Tables

TABLE 1—SHALE RANKING PARAMETERS						
Ranges	**Parameters**	**Score**				
1-10 wt. %	TOC Class	<1.0	1.0-3.0	3.0-6.0	6.0-9.0	>9.0
	Points	0	4	6	8	10
0.5-2.0 R_0	R_0 Class	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	>2.0
	Points	0	4	6	8	10
0<S_2<30	Rock Potential	<2	2.0-5.0	5.0-10.0	10.0-20.0	>20
	Points	0	4	6	8	10
50-300 ft	Shale Thickness	<50	50-100	100-200	200-300	>300
	Points	2	4	6	8	10
2-8%	Gas Field Porosity	<2.0	2.0-4.0	4.0-6.0	6.0-8.0	>8.0
	Points	0	4	6	8	10
50-15%	Clay Content	>60	45-60	30-45	15-30	<15
	Points	2	4	6	8	10
15-60%	Qtz / CaCO3 Content	<15	15-30	30-45	45-60	>60
	Points	2	4	6	8	10
4.0-1.0	CST Ratio	>4.0	3.0-4.0	2.0-3.0	1.0-2.0	<1.0
	Points	2	4	6	8	10
1-9 per ft	Fracture Intensity	0	1.0-3.0	4.0-6.0	7.0-9.0	>9
	Points	2	4	6	8	10
0.4-0.7 psi/ft	Pressure Gradient	<0.4	0.4-0.5	0.5-0.6	0.6-0.7	>0.7
	Points	2	4	6	8	10

Table 2—CANNING BASIN SHALE CHARACTERISTICS COMPARED WITH AVERAGE OF RECENT US SHALE GAS PLAY											
	Ave US Play	**Goldwyer**	**Laurel**	**Gogo**	**Ander.**	**Noon.**	**Nita**	**Grant**	**Poole**	**Reeves**	**Carribuddy**
Estimated Area, km²	66 770	530 000	530 000	530 000	530 000	530 000	530 000	530 000	530 000	530 000	530 000
Age, Period	Paleozoic	Ordovician	Mississ.	Devonian	Mississ.	Permian	Ordovician	Permian	Permian	Pennsyl.	Ordovician
Play Type	Bl/ Gr Sh	Green/bl Sh, Ls/Sts	Gr-bl Sh, Ss/minor Ls	Gr to bl silty Sh	Med-dark gr Sh, Sts/Ss	Dark Sh, Sts/minor Ss	Ls, gr/ green/ red Sh	Ss, Sh/Sts	Ss / Sh	Ss	Sh / evaporites
Sub Play	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic	Thermo-genic
Maturation, R_0 percent	1.5	1.0	0.8	0.7	1.1	0.7	0.5	0.8	0.6	1.2	0.9
Richness, TOC percent	6.4	ave 0.6, max 6.4	ave 0.7, max 4.8	ave 0.5, max 4	ave 0.6, max 3.3	ave 1.8, max 4.8	ave 0.3, max 4.0	ave 0.6, max 4.8	ave 3.2, max 5.3	ave 1.1, max 3.7	ave 0.2, max 1.9
Porosity, percent	7.4	8.8	13.9	8.7	12.4	16.6	6.6	17.3	17.7	15.1	7.2
Mineralogy, % non-clay	60	40-80	56	80	44	23	97	7	90	21	30
Thickness, m	98	408	553	421	384	328	120	740	97	423	712
Depth, m	1787	1011	1593	1839	1649	483	1394	770	760	1596	926
Pressure Gradient, psi/ft	0.5	0.6	0.4	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Vertical Well, EUR / Bcfe	1.2	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Horizontal Well, EUR /	2.4	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Natural Fractures	Critical	Exist	Exist	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
GIIP, Tcf; EIA 2012	335	764	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Tech. Recoverable Resource, Tcf; EIA 2012	69	229	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Ls: limestone, Sts: Siltstone, Ss: Sandstone, Sh: shale, gr: grey, bl: black											

TABLE 3—RESULTS OF SHALE RANKINGS IN THE CANNING BASIN										
Parameters	**Goldw**	**Laurel**	**Gogo**	**Ander**	**Noon.**	**Nita**	**Grant**	**Poole**	**Reeve**	**Carr.**
TOC Class	8	6	6	6	6	4	6	6	6	4
R_0 Class	8	4	4	6	4	4	4	4	6	4
Rock Potential	4	10	0	4	0	4	4	0	0	0
Shale Thickness	10	10	10	10	10	4	10	4	10	10
Gas Field Porosity	10	10	10	10	10	8	10	10	10	8
Clay Content	8	4	8	4	10	10	2	10	2	0
Qtz / CaCO3 Content	6	6	8	4	4	10	6	4	4	6
CST Ratio	4	2	2	2	2	2	2	2	2	2
Fracture Intensity	4	4	2	2	2	2	2	2	2	2
Pressure Gradient	6	4	4	2	2	2	2	2	2	2
Total	68	60	54	50	50	50	48	44	44	38

