The Source of Oil and Gas Accumulations in the Browse Basin, North West Shelf of Australia: A Geochemical Assessment*

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Abstract

The Browse Basin located offshore on Australia's North West Shelf hosts considerable, but as yet undeveloped, petroleum resources with 36 Tcf EUR (Estimated Ultimate Recovery) of gas and 1148 MMbbl of condensate. It is poised to become Australia's next major conventional liquefied natural gas (LNG) province with the Ichthys, Prelude and Concerto fields expected to be in production by the end of 2016. Significant gas accumulations are also found along, and to the northeast of, the Brecknock-Scott Reef Trend (Calliance, Brecknock, Torosa and Poseidon) and in the Heywood Graben (Crux). Despite the economic importance of these fields and the extensive ongoing exploration activity, the origin of hydrocarbons remains ambiguous and a thorough geochemical evaluation of reservoir fluids and source rocks was carried out to redefine the petroleum systems of the Browse Basin. Geochemical data reveal that the gas-prone source rocks occurring throughout the Lower to Middle Jurassic Plover Formation have pervasively charged reservoirs of the Browse Basin at numerous stratigraphic levels.

On the other hand, oil-prone source rocks within the Upper Jurassic Lower Vulcan and Lower Cretaceous Echuca Shoals formations appear to be charge limited. The fluvio-deltaic sediments of the Plover Formation are the primary source for the dry gas found in the Plover reservoirs of the Brecknock-Scott Reef Trend and Ichthys fields. The Plover source rocks have also contributed to the wet gas accumulations reservoired within the Upper Jurassic Brewster Member of the Ichthys and Prelude/Concerto fields with additional inputs from the Lower Vulcan Formation. Gases from the Crux Field in the Heywood Graben are isotopically more enriched in 13C than any gases generated from the Caswell Sub-basin depocenter, suggesting derivation from coal-rich facies within thick Jurassic syn-rift sediments. The few sub-economic oil discoveries made in the Browse Basin are confined to the central Caswell Sub-basin (Caswell) and to the Yampi Shelf (Cornea, Gwydion and surrounds) where oil, together with some gas, is found in Cretaceous reservoirs. Molecular and carbon isotopic data show that the oil, and the

gas to some extent, is derived from marine organic matter within the Echuca Shoals Formation. However, accumulations on the Yampi Shelf also contain gases sourced from Plover source rocks, emphasising the migration of multiple hydrocarbon charges towards the basin margins.

References Cited

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http://www.searchanddiscovery.com/abstracts/pdf/2006/intl_perth/abstracts/ndx_edwards.pdf?q=%2BauthorStrip%3Aedwards+%2ByearSort%3A%5B2006+TO+2006%5D

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Geoscience Australia, Energy Systems Group, Resources Division
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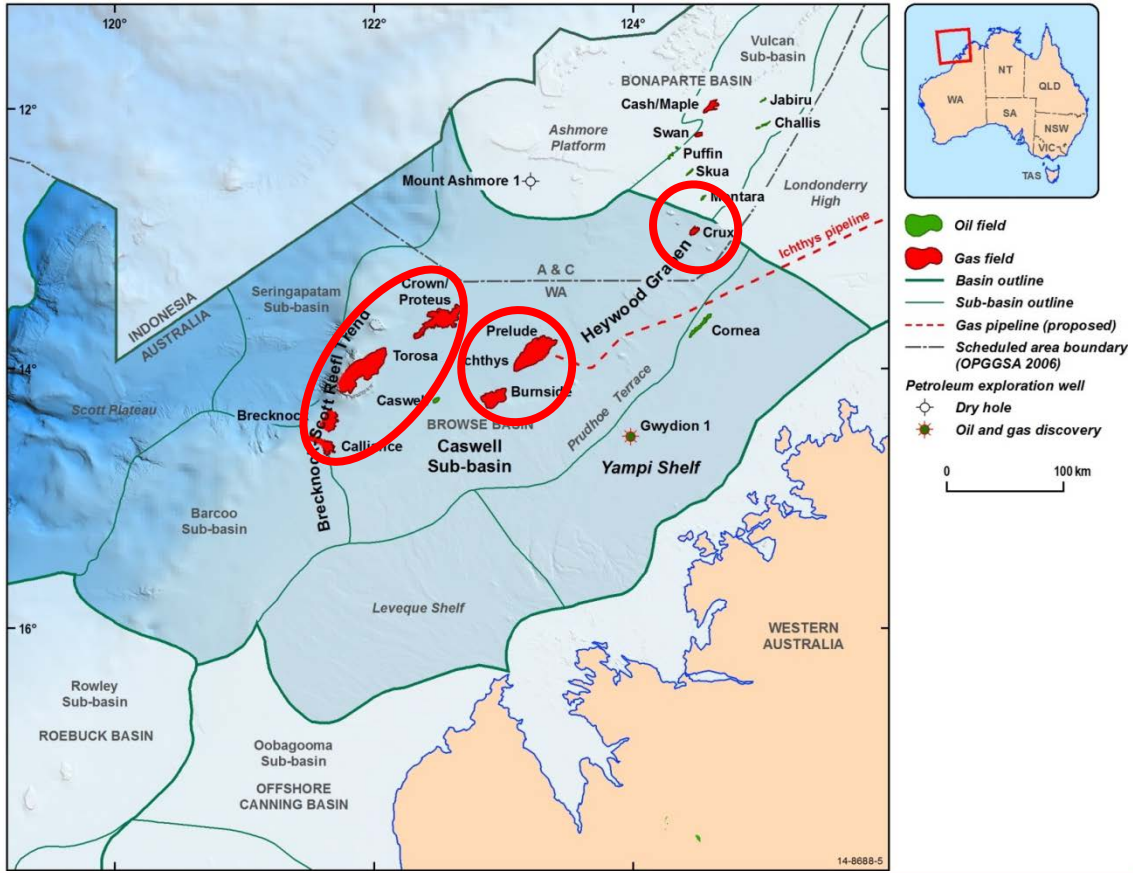
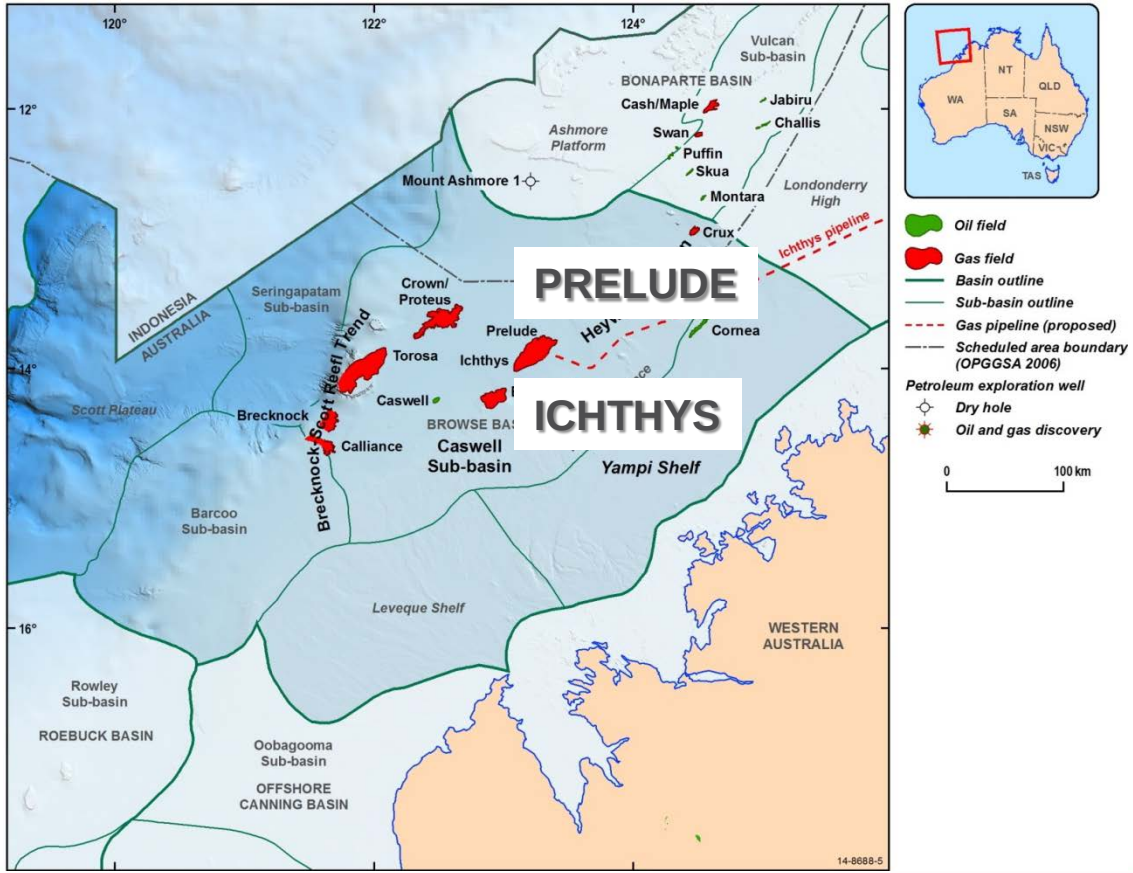
AAPG/SEG ICE,
Melbourne 13–16 September 2015

Browse Basin oil and gas accumulations



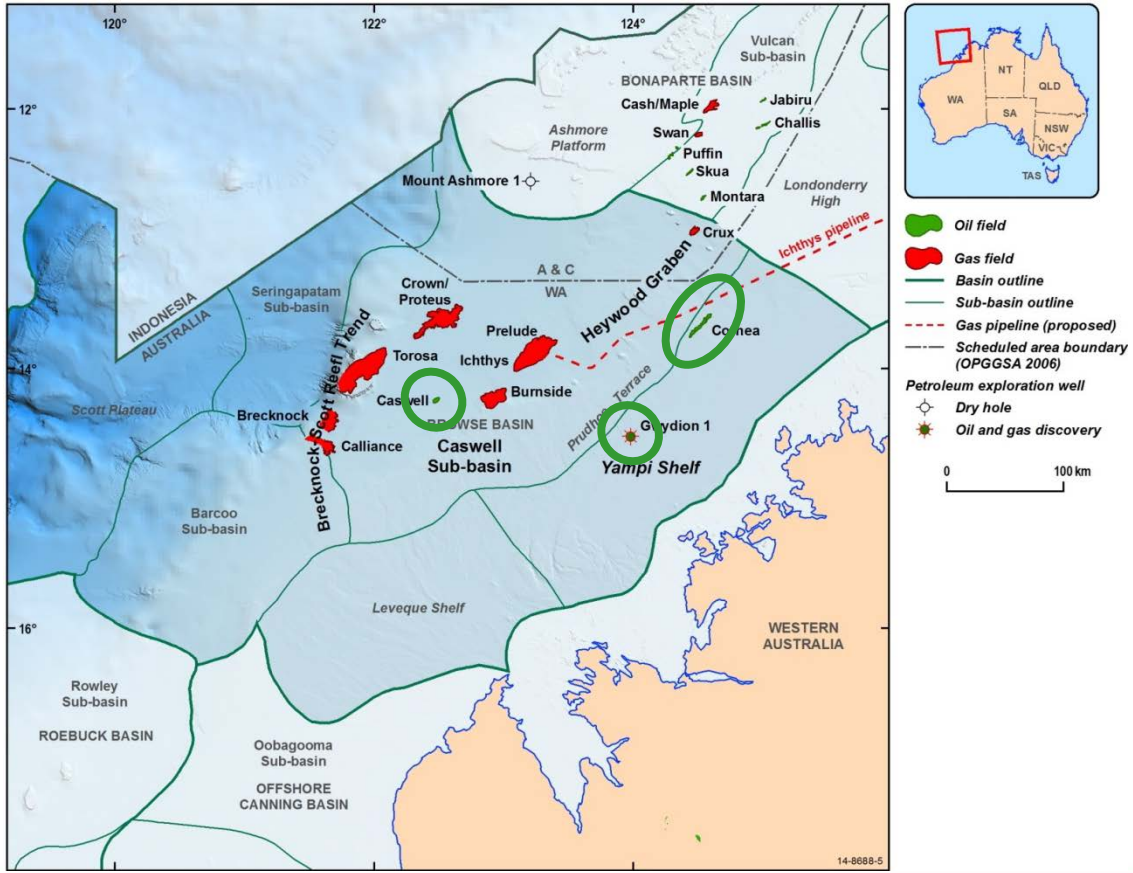
- Gas accumulations in Calliance/Brecknock/Torosa, Ichthys/Prelude and Crux

Browse Basin oil and gas accumulations



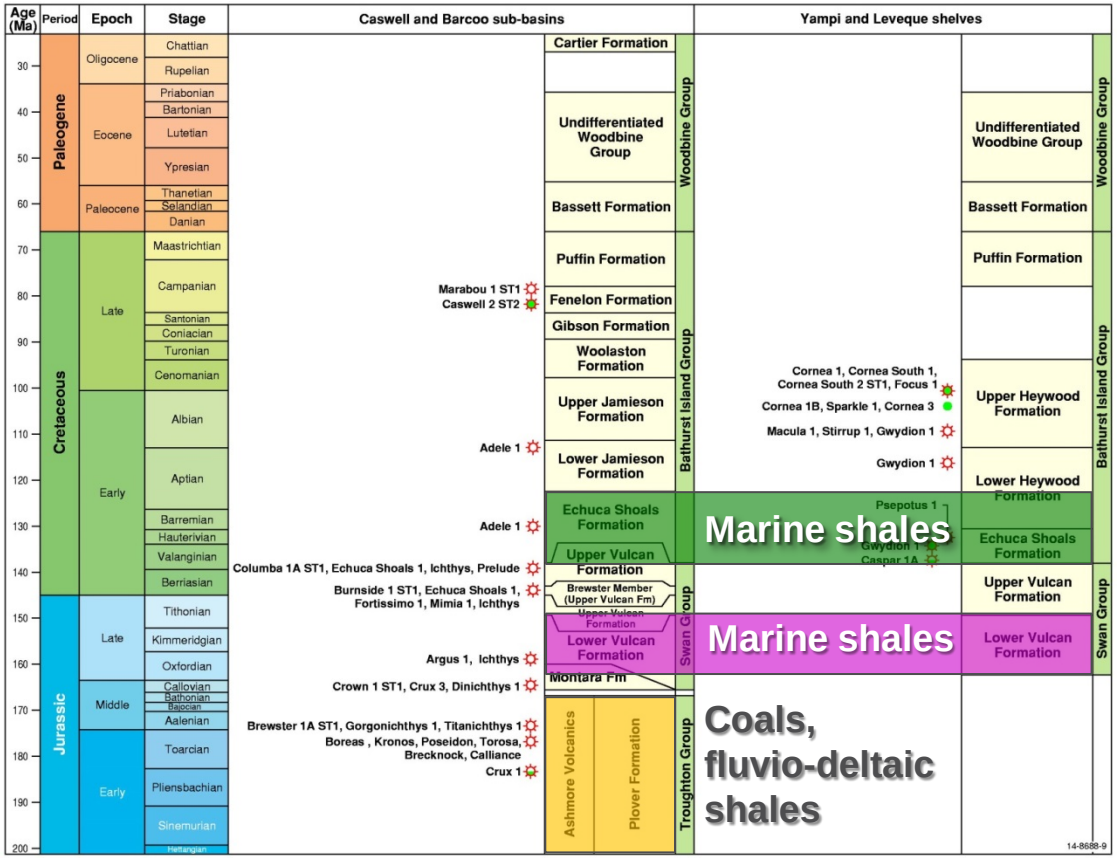
- Gas accumulations in Calliance/Brecknock/Torosa, Ichthys/Prelude and Crux
- Ichthys/Prelude: on track to deliver first LNG volumes in 2016

Browse Basin oil and gas accumulations



- **Gas accumulations in Calliance/Brecknock/Torosa, Ichthys/Prelude and Crux**
- **Ichthys/Prelude: on track to deliver first LNG volumes in 2016**
- **Oil accumulations:**
  - Cornea/Gwydion 1
  - Caswell 1 and 2

