



Shale Core Analysis

Anadarko Petroleum Corporation

Rissler State 29C-36HZ

Weld County, Colorado

CL File No.: 150075

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Shale Core Analysis

		As received				Dry & Dean Stark Extracted Conditions ⁽²⁾				
Sample	Depth (ft)	Bulk Density (g/cc)	Matrix Permeability ⁽¹⁾ (mD)	Gas-filled Porosity (%)	Gas Saturation (%)	Grain Density (g/cc)	Matrix Permeability ⁽⁵⁾ (mD)	Porosity (%)	Oil Saturation ⁽³⁾ (%)	Water Saturation ⁽⁴⁾ (%)
1A GRI	7011.50 - 7012.00	2.478	5.60E-05	4.55	49.3	2.681	2.12E-03	9.23	11.8	38.9
2A GRI	7013.40 - 7014.00	2.482	2.73E-05	4.40	50.4	2.675	3.33E-04	8.73	10.8	38.8
3A GRI	7015.40 - 7016.00	2.478	7.00E-06	4.35	49.0	2.675	4.25E-04	8.89	21.0	30.1
4A GRI	7017.40 - 7018.00	2.472	1.70E-05	4.71	51.6	2.676	8.66E-04	9.12	17.2	31.1
5A GRI	7019.40 - 7020.00	2.503	4.61E-06	3.23	39.1	2.676	3.95E-04	8.24	15.2	45.6
6A GRI	7021.00 - 7021.65	2.520	4.09E-06	3.81	47.9	2.695	1.61E-03	7.95	13.4	38.7
7A GRI	7023.40 - 7024.00	2.503	1.12E-05	4.85	63.1	2.684	6.12E-04	7.69	15.9	21.1
8A GRI	7025.40 - 7026.00	2.446	2.62E-05	6.64	68.7	2.680	1.62E-03	9.67	18.7	12.6
9A GRI	7027.40 - 7028.00	2.445	6.82E-04	8.31	80.2	2.708	1.51E-03	10.36	13.1	6.7
10A GRI	7029.40 - 7030.00	2.360	4.75E-03	11.53	89.2	2.697	5.21E-03	12.92	6.9	3.9
11A GRI	7031.20 - 7031.80	2.396	1.82E-03	10.25	88.9	2.697	4.27E-03	11.53	9.6	1.5
12A GRI	7033.40 - 7034.00	2.381	4.81E-03	11.18	89.7	2.708	5.88E-03	12.47	7.0	3.3
13A GRI	7035.40 - 7036.00	2.383	2.59E-03	10.37	87.9	2.688	5.36E-03	11.80	8.3	3.8
14A GRI	7037.35 - 7038.00	2.397	5.91E-03	11.09	87.0	2.732	1.11E-02	12.75	10.4	2.7
15A GRI	7039.40 - 7040.00	2.428	1.67E-03	9.49	85.4	2.717	7.29E-03	11.11	11.5	3.1
