A Slingram Survey at Yucca Mountain on the Nevada Test Site

by

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

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Introduction

Electromagnetic (EM) data presented in this report is part of study by the U.S. Geological Survey aimed at evaluating the Miocene (?) and Pliocene Yucca Mountain Member of various units of the Paintbrush Tuff in the vicinity of Yucca Mountain as a possible repository for nuclear wastes (Lipman and McKay, 1965). The survey area is located about 97 km northwest of Las Vegas, Nevada on the Nevada Test Site (fig. 1). Data contained in this report were taken along the eastern edge of Yucca Mountain.

Fig. 1.--Near Here

The specific purpose of this survey was to determine with EM methods, whether or not northwest-trending valleys in the Yucca Mountain area were fault controlled. Fault and fracture zones in the tuff units were expected to have a somewhat higher conductivity than the unfractured tuff. This is due to the greater porosity, clay and moisture content expected in the fault zones than in unfaulted rock. Depending upon a number of factors, such as the conductivity contrast between fault zones and unfaulted rock, and the depth and conductivity of the overburden, it may be possible to recognize fault zones from surface EM measurements.

Several EM methods were tested to determine which one gave the best results in this environment. The methods tried included' slingram, Turam and VLF (very low frequency). Slingram data proved to be most diagnostic in delineating a mapped fault on the east edge of Yucca Mountain, and hence was used in the survey traverses crossing the northwest valleys cutting into Yucca Mountain.

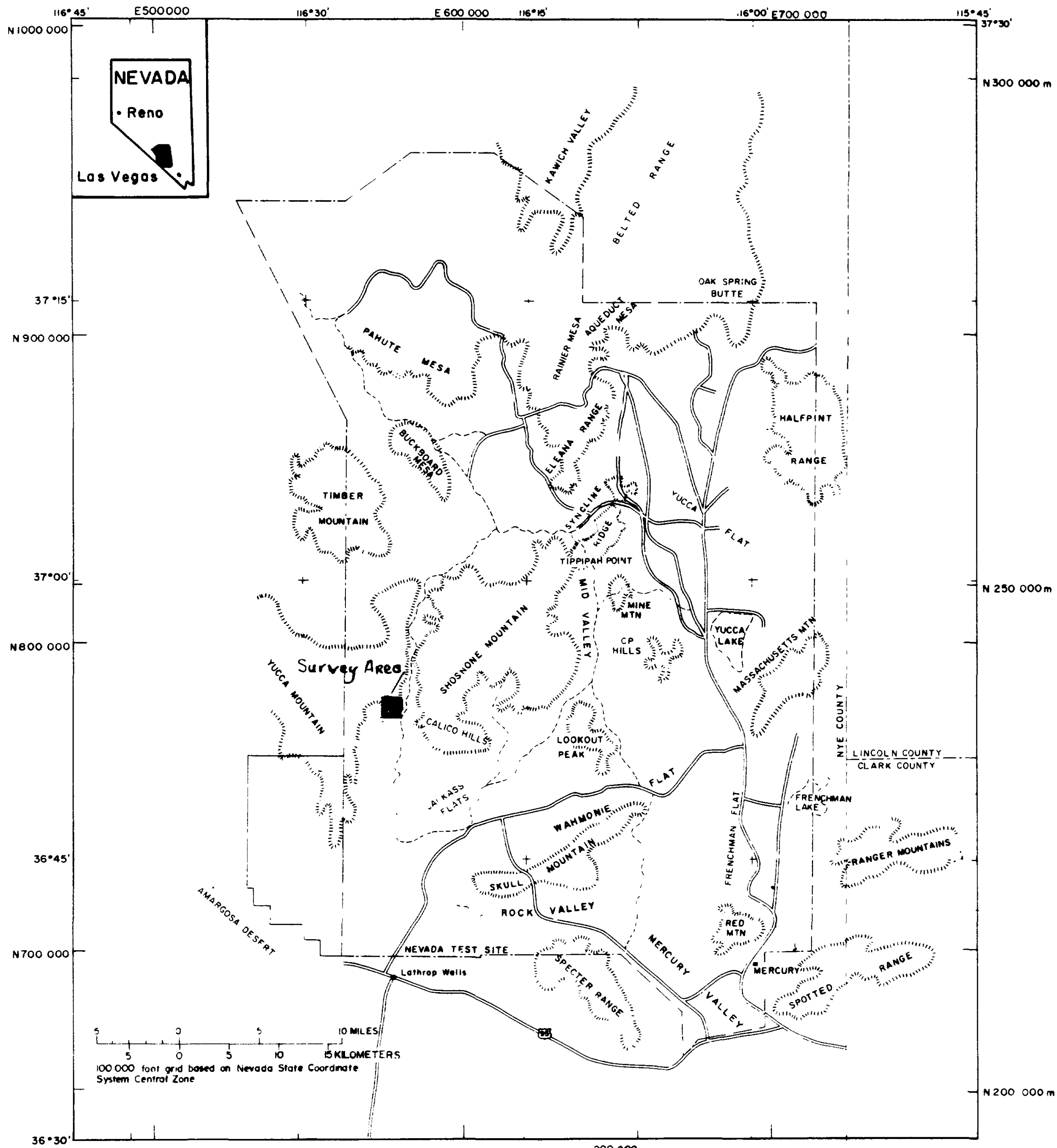

Figure 1. Index map of South Central Nevada showing location of geophysical survey on the Nevada Test Site.

The slingram method and interpretation are described in detail by Keller and Frischknecht (1966) and Frischknecht (1967). The method used for calibration and testing of the slingram unit prior to the field survey is described by Flanigan (1979).

Slingram measurements were made using horizontal coplanar coil configuration with the transmitter-receiver coil separation at 243 m (800 ft). Measurements were taken at five frequencies (222, 444, 888, 1777, 3555 Hz) at 61 m intervals along the traverses. At 243 m coil separation, the depth of penetration of the EM field at 888 Hz is about 122 m (400 ft). VLF measurements were made at the same measurement interval as the slingram survey. Four components of the EM field originating from a VLF transmitter operating at 18.6 KHz located near Jim Creek, Washington, were measured. The four components measured are the inclination or dip, ellipticity or quadrature (quad.), apparent resistivity and the phase angle of the surface impedance. The VLF dip and quad are an approximate measure of the VLF polarization ellipse in the vicinity of the measurement. The apparent resistivity of the earth beneath the measurement point is determined by measuring the relative field strength of the vertical magnetic and horizontal electric fields at the transmitted frequency (Patterson and Ronka, 1971). The effective depth of penetration or skin depth of the VLF method at 18.6 KHz over an homogeneous earth of 250 Ω-m is about 60 m.

Discussion of Results

In order to test the relative effectiveness of the slingram and VLF method two parallel traverses (Y-1 and Y-2) were made crossing an area expected to contain a major north-trending fault concealed beneath alluvium but mapped by Lipman and McKay (1965) (Fig. 2). A detail map showing the

Fig. 2.--Near Here

relative location of the geophysical traverses and the axis location of the EM conductor interpreted in the test area is shown in figure 3. The slingram

Fig. 3.--Near Here

EM data taken along traverses Y-1 and Y-2 show similar responses (figs. 4, 5).

Fig. 4 & 5.--Near Here

A broad low in the slingram data, particularly noticeable in the two highest frequencies (1777 and 3555 Hz), indicates a conductor of slightly greater conductivity than the surrounding medium exists near the center of the traverse. The apparent width of the conductor, and the fact that the conductor crosses the two parallel traverses at different station numbers, suggests that the traverses crossed the strike of the conductor at an oblique angle.

The VLF data along traverses Y-1 and Y-2 (not shown) has suggestion of response to the EM conductor detected by the slingram method where apparent resistivity measurements drop slightly over the conductive zone. The VLF response along traverse Y-1 and Y-2, taken alone, would have been difficult to relate with certainty to a fault, had not its location been known from the slingram EM measurements.

Slingram traverses (Y-3 and Y-4) (figs. 6, 7) were made such that they crossed the conductor axis at approximately right angles. The data show

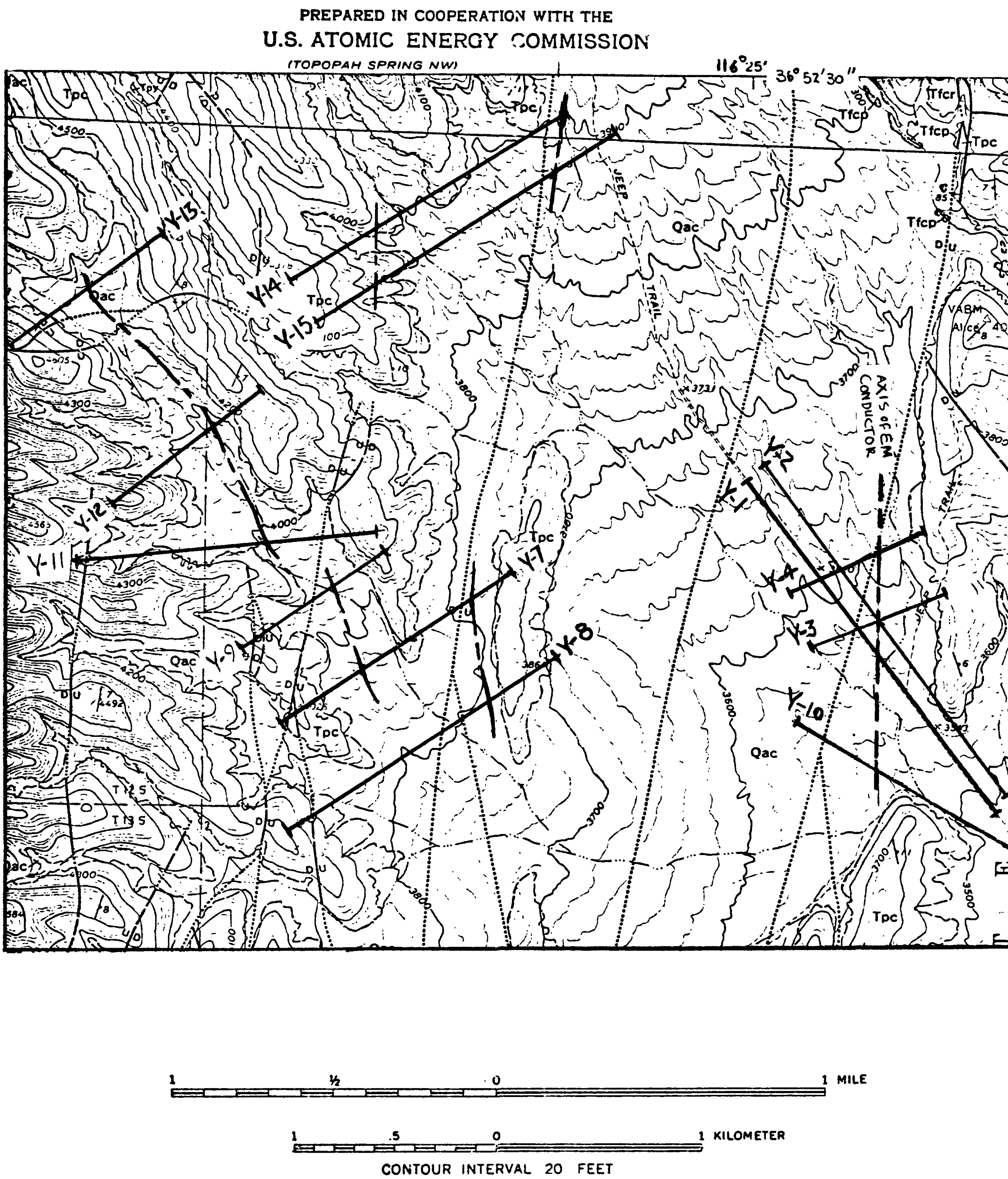

Figure 2. Part of the Topopah Spring SW geologic map by Lipman and McKay showing locations of geophysical traverse (heavy solid lines), the dashed lines show location of interpreted EM conductors, thin solid lines, mapped faults; dotted where concealed.

