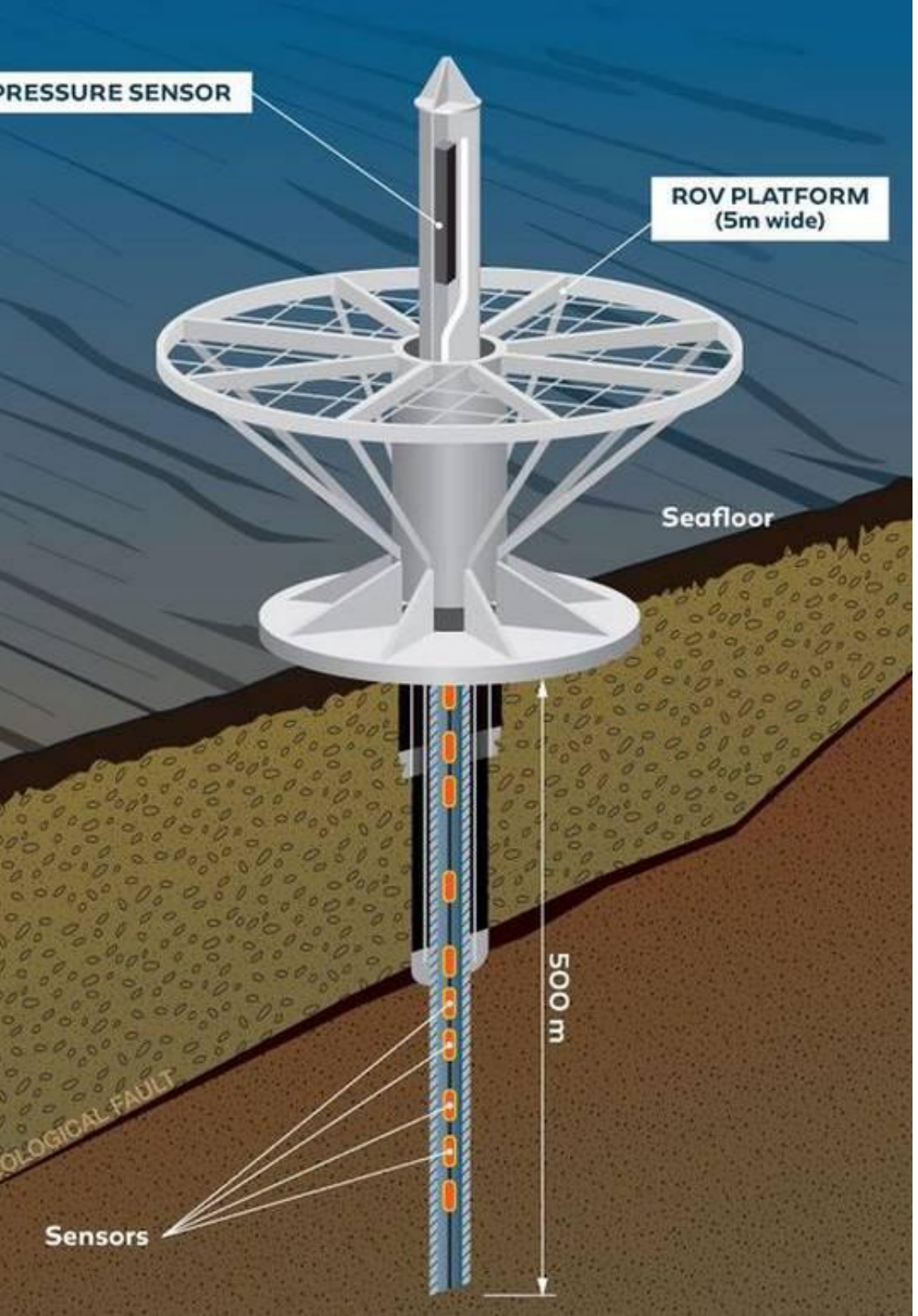
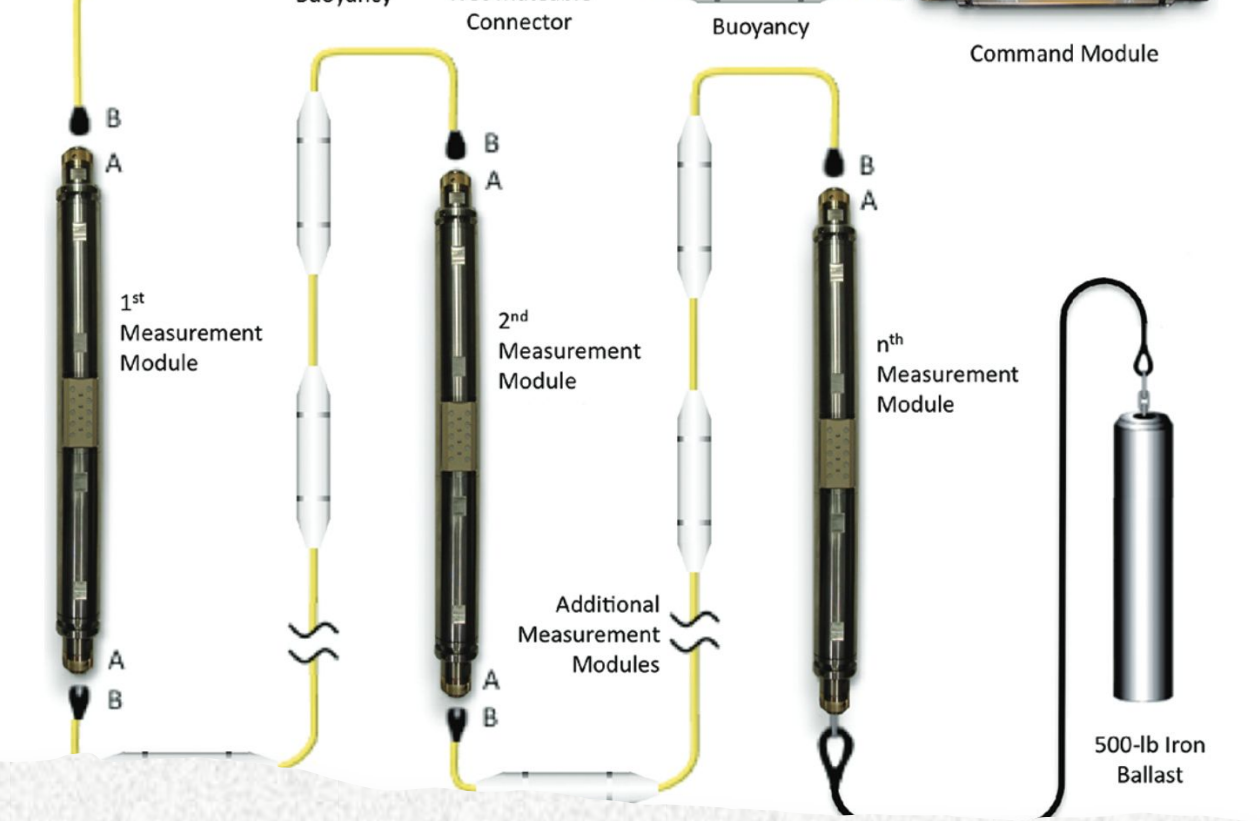


