Priorities in Marine Geology & Geophysics

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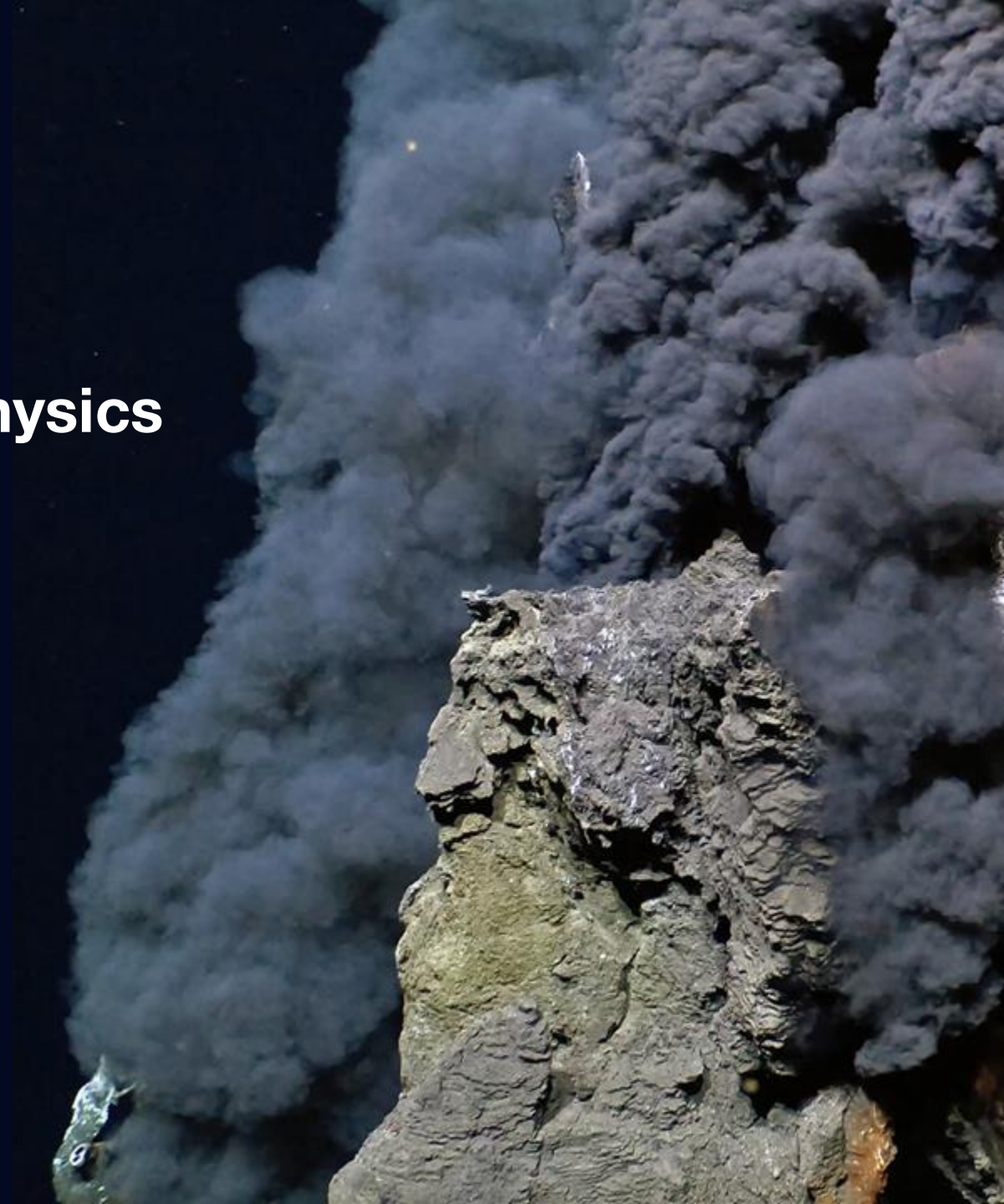


