Datashare 89

Fractal analysis of tight shaly sandstones using nuclear magnetic resonance measurements

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AAPG Bulletin, v. 102, no. 2 (February 2018), pp. 175–193

Table S1. Nuclear Magnetic Resonance Transverse Relaxation Time Parameters and Fractal Dimensions

Well	Number	Porosity (%)	Permeability (md)	$T_{2cutoff}$ (ms)	T_{2gm} (ms)	BVI (%)	T_2 Distribution Behavior	T_{2peak} (ms)	*Df*	R^2
G273	1	13.74	0.310	6.16	5.41	63.75	Uni	3.87	2.764	0.979
G273	2	14.29	0.255	3.91	5.21	55.58	Uni	2.23	2.838	0.973
G273	3	12.76	0.136	4.63	5.40	57.21	Uni	2.23	2.768	0.979
H212	4	6.91	0.003	16.17	8.86	64.65	Bio	2.23	2.706	0.982
H212	5	10.74	0.091	6.75	4.98	66.77	Uni	2.23	2.781	0.987
H212	6	13.62	1.479	11.22	13.31	50.01	Bio	34.65	2.621	0.987
Z143	7	11.13	0.015	26.06	9.33	76.55	Uni	4.64	2.707	0.984
Z143	8	11.24	0.036	13.74	8.88	65.10	Uni	16.68	2.636	0.985
Z143	9	11.22	0.025	24.68	8.83	76.29	Uni	6.69	2.628	0.990
Z143	10	11.72	0.019	15.76	8.43	69.12	Uni	6.69	2.664	0.982
Z143	11	11.29	0.003	15.13	7.81	70.93	Uni	9.64	2.681	0.976
Z143	12	11.68	0.003	13.27	8.75	67.12	Uni	9.64	2.676	0.988
Z143	13	9.89	0.003	11.41	7.29	68.53	Uni	9.64	2.723	0.981
L89	14	8.73	0.003	13.88	6.16	70.41	Bio	1.86	2.787	0.993
L89	15	10.89	0.073	37.62	10.68	76.39	Bio	20.03	2.659	0.987
L89	16	11.28	0.053	28.35	12.41	67.22	Bio	28.86	2.652	0.986
L89	17	9.99	0.013	24.84	7.69	76.00	Bio	16.68	2.676	0.988
L89	18	9.53	0.003	22.54	8.41	70.93	Bio	1.86	2.744	0.984
A92	19	8.63	0.036	13.89	4.19	77.24	Uni	1.29	2.926	0.986
A92	20	13.29	0.257	7.54	5.31	65.27	Bio	1.55	2.879	0.986
A92	21	12.45	0.160	17.58	4.88	76.05	Bio	1.29	2.907	0.984
A92	22	12.13	0.235	5.16	5.37	63.40	Bio	1.55	2.863	0.985
A92	23	11.19	0.357	5.89	8.38	53.98	Bio	1.86	2.724	0.985
A92	24	12.72	0.174	7.17	5.60	63.63	Bio	1.55	2.864	0.985
Y63	25	12.24	0.003	11.93	4.26	76.51	Uni	1.55	2.922	0.984
Y63	26	8.60	0.003	7.09	3.78	76.00	Uni	1.55	2.919	0.979
Y63	27	11.50	0.003	3.78	3.63	68.32	Uni	1.55	2.938	0.982
Y63	28	8.56	0.110	39.78	16.25	67.59	Bio	49.94	2.470	0.988
B272	29	9.39	0.003	40.86	9.97	80.48	Bio	41.60	2.626	0.989
B272	30	9.70	0.003	18.14	6.43	76.07	Uni	2.23	2.822	0.988
Z30	31	12.04	0.129	17.64	14.02	55.93	Bio	34.65	2.528	0.986
Z30	32	11.73	0.382	23.00	18.00	54.43	Bio	86.4	2.530	0.985
A67	33	3.35	0.003	8.75	2.92	82.43	Uni	1.29	2.995	0.973
Hu56	34	7.40	0.003	34.79	7.74	80.75	Bio	1.86	2.682	0.989
Hu56	35	8.16	0.003	27.33	7.84	76.99	Bio	28.86	2.685	0.988

(*continued*)

