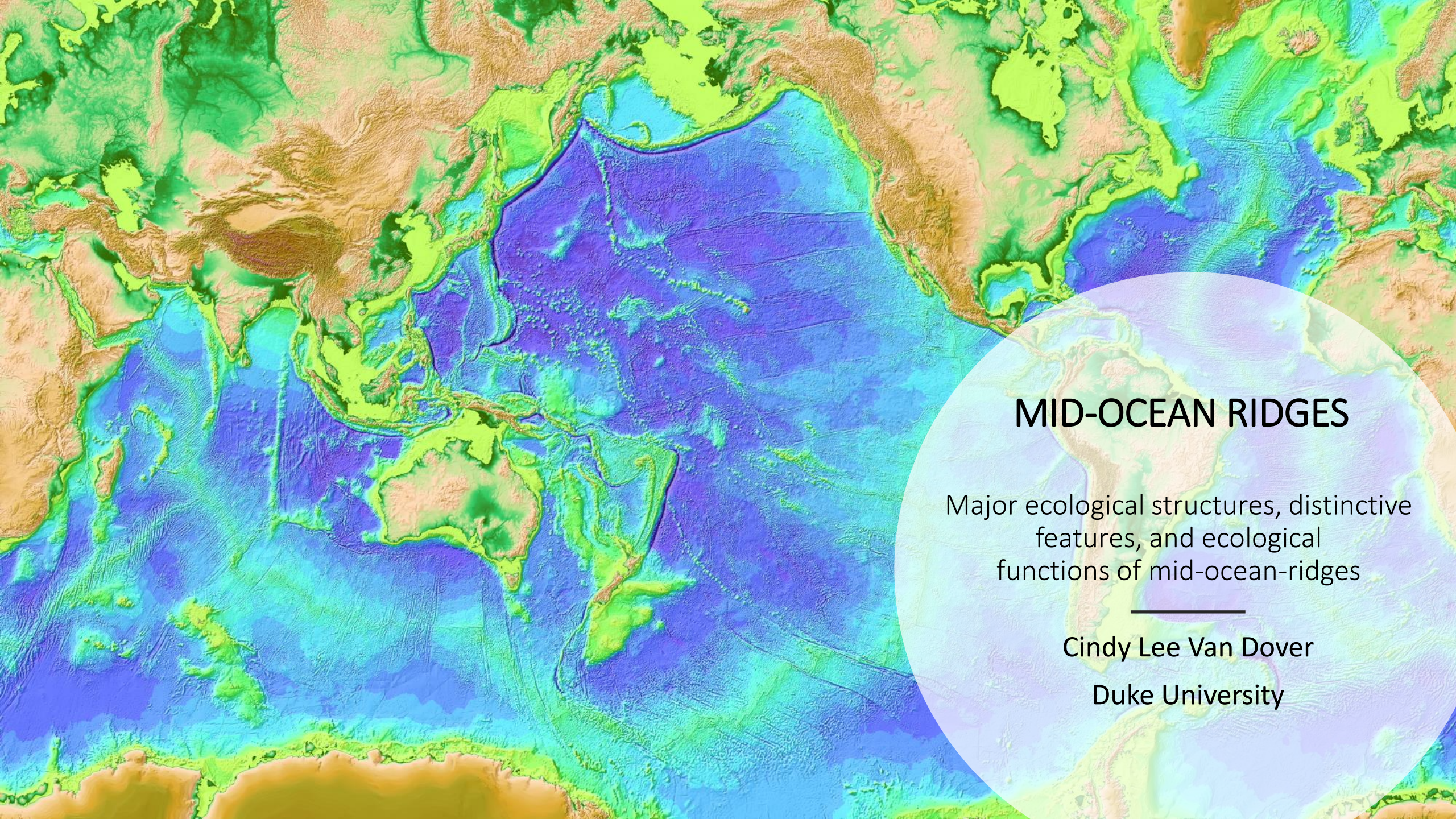


MID-OCEAN RIDGES

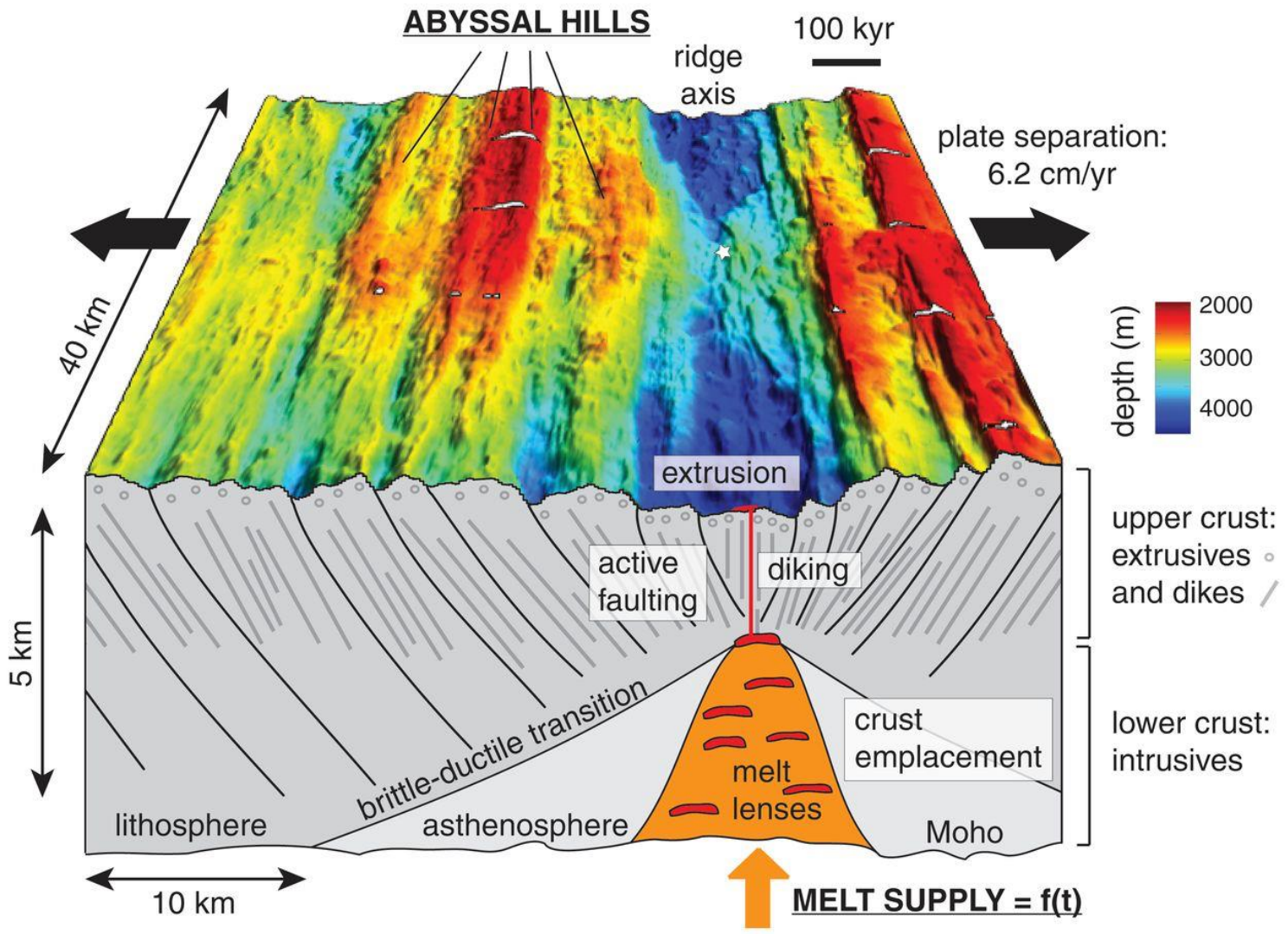
Major ecological structures, distinctive features, and ecological functions of mid-ocean-ridges

Cindy Lee Van Dover

Duke University

Mid-Ocean Ridges

Chile Ridge
(looking south)



Olive et al. 2015

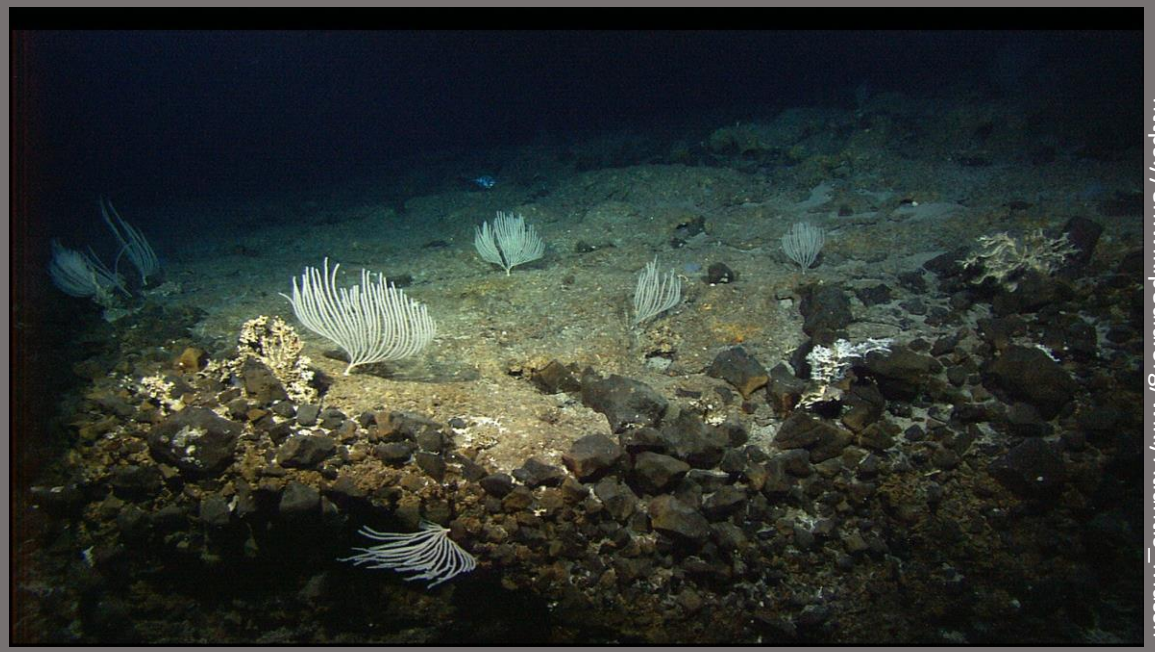
Basaltic Pavement

https://irrelevantaxiom.wordpress.com/tag/mid-ocean-ridge/

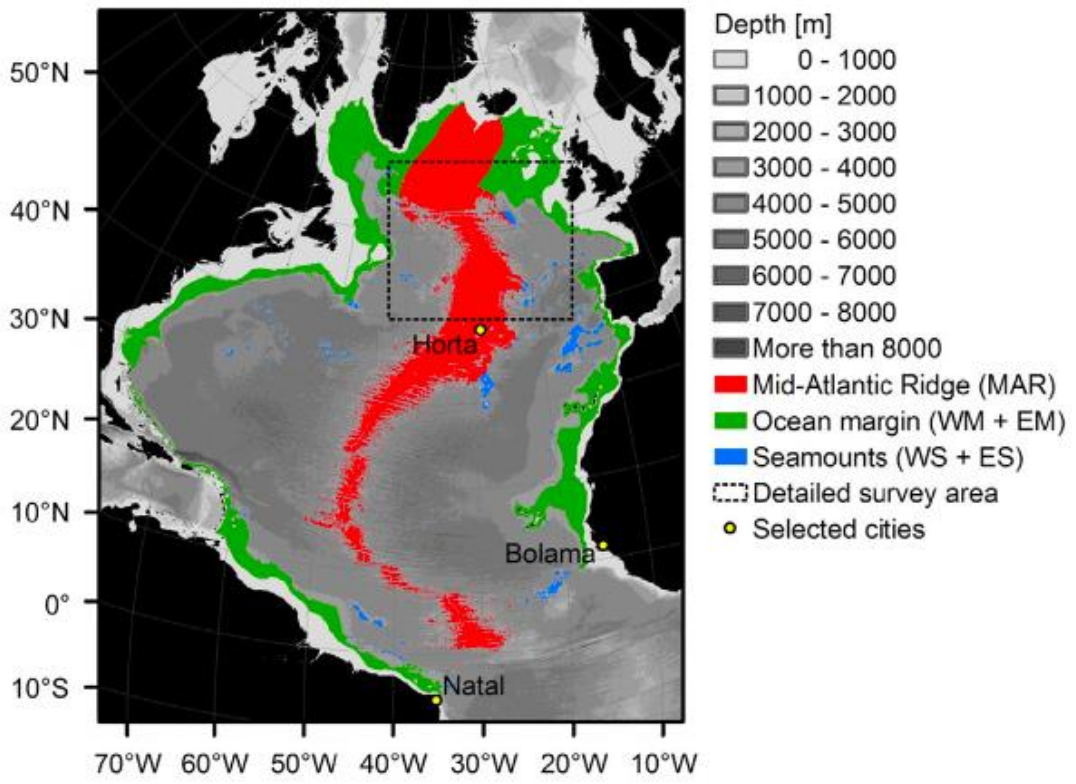
Fauna of Hard Substrata

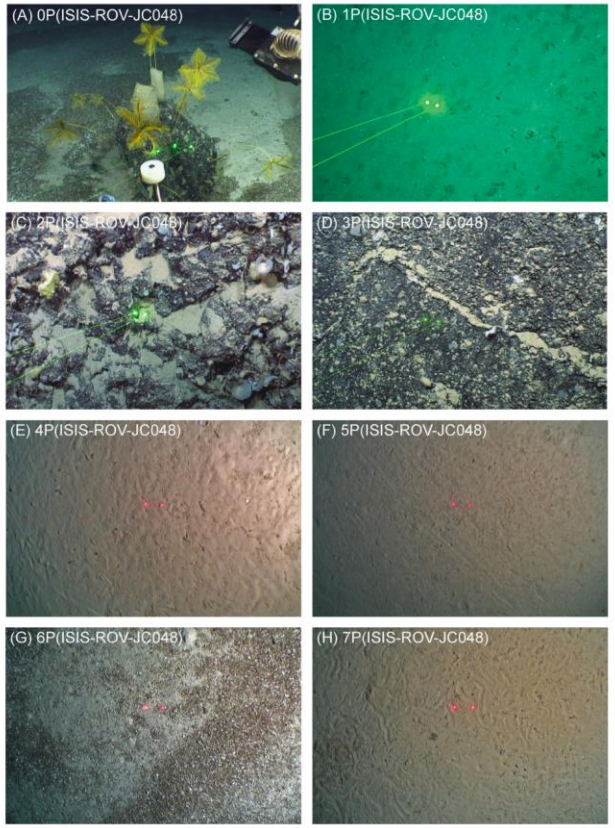
(suspension feeders)

