UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Audio-magnetotelluric data log and station-location map for the Ennis Hot Springs area, Montana

by

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

Four days were spent collecting 20 audio-magnetotelluric (AMT) soundings in the area of the Ennis Hot Springs, Mont. (fig. 1). These soundings were made to assist in a regional evaluation of the geothermal potential of the Ennis Hot Springs area.

Scalar resistivities from the data log (table 1) are indicative of thermal water altering the Quaternary alluvium to the southeast. The alteration extends over an area of 1.5 km by 4 km. The geothermal system is probably along a north-south range fault between the Precambrian gneiss and the Tertiary gravels. The scalar resistivities also indicate a northwest trend that may be an intersecting fault. Therefore any geothermal potential would probably be in the area near the existing hot spring, with a possible extent to the northwest of 1 km and to the southeast some 3 km.

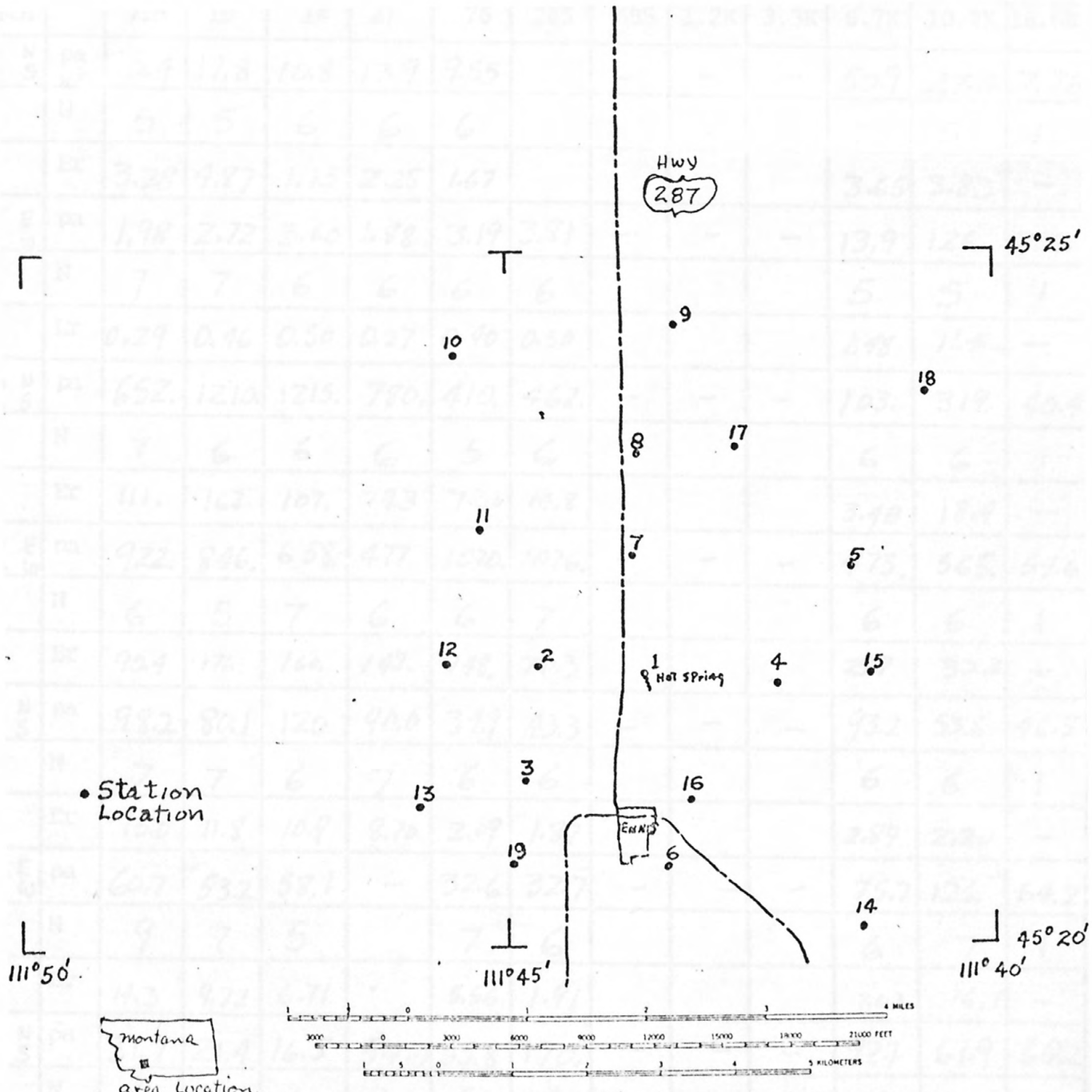

Figure 1 - Audio-magnetotelluric station location map of Ennis Hot Springs area, Montana.

Table 1 - U.S. GEOLOGICAL SURVEY A.M.T. DATA LOG

Ennis, Montana
OCT., 1978

ρa = observed apparent resistivity in ohm-meters
