

East Coast Gas: Resource potential at different gas price scenarios

Part 1: Quantification of unconventional gas resource potential

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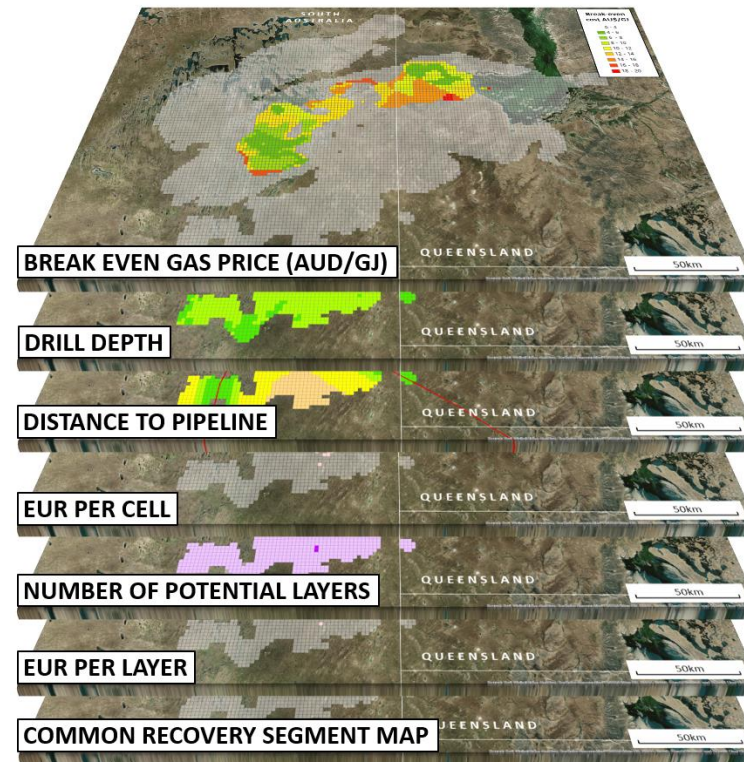
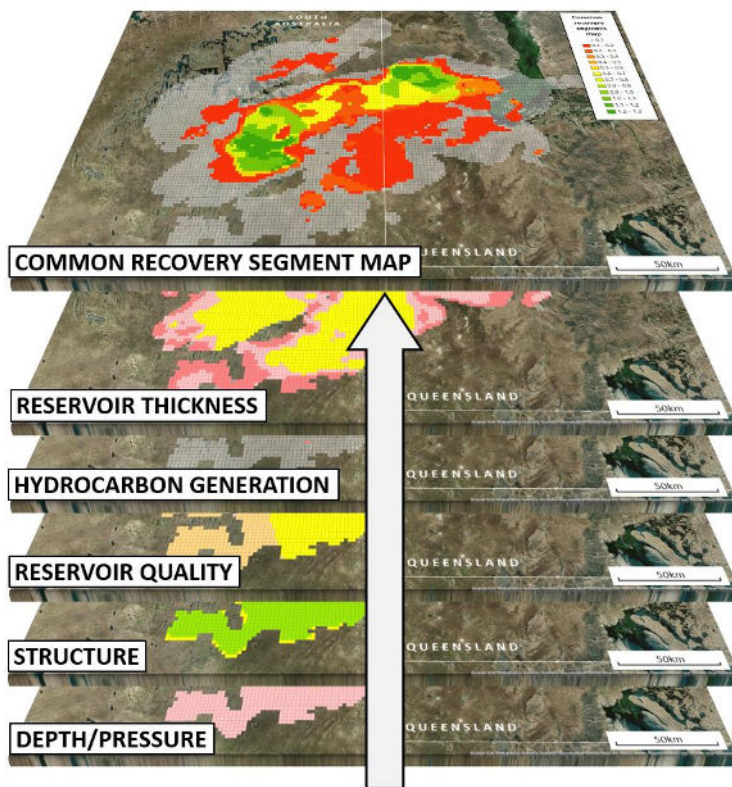
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Heterogeneity in Eastern Australian unconventional plays

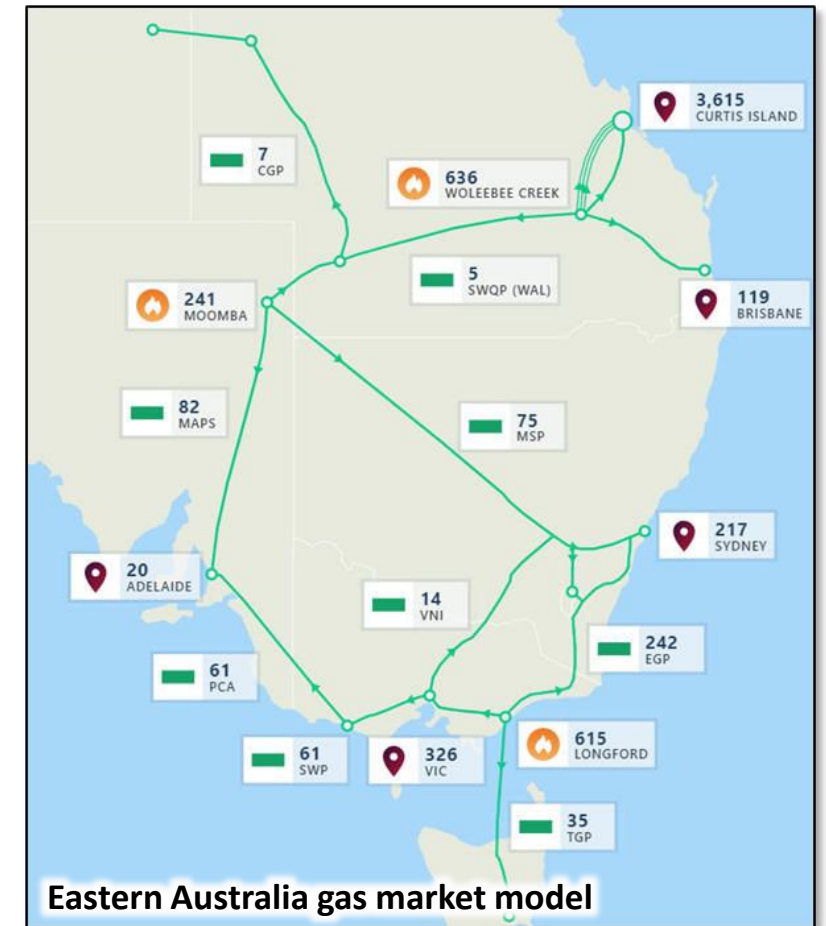
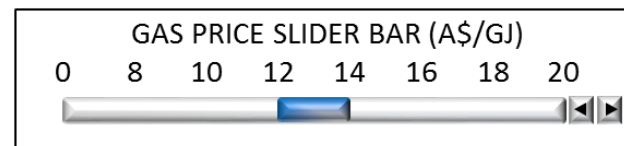
At what gas price does it make sense to exploit Eastern Australian unconventional gas potential?

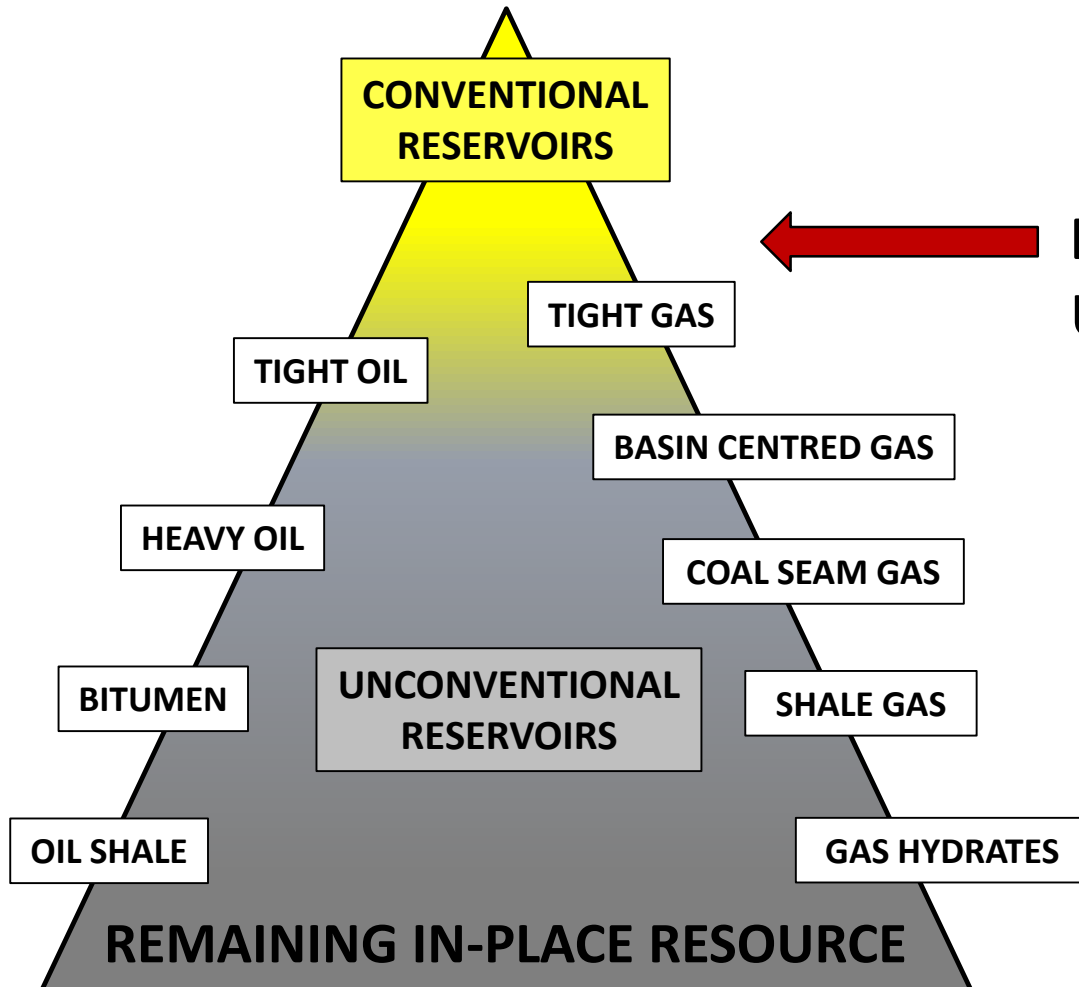
Part 1: Quantification of unconventional gas resource potential

Part 2: Commercialisation of unconventional gas resources



Common Recovery
Segment Mapping





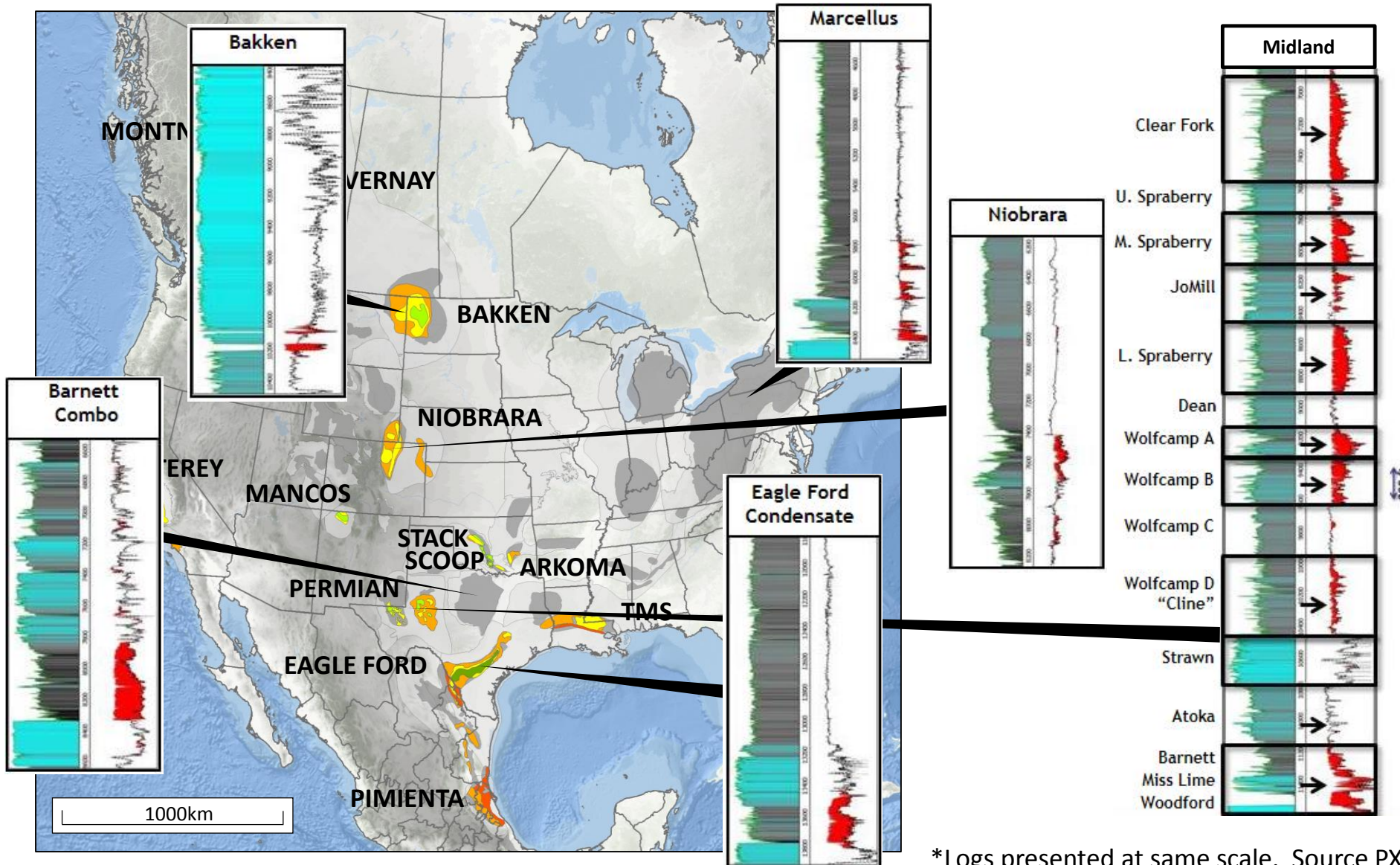
THERE ARE NO HARD LINES
BETWEEN CONVENTIONAL AND
UNCONVENTIONAL RESOURCES

**UNCONVENTIONAL RESERVOIRS SHARE A LOT OF
SIMILAR CHARACTERISTICS TO CONVENTIONAL RESERVOIRS**

- Zones of higher porosity / permeability
- Zones of higher resistivity
- Zones of higher pressure
- Regional structures or structural highs

