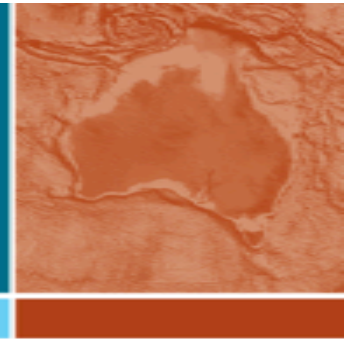
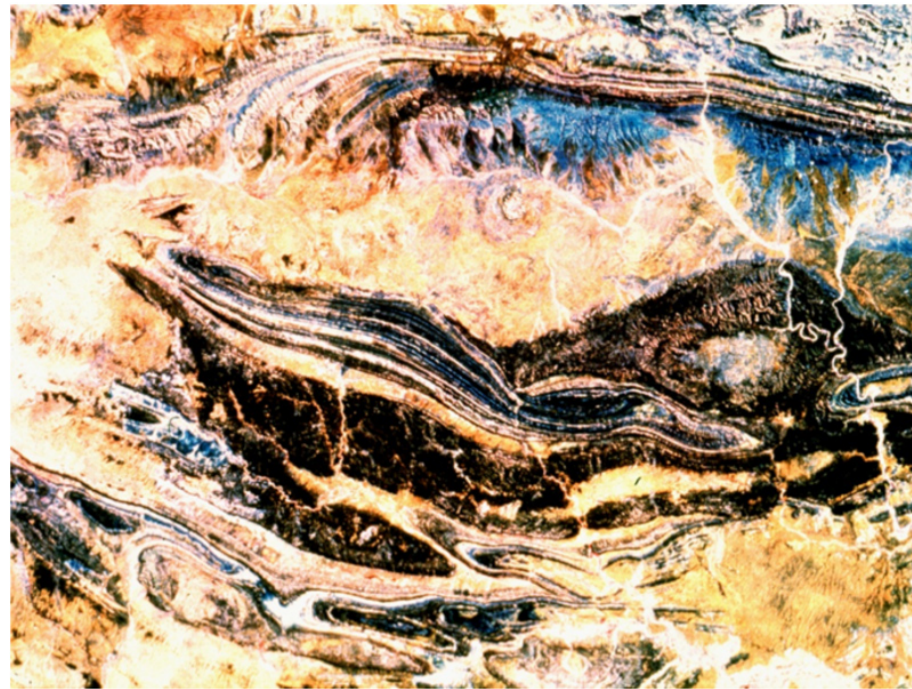




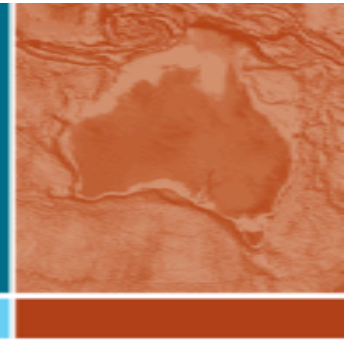
Australian Government
Geoscience Australia



Unconventional hydrocarbons - Australia's old rocks prove their worth



Marita Bradshaw
Geoscience Australia



Unconventional hydrocarbons - CSG

- Australia's Permian coals have proven their worth

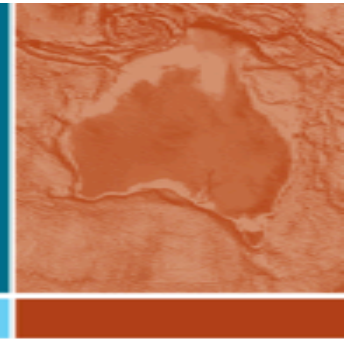


Shale gas & liquids, tight gas & light tight oil

- Will Australia's rocks prove their worth ?



Australian Government
Geoscience Australia

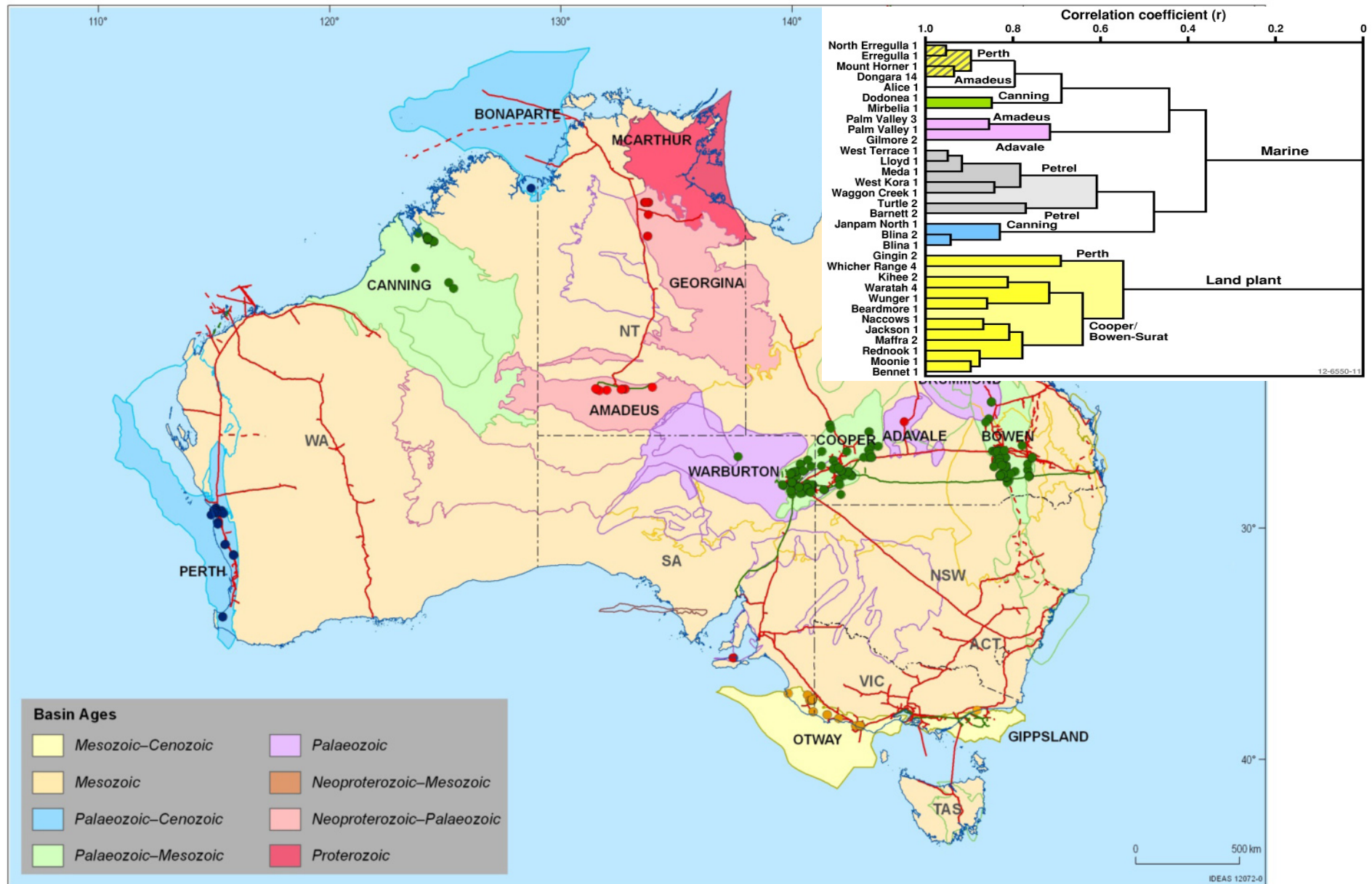


Shales for the Future



**Lidena Carr, Chris Boreham, Dianne Edwards,
John Laurie, Tegan Smith, Lisa Hall, Andrew Stacey**

Oils of Australia



Edwards & Zumberge, 2005; Geoscience Australia & GeoMark Research, 2002



The World's Oldest Oil The World's Oldest Gas?

