

The Devonian Reef Complexes of the Canning Basin in Context: Subsurface and Adjacent Basins*

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Abstract

The field geology of the Devonian reef complexes along the Lennard Shelf in the Canning Basin, Western Australia, was exhaustively described in GSWA Bulletin 145, which covered the outcropping HST part of the complexes. Outcrops show an intricate interplay between tectonism, long term eustasy, climate, and locally focused coarse-grained terrigenous influx. Reef complexes became established in the Givetian, with a bank-like margin. Reef scarps developed in the Frasnian. An overall back-stepping pattern reflected the transgressive phase of a long-term Late Devonian depositional cycle. Transgression peaked in the latest Frasnian, after which there was a prograding 'regressive' pattern through the Famennian. Conglomerate bodies interfingered with and cut through the reefs in the later Frasnian and Famennian. Reef builders showed remarkable resilience in persisting through and beside clastic influx. Further outboard in the subsurface, localized major clastic wedges correspond partly but not wholly to conglomerates in outcrop, and like them must be tectonically rather than eustatically controlled. A simple LST clastic/HST carbonate model cannot apply.

In the Bonaparte Basin to the north, Frasnian tectonism led to siliciclastic deposition, and reefs only developed when tectonism lessened in the Famennian. Even then, a complete transgressive-regressive cycle is preserved, unlike the Famennian of the Canning Basin. Between the Bonaparte and Canning Basins in the Ord Basin, active tectonism led to extensive Frasnian sandy and conglomeratic deposition, with an apparent hiatus in the Famennian. In the Carnarvon Basin to the southwest, the Frasnian is marked by mixed carbonate – clastic deposition, in a ramp setting except for local reefal buildups. Siliciclastic deposition, of coastal sands and then alluvial fan deposits, extended through the Famennian. The differing timing and patterns of carbonate development in each basin indicate a similar climatic setting, but different tectonic regimes and timing across the basins. Famennian clastic pulses in the basins may be far-field effects of the intra-plate Alice Springs Orogeny of central Australia. Frasnian clastic deposition in the Kimberley is attributed to more local transcurrent movement along reactivated Proterozoic sutures of the eastern Halls Creek Orogen. Integrated chronostratigraphic studies may be the best tools for resolving the tectonic and climatic variability in the Devonian of WA.

Selected References

Klootwijk, C., 2013, Middle-late Paleozoic Australia-Asia convergence and tectonic extrusion of Australia: *Gondwana Research*, v. 24/1, p. 5-54.

Mory, A.J., and P.W. Haines, 2013, A Paleozoic perspective of Western Australia: *Western Australian Basins Symposium 2013 Proceedings*, Perth, WA, Australia, 25p.

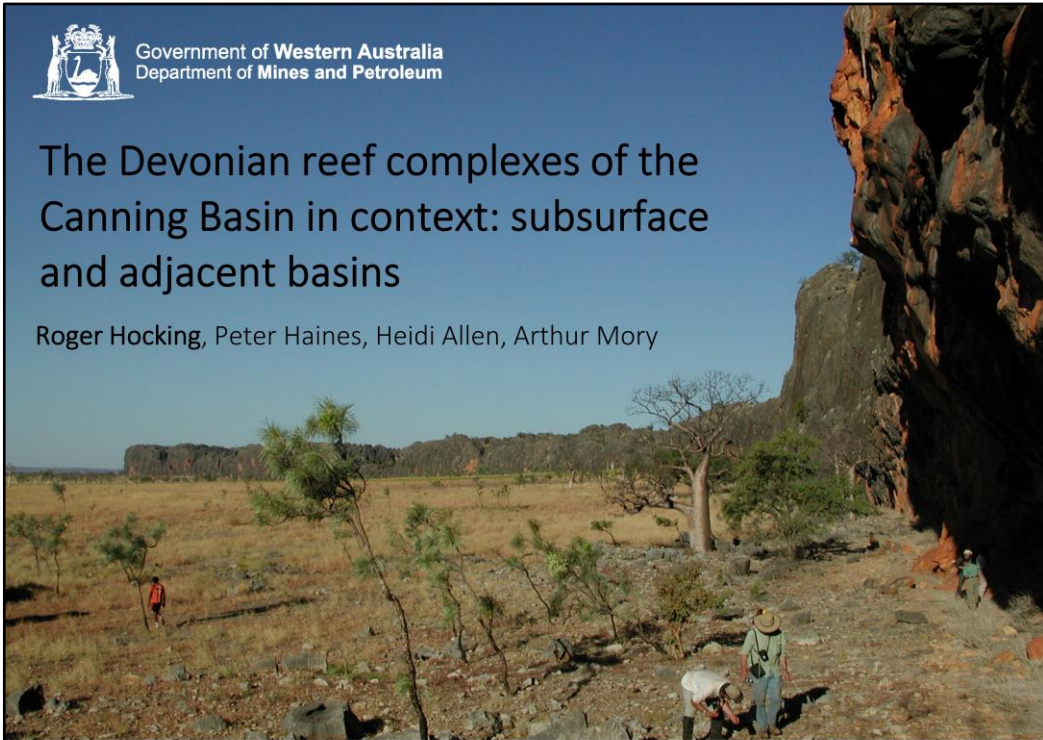
Playford, P.E., R.M. Hocking, and A.E. Cockbain, 2009, Devonian reef complexes of the Canning Basin, Western Australia: *Geological Survey of Western Australia Bulletin 145*, 444 p.



Government of **Western Australia**
Department of **Mines and Petroleum**

The Devonian reef complexes of the Canning Basin in context: subsurface and adjacent basins

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Famennian reef scarp, N Oscar Range

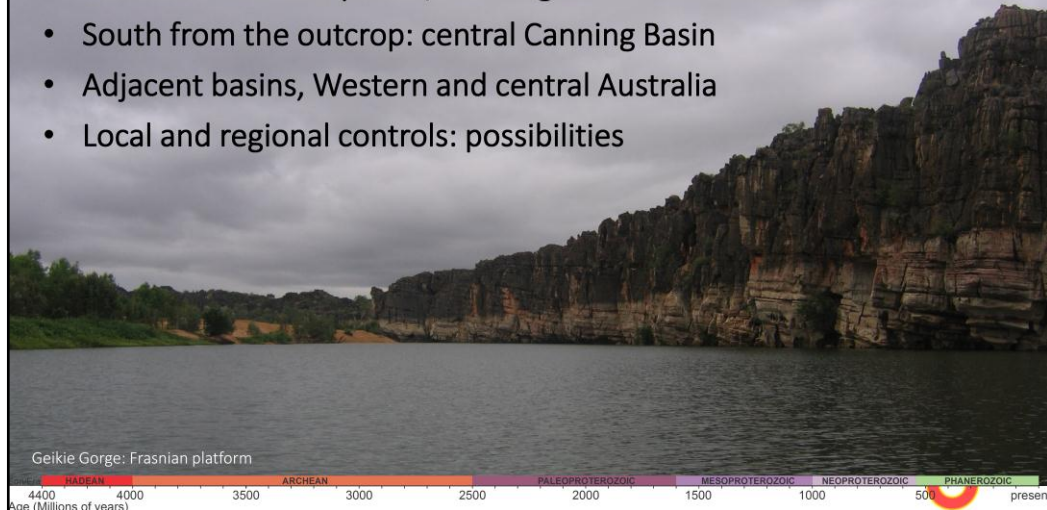
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Presenter's notes: Reef scarp as in late Famennian, Morown Cliffs. Upright scarp, debris in front, basin beyond that.
Not re-hashing basic Lennard Shelf geology and setting at length.
Presentation tries to place outcrops on Lennard Shelf in context with other Late Devonian sequences in adjoining basins

