

Appendix 14. Location, physical characteristics, borehole-geophysical logs and interpreted structures for well Shr 1.

After construction of the new high school in 2004, the Town of Shrewsbury, MA commissioned the drilling of three bedrock wells around the athletic facilities for use on the grounds. Two wells were drilled eventually. One well yielded 60 gallons per minute, while the second yielded 15 gallons per minute. The wells are not currently in use. The lower yielding well was logged for this project. The ID is shr1.061807 and the well elevation is approximately 173 meters above sea level. The high school is located at the top of hill with large areas of exposed bedrock nearby. The site is approximately 3 km from the Assabet Reservoir.

The overburden is approximately eight meters thick. The overburden is thick nonsorted, unstratified till with some clay, silt and boulders. The bedrock is a dark gray to greenish gray medium-grained amphibolite. The well site is also approximately 3 km from the Clinton Newbury Fault Zone, which forms the west boundary of the Nashoba terrane. .

The well was approximately 214 meters deep. Ninety-five fractures were measured. Of the total fractures measured, 3 are subhorizontal unloading joints, 24 are tectonic joints, and 68 are FPF indicating that the unit is strongly foliated. The water level in the well at the outset of logging was 7.36 meters below ground surface. The well was pumped at 0.5 gallons per minute for three hours and 25 minutes during which time the water level was drawn down 0.23 meters. Results from the heat pulse flow meter testing show four flowing fractures in the well. The fractures were located at 21.3, 24.1, 26.6 and 60 meters depth. Of the flowing fractures 1 was a subhorizontal joint and 3 were FPF.

Appendix 14, continued. Midpoint depth, strike and dip of features identified in optical televiewer log, fracture type and heat pulse flowmeter data from Shr 1 (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: shr1.061807
 Location: Shrewsbury HS Shrewsbury, MA

Elevation (m) 173
 Reported Yield (gpm) 15
 Rock Type: amphibolite

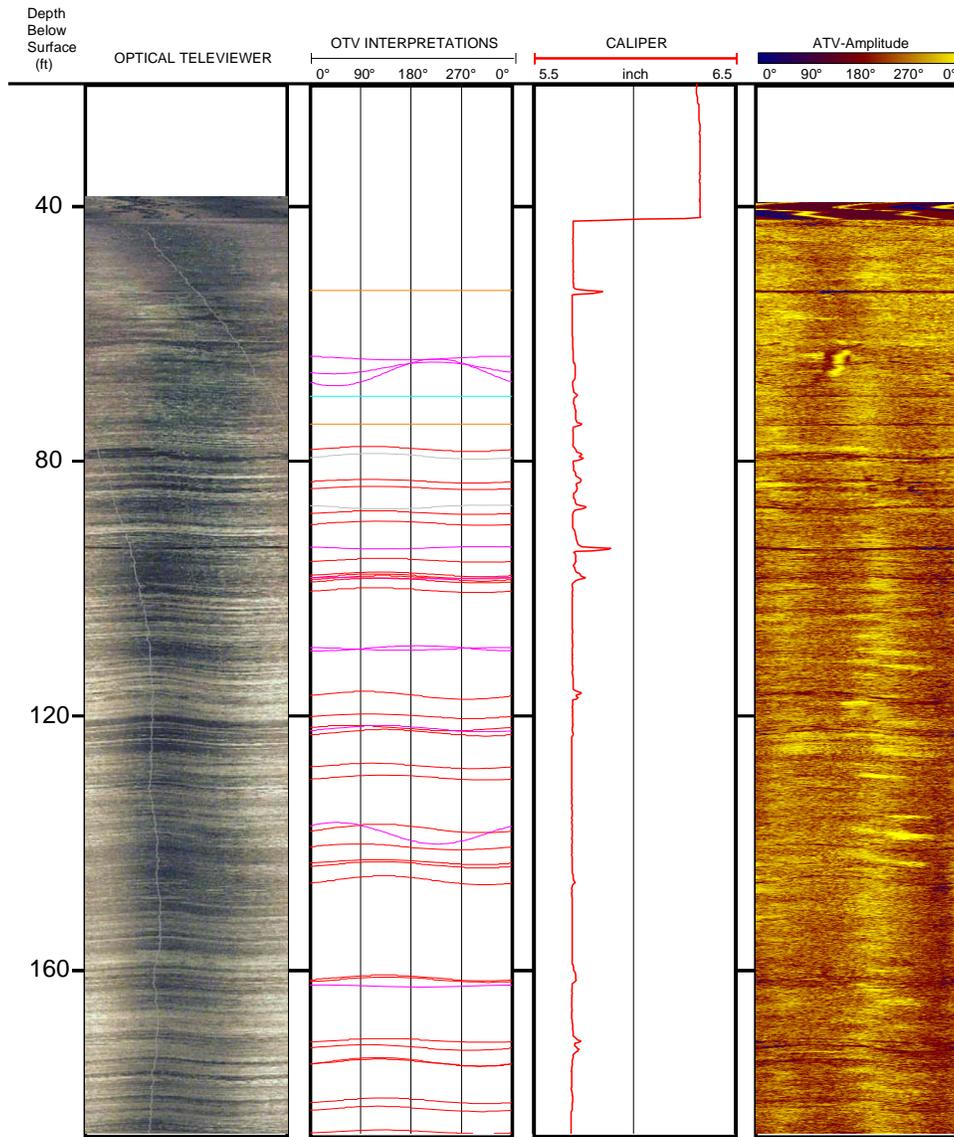
Depth to water: 24.15 ft 7.36 m
 Depth of casing: 42 ft 12.80 m
 Depth of well: 703 ft 214.27 m
 Land surface to MP: 2.18 ft 0.66 m

