Durham University

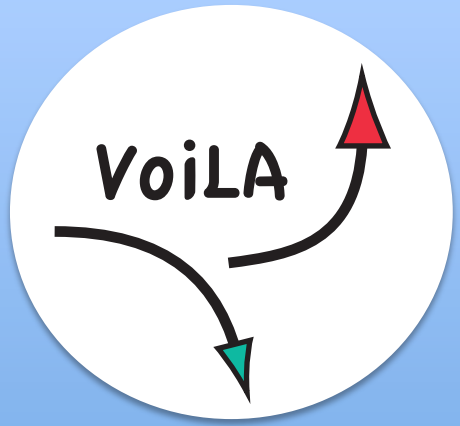
Imperial College London

University of BRISTOL

UNIVERSITY OF LEEDS

UNIVERSITY OF LIVERPOOL

UNIVERSITY OF Southampton



Volatile recycling in the Lesser Antilles arc

Processes and Consequences

Oct 2015-Sep 2019

Funded by:

NATURAL ENVIRONMENT RESEARCH COUNCIL

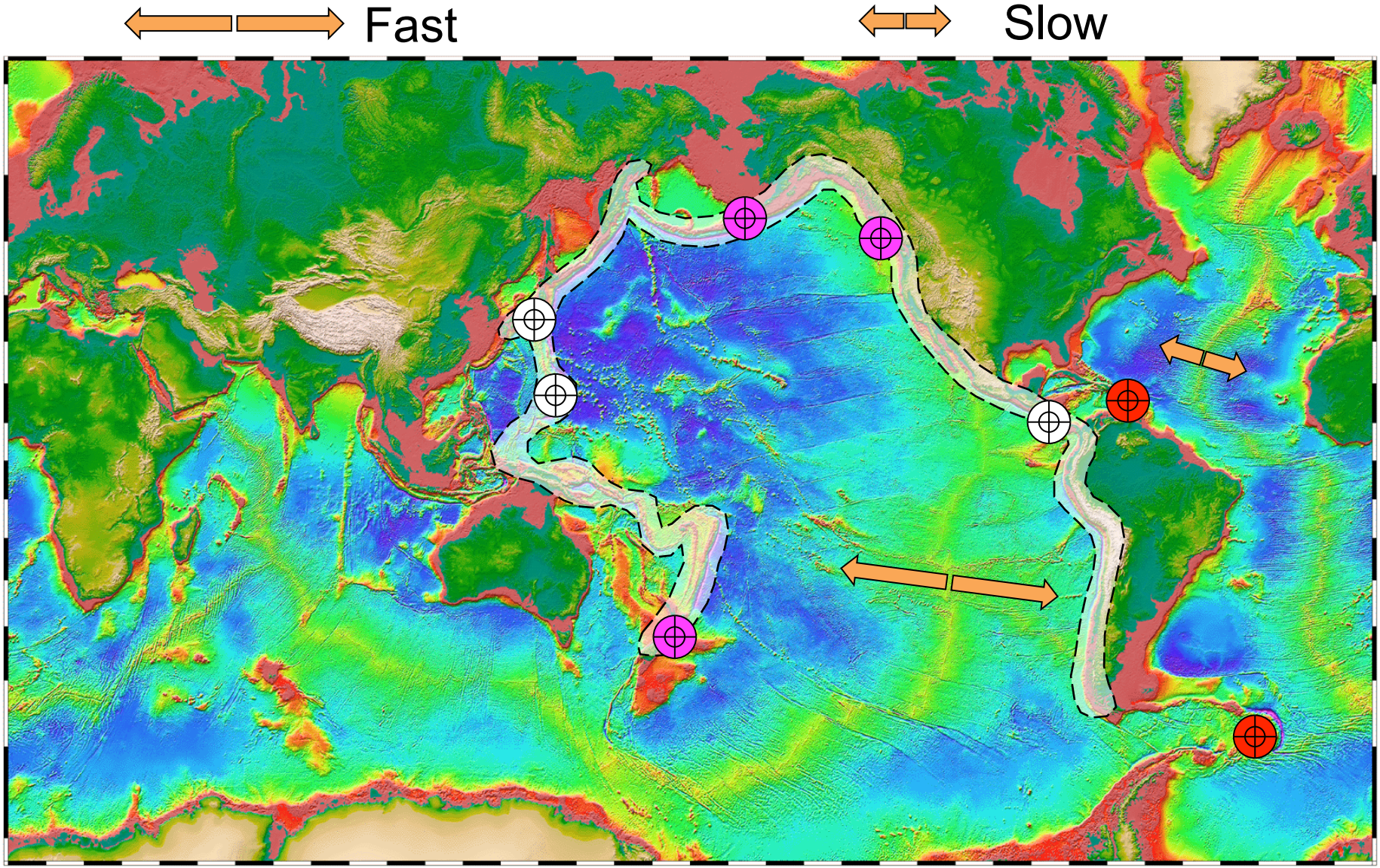
Université des Antilles de la Guyane

STREVA

Geo PRISMS

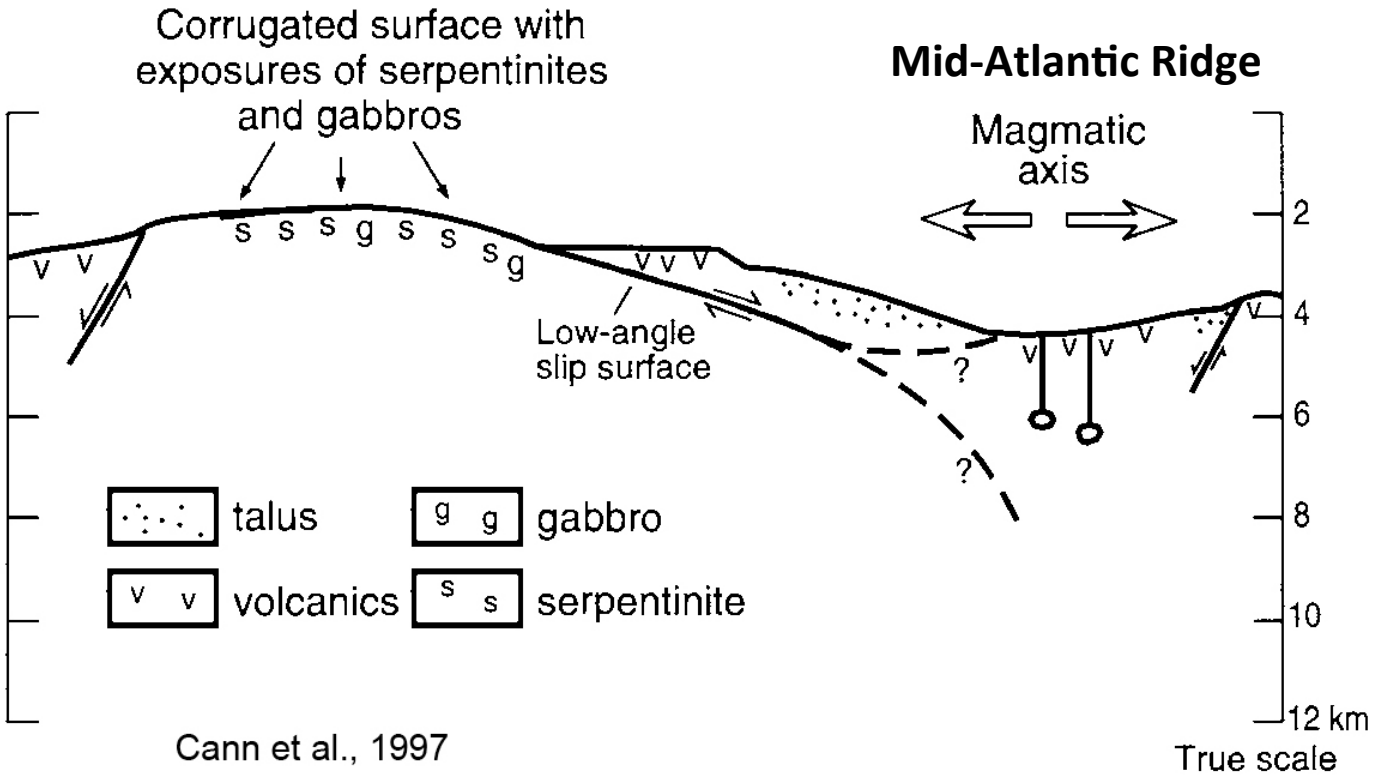
University of West Indies

Subduction Zone Diversity



Volatile input: serpentinised oceanic lithosphere

Oceanic Core Complexes discovered in 1997 at the Atlantis FZ, MAR.
Only formed at **slow-spreading oceanic crust**.
Completely different oceanic **lithosphere architecture.**
Serpentinisation of large areas at seabed.