Outline



- Regional setting: context
- Devonian reef complexes, Canning Basin: the 5 minute tour
- South from the outcrop: central Canning Basin
- Adjacent basins, Western and central Australia
- Local and regional controls: possibilities



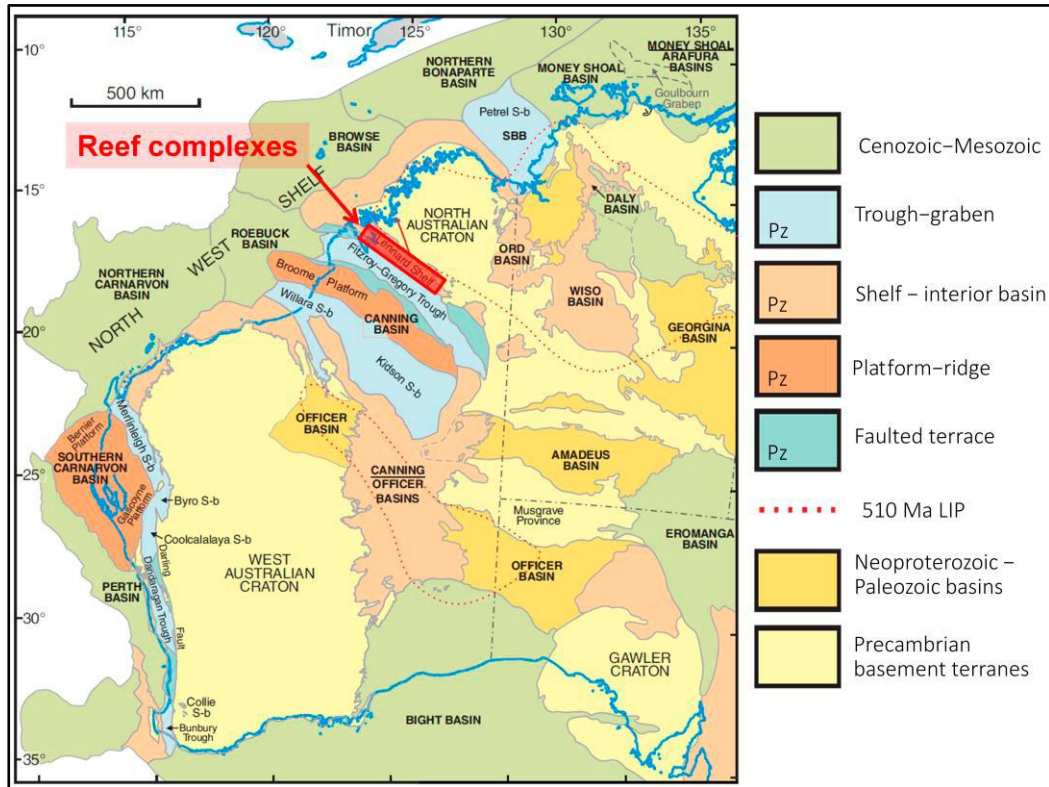
Geikie Gorge: Frasnian platform



Presenter's notes: Reefs are small part of WA geology – 30 out of 4400 m.y.

- Quick summary of reefs for later talks
- Show how they fit with rest of Canning, and then other Late Devonian successions in WA and central Australia
- Then suggest a couple of controls to explain variations.
- Lack detailed correlation, but broad comparison possible.
- Should demonstrate what this session is all about

So, where are we?



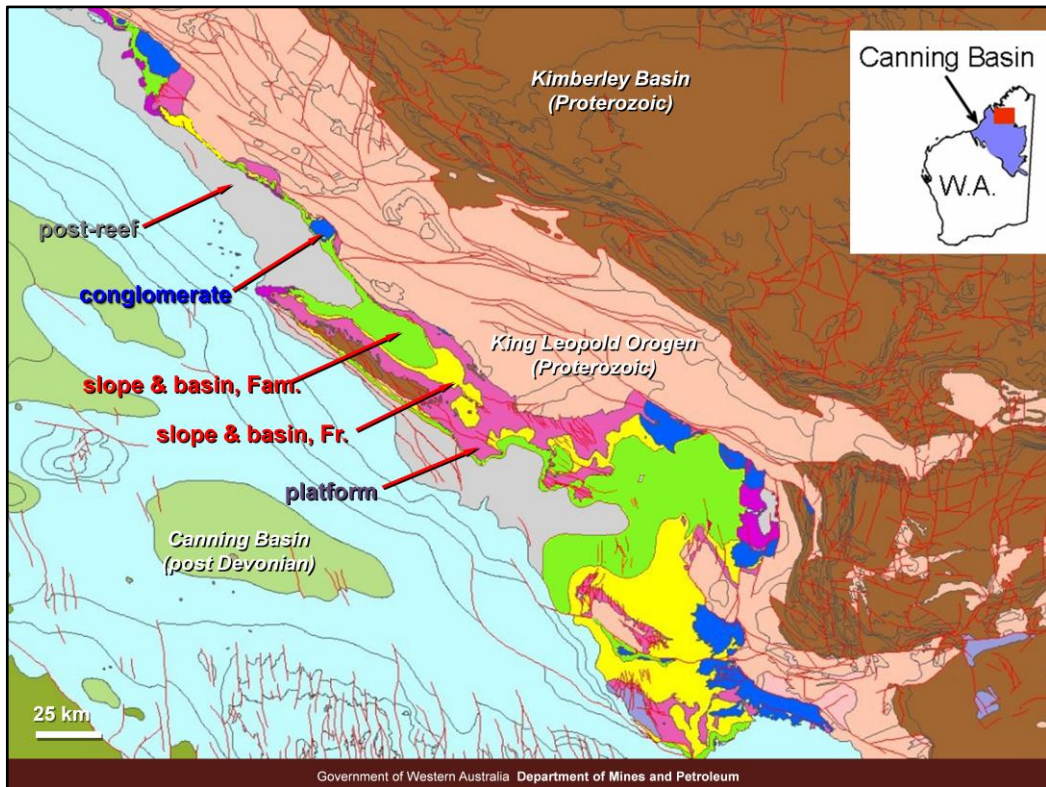
Presenter's notes: Regional setting.