16A GRI	7041.00 - 7041.50	2.403	4.34E-03	10.16	84.0	2.716	9.21E-03	12.09	11.7	4.3
17A GRI	7043.20 - 7043.75	2.427	6.06E-03	9.59	87.9	2.713	9.30E-03	10.91	9.9	2.2
18A GRI	7045.55 - 7046.10	2.432	2.96E-03	9.49	89.0	2.712	7.78E-03	10.66	8.4	2.6
19A GRI	7047.40 - 7048.00	2.448	2.75E-03	8.81	81.5	2.726	3.95E-03	10.81	10.3	8.1
20A GRI	7049.15 - 7049.75	2.447	1.61E-03	7.98	79.3	2.701	1.92E-03	10.05	12.0	8.6
21A GRI	7051.40 - 7052.05	2.430	5.52E-04	8.57	80.0	2.701	5.53E-03	10.71	10.4	9.6
22A GRI	7053.40 - 7054.00	2.482	1.08E-04	6.80	76.3	2.703	6.30E-04	8.92	5.9	17.9
23A GRI	7055.40 - 7056.00	2.515	8.88E-05	6.18	75.2	2.719	4.22E-04	8.22	7.3	17.5
24A GRI	7057.40 - 7058.00	2.479	3.26E-04	7.25	79.6	2.710	3.80E-04	9.12	8.8	11.7
25A GRI	7059.40 - 7060.00	2.478	7.89E-05	6.82	76.7	2.699	6.11E-04	8.90	7.3	16.0
26A GRI	7061.00 - 7061.65	2.516	1.76E-04	6.60	77.1	2.731	5.33E-04	8.56	4.1	18.8
27A GRI	7063.40 - 7064.00	2.422	2.12E-03	9.34	85.2	2.704	3.10E-03	10.96	6.9	7.9
28A GRI	7065.40 - 7066.00	2.499	1.76E-04	6.64	74.3	2.719	1.00E-03	8.94	3.6	22.1
29A GRI	7067.15 - 7067.75	2.501	2.46E-04	5.57	64.2	2.708	5.61E-04	8.68	15.2	20.6
30A GRI	7069.40 - 7070.00	2.513	4.37E-05	5.27	65.8	2.704	7.50E-04	8.00	11.7	22.5
31A GRI	7071.40 - 7072.00	2.489	1.34E-04	5.49	65.8	2.690	7.30E-04	8.34	21.7	12.5
32A GRI	7073.40 - 7074.00	2.431	1.09E-03	8.49	81.0	2.696	1.34E-03	10.48	9.3	9.7
33A GRI	7075.40 - 7076.00	2.473	8.25E-04	7.36	73.9	2.721	2.20E-03	9.95	10.4	15.7
34A GRI	7077.40 - 7078.00	2.450	4.42E-04	6.70	70.6	2.682	1.36E-03	9.50	18.3	11.1
35A GRI	7079.40 - 7080.00	2.510	1.40E-05	3.95	50.1	2.685	6.70E-04	7.89	10.5	39.4
36A GRI	7081.40 - 7082.00	2.503	1.61E-04	5.24	57.8	2.712	8.29E-04	9.07	9.5	32.7



