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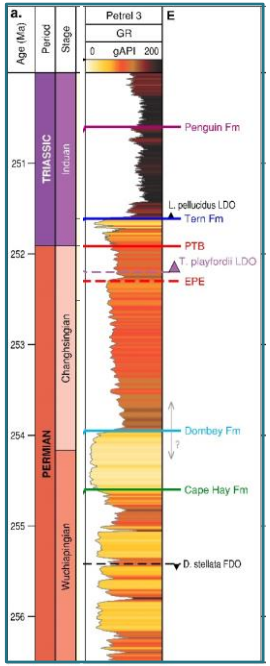

Late Permian–Early Triassic depositional history in the southern Bonaparte Basin

New biostratigraphic insights into reservoir heterogeneity

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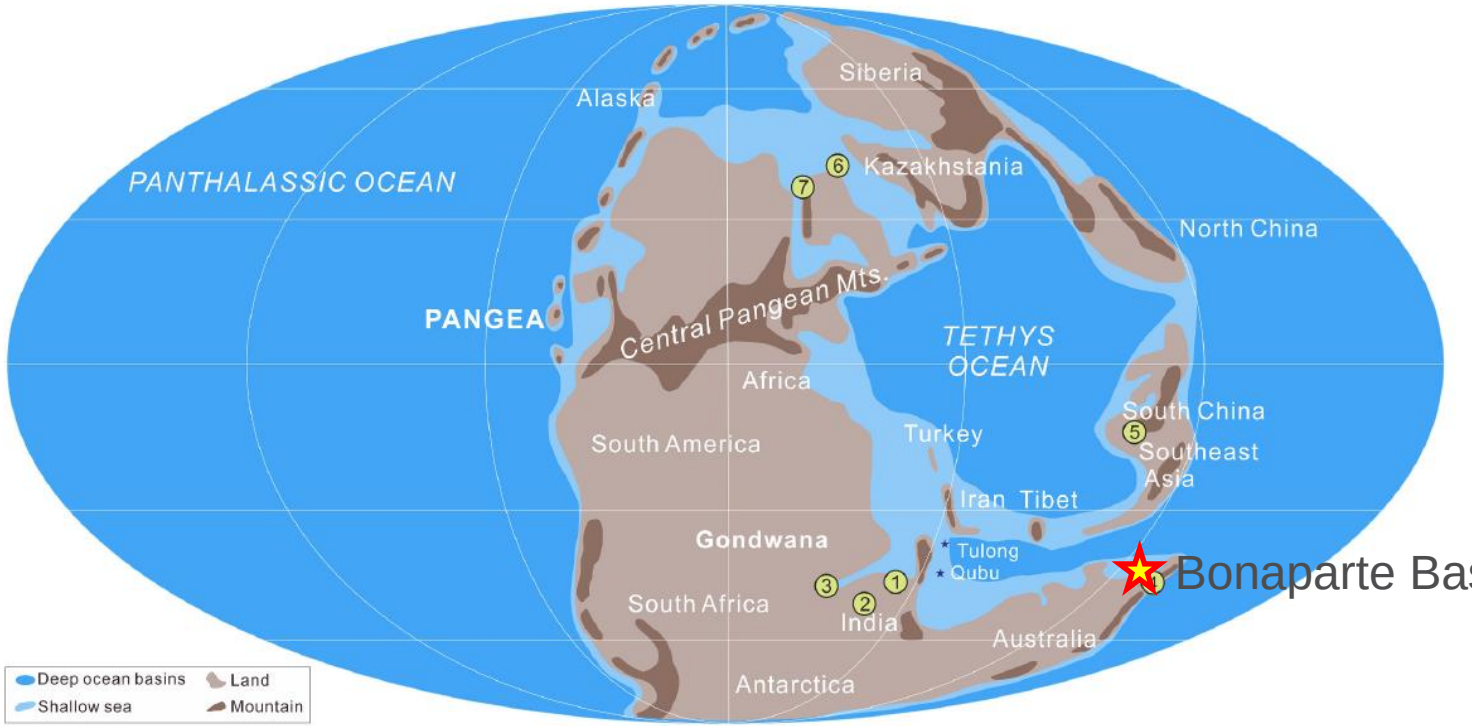
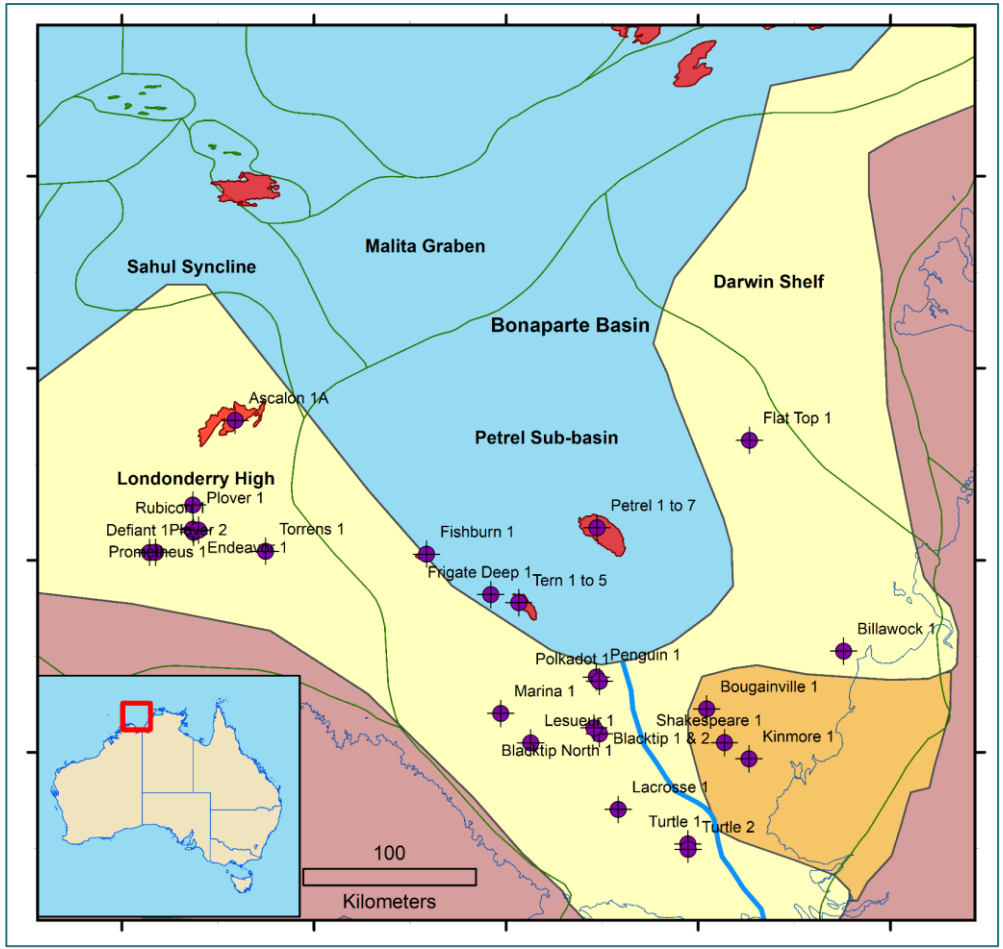
Tom Bernecker and Barry Bradshaw
Energy Resources Advice & Promotion
Minerals, Energy & Groundwater Division

