

Comparing Basin-Centred Gas Prospectivity in the Bowen-Surat Basin (Queensland, Australia) With the Deep Basin of Western Canada and the Piceance Basin of Utah*

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Abstract

The Western Canada Sedimentary Basin contains some of the best-documented basin-centred gas accumulations in the world. The “Deep Basin” concept was first advanced here in the 1970's, and now encompasses huge tight gas resources in Triassic through Upper Cretaceous clastic reservoirs. A variety of drilling and completion strategies have been designed to exploit specific reservoirs and groups of reservoirs. The Piceance Basin produces gas from very thick tight Cretaceous reservoirs, composed of marginal marine to channelized tight sandstones, interbedded with finer-grained clastics. Closely-spaced vertical wells are drilled to efficiently access stacked discontinuous reservoir sandstones. The Bowen-Surat Basin of Queensland is a well-known petroleum province because of a long history of relatively shallow conventional oil and gas production from Mesozoic reservoirs, and more recently prolific coal-seam gas (CSG) production from the Jurassic Walloon Coal Measures. Regional seismic and a small number of recent exploration wells now demonstrate immense gas and liquids potential in deeper Triassic and Permian clastic reservoirs in the central Taroom Trough, which share many key features with the western Canada Deep Basin and Rocky Mountain basins, including the Piceance Basin. Three comparisons stand out: The Permian Tinowon Formation is a thick, overpressured reservoir section dominated by shallow marine and deltaic sandstones that offers reservoir properties, continuity, and gas volumes comparable to the Triassic Montney Formation of the WCSB; Upper Permian through Lower Triassic reservoirs of the Bowen Basin can be compared to the Cretaceous Deep Basin section in western Canada – both contain several hundred metres of marine to marginal marine sediments, including shoreface, deltaic, channel and coal measure deposits, deposited in settings controlled largely by changes in relative sea level; Lower to Middle Triassic reservoirs of the Bowen Basin (Rewan Formation, Showgrounds Sandstone) are like the thick Cretaceous Mesaverde Group succession of the Piceance Basin – both sections consist of dominantly marine facies at the base, grading upward to fluvial-dominated strata characterized by discontinuous tight sandstones interbedded with finer clastic rocks. Future exploration and development in Bowen-Surat Basin reservoirs will be supported by consideration of successful exploration and development strategies employed for their North American analogues.

Selected Reference

Masters, J.A., 1979, Deep Basin Gas Trap, Western Canada: AAPG Bulletin, v. 63/2, p. 152-181.

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Brad J. Hayes, Petrel Robertson Consulting Ltd.

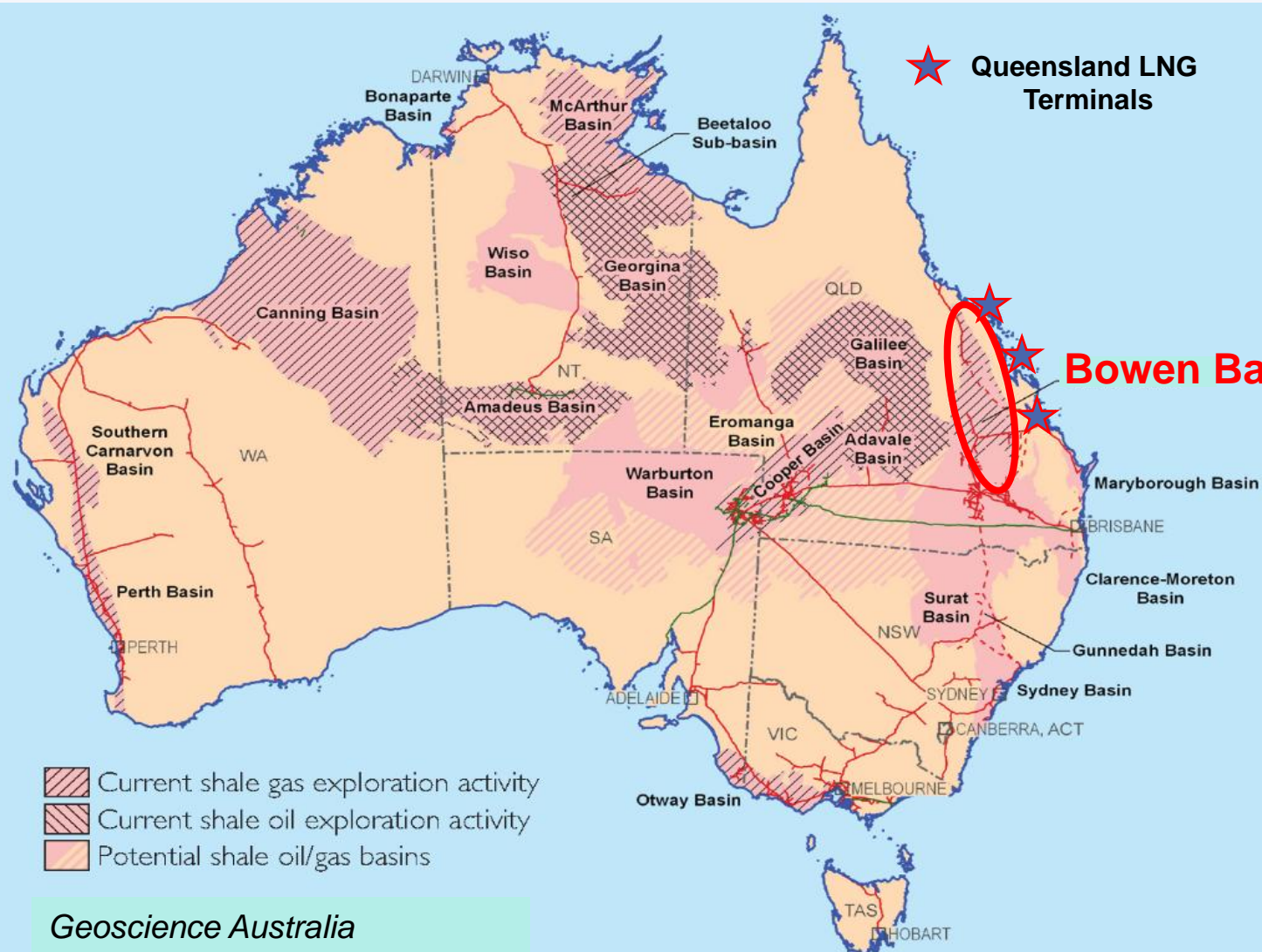
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Introduction



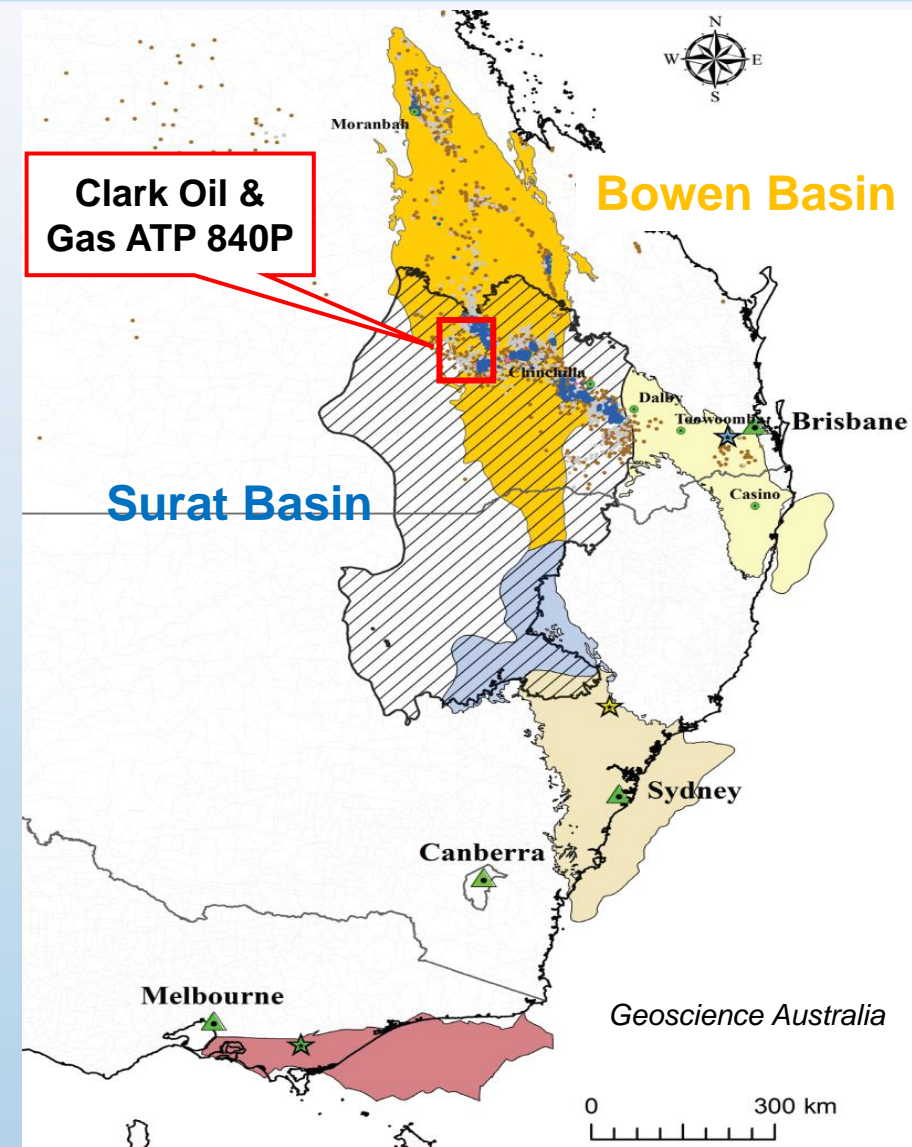
- Exploration drilling in the Bowen Basin demonstrates all the ingredients for large basin-centred gas / liquids resources:
 - Thick, low permeability reservoirs
 - Anomalous pressures
 - Abundant mature source rocks
- Current well control is inadequate to map prospective fairways with confidence, and so we look to more mature, better-understood analogues to guide appraisal and development
- WCSB and Piceance Basin offer excellent reservoir analogues and extensive appraisal / development histories

