



Fluids Circulation in Subduction Zones: How Fluids Impact Seismic/Aseismic Slip in Ecuador ?

A. Galv , Andreas Rietbrock, Alessandra Ribodetti, Mireille Laigle, Fran ois Michaud, Louis G li, Jerome Lebrun, Nadaya Cubas, Jean-No l Proust, Alexandra Skrubej, et al.

► To cite this version:

A. Galv , Andreas Rietbrock, Alessandra Ribodetti, Mireille Laigle, Fran ois Michaud, et al.. Fluids Circulation in Subduction Zones: How Fluids Impact Seismic/Aseismic Slip in Ecuador ?. American Geophysical Union, Fall Meeting 2022 (AGU 2022), American Geophysical Union, Dec 2022, Chicago, United States. pp.T32E-0202. insu-03937480

HAL Id: insu-03937480

<https://insu.hal.science/insu-03937480>

Submitted on 23 Nov 2023

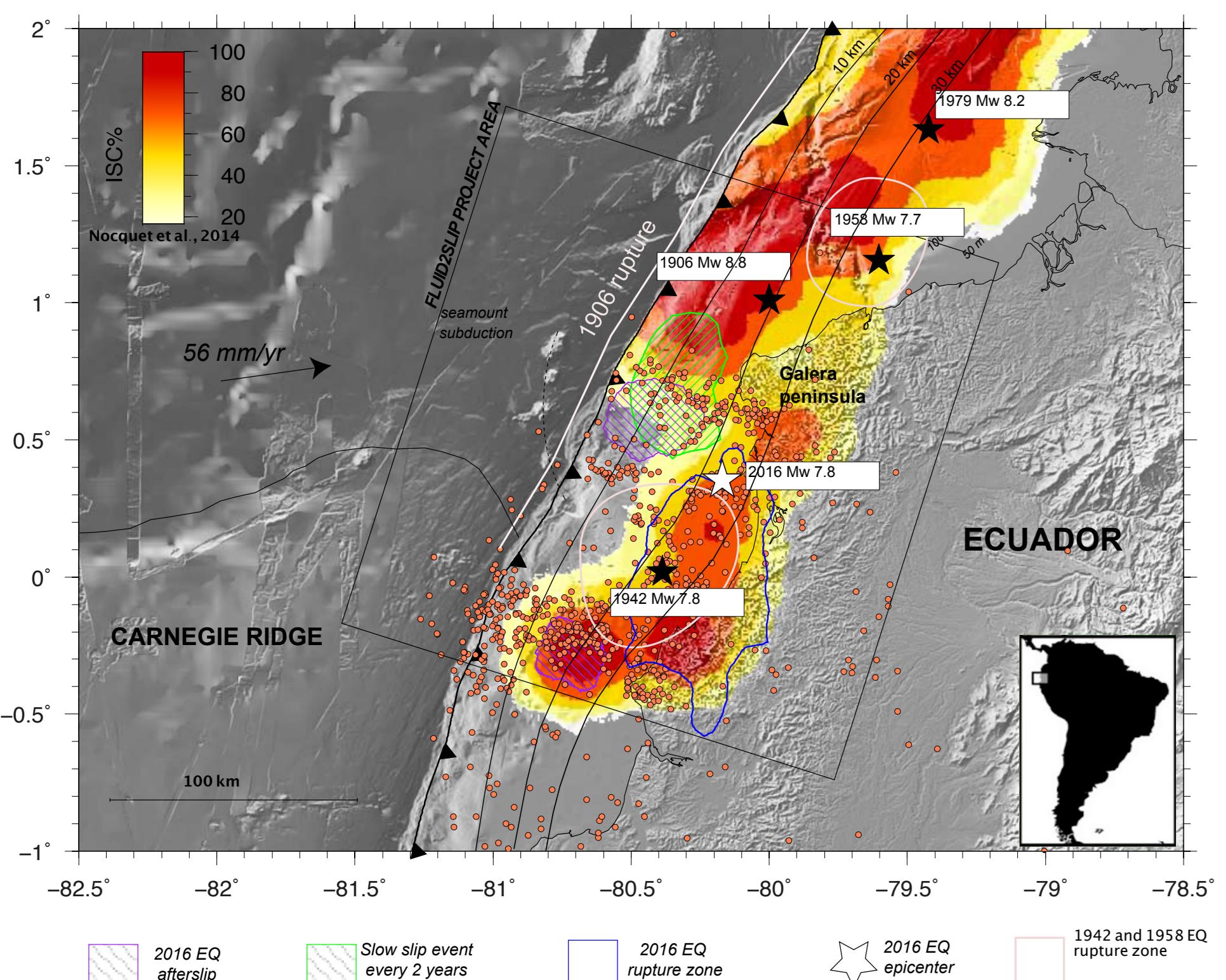
HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destin e au d p t et   la diffusion de documents scientifiques de niveau recherche, publi s ou non,  manant des  tablissements d'enseignement et de recherche fran ais ou  trangers, des laboratoires publics ou priv s.