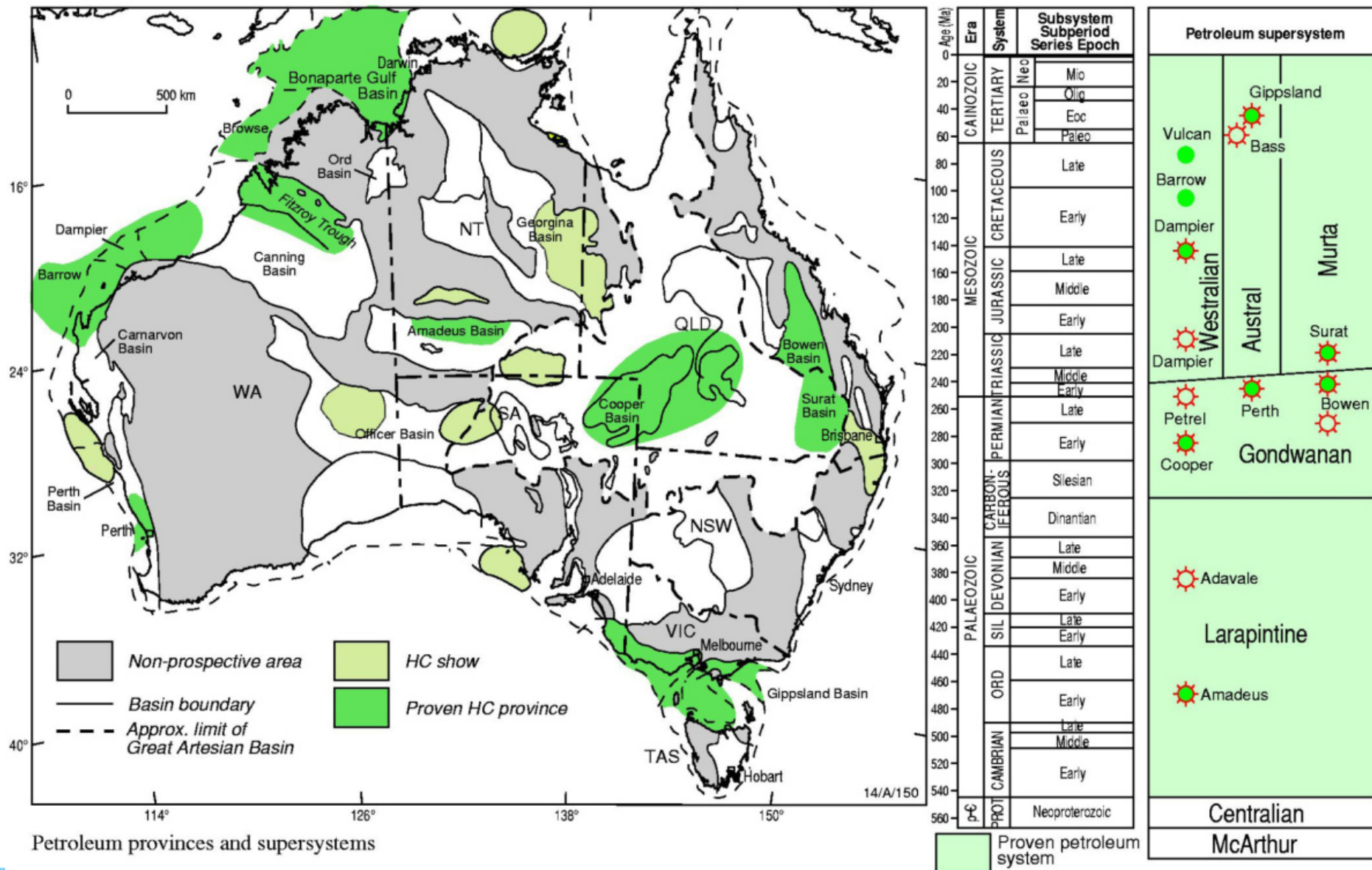


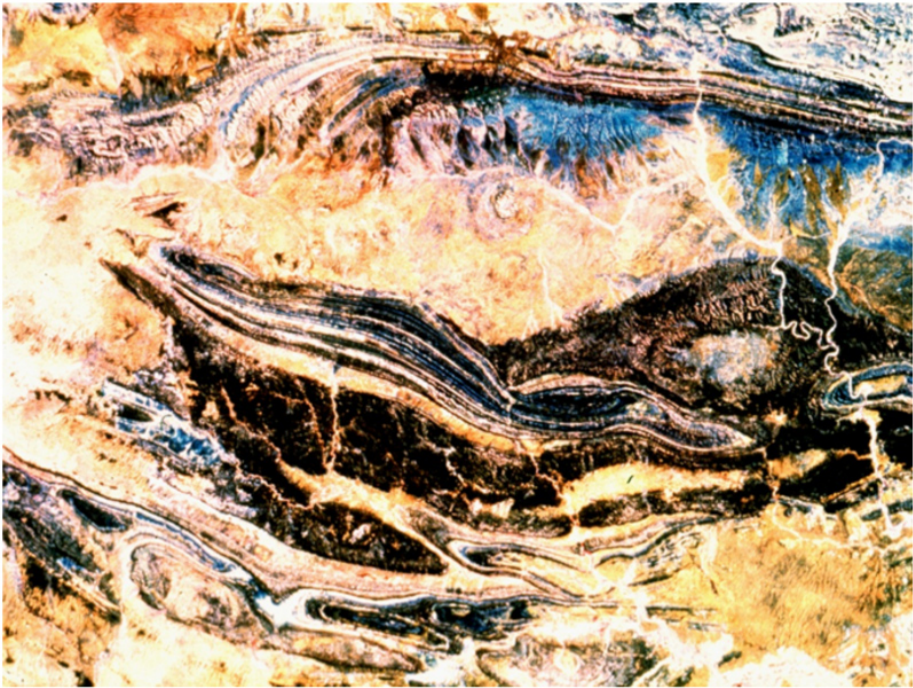
letters to nature

Nature 322, 727 - 729 (21 August 1986); doi:10.1038/322727a0

Hydrocarbon shows and petroleum source rocks in sediments as old as 1.7×10^9 years

Distribution of Australian Petroleum in time – Mesoproterozoic to Cenozoic, oldest commercial production from Ordovician





Spatial Distribution of Australia's oil & gas resources

90% Oil & Gas in offshore basins

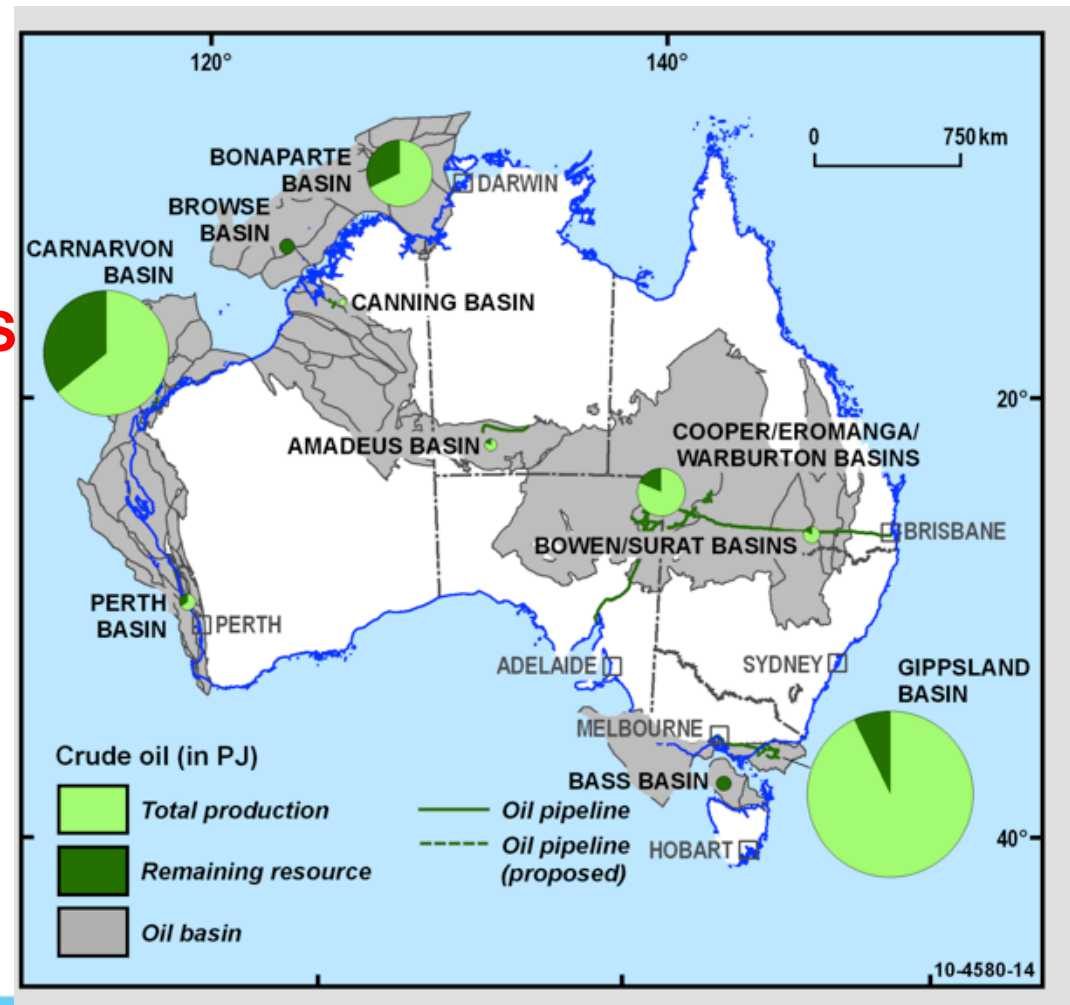
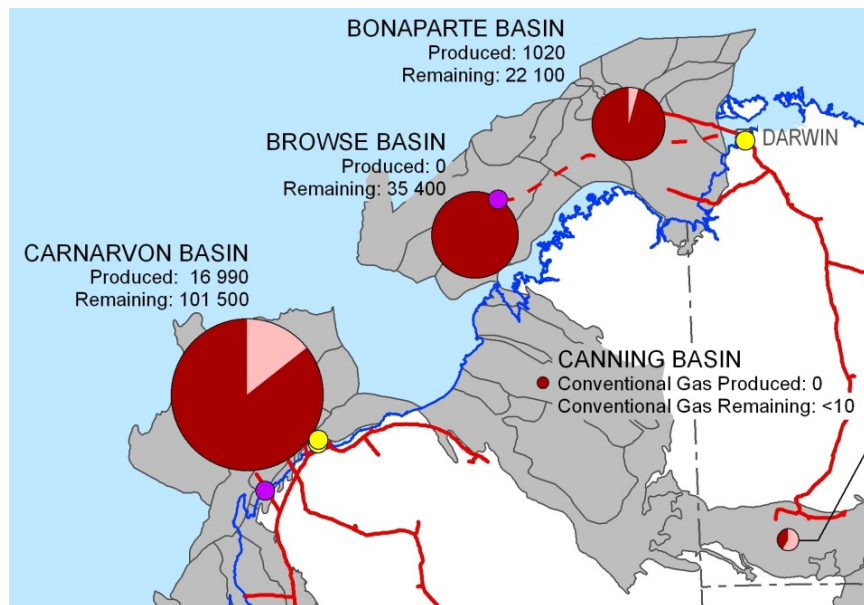
North West Shelf & Gippsland

Mesozoic clastic facies

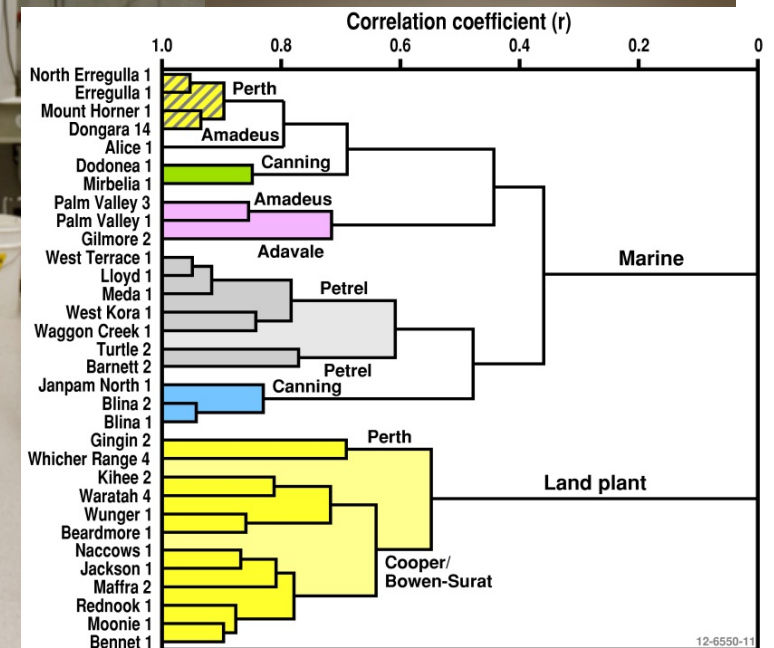
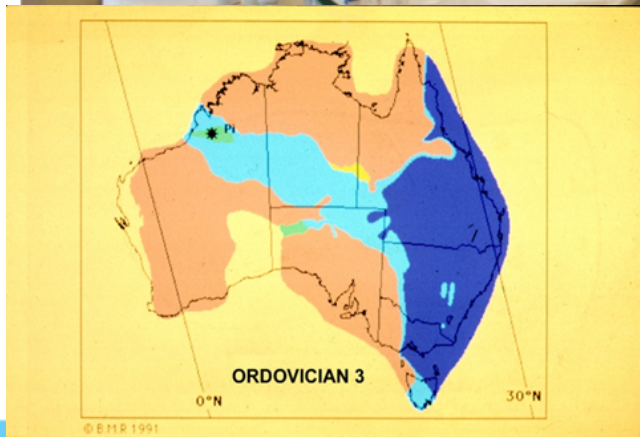
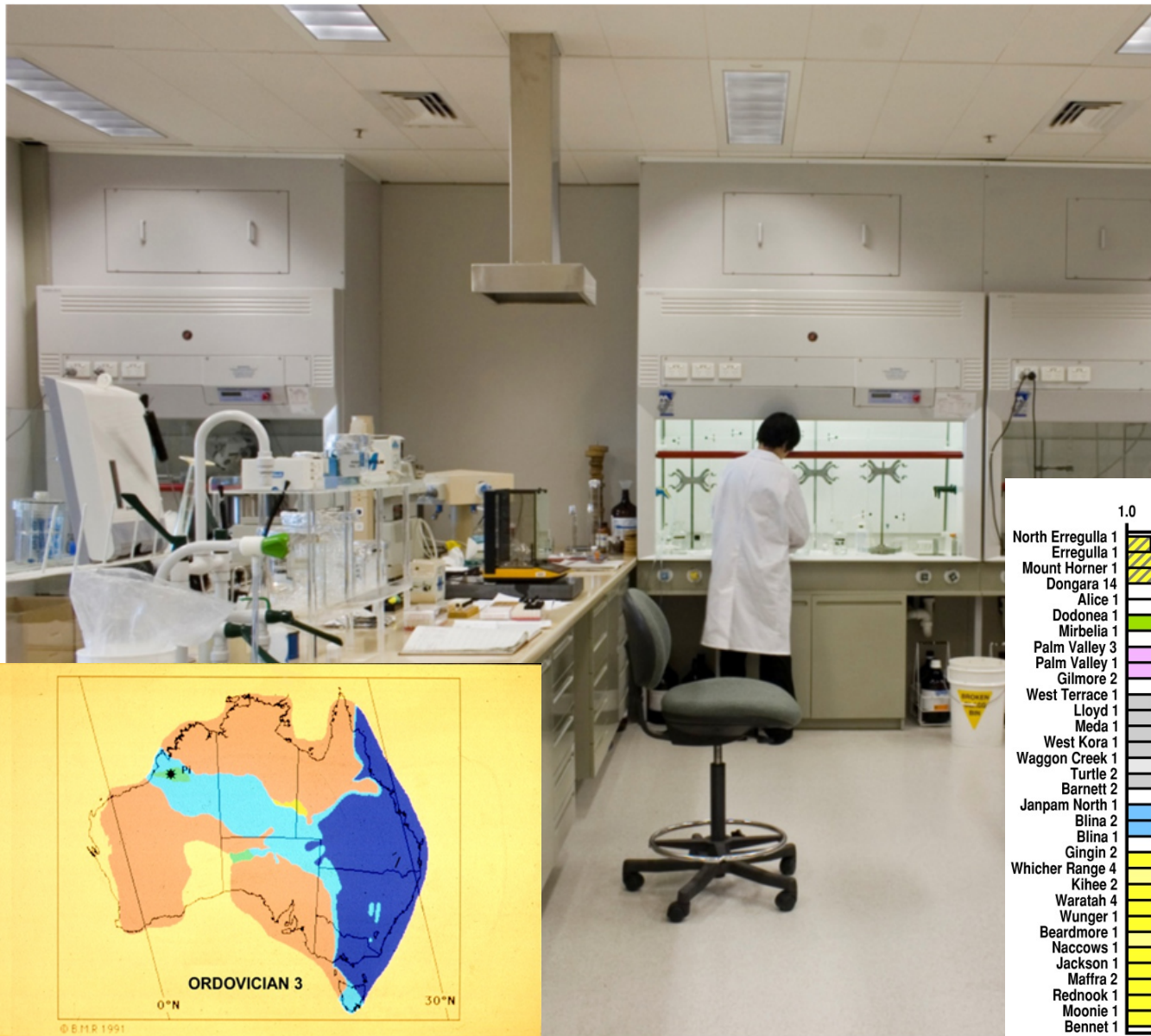
Coaly fluvio-deltaic source rocks

