Seven Cretaceous Low-Order Depositional Sequences from the Browse Basin, North West Shelf, Australia: A Framework for CO_2 Storage Studies*

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Abstract

The Browse Basin Cretaceous succession comprises seven low-order depositional sequences (K10-K50, K60a and K60b). Sequence development was controlled by tectonic events associated with the separation of Greater India and Antarctica from Australia. These events punctuated a long-term accommodation trend that combined thermal subsidence and first-order eustasy. Sediment sourced from the Kimberly Basin hinterland was delivered to the basin via entrenched drainage systems. The main direction of sequence progradation varies from WNW in the Early Cretaceous to N in the Late Cretaceous. The updated sequence analysis presented here underpins a recent CO_2 storage study by Geoscience Australia. Sequence K10 (late Tithonian-early Valanginian) is a sand-rich, deltaic package that includes a distinctive lowstand wedge. Deep-water sands are present in the lower part of the sequence, especially in the lowstand wedge (Brewster Member). K20 (early Valanginian - late Hauterivian) and K30 (late Hauterivian - early Aptian) display aggradational and back-stepping stratal geometries. They are mud-prone and sands were mainly trapped inboard. Deep-water sands (Asterias Member) that occur in both sequences are known only in the north. K40 (early Aptian-late Cenomanian) is marked by a basinward shift in facies indicated by a basal sand (Aptian Windalia Sandstone equivalent) present in some inboard wells and a sand-rich progradational package on the Yampi Shelf. Rapid transgression followed, resulting in a condensed interval (Aptian Windalia Radiolarite equivalent) and a thick, mud-dominated Albian-Cenomanian section. K50 (late Cenomanian-early Campanian) coincides with a peak in eustasy and is incised by the

K60 sequence boundary. The remnant outboard part of K50 comprises mainly mudstone and marl, and foreset to bottomset stratal geometries. K60a (early Campanian-mid Maastrichtian) and K60b (mid to end Maastrichtian) represent a change to regressive architecture associated with falling eustasy and lower subsidence rates. Fluvio-deltaic sediments prograde over deep-water fan complexes sourced from lowstand channel systems. The sequence analysis has refined relationships between stratigraphic play elements both within and between sequences. Deep-water sands in K10, K20, K30, K60a and K60b are prospective storages because they are well sealed by downlapping muds. After application of risk criteria, deep-water sands in K60a and K60b have been high-graded as potential CO_2 storages.

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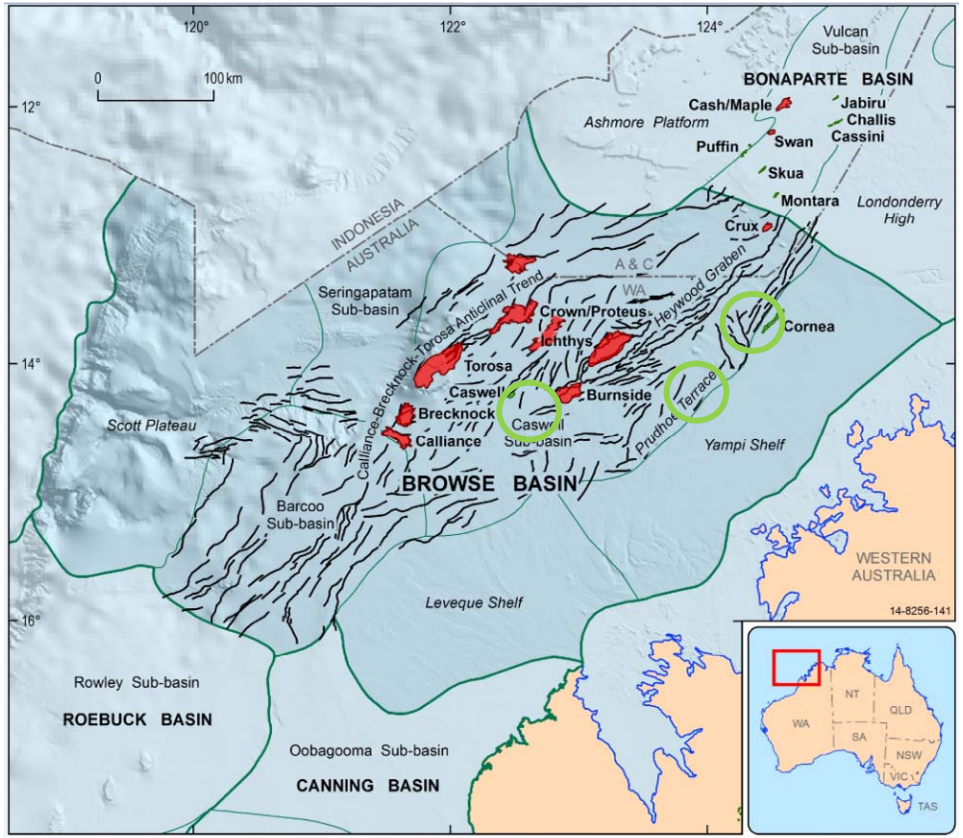
Introduction

- The Browse contains large accumulations of gas and condensate, and minor oil accumulations
- Stratigraphic framework for a regional assessment of CO_2 storage potential in the Browse Basin



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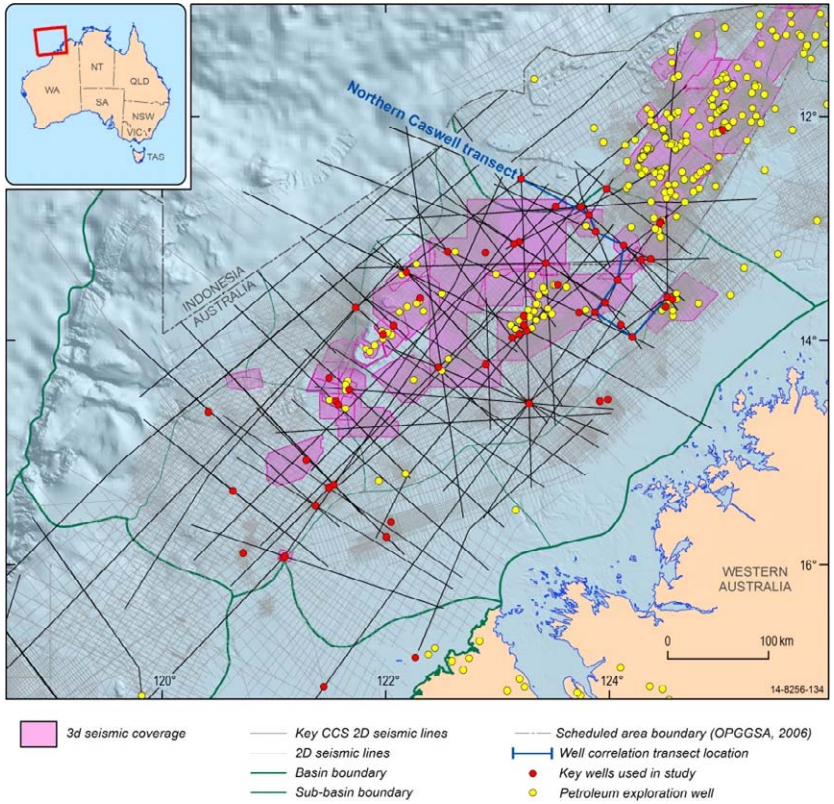
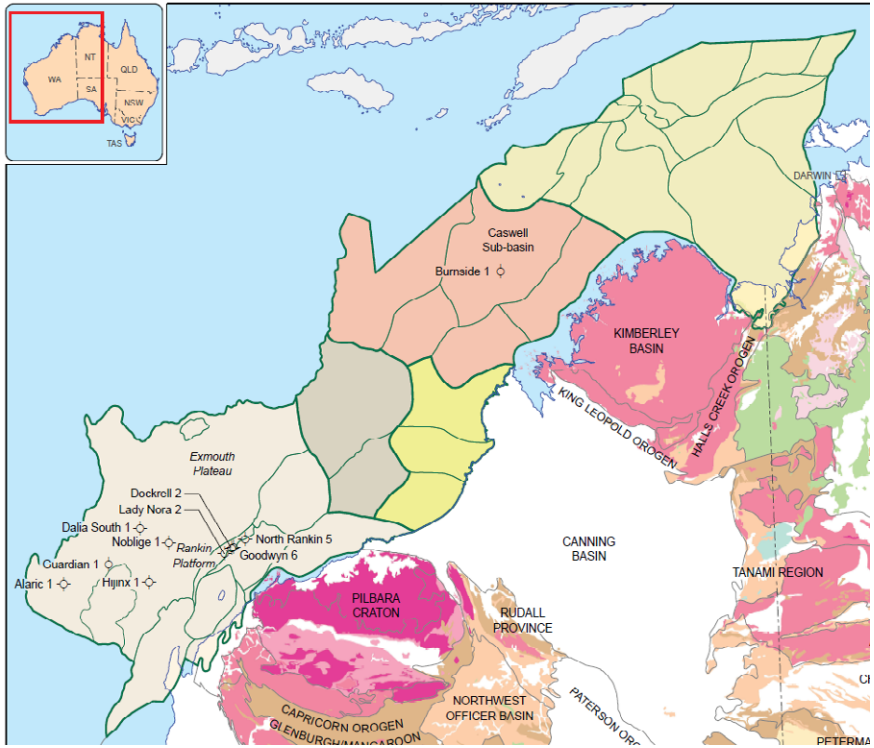
Data

