Appendix 5. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Box 1.

Wolf Swamp is located off of Rte 111 in Boxborough, MA a mile from I-495. The town drilled a suite of wells on the edge of the swamp several years ago with the hope of finding a sustainable groundwater source for public supply. The wells are not currently in use; the well used in this study yielded 0.75 gallons per minute based on results of driller pumping tests. The well, with ID box1.073007, is located off of Burroughs Road. The well was logged at various times between July 7 and August 8, 2007. Box1.073007 is located in a heavily wooded area approximately 200 meters from Wolf Swamp, approximately 93 meters above sea level.

The overburden is approximately 9 meters thick. The overburden is comprised of nonsorted nonstratified till with a matrix of sand with some clay, silt and boulders. The bedrock is schist of the Nashoba Formation. It is a fine to medium grained, and well foliated, gray to silvery-gray quartz-mica schist that may contain biotite, garnet and sillimanite.

The well is approximately 182 meters deep with 212 fractures identified over that length. Of the total, 42 are subhorizontal unloading joints, 86 are FPF and the remaining 84 are tectonic joints.

The water table in the well was 1.88 meters below the surface. For the heat pulse flow meter testing, the well was pumped at a 0.5 gallons per minute for four hours and was drawn down approximately 5 meters over that period. During the test, one flowing fracture was identified at 154.0 meters depth. The single flowing fracture is an FPF.

Appendix 5, continued. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Box 1 (Azimuths and dips follow right hand rule, t=tectonic, s = sheeting, p = foliation parallel fractures). Data shown for pumping conditions have not been normalized.

Site ID: box1.073007
Location: "Wolf Swamp" Boxboro, MA

Elevation (m) 93
Reported Yield (gpm) 0.75
Rock Type: Nashoba Formation Schist

Depth to water:	6.17	ft	1.88	m
Depth of casing:	39	ft	11.89	m
Depth of well:	600	ft	182.88	m
Land surface to MP:	0.81	ft	0.25	m

Fractures						Ambient			Pump	at 0.5 gpm	
number	depth (m)	depth (ft)	Azimuth	Dip	Type	Flow (y/n)	gpm	notes	Flow (y/n)	gpm	notes
1	12.0	39.4	85	72	p	n	0		n	0.09	
2	13.8	45.3	64	57	p	n	0		n	0.09	
3	15.5	50.9	319	68	t	n	0		n	0.09	
4	16.2	53.2	182	76	t	n	0		n	0.09	
5	17.4	57.2	77	72	p	n	0		n	0.09	
6	18.0	59.1	269	78	t	n	0		n	0.09	
7	18.4	60.3	269	75	t	n	0		n	0.09	
8	18.6	60.9	251	63	t	n	0		n	0.09	
9	18.7	61.2	81	38	p	n	0		n	0.09	
10	18.9	62.0	107	47	p	n	0		n	0.09	
11	20.1	66.1	293	77	t	n	0		n	0.09	
12	20.3	66.5	21	46	t	y	-0.02	flow in	n	0.09	
13	21.0	69.0	353	70	t	n	-0.02		n	0.09	
14	21.2	69.7	233	67	t	n	-0.02		n	0.09	
15	21.9	71.9	263	63	t	n	-0.02		n	0.09	
16	23.9	78.3	180	70	t	n	-0.02		n	0.09	
17	24.6	80.8	63	51	p	n	-0.02		n	0.09	
18	25.0	82.0	158	81	t	n	-0.02		n	0.09	
19	25.0	82.2	185	63	t	n	-0.02		n	0.09	
20	25.3	82.9	302	61	t	n	-0.02		n	0.09	
21	28.7	94.1	67	75	p	n	-0.02		n	0.09	
22	29.5	96.7	181	78	t	n	-0.02		n	0.09	
23	29.8	97.8	318	66	t	n	-0.02		n	0.09	
24	30.4	99.7	333	72	t	n	-0.02		n	0.09	
25	30.6	100.3	316	60	t	n	-0.02		n	0.09	
26	31.1	102.2	104	75	p	n	-0.02		n	0.09	
27	34.4	112.8	37	58	t	n	-0.02		n	0.09	
28	34.5	113.3	58	78	p	n	-0.02		n	0.09	
29	35.0	114.9	330	46	t	n	-0.02		n	0.09	
30	35.1	115.1	325	21	s	n	-0.02		n	0.09	
31	35.4	116.0	291	40	t	n	-0.02		n	0.09	
32	35.5	116.6	79	34	p	n	-0.02		n	0.09	
33	36.2	118.7	141	74	t	n	-0.02		n	0.09	
34	38.8	127.2	184	79	t	n	-0.02		n	0.09	
35	41.6	136.5	54	40	p	n	-0.02		n	0.09	
36	42.1	138.1	202	79	t	n	-0.02		n	0.09	
37	43.9	144.0	76	41	p	n	-0.02		n	0.09	
38	45.3	148.6	172	58	t	n	-0.02		n	0.09	
39	48.0	157.4	259	65	t	n	-0.02		n	0.09	
40	48.6	159.6	98	64	p	n	-0.02		n	0.09	
41	49.9	163.7	69	16	s	n	-0.02		n	0.09	
42	51.0	167.3	64	65	p	n	-0.02		n	0.09	
43	51.2	168.1	75	68	p	n	-0.02		n	0.09	
44	51.4	168.6	279	70	t	n	-0.02		n	0.09	
45	51.6	169.3	100	51	p	n	-0.02		n	0.09	
46	51.8	169.9	86	57	p	n	-0.02		n	0.09	
47	51.9	170.3	62	42	p	n	-0.02		n	0.09	
48	52.2	171.2	28	82	t	n	-0.02		n	0.09	
49	52.2	171.2	174	71	t	n	-0.02		n	0.09	
50	52.3	171.5	194	37	t	n	-0.02		n	0.09	