2025-2035 Decadal Survey of Ocean Sciences | 21 May 2024

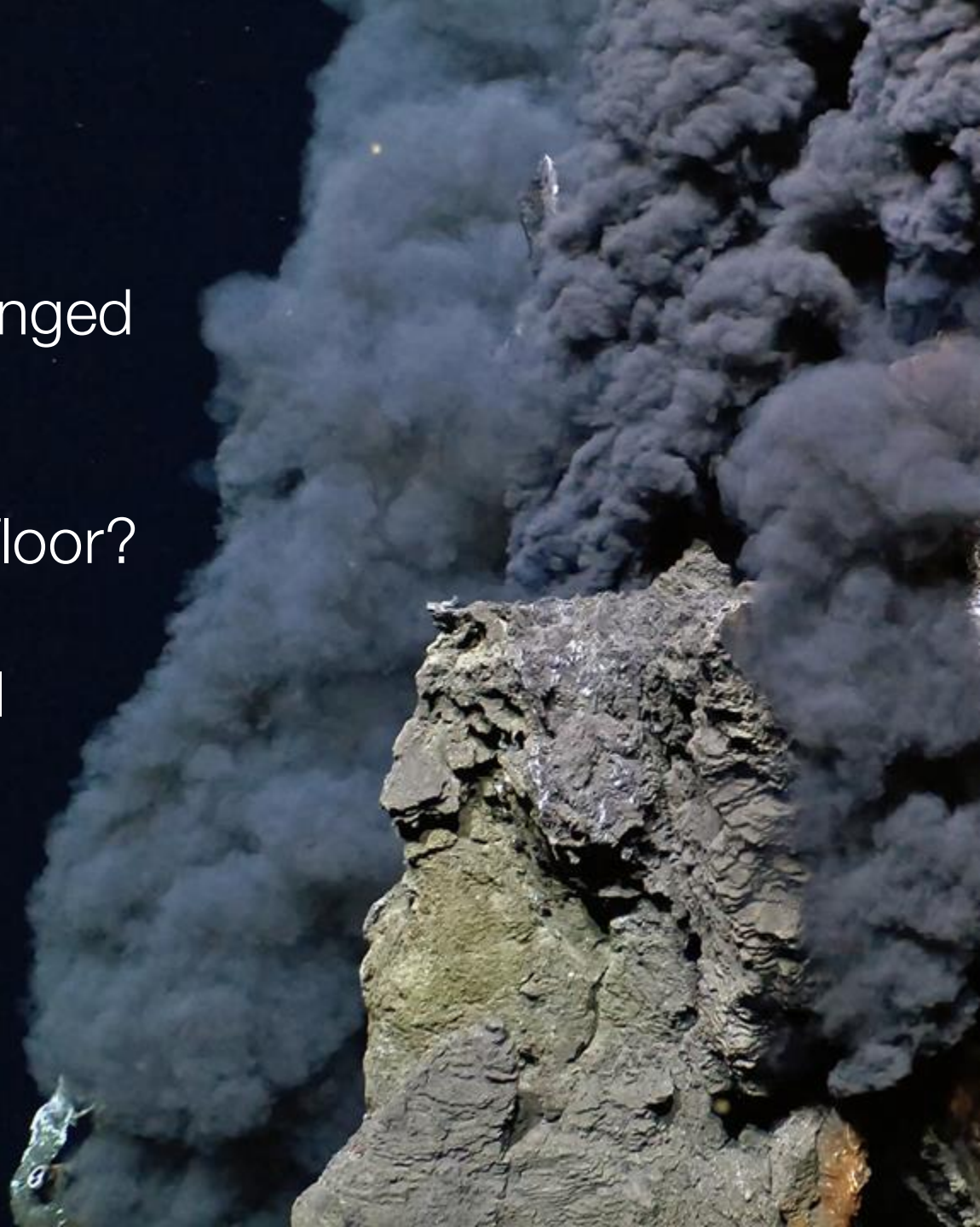
Outline

1. How are fluids, heat, and matter exchanged between ocean and crust?

