



Government of Western Australia
Department of Mines, Industry Regulation and Safety

Permian source rock investigation of the Carnarvon Basin

Charmaine Thomas



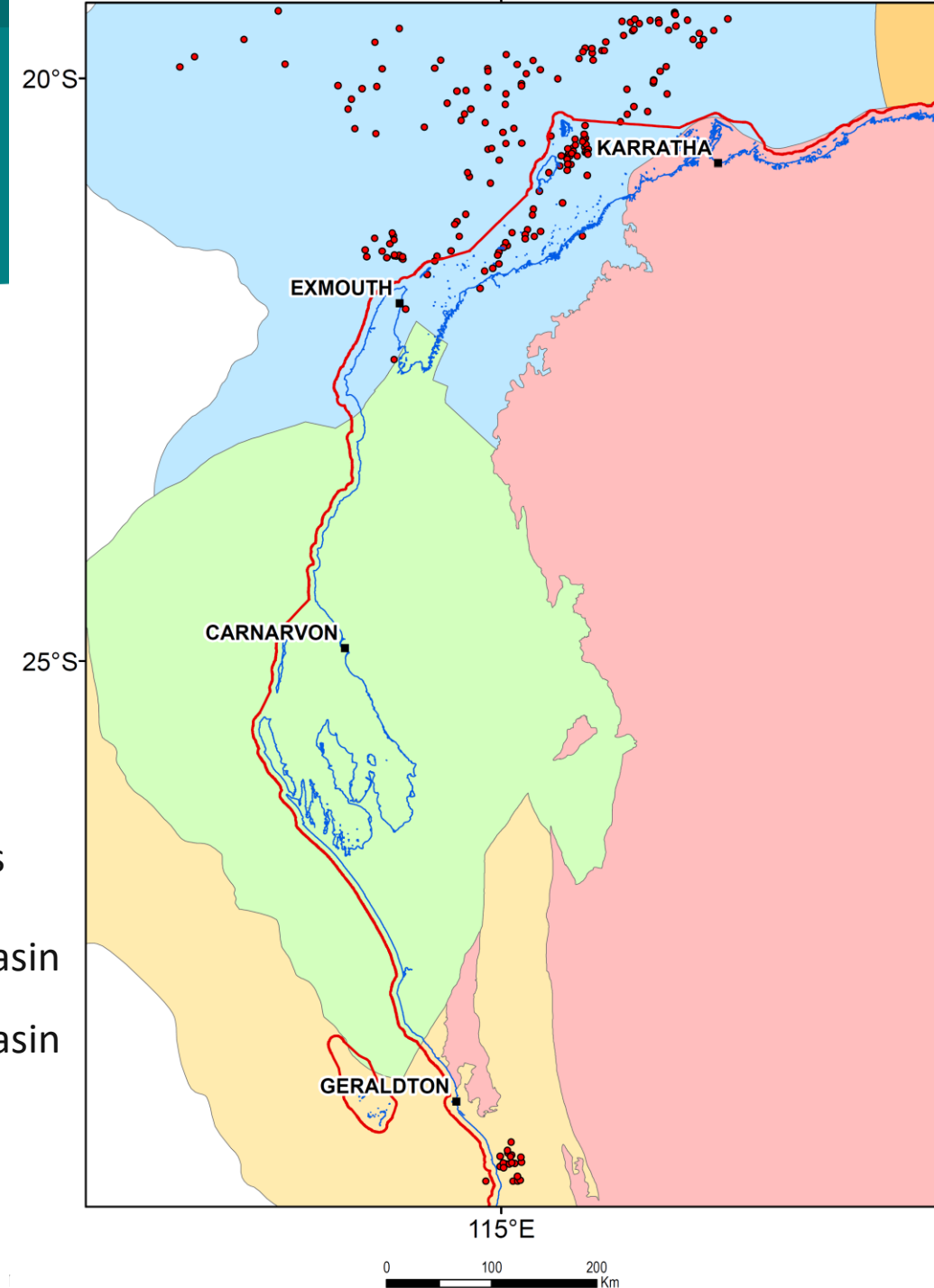
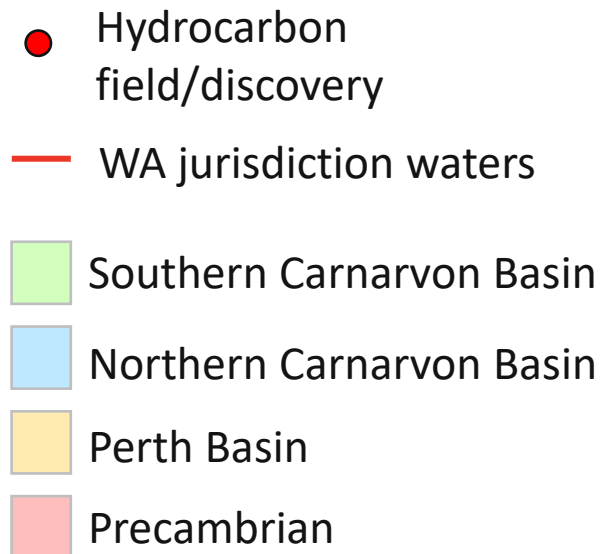
Background

