



GIS PAX

GIS packages for exploration success



PLAYER



PLAYHOUSE



PLAYPEN



**THE "NEW"/REDISCOVERED LIQUIDS
RICH OFFSHORE CANNING - WHY ITS
THERE AND ARE THERE ANY MORE
HIDING OUT THERE?**

IAN Longley, JOHN BRADSHAW, Peter Purcell



Outline

1. Introduction
2. The NW Shelf projects
3. Why the South Phoenix area works
4. Delta Top Ponding
 - Concept
 - Sahul/Plover Example
 - Beagle/Dampier/Legendre Example
5. Remaining Potential/Summary



Introduction

- We have all watched with great interest the Carnarvon/Quadrant exploration program in the Bedout Sub-basin of the Offshore Canning.. Oil?!! Plus some interesting wet gas volumes.. Which looks like it should be economically viable..

Greater regional prospects and leads

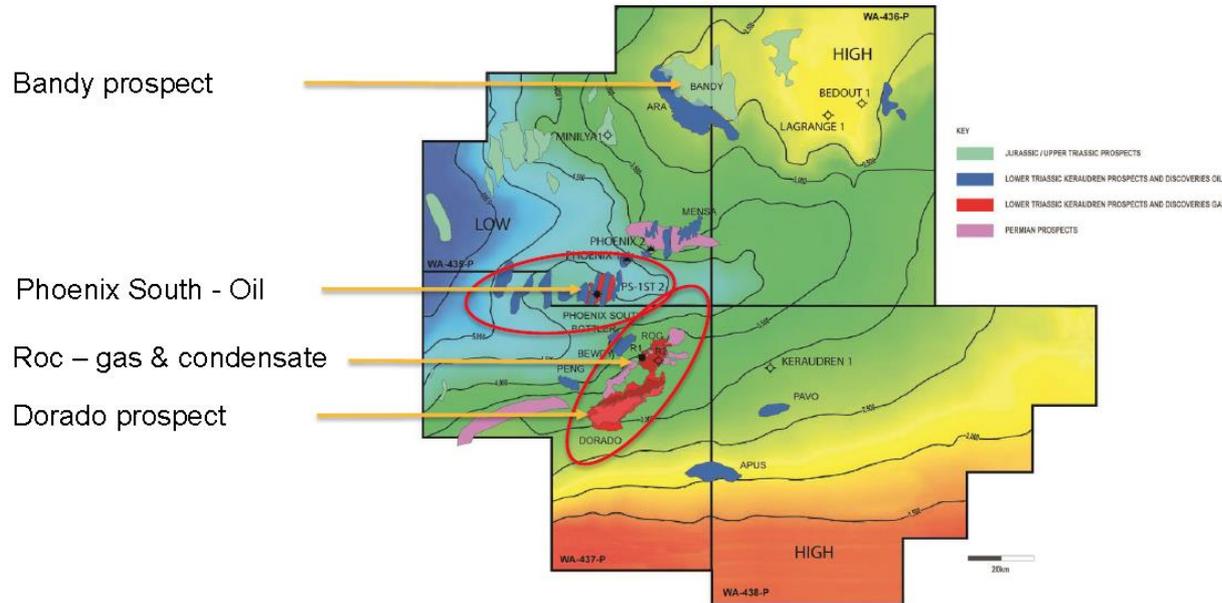
Enormous blue sky

Working source rocks

3D/2D coverage



BASE TRIASSIC / TOP PERMIAN TIME STRUCTURE MAP (MILLISECONDS TWO WAY TIME)





Surprises

- No-one (I know) saw the HC/oil potential
 - I saw the wet gas/oily mudlog shows that looked interesting but never made the connection..
- No-one (I know) expected the reservoir potential to be so effective at such depths..
- Which is all great but the main interest to us is why is the area liquids rich when most of the Triassic is lean or dry gas source at best??



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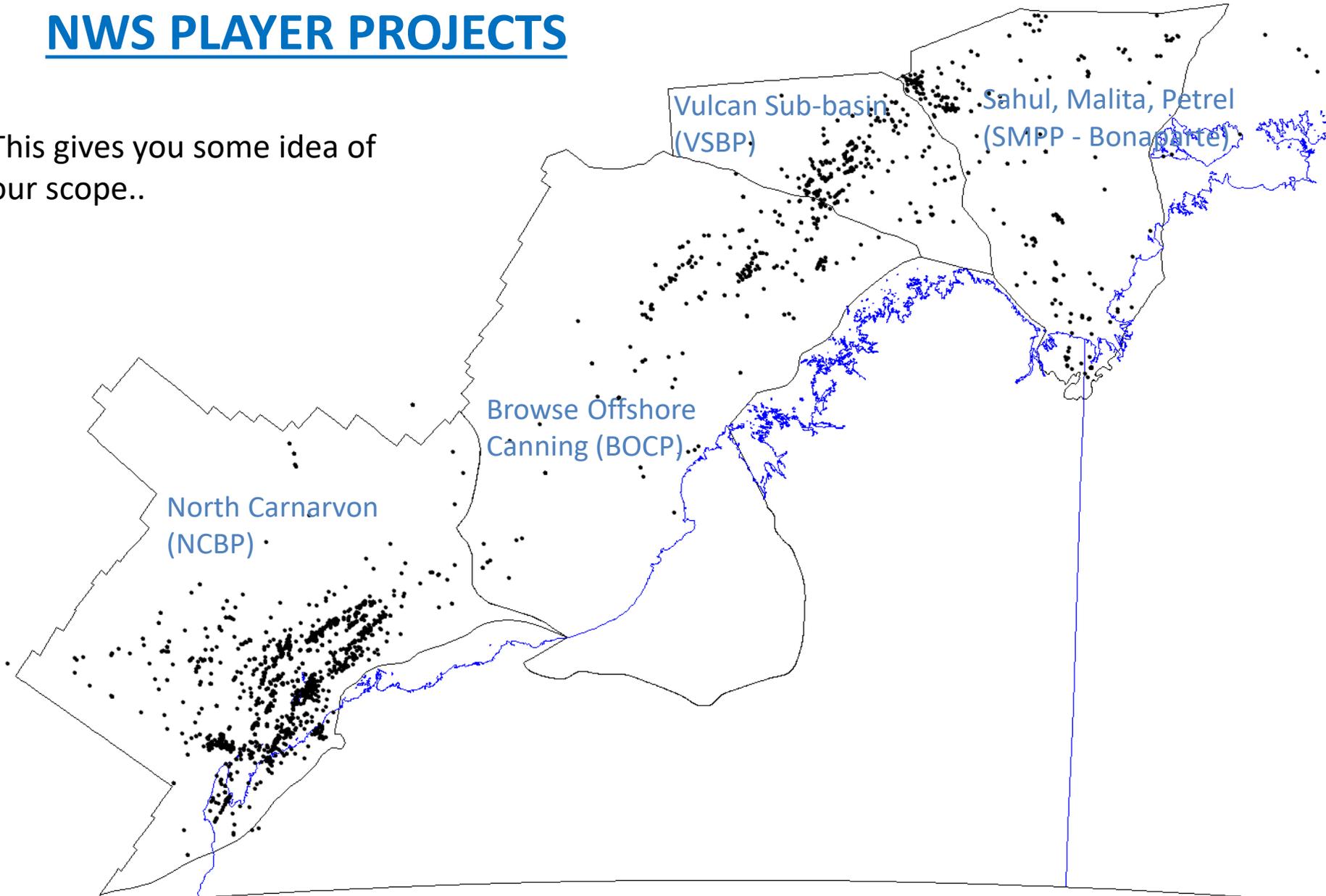


The NW Shelf Projects

- Some background...
- I spent ~12 years as a geo at Woodside (96-07) working the NW Shelf mainly doing gazettal rounds/ new business and regional studies – John B was my equivalent at GA doing their regional studies...
- In 2011 when I was starting my Player Software rollercoaster ride (aka Ian & Tom's Excellent Adventure) we were selling the software to companies along the Terrace and they liked it but asked us to populate the data from open file sources. I then partnered with John and others to do this..
- 5 years later we have a unique comprehensive database of well and seismic data along the whole margin which most older people over 50 would call “framework or regional studies” i.e. things that most companies stopped doing a decade ago..
 - Many companies have bought these studies over the years and we maintain them annually to help new customers evaluate the gazettal round offerings

NWS PLAYER PROJECTS

This gives you some idea of our scope..