1. What controls the shape of the ocean floor?

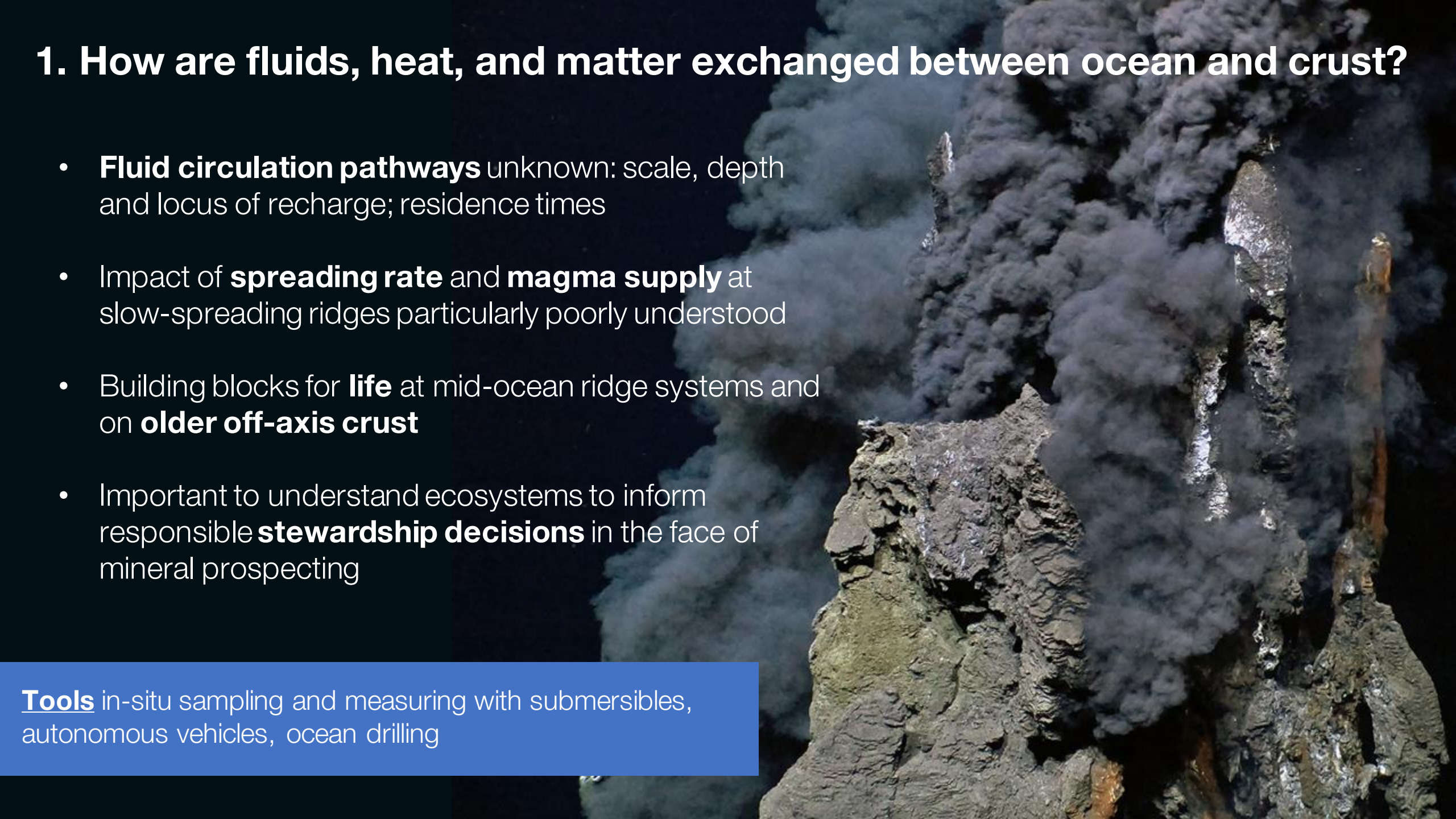
1. How does oceanic plate history control subduction zone behavior?