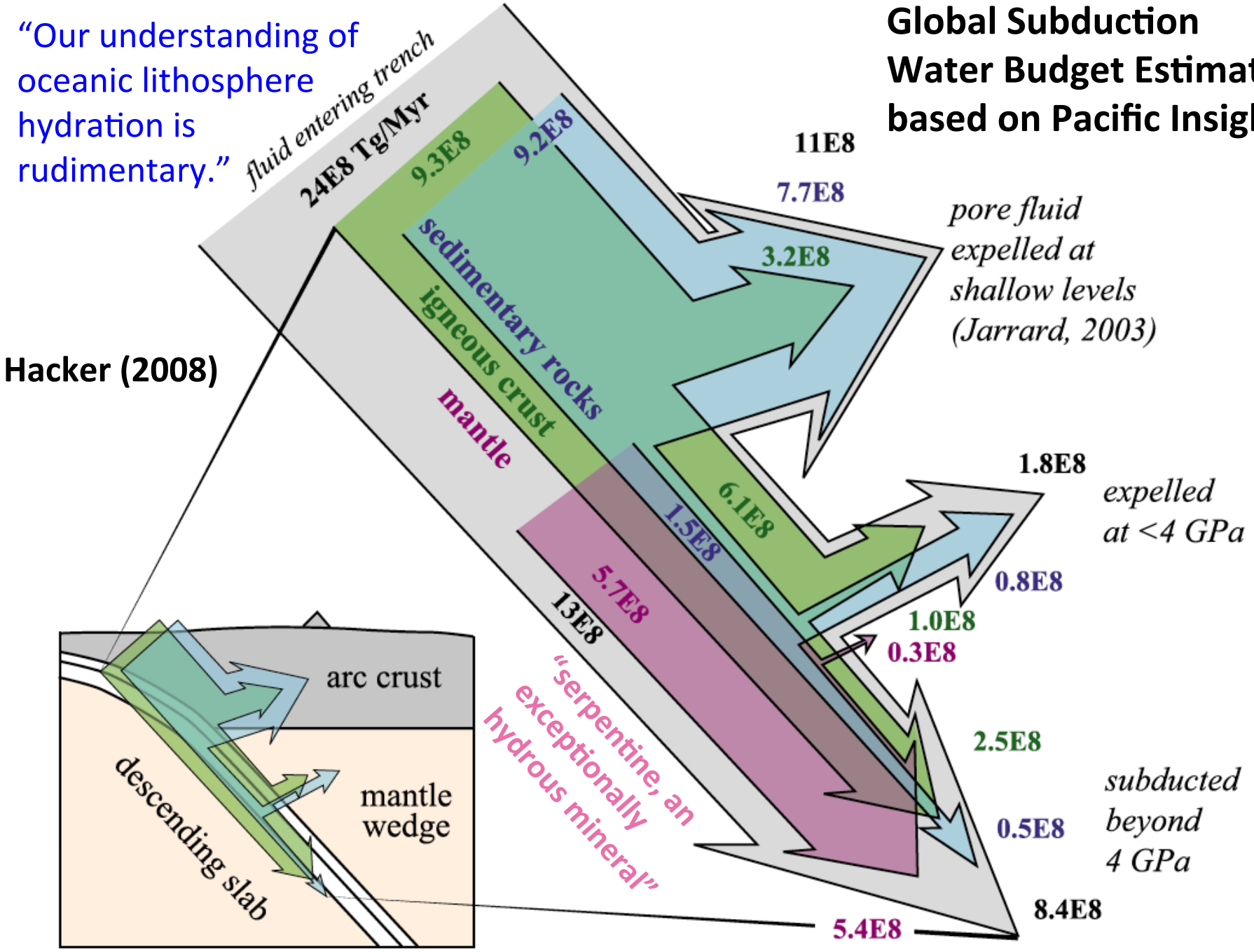


Cann et al., 1997

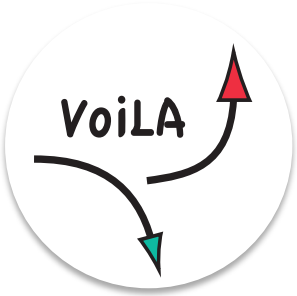
"Our understanding of oceanic lithosphere hydration is rudimentary."

Global Subduction Water Budget Estimate based on Pacific Insights

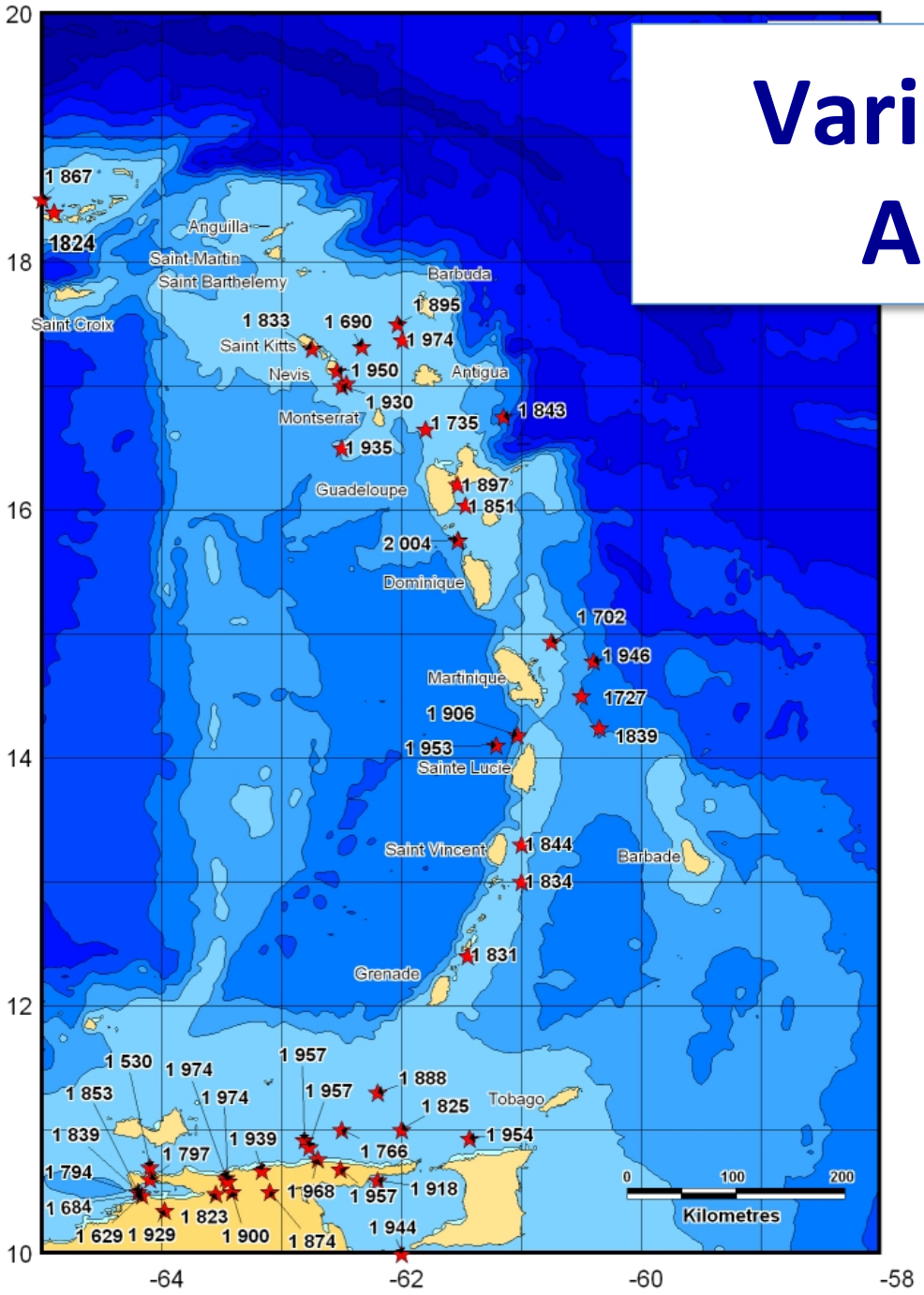
Hacker (2008)



Why Antilles?

