Australian Government
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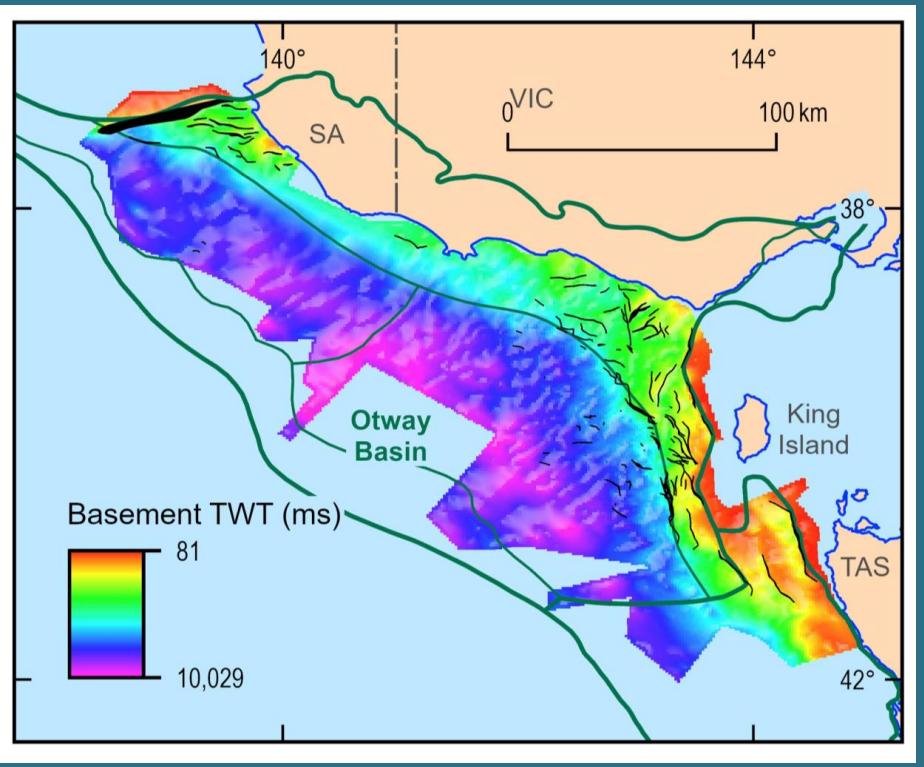



# A new perspective on regional structural architecture across the offshore Otway Basin

Chris Nicholson, Steve Abbott, George Bernardel, Yvette Poudjom Djomani

# Acknowledgement of Country

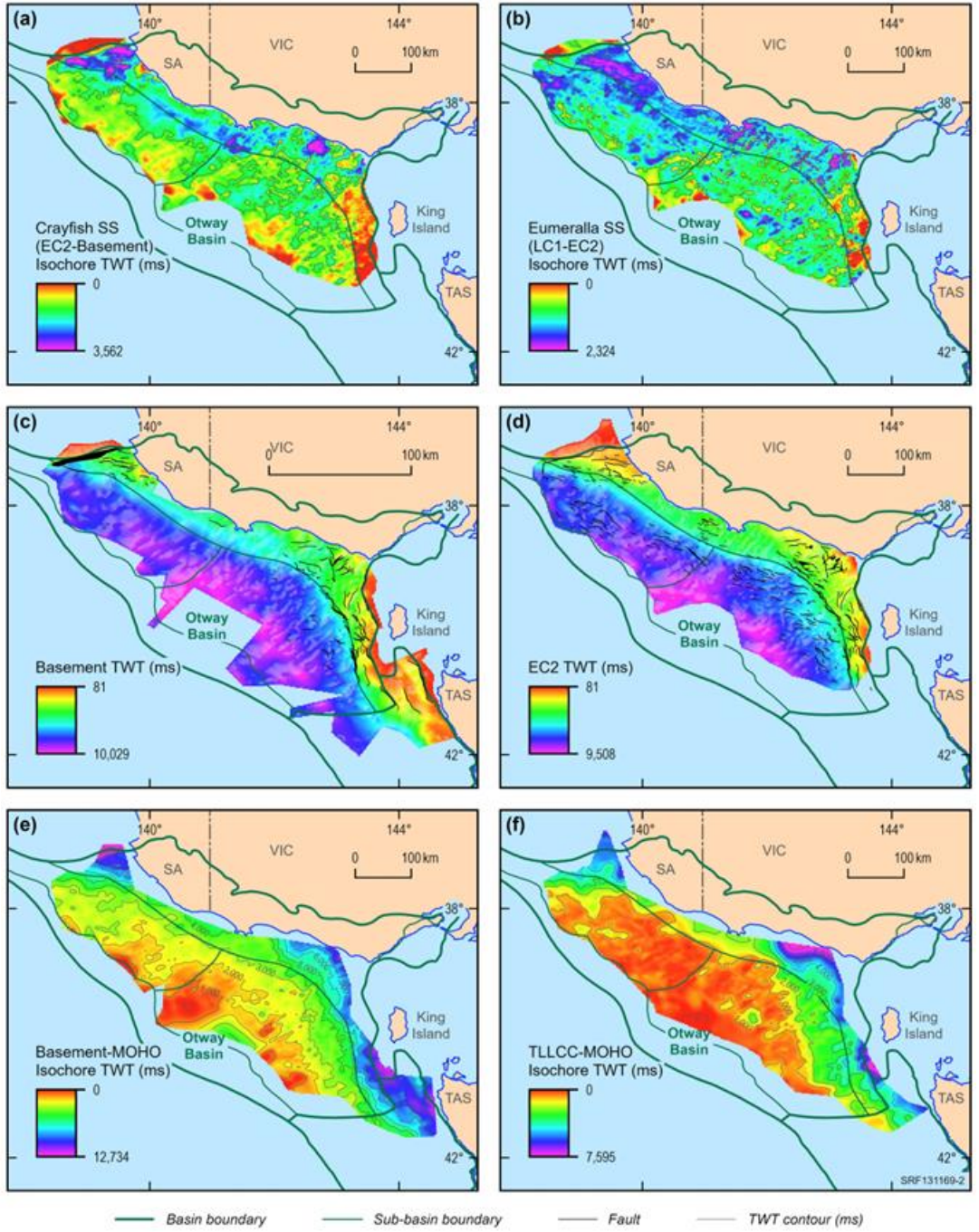
Geoscience Australia acknowledges the traditional owners and custodians of Country throughout Australia and acknowledges their continuing connection to land, waters and community. We pay our respects to the people, the cultures and the elders past and present.

Image: Caterpillar Tracks: Artwork by Roseanne Kemarre Ellis on Geoscience Australia's Alice Springs antenna

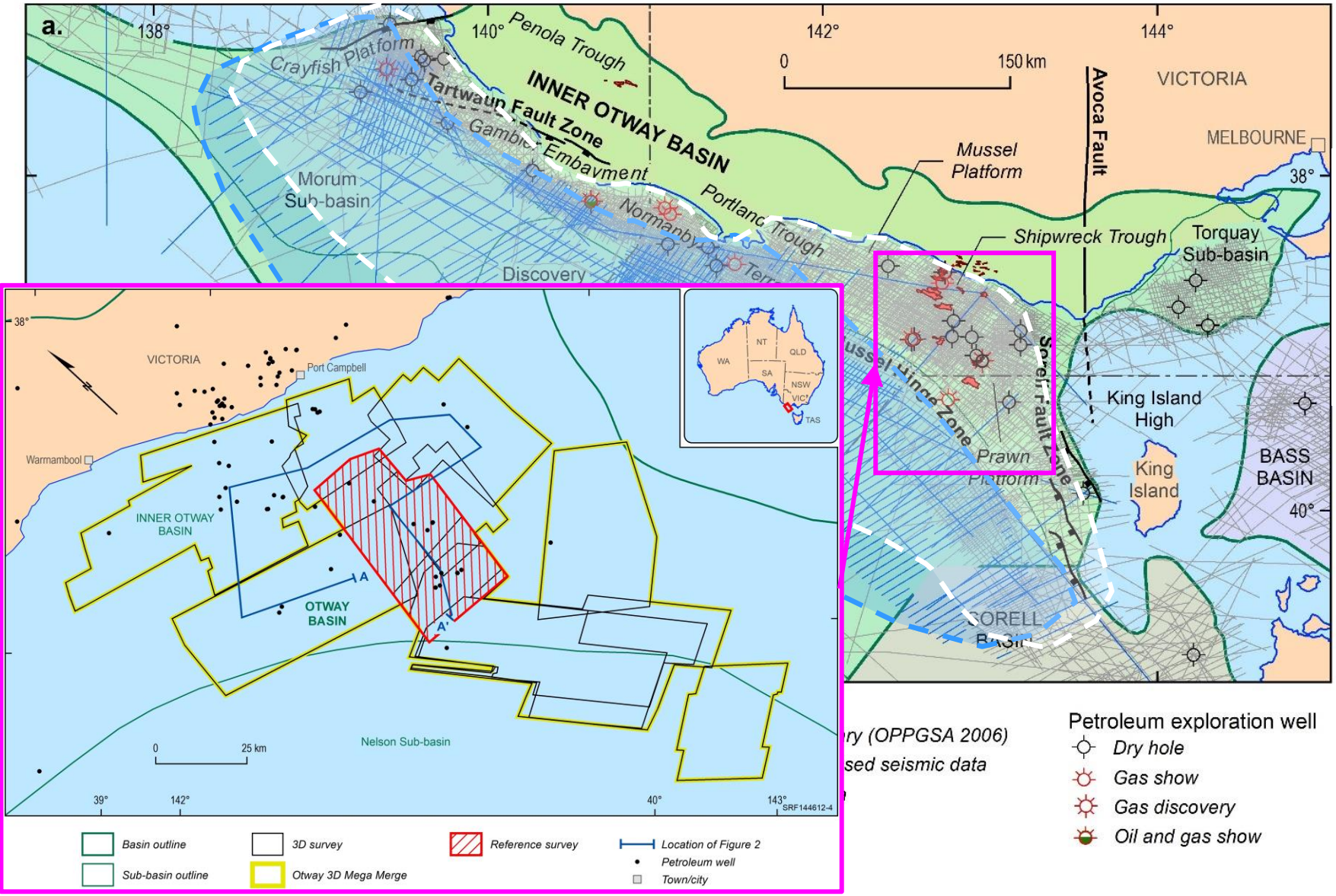
# Introduction

Offshore Otway Basin regional seismic mapping provides new insights into:

- Cretaceous rift related stratigraphic framework
- Cretaceous and basement structural architecture
- Crustal thinning trends



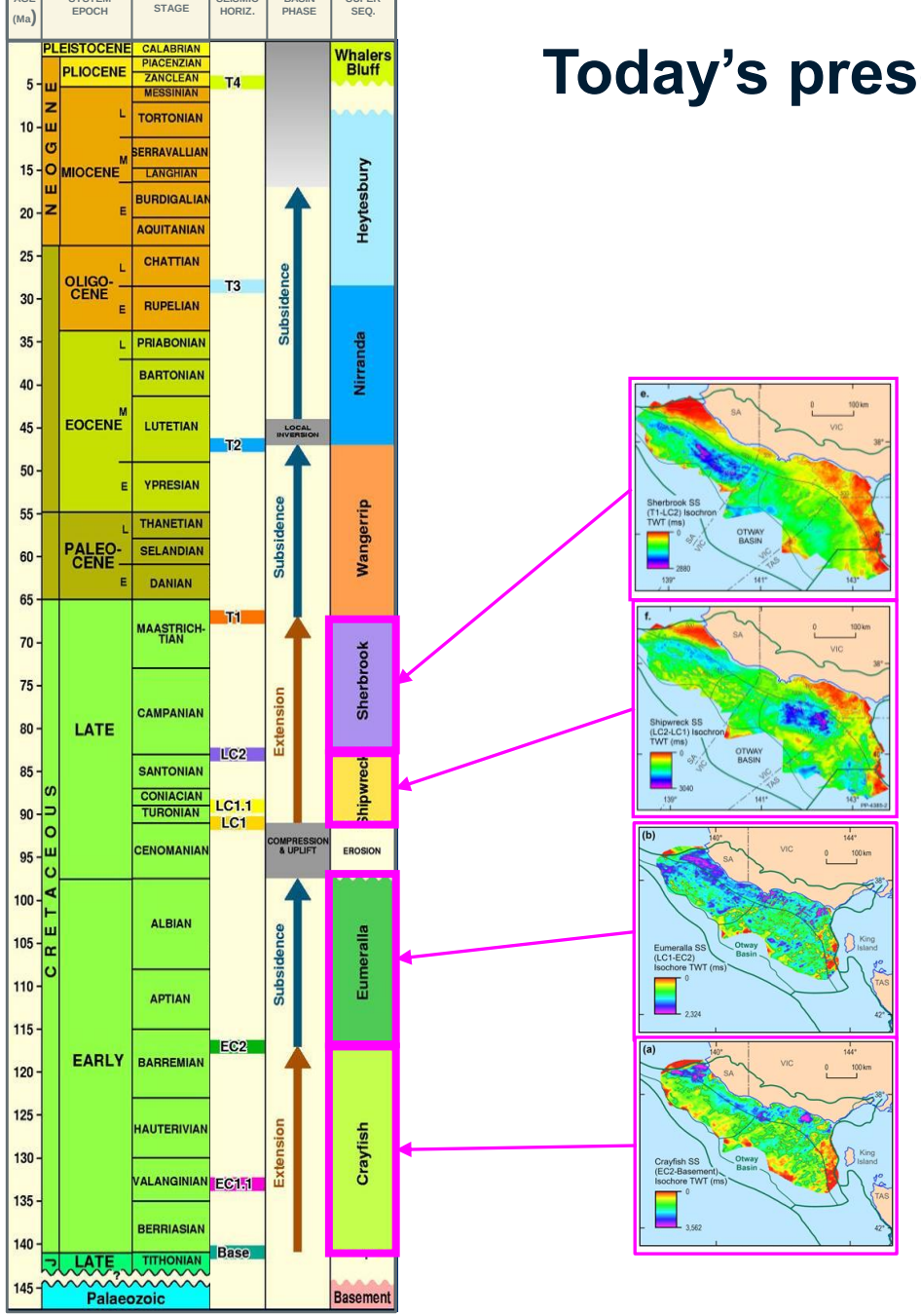
# Offshore Otway Basin regional seismic mapping of key supersequences




- Builds on existing sequence frameworks and interpretations *(Krassay et al. 2004, Romine et al. 2020 & Schenk et al. 2021)*