Ecuador: a natural laboratory
to study in situ seismic/aseismic slip

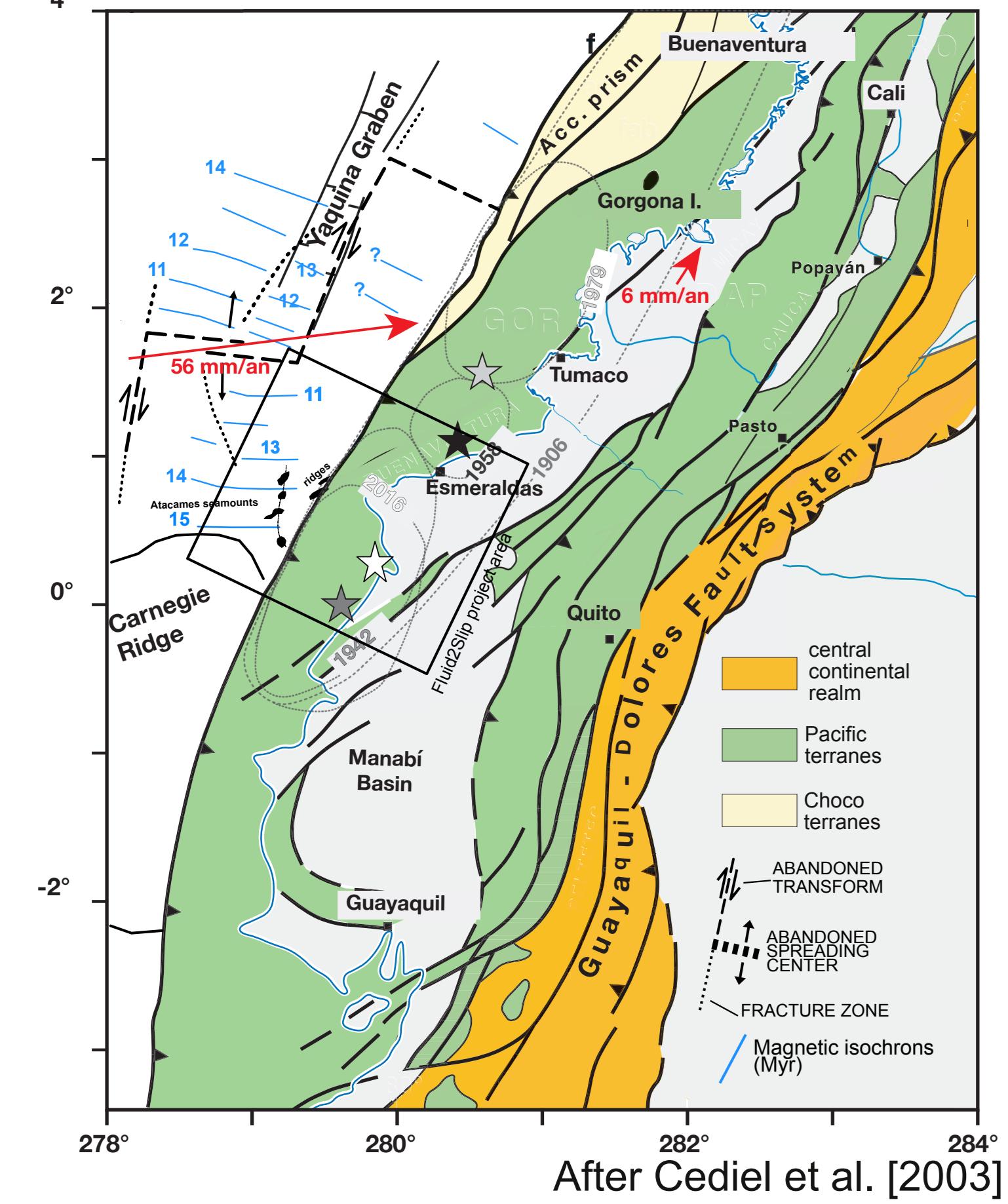
- Four Mw>7.5 earthquakes since Mw 8.8 1906 earthquake
- Slow slip events (SSE) in the up-dip part of the megathrust fault (green contour - 2013/2014 SSE from Vaca et al., 2018)
- Two patches of non-classical afterslip observed after 2016 Pedernales earthquake (purple contour from Rolandone et al., 2018)
- A shallow megathrust fault (depth < 10-15 km offshore)
- Short distance from the trench to the coast line (55 to 35 km)
- An access to an unprecedented onshore-offshore geological and geophysical dataset (20 years of offshore/onshore experiments)