ROV Holland II, Celtic Explorer



https://en.wikipedia.org/wiki/Atlantis_Massif

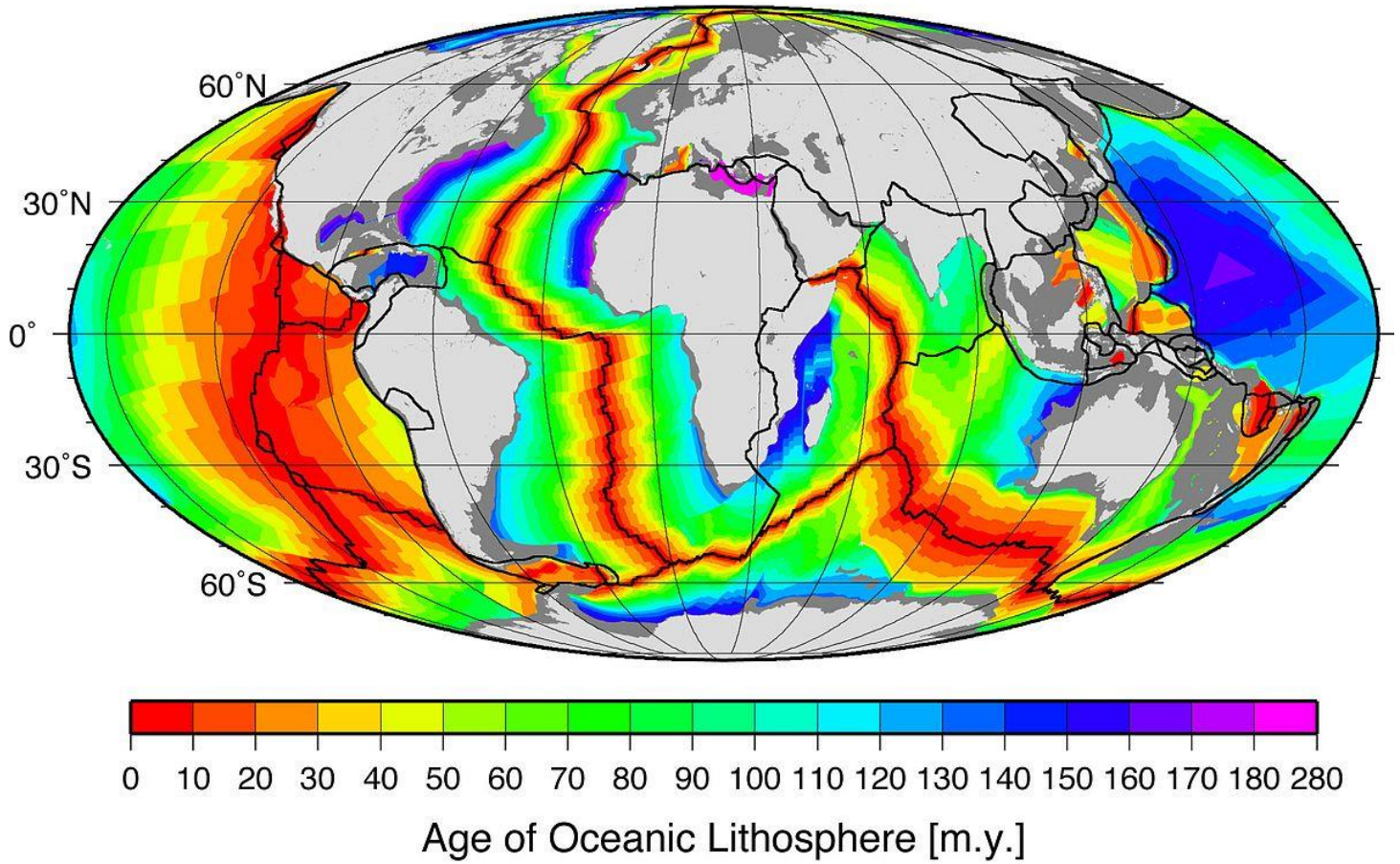




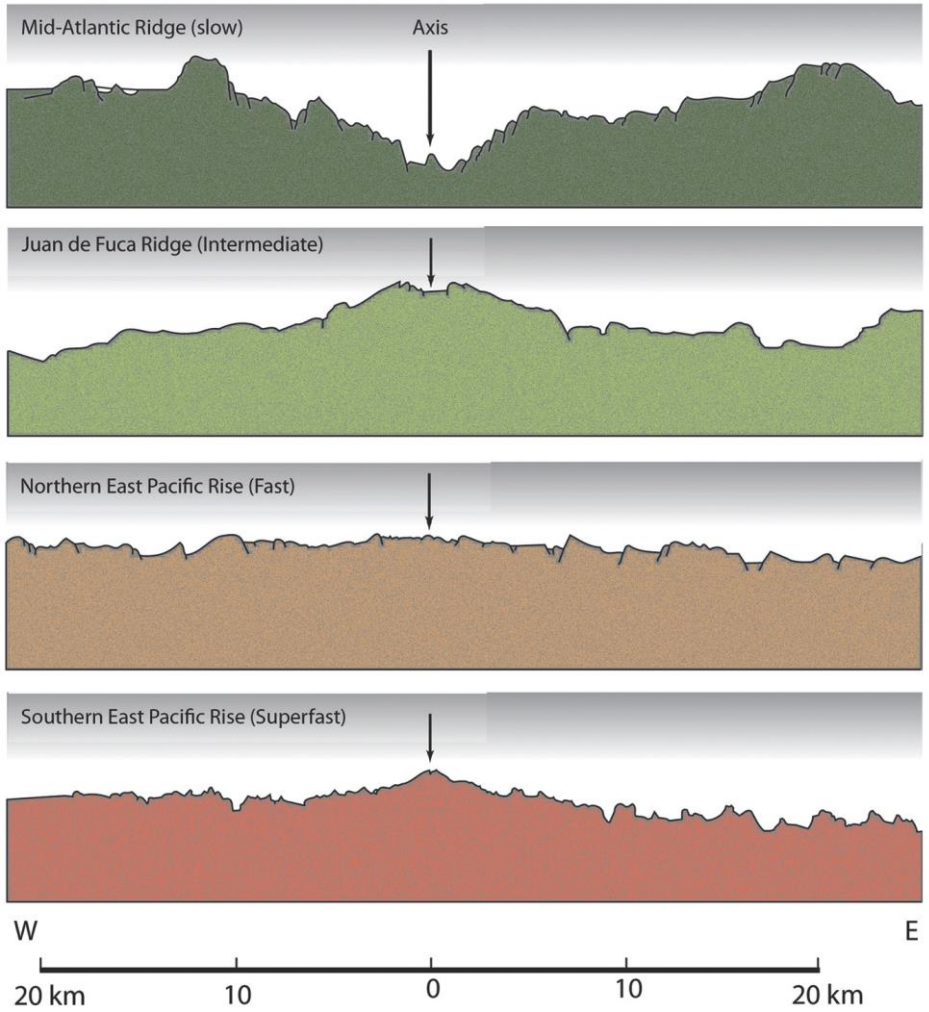
95% of Lower Bathyal Zone: Sedimented

Niedzielski et al. 2013

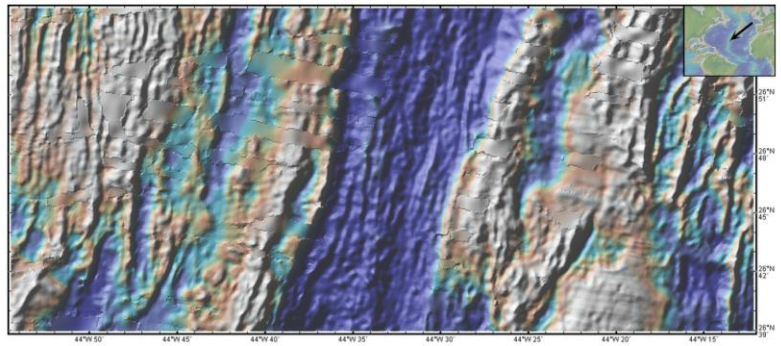
Seafloor Spreading Rates



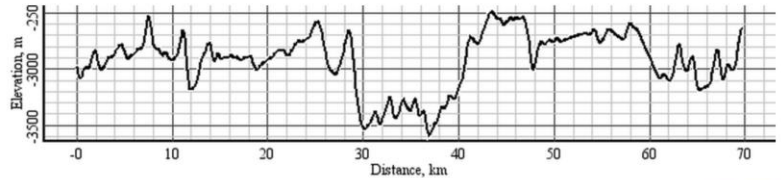
Ultraslow (< 20 mm yr^{-1})
SW Indian Ridge
Gakkel Ridge
Mid-Cayman Spreading Center
Slow (20-50 mm yr^{-1})
Mid-Atlantic Ridge
Central Indian Ridge
Intermediate (50-80 mm yr^{-1})
Juan de Fuca Ridge
SE Indian Ridge
Fast (80-120 mm yr^{-1})
N East Pacific Rise
Superfast (> 120 mm yr^{-1})
S East Pacific Rise