Nth, WA and Sth Aus Cratons;

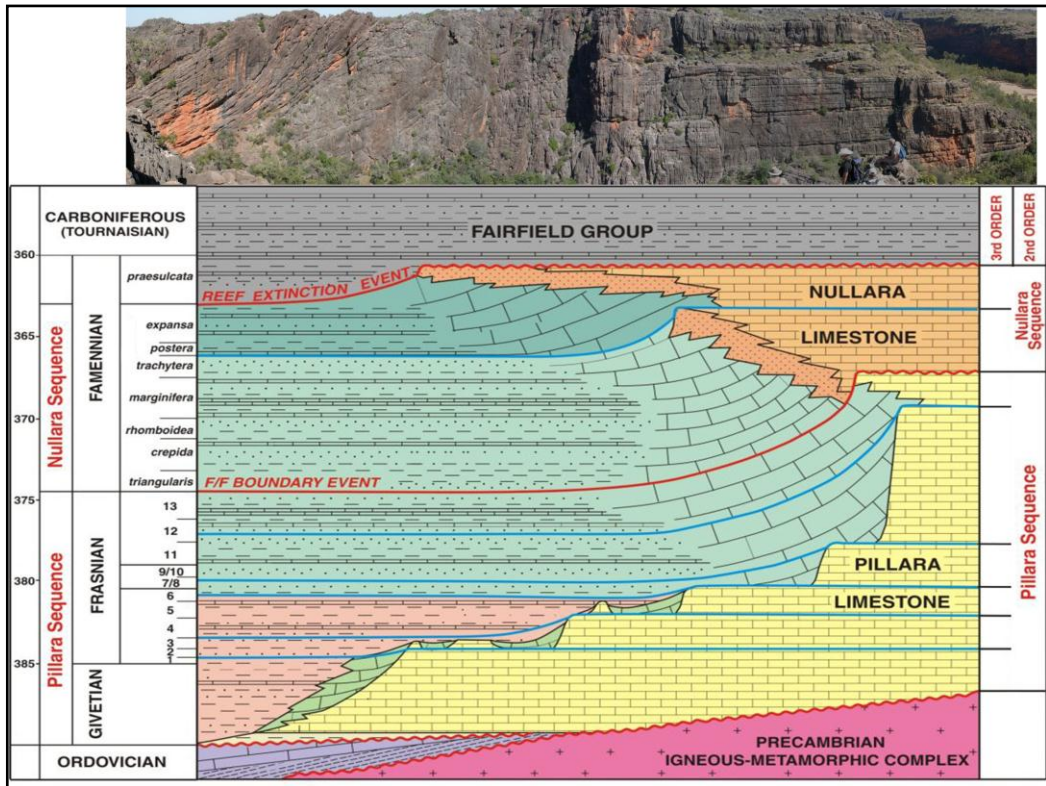
Canning sits between N and WA cratons.

Outcropping complexes in nth Canning, against Kimberley Craton (CLICK, red)

Correlative sections are in central Canning, Bonaparte, Amadeus, southern Officer, and Southern Carnarvon Basins.



Presenter's notes: 50c tour of reef complexes, highlighting lesser known aspects.
 Platforms pasted against Precambrian craton and outliers.
 South facing overall (point facies, conglomerates out).
 All you see are the high stands – low stands all off below younger stuff to sth!
But now, the reefs summary



Presenter's notes: The model. Standard facies diagram, time scaled on left

3 main groups

- *platform* - subdivide into back reef and reef itself. Good cyclicity, bad dating
- *marginal slope*. Good dating, not so good cyclicity – less sensitive
- *basin*
- Conglomerates up the top, down bottom, and stuck to slope.

Chronostrat project about tying platform and slope better, linking to and filling in global events

- Pillara grows up, then backsteps abruptly. Thick. Thickness variable - tectonism during deposition – 1100 m.
- Relative sealevel rising rapidly overall, late Frasnian peak.
- Nullara grows out rapidly. Thinner - ?250 m normally. Sealevel falling, accommodation low & generated by subsidence.
 - Together may be 2nd order cycle

Extinctions at F/F, end reefs. Kliti explained.

The reefs, from above



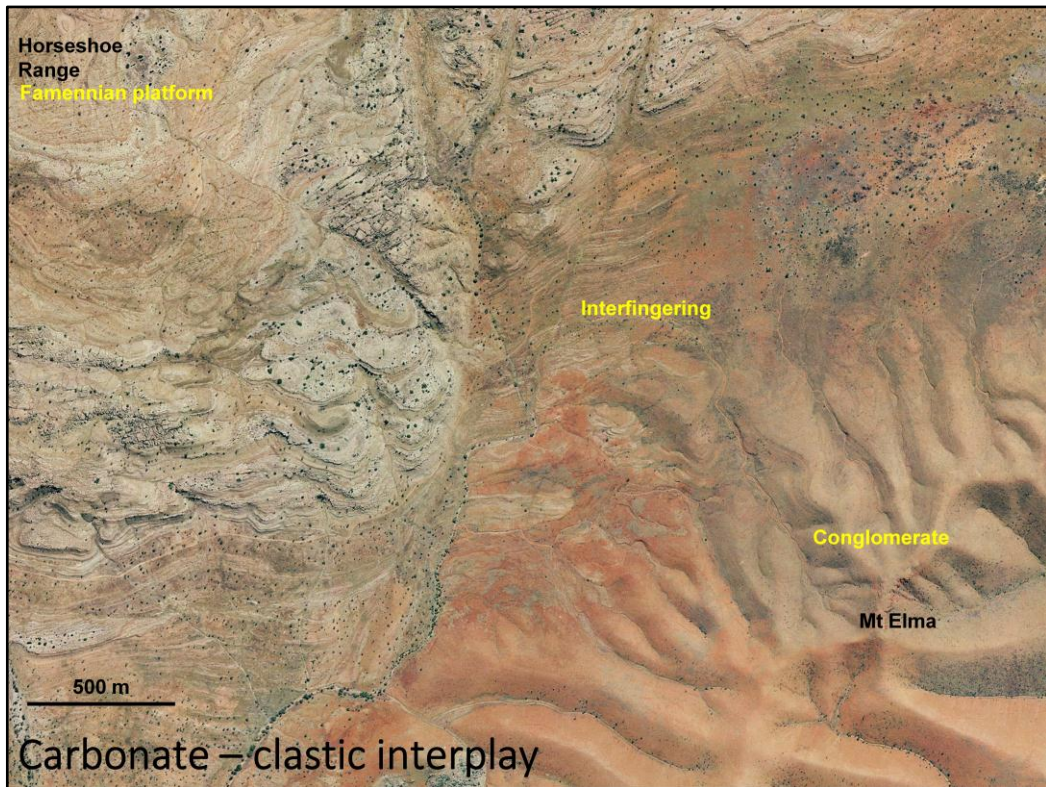
Presenter's notes: Pristine preservation.

