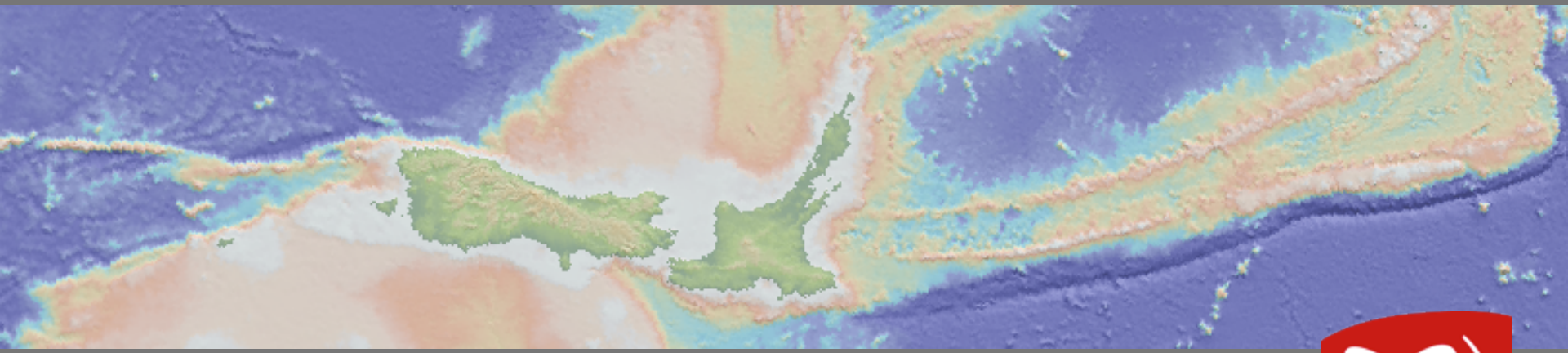
The expression of subduction initiation in New Zealand

Rupert Sutherland



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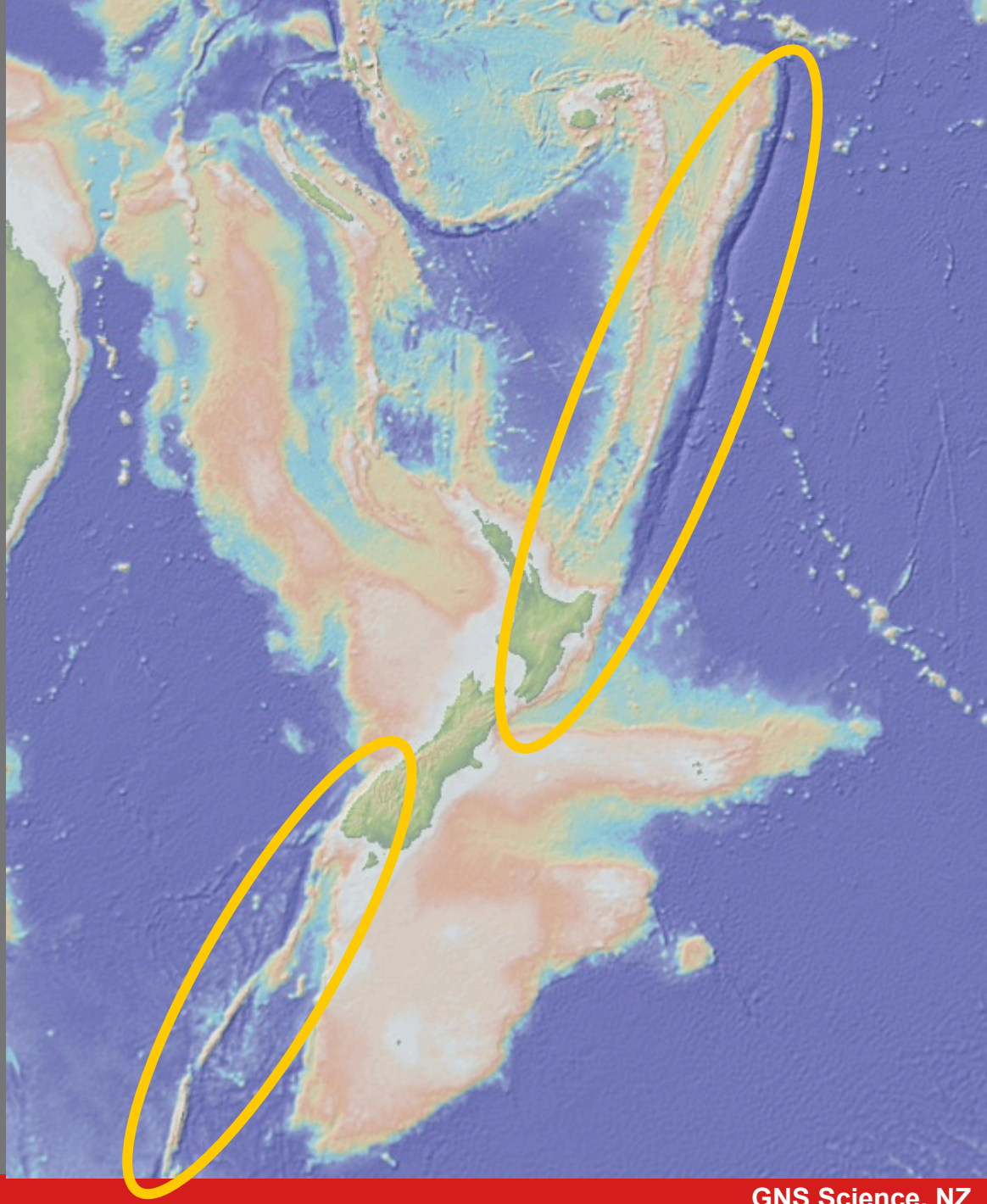
r.sutherland@gns.cri.nz

Geoprisms, Te Papa, Mon 15 April 2013

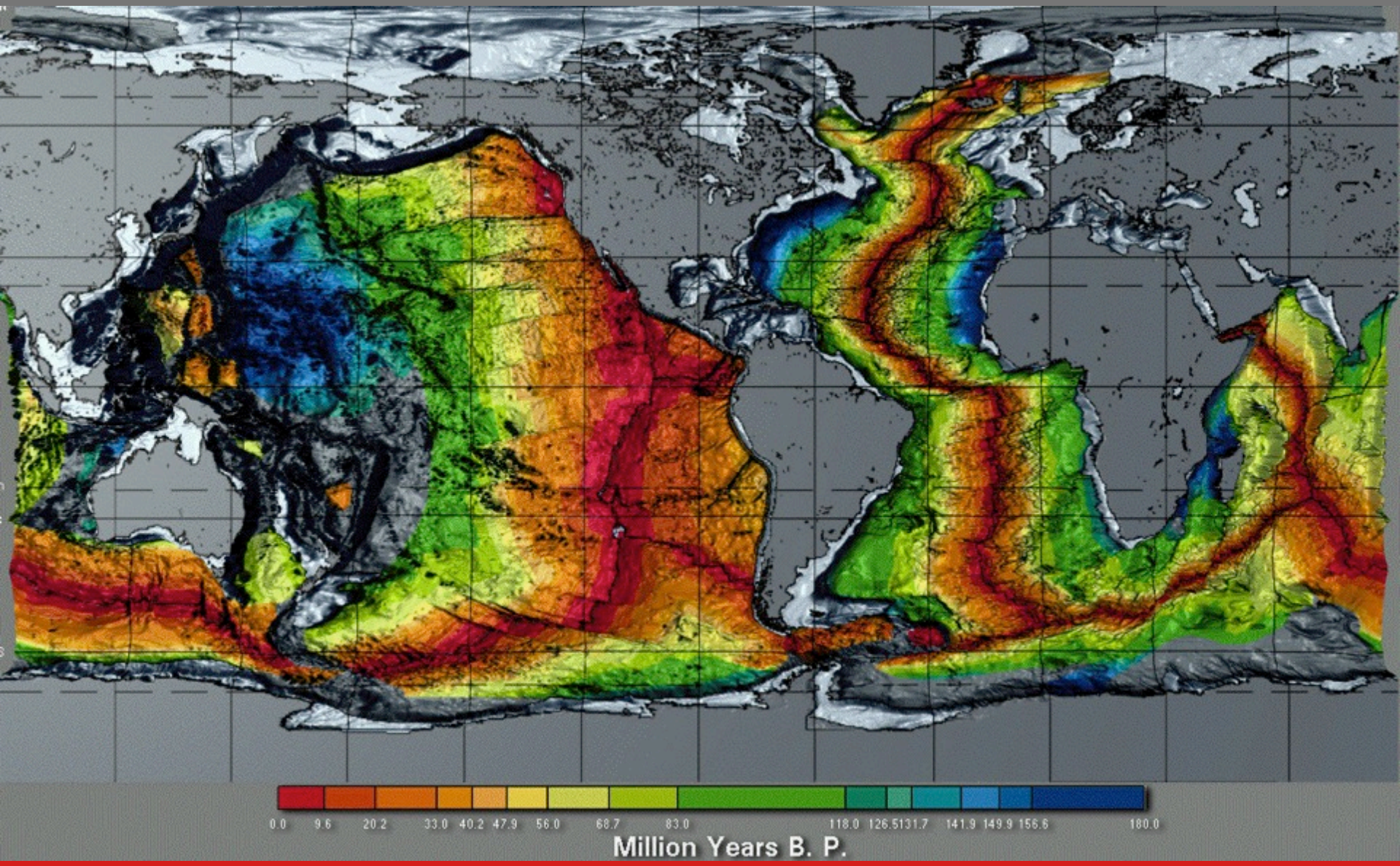
NZ subduction

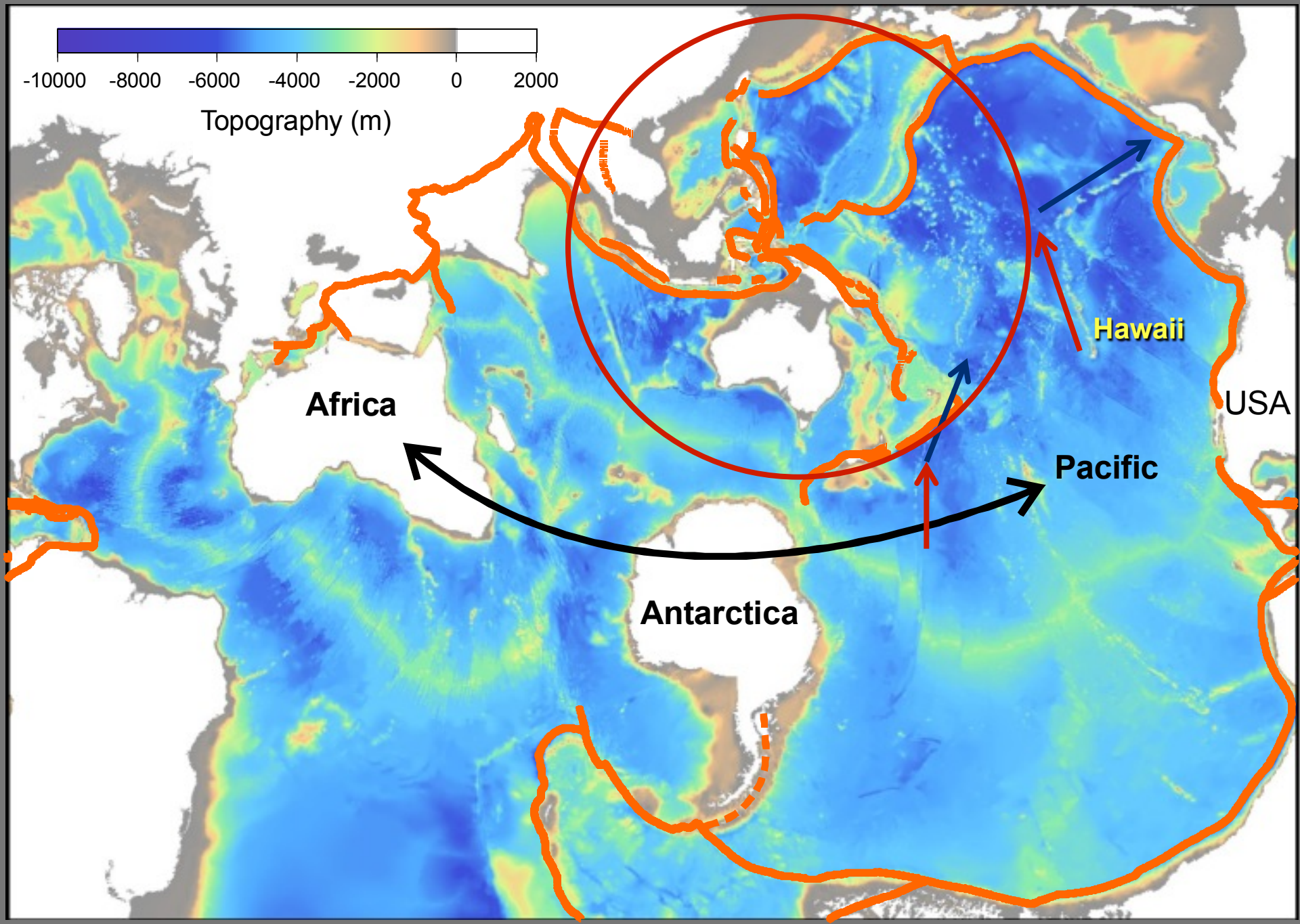
Tonga-Kermadec-Hikurangi

Puysegur-Macquarie-Hjort



Global plate motions precise since 83 Ma




-10000
-8000
-6000
-4000
-2000
0
2000
Topography (m)
Africa
Antarctica
Pacific
Hawaii
USA

