Magnetotelluric imaging studies of the Hikurangi margin – from arc to forearc

Mount Hikurangi - Raukumara Range

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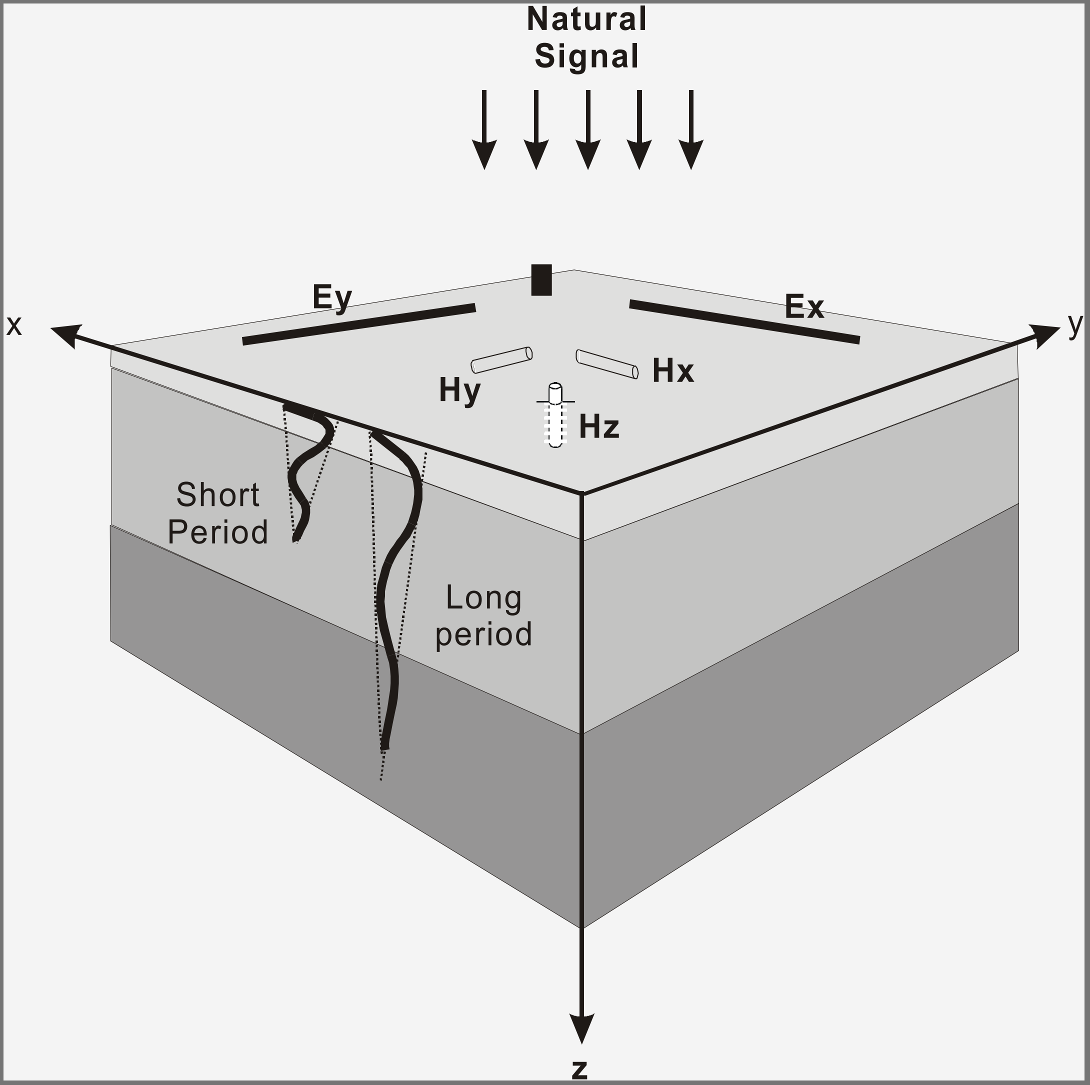
The magnetotelluric (MT) method

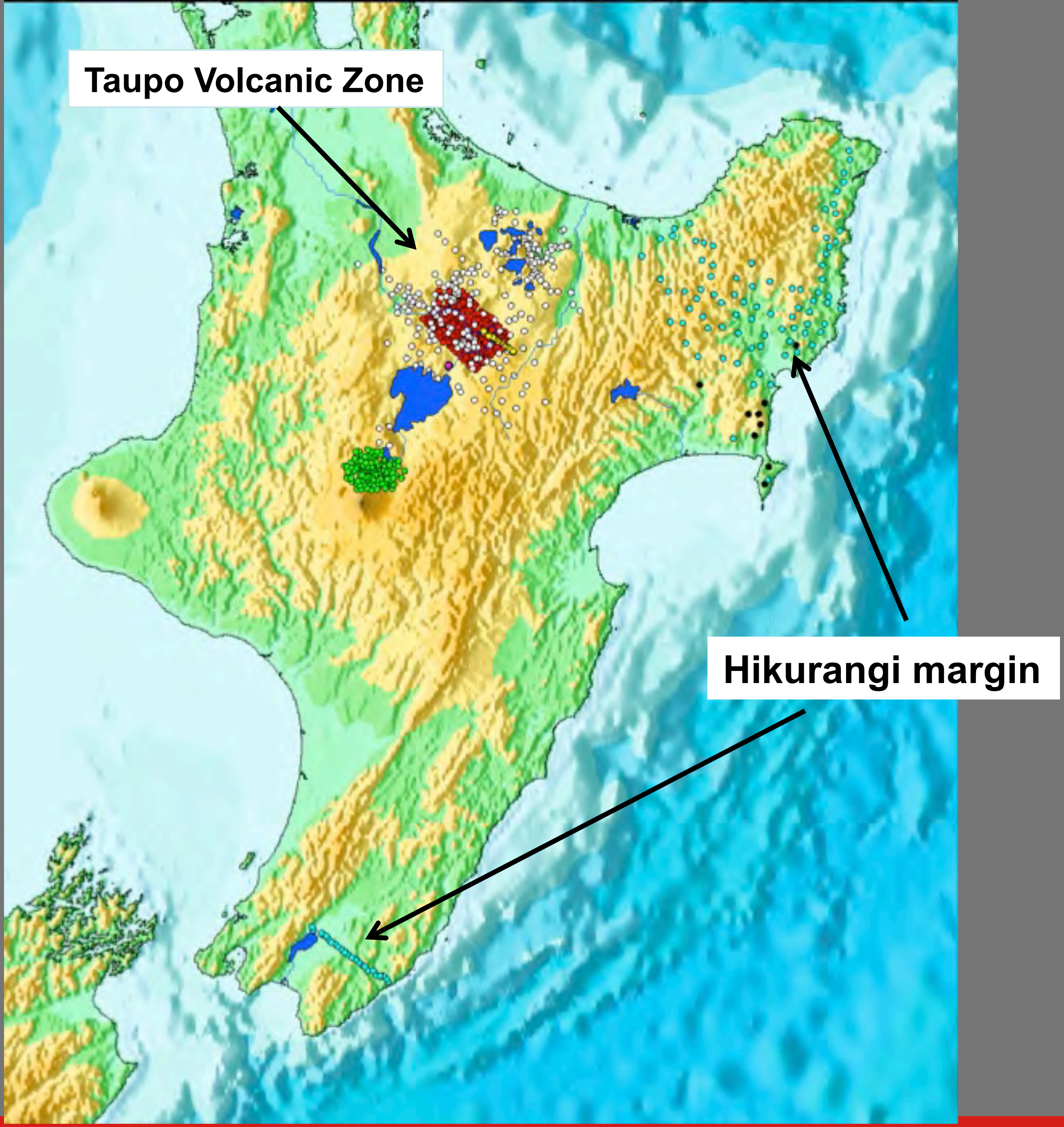
Surface recordings of the natural, time varying electric (E) and magnetic (H) field vectors.