1 - extensions of reef spine

2, 4 - reef knolls

3 - patch reef

5 - is lump of Permian glacials



Presenter's notes: Not all carbonates.

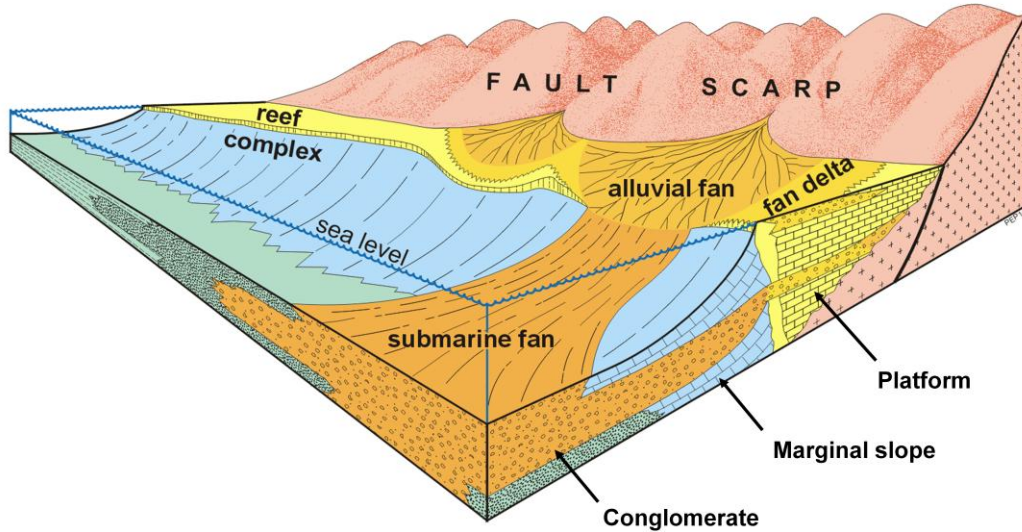
Coarse clastics cut thru and interfinger (CLICK).

Not reciprocal – phases last >2 m.y., so tectonic – at notches in basin margin.

Cyclicality brilliant, but dating poor. Need ties to well-dated slope and basin.



Presenter's notes: Cyclicity of several sorts, including counter-intuitive (clastics at bottom).
20-100 Ka duration. But difficult to quantify. Better ties to slope would help.
Platform cyclicity at Guppy Hills, basinal cycles at Wade Knoll, conglomerate cycles in central Sparke Range, counter-intuitive conglomerate>carbonate cycles near Mt Elma.



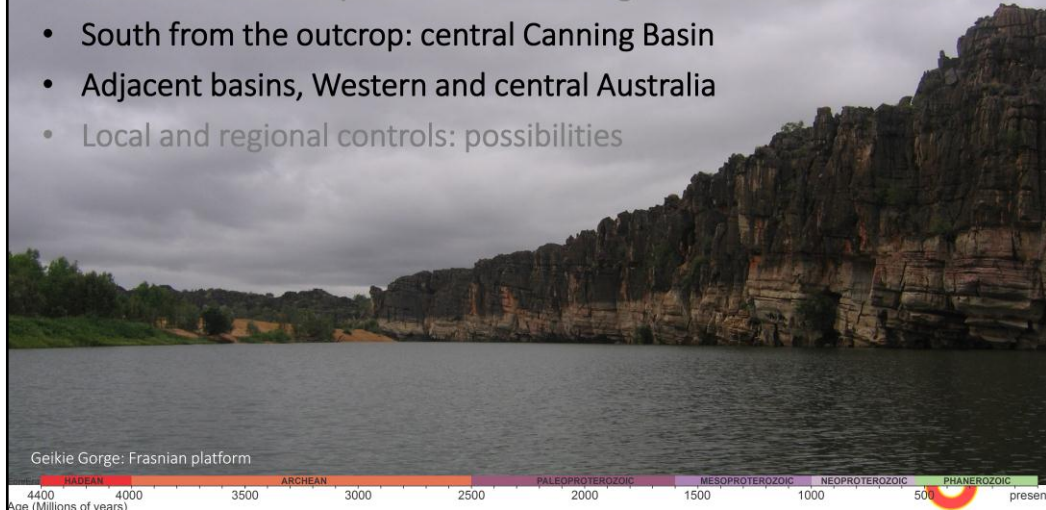
from Playford et al., 2009

Presenter's notes: The model, summarized.
Now look further away

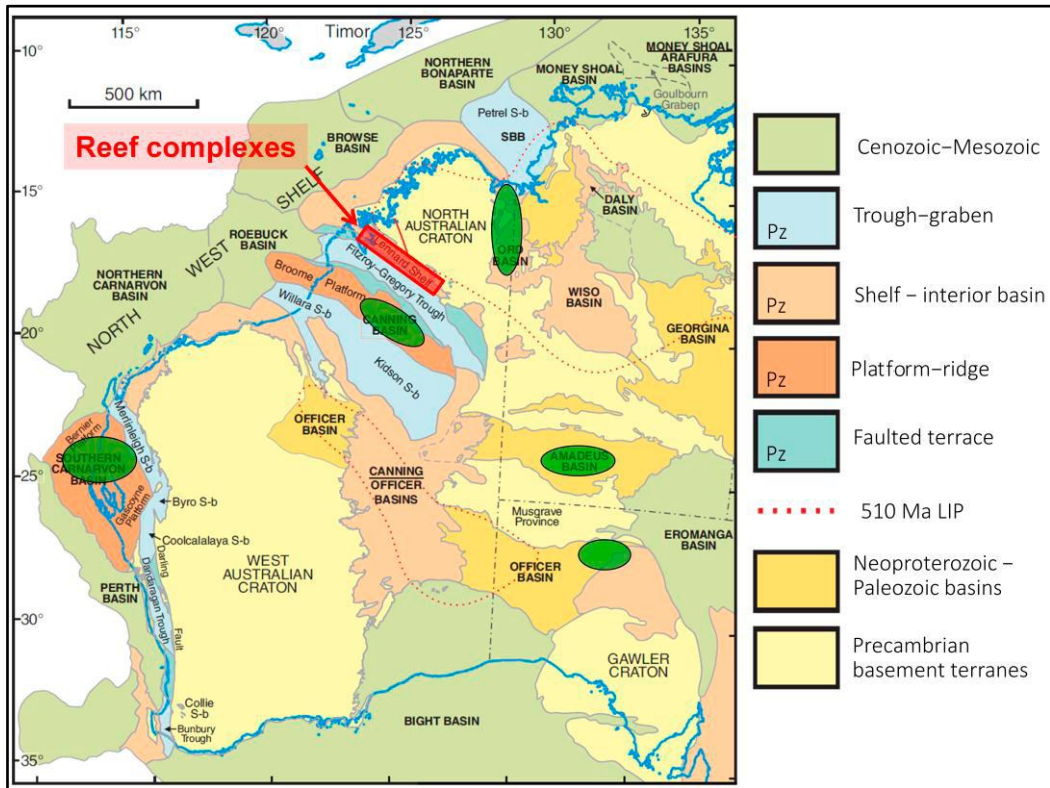
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Presenter's notes: Move on to the context part: central Canning, then other basins.



