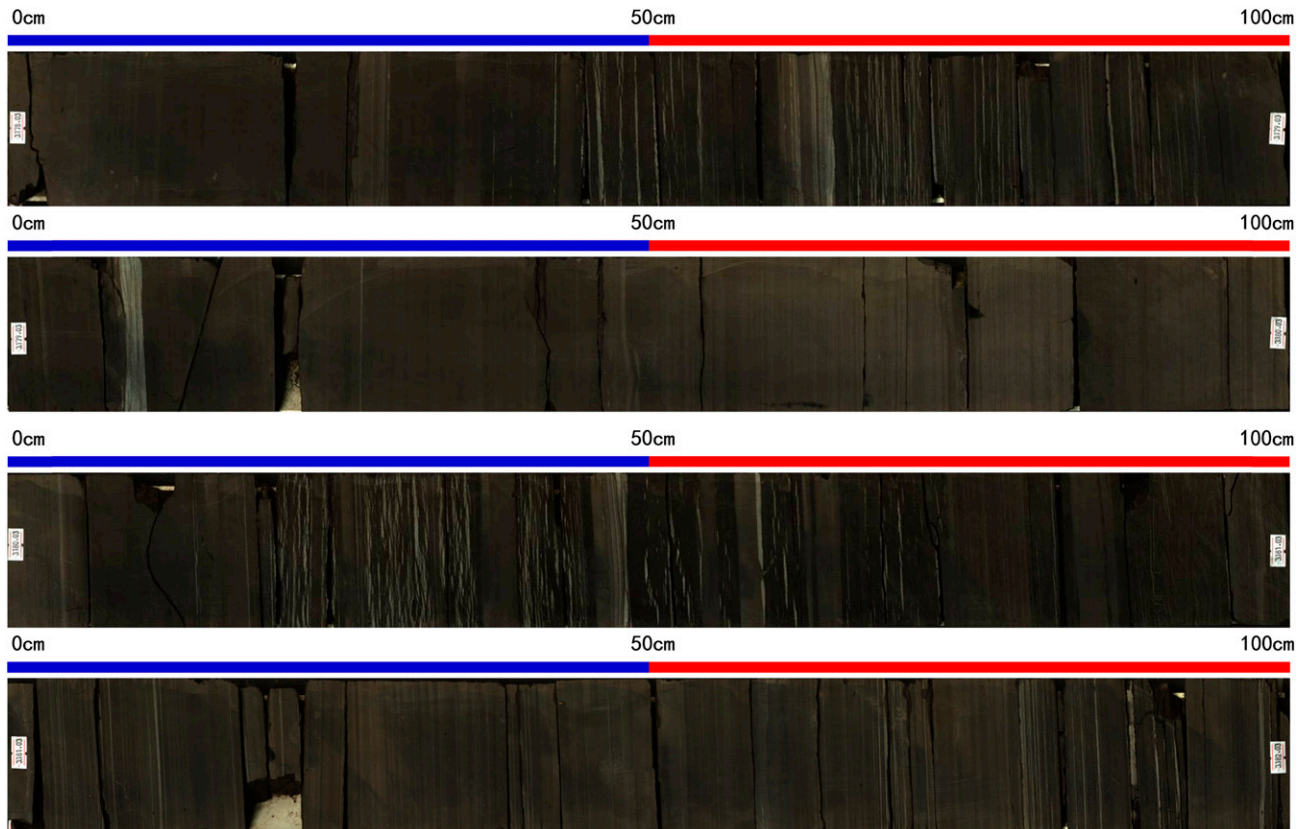


*Structural features and genesis of microscopic pores in lacustrine shale in an oil window: A case study of the Dongying depression*

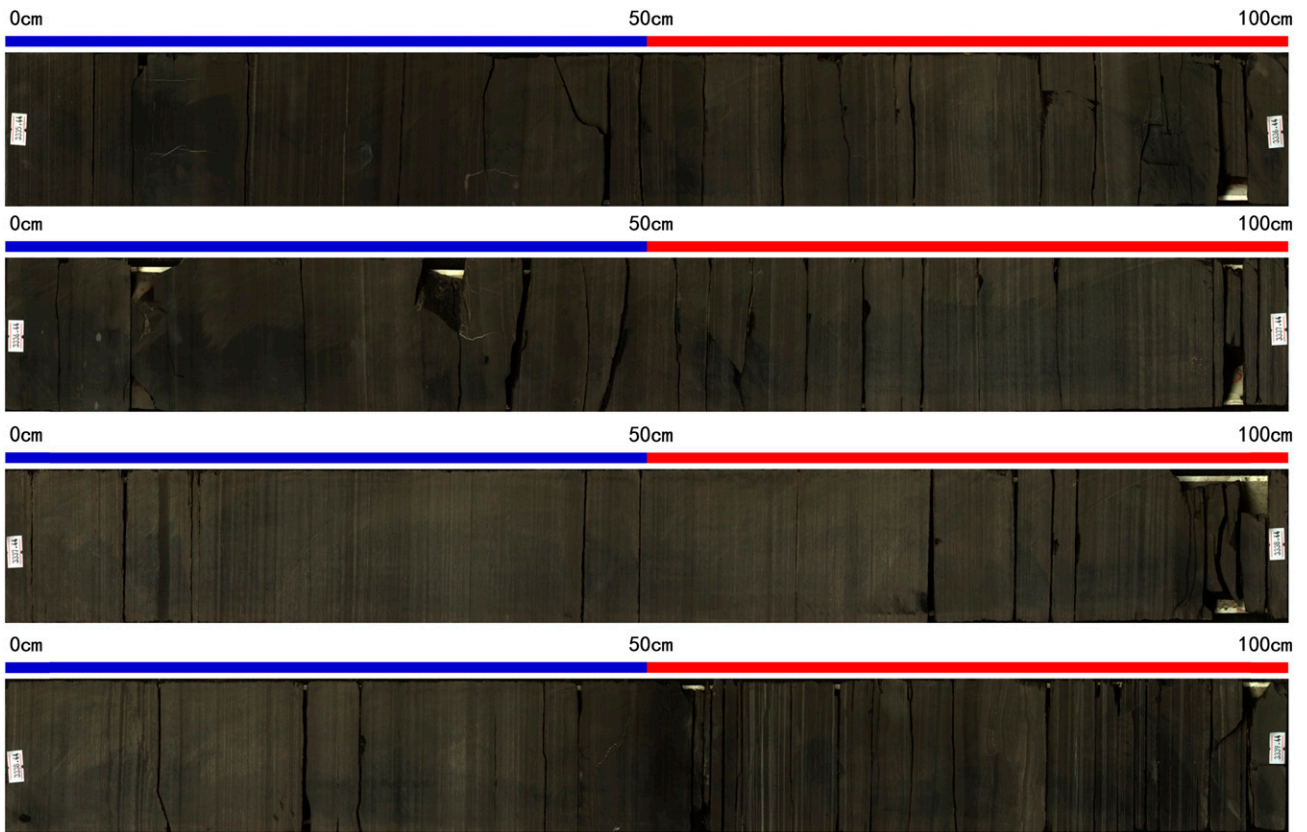
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**Figure S1.** Sweep photographs of Shahejie lower member 3 shales (3178.03–3182.03 m [10,423.94–10,437.06 ft]) of the well FY 1 in the Dongying sag.