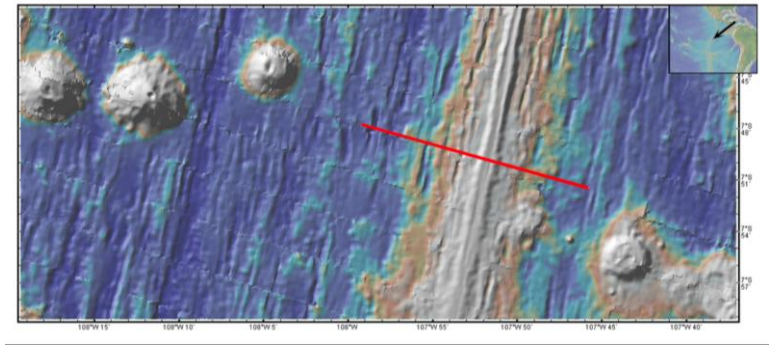


Karson et al. 2015

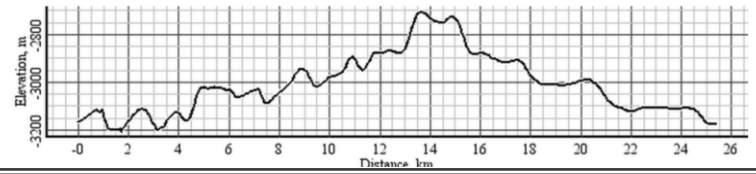


Mid-Atlantic Ridge

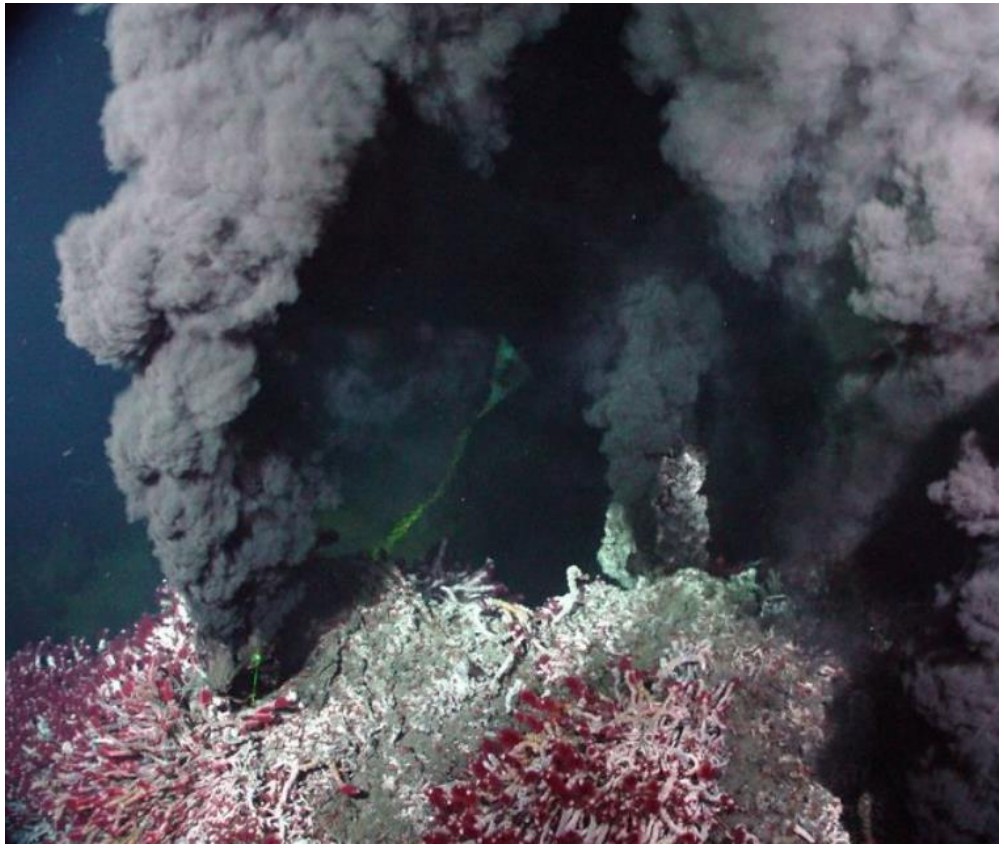


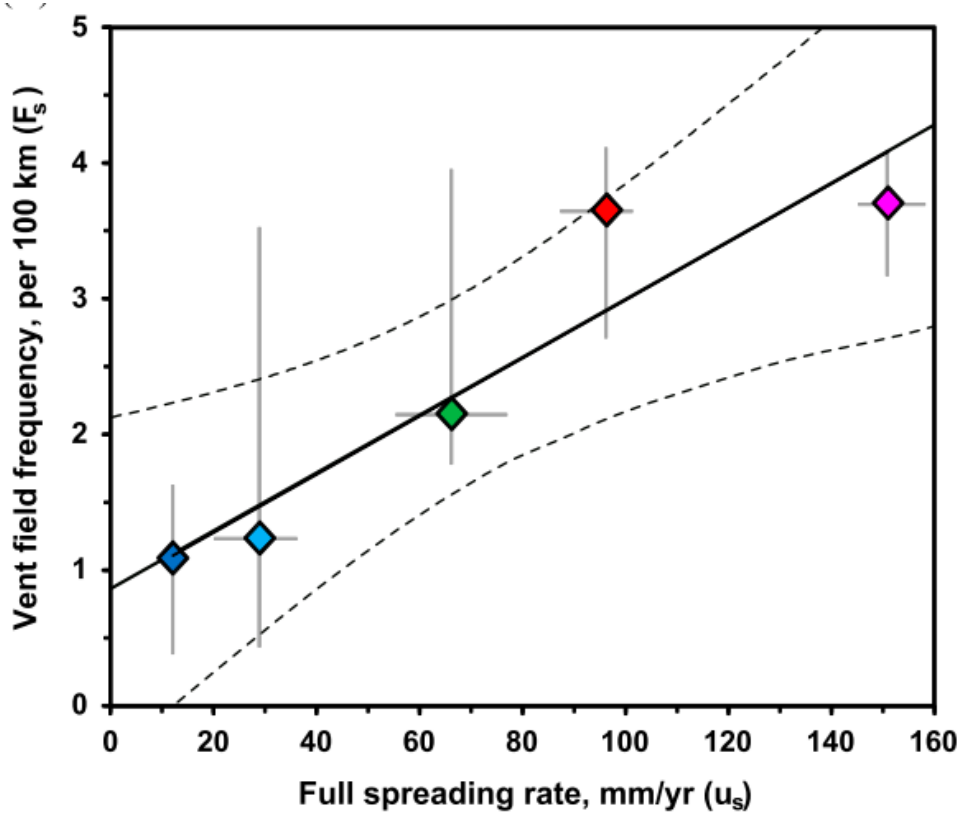


East Pacific Rise



Comparative Axial Morphology





German et al. 2015

Frequency of Vent Fields with Spreading Rate

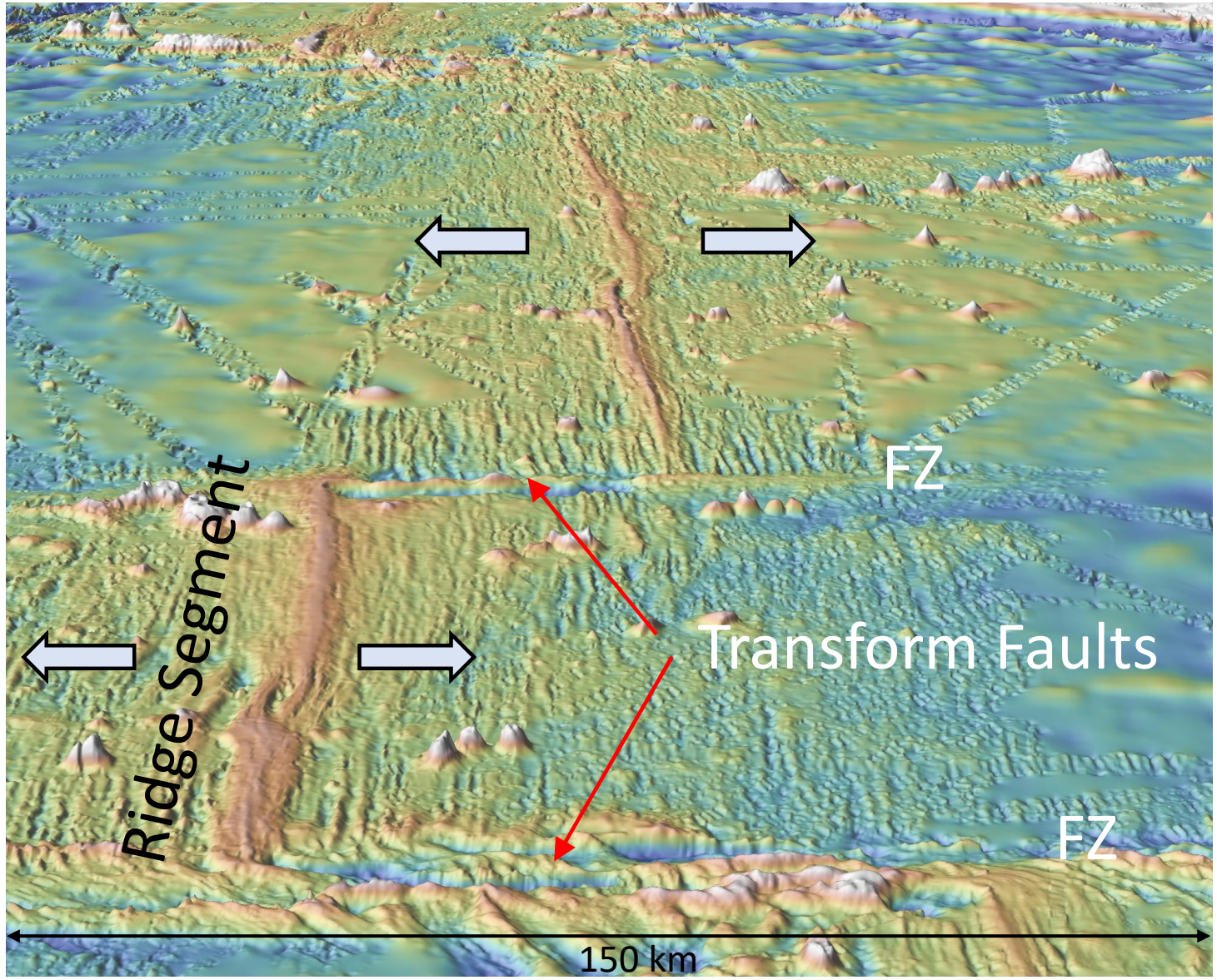
Segments

Transform Faults

Fracture Zones

Seamounts

Abyssal Hills



East Pacific Rise 7N

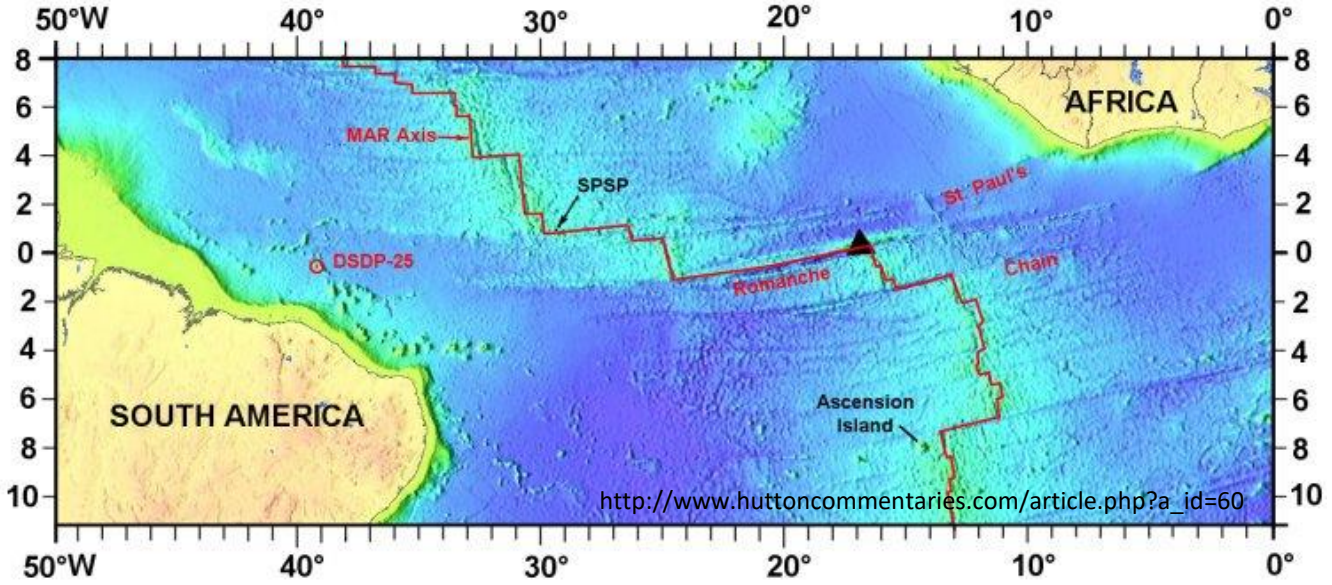
http://www.geomapapp.org/gallery/Midoceanridgesgallery.html

