

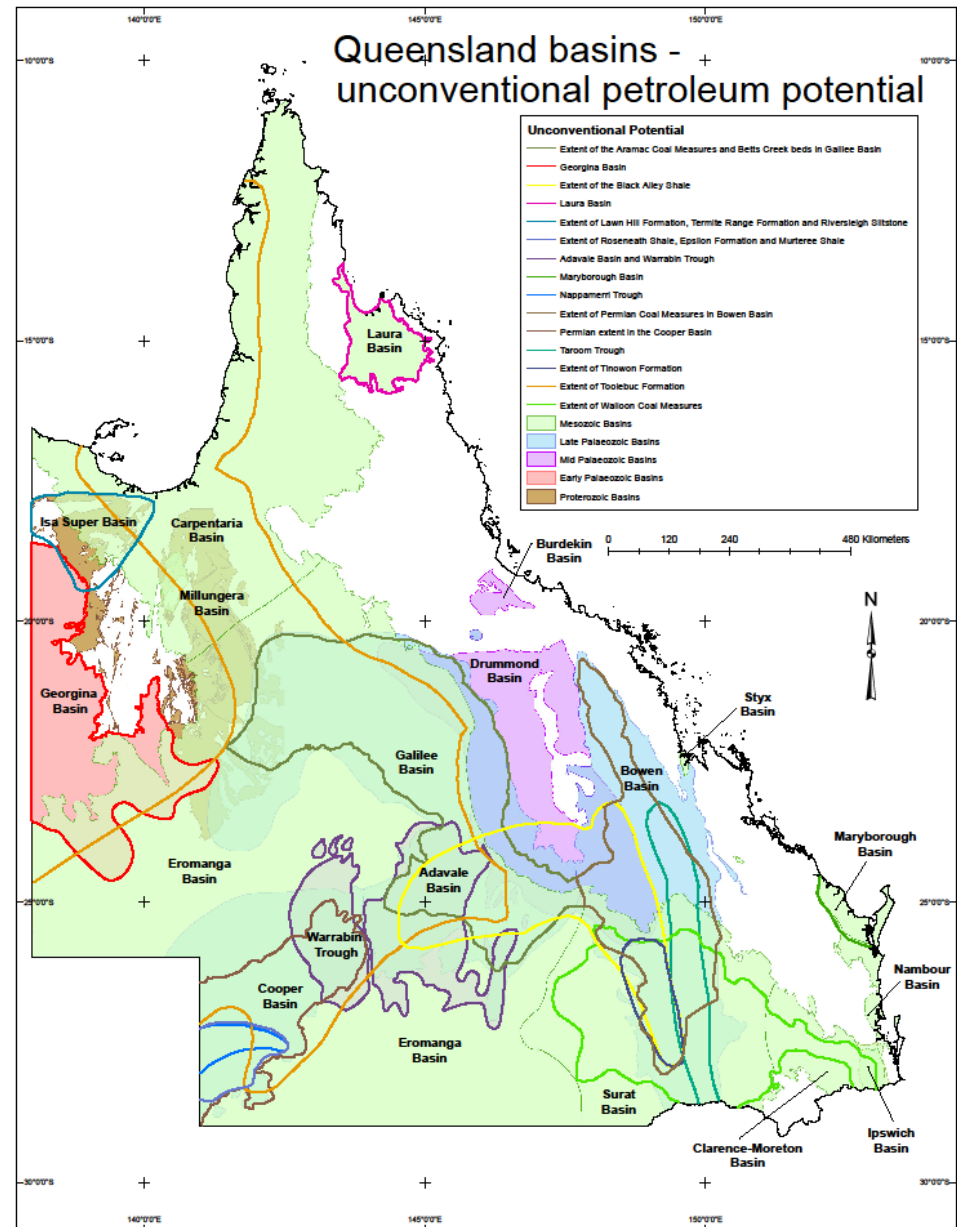


Toolebuc Formation - unconventional hydrocarbon potential

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Geological Survey of Queensland

Unconventional Petroleum Assessment

- Review of basins and formations across Queensland for unconventional petroleum potential
- Desktop based study highlighted the Toolebuc Formation as possibly representing a new unconventional petroleum exploration target.