**Figure S2.** Sweep photographs of Shahejie upper member 4 shales (3335.44–3339.44 m [10,940.24–10,953.36 ft]) of the well FY 1 in the Dongying sag.

**Table S1.** The Measured Vitrinite Reflectance Data of Shahejie Lower Member 3 and Upper Member 4 Shales in the Dongying Sag

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Bin 133	Lower Es <sub>3</sub>	Dark-gray mudstone	3136	10,286.1	0.42
Bin 649	Lower Es <sub>3</sub>	Gray mudstone	2649	8688.7	0.48
Chun 11	Lower Es <sub>3</sub>	Dark-gray shale	2297	7534.2	0.37
Fan 1	Lower Es <sub>3</sub>	Dark-gray calcareous mudstone	3076.9	10,092.2	0.53
Fan 1	Lower Es <sub>3</sub>	Dark-gray laminated mudstone	3076.9	10,092.2	0.4
Fan 1	Lower Es <sub>3</sub>	Dark-gray mudstone	3076.9	10,092.2	0.53
Fan 101	Lower Es <sub>3</sub>	Dark-gray mudstone	3169.9	10,397.3	0.42
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3030.44	9939.8	0.6
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3058.28	10,031.2	0.61
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3024.94	9921.8	0.63
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3047.21	9994.8	0.63
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3044.61	9986.3	0.64
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3057.58	10,028.9	0.64
Fan 23	Lower Es <sub>3</sub>	Dark-gray mudstone	3061.08	10,040.3	0.66
Feng 112	Lower Es <sub>3</sub>	Gray calcareous mudstone	3101.7	10,173.6	0.39
Feng 112	Lower Es <sub>3</sub>	Dark-gray calcareous mudstone	3108.6	10,196.2	0.4
Feng 112	Lower Es <sub>3</sub>	Dark-gray calcareous mudstone	3109.4	10,198.8	0.4
Feng 112	Lower Es <sub>3</sub>	Dark-gray mudstone	3105.8	10,187.0	0.34
Feng 112	Lower Es <sub>3</sub>	Gray calcareous mudstone	3118.26	10,227.9	0.41
Feng 112	Lower Es <sub>3</sub>	Gray calcareous mudstone	3112.7	10,209.7	0.41
Feng 112	Lower Es <sub>3</sub>	Gray mudstone	3117	10,223.8	0.41
Fengshen 1	Lower Es <sub>3</sub>	Dark-gray mudstone	2868.1	9407.4	0.51
Gao 23	Lower Es <sub>3</sub>	Gray green mudstone	2568.8	8425.7	0.42
Guan 14	Lower Es <sub>3</sub>	Gray calcareous mudstone	2024	6638.7	0.36
Guan 14	Lower Es <sub>3</sub>	Gray calcareous mudstone	2024	6638.7	0.37
Guan 14	Lower Es <sub>3</sub>	Gray calcareous mudstone	2024	6638.7	0.37
He 130	Lower Es <sub>3</sub>	Dark-gray calcareous mudstone	3218.53	10,556.8	0.52
He 130	Lower Es <sub>3</sub>	Dark-gray mudstone	3242.1	10,634.1	0.57
He 130	Lower Es <sub>3</sub>	Dark-gray mudstone	3268.5	10,720.7	0.58
He 130	Lower Es <sub>3</sub>	Dark-gray oil shale	3228.7	10,590.1	0.53
He 130	Lower Es <sub>3</sub>	Dark-gray oil shale	3245.53	10,645.3	0.57
Lai 104	Lower Es <sub>3</sub>	Black shale	2310.5	7578.4	0.36
Lai 64	Lower Es <sub>3</sub>	Dark-gray mudstone	3150.68	10,334.2	0.52
Lai 64	Lower Es <sub>3</sub>	Dark-gray mudstone	3155.15	10,348.9	0.52
Laixie 61	Lower Es <sub>3</sub>	Gray mudstone	2294	7524.3	0.36
Li 85	Lower Es <sub>3</sub>	Light-gray mudstone	2350	7708.0	0.41
Li 85	Lower Es <sub>3</sub>	Light-gray mudstone	2402	7878.6	0.42
Liang 212	Lower Es <sub>3</sub>	Dark-gray mudstone	2674.98	8773.9	0.43
Liang 241	Lower Es <sub>3</sub>	Dark-gray mudstone	2825.05	9266.2	0.51
Liang 241	Lower Es <sub>3</sub>	Gray mudstone	2595	8511.6	0.5
Liang 241	Lower Es <sub>3</sub>	Gray mudstone	2906.5	9533.3	0.52
Qing 1	Lower Es <sub>3</sub>	Dark-gray mudstone	3516	11,532.5	0.6
Qing 1	Lower Es <sub>3</sub>	Dark-gray mudstone	3496.1	11,467.2	0.58
Qing 1	Lower Es <sub>3</sub>	Dark-gray mudstone	3496.1	11,467.2	0.58
Qingdong 1	Lower Es <sub>3</sub>	Dark-gray mudstone	1853.3	6078.8	0.41
Shi 142	Lower Es <sub>3</sub>	Dark-gray mudstone	3643.45	11,950.5	0.92