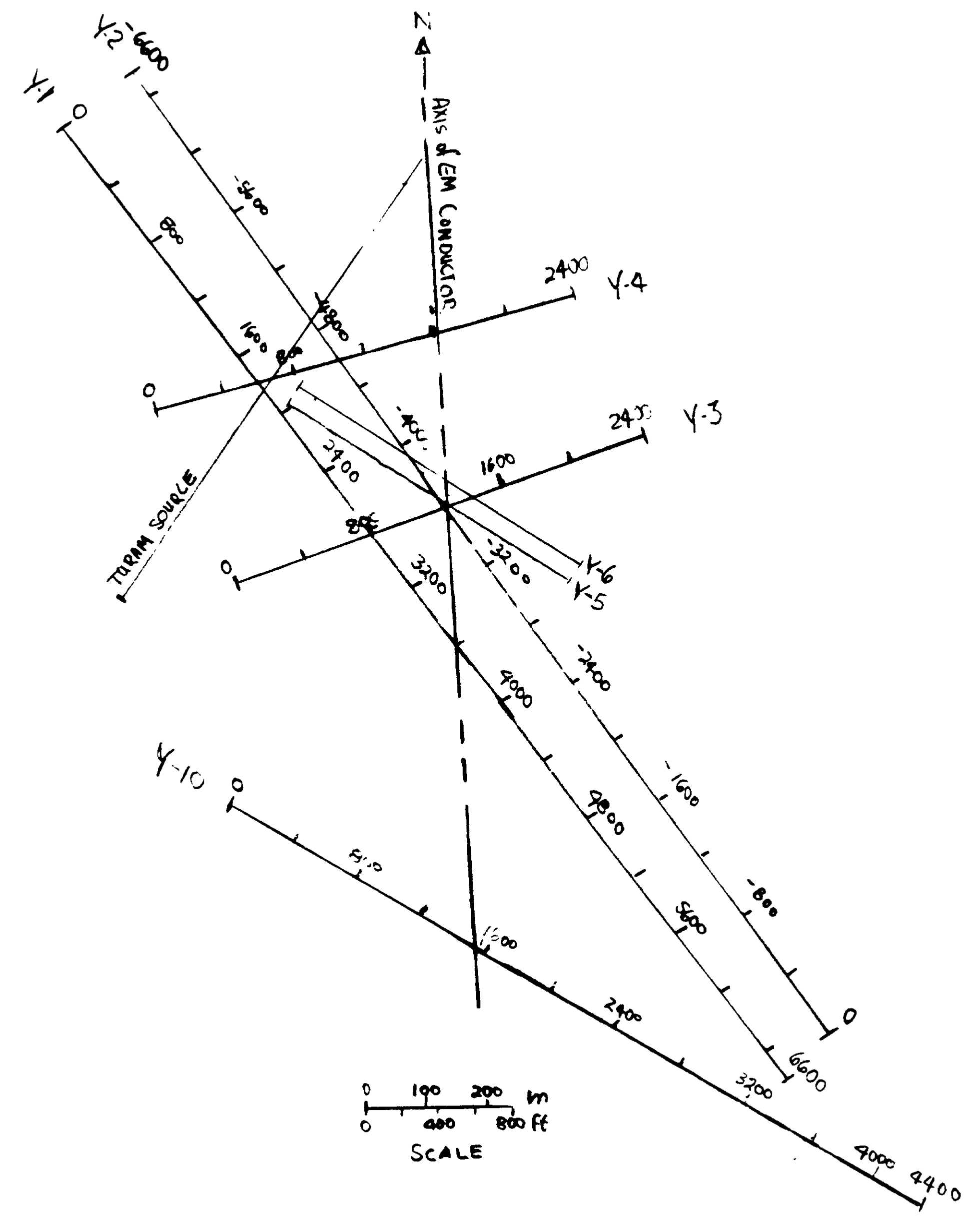

Figure 3. Map showing the relative location of traverses Y-1, Y-2, Y-3, Y-4, and Y-10.

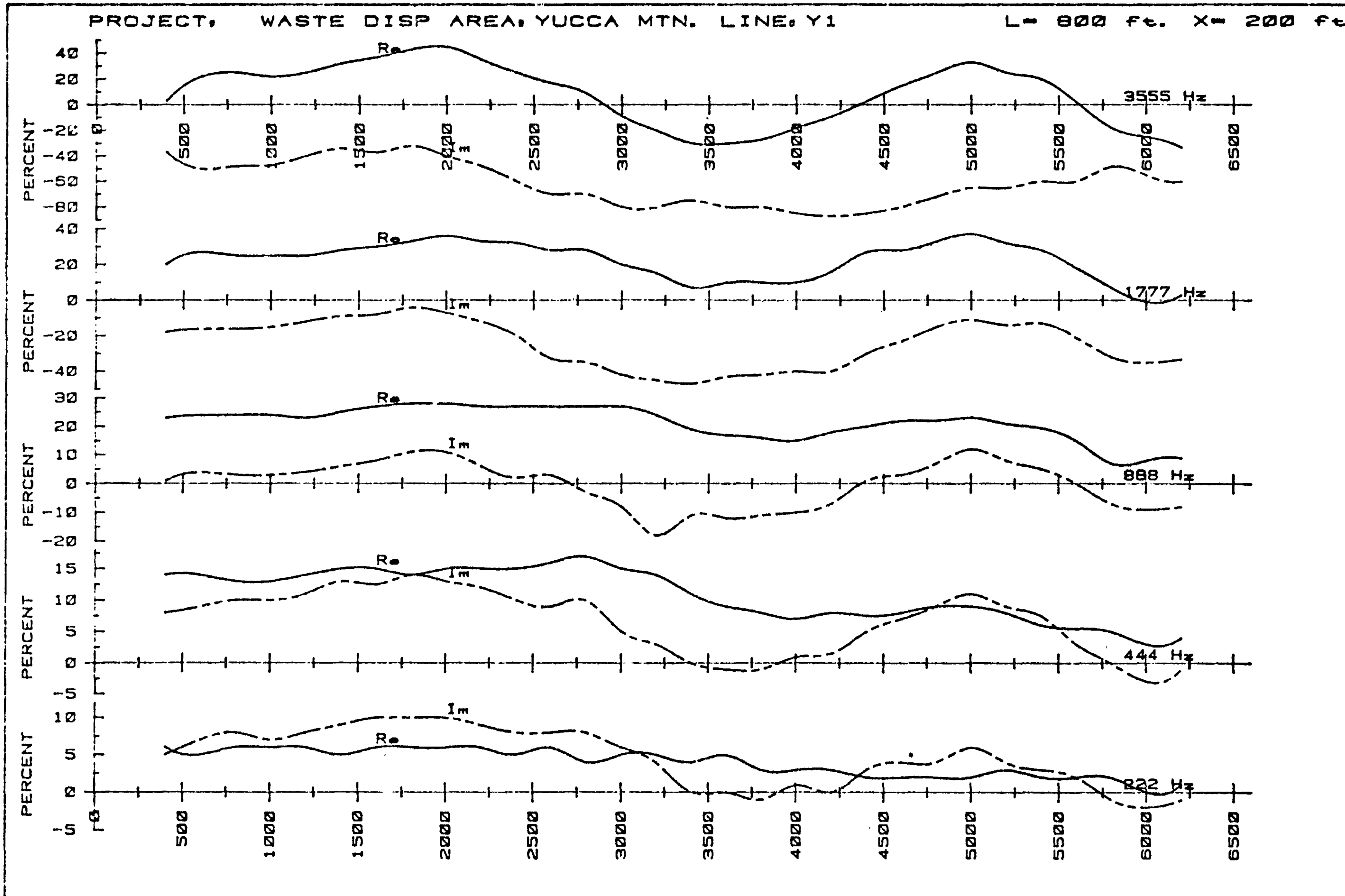

Figure 4: Slingram data profile along traverse Y-1.

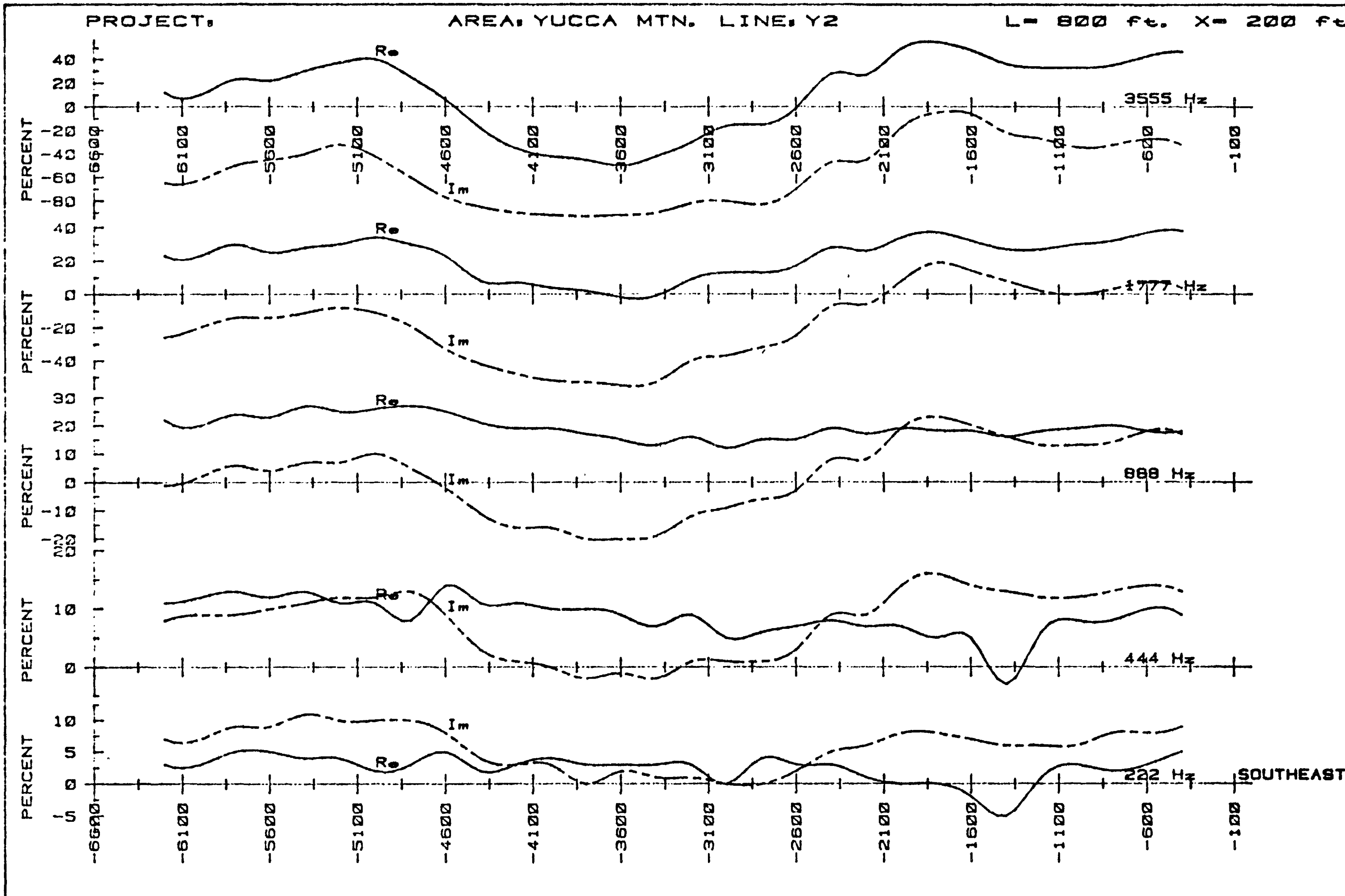

Figure 5: Slingram data profile along traverse Y-2.

responses similar to that of the previous two traverses except that the

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Fig. 6 and 7.--Near Here

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apparent width of the conductor is somewhat less than seen on slingram traverses Y-1 and Y-2. Width determinations from traverses Y-3 suggest that the conductor is about 120 m wide.