Australia – Unconventional Gas Potential



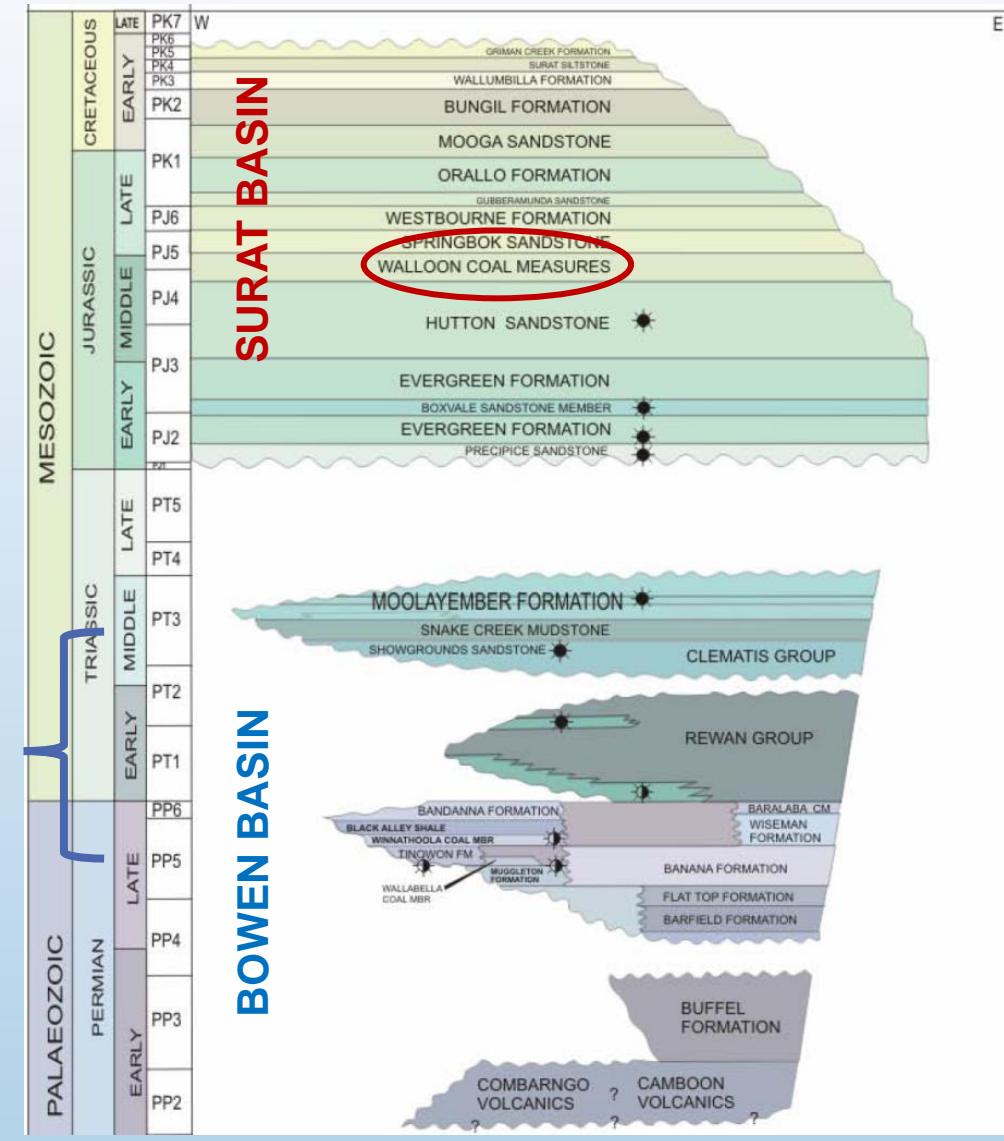
- Unconventional gas potential is recognized in sedimentary basins throughout Australia
- New LNG export capacity in Queensland offers markets for deep unconventional gas resources in the Bowen Basin

Bowen – Surat Basins

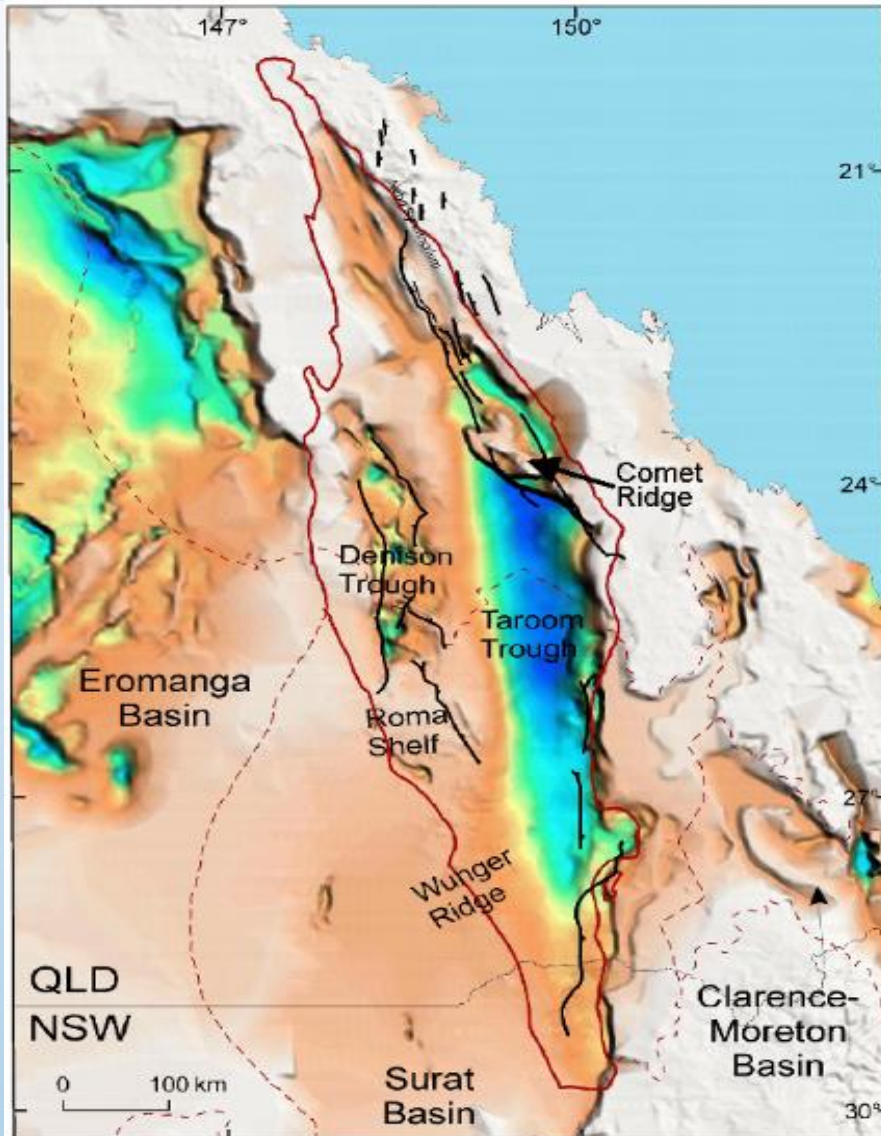


- Younger Surat Basin hosts Jurassic and younger **coal seam gas** (CSG) reservoirs

- Older Bowen Basin hosts Permo-Triassic **unconventional gas and condensate** reservoirs

