

History of Petroleum Exploration and Development in the Cooper and Eromanga Basins*

Steve Mackie¹

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¹Manager – Geophysics, Santos, Adelaide, SA, Australia (steve.mackie@santos.com)

Abstract

Licenses covering the Cooper and Eromanga basins were first acquired by Santos in 1954 with the first gas discovery, Gidgealpa-2, being made nine years and ten wells later. The Cooper and Eromanga basins together now make up Australia's largest onshore petroleum province with approximately 190 gas fields and 115 oil fields currently on production from 820 producing gas wells and more than 400 producing oil wells. These wells feed into approximately 5,600 km of pipelines and flowlines via 15 major satellite facilities. Gas is exported (via pipeline) to Adelaide, Sydney and Brisbane (East Coast gas market) and liquids, together with NGL, via pipeline to Port Bonython. Gas has primarily been discovered to date in Permo-Carboniferous glacial, coal measure and lacustrine sediments of the Cooper Basin, whilst oil has primarily been discovered in the Jurassic/Early Cretaceous fluvial sediments of the Eromanga Basin.

The petroleum history of the past 60 years consists not just of technical innovation leading to new play discoveries and reversal of long held ideas but also the story of people who were focused on bringing those innovations into realities. Both exploration and development have responded to several periods of low petroleum prices. Notwithstanding poor prices, exploration and development are driven by the financial inertia of the existing infrastructure. Although the reservoirs of the Cooper and Eromanga basins could never be considered typically “conventional” the move to exploring for and producing from “unconventional” reservoirs also builds on the back of the existing infrastructure. Future exploration and development will likely move towards the shallower (Late Cretaceous of the Eromanga Basin) and deeper (Warburton Basin) reservoirs as well the unconventional reservoirs of the Cooper Basin.

Exploration and Development History of the Cooper and Eromanga Basins

Dr Steve Mackie

AAPG/SEG/PESA ICE– September 2015



Disclaimer

This presentation contains forward looking statements that are subject to risk factors associated with the oil and gas industry. It is believed that the expectations reflected in these statements are reasonable, but they may be affected by a range of variables which could cause actual results or trends to differ materially, including but not limited to: price fluctuations, actual demand, currency fluctuations, geotechnical factors, drilling and production results, gas commercialisation, development progress, operating results, engineering estimates, reserve estimates, loss of market, industry competition, environmental risks, physical risks, legislative, fiscal and regulatory developments, economic and financial markets conditions in various countries, approvals and cost estimates.

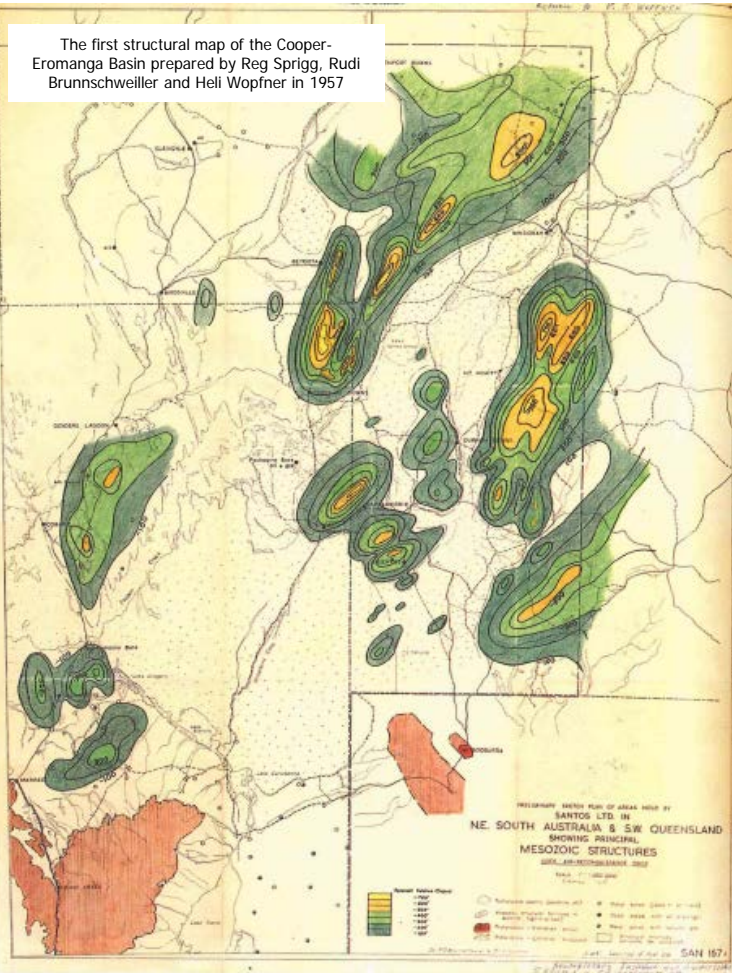
All references to dollars, cents or \$ in this document are to Australian currency, unless otherwise stated. All references to project completion percentages are on a value of work done basis, unless otherwise stated.

Outline

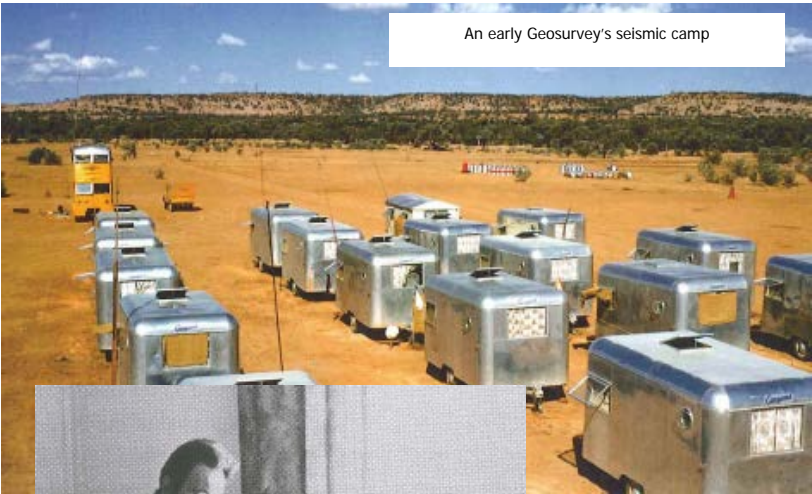
“Tell ‘em what you are going to tell ‘em”

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- Early Pioneers
 - Geological Understanding
 - A history of Exploration and Development
 - A history of plays
 - A history of technology
 - A history of politics
 - Summary