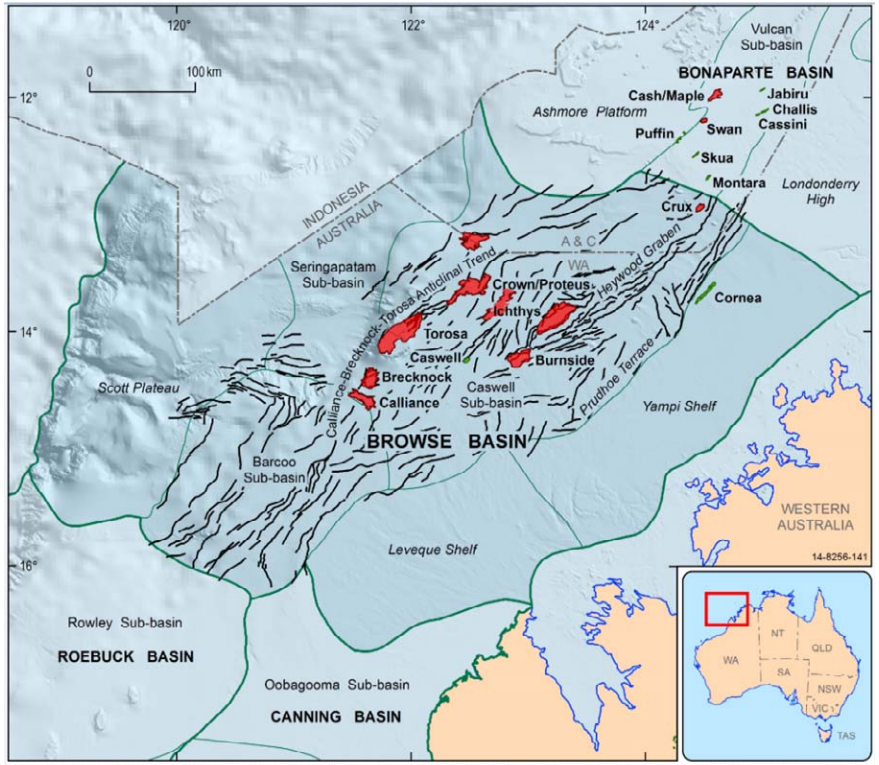
- Seismic horizons (sequence boundaries) mapped on regional 2D surveys
- Composite well logs prepared for 60 Key wells (including generation of new synthetic seismograms)
- Biostratigraphy calibrated to Geologic Time Scale 2012 (Gradstein et al., 2012)



Regional geologic setting



Lewis & Sircombe 2013



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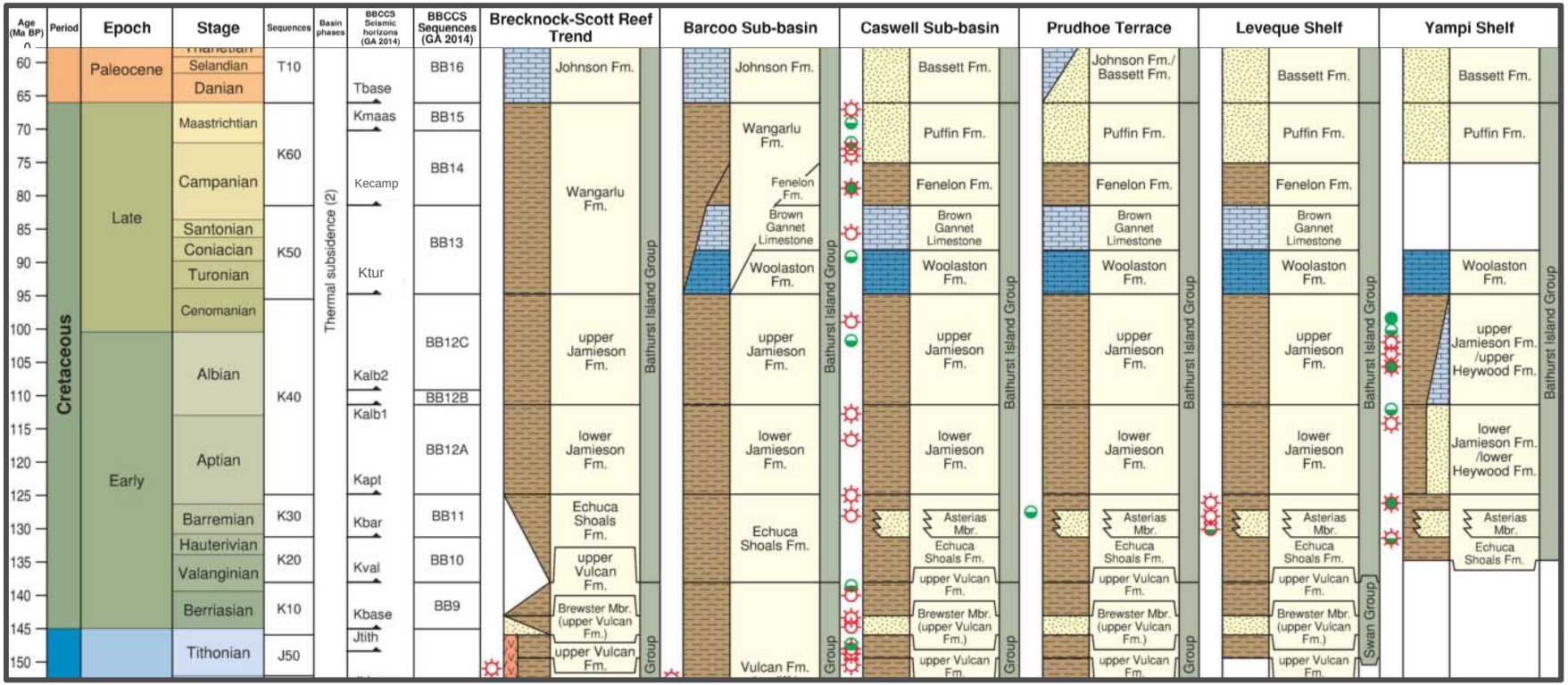
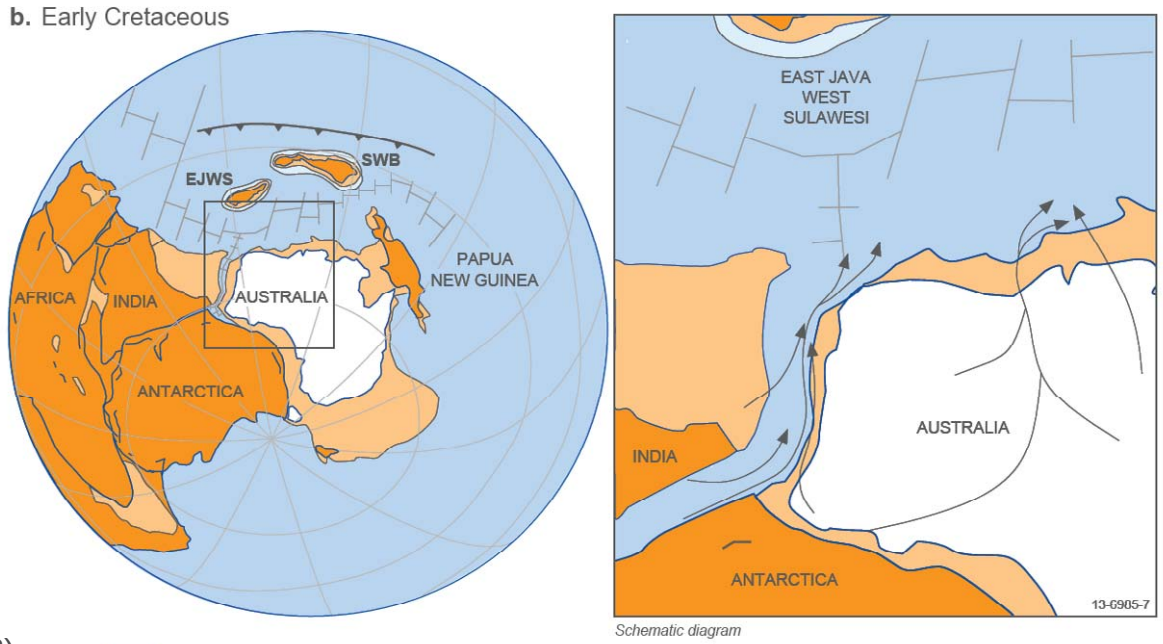
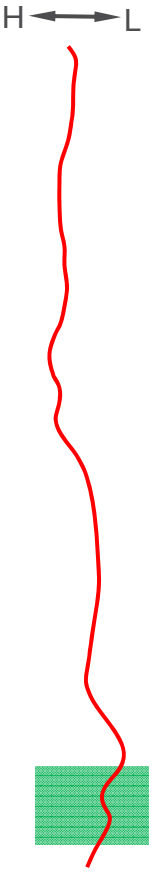
Regional stratigraphic setting