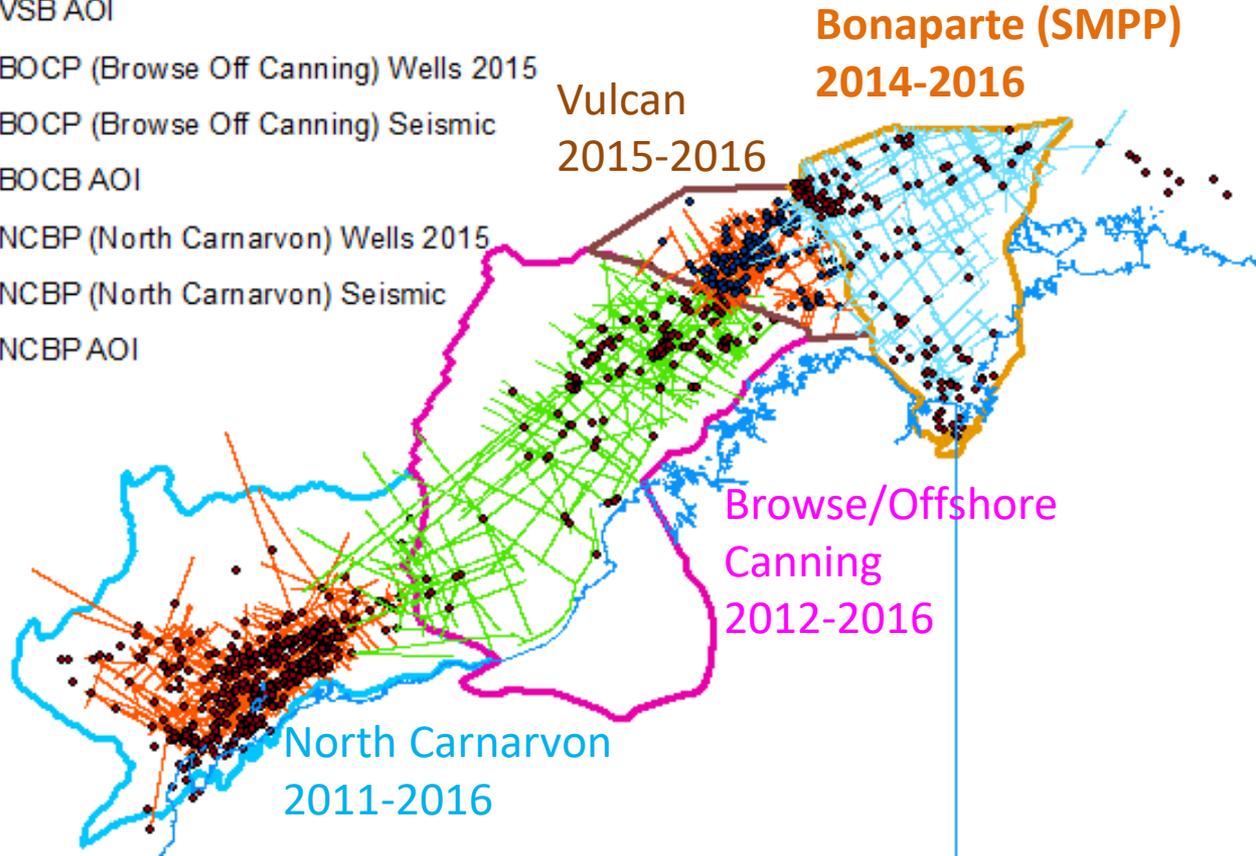
Plaver NWS Proiects

- Essentially every exploration well in each basin has been tied to seismic, and the databases compiled and corrected;
- Post Drill audit (failure/success) of every exploration well
- Every field described with volumetrics and characteristics;
- Play risk maps made for every prospective interval

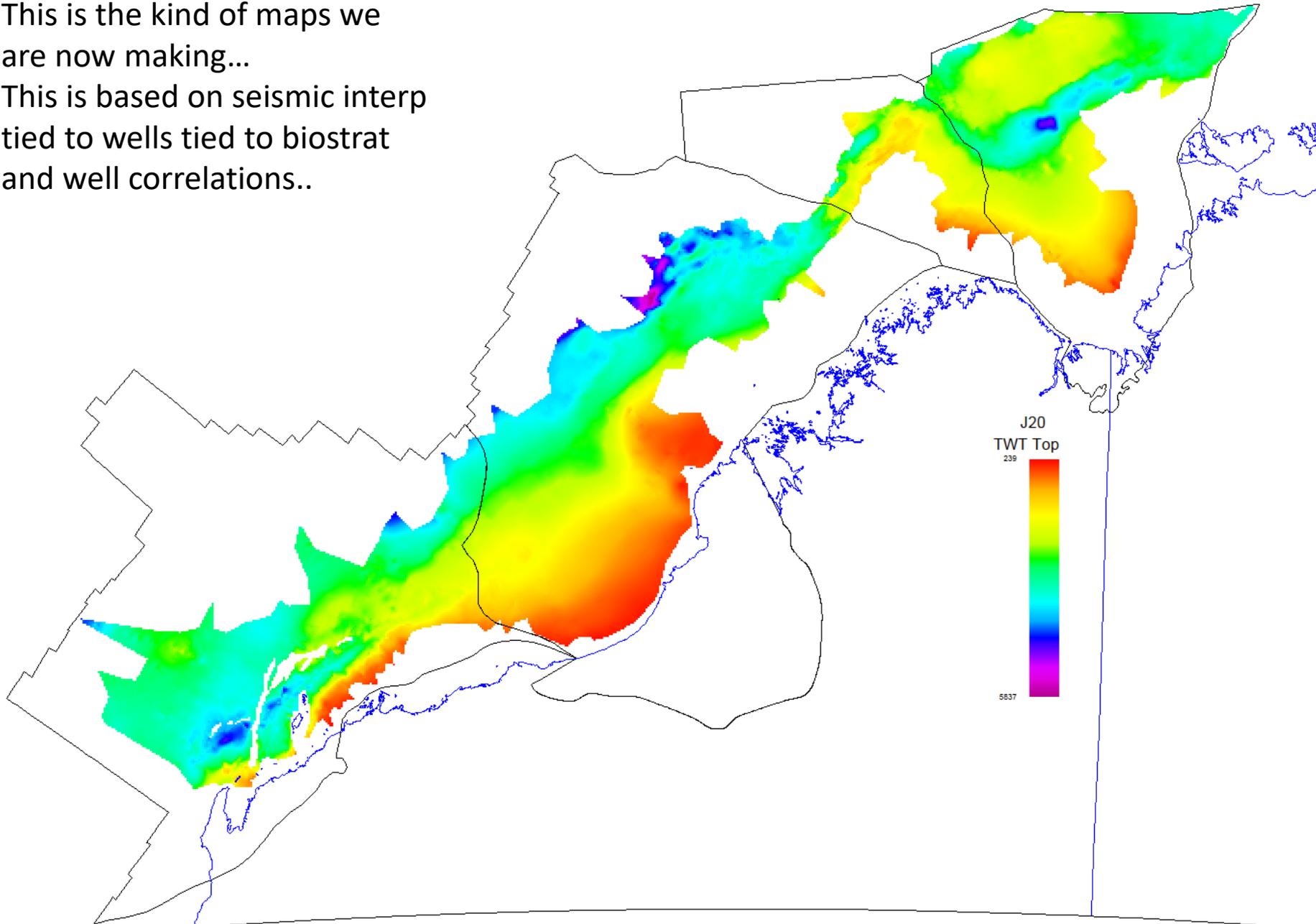
Legend

- coastline
- SMPP (Bonaparte) Wells 2015
- SMPP (Bonaparte) seismic
- SMPP AOI
- VSB (Vulcan) Wells 2015
- VSBP (Vulcan) seismic
- VSB AOI
- BOCB (Browse Off Canning) Wells 2015
- BOCB (Browse Off Canning) Seismic
- BOCB AOI
- NCBP (North Carnarvon) Wells 2015
- NCBP (North Carnarvon) Seismic
- NCBP AOI

Note: Vulcan Sub-basin; the interpretive project began in December 2015 and will finalise end 2016



This is the kind of maps we
are now making...
This is based on seismic interp
tied to wells tied to biostrat
and well correlations..