Table S1. Continued

Well	Number	Porosity (%)	Permeability (md)	$T_{2cutoff}$ (ms)	T_{2gm} (ms)	BVI (%)	T_2 Distribution Behavior	T_{2peak} (ms)	*Df*	R^2
Hu56	36	10.12	0.003	25.95	13.95	65.25	Bio	34.65	2.485	0.987
Hu56	37	9.04	0.003	34.57	11.84	75.56	Uni	41.60	2.565	0.985
Hu56	38	9.50	0.003	31.46	13.28	69.03	Bio	49.94	2.567	0.986
Hu56	39	8.89	0.003	27.99	9.77	74.69	Bio	20.03	2.627	0.987
A81	40	6.51	0.032	39.28	14.74	70.33	Bio	28.86	2.588	0.992
A81	41	7.60	0.038	56.98	16.80	74.50	Bio	28.86	2.512	0.991
A81	42	9.95	0.092	7.17	6.26	63.79	Uni	1.55	2.856	0.983
A81	43	10.61	0.085	8.33	5.10	67.92	Uni	1.55	2.823	0.985
L47	44	10.83	0.054	6.75	4.98	66.77	Uni	2.23	2.787	0.984
L47	45	11.49	0.125	29.63	16.13	61.84	Bio	59.95	2.536	0.988
L47	46	11.32	0.228	27.44	17.26	59.71	Bio	59.95	2.499	0.990
L47	47	10.80	0.003	18.94	7.54	74.99	Uni	3.87	2.663	0.984
L47	48	8.24	0.003	12.79	5.51	74.39	Uni	2.23	2.733	0.987
L47	49	11.91	0.045	14.61	11.47	59.27	Uni	28.86	2.557	0.982
M53	50	10.36	0.118	27.92	20.72	55.01	Bio	71.97	2.490	0.983
M53	51	9.11	0.011	34.23	13.34	68.71	Bio	41.6	2.629	0.987
M53	52	9.82	0.068	44.19	18.53	66.34	Bio	86.4	2.523	0.986
M53	53	7.56	0.003	14.73	7.75	69.05	Uni	3.22	2.659	0.983
M53	54	5.00	0.002	4.76	2.72	77.90	Uni	1.55	2.913	0.982
M53	55	11.58	0.003	25.67	11.60	70.42	Uni	24.04	2.549	0.977
M53	56	10.60	0.103	34.96	20.84	59.58	Bio	71.97	2.450	0.984
M53	57	7.21	0.003	33.36	7.52	82.68	Bio	3.87	2.654	0.988
M53	58	1.15	0.003	6.55	2.87	77.83	Uni	1.08	2.974	0.980
M53	59	11.50	0.122	28.32	20.90	55.79	Bio	71.97	2.465	0.984
M53	60	8.02	0.003	23.60	6.80	80.87	Uni	4.64	2.778	0.974
M53	61	8.63	0.009	17.92	10.68	62.16	Bio	34.65	2.611	0.985
M53	62	8.17	0.003	21.10	7.43	75.21	Bio	1.86	2.711	0.983
M53	63	8.94	0.003	25.21	13.71	64.12	Uni	49.94	2.583	0.986
M53	64	17.74	2.563	8.14	5.44	75.85	Uni	5.57	2.720	0.962
M53	65	3.52	0.376	27.55	6.26	82.21	Bio	1.29	2.723	0.992
Zh70	66	10.04	0.002	4.52	4.24	65.68	Uni	3.22	2.818	0.981
Zh70	67	8.45	0.003	4.14	3.25	75.17	Uni	1.55	2.973	0.968
Zh70	68	7.34	0.005	14.50	4.59	80.09	Uni	1.86	2.884	0.978
Zh70	69	9.37	0.001	21.53	7.01	78.70	Uni	8.03	2.747	0.982
Zh70	70	7.40	0.028	14.93	9.07	60.53	Bio	20.03	2.681	0.992
Zh40	71	0.40	0.002	15.66	2.85	87.34	Bio	1.08	2.973	0.981
Zh40	72		0.884	12.24	9.83	56.09	Bio	20.03	2.657	0.991
Hu317	73	1.29	0.003	17.64	6.97	92.46	Bio	0.9	2.819	0.983
Hu317	74	6.73	0.003	11.40	4.01	85.22	Uni	3.22	2.799	0.961
Hu317	75	11.24	0.177	13.35	16.37	46.69	Bio	59.95	2.446	0.993
L231	76	11.35	0.147	21.11	14.31	59.48	Bio	41.6	2.496	0.987
L231	77	12.13	0.182	23.08	15.10	58.51	Bio	49.94	2.524	0.990
L231	78	5.16	0.003	10.73	4.39	78.82	Uni	2.23	2.831	0.974
L231	79	6.03	0.003	16.41	3.50	86.28	Uni	1.55	2.835	0.986
L231	80	6.68	0.003	7.88	3.06	86.26	Uni	2.68	2.877	0.975

(*continued*)