Browse Basin Stratigraphy: Source Rocks



Echuca Shoals Fm.: Source of oils in the Browse Basin

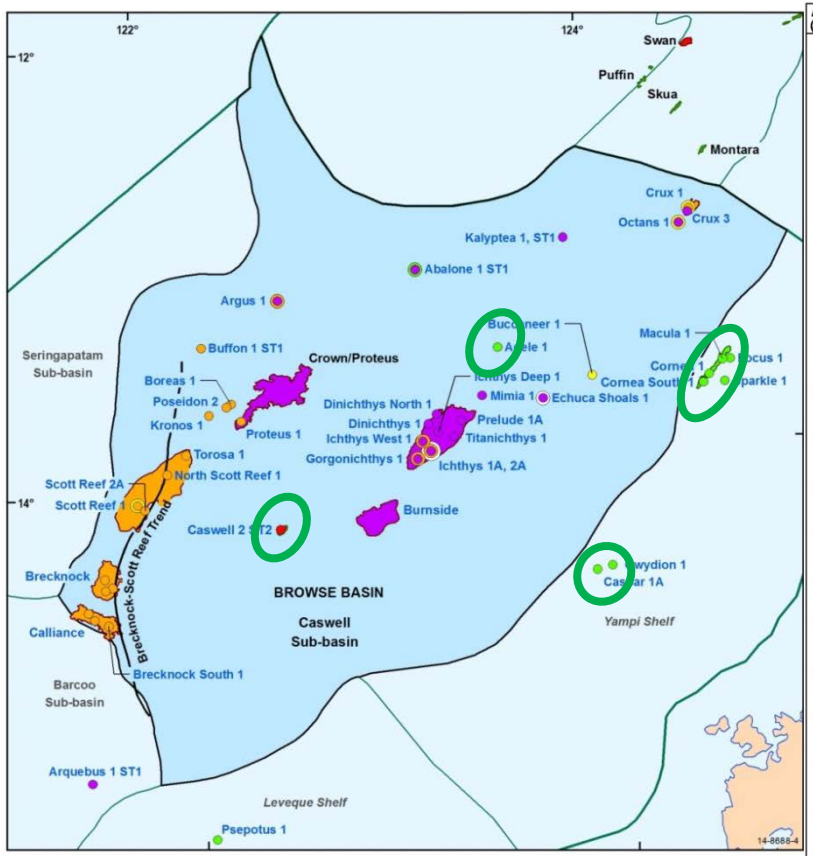
Blevin et al., 1998
BBHR study

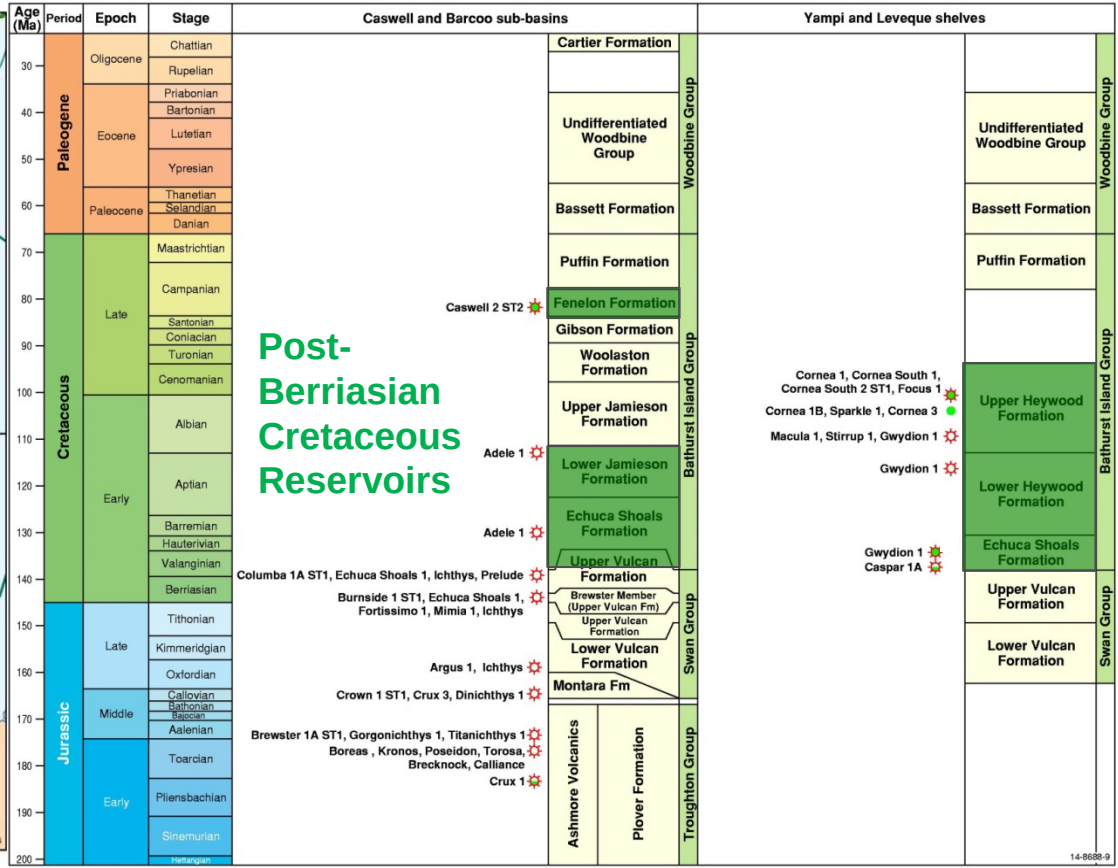
Echuca Shoals

Lower Vulcan

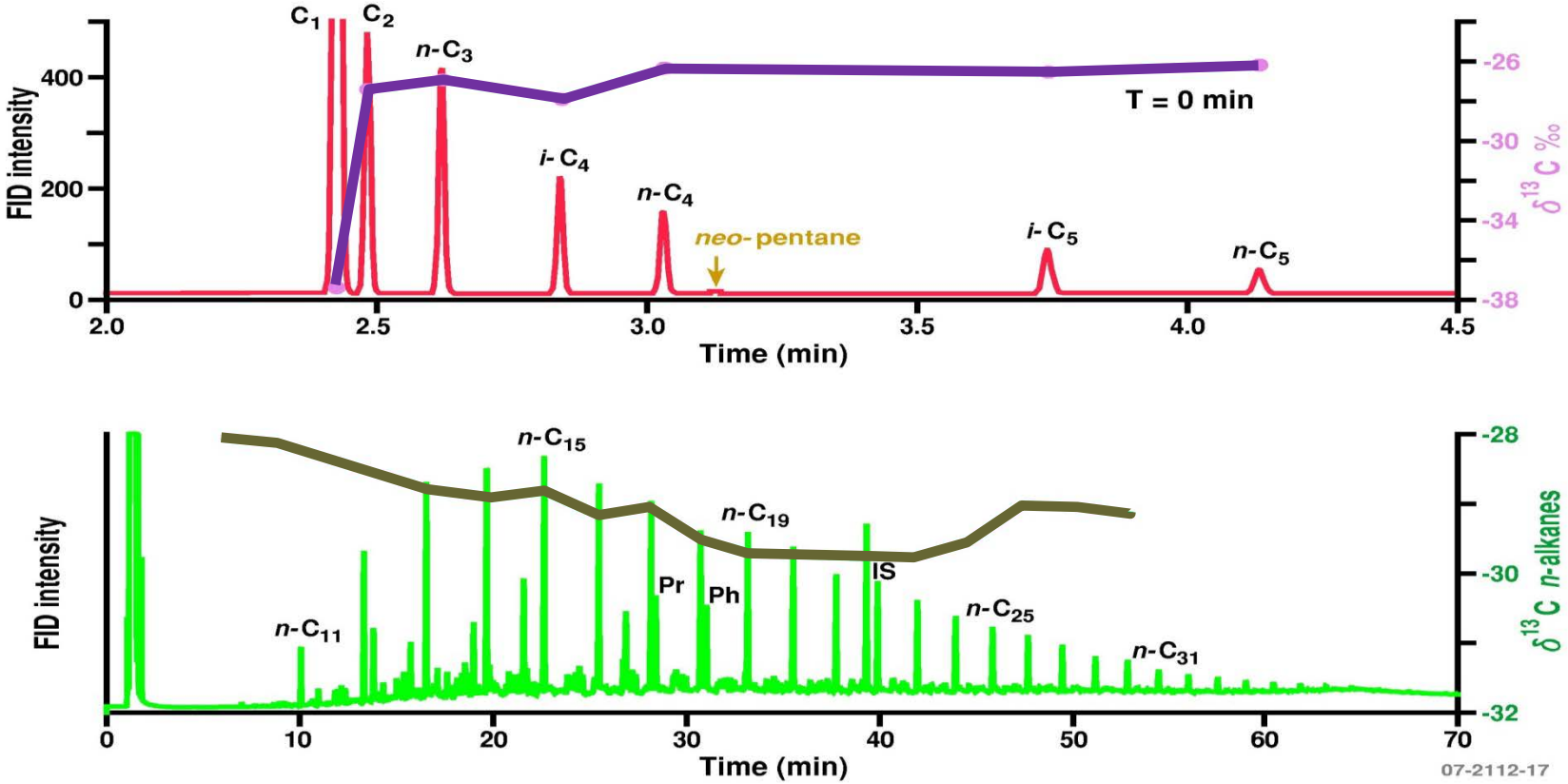
Plover

Accumulations by Reservoir: Post-Berriasian Cretaceous

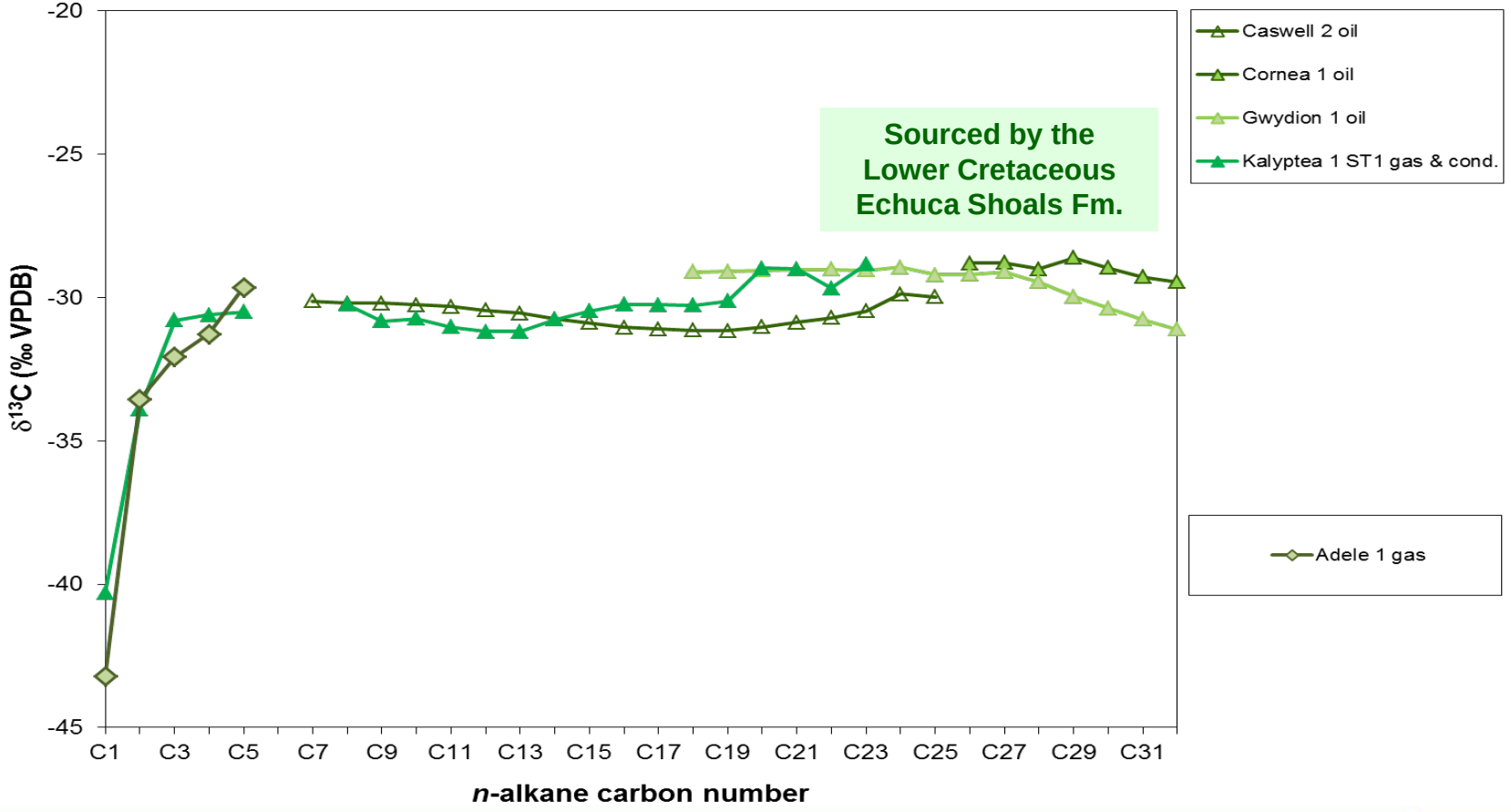




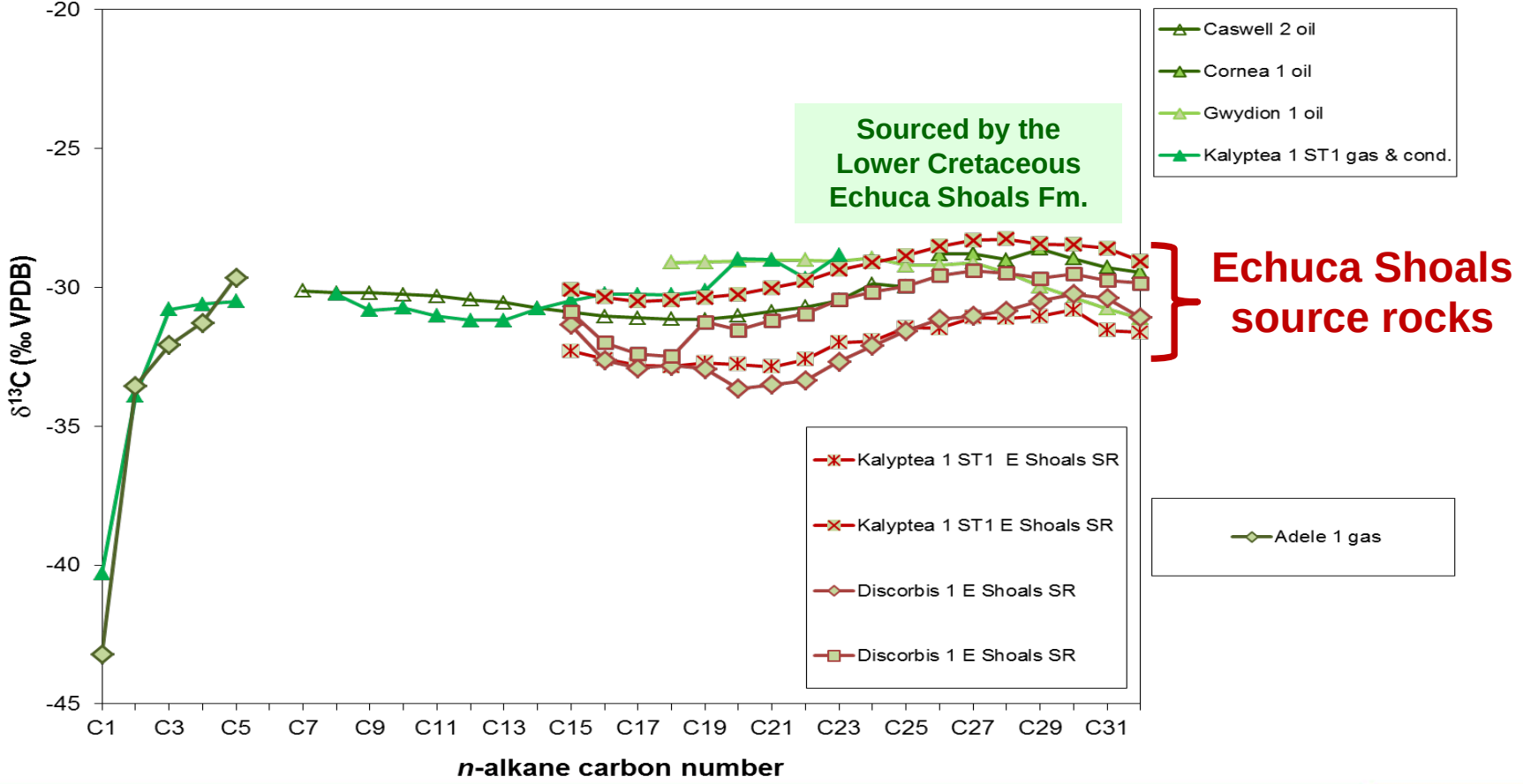
Compound-specific Isotopes



Browse Basin Gas & Oil/Condensate Families



Browse Basin Gas & Oil/Condensate Families

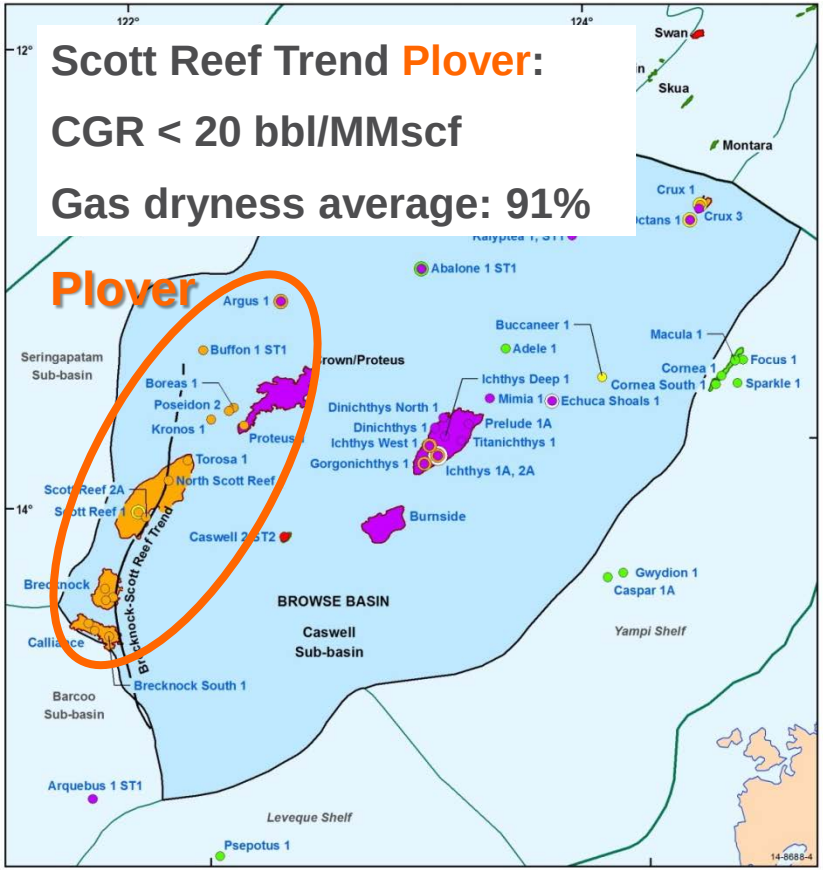


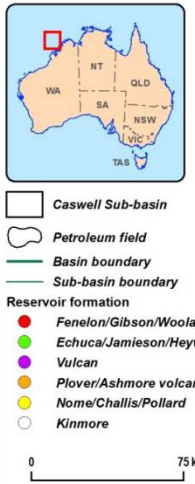
Gas accumulations: Brecknock/Scott Reef Trend