**ITS NOT JUST A GAME OF FINDING A SHALE AND
FRACING THE BEJEEZUS OUT OF IT**

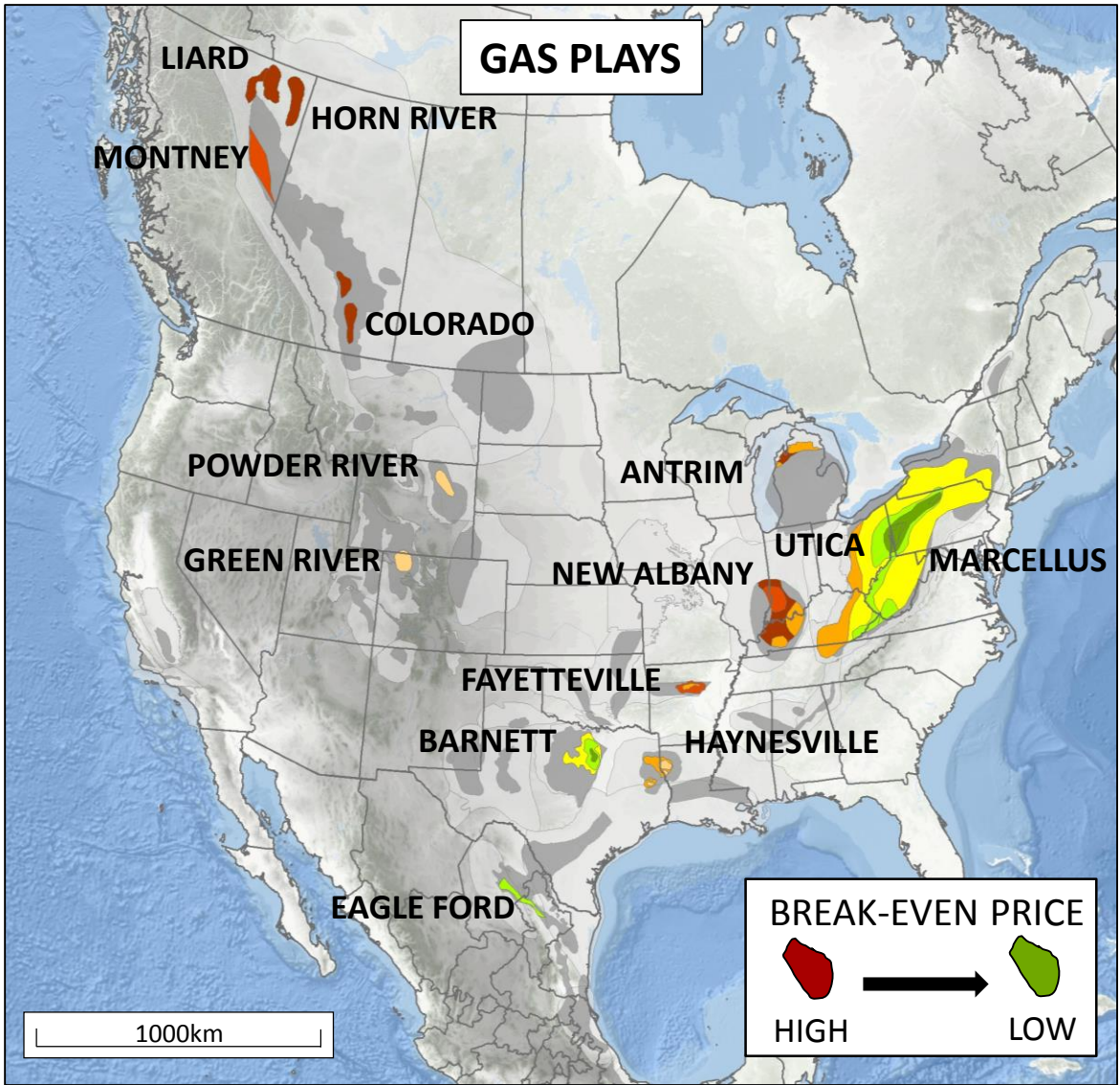
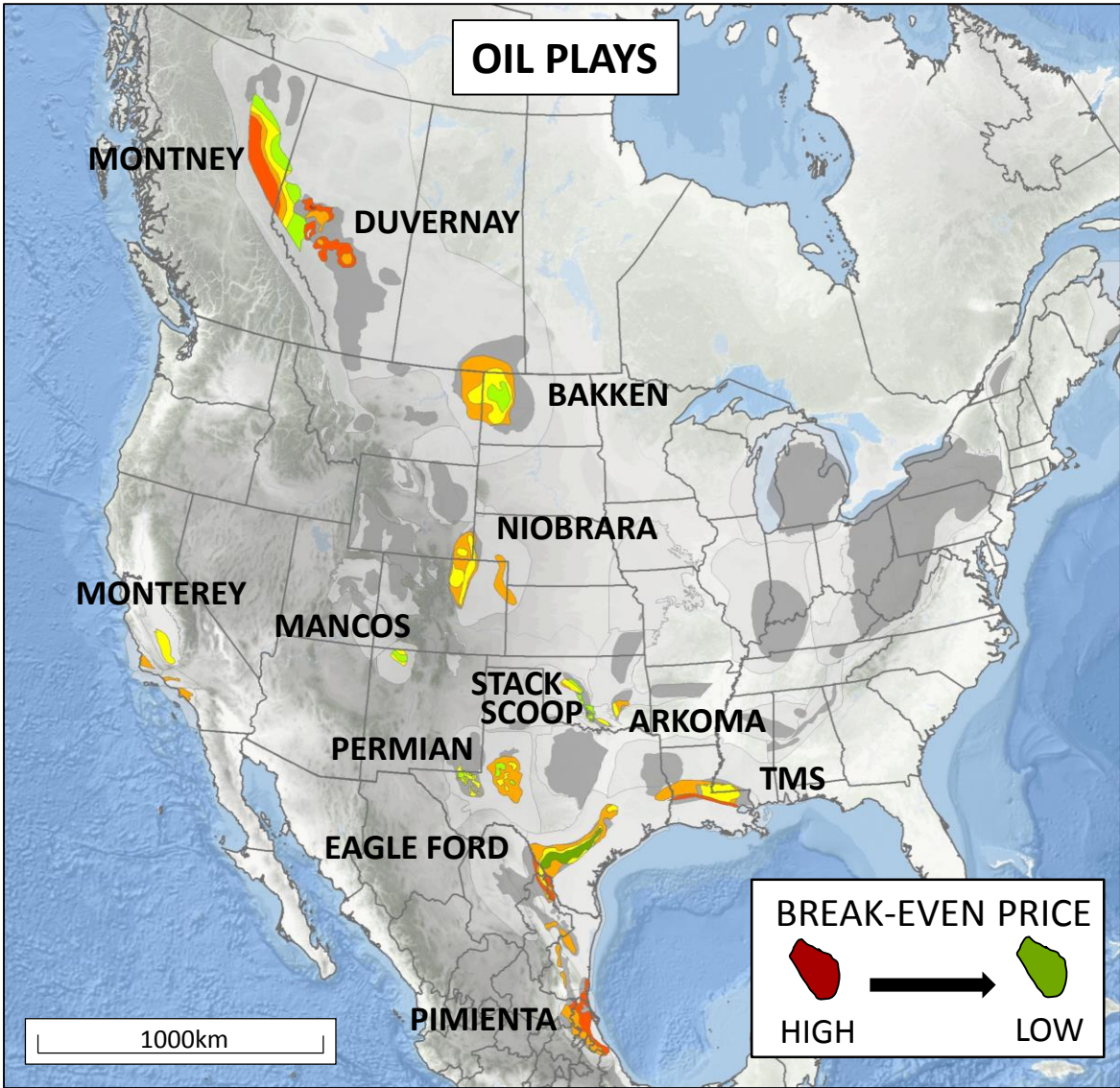
Major North American unconventional plays



- Discrete zones of higher porosity /higher resistivity
- Plays are laterally heterogeneous
- Over-pressure. Rate more important than in-place
- Finding the balance in GOR. Rate versus product
- Areas of very mature conventional production – data / infrastructure / tolerant community stakeholders

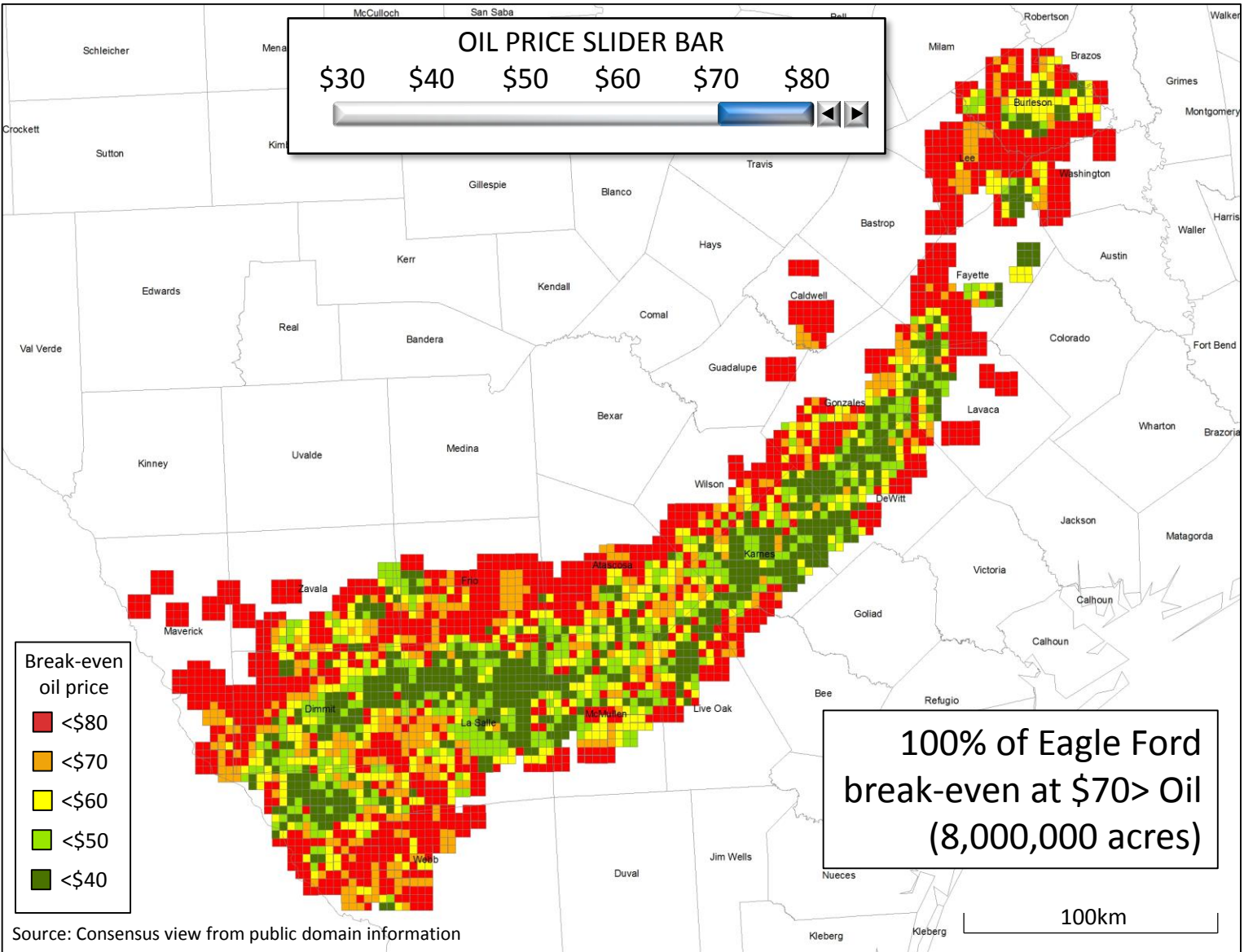
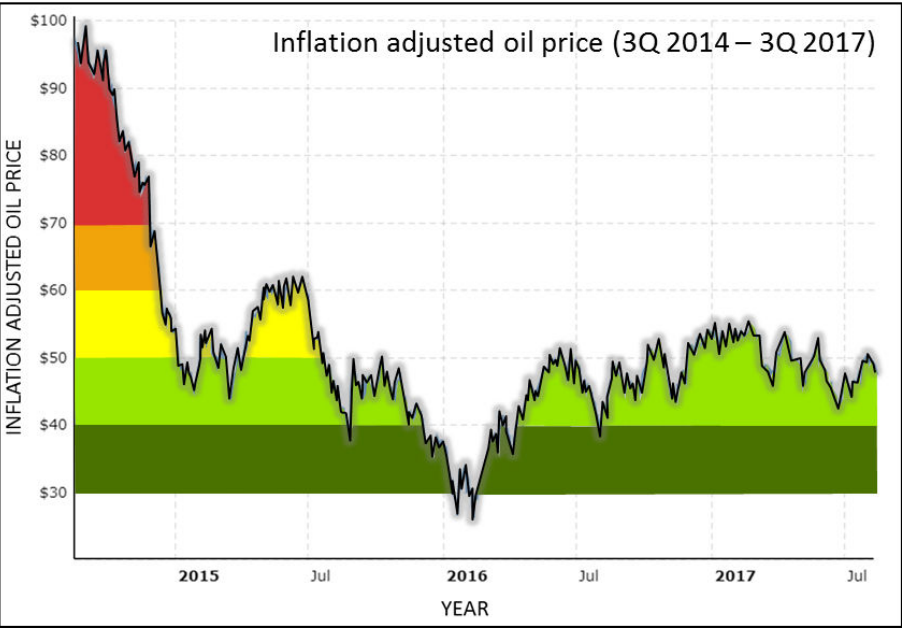
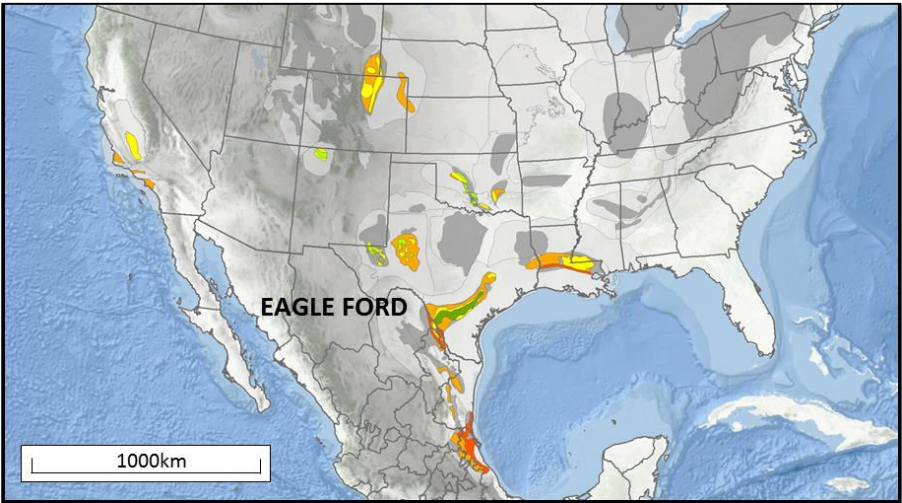
*Logs presented at same scale. Source PXD