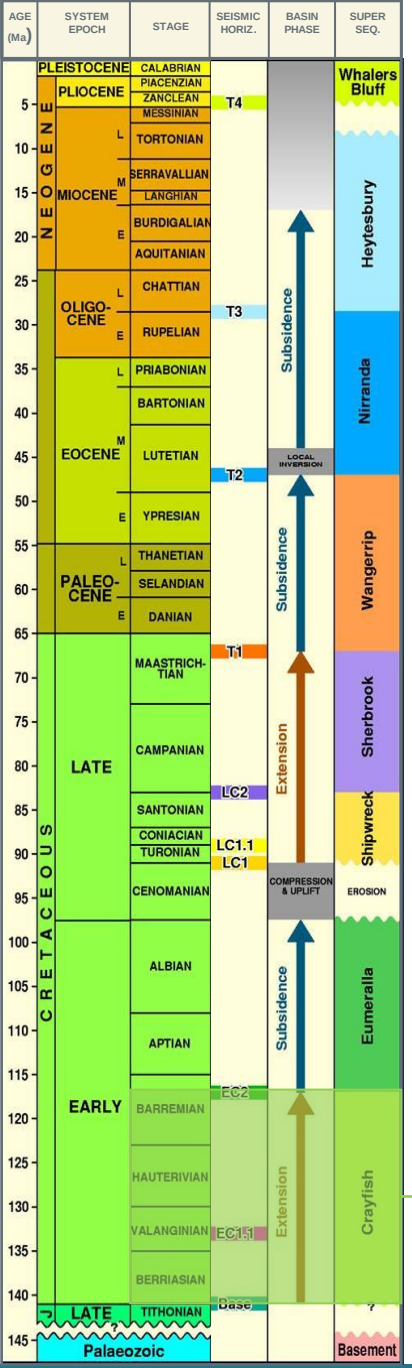
# Today's presentation

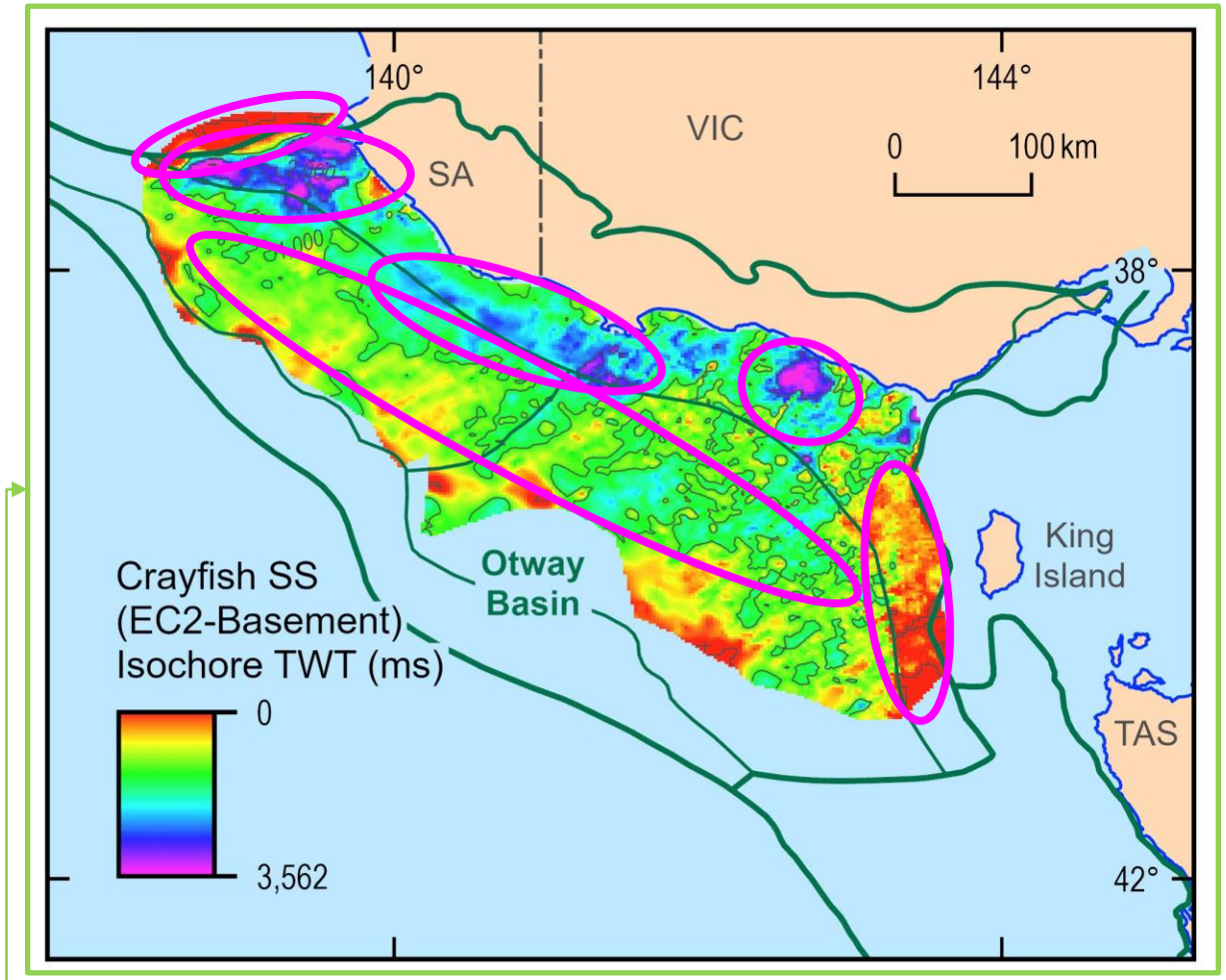
- Cretaceous rift and supersequence depocentre evolution



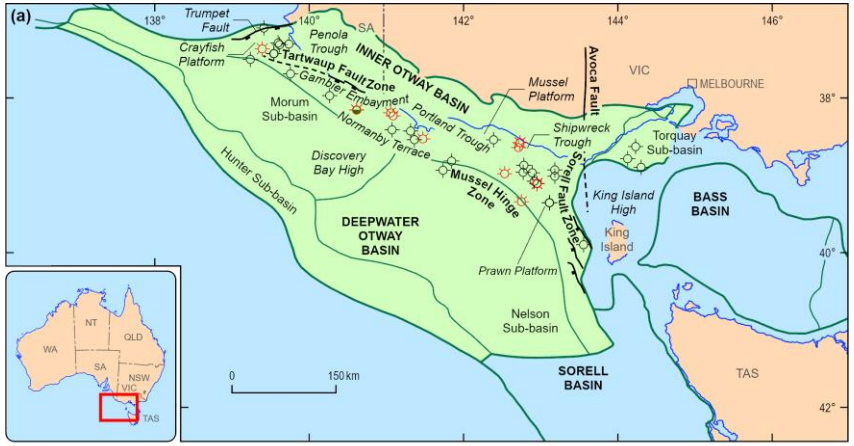
# Crayfish Supersequence and depocentres

## Jurassic-Barremian Extension



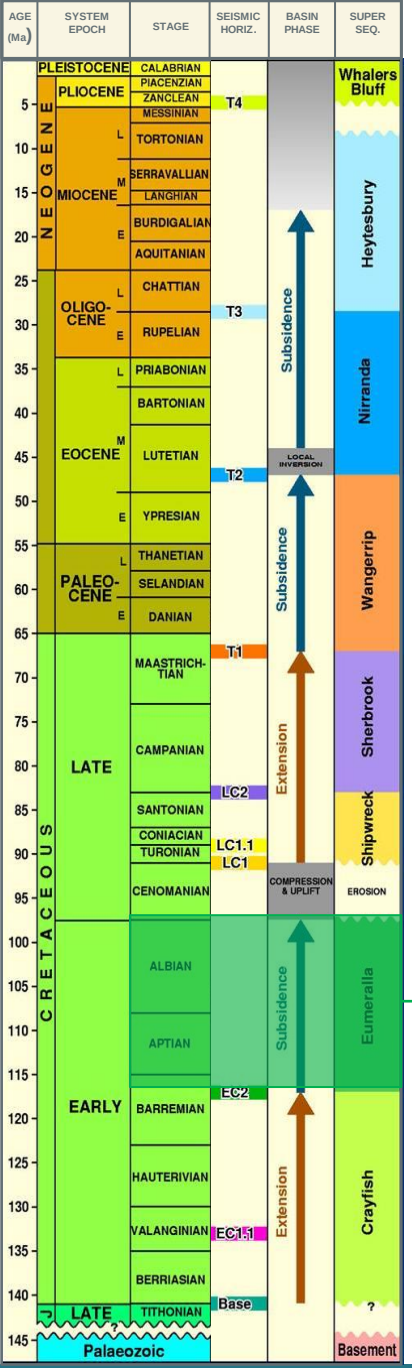

Casterton, Pretty Hill, Laira, Katnook sandstone lithostratigraphy equivalents

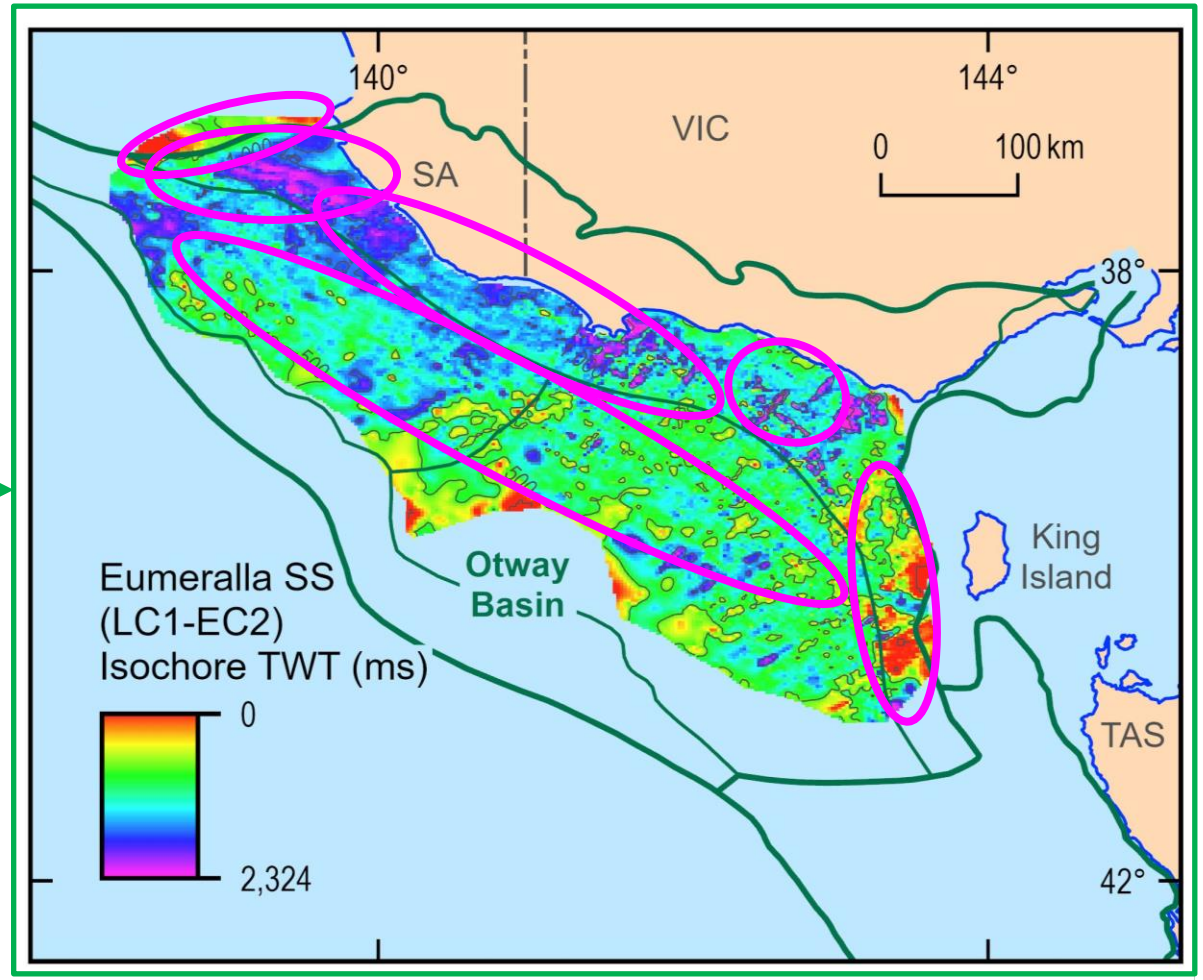



- Fluvio-lacustrine succession, representing the initial inboard extension phase
- Thickest in extensional depocentres across inboard platform area (~3500 ms TWT)
- Thins outboard in the deep-water region
- Absent over basement highs in the southeastern and northwestern basin margins

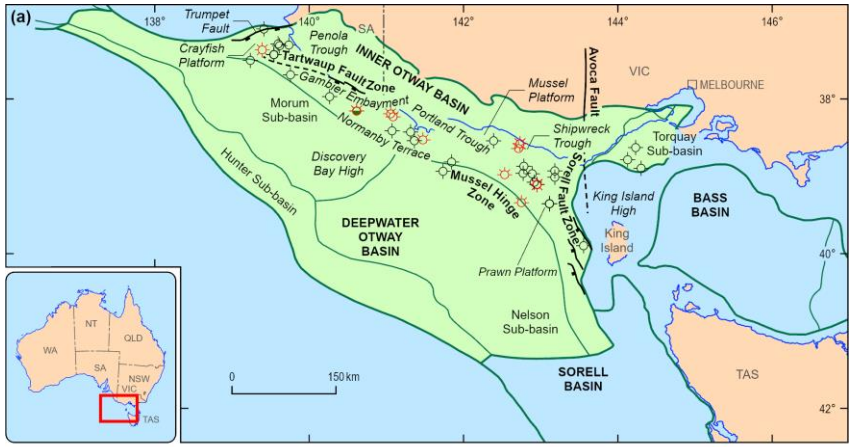
# Eumeralla Supersequence and depocentres