Table S1. Continued

Well	Number	Porosity (%)	Permeability (md)	$T_{2cutoff}$ (ms)	T_{2gm} (ms)	BVI (%)	T_2 Distribution Behavior	T_{2peak} (ms)	*Df*	R^2
L231	81	14.11	0.189	17.71	12.90	60.90	Uni	28.86	2.504	0.980
L231	82	3.81	0.750	5.08	3.39	73.48	Bio	5.57	2.816	0.983
L231	83	1.95	0.375	9.14	3.55	80.58	Bio	1.08	2.879	0.978
Z230	84	10.91	0.263	28.30	16.16	60.50	Bio	59.95	2.547	0.987
Z230	85	11.17	0.357	21.99	17.38	54.06	Bio	71.97	2.543	0.986
Z230	86	7.24	0.004	8.05	6.34	62.23	Uni	1.55	2.746	0.988
Z230	87	8.00	0.003	16.48	7.60	70.83	Bio	3.87	2.660	0.986
Z230	88	10.45	0.029	14.87	10.03	63.22	Uni	20.03	2.577	0.984
Z230	89	12.14	0.219	18.39	18.49	50.48	Bio	49.94	2.482	0.991
Xi233	90	10.52	0.030	30.12	14.02	64.76	Bio	49.94	2.606	0.987
Xi233	91	10.14	0.003	49.19	12.05	78.68	Bio	34.65	2.656	0.989
Xi233	92	9.50	0.008	23.47	11.37	63.81	Bio	41.6	2.645	0.987
Z233	93	9.15	0.002	2.21	3.00	60.39	Uni	1.55	2.974	0.970
Z233	94	10.63	0.098	24.84	14.54	62.21	Bio	59.95	2.484	0.980
Z30	95	10.35	0.050	23.43	9.99	69.19	Bio	28.86	2.621	0.988
Z30	96	10.60	0.153	11.59	13.47	49.01	Bio	49.94	2.594	0.988
Z30	97	10.26	0.063	18.07	11.77	59.38	Bio	41.6	2.596	0.987
Z30	98	9.98	0.055	19.09	10.09	64.54	Bio	34.65	2.622	0.987
Z30	99	10.71	0.147	25.69	13.54	62.97	Bio	49.94	2.605	0.989
Z30	100	10.98	0.089	13.79	12.85	53.04	Bio	41.6	2.521	0.987

Abbreviations: Bio = biomodal behavior; BVI = bulk volume irreducible; *Df* = fractal dimension; T_2 = transverse relaxation time; $T_{2cutoff}$ = value of T_2 separating the bulk volume irreducible from free fluid index; T_{2gm} = the amplitude weighted mean on a logarithmic scale; T_{2peak} = the value of T_2 that shows the highest frequency on the T_2 spectrum; Uni = unimodal behavior.

Table S2. Nuclear Magnetic Resonance Transverse Relaxation Time Incremental Spectra and Transverse Relaxation Time Cumulative Spectra for Sample 36

T_2 (ms)	T_2 Incremental Spectra V_{pi}	T_2 Cumulative Spectra $\sum_{i=1}^{n} V_{pi}$	$\sum_{j=i+1}^{n} \frac{V_{pj}}{(T_{2j})^3}$	$\frac{V_{pi}}{(T_{2i})^3}$	$\log\left(\sum_{j=i+1}^{n} \frac{V_{pj}}{(T_{2j})^3}\right)$	$\log(T_2)$
0.10	0.00	0.00	11.04	0.39	1.04	−1.00
0.12	0.00	0.00	10.37	0.67	1.02	−0.92
0.14	0.00	0.00	9.31	1.06	0.97	−0.85
0.17	0.01	0.01	8.04	1.27	0.91	−0.77
0.21	0.01	0.02	6.76	1.28	0.83	−0.68
0.25	0.02	0.04	5.43	1.33	0.73	−0.60
0.30	0.03	0.08	4.19	1.24	0.62	−0.52
0.36	0.05	0.13	3.10	1.08	0.49	−0.44
0.43	0.07	0.20	2.20	0.90	0.34	−0.37
0.52	0.10	0.30	1.51	0.68	0.18	−0.28
0.62	0.12	0.42	1.00	0.51	0.00	−0.21
0.75	0.15	0.57	0.65	0.35	−0.19	−0.12
0.90	0.17	0.74	0.41	0.24	−0.39	−0.05
1.08	0.20	0.94	0.25	0.16	−0.60	0.03
1.29	0.22	1.15	0.15	0.10	−0.82	0.11

(*continued*)