Early Pioneers

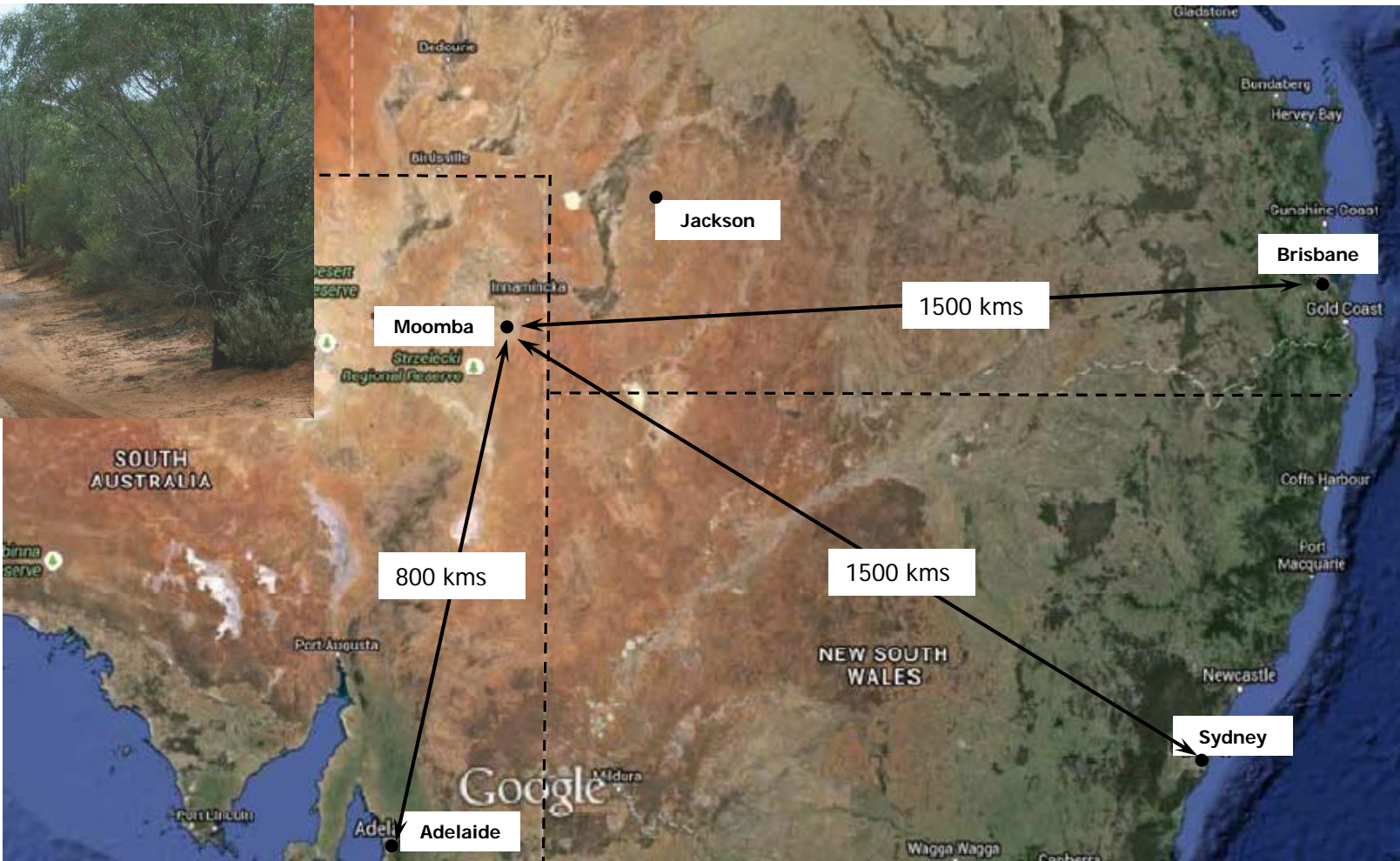


Reg Sprigg, Heli Wopfner and Rudi Brunnschweiler (Geoservices)



Geographically Remote
and Challenging

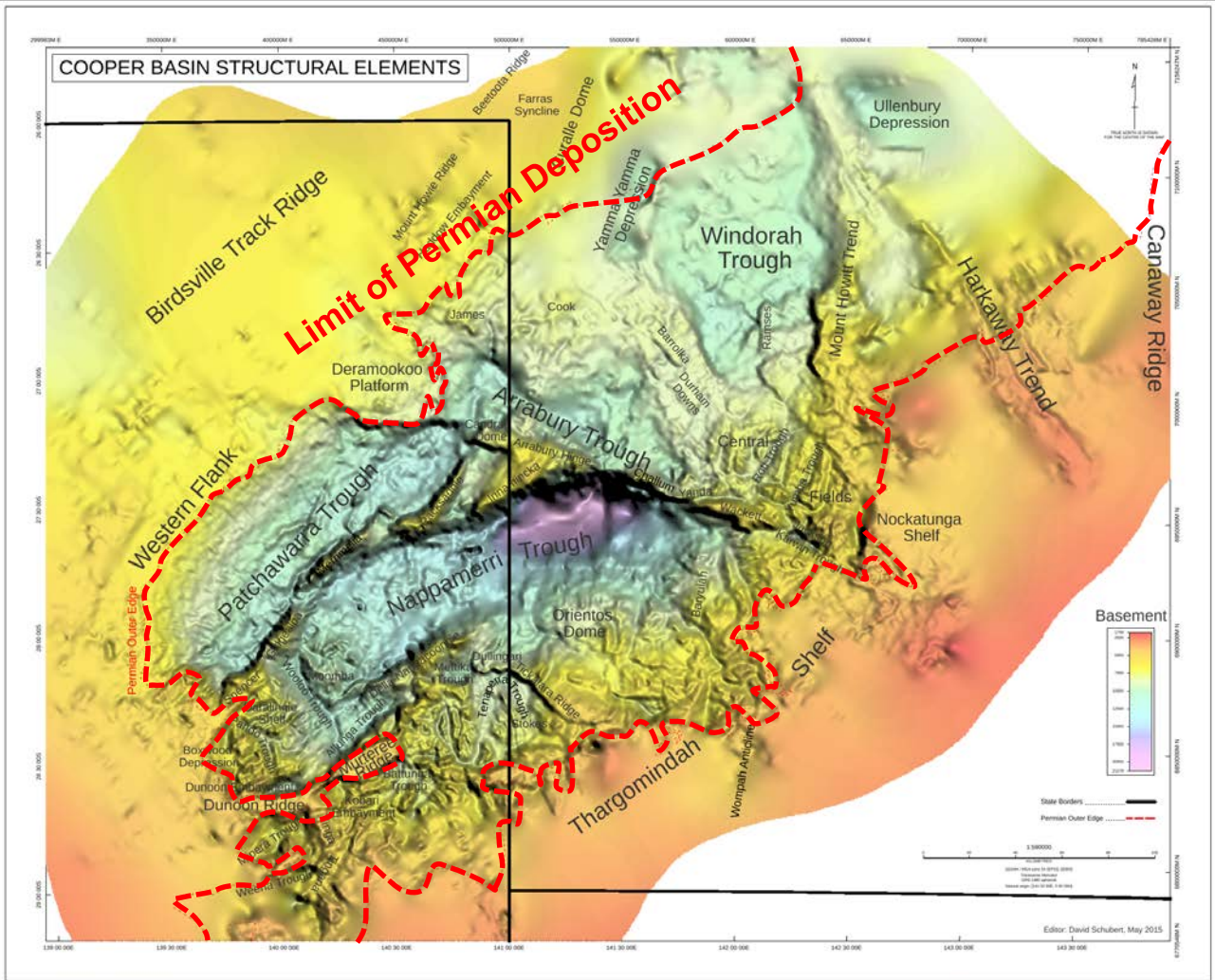
Centre of Australia – 800kms from Adelaide and 1500kms from Brisbane
Present Day Landform – desert intersected by seasonal channels