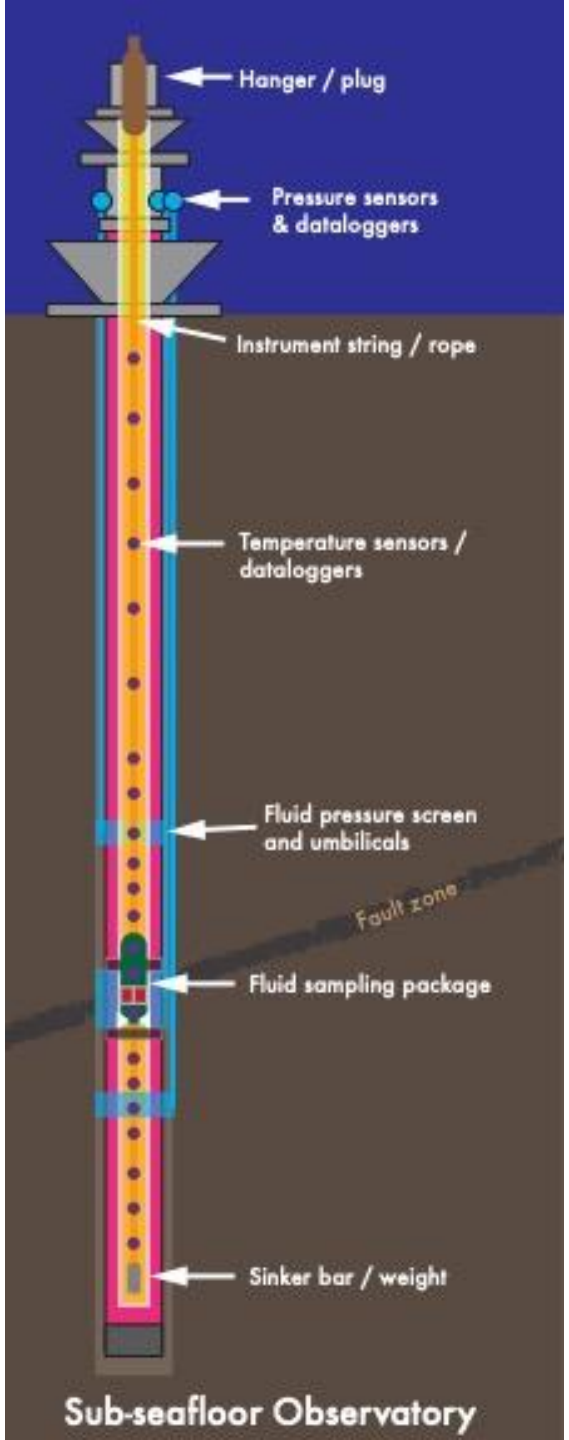
Sub-seafloor observatories

Patrick Fulton
pfulton@cornell.edu



SCIMPI

Lado-Insua et al., 2013



For studying processes and conditions

- Hydrologic
- Thermal
- Geochemical
- Microbiologic
- Geodetic


IODP
INTEGRATED OCEAN
DRILLING PROGRAM


U.S. SCIENCE
SUPPORT
PROGRAM


JAMSTEC

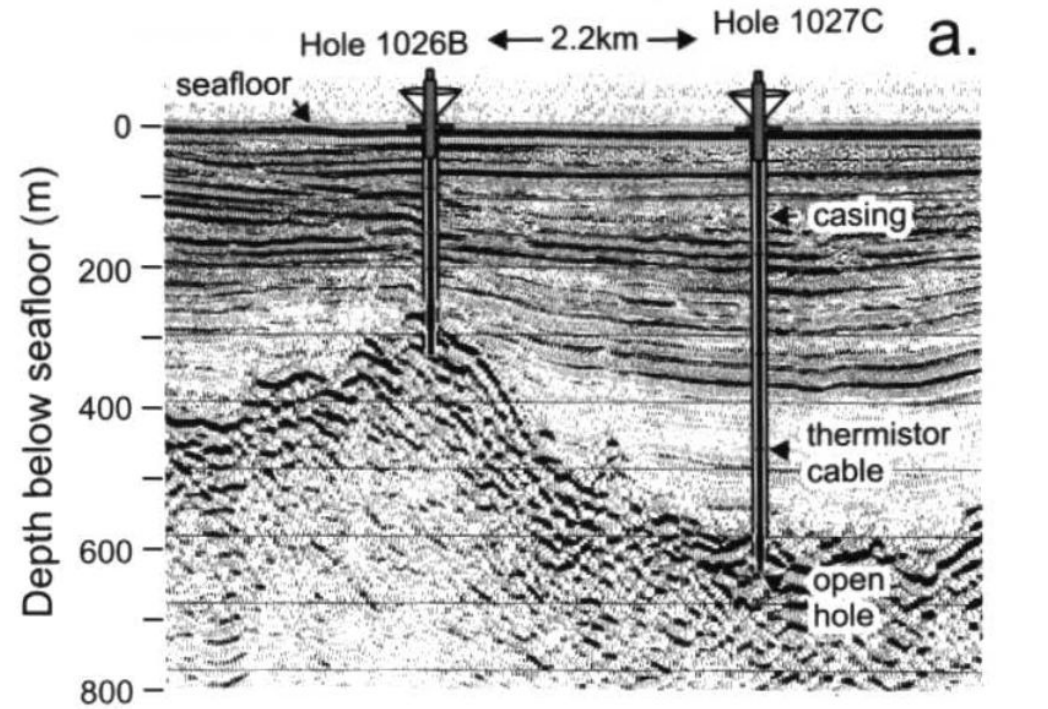

IODP
INTERNATIONAL OCEAN
DISCOVERY PROGRAM


GORDON AND BETTY
MOORE
FOUNDATION

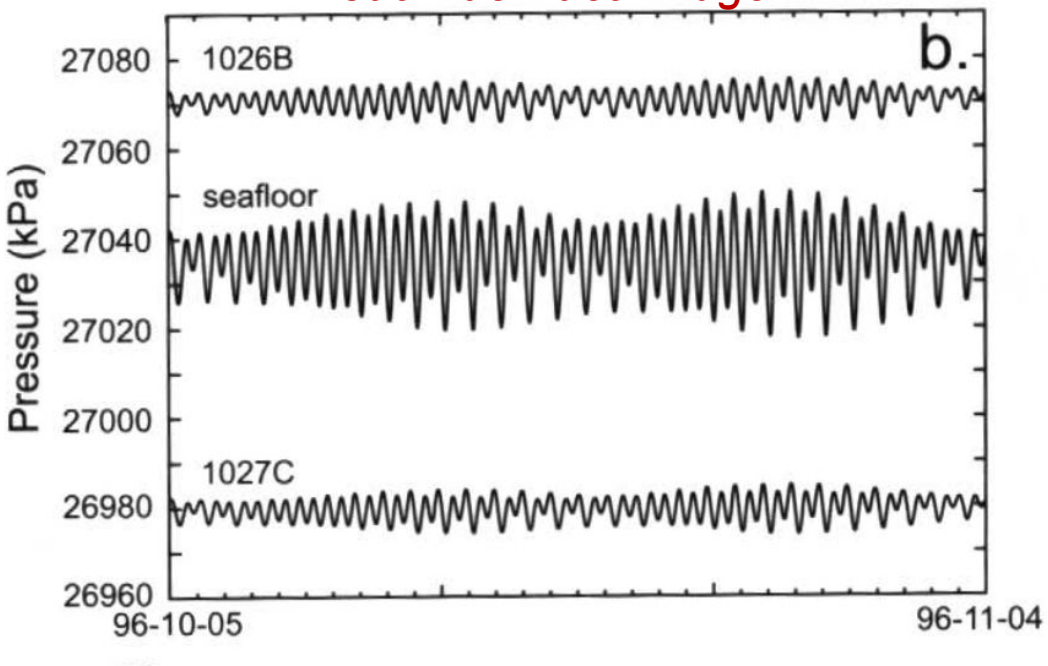

NSF

Pressure

Characterizing hydrologic conditions and flow patterns



