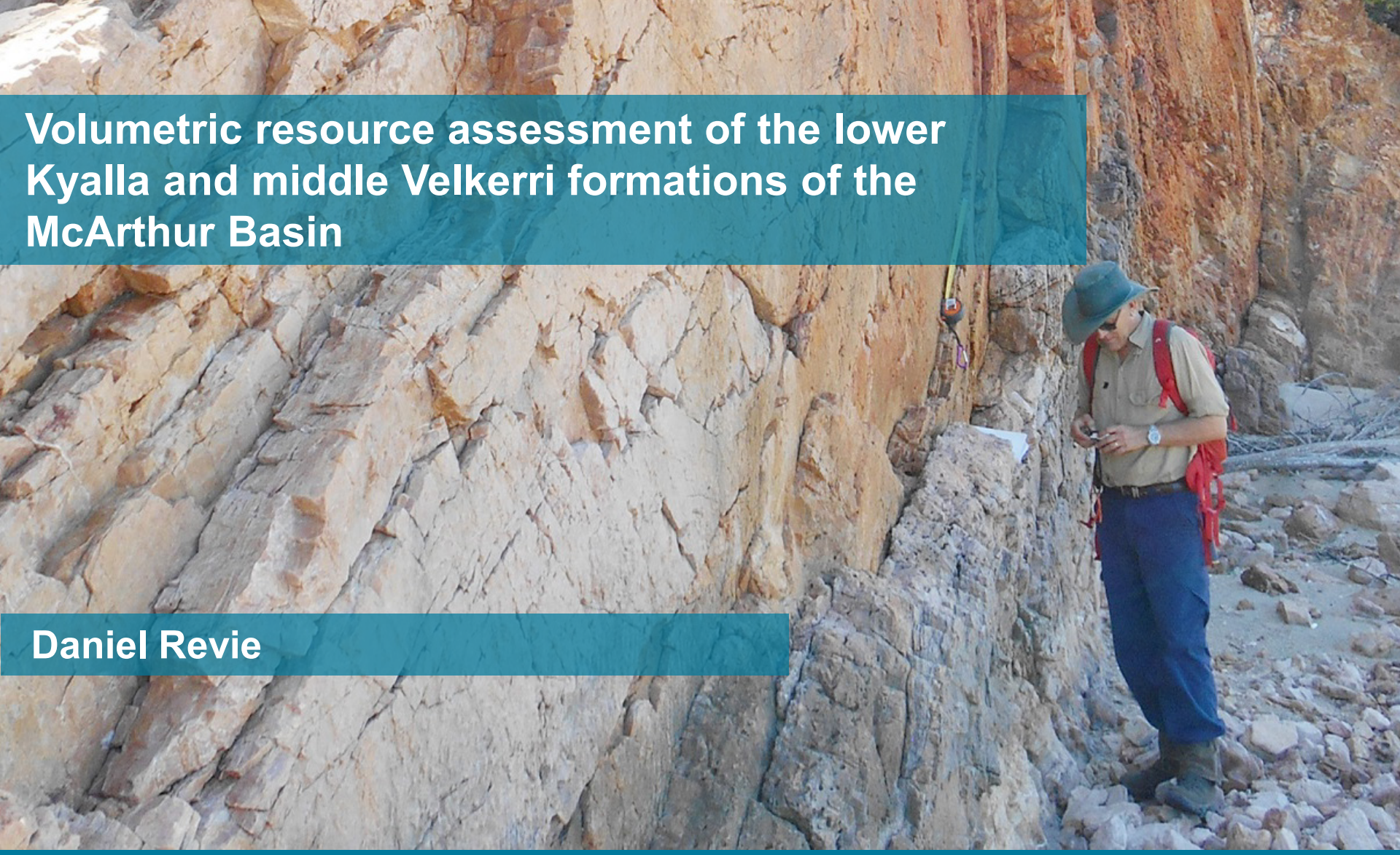
Volumetric resource assessment of the lower Kyalla and middle Velkerri formations of the McArthur Basin



Daniel Revie

AUSTRALIA'S NORTHERN TERRITORY

NORTHERN TERRITORY GEOLOGICAL SURVEY
AGES2017
ANNUAL GEOSCIENCE EXPLORATION SEMINAR
Alice Springs, 28–29 March 2017, Northern Territory

NTGS
greater McArthur Basin shale study

- provide valuable datasets to assist with mineral and hydrocarbon exploration
  - Moving from imprecision to a more robust dataset
- estimate the resources in place in the greater McArthur Basin; P10, P50 and P90 values for Oil In Place (**OIP**) and Gas In Place (**GIP**)
- The government can quote this resource to support science-based decision making with repeatable assessment volumes
- Resource unrestrained by tenement boundaries
- Publicly available dataset – Digital Information Package 014

Certainty in estimation

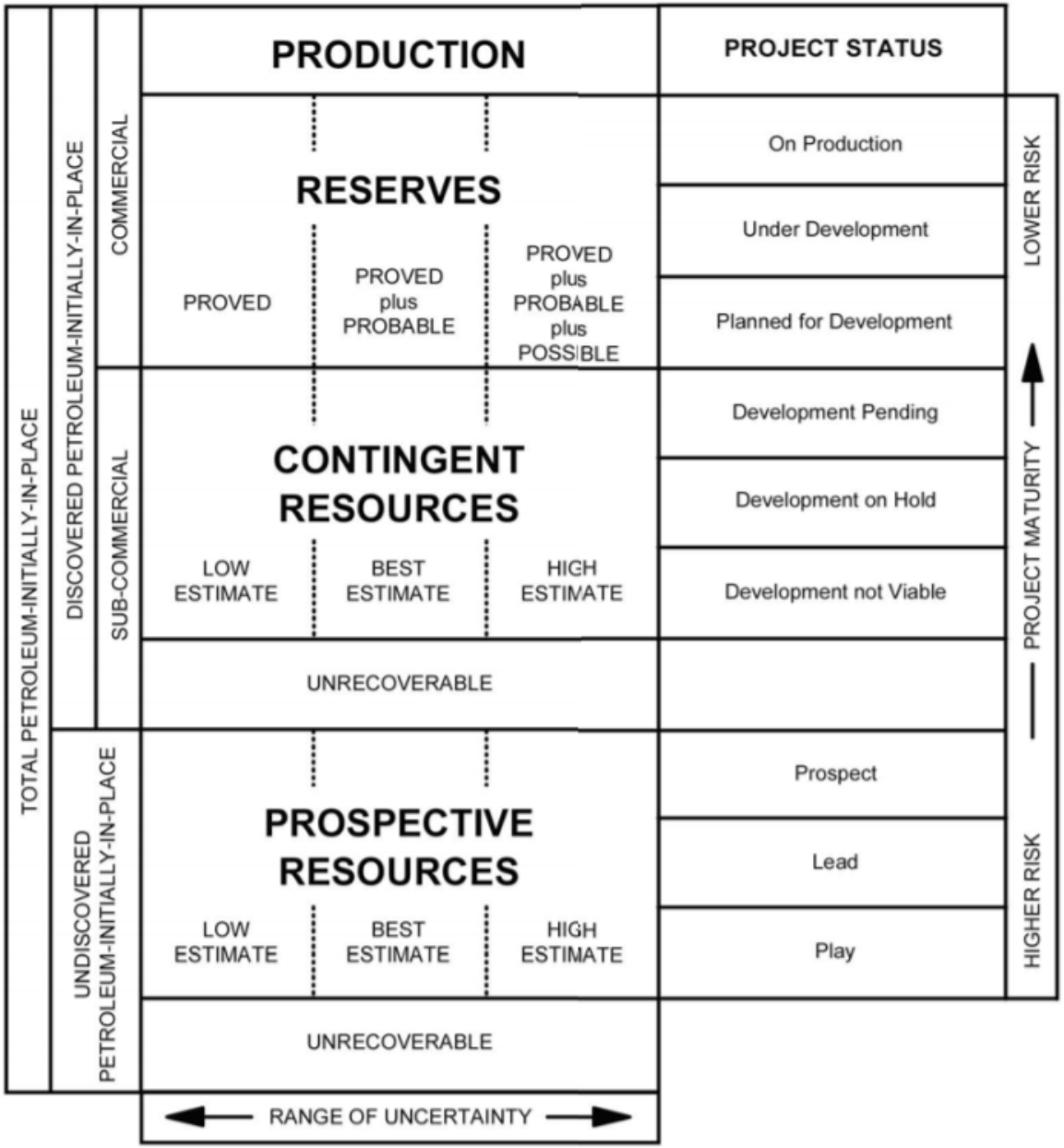
Quantity actually recovered will equal or exceed the calculated value given:

