

Appendix 8. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Gates 3.

The Gates Pond site is located in Berlin, MA along I-495. There are four wells. The wells are approximately ± 100 meters from Gates Pond, which is the surface water supply for the Town of Hudson, MA. The Town of Hudson commissioned the drilling of the wells in attempt to find a clean and sustainable groundwater source to augment their surface supplies. No such source was found so all four wells remain unused but open. The wells produced five gallons per minute or less based on driller pumping tests. Three wells were investigated for this study. They are named gates1.051507, gates2.062607 and gates3.071807.

The overburden material in the area is glacial till, with thicknesses less than 3 meters. The till is composed of a nonsorted, nonstratified matrix of sand with some clay, silt and boulders. The bedrock is schist of the Nashoba Formation. The Nashoba is a fine to medium grained, and well foliated, gray to silvery-gray quartz-mica schist that may contain biotite, garnet and sillimanite. All wells are cased approximately four meters into the bedrock.

Well gates3.071807 is approximately 100 meters away from gates1.051507. It is also the closest well to Gates Pond. Logging in gates3.0718107 began on July 18, 2007 and concluded on May 25, 2008. The hiatus in logging was due to time-sensitive logging opportunities elsewhere. The well is 243.8 meters deep with a 6.4 meter casing. There is approximately two meters of overburden. A total of 149 fractures were identified in the well. Of the total number of fractures 12 are subhorizontal unloading joints, 99 are tectonic joints and 38 are FPF.

The water table was 4.21 meters below ground surface in this well at the outset of pumping for the heat pulse flow meter tests. The well was pumped for three hours and 16 minutes; during that time the water level was drawn down 0.2 meters. Four fractures were found to be flowing during the HPFM ambient and pump tests. The fractures were at 13.2, 24.6, 40.8 and 72.2 meters depth. Of all the flowing fractures, one was subhorizontal, three were tectonic fractures and one was a foliation parallel fracture.

Appendix 8, continued. Midpoint depth, strike and dip of features identified in optical televiewer log, fracture type and heat pulse flowmeter data from Gates 3 (azimuth and dip reported using right hand rule convention; t = tectonic fractures, s = sheeting joints, p = foliation parallel fractures). Data shown under the pumping test have been normalized.

Site ID: gates3.071807
 Location: "Gates Pond III" Berlin, MA
 Elevation (m) 88
 Reported Yield (gpm) 5
 Rock Type: Nashoba Formation Schist

Depth to water: 13.81 ft 4.21 m
 Depth of casing: 21 ft 6.40 m
 Depth of well: 800 ft 243.84 m
 Land surface to MP: 2.25 ft 0.69 m