Late Permian Palaeogeography



Bonaparte Basin

Liu et al, 2020

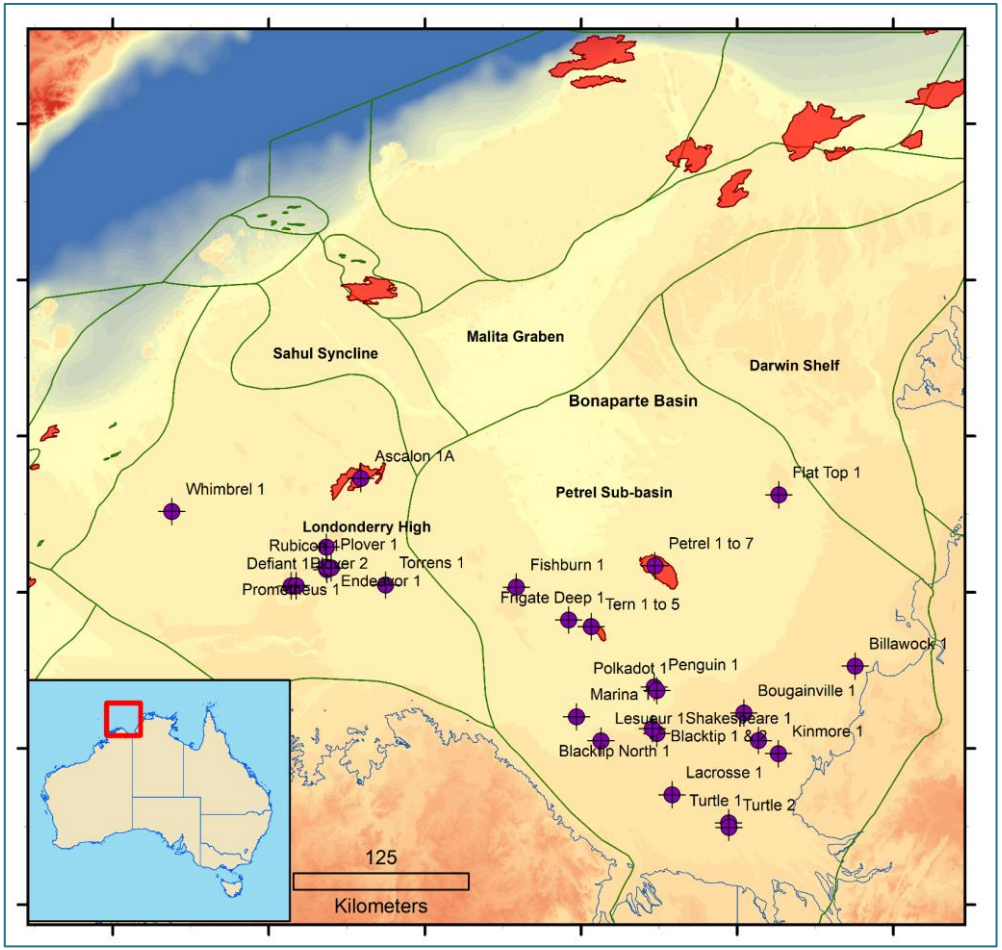


Bonaparte Basin Paleogeography

- extensive marginal marine depositional system
- inboard - shallow marine and deltaic clastics (yellow)
- outboard - broad marine shelf, shallow carbonates (blue)

Uplands
Shallow marine carbonates and mixed clastics
Shallow marine and deltaic clastics
Non-marine fluvial/ lacustrine
Low lying ersional areas
Sub-basin outline
Oil field
Gas field
Palaeo-river
Modern coastline
Location of Figure 2
Studied well