> U.S. Marine Geophysical Facilities

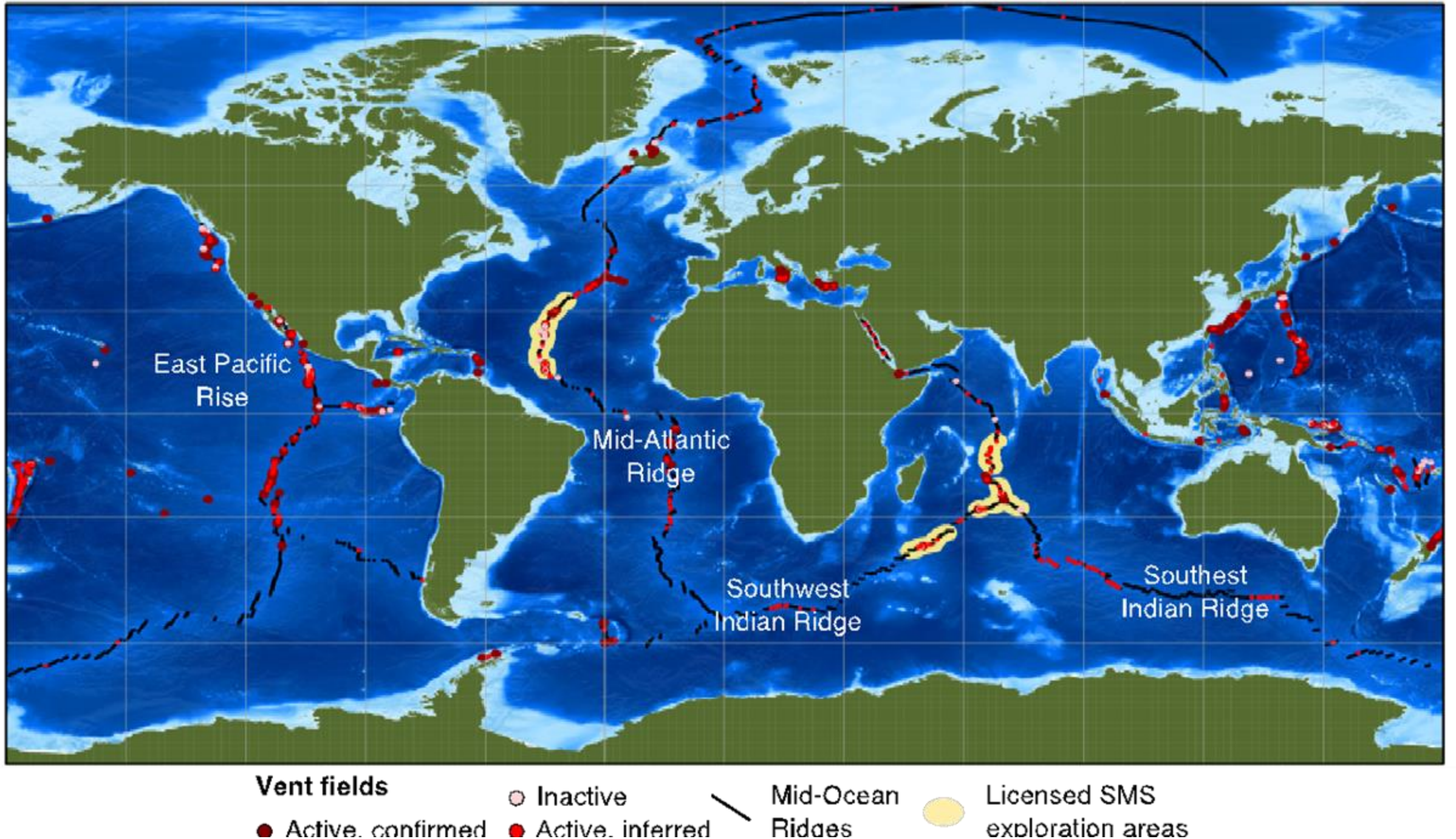


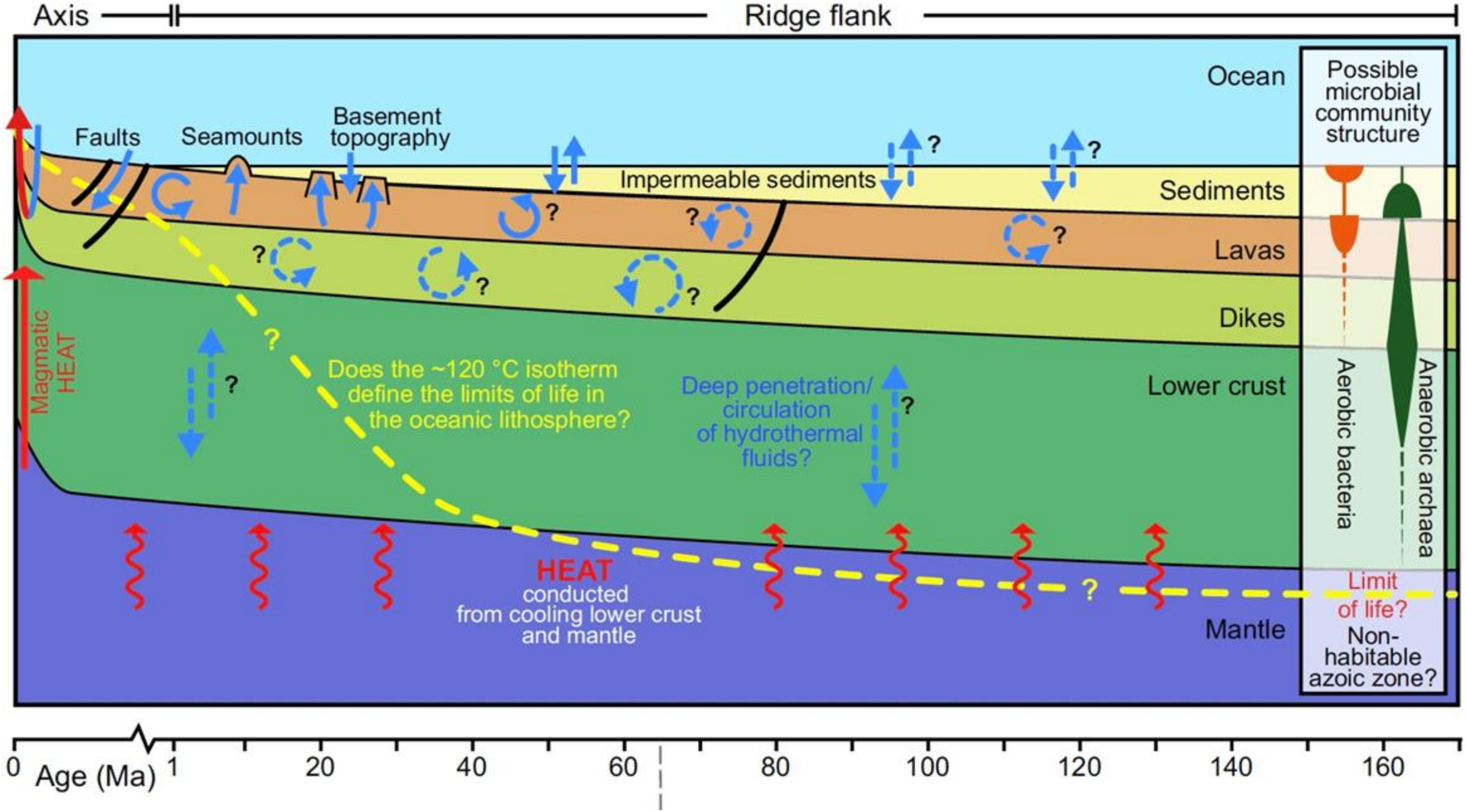
1. How are fluids, heat, and matter exchanged between ocean and crust?