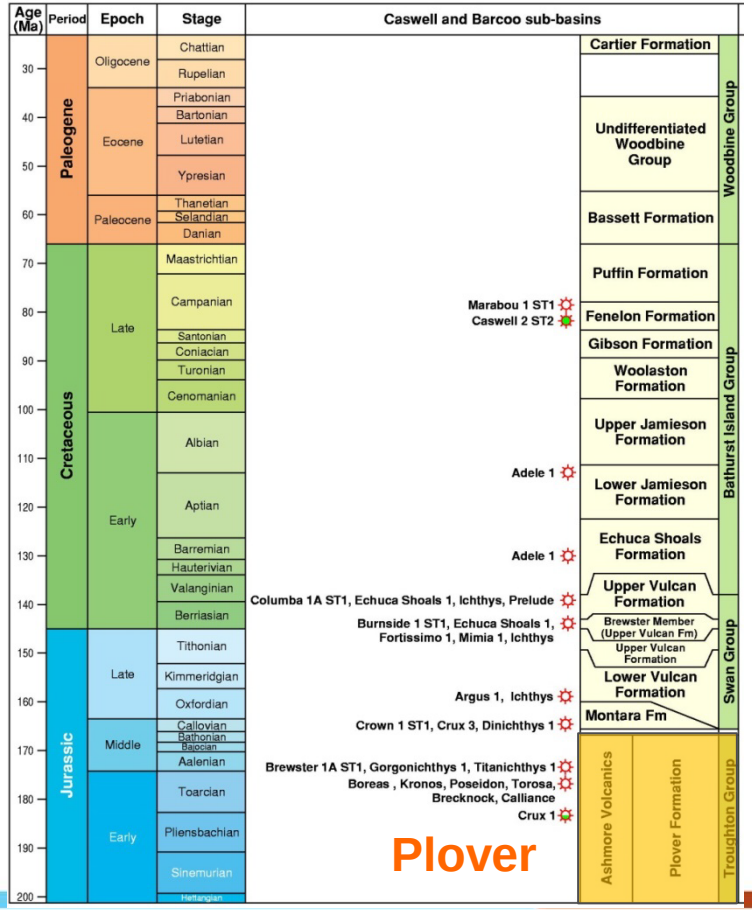
Scott Reef Trend Plover:

CGR < 20 bbl/MMscf

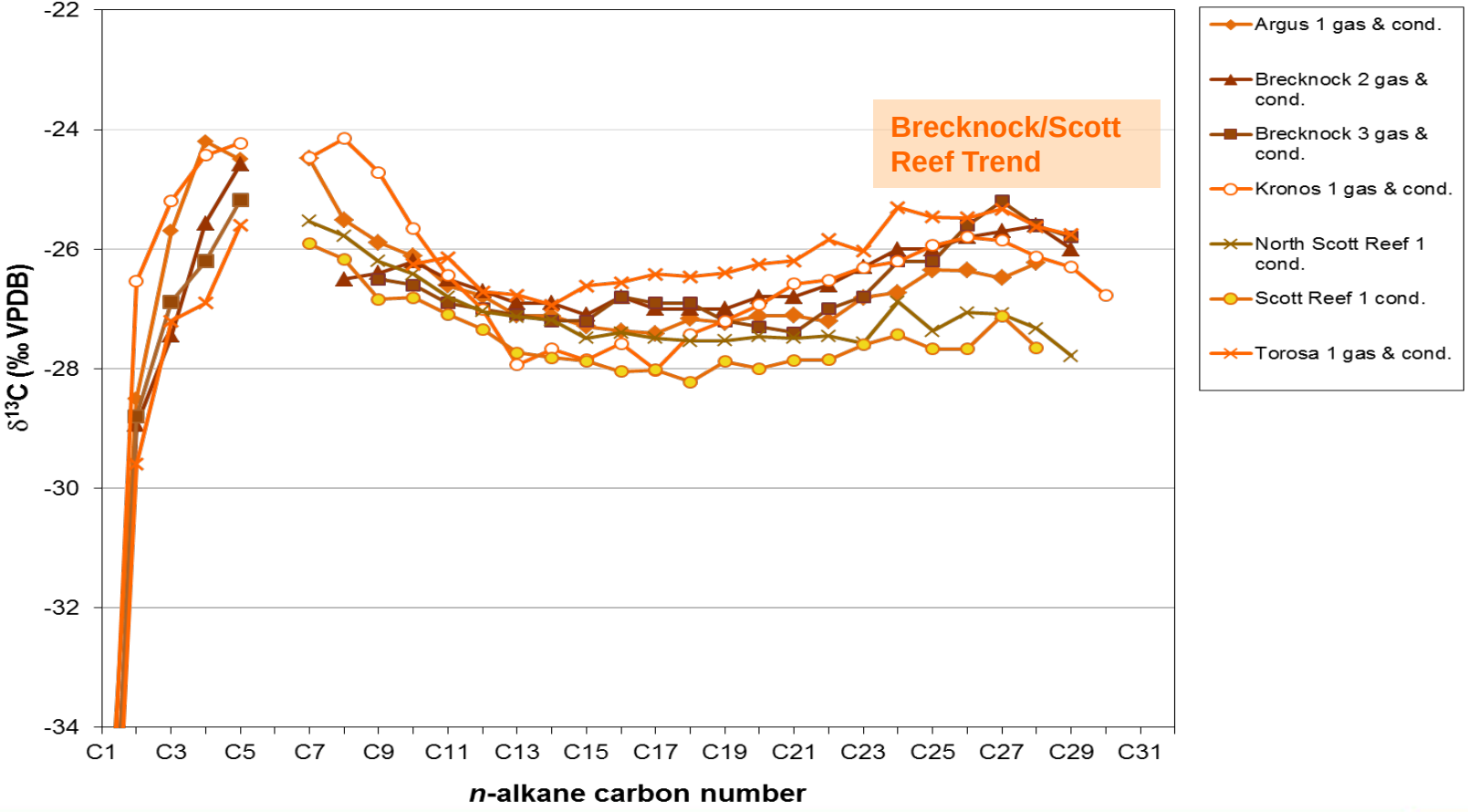
Gas dryness average: 91%



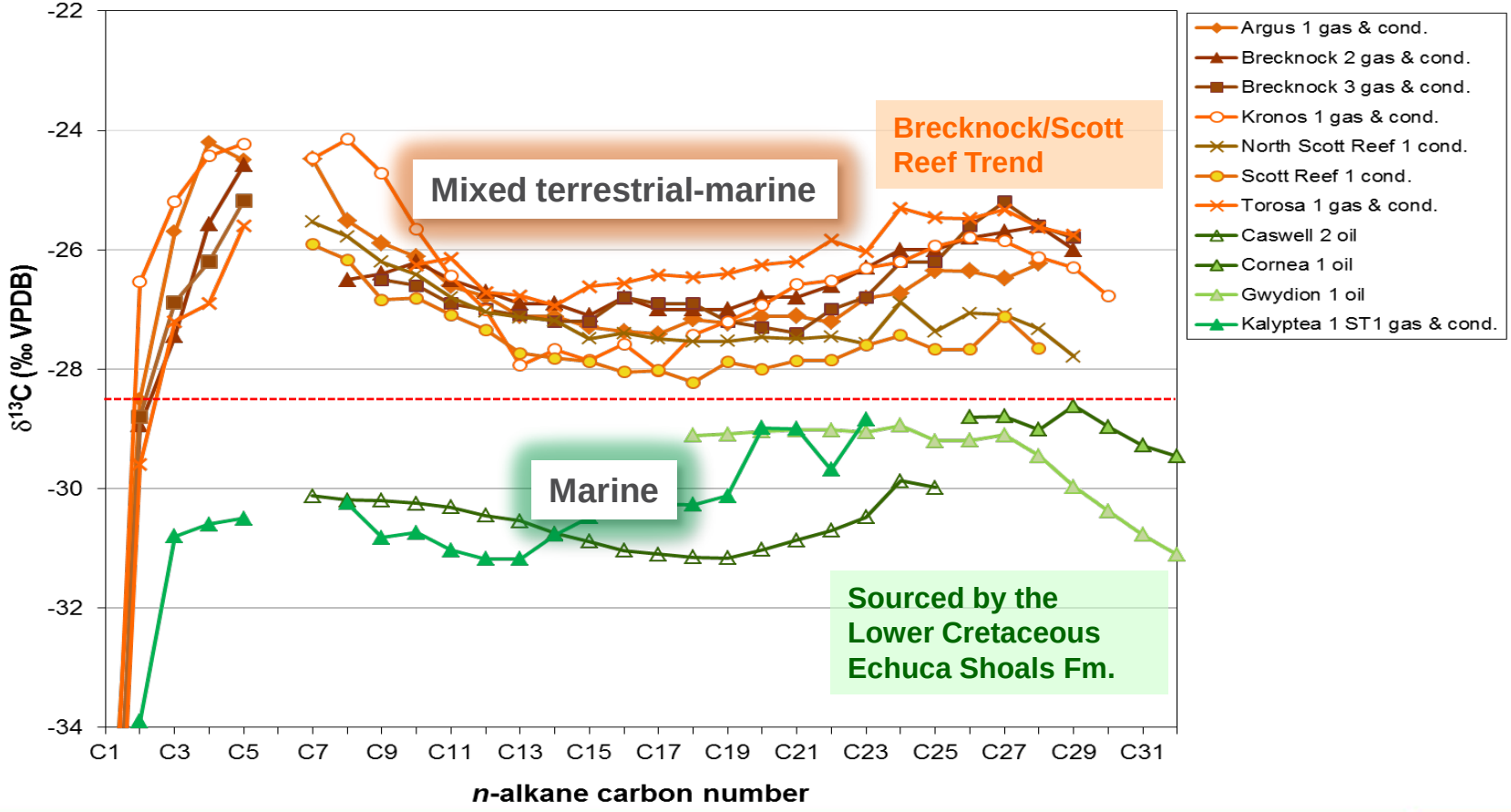




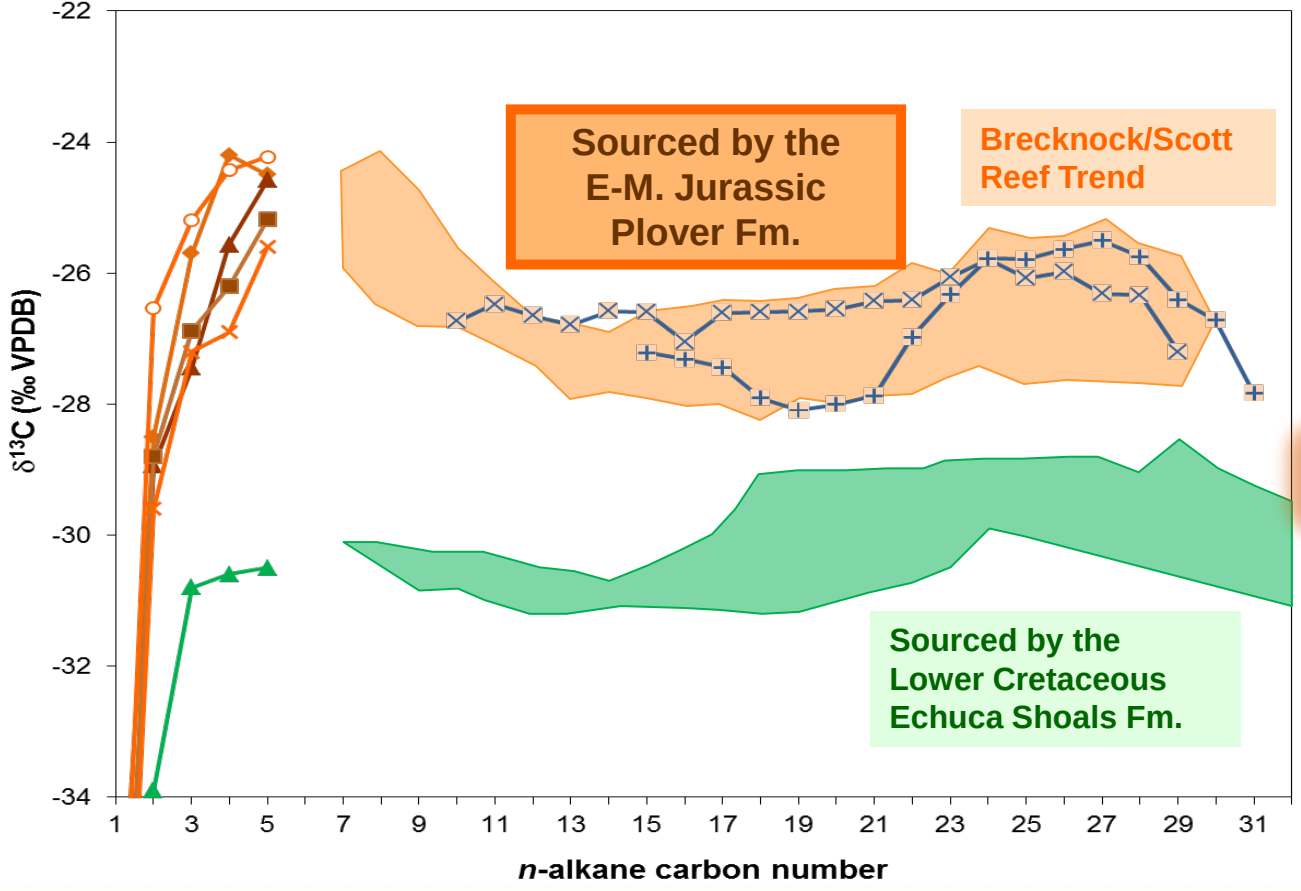
Source of Brecknock/Scott Reef Trend Fluids