Heterogeneity in unconventional plays



Source: Consensus view from public domain information

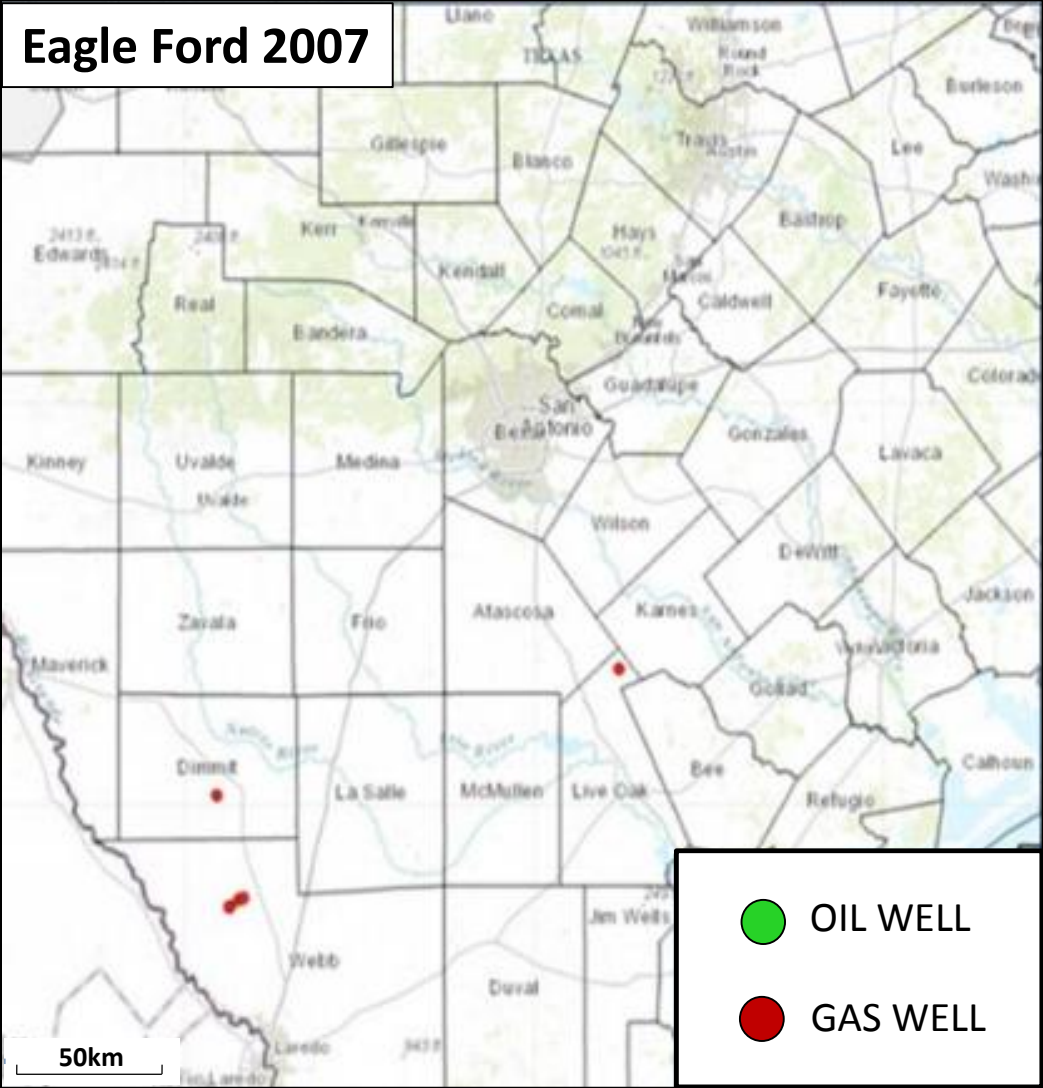
Eagle Ford break-even analysis



Growth of the Eagle Ford



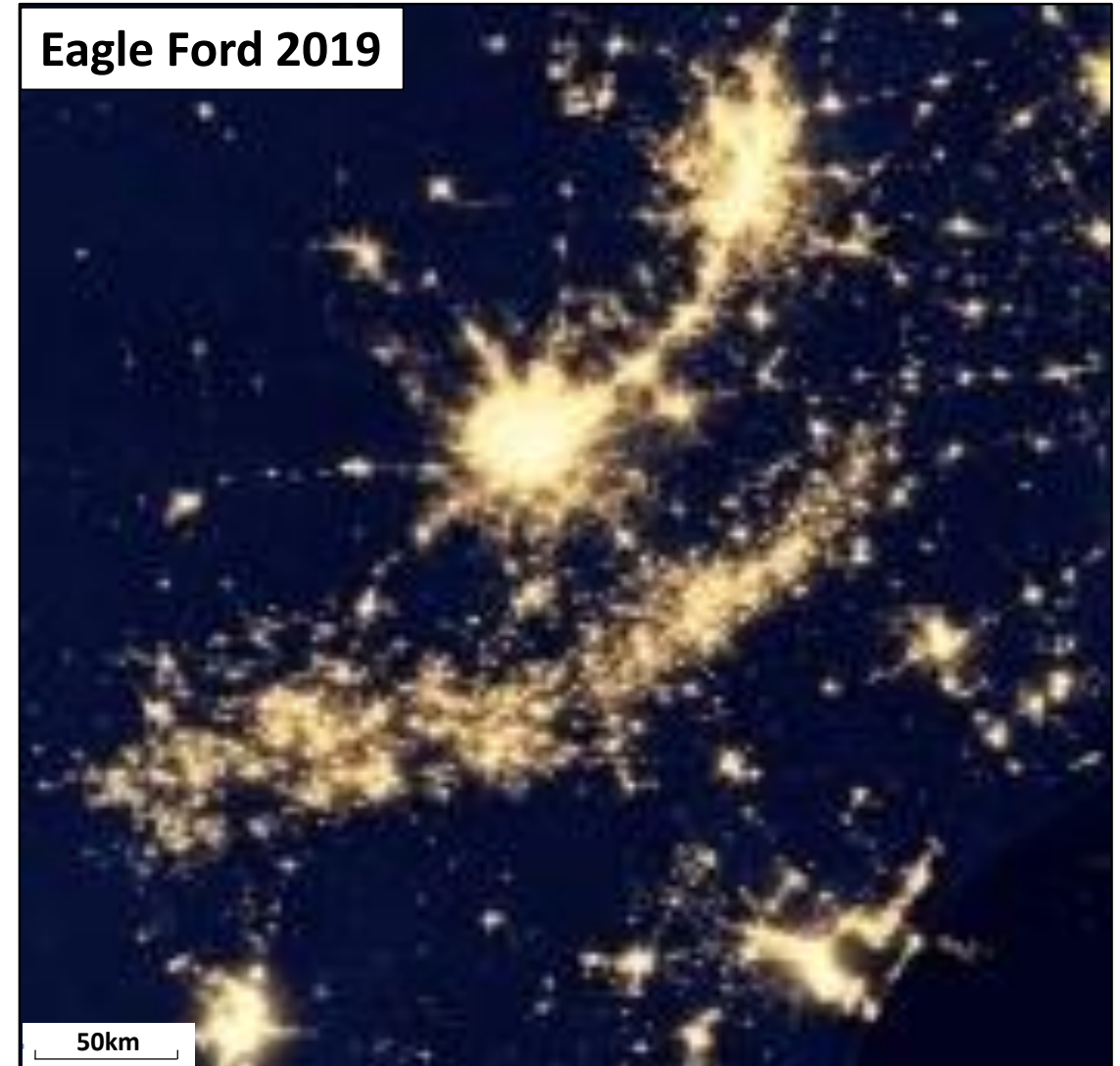
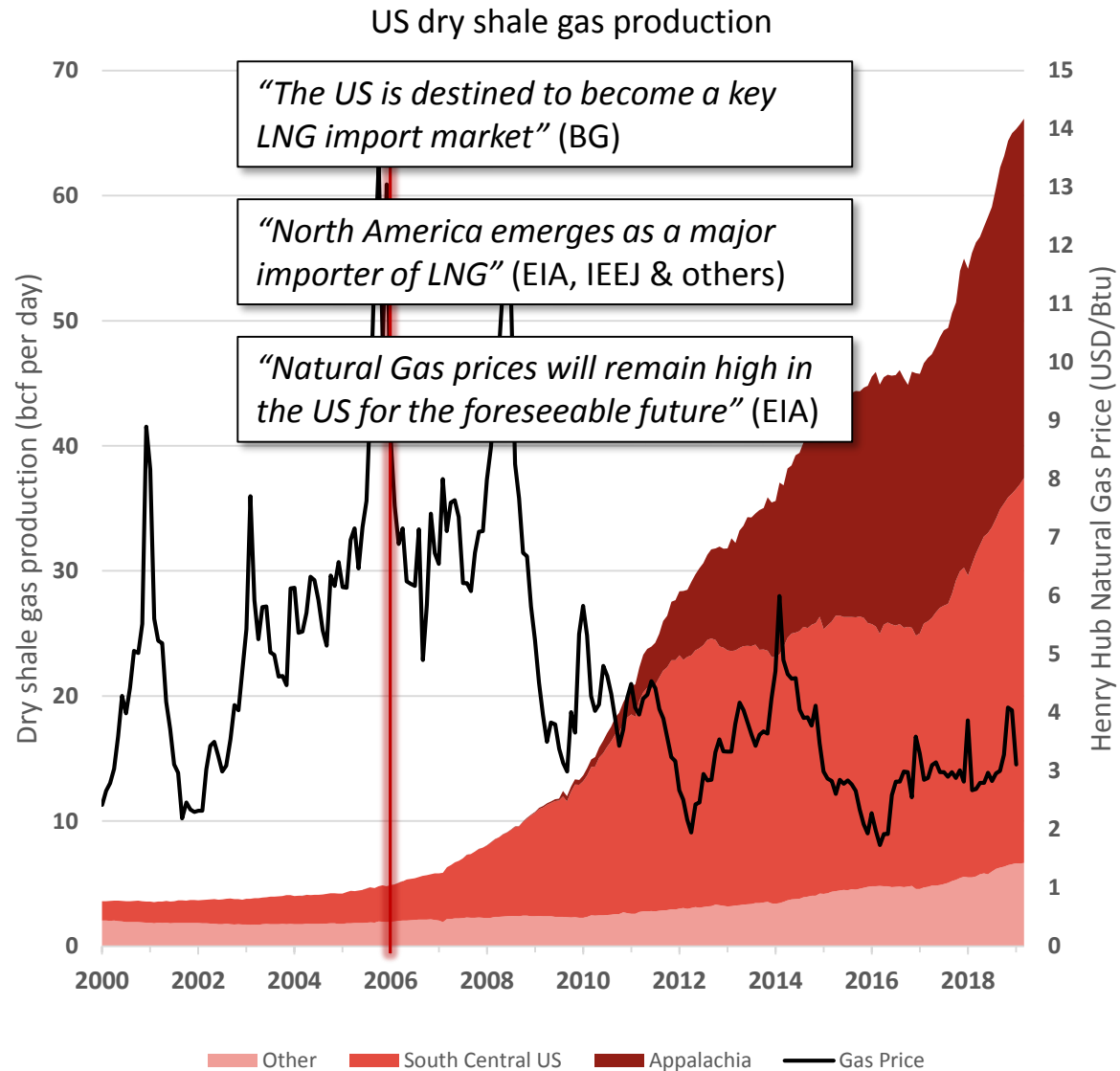
Eagle Ford 2007



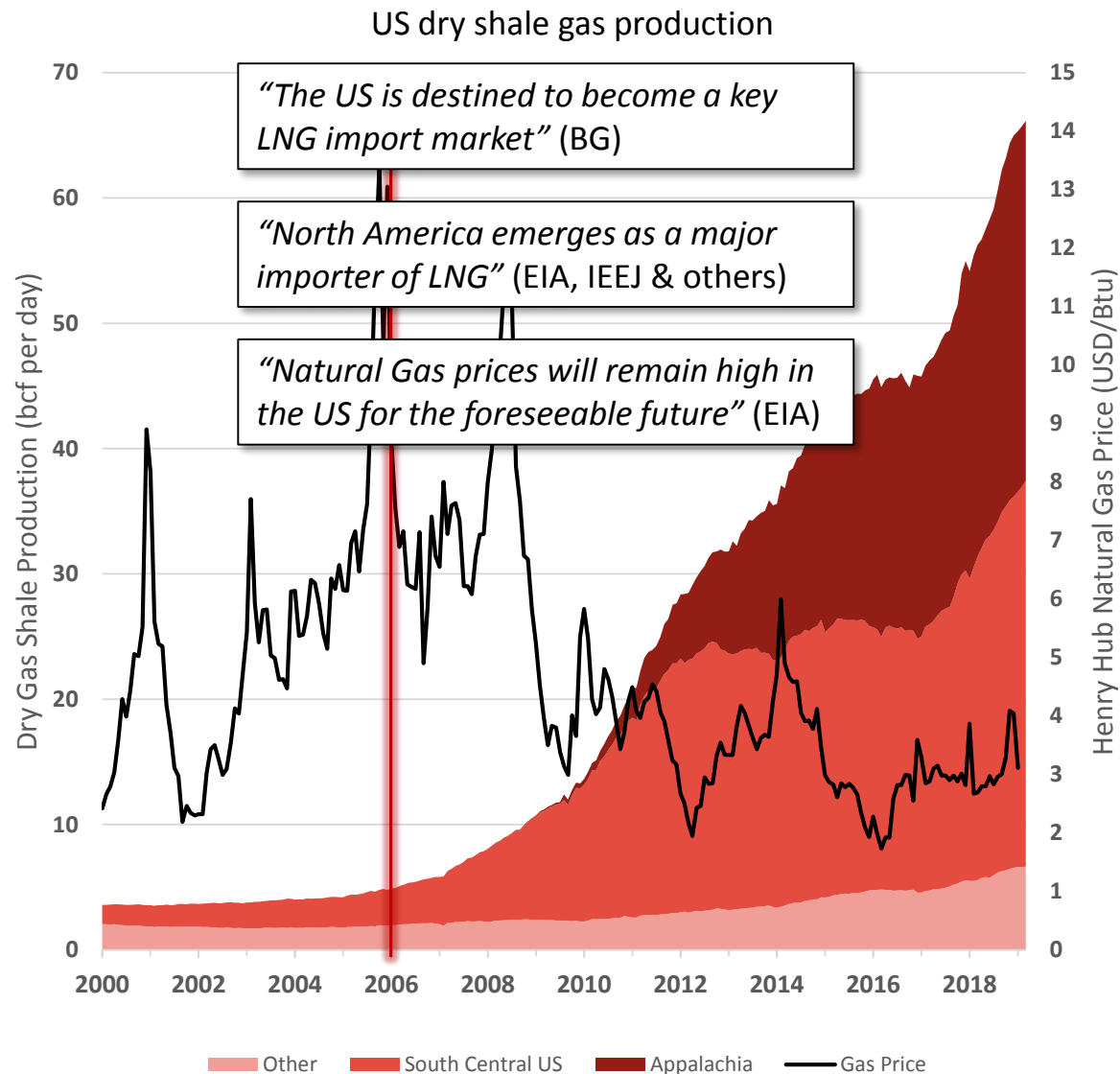
Eagle Ford 2019



Growth in US natural gas production



History repeating itself on Australia's east coast



NATURAL GAS — 27 Feb 2019 | 07:44 UTC — Sydney

Australia's east coast needs to urgently start importing LNG: EnergyQuest

Sydney — Australia's gas-strapped east coast needs to urgently start importing LNG in order to mitigate a range of risk factors stretching from supply issues to regulatory uncertainties, energy consultancy EnergyQuest said Wednesday.

When insanity makes sense: Australia's best option is LNG imports

By Clyde Russell

March 7, 2019 — 12:06pm

Australia has painted itself into a corner with its natural gas industry and faces the stark reality that there are no easy choices to alleviate the dual problem of a looming supply crunch and the associated higher prices.

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LNG import terminal approval — an Australian first — a sign of hope for NSW manufacturing

ABC Illawarra By Kelly Fuller and Gavin Coote

FROM ABC ILLAWARRA

- Why Tania Daykin is putting old chickens before the eggs
- Art and alcohol bringing out creative flair in expanding entertainment landscape
- Liberal candidate angry over 'go back to where you came from' comment

RISC Eastern States gas market study and unconventional play atlas



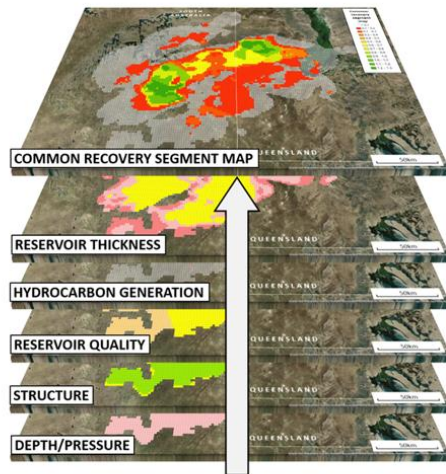
decisions with confidence

Australian Eastern States gas market study and unconventional play atlas

RISC has developed a comprehensive Australian Eastern States gas market study. The study is based on the 2P reserves positions for domestic gas producers paired with a range of gas demand forecasts to identify probable supply gaps on the East Coast over the next 10 years. A market response to the high gas pricing on the East Coast in the form of new developments is already underway.