TABLE 4—DETERMINISTIC CALCULATION OF UN-RISKED GIIP OF GOLDWYER III SHALE

Description	Barnett Shale (Base Case)	Goldwyer III Sector Thickness (m) 0-50	50-100	100-150	150-200	200-250	250-300	Total
TOC_{pd}	4.09	1.70	1.70	1.70	1.70	1.70	1.70	
TOC_o, wt. %, estimated ave	6.41	1.87	1.87	1.87	1.87	1.87	1.87	
TOC_c,wt. %, measured ave	2.32	0.17	0.17	0.17	0.17	0.17	0.17	
Original Generation Potential (S_2), mg HC/g rock	27.84	8.70	8.70	8.70	8.70	8.70	8.70	
Estimated oil generated from kerogen (70% of total), bbl/ac-ft	426.61	133.31	133.31	133.31	133.31	133.31	133.31	
Estimated gas generated from kerogen (30% of total), MMcf/ac-ft	1097.00	342.80	342.80	342.80	342.80	342.80	342.80	
Source rock thickenss, ft	350.00	82.00	126.00	410.00	574.00	738.00	902.00	
Area, sq m	1500.00	1055.60	450.97	3151.95	4005.81	3419.71	347.88	
Primary oil generated from kerogen, Bcf/section	573.36	41.98	125.93	209.88	293.84	377.79	461.74	
Primary gas generated from kerogen, Bcf/section	245.73	17.99	53.97	89.95	125.93	161.91	197.89	
Total HC from primary cracking of kerogen, Bcfe/section	819.09	59.97	179.90	299.83	419.77	539.70	659.63	
Expulsion factor	0.60	0.70	0.70	0.70	0.70	0.80	0.80	
Oil expelled, bbl/ac-ft	255.97	93.32	93.32	93.32	93.32	106.65	106.65	
Gas expelled, MMcf/ac-ft	658.20	239.96	239.96	239.96	239.96	274.24	274.24	
Primary oil retained in shale, bbl/ac-ft	170.64	39.99	39.99	39.99	39.99	26.66	26.66	
Primary gas retained in shale, MMcf/ac-ft	438.80	102.84	102.84	102.84	102.84	68.56	68.56	
Correction factor for insufficient hydrogen in oil	0.47	0.47	0.47	0.47	0.47	0.47	0.47	
Gas yield from secondary cracking, MMcf/ac-ft	481.22	112.78	112.78	112.78	112.78	75.19	75.19	
Total retained gas (primary plus secondary), MMcf/ac-ft	920.02	215.62	215.62	215.62	215.62	143.75	143.75	
Total retained HC, Bcf/section	206.08	11.32	33.95	56.58	79.21	67.89	82.98	
Resources, Bcf	309 124.57	11 944.91	15 309.05	178 332.57	317 330.25	232 178.59	28 867.59	783 962.96
Total GIIP, Tcf								**783.93**

TABLE 5—DETERMINISTIC CALCULATION OF UN-RISKED GIIP OF LOWER LAUREL SHALE

Description	Barnett Shale (Base Case)	Lower Laurel Sector Thickness (m) 0-50	50-100	100-200	200-300	Total
TOC_{pd}	4.09	1.63	1.63	1.63	1.63	
TOC_o, wt. %, estimated ave	6.41	1.84	1.84	1.84	1.84	
TOC_c,wt. %, measured ave	2.32	0.21	0.21	0.21	0.21	
Original Generation Potential (S_2), mg HC/g rock	27.84	4.60	4.60	4.60	4.60	
Estimated oil generated from kerogen (70% of total), bbl/ac-ft	426.61	70.49	70.49	70.49	70.49	
Estimated gas generated from kerogen (30% of total), MMcf/ac-ft	1097.00	181.25	181.25	181.25	181.25	
Source rock thickenss, ft	350.00	82.00	246.00	350.00	450.00	
Area, sq m	1500.00	347.88	347.88	347.88	347.88	
Primary oil generated from kerogen, Bcf/section	573.36	22.19	66.58	94.73	121.80	
Primary gas generated from kerogen, Bcf/section	245.73	9.51	28.54	40.60	52.20	
Total HC from primary cracking of	819.09	31.71	95.12	135.33	174.00	
Expulsion factor	0.60	0.60	0.60	0.60	0.60	
Oil expelled, bbl/ac-ft	255.97	42.29	42.29	42.29	42.29	
Gas expelled, MMcf/ac-ft	658.20	108.75	108.75	108.75	108.75	
Primary oil retained in shale, bbl/ac-ft	170.64	28.19	28.19	28.19	28.19	
Primary gas retained in shale, MMcf/ac-ft	438.80	72.50	72.50	72.50	72.50	
Correction factor for insufficient hydrogen in oil	0.47	0.47	0.47	0.47	0.47	
Gas yield from secondary cracking, MMcf/ac-ft	481.22	79.51	79.51	79.51	79.51	
Total retained gas (primary plus secondary), MMcf/ac-ft	920.02	152.01	152.01	152.01	152.01	
Total retained HC, Bcf/section	206.08	7.98	23.93	34.05	43.78	
Resources, Bcf	309 124.57	17 390.65	6 560.56	74 228.40	95 436.49	193 616.1
Total GIIP, Tcf						**193.62**

TABLE 6—PROBABILISTIC ESTIMATION OF UN-RISKED GIIP FOR GOLDWYER III AND LOWER LAUREL SHALES

Sector	Goldwyer III			Lower Laurel		
	P90	P50	P10	P90	P50	P10
Sector 1	10.7	18.2	30.2	14.1	20.1	28.6
Sector 2	13.6	16.4	19.6	5.4	6.5	7.8
Sector 3	211.1	249.2	287.9	71.2	90.5	119.3
Sector 4	271.9	315.9	364.6	101.4	154.4	244.1
Sector 5	204.2	239.0	281.0			
Sector 6	24.7	28.7	33.1			
Total (Tcf)	**736.2**	**867.4**	**1016.4**	**192.1**	**271.5**	**399.8**

Table 7—COMPARISON OF VOLUMETRIC ESTIMATES FOR CANNING BASIN SHALE GAS (TCF)