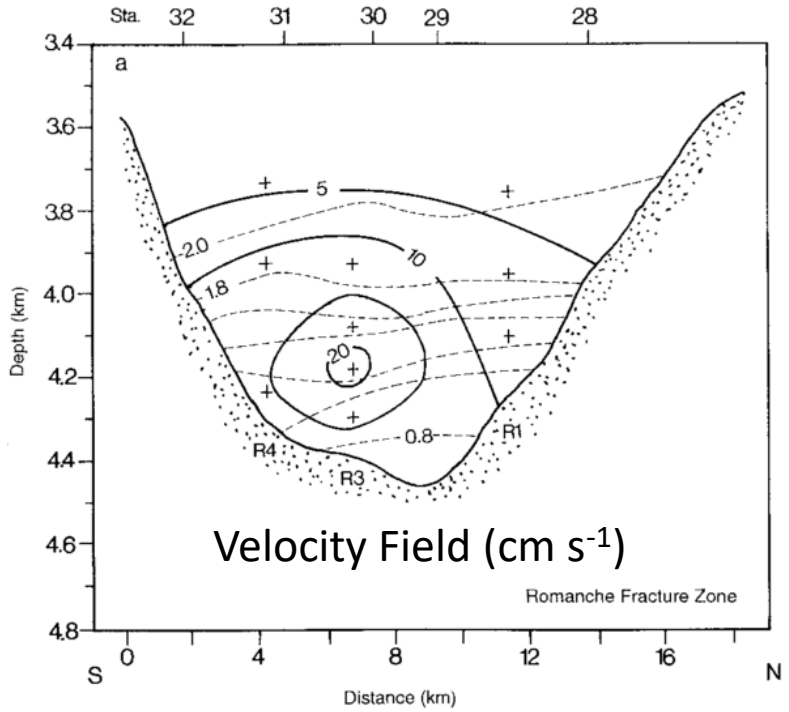
Romanche Fracture Zone

*Eastward Mass Transport

*Hadal Depths

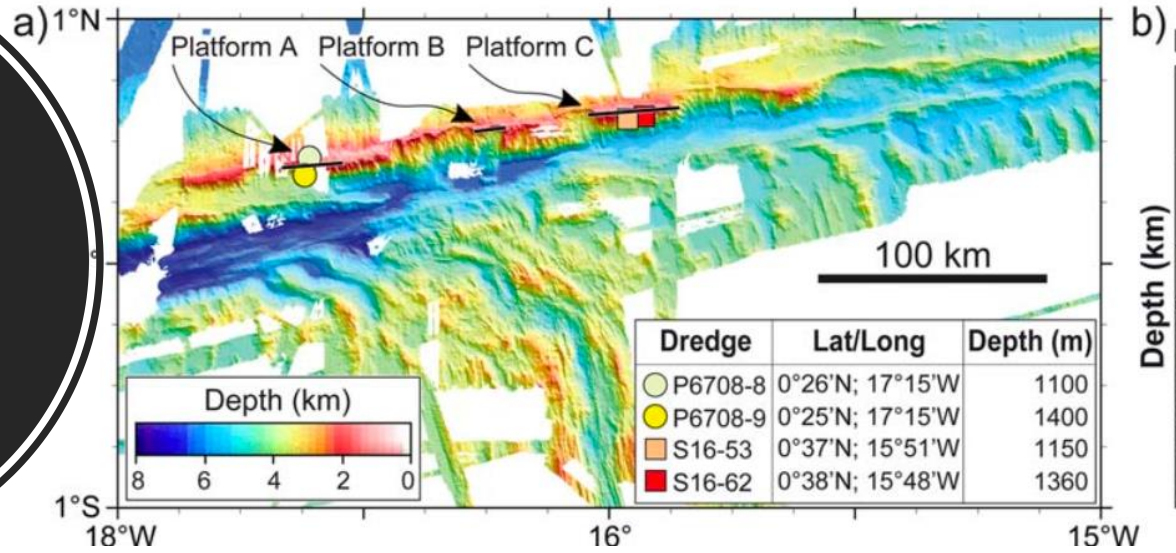
Mercier & Speer 1998

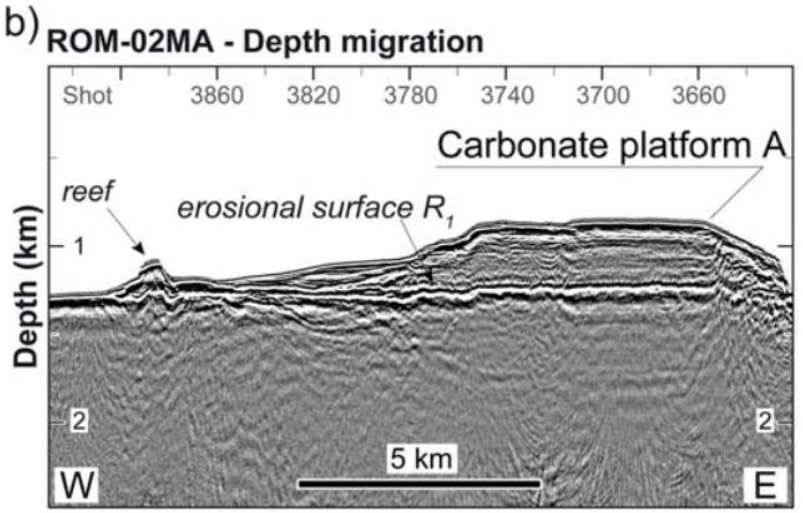




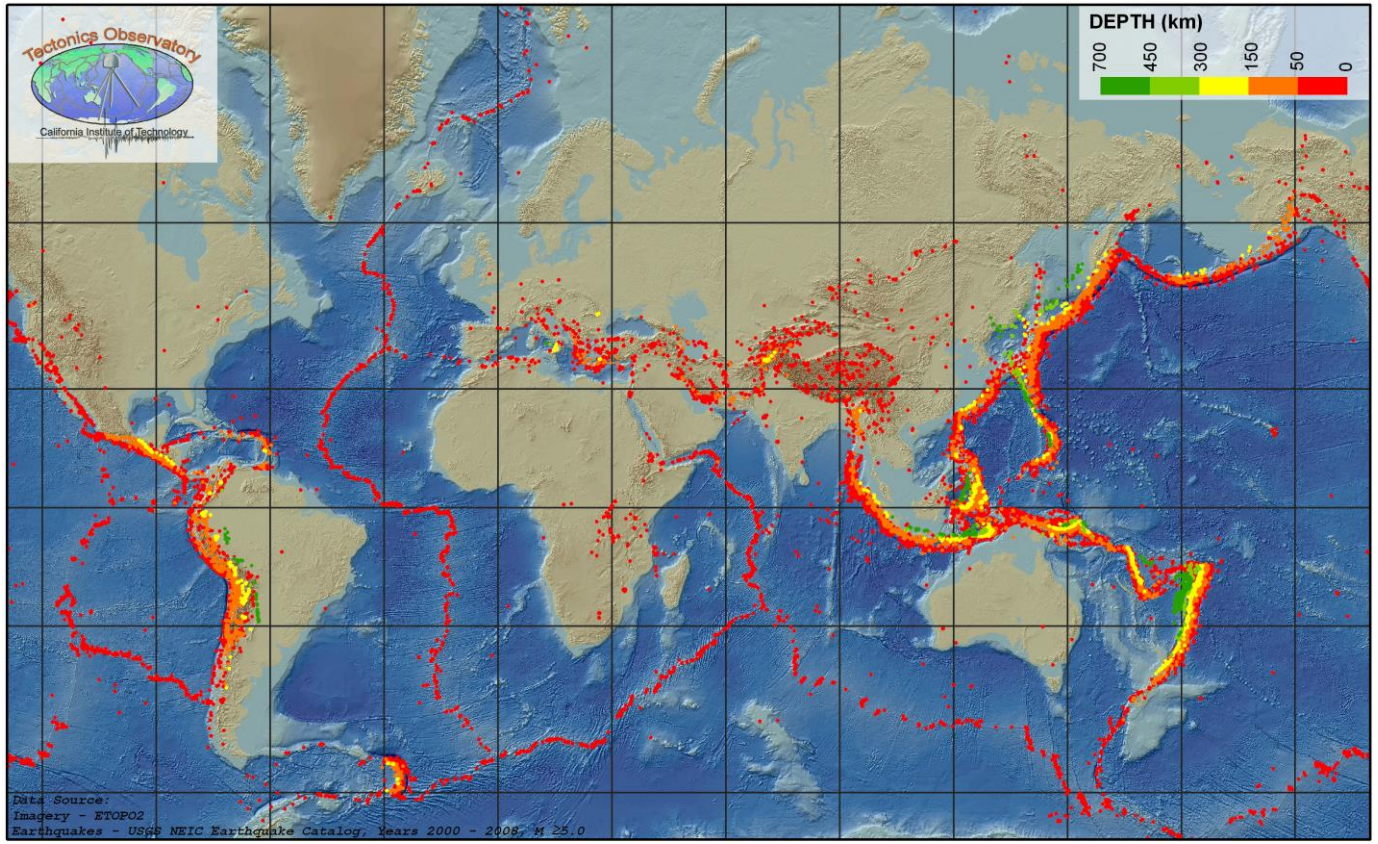
Velocity Field (cm s^{-1})

Romanche Megatransform: Submerged Islands





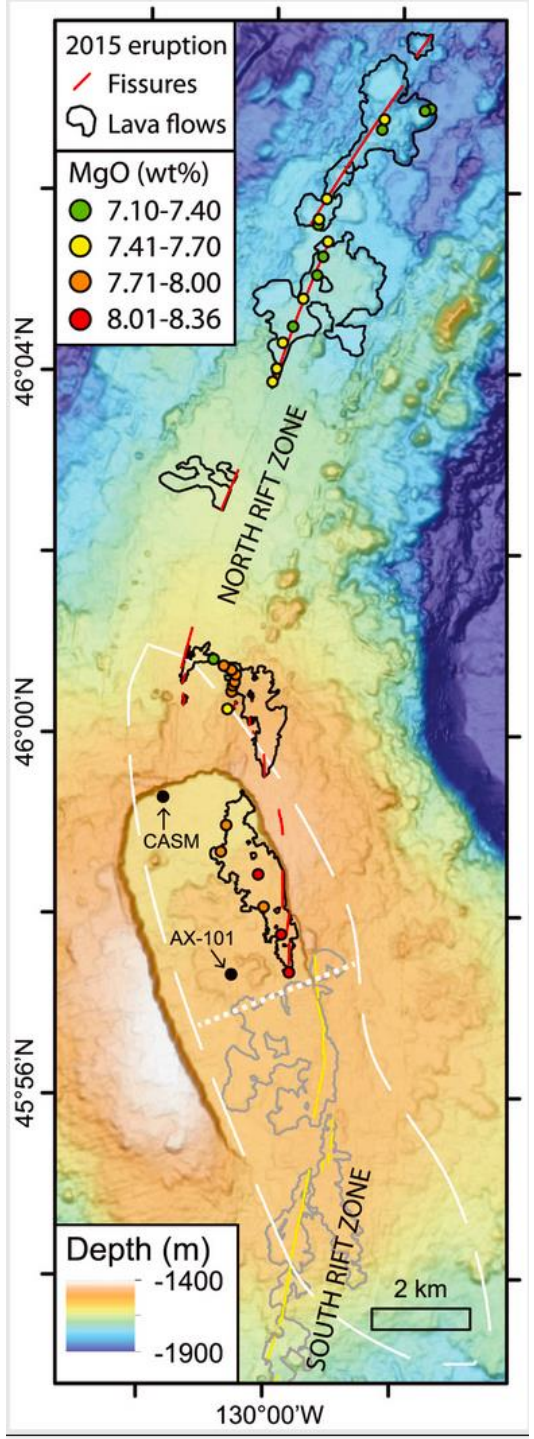
Palmiotto et al. 2013



Global Earthquake Activity M > 5.0 (2000-2008)

Lisa Christiansen, Caltech Tectonics Observatory

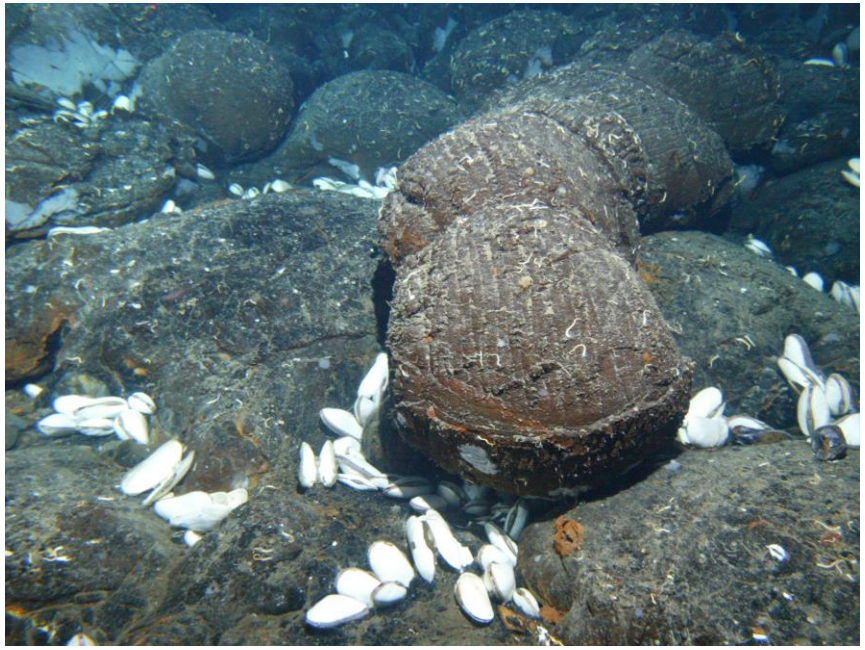
Volcanic Eruptions



Black outlines: 2015

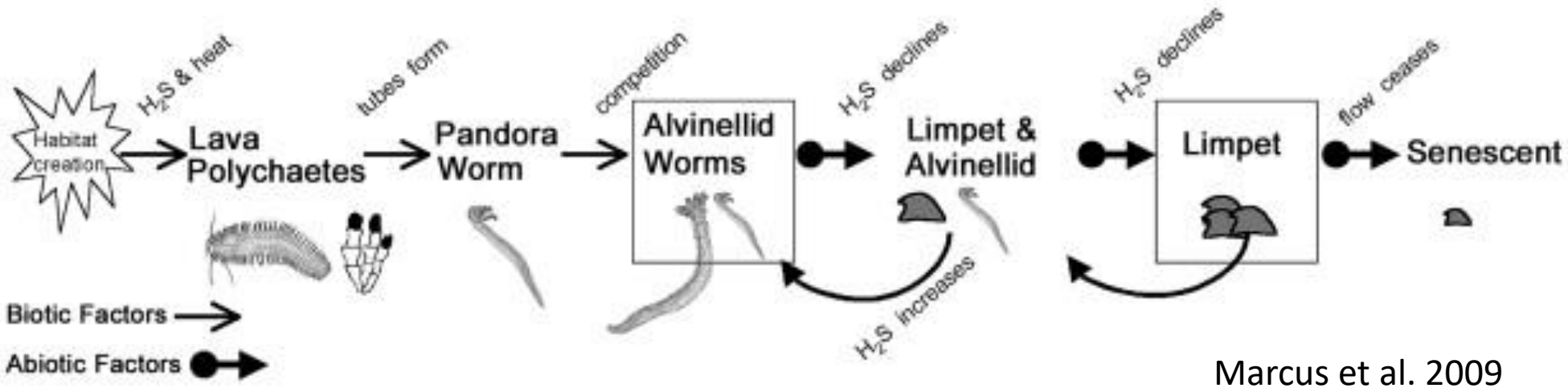
Grey outlines: 2011

White outline: magma reservoir (MCS)
https://volcano.si.edu/volcano.cfm?vn=331021