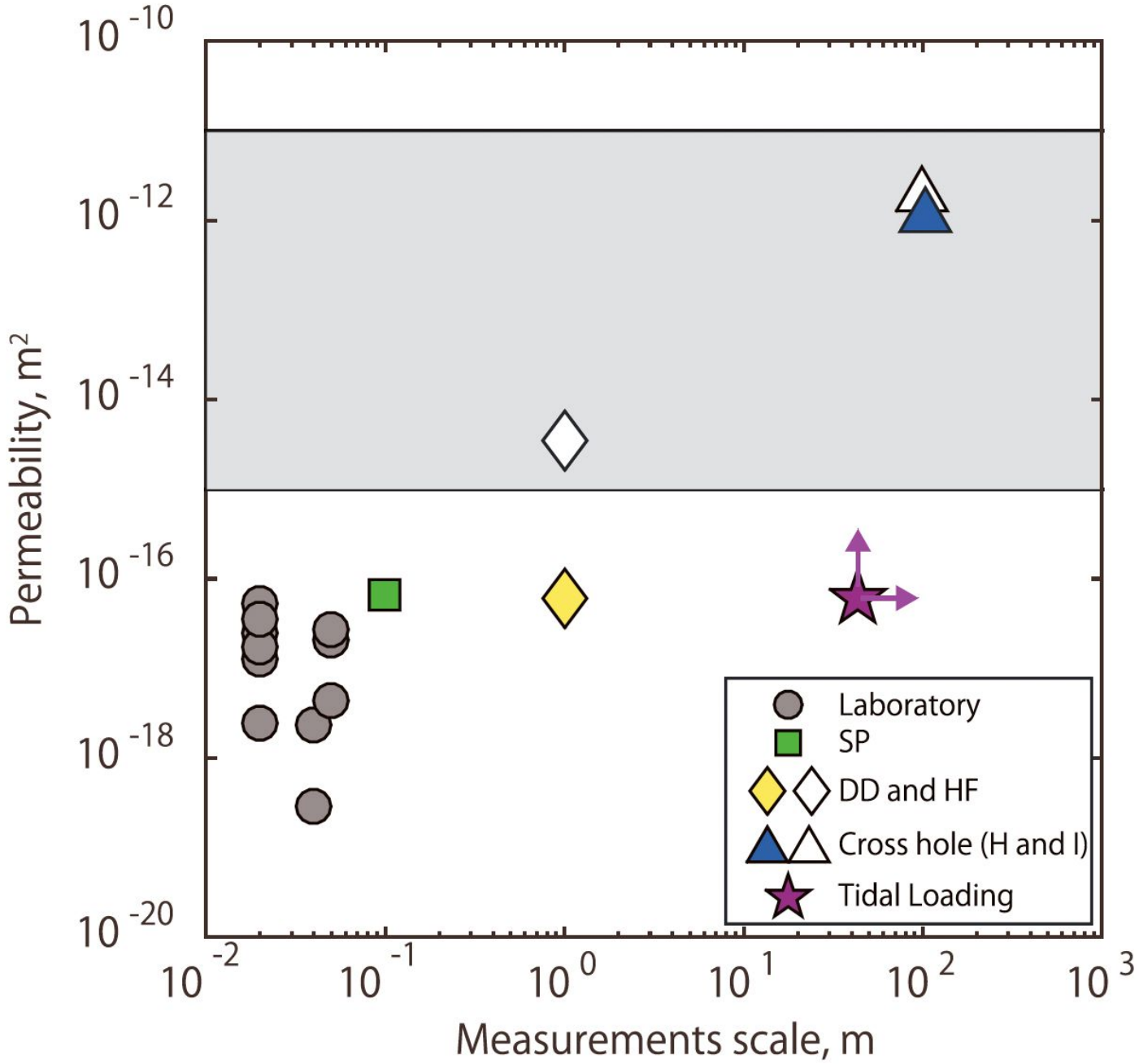
Juan de Fuca Ridge



Davis and Becker, 1998

Pressure

Cross-borehole experiments

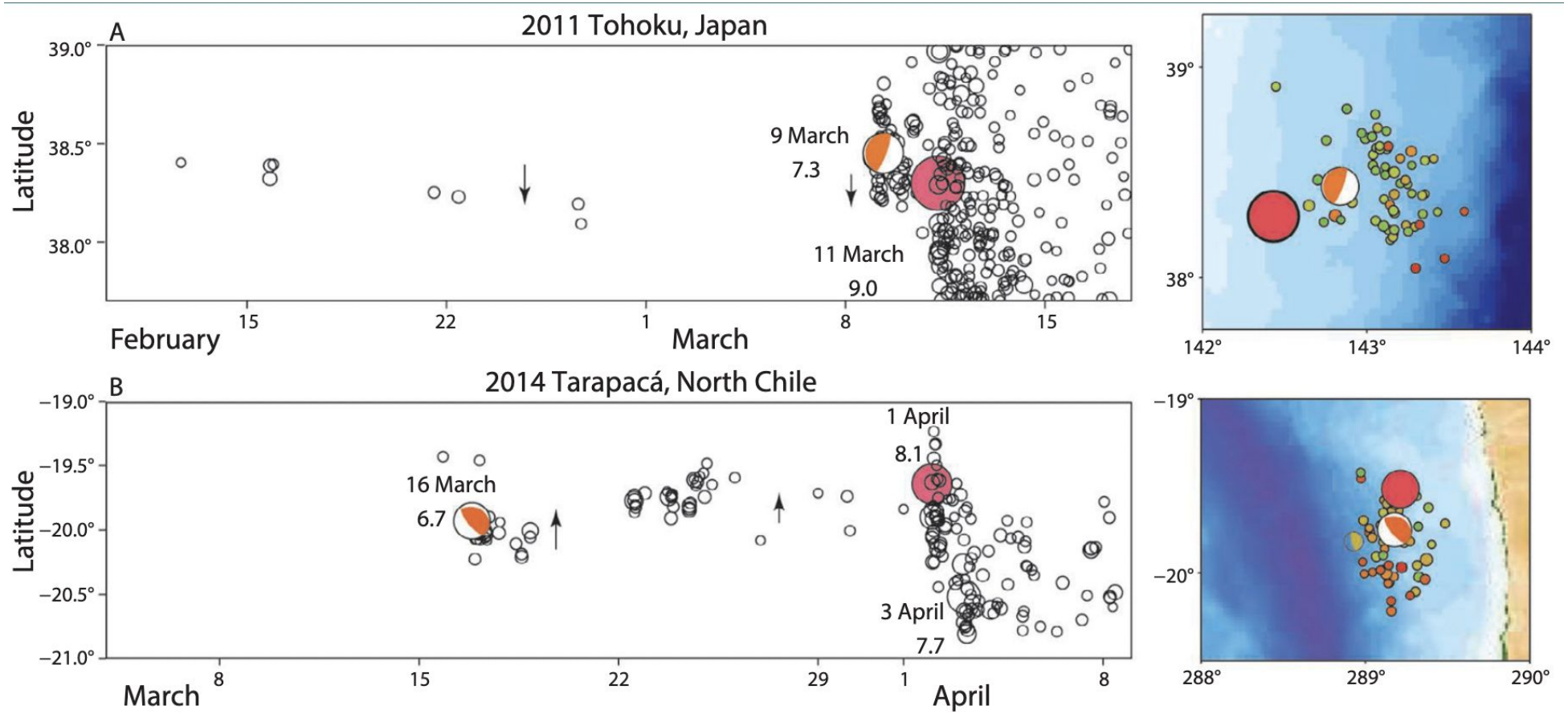


Kinoshita and Saffer, *GRL*, 2018

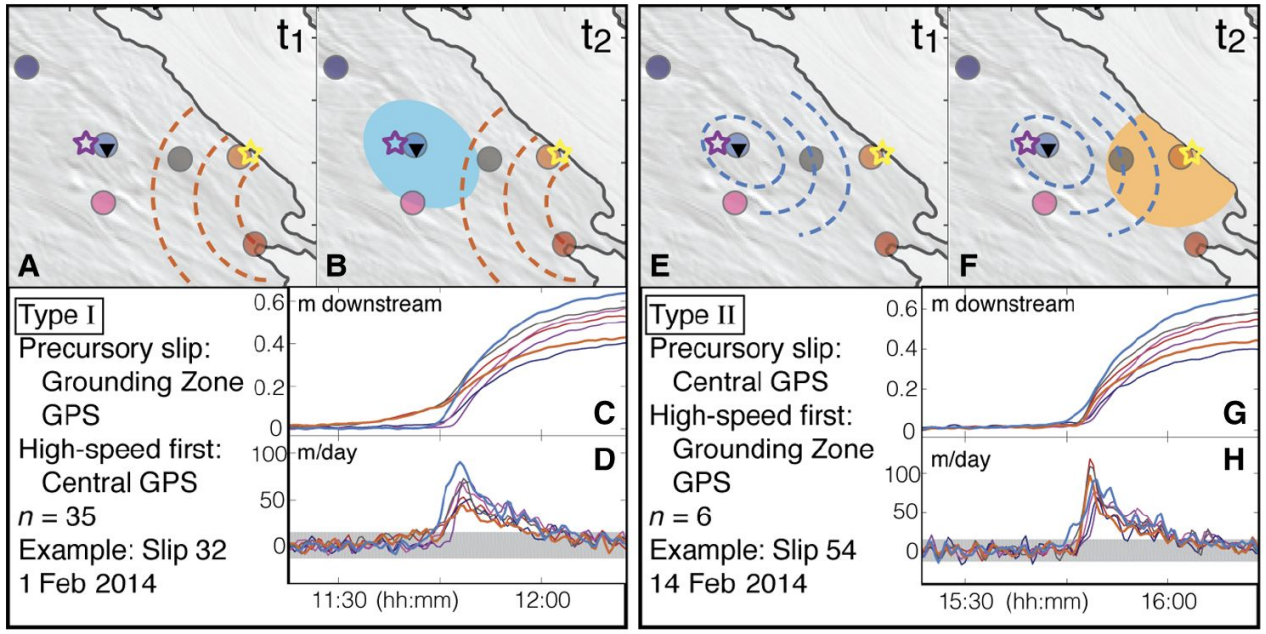
Pressure

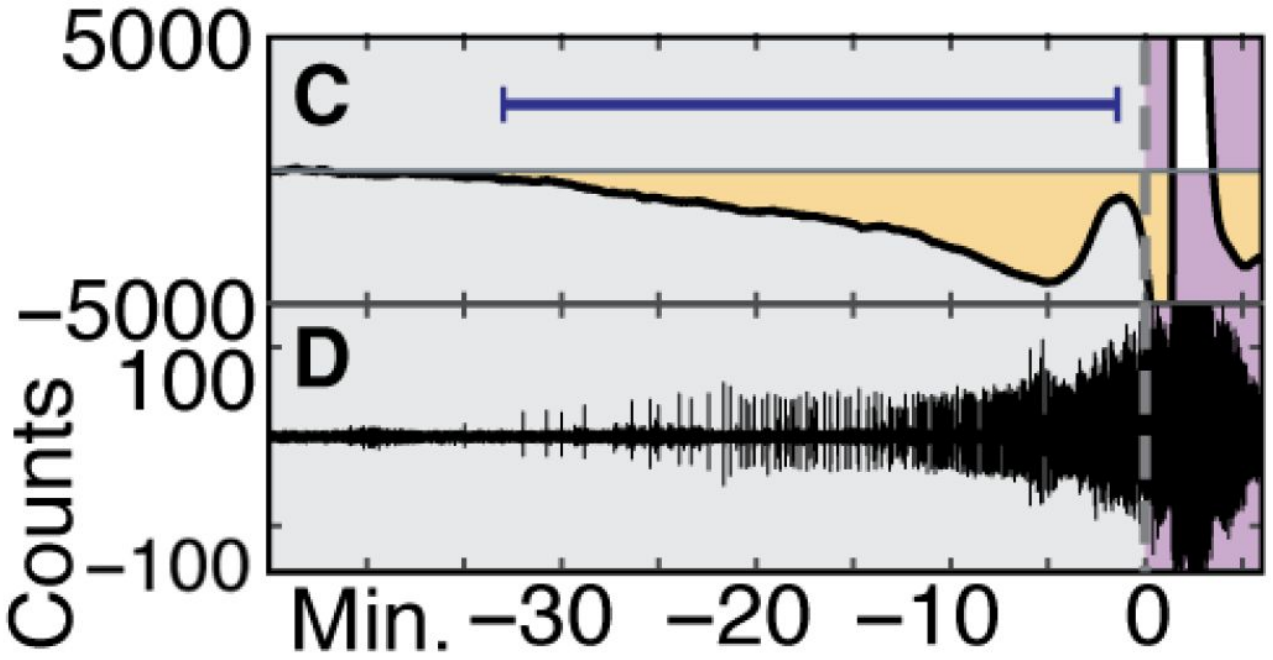
Strain / Geodesy

Seafloor geodesy – slow precursory signals before many large megathrust earthquakes



Brodsky and Lay, *Science* 2014

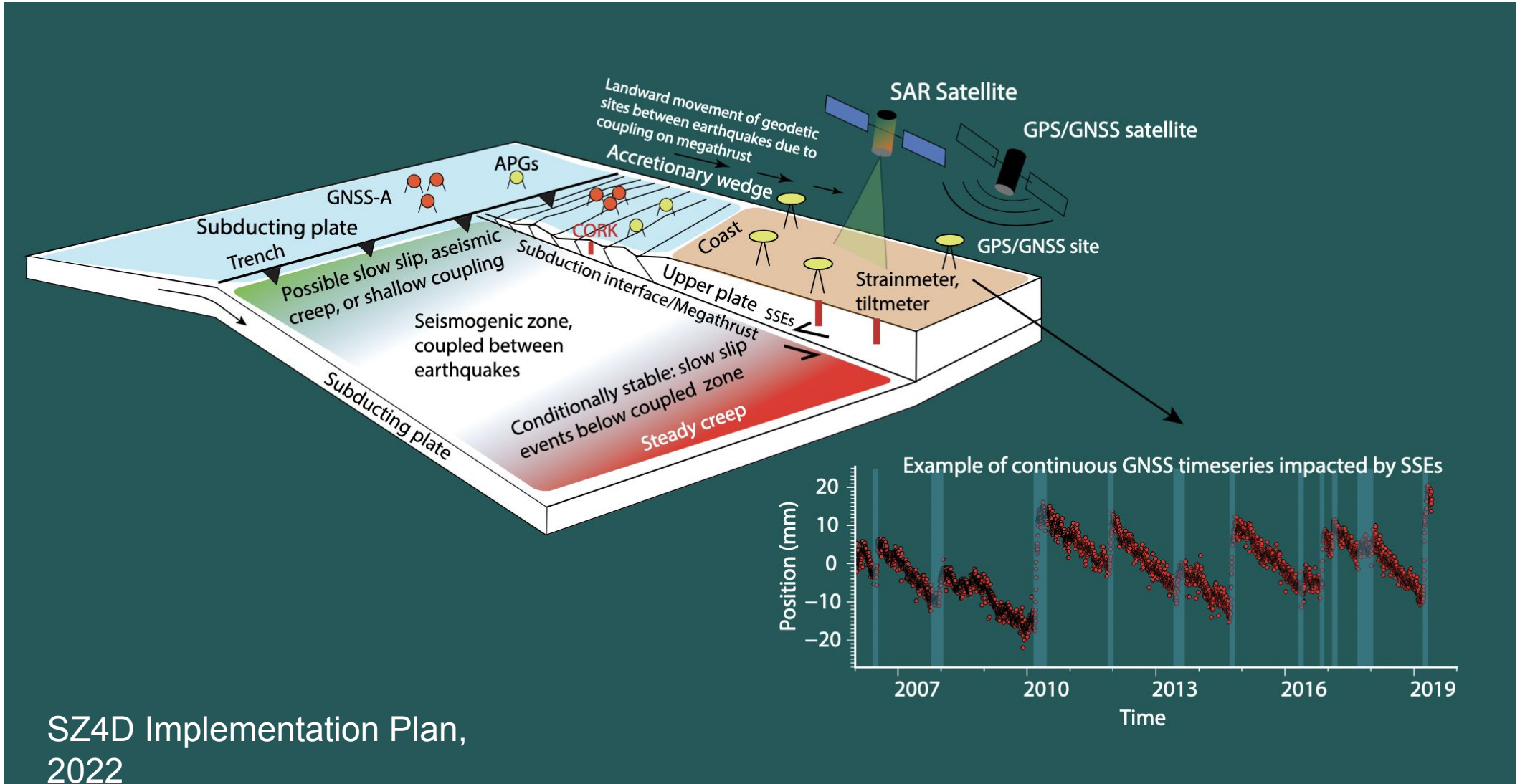




Migrating pre-cursory slow slip observed before 63 of 75 M7 earthquakes in an Antarctic ice stream (84%).