MT data are the magnitude and phase relationships of E and H in frequency-domain (period-domain).

The phase relationship between the horizontal components of E and H is a tensor (Φ) which expresses the polarization dependence of the phase.

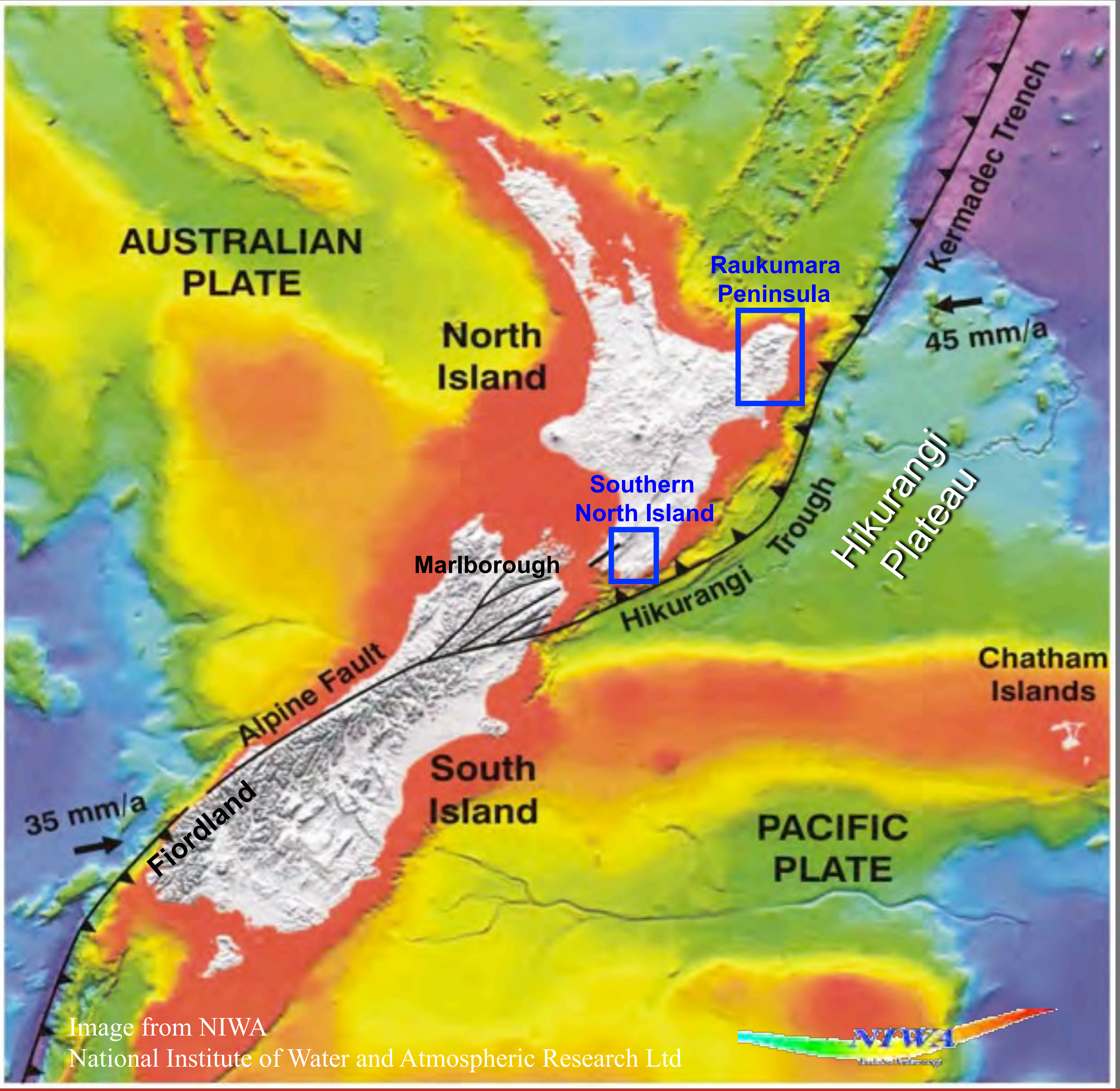
Relationship between vertical and horizontal components of H is expressed by the 'induction vector'.