Aptian-Albian volcaniclastic sag succession



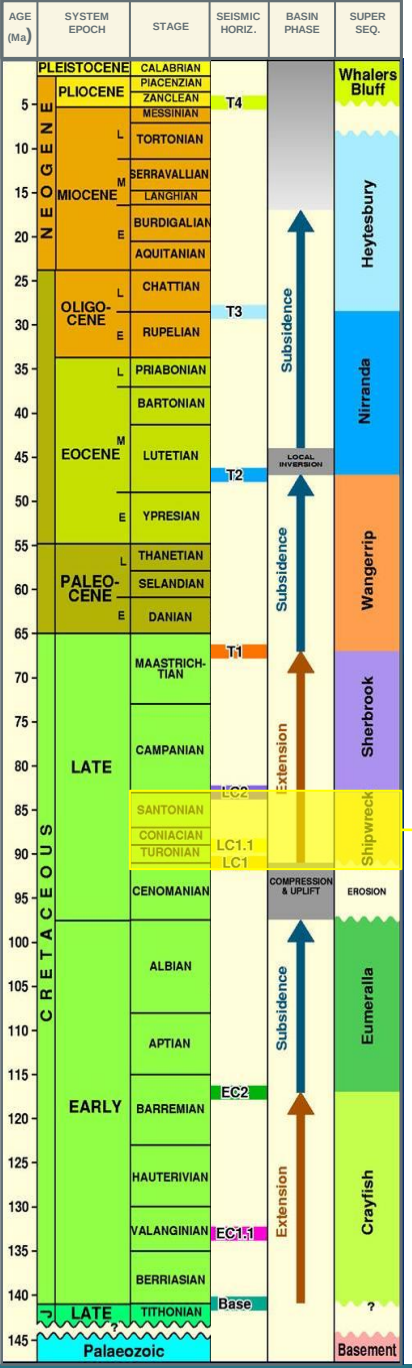

Eumeralla formation lithostratigraphic equivalent

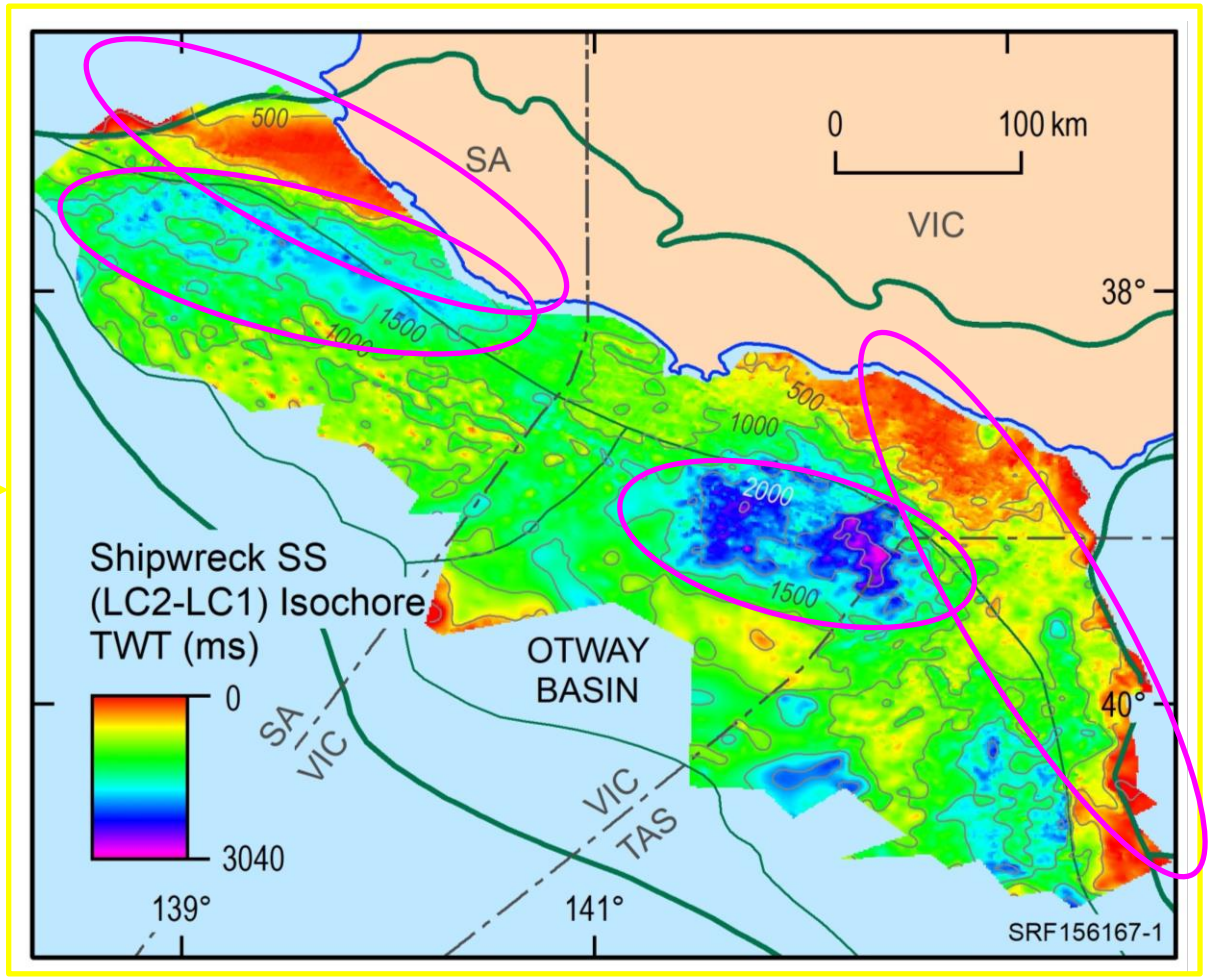



- Thickest overlying synrift depocentres where you would expect maximum thermal sag (~2300 ms TWT)
- Thins outboard in the deep-water region where it is broadly isopachous
- Thin to absent over basement highs in the southeastern and northwestern basin margins

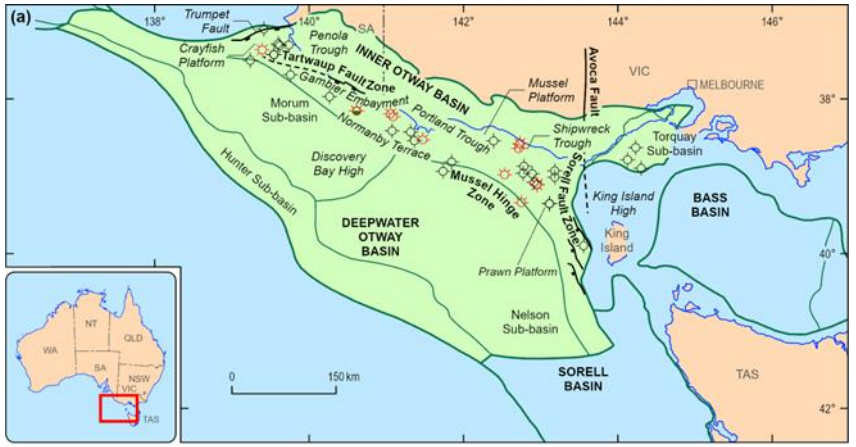
# Shipwreck Supersequence and depocentres (Nicholson *et al.* 2022)

## Turonian–Santonian Extension



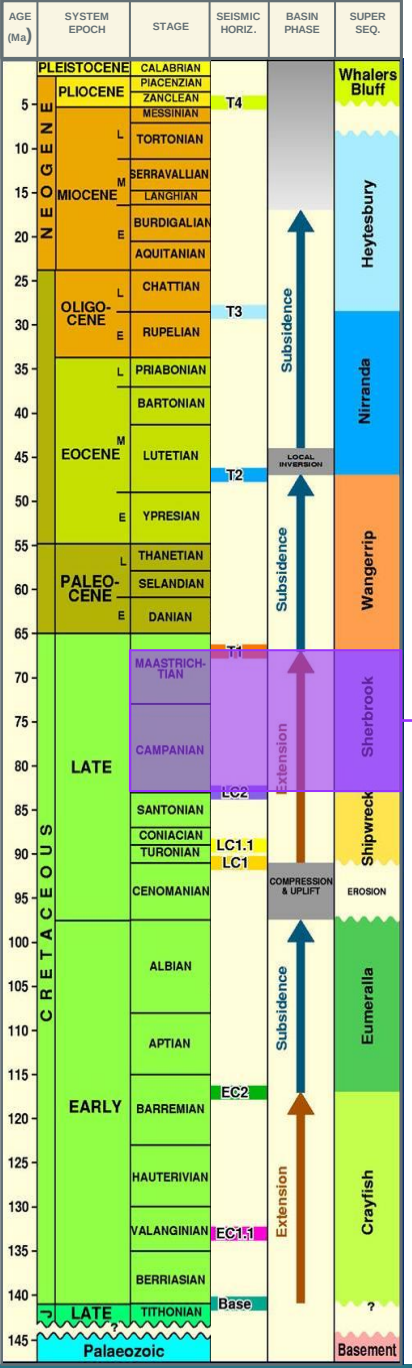

Waarre, Flaxman, Belfast Mudstone lithostratigraphy equivalents

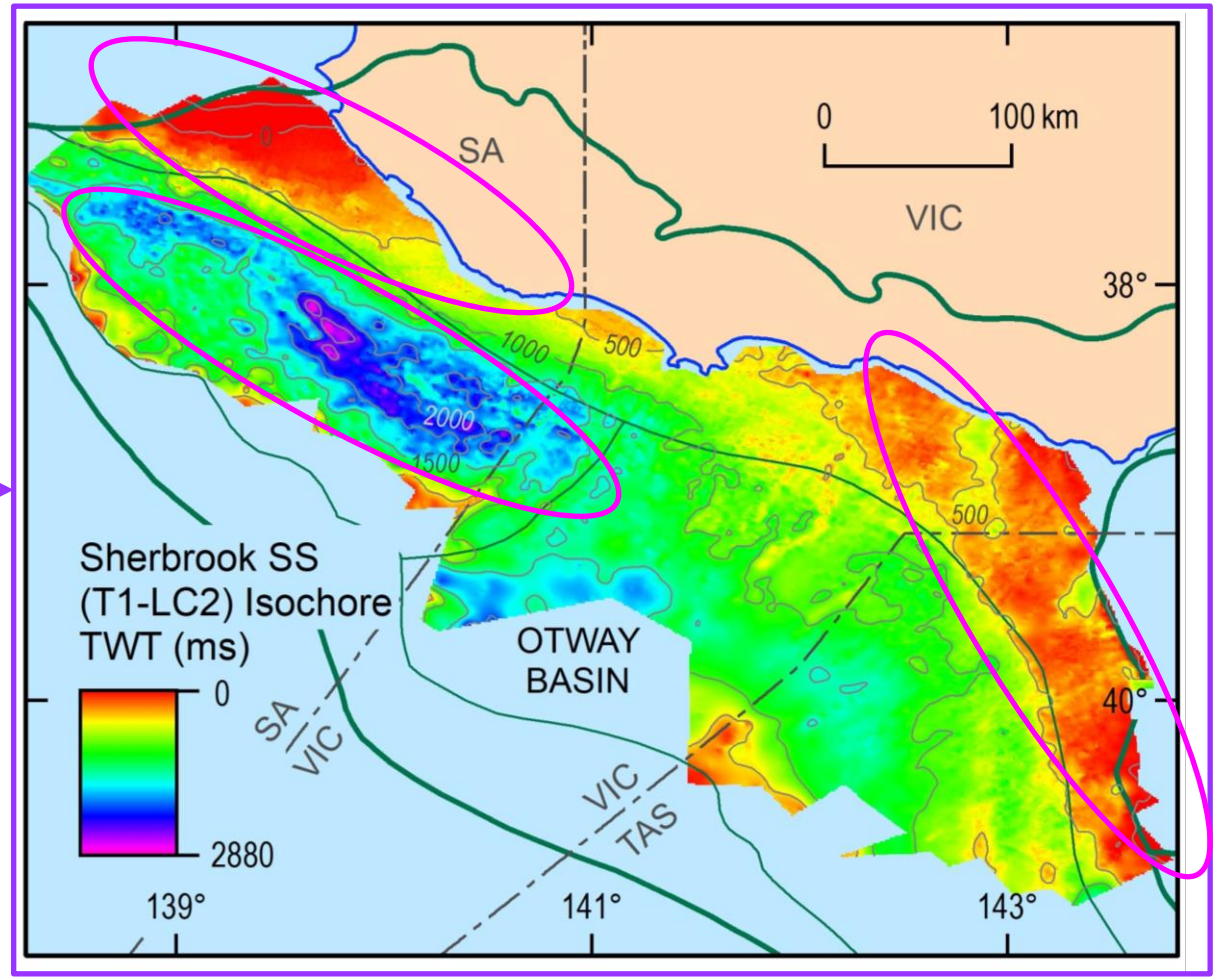



- Thinnest over platform areas (< 1000 ms TWT)
- Thickens outboard of platform edges
- Forms two distinct depocentres
  1. Nelson Sub-basin (~3000 ms TWT)
  2. Morum Sub-basin (~2000 ms TWT)

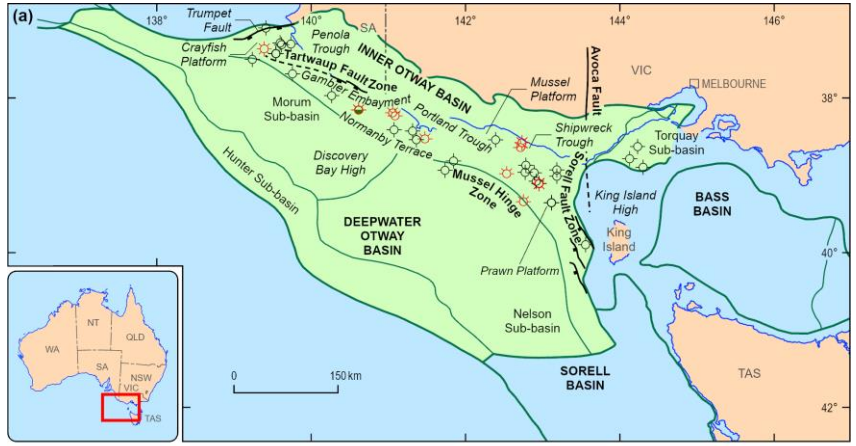
# Sherbrook Supersequence and depocentres (Nicholson *et al.* 2022)

## Campanian–late Maastrichtian Extension



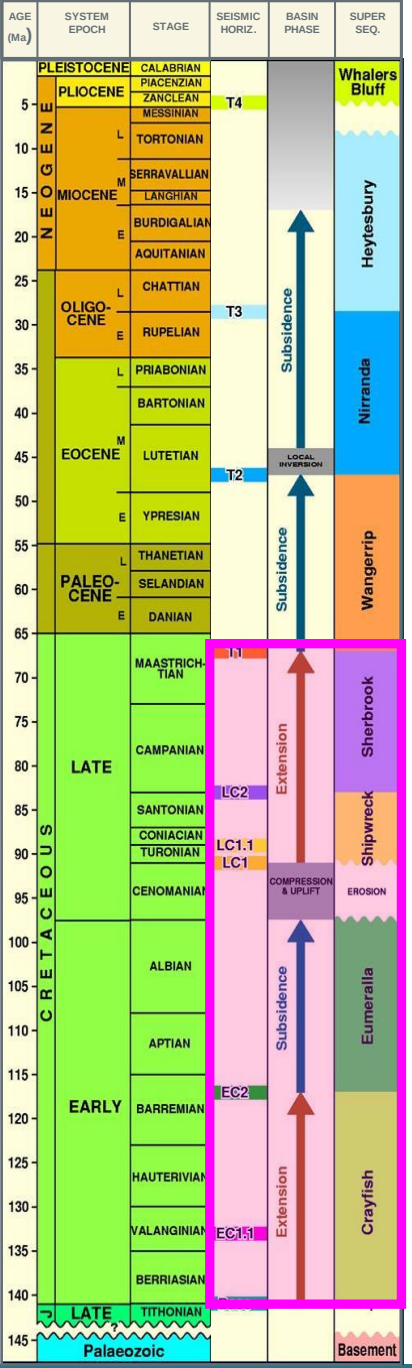

Skull Creek Mudstone, Paaratte Formation, Timboon Sandstone lithostratigraphy equivalents

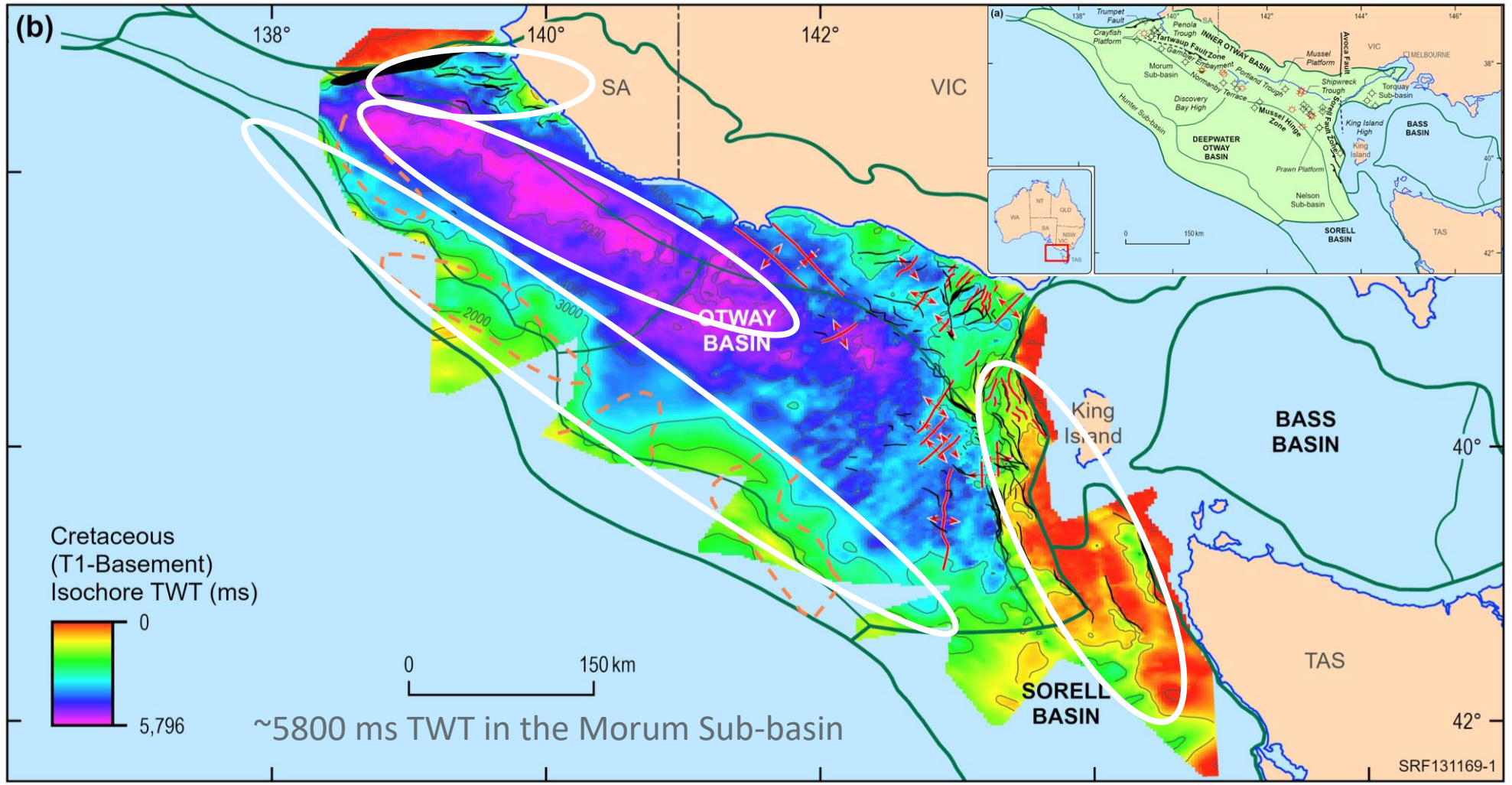



- Thinnest over platform areas (< 1000 ms TWT)
- Thickens outboard of platform edges
- Locus of sedimentation shifts west to an elongate NW-SE depocentre
  1. Morum Sub-basin (~2800 ms TWT)
  2. < 2000 ms TWT in the Nelson Sub-basin
- Outboard stepping synrift sedimentation over time

