EXPANDED SELF-POTENTIAL SURVEY

ANIMAS PROSPECT
HIDALGO COUNTY, NEW MEXICO

Prepared for AMAX Exploration, Inc., Geothermal Group

Robert F. Corwin
April, 1977

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Introduction

On 11-19 March, 1977, a self-potential survey covering approximately 120 km^2 was conducted in the Animas, New Mexico area. The locations of the survey lines are shown in Plates 1-4. Survey and data reduction procedures, data for three earlier lines, and a description of the equipment used are given in an earlier report (Corwin, 1977a) and will not be repeated here. This report includes listings (in the Appendix) and plots (Figs. 1-9) of the raw and corrected data for lines SP-1A and SP-3A, which are the westward extensions of two previous lines (SP-1 and SP-3, respectively) and seven additional lines (SP-4 through SP-9); a summary plot of the smoothed data from all nine lines (Fig. 10), and a brief discussion of the significance of the results. No significant telluric activity during the survey periods was seen on the telluric current monitor, and no corrections were made for telluric variations (the telluric monitor read between 6450 W and 6550 W on line SP-1; Plate 3).

Survey Results

1) Description of data

The corrected, unsmoothed data plotted at a horizontal scale of 1 in = 1 km for lines SP-1 through SP-9 is shown in Figs. 1-9 respectively. The data for all nine lines, smoothed by use of a 3-point running mean, is plotted at 1:62500 map scale in Fig. 10, and also included as an overlay as Plate 5. Each of the lines will be discussed briefly below, beginning with line SP-1 and moving first to the north and then to the south.

...ECTED SELF-POTENTIAL DATA, LINES SP-1 AND 1A, ANIMAS, N.M.