Map of the Ecuadorian margin showing areas of seismic and aseismic slip on top of the seismic coupling

in a complex context,
on a relatively small area

- Subducting seamounts (Atacames seamounts)
- Subducting ridges

Geological sketch of North Ecuador and South Colombia



Rupture zones and aftershock areas of the 1942, 1958, 1979 and 2016 earthquakes are contoured by dashed grey lines [Beck and Ruff, 1984; Mendoza and Dewey, 1984].

Fluids circulation in subduction zones: How fluids impact seismic/aseismic slip in Ecuador ?

Audrey Galve (1), Andreas Rietbrock (2), Alessandra Ribodetti (1), Mireille Laigle (1), François Michaud (3), Louis Gély (4), Jérôme Lebrun (5), Nadaya Cubas (6), Jean-Noël Proust (7), Alexandra Skrubelj (1), Laure Schenini (1), Monica Segovia (8), Michele Paulatto (9), Laura Wallace (10)

(1) - Université Côte d'Azur, IRD, CNRS, Observatoire de la Côte d'Azur, Géoazur, 06560 Valbonne, France (2) - Karlsruhe Institute of Technology, Geophysical Institute, Karlsruhe, 76187, Germany (3) Géoazur - Sorbonne Université, Valbonne, France (4) - Geo-Ocean, Université Brest, CNRS, Brest, France (5) - Université Côte d'Azur, CNRS, I3S, 06560 Valbonne, France (6) - CNRS-INSU, Institut des Sciences de la Terre Paris, Sorbonne Université, ISTEPI UMR 7193, 75005 Paris, France (7) - Géosciences Rennes, CNRS, Université de Rennes 1, Campus de Beaulieu, 35042 Rennes cedex, France (8) - Instituto Geofísico, Escuela Politécnica Nacional, Quito, 170525, Ecuador (9) - Imperial College London, Earth Science and Engineering, Prince Consort Road, London SW7 2BP, UK (10) - University of Texas at Austin, Institute for Geophysics, Austin, United States

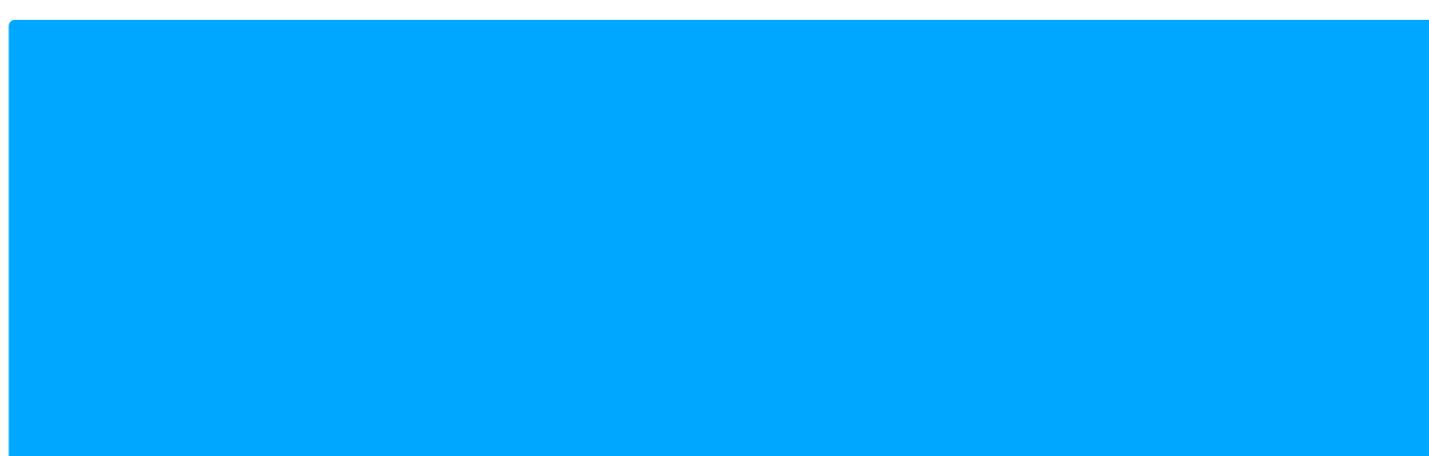


FLUID2SLIP
(2021-2025)