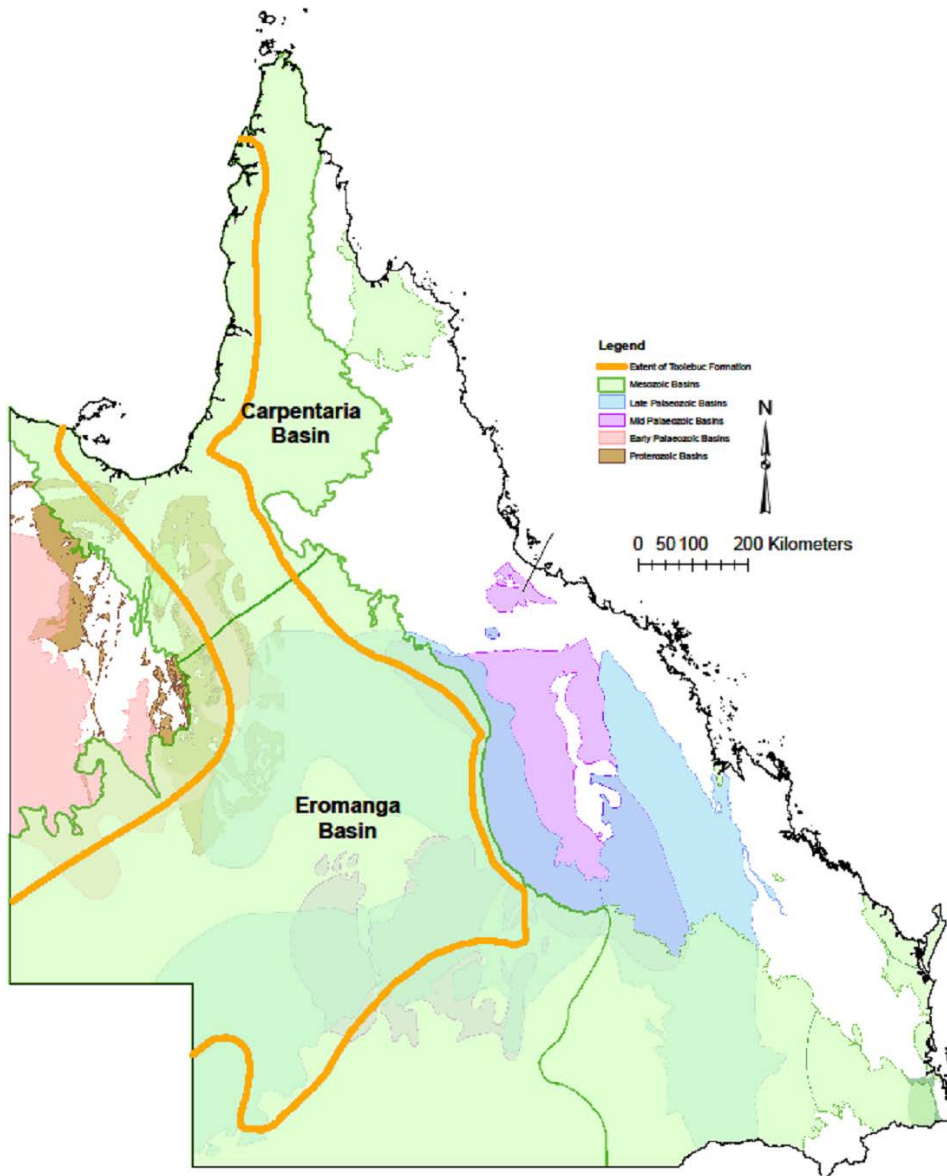


Regional Assessment



- **USGS Minimum Requirements for Shale Gas assessment**
 - Net thickness > 15m
 - TOC >2 wt %
 - Kerogen type I, II or IIS
 - Ro > 1.1% (formation within the gas window)
 - Gas is thermogenic
 - Evidence of gas in matrix/organic storage

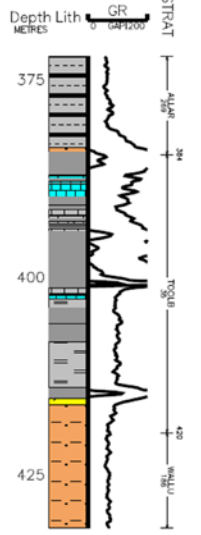
Toolebuc Formation



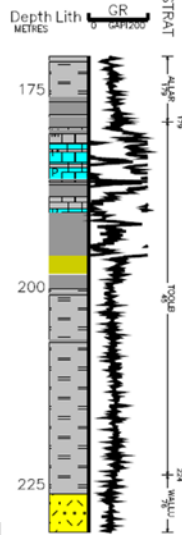
- Early Cretaceous marine formation
- Laminated calcareous and kerogenous mudstone, with minor coquinitic limestone and labile sandstone
- Organic rich marine source rock
- Known for oil shale potential around Julia Creek.
- Distinctive high gamma-ray anomaly
- Typically considered to have low maturity
- Gas shows known from mudlogs

Lithological Framework

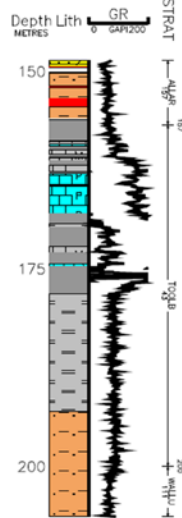
GSQ NORMANTON 1



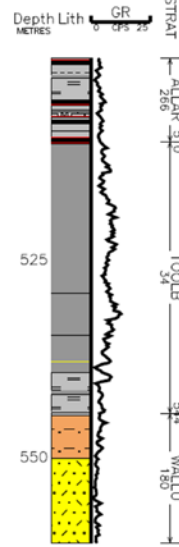
GSQ DOBBYN 2



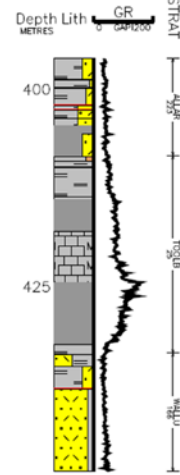
GSQ JULIA CREEK 1



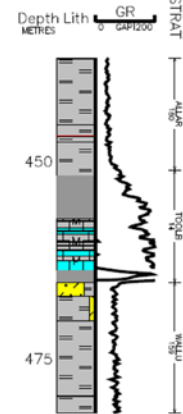
GSQ MANUKA 1



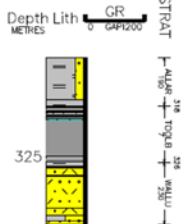
GSQ MUTTABURRA 1



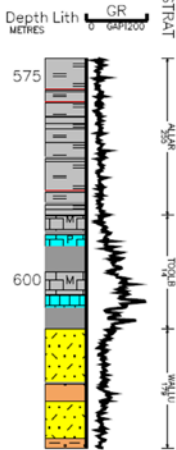
GSQ LONGREACH 1-1B



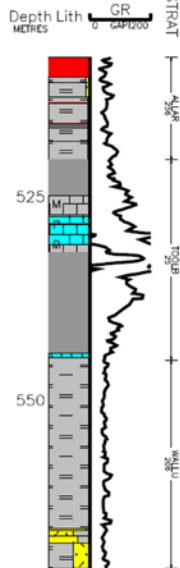
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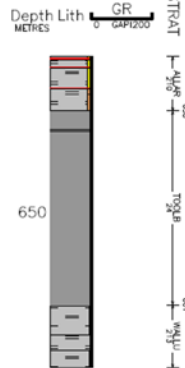
GSQ CONNEMARA 1



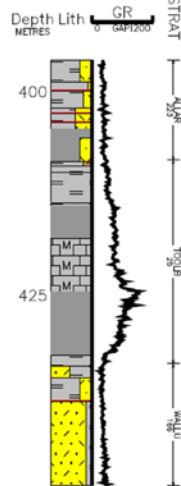
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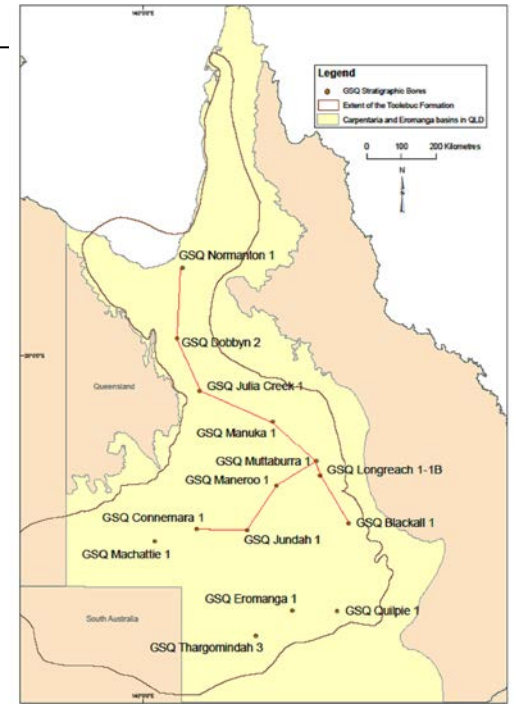
GSQ MANEROO 1