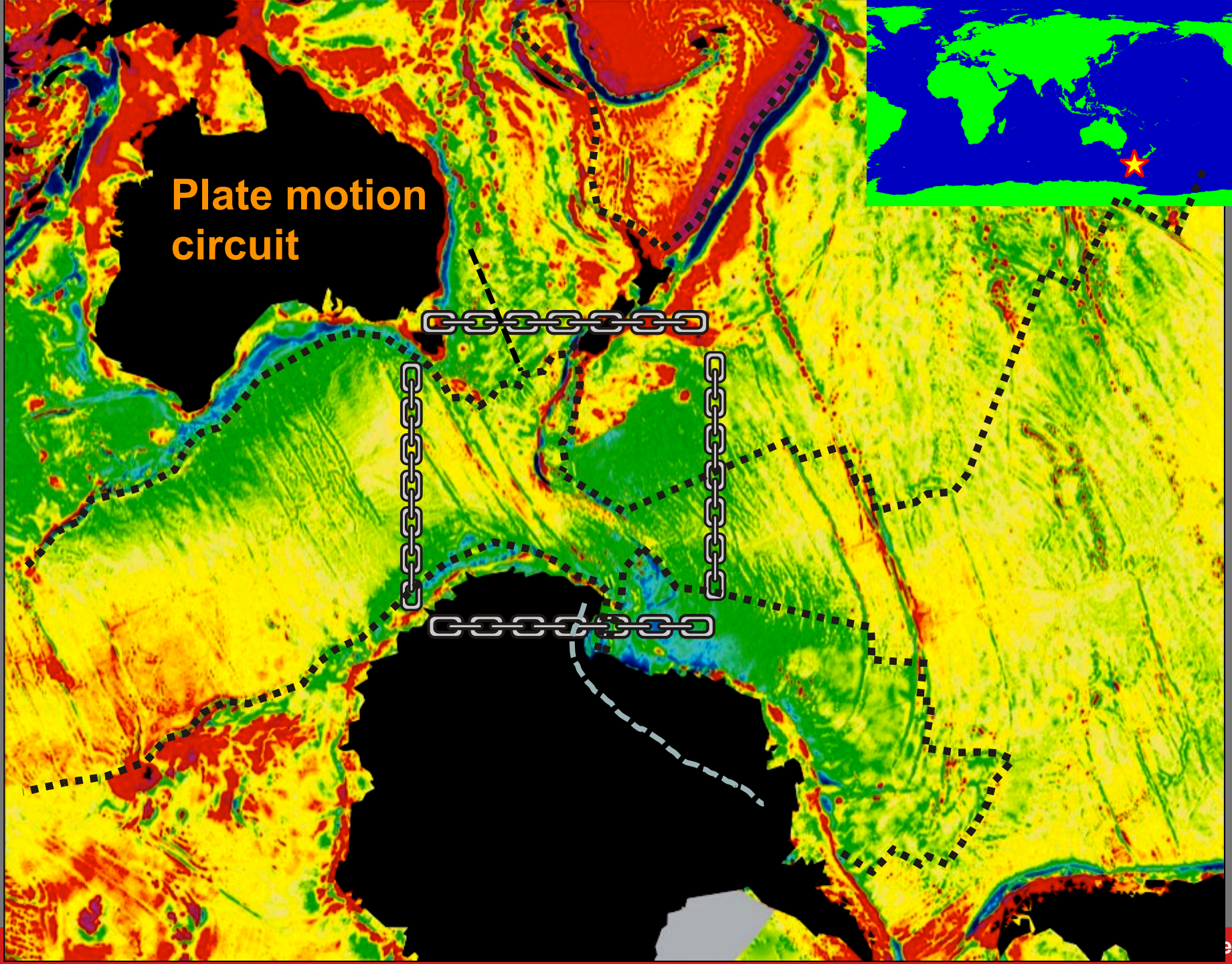
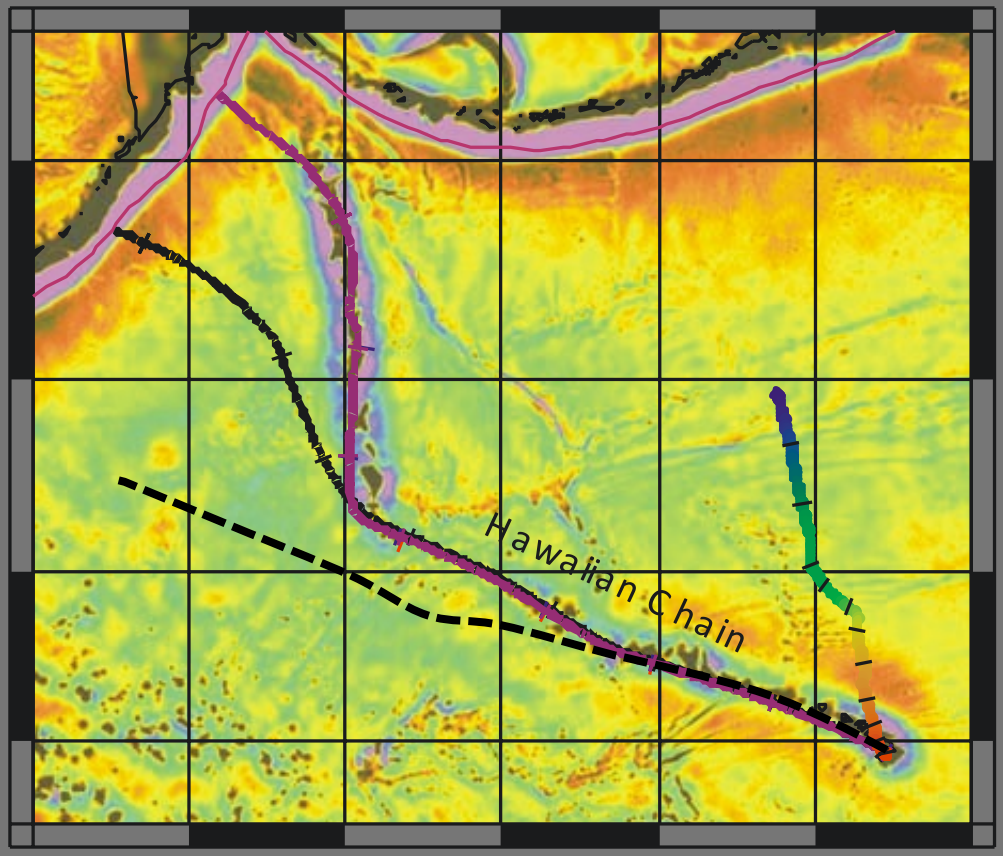


Plate motion
circuit

Reconcile:
Global & SW Pacific kinematics
Hotspots & mantle flow

Implications for understanding subduction initiation:

Profound global plate motion change 52-43 Ma synchronous with W Pacific subduction initiation



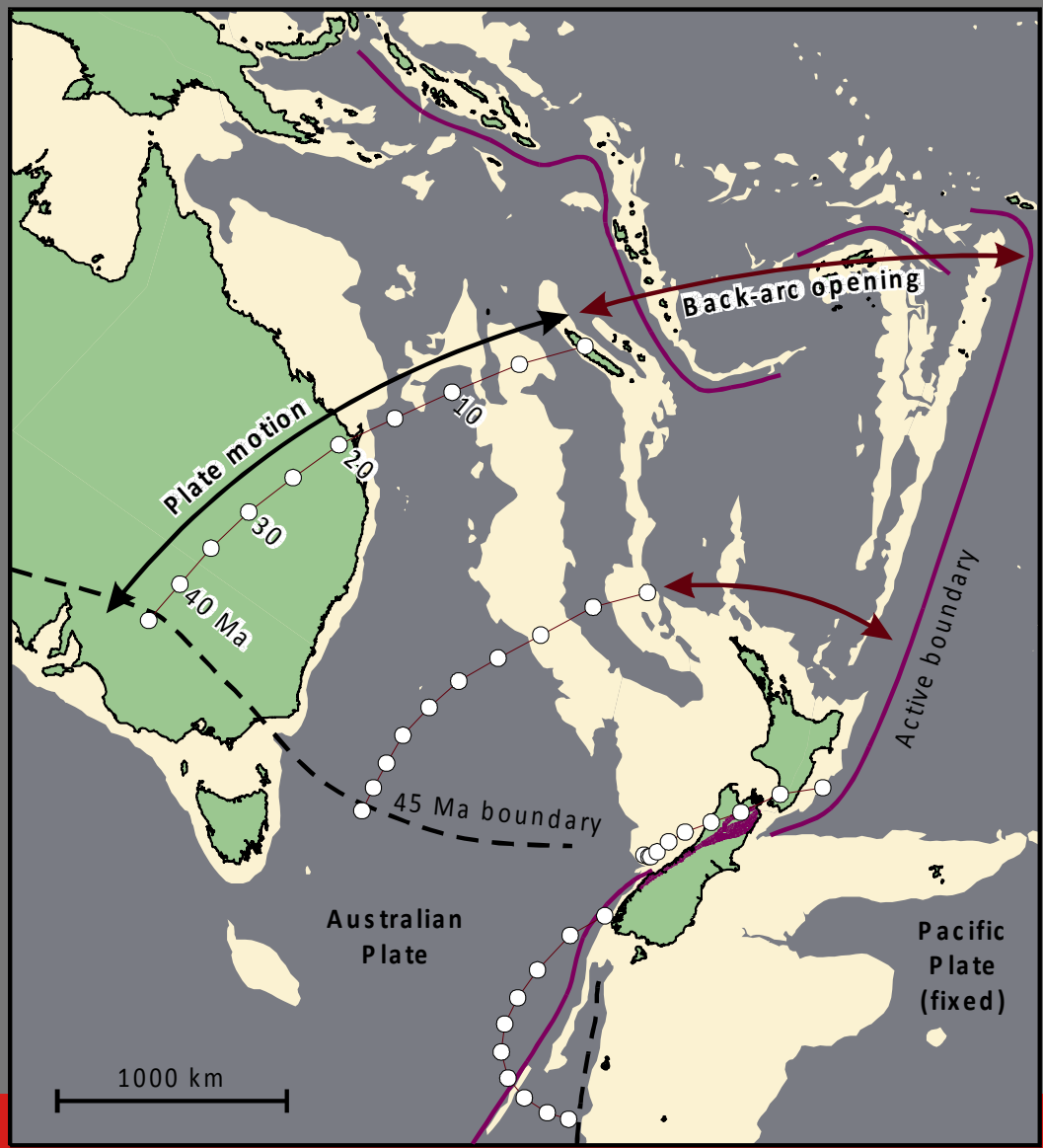
Steinberger et al. 2004

Tonga-Kermadec subduction a key part

Precise plate motion estimate

Continental margin
(old Gondwana subduction)