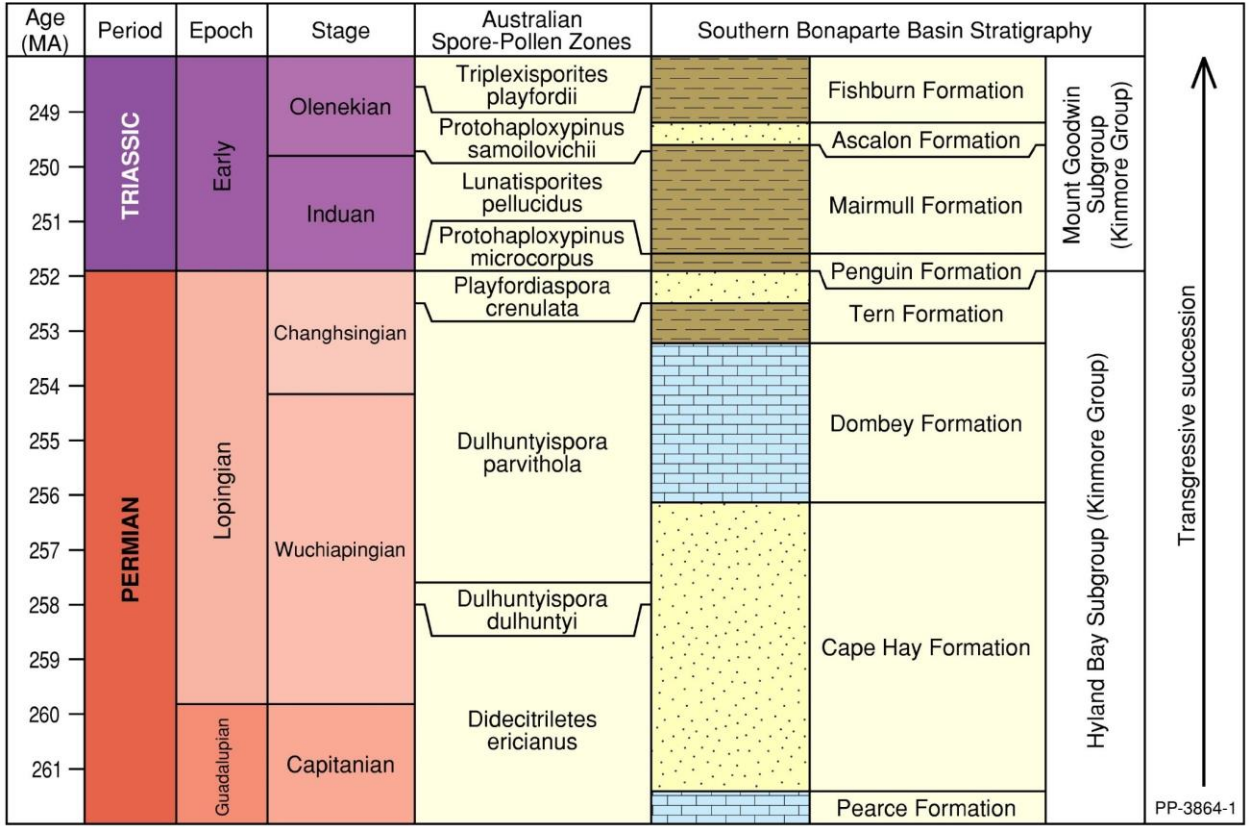
after Norvick, 2003



Permo-Triassic well intersections

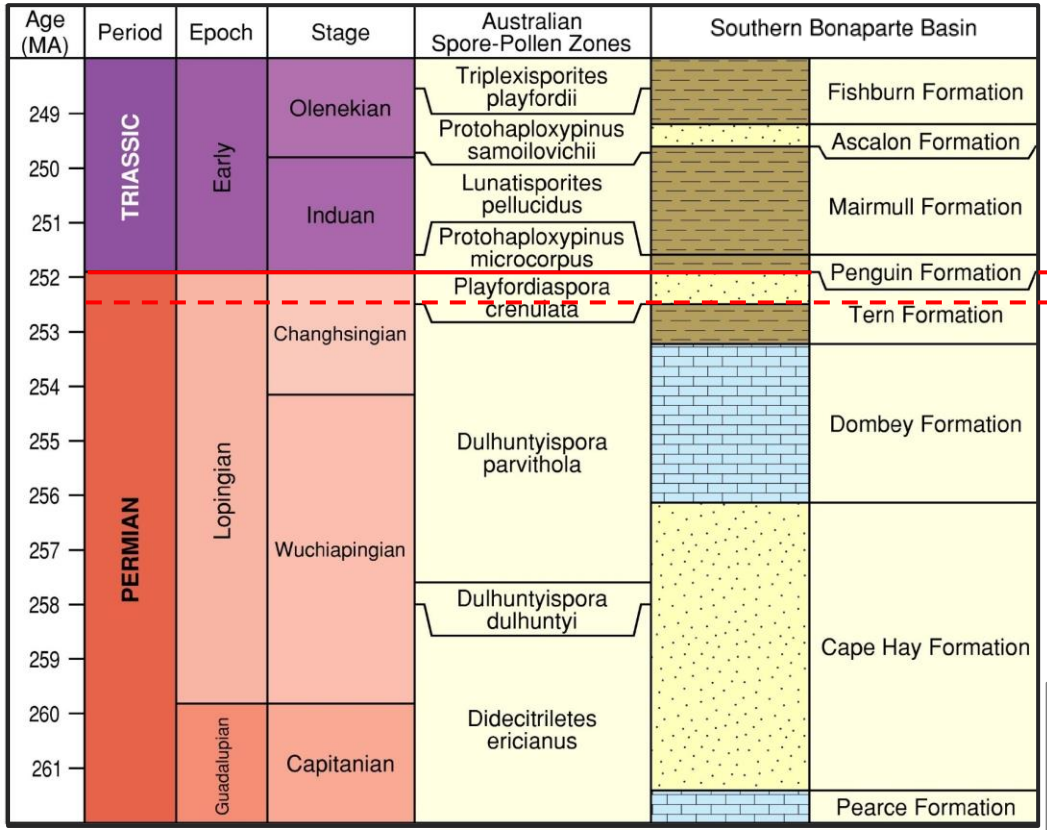
- ~35 wells sampling across the boundary, with a potentially continuous record in some cases
- provide insights that inform exploration targeting late Permian plays
- reservoir quality and distribution a key issue

Upper Permian – Lower Triassic Stratigraphy



- Transgressive succession
- Hyland Bay Sub-group
  - Cape Hay Formation
  - Dombey Formation
  - Tern Formation
- Mount Goodwin Sub-group
  - Penguin Formation
  - Mairmull Formation

Upper Permian – Lower Triassic Stratigraphy



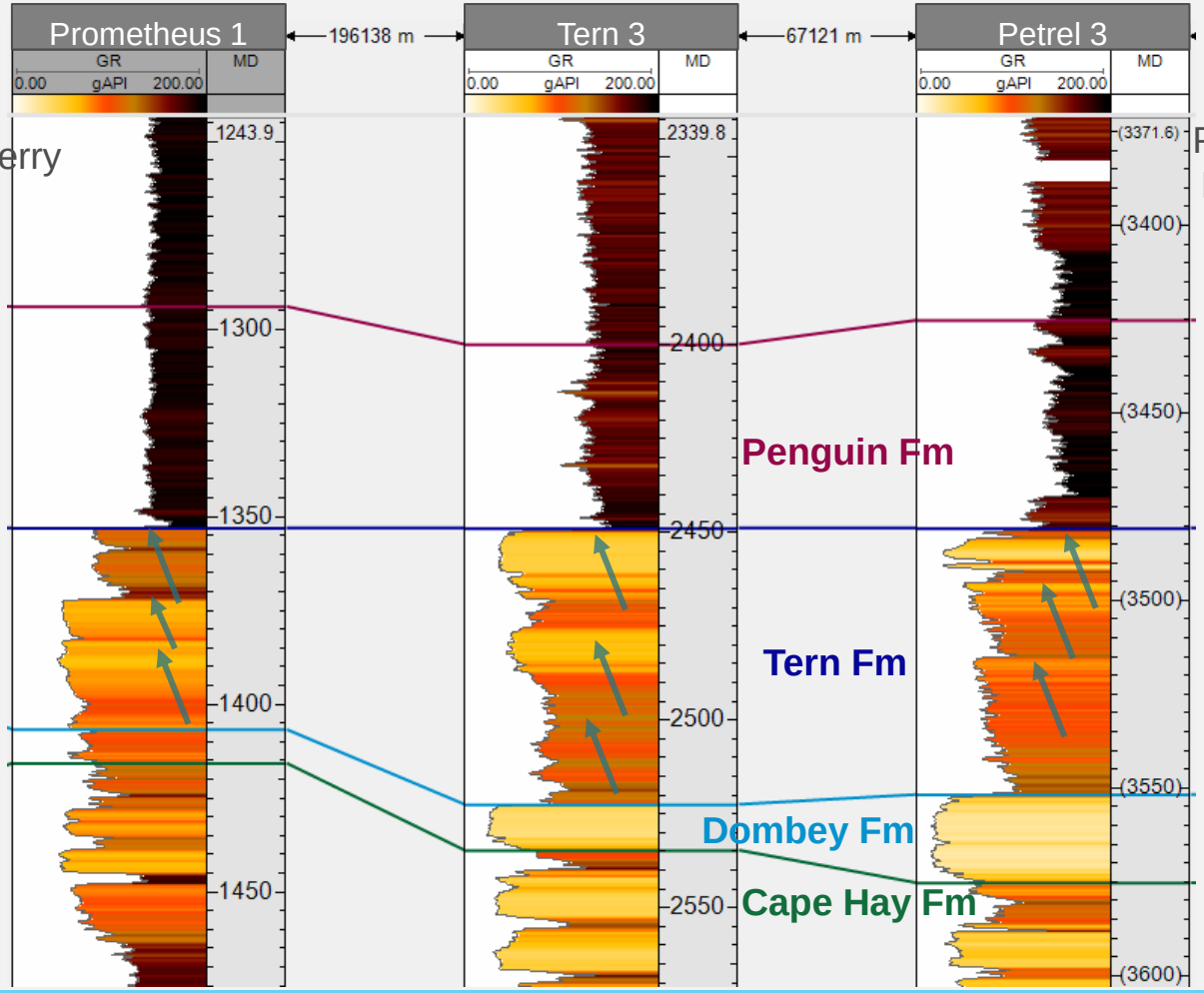
PTB – Permo-Triassic Boundary (inc. marine mass extinction)

EPE – onset of End Permian terrestrial Extinction, predates the marine mass extinction and PTB