Taupo Volcanic Zone
Hikurangi margin

Hikurangi subduction margin – tectonic setting

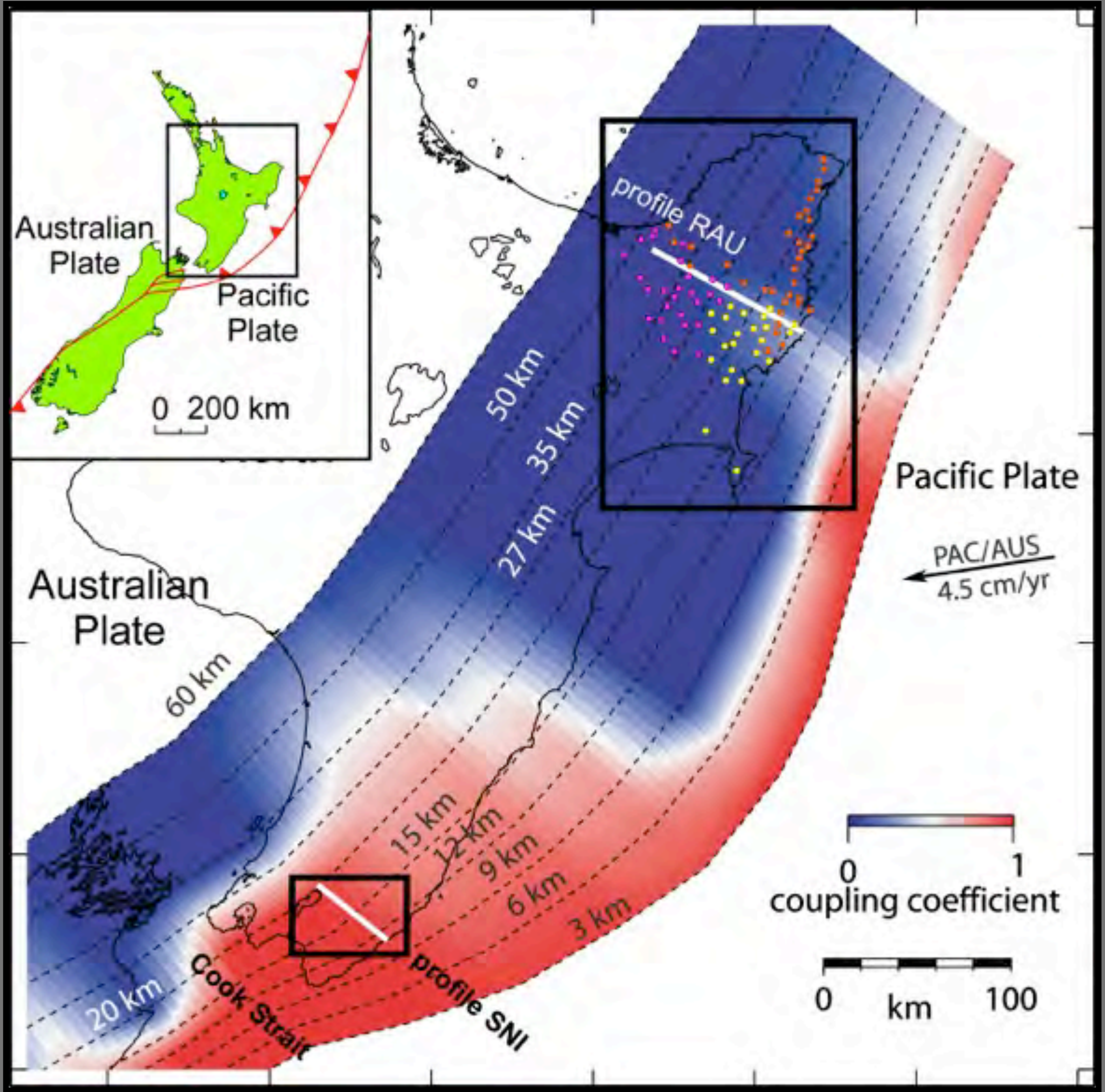
- Oblique subduction of the Hikurangi Plateau (Pacific plate) beneath the North Island (Australian plate)
- Convergence rate at trench decreases from north to south
- Upper plate is sediment rich. Thickness of sediment increases southward
- Tomographic evidence for abundant fluids in the upper plate in the northern and central part of the margin



Seismic coupling of the Hikurangi subduction margin

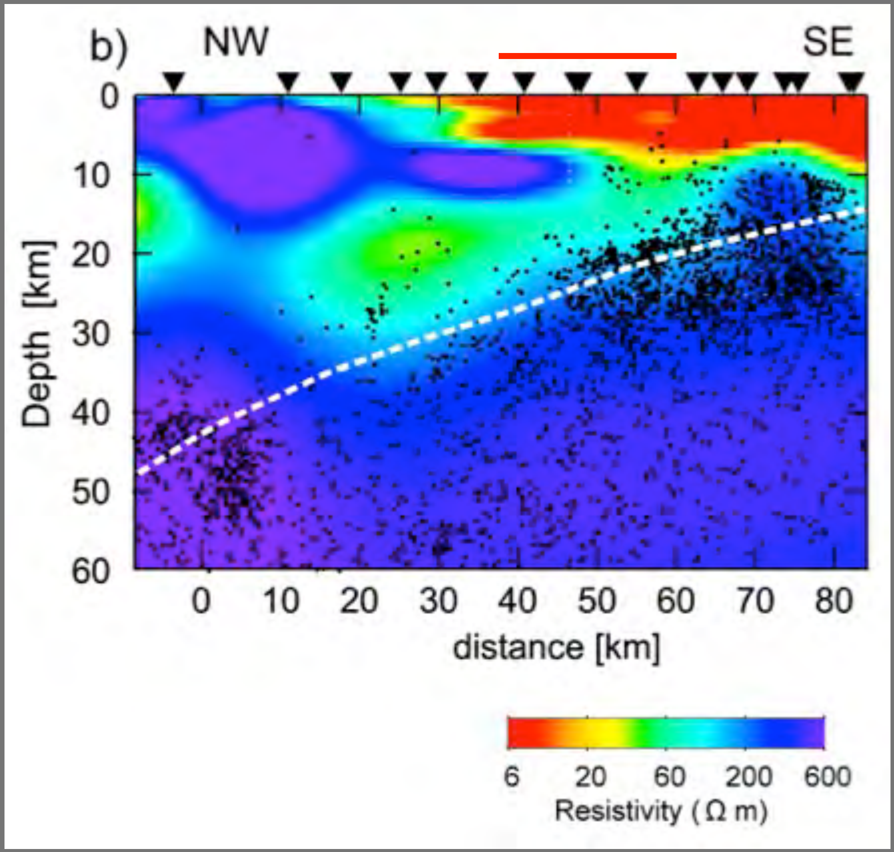
Fault locking using campaign GPS velocities averaged over the last ~15 years

MT survey of 84 soundings in the north, profile of 34 MT soundings in the southern part of the margin