Controls on sequence development

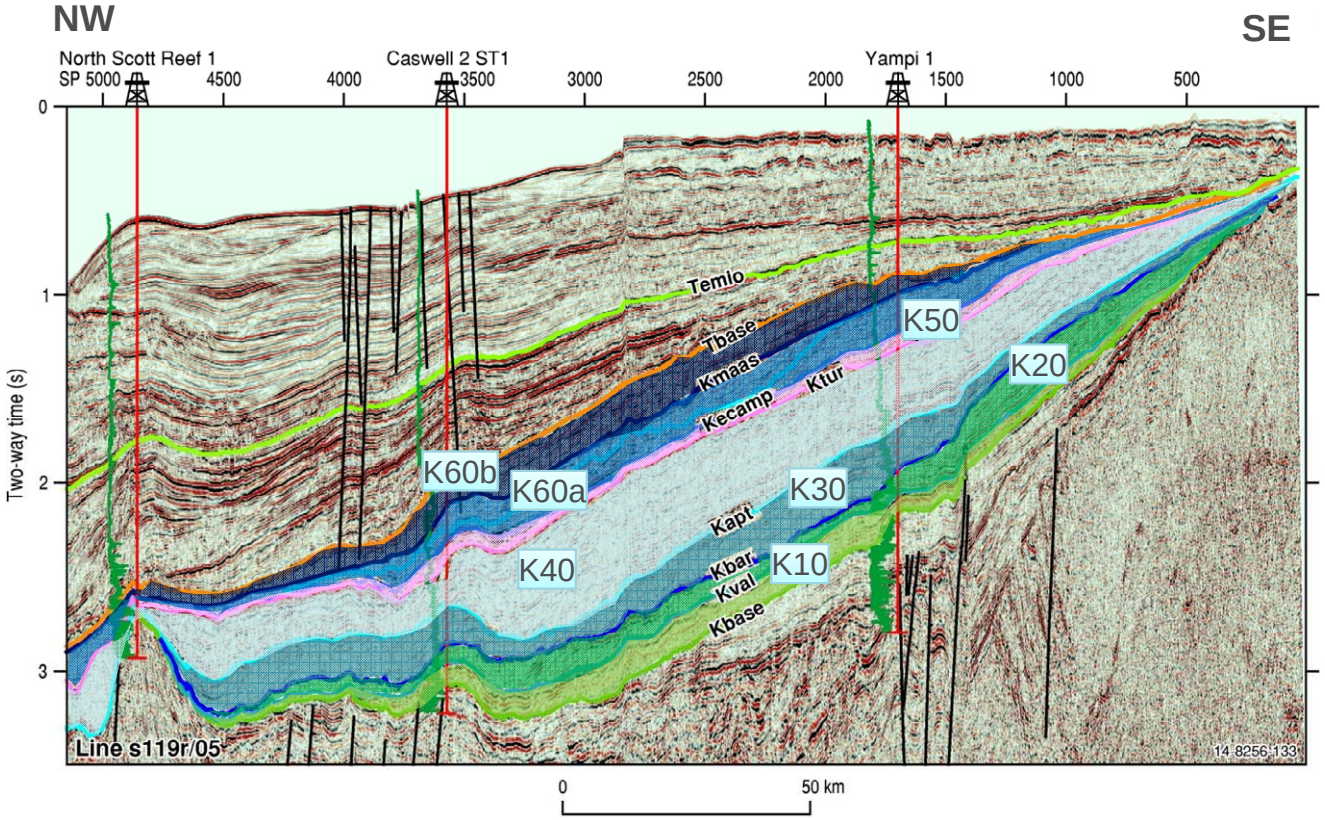


Lewis & Sircombe (2013) compiled from various publications by Hall, Metcalf, Zhu et al.

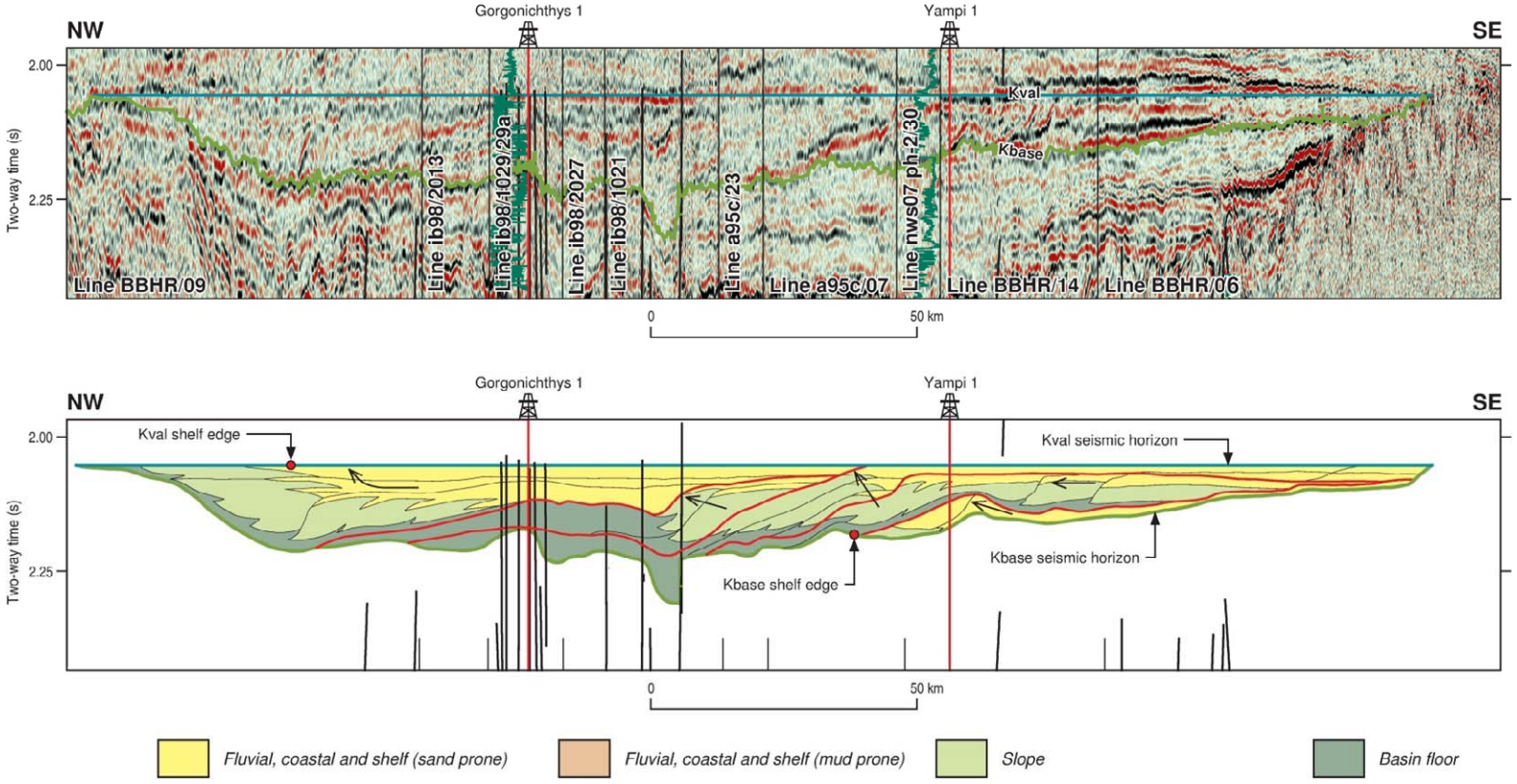


Sealevel curve from Haq (2014)

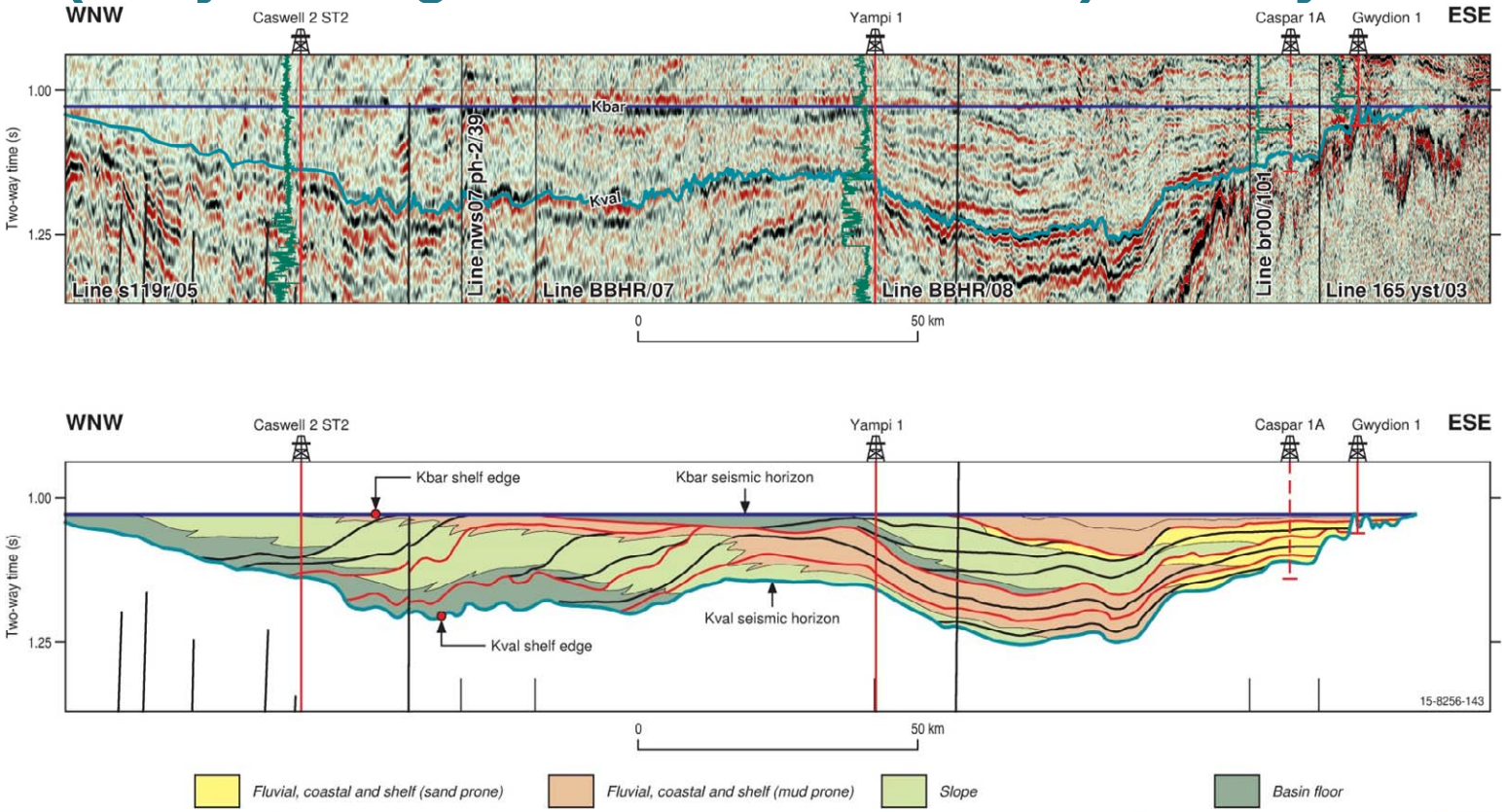
Introduction to the Browse supersequences