GSQ MUTTABURRA 1

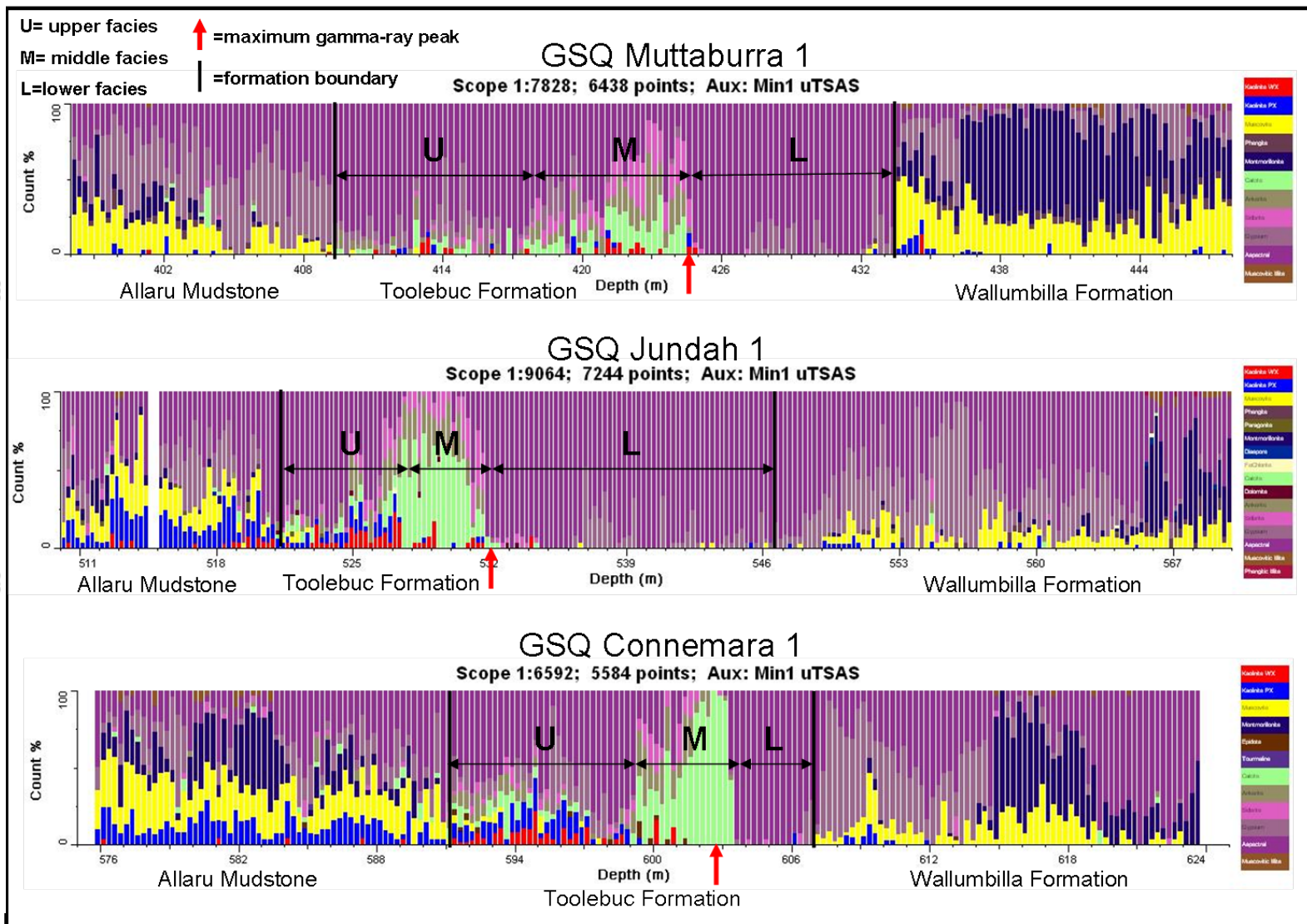
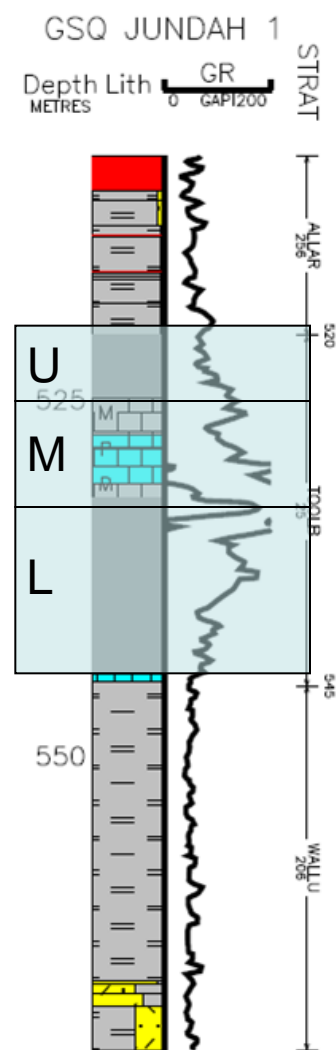


