

Overview of Zealandia and its subduction record



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SW Pacific geography

Scattered,
remote
islands

4 million people

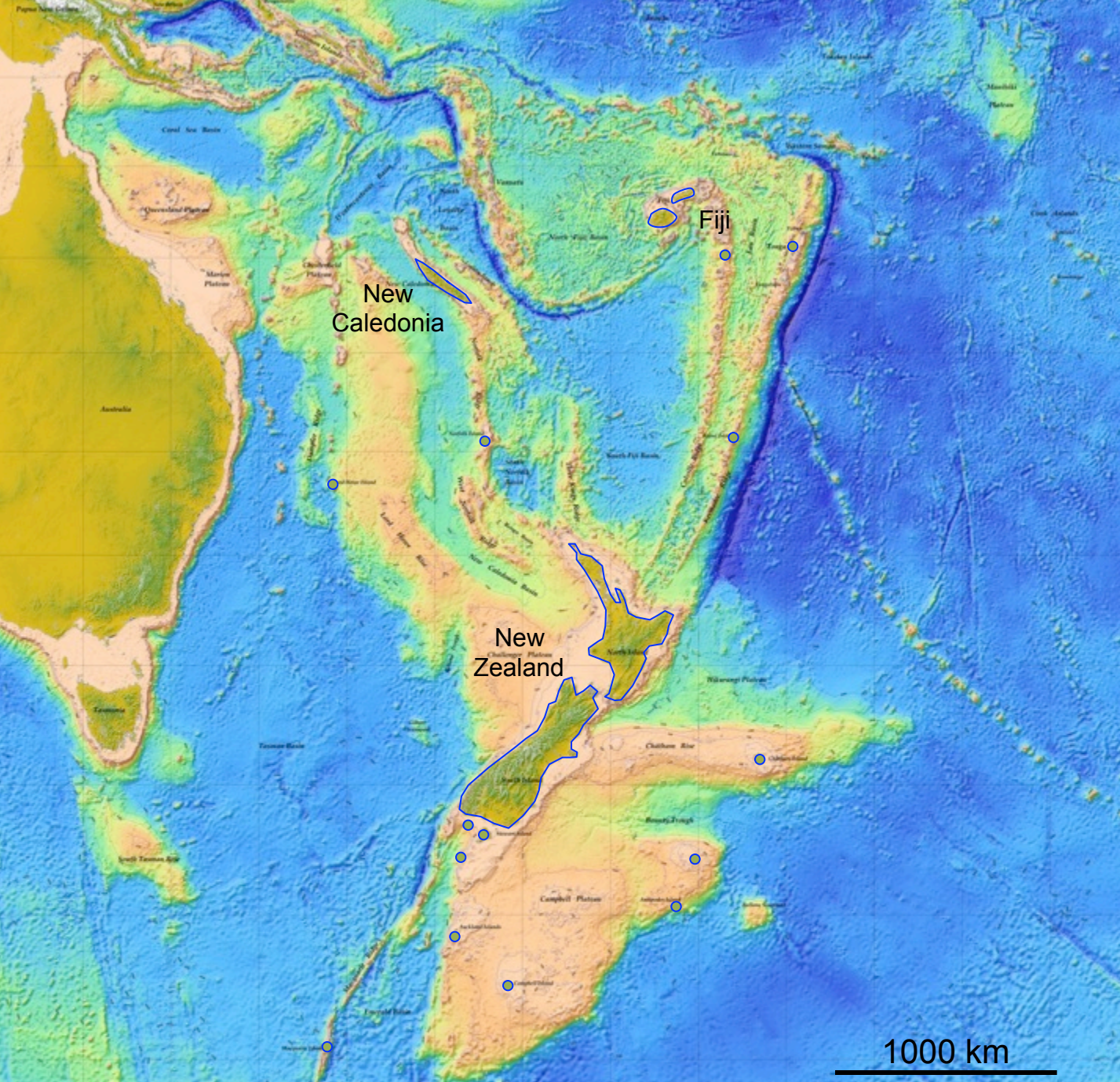
Near Australia

1000 km

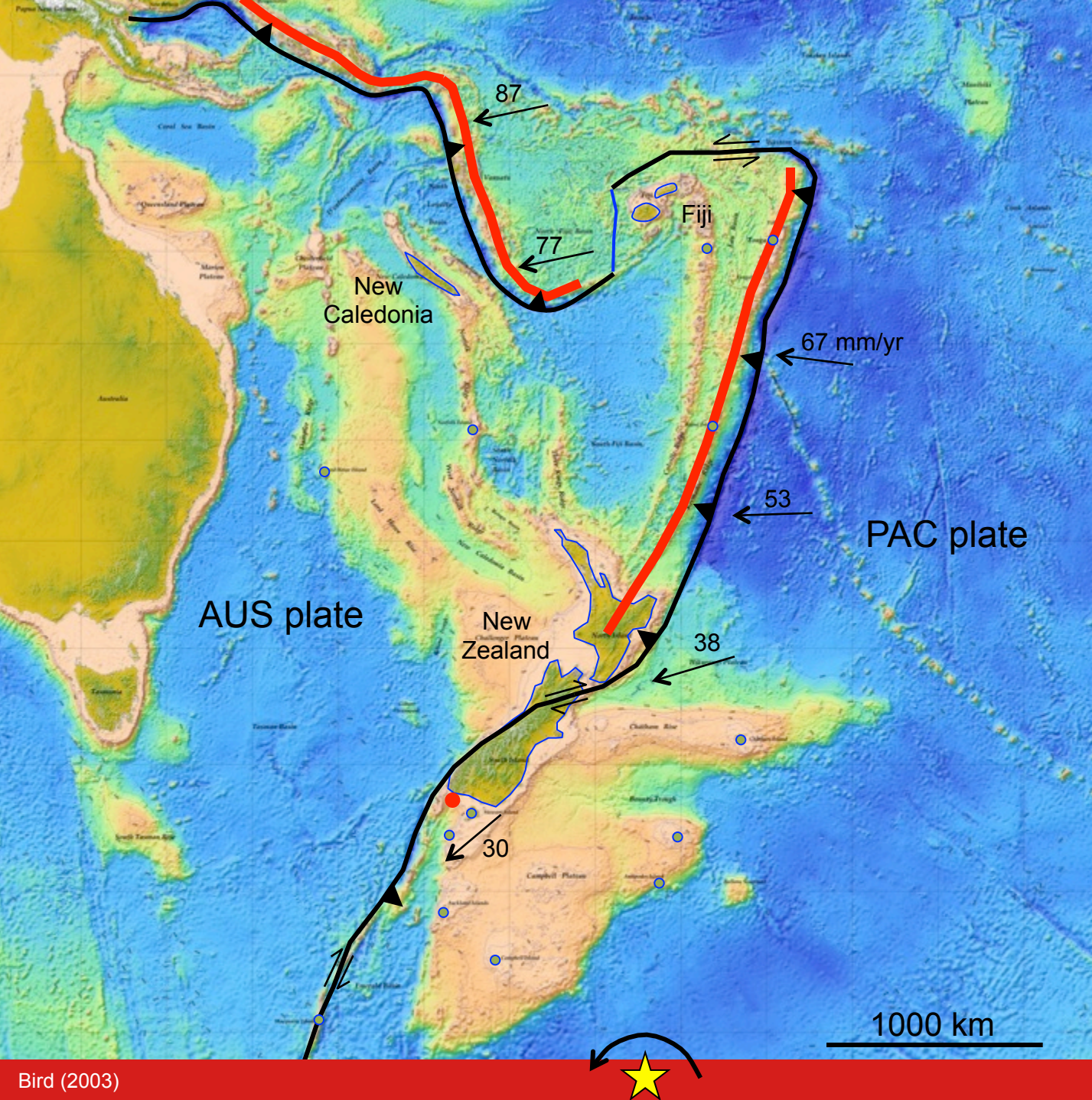
SW Pacific bathymetry

Based on satellite gravity

Broad plateaus and ridges 1-2 km water depth



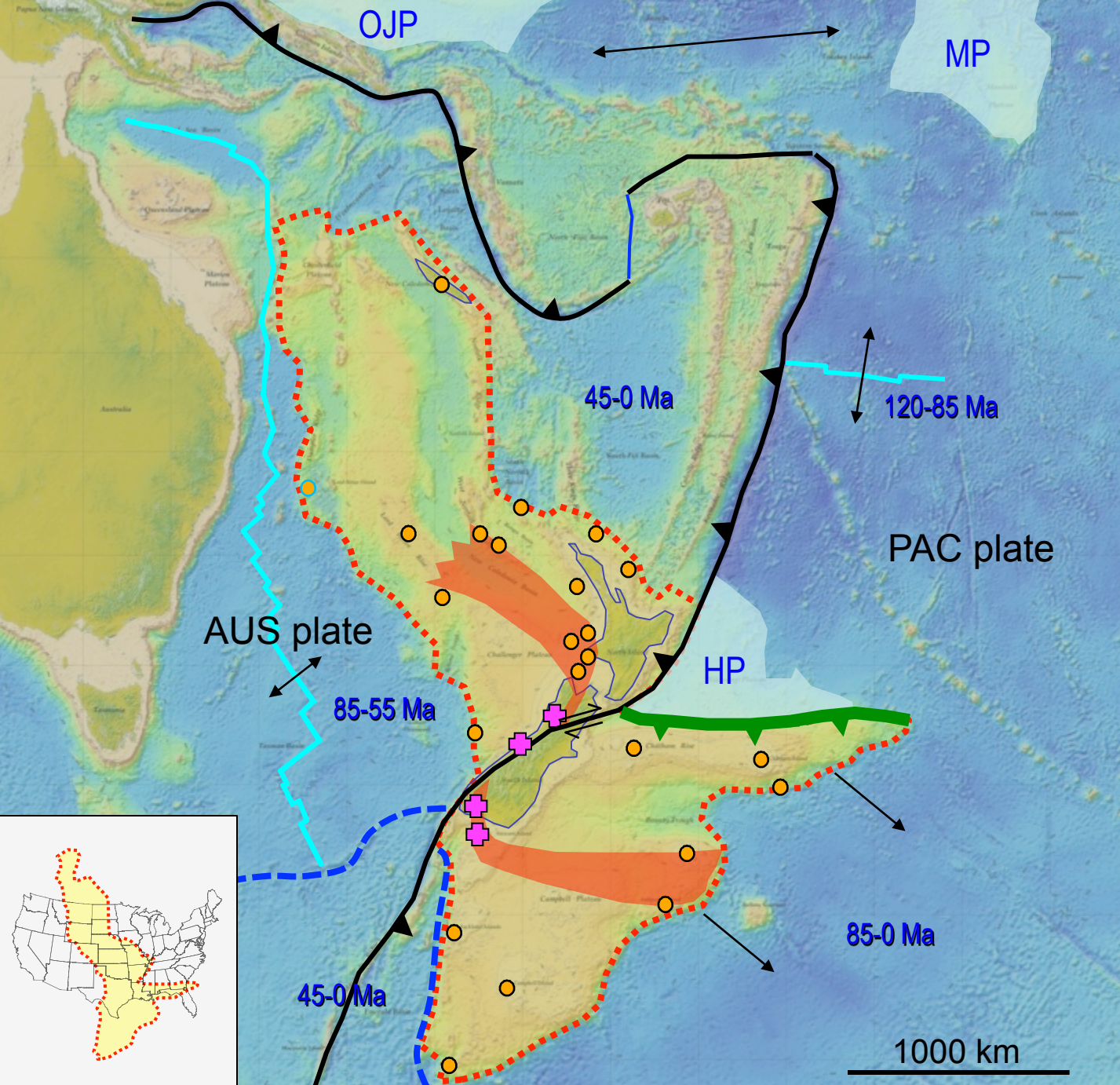
SW Pacific present day tectonics



- Pacific and Australian plates
- nearby pole of rotation ★
- convergence variably oblique
- subduction polarity changes

