ELECTRICAL RESISTIVITY SURVEY AT
BURNS PROSPECT
HARNEY COUNTY, OREGON

Prepared for

AMAX EXPLORATION, INC.

Geothermal Group

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by

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Abstract

A reconnaissance electrical survey was conducted by Terraphysics in the Burns area, Harney County, Oregon.

A combination of telluric and magnetotelluric methods was used. Data were obtained at two frequencies, 8 Hz and 0.05 Hz.

The results appear to reflect some of the geological formations in the area.

A low apparent resistivity area is observed in a portion of the basin (< 16 ohm meters at 0.05 Hz). This conductive area appears to be fairly thick.

The remaining portion of the surveyed area appears to become more resistive with depth and may be reflecting various depths to an underlying basalt and andesite formation.

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Introduction

Terraphysics conducted electrical surveys in the vicinity of Burns, Harney County, Oregon, on behalf of the Geothermal Group of Amax Exploration, Inc., during the interval 21 October to 13 November 1975. Telluric and magnetotelluric (MT) measurements were made.

Survey Objective

The objective of the survey was to aid in the evaluation of the geothermal energy potential in the area. Various warm springs exist in the region.

Many geophysical techniques are used to evaluate a geothermal area. Since a decrease in resistivity usually occurs where the temperature of the earth increases, an electrical resistivity survey can be a useful diagnostic technique. The resistivity change with temperature can be on the order of $2.5\%/C^{o}$ (Keller and Frischnecht, 1970). Consequently, resistivity decreases on the order of a factor of 5 or more may be associated with geothermal brines (Keller, 1970). Intrinsic resistivities of less than 10 ohm meters may be expected.

If a geothermal area is at a sufficiently high temperature that a vapor phase is present, higher electrical resistivities are likely. Zohdy, et. al. (1973) report intrinsic resistivities of about 75-130 ohm meters for a vapor-dominated layer in Yellowstone National Park.

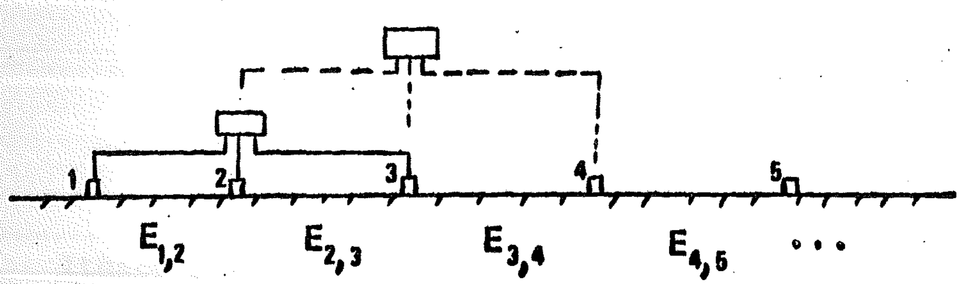
Procedure and Instrumentation

A combination of telluric and magnetotelluric methods was used as a reconnaissance technique. The collinear telluric method is illustrated in Figure 1, and has been described by Dahlberg (1945), and Boissonnas and Leonardon (1948). The technique involves measuring the ratio of the electric fields (E) between two adjacent collinear dipoles. After the readings are completed at one station, the instruments are moved to the next site and the next dipole ratio is measured.

The electric field ratio is proportional to the square root of the apparent resistivity ratio beneath the particular dipoles, see Figure 1, (Slankis and Becker, 1969; Slankis, Telford and Becker, 1972). Successive ratios are referenced back to an initial dipole to obtain a relative resistivity profile across the region.

The equipment used is itemized in Table 1 and illustrated in the schematic of Figure 1. Porous pots are used as electrodes for the telluric dipoles, each electrode consisting of a porous ceramic cup and a copper rod in a saturated copper sulphate solution. Voltages from two adjacent telluric dipoles are narrow-band filtered, amplified (2 Ithaco filters) and displayed on an X-Y chart recorder (Simpson). The voltage ratio is easily measured as the slope of the resulting X-Y plot. An example of such data is shown in Figure 2. Measurements are usually made at 0.05 Hz and may be supplemented by data at other frequencies, such as 8 Hz, to provide additional depth information. A theoretical example is described in Appendix A.

Magnetotelluric measurements are made at intervals along the telluric lines, providing control points for calibrating the relative telluric profiles. Continuous profiles of apparent resistivity values across the area are obtained.



ELECTRIC FIELD RATIO

$$\frac{E_{i,j}}{E_{1,2}} = \frac{E_{2,3}}{E_{1,2}} \frac{E_{3,4}}{E_{2,3}} \cdots \frac{E_{i,j}}{E_{i-1,j-1}} = \left(\frac{\rho_{a\,i,j}}{\rho_{a\,1,2}} \right)^{\frac{1}{2}}$$