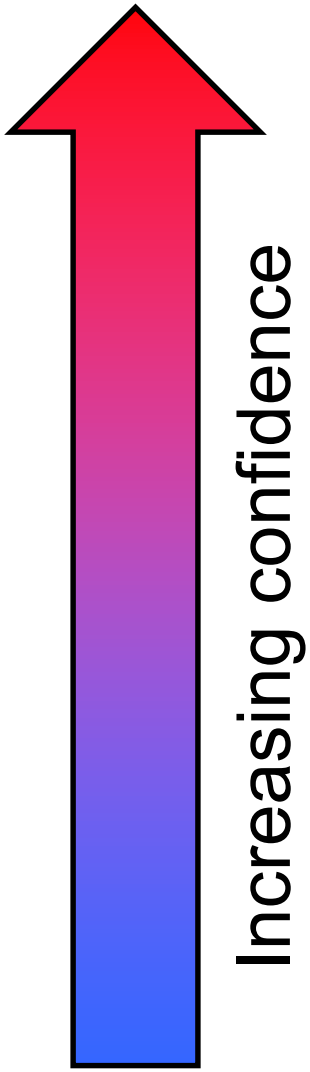
P10 (3P) – 10% probability (proved+probable+possible)

P50 (2P) – 50% probability (proved+probable)

P90 (1P) – 90% probability (proved)

P90 & P10 forecasts change with time, dependent on information well beyond reservoir characterisation, engineering and management.