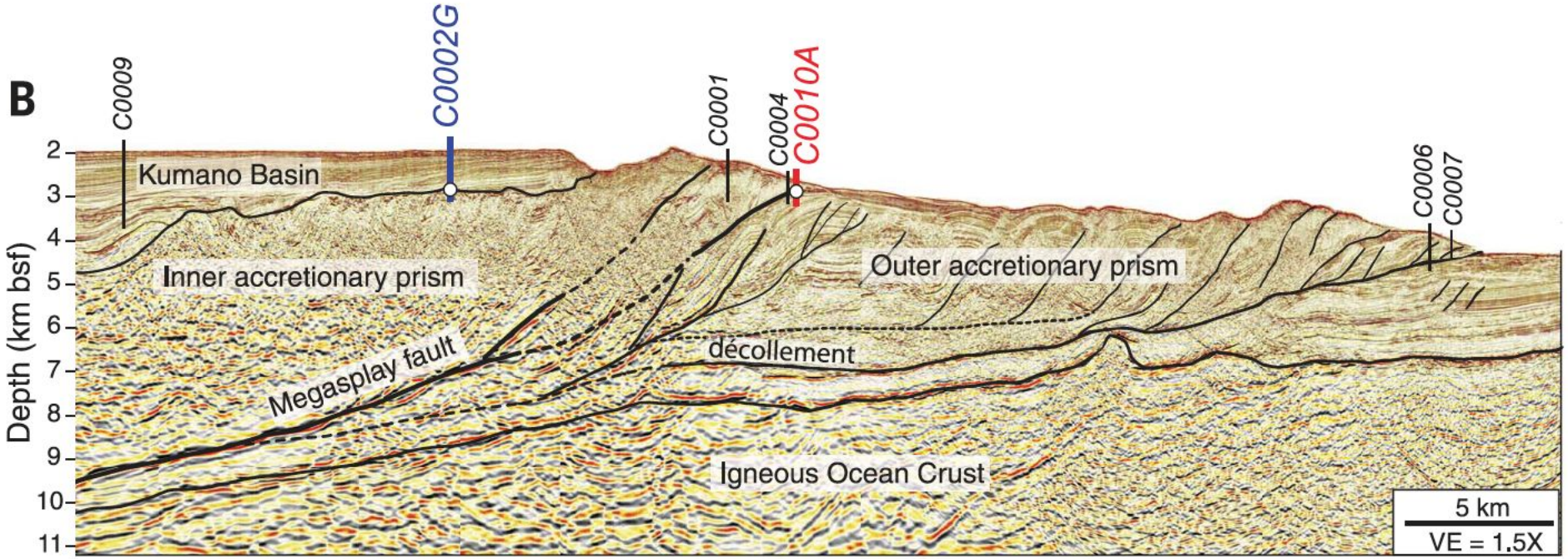
Barcheck et al., Science Adv., 2021

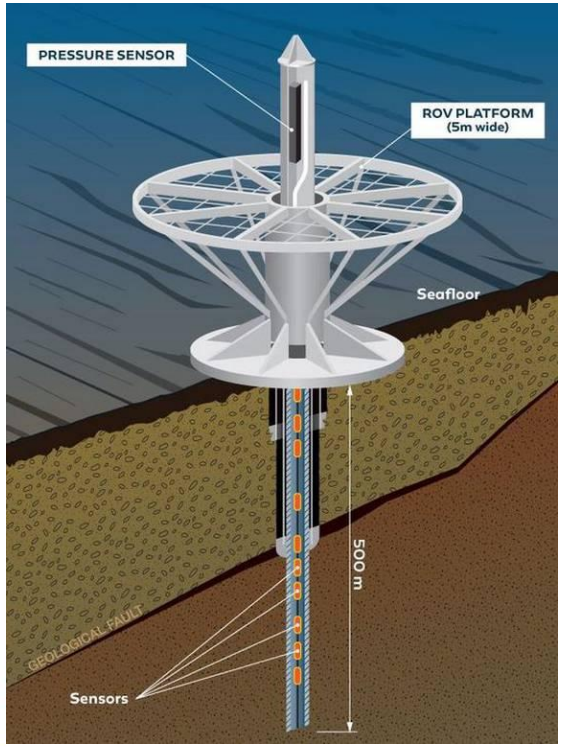
Seafloor geodesy – where is the plate locked? Where and when is transient slow slip occurring?



