Chatham Rise Phosphorite

Observations from the literature

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Content

1. Where is it?
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   i. Stratigraphy
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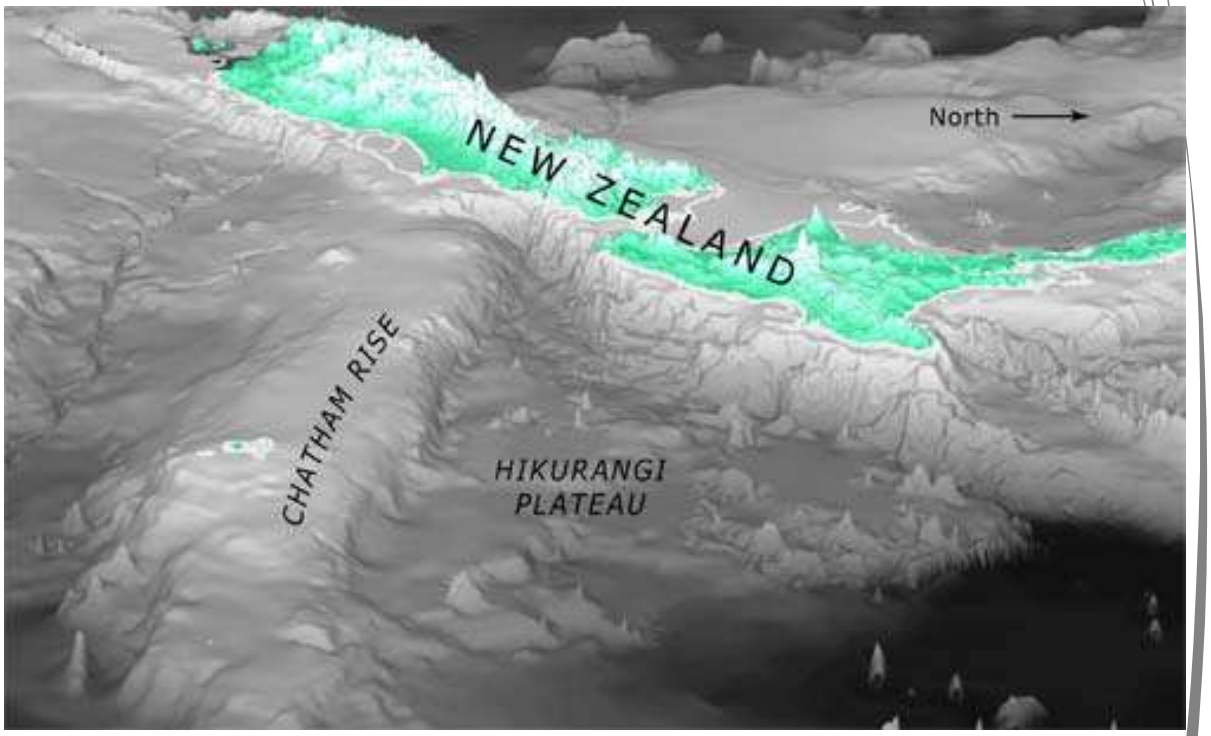

Vertically exaggerated sun-shaded satellite bathymetry image from GNS, Lower Hutt, NZ

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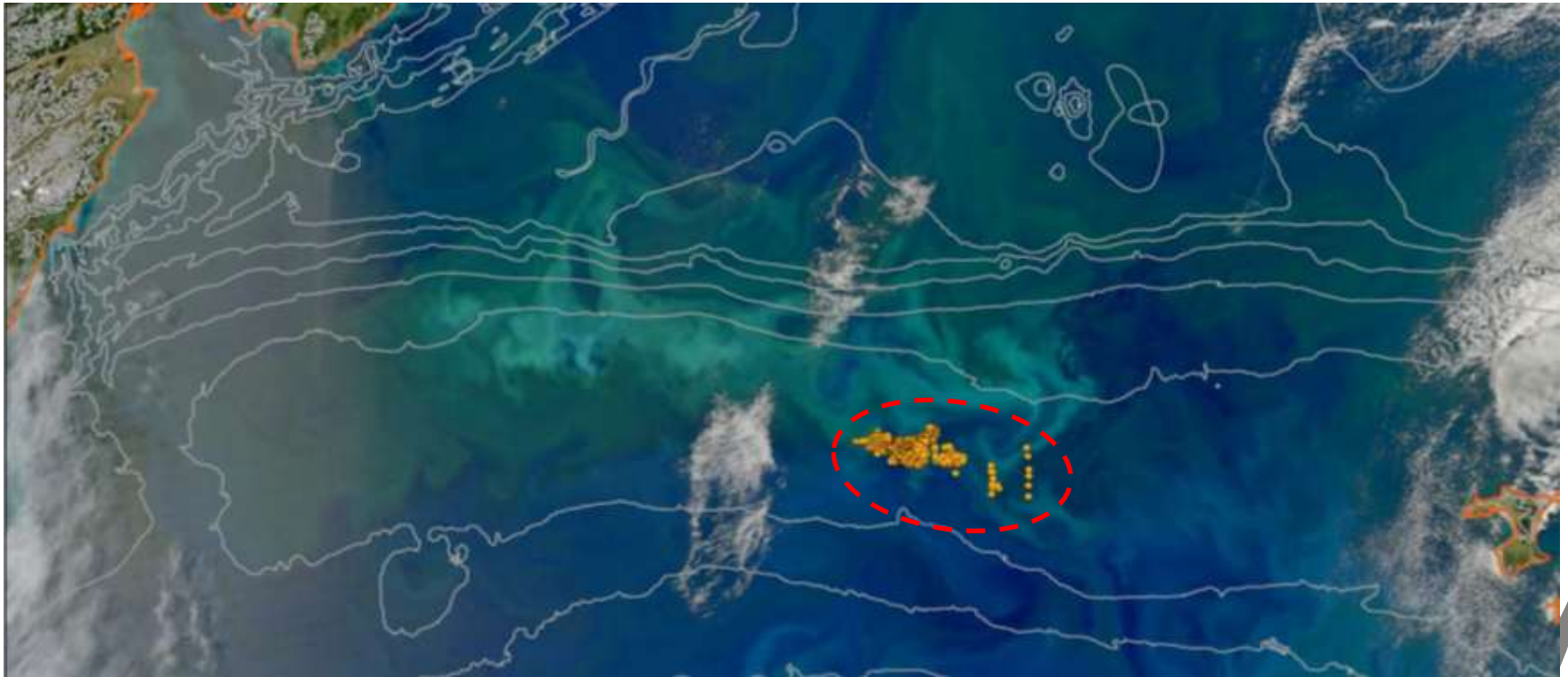
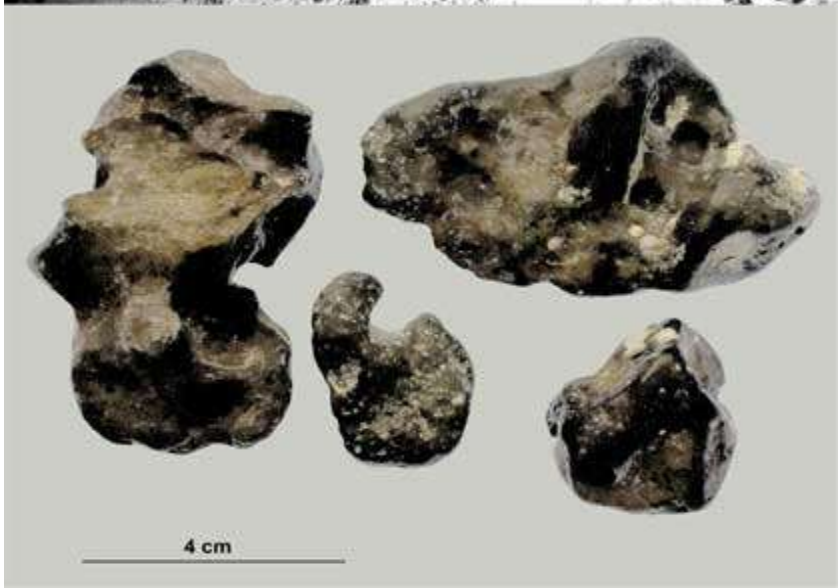
Where is it?