Appendix 5, continued. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Box 1 (Azimuths and dips follow right hand rule, t=tectonic, s = sheeting, p = foliation parallel fractures). Data shown for pumping conditions have not been normalized.

51	52.4	171.9	248	49	t	n	-0.02	n	0.09
52	53.0	174.0	71	53	p	n	-0.02	n	0.09
53	53.2	174.5	42	53	p	n	-0.02	n	0.09
54	53.6	175.9	333	32	t	n	-0.02	n	0.09
55	53.8	176.5	330	33	t	n	-0.02	n	0.09
56	54.0	177.0	186	62	t	n	-0.02	n	0.09
57	54.3	178.0	317	35	t	n	-0.02	n	0.09
58	54.3	178.2	337	41	p	n	-0.02	n	0.09
59	54.4	178.6	296	34	p	n	-0.02	n	0.09
60	54.5	179.0	294	35	p	n	-0.02	n	0.09
61	55.3	181.4	320	24	s	n	-0.02	n	0.09
62	55.8	183.1	155	68	t	n	-0.02	n	0.09
63	56.7	186.2	66	44	p	n	-0.02	n	0.09
64	57.0	187.0	298	59	t	n	-0.02	n	0.09
65	57.2	187.7	357	48	t	n	-0.02	n	0.09
66	57.4	188.3	70	32	p	n	-0.02	n	0.09
67	57.4	188.5	327	18	s	n	-0.02	n	0.09
68	58.6	192.4	168	70	t	n	-0.02	n	0.09
69	58.9	193.1	121	53	t	n	-0.02	n	0.09
70	59.0	193.7	280	71	t	n	-0.02	n	0.09
71	62.1	203.8	152	57	t	n	-0.02	n	0.09
72	63.1	207.1	171	81	t	n	-0.02	n	0.09
73	63.4	207.9	10	16	s	n	-0.02	n	0.09
74	63.6	208.6	191	76	t	n	-0.02	n	0.09
75	63.9	209.8	24	74	t	n	-0.02	n	0.09
76	64.8	212.8	38	17	s	n	-0.02	n	0.09
77	65.3	214.3	63	72	p	n	-0.02	n	0.09
78	65.5	214.9	57	77	p	n	-0.02	n	0.09
79	66.0	216.5	4	15	s	n	-0.02	n	0.09
80	67.7	222.1	174	64	t	n	-0.02	n	0.09
81	68.3	224.1	108	65	p	n	-0.02	n	0.09
82	69.2	227.1	191	27	t	n	-0.02	n	0.09
83	69.9	229.3	80	48	p	n	-0.02	n	0.09
84	70.3	230.6	79	66	p	n	-0.02	n	0.09
85	72.2	236.7	252	34	p	n	-0.02	n	0.09
86	81.4	267.1	95	46	t	n	-0.02	n	0.09
87	82.5	270.6	72	46	p	n	-0.02	n	0.09
88	83.5	274.1	314	61	t	n	-0.02	n	0.09
89	84.2	276.3	41	41	t	n	-0.02	n	0.09
90	88.3	289.6	110	66	p	n	-0.02	n	0.09
91	88.5	290.5	99	49	p	n	-0.02	n	0.09
92	89.4	293.4	62	20	s	n	-0.02	n	0.09
93	89.6	293.9	221	7	s	n	-0.02	n	0.09
94	90.1	295.7	237	66	t	n	-0.02	n	0.09
95	90.4	296.5	263	73	t	n	-0.02	n	0.09
96	93.2	305.8	230	30	t	n	-0.02	n	0.09
97	93.5	306.8	332	33	t	n	-0.02	n	0.09
98	93.9	308.1	227	56	t	n	-0.02	n	0.09
99	100.9	331.0	50	81	p	n	-0.02	n	0.09
100	103.5	339.6	223	61	p	n	-0.02	n	0.09
101	103.9	341.1	195	64	p	n	-0.02	n	0.09
102	104.2	342.0	181	68	p	n	-0.02	n	0.09
103	105.4	345.9	219	66	p	n	-0.02	n	0.09
104	105.6	346.6	340	70	t	n	-0.02	n	0.09
105	107.8	353.7	53	69	p	n	-0.02	n	0.09
106	109.9	360.7	171	24	s	n	-0.02	n	0.09
107	111.7	366.6	296	30	t	n	-0.02	n	0.09
108	111.8	366.7	69	40	p	n	-0.02	n	0.09
109	111.8	366.9	69	48	p	n	-0.02	n	0.09
110	113.1	371.1	88	62	p	n	-0.02	n	0.09
111	113.7	373.2	171	37	t	n	-0.02	n	0.09
112	114.6	375.9	109	44	p	n	-0.02	n	0.09
113	115.3	378.4	109	49	p	n	-0.02	n	0.09
114	115.5	379.0	126	34	p	n	-0.02	n	0.09