Southern Carnarvon Basin

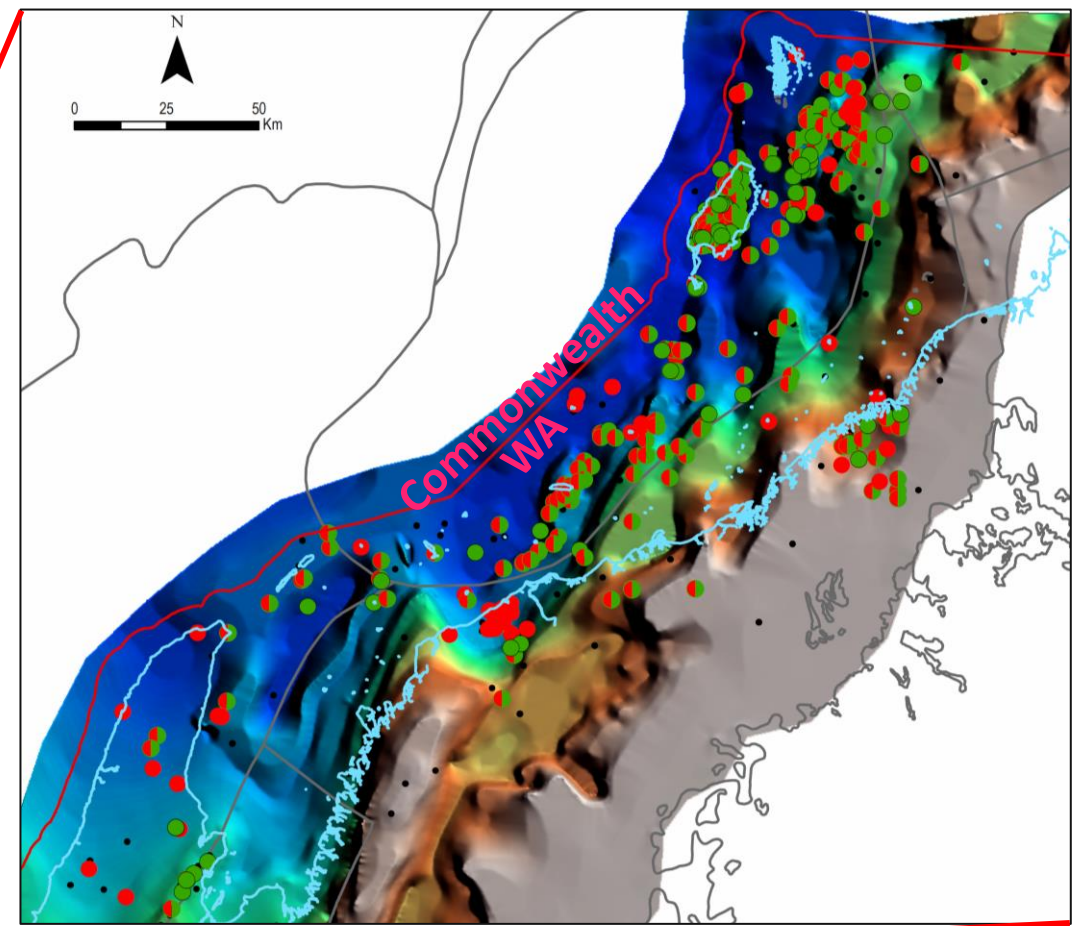
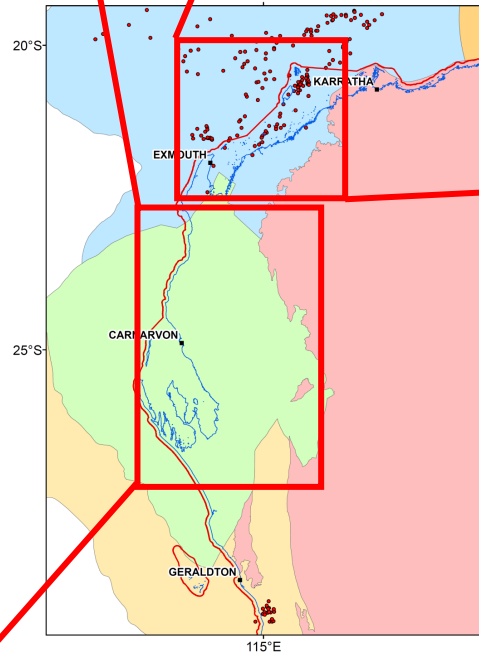
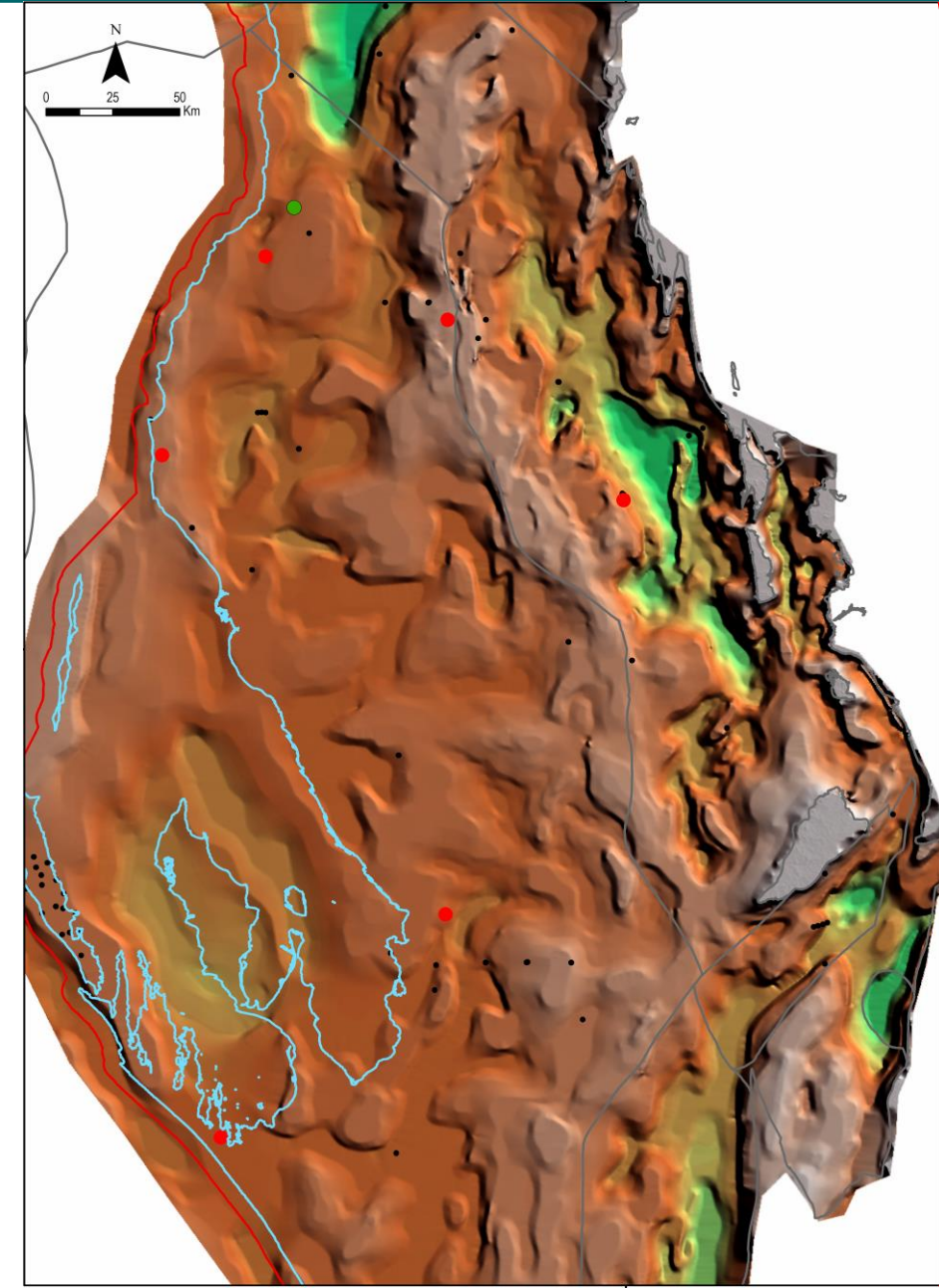
- mostly Paleozoic and post-breakup Cretaceous preserved
- No produced hydrocarbons to date





Northern Carnarvon Basin

- Paleozoic and Triassic intersected inboard margin (mostly onshore)



Hydrocarbon shows & discoveries



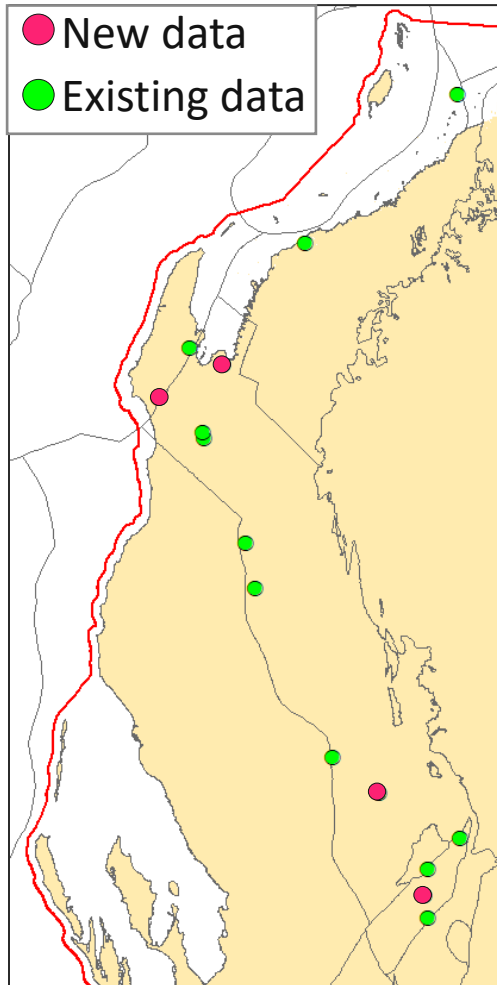
-  Oil and gas discovery or show
-  Gas discovery or show
-  Oil discovery or show
-  Dry hole – nil shows

