Australian Government
Geoscience Australia

Queensland Government

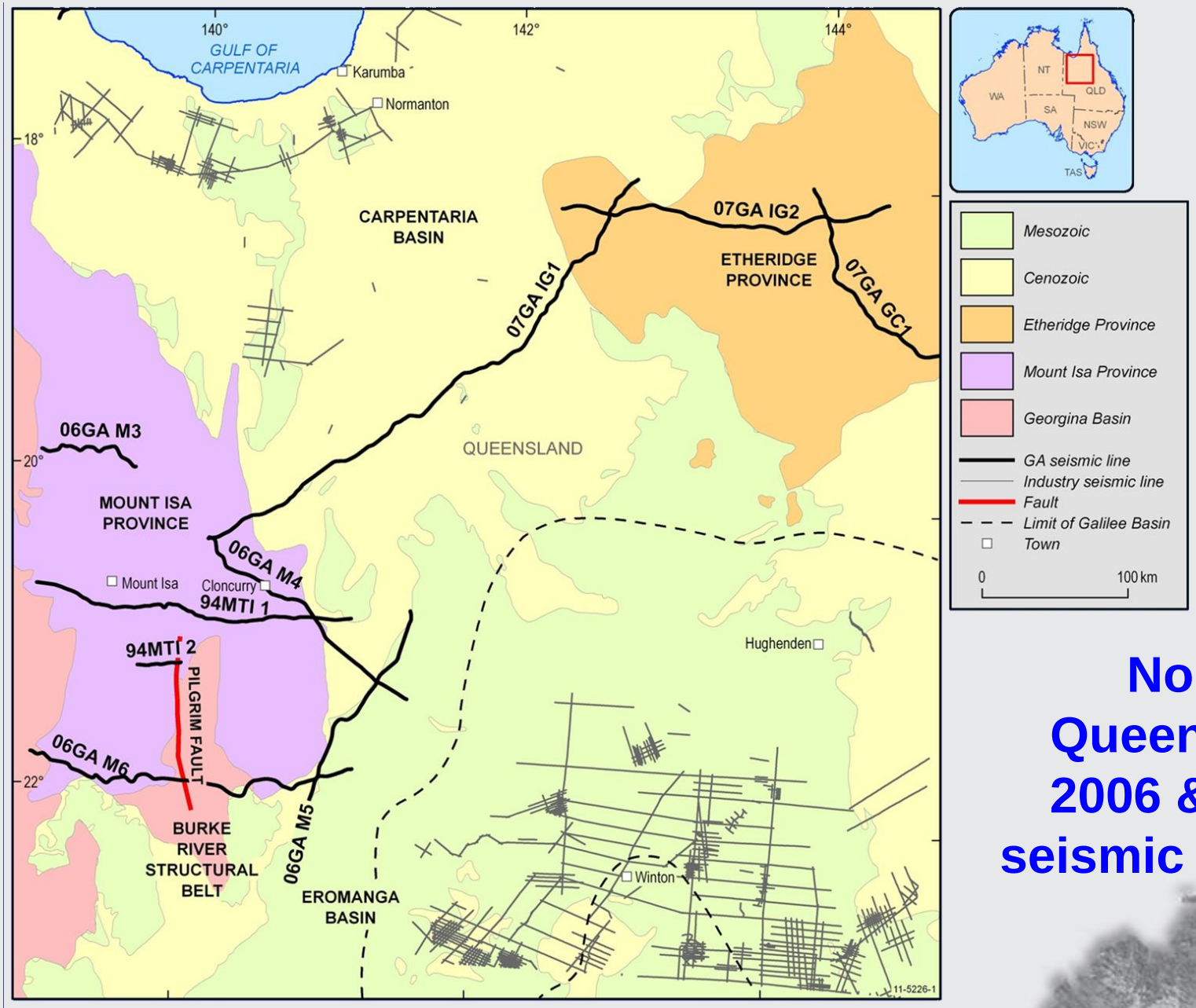
Energy potential of the Millungera Basin: a newly discovered basin in North Queensland

Russell Korsch[1], H. Struckmeyer[1], A. Kirkby[1], L Hutton[2], L Carr[1], K. Hoffmann[2], R. Chopping[1], I. Roy[1], M. Fitzell[2], J. Totterdell[1], M. Nicoll[1] and B. Talebi[2]

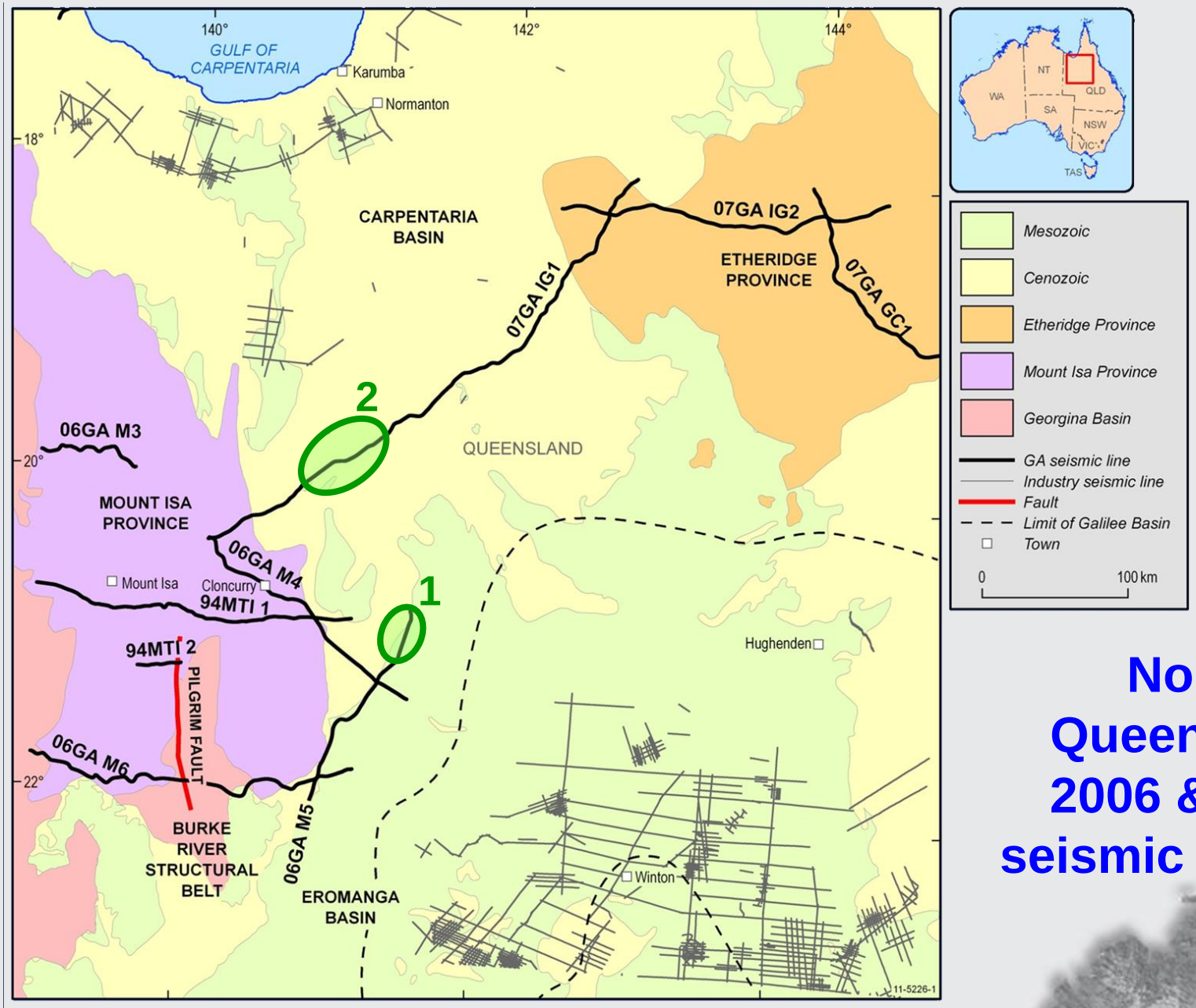
[1]Geoscience Australia, [2]Geological Survey of Queensland

Outline

- Discovery
- Geophysical data
- Existing drillholes
- Age of basin?
- Petroleum systems modelling
- Geothermal modelling

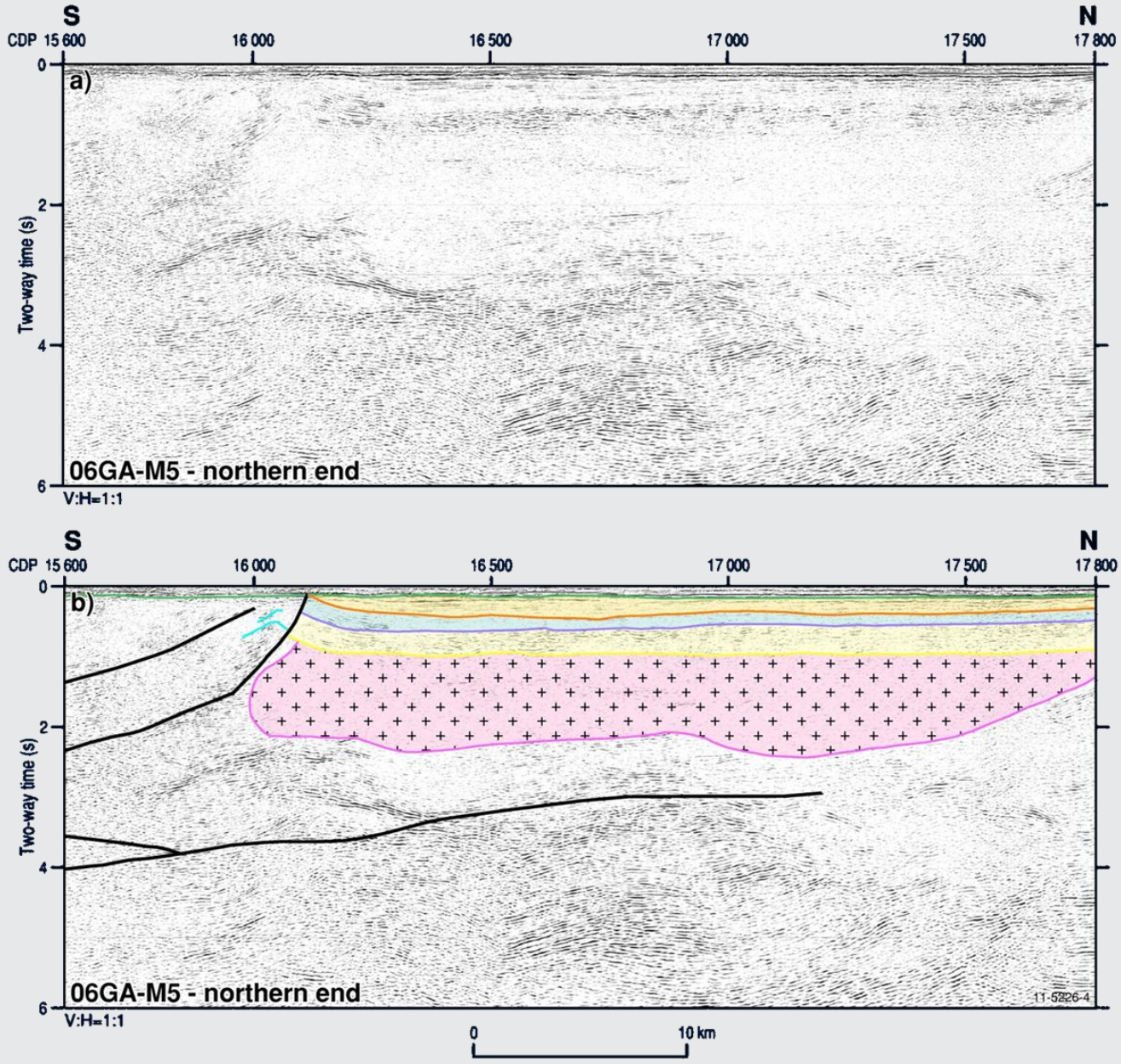


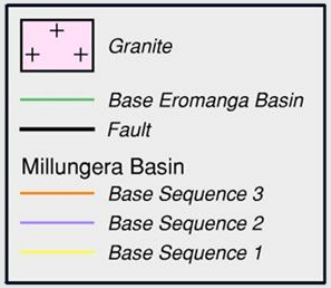
North Queensland 2006 & 2007 seismic surveys