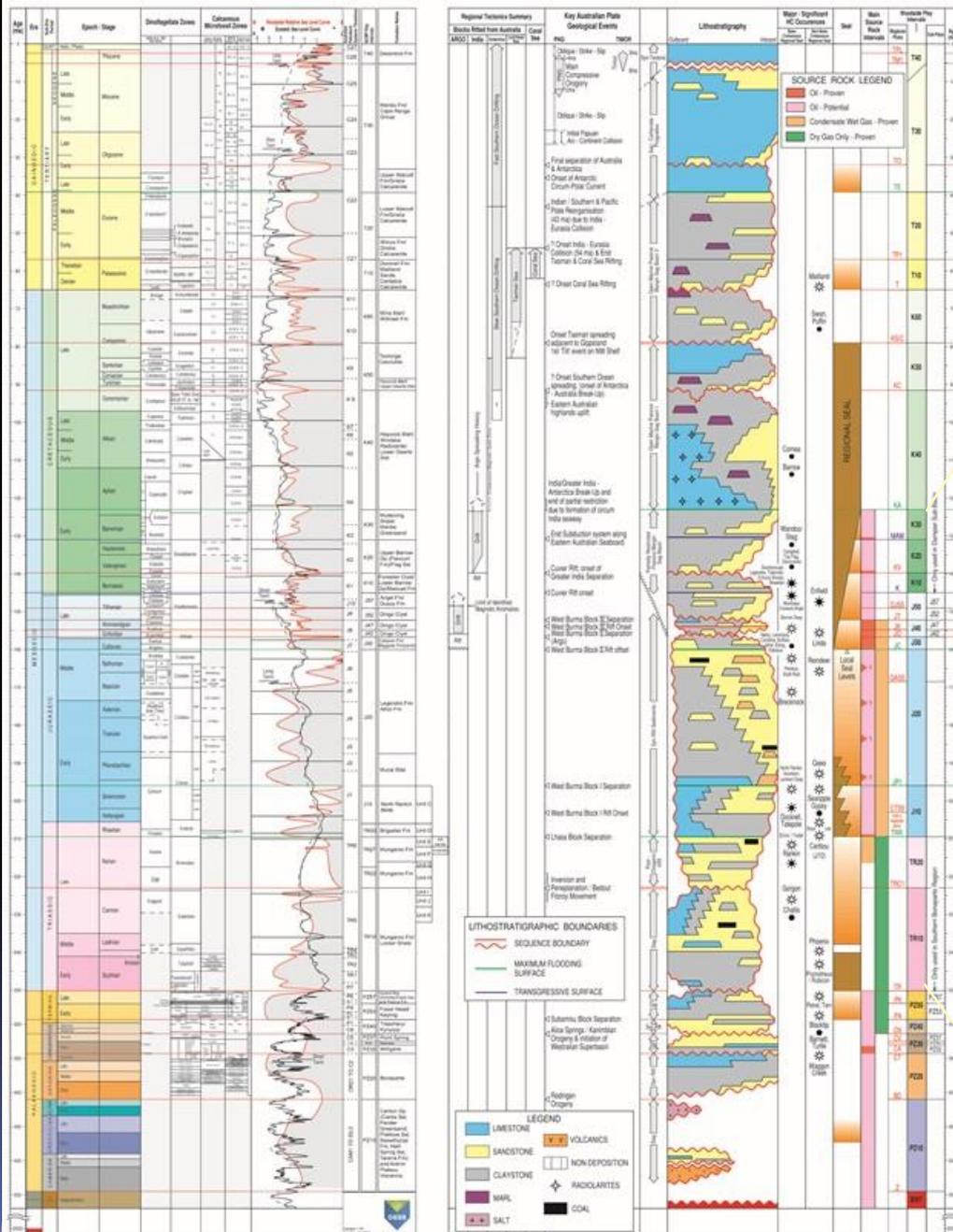


Player Projects Product List - Current

NORTH WEST SHELF REGIONAL STUDY PRODUCT LISTS

Product Delivery List	NORTH CARNARVON BASIN PROJECT (NCBP)	BROWSE OFFSHORE CANNING BASINS PROJECT (BOCP)	SAHUL/MALITA AND PETREL PROJECT (SMPP)	VULCAN SUB-BASIN PROJECT (VSBP)
Fully interpreted KINGDOM © project (loaded into EarthPak and 2D3DPak)				
2D OpenSeis Dataset (requires separate access to License from EDS)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Digital logs (decimated)	279	188	165	165 +
- Others digital logs available for set fee discount	<input checked="" type="checkbox"/>	NA	NA	NA
Play intervals (Woodside terminology)	19	20	29	29
Biostratigraphic data	410 out of 528 well bores	145 out of 222 well bores	142 out of 189 well bores	158 out of 197 well bores
Hydrocarbon shows	285 out of 528 well bores (above level 0 show)	182 out of 222 well bores (above level 0 show)	128 out of 189 well bores	114 out of 197 well bores
Palaeogeographic Maps	all play intervals - 19	all play intervals - 16	21	21
- tied to seismic and wells and of rock volume present/preserved	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Correlated formation/biostrat tops and database	489 out of 528 well bores	130 out of 222 well bores	156	~158
Interpreted seismic horizons	all play intervals plus sub-sets (total 28 horizons)	all relevant play intervals (total 22 horizons)	all relevant play intervals (total 23 horizons)	all relevant play intervals (total 23 horizons)
- regional	~30,000 km	NA	NA	NA
- local	~10,000 km	~ 31,400 km	21,670	12,300
Seismic Grids and Isochores	all play intervals plus sub-sets (total 115 maps)	all relevant play intervals (total 132 maps)	all relevant play intervals (total 124 maps)	all relevant play intervals (total ~100 maps)
Source Kitchen maps (70-120-135-160-200 DEG C)	<input checked="" type="checkbox"/>	33 maps of Isotherms and DegC at Top Structure	14 maps of Isotherms and DegC at Top Structure	~14 maps of Isotherms and DegC at Top Structure
PakNotes - Help, methodology and descriptions	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
- Use of Project (Legals), Seismic Integration, Well Integration, Summary Folio and Poster, Zones and Maps, Biostrat and Shows, Deviation Data, TZ Curve Assignment, Log Aliasing, Cross Sections, Horizons and Descriptions, Seismic Summary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fully interpreted PLAYER © project (ArcGIS10 add-on)				
Trial PLAYER © licence	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Well failure analysis	463/495 wells	176 / 221 wells	167 wells	~158 wells
Pool and field volumes	all accumulations (open file)	all accumulations (open file)	all accumulations (open file - 53)	all accumulations (open file)
Field Analysis	all accumulations (open file)	all accumulations (open file)	all accumulations (open file)	all accumulations (open file)
Palaeogeographic Maps	all play intervals - 19	all play intervals - 16	all play intervals - 21	all play intervals - 21
Summary Statistics of reservoir quality and geochem by play interval	all play intervals - 19 (~114 maps)	all play intervals - 20 (119 Maps)	all play intervals - 21	all play intervals - 21
Common Risk Segment Maps	all relevant play intervals (~12/play + multiply stacks)	all relevant play intervals (~12/play + multiply stacks)	all relevant play intervals (~12/play + multiply stacks)	all relevant play intervals (~12/play + multiply stacks)
Geolocated Images	selected maps from public domain reports	selected maps from public domain reports	selected maps from public domain reports	selected maps from public domain reports
- Includes Charge, Interval, Prospects & leads, Tectonics, Structure, Palaeogeography, Sub-Crop, etc	~ 130 maps	~ 75 maps	~200 maps	~100 maps
Public Domain Layers	Selected public domain GIS coverages	Selected public domain GIS coverages	Selected public domain GIS coverages	Selected public domain GIS coverages
- Includes SeeBase (depth to basement), Oils of Australia (oil geochemistry), Surface Geology, Bathymetry, Coastline, Licence Areas, Contractor Seismic coverages, Regional Maps	~ 45 maps	~ 37 maps	~ 30 maps	~ 30 maps
Portfolio Valuation - Total BOE Value (EMV) & Volume; Exploration Cost	All relevant areas of interest (gazettal blocks)	All relevant areas of interest (gazettal blocks)	All relevant areas of interest (gazettal blocks)	All relevant areas of interest (gazettal blocks)
Report Data				
Seismic Reports	all open file reports (17 GB)	all open file reports (41GB - with permit reports)	all open file reports	all open file reports
Well Completion Reports; including composite well & mud logs	463/495 wells (388 GB)	176 / 221 wells (180 GB)	142 wells	198 wells
Permit Reports	all open file reports (19GB)	all open file reports (41GB - with seismic reports)	all open file reports	all open file reports
Well Summary Sheets	~420 wells	~150 wells	-	-
Databases (Oracle and flat files)				
Detailed shows descriptions for each show type and test method	28,804 data rows	7,387 data rows	6,392 data rows	3,889 data rows
- Includes Core, Cuttings, SWC, DST, Mudlogs, Recovery, Pressure surveys, Logs	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Row specific data for biostrat, checkshot, deviation survey	99,704 data rows	35,216 data rows	25,379 data rows	48,149 data rows
Summary statistics of reservoir quality and geochem by play	all play intervals (~ 7,500 data rows)	all play intervals (~ 4,744 data rows)	all play intervals	all play intervals
Row specific data (depth/value) of reservoir quality and geochem	209,462 data rows	109,831 data rows	39,292 data rows	27,634 data rows
Temperature database with Isotherm vs TWT grid	~ 350 wells	~ 139+ wells	139 wells (949 data rows)	TBD
Project PowerPoint Files				
Project meetings over 12 month project duration	<input checked="" type="checkbox"/> (12 meetings)	<input checked="" type="checkbox"/> 7 meetings)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Chronostrat Charts	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Palaeogeography maps overlain with reservoir and geochem statistics	<input checked="" type="checkbox"/> (114 maps)	<input checked="" type="checkbox"/> (119 Maps)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Field Summaries	<input checked="" type="checkbox"/> (242 fields where open file available)	<input checked="" type="checkbox"/> (35 fields where open file available)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Availability	Completed (Non-exclusive)	Completed (Non-exclusive)	Completed (Non-exclusive)	Underway (Exclusive)
Price	POA	POA	POA	POA
	Note: TBD = To Be Determined during project	Note: Well number totals are locations / locations plus sidetracks/respuds that exist in the project and were examined for data		

Note: Comprehensive Oracle database front-end with data compiled and QC'd by BGC of all NWS well related data available separately

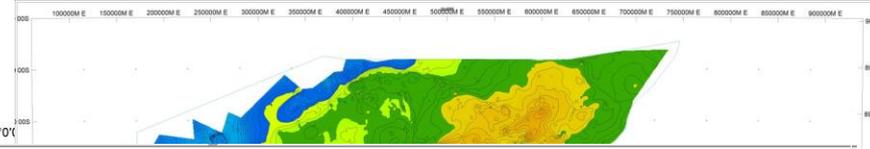


Example Stratigraphic Column

- K30** → Muderong Shale/Mardie Greensand
- K20** → Upper Barrow Grp/Flag ss/Birdrong
- K10** → Lower Barrow Grp/Forestier Clst
- J57** → Angel Fm/Dupuy Fm
- J52** → Dingo
- J47** → Dingo
- J42** → Dingo
- J30** → Calypso Fm/Biggada ss
- J20** → Legendre Fm/Athol Fm
- J10** → North Rankin Beds
- TR30** → Brigadier Fm
- TR27** → Mungaroo Fm
- TR10** → Mungaroo Fm/Locker Sh

Source: Adapted from I.M. Longley et al, 2002, The North West Shelf of Australia - a Woodside perspective, in Keep, M. & Moss, S.J. (Eds), 2002, *The Sedimentary Basins of Western Australia 3: Proceedings of the Petroleum Exploration Society of Australia Symposium*, Perth, WA, p27-88.

