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Geological Survey

Telluric Traverse Data Release for the Getchell and Preble Disseminated Gold Deposits, Humboldt County, Nevada

by

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Introduction

During June 1984, four telluric traverses were made on the east side of the Osgood mountains at the Preble and Getchell disseminated gold deposits. Two traverses were made across each deposit to help define the geoelectrical structure at each, and to look for a possible electrical signature associated with disseminated gold deposits. This work is part of a group of integrated studies performed under the Development of Assessment Techniques (DAT) program of the USGS, directed at developing a more complete understanding of disseminated precious metal deposits. This report presents the telluric data without interpretations to effect timely release of the data.

The Telluric Traverse Method

The telluric traverse (TT) method employs natural earth currents (telluric currents) at various frequencies to measure, indirectly, changes in earth resistivity along a traverse. It was used as early as 1921 (Leonardon, 1928) by C. Schlumberger, but until recently has been little used in the United States. Beyer (1977) discusses the method in some detail and presents a series of model results computed for two-dimensional structures. He concludes that the method is well suited for rapid reconnaissance of regions several hundred square-kilometers in area searching for targets such as hydrothermal systems. The method should be applicable as well to fossil hydrothermal systems, some of which are associated with mineral deposits, because rock alteration will remain long after the hydrothermal convection cells have ceased.

In applying the technique a receiving array of three electrodes are used, spaced equidistant and in line. This array is, in effect, two colinear dipoles sharing a common electrode. The potential difference across each dipole is then proportional to the component of the telluric field in the direction of the array. This configuration permits the measurement of the ratio of the telluric field at each dipole in the direction of the dipole line. The traverse data is extended by moving the three-electrode array forward one dipole length so that the forward electrode becomes the center electrode for the next ratio measurement. This process is repeated for as long as desired.

Telluric measurements are made in a narrow frequency band typically using micropulsations near 30 second periods (0.033 Hz), but may be made over a wide range of frequencies. Because lower frequency electromagnetic signals penetrate to greater depths than higher frequencies, one can, to some extent, select a maximum depth of exploration. The maximum depth, however, is a function of earth resistivity as well as frequency. A useful criterion for the maximum depth of exploration in a half-space is given by (Bostick, 1977)

$$1) \qquad D = 355 \sqrt{\rho/f} \text{ meters}$$

where D is the depth in meters

ρ is the half-space resistivity in ohm-meters

f is the frequency in Hz.

The USGS has recently designed a multi-frequency telluric receiver operating from 25 Hz to .016 Hz. This receiver was used for data acquisition. Frequencies of 25, 16.7, and 7.5 Hz were measured on all lines in the survey. On line 1 at the Preble deposit measurements were also tried at 4.5 Hz. High winds however generated excessive noise at this frequency making measurements difficult and time consuming. To make better use of field time, only the upper three frequencies listed were used on the other lines. From preliminary audio-magnetotelluric (AMT) measurements in the area, the Preble Formation has a resistivity generally in the range of 100 ohm-meters at these frequencies. From equation 1, the maximum depth of exploration would be in the range of 700 to 1300 meters in this environment.

The natural signal sources used in the 4.5 Hz to 25 Hz frequency range arise from world-wide lightning storms. These signals are very impulsive, but occur essentially continuously throughout the day. In this frequency band there are few problems with the effective use of natural electromagnetic signals.

On all traverses 125 meter dipoles were used, one fifth or less of the maximum exploration depth. Short spacial wavelength anomalies seen on the traverse data imply shallow structures, or structures whose top is shallow, exactly analogous to other potential field data. The close correlation seen between the curves at each frequency is typical of telluric data measured over a short frequency span and results from the measurements averaging the earth resistivity from the surface to the maximum depth of exploration. For electromagnetic fields in a non-layered earth the electric field at a point varies with the direction of measurement as does the resistivity. They are tensor quantities. The horizontal electric field variations rather than the magnetic field, in general, reflect the variations in earth resistivity. For two-dimensional structures it can be shown (Beyer, 1977) that the electric field measured normal to strike (the transverse magnetic TM mode) is proportional to the square root of the resistivity variation measured with the electric field normal to strike and magnetic field parallel to strike. Because of this, telluric traverses are typically run normal to the expected regional trends in a survey area. The traverses also are kept in a straight line because of the tensor nature of the electric field.

