Play-based exploration in the Cooper Basin: a systematic approach to exploration in a mature basin

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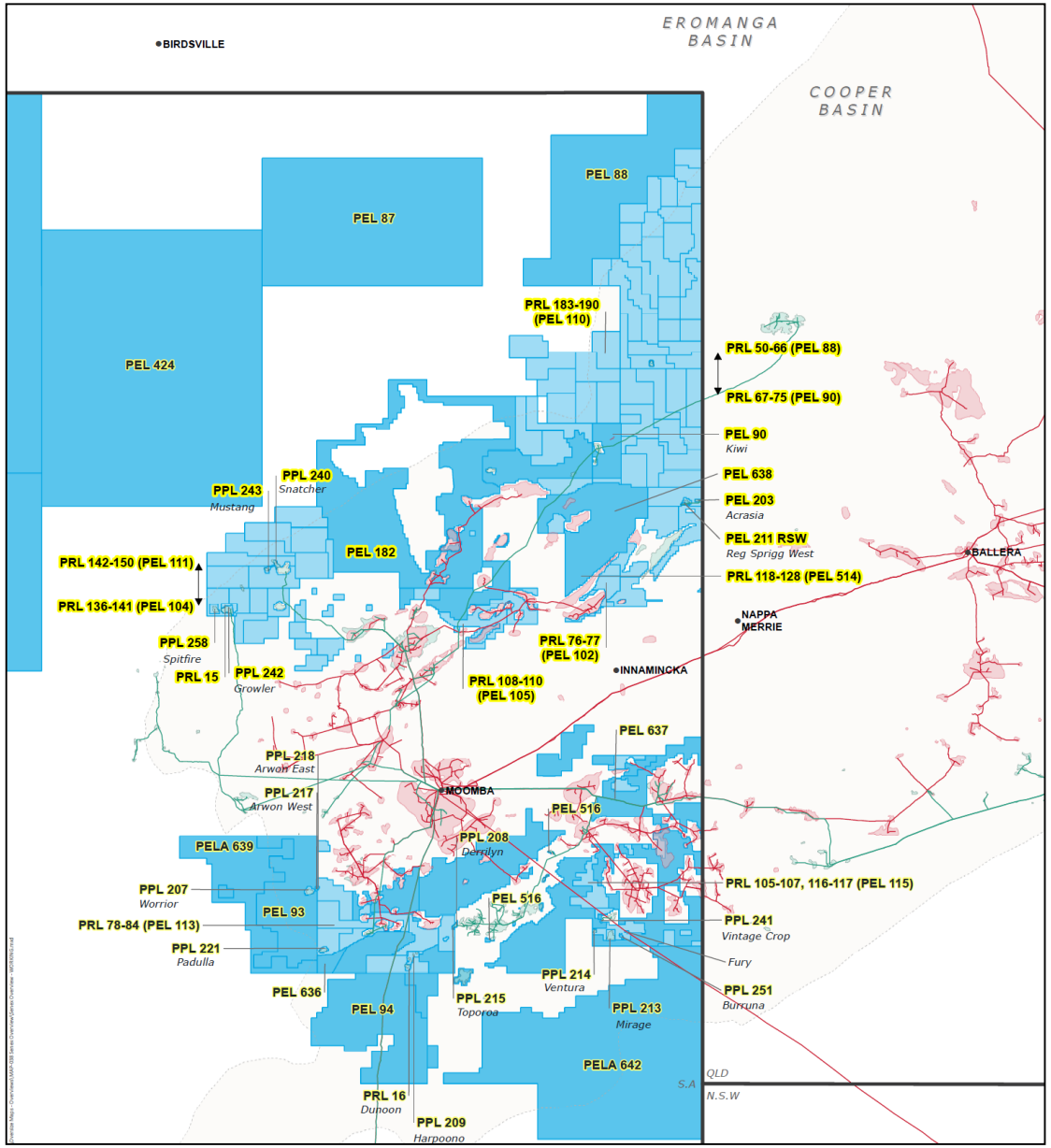
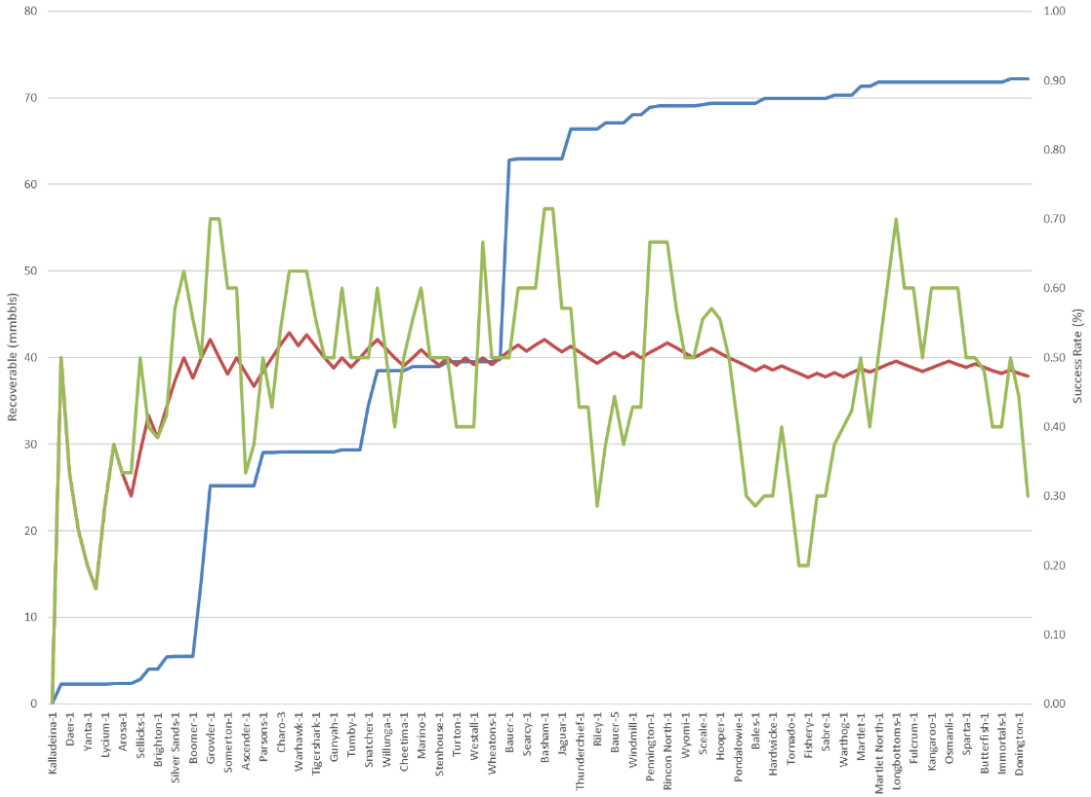
Cooper Basin Exploration



- **Senex** has a **premier acreage** position in the South Australian and Queensland Cooper/Eromanga Basins holding 70,000 km^2
- **Strong operational capability**: operating 14 oil fields & 1 gas field, drilled 80+ exploration wells, acquired material 2D and 3D seismic
- **A plethora of proven and emerging plays** exist within the Senex acreage:
  - High productivity light sweet oil
  - Tight oil
  - Conventional gas
  - Tight gas, and
  - Emerging Deep Coal play

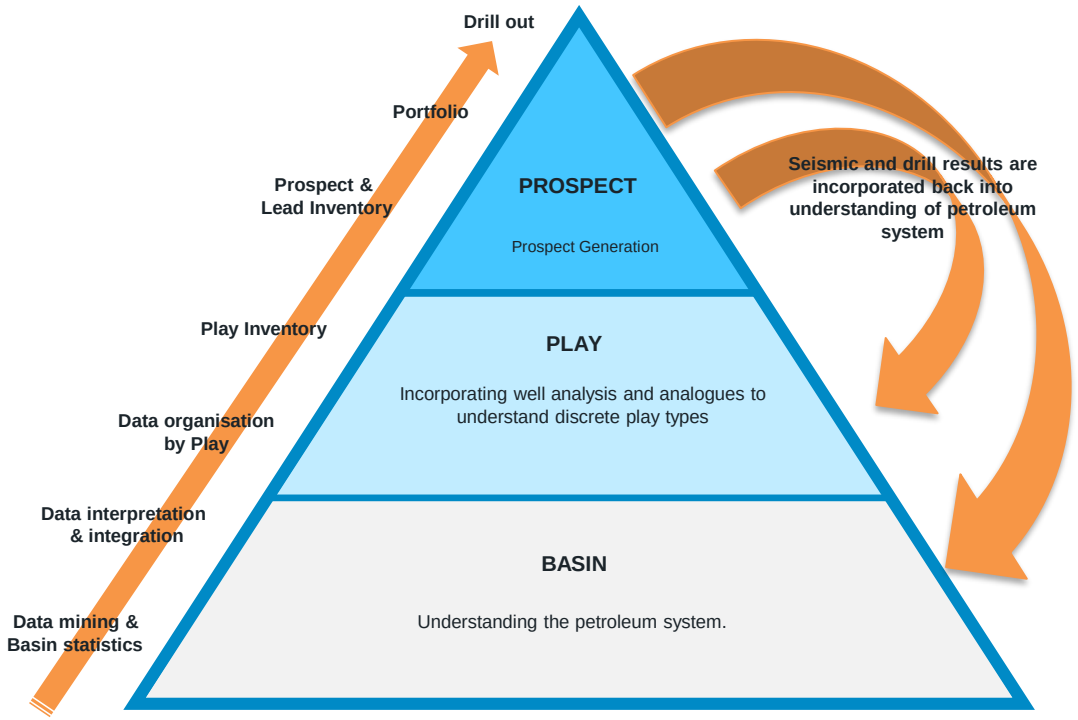
Why Play Based Exploration for Senex

- The business environment:
  - *A disappointing round of exploration in 2014-2015;*
  - *A challenging oil price market;*
  - *A huge acreage position competing for funding with a smaller work force and available capital, and*
  - *Internal competition from our emerging CSG business in the Western Surat Basin.*
- Our approach had to change from **prospecting** to **exploring** as it was obvious that in a very mature basin success rates were in natural decline and the easy targets were gone
- Undertaking a full **play-based exploration approach** to exploration in the basin was proposed and successfully adopted by Senex