Eromanga and Cooper Basin Stratigraphy

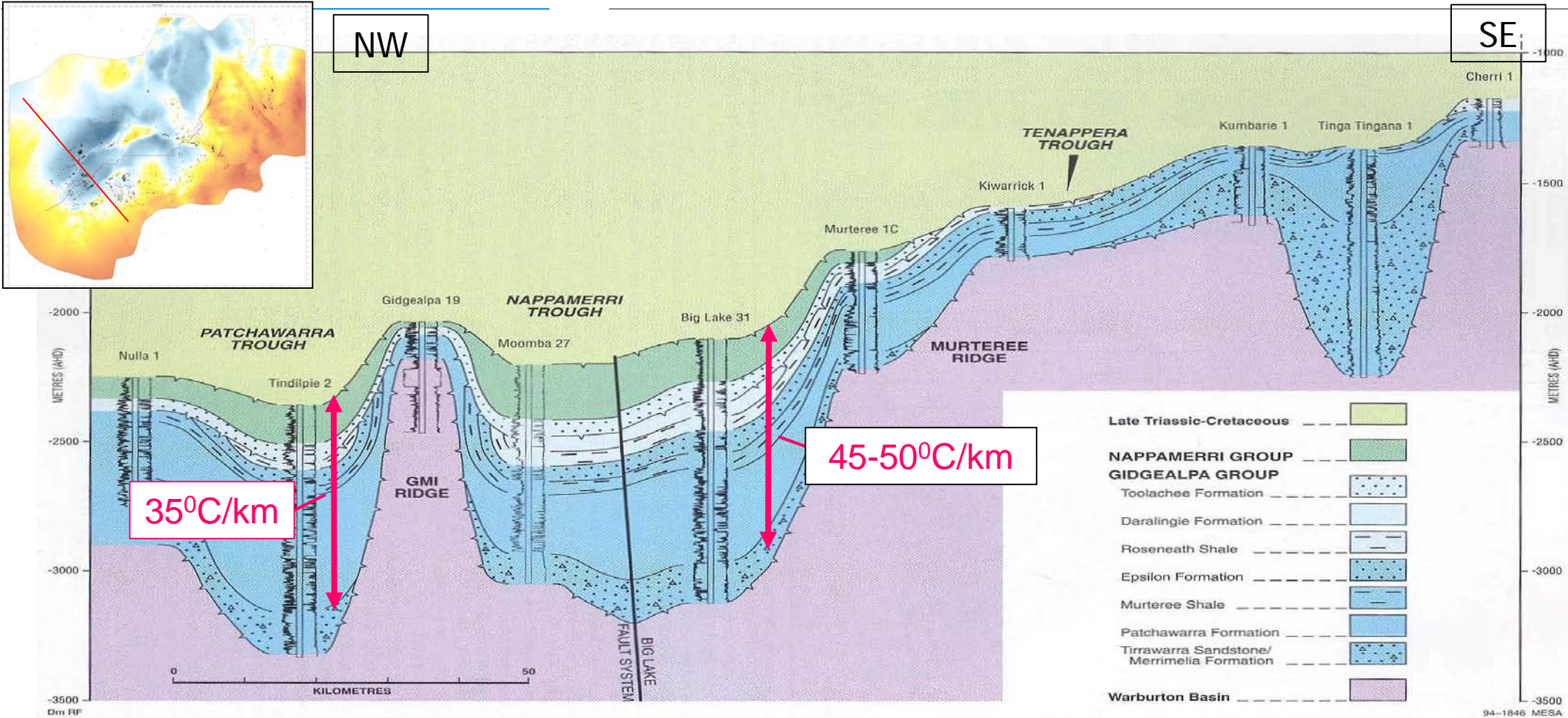
Cooper Basin





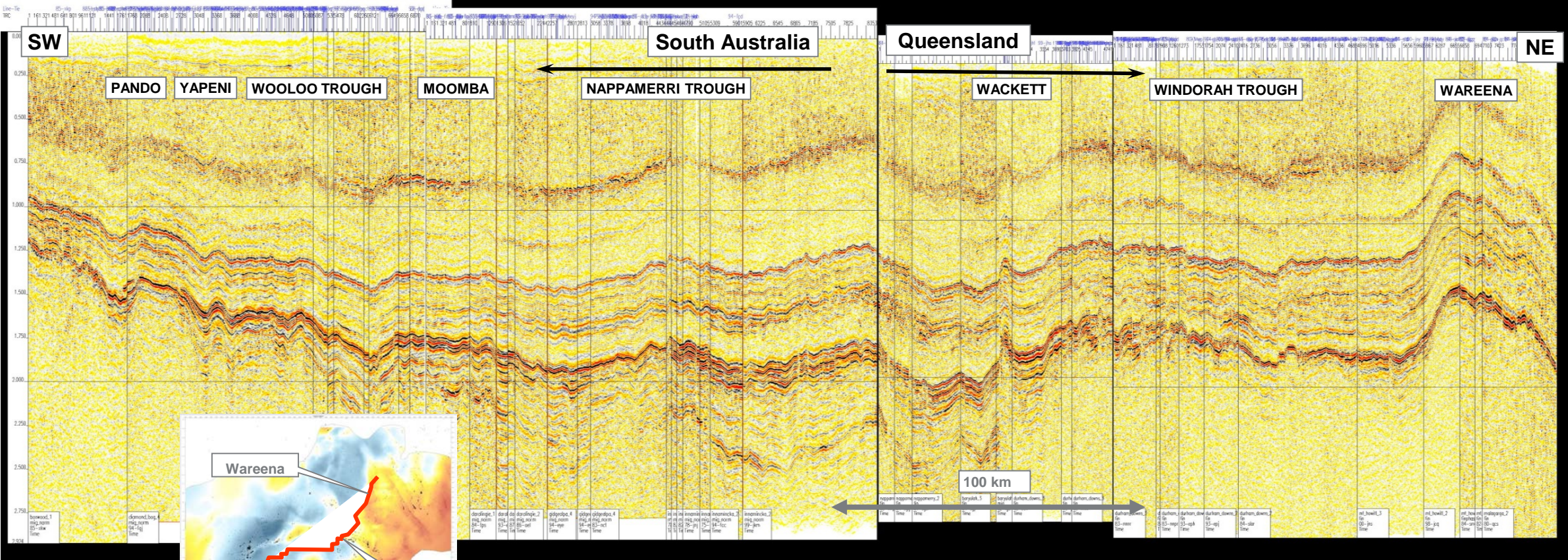
Geological Understanding

NW-SE Section across the Southern Patchawarra and Nappamerri Troughs



Geological Understanding

SW-NE Section across the Cooper Basin

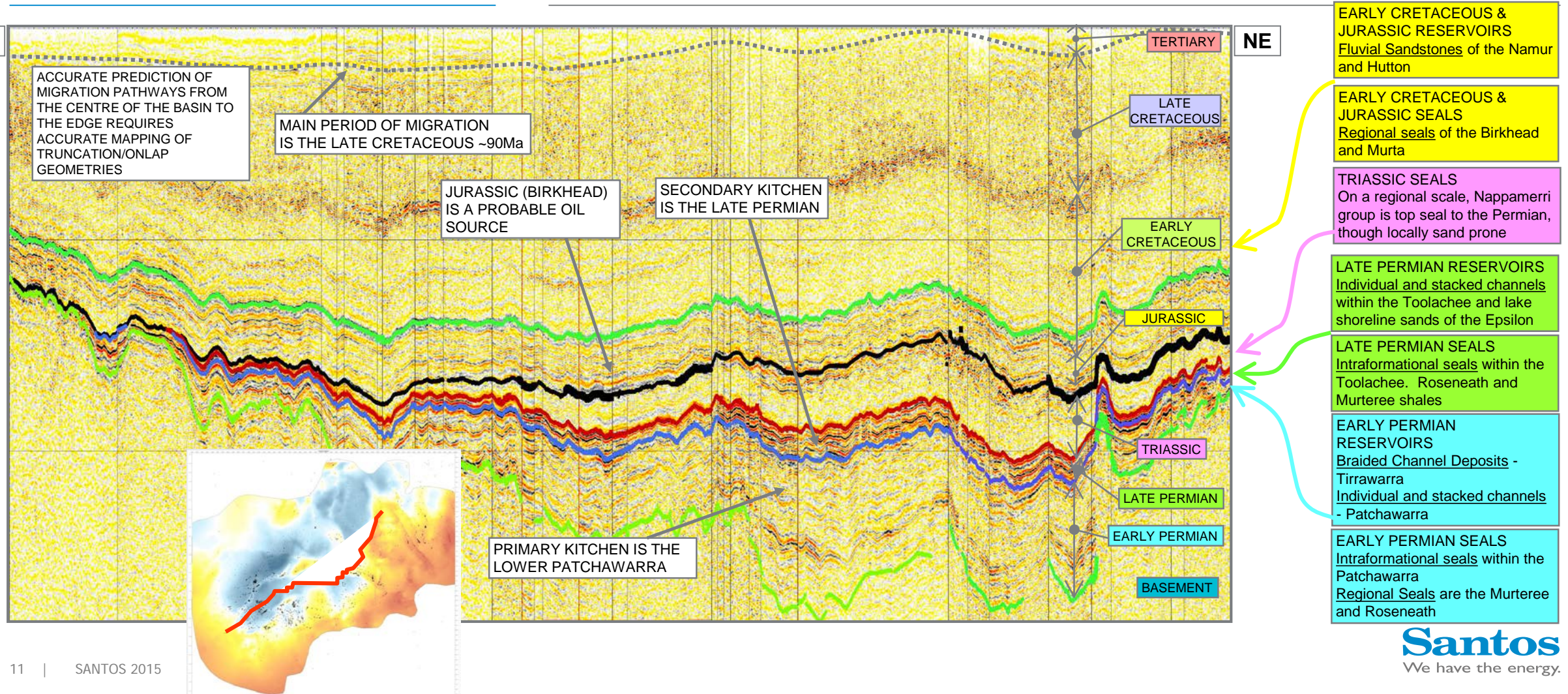


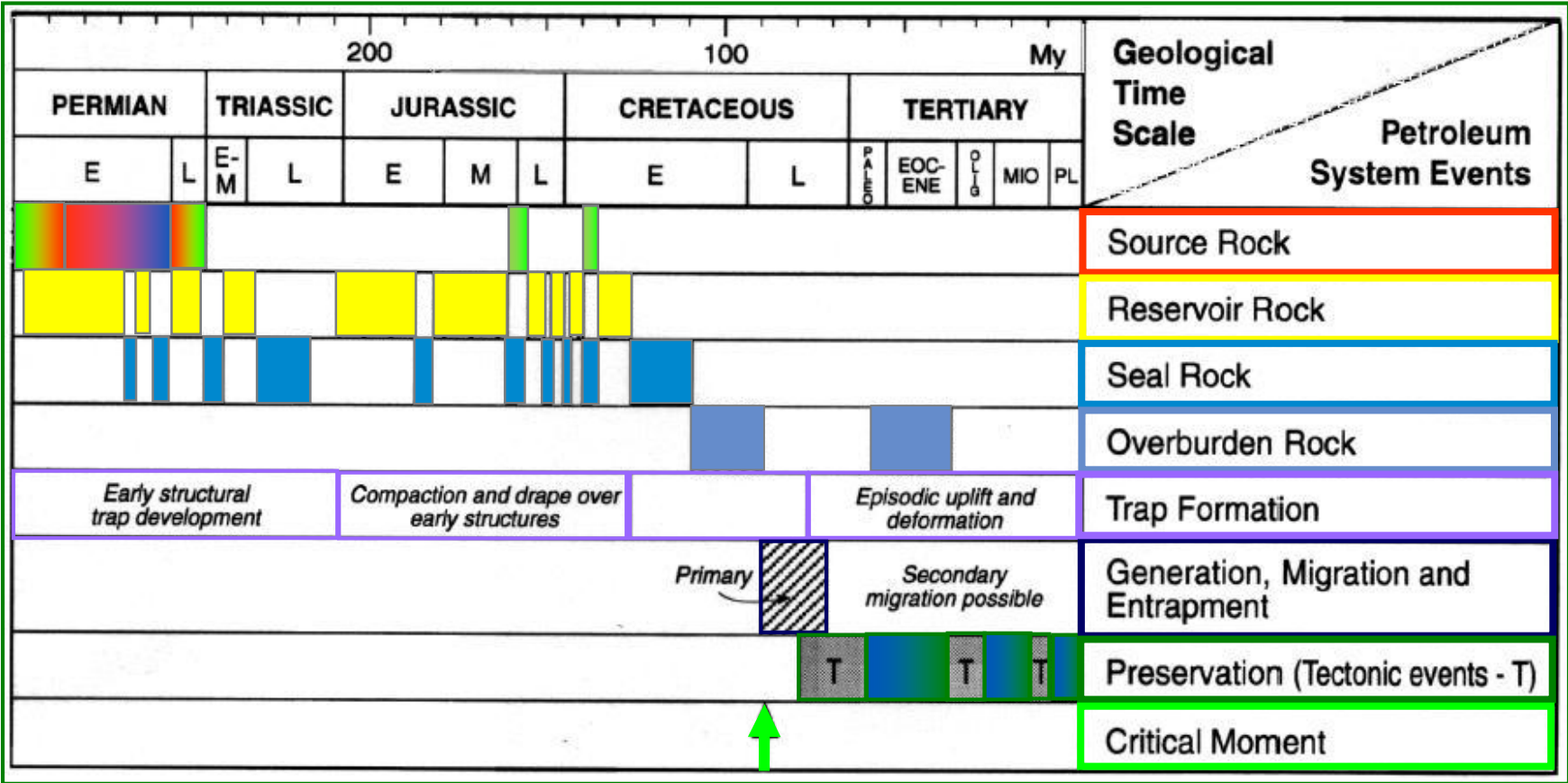
Seismic flattened on base regional seal showing key unconformities