SZ4D Implementation Plan, 2022

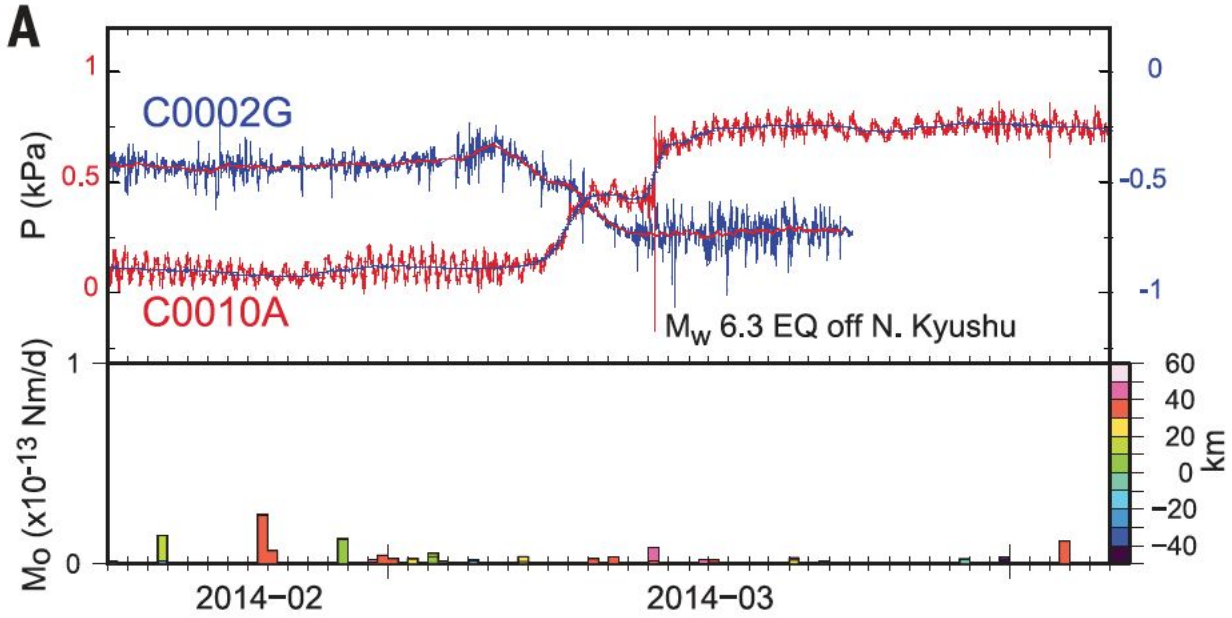
Example from Nankai Trough, SW Japan

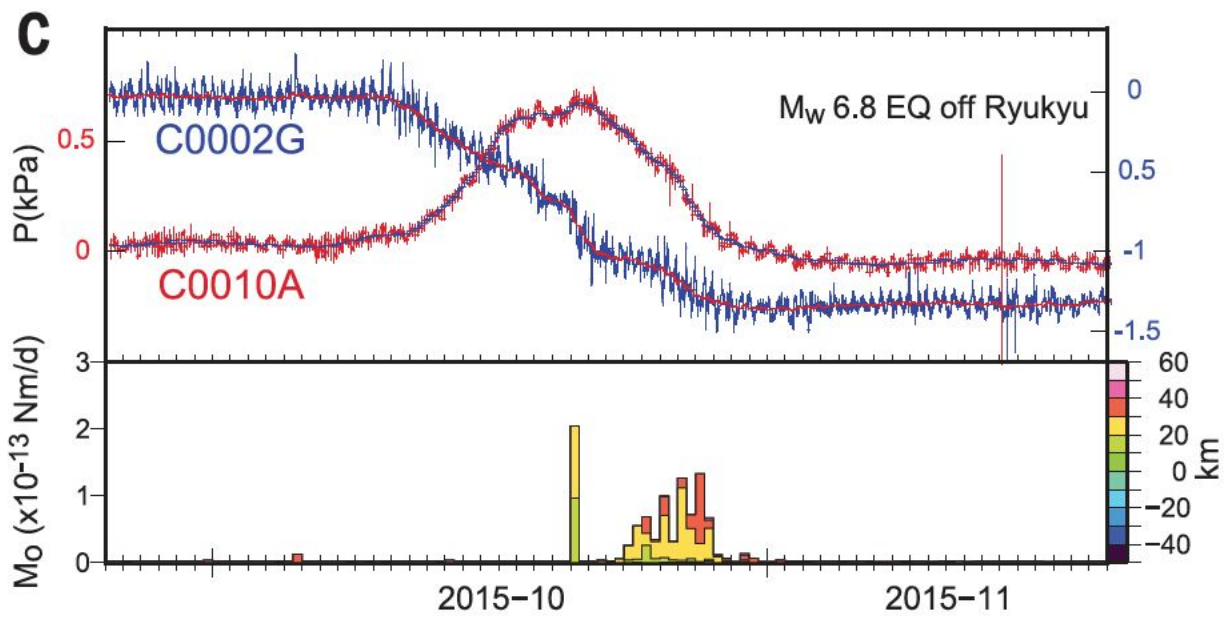




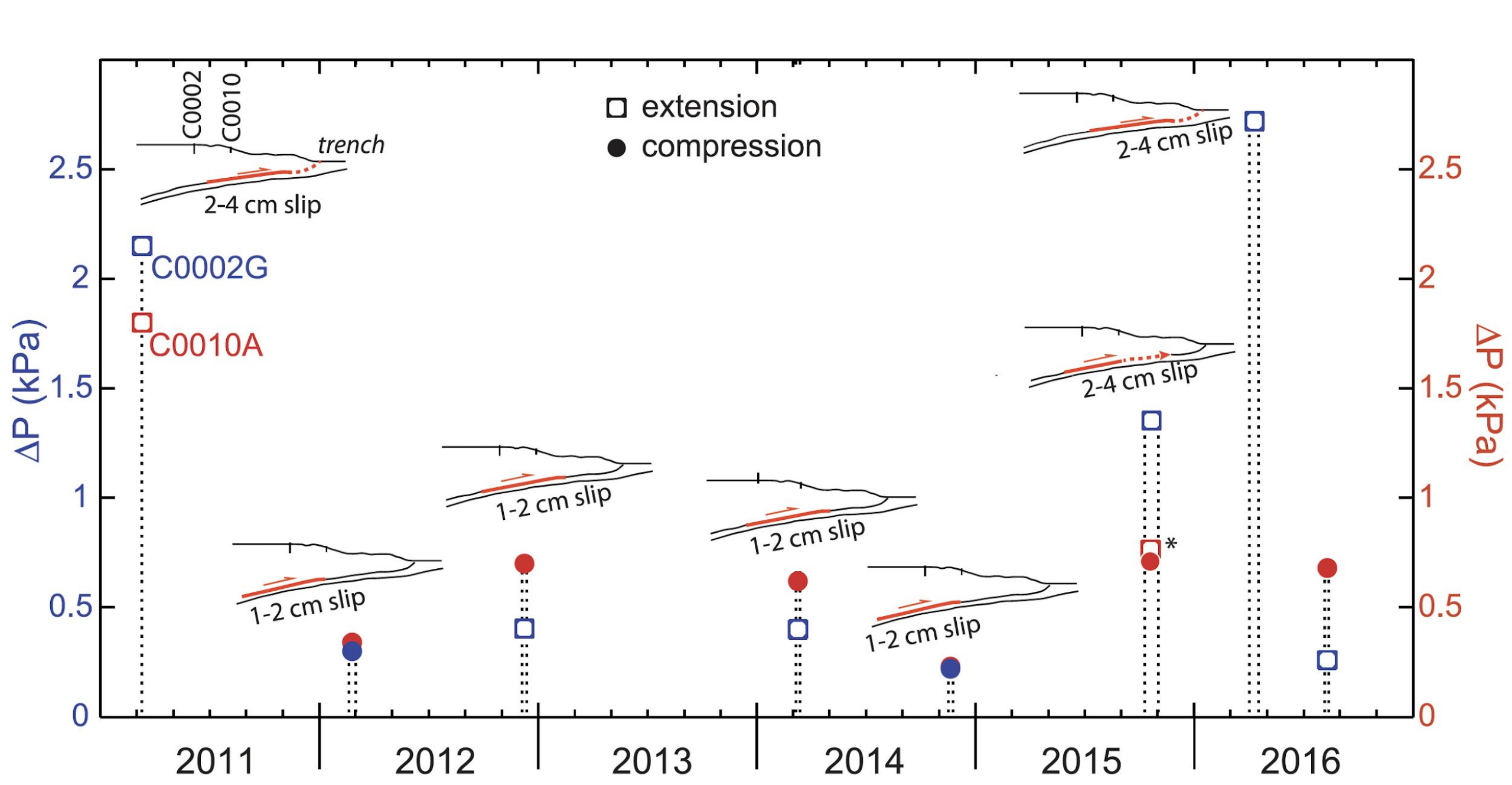
Araki et al., *Science*, 2017

Example from Nankai Trough, SW Japan

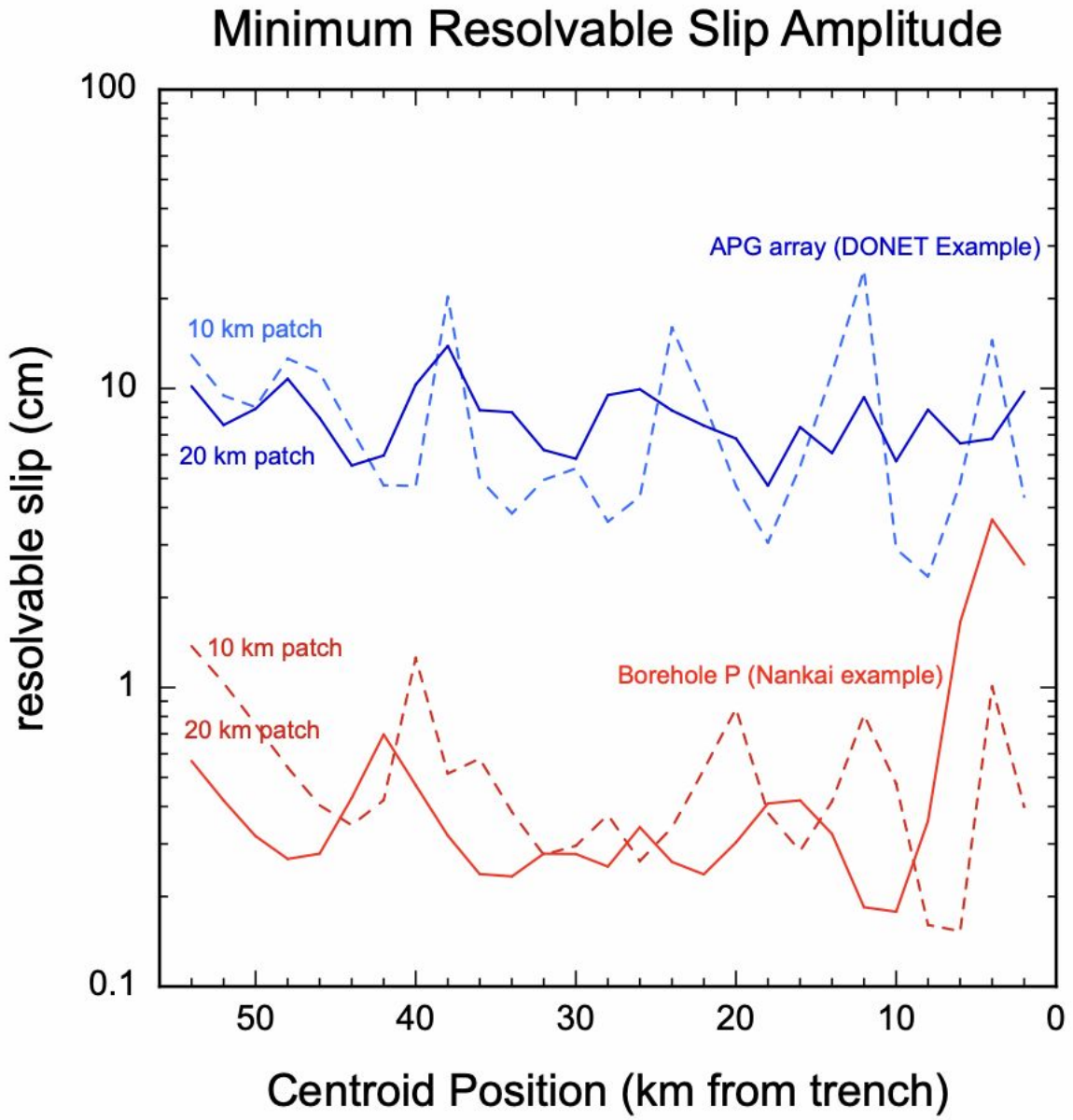




Araki et al., *Science*, 2017

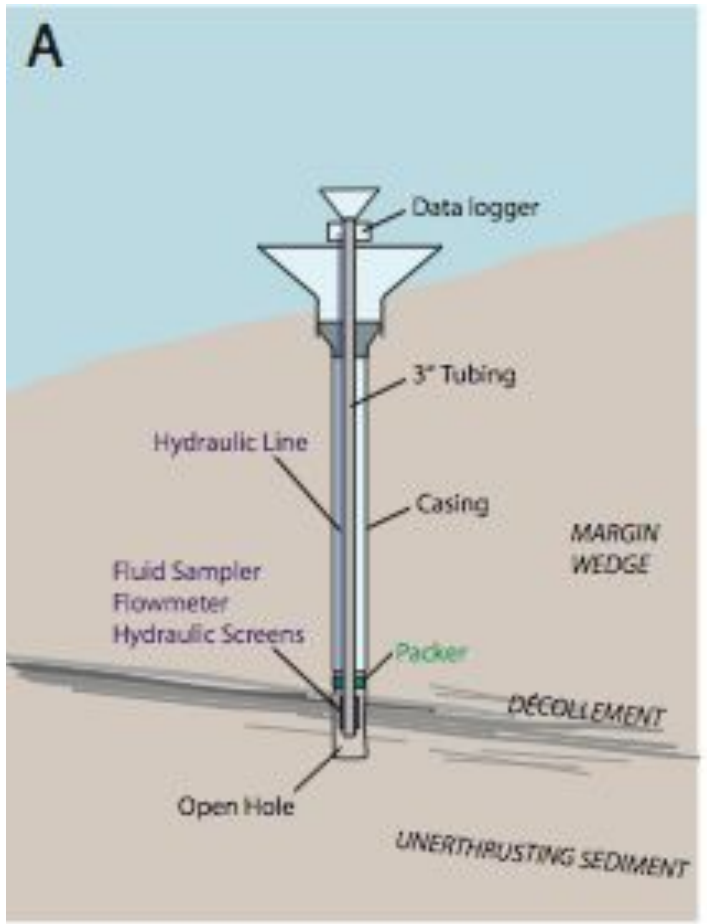