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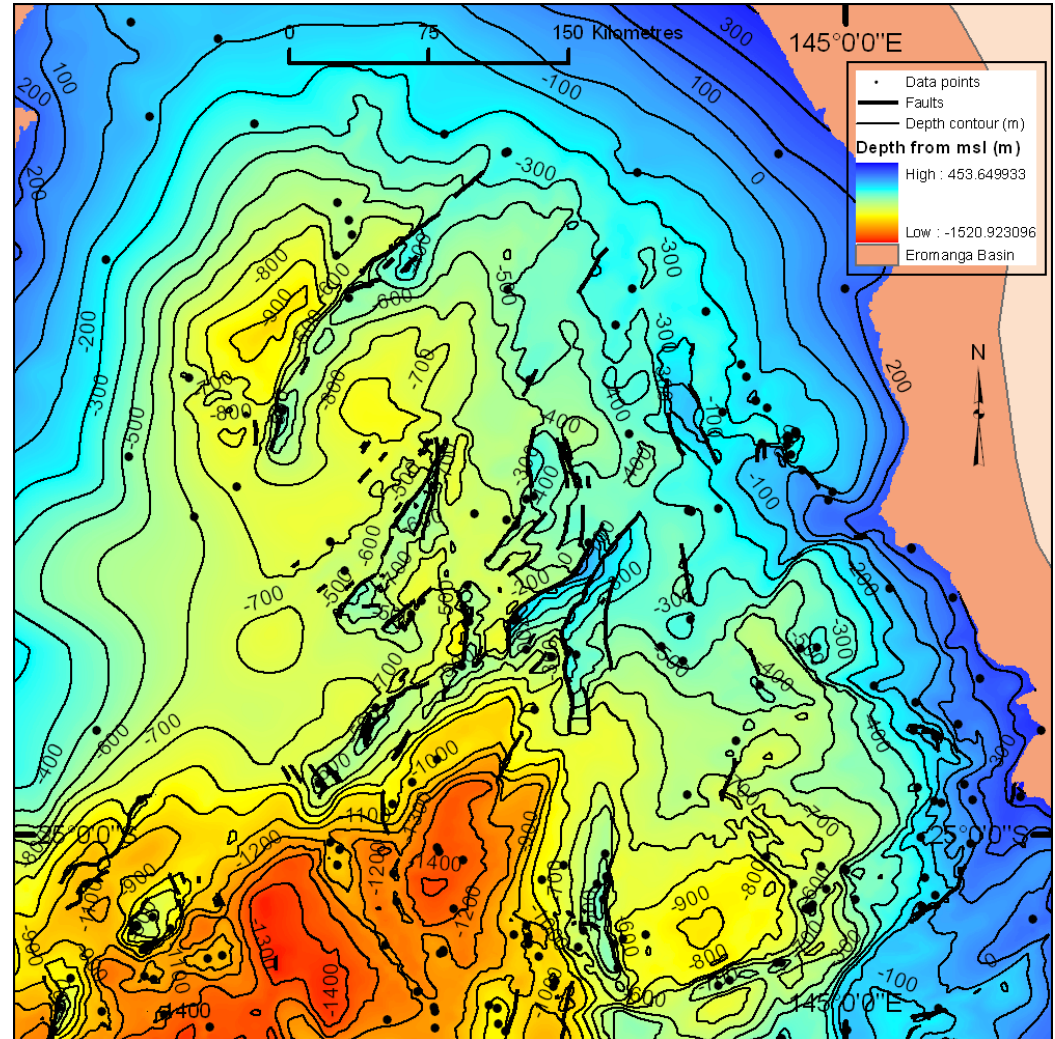
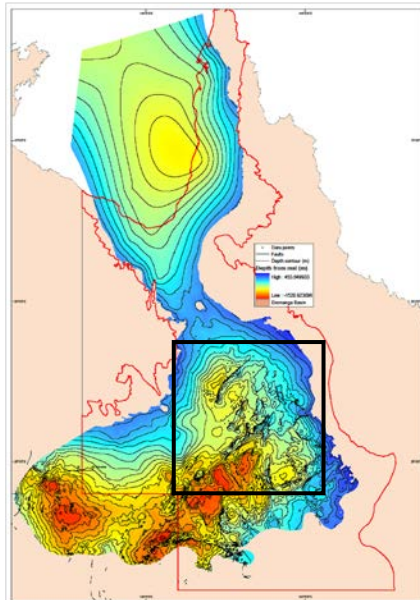
Datum: Top Toolebuc Formation

Mineralogy



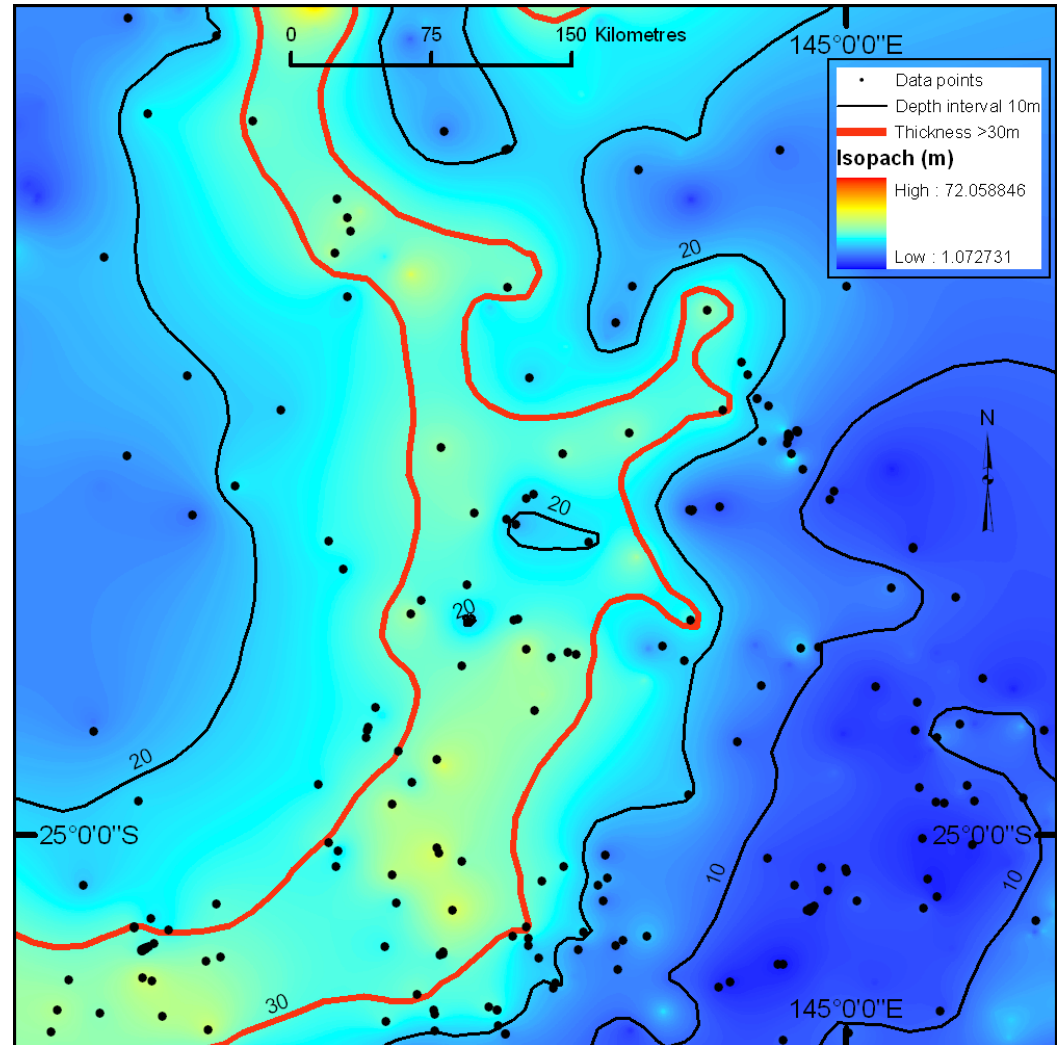
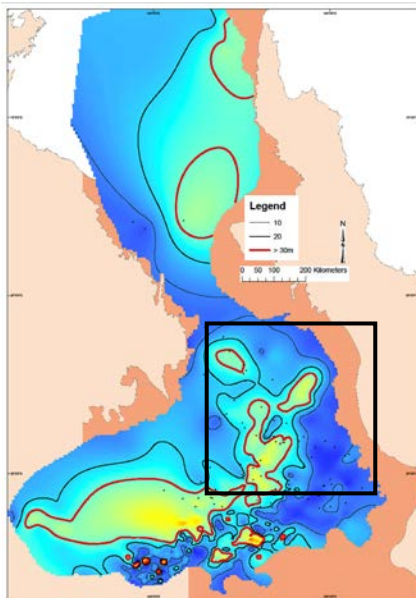
Depth (m from mean sea level)