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Sample	Depth (ft)	Bulk Density (g/cc)	Matrix Permeability ⁽¹⁾ (mD)	Gas-filled Porosity (%)	Gas Saturation (%)	Grain Density (g/cc)	Matrix Permeability ⁽⁵⁾ (mD)	Porosity (%)	Oil Saturation ⁽³⁾ (%)	Water Saturation ⁽⁴⁾ (%)
37A GRI	7083.50 - 7084.00	2.491	1.38E-04	6.15	70.1	2.703	4.08E-04	8.77	5.8	24.1
38A GRI	7085.40 - 7086.00	2.421	1.50E-04	7.93	80.8	2.665	2.75E-04	9.82	7.1	12.2
39A GRI	7087.40 - 7088.00	2.484	3.13E-05	6.10	72.6	2.689	4.52E-04	8.40	10.4	17.0
40A GRI	7089.40 - 7090.00	2.417	2.16E-03	8.50	82.1	2.678	6.01E-03	10.35	11.3	6.6
41A GRI	7091.40 - 7092.00	2.480	1.82E-04	5.96	73.0	2.679	3.74E-04	8.16	11.8	15.2
42A GRI	7093.40 - 7094.00	2.437	1.61E-03	8.74	80.6	2.712	4.65E-03	10.85	6.5	12.9
43A GRI	7095.40 - 7096.00	2.449	4.01E-04	6.76	75.2	2.669	2.51E-03	8.98	13.0	11.8
44A GRI	7097.40 - 7098.00	2.446	9.18E-04	7.17	77.0	2.676	4.22E-03	9.31	7.9	15.1
45A GRI	7099.25 - 7099.85	2.481	1.48E-04	5.84	72.6	2.676	3.19E-04	8.05	9.7	17.7
46A GRI	7101.40 - 7102.00	2.442	5.43E-04	7.52	81.5	2.674	6.86E-04	9.23	9.0	9.5
47A GRI	7103.40 - 7104.00	2.439	1.24E-03	7.50	80.7	2.671	1.54E-03	9.28	8.0	11.3
48A GRI	7105.40 - 7106.00	2.411	1.77E-03	8.92	86.1	2.675	2.30E-03	10.36	5.4	8.5
49A GRI	7107.40 - 7108.00	2.364	3.99E-03	10.61	88.1	2.674	4.57E-03	12.05	7.7	4.2
50A GRI	7109.40 - 7110.00	2.374	2.55E-03	10.14	84.0	2.682	5.01E-03	12.08	10.4	5.6
51A GRI	7111.40 - 7112.00	2.375	3.28E-03	10.10	87.5	2.672	4.69E-03	11.53	9.5	3.0
52A GRI	7113.40 - 7114.00	2.394	2.66E-03	9.18	88.1	2.661	3.16E-03	10.42	6.9	5.0