Complements studies of IBM



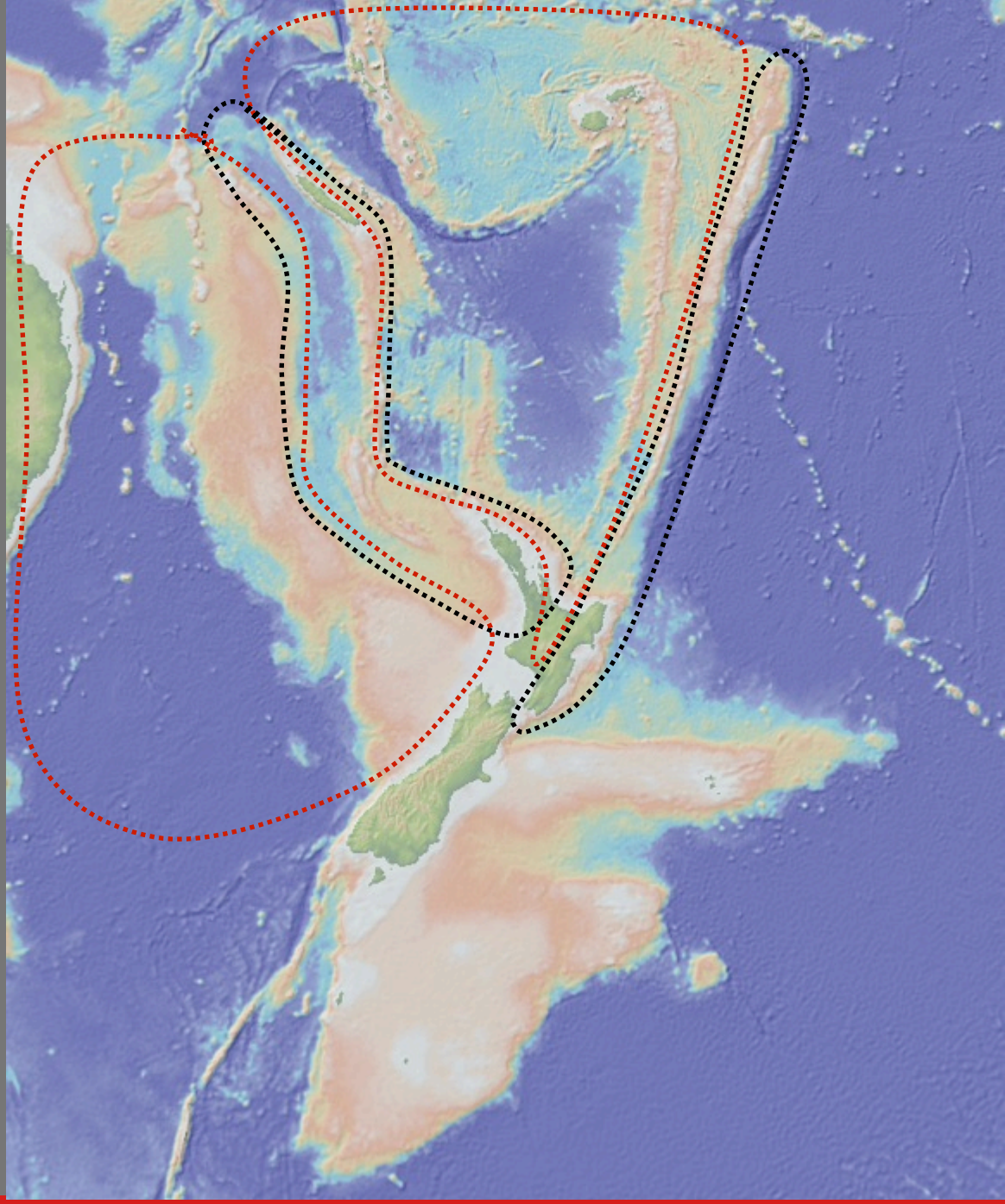
Tonga-Kermadec

Forearc

Arc-backarc

Proximal

Distal



Tasman Frontier Database

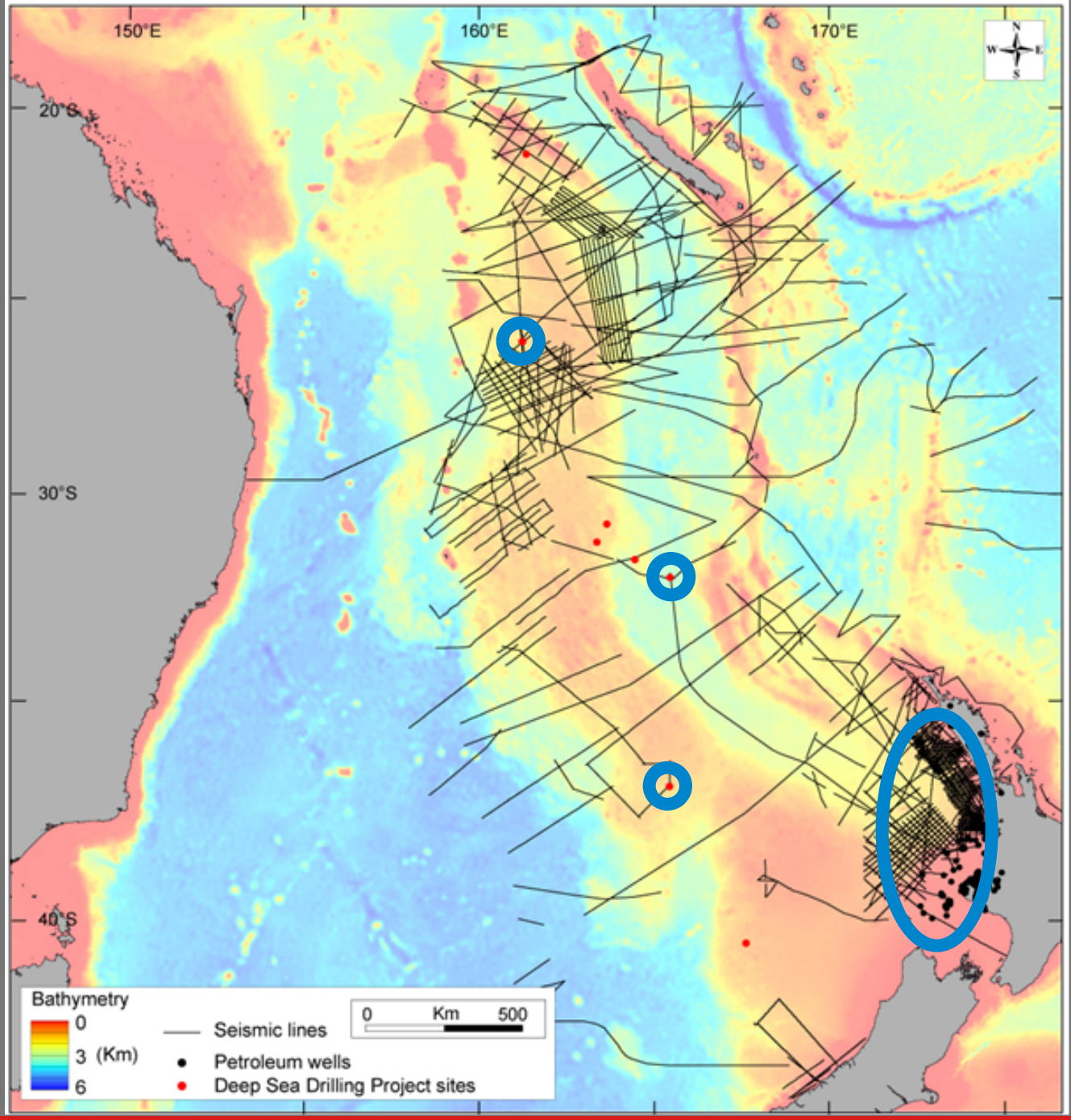
PDF report

SEG-Y files

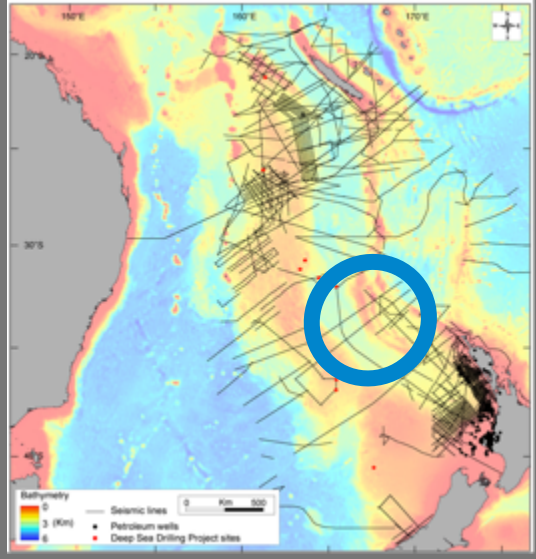
c. 100,000 line km

Mixed academic-industry

DSDP leg 21 provides remote ties to Taranaki

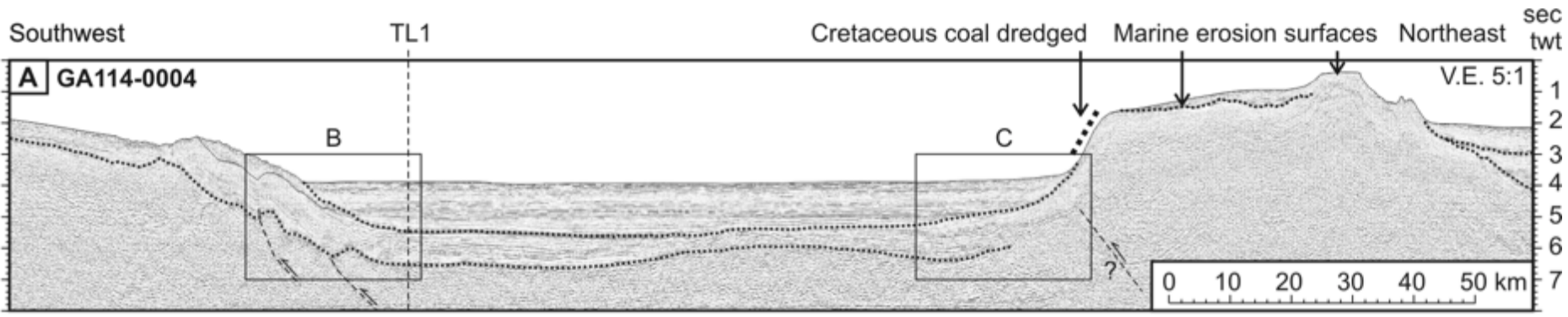


Tasman Frontier
Tonga-Kermadec subduction initiation

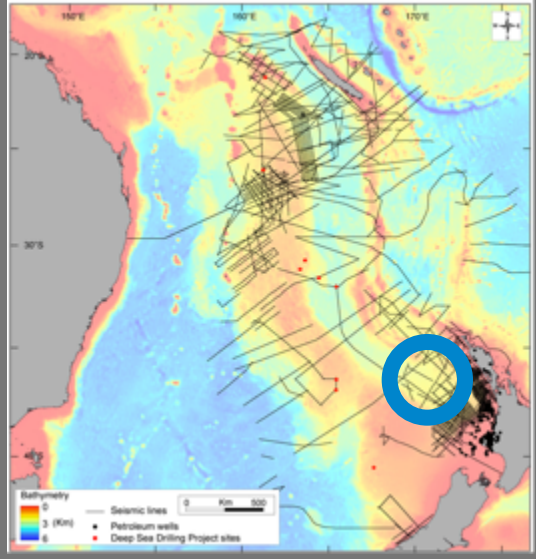


- Relatively simple structure; sedimentary record
- Cenozoic deformation
- Transient and permanent uplift-subsidence

Sutherland et al. 2010

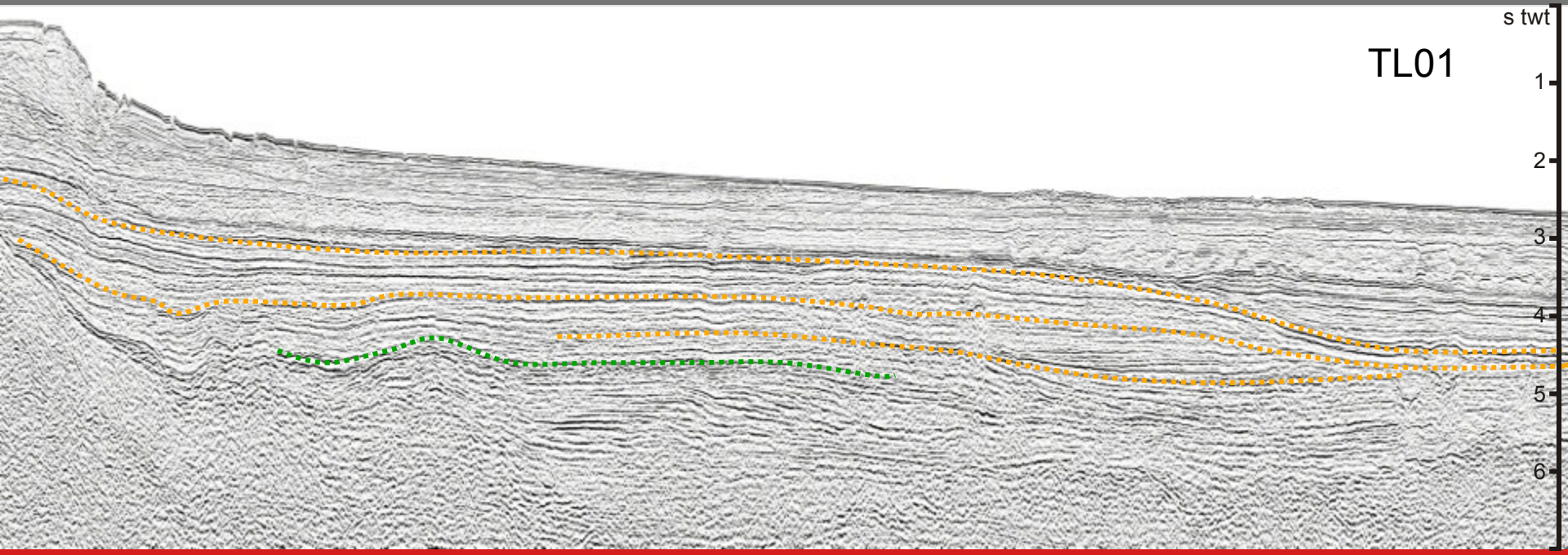


Deep-water sedimentary basin



Cenozoic tectonic subsidence >2.2 km

Process of deep-water basin formation? Widespread globally?