Conductance estimates taken from traverse Y-4 suggest that the conductance of the fault zone is about 0.35 mhos. Using the estimated width of 120 m, this yields a conductivity of 0.0029 mhos/m (343 ohm-m resistivity), which is somewhat higher than VLF apparent resistivity measurements. It must be cautioned, however, that these estimates are subject to large errors, because they are made using response curves derived from models suspended in air. The conductive earth responses are expected to yield depth to top of conductor estimates which are too great and conductance estimates which are too high (Keller and Frischknecht, 1966).

Another slingram traverse Y-10 (fig. 8) was made several hundred meters south of the test area to confirm the strike of the conductor crossed by traverses Y-1 to Y-4. The data show that the conductor was crossed at about station 1600 on the traverse.

Figure 8 Near Here

Turam EM measurements (not shown), using a 900-m grounded wire source, were made along traverse Y-5 and 6. The data showed little if any response to the EM conductor. The reason for this is not entirely clear but most probably relates to the low conductivity contrast between fault and the surrounding rock, or the source wire was not placed so as to be in optimum coupling to the

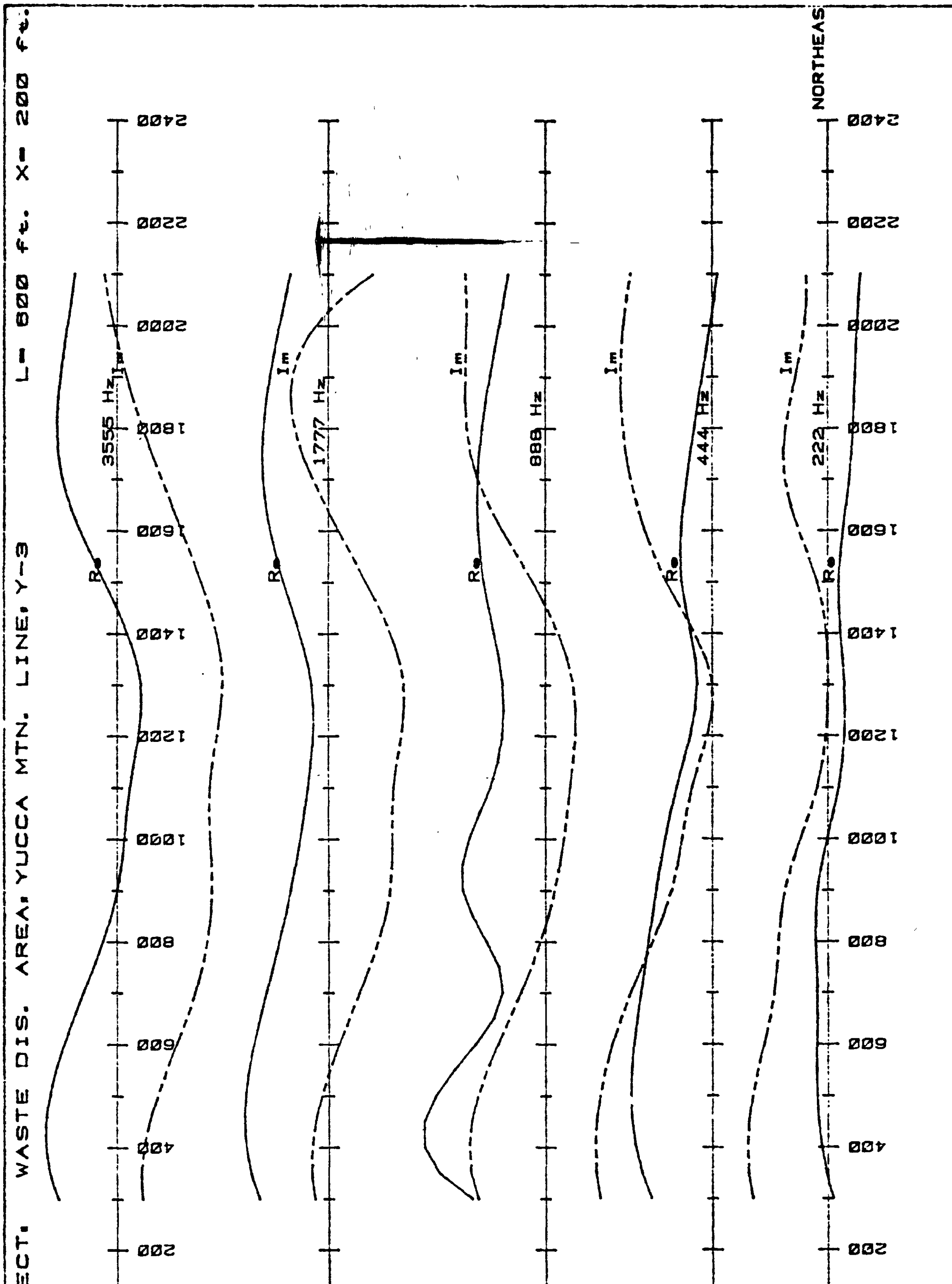

Figure 6: Slingram data profiles along traverse Y-3.

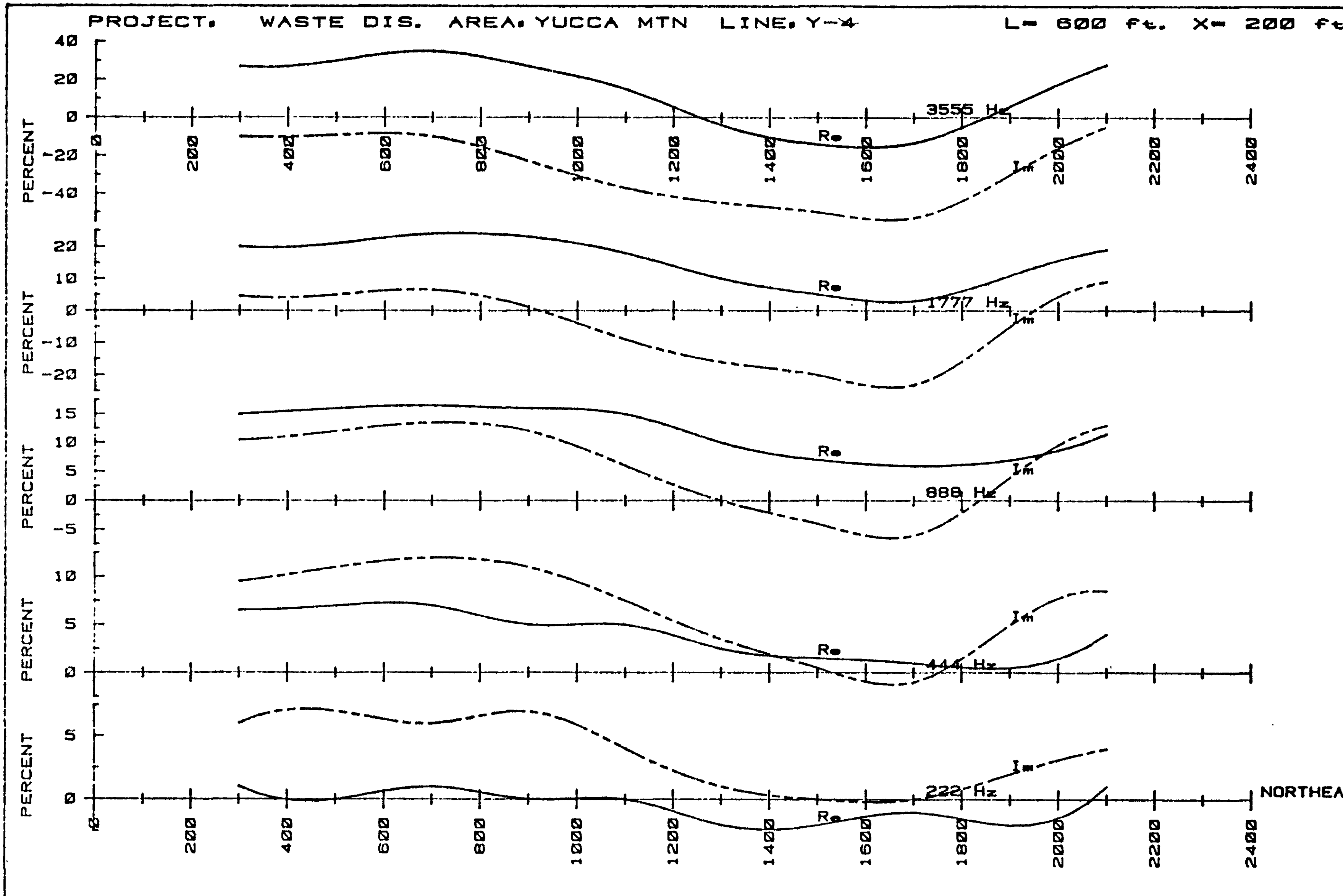

Figure 7: Slingram data profile along traverse Y-4.

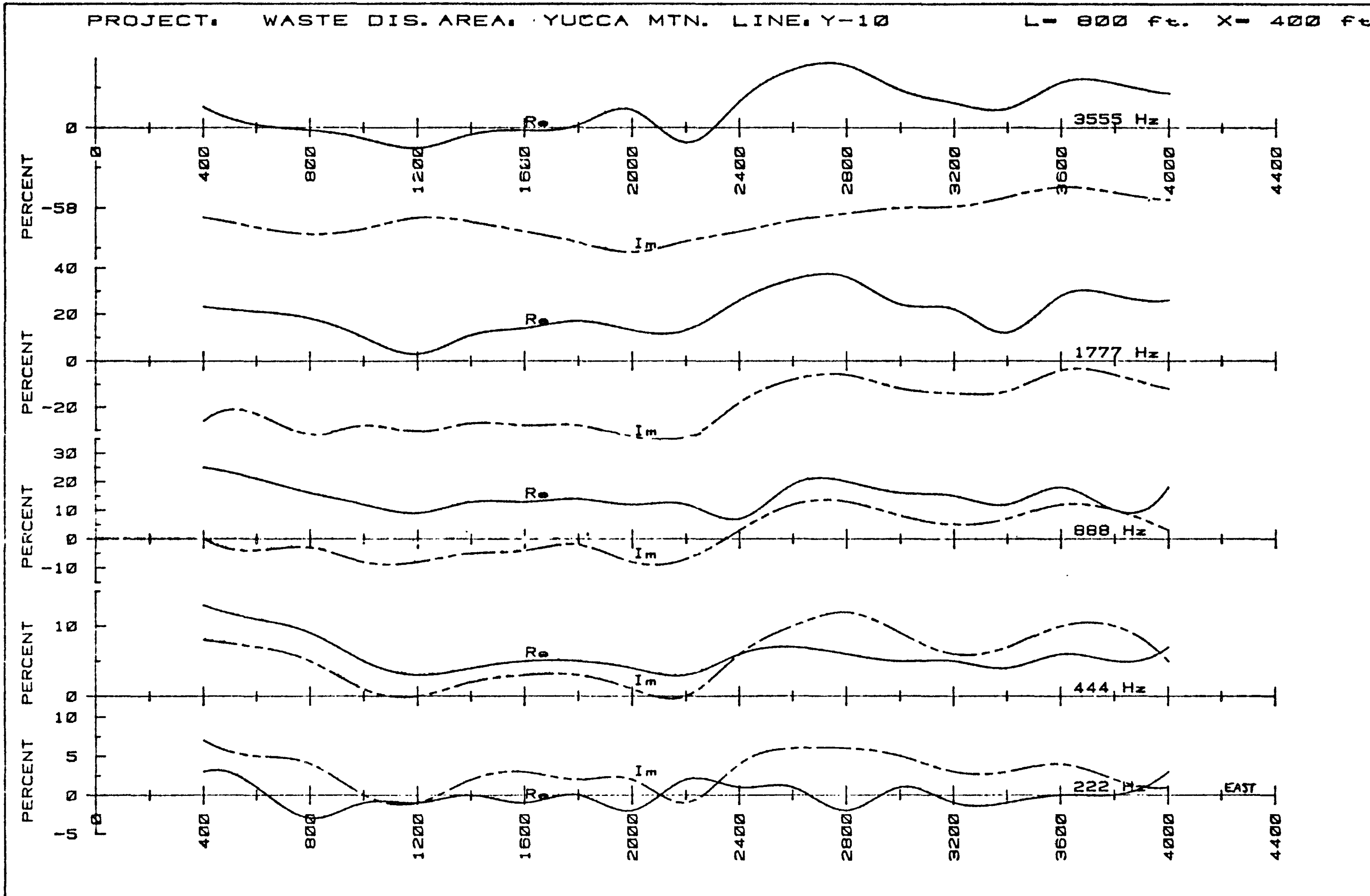

Figure 8. Slingram data profile along traverse Y-10.

conductive zone.

