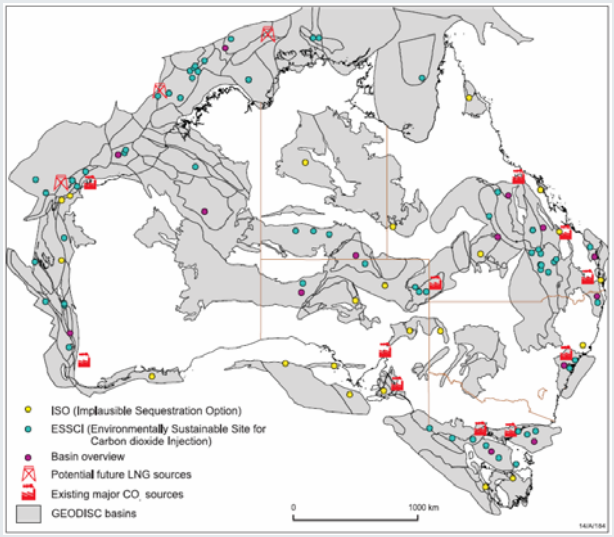
Australian Government

Geoscience Australia

Regional Assessment of Australia's Storage Potential

Rick Causebrook – Geoscience Australia

Geoscience Australia's Involvement in CCS Studies
Australian High Level Storage Potential Studies

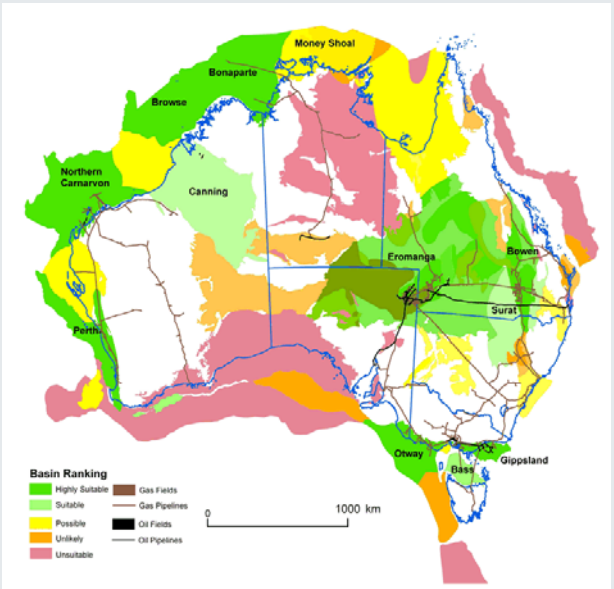


GEODISC 2000

(APCRC)

Increasing world-wide development of methodologies

In between we have also conducted many detailed Regional Studies



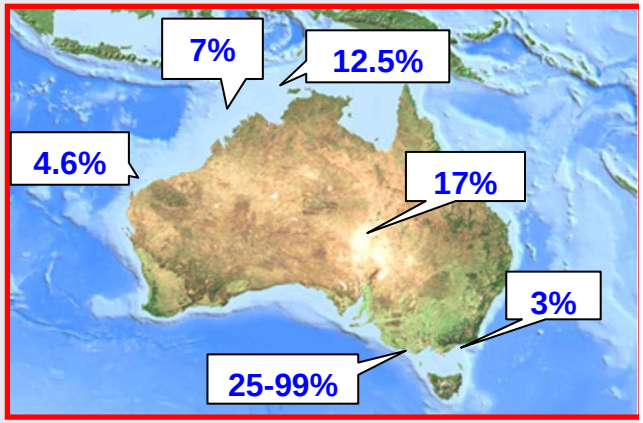
Carbon Storage Task Force 2009

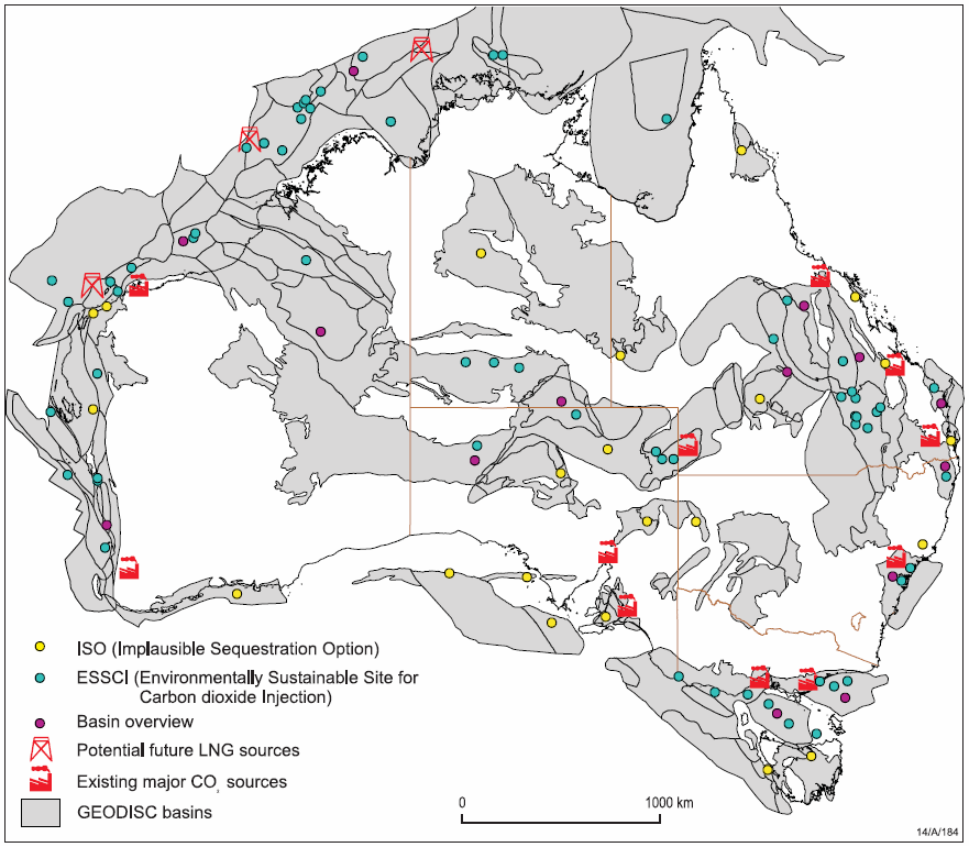
Access to Data

These regional studies could not have completed successfully without access to a considerable amount of exploration data.