- Relatively shallow
 - Outcrop to approximately 1500m
- Deepens to the south-west
- Shallows over the Eureka Ridge



Thickness

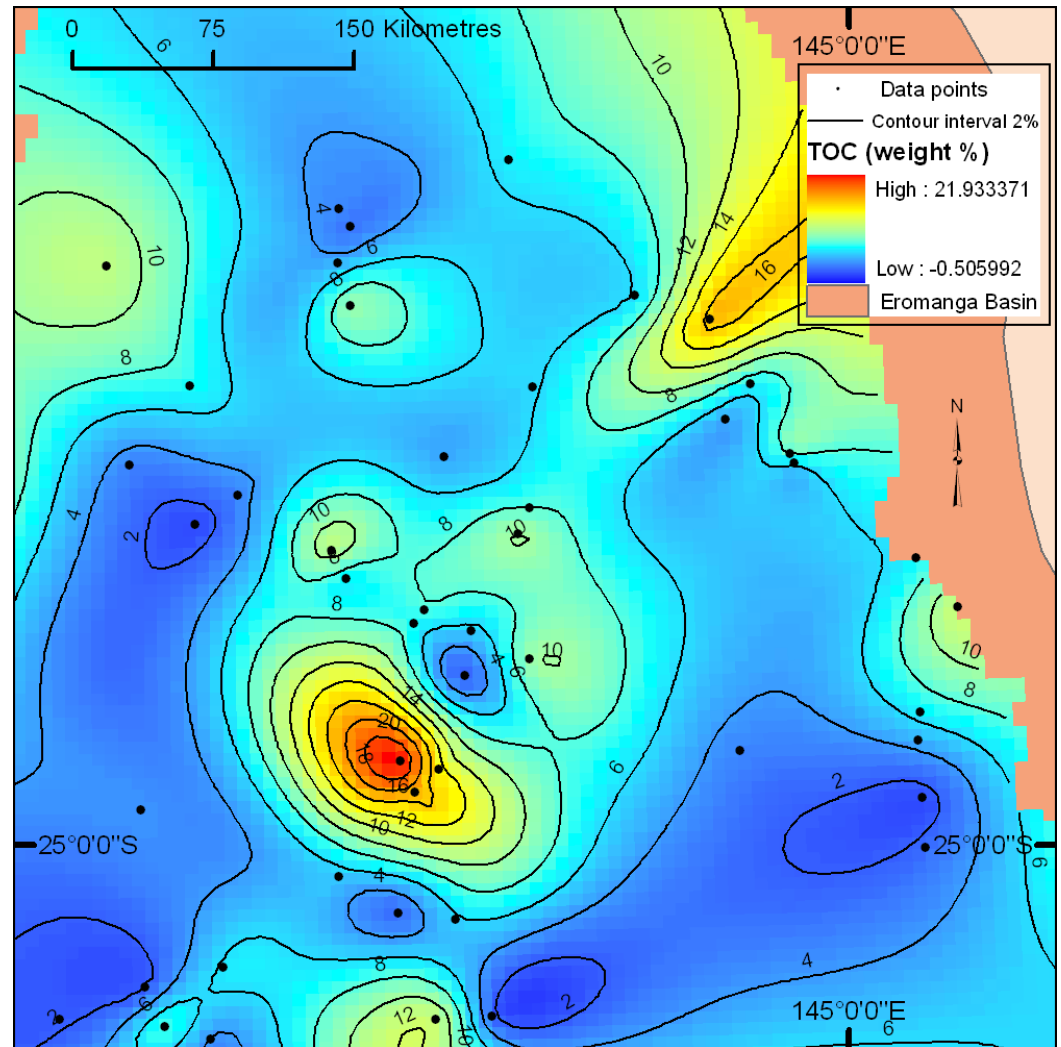
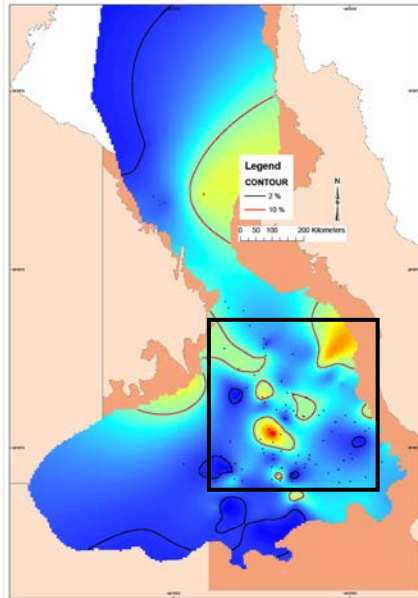
- Average thickness of 23m across the formation
- Formation is generally thicker over the central Eromanga Basin