N = number of observations
Er = standard error in ohm meters
- = no data

"NOTE" - Telluric line orientation indicated with station numbers.

Sta. No.		FREQUENCY 7.5	10	14	27	76	285	685	1.2K	3.3K	6.7K	10.2K	18.6K
1 NS	ρa	13.4	17.8	10.8	13.9	9.55		-	-	-	50.9	23.4	7.78
	N	5	5	6	6	6					7	5	1
	Er	3.28	4.87	1.15	2.25	1.67					3.65	3.83	-
1 EW	ρa	1.98	2.72	3.60	1.88	3.19	3.81	-	-	-	13.9	126.	226.
	N	7	7	6	6	6	6				5	5	1
	Er	0.29	0.46	0.50	0.37	0.40	0.50				1.48	11.4	-
2 NS	ρa	652.	1210.	1215.	780.	410.	462.	-	-	-	103.	319.	40.4
	N	7	6	6	6	5	6				6	6	1
	Er	111.	162.	107.	79.3	7.30	14.8				3.48	18.4	-
2 EW	ρa	922.	846.	658.	477.	1070.	1076.	-	-	-	473.	565.	54.6
	N	6	5	7	6	6	7				6	6	1
	Er	90.4	176.	160.	142.	148.	70.3				25.7	32.3	-
3 NS	ρa	98.2	80.1	120	90.0	34.9	43.3	-	-	-	93.2	53.6	46.5
	N	7	7	6	7	6	6				6	6	1
	Er	15.0	11.8	10.9	8.70	2.09	1.87				2.89	2.20	-
3 EW	ρa	60.7	53.2	58.1	-	32.6	32.7	-	-	-	75.7	126.	64.2
	N	9	7	5		7	6				6	7	1
	Er	14.3	9.72	6.71	-	5.56	1.91				7.03	16.1	-
4 NS	ρa	31.7	21.4	16.5	54.0	65.8	170.	-	-	-	97.7	61.9	60.2
	N	6	5	6	6	5	4				6	6	1
	Er	4.09	3.90	2.50	8.50	7.39	3.91				2.15	2.50	-
4 EW	ρa	25.2	19.6	26.3	37.2	46.5	34.7	-	-	-	146.	151.	80.6
	N	5	5	5	6	7	6				7	5	1
	Er	1.57	3.11	8.56	3.38	7.40	4.01				5.06	8.26	-