Zealandia

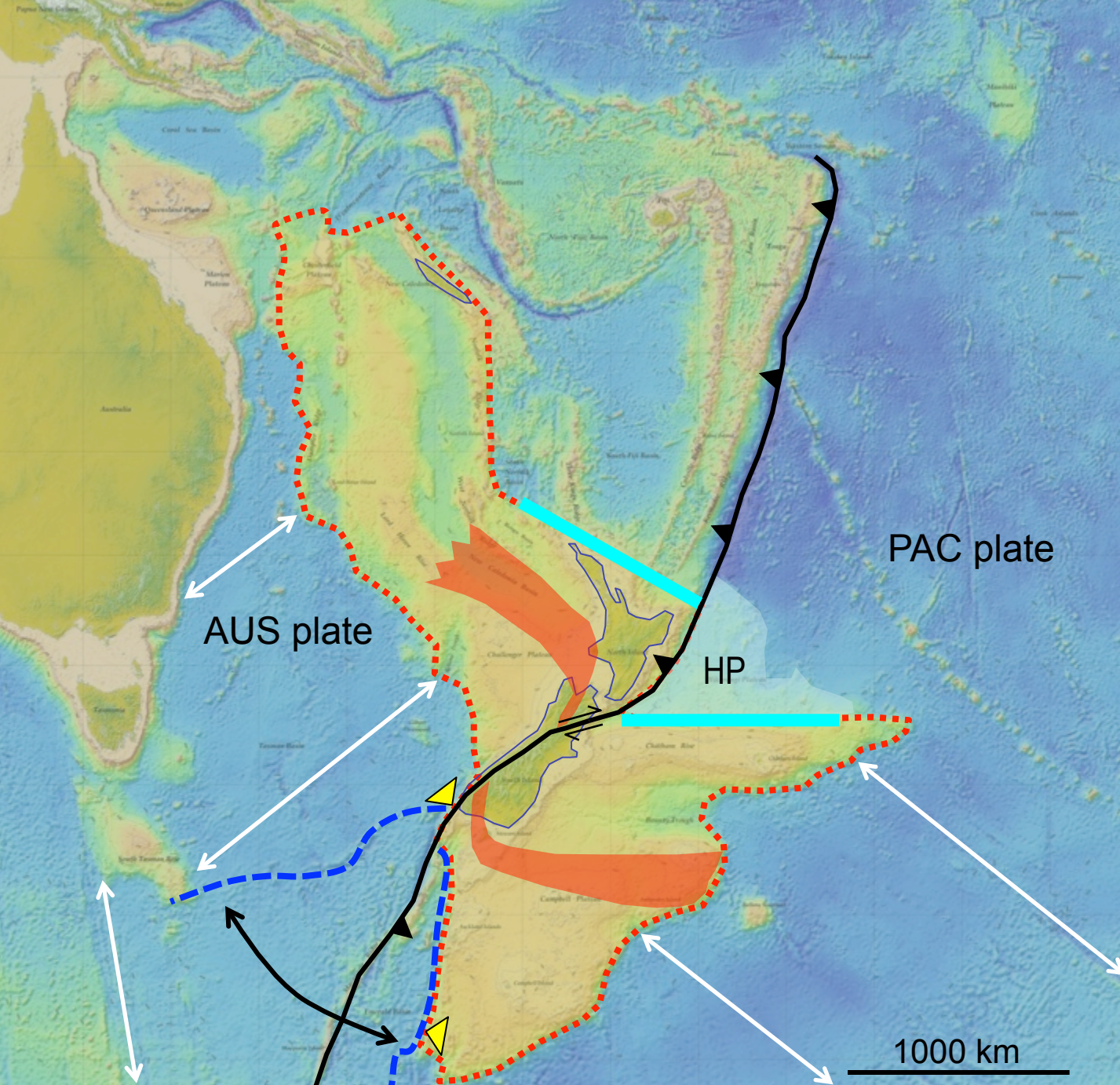
- continent that is 95% submerged
- rifted internally and on most margins
- now on two plates
- Hikurangi Plateau adjacent



- continental rock samples
- Median Batholith (Cambrian-Cret)
- ✚ Late Cret. MCCs
- Early Cret LIPs
- ▼ Preserved E Cret subduction zone

Zealandia and Gondwana

- ZLD on PAC and AUS plates
- match piercing points
- track fracture zones
- rotation and translation