— Thickness >30m

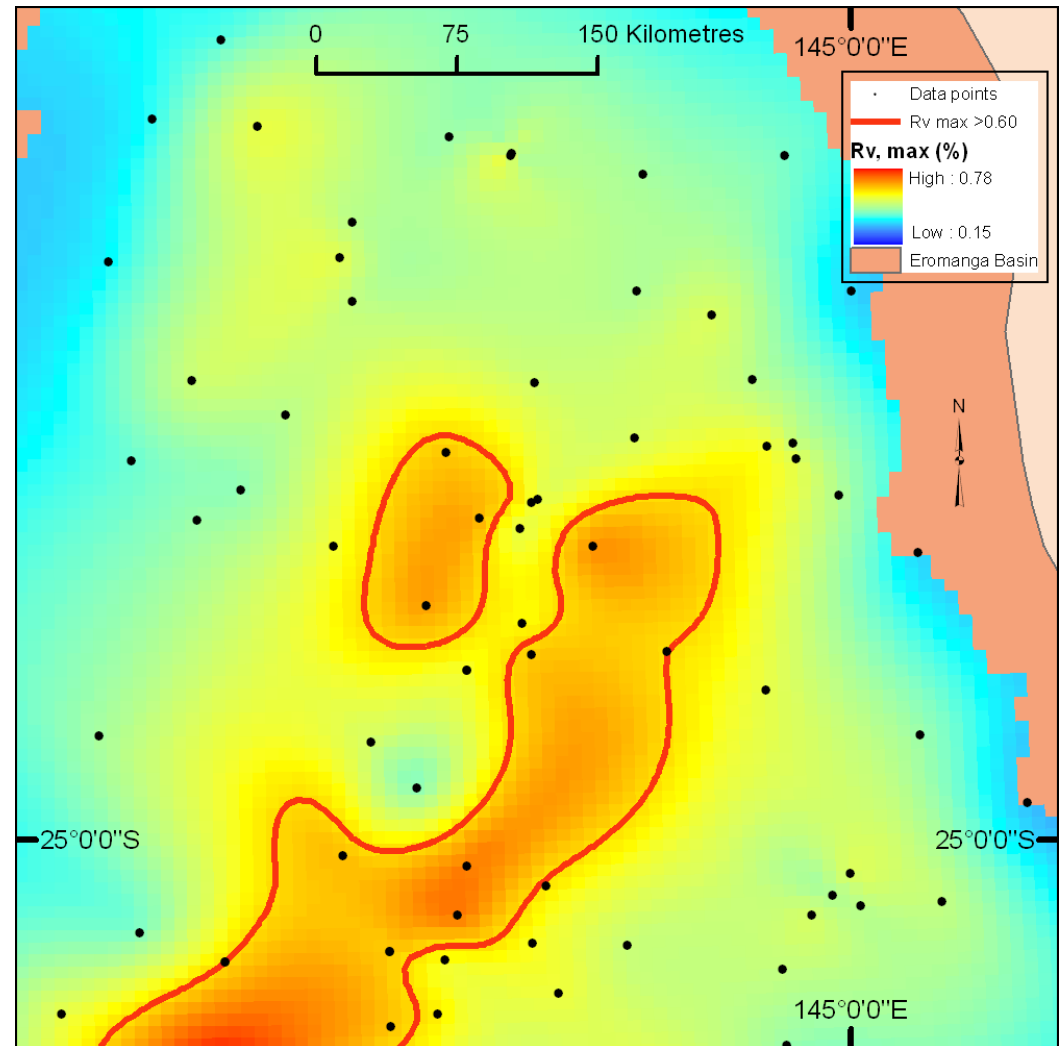
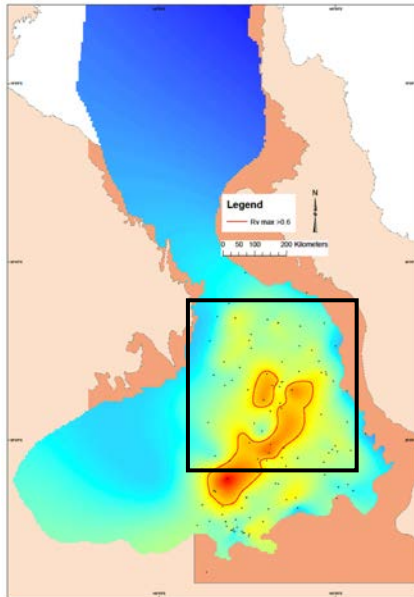
TOC

- TOC ranging from 0.2-26.1 wt %
- Pyrolysis data used where available
 - $\Delta \log R$ Passey equation used as an additional data source
- Exceeds 2 wt% across nearly all of the formation