- Located on crest of Chatham Rise, 400m water depth
- Nodules within a layer up to 70cm thick, surficial or subsurface
- Nodules exhibit two distinct phases of boring and burrowing
- Patchy distribution reflects irregular development of phosphatic “duricrust”
- 25Mt @ 9.4%P (21.5% P_2O_5) concentrated at 66kg m^{-2} covering ~400km^2



Why is it there?

- P initially delivered to the ocean via continental weathering and fluvial transport
- P processed by plankton and liberated to the sediments by the decay of marine organisms
- Super saturation of pore water occurs in organic rich sediments at the sediment/sea-water interface
- **<u>Diagenetic:</u> replacement of calcareous precursor on offshore topographic highs**
- In the case of the Chatham Rise, this occurred where sediments of the calcareous Oligocene to Plio-Pleistocene Penrod Group were exposed at the sea floor



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Why is it there? The underlying stratigraphy...

- Calcareous Penrod Group
- Transition from non-marine Hoiho to marine Pakaha

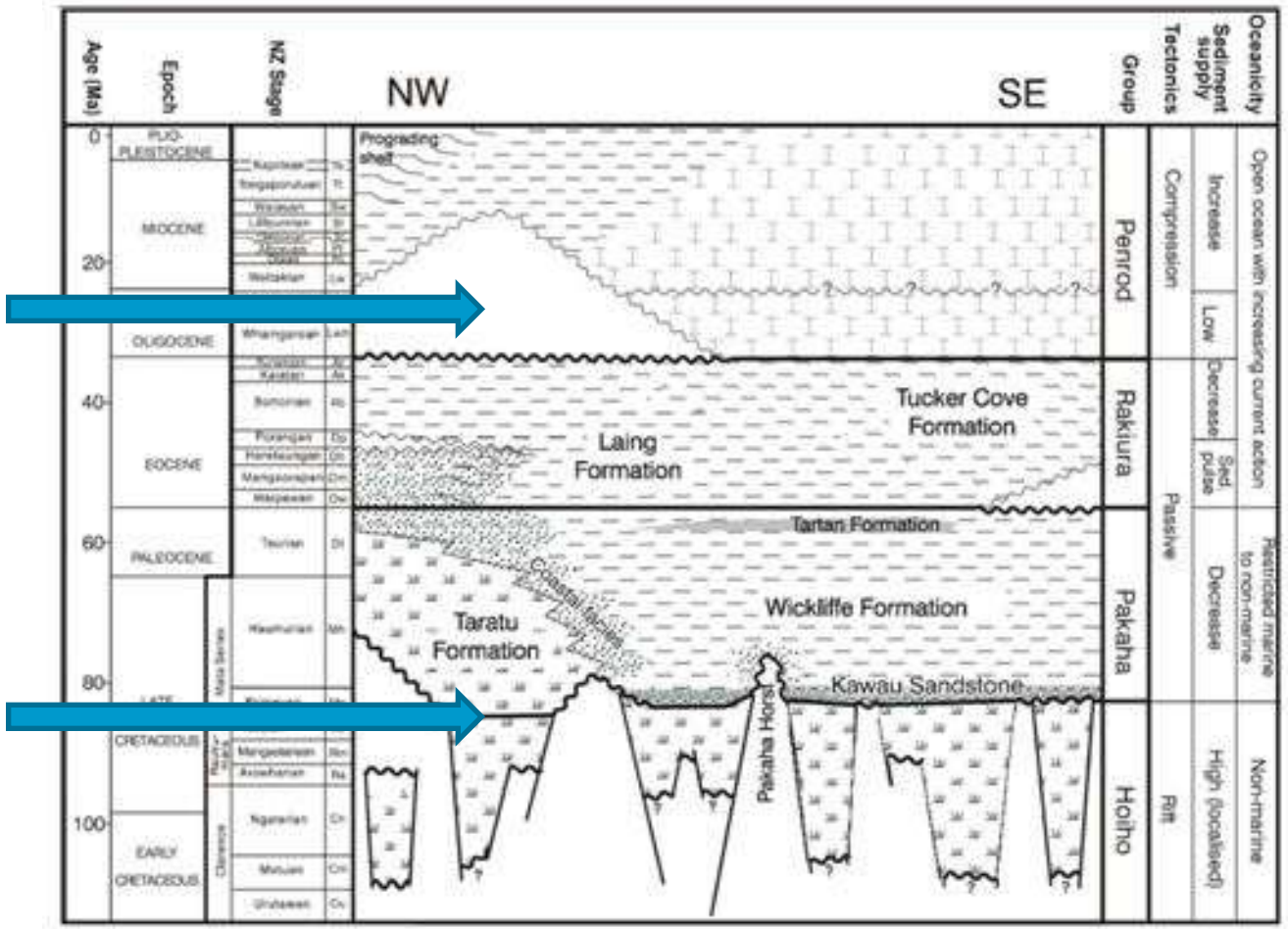

Figure 1: Generalised stratigraphy of the Canterbury and Great South Basins (Cook et al, 1999).

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Why is it there? The structural history...

- Modern coastlines shown in their Gondwanan configuration
- **Key features**
  - Wishbone Scarp (active through the K) formed northern margin of the Chatham Rise
  - Bounty Trough (failed extension of the New Caledonia and deep-water Taranaki basins) formed southern margin of the Chatham Rise

Figure 2: Location of the Wishbone Scarp in relation to the Chatham Rise. (Reproduced from Sutherland et al (2001)).