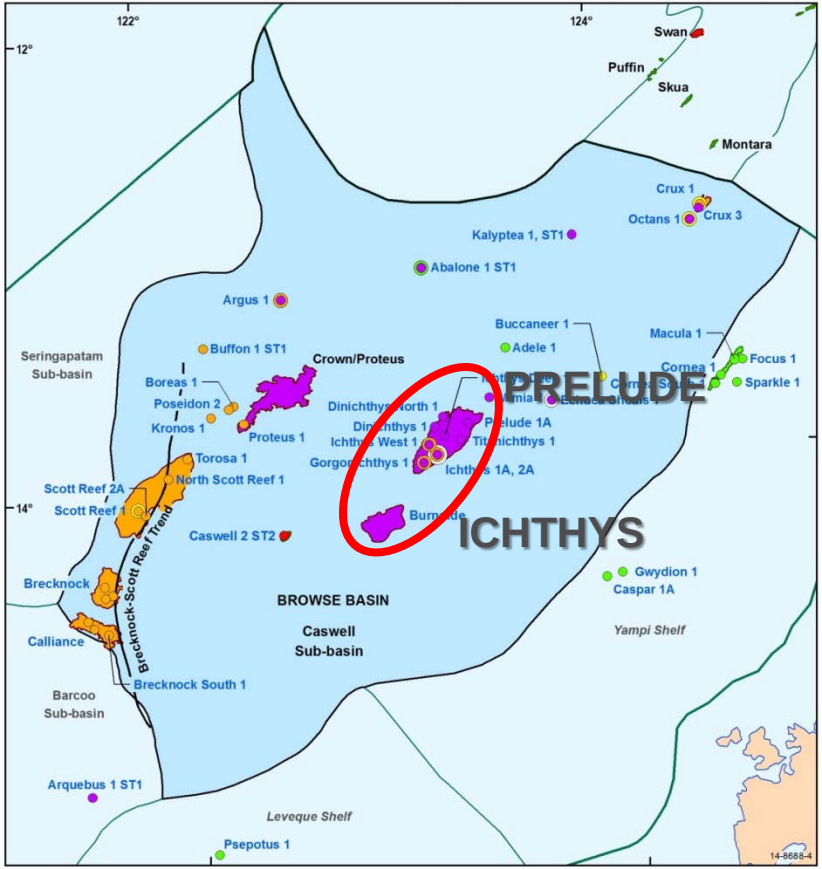
Source of Brecknock/Scott Reef Trend Fluids