Geological Understanding

Source, Migration, Reservoir/Seal pairs





History of Exploration and Development

Phase 1 – 1960's



Key Outcomes

- Joint Venture agreement with Delhi Taylor Oil Corporation
- First seismic survey
- First deep well: Innamincka-1
- First hydrocarbon discovery in the basin at Gidgealpa-2
- Discovery of sufficient gas at Gidgealpa and Moomba to commence construction of the Moomba gas plant and an export pipeline to Adelaide

History of Exploration and Development

Phase 2 – 1970's

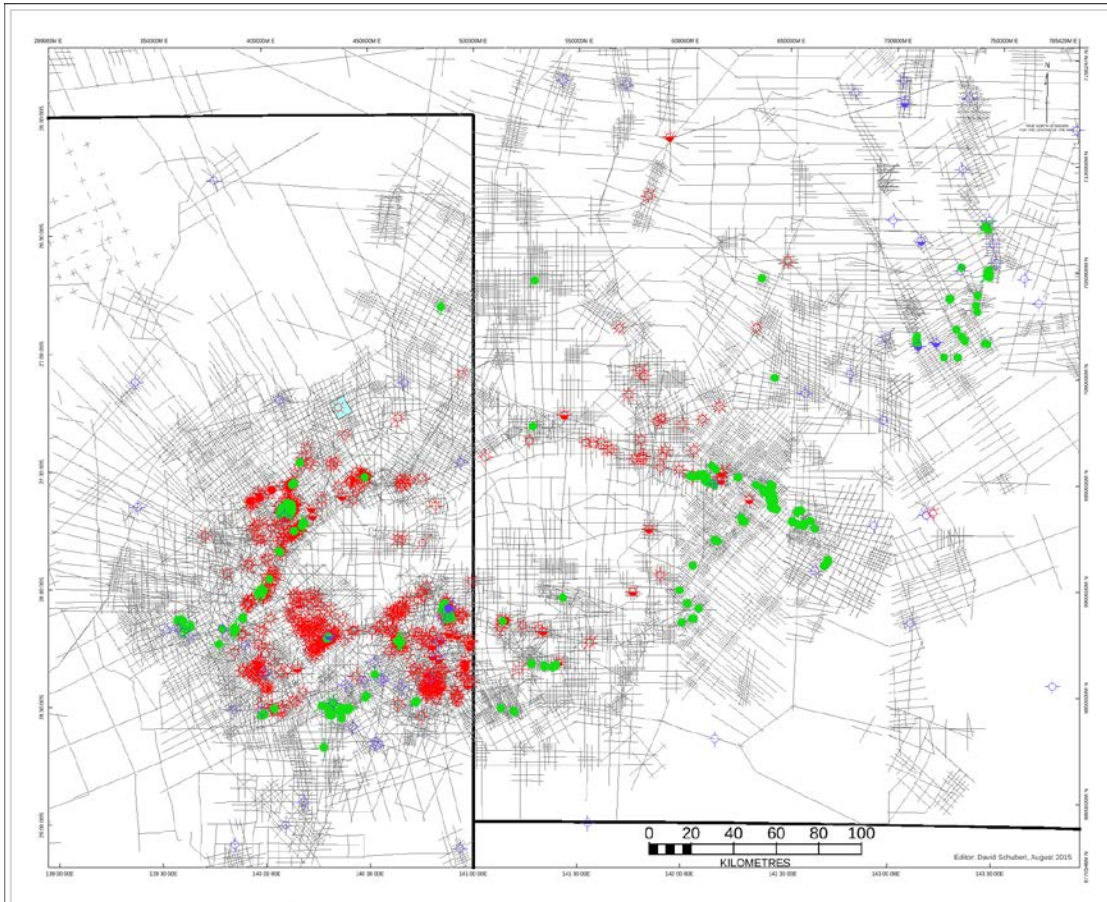


Key Outcomes

- Series of major farmouts leading to a dramatic increase in activity but the challenges of unitisation
- Major discoveries leading to construction of the Moomba-Sydney pipeline
- Discovery of Permian oil at Tirrawarra
- Major Jurassic oil discovery at Strezlecki

History of Exploration and Development

Phase 3 – 1980's

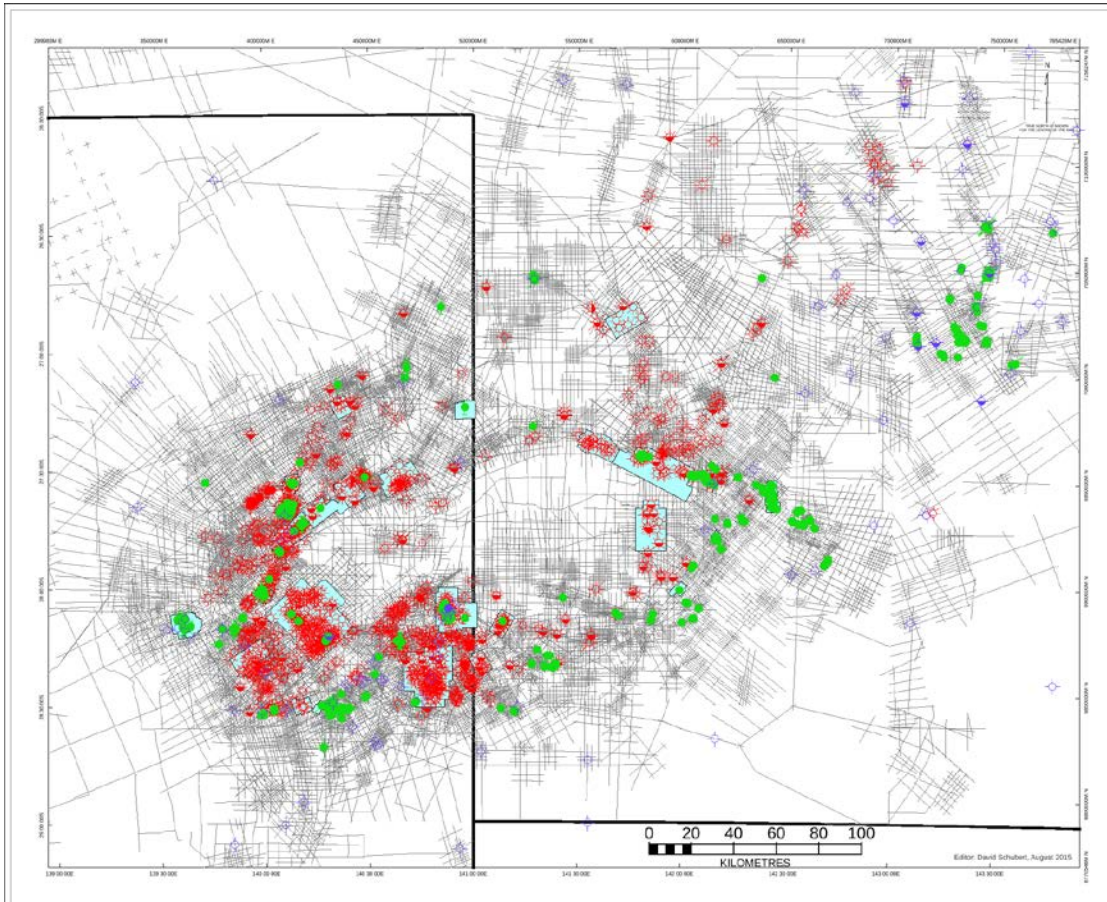


Key Outcomes

- Major exploration focus turns to Mesozoic oil with Strezlecki-3 discovery
- Jackson oil plant and an oil pipeline to Brisbane
- A liquids pipeline and export facility at Port Bonython
- Santos assumes Operatorship of gas development program – Delhi is exploration and oil development Operator
- Delhi's interests sold to CSR
- Accelerated Gas Program to assure gas to South Australia beyond contract end
- First experimental 3D seismic survey at Cuttapiirrie