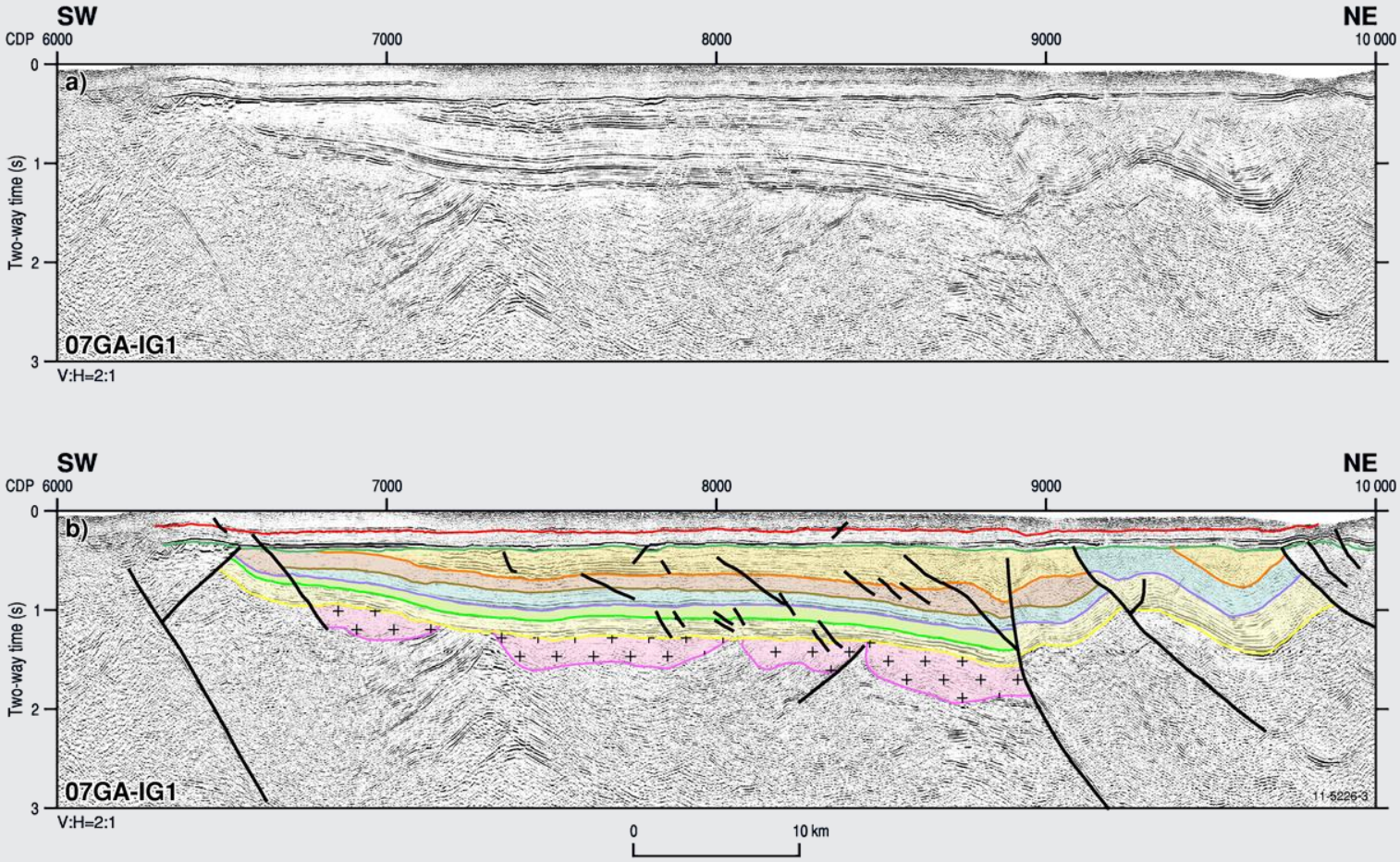
North Queensland 2006 & 2007 seismic surveys

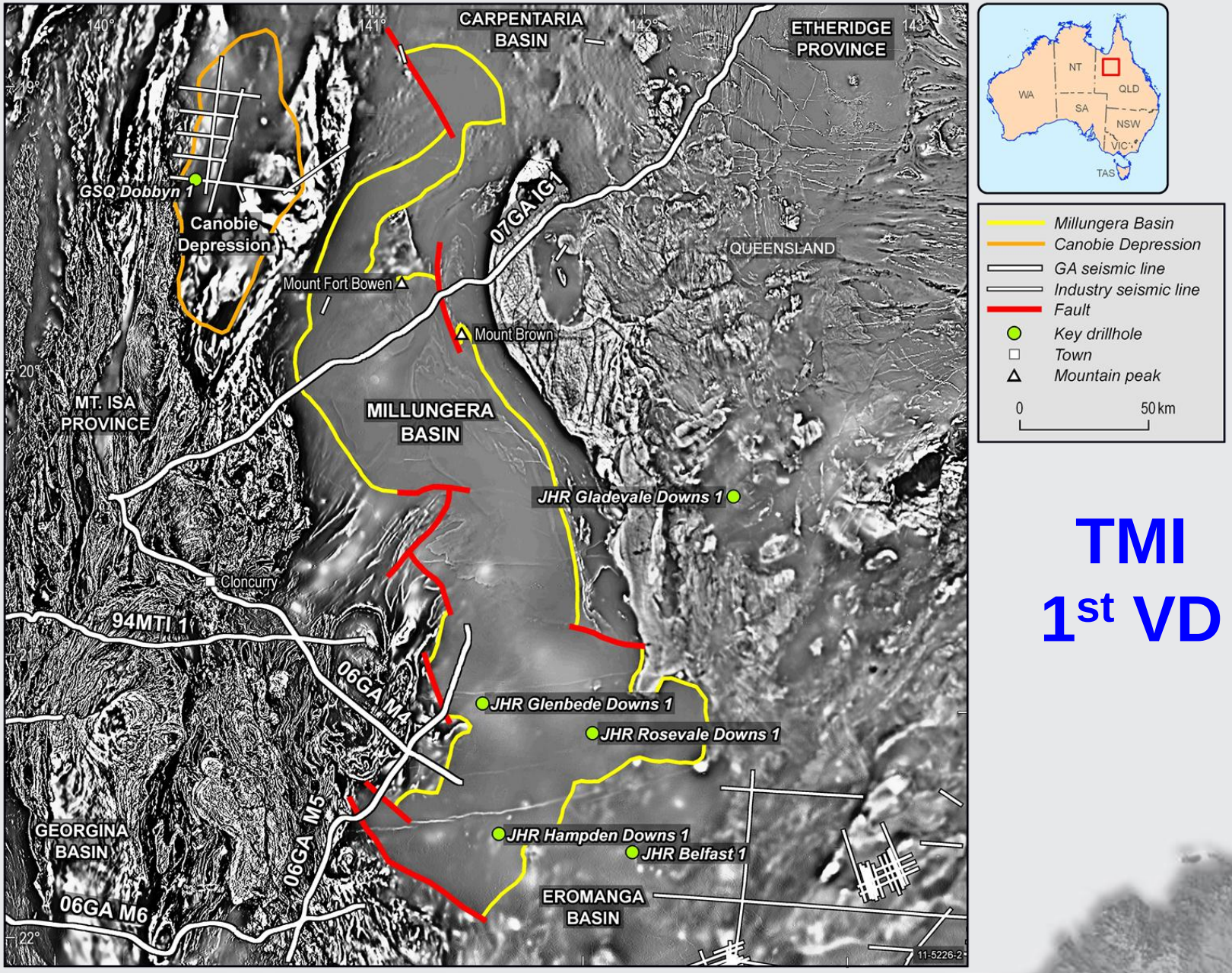
06GA-M5


S
N
CDP 15 600
16 000
16 500
17 000
17 500
17 800
a)
Two-way time (s)
0
2
4
6
06GA-M5 - northern end
V:H=1:1
b)
06GA-M5 - northern end
V:H=1:1
11-5226-4
0
10 km


Granite
Base Eromanga Basin
Fault
Millungera Basin
Base Sequence 3
Base Sequence 2
Base Sequence 1

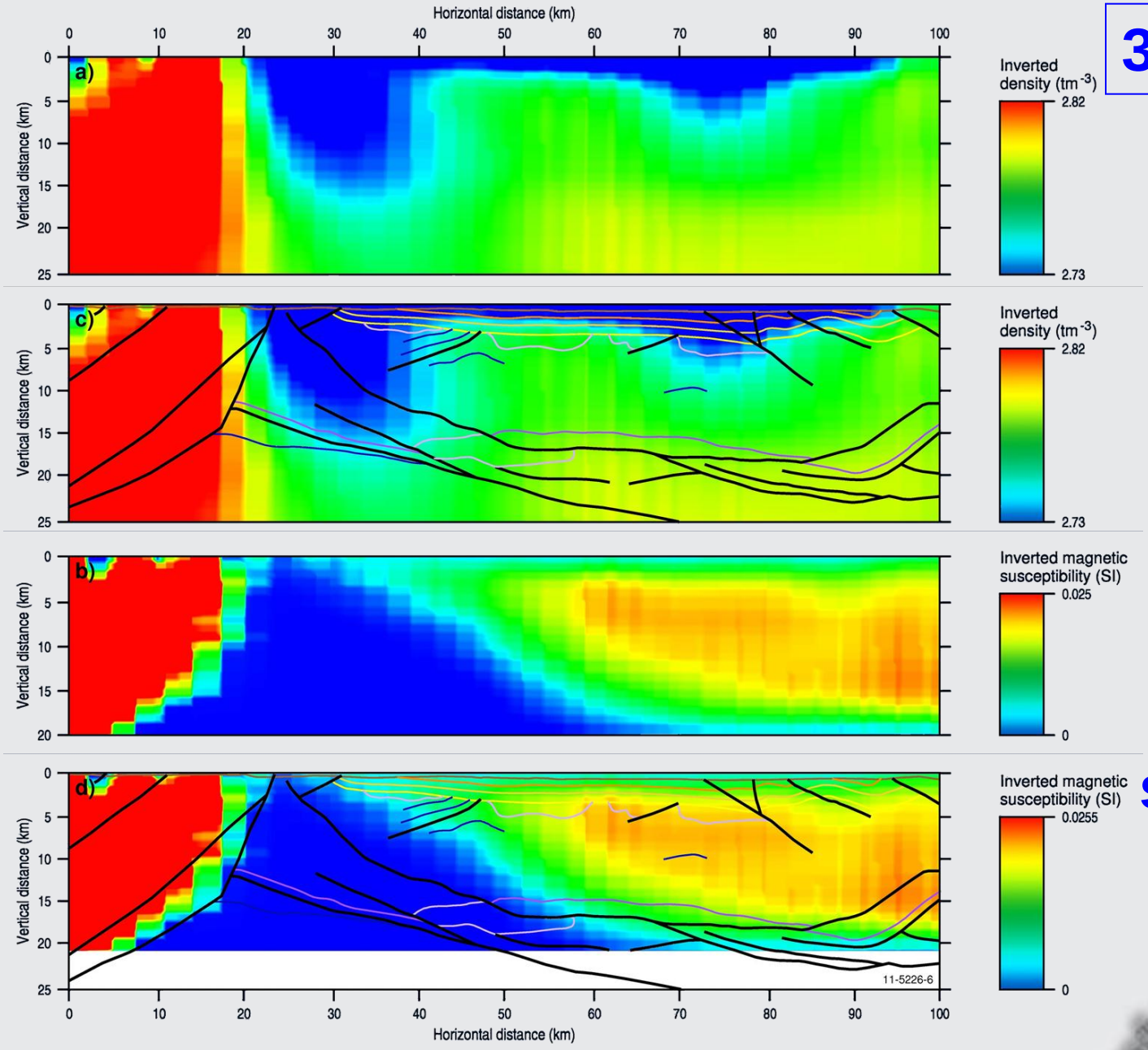
07GA-IG1


SW
NE
CDP 6000
7000
8000
9000
10 000
a)
b)
Two-way time (s)
0
1
2
3
07GA-IG1
V:H=2:1
11-5226-3
0
10 km
Granite
Fault
Base Toolebuc Formation
Base Carpentaria Basin
Millungera Basin
Base Sequence 3
Mid Sequence 2
Base Sequence 2
Mid Sequence 1
Base Sequence 1


CARPENTARIA BASIN
ETHERIDGE PROVINCE
GSQ Dobbyn 1
Canobie Depression
07GA IG1
QUEENSLAND
Mount Fort Bowen
Mount Brown
MT. ISA PROVINCE
MILLUNGERA BASIN
JHR Gladevale Downs 1
Cloncurry
94MTI 1
06GA M4
JHR Glenbede Downs 1
JHR Rosevale Downs 1
06GA M5
GEORGINA BASIN
JHR Hampden Downs 1
JHR Belfast 1
06GA M6
EROMANGA BASIN
11-5226-2
NT
QLD
WA
SA
NSW
VIC
TAS
Millungera Basin
Canobie Depression
GA seismic line
Industry seismic line
Fault
Key drillhole
Town
Mountain peak
0
50 km