General Work Flow with Products

The fundamental elements or building blocks of the PBE methodology are represented by the PBE Pyramid. It is organised into levels of Basin, Play and Prospect focus with appropriate key inputs and activities identified.



Basin Scale

- Initial data mining and loading into software
- Initial wagon wheel construction
- Creaming curves, success rates and statistics
- Regional seismic mapping
- Structural Elements
- Regional Basin Model
- Play selection

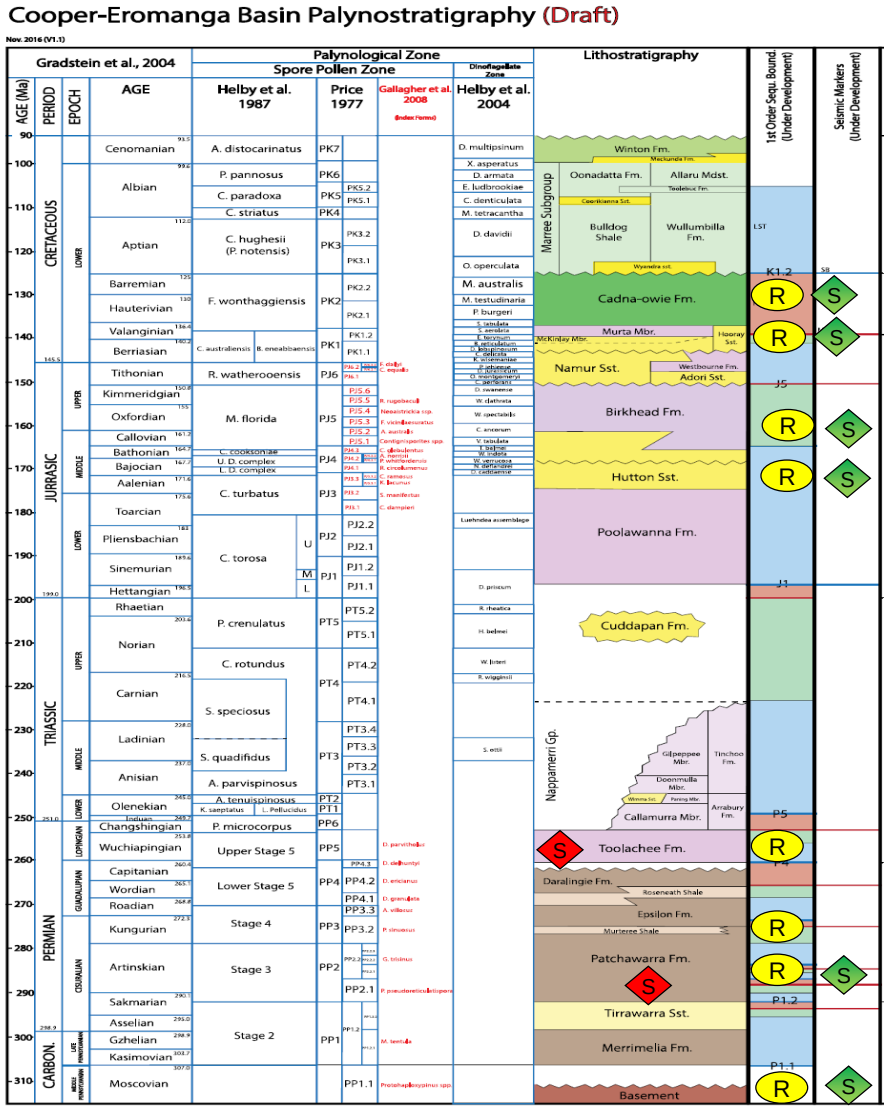
Play Scale

- Detailed well analysis
- Basic petrophysics (Poro/Perm, Porosity vs depth, spatial trends etc.)
- Gross Depositional Environment (GDE) maps
- Common Risk Segment (CRS) maps
- Reintegration into basin model
- Concept and leads identified
- Use CRS maps and scouting volumes to high-grade areas

Prospect Scale

- Detailed local mapping
- Detailed local basin model
- Volumes and risk calculated
- Portfolio created
- Drill candidates selected

Cooper/Eromanga Basin Stratigraphy



Source Rocks:

- Dispersed dominantly terrestrial (Type I, III kerogens)
- Mixed oil and gas potential

Reservoirs:

Clastic Reservoirs

- CadnaOwie reservoir
- Murta transgressive sheet sands, not laterally continuous regionally, highly effected by diagenetic cements
- Birkhead and Hutton reservoirs
- Patchawarra meandering rivers within coal and mire swamps
- Toolachee meandering rivers within coal and mire swamps
- Murta channels and distributary mouthbars
- Potential for an Epsilon sheet sand

Seal:

- Birkhead seal MFS at the Birkhead transgression
- Murteree regional seal which is a MFS shale thick and laterally extensive, key for the Patchawarra top seal
- Evidence for intraformation seals within the Patchawarra as presented Marilea-1

Structure & Traps:

- Fault blocks, fault propagation folds Stratigraphic traps of primarily anticlinal structures drilled to date
- pinch-outs and wedges in the Patchawarra

Basin statistics and play analysis

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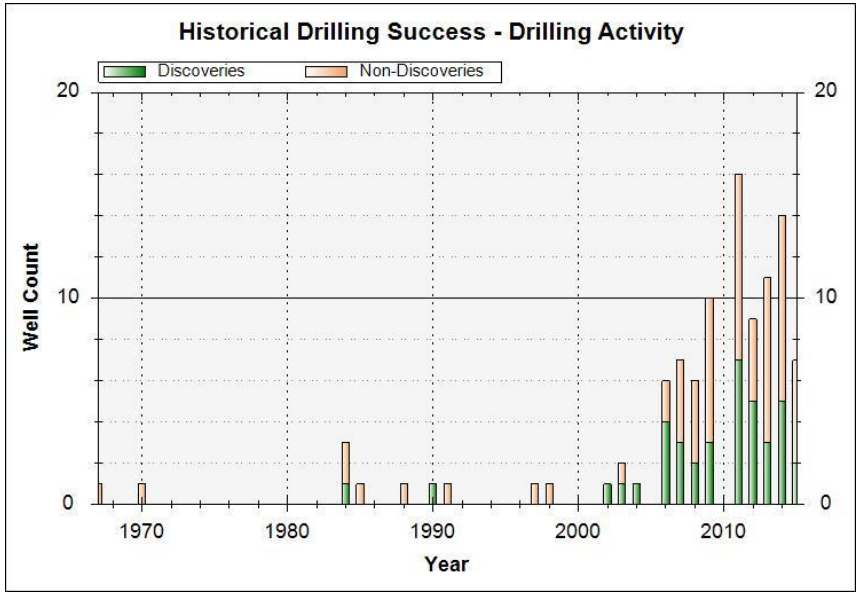
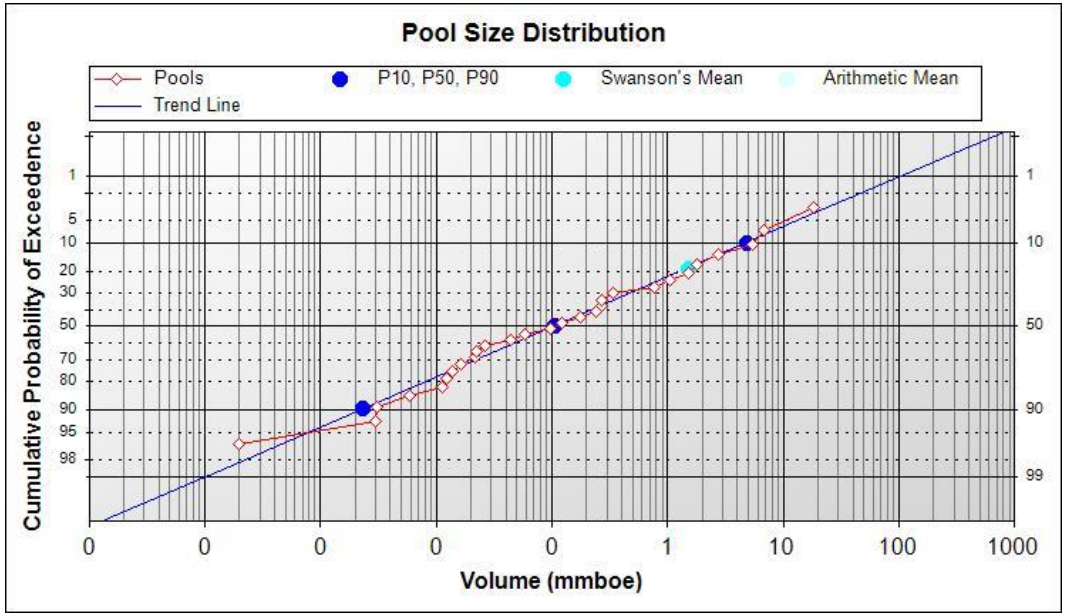
Basin and Play Statistics