> 7 BBO crude oil
(original recoverable)
4 BBO in Gippsland Basin

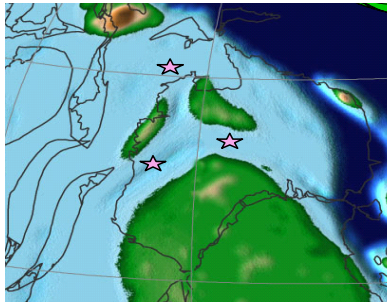
~200 TCF conventional gas on NWS



Petroleum supersystems - oil families - paleogeography

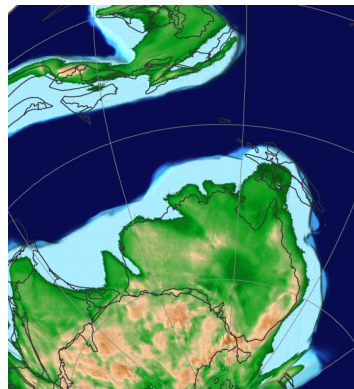


Australian Petroleum Supersystems



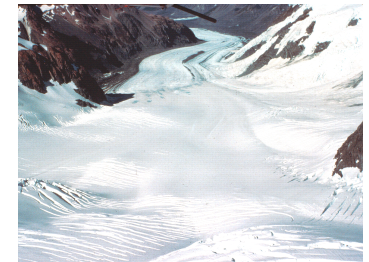
Early Palaeozoic – **LARAPINTINE**

- tropical seaways, marine source rocks from Australia to China



Late Palaeozoic – **GONDWANAN**

- mountain building, glaciation, – coal deposition



Mesozoic – **WESTRALIAN, AUSTRAL**

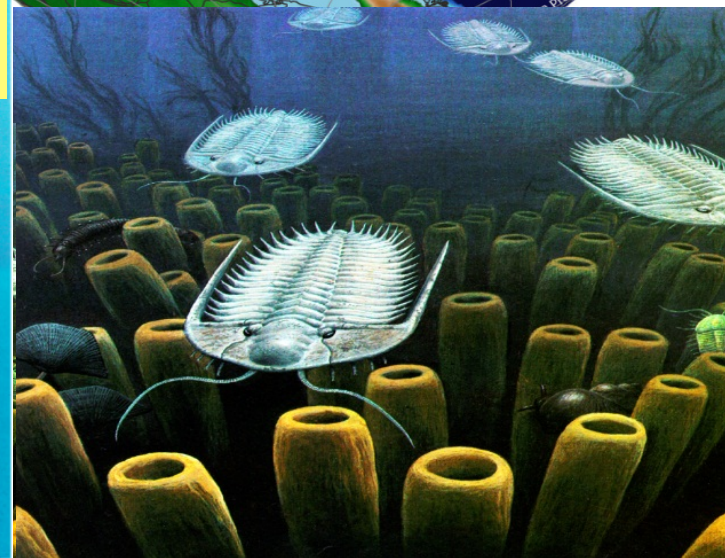
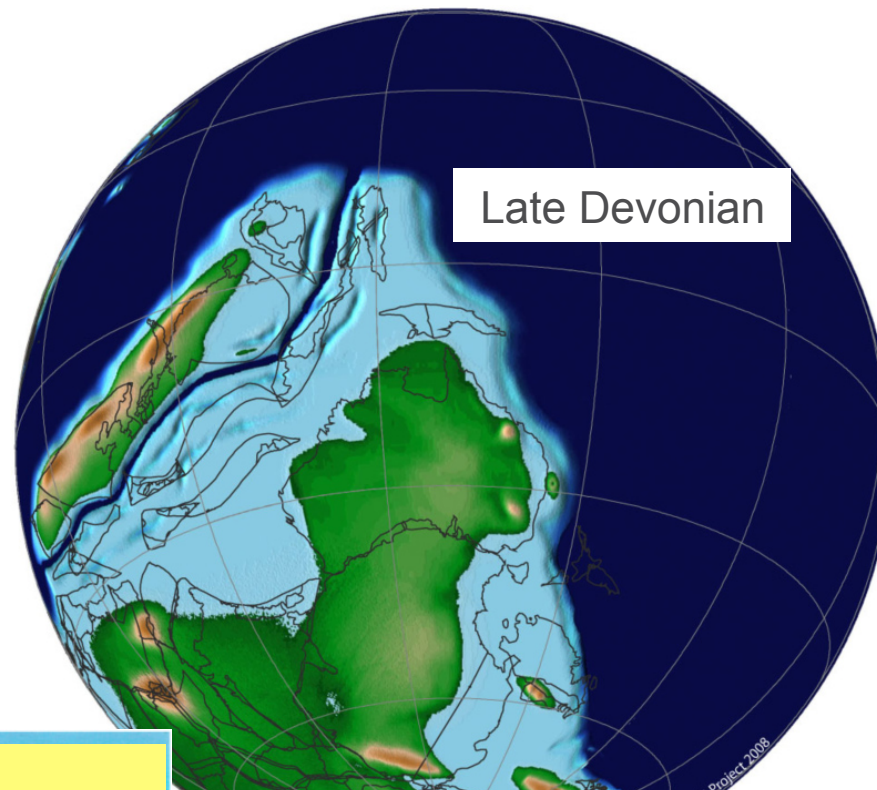
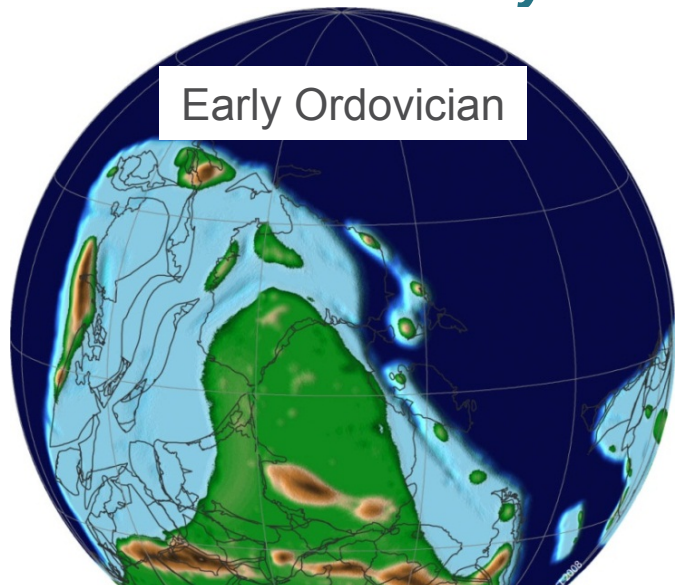
- Gondwana break up – oil & gas in rifted margins