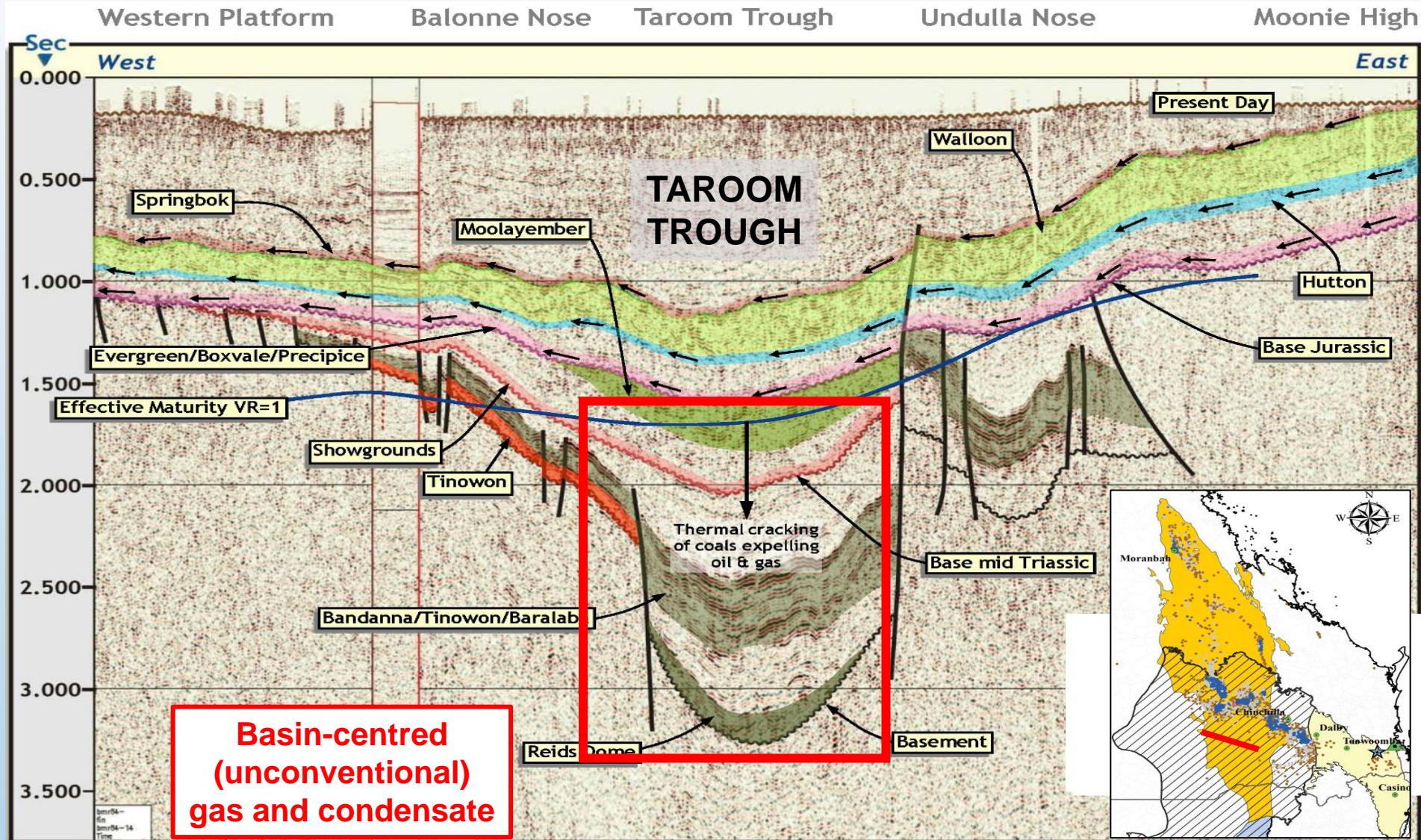


Bowen Basin Setting



- Bowen Basin is a proven petroleum province
 - >100 conventional oil and gas discoveries lie on the basin flanks in structural and stratigraphic accumulations
- The central Taroom Trough has a deep, thick stratigraphic section – ideal conditions for unconventional, basin-centred “Deep Basin” gas and liquids
 - Established North American unconventional plays provide excellent reservoirs and development analogues

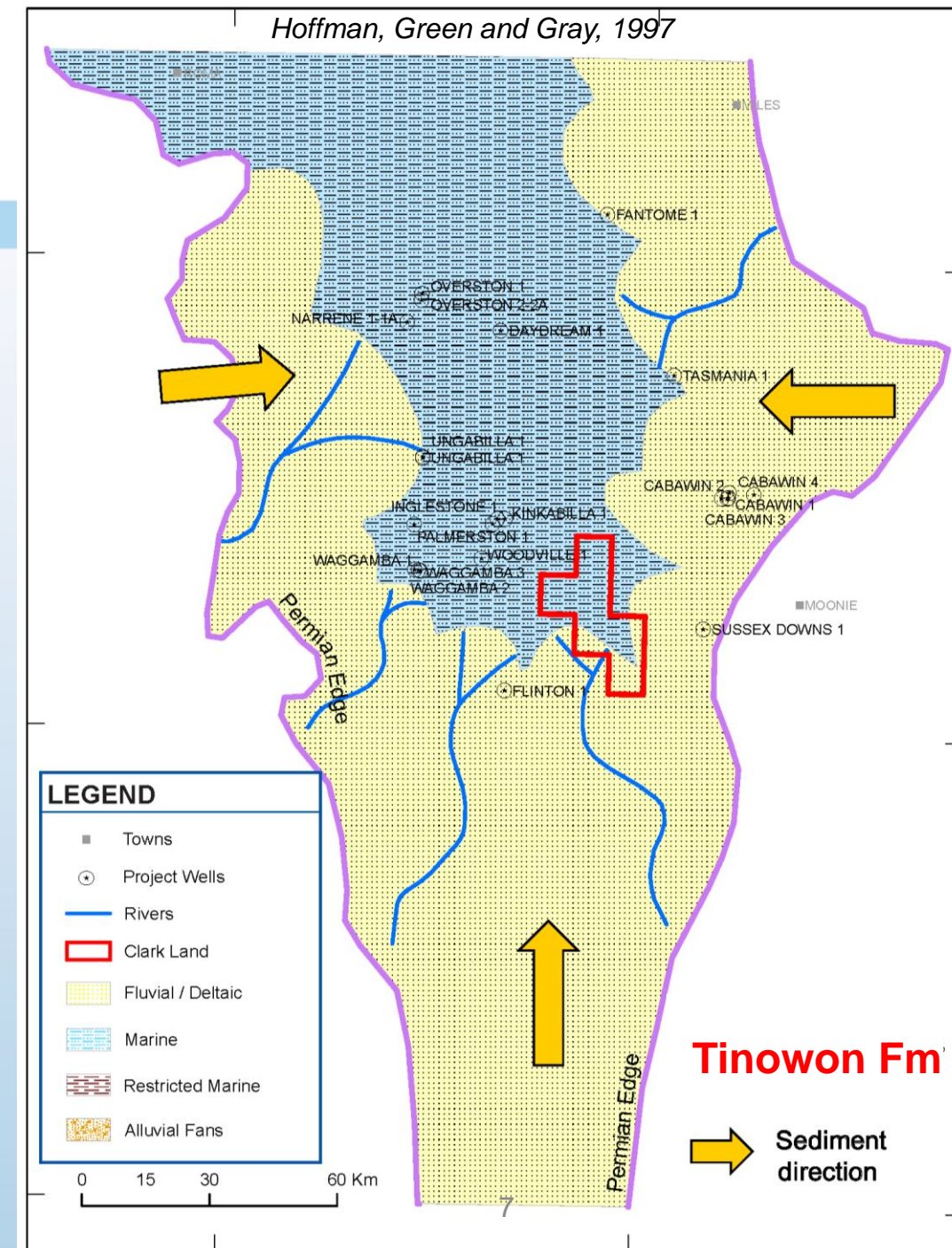
Basin Transect Seismic Section



Modified from
Origin Energy

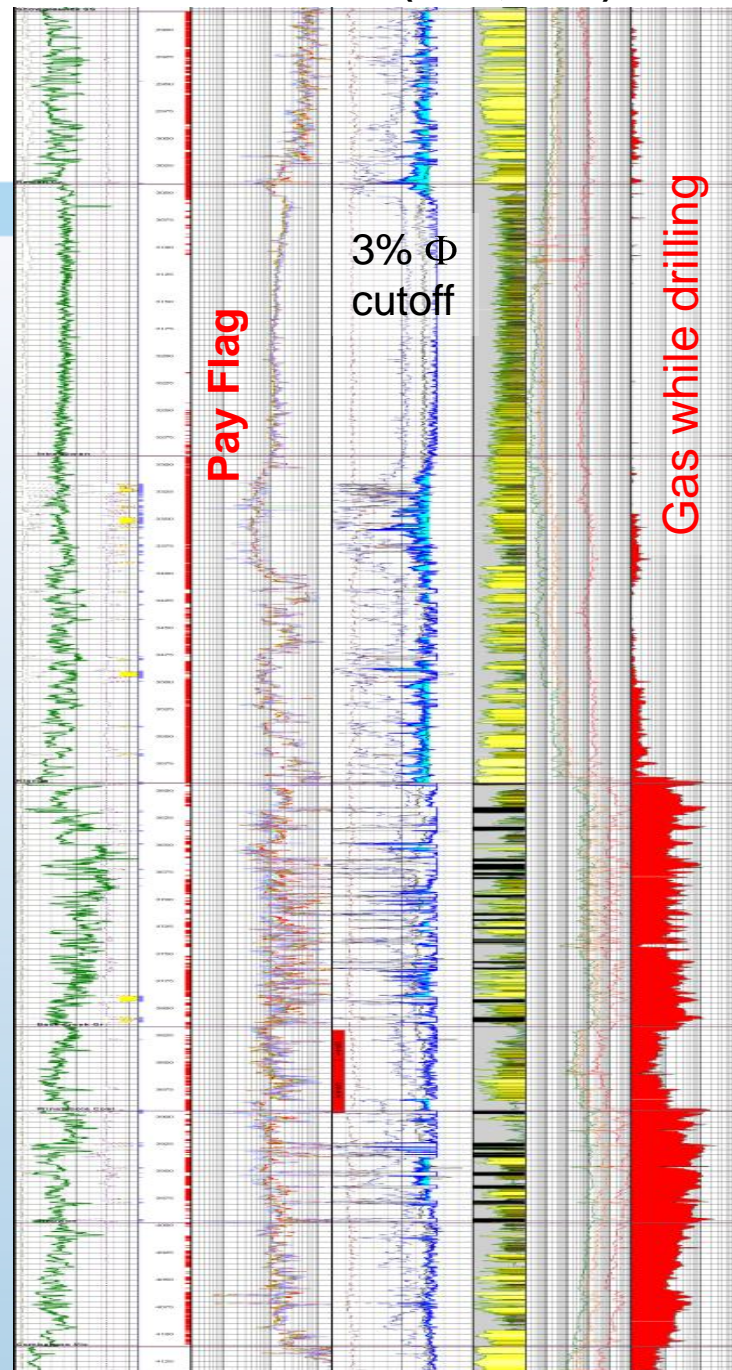
Prospective Stratigraphic Section

- Thick (>4000m) Permian – Triassic succession fills the Taroom Trough
- Stacked fluvial / shoreline / marine sandstones and siltstones are prospective reservoirs
 - Low porosity / permeability characteristics are typical of regional “tight gas” fairways
- Abundant rich source rocks, ranging from marine shales to coals, have generated gas and condensate produced from existing conventional pools





