

CarbonNet Storage Site Characterisation*

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Editor's note: Search and Discovery Article #80507 (2016), #80508 (2016), # 80509 (2016), and #80510 (2016) are contributions from The CarbonNet Project, Gippsland Basin, Australia.

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Abstract

During its assessment of Carbon Storage sites in the nearshore Gippsland Basin, within 25 km of the coastline, the CarbonNet project screened >20 potential sites, comparing storage Capacity (total CO₂ volume), Injectivity (CO₂ injection rate), and Containment (security). Several play fairways, and a wide range of trap types were compared. Progressively more-detailed geological models were built to enable site- and scenario-specific injection modelling, and for studies of the evolution of the injected CO₂ plume using state-of-the-art petroleum industry software. After screening, three key sites were prioritised, each with a secure storage capacity of >25 Mt CO₂, and containment over 1000 years of dynamic modelling. The geological context, storage concept, and specific reservoir and seal elements of these three sites will be described and compared, in the context of Australian legislation which requires a demonstration of the “fundamental suitability determinants for CO₂ storage” leading to a Declaration of Storage Formation. Different trap types impact the effort required, and the key issue is the (statistical) area covered by any supercritical or dissolved CO₂ plume - which depends on injection pressure, reservoir property distribution, and trap geometry. The main interactions with nearby resource owners are coupled by reservoir pressure. Depending on the location of each site and the trap concept, different approaches are required, but these all require a detailed and functional geological model of not just the site, but the context within which it sits. Given this model, a detailed dynamic reservoir model can be built, checked for quality, and used for a wide range of purposes including plume extent, pressure influence, storage security, and development of a site monitoring plan including the best locations and technologies for surface and subsurface monitoring. A number of preconceptions for the basin were addressed that directly affect seal integrity (both the regional petroleum caprock, and additional intraformational seals). In order to understand the capacity and effectiveness of these seals, updated petroleum migration models were required that explain the distribution of primary hydrocarbons, and those modified by water washing, biodegradation, etc. Significant advance has been made in understanding the basin paleogeography and palaeobathymetry during seal deposition, and mapping seal facies and seal perturbations in extensive detail.

Reference Cited

Norvick, M.S., M.A. Smith, and M.R. Power, 2001, The Plate Tectonic Evolution of Eastern Australasia Guided by the Stratigraphy of the Gippsland Basin: Eastern Australian Basin Symposium, *in* K.C. Hill and T. Bernecker (eds.), Eastern Australasian Basins Symposium, A Refocused Energy Perspective for the Future, Petroleum Exploration Society of Australia, Special Publication, p. 15-23.

AAPG | **SEG**

International Conference
& Exhibition **2015**

13-16 September • Melbourne, Australia

PESA Incorporating PESA's Eastern
Australasian Basins Symposium

CarbonNet Storage Site Characterisation

Dr. Nick Hoffman, Storage Advisor

15th September 2015

The CarbonNet Project



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CarbonNet Storage Site Characterisation

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15th September 2015

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GLOBAL
CCS
INSTITUTE

Department of
Economic Development,
Jobs, Transport & Resources



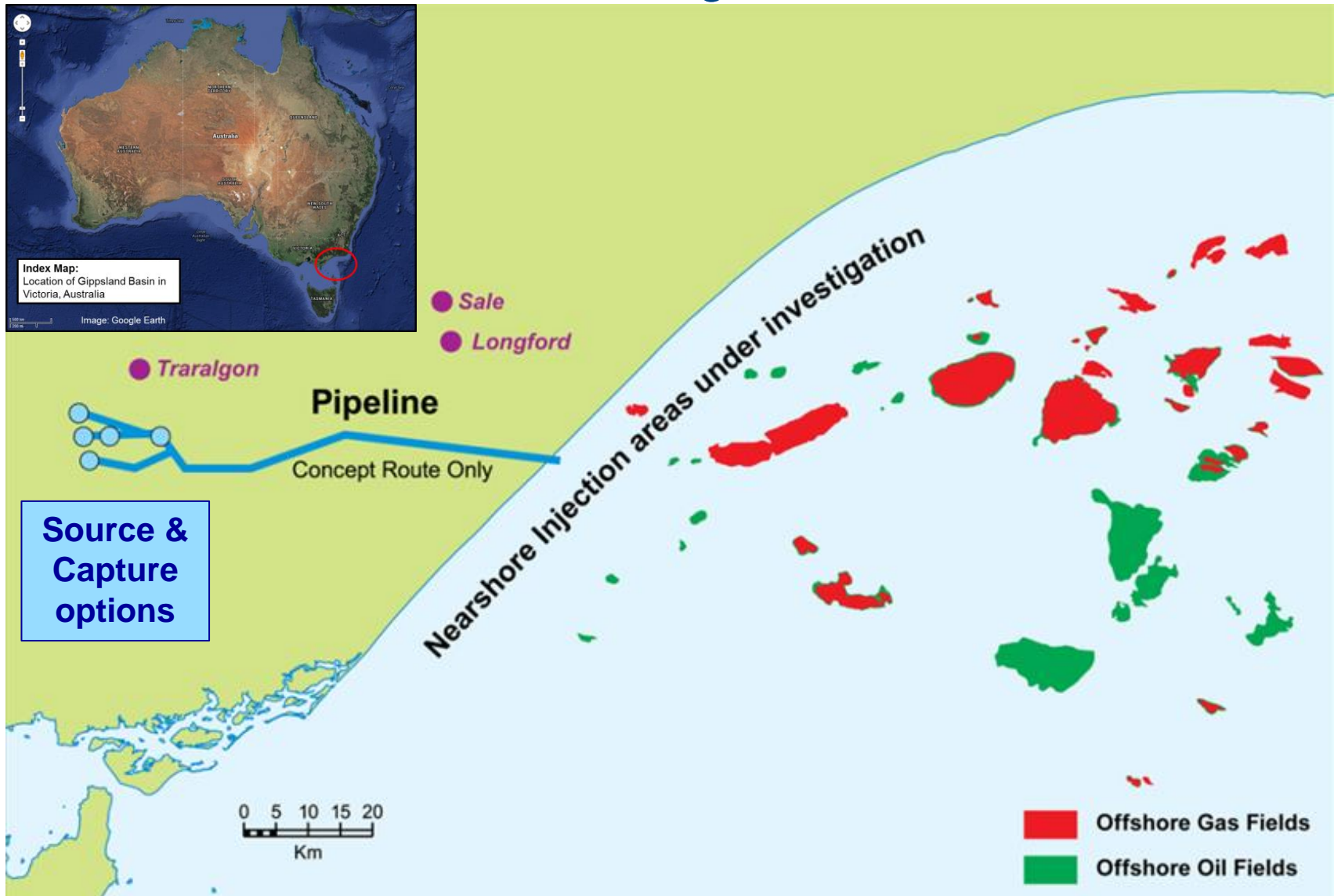
Technical collaboration and review



Acknowledgements

& many consultants,
specialists and researchers

The CarbonNet Project



Outline

- Database
- The Present is the Key to the Past
- Site Characterisation
 - Injectivity
 - Modelling
 - Risk Analysis
 - Appraisal Plan
- Lessons Learned: Issues & Challenges

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Working in a known and prolific petroleum basin

+ Lots of data (open access)