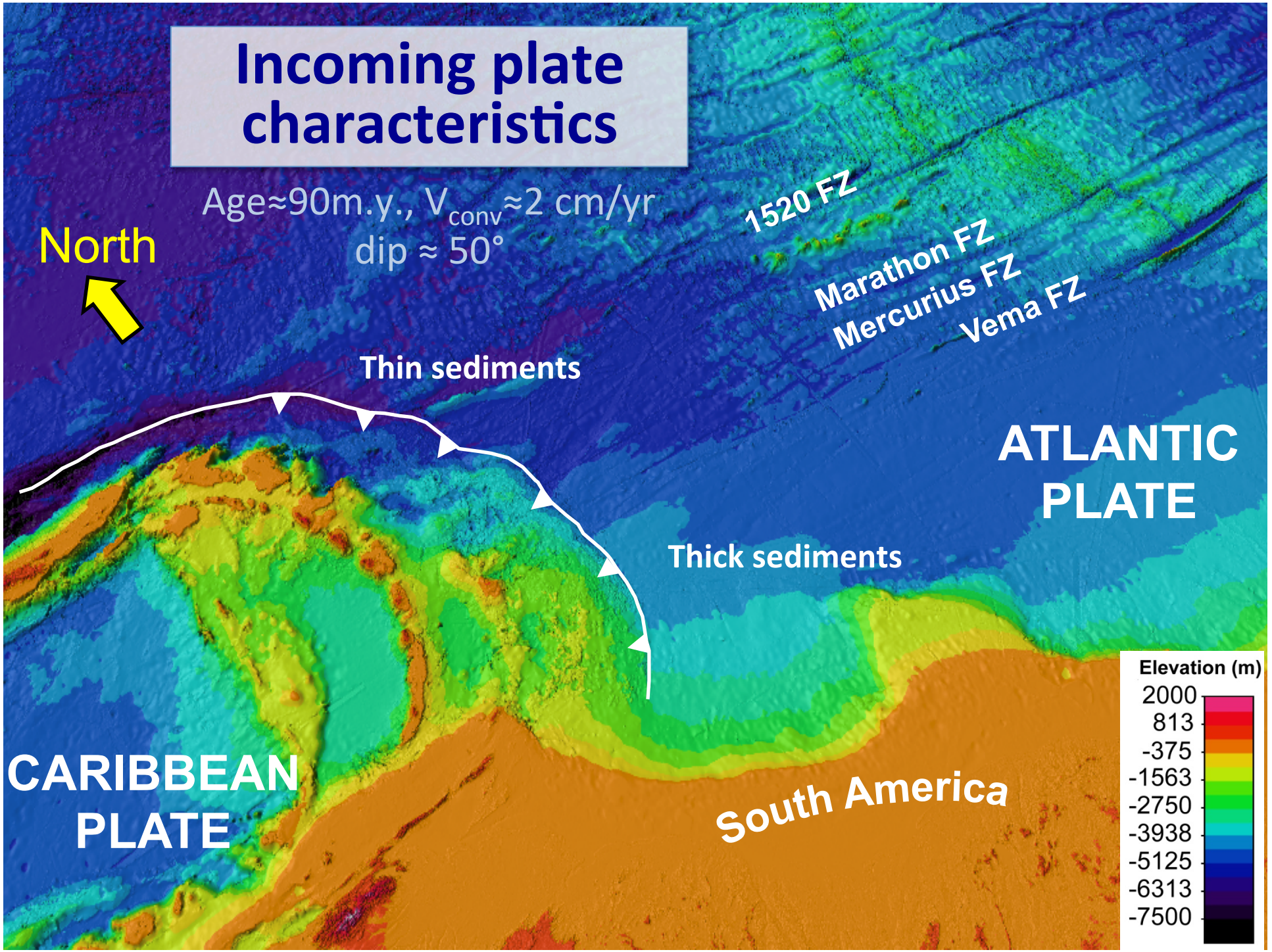


- Expect slow-formed Atlantic crust to have a fundamentally different water distribution than Pacific Ocean crust.
- Antilles most accessible slow subduction system
- Global end-member of subduction systems.