In Australia data and samples submitted under Commonwealth and State legislation is held for public use at Geoscience Australia and by State Geological Surveys

Mapping the storage potential of Australia's sedimentary basins - The first significant attempt





GEODISC (APCRC) 1999-2003

- First review of sedimentary basins & creation of portfolio of storage options
- Carried out under the APCRC
- 48 basins (out of >300)
- 65 sites (out of 102) viable and ranked based on capacity, injectivity, technical & economic viability, containment, existing resources
- Disparity between sources & sinks
- Theoretically >1600 years of storage
- Realistically 100-115Mt/y

Carbon Storage Task Force
GHG Storage Project 2009

Reasons behind study

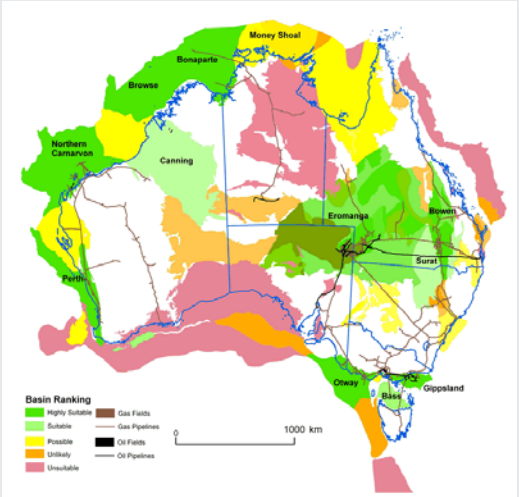
- Carbon Storage Task Force
- Established by Australian Government in October 2008 under the:
- National Low Emissions Coal Initiative
- to develop the
- National Carbon Mapping and Infrastructure Plan

Geological Storage Assessment Participants

- Geoscience Australia
- Department of Primary Industries Victoria
- Department of Employment, Economic Development and Innovation , Queensland
- Department of Mines and Petroleum, WA
- Department of Primary Industries, NSW
- Department of Primary Industries and Resources, SA

Carbon Storage Task Force
Basin Ranking and Capacity

- Updated high level assessment completed 2009
  - Development of prospectiviy and capacity assessment methodologies
  - New information from recent regional and basin studies
  - Basins summarised and ranked using publicly available data (OPA)
- Outcomes
  - Basins ranked
  - Eliminated small eastern basins & other poor, but convenient, sites
  - Identified and documented prospective and non-prospective basins
  - Scientific rationale for recommendations regarding priorities for future study and data acquisition programmes



Process

1. Critical Geologic Inputs
   - Distribution of top and fault seal (containment)
   - Criteria - Seismic activity, Size, **Depth***, Type, **Fault seal***, Hydrogeology, Geothermal gradient, Hydrocarbon potential, Basin maturity, Coal and CBM, **Reservoir*, Seal integrity*, Reservoir/Seal pairs***, Onshore/offshore, Climate, Accessibility, Infrastructure, CO_2 sources, Knowledge level & Data availability
   - Basin outlines - single agreed set
   - Key boundary issues
     - 800 m top aquifer (supercritical phase change)
     - 3500 m top of basal aquifer (generous)
     - 250 m bathymetric contour
   - Distribution of oil & gas fields

2. Just geology – nothing discounted on economic, resource conflict, commercial, logistical issues

Process continued

- Development of project
  - Easily updated- common platform ArcGIS v9.2
- Ranking of basins
  - Modified after Bachu (2003)
  - ‘zeroed’ on non geologic factors – just the rocks
  - Weighted heavily toward seal and reservoir-containment is the priority at this scale
  - 5 colour class code
- Capacity- using DOE 2008 simple formula
  - Efficiency set between 0.5-5%
  - Order of magnitude calculation
  - Input parameters ‘Monte Carlo’

“Modified Bachu” Ranking Criteria

Basin Ranking Criteria		Note: Any changes to the definition of Criteria should be made in this table only					
	Basin Criterion	Classes					
		1	2	3	4	5	Weighting
1	Tectonics (Seismicity)	High	High/Medium	Medium	Medium/Low	Low	0.00
2	Size	Small (<5000km2)	Medium (5000-25000km2)	Large (25000-50000km2)	Very Large (>50000km2)		0.06
3	Depth	Shallow (<1,500m)	Deep (>3,500m)	Intermediate (1,500 - 3,500m)			0.10
4	Type	Non-marine	Non-marine and marine	Marine			0.04
5	Faulting intensity	Extensive	Moderate	Limited			0.14
6	Hydrogeology	Poor (fractured rock system, short flow system)	Intermediate (faulted-fractured rock system, intemediate flow)	Good (regional, long-range flow systems; topography or erosional flow			0.04
7	Geothermal	Warm basin (>40°C/km)	Moderate (30-40oC/km)	Cold basin (<30°C/km)			0.05
8	Hydrocarbon potential	None	Small	Medium	Large	Giant	0.05
9	Maturity	Unexplored	Exploration	Developing	Mature	Over-mature	0.05
10	Coal and CBM	None	Shallow (200-800m)	Deep (>800m)			0.00
11	Reservoir	None	Potential	Poor	Good	Excellent	0.16
12	Seal	None	Potential	Poor	Good	Excellent	0.18
13	Reservoir/Seal Pairs	None	Poor	Good (Single)	Excellent (Multiple)		0.03
14	Onshore / offshore	Deep offshore (>200 m)	Shallow offshore (<200 m)	Onshore			0.00
15	Climate	Harsh	Desert	Tropical	Subtropical	Temperate	0.00
16	Accessibility	Inaccessible	Difficult	Acceptable	Easy		0.00
17	Infrastructure	None	Minor	Moderate	Extensive		0.00
18	CO2 sources	None	Few	Moderate	Major		0.00
19	Knowledge level	Limited	Moderate	Good	Extensive		0.05
20	Data availability	Poor	Moderate	Good	Excellent		0.05