500 metres



Showgrounds sandstone

Rewan Group

Lower Rewan

Bandanna Coals

Back Creek Group

Winnathoola coals

Tinowon Fm

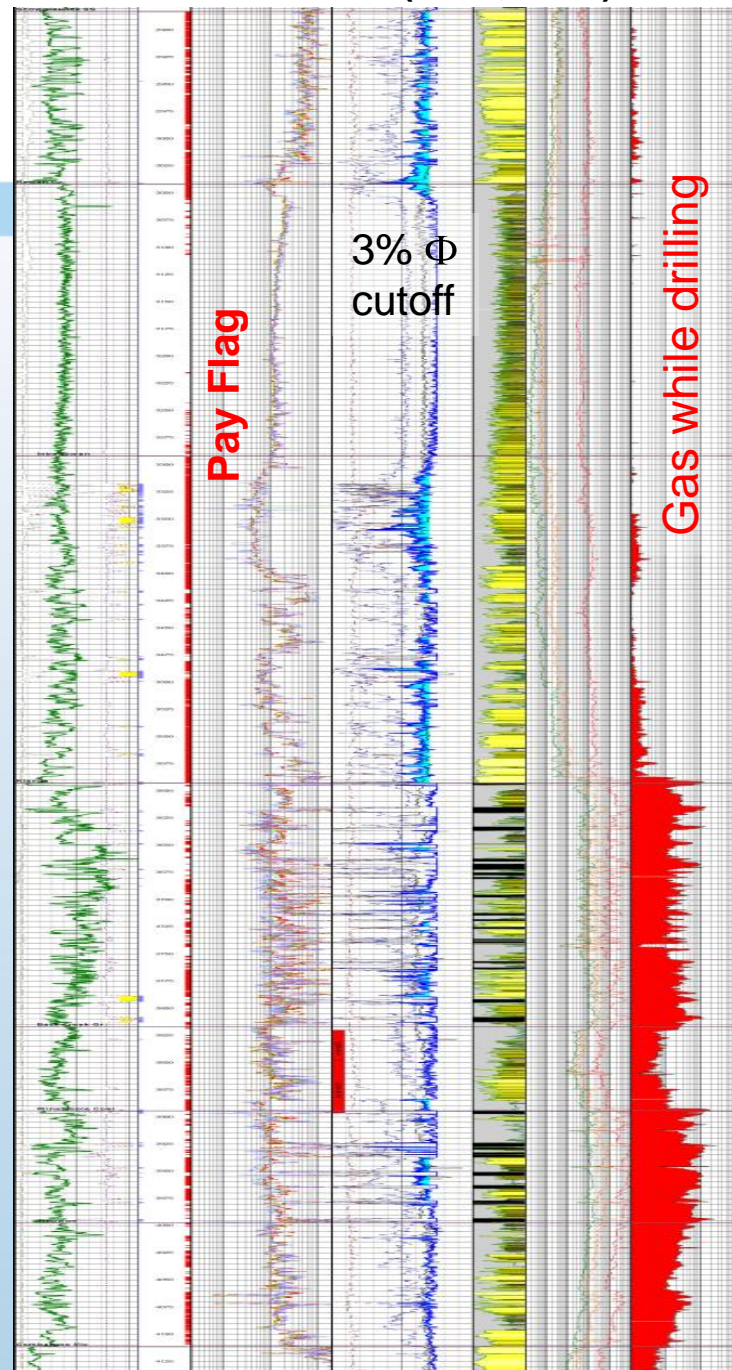
Bowen Basin Reservoirs and Analogues

Williams Fork
Piceance Basin

Montney Fm
WCSB



500 metres



Showgrounds sandstone

Rewan Group

Lower Rewan

Bandanna Coals

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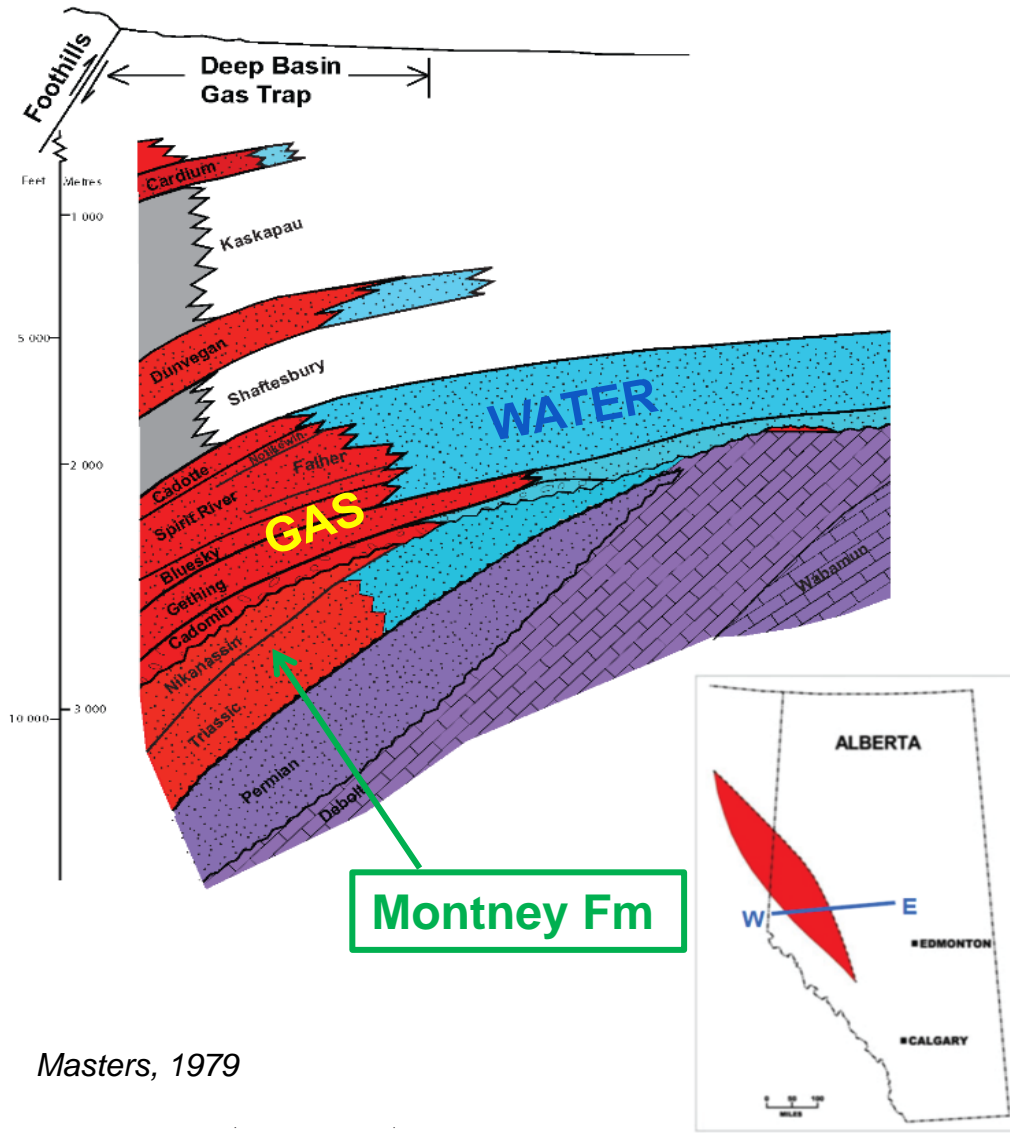
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Bowen Basin Reservoirs and Analogues