TR10 PALAEOGEOGRAPHY MAP



For every prospective play interval
For the entire NWS

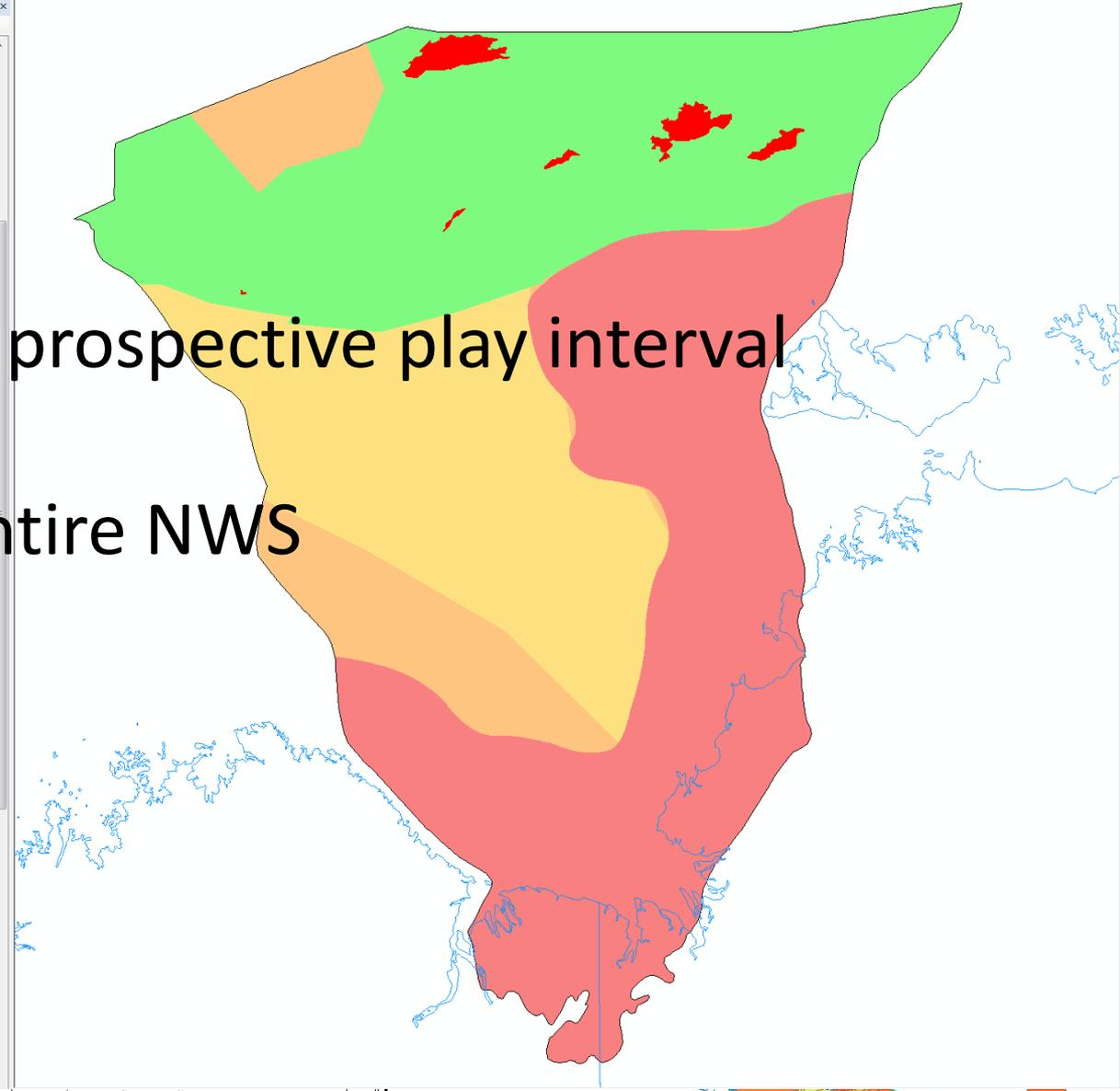


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So...

- So this is the dataset that we can apply to understanding the South Phoenix area discoveries
- Plus John and I, together with Peter P, probably have +/- 100 years of practical exploration experience along the NW Shelf margin
 - Does not mean we are right but we will hold opinions.
 - I'm wrong a lot and am still working so its self evident I'm not that clever..
- In addition Peter P and myself will be running our first PGNWS training course in April next year –
 - Based on public domain data only, not the Player Projects



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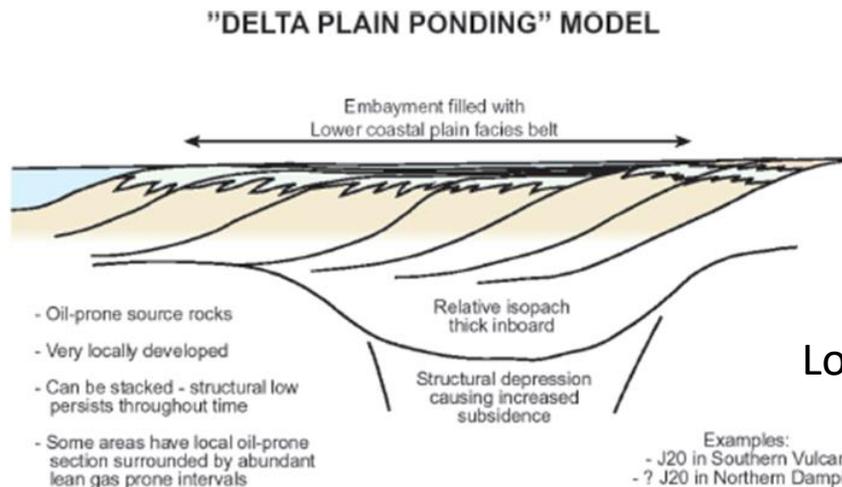


We believe

- The SP area works (and other Triassic kitchens don't) because there are effective source rocks deposited within the lower/early Triassic section
 - These are there because of “Delta Top Ponding” during this time period

Delta Top Ponding

- Was a model we developed at Woodside in the late 1990s to explain the distribution of HC's in other areas of the NW Shelf



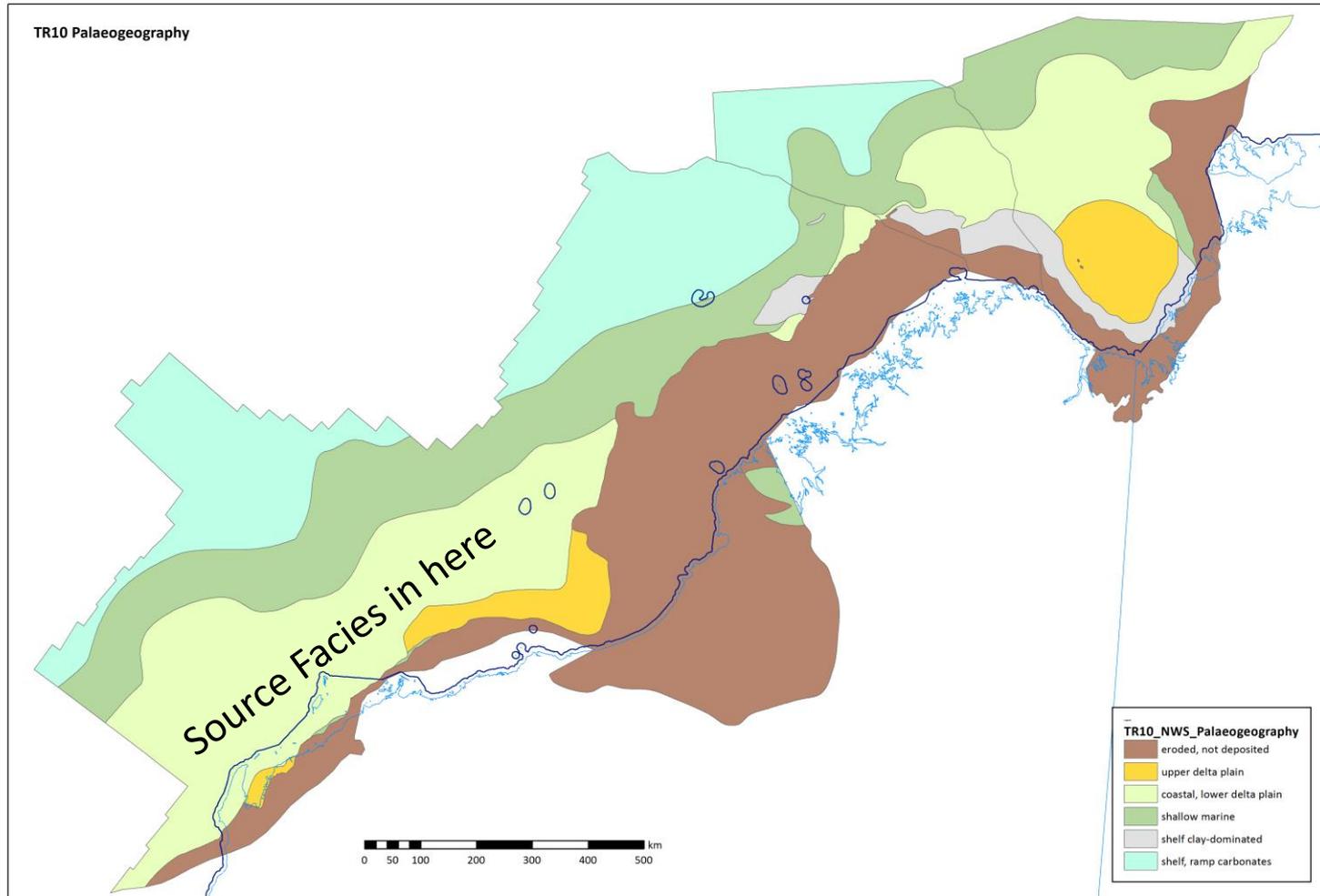
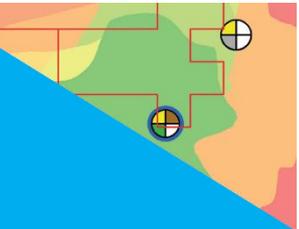
Longley et al., 2002

Examples:
- J20 in Southern Vulcan
- ? J20 in Northern Dampie

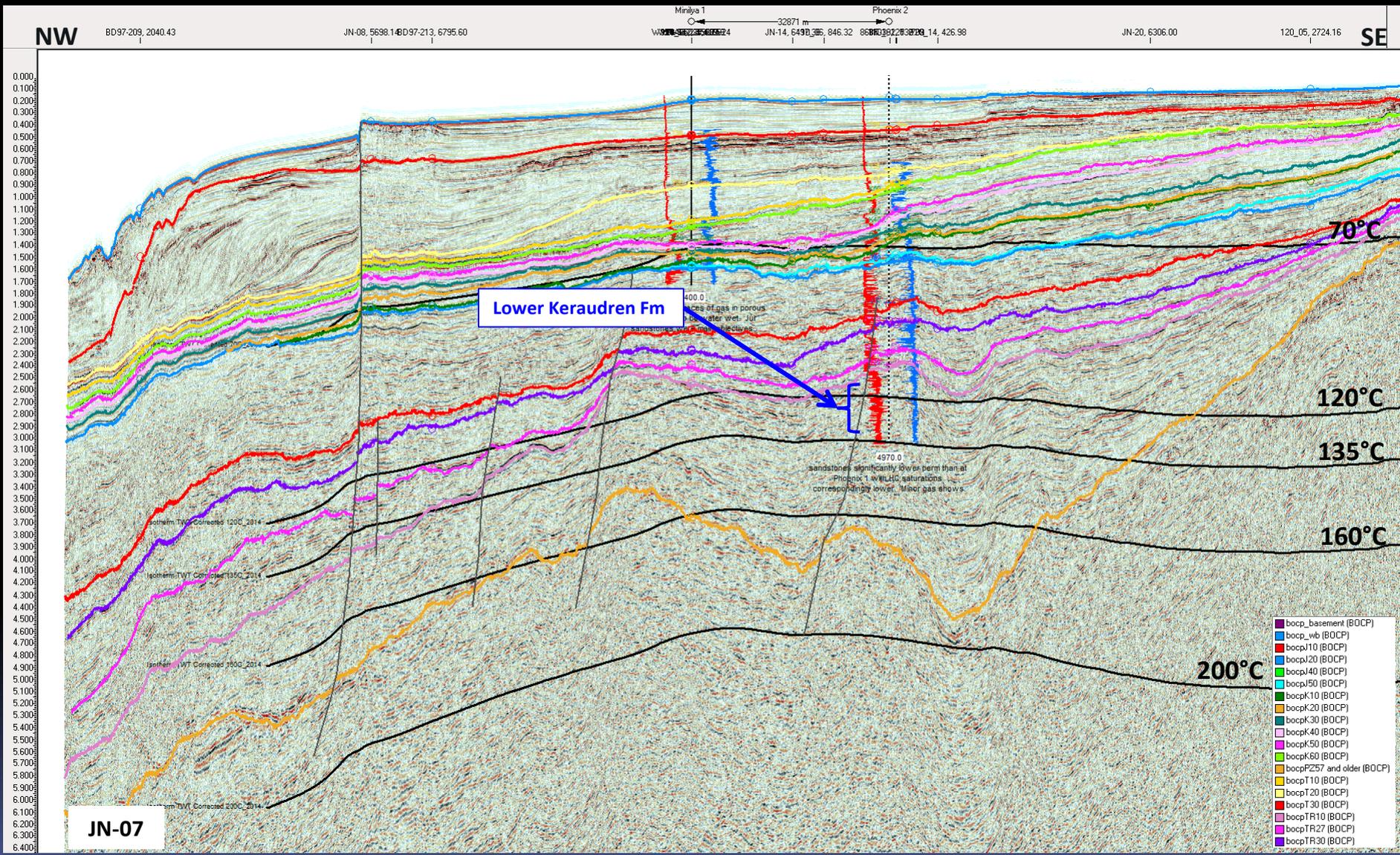
- This model is poorly understood I think – or maybe just poorly explained..