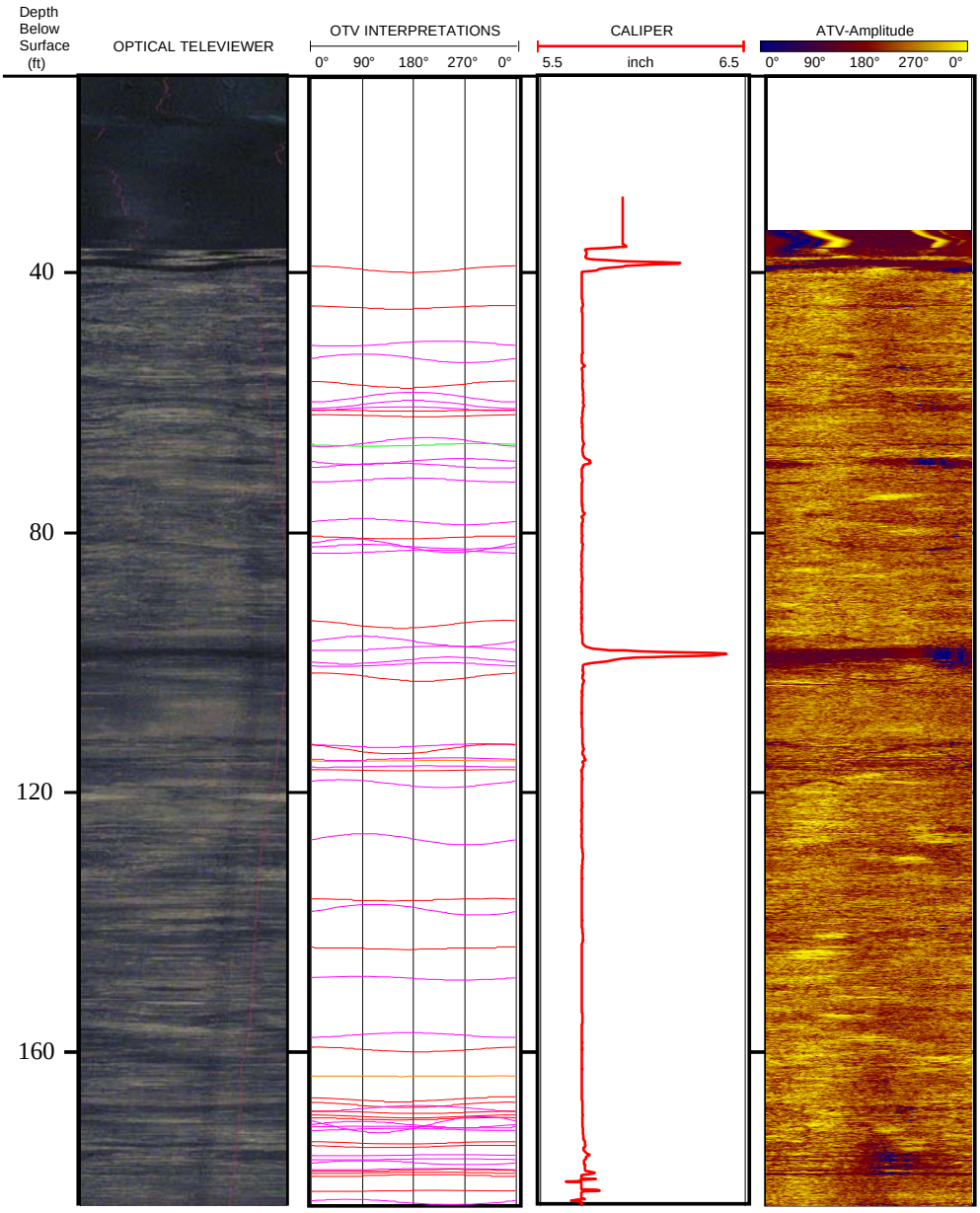
Appendix 5, continued. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Box 1 (Azimuths and dips follow right hand rule, t=tectonic, s = sheeting, p = foliation parallel fractures). Data shown for pumping conditions have not been normalized.