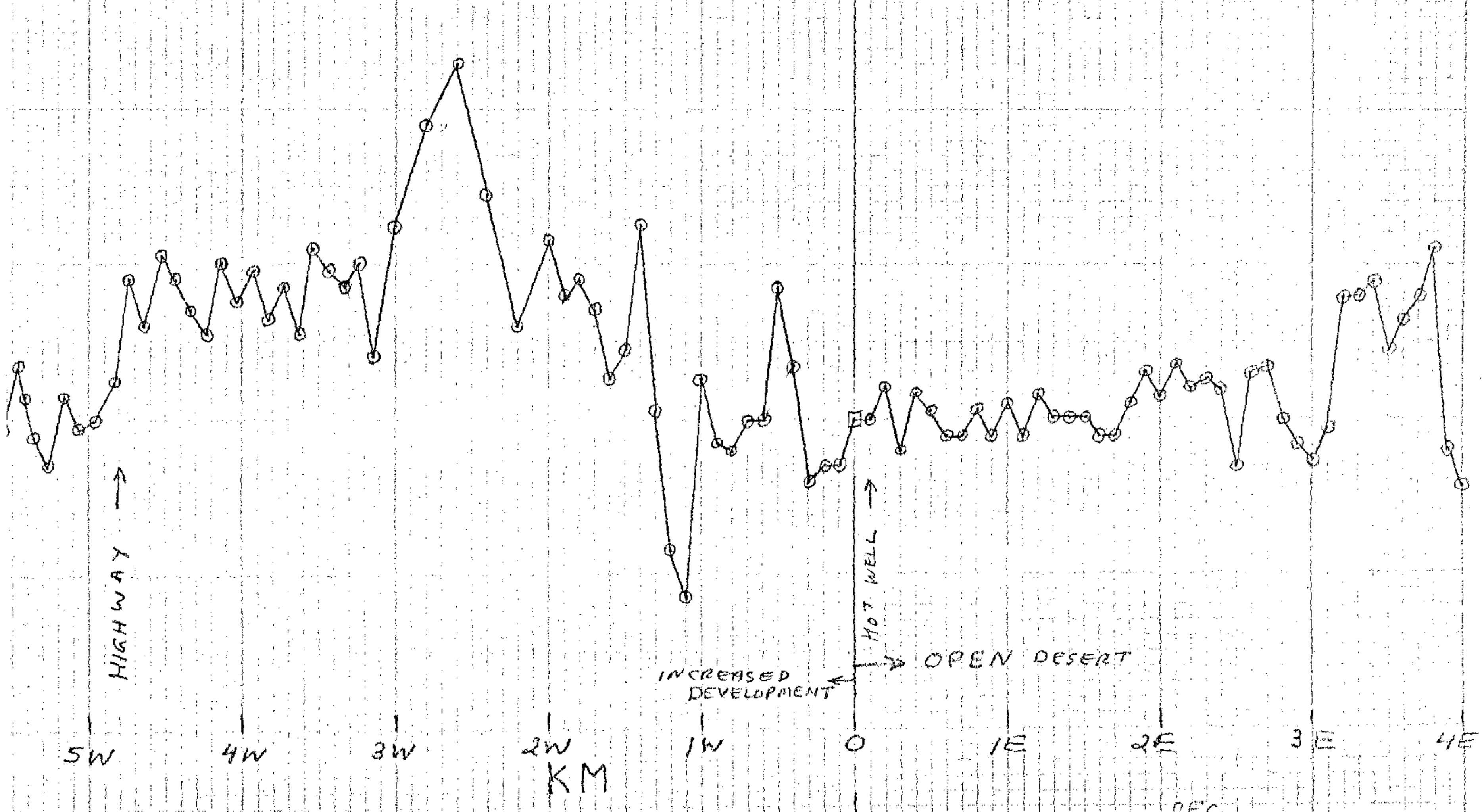


FIG. 2

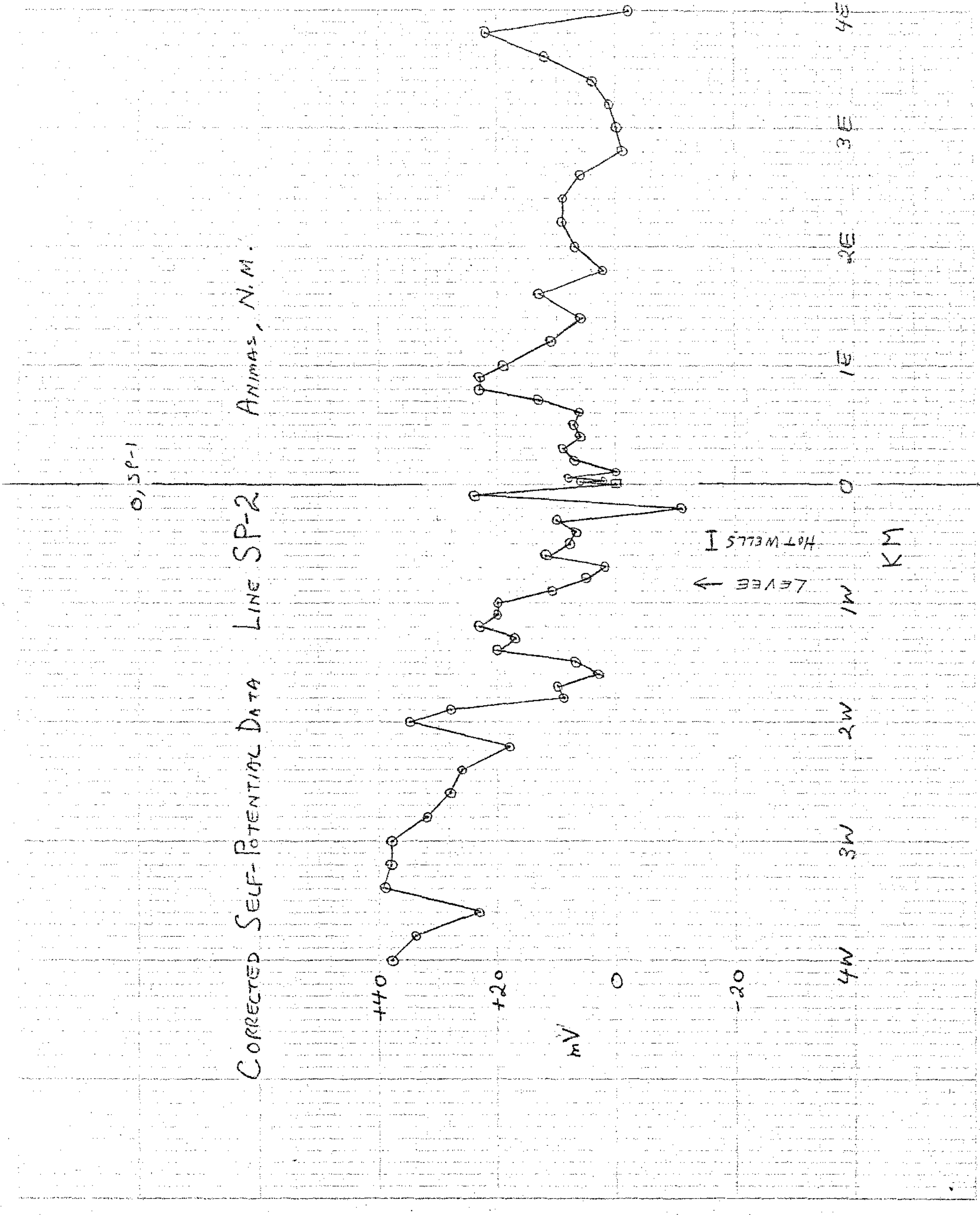

CORRECTED SELF-POTENTIAL DATA LINE SP-2 ANIMAS, N.M.
0, SP-1
HOT WELLS I
LEVEE →
+40
+20
0
-20
mV
4W
3W
2W
1W
0
1E
2E
3E
4E
KM

FIG. 3

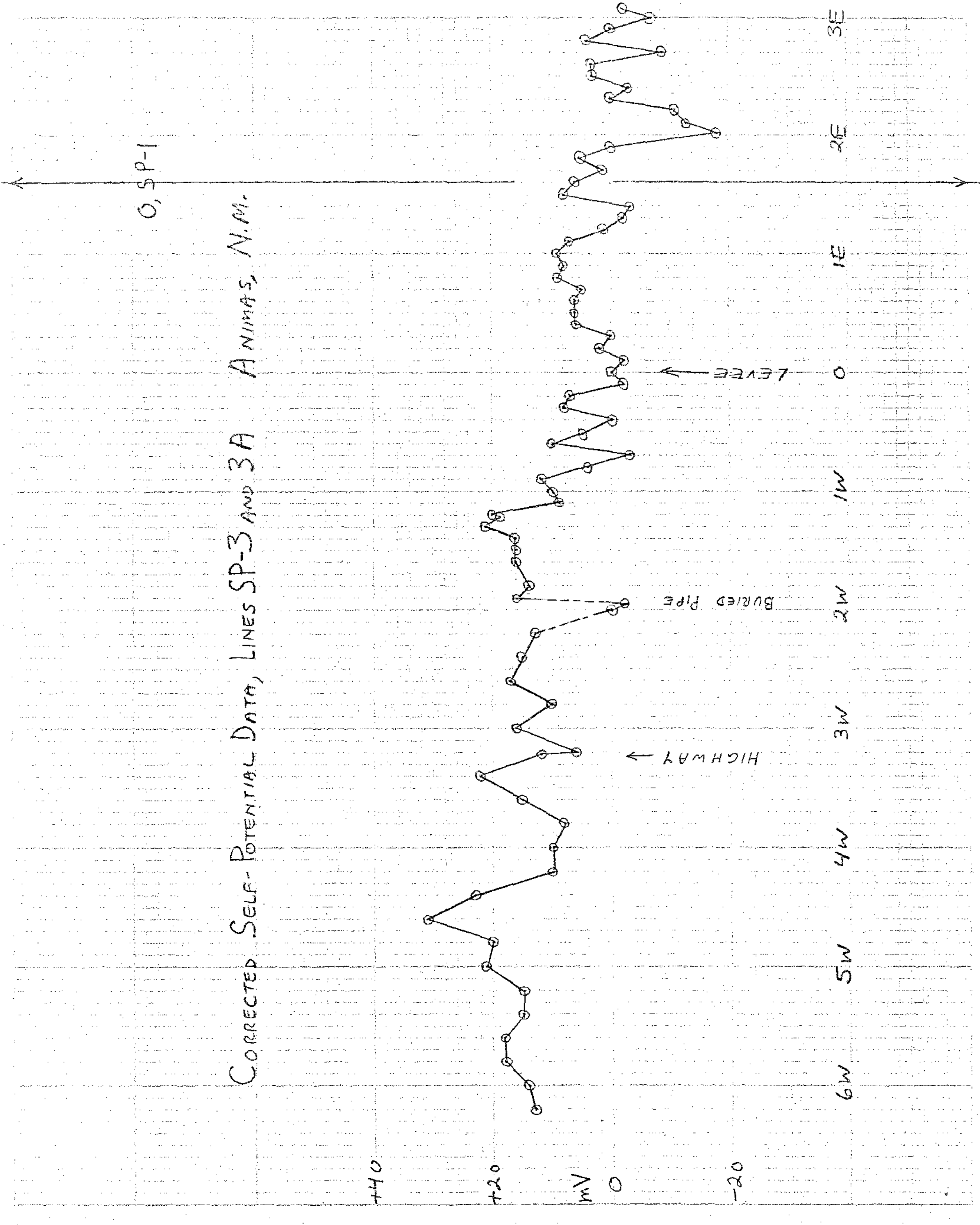
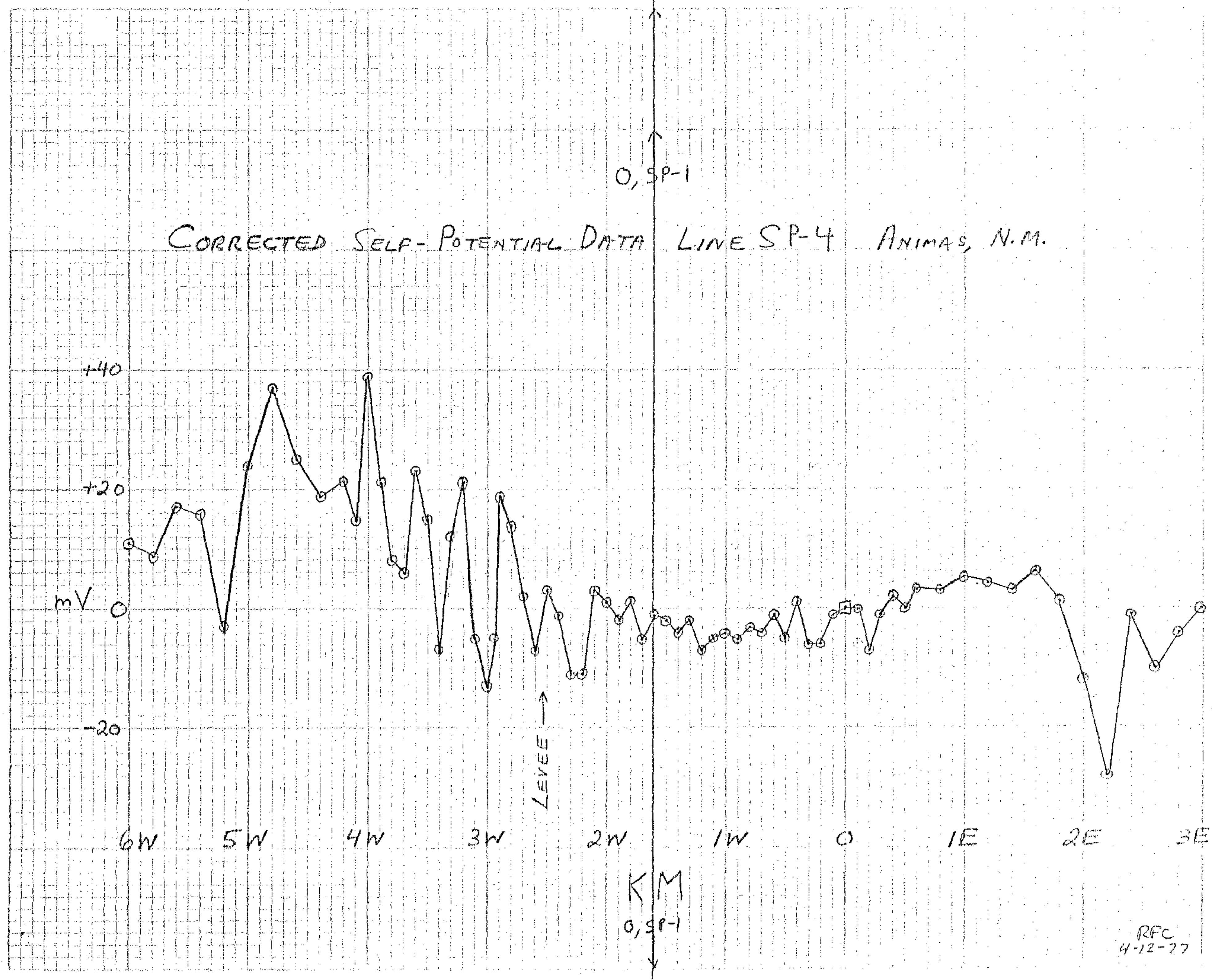