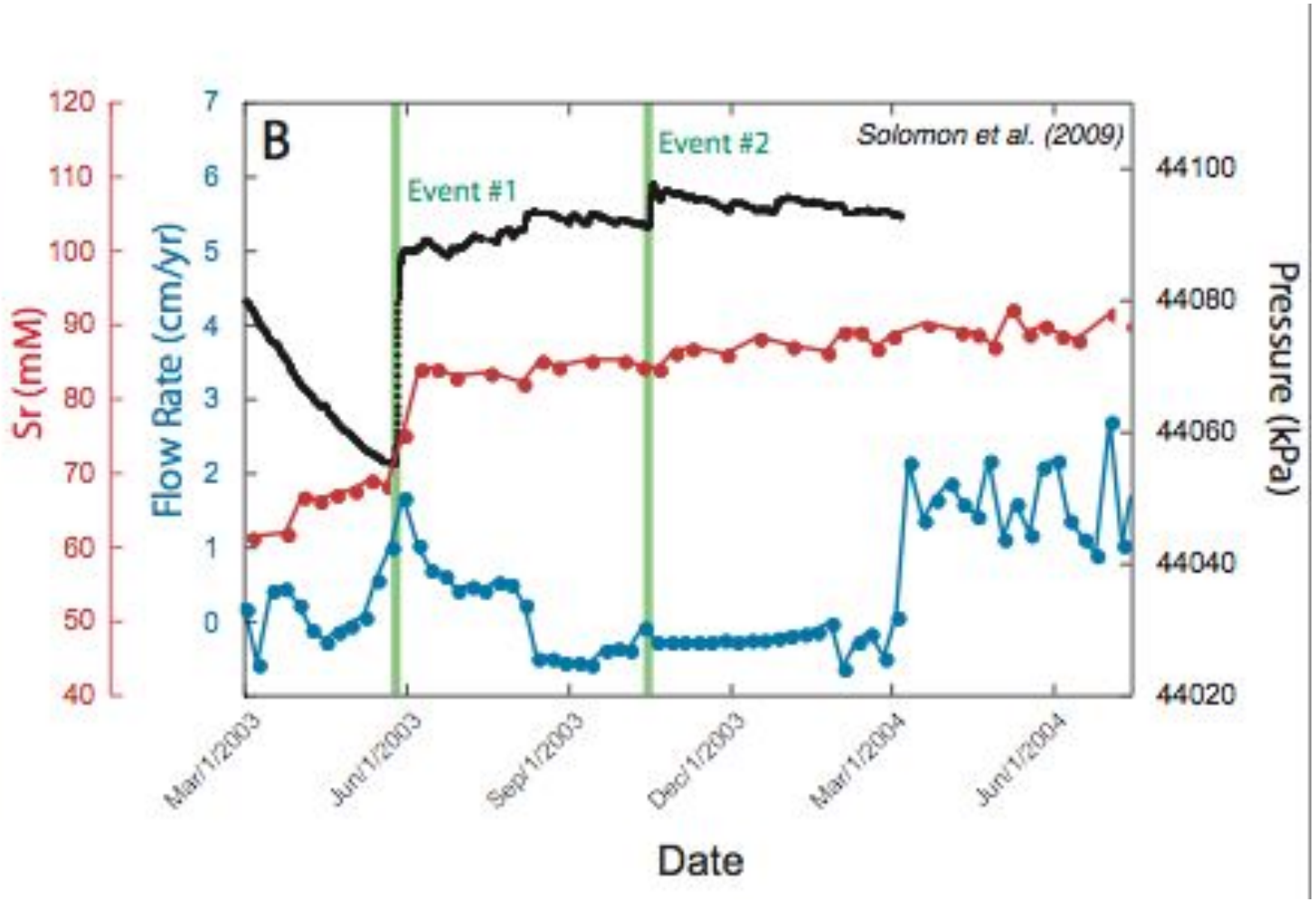
Araki et al., *Science*, 2017



Demian Saffer

Example from Costa Rica

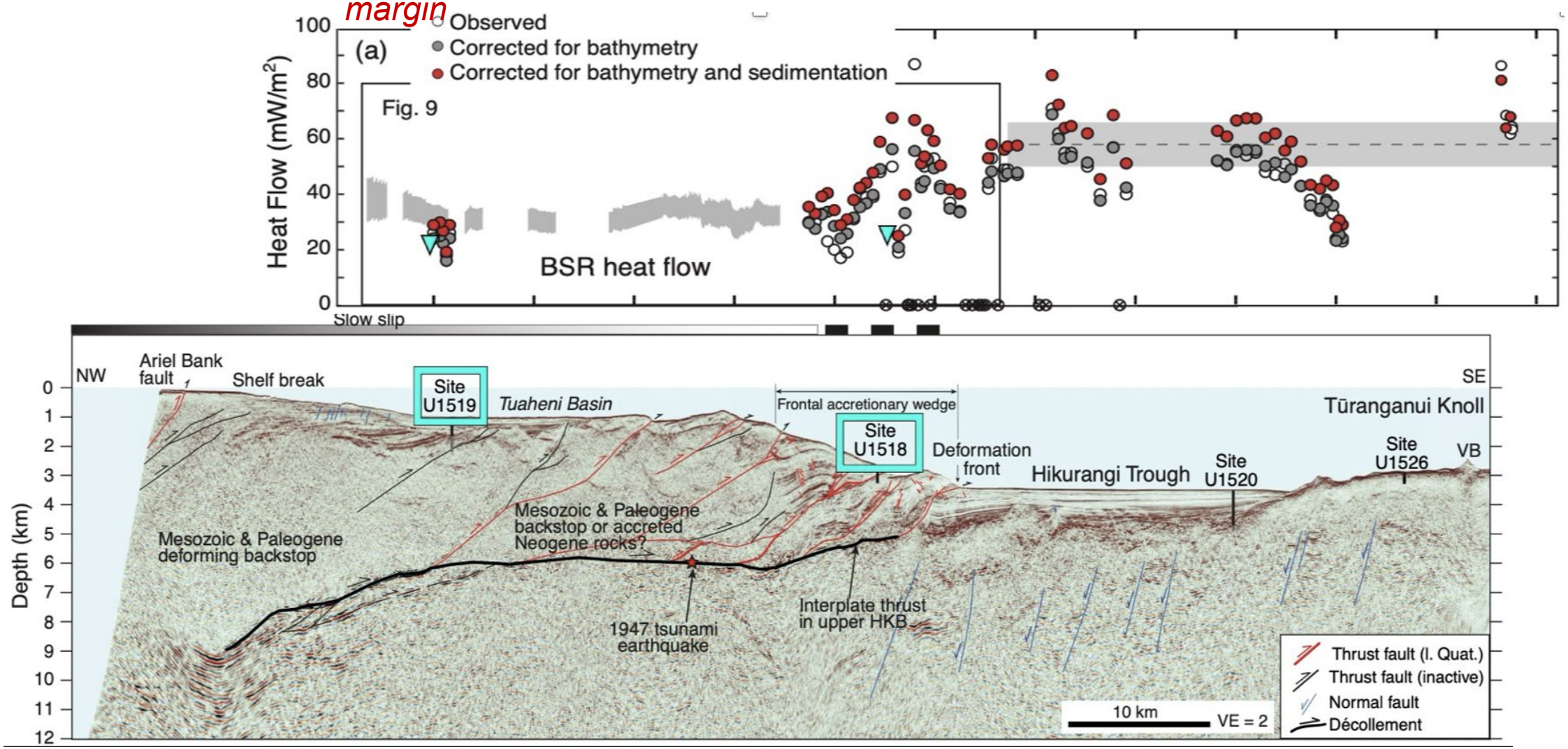




Solomon et al. *EPSL*, 2009

Temperature

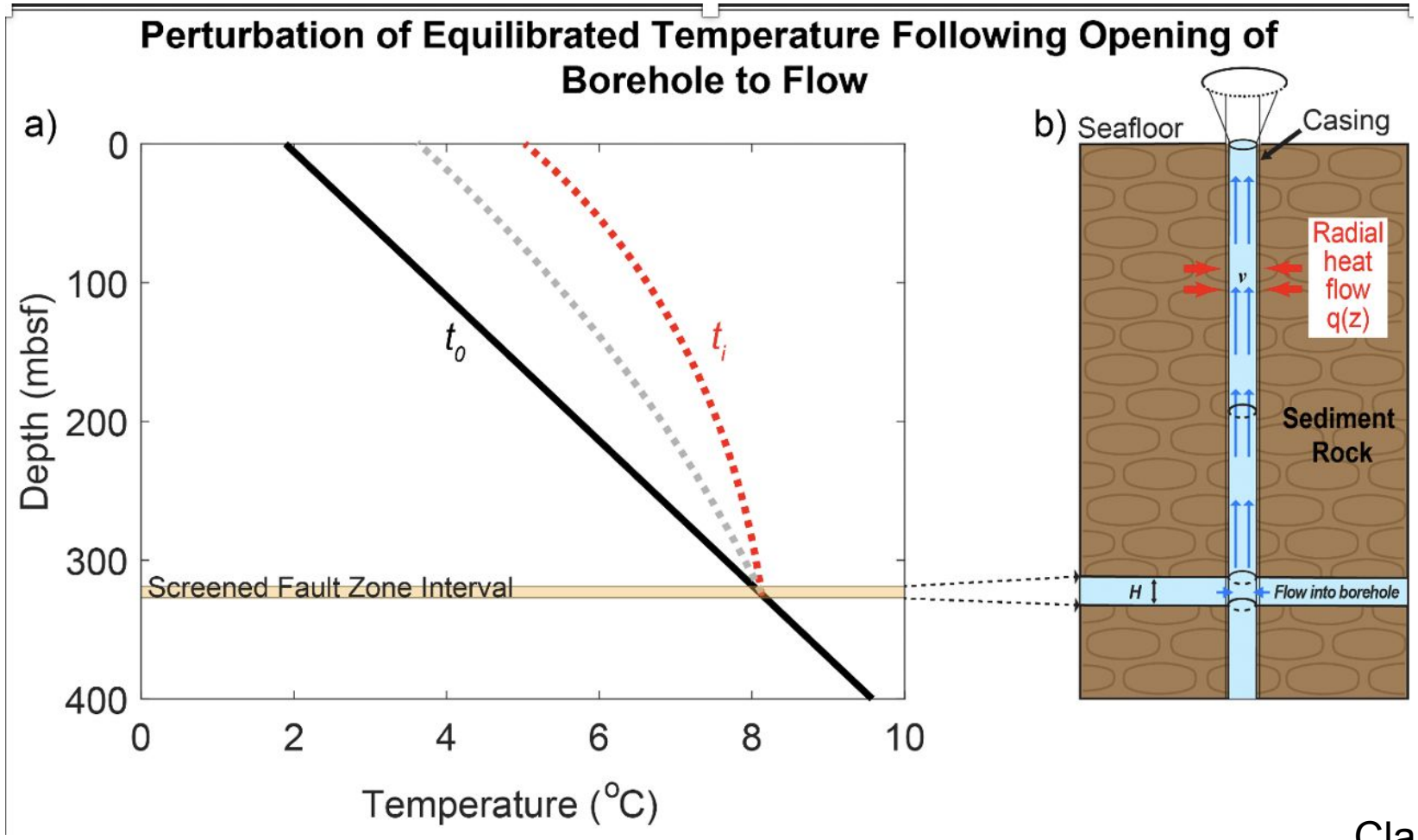
Hikurangi margin



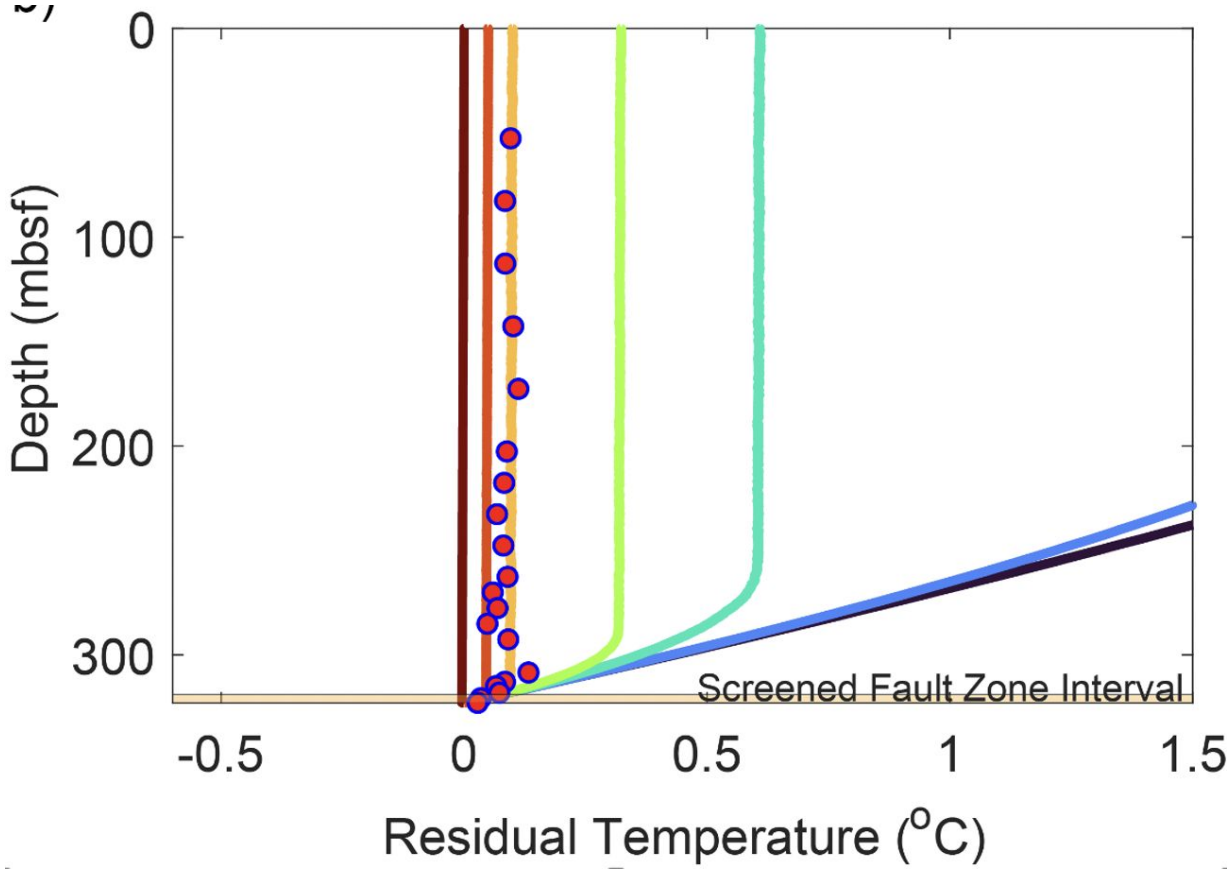
Fresonke, Fulton, & Harris, AGU

Temperature

uncorked flow permeability