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	16.2	53.2	270	0	s	n	0		n	0.50	
2	19.5	63.8	70	61	t	n	0		n	0.50	
3	19.9	65.3	311	80	t	n	0		n	0.50	
4	20.1	66.1	315	86	t	n	0		n	0.50	
5	21.3	69.8	270	0	s	y	0.04	flow out	y	0.50	flow in
6	22.6	74.2	270	0	s	n	0.04		n	0.44	
7	23.8	76.1	196	67	p	n	0.04		n	0.44	
8	24.1	79.2	205	70	p	n	0.04		y	0.44	flow in
9	25.3	83.1	197	58	p	n	0.04		n	0.30	
10	25.7	84.2	205	61	p	n	0.04		n	0.30	
11	26.6	87.2	44	62	t	y	0.04	flow in	y	0.30	flow in
12	26.8	88.1	204	61	p	n	0		n	0.02	
13	27.3	89.7	217	63	p	n	0		n	0.02	
14	28.5	93.6	39	52	t	n	0		n	0.02	
15	29.1	95.6	219	62	p	n	0		n	0.02	
16	29.8	97.7	215	65	p	n	0		n	0.02	
17	29.9	98.1	209	67	p	n	0		n	0.02	
18	30.0	98.4	218	69	p	n	0		n	0.02	
19	30.0	98.4	113	31	t	n	0		n	0.02	
20	30.1	98.7	215	67	p	n	0		n	0.02	
21	30.6	100.3	206	67	p	n	0		n	0.02	
22	33.3	109.4	282	68	t	n	0		n	0.02	
23	33.4	109.5	71	50	t	n	0		n	0.02	
24	35.6	116.8	187	75	p	n	0		n	0.02	
25	36.6	120.0	195	65	p	n	0		n	0.02	
26	37.2	121.9	162	68	p	n	0		n	0.02	
27	37.2	122.0	219	71	t	n	0		n	0.02	
28	37.4	122.6	223	72	p	n	0		n	0.02	
29	39.0	127.9	201	69	p	n	0		n	0.02	
30	39.5	129.7	222	66	p	n	0		n	0.02	
31	42.0	137.7	214	76	p	n	0		n	0.02	
32	42.2	138.4	137	84	t	n	0		n	0.02	
33	42.8	140.6	175	71	p	n	0		n	0.02	
34	43.5	142.9	211	67	p	n	0		n	0.02	
35	43.7	143.4	215	71	p	n	0		n	0.02	
36	44.4	145.8	220	77	p	n	0		n	0.02	
37	49.1	161.2	221	70	p	n	0		n	0.02	
38	49.2	161.4	227	68	p	n	0		n	0.02	
39	49.5	162.4	110	50	t	n	0		n	0.02	
40	52.1	171.0	223	61	p	n	0		n	0.02	
41	52.5	172.1	192	70	p	n	0		n	0.02	
42	53.1	174.3	211	76	p	n	0		n	0.02	
43	53.2	174.4	212	72	p	n	0		n	0.02	
44	55.0	180.5	221	70	p	n	0		n	0.02	
45	55.4	181.7	211	68	p	n	0		n	0.02	
46	56.5	185.3	218	64	p	n	0		n	0.02	
47	58.7	192.6	267	76	p	n	0		n	0.02	
48	59.5	195.3	198	70	p	n	0		n	0.02	
49	60.0	196.8	207	71	p	n	0		y	0.02	flow in
50	60.9	199.8	205	68	p	n	0		n	0.00	