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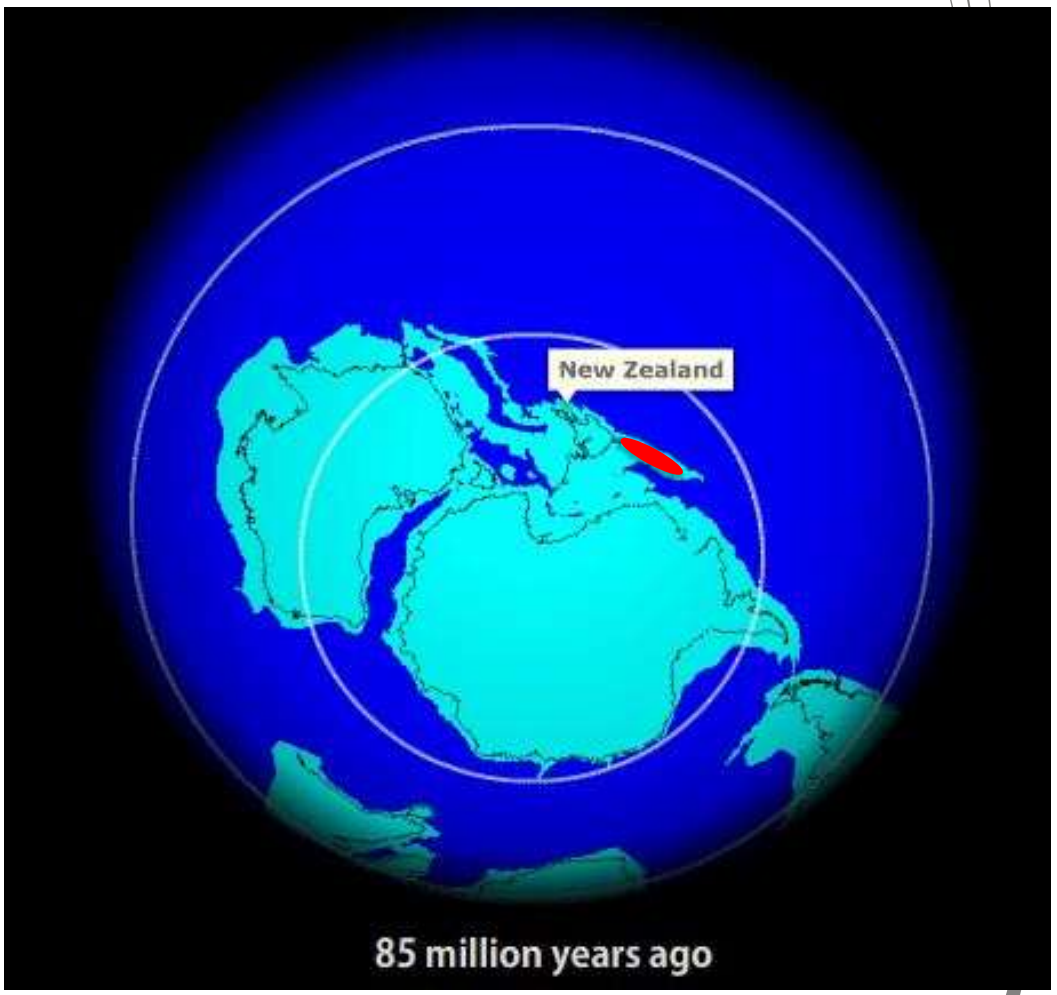
Structural history: Late Cretaceous – 85Ma

Latitude of CR ~65°S @ 85Ma

- Initial split from Gondwana

- Wishbone Scarp active
- Bounty trough opening



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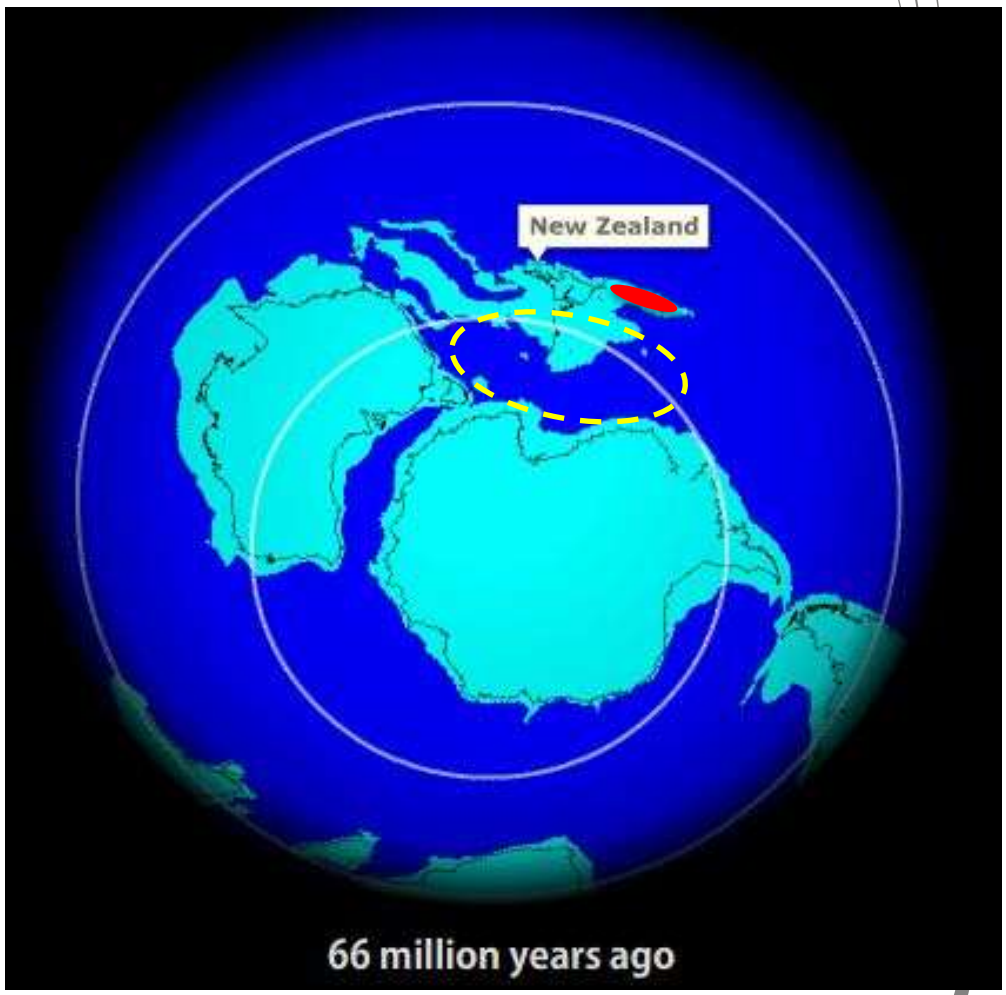
Structural history: Early Paleocene – 66Ma