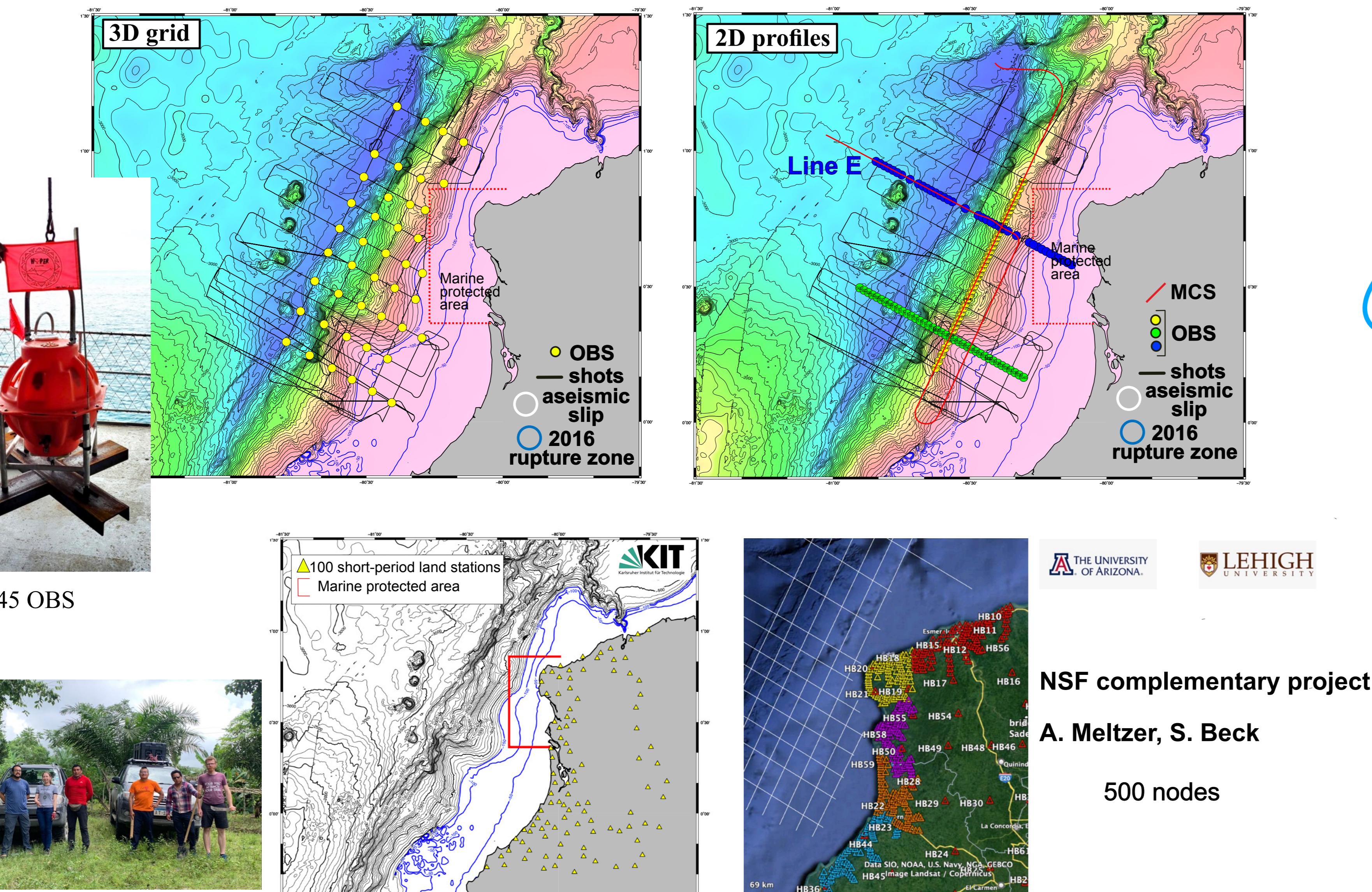
Objectives:

- quantify the fluid content and lithospheric structure by 2D and 3D seismic and heat flow mapping physical properties of rocks
- characterize fluids flowing through the margin by relating fluid seepages to crustal deformation and interplate slip behaviour
- detect and locate seismic and transient signals activity with regard to fluids and slip behaviour using deep-learning techniques
- monitor seismic velocity time changes
- model slip processes in 4D onto two subduction zones in Ecuador and New Zealand.