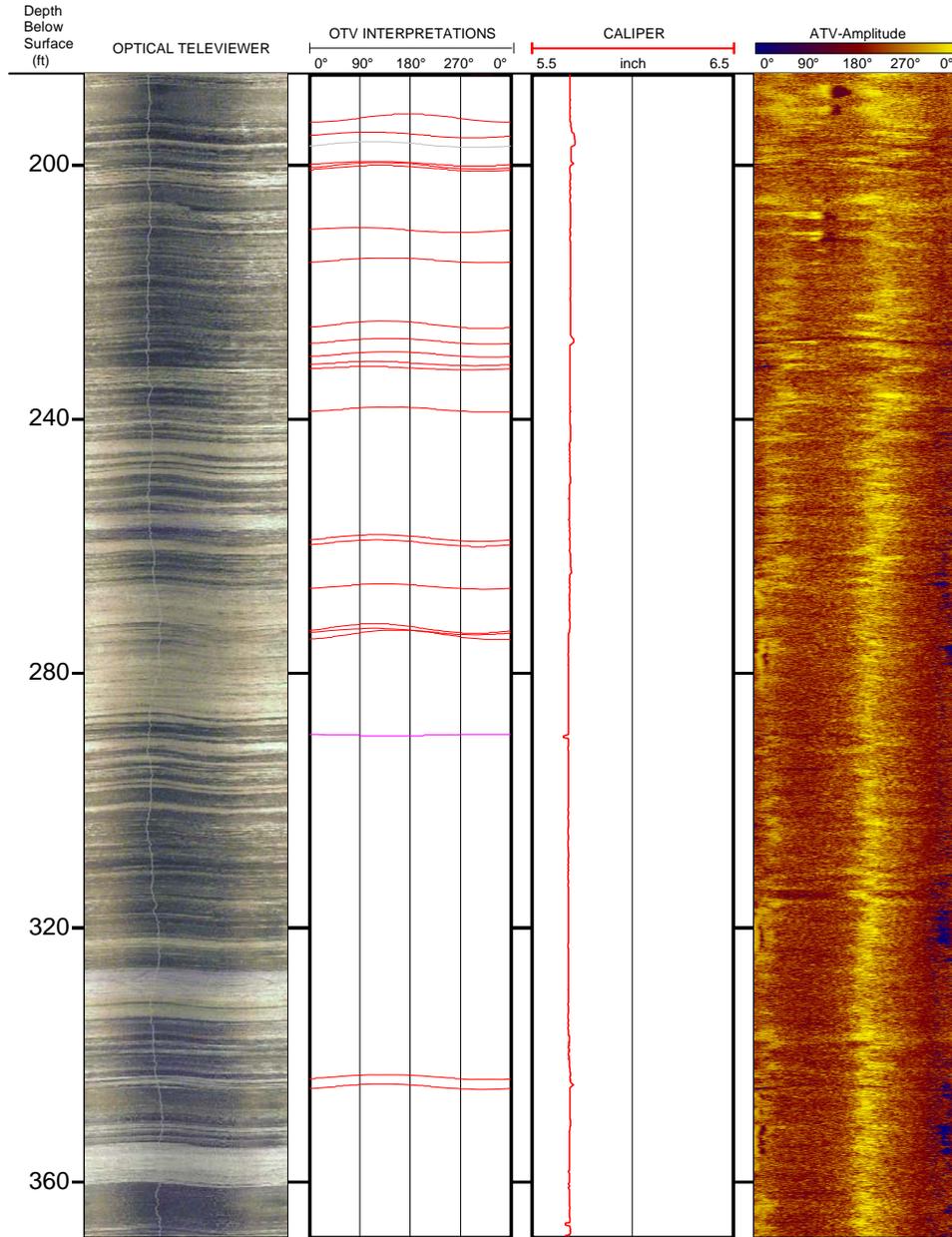
Appendix 14, continued. Midpoint depth, strike and dip of features identified in optical televiewer log, fracture type and heat pulse flowmeter data from Shr 1 (azimuth and dip reported using right hand rule convention; t = tectonic fractures, s = sheeting joints, p = foliation parallel fractures). Data shown under the pumping test have been normalized.