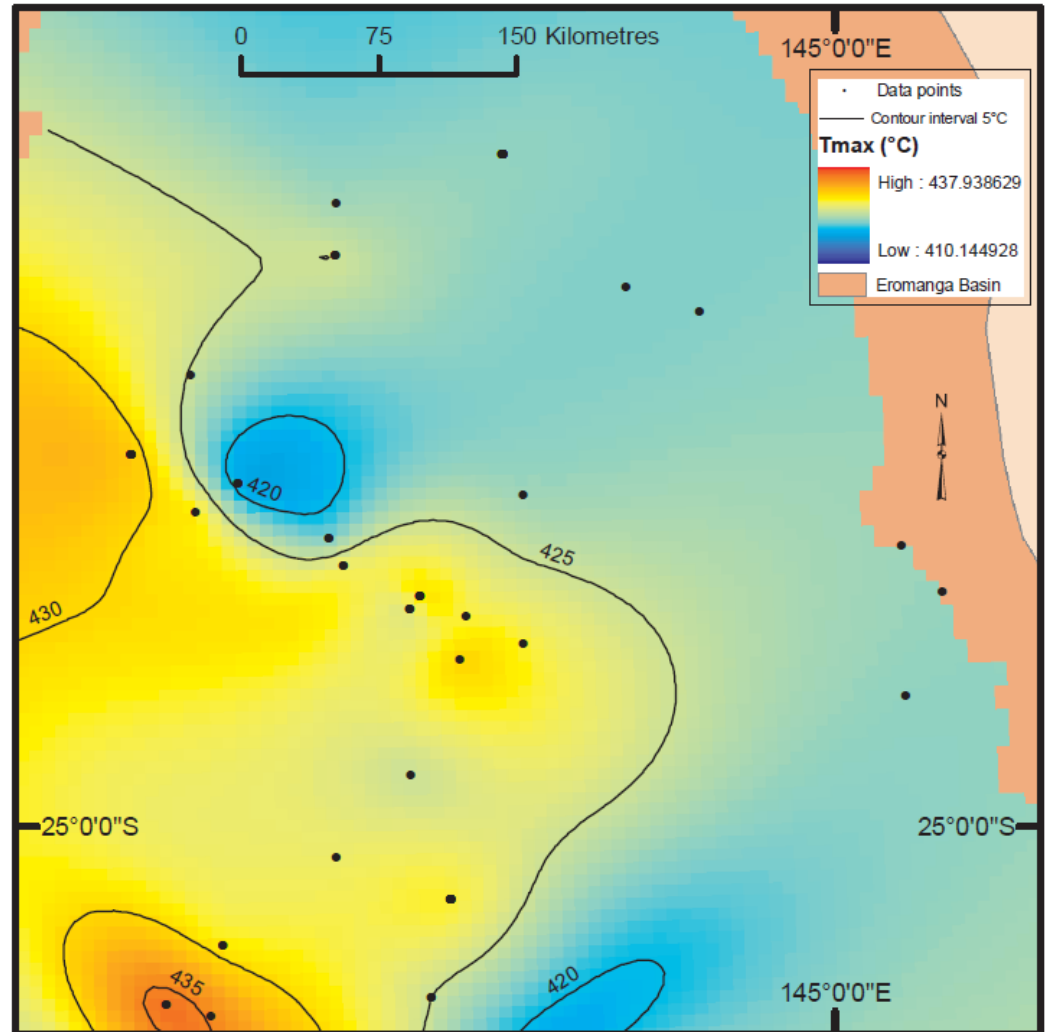
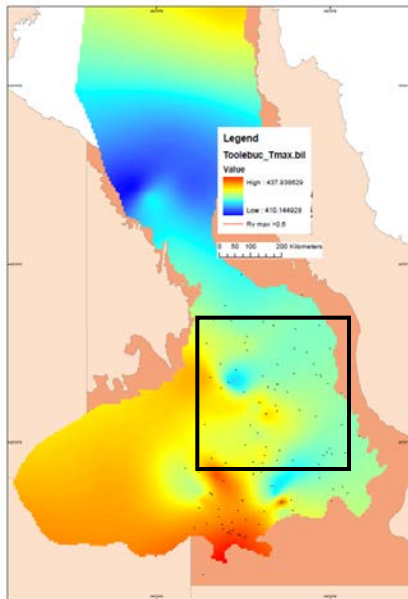
Thermal Maturity

- Rv_{max} has been estimated from reflectance profiles established from petroleum wells across the Eromanga Basin
- Ranges from 0.20 to 0.78%
- Zone of higher maturity through the deeper part of the study area



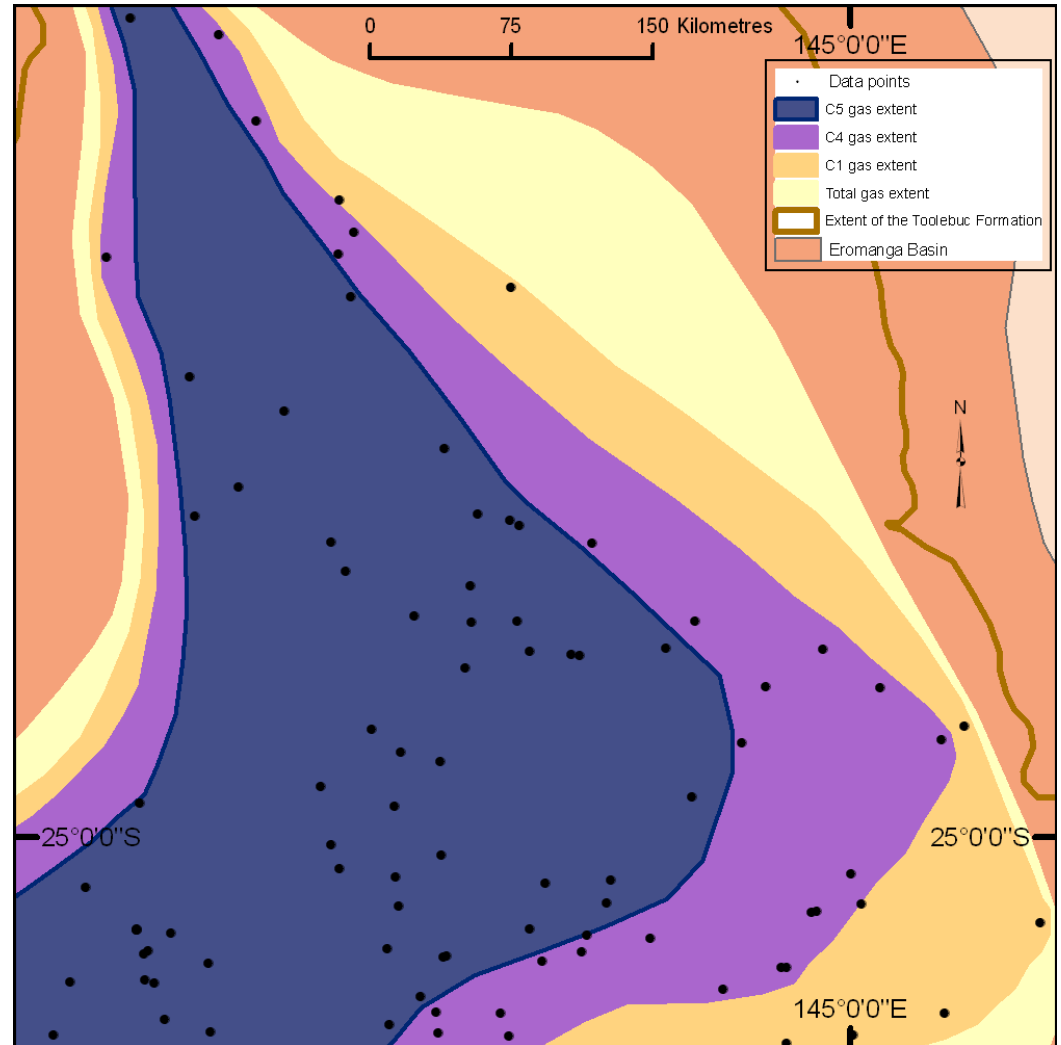
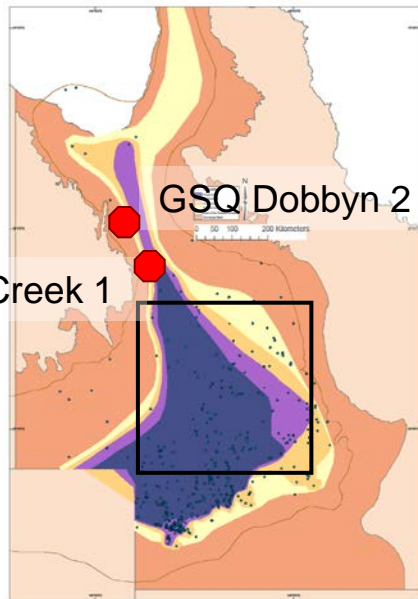
Thermal Maturity