Telluric traverse data is presented as curves of relative telluric voltage. A value of unity is arbitrarily assigned to one dipole on the traverse and, for each frequency, the value of all other dipoles are computed relative to it. Without other information there is no way to reference, in an absolute sense, a curve at one frequency to that of another frequency. The curves presented in this report for each line have been nested with an arbitrary shift of 0.2 units between the initial values. The relative voltage is plotted on a logarithmic scale.

Telluric Data

Traverse locations are shown in figure 1 for the Preble deposit and in figure 4 for the Getchell deposit. At Preble the traverses are run along lines established for geochemical gas sampling (H. McCarthy, Jr., oral communication). Traverse 1 runs across the center of the ore zone, and was made prior to extensive mining operations. The approximate ore zone is indicated on the traverse data, figure 2, and correlates with a telluric low. The data for Preble traverse 2 are shown in figure 3.

At the Getchell deposit traverses were run at the north and south ends of the mined area, figure 4, and normal to the Getchell fault zone along which mineralization occurs. Data for the southern line, line 1, is shown in figure 5. The Getchell fault zone is indicated in the figure and also correlates with a telluric low. High telluric values to the west correlate with outcropping Cretaceous granodiorite. Line 2, figure 6, on the north end of the deposit shows very similar features to line 1 along the entire traverse even though separated by more than 2 km. The approximate extension of the Getchell fault zone and Village fault are shown in figure 6 adapted from Silberman and others, 1974.

Acknowledgements

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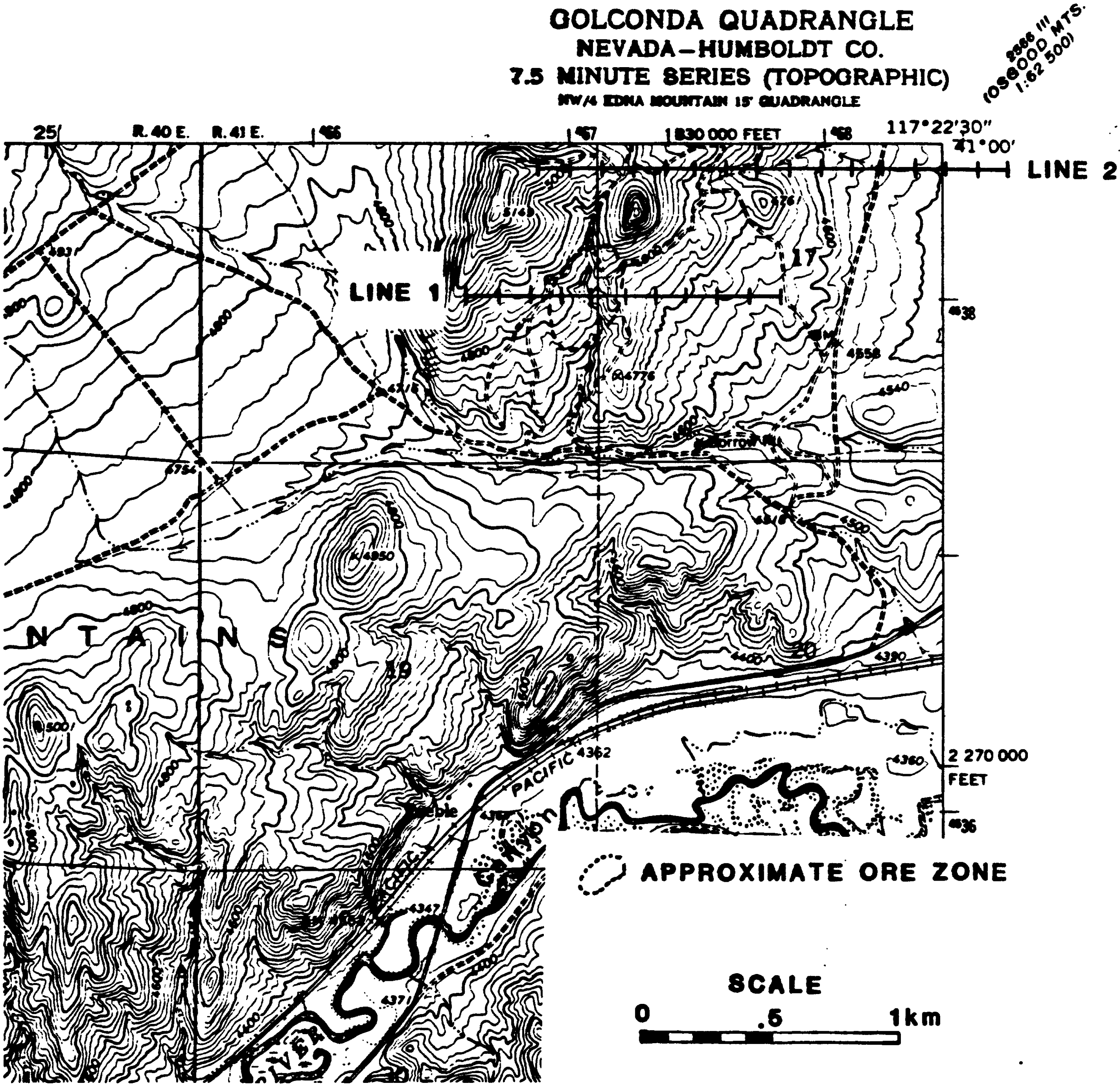

