

Supplementary Material

Petrophysical interpretation and reservoir characterisation on Proterozoic shales in National Drilling Initiative Carrara 1, Northern Territory

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Supplementary tables

Table S1. Correlation coefficients (R^2) between well logs and laboratory measured mineral contents (wt%).

Mineral	GRPON	GRTHN	GRURN	DTCN	DENNN	PDPEN	NPRLNC	RD ^A
Quartz	0.0222	0.0319	0.0503	0.034	0.0508	0.2178	0.0121	0.0255
K-feldspar	0.5247	0.3163	0.0562	0.0052	0.0859	0.197	0.0228	0.1005
Plagioclase	0	0.048	0.0389	0.4346	0.0408	0.0805	0.4821	0.1519
Calcite	0.4231	0.4654	0.15	0.3484	0.0552	0.463	0.2287	0.4029
Dolomite	0.0692	0.0744	0.0268	0.0477	0.0371	0.0404	0.0052	0.0292
Mica	0.3074	0.4033	0.0848	0.3766	0.0315	0.2058	0.2775	0.3846
Chlorite	0.0283	0.1	0.0235	0.3487	0.0123	0.0936	0.3814	0.1719
Kaolinite	0.0116	0.0033	0.0059	0.0098	0.0093	0.0023	0.0074	0.0055
Siderite	0.0065	0	0.0062	0	0.1992	0.0637	0.0002	0.0005
Pyrite	0.0268	0.045	0.0381	0.0711	0.001	0	0.1129	0.0177
Feldspar	0.5068	0.3834	0.1006	0.0895	0.1395	0.3071	0.0072	0.1803
Clay	0.2805	0.3558	0.0911	0.3602	0.0432	0.2205	0.2583	0.3287
Carbonate	0.394	0.4503	0.1374	0.3275	0.0625	0.4371	0.1877	0.3379
Minors	0.0041	0	0.0024	0.0026	0.1081	0.0497	0.0023	0.0044
MINC	0.3972	0.4448	0.1707	0.3239	0.1042	0.4524	0.1692	0.3492

^ARD: logarithmic deep resistivity from deep resistivity (RTAFN, ohmm).

Table S2. Correlation coefficients (r and R^2) between the mineral contents from laboratory measurements and neural network interpretations of all training patterns.

Mineral group	Correlation coefficient (r)	Correlation coefficient (R^2)
Quartz	0.8525	0.7268
K-feldspar	0.9052	0.8194
Plagioclase	0.9018	0.8132
Calcite	0.9395	0.8827
Dolomite	0.5826	0.3394
Siderite	0.7900	0.6241
Mica	0.7690	0.5914
Chlorite	0.8406	0.7066
Kaolinite	0.8445	0.7132
Pyrite	0.8095	0.6552
Apatite	0.8486	0.7201
Rutile	0.5275	0.2782
Epidote	0.9745	0.9497
Grossular	0.8254	0.6813
Feldspar	0.8044	0.6471
Carbonate	0.9267	0.8587
Clay	0.7864	0.6184
Minors	0.5827	0.3395
MINC	0.9144	0.8362

Table S3. Correlation coefficient (R^2) between laboratory measured petrophysical properties, well logs and interpretations from density logs and neutron-density crossplot in NDI Carrara 1.

Well logs	Total porosity (m^3/m^3)	Gas porosity (m^3/m^3)	Logarithmic permeability (mD)
GRPON (%)	0.0058	0.1463	0.0156
GRTHN (ppm)	0.0009	0.0818	0.0083
GRURN (ppm)	0.0074	0.0014	0.0189
DTCN ($\mu\text{s}/\text{ft}$)	0.1424	0.1724	0.1503
DENNN (g/cm^3)	0.1437	0.0415	0.0002
NPRLNC (m^3/m^3)	0.1755	0.0939	0.1438
Logarithmic RTAFN (ohmm)	0.0063	0.1186	0.026
Total density porosity (m^3/m^3)	0.3912	0.0206	0.0177
Effective density porosity (m^3/m^3)	0.0333	0.0017	0.0908
Neutron-density V_{shale} (m^3/m^3)	0.0041	0.0387	0.0707
Neutron-density total porosity (m^3/m^3)	0.2509	0.0578	0.1041
Neutron-density effective porosity (m^3/m^3)	0.0405	0.0588	0.0111
TOC content (wt%)	0.0007	0.0012	0.0178

Table S4. Averages of interpreted TOC and mineral contents, petrophysical properties and gas concentrations from mudlog gas in different packages of the Proterozoic succession.

Parameter	P1	P2	P3	P4
QuartzFInt (wt%)	45.19	40.89	28.96	29.87
FeldsparInt (wt%)	21.63	17.04	10.11	7.06
CarbonateInt (wt%)	3.61	4.35	36.41	46.02
ClayInt (wt%)	27.90	29.70	20.08	17.74
TOCNN (wt%)	0.39	1.10	0.97	0.41
PHIT_NN (%)	2.56	2.52	3.71	4.72
PHIG_NN (%)	0.50	0.49	0.59	0.62
PERM_NN (μD)	1.20	7.44	1.43	0.79
Sgt_NN (m^3/m^3)	0.051	0.238	0.009	0
Gross_thickness (m)	320.7	303.8	438.4	57.5
Methane (ppm)	1655	4197	1117	1310
Ethane (ppm)	398	529	424	397

Table S5. Averages of interpreted TOC and mineral contents, petrophysical properties and gas concentrations from mudlog gas for the organic-rich shales in P2 and P3.