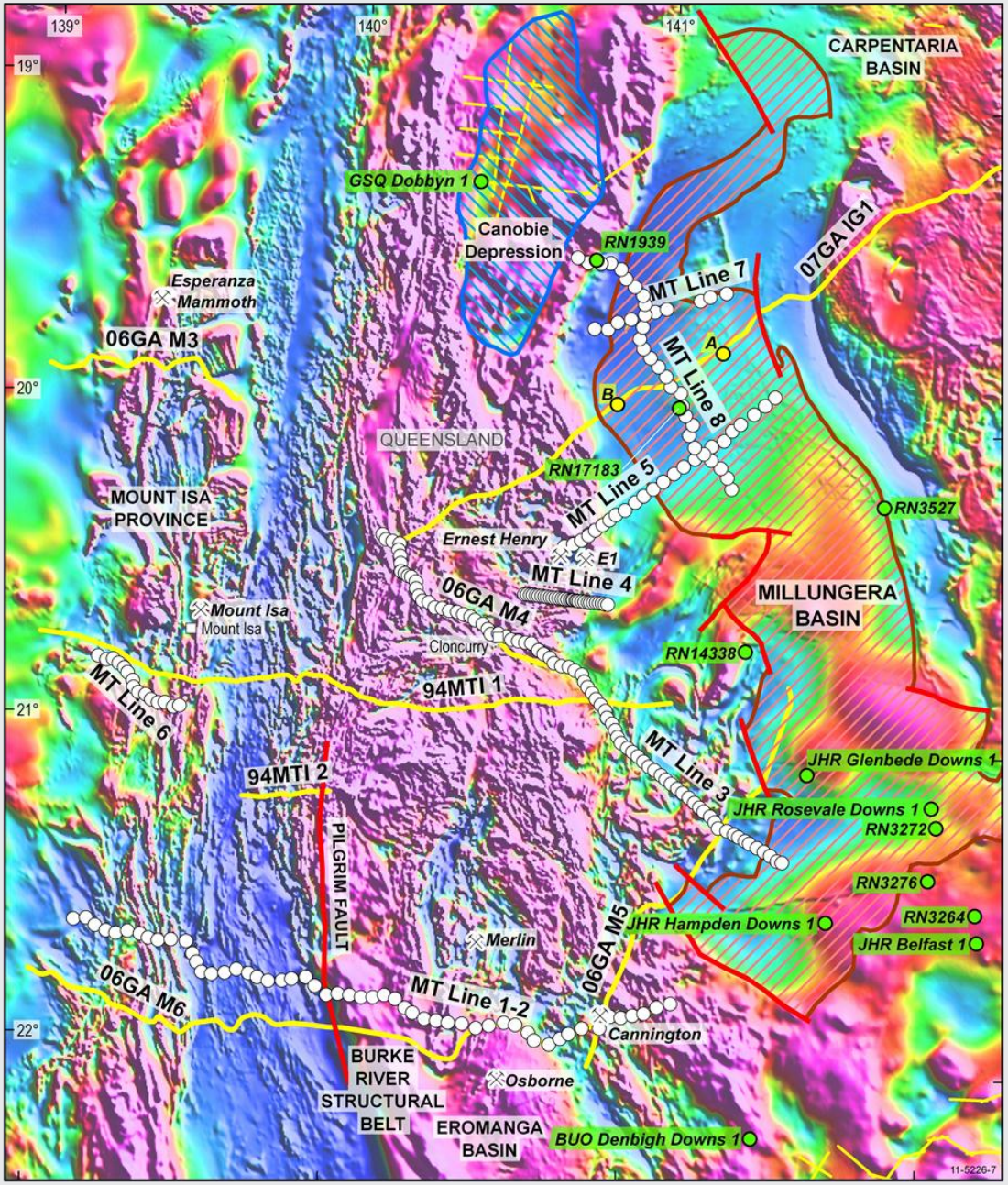
TMI 1st VD

3D inversions



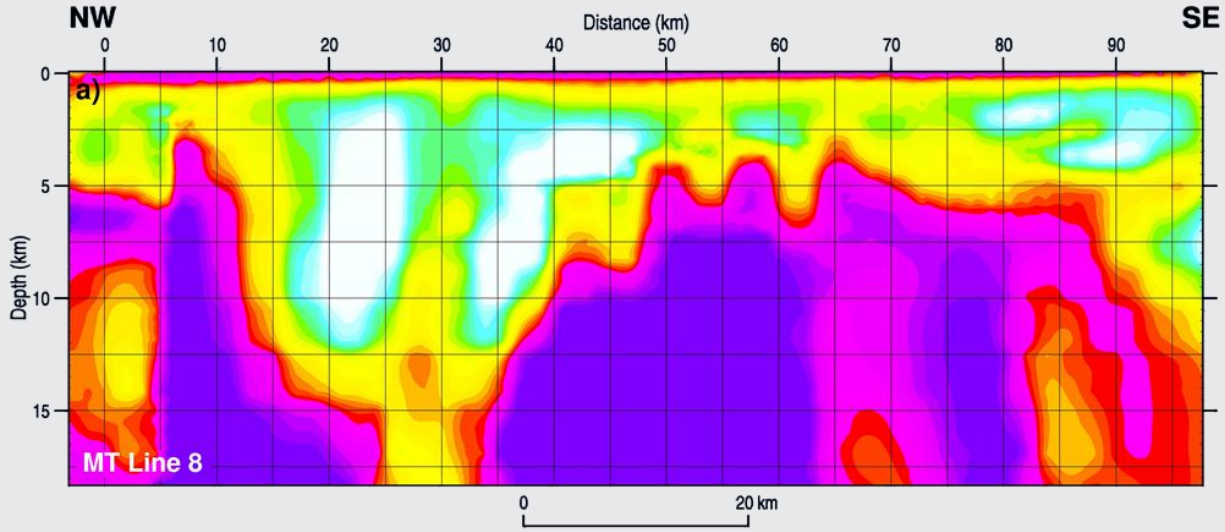
Density

Magnetic susceptibility

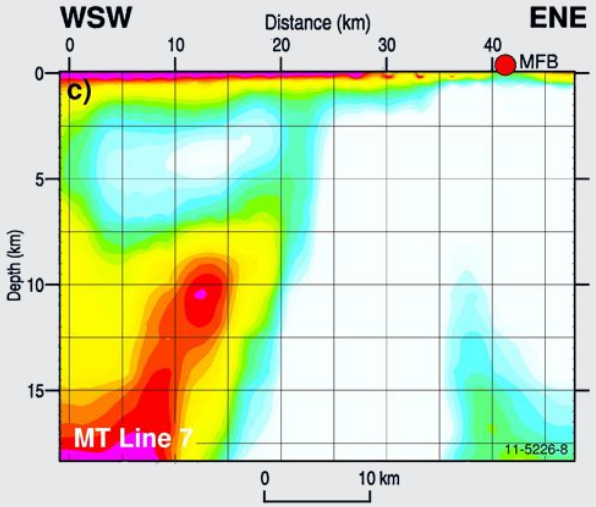


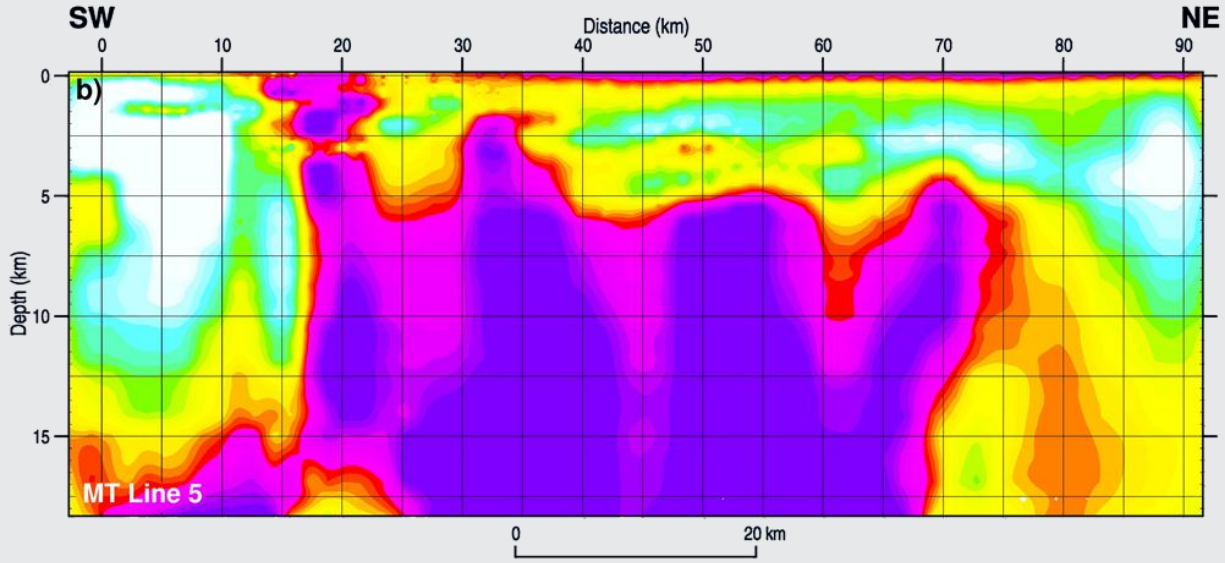
Locations of MT stations (Lines 5, 7, 8)