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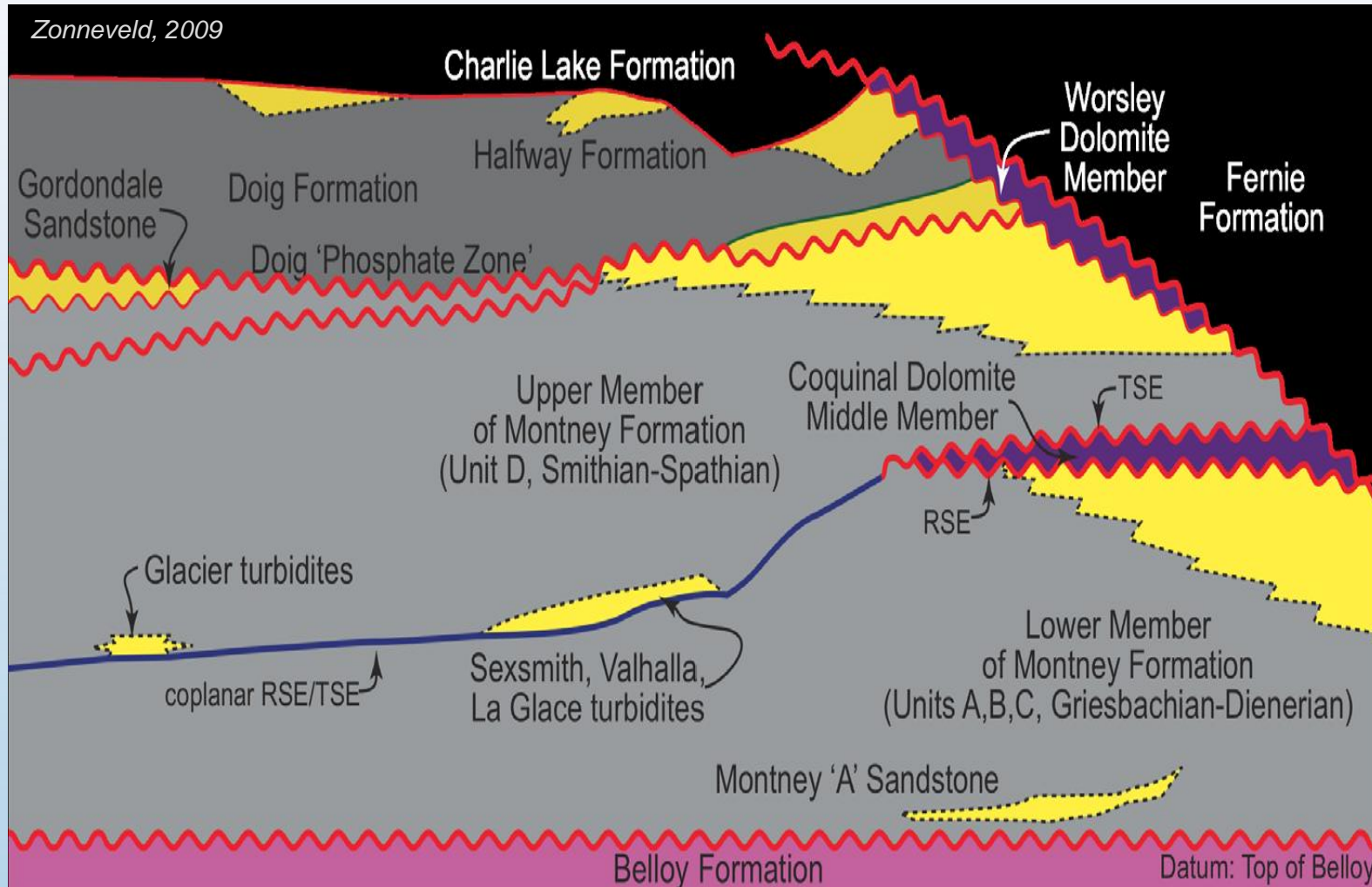
Western Canada "Deep Basin" Play Analogue



Masters, 1979

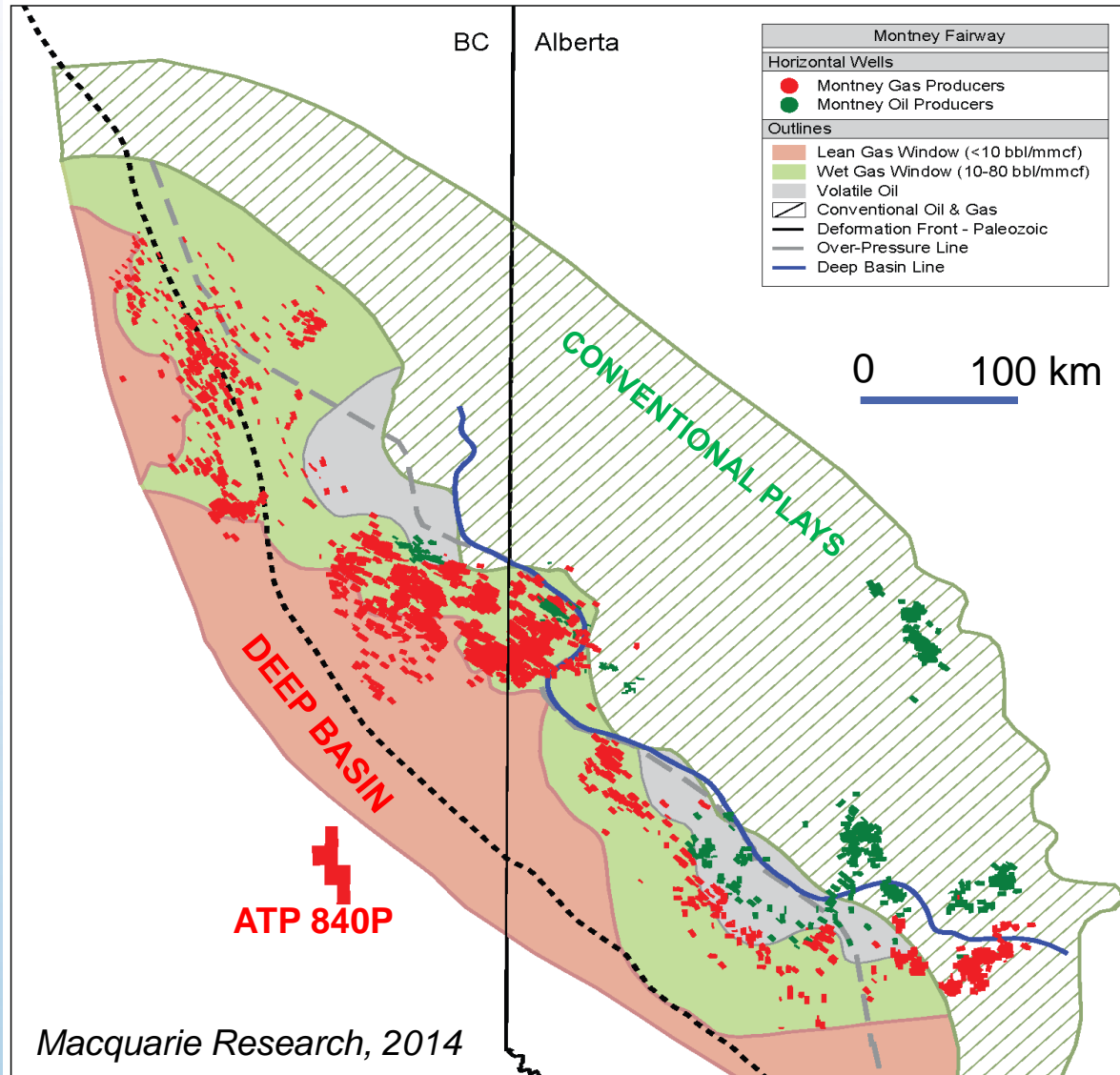
- Thick Mesozoic succession saturated with gas and liquids, lies downdip of regional aquifers
- Huge in-place gas and liquids resources
- Anomalous reservoir pressures
- Regional source rocks lie within and below reservoir units
- Horizontal / multi-frac wells have dramatically increased productivity in last 10 years in thick, continuous, mappable units

Montney Fm – Regional Geology



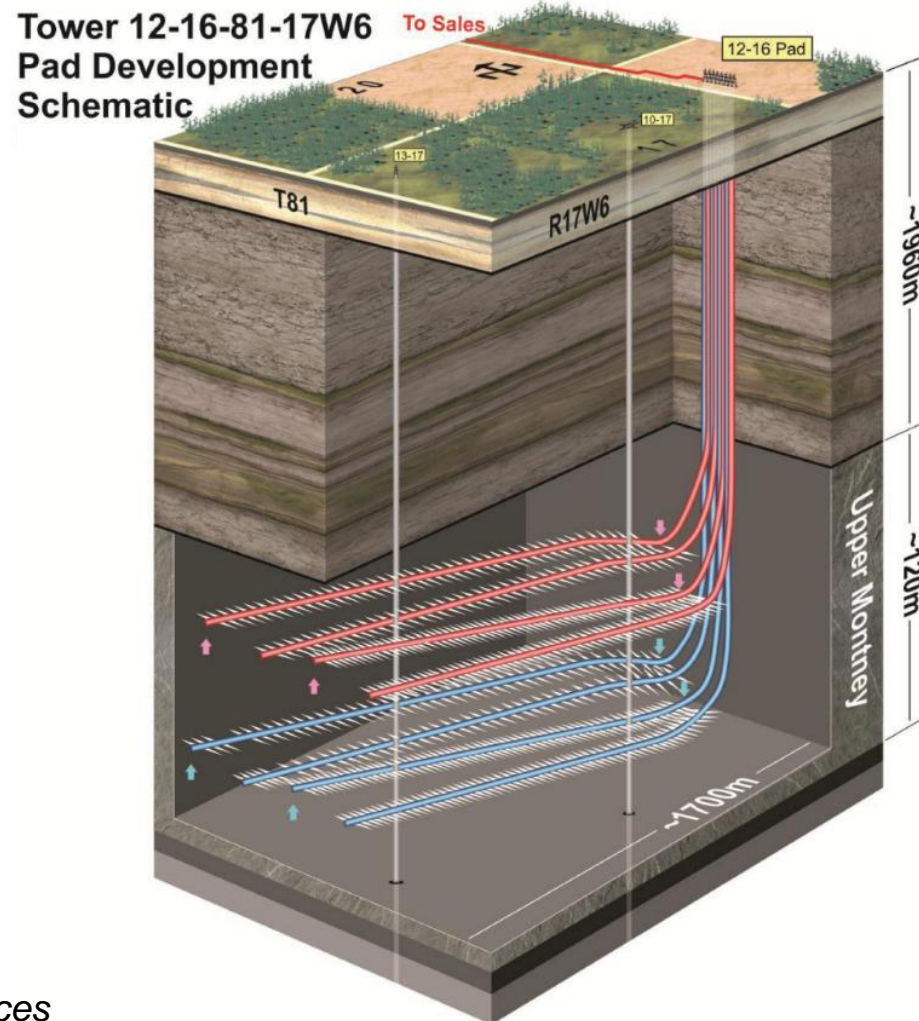
- 300m (+) thick succession of marine sandstones and siltstones
- “Tight” reservoir – low porosity and permeability – in anomalously-pressured Deep Basin regime
- Reservoir characteristics comparable to Bowen Basin Tinowon Fm and Black Alley siltstones