number	Fractures					Ambient			Pump at 0.5 gpm		
	depth (m)	depth (ft)	Azimuth	Dip	Type	Flow (y/n)	gpm	notes	Flow (y/n)	gpm	notes
1	7.69	25.2	101	48	t	n	0		n	0.5	
2	8.5	27.9	269	71	t	n	0		n	0.5	
3	9.02	29.6	10	70	t	n	0		n	0.5	
4	9.82	32.2	167	59	t	n	0		n	0.5	
5	10.56	34.6	96	69	t	n	0		n	0.5	
6	11.02	36.2	180	61	t	n	0		n	0.5	
7	11.56	37.9	232	39	p	n	0		n	0.5	
8	11.95	39.2	269	72	t	n	0		n	0.5	
9	12.69	41.6	213	30	p	n	0		n	0.5	
10	13.2	43.3	116	74	t	y	-0.017	flow in	y	0.5	flow in
11	13.68	44.9	115	75	t	n	-0.017		n	0.14	
12	13.77	45.2	109	36	t	n	-0.017		n	0.14	
13	14.25	46.8	121	69	t	n	-0.017		n	0.14	
14	14.71	48.3	79	12	s	n	-0.017		n	0.14	
15	15.04	49.3	47	77	p	n	-0.017		n	0.14	
16	15.76	51.7	135	73	t	n	-0.017		n	0.14	
17	16.17	53.1	144	68	t	n	-0.017		n	0.14	
18	16.74	54.9	149	72	t	n	-0.017		n	0.14	
19	17.48	57.4	190	69	t	y	-0.08	flow in	n	0.14	
20	18.01	59.1	92	12	s	n	-0.08		n	0.14	
21	19.17	62.9	172	71	t	n	-0.08		n	0.14	
22	20.63	67.7	335	55	t	n	-0.08		n	0.14	
23	21.36	70.1	360	54	t	n	-0.08		n	0.14	
24	21.71	71.2	8	62	t	n	-0.08		n	0.14	
25	23.33	76.5	40	66	p	n	-0.08		n	0.14	
26	24.04	78.9	29	73	p	n	-0.08		n	0.14	
27	24.59	80.7	82	61	t	y	-0.27	flow in	y	0.14	flow in
28	26.82	88.0	161	68	t	n	-0.27		n	0.02	
29	32.35	106.1	26	67	p	n	-0.27		n	0.02	