CORRECTED SELF-POTENTIAL DATA, LINES SP-3 AND 3A ANIMAS, N.M.
0, SP-1
LEVEE
BURIED PIPE
HIGHWAY
+40
+20
mV
0
-20
3E
2E
1E
0
1W
2W
3W
4W
5W
6W

FIG. 4


CORRECTED SELF-POTENTIAL DATA LINE SP-4 ANIMAS, N.M.
0, SP-1
+40
+20
mV 0
-20
LEVEE
6W
5W
4W
3W
2W
1W
0
1E
2E
3E
KM
0, SP-1
RFC
4-12-77

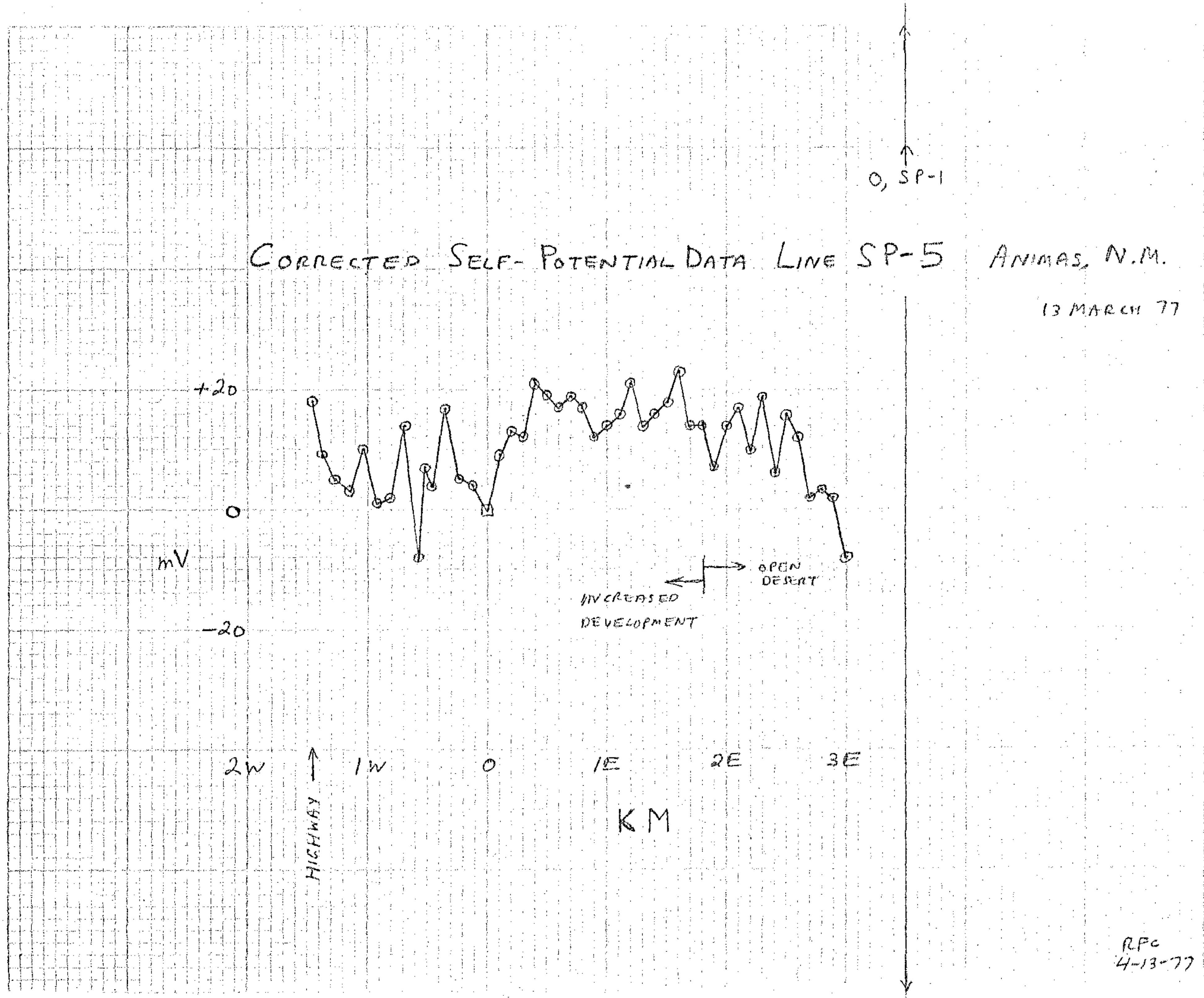

0, SP-1
Corrected Self-Potential Data Line SP-5
Animas, N.M.
13 March 77
+20
0
mV
-20
Increased Development
Open Desert
2W
1W
0
1E
2E
3E
Highway
KM
RPC
4-13-77