	Goldwyer III		Goldwyer Fm.			Lower Laurel		Laurel Fm.
	Triche and Bahar		ACOLA 2013	EIA 2013	EIA 2011	Triche and Bahar		ACOLA 2013
	Determ-inistic	Probab-ilistic				Determ-inistic	Probab-ilistic	
GIIP	783.9	867.4	2580.0*	2496*	2547*	193.6	271.5	420*
Recoverable Resource	117.6	130.1	387.0	374.4*	382.1*	29.0	40.7	63.0
Risked GIIP (50% RF)	392.0	433.7	1290*	1248*	1273.5*	96.8	135.8	210*
Risked GIIP (30% RF)	235.2	260.2	774*	748.7	764.0	58.1	81.5	126*
Risked Recoverable Resource (30% RF, 15% ReF)	35.3	39.0	116.1*	112.3*	114.6*	8.7	12.2	18.9
Risked Recoverable Resource (30% RF, 20% ReF)	47.0	52.0	154.8*	149.7	152.8*	11.6	16.3	25.2*
Risked Recoverable Resource (30% RF, 30% ReF)	70.6	78.1	232.2*	224.6*	229.0	17.4	24.5	37.8*

RF: Risk Factor ReF: Recovery Factor *extrapolated here from published data

Figures

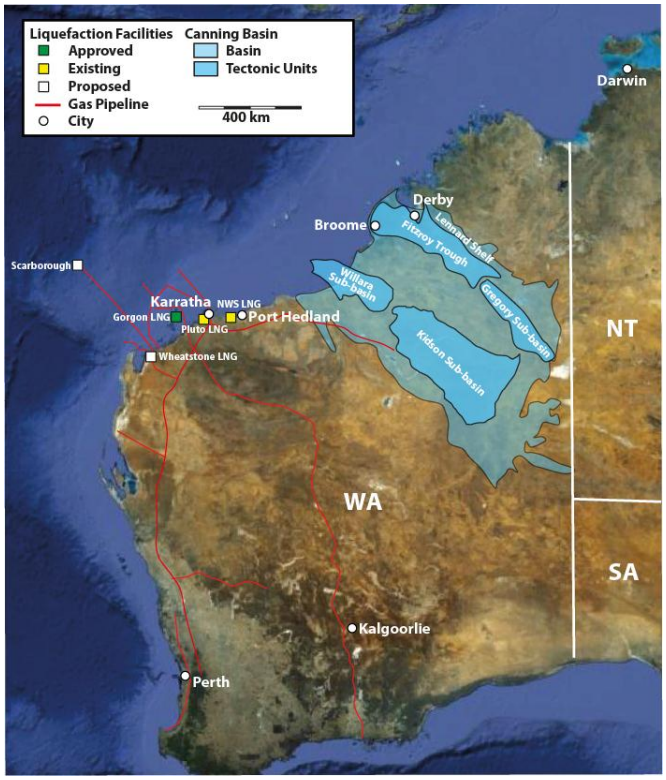

Fig. 1—Map of the Canning Basin, Western Australia, illustrating the scale of the basin as compared to the state and its distance from nearby facilities and markets (Perth, Australia). Prospective areas and LNG production facilities are highlighted.

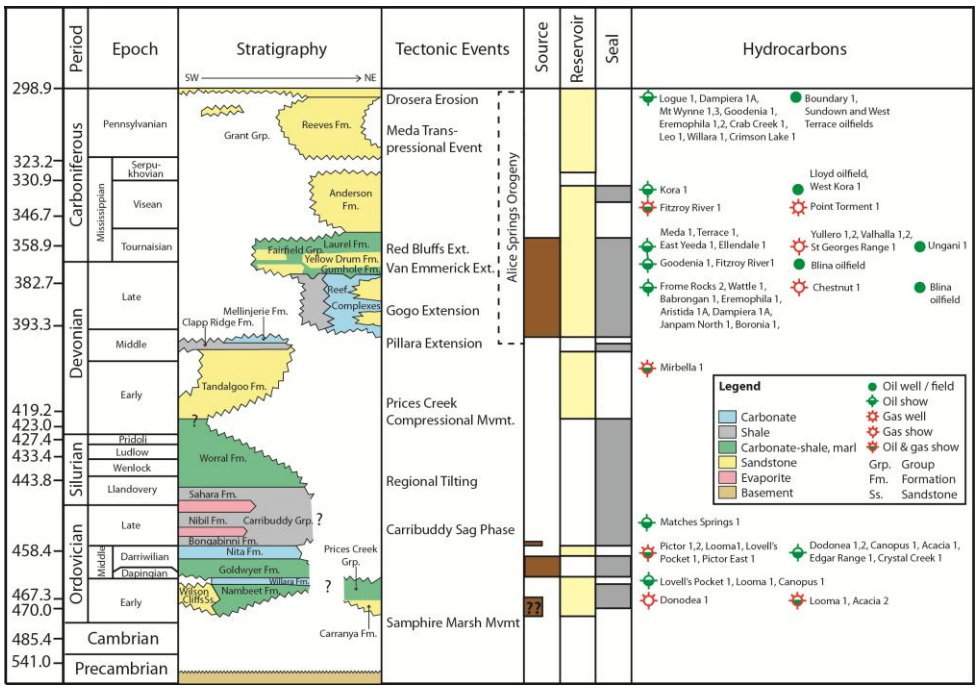

Fig. 2—Early Paleozoic Canning Basin stratigraphy (modified from Zhan & Mory *in press*).