51	61.0	200.1	217	73	p	n	0	n	0.00
52	61.1	200.5	217	70	p	n	0	n	0.00
53	64.1	210.2	176	68	p	n	0	n	0.00
54	65.5	215.0	229	67	p	n	0	n	0.00
55	68.6	225.1	224	75	p	n	0	n	0.00
56	69.4	227.7	229	70	p	n	0	n	0.00
57	70.1	229.8	231	69	p	n	0	n	0.00
58	70.5	231.3	203	63	p	n	0	n	0.00
59	70.7	232.0	195	59	p	n	0	n	0.00
60	72.7	238.5	232	68	p	n	0	n	0.00
61	78.8	258.7	213	73	p	n	0	n	0.00
62	79.1	259.5	211	72	p	n	0	n	0.00
63	81.2	266.4	223	69	p	n	0	n	0.00
64	83.2	272.9	206	78	p	n	0	n	0.00
65	83.3	273.4	205	72	p	n	0	n	0.00
66	83.5	273.9	245	78	p	n	0	n	0.00
67	88.3	289.7	57	27	t	n	0	n	0.00
68	104.7	343.5	224	68	p	n	0	n	0.00
69	105.2	345.0	221	69	p	n	0	n	0.00
70	117.3	384.9	145	81	t	n	0	n	0.00
71	125.0	410.2	211	71	p	n	0	n	0.00
72	129.0	423.4	201	74	p	n	0	n	0.00
73	137.3	450.4	231	70	p	n	0	n	0.00
74	138.5	454.5	207	77	p	n	0	n	0.00
75	139.1	456.4	211	81	p	n	0	n	0.00
76	139.7	458.5	206	77	p	n	0	n	0.00
77	147.3	483.2	87	29	t	n	0	n	0.00
78	154.2	505.9	233	65	p	n	0	n	0.00
79	156.8	514.6	215	81	p	n	0	n	0.00
80	156.0	518.3	210	74	p	n	0	n	0.00
81	159.1	522.2	130	75	t	n	0	n	0.00
82	168.3	552.1	209	54	p	n	0	n	0.00
83	172.4	565.6	191	65	p	n	0	n	0.00
84	174.5	572.6	184	67	p	n	0	n	0.00
85	175.8	576.6	205	47	t	n	0	n	0.00
86	180.6	592.6	100	34	t	n	0	n	0.00
87	180.9	593.4	145	59	t	n	0	n	0.00
88	181.1	594.2	149	71	p	n	0	n	0.00
89	181.1	594.3	180	74	t	n	0	n	0.00
90	204.4	670.6	157	57	t	n	0	n	0.00
91	206.4	677.3	82	46	t	n	0	n	0.00
92	207.6	681.2	293	49	t	n	0	n	0.00
93	208.0	682.5	294	63	t	n	0	n	0.00
94	209.0	685.7	95	84	t	n	0	n	0.00
95	209.6	687.7	111	51	t	n	0	n	0.00