*(continued)*

**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Shi 142	Lower Es <sub>3</sub>	Dark-gray silty mudstone	3647.56	11,964.0	0.95
Shi 142	Lower Es <sub>3</sub>	Dark-gray silty mudstone	3645.97	11,958.8	0.94
Tong 29	Lower Es <sub>3</sub>	Dark-gray mudstone	1976.5	6482.9	0.38
Tong 29	Lower Es <sub>3</sub>	Dark-gray mudstone	1987.96	6520.5	0.39
Tuo 142	Lower Es <sub>3</sub>	Dark-gray shale	3286.5	10,779.7	0.55
Tuo 715	Lower Es <sub>3</sub>	Dark-gray mudstone	3273.5	10,737.1	0.52
Tuo 715	Lower Es <sub>3</sub>	Dark-gray mudstone	3218	10,555.0	0.53
Tuo 719	Lower Es <sub>3</sub>	Dark-gray mudstone	3339	10,951.9	0.55
Tuo 73	Lower Es <sub>3</sub>	Dark-gray mudstone	3109.9	10,200.5	0.42
Tuo 73	Lower Es <sub>3</sub>	Dark-gray mudstone	3156.6	10,353.6	0.42
Tuo 761	Lower Es <sub>3</sub>	Dark-gray mudstone	3440.7	11,285.5	0.62
Tuo 762	Lower Es <sub>3</sub>	Dark-gray mudstone	3058.3	10,031.2	0.4
Wang 31	Lower Es <sub>3</sub>	Dark-gray mudstone	2448	8029.4	0.38
Wang 31	Lower Es <sub>3</sub>	Dark-gray mudstone	2442.47	8011.3	0.4
Wang 31	Lower Es <sub>3</sub>	Dark-gray mudstone	2443.37	8014.3	0.4
Wang 33	Lower Es <sub>3</sub>	Dark-gray mudstone	1842.5	6043.4	0.39
Wang 33	Lower Es <sub>3</sub>	Dark-gray shale	1816.67	5958.7	0.35
Wang 33	Lower Es <sub>3</sub>	Gray mudstone	1832	6009.0	0.36
Wang 35	Lower Es <sub>3</sub>	Gray mudstone	1964	6441.9	0.39
Wang 57	Lower Es <sub>3</sub>	Dark-gray shale	3485.6	11,432.8	0.51
Wang 57	Lower Es <sub>3</sub>	Dark-gray shale	3405	11,168.4	0.5
Wang 78	Lower Es <sub>3</sub>	Dark-gray mudstone	3735.65	12,252.9	0.64
Wang 78	Lower Es <sub>3</sub>	Dark-gray shale	3736	12,254.1	0.61
Wang 78	Lower Es <sub>3</sub>	Dark-gray shale	3732	12,241.0	0.61
Wang 78	Lower Es <sub>3</sub>	Dark-gray shale	3741.5	12,272.1	0.64
Xin 138	Lower Es <sub>3</sub>	Dark-gray shale	3355	11,004.4	0.53
Yingxie 641	Lower Es <sub>3</sub>	Dark-gray mudstone	3156	10,351.7	0.46
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2410.5	7906.4	0.39
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2605	8544.4	0.4
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2525	8282.0	0.4
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2501	8203.3	0.41
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2549	8360.7	0.43
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2388.5	7834.3	0.44
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2373	7783.4	0.45
Yong 551	Lower Es <sub>3</sub>	Gray mudstone	2341	7678.5	0.46
Zhongcan 1	Lower Es <sub>3</sub>	Calcareous shale	2296.5	7532.5	0.42
Dongfeng 5	Upper Es <sub>4</sub>	Dark-gray mudstone	3068.05	10,063.2	0.62
Dongfeng 5	Upper Es <sub>4</sub>	Dark-gray mudstone	3096.66	10,157.0	0.62
Dongfeng 5	Upper Es <sub>4</sub>	Dark-gray mudstone	3051.92	10,010.3	0.63
Dongfeng 5	Upper Es <sub>4</sub>	Dark-gray mudstone	3046.25	9991.7	0.65
Fan 15-8	Upper Es <sub>4</sub>	Black mudstone	3005.3	9857.4	0.56
Lai 1-213	Upper Es <sub>4</sub>	Dark-gray laminated mudstone	2590.5	8496.8	0.42
Lai 1-213	Upper Es <sub>4</sub>	Dark-gray mudstone	2561	8400.1	0.42
Lai 1-213	Upper Es <sub>4</sub>	Dark-gray mudstone	2592.35	8502.9	0.42
Lai 1-213	Upper Es <sub>4</sub>	Dark-gray oil shale	2612	8567.4	0.42
Lai 1-213	Upper Es <sub>4</sub>	Dark-gray shale	2608	8554.2	0.42

*(continued)*

**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Lai 38-Geng 9	Upper Es <sub>4</sub>	Dark-gray mudstone	2586.2	8482.7	0.4
Liang 8-7-17	Upper Es <sub>4</sub>	Light-gray mudstone	2663.67	8736.8	0.41
Mian 14-7-5	Upper Es <sub>4</sub>	Dark-gray shale	1215.6	3987.2	0.35
Mian 14-7-5	Upper Es <sub>4</sub>	Gray mudstone	1118.2	3667.7	0.36
Mian 14-7-5	Upper Es <sub>4</sub>	Gray mudstone	1174.26	3851.6	0.38
Mian 2-1	Upper Es <sub>4</sub>	Calcareous shale	1365	4477.2	0.25
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1288.8	4227.3	0.26
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1271.5	4170.5	0.3
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1297.2	4254.8	0.32
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1314.8	4312.5	0.33
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1365.3	4478.2	0.34
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1348.8	4424.1	0.36
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1311.4	4301.4	0.38
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1349	4424.7	0.64
Qiangdong 121	Upper Es <sub>4</sub>	Gray mudstone	2252.9	7389.5	0.43
Qiangdong 121	Upper Es <sub>4</sub>	Gray mudstone	2250.9	7383.0	0.44
Qiangdong 121	Upper Es <sub>4</sub>	Gray mudstone	2251.9	7386.2	0.44
Qiangdong 121	Upper Es <sub>4</sub>	Gray mudstone	2254.7	7395.4	0.45
Qiangdong 121	Upper Es <sub>4</sub>	Gray mudstone	2253.9	7392.8	0.46
Qiangdong 121	Upper Es <sub>4</sub>	Gray mudstone	2249.9	7379.7	0.47
Qingdong 121	Upper Es <sub>4</sub>	Dark-gray mudstone	2247.9	7373.1	0.41
Qingdong 121	Upper Es <sub>4</sub>	Dark-gray mudstone	2247.5	7371.8	0.44
Qingdong 121	Upper Es <sub>4</sub>	Gray mudstone	2241.9	7353.4	0.46
Wang 12	Upper Es <sub>4</sub>	Calcareous shale	1696	5562.9	0.4
Wang 12	Upper Es <sub>4</sub>	Dark-gray mudstone	1691.5	5548.1	0.35
Zhencan 1	Upper Es <sub>4</sub>	Dark-gray shale	1141.78	3745.0	0.28
Zhencan 1	Upper Es <sub>4</sub>	Dark-gray shale	1144	3752.3	0.4
Bin 612	Upper Es <sub>4</sub>	Dark-gray oil shale	1737	5697.4	0.37
Bin 620	Upper Es <sub>4</sub>	Tawny mudstone	1562.7	5125.7	0.34
Bin 622	Upper Es <sub>4</sub>	Dark-gray oil shale	1520.4	4986.9	0.23
Bin 644	Upper Es <sub>4</sub>	Gray mudstone	2662.5	8733.0	0.47
Bin 648	Upper Es <sub>4</sub>	Dark-gray mudstone	2230.8	7317.0	0.35
Bin 648	Upper Es <sub>4</sub>	Dark-gray oil shale	2172	7124.2	0.35
Bin 653	Upper Es <sub>4</sub>	Dark-gray mudstone	2792	9157.8	0.41
Bin 653	Upper Es <sub>4</sub>	Gray mudstone	2728.5	8949.5	0.38
Bin 653	Upper Es <sub>4</sub>	Gray mudstone	2754.3	9034.1	0.39
Bin 653	Upper Es <sub>4</sub>	Gray mudstone	2803.5	9195.5	0.47
Bin 653	Upper Es <sub>4</sub>	Gray mudstone	2812	9223.4	0.47
Bin 653	Upper Es <sub>4</sub>	Gray mudstone	2820.85	9252.4	0.49
Bin 653	Upper Es <sub>4</sub>	Gray mudstone	2824.25	9263.5	0.51
Bin 653-1	Upper Es <sub>4</sub>	Gray green mudstone	1906.13	6252.1	0.3
Bin 670	Upper Es <sub>4</sub>	Dark-gray gypsiferous mudstone	3409.5	11,183.2	0.64
Bin 670	Upper Es <sub>4</sub>	Dark-gray laminated mudstone	3410	11,184.8	0.68
Chun 372	Upper Es <sub>4</sub>	Dark-gray mudstone	2682.35	8798.1	0.45
Chun 372	Upper Es <sub>4</sub>	Dark-gray oil shale	2606	8547.7	0.52
Chun 372	Upper Es <sub>4</sub>	Gray oil shale	2568	8423.0	0.46