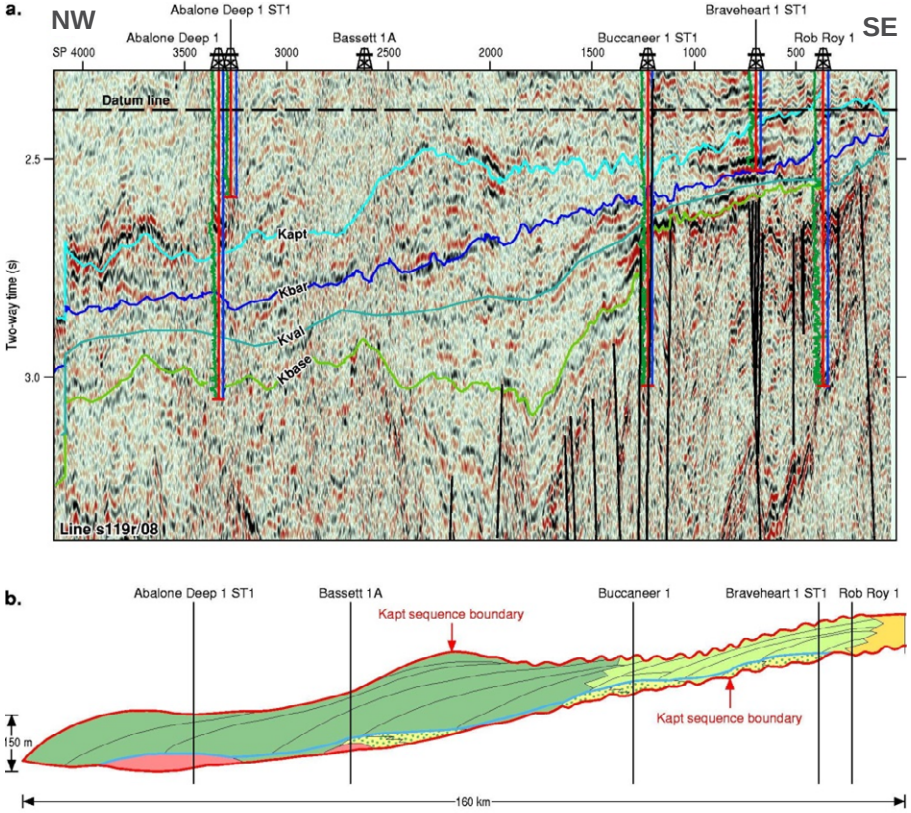
K10 (late Tithonian-early Valanginian) 7.9 m.y.

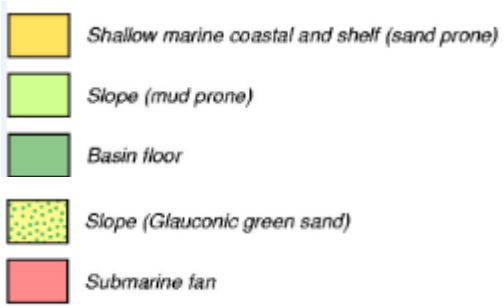


K20 (early Valanginian-late Hauterivian) 6.8 m.y.

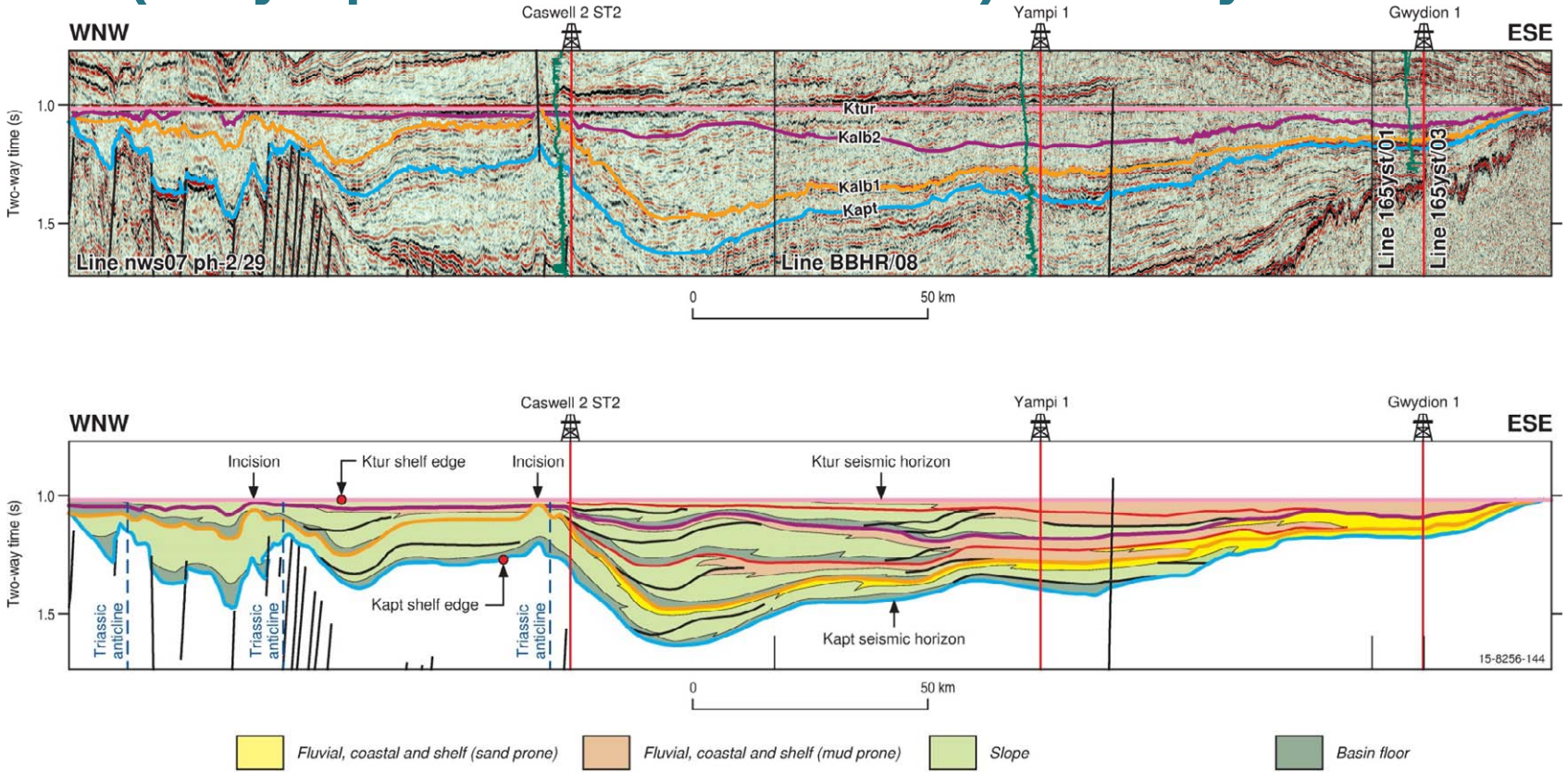


K30 (late Hauterivian-early Aptian) 6.4 m.y.