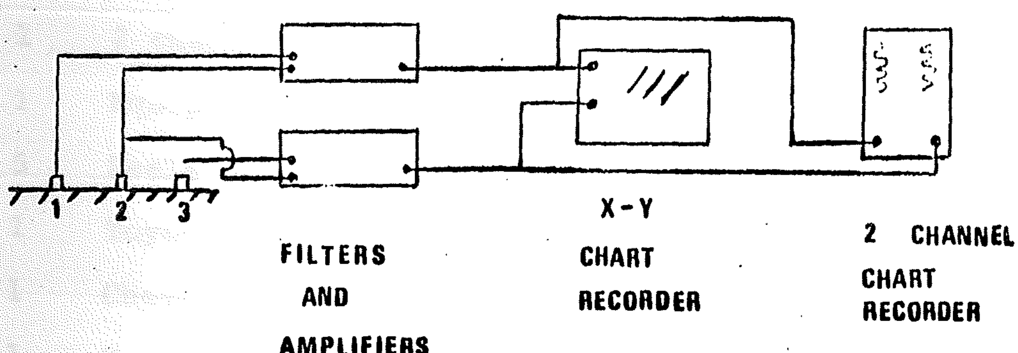


Figure 1. Collinear telluric method and instrumentation

Table 1

SURVEY EQUIPMENT

4	Ithaco model 4211 filters with amplifier options
2	Simpson X-Y model 2745 chart recorders
1	2 channel Brush 222 chart recorder
1	2 channel Gulton model TR 722J chart recorder
1	Develco 3 component superconducting Josephson Junction magnetometer
1	Tektronix 2 channel oscilloscope
2	2 channel amplifiers
1	2 channel 60 Hertz notch filter
1	Equipment trailer
5	Reels,wire (30,000 feet)
1	Toyota Landcruiser 4 wheel drive
1	Chevrolet 1/2 ton pickup with instrument camper shell
1	Vacuum pump (for pumping vacuum on cryogenic devices)
1	Liquid He Transfer line
1	Liquid He Level indicator
1	Simpson digital voltmeter
1	100 liter Liquid He dewar (Rental)

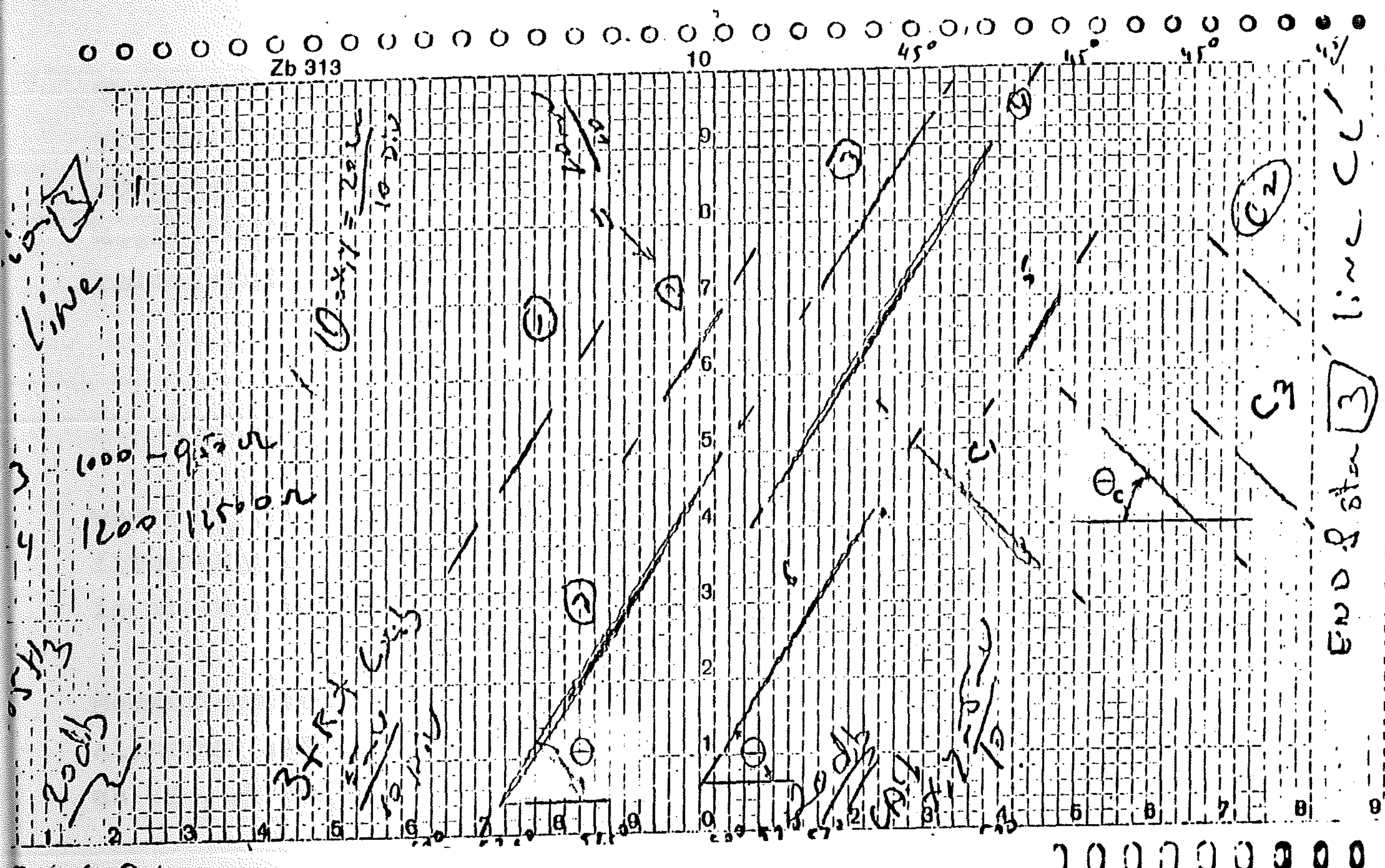


Figure 2. The X axis represents the voltage monitored from dipole 2-3 and the Y axis represents dipole 3-4. The ratio of the voltages of these adjacent dipoles is determined from the tangent of the angle Θ from the expression

$$\frac{V_{3,4}}{V_{2,3}} = \frac{\tan\Theta}{\tan\Theta_c}$$

Calibration of the instruments is taken into consideration by the measurement of the angle Θ_c