Increasing confidence

sub-basins of the McArthur Basin region

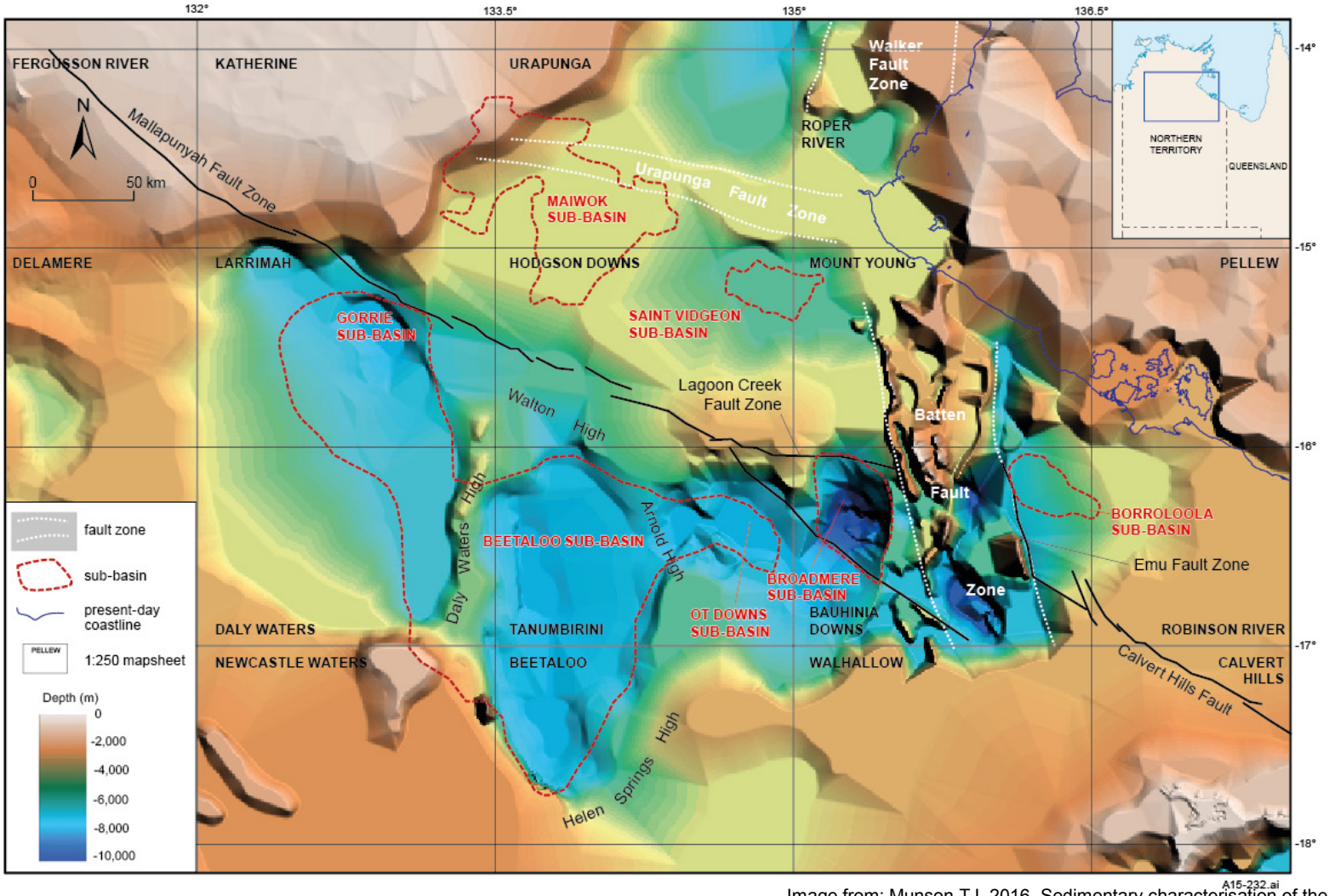
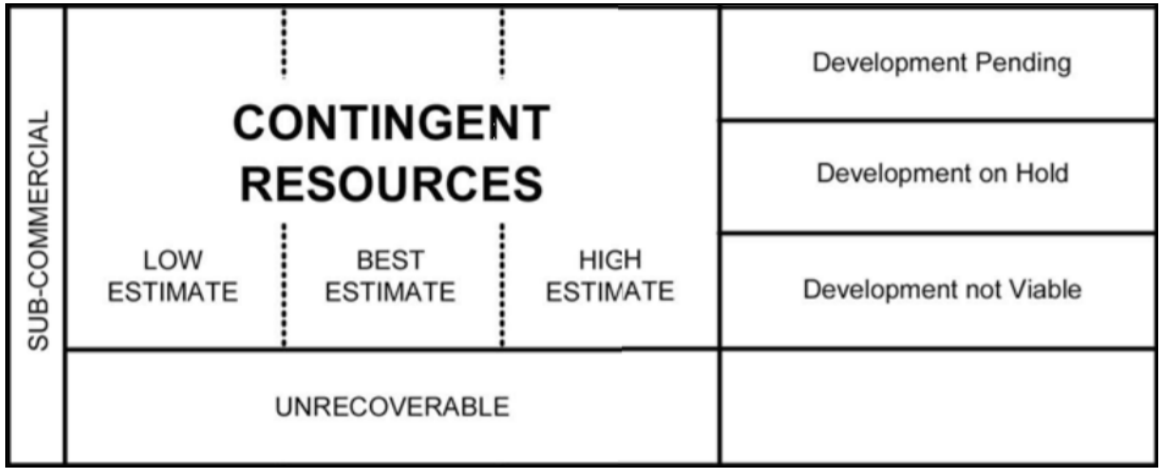
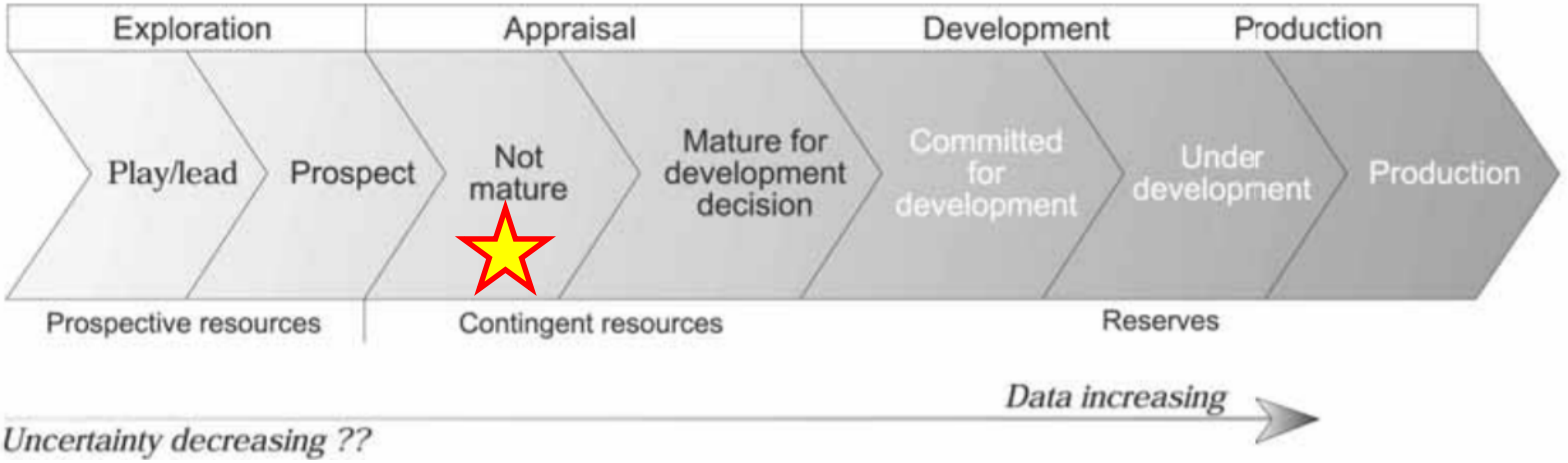


Image from: Munson TJ, 2016. Sedimentary characterisation of the Wilton package, greater McArthur Basin, Northern Territory. *Northern Territory Geological Survey, Record* 2016-003.