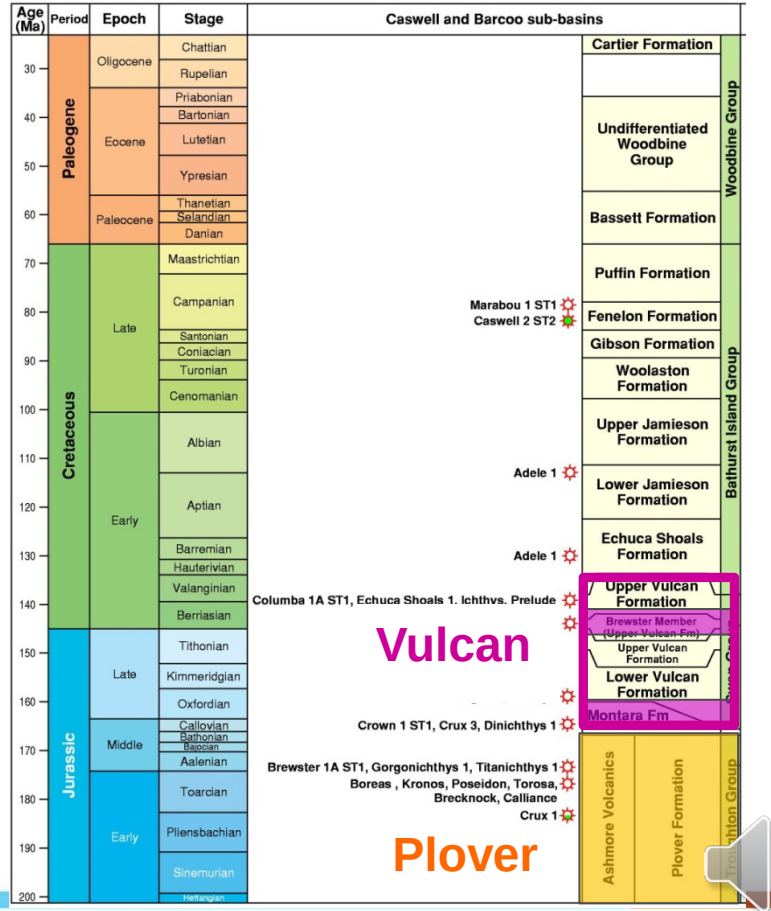


Source of Brecknock/Scott Reef Trend Fluids

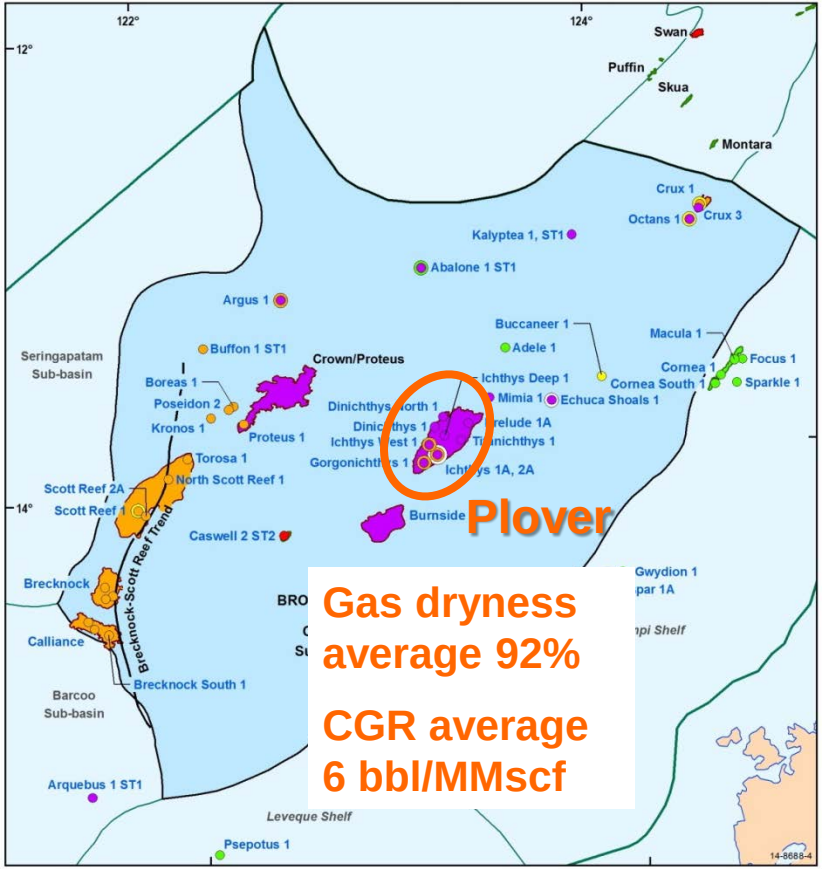


Gas accumulations: Ichthys/Prelude



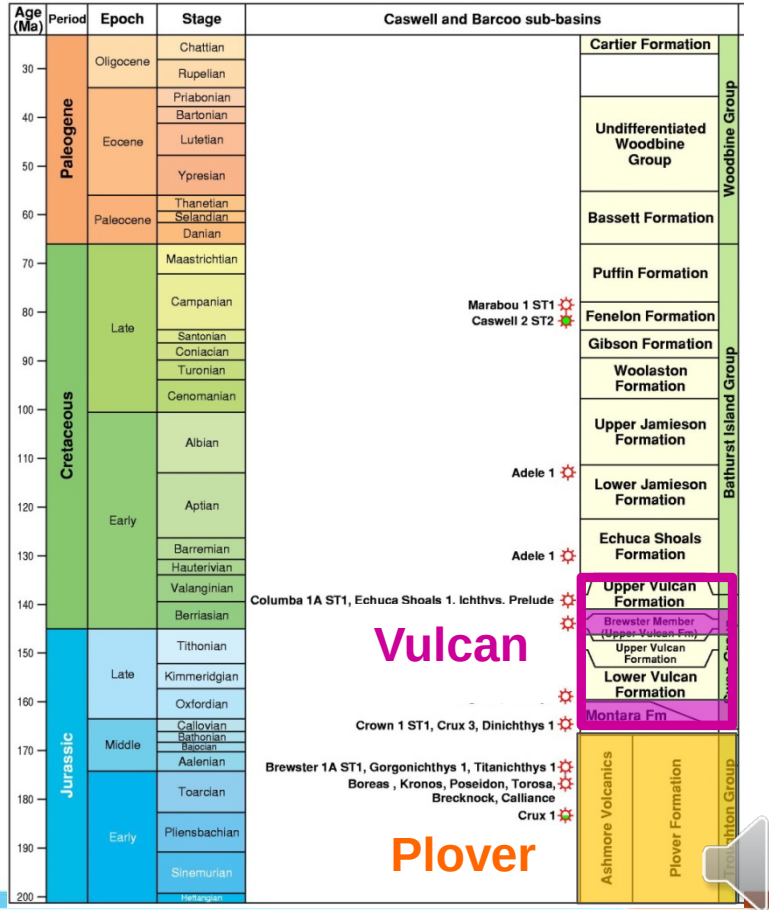


Gas accumulations: Ichthys/Prelude

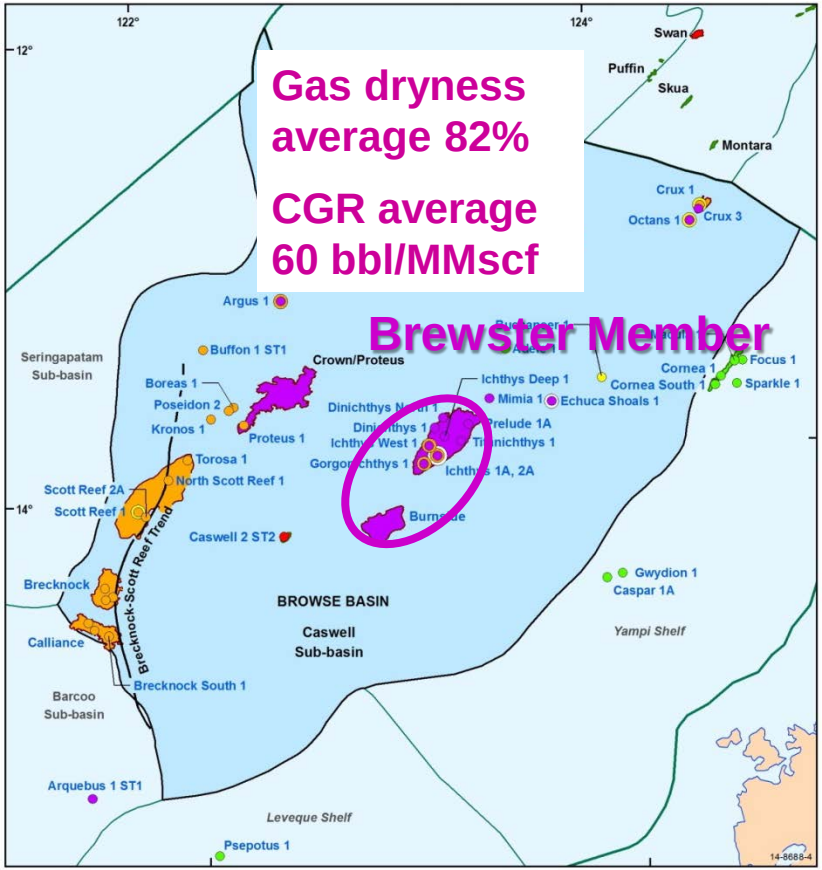


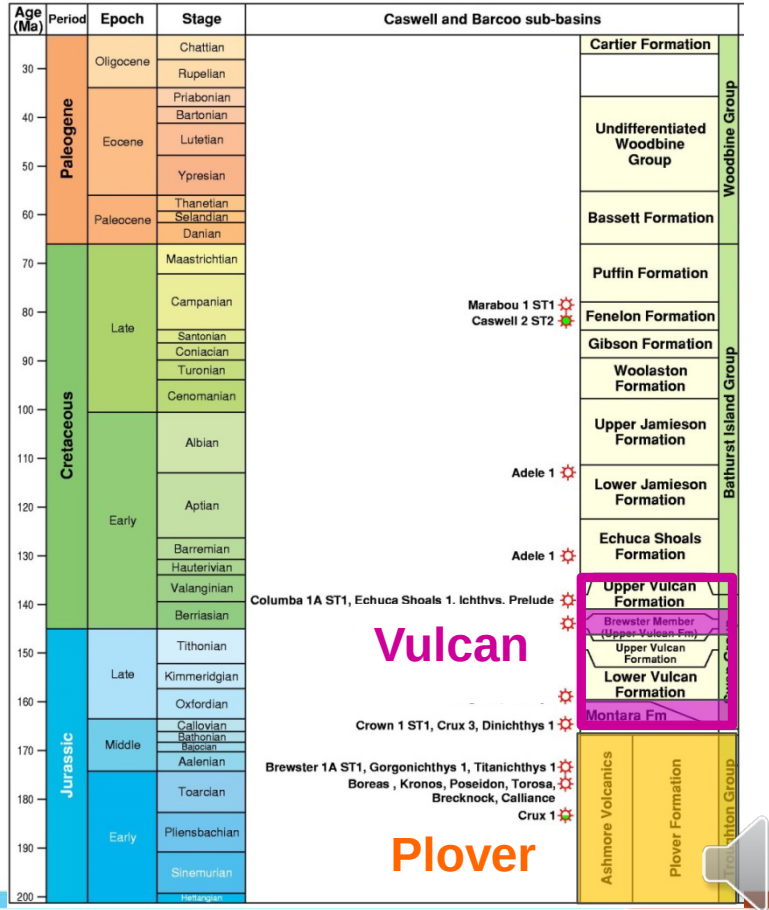
Gas dryness average 92%

CGR average 6 bbl/MMscf

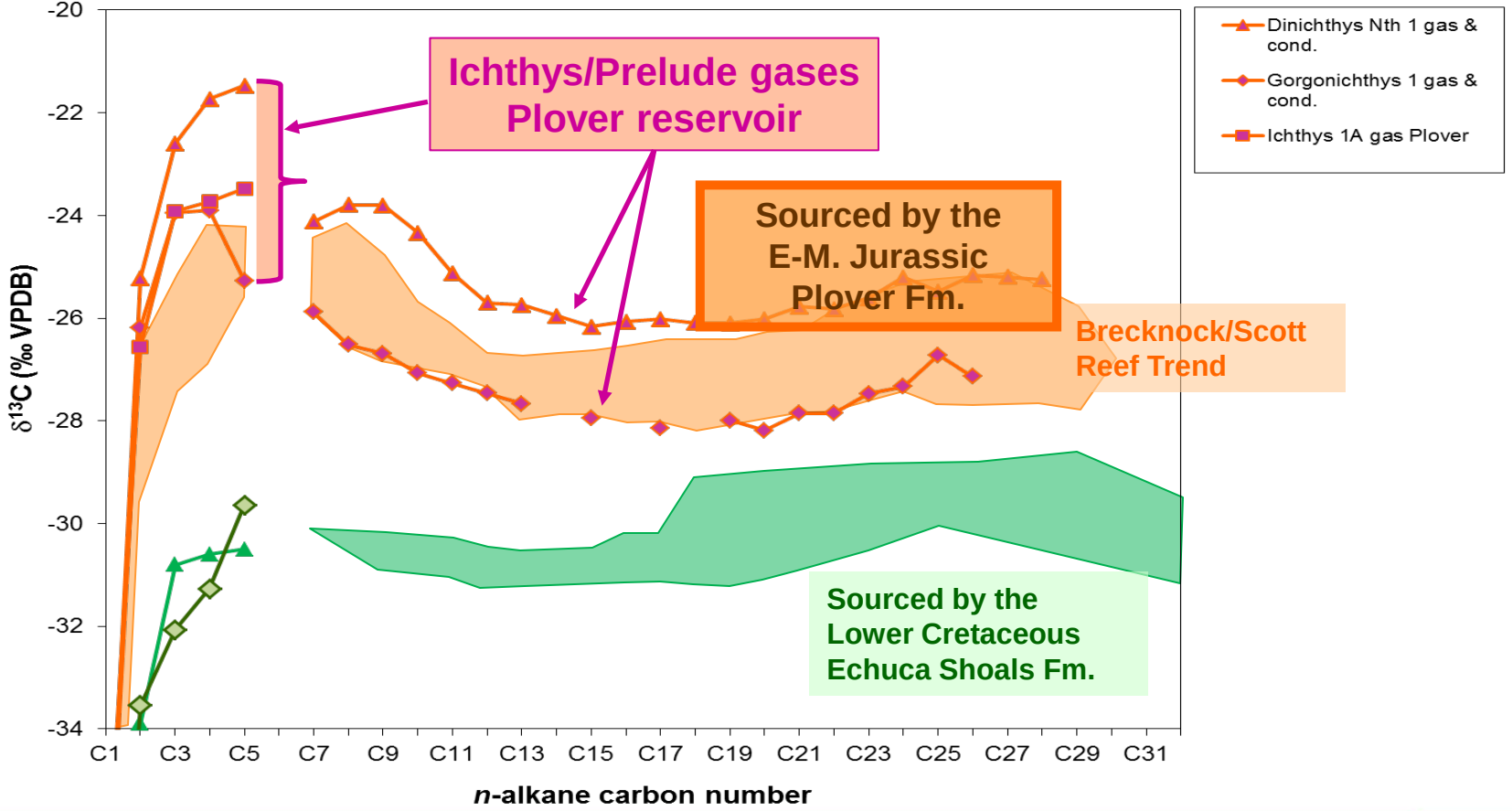


Gas accumulations: Ichthys/Prelude

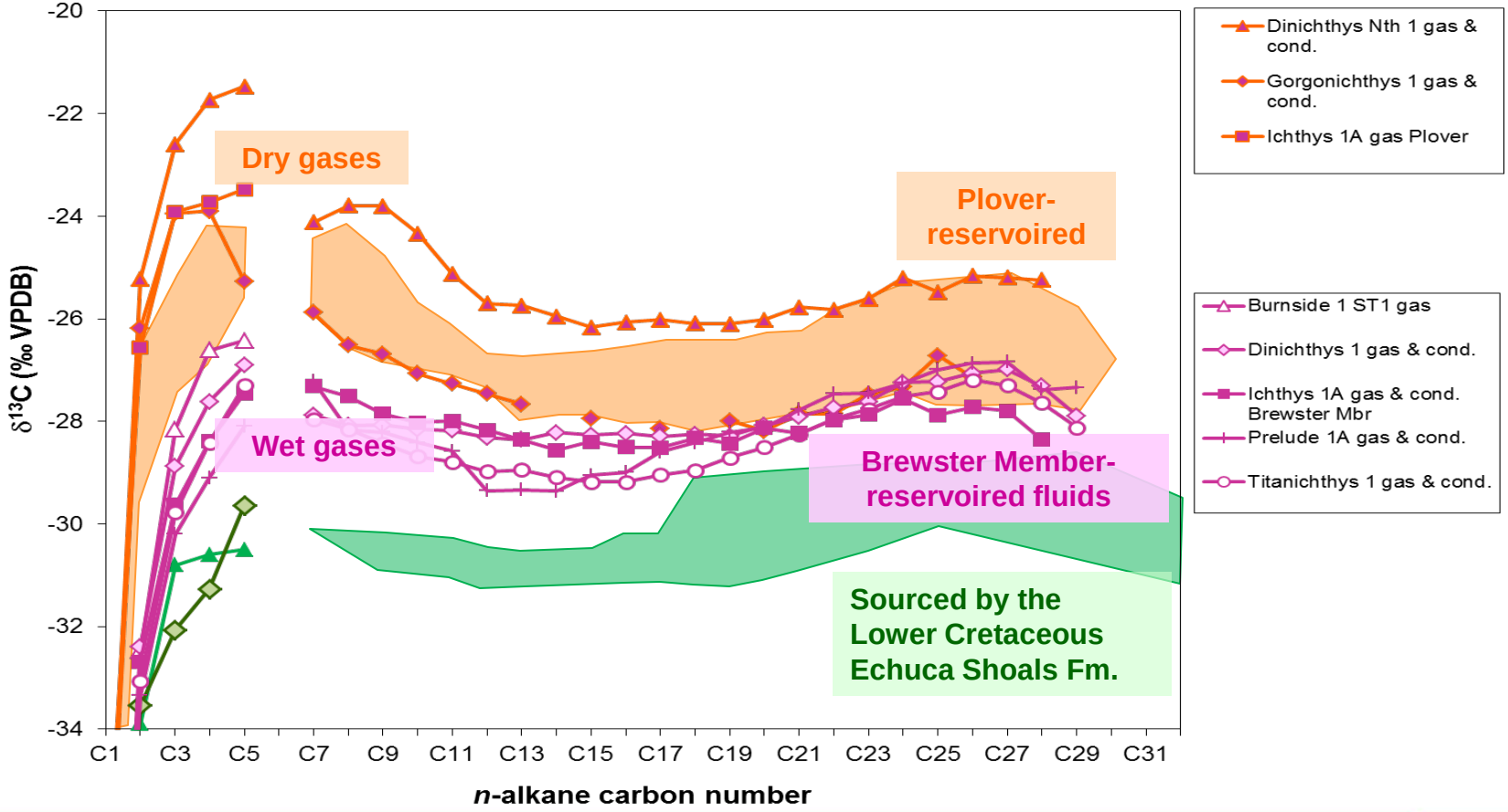




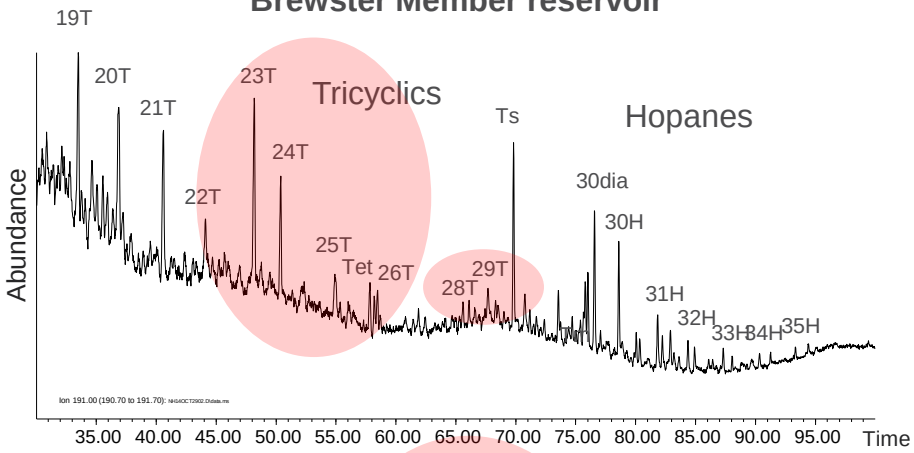
Source of Ichthys/Prelude Fluids: Plover reservoirs

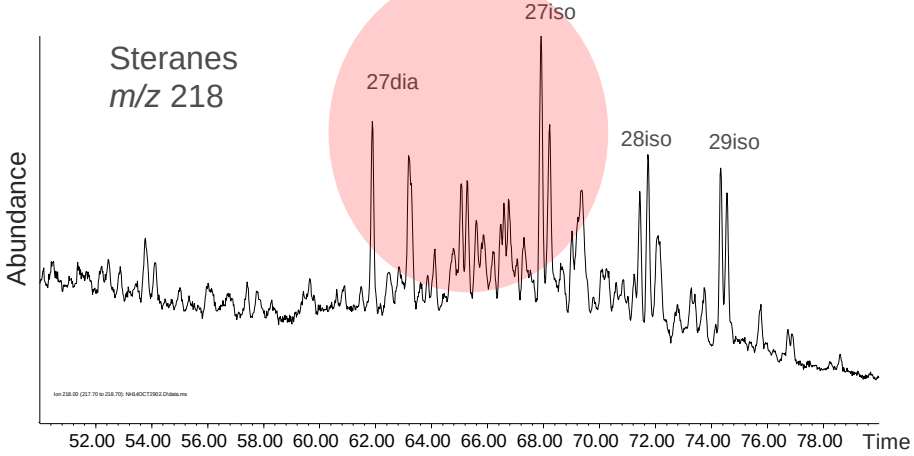


Source of Ichthys/Prelude Fluids: Brewster Member reservoirs

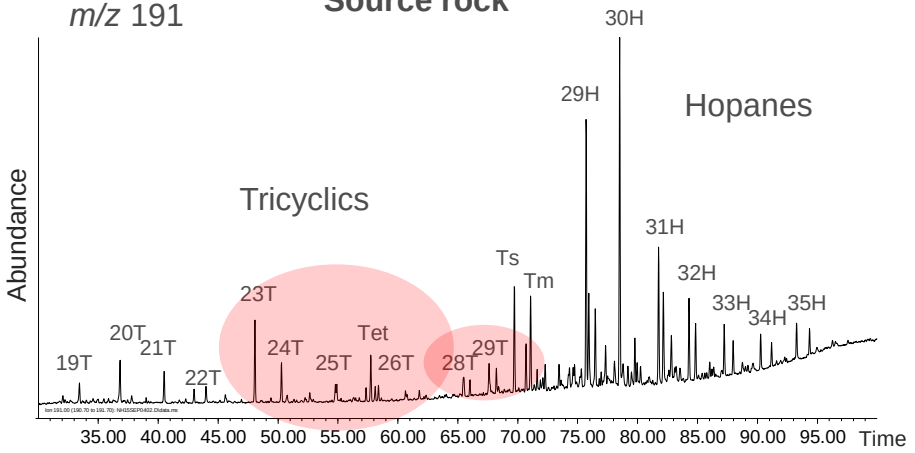


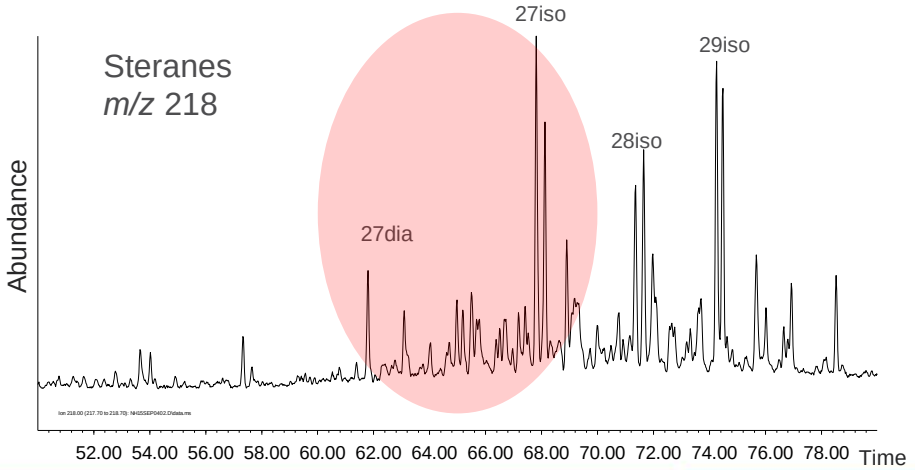
Dinichthys 1 condensate
Brewster Member reservoir



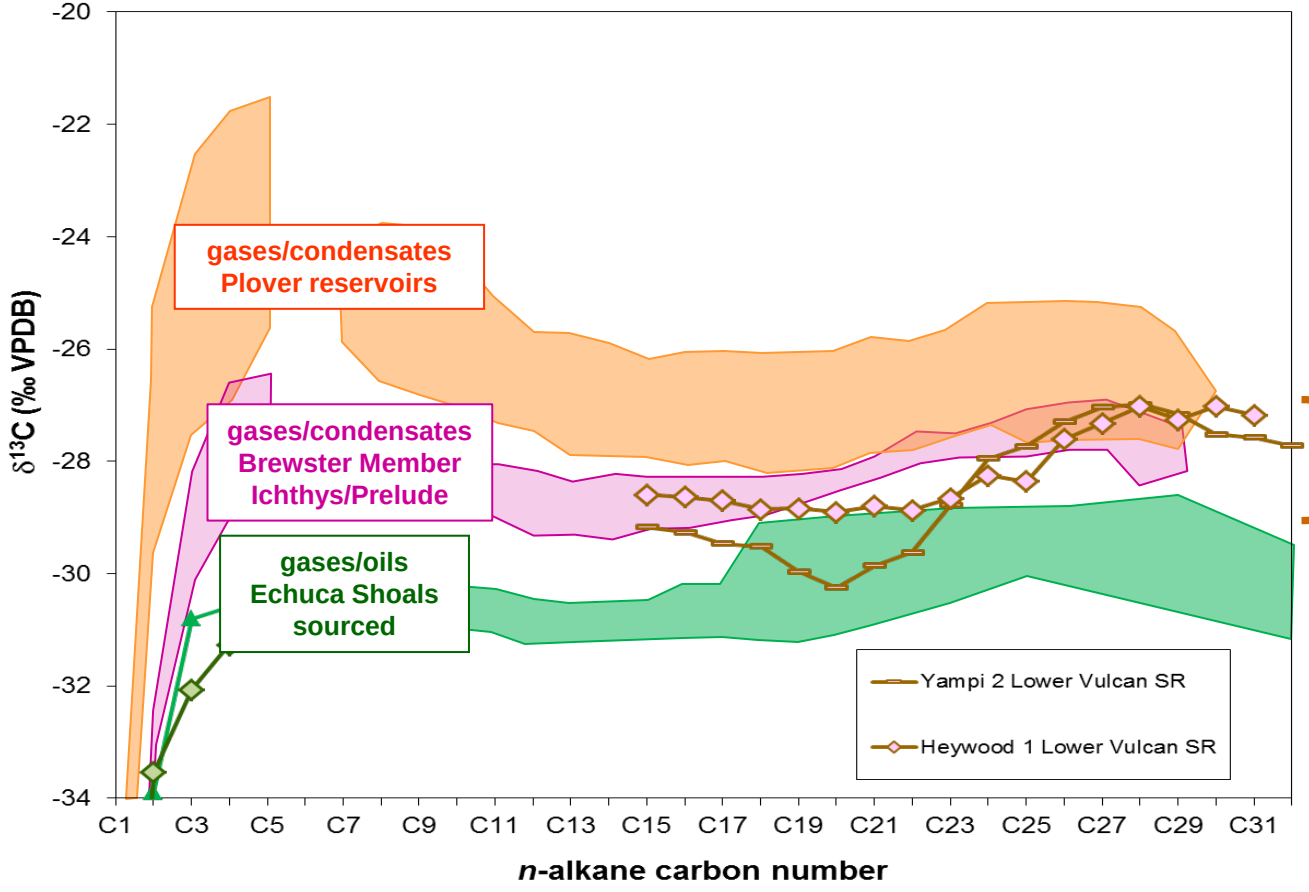


Heywood 1 Lower Vulcan
Source rock





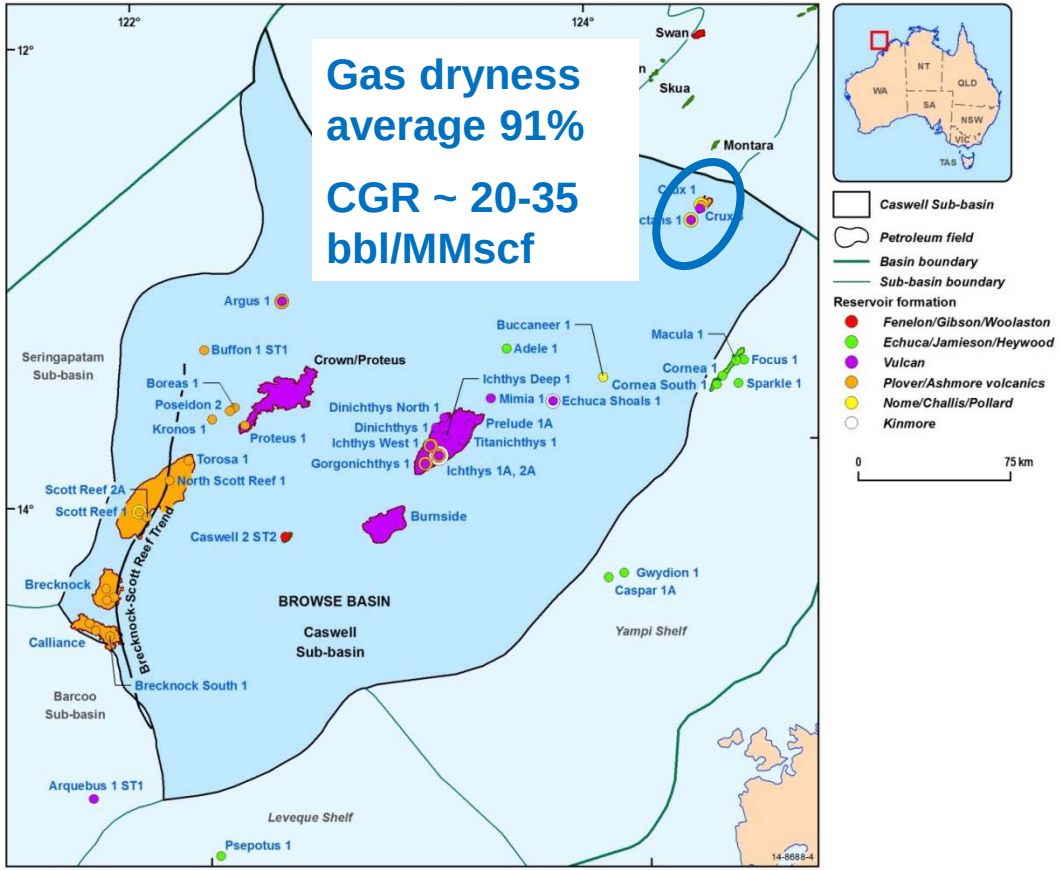
Source of Ichthys/Prelude Fluids: Brewster Member reservoirs