Map of the Ecuadorian margin showing areas of seismic and aseismic slip on top of the seismic coupling



High resolution seismic imaging (MCS and wide-angle refraction profiles)



Objectives: Build a 3D model of physical properties

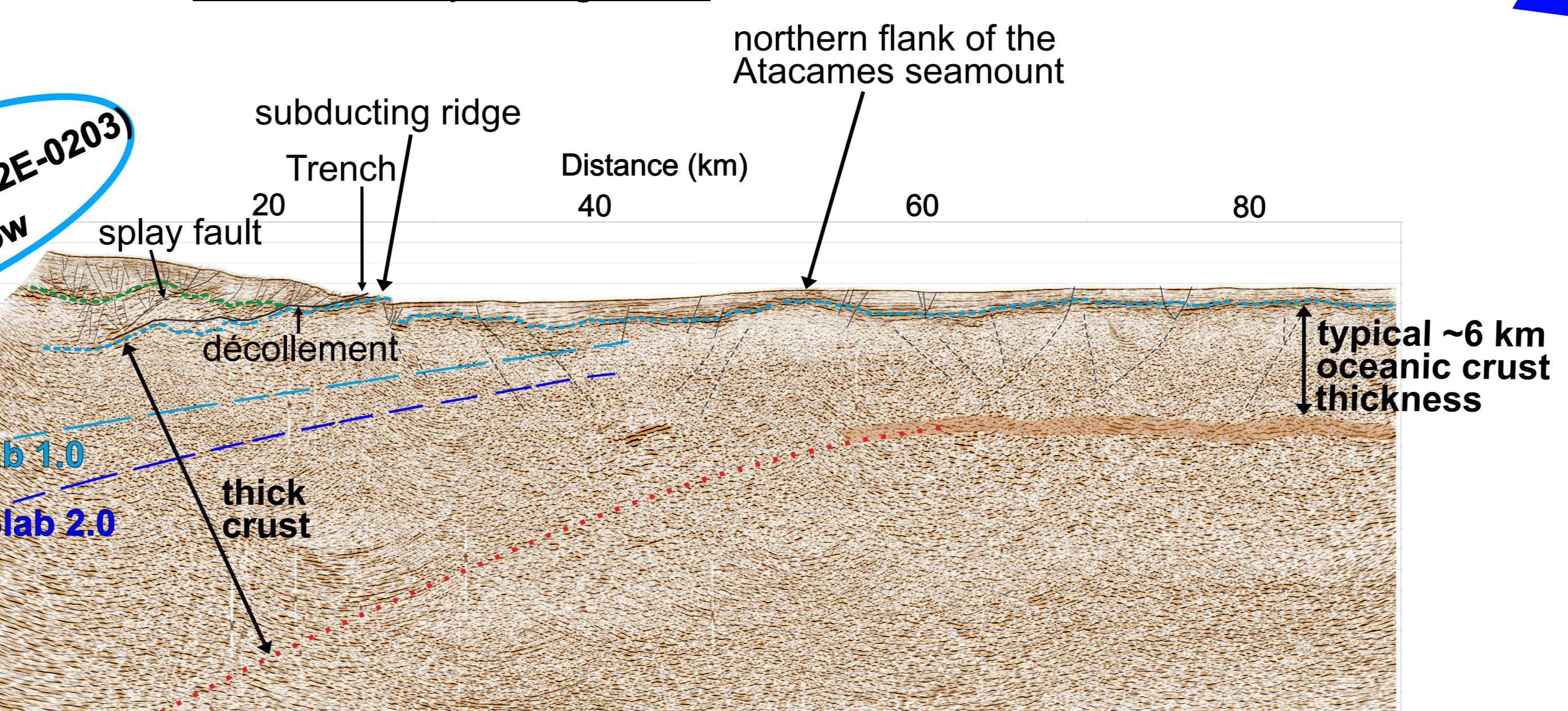
- P- and S-wave velocities (V_p and V_s), density ρ , attenuation Q_P and Q_S , temperature T with kilometer to sub-kilometer resolutions to depths of 20-30 km.
- Imaging of active faults and major lithospheric interfaces to establish spatial correlations with fluid paths, relocate local seismicity and unconventional signals
- pre-stack time and depth migration on MCS data
- Tomographic inversion, slope tomography
- Full waveform inversion