After Bachu 2003

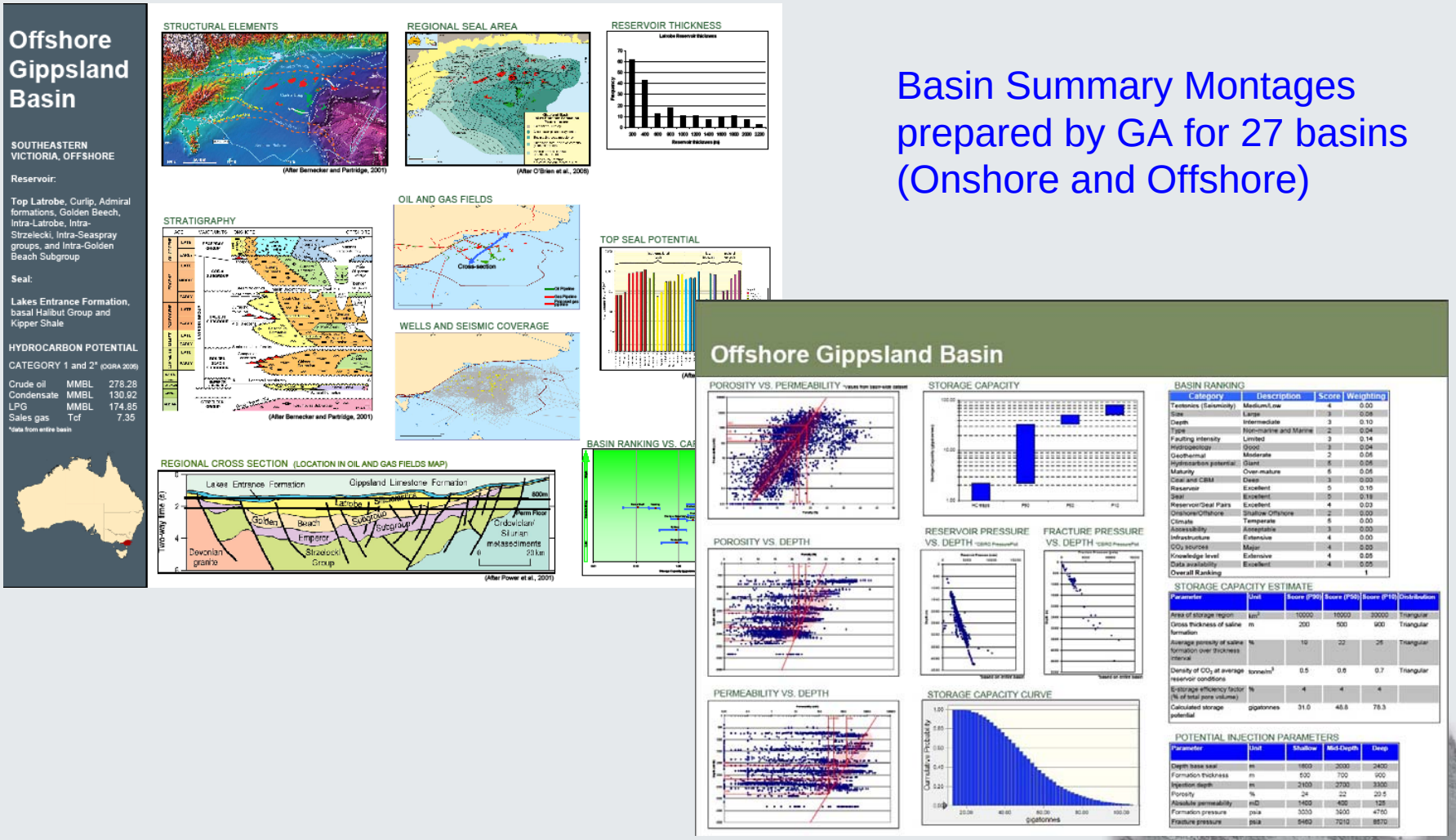
"Modified Bachu" Basin Ranking Schema

			Weightings:-		0.00	0.04	0.10	0.04	0.14	0.04	0.05
State	**Onsghore**	**Basin Name**	**Total Score**	**Ranking**	**Seismicity**	**Size**	**Depth**	**Type**	**Fault seal**	**Hydrogeology**	**Geothermal gradient**
VIC	Offshore	Gippsland Basin	0.92	1	4	3	3	2	3	3	2
WA	offshore	North Perth Basin	0.82	2	4	4	3	2	2	3	2
SA	Onshore	Eromanga Basin	0.79	3	4	4	3	1	3	3	1
WA	offshore	Northern Carnarvon Basin	0.78	4	5	4	3	2	1	2	2
SA	Onshore	Cooper Basin	0.69	5	5	3	3	2	2	3	1
WA	offshore	Browse Basin	0.68	6	5	4	3	3	2	1	2
QLD	Onshore	Bowen	0.67	7	4	3	3	2	2	3	3
WA	offshore	Northern Bonaparte	0.65	8	5	4	3	2	1	3	2
SA	Offshore	Otway Basin	0.63	9	3	3	3	1	1	3	3
NT	offshore	Money Shoal	0.62	10	3	4	3	2	3	2	3
QLD	Onshore	Galilee	0.62	11	5	4	3	2	3	3	1

Input for Monte Carlo Simulation for Capacity Estimation

Parameter	Unit	Score (P90)	Score (P50)	Score (P10)	Distribution
Area of storage region	km^2	10000	16000	30000	Triangular
Gross thickness of saline formation	m	200	500	900	Triangular
Average porosity of saline formation over thickness interval	%	19	22	25	Triangular
Density of CO_2 at average reservoir conditions	t/m3	0.5	0.6	0.7	Triangular
E-storage efficiency factor (% of total pore volume)	%	4	4	4	
Calculated storage potential	gigatons	31.0	48.8	78.3	

