Multiphase oblique extension on the North West Shelf of Australia

Chris Elders & Sara Morón

With contributions from: Amy l'Anson, Peng Chen, Halla Rohead O'Brien, Sam McHarg, Ruijie Chen, Mulky Winata, Mike Gurnis, Stephen Gallagher, Jackson McCaffrey

You can also watch a version of this presentation at: https://www.youtube.com/watch?v=IfYXtLztL5s



Tectono-stratigraphic synthesis -Devonian to Triassic

(? Ordovician) – Devonian

- Rifting of the Canning, Petrel and Perth basins
- Far-field stresses caused lithospheric stretching and changes in base level, which in turn resulted in denudation of the sedimentary cover in Pilbara Craton



Morón et al., (2020), Tectonics



Petrel Basin









From Ruijie Chen (PhD student)

Carboniferous-Permian

- Localisation of rifting into the Fitzroy Trough and Petrel Basin in the Early Carboniferous
- Localized sedimentation in Fitzroy Trough >3km



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- Localized sedimentation in Fitzroy Trough >3km
- Widespread rifting on NE-SW trending basins on the NW Shelf and N-S trending Perth Basin in the Late Carboniferous to Permian
- Development of marginal faults



Carboniferous-Permian

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Permian rifting





SE

Triassic

- Continued rifting in the Browse & Bonaparte
- Post-rift subsidence in the N Carnarvon
- Fluvio-deltaic deposition in N Carnarvon and Roebuck by a large-scale drainage system with headwaters in Antarctica, SW and central AU + local volcanic sources
- Extensive volcanism in the Roebuck Basin



Base Triassic Structure map

stem

ulter

Basin Margin Fast



250000m

10000.00



Triassic sediment provenance



Morón et al., (2019), Geology

Triassic volcanism



Triassic paleodrainage area

Scaling relationships support the idea of a continental-scale catchment



Martin et al., (2018), JSG



Morón et al., (2019), Geology

Triassic

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- Failed arm of the rift system and flexural subsidence might account for large subsidence in a post-rift setting.



Role of flexural subsidence in continental scale deltas



Change in the geodynamics of the region triggers lithospheric extension in the NW Shelf



Tectono-stratigraphic synthesis – Latest Triassic to Lower Cretaceous

L. Triassic - M. Jurassic

- Rifting of Argoland
- Latest Triassic to Middle Jurassic rifting in the N Carnarvon Basin, starts progressively younger and becomes less intense from west to east
- Formation of marginal basins (Exmouth, Barrow).
- Palaeozoic fault patterns have clearly influenced Mesozoic architecture
- Sediment input mainly from the east (Legendre delta/shelf)



l'Anson et al., (2019), Marine&Petroleum Geology

Barrow sub-basir

Strong lower crust helps explain the marginal rifting and distributed deformation observed in the Northern Carnarvon Basin



https://www.youtube.com/watch?v=6qJ8aM4w3hM

l'Anson (2020) PhD thesis

Top Triassic Structure map

Exmouth Plateau

Inis Trough

Ermouthsubbas

Interpretation from Peng Chen, Geoscience Australia, Amy l'Anson, Sam McHarg, Halla Rohead O'Brien, Sean De Costa, Jerome Paz

250000m

1500.00

-3500.00

-6500.00

Jurassic & Lower Cretaceous Thickness map

3500.00

1500.00

250000m



Jurassic & Lower Cretaceous Thickness map



Upper slope defilied canyons

Jurassic & Lower Cretaceous Thickness map



Shelf break slumps

Upper slope
mud-filled canyons

Upper slope

gullies

Upper Jurassic - Valanginian

- Rifting of Greater India
- Extensional faulting limited to Exmouth sub-basin, and then in Vulcan and parts of Bonaparte
- Formation of Valanginian planation surface in outer parts of Beagle and Roebuck basins
- Major sediment input from SE (Barrow delta) in Lower Cretaceous.



Lowermost Cretaceous (Berriasian) sediment input

250000m

Interpretation from Halla Rohead O'Brien

Lowermost Cretaceous (Berriasian) sediment input

3800 00

250000m

Lower Barrow Group

Shelf edge

Sedimentinput

Interpretation from Halla Rohead O'Brien

Valanginian Unconformity Structure map







250000m

Interpretation from Peng Chen

Post-Valanginian sediment input

2000.00

-3200.00

250000m



Post-Valanginian sediment input

ovisional versions of map



row Gre

-2000.00

-3200.00

ic Sediment input

Tectono-stratigraphic synthesis – Upper Cretaceous to Neogene

Late Cretaceous- Campanian

- Regional compression and inversion
- Anticlines of various ages and various orientations forming throughout the Cenozoic



Muderong Shale (Aptian) Structure map



Muderong Shale (Aptian) Structure map





Eocene

Onset of rapid migration of Australia northwards at 50 Ma

Oligocene

Initiation of a reef system as large as the Great Barrier Reef (34–28 Ma)



Gallagher & de Menocal (2019) Oceanography



McCaffrey et al., (2020) Global and Planetary Change

Neogene- Present

Miocene

- Arid conditions 16-6 Ma
- This giant reef system backstepped in the late Miocene (~10 Ma), forming a series of isolated atolls and pinnacle reefs.
- High subsidence and changed oceanographic conditions in the Late Miocene initiated drowning.

Miocene- Present

- Fluctuations between monsoonal and arid conditions from 6 Ma
- Anomalous subsidence 6-5 Ma and uplift 2-1 Ma. Explored range of mechanisms to interpret the observations, but no suitable explanation found. A new geodynamic or tectonic model is needed.



McCaffrey et al., (2020) Global and Planetary Change



Gurnis et al., (2020) Earth and Planetary Science Letters

Seabed Structure map

Exmouth Arch

-1250.00

-2750.00

250000m



Shelf Edge MTCS