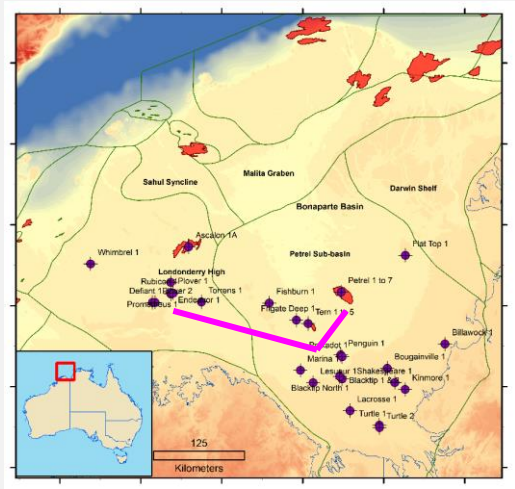
Spore pollen zones calibrated with radiometric ages from Laurie et al. 2016, Fielding et al. 2019 and Mays et al. 2020

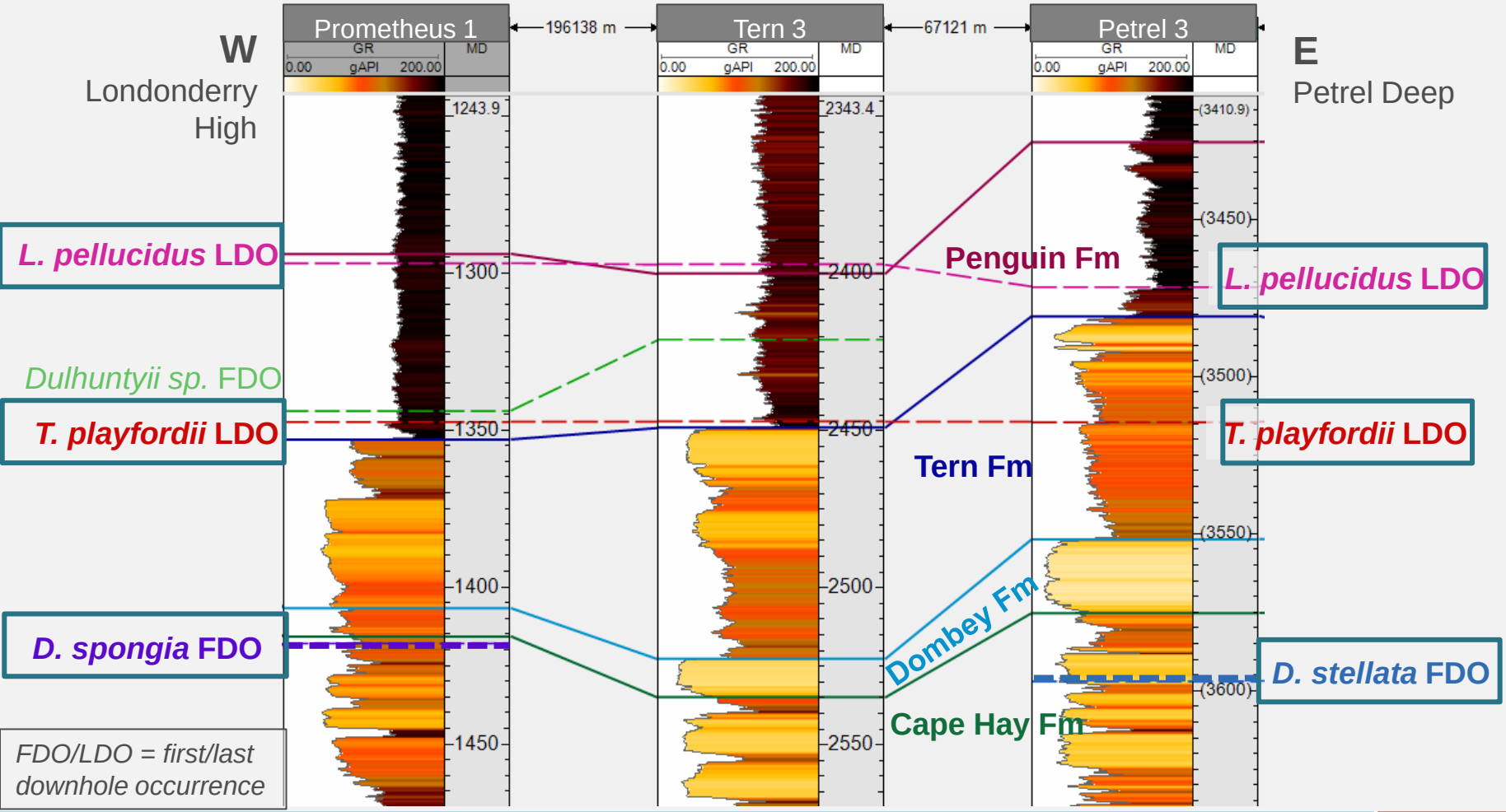
W
Londonderry High

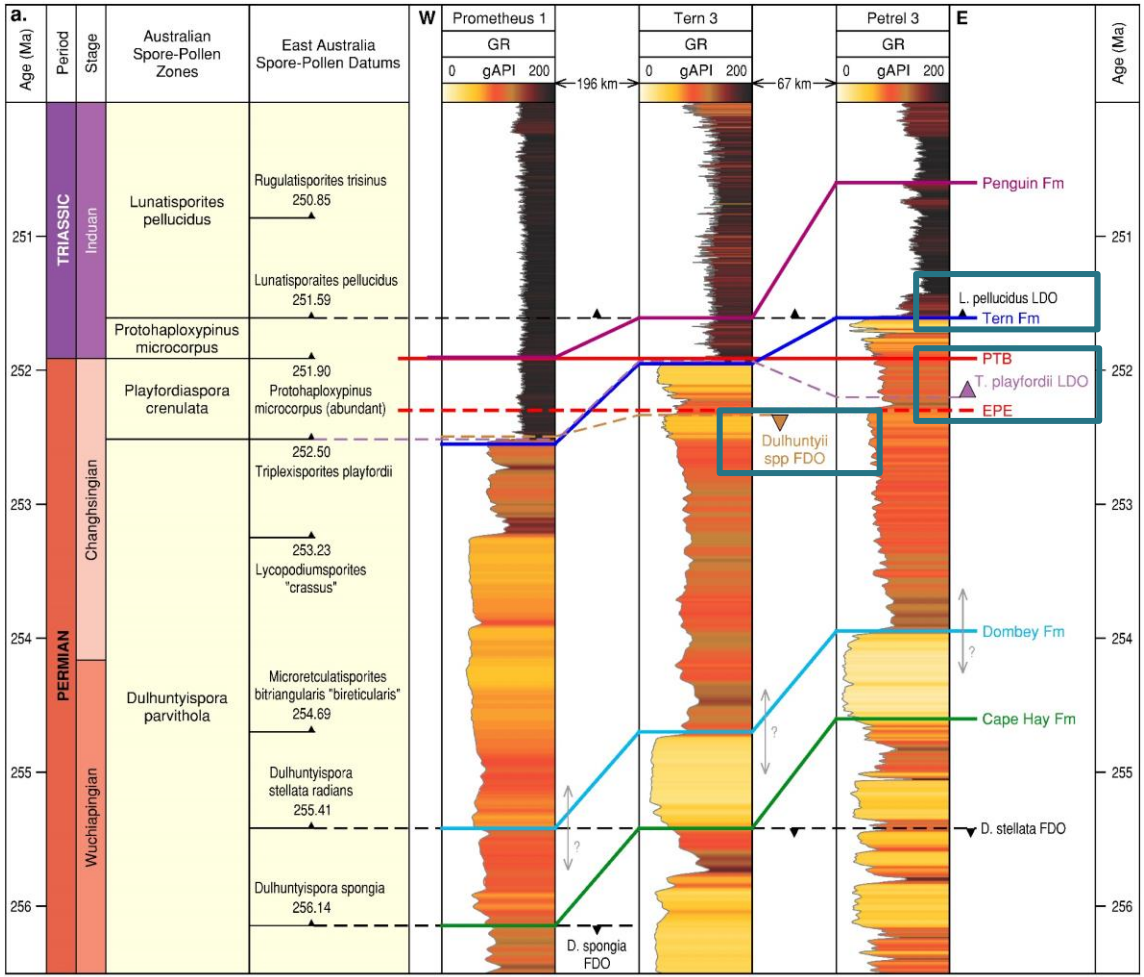
E
Petrel Deep



Well correlation in depth





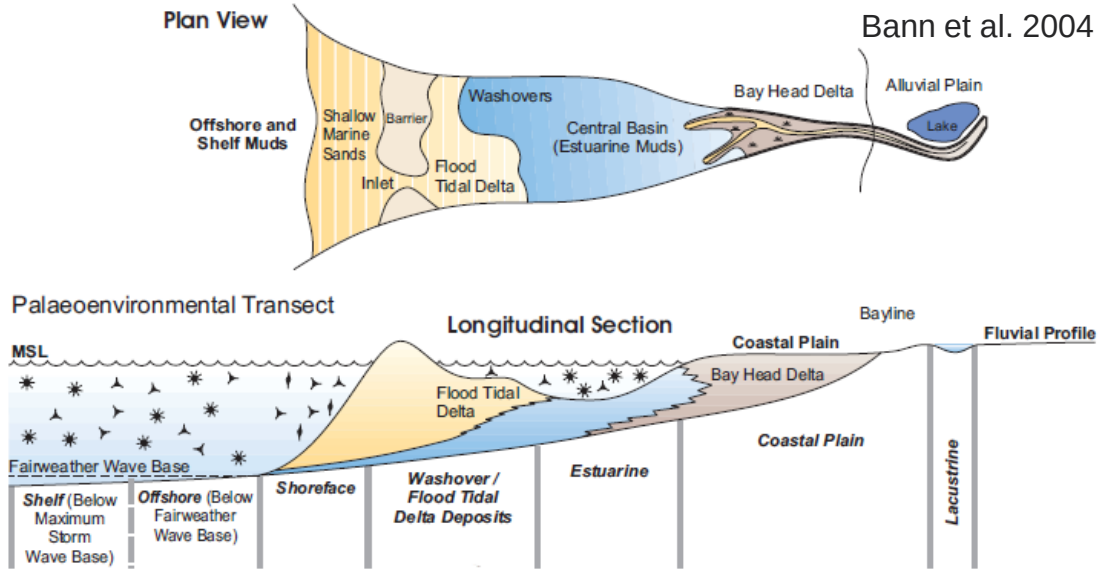


Well correlation in time

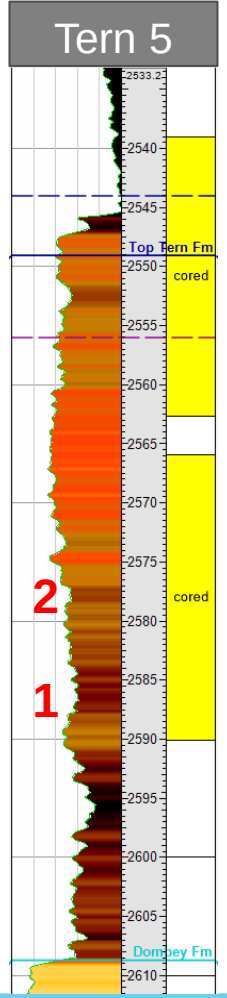
- Cape Hay Fm to Dombey Fm transition earlier on Londonderry High
- Tern Fm shoreface facies progressively younger to the east, possibly extending into the Triassic in Petrel area
- Limited age control from base Dombey to near top Tern

Tern Formation – shoreface to offshore facies

- Offshore – between fair-weather and storm wave base
- Shoreface – wave and sea-swell dominated
  - upper, middle and lower zones
- These systems accumulate in a prograding manner
- Accommodation and energy key determinants of the character of the preserved succession