History of Exploration and Development

Phase 4 – 1990's

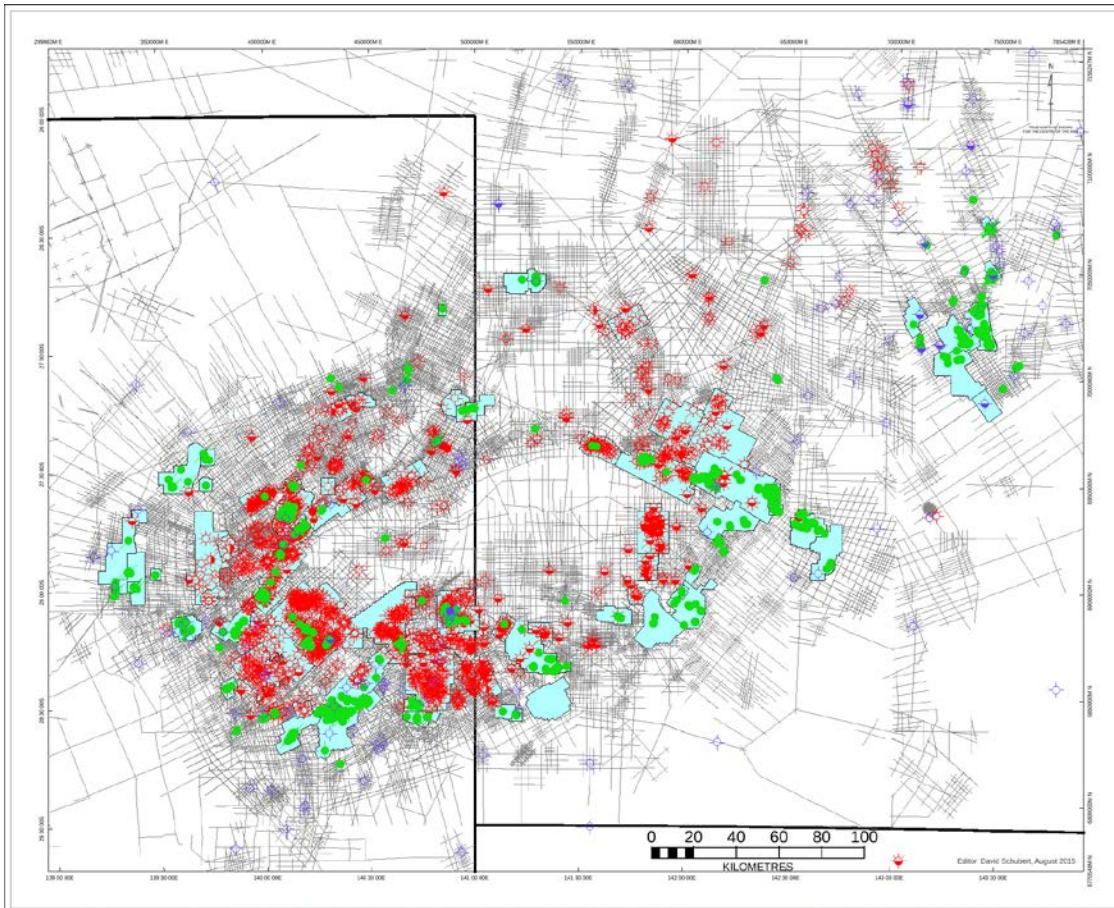


Key Outcomes

- Delhi interests sold to Exxon
- Santos assumes Operatorship for entire basin
- Queensland government allows hydrocarbons to be exported to South Australia leading to a major gas exploration and development effort in Queensland
- Construction of Ballera gas plant and pipeline to Moomba
- Introduction of 3D seismic
- A Ethane sales agreement is signed which is facilitated by gas storage in depleted reservoirs in Moomba Field
- Fixed factors for the South Australia and SWQ units agreed

History of Exploration and Development

Phase 5 – 2000's

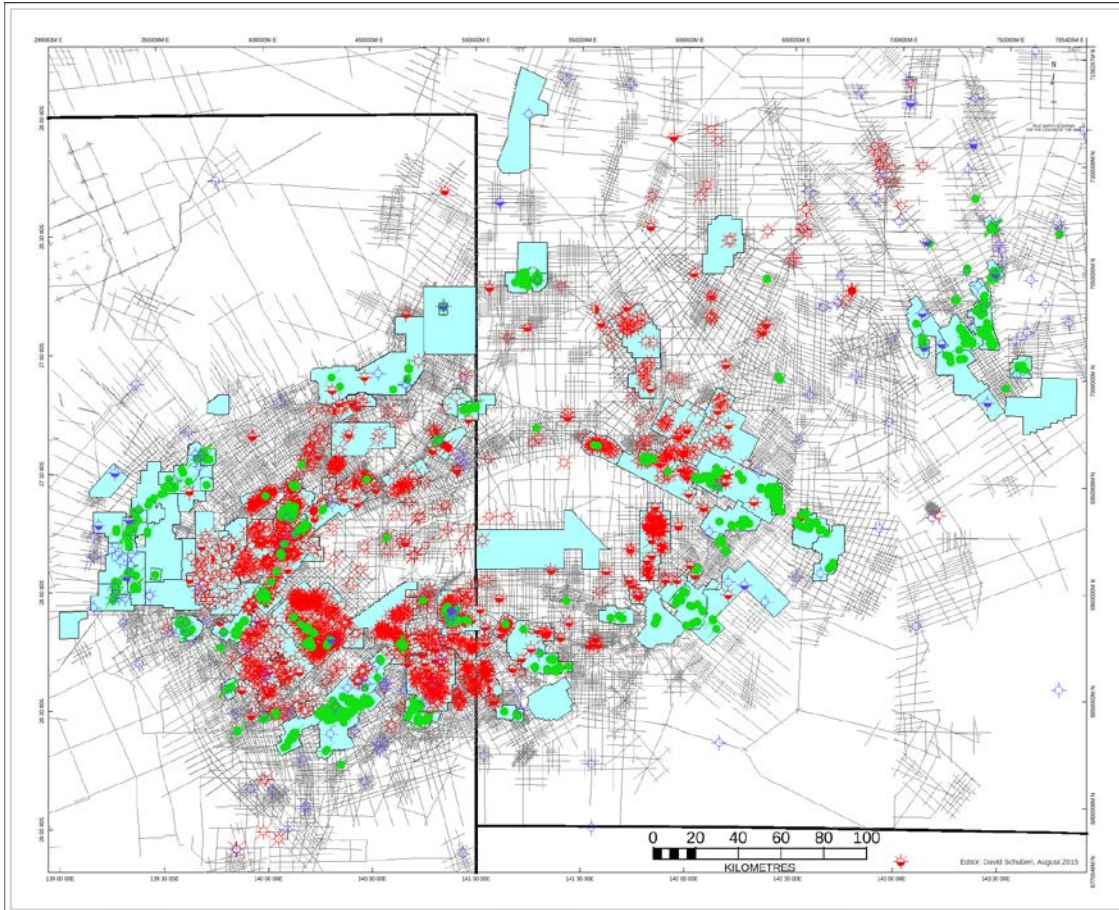


Key Outcomes

- Delhi interests sold to Beach
- Major relinquishment in South Australia opens new blocks with wave of new explorers
- Failure of Brisbane oil pipeline leads to new export pipeline to Moomba to link with Liquids pipeline

History of Exploration and Development

Phase 6 – 2010's



Key Outcomes

- Consolidation of various operatorships to have 4 key operators in the basin – Santos, Beach, Senex and Drillsearch
- Opening of the various unconventional plays with the first flows from shale gas and deep coal gas

A History of Plays

How were the plays conceived and discovered?