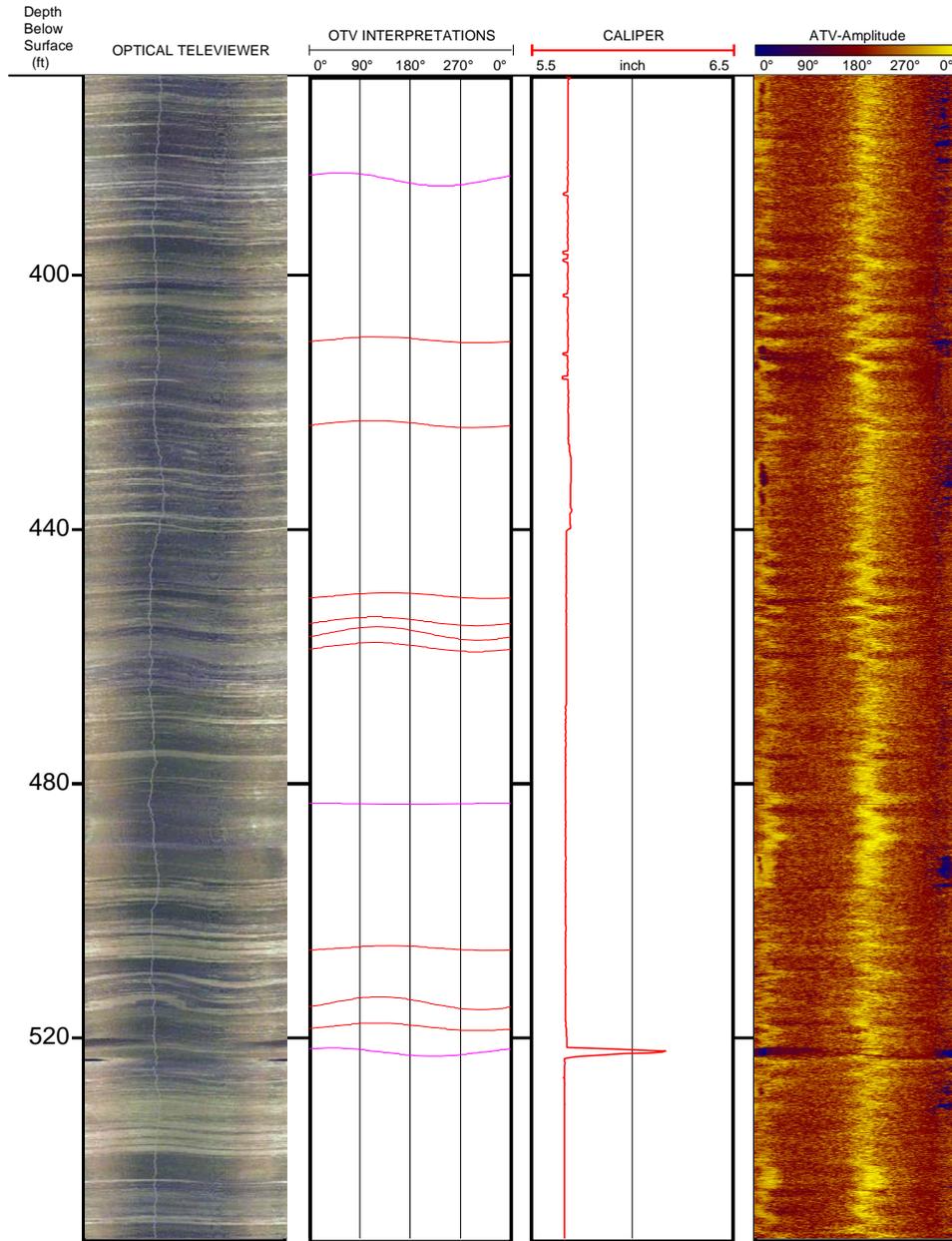
Appendix 14, continued. Interpreted features for Shr 1. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