At what gas price does it make sense to start developing unconventional resources in the Eastern states?

Resource play quantification for all of the Eastern States recognised potential unconventional plays

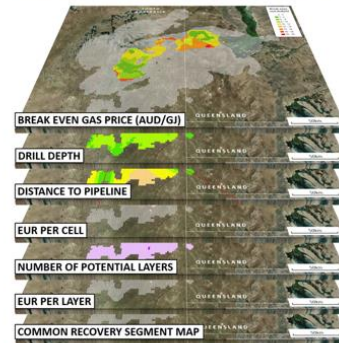


The study has analysed all of the potential sources of unconventional gas to fill the East Coast market gap and determines likely gas supply rates, development schedules and breakeven supply costs for each of the major demand centres.

The study illustrates the required gas prices to drive unconventional gas development in Eastern Australia, the subsequent scale of new unconventional gas supplies to the forecast gaps in the market and describes how those developments can reverse the trend of rising prices over time.



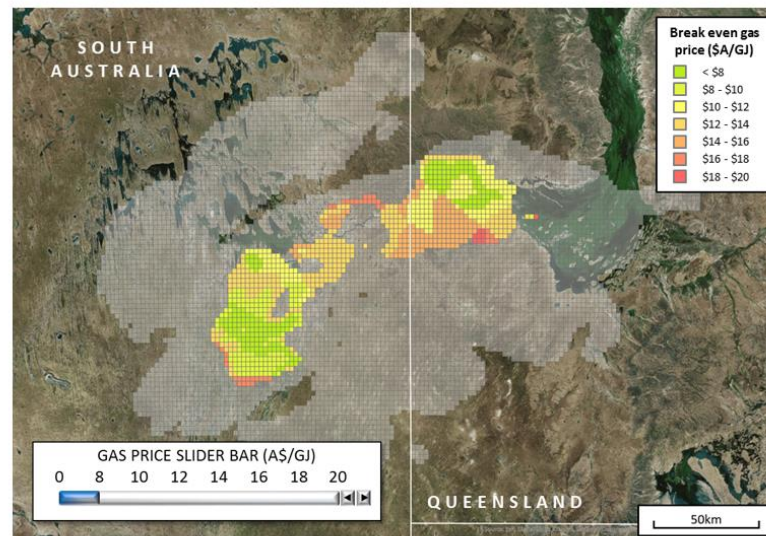
Resource development break-even analysis



decisions with confidence

A quantitative analysis of the unconventional gas potential of Eastern Australian basins has been undertaken using a spatial analysis methodology of play fairway sweet-spot mapping. Play components considered important for the presence and recovery of unconventional gas were mapped across the plays of interest. Modelled horizontal well type curves and development plans from North American analogues for unconventional gas production have been used to quantify the sweet-spot mapping using a methodology RISC has developed called common recovery segment mapping.

The gas price slider bar provides interactive break even development maps for all of the recognised unconventional plays in Eastern Australia

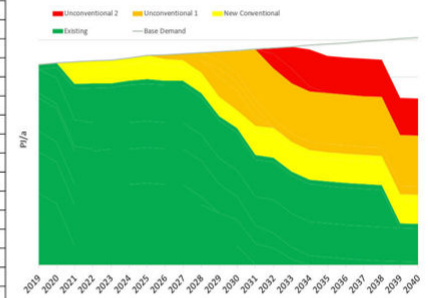


decisions with confidence

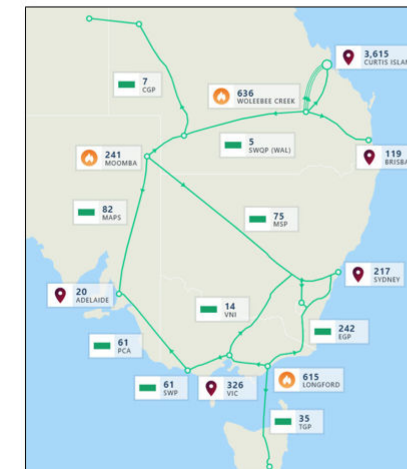
All major gas resource plays identified in Eastern Australia have been quantified

BASIN	PLAY / RESERVOIR	PLAY TYPE
COOPER	TOOLACHEE	SHAPE GAS
COOPER	DARLINGIE	TIGHT GAS
COOPER	ROSENEATH	SHAPE GAS
COOPER	EPILON	TIGHT GAS
COOPER	MURTEREE	SHAPE GAS
COOPER	PATCHAWARRA	TIGHT GAS
EROMANGA	WINTON	TIGHT GAS
BOWEN	BANDANNA-BARALABA	COAL SEAM GAS
BOWEN	TINWON	TIGHT GAS
BOWEN	REIDS DOME BEDS	TIGHT GAS
SURAT	WALLOON	COAL SEAM GAS
SURAT	PRECIPICE	TIGHT GAS
SURAT	SPRINGBOK	TIGHT GAS
GALILEE	ARAMAC	COAL SEAM GAS
BEETALOO	VELKERRI	SHAPE GAS

Eastern Australia gas supply forecast



Eastern Australia gas market model



A quantitative understanding of unconventional resource potential at different gas price scenarios allows us to understand how potential unconventional resource developments could contribute towards the Eastern Australia energy supply mix

Deliverables

The Eastern Australia unconventional play atlas is provided in both hyperlinked and interactive .pdf report and as an optional ArcGIS project.

The Eastern Australia gas market study is provided as a .pdf and an optional excel model

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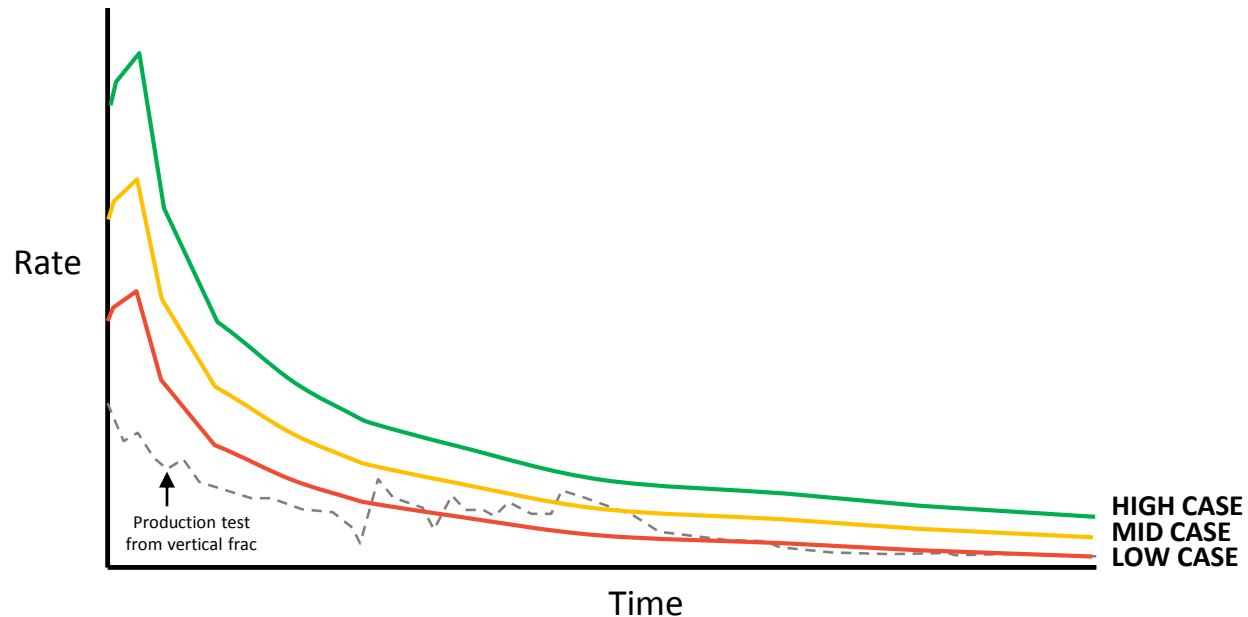
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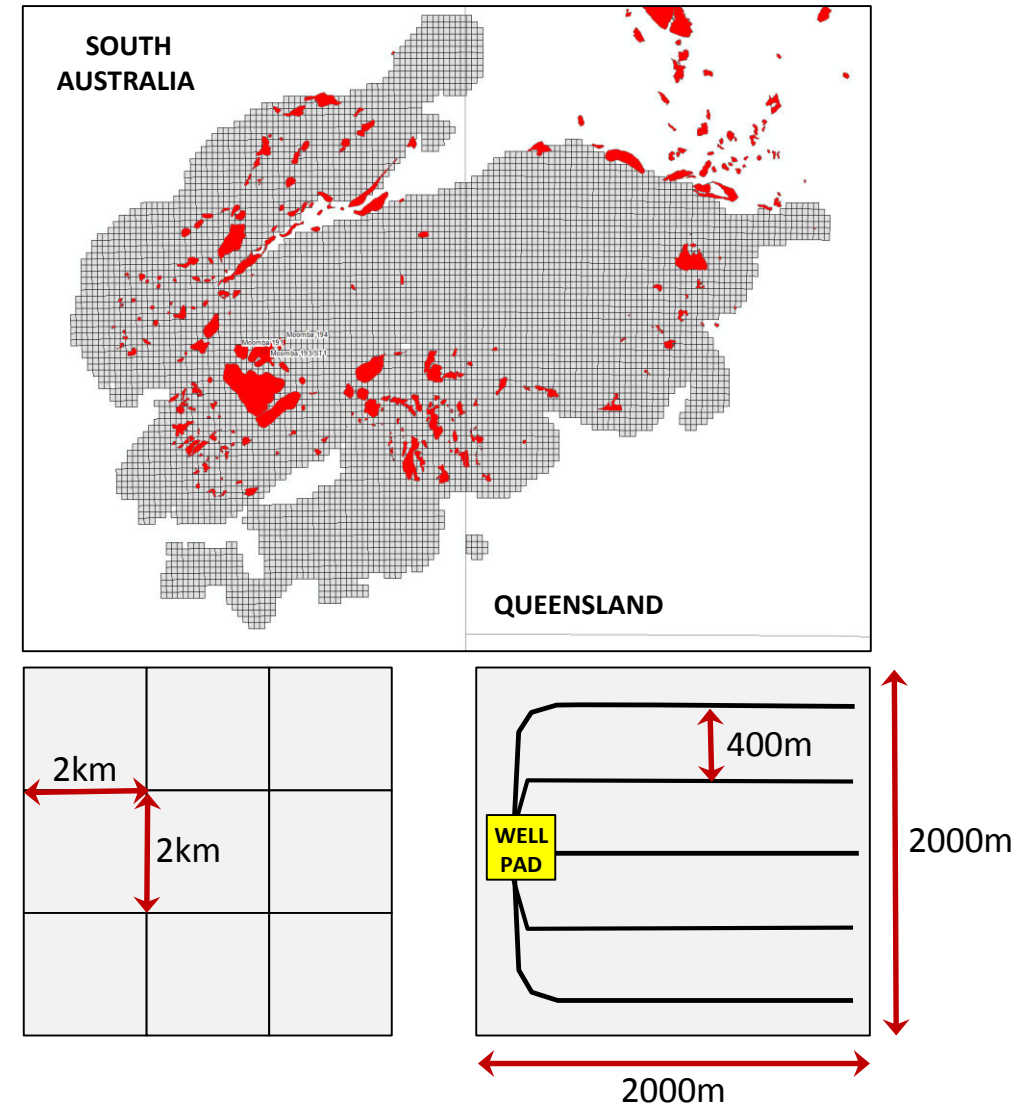
Joe Collins
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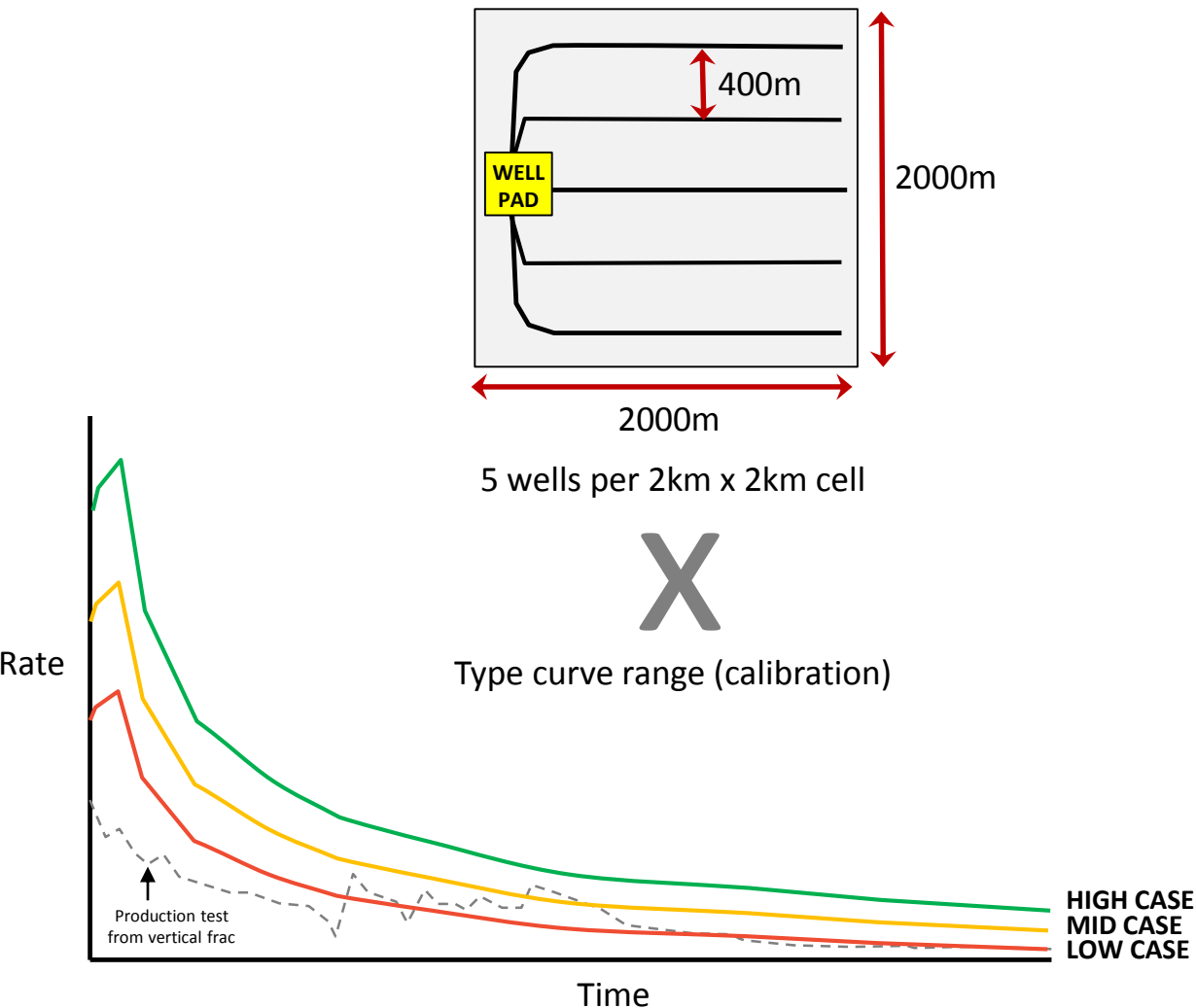
Developing control calibration data points for each play

