Evolution of complex 4D plate boundary transition zone in central New Zealand illuminated by topographic fabric

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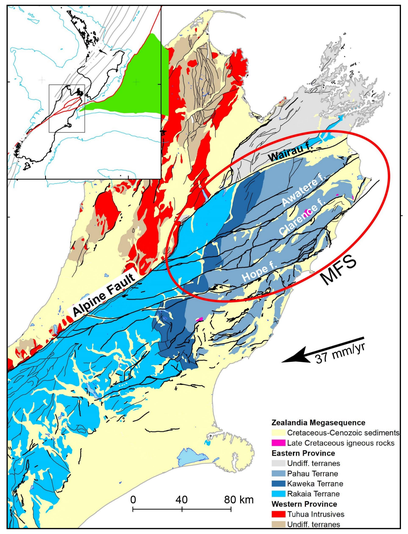
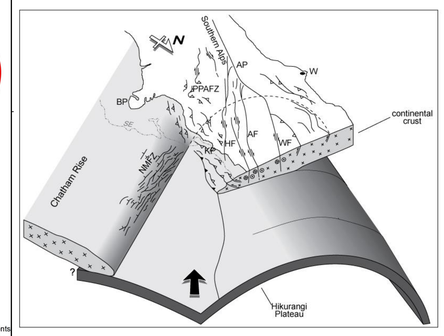
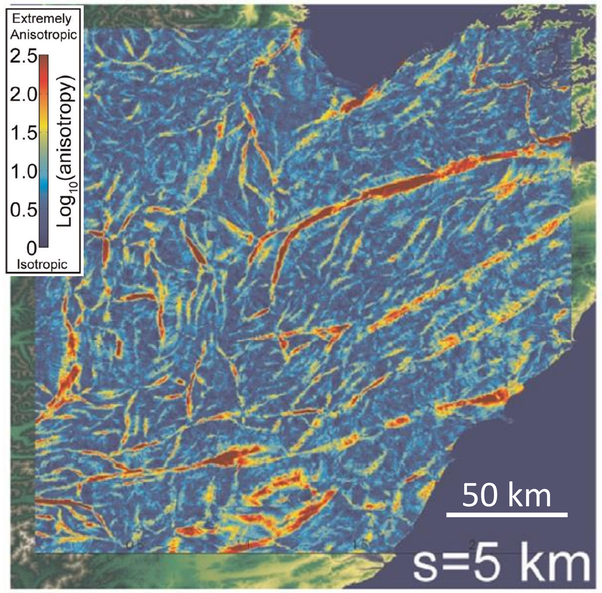
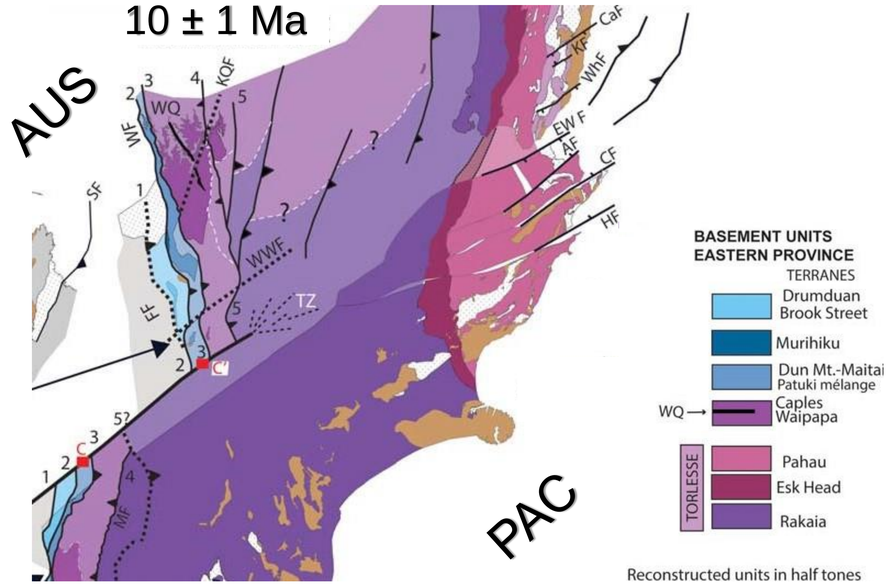