FIG. 6

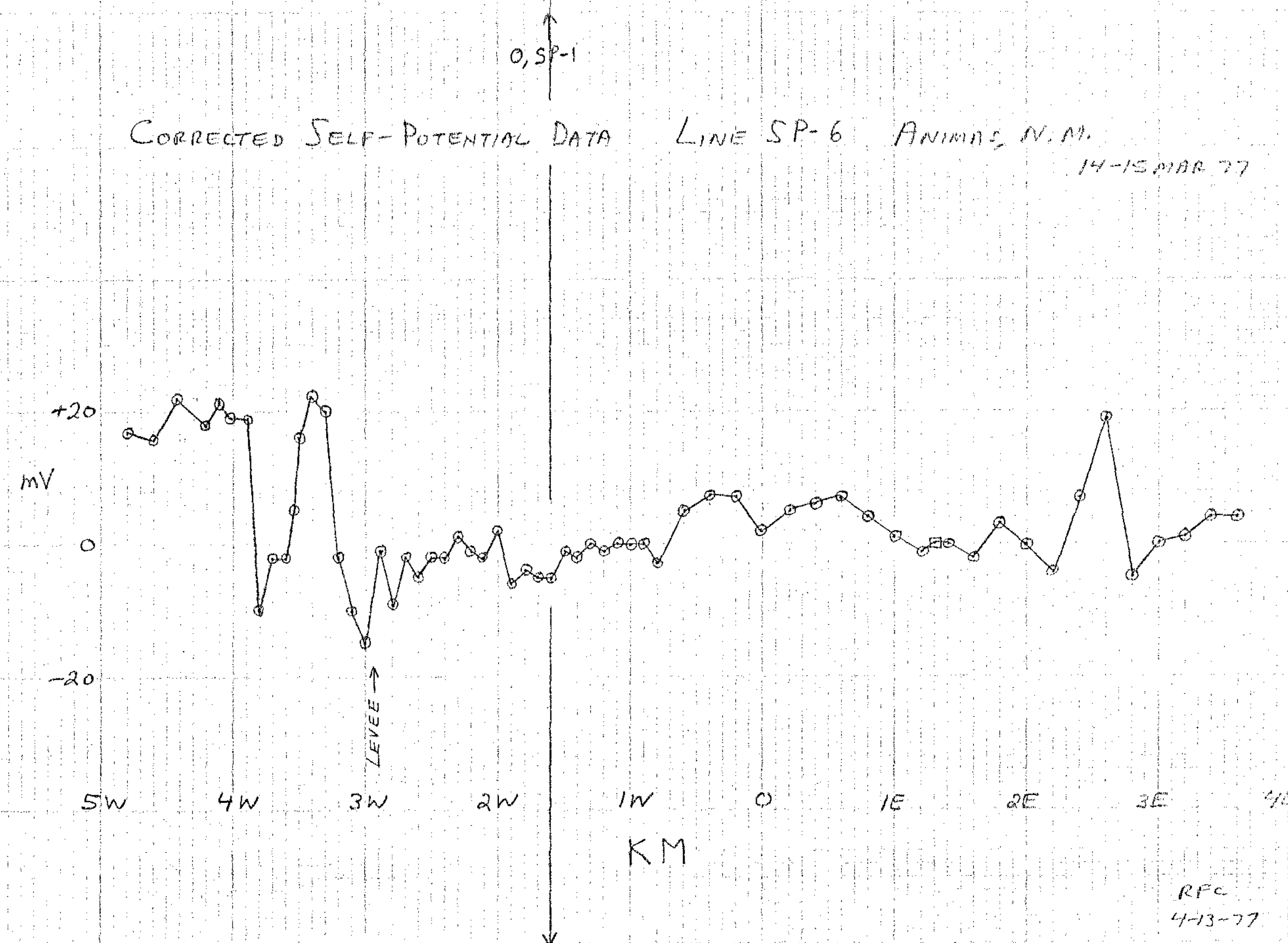

0, SP-1
CORRECTED SELF-POTENTIAL DATA
LINE SP-6
ANIMAS, N.M.
14-15 MAR 77
+20
mV
0
-20
LEVEE
5W
4W
3W
2W
1W
0
1E
2E
3E
4E
KM
RPC
4-13-77

FIG. 7

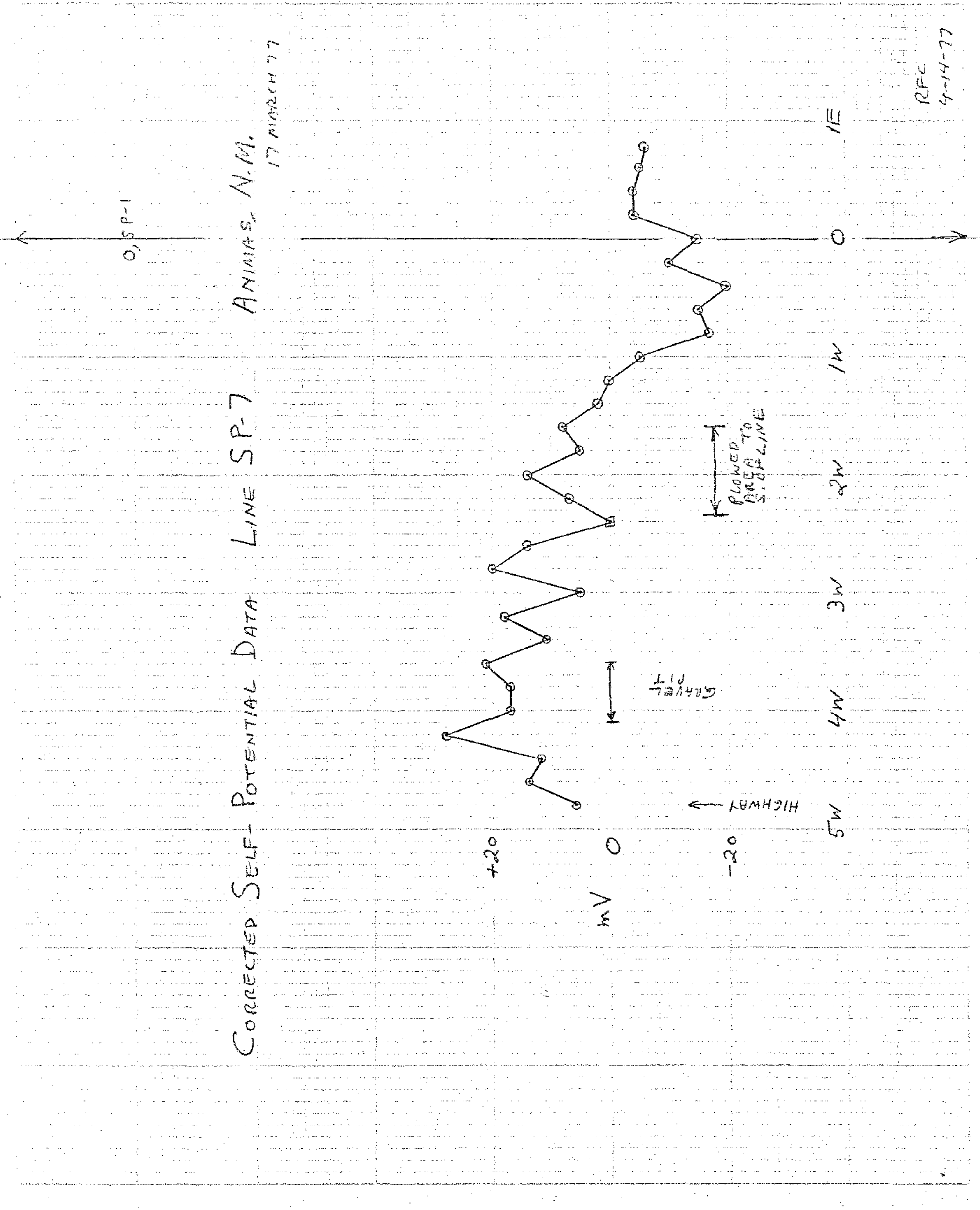
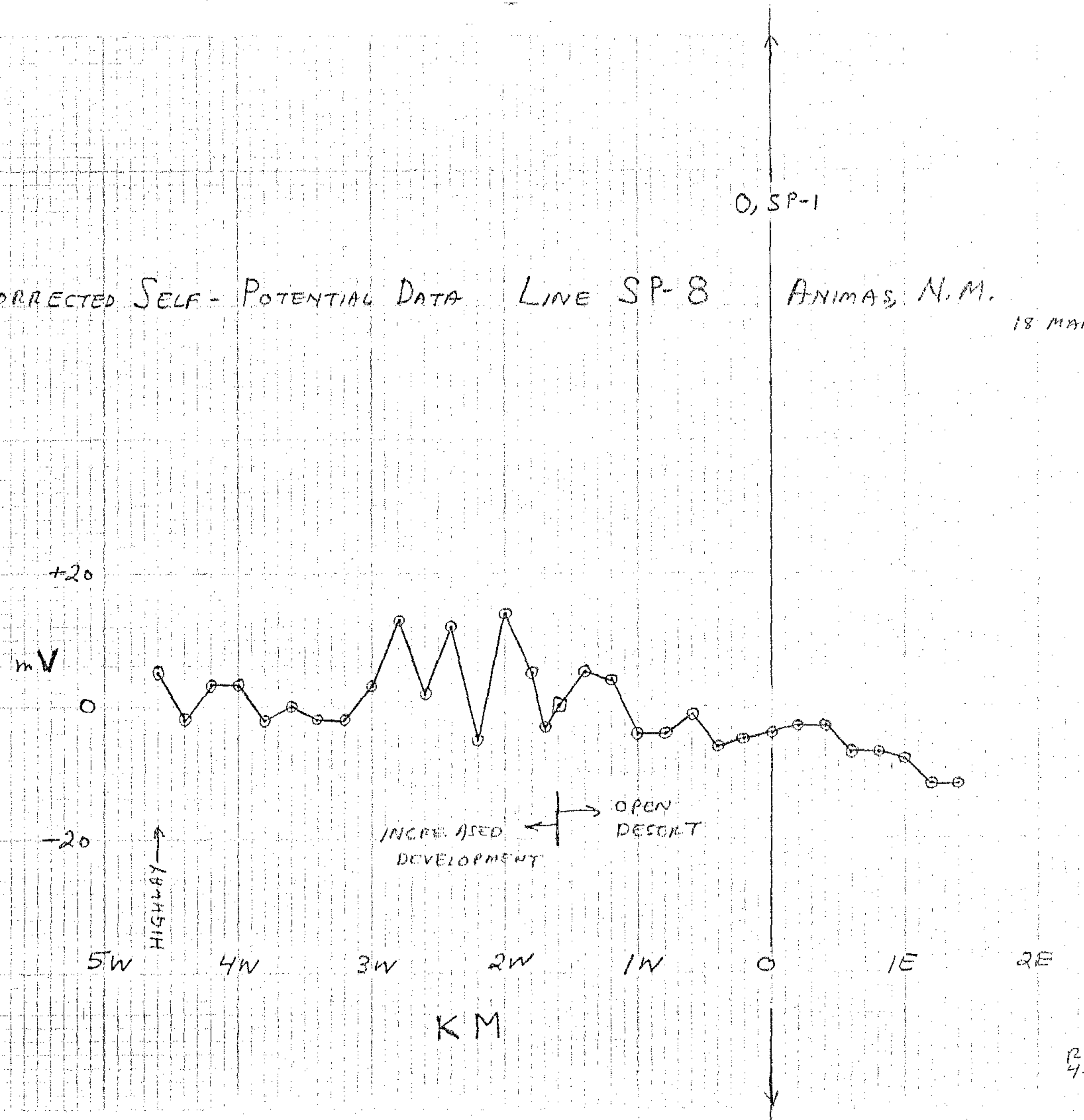