*(continued)*

**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Chun 372	Upper Es <sub>4</sub>	Gray oil shale	2640	8659.2	0.45
Chun 43	Upper Es <sub>4</sub>	Gray mudstone	2531.57	8303.5	0.5
Fan 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3350.83	10,990.7	0.62
Fan 101	Upper Es <sub>4</sub>	Calcareous mudstone	3282.5	10,766.6	0.43
Fan 138	Upper Es <sub>4</sub>	Dark-gray mudstone	3097.3	10,159.1	0.64
Feng 112	Upper Es <sub>4</sub>	Dark-gray mudstone	3425.58	11,235.9	0.48
Feng 112	Upper Es <sub>4</sub>	Gray carbonaceous mudstone	3431.8	11,256.3	0.44
Feng 112	Upper Es <sub>4</sub>	Gray carbonaceous mudstone	3424.5	11,232.4	0.48
Feng 112	Upper Es <sub>4</sub>	Gray mudstone	3333.8	10,934.9	0.43
Feng 112	Upper Es <sub>4</sub>	Gray mudstone	3341.1	10,958.8	0.42
Feng 112	Upper Es <sub>4</sub>	Gypsiferous mudstone	3499.17	11,477.3	0.62
Feng 112	Upper Es <sub>4</sub>	Laminated mudstone	3430.58	11,252.3	0.61
Feng 8	Upper Es <sub>4</sub>	Dark-gray mudstone	3403.51	11,163.5	0.54
Feng 8	Upper Es <sub>4</sub>	Dark-gray oil shale	3403.4	11,163.2	0.7
Feng 8	Upper Es <sub>4</sub>	Dark-gray oil shale	3403.4	11,163.2	0.7
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3684.8	12,086.1	0.63
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3687.5	12,095.0	0.55
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3916.7	12,846.8	0.75
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray laminar mudstone	3685.8	12,089.4	0.58
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray laminar mudstone	3760.5	12,334.4	0.62
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray laminar mudstone	3763	12,342.6	0.69
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray laminated mudstone	3819	12,526.3	0.7
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3442	11,289.8	0.59
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3215.5	10,546.8	0.56
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3440	11,283.2	0.57
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3916.7	12,846.8	0.75
Fengshen 1	Upper Es <sub>4</sub>	Dark-gray shale	3915.5	12,842.8	0.84
Fengshen 1	Upper Es <sub>4</sub>	Laminated mudstone	3687.5	12,095.0	0.55
Fengshen 1	Upper Es <sub>4</sub>	Laminated mudstone	3762.8	12,342.0	0.62
Fengshen 1	Upper Es <sub>4</sub>	Laminated mudstone	3762.8	12,342.0	0.62
Fengshen 1	Upper Es <sub>4</sub>	Laminated mudstone	3685.6	12,088.8	0.58
Fengshen 1	Upper Es <sub>4</sub>	Laminated mudstone	3915.2	12,841.9	0.99
Gao 61	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3161.5	10,369.7	0.43
Gao 893	Upper Es <sub>4</sub>	Dark-gray mudstone	3278.8	10,754.5	0.57
Gao 893	Upper Es <sub>4</sub>	Dark-gray shale	3208	10,522.2	0.51
Gaoxie 311	Upper Es <sub>4</sub>	Gray calcareous mudstone	2805.75	9202.9	0.52
Gaoxie 311	Upper Es <sub>4</sub>	Gray mudstone	2922.3	9585.1	0.53
Guan 127	Upper Es <sub>4</sub>	Calcareous oil shale	2377.805	7799.2	0.36
Guan 127	Upper Es <sub>4</sub>	Gray calcareous mudstone	2371.8	7779.5	0.3
Guan 127	Upper Es <sub>4</sub>	Gray laminated mudstone	2379.27	7804.0	0.38
Guan 2	Upper Es <sub>4</sub>	Gray mudstone	2587.33	8486.4	0.3
Guan 2	Upper Es <sub>4</sub>	Gray mudstone	2587.33	8486.4	0.37
Jiao 4	Upper Es <sub>4</sub>	Calcareous shale	1832.5	6010.6	0.28
Lai 105	Upper Es <sub>4</sub>	Dark-gray calcareous shale	2713	8898.6	0.43
Lai 64	Upper Es <sub>4</sub>	Dark-gray dolomite mudstone	3662.8	12,014.0	0.59
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3950	12,956.0	0.77