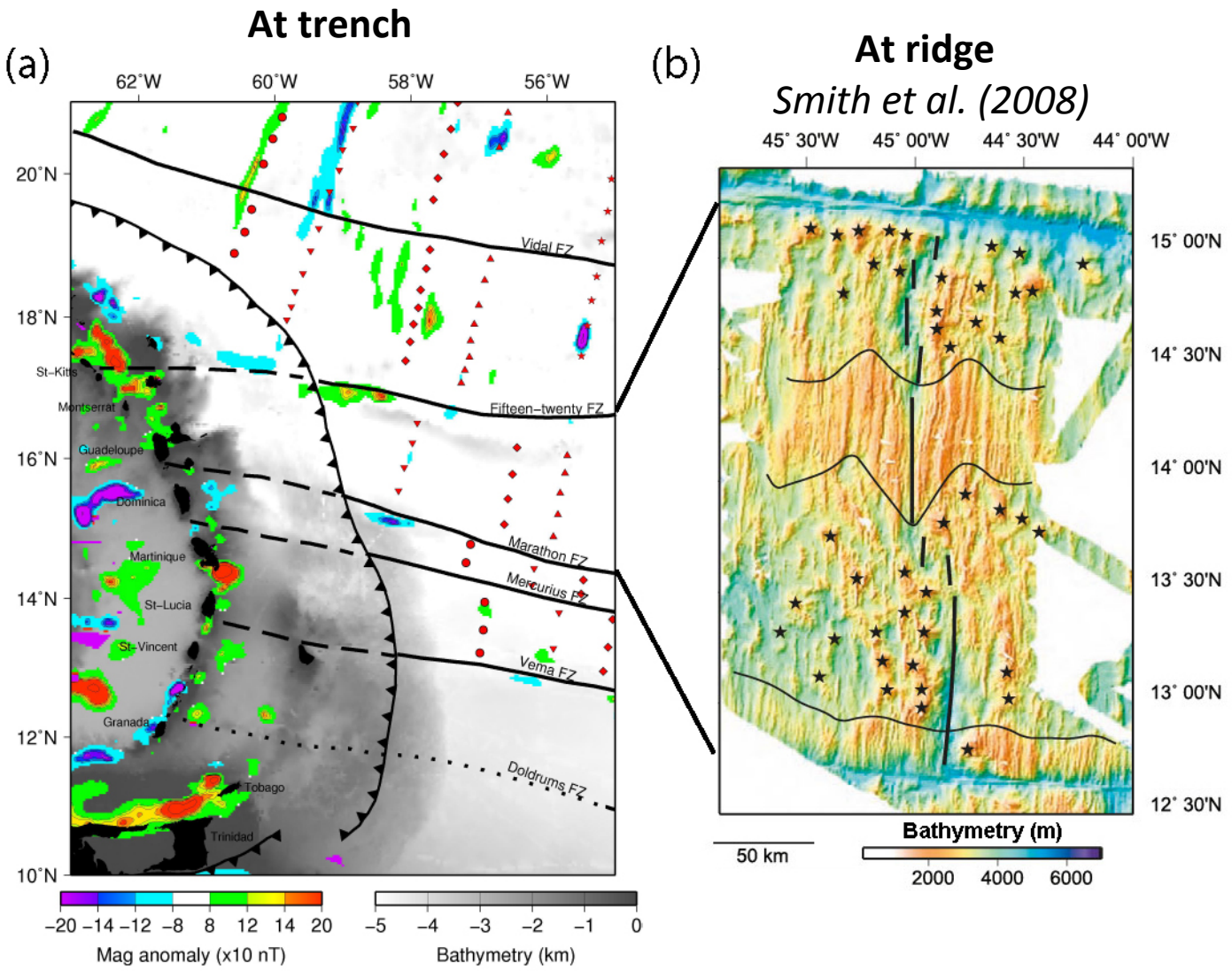


Variability along Antilles arc

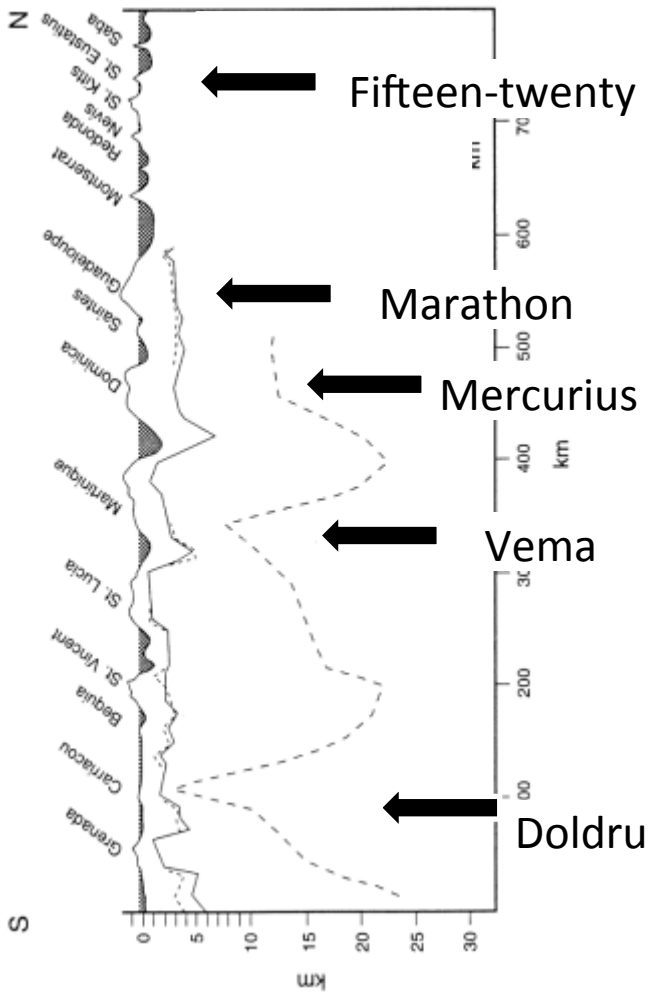
- **Seismicity** increases from south to north
- Large historic interplate **earthquakes** in center only
- Double **arc** in north
- Largest islands, **magmatic productivity** in center
- Difference in **back-arc** bathymetry south to north
- Thick **sediments** in south, pelagic only in north
- **Geochemical** signatures reflects sediments in source + fluids ?
- GPS indicates **coupled** forearc block in north, uncoupled in south.


Incoming plate characteristics
Age≈90m.y., V_{conv}≈2 cm/yr
dip ≈ 50°
North
1520 FZ
Marathon FZ
Mercurius FZ
Vema FZ
Thin sediments
Thick sediments
ATLANTIC PLATE
CARIBBEAN PLATE
South America
Elevation (m)
2000
813
-375
-1563
-2750
-3938
-5125
-6313
-7500

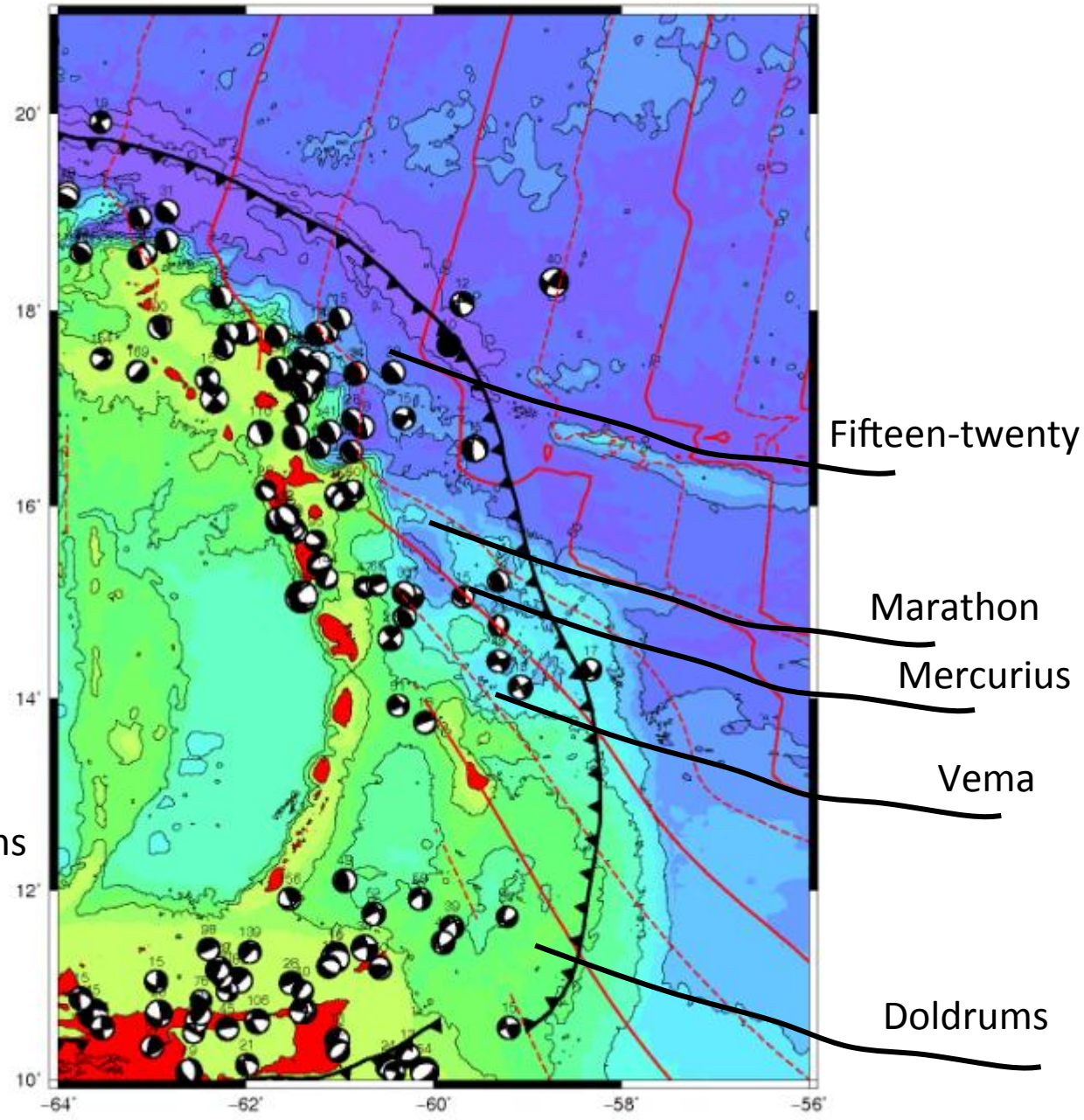
Atlantic plate hydration from ridge to trench