Beetaloo Sub-basin



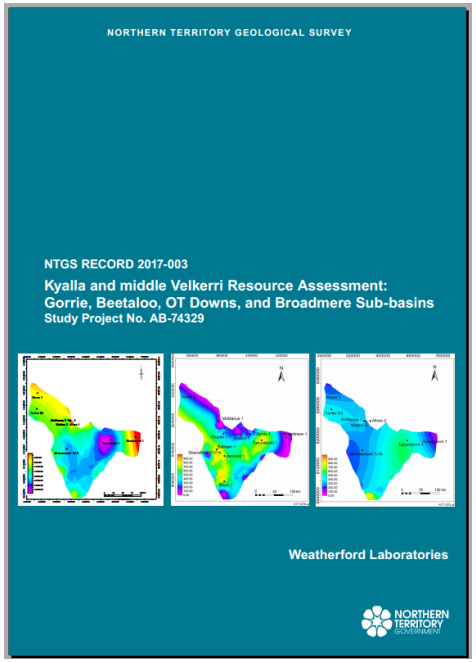


GAS IN PLACE

middle Velkerri Formation

118 – 293 TCF

(P90-P10) TCF = trillion cubic feet



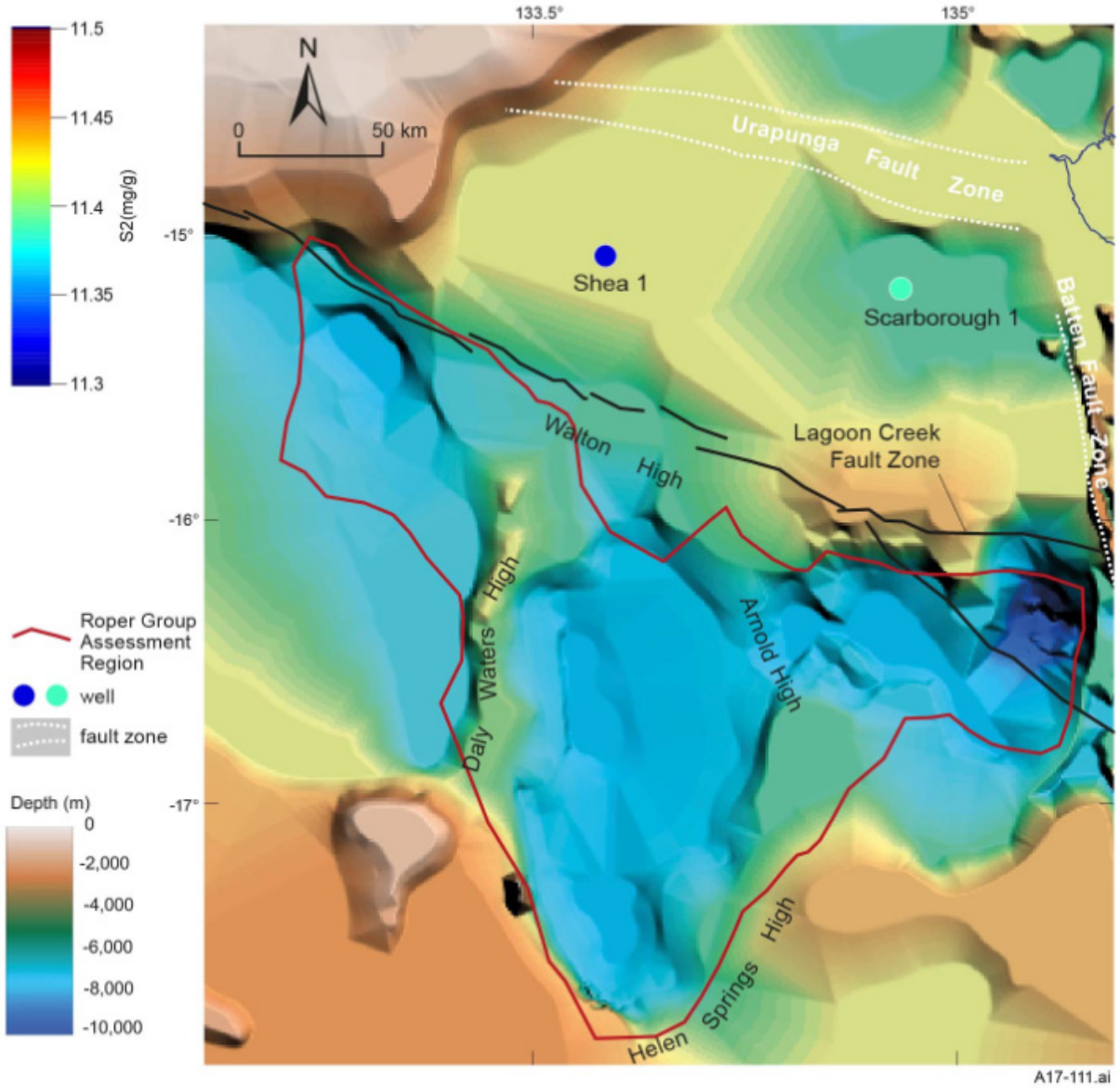
Weatherford Laboratories, 2017. Kyalla and middle Velkerri Resource Assessment: Gorrie, Beetaloo, OT Downs, and Broadmere Sub-basins. Study Project No. AB-74329. Northern Territory Geological Survey, Record 2017- 003.

Multiple methods used in the volumetric calculation

	P10	P50	P90
Kyalla Formation		**Oil (MMbbl's)**	
Map Based Volumetric	1164	772	414
SRP Based Volumetric		143	
S1 Based Volumetric		94	
HC Yield Based Volumetric		293	
middle Velkerri Formation		**Oil (MMbbl's)**	
Map Based Volumetric	113	83	62
SRP Based Volumetric		9	
S1 Based Volumetric		13	
HC Yield Based Volumetric		24	
middle Velkerri Formation		**Gas (TCF)**	
Map Based Volumetric	**293**	**202**	**118**
S1 Based Volumetric		752	

- Australia consumed 1.3 TCF in 2014-15
- Around 13.5 TCF produced from USA shale reservoirs in 2015.

Volumetric assessment region

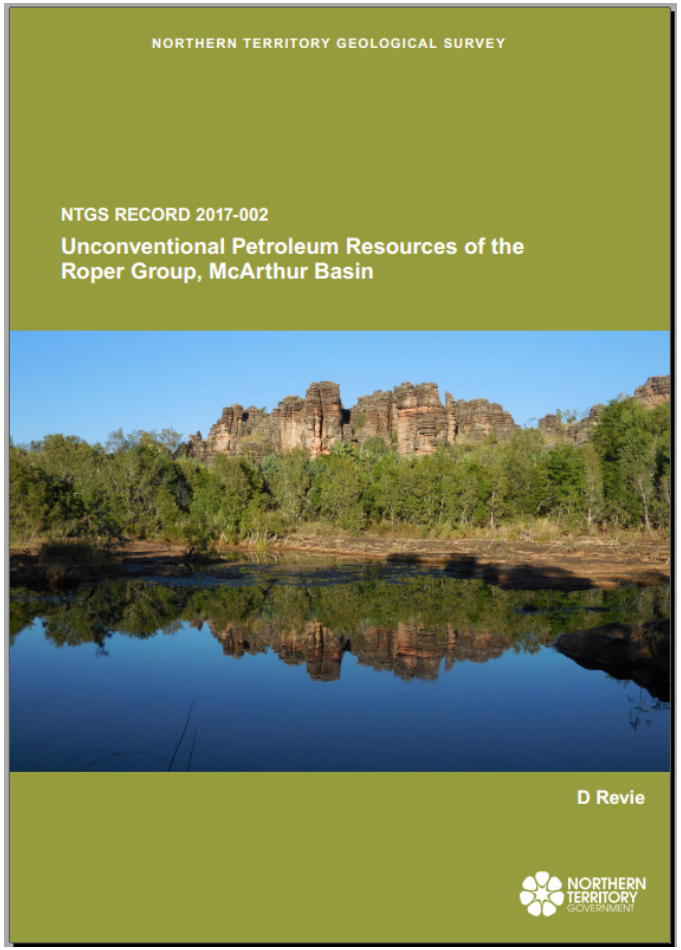


Process of the NTGS volumetric resource estimation of the Roper Group

- **Desktop study** ~ 6300 historical samples
- **Sampling program** ~1600 new samples
- **Analyses** (TOC, XRD, pyrolysis, element ratios in organics, GCMS, biomarkers, organic reflectance, porosity, permeability, fluid saturations)
- **Interpretation** and **calculation**
- **Integration** of the data into the depth and volume of the formation