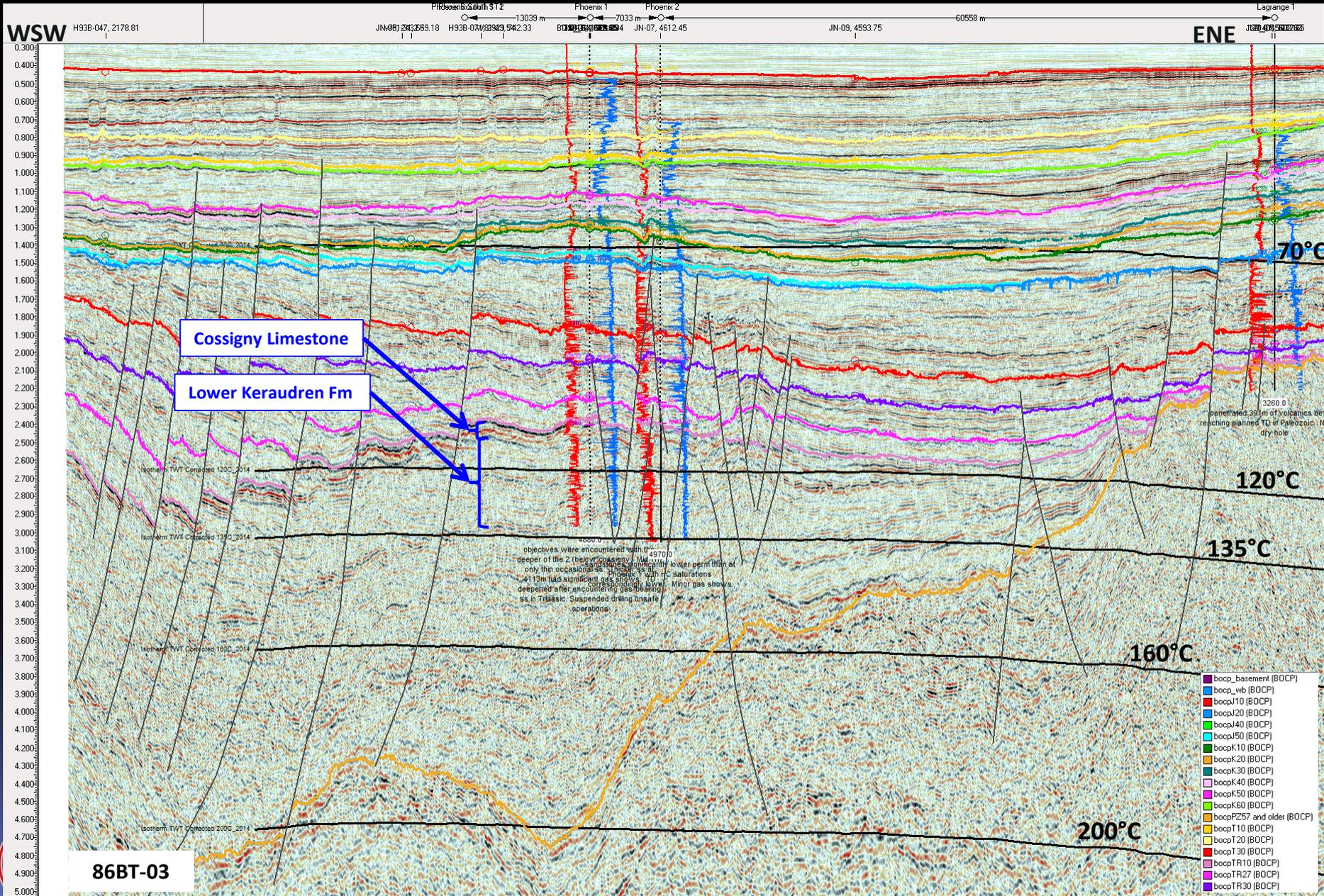
NWS Player Project – Mega-regional TR10 Paleogeography



Bedout Sub-basin – Regional Dip Line



Bedout Sub-basin – Regional Strike Line





Barry/John

- Can we get a South Phoenix area isochore map for tr10 zoomed that shows some thicks in the area? Maybe also give GDE map for same map area??



Outline

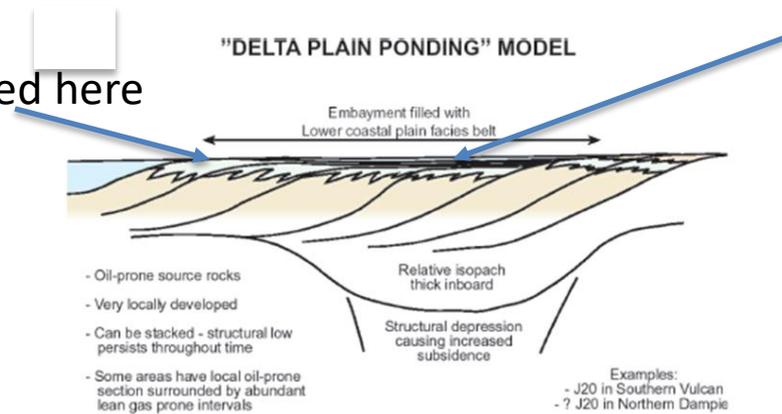
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Delta Top Ponding

- Pepper & Corvi Type D/E source facies
- Exinitic rich non marine deltaic source
- Classic dispersed source rocks
 - Hard to identify using common screening Rock Eval etc methods (modern synthetic mud contaminants don't help either)
 - Initial HI's max 300-400 small oil slug at ~135-145 degC then expulsion with gas as light oil and condensate through 160degC– latter requires later leakage to make into an oil field.. ie Laminaria

Coastline is pinned here



Repeated cycles develop thickened delta top organic rich facies stck here

Source rock development is localised/focussed into structural lows BEHIND coastlines – marine section is non source rock