Basin assessment

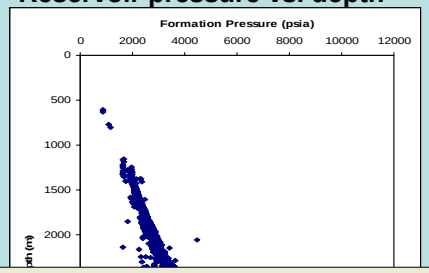


Basin Summary Montages prepared by GA for 27 basins (Onshore and Offshore)

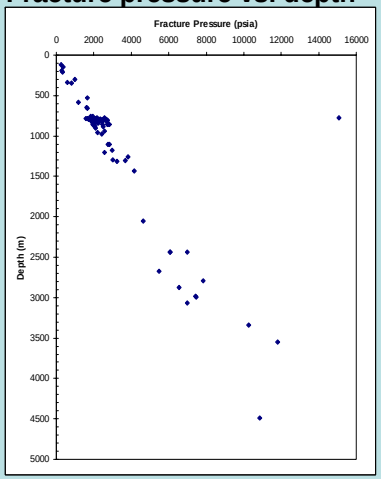
Storage capacity estimate

Parameter	Unit	Score (P90)	Score (P50)	Score (P10)	Distribution
Area of storage region	km^2	10000	16000	30000	Triangular
Gross thickness of saline formation	m	200	500	900	Triangular
Average porosity of saline formation over thickness interval	%	19	22	25	Triangular
Density of CO_2 at average reservoir conditions	t/m3	0.5	0.6	0.7	Triangular
E-storage efficiency factor (% of total pore volume)	%				
Calculated storage potential	gigatons	3			