Study summary

- Increased spatial resolution of source rock data with aim to identify new areas or intervals with source rock potential
- Rock-eval screening of f.g. lithologies in previously unsampled cores/drillholes (includes mineral holes) & fresh outcrop
- Visual kerogen assemblage estimates
 - Organic petrography (incl. vitrinite reflectance)
 - Palynofacies analysis of kerogen slides



Callytharra Formation

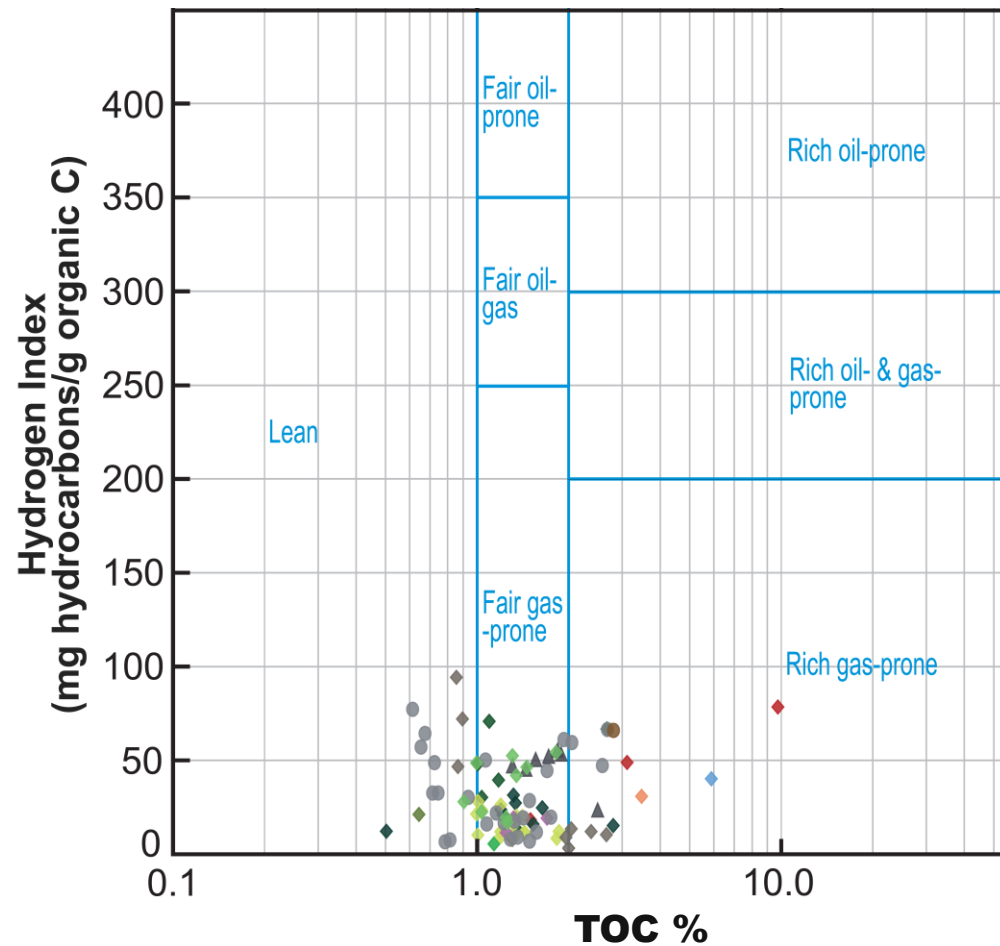
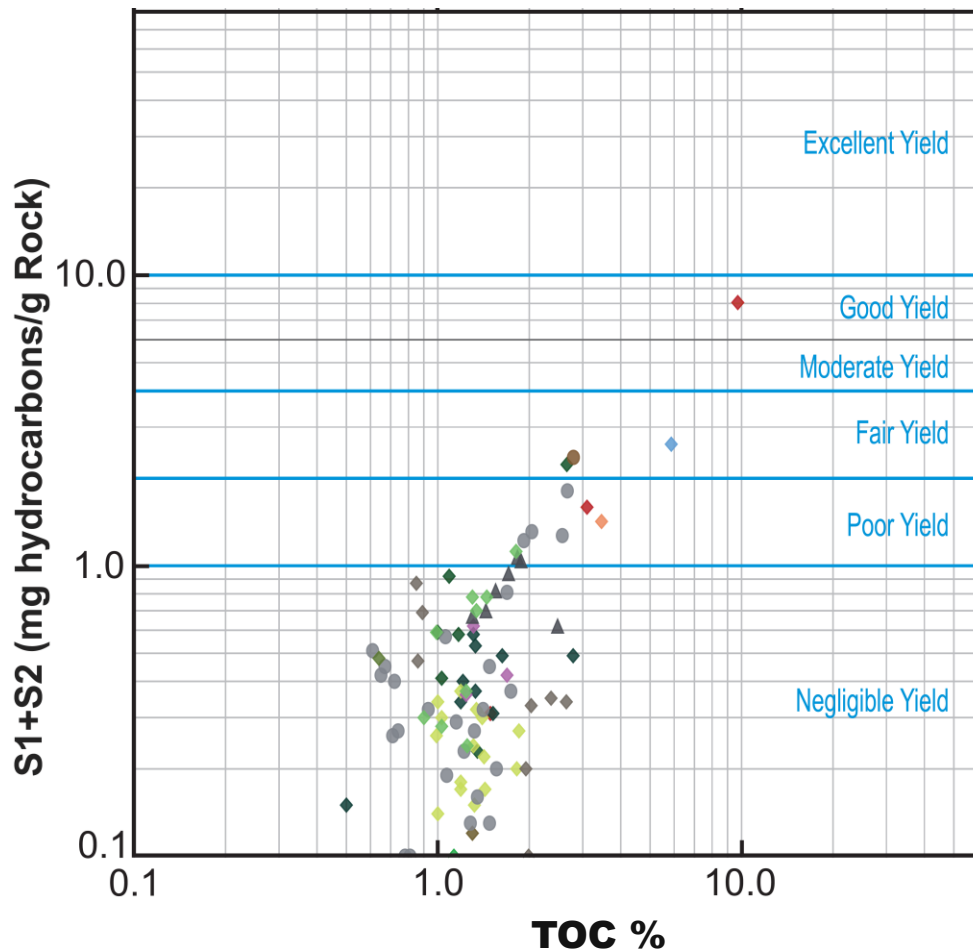


Age	Stratigraphy		
	Camarvon Basin		
	Byro Sub-basin	Merlinleigh Sub-basin	Peedamullah Shelf
Triassic			Locker Shale
Late Permian	Tatarian to Kazanian		Chinty Fm
	Ufimian	Kennedy Group	Kennedy Group
		Binthalya Fm	
		Mungadan Ss	
Early Permian	Kungurian	Byro Group	
	Artinskian	Wooramel Group	
		Keogh Fm	Billidee Fm
			Moogooloo Ss
			Gordalia Fm
	Ballythanna Ss Mbr	Callytharra Fm	? Callytharra Fm
Sakmarian	Callytharra Fm		
Asselian	Lyons Group	Lyons Group	Lyons Group

- Marine unit comprising mostly fossiliferous limestones and/or dark shales
- Existing data show best source rock developed in Byro Sub-basin
- New data from Byro Sub-basin
 - Including hole with possible oil slicks
- New data from Cape Range area (onshore Exmouth Sub-basin)