14 April 84,000,000 B.P.

1000 km



Just before major breakup episode

Gondwana reconstruction

  
Continental crust


Oceanic crust


Hikurangi LIP

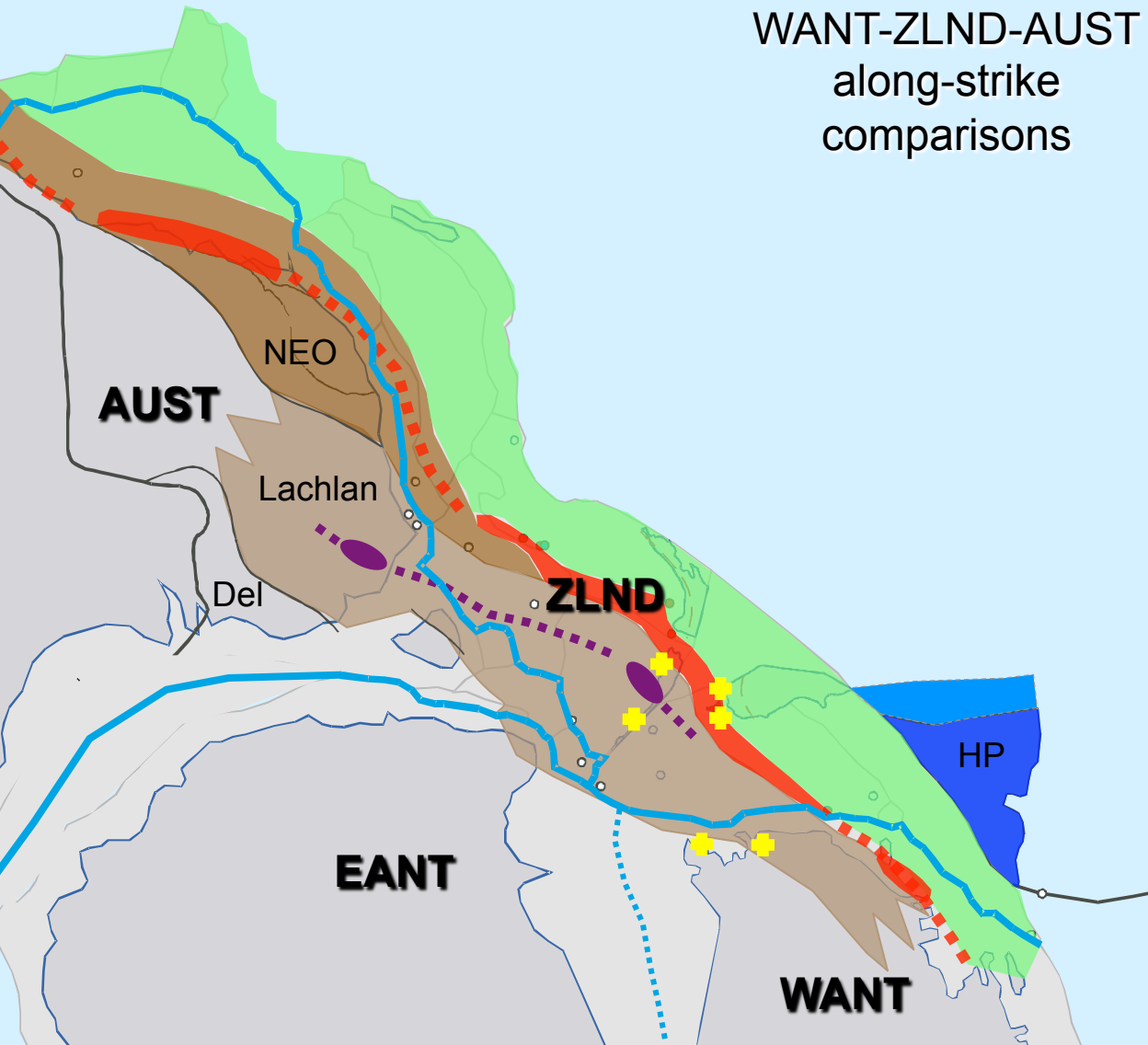

<85 Ma continental breakup lines

- Zealandia was a ribbon continent

Gondwana geology

1000 km

WANT-ZLND-AUST
along-strike
comparisons



CONVERGENT OROGENS

MESOZOIC

 Sed-volc-met

 Plutonic

PALEOZOIC

 Sed-volc-met

 Plutonic

EXTENSIONAL OROGEN

CRETACEOUS

 pre-breakup
MCCs

*Rifting, thin crust, breakup,
cooling, subsidence,
submergence: Zealandia*



New Zealand's subduction history

Cambrian to Now

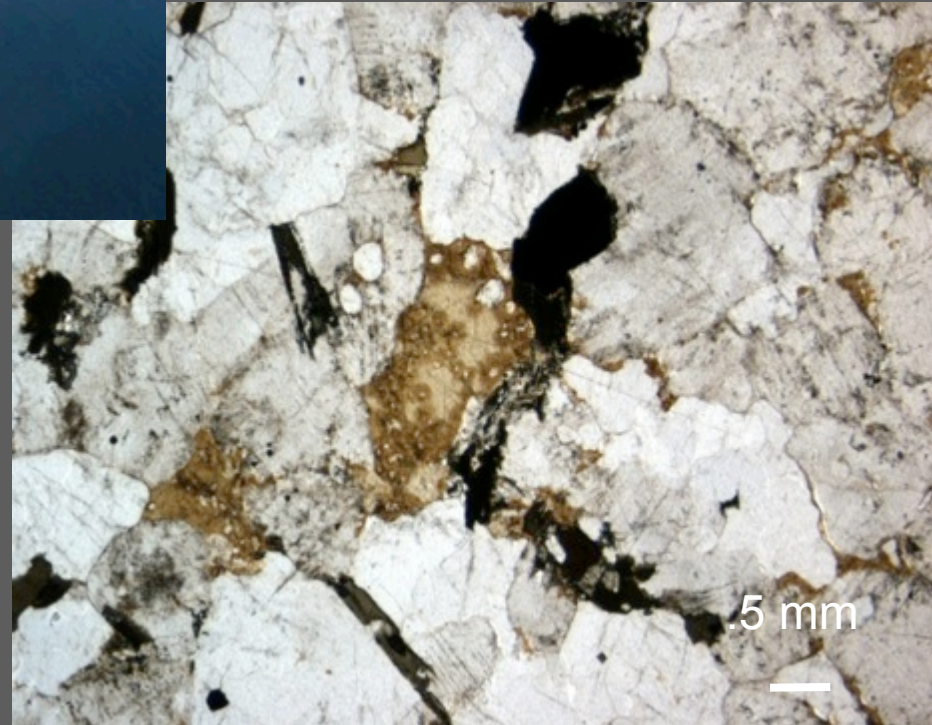
500 Ma Jaquierey Granite, Fiordland

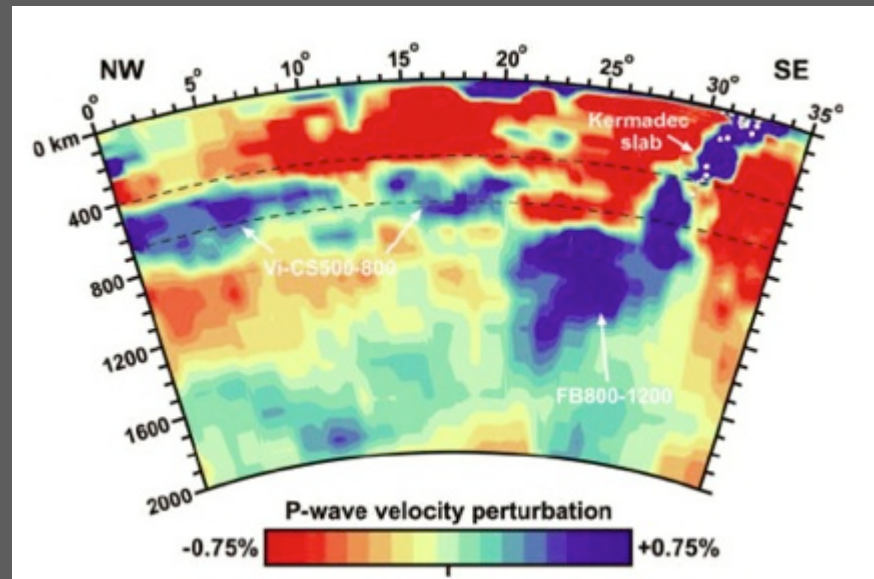
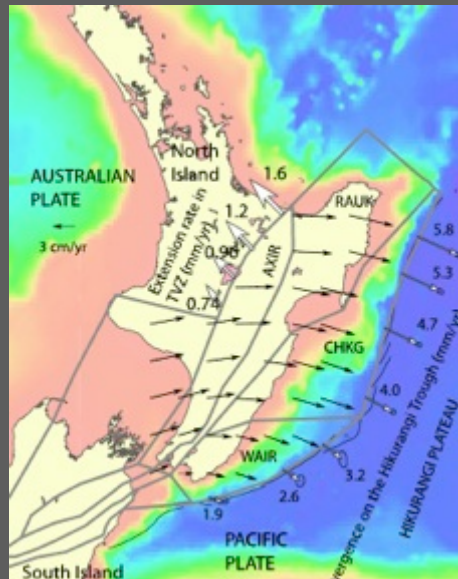
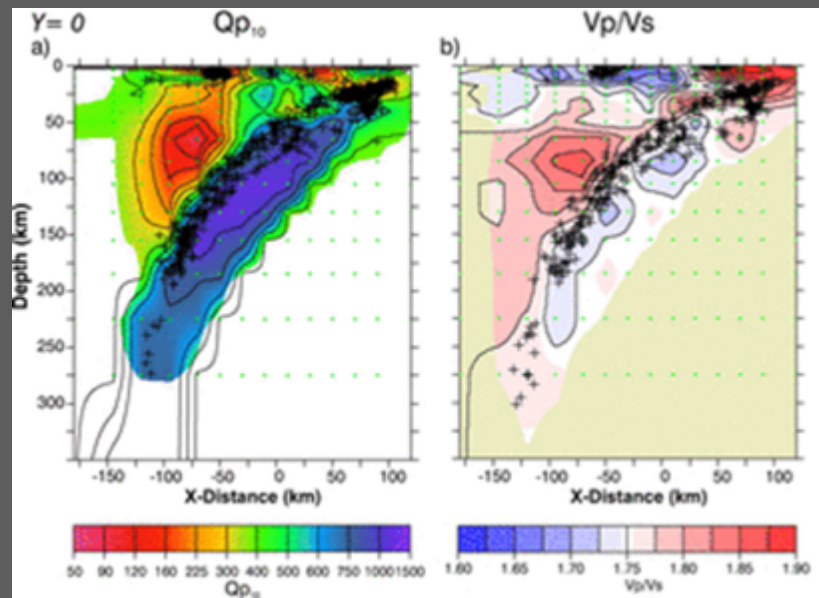
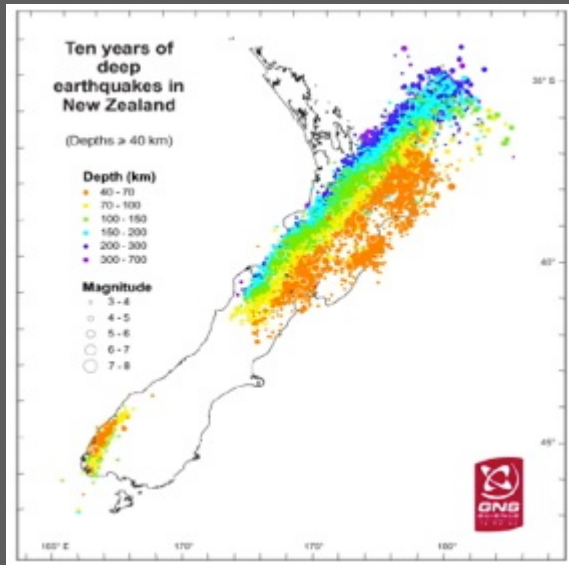


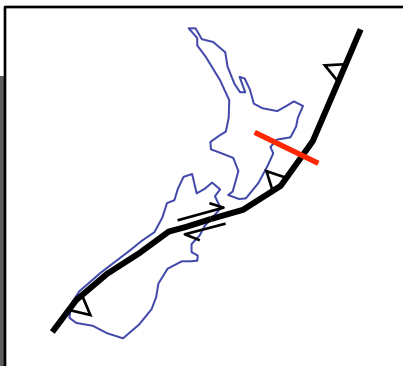
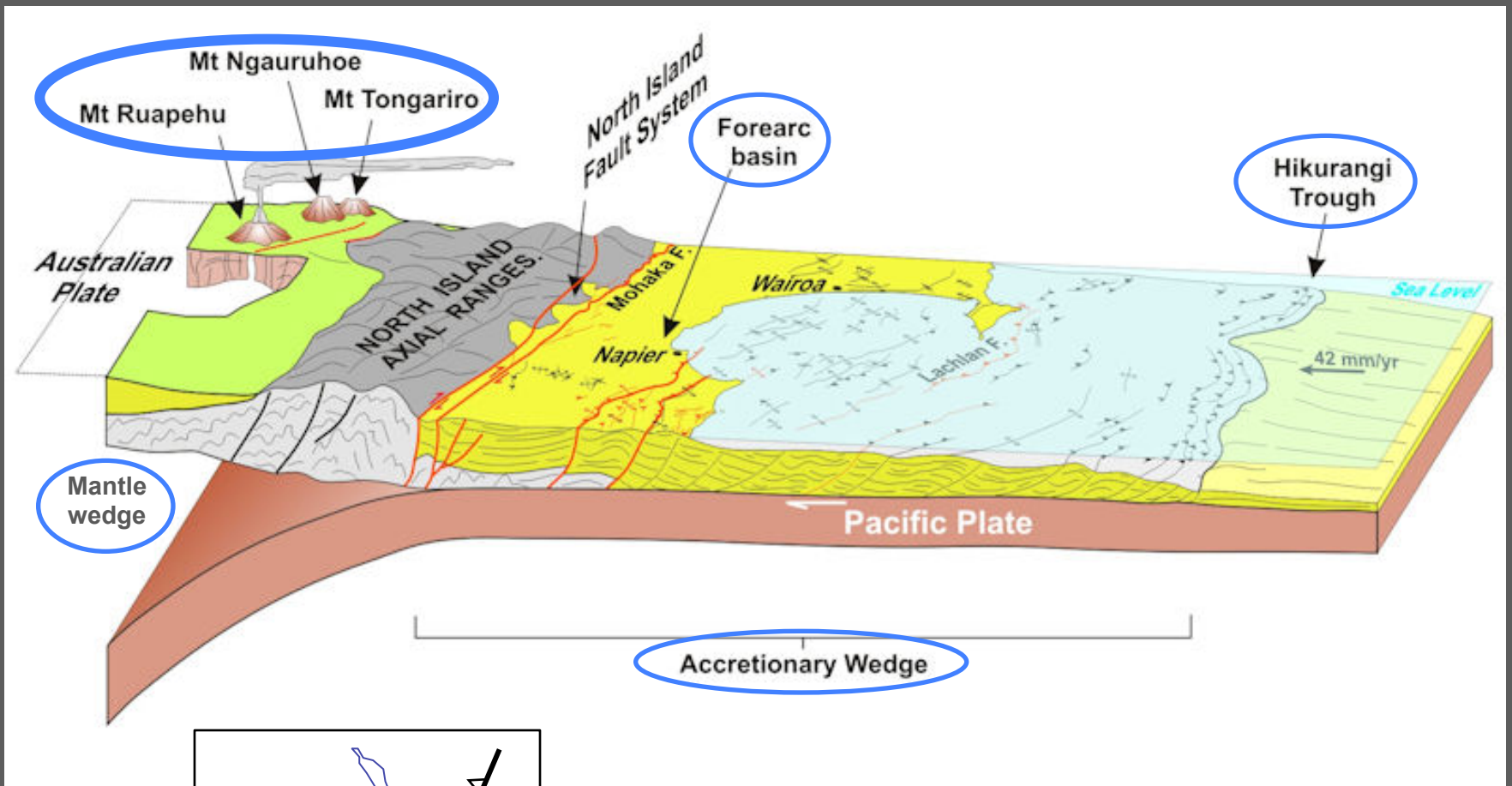
White Island, August 2012

Expressions of subduction:

plate convergence, Benioff zone
EQs, magmatic arc with distinct
petrochemistry, fore-arc basin,
back-arc basin, accretionary
wedge

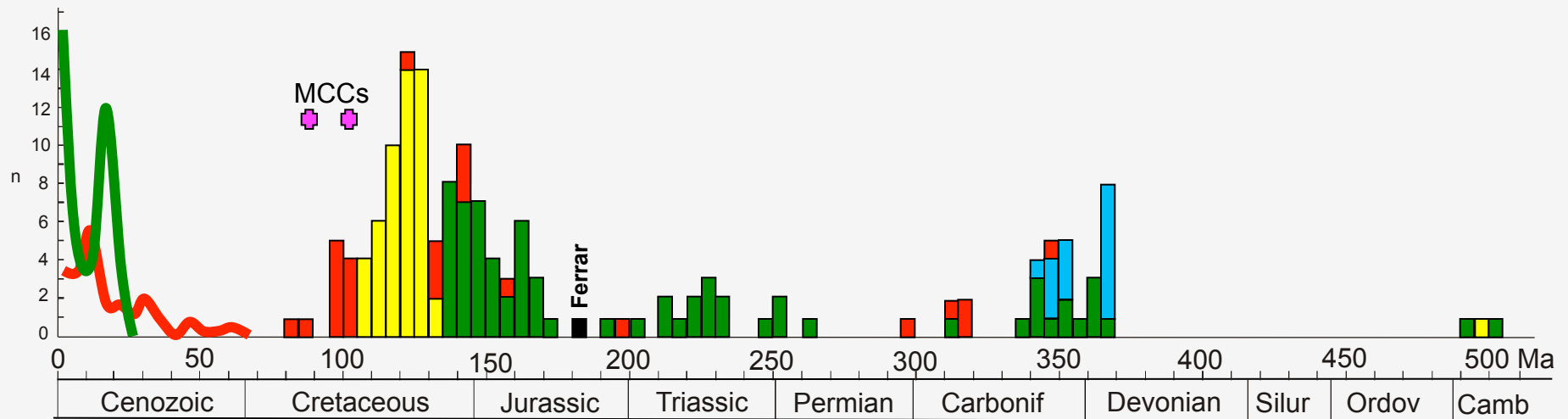






New Zealand's igneous rock record

Interpreted subduction episodes



SUBDUCTION?

Yes

Maybe

No

Cz VOLCANICS (K-Ar, Ar-Ar)

Subduction-related
 Intraplate

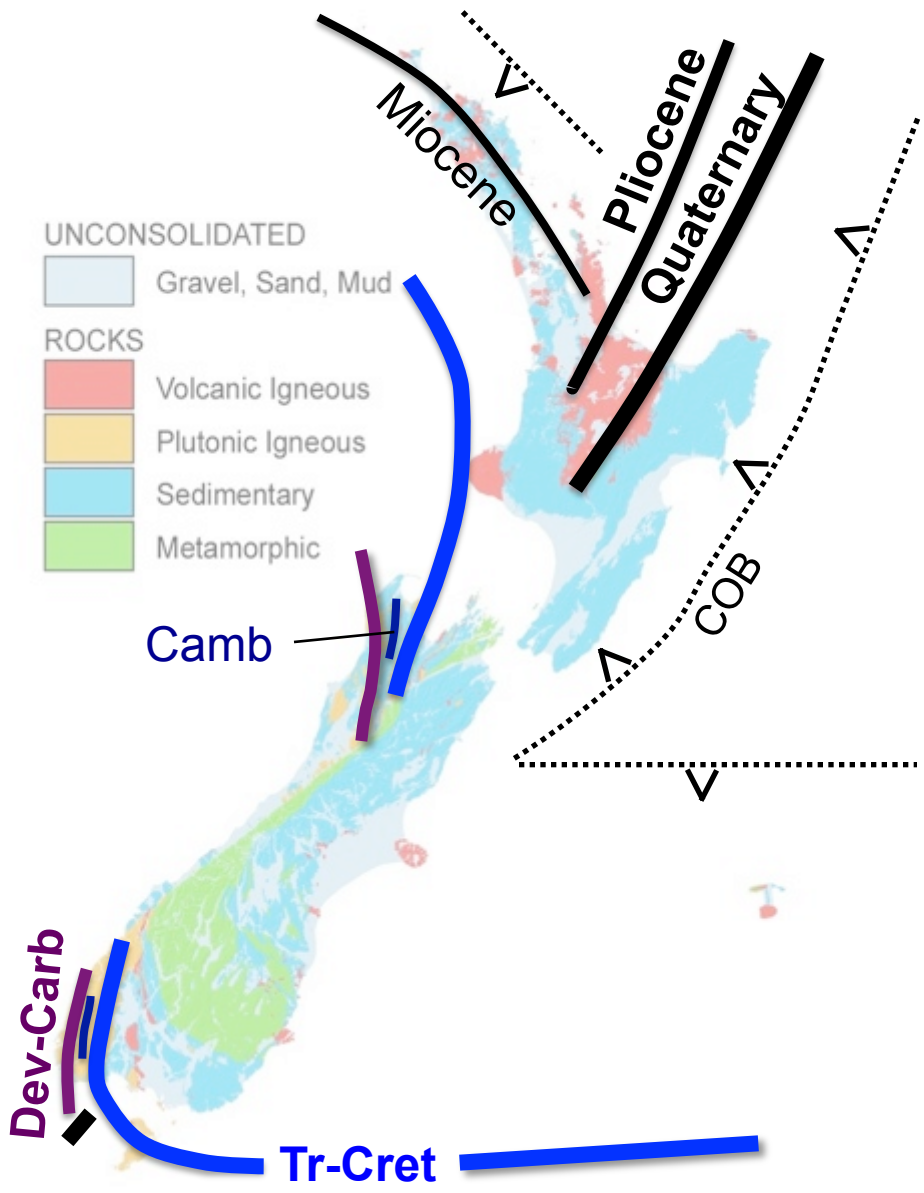
Mz-Pz BATHOLITH SUITES (U-Pb zc)