NOAA Ocean Exploration

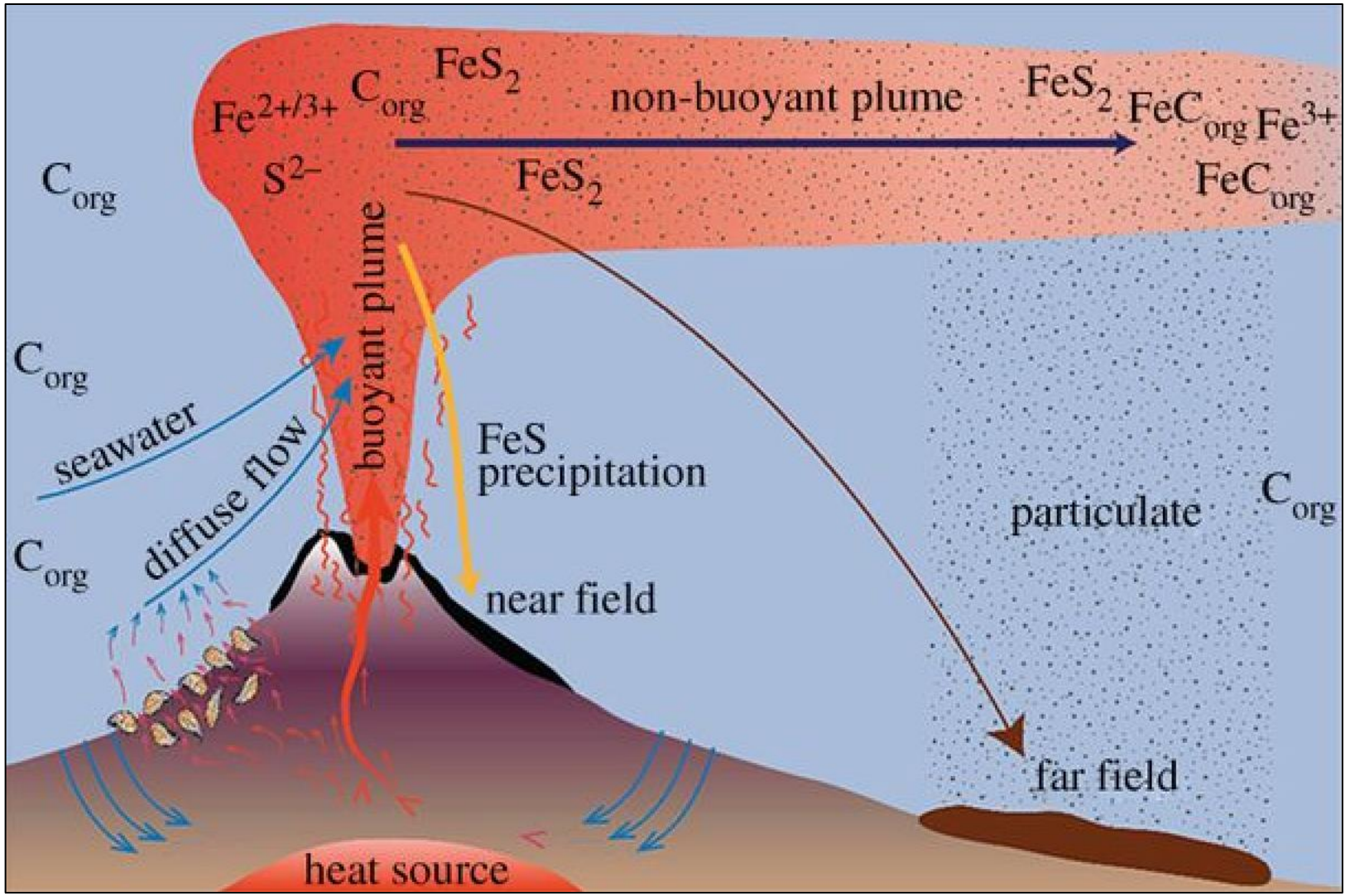
Girguis



Marcus et al. 2009

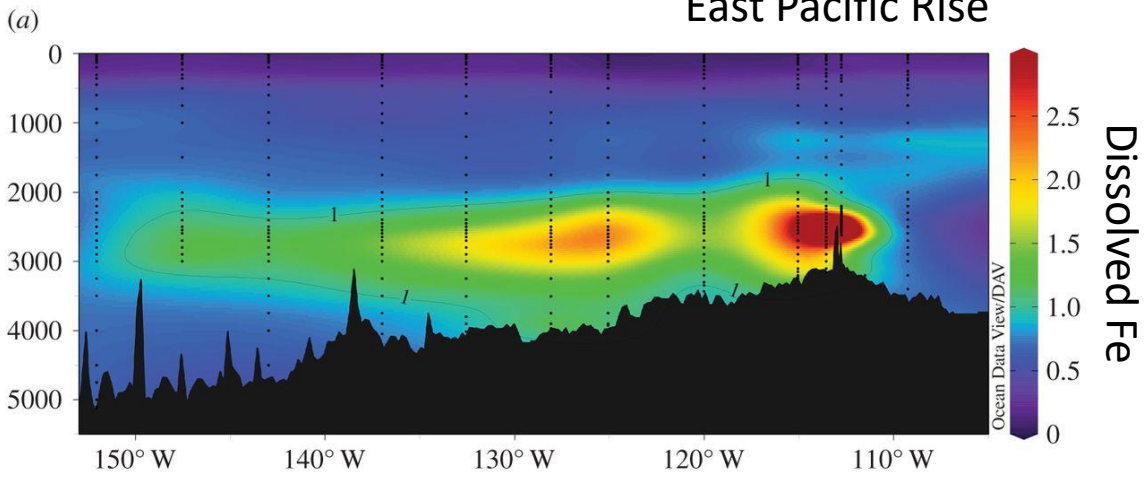
Successional Sequences
Axial Volcano

Hydrothermal vent plumes

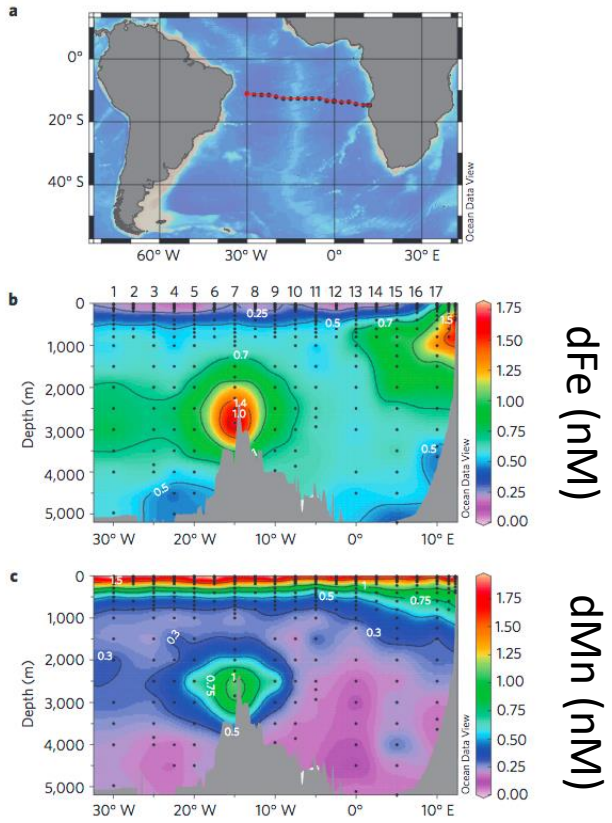


German et al. 2016

East Pacific Rise



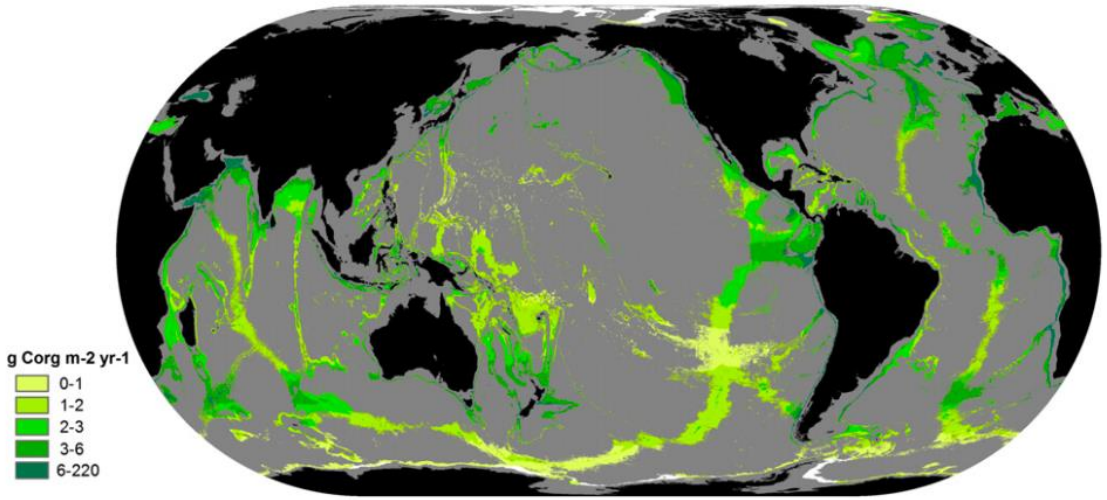
German et al. 2016



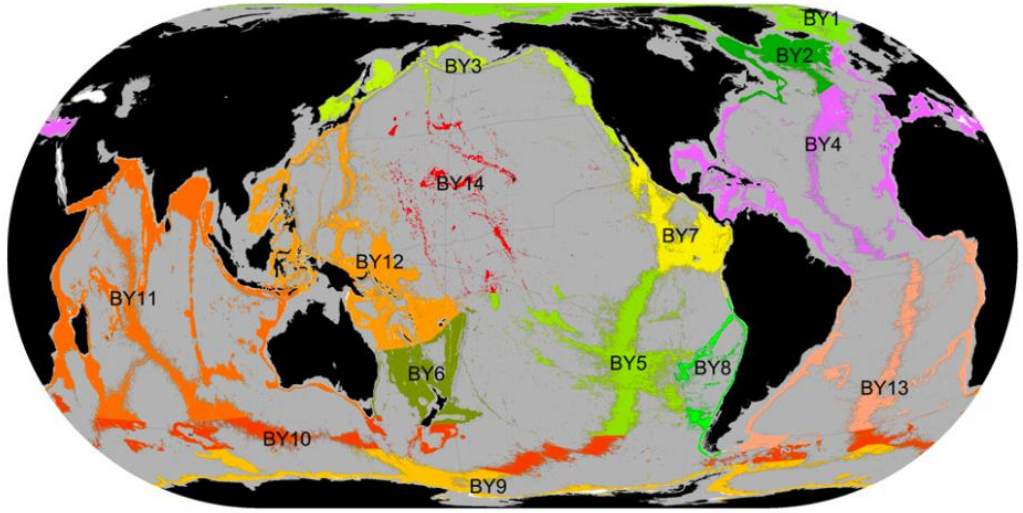
Saito et al. *Nature Geoscience* 2013

Hydrothermal Vent Plumes

Particulate Organic Carbon (POC) Flux



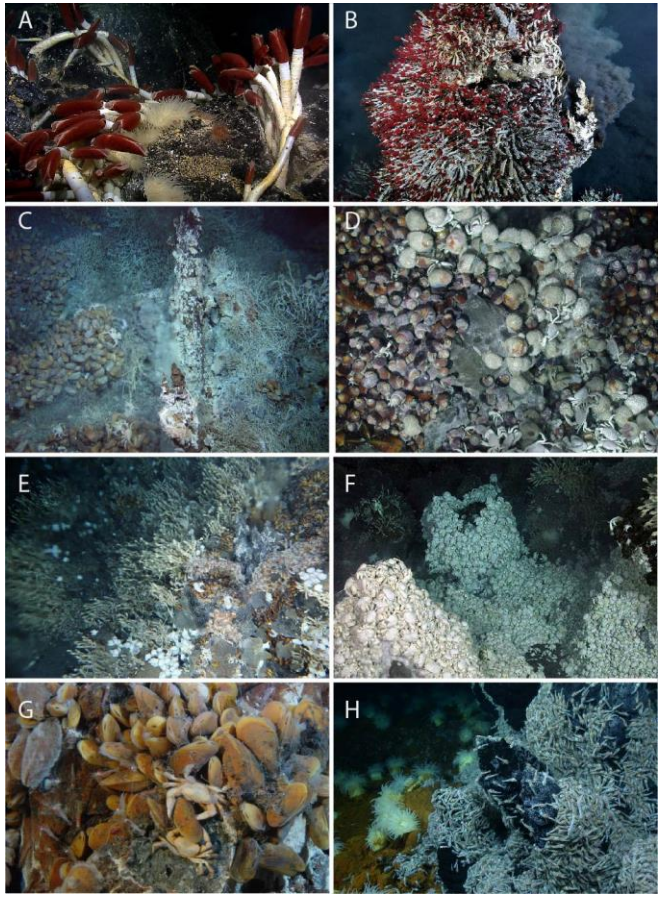
Biogeographic Regions

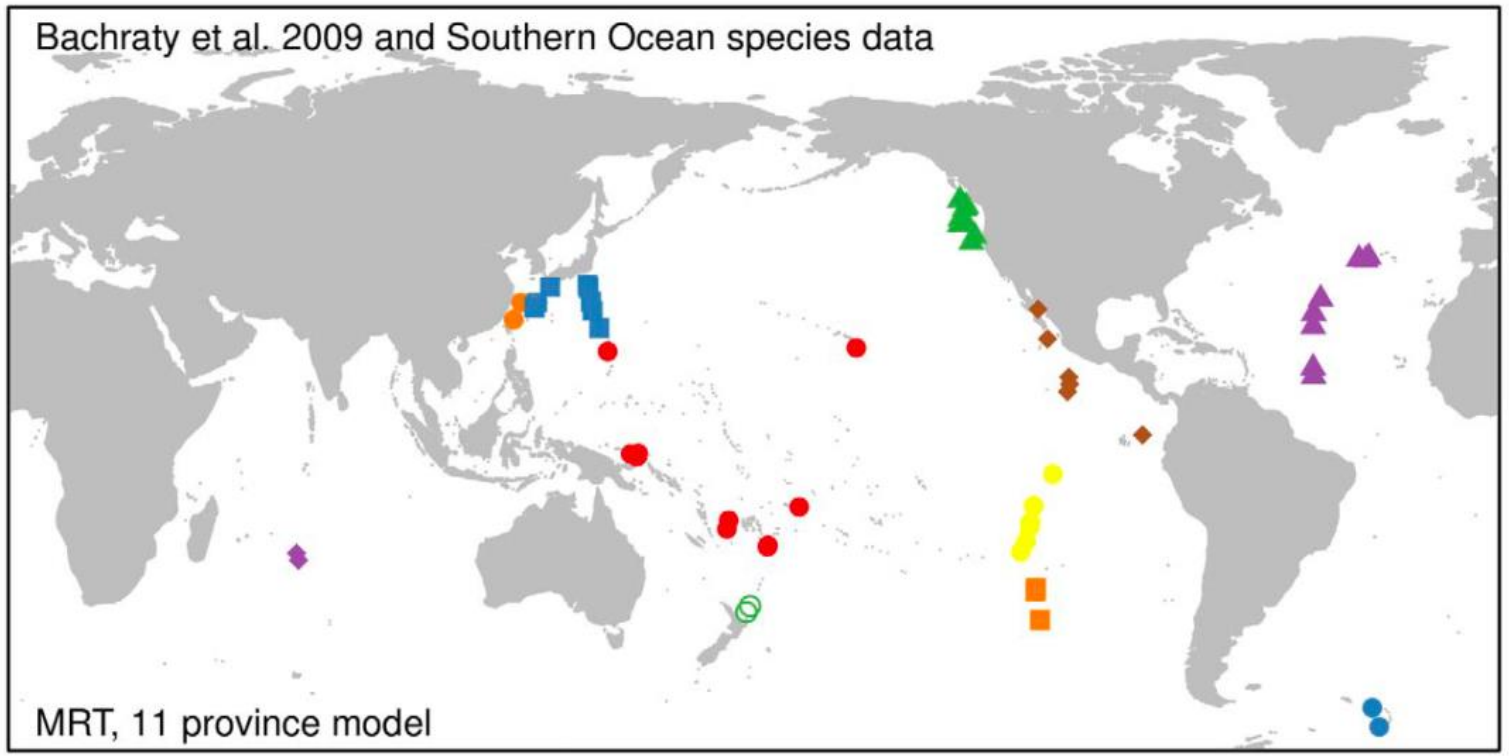


BY1: Arctic
BY2: Northern Atlantic Boreal
BY3: Northern Pacific Boreal
BY4: North Atlantic
BY5: Southeast Pacific Ridges
BY6: New Zealand-Kermadec
BY7: Cocos Plate
BY8: Nazca Plate
BY9: Antarctic
BY10: Subantarctic
BY11: Indian
BY12: West Pacific
BY13: South Atlantic
BY14: North Pacific

Lower Bathyal (800-3500 m)