Figure 1. Telluric traverse location map for lines 1 and 2 Preble Mine area, Humboldt County, Nevada. Station interval is 125 meters.

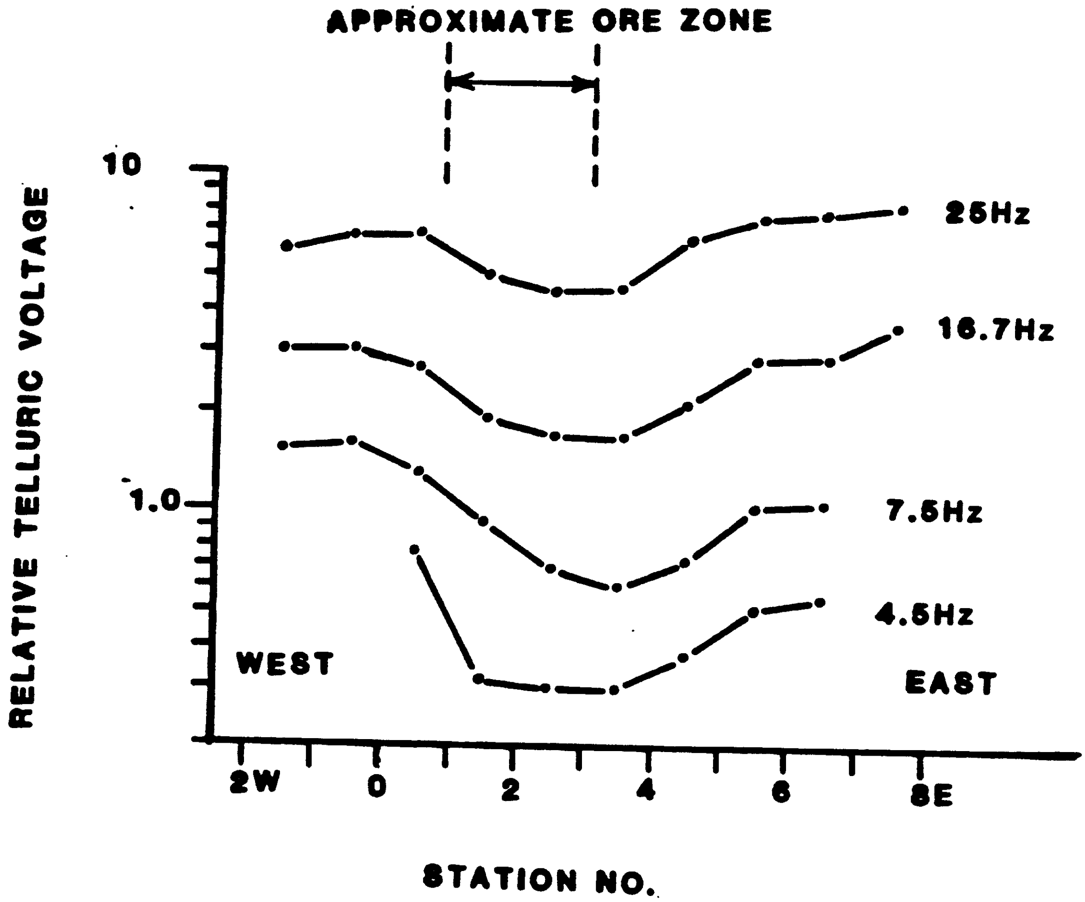

Figure 2. Telluric traverse data for line 1 Preble Mine area, Humboldt County, Nevada. Station interval is 125 meters.