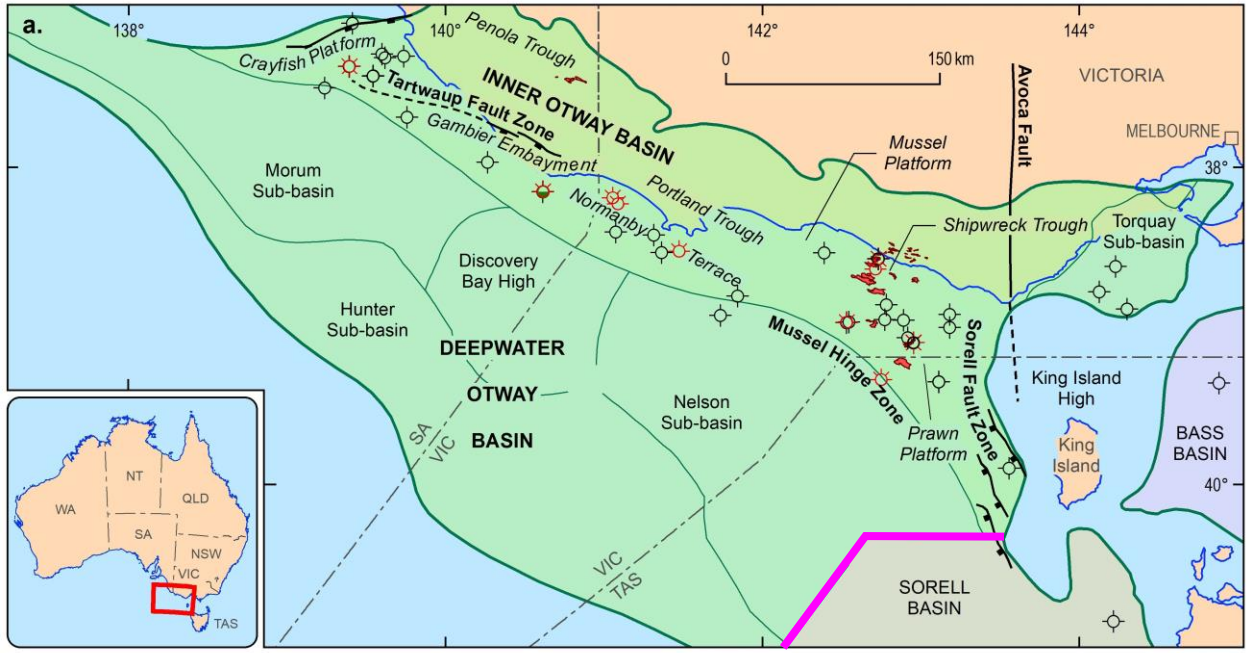
# Cretaceous depocentre as a whole

## Breakup unconformity (T1) to Basement isochore



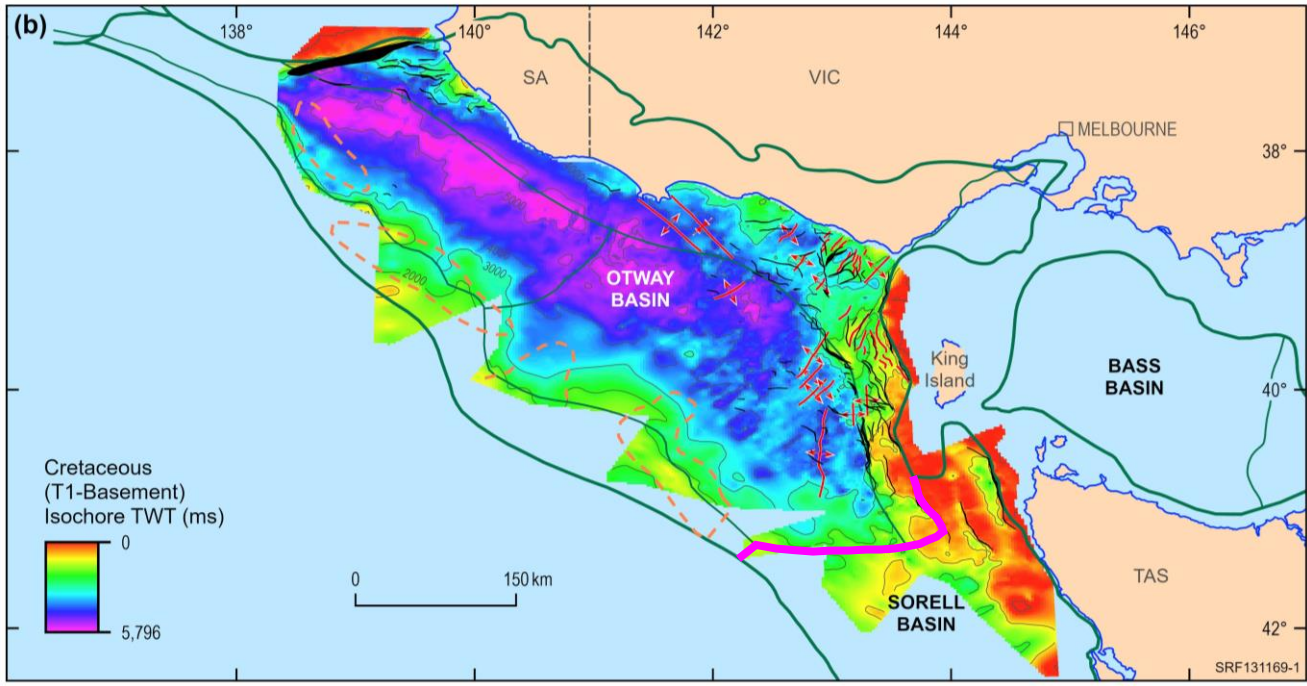



# Updates to basin boundaries and structural elements




Previous boundaries

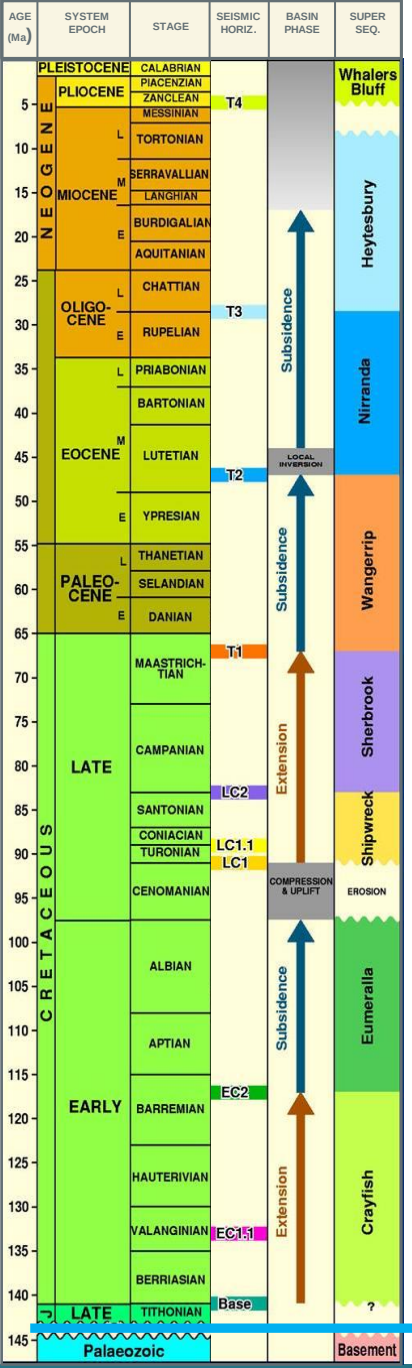
Updated boundaries

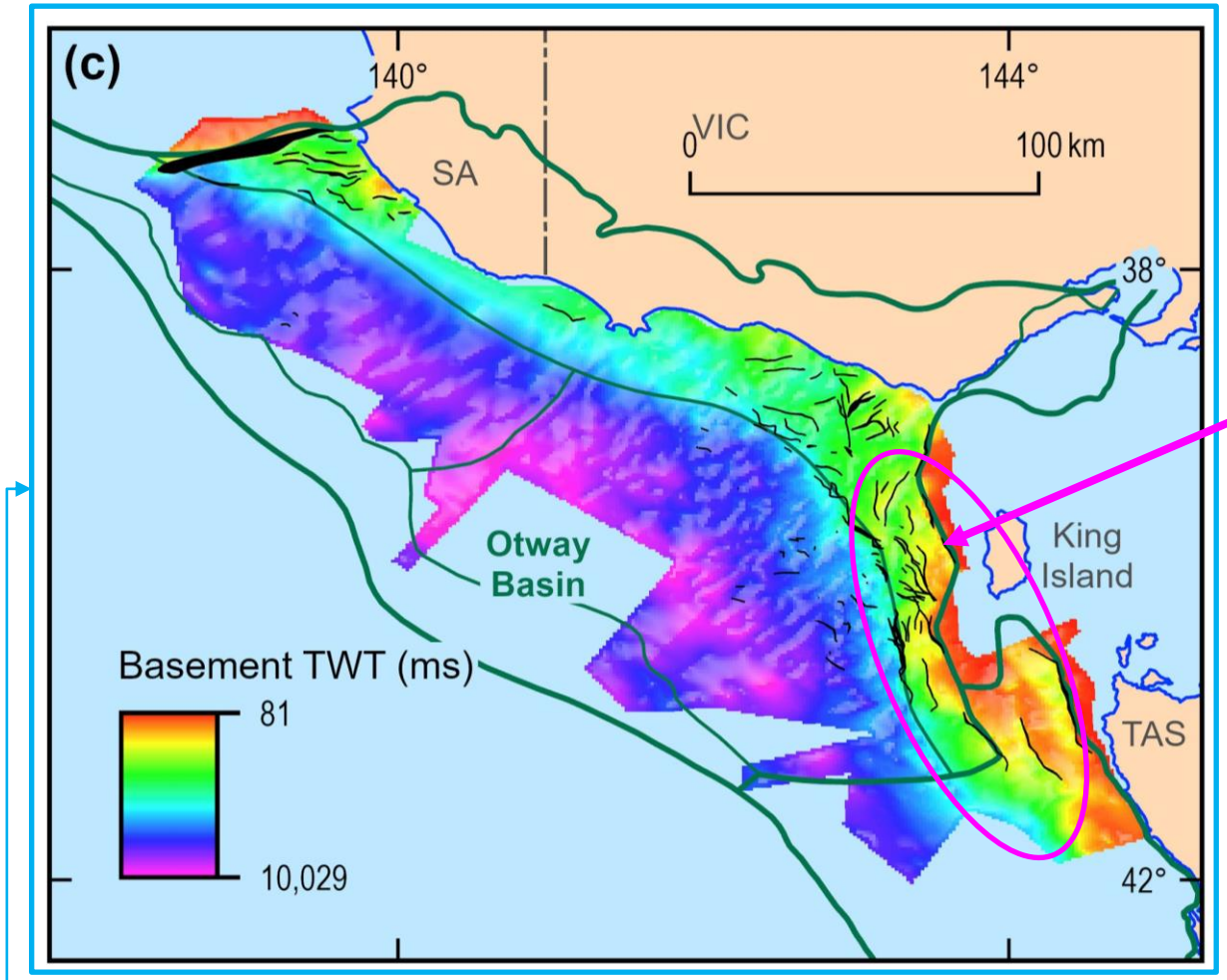



- The Cretaceous isochore map highlights a need to update structural elements and basin boundaries

