.georg@ucd.ie
Bramley Murton (marine geology, igneous petrology and geochemistry), National Oceanography Centre, Southampton, UK, bramley.murton@noc.ac.uk

Co-proponents (in alphabetical order)
Jason Chaytor (marine geology, sedimentology, geophysics), US Geological Survey, Woods Hole
Patrick Collins (marine ecology), Queen's University Belfast
Steven Hollis (igneous petrology, ore geology), University College Dublin
Maria Judge (marine geology, geomorphology), Geological Survey Ireland
Sebastian Krastel (marine geology and geophysics), Christian-Albrechts University of Kiel
Paraskevi Nomikou (marine geology, tectonics and geophysics), University of Athens, Greece
Katleen Robert (marine ecology and habitat mapping), Memorial University Newfoundland
Isobel Yeo (marine geology, igneous petrology), National Oceanography Centre

WILLING TO ATTEND WORKSHOP? Yes
TARGET NAME: Charlie-Gibbs Fracture Zone
GEOGRAPHIC AREA(S) OF INTEREST WITHIN THE NORTH ATLANTIC OCEAN: North Central
RELEVANT SUBJECT AREAS: Geology, Biology, Chemistry, Physical Oceanography

DESCRIPTION OF TOPIC OR REGION RECOMMENDED FOR EXPLORATION

Brief Overview of Area or Feature

Oceanic crust covers 72% of the Earth's surface, and is continuously regenerated along 75,000 km of mid-ocean ridges (MOR) worldwide. These spreading centres are interrupted along their length by deep and linear fracture zones that host major strike-slip plate boundaries. While there have been substantial advances in our understanding of oceanic spreading ridges, their volcanic, tectonic and hydrothermal activity, and their role in the evolution of the Earth, relatively little work has been done on oceanic fracture zones and their bounding transform faults. Recent developments have identified oceanic fracture zones as playing important roles in the chemical interaction between the Ocean and Earth's interior; hosting important marine mineral deposits; controlling the evolution of passive margin basins; providing insights into the role of serpentinisation on reducing seismic activity and hazards at strike-slip plate boundaries; providing important pathways for deep-ocean circulation; and fostering high degrees of biodiversity and benthic population connectivity.

The Charlie-Gibbs Fracture Zone (CGFZ) is one of the most spectacular and significant examples of an oceanic fracture zone intersecting a MOR. It forms a major transform fault complex that has been active since continental break-up. It offsets the Mid Atlantic Ridge (MAR) approximately 370 km left-laterally, between Iceland and the Azores (52° to 53° N) (Figure 1). It is thought to have initiated on a continental plate and continued to evolve with the opening of the N Atlantic. The CGFZ provides a major pathway for the flow of deep, cold and oxygenated Atlantic Deep Water. The supply of nutrient-rich water at the convergence between the Polar and Atlantic Ocean fronts supports a rich ecosystem. So rich is the biodiversity here that the area of the CGFZ was declared one of the first Marine Protected Areas in the high-sea. Baseline and geological investigations will contribute to environmental protection measures.

Brief Summary of Current State of Knowledge

The CGFZ comprises two seismically active E-W transform-fault valleys separated by a short ridge. The width of the ridge spreading centre is 40 km. Hence the central rift is simultaneously an inside corner, a slow spreading centre, and a cold low-magma supplied system. The median ridge between the double transform faults was first studied in the 60's and 70's. More recent opportunistic AORA backed transit high resolution multibeam data, acquired by the Irish lead AORA transatlantic expeditions of 2015, 2016 and 2017 have provided greater detail of

the area of spreading between the double transform faults. Following these expeditions, the Irish lead TOSCA expedition (CE18008) May-June 2018, surveyed and sampled a portion of the median ridge, using high resolution multibeam swath sonar and multichannel seismic reflection profiles, dredge, gravity core and ROV sampling. Alpine scale corrugated dome-shaped massifs to the east and west of the central spreading centre confirm the presence of a series of OCCs between the fracture zones. Cyclical OCC formation with no obvious localised volcanism indicates spreading is accommodated by movement of upper crustal and lower mantle rocks along deep detachment faults exclusively.

The varying and abrupt topography of the CGFZ has had a demonstrable effect on North Atlantic current circulation and the Atlantic overturning (i.e. North Atlantic Current). Dramatic topographic relief and deep parallel transform fault valleys create flow paths across the MAR, these are known to be responsible for generating surface eddies and stimulating a hotspot of biodiversity here.

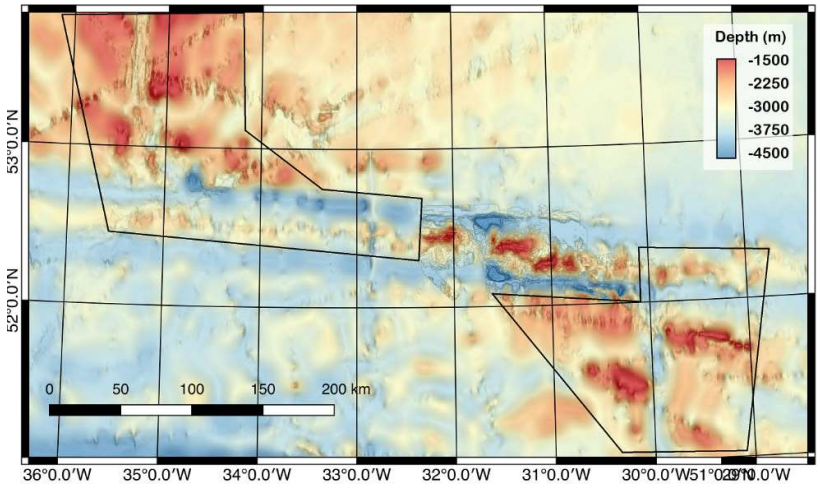

Figure 1. Proposed area of future investigations adjacent to the AORA and TOSCA mapped area at the CGFZ. Marked with black boxes are areas of priority interest.

Rationale for Future Exploration

Data collected from the area to date testify to the significance of this site in the Central North Atlantic in terms of geological processes, plate tectonics, geohazards, biological activity and physical oceanography. Additional high resolution imaging in this region would significantly increase our understanding of the unique spreading history in a region of the Atlantic where there is least influence of the Icelandic Hotspot and the Azores hotspot. The spreading axis between the Charlie Gibbs Fracture zones, has yet to be sampled. Sampling here is of particular interest considering a lack of basaltic samples yet retrieved in previous sampling champagnes... During the TOSCA expedition, ROV dives retrieved geological samples and some Eh anomalies which may indicate the presence of hydrothermal activity, but as yet no active venting has been recorded here.

The CGFZ presents a unique opportunity to study the effects of a long-lived asymmetric spreading and associated hydrothermal venting and to establish the extent of volcanism, investigate the landslide-generated tsunami hazard associated with these edifices and analyse the biodiversity hosted in these environments.

Relevant partnerships

ECOMAR, MAR-ECO, AORA, Blue Mining, MarineE-tech, InterRidge newly formed working group on mid-ocean ridge islands and seamounts