

## Supplementary Materials

**Table S1** Predictive (Input) variables to predict ECD

ID	Abbreviation	Variable*	Unit
1	WELL	Name of the wellbore	N/A
2	DEPT	Depth	(m)
3	BIT_DEPTH	Actual bit depth	(m)
4	HDTH	Hole Depth	(m)
5	TVD	Hole True Vertical Depth	(m)
6	ROP	Rate of penetration	(m/hr)
7	BLKP	Height of the block above the rig floor	(m)
8	HKLA	Hookload	(lbf)
9	STOR	Surface Torque	(ft-lbf)
10	SWOB	Weight on the Bit	(lbf)
11	TFLO	Total flow rate	(L/min)
12	SPPA	Standpipe Pressure	(psi)
13	RPM	Rotational Speed	(round /min)
14	SPM1	Pump No. 1: Stroke rate	(Stroke/min)
15	SPM2	Pump No. 2: Stroke Rate	(Stroke/min)
16	SPM3	Pump No. 3: Stroke Rate	(Stroke /min)
17	SPM	Total pump stroke rate	(Stroke/min)
18	BIT_CONF	Telemetry Demodulation of Bit Confidence	Percentage
19	TEMP_DNI	Direction and Inclination Temperature of the Sensor	(degC)
20	DHAP	Downhole annulus pressure	(psi)
21	DHAT	Downhole annulus temperature	(degC)
22	ECD	Equivalent circulating density	(SG or g/cm <sup>3</sup> )
23	TVDSS	Subsea True Vertical Depth	(m)
24	ROP5	Rate of penetration averaged over the last 1.5 m	(m/hr)
25	GR	Gamma Ray	(gAPI)
26	A10H	Attenuation Resistivity of 10 in Spacing at 2 MHz	(Ω·m)
27	A16H	Attenuation Resistivity of 16-inch Spacing at 2 MHz	(Ω·m)
28	A22H	Attenuation Resistivity of 22-inch Spacing at 2 MHz	(Ω·m)
29	A28H	Attenuation Resistivity of 28 in Spacing at 2 MHz	(Ω·m)
30	A34H	Attenuation Resistivity of 34-inch Spacing at 2 MHz	(Ω·m)
31	P10H	Phase Shift Resistivity of 10 in Spacing at 2 MHz	(Ω·m)
32	P16H	Phase Shift Resistivity of 16-inch Spacing at 2 MHz	(Ω·m)
33	P22H	Phase Shift Resistivity of 22-inch Spacing at 2 MHz	(Ω·m)
34	P28H	Phase Shift Resistivity of 28 in Spacing at 2 MHz	(Ω·m)
35	P34H	Phase Shift Resistivity of 34-inch Spacing at 2 MHz	(Ω·m)
36	RHOB	Bulk Density	(SG or g/cm <sup>3</sup> )
37	DRHO	Bulk density correction	(SG or g/cm <sup>3</sup> )
38	TNPH	Thermal Neutron Porosity in Selected Lithologies Determined by the Ratio Method	(m <sup>3</sup> /m <sup>3</sup> )
39	DCAV	Density Caliper	(SG or g/cm <sup>3</sup> )
40	FAR	Far Total Count Rate	1/s
41	NEAR	Near-total count rate	1/s
42	Mud_Wt_Out	Mud Density	(SG or g/cm <sup>3</sup> )
43	ROP5.1	Rate of penetration (ROP) averaged over the most recent 5 m	(m/hr)
44	PEB	Photoelectric bottom total count rate	photon
45	PEF	Filtered photoelectric factor	photon
46	TEMP_DNI.1	Direction and Inclination Temperature of the Sensor over the last 1 m	(degC)

Source: \*Schlumberger (2019).

**Table S2** Descriptive statistics of the 24 independent and 1 dependent variables

ID	Variable	Count	Mean	Sd	Min	Max
1.	DEPT (m)	48,579	2,827.88	538.21	1,600.05	3,960.88
2.	BIT_DEPTH (m)	48,579	2,827.88	538.21	1,600.07	3,960.88
3.	HDTH (m)	48,579	2,827.88	538.21	1,600.00	3,960.88
4.	TVD (m)	48,579	2,062.27	322.39	1,430.96	2,786.20
5.	ROP (m/hr)	48,579	54.55	29.23	0.64	539.47
6.	BLKP (m)	48,579	15.79	8.38	0.50	31.40
7.	SPM (stroke/min)	48,579	73.85	12.14	0.00	218.65
8.	TEMP_DNI (degC)	48,579	133.46	14.70	1.50	190.50
9.	DHAP (psi)	48,579	4,240.77	1,344.51	419.00	7,522.22
10.	DHAT (degC)	48,579	132.99	16.39	-52.00	197.00
11.	P10H (ohm.m)	48,579	41.02	423.28	0.10	5,000.00
12.	TVDSS (m)	48,579	2,030.88	322.40	1,399.54	2,754.65
13.	HKLA (lbf)	48,579	153.44	22.93	-91.40	213.78
14.	TFLO (L/min)	48,579	967.89	109.16	0.00	2,972.53
15.	SPPA (psi)	48,579	2,715.69	407.15	54.19	3,856.88
16.	RPM (round/min)	48,579	166.55	25.05	0.00	200.71
17.	RHOB (SG)	48,579	2.49	0.17	-3.89	3.05
18.	Mud_Wt_Out (SG)	48,579	1.25	0.13	1.03	1.57
19.	STOR (ft-lbf)	48,579	12.15	3.59	0.00	23.07
20.	SWOB (lbf)	48,579	13.58	5.29	0.00	231.18
21.	GR (gAPI)	48,579	123.55	36.67	24.48	384.81
22.	A10H (ohm.m)	48,579	4.61	6.37	0.10	150.00
23.	DRHO (SG)	48,579	-0.02	0.22	-6.87	0.71
24.	TNPH (ratio: m3/m3)	48,579	0.26	0.06	0.04	0.58
25.	ECD (SG)	48,579	1.44	0.36	0.11	1.90