methods

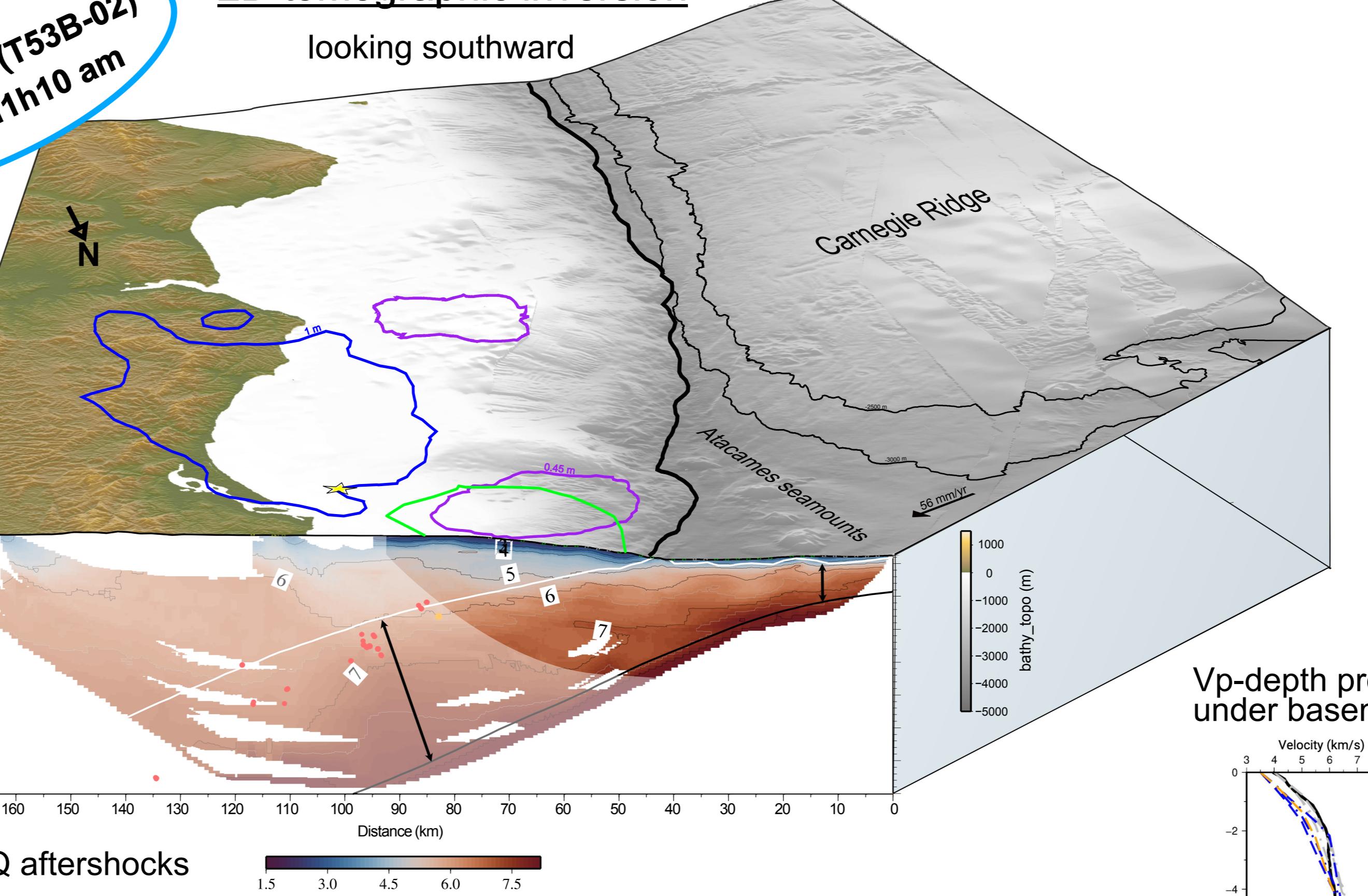
First results

What goes into subduction ? a view along Line E

Pre-stack depth migration



2D tomographic inversion



Thick oceanic crust under the margin having P-waves velocities compatible with Carnegie ridge P-waves velocities (Sallares et al., 2003, 2005)