- Tmax (°C) data suggests only small areas are mature for generation
- Limited pyrolysis data are available across the formation.

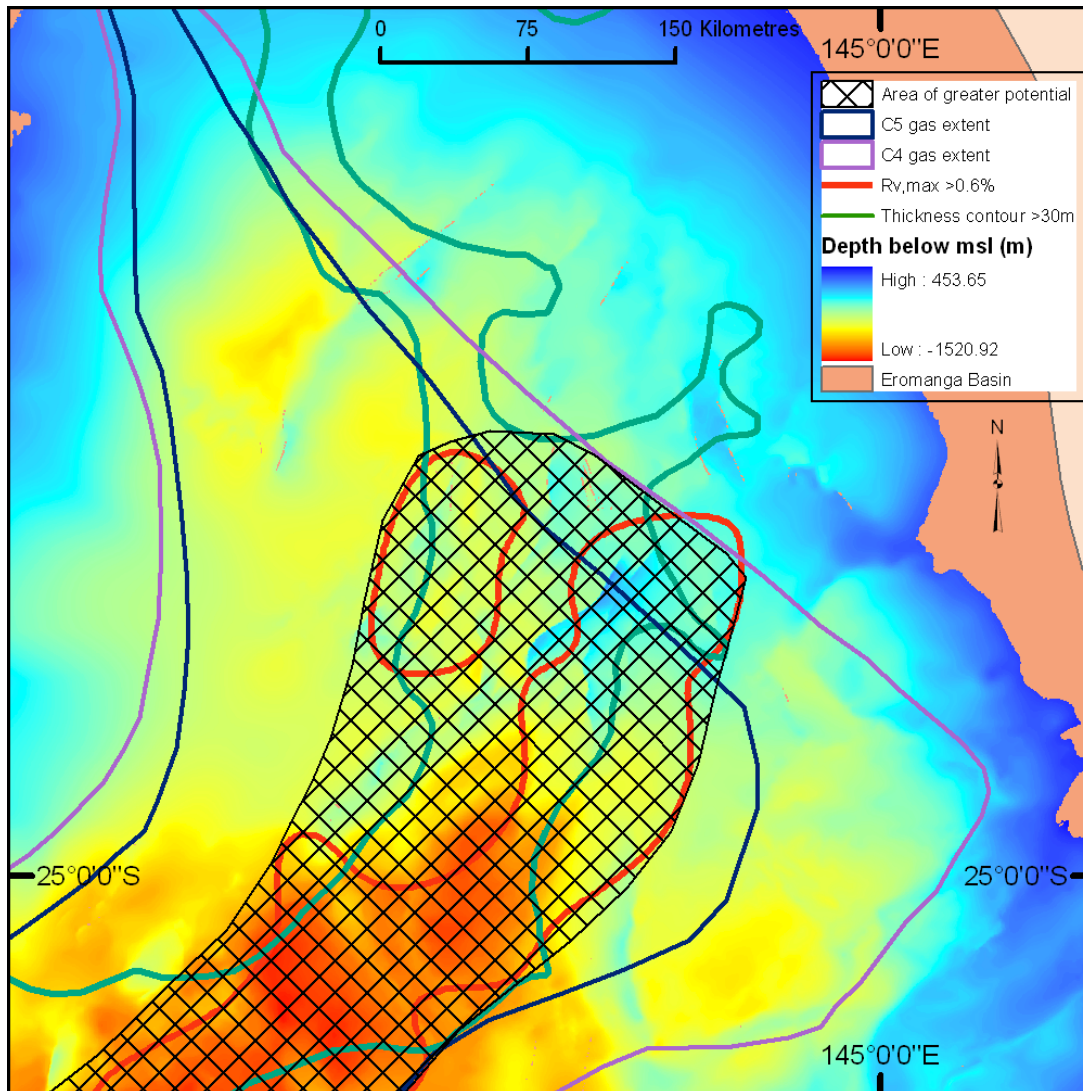


Gas Composition

- Methane present across the Toolebuc Formation where depths are greater than 300m
- Gasses up to C5 are present where depths are greater than 600m.
 - C4 and C5 also occur to the north, where the formation is much shallower

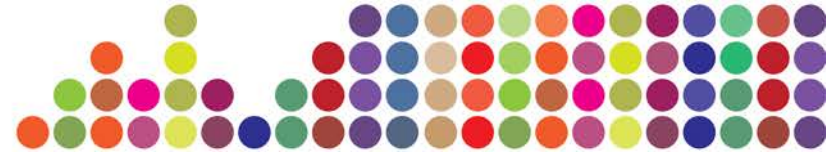


'Sweet Spot'



- **USGS Minimum Requirements for Shale Gas assessment**
 - ✓ **Net thickness > 15m**
 - ✓ **TOC >2 wt %**
 - ✓ **Kerogen type I, II or IIS**
 - $R_o > 1.1\%$ (formation within the gas window)
 - ✓ **Gas is thermogenic**
 - ✓ **Evidence of gas in matrix/organic storage**

Summary



- The Toolebuc Formation is regionally extensive and relatively shallow across the Eromanga and Carpentaria basins
- The extent, thickness, lithology, organic content and maturity show similarities to successful plays in North America
- Key criteria overlap in the central Eromanga Basin