- Using existing production (i.e. Walloon coal seam gas production history)
- Upscaling from horizontal fracked completions (i.e. Amungee Mid Velkerri shale test)
- Upscaling from vertical fracs and production test history (i.e. Moomba Murteree shale tests)

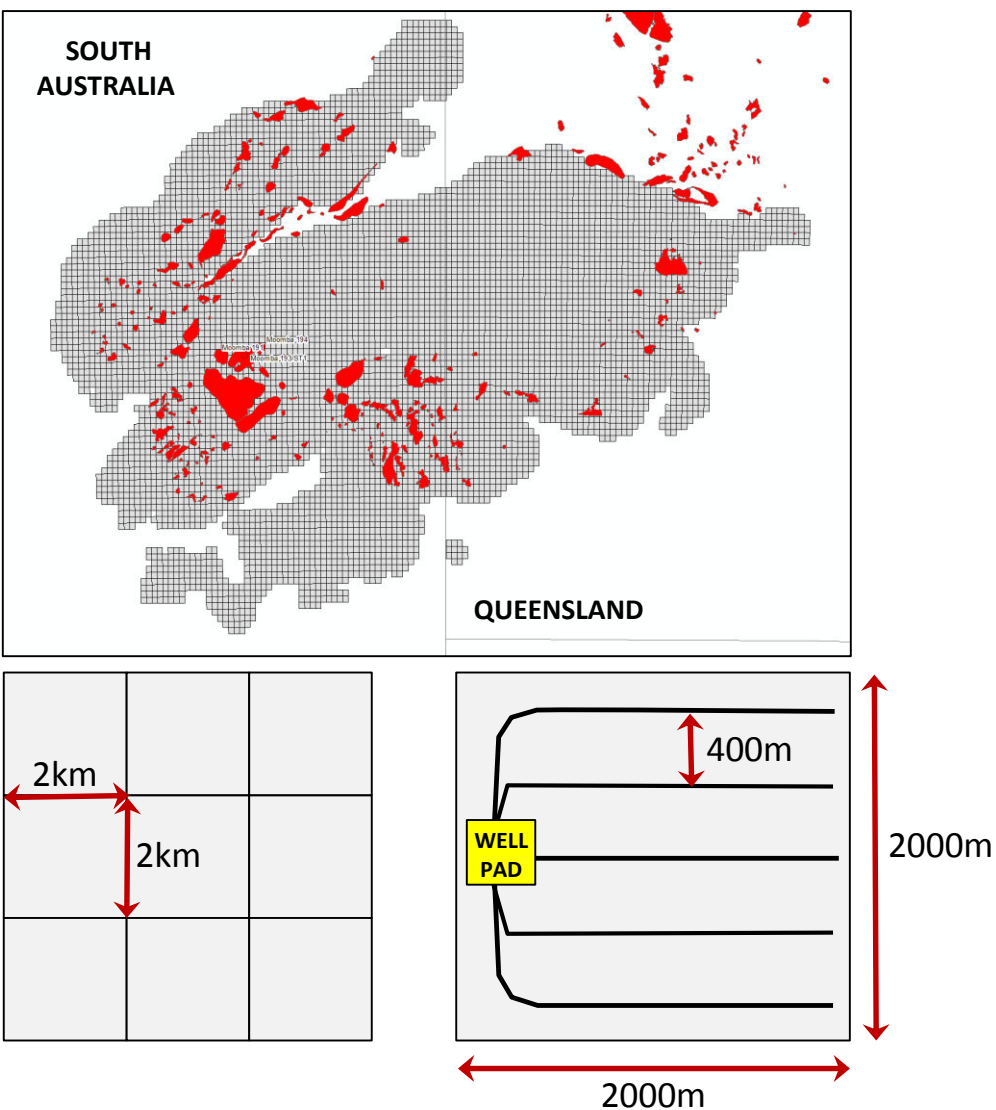


Creating a spatial grid over each play

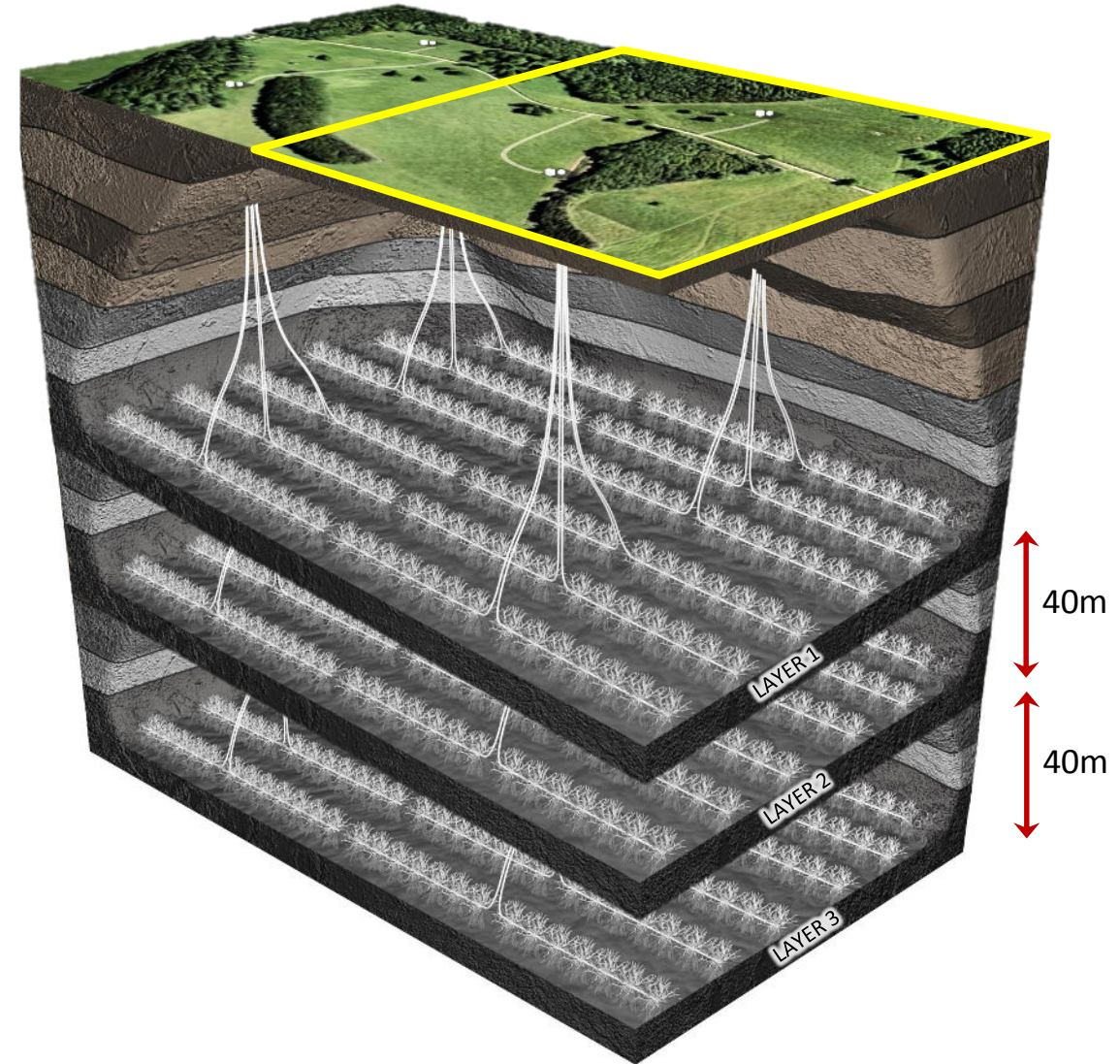
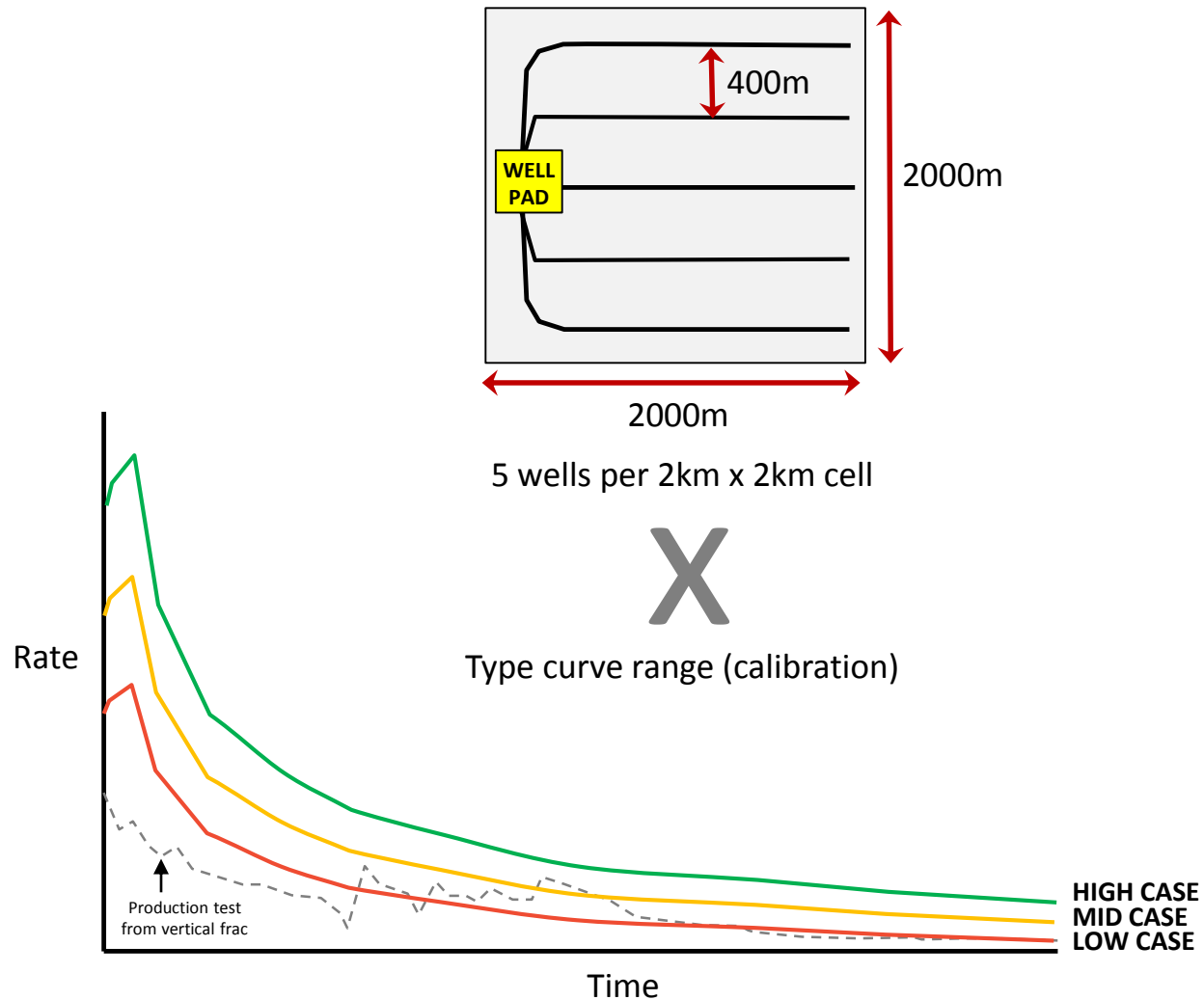