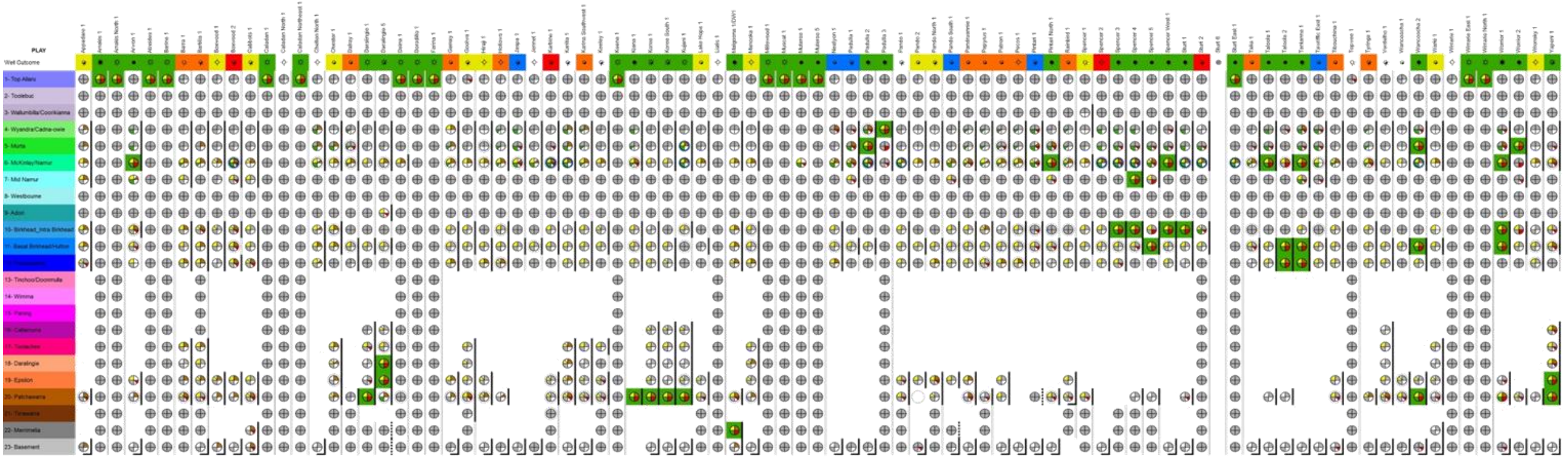
- Sense checking against play statistics quickly sets the tone for expectation and allows the identification in gaps
- Exploration histories
- Creaming curves
- Field size distribution analysis

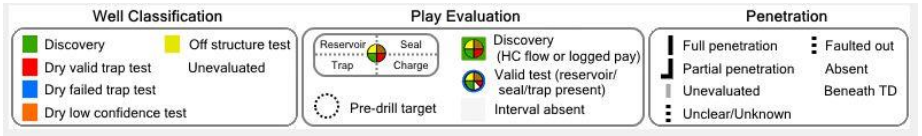




Well Failure Analysis the Wonderwall

- Easy to see trends in the data when all wagon wheels are plotted (green boxes are successes)





Regional reservoir analysis and Gross Depositional Environment construction – multiple plays

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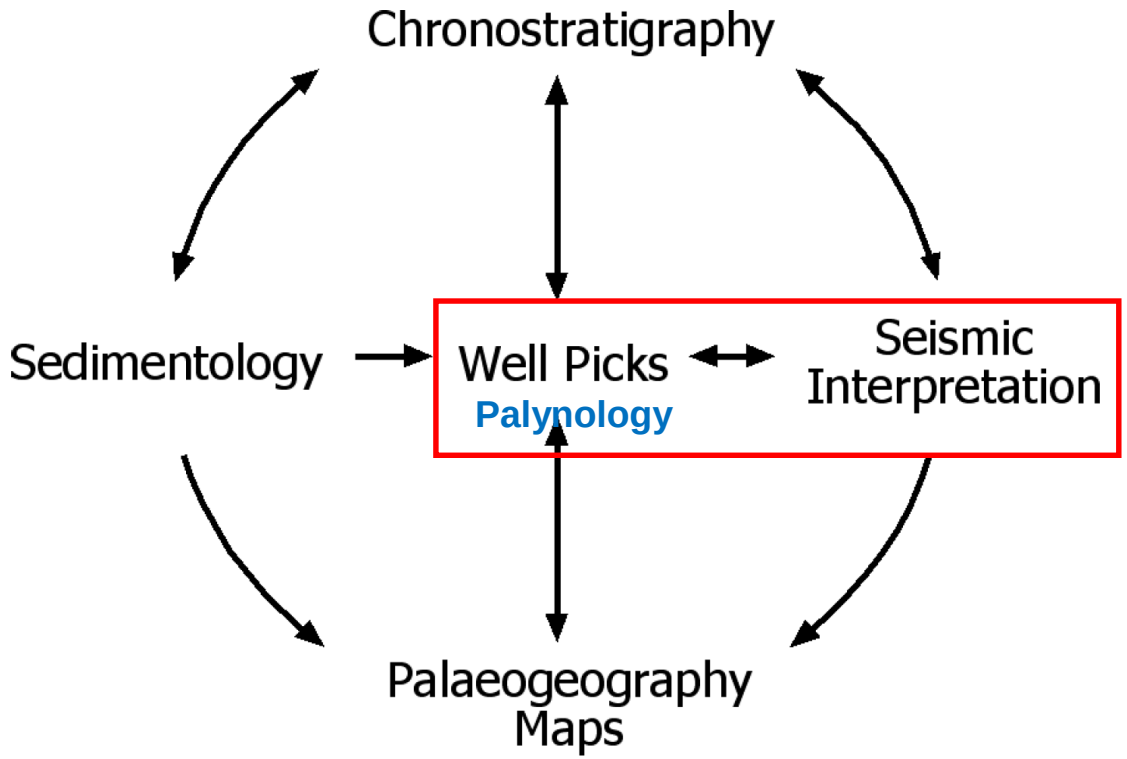
GDE Workflow

Multidisciplinary Workflow



- Many iterations between each step!