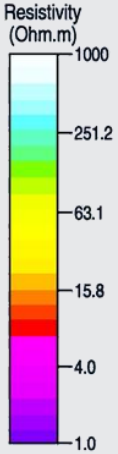
MT Line 8



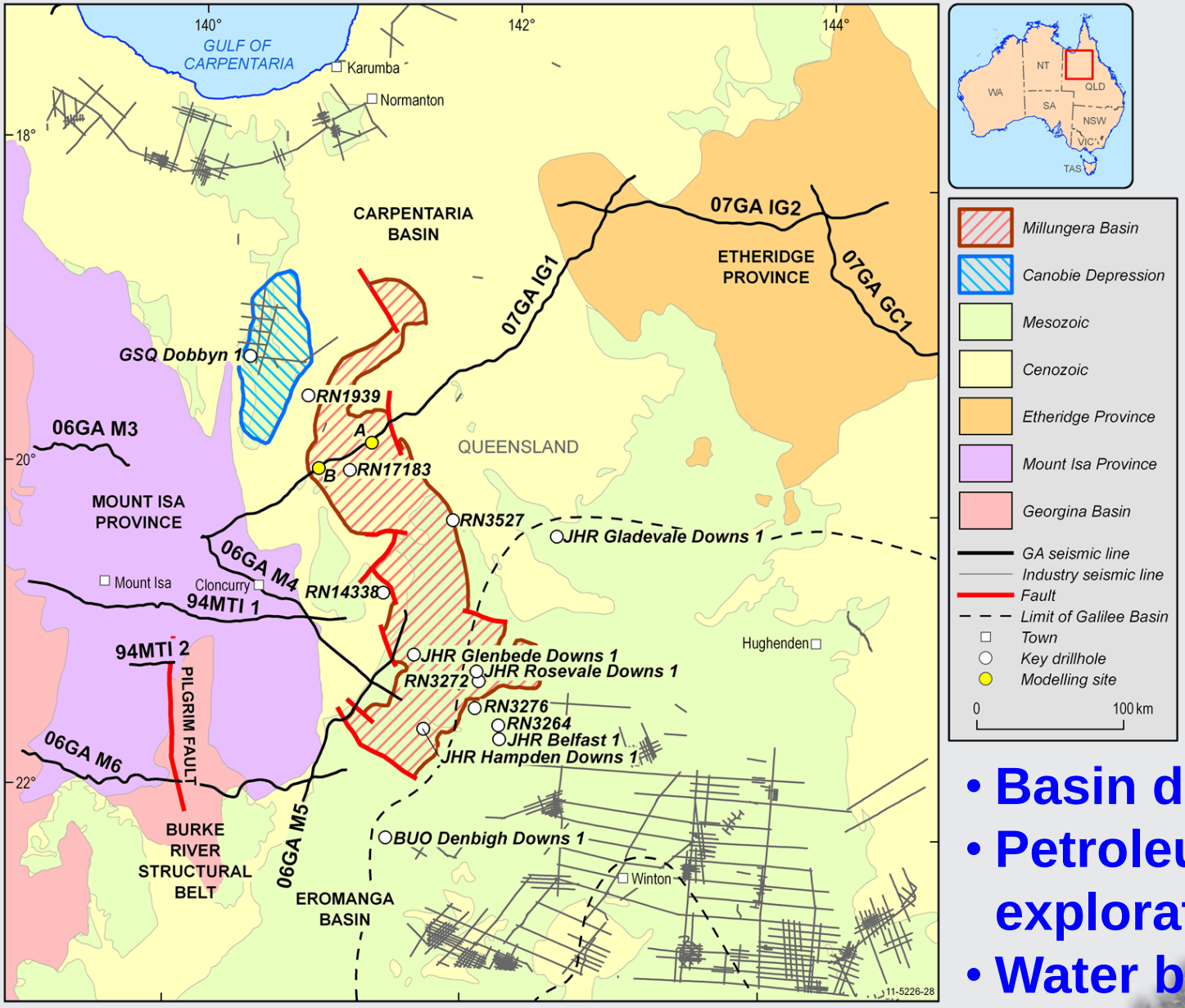
MT Line 7





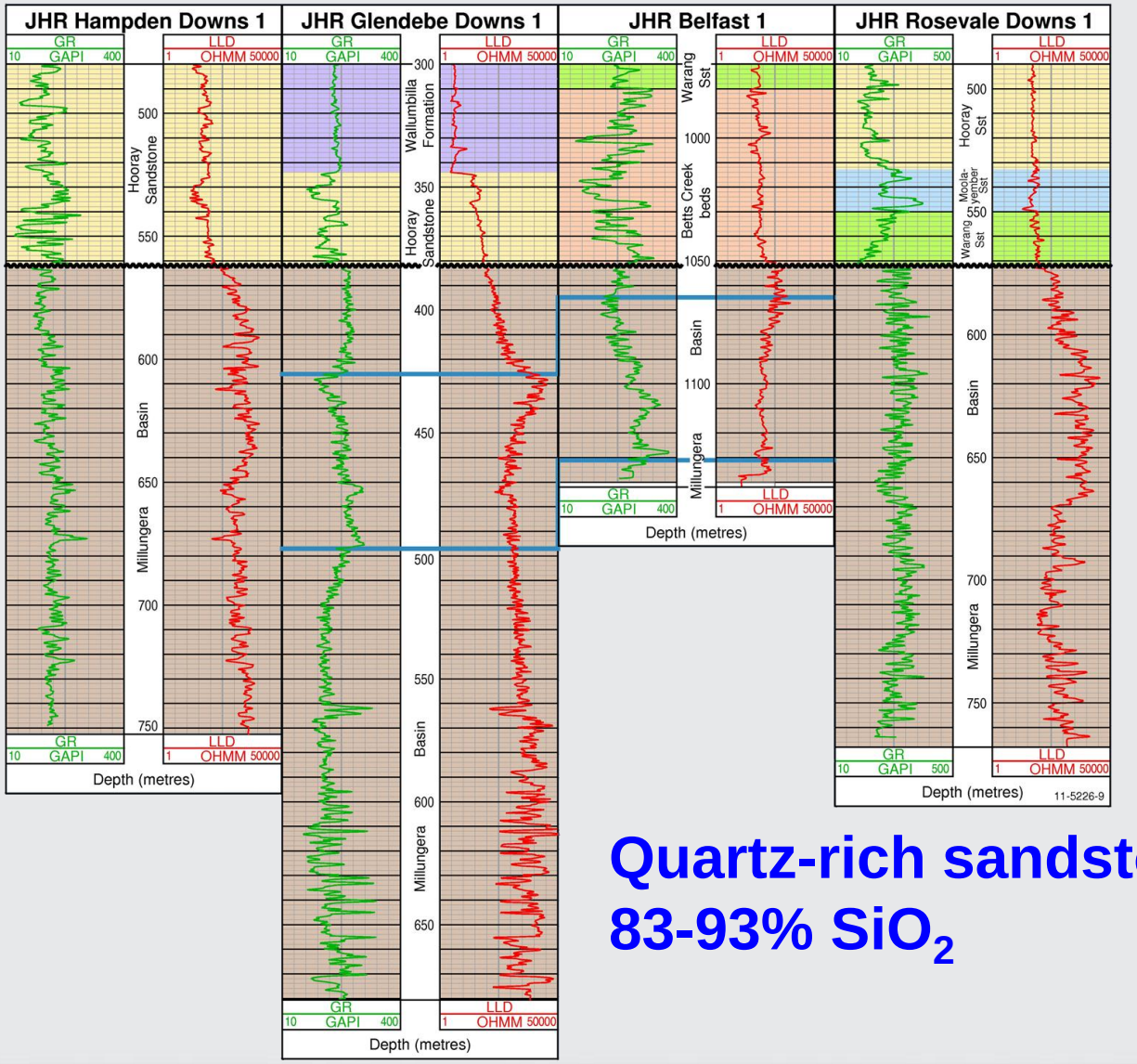


MT Line 5



- **Basin distribution**
- **Petroleum exploration wells**
- **Water bores**

Natural gamma ray and electrical resistivity logs



— Top of Millungera Basin

Quartz-rich sandstones
83-93% SiO_2

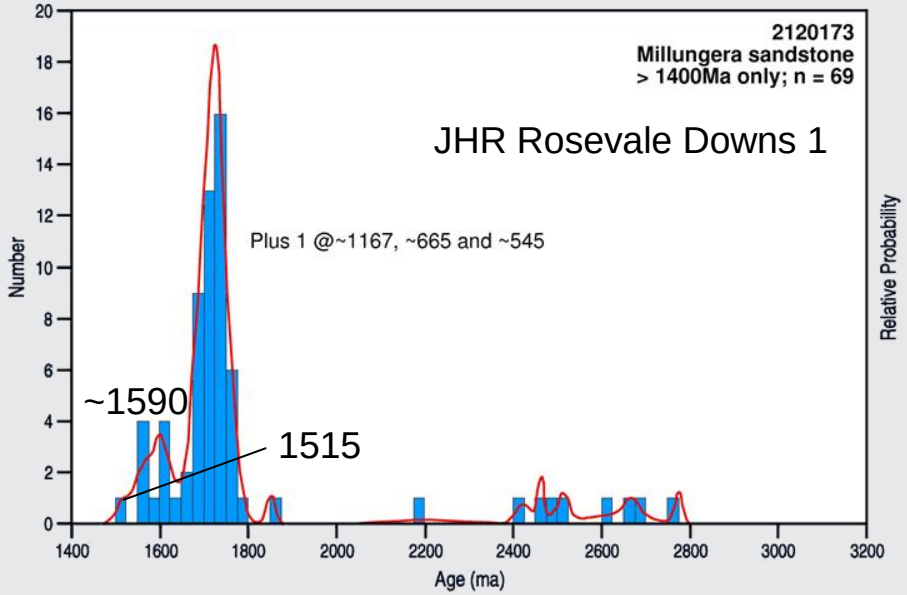
Age of the Millungera Basin

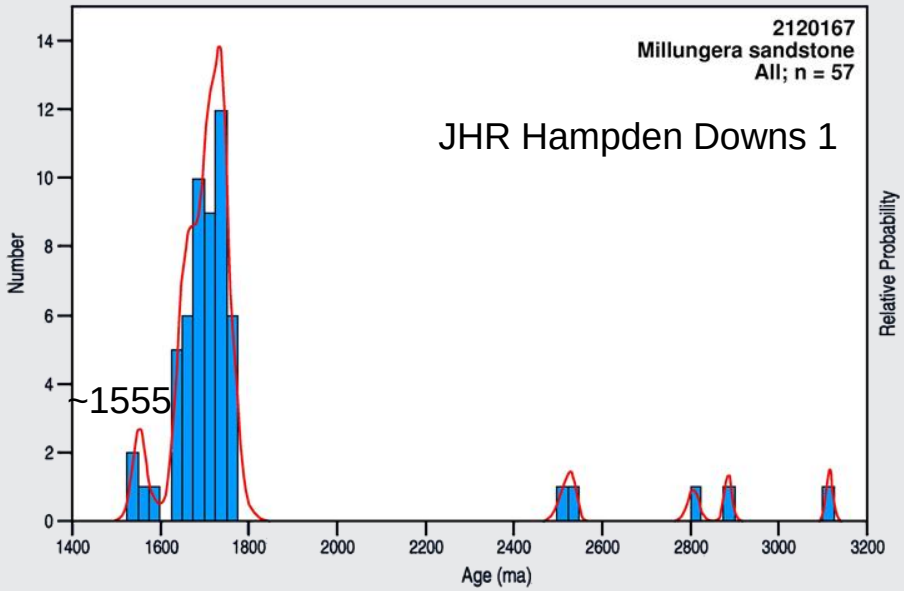
- Older than Jurassic Eromanga Basin
- Younger than Soldiers Cap Group (Mt Isa Province – ~1660 Ma)

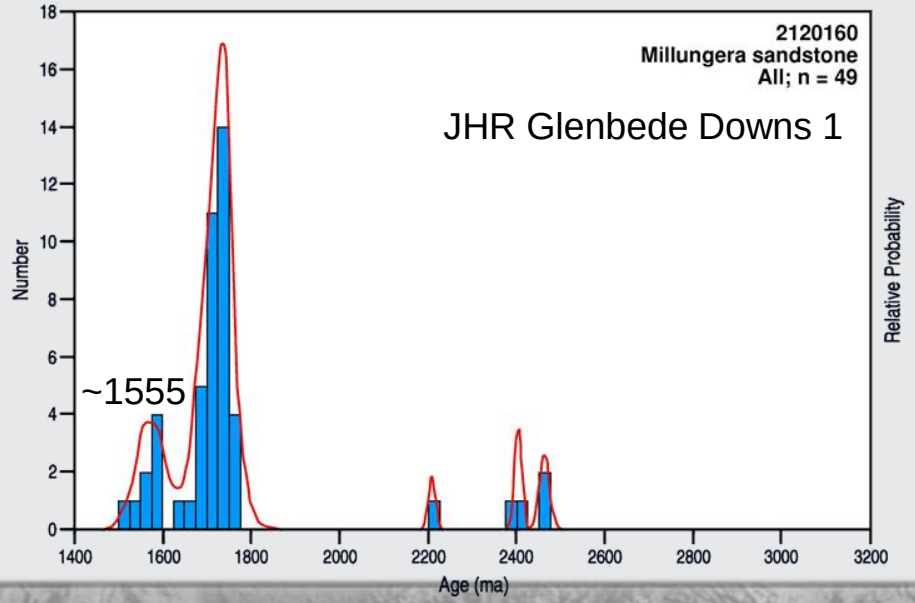
Possible correlatives

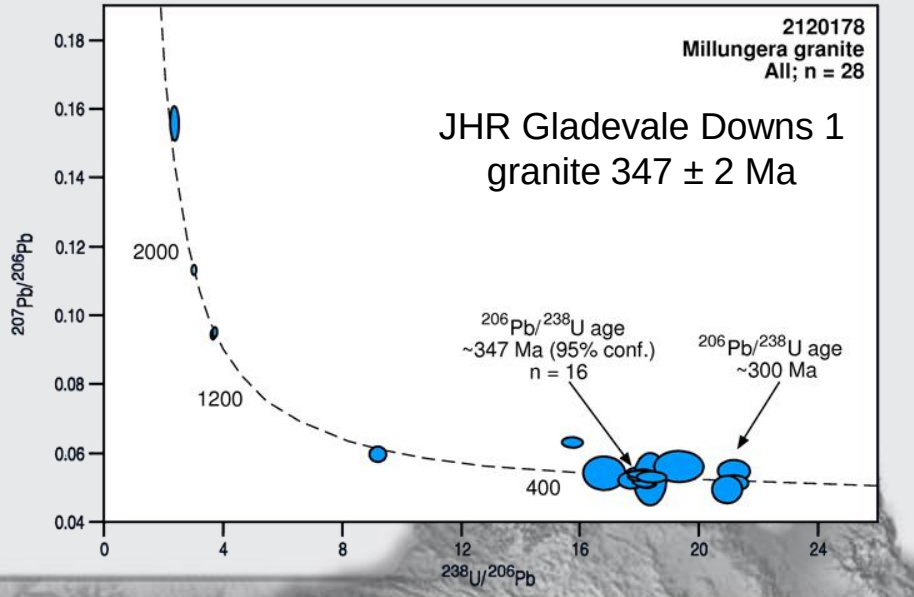
- Galilee Basin (Permian-Triassic)
- Drummond Basin (Devonian-Carboniferous)
- Adavale Basin (Devonian)
- Georgina Basin (Neoproterozoic-Devonian)
- Mt Isa Superbasin (Mesoproterozoic)

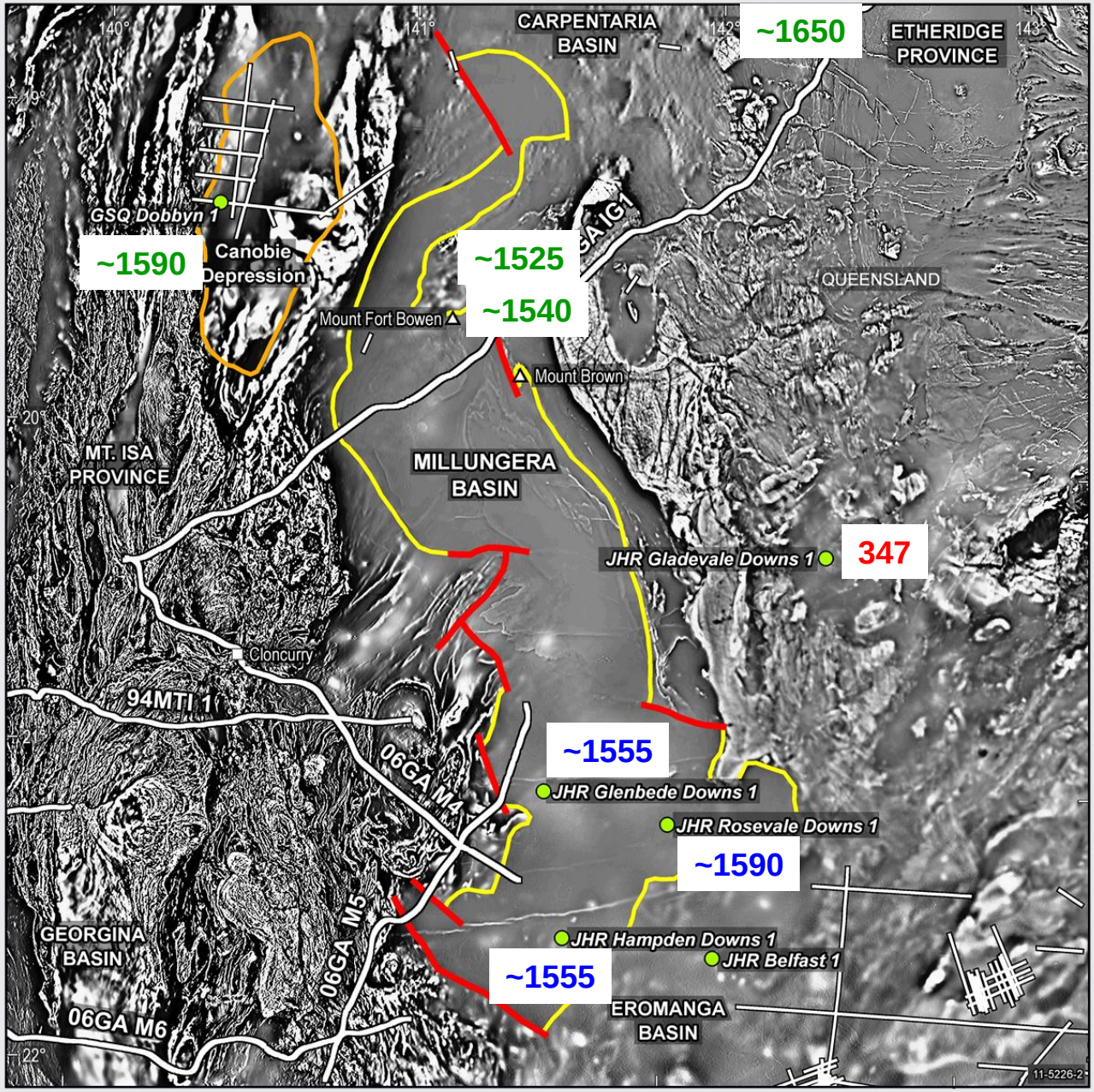
SHRIMP geochronology











Millungera Basin
Canobie Depression
GA seismic line
Industry seismic line
Fault
Key drillhole
Town
Mountain peak
0
50 km