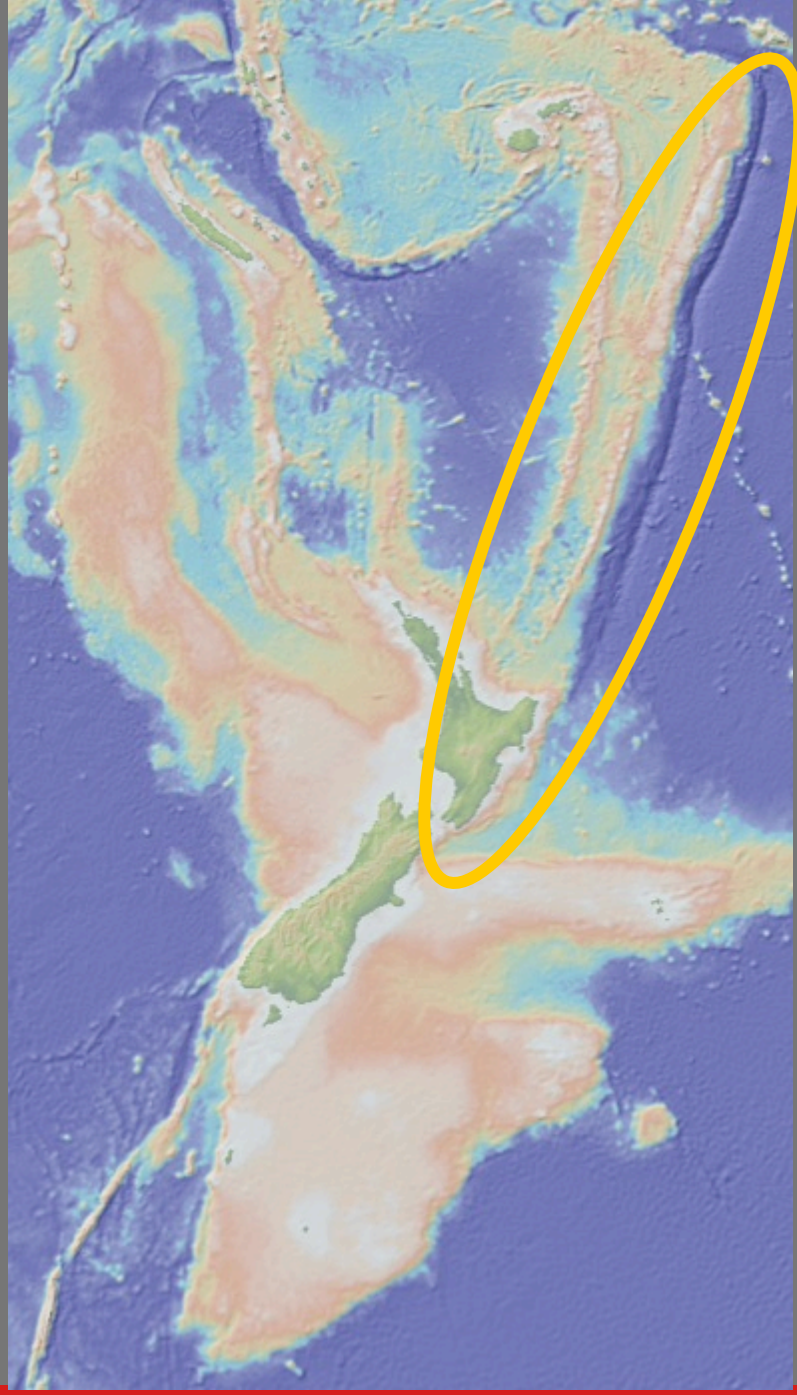


Tonga-Kermadec-Hikurangi

- Most profound global tectonic event
- Precise plate motions known

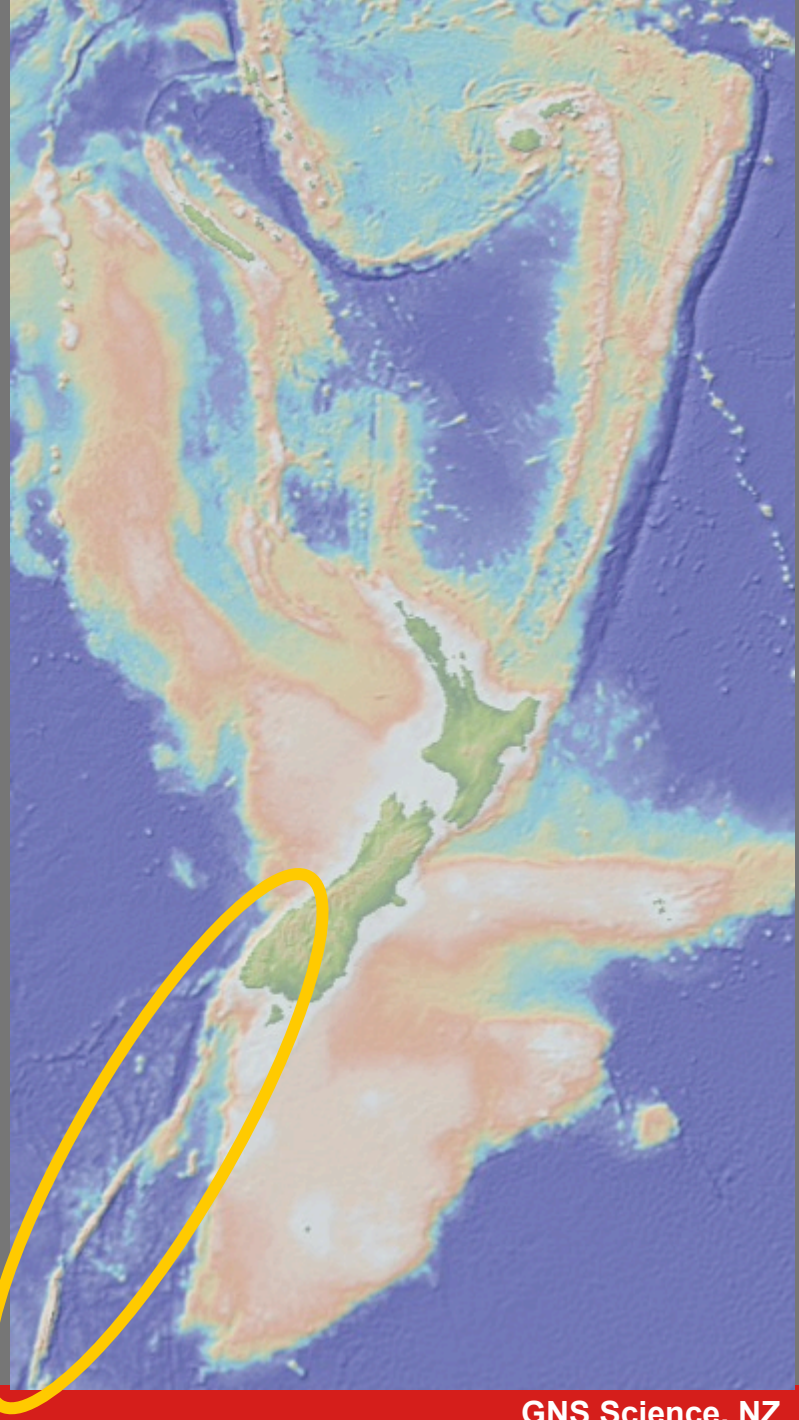
- Forearc, arc, & continental records
- New proximal-distal insights
- Deep-water sedimentary basins

- New data freely available
- Complementary to IBM studies



Puysegur-Macquarie-Hjort

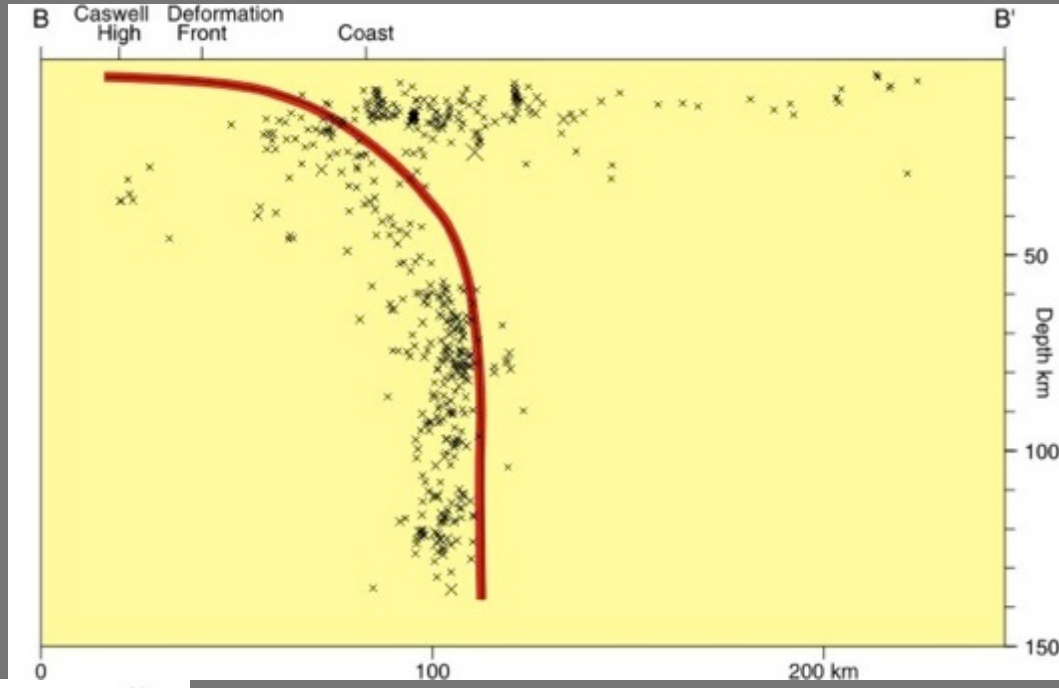
- Active subduction initiation

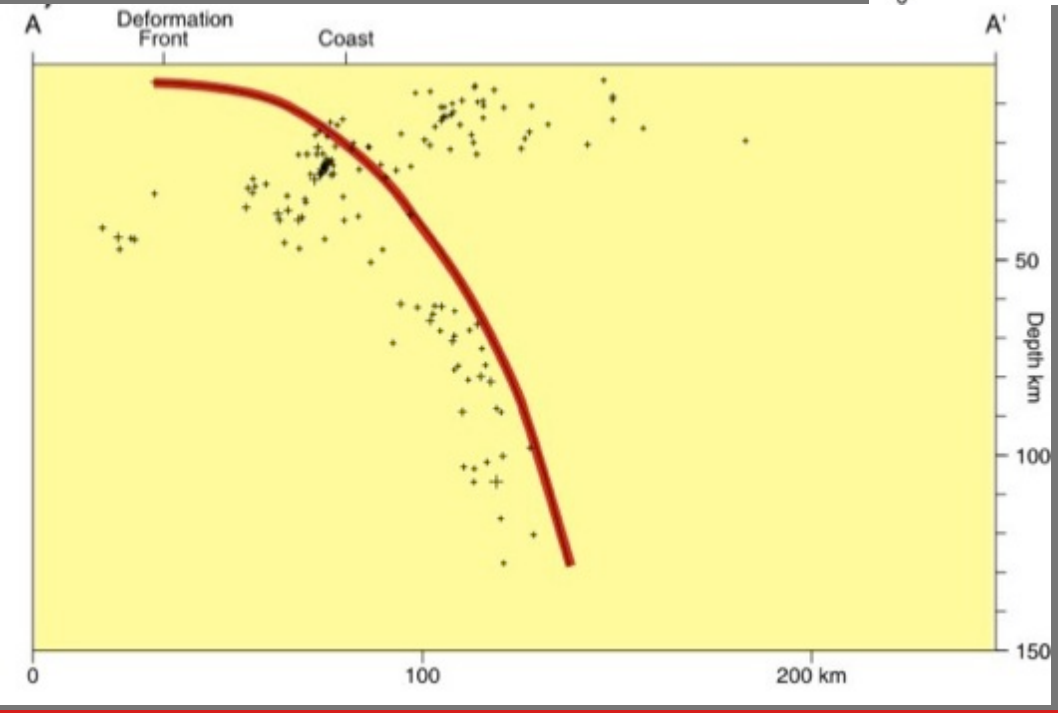


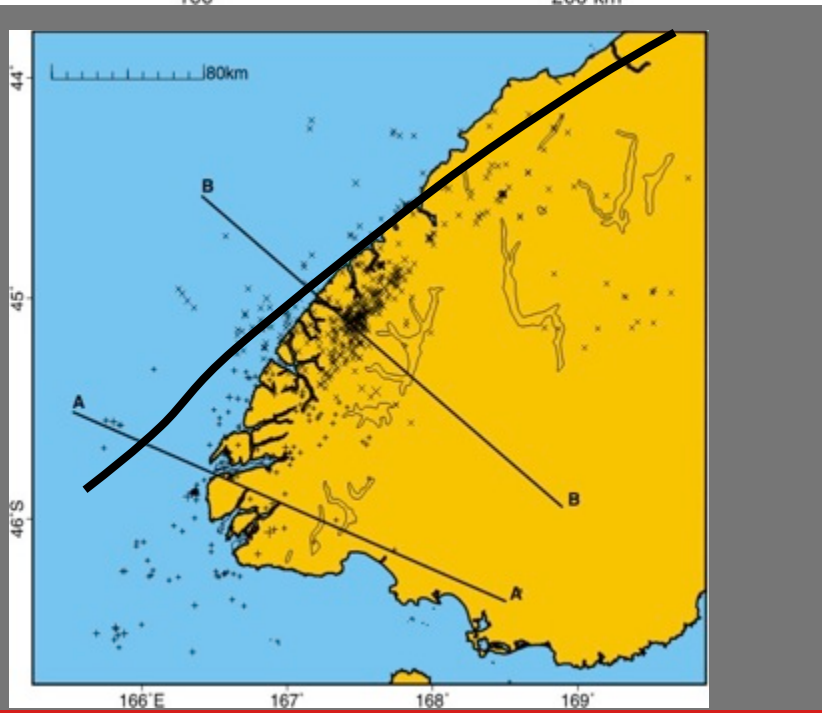
Deep earthquakes: subduction

Eberhart-Phillips, Reyners

Christoffel, van der Linden, Davey, Smith...