Callytharra Formation

Rock-eval plots – new and existing data



Callytharra Formation

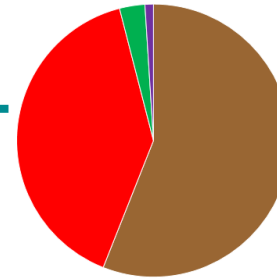
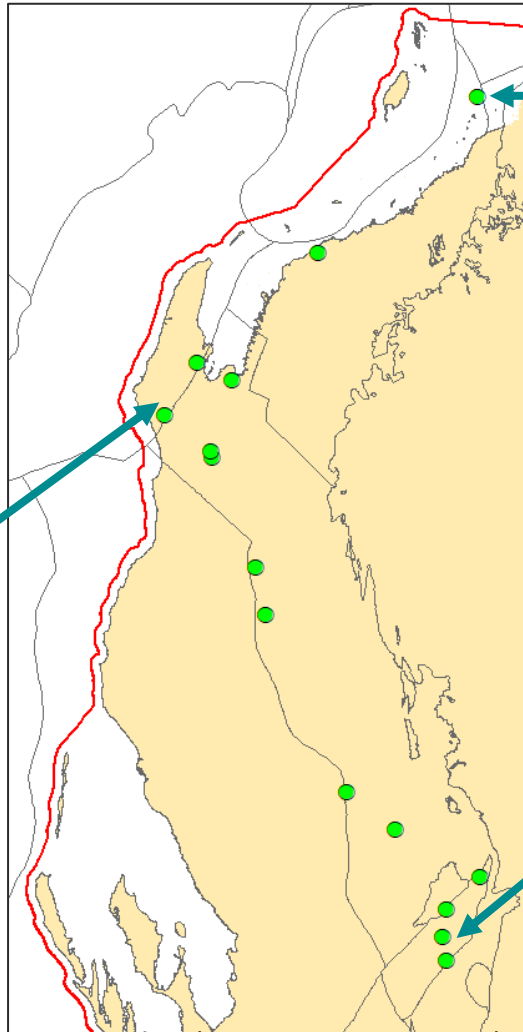
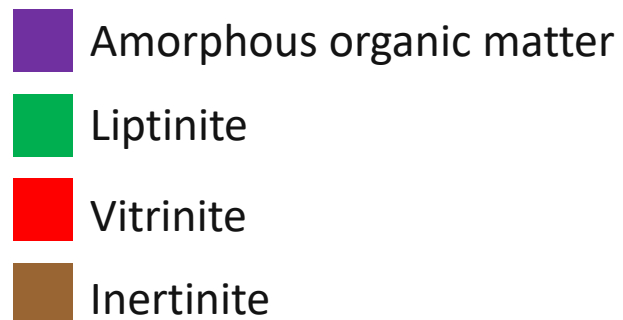
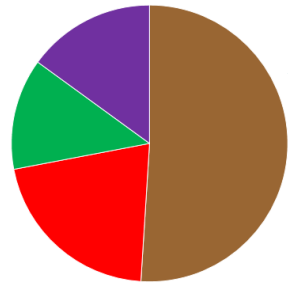
- ◆ Bidgemia 1 ★
- ◆ BMR 08 Glenburgh
- ◆ BMR 09 Glenburgh
- ◆ Burna 1
- ◆ Candace 1
- ◆ Gascoyne 1
- ◆ Giralia 1
- GSWA Ballythanna 1
- ▲ North Giralia 1 ★
- ◆ Onslow 1
- Pioneer Resources Bogadi BORO-06 ★
- ◆ Quail 1
- ◆ Remarkable Hill 1
- ◆ Rough Range 1
- ◆ Whaleback 1 ★

★ New Rock-eval sampling

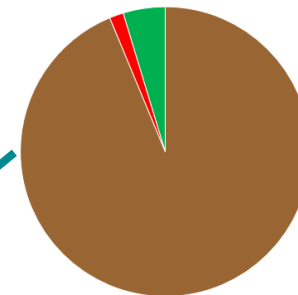
Callytharra Formation

Whaleback 1 – Exmouth Sub-basin

- Possibly 20% amorphous organic matter



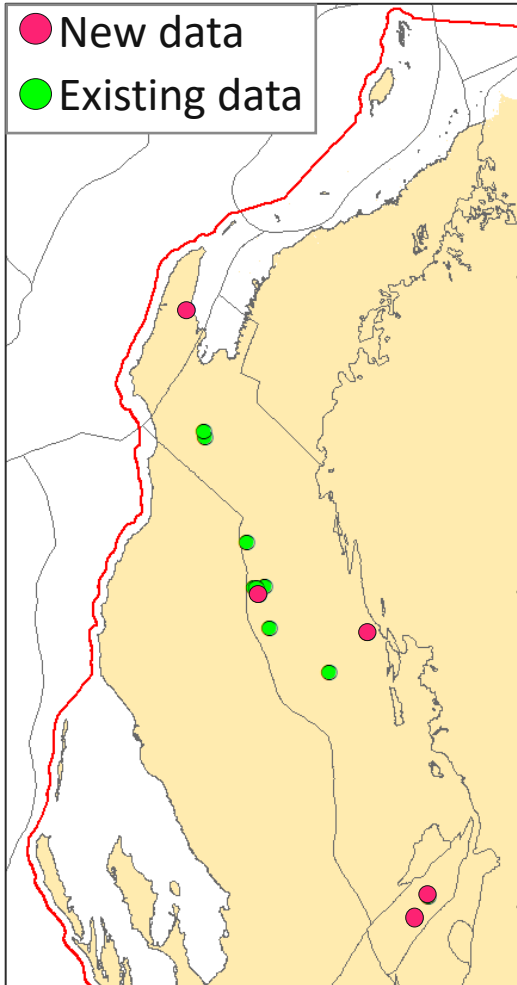
Candace 1 – Peedamullah Shelf



Borc-06 – Byro Sub-basin

- Rare bitumen

Wooramel Group



Age	Stratigraphy		
	Carnarvon Basin		
	Byro Sub-basin	Merlinleigh Sub-basin	Peedamullah Shelf
Triassic			Locker Shale
Late Permian			Chinty Fm
		Binthalya Fm	Kennedy Group
		Mungadan Ss	
		Coolkilya Ss	
Early Permian		Byro Group	? Callytharra Fm
		Wooramel Group	
		Keogh Fm	
		Billidee Fm	
	Ballythanna Ss Mbr	Moogooloo Ss	
	Callytharra Fm	Cordalia Fm	
	Winnamea Ss Mbr		
	Callytharra Fm		
	Lyons Group	Lyons Group	Lyons Group
	Lyons Group	Lyons Group	Lyons Group
	Lyons Group	Lyons Group	Lyons Group