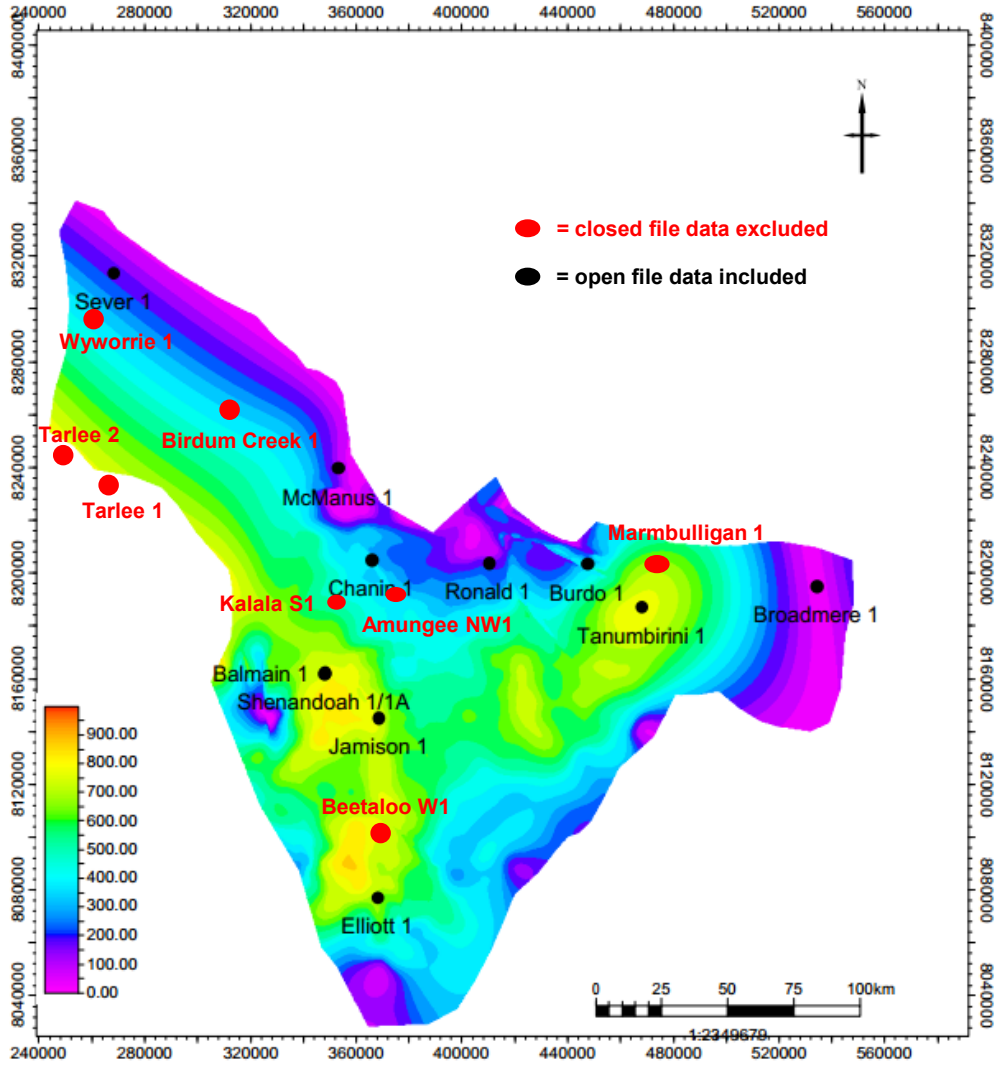
Interpretation of results

- **Interpretation available now as NTGS Record 2017-002**



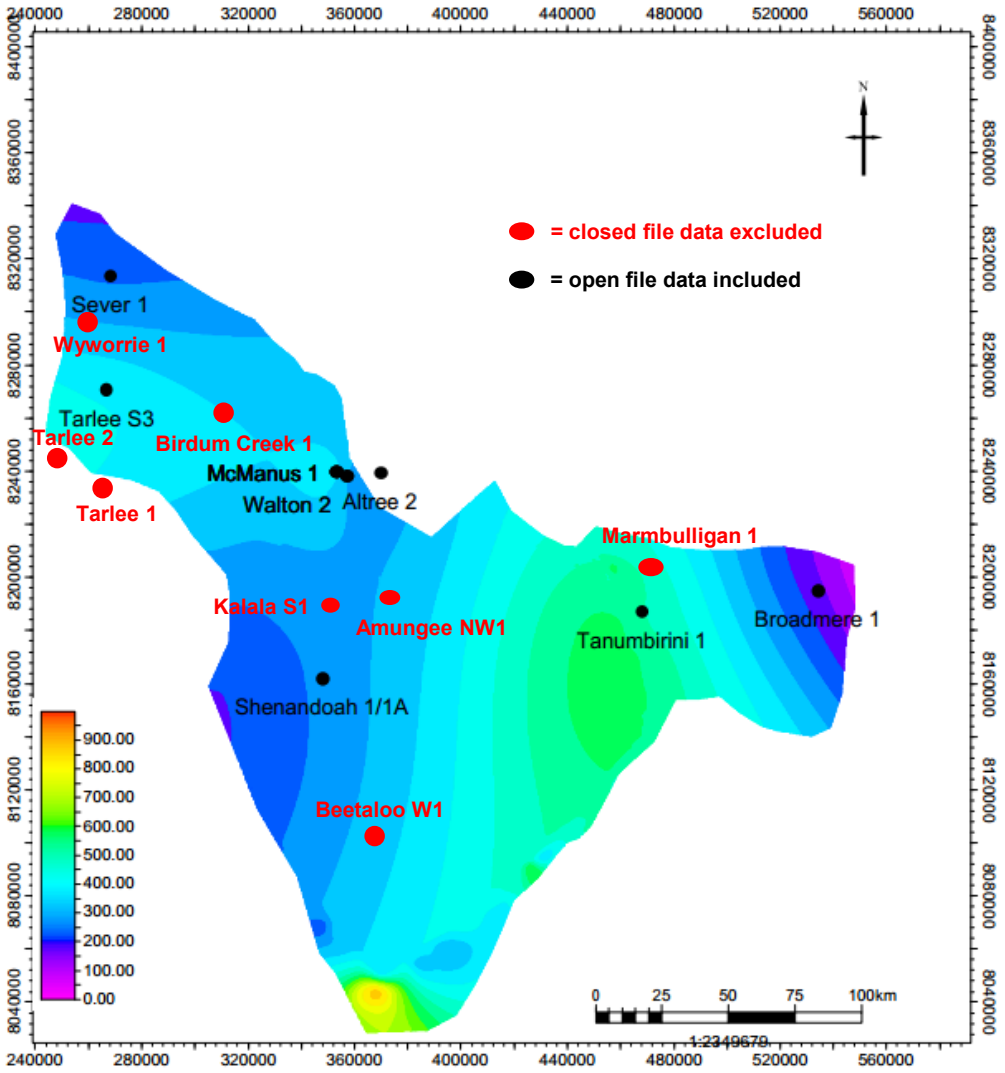
Modelling thickness

- Kyalla Formation
- more data so more constrained than the Velkerri Fm
- Thickest in the central part of the basin
- lower Kyalla shale 50% of volume