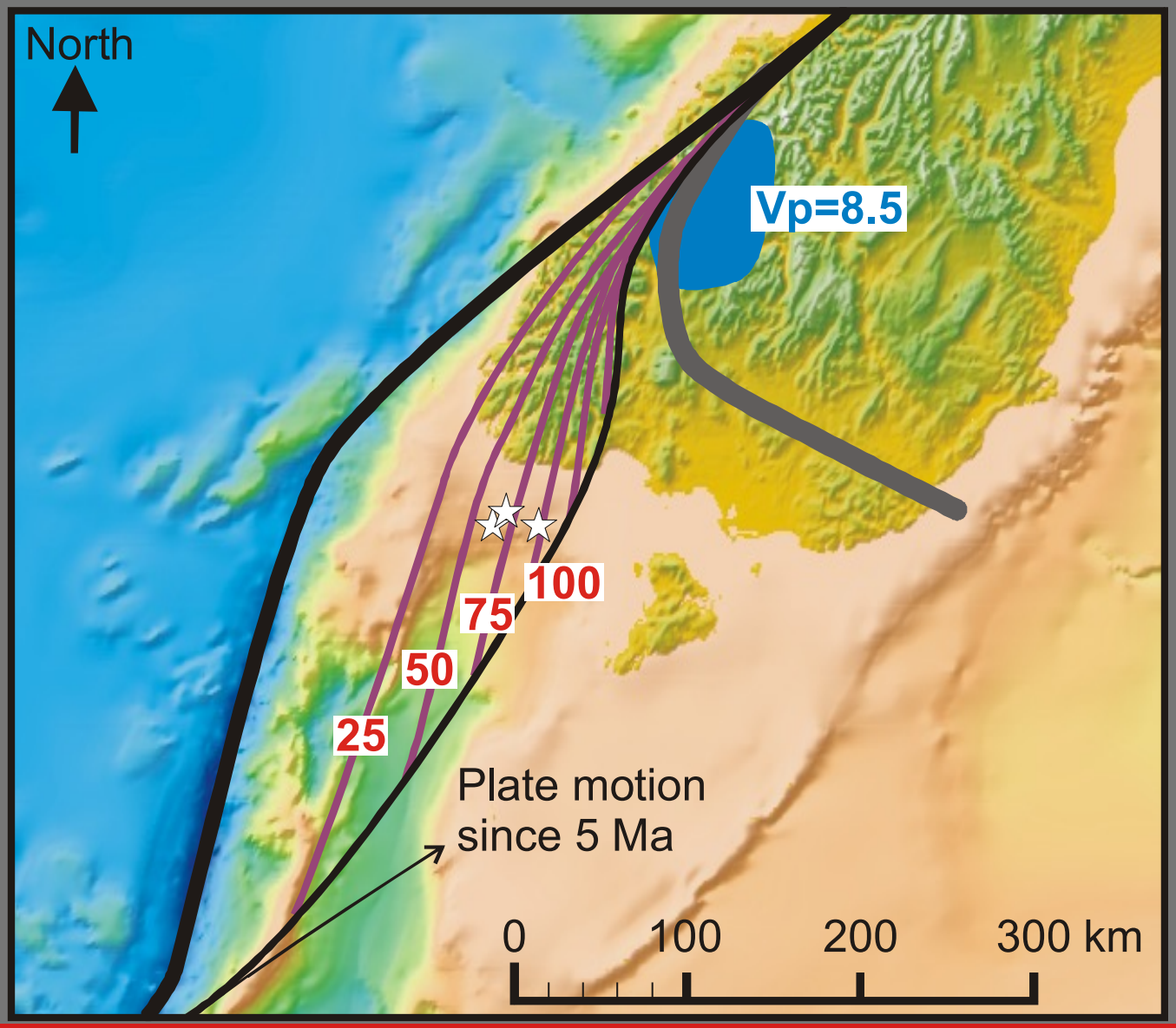


Geometry of the subducted slab

Plough

Volcanoes

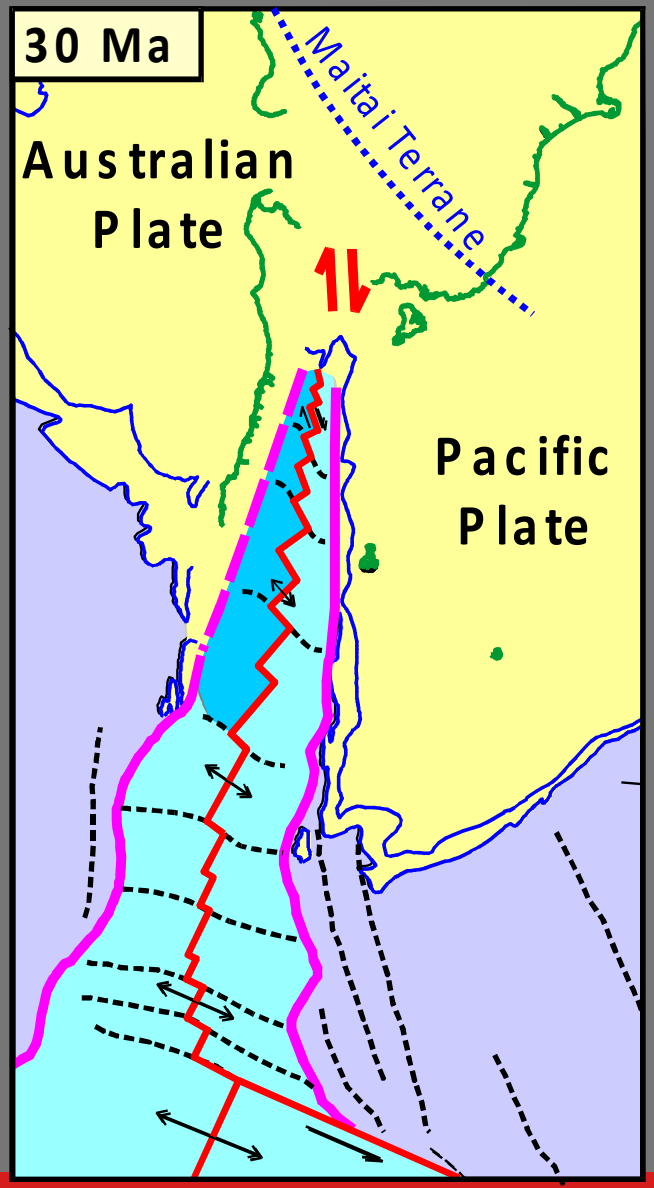
Bending

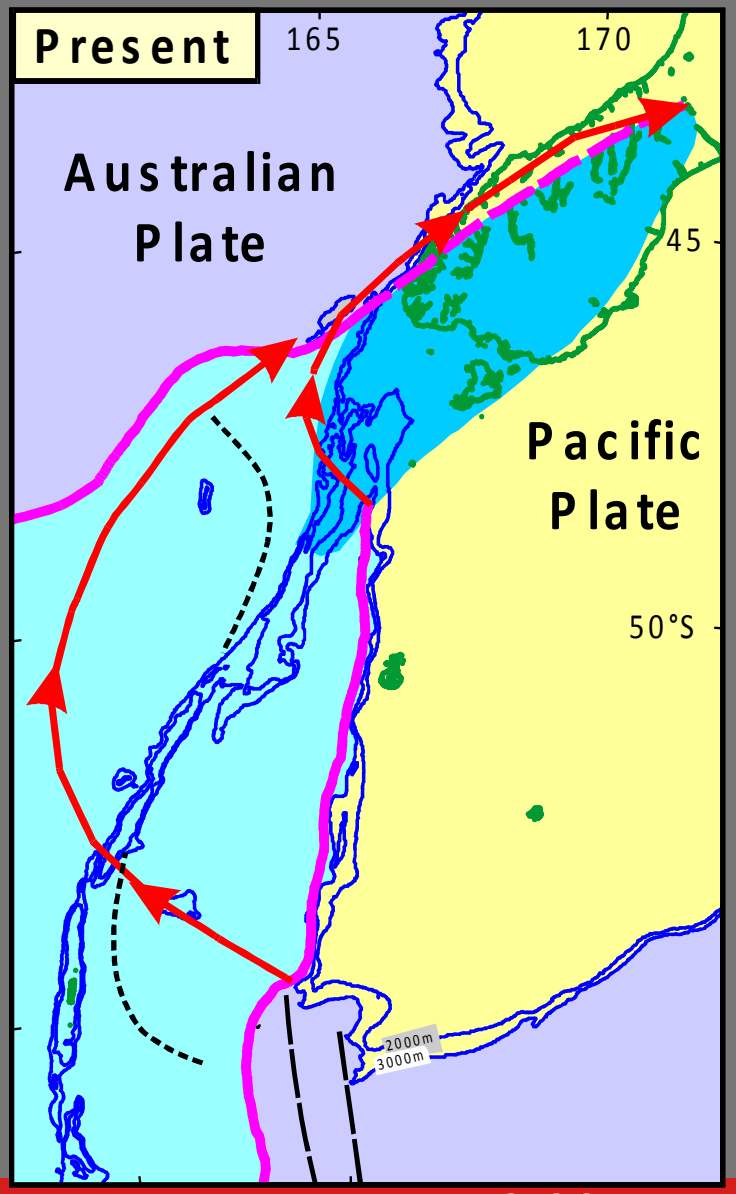


To subduct, or not?
Alpine Fault – subduction: inheritance

passive margin emplacement

Buoyancy

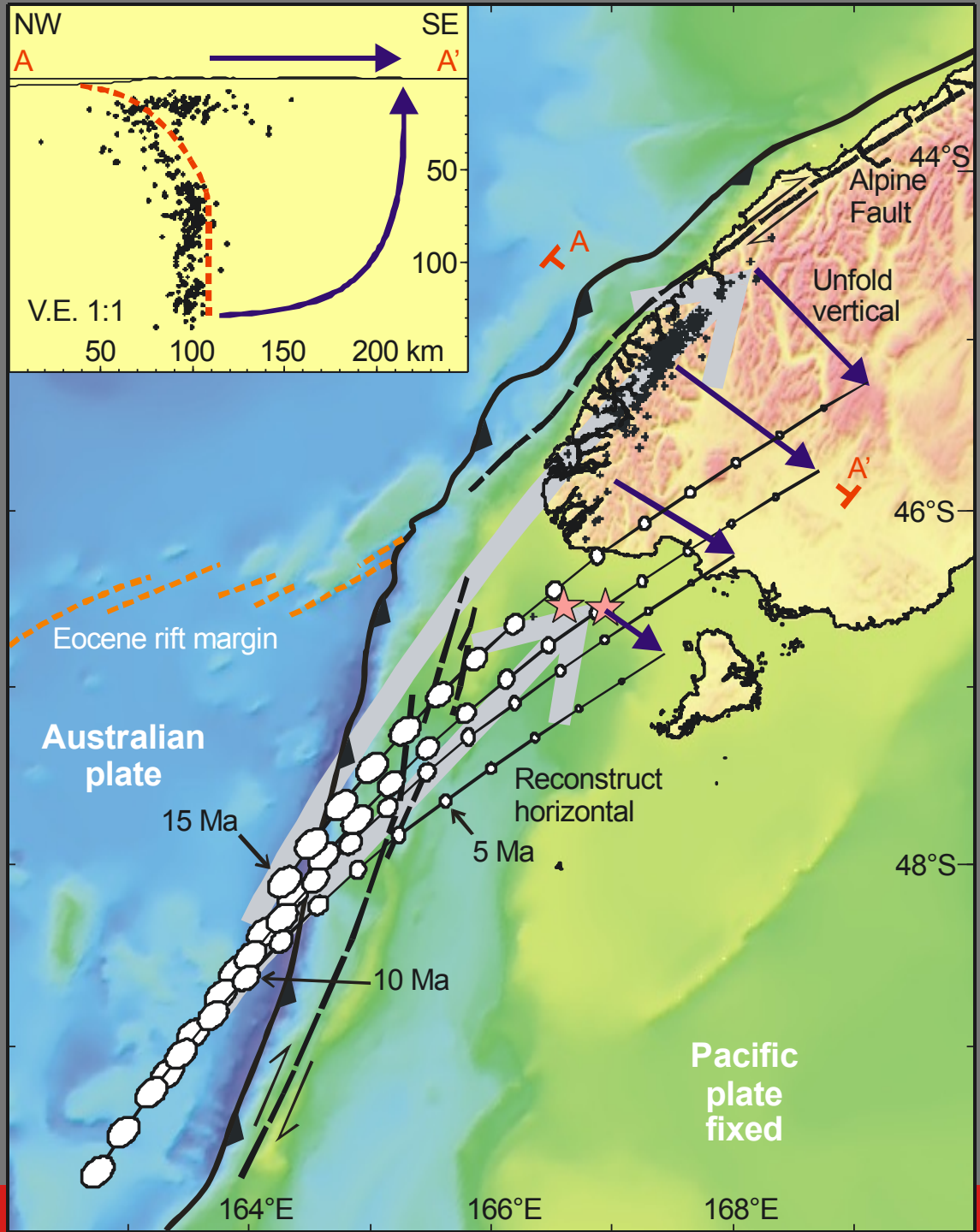




EPSL (2000)
177: 141-151

Unfolding and reconstructing the slab