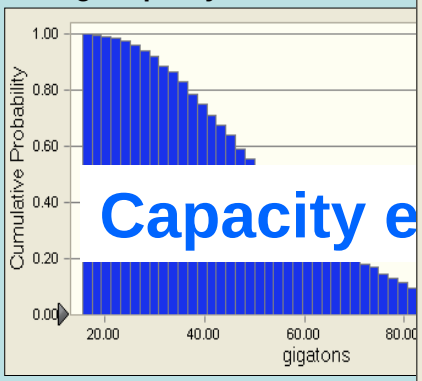
Reservoir pressure vs. depth

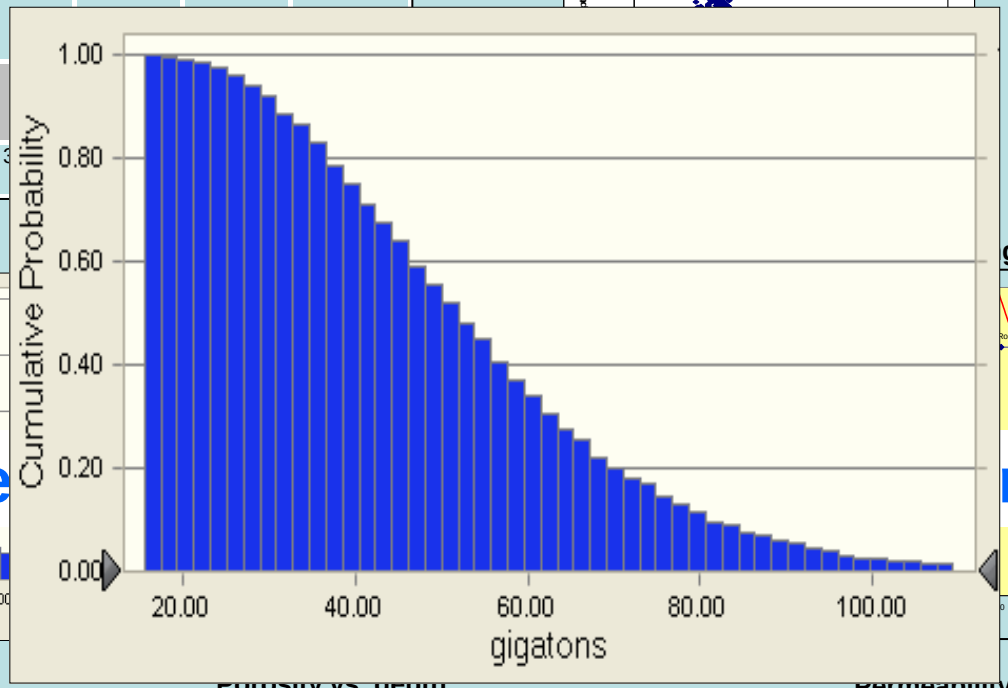


Fracture pressure vs. depth

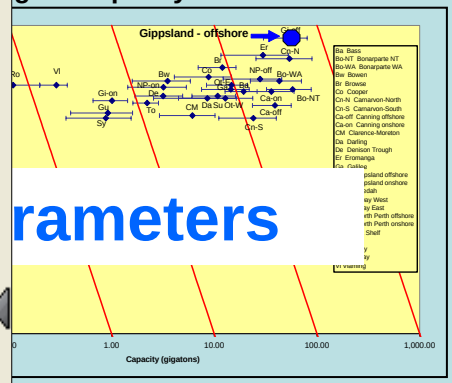


Storage capacity curve

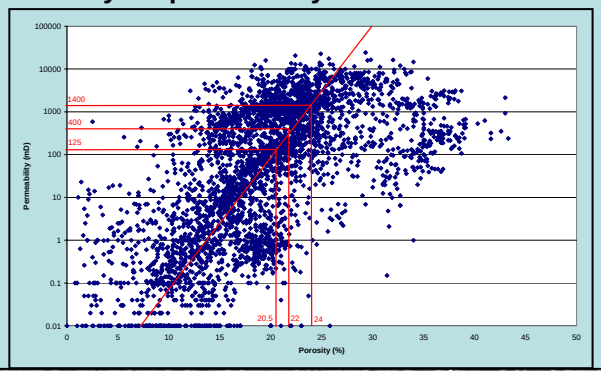




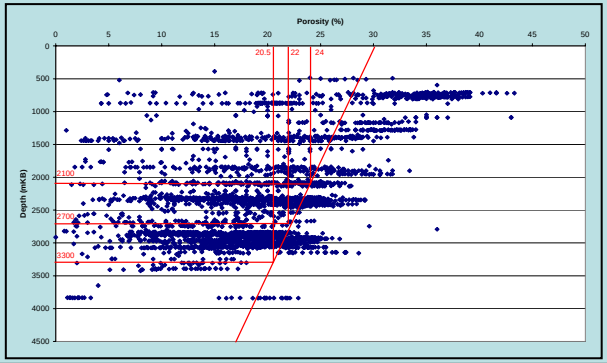
g vs. capacity



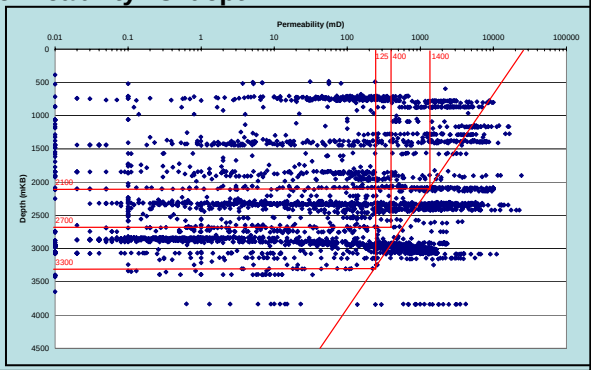
Porosity vs. permeability



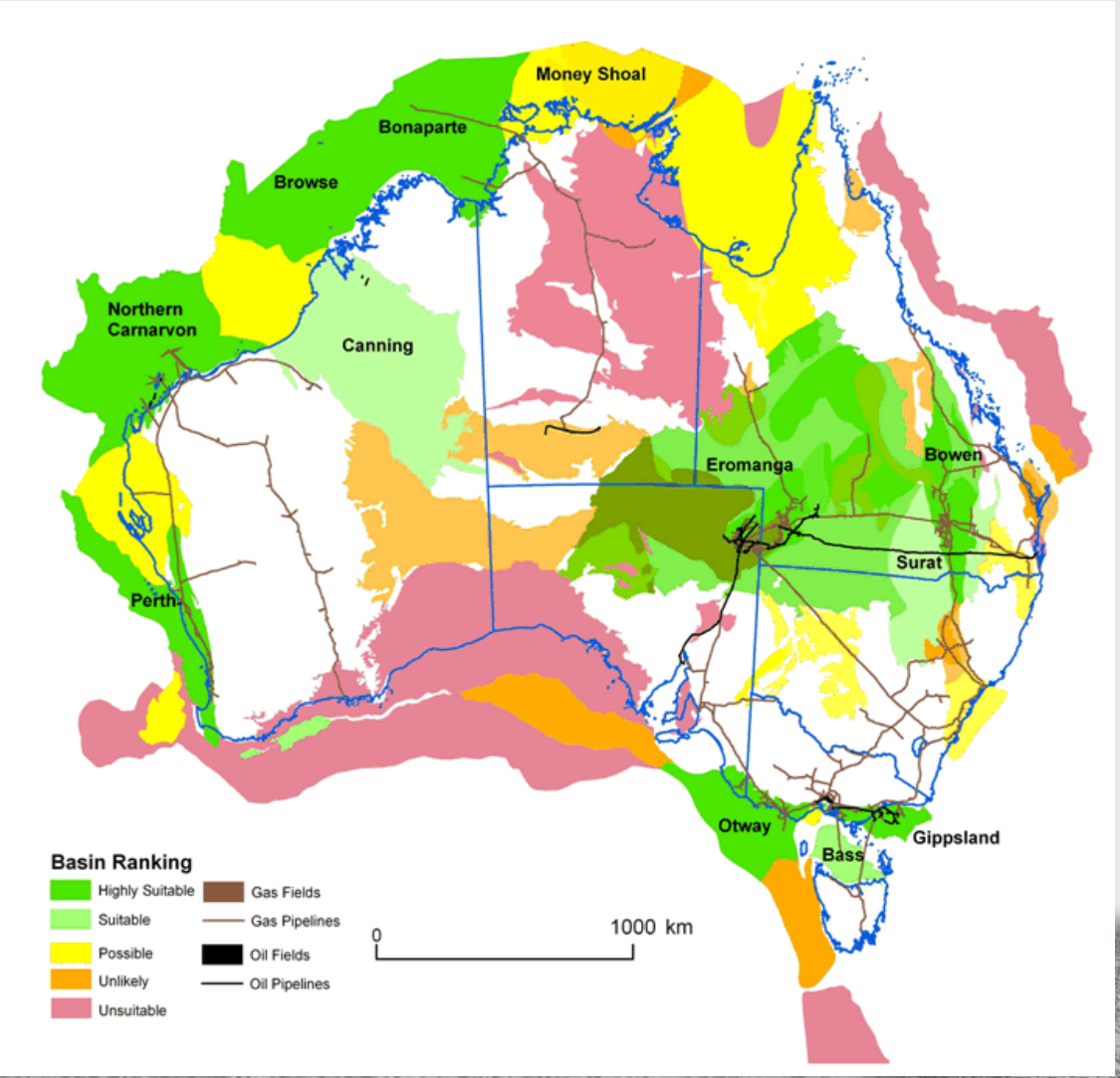
Porosity vs. depth



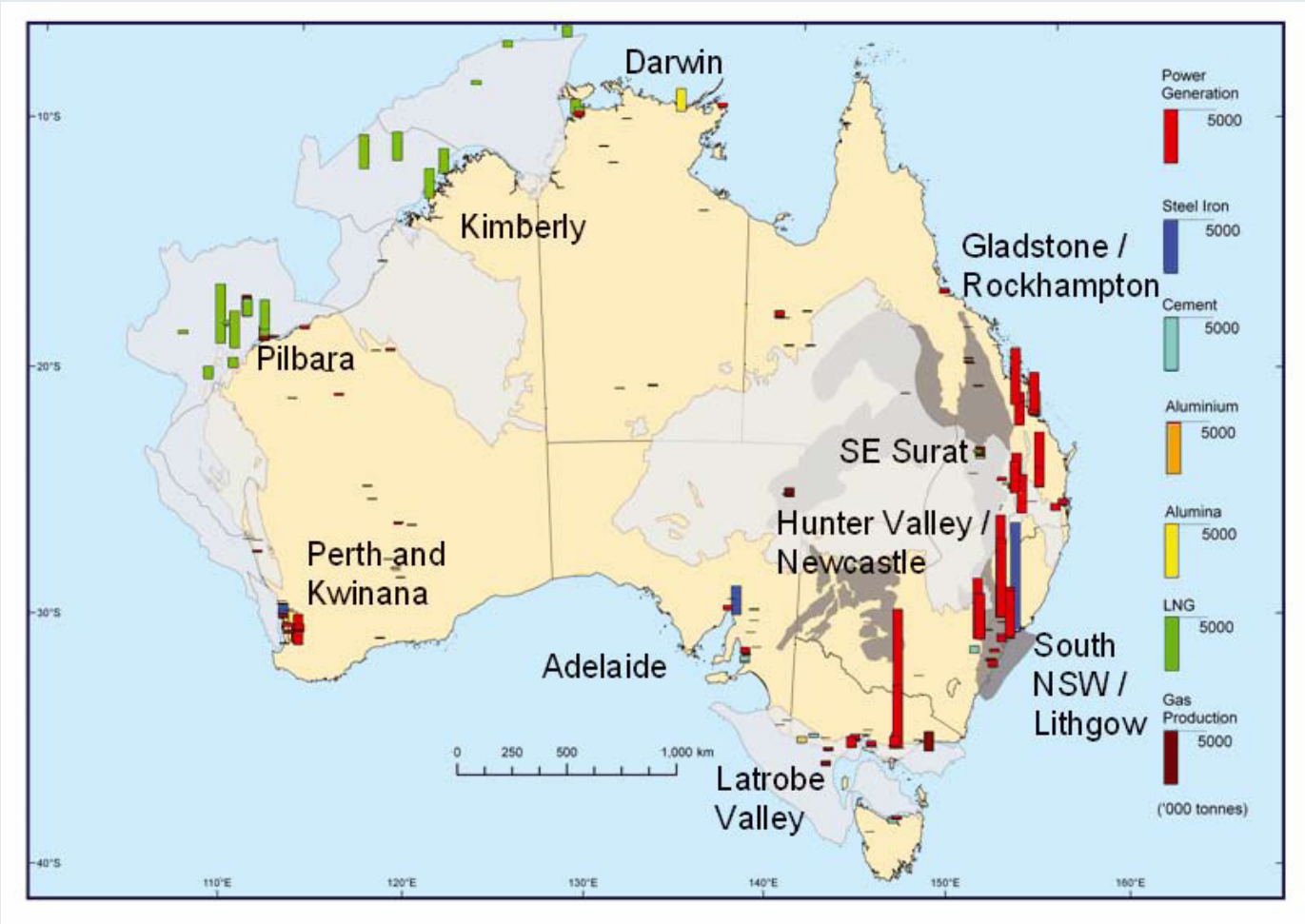
Permeability vs. depth