CORRECTED SELF POTENTIAL DATA LINE SP-7
ANIMAS, N.M.
17 MARCH 77
RFC
4-14-77
0, SP-1
mV
+20
0
-20
5W
4W
3W
2W
1W
0
1E
HIGHWAY
GRAVEL PIT
PLOWED AREA TO S. OF LINE

FIG. 8

CORRECTED SELF-POTENTIAL DATA LINE SP-8 ANIMAS, N.M.

18 MARCH 77



RFC
4-14-77

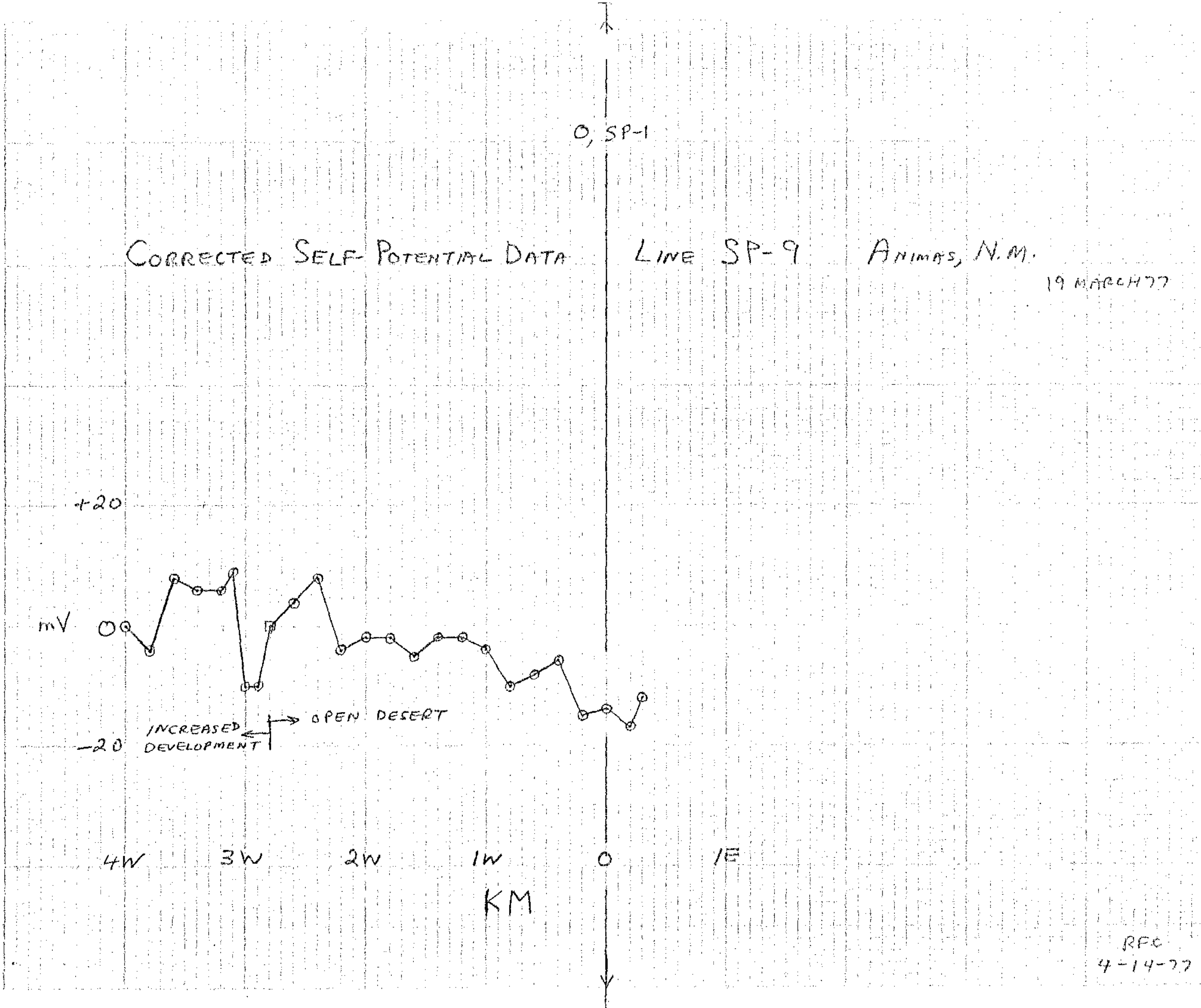
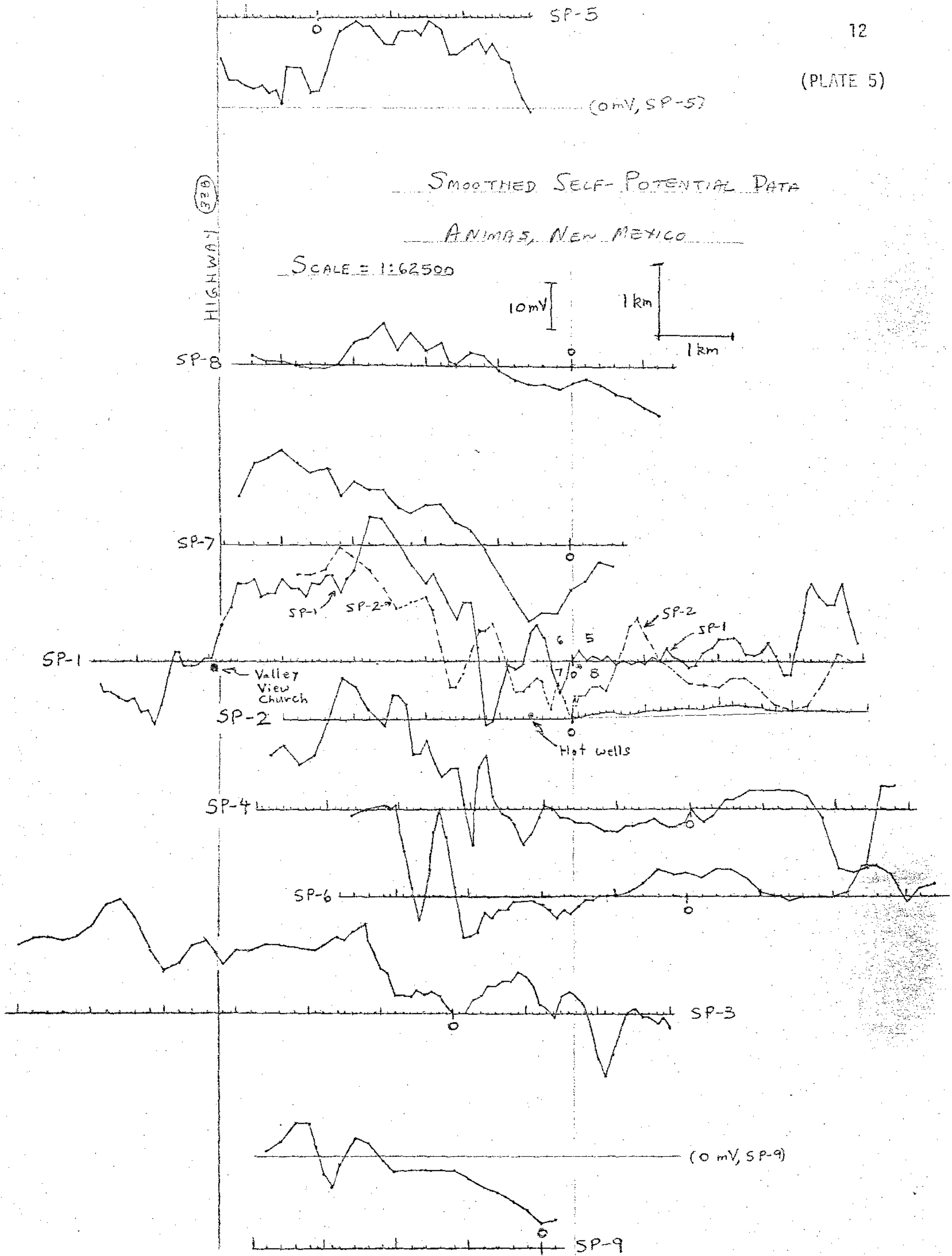