30	35.09	115.1	243	78	p	n	-0.27		n	0.02	
31	35.34	116.0	45	77	p	n	-0.27		n	0.02	
32	35.95	118.0	312	78	t	n	-0.27		n	0.02	
33	36.11	118.5	262	77	t	n	-0.27		n	0.02	
34	36.82	120.8	220	74	p	n	-0.27		n	0.02	
35	36.83	120.8	50	67	p	n	-0.27		n	0.02	
36	39.01	128.0	253	67	p	n	-0.27		n	0.02	
37	40.76	133.7	82	55	p	n	-0.27		y	0.02	flow in
38	41.61	136.5	282	75	t	n	-0.27		n	-0.1	
39	41.97	137.7	270	74	t	n	-0.27		n	-0.1	
40	43.98	144.3	178	35	t	n	-0.27		n	-0.1	
41	44.22	145.1	265	72	p	n	-0.27		n	-0.1	
42	44.45	145.8	249	75	p	n	-0.27		n	-0.1	
43	45.25	148.5	247	72	p	n	-0.27		n	-0.1	
44	45.44	149.1	183	53	t	n	-0.27		n	-0.1	
45	48.86	160.3	65	56	p	n	-0.27		n	-0.1	
46	50.23	164.8	190	46	t	n	-0.27		n	-0.1	
47	53.05	174.1	254	71	p	n	-0.27		n	-0.1	
48	59.22	194.3	266	76	p	n	-0.27		n	-0.1	
49	60.3	197.8	187	59	t	n	-0.27		n	-0.1	
50	60.38	198.1	257	76	p	n	-0.27		n	-0.1	

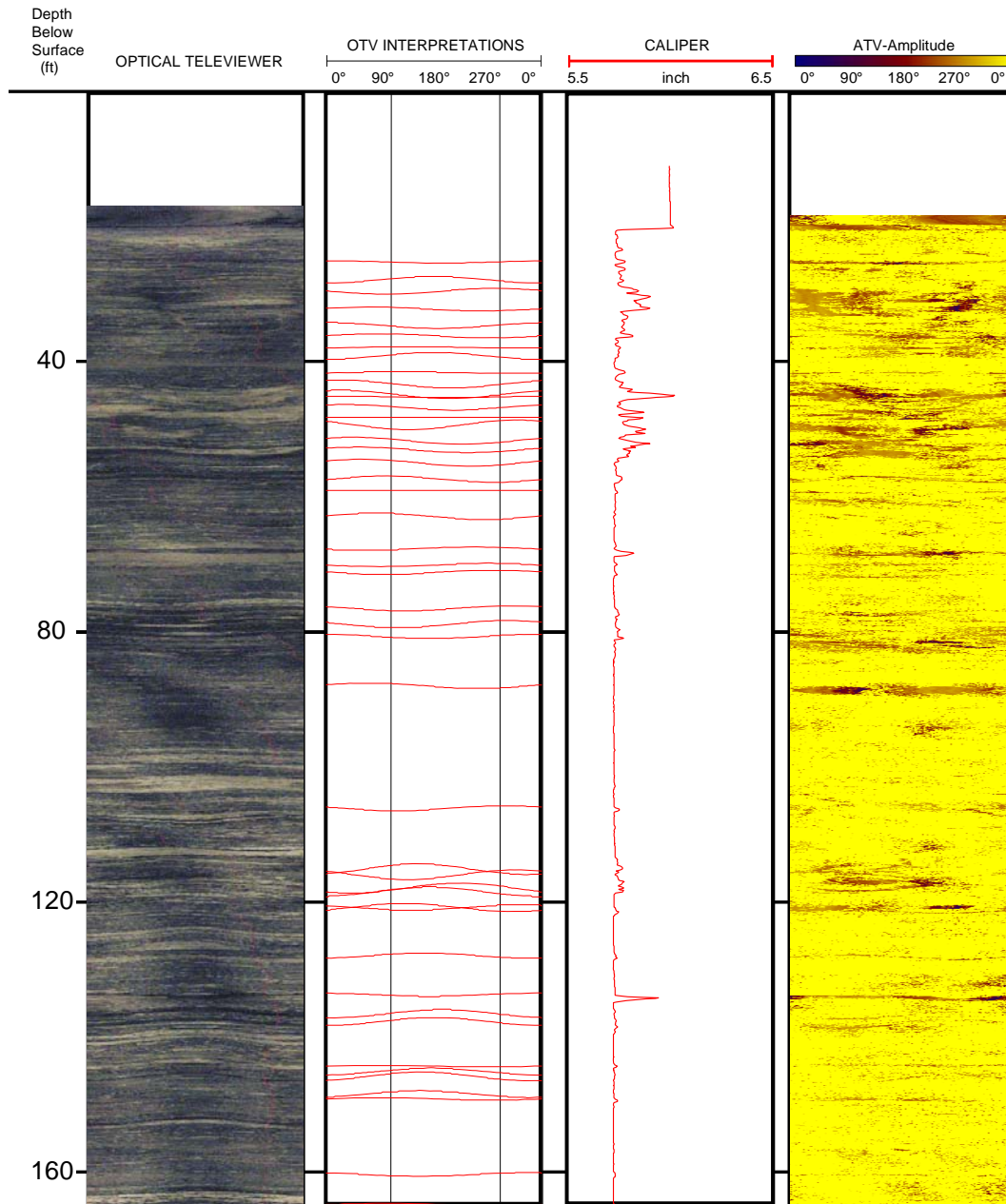
Appendix 8, continued. Midpoint depth, strike and dip of features identified in optical televiewer log, fracture type and heat pulse flowmeter data from Gates 3 (azimuth and dip reported using right hand rule convention; t = tectonic fractures, s = sheeting joints, p = foliation parallel fractures). Data shown under the pumping test have been normalized.