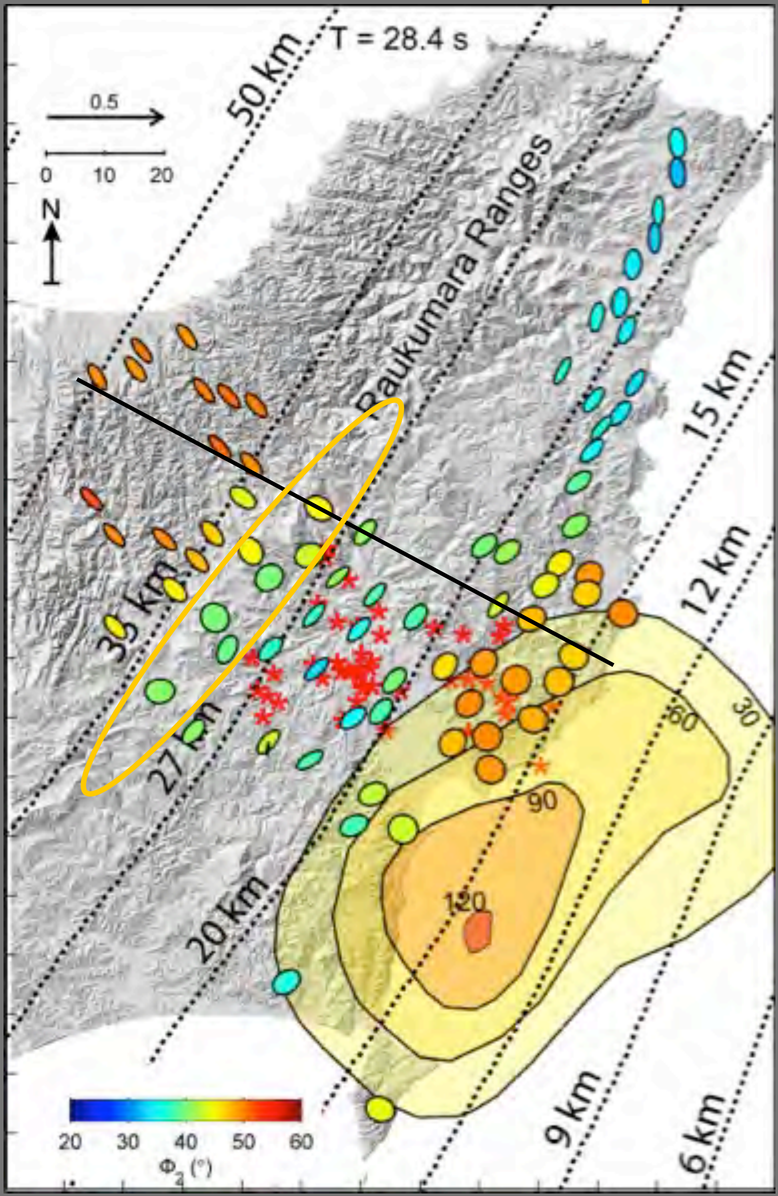


After Wallace and Beavan , 2010

Seismic tremor associated with March 2010 – Gisborne slow slip event from Kim et al. *GRL* (2011)



March 2010 tremor projected onto the resistivity model



* Tremor during/prior to slow slip

NW – SE slice though 3-D resistivity model

MT data inverted using 3-D inversion code of (Siripunvaraporn, 2006)
7th iteration rms: 1.2

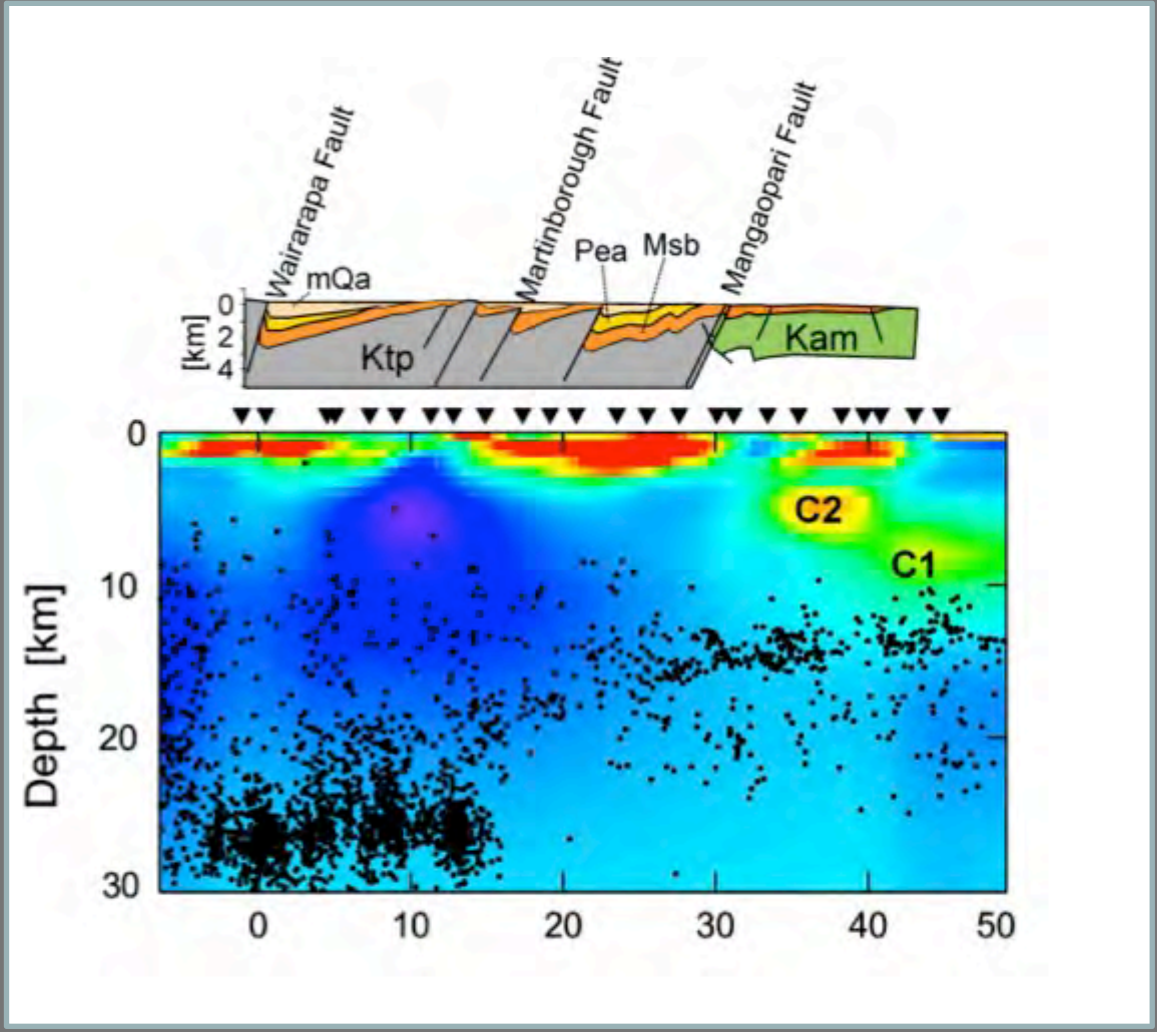
Black dots show earthquake hypocenters in 25 km either side of the MT profile.