115	115.7	379.5	163	19	s	n	-0.02		n	0.09	
116	115.9	380.2	141	22	s	n	-0.02		n	0.09	
117	115.9	380.3	85	33	p	n	-0.02		n	0.09	
118	116.0	380.6	96	38	p	n	-0.02		n	0.09	
119	116.5	382.3	95	41	p	n	-0.02		n	0.09	
120	116.7	382.8	154	49	t	n	-0.02		n	0.09	
121	117.6	385.8	46	76	p	n	-0.02		n	0.09	
122	118.2	387.8	69	66	p	n	-0.02		n	0.09	
123	118.9	390.2	95	23	s	n	-0.02		n	0.09	
124	119.9	393.2	118	14	s	n	-0.02		n	0.09	
125	119.9	393.5	87	17	s	n	-0.02		n	0.09	
126	120.0	393.6	339	2	s	n	-0.02		n	0.09	
127	120.2	394.3	146	9	s	n	-0.02		n	0.09	
128	120.2	394.4	291	14	s	n	-0.02		n	0.09	
129	120.9	396.7	173	77	t	n	-0.02		n	0.09	
130	121.5	398.6	72	29	p	n	-0.02		n	0.09	
131	121.5	398.8	58	68	p	n	-0.02		n	0.09	
132	121.6	399.1	227	75	t	n	-0.02		n	0.09	
133	121.9	399.8	185	64	p	n	-0.02		n	0.09	
134	121.9	400.0	72	58	t	n	-0.02		n	0.09	
135	122.4	401.7	72	14	s	n	-0.02		n	0.09	
136	122.5	402.0	81	21	s	n	-0.02		n	0.09	
137	124.9	409.8	239	64	t	n	-0.02		n	0.09	
138	126.0	413.5	237	60	t	n	-0.02		n	0.09	
139	126.8	415.9	315	57	t	n	-0.02		n	0.09	
140	129.4	424.6	103	68	p	n	-0.02		n	0.09	
141	129.7	425.7	69	82	p	n	-0.02		n	0.09	
142	130.9	429.3	255	45	t	n	-0.02		n	0.09	
143	132.2	433.7	101	54	p	n	-0.02		n	0.09	
144	135.9	445.8	79	54	p	n	-0.02		n	0.09	
145	136.6	448.0	325	27	t	n	-0.02		n	0.09	
146	137.3	450.6	40	32	t	n	-0.02		n	0.09	
147	138.4	454.3	17	14	s	n	-0.02		n	0.09	
148	138.8	455.4	64	18	s	n	-0.02		n	0.09	
149	138.9	455.8	67	34	p	n	-0.02		n	0.09	
150	139.1	456.3	270	0	s	n	-0.02		n	0.09	
151	139.4	457.3	305	33	t	n	-0.02		n	0.09	
152	140.5	461.0	195	80	t	n	-0.02		n	0.09	
153	141.7	464.8	106	25	s	n	-0.02		n	0.09	
154	141.8	465.3	133	22	s	n	-0.02		n	0.09	
155	145.5	477.5	88	19	s	n	-0.02		n	0.09	
156	146.7	481.5	116	37	t	n	-0.02		n	0.09	
157	146.9	482.1	130	29	t	n	-0.02		n	0.09	
158	147.4	483.6	166	24	s	n	-0.02		n	0.09	
159	148.8	488.3	107	25	s	n	-0.02		n	0.09	
160	149.2	489.5	57	24	s	n	-0.02		n	0.09	
161	151.5	497.2	90	48	p	n	-0.02		n	0.09	
162	152.1	499.1	61	65	p	n	-0.02		n	0.09	
163	152.7	501.0	89	57	p	n	-0.02		n	0.09	
164	152.8	501.5	65	75	p	n	-0.02		n	0.09	
165	153.3	503.0	348	62	t	n	-0.02		n	0.09	
166	153.5	503.7	94	63	p	n	-0.02		n	0.09	
167	153.9	504.8	70	59	p	n	-0.02		n	0.09	
168	154.0	505.2	198	74	t	n	-0.02		n	0.09	
169	154.0	505.3	75	65	p	y	-0.02	flow out	y	0.09	flow in
170	155.2	509.2	52	79	p	n	0		n	0	
171	158.9	521.2	87	30	p	n	0		n	0	
172	161.3	529.2	80	63	p	n	0		n	0	
173	161.7	530.5	88	66	p	n	0		n	0	
174	161.7	530.6	81	63	p	n	0		n	0	
175	162.4	533.0	93	54	t	n	0		n	0	
176	162.7	533.7	91	59	p	n	0		n	0	
177	162.8	534.1	200	84	t	n	0		n	0	
178	162.9	534.5	76	58	p	n	0		n	0	