Results of the EM data in this test area indicated that the Slingram method could detect a fault zone inferred by geologic mapping in this environment, although the location and strike direction are somewhat different than indicated by the geologic mapping (fig. 2).

Turam EM and VLF measurements made in the test area were not conclusive, and hence only the Slingram method was used in the balance of the survey.

Six Slingram traverses (Y-7, 8, 9, 11, 12 and 13) were made across a major northwest-trending valley along the west edge of Yucca Mountain (fig. 2). Traverse Y-7 (fig. 9) crossed two conductors. The northeasternmost of the two, centered near station 3600, conforms reasonably well with a north-south fault inferred by geologic mapping (fig. 2). A second conductor at station 1600 lies at the mouth of the northwest-trending valley. Traverse Y-8, 800 m southeast of Y-7 (fig. 10), crossed a conductor centered at about

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Figure 9 & 10 Near Here

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station 4000, which is interpreted to be the southern continuation of the northeasternmost conductor crossed by traverse Y-7. A second possible conductor may exist at station 2600, although it is not as clearly seen as on traverse Y-7. The reason for this may be that the conductive zone is covered by a deeper layer of overburden than in the area of traverse Y-7.

Data from traverse Y-9 (Fig. 11) crossed a conductor at station 1800 suggesting that the second conductor of traverse Y-7 extends northwestward into the valley. The EM responses are similar in amplitude and apparent width, suggesting that they are caused by the same geologic feature. Traverses Y-11 through Y-13 (Fig. 12, 13, 14) indicate that the conductor

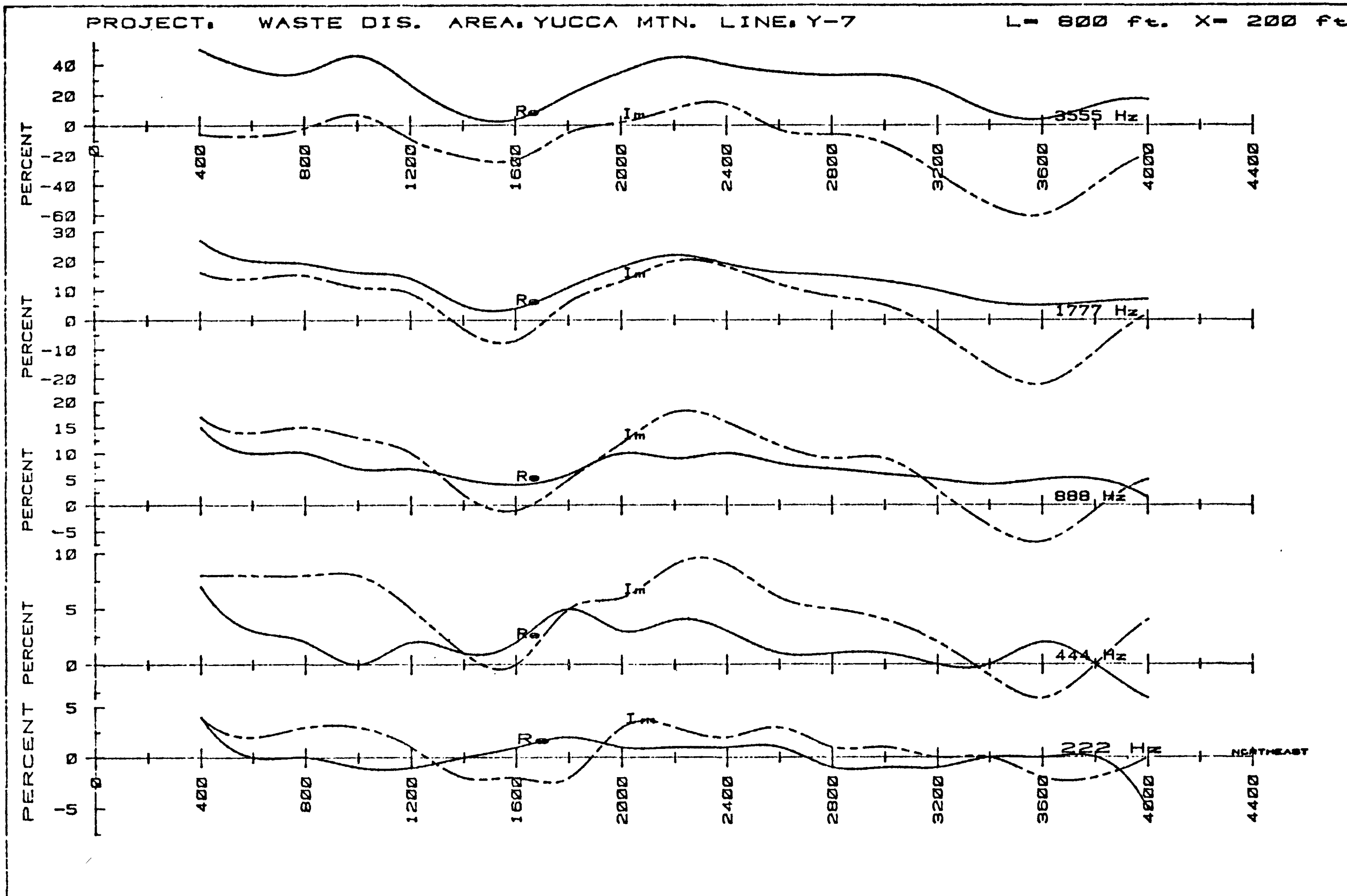

Figure 9: Slingram data profiles along traverse Y-7.

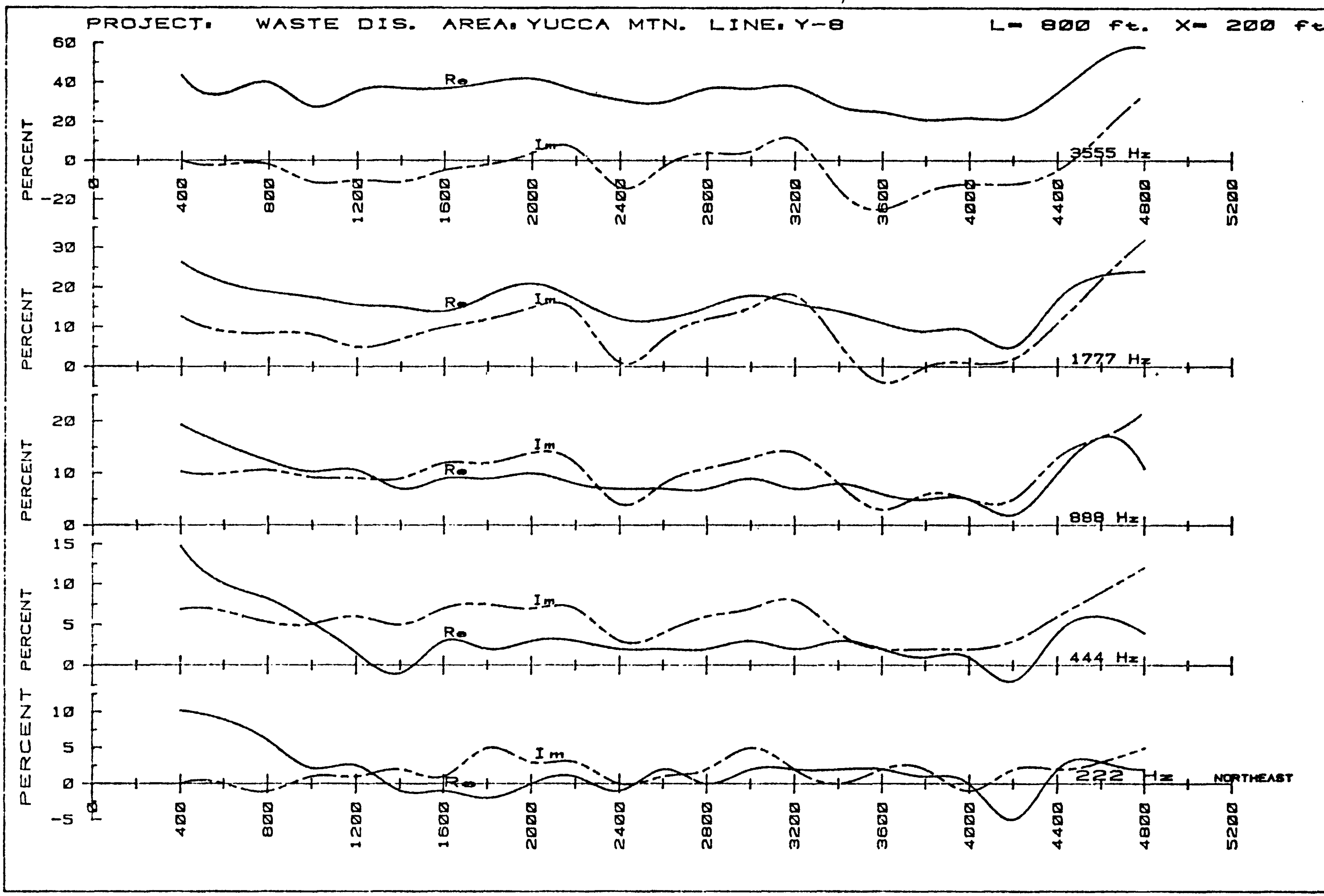

Figure 10: Slingram data profile along traverse Y-8.

continues up the valley; although the single conductor characteristics seen on traverses Y-7, Y-9, and Y-11, changes into a complex anomaly on traverses Y-12 and Y-13 suggesting the possibility of two closely spaced conductors.