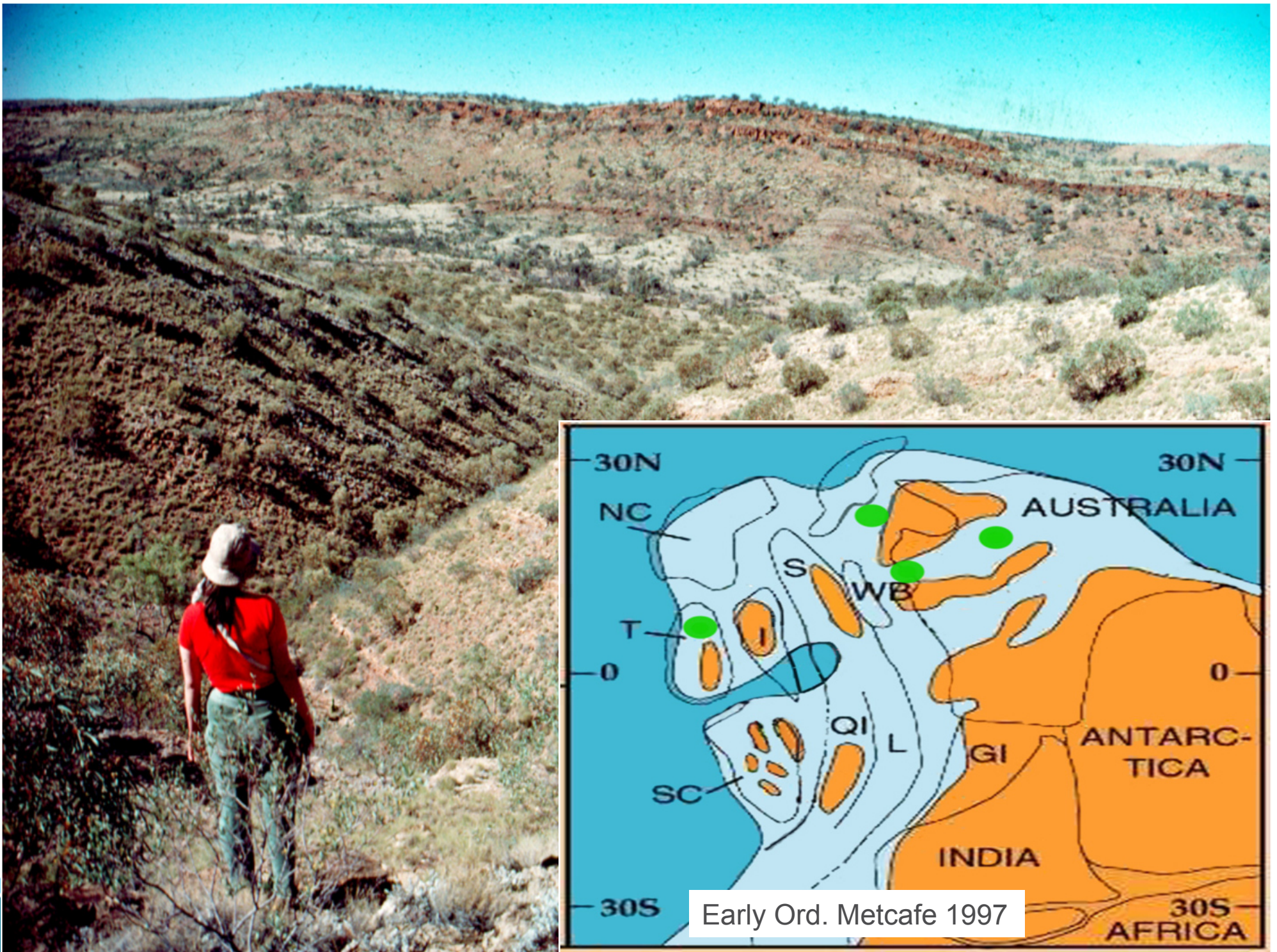
Cenozoic – Asian Collision

- basin & trap formation/destruction

Larapintine Regime

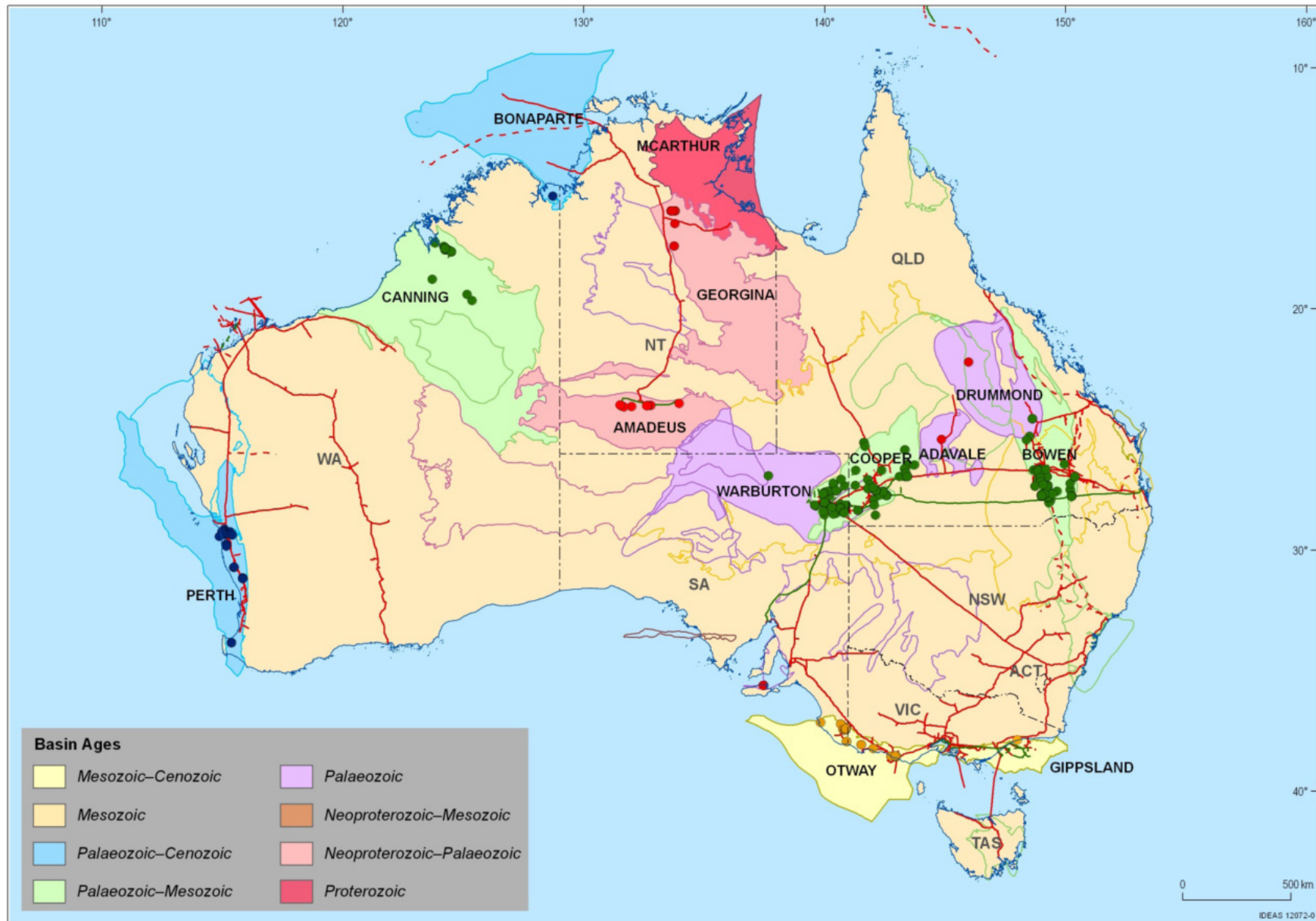
Cambrian to Early Carboniferous





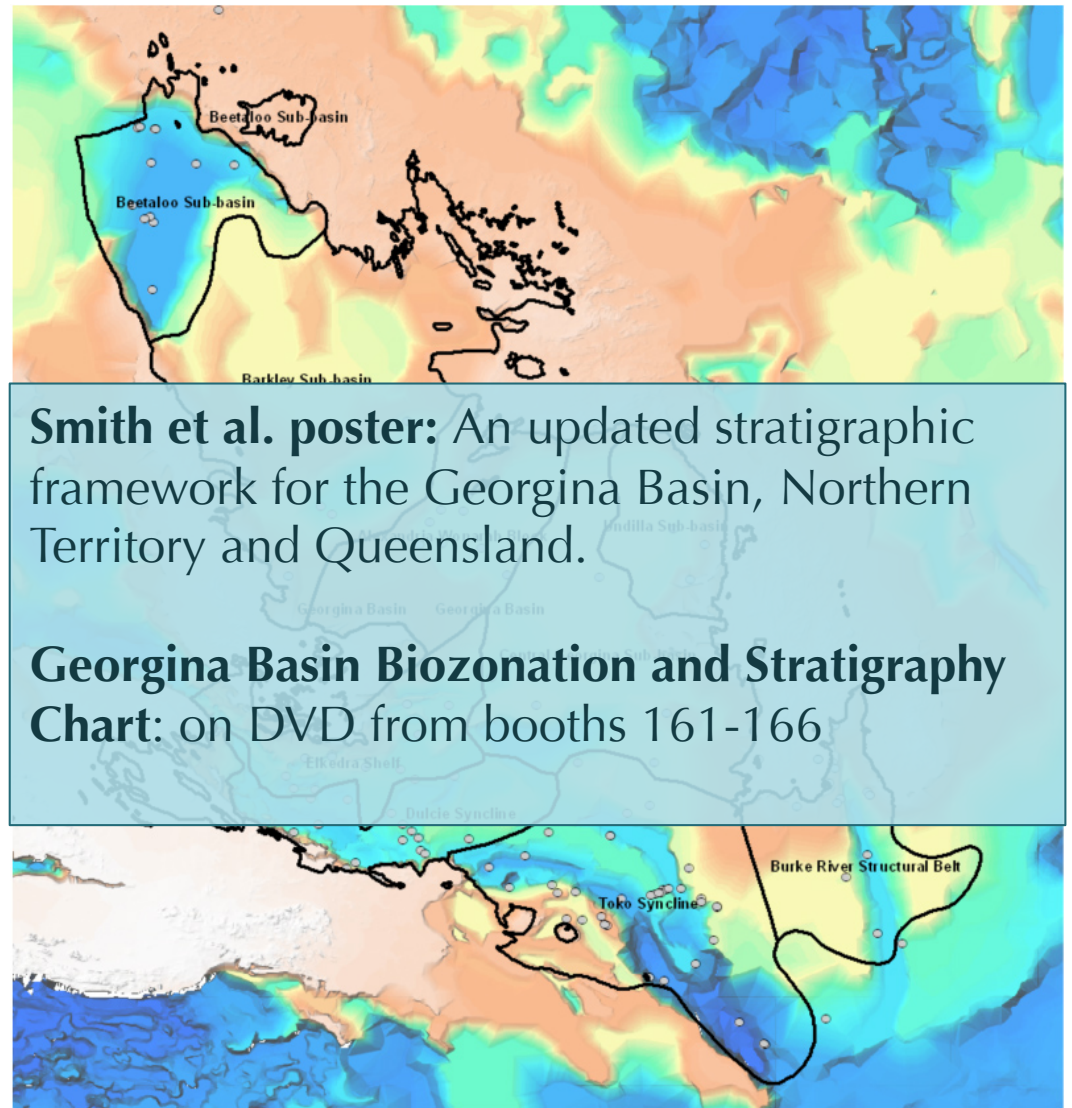
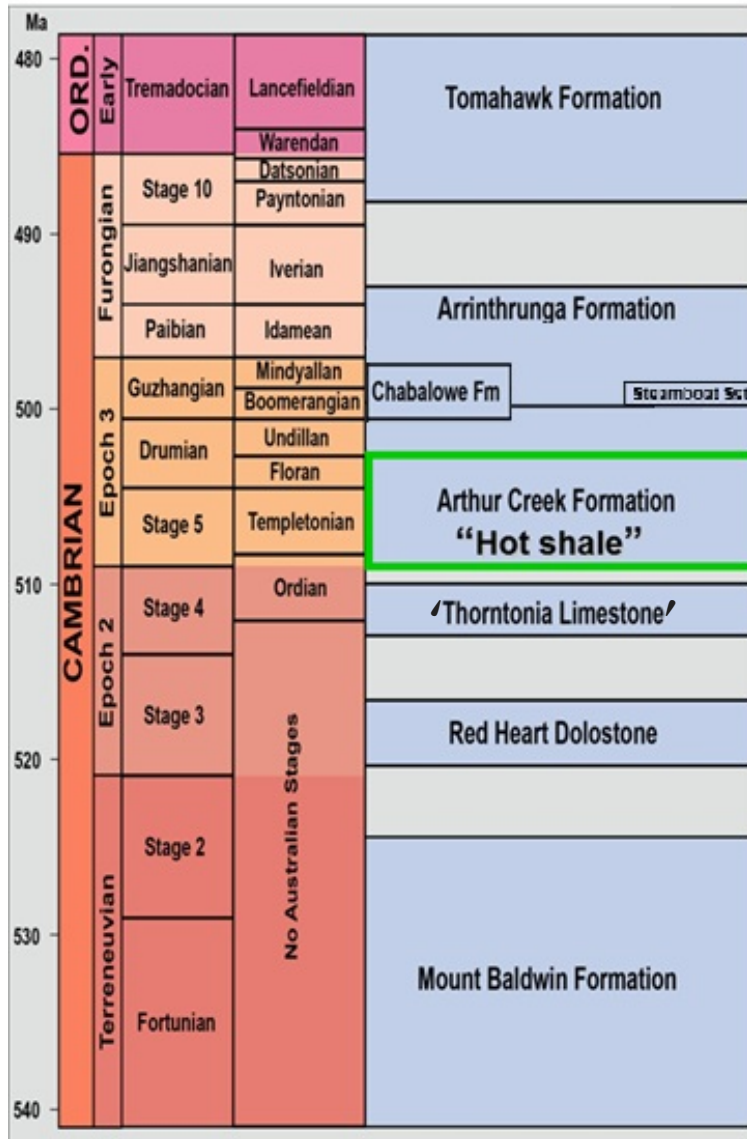
Early Ord. Metcafe 1997

