

Subduction zone fluid flow: Direct evidence from mineral & water samples

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Land Acknowledgement

The research presented here partly took place at

- The University of Saskatchewan on Treaty 6 Territory and the Homeland of the Métis.
- The University of Washington on the ancestral lands of the Coast Salish people
- Gisborne region of New Zealand, land of the the Māori iwi and hapū

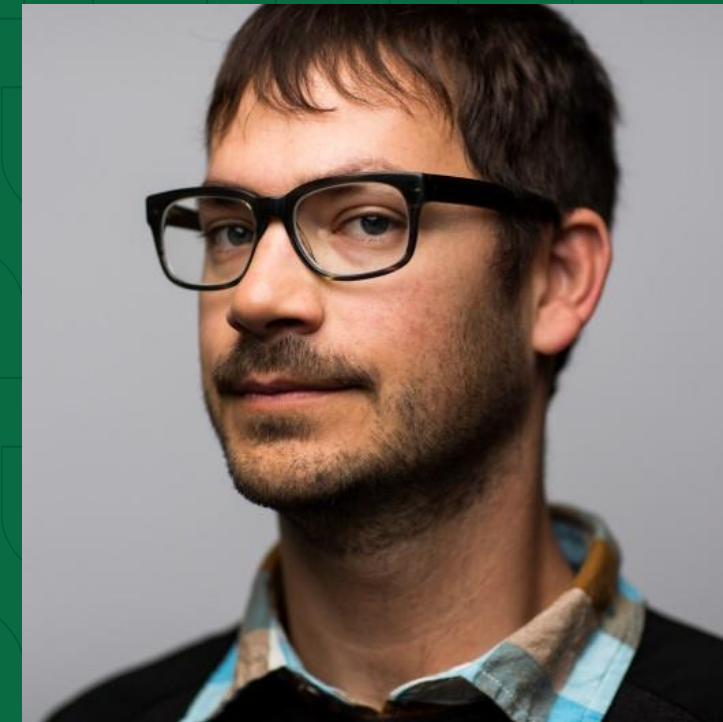
Acknowledgement



Yuzuru Yamamoto,
Kobe University



Stephen Bowden,
University of Aberdeen /
Kobe University



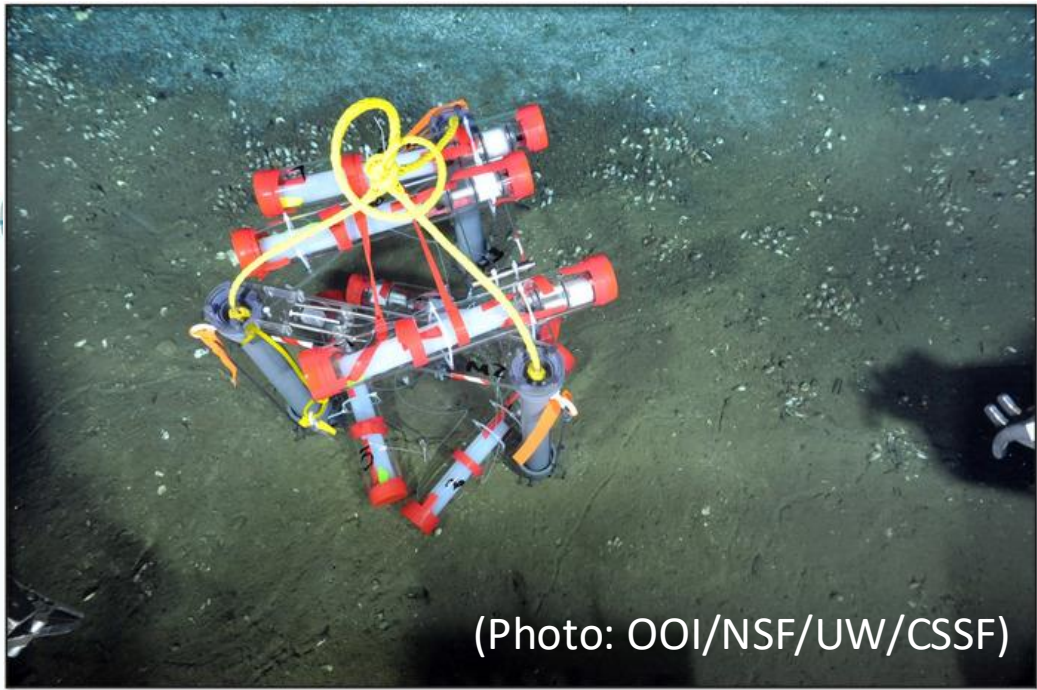
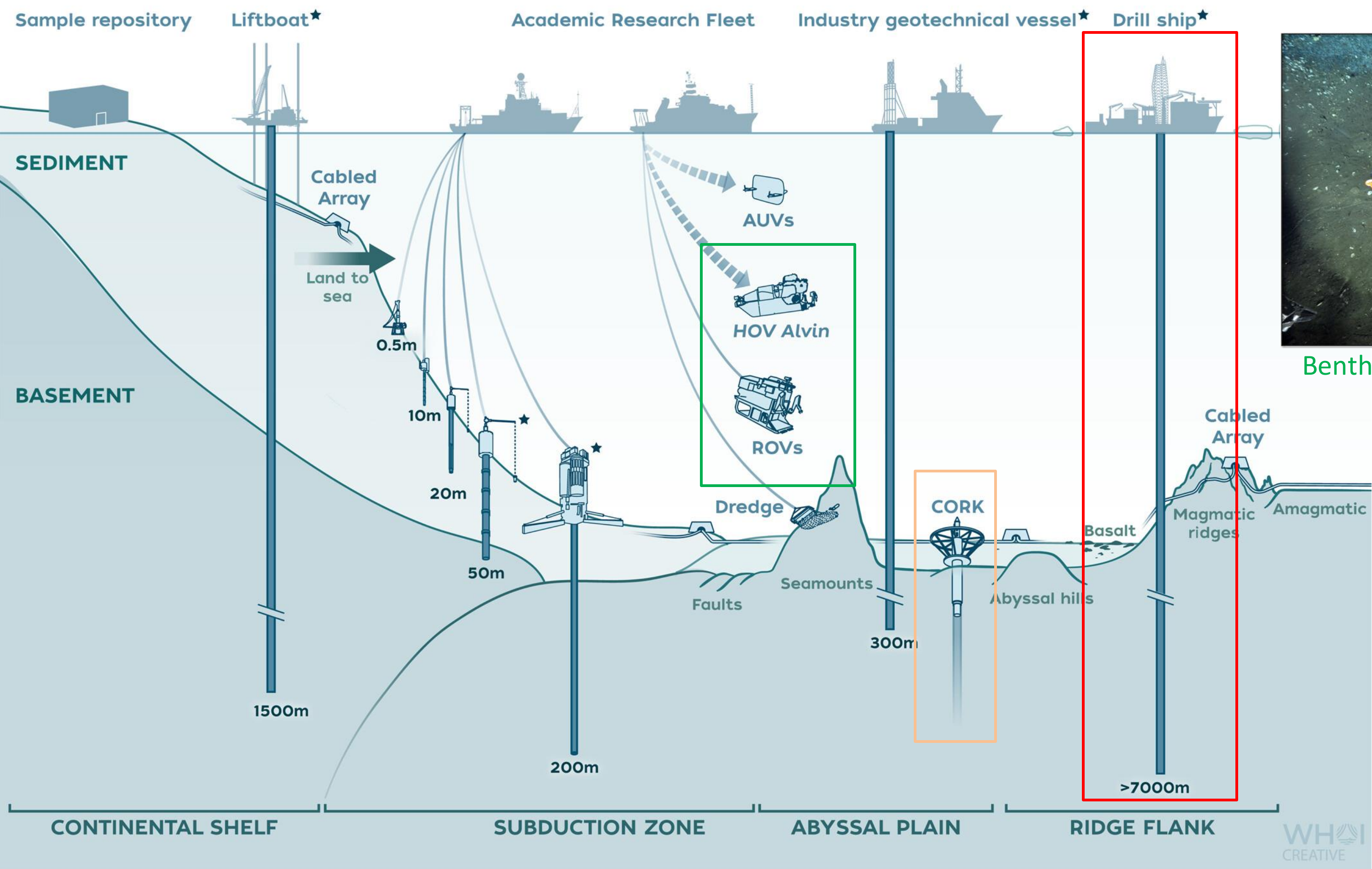
Evan Solomon,
University of Washington

Why do we sample subduction-zone fluids?

A Geochemist's perspective:

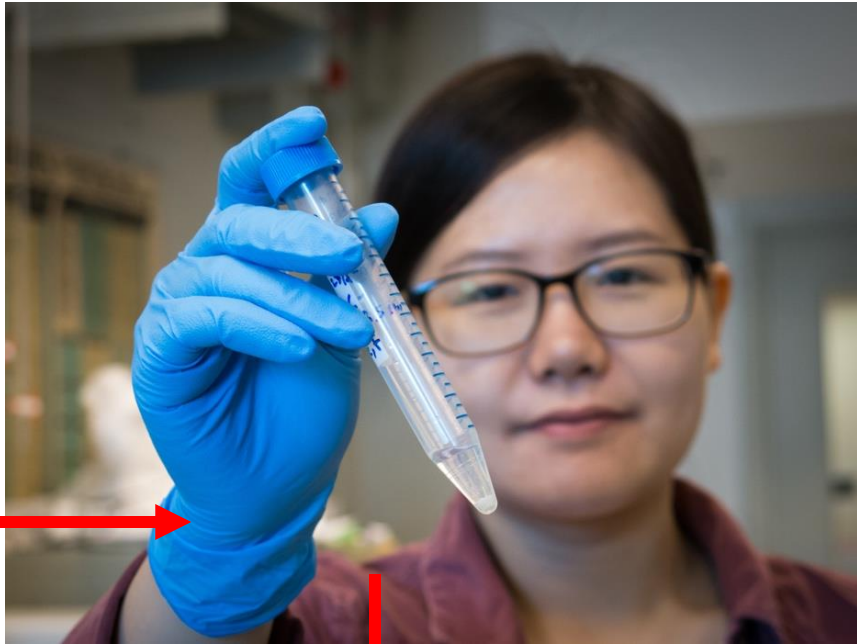
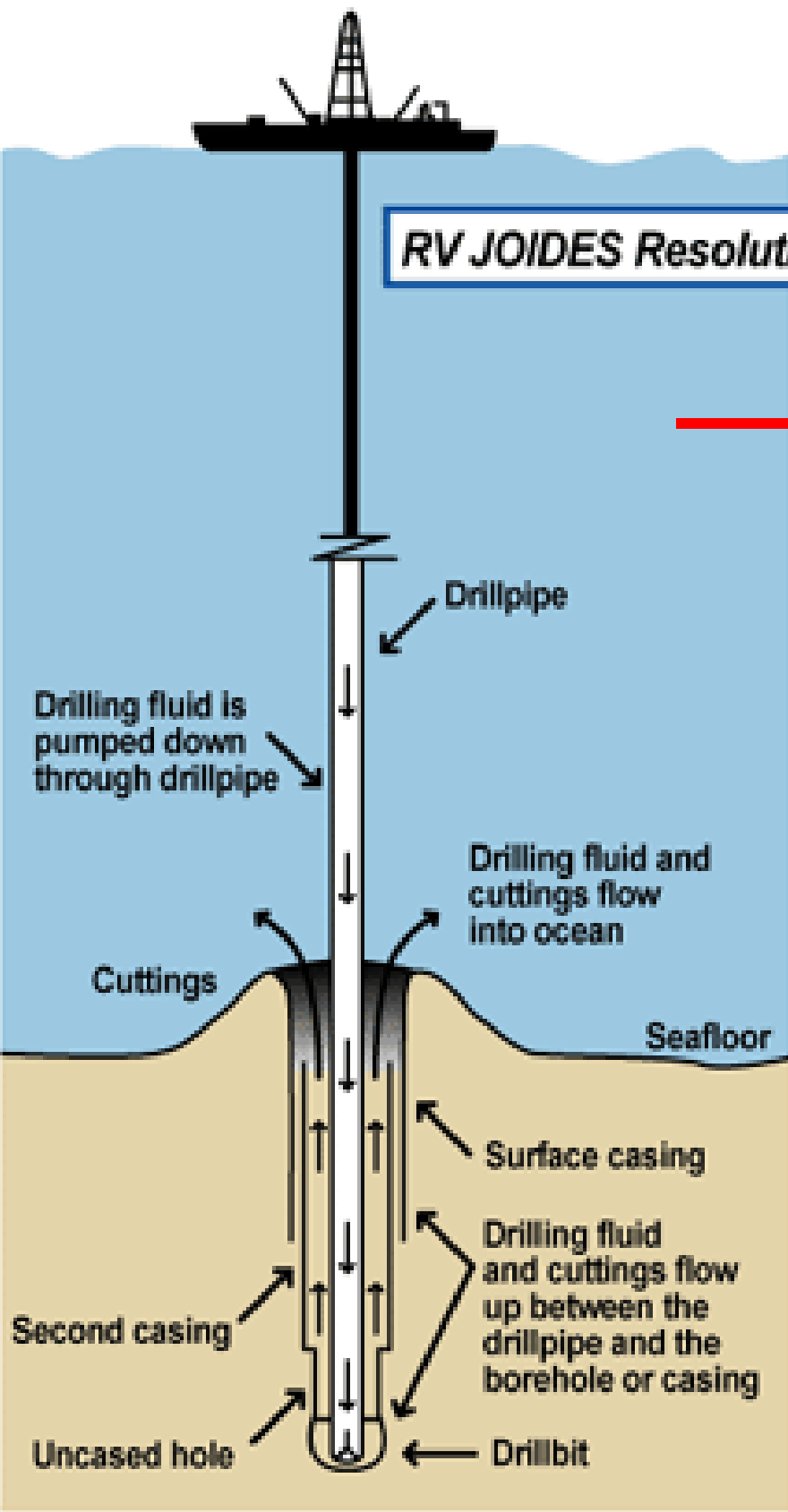
- Identifying the sources of the fluids
- Studying geochemical reactions occurring at great depths (e.g., mineral dehydration)
- Tracking the distribution of fluids and zones with excess pore fluid pressures
- Quantifying the rate of non-steady-state processes (e.g., slips)

