ASPIRE WHITE PAPER: GEOLOGY AND BIOLOGY OF THE AZORES SUBMARINE PLATEAU

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WILLING TO ATTEND WORKSHOP? Yes

TARGET NAME(S): Azores submarine Plateau

GEOGRAPHIC AREA(S) OF INTEREST WITHIN THE NORTH ATLANTIC OCEAN: North Central Atlantic

RELEVANT SUBJECT AREA(S): Biology, Geology, Other: Geophysics, Oceanography

DESCRIPTION OF TOPIC OR REGION RECOMMENDED FOR EXPLORATION

Rising several kilometers above the surrounding ocean floor and intersecting water masses of multiple origins, the topographically-rich Azores Plateau is of exceptional geological and ecological interest. For decades, this enigmatic feature, which consist of a triple plate junction, hundreds of seamounts and 9 inhabited islands, has attracted groundbreaking marine geological and biological research. As important aspects on the origin of the magmatic rocks, the structural evolution and the biological distributions are still missing, detailed studies will have to continue. The lack of submarine samples and imagery from this unique geological and biological habitat and the interaction between volcanism, tectonic evolution and the biological communities here makes new exploration of great interest to a broad scientific community of biologists, oceanographers and geoscientists. Our white paper brings together exploration interests from a broad community of biologists, oceanographers and geoscientists working on three prominent issues: (i) the origin of magmatic eruptives at the Azores Plateau, (ii) the chronological and structural evolution of the edifices emplaced and (iii) the way the distinct and variably geomorphology regulates the distribution of biological assemblages.

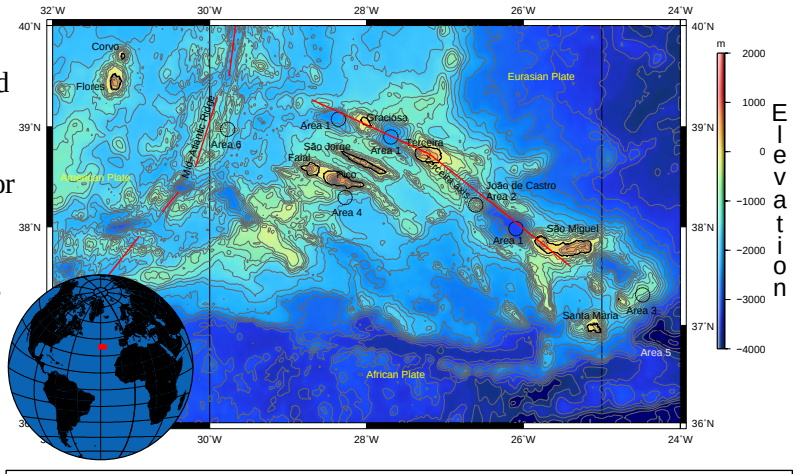

Fig. 1: Areas of interest for exploration in the Azores archipelago. Areas refer to hypotheses to be tested (see main text)

Filling these gaps is important for assessing critical hazards (e.g., landslides, volcanic eruptions, sea storms, ocean acidification and temperature changes, commercial fishing pressure and marine litter pollution), which may physically impact on human populations, the marine economy and ecology. Resolving these issues critically depends on further survey work across the full depth range and extent of the Azores Plateau. Using modern ROV technology to conduct image-supported collection of seafloor samples is instrumental, particularly in the poorly sampled deeper reaches of the Plateau,

which have been targeted by a limited number of expeditions (EMEPC/LUSO/AÇORES/G3 2008 and 2009 cruises and the RV Meteor M128 cruise in 2016).

We propose testing a number hypotheses in the course of an exploration cruise: a) do the deep basins along the northern Terceira Rift axis between the islands of São Miguel, Terceira and Graciosa show evidence for volcanic activity (Area 1 in Fig. 1), b) have the sedimentary deposits in these basins been influenced by hydrothermal venting and faulting in the past (Area 1), c) are biological vent communities in these areas similar to those in active intraplate hydrothermal systems, e.g., at João de Castro (Area 2), d) did faulting at the eastern Formigas bank influence the early igneous edifices in the Azores (Area 3), e) are both the eastern and western extensions of the Azores Plateau defined by volcanism that is chemically less enriched than that currently observed on the islands, f) can turbidites in the interisland basins be associated with recent earthquakes and, along with submarine fault breaks, assist earthquake hazard assessment (Area 4)?