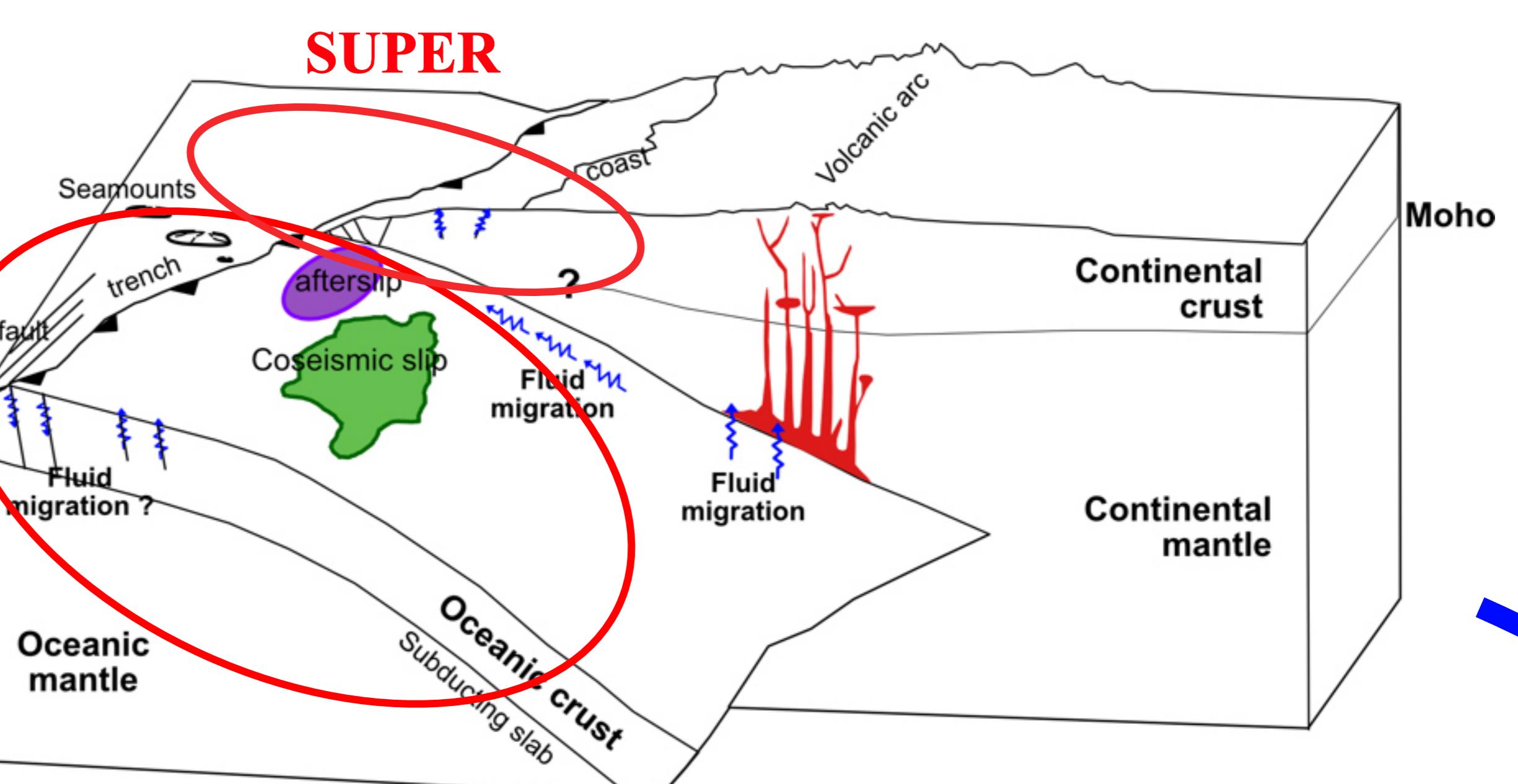
Conclusions:

- No clear insight of a hydrated downgoing oceanic crust in the P-waves signature
- > need to add S-waves arrivals and use full waveforms to investigate further the role of fluids

A rough seafloor, damaging the forearc crust, and a rough décollement: might explain the slow-slip behaviours in the up-dip part of the megathrust ?

How is this different from where the Atacames seamounts are subducting and where no slow slip events have been observed?