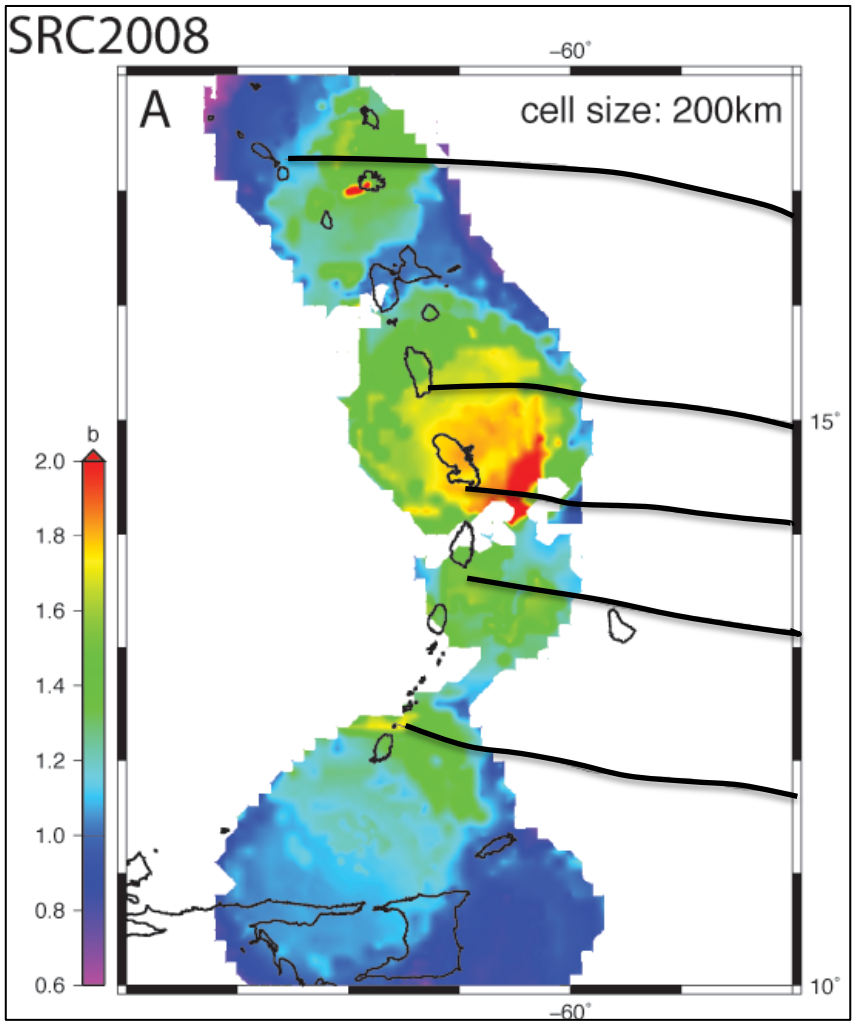
FZ and Crustal Structure?

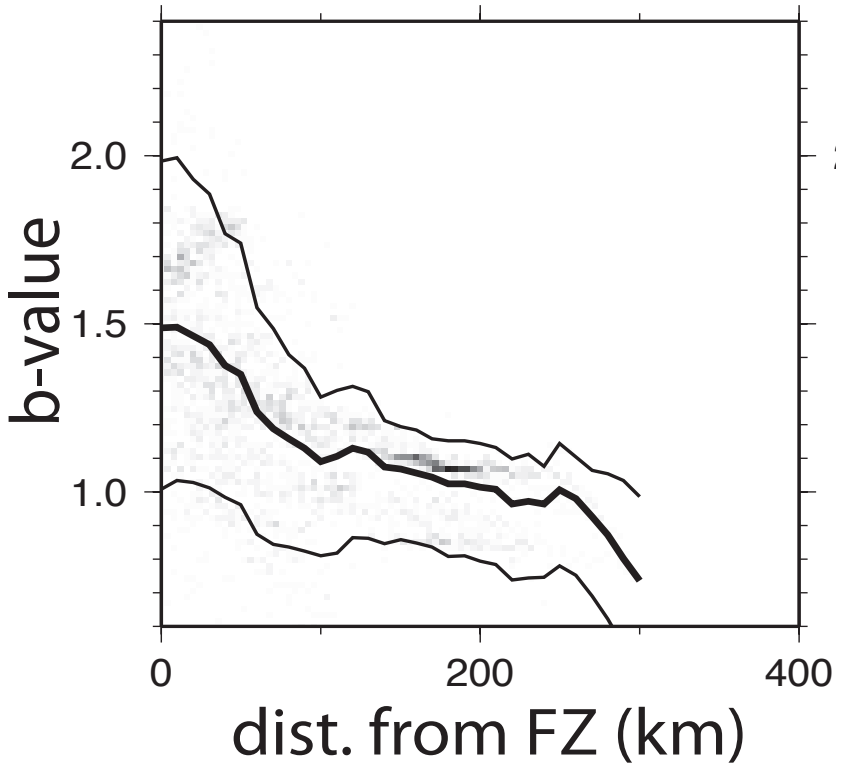


Boynton et al. (1979)