I-type
 Low Sr/Y
 High Sr/Y

S & IS-type
 Low Sr/Y

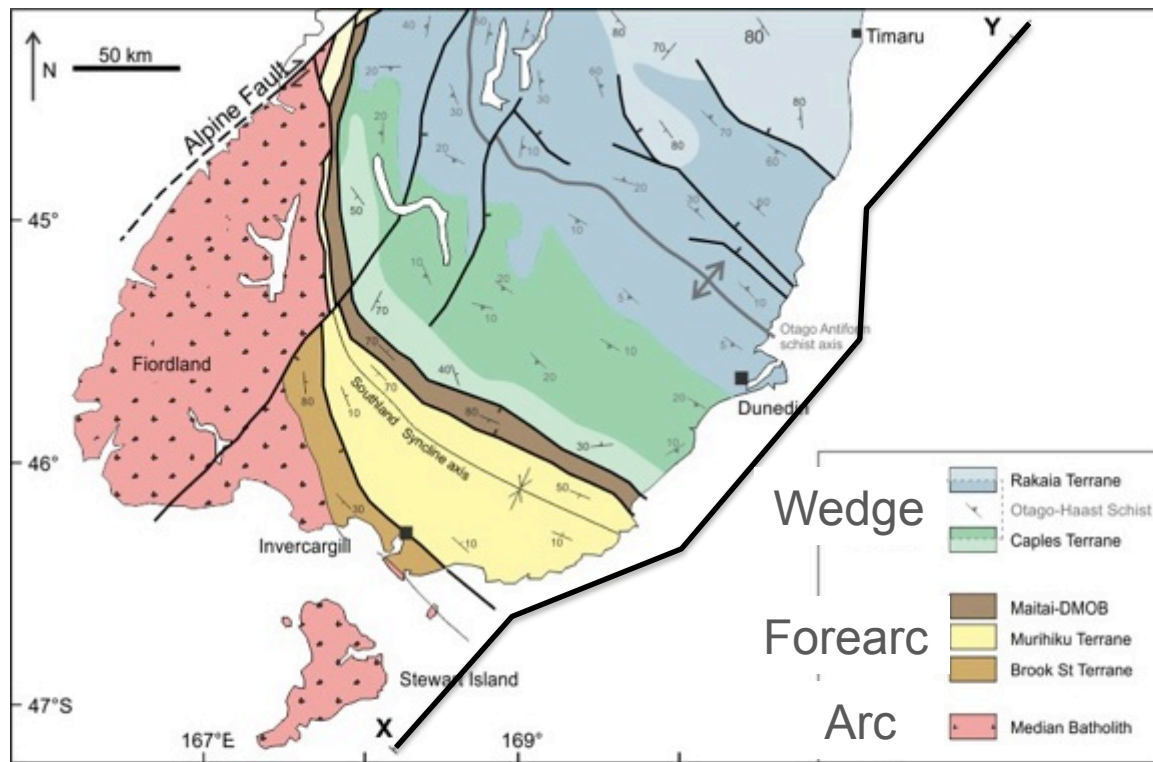
A-type

New Zealand's magmatic arcs

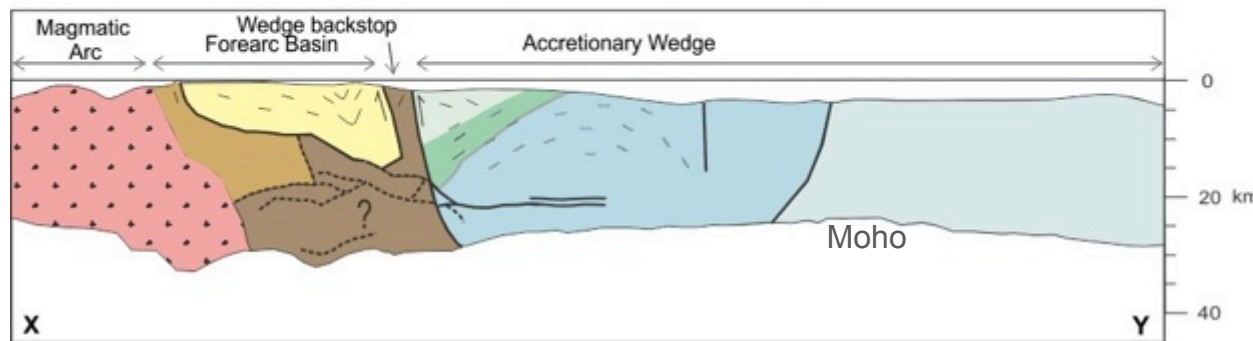


- different arcs give insights into different arc processes
- only some have associated FABs, accretionary wedges
- Cenozoic arcs founded on Mesozoic accretionary wedge
- ignore Pz, just talk about Mz, Cz subduction

Mesozoic orogen

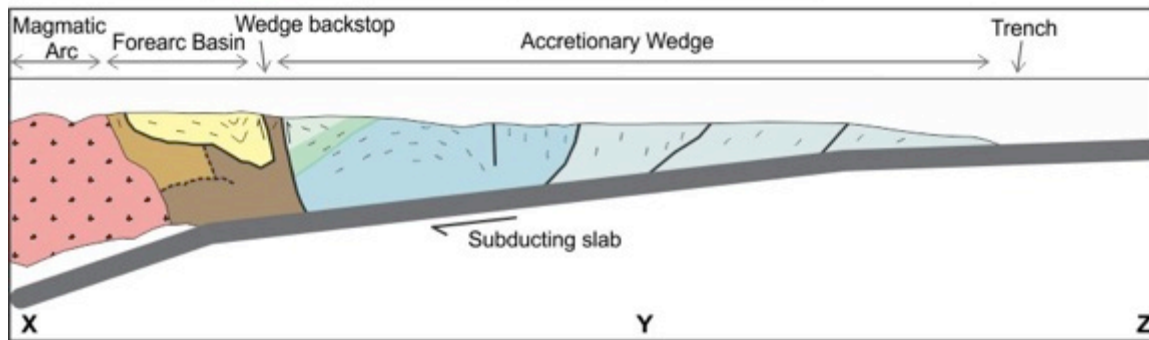
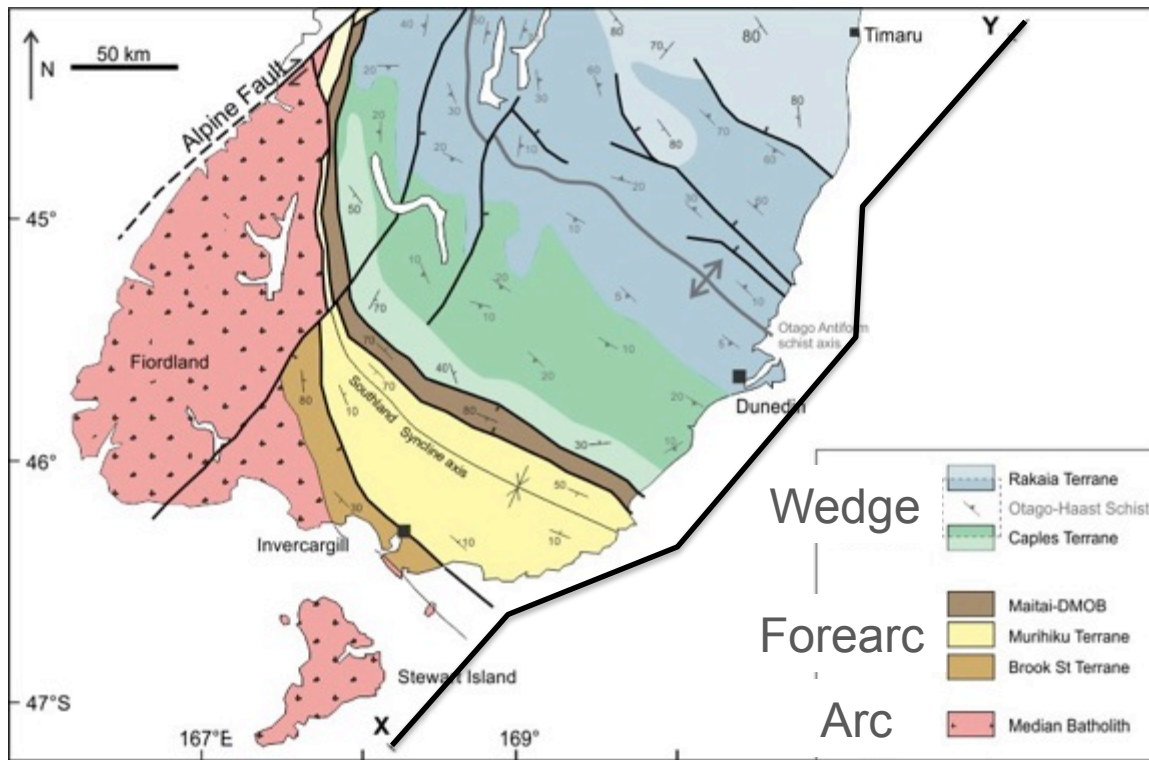