The electric field ratio is obtained from the expression

$$\frac{E_{3,4}}{E_{2,3}} = \frac{V_{3,4}}{L_{3,4}} \cdot \frac{L_{2,3}}{V_{2,3}} = \frac{L_{2,3}}{L_{3,4}} \frac{\tan\Theta}{\tan\Theta_c}$$

Where $L_{2,3}$ and $L_{3,4}$ are the lengths of the dipoles 2-3 and 3-4 respectively.

The electric field (E_x) is measured at the same stations as the collinear telluric data. The orthogonal magnetic field component H_y is measured with a Josephson Junction ("J.J.") magnetometer. Scalar apparent resistivities ρ_{a_x} are calculated from the expression

$$\rho_{a_x} = \frac{.2}{f} \left(\frac{E_x}{H_y} \right)^2$$

where E_x is in millivolts/km, H_y is in gammas and f is the frequency in Hertz (Hz), the resulting apparent resistivity is in ohm meters.

Measurements are made at a narrow-band frequency of 0.05 Hz, although additional measurements at other frequencies, such as .1, .8 and 8 Hz are sometimes obtained.

The orthogonal pair of field components E_y and H_x is measured at some stations, with the resulting determination of apparent resistivity ρ_{a_y} giving an indication of the anisotropic nature of the earth.

In summary, the field procedure is as follows:

1) Telluric lines are run in a direction normal to geologic strike where feasible.
2) MT measurements are made at appropriate sites to calibrate the telluric lines.
3) Results of the above may warrant supplementary deep d.c. resistivity soundings and/or electromagnetic (EM) measurements over possible geothermal target zones.

Field Operation at Burns

In the Burns survey, telluric dipoles ranging from .4 to 1.3 kilometers in length were employed, depending on topographic conditions. Telluric measurements were made at 8 Hz and 0.05 Hz.

Geologic strike in the area is difficult to define. Many features appear to be three-dimensional (Greene, 1972). The major mapped feature in the region is a large sedimentary basin; in the area of the survey the contact runs east-west. Telluric lines were run predominantly north-south as determined by roads and access, and as specified by the client. Sixty-three (63) telluric stations were measured, and eighteen (18) MT stations were occupied at strategic locations on the telluric lines.

Composition of Crew

A detailed summary of the work and personnel is documented in Appendix B. The personnel involved on the project are listed below.

A. Pessah	Party Chief	Instrumentation, survey and data analysis
J. Moroney	Field Enginner	Survey, wire crew, data analysis
P. Guzman	Field Hand	Wire crew, equipment maintenance

Terraphysics personnel worked a total of thirty-three (33) field man days in the Burns area of Oregon over a period of seventeen (17) days.

Operating Conditions

The weather was generally favorable and work proceeded smoothly except on four days when low signal levels and high winds hindered the MT measurements.

The personnel stayed at the Ponderosa Motel in Burns, Oregon during the period of the survey work. Maximum commuting time to the farthest station was about 30 minutes.

Specific vehicles used in the project were a Toyota Landcruiser (4 wheel drive), a Chevrolet 1/2 ton pickup with a camper shell and an equipment trailer (see Table 1).

DATA

The locations of the telluric lines and stations are shown in Plate 1. (The Figures and Plates for the data are in the second binder.)

The telluric profiles are plotted in Figures 3 through 6. The relative electric field strength is plotted on the left side ordinate. The station locations are projected on the abscissa at the top of the plot, with the E-field ratio plotted midway between the electrode stations.

Each station represents an average of 4 to 12 measurements. In some cases, in particular when the ground becomes anisotropic, wide variations in the telluric ratio are observed. The various values are plotted.

Considerable scatter was observed in the 8 Hz data. (See item four on sources of error, page 15.) The standard deviations for these values are represented as error bars in the figures.

MT readings are shown in the rectangles at their corresponding locations. The average resistivity and standard deviation are indicated. Telluric values between MT readings on a given profile have been adjusted linearly to correspond to the MT readings. An apparent resistivity scale in ohm meters is shown on the right side ordinate. A summary of all the magnetotelluric data is presented in Table 2.

Contour maps of apparent resistivities for the 8 and 0.05 Hz frequencies, as described from the profile data, are depicted in Plates 2 and 3. The apparent resistivities are plotted in logarithmic contour intervals.

