The Legacy & Challenges (and Future) of Seafloor Sampling

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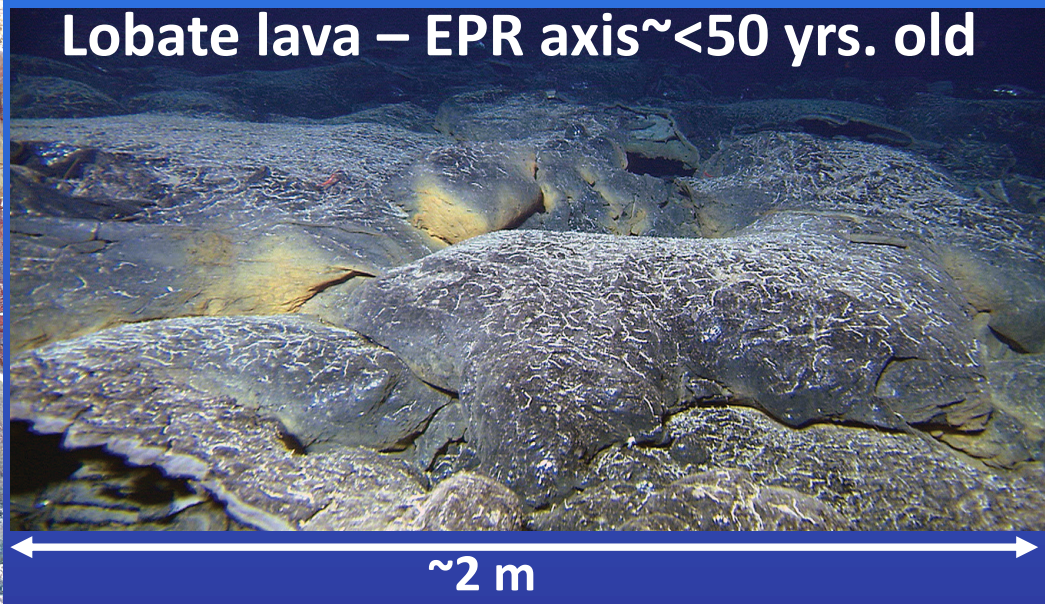
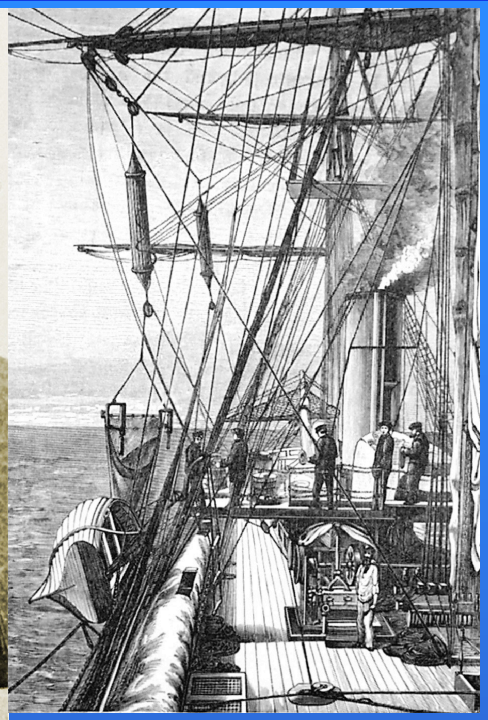
- why we did it, where we did it, how we did it, could we have done it better (then), are we doing it (can we do it) better now and in the future….

- a key to seafloor sampling (or any scientific sampling) is properly establishing the context for the sample: location, environment, association (e.g., with biology or geochemical processes – hydrothermal vents or cold seeps)
- in the ocean that means high-resolution mapping to determine where you want to collect the sample from, and how it relates to surrounding features, lithologies and earth/ocean phenomena

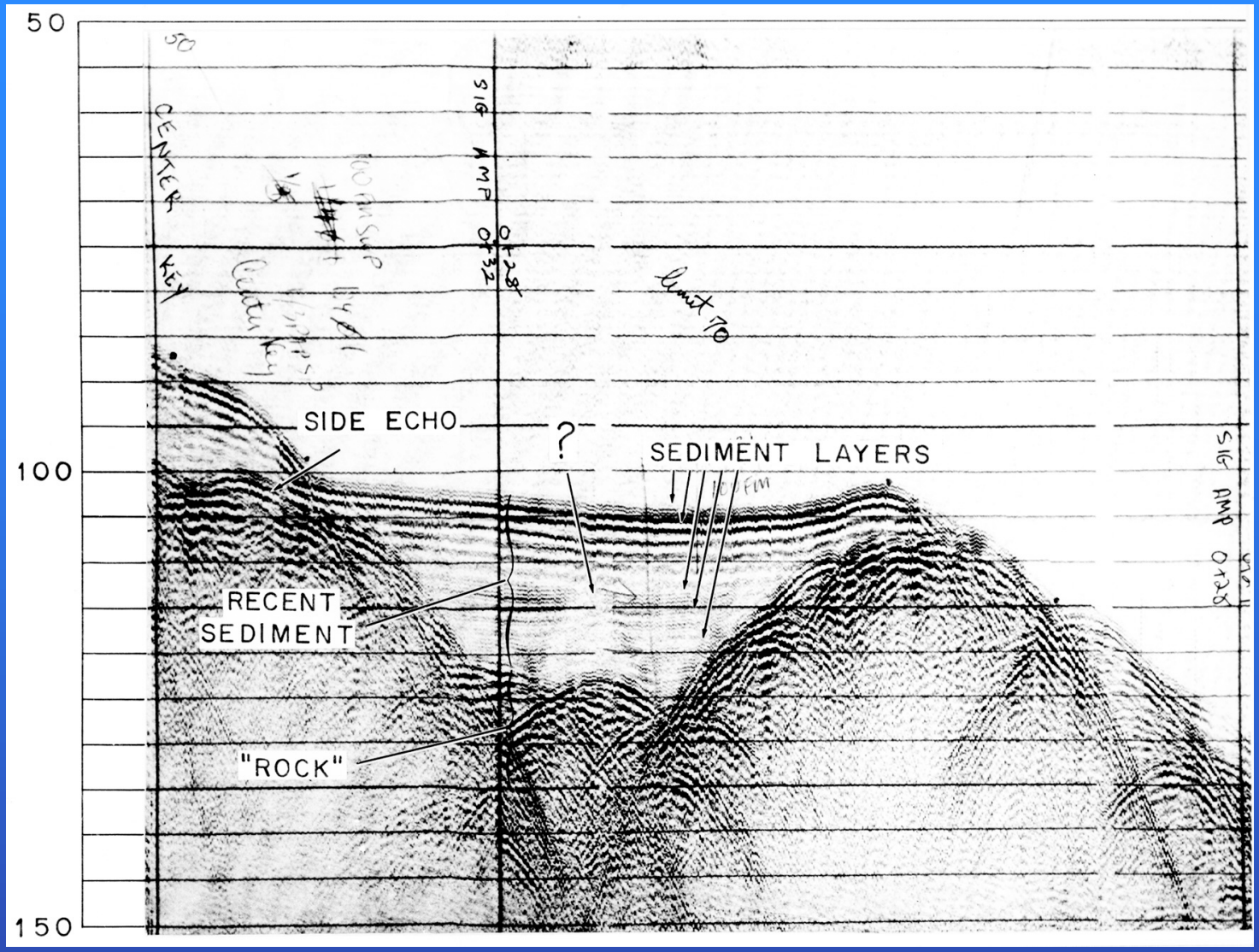




HMS *Challenger* – 1872 –St. Thomas Harbor

RV *Vema* – 1953-1981

Sampling the Ocean Floor for ~>150 yrs



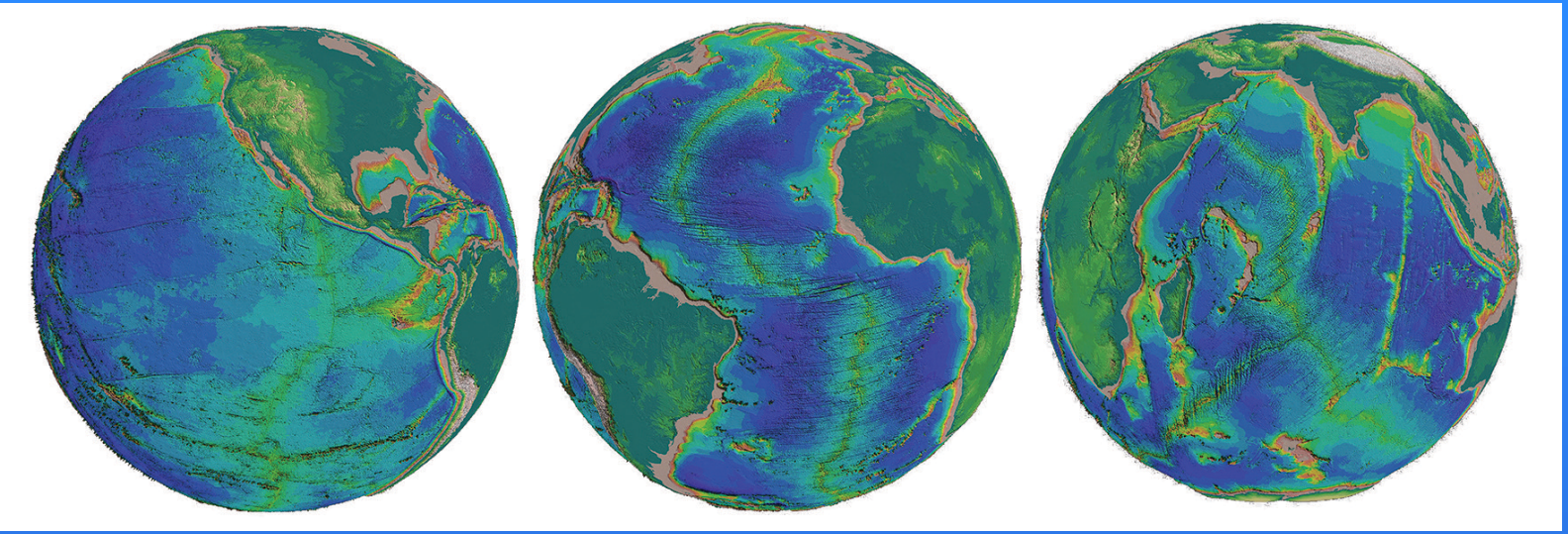
3.5 kHz echosounder record – interpreting acoustic returns from the seafloor and implications for how to sample it