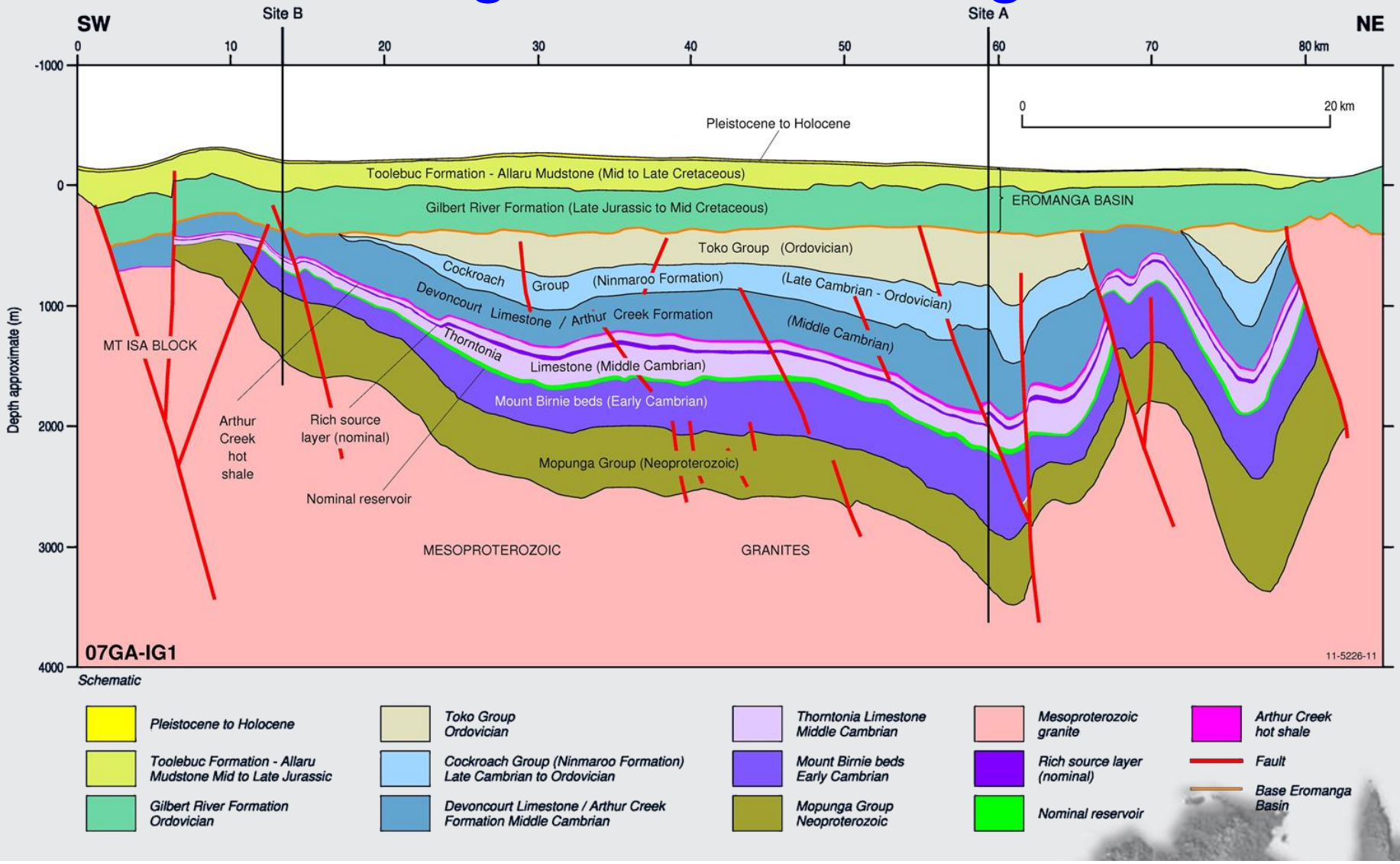
Geochronology (MDA ages)

Local derivation: Mt Isa and/or Etheridge provinces

Petroleum systems modelling

- **Two scenarios**
  - **Georgina Basin analogue (Neoproterozoic to Devonian)**
  - **Galilee Basin analogue (Permian-Triassic)**
- **Two sites on seismic line 07GA-IG1**
- **1D modelling (IES Petromod 11) for possible:**
  - **Burial histories**
  - **Thermal histories**
  - **Generation and expulsion of hydrocarbons from postulated source rocks**

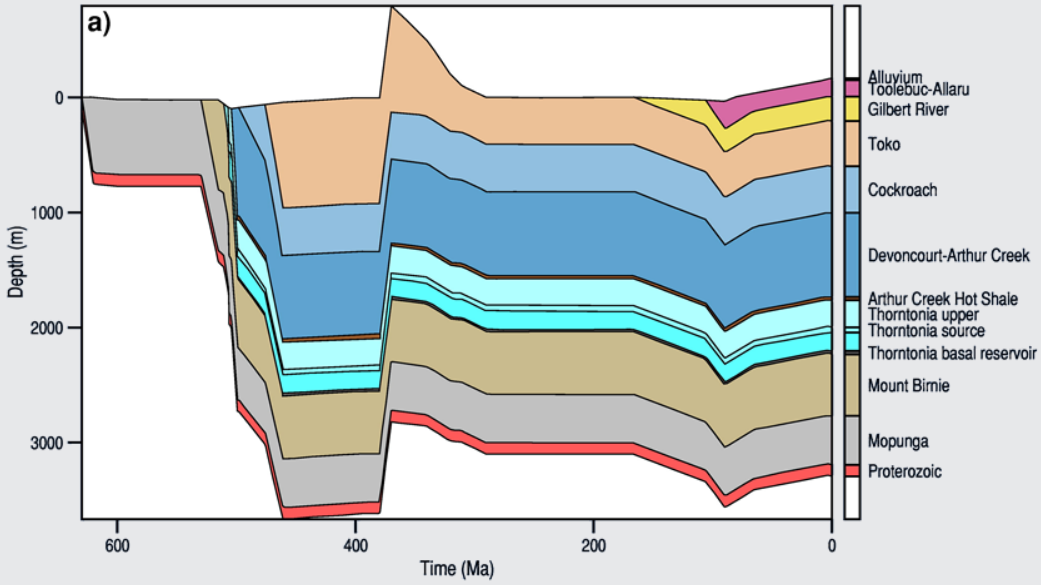
Georgina Basin analogue



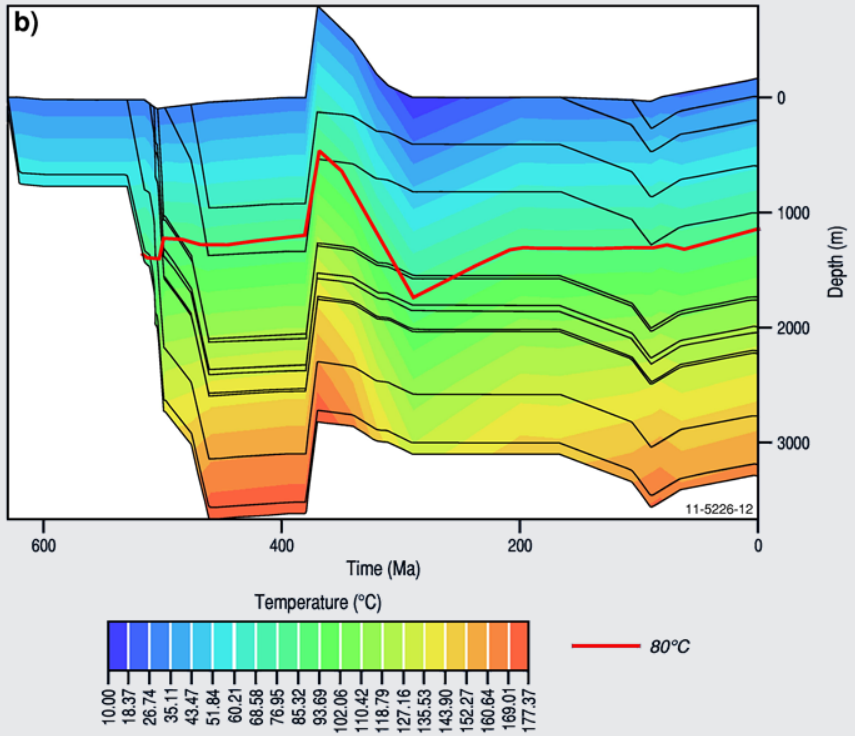
Possible source rocks = Thorntonia Lst, Arthur Creek Fm/Inca Shale

Site A

Burial history

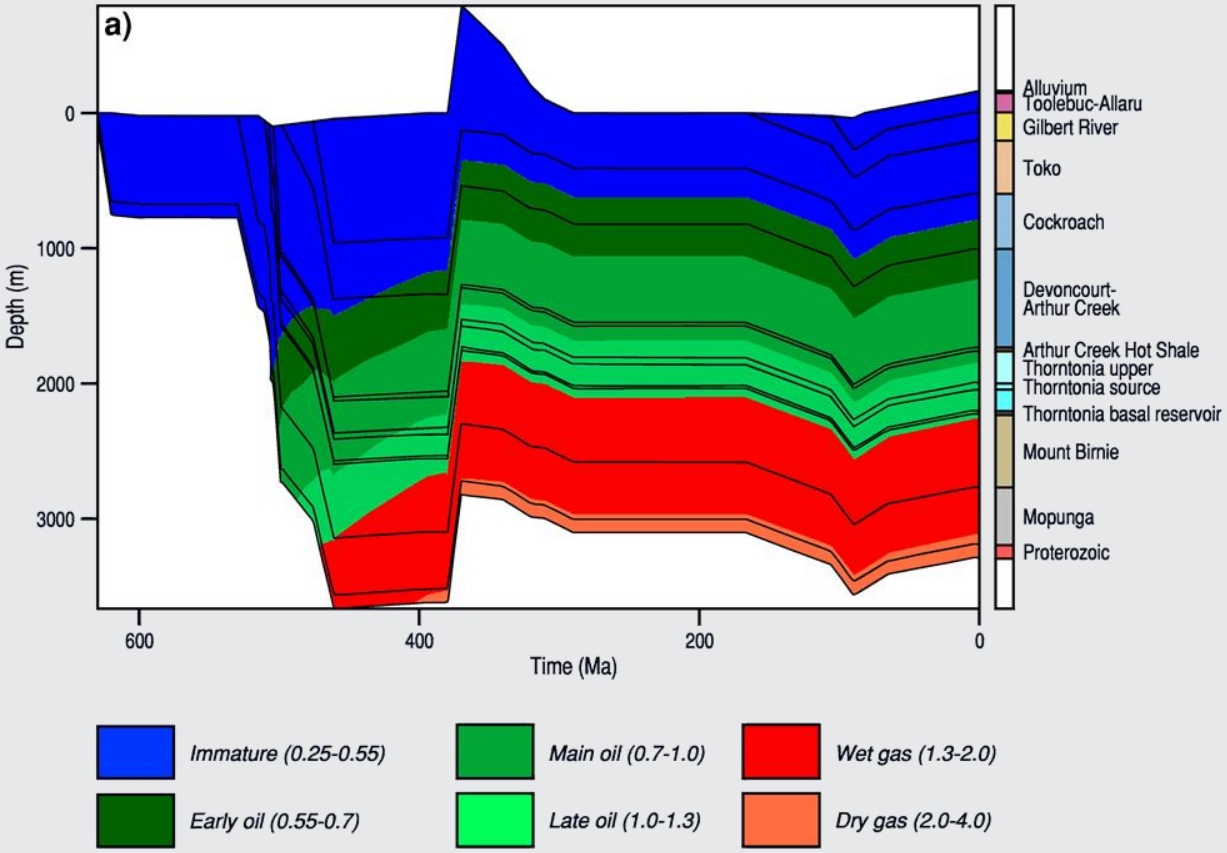


Thermal history (constant heat flow)