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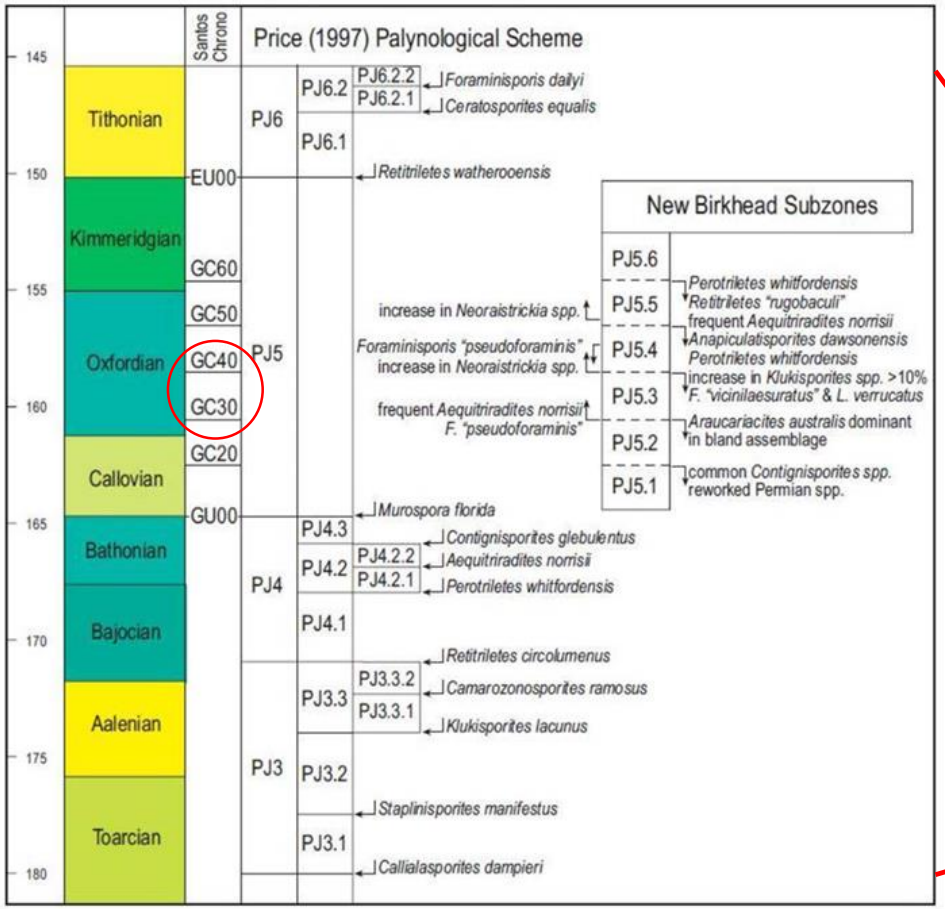
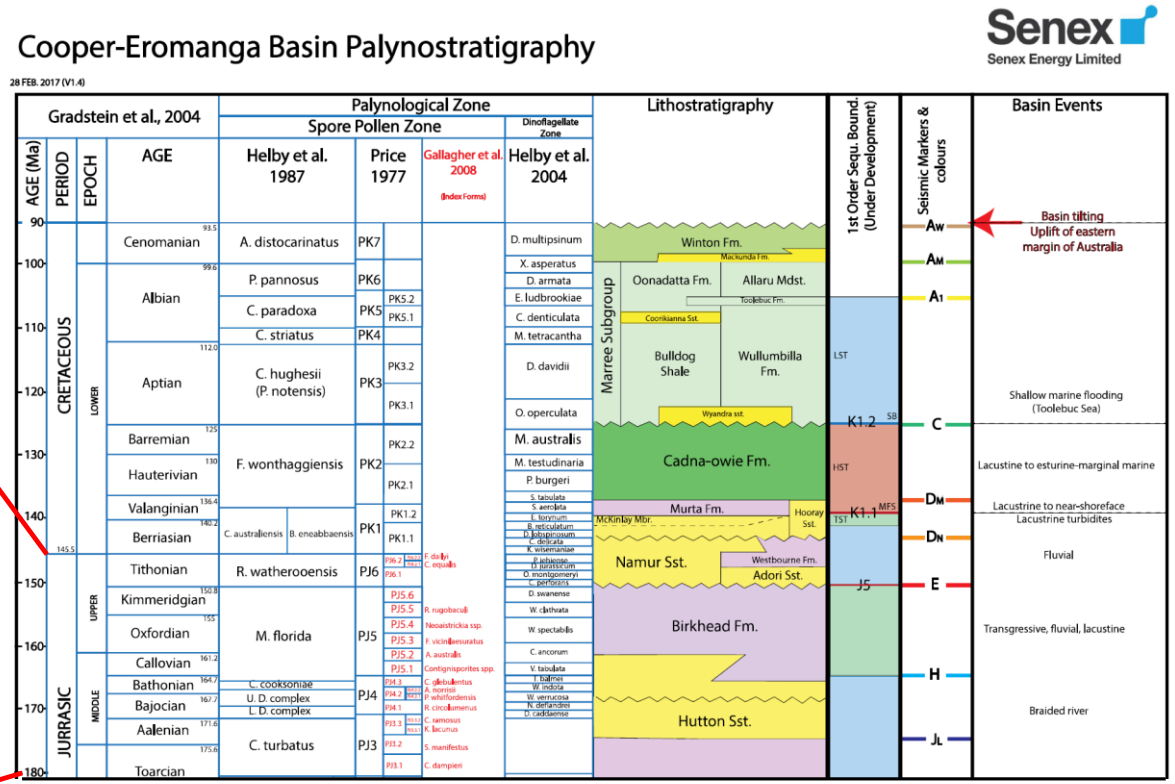
An Example: Birkhead Formation Sequence Stratigraphy

- Gallagher et al., 2008 scheme has already been adopted as the basis stratigraphic sub-division of the Birkhead
- Continuity with partners and other Operators in the region allowing excellent basis for regional correlations



Gallagher et al., 2008



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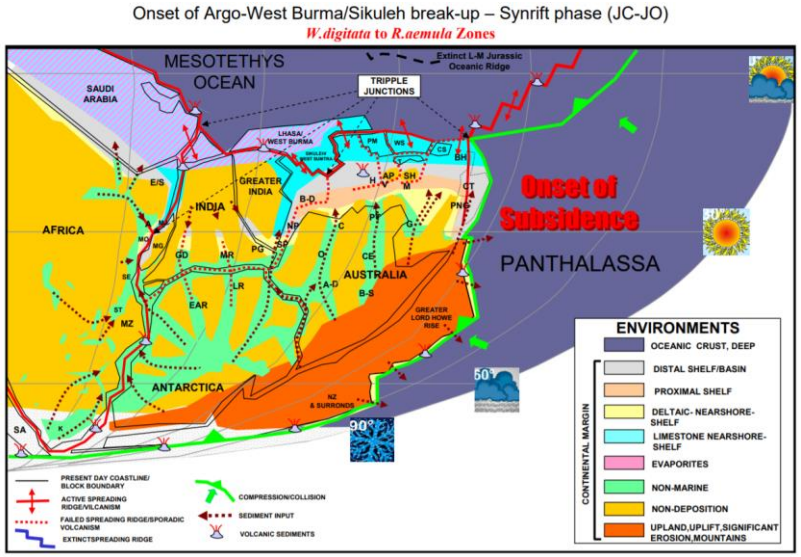
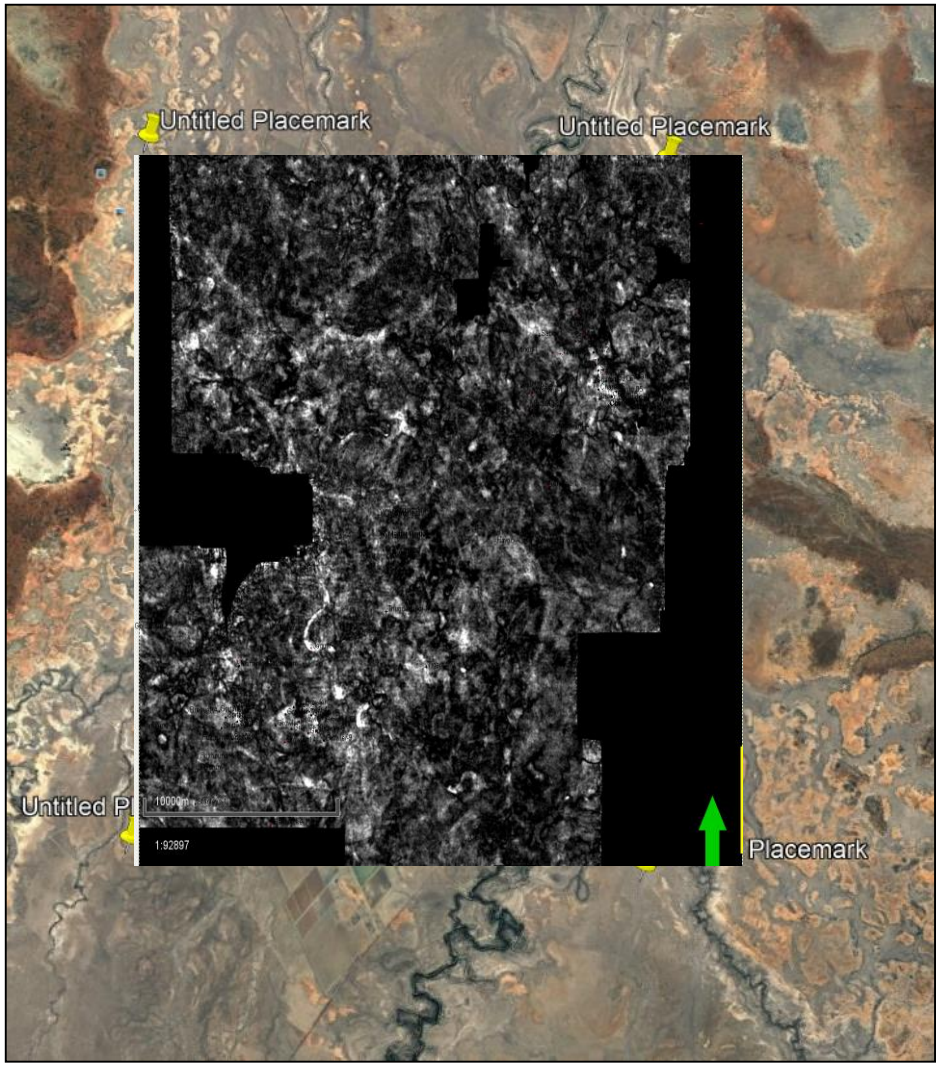
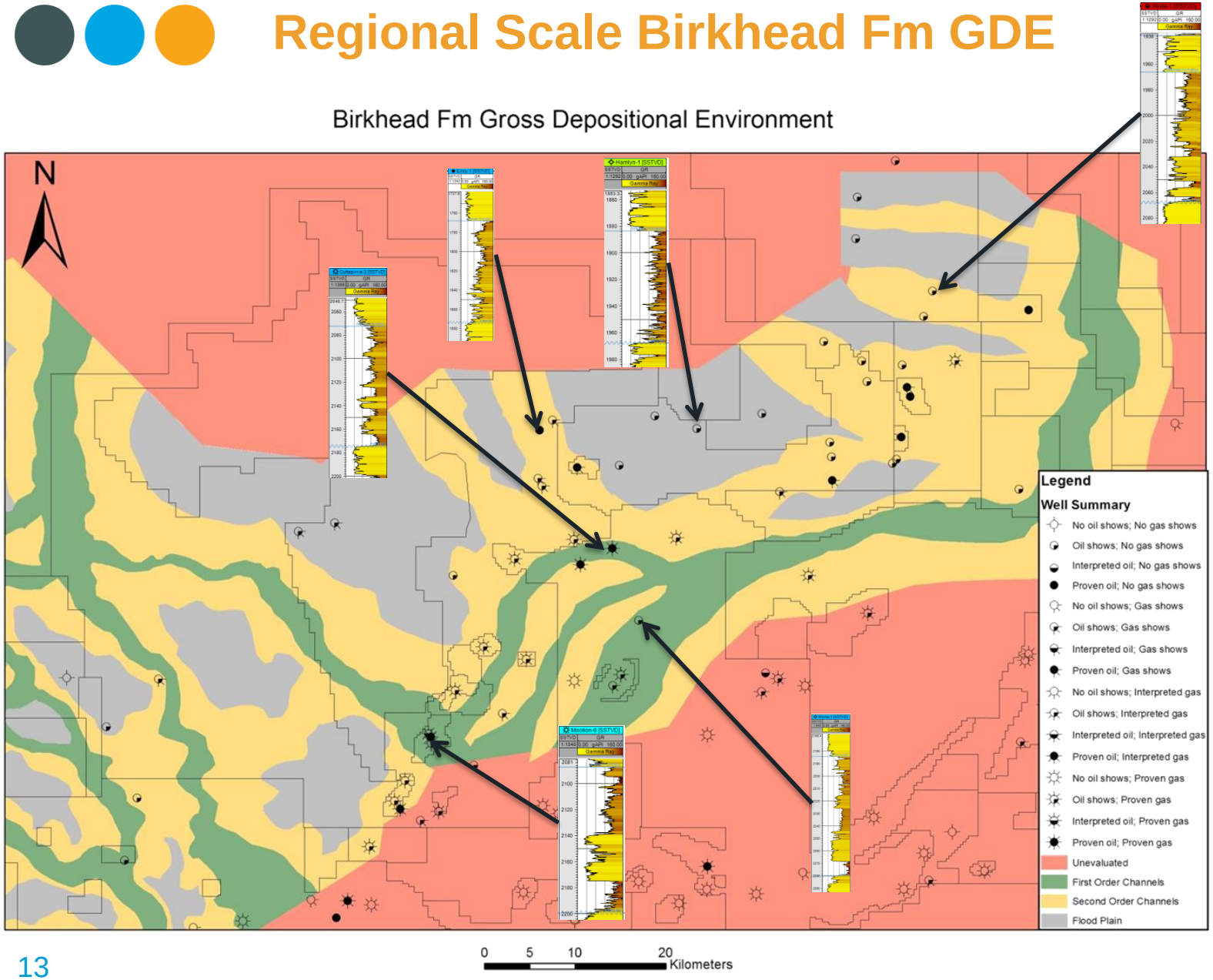
Gross Depositional Environment Maps - Analogues