- Resource interaction

WELL DATA

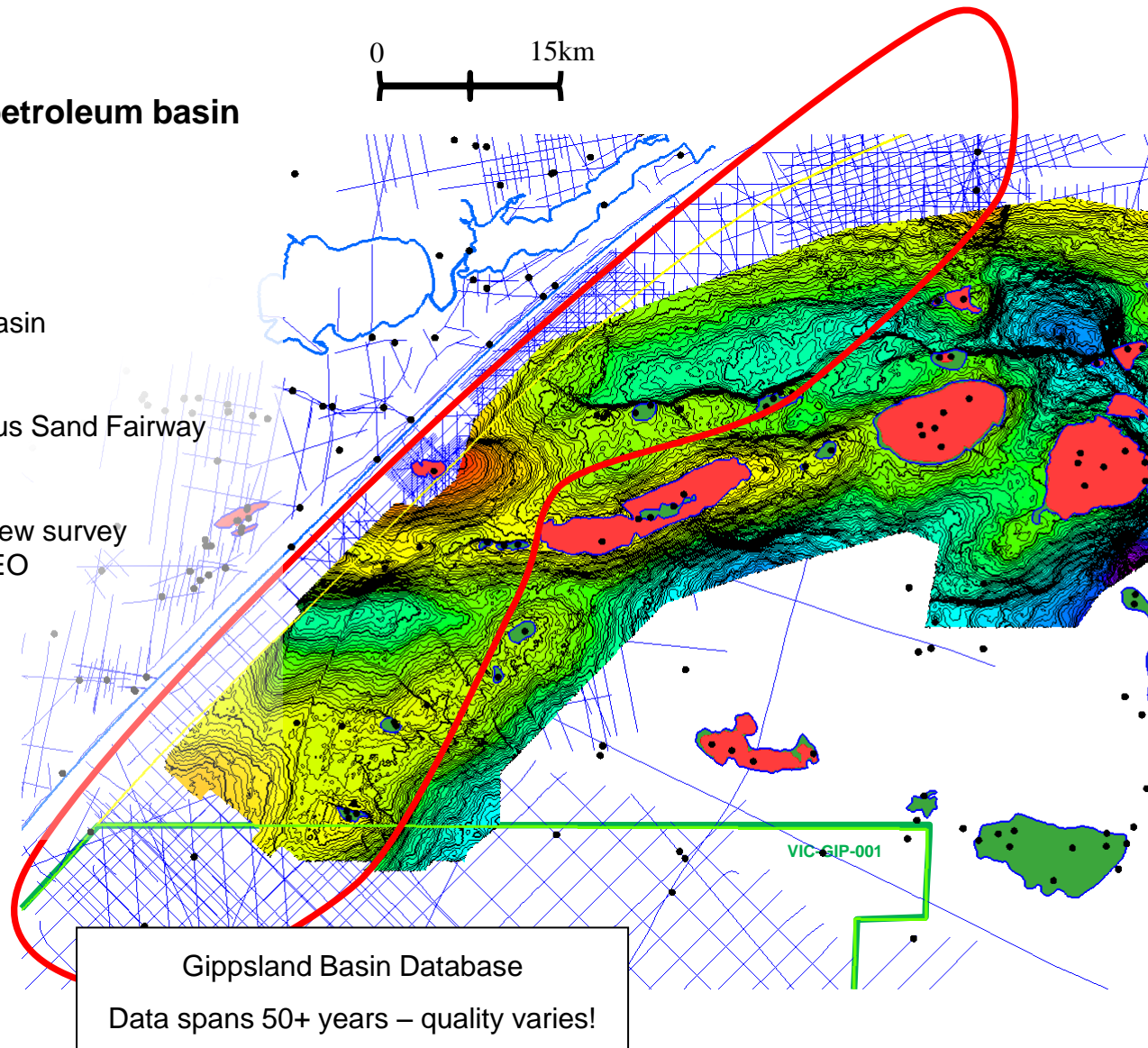
- 1562 wells and boreholes in whole basin
- 811 wells with basic geological data
- 546 wells with relevant log data
- 50 local E&P wells in Upper N.asperus Sand Fairway

SEISMIC DATA

- 69 X 2D surveys including GDPI10 new survey
- 34 X 3D surveys – merged by 3D-GEO

3 CONTINGENT SITES

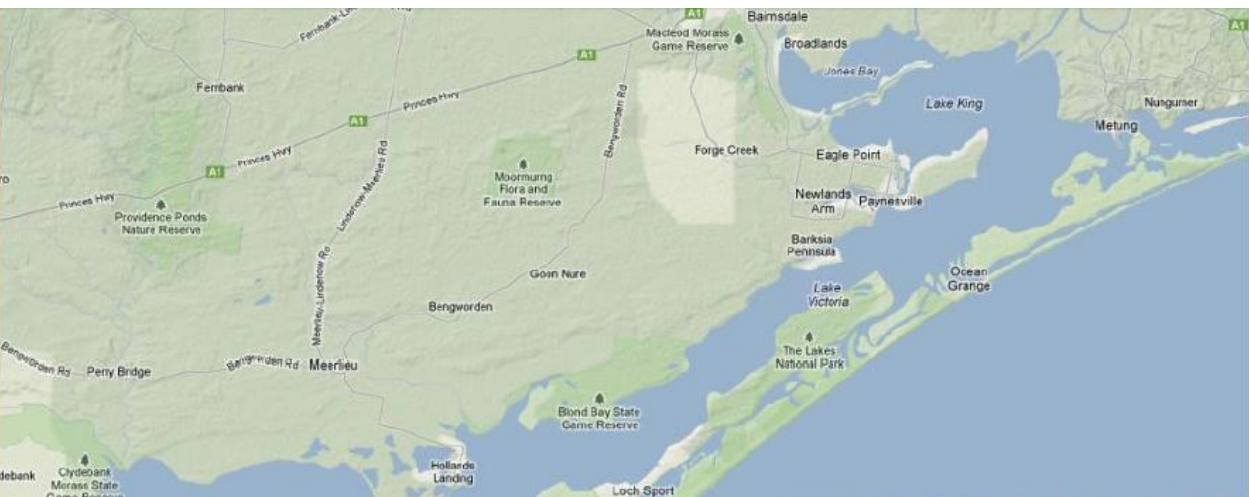
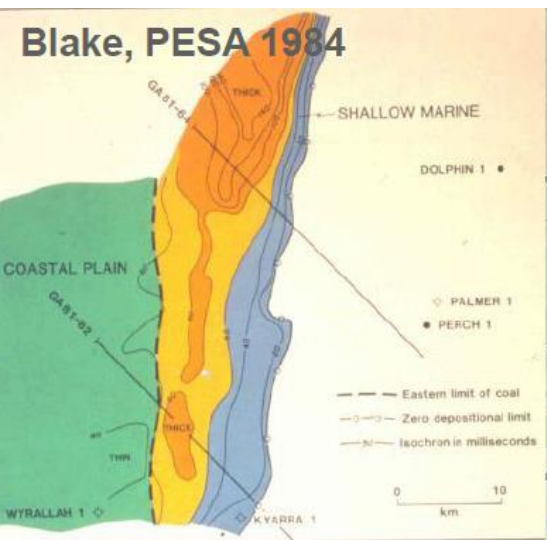
- Site A : 2 wells 2D & 3D seismic
- Site B : >2 wells 3D seismic
- Site C : 1-3 wells 2D seismic