Figure 11-14 Near Here

The slingram responses from traverses Y-7, 8, 9, 11, 12 and 13 could be reflecting a thickened layer of alluvial fill in the valley bottom, there is some suggestion of this in the highest frequency measurements (3555 and 1777 Hz). However, it seems clear that the lowest frequencies (222 and 444 Hz) which are not influenced greatly by near surface materials, have detected a conductive zone extending up the northwest trending valley. Whether or not the interpreted conductor is continuous up the valley is not certain, inasmuch as Y-9 and Y-11 may have detected north-south mapped faults. Rough estimates of the conductor parameters suggest that the conductance is between 0.3 and 0.7 mhos and that the width is less than 30 m:

Slingram traverses Y-14 and Y-15 (figs. 15, 16) were made cutting across several smaller northwest trending valleys north of the valley just discussed (fig. 2). Data from traverse Y-14 indicate the presence of two conductors. The northeasternmost conductor near station 4800 is probably due to the same fault intersected by traverses Y-7 and Y-8. This conductor is also seen on traverse Y-15, at about station 4200. A second conductor is seen on traverse

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Figure 15 & 16 Near Here

Y-14 at about station 1600, and on traverse Y-15 at station 1200. Furthermore, the traverses appear to have crossed the conductor at an oblique angle, making estimates of the apparent conductor width larger than the true

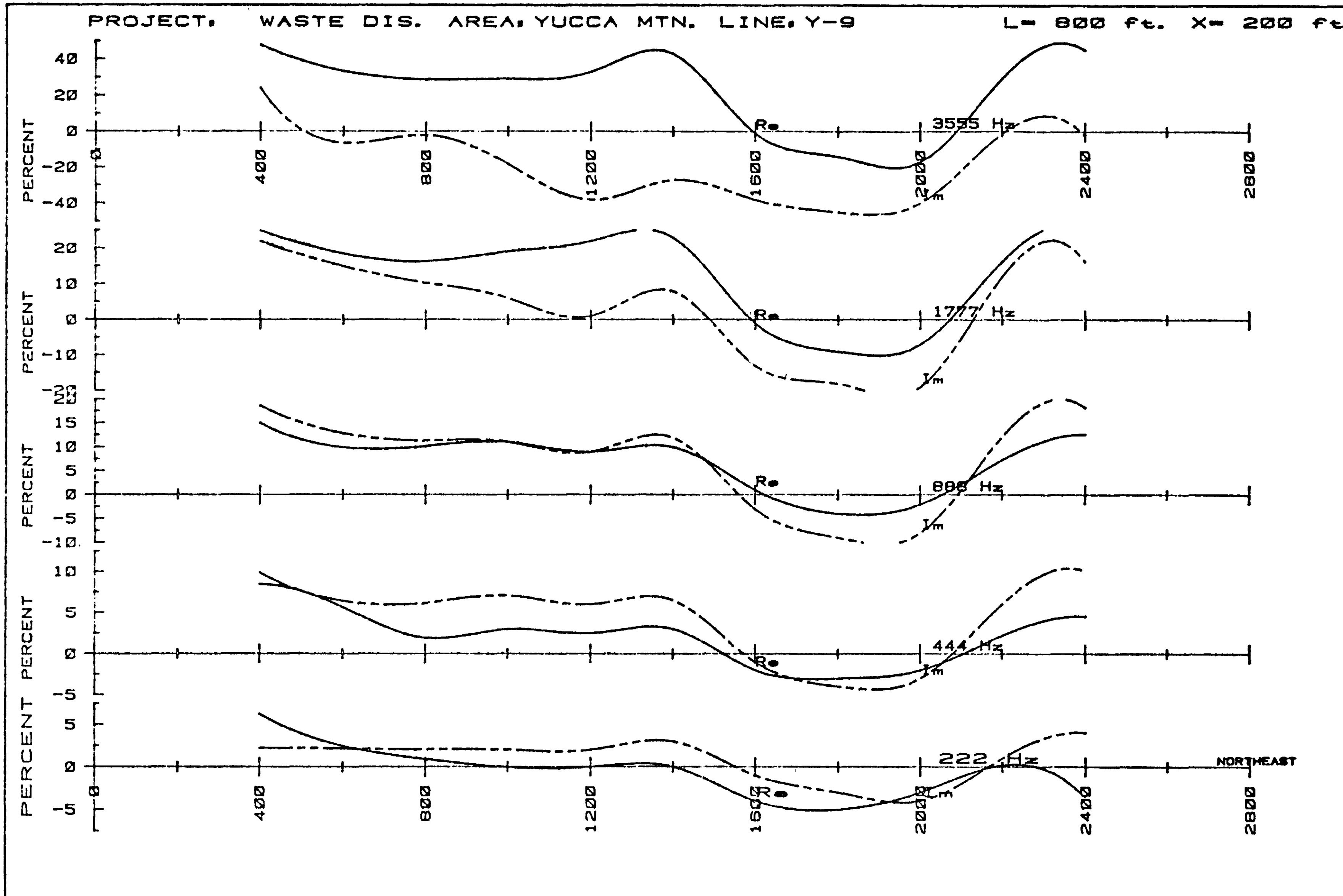

Figure 11: Slingram data profile along traverse Y-9.

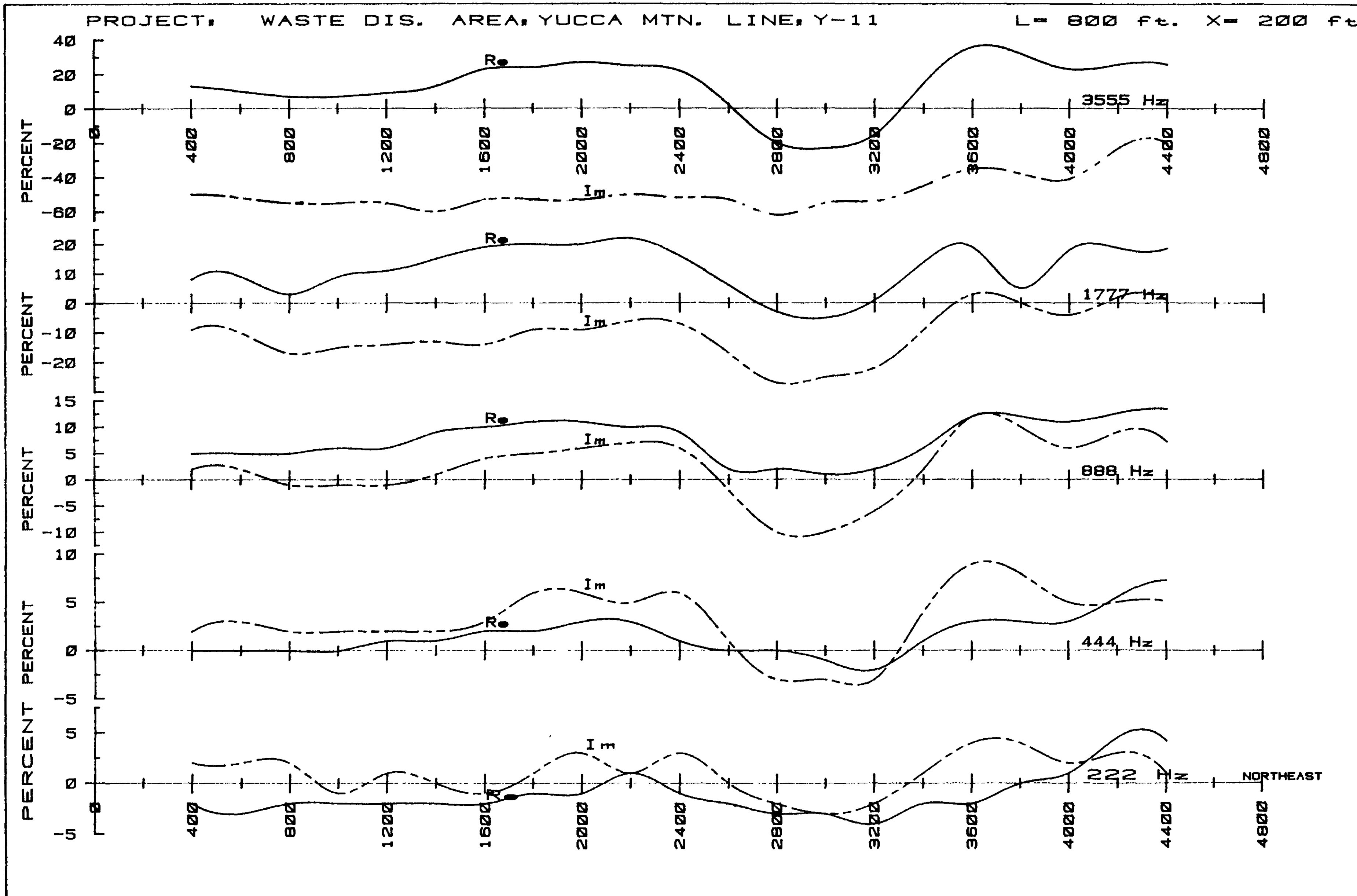

Figure 12: Slingram data profile along traverse Y-11.

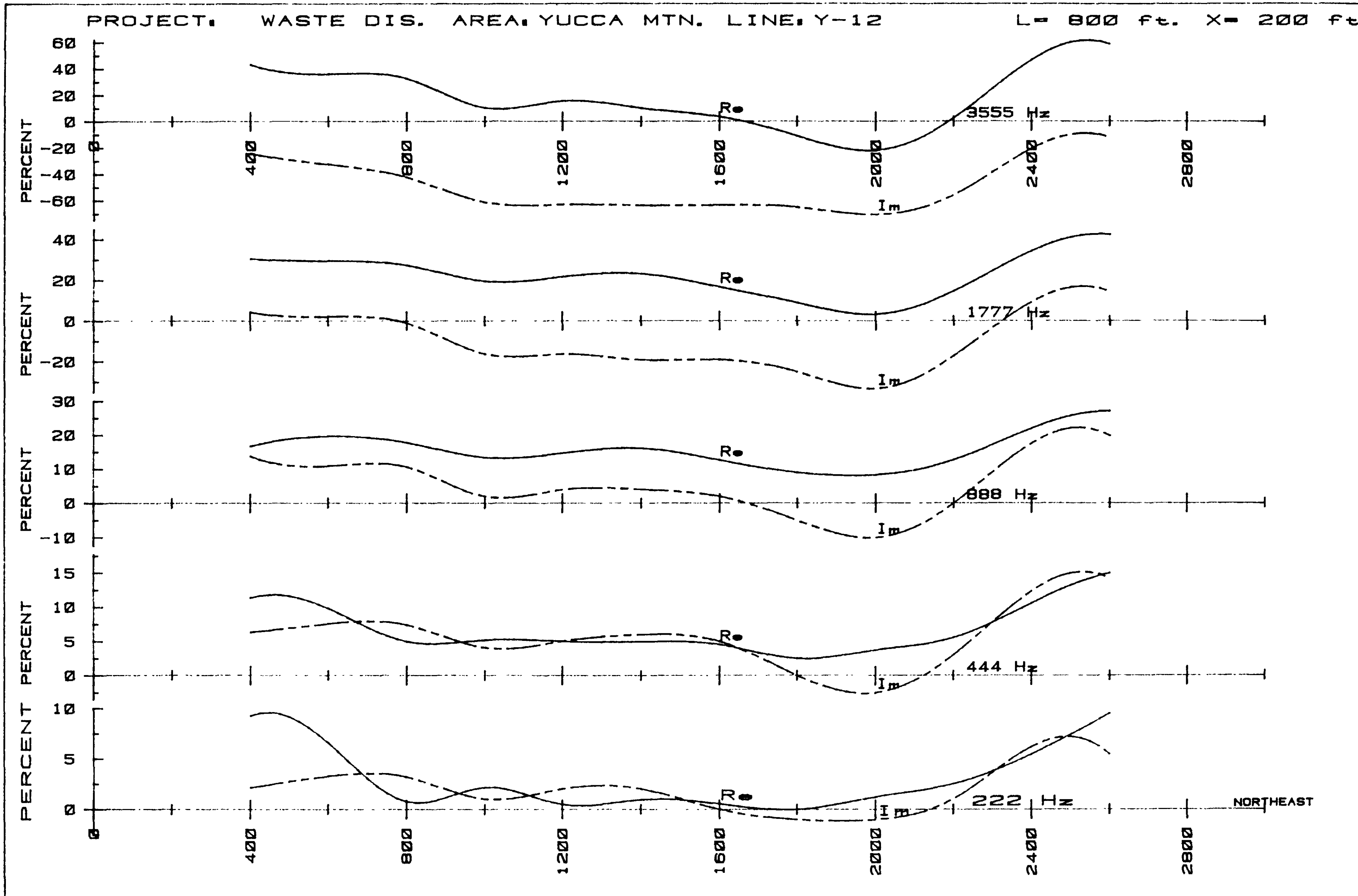

Figure 13: Slingram data profiles along traverse Y-12.