Sampling fluid in subduction zones:



Benthic fluid sampler and flow meter

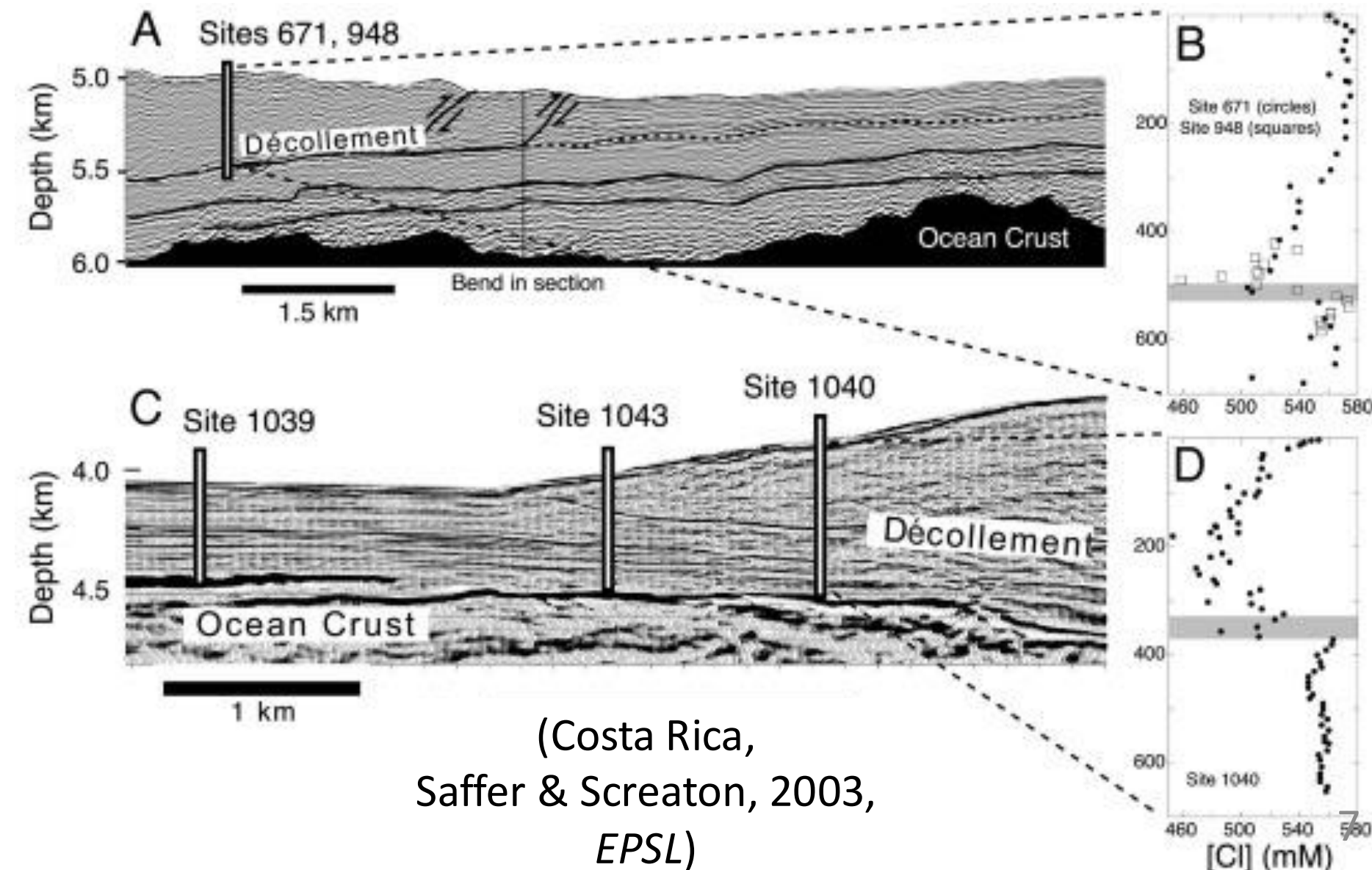
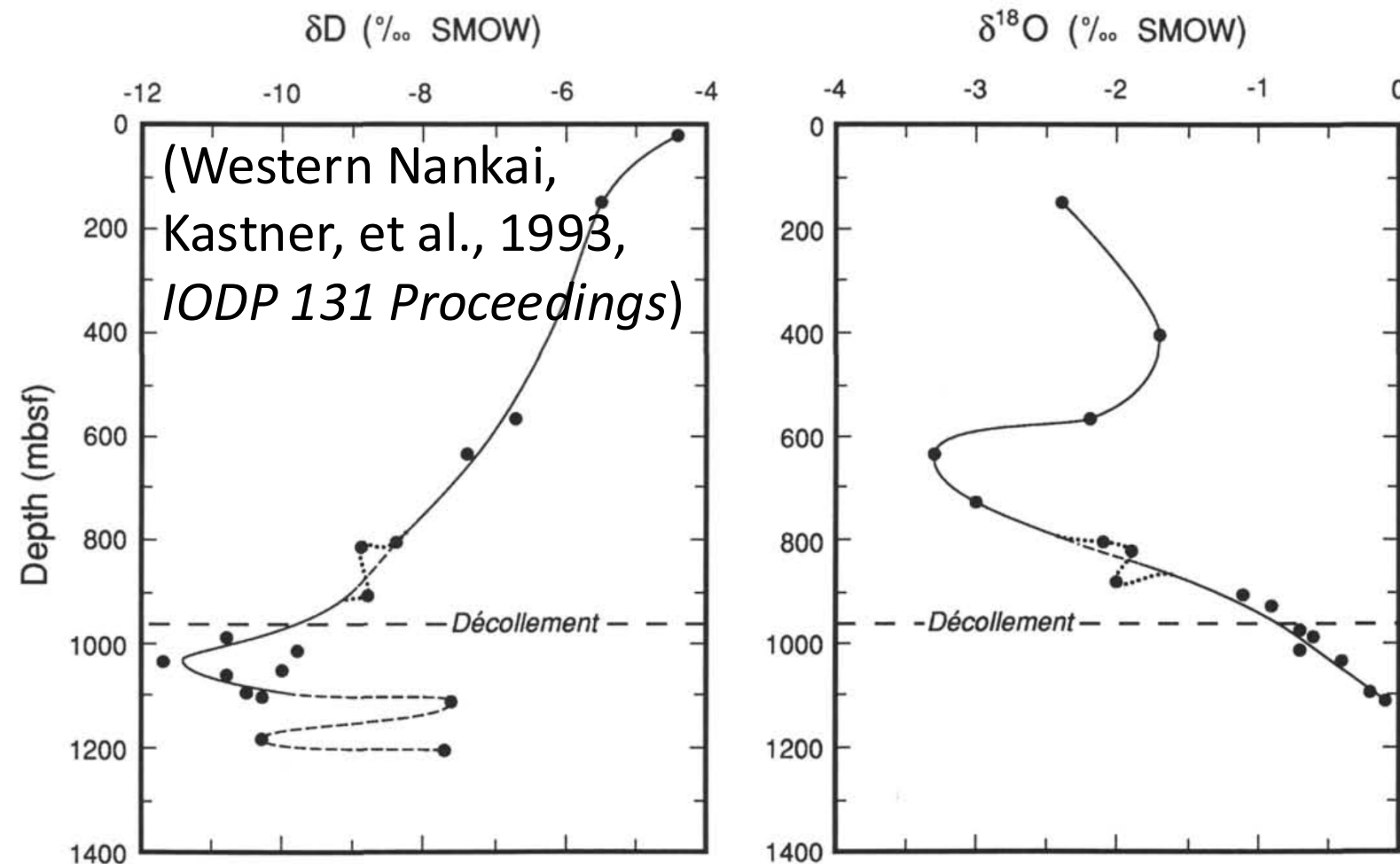
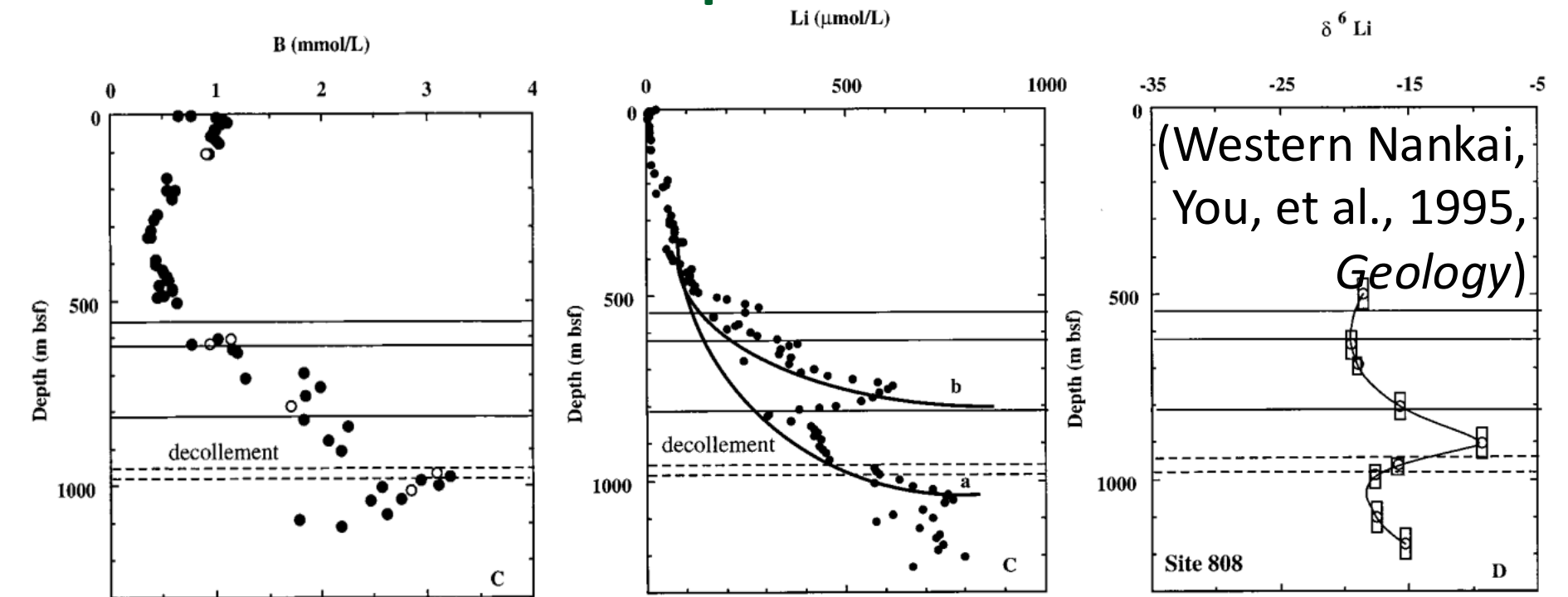
Ocean Drilling providing sediment pore fluids:



(Image credit: Taira et al., 2014; JOIDES Resolution, 2014; GOM2-2, 2023; SERC)