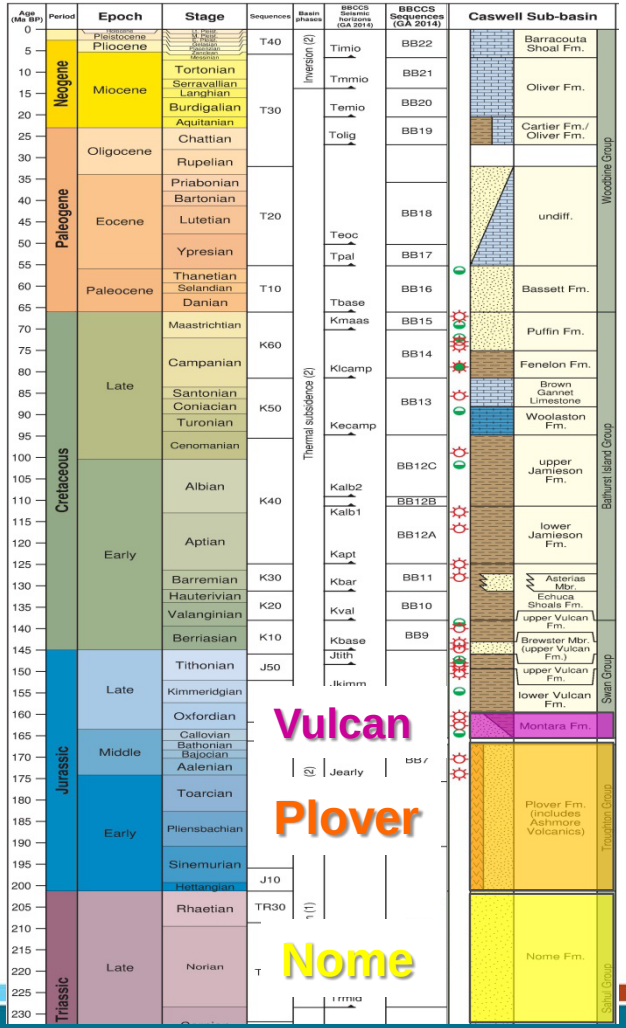


Lower Vulcan source rocks

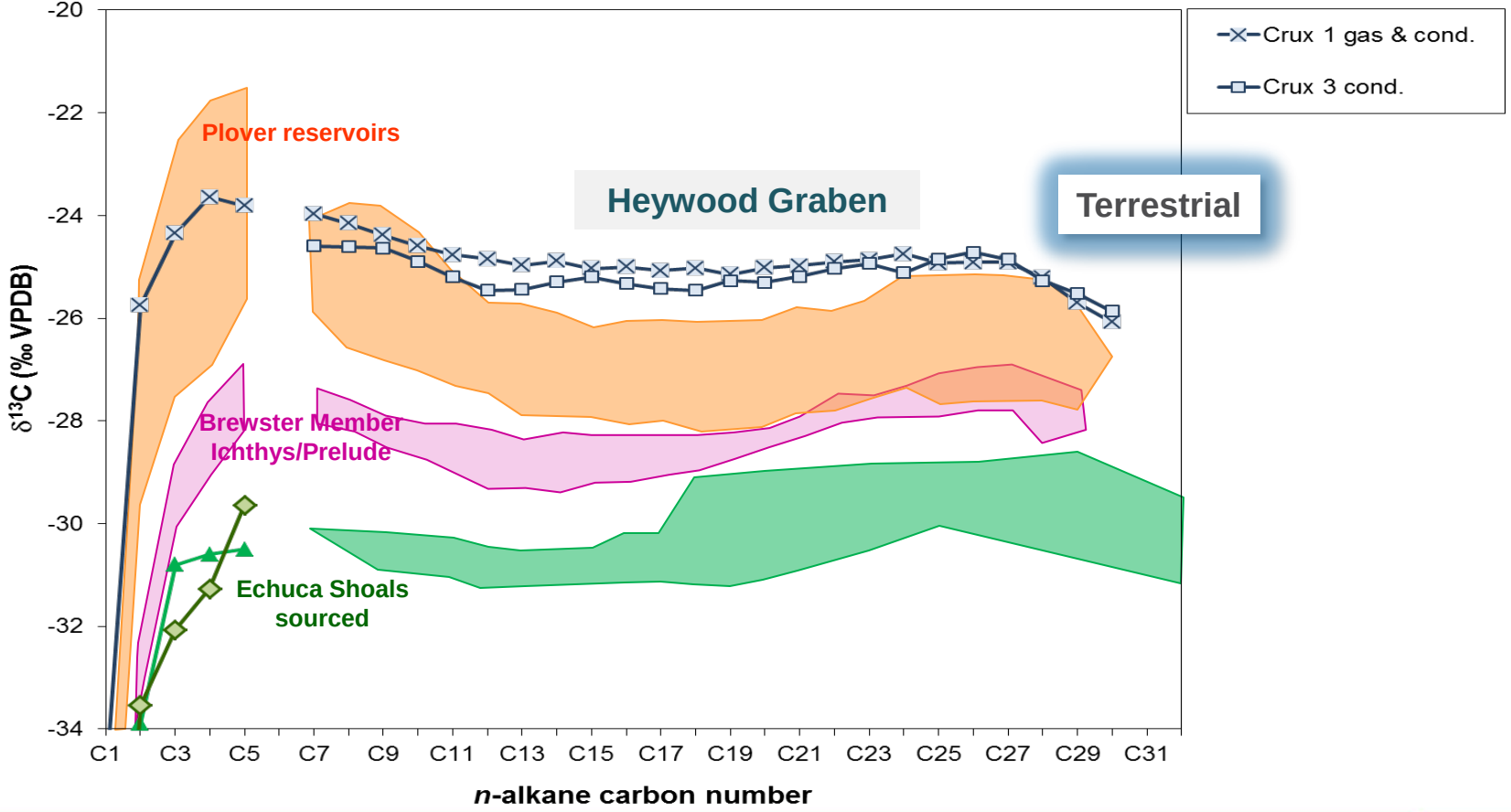
Contribution from Upper Jurassic lower Vulcan Fm.