- **Fluid circulation pathways** unknown: scale, depth and locus of recharge; residence times
- Impact of **spreading rate** and **magma supply** at slow-spreading ridges particularly poorly understood
- Building blocks for **life** at mid-ocean ridge systems and on **older off-axis crust**
- Important to understand ecosystems to inform responsible **stewardship decisions** in the face of mineral prospecting



Tools in-situ sampling and measuring with submersibles, autonomous vehicles, ocean drilling


East Pacific Rise
Mid-Atlantic Ridge
Southwest Indian Ridge
Southest Indian Ridge
Vent fields
Active, confirmed
Inactive
Active, inferred
Mid-Ocean Ridges
Licensed SMS exploration areas

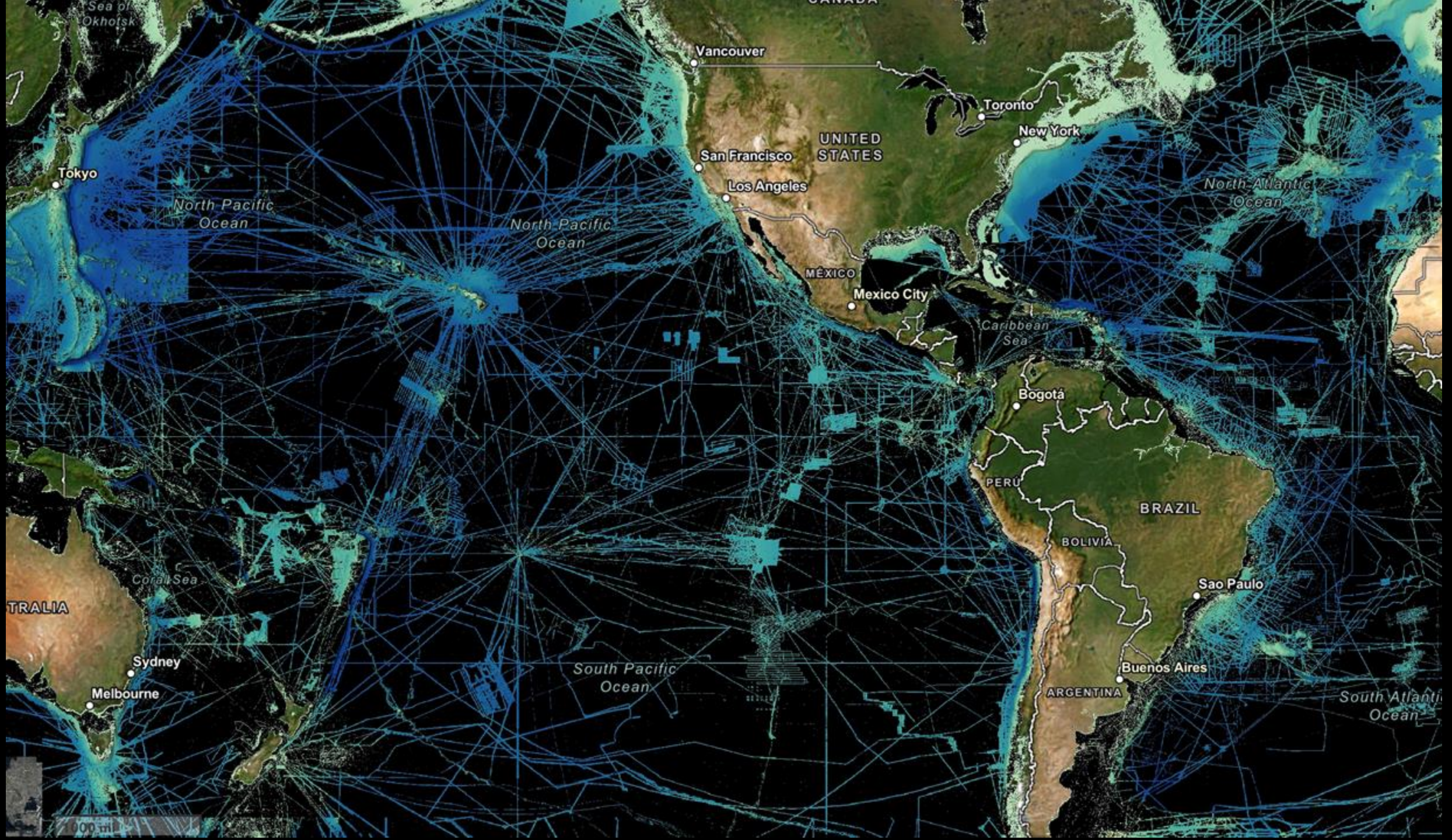


Coggon et al., 2024

2. What controls the shape of the ocean floor?

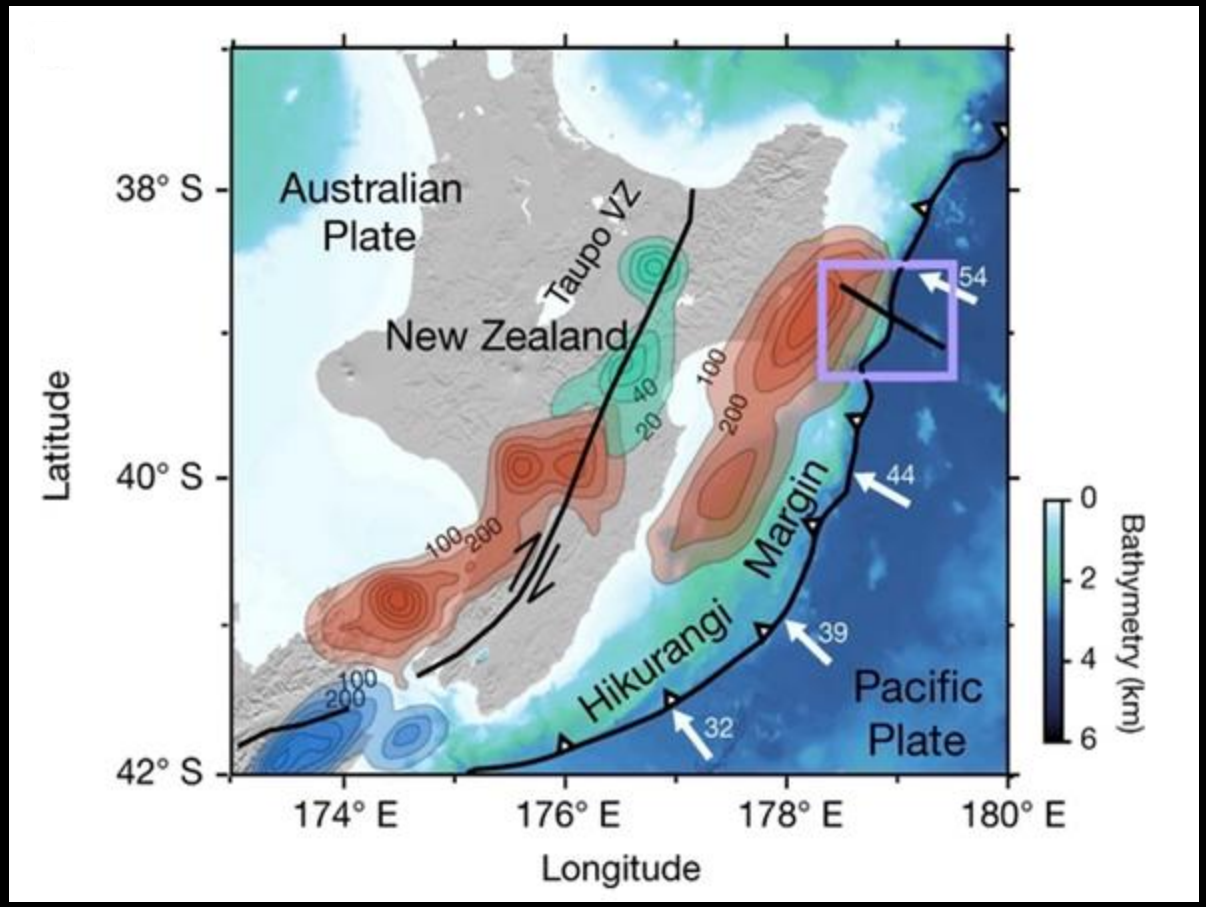
- Volcanism at ridges **paves ocean basins**
- Important to understand crust formation, ocean circulation and **mixing**
- Can inform **volcanic hazard assessment;** oceans are tractable
- We don't understand how **melt** is stored and transported, the impact of melt composition and the potential role of **glacial cycles**
- **Challenge: less than 30%** ocean floor is mapped

Tools long-term observations e.g. seismicity; mapping seismic imaging, fluid temperature and chemistry, geodesy


Sea of Okhotsk
Vancouver
Toronto
New York
UNITED STATES
San Francisco
Los Angeles
Tokyo
North Pacific Ocean
North Pacific Ocean
North Atlantic Ocean
MÉXICO
Mexico City
Caribbean Sea
Bogotá
PERÚ
BRAZIL
BOLIVIA
Sao Paulo
Coral Sea
TRALIA
Sydney
Melbourne
South Pacific Ocean
Buenos Aires
ARGENTINA
South Atlantic Ocean