CORRECTED SELF-POTENTIAL DATA
LINE SP-9
ANIMAS, N.M.
19 MARCH 77
0, SP-1
+20
mV 0
-20
INCREASED DEVELOPMENT
OPEN DESERT
4W
3W
2W
1W
0
1E
KM
RFC
4-14-77

FIG. 9

(PLATE 5)


SP-5
0
(0 mV, SP-5)
SMOOTHED SELF-POTENTIAL DATA
ANIMAS, NEW MEXICO
SCALE = 1:62500
HIGHWAY (338)
10mV
1km
1km
SP-8
0
SP-7
0
SP-1
SP-2
SP-1
SP-2
SP-1
6
5
7
0
8
Valley View Church
SP-2
0
Hot wells
SP-4
0
SP-6
0
SP-3
0
(0 mV, SP-9)
0
SP-9

Line SP-1

The westward extension of line SP-1 revealed that the steep westward positive climb of the data to the west of the thermal area reverses at about 2.5 km W, forming a large, broad positive anomaly. Other features of this line are discussed in the previous report.

Line SP-2

Features of this line are discussed in the previous report. The levee separating the more developed area to the west from more open desert to the east (described below) is at 0.85 km W.

Line SP-4

This line is generally similar in character to line SP-1, showing the positive anomaly to the west, a "quiet zone" between about 2 W and 1.5 E, and a negative anomaly centered at about 2.2 E, similar in location but of opposite polarity to anomalies at roughly the same location on lines SP-1 and SP-2. A levee at 2.5 W marks a topographic break and a transition from generally open desert to the east to more built-up and heavily grazed (and possibly irrigated) conditions to the west. Many readings west of the levee were taken in soil which obviously had been distrubed by plowing, road shoulders, and heavy grazing. (These conditions apply to all lines to the west of the levee, or to the west of the onset of increased cultural development). The increased self-potential activity on line SP-4 appears to begin a few hundred m to the east of the levee.

Line SP-6

This line appears similar to line SP-4. The positive anomaly at 2.6 E is similar to but somewhat smaller than the similarly located anomalies on lines SP-1, SP-2, and SP-4, and the increased activity to the west again begins near the levee, which bears to the southwest between lines SP-4 and SP-6.

Line SP-3

The westward extension of line SP-3 showed a much smaller positive rise to the west than for the lines to the north, with no real indication of the positive anomaly seen to the west on lines SP-1 and SP-4. The levee is located at 0 km on SP-3 but there is no apparent change in the character of the data at the levee on this line.

Line SP-9

The positive westward rise of the data is still seen on line SP-9, although smaller in magnitude than on the lines to the north. The transition from open desert to the east to an area of large, actively pumping irrigation wells to the west takes place at 2.8 W. While there is an increase in self-potential activity at this point, it is not as large as that seen on the lines to the north, where the irrigation and pumping activity was much less. The small westward positive rise of the data from 0.3 km E to about 1 km W takes place in open desert, unlike the northern lines (SP-1 through SP-3) in which this trend is seen in a more developed area. An eastward extension of line SP-9 to see if a negative anomaly developed at 0 km would have been useful, but was precluded by lack of time and access.

Line SP-7

This line shows a strong similarity to line SP-2, with a well-developed negative anomaly centered at about 0.5 km W, most of which was mapped in open desert. Little effect was seen from a highly disturbed area running through a gravel pit from about 3.6 to 4.1 km W.

Line SP-8

Aside from a gentle westward rise, little activity is seen on this line. Unless it has moved considerably to the east, the negative anomaly of SP-7 is absent from SP-8. Open desert to the west begins at 1.6 W, and a definite increase in self-potential activity to the west correlates with increased development. The increased activity, however, is much smaller than that seen on the equally developed lines to the south of SP-7.

Line SP-5

Self-potential activity on SP-5 is considerably greater than on SP-8, with a suggestion of the steep rise and positive anomaly to the west characteristic of lines SP-7 through SP-6. Increased development to the west begins at 1.8 E on SP-5, but is not reflected in the data. In retrospect, it would have been worthwhile to extend this line to the east (access in this case is not difficult).

2) Importance of cultural activity

The most important question regarding this survey is whether the steep positive rise to the west and the negative area enclosing the known thermal activity (best seen on lines SP-7 and SP-2, but possibly present on all the lines to the south of SP-7) are related to the thermal activity or are artifacts of cultural development. Arguing for a cultural origin for these features are the facts that moist and/or plowed ground have been known to produce positive self-potential readings, and that the onset of increased self-potential activity and a positive westward trend to the data are very closely coincident with such conditions on lines SP-8, SP-1, SP-6, and SP-9, although the effect is smallest on SP-9, where pumping and irrigation are greatest. However, the same type of conditions did not seem to affect the data on lines SP-5, SP-7 (where the single plowed area was 50 m to the south of the line), SP-2 (where a high level of self-potential activity persisted throughout the entire line), SP-4 (where the increased activity began several hundred m to the east of the levee), or SP-3. Also arguing against a cultural origin for the westward positive trend (and to some extent the increased noise level) in developed areas is the fact that there was no consistent correlation between soil type or degree of disturbance in these areas and the point-to-point variations or general trend of the data; e.g., moist, plowed areas did not always produce more positive readings, and obvious cultural disturbances such as the gravel pit on SP-7 and the heavy pumping and irrigation on SP-9 did not lead to variations as large as those seen in the known thermal area.

Obviously, it is impossible to decide definitely from the discussion above whether the observed self-potential variations are caused by thermal activity, cultural noise, or some combination of the two. As with any other geophysical data, the self-potential data must be considered along with all other available information about the area. From the material above, and in light of the discussion to follow, it seems that there is at least a good possibility that the negative anomaly enclosing the thermal area and, to a lesser extent, the westward rise of the data are related to the thermal activity.

Relation of self-potential data to thermal activity

The relation of self-potential and geothermal activity in general was discussed in an earlier report (Corwin, 1977 a) and will not be repeated here. Some features of this expanded survey do, however, merit additional comment.

First, there is a definite resemblance between this data and that obtained at Roosevelt Hot Springs KGRA, Utah (Corwin, 1977 b), although the activity is at a smaller scale at Animas. In both cases a negative area seems to enclose the area of known thermal activity, roughly centered on a fault thought to act as a conduit for the thermal fluids (the Dome fault at Roosevelt, and a north-south trending fault which closely follows the section line passing through the zero of line SP-1 and extends from north of SP-5 to the hot wells on SP-2 (Reeder, 1957)). Also in both cases a positive anomaly seems to flank one side of the negative, although at Animas the positive roughly coincides with a low resistivity zone possibly related to a thermal water sink (Jiracek and Smith, 1976; Mazzella, 1976), while at Roosevelt the positive is on the opposite side of the fault from a similar low-resistivity zone (Ward and Sill, 1976 a and 1976 b). The negative anomaly on lines SP-7 and south, then, would appear to be the most significant feature of the data.

Second, the anomaly appearing at the eastern end of lines SP-1, SP-2, SP-4, and SP-6 is significant, as it occurs in an area of open, undeveloped desert. Quite possibly it is caused by a fault (or fault zone, based on its significant width). Although it is not known whether thermal activity occurs along the fault, an area of interest certainly is indicated.

Third, a striking similarity is seen between the self-potential pattern on the central lines (SP-7 through SP-4) and the map of temperature at 1 m depth given by Kintzinger (1956), shown in Fig. 11 (the 1:62500 plot may be overlaid on Fig. 11, as they are almost the same scale). The edge of the westward rise of the data on these lines corresponds to the western boundary of the thermal anomaly, with a similar,but smaller, rise at the eastern boundary. It is interesting that the same self-potential pattern appears to continue to the south of the observed shallow thermal anomaly.