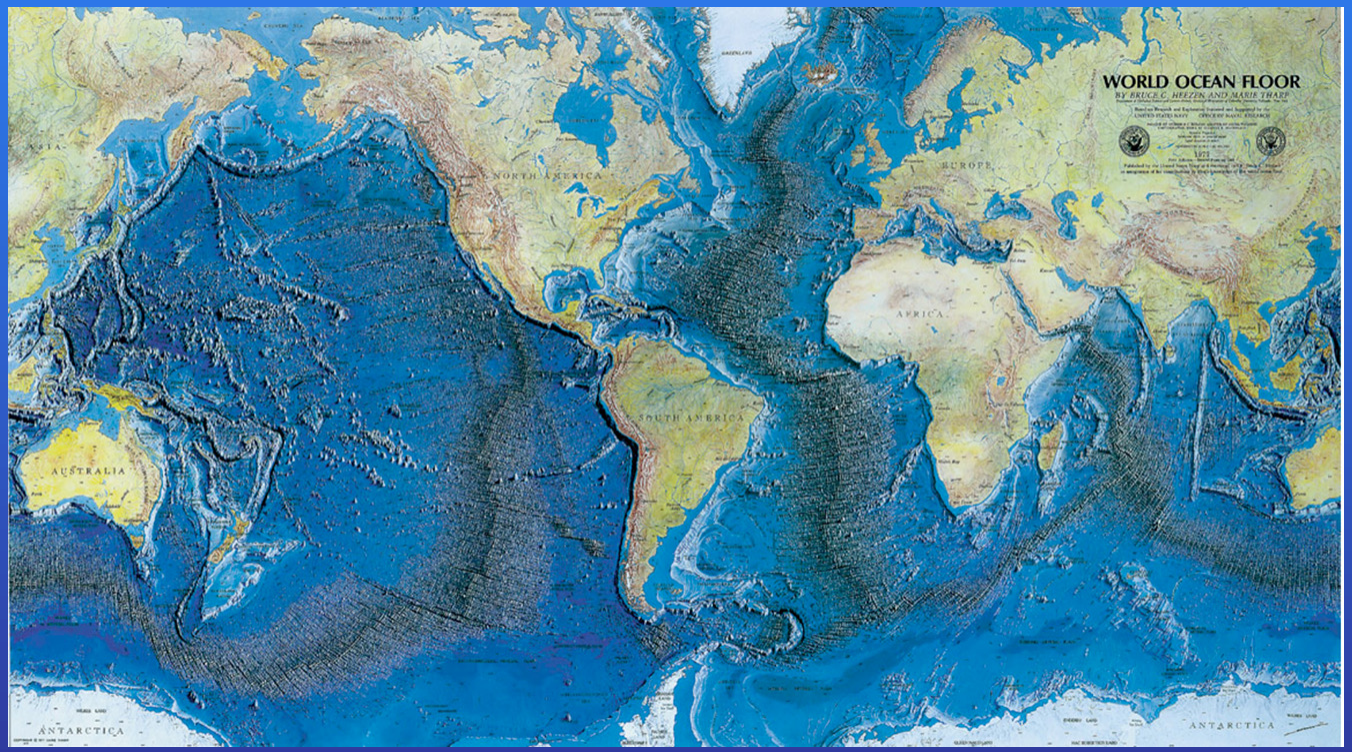
Sampling methods appropriate to the terrain and scope of research problem

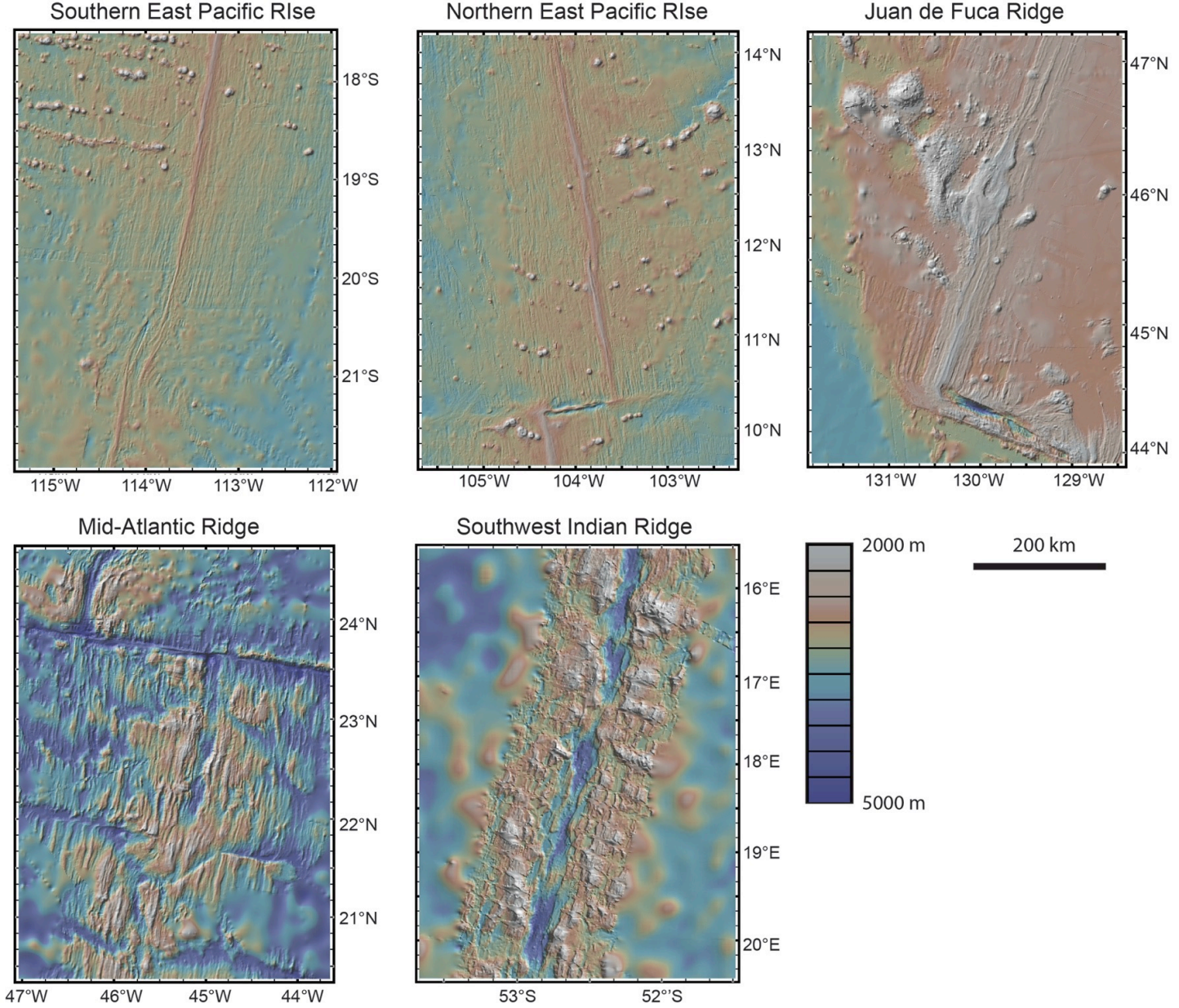
Ophiolites - Bay of Islands Ophiolite (top) and Oman Ophiolite (top right)

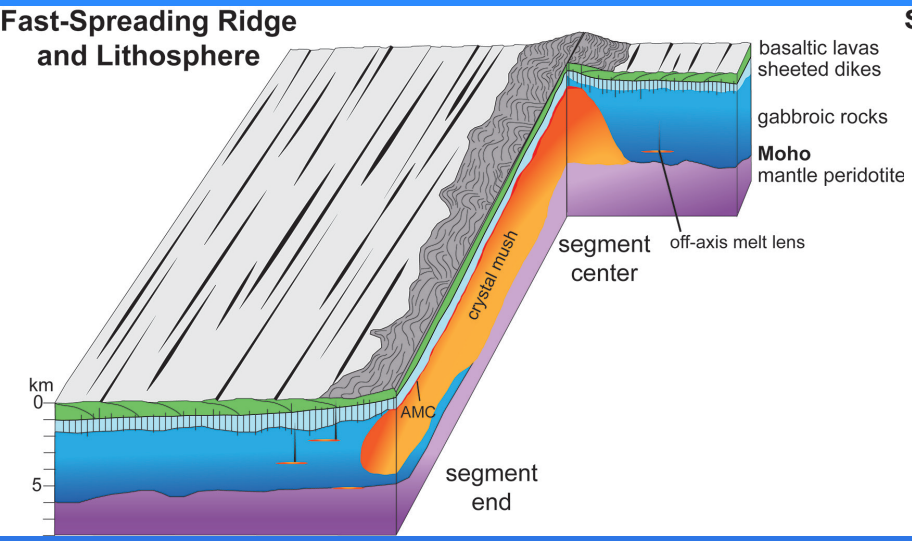
Basalt lava flows – Iceland (bottom right)