Fracture zones and Seismicity



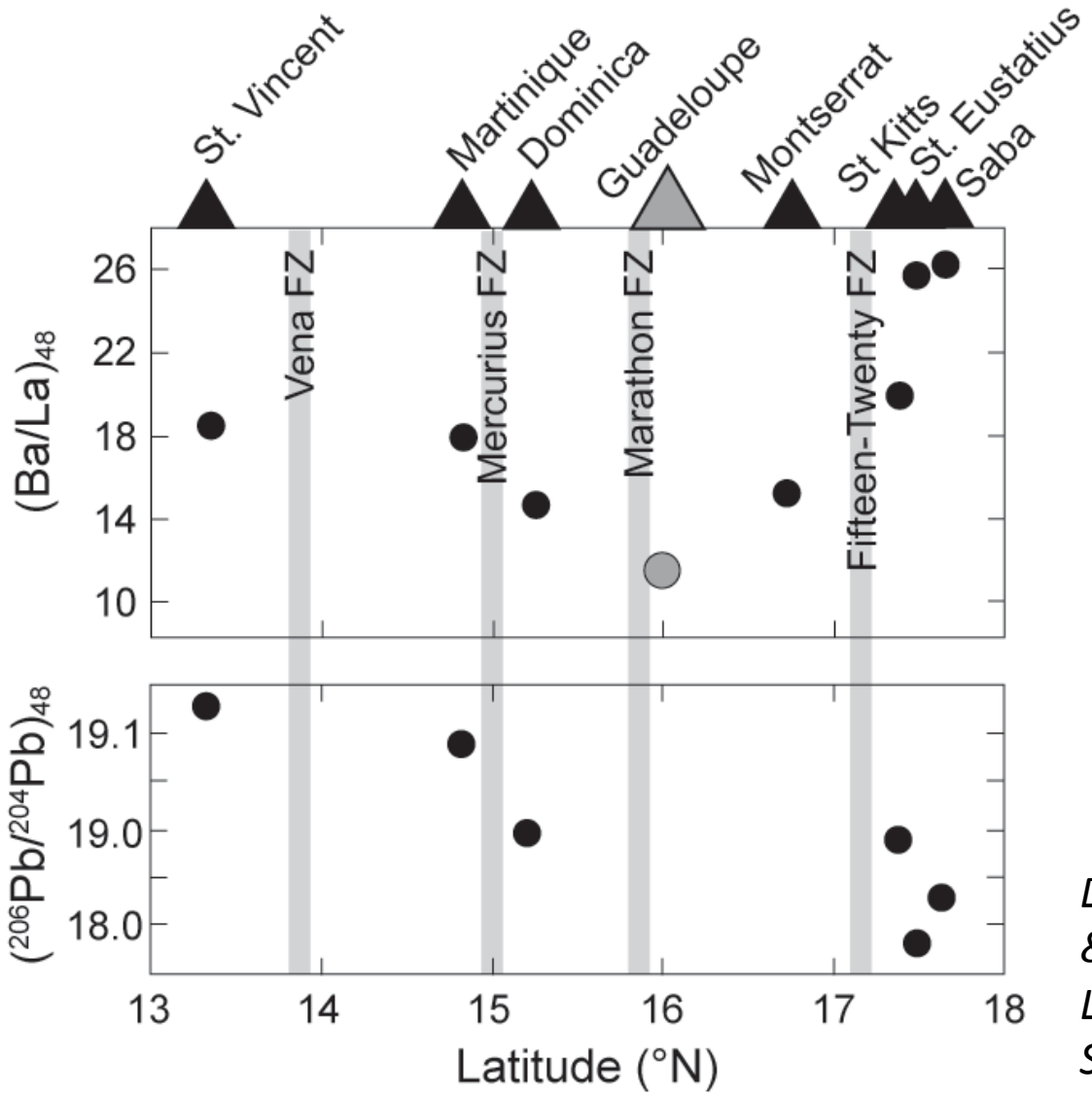


Schlaphorst, Kendall, Collier et al., *in revision,* 2015

Geochemical signatures in arc magmas

Fluids?

Sediments?



Data from Davidson & Wilson 2011; Lindsay et al., 2005; Samper et al., 2009.

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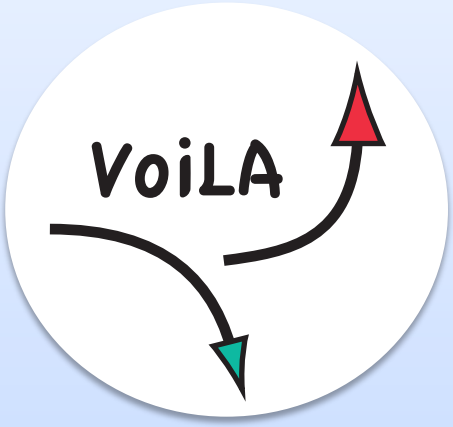
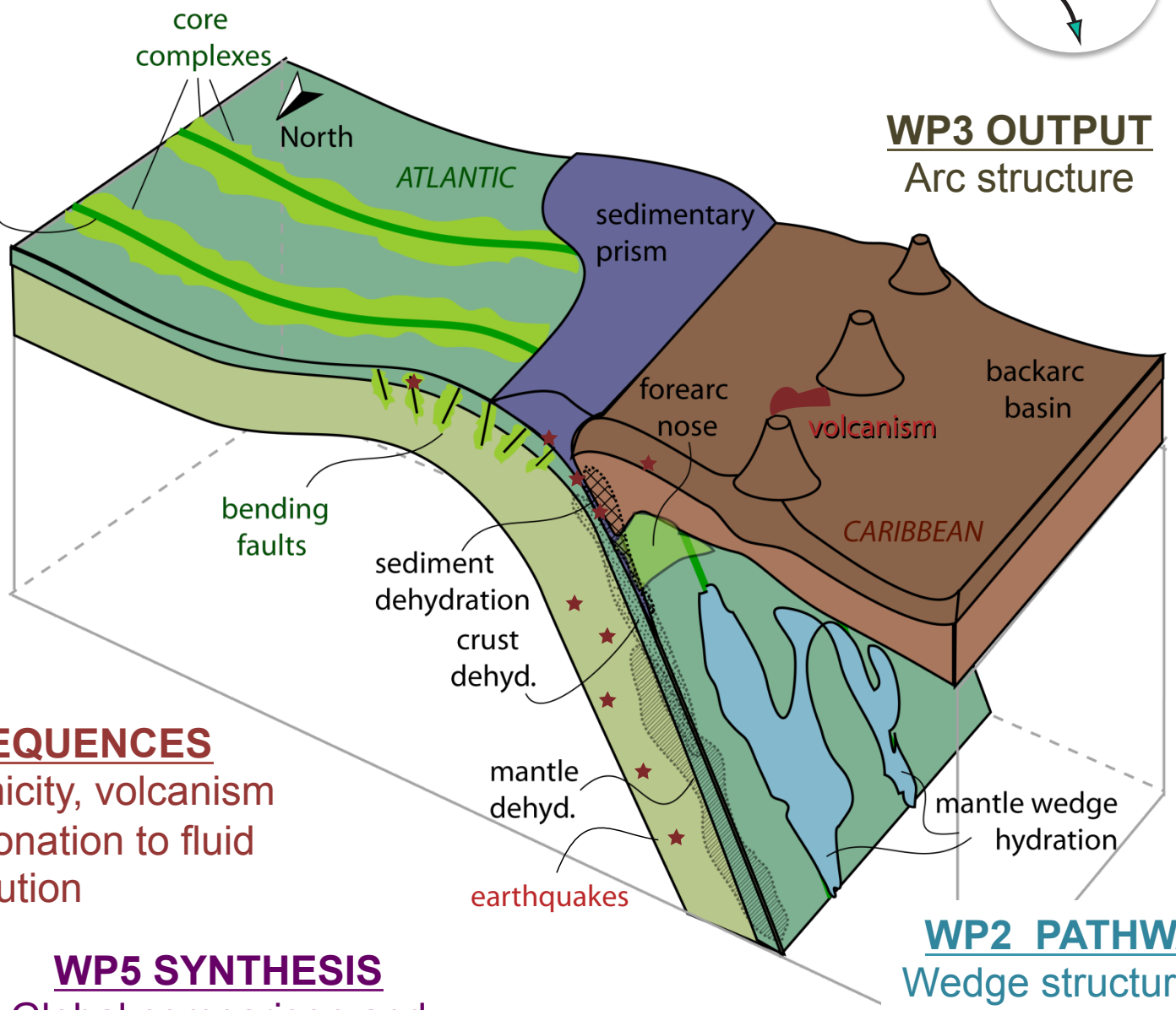


The project

NATURAL ENVIRONMENT RESEARCH COUNCIL

Research programme

WP1 INPUT
Distribution of hydration of incoming plate



WP3 OUTPUT
Arc structure

WP4 CONSEQUENCES
Relation of seismicity, volcanism and metal fractionation to fluid distribution