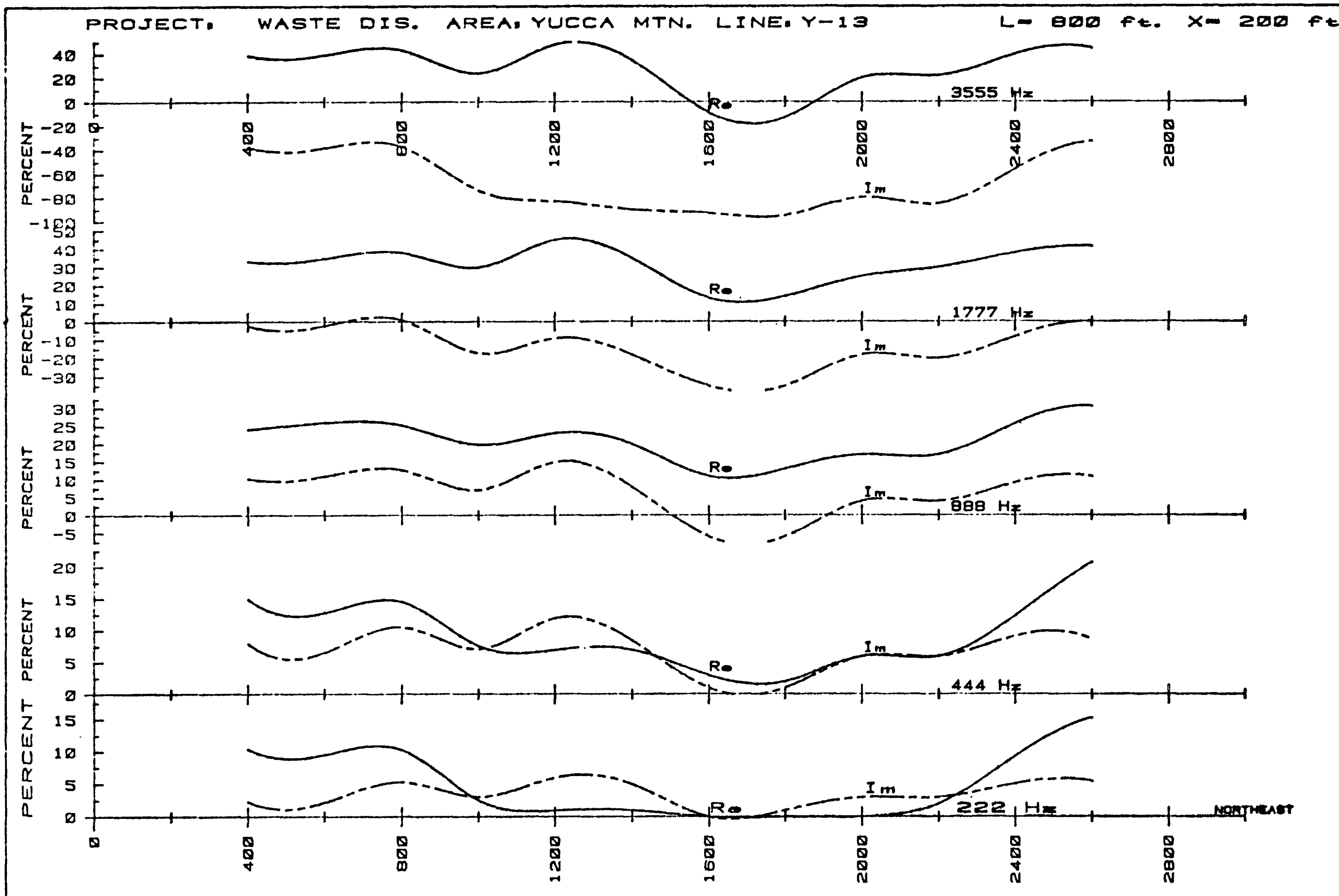

Figure 14: Slingram data profiles along traverse Y-13.

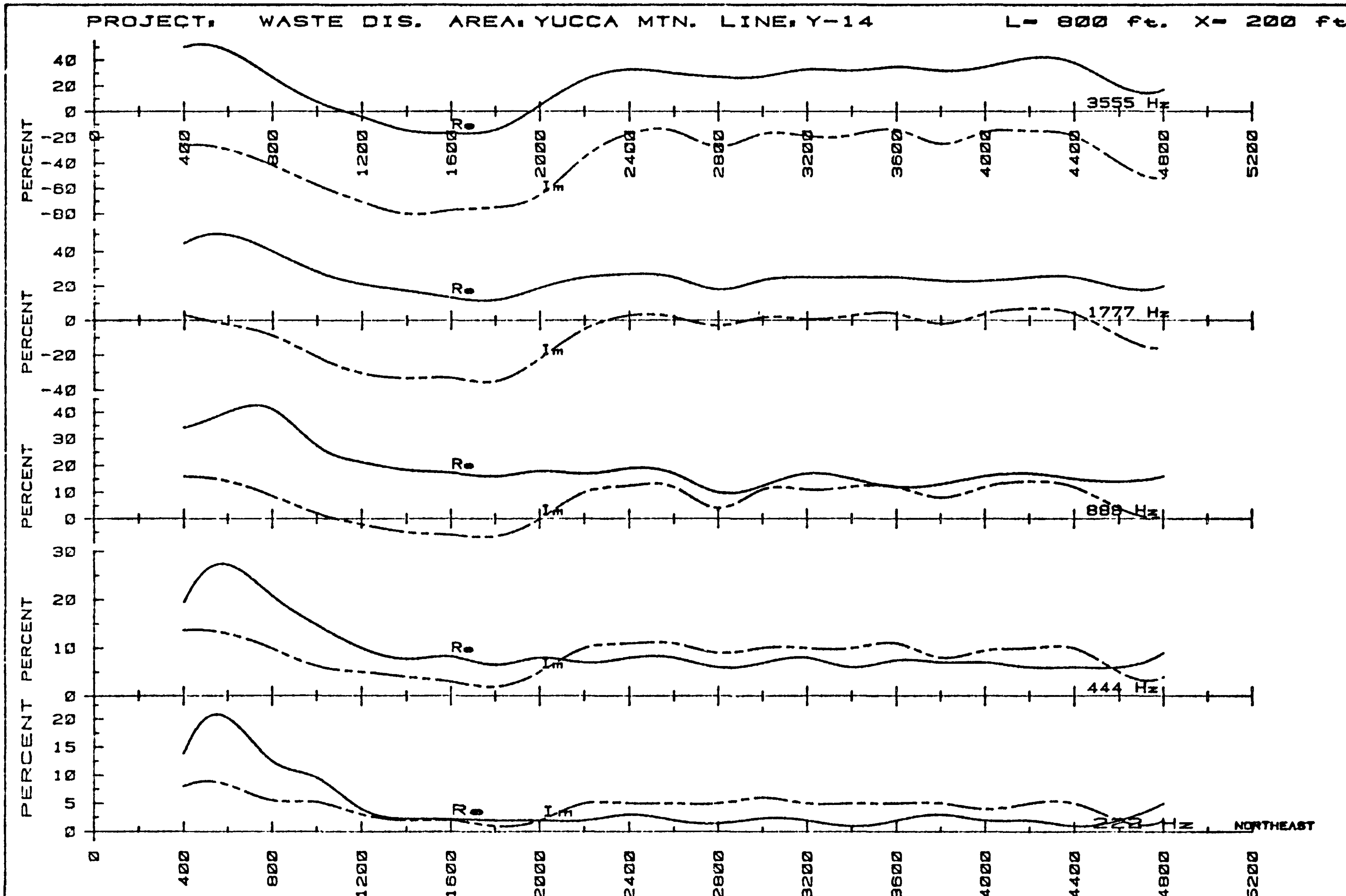

Figure 15: Slingram data profiles along traverse Y-14.

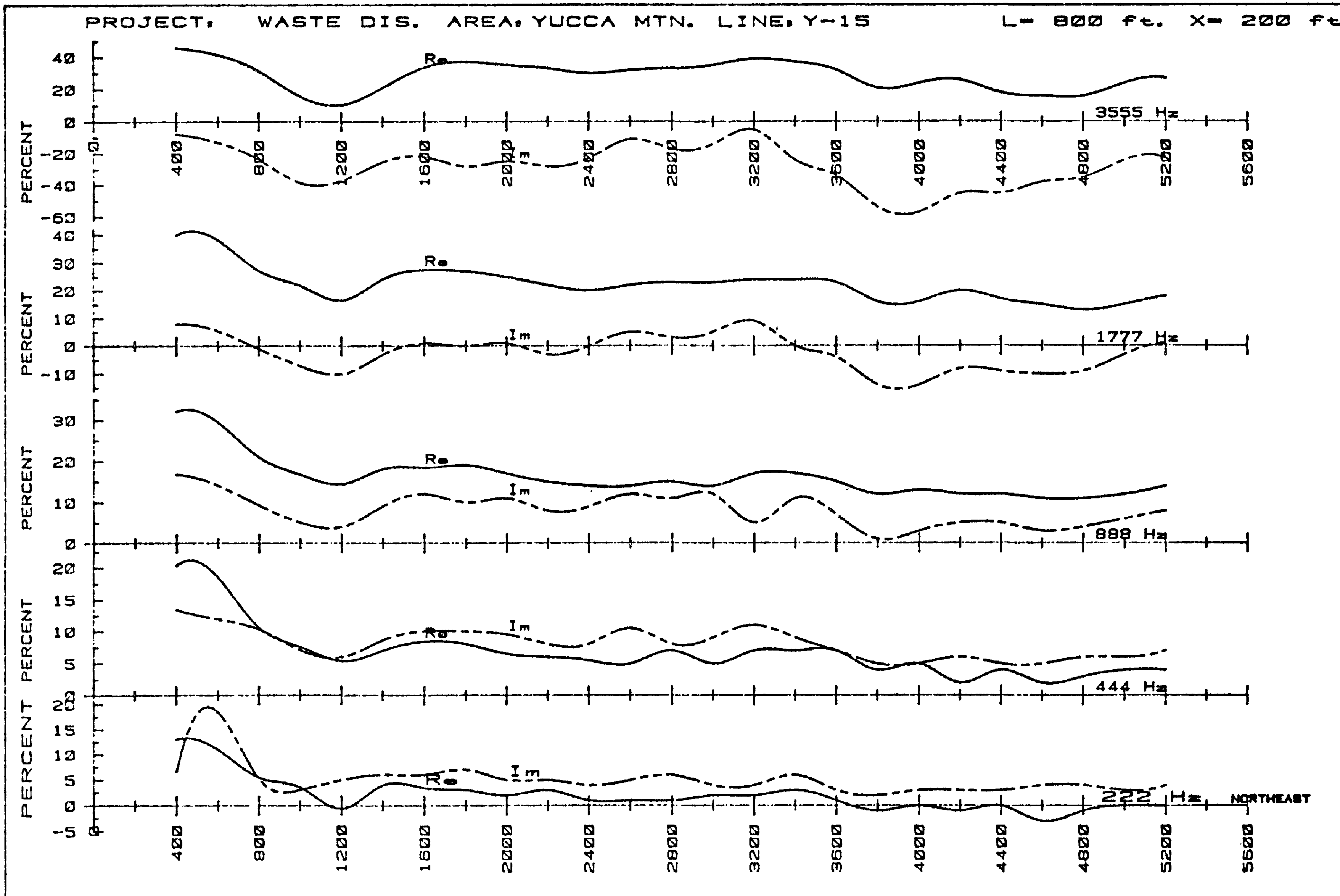

Figure 16: Slingram data profiles along traverse Y-15.

width. The strike of the conductor axis is about due north and its location is south of the axis of the valley cutting into Yucca Mountain. One might suppose that the southwestern conductor intersected by traverses Y-14 and Y-15 is the geophysical expression of the northern continuation of a mapped fault zone in this area (fig. 2). There is no evidence from these two traverses that this valley contains a centrally located conductive zone which might be associated with a fault zone.