Modelling thickness

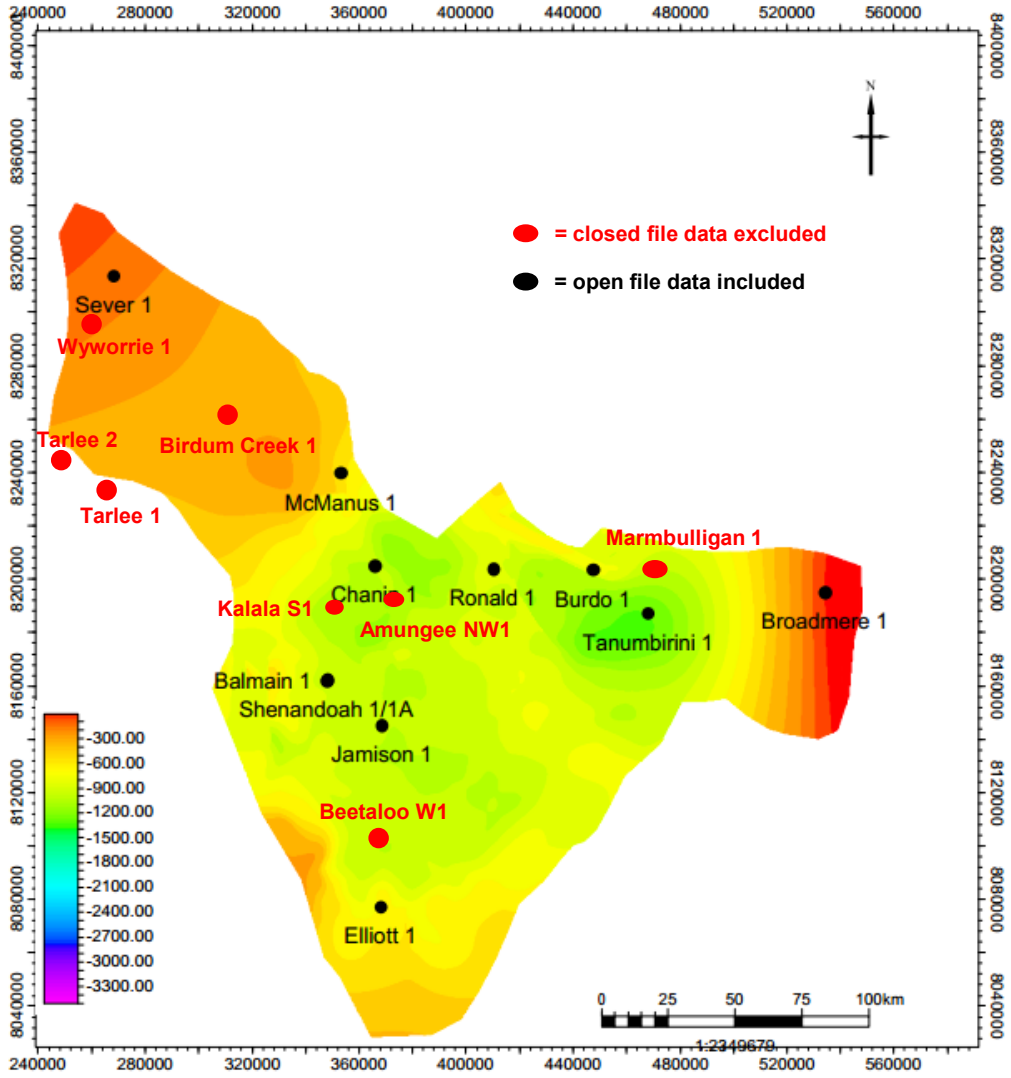
- Middle Velkerri Formation
- less data so less constrained
- Additional drilling data will change the model
- A, B & C shales make up about 33% total volume



Modelling depth

Kyalla Formation

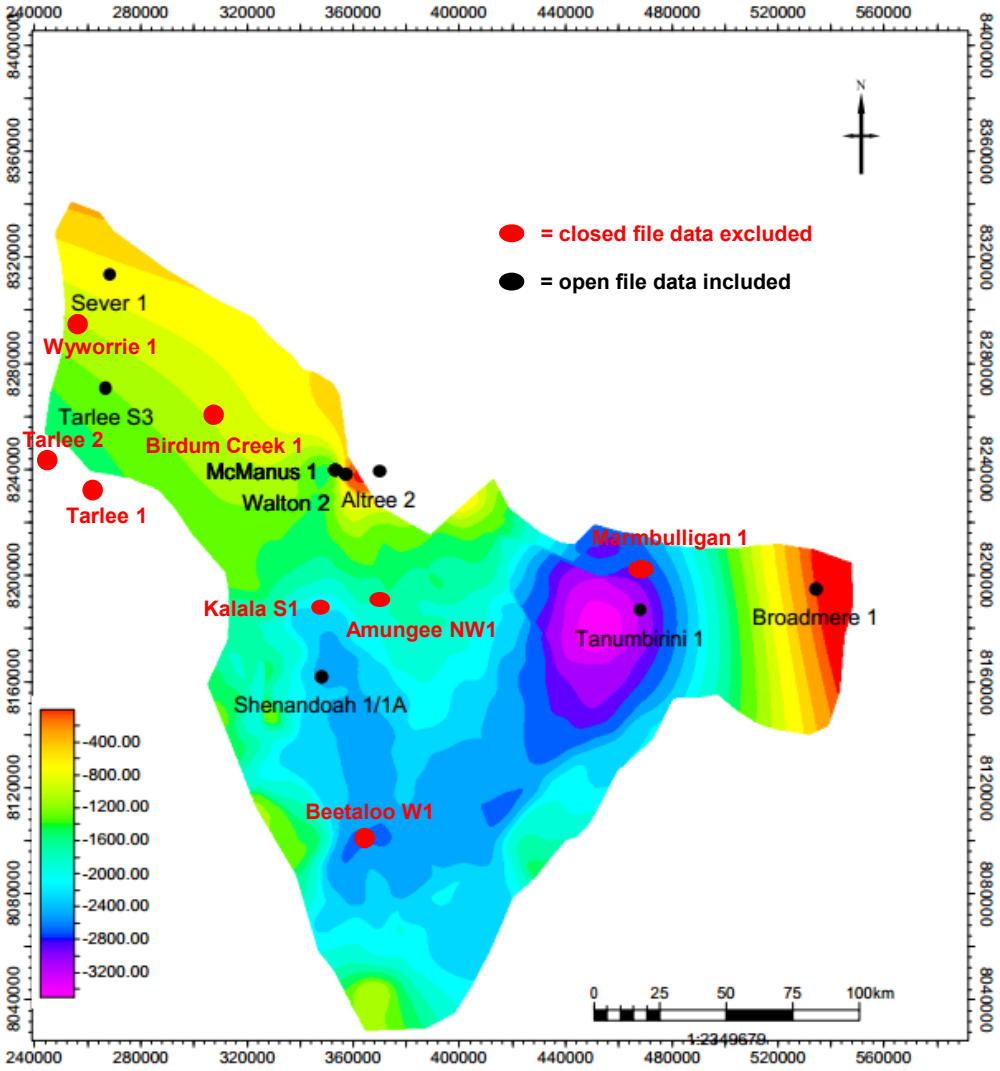
- Shallow – early to late oil window (600 - 1500 m)
- Depth is greatest in the central region of the basin