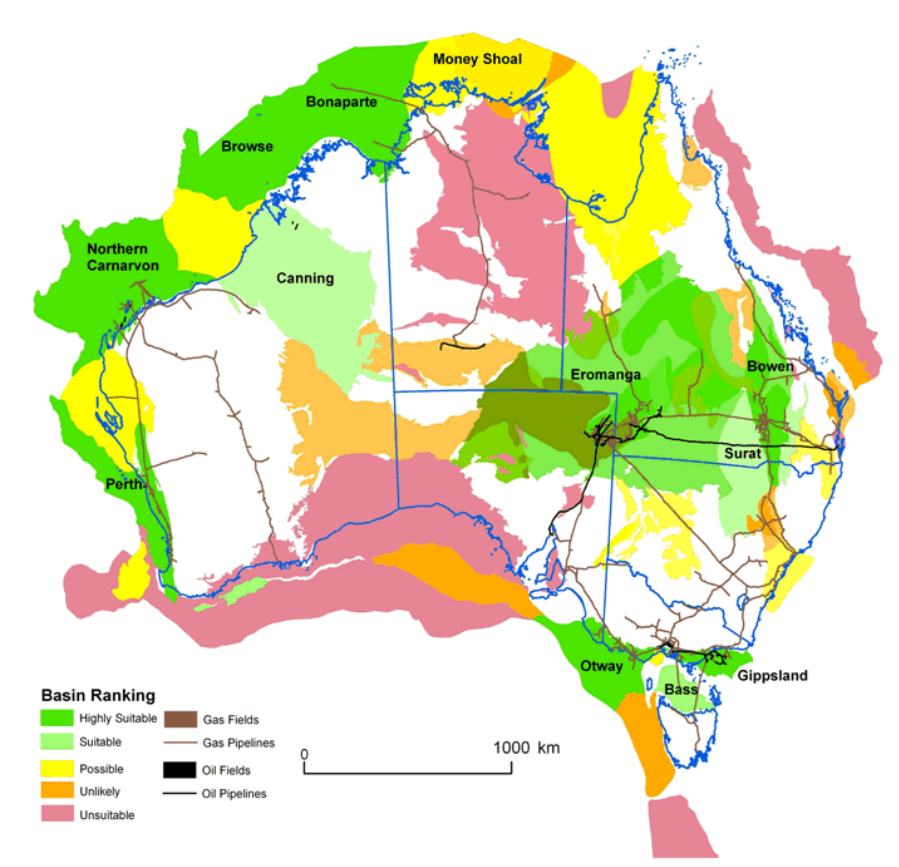
CCS Prospectivity of Australian Basins



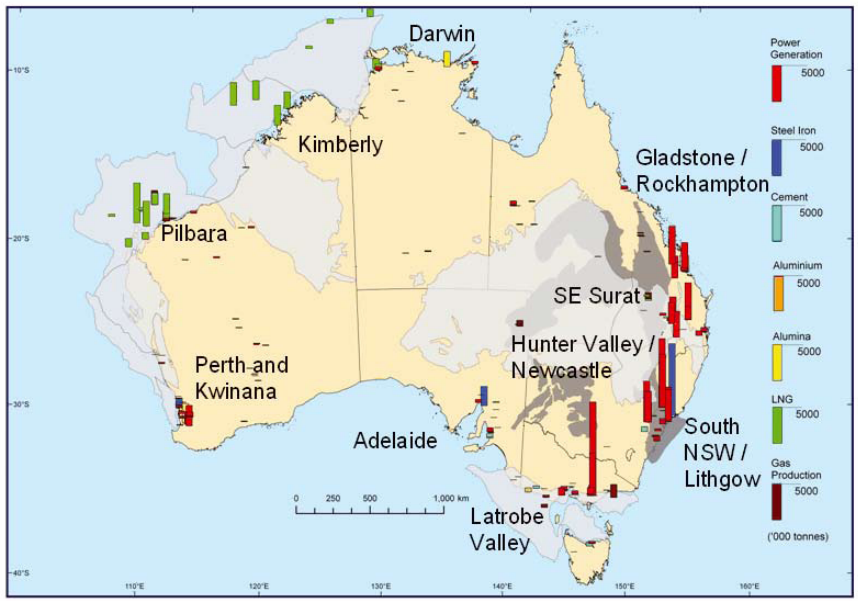
Geographical distribution of emissions by industry estimated for 2020



Carbon Storage Taskforce 2009, *National Carbon Mapping and Infrastructure Plan – Australia: Concise Report*, Department of Resources, Energy and Tourism, Canberra.



Australia's Storage Prospectivity as understood in 2009



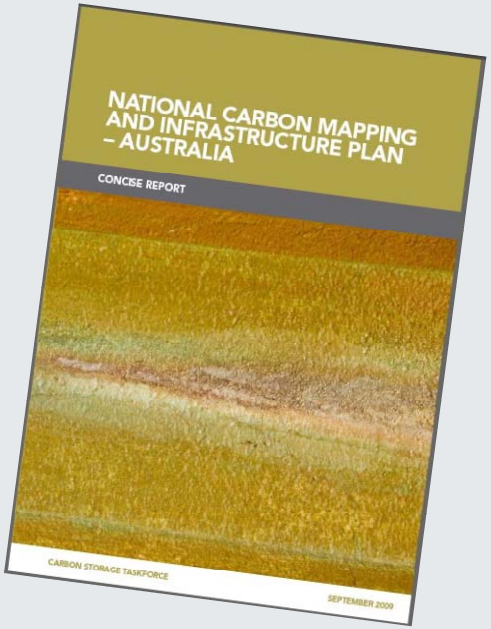
Geographical distribution of emissions by industry estimated for 2020

Engineering and economic analyses

- These basin analyses formed the input to high level engineering and economic assessments involving conceptual pipeline length and well number to transport and inject an industrial scale volume > ~40 Mtpa for 25yrs

National Carbon Mapping and Infrastructure Plan-Australia

- Concise report delivered to the Minister of Resources and Energy in September 2009
- Released publically December 2009
- http://www.ret.gov.au/resources/resources_programs/nleci/cst/Pages/default.aspx