Presenter's notes: Regional setting.

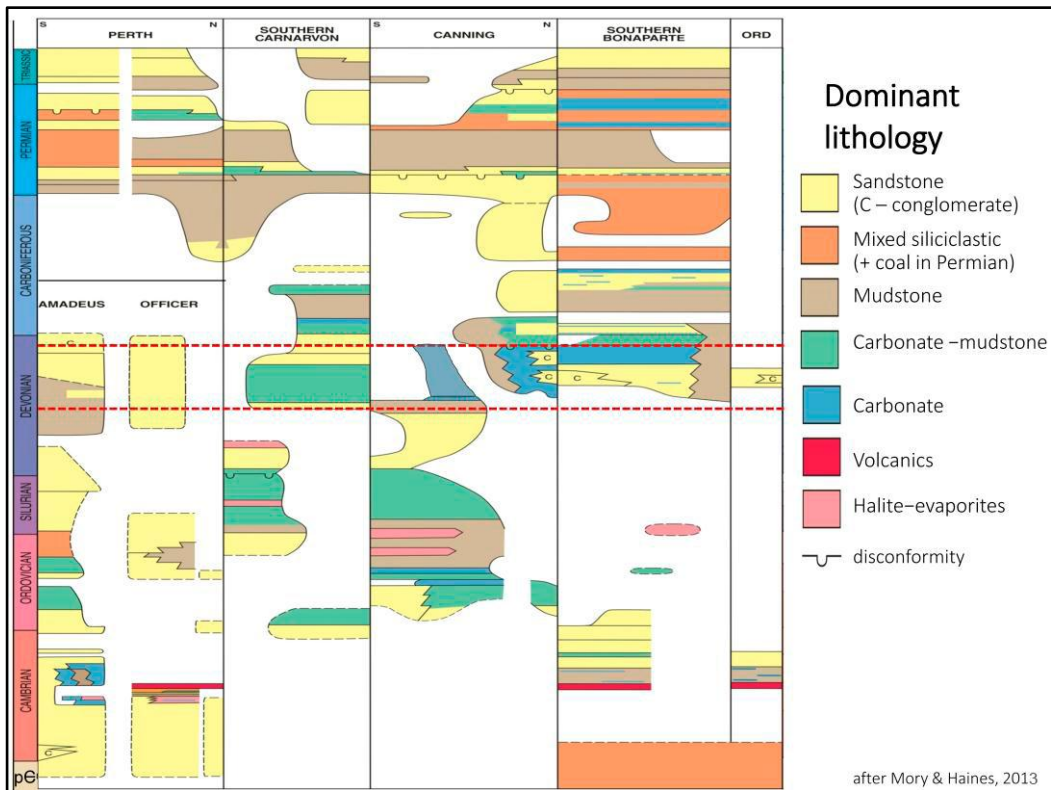
Nth, WA and Sth Aus Cratons;

Canning sits between N and WA cratons.

Outcropping complexes in nth Canning, against Kimberley Craton (CLICK, red)

Correlative sections in.... (point, CLICK, green).

Next: P_z successions in these basins



Presenter's notes: Pz successions in each basin

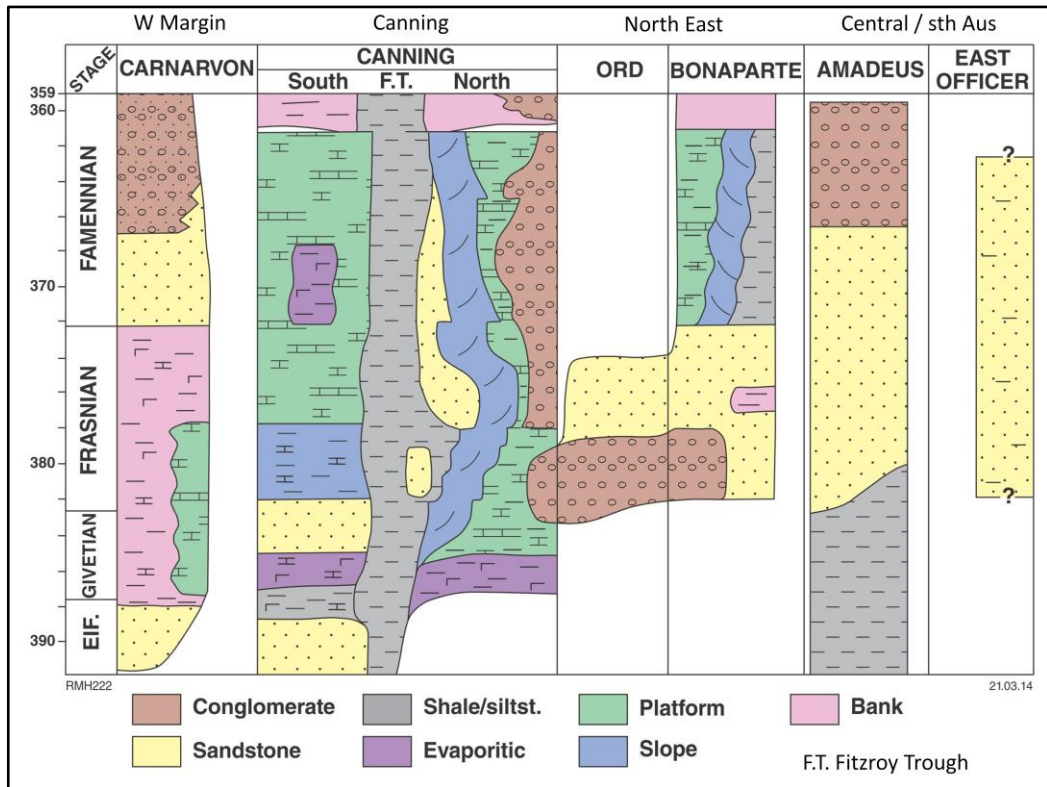
- Note Amadeus and Officer, from central Oz, stuck under W margin for convenience

Hole in central Canning is an unpenetrated 15 km deep trough.