Oils of Australia



Edwards & Zumberge, 2005; Geoscience Australia & GeoMark Research, 2002

Georgina Basin: Cambrian petroleum systems

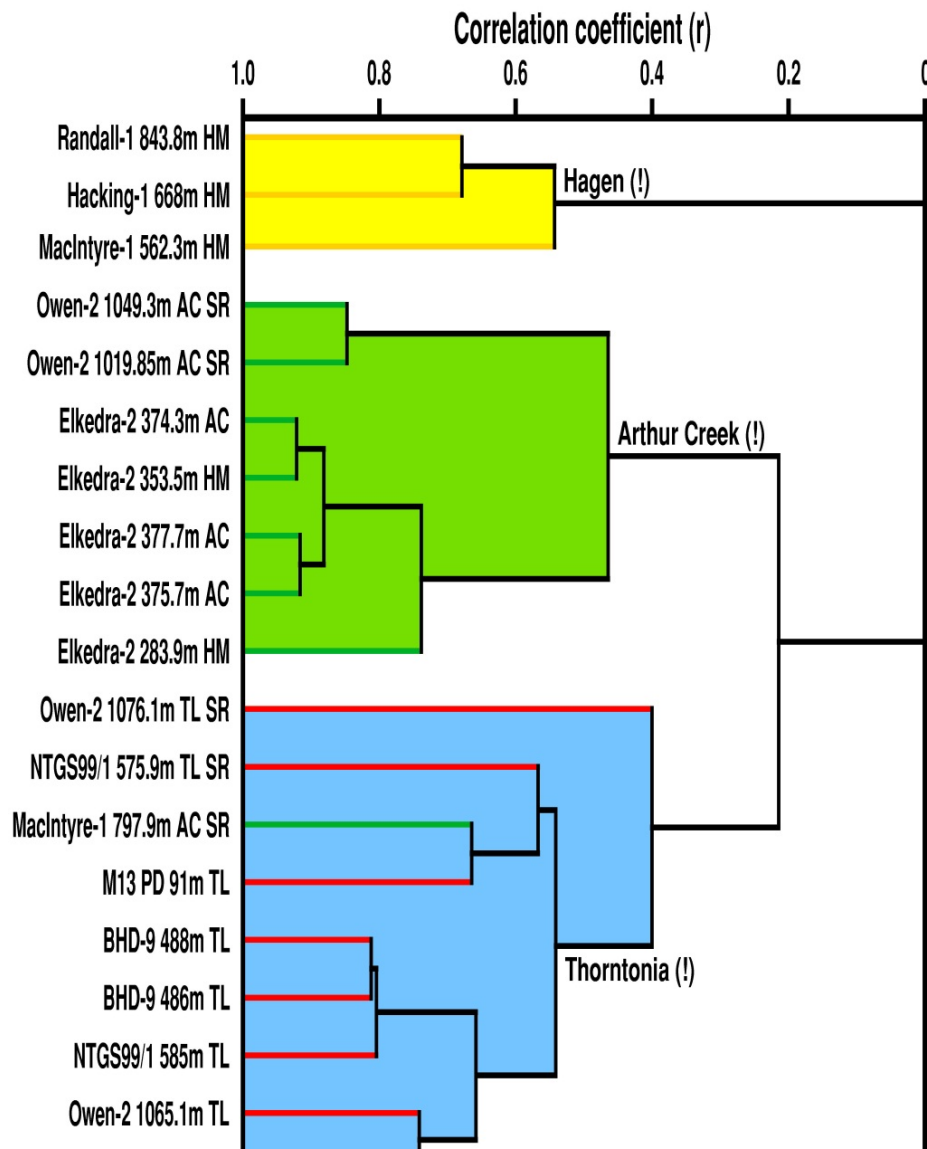


Smith et al. poster: An updated stratigraphic framework for the Georgina Basin, Northern Territory and Queensland.

Georgina Basin Biozonation and Stratigraphy Chart: on DVD from booths 161-166

FrogTech Seebase image showing depth to basement

Southern Georgina Basin



Boreham et al., 2007; IMOG abstract, poster

Total Petroleum System Elements

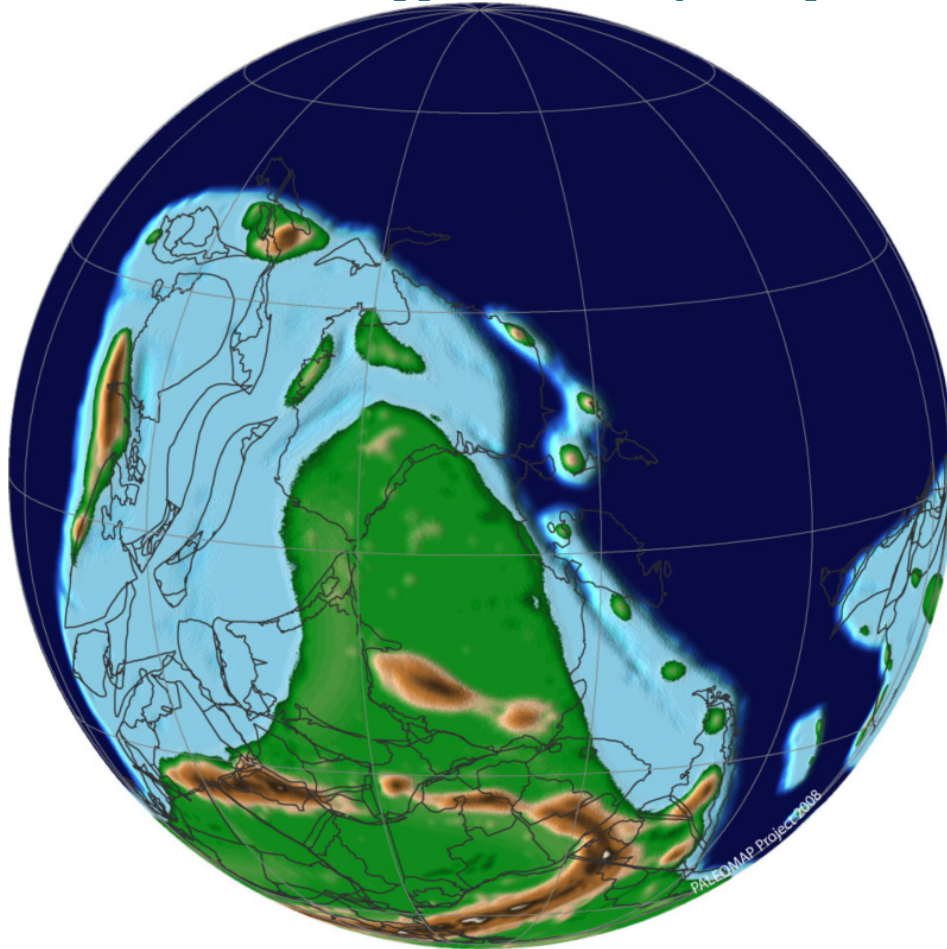


Tight gas/oil, evaporitic source
Type II marine source rocks
Shale oil, gas

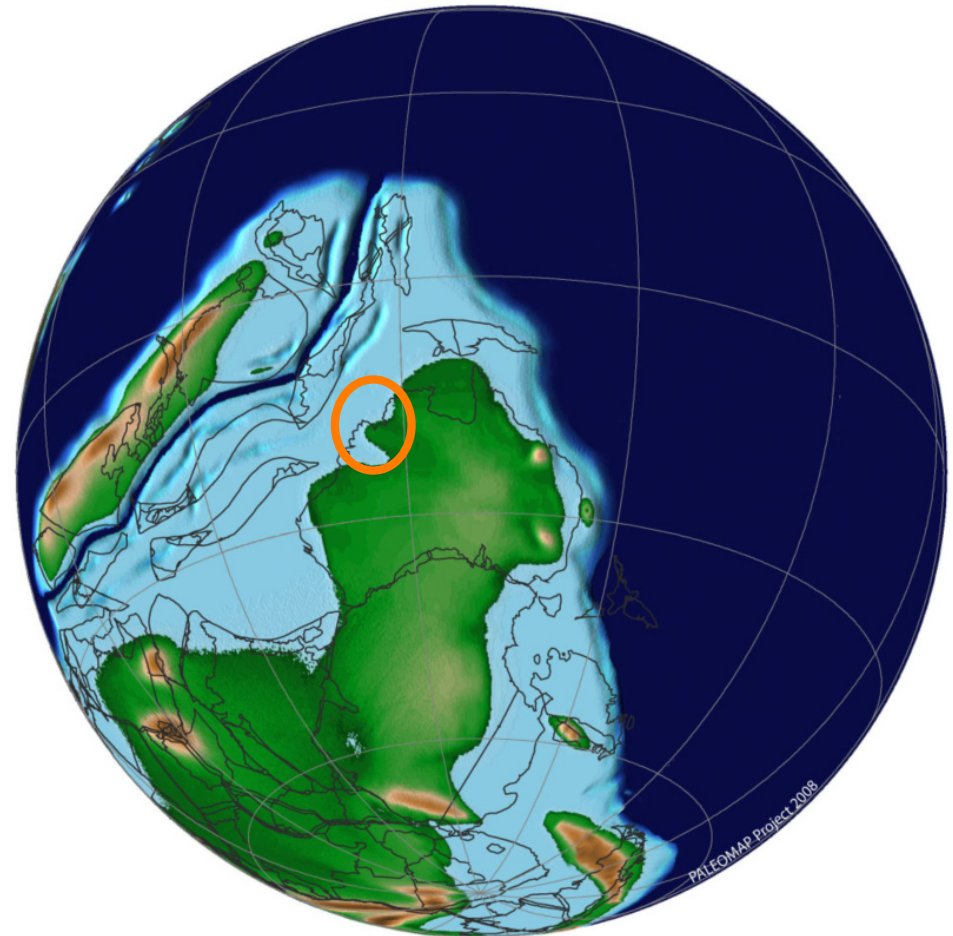
Type II marine source rock
Oil reservoir