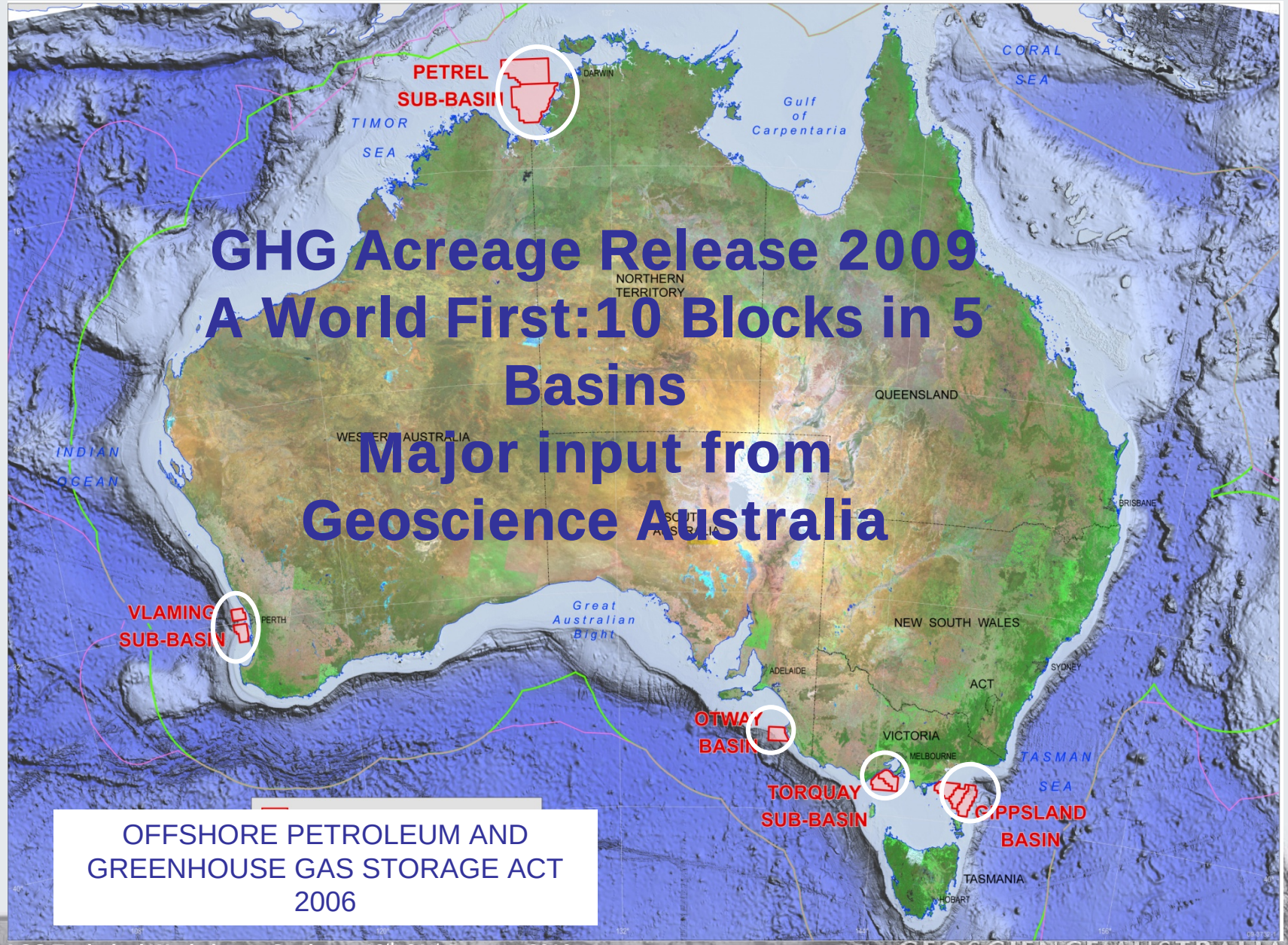
Conclusions on Storage Capacity

- There is high confidence that the east of Australia has aquifer storage capacity for 70 -450 years at a storage rate of 200 Mtpa, and that the west of Australia has capacity for 260-1120 years at 100 Mtpa, with the possibility that a far greater capacity will be defined as basins and their CO2 storage behaviour become better known.

Carbon Storage Task Force 2009, National Carbon Mapping and Infrastructure Plan – Australia: Concise report, Department of Resources, Energy and Tourism, Canberra.

National Carbon and Infrastructure Plan

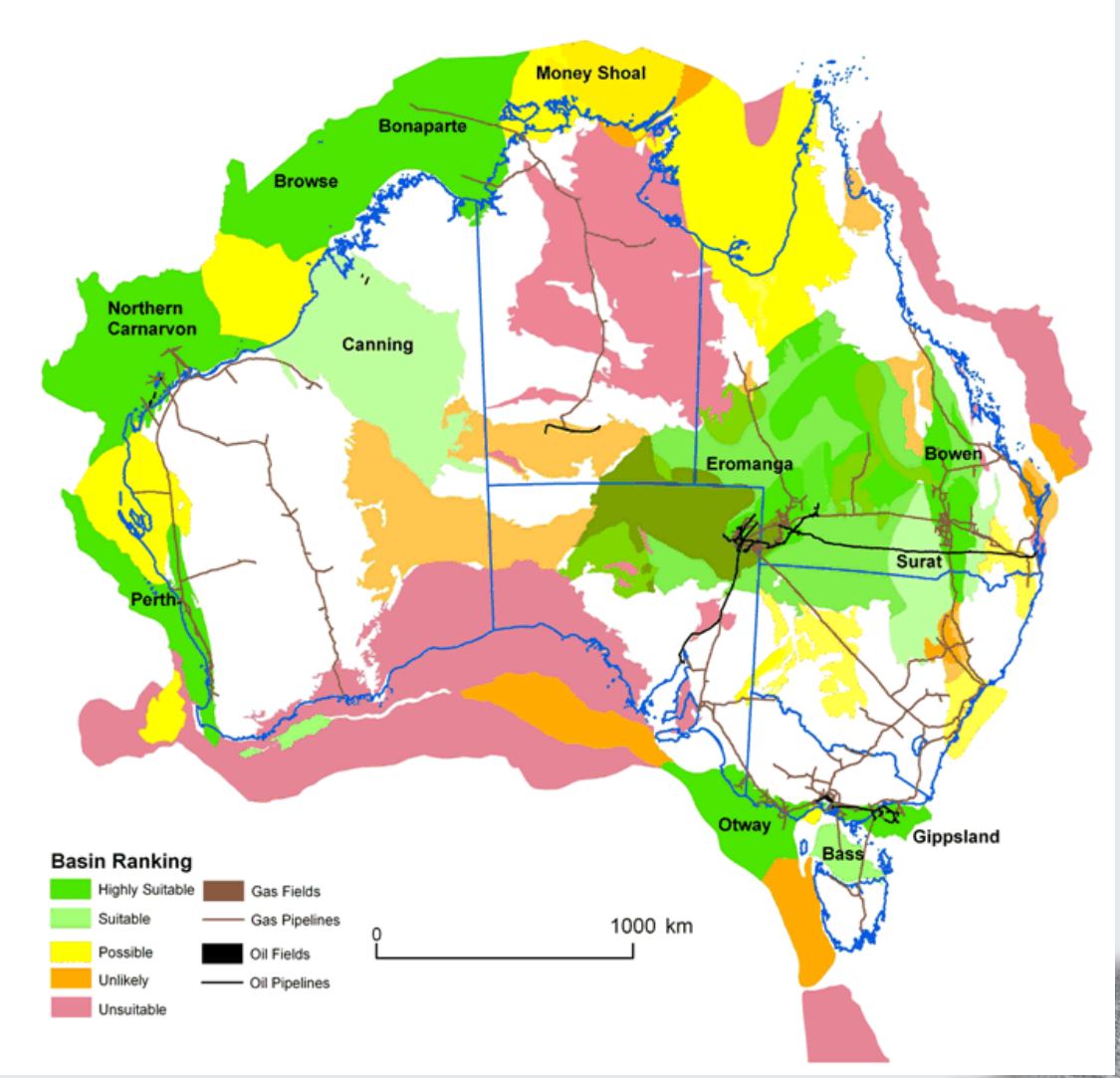
- Element 1: Pre-Competitive Exploration Programme:
  - Recommended acquisition of strategic data by State and Commonwealth Governments to encourage exploration.
- Element 2: Exploration:
  - Acreage release under OPGGSA 2006
- Element 3: Demonstration:
  - Encouragement of significant scale (>1Mtpa) projects



GHG Acreage Release 2009
A World First:10 Blocks in 5 Basins
Major input from Geoscience Australia

OFFSHORE PETROLEUM AND GREENHOUSE GAS STORAGE ACT 2006

Questions?


Money Shoal
Bonaparte
Browse
Northern Carnarvon
Canning
Eromanga
Bowen
Surat
Perth
Otway
Bass
Gippsland
Basin Ranking
Highly Suitable
Suitable
Possible
Unlikely
Unsuitable
Gas Fields
Gas Pipelines
Oil Fields
Oil Pipelines
0
1000 km