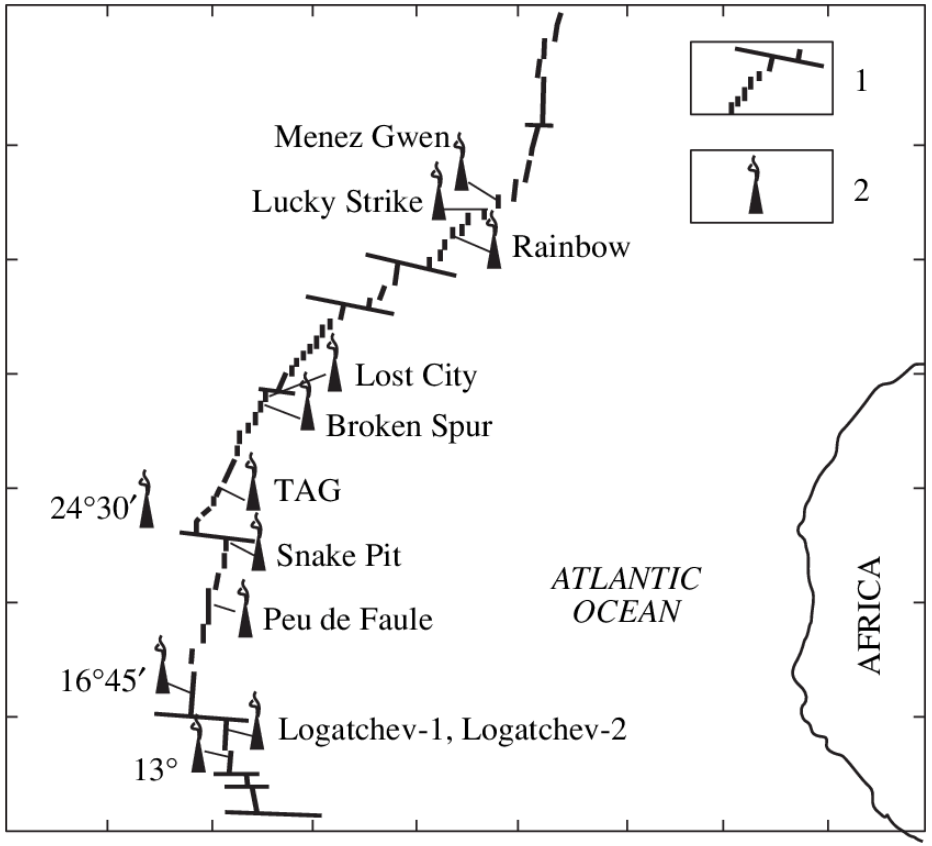
Watling et al. 2013



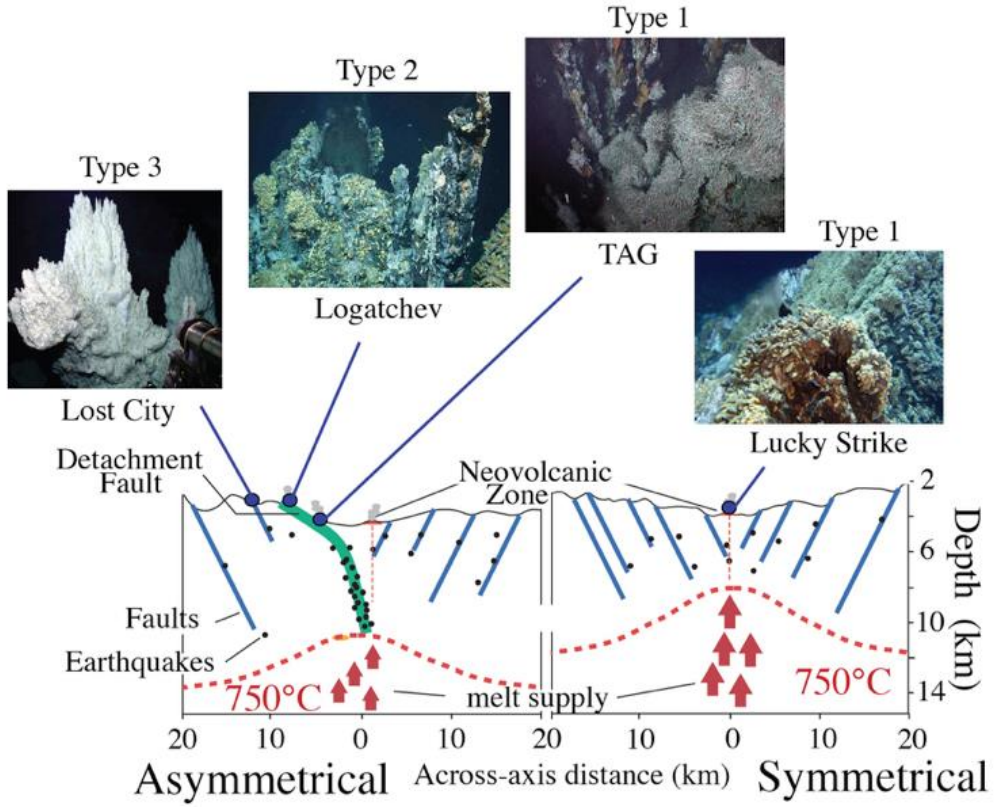


Rogers et al. 2012

Vent Biogeography



Moskova et al. 2005

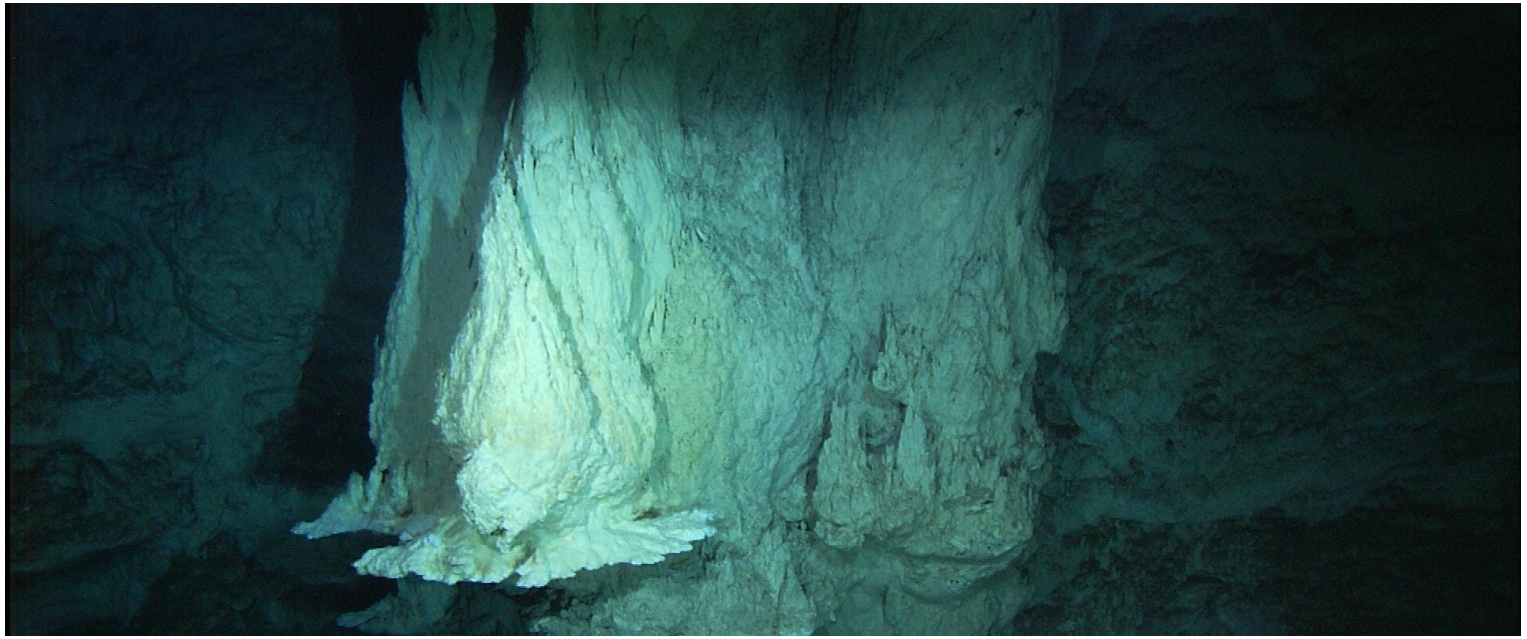


Karson et al. 2015

Vent Heterogeneity

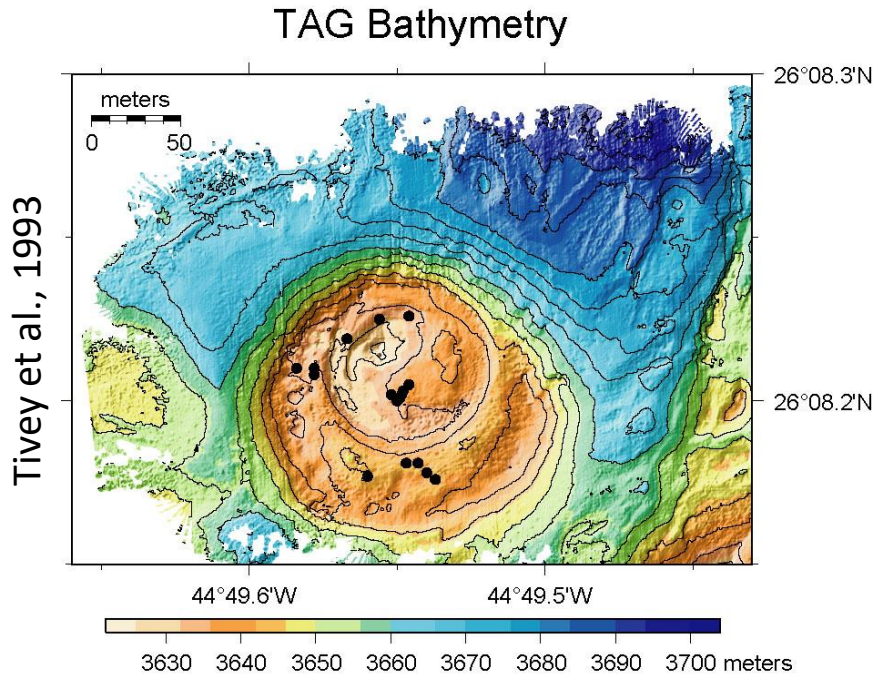
Snake Pit (Moose)

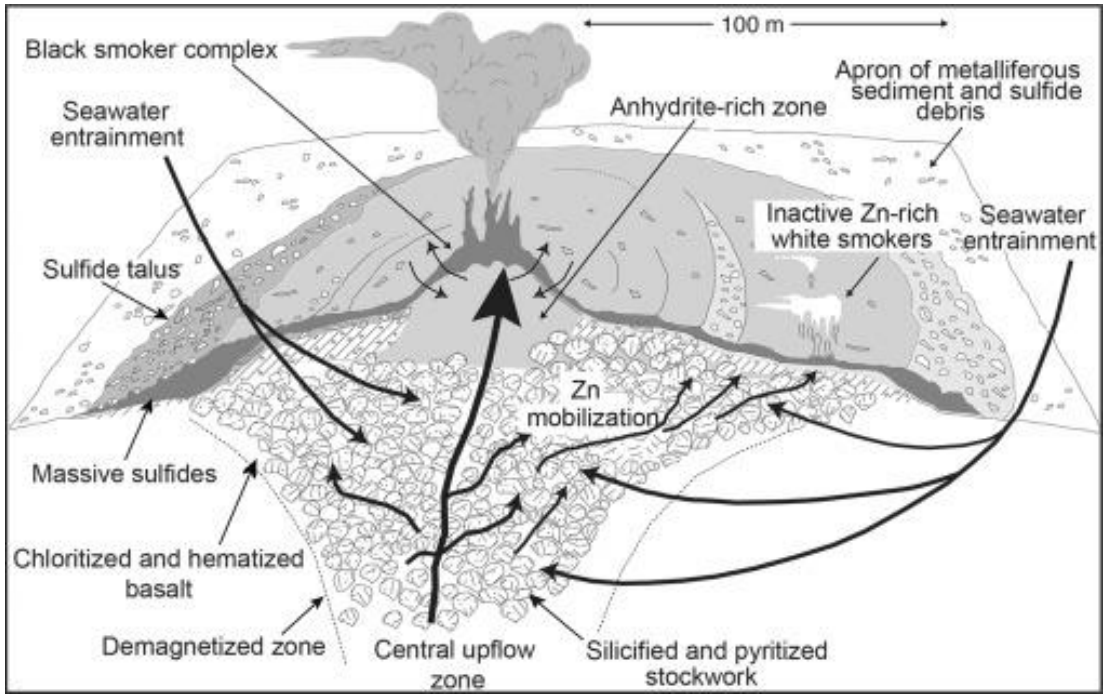
https://irrelevantaxiom.wordpress.com/tag/mid-ocean-ridge/



Lost City: A carbonate (non-metal-rich) vent

TAG Hydrothermal Mound





Adaptation to Extreme Environments

B Briand Ifremer

Scaly-Foot Gastropod

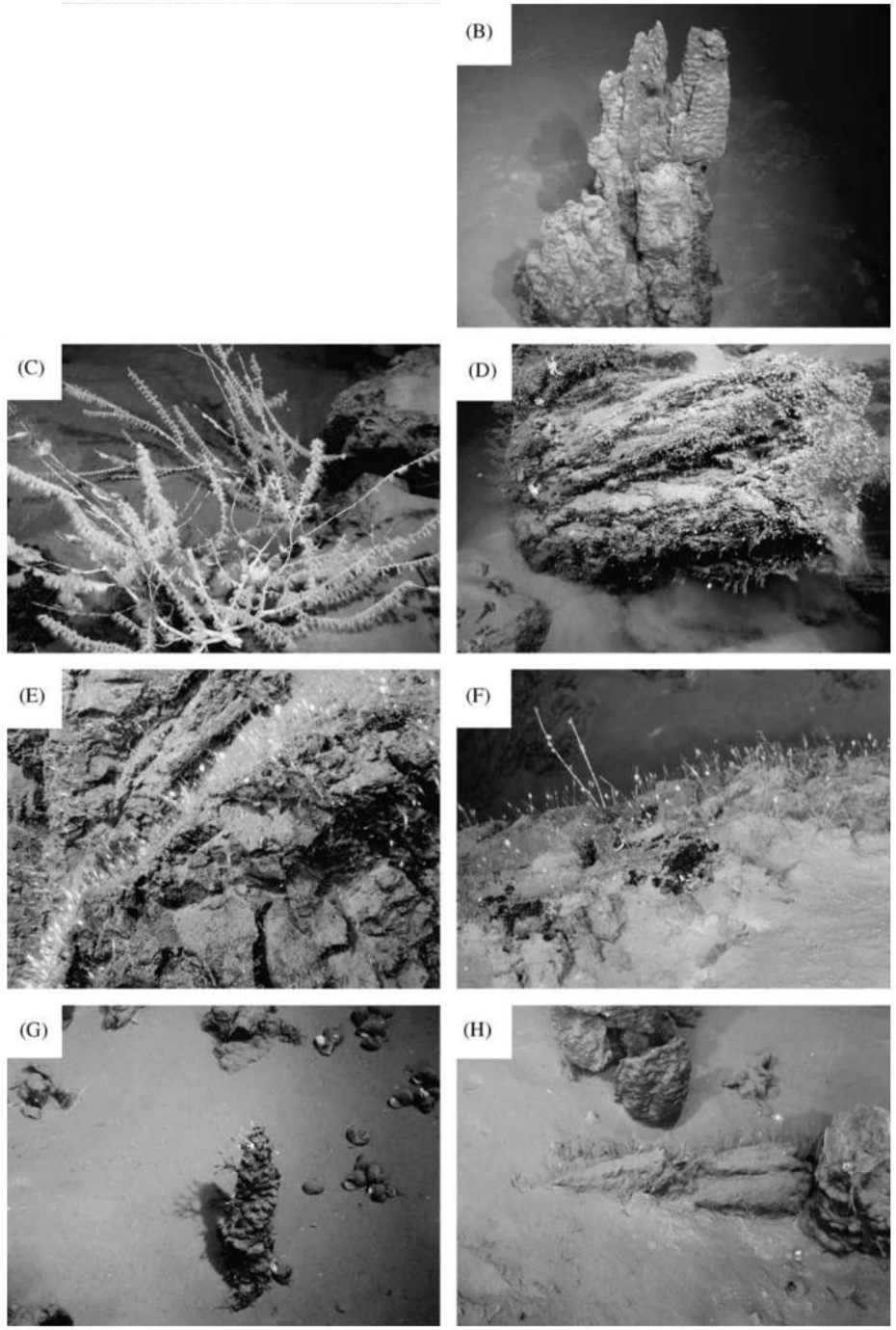
https://www.zmescience.com/science/biology/snail-armor/