Some carbonates, some clastics, some mixed.

- Common thread, look into it.

- *Zero in*

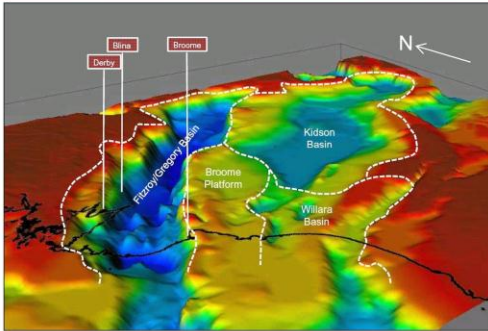


Presenter's notes: Devonian successions

Platform > slope > basin > back up to platform S of Fitzroy Trough. Coeval clastics. Variable. In Canning Basin from nth to sth, platform...

Now look into the variations and similarities in other basins adjoining Lennard Shelf and Canning

South-central Canning

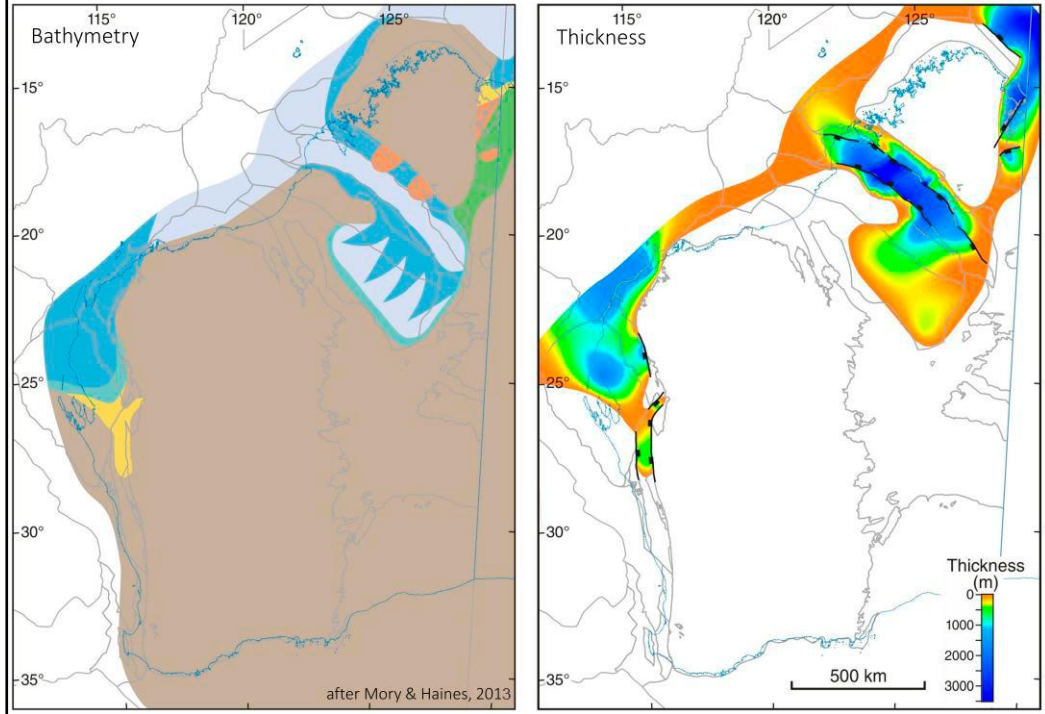


- Separated by deep trough
- Vuggy dolomite (deep evap source)
- Some framework indicators



Presenter's notes: Note oblique block diagram, central trough with basal facies. S of trough, have vuggy dolomites (*right*) – maybe caused by evaporites leaking up from thick Ord and Sil units. Some preserved framework (*Actinostroma*, center bottom), so reef setting probable.

Mid-late Devonian



Presenter's notes: Paleogeography from drillhole data.

- Deep trough separating N and S Canning.
- Seaways into E Kimberley and S Carnarvon
- No Larapintine seaway to central Oz
- *Now deal with other basins*

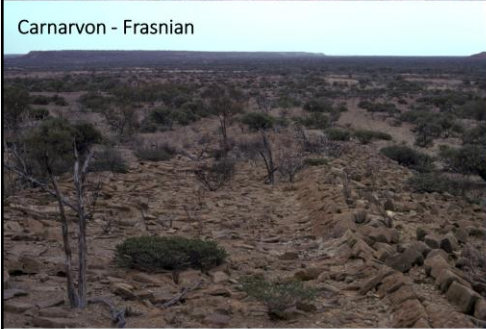
Different basins: differences and similarities