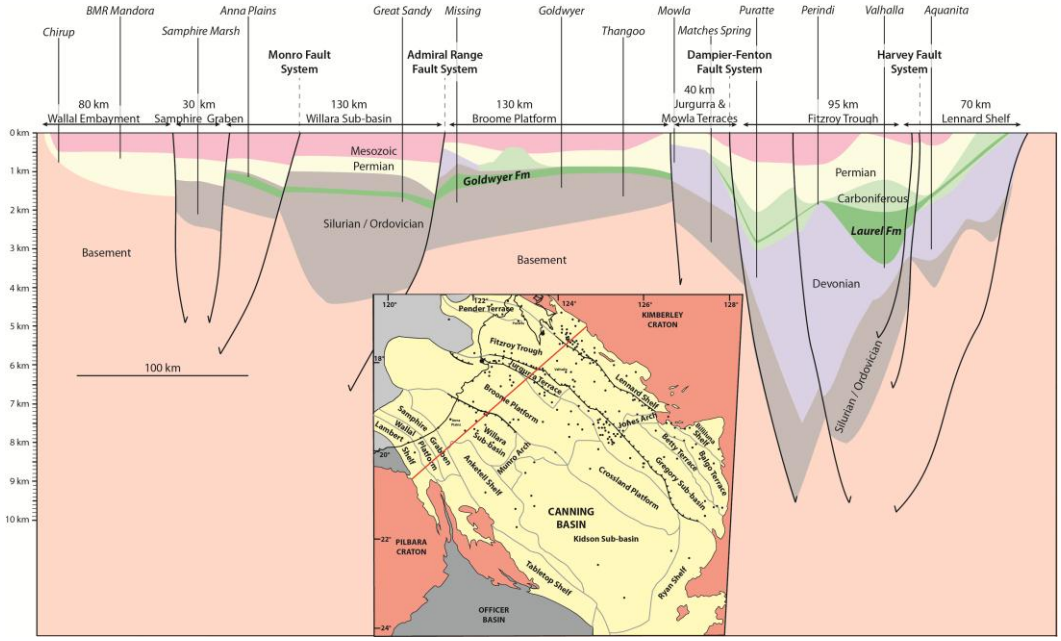

Fig. 3—Cross-section through the northern Canning Basin, showing typical well penetrations, estimated thicknesses of major depositional intervals, and shales of interest.

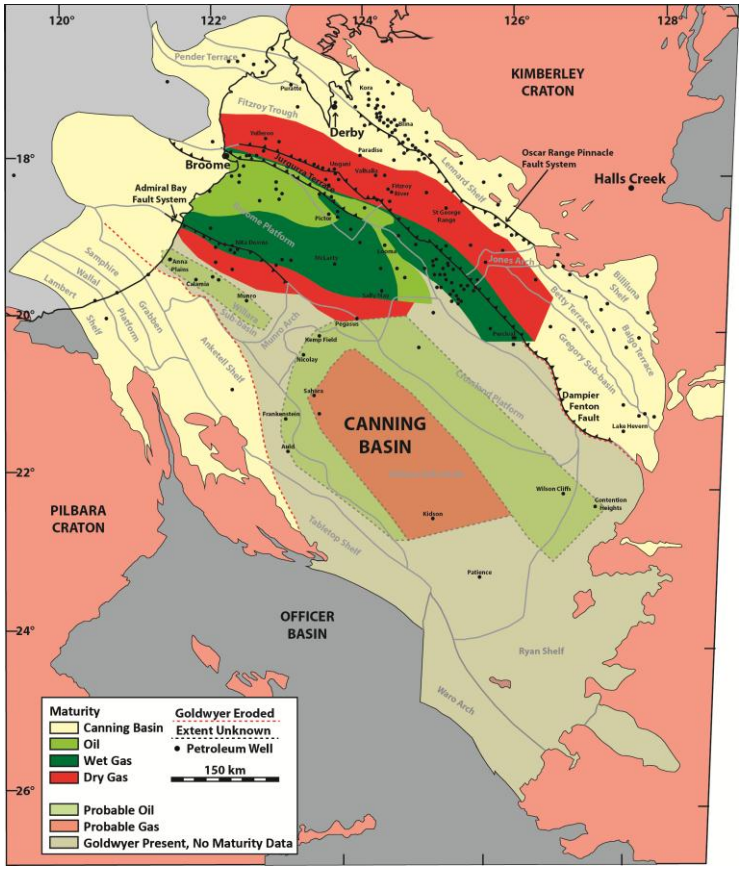

Fig. 4—Goldwyer Formation maturity map.

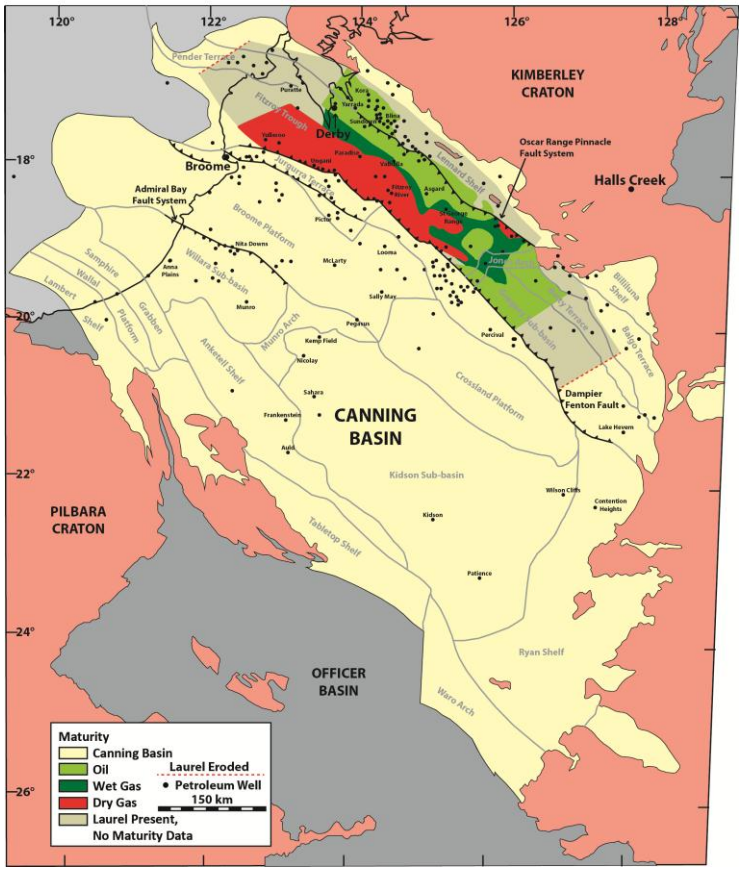

Fig. 5—Laurel Formation maturity map.