Clairmont & Fulton,



Flow rate: ~1.2 x 10^{-3} $m.s^{-1}$

Permeability: >2.5 x 10-14 m^2

Clairmont & Fulton,

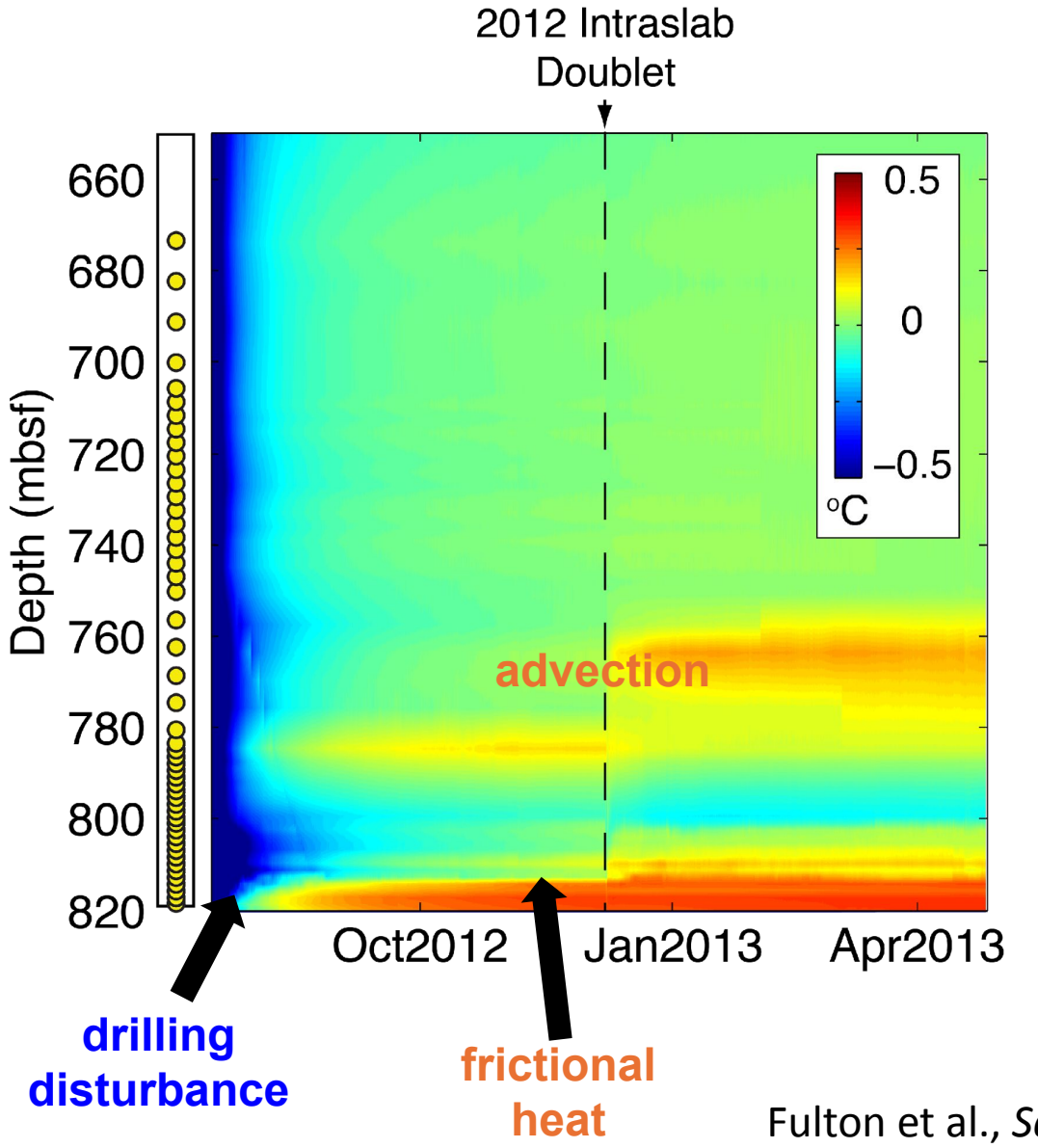
Temperature

Hydrologic structure and transient processes

Residual temperature (geotherm removed)

Japan Trench
2011 Mw 9.0
Earthquake Fault

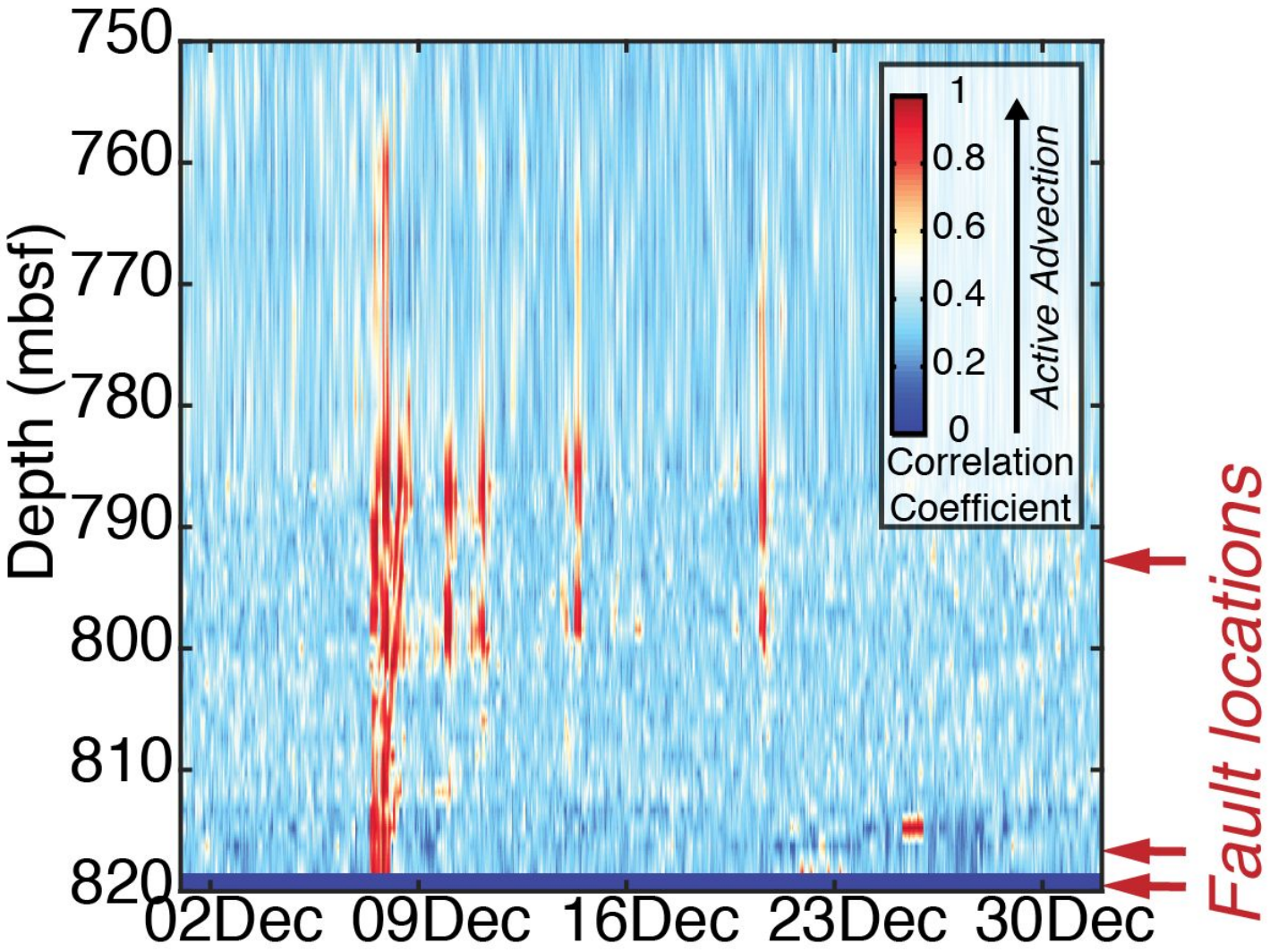
820 m below
seafloor
in 7 km water depth