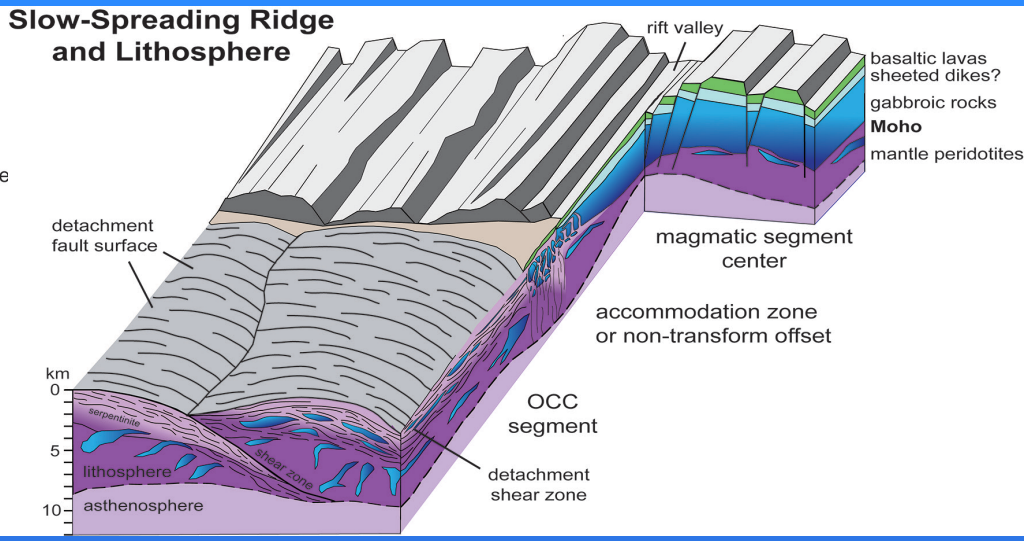
J. Karson

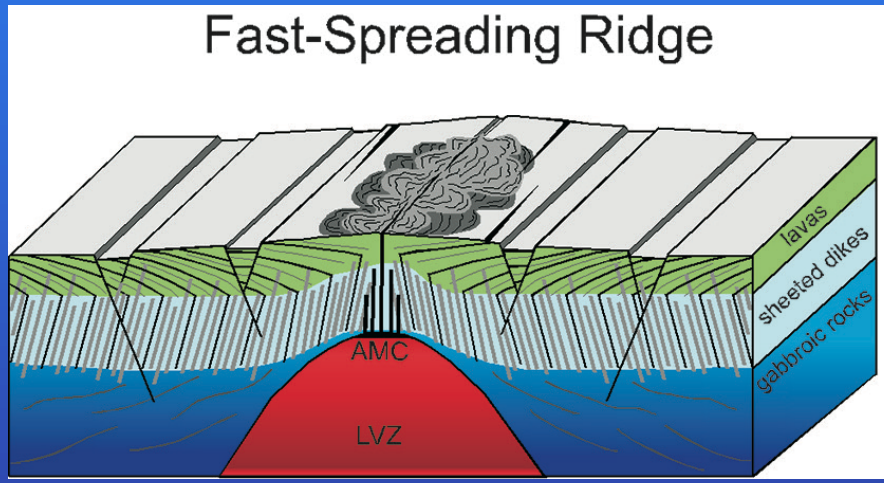


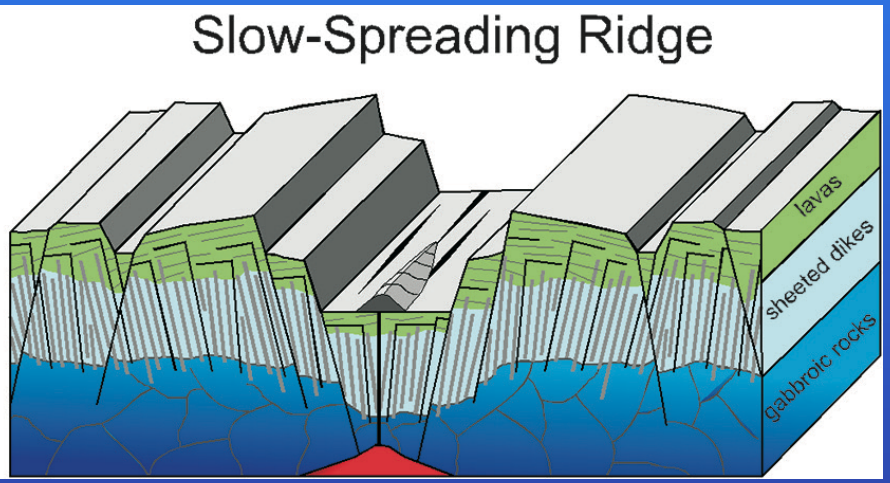

WORLD OCEAN FLOOR
BY BRUCE C. HEEZEN AND MARIE THARP
NORTH AMERICA
EUROPE
AFRICA
SOUTH AMERICA
AUSTRALIA
ANTARCTICA
ANTARCTICA

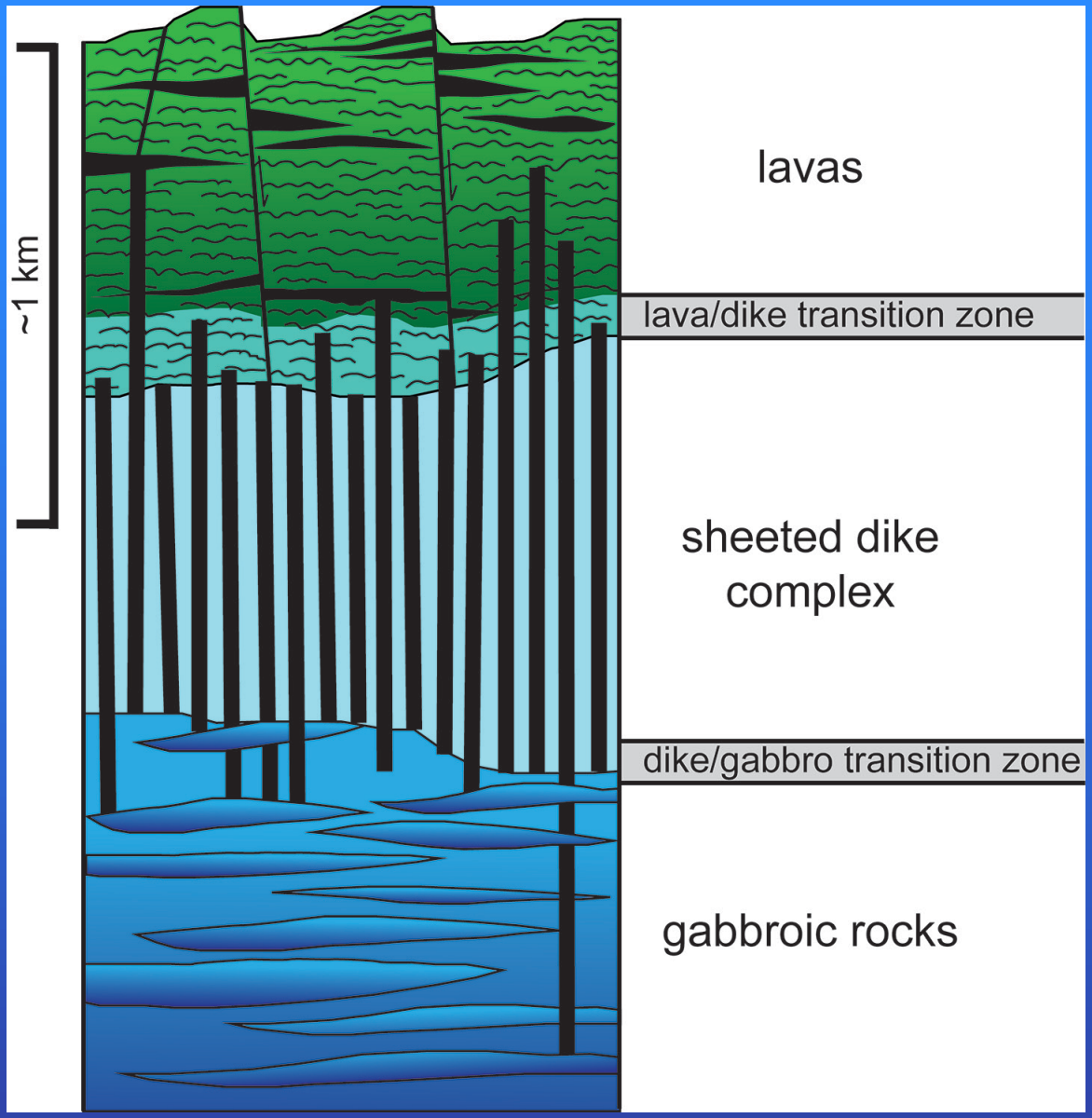

Southern East Pacific RIse
18°S
19°S
20°S
21°S
115°W
114°W
113°W
112°W
Northern East Pacific RIse
14°N
13°N
12°N
11°N
10°N
105°W
104°W
103°W
Juan de Fuca Ridge
47°N
46°N
45°N
44°N
131°W
130°W
129°W
Mid-Atlantic Ridge
24°N
23°N
22°N
21°N
47°W
46°W
45°W
44°W
Southwest Indian Ridge
16°E
17°E
18°E
19°E
20°E
53°S
52°'S
2000 m
5000 m
200 km

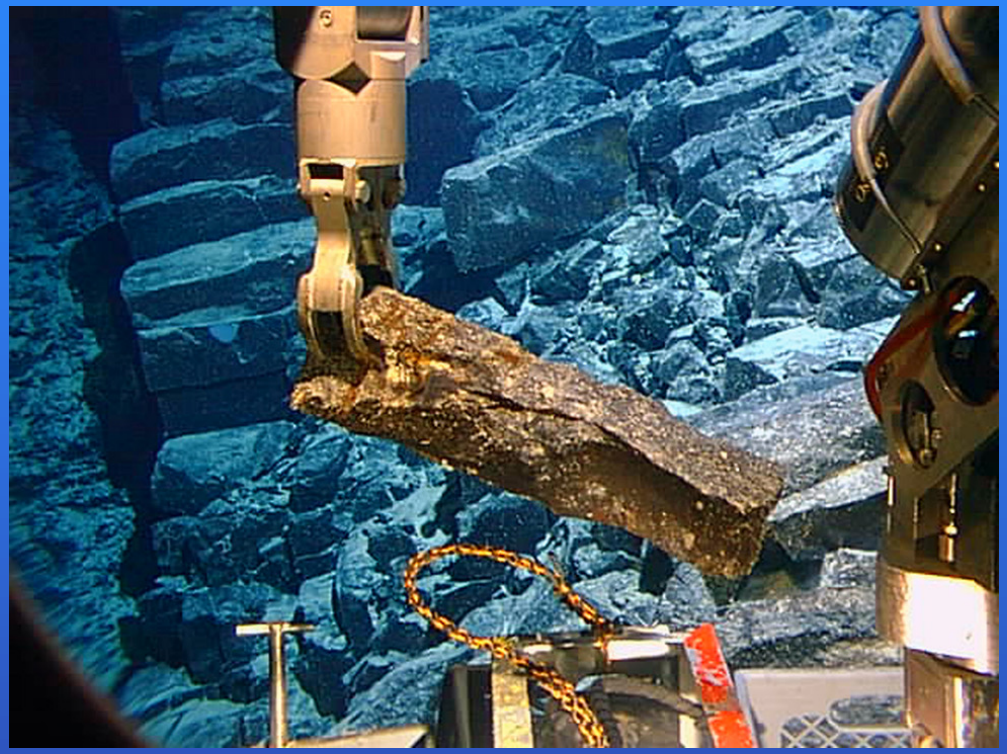

Fast-Spreading Ridge
and Lithosphere
basaltic lavas
sheeted dikes
gabbroic rocks
Moho
mantle peridotite
crystal mush
segment
center
off-axis melt lens
km
0
5
AMC
segment
end


Slow-Spreading Ridge
and Lithosphere
rift valley
basaltic lavas
sheeted dikes?
gabbroic rocks
Moho
mantle peridotites
detachment
fault surface
magmatic segment
center
accommodation zone
or non-transform offset
km
0
5
10
serpentinite
lithosphere
asthenosphere
shear zone
OCC
segment
detachment
shear zone