*(continued)*

**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3346.77	10,977.4	0.54
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3400	11,152.0	0.54
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3456.86	11,338.5	0.54
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3450	11,316.0	0.55
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3460.8	11,351.4	0.56
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3500	11,480.0	0.56
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3667.32	12,028.8	0.58
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3550	11,644.0	0.59
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3746.04	12,287.0	0.68
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3794	12,444.3	0.73
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3900	12,792.0	0.74
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3816.73	12,518.9	0.75
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	3910.6	12,826.8	0.75
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	4000	13,120.0	0.77
Lai 64	Upper Es <sub>4</sub>	Dark-gray mudstone	4048	13,277.4	0.82
Lai 64	Upper Es <sub>4</sub>	Dark-gray oil shale	3732	12,241.0	0.68
Lai 64	Upper Es <sub>4</sub>	Dark-gray oil shale	3747.17	12,290.7	0.68
Lai 64	Upper Es <sub>4</sub>	Dark-gray oil shale	3750.5	12,301.6	0.69
Lai 64	Upper Es <sub>4</sub>	Dark-gray silty mudstone	3650	11,972.0	0.58
Lai 64	Upper Es <sub>4</sub>	Dark-gray silty mudstone	3599	11,804.7	0.6
Lai 64	Upper Es <sub>4</sub>	Dark-gray silty mudstone	3700	12,136.0	0.64
Lai 64	Upper Es <sub>4</sub>	Dark-gray silty mudstone	3800	12,464.0	0.71
Laixie 61	Upper Es <sub>4</sub>	Dark-gray mudstone	2430.5	7972.0	0.34
Laixie 61	Upper Es <sub>4</sub>	Dark-gray mudstone	2430	7970.4	0.38
Laixie 61	Upper Es <sub>4</sub>	Dark-gray mudstone	2431	7973.7	0.39
Laixie 61	Upper Es <sub>4</sub>	Dark-gray mudstone	2428	7963.8	0.38
Laixie 61	Upper Es <sub>4</sub>	Gray green mudstone	2433	7980.2	0.4
Laixie 61	Upper Es <sub>4</sub>	Gray mudstone	2432	7977.0	0.4
Laixie 61	Upper Es <sub>4</sub>	Gray mudstone	2432.3	7977.9	0.37
Laixie 61	Upper Es <sub>4</sub>	Gray mudstone	2500	8200.0	0.41
Li 85	Upper Es <sub>4</sub>	Light-gray mudstone	2550	8364.0	0.42
Li 89	Upper Es <sub>4</sub>	Dark-gray laminated mudstone	3387	11,109.4	0.53
Li 89	Upper Es <sub>4</sub>	Dark-gray oil shale	3435	11,266.8	0.54
Li 89	Upper Es <sub>4</sub>	Dark-gray shale	3387	11,109.4	0.53
Li 90	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3109	10,197.5	0.67
Li 912	Upper Es <sub>4</sub>	Dark-gray laminar mudstone	3429	11,247.1	0.66
Li 98	Upper Es <sub>4</sub>	Dark-gray mudstone	3428.71	11,246.2	0.59
Liang 107	Upper Es <sub>4</sub>	Dark-gray shale	3400	11,152.0	0.74
Liang 206	Upper Es <sub>4</sub>	Dark-gray calcareous shale	2762.6	9061.3	0.49
Liang 212	Upper Es <sub>4</sub>	Dark-gray mudstone	2681.93	8796.7	0.43
Liang 75	Upper Es <sub>4</sub>	Gray mudstone	3429	11,247.1	0.74
Mian 20	Upper Es <sub>4</sub>	Calcareous shale	1113.2	3651.3	0.28
Mian 20	Upper Es <sub>4</sub>	Gray mudstone	1136.5	3727.7	0.24
Mian 20	Upper Es <sub>4</sub>	Gray mudstone	1136.5	3727.7	0.24
Mian 20	Upper Es <sub>4</sub>	Gray mudstone	1138	3732.6	0.31
Mian 20	Upper Es <sub>4</sub>	Gray mudstone	1097	3598.2	0.31

*(continued)*

**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Mian 20	Upper Es <sub>4</sub>	Gray mudstone	1111	3644.1	0.26
Mian 5	Upper Es <sub>4</sub>	Dark-gray mudstone	1238	4060.6	0.24
Niu 11	Upper Es <sub>4</sub>	Dark-gray mudstone	3603.23	11,818.6	0.72
Niu 11	Upper Es <sub>4</sub>	Dark-gray shale	3600	11,808.0	0.69
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2594.2	8509.0	0.32
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2614.1	8574.2	0.34
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2612.3	8568.3	0.34
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2603.5	8539.5	0.35
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2604.9	8544.1	0.36
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2617	8583.8	0.38
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2645.3	8676.6	0.41
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2648	8685.4	0.41
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2680.8	8793.0	0.44
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2685.4	8808.1	0.47
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2692.5	8831.4	0.5
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2661.5	8729.7	0.43
Niu 5	Upper Es <sub>4</sub>	Dark-gray shale	2634.2	8640.2	0.44
Niu 5	Upper Es <sub>4</sub>	Gray Mudstone	2615	8577.2	0.34
Shi 142	Upper Es <sub>4</sub>	Dark-gray mudstone	3691.34	12,107.6	0.94
Shi 142	Upper Es <sub>4</sub>	Dark-gray mudstone	3692.11	12,110.1	0.95
Shi 142	Upper Es <sub>4</sub>	Dark-gray mudstone	3689.6	12,101.9	0.95
Shi 142	Upper Es <sub>4</sub>	Dark-gray mudstone	3688.47	12,098.2	0.96
Shi 142	Upper Es <sub>4</sub>	Dark-gray mudstone	3690.53	12,104.9	1.03
Tong 29	Upper Es <sub>4</sub>	Dark-gray oil shale	2114	6933.9	0.4
Tong 29	Upper Es <sub>4</sub>	Dark-gray mudstone	2096.5	6876.5	0.4
Tong 29	Upper Es <sub>4</sub>	Dark-gray oil shale	2077.8	6815.2	0.39
Tong 29	Upper Es <sub>4</sub>	Dark-gray shale	2053	6733.8	0.4
Tong 29	Upper Es <sub>4</sub>	Gray mudstone	2021	6628.9	0.38
Tong 41	Upper Es <sub>4</sub>	Dark-gray shale	1280.5	4200.0	0.25
Tong 41	Upper Es <sub>4</sub>	Dark-gray shale	1307	4287.0	0.27
Tuo 134	Upper Es <sub>4</sub>	Dark-gray mudstone	3050.5	10,005.6	0.52
Tuo 135	Upper Es <sub>4</sub>	Gray mudstone	2603	8537.8	0.45
Tuo 153	Upper Es <sub>4</sub>	Dark-gray mudstone	3345.5	10,973.2	0.5
Tuo 153	Upper Es <sub>4</sub>	Dark-gray mudstone	3375.8	11,072.6	0.57
Tuo 153	Upper Es <sub>4</sub>	Dark-gray mudstone	3654.8	11,987.7	0.74
Tuo 153	Upper Es <sub>4</sub>	Dark-gray shale	3371.8	11,059.5	0.51
Tuo 153	Upper Es <sub>4</sub>	Dark-gray shale	3468.3	11,376.0	0.56
Tuo 153	Upper Es <sub>4</sub>	Dark-gray shale	3473	11,391.4	0.57
Tuo 153	Upper Es <sub>4</sub>	Laminated mudstone	3494.25	11,461.1	0.67
Tuo 153	Upper Es <sub>4</sub>	Laminated mudstone	3552.5	11,652.2	0.67
Tuo 153	Upper Es <sub>4</sub>	Laminated mudstone	3513.9	11,525.6	0.68
Tuo 153	Upper Es <sub>4</sub>	Laminated mudstone	3567.8	11,702.4	0.73
Tuo 73	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3270.58	10,727.5	0.44
Tuo 73	Upper Es <sub>4</sub>	Dark-gray mudstone	3380.33	11,087.5	0.69
Tuo 73	Upper Es <sub>4</sub>	Dark-gray mudstone	3270	10,725.6	0.48
Tuo 73	Upper Es <sub>4</sub>	Dark-gray mudstone	3383.3	11,097.2	0.5