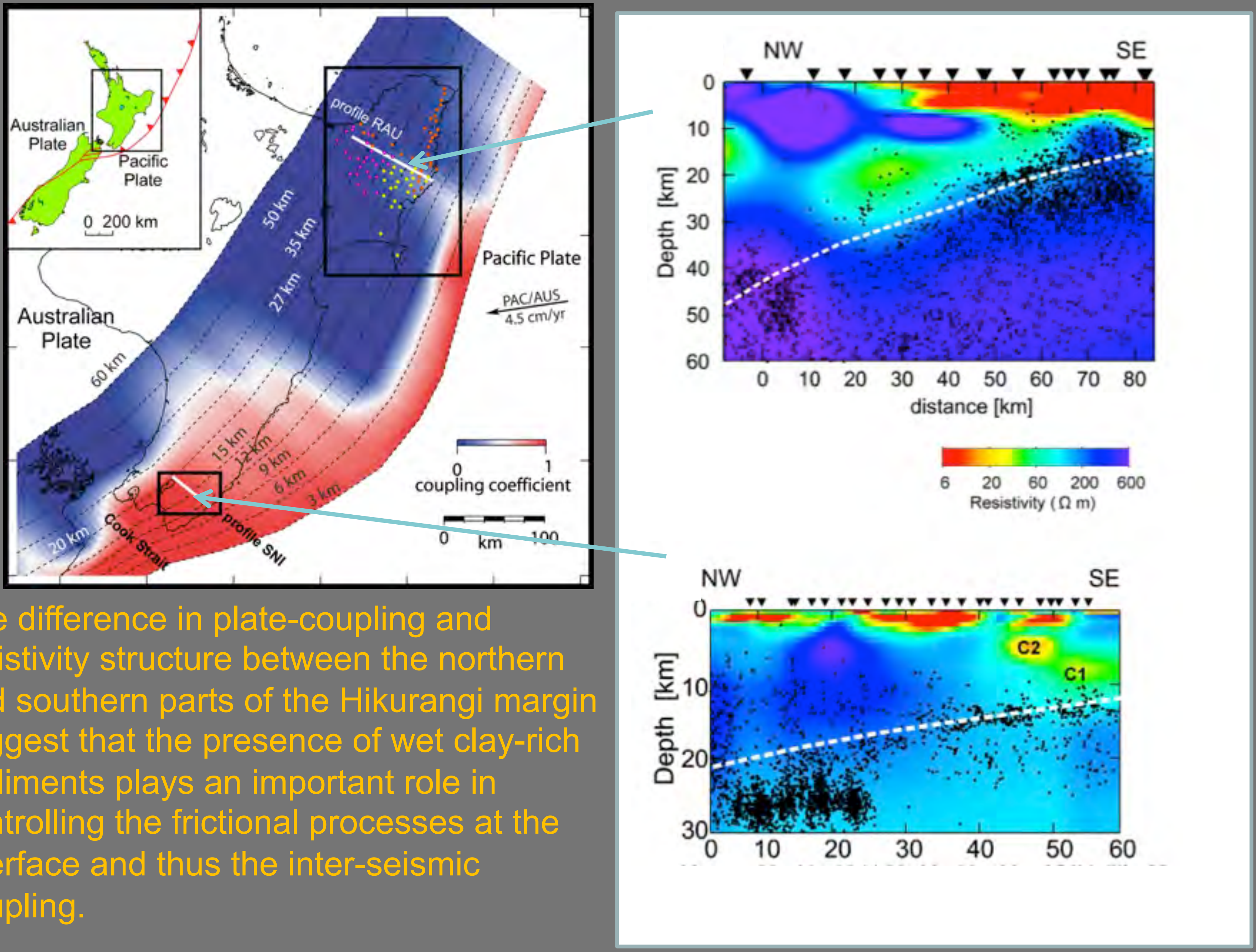
Key results

Thick layers of conductive sediments in good agreement with surface geology.
C1/C2 conductors related to dewatering of sediments

No obvious conductor above the plate interface

Down going plate seems less resistive than in the north





The difference in plate-coupling and resistivity structure between the northern and southern parts of the Hikurangi margin suggest that the presence of wet clay-rich sediments plays an important role in controlling the frictional processes at the interface and thus the inter-seismic coupling.

Conclusions

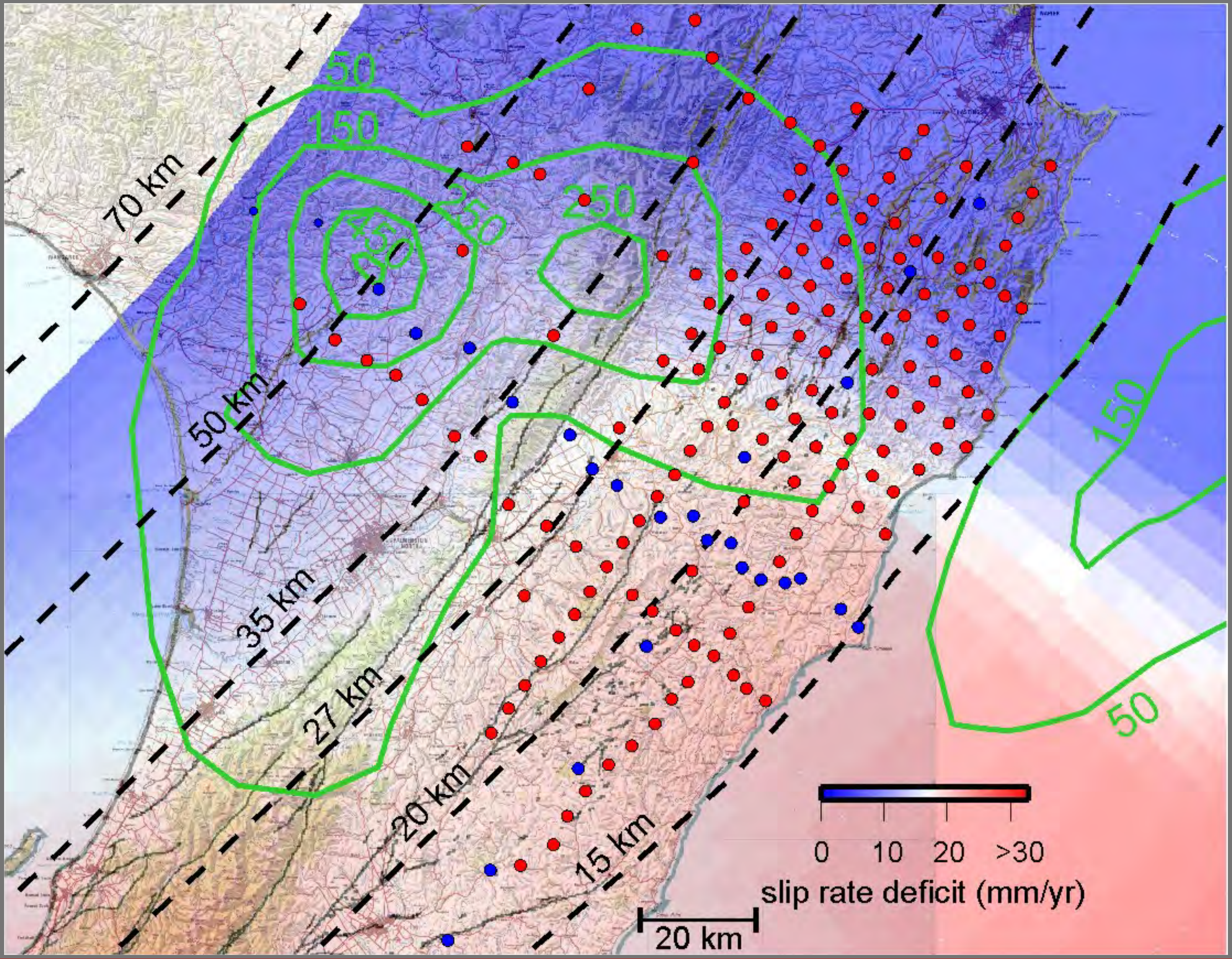
- **Northern part of the margin (weakly coupled):**
- Low resistivities indicate the presence of wet, clay rich sediment on the interface and in the upper plate.