- Mz arc, forearc, wedge elements all in position



- crustal thickness affected by widespread extension

Mesozoic orogen

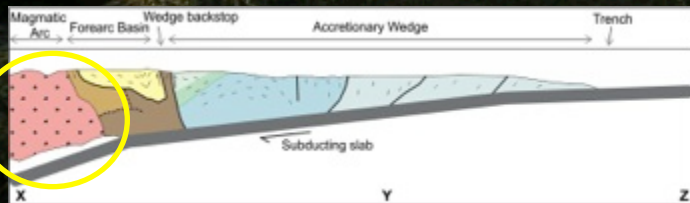


Arc Forearc

Wedge

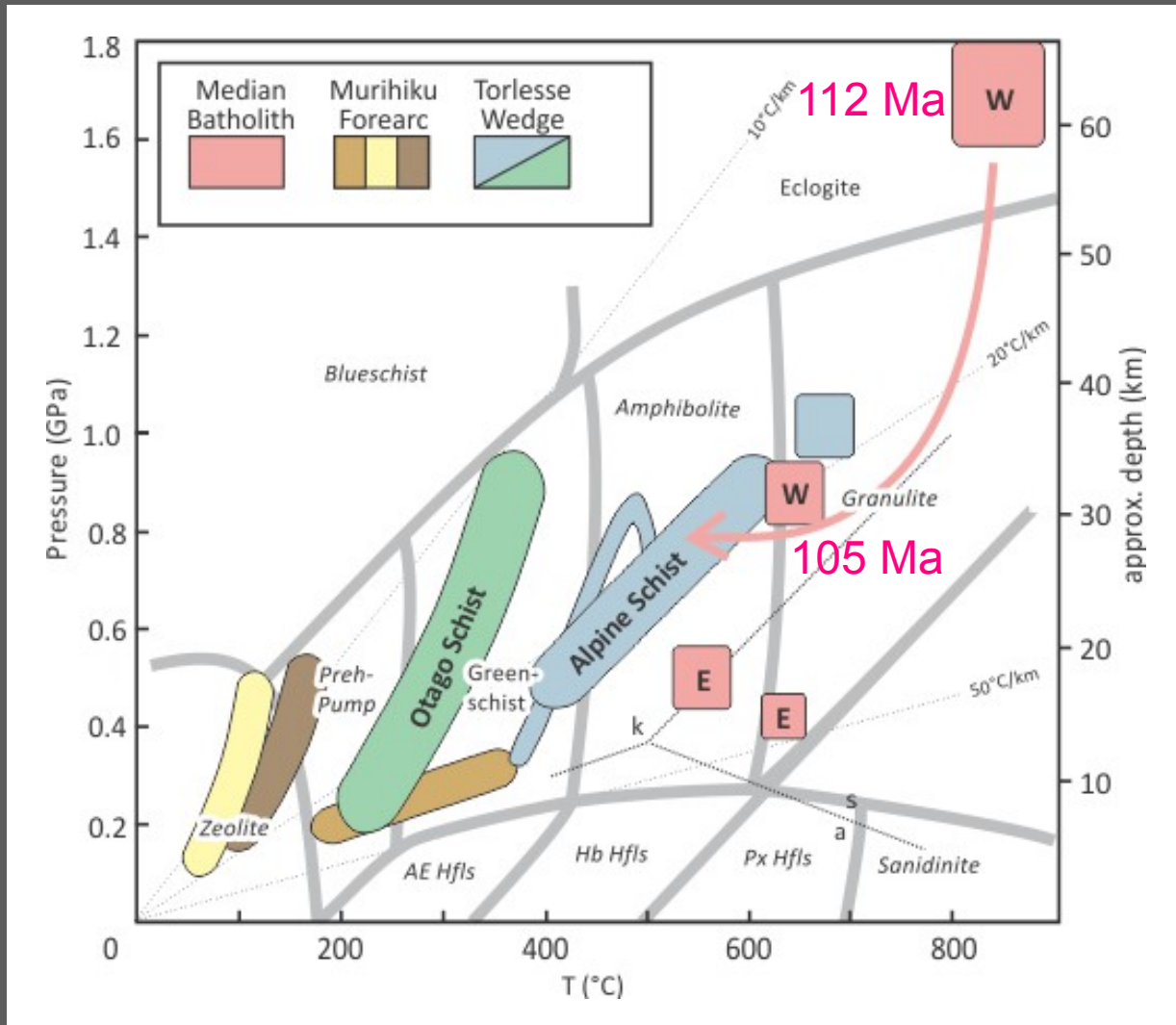
- preserved long-lived, convergent margin
- variably exhumed, so can study shallow and deep levels

The Mesozoic Arc



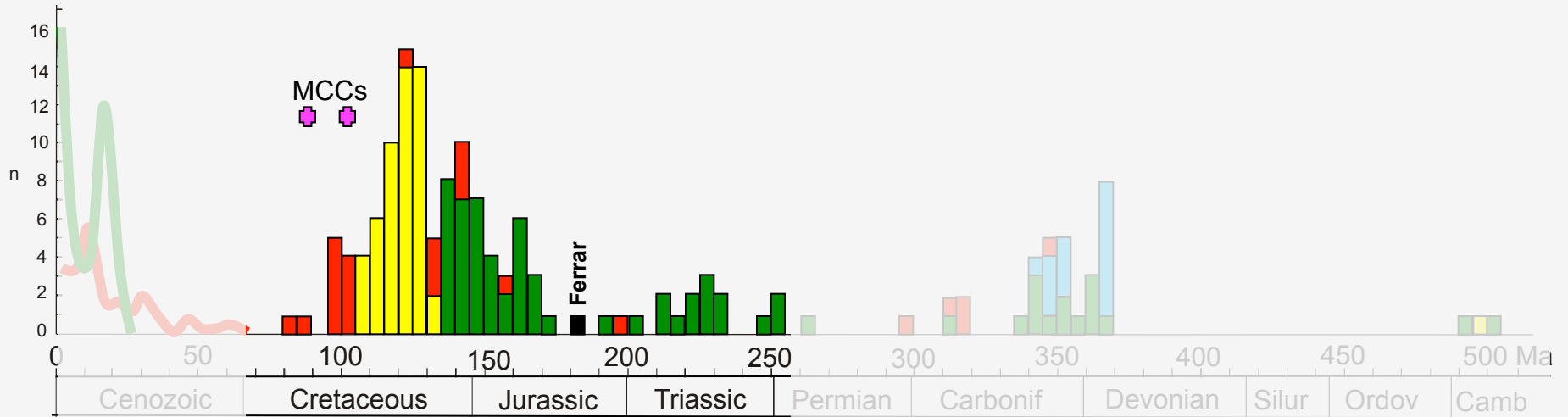
**Median Batholith = site of most NZ
Phanerozoic magmatism**

Thermobarometry



Mesozoic plutonic record

Interpreted subduction episodes



SUBDUCTION?

 Yes	 Maybe	 No
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Cz VOLCANICS (K-Ar, Ar-Ar)

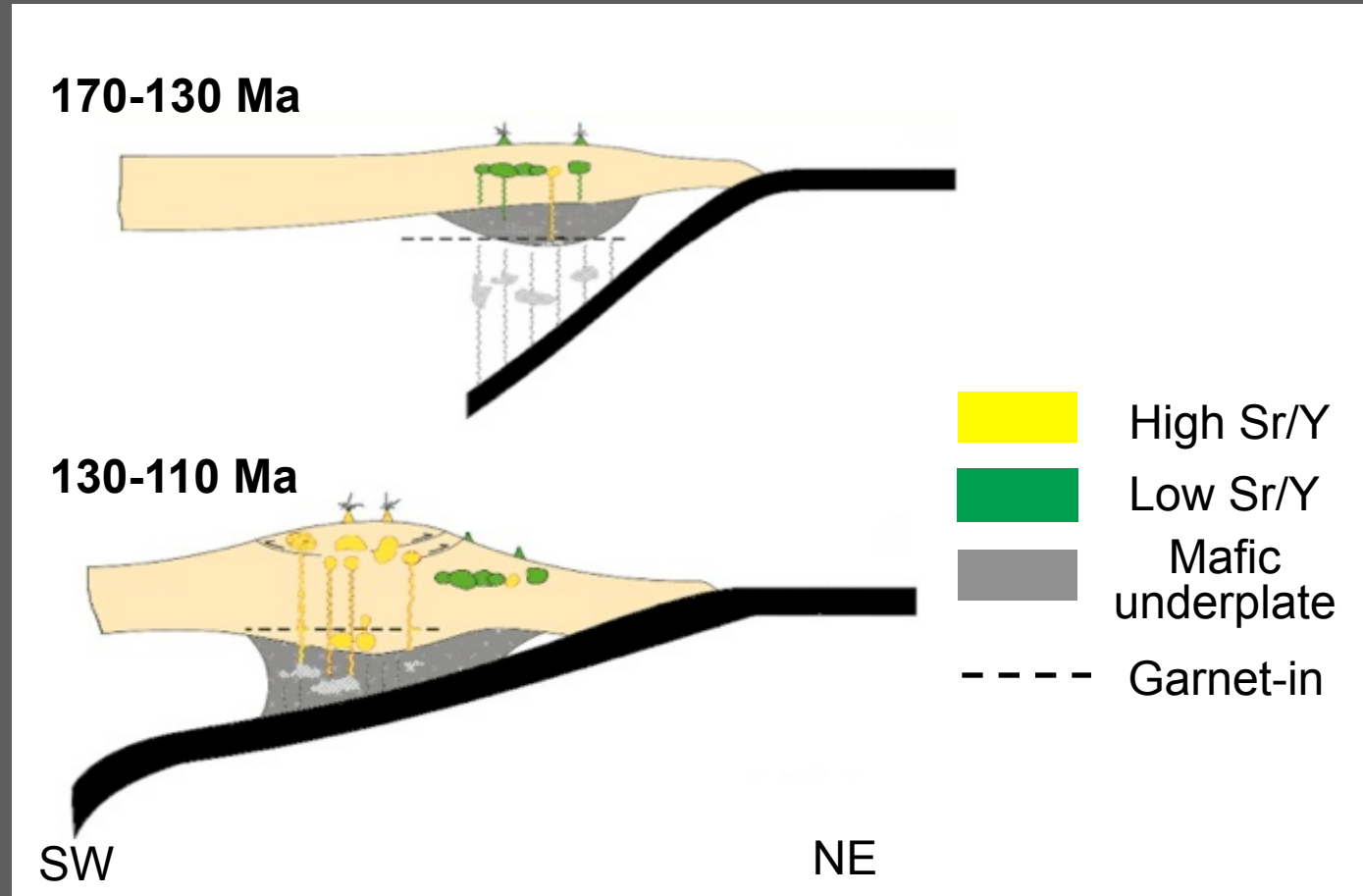
- Subduction-related
- Intraplate

Mz-Pz BATHOLITH SUITES (U-Pb zc)

- | | | |
|--|--|---|
| I-type | S & IS-type | A-type |
| Low Sr/Y | Low Sr/Y | |
| High Sr/Y | | |



Major change in Zealandia arc at c. 130 Ma



- thickening crust in maturing arc and/or flat slab subduction

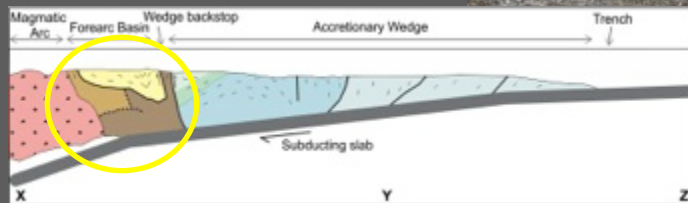
Mesozoic fore-arc basin



Monotis
205-212 Ma



- at least 13 km Murihiku Terrane strata over 120 m.y.
- marine and non-marine fossils
- zeolite facies



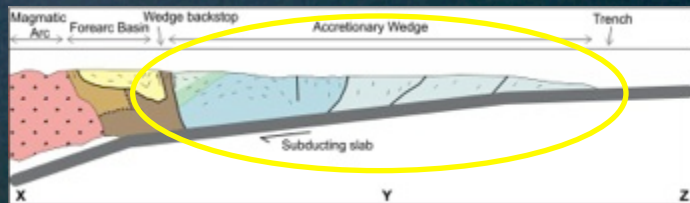
Curio Bay, 160 Ma
fossil forest

Mesozoic fore-arc basin

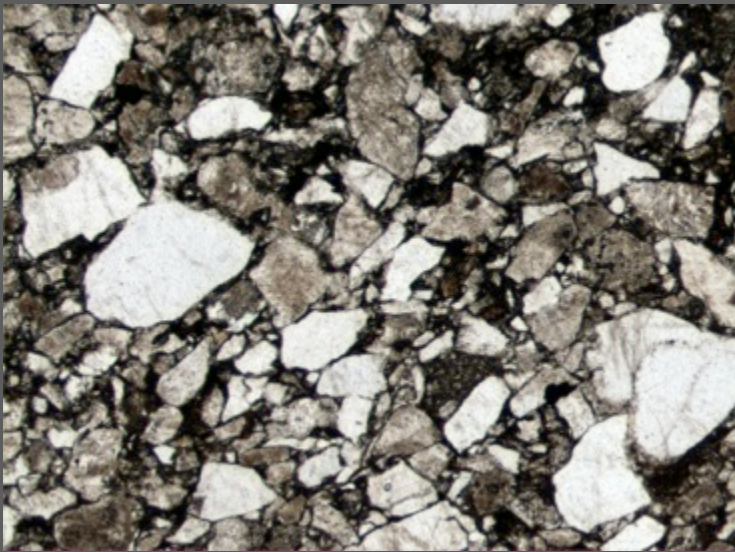


- in New Caledonia as well as New Zealand
- structurally simple
- provenance links to Median Batholith arc