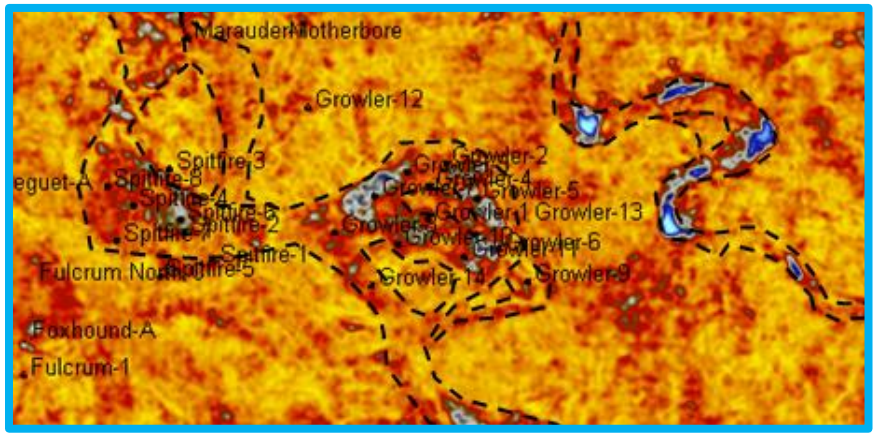




Regional Scale Birkhead Fm GDE



- Spectral decomposition, Well logs and isopach maps integrated to create a broad regional and prospect scale Gross Depositional Environment map of the Birkhead Formation



Charge Analysis

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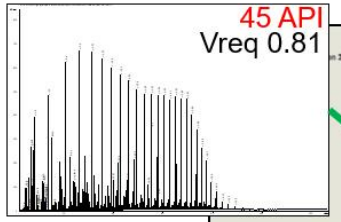
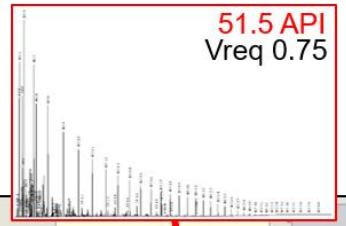
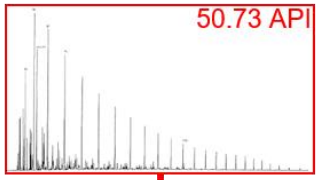
3D Basin Modelling

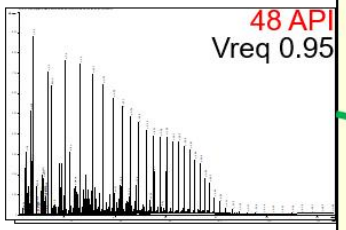
- Senex has developed a 3D Trinity model incorporating Senex mapped regional depth grids and all available source rock data including;
  - Source rock thickness maps derived from well isopachs and a review of basin-wide pyrolysis data for initial HI and TOC
  - Several hundred wells calibrated for present day temperature, Vr, Tmax, FAMM and fission track considerations
  - Estimated uplift and erosion and measured kinetics (in some cases from resampled wells)
- Gross Depositional Environment maps have also been incorporated as pseudo-facies maps for migration considerations (lateral and vertical migration)
- To account for uncertainty in the charge model (given the inherent spread of uncertainty throughout the inputs) a pseudo-Bayesian approach has been used
- The subsequent charge risk maps are the result of 27 iterations of Trinity charge maps for low, mid and high cases
- The model has been calibrated and produces a good fit with observed fill-spill relationships and hydrocarbon shows