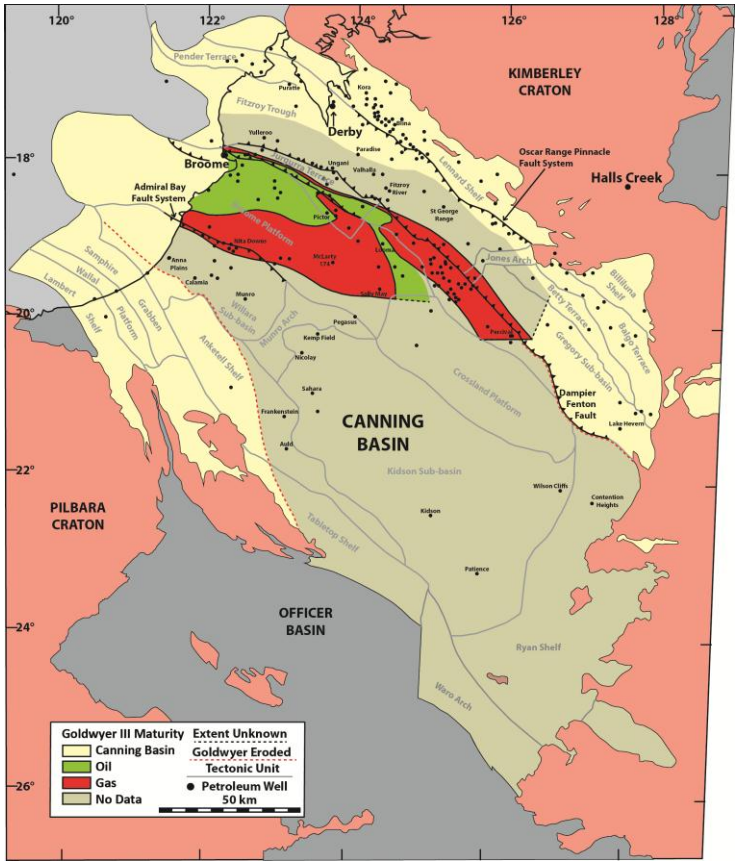

Fig. 6—Goldwyer III shale, prospectivity map.

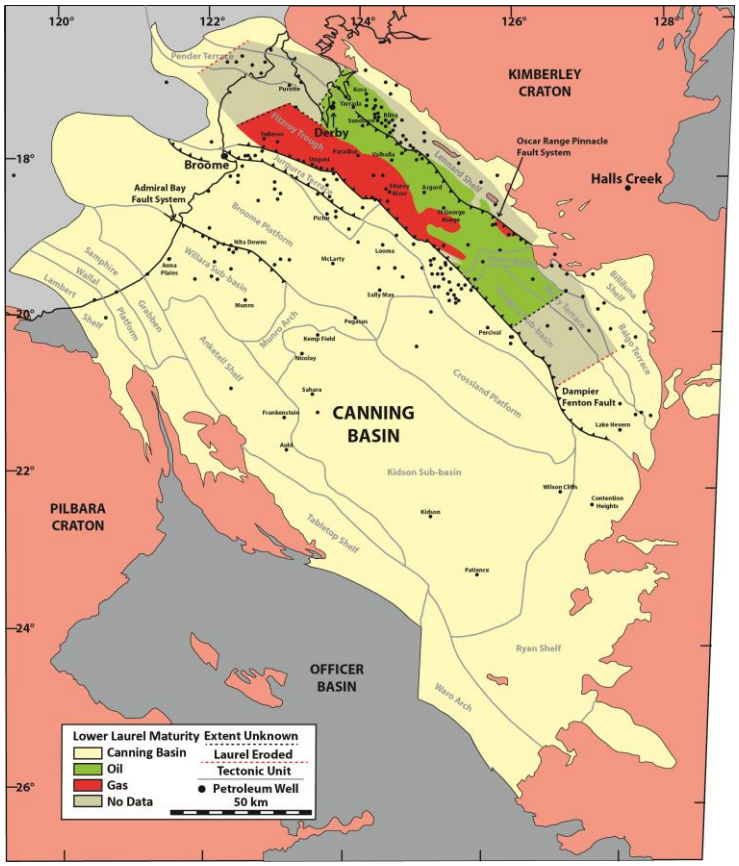

Fig. 7—Lower Laurel shale, prospectivity map.

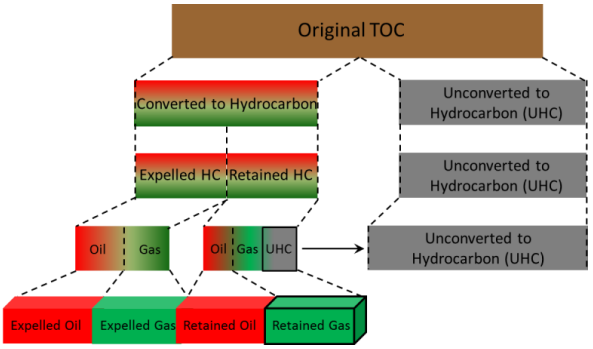

Fig. 8—Schematic diagram of Jarvie's method for estimating retained gas in a rock from original TOC (modified from Jarvie et al. 2007).