- **Southern part of the margin (strongly coupled):**
- **Different** from the northern part, no obvious conductor along the plate interface suggesting less or no subducted sediment

- **The difference in plate-coupling and resistivity structure between the northern and southern parts of the Hikurangi margin suggest that the presence of wet clay-rich sediments plays an important role in controlling the frictional processes at the interface and thus the inter-seismic coupling.**

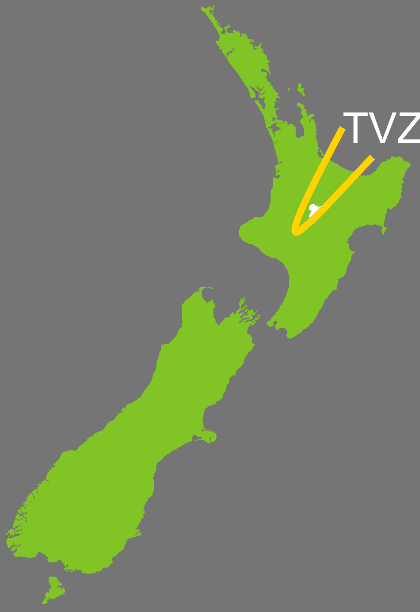
Future work

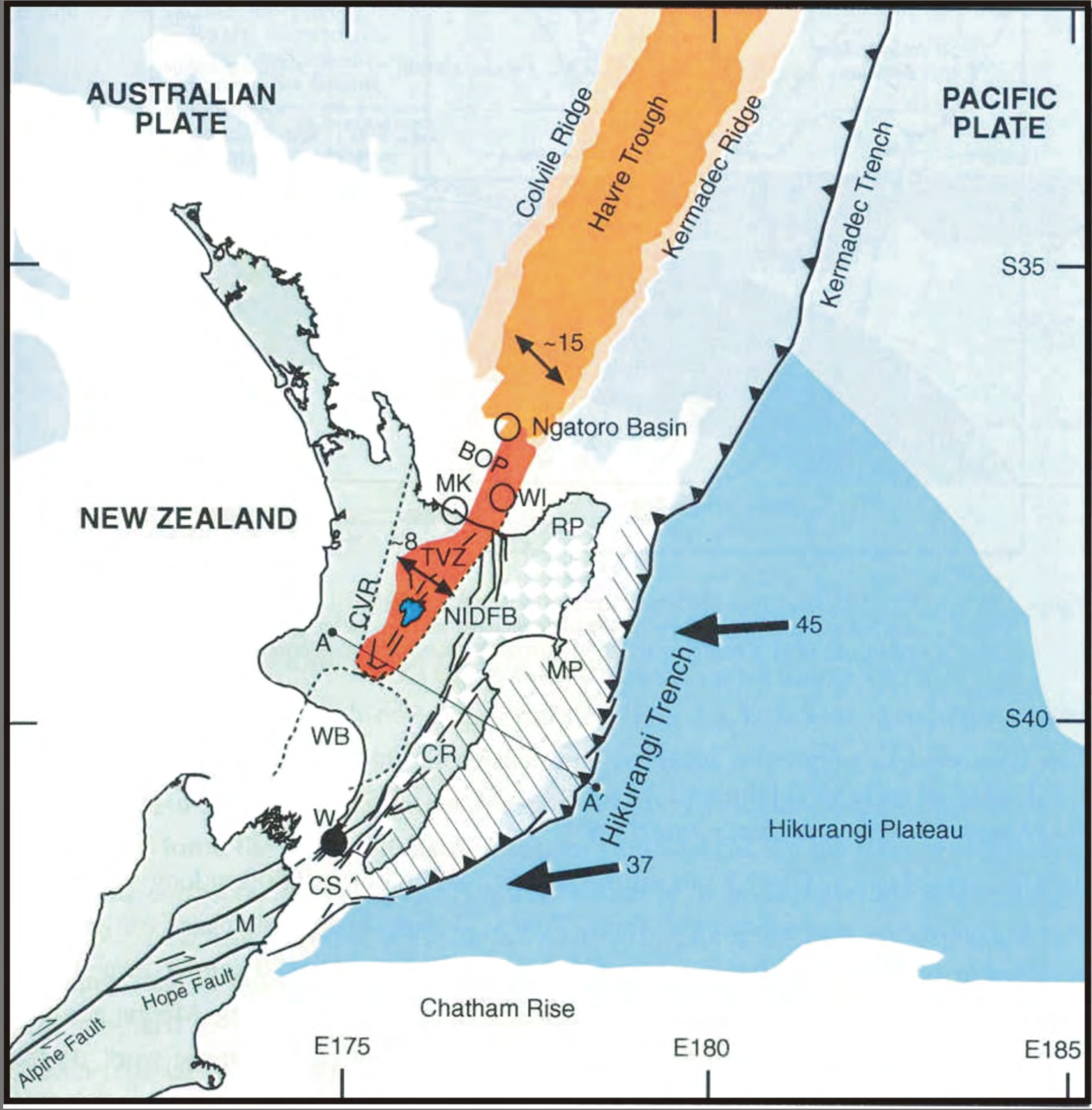
MT survey crossing the transition between locked and unlocked part of the plate