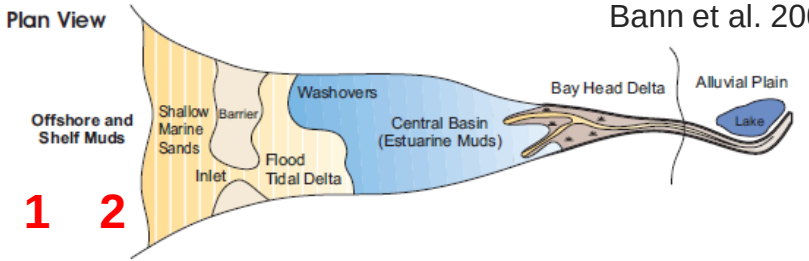
Bann et al. 2004

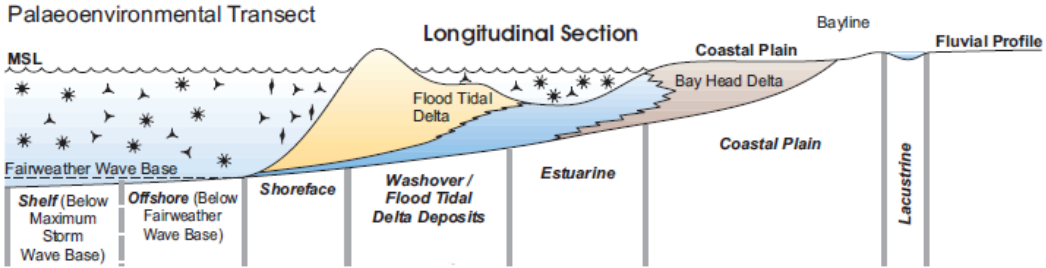


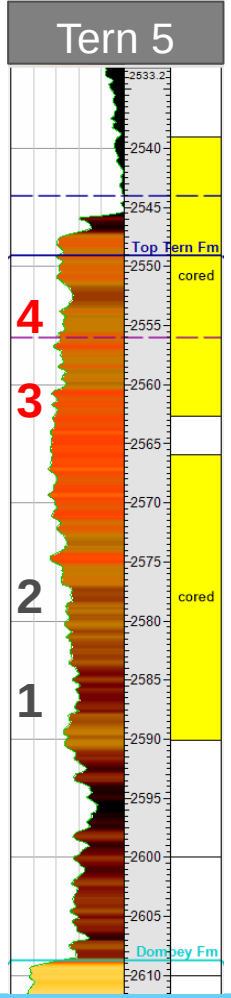
Prograding shoreface succession

1. lower offshore deposits
2. heavily bioturbated upper offshore

Bann et al. 2004



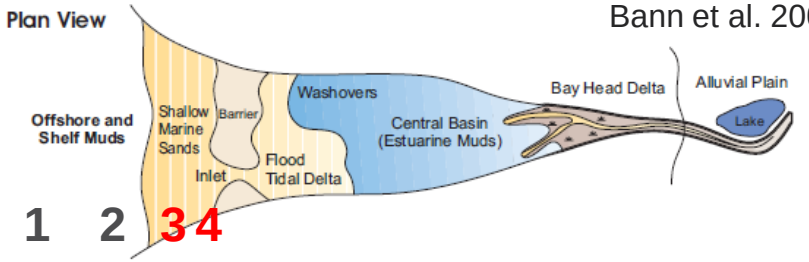


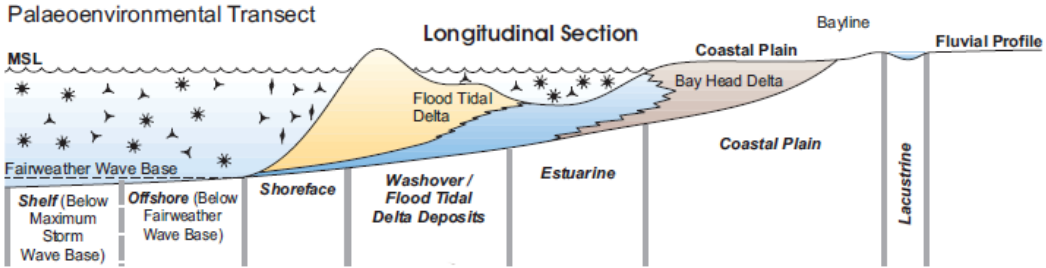


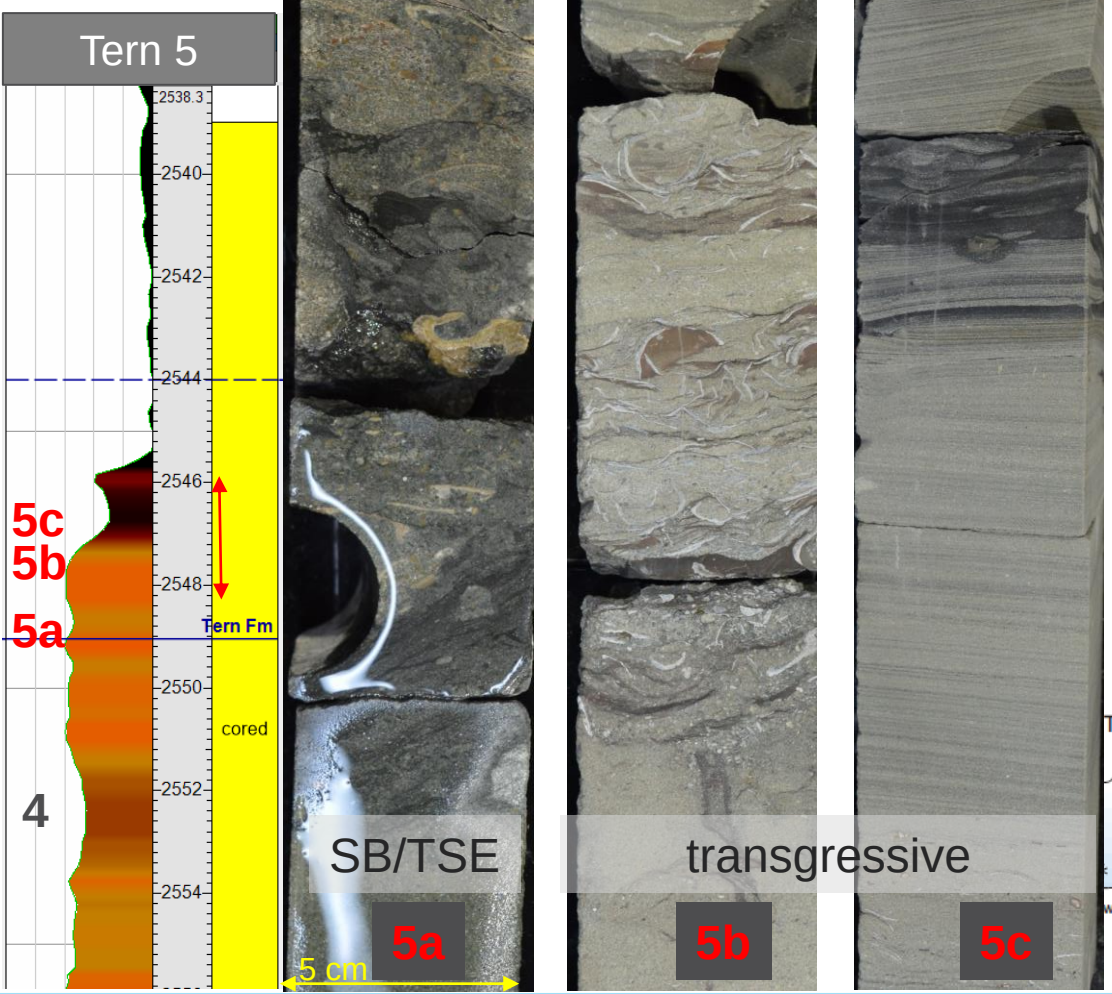
Prograding shoreface succession

1. lower offshore deposits
2. heavily bioturbated upper offshore
3. upper shoreface – reservoir sands
4. upper shoreface with chlorite and hematite alteration

Bann et al. 2004



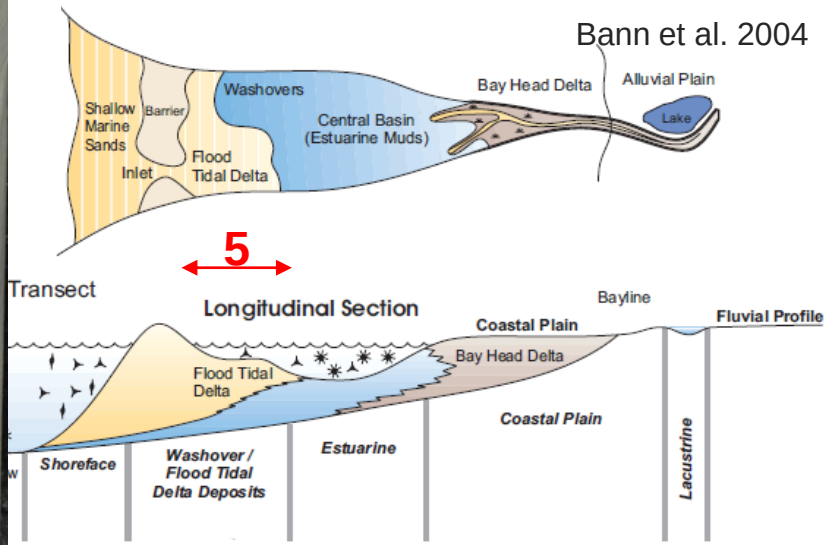


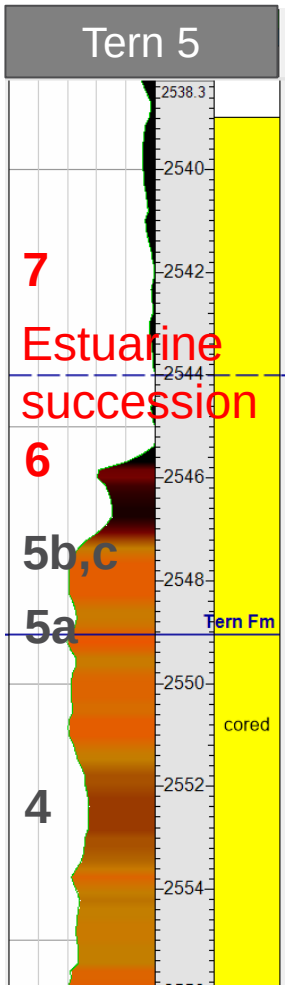


Transgressive succession

5a. transgressive surface of erosion (sequence boundary)
5b and 5c. sandy lithologies interpreted as flood tidal delta and sandy embayment facies