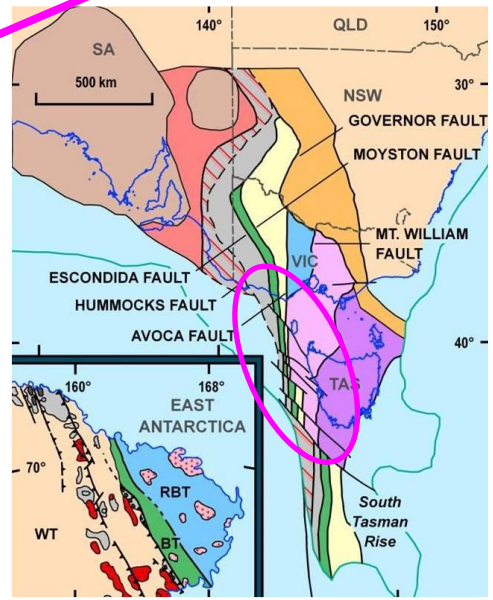
# Basement structure

Paleozoic basement and basement involved faults – base Crayfish Supersequence







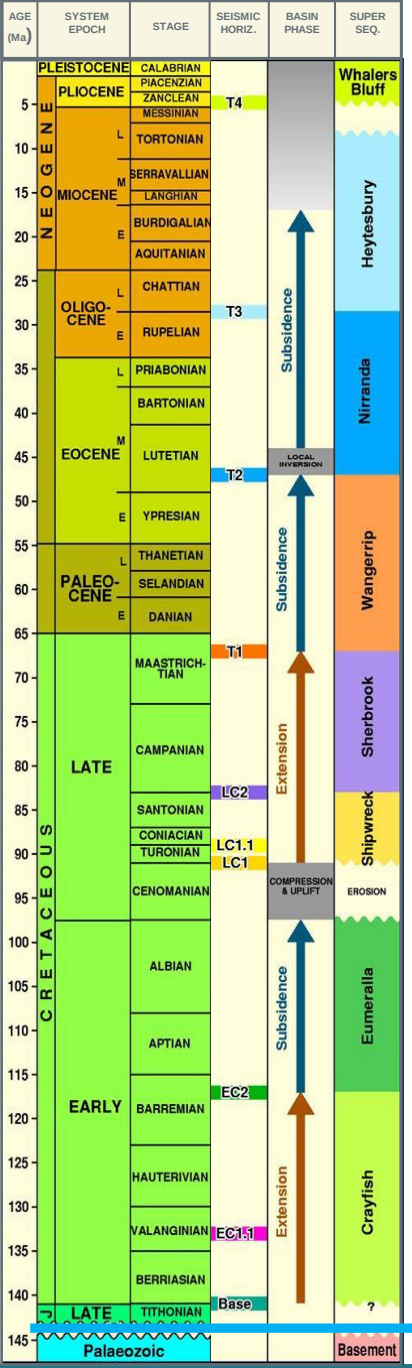


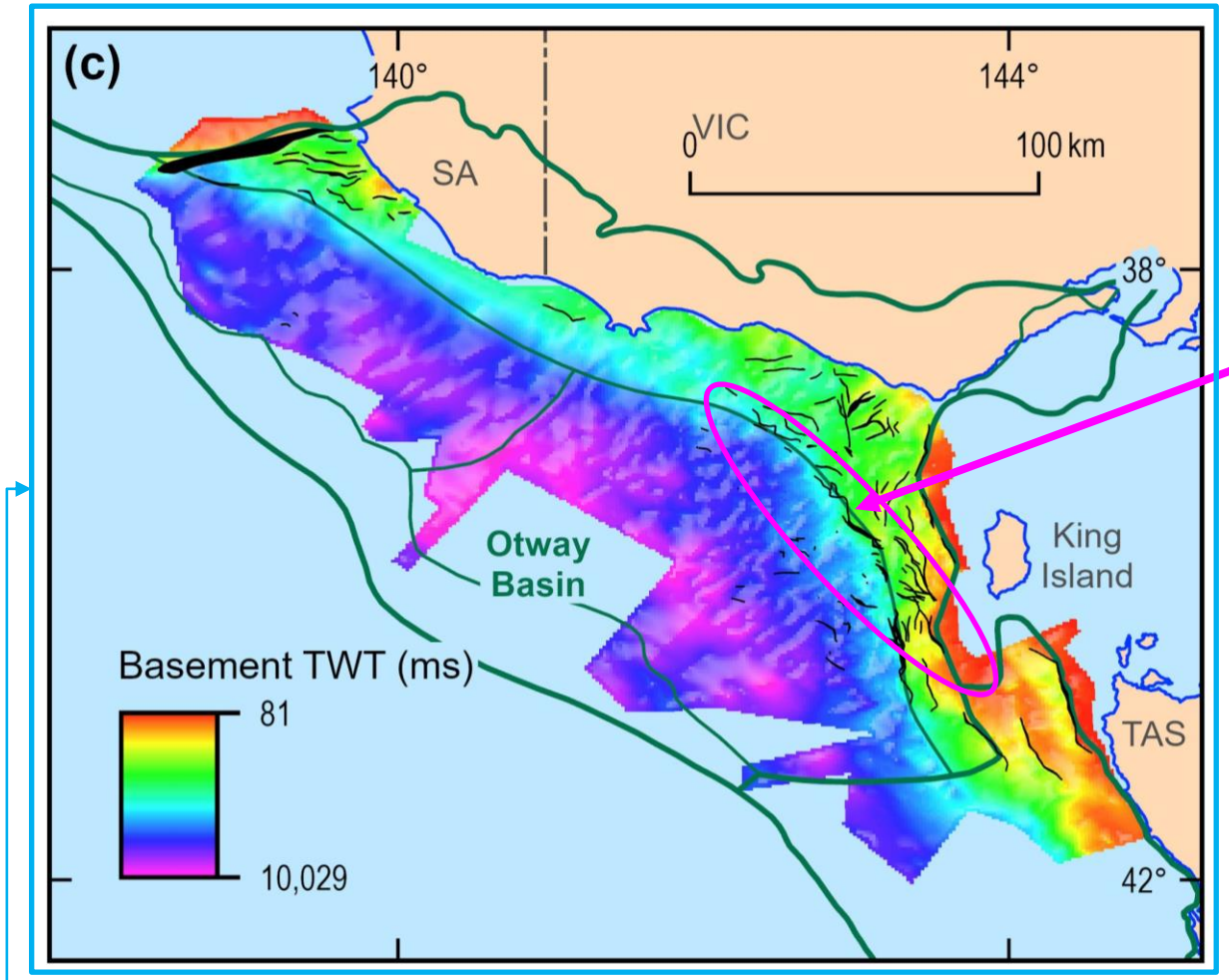
Basement terranes & terrane boundaries *(Gibson et al, 2011)*

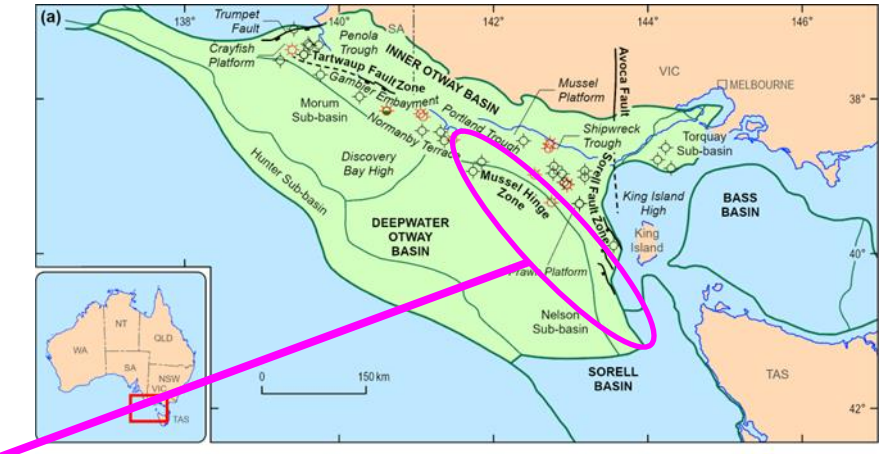
NNW-SSE basement grain controls faulting, basement features, and basin architecture in the SE, basement-involved faults from the Sorell Fault Zone define the basin boundary

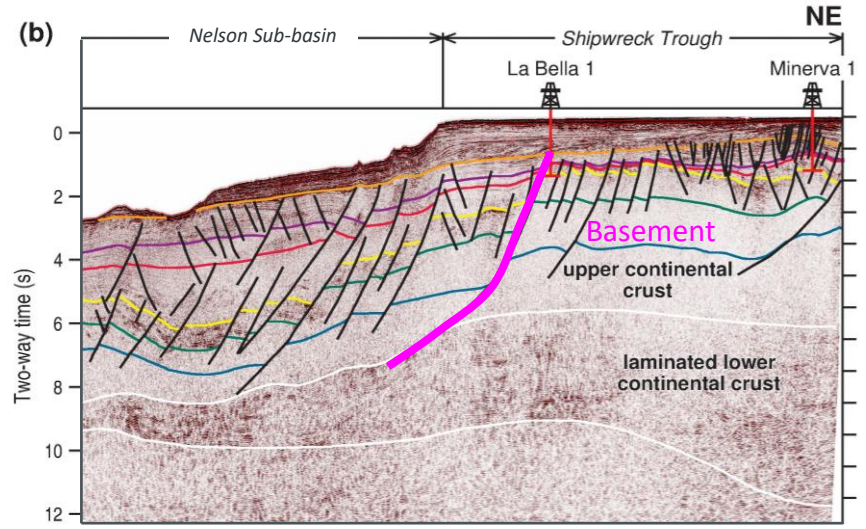
# Basement structure

Paleozoic basement and basement involved faults – base Crayfish Supersequence



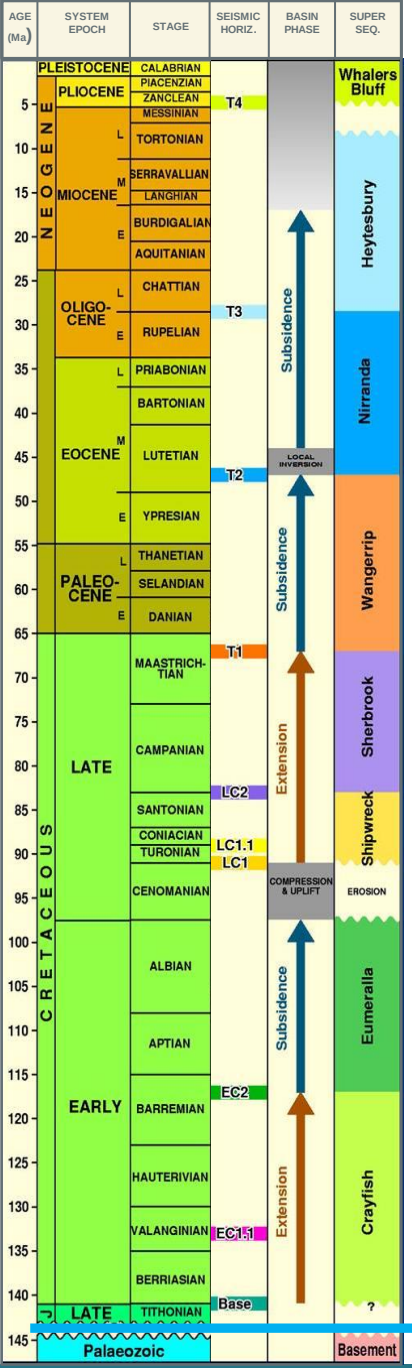



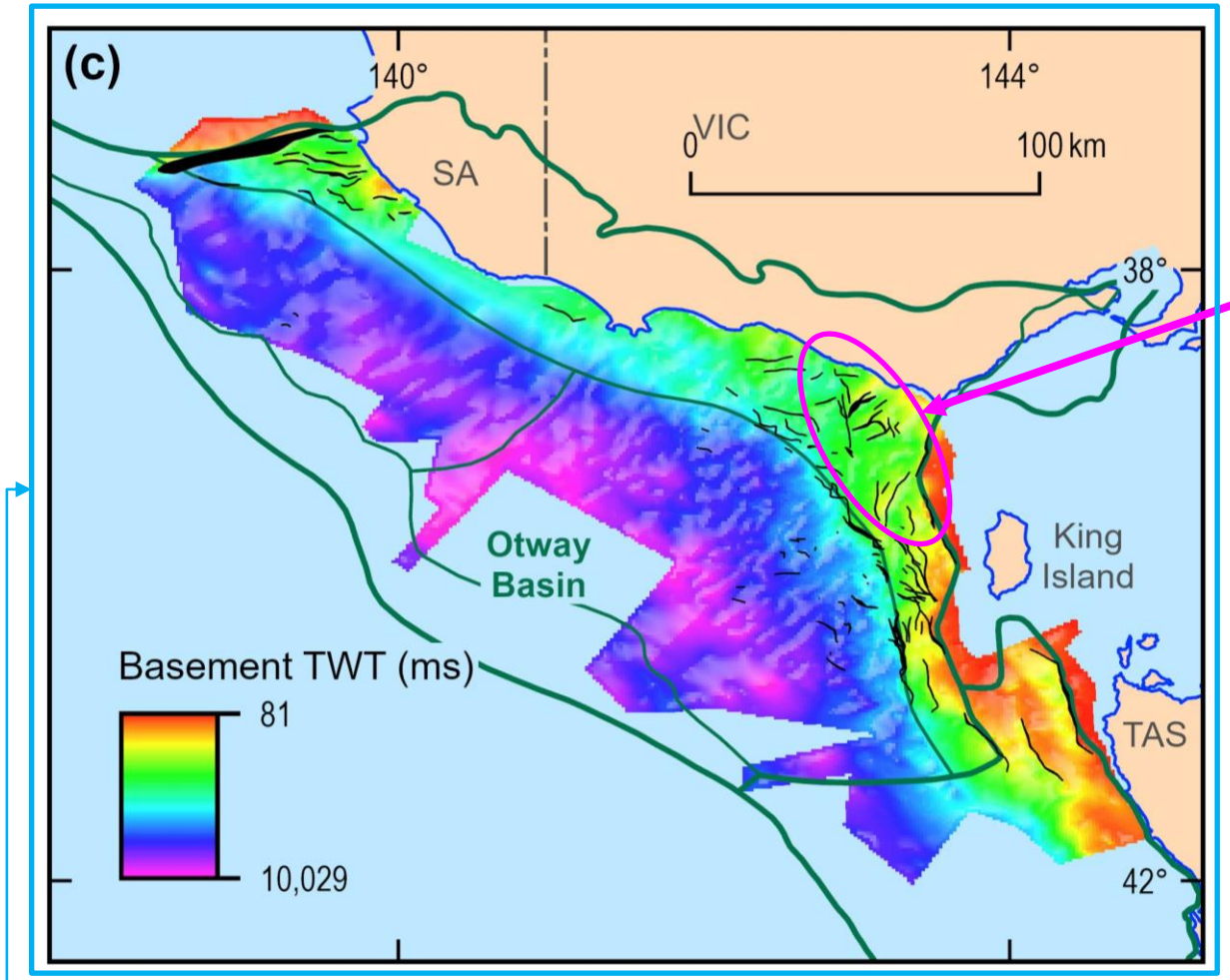



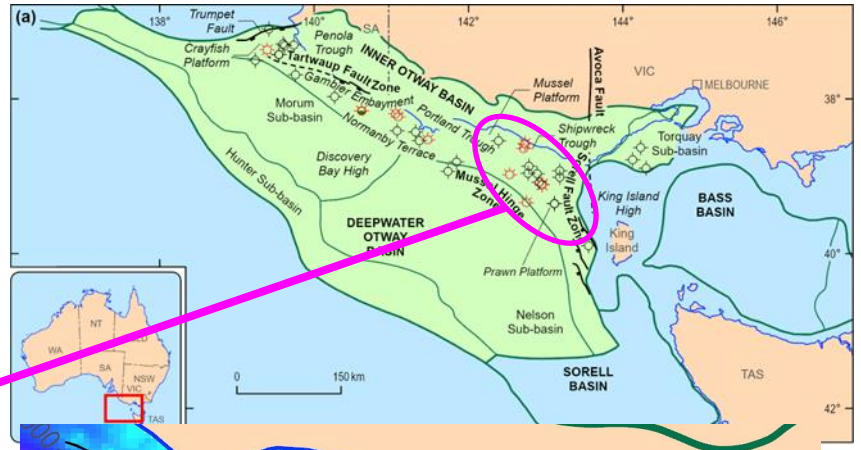

En échelon, NNW-SSE to NW-SE oriented, crustal-scale detachment faults, step down from the platform edge and offset basement, separating the Deepwater and Inner Otway Basin