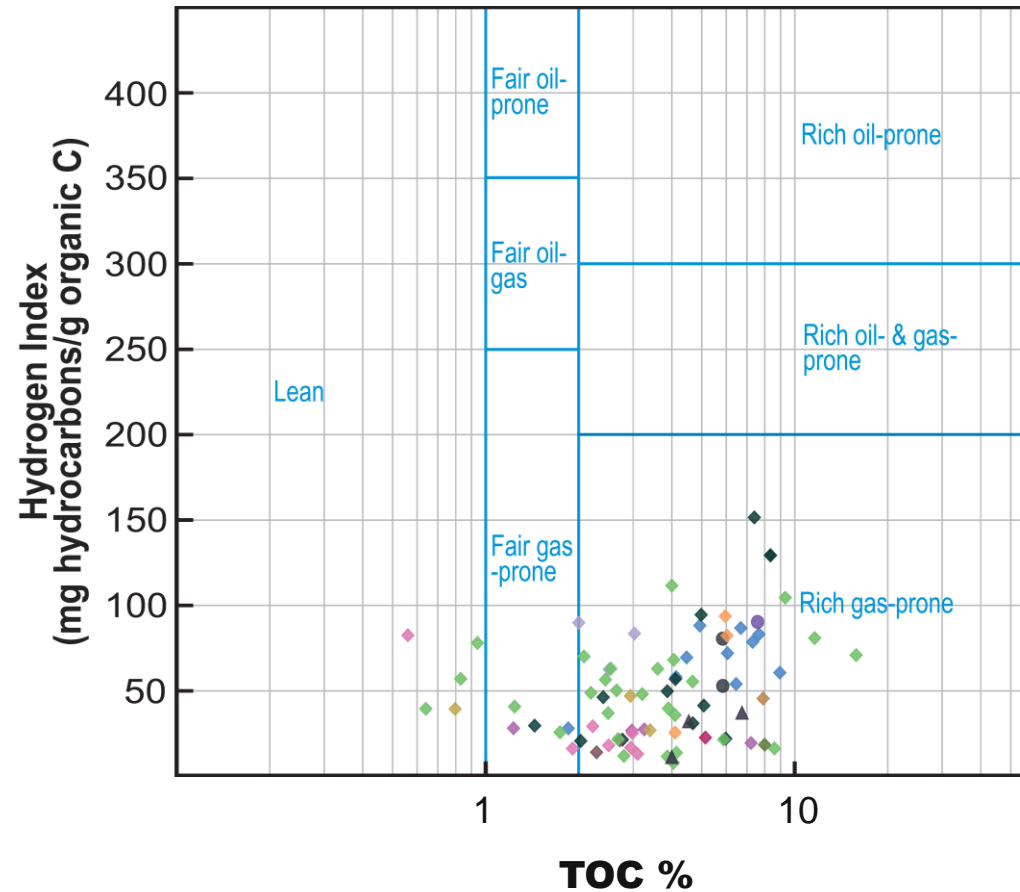
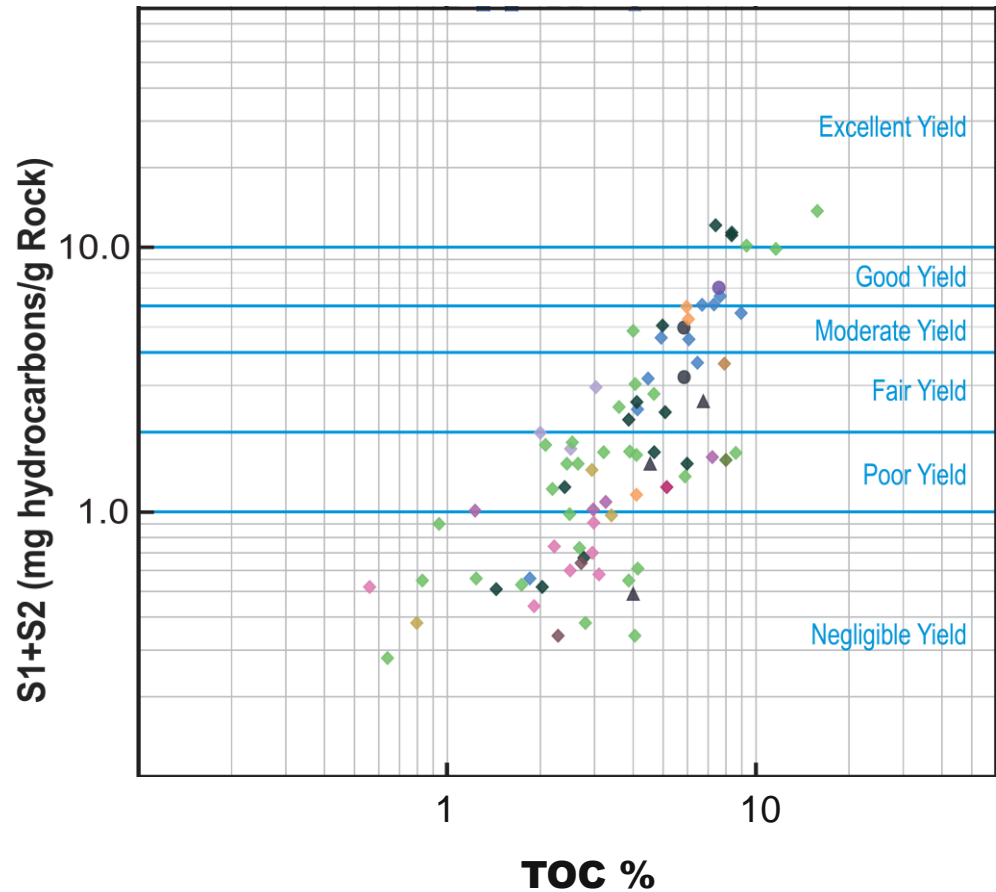
- Marine-deltaic succession interbedded sandstone, shales and coal
 - best gas-prone source rock onshore Carnarvon Basin
- New sampling at eastern edge of Merlinleigh Sub-basin and Byro Sub-basin (no previous data)



5.96 % TOC
 S2 = 5.96 mg HC/g

Wooramel Group

Rock-eval plots – new and existing data



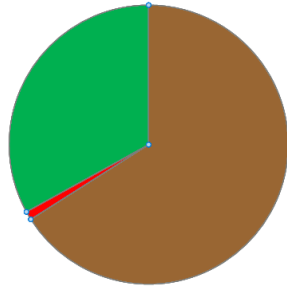
Wooramel Group

- ◆ BHP Wandagee 1
- ◆ BHP Wandagee 6
- ◆ Burna 1
- ◆ CC19 ★
- ◆ CC21 ★
- ◆ GBH4
- ◆ Giralia 1
- ◆ Kennedy Range 1
- ◆ Learmonth 1 ★
- ◆ Moogooree 1 ★
- ◆ Nth Ballythanna 1 ★
- ◆ Nth Ballythanna 3 ★
- ◆ Quail 1
- ◆ Remarkable Hill 1
- ▲ Wooramel Seismic Line 3 SP314 ★

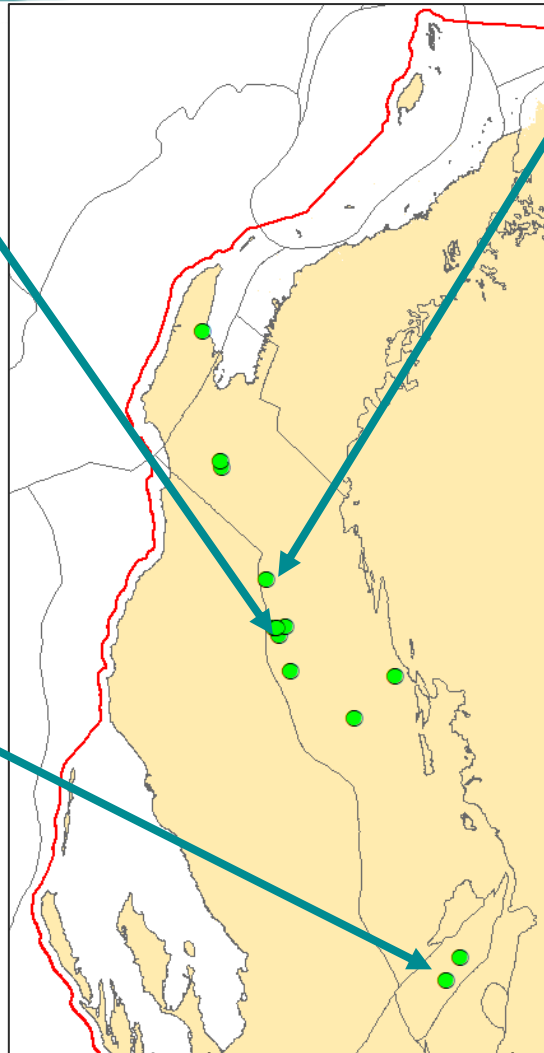
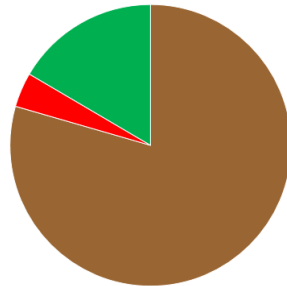
★ New Rock-eval sampling