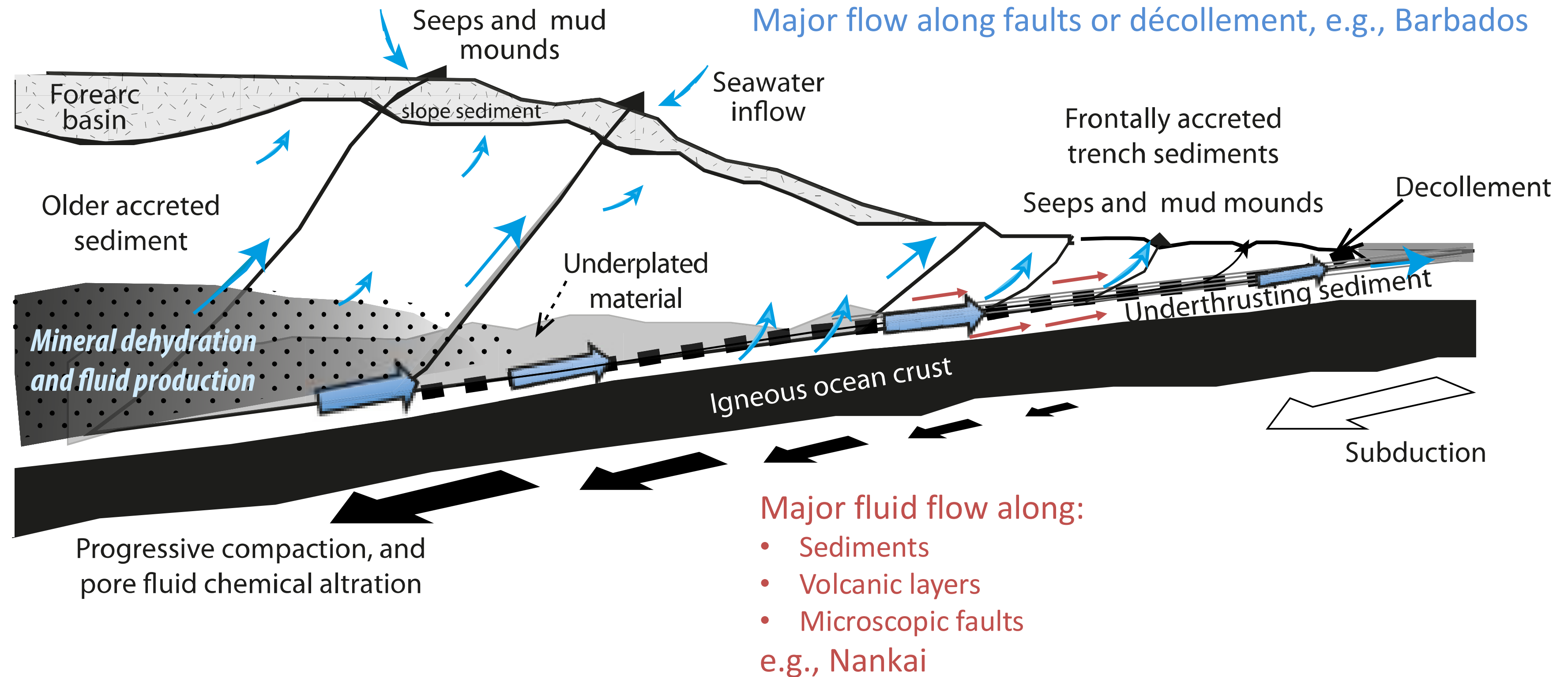
Deep-sourced fluids often bring chemical anomalies to porewater

- Elevated [B], [Li]
- Reduced [Cl]
- Changes in Sr, water-O, water-H isotope ratios
- Changes in He isotope ratios (indication of mantle contribution)
- Non-steady state porewater profiles
- Sometimes lead to mineralization



(Costa Rica,
Saffer & Scretton, 2003,
EPSL)

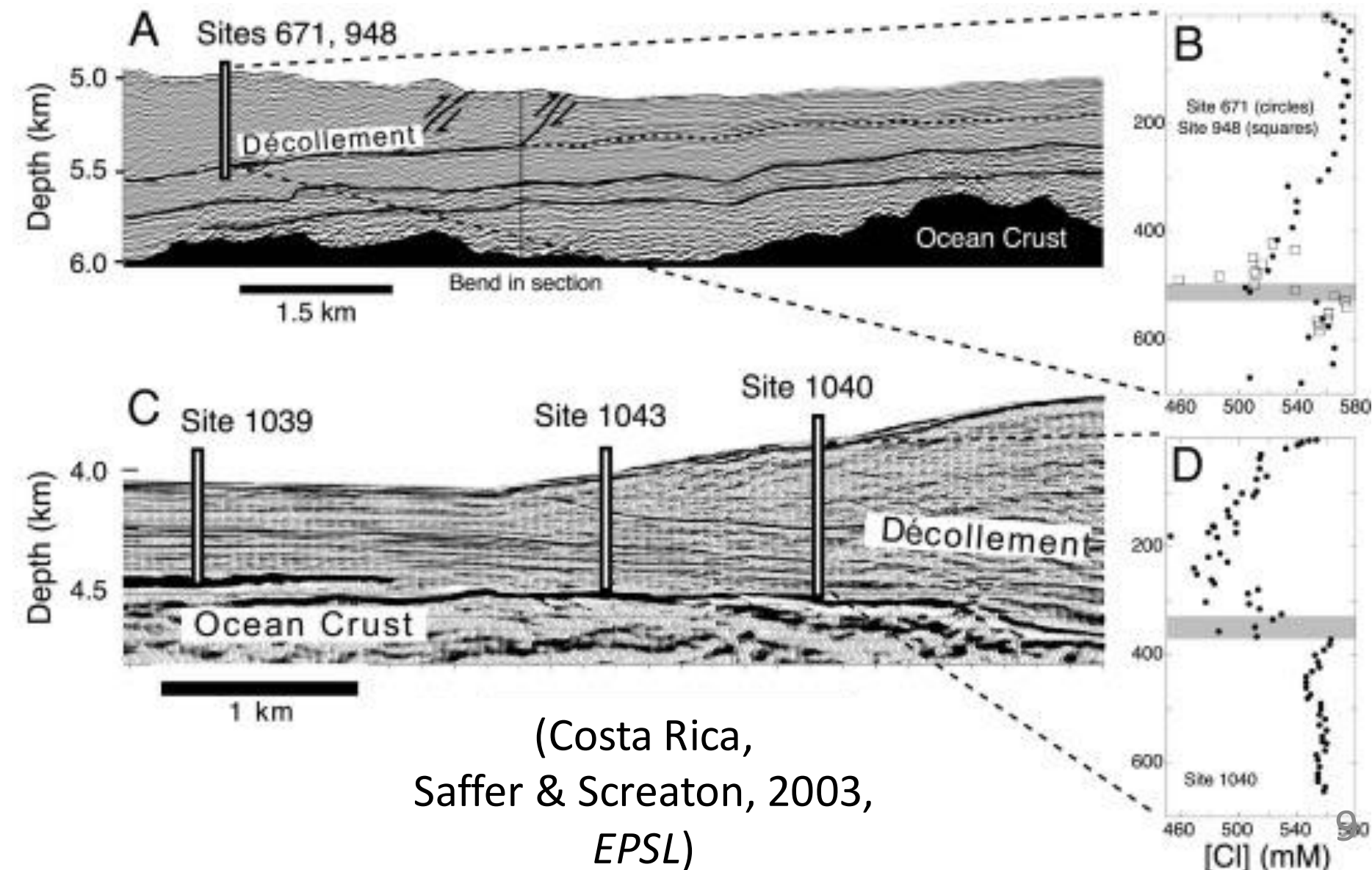
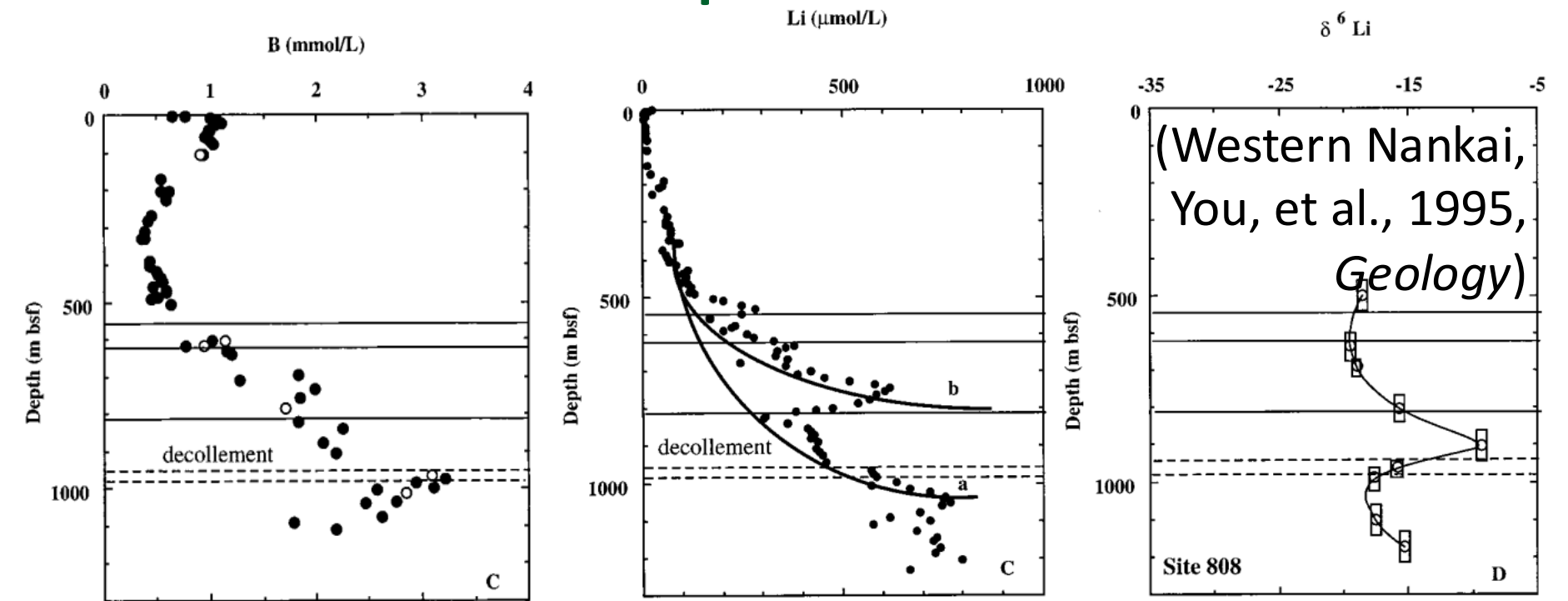
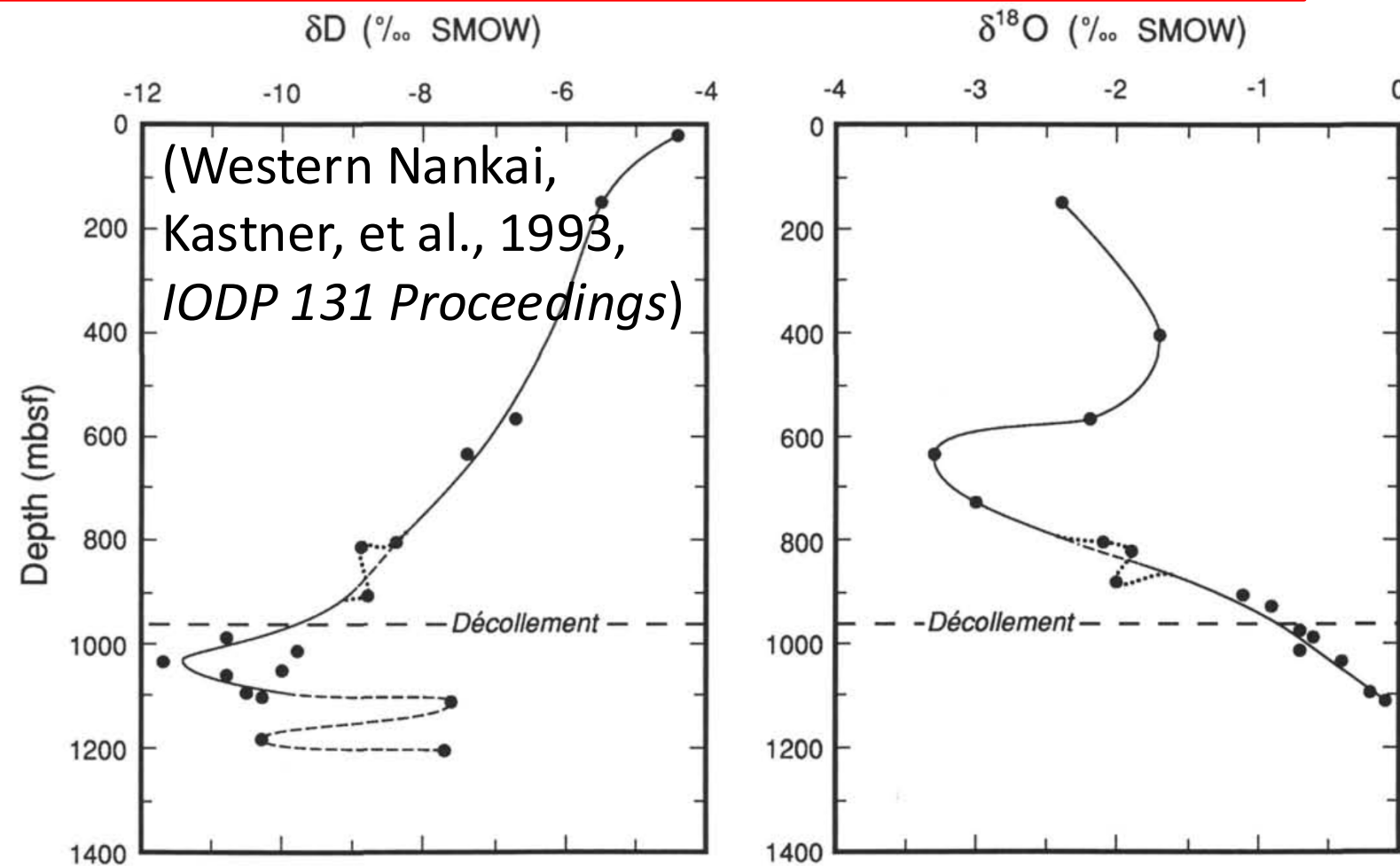
Porewater anomalies help us track fluid flow in accretionary/erosional prisms:



(Figure: Kastner et al., 2014, *Developments in Marine Geology*)

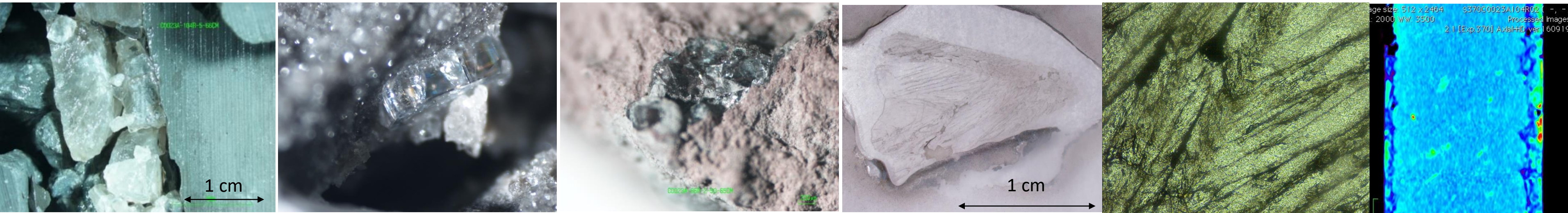
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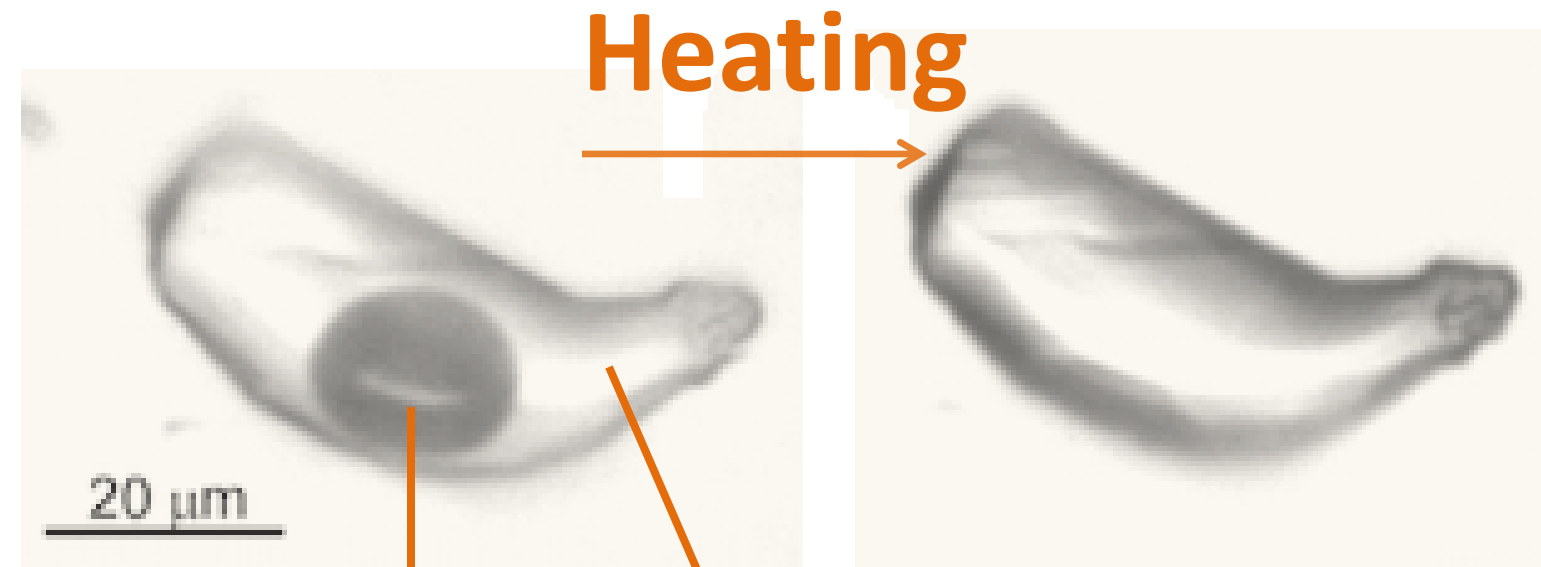
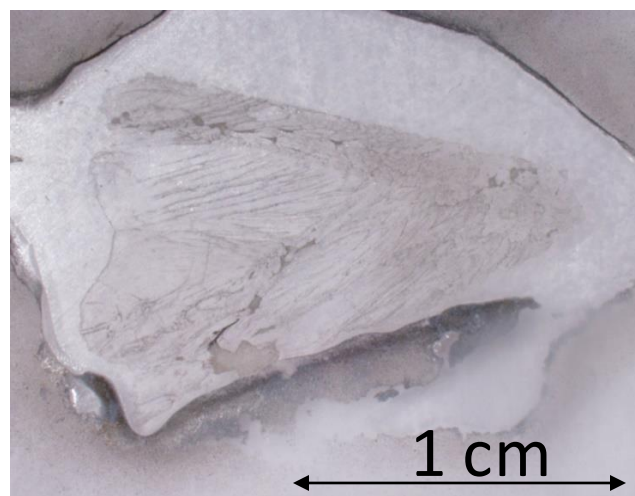


Using sediment cores to determine fluid temperatures:

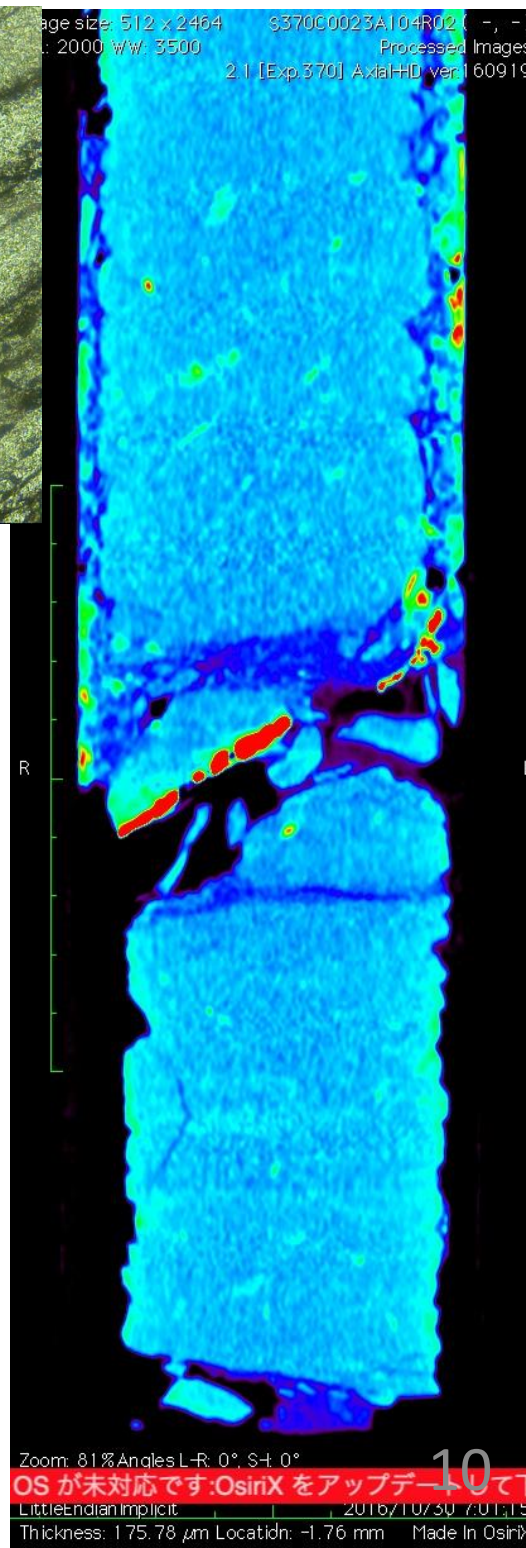
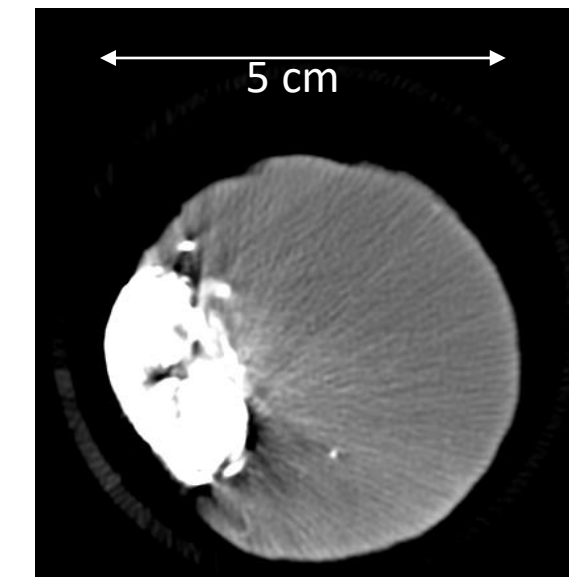
- Fluid inclusions in crystals (veins, slickencrysts, filling sediment voids, etc.)
- Biomarkers, thermal maturity as indicators of long-term heating