Mesozoic accretionary wedge



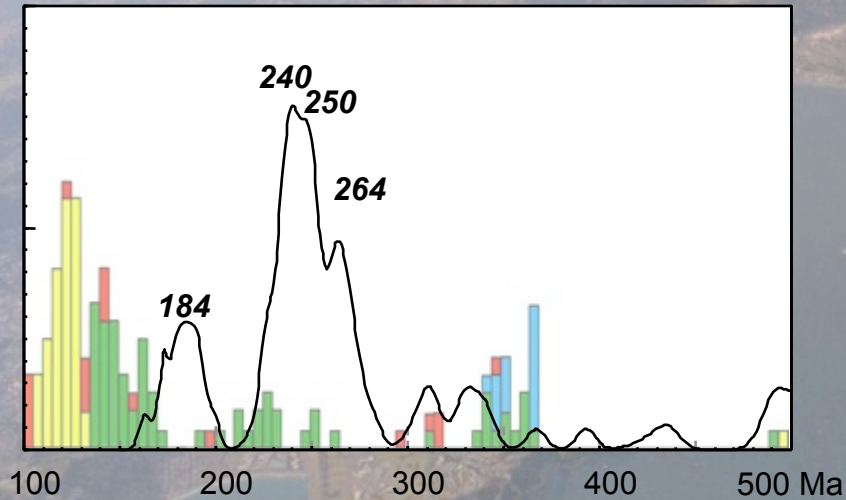
Mesozoic accretionary wedge



- first cycle sandstones
- different Perm-Cret basins accreted in wedge
- frontal accretion and underplating
- polyphase Jura-Cret schist overprint

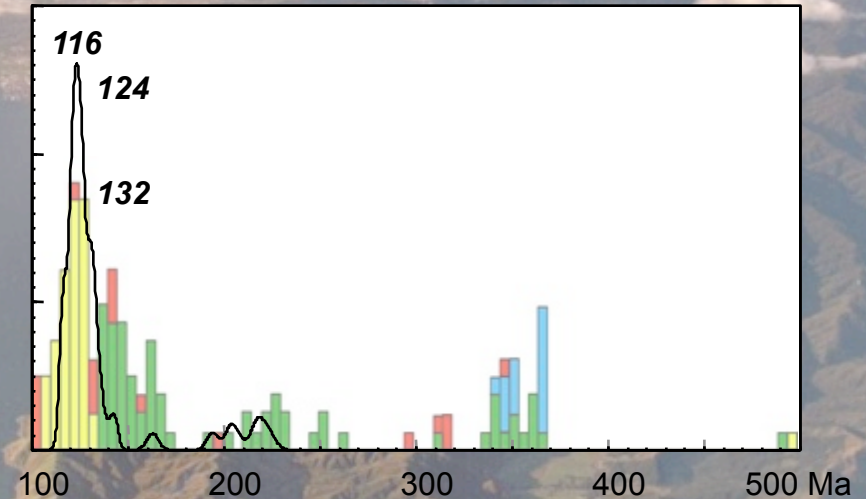
Exotic vs local provenance

Older Jura-Trias wedge



- detrital zircon peaks don't match NZ pluton chronology
- northern Queensland source

Younger Cretaceous wedge



- detrital zircon peaks do match NZ pluton chronology
- local Median Batholith source
- constrain time of wedge cessation

- **detrital zircon studies of Mesozoic accretionary wedge**

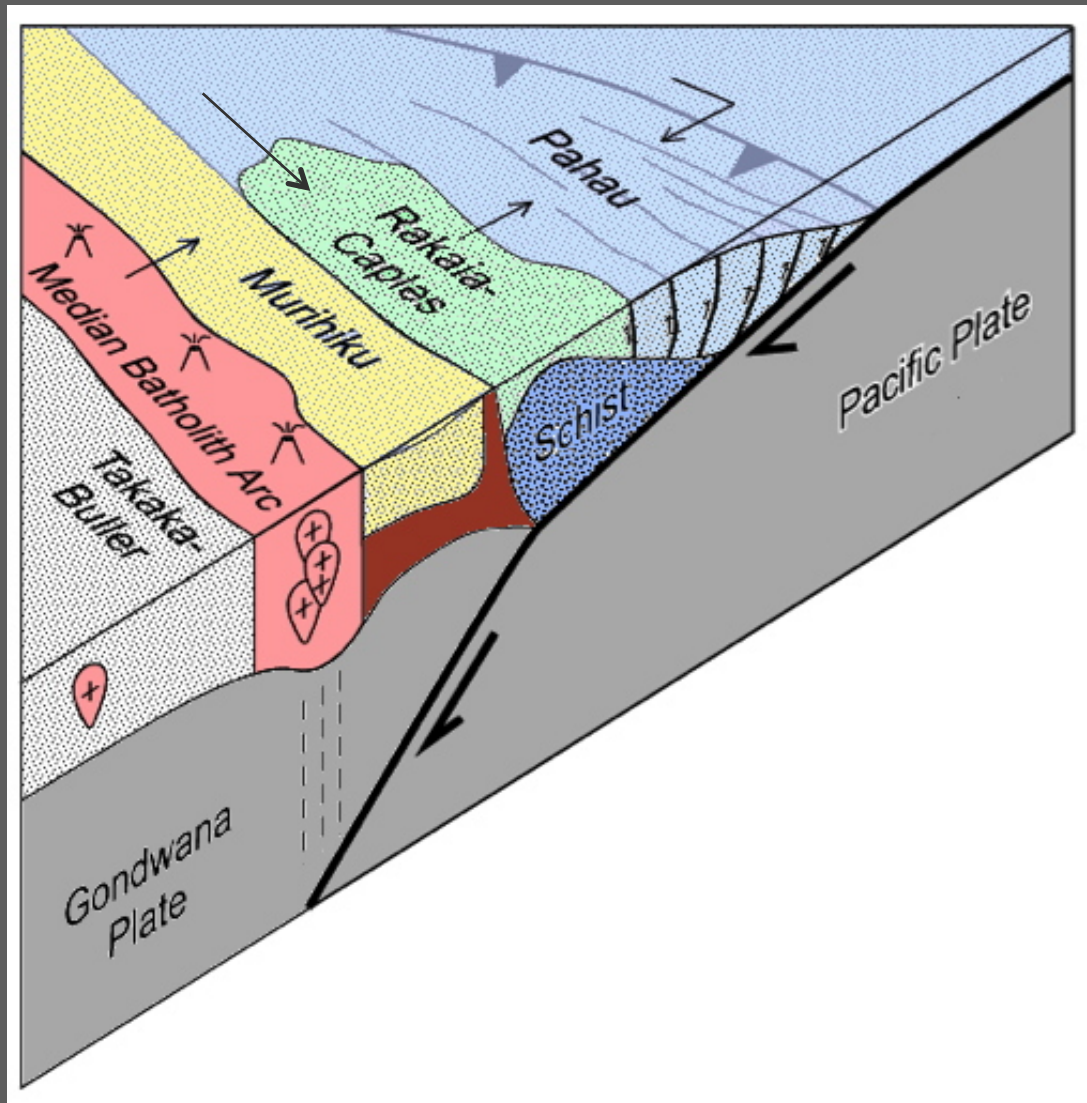




**Haast Schist:
an exhumed
accretionary
wedge**

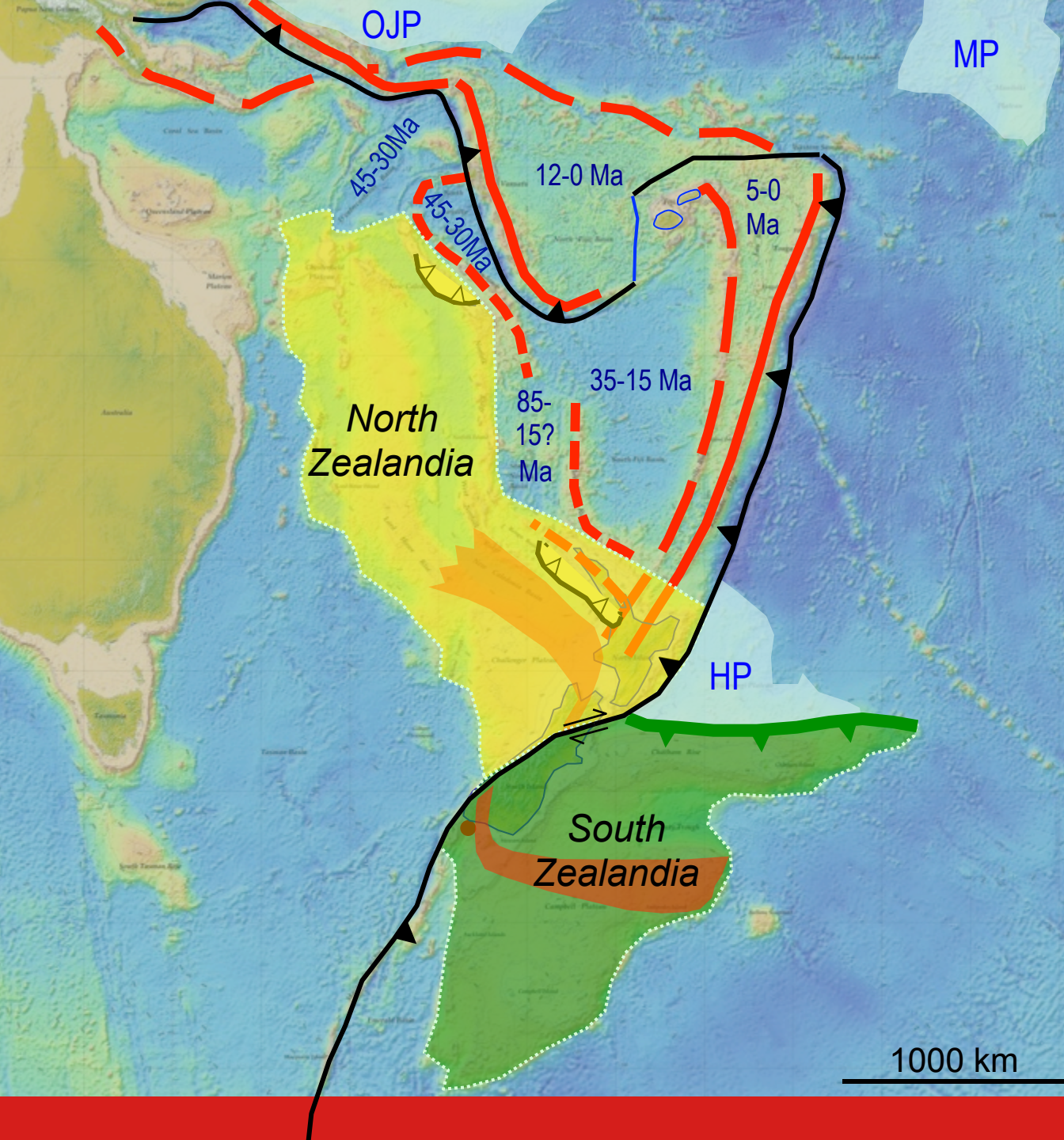
**quartz veins, fluids, mass balance, Ar-Ar, thermochronology,
PTt paths, c. 135 Ma exhumation & mesothermal Au-W**