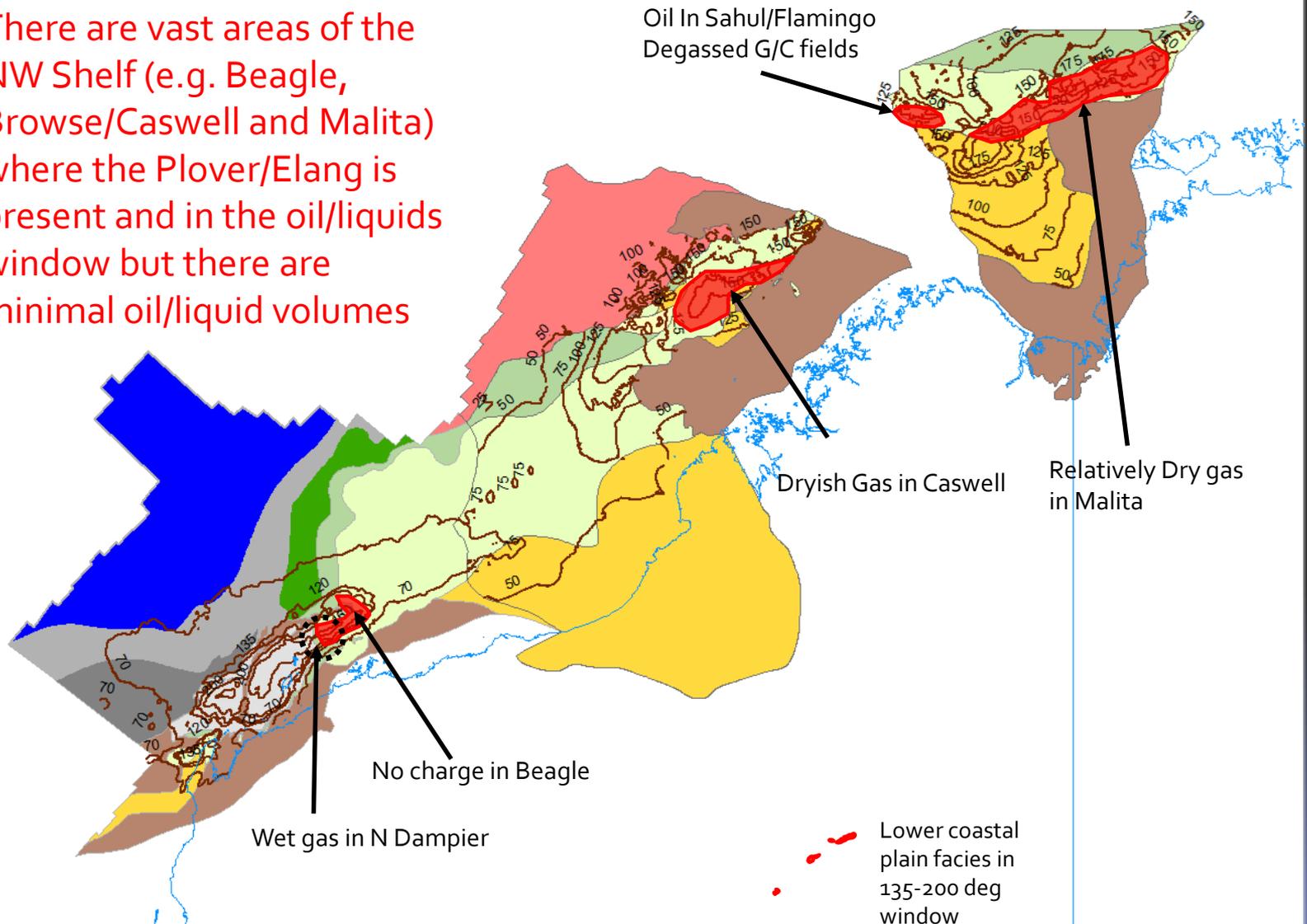


Delta Top Ponding

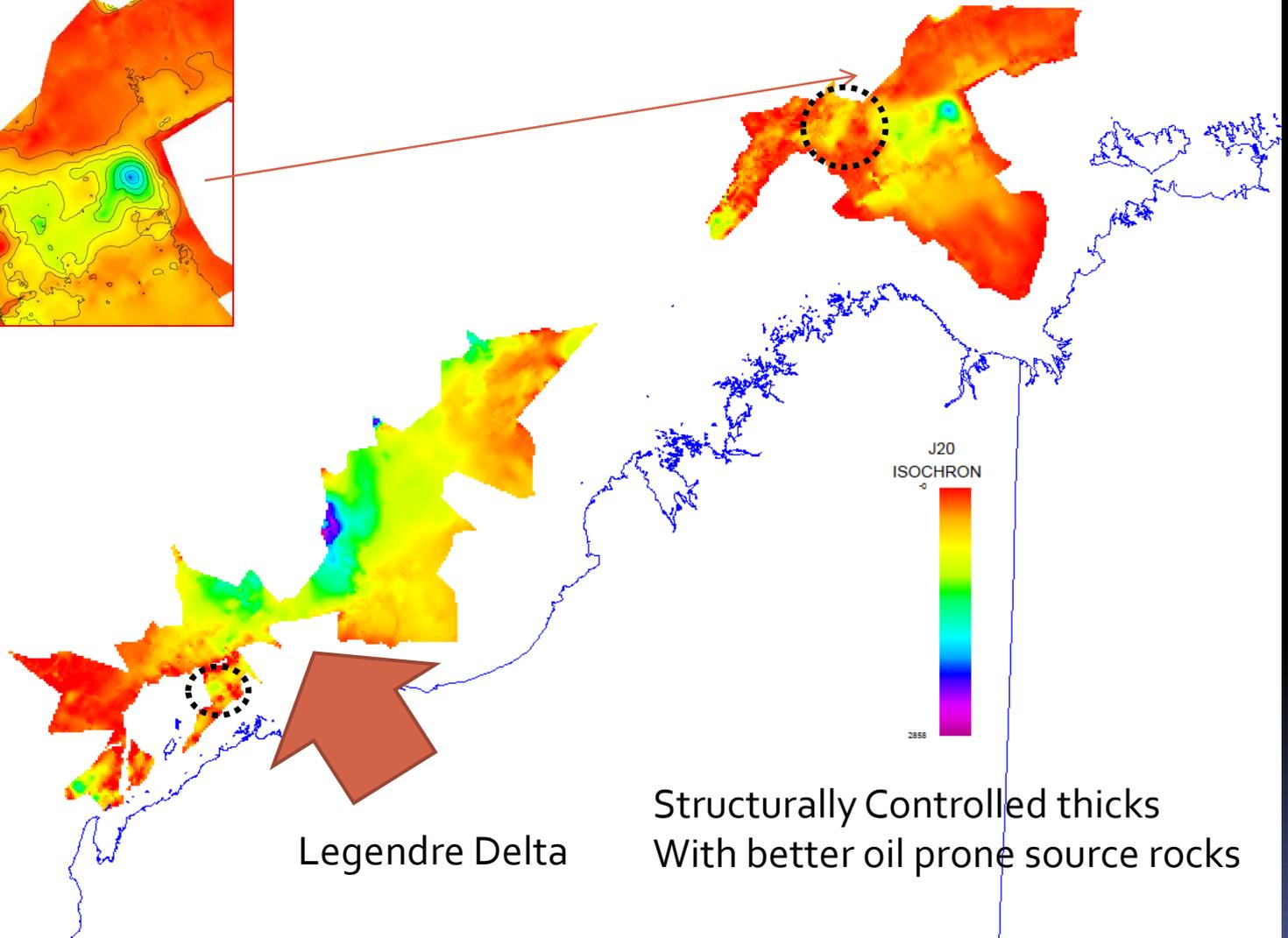
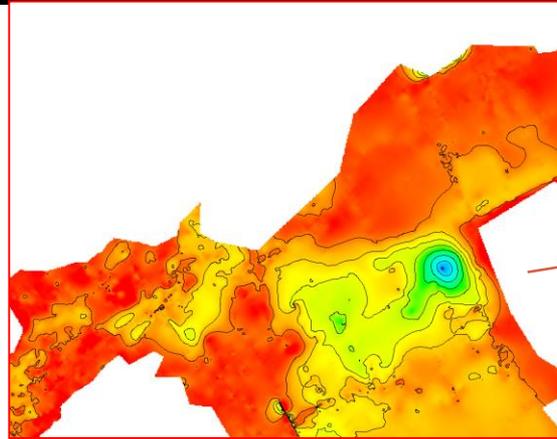
- Model established for NW Shelf to explain Jurassic petroleum systems
 - Since then I have seen applicability in SE Asian circum-Borneo basins and in Gippsland and Taranaki Basins..
- In SE Asia the structural grain appears to control the development of source rocks in the delta top (or not)..
 - Plus the Miocene deltas are better/effective vs the Pliocene deltas

NWS Player Project – J20 Palaeogeography

There are vast areas of the NW Shelf (e.g. Beagle, Browse/Caswell and Malita) where the Plover/Elang is present and in the oil/liquids window but there are minimal oil/liquid volumes