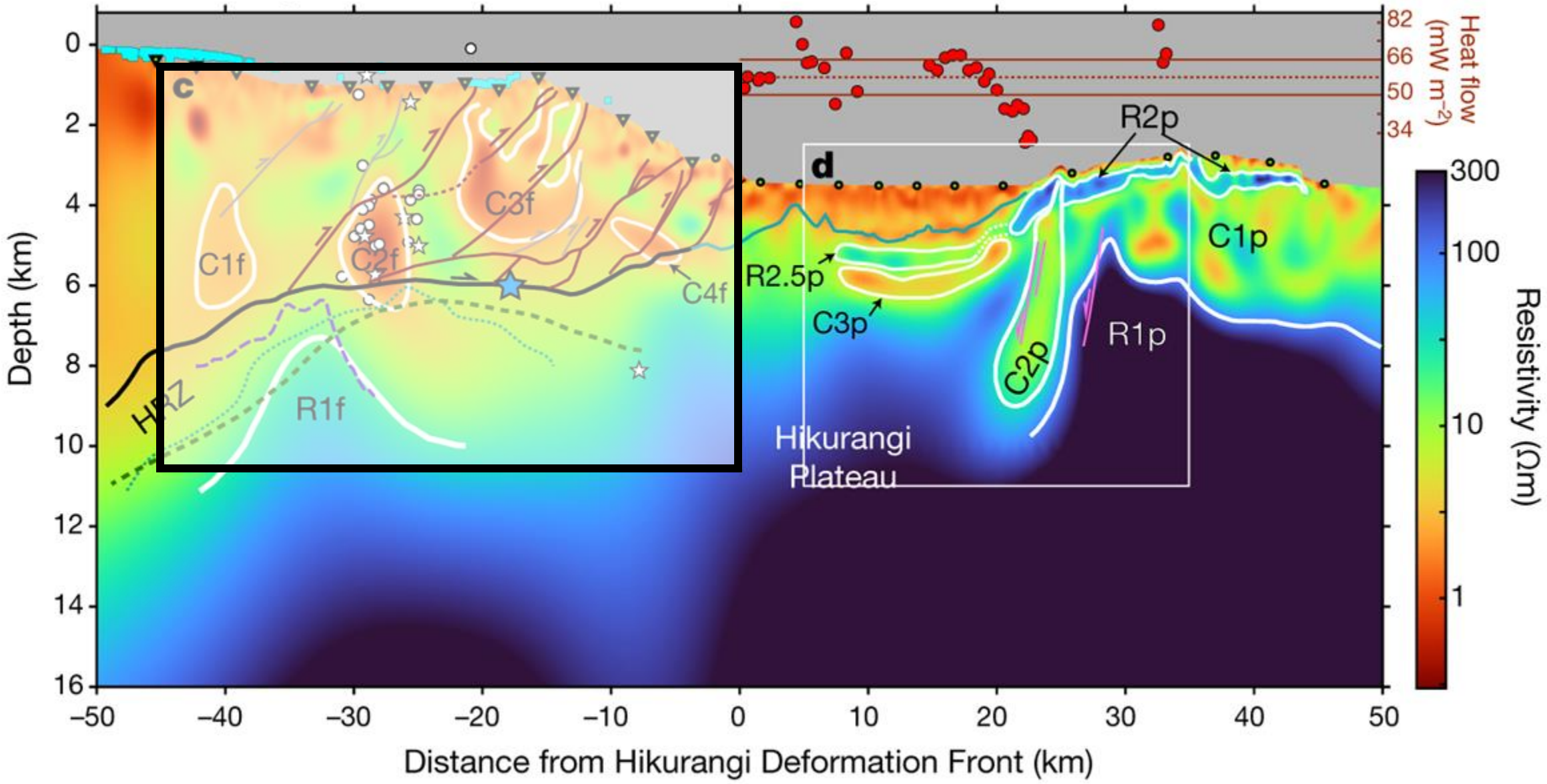
3. How does oceanic plate history control subduction zone behavior?

- **Fluids** play a key role in rheology and seismogenesis, but difficult to quantify
- Plates arrive at the subduction zone having experienced **variable histories** of volcanism, hydrothermal alteration, and stress
- Need to know about both **structure and fluid content** to understand dynamics
- **Hikurangi example: subducting seamounts deliver water to deeper mantle**