Bann et al. 2004



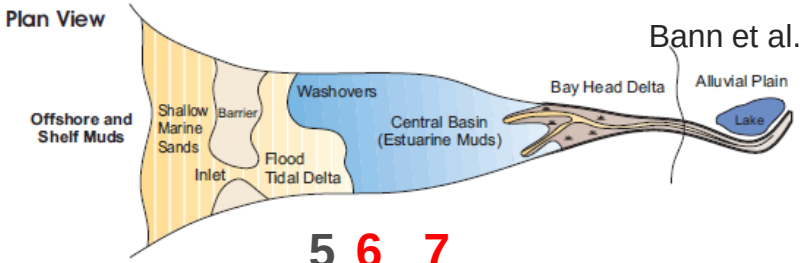


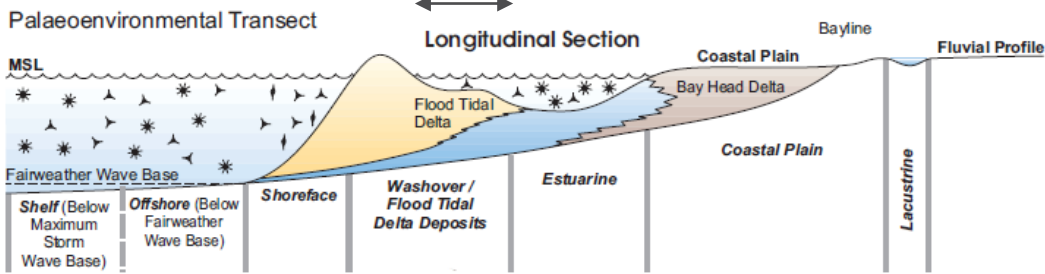
Estuarine/restricted succession

6. Lagoon

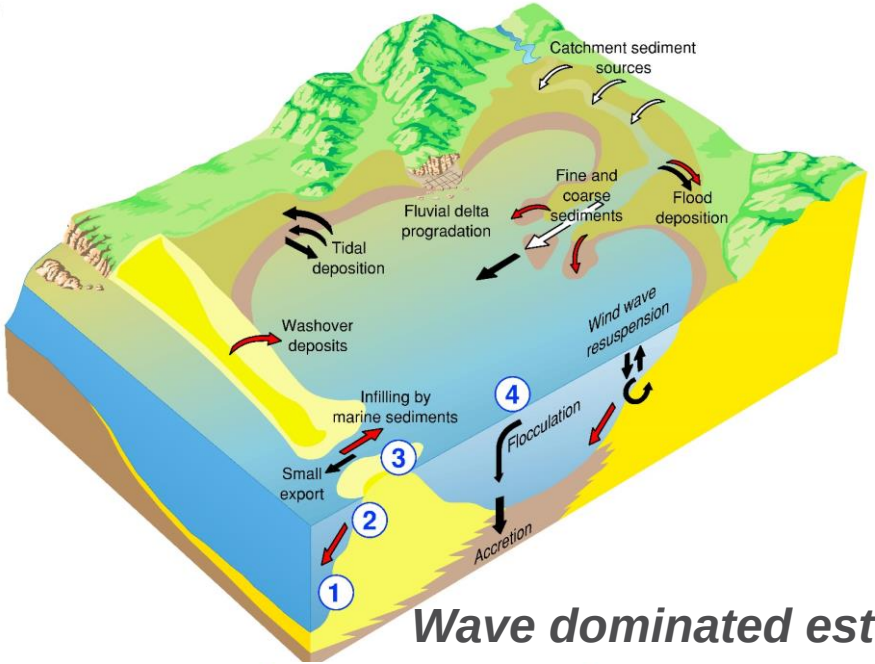
7. Mud basin

Bann et al. 2004





Depositional progression



Wave dominated estuary

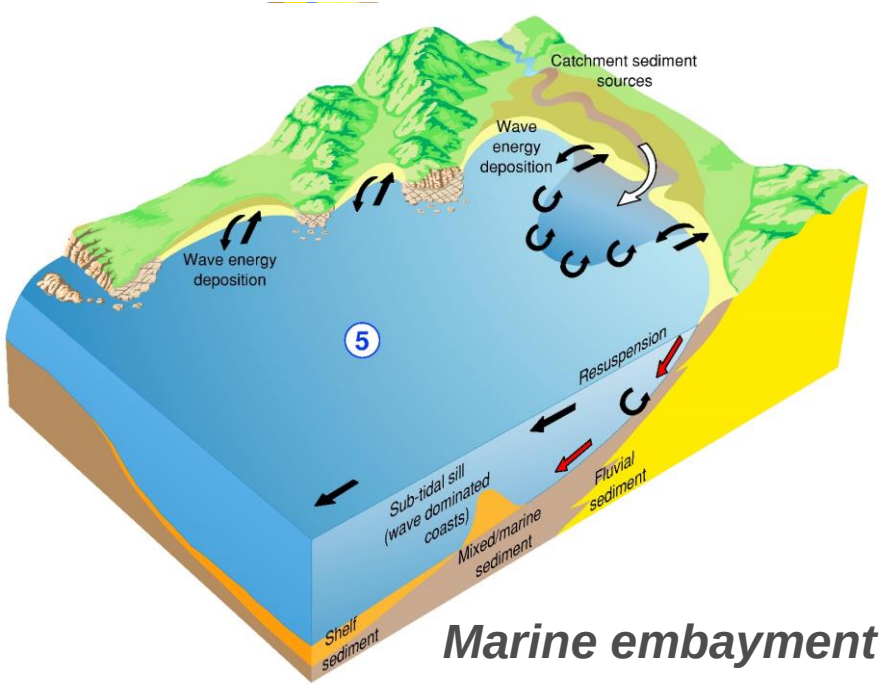
- *Fine and coarse sediment*
- *Fine sediments (muds and clays)*
- *Coarse sediments (sands and gravels)*

1. *Offshore to distal lower shoreface, lower Tern Formation*
2. *Middle to upper shoreface, upper Tern Formation*
3. *Flood tide delta, uppermost Tern Formation chaotic transgressive sands (Tern wells)*
4. *Restricted embayment, lower Penguin Formation*
5. *Open shallow-marine embayment, upper Penguin/Mairmull Formation*

model after Ryan et al. 2003

Lake Illawarra, NSW

Depositional progression



Marine embayment

- *Fine and coarse sediment*
- *Fine sediments (muds and clays)*
- *Coarse sediments (sands and gravels)*

1. *Offshore to distal lower shoreface, lower Tern Formation*
2. *Middle to upper shoreface, upper Tern Formation*
3. *Flood tide delta, uppermost Tern Formation chaotic transgressive sands (Tern wells)*
4. *Restricted embayment, lower Penguin Formation*
5. *Open shallow-marine embayment, upper Penguin/Mairmull Formation*