Latitude of CR ~55°S @ 66Ma

K/T boundary

- Drake passage not open
- Tasman Sea not open
- No circumpolar current

- Quiet, warm seas
- Late Paleocene thermal maximum



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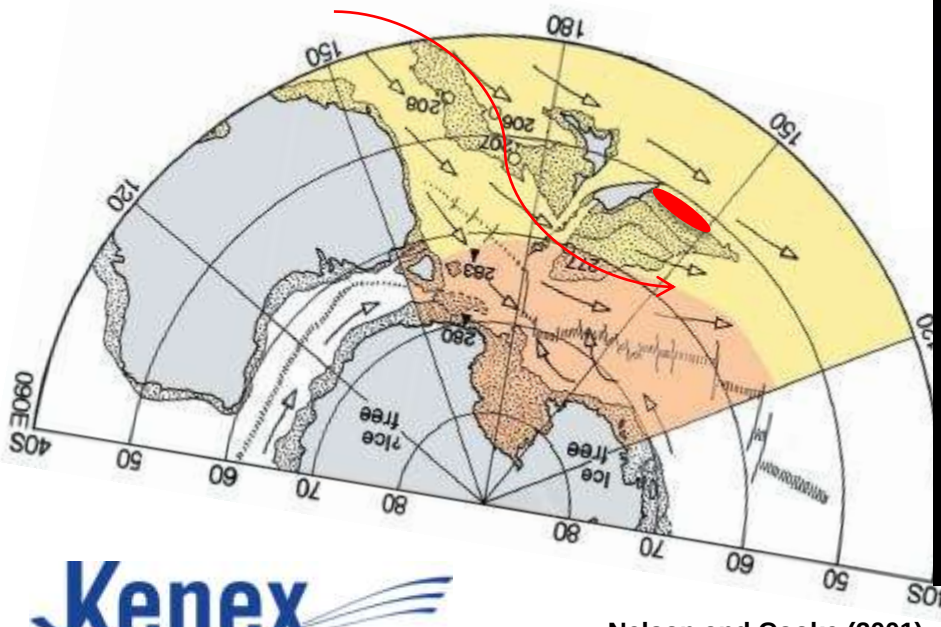
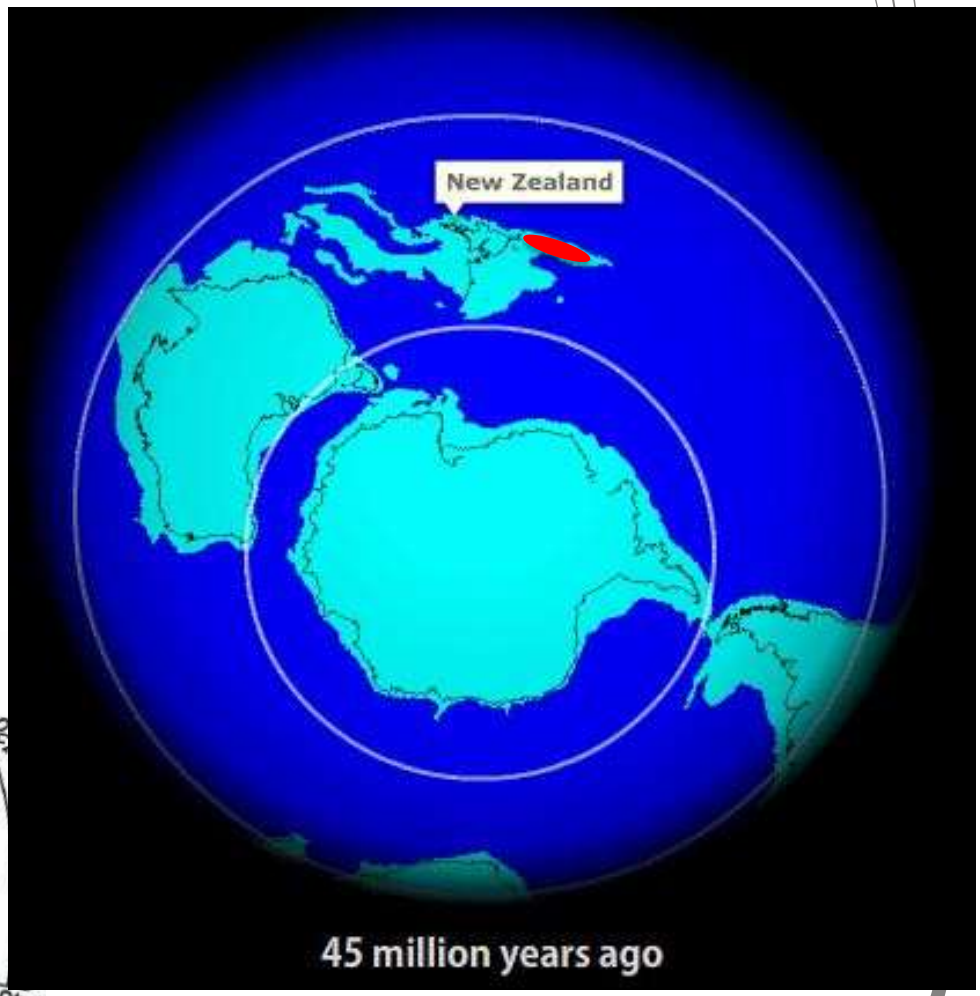
Structural history: Mid Eocene – 45Ma

Latitude of CR ~45°S @ 45Ma

- Drake passage not open
- Tasman Sea not open
- No circumpolar current
- Antarctica ice free



Nelson and Cooke (2001)



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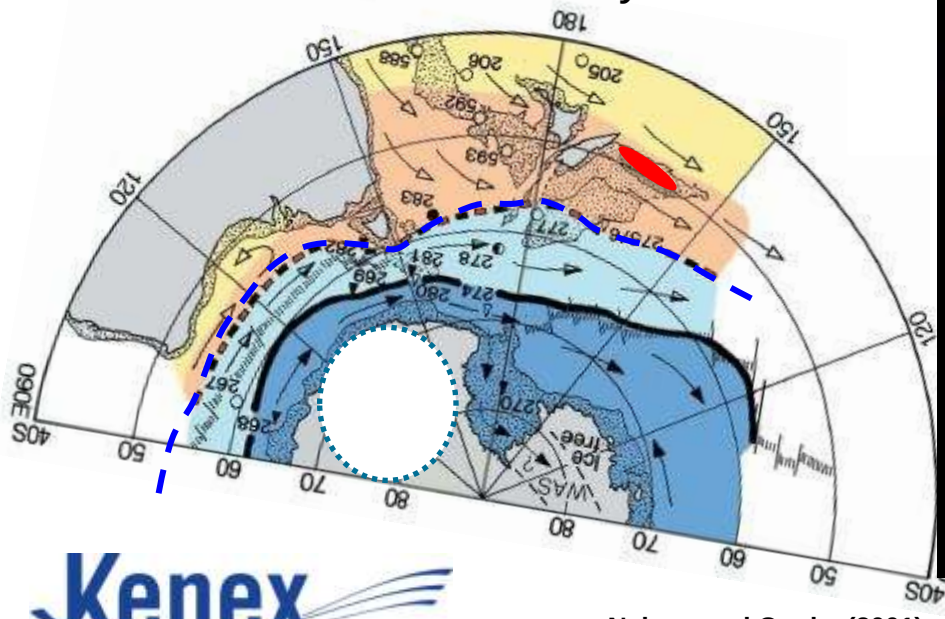
Structural history: Late Eocene/Oligocene – 33Ma