51	61.08	200.4	250	2	s	n	-0.27	n	-0.1
52	61.62	202.2	248	59	p	n	-0.27	n	-0.1
53	62.91	206.4	263	2	s	n	-0.27	n	-0.1
54	62.97	206.6	161	31	t	n	-0.27	n	-0.1
55	67.27	220.7	242	76	p	n	-0.27	n	-0.1
56	71.04	233.1	79	13	s	n	-0.27	n	-0.1
57	71.08	233.2	189	28	t	n	-0.27	n	-0.1
58	72.21	236.9	92	56	t	n	-0.27	n	-0.1
59	72.22	237.0	221	64	p	n	-0.27	y	0 flow out
60	73.21	240.2	351	73	t	n	-0.27	n	0
61	73.23	240.3	253	4	s	n	-0.27	n	0
62	73.31	240.5	88	62	t	n	-0.27	n	0
63	73.73	241.9	206	45	t	n	-0.27	n	0
64	74.28	243.7	290	72	t	n	-0.27	n	0
65	74.38	244.0	251	4	s	n	-0.27	n	0
66	75.73	248.5	259	78	p	n	-0.27	n	0
67	76.18	249.9	191	50	t	n	-0.27	n	0
68	76.49	251.0	93	60	t	n	-0.27	n	0
69	76.94	252.4	167	44	t	n	-0.27	n	0
70	78.57	257.8	247	68	p	n	-0.27	n	0
71	79.07	259.4	247	6	s	n	-0.27	n	0
72	80.24	263.3	54	60	p	n	-0.27	n	0
73	80.58	264.4	257	74	p	n	-0.27	n	0
74	81.6	267.7	237	70	p	n	-0.27	n	0
75	81.71	268.1	4	60	t	n	-0.27	n	0
76	81.83	268.5	8	53	t	n	-0.27	n	0
77	82.45	270.5	359	63	t	n	-0.27	n	0
78	82.54	270.8	259	76	p	n	-0.27	n	0
79	83.46	273.8	250	6	s	n	-0.27	n	0
80	83.67	274.5	290	74	t	n	-0.27	n	0
81	85.35	280.0	220	64	p	n	-0.27	n	0
82	87.13	285.9	258	75	p	n	-0.27	n	0
83	92.37	303.1	246	6	s	y	-0.015 flow out	n	0
84	92.48	303.4	116	63	t	n	-0.015	n	0
85	93.34	306.2	102	62	t	n	-0.015	n	0
86	94.6	310.4	293	72	t	n	-0.015	n	0
87	94.81	311.1	251	6	s	n	-0.015	n	0
88	95.42	313.1	335	69	t	n	-0.015	n	0
89	96.04	315.1	166	39	t	n	-0.015	n	0
90	96.11	315.3	283	57	t	n	-0.015	n	0
91	96.43	316.4	2	63	t	n	-0.015	n	0
92	98.19	322.2	215	57	p	n	-0.015	n	0
93	108.49	356.0	277	78	t	n	-0.015	n	0
94	111.3	365.2	179	46	t	n	-0.015	n	0
95	113.33	371.8	228	63	p	n	-0.015	n	0
96	113.53	372.5	270	83	t	n	-0.015	n	0
97	113.82	373.4	85	72	t	n	-0.015	n	0
98	114.43	375.4	115	52	t	n	-0.015	n	0
99	116.6	382.6	270	85	t	n	-0.015	n	0
100	120.92	396.7	262	87	p	n	-0.015	n	0
101	123.57	405.4	256	70	p	n	-0.015	n	0
102	128.59	421.9	321	65	t	n	-0.015	n	0
103	129.78	425.8	304	76	t	n	-0.015	n	0
104	130.89	429.5	279	76	t	n	-0.015	n	0
105	132.54	434.9	298	81	t	n	-0.015	n	0
106	133.58	438.3	261	78	p	n	-0.015	n	0
107	135.05	443.1	270	69	t	n	-0.015	n	0
108	135.99	446.2	248	79	p	n	-0.015	n	0
109	146.28	479.9	233	82	p	n	-0.015	n	0
110	147.41	483.7	277	62	t	n	-0.015	n	0
111	147.96	485.5	272	70	t	n	-0.015	n	0
112	152.78	501.3	216	73	p	n	-0.015	n	0
113	157.68	517.3	237	70	p	n	-0.015	n	0
114	157.74	517.5	48	69	p	n	-0.015	n	0