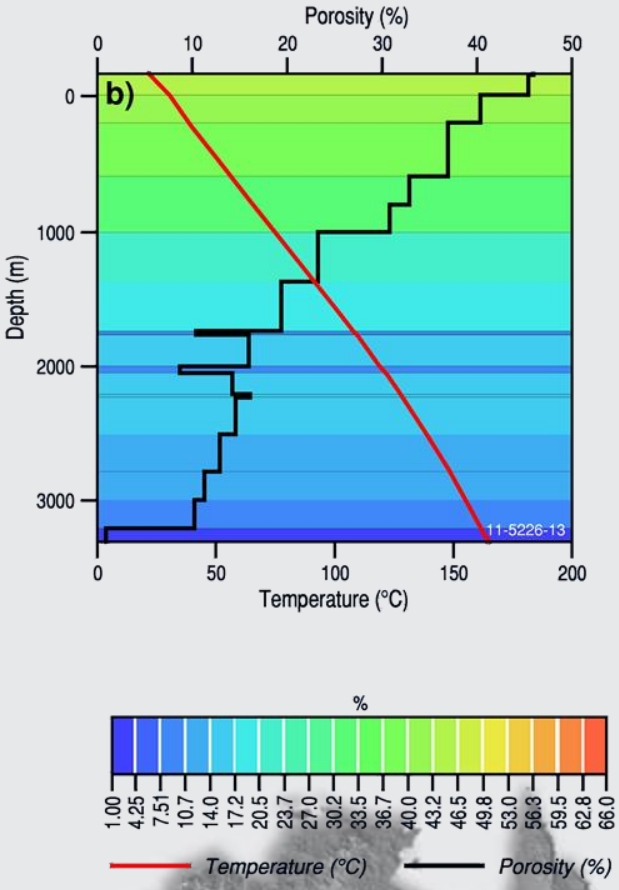


Site A

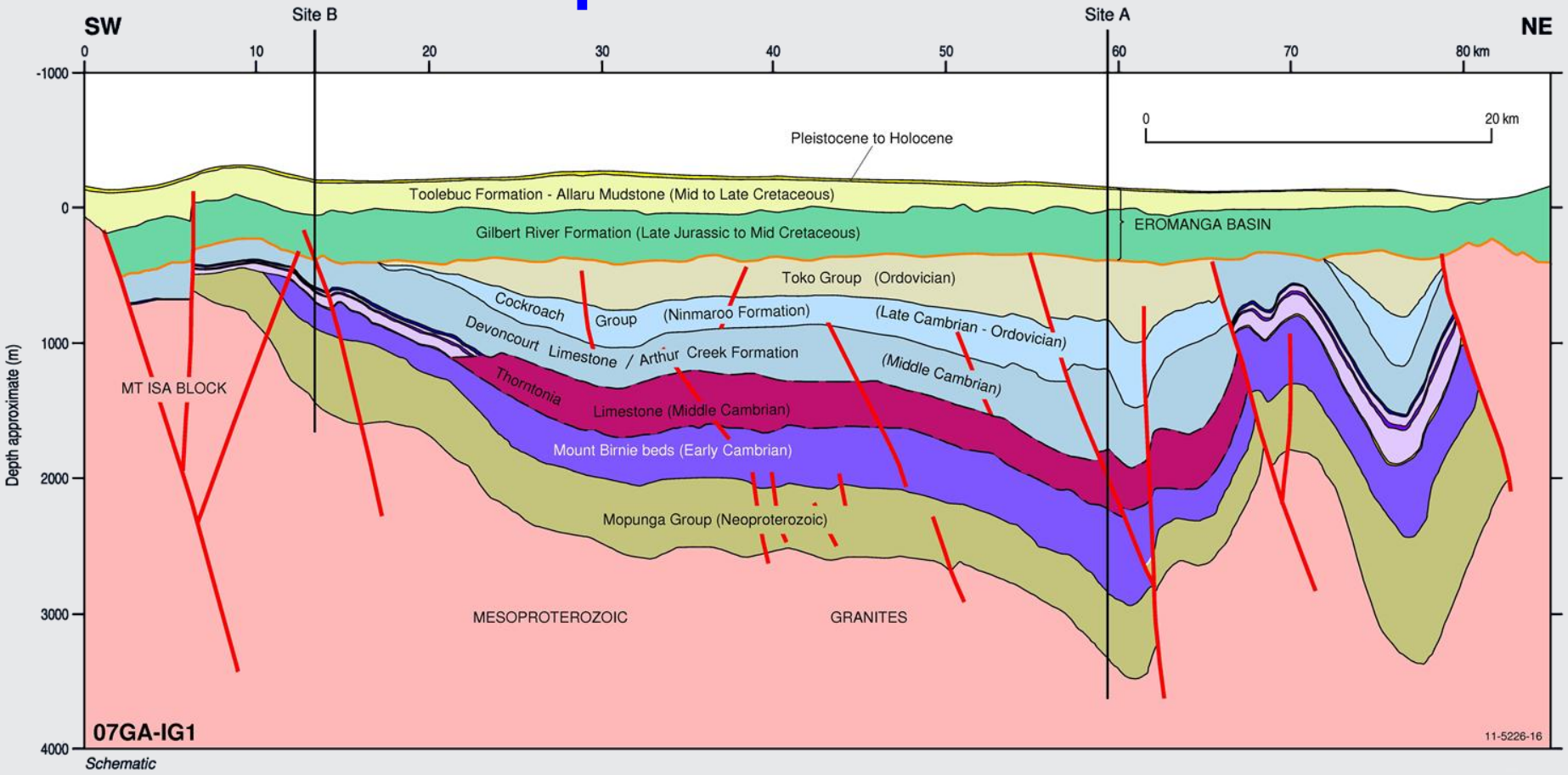
Vitrinite maturity



Porosity & temperature



Georgina Basin analogue
Location of potential source kitchen



Pleistocene to Holocene

Toolebuc Formation - Allaru Mudstone Mid to Late Jurassic

Gilbert River Formation Ordovician

Toko Group Ordovician

Cockroach Group (Ninmaroo Formation) Late Cambrian to Ordovician

Devoncourt Limestone / Arthur Creek Formation Middle Cambrian

Thorntonia Limestone Middle Cambrian

Mount Birnie beds Early Cambrian

Mopunga Group Neoproterozoic

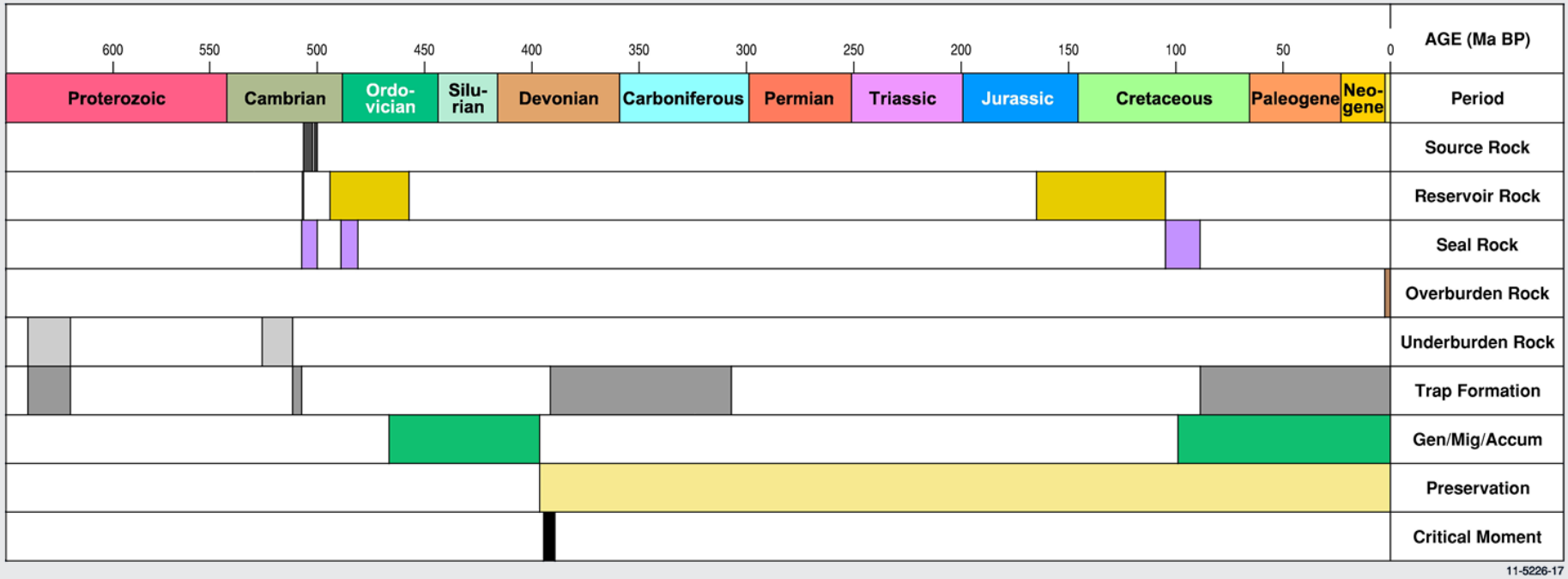
Mesoproterozoic granite

Potential source kitchen

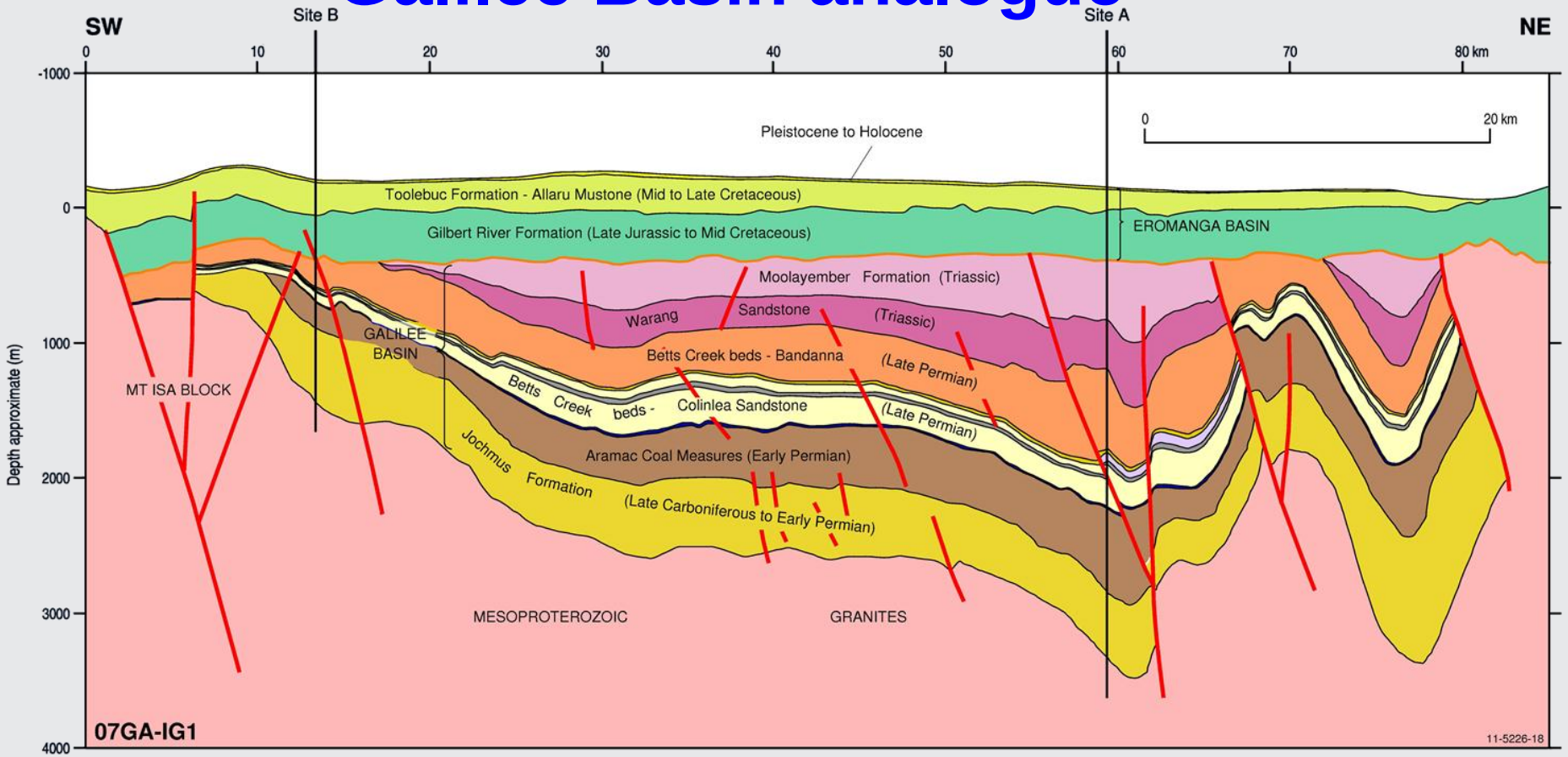
Fault

Base Eromanga Basin

Georgina Basin analogue
Petroleum systems event chart



Galilee Basin analogue



Pleistocene to Holocene

Toolebuc Formation - Allaru Mudstone Mid to Late Jurassic

Gilbert River Formation Mid Jurassic

Moolayember Formation Triassic

Warang Sandstone Triassic

Betts Creek beds - Bandanna Late Permian

Betts Creek beds - Colinlea Sandstone Late Permian

Aramac Coal Measures Early Permian

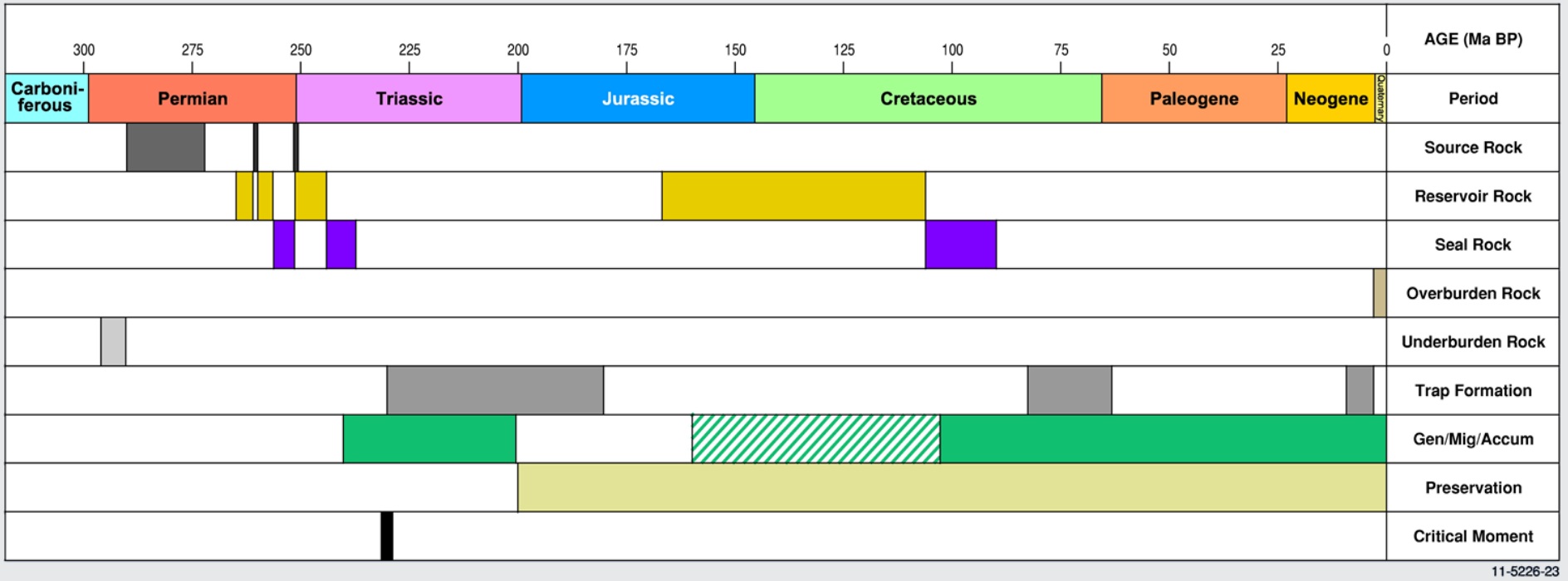
Jochmus Formation Late Carboniferous to Early Permian