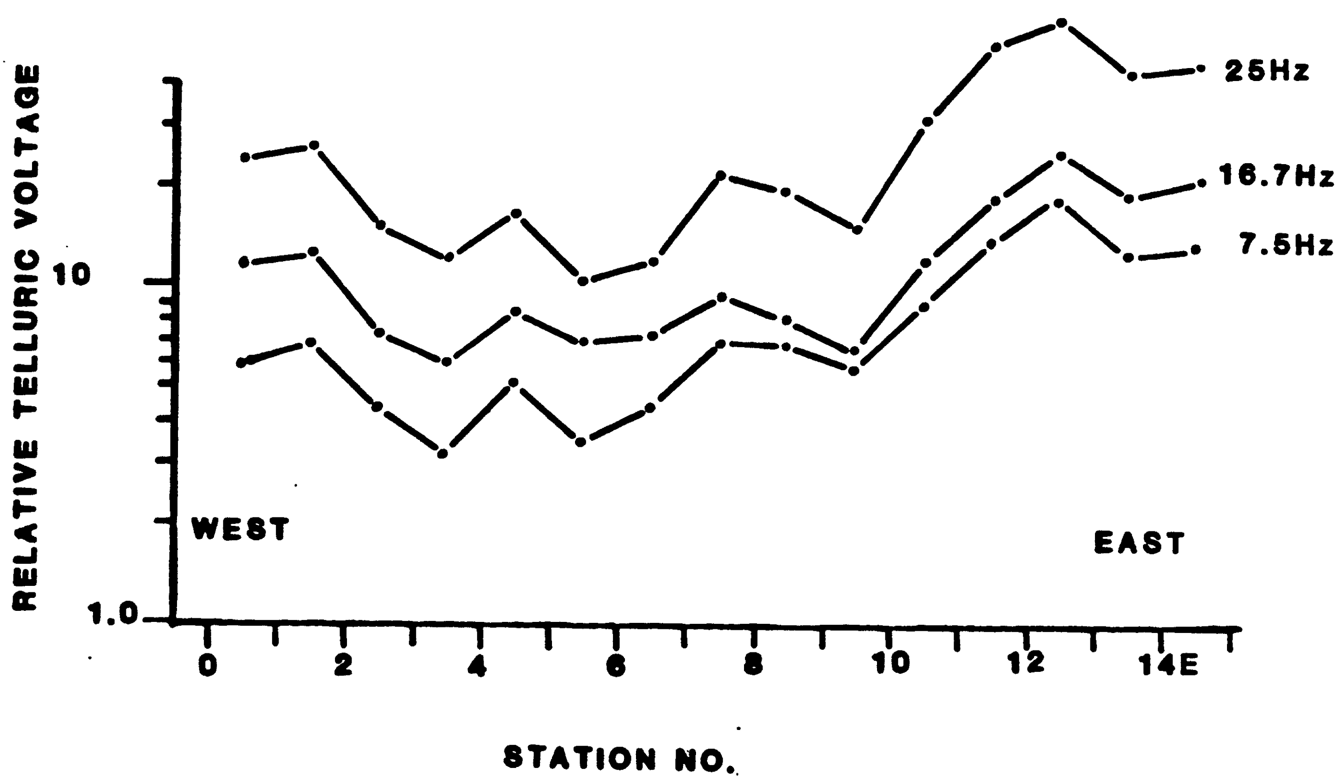

Figure 3. Telluric traverse data for line 2 Preble Mine area, Humboldt County, Nevada. Station interval is 125 meters.