Taupo Volcanic Zone – a rifted arc

- rapid crustal extension
- recent rhyolitic volcanism
- exceptionally high heat flux (>4000 MW)
- 23 high temperature geothermal systems



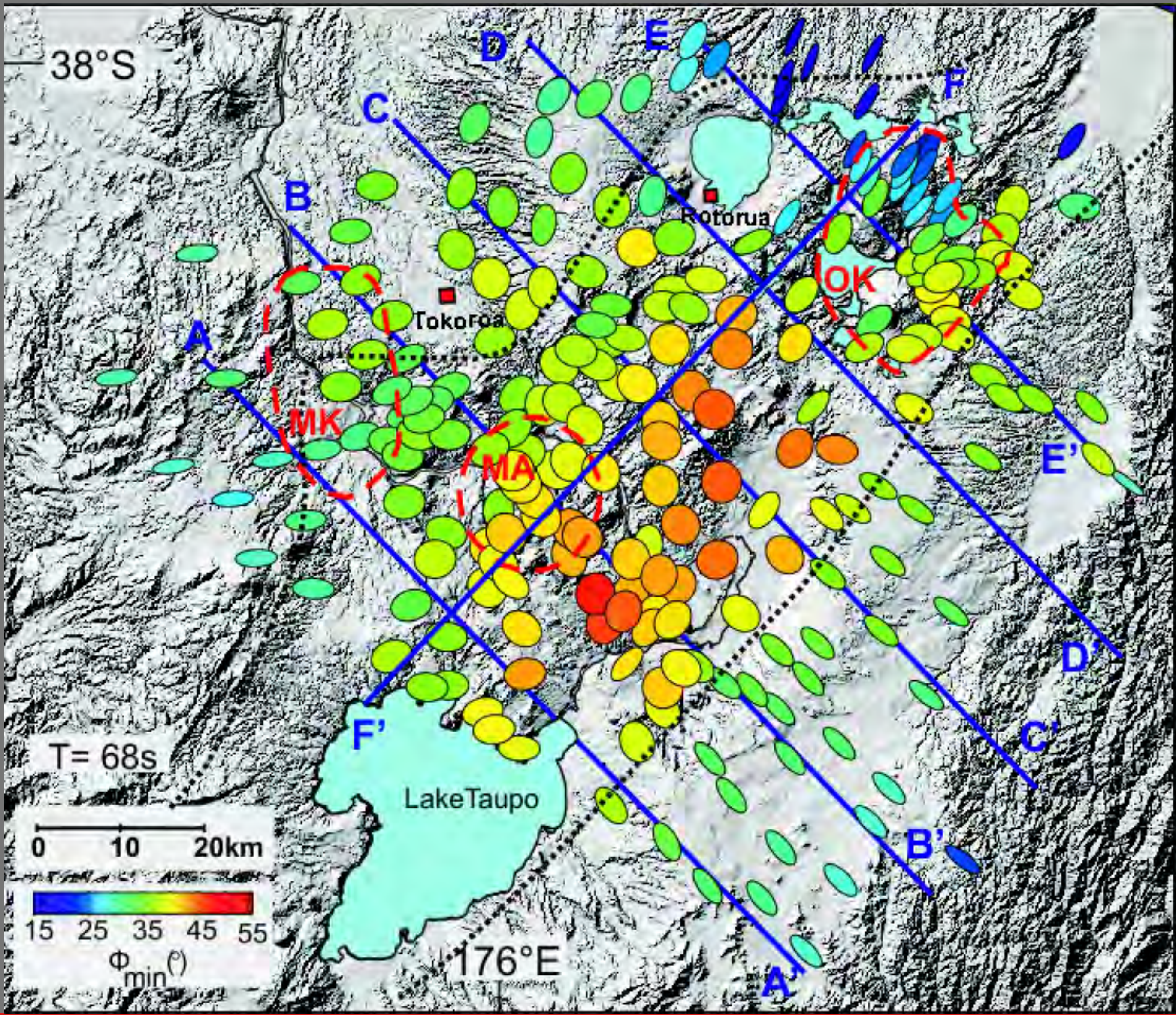


Observed phase tensor ellipses at 68 s.