Latitude of CR ~45°S @ 33Ma

- Cool water in latest Eocene
- Drake passage open
- Tasman Sea begins to open
- Deposition of calcareous Penrod Group begins
- Marshall Paraconformity 33Ma



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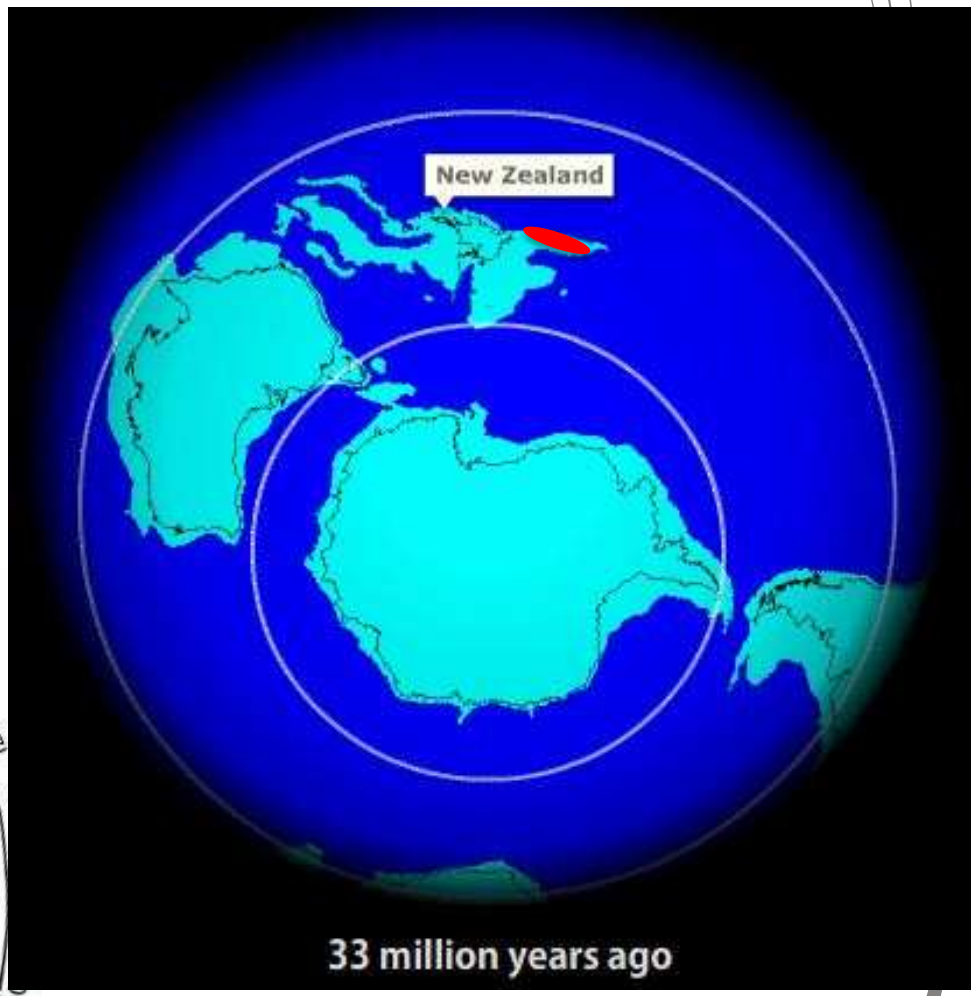

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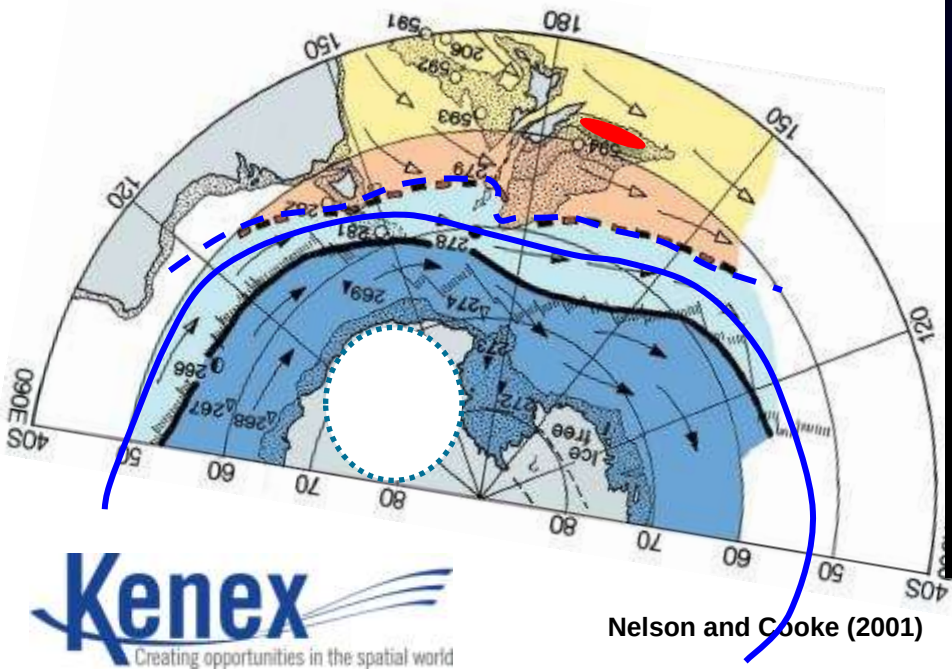
Structural history: Early Miocene – 20Ma

Latitude of CR ~42°S @ 20Ma

- Drake passage open
- Tasman Sea open
- Tasmania moves away from Antarctica
- Circumpolar current established