53A GRI	7115.40 - 7116.00	2.512	4.14E-04	5.58	73.9	2.699	8.57E-04	7.55	12.9	13.1
54A GRI	7117.65 - 7118.25	2.519	1.92E-05	3.63	57.9	2.661	2.04E-04	6.28	10.3	31.9
55A GRI	7119.40 - 7120.00	2.500	4.23E-05	4.17	57.5	2.665	3.25E-04	7.26	14.2	28.4
56A GRI	7121.40 - 7122.00	2.478	1.81E-04	5.62	69.3	2.671	6.94E-04	8.12	5.7	25.0
57A GRI	7123.40 - 7124.00	2.480	4.24E-05	4.94	67.6	2.652	6.36E-04	7.31	10.9	21.5
58A GRI	7125.45 - 7126.10	2.480	2.27E-04	5.32	67.5	2.667	1.17E-03	7.88	12.2	20.3
59A GRI	7127.40 - 7128.00	2.507	3.30E-05	3.70	55.6	2.655	4.22E-04	6.64	12.0	32.4
60A GRI	7129.40 - 7130.00	2.495	6.98E-05	4.24	59.4	2.658	1.55E-04	7.14	9.1	31.5
61A GRI	7131.40 - 7132.00	2.484	4.54E-05	4.11	55.9	2.649	8.18E-04	7.35	12.5	31.6
62A GRI	7133.40 - 7134.00	2.485	3.72E-05	4.36	57.4	2.656	7.51E-04	7.60	12.2	30.4
63A GRI	7135.40 - 7136.00	2.474	4.41E-05	4.77	57.4	2.662	3.22E-04	8.31	11.4	31.2
64A GRI	7137.40 - 7138.00	2.504	1.01E-05	4.05	53.4	2.673	4.19E-04	7.59	6.7	39.9
65A GRI	7139.40 - 7140.00	2.507	1.01E-05	3.90	53.2	2.670	2.84E-04	7.34	12.5	34.2
66A GRI	7141.50 - 7142.10	2.509	2.34E-05	4.57	57.9	2.689	4.11E-04	7.88	5.5	36.6
67A GRI	7143.40 - 7144.00	2.515	8.05E-06	3.44	46.9	2.672	2.60E-04	7.34	4.8	48.3
68A GRI	7145.40 - 7146.00	2.523	1.47E-05	4.02	56.5	2.684	3.22E-04	7.11	7.9	35.6
69A GRI	7147.40 - 7148.00	2.500	7.42E-05	4.29	56.1	2.671	4.86E-04	7.64	6.3	37.6
70A GRI	7149.40 - 7150.00	2.507	2.93E-05	4.17	60.4	2.665	4.11E-04	6.91	8.3	31.3
71A GRI	7151.65 - 7152.10	2.534	1.69E-05	3.81	57.4	2.685	3.19E-04	6.64	8.6	34.0
72A GRI	7153.40 - 7154.00	2.514	1.54E-05	3.82	56.5	2.668	3.67E-04	6.77	17.4	26.1