Two marine campaigns: HIPER and SUPER

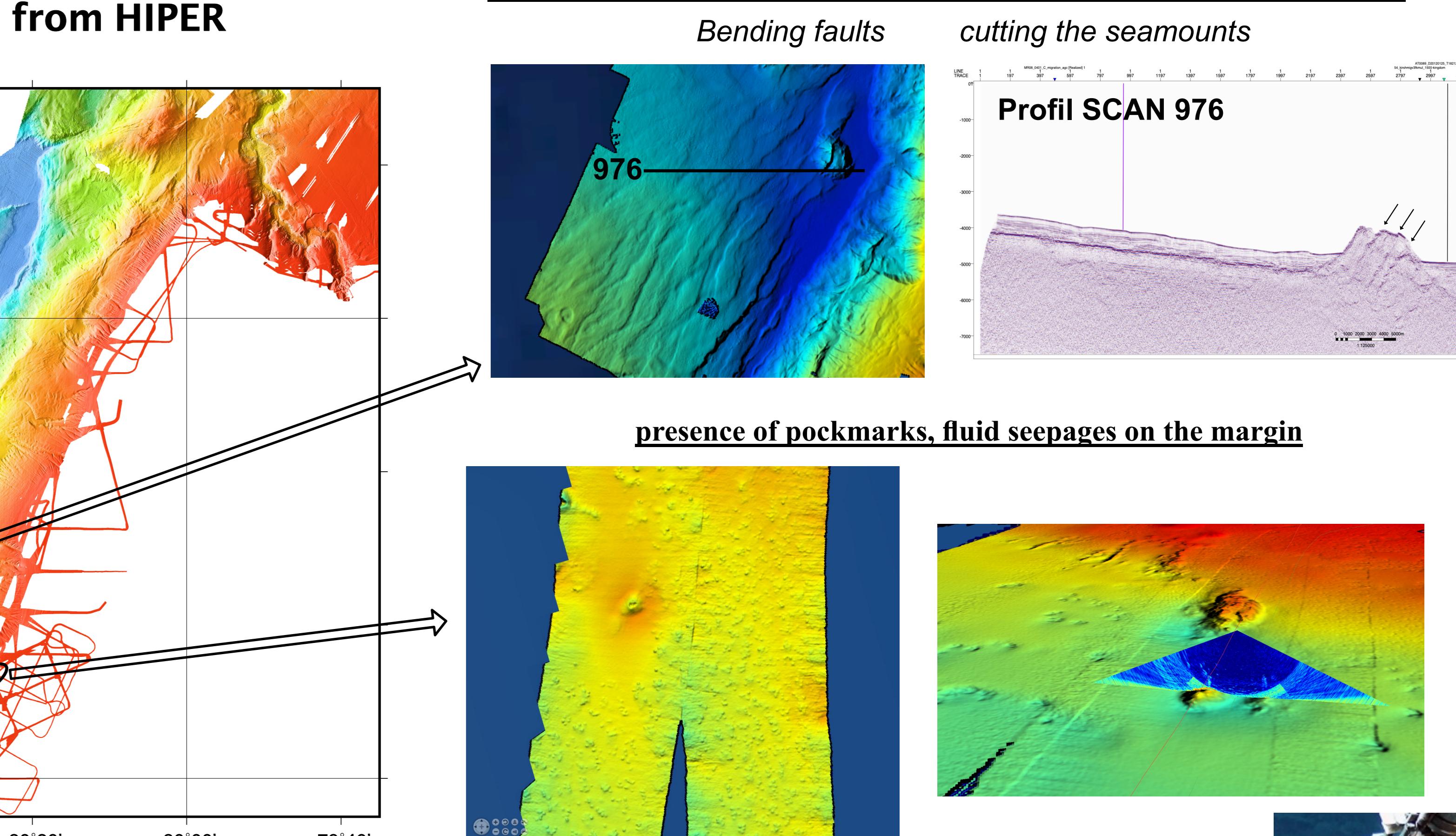


HIPER: image the lithosphere and track fluids
SUPER: image the subsurface, track and sample fluids

SUPER

Subsurface Imaging of the Pedernales Earthquake Rupture zone

subsurface insight of fluids from HIPER



Objectives:

- Identify the geochemical nature, thermal signature and deep origin of fluid seepages
- constrain fluid flow pathways from depth to surface, potentially controlled by faults and stratigraphy
- correlate the distribution of fluid seepages, heat flow anomalies, and the depth origin of fluids with lateral variations in slip mode and the distribution of aftershocks and unconventional signals