*(continued)*



**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Tuo 73	Upper Es <sub>4</sub>	Dark-gray mudstone	3403	11,161.8	0.56
Tuo 73	Upper Es <sub>4</sub>	Gray mudstone	3376.5	11,074.9	0.5
Tuo 732	Upper Es <sub>4</sub>	Dark-gray mudstone	3531.5	11,583.3	0.72
Tuo 732	Upper Es <sub>4</sub>	Dark-gray mudstone	3583	11,752.2	0.69
Tuo 762	Upper Es <sub>4</sub>	Dark-gray mudstone	3442.78	11,292.3	0.68
Tuo 762	Upper Es <sub>4</sub>	Dark-gray mudstone	3428.35	11,245.0	0.43
Tuo 762	Upper Es <sub>4</sub>	Dark-gray mudstone	3437.23	11,274.1	0.44
Tuo 762	Upper Es <sub>4</sub>	Dark-gray mudstone	3321.8	10,895.5	0.44
Tuo 762	Upper Es <sub>4</sub>	Dark-gray mudstone	3449.48	11,314.3	0.48
Tuo 762	Upper Es <sub>4</sub>	Dark-gray mudstone	3493.4	11,458.4	0.52
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	4087.6	13,407.3	0.83
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	4164.15	13,658.4	0.96
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	3842.4	12,603.1	0.68
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	3840.75	12,597.7	0.7
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	3837.2	12,586.0	0.71
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	3843.5	12,606.7	0.72
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	4092	13,421.8	0.82
Tuo 764	Upper Es <sub>4</sub>	Dark-gray mudstone	3960.7	12,991.1	0.86
Tuo 764	Upper Es <sub>4</sub>	Dark-gray oil shale	4090.9	13,418.2	0.8
Tuo 764	Upper Es <sub>4</sub>	Gray silty mudstone	4170.85	13,680.4	0.95
Wang 103	Upper Es <sub>4</sub>	Dark-gray sandshale	3081.6	10,107.6	0.51
Wang 108	Upper Es <sub>4</sub>	Dark-gray oil shale	2596.25	8515.7	0.64
Wang 129	Upper Es <sub>4</sub>	Dark-gray mudstone	2554.1	8377.4	0.32
Wang 161	Upper Es <sub>4</sub>	Black shale	1986	6514.1	0.39
Wang 161	Upper Es <sub>4</sub>	Dark-gray shale	1866.5	6122.1	0.33
Wang 161	Upper Es <sub>4</sub>	Dark-gray shale	1906.1	6252.0	0.37
Wang 161	Upper Es <sub>4</sub>	Dark-gray shale	1901.5	6236.9	0.4
Wang 18	Upper Es <sub>4</sub>	Dark-gray shale	1652.25	5419.4	0.28
Wang 18	Upper Es <sub>4</sub>	Dark-gray shale	1629	5343.1	0.28
Wang 31	Upper Es <sub>4</sub>	Dark-gray shale	2605.2	8545.1	0.43
Wang 31	Upper Es <sub>4</sub>	Dark-gray shale	2509.5	8231.2	0.39
Wang 31	Upper Es <sub>4</sub>	Gray oil shale	2491	8170.5	0.44
Wang 31	Upper Es <sub>4</sub>	Oil shale	2576.4	8450.6	0.36
Wang 31	Upper Es <sub>4</sub>	Oil shale	2577.8	8455.2	0.39
Wang 33	Upper Es <sub>4</sub>	Dark-gray calcareous shale	1849	6064.7	0.38
Wang 33	Upper Es <sub>4</sub>	Dark-gray shale	1958	6422.2	0.39
Wang 33	Upper Es <sub>4</sub>	Dark-gray shale	1948	6389.4	0.4
Wang 35	Upper Es <sub>4</sub>	Dark-gray shale	2170.7	7119.9	0.23
Wang 35	Upper Es <sub>4</sub>	Gray calcareous mudstone	2014.2	6606.6	0.36
Wang 35	Upper Es <sub>4</sub>	Gray mudstone	2019.8	6624.9	0.36
Wang 35	Upper Es <sub>4</sub>	Gray mudstone	2143.2	7029.7	0.4
Wang 35	Upper Es <sub>4</sub>	Gray mudstone	2174.3	7131.7	0.52
Wang 35	Upper Es <sub>4</sub>	Gray shale	2142.2	7026.4	0.39
Wang 35	Upper Es <sub>4</sub>	Oil shale	2029.8	6657.7	0.38
Wang 35	Upper Es <sub>4</sub>	Oil shale	2041.5	6696.1	0.39
Wang 7	Upper Es <sub>4</sub>	Gray mudstone	2593.5	8506.7	0.32

*(continued)*

**Table S1.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Ro, %
Wang 7	Upper Es <sub>4</sub>	Gray mudstone	2621.5	8598.5	0.36
Wang 7	Upper Es <sub>4</sub>	Oil shale	2637.2	8650.0	0.37
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3905	12,808.4	0.62
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3907	12,815.0	0.63
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3904.68	12,807.4	0.7
Yong 551	Upper Es <sub>4</sub>	Dark-gray shale	3042.5	9979.4	0.51
Yong 551	Upper Es <sub>4</sub>	Gray mudstone	2763	9062.6	0.35
Yong 551	Upper Es <sub>4</sub>	Gray mudstone	2957	9699.0	0.42
Yong 551	Upper Es <sub>4</sub>	Gray mudstone	2643	8669.0	0.42
Yong 551	Upper Es <sub>4</sub>	Gray mudstone	2873	9423.4	0.42
Yong 551	Upper Es <sub>4</sub>	Gray mudstone	2905	9528.4	0.44

Abbreviations: Es<sub>3</sub> = Shahejie member 3; Es<sub>4</sub> = Shahejie member 4; R<sub>o</sub> = vitrinite reflectance.