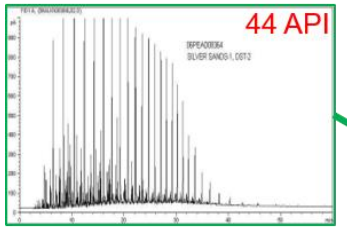
Charge

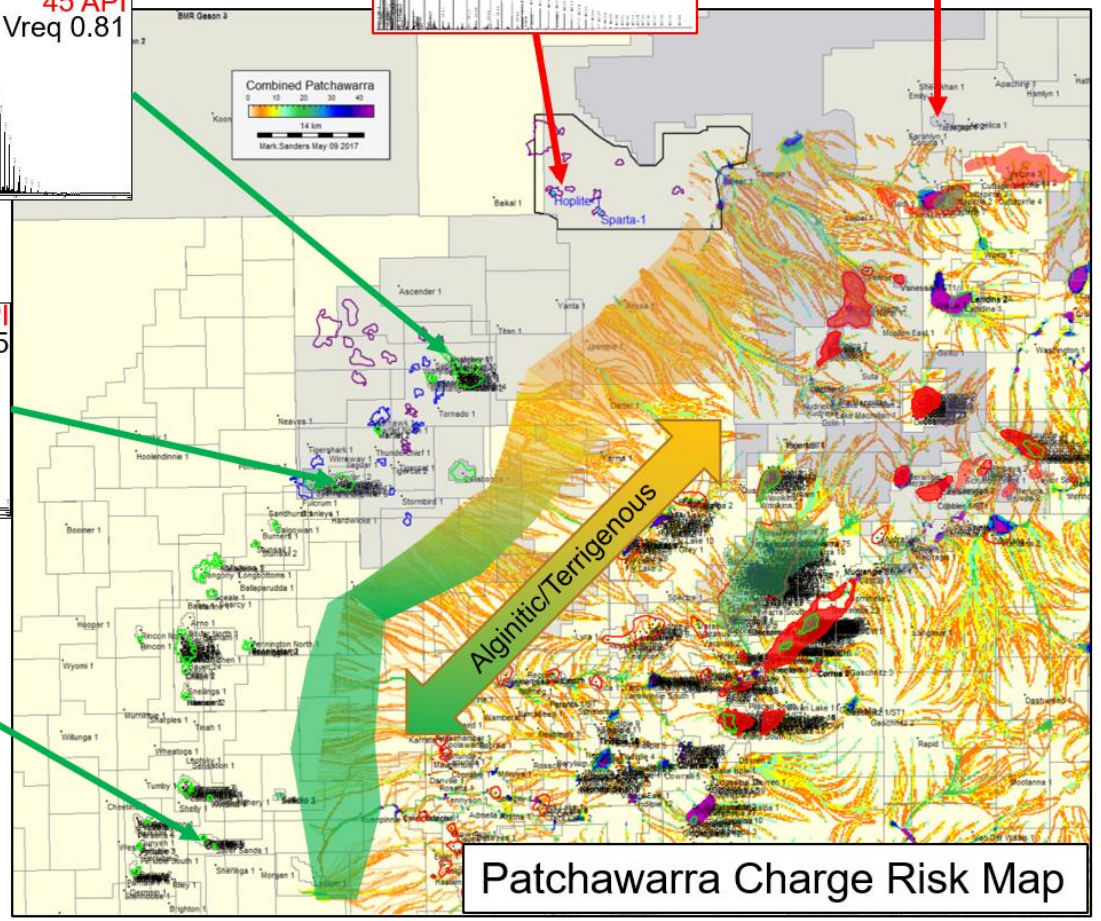

45 API
Vreq 0.81

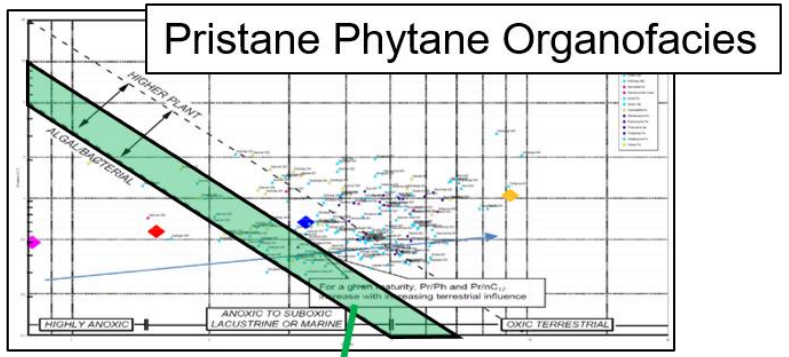

51.5 API
Vreq 0.75

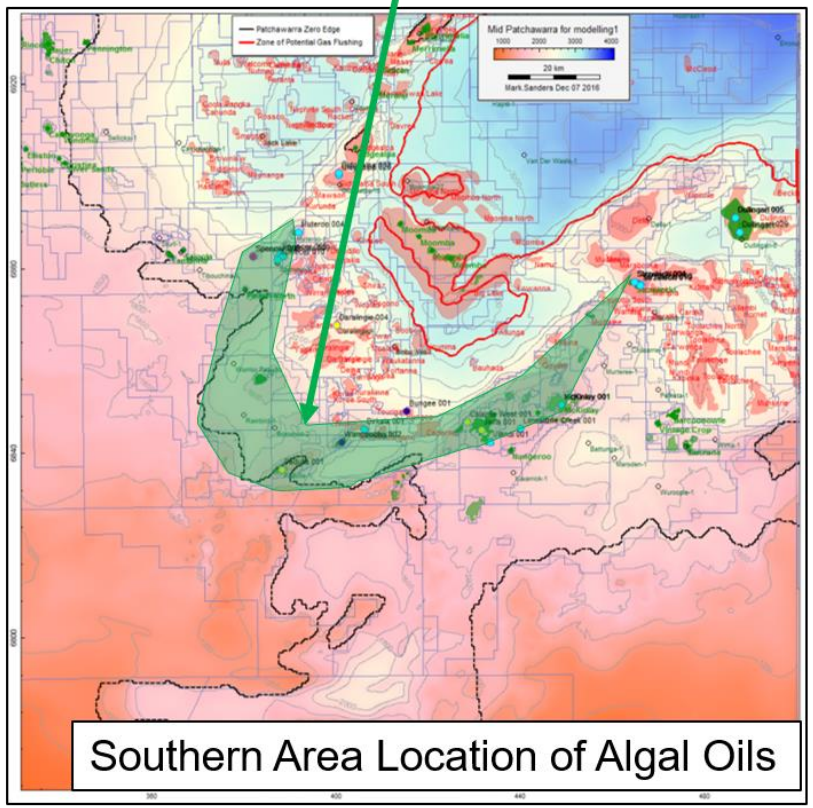

50.73 API


48 API
Vreq 0.95


44 API

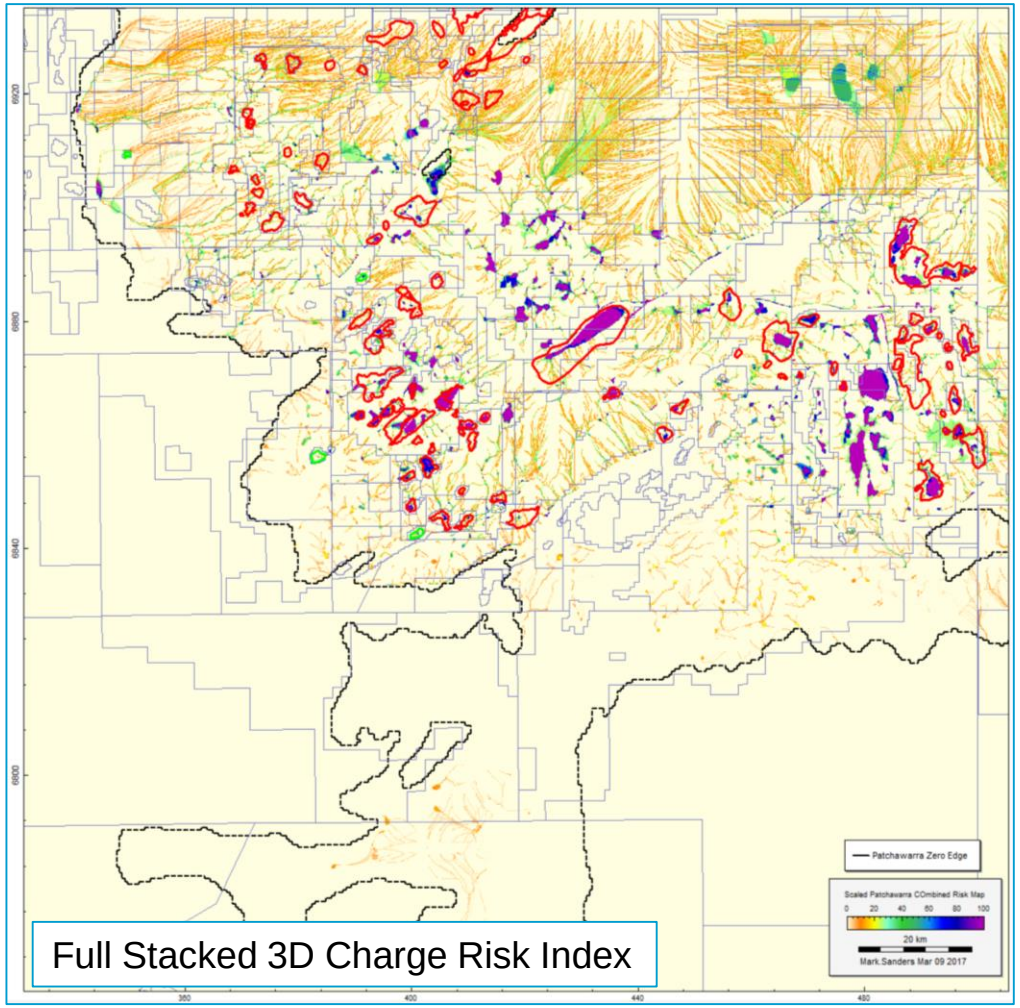

Combined Patchawarra
Hopliter
Sparta-1
Alginitic/Terrigenous
Patchawarra Charge Risk Map


Pristane Phytane Organofacies
HIGHER PLANT
ALGAL/BACTERIAL
HIGHLY ANOXIC
ANOXIC TO SUBOXIC LACUSTRINE OR MARINE
OXIC TERRESTRIAL