Conclusions

Assuming that the features of the self-potential data are not significantly influenced by cultural development, and that the broad central negative anomaly and the steep westward rise are related to thermal activity, the northern boundary of the zone of maximum interest lies between lines SP-7 and SP-8 (although there is a hint of increasing activity on line SP-5). The zone appears to extend at least to line SP-6 on the south, and may extend, with diminishing amplitude (possibly indicative of increasing depth to the source) to line SP-9. The mechanism by which the anomalies are generated probably is a combination of thermoelectric coupling and streaming potentials (discussed in Corwin, 1977 a), but analytical techniques for relating the observed anomalies to source parameters are not yet developed.

FIG. 11

...meat and then returned to ...an, and do not attract any re-...lts if living oysters are near. ...(*Mercenaria*) and mussels (*Vol-*...) placed in aquaria with *O. im-*... and oysters, do not attract snails; ... that crawl on them do not stay ...

...pecimens and records of the Charles-... Museum indicate that *O. impressa* is ... commonest *Odostomia* in South ...olina; it has been taken from a num-... of localities by many collectors, start-... with Edmund Ravenel prior to 1870. ...er (3) and various shell collectors' ...les mention that *O. impressa* often ...urs on oyster beds. At Bears Bluff, ... of the population is found between ... above and 1 ft below mean low-... water level. At the beginning of July ...6, the individuals collected ranged ... 3.3 to 5.2 mm in height and aver-... 4.2 mm. These older snails soon dis-...ared, and at the end of July they ... replaced by a younger group of ...ls 0.7 to 3.3 mm high, with a mode at ... mm.

SEWELL H. HOPKINS
...s *Bluff Laboratories, Wadmalaw* ...*d, South Carolina, and A. & M.* ...*ge of Texas, College Station*

References

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2. T. Abbott, *American Seashells* (Van Nos-...nd, New York, 1954).
3. ... Miner, *Field Book of Seashore Life* ...n, New York, 1950).

...ust 1956.

...thermal Survey of Hot Ground ... Lordsburg, New Mexico

...the late fall of 1954, newspapers ...ted live steam and boiling water is-... from shallow wells being drilled in ...ea between the Pyramid and the ...illo Mountains, 15 miles south-...west of Lordsburg, N.M. Marx ... of the research and development ...on of the New Mexico Institute of ...g and Technology, made a pre-...ary examination of the area in De-...r 1954, at which time water sam-...ere collected for analysis. Shortly ...fter it was recommended that a ...rmal survey of the area be made. ... locations of three principal wells ... area are shown by solid circles in ... These wells penetrate approxi-...y 50 ft of sand and claylike soil ...ain by 20 ft of warm-water-bearing ... The water-bearing gravel rests on ...tively impervious layer of clay that ...mately 8 ft thick, which in turn ...hot rhyolite rock. As the drilling ...ion proceeds through the clay, ... temperatures are encountered, and the water becomes superheated as contact is established with the hot rhyolite.

Two of the three wells were completed at 5 to 10 ft into the rhyolite. One of these behaved like a geyser when it was disturbed by the drilling tools. The third well, which was completed at the upper surface of the rhyolite, can be pumped at the rate of 200 to 300 gal of boiling water per minute.

A geothermal survey was made using resistance thermometers, with the elements installed 1 m below the ground surface. The thermometers were made by installing a thermistor element at the end of a thin (0.25-in. diameter) Bakelite tube, which was subsequently filled with insulating material. Two fine copper wires connect the thermistor to extended leads at the upper end of the tube, where resistance measurements were made with a portable impedance bridge. The thermistor elements at 20°C had a resistance of 18,000 ohm and a sensitivity of approximately 550 ohm per degree centigrade. A hole for receiving the thermometer tube was made by driving a stake 4 ft in length into the ground, and the excess space around the tube was filled with dry sand. This arrangement gave steady-state resistance measurements 30 minutes after installation.

The temperature anomaly is mapped on Fig. 1 with a contour interval of 2°C. Points of temperature observation are indicated by open circles.

The maximum observed temperature at 1 m below the surface was 23°C, approximately 12°C higher than the corresponding readings outside the anomalous region. At one station, a thermistor remained in the ground for 5 days, during which time the air temperature changed from −5°C to +22°C. However, no change in temperature at the 1-m depth was noted during this interval, and in general, during the time of the study, no changes of temperature at this depth were observed. One thermistor has been installed permanently at a depth of 6 m for the purpose of detecting possible changes in ground temperatures at that depth throughout an extended period.

Temperature readings were taken at both 1- and 2-m depths at three locations in the warmest area, and a mean vertical gradient of 10°C/m was determined. Calculations based on a reasonable value of the heat conductivity of the earth material and the observed temperature gradient indicate a power flow of approximately 7500 kw for the area enclosed by the 18°C contour line.

Ranchers of the neighborhood have noticed that the winter snows melt almost immediately over an area approximately 0.5 mile in diameter in the neighborhood of the wells. Distinct changes occur in vegetation at the edges of the thermal anomaly. This is especially striking toward the south end of the area, where the temperature contour lines are close together. On the southeast, creosote bushes begin to grow where the anomaly ends. On the southwest, the hot area cuts through a cotton field. Over the hot area, the cotton stalks grow only 6 in. tall, whereas off the anomaly they attain a height of about 2 ft. Aerial photographs show the outline of the hot region as revealed by changes in vegetation at the edges.

Three hypotheses might explain the origin of the heat: (i) Hot steam and vapors, ascending from great depth along faults and fractures, are the source of heat. (ii) A postrhyolite and relatively recent intrusive has been emplaced beneath the rhyolite and is the source of heat. (iii) The rhyolite is itself the heat source. Since, however, the rhyolite, if correlated with similar rhyolites in adjacent areas, is probably of mid- to late-Tertiary age, it is highly improbable that its original heat could be retained.

It is possible that further study will indicate the true heat source. In the meantime, it would appear desirable to employ modern core-drilling methods, using compressed air, for the purpose of drilling deeper into the rhyolite mass for more significant temperature measurements.

Because of the high thermal gradient, an attempt was made to detect possible potential differences generated by the differential movement of ions in an electrolyte subject to a temperature gradient (Soret effect). Ground potentials owing

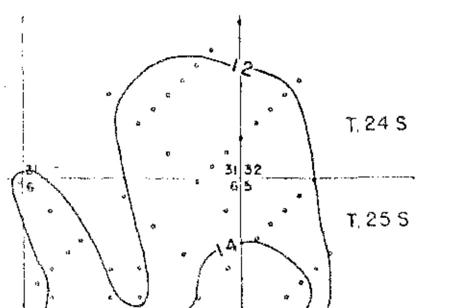

Fig. 1. Geothermal map. Temperature 1 m below surface; contour interval 2°C.

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APPENDIX

SELF-POTENTIAL DATA LINE SP-1A ANIMAS, N.M.

(Line SP-1A is the westward continuation of line SP-1)

(* Col. ④ includes +16 mV to tie 3620E on SP-1A to 2800W, SP-1) 11 March 77

① STATION (m)	② TIME (MST)	③ ΔV_{RAW} (mV)	④ CORRECT.* DRIFT & POLARIZAT. (mV)	⑤ ΔV_{FINAL} (mV)	⑥ 3-POINT RUNNING MEAN (mV)	①a STATION ON SP-1 (m)	⑦ COMMENT
							(6460 W on SP-1) 0 at abandoned house; power lines
100E	1244	-29	+21	-8	-7	6360W	Soil is dry-appearing clay
200E	1254	-27	+21	-8	-8	6260W	
300E	1259	-29	+20	-9	-9	6160W	
400E	1304	-29	+20	-9	-8	6060W	
500E	1310	-25	+19	-6	-9	5960W	
600E	1317	-32	+19	-13	-11	5860W	
700E	1321	-33	+18	-15	-14	5760W	
800E	1331	-33	+18	-15	-10	5660W	
900E	1336	-18	+17	-1	-3	5560W	
1000E	1342	-10	+17	+7	+3	5460W	Soil dryer, loose; N-S linear mound: pipeline?
1050E	1441	-11	+14	+3	+3	5410W	
1100E	1351	-18	+16	-2	-2	5360W	
1200E	1356	-22	+16	-6	-2	5260W	Previously cultivated.
1300E	1402	-12	+15	+3	-1	5160W	Soil wetter, muddy
1400E	1407	-16	+15	-1	+1	5060W	
1500E	1413	-14	+14	0	+1	4960W	Cross road to N shoulder; disturbed
1630E	1427	-9	+14	+5	+8	4830W	Across highway on N side
2W	1511	-19	+14	-5	-7	6462W	
25W	1506	-21	+14	-7	-5	6485W	
100W	1501	-17	+14	-3	—	6560W	
1700E	1547	+4	+14	+18	+12	4730W	Reference now at 1630E
1800E	1552	-2	+14	+12	+17	4630W	
1900E	1556	+7	+14	+21	+17	4530W	
2000E	1601	+3	+15	+18	+18	4430W	

