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

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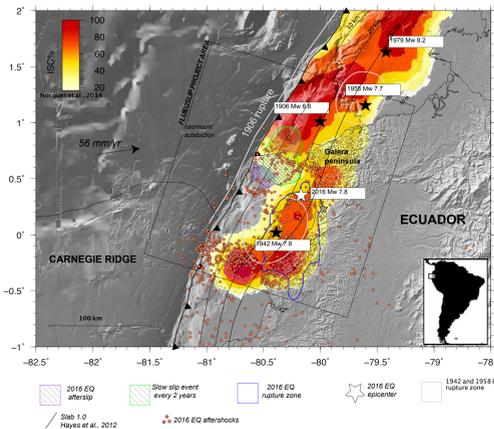
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**Ecuador: a natural laboratory to study in situ seismic/aseismic slip**

- Four Mw>7.5 earthquakes since Mw 8.8 1906 earthquake
- Slow slip events (SSE) in the updip 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)

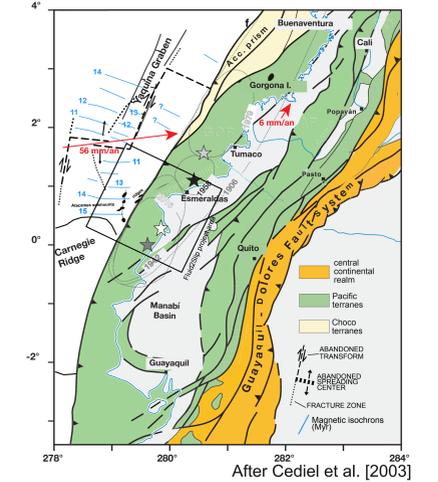
Map of the Ecuadorian margin showing areas of seismic and aseismic slip on top of the seismic coupling



**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 aftershocks 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 ?

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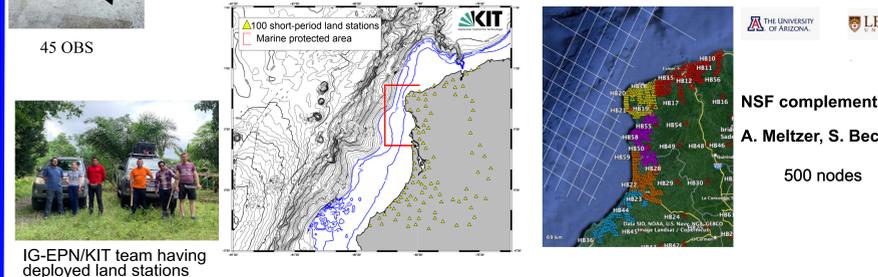
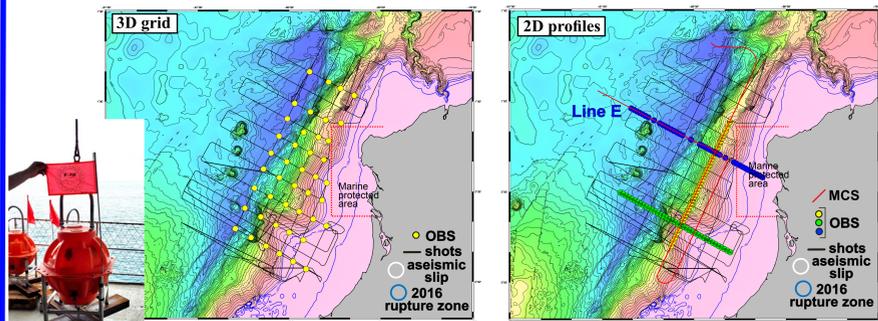


**Objectives:**

- quantify the fluid content and lithospheric structure by 2D and 3D seismic and heat flow mapping of 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.

**HIPER High resolution Imaging of the Pedernales Earthquake Rupture zone**

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



**Objectives: Build a 3D model of physical properties**

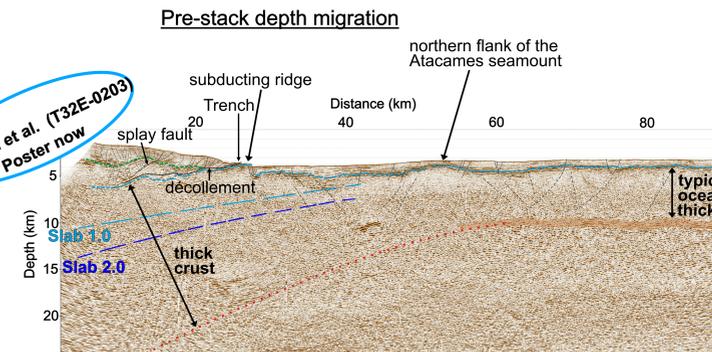
- P- and S-wave velocities (Vp and Vs), density  $\rho$ , attenuation QP and QS, temperature T with kilometer to sub-kilometer resolutions to depths of 20-30 km.
- Imaging of active faults and major lithospheric interfaces to establish spatial correlations with fluid paths, relocate local seismicity and unconventional signals