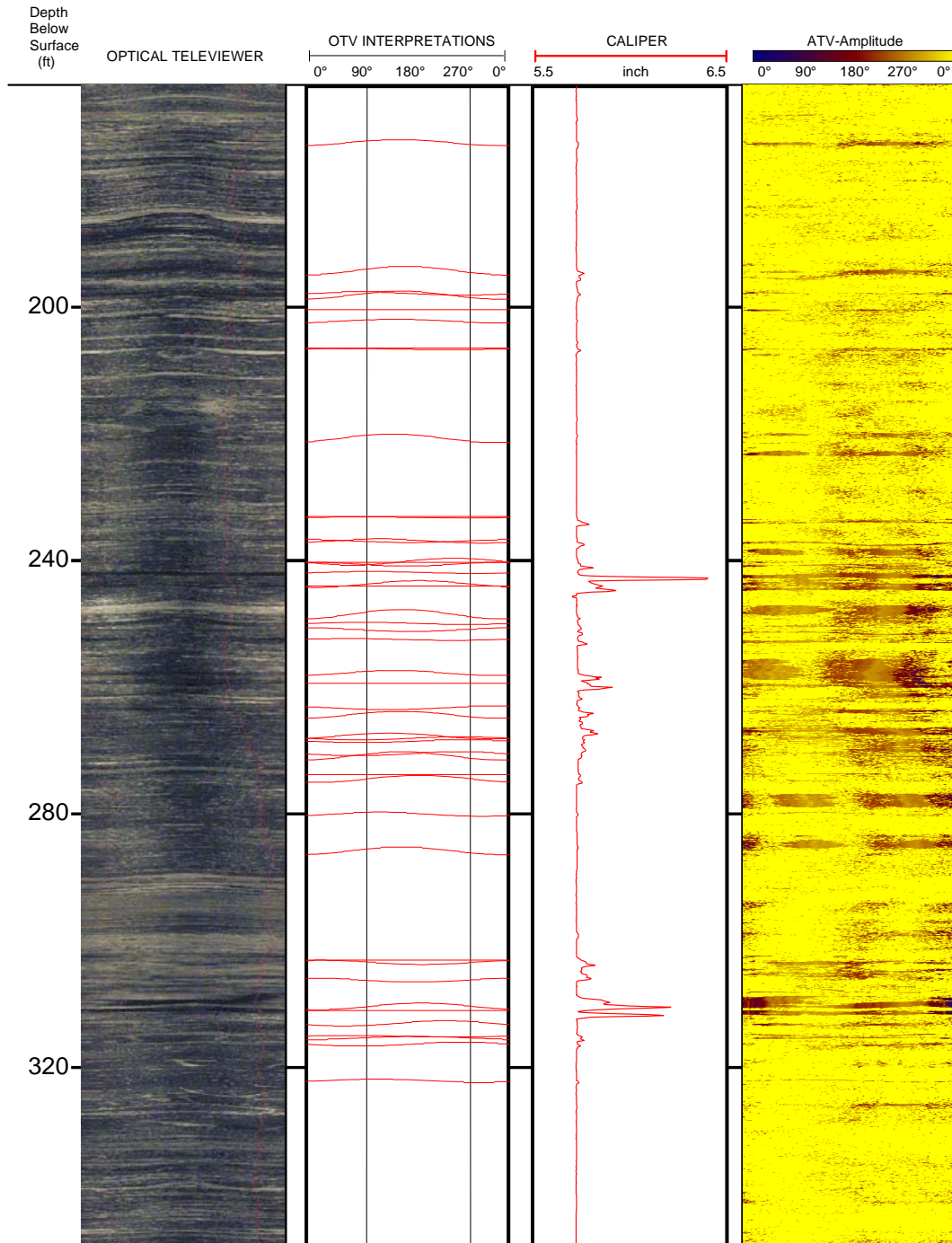
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115	164.52	539.8	245	70	p	n	-0.015	n	0
116	166.41	546.0	219	42	t	n	-0.015	n	0
117	166.86	547.5	212	63	p	n	-0.015	n	0
118	167.4	549.2	323	62	t	n	-0.015	n	0
119	172.48	565.9	304	70	t	n	-0.015	n	0
120	172.86	567.2	289	75	t	n	-0.015	n	0
121	174.1	571.2	252	52	p	n	-0.015	n	0
122	175.8	576.8	260	33	t	n	-0.015	n	0
123	177.07	581.0	218	54	p	n	-0.015	n	0
124	178.31	585.0	326	60	t	n	-0.015	n	0
125	178.85	586.8	256	57	p	n	-0.015	n	0
126	180.7	592.9	274	51	t	n	-0.015	n	0
127	181.26	594.7	289	63	t	n	-0.015	n	0
128	183.02	600.5	314	77	t	n	-0.015	n	0
129	183.46	601.9	287	69	t	n	-0.015	n	0
130	183.8	603.0	292	73	t	n	-0.015	n	0
131	184.36	604.9	292	70	t	n	-0.015	n	0
132	185.42	608.4	236	8	s	n	-0.015	n	0
133	185.66	609.2	258	55	p	n	-0.015	n	0
134	187.41	614.9	266	73	p	n	-0.015	n	0
135	187.83	616.3	281	76	t	n	-0.015	n	0
136	188.96	620.0	276	67	t	n	-0.015	n	0
137	189.66	622.3	265	61	p	n	-0.015	n	0
138	195.28	640.7	236	58	p	n	-0.015	n	0
139	197.03	646.5	246	69	p	n	-0.015	n	0
140	202.05	662.9	273	80	t	n	-0.015	n	0
141	207.79	681.8	254	60	p	n	-0.015	n	0
142	208.06	682.6	277	71	t	n	-0.015	n	0
143	210.93	692.1	56	52	p	n	-0.015	n	0
144	212.72	697.9	225	60	p	n	-0.015	n	0
145	213.76	701.3	277	59	t	n	-0.015	n	0
146	214.34	703.2	308	65	t	n	-0.015	n	0
147	218.41	716.6	243	62	p	n	-0.015	n	0
148	219.68	720.8	287	68	t	n	-0.015	n	0
149	234.01	767.8	278	72	t	n	-0.015	n	0