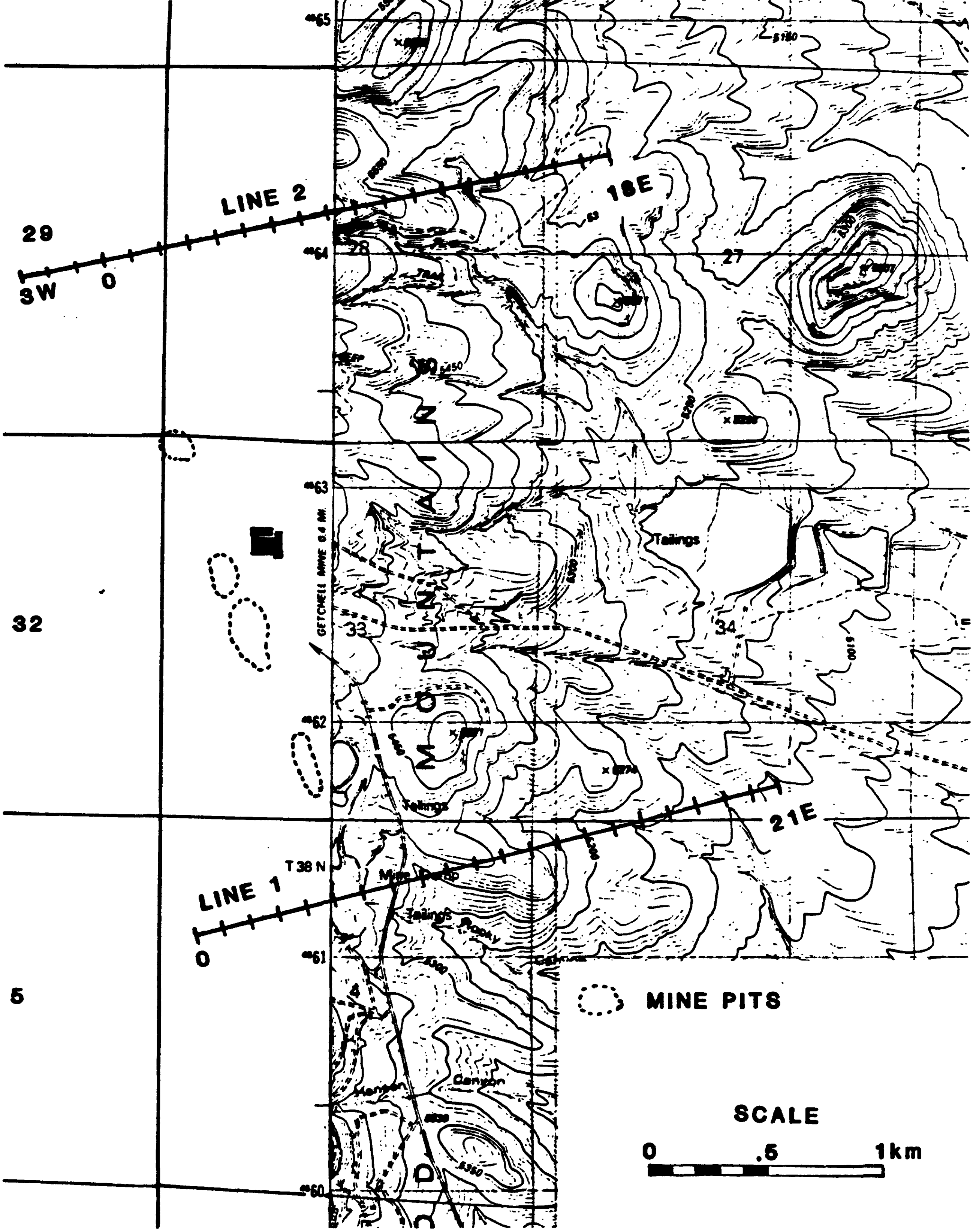

Figure 4. Telluric traverse location map for lines 1 and 2 Getchell Mine area, Humboldt County, Nevada. Station interval is 125 meters.