Larapintine Regime travelling south, departure of Asian blocks



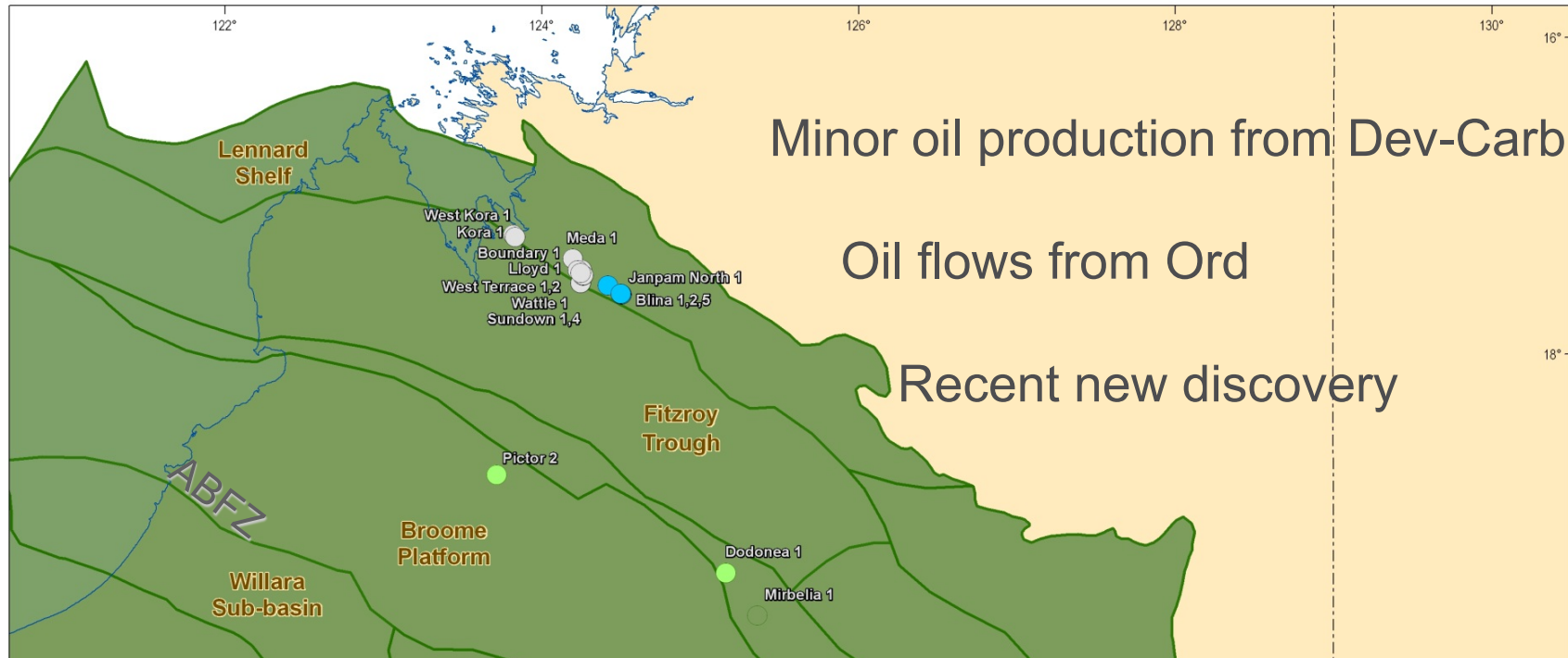
Map 44 Early Ordovician (early Tremadoc, 500 Ma)



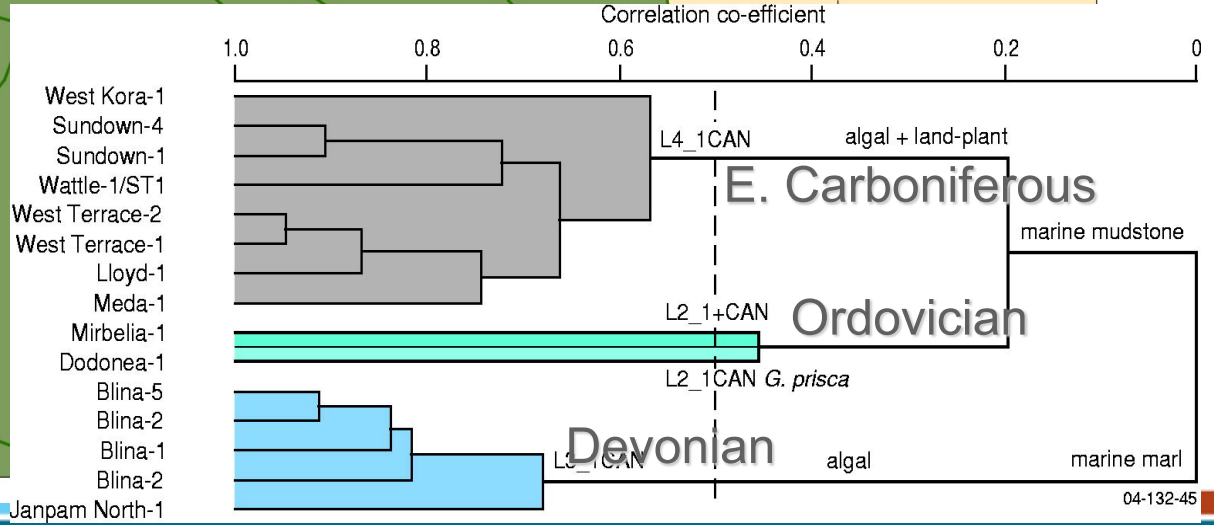
Map 35 Late Devonian (middle Famennian, 363 Ma)