10-15 Myr required to explain observed Benioff zone



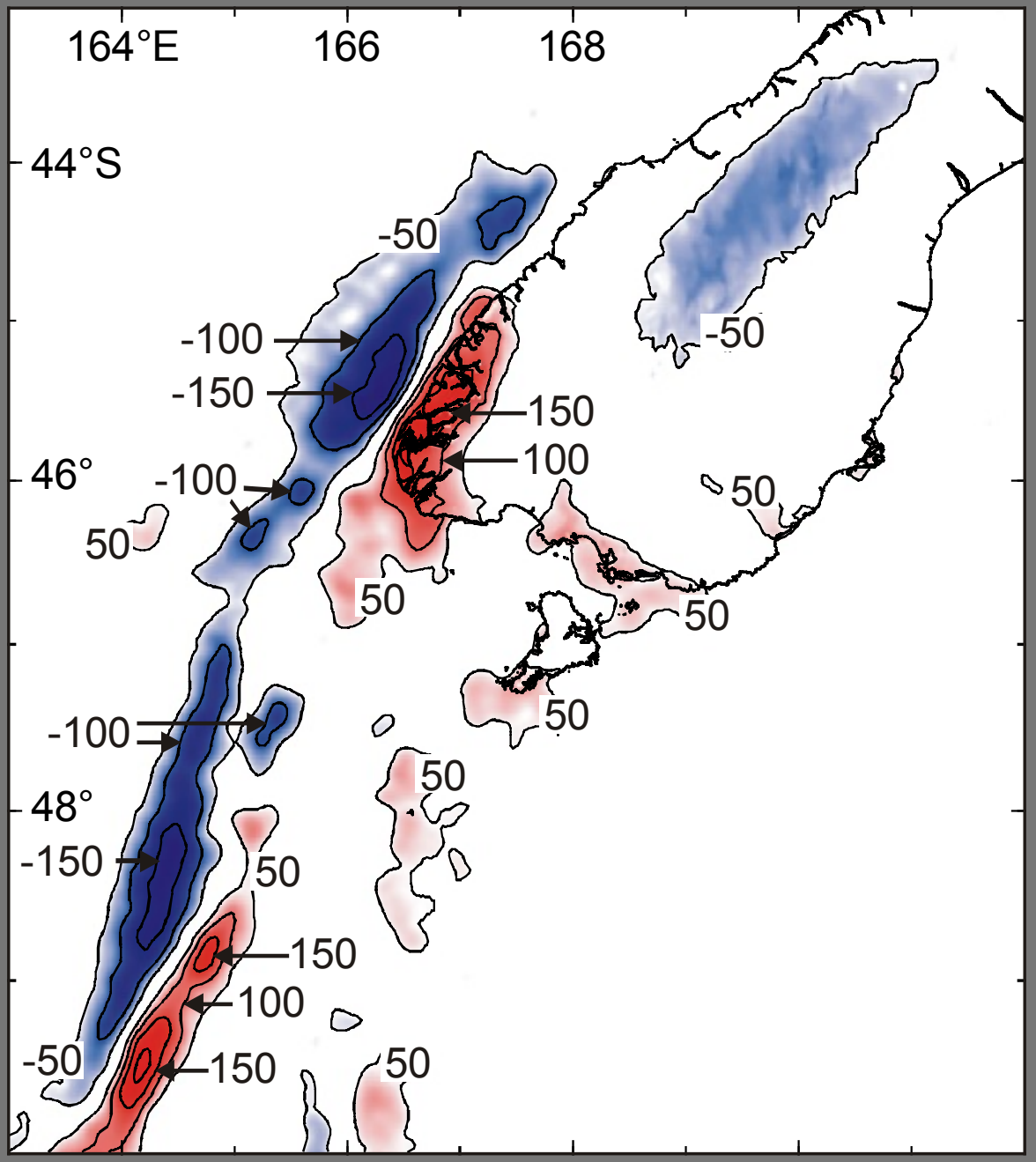
Gravity (mGal)

Paired anomalies

plate strength

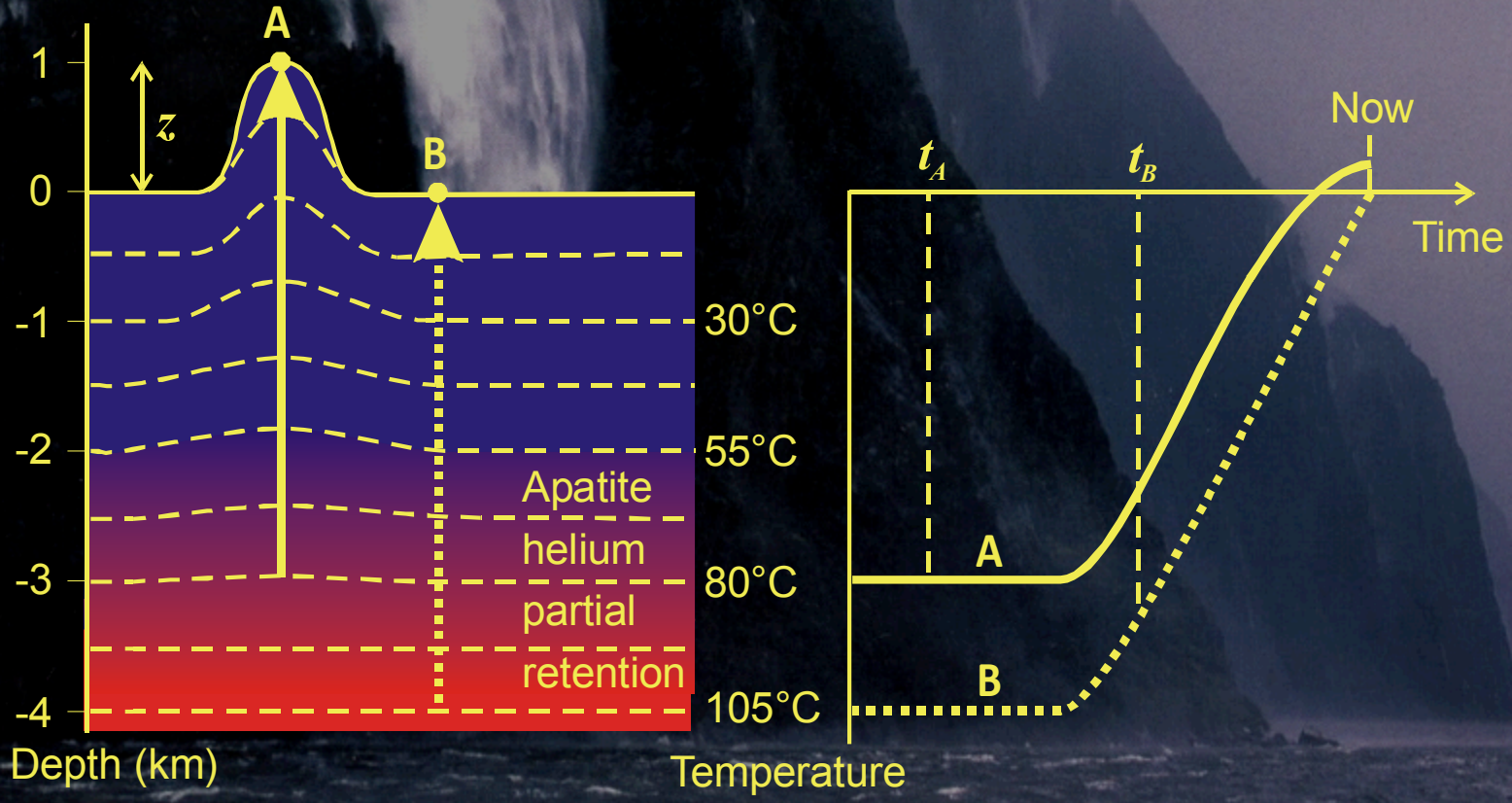
Topographic signal

Free Air offshore
Bouger onshore



Fiordland exhumation: Thermochronology

- Warmer at depth
- Diffusion of gases or defects within crystals is temperature-dependent