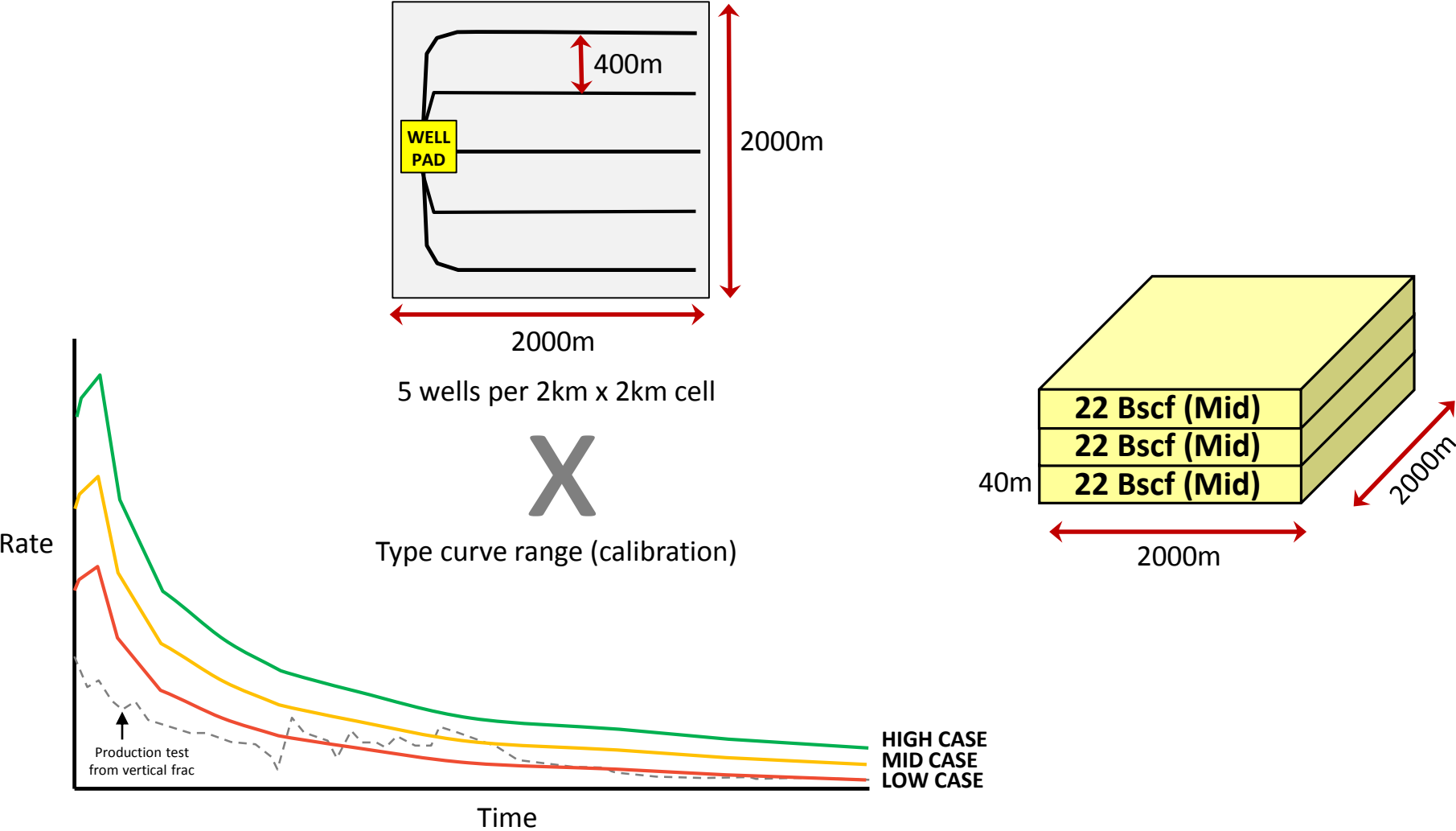
Creating a spatial grid over each play



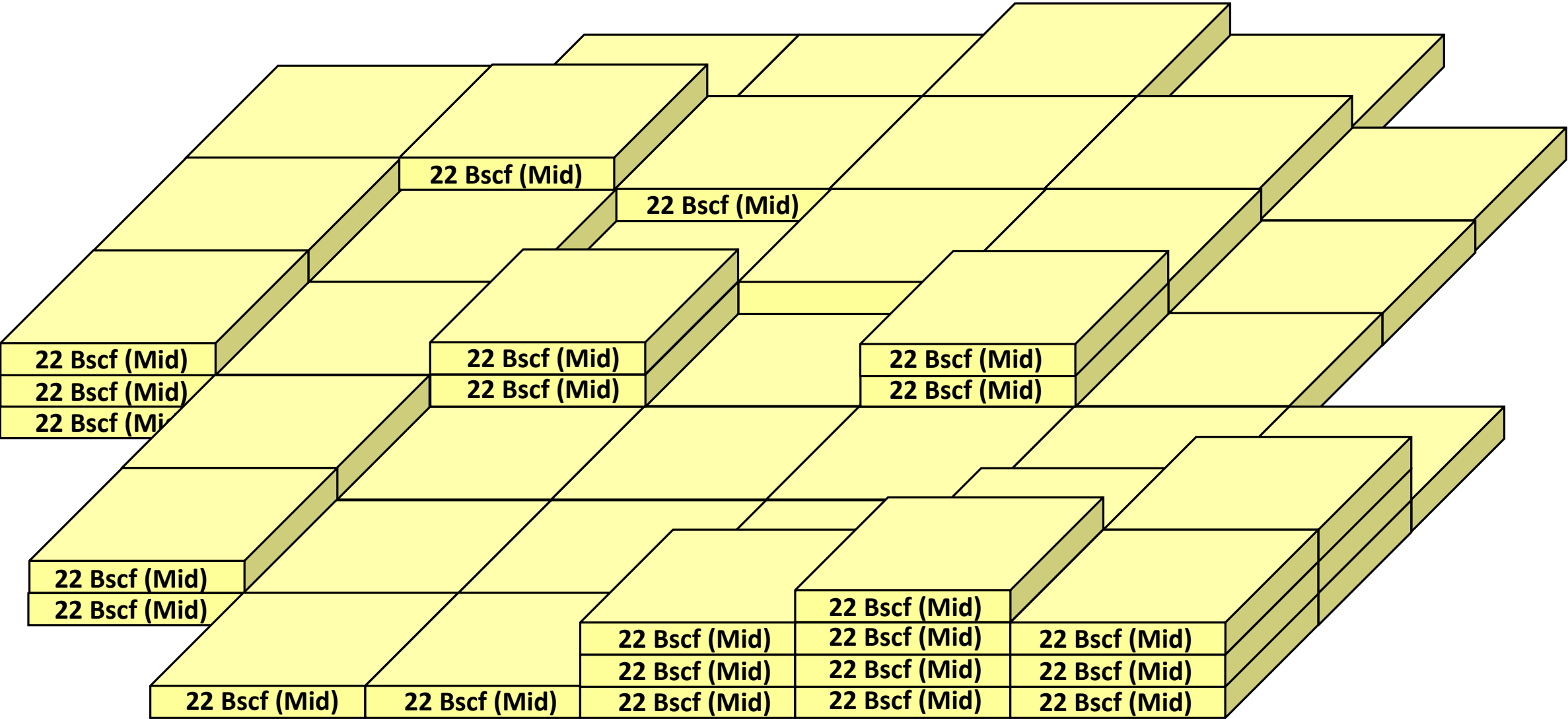
Quantifying unconventional potential – standardising development



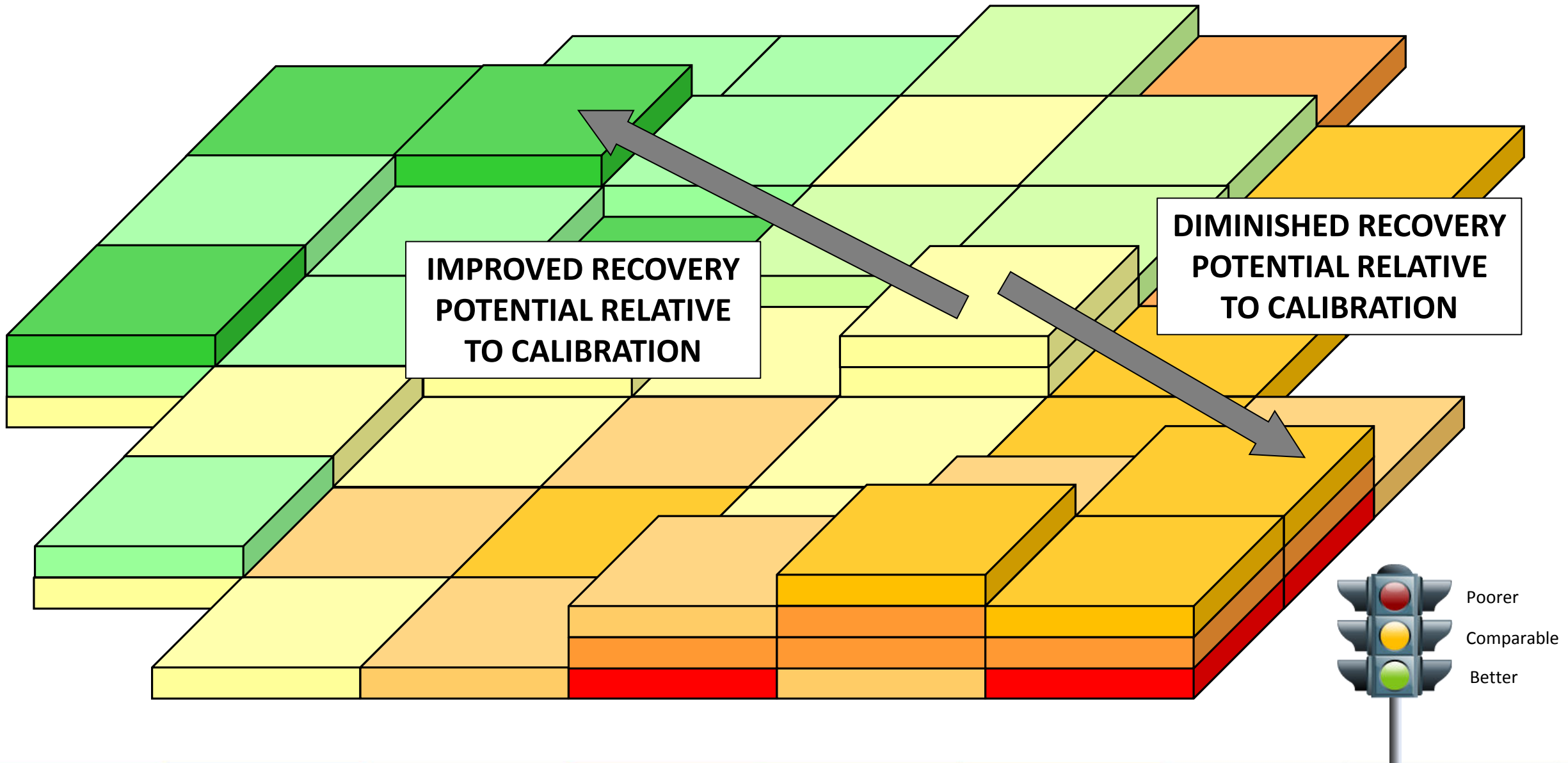
Estimated Ultimate Recovery (EUR) of calibration cells



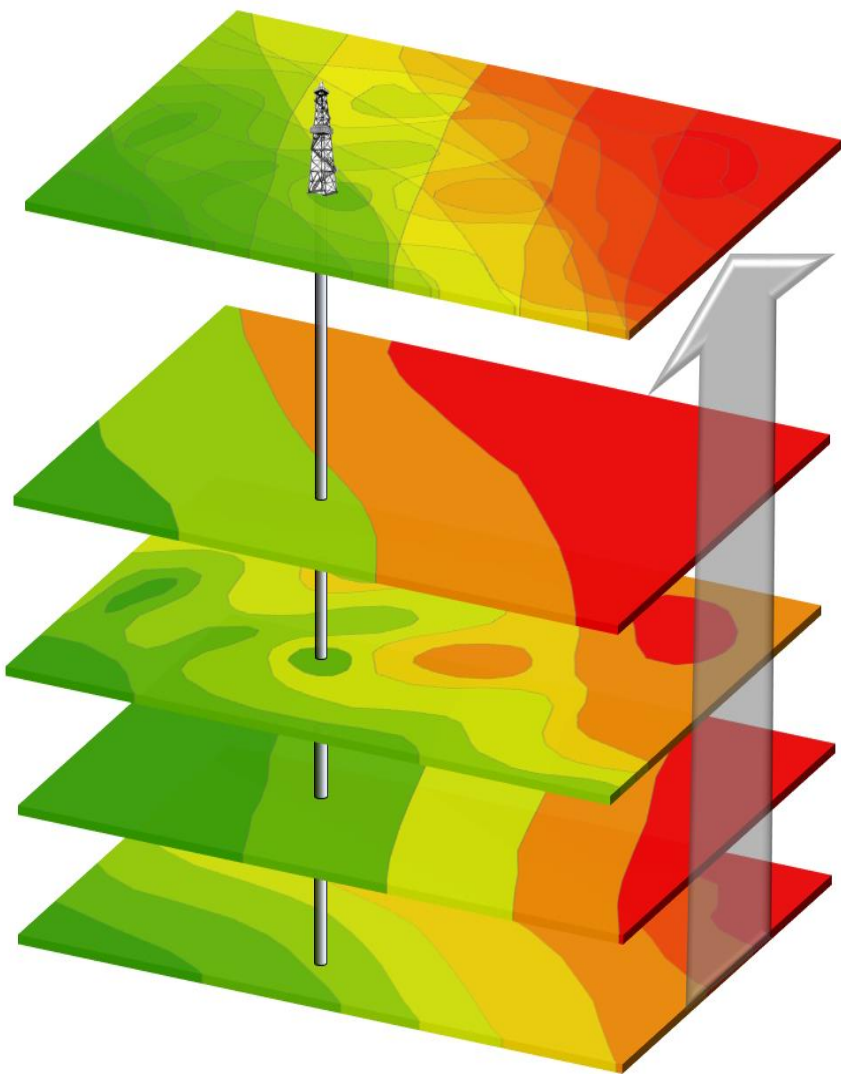
Mapped spatial extent of the play



How does that EUR potential change spatially?