Conclusions

EM conductors delineated in this survey are interpreted to be associated with the increase of conductivity in zone of rocks disturbed by fracturing and faulting. These supposed faults need not have a high degree of fracturing or significant movement either up or down or laterally to have increased porosity allowing increased ground-water circulation along with accompanying salts. Further, the amplitude of the estimated conductivity values suggest that there is a low conductivity contrast between the fractured zones and the surrounding rocks, leading one to think the increase in porosity is low.

The data suggest that some of the northwest-trending valleys contain EM conductors which may be related to fracturing and faulting. Other independent means of geologic and geophysical evidence are necessary to ascertain whether these EM conductors are indeed fault zones, and if they would have a significant bearing on the viability of Yucca Mountain as a repository site.

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APPENDIX A - Profile data listing

FILE> YUCCA1 PROJECT> WASTE DISPOSAL LINE> Y1 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
*Frq	222		444		688		1777		3555		mv.		nT
	*re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
400.0	6	5	14	8	23	1	20	20	3	-37			
600.0	5	7	14	9	24	4	27	27	22	-50			
800.0	6	8	13	10	24	3	25	25	25	-48			
1000.0	6	7	13	10	24	3	25	25	22	-47			
1200.0	6	8	14	11	23	4	25	25	25	-40			
1400.0	5	9	15	13	25	6	28	28	32	-34			
1600.0	6	10	15	12.	27	8	30	30	37	-37			
1800.0	6	10	14	14	28	11	33	33	43	-32			
2000.0	6	10	15	13	28	11	36	36	45	-40			
2200.0	6	9	15	12	27	6	33	33	35	-48			
2400.0	5	8	15	10	27	2	32	32	25	-60			
2600.0	6	8	16	9	27	3	28	28	17	-70			
2800.0	4	8	17	10	27	-3	28	28	9	-70			
3000.0	5	6	15	5	27	-8	20	20	-9	-80			
3200.0	5	4	14	3	24	-18	15	15	-20	-80			
3400.0	4	0	11	0	19	-11	7	7	-30	-75			
3600.0	5	0	9	-1	17	-12	10	10	-30	-80			
3800.0	3	-1	8	-1	16	-11	10	10	-27	-80			
4000.0	3	1	7	1	15	-10	10	10	-18	-85			
4200.0	3	0	8	1.5	18	-7	16	16	-9	-87			
4400.0	2	3	7.5	5	20	1	27	27	3	-85			
4600.0	2	4	8	7	22	3	28	28	15	-80			
4800.0	2	4	9	9	22	7	33	33	25	-72			
5000.0	2	6	9	11	23	12	37	37	33	-65			
5200.0	3	4	8	9	21	8	32	32	25	-65			
5400.0	2	3	6	7.5	19.	5	28	28	20	-60			
5600.0	2	2	5.5	3	15	0	18	18	2	-60			
5800.0	2	-1	5	0	7	-7	7	7	-18	-48			
6000.0	0	-2	3	-3	8	-9	-1	-1	-25	-55			
6200.0	1	-1	4	-1	9	-8	3	3	-33	-60			

*Frq - frequency in Hz.

re - real component of EM response.

im. - imaginary component of EM response.

FILE> YUCCA2 PROJECT> LINE> Y2 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq	222		444		888		1777		3555	mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
-6200.0	3	7	11	8	22	-1	23	23	12	-65			
-6000.0	3	7	12	9	20	2	23	23	10	-62			
-5800.0	5	9	13	9	24	6	30	30	23	-50			
-5600.0	5	9	12	10	23	4	25	25	22	-45			
-5400.0	4	11	13	11	27	7	28	28	30	-40			
-5200.0	4	10	11	12	25	7	30	30	37	-32			
-5000.0	2	10	11	12	26	10	34	34	40	-42			
-4800.0	3	10	8	13	27	5	30	30	25	-60			
-4600.0	5	8	14	9	25	-2	23	23	6	-77			
-4400.0	2	4	11	3	21	-11	8	8	-18	-85			
-4200.0	3	3	11	1	19	-16	7	7	-35	-90			
-4000.0	4	3	10	0	19	-16	4	4	-42	-92			
-3800.0	3	0	10	-2	17	-20	2	2	-45	-93			
-3600.0	3	2	9	-1	15	-20	-2	-2	-50	-92			
-3400.0	3	1	7	-2	13	-19	-1	-1	-42	-90			
-3200.0	3	1	9	1	16	-12	9	9	-30	-82			
-3000.0	0	0	5	1	12	-9	13	13	-16	-80			
-2800.0	4	0	6	1	15	-6	13	13	-15	-83			
-2600.0	3	2	7	3	15	-3	17	17	-1	-70			
-2400.0	3	5	8	9	19	8	28	28	28	-47			
-2200.0	1	6	7	9	17	8	26	26	27	-45			
-2000.0	0	8	7	14	19	19	34	34	50	-17			
-1800.0	0	8	5	16	18	23	37	37	55	-5			
-1600.0	-2	7	5	14	18	20	32	32	48	-6			
-1400.0	-5	6	-3	13	16	16	27	27	36	-22			
-1200.0	1	6	6	12	18	13	27	27	33	-27			
-1000.0	3	6	8	12	19	13	30	30	33	-34			
-800.0	2	8	8	13	20	14	32	32	35	-32			
-600.0	3	8	10	14	18	18	37	37	43	-27			
-400.0	5	9	9	13	18	17	38	38	47	-32			

FILE> YUC-3 PROJECT> WASTE DIS. LINE> Y-3 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq 222		444		888		1777		3555		mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
300.0	-.5	7	6	11	12	11	20	20	28	-12			
500.0	1	7	8	11	18	11	24	24	32	-19			
700.0	1	5	7	8	7	4	18	18	16	-37			
900.0	1	4	5.5	4	13.	-1.	11	11	0	-45			
1100.0	-1	1	3.5	2	9	-4	6	6	-6	-44			
1300.0	-1.	0	1.5	0	7	-4.	5	5	-11	-50			
1500.0	-1	1	3	4.5	10	2	13	13	6	-40			
1700.0	-2	4	2.5	8	11	11	19	19	26	-21			
1900.0	-2.	3	1	9	9	13	17	17	27	-4.			
2100.0	-3	2	-.5	8	6	13	11	11	20	6			

FILE> YUC-4 PROJECT> WASTE DIS. LINE> Y-4 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq	222		444		888		1777		3555	mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
300.0	1	6	6.5	9.5	15	10.	20	20	27	-10			
500.0	0	7	7	11	16	12	21	21	30	-9			
700.0	1	6	7	12	16.	13.	24	24	35	-10			
900.0	0	7	5	11	16	12	23	23	27	-23			
1100.0	0	4	5	7.5	15	6	18	18	15	-37			
1300.0	-2	1	2.5	3.5	10	0	10	10	-4	-45			
1500.0	-2	0	1.5	.5	7	-4	5	5	-14	-50			
1700.0	-1	0	1	-1	6	-6	3	3	-13	-53			
1900.0	-2	2	.5	5	7	4	11	11	6	-30			
2100.0	1	4	4	8.5	11.	13	19	19	28	-5			

FILE> YUC-7 PROJECT> WASTE DIS. LINE> Y-7 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq	222		444		888		1777		3555	mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
400.0	4	4	7	8	15	17	27	27	50	-6			
600.0	0	2	3	8	10	14	20	20	37	-7			
800.0	0	3	2	8	10	15	19	19	35	-2			
1000.0	-1	3	0	8	7	13	16	16	46	7			
1200.0	-1	1	2	5	7	10	14	14	27	-9			
1400.0	0	-2	1	1	5	2	5	5	7	-21			
1600.0	1	-2	2	0	4	-1	4	4	4	-23			
1800.0	2	2	5	5	6	5	11	11	20	-5			
2000.0	1	3	3	6	10	12	18	18	35	2			
2200.0	1	3	4	9	9	18	22	22	45	11			
2400.0	1	2	3	9	10	16	19	19	40	14			
2600.0	1	3	1	6	8	11.	16	16	35	-3			
2800.0	-1	1	1	5	7	9	15	15	33	-6			
3000.0	-1	1	1	4	6	9	13	13	33	-12			
3200.0	-1	0	0	2	5	3	10	10	25	-32			
3400.0	0	0	0	-1	4	-4	6	6	9	-53			
3600.0	0	-2	2	-3	5	-7	5	5	4	-60			
3800.0	0	-2	0	0	5	-1	6	6	13	-40			
4000.0	-5	0	-3	4	1.5	5	7	7	17	-19			

FILE> YUC-8 PROJECT> WASTE DIS. LINE> Y-8 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq 222		444		888		1777		3555		mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
400.0	10.	0	14.	6.8	19.	10.	26.	26.	43.	0			
600.0	8.9	0	10.	6.6	15.	10.	21.	21.	34.	-2.			
800.0	6.0	-1.	8.1	5.3	12.	10.	18.	18.	39.	-2.			
1000.0	2.1	1.0	5.2	5.1	10.	9.1	17.	17.	27.	-11			
1200.0	2.5	1.0	1.5	6.0	10.	9.0	15.	15.	35.	-10			
1400.0	-.9	2.0	-.9	5.0	7.0	9.0	15.	15.	37.	-11			
1600.0	-1	1	3	7	9	12	14	14	37	-5			
1800.0	-2	5	2	7.5	9	12	18	18	40	-2			
2000.0	.01	3.0	3.0	7.0	10.	14.	21.	21.	42.	4.0			
2200.0	1	3	3	7	8	12	17	17	36	6			
2400.0	-1	0	2	3	7	4	12	12	31	-14			
2600.0	2	1	2	4	7	8	12	12	30	-3			
2800.0	0	2	2	6	7	11	15	15	37	4			
3000.0	2	5	3	7	9	13	18	18	37	5			
3200.0	2	2	2	8	7	14	16	16	38	11			
3400.0	2	0	3	4	8	8	14	14	28	-15			
3600.0	2	2	2	2	6	3	11	11	25	-25			
3800.0	1	2	1	2	5	6	9	9	21	-16			
4000.0	0	-1	1	2	5	5	9	9	22	-12			
4200.0	-5	2	-2	3	2	5	5	5	22	-12			
4400.0	2	2	4	6	10	13	17	17	35	-5			
4600.0	3	3	6	9	17	17	23	23	52	14			
4800.0	2	5	4	12	11	22	24	24	58	34			

FILE> YUC-9 PROJECT> WASTE DIS. LINE> Y-9 UNITS> FEET

STATION	SLINGRAM Frq 222 re.	im.	444 re.	im.	888 re.	im.	1777 re.	im.	3555 re.	im.	SP mv.	TOPO	MAG nT
400.0	6.2	2.1	8.4	9.8	14.	18.	24.	24.	47.	24.			
600.0	2.4	2.1	5.6	6.4	9.8	12.	18.	18.	33.	-6.			
800.0	.89	2.0	1.9	6.1	10.	11.	16.	16.	28.	-2.			
1000.0	-.0	2.0	2.9	7.0	11.	11.	19.	19.	29.	-18			
1200.0	0	2	2.5	6	9	9	22	22	33	-38			
1400.0	0	3	3	6.5	10	12	23	23	43	-27			
1600.0	-4	-1	-2	-1	1	-3	-1	-1	-1	-38			
1800.0	-5	-3	-3	-4	-4	-9	-9	-9	-14	-45			
2000.0	-3	-4	-2	-3	-2	-8	-7	-7	-17	-40			
2200.0	.20	1.0	2.2	6.0	7.2	12.	16.	16.	29.	-1.			
2400.0	-3.	4.0	4.5	10.	12.	18.	24.	24.	45.	-2.			