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73A GRI	7155.40 - 7156.00	2.486	3.90E-05	5.41	70.0	2.671	5.11E-04	7.73	11.7	18.4
74A GRI	7157.45 - 7158.00	2.511	3.44E-05	4.23	63.5	2.667	5.26E-04	6.66	15.0	21.6
75A GRI	7159.35 - 7159.80	2.513	2.08E-05	4.40	62.7	2.675	6.04E-04	7.01	9.0	28.3
76A GRI	7161.40 - 7162.00	2.505	1.90E-05	4.28	59.6	2.671	5.36E-04	7.19	15.4	25.0
77A GRI	7163.40 - 7164.00	2.543	1.11E-06	3.09	48.4	2.683	2.05E-04	6.39	11.7	39.9
78A GRI	7165.40 - 7166.00	2.539	1.11E-06	3.36	50.7	2.684	5.57E-05	6.63	2.9	46.4
79A GRI	7167.40 - 7168.00	2.536	1.66E-06	3.62	57.7	2.679	6.38E-05	6.28	7.5	34.9
80A GRI	7169.40 - 7170.00	2.530	6.77E-06	4.42	60.6	2.700	8.75E-05	7.30	8.2	31.2
81A GRI	7171.40 - 7172.00	2.540	1.99E-06	3.27	59.1	2.665	4.69E-05	5.53	4.6	36.3
82A GRI	7173.40 - 7174.00	2.537	1.45E-06	3.86	59.8	2.684	1.41E-04	6.45	4.1	36.1
83A GRI	7175.40 - 7176.00	2.529	4.56E-06	5.29	73.8	2.705	1.54E-04	7.16	8.5	17.7
84A GRI	7177.40 - 7178.00	2.490	4.56E-05	6.25	79.5	2.687	9.11E-05	7.85	9.1	11.4
85A GRI	7179.40 - 7180.00	2.487	5.56E-06	5.28	79.6	2.649	6.40E-05	6.63	4.3	16.1
86A GRI	7181.40 - 7182.00	2.450	6.51E-05	7.60	82.2	2.684	1.03E-04	9.25	12.1	5.7
87A GRI	7183.40 - 7184.00	2.418	8.74E-05	8.33	88.9	2.656	1.42E-04	9.37	1.8	9.3
88A GRI	7185.40 - 7186.00	2.404	2.56E-04	9.11	88.1	2.670	4.46E-04	10.34	6.9	5.0
89A GRI	7187.40 - 7188.00	2.445	1.63E-04	7.17	84.2	2.659	2.40E-04	8.51	7.6	8.2
90A GRI	7189.25 - 7189.80	2.428	2.49E-04	8.56	87.2	2.681	3.32E-04	9.82	7.4	5.3
91A GRI	7191.40 - 7192.00	2.435	1.08E-04	7.66	86.8	2.660	1.88E-04	8.83	5.3	7.9
92A GRI	7193.40 - 7194.00	2.432	4.18E-05	7.65	86.8	2.655	1.18E-04	8.81	3.3	9.9
93A GRI	7195.40 - 7196.00	2.472	6.13E-06	5.54	75.7	2.650	1.13E-04	7.32	7.4	17.0
94A GRI	7197.40 - 7198.00	2.455	9.97E-06	6.14	79.9	2.645	1.16E-04	7.69	10.9	9.2
95A GRI	7199.40 - 7200.00	2.411	1.76E-04	8.88	90.8	2.664	2.58E-04	9.78	3.9	5.3
96A GRI	7201.40 - 7202.00	2.488	1.87E-04	5.43	73.6	2.667	3.27E-04	7.38	10.9	15.5
97A GRI	7203.40 - 7204.00	2.422	2.57E-04	8.39	80.5	2.682	3.24E-04	10.43	4.5	15.0
98A GRI	7205.40 - 7206.00	2.404	2.47E-04	8.14	82.3	2.650	3.74E-04	9.89	3.7	14.0
99A GRI	7207.40 - 7208.00	2.408	6.38E-05	8.12	77.9	2.664	5.80E-04	10.43	3.9	18.2
100A GRI	7209.40 - 7210.00	2.371	6.38E-04	11.33	90.0	2.699	7.98E-04	12.59	3.3	6.8
101A GRI	7211.40 - 7212.00	2.463	2.18E-05	5.36	62.3	2.661	5.59E-04	8.61	9.3	28.4
102A GRI	7213.40 - 7214.00	2.478	3.33E-06	5.19	63.7	2.669	4.17E-04	8.15	12.3	24.0
103A GRI	7215.40 - 7216.00	2.490	1.28E-06	4.50	62.2	2.655	3.81E-04	7.23	8.1	29.7
104A GRI	7217.40 - 7218.00	2.460	1.91E-06	4.81	64.2	2.633	4.90E-04	7.49	14.6	21.2
105A GRI	7219.40 - 7220.00	2.482	9.69E-07	4.16	58.5	2.640	4.69E-04	7.11	3.8	37.7
106A GRI	7221.40 - 7222.00	2.479	1.27E-06	3.74	60.8	2.616	2.47E-04	6.16	2.0	37.2
107A GRI	7223.40 - 7224.00	2.480	8.28E-06	4.38	60.7	2.645	4.42E-04	7.23	12.3	27.0
108A GRI	7225.40 - 7226.00	2.472	5.87E-06	5.04	65.0	2.653	6.31E-04	7.74	12.0	22.9