Wooramel Group

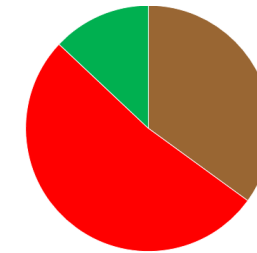
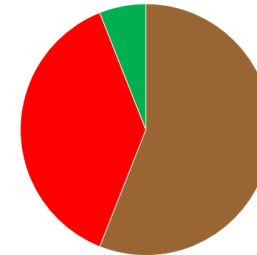
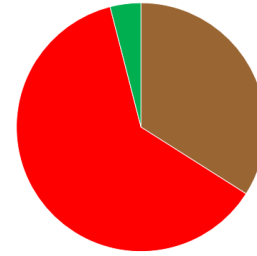
GBH4 coal drillhole – Merlinleigh Sub-basin



Wooramel seismic line – Byro Sub-basin

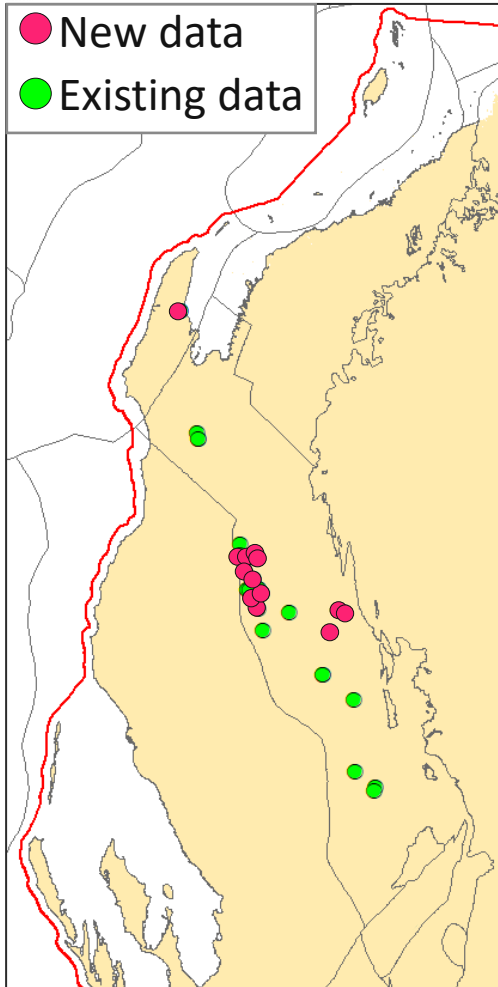


Burna 1 – Merlinleigh Sub-basin



- Liptinite
- Vitrinite
- Inertinite

Byro Group – Lower Permian



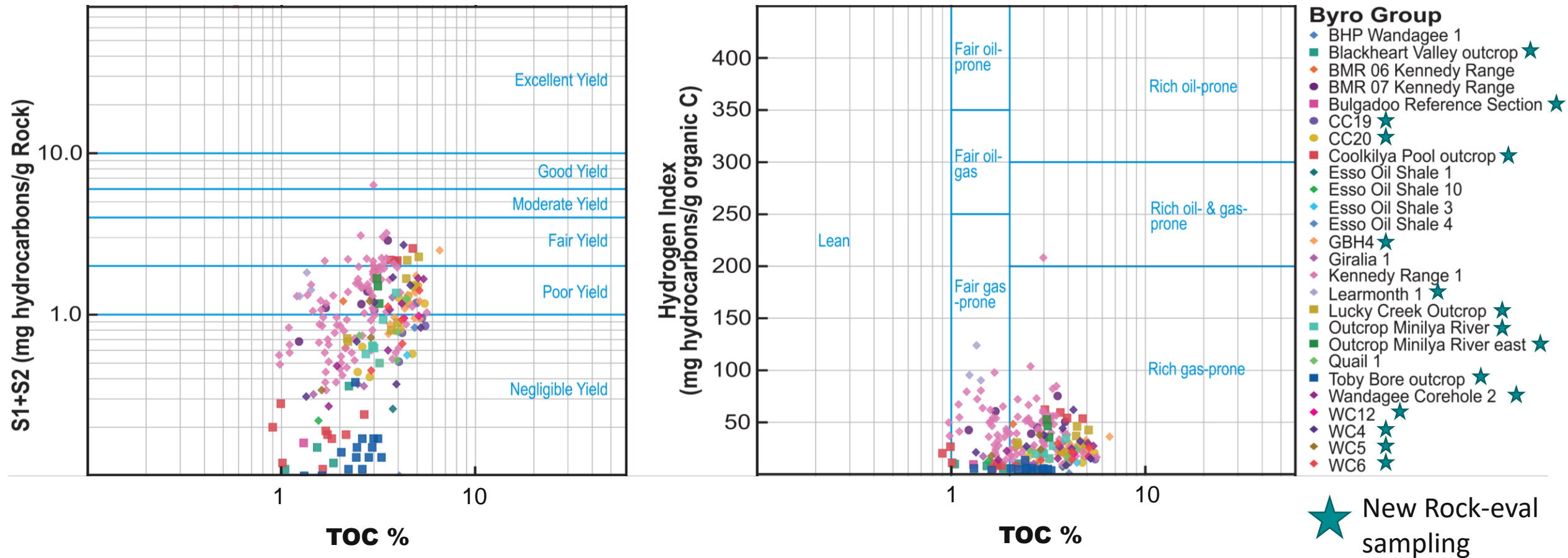
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	Sakmarian	Ballythanna Ss Mbr	Cordalia Fm
Callytharra Fm		Winnamesa Ss Mbr	? Callytharra Fm
Asselian	Lyons Group	Lyons Group	Lyons Group

- Marine succession of shales and sandstones
- New data for sparsely sampled formations



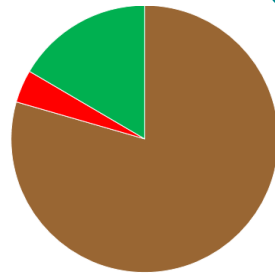
Byro Group

Rock-eval plots – new and existing data

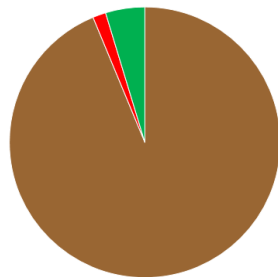


Byro Group

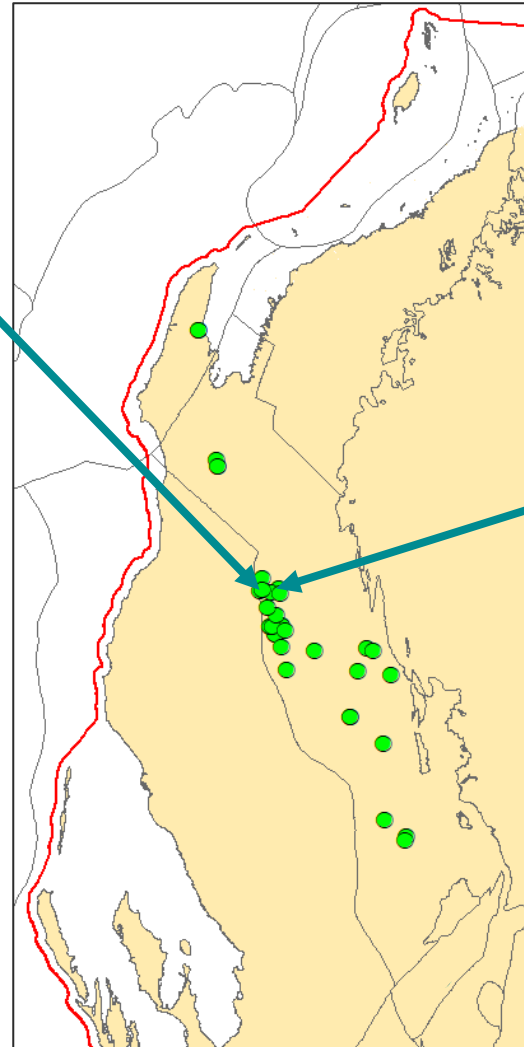
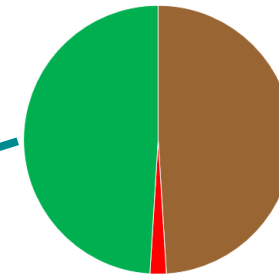
Coolkilya Pool outcrop - Wandagee Fm
Rich gas-prone with fair generating potential