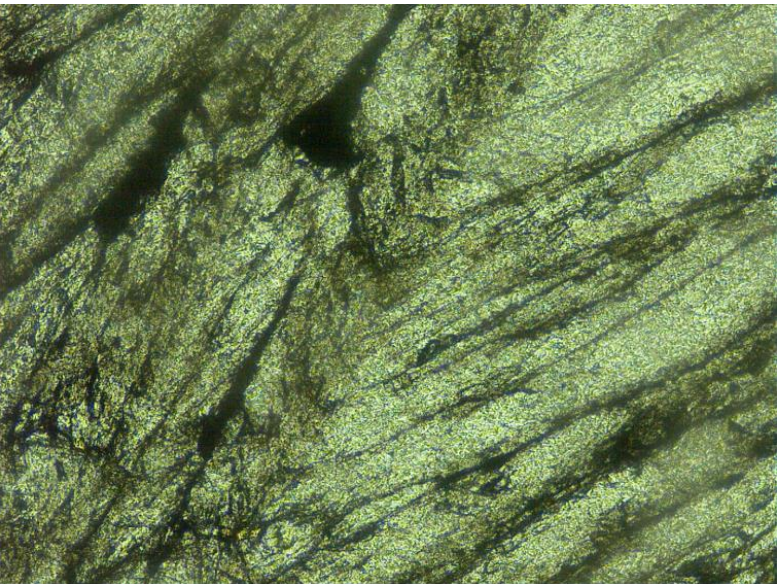
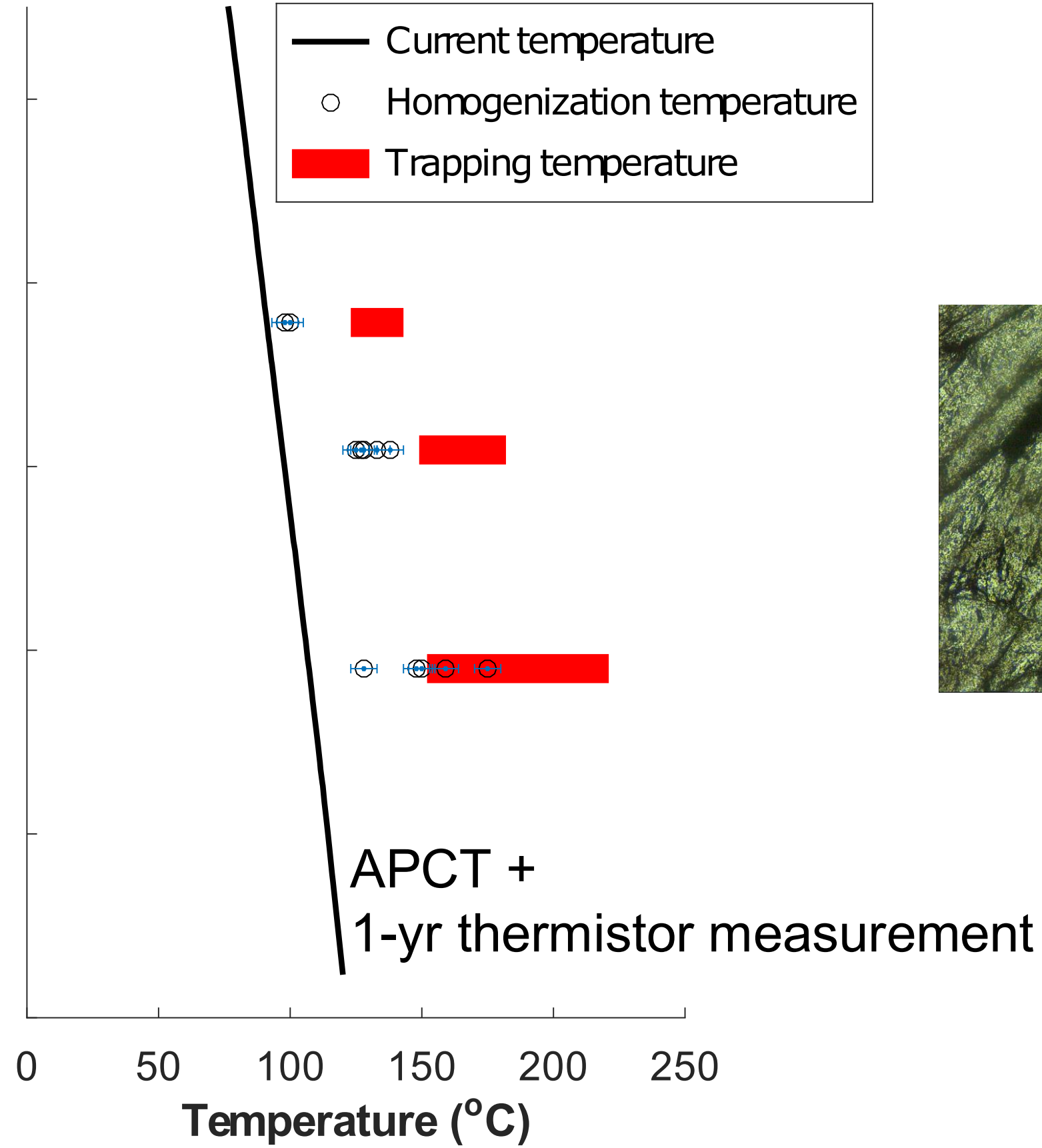
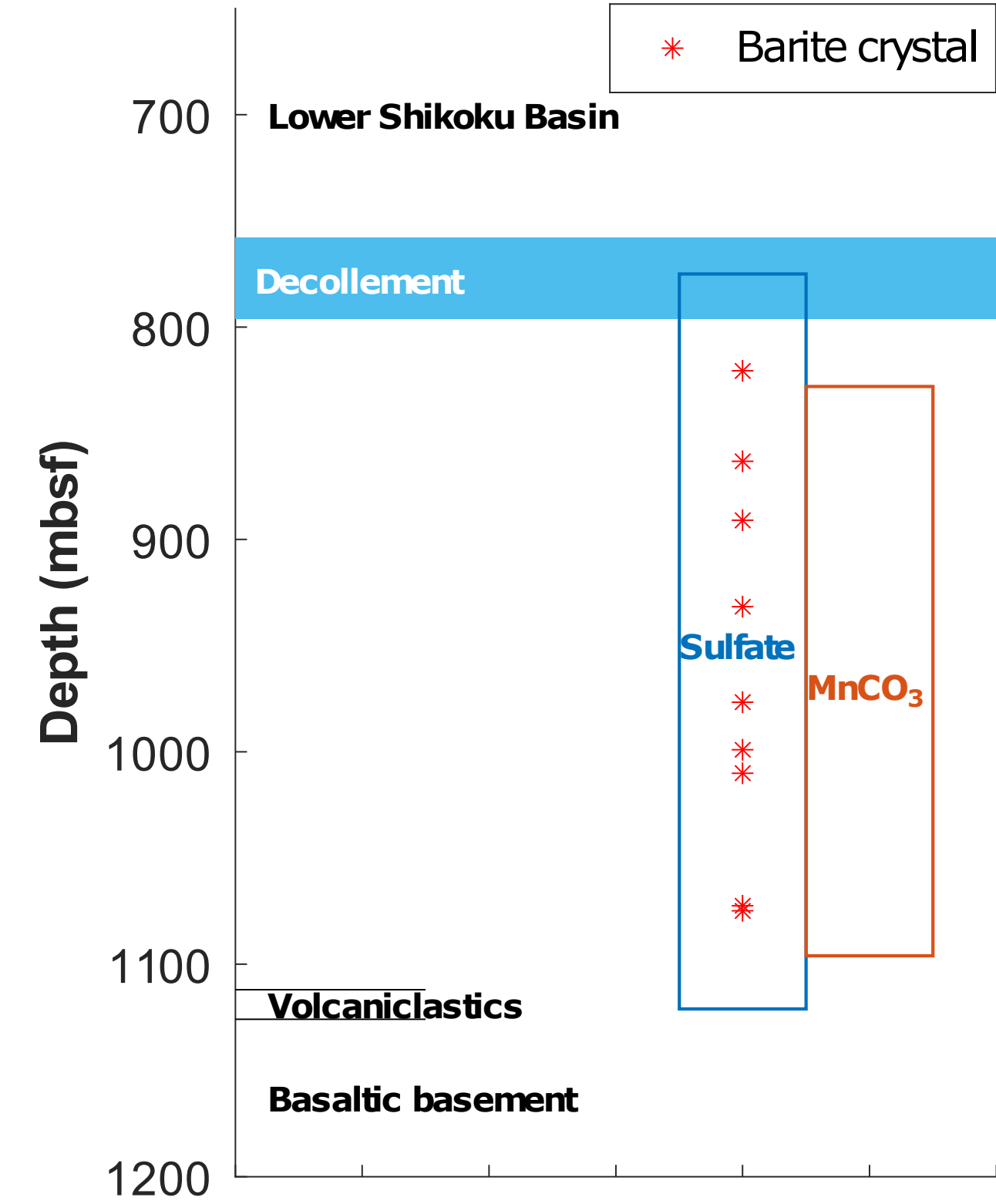
Diagenetic/epithermal barite crystals in Western Nankai



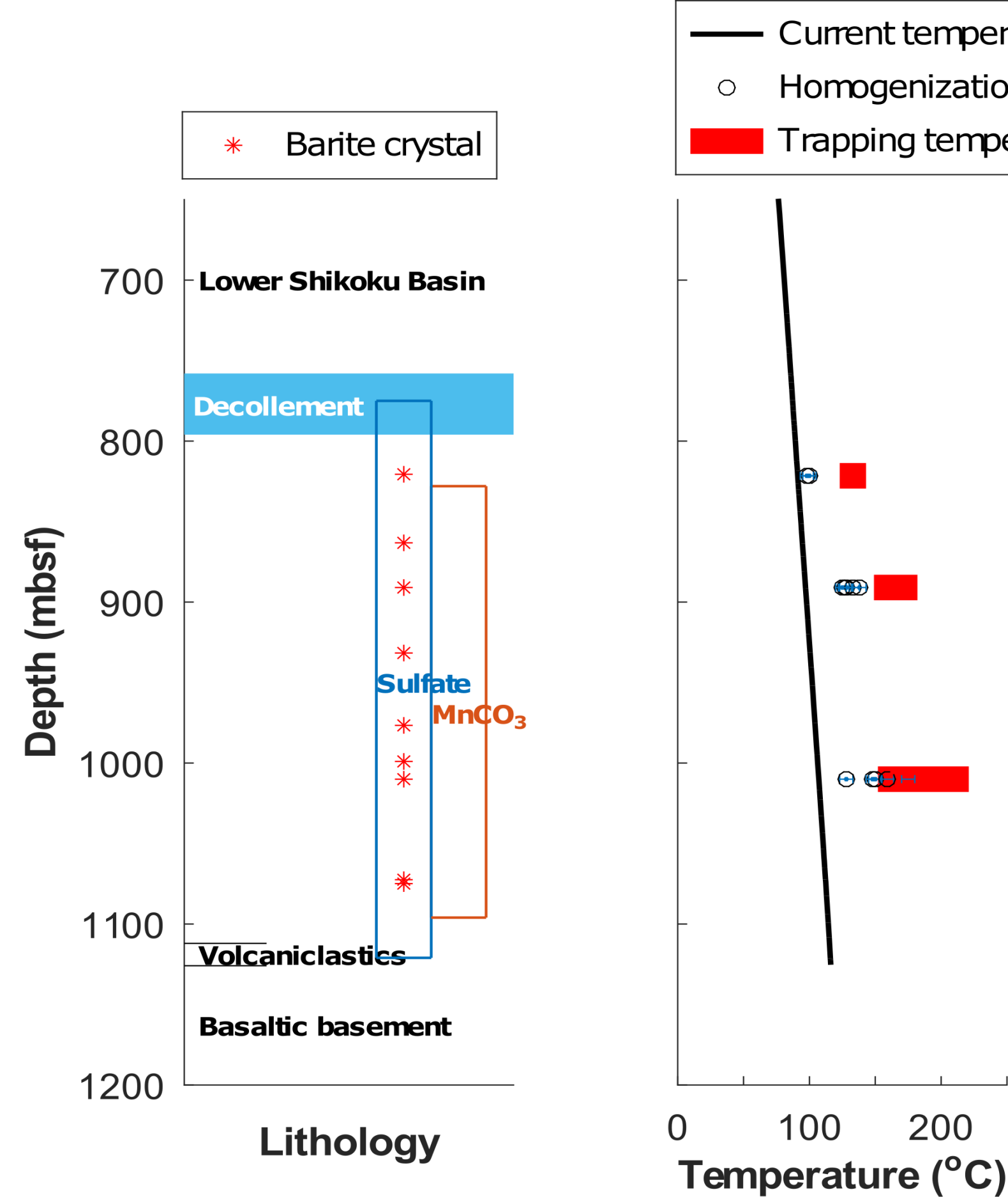
vapour liquid



Western Nankai (Tsang et al., 2020, *Marine & Petroleum Geology*):