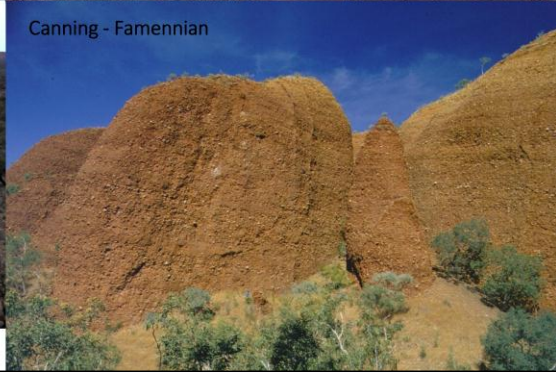
Carnarvon - Famennian



Amadeus - Famennian



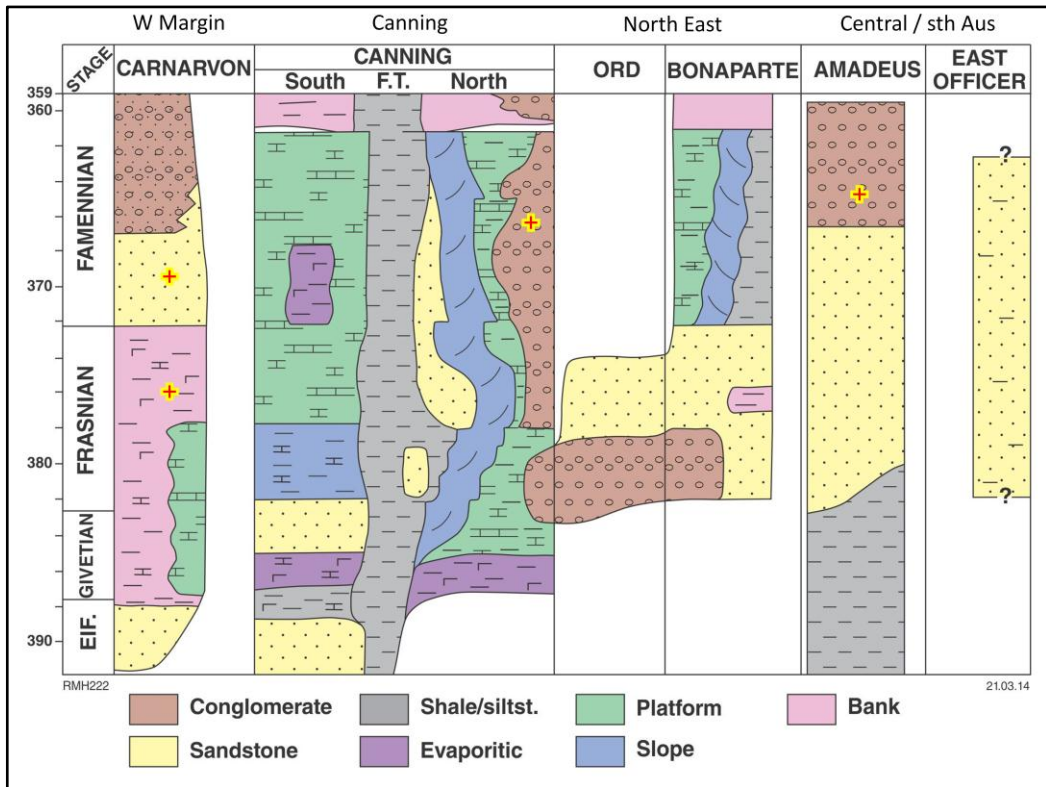
Carnarvon - Frasnian



Canning - Famennian

Canning - Frasnian=reefs

Presenter's notes: Quick overview of variation between basins
Frasnian: reefs in Canning, bank in S Carnarvon, sandstone in central Aus
Famennian: Sandstone then cong in Carnarvon, cong and reefs in Canning, foreland cong in central Aus



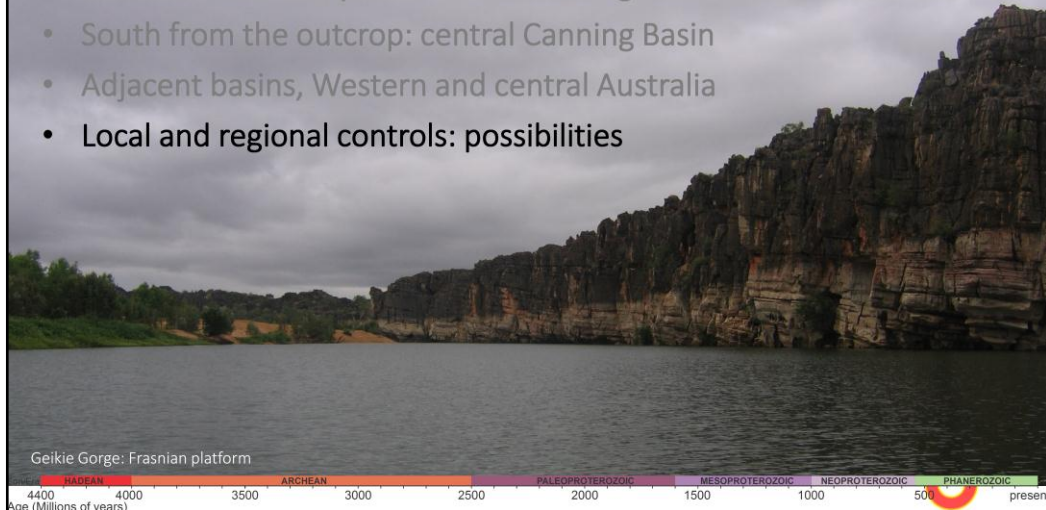
Presenter's notes: Facies and lithology slide again. Some similarities, some differences.

- Crosses show outcrop pics previous
- How to explain, what common threads

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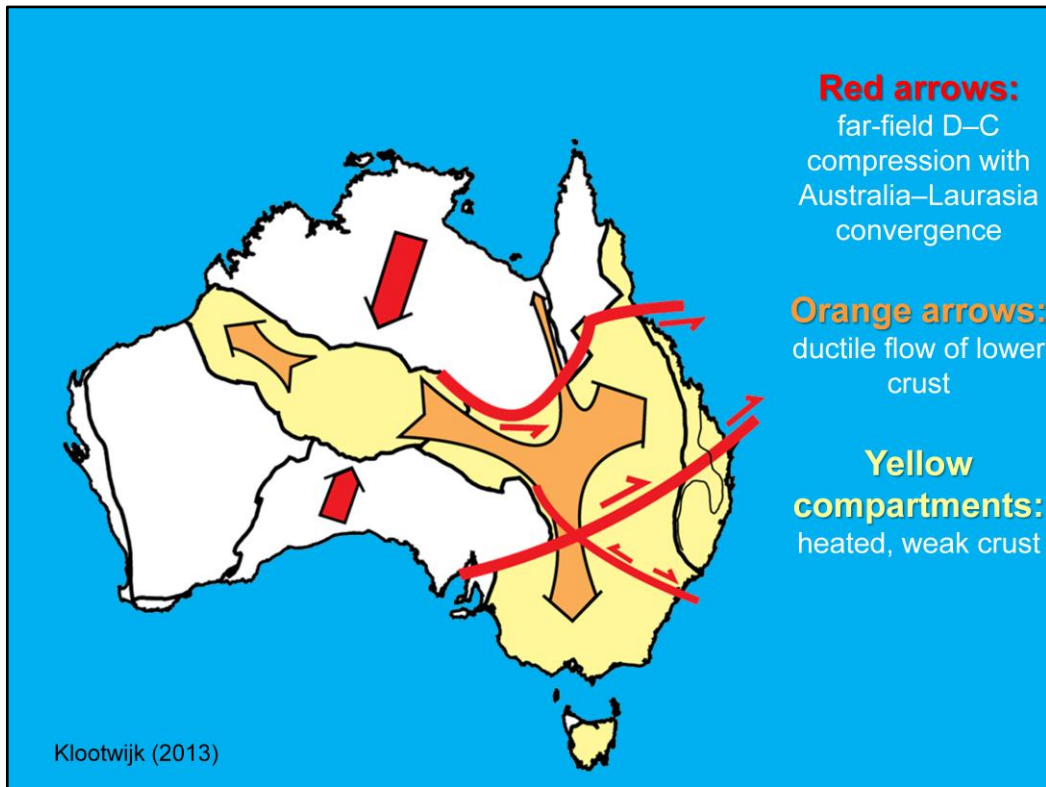