The contours for both the 8 Hz and 0.05 Hz data may be subject to some uncertainty due to the slightly different telluric line directions and possible anisotropic effects. Apparent resistivity values are summarized in Table 3 for adjacent points of different telluric line directions. Some variation is observed at line AA', stations 18-20, at 8 Hz. It is believed that this is probably due to a lateral resistivity variation between the stations. Within the statistics of the measurements, the apparent resistivity values generally agree.

Orthogonal telluric measurements were obtained at one station, line AA', station 3A. Wide variations in both the phase and the amplitude ratio were observed between the orthogonal dipoles over a period of time. The phase varied from zero to 180 degrees, and the electric field direction appeared to vary from N 68° W to N 73° E.

(NUMBER OF SAMPLES)

LINE & STATION	LENGTH IN METERS	DATE	0.05 Hz	8.0 Hz	0.1 Hz	0.8 Hz	COMMENTS
AA' 3-4A	747	10/29	39 ∓ 16 (21)	——			8 Hz data; no correlation local noise?
14-15	1144	10/30	35 ∓ 20 (28)	12 ∓ 6 (19)			
15-16	861	10/31	45 ∓ 17 (22)	12 ∓ 7 (20)			
18-19	800	10/31	64 ∓ 19 (26)	31 ∓ 15 (23)			
19-20	641	10/31	79 ∓ 34 (22)	15 ∓ 8 (11)			
24-25	1053	11/1	135 ∓ 72 (25)	22 ∓ 7 (20)			
BB' 1-2	1053	11/3	20 ∓ 4 (18)	6 ∓ 6 (14)			very poor correlation, 8 Hz data
7-8	674	11/4	29 ∓ 14 (24)	17 ∓ 4/ (10) 7 ∓ 2/ (10) 12 ∓ 6/ (20)			2 groups, 8 Hz data

(NUMBER OF SAMPLES)

LINE & STATION	LENGTH IN METERS	DATE	0.05 Hz	8.0 Hz	0.1 Hz	0.8 Hz	COMMENTS
BB' 8-9	962	11/4	35 ∓ 11 (24)	9 ∓ 3 (20)			windy
13-14	708	11/4	150 ∓ 59 (21)	38 ∓ 25 (20)			
CC' 20-21	480	11/12	17 ∓ 6 (19)	11 ∓ 9 (26)			low signal 8 Hz poor correlation
1-2	800	11/6	10 ∓ 6 (24)	17 ∓ 12 (33)			
9-10	795	11/7	45 ∓ 10 (23)	6 ∓ 3 (38)			
14-15	709	11/7	97 ∓ 17 (20)	25 ∓ 12 (23)			
DD' 3-4	1091	11/9	51 ∓ 25 (11)	22 ∓ 11 (36)			
4-5	961	11/9	52 ∓ 14 (22)	12 ∓ 9 (54)			

(NUMBER OF SAMPLES)

LINE & STATION	LENGTH IN METERS	DATE	0.05 Hz	8.0 Hz	0.1 Hz	0.8 Hz	COMMENTS
DD' 8-9	785	11/10	71 ∓ 34 (13)	8 ∓ 9 (17)			very windy poor correlation 8 Hz data

Table 3

Comparison of Apparent Resistivity Values for Different Telluric Line Directions

Line	Station	Telluric Line Direction	Apparent Resistivity Values ∓ Standard Deviation Ohm Meters 8 Hz	0.05 Hz	Comments
AA'	14-15	North	12 ∓ 6	35 ∓ 20	Not Statistically Different
	15-16	N 28° W	12 ∓ 7	45 ∓ 17	
AA'	18-19	N 28° W	31 ∓ 15	64 ∓ 19	(see text for comment on 8 Hz data)
	19-20	N 18° E	15 ∓ 8	79 ∓ 34	
BB'	7-8	N 19° W	12 ∓ 6	29 ∓ 14	Not Statistically Different
	8-9	N 16° E	9 ∓ 3	35 ∓ 11	
DD'	3-4	N 28° W	22 ∓ 11	51 ∓ 25	Not Statistically Different
	4-5	N 15° E	12 ∓ 9	52 ∓ 14	

Sources of Error

The principal sources of error in the telluric-magnetotelluric methods are:

1) Station locations and dipole lengths are determined from topographical maps, bench marks, and actual field measurements. In general, dipole lengths are determined to within 5%. The possibility of the accumulation of small errors yielding a large uncertainty after a number of stations has been reduced by taking magnetotelluric measurements at intervals along the telluric profiles. Telluric values between MT readings have been adjusted linearly to correspond to the MT values.

2) Errors due to instrumentation are kept to a minimum by calibrating the instruments at each station. In some cases, calibrations were taken both before and after each frequency reading.

3) When the earth becomes highly anisotropic, a phase shift can occur between measurements of adjacent telluric dipoles. In this case, the E-field ratio depends upon the polarization of the incident field and, in general, wide variations in both amplitude and phase are observed. Then attempts are made to obtain information over as much of the area as possible with MT readings and d.c. resistivity measurements.

4) In some areas, considerable noise is observed on the higher frequency data, 8 Hz, probably caused by local industrial electrical activity. Attempts have been made to minimize any error from these near-field sources by careful inspection of each cycle of data on high speed oscillographic records. Considerable scatter in the data usually results, however, in those areas.