Gas accumulations: Crux field

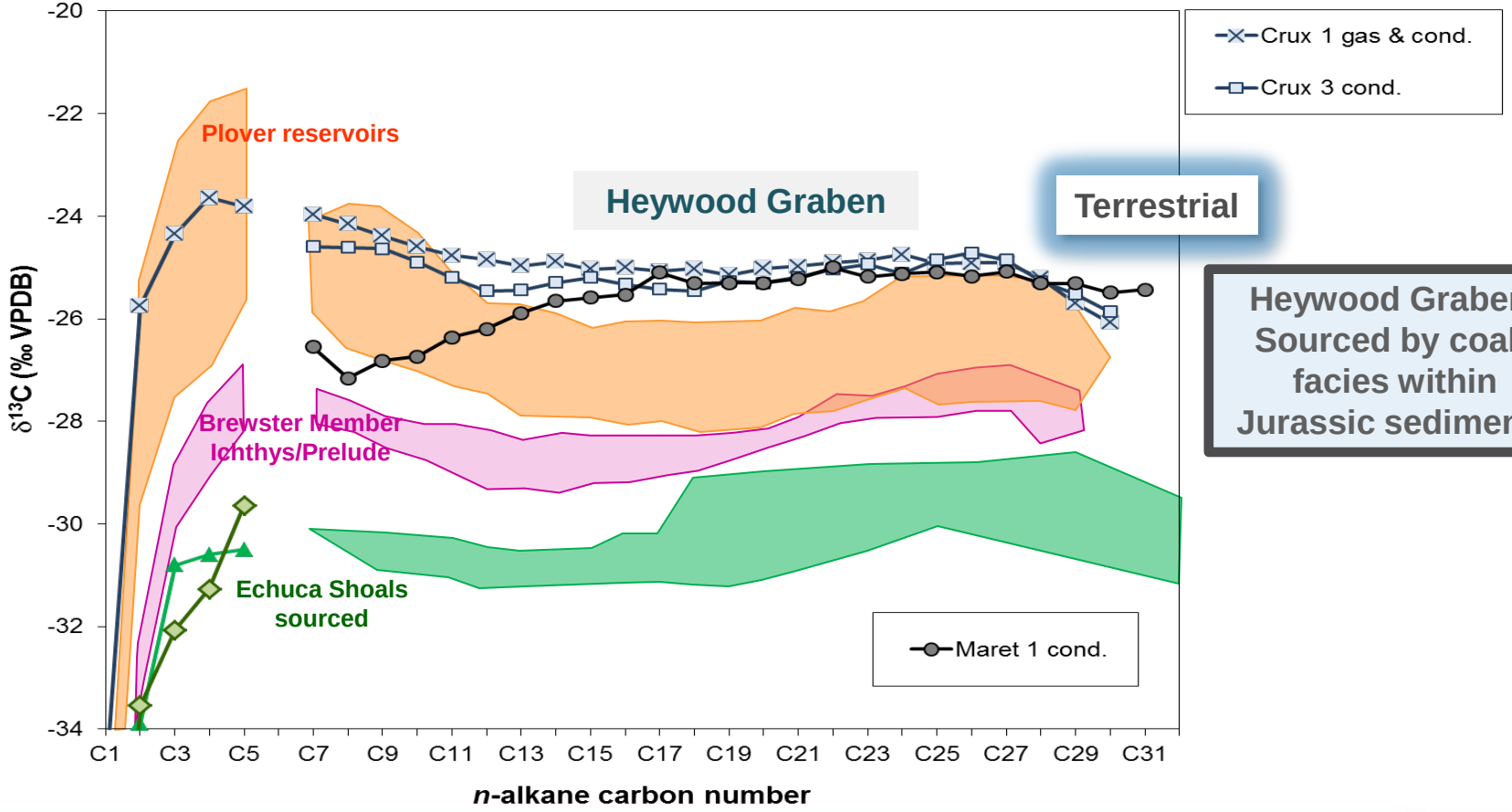




Source of Crux Fluids

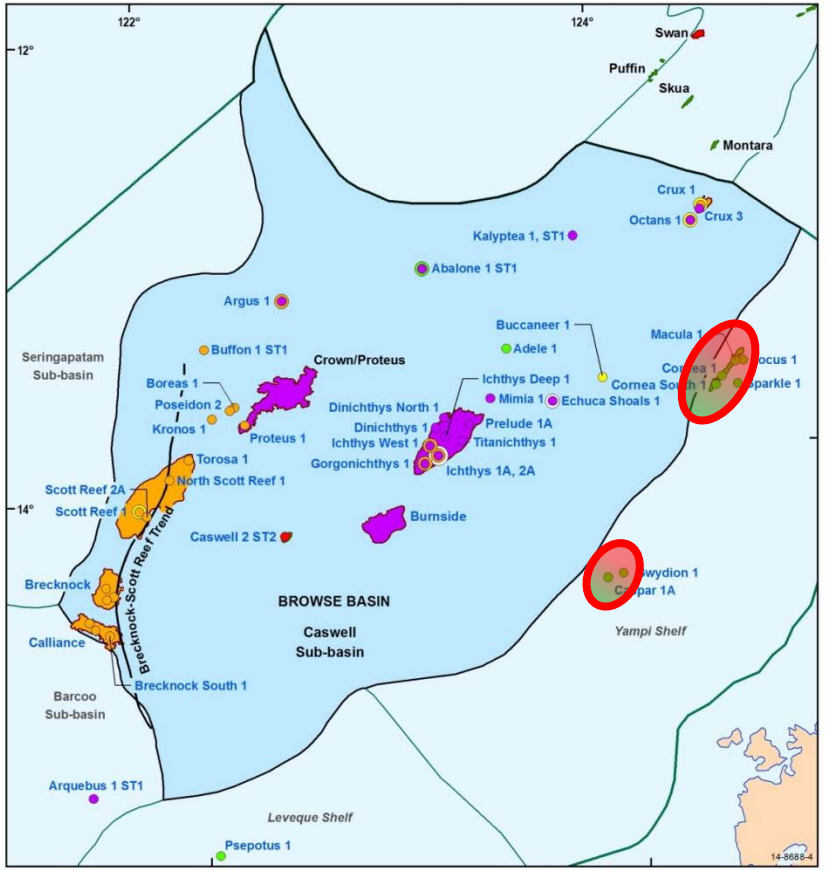


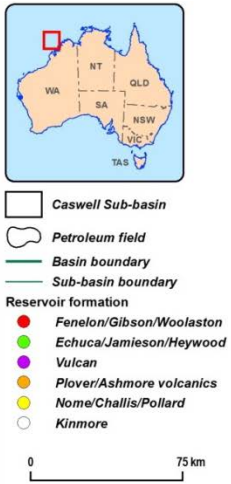
Source of Crux Fluids

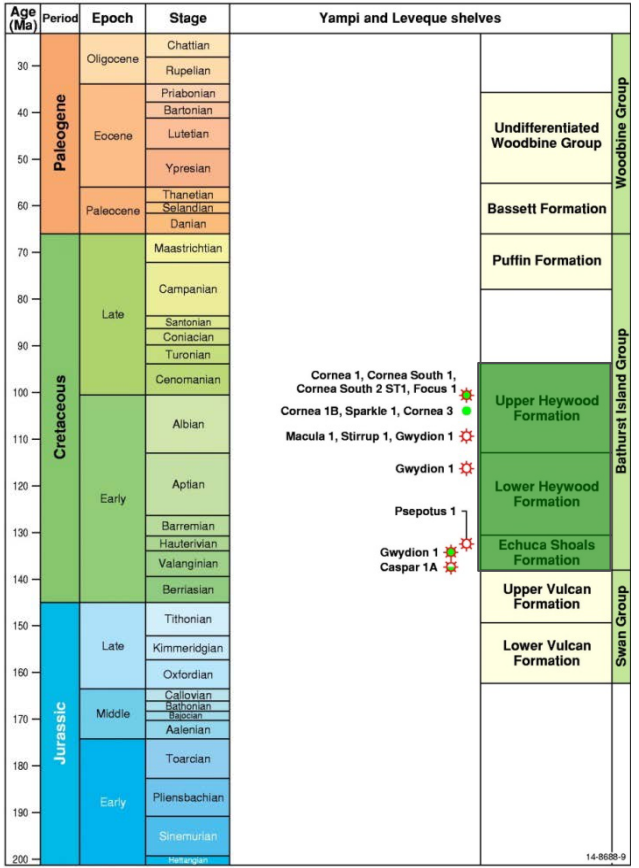


Heywood Graben: Sourced by coaly facies within Jurassic sediments

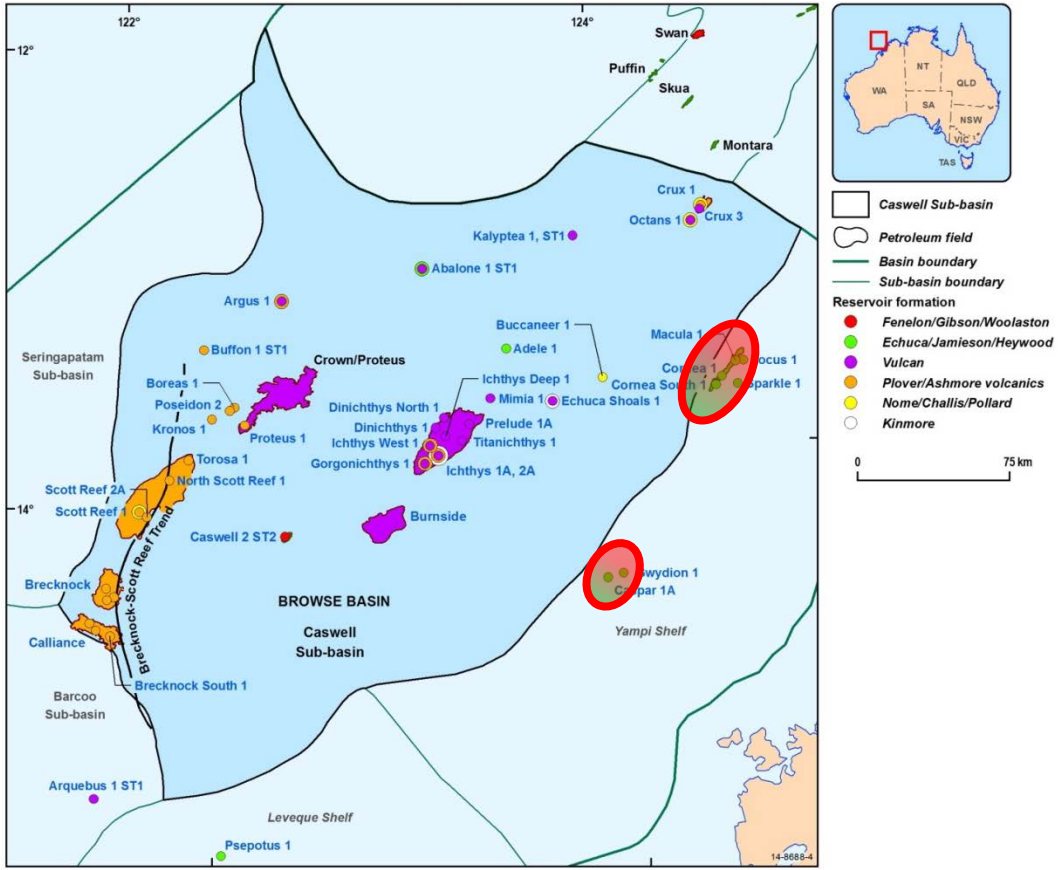
Source of gases on Yampi Shelf





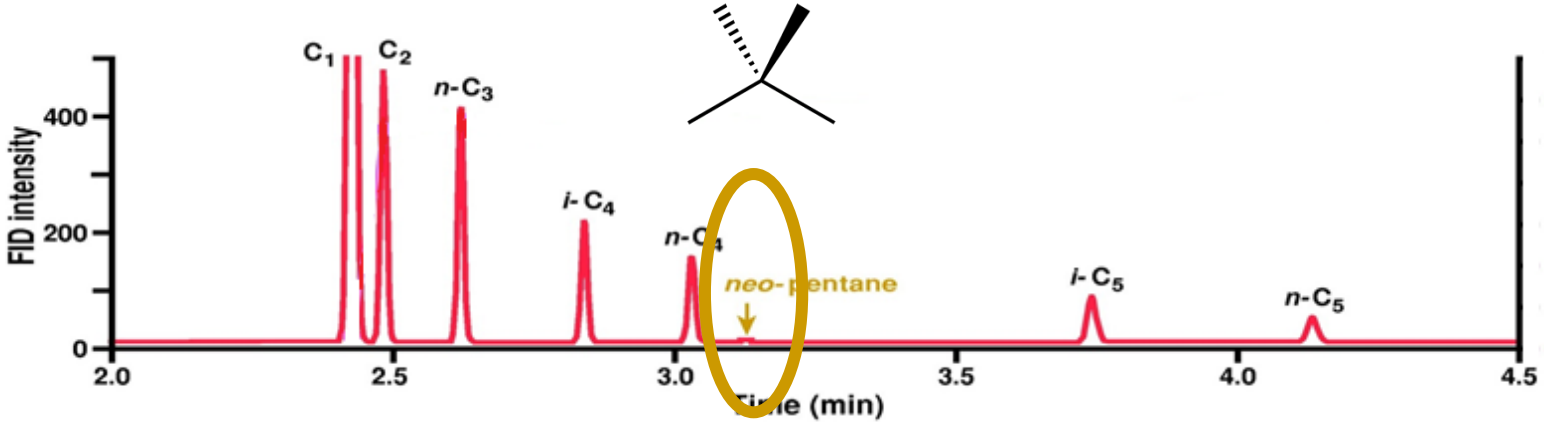


Source of gases on Yampi Shelf



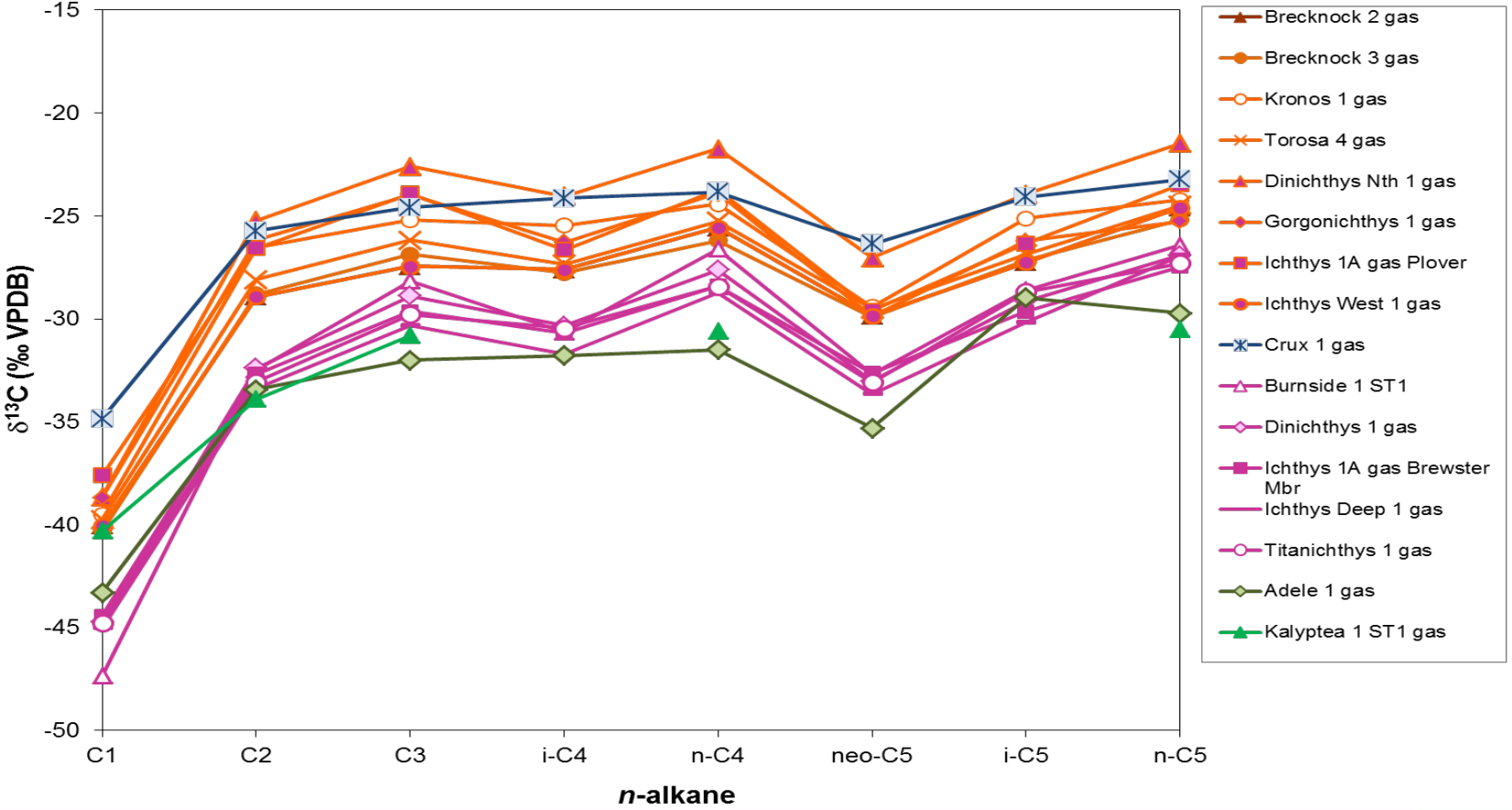
- **Gases very dry**
  - Gas dryness > 98%
- **Shallow reservoirs (< 1000 m)**
- **Oils biodegraded to various extent: Cornea 1/Cornea South 2/Focus 1/Sparkle 1/Gwydion 1**
- **Gases affected by in-reservoir biodegradation**

Geochemical analyses of gases: *neo*-pentane

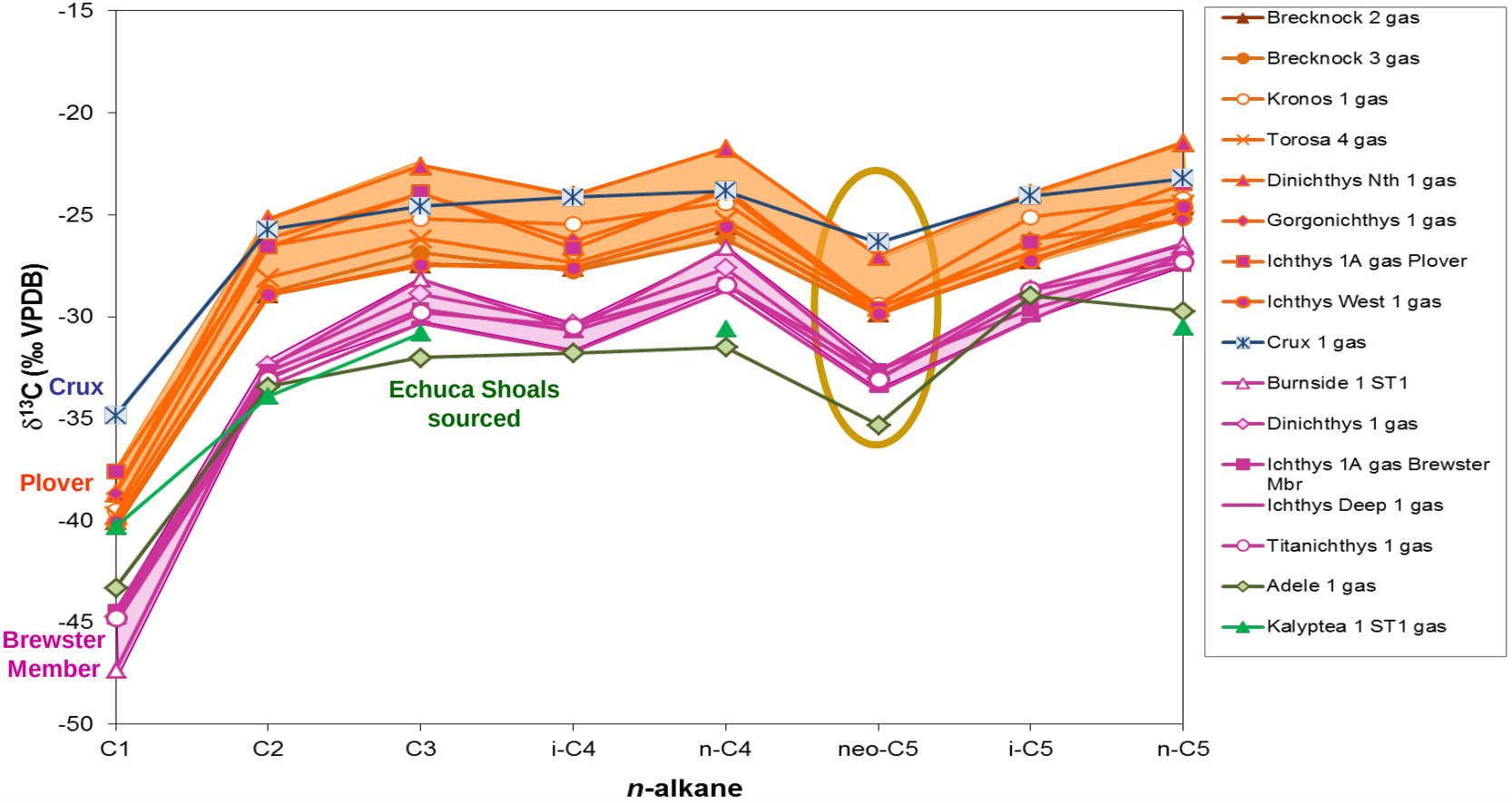


- ***neo*-pentane (*Boreham and Edwards, 2008*)**
  - Resistant to biodegradation
  - Excellent source correlation tool