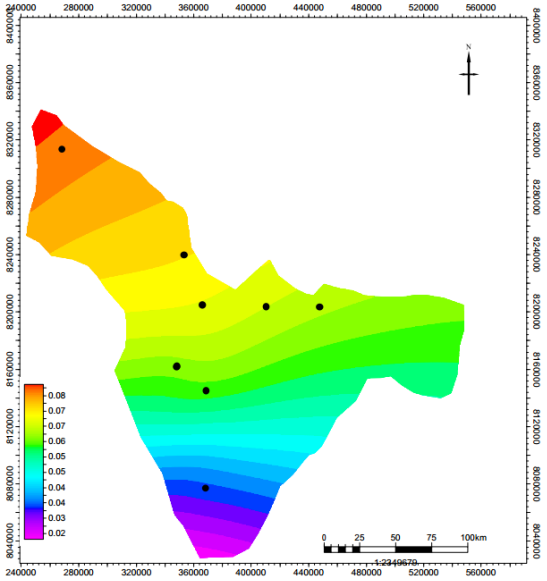


Modelling depth

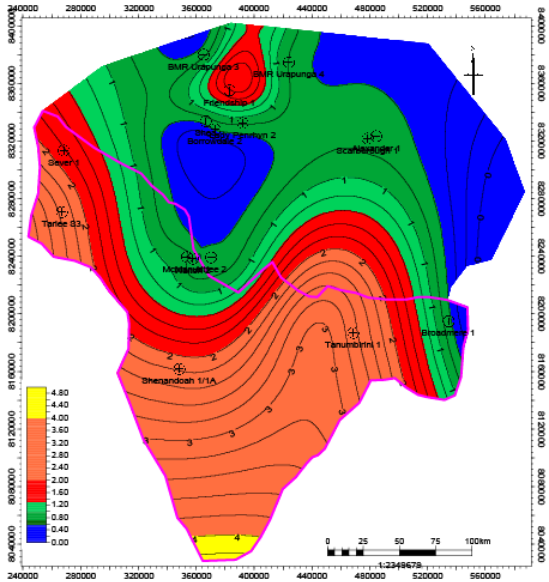
middle Velkerri Formation

- Deep – dry-gas window (1700 m+)
- Surface will change with additional data
- Need to be in gas window for overpressure