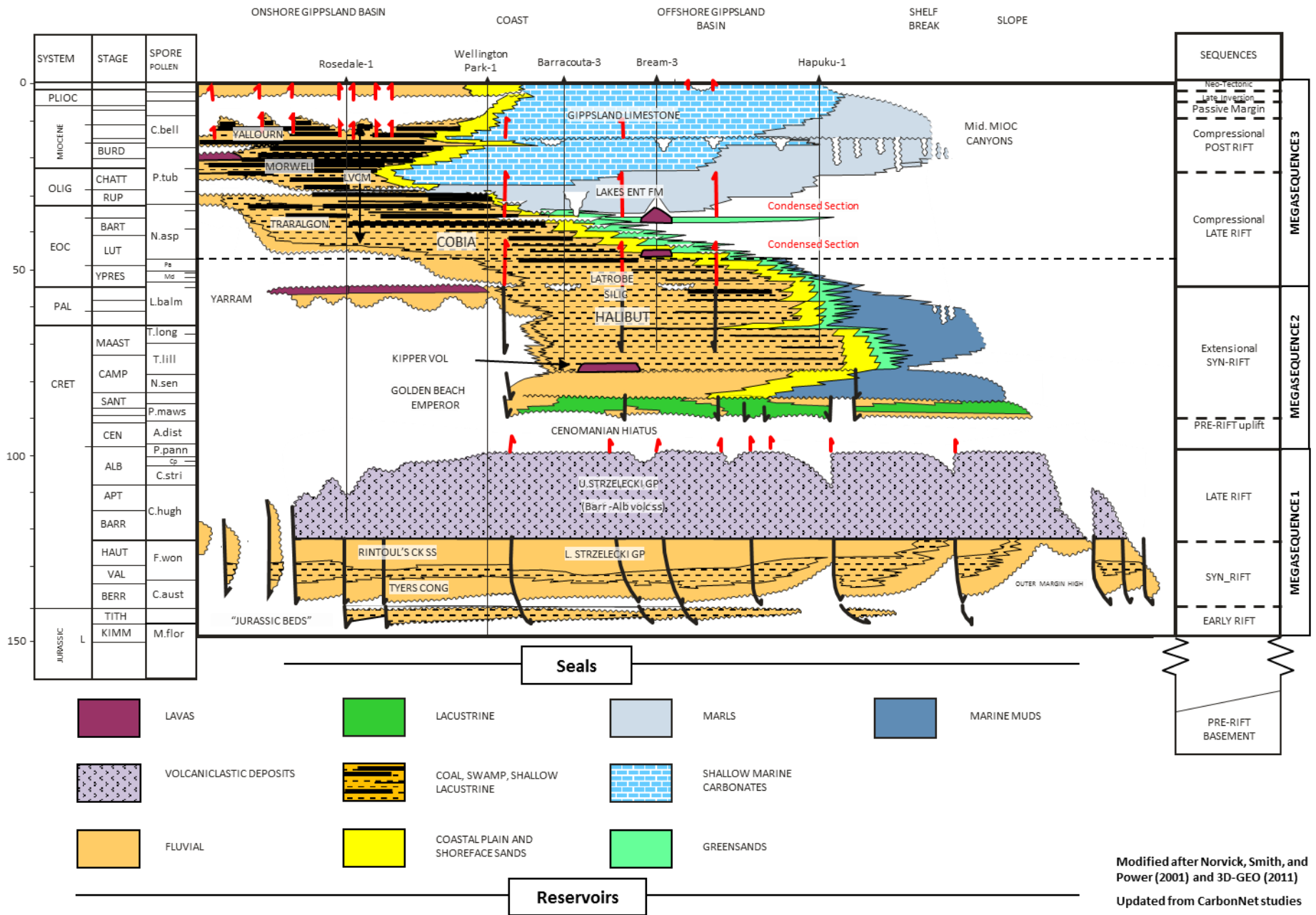
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Blake, PESA 1984



“The Present is the Key to the Past”



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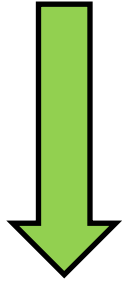
Aquifer

The pressure-connected aquifer seen by oil and gas fields in Gippsland basin is at least 1 Petalitre (10^{15} L)