Fulton et al., *Science 2013*

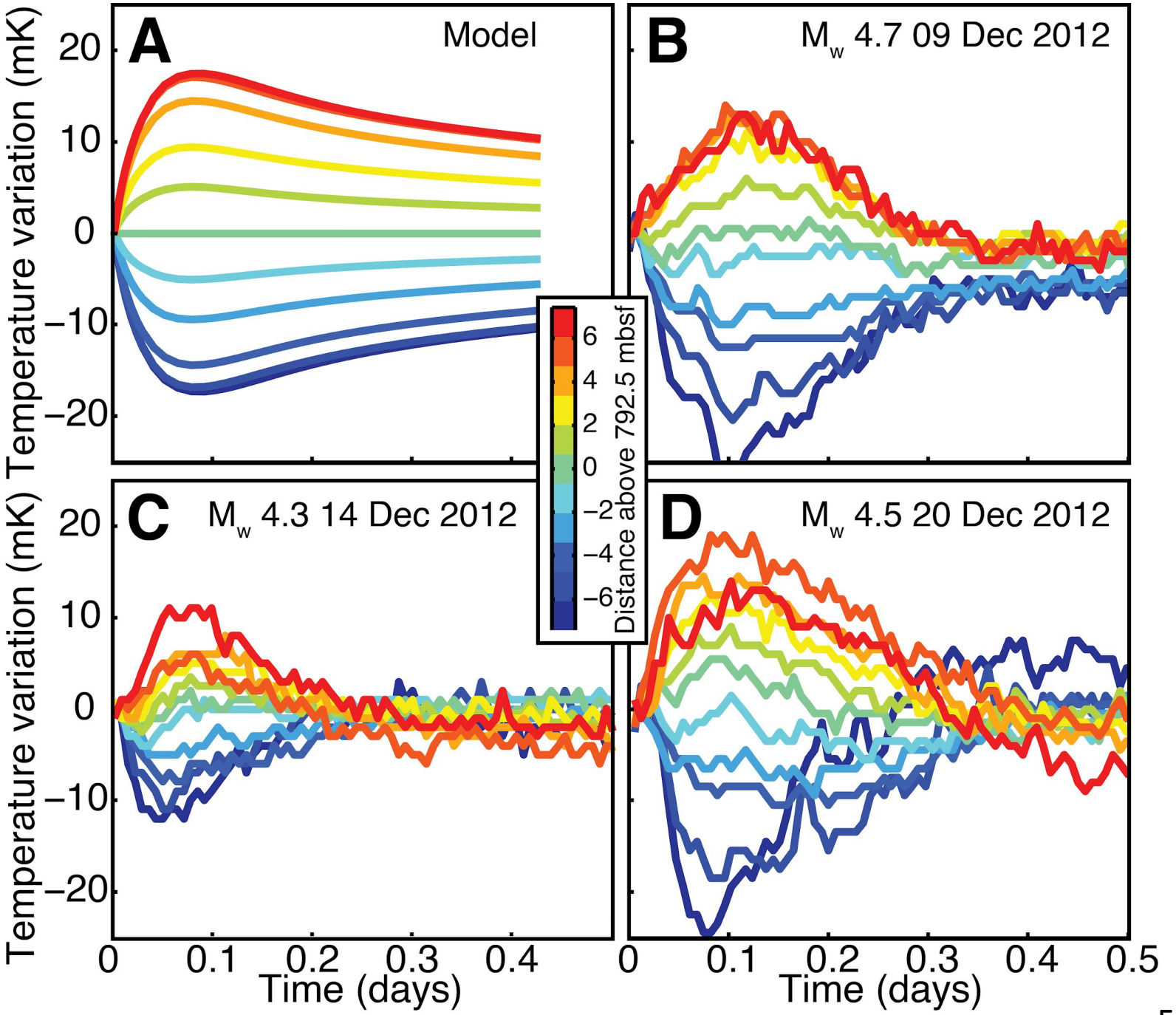
Observatories reveal the hydrologic response to distant earthquakes: transient fluid pulses in fault damage zone

Correlation coefficient shows **where and when advection is occurring**



6-hour overlapping windows

Fulton & Brodsky, *Geology, 2016*



Transient pulses of vertical fluid advection

Fulton & Brodsky, *Geology, 2016*

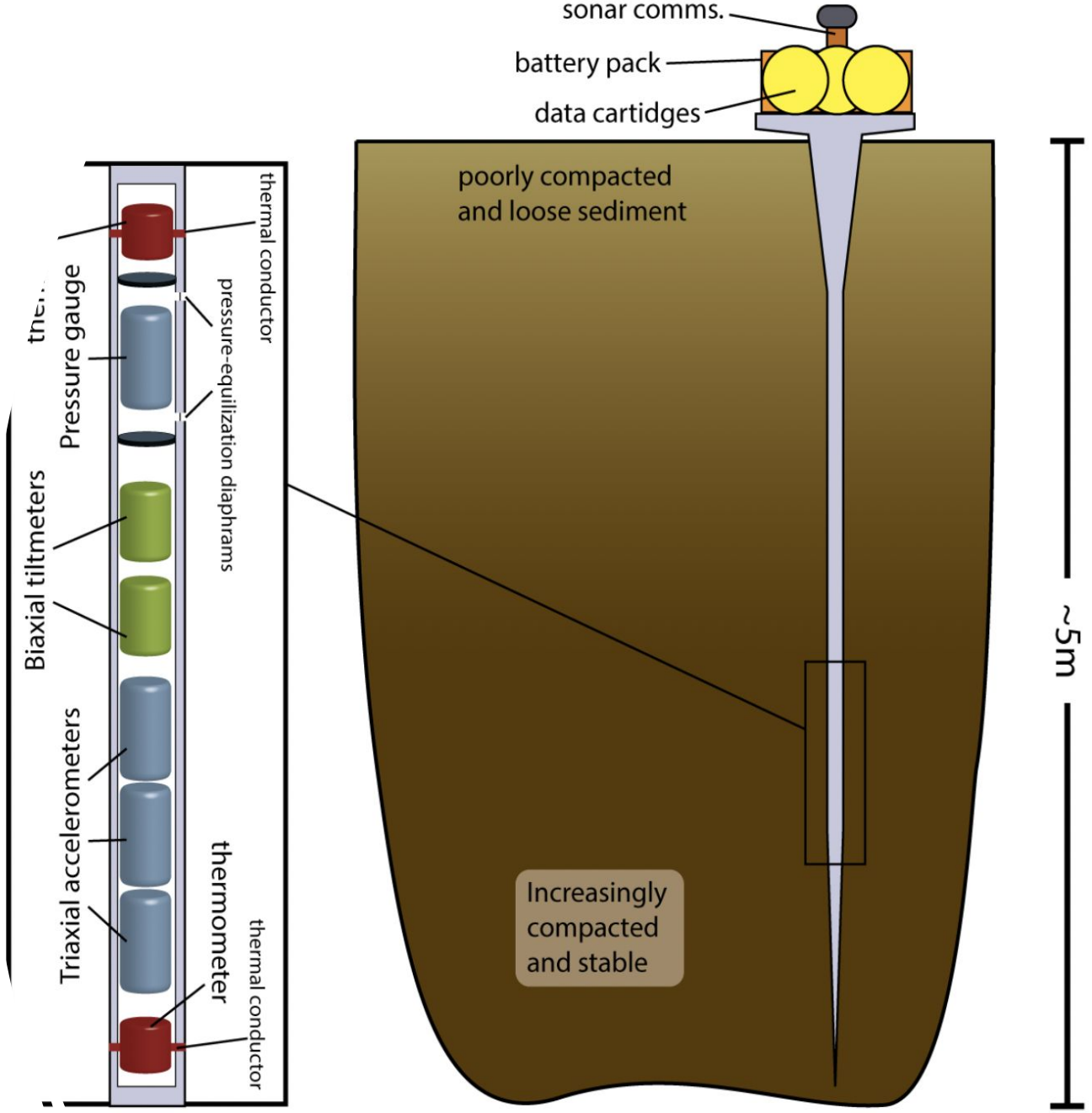
CONTINUE TO UTILIZE EXISTING OBSERVATORIES AND DATASETS

BE CREATIVE: DESIGN SHALLOW OBSERVATORY SYSTEMS DEPLOYABLE SHIP-SIDE

MAINTAIN EXISTING KNOWLEDGE AND EXPERIENCE

SUPPORT AND TRAIN THE NEXT GENERATION OF OBSERVATORY SCIENTISTS AND ENGINEERS NOW.

Gravity-driven **P**enetrative **I**nstrument **P**latform **(GPIP)**



A. Newman and P.Fulton