Mesoproterozoic granite

Fault

Base Eromanga Basin

Galilee Basin analogue
Petroleum systems event chart



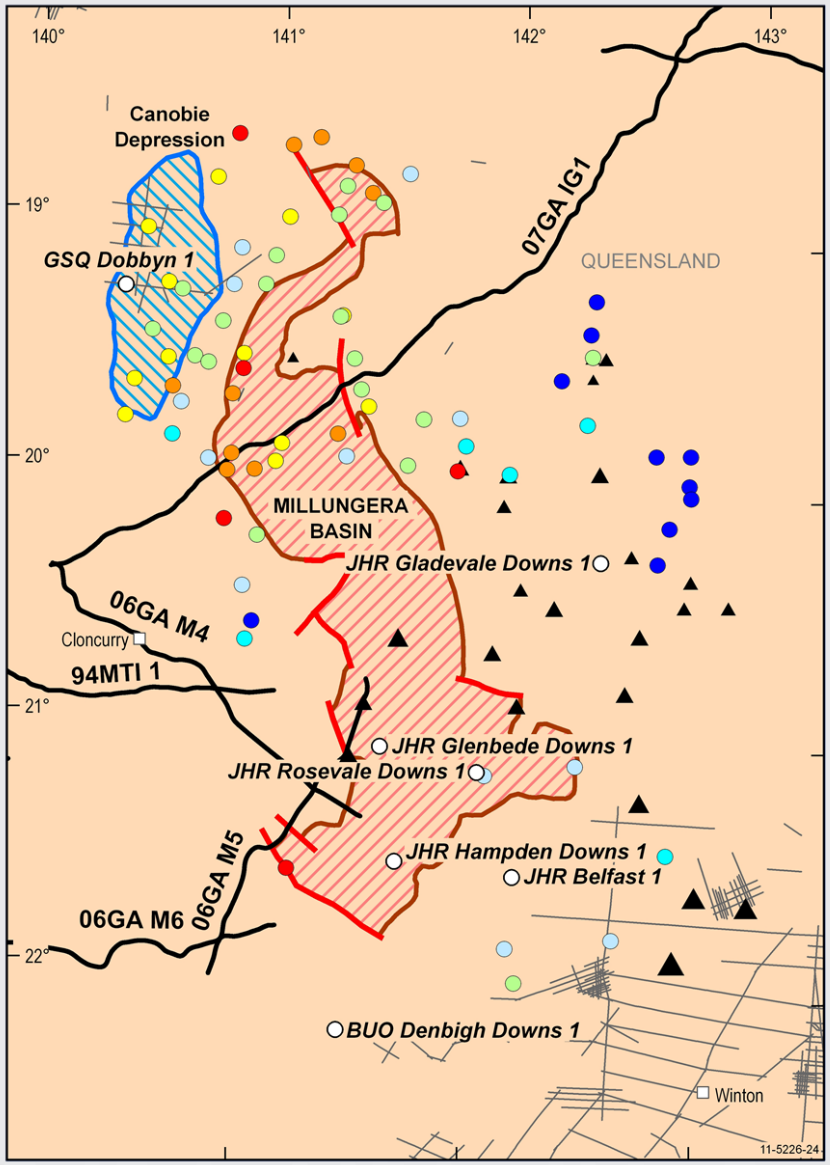
Summary of petroleum systems modelling

	Georgina Basin analogue	Galilee Basin analogue
Site A	Mid Cambrian source rocks in main oil window	Permian source rocks in main oil to gas window
Site B	Mid Cambrian source rocks in early oil window	Permian source rocks immature

Geothermal modelling

- 3D potential field inversions
- 3D geological model (sediments + granites)
- Thermal modelling
  - predict temperatures at depth and surface heat flow
- Inputs
  - Surface temperature (constant 31ºC)
  - Basal heat flow (constant 40 mWm^{-2})
  - Heat production rate of granite (variable 8, 5, 2 μWm^{-3})
  - Thermal conductivity of sediments (variable 2.9, 2.6, 2.3 WmK^{-1})
  - 9 scenarios modelled

Water bores – temperature gradients



Millungera Basin

Canobie Depression

GA seismic line

Industry seismic line

Fault

Key drillhole

Town

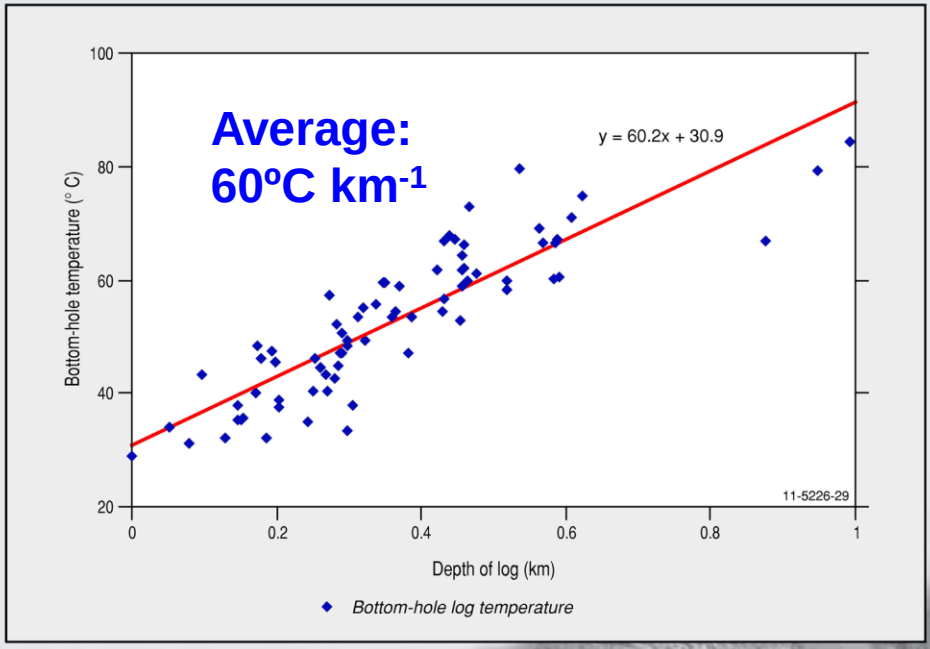
Borehead temperature - artesian bores (°C)

- < 30°
- 30° - 40°
- 40° - 50°
- 50° - 60°
- 60° - 70°
- > 70°

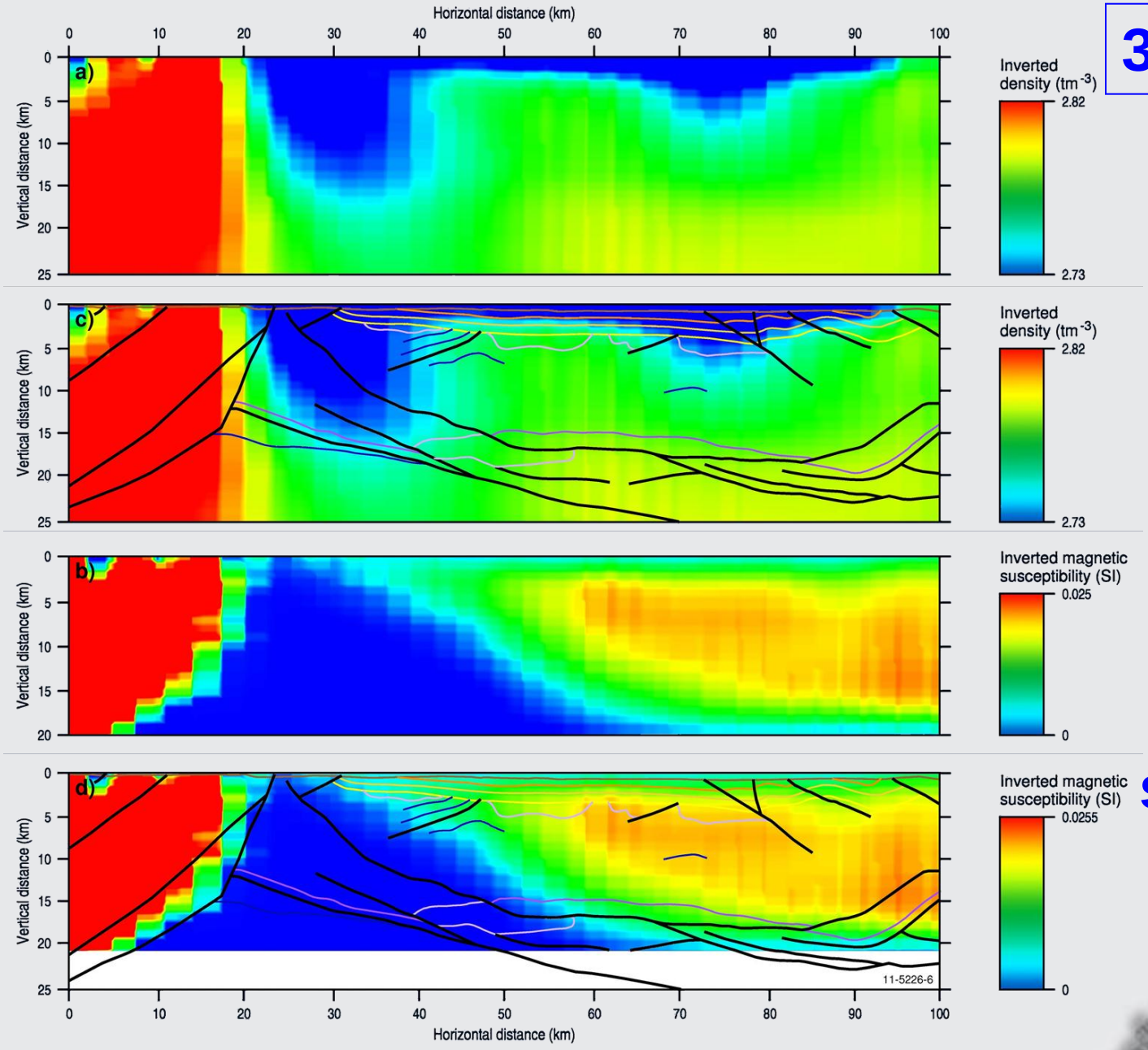
Temperature gradient - logged bores (°C/km)