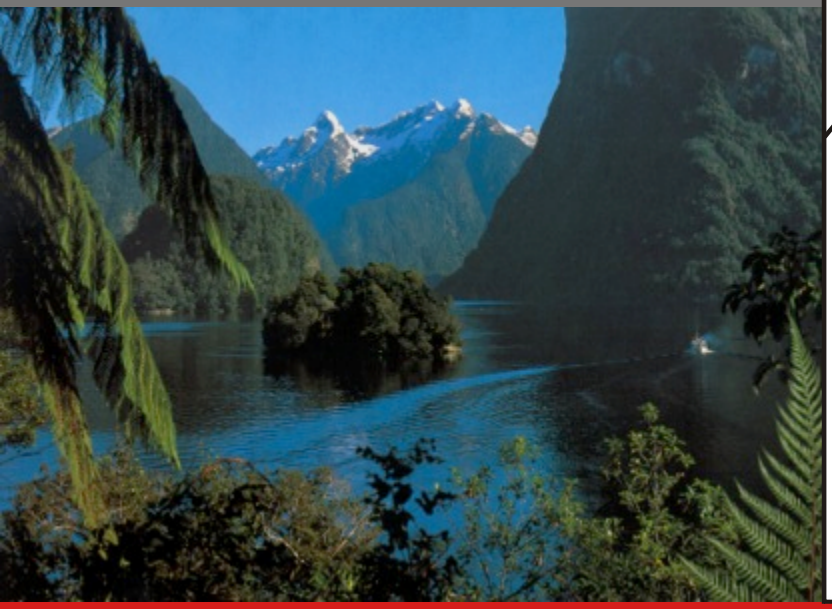
Fiordland onshore Sample locations

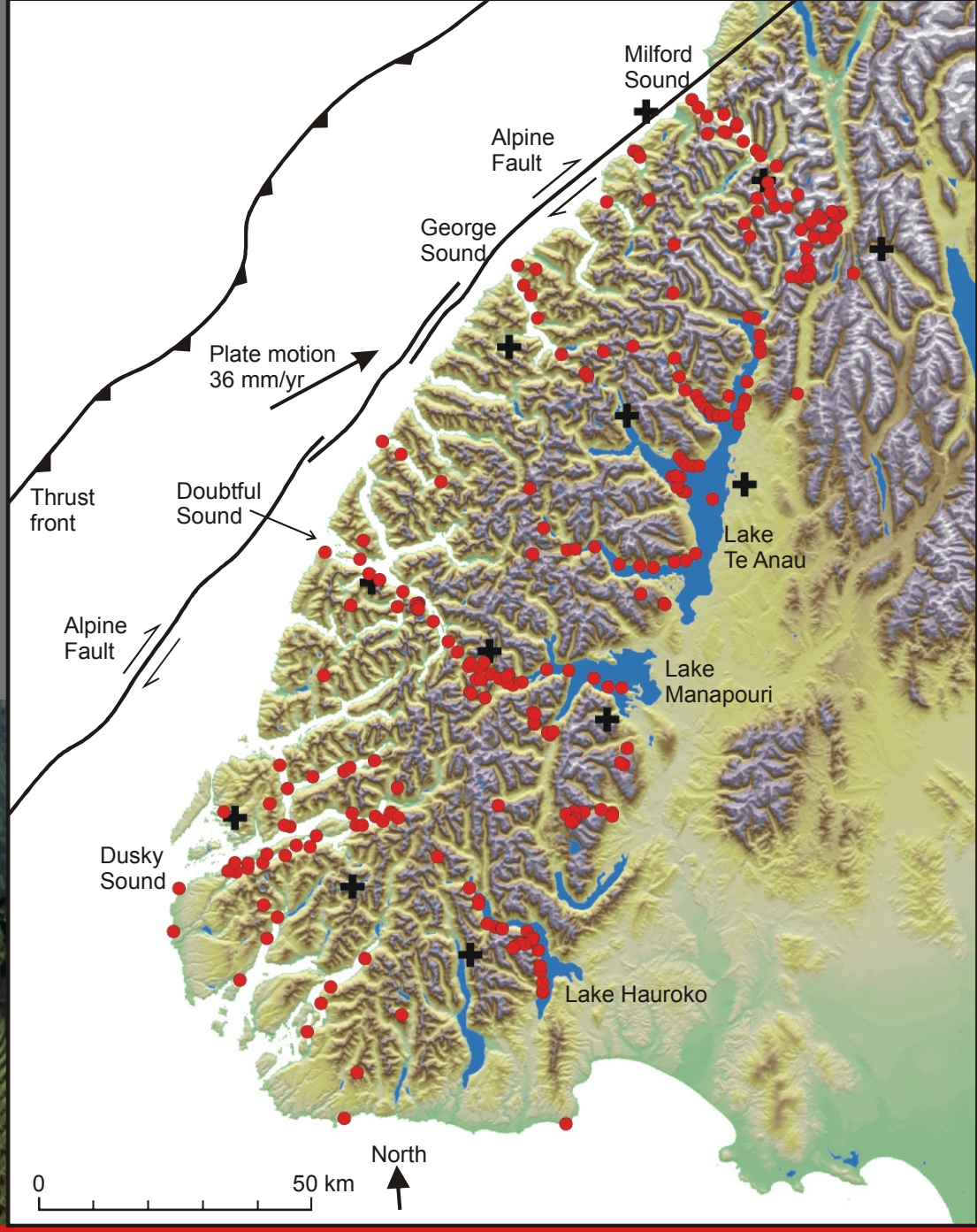
>400 useful analyses

U-Th/He

Fission track

Model grid nodes



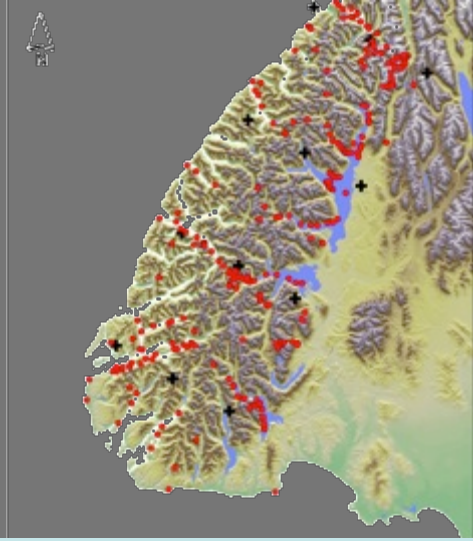


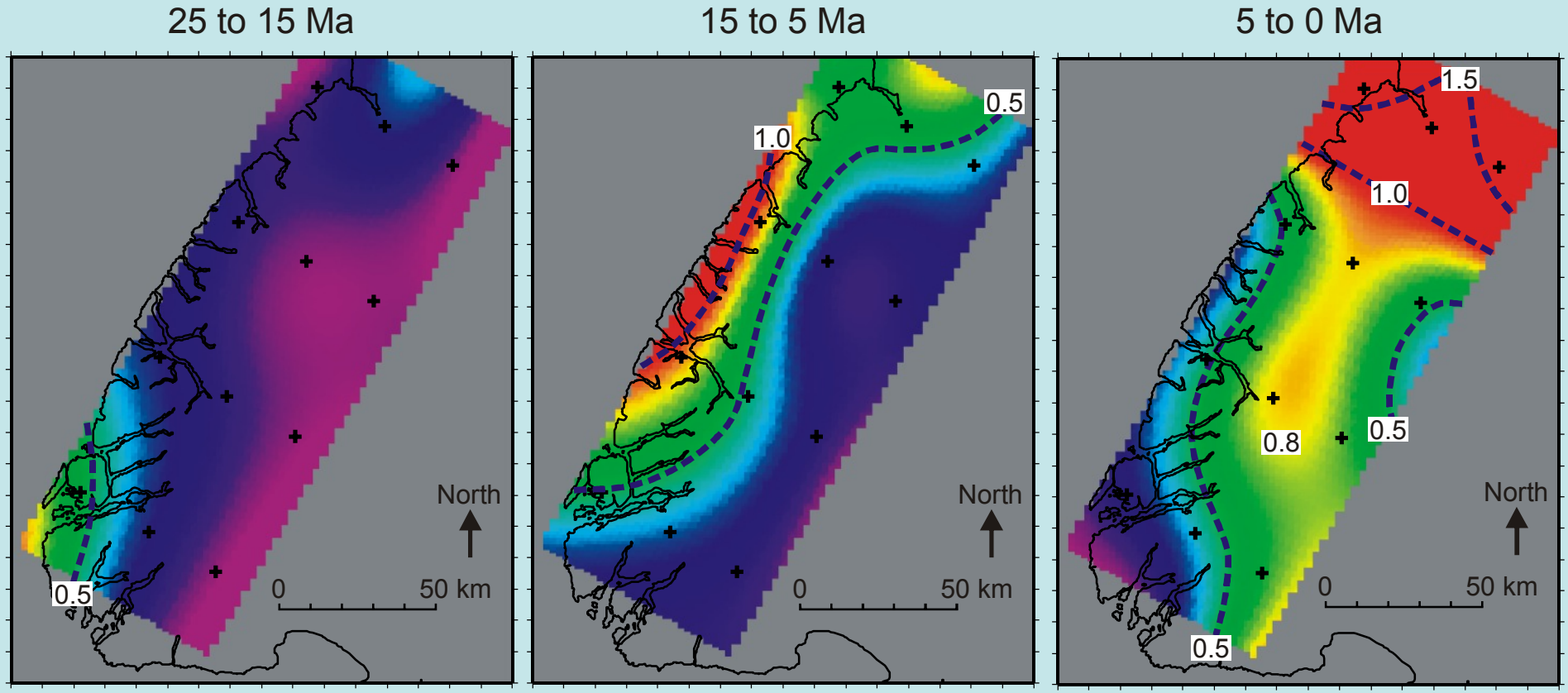
Results: uplift rate summary

Migration of exhumation:

- **NE, but at less than Alpine Fault slip rate**
- **Broadening of zone**

Geosphere 2009, v.5, p. 409–425

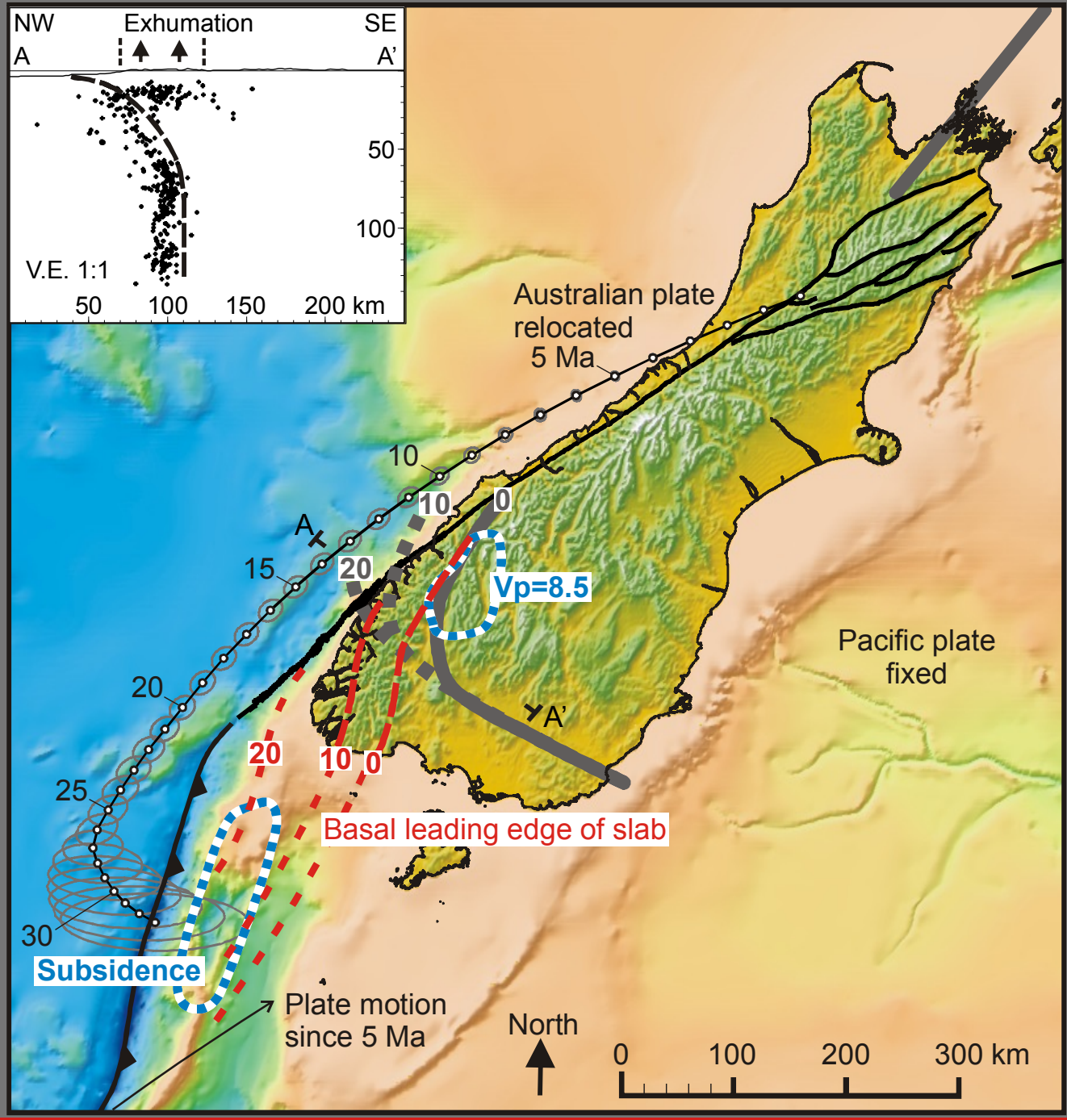




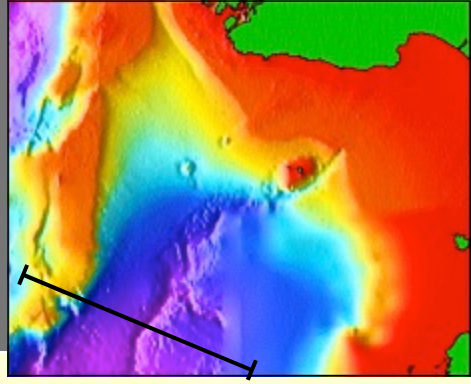
History of the over-riding Pacific plate

SW propagation of subduction thrust, subsidence

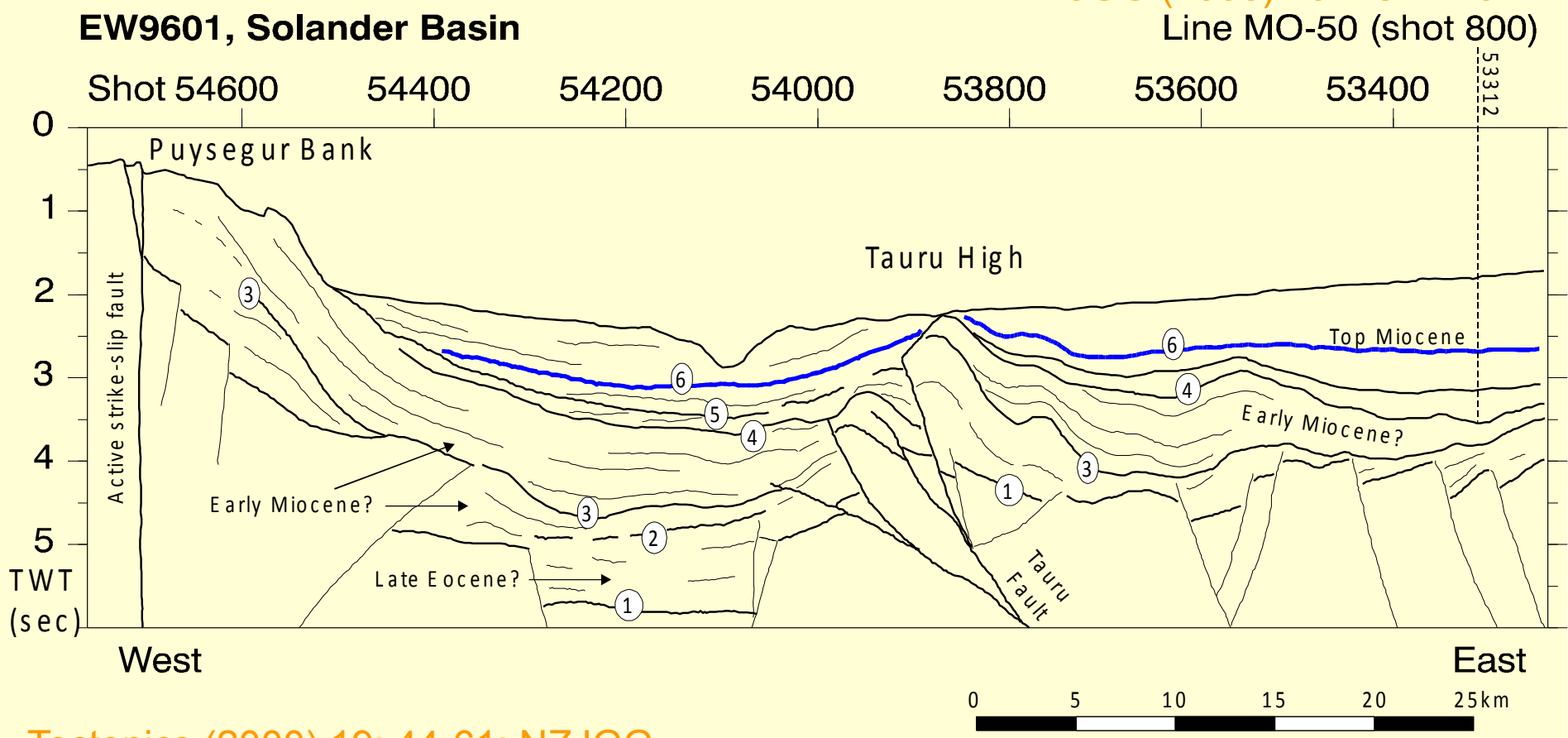
Growth of slab; NE obstruction to subducted slab; smearing of hanging-wall; uplift, volcanism