Conventional Reservoirs

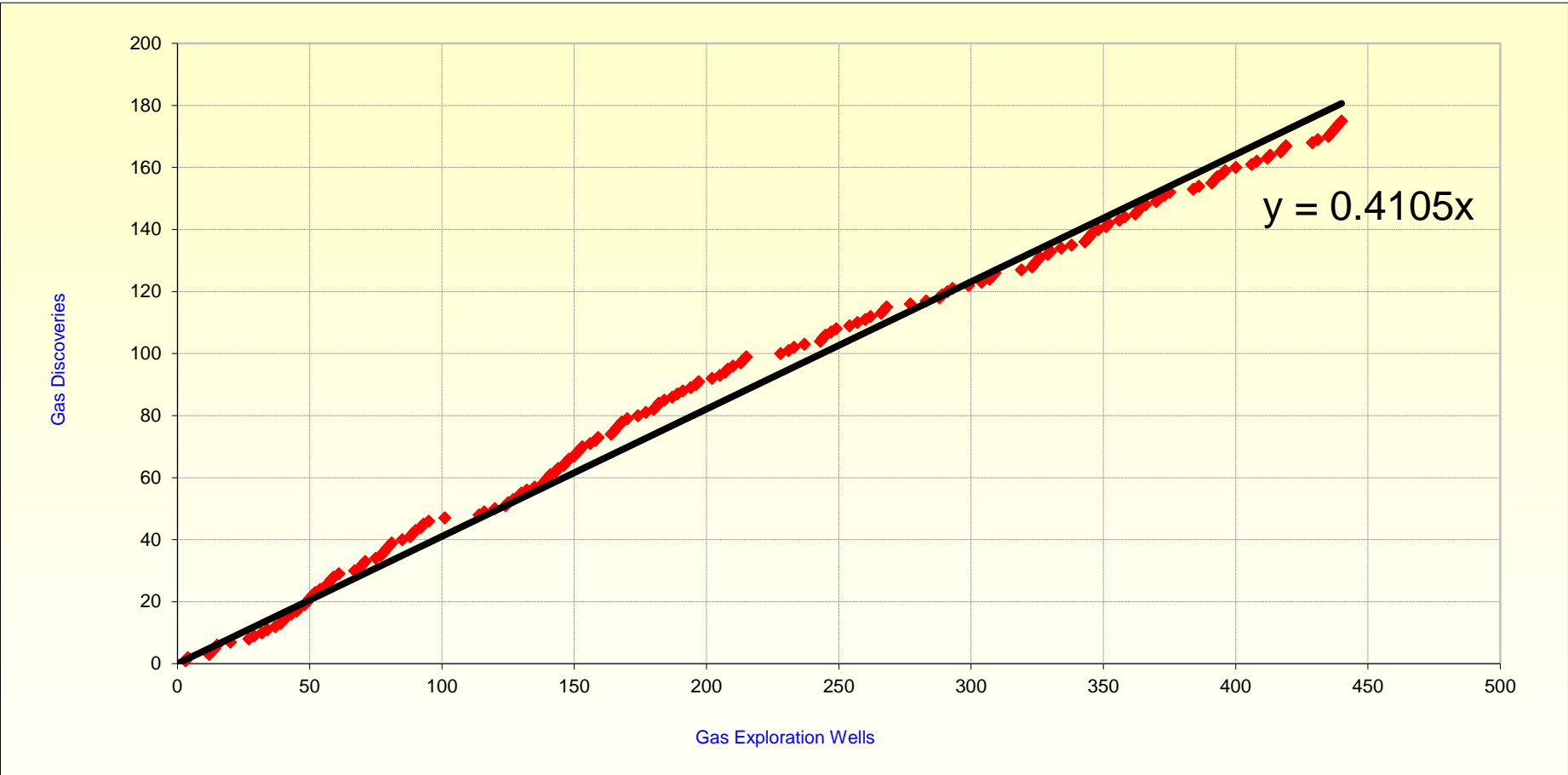
- › **Cambrian:** clastic and carbonate reservoirs, side charged from mature Permian coal measure source, trapped in major basin anticlinal trends – no discoveries; original play; re-emerging
- › **Permian:** both oil and gas; clastic fluvial/lacustrine reservoirs, charged from mature Permian coal measure source, anticlinal, stratigraphic and fault traps – structural traps in mature phase, stratigraphic traps in growth phase. 6.5 TCF produced to date; 1.6 TCF yet to find. First gas discovery: Gidealpa-2 (1963). First oil discovery: Tirrawarra-1 (1970).
- › **Jurassic/Cretaceous:** primarily oil; clastic fluvial reservoirs, charged from mature Permian coal measure source (some Jurassic lacustrine source), anticlinal traps – in mature phase. 520 mmbbls produced to date; 150 mmbbls remaining. First gas discovery: Namur-1 (1976). First oil discovery: Strezlecki-3 (1978)