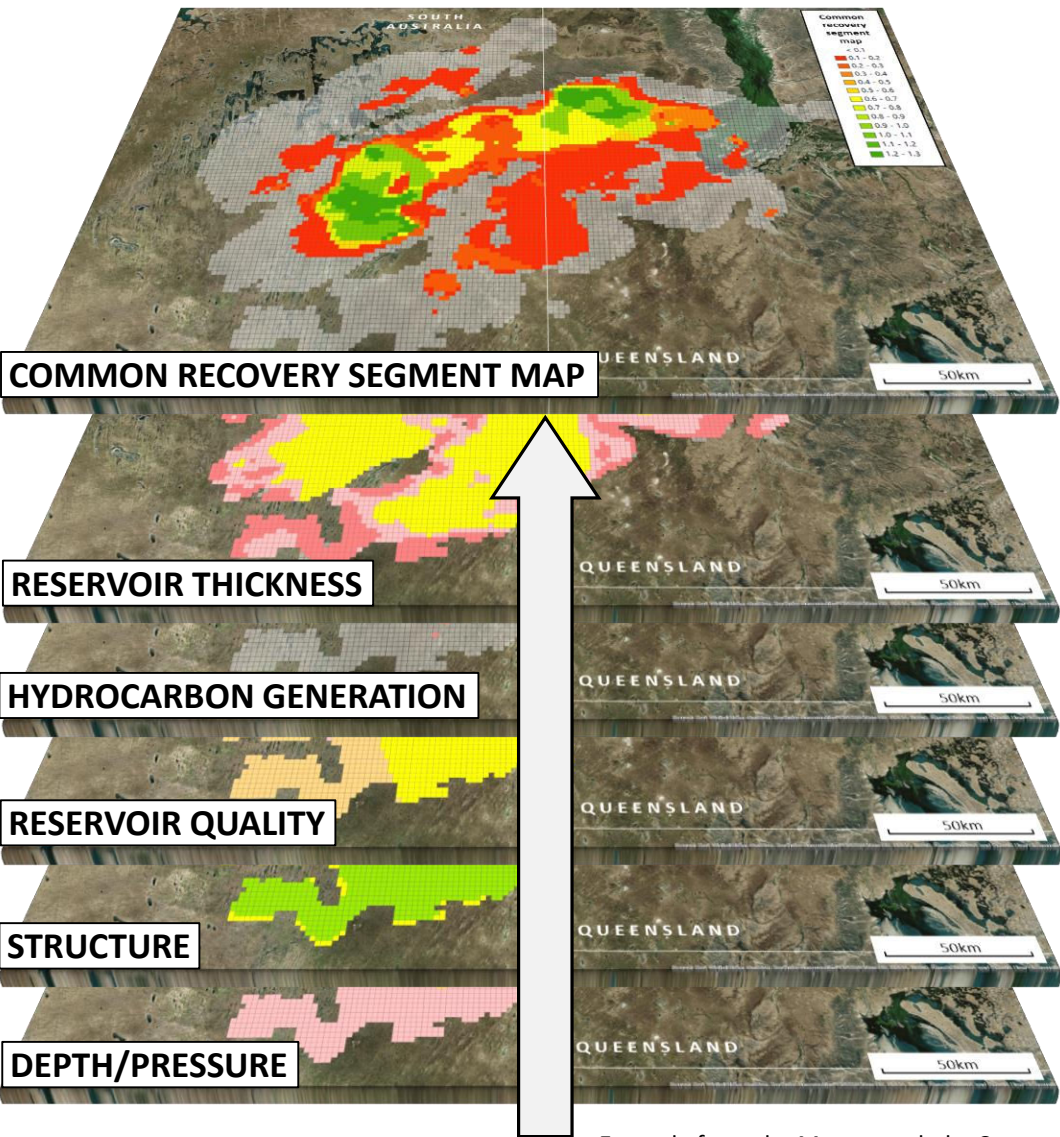


Common recovery segment mapping



**COMMON RECOVERY
SEGMENT MAP
(Sweet Spot Map)**

RECOVERY
POTENTIAL IS THE
COMBINED
EFFECT OF
MULTIPLE
ATTRIBUTES

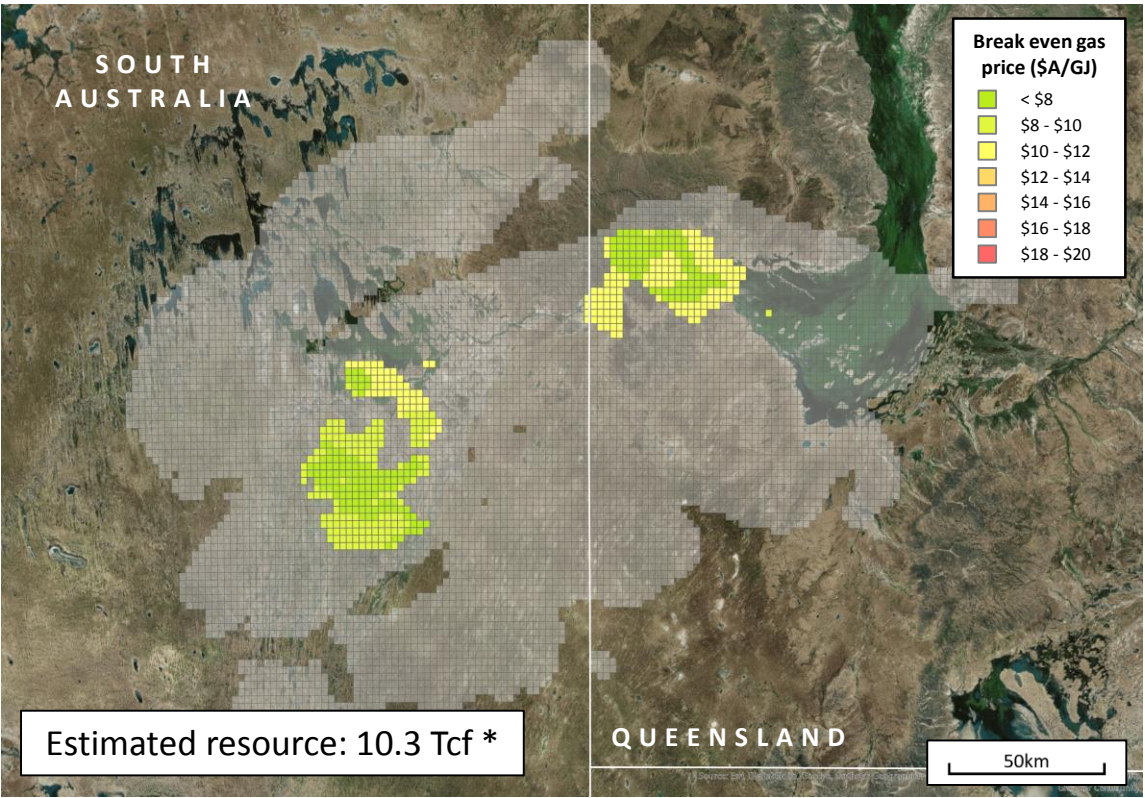
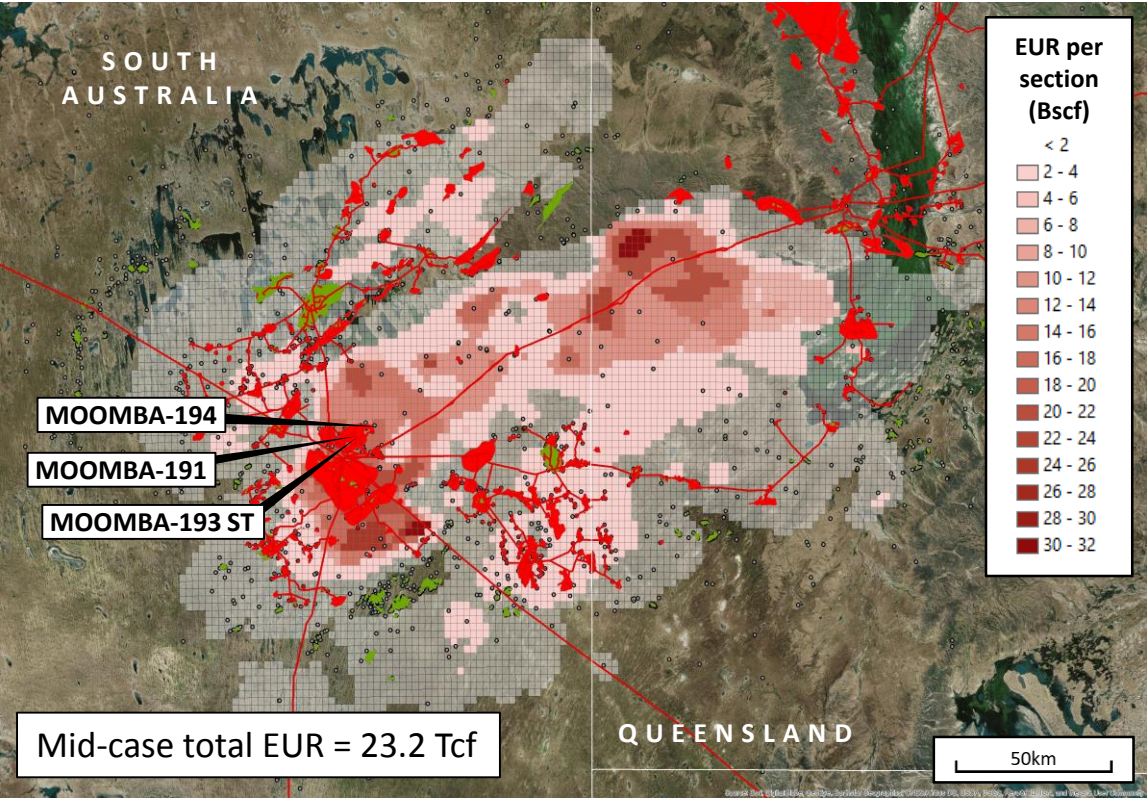
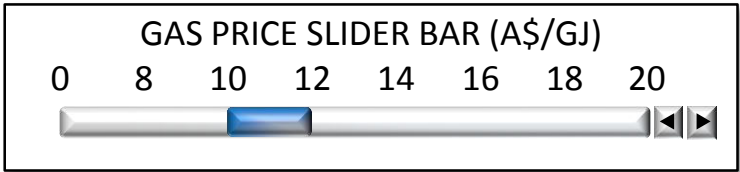


Example from the Murterree shale, Cooper basin

Break-even price development of the Murteree play



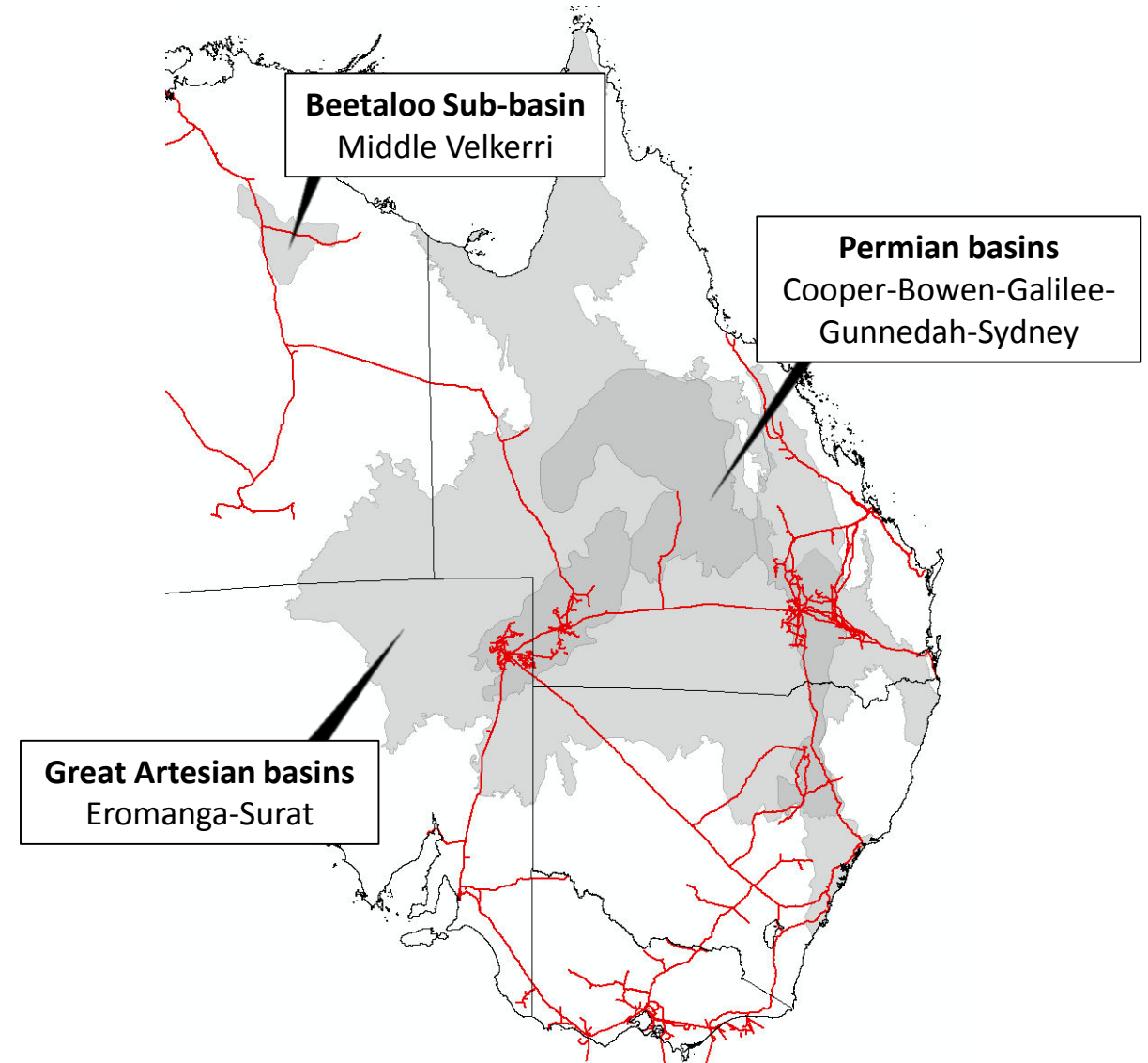
MURTEREE ESTIMATED ULTIMATE RECOVERY POTENTIAL

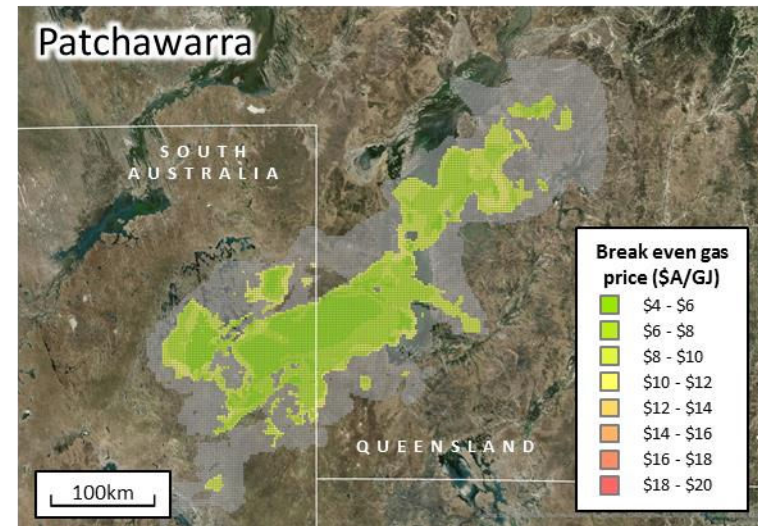
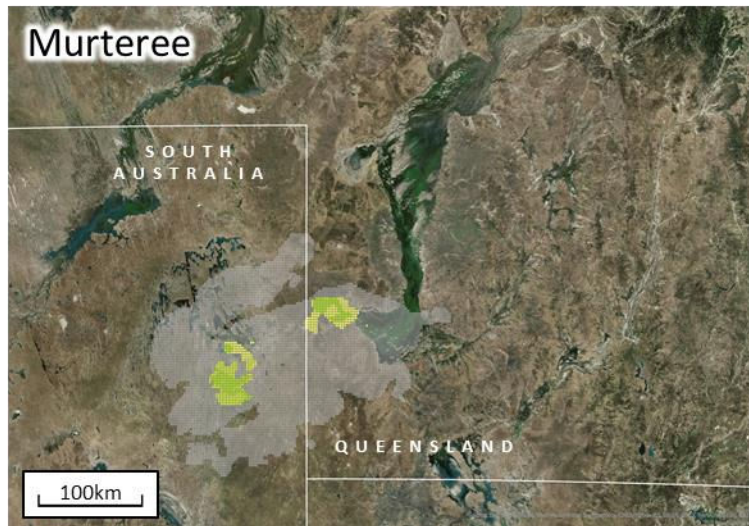
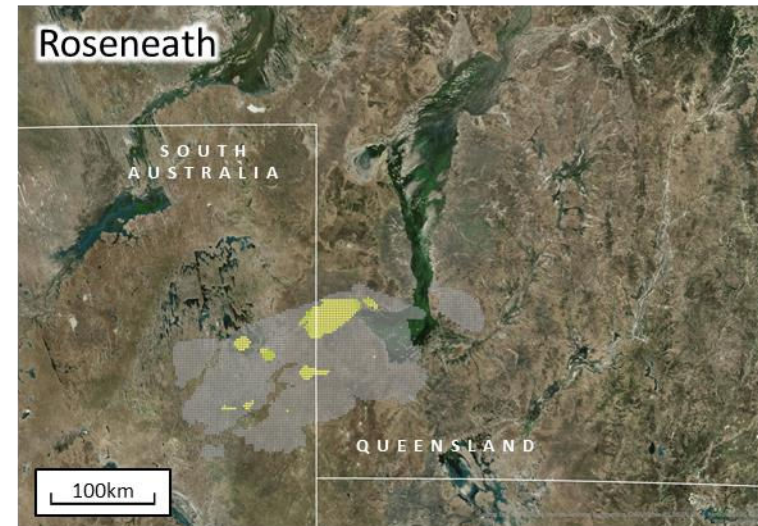
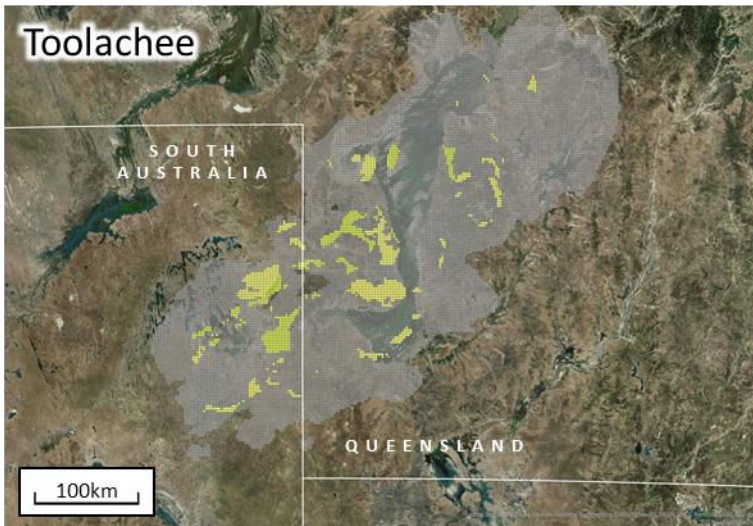
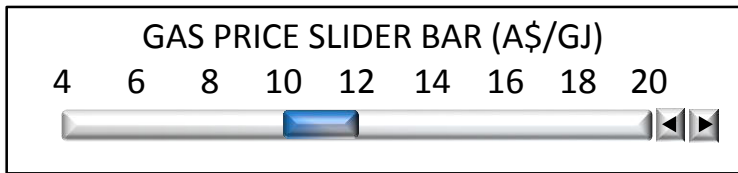


* Mid-case type curve EUR with full development (Well count: **2828**)

Eastern Australian unconventional plays of interest

BASIN	PLAY / RESERVOIR	PLAY TYPE
COOPER	TOOLACHEE	SHALE GAS
COOPER	DARALINGIE	TIGHT GAS
COOPER	ROSENEATH	SHALE GAS
COOPER	EPSILON	TIGHT GAS
COOPER	MURTEREE	SHALE GAS
COOPER	PATCHAWARRA	TIGHT GAS
EROMANGA	WINTON	TIGHT GAS
BOWEN	BANDANNA-BARALABA	COAL SEAM GAS
BOWEN	TINWON	TIGHT GAS
BOWEN	REIDS DOME BEDS	TIGHT GAS
SURAT	WALLOON	COAL SEAM GAS
SURAT	PRECIPICE	TIGHT GAS
SURAT	SPRINGBOK	TIGHT GAS
GALILEE	BETTS CREEK / ARAMAC	COAL SEAM GAS
BEETALOO	VELKERRI	SHALE GAS