- < 35
- 35 - 45
- 45 - 55
- 55 - 65
- 65 - 75
- 75 - 85
- > 85

0 100 km



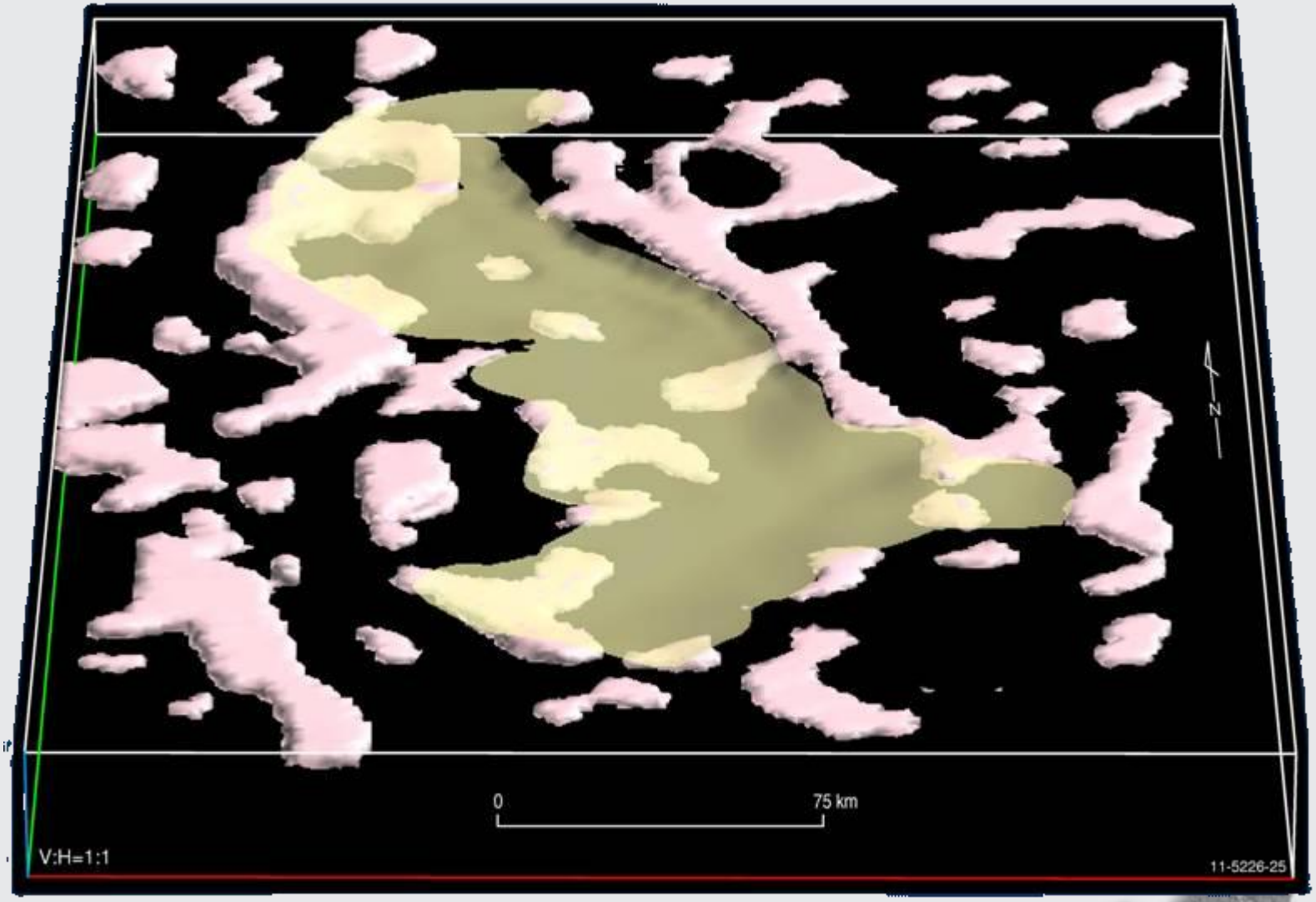
3D inversions



Density

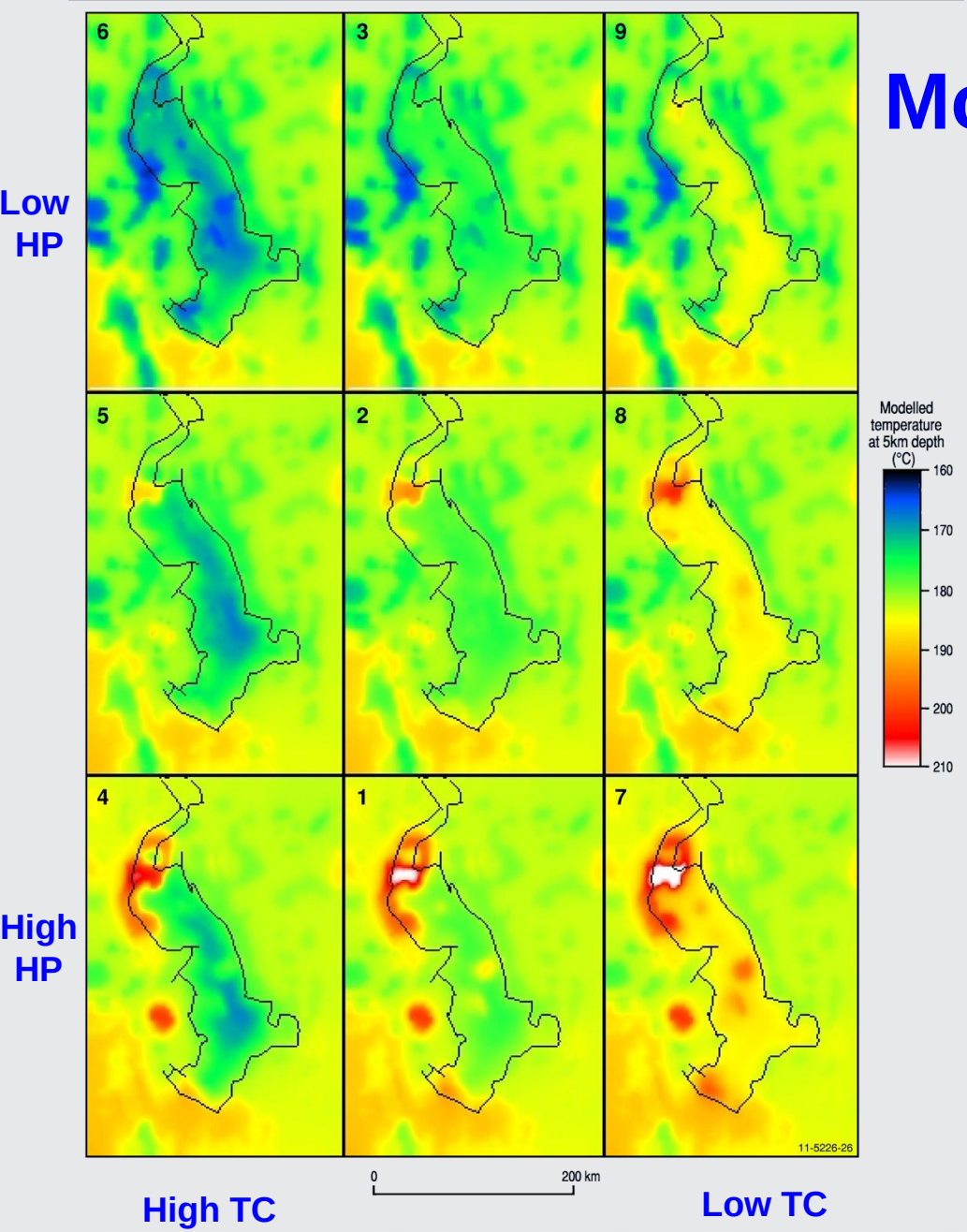
Magnetic susceptibility

3D model



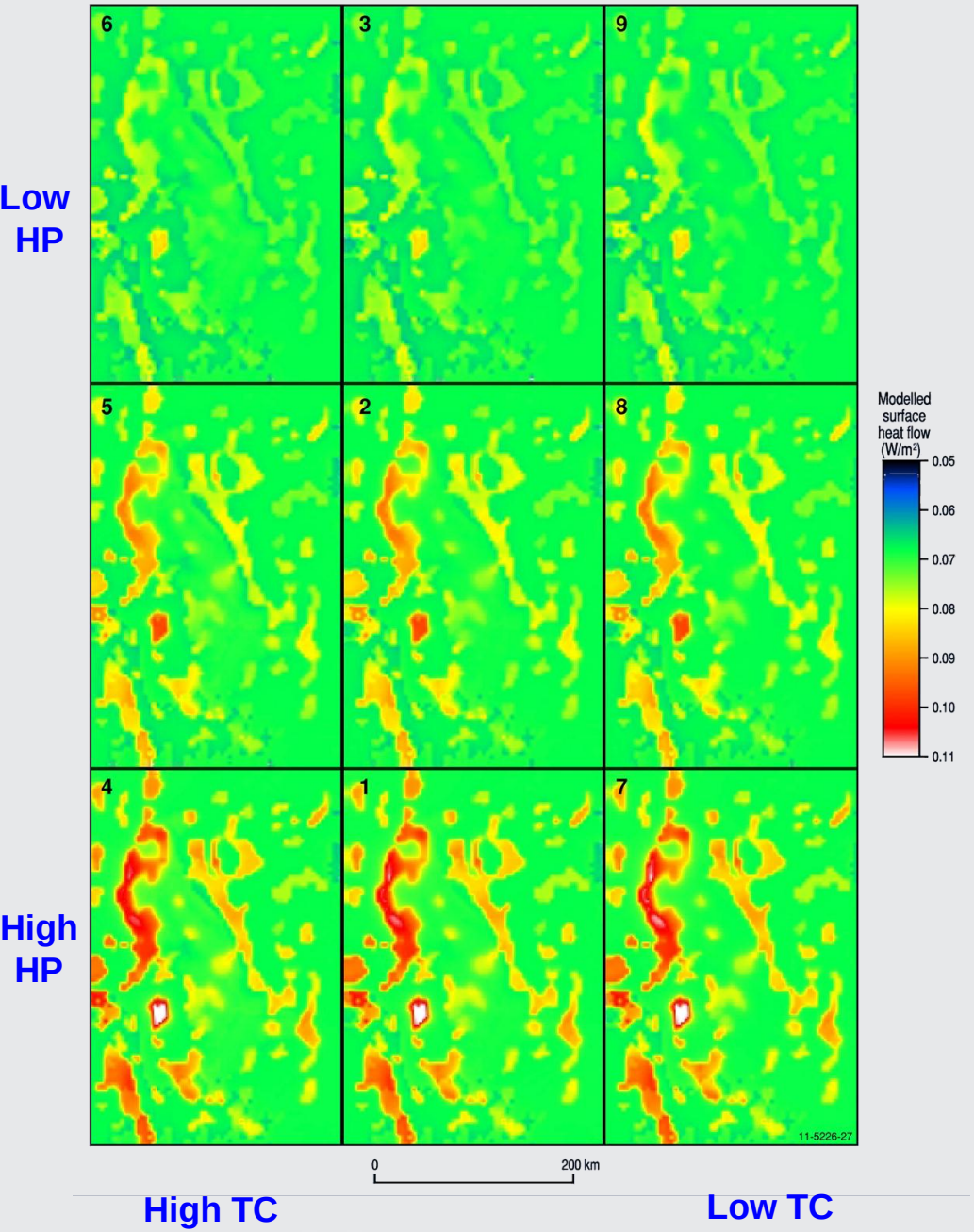
Base of Millungera Basin (brown)
Granite (pink; yellow beneath basin)

Modelled temperatures at 5 km depth



Results

- Low-heat production granite
  - 183-188ºC
- High-heat production granite
  - 206-220ºC
  - Elevated temperatures
  - Prospective for geothermal energy



Modelled surface heat flow

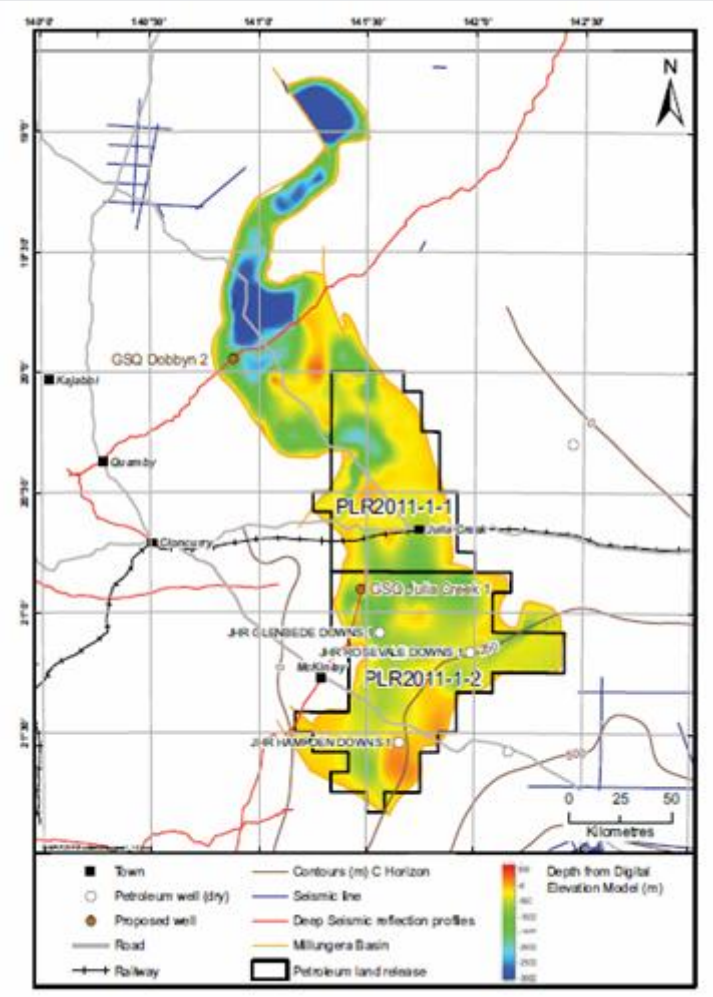
Results

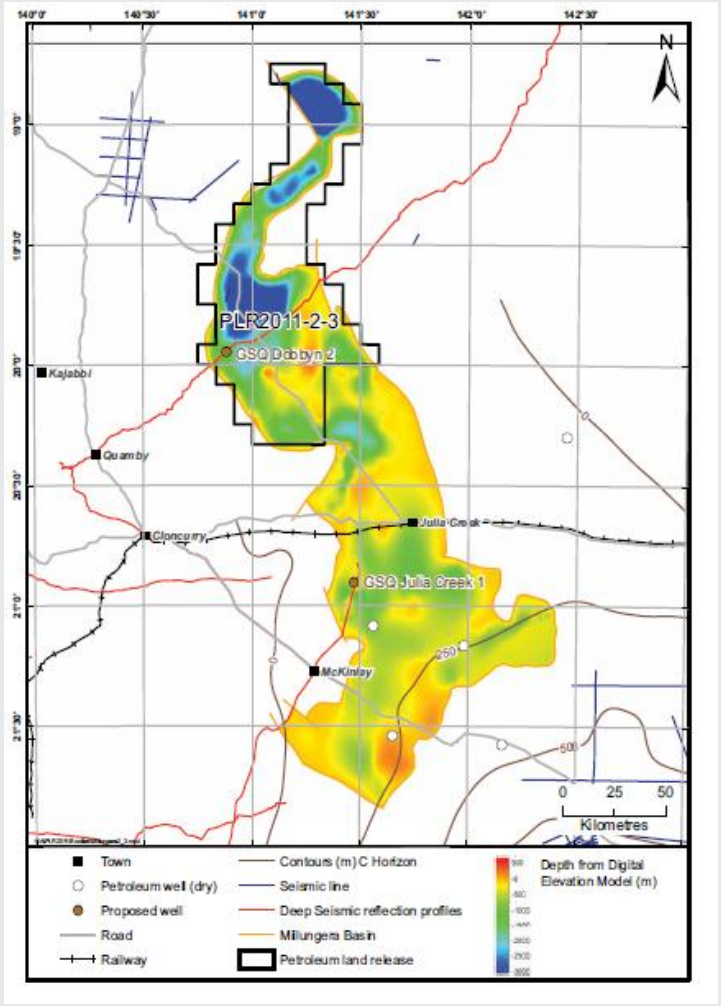
- Low-heat production granite
  - 80-82 mWm^{-2}
- High-heat production granite
  - 108-110 mWm^{-2}
  - Elevated heat flow
  - Prospective for geothermal energy

Summary

- Newly discovered Millungera Basin
  - 280 km x 95 km
- Maximum depth ~3370 m on seismic section
- Three stratigraphic successions
- Age –unknown
  - clastic sediments locally derived
- Petroleum systems and geothermal modelling (models dependent on input parameters)
  - Georgina Basin analogue – source rocks mature
  - Galilee Basin analogue – source rocks mature to immature
- High geothermal potential if high-heat production granites at depth

Call for Tenders – 25 March 2011





Applications close 14 November 2011

Acknowledgements

- 2006 seismic survey – GA (OESP), GSQ, pmd*CRC, Zinifex
- 2007 seismic survey – GA (OESP), GSQ, AuScope
- North Queensland Project (GA, GSQ, AuScope)
- Mark Livingstone – GSQ Core Store
- Theo Chiotis, Veronika Galenic, David Arnold, GA – figures
- Peter Milligan, GA – aeromagnetic images
- Simon van der Wielen, GA – water bore data