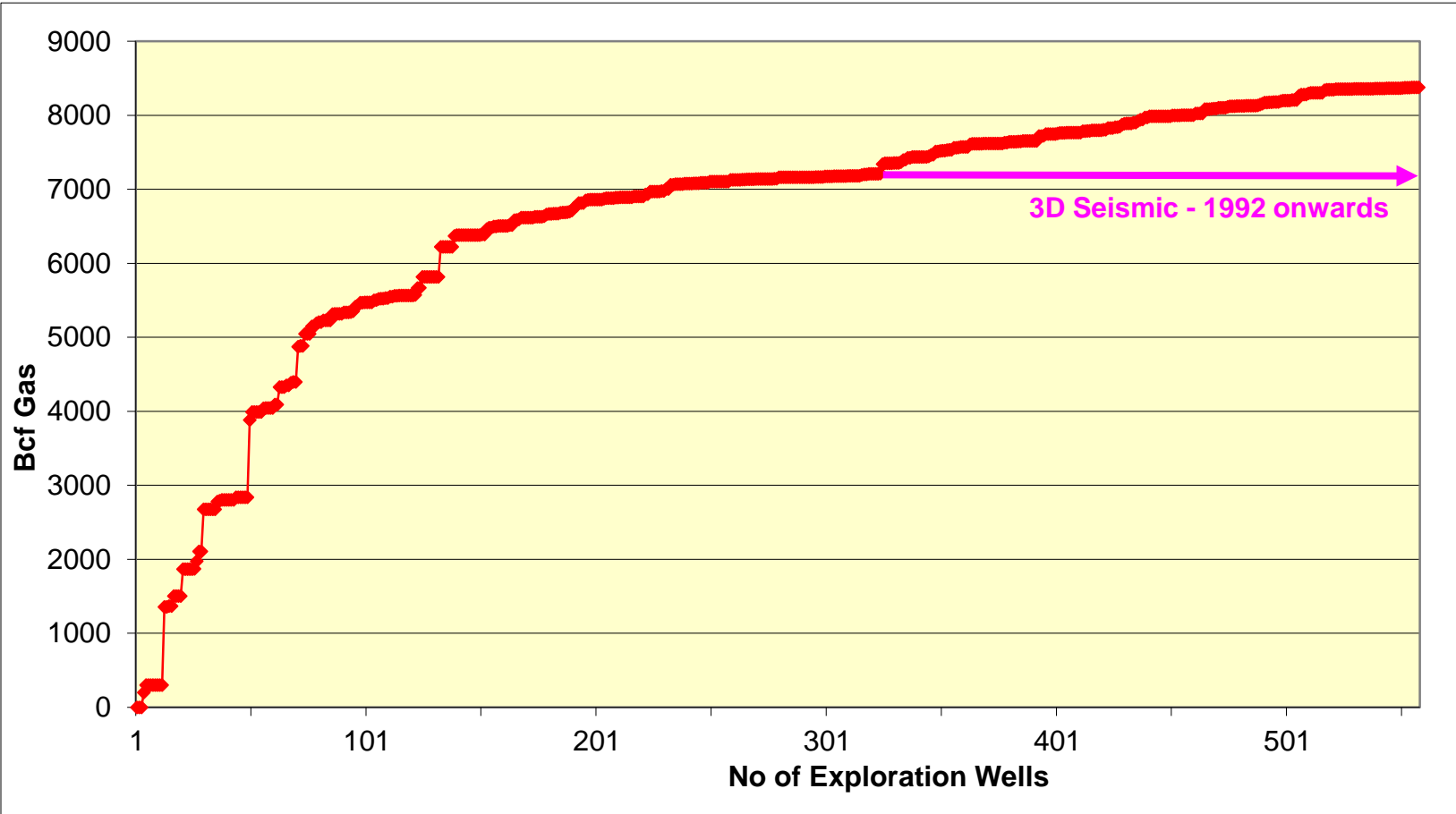
Unconventional Reservoirs

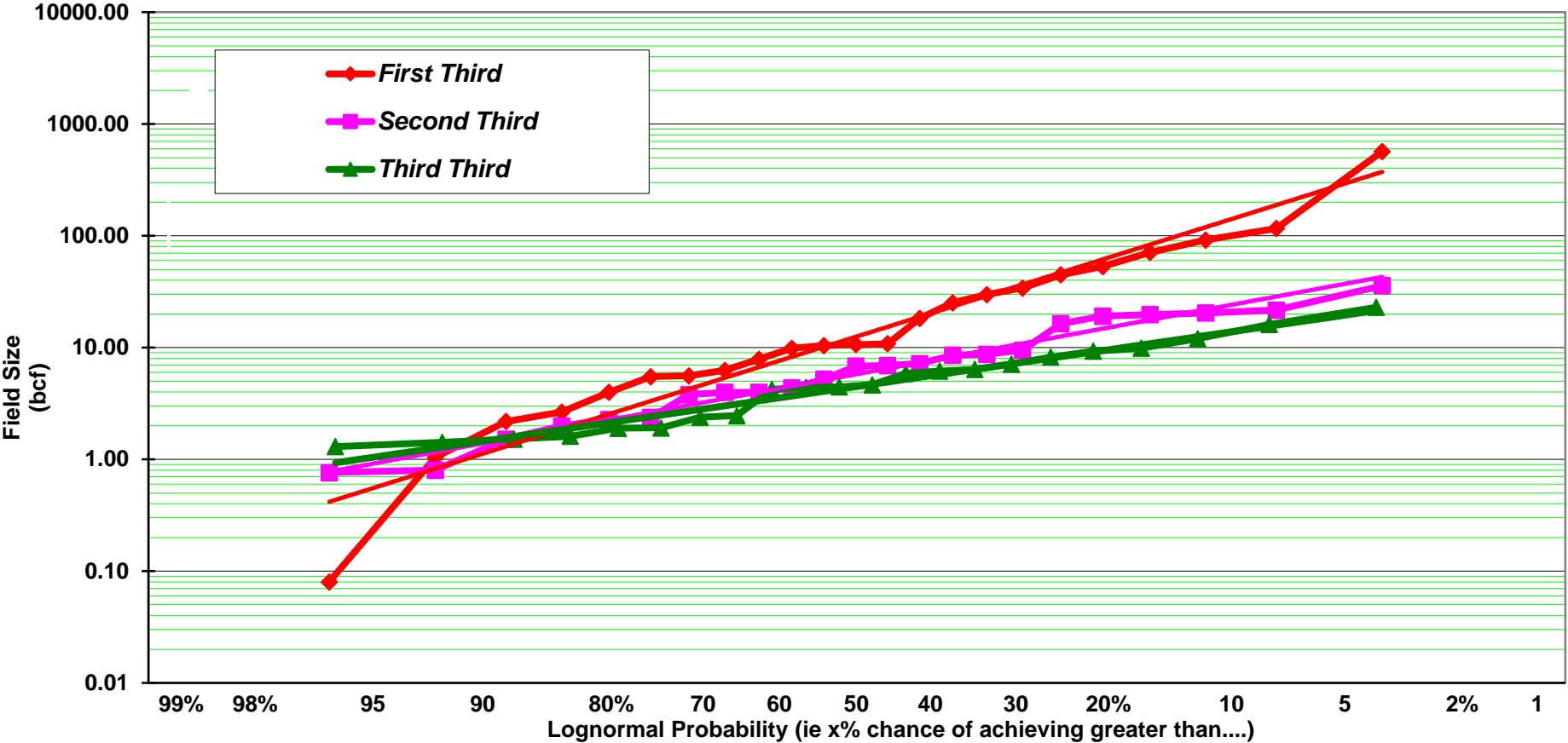
- › **Permian:** Deep Coal, Tight Sand, Shale Gas/Oil, Basin Centred Gas

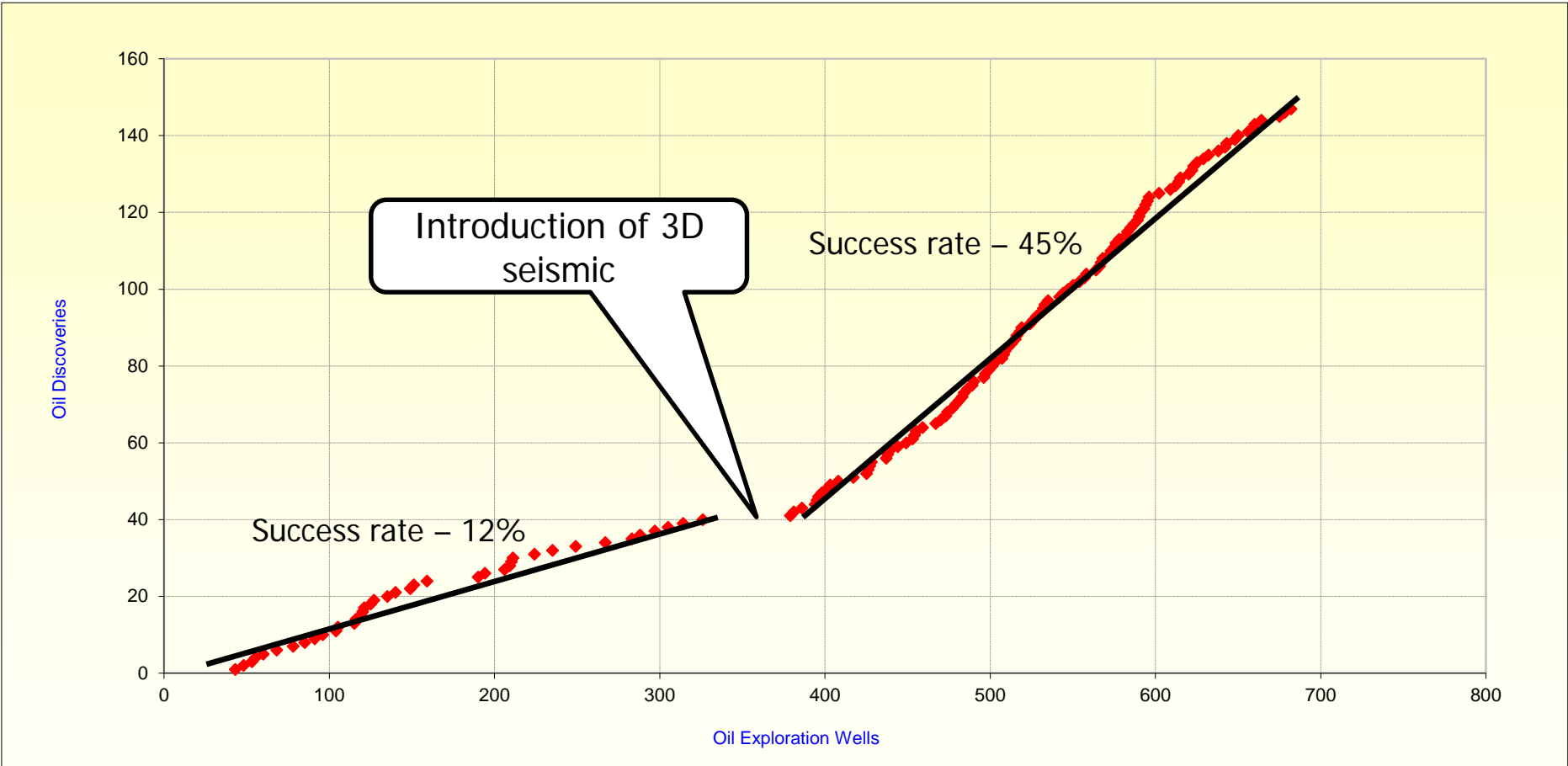
A History of Plays

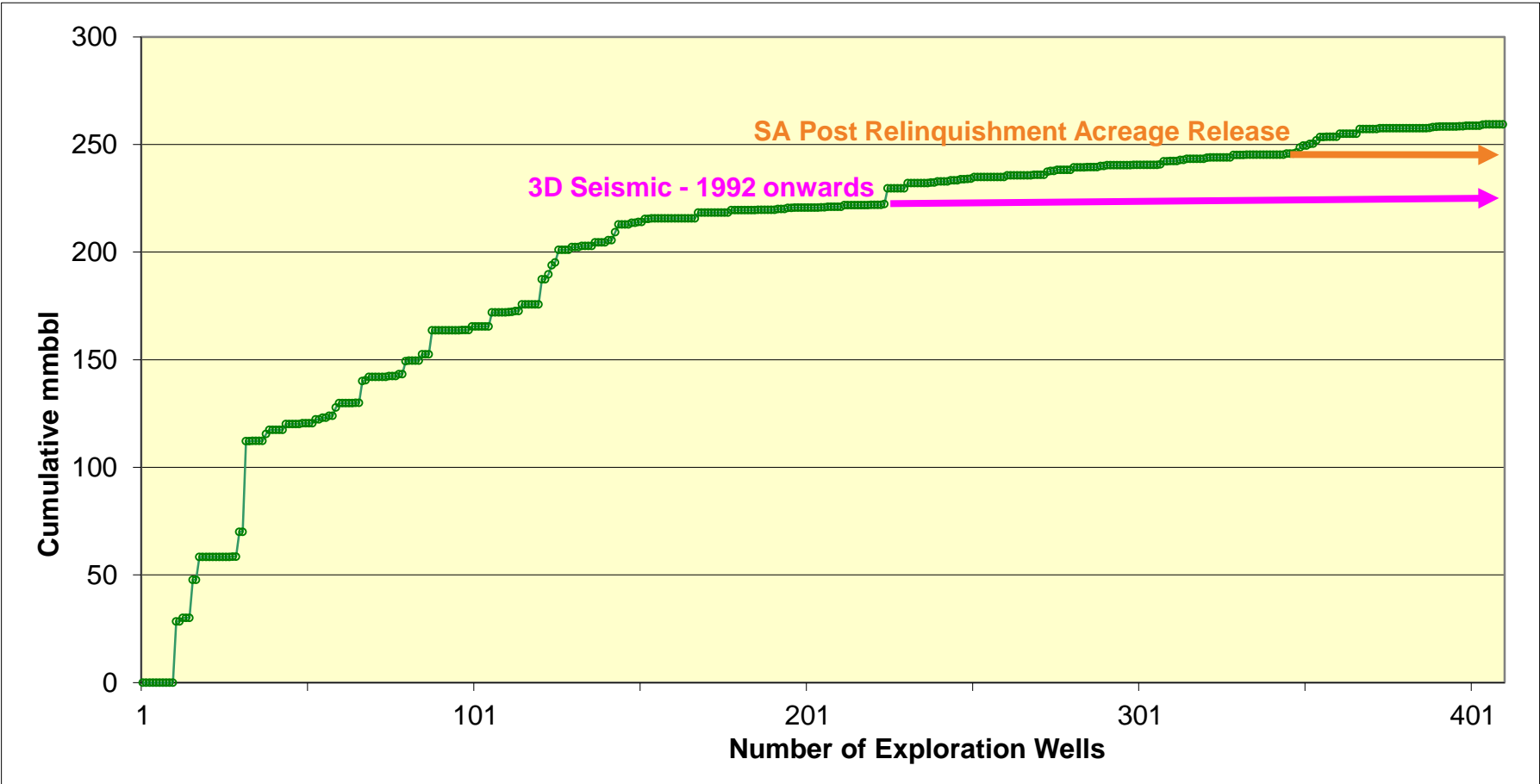
Permian Gas Play – averages 40% success rate