The biological diversity of the Azores submarine plateau at deeper levels has barely been investigated. The interaction between geological structures and biological targets has rarely been studied, sampled or imaged during past cruises, but new exploration will allow a better understanding of the interaction between geological processes creating different substrates and the species settling in these environments.

The Azores archipelago is known to be highly active seismically and earthquakes can exceed M=6.0, as well as slope failure, volcanic eruptions and gas discharges. At present, the active lengths of faults and some of their recent offset histories are known from trenching and mapping on land, but there have been many earthquakes offshore between the islands, so it seems likely that the active lengths of faults are much larger, implying a risk of larger events. Imaging the structures of faults crossing the turbidite-floored basins between some islands could provide data on fault lengths, as well as data to constrain the timescale over which seabed breaks are preserved, before bioturbation and later turbidites destroy them, hence this problem requires biological input. The SE corner of the Azores Plateau, where the Terceira Ridge connects to the active Gloria transform Fault is also a source of seismicity that deserves attention (Area 5). In this place, strain partitioning makes earthquake focal mechanisms difficult to interpret and therefore more investigation is needed to better constrain active tectonics. Additionally, the area is key for our comprehension of the Azores Triple Junction, given that the onset of the Terceira Rift is linked to the deactivation of the East Azores Fault Zone, and the timing is poorly constrained. Samples and multibeam survey data would eventually shed light on this crucial moment in the evolution of the Azores (Area 5).

At shallower water depths (180-500 mbsl), multibeam surveys have recently provided evidence of past arrivals of icebergs to this remote mid-ocean mid-latitude area. Investigating the iceberg drag and bump marks on some Azores islands and seamounts will add a paleoclimatological aspect and also contribute to a better understanding of the forces shaping ocean island margins. ROV sediment push-core samples will be key to detecting stratigraphic discontinuities and estimating the age of these features (cf. Heinrich events?). Such information would contribute to timing extreme ocean climate episodes that likely explain the low levels of endemism of the fauna and flora currently present on the remote archipelago. ROV imaging of a selection of iceberg ploughmarks at >200m depth would further permit investigating whether the reshaped sediments exhibit vulnerable marine ecosystems (VMEs). Certain filter feeding assemblages of gorgonians, tall hydroids, scleractinian corals and sponges are known to colonize and exploit the ploughmark relief (levees, furrows) and form VMEs like corals gardens, coral reefs or sponge aggregations.

A new actively venting hydrothermal field named Luso has recently been discovered at the Gigante Seamount (Area 6), a few tens of km W of the mid-Atlantic Ridge and almost ~100 km W of the active Azores raises questions on its geological origin and whether other comparable vents exist in similar settings. The Luso site lies at only 570 mbsl and the geological, hydrothermal and biological characterization of its geomorphological context and water column imprint would greatly benefit from work with the multibeam, the echosounder and the Ocean Surveyor ADCP available onboard. Mapping the distribution and composition of fluid emissions, their hydrothermal deposits and the associated biological assemblages would benefit from further ROV surveys. The data will shed light on multidisciplinary topics such as a) the specific composition of biological vent assemblages sitting in upper bathyal grounds and what local physico-chemical conditions differ from those of deeper spreading-ridge sites and shallower hot springs, b) how off-axis magma dynamics function and what role the melt supply from the Azores melting anomaly has, c) how discharge relates to structural features and if those features are implicated in the formation and evolution of a new volcanic edifice, i.e. the position of Gigante Seamount in a E-W direction east of the mid-Atlantic Ridge may suggest that the off-axis magmas are focused into a transform fault system; this has rarely been observed in spreading axis systems globally and may be the result of the nearby placement of the Azores melting anomaly.

PARTNERSHIPS: InterRidge newly formed working group on mid-ocean ridge islands and seamounts