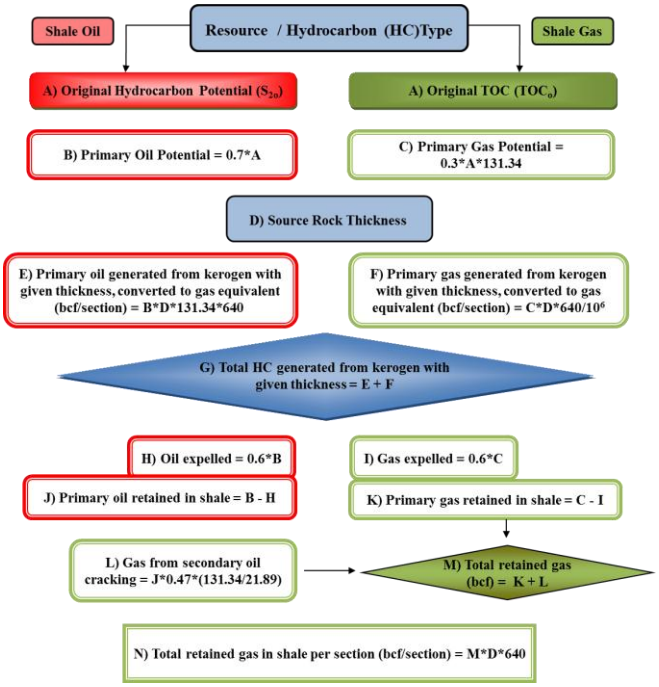

Fig. 9—Schematic diagram of deterministic resource estimation (based on Jarvie et al. 2007).

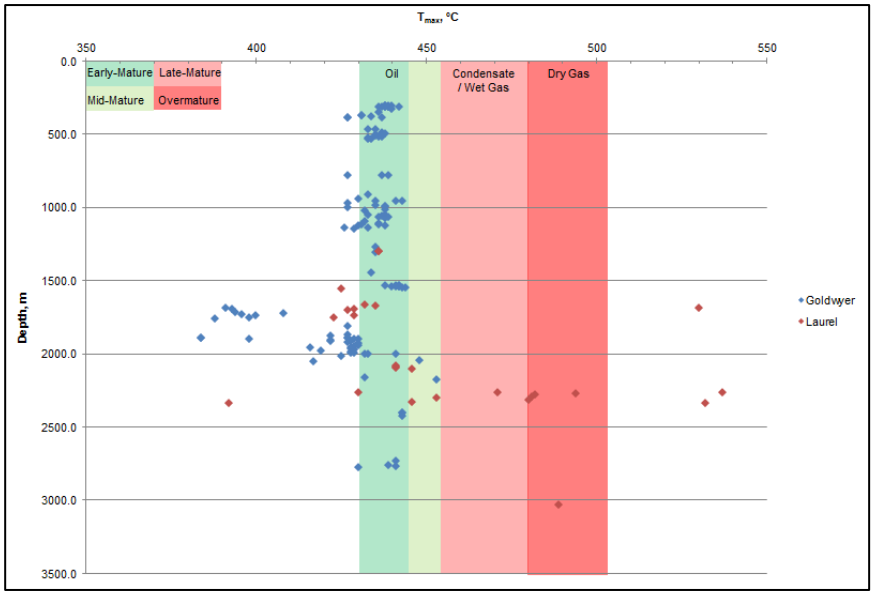

Fig. 10—RockEval data indicating T_{max} vs. depth for all Goldwyer and Laurel Formation well samples (TOC ≥1%).

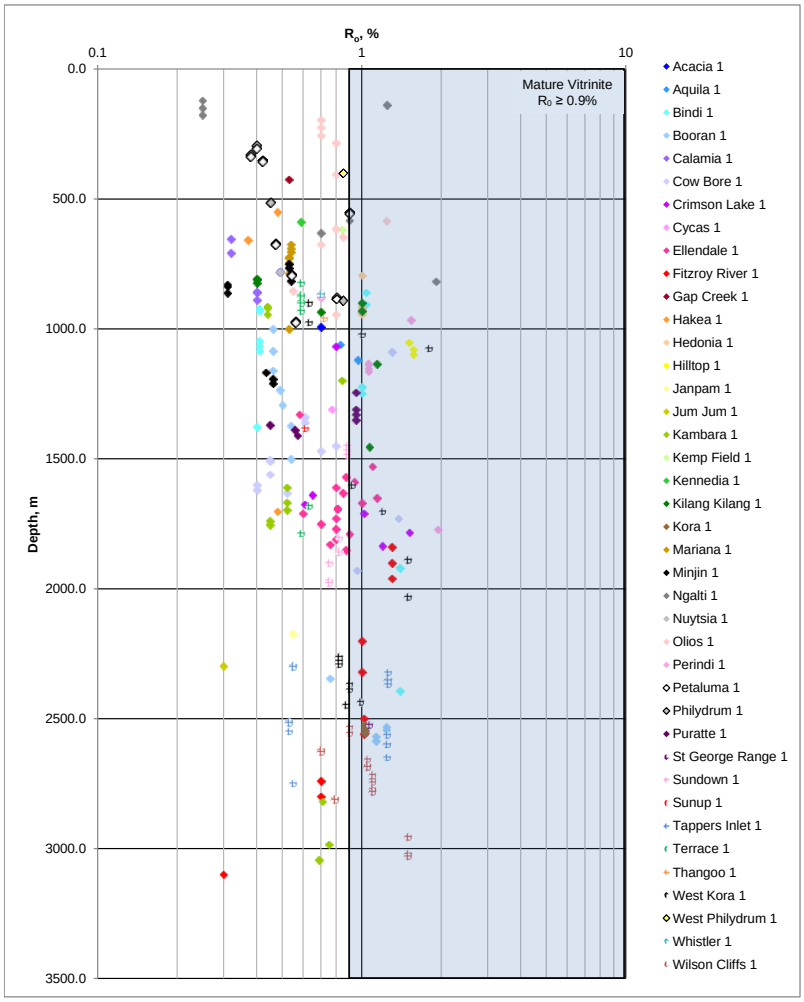

Fig. 11—Vitrinite Reflectance or its equivalent vs. depth for all Canning Basin well samples in all investigated shales.