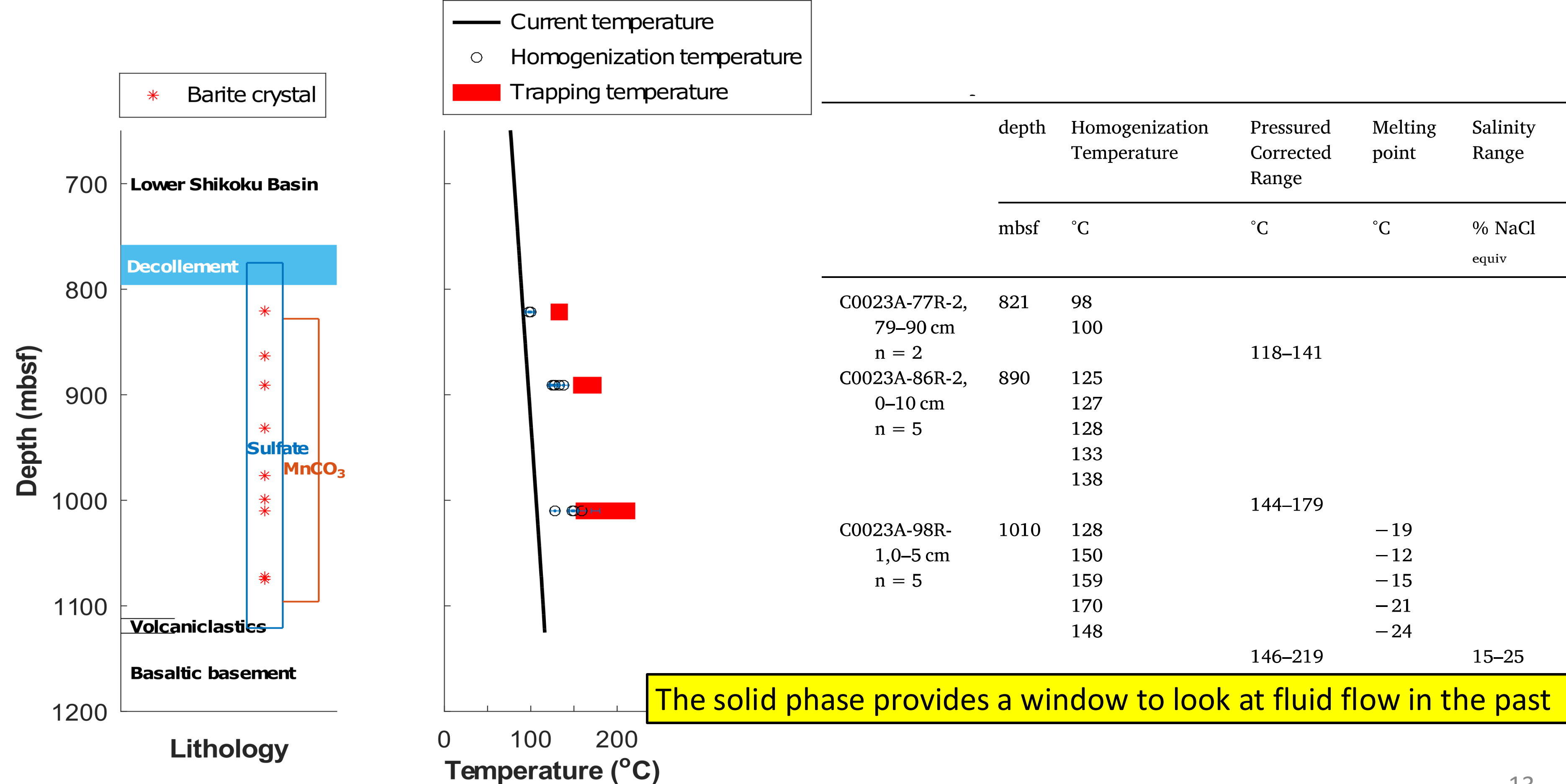


Western Nankai (Tsang et al., 2020, *Marine & Petroleum Geology*):



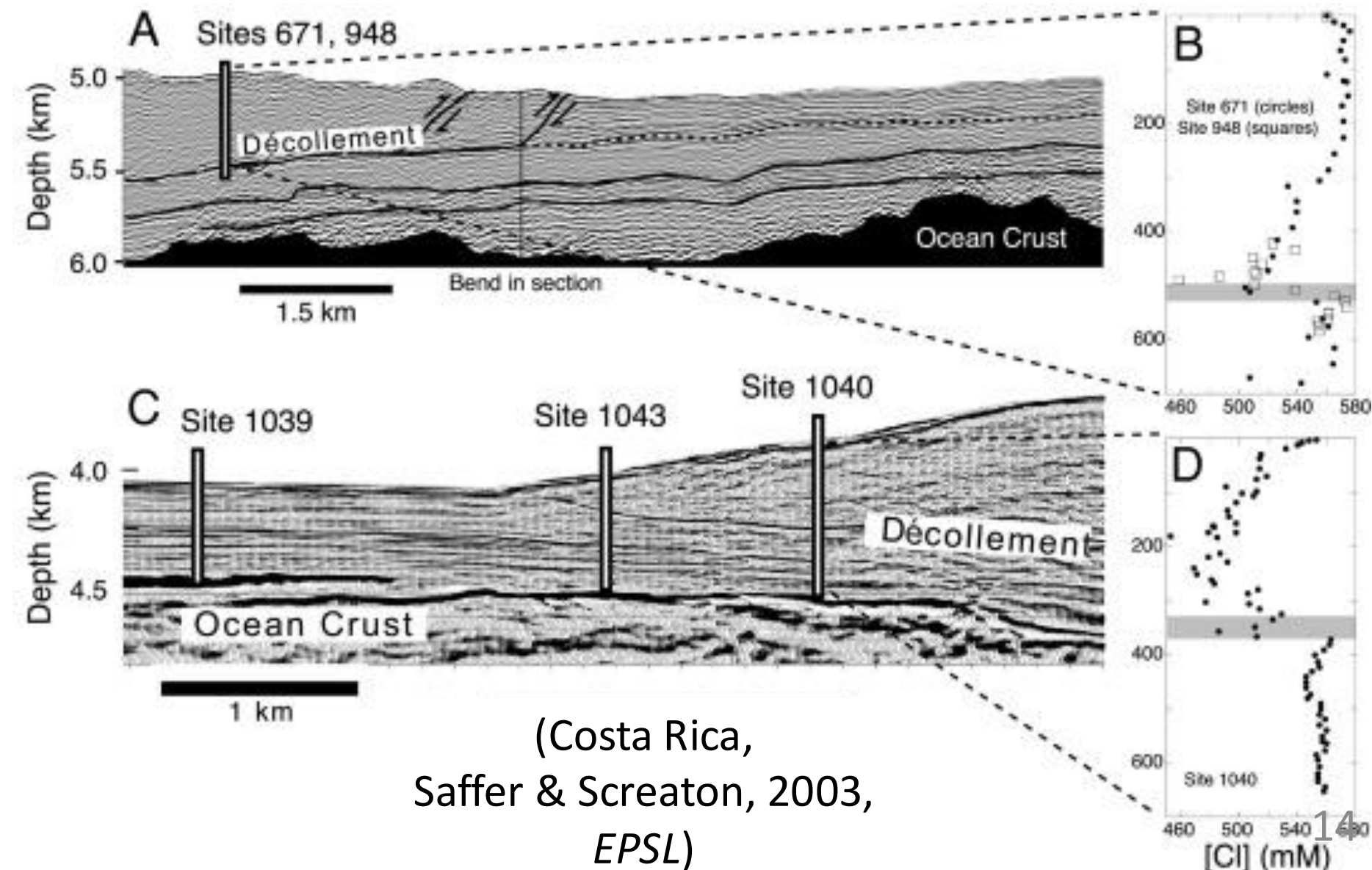
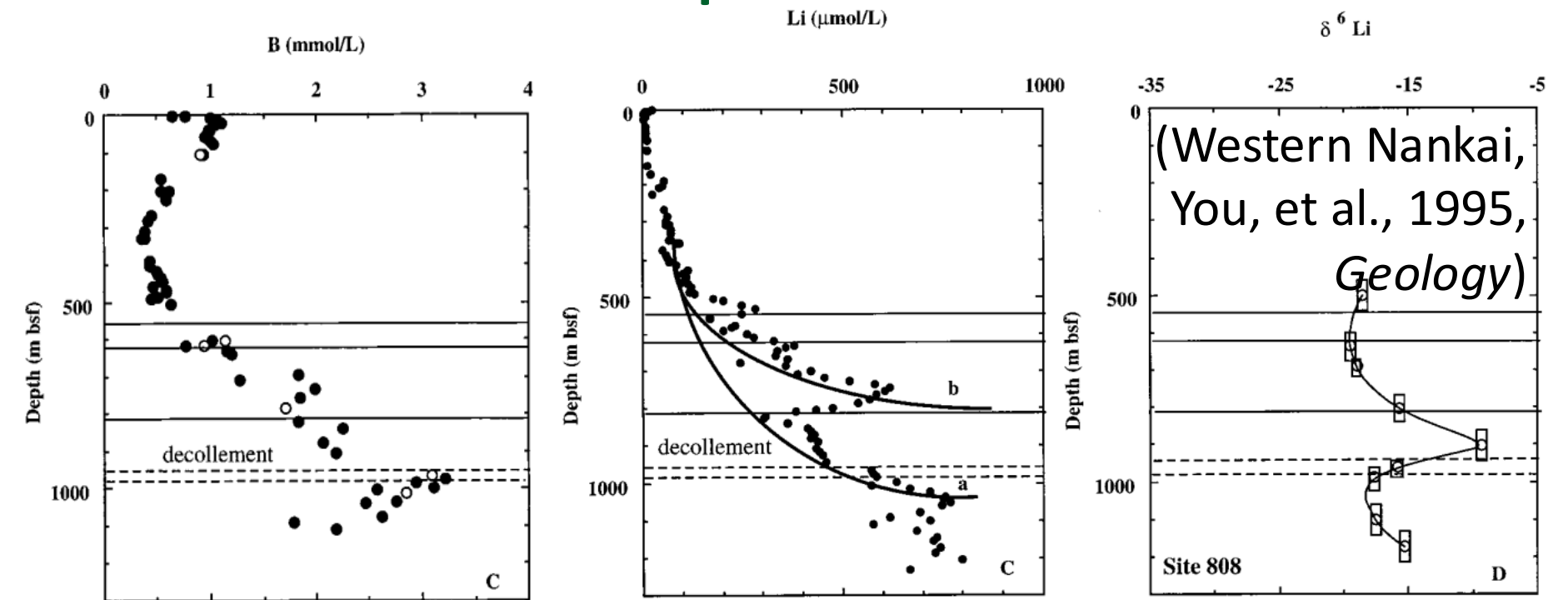
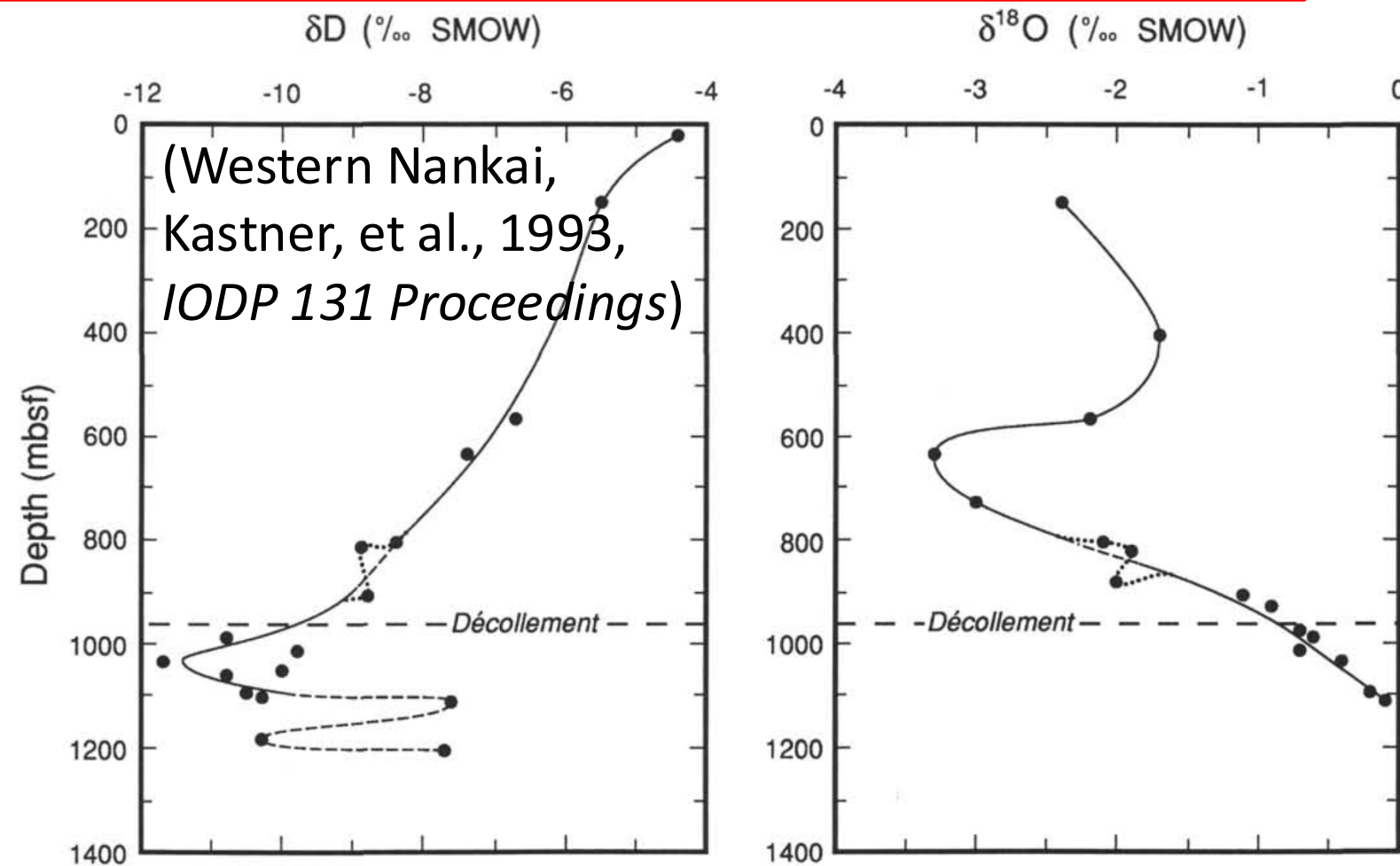
	depth	Homogenization Temperature	Pressured Corrected Range	Melting point	Salinity Range
	mbsf	°C	°C	°C	% NaCl equiv
C0023A-77R-2, 79–90 cm n = 2	821	98 100	118–141		
C0023A-86R-2, 0–10 cm n = 5	890	125 127 128 133 138			
C0023A-98R- 1,0–5 cm n = 5	1010	128 150 159 170 148			
		+/- 5 °C	146–219	+/- 2 °C	15–25

