Strike-slip enables subduction initiation beneath a failed rift: new seismic constraints from Puységur Margin, New Zealand

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Forced Subduction Initiation at Incipient Puységur Trench, New Zealand

- The best place to study forced subduction initiation in-situ! AUS-PAC plate boundary experienced rifting to strike-slip to subduction since ~45 Ma
- Past plate motion is well constrained, Evidence of quaternary adakite volcanism, Active Benioff zone to ~150 km, Deep ocean trench (up to 6 km)

February-March 2018 using R/V Marcus G. Langseth
- 1251 km of multichannel seismic data
- Two coincident OBS lines
- Multibeam bathymetry
- 3.5 KHz CHIRP
- Magnetics/Gravity data
- Post-cruise seismic processing of trace editing, noise & multiple suppression, velocity analysis, pre-stack depth migration

Results
- Initial results in Gurnis et al. (2019) EPSL
- Stratigraphic evolution of Solander Basin in Patel et al. (in press), Basin Research
- Tectonic/structural analysis of Puységur Margin presented here
Rough incoming oceanic lithosphere
- No apparent sediment accretion (erosion ?)
- Basement outcrops along Puysegur Ridge
- Large velocity contrast across axial valley
- Solander Basin has continental rift blocks
- Syn-rift sediment ~1.5 km thick
- Evidence for rift-related magmatism and high velocity (>7.1 km/s) lower crust
• Oceanic fabric reactivated close to trench
• Accretionary prism with deformed sediments
• Large velocity contrast across “Snares Zone”
• Solander Basin simple-shear tilted rift blocks
• Less evidence for rift-related magmatism
• Crust is thickest beneath Puysegur Ridge and thins eastward towards Campbell Plateau
Tectonic Summary

- **North**: Wide, thick oceanic sliver.
- **South**: Widest rift basin, greatest extension and magmatism.

**Legend**
- Continental crust
- Subcontinental mantle
- Transitional crust
- Oceanic crust
- Suboceanic mantle
- Oceanic sliver
- Subducting sediments
- Accreted sediments
- Slope sediments
- Rift volcanism
- Post-thrust sediments
- Syn-thrust sediments
- Post-rift sediments
- Syn-rift sediments

**Notes**
- Stride-slip severed failed rift and juxtaposed buoyant continental crust from rift phase with thin and dense oceanic lithosphere.
- Distributed extension and later localized thrusting.
- Extended continental crust in upper plate – rifting never proceeded to breakup & seafloor spreading.
- Reverted structures recorded change from extension to compression associated with subduction initiation.
- Distributed extension and later localized thrusting.
- At present, northern margin is transitioning to mature subduction zone. Southern margin is still incipient and experiencing forced uplift.
- Subduction initiated in the north at ~15 Ma near Puysegur Bank and gradually migrated southward.

**SISIE-2**
- Thick pile of accreted sediments.
- High topography on rift blocks, localized extension.
- Subduction initiation took advantage of buoyancy contrasts and older fault structures.

**SISIE-1**
- No accreted sediments, erosion?
- Widest rift basin, greatest extension and magmatism.
- Subduction initiated in the north at ~15 Ma near Puysegur Bank and gradually migrated southward.