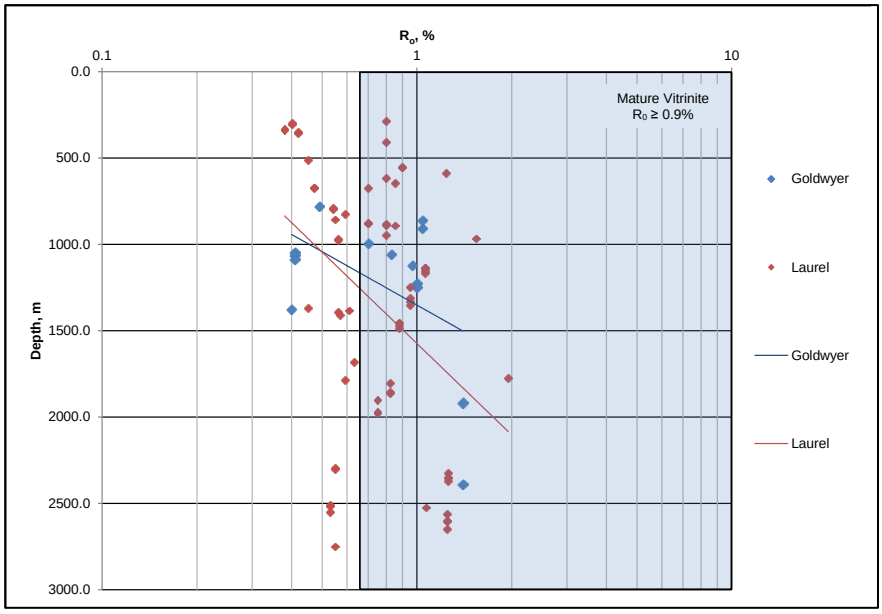

Fig. 12—Vitrinite Reflectance or its equivalent vs. depth for all Laurel and Goldwyer Formation samples.

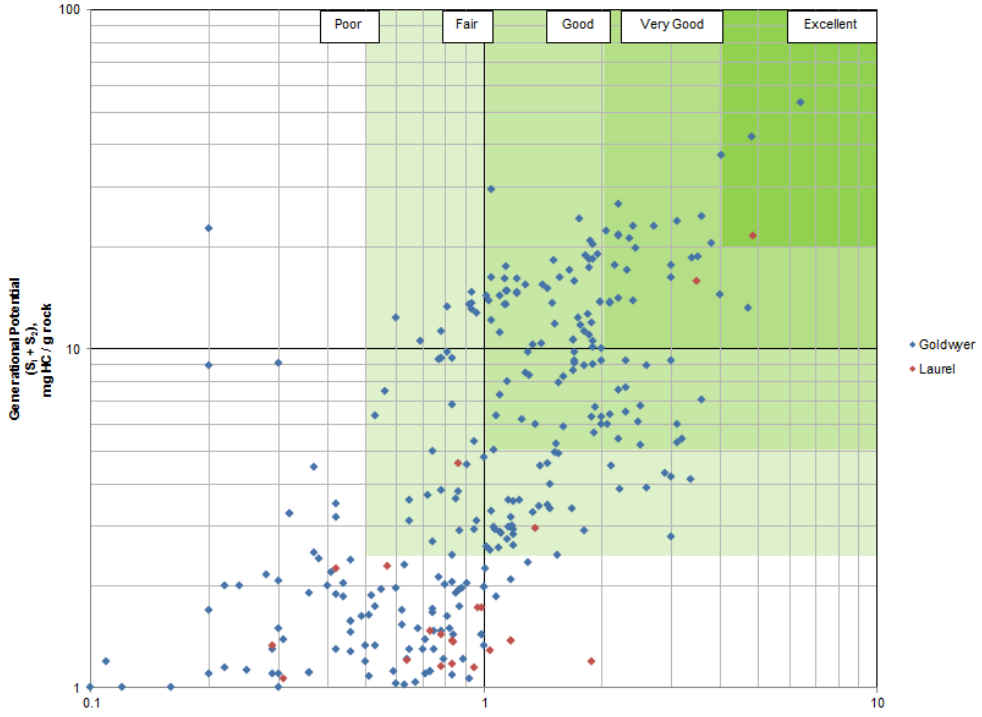

Fig. 13—Source rock production potential vs. TOC for all Laurel and Goldwyer Formation samples (TOC > 0.1%).

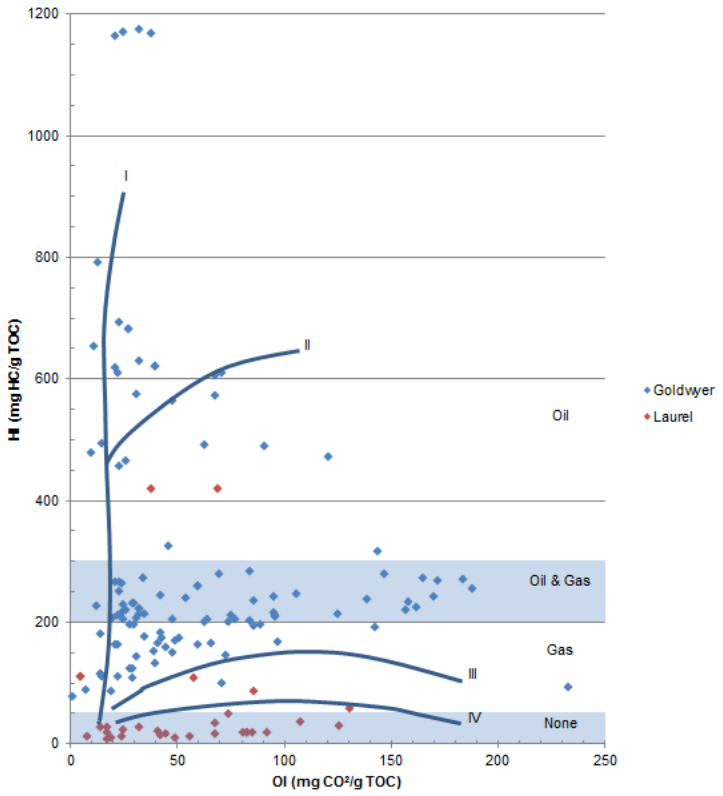

Fig. 14—HI vs. OI for all Laurel and Goldwyer Formation samples (TOC ≥1%).