Western Nankai (Tsang et al., 2020, *Marine & Petroleum Geology*):

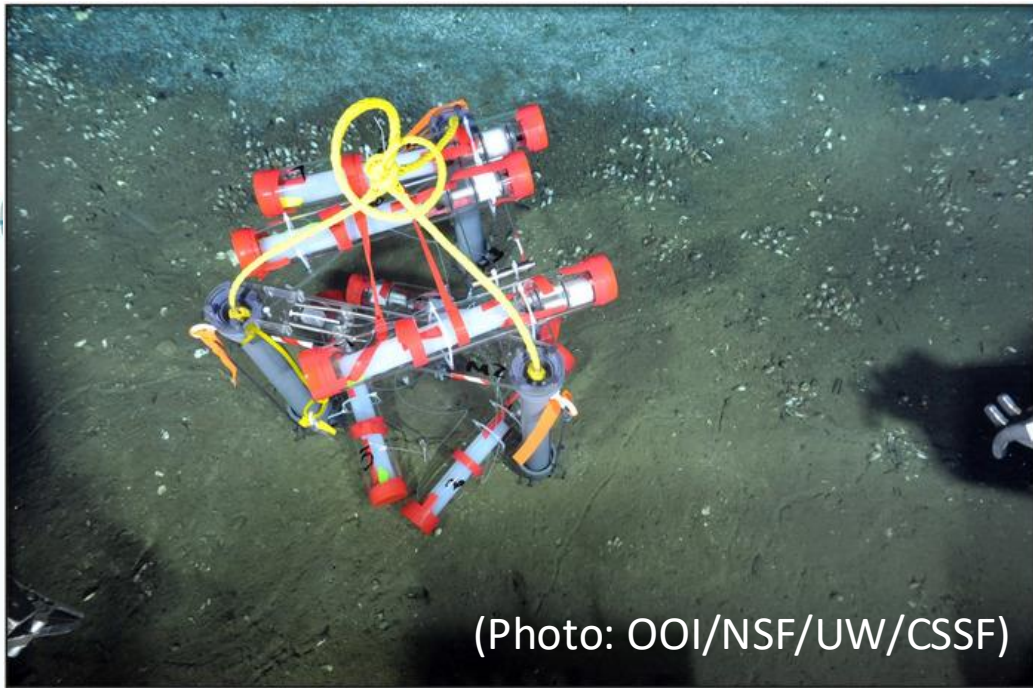
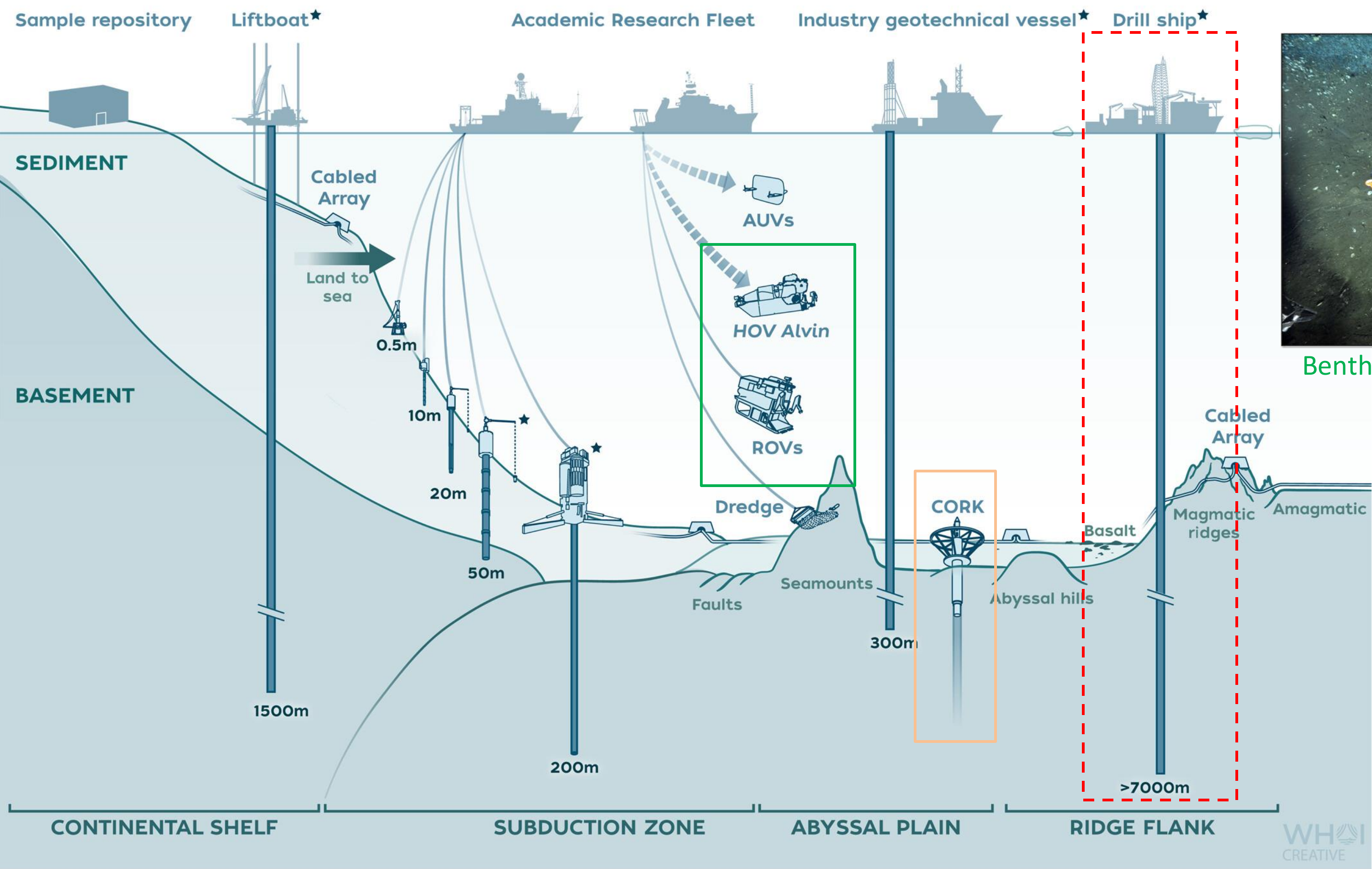


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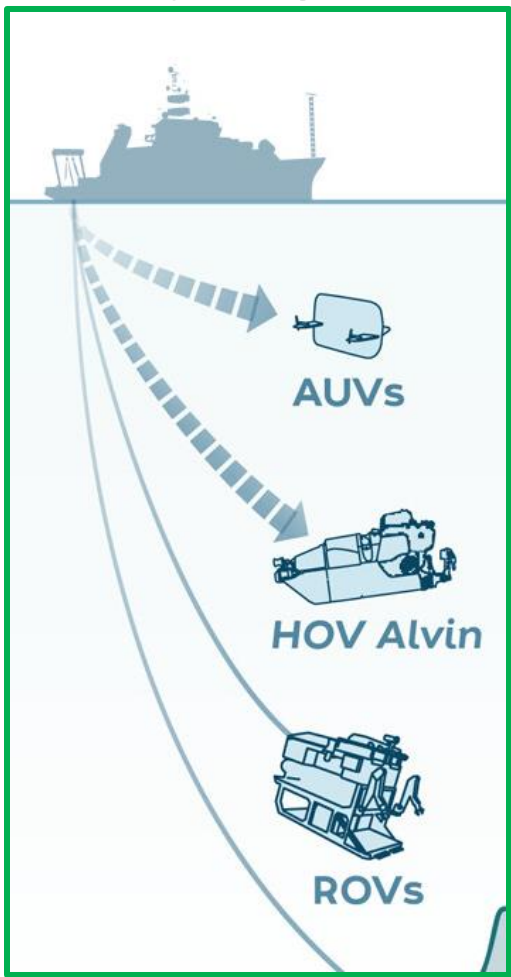
Sampling fluid in subduction zones:



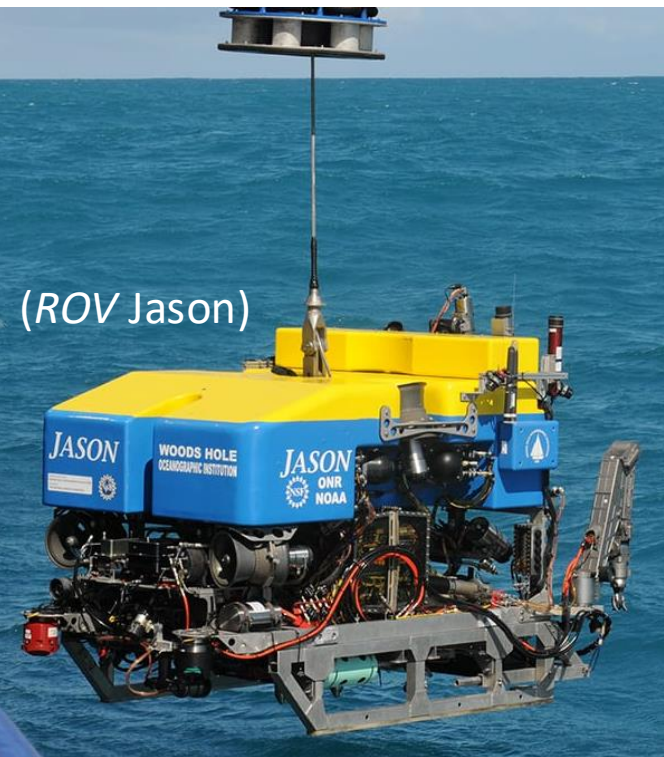
(Photo: OOI/NSF/UW/CSSF)