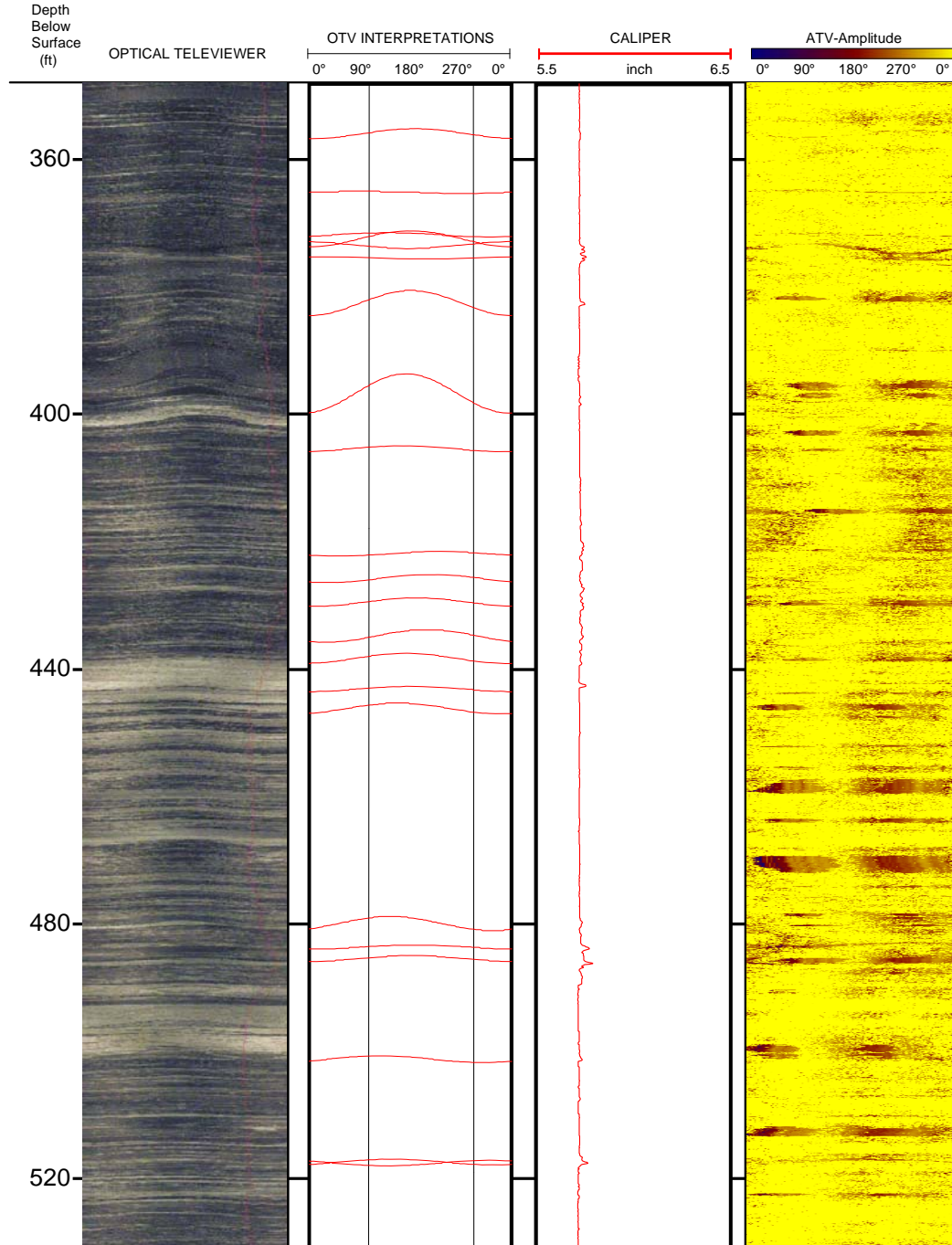
Appendix 8, continued. Interpreted features for Gates 3. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