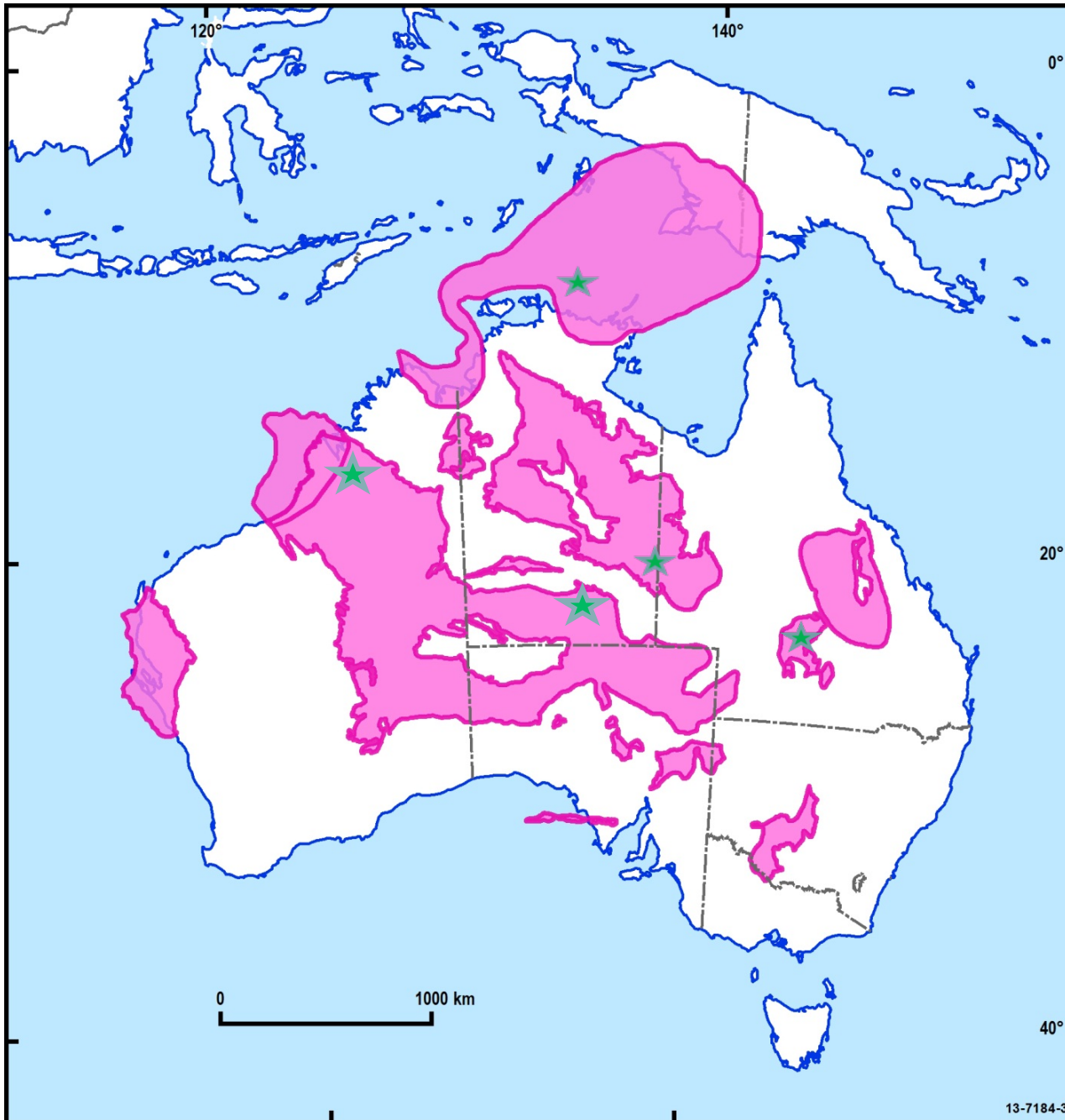


Canning Basin Oil Families



Minor oil production from Dev-Carb
 Oil flows from Ord
 Recent new discovery





 *Larapintine*

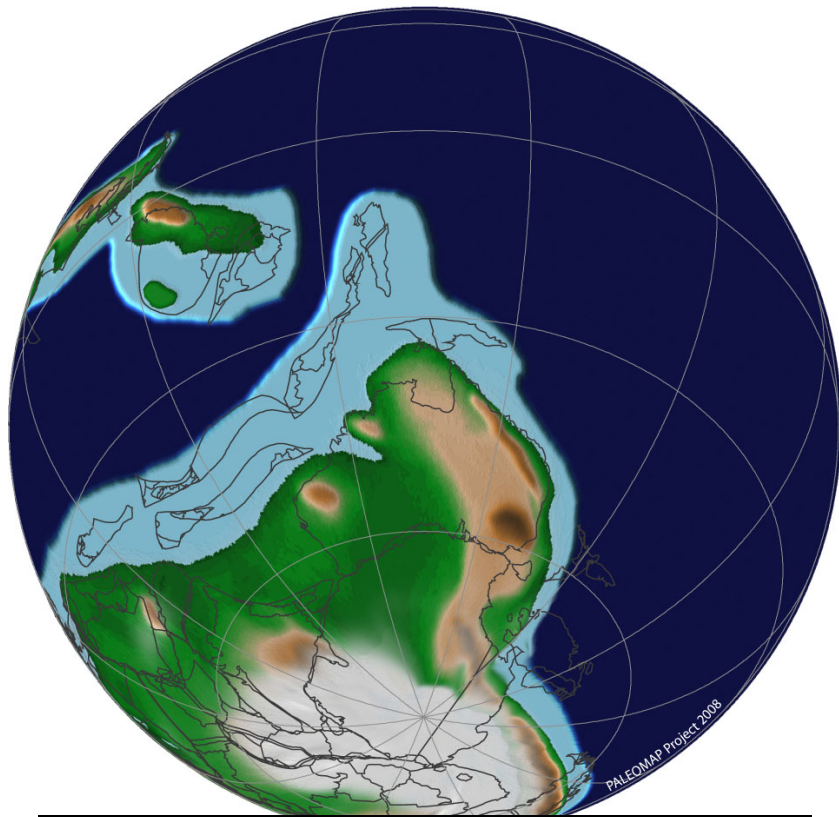
Organic-rich marine source rocks

Modest conventional oil & gas fields in Amadeus, Canning & Adavale basins ★

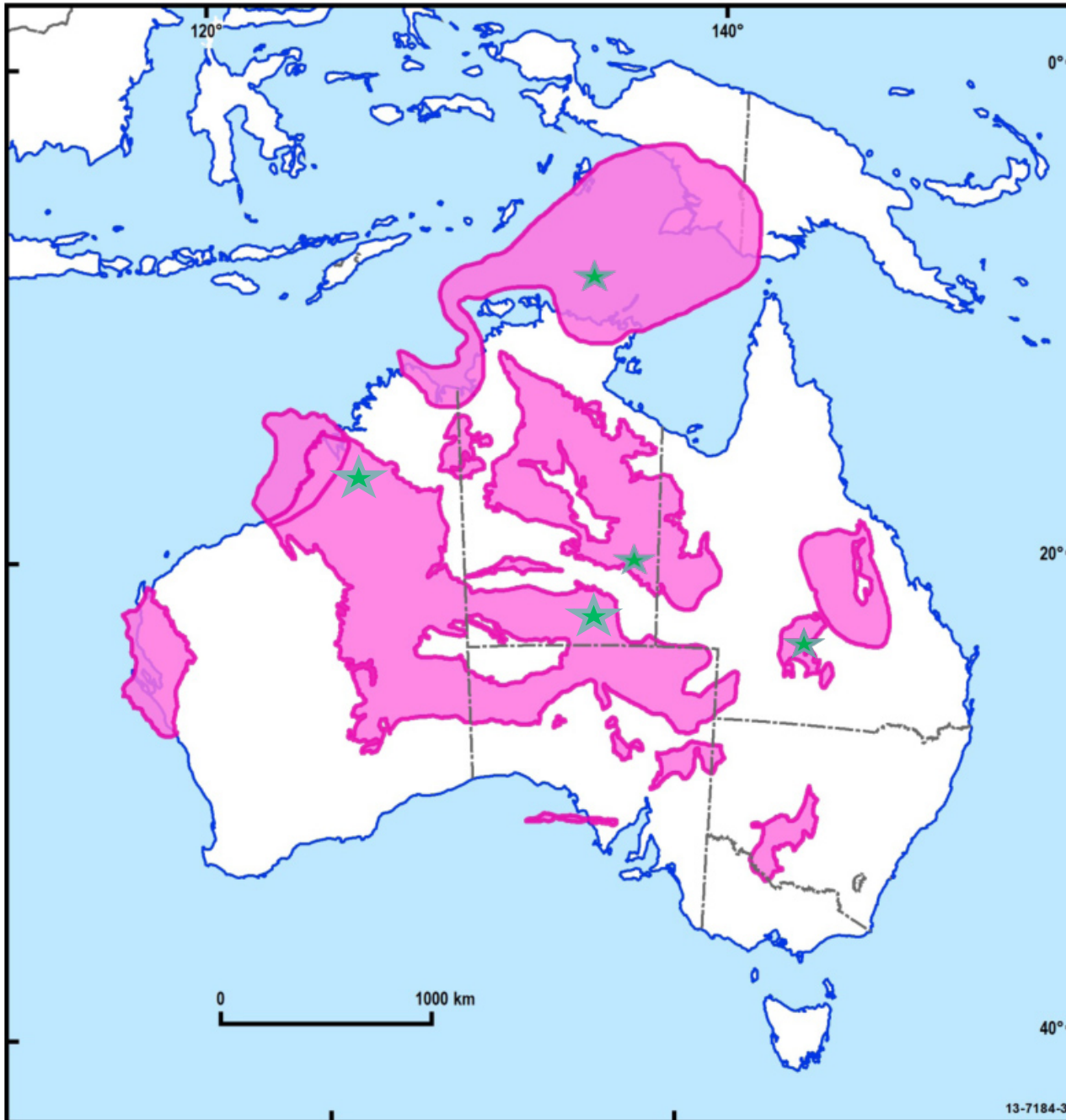
Oil shows in Arafura & Georgina basins

13-7184-3

Carboniferous – Pangea formation, moving into icehouse



Jurassic	Westralian Petroleum Supersystem
Triassic	<i>Fitzroy Movement</i>
Permian	Gondwanan Petroleum Supersystem
Carboniferous	<i>Peak Alice Spings Orogeny - Transitional Pet. Sys</i>
Devonian	Larapintine Petroleum Supersystem



 Larapintine

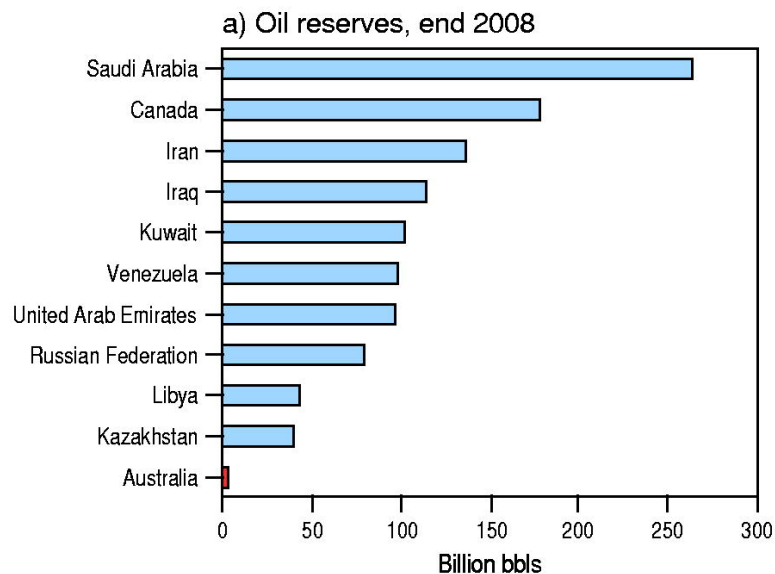
**Organic-rich marine
source rocks**

**Maturation history
not optimal for
conventionals
- Alice Springs
Orogeny**

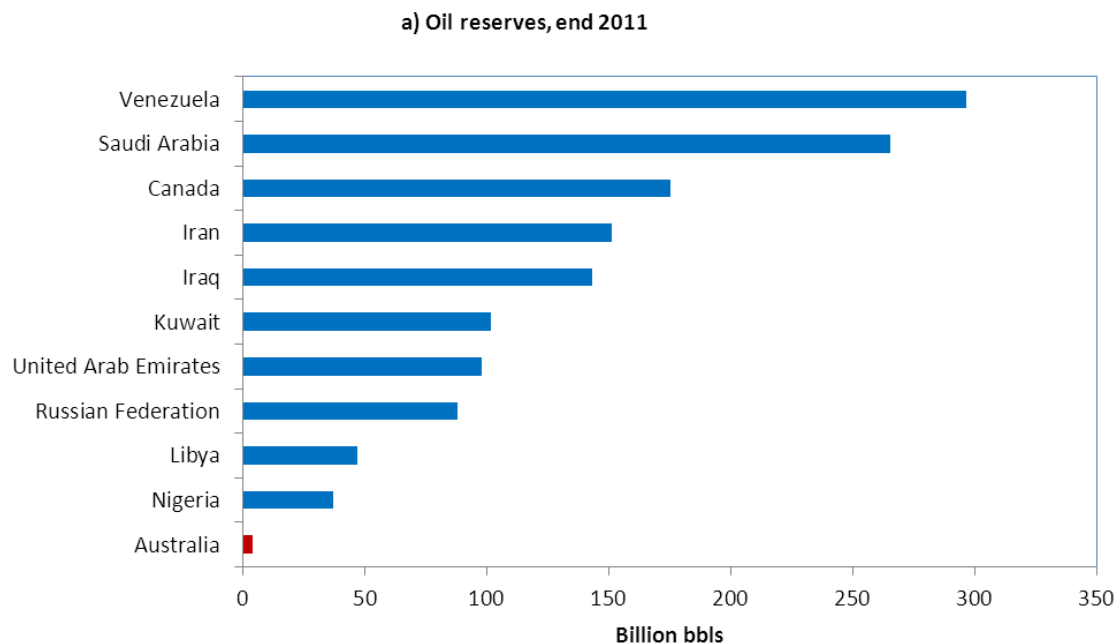
**Potential for
shale gas,
tight gas
Liquids ?**

Unconventional Oil & Gas is re-ordering the world

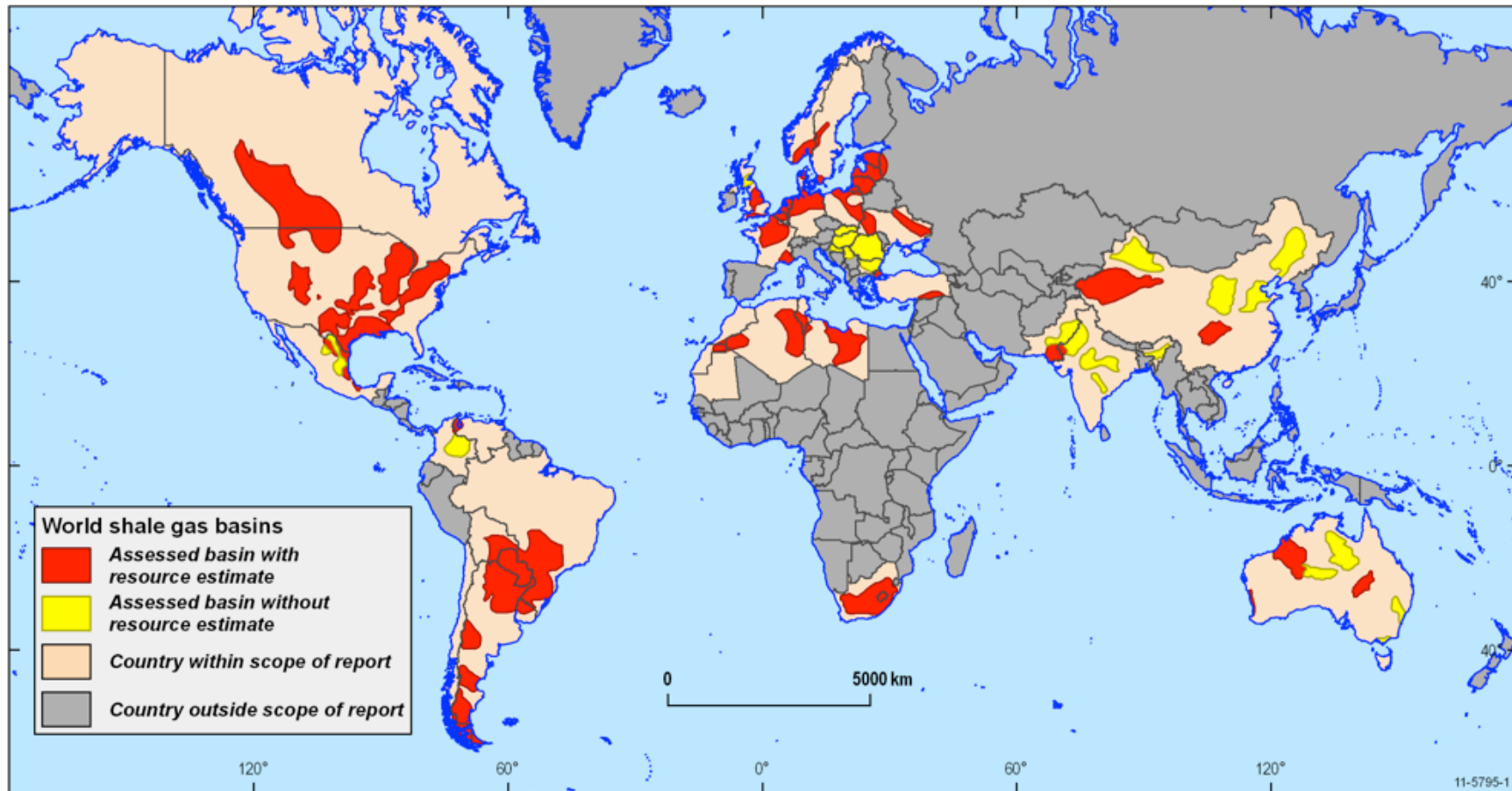
Oil Reserves 2008 & 2011



Venezuela from 6th to 1st place
as heavy oil now considered reserves



Shale gas: Will the US experience be repeated elsewhere and over what time frames?