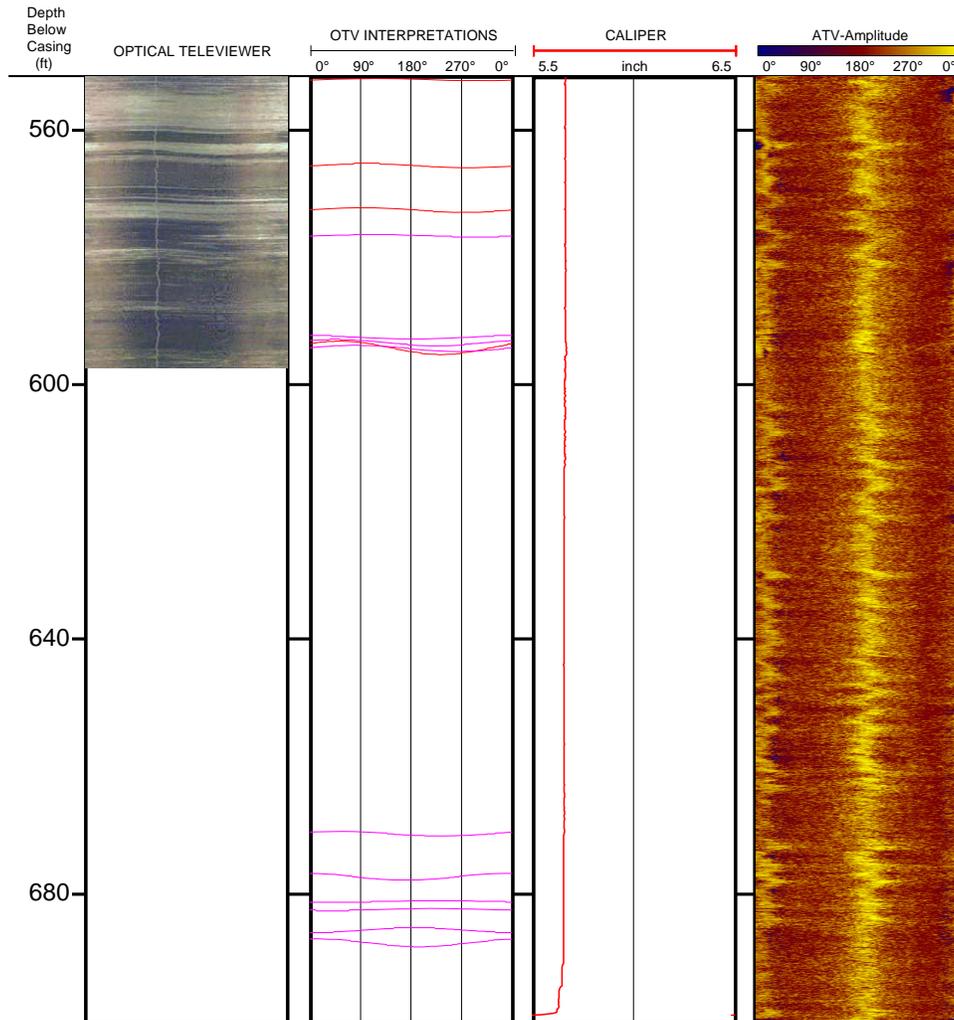
Appendix 14, continued. Interpreted features for Shr 1. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