Table S2. Continued

T_2 (ms)	T_2 Incremental Spectra V_{pi}	T_2 Cumulative Spectra $\sum_{i=1}^{n} V_{pi}$	$\sum_{j=i+1}^{n} \frac{V_{pj}}{(T_{2j})^3}$	$\frac{V_{pi}}{(T_{2i})^3}$	$\log\left(\sum_{j=i+1}^{n} \frac{V_{pj}}{(T_{2j})^3}\right)$	$\log(T_2)$
1.55	0.23	1.38	0.09	0.06	−1.05	0.19
1.86	0.24	1.62	0.05	0.04	−1.28	0.27
2.23	0.24	1.86	0.03	0.02	−1.52	0.35
2.68	0.24	2.10	0.02	0.01	−1.75	0.43
3.22	0.24	2.35	0.01	0.01	−1.98	0.51
3.87	0.24	2.59	0.01	0.00	−2.21	0.59
4.64	0.25	2.84	0.00	0.00	−2.43	0.67
5.57	0.25	3.09	0.00	0.00	−2.65	0.75
6.69	0.26	3.35	0.00	0.00	−2.86	0.83
8.03	0.28	3.63	0.00	0.00	−3.07	0.90
9.64	0.29	3.92	0.00	0.00	−3.29	0.98
11.57	0.31	4.24	0.00	0.00	−3.50	1.06
13.89	0.33	4.57	0.00	0.00	−3.72	1.14
16.68	0.35	4.92	0.00	0.00	−3.94	1.22
20.03	0.37	5.29	0.00	0.00	−4.16	1.30
24.04	0.38	5.67	0.00	0.00	−4.37	1.38
28.86	0.39	6.05	0.00	0.00	−4.58	1.46
34.65	0.39	6.44	0.00	0.00	−4.77	1.54
41.60	0.38	6.83	0.00	0.00	−4.94	1.62
49.94	0.37	7.20	0.00	0.00	−5.07	1.70
59.95	0.36	7.56	0.00	0.00	−5.16	1.78
71.97	0.34	7.90	0.00	0.00	−5.22	1.86
86.40	0.32	8.22	0.00	0.00	−5.26	1.94
103.72	0.29	8.52	0.00	0.00	−5.28	2.02
124.52	0.27	8.78	0.00	0.00	−5.30	2.10
149.49	0.23	9.02	0.00	0.00	−5.30	2.17
179.46	0.19	9.21	0.00	0.00	−5.30	2.25
215.44	0.16	9.36	0.00	0.00	−5.31	2.33
258.64	0.11	9.48	0.00	0.00	−5.31	2.41
310.50	0.07	9.55	0.00	0.00	−5.31	2.49
372.76	0.03	9.58	0.00	0.00	−5.31	2.57
447.50	0.00	9.58	0.00	0.00	−5.31	2.65
537.23	0.00	9.58	0.00	0.00	−5.31	2.73
644.95	0.00	9.58	0.00	0.00	−5.31	2.81
774.26	0.00	9.58	0.00	0.00	−5.31	2.89
929.51	0.00	9.58	0.00	0.00	−5.31	2.97
1115.88	0.00	9.58	0.00	0.00	−5.31	3.05
1339.63	0.00	9.58	0.00	0.00	−5.31	3.13
1608.23	0.00	9.58	0.00	0.00	−5.31	3.21
1930.70	0.00	9.58	0.00	0.00	−5.31	3.29
2317.82	0.00	9.58	0.00	0.00	−5.31	3.37
2782.56	0.00	9.58	0.00	0.00	−5.31	3.44
3340.48	0.00	9.58	0.00	0.00	−5.31	3.52
4010.28	0.00	9.58	0.00	0.00	−5.31	3.60
4814.37	0.00	9.58	0.00	0.00	−5.31	3.68
5779.69	0.00	9.58	0.00	0.00	−5.31	3.76

(*continued*)

Table S2. Continued

T_2 (ms)	T_2 Incremental Spectra V_{pi}	T_2 Cumulative Spectra $\sum_{i=1}^{n} V_{pi}$	$\sum_{j=i+1}^{n} \frac{V_{pj}}{(T_{2j})^3}$	$\frac{V_{pi}}{(T_{2i})^3}$	$\log\left(\sum_{j=i+1}^{n} \frac{V_{pj}}{(T_{2j})^3}\right)$	$\log(T_2)$
6938.57	0.00	9.58	0.00	0.00	−5.31	3.84
8329.81	0.00	9.58	0.00	0.00	−5.31	3.92
10000.00	0.00	9.58	0.00	0.00	−5.31	4.00

Abbreviations: T_2 = transverse relaxation time; V_{pi} = pore volume.