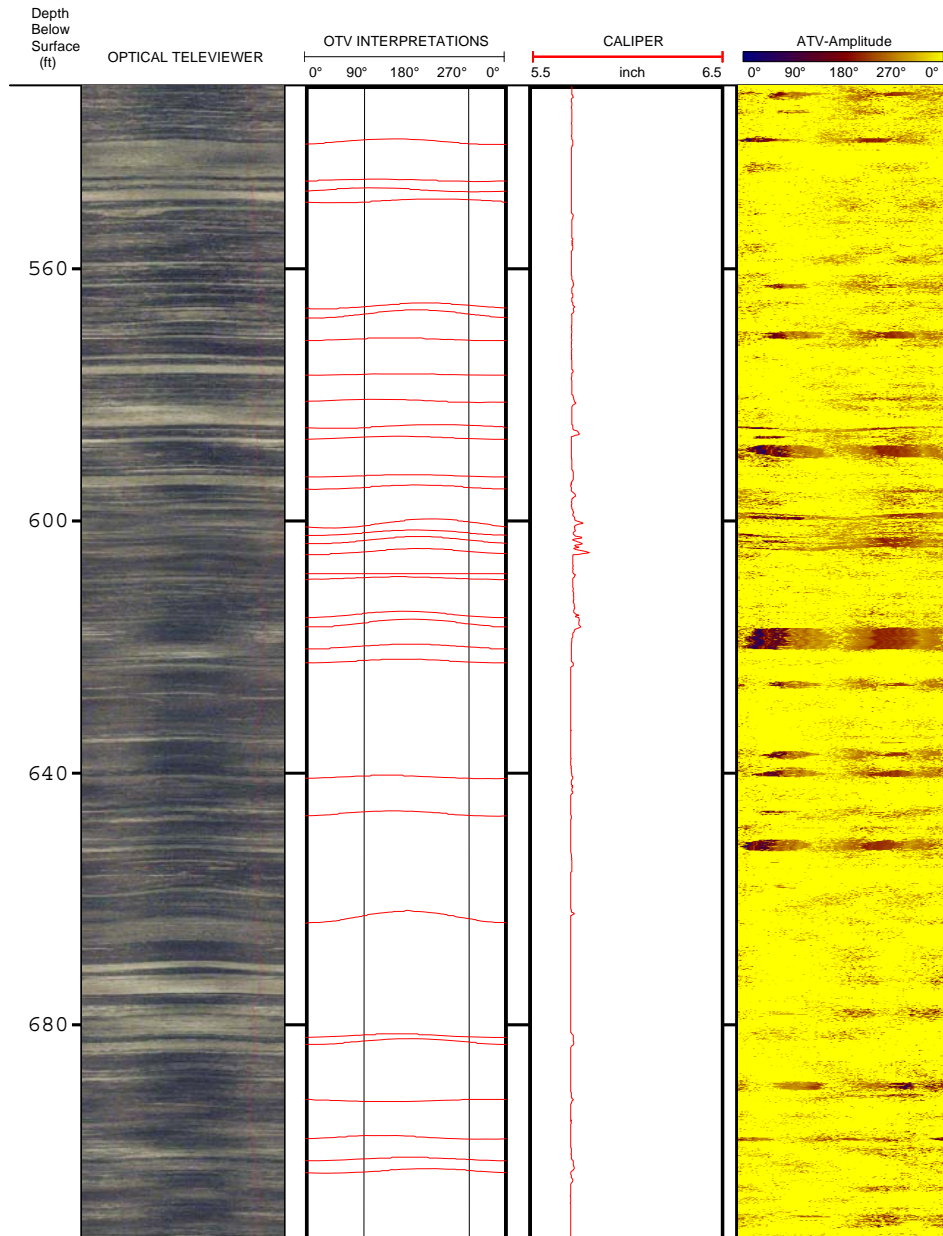
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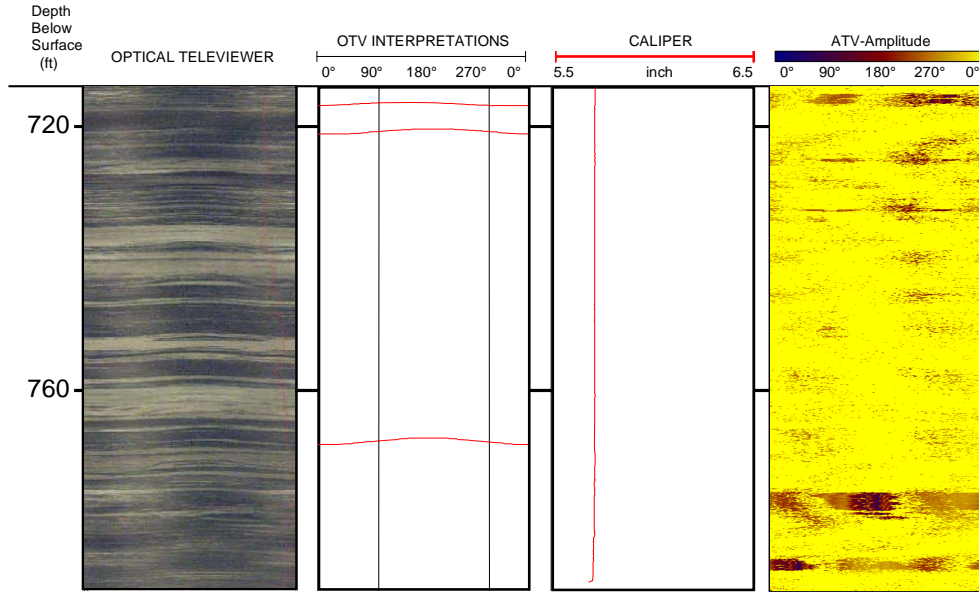
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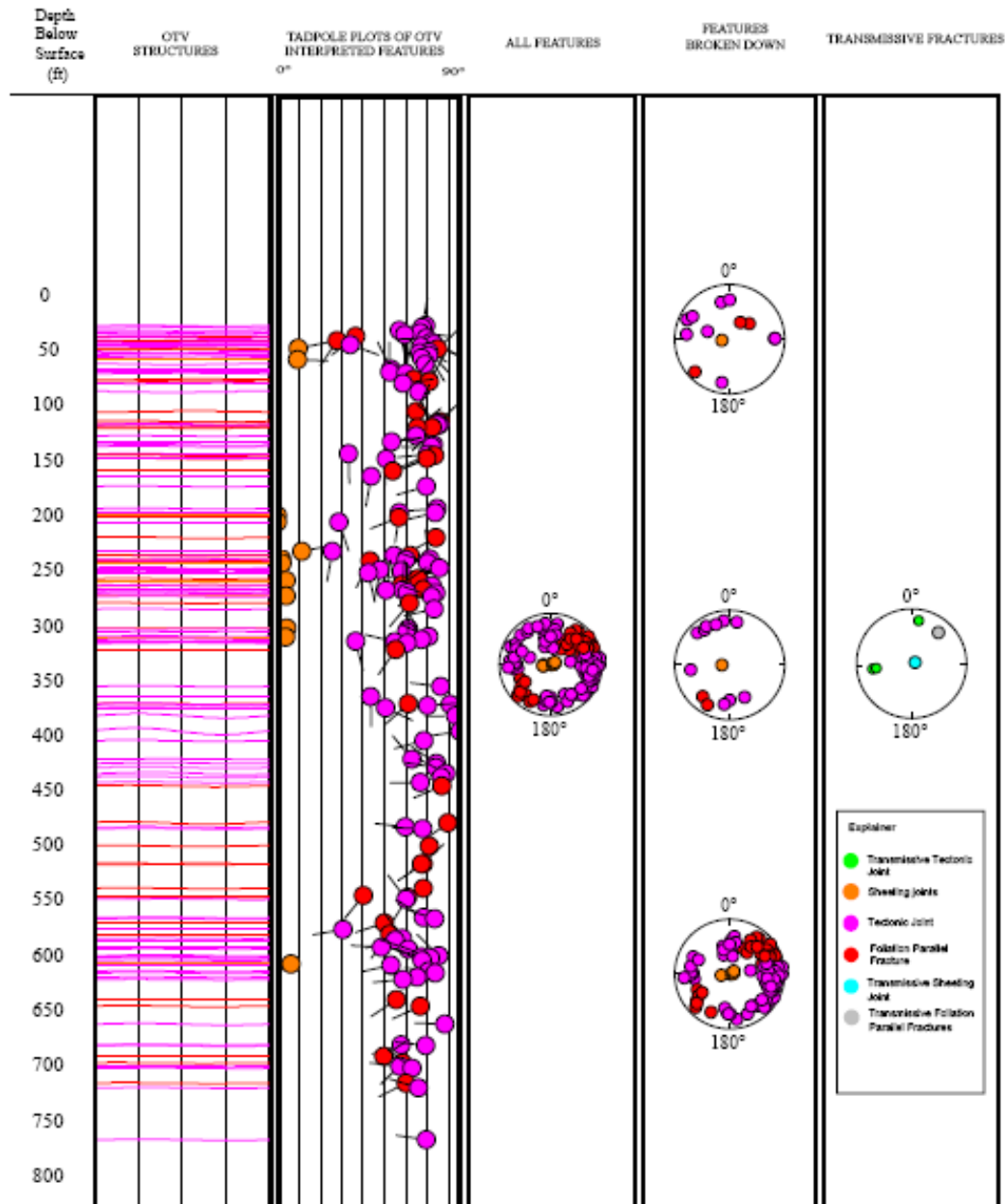
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Appendix 8, continued. Tadpole plots and stereoplots of interpreted optical televiewer (OTV) structures for Gates 3. In the tadpole plot depth is plotted along the y-axis and magnitude of the dip plotted on the x-axis. The tail of the tadpole points in the direction of the dip, relative to true north, which is toward the top of the page. The stereonets represent poles to planar features plotted on a lower-hemisphere equal-area stereonet. Stereonets use right hand rule convention. Colors on the OTV structures plot correspond to those in the tadpole explanation.



Appendix 8, continued. Composite log for Gates 3 of natural gamma, fluid resistivity, fluid temperature and heat pulse flowmeter data under ambient and stressed (pumping) conditions. For the heat pulse flowmeter data collected under pumping conditions, the well was pumped at 0.5 gallons per minute and data have been normalized.