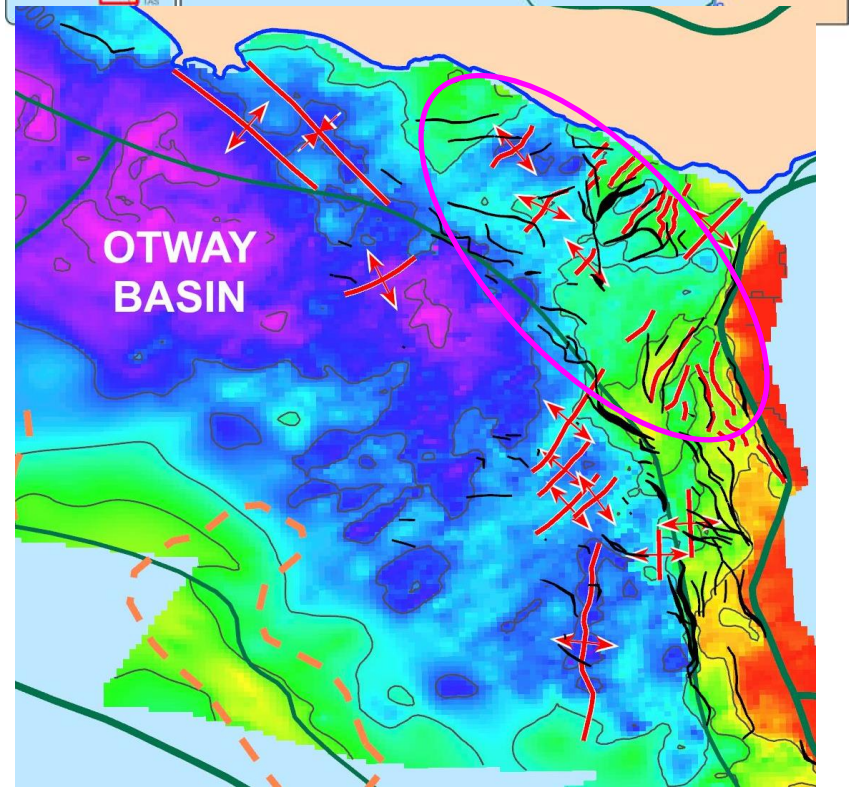
# Basement structure

Paleozoic basement and basement involved faults – base Crayfish Supersequence



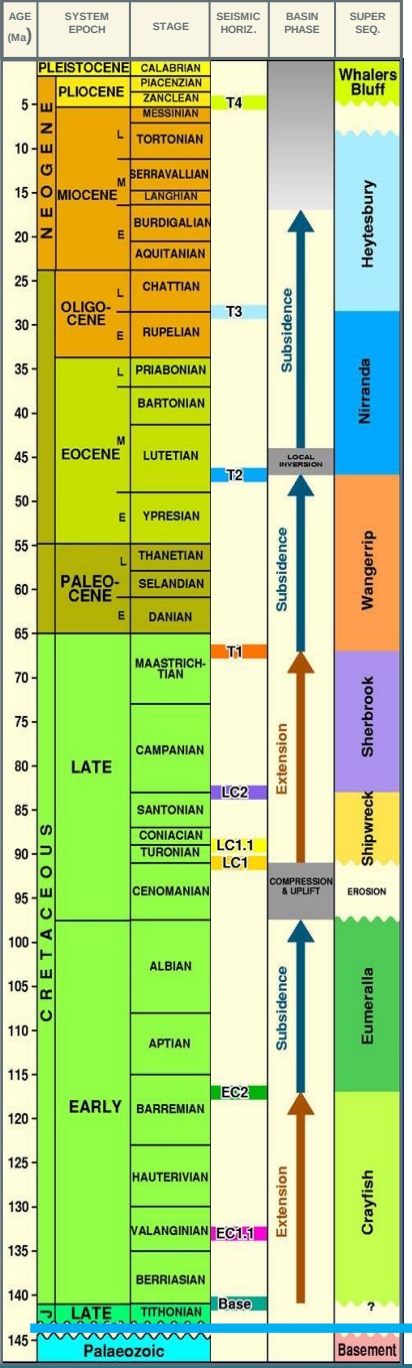



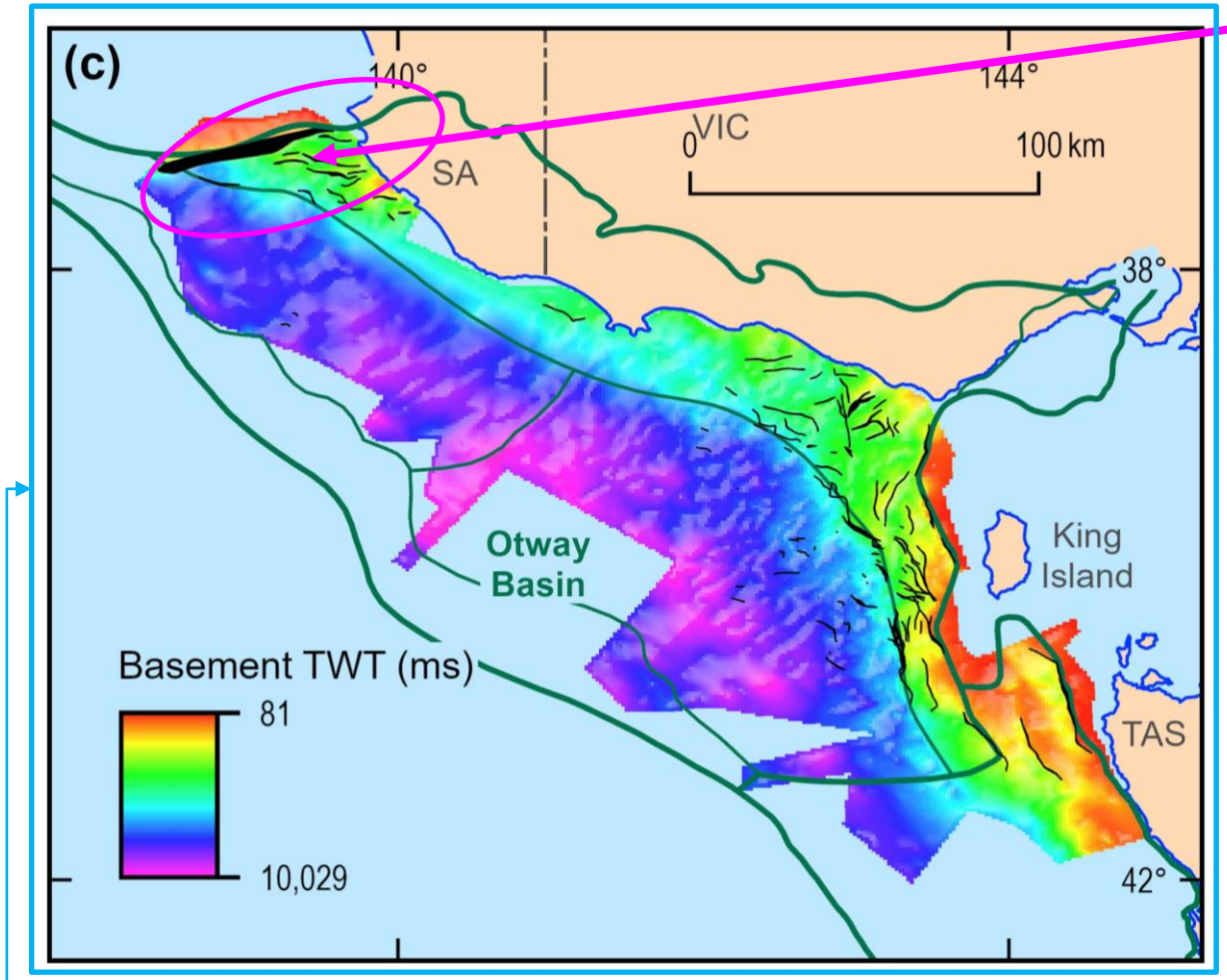



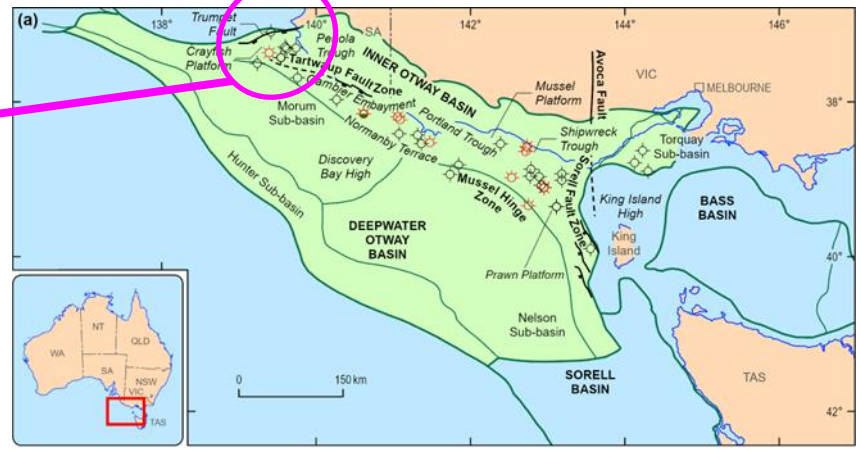

Across the Prawn Platform, Shipwreck Trough and Mussel Platform, basement faults trend NE-SW to N-S and are commonly aligned with Cretaceous fold axes, indicating that deformation was basement-controlled

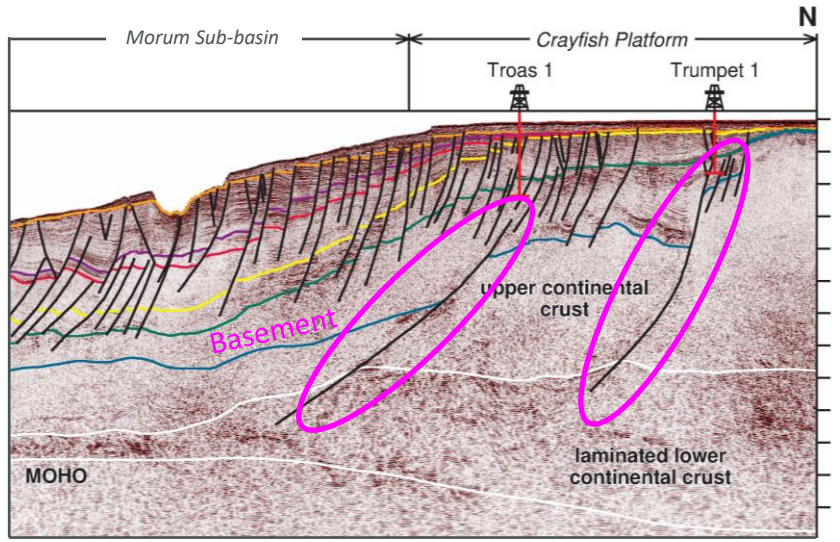
# Basement structure

Paleozoic basement and basement involved faults – base Crayfish Supersequence



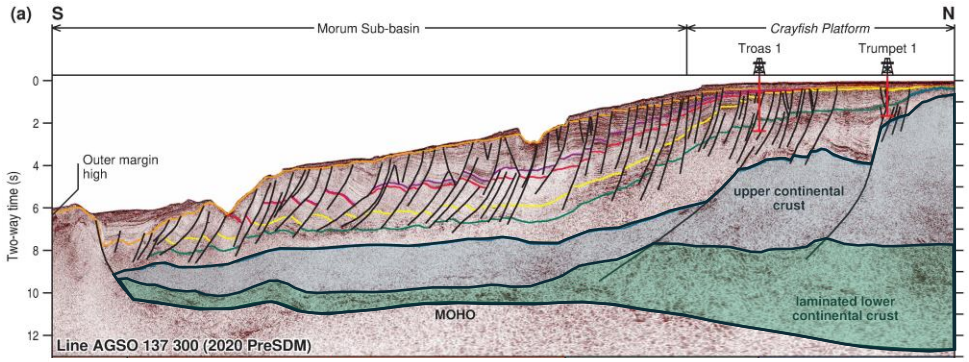



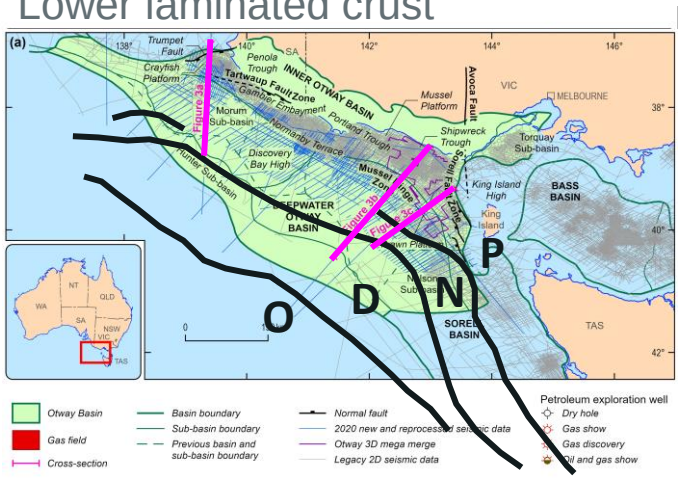



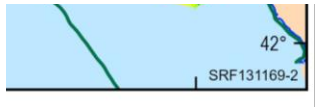

In the northwest, the ENE-WSW oriented Trumpet Fault marks the basin-basement boundary and is accompanied by a series of E-W oriented faults that offset basement to the south