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109A GRI	7227.40 - 7228.00	2.468	6.73E-06	4.12	61.0	2.621	4.12E-04	6.75	12.8	26.2
110A GRI	7229.40 - 7230.00	2.509	3.70E-06	4.04	55.0	2.673	5.30E-04	7.34	8.4	36.6
111A GRI	7231.40 - 7232.00	2.496	1.05E-05	3.30	50.8	2.637	2.84E-04	6.49	10.5	38.7
112A GRI	7233.40 - 7234.00	2.495	2.66E-05	4.72	62.8	2.669	5.69E-04	7.51	11.0	26.2
113A GRI	7235.40 - 7236.00	2.400	3.85E-05	7.73	78.0	2.644	1.39E-03	9.91	15.1	7.0
114A GRI	7237.40 - 7238.00	2.482	1.64E-05	5.09	69.1	2.657	3.43E-04	7.36	11.5	19.3
115A GRI	7239.40 - 7240.00	2.530	9.27E-07	2.53	44.7	2.649	1.04E-04	5.65	3.9	51.3
116A GRI	7241.40 - 7242.00	2.493	3.20E-06	4.33	68.0	2.642	2.68E-04	6.37	6.8	25.2
117A GRI	7243.40 - 7244.00	2.395	2.34E-04	9.19	88.4	2.661	1.10E-03	10.40	5.0	6.6
118A GRI	7245.40 - 7246.00	2.436	3.97E-04	7.84	80.5	2.679	8.35E-04	9.74	5.2	14.4
119A GRI	7247.40 - 7248.00	2.475	3.66E-06	4.94	63.2	2.656	5.64E-04	7.81	11.8	25.1
120A GRI	7249.40 - 7250.00	2.437	1.56E-05	4.97	61.0	2.623	7.26E-04	8.16	18.5	20.6
121A GRI	7251.40 - 7252.00	2.426	2.93E-06	5.13	59.1	2.622	7.65E-04	8.69	14.9	26.1
122A GRI	7253.40 - 7254.00	2.560	5.65E-06	6.65	66.7	2.807	1.03E-03	9.98	3.8	29.5
123A GRI	7255.40 - 7256.00	2.458	3.88E-06	4.62	61.8	2.629	4.19E-04	7.47	19.3	18.9
124A GRI	7257.00 - 7257.60	2.504	6.69E-06	5.56	71.9	2.691	3.65E-04	7.73	7.9	20.2
125A GRI	7259.40 - 7260.00	2.599	2.73E-07	1.83	33.2	2.713	1.51E-04	5.51	12.5	54.2
126A GRI	7265.40 - 7266.00	2.564	3.37E-07	3.18	46.7	2.713	4.11E-04	6.81	7.8	45.5
127A GRI	7270.40 - 7271.00	2.613	1.28E-06	2.54	48.5	2.731	1.03E-04	5.24	15.9	35.6
128A GRI	7275.40 - 7276.00	2.626	4.79E-07	2.78	56.6	2.740	5.29E-05	4.91	5.1	38.3
129A GRI	7280.40 - 7281.00	2.610	1.10E-06	2.47	44.8	2.730	4.33E-05	5.52	0.8	54.4
130A GRI	7285.40 - 7286.00	2.618	8.93E-07	1.73	32.3	2.727	3.23E-05	5.36	1.0	66.6
131A GRI	7290.40 - 7291.00	2.640	6.13E-07	1.45	34.7	2.728	1.32E-05	4.19	11.1	54.2
132A GRI	7295.00 - 7295.60	2.611	8.78E-07	1.60	29.2	2.721	3.07E-05	5.49	0.4	70.4
133A GRI	7297.70 - 7298.30	2.582	4.81E-05	4.47	83.9	2.719	5.63E-05	5.33	5.6	10.5
134A GRI	7300.70 - 7301.30	2.585	4.56E-06	4.66	88.5	2.723	1.21E-05	5.26	5.8	5.7
135A GRI	7303.00 - 7303.60	2.586	8.68E-06	4.44	89.5	2.717	1.49E-05	4.96	6.7	3.8
136A GRI	7306.55 - 7307.10	2.518	7.57E-05	7.10	93.0	2.722	1.26E-04	7.64	4.6	2.4
137A GRI	7309.35 - 7309.80	2.553	4.20E-05	5.83	93.1	2.719	6.32E-05	6.26	4.0	2.9
138A GRI	7312.75 - 7313.30	2.585	3.23E-05	4.76	79.9	2.737	2.31E-04	5.95	4.5	15.6
139A GRI	7315.40 - 7316.00	2.546	1.42E-05	5.26	74.9	2.721	4.18E-04	7.02	9.5	15.6
140A GRI	7318.40 - 7319.00	2.612	5.30E-07	2.37	48.3	2.721	6.22E-05	4.90	5.9	45.8
154A GRI	7325.25 - 7325.80	2.461	3.22E-05	5.65	55.1	2.691	6.09E-04	10.25	4.0	40.9
176A GRI	7335.50 - 7336.10	2.469	1.10E-04	6.00	63.6	2.689	6.89E-04	9.44	4.4	32.0
179A GRI	7338.40 - 7339.00	2.576	4.86E-07	2.10	32.1	2.709	3.43E-04	6.55	2.7	65.2
180A GRI	7343.40 - 7344.00	2.567	1.96E-07	1.37	18.8	2.707	4.52E-04	7.28	10.3	70.9



