UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Audio-magnetotelluric Investigation of the North End Wilderness Study Area, Cochise County, Arizona

by

Kevin H. Nervick and Frances M. Boler

USGS Open File Report 81-774

1981

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

Audio-magnetotelluric Investigation of the North End Wilderness Study Area, Cochise County, Arizona

by

Kevin H. Nervick and Frances M. Boler

Introduction

In May of 1980, the U.S. Geological Survey conducted an audio-magnetotelluric (AMT) survey of the North End Wilderness study area in the Chiracahua Mountains. With the use of a helicopter, eight scalar AMT stations were occupied in the study area. The AMT method used measures the natural electromagnetic (EM) field at 19 frequencies from 4.5 to 27,000 Hz using equipment and procedures described by Hoover and others (1976 and 1978), and Hoover and Long (1976). The data complement other geophysical work done to assess the mineral potential of the area.

Discussion

The station locations are shown in Figure 1. Apparent resistivities are listed in Table 1. Apparent resistivities at station 8 in the San Simon Valley range from 25 to 125 ohm-meters, about one order of magnitude lower than the other seven stations which are located in the mountains. Resistivities with depth at station 8 are fairly uniform indicating that the sounding probably did not penetrate the entire thickness of the alluvial fill in the valley. The seven soundings in the Chiracahua Range have apparent resistivities at 7.5 Hz ranging from 500 to 8500 ohm-meters. At 27 Hz the apparent resistivities range from 100 to 4000 ohm-meters. The resistivities increase with depth, implying that basement rocks exposed at the surface become more resistive with depth.

A bias in either of the measured fields (E or H) can be related to various culturally induced EM signals such as 60 cycle power lines, to low signal strength, or to deviations from a uniform H-field that is used to derive the apparent resistivity equation. Several measurements at various frequencies were rejected for such reasons. Data at 4.5 Hz was rejected because the signal to noise ratio was too low to make accurate calculations of apparent resistivity.

Current induced by the EM field may flow in a direction controlled by the local geology rather than in a perpendicular direction as expected when no resistivity contrast is present. In addition, lateral changes in the geology may result in scalar data which show significant changes in the observed apparent resistivity with sensor orientation (Strangway and others, 1973). Stations 1, 2, and 3 in the vicinity of Emigrant Pass show apparent resistivities lower than the surrounding stations. This may be due to the lateral effect of the Emigrant Canyon-Apache Pass fault system alone or in conjunction with alteration along the same system. Definitive interpretation based on the AMT data alone is speculative in this case due to the complexity of the geology and inadequate station density. Further electrical surveys could be informative but would be expensive because of the limited accessibility.