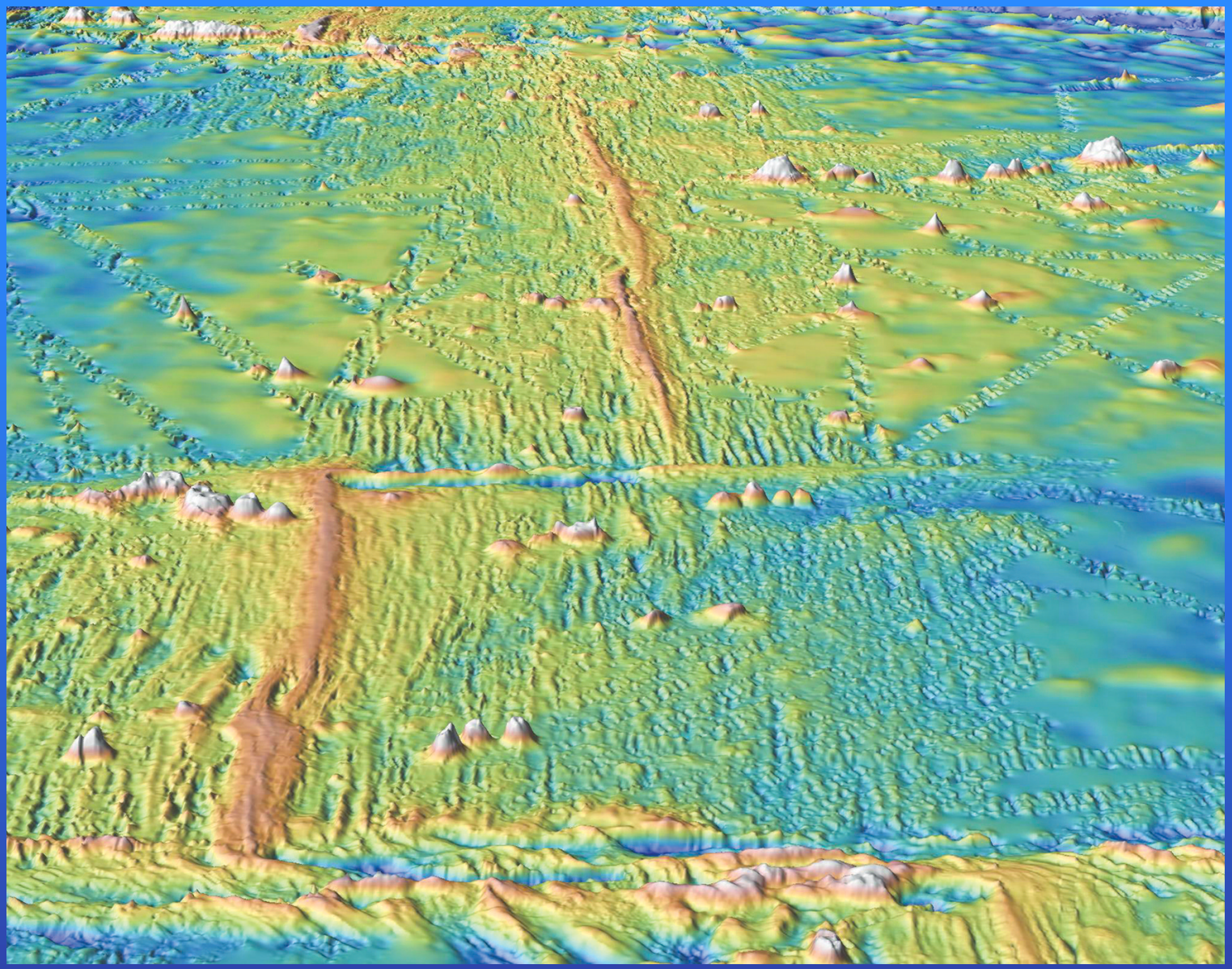

Fast-Spreading Ridge
lavas
sheeted dikes
gabbroic rocks
AMC
LVZ


Slow-Spreading Ridge
lavas
sheeted dikes
gabbroic rocks

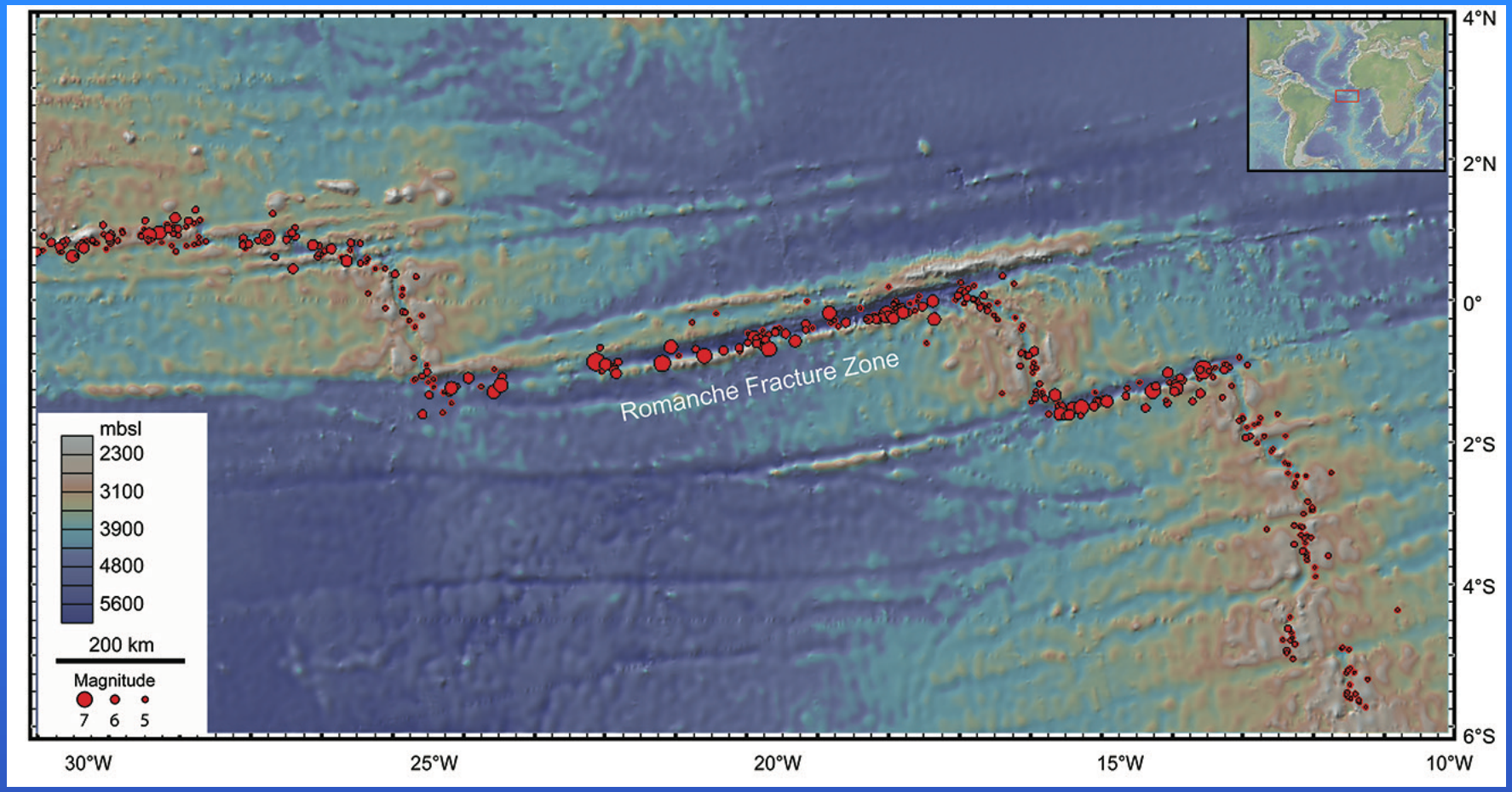

~1 km
lavas
lava/dike transition zone
sheeted dike complex
dike/gabbro transition zone
gabbroic rocks



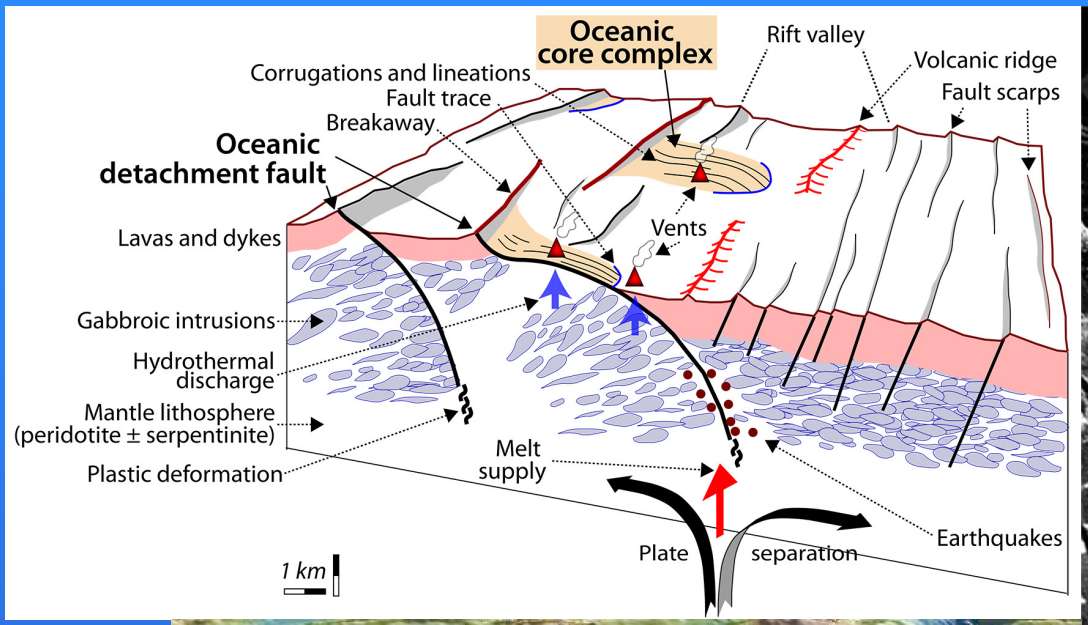
Icelandic dike (left). (right) Alvin sampling dike exposures in Hess Deep Rift – J. Karson