This is 1000 cu km of water, 3,000 cu km of rock

CarbonNet has no issues with pressure

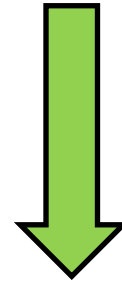
Injectivity, Injectivity, Injectivity



Capacity

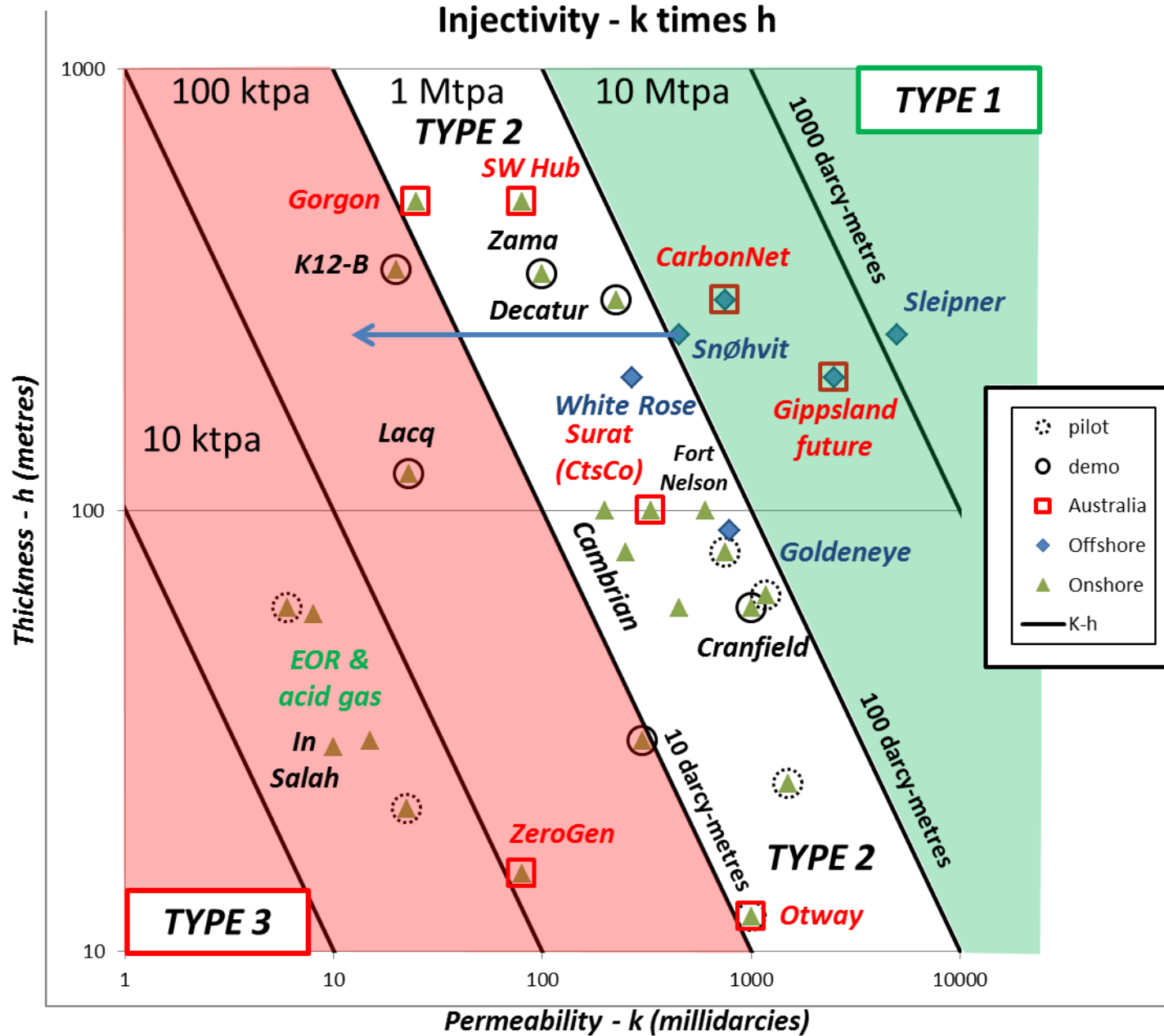


Commerciality



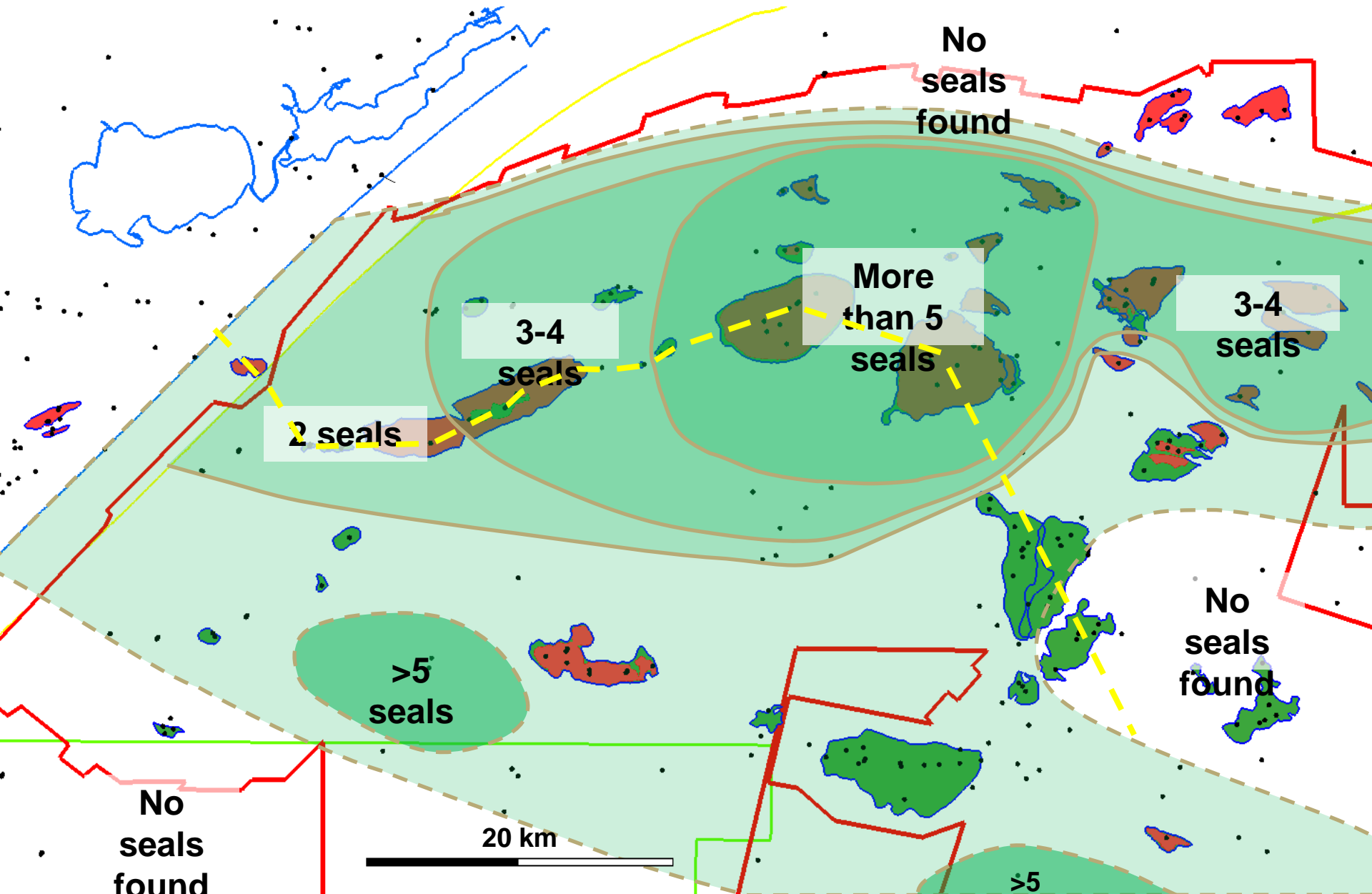
Containment

Injectivity



Containment

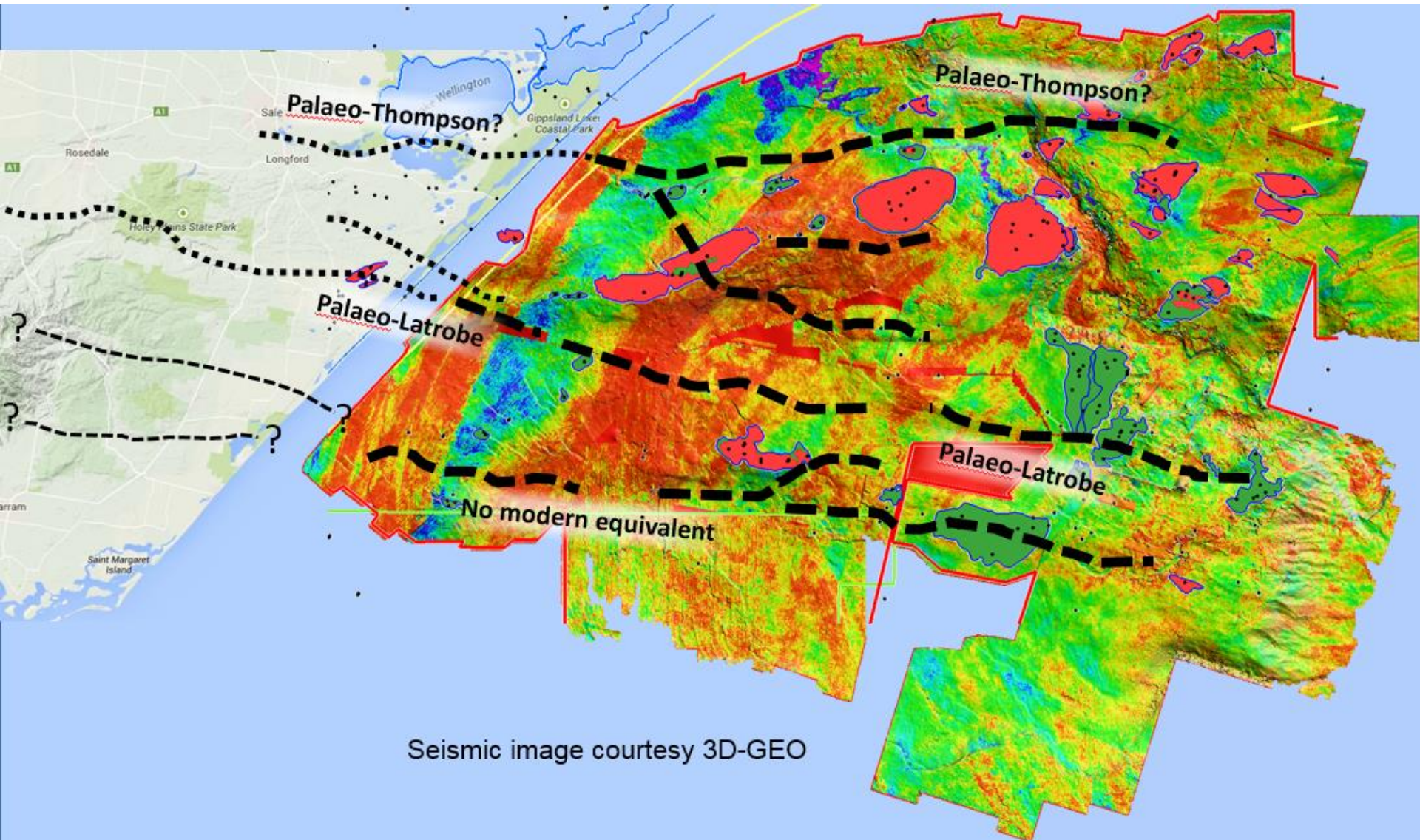
Gippsland Basin
Number of Intraformational Seals