Discussion of Data

Geological Province

The Burns area lies at the border between the Blue Mountains and Basin and Range Provinces in the eastern central part of the state of Oregon. This area is "characterized by north trending mountain ranges and intervening flat valleys, which are blanketed with alluvium or recent lava flows" (McKee, 1972). "The rocks consist primarily of extensive sheets of solidified lava. Much of the lava is basalt, but some widespread silicic ash flows and tuffs are present" (McKee, 1972). Nonmarine sandstone, shale and conglomerates are interbedded with the volcanic strata.

Numerous steeply dipping faults occur in the region. They generally trend in a north-south direction and many of the mountain ranges have been raised by block fault systems. Some of the faults in the region have been recently active.

Burns Area, Oregon

The area surveyed was to the north and northeast of the town of Burns, Oregon. A warm spring (22^{o}C) occurs about 27 kilometers northeast of Burns (Waring, 1965), however, the survey area did not extend that far.

A wide variety of rocks has been mapped in this area, predominately consisting of younger Cenozoic (Miocene and Pliocene) sedimentary and volcanic rocks, and Quaternary alluvium and sedimentary rocks (McKee, 1972). Many features appear to be three-dimensional (Greene, et. al., 1972).

Three short fault segments have been mapped in the area. They range from 1.6 to 2.2 kilometers in length. Two segments trend east-west and the third lies in a north-south direction.

The major feature in the area is a large sedimentary basin. A sequence of welded tuff members lies to the north of the basin. In the area of the survey, the contact runs predominately east-west. The tuff formations are perhaps 150 meters thick (Greene, et. al., 1972). Some Quaternary sediments have been mapped with the tuff units. Basalt and andesite may underlie these formations.

(a) 8 Hz Data

The 8 Hz data depicted in Plate 2 appear to reflect some of the different rock types mapped in the area. The low apparent resistivity values on line CC', from stations 20 to 11, are believed to reflect Quaternary sedimentary rocks and alluvium deposits. This area of low resistivity (< 16 ohm meters) also occurs on line BB', from stations 1 to 10. Welded tuff of the Double O Ranch has been mapped in this area. This unit is typically from 15 to 70 meters thick.

There is a resistivity high peak of about 40 ohm meters on line BB' between stations 11-12, which appears to occur at the contact between the welded tuff of the Double O Ranch and Prater Creek units. The Prater Creek unit may be only 15 meters thick (Greene, et. al., 1972).

On the north end of line BB' and CC', the apparent resistivity reaches its highest value, 60 ohm meters, and appears to reflect the basalt and andesite unit mapped in this section. The skin depth of an 8 Hz E.M. wave for a 16 ohm meter material is 711 meters and for 40 ohm meters is 1125 meters. Since the welded tuff units are on the order of 150 meters thick, the variations in the 8 Hz data may be reflecting different depths to the basalt and andesite formation.

(b) 0.05 Hz Data

The 0.05 Hz data reflect deeper resistivity properties of the area. The contours depicted in Plate 3 exhibit some similarity in pattern to the 8 Hz data. Within the statistics of the measurements, the apparent resistivity values are equal to or greater than those observed at 8 Hz.

Low apparent resistivity values ($<$ 16 ohm meters) are indicated on line CC', stations 20 to 6, suggesting that the Quaternary sediments in the basin may be fairly thick. They may also reflect warm geothermal brines or a combination of the two cases.

These low values are not observed farther to the west; on line AA', stations 1 to 15, resistivity values of 25 to 160 ohm meters are indicated.

Considerable scatter and elliptical patterns were observed in the telluric data on line AA', stations 3 to 7, see Figure 3. Since an electrical power substation is located at line AA', station 5, these results could be reflecting anisotropic effects of the earth, noise from the substation, or a combination of the two effects.

A resistivity high peak of 180 ohm meters occurs on line AA', stations 12-13. A smaller peak of 18 ohm meters is seen at 8 Hz in this same area. On line BB', station 11-12, another resistivity high peak of 240 ohm meters coincides with the resistivity peak observed at 8 Hz, 42 ohm meters. These peaks may be reflecting shallower depths to the basalt and andesite formation. The effects are more pronounced for the 0.05 Hz data due to the greater depth of exploration; for example, the apparent skin depth at 0.05 Hz for a 160 ohm meter resistivity is 28,453 meters while the skin depth at 8 Hz for an 18 ohm meter material is 755 meters. The actual sensing depths are usually much less than these skin depths. Additional multi-frequency data with a complete model solution would be required to determine the actual properties and depths.

North of the resistivity peak on line AA', the apparent resistivity drops to about 35 ohm meters at stations 14-15, perhaps reflecting a small three-dimensional deposit of Quaternary sedimentary rocks.

Two short fault segments, trending east-west, have been mapped in the area of line AA', station 14, and line BB', stations 7-8. The telluric lines, however, intersect only an end of one of the mapped segments, at line BB', stations 7-8. Expressions for these faults are not clearly evident in the data. A third short north-south fault segment occurs about 2.5 kilometers east of line BB', station 13. The telluric lines do not intersect this segment, and there is no evidence of the fault in the data.

Summary and Recommendations

The results of the present resistivity survey appear to reflect some of the geological formations in the area.

Low apparent resistivity values ($<$ 16 ohm meters) are observed in a portion of the basin. These may be reflecting Quaternary sediments, geothermal brines or a combination of the two cases. The conductive zone appears to be fairly thick.