**Table S2.** The Measured Porosity Data of Shahejie Lower Member 3 and Upper Member 4 Shales in the Dongying Sag

Well	Formation	Lithology	Depth, m	Depth, ft	Porosity, %
Mian 4-6-19	Lower Es <sub>3</sub>	Dark-gray mudstone	1200.4	3937.3	23.9
Mian 5	Lower Es <sub>3</sub>	Dark-gray shale	1238	4060.6	29.3
Bin 512	Lower Es <sub>3</sub>	Dark-gray mudstone	1264.17	4146.5	19.8
Bin 512	Lower Es <sub>3</sub>	Dark-gray mudstone	1264.29	4146.9	14.2
Bin 512	Lower Es <sub>3</sub>	Dark-gray mudstone	1264.42	4147.3	16.2
Jiao 4-5	Lower Es <sub>3</sub>	Dark-gray mudstone	1676	5497.3	18.1
Tuo 123	Lower Es <sub>3</sub>	Dark-gray mudstone	2226.8	7303.9	12.74
Yong 556	Lower Es <sub>3</sub>	Dark-gray oil shale	2467.18	8092.4	4.3
Wang 7	Lower Es <sub>3</sub>	Mudstone	2621.5	8598.5	7.8
Ying 13-2	Lower Es <sub>3</sub>	Dark-gray mudstone	2622	8600.2	8.3
Lai 105	Lower Es <sub>3</sub>	Gray mudstone	2670	8757.6	14.4
Liang 241	Lower Es <sub>3</sub>	Gray mudstone	2825.05	9266.2	0.7
Ying 691	Lower Es <sub>3</sub>	Dark-gray mudstone	2877.09	9436.9	6.7
Ying 691	Lower Es <sub>3</sub>	Dark-gray mudstone	2881.73	9452.1	12.2
Ying 80	Lower Es <sub>3</sub>	Dark-gray mudstone	2925.84	9596.8	6.2
Tuo 134	Lower Es <sub>3</sub>	Dark-gray mudstone	3050.5	10,005.6	0.5
Ying 68	Lower Es <sub>3</sub>	Dark-gray mudstone	3056.1	10,024.0	4.5
Fan 26	Lower Es <sub>3</sub>	Dark-gray mudstone	3072	10,076.2	0.6
Fengg 112	Lower Es <sub>3</sub>	Dark-gray laminar mudstone	3118.26	10,227.9	1.3
Bin 172	Lower Es <sub>3</sub>	Dark-gray mudstone	3121.52	10,238.6	14.8
Bin 172	Lower Es <sub>3</sub>	Dark-gray mudstone	3121.7	10,239.2	12.2
Bin 172	Lower Es <sub>3</sub>	Dark-gray mudstone	3122.8	10,242.8	10.5
Bin 172	Lower Es <sub>3</sub>	Dark-gray mudstone	3122.92	10,243.2	18.2
Feng 112	Lower Es <sub>3</sub>	Dark-gray shale	3123.3	10,244.4	1.7
Xinxie 159	Lower Es <sub>3</sub>	Dark-gray shale	3178.93	10,426.9	7.8
Li 983	Lower Es <sub>3</sub>	Dark-gray mudstone	3199.18	10,493.3	3.6
Li 983	Lower Es <sub>3</sub>	Dark-gray mudstone	3199.25	10,493.5	3.6

(continued)

**Table S2.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Porosity, %
He 130	Lower Es <sub>3</sub>	Dark-gray oil shale	3240	10,627.2	3.5
Niu 28	Lower Es <sub>3</sub>	Dark-gray oil shale	3279.28	10,756.0	2
Niu 107	Lower Es <sub>3</sub>	Dark-gray oil shale	3394	11,132.3	1.4
Niu 107	Lower Es <sub>3</sub>	Dark-gray oil shale	3394	11,132.3	1.9
Tuo 719	Lower Es <sub>3</sub>	Dark-gray oil shale	3399	11,148.7	2.9
Wang 57	Lower Es <sub>3</sub>	Dark-gray oil shale	3419	11,214.3	19
Wang 57	Lower Es <sub>3</sub>	Gray mudstone	3421.5	11,222.5	13.8
Qing 1	Lower Es <sub>3</sub>	Dark-gray shale	3496.1	11,467.2	13.8
Lai 64	Lower Es <sub>3</sub>	Gray silty mudstone	3746.4	12,288.2	1.63
Wu 4	Upper Es <sub>4</sub>	Dark gray calcareous mudstone	750	2460.0	24.7
Wu 4	Upper Es <sub>4</sub>	Dark gray calcareous mudstone	800	2624.0	20.2
Wu 4	Upper Es <sub>4</sub>	Dark gray calcareous mudstone	840	2755.2	26.2
Wu 4	Upper Es <sub>4</sub>	Dark gray calcareous mudstone	905	2968.4	26.9
Zhencan 1	Upper Es <sub>4</sub>	Dark-gray shale	1136.73	3728.5	23.8
Zhencan 1	Upper Es <sub>4</sub>	Dark-gray calcareous shale	1138	3732.6	33.9
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1286.22	4218.8	24.6
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1286.37	4219.3	16.3
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1286.71	4220.4	13.7
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1286.91	4221.1	24.9
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1287.2	4222.0	16.9
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1287.31	4222.4	14.7
Bin 512	Upper Es <sub>4</sub>	Dark-gray shale	1287.59	4223.3	13.5
Mian 4-5-16	Upper Es <sub>4</sub>	Dark-gray shale	1348.5	4423.1	31.1
Bin 707	Upper Es <sub>4</sub>	Dark-gray shale	1496.06	4907.1	18.9
Bin 77	Upper Es <sub>4</sub>	Gray calcareous mudstone	1509.82	4952.2	18
Bin 77	Upper Es <sub>4</sub>	Gray calcareous mudstone	1509.93	4952.6	16.4
Bin 77	Upper Es <sub>4</sub>	Gray calcareous mudstone	1510.09	4953.1	36.9
Bin 77	Upper Es <sub>4</sub>	Gray calcareous mudstone	1510.38	4954.0	21.5
Bin 77	Upper Es <sub>4</sub>	Gray calcareous mudstone	1510.63	4954.9	18.6
Bin 77	Upper Es <sub>4</sub>	Gray calcareous mudstone	1510.85	4955.6	29
Wang 12	Upper Es <sub>4</sub>	Dark-gray shale	1696	5562.9	20.8
Bin 338-6	Upper Es <sub>4</sub>	Dark-gray shale	1736.88	5697.0	18.2
Wang 33	Upper Es <sub>4</sub>	Dark-gray shale	1849	6064.7	27.4
Wang 161	Upper Es <sub>4</sub>	Dark-gray shale	1866.5	6122.1	15.5
Wang 161	Upper Es <sub>4</sub>	Dark-gray shale	1901.5	6236.9	3.4
Shan 142	Upper Es <sub>4</sub>	Dark-gray dolomited mudstone	1909.01	6261.6	32.6
Shan 142	Upper Es <sub>4</sub>	Dark-gray dolomited mudstone	1909.11	6261.9	28.6
Shan 142	Upper Es <sub>4</sub>	Dark-gray dolomited mudstone	1909.27	6262.4	32.2
Wang 35	Upper Es <sub>4</sub>	Gray mudstone	2019.8	6624.9	15.2
Wang 35	Upper Es <sub>4</sub>	Gray shale	2041.5	6696.1	20.3
Wang 35	Upper Es <sub>4</sub>	Gray oil shale	2140	7019.2	25.7
Wang 35	Upper Es <sub>4</sub>	Gray shale	2142.2	7026.4	16.9
Wang 35	Upper Es <sub>4</sub>	Gray mudstone	2143.2	7029.7	26.7
Chun 11	Upper Es <sub>4</sub>	Gray calcareous shale	2269.33	7443.4	14.6
Chun 11	Upper Es <sub>4</sub>	Gray calcareous shale	2287.57	7503.2	7.5
Chun 17	Upper Es <sub>4</sub>	Gray calcareous shale	2297.72	7536.5	21