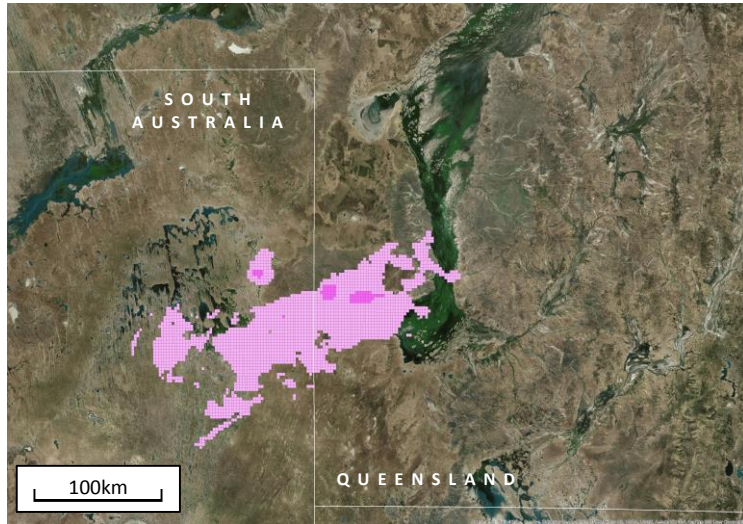




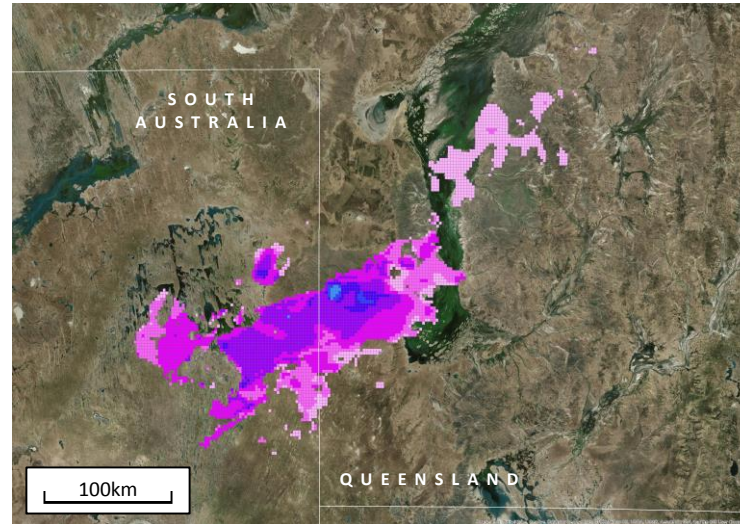
Cooper basin resource totals (all prospective units) at \$8/GJ break-even



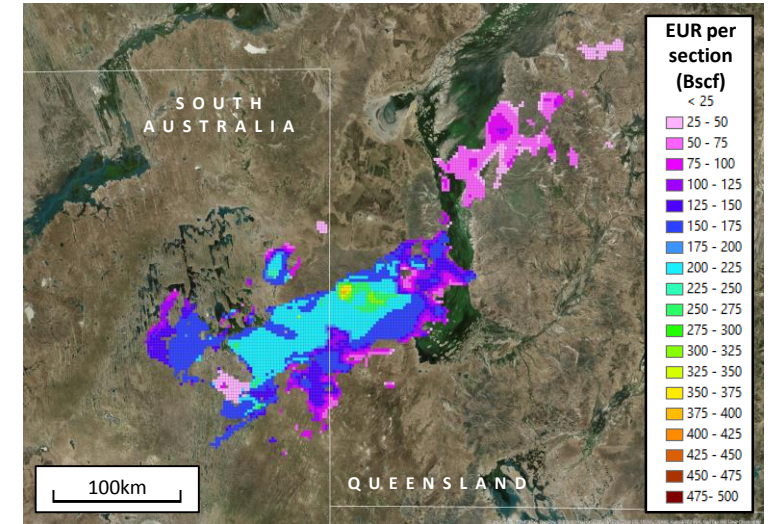
Low estimate



Mid estimate



High estimate



Total resource estimates for Cooper unconventional plays at \$8/GJ

106 Tcf

288 Tcf

548 Tcf

-10% for inert gas and assuming 40% of maximum development

-5.4 Tcf of produced gas to date

33 Tcf

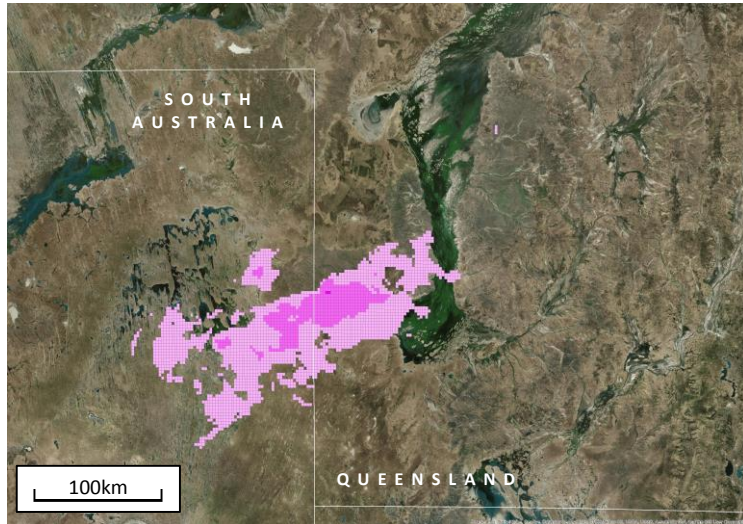
99 Tcf

192 Tcf

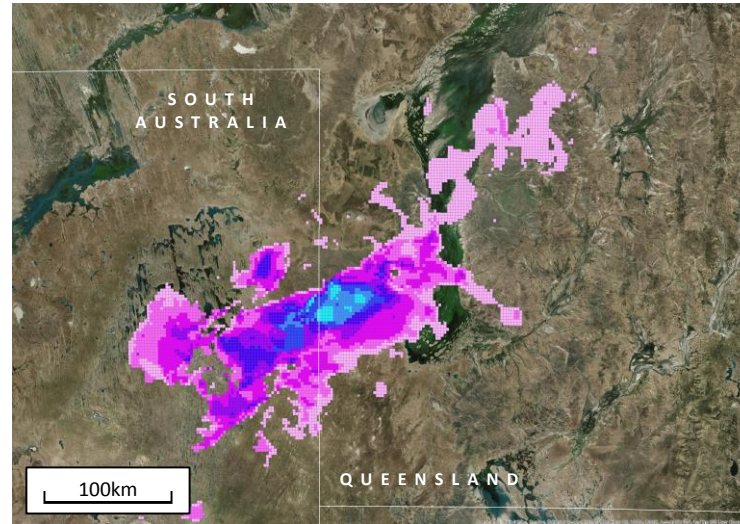
Cooper basin resource totals (all prospective units) at \$12/GJ break-even



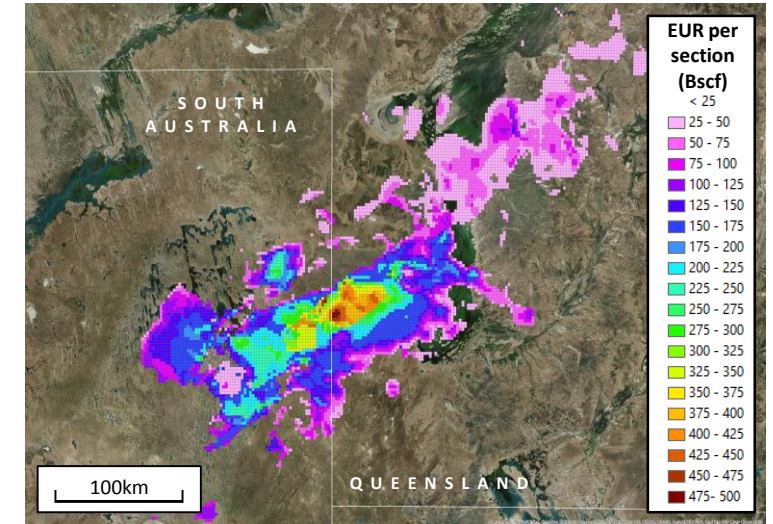
Low estimate



Mid estimate



High estimate



Total resource estimates for Cooper unconventional plays at \$12/GJ

158 Tcf

427 Tcf

829 Tcf

-10% for inert gas and assuming 40% of maximum development

-5.4 Tcf of produced gas to date

52 Tcf

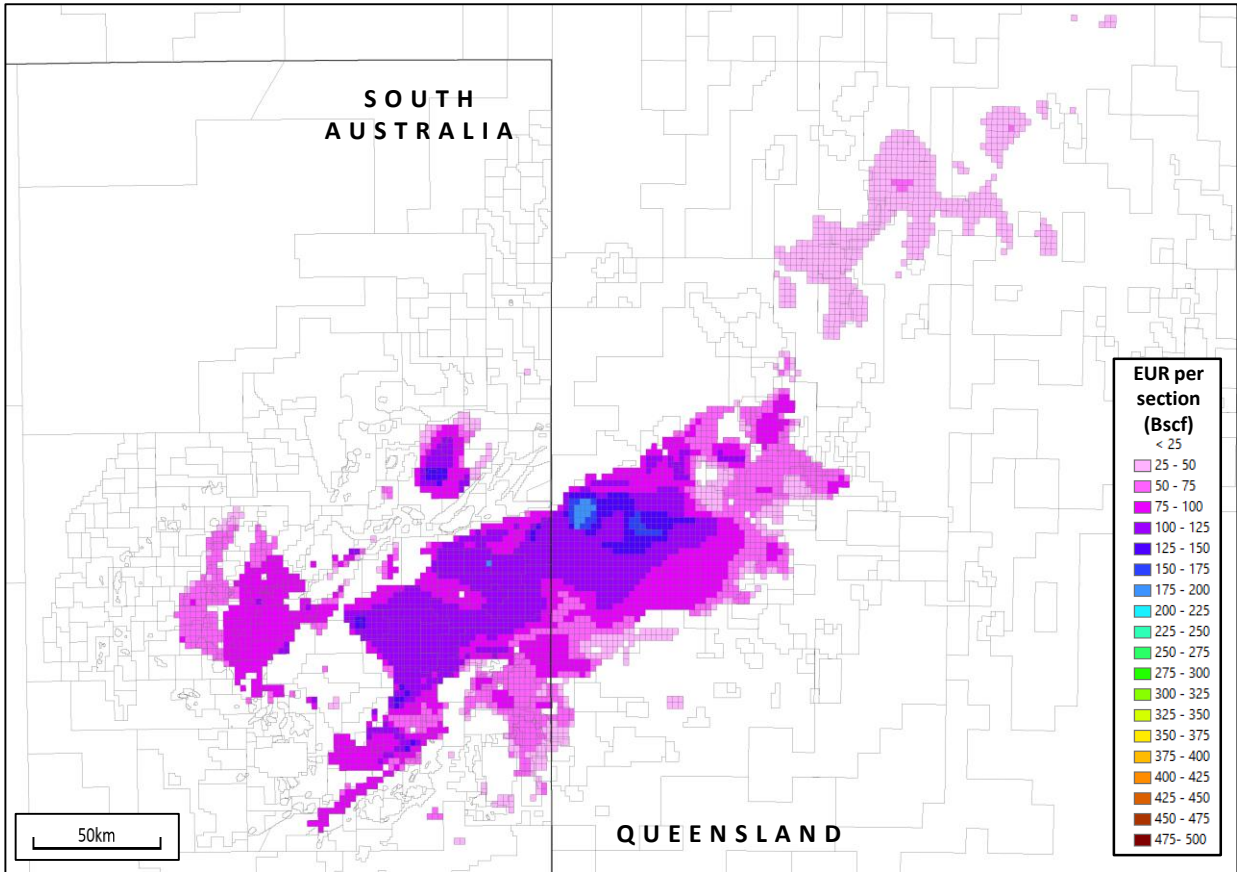
149 Tcf

294 Tcf

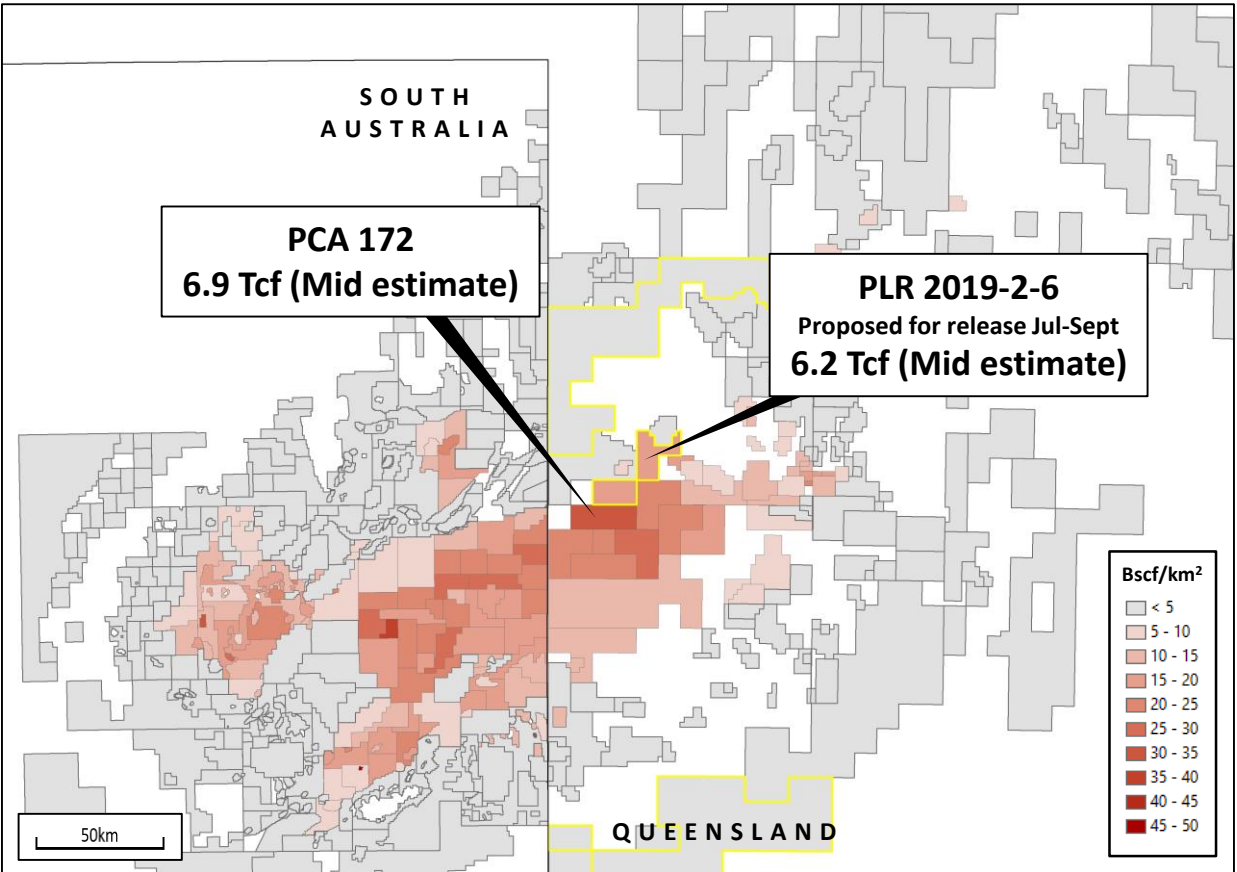
Cooper basin resource totals by permit area



Cooper Basin total unconventional prospective resource potential at \$8/GJ by grid cell



Cooper Basin total unconventional prospective resource potential at \$8/GJ by permit area



- Proven unconventional systems are typically extensions of conventional petroleum systems
- Heterogeneity is key. Resource potential is tied to wells drilled – which is tied to demand and pricing. The *'unconventional accordion'*
- Rising gas prices in the Eastern Australian gas market are driving speculation about LNG import requirements for the market. The same speculation occurred in the US in the mid 2000's. The US responded by developing unconventional resources
- We need to quantify and understand Eastern Australian unconventional potential to determine in what gas price environment does it make sense to develop our unconventional resource potential