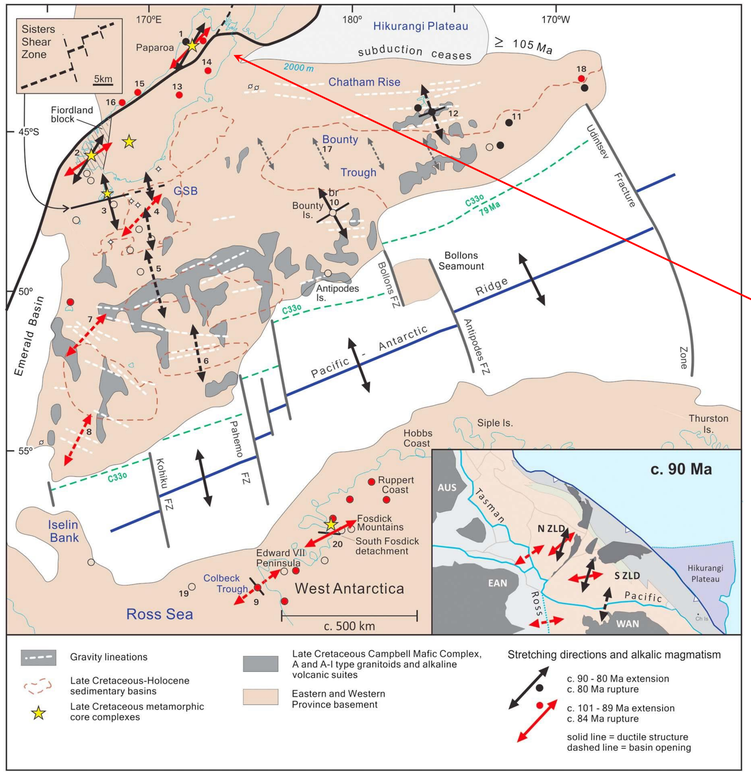
The Marlborough Fault System links the Alpine Fault in the southwest of New Zealand to the Hikurangi Subduction Margin to the northeast. The region, the southern half of which is shown in the 3D block diagram (modified from Barnes 1994), is a complex 4D boundary which has been evolving in space and time since the inception of the PAC-AUST plate boundary in the Miocene.
We use topographic fabric along with thermochronology, tectonic reconstructions and sedimentology to explore the evolution of this region.



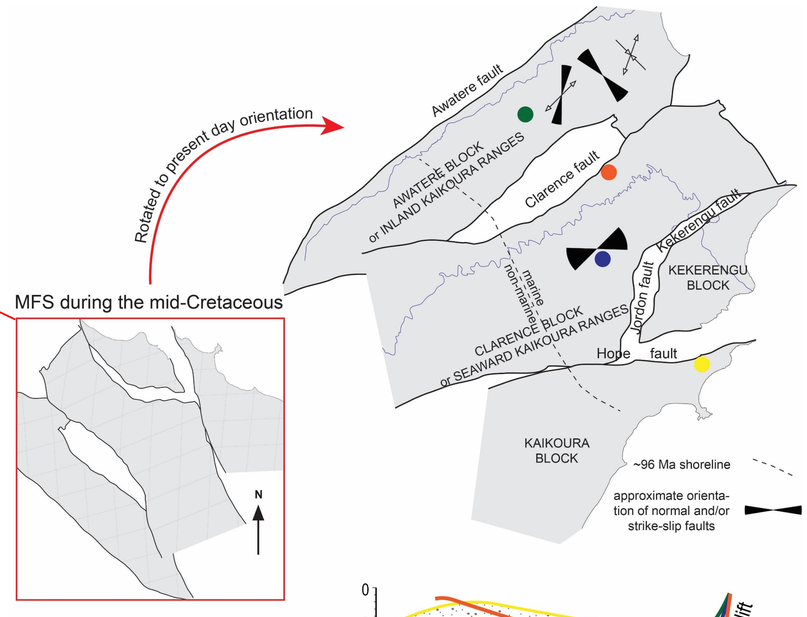
Topographic anisotropy at 5 km scale from Roy et al. (2016), showing a significant change in the topographic fabric from west to east.



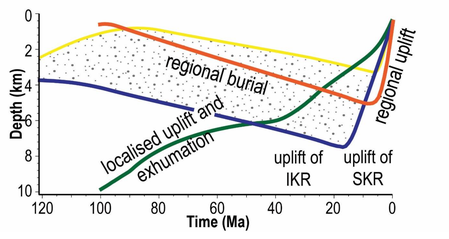
Ghisetti et al. (2021) restoration of the MFS at 10 ± 1 Ma focussing on horizontal movements. Note that the Alpine and Wairau fault are not continuous. TZ – Alpine Fault slip transfer zone. The present day MFS faults exist only in the eastern part of the region.



The 2-stage mid-Cretaceous extension throughout Zealandia is preserved in the features shown on this figure (Tulloch et al., 2019). During widespread stage-2 extension (black arrows) across southern Zealandia the NNW-SSE extension direction was with associated NNW-SSE transfer faults. The Awatere, Clarence and Hope faults, when recent rotation has been restored, subparallel to these transfer faults at this time.



Eastern MFS in mid-Cretaceous based on palinspastic reconstructions (Crampton et al. 2003).
These structures formed parallel to 90-80 Ma extension (black arrows) which eventually led to breakup between Zealandia and West Antarctica.



Modelled depth/time paths which show that a proto-Clarence fault has been active since ~100Ma (Collett et al., 2019).

Topographic fabric reflects both tectonic history and the present day tectonic setting of the region.

The eastern, central and western (not addressed here) portions of the MFS have distinct topographic fabric which result from different tectonic histories and pre-existing structures characteristic to each region.

Eastern MFS:
- Crustal scale faults formed during Gondwana breakup which have controlled extension (Cretaceous), uplift (late Miocene-Pliocene) and now strike-slip plate motion.
- Single dominate topographic fabric.

Central MFS:
- No evidence for large scale NE trending crustal structures as those seen in the eastern MFS.
- N-trending fabric - orientation of Gondwana terrane boundaries and late Plio-Pleistocene Southern Alps faults. Evident in the topography as many rivers flow in an ~NS direction for 10s of kms.
- ENE-trending fabric – river capture along ENE trending faults (some inherited, some younger) as the strike-slip regime overprints the structures of earlier oblique-collisional regime.

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