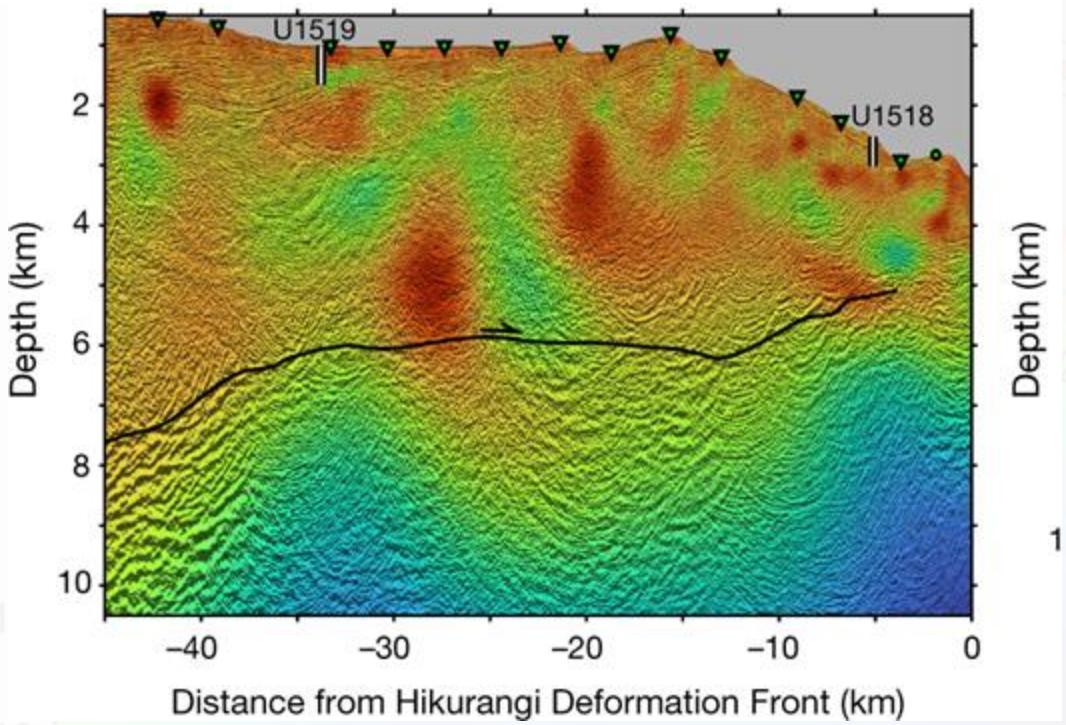


Chesley et al., 2021

Tools combined electromagnetism, reflection and refraction seismic imaging, full-waveform inversion, models



Chesley et al., 2021



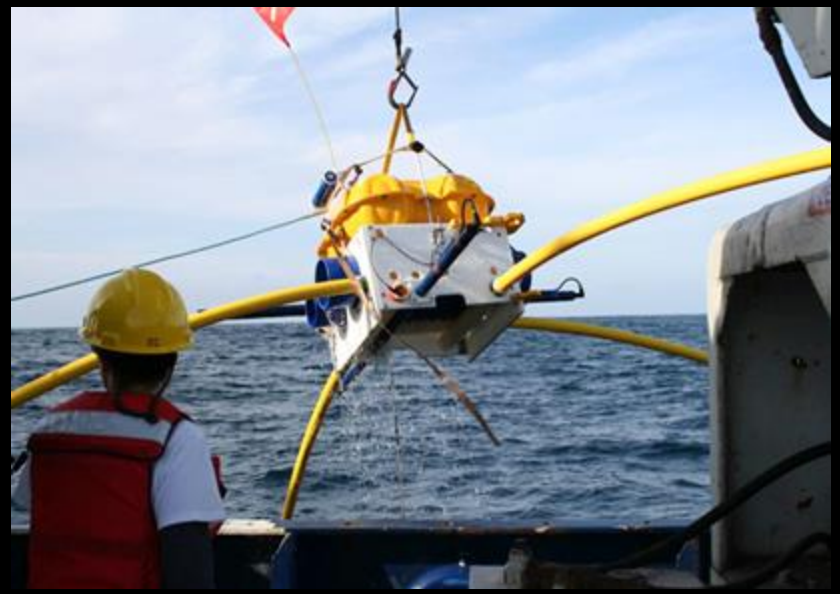
- Co-located **electromagnetic** profile, seismic reflection data, **IODP core**, and **ocean bottom seismometers**
- Subducted seamount associated with **fracture network and fluids**
- Burst-type **repeating earthquakes** and seismicity associated with a recent slow slip event

Chesley et al., 2021

U.S. Marine Geophysical Facilities

Ocean Bottom Seismographs

- Small instrument pool **prevents high-resolution experiments**
- Large, complex platforms are expensive to operate & maintain
- 20+ year old instruments are unreliable, cost per datum is high



Marine Electromagnetics

- No central NSF facility
- Critical to understand subsurface fluids
- Instrument design 20+ years old

Active Source Seismology

- Seismic vessel ***R/V Langseth*** nearing end of service life (built 1991; refit 2007)
- No longer NSF facility: **uncertainty suppresses science**
- Ageing equipment maintenance, e.g. acoustic sources
- **Long streamer**, tuned source, 3d-imaging: essential for future science questions

Deep Submergence Facility

- High demand but limited availability of assets
- HOV *Alvin*, ROV *Jason* & AUV *Sentry*
- Sampling options limited with retirement of *JOIDES Resolution*

U.S. Marine Geophysical Facilities

- Urgent need to address **ageing infrastructure**
- Limited assets **drive pace of science:** vehicles and instruments
- Opportunity to answer new questions by accessing new technology, increase efficiencies and **reduce complexity**
- Ageing equipment is **now failing**, hampering science
- Need interoperable, **collaborative instrumentation**