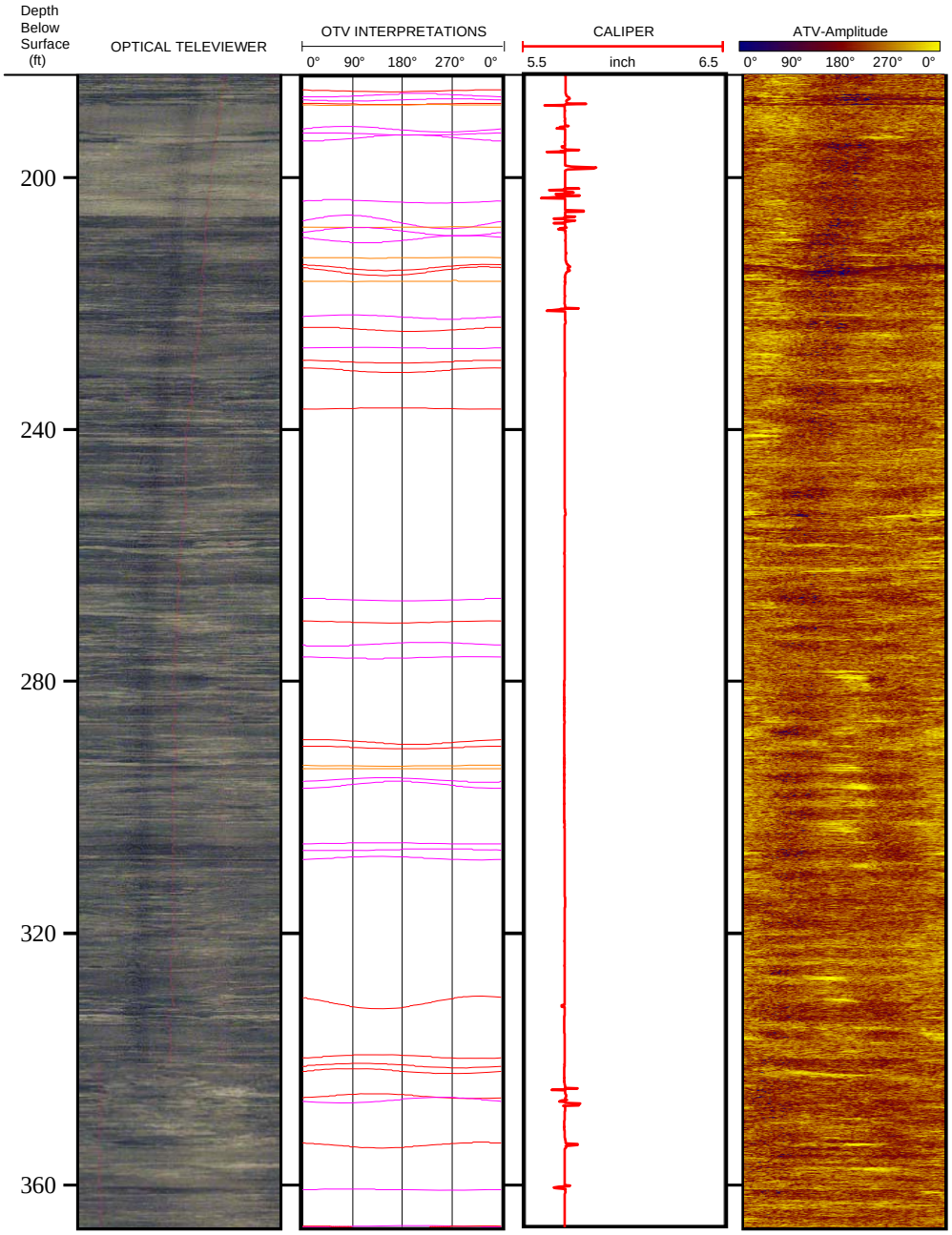
Appendix 5, continued. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Box 1 (Azimuths and dips follow right hand rule, t=tectonic, s = sheeting, p = foliation parallel fractures). Data shown for pumping conditions have not been normalized.