NWS Player Project – J20 Isochore

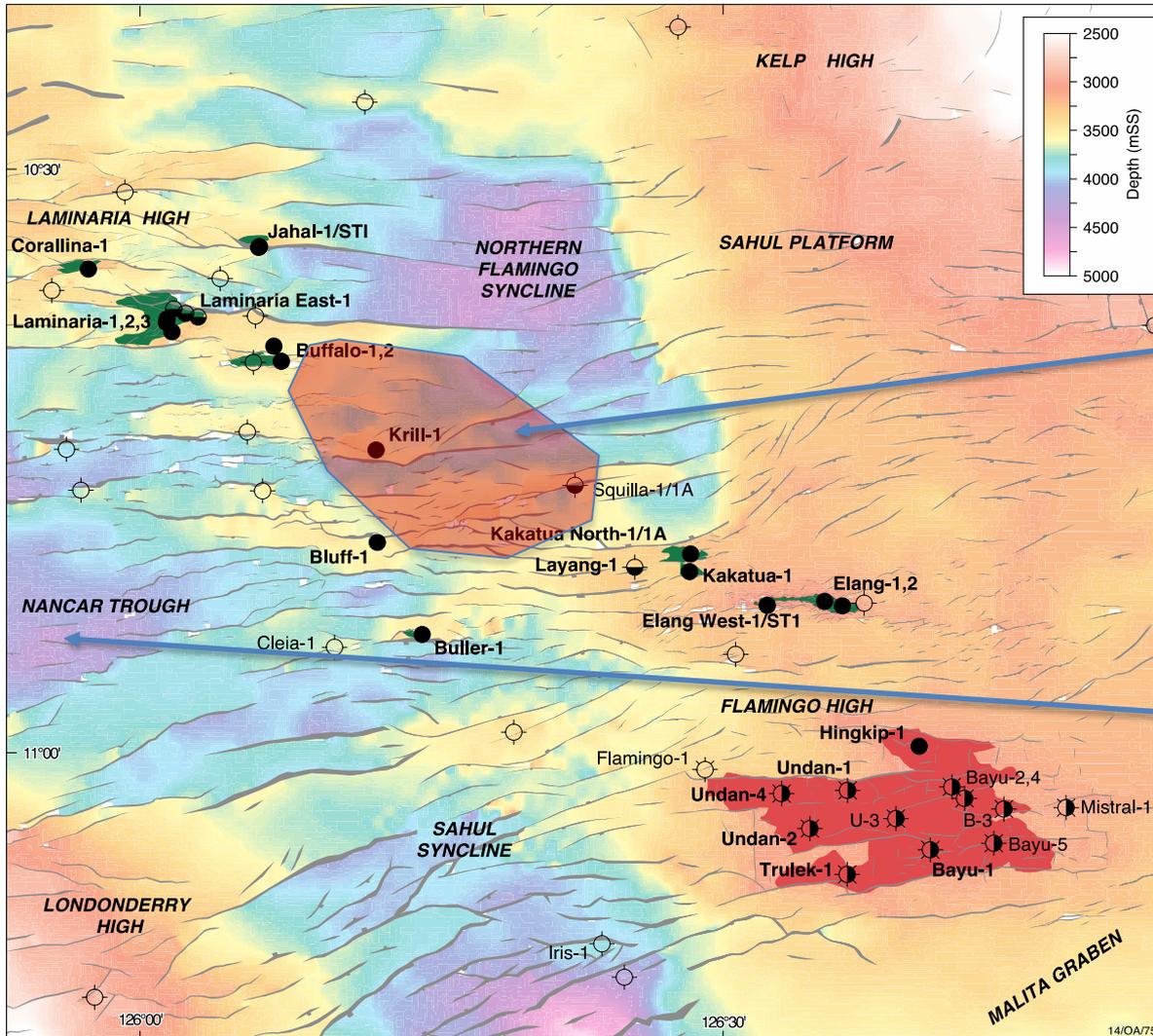


Legendre Delta

Structurally Controlled thicks
With better oil prone source rocks

Laminaria /Flamingo Area

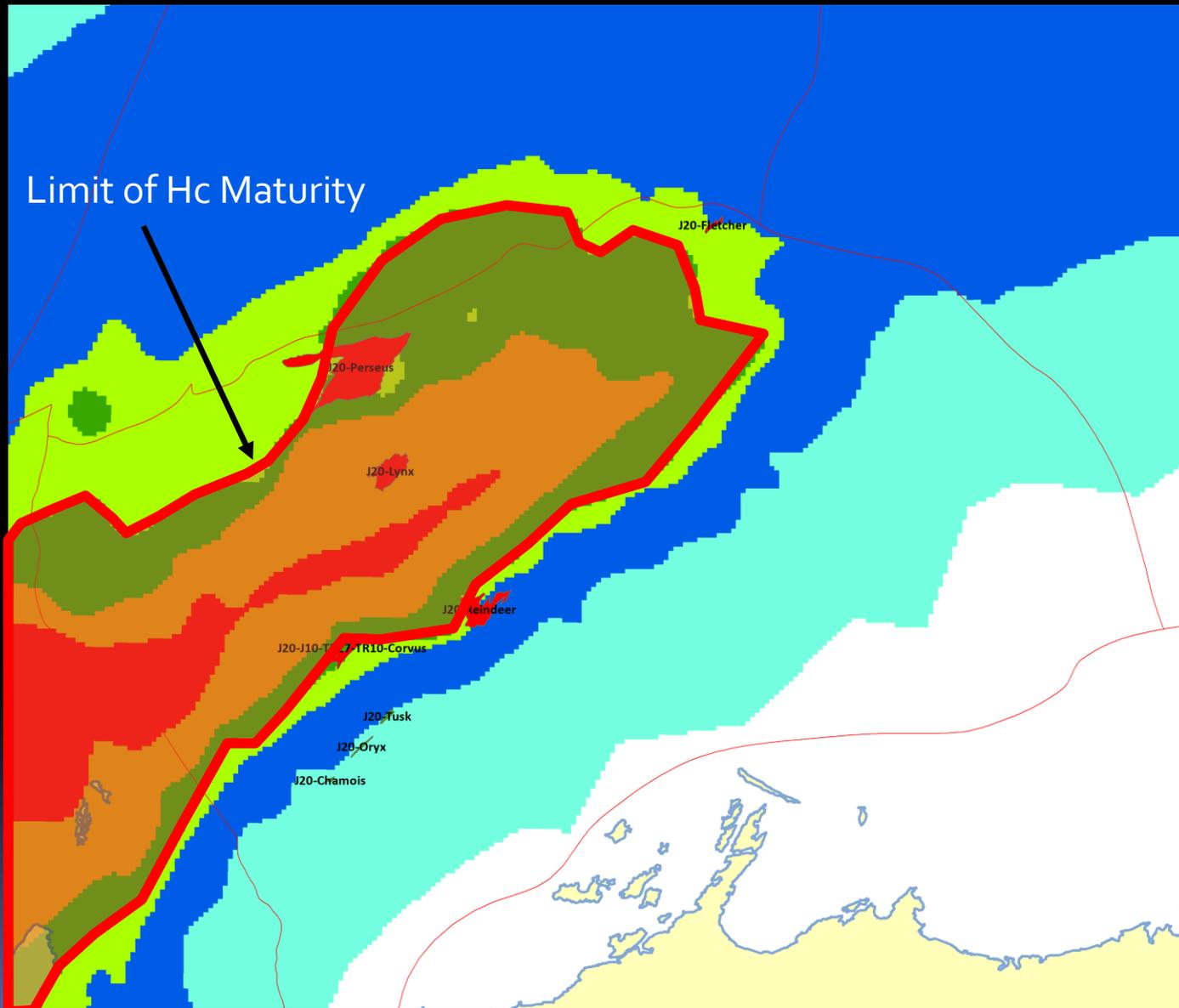
Yes leakage is an issue in the Sahul/Flamingo Area.. But there is ALSO a more subtle source rock story..



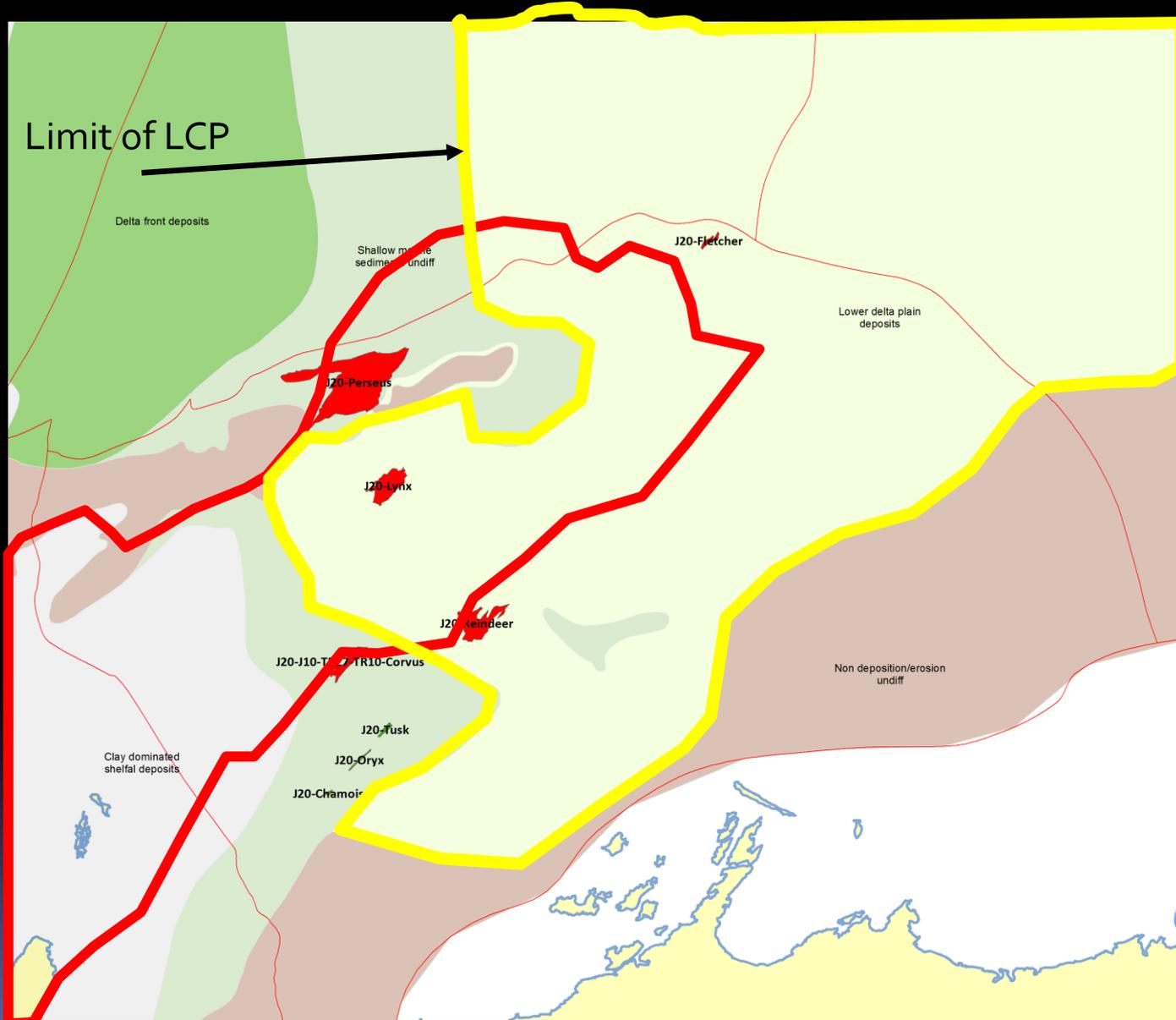
All oil fields (not U-B) can be explained via fill spill from a kitchen in this red blob area

Lots of wells around mature Nancar area failed.. Leakage or no source rocks?