A number of resistive peaks are observed in the area. These may be reflecting shallower depths to a basalt and andesite formation.

The majority of the survey area, with the exception of a portion of the basin, appears to become more resistive with depth.

Many of the contours and interpretations have been governed by the direction of the telluric lines. In view of the complex geology, some orthogonal measurements should be obtained, for example, an east-west telluric line in the basin would help verify the boundary of the thick conductive zone that appears to occur between lines AA' and CC'.

In view of the three-dimensional nature of the area, solutions for MT impedance tensors (Grillot, 1975), and at least two-dimensional modelling probably would be required to unfold the deep intrinsic properties of the area.

In general, unless other geophysical evidence suggests the presence of steam at depth, these results, with the possible exception of the basin mentioned above, are not encouraging for finding significant geothermal potential in the area.

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APPENDIX A

Theoretical telluric results over hypothetical models are shown in Figures A1 and A2. The difference between the two models is the inclusion of a one ohm meter body in Figure A2. This could be representative of a geothermal target.

Two points are of particular note.

(1) The telluric response is characteristically dominated by resistivity variations occurring beneath the measuring stations. This is seen in both the figures.

(2) The use of multifrequencies provides some initial determination of depth information. For example, a significant difference is observed between the 0.03 Hz telluric response over the two models. The 8 Hz response is not affected. The 8 Hz E.M. wave in this case does not significantly penetrate to the depth of the one ohm meter body. (The skin depth of an 8 Hz E.M. wave is 562 meters in a 10 ohm meter material. The top of the one ohm meter body was 500 meters deep.) These results place a bound on the depth of the anomoly observed on the 0.03 Hz data. It must be deeper than a few hundred meters and less than a few thousand meters. A more precise depth could, of course, be determined with intermediate frequency data.

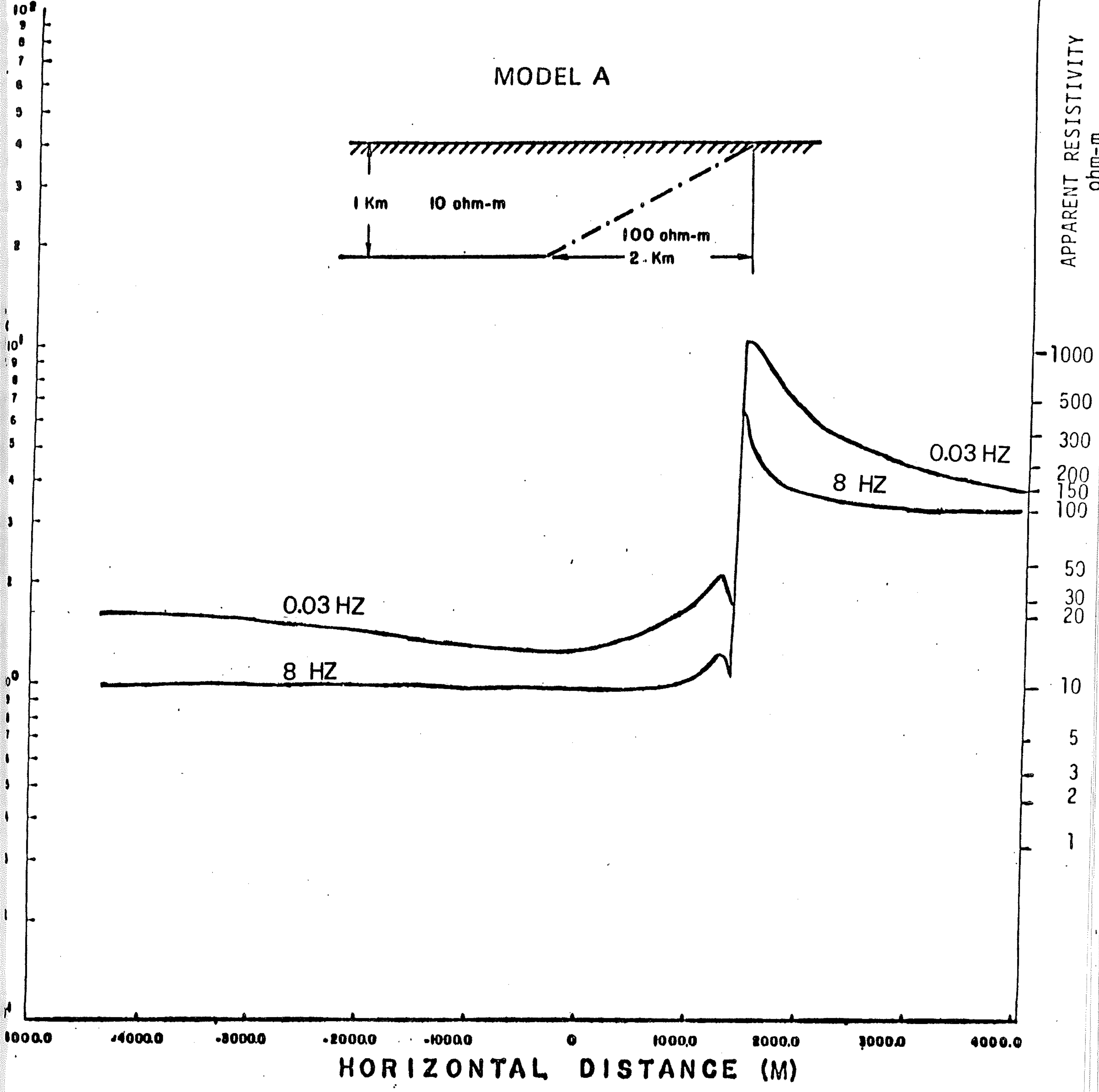

Figure A1. Telluric response at 8 Hz and at 0.03 Hz over Model A.