Traralgon T2 Seal in cores

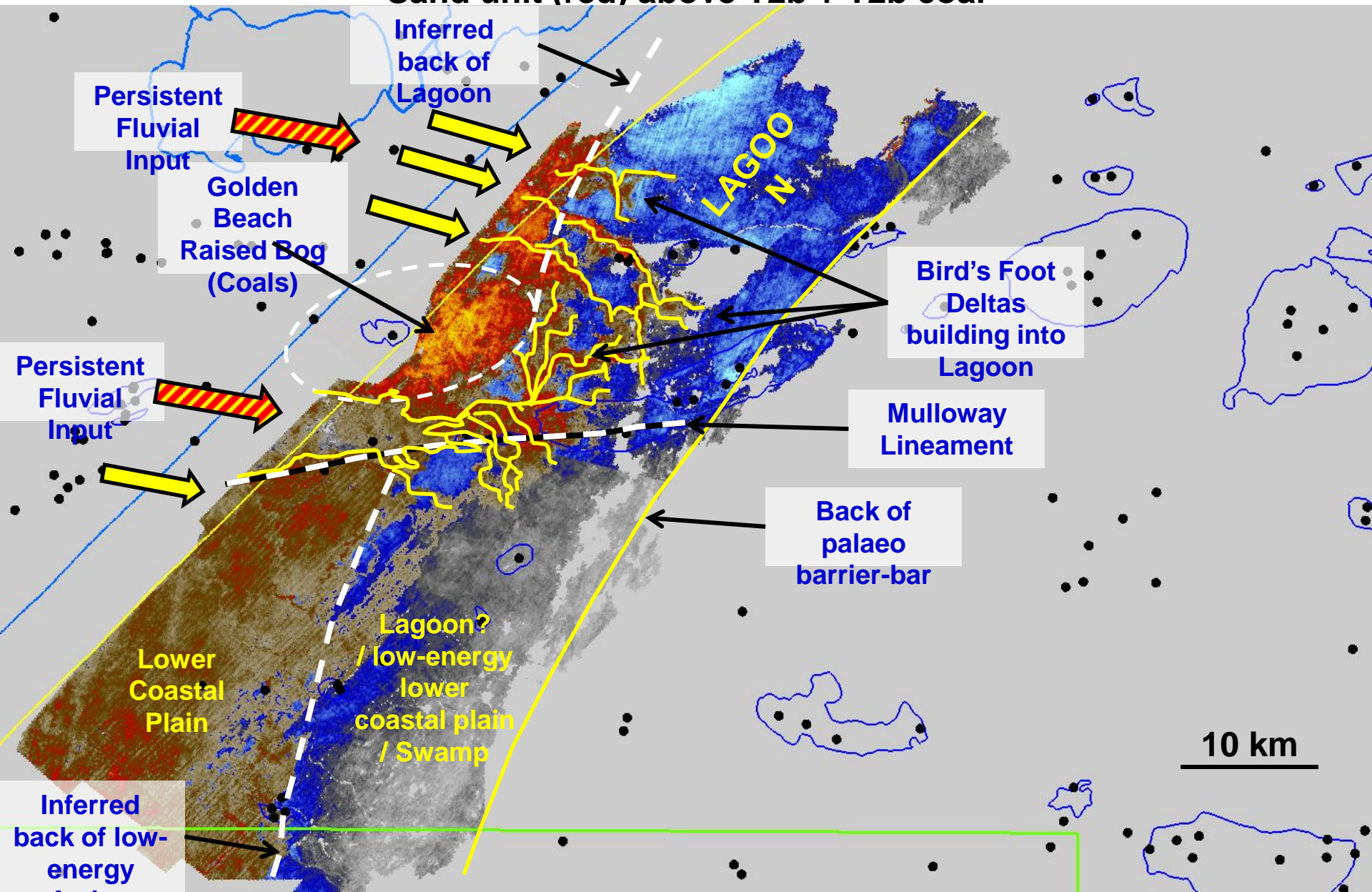


GIPPSLAND BASIN – Integrated Fluvial Palaeogeography (Upper *P. asperopolus* to T0)



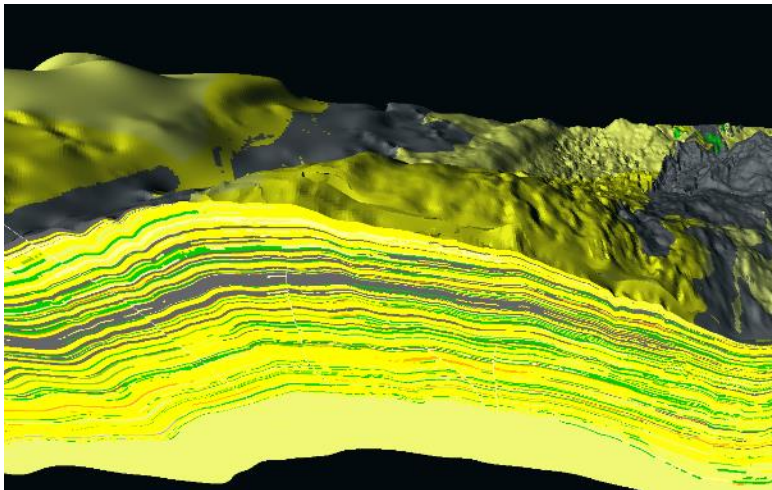
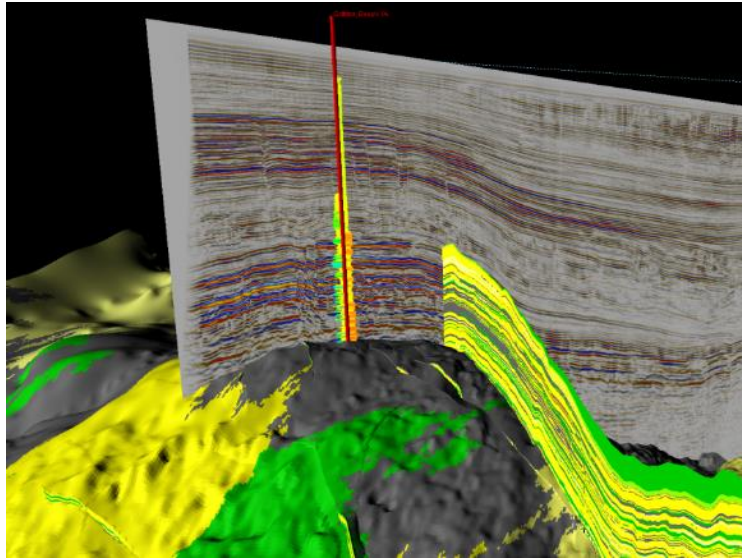
Dimensions of Sand Bodies – intra-Latrobe

Sand unit (red) above T2b + T2b coal



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1st Generation models:

Models	Site A	Site B	Site C	Site D
Resolution (m)	50 x 50	50 x 50	25 x 25	50 x 50
km x km	44.5 x 27.1	34.3 x 25.7	23.3 x 25.3	31 x 52
Layers	51	71	44	53
Total grid cells	24.7 million	26 million	25 million	31 million
Lake Entrance thickness	124m	268m	102m	136m
Cobia thickness	335m	113m	347m	302m
IntraFmn seals (# layers)	100m (6)	50m (4)	80m (8)	50m (6)
Halibut thick (m)	820m	243m	353m	300m

3rd Generation models – 220 layers

c.80 million cells

PETREL and Eclipse E100 and E300

Oil industry standard software

Good, but not cheap

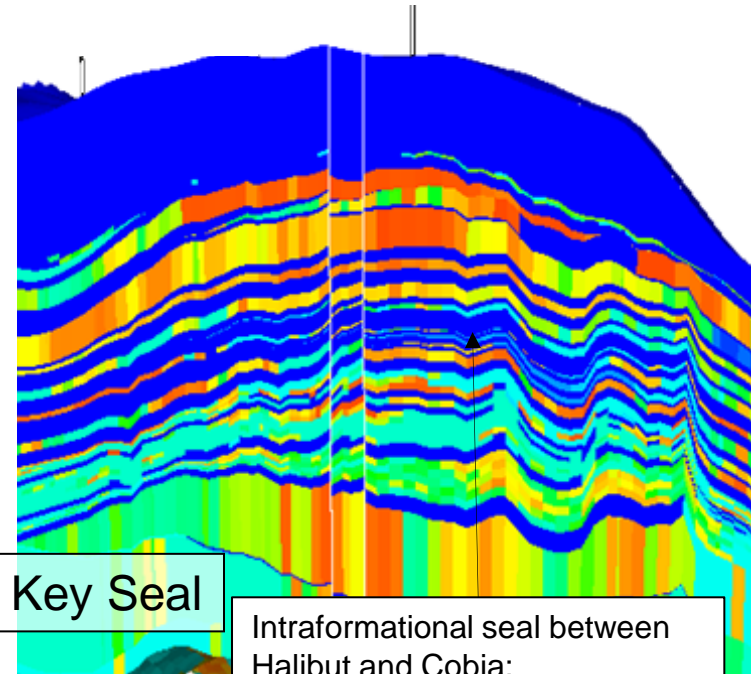
STATIC MODELLING SUMMARY



To scale

	Formation	Layer No.	Avg. Permeability X		Avg. effective		Avg. Thickness (m)
			(md)		Porosity (fraction)		
	Lakes Entrance	1	0.1		0.05		127
	Green Sand	2-3	21		0.05		9
	Y-Top Latrobe	4	520	Nil	0.13	Nil	Nil
	X-Top Latrobe	5		0.01		0.06	13
	W-Top Latrobe	6		2016		0.26	20
	V-Top Latrobe	7		0.007		0.05	7.4
	U-Top Latrobe	8		1035		0.17	23.6
	T-Top Latrobe	9		0.01		0.05	6.6
	S-Top Latrobe	10		1392		0.23	41
	R-Shale	11	520	0.04	0.13	0.03	11
	Q-Shale	12		1496		0.19	10.3
	P-Coal,Shale	13		0.65		0.05	17.6
Cobia	O-Sand5	14		615		0.18	17.4
	N-Coal,Shale	15		0.05		0.05	9.4
	M-Sand4	16		362		0.15	6.5
	L-Coal,Shale	17		0.02		0.05	20.3
	K-Sand3	18		856		0.15	7.2
	J-Coal,Shale	19		0.1		0.05	10
	G-Sand2	20		565		0.15	6.6
	F-Coal,Shale	21		0.2		0.05	13.5
	E-Sand A1	22		397		0.12	6.5
	D-Shale1	23		0.01		0.06	4.5
	C-Sand1	24		1008		0.2	13
	B-Coal, Shale	25-26		0.05		0.05	17
Halibut	Halibut	27-31	370	545	0.16	0.17	27
	G	32-39		118		0.13	47.4
	F	40-44		431		0.19	39
	E	45		103		0.08	19.2
	D	46		103		0.08	92
	C	47		94		0.075	3
	B	48		309		0.16	68
	A	49		640		0.17	46

Secondary Seal



Key Seal

Intraformational seal between Halibut and Cobia:
Sand/Coal/Shale sequence:

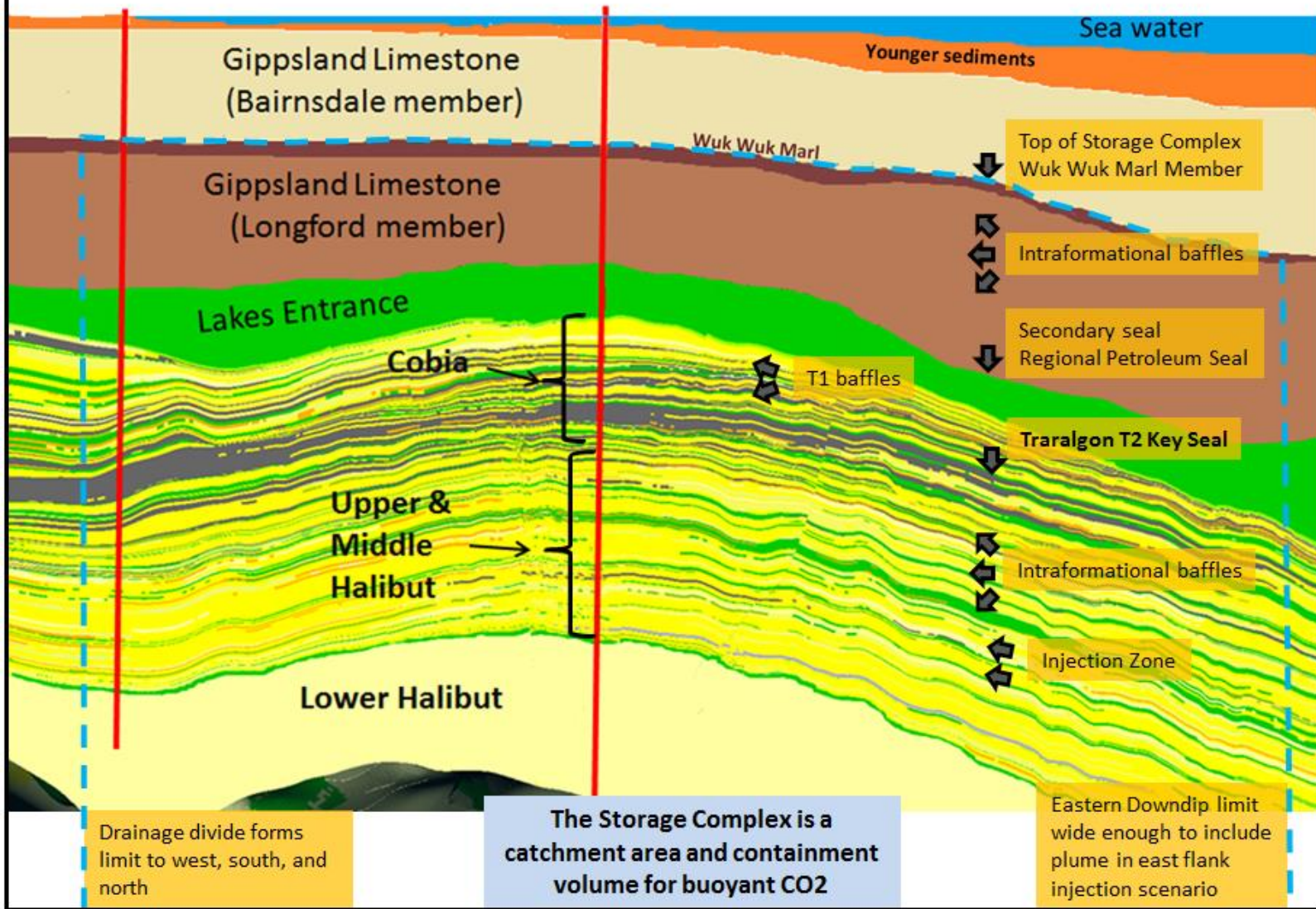
- 71m gross interval
- 45m nett shale and coal

Injection Reservoir

Dynamic model 3.9 million cells (169 x 103 x 222) model.