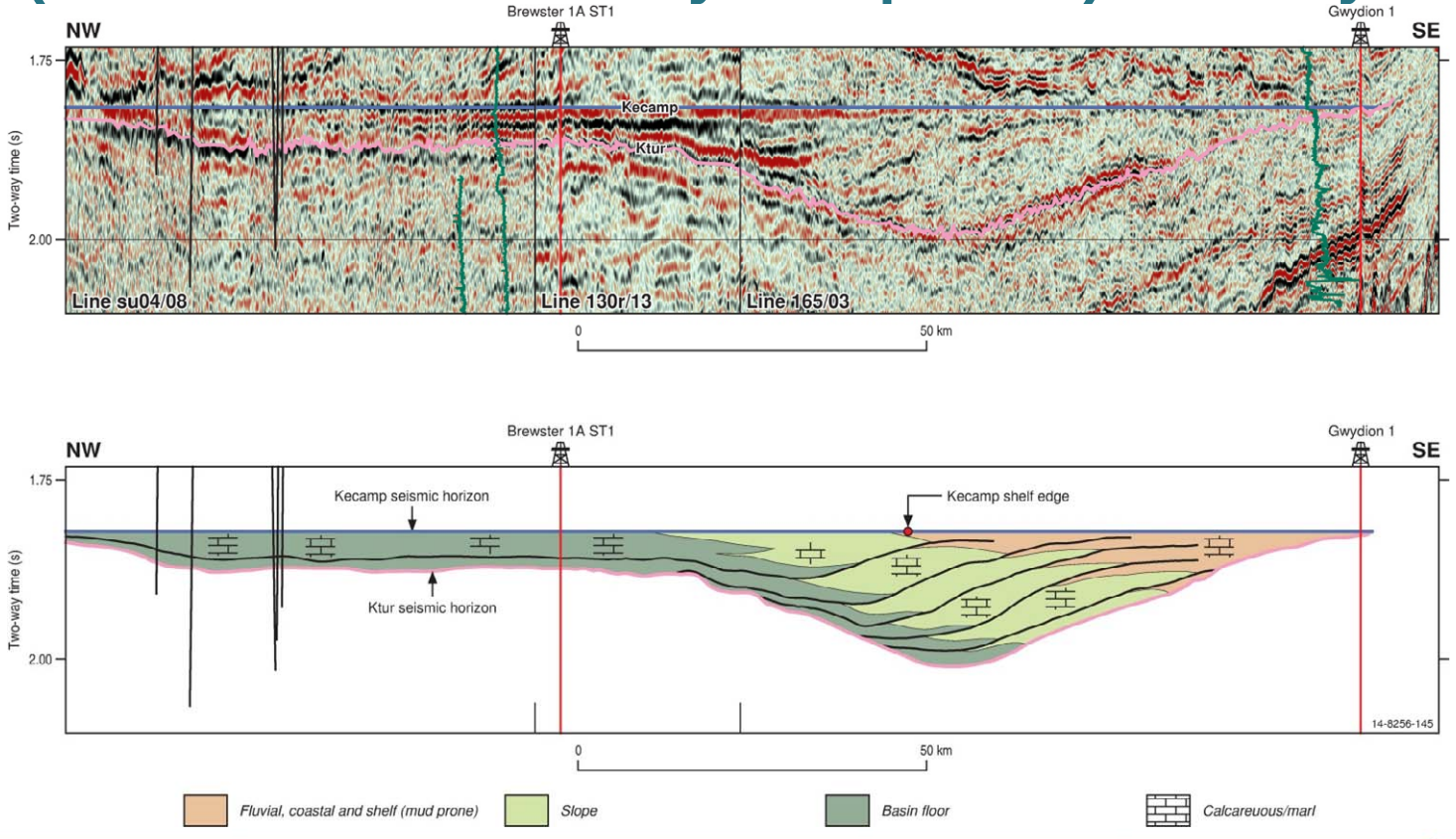




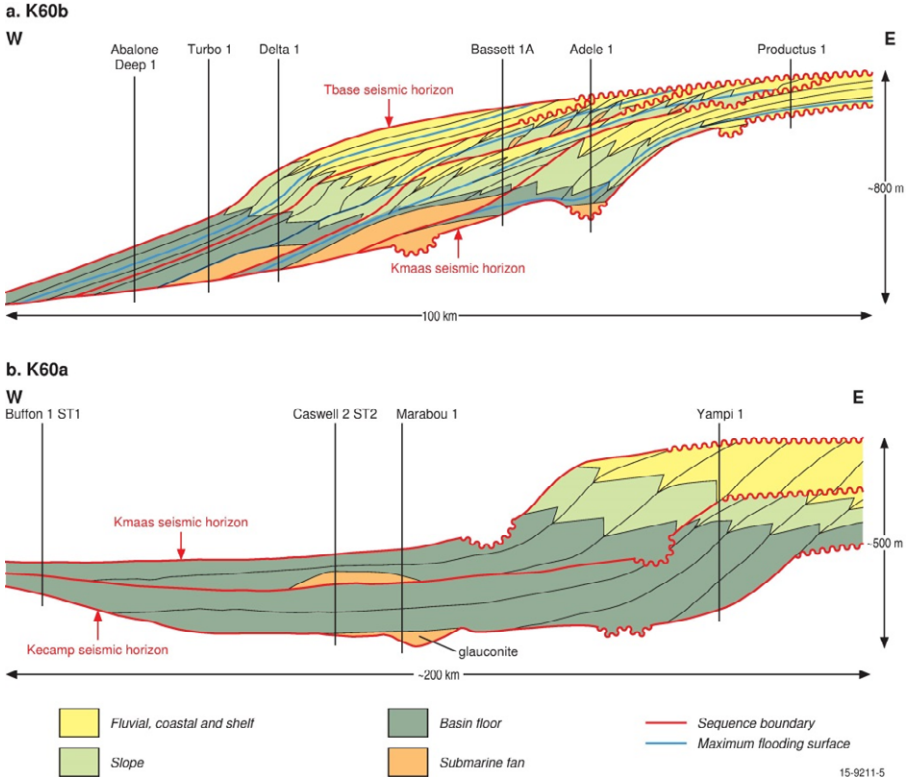
K40 (early Aptian-late Cenomanian) 29.3 m.y.



K50 (late Cenomanian-early Campanian) 14.1 m.y.



K60 (early Campanian-end Maastrichtian)



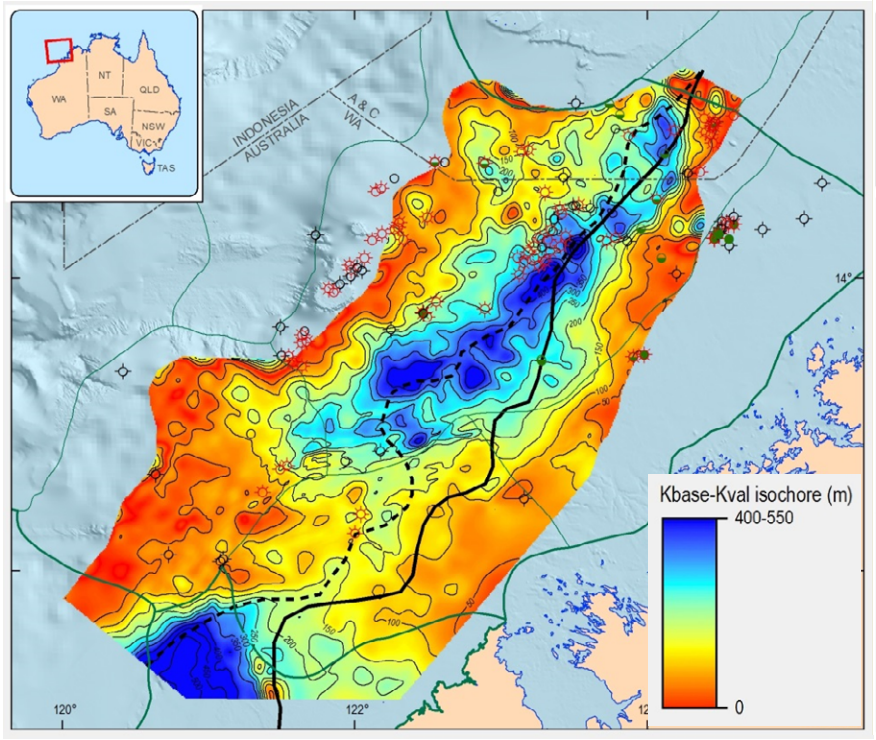
K60b (mid to end Maastrichtian)

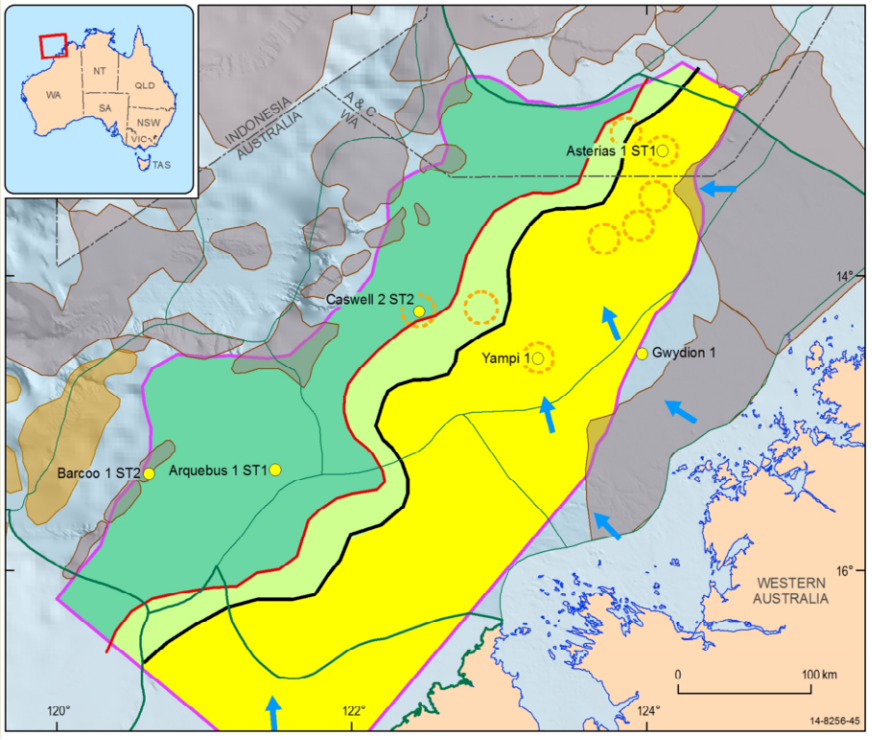
3.9 m.y.

K60a (early Campanian-mid Maastrichtian)

11.4 m.y.

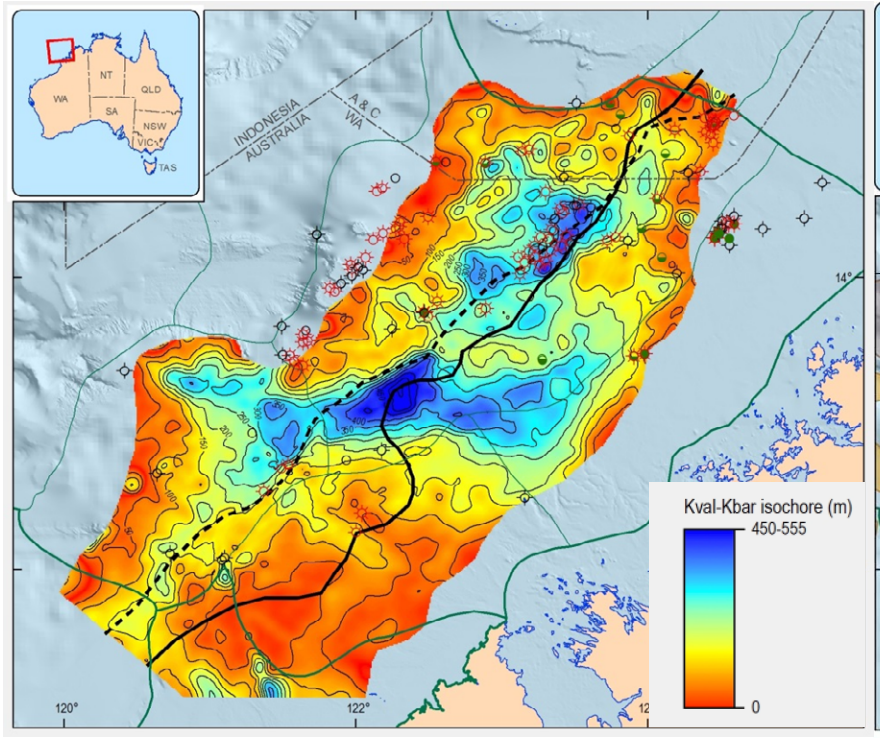
K10 palaeogeography (late Tithonian-early Valanginian)