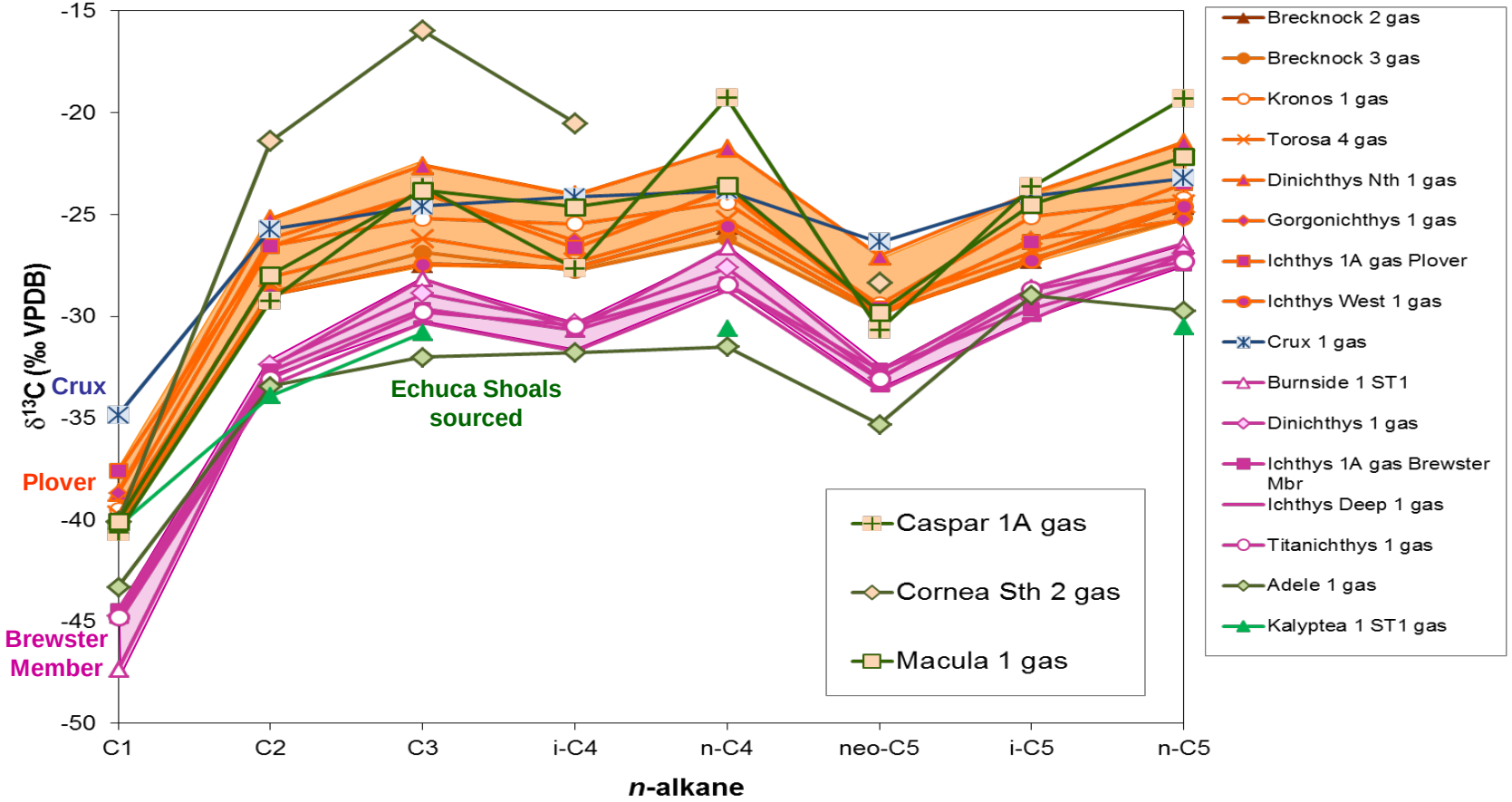
Source of gases on Yampi Shelf



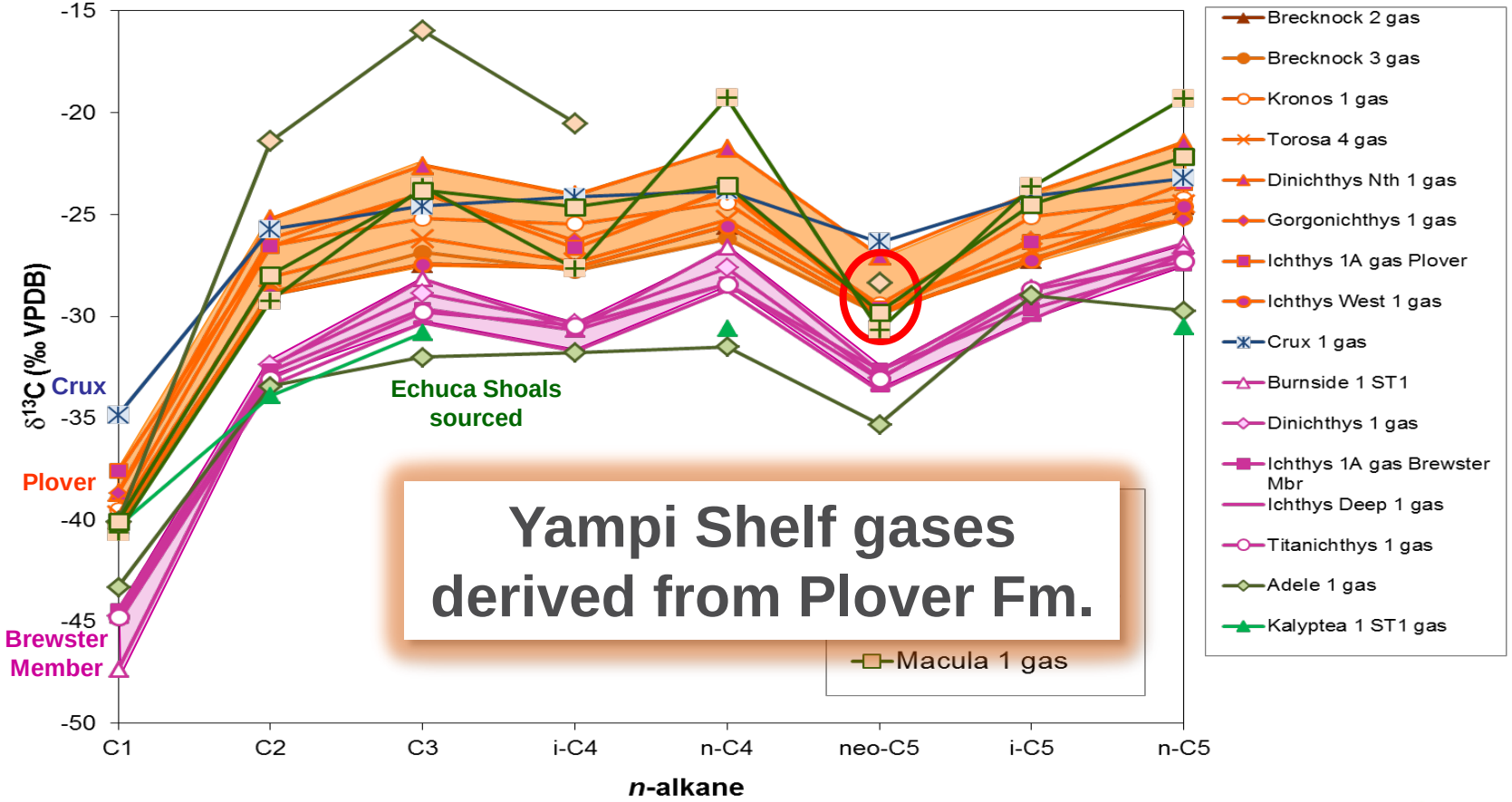
Source of gases on Yampi Shelf



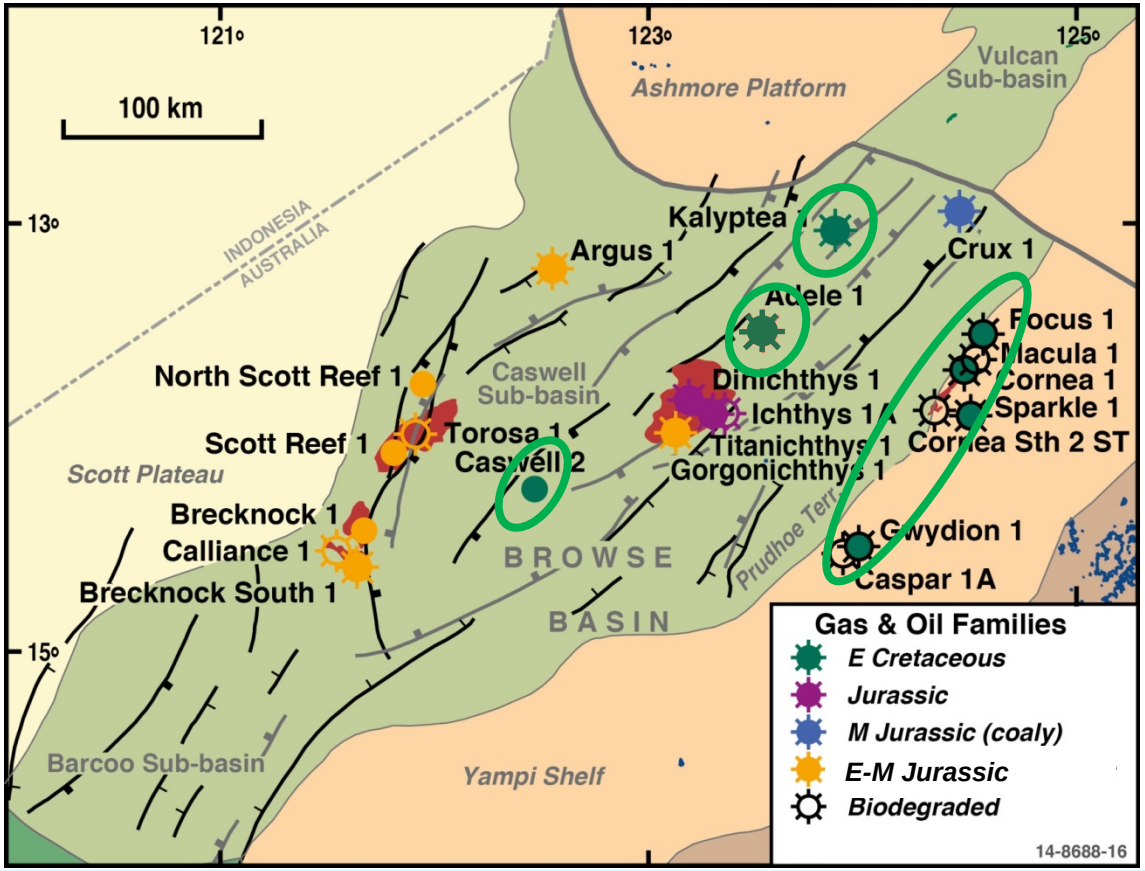
Source of gases on Yampi Shelf



Source of gases on Yampi Shelf



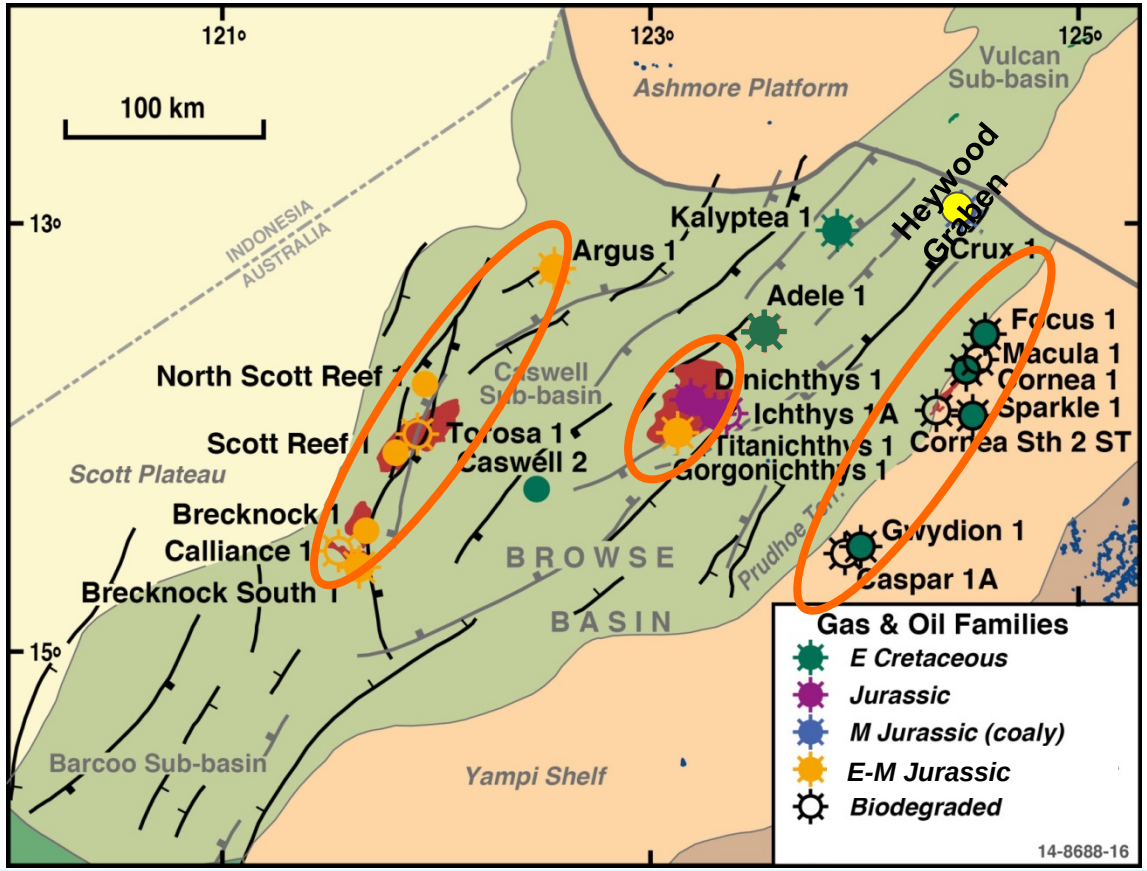
Lower Cretaceous-Sourced Oil and Gas



Lower Cretaceous Echuca Shoals-sourced oil and gas

Edwards et al, 2006 AAPG

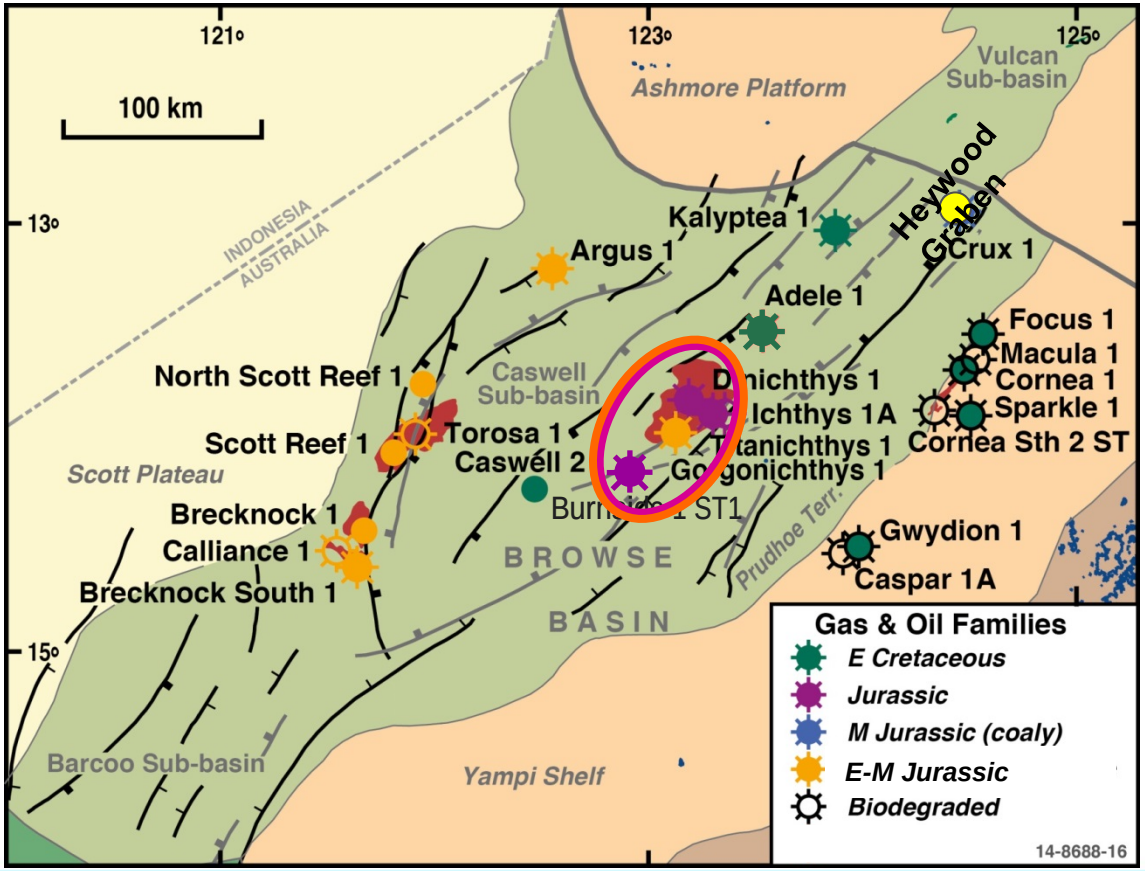
Gas & Condensate Families; Plover-sourced



Plover-sourced
Dry gas

Edwards et al, 2006 AAPG

Ichthys Gas & Condensate; Plover/Vulcan sourced

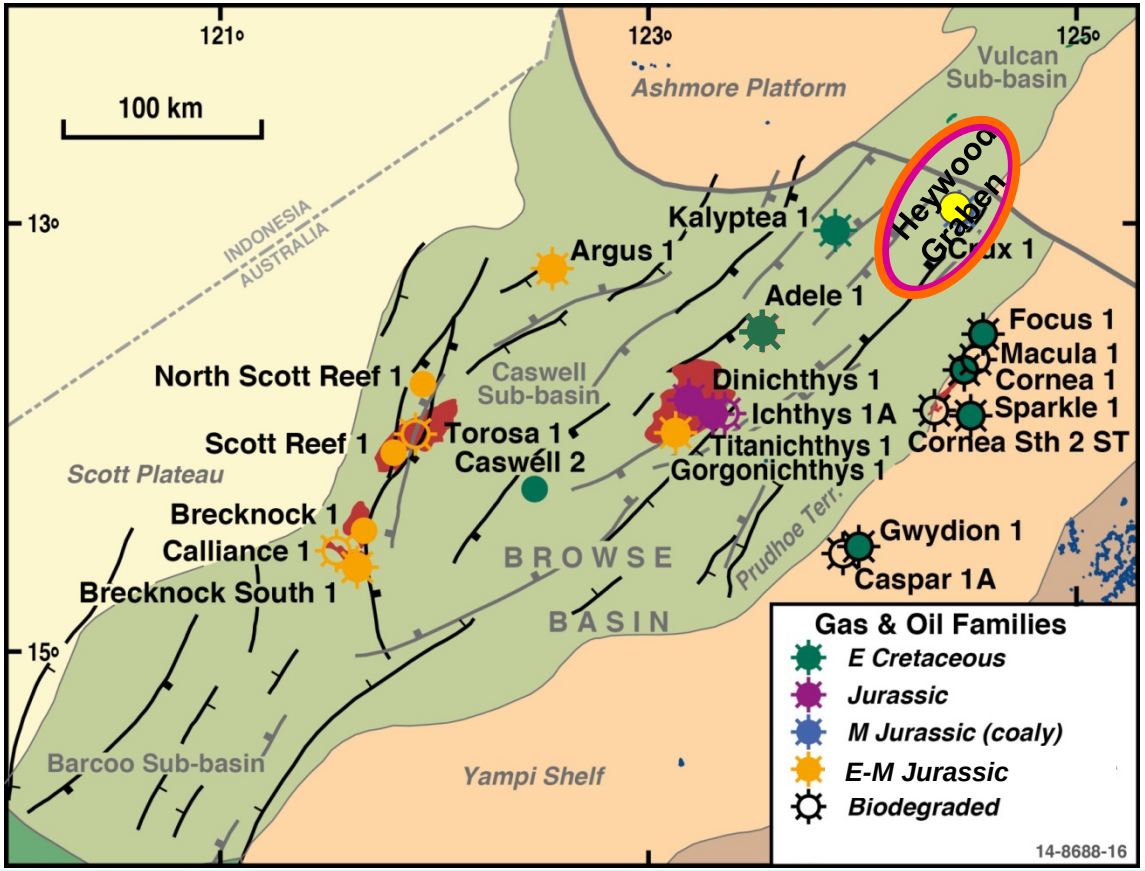


Brewster Member reservoirs Ichthys

Vulcan- + Plover-sourced Wet gases

Edwards et al, 2006 AAPG

Crux Gas/Condensate; Plover/Vulcan-Sourced



Heywood Graben

Plover & Vulcan-sourced gas

Edwards et al, 2006 AAPG

Acknowledgments

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Andrew Murray (Murray Partners)

Paul Stephenson (GSWA)

More on the Browse Basin from Geoscience Australia

→ C. Nicholson et al. in CO_2 Storage: Results Thus Far - Tuesday morning (presentation)

Browse Basin 2014 Marine Survey—Investigating Containment for Potential Late Cretaceous CO2 Storage Plays

→ N. Rollet et al. in CO_2 Storage: Site Selection - Tuesday afternoon (presentation)

Cretaceous Stratigraphic Play Fairways and Risk Assessment in the Browse Basin: Implications for CO2 Storage

→ S. T. Abbott et al. in Seismic Stratigraphy - Tuesday afternoon (presentation)

Seven Cretaceous Low-Order Depositional Sequences From the Browse Basin, North West Shelf, Australia: A Framework for CO2 Storage Studies

→ M. E. Lech et al. in Marita Bradshaw – Palaeographic Evolution of Oz - Tuesday morning (poster)

Paleogeographic Evolution of Early Campanian to Maastrichtian Supersequences in the Caswell Sub-Basin—Implications for CO2 Storage and Hydrocarbon Entrapment

Thank you

Any questions?

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