DYNAMIC MODELLING SUMMARY

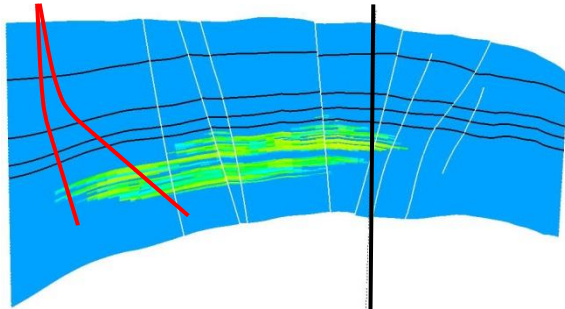
Two wells + 2D and 3D seismic data define the structure



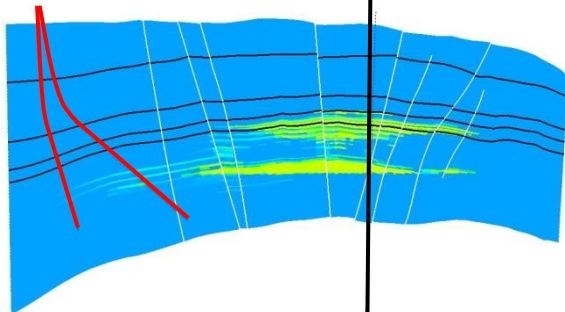
EXAMPLE: Defining a Storage Complex

WEST FLANK INJECTION 80 Mt

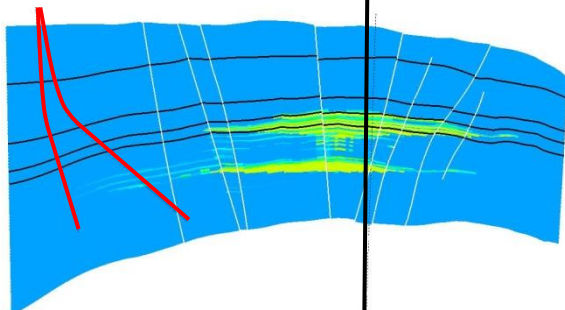
WSW Crest ENE



25 Years



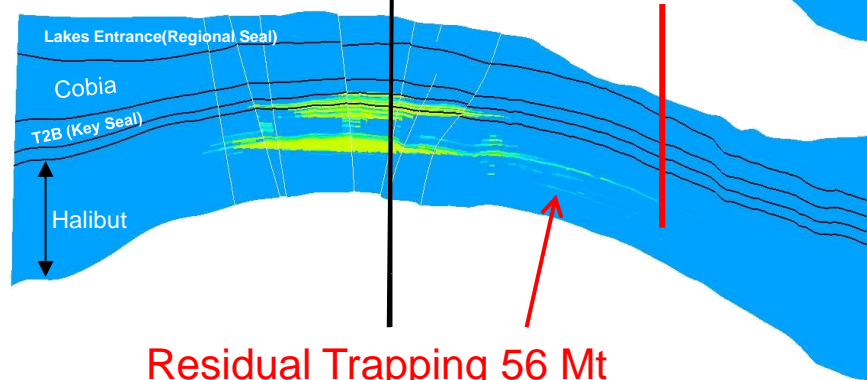
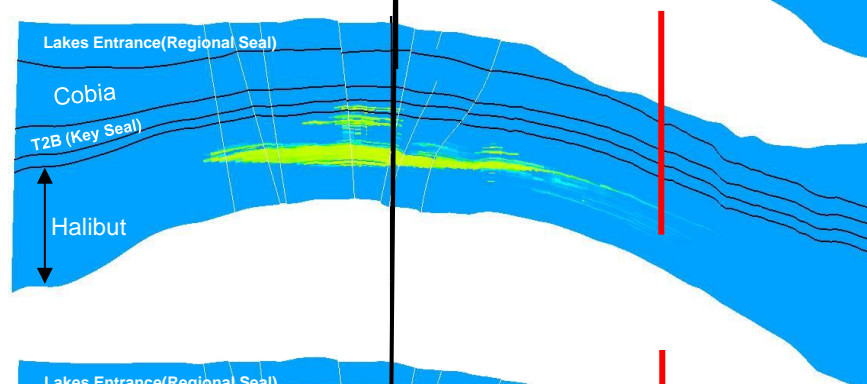
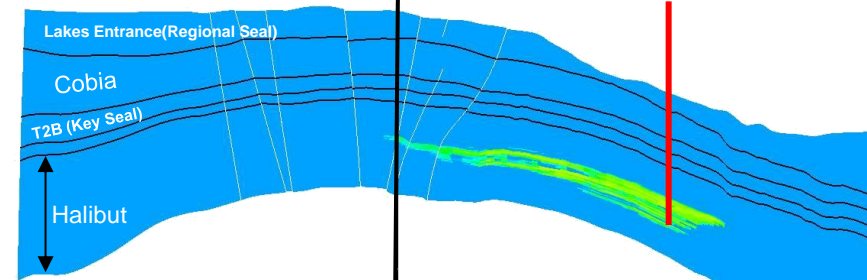
300 Years