Table 1 - U.S. GEOLOGICAL SURVEY A.M.T. DATA LOG - Continued

ρa = observed apparent resistivity in ohm-meters
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Ennis, Montana
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Sta. No.		FREQUENCY 7.5	10	14	27	76	285	685	1.2K	3.3K	6.7K	10.2K	18.6K
5 NS	ρa	19.7	34.0	20.0	56.3	65.5	69.8	-	-	-	107.	112	61.8
	N	6	5	8	5	5	5				6	1	1
	Er	2.53	3.26	1.96	12.3	12.9	4.59				4.18	-	-
5 EW	ρa	17.2	25.9	23.2	46.3	81.4	62.1	-	-	-	139.	125.	119.
	N	6	5	6	5	6	6				5	1	1
	Er	2.69	6.28	3.03	5.82	19.5	9.17				17.1	-	-
6 NS	ρa	40.3	38.8	30.4	46.5	24.1	42.8	-	-	-	93.2	65.6	47.5
	N	6	5	6	5	6	6				7	3	1
	Er	9.04	4.56	6.09	6.48	0.87	5.02				4.03	1.66	-
6 EW	ρa	31.7	37.2	30.2	46.3	44.9	26.4	-	-	-	127.	72.8	70.0
	N	5	6	5	6	6	6				6	1	1
	Er	5.04	6.16	3.88	3.13	6.87	1.19				5.92	-	-
7 NS	ρa	28.8	34.0	24.9	36.8	29.2	26.9	-	-	-	53.4	37.0	23.1
	N	7	7	6	6	6	4				5	7	1
	Er	2.74	4.06	5.23	2.20	0.26	0.46				2.74	1.76	-
7 EW	ρa	28.7	10.2	11.7	11.6	15.2	11.9	-	-	-	108.	117.	50.0
	N	7	7	6	7	6	5				5	7	1
	Er	7.57	1.00	0.54	0.75	0.92	1.38				14.4	9.02	-
8 NS	ρa	200.	222.	191.	210.	104.	43.4	-	-	-	55.2	80.7	42.6
	N	5	5	6	5	6	5				4	3	1
	Er	21.7	8.83	24.6	39.3	0.43	1.48				3.55	15.6	-
8 EW	ρa	39.0	33.5	31.0	23.2	11.7	7.05	-	-	-	161.	357.	74.2
	N	6	6	5	5	4	4				3	3	1
	Er	4.34	3.92	2.18	1.47	0.65	0.13				6.83	147.	-

Table 1 - U.S. GEOLOGICAL SURVEY A.M.T. DATA LOG - Continued

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OCT., 1978

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		FREQUENCY											
Sta. No.		7.5	10	14	27	76	285	685	1.2K	3.3K	6.7K	10.2K	18.6K
9 N S	ρa	9.44	-	9.48	17.4	27.5	31.6	-	-	-	173.	75.6	62.4
	N	6		7	6	6	6				5	6	1
	Er	2.69		1.46	1.38	0.95	0.90				16.3	3.26	-
9 E W	ρa	13.7	12.3	8.64	9.34	19.4	20.3	-	-	-	174.	198.	89.1
	N	7	6	5	6	7	6				5	3	1
	Er	1.37	1.46	1.03	0.56	1.23	2.83				6.41	20.4	-
10 N S	ρa	723.	1164.	1002.	285.	86.2	148.	-	-	-	91.1	48.7	27.5
	N	5	4	3	4	5	4				5	4	1
	Er	83.3	75.2	54.6	77.0	8.26	30.5				2.42	2.71	-
10 E W	ρa	281.	435.	377.	113.	118.	133.	-	-	-	128.	111.	83.6
	N	6	4	4	4	4	4				4	4	1
	Er	40.0	62.6	80.5	16.2	13.8	28.7				3.55	9.82	-
11 N S	ρa	2437.	2510.	3080.	1728.	1083.	584.	-	-	-	303.	138.	152.
	N	7	6	6	6	5	5				6	1	1
	Er	167.	223.	552.	84.8	30.2	44.4				19.8	-	-
11 E W	ρa	1181.	1227.	1326.	985.	766.	487.	-	-	-	294.	75.1	606.
	N	6	6	5	6	6	6				5	1	1
	Er	69.3	234.	226.	181.	59.4	62.2				13.8	-	-
12 N S	ρa	2206.	2538.	1584.	1523.	722.	594.	-	-	-	272.	158.	122.
	N	6	7	6	6	5	5				4	1	1
	Er	162.	427.	272.	126	67.7	34.8				9.84	-	-
12 E W	ρa	1374.	1358.	1142.	1243.	972.	297.	-	-	-	398.	285.	245.
	N	4	4	5	5	5	4				3	1	1
	Er	99.2	497.	144.	149.	143.	3.85					-	-