Subduction termination




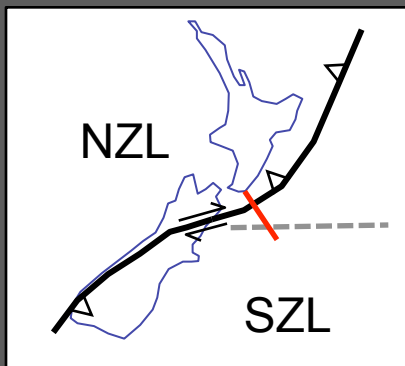
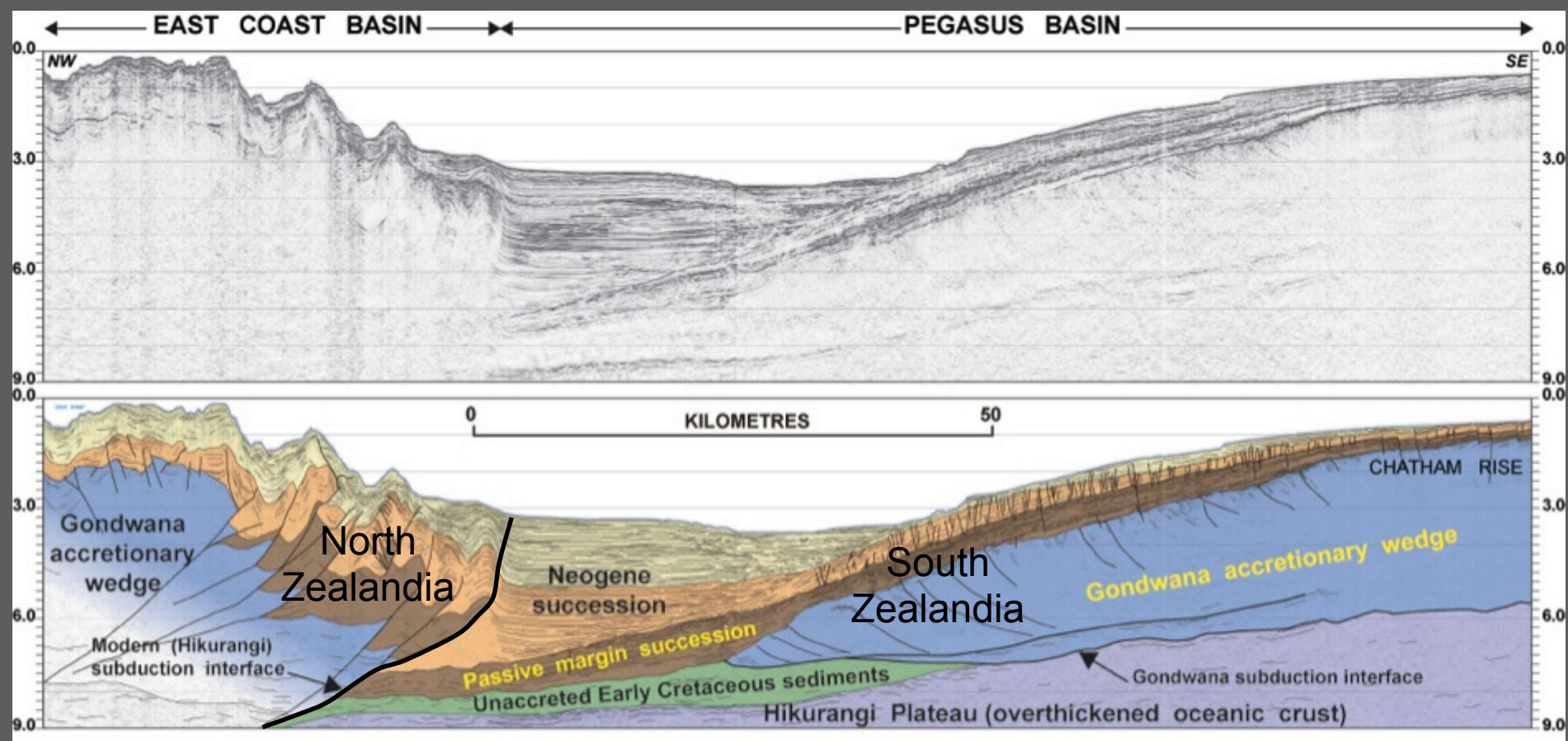
- 130, 105, 85 Ma?
- youngest rocks in arc and wedge c. 110 Ma
- oldest Zealandia intraplate c. 97 Ma
- reason = Hikurangi Plateau collision. Other models
- BUT – did it ever really stop to the north?

North vs South Zealandia



-  Cenozoic arcs
-  Cz allochthons with back-arc basin ophiolitic basalts

 12-0 Ma Age of back arc basin



SOUTH ZEALANDIA

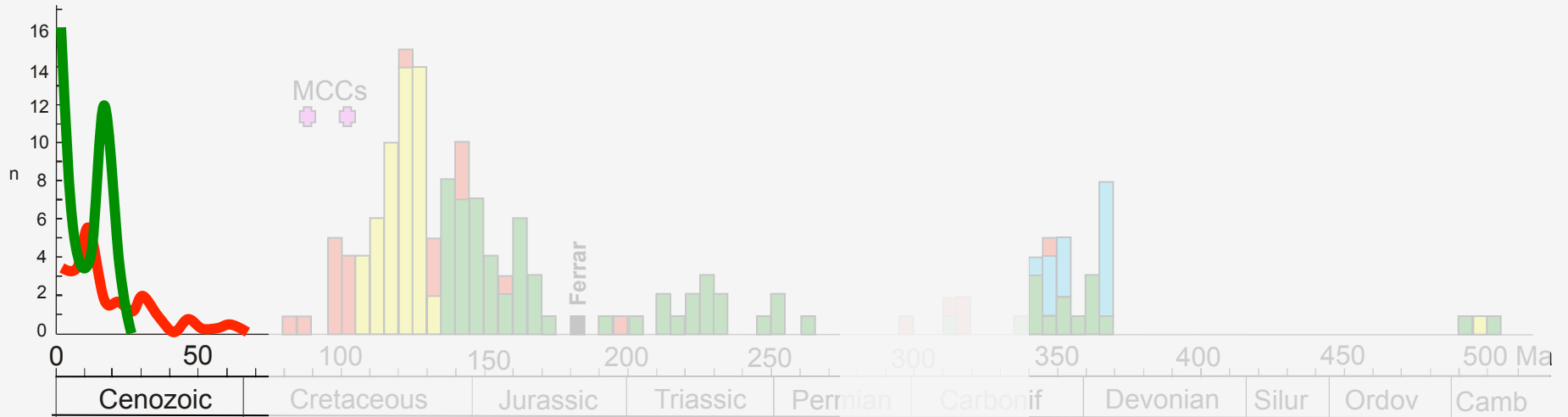
Subsiding, simple, passive, on Pacific Plate since 84 Ma

NORTH ZEALANDIA

Subsiding, but complex: arcs, back-arc basins, allochthons, ophiolites, (re) captured by Australian Plate

Cenozoic volcanic record

Interpreted subduction episodes



SUBDUCTION?

Yes

 Maybe

 No

Cz VOLCANICS (K-Ar, Ar-Ar)

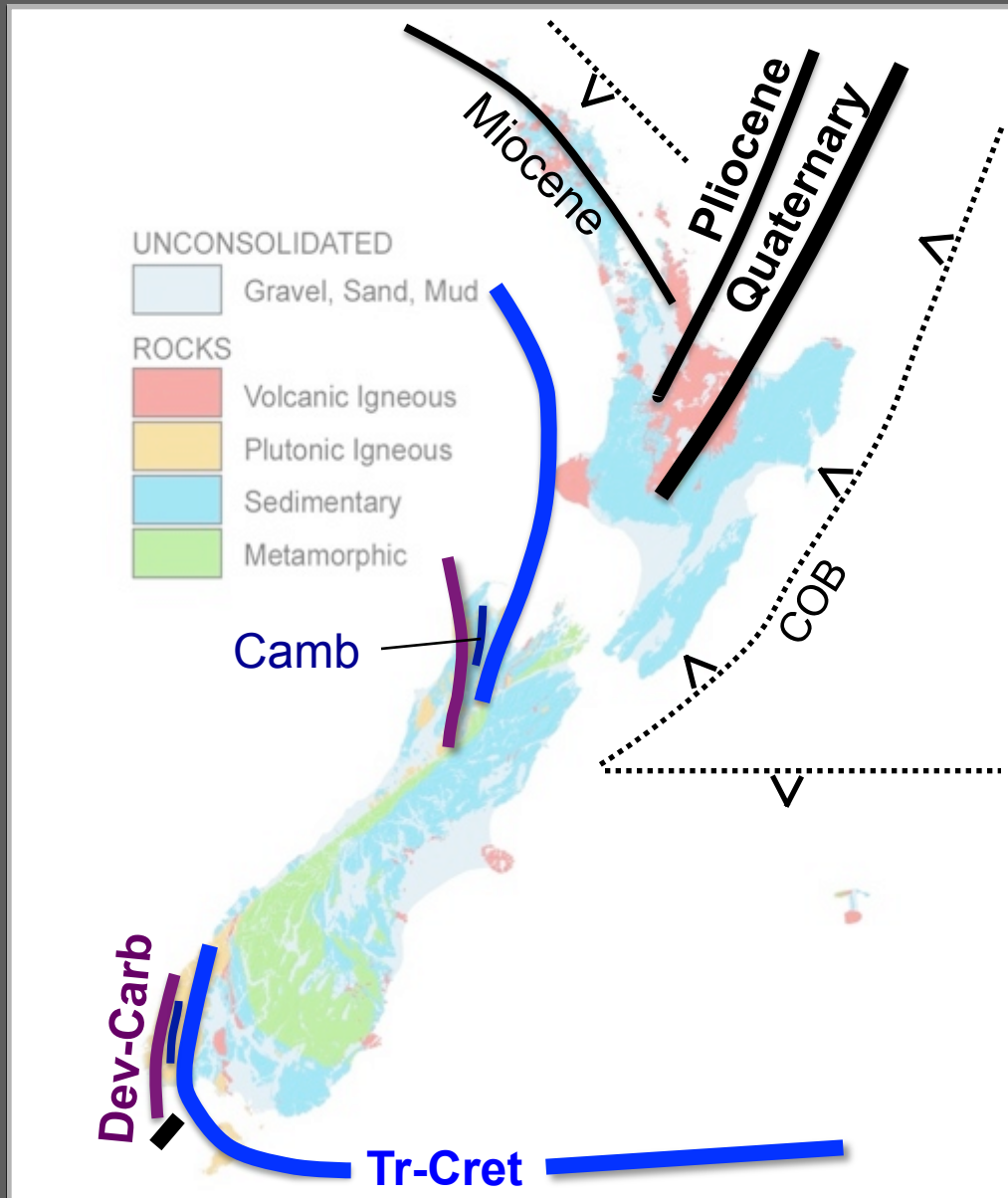
Subduction-related = NORTH
 Intraplate = SOUTH

Mz-Pz BATHOLITH SUITES (U-Pb zc)

I-type Low Sr/Y
 S & IS-type Low Sr/Y
 A-type

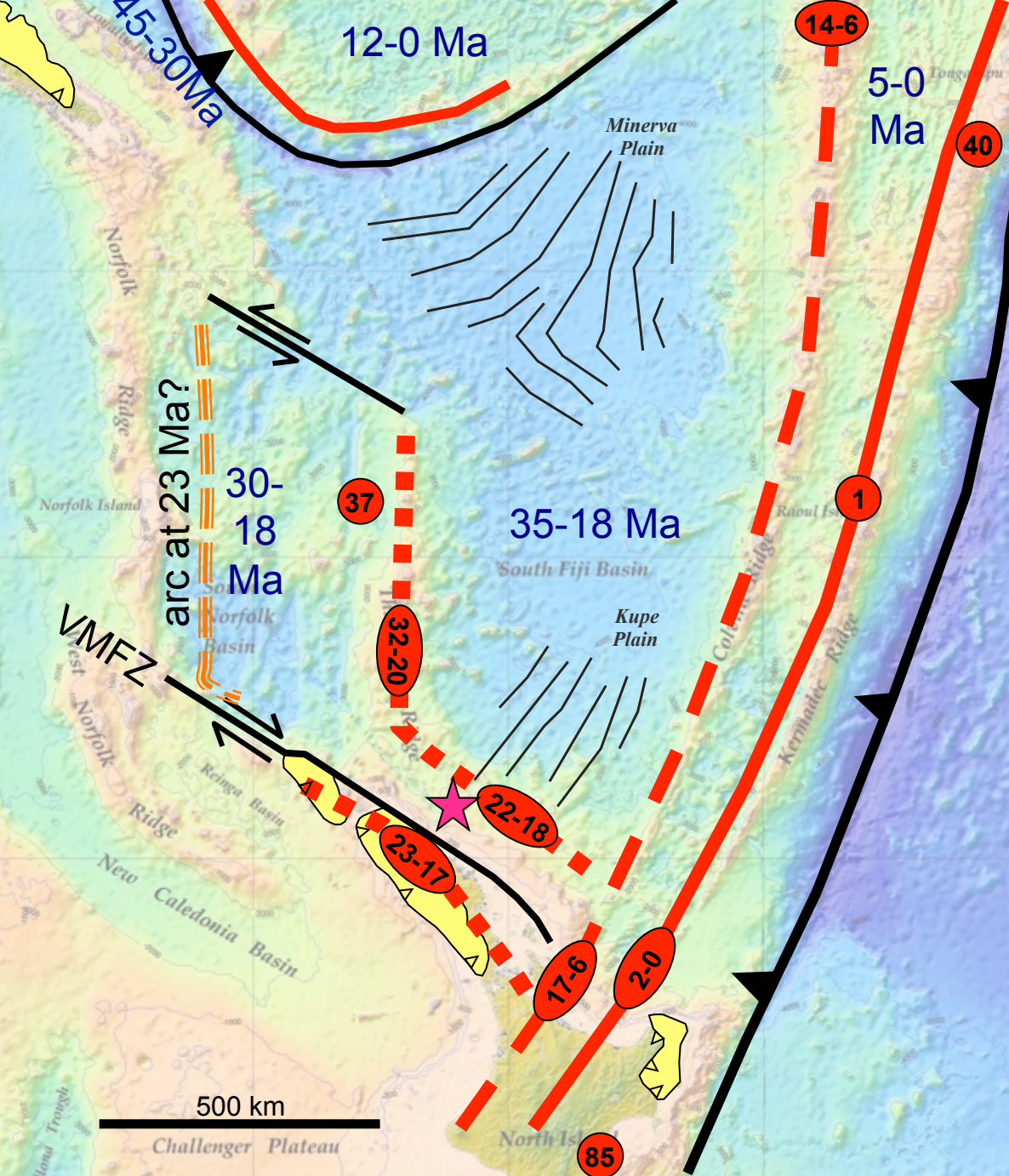
High Sr/Y

Onland Cenozoic arc footprint



- volcanic levels exposed onland
- migration in space and time
- age and cause of inception near NZ is speculative