1000 Years

EAST FLANK INJECTION 125 Mt

WSW Crest ENE



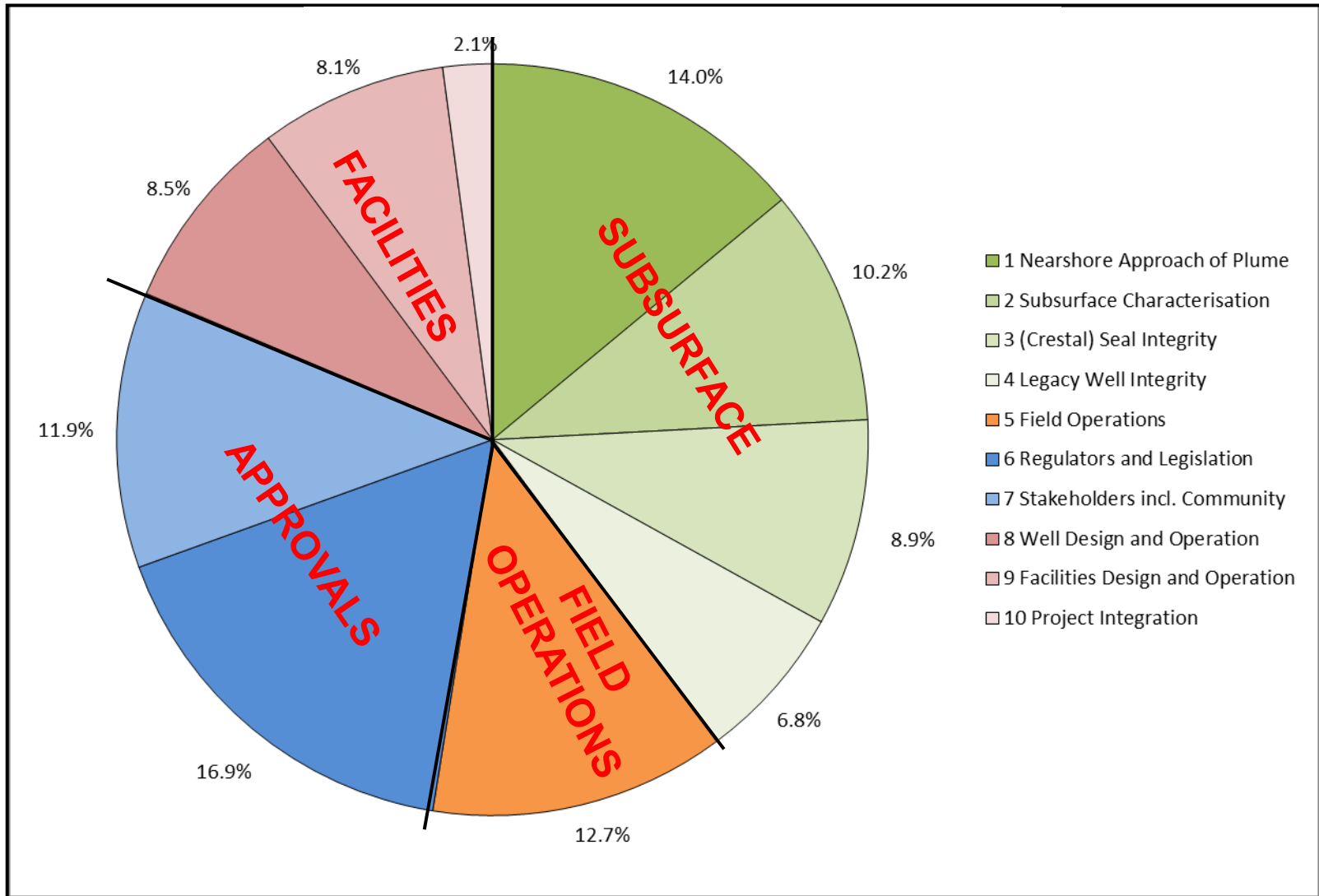
Residual Trapping 56 Mt

EXAMPLE: Injection Scenarios

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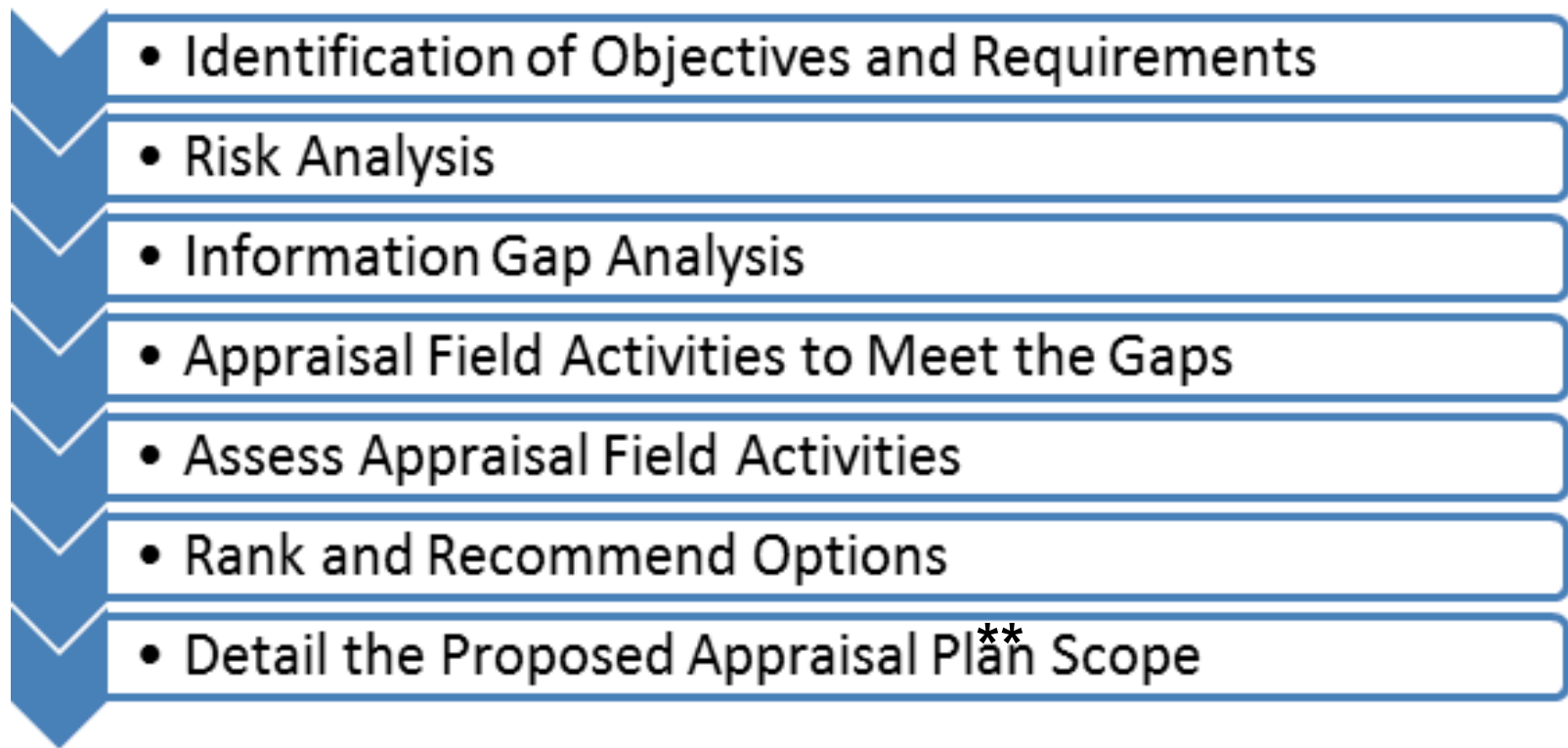
Post-treatment Storage risk (60% of untreated)



Risk Register Evolution: Sept-14 High-level classes

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** includes Value-for-Money analysis

A multi-year work programme is envisaged to Appraise each site – requiring around \$100m of expenditure, so it is important to choose the best site before starting appraisal – see other projects for approaches that were less successful.

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Lessons learned

- **Injectivity, Injectivity, Injectivity**
- Systematic approach with strong process to support decisions
- A good in-house Geoscience and Engineering team
- **Data-rich basin plus Play Fairway** approach ensures viability of storage sites, **but brings other resources into close proximity**
- A high level of government involvement is required at this pre-commercial stage of CCS, **BUT** government procurement process is not ideal for flexibility and speed

Lessons learned

TECHNICAL ISSUES

- **Seal** – “Proving” Containment – can never be ***definitive*** before injection commences
- **Injectivity** – absolutely crucial to ALL projects, especially offshore
- **Capacity** – Must be clear from the start, what is the goal
- **Perceptions** of Stakeholder Reactions (Petroleum operator, Regulator, Community)
- Sensitivity of **Environmental** Footprint
- Sensitivity of Interaction with **Aquifer**
- **“Mind Your Language”** Perceived Sensitivities to Jargon frustrates the technical progress
- Beware Scientific Community challenges ... speciality inputs, Grandstanding,
- Publication restraints – now becoming more open

CLOSING COMMENTS

A satellite map of a coastal region, likely Victoria, Australia, showing a large body of water and surrounding land. A blue rectangular overlay box is positioned in the top left corner.

The CarbonNet Project

Thank You
- Any questions?

Image © 2012 Google

CarbonNet Storage Site Characterisation