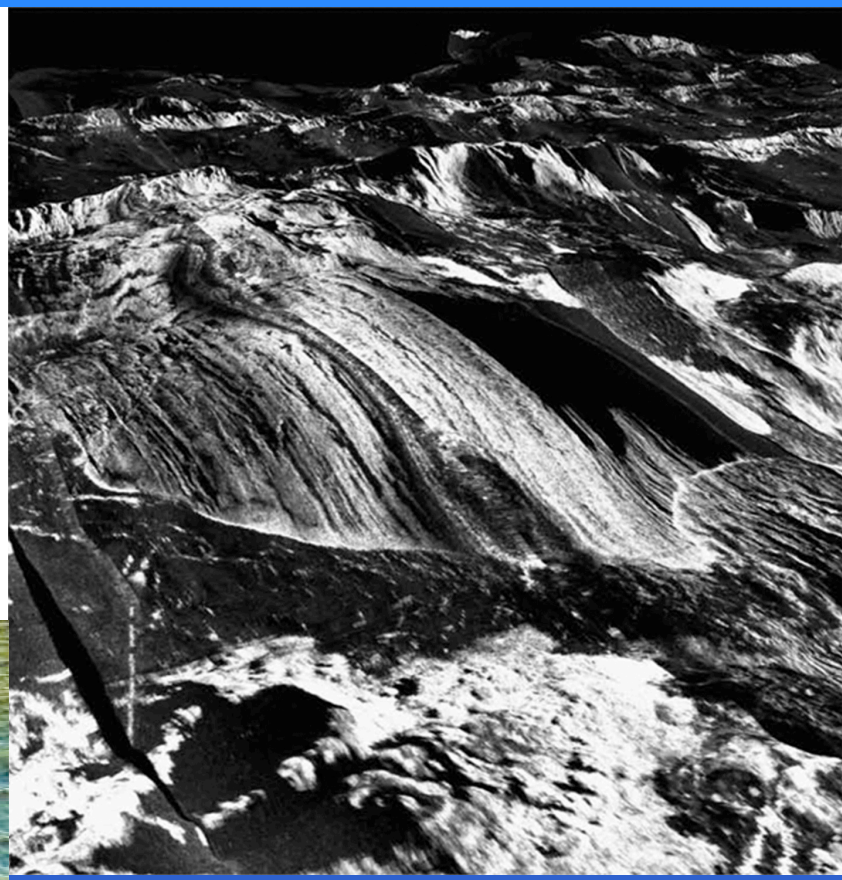


East Pacific Rise – view to the North – Siqueiros, Clipperton to Orozco

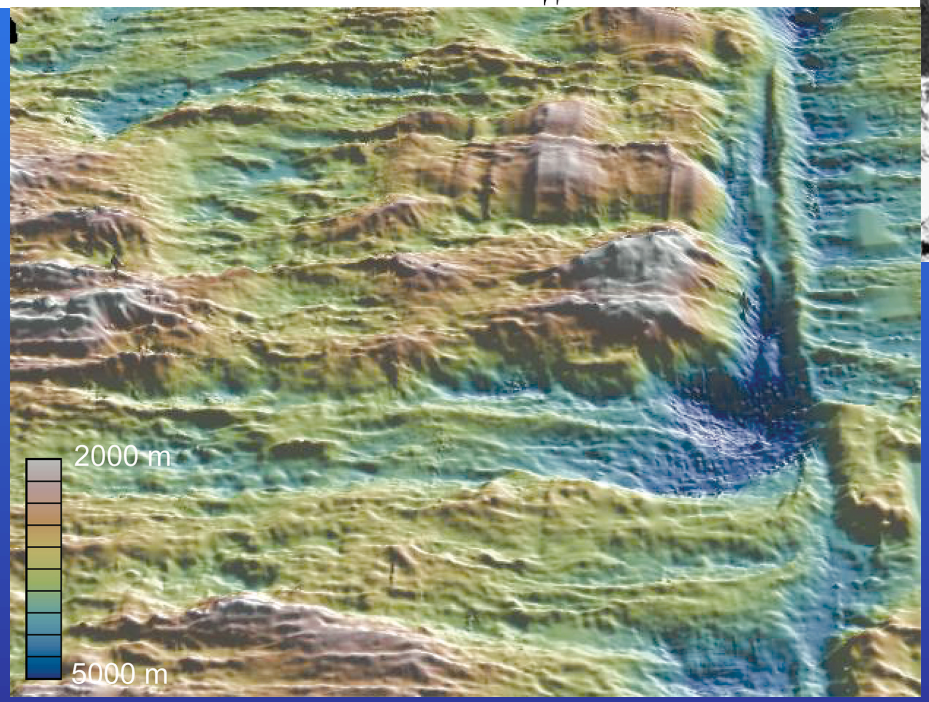


Fracture Zones, Transform Faults, Triple-Junction Deeps
Important (Sampling) Windows into Oceanic Crust