# Crustal architecture that has influenced basin evolution

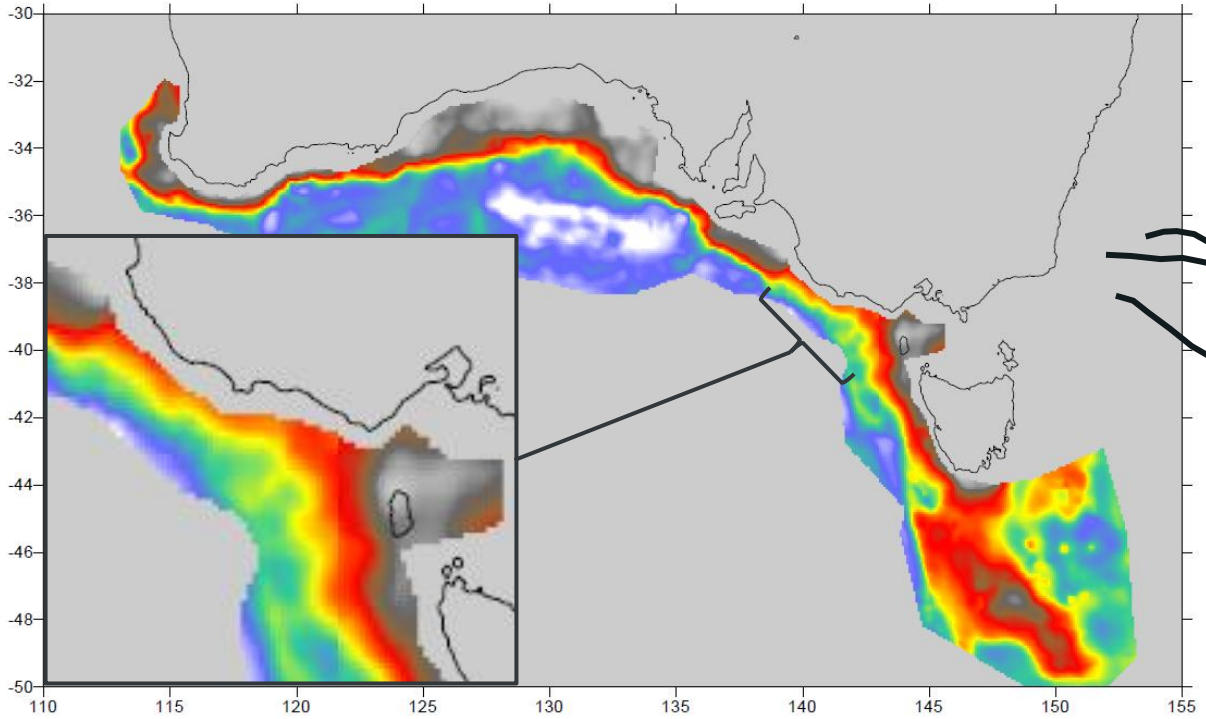


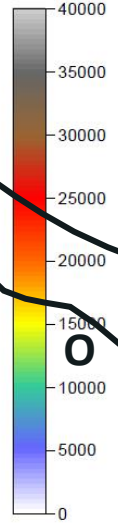

Lower laminated crust



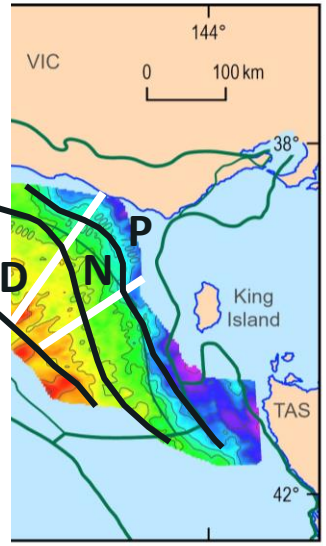




## Crustal Thickness (m)

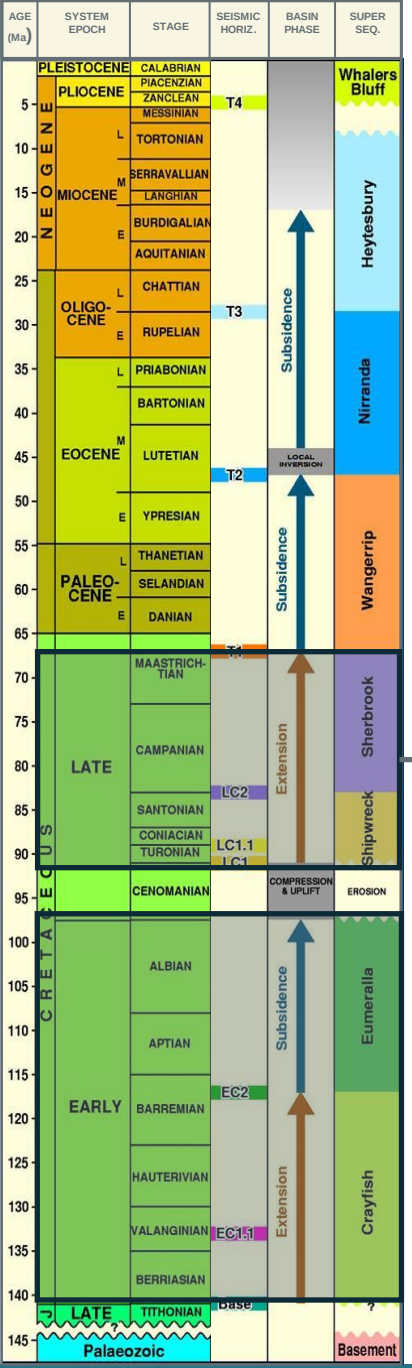


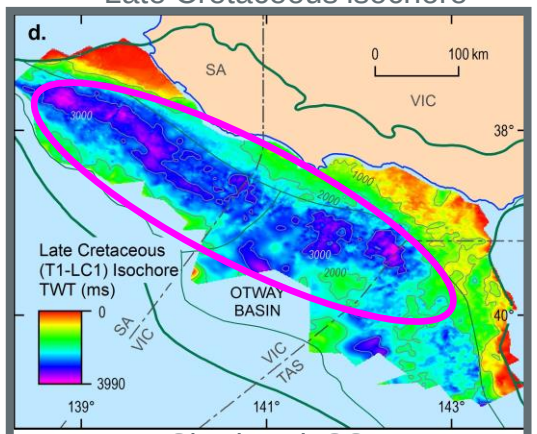

laminated crust



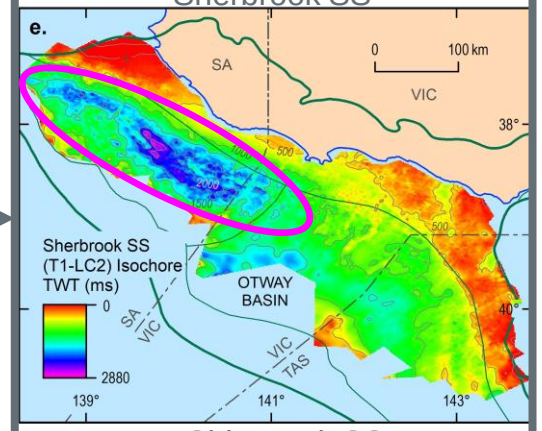
# Influence on Upper Cretaceous depocentres



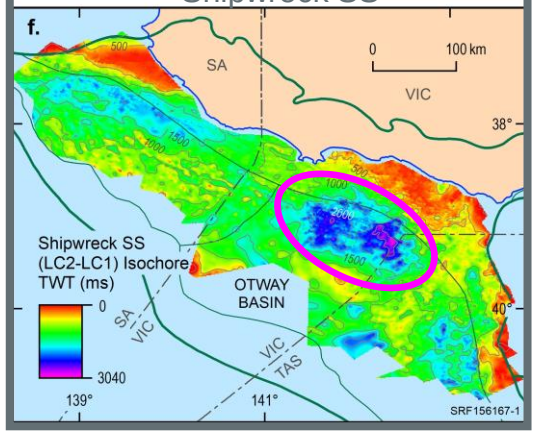

Late Cretaceous isochore



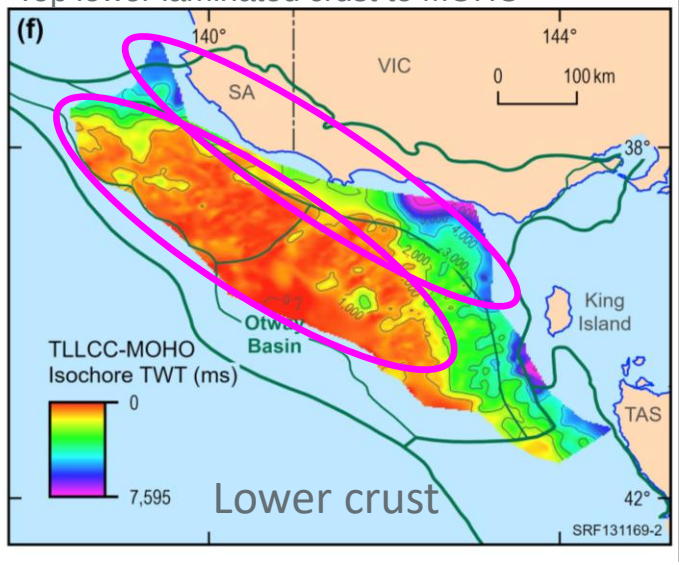

Sherbrook SS



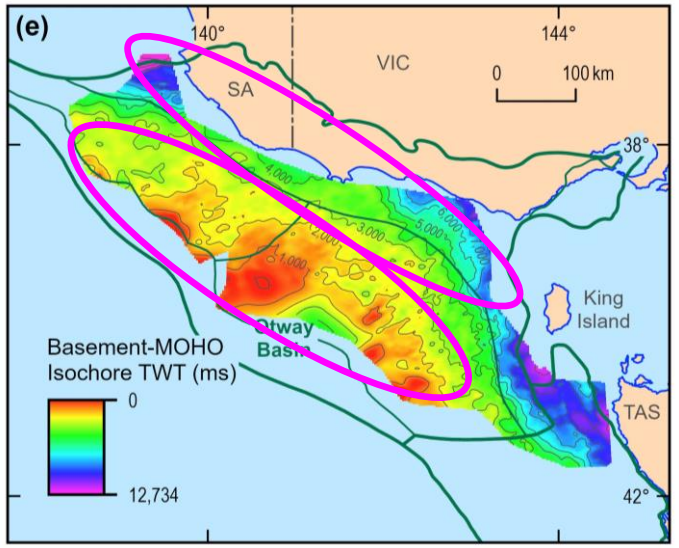

Shipwreck SS




Top lower laminated crust to MOHO

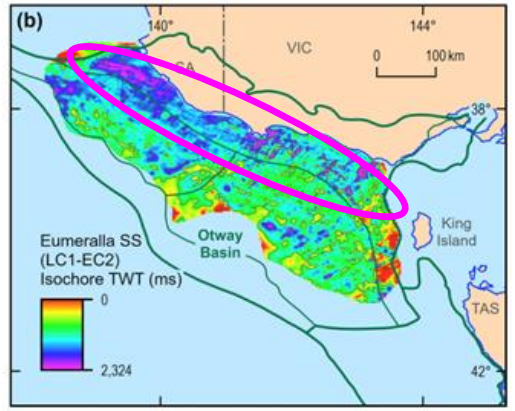



Basement to MOHO

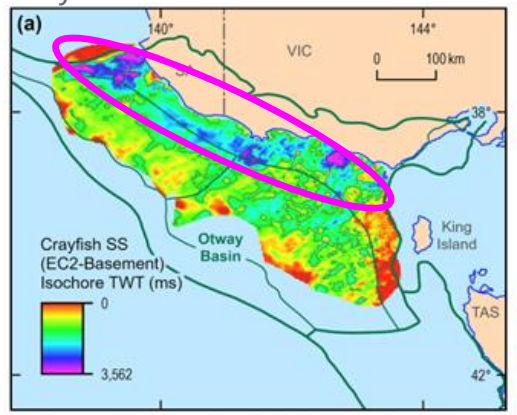



- Crustal thinning corelates with Upper Cretaceous depocentres and the second phase of extension

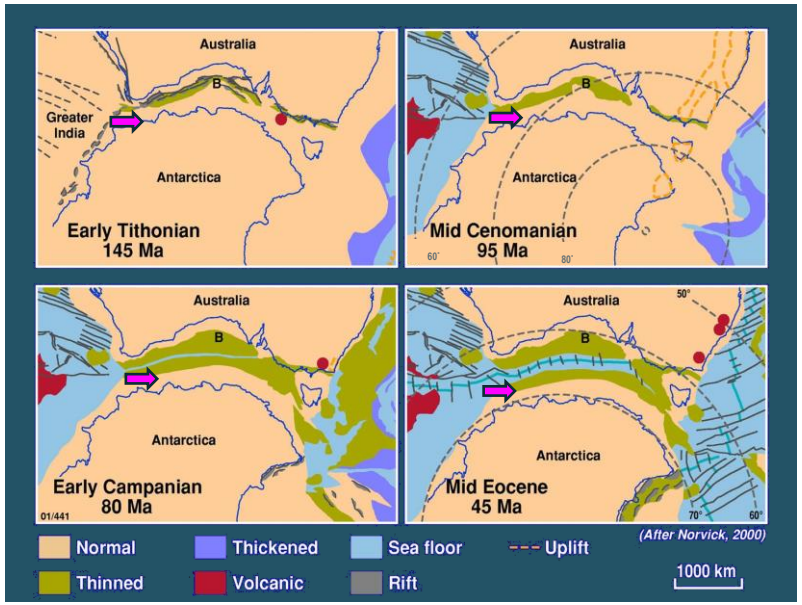
Eumeralla SS

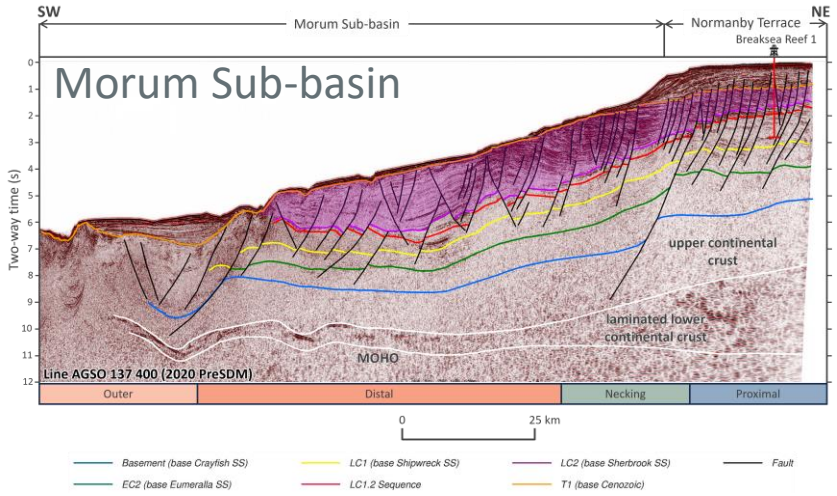


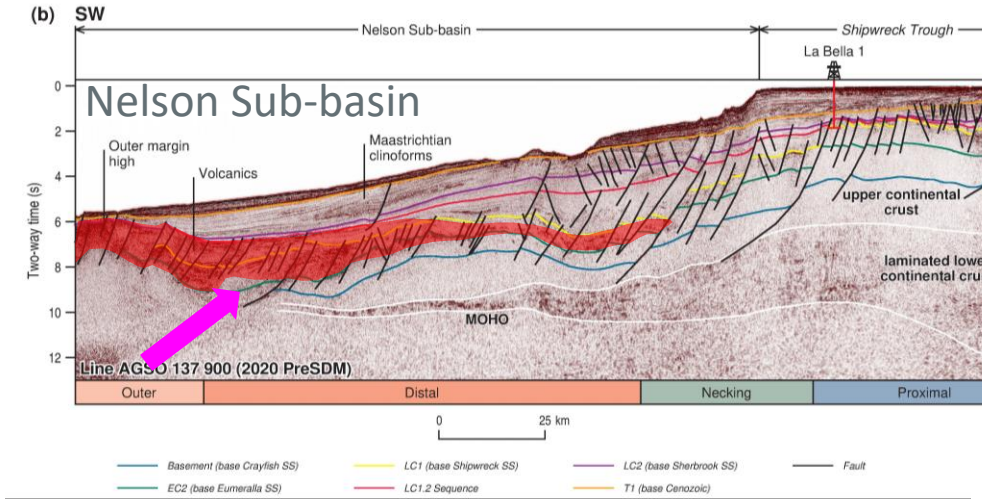

Crayfish SS

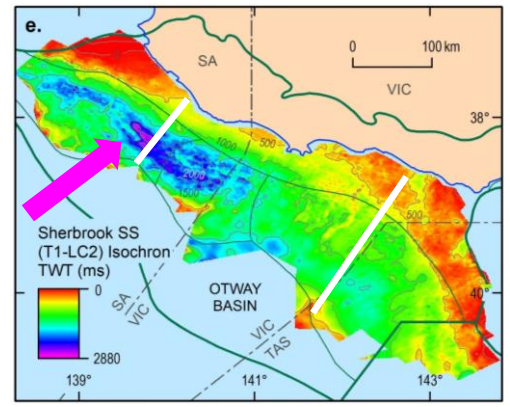


# Why the westerly shift in Late Cretaceous depocentres?



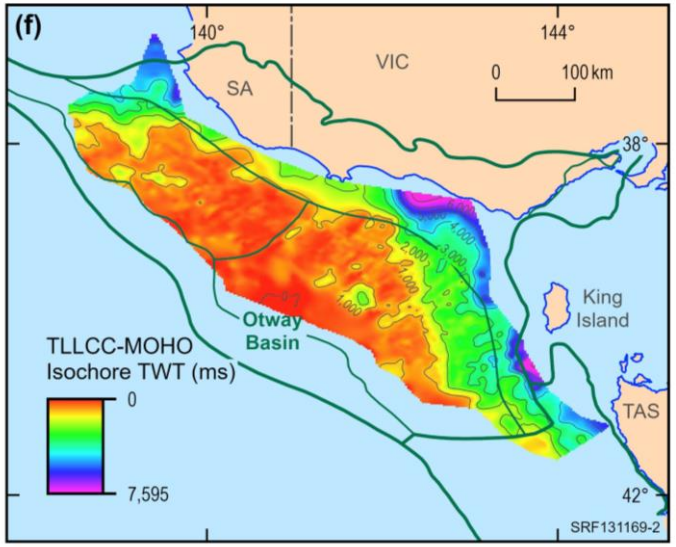



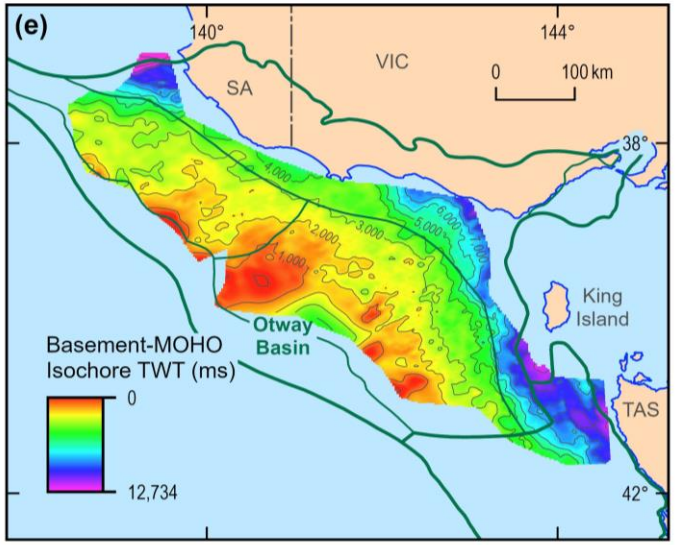



# Influence on the distribution of regional gross depositional environments

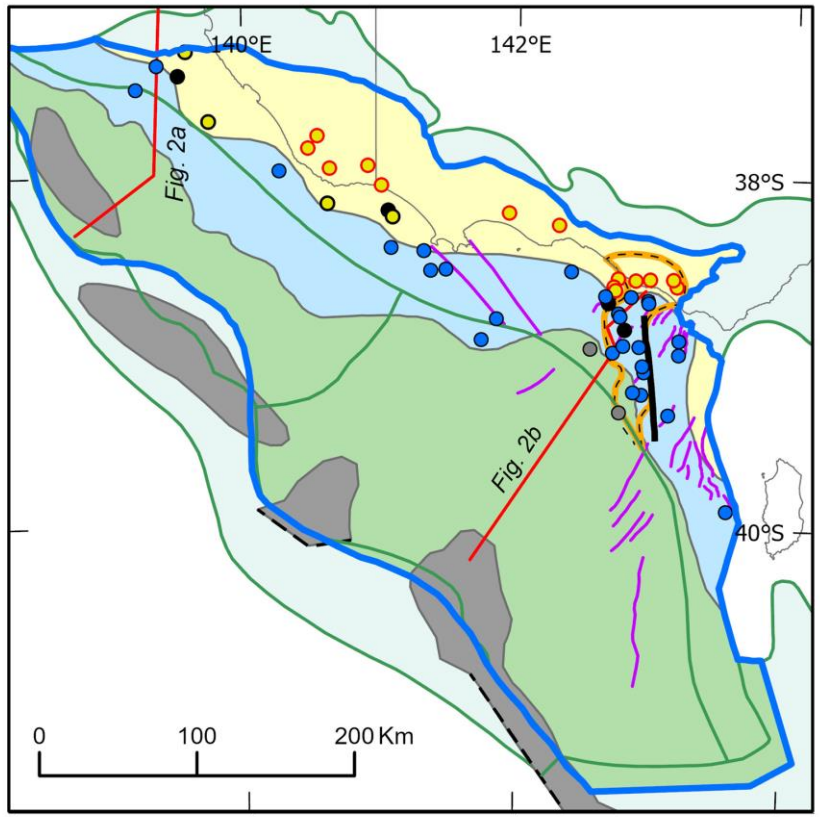
Top lower laminated crust to MOHO




Basement to MOHO




Shipwreck Supersequence
(LC1.2 sequence)