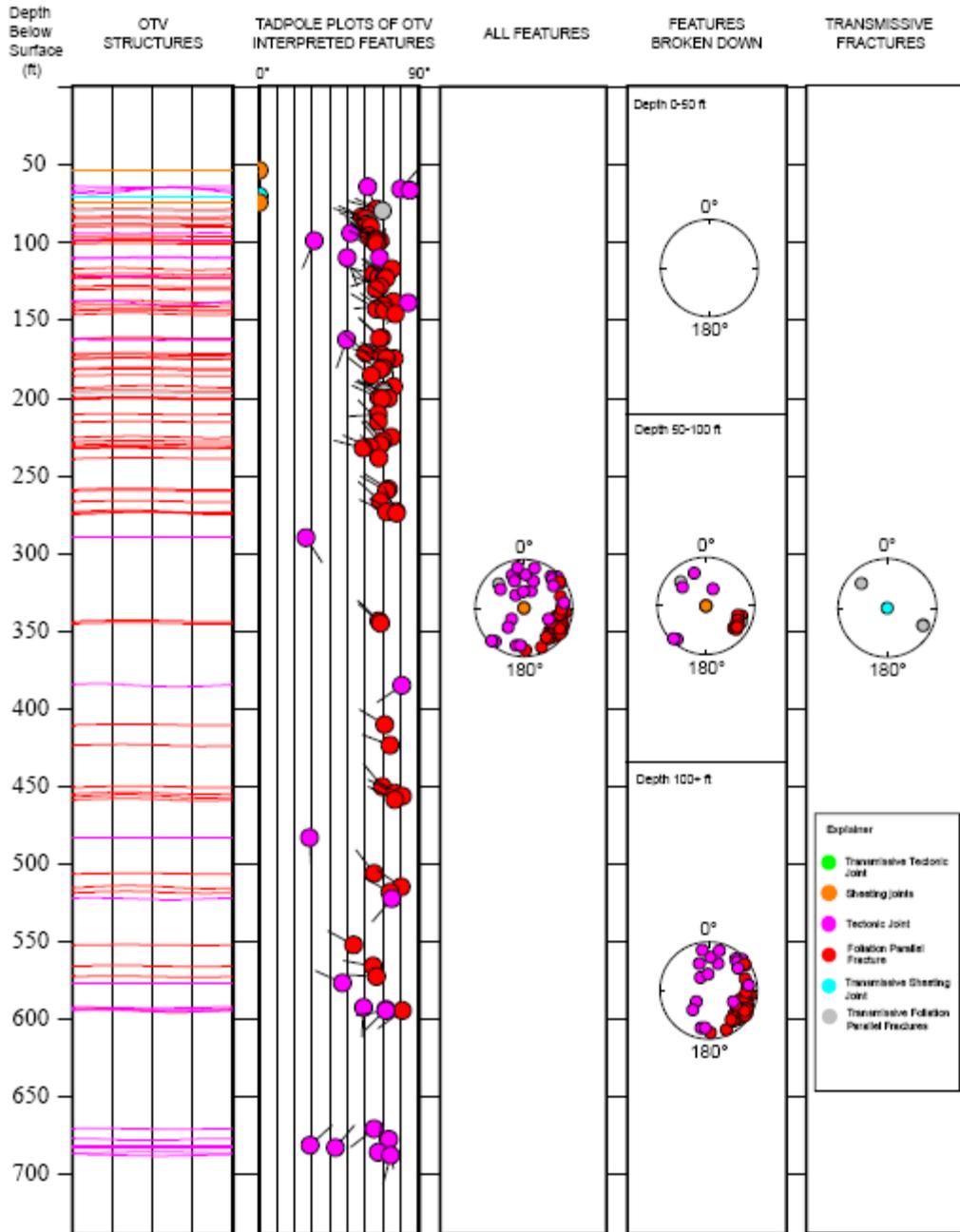
Appendix 14, continued. Interpreted features for Shr 1. Optical televiewer interpretations indicated by color: orange – subhorizontal sheeting joint; magenta – tectonic joint; red – foliation parallel fracture (FPF); cyan – transmissive subhorizontal sheeting joint; green – transmissive tectonic joint; grey – transmissive foliation parallel fracture (FPF). OTV – optical televiewer; ATV – acoustic televiewer.



Appendix 14, continued. Interpreted features for Shr 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. No optical televiewer data below 600 feet.



Appendix 14, continued. Tadpole plots and stereoplots of interpreted optical televiewer (OTV) structures for Shr 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. Colors on the OTV structures plot correspond to those in the tadpole explanation.



Appendix 14, continued. Composite log for Shr 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.