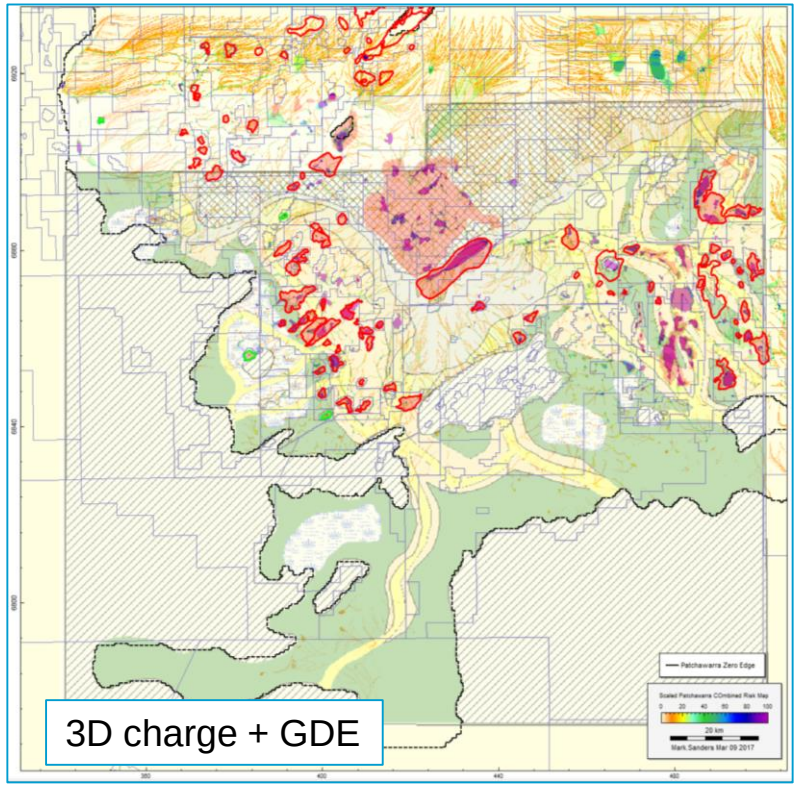

Patchawarra Zero Edge
Zone of Potential Gas Flushing
Mid Patchawarra for modelling1
Southern Area Location of Algal Oils

Full Stack, Weighted, Scaled Charge Model

- Patchawarra



Full Stacked 3D Charge Risk Index



3D charge + GDE

- **Calibrated to discoveries**

Common Risk Segment Maps

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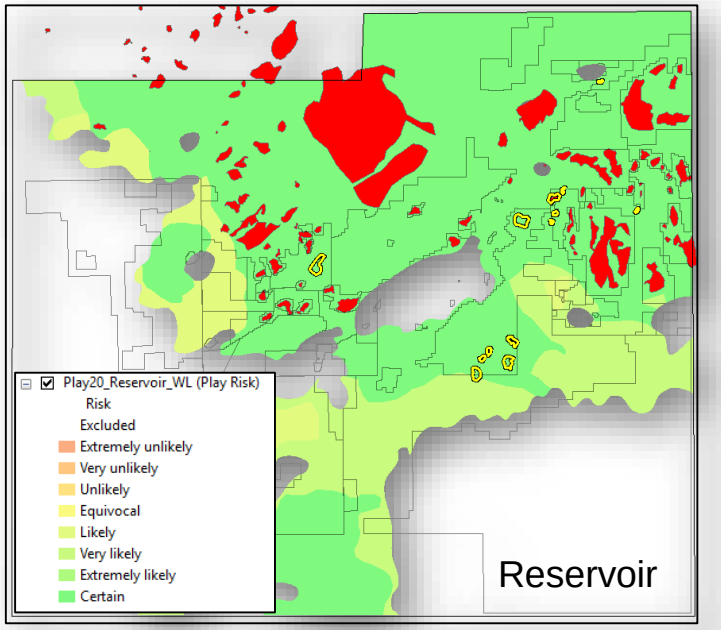
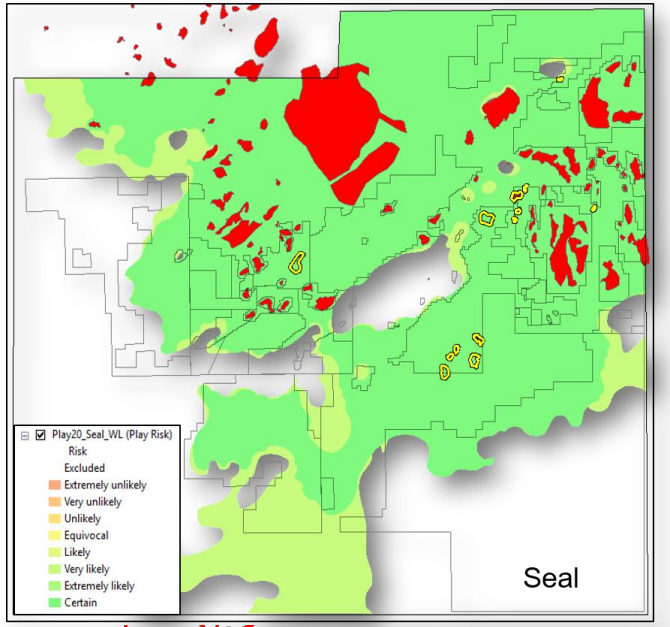
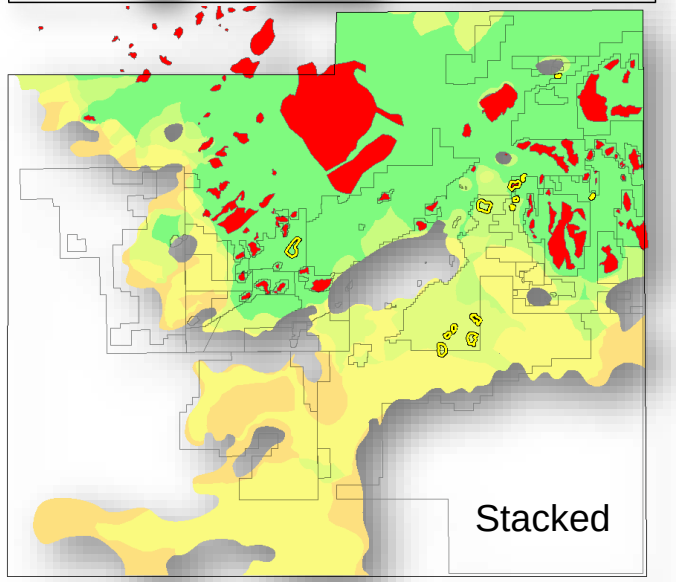
Patchawarra Formation – CRS