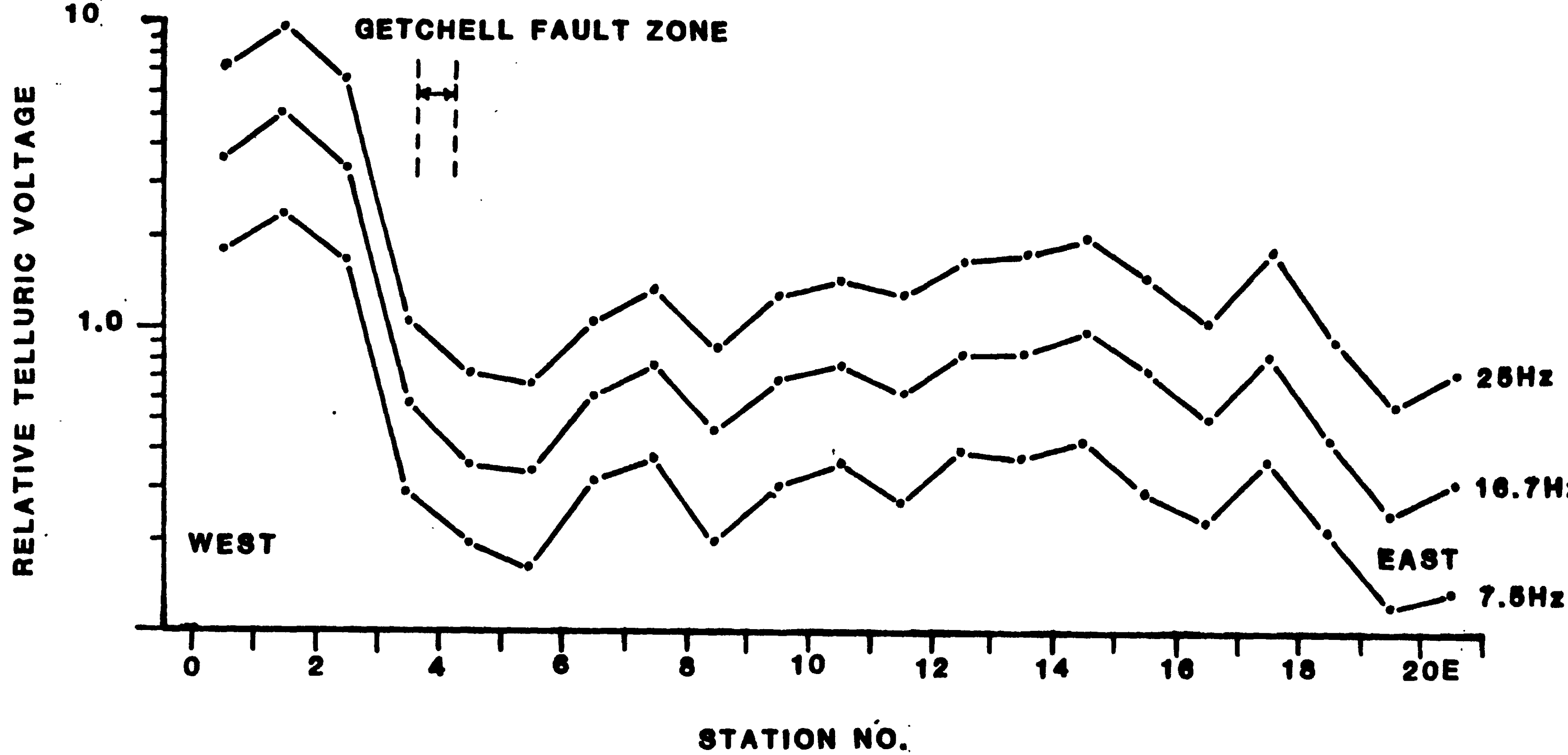

Figure 5. Telluric traverse data for line 1 Getchell Mine area, Humboldt County, Nevada. Station interval is 125 meters.