*(continued)*

**Table S2.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Porosity, %
Chun 17	Upper Es <sub>4</sub>	Gray calcareous shale	2297.95	7537.3	20
Laixie 61	Upper Es <sub>4</sub>	Dark-gray oil shale	2432.24	7977.7	6.8
Wang 31	Upper Es <sub>4</sub>	Gray shale	2442	8009.8	8.8
Guan 110	Upper Es <sub>4</sub>	Gray shale	2450.5	8037.6	1.6
Chun 372	Upper Es <sub>4</sub>	Gray oil shale	2568	8423.0	0.9
Wang 31	Upper Es <sub>4</sub>	Gray oil shale	2577.8	8455.2	9.9
Wang 31	Upper Es <sub>4</sub>	Gray oil shale	2605.2	8545.1	2.3
Chun 372	Upper Es <sub>4</sub>	Dark-gray oil shale	2607	8551.0	5.6
Wang 7	Upper Es <sub>4</sub>	Gray oil shale	2637.2	8650.0	7.3
Wang 7	Upper Es <sub>4</sub>	Gray oil shale	2718.3	8916.0	18.6
Wang 7	Upper Es <sub>4</sub>	Gray oil shale	2738.2	8981.3	27.8
Xin 139	Upper Es <sub>4</sub>	Gray mudstone	2901	9515.3	2.7
Xin 139	Upper Es <sub>4</sub>	Gray shale	2908	9538.2	4
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2915.7	9563.5	14.7
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2916	9564.5	11
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2916.13	9564.9	10.7
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2916.3	9565.5	13
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2916.66	9566.6	8.6
Liang 242	Upper Es <sub>4</sub>	Dark-gray mudstone	2916.95	9567.6	12.4
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2917.11	9568.1	12.5
Liang 242	Upper Es <sub>4</sub>	Dark-gray mudstone	2917.9	9570.7	11
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2917.97	9570.9	7.5
Fan 132	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	2918.04	9571.2	8.6
Liang 242	Upper Es <sub>4</sub>	Dark-gray mudstone	2921.15	9581.4	15.1
Liang 242	Upper Es <sub>4</sub>	Dark-gray mudstone	2922.3	9585.1	5.8
Liang 242	Upper Es <sub>4</sub>	Dark-gray mudstone	2922.7	9586.5	9
Liang 242	Upper Es <sub>4</sub>	Dark-gray mudstone	2923.4	9588.8	12.5
Liang 219	Upper Es <sub>4</sub>	Dark-gray mudstone	3009.5	9871.2	0.6
Yong 89	Upper Es <sub>4</sub>	Gray shale	3086.6	10,124.0	9.2
Tuo 73	Upper Es <sub>4</sub>	Gray mudstone	3159	10,361.5	1.6
Feng 111	Upper Es <sub>4</sub>	Dark-gray mudstone	3222.86	10,571.0	1.9
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3266.89	10,715.4	5.4
Tuo 73	Upper Es <sub>4</sub>	Gray shale	3270	10,725.6	0.9
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3270.39	10,726.9	4.1
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3270.69	10,727.9	1.9
Tuo 73	Upper Es <sub>4</sub>	Gray mudstone	3270.88	10,728.5	2.6
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3270.89	10,728.5	2.5
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3274.6	10,740.7	3.3
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3278.95	10,755.0	1.4
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3280.9	10,761.4	1.3
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3282.3	10,765.9	2.8
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3283.6	10,770.2	1.9
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3283.9	10,771.2	0.3
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3285.9	10,777.8	3.6
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3319.25	10,887.1	1.4
Fan 120	Upper Es <sub>4</sub>	Gray calcareous mudstone	3320.1	10,889.9	1.2

*(continued)*

**Table S2.** Continued

Well	Formation	Lithology	Depth, m	Depth, ft	Porosity, %
Fan 120	Upper Es <sub>4</sub>	Gray calcareous mudstone	3320.55	10,891.4	1.4
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3321.1	10,893.2	4.2
Fan 120	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3321.34	10,894.0	0.9
Feng 112	Upper Es <sub>4</sub>	Dark-gray oil shale	3340	10,955.2	8.8
Tuo 153	Upper Es <sub>4</sub>	Dark-gray mudstone	3375.8	11,072.6	1.1
Tuo 73	Upper Es <sub>4</sub>	Dark-gray oil shale	3375.9	11,073.0	5.8
Li 89	Upper Es <sub>4</sub>	Gray mudstone	3385	11,102.8	3.9
Tuo 73	Upper Es <sub>4</sub>	Dark-gray mudstone	3400	11,152.0	7.5
Li 912	Upper Es <sub>4</sub>	Dark-gray mudstone	3429.1	11,247.4	3.9
Li 912	Upper Es <sub>4</sub>	Dark-gray mudstone	3430	11,250.4	8.1
Li 912	Upper Es <sub>4</sub>	Dark-gray calcareous mudstone	3430.7	11,252.7	8
Tuo 153	Upper Es <sub>4</sub>	Dark-gray mudstone	3473.1	11,391.8	5
Tuo 153	Upper Es <sub>4</sub>	Laminar mudstone	3494.25	11,461.1	4.4
Tuo 153	Upper Es <sub>4</sub>	Laminar mudstone	3513.9	11,525.6	7.3
Tuo 153	Upper Es <sub>4</sub>	Laminar mudstone	3543.85	11,623.8	6.3
Tuo 153	Upper Es <sub>4</sub>	Dark-gray laminar mudstone	3552.5	11,652.2	5.3
Tuo 153	Upper Es <sub>4</sub>	Dark-gray laminar mudstone	3567.8	11,702.4	6.5
Niu 11	Upper Es <sub>4</sub>	Gray mudstone	3600	11,808.0	3.7
Niu 11	Upper Es <sub>4</sub>	Dark-gray oil shale	3607.5	11,832.6	23.1
Tuo 153	Upper Es <sub>4</sub>	Dark-gray shale	3654.8	11,987.7	5.9
Fenggshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3689.2	12,100.6	3.2
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3734.8	12,250.1	9.8
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3741.5	12,272.1	13.9
Fenggshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3763	12,342.6	2.5
Fenggshen 1	Upper Es <sub>4</sub>	Dark-gray shale	3819	12,526.3	3.1
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3904	12,805.1	12.8
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3904.66	12,807.3	10.3
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3905	12,808.4	10.3
Wang 78	Upper Es <sub>4</sub>	Dark-gray shale	3907	12,815.0	9.1
Fenggshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	3916.7	12,846.8	1.5
Fenggshen 1	Upper Es <sub>4</sub>	Dark-gray mudstone	4026.6	13,207.2	1.0

Abbreviations: Es<sub>3</sub> = Shahejie member 3; Es<sub>4</sub> = Shahejie member 4.