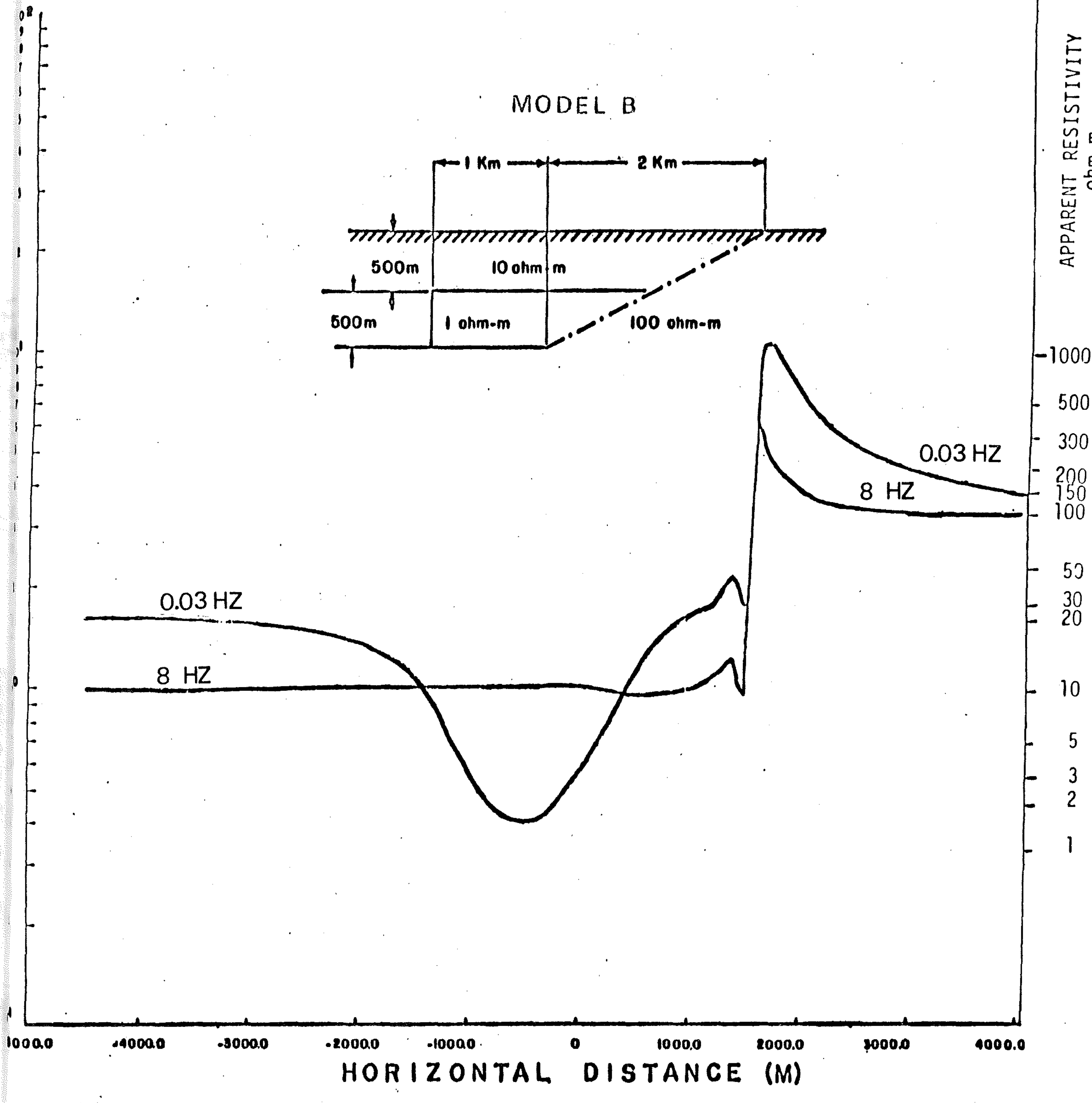

Figure A2. Telluric response at 8 Hz and at 0.03 Hz over Model B, inclusion of a one ohm meter body at 500 meters depth.