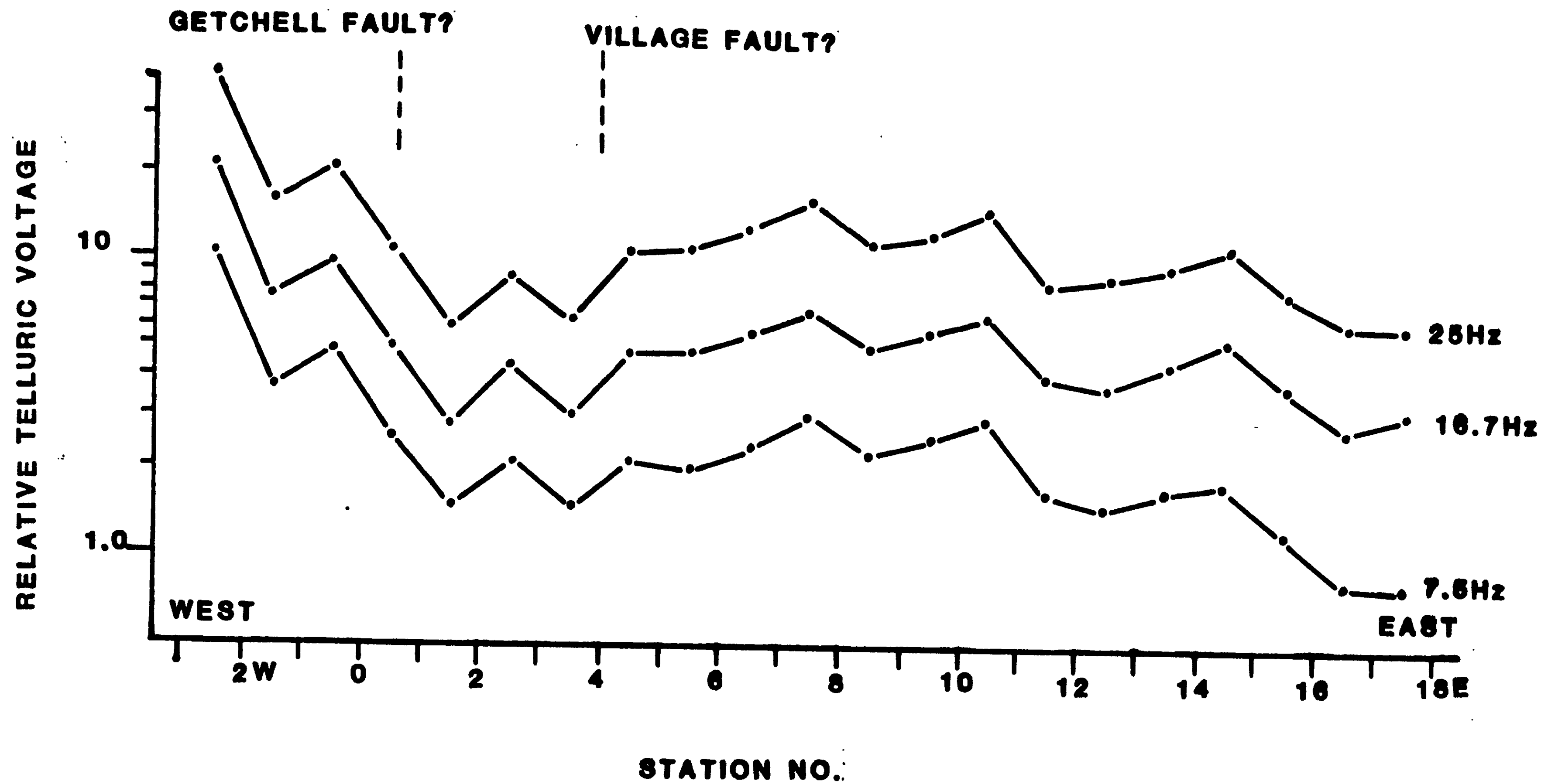

Figure 6. Telluric traverse data for line 2 Getchell Mine area, Humboldt County, Nevada. Station interval is 125 meters.

Appendix I

Tabulated telluric data follows for the Preble Mine area lines 1 and 2, and Getchell Mine area lines 1 and 2. The tables show the voltage ratio measured at each station between adjacent dipoles and the standard deviation of the measured data. The calculated relative voltage is also shown referenced to a starting dipole value of 1 unit.

Telluric Traverse Data
Preble, Line 1
125 m dipoles

Station No.	Ratio/Std. Deviation				Relative Voltage			
	25Hz	16.7Hz	7.5Hz	4.5Hz	25Hz	16.7Hz	7.5Hz	4.5Hz
					1	1	1	
1W x	1.11/.10	1.00/.08	1.08/.19					
					1.11	1	1.08	
0 ÷	0.98/.22	1.09/.09	1.22/.15					
					1.13	.92	.08	1
1E x	0.74/.03	0.71/.14	0.71/.05	0.58/.11				
					0.84	.65	.63	.41
2 ÷	1.10/.15	1.15/.28	1.39/.42	1.06/.16				
					.76	.57	.45	.39
3 x	1.04/.15	1.00/.26	0.88/.13	1.03/.26				
					.79	.57	.40	.40
4 ÷	0.73/.03	0.79/.12	0.82/.07	0.82/.07				
					1.09	.72	.48	.49
5 x	1.16/.07	1.35/.14	1.43/.09	1.44/.31				
					1.26	.97	.69	.70
6 ÷	0.98/.10	0.98/.10	0.98/.04	0.94/.10				
					1.28	.99	.71	.75
7 x	1.08/.06	1.27/.08						
					1.39	1.25		
8								

Telluric Traverse Data
Preble, Line 2
125 m dipoles

Station No.		Ratio/Std. Deviation			Relative Voltage		
		25Hz	16.7Hz	7.5Hz	25Hz	16.7Hz	7.5Hz
					1	1	1
1	÷	0.91/.14	0.92/.03	0.84/.08			
					1.10	1.09	1.19
2	x	0.58/.03	0.58/.05	0.62/.06			
					.64	.63	.74
3	÷	1.25/.04	1.23/.06	1.34/.37			
					.51	.51	.55
4	x	1.39/.07	1.42/.14	1.63/.52			
					.71	.73	.90
5	÷	1.60/.32	1.24/.22	1.50/.21			
					.44	.59	.60
6	x	1.14/.19	1.07/.14	1.26/.34			
					.50	.63	.75
7	÷	0.54/.10	0.77/.22	0.63/.15			
					.94	.82	1.20
8	x	0.91/.10	0.85/.12	0.98/.06			
					.85	.70	1.17
9	÷	1.31/.16	1.20/.23	1.19/.05			
					.65	.58	.99
10	x	2.07/.37	1.79/.44	1.57/.42			
					1.34	1.04	1.55
11	÷	0.58/.07	0.64/.13	0.65/.10			
					2.32	1.62	2.38
12	x	1.18/.35	1.38/.37	1.39/.30			
					2.74	2.24	3.31
13	÷	1.44/.23	1.34/.13	1.50/.33			
					1.90	1.67	2.21
14	x	1.03/.12	1.11/.27	1.05/.27			
					1.96	1.85	2.32