Maurice Ewing 1996, Solander Basin

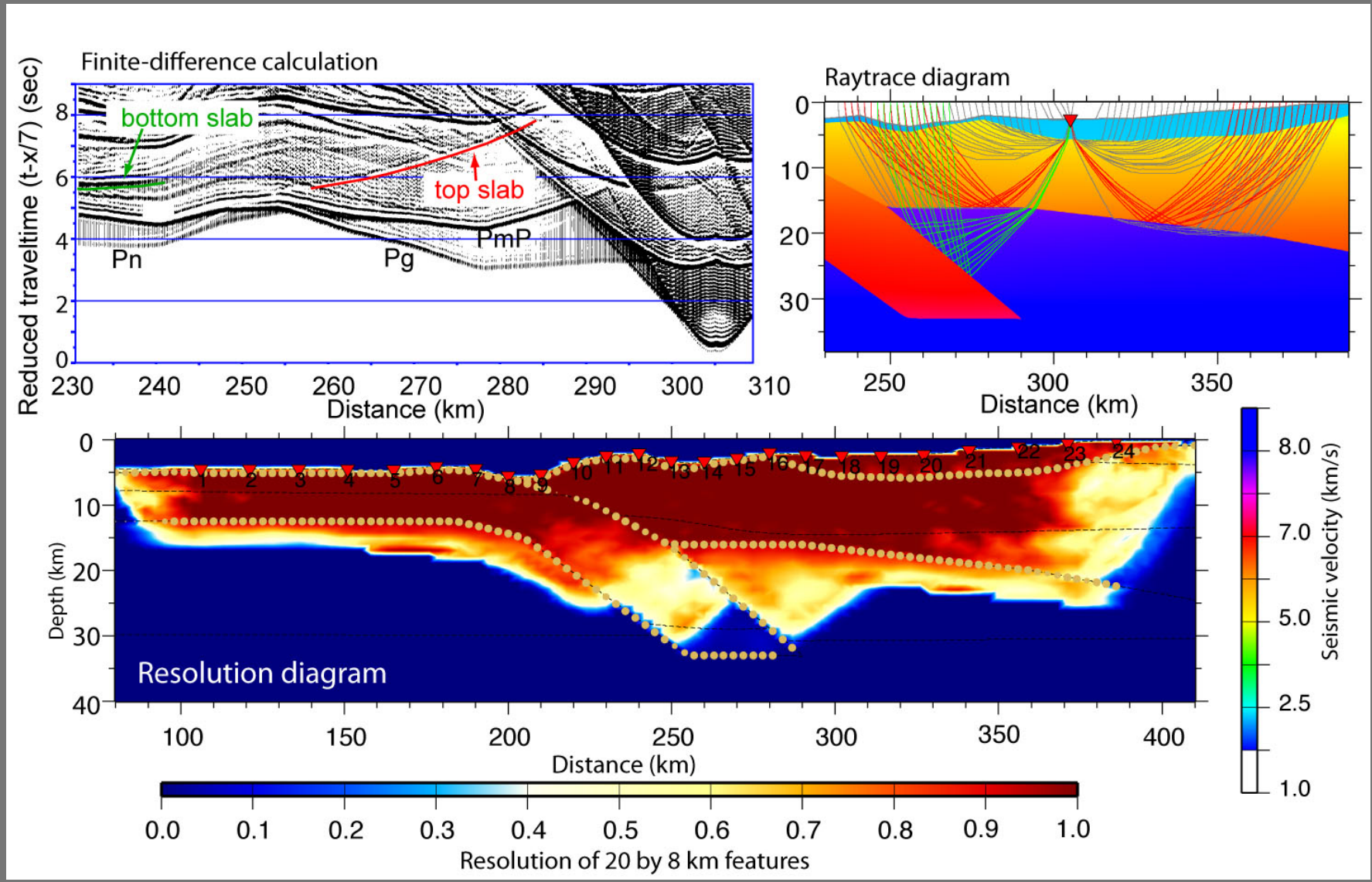


NZJGG (2006) 49: 131-149



Tectonics (2000) 19: 44-61; NZJGG

Possibility to collect a snapshot of initiation



Conclusions

Two of the best global examples of subduction initiation

Tonga-Kermadec-Hikurangi

Most profound global tectonic event

Precise plate motions known

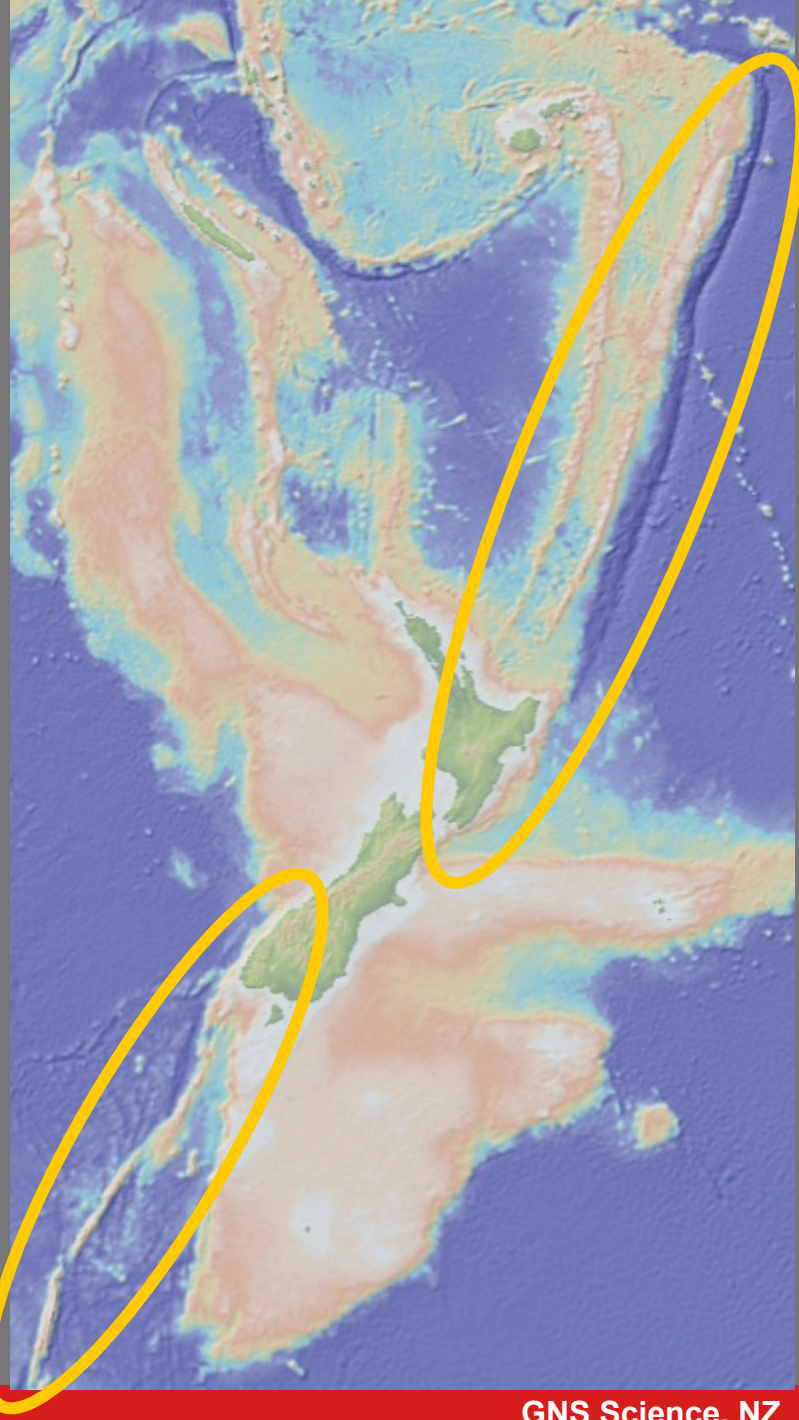
Forearc, arc, & continental records

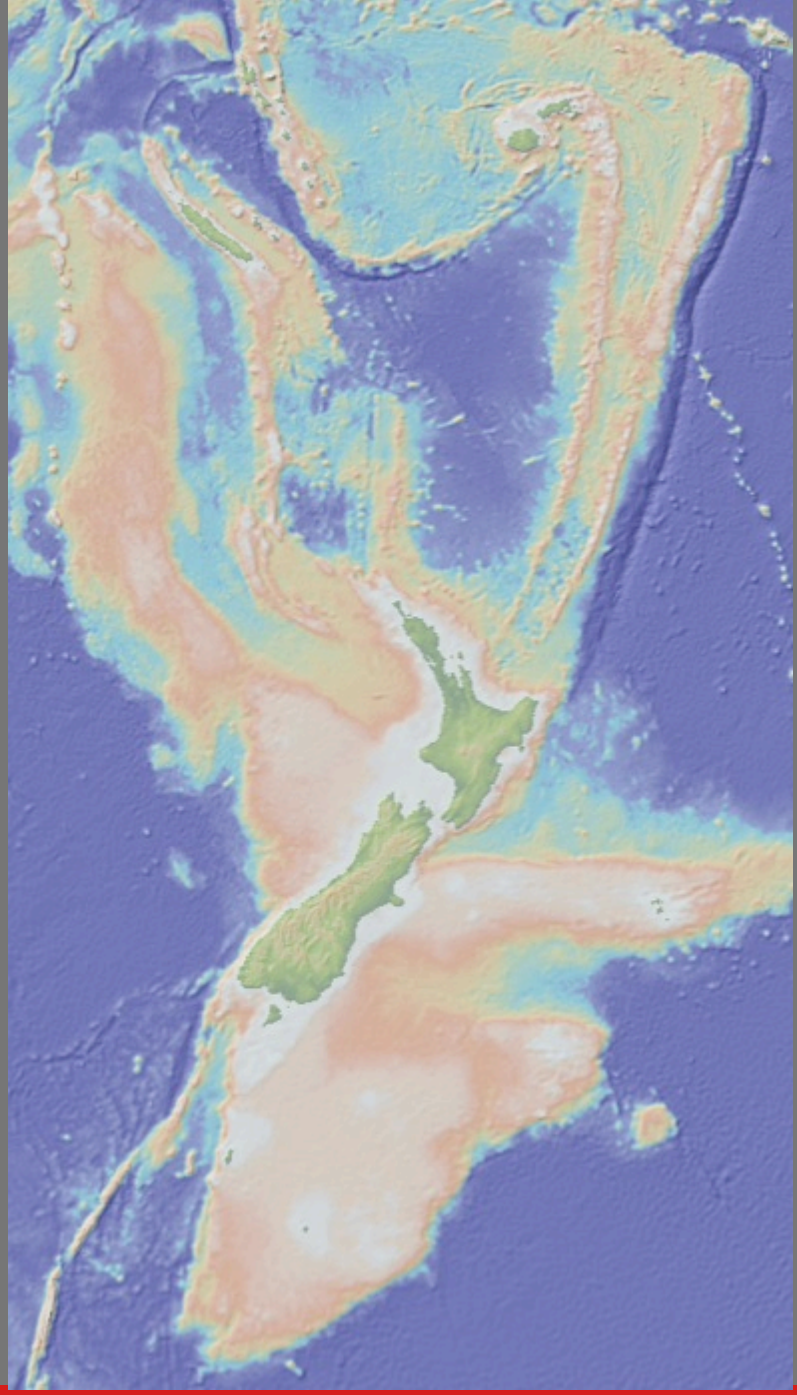
Complementary to IBM studies

- Deep-water sedimentary basins

Puysegur-Macquarie-Hjort

Clearest example on Earth of subduction initiation in action





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