FILE> YUC-10 PROJECT> WASTE DIS. LINE> Y-10 UNITS> FEET

STATION	SLINGRAM Frq 222 re.	222 im.	444 re.	444 im.	888 re.	888 im.	1777 re.	1777 im.	3555 re.	3555 im.	SP mv.	TOPO	MAG nT
400.0	3	7	13	8	25	0	23	23	15	-65			
600.0	1	5	11	7	21	-4	21	21	2	-72			
800.0	-3	4	9	5	16	-3	18	18	-2	-77			
1000.0	-1	0	5	1	12	-8	10	10	-8	-73			
1200.0	-1	-1	3	0	9	-8	3	3	-15	-65			
1400.0	0	2	4	2	13	-5	11	11	-5	-68			
1600.0	-1	3	5	3	13	-4	14	14	-2	-75			
1800.0	0	2	5	3	14	-2	17	17	2	-83			
2000.0	-2	2	4	1	12	-8	13	13	13	-90			
2200.0	2	-1	3	0	12	-7	13	13	-11	-82			
2400.0	1	4	6	6	7	3	26	26	19	-75			
2600.0	1	6	7	10	19	12	35	35	42	-67			
2800.0	-2	6	6	12	20	13	36	36	45	-62			
3000.0	1	5	5	9	16	8	24	24	27	-58			
3200.0	-1	3	5	6	15	5	22	22	18	-57			
3400.0	-1	3	4	7	12	7	12	12	14	-50			
3600.0	0	4	6	10	18	12	28	28	33	-43			
3800.0	0	2	5	10	10	10	28	28	32	-47			
4000.0	3	1	7	5	18	3	26	26	25	-52			

FILE> YU-10A PROJECT> WASTE DIS. LINE> Y-10 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq	222		444		888		1777		3555	mv.		nT
		re.	im.	re.	im.	re.	im.	re.	im.	re.	im.		
-8400.0		0	0	3	5	8	7	13	13	25	-8		
-8000.0		-1	1	1	6	8	8	13	13	25	-8		
-7600.0		0	2	3	6	9	11	16	16	25	-7		
-7200.0		0	2	2	5	8	5	12	12	18	-17		
-6800.0		0	2	2	7	9	10	15	15	23	-18		
-6400.0		0	3	4	6	10	8	17	17	25	-16		
-6000.0		1	4	6	8	15	9	22	22	30	-27		
-5600.0		2	3	6	5	14	3	16	16	10	-37		
-5200.0		1	-1	3	-2	8	-10	-3	-3	-25	-48		
-4800.0		3	6	13	8	22	0	23	23	1	-45		
-4400.0		6	8	15	10	23	-1	22	22	15	-38		
-4000.0		5	10	15	13	25	6	27	27	30	-25		
-3600.0		2	6	9	10	20	14	27	27	42	-10		
-3200.0		3	4	8	7	16	7	22	22	28	-20		
-2800.0		2	4	8	4	18	4	22	22	30	-43		
-2400.0		6	2	11	2	19	-4	22	22	8	-68		
-2000.0		17	7	23	15	38	20	60	60	90	-30		
-1600.0		3	7	10	15	25	20	42	42	55	-45		
-1200.0		2	5	7	7	18	7	30	30	28	-43		
-800.0		2	5	7	12	20	13	35	35	33	-38		
-400.0		2	4	8	6	19	5	25	25	23	-50		

FILE> YUC-11 PROJECT> WASTE DIS. LINE> Y-11 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
Frq	222		444		888		1777		3555		mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
400.0	-2	2	0	2	5	2	8	8	13	-50			
600.0	-3	2	0	3	5	2	9	9	10	-52			
800.0	-2	2	0	2	5	-1	3	3	7	-55			
1000.0	-2	-1	0	2	6	-1	9	9	7	-55			
1200.0	-2	1	1	2	6	-1	11	11	9	-55			
1400.0	-2	0	1	2	9	1	15	15	13	-60			
1600.0	-2	-1	2	3	10	4	19	19	23	-53			
1800.0	-1	1	2	6	11	5	20	20	24	-53			
2000.0	-1	3	3	6	11	6	20	20	27	-53			
2200.0	1	1	3	5	10	7	22	22	25	-50			
2400.0	1	3	1	6	9	6	16	16	22	-52			
2600.0	-2	0	0	1	2	-2	6	6	2	-53			
2800.0	-3	-2	0	-3	2	-10	-3	-3	-20	-62			
3000.0	-3	-3	-1	-3	1	-10	-5	-5	-23	-55			
3200.0	-4	-2	-2	-3	2	-6	1	1	-15	-54			
3400.0	-2	1	1	4	6	2	14	14	15	-45			
3600.0	-2	4	3	9	12	12	19	19	36	-35			
3800.0	0	4	3	8	12	10	5	5	32	-38			
4000.0	1	2	3	5	11	6	18	18	23	-41			
4200.0	4.5	3.0	5.5	5.0	12.	9.0	18.	18.	25.	-23			
4400.0	4.2	1.0	7.2	5.1	13.	7.1	18.	18.	25.	-20			

FILE> YUC-12 PROJECT> WASTE DIS. LINE> Y-12 UNITS> FEET

STATION	SLINGRAM										SP	TOPO	MAG
	Frq	222		444		888		1777		3555	mv.		nT
	re.	im.	re.	im.	re.	im.	re.	im.	re.	im.			
400.0	9.2	2.1	11.	6.3	16.	13.	30.	30.	43.	-24			
600.0	6.5	3.2	9.8	7.6	19.	10.	29.	29.	35.	-32			
800.0	.75	3.1	4.9	7.4	17.	10.	27.	27.	32.	-42			
1000.0	2.1	1.0	5.2	4.0	13.	2.0	19.	19.	10.	-61			
1200.0	.48	2.0	5.0	5.0	14.	4.0	21.	21.	15.	-62			
1400.0	.96	2.0	4.9	6.0	16.	4.0	23.	23.	10.	-63			
1600.0	.54	0	4.5	5.0	12.	2.0	16.	16.	3.5	-63			
1800.0	0	-1	2.5	0	9	-5	9	9	-11	-65			
2000.0	1.2	-1.	3.7	-2.	8.3	-10	3.2	3.2	-22	-70			
2200.0	2.5	1.0	5.5	3.0	12.	0	14.	14.	2.5	-55			
2400.0	5.4	6.2	10.	12.	22.	17.	34.	34.	46.	-20			
2600.0	9.5	5.4	14.	14.	27.	19.	42.	42.	58.	-12			

FILE> YUC-13 PROJECT> WASTE DIS. LINE> Y-13 UNITS> FEET

STATION	SLINGRAM Frq 222 re.	222 im.	444 re.	444 im.	888 re.	888 im.	1777 re.	1777 im.	3555 re.	3555 im.	SP mv.	TOPO	MAG nT
400.0	10.	2.2	14.	7.9	24.	10.	33.	33.	38.	-37			
600.0	9.5	2.1	12.	6.5	25.	10.	34.	34.	39.	-38			
800.0	10.	5.3	14.	10.	25.	12.	37.	37.	43.	-37			
1000.0	2.5	5.0	7.5	7.1	19.	7.1	29.	29.	23.	-74			
1200.0	1	6	7	12	23	15	45	45	48	-83			
1400.0	1	5	7	8.5	20	8	35	35	35	-90			
1600.0	0	0	3	1	11	-6	13	13	-9	-93			
1800.0	0	1	2	1	13	-6	14	14	-13	-95			
2000.0	0	3	6	6	17	4	25	25	20	-80			
2200.0	2	3	6	6	17	4	30	30	22	-85			
2400.0	9.3	5.1	12.	9.1	25.	9.1	37.	37.	39.	-56			
2600.0	15.	5.4	20.	8.7	30.	10.	41.	41.	44.	-32			

FILE> YUC-14 PROJECT> WASTE DIS. LINE> Y-14 UNITS> FEET

STATION	SLINGRAM Frq 222 re.	222 im.	444 re.	444 im.	888 re.	888 im.	1777 re.	1777 im.	3555 re.	3555 im.	SP mv.	TOPO	MAG nT
400.0	13.	7.9	19.	13.	34.	15.	44.	44.	50.	-26			
600.0	20.	8.2	27.	12.	40.	14.	49.	49.	47.	-29			
800.0	12.	5.5	20.	9.9	41.	8.8	40.	40.	26.	-41			
1000.0	9.5	5.2	14.	6.2	27.	2.0	28.	28.	7.4	-57			
1200.0	3.9	3.0	10.	5.0	21.	-2.	21.	21.	-4.	-70			
1400.0	2.2	2.0	7.7	4.0	18.	-5.	17.	17.	-14	-80			
1600.0	2.2	2.0	8.2	3.0	17.	-6.	13.	13.	-16	-77			
1800.0	2	1	6.5	2	16	-6.	12	12	-14	-75			
2000.0	2	2	8	5	18	0	19	19	5	-65			
2200.0	2	5	7	10	17	10	25	25	25	-35			
2400.0	3	5	8	11	19	12.	27	27	33	-17			
2600.0	2	5	8	11	17	12	25	25	30	-15			
2800.0	1.5	5	6	9	10	4	18	18	27	-27			
3000.0	2.3	6.0	6.8	10.	12.	11.	23.	23.	27.	-17			
3200.0	2	5	8	10	17	11	25	25	33	-19			
3400.0	1	5	6	10	15	12	25	25	32	-18			
3600.0	2	5	7.5	11	12	12	25	25	35	-14			
3800.0	3	5	7	8	13	8	23	23	32	-25			
4000.0	2	4	7	9.5	16	12	23	23	35	-16			
4200.0	2	5	6	10	17	14	25	25	42	-15			
4400.0	1	5	6	10	15	12	25	25	38	-19			
4600.0	2	2	6	5	14	4	19	19	20	-40			
4800.0	5	2	9	4	16	1	20	20	17	-52			

FILE> YUC-15 PROJECT> WASTE DIS. LINE> Y-15 UNITS> FEET

STATION	SLINGRAM Frq 222 re.	222 im.	444 re.	444 im.	888 re.	888 im.	1777 re.	1777 im.	3555 re.	3555 im.	SP mv.	TOPO	MAG nT
400.0	13.	6.7	20.	13.	32.	16.	39.	39.	45.	-7.			
600.0	10.	18.	18.	11.	29.	14.	38.	38.	41.	-13			
800.0	5.4	5.1	10.	10.	20.	9.3	27.	27.	31.	-23			
1000.0	3.5	3.0	7.5	7.1	16.	5.0	21.	21.	15.	-38			
1200.0	-.6	5.0	5.3	6.0	14.	4.0	16.	16.	10.	-37			
1400.0	3.9	6.0	7.0	8.5	18.	9.0	24.	24.	21.	-25			
1600.0	3.3	5.0	8.4	10.	18.	12.	27.	27.	33.	-22			
1800.0	3	7	8	10	19	10	27	27	37	-28			
2000.0	2	5	6.5	9.5	17	11	25	25	35	-25			
2200.0	3	5	6	8	15	8	22	22	33	-28			
2400.0	1	4	5.5	8	14	9	20	20	30	-23			
2600.0	1	5	5	10.	14	12	22	22	32	-11			
2800.0	1	6	7	8	15	11	23	23	33	-17			
3000.0	2	4	5	9	14	12	23	23	35	-14			
3200.0	2	4	7	11	17	5	24	24	39	-5			
3400.0	3	6	7	9	17	11	24	24	37	-24			
3600.0	1	3	7	7	15	7	23	23	32	-34			
3800.0	-1	2	4	5	12	1	16	16	21	-54			
4000.0	0	3	5	5	13	3	16	16	24	-57			
4200.0	-1	3	2	6	12	5	20	20	26	-45			
4400.0	0	3	4	5	12	5	17	17	18	-45			
4600.0	-3	4	2	5	11	3	15	15	16	-38			
4800.0	-1	4	3	6	11	4	13	13	16	-35			
5000.0	0	3	4	6	12	6	15	15	24	-24			
5200.0	0	4	4	7	14	8	18	18	27	-23			