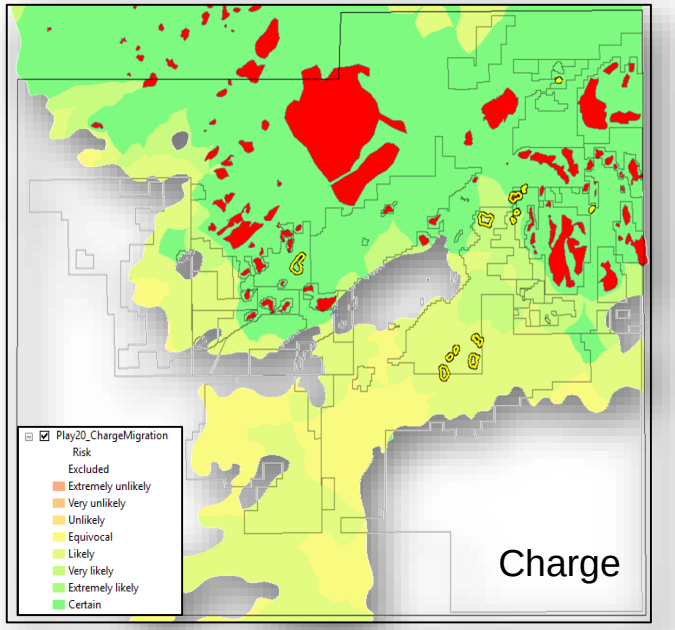


X





X



How Senex uses our PBE evaluation

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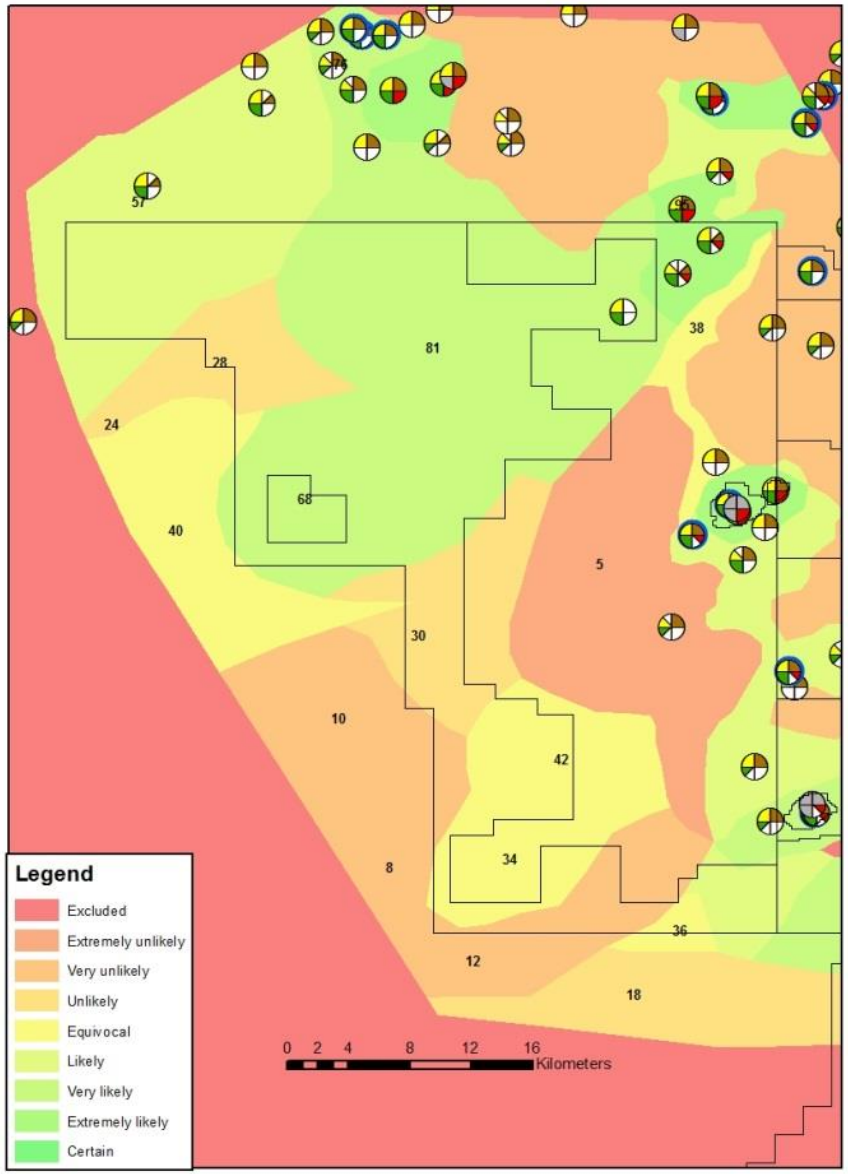
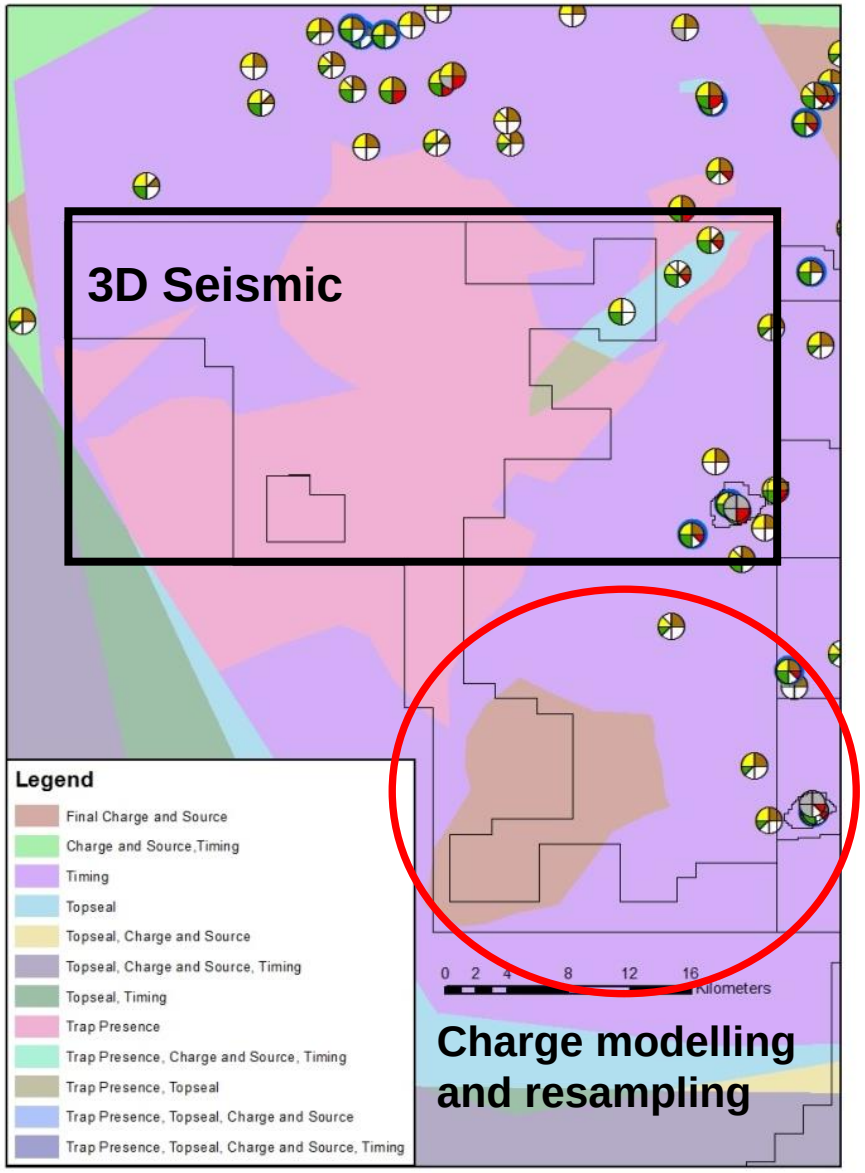
Critical Risk Maps and Work Program Design

McKinlay/Namur Final Stack (Play Risk)



McKinlay/Namur Final Stack (Overall Risk)



- Final stacks can be turned into critical risk maps
- This shows the critical risk (minimum risk value) for each area
- These maps are critical for defining work programs
- In this example the trap presence was identified as the key risk in the north – therefore a program of 3D seismic has been planned.
- The key risk in this area is charge; a geochemical sampling program was subsequently undertaken to de-risk the charge model

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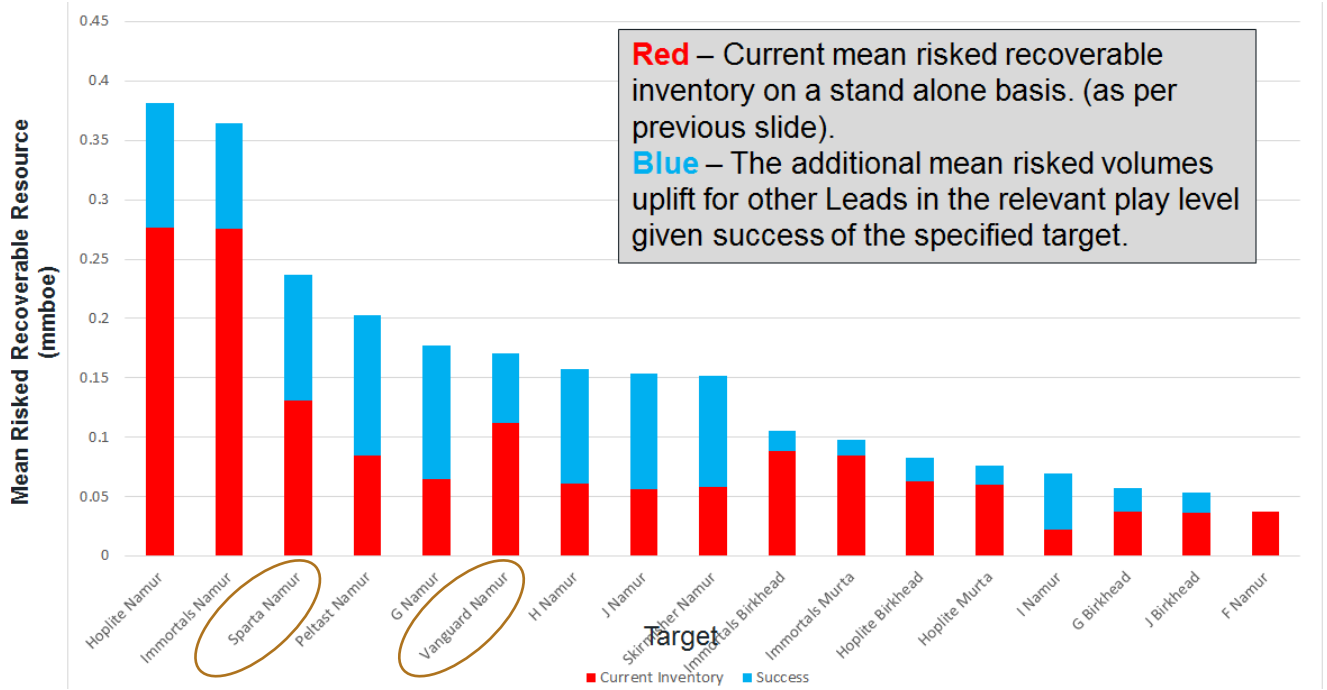
CRS Maps and the Impact on Portfolio

- CRS maps also have an impact on the portfolio in the form of success volumes
- When multiple prospect fall within the same CRS polygon they can be positively affected by success of another related prospect
- If success occurs in a polygon the play chance becomes 100% which increases the Pg of the other prospects
- In this example the Sparta and Vanguard prospects have similar risked recoverable volume but Sparta would have a greater impact on other opportunities and was therefore elevated in the portfolio



Conclusion

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The Impact of PBE on Senex Exploration

- **Systematic Exploration Approach** allowing a **consistent** risking methodology and volumetric assessment across the portfolio
- **Value creation** by ranking acreage across the basin and providing a technical sound perspective for future new ventures and commercial activity
- Allows **efficient allocation of capital resources**
- A balanced drilling campaign; enables a **strategy** of low risk-high reward NFE providing near term production to be complimented by high reward moderate risk exploration **for future growth**
- **Eliminates expenditure** on low reward high risk areas within the portfolio **by identifying areas for divestment**
- Developed a **methodology and work flows** which can be used for new basin entry and **proactive business development** with the knowledge that there is a **valid comparison with the existing portfolio**

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