2018 ASPIRE WHITE PAPER: Missing Venting of the Mid-Atlantic Ridge, 35°-39°N

Contact Information

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Willing to Attend Workshop?

Yes

Target Name(s)

Mid-Atlantic Ridge, 35°-39°N

Geographic Area(s) of Interest within the North Atlantic Ocean (Indicate all that apply)

North Central

Relevant Subject Area(s) (Indicate all that apply)

Biology	Geology
Chemistry	Physical Oceanography

Relevant Partnerships

U. Bremen (Germany) Cluster of Excellence: The Ocean Crust – Earth's Uncharted Interface
InterRidge, GEOTRACES, INDEEP

Description of Topic or Region Recommended for Exploration

Overview

The Mid Atlantic Ridge (MAR) between 35°N and 39°N is already known to host abundant, geologically diverse styles of hydrothermal venting and these sites give rise to a broad variety of vent-fluid compositions and habitats for life that, in turn, host a broad spectrum of chemosynthetic organisms with metabolisms that reflect, and are presumably controlled by, that geologic diversity. Twenty-five years on from the original discoveries of the Rainbow, Lucky Strike and Menez Gwen hydrothermal fields, however, many of the plume signals identified during the initial exploration of this region have still never been tracked to source while ROV-based geological transects have encountered unexpected additional diffuse flow sites (Fig.A1).

Over the same time-period, our ability to explore for seafloor fluid flow has been revolutionized in three important ways:

- the power of CTD tow-yo techniques has been vastly expanded with the addition of *in situ* redox (ORP) sensors as well as optical back-scatter sensors for plume detection and characterization.
- AUVs have been demonstrated to be particularly effective at tracking hydrothermal plumes to source and locating them precisely, to guide ROV-based investigations.
- In suitably shallow/gas-rich systems (primarily at ocean margins, but also on shallow ridges) it has been shown that water-column surveys using shipboard multibeam sonars can be used to detect gas-rich flares rising from the seafloor and trace them back to their source.

This white paper proposes a plan of campaign to return to the Mid Atlantic Ridge south of the Azores, informed by the latest scientific understanding *and* technological approaches, to complete a program of systematic hydrothermal exploration. The approach proposed would not only be anticipated to find new seafloor vents but also new *styles* of seafloor venting and associated chemosynthetic habitats.

Current State of Knowledge

Hydrothermal research and, more specifically, hydrothermal plume based exploration and discovery has been revolutionized in the past few years. First, it has been demonstrated that fluxes of metals from hydrothermal systems extend much farther out into the global deep ocean than can be traced by *in situ* sensors mounted on a CTD rosette. Such trace metal distributions, as revealed by the international GEOTRACES program, have now been identified in every ocean basin on Earth. Indeed, it is now predicted that stabilized dissolved Fe release through seafloor venting can persist so far that it can be upwelled into the surface ocean at high latitudes where, as an essential micro-nutrient, it can control 10-30% of CO_2 uptake and primary productivity in the Arctic and Antarctic regions, respectively. Second, theoretical modelling undertaken by SCOR Working Group 135 has predicted that the vast majority of this stabilized dissolved Fe dispersed through hydrothermal plumes may not be sourced by the high-temperature "black-smoker" venting that has been the focus of much past seafloor hydrothermal studies. Rather, it may be sourced via diffuse hydrothermal flow associated with these high temperature systems, where abundant life may lead to a ready supply of organic binding ligands. Finally, extension to the use of ORP sensors alongside traditional optical back-scatter sensors has led to a realization – based, to date, on just one study site on the northern East Pacific Rise (EPR) - that traditional CTD tow-yo surveys used routinely for hydrothermal exploration since the 1980s may have only detected a subset of all the diversity of seafloor fluid flow present. Consequently, the global-scale impact of seafloor venting may until now have remained grossly under-estimated.

Rationale for Future Exploration

New work to address the relative importance of diffuse rather than focused hydrothermal flow is now planned for the fast-spreading EPR, using the Sentry AUV and updated tow-yo techniques equipped with ORP sensors. However, slow spreading ridges such as the MAR make up more than 50% of the global ridge crest and express a much wider pattern of geologic diversity. Consequently, this white paper proposes to take the current state of the art technology for vent exploration (also including bubble mapping for shallow ± gas-rich vent-sources) and complete a more comprehensive survey for hydrothermal venting than has ever previously been achieved in this natural laboratory, known to be one of the most geologically-diverse and vent-rich sections of slow-spreading ridge-crest world-wide.

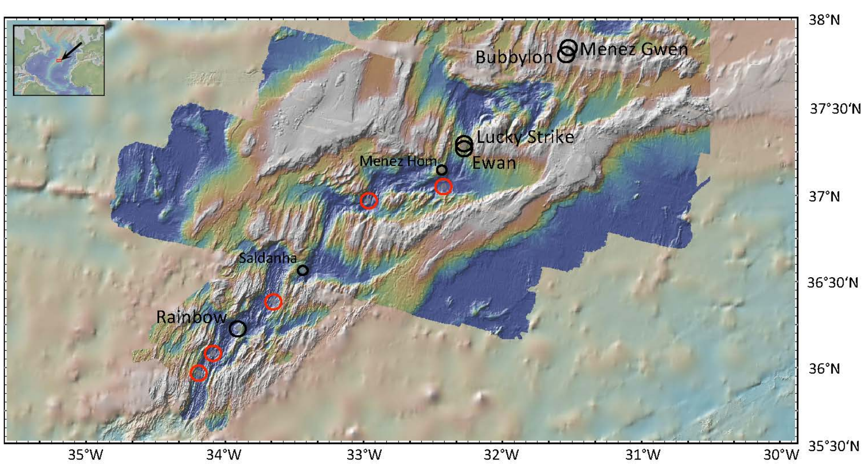

Fig.1 Map of MAR south of the Azores showing (black circles) known locations of high-T and low-T venting already known (likely a subset of everything present) plus (in red circles) the locations of additional plume signals that were first detected in 1992-1994 but which have never yet been tracked to source.