Geikie Gorge: Frasnian platform

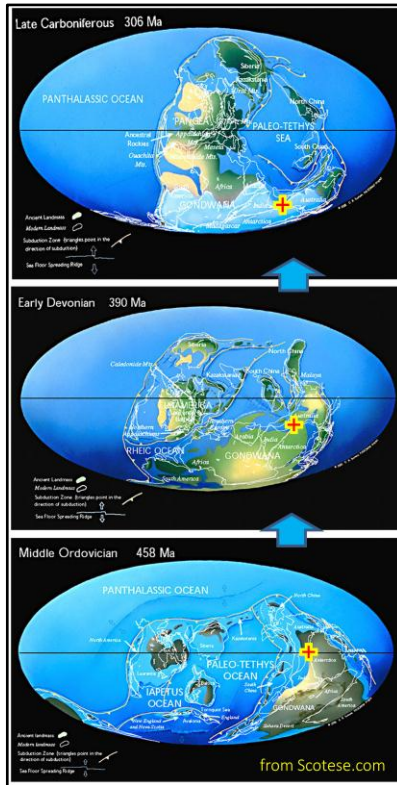


Presenter's notes: Last part of talk.

To do with local controls, global climate, regional tectonics.



Presenter's notes: Australia in the Late Devonian.
Regionally: compression central Oz.
Ductile flow of lower crust out to sides
Sag in Canning.
Explains simultaneous compression and sag/downwarping
Attempted rift down W margin.



L Carboniferous

Where was Australia?

- Equatorial in Ordovician
- Subpolar & glaciated in L Carboniferous
- Subtropical in L Devonian, facing Paleo-Tethys

E Devonian

M Ordovician

Presenter's notes: Oz thru time.

Crosses mark Canning.

Bottom to top, from equatorial in Ordovician > temperate in L Devonian > Subpolar by L Carb.

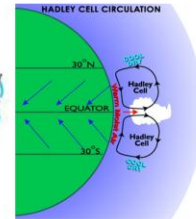
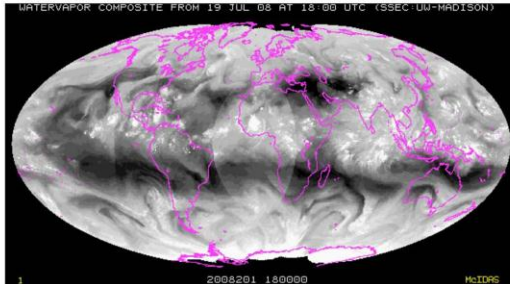
So, migrating south generally, Canning about 30S, Carnarvon a bit more.

Faced to paleo Tethys ocean, same as to Indian now.

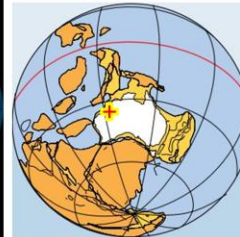
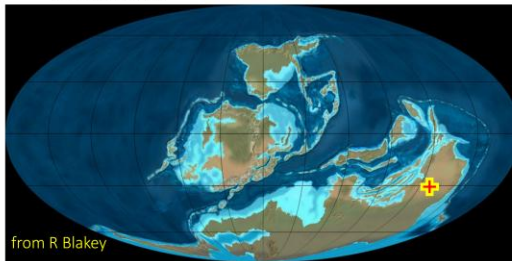
Climate and tectonics



Present day – climate cells

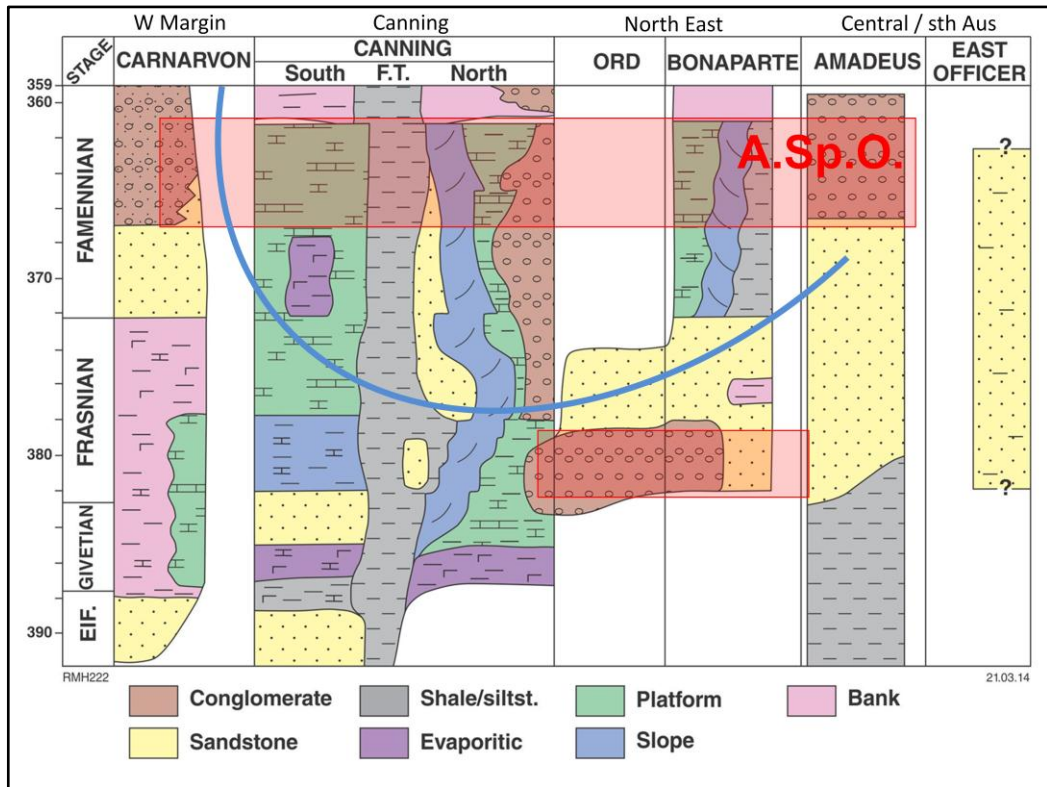


Devonian



- Reefs in sub-tropics
- Banks further south
- Intraplate compressive overprint > Famennian conglomerates
- Both tectonic and climatic controls

Presenter's notes: Climatic controls, from position of WA.
Cells may vary over time as continents move, but prob near intersection of Hadley and Ferrel Cells.



Presenter's notes: Put all together.

Alice Springs Orogeny > tectonism, conglomerate trigger

Latitude may control reef vs bank – Carnarvon just that bit further south

Sum up: in intro, said

- Lack detailed correlation, but broad comparison possible.
 - Detail developing in Canning thru Chronostrat project
 - Need to extend elsewhere to go much further

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