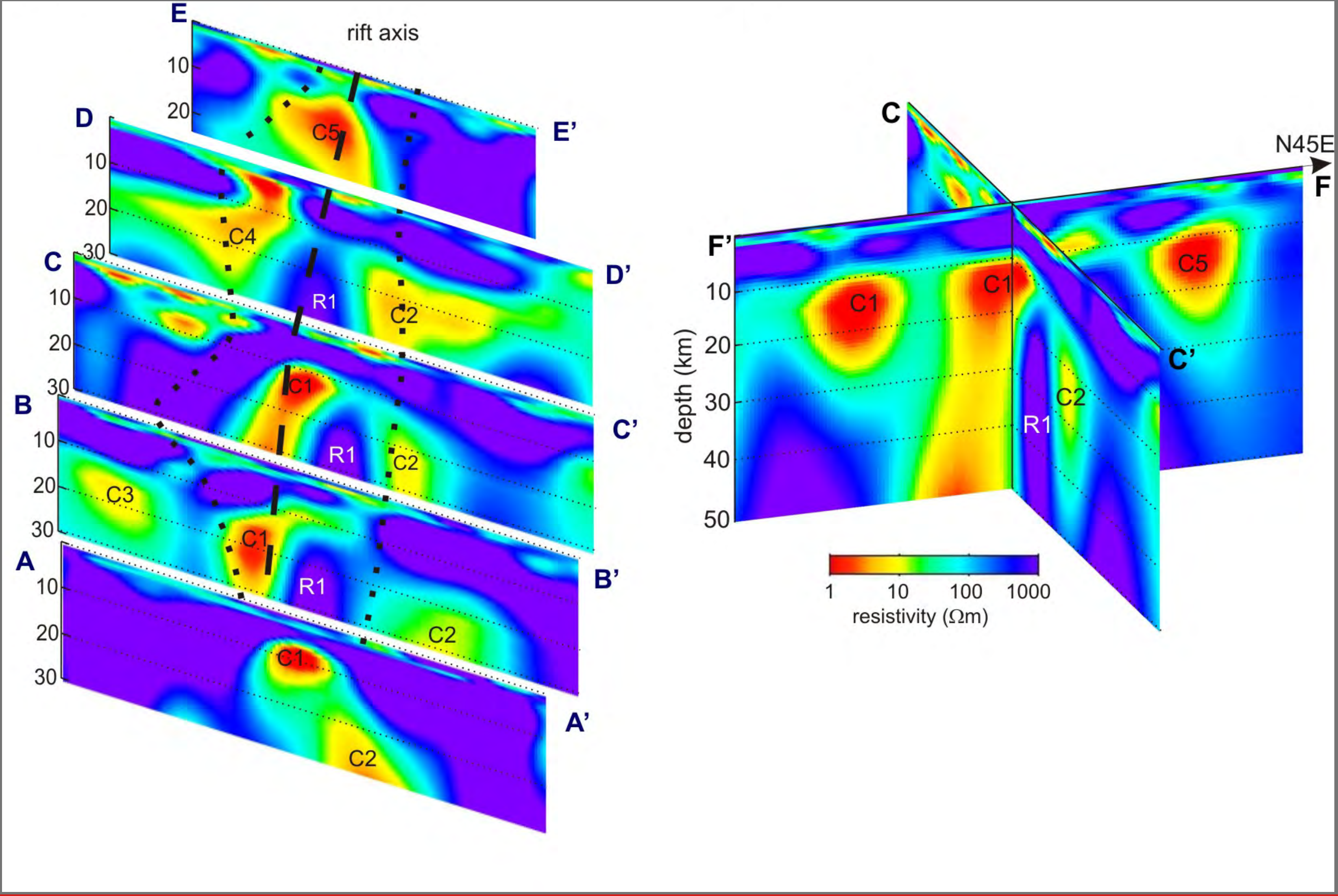
The relatively high phase values (warm colors) in the central part of the TVZ indicate high conductivities at depth.

Dashed white lines show the outlines of the Maroa (MA), Mangakino (MK) and Okataina (OK) volcanic centre.

Dotted lines show the outline of the TVZ .

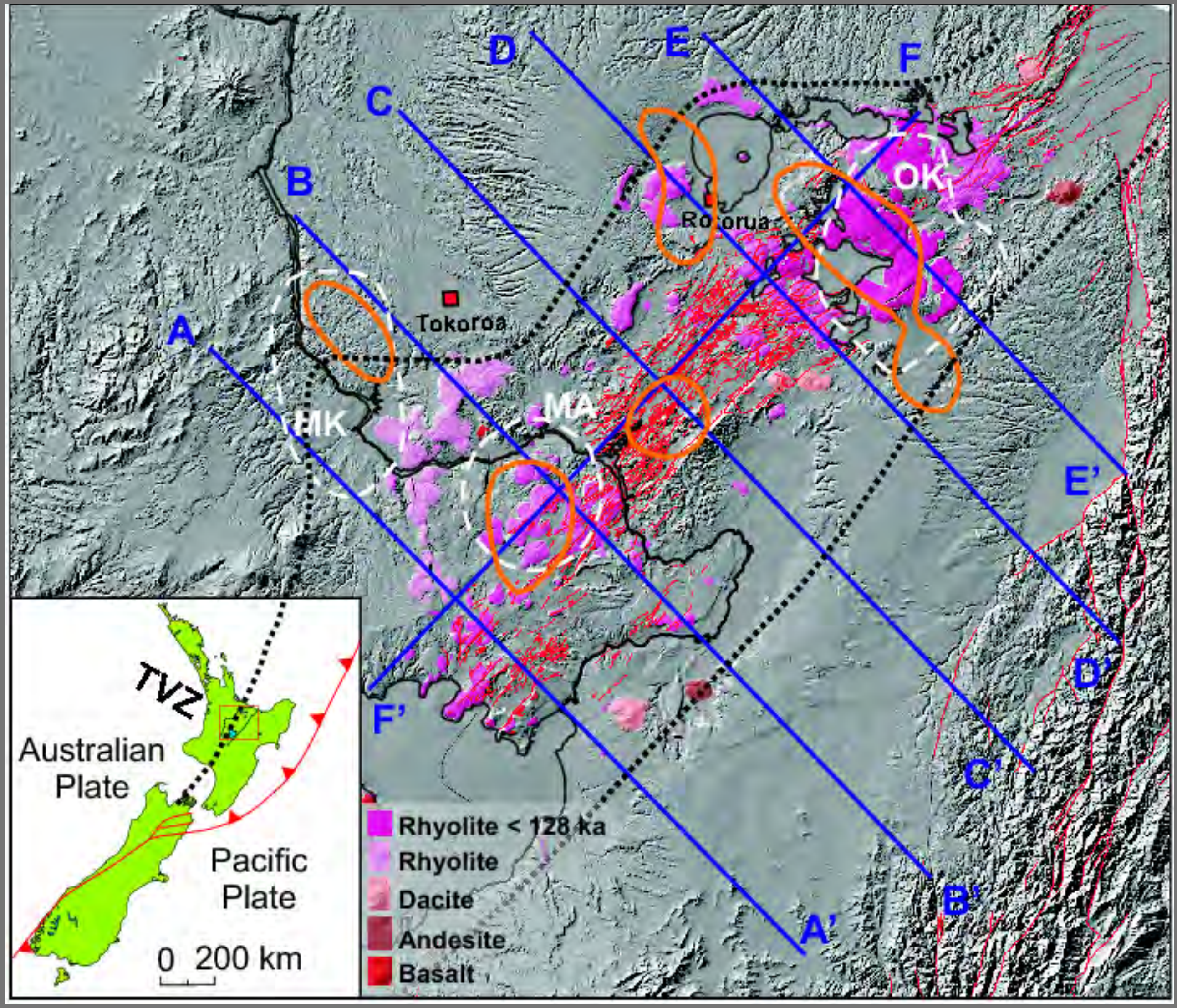


3D inversion model



Quaternary lavas and active surface fault traces (red).
Dotted lines show the outline of the TVZ .
Dashed white lines show the outlines of the Maroa (MA), Mangakino (MK) and Okataina (OK) volcanic centre.

Orange lines show the 5 Ωm contour at 13 km from the inverse model



3-D inversion results shown are consistent with the distribution of magma that might be expected on the basis of the distribution of the rift faulting and the location of recent silicic volcanism

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