Parameter	P2	P3
QuartzFInt (wt%)	39.26	25.27
FeldsparInt (wt%)	17.42	5.61
CarbonateInt (wt%)	4.38	54.04
ClayInt (wt%)	30.62	10.34
TOCNN (wt%)	1.50	1.89
PHIT_NN (%)	2.58	3.70
PHIG_NN (%)	0.57	0.45
PERM_NN (μD)	10.38	0.62
Sgt_NN (m^3/m^3)	0.395	0.022
GCa_NN (cm^3/g)	0.941	0.452
GCf_NN (cm^3/g)	0.310	0.026
GCt_NN (cm^3/g)	1.251	0.479
Brittleness (unitless)	0.91	0.41
Net_shale (m)	150.3	166.6
Methane (ppm)	5427	1100
Ethane (ppm)	589	424

Table S6. Averages of interpreted TOC and mineral contents, petrophysical properties and gas concentrations from mudlog gas for the tight non-organic-rich rocks (TOC content < 1 wt% and Sgt > 0) in different packages.

Parameter	P1	P2	P3
QuartzFInt (wt%)	43.90	41.66	38.11
FeldsparInt (wt%)	19.03	17.39	14.87
CarbonateInt (wt%)	5.32	3.91	7.42
ClayInt (wt%)	27.76	29.80	32.23
TOCNN (wt%)	0.59	0.81	0.77
PHIT_NN (%)	3.27	2.77	5.41
PHIG_NN (%)	0.55	0.49	0.68
PERM (μ D)	0.48	4.34	2.75
Sgt (m^3/m^3)	0.174	0.179	0.078
Brittleness (unitless)	0.874	0.879	0.883
Methane (ppm)	1731	3267	1184
Ethane (ppm)	395	481	433

Table S7. Average and maximum of interpreted parameters and mudlog gas profiles for the organic-rich shales in the three internal units in P2.

Parameter	P2U1		P2U2		P2U3	
	Average	Maximum	Average	Maximum	Average	Maximum
QuartzFInt (wt%)	38.75	50.50	39.48	66.80	39.54	54.40
FeldsparInt (wt%)	18.66	29.50	16.01	22.30	16.85	24.60
CarbonateInt (wt%)	3.52	9.88	4.81	8.21	4.86	17.30
ClayInt (wt%)	30.34	43.00	31.43	42.80	30.67	43.60
TOCNN (wt%)	1.27	1.24	1.26	1.24	1.68	1.58
PHIT_NN (%)	2.76	4.84	2.19	3.52	2.54	5.50
PHIG_NN (%)	0.58	1.64	0.46	1.10	0.58	1.52
PERM (μ D)	6.60	27.74	12.07	52.11	25.31	120.44
Sgt (m^3/m^3)	0.343	0.753	0.222	0.808	0.456	0.850
GCa (cm^3/g)	0.942	1.172	0.905	1.173	0.946	1.221
GCf (cm^3/g)	0.271	1.544	0.094	0.847	0.369	1.886
GCt (cm^3/g)	1.213	2.630	0.999	1.723	1.315	3.007
Brittleness (unitless)	0.89	0.99	0.90	0.95	0.92	0.99
Gross_thickness (m)	95.1		64.0		144.7	
Net_shale (m)	53.5		13.5		83.3	
Methane (ppm)	3513	5967	2598	4954	6556	15807
Ethane (ppm)	461	590	449	570	656	1124

Table S8. Average and maximum of interpreted parameters and mudlog gas profiles for the organic-rich source rocks in the four internal units in P3.

Parameter	P3U1		P3U2		P3U3		P3U4	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
QuartzFInt (wt%)	21.66	55.30	39.59	42.40	24.23	36.90	40.31	57.40
FeldsparInt (wt%)	3.37	24.60	15.91	17.40	3.21	8.27	15.12	21.00
CarbonateInt (wt%)	65.42	100.00	3.83	8.80	62.95	84.60	6.01	42.50
ClayInt (wt%)	5.72	38.90	30.63	35.60	6.52	20.80	29.85	41.70
TOCNN (wt%)	1.64	1.59	1.24	1.22	1.18	1.17	3.07	2.66
PHIT_NN (%)	3.61	6.46	2.83	3.34	3.07	4.01	4.18	11.28
PHIG_NN (%)	0.40	1.24	0.57	0.90	0.34	0.55	0.66	2.82
PERM (μ D)	1.07	32.52	24.68	98.19	6.26	29.73	17.03	135.55
Sgt (m^3/m^3)	0.002	0.325	0	0	0.003	0.105	0.113	0.775
GCa (cm^3/g)	0.350	0.961	0.621	1.068	0.369	0.726	0.895	1.272
GCf (cm^3/g)	0.002	0.497	0	0	0.001	0.022	0.133	2.252
GCt (cm^3/g)	0.352	1.265	0.621	1.068	0.370	0.726	1.028	3.523
Brittleness (unitless)	0.28	0.92	0.88	0.95	0.32	0.61	0.92	0.98
Gross_thickness (m)	188.1		140.7		73.7		35.9	
Net_shale (m)	130.7		1.1		4.2		30.6	
Methane (ppm)	1000	1329	1067	1083	1325	1472	1475	3838
Ethane (ppm)	393	492	407	434	412	428	549	1383