179	163.1	535.2	98	47	p	n	0	n	0
180	165.0	541.3	100	42	p	n	0	n	0
181	165.4	542.7	223	32	t	n	0	n	0
182	165.5	543.0	12	34	t	n	0	n	0
183	166.1	544.9	69	15	s	n	0	n	0
184	166.8	547.4	87	45	p	n	0	n	0
185	166.9	547.7	70	48	p	n	0	n	0
186	167.1	548.2	71	47	p	n	0	n	0
187	167.3	549.0	84	54	p	n	0	n	0
188	167.8	550.7	16	16	s	n	0	n	0
189	167.9	550.7	141	15	s	n	0	n	0
190	168.2	551.8	92	43	p	n	0	n	0
191	169.5	556.3	110	74	p	n	0	n	0
192	169.7	556.6	102	63	p	n	0	n	0
193	170.2	558.3	131	14	s	n	0	n	0
194	170.6	559.8	340	29	t	n	0	n	0
195	170.6	559.9	180	14	s	n	0	n	0
196	171.2	561.8	57	35	p	n	0	n	0
197	172.0	564.3	77	49	p	n	0	n	0
198	172.4	565.6	78	49	p	n	0	n	0
199	172.7	566.7	323	7	s	n	0	n	0
200	173.9	570.5	208	17	s	n	0	n	0
201	174.0	570.7	67	16	s	n	0	n	0
202	174.6	572.9	75	18	s	n	0	n	0
203	174.7	573.2	66	14	s	n	0	n	0
204	174.8	573.4	83	21	s	n	0	n	0
205	175.4	575.5	190	37	p	n	0	n	0
206	175.8	576.7	225	23	s	n	0	n	0
207	176.7	579.9	341	29	t	n	0	n	0
208	179.2	588.1	254	42	t	n	0	n	0
209	179.5	588.9	210	20	s	n	0	n	0
210	179.9	590.4	214	51	t	n	0	n	0
211	180.1	590.8	338	33	t	n	0	n	0
212	181.3	594.8	5	50	t	n	0	n	0