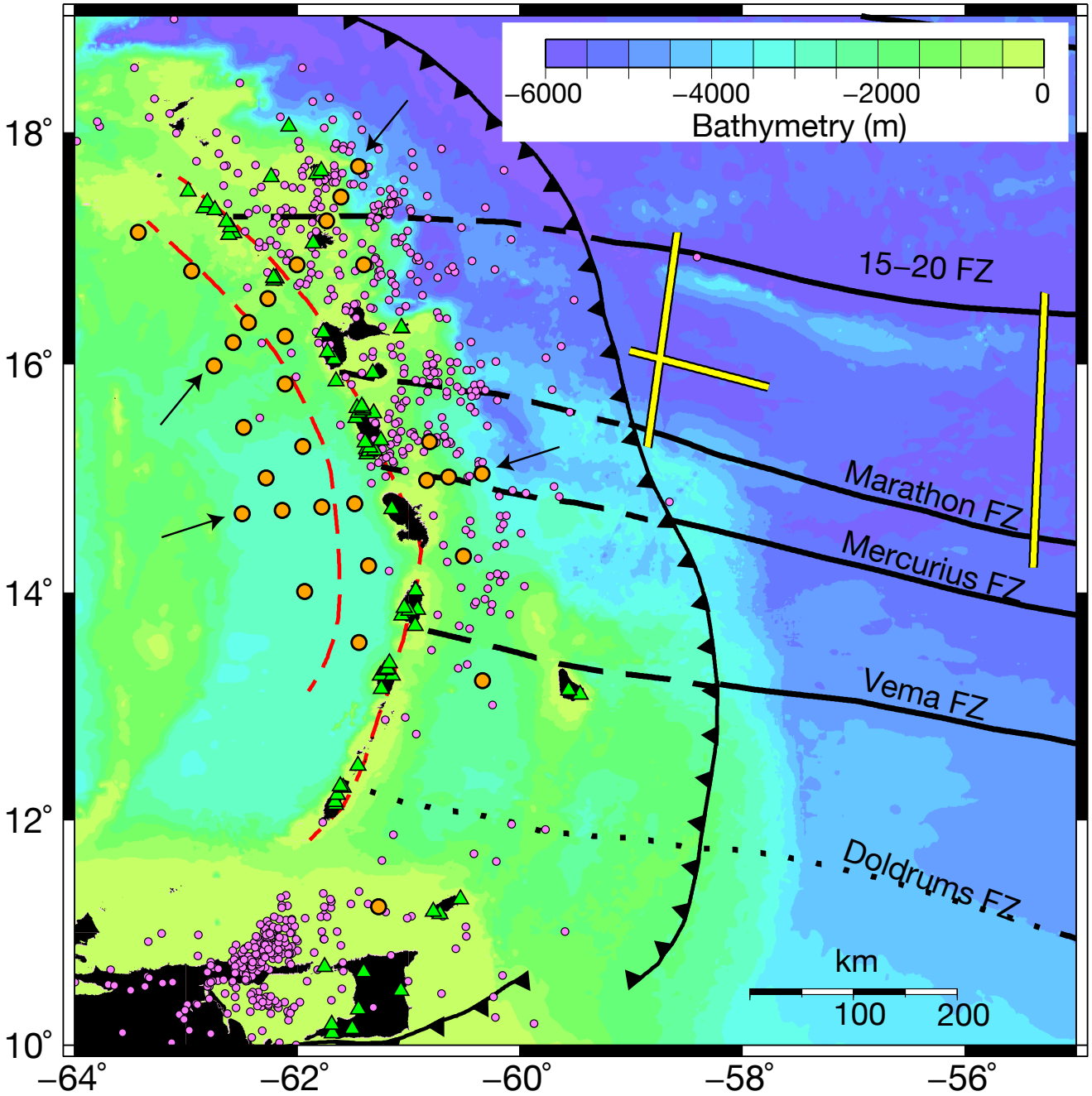
WP5 SYNTHESIS
Global comparison and broader implications

WP2 PATHWAYS
Wedge structure and flow

Geophysical Experiments

WP2
Passive-source experiment

WP3
Along-arc shoot



WP1
Active-source experiment

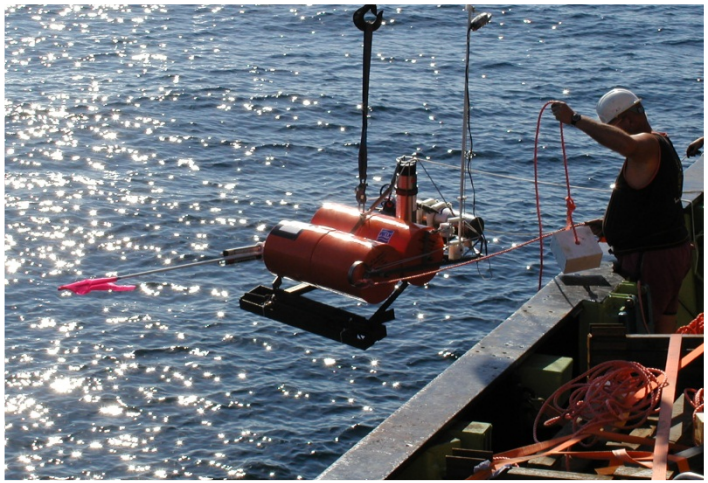
(is)land stations

earth-quakes

Project Team

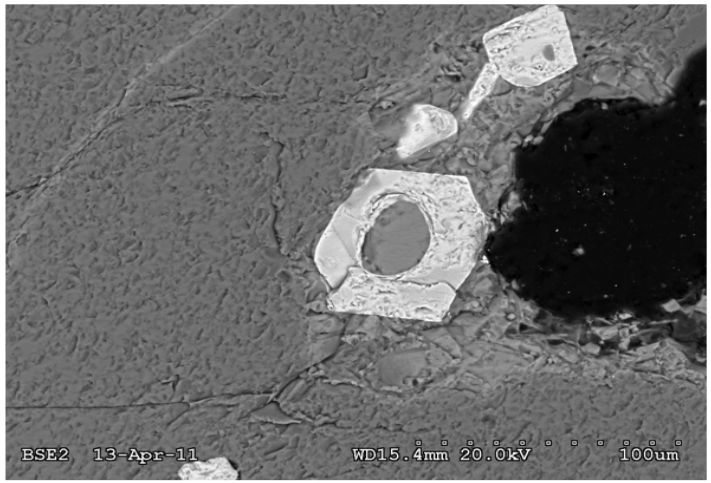
Seismology

Collier, Rietbrock, Henstock, Kendall, Harmon, Rychert



Mantle Geochemistry

Blundy

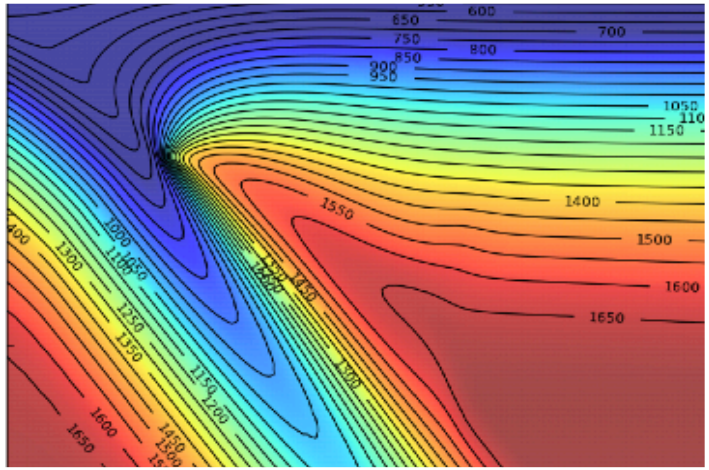


Crustal Petrology/Geochemistry

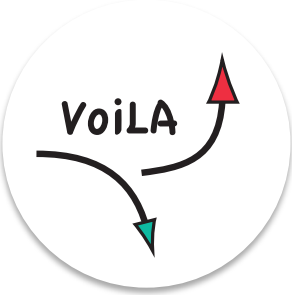
Davidson, Macpherson, Wilkinson, Wilson

Numerical modelling

Van Hunen, Goes



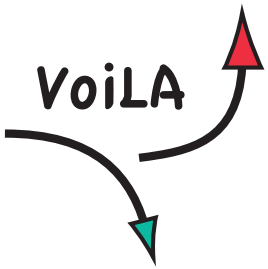
Project objectives



- produce the first high resolution image of slow-spread (Atlantic) subduction-arc system
- determine pathways of fluid subducted and recycled via serpentine
- identify links between volatile recycling seismicity, volcanism and metal pathways

First integrated analysis of an Atlantic subduction zone

Themes joint with GeoPRISMS



- Volatile cycling through subduction systems
- Magma genesis and pathways
- Crust formation and architecture
- Controls on seismogenesis
- Mineralisation processes

Some other UK efforts relevant for GeoPRISMS

NATURAL ENVIRONMENT RESEARCH COUNCIL

Research Program:

- **Volatiles, Geodynamics & Solid Earth Controls on the Habitable Planet** (2014-2019) (http://www.deepvolatiles.org)

Standard grant:

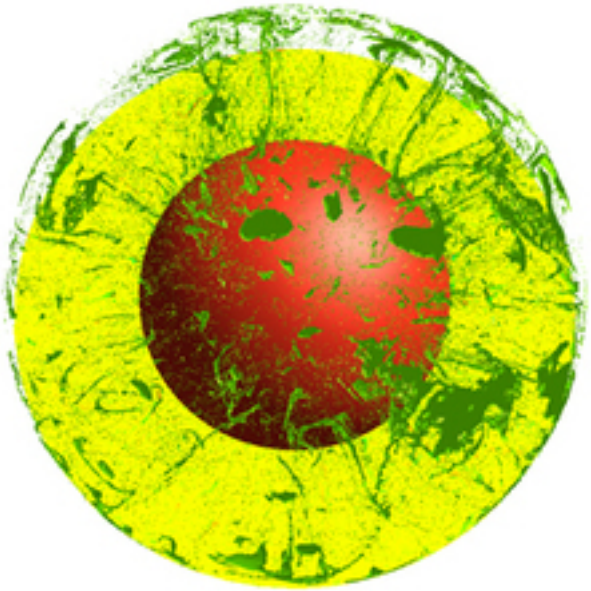
- **The Louisville Ridge-Tonga Trench collision: Implications for subduction zone dynamics** (2010-2015) (Durham, Oxford)

Large grants rifting:

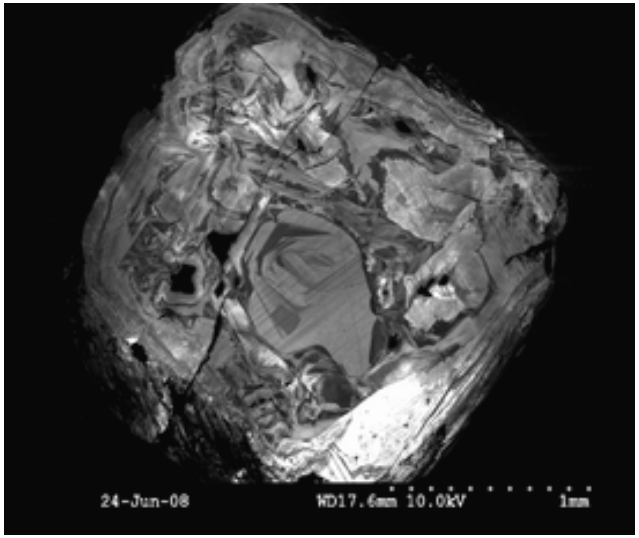
- **Looking inside the Continents from Space: Insights into Earthquake Hazard and Crustal Deformation** (2013-2018) (Alpine-Himalayan belt and EAR) (Oxford, Leeds, Cambridge, UCL, Bristol, Glasgow)
- **Rift volcanism: past, present and future** (EAR) (2014-2019) (BGS, Edinburgh, Bristol, Oxford, Cambridge, Leeds, Southampton) (http://www.bgs.ac.uk/research/volcanoes/RiftVolc.html)

Deep Volatiles: 3 Consortia

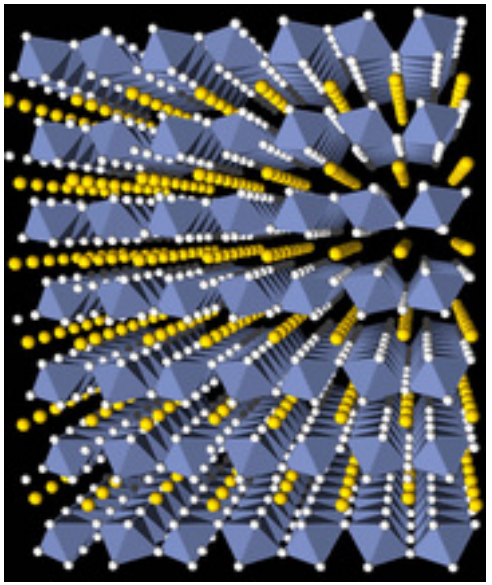
About 60 researchers, ~ 12 UK universities



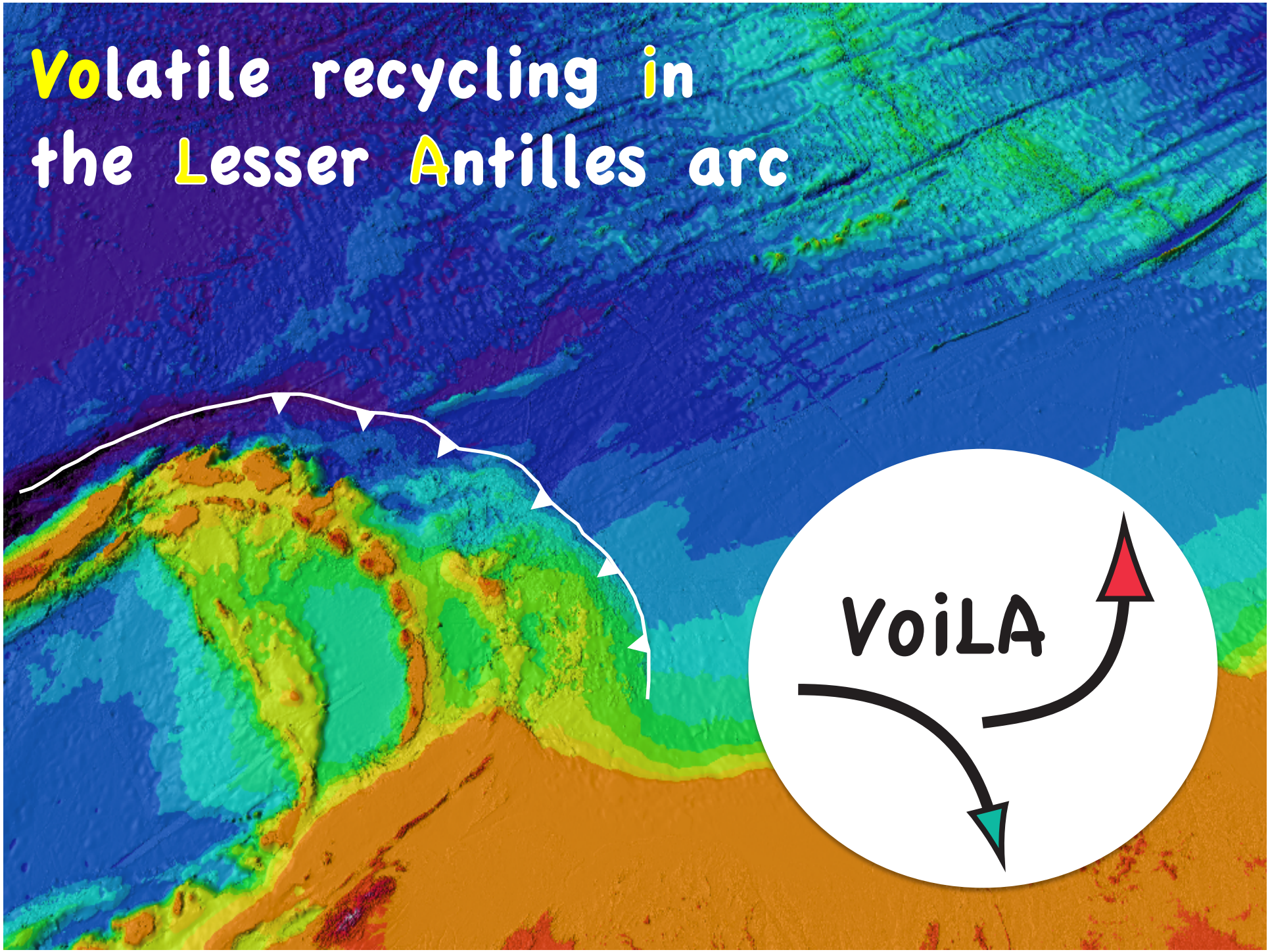
Mantle volatiles: processes, reservoirs and fluxes



The volatile legacy of the Earth



The feedback between volatiles and mantle dynamics


Volatile recycling in
the Lesser Antilles arc
VoiLA