Montney Play Fairway, WCSB



- Productive across a huge fairway in Western Canada
- Extensive drilling / production facilitates detailed understanding of reservoir characteristics and pressure / saturation regimes
 - Ultimate recoverable resource (NEB) 449 TCF, 15.6 BBO
- Explosion of activity since first horizontal well in 2005
 - Currently producing >5 BCF/D + liquids
 - Evaluation and production techniques continually evolving

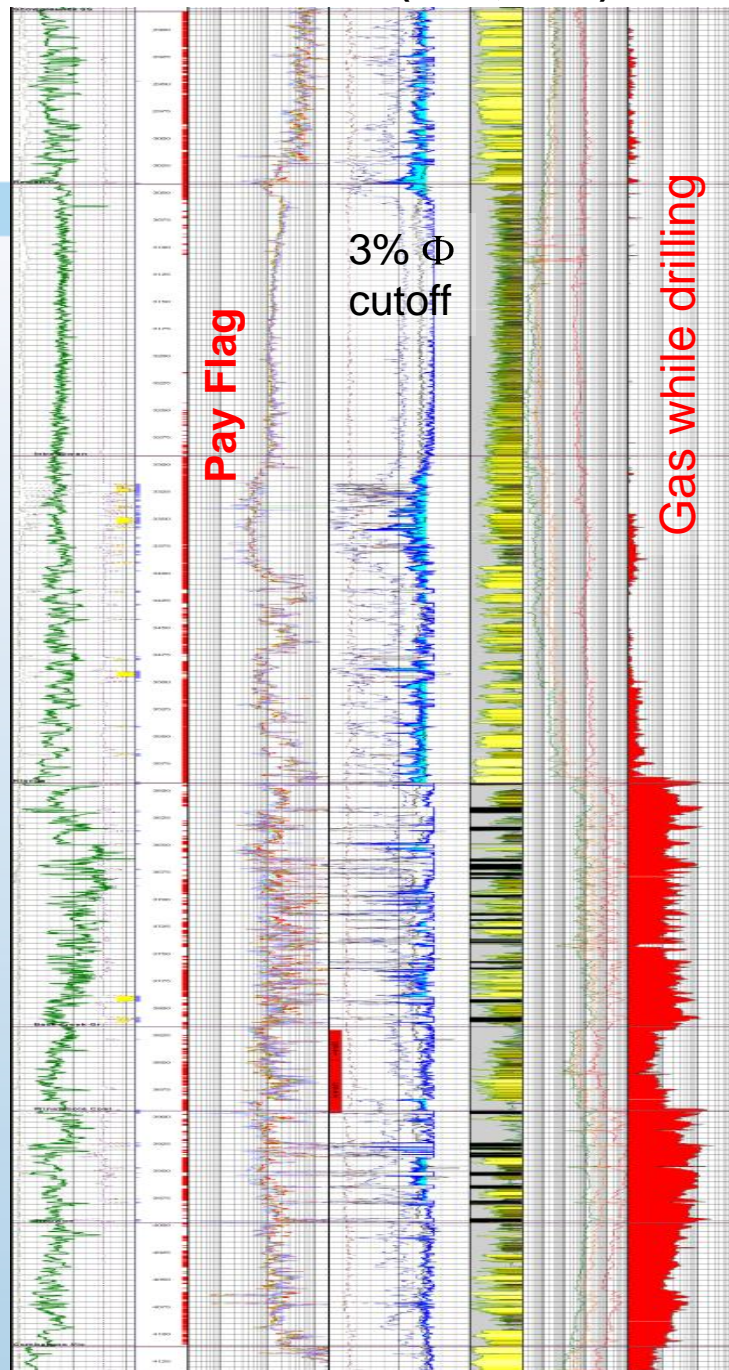
Montney Development



- Horizontal, multi-frac wells drilled from central well pads most commonly used
- Extensive experimentation on horizontal well placement and frac design
- Detailed understanding of reservoir architecture supports design of development programs focused on specific high-quality reservoir intervals