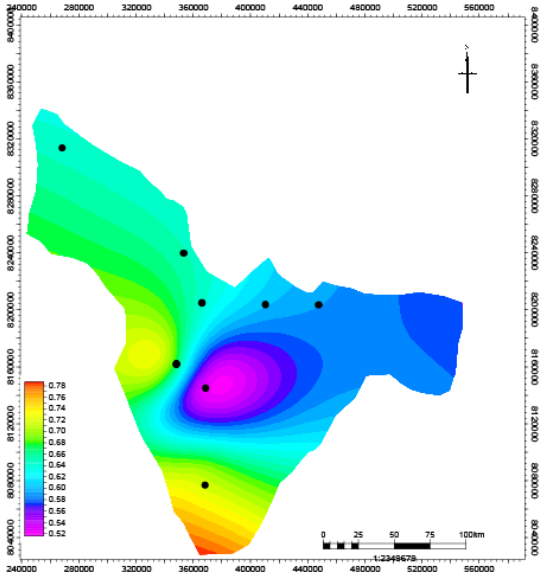




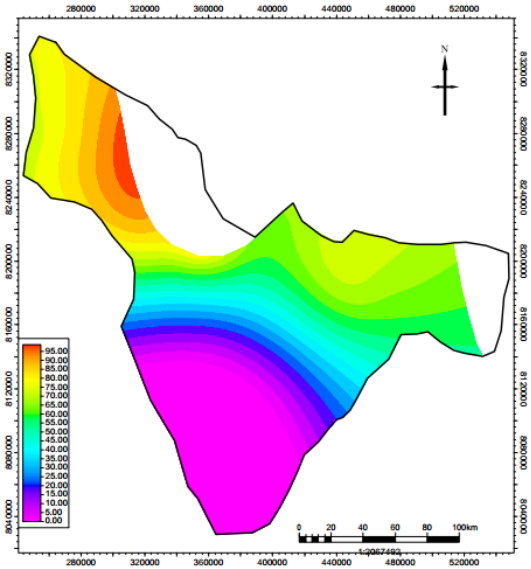
porosity



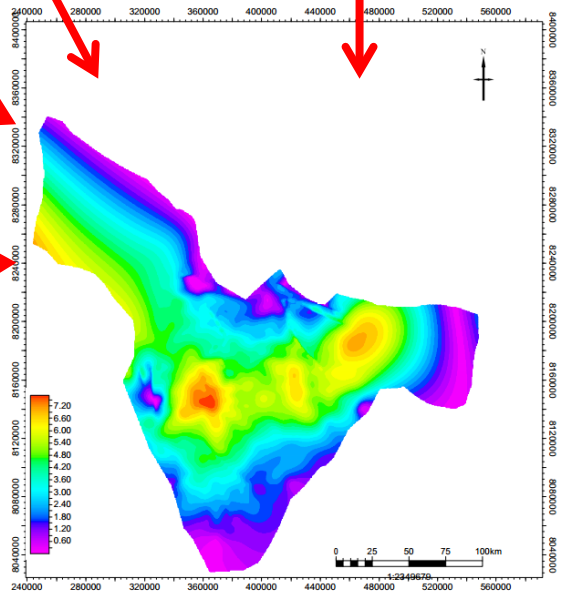
thermal maturity



fluid saturations



adsorbed gas content



Original hydrocarbons in place

middle Velkerri Formation: A, B and C shale

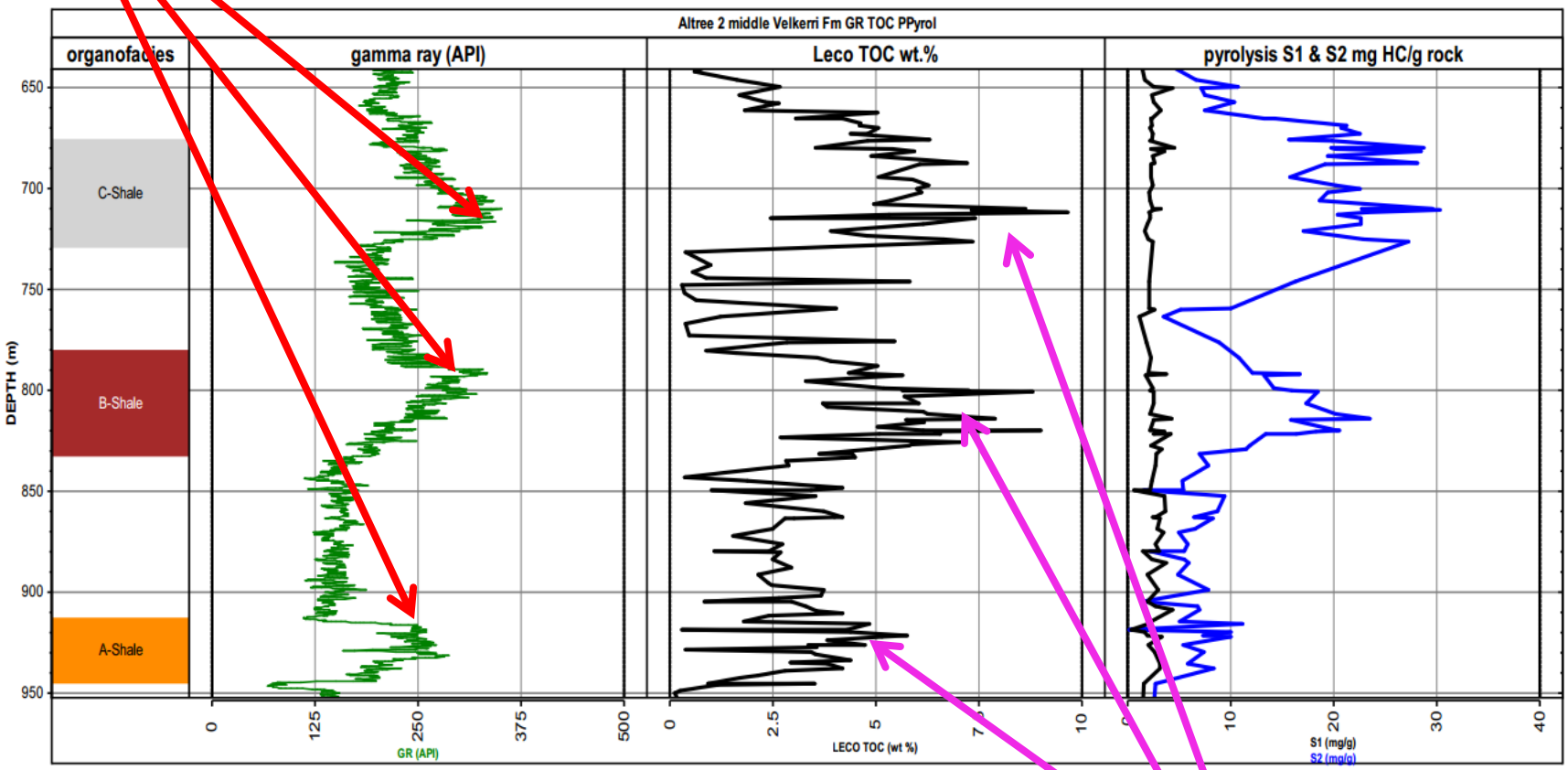
- three distinct facies within middle Velkerri
- unique geophysical responses and geochemical composition

- continuous across the region
- each facies an individual shale gas play
- B shale most consistent across the basin

Shale plays of the middle Velkerri Formation

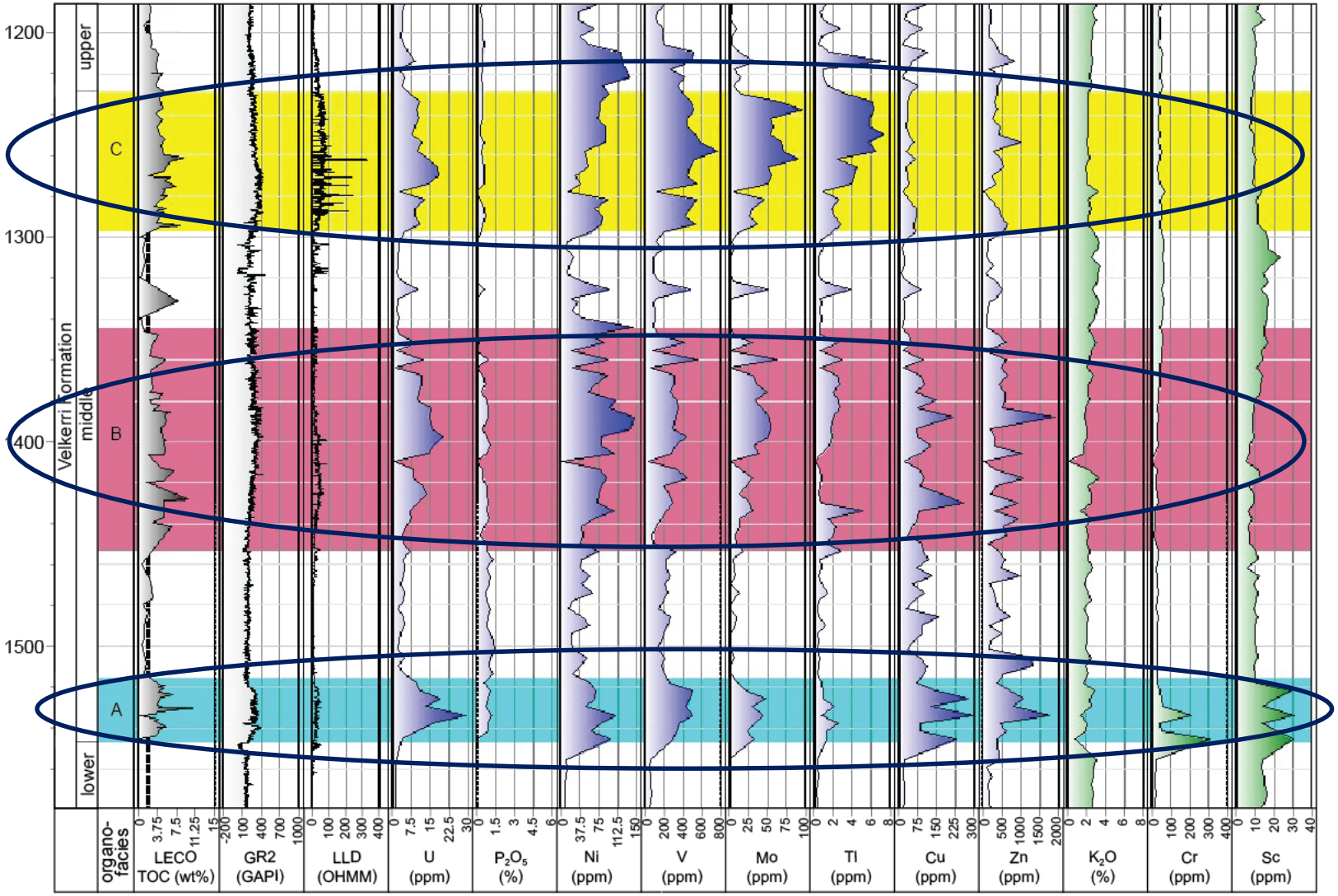
Gamma-ray spikes

A, B and C shales – basic indicators



High total organic carbon

Shale plays of the middle Velkerri Formation



Open-file data

- only open-file data could be used
- **significant impact** on volumetric assessment when recent drilling included
- this assessment has significant volumes already, 100’s TCF defined

risks

- old drill core – compositional change over time
- frontier basin, large region with a paucity of data
- homogeneity assumed for heterogeneous rocks
- individual facies grouped into one volume

Where to next?

- Determine the RESERVES:

recoverable **oil** reserves (STB):
STB = OIP X RF

recoverable **gas** reserves (SCF):
SCF = GIP X RF

Recovery Factor (RF)

USA RF's: shale oil ≈ 4-5% shale gas ≈ 15-25%

Amungee NW-1H announced as RF= 16%

based on one well, multiple wells needed to increase confidence

summary

- The Beetaloo Sub-basin has an enormous shale gas resource, 50% of Australia's shale gas potential.
- Resource estimation work has produced estimates in the 100's of TCF of gas
- This resource is still in appraisal, the estimates will change with increases in knowledge