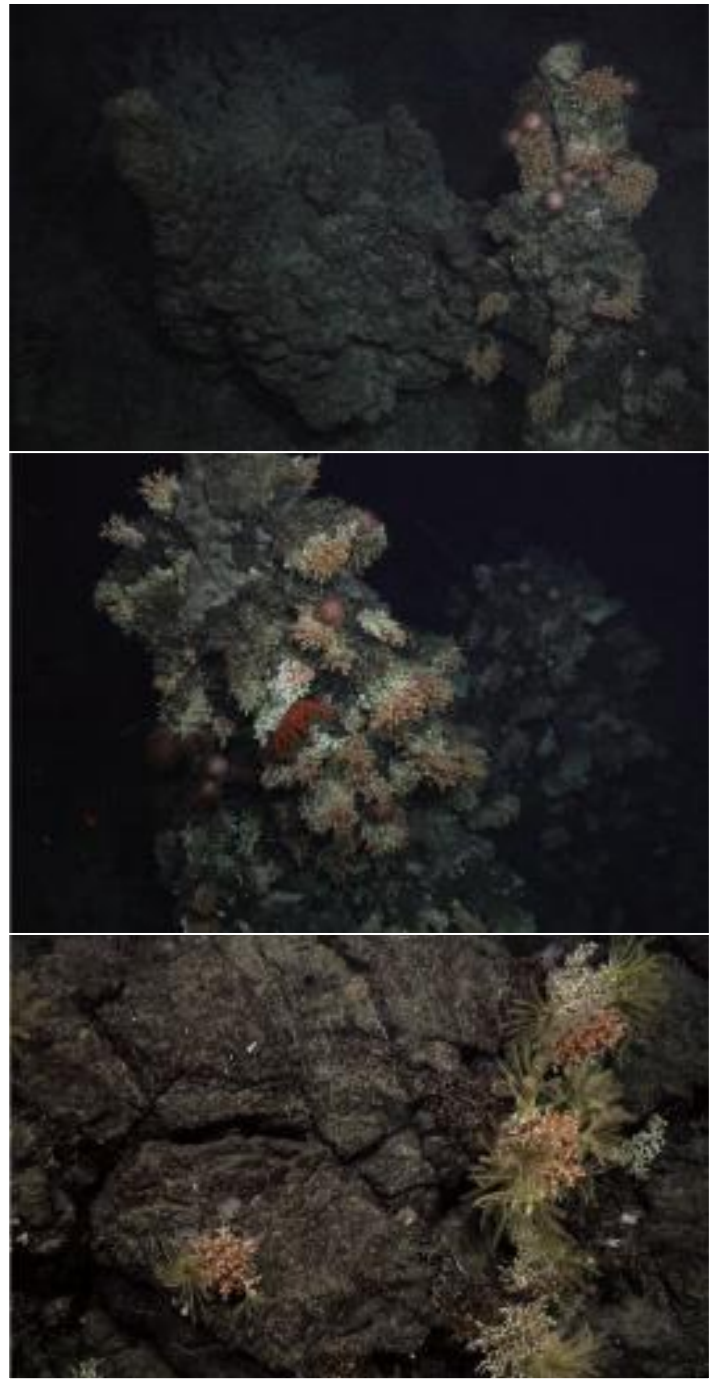
NEAFC* closed areas (2009-2022)

http://vme.ices.dk/map.aspx

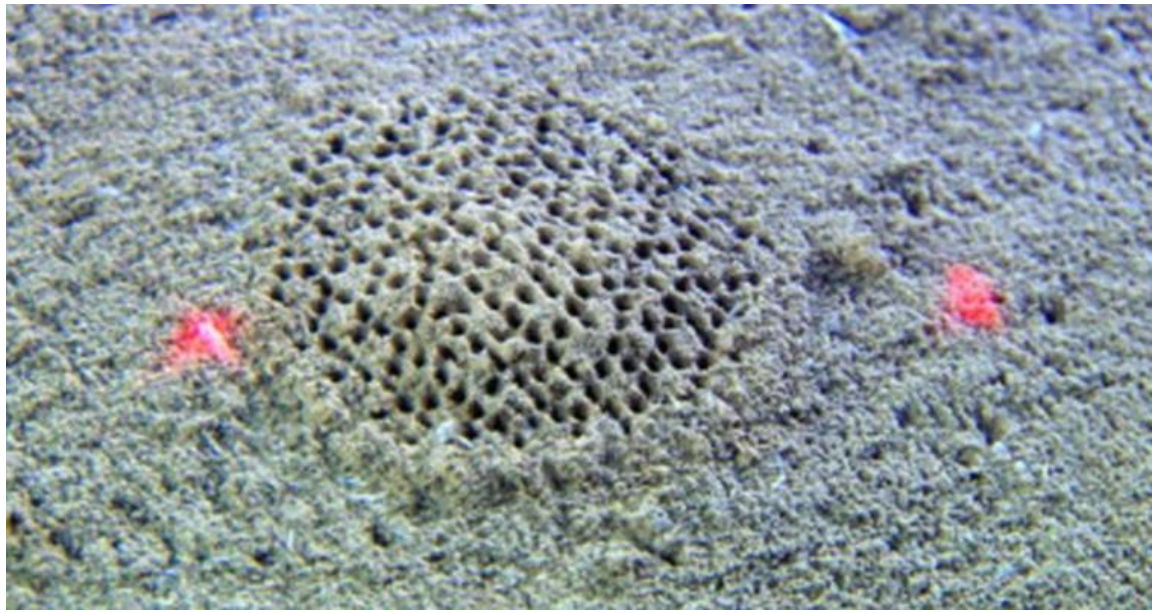
*North East Atlantic Fisheries Commission

Fauna of Inactive Vents

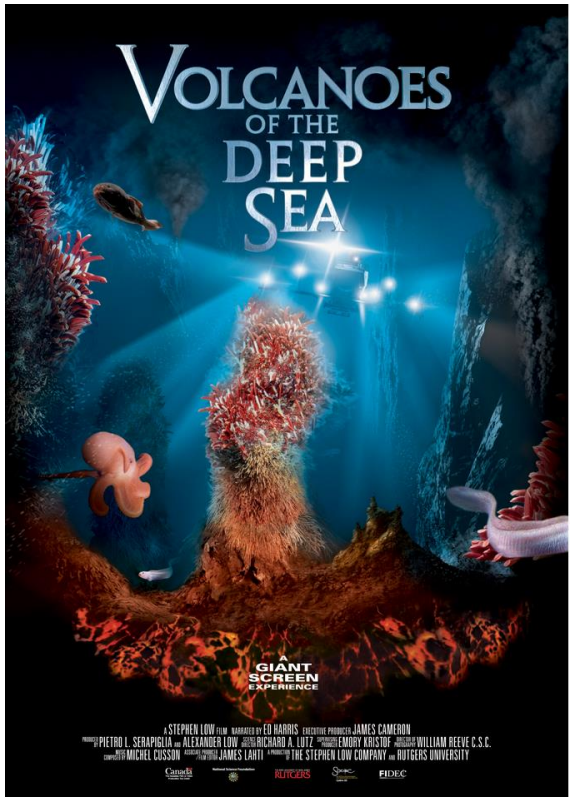




Erickson et al. 2009; Boschen et al. 2016



Stephen Low Company



Paleodictyon

Planktonic Larval Duration (PLD)

75% of species:

69 d

Hilario et al. 2015

Larval Dispersal Distances

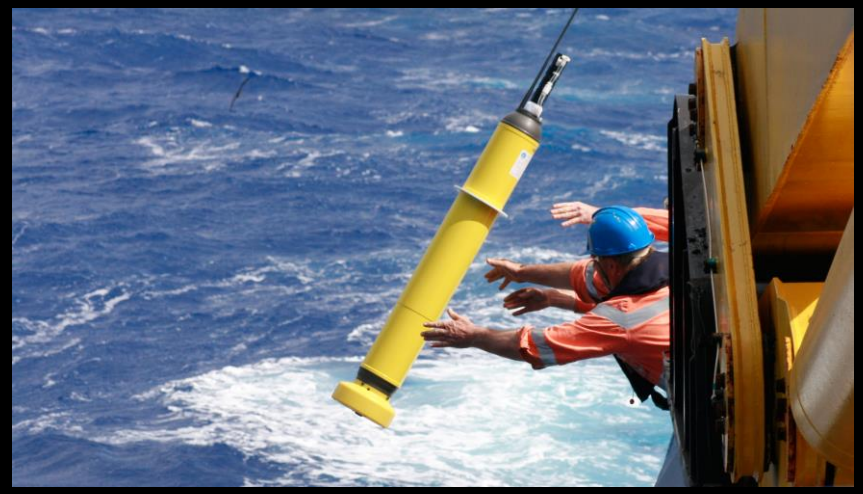
75% of species:

