CONTACT INFORMATION

Primary Contact: Marie-Helene Cormier
E-mail Address: mhcormier@uri.edu
Home Institution: University of Rhode Island, Graduate School of Oceanography
Office Phone: (401) 874-6494

WILLING TO ATTEND WORKSHOP?

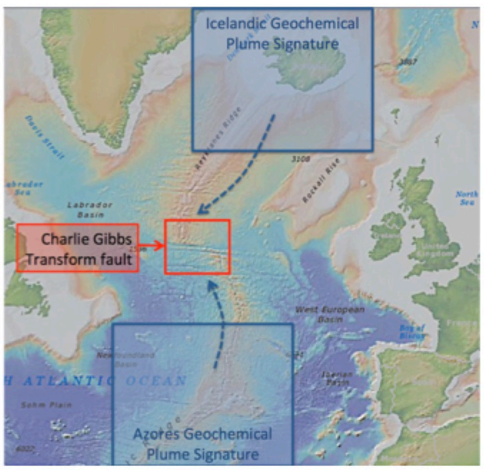
Yes

TARGET NAME

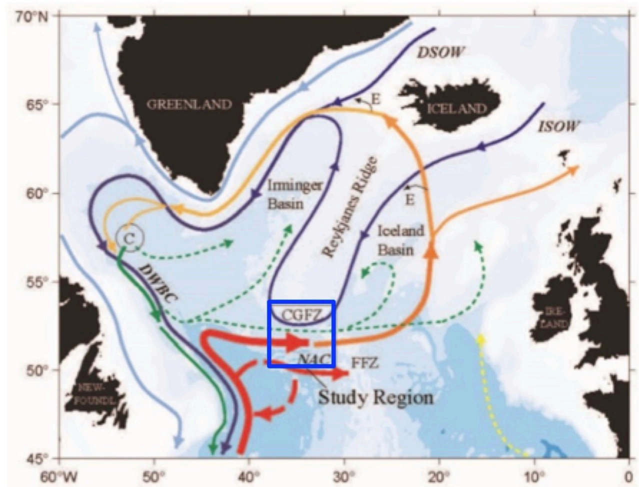
Charlie-Gibbs Fracture Zone, 52°-53°N

GEOGRAPHIC AREA OF INTEREST WITHIN THE NORTH ATLANTIC OCEAN

North Central



The Charlie-Gibbs transform separates two regions of the Mid-Atlantic Ridge with contrasting morphology and mantle geochemistry.



The blue box outlines the position of the Charlie-Gibbs transform. At depth, the cold ISOW (blue) flows westward across the transform fault. Near the surface, the warm North Atlantic Current (NAC) flows eastward.

RELEVANT SUBJECT AREAS

Biology, Geology, Chemistry, and Physical Oceanography

DESCRIPTION OF REGION RECOMMENDED FOR EXPLORATION

Large oceanic transform faults are associated with valleys 10-20 km wide and >1,000m deeper than the ridge segments that abut them. As such, they provide strategic gateways across the mid-ocean ridge for bottom waters, and may also provide critical stepping-stones for the spread of bathyal ecosystems. The tectonic evolution of ocean basins is nicely recorded in the geometry and morphology of fracture zones (the fossil extensions of transform faults), their varying characteristics informing about former changes in plate motions and spreading rates. Furthermore, the largest (Mw > 6) earthquakes along the mid-ocean ridge system occur at transform faults – although the impacts at the seafloor of such earthquakes remain undocumented.

With a left-stepping offset of 340 km, the Charlie-Gibbs is the longest transform fault in the North Atlantic, its offset comparable to those of the prominent equatorial transform faults between 1°N and 2°S. It is centered at 52°-53°N and is the only significant transform fault between the Azores (38°N) and Iceland (63°N). It offers the deepest gateway (~3,600 m) between western and eastern ocean basins over a 2,800 km-long section of the northern Atlantic. Hydrographic surveys show that the transform valley is a crossroads for water masses comprising both the warm and cold branches of the Atlantic Meridional Overturning Circulation. The North Atlantic Current (NAC) transports eastward warm and relatively nutrient-poor surface water as well as colder Labrador Sea Water between 1000 and 2000 m. Below 2000 m, the transform valley is mainly filled with sediment-laden Iceland-Scotland Overflow Water (ISOW), which, along with the Labrador Sea Water, is a component of the North Atlantic Deep Water. Because the different currents and water masses are squeezed through the narrow valleys of the transform fault, it is the site of a permanent but mobile front with a particularly high productivity and species richness. In turn, this enhanced biological productivity fertilizes the deep seafloor below. Numerous species of cold-water corals, cephalopods, demersal fishes, and cetaceans have recently been identified in that area.

The Charlie-Gibbs transform fault represents a key morphological and geochemical boundary between contrasting sections of the Mid-Atlantic Ridge. To the north, the ridge is shallow and "inflated", and rock samples reveal a marked influence of the Icelandic hot spot. To the south, the ridge has a morphology and geochemistry typical of slow-spreading ridges. Recent models suggest that large-offset transform faults may generate strong lateral flow and mixing between mantle reservoirs, possibly explaining the observations. In terms of morphology, the Charlie-Gibbs comprises two branches separated by a 40 km-long spreading segment. The northern branch is heavily sedimented, suggesting that the ISOW passes preferentially through that branch, moving westward at times when the eastward NAC transport slackens or retreats southward. Lastly, the Charlie-Gibbs transform fault displays a puzzling along-strike variation in seismic behavior: The northern branch has hosted several large earthquakes (M>6.5) since 1923 with a repeating interval of 20-40 years. In contrast, the southern (unsedimented) branch has not generated any large earthquakes and may slip mostly aseismically.

Yet, despite all its superlative characteristics and strategic location, the Charlie-Gibbs transform fault remains surprisingly under-investigated, with only a small fraction of its length mapped with multibeam bathymetric resolution. Possible exploration activities could include the acquisition of full multibeam bathymetric coverage, hull-mounted sub-bottom profiling data, hull-mounted ADCP data, as well as lowered ADCP on a rosette. The collection of full-depth water samples for standard hydrography (T,S), nutrients (PO4, NO3 + NO2, SiOH4), and carbon (DIC, total alkalinity) would also prove invaluable. Lastly, near-bottom investigations with a ROV equipped with a suite of sensors, cameras, and sampling tools, would provide unique data on bathyal ecosystems and geological processes.

RELEVANT PARTNERSHIPS

Physical oceanographers at the University of Rhode Island's Graduate School of Oceanography (GSO) have long investigated the Atlantic Meridional Overturning Circulation in the general area of the Charlie-Gibbs transform fault, and GSO's geoscientists are most interested in the study of oceanic transform faults and processes affecting their evolutions.

OSPAR (a mechanism by which 15 Governments and the EU cooperate to protect the marine environment of the North-East Atlantic) has created in 2010 the "*Charlie-Gibbs Marine Protected Area"* (http://www.charlie-gibbs.org/charlie). Because this Protected Area covers a large expanse, coordinating investigations from both sides of the Atlantic would be of great benefit. The Mar-Eco project, a project of the Census of Marine Life campaign, was launched in 2001. For 10 years, scientists from 16 countries deployed an array of methods to investigate how ocean currents influence the health of the ocean around the northern Mid-Atlantic Ridge. The follow-up project ECOMAR investigated the North-South and East-West differences in the ridge ecosystems around the Charlie-Gibbs fracture zone. Last year, the *R/V Celtic Explorer* from Ireland conducted a partial multibeam survey, and this year, the same team deployed the *ROV Holand-1* (depth rated to only 3,000 m depth) to image benthic ecosystems.