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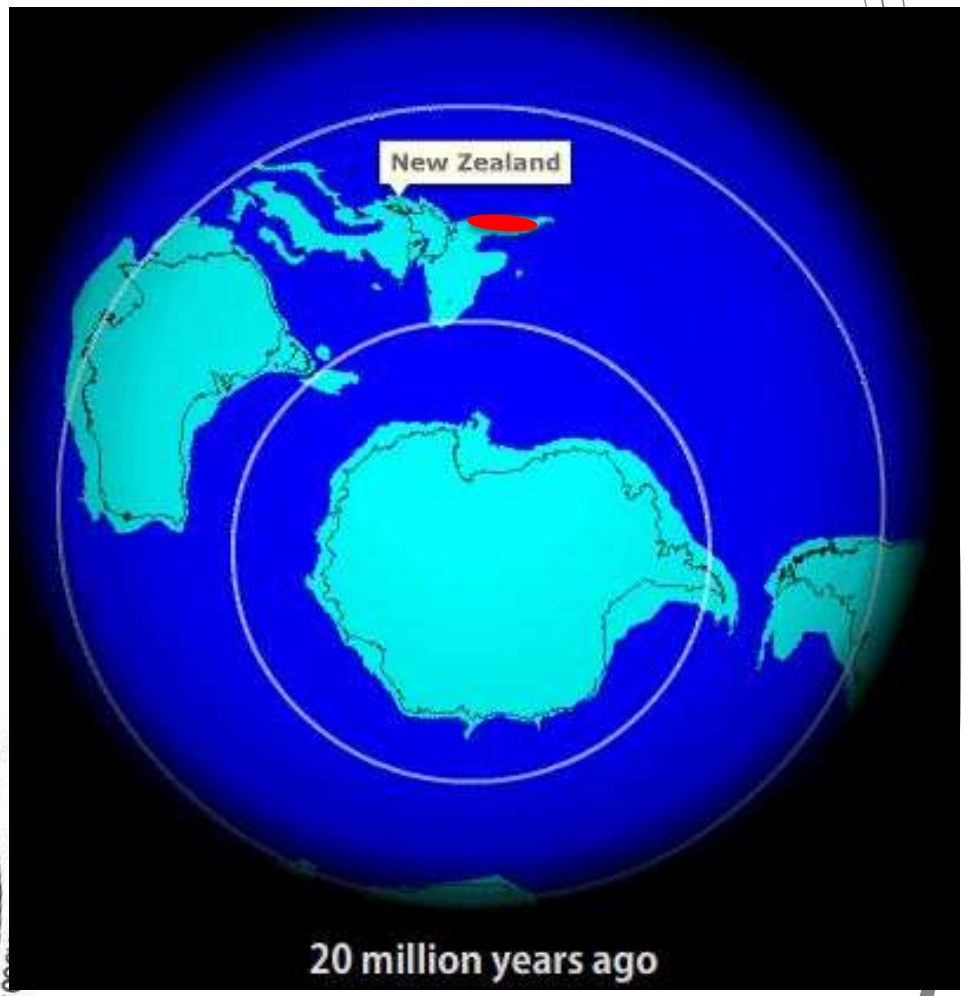

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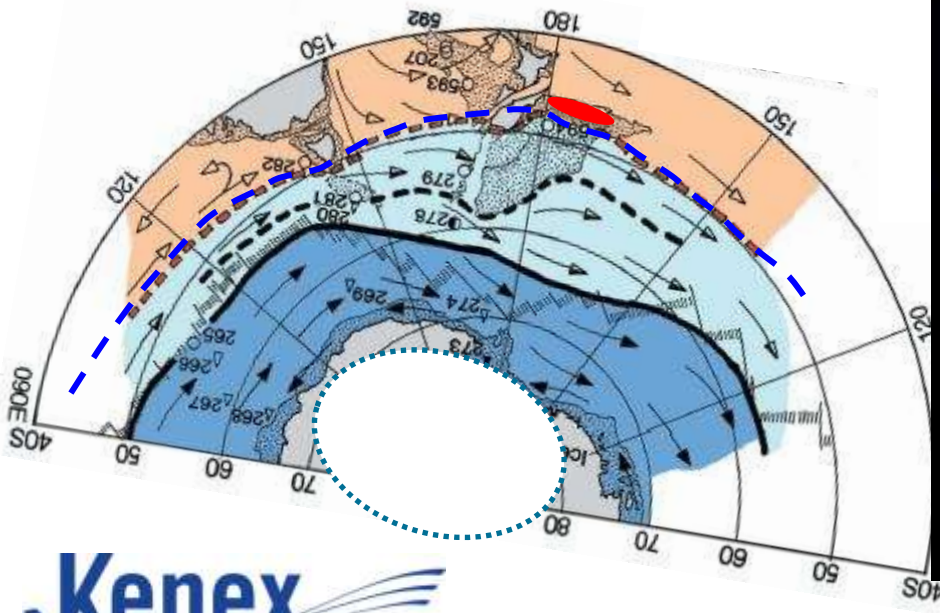
Structural history: Mid Miocene – 12Ma

Latitude of CR ~42°S @ 12Ma

- Constant latitude >Mid Eocene
- Climate deteriorates >16Ma max
- Ice increasing on Antarctica (E/W)
- Cool waters migrates northward
- Oldest reliable date for P nodules



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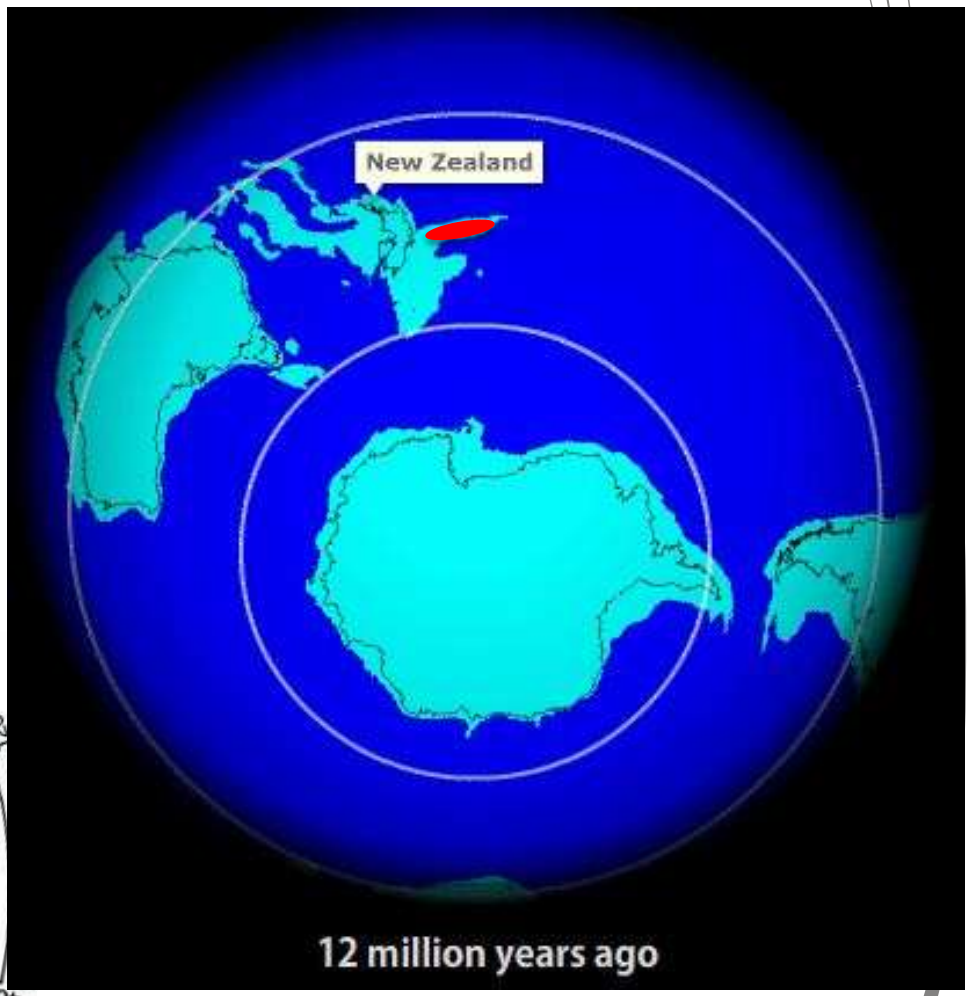