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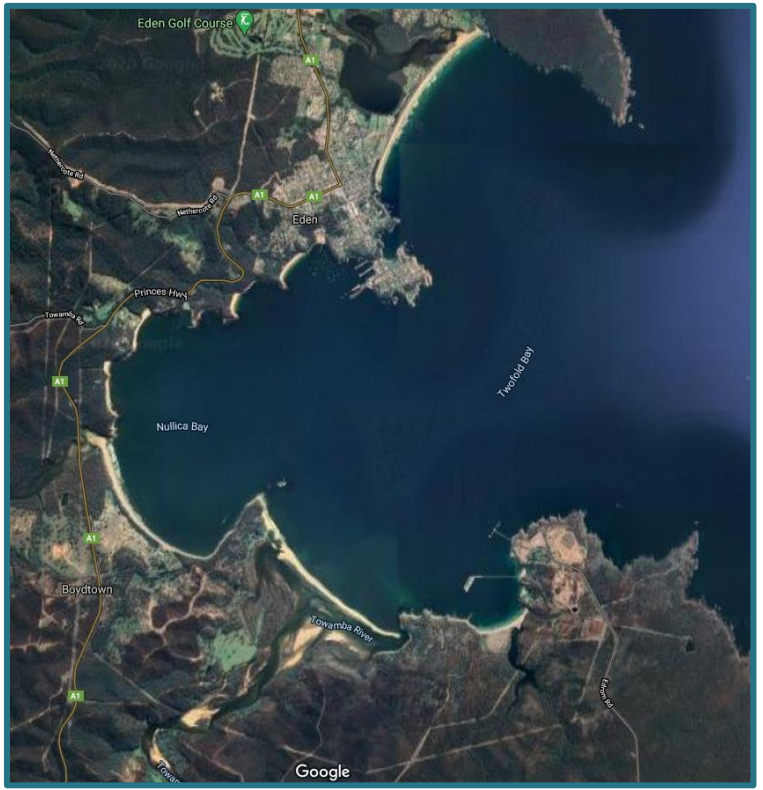
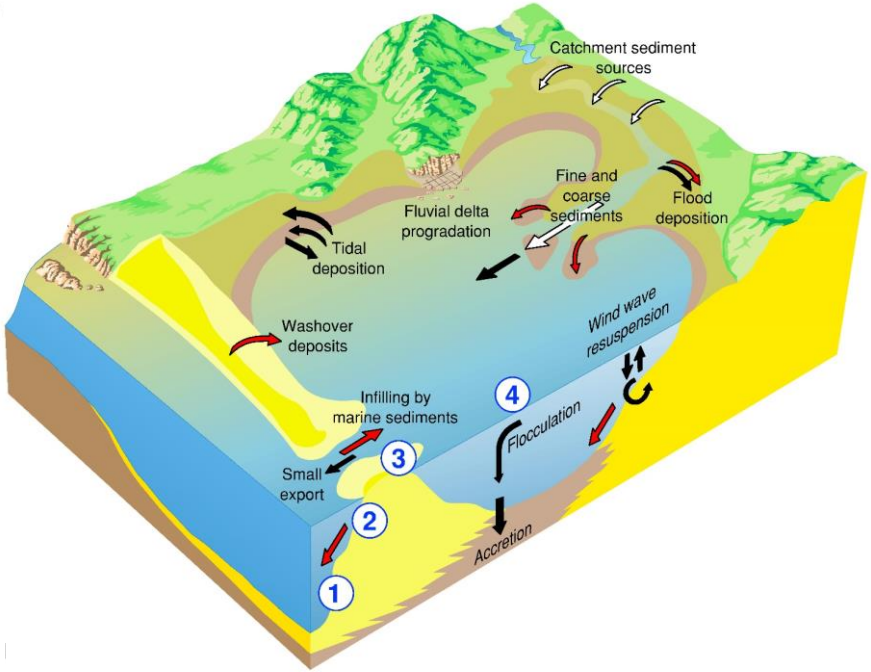


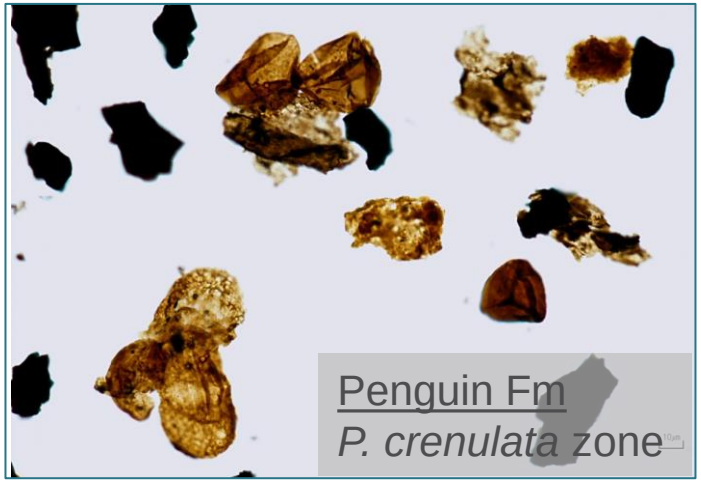
Two Fold Bay, NSW

Tern Formation facies

- Shoreface
  - Short lived
  - Mobile
  - Only partially preserved
  - Incomplete/stacked



P/Tr palynological review

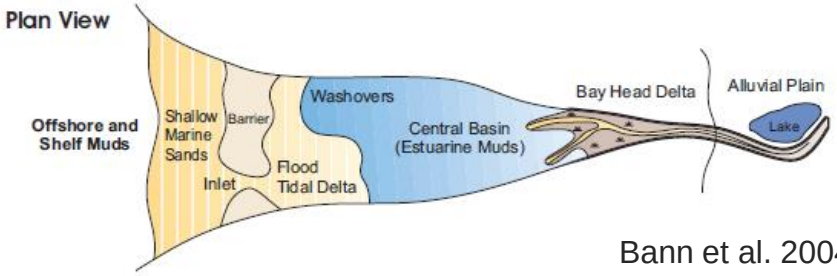


Images: Dan Mantle (MGP)

- Selected wells across the southern Bonaparte Basin
  - infill sampling and palynological analysis to improve biostratigraphic control
  - consistent zonal assignments - clarify biostratigraphic assignments contained within the legacy data
  - is the late Permian succession diachronous or a result of evolving palynological interpretations?
  - detailed study of Tern 5

Key points

- Available biostratigraphic data indicates the P/Tr succession is diachronous across the basin
- Tern Formation has variable reservoir quality due to complex sedimentary facies associations and diagenetic history
- Optimal environments for reservoir formation were likely mobile, limited in duration, and represent only a portion of the preserved sediments
- Palynological review underway to further build on these findings



Bann et al. 2004

Implications

- Finely-tuned sedimentological/biostratigraphic studies address exploration uncertainties
- High-resolution biostratigraphy (palynology) highlight mismatches in well correlations
- Improved understanding of the depositional history assists with the prediction of lateral facies distribution
- Such approaches are relevant not only in the context of identifying suitable reservoirs in exploration for and production of hydrocarbons, but also for the storage of CO_2

For more on this topic

- Visit our team at the Australian Government booth, #34
- Contact us: ryan.owens@ga.gov.au