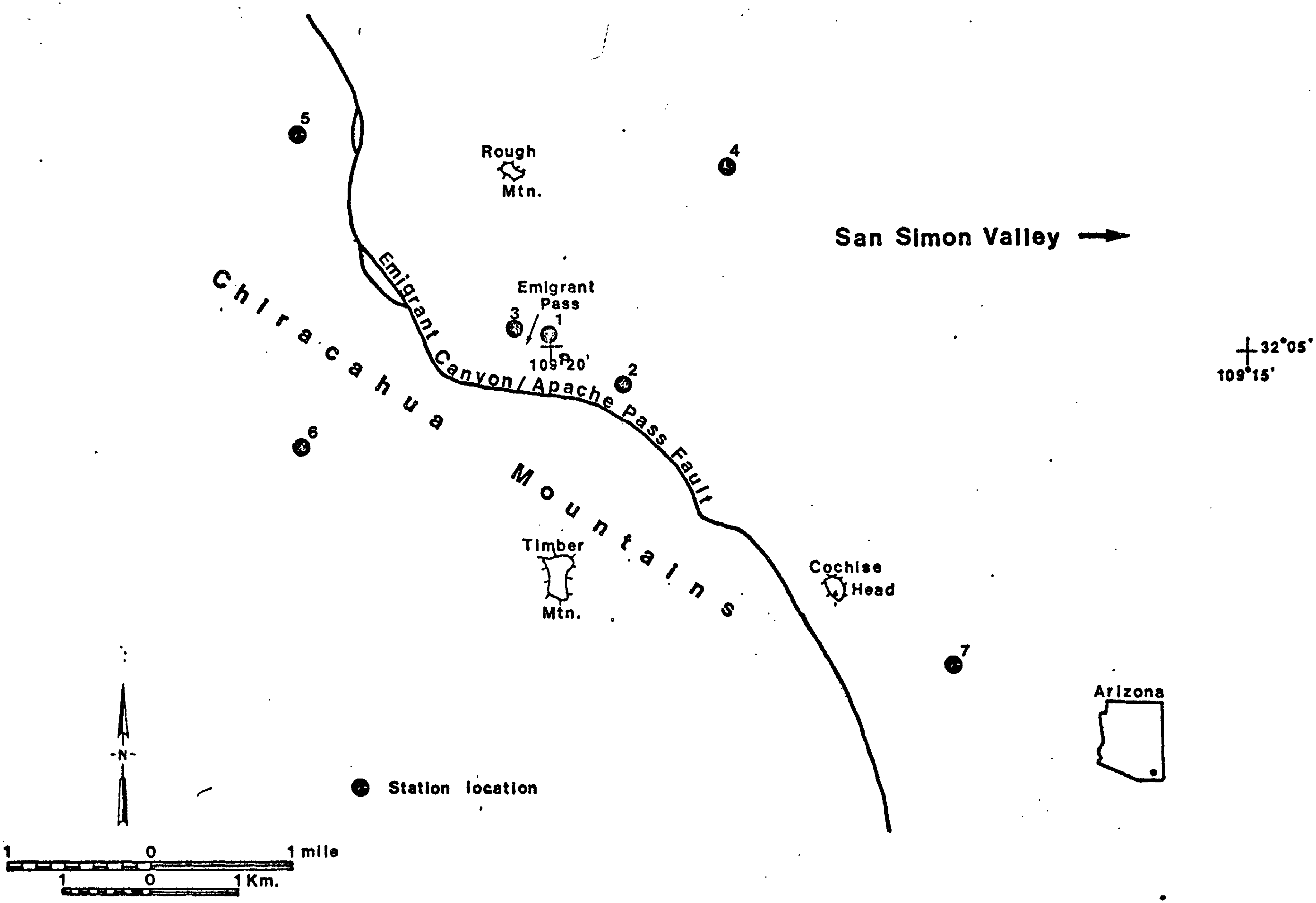

Figure 1. Station location map showing fault system.
Station 8 not shown.

Table 1

Sta. No.		Frequency 7.5	13.6	27	45	75	136	270	450	750	1.36K	2.7K	4.5K	7.5K
	pa	709					295	362	387	242				127
1 N/S	N	5					8	6	10	6				7
	Err	84.6					24.0	33.9	19.6	22.9				5.00
	pa	1025	921		395	251		188	229	145		64.8		324
E/W	N	8	5		11	9		12	9	10		6		10
	Err	57.7	91.4		7.61	5.67		3.79	11.7	7.09		5.82		7.06
	pa		250								1751		351	354
2 N/S	N		4								3		6	8
	Err		29.1								98.9		31.1	30.2
	pa	1260	1349	603	1483	670	860		1353				1515	2258
E/W	N	10	9	8	11	12	15		17				12	6
	Err	82.7	141	58.0	122	34.5	23.5		93.26				21.0	69.5
	pa						165			105				
3 N/S	N						11			10				
	Err						16.3			9.89				
	pa		1420	1200	647	447	436	455	330					
E/W	N		4	5	5	8	6	4	3					
	Err		63.9	103	42.9	15.0	20.0	38.7	29.4					
	pa			204				205	188					226
4 N/S	N			7				6	6					7
	Err			24.2				9.45	15.6					16.2
	pa		575	533	415	286		250		255	127		259	199
E/W	N		5	8	8	6		5						
	Err		82.7	29.5	12.6	7.75		12.0		8.51	7.43		19.8	4.54
	pa						634	410	295	228		122	155	208
5 N/S	N						12	11	9	7		2	9	10
	Err						110	47.0	43.3	45.4		98.2	15.1	12.3
	pa	8474		3950	2115	852	545	470		292			116	296
E/W	N	7		9	5	7	7	9		9			7	8
	Err	446		534	218	31.4	81.0	60.0		28.0			17	17
	pa	1070	792	553	495	363	577	498	382					
6 N/S	N	10	13	12	14	11	12	11	8					
	Err	101	84.2	52.5	41.2	58.2	81.4	128	43.1					
	pa		1130	635	476	340	416	388	281	107				100
E/W	N		8	8	8	8	12	9	15	6				8
	Err		108	28.2	7.84	16.2	7.40	10.5	14.7	22.2				6.96
	pa	1134	602	283	266	236	149	91.9		44.7	29.0			100
7 N/S	N	9	8	8	7	7	8	7		5	2			7
	Err	84.4	59.2	17.7	16.8	20.9	32.9	12.4		18.4	2.19			7.97
	pa		292	102	109	84.4	74.9	85.9		61.6			221	58.5
E/W	N		7	6	5	6	7	10		8			6	10
	Err		52.6	28.3	20.8	15.4	19.5	12.1		9.72			13.8	11.4
	pa		19.5	24.5	23.1	24.5	20.2	15.8	21.6	8.95			36.6	35.1
8 N/S	N		7	3	8	7	7	5	9	7			8	9
	Err		1.05	1.25	0.96	0.83	1.04	0.63	3.13	1.11			0.62	2.32
	pa			71.49	41.3	25.4	28.8	41.7	69.4	26.0			72.1	125
E/W	N			6	5	7	8	5	7	7			6	9
	Err			8.76	5.3	2.1	1.78	6.49	3.94	7.63			4.54	6.57

Explanation

pa - apparent resistivity in ohm-meters

N - number of observations

Err - standard error

References Cited

Hoover, D. B., Frischknecht, F. C., and Tippens, C. L., 1976, Audio-magnetotelluric soundings as a reconnaissance exploration technique in Long Valley, California: Journal of Geophysical Research 81, p. 801-809.

Hoover, D. B., and Long, C. L., 1976, Audio-magnetotelluric methods in reconnaissance geothermal exploration: Proc. 2nd U.N. Sympos. Devel. Geotherm. Res., p. 1059-1064.

Hoover, D. B., Long, C. L., and Senterfit, R. M., 1978, Some results from audio-magnetotelluric investigations in geothermal areas: Geophysics, v. 43, no. 7, p. 1501-1514.

Strangway, D. W., Swift, C. M., Jr., and Holmer, R. C., 1973, The application of audiofrequency magnetotellurics (AMT) to mineral exploration: Geophysics, v. 38, no. 6, p. 1159-1175.