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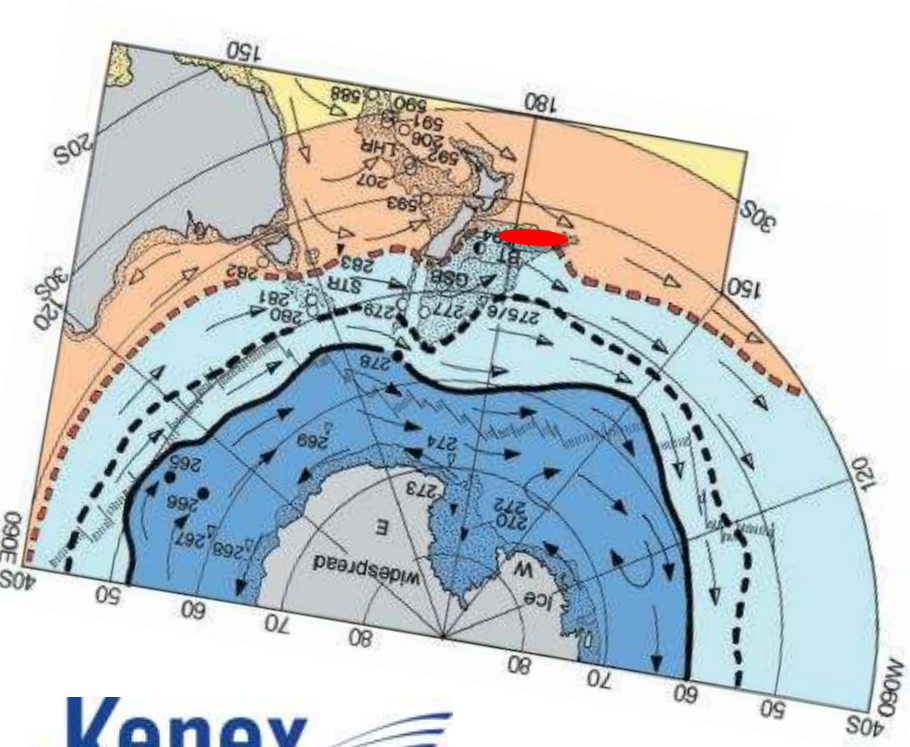
Structural history: Pliocene – 5Ma

Latitude of CR 42°S @ 5Ma

- Youngest reliable date for formation of phosphorite
- Position of ocean fronts stable



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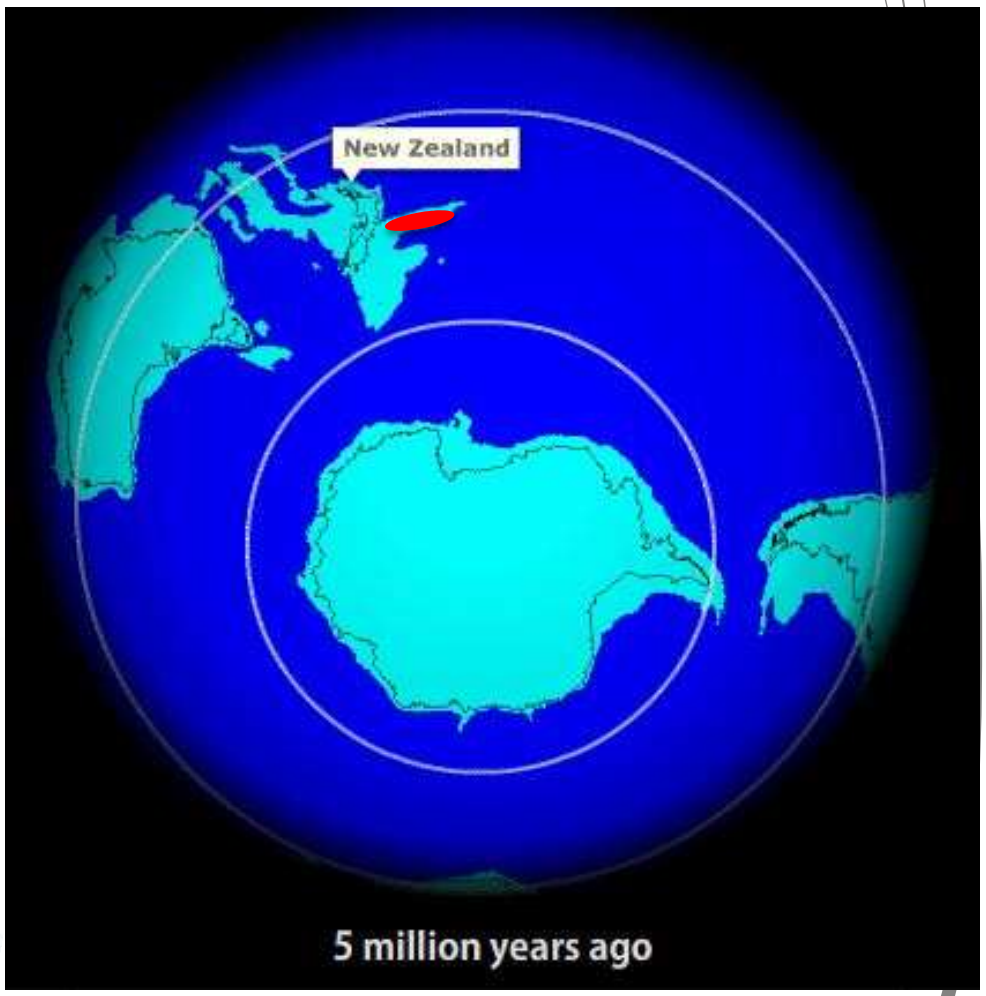