500 metres



Showgrounds sandstone

Rewan Group

Lower Rewan

Bandanna Coals

Back Creek Group

Winnathoola coals

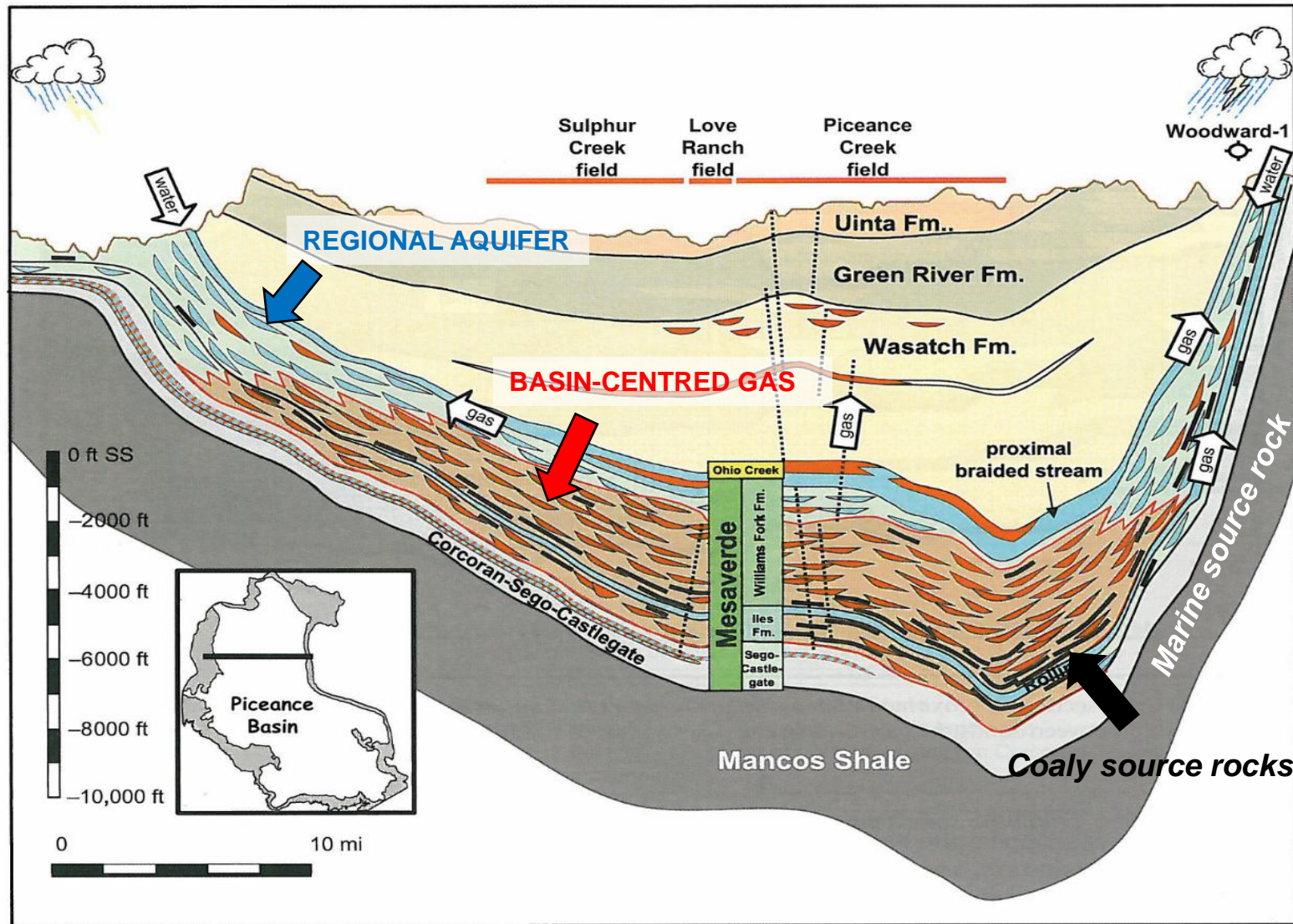
Tinowon Fm

Bowen Basin Reservoirs
and Analogues

Williams Fork
Piceance Basin

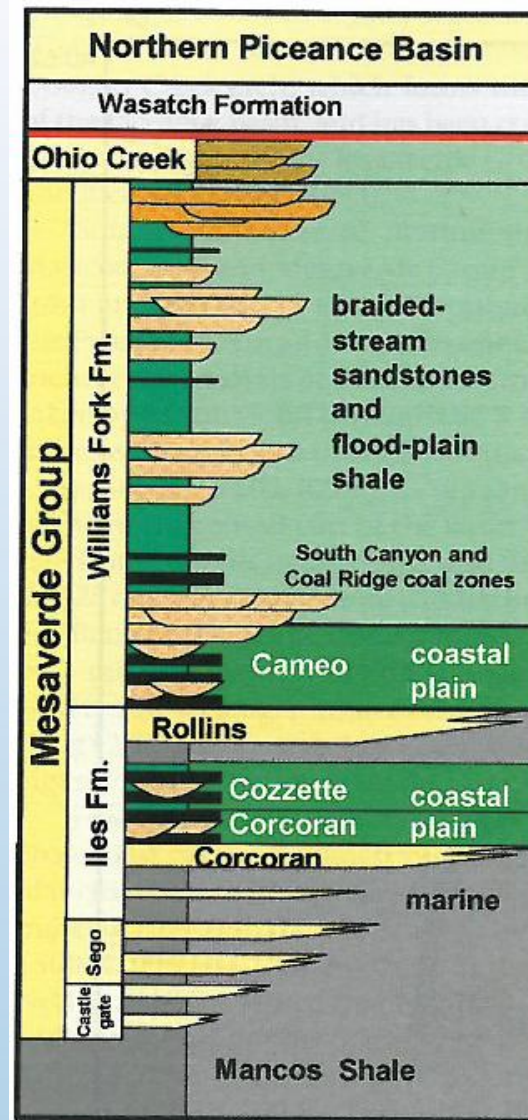
Montney Fm
WCSB

Piceance Basin Play Analogue



- Basin architecture very similar to Taroom Trough
- Coal-rich beds lie directly beneath thick fluvial / channelized succession
- Gas in place estimates range up to >400 TCF
- Producing > 1.3 BCF/D

Piceance Basin Play Analogue



Bowen Basin

Showgrounds sst

Rewan Group

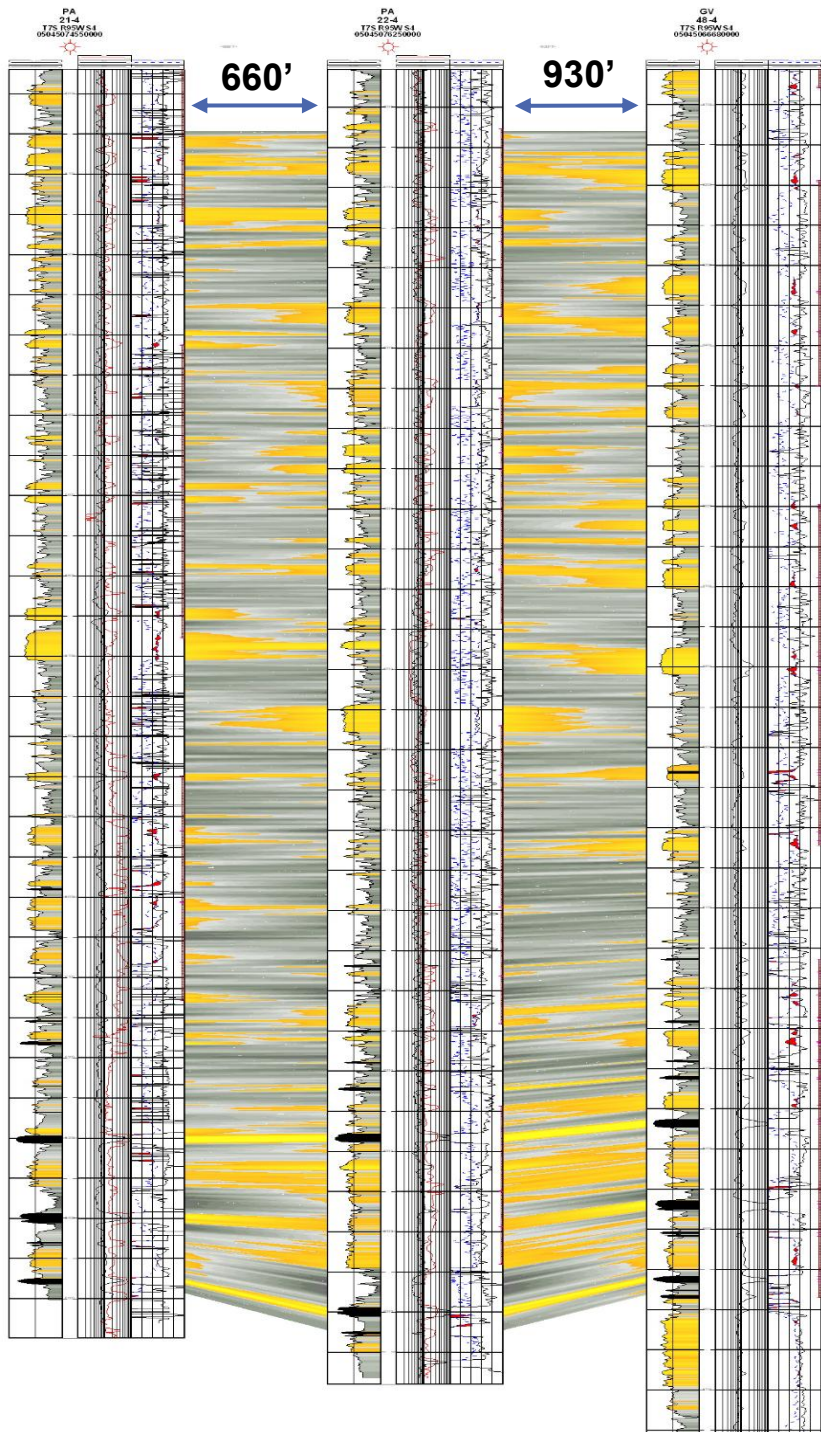
Bandanna Fm

Back Creek Group

Winnathoola CM

Tinowon sst

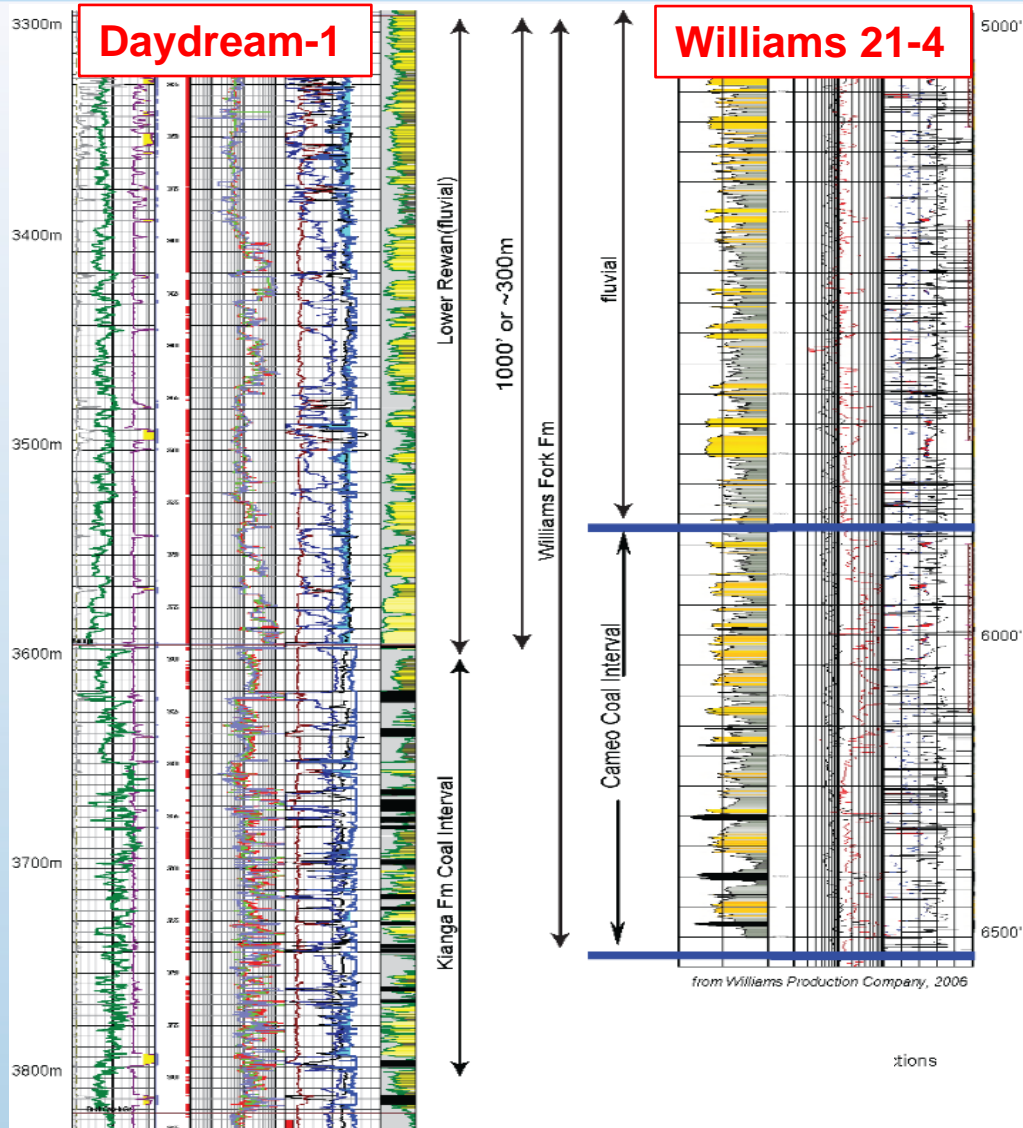
- Piceance Basin and Taroom Trough have similar petroleum systems elements and stratigraphic architecture
 - Mature, marine and coaly source rocks
 - Thick reservoir section – very similar depositional environments and reservoir attributes throughout
 - Overpressured, basin-centred gas