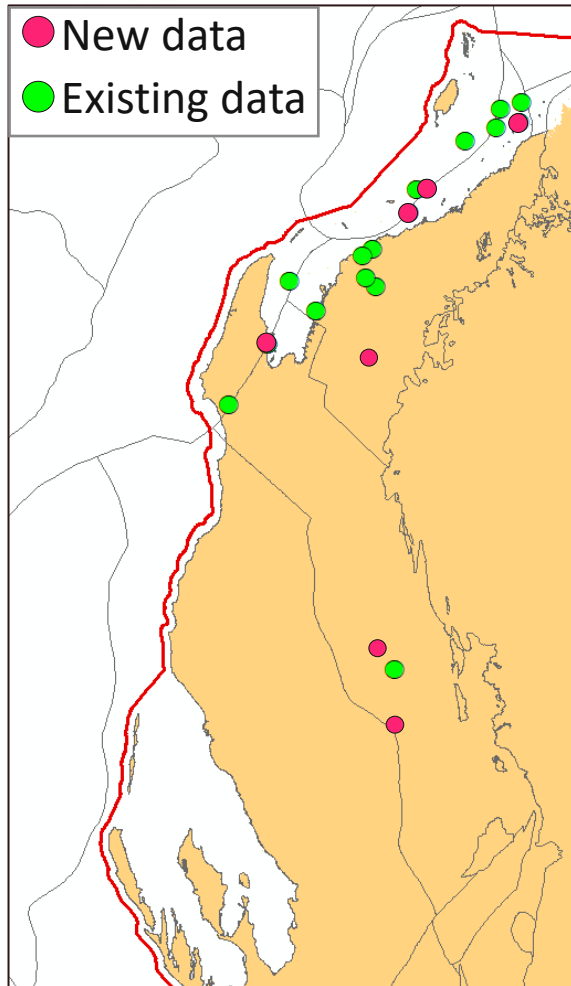
Coolkilya Pool outcrop - Quinanie Shale
Poor source rock



Minilya River outcrop - Bulgadoo Shale



Kennedy Group – Upper Permian

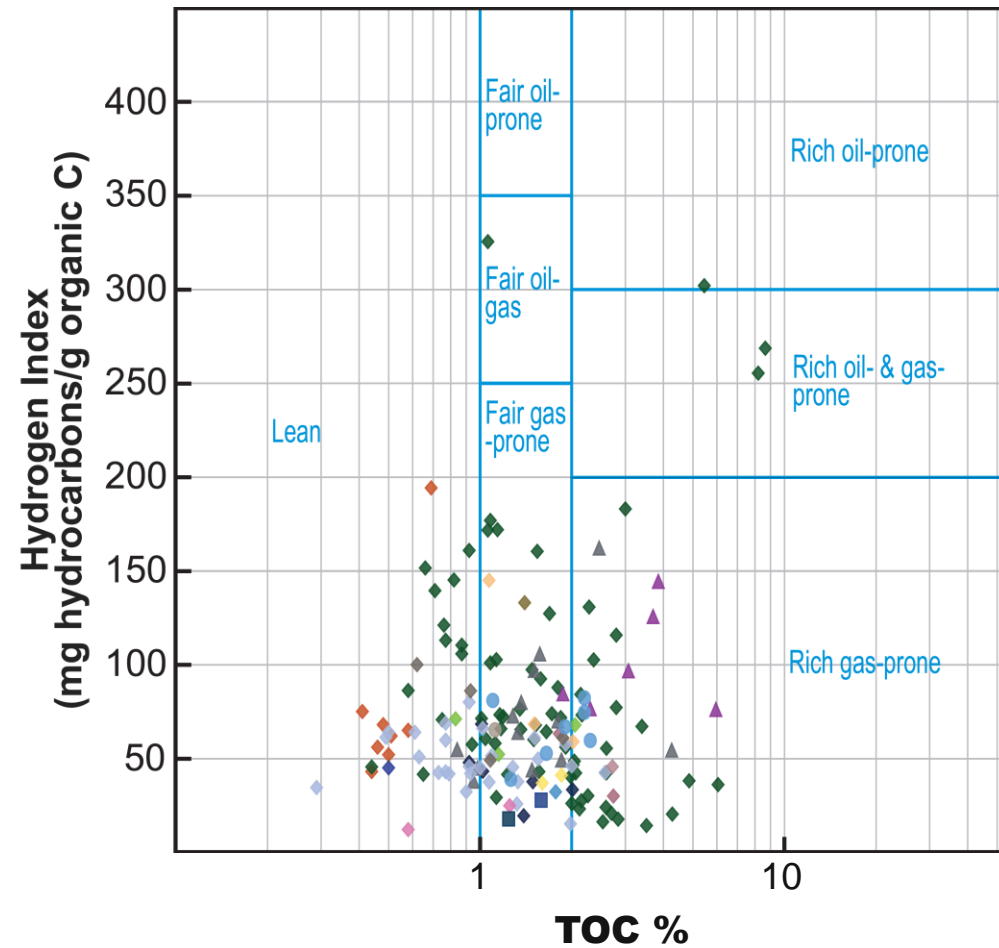
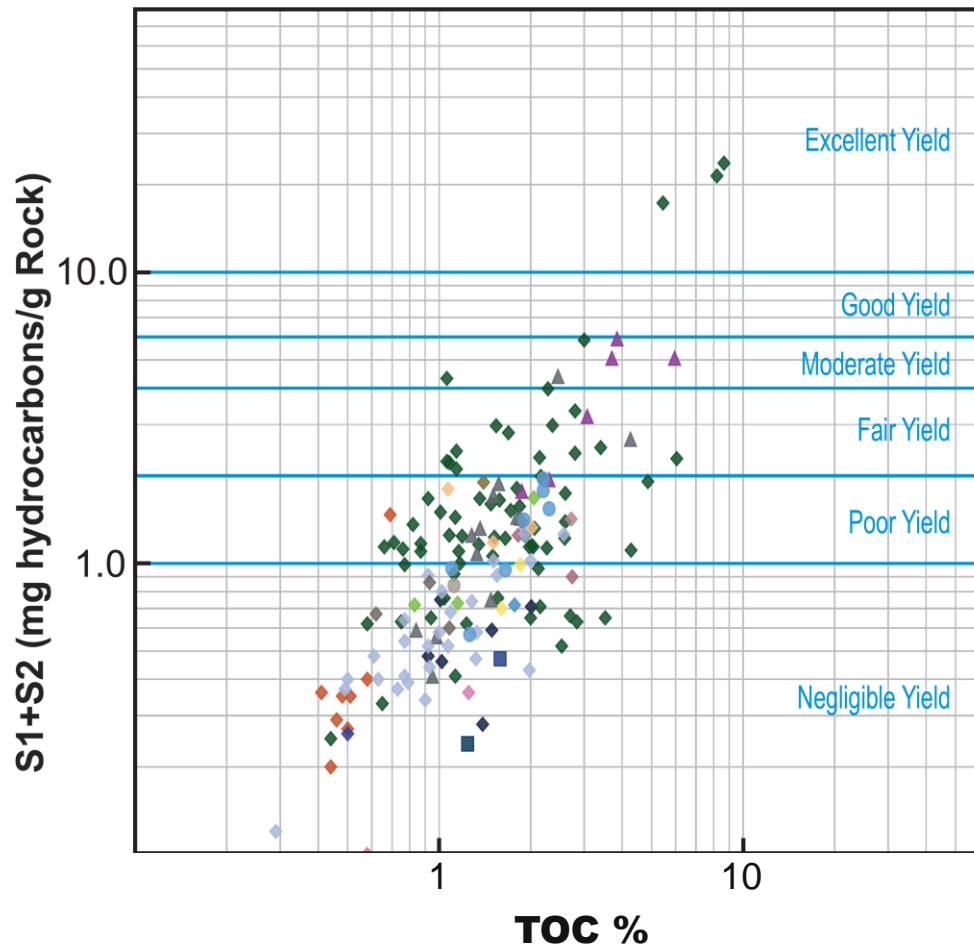