Arc footprints offshore

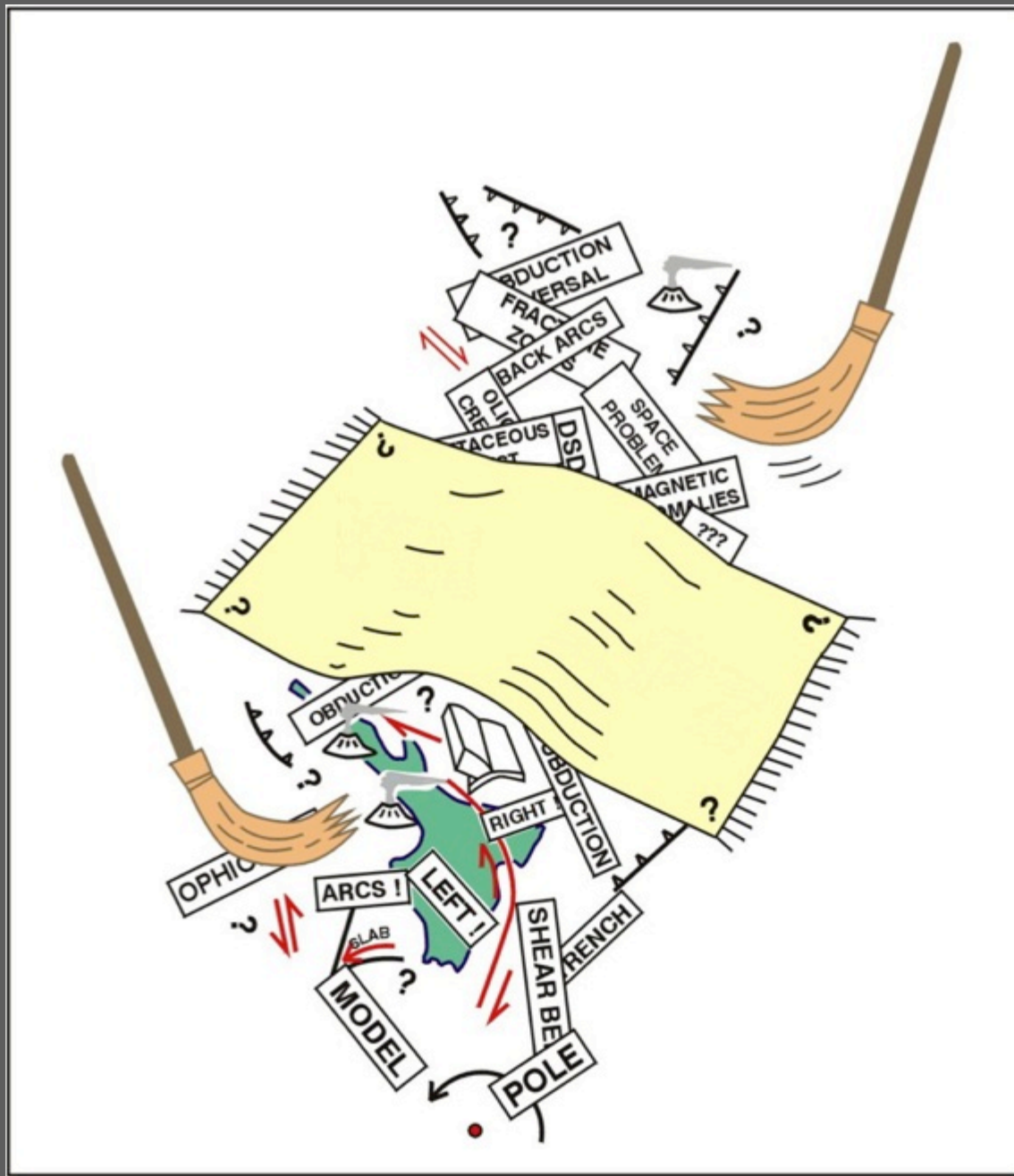


- 0-2 Ma
- - - 6-17 Ma
- · · 17-23 Ma

★ 20 Ma MCC

▲ Ophiolite allochthon emplaced 25 Ma

- 23-18 Ma = rapid trench rollback to east
- pre-23Ma initiation = uncertain time and mechanism



New Zealand National Databases

The screenshot displays the PETLAB Database web interface. The browser address bar shows `pet.gns.cri.nz/worldMap.jsp`. The page features a navigation menu on the left with options like 'PETLAB Home', 'Quick Start', 'About', 'Partners', 'FAQ', 'Simple Query', 'Advanced Query', 'Saved Queries', 'Interactive Map', 'Data Entry', 'Contacts and Links', 'Terms and Conditions', 'Database Administration', and 'Login'. The main content area is titled 'Matching Locations' and shows a map of New Zealand with numerous colored markers representing sample locations. A pop-up window for 'PETLAB Sample' provides details for sample 15162: Type: Victoria University, Number: 15162, Collector(s): Palmer, A.S., Date: 1979-12-12, and a link for 'WFS Query'. A 'Layers' panel on the right allows users to toggle various data layers, including GNS P, GNS R, Geophysics Div, NZGS Sed Lab, GNS Core, GNS Dredge, Auckland University, Waikato University, Massey University, Victoria University, Canterbury University, Otago University, ANU, DEVORA, WIOF, and other. A scale bar indicates 10 km and 5 mi, and the map's coordinates are Longitude: 175.17981, Latitude: -41.20731. Below the map, instructions for zooming and panning are provided.

Double-click to zoom in, and drag to pan. Hold down the shift key and drag to zoom to a particular region.
Drag layers in the legend to change the plot order of collections' points.
Use the layer switcher in the top right hand corner (+ sign) to change map backgrounds.

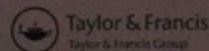
QMAP data.gns.cri.nz/geology
1:250K geol map data

PETLAB pet.gns.cri.nz
Rocks, analyses

FRED fred.org.nz
Fossils

NEW ZEALAND JOURNAL OF GEOLOGY AND GEOPHYSICS

An International Journal of Pacific Rim Geoscience



NEW ZEALAND JOURNAL OF GEOLOGY AND GEOPHYSICS

Volume 55 Number 3 September 2012

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Guest Editors: J Townend, P Villamor and M Quigley

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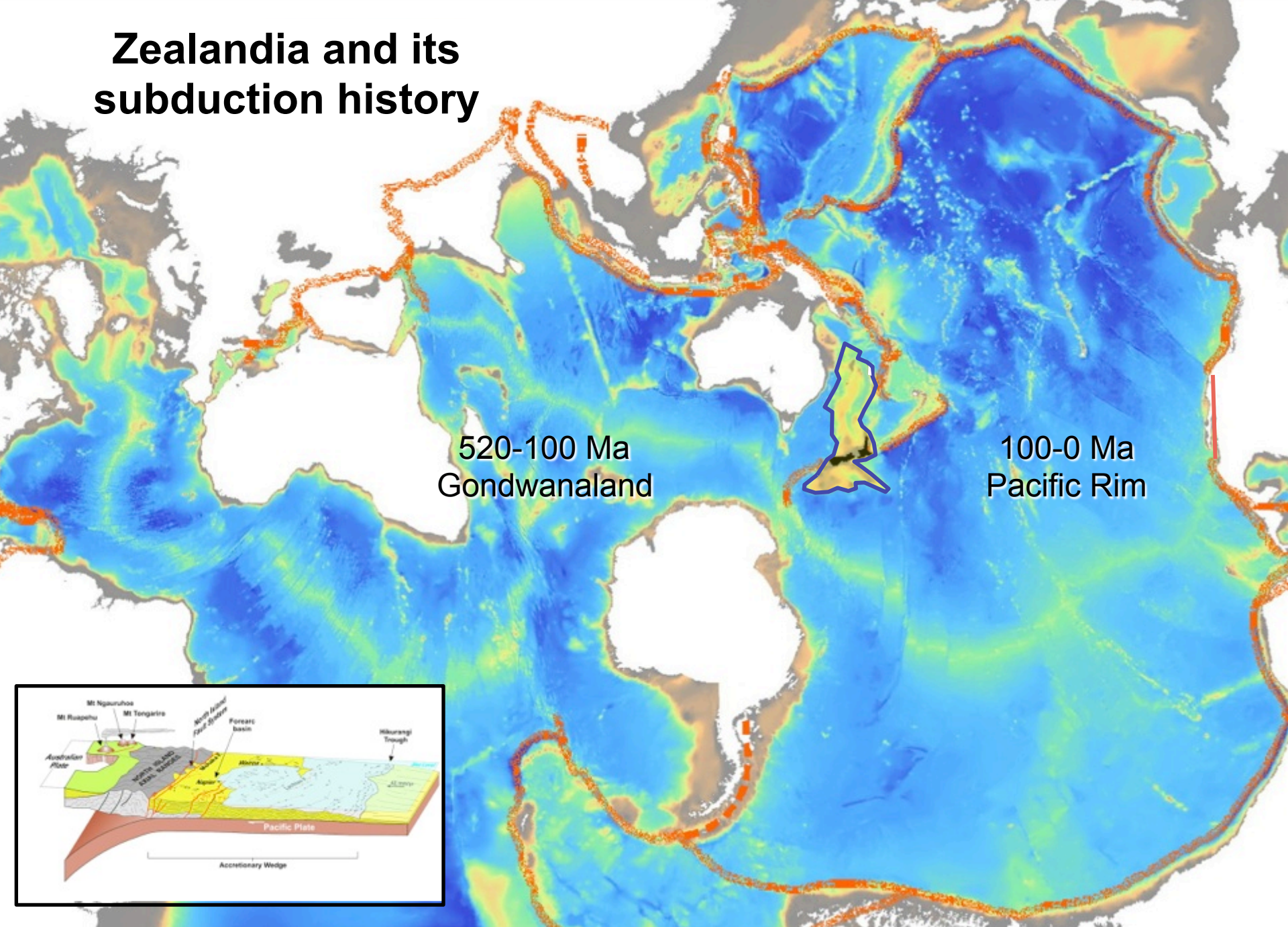
Map of the 2010 Greendale Fault surface rupture, Canterbury, New Zealand: application to land use planning

P Villamor, N Litchfield, D Barrell, RV Dissen, S Hornblow, M Quigley, S Levick, W Ries, B Duffy, J Begg, D Townsend, T Stahl, E Bilderback, D Noble, K Furlong and H Grant 223

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Zealandia and its subduction history



520-100 Ma
Gondwanaland

100-0 Ma
Pacific Rim