Shale Core Analysis

		As received				Dry & Dean Stark Extracted Conditions ⁽²⁾				
Sample	Depth (ft)	Bulk Density (g/cc)	Matrix Permeability ⁽¹⁾ (mD)	Gas-filled Porosity (%)	Gas Saturation (%)	Grain Density (g/cc)	Matrix Permeability ⁽⁵⁾ (mD)	Porosity (%)	Oil Saturation ⁽³⁾ (%)	Water Saturation ⁽⁴⁾ (%)
181A GRI	7348.40 - 7349.00	2.584	7.40E-07	1.86	26.5	2.723	3.37E-04	7.02	2.0	71.5
182A GRI	7353.40 - 7354.00	2.583	4.68E-07	1.54	23.6	2.710	3.04E-04	6.54	2.8	73.6
183A GRI	7359.00 - 7359.60	2.584	3.90E-07	2.28	38.2	2.709	2.79E-04	5.97	5.6	56.2
184A GRI	7363.90 - 7364.40	2.587	8.04E-07	2.28	39.2	2.710	2.50E-04	5.83	4.9	56.0
185A GRI	7368.40 - 7369.00	2.588	7.78E-07	2.33	42.4	2.707	2.27E-04	5.50	10.1	47.5

Footnotes:

- (1) Matrix Permeability is an effective Kg determined from pressure decay results on the fresh, crushed, 20/35 mesh size sample.
(2) Dean Stark extracted sample (20/35 mesh size) dried at 110 °C. Porosity and saturations are relative to total interconnected pore space.
(3) Oil volume computed assuming an oil density of 0.73 g/cc
(4) Water volume corrected assuming a brine concentration of 25,000 ppm NaCl with an ambient density of 1.015 g/cc
(5) Matrix Permeability is an absolute Kg determined from pressure decay results on the clean and dry 20/35 mesh size sample.

Reference: "Development of Laboratory and Petrophysical Techniques for Evaluating Shale Reservoirs", GRI-95/0496, Gas Research Institute, April 1996



Shale Core Analysis Protocol

SAMPLE PREPARATION

Approximately 300g of sample was removed from each core section by making a longitudinal slice with a band saw, using chilled nitrogen as the blade lubricant. Each sample was weighed to ± 0.001 g and the bulk volume by mercury immersion was measured to ± 0.01 cc. These initial measurements were performed to determine natural sample density (Bulk Density).

Each 300g sample was processed using a mechanical rock crusher and sieved through 20 and 35 US mesh sieve screens. The material retained on the 35-mesh screen was separated into a Dean Stark sub-sample (~100g) and a permeability sub-sample (~50g). These procedures were performed while minimizing exposure time and evaporative losses. These sample splits were sealed in airtight vials pending analysis. Any sample remnants were collected and preserved for future use.

MEASUREMENTS

Matrix Permeability:

Matrix permeability was determined by monitoring pressure decay as defined in the "Advances in Shale Analyses Report, D.L. Luffel, 1993 ". The permeability sub-sample was placed into a sealed sample chamber and approximately 30 cc of helium gas at ~200 psig was injected into the sample chamber system. Pressure decay was recorded in 0.25 sec increments to a maximum time of 2000 sec. Pressure vs. time data were used to calculate matrix permeability.

Fluid Saturations – Dean Stark Technique:

Reagent grade toluene was conditioned to remove excess water and used for the extraction. The Dean Stark sub-samples were placed in glass thimbles to eliminate grain loss and weighed to ± 0.001 g. The samples were loaded into the Dean-Stark apparatus under an argon bath and refluxed for 7 days. Water volumes were recorded twice daily to ensure complete water extraction. The extraction solvent discoloration was noted to validate removal of trace quantities of mobile hydrocarbon.

Sample Drying:

Samples were dried in a vacuum oven at 110°C until weight equilibrium was achieved (± 0.001 g). The minimum drying time was 1 week. After weight stabilization, samples were stored in a desiccator while awaiting further measurement.

Porosity and Grain Density:

Porosity was determined by measuring grain volume at ambient conditions using the Boyle's Law double-cell technique with helium as the expansion gas (API RP-40, Sec 5.3.2.1). Sample bulk volume is calculated using the weight of the sample before extraction and the bulk density of the original core piece. Grain density values were calculated by direct measurement of grain volume and weight on dried crushed samples.