Williams Fork Development

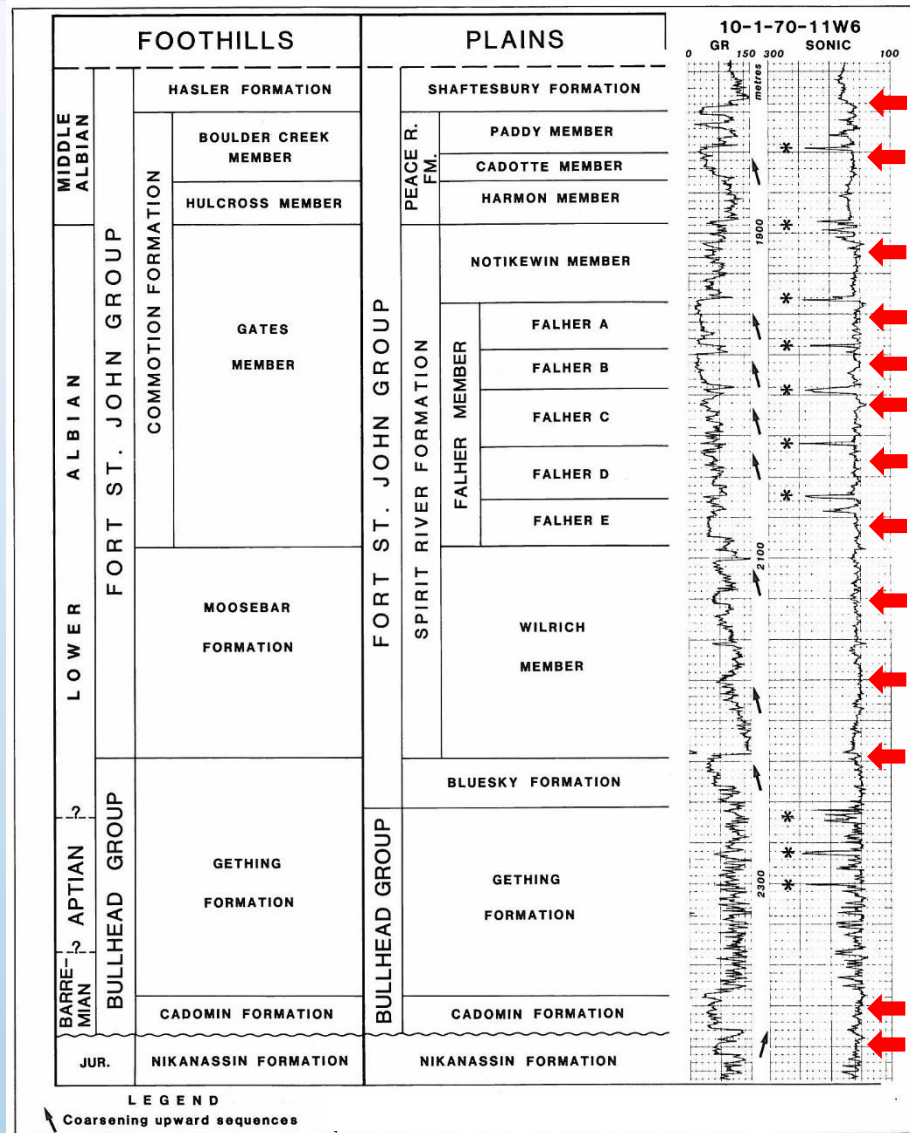
- Discontinuous, tight channel sandstones of the Williams Fork Fm produce most of the gas and hold most of the reserves in the Piceance Basin
- Developed by drilling closely-spaced vertical wells through thick (300m or more) fluvial successions
 - Optimal well spacing 10 to 20 acres
 - Huge in-place gas resource and low-permeability reservoirs allow each well to produce significant reserves without interference from adjacent wellbores.

Piceance – Bowen Basin Comparison



- Lower Rewan (Bowen) has an architecture very similar to the productive Williams Fork (Piceance) reservoir
- Underlying coals provide gas source
- Suggests that Lower Rewan will be best developed using closely-spaced, multi-zone vertical wells
 - Further appraisal work required to assess resource base and optimize drill / complete methodologies

Another WCSB Analogue

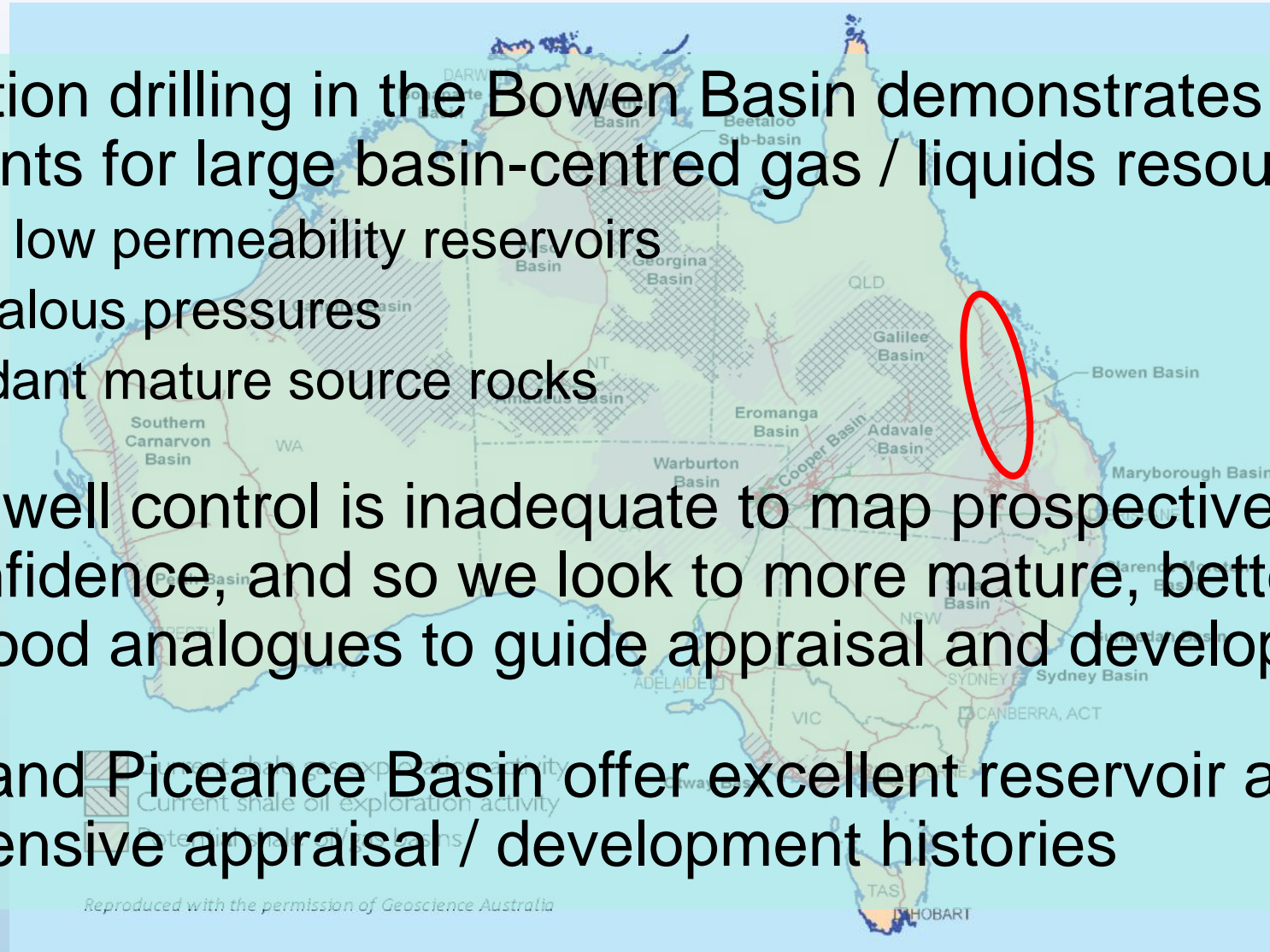


- Where parts of the WCSB thick Cretaceous stacked reservoir section can be mapped with confidence, zone-specific mapping is used to prioritize drilling programs
 - Where resource volumes are sufficient to support development of a single zone, horizontal wells may be best
 - Where economic resource volumes are distributed over several zones, mapping can prioritize best areas for vertical commingled wells
- Similar techniques can be used in the Bowen Basin when more well control is established

Summary



- Exploration drilling in the Bowen Basin demonstrates all the ingredients for large basin-centred gas / liquids resources:
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