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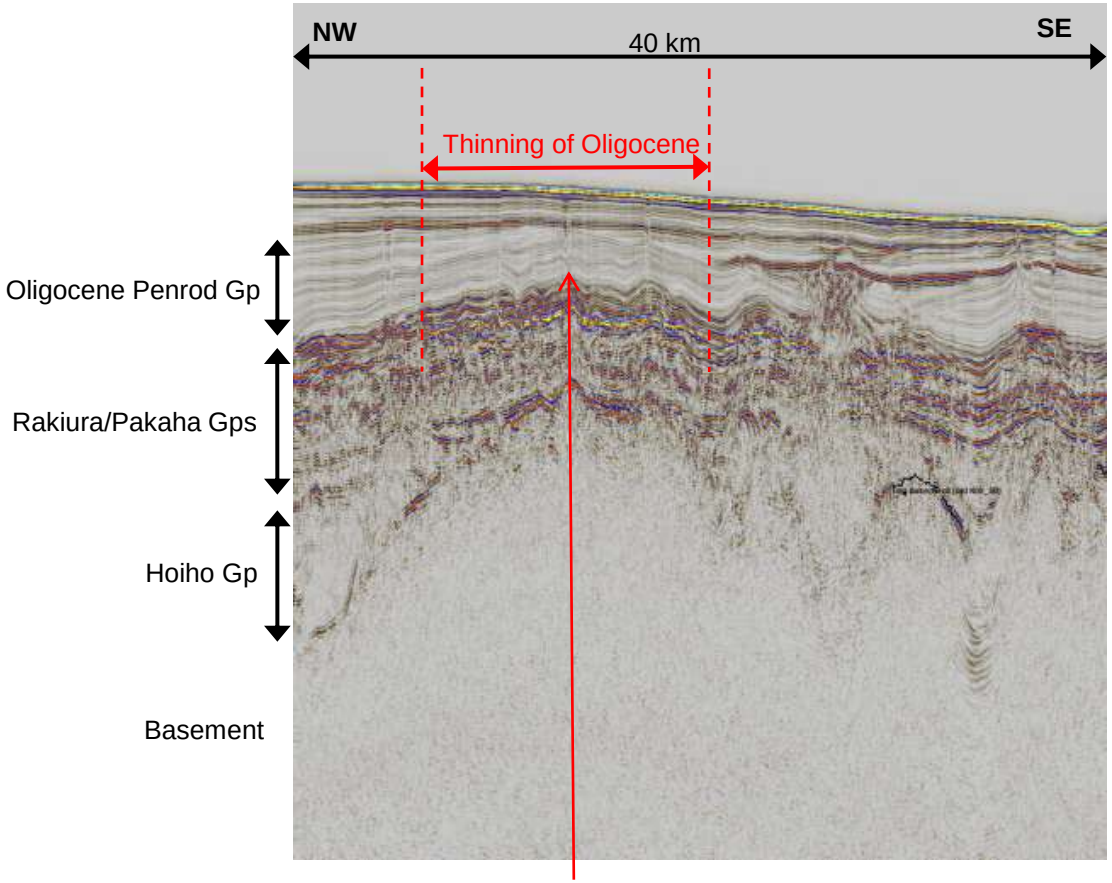
The final piece in the puzzle ...



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To summarise ...

- Continental rifting initiated changes in ocean chemistry and current flow directions
- Oligocene deposition of calcareous Penrod Group
- Late Oligocene uplift perpendicular to the Chatham Rise exposed younger Oligocene carbonates
- Miocene topographic high of the Chatham Rise became a locus for up-welling
- Polar ocean front advanced towards the Chatham Rise as ice sheets developed in the Antarctic
- Phosphorite duricrust formed where Oligocene carbonates remained exposed
- Phosphorite precipitation ceased as cold water regime became established in the NZSSO

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Acknowledgements

- Chatham Rock Phosphate
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- GNS – Rupert Sutherland
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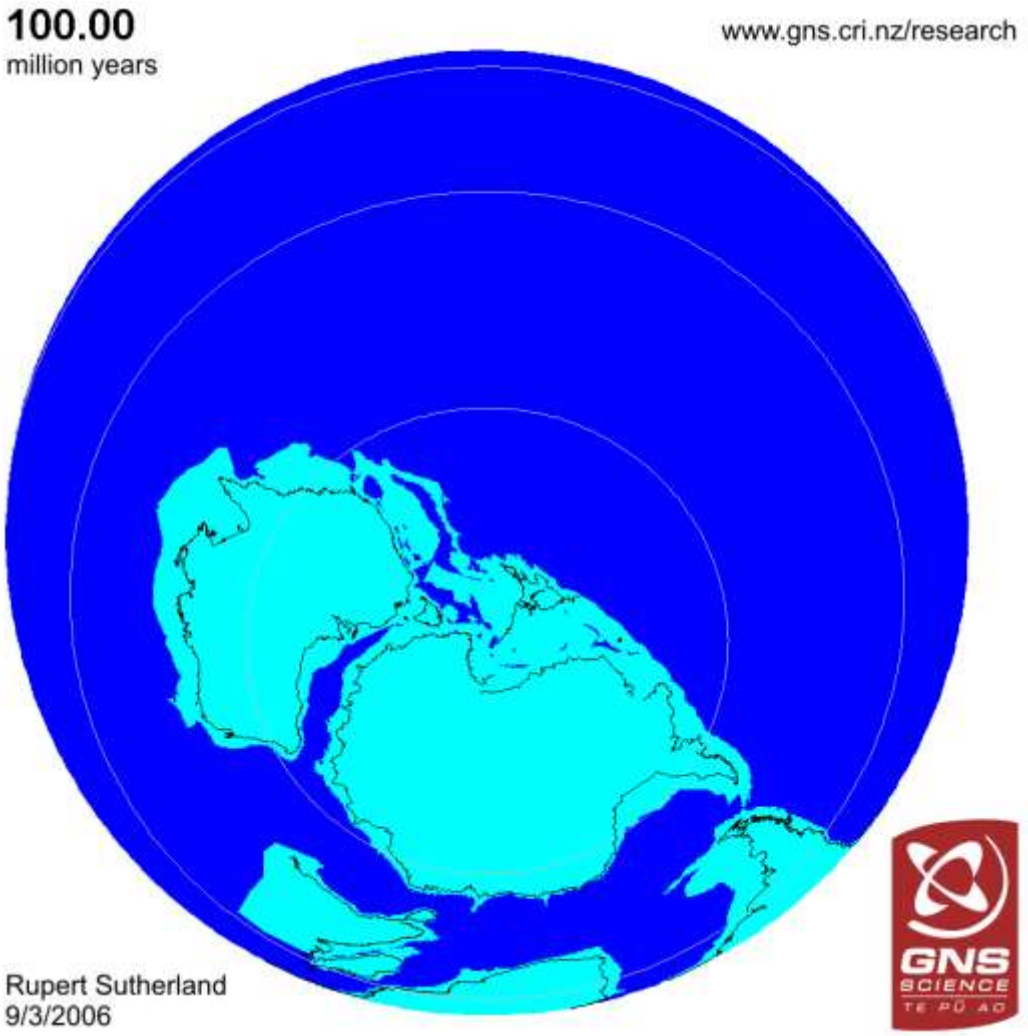
- Husband – Tim Allan
- All the researchers...



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