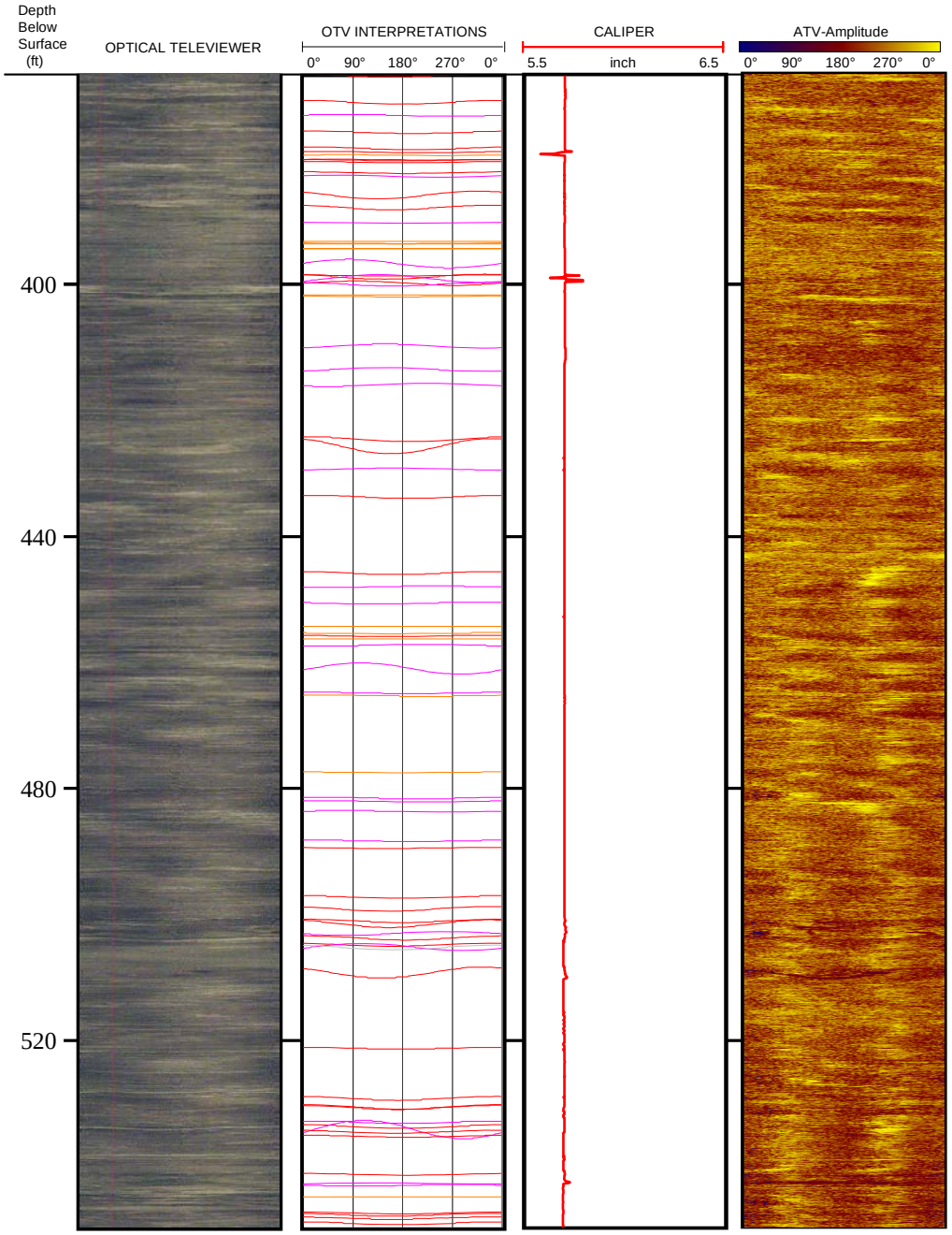
Appendix 5, continued. Interpreted features for Box 1. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



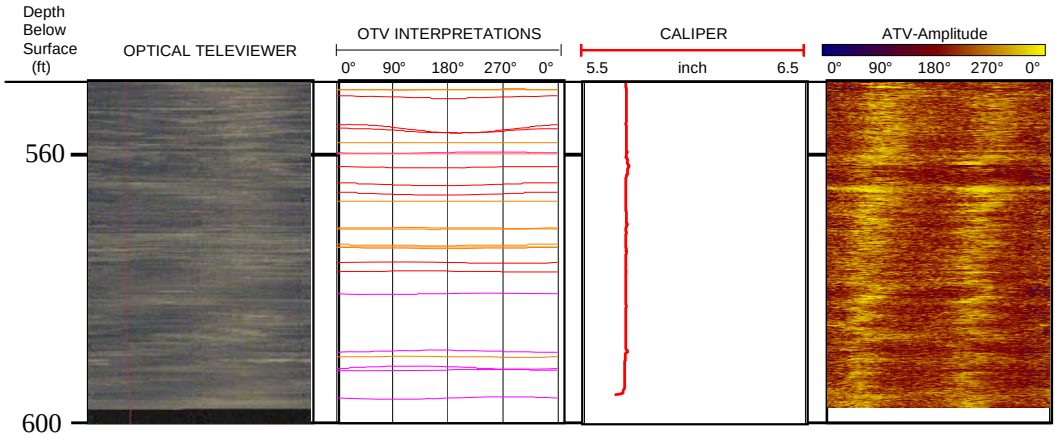
Appendix 5, continued. Interpreted features for Box 1. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