Appendix B

Personnel and Operations Summary

MONTH

Oct/November

TERRAPHYSICS

PROJECT Burns, Oregon

DAY	DATE	TECHNIQUE	TOTAL STATIONS	LOCATIONS	FREQ.S Hz 05	01	08	8		PERSONNEL MAZZELLA	PESSAH	GUZMAN	HARVEY	MORONEY
OCTOBER		T	8	Line AA' ST 2, 3, 4, 5, 6, 7, 8, 9	X			X			X	X		
Wed.	29th	OT	1	Line AA' ST (3A)	X			X			X	X		
		MT	1	Line AA' ST (3A-4)	X			X			X	X		
Thu.	30th	T	5	Line AA' ST 10, 11, 12, 13, 14	X			X			X	X		
		MT	--	Line AA' (Poor data ST (14-15), (15-16))	X			X			X	X		
Fri.	31st	T	5	Line AA' ST 16, 17, 18, 20, 21	X			X			X	X		
		MT	4	Line AA' ST (15-16), (18-19), (19-20) (Poor 8 Hz data ST (14-15))	X			X			X	X		
NOVEMBER														
Sat.	1st	T	3	Line AA' ST 22, 23, 24	X			X			X	X		
		MT	2	Line AA' ST (24-25) (8 Hz only on ST (14-15))	X			X			X	X		
Sun.	2nd			Data analysis							½			
				Day off							½			
Mon.	3rd	T	6	Line BB' ST 2, 3, 4, 5, 6, 7	X			X			X	X		
		MT	1	Line BB' ST (1-2)	X			X			X	X		

TECHNIQUE CODES T - TELLURICS OT - ORTHOGONAL TELLURICS MT - MAGNETOTELLURICS

R - D.C. RESISTIVITY EM - ELECTROMAGNETIC (ACTIVE)

MONTH

October

TERRAPHYSICS

PROJECT Burns, Oregon

DAY	DATE	TECHNIQUE	TOTAL STATIONS	LOCATIONS	FREQ.S Hz 05	01	08	8		MAZZELLA	PESSAH	GUZMAN	HARVEY	MORONEY
Tue.	21st			Load equipment Mobilization to Burns, Oregon Unload equipment Mobilization to Richmond, California							X	X	X X	X
Wed.	22nd			Survey stations Equipment maintenance, testing							X	½		½
Thu.	23rd			Survey stations Equipment maintenance, testing							X	½		½
Sat.	25th			Day off (awaiting parts)										
Sun. Mon.	26th 27th			Day off Mobilization to Richmond, California										X
Tue.	28th	T	--	Line AA' (Low signal levels, ST 2 & 3A)	X			X			X	X		
		MT	--	Line AA' Low signal levels ST (1-2) Electrical power substation, noise pickup?	X			X			X	X		

TECHNIQUE CODES T - TELLURICS OT - ORTHOGONAL TELLURICS MT - MAGNETOTELLURICS

R - D.C. RESISTIVITY EM - ELECTROMAGNETIC (ACTIVE)

MONTH

November

TERRAPHYSICS

PROJECT Burns, Oregon

DAY	DATE	TECHNIQUE	TOTAL STATIONS	LOCATIONS	FREQ.S Hz 05	01	08	8		PERSONNEL MAZZELLA	PESSAH	GUZMAN	HARVEY	MORONEY
Tue.	4th	T	5	Line BB' ST 9, 10, 11, 12, 13	X			X			X	X		
		MT	3	Line BB' ST (7-8), (8-9), (13-14)	X			X			X	X		
Wed.	5th	T	1	Line BB' ST 14	X			X			X	X		
				2 Flat tires										
				Surveyed Line CC'	X			X			X	X		
Thu.	6th	T	8	Line CC' ST 2, 3, 4, 5, 6, 7, 8, 9	X			X			X	X		
		MT	1	Line CC' ST (1-2)	X			X			X	X		
Fri.	7th	T	6	Line CC' ST 10, 11, 12, 13, 14, 15	X			X			X	X		
		MT	2	Line CC' ST (9-10), (14-15)	X			X			X	X		
Sat.	8th	T	2	Line DD' ST 2, 3	X			X			X	X		
		MT	--	Line DD' (Poor data due to lightning activity and wind ST (3-4), (4-5)	X			X			X	X		
Sun.	9th	T	2	Line DD' ST 9, (Poor 8 Hz data on ST 8)	X			X			X	X		
		MT	2	Line DD' ST (3-4), (4-5),(Poor data due to wind ST (9-10)	X			X			X	X		

TECHNIQUE CODES T - TELLURICS OT - ORTHOGONAL TELLURICS MT - MAGNETOTELLURICS

R - D.C. RESISTIVITY EM - ELECTROMAGNETIC (ACTIVE)

MONTH

November

TERRAPHYSICS

PROJECT Burns, Oregon

DAY	DATE	TECHNIQUE	TOTAL STATIONS	LOCATIONS	FREQ.S Hz 05	01	08	8		PERSONNEL MAZZELLA	PESSAH	GUZMAN	HARVEY	MORONEY
Mon.	10th	T MT	3 1	Line DD' ST 5, 6, 7, (repeat 8 Hz only ST 8) Line DD' ST (9-8)	X X			X X			X X			
Wed.	12th	T MT	6 1	Line CC' ST 21, 22, 23, 24, 25, 26 Line CC' ST (20-21)	X X	 X	 X	X X			X X	X X		
Thu.	13th	T	2	Line CC' ST 27, 1 Chain Line CC' ≈ 6 kilometers	X			X			X	X		

TECHNIQUE CODES T - TELLURICS OT - ORTHOGONAL TELLURICS MT - MAGNETOTELLURICS

R - D.C. RESISTIVITY EM - ELECTROMAGNETIC (ACTIVE)

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