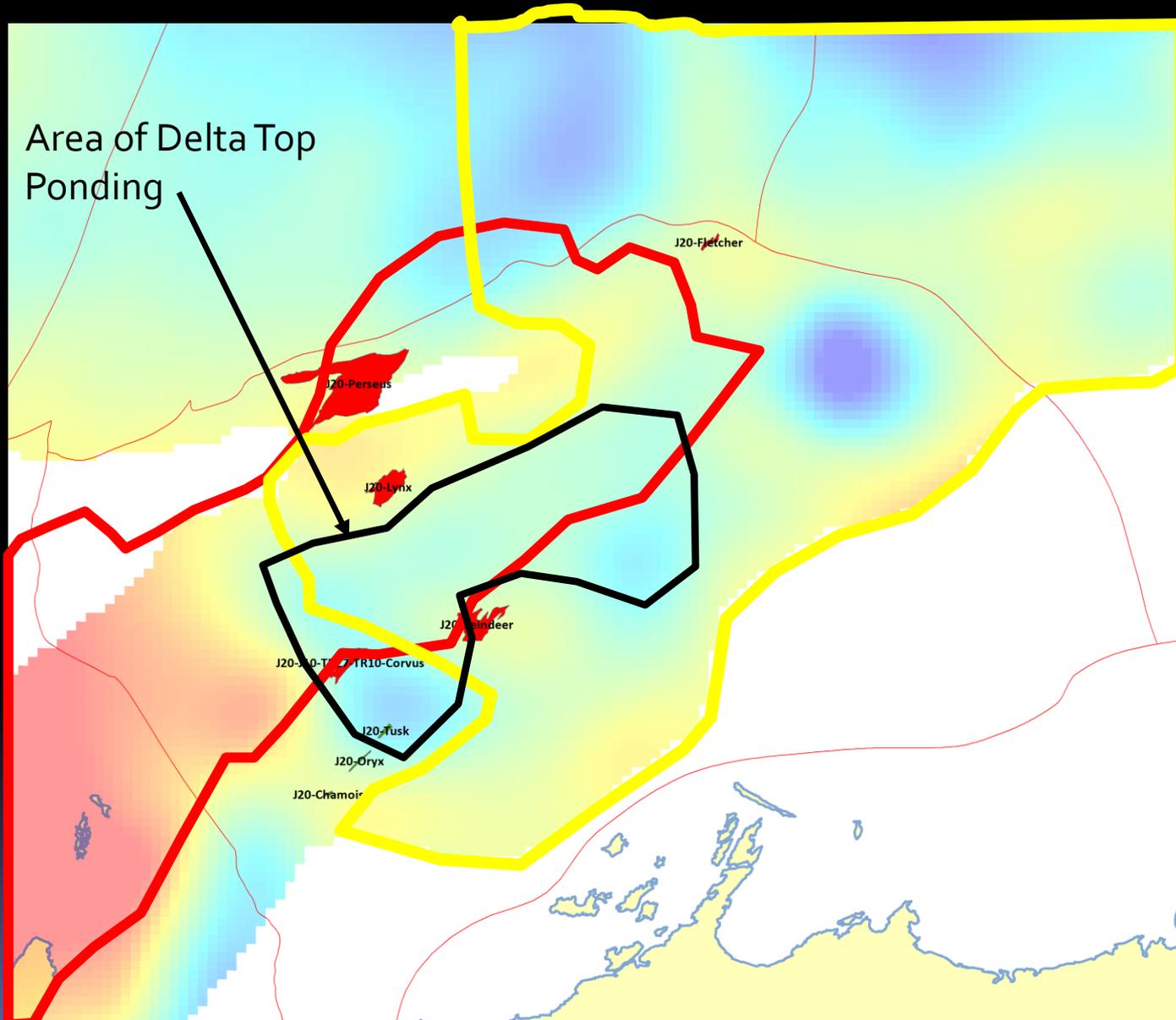
Dampier Sub-basin – J20 Maturity



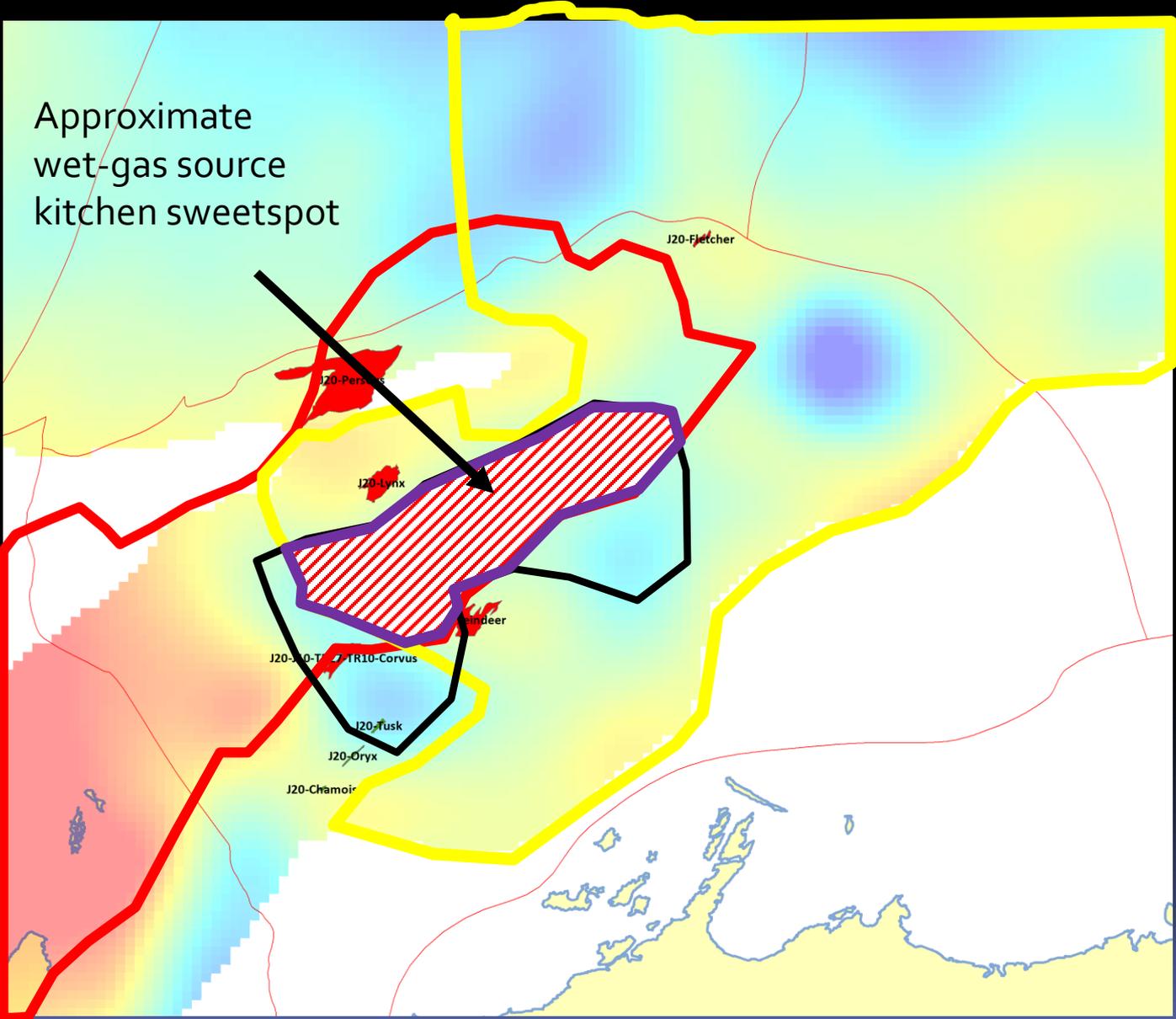
Dampier Sub-basin – J20 Palaeogeography



Dampier Sub-basin – J20 Isochore



Dampier Sub-basin – J20 Wet Gas Sweetspot





Summary

- Oil prone/liquids source rocks are NOT ubiquitous within the Jurassic of the NW Shelf
- Some deltaic sediments have no source potential (Beagle) or lean gas prone source rocks (Browse, Malita etc)
- Oil prone source sequences are localised and are structurally controlled areas behind the coastline within a delt top environment = delta top ponding.



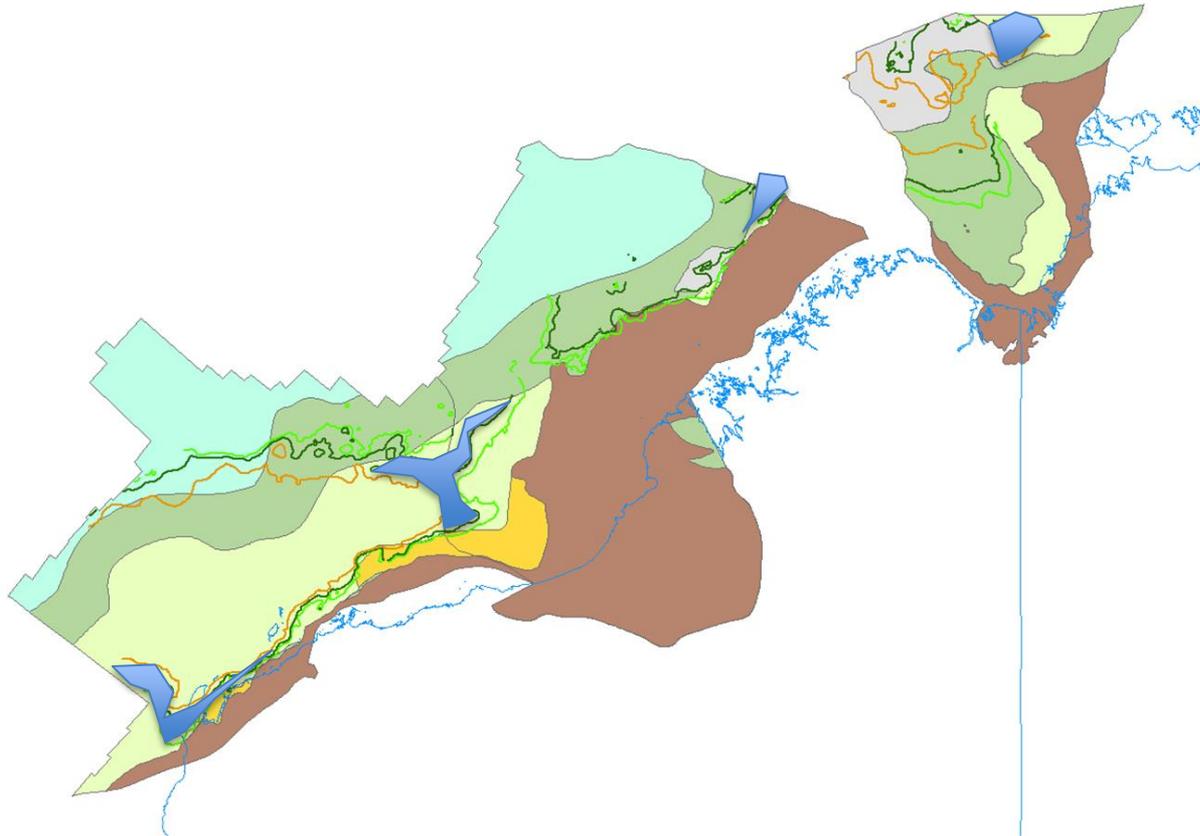
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So are there any more TR10 liquid-rich kitchens out there??..

- TR10 with current day maturity overlay



Suggest ?3 other analog areas might be present..



Summary

- The South Phoenix area is liquid-prone because there are lower coastal plain source rocks present in the source kitchens beneath and adjacent to the discoveries
- These have probably been enhanced due to structural control of synclines where liquid prone material has been concentrated
- There are possibly 3 other areas where similar Triassic sequences might be effective along the margin



Contacts

- ian.longley@iinet.net.au
- John.Bradshaw@cgss.com.au