Benthic fluid sampler and flow meter

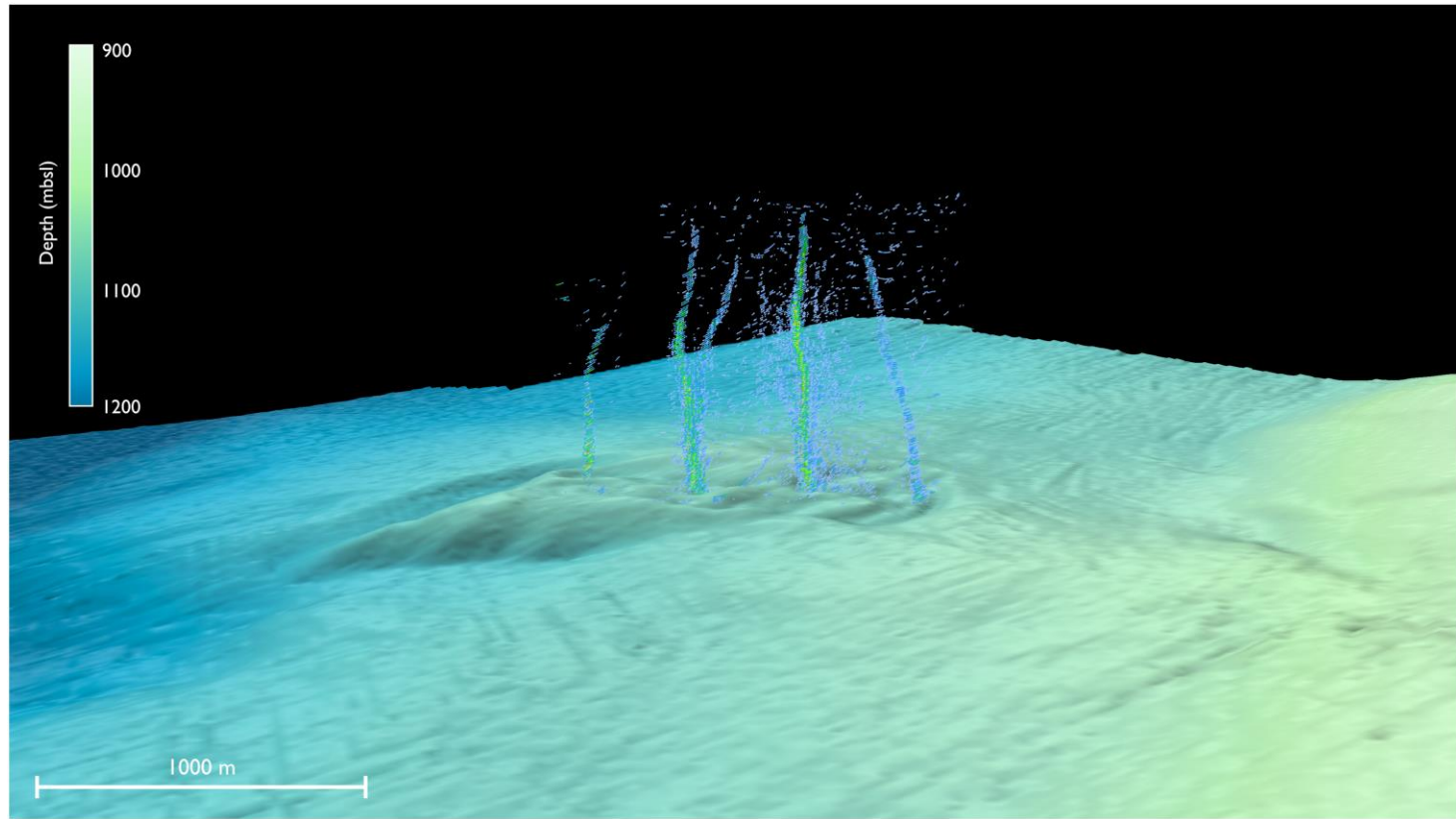
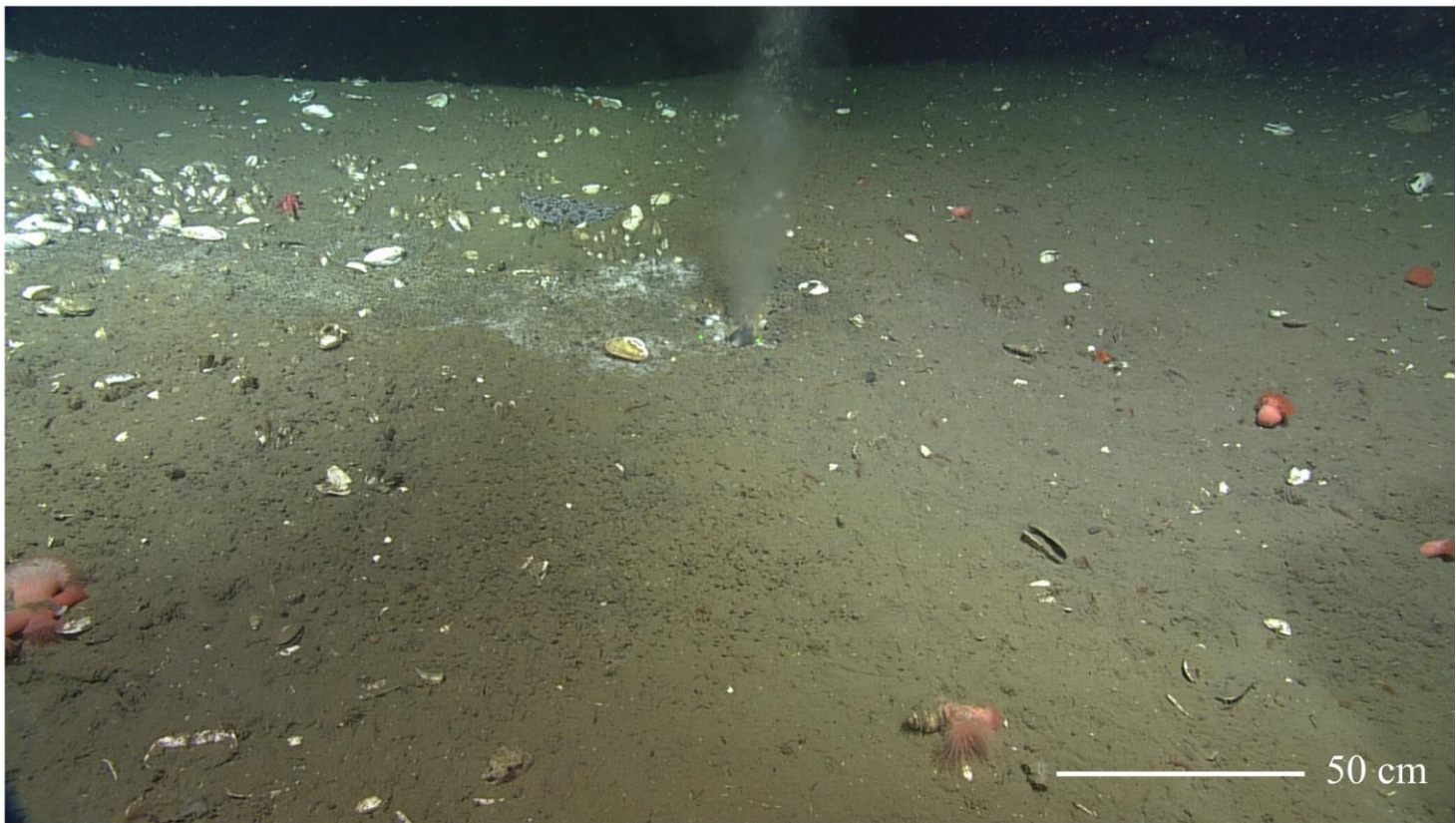
Sampling fluids in subduction zones (not many sites have been sampled and reported):



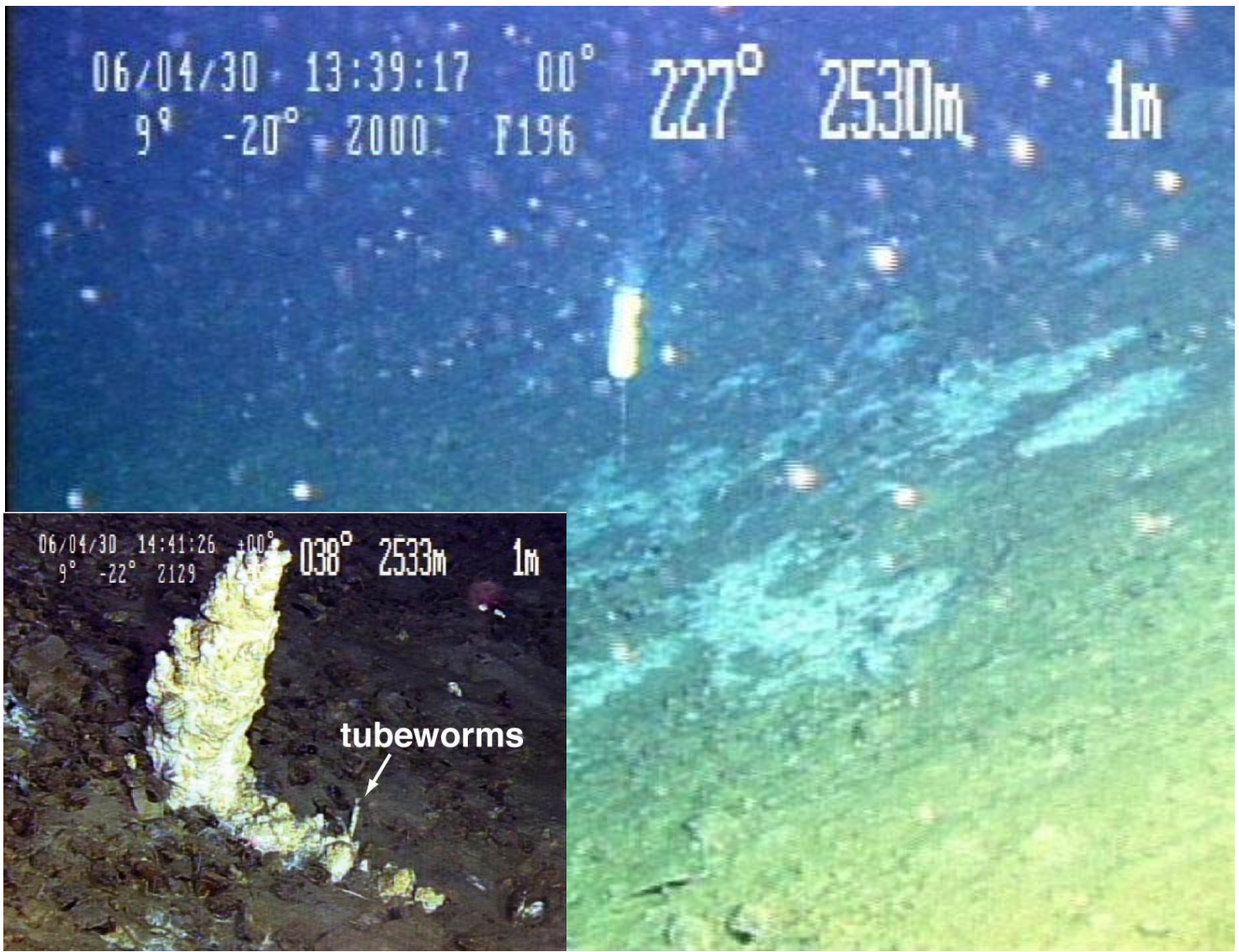
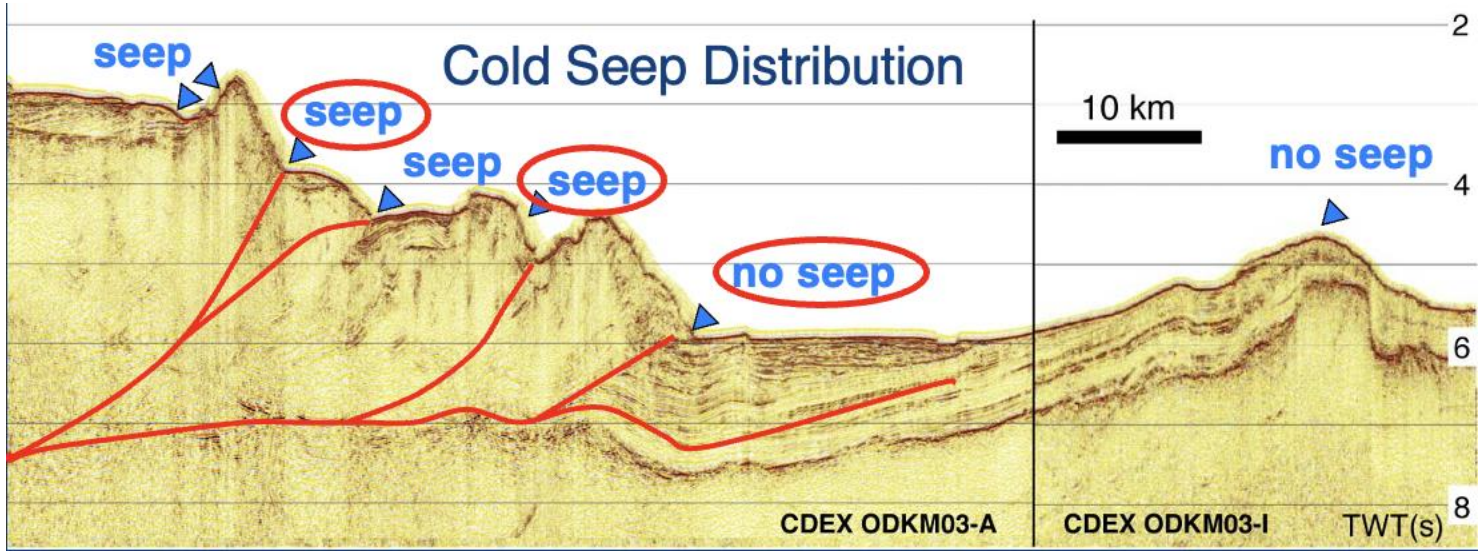
(The FUTURE PI Team et al, 2025, AGU Advances)



(Image: WHOI)



Pythia's Oasis, Cascadia
(Images: Philip et al., 2023, Science Advances)



Nankai, Japan
(Images: Ashi et al., 2006, JAMSTEC)

Sampling fluid through time using osmosamplers and flow meters:

- Northern Hikurangi, New Zealand (Aylward, 2024, *UW dissertation*)
- Used an flow meter network to record fluid-flow rates on the seafloor
 - before, during, and after a major slow slip event
- Flow rate changed when the slow slip event occurred