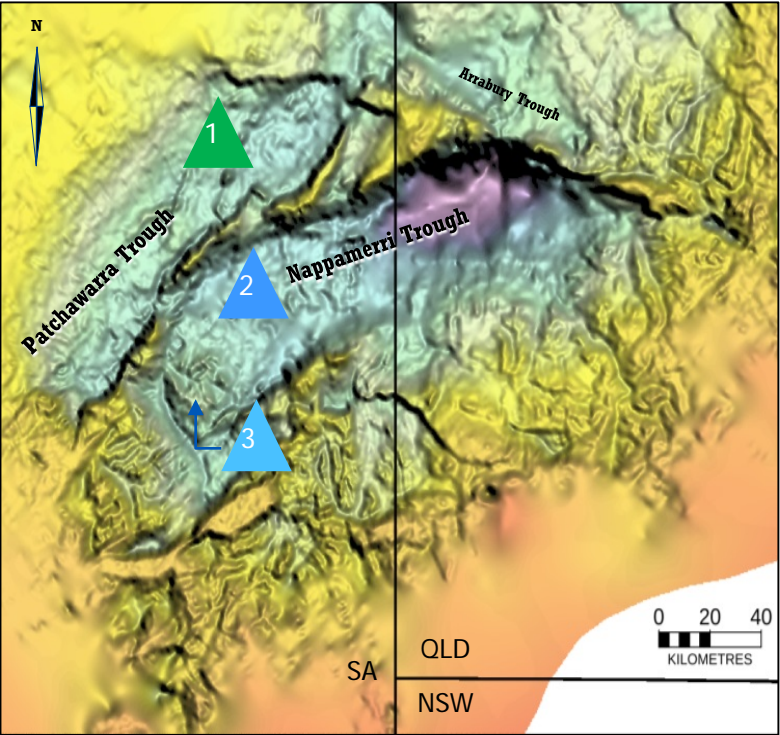






A History of Plays

Unconventional Plays



The economic success of unconventional resource plays depends upon the interplay between:

- **Reservoir Quality (RQ)** “how good is the rock?”
- **Completions Quality (CQ)** “what can we do to the rock to make it flow?”

Rank	Region	Targets	Reservoir Quality	Completion Quality	Comments
1	Patchawarra Trough	Deep Coal			<ul style="list-style-type: none"> ➤ High RQ, “the source-rock” with high gas content and liquids in some areas ➤ Add-on coal frac program in SACBJV development wells is de-risking CQ ➤ Rates per frac stage encouraging
2	Nappamerri Trough	Tight Sand, Shale, Hybrid Shale, Deep Coal			<ul style="list-style-type: none"> ➤ Multi-lithologies within large gas column provides multiple opportunities ➤ Strong overpressure – positive for drive and volumes ➤ Requires effective fracturing in high stress environment
3	Moomba Big Lake	Shale, Hybrid Shale			<ul style="list-style-type: none"> ➤ Shale has low RQ (storage) & minor over-pressure ➤ Requires higher frac effectiveness (CQ) to compensate

A History of Technology

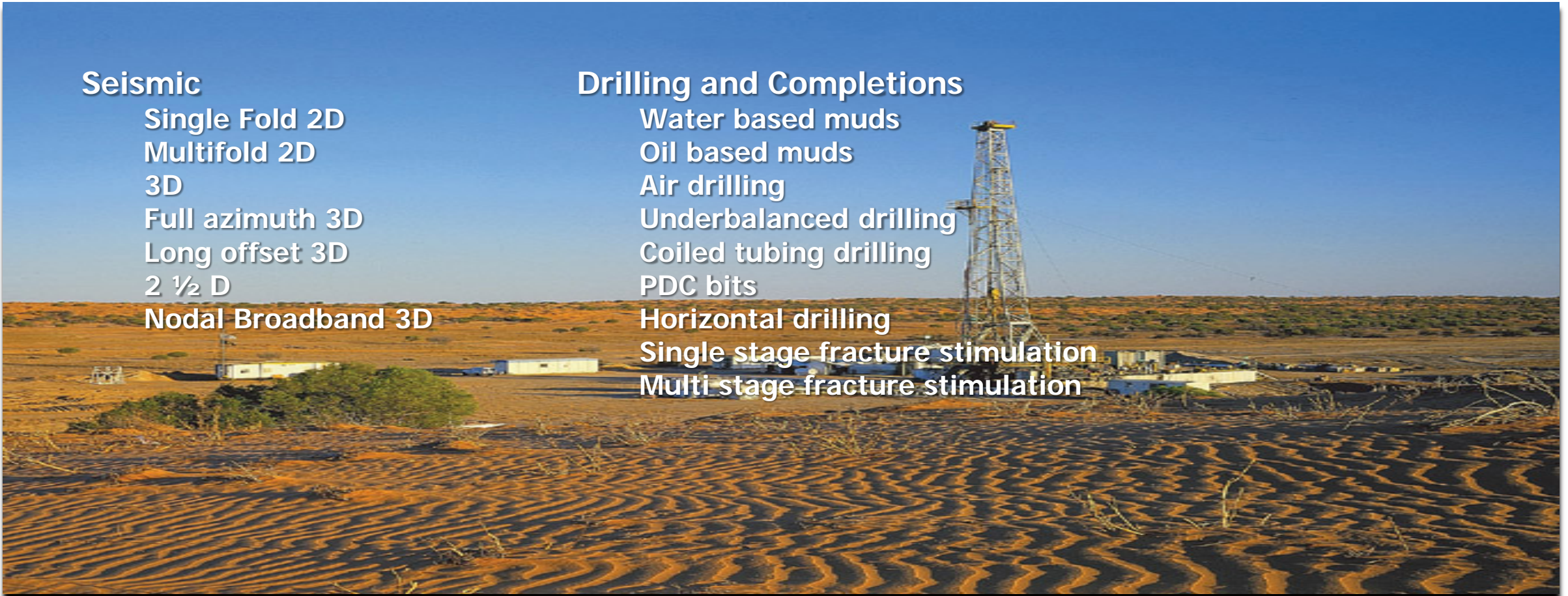
Continuously improving the things that work in the Basin

Seismic

- Single Fold 2D
- Multifold 2D
- 3D
- Full azimuth 3D
- Long offset 3D
- 2 ½ D
- Nodal Broadband 3D

Drilling and Completions

- Water based muds
- Oil based muds
- Air drilling
- Underbalanced drilling
- Coiled tubing drilling
- PDC bits
- Horizontal drilling
- Single stage fracture stimulation
- Multi stage fracture stimulation



- 
- Early Gas and Oil discoveries made in South Australia – therefore gas processing plant and export pipelines set up in South Australia
 - Largest oil discovery made in Queensland and facilitated oil processing plant at Jackson and export pipeline to the Moonie/Brisbane oil pipeline
 - A "Liquids Project" set up in South Australia to export South Australian oil and gas liquids via Port Bonython
 - Potential takeover of Santos leads to South Australian government placing a cap on shareholding in Santos
 - Queensland government allows export of petroleum to South Australia leading to a gas processing plant being built at Ballera with an interconnect pipeline to Moomba and one to Wallumbilla thus allowing the eastern gas market to be totally interconnected
 - The Moonie to Brisbane oil pipeline failed and eventually closed. All oil to the South Australian export facilities
 - Santos shareholding cap removed on conditions

Summary

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