Telluric Traverse Data
Getchell, Line 1
125 m dipoles

Station No.	Ratio/Std. Deviation			Relative Voltage		
	25Hz	16.7Hz	7.5Hz	25Hz	16.7Hz	7.5Hz
				1	1	1
1E ÷	0.75/.03	0.74/.01	0.75/.01			
				1.33	1.35	1.33
2 x	0.70/.00	0.70/.00	0.71/.01			
				.93	.95	.95
3 ÷	6.04/.08	6.00/.12	6.00/.12			
				.15	.16	.16
4 x	0.64/.02	0.66/.05	0.68/.03			
				.099	.10	.11
5 ÷	1.05/.01	1.07/.06	1.18/.06			
				.094	.097	.091
6 x	1.59/.12	1.75/.05	1.99/.04			
				.15	.17	.18
7 ÷	0.80/.01	0.83/.00	0.85/.01			
				.19	.21	.21
8 x	0.63/.03	0.61/.03	0.52/.03			
				.12	.13	.11
9 ÷	0.65/.03	0.67/.02	0.67/.07			
				.18	.19	.17
10 x	1.10/.07	1.10/.05	1.19/.10			
				.20	.21	.20
11 ÷	1.13/.04	1.22/.04	1.31/.13			
				.18	.17	.15
12 x	1.33/.05	1.37/.03	1.46/.09			
				.23	.23	.22
13 ÷	0.96/.02	1.00/.05	1.03/.07			
				.24	.23	.21
14 x	1.16/.01	1.16/.00	1.15/.07			
				.28	.27	.24
15 ÷	1.33/.02	1.36/.03	1.49/.07			
				.21	.20	.16
16 x	0.72/.00	0.73/.01	0.79/.02			
				.15	.14	.13
17 ÷	0.61/.01	0.62/.01	0.62/.02			
				.25	.23	.21
18 x	0.52/.01	0.53/.00	0.59/.06			
				.13	.12	.12
19 ÷	1.70/.14	1.76/.08	1.79/.07			
				.077	.070	.069
20 x	1.32/.10	1.23/.13	1.15/.12			
				.10	.086	.079

Telluric Traverse Data
Getchell, Line 2
125 m dipoles

Station No.	Ratio/Std. Deviation			Relative Voltage		
	25Hz	16.7Hz	7.5Hz	25Hz	16.7Hz	7.5Hz
				1	1	1
2W ÷	2.67/.26	2.76/.03	2.76/.31			
				.37	.36	.36
1W x	1.29/.02	1.27/.02	1.32/.06			
				.48	.46	.48
0 ÷	1.85/.08	1.89/.11	1.97/.10			
				.26	.24	.24
1E x	0.55/.00	0.55/.00	0.56/.02			
				.14	.13	.14
2 ÷	0.64/.02	0.65/.02	0.68/.03			
				.22	.21	.20
3 x	0.69/.01	0.68/.03	0.69/.03			
				.15	.14	.14
4 ÷	0.62/.02	0.62/.01	0.69/.07			
				.25	.23	.20
5 x	1.04/.05	1.04/.07	0.95/.07			
				.26	.23	.19
6 ÷	0.86/.02	0.87/.02	0.88/.05			
				.30	.27	.22
7 x	1.22/.09	1.19/.13	1.35/.08			
				.37	.32	.29
8 ÷	1.36/.11	1.35/.14	1.39/.18			
				.27	.24	.21
9 x	1.06/.03	1.15/.08	1.16/.04			
				.29	.27	.24
10 ÷	0.81/.07	0.87/.07	0.87/.07			
				.35	.31	.28
11 x	0.56/.02	0.60/.07	0.57/.09			
				.20	.19	.16
12 ÷	0.95/.06	1.02/.05	.12/.11			
				.21	.18	.14
13 x	1.09/.04	1.15/.08	1.14/.09			
				.23	.21	.16
14 ÷	0.83/.02	0.82/.05	0.94/.16			
				.27	.26	.17
15 x	0.70/.03	0.69/.05	0.67/.05			
				.19	.18	.12
16 ÷	1.30/.11	1.34/.08	1.47/.10			
				.15	.13	.08
17 x	1.05/.09	1.12/.03	1.06/.03			
				.15	.15	.08