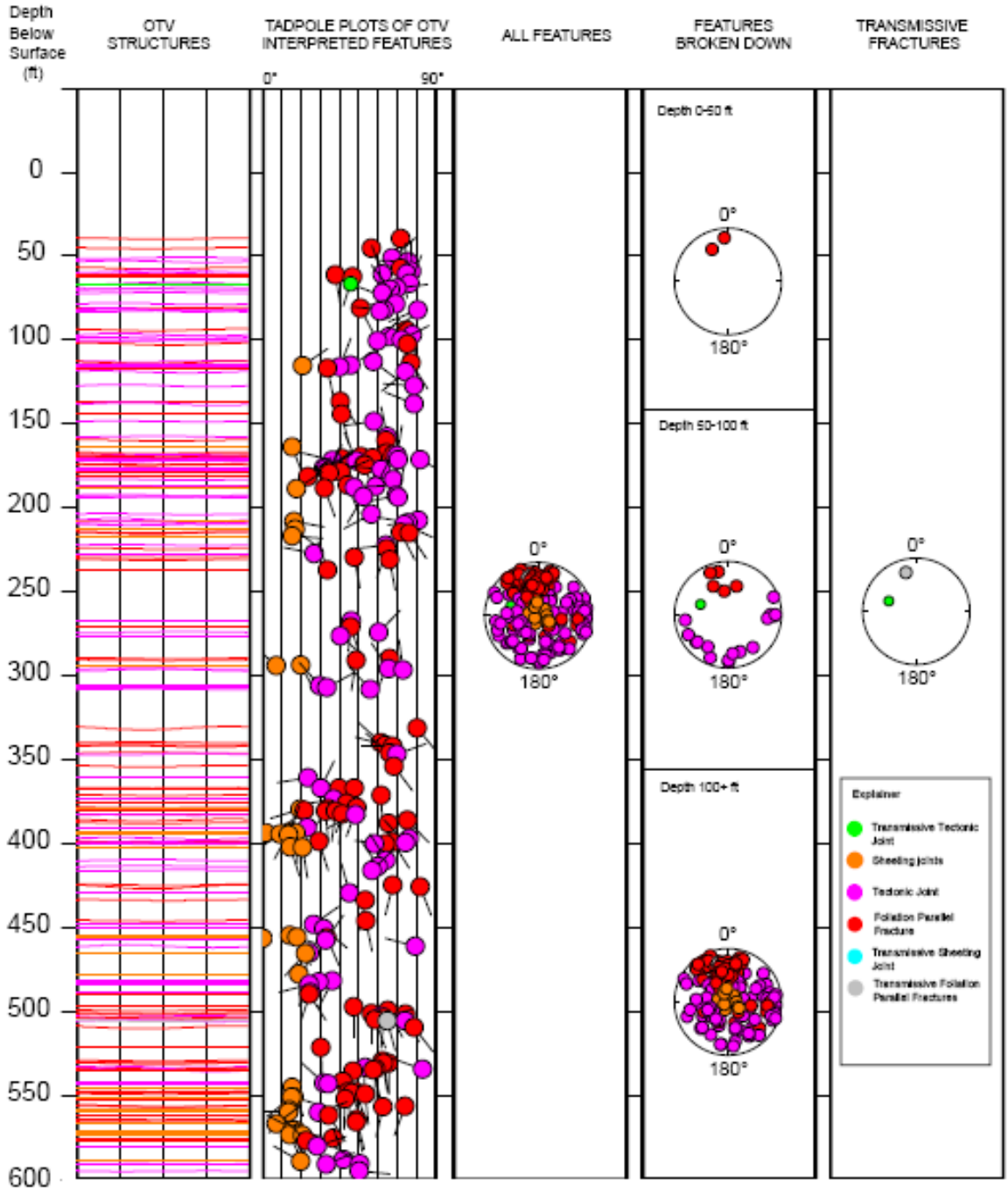
Appendix 5, continued. Interpreted features for Box 1. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



Appendix 5, continued. Interpreted features for Box 1. 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.



Appendix 5, continued. Tadpole plots and stereoplots of interpreted optical televiewer (OTV) structures for Box 1. 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 5, continued. Composite log for Box 1 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.