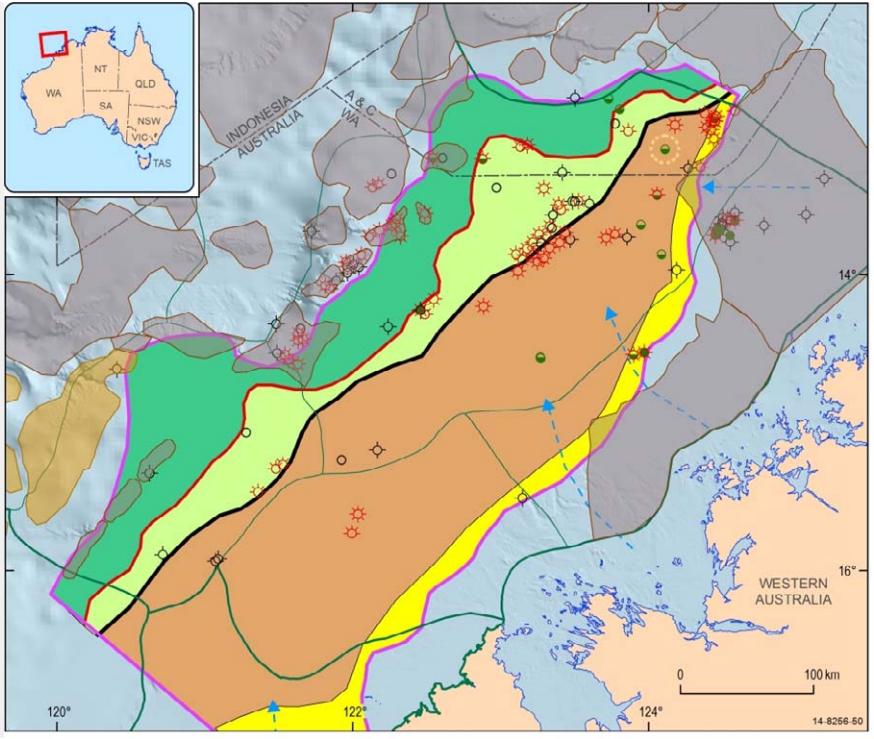




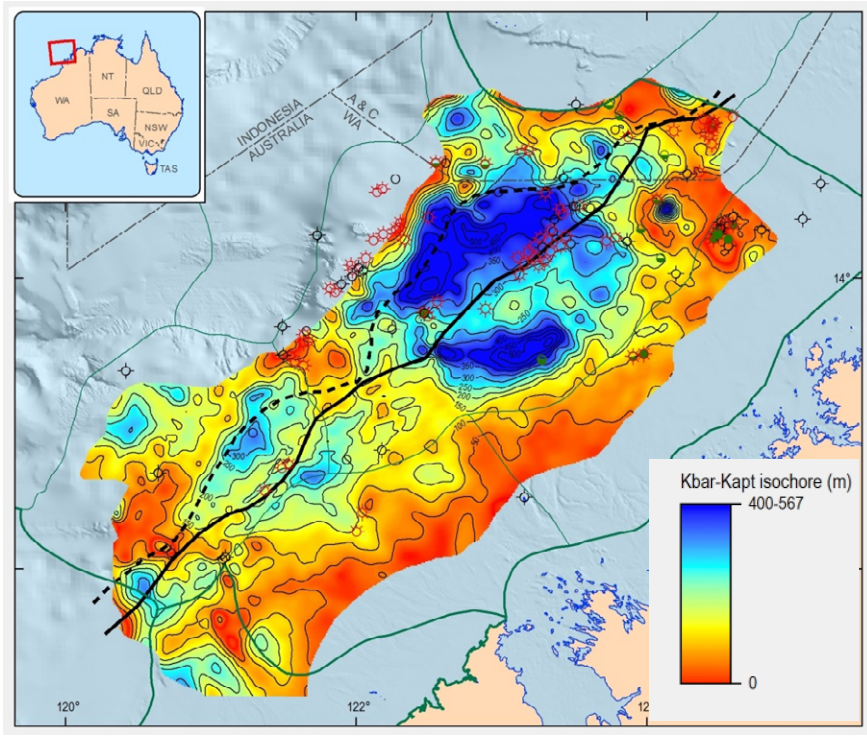
Sealevel curve from Haq (2014)

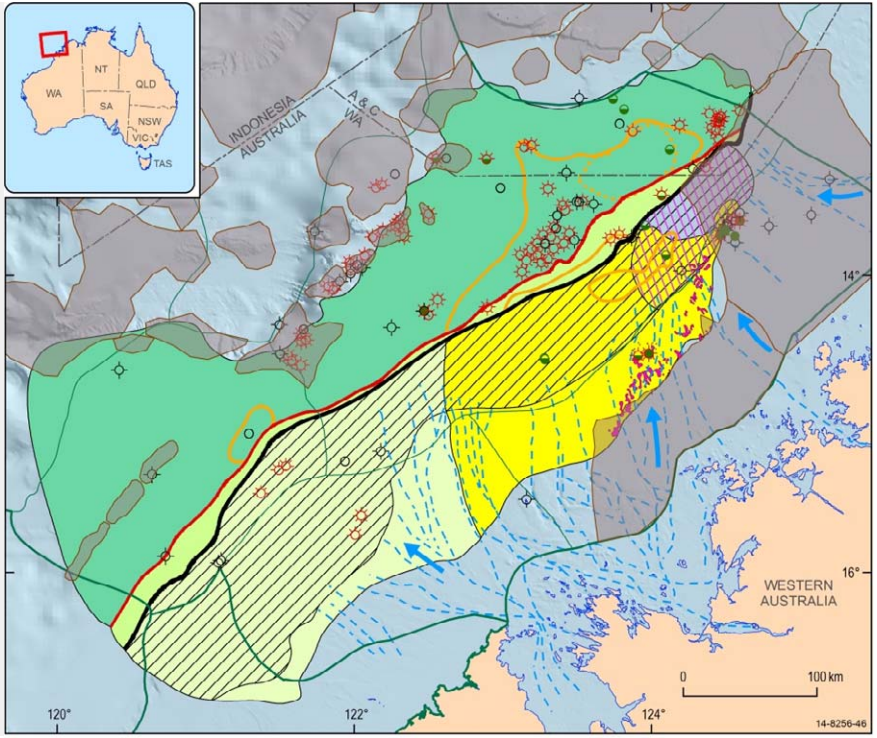
K20 palaeogeography (early Valanginian-late Hauterivian)

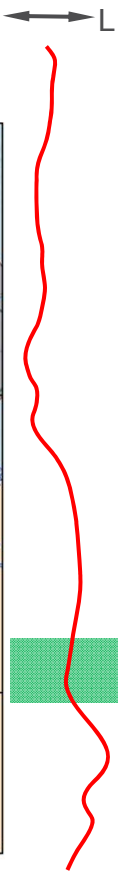




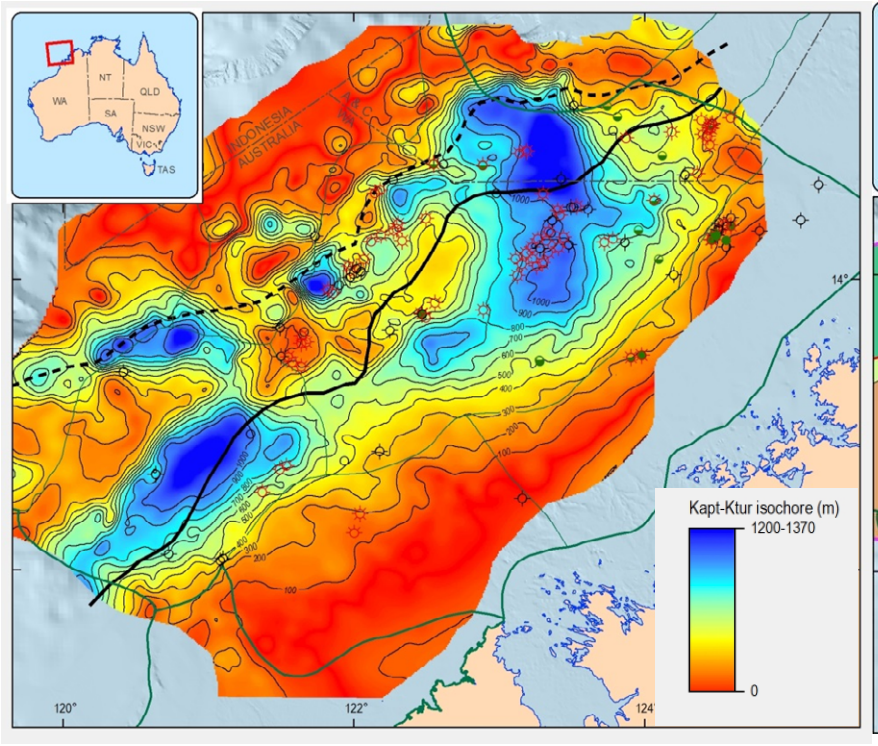
K30 palaeogeography (late Hauterivian-early Aptian)