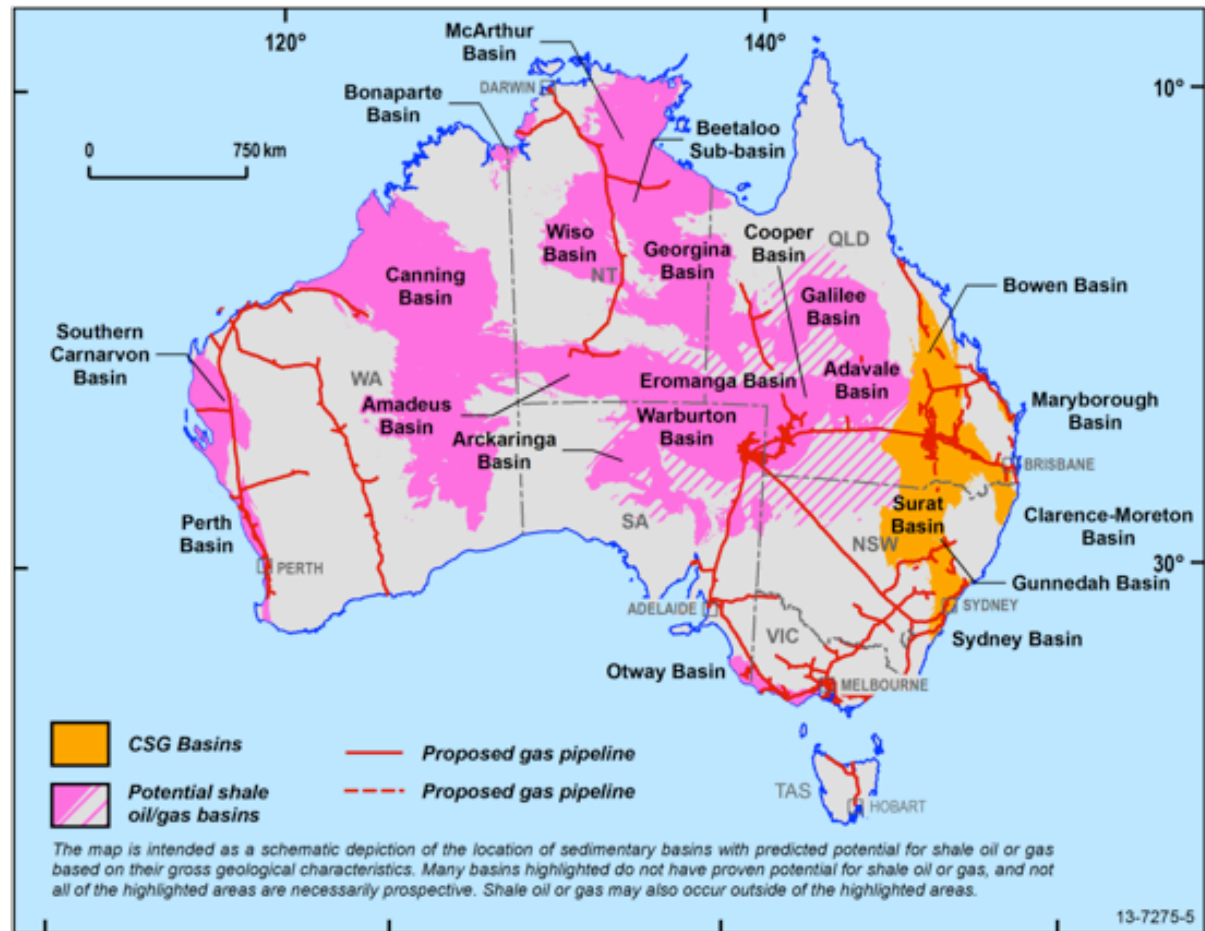
Source: US Energy Information Administration, April 2011: <http://www.eia.gov/analysis/studies/worldshalegas/>

Shale Gas potential in Australia

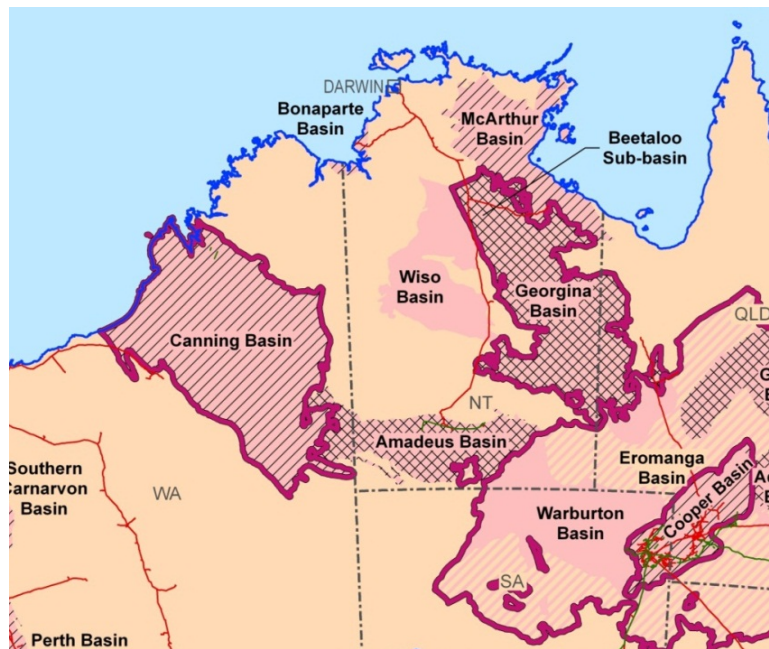
396 tcf “technically recoverable” (EIA 2011)

How much shale gas will be produced & when?

Are there liquids?



	investing company	partner	basin	potential resources
	2010 BPRL (Indian)	Norwest	Perth	Triassic & Pz shale gas/oil
	CNOOC (China)	Exoma	Galilee/Eromanga	CSG Permian; Toolebuc shale oil
	2011 Hess Corp (US)	Falcon	Beetaloo	Proterozoic shale gas/oil
	ConocoPhillips (US)	New Standard	Canning Goldwyer	Ordovician shale gas/oil
	Mitsubishi (Japan)	Buru Energy	Canning	Devonian-Carb.shale gas/oil
	2012 Statoil (Norway)	PetroFrontier	Georgina	Cambro-Ord shale gas/oil
	Total (France)	Central Petroleum	Georgina	Cambro-Ord shale gas/oil
	2013 Chevron (US)	Beach Energy	Cooper	Permian shale/tight gas



Over \$100m already committed
a *potential* investment of ~ \$1 billion
in staged exploration programs

Shales for the future

How do we get from pore or fracture scale to basin scale estimates of potential?

How do we pick the sweet spots ?



Is the science still at the descriptive (Linnaean) stage ?

learning by drilling

reliance on analogues

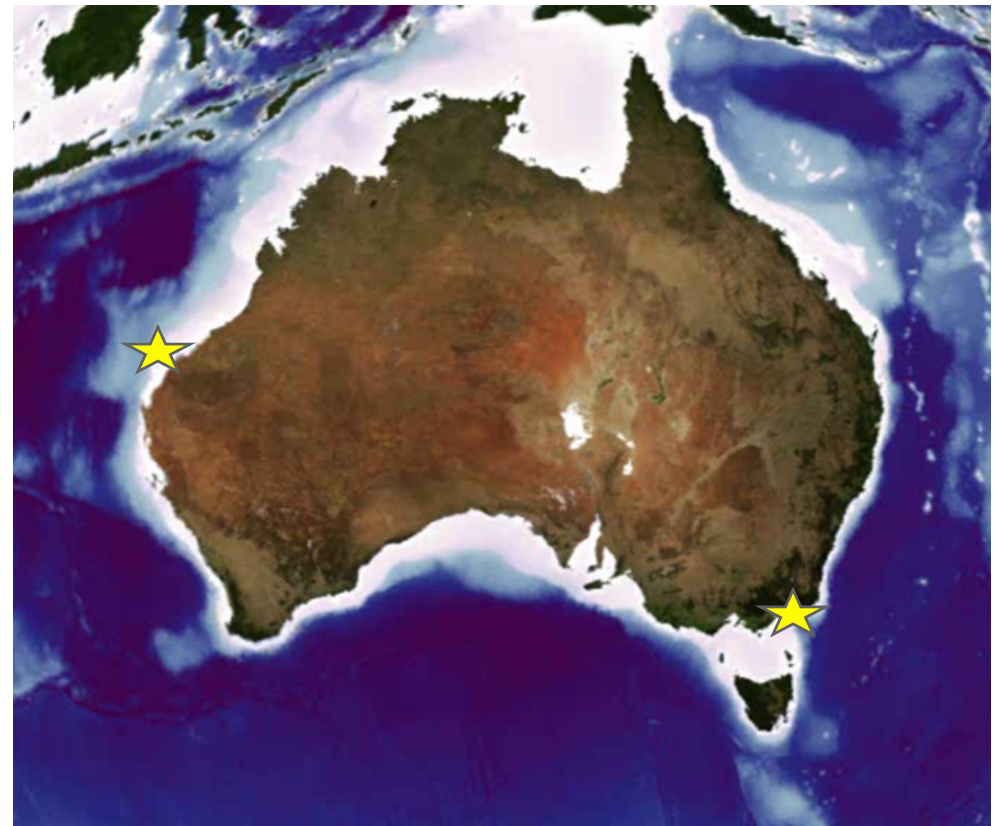
1972 forecast – Australia’s oil resources

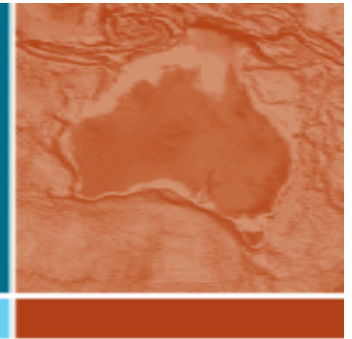
“..... 120 billion barrels” (Konecki, 1972)

Estimated extrapolating Gippsland success to the rest of the continental shelf

*Took another 40 years,
billions of \$ of investment
to prove up another
~ 3 billion barrels*

2011 forecast – Shale gas
.....396 tcf (EIA 2011)





Unconventional hydrocarbons - Australia's old rocks prove their worth