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13 N S	ρa	13.0	—	16.3	19.0	—	52.9	—	—	—	37.6	31.0	20.6
	N	8		7	7		8				7	4	1
	Er	1.73	3.66	1.39	1.93		3.20				1.29	3.02	—
13 E W	ρa	148.	170.	201	264	134	83.2	—	—	—	54.7	16.2	22.8
	N	7	6	7	7	8	7				7	1	1
	Er	14.3	30.1	9.58	28.4	2.9	4.61				1.70	—	—
14 N S	ρa	20.5	32.6	32.4	26.8	25.5	79.5	—	—	—	24.0	46.6	12.6
	N	5	6	5	6	5	5				6	1	1
	Er	0.97	7.01	7.50	1.00	2.72	9.51				1.29	—	—
14 E W	ρa	21.3	37.7	40.8	47.5	43.8	52.1	—	—	—	32.9	75.1	49.7
	N	6	5	5	5	4	5				5	1	1
	Er	2.05	1.76	11.8	4.26	5.58	1.41				2.54	—	—
15 N S	ρa	16.7	26.4	28.8	39.8	41.2	61.9	—	—	—	40.0	47.4	24.9
	N	7	7	6	6	6	6				5	1	1
	Er	2.52	1.90	3.48	3.28	1.38	1.56				1.50	—	—
15 E W	ρa	11.0	15.5	16.7	26.0	30.8	38.1	—	—	—	22.7	61.4	48.2
	N	7	7	6	6	5	5				5	1	1
	Er	1.47	2.04	1.23	3.10	0.74	5.09				2.57	—	—
16 N S	ρa	15.8	30.0	18.4	23.5	—	30.8	—	—	—	190.	145.	61.9
	N	6	8	6	6		6				3	3	1
	Er	3.46	3.90	0.65	1.25		0.66				16.6	13.1	—
16 E W	ρa	16.3	22.8	15.7	21.0	31.9	41.5	—	—	—	313.	291.	—
	N	6	6	13	7	5	3				3	3	
	Er	1.66	4.73	0.78	1.32	2.99	4.10				8.10	21.8	

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		FREQUENCY											
Sta. No.		7.5	10	14	27	76	285	685	1.2K	3.3K	6.7K	10.2K	18.6K
17 N S	ρa	22.5	34.4	23.7	31.0	37.2	33.1	—	—	—	171	58.3	59.8
	N	5	5	5	6	6	6				6	1	1
	Er	0.98	1.94	1.23	3.00	5.18	1.75				7.23	-	-
17 E W	ρa	10.7	12.7	20.5	20.4	21.9	27.3	—	—	—	214.	184.	63.0
	N	6	6	6	6	7	5				5	1	1
	Er	0.47	1.95	1.79	1.90	1.99	1.09				10.0	-	-
18 N S	ρa	42.4	92.5	114.	229.	293.	-	—	—	—	142.	73.9	50.2
	N	10	7	5	5	5					4	4	1
	Er	7.85	11.7	27.6	32.8	10.9					18.6	2.0	-
18 E W	ρa	15.9	65.7	42.5	234.	269.	—	—	—	—	304.	227.	66.4
	N	6	5	8	5	5					4	3	1
	Er	3.49	8.78	10.4	16.8	17.9					6.98	81.9	-
19 N S	ρa	272.	314.	192.	189.	53.5	41.6	—	—	—	63.6	43.0	39.8
	N	5	5	7	7	6	1				5	7	1
	Er	26.5	13.6	10.4	16.3	2.07	-				4.15	1.60	-
19 E W	ρa	61.1	108.	93.7	49.9	25.8	15.1	—	—	—	168.	127.	56.4
	N	7	5	6	6	6	1				5	1	1
	Er	14.0	25.5	23.8	8.54	2.12	-				9.16	-	-
20 N S	ρa	13.0	12.2	8.28	5.69	5.45	18.6	—	—	—	85.1	56.7	44.5
	N	8	6	8	5	8	5				8	8	1
	Er	1.42	2.45	0.82	0.33	0.21	1.83				6.11	2.21	-
20 E W	ρa	3.38	4.12	3.85	3.40	4.09	10.6				157.	165.	3.11
	N	7	7	6	8	8	6				5	5	1
	Er	0.48	0.42	0.49	0.31	0.30	0.97				3.85	16.3	-