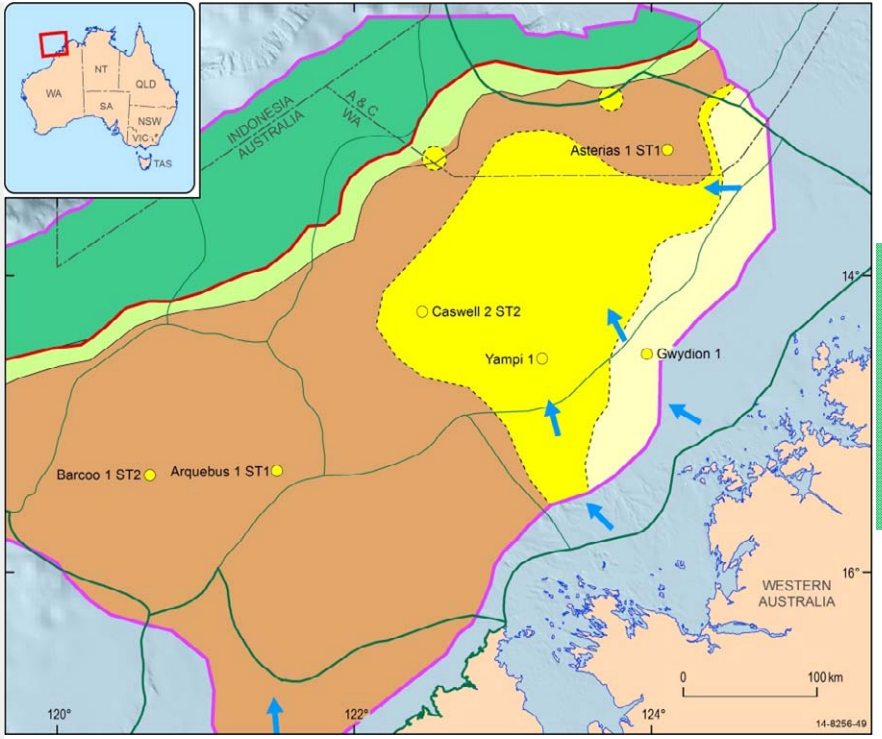


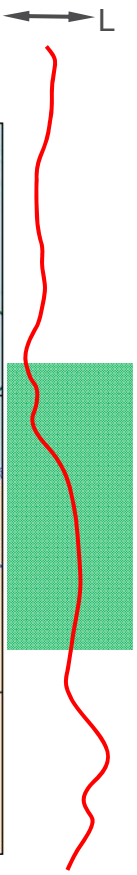




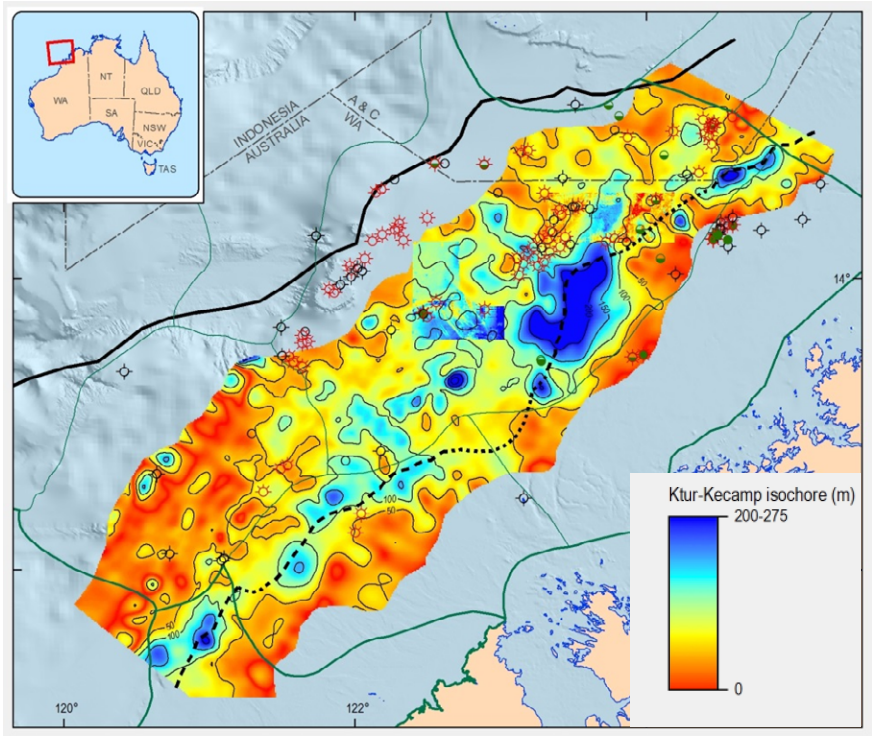
K40 palaeogeography (early Aptian-late Cenomanian)

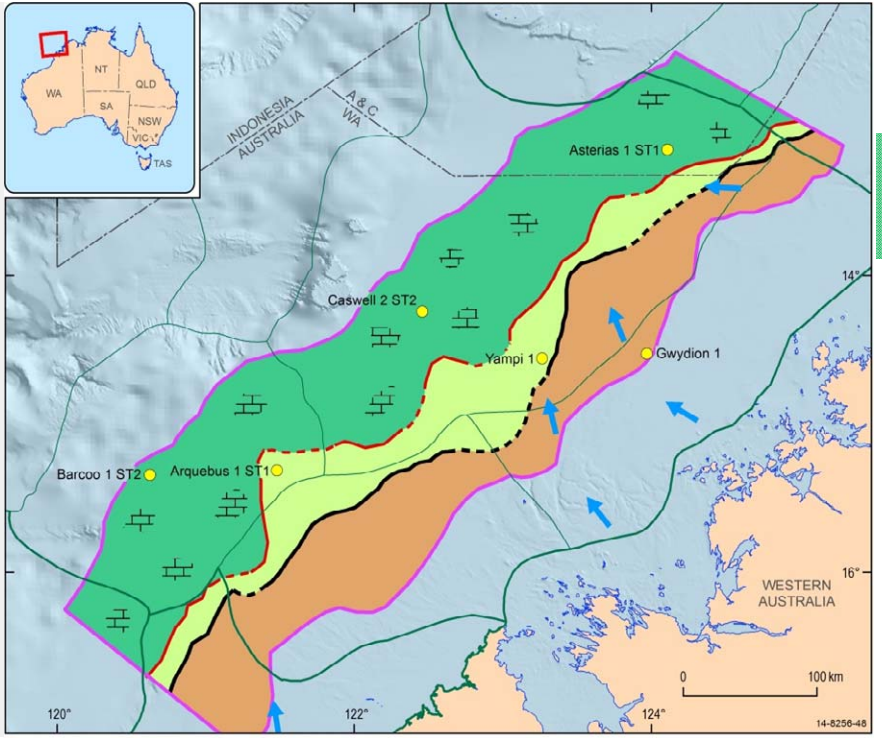




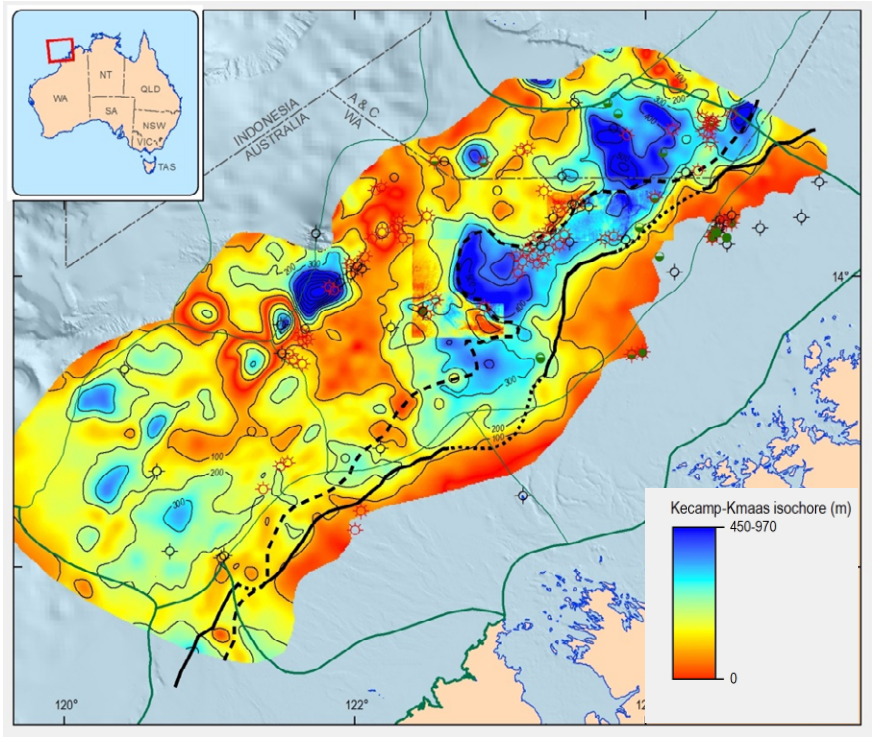


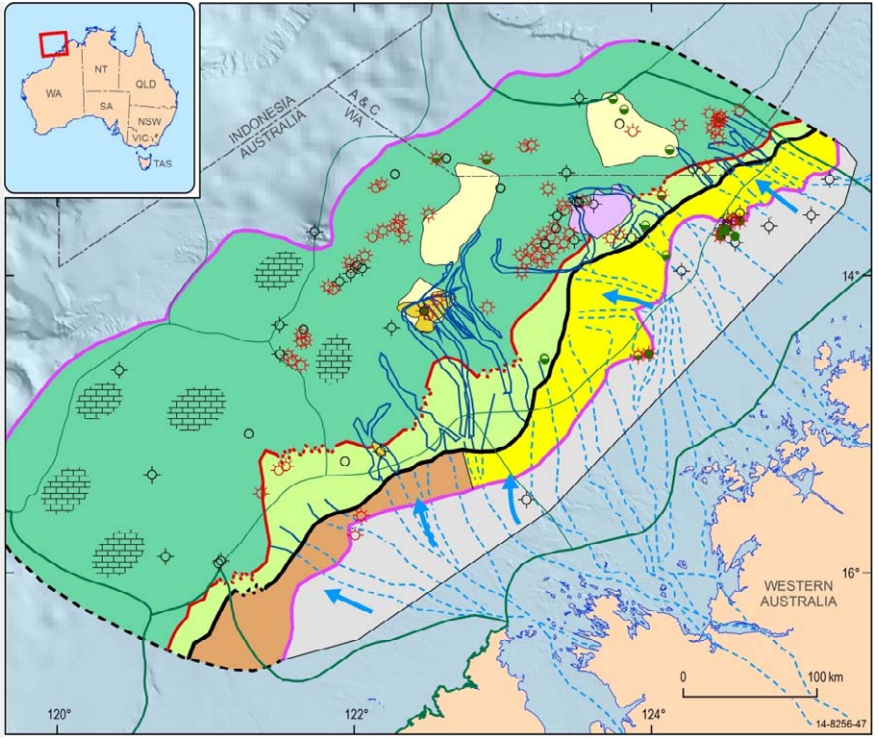
K50 palaeogeography (late Cenomanian-early Campanian)