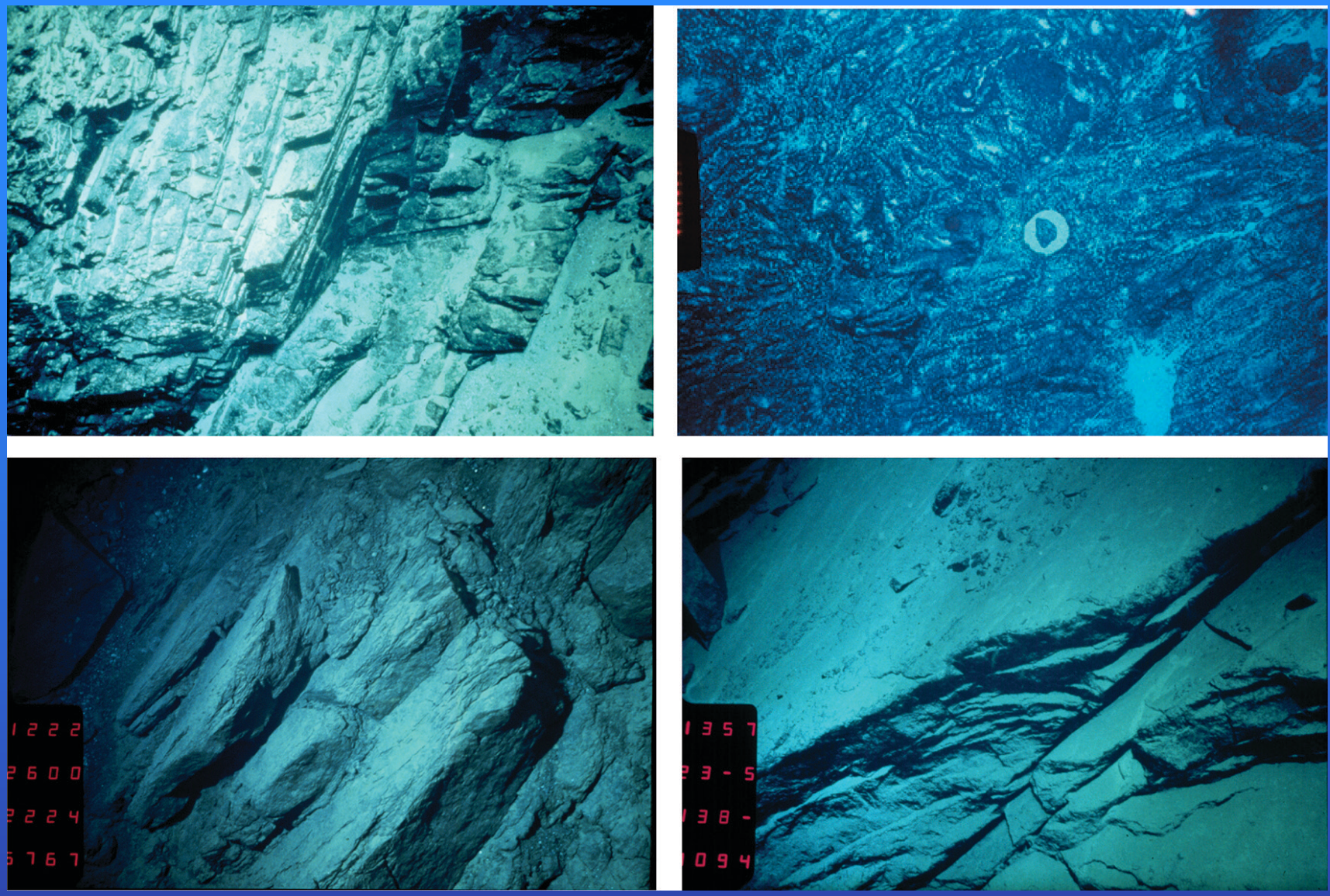




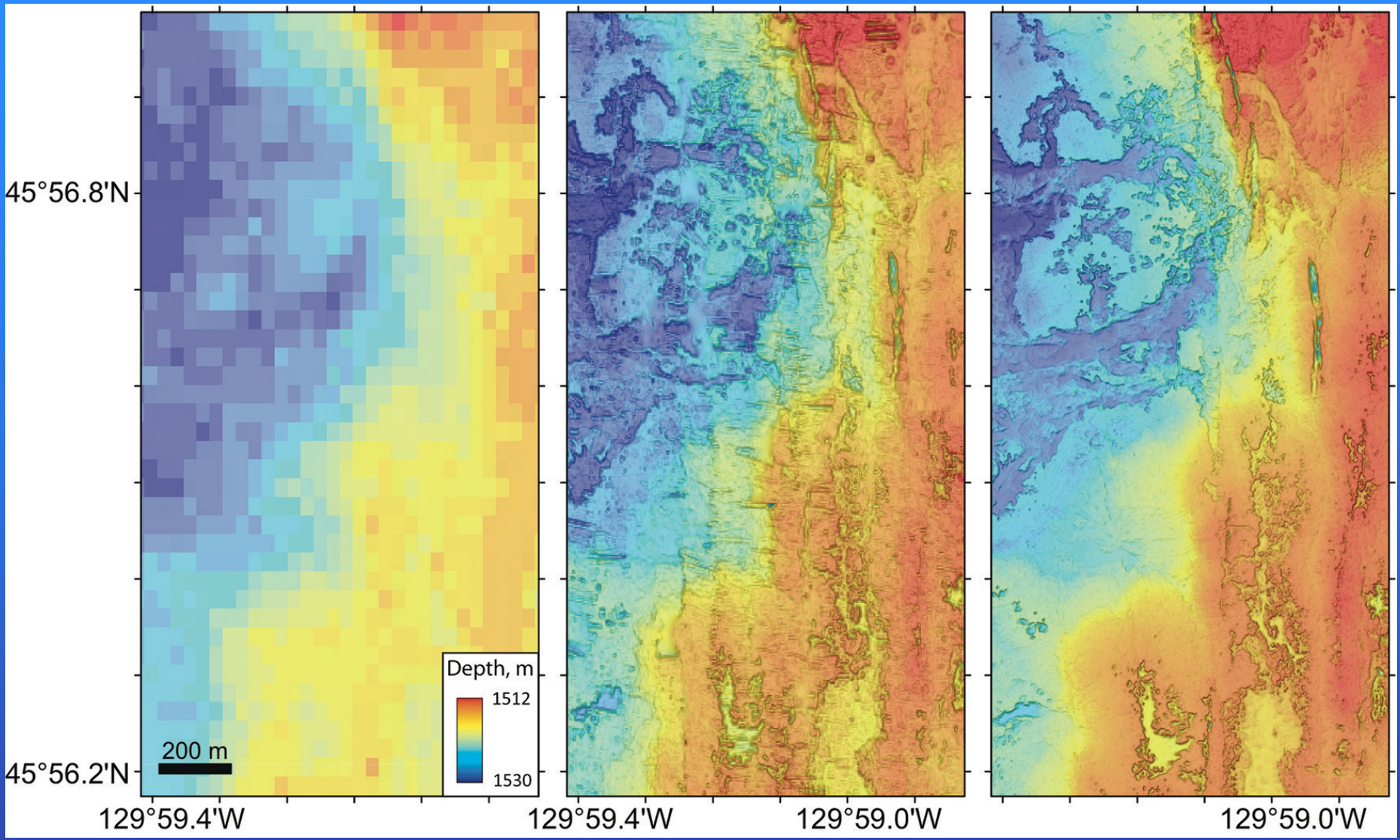
MacLeod et al., 2009



Escartin & Canales, 2010



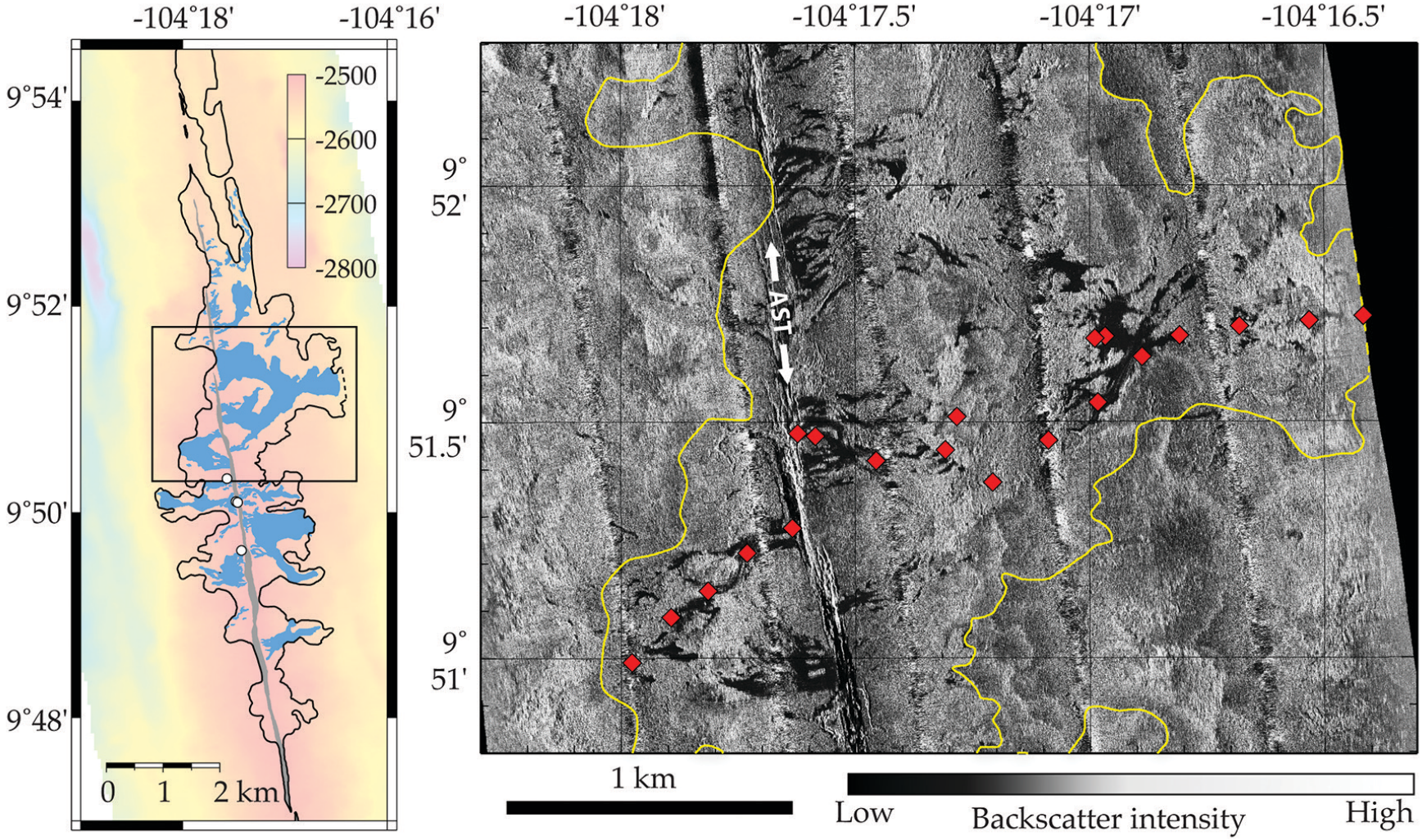
Gabbroic rock outcrops in OCCs, Kane transform and Atlantis Bank – J. Karson



30 kHz multibeam (25m) ROV 675 kHz (2m) 200 kHz (1m)

Caress et al., 2012 – Axial Smt.

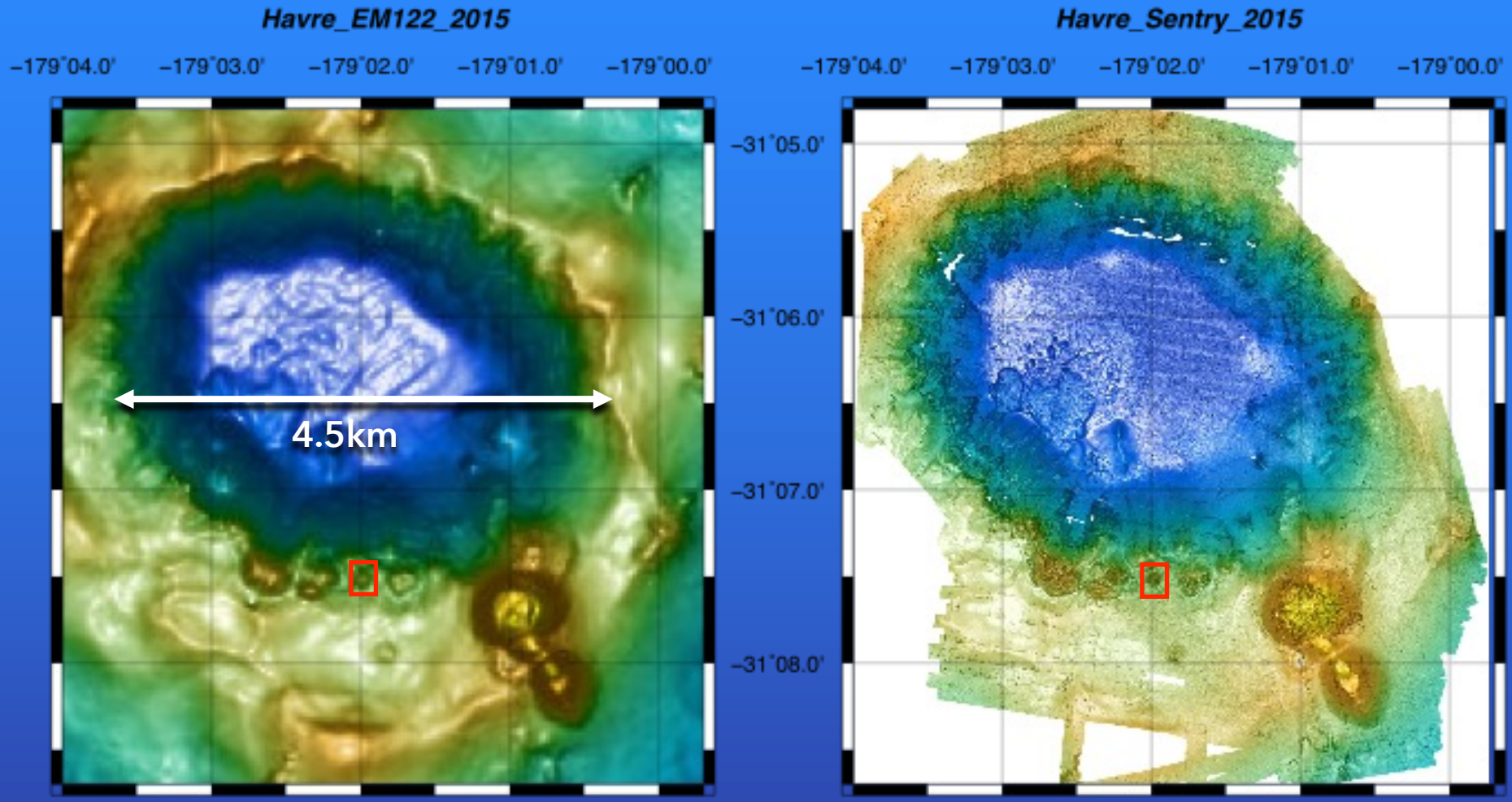
2011 lava flow on Axial Smt. overlying older, sediment covered flows



EPR 9° 50’N lava channel – ROV Jason sampling of lava from eruptive fissure to downslope channel terminus (Soule et al., 2012).

Successful dredge??

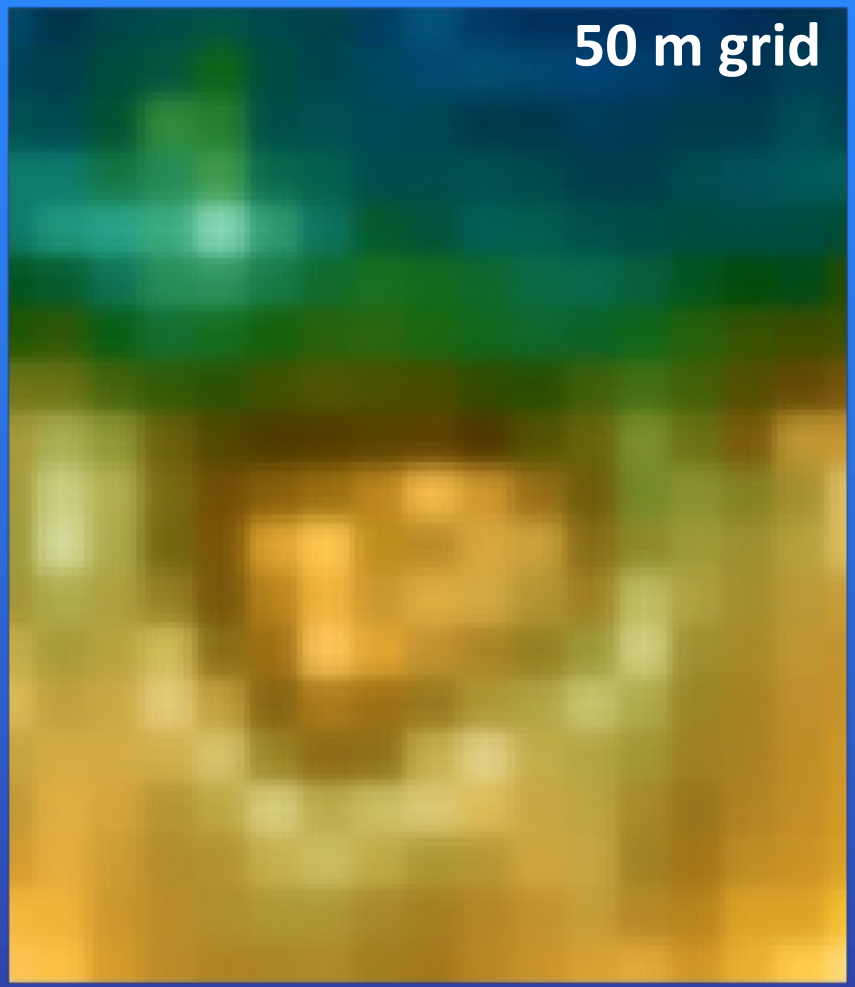
Sentry mapping capabilities – routine production of DEMs for submarine terrains



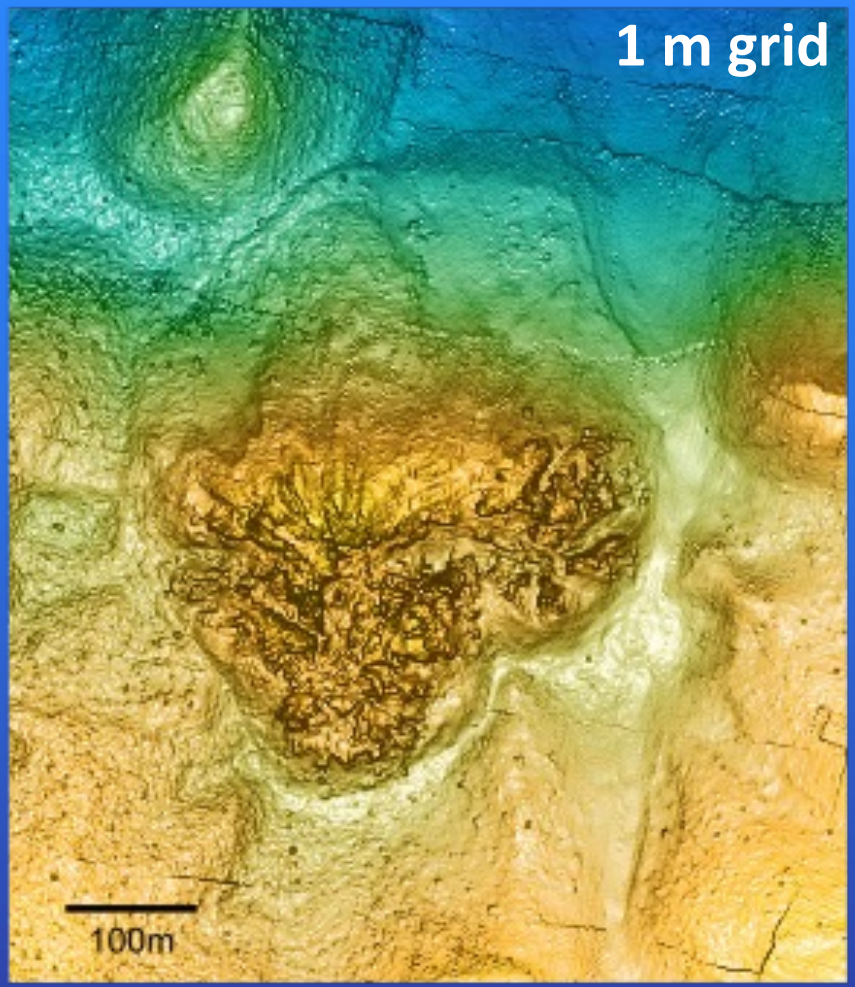
Adam Soule (WHOI) & Rebecca Carey (U. Tasmania)