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	Artinskian	Byro Group	
		Wooramel Group	Billidee Fm
		Keogh Fm	Moogooloo Ss
		Woonamal Group	Moogooloo Ss
			Cordalia Fm
Sakmarian	Ballythanna Ss Mbr	Callytharra Fm	? Callytharra Fm
	Callytharra Fm		
Asselian	Lyons Group	Lyons Group	Lyons Group

- Marine-deltaic succession, sand-dominated in south, increase in shales to the north
- Only Permian source rock with thin oil-prone source intervals
 - Intervals confined to NE Peedamullah Shelf

Kennedy Group

Rock-eval plots – new and existing data

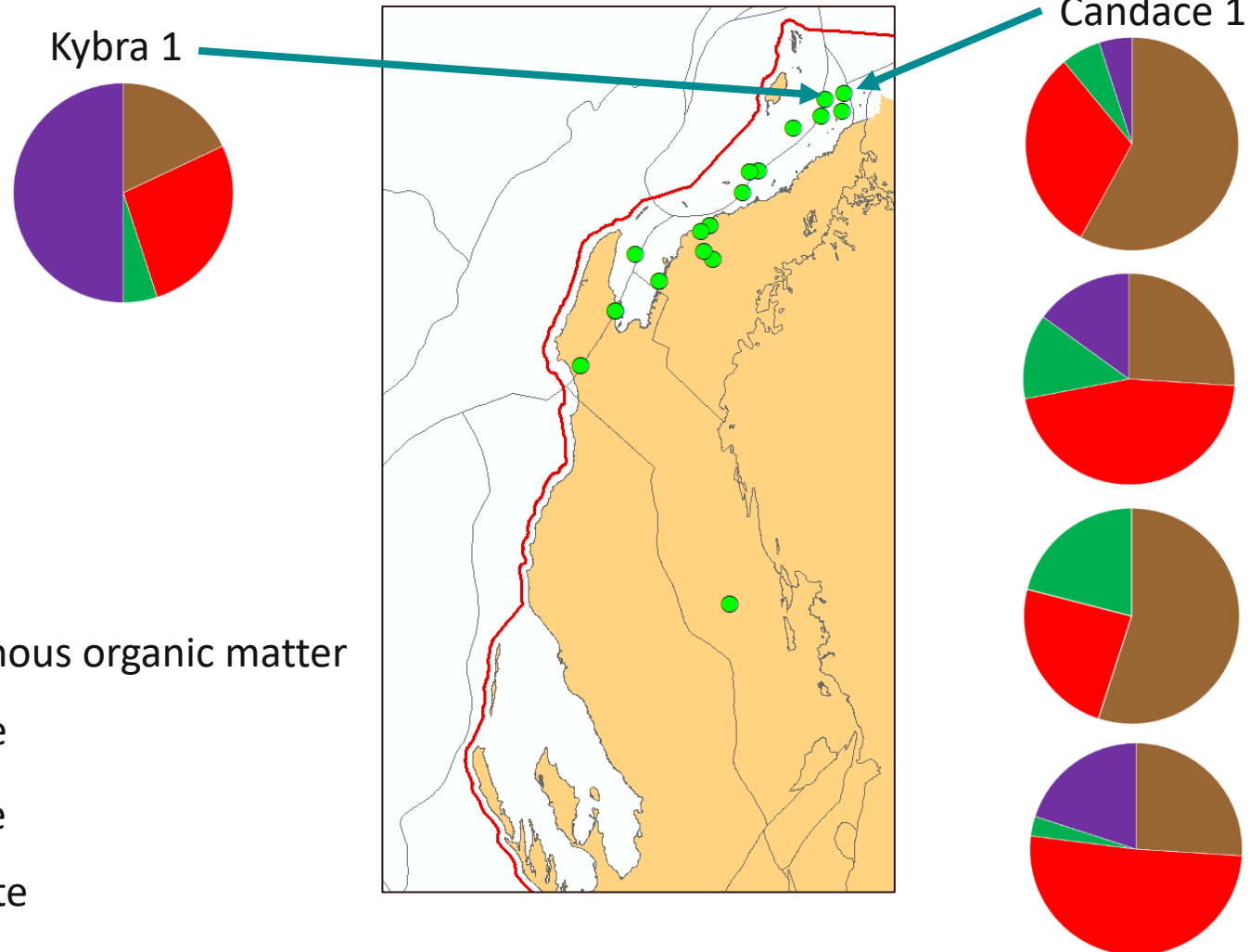


Kennedy Group

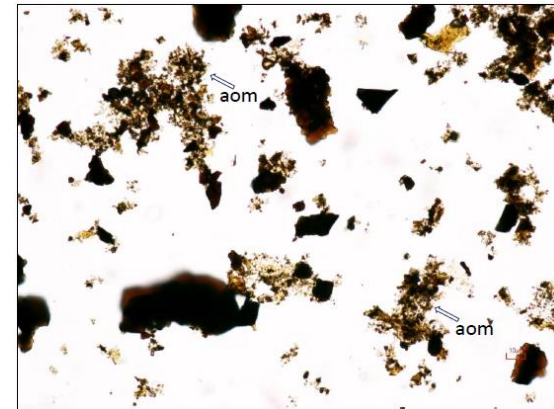
- ◆ Abduls Dam 1
- ◆ Arabella 1
- ◆ Candace 1
- ◆ Cody 1
- ◆ Dillson 1
- ◆ Direction Island 1 ★
- ◆ Fennel 1
- ▲ Flinders Shoal 1
- ◆ Fortescue 1 ★
- ◆ Hope Island 1
- ◆ Kennedy Range 1
- ◆ Kybra 1
- ◆ Lefroy Hill 1 ★
- ◆ Lever section 24 outcrop ★
- ◆ Lindsay 1 ★
- ◆ Onslow 1
- ◆ Outcrop Watermelon Creek ★
- Sandalwood 1
- ◆ Sholl Island 1
- ◆ Wonangarra 1

★ New Rock-eval sampling

Kennedy Group



- Nearly all samples contain “amorphous organic matter”



Summary

- Rich Permian source rocks more widespread than previously known with fair to excellent generative potential
- Possibly more potential for liquids than simple Rock-eval plots would suggest
- More work needed to understand “amorphous organic matter” component of source rocks