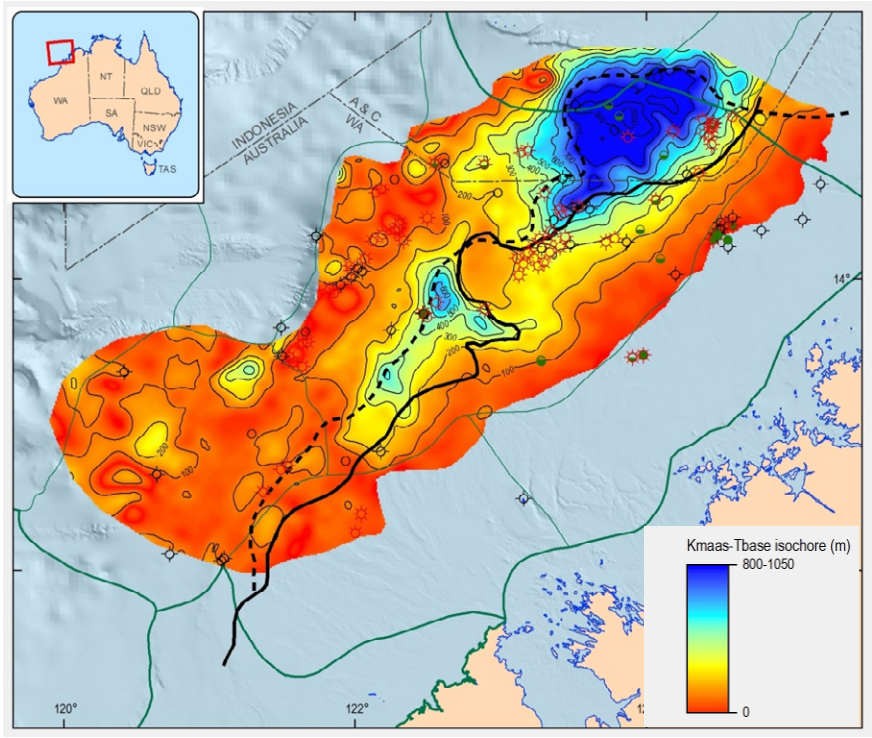


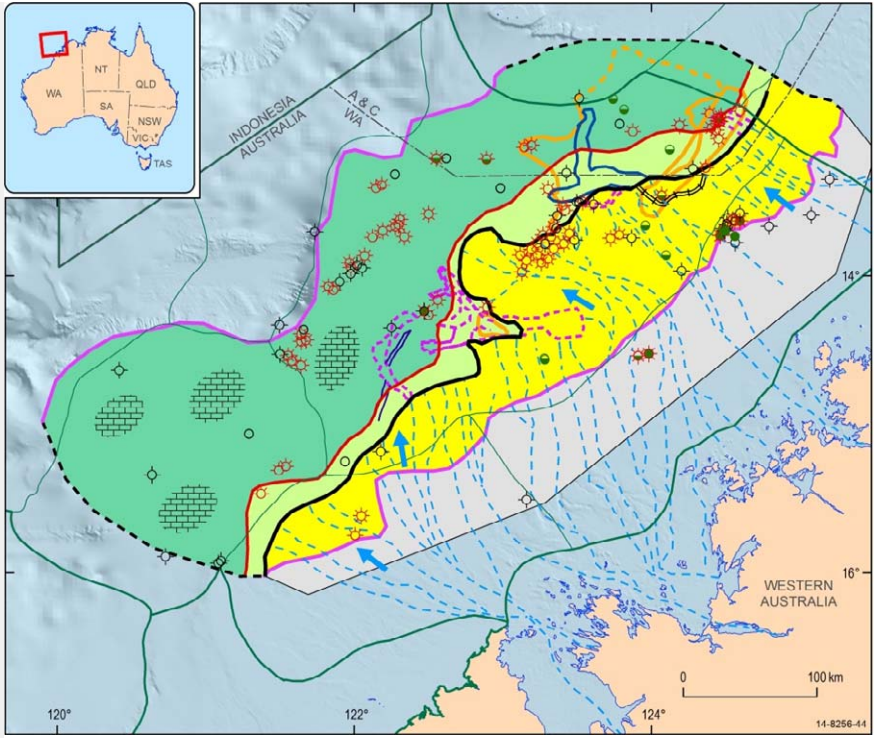
K60a palaeogeography (early Campanian-mid Maastrichtian)





K60b palaeogeography (mid to end Maastrichtian)





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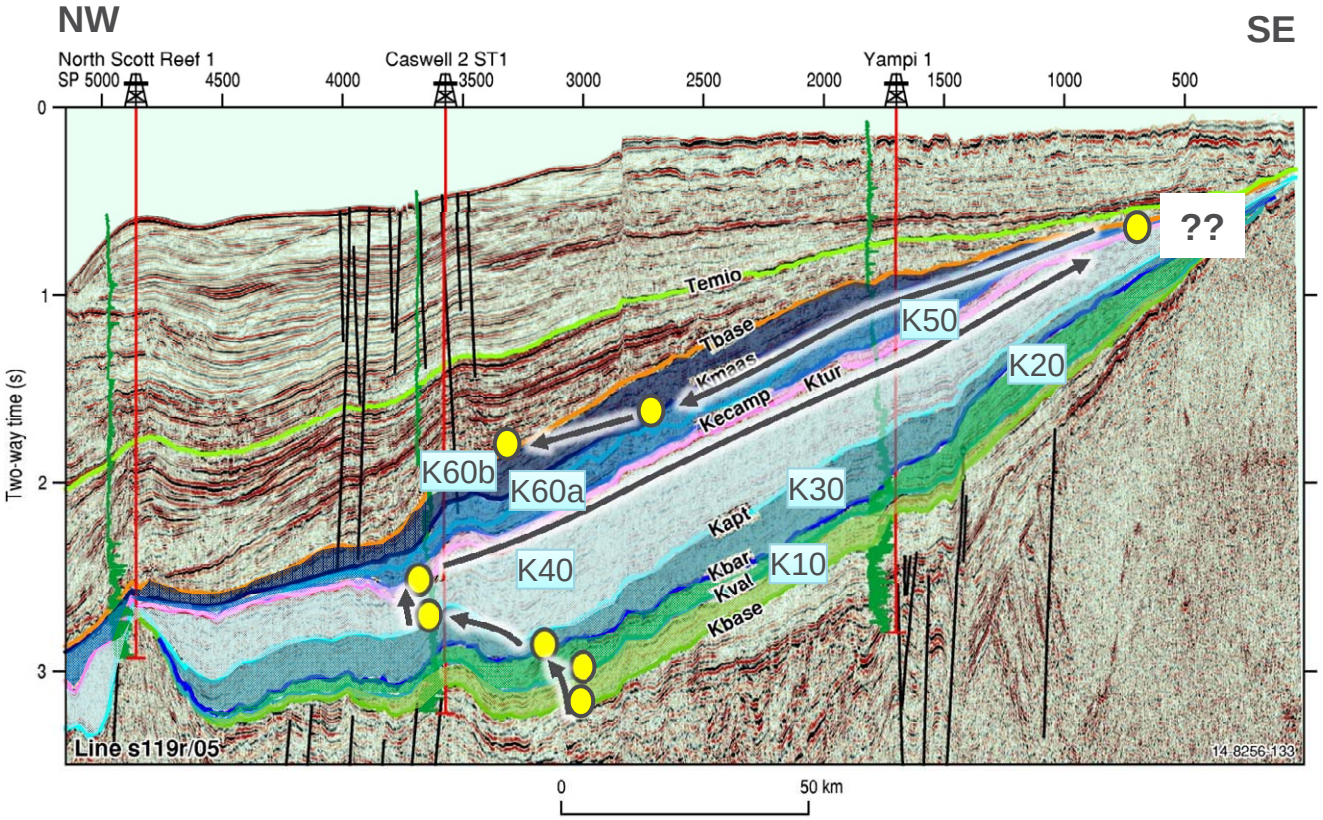
Summary of the Browse supersequences



Summary & conclusions

- The sequence analysis presented here has mapped out the regional facies architecture of the basin and this provides a stratigraphic framework for the CO_2 storage study
- The higher order packages shown in some of the sequence cross-sections may be mappable on a regional scale leading to refinement of this framework
- Updated or alternative interpretations for some parts of the stratigraphy e.g. Brewster Member in the K10 supersequence and the Windalia Sandstone equivalent in the K40 supersequence may lead to reassessment of their significance for CO_2 storage and hydrocarbon studies.
- Sequence architecture explains the general lack of submarine fans in the Early Cretaceous
- Palaeogeographic maps highlight the differences between the Caswell and Barcoo sub-basins

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- Visit Geoscience Australia at the Australia Petroleum booth #529