Resolution comparison between shipboard multibeam & Sentry near-bottom multibeam

Havre_EM122_2015



Havre_Sentry_2015



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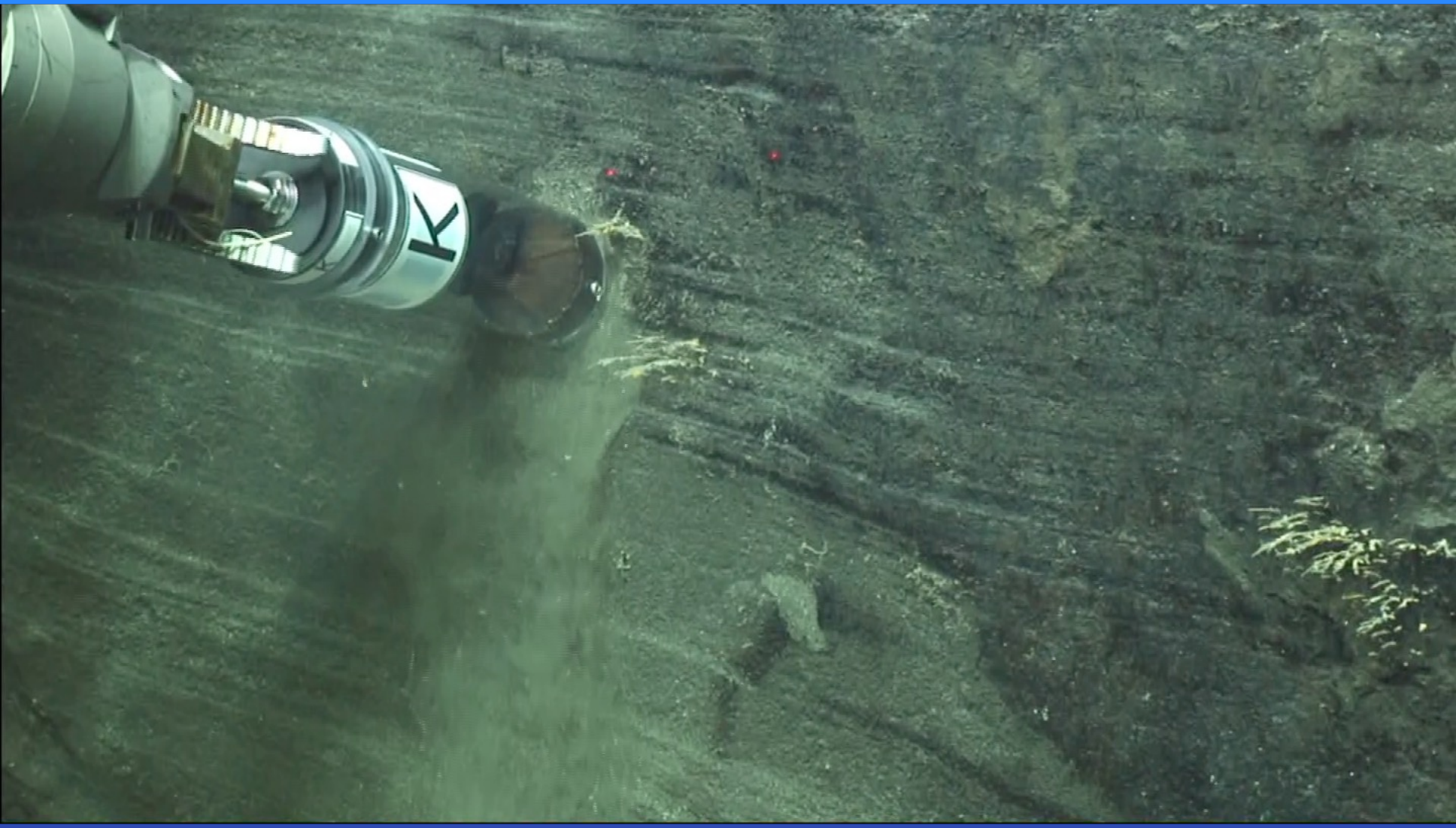
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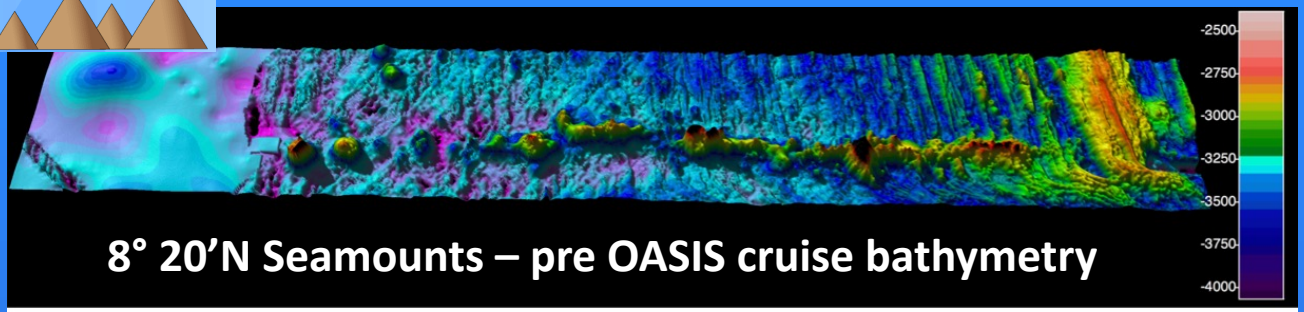
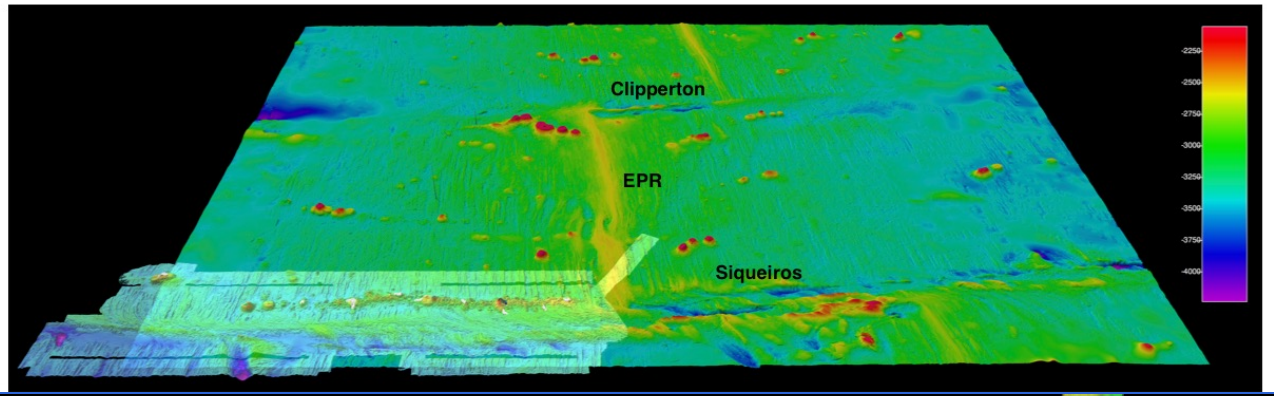
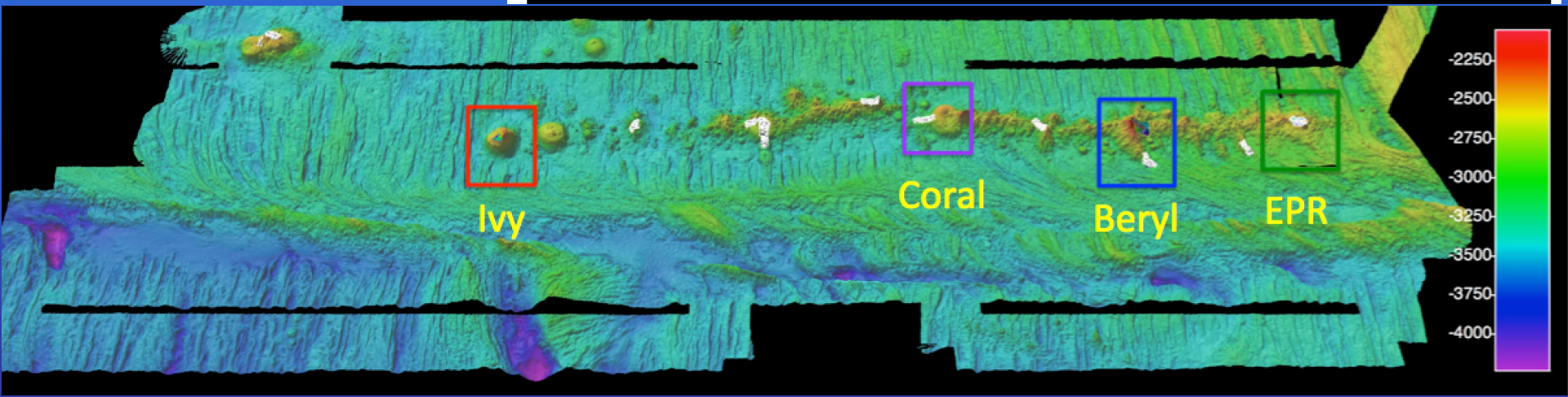
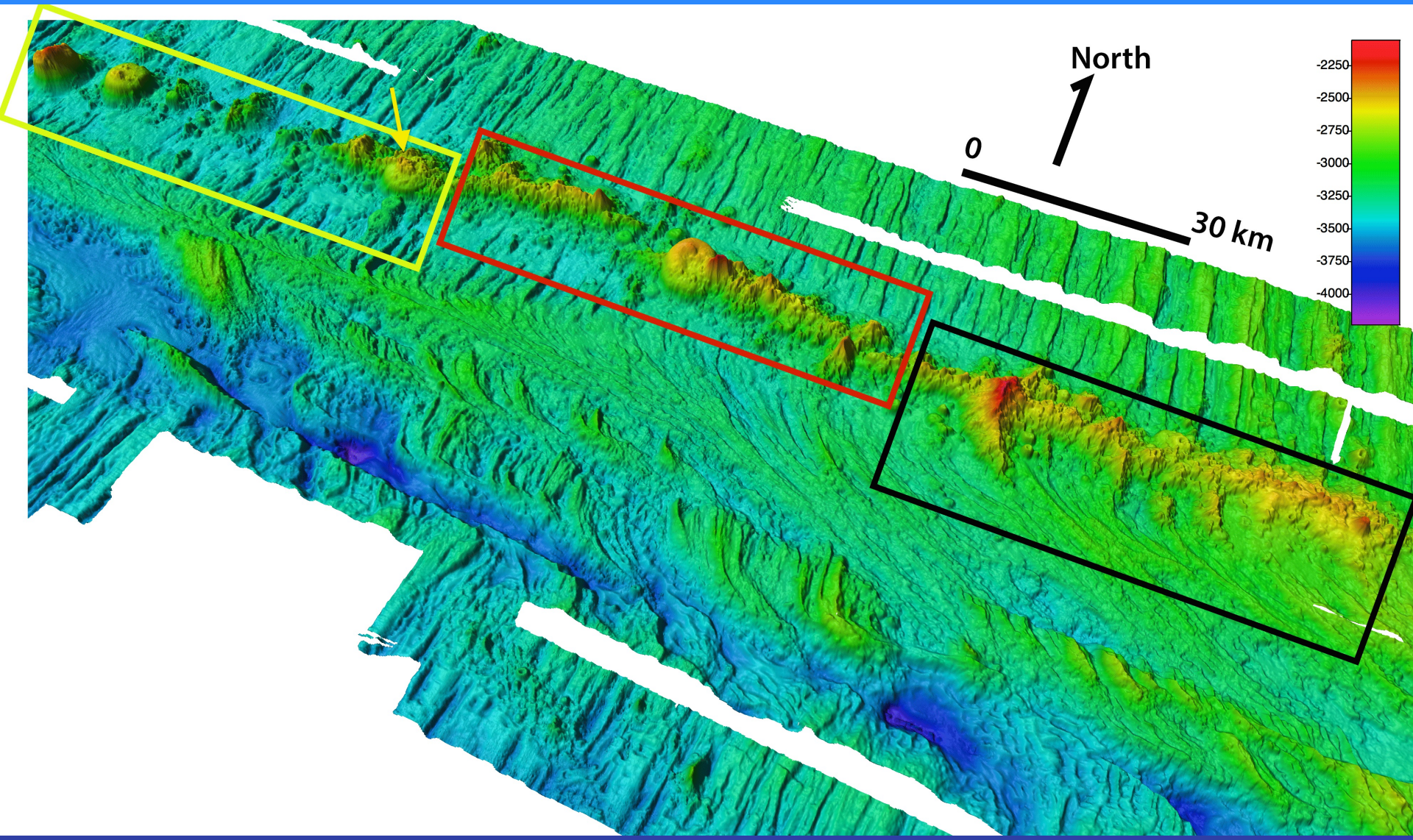