74-100 km

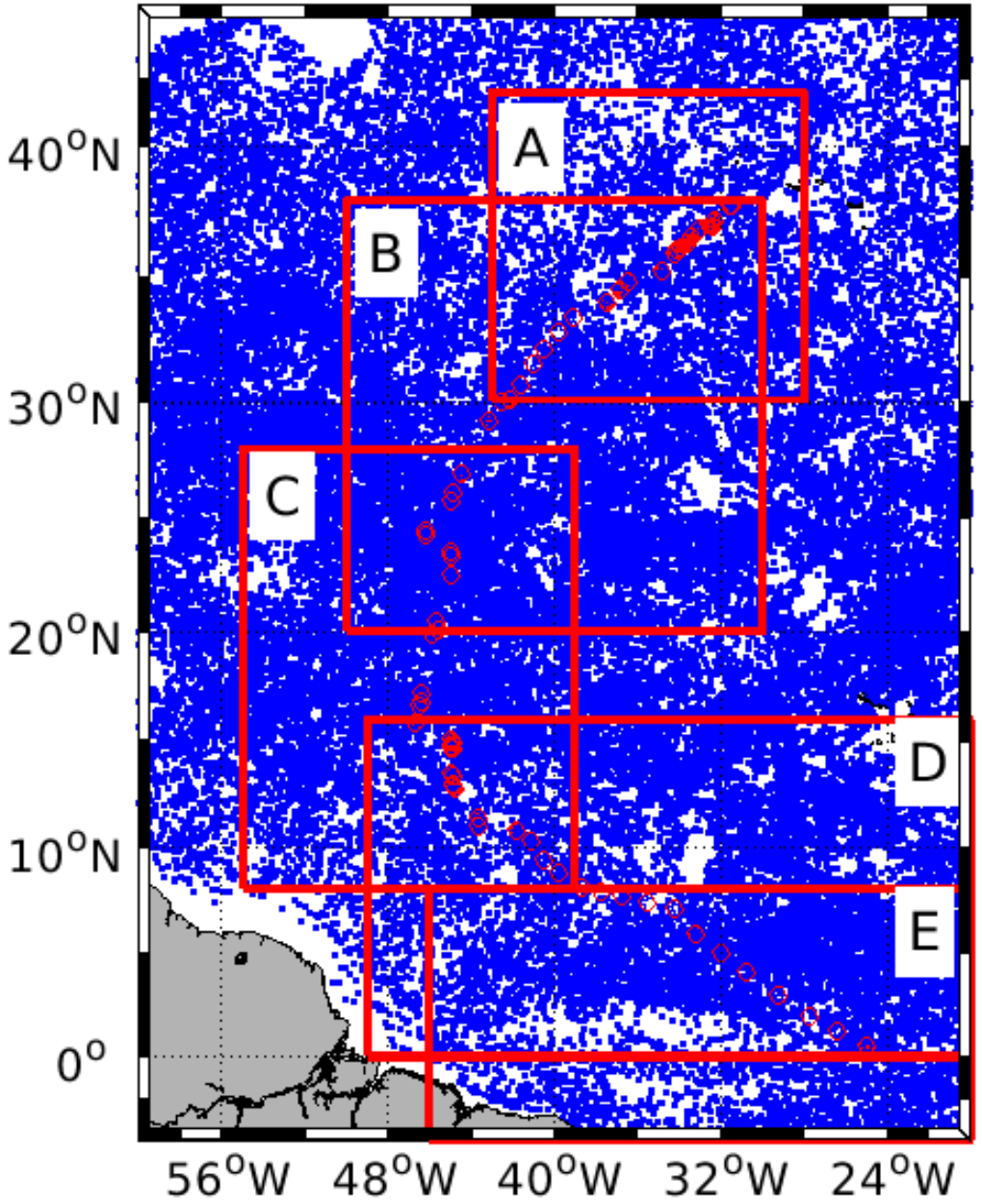
Baco et al. 2016

Natural Population Units

Argo Data
2005-2014
1000m

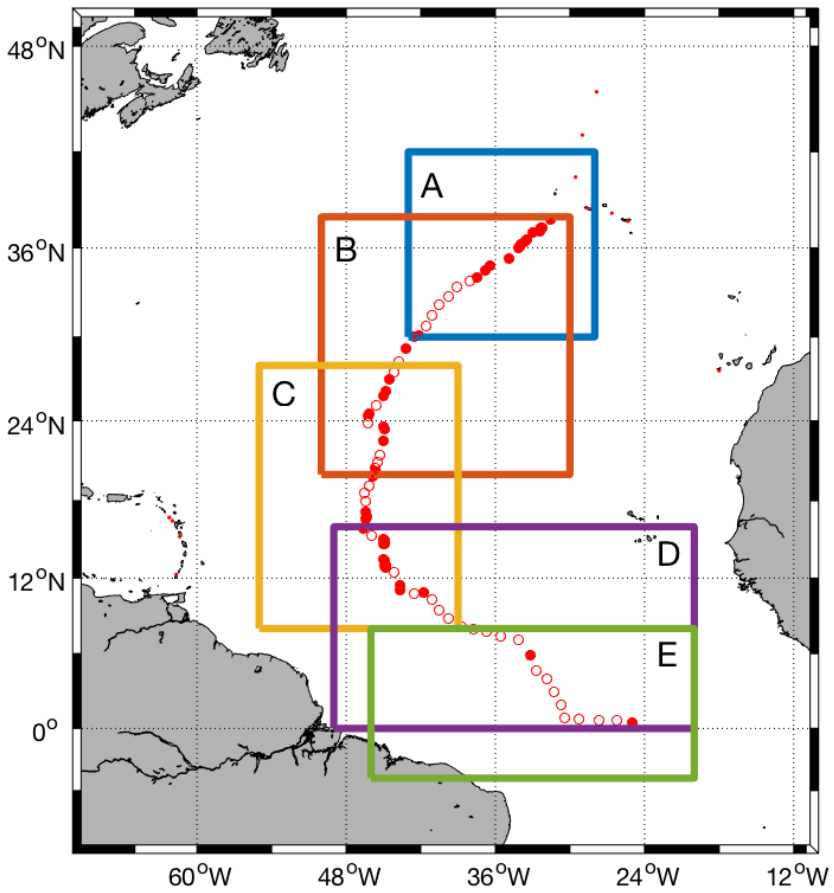


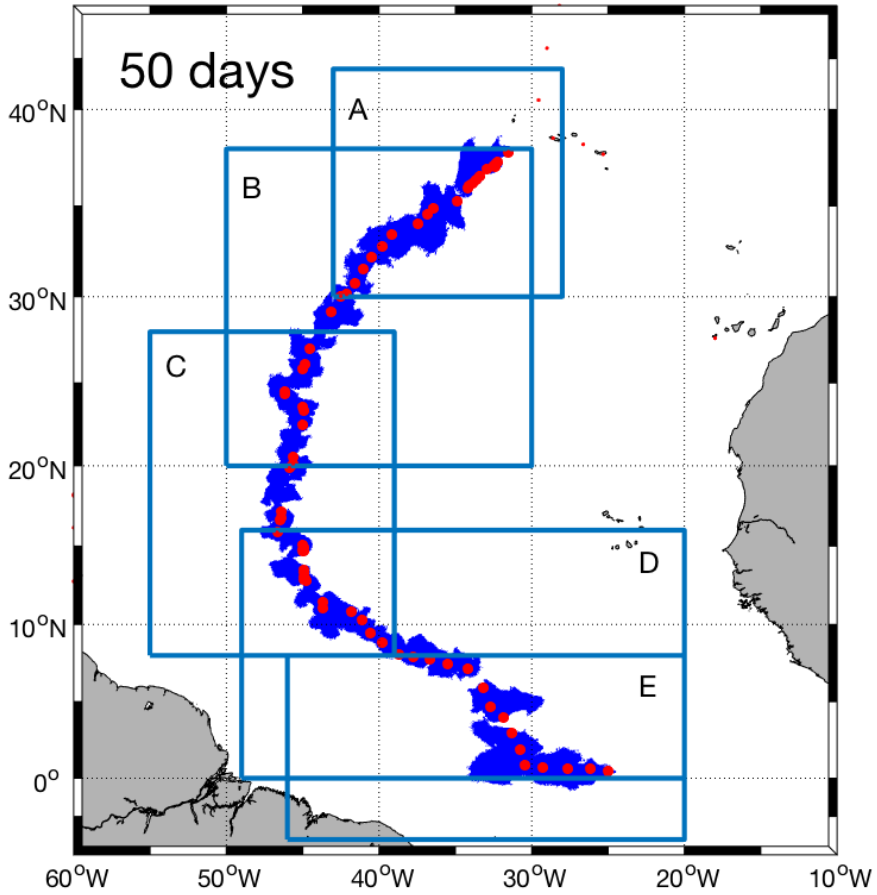
Yearsley et al. unpublished



Parking Depth 1000m
23,598 are within windows A – E.

50-d dispersal

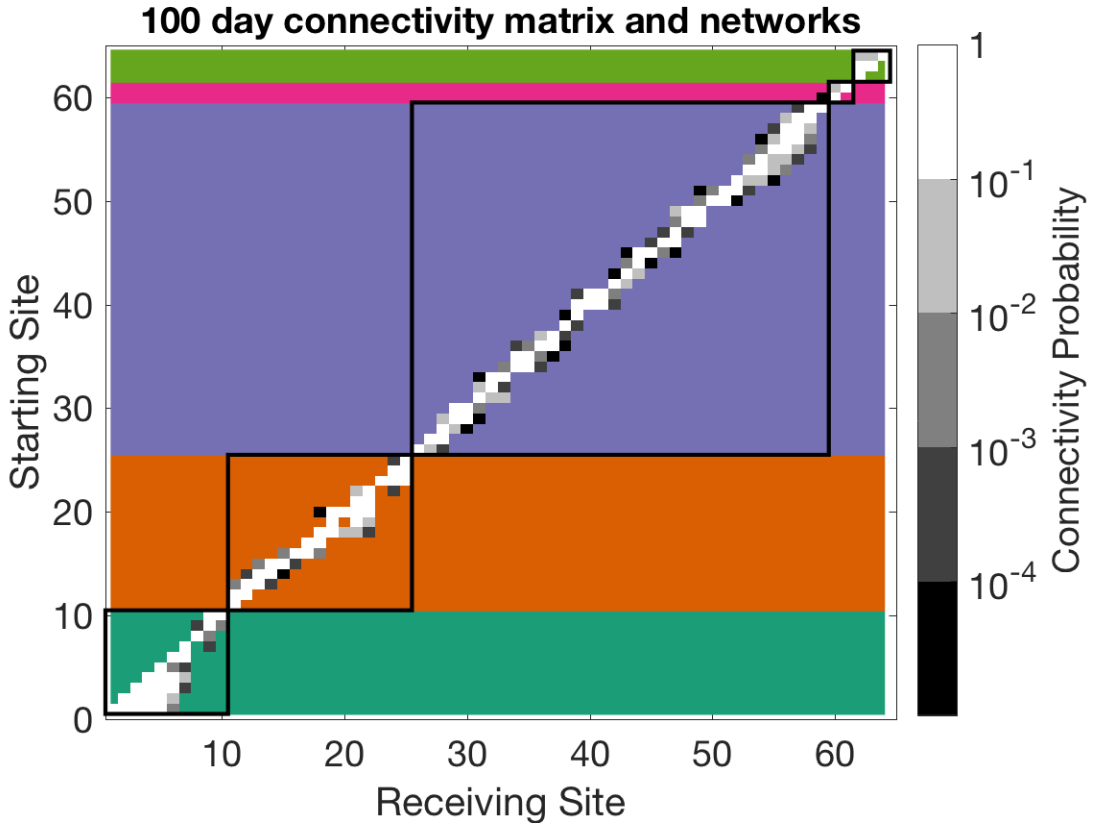


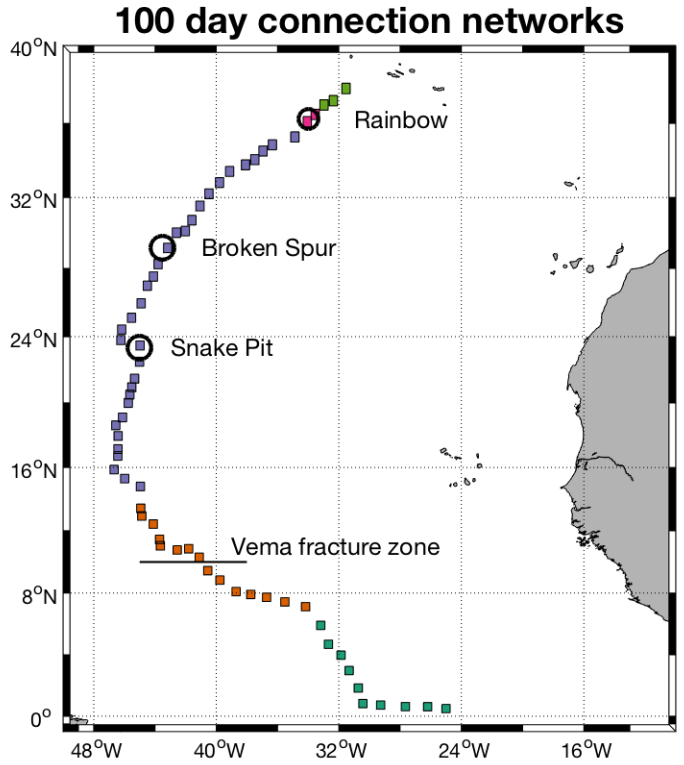


● Known vents
○ Ghost vents

6.5M particles; with 'ghost vents'

Yearsley et al., unpublished

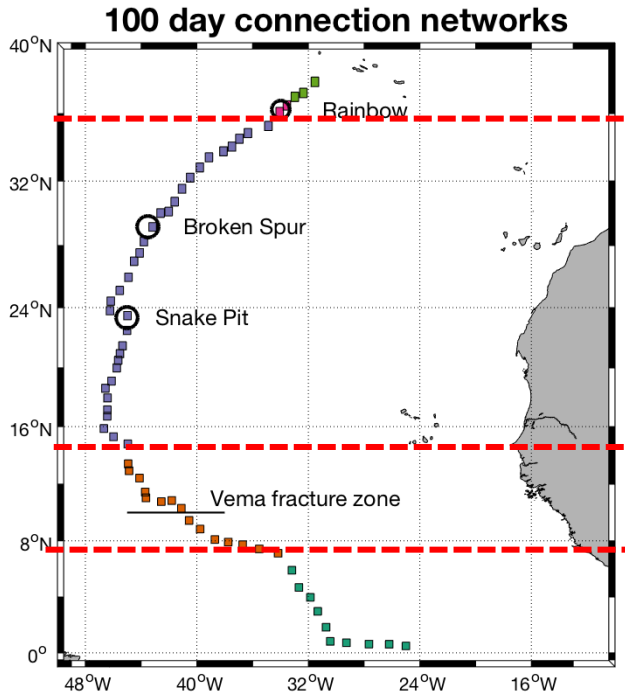




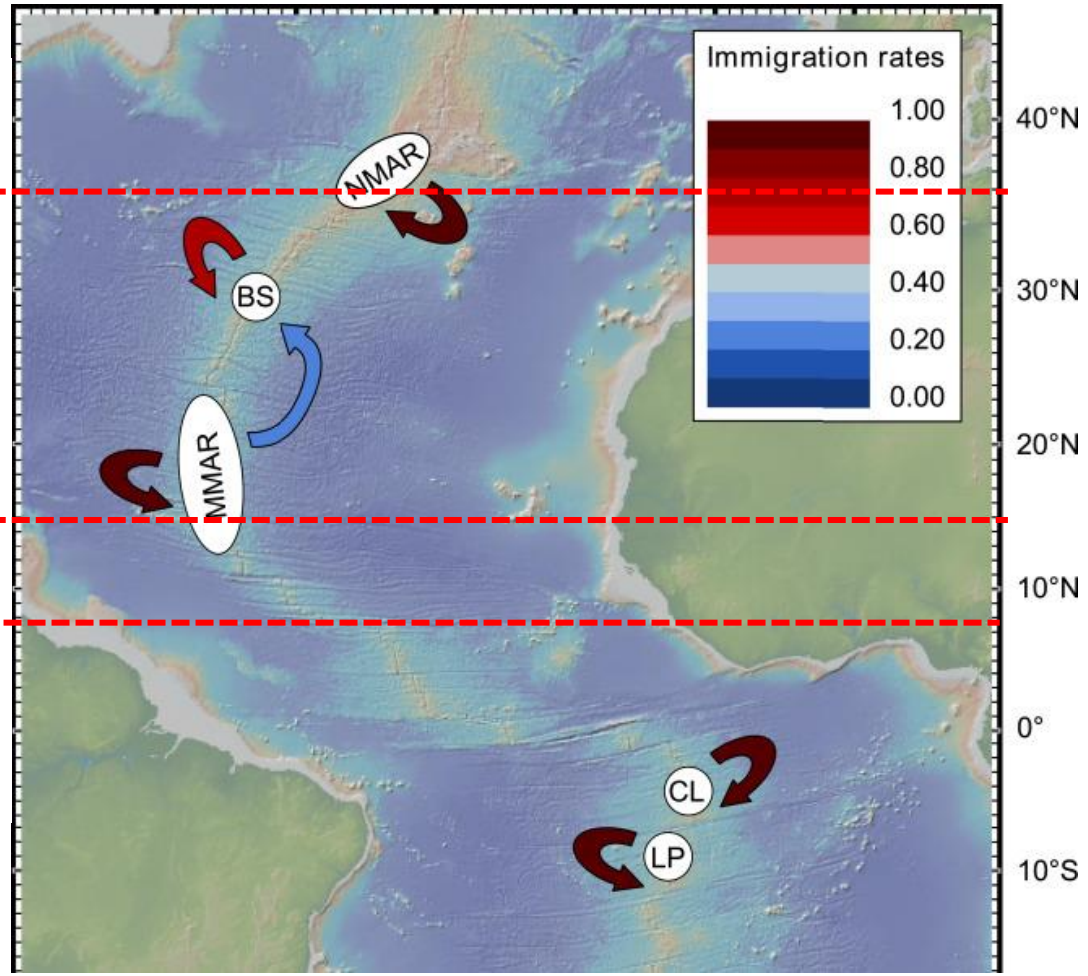
J Yearsley et al., unpublished

Connectivity: 100-d dispersal

64 ‘target boxes’ are 0.05x0.05 deg (approx 5x5 km)
Connection network: cutoff of 1:10,000 connection probability



Yearsley et al. unpublished



Mussel Population Connectivity

Breusing et al. 2016

Key Points

1) The Mid-Ocean Ridge may be a single geological feature, but it is diverse, both geologically and biologically
2) MORs are complex systems, with segmentation, transform faults, seamounts, submerged islands, abyssal hills, etc, all of which are likely to be ecologically distinctive habitats
3) The MOR system is dynamic; natural disturbances include earthquakes and volcanic eruptions
4) Hard substratum is limited to a relatively narrow corridor along MORs and supports suspension-feeding faunas
5) Active hydrothermal vents are extremely rare habitats in areal extent and, arguably, no two vents are alike
6) Extreme environments on MORs are engines that fuel evolution of novel adaptations
7) Pelagic, sediment, and inactive vent ecosystems associated with MORs are understudied
8) Biophysical processes subdivide MORs into natural biogeographic and population units, though the extent and boundaries of these units are not yet well defined; source-sink dynamics matter

END