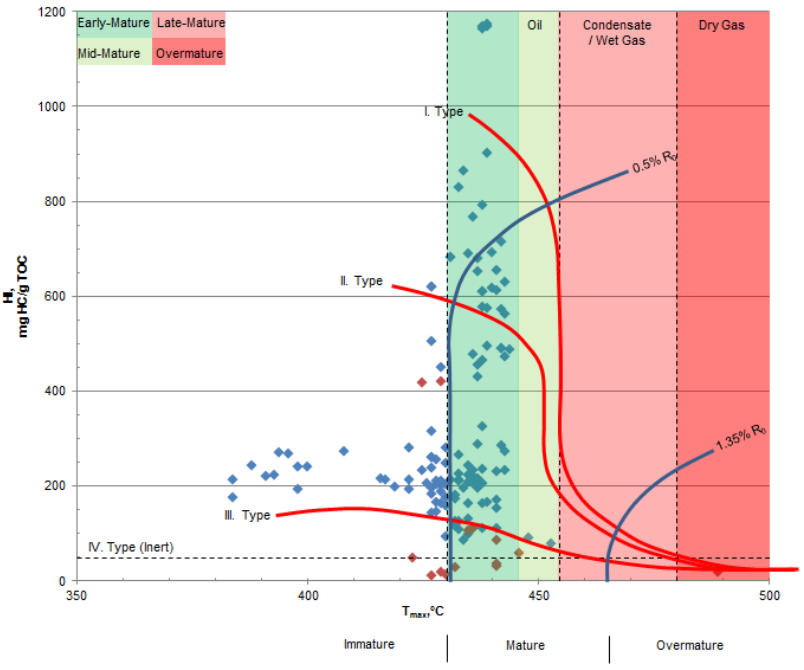

Fig. 15—Kerogen typing and maturity (HI vs. T_{max}) for all Goldwyer and Laurel Formation samples.

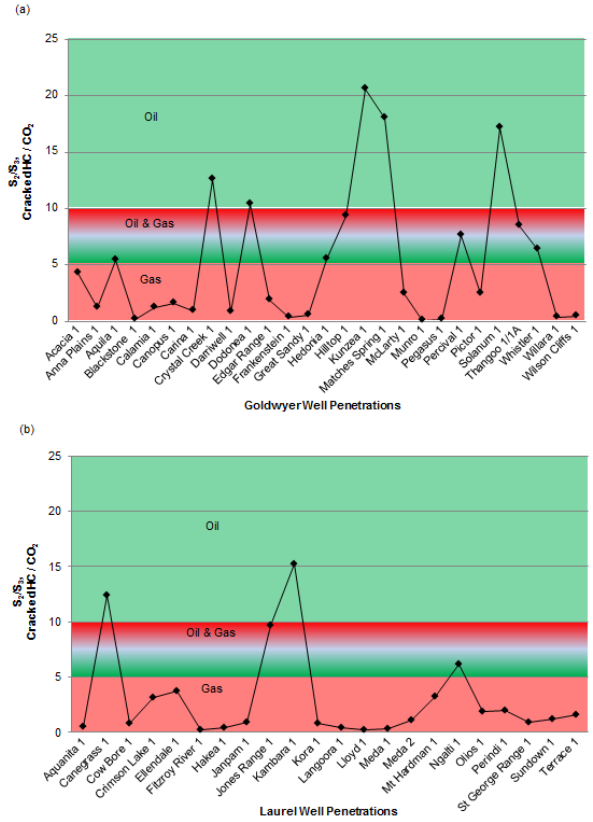

Figure 16—Organic matter typing from amount of cracked hydrocarbon. (a) Goldwyer Formation. (b) Laurel Formation).

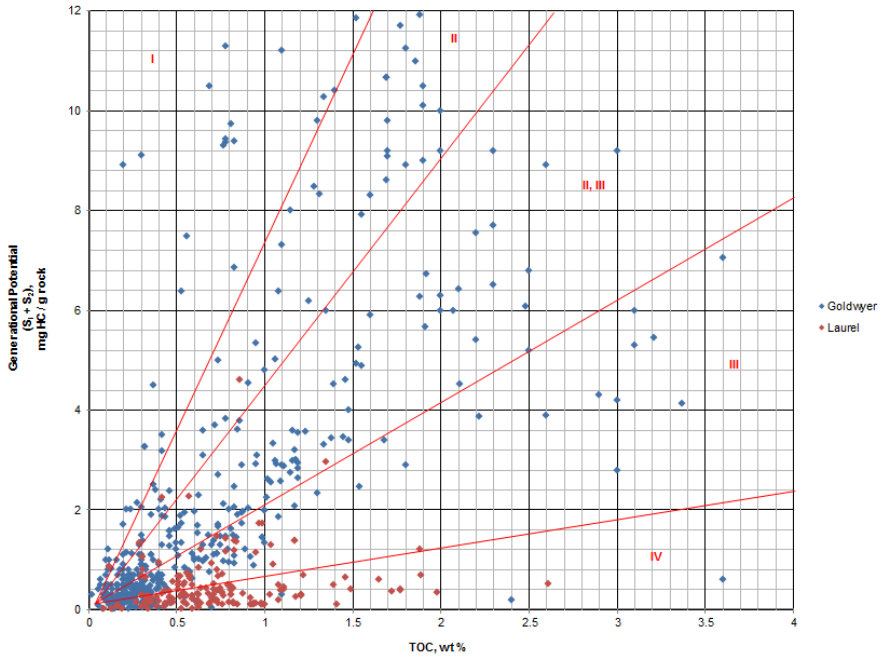

Figure 17—Generational Potential vs. TOC for all Laurel and Goldwyer Formation samples, indicating kerogen typing.