**methods**

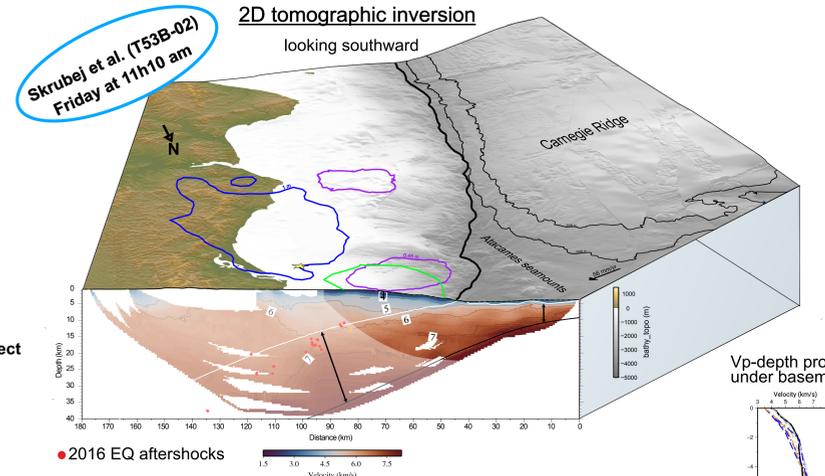
- pre-stack time and depth migration on MCS data
- Tomographic inversion, slope tomography
- Full waveform inversion

**First results**

**What goes into subduction ? a view along Line E**



Slab Moho from tomographic inversion  
- a rough top of the oceanic crust  
- presence of a splay fault

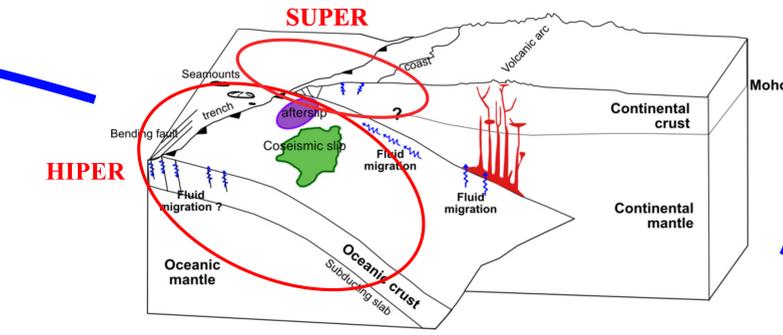


Thick oceanic crust under the margin having P-waves velocities compatible with Carnegie ridge P-waves velocities (Sallares et al., 2003, 2005)

**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 updip part of the megathrust ?
- How is this different from where the Atacames seamounts are subducting and where no slow slip events have been observed?

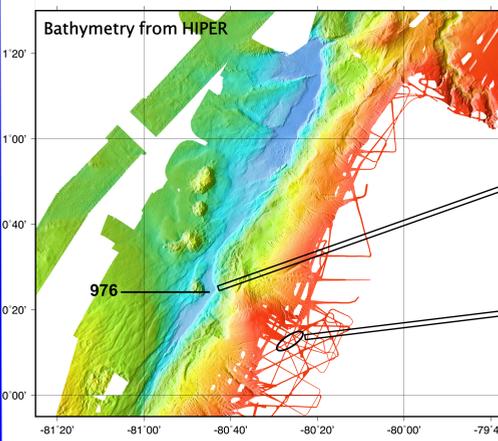
**Two marine campaigns: HIPER and SUPER**



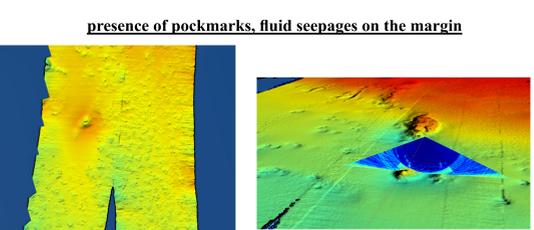
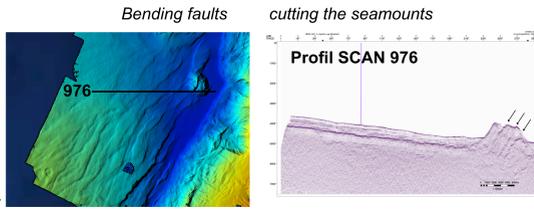
HIPER: image the lithosphere and track fluids  
SUPER: image the subsurface, track and sample fluids

**SUPER Subsurface Imaging of the Pedernales Earthquake Rupture zone**

**subsurface insight of fluids from HIPER**



**structures that can contribute to the circulation of fluids at depth**



**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

Coming soon