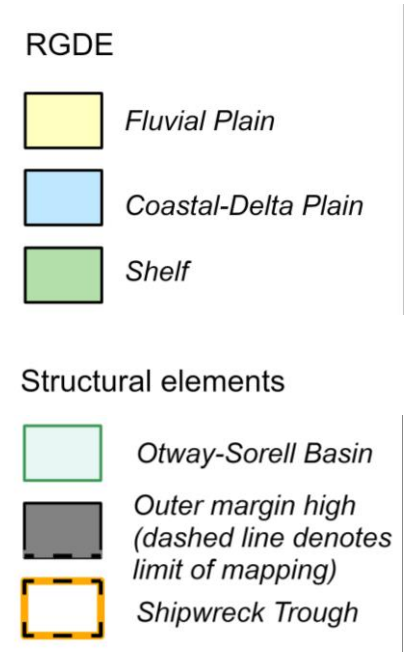

Linkage between crustal thinning, deposition and depositional environment distribution

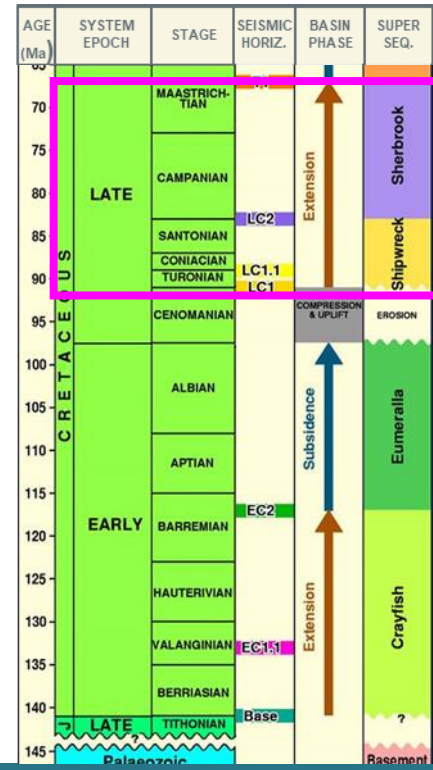
- Posters in the main conference hall

Shipwreck and Sherbrook Supersequence Regional Gross Depositional Environments, offshore Otway Basin (Abbott *et al.* 2024)

The Central and Southeast Offshore Otway Basin Well Folio *(Nguyen et al. 2024)*

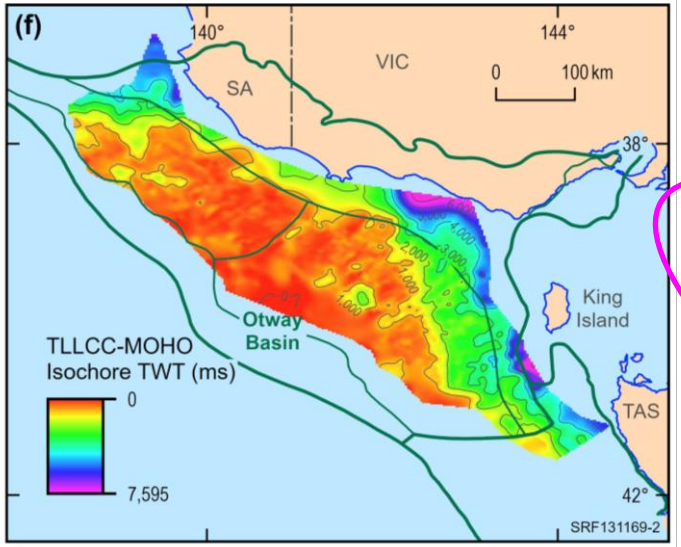
Offshore Otway Basin core log data package *(Cubitt et al. 2024)*



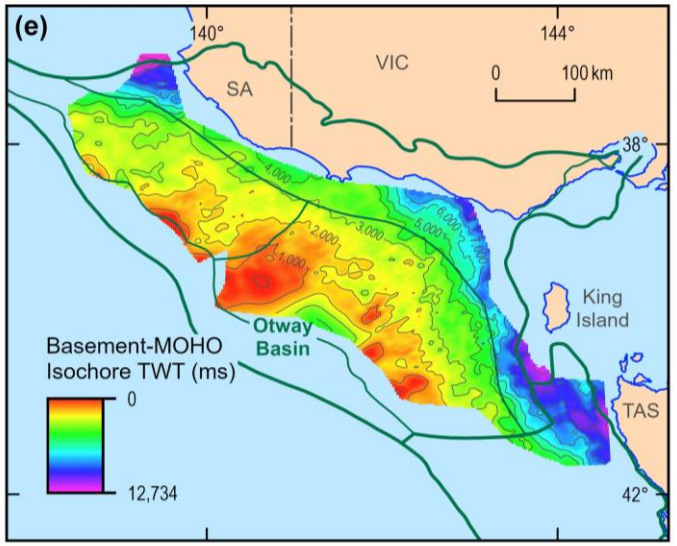



# Late Cretaceous crustal extension may have favoured elevated heat flow

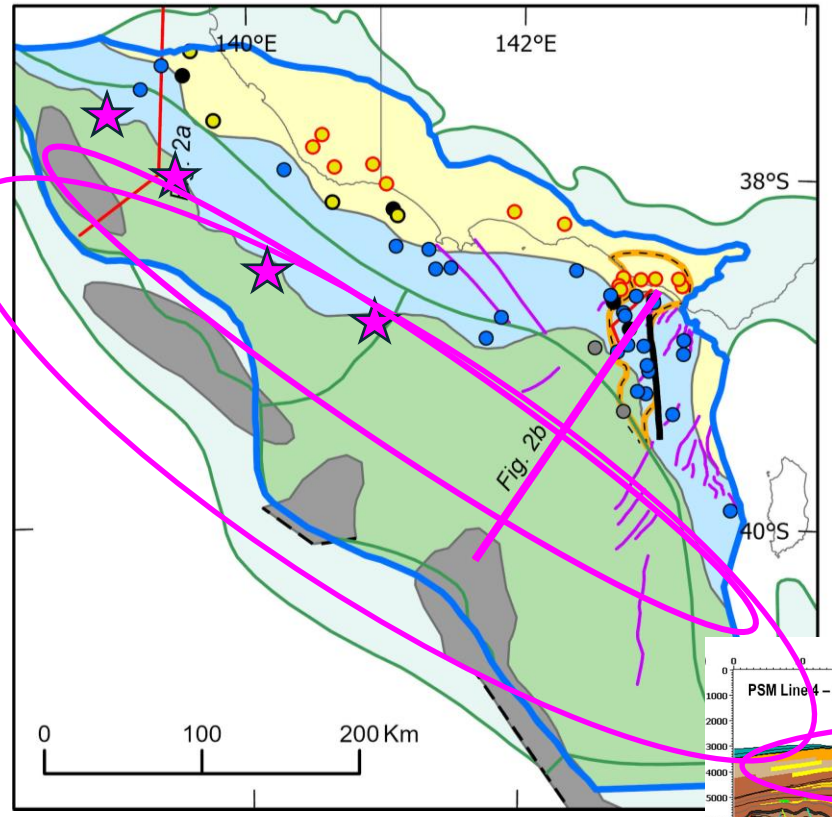
Top lower laminated crust to MOHO




Basement to MOHO

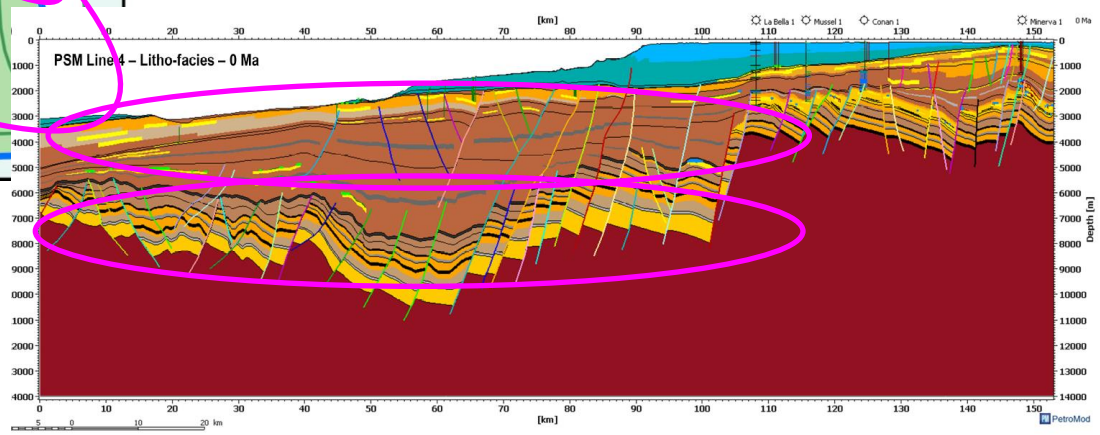



Sherbrook Supersequence





Possible generation in the Sherbrook depocentre

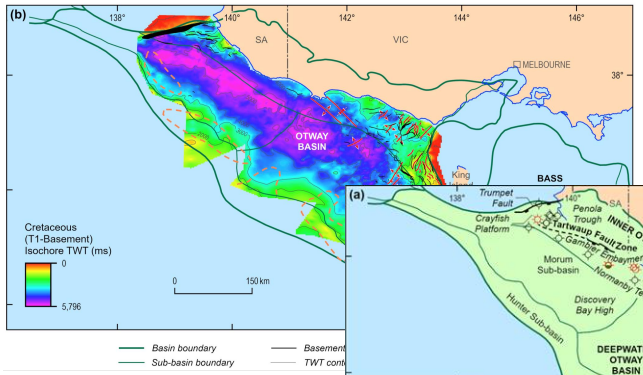



## Potential Sherbrook plays

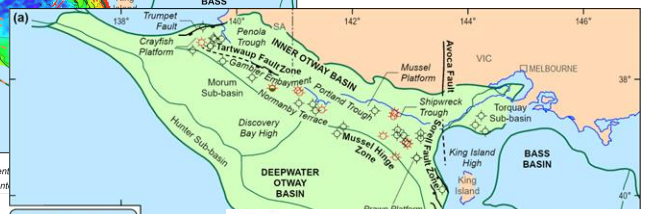
- Marine source rocks with minor delta topset reservoirs within the Shelf RGDE

(Schenk *et al.* 2021, 2023)

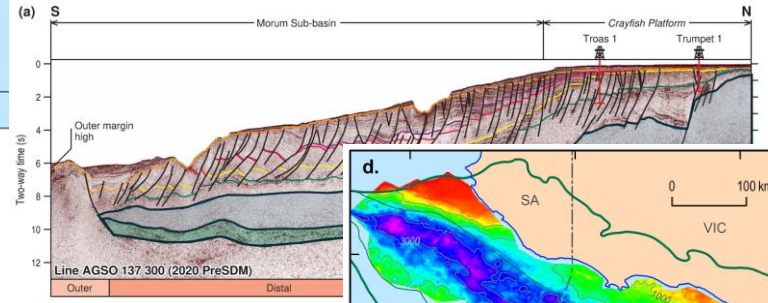
# Conclusions Insights into the tectonostratigraphic evolution of the deep-water Otway Basin




Otway Basin Cretaceous supersequence depocentres mapped across the basin

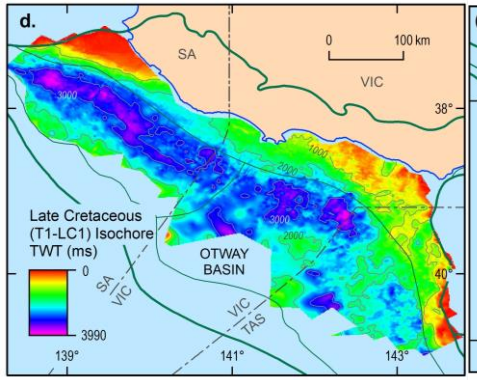


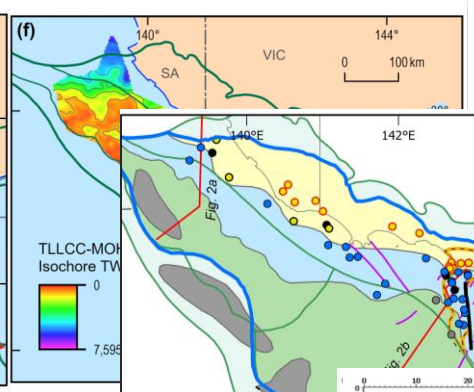

Enabling geologically supported updates to structural elements and basin boundaries – Otway-Sorell




Deep crustal reflectors regionally mappable - illustrate highly extended crust in deep-water areas

Crustal thinning controlled the location of the Upper Cretaceous supersequences

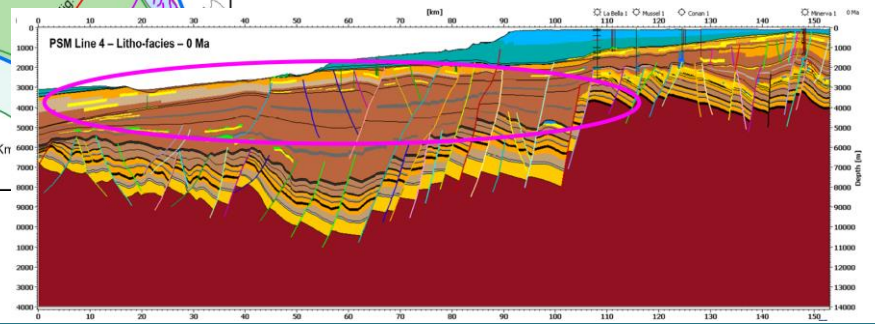






Influenced the evolution and distribution of Late Cretaceous depositional environments




Implications for petroleum system elements and Upper Cretaceous source rock maturity – scope to update existing petroleum system models

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Geoscience Australia

# Thank You

## Data packages in preparation

- Offshore Otway Basin core log data package *(Cubitt et al. 2024)*
- The Central and Southeast Offshore Otway Basin Well Folio *(Nguyen et al. 2024)*
- Offshore Otway Basin: Surface Grids, Isochore Grids, and Fault Maps *(Abbott et al. 2024)*
- Defining a chemostratigraphic framework for the Sherbrook Supersequence *(Riley et al. 2024)*

## Further information

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