8° 20'N Seamounts – pre OASIS cruise bathymetry

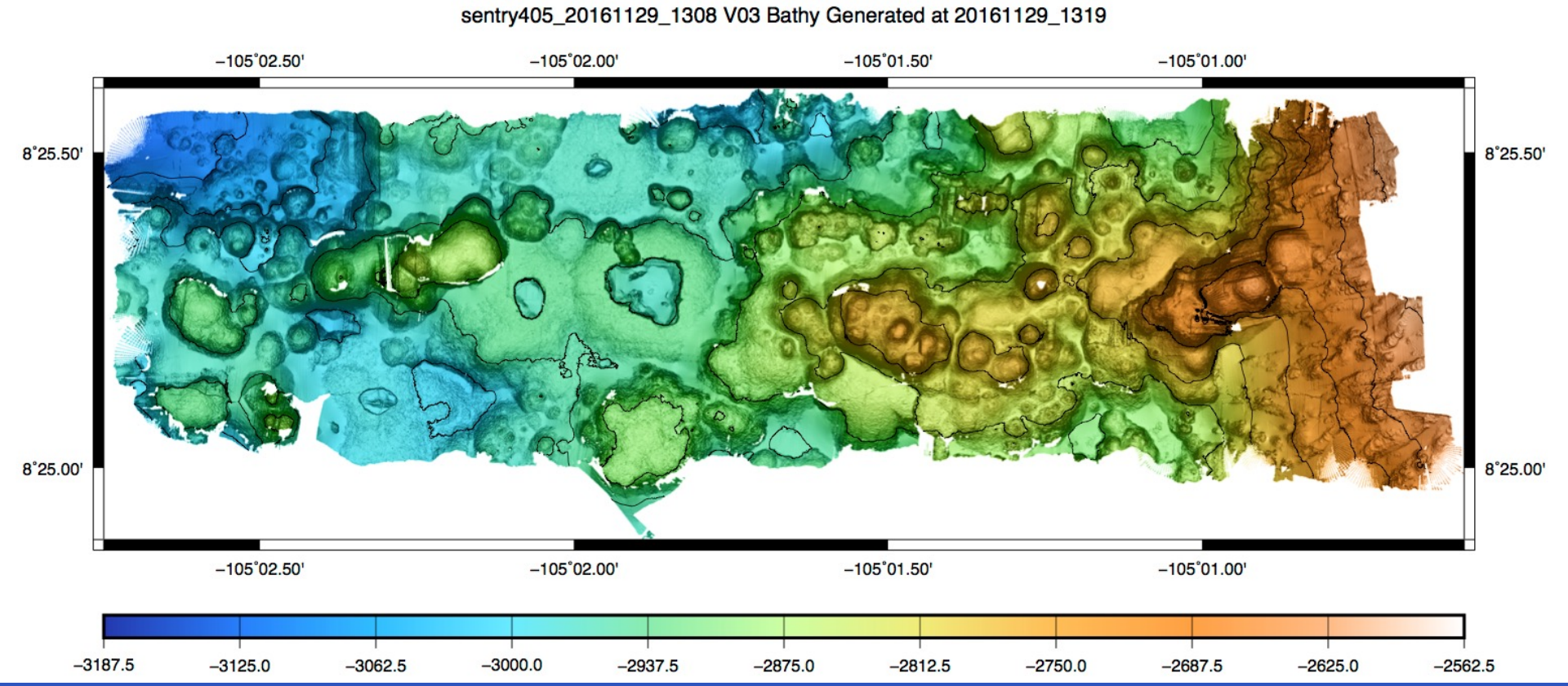


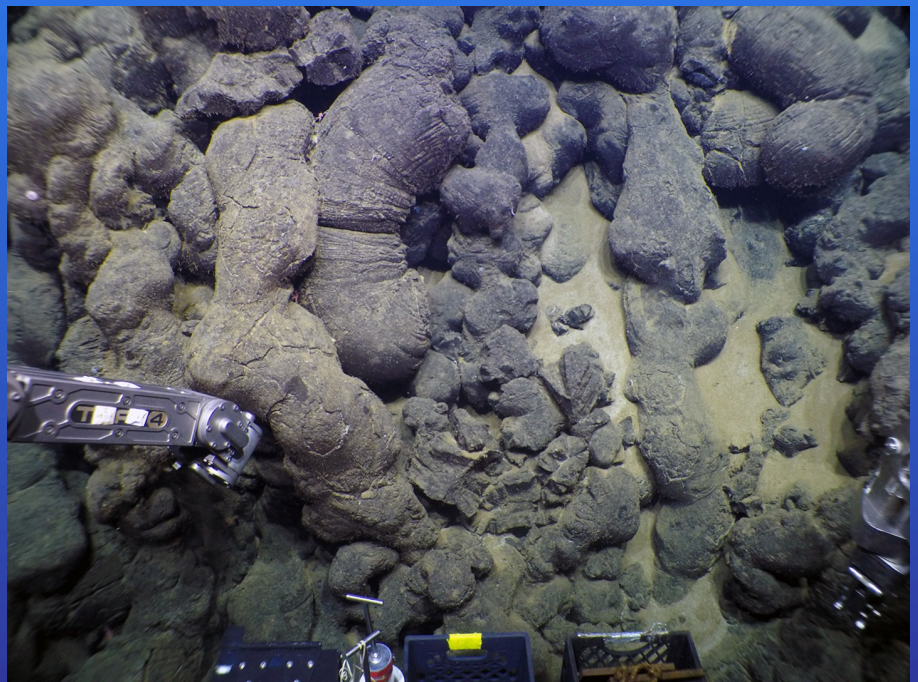


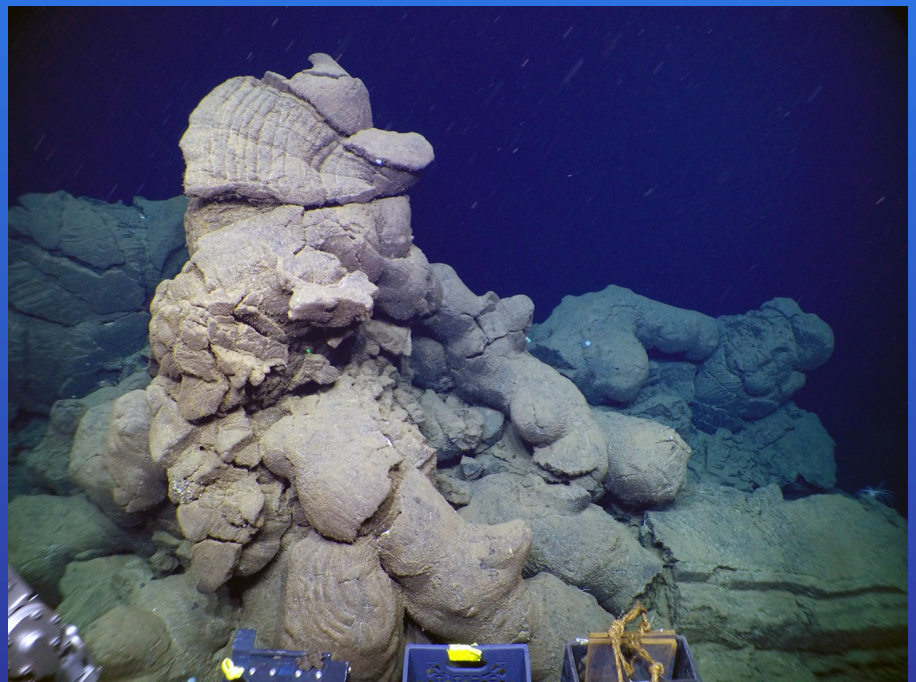
8° 20'N Seamount – EM122 multibeam from OASIS cruise
Interplay between constructional volcanism and off-axis and R-T tectonics



Coral Seamount - Sentry 1-m bathymetry







- **Need seafloor maps with bathymetric resolution that is relevant and appropriate to sampling strategy – AUV near-bottom mapping (do we have enough AUVs to have them be a routine pre-sampling data collection tool?)**

- **Need sampling techniques that provide accurate spatial and stratigraphic resolution to properly interpret geochemical results**

- **Routine navigation technologies for ship/vehicle/sampling devices**

- **Remote observational information prior to remote sampling – (e.g., camera tow/lowering prior to dredging)**

- **New tools to collect oriented samples from seafloor rock exposures – (e.g., manipulator held drills)**