LINE SP-1A (Cont'd)

①	②	③	④	⑤	⑥	①a	⑦
2100E	1607	−1	+15	+14	+14	4330W	
2200E	1613	−4	+15	+11	+15	4230W	
2300E	1618	+5	+15	+20	+15	4130W	
2400E	1623	−1	+16	+15	+18	4030W	
2500E	1627	+3	+16	+19	+16	3930W	
2600E	1632	−3	+16	+13	+16	3830W	
2700E	1639	+1	+16	+17	+14	3730W	
2800E	1644	−5	+16	+11	+17	3630W	
2900E	1649	−5	+17	+22	+17	3530W	
3000E	1654	+2	+17	+19	+19	3430W	
3100E	1659	0	+17	+17	+19	3330W	
3200E	1705	+3	+17	+20	+15	3230W	6 m. E. of 1 | 2 / 11 | 12
3300E	1712	−10	+18	+8	+18	3130W	
3470E	1724	+7	+18	+25	+20	3000W	
3670E	1734	+10	+18	+28	+30	2800W	

LINE SP-3A

16 MARCH 77

(Continuation of line SP-3)

*Col. ④ includes +16mV to tie to line SP-3 at 1600 W)

①	②	③	④ *	⑤✓	⑥	⑦
1600W	1326	0	—	+16	+15	Ref. at 1600W; ΔV=+16mV
1800W	1333	-8	+22	+14	+15	
1900W	1448	-5	+21	+16	+14	
1950W	1444	-19	+17	-2	—	Exposed, buried pipeline? do not use data
2000W	1341	-17	+17	0	—	" " "
2200W	1347	-8	+21	+13	+15	
2400W	1353	-5	+20	+15	+15	
2600W	1358	-2	+19	+17	+14	
2800W	1403	-8	+18	+10	+14	
3000W	1408	-2	+18	+16	+11	
3200W	1415	-11	+17	+6	+11	E. shoulder of highway
3200+W	1424	-5	+17	+12	+13	W. shoulder of highway
3400W	1527	+4	+18	+22	+16	Reference now at 3200+W
3600W	1533	-3	+18	+15	+15	
3800W	1542	-10	+18	+8	+11	
4000W	1548	-8	+18	+10	+9	
4200W	1555	-8	+18	+10	+14	
4400W	1601	+5	+18	+23	+21	
4600W	1608	+13	+18	+31	+25	
4800W	1618	+1	+19	+20	+24	
5000W	1624	+2	+19	+21	+19	
5200W	1629	-4	+19	+15	+17	
5400W	1634	-4	+19	+15	+16	
5600W	1641	-1	+19	+18	+17	
5800W	1646	-1	+19	+18	+17	
6000W	1652	-5	+19	+14	+15	
6200W	1700	-6	+19	+13	0	

LINE SP-4

12 MARCH 77

①	②	③	④	⑤✓	⑥		⑦
0	0954	0	—	0	—		at 1/4 sect. 8/17 9/16
100E	1002	-6	+6	0	-2		
200E	1008	-12	+5	-7	-3		
300E	1013	-6	+5	-1	-2		
400E	1019	-2	+4	+2	0		
500E	1024	-3	+3	0	+2		
600E	1031	0	+3	+3	+2		
800E	1038	+1	+2	+3	+4		
1000E	1044	+4	+1	+5	+4		
1200E	1054	+3	+1	+4	+4		
1400E	1104	+3	0	+3	+4		
1640E	1112	+7	-1	+6	+3		at section line
1800E	1121	+2	-1	+1	-2		
2000E	1131	-10	-2	-12	-13		
2200E	1139	-25	-3	-28	-14		
2400E	1146	+2	-3	-1	-13		
2600E	1156	-6	-4	-10	-5	} ?	at topographic break
2800E	1205	+1	-5	-4	-5		on steep upslope
3000E	1224	+6	-6	0	—		"
100W	1427	+5	-6	-1	-3		
200W	1431	0	-6	-6	-4		
300W	1438	0	-6	-6	-4		
400W	1444	+7	-6	+1	-3		
500W	1451	0	-5	-5	-2		
600W	1458	+4	-5	-1	-3		

LINE SP-4 CONT'D 12 MAR 77

①	②	③	④	⑤	⑥	⑦
700W	1503	+1	-5	-4	-3	
800W	1509	+2	-5	-3	-4	
900W	1515	0	-5	-5	-4	
1000W	1522	+1	-5	-4	-5	
1100W	1529	0	-5	-5	-5	
1200W	1534	-3	-4	-7	-5	
1300W	1539	+2	-4	-2	-4	
1400W	1545	0	-4	-4	-3	
1500W	1551	+2	-4	-2	-3	
1600W	1602	+5	-4	-1	-3	
1700W	1611	-1	-4	-5	-2	
1800W	1616	+5	-4	+1	-2	
1900W	1621	+1	-3	-2	0	
2000W	1626	+4	-3	+1	+1	
2100W	1634	+6	-3	+3	-2	
2200W	1639	-8	-3	-11	-6	
2300W	1644	-8	-3	-11	-8	
2400W	1651	+2	-3	-1	-3	
2500W	1656	+6	-3	+3	-2	
2600W	1702	-5	-2	-7	-1	
2700W	1708	+4	-2	+2	+3	
2800W	1712	+16	-2	+14	+12	
2900W	1721	+21	-2	+19	+9	Soft, wet soil. Plowed to S.

LINE SP-4 CONT'D

20 MAR 77

* Col. ① includes +19 mV for tie to 2900 W

①	②	③	④*	⑤✓	⑥	⑦
2900W	0908	—	—	+19		Ref. at 2900W.
2950W	1254	-11	+6	-5	0	
3000W	0920	-32	+19	-13	-8	
3100W	0924	-23	+18	-5	+1	
3200W	0929	+3	+18	+21	+9	
3300W	0933	-5	+17	+12	+9	
3400W	0938	-24	+17	-7	+7	
3500W	0949	-1	+16	+15	+10	
3600W	0956	+8	+15	+23	+15	
3700W	1001	-9	+15	+6	+12	
3800W	1007	-6	+14	+8	+12	
3900W	1012	+9	+13	+21	+23	
4000W	1018	+26	+13	+39	+25	
4100W	1029	+3	+12	+15	+25	
4200W	1035	+9	+12	+21	+18	
4400W	1042	+8	+11	+19	+22	
4600W	1052	+15	+10	+25	+27	
4800W	1059	+27	+10	+37	+29	
5000W	1107	+15	+9	+24	+19	
5200W	1117	-11	+8	-3	+12	
5400W	1124	+8	+8	+16	+10	
5600W	1132	+10	+7	+17	+14	
5800W	1148	+2	+7	+9	+12	
6000W	1155	+5	+6	+11	—	

LINE SP-5 ANIMAS N.M. 13 MARCH 77

①	②	③	④	⑤	⑥	⑦
0	1152	0	—	0	+4	Ref. elect. ~ 2m E of metal cattleguard
100E	1158	+5	+4	+9	+8	Flat, grassy, heavily grazed
200E	1203	+11	+4	+15	+13	from 1300W to 1900E
300E	1207	+11	+3	+14	+17	
400E	1212	+18	+3	+21	+18	
500E	1218	+17	+2	+19	+19	
600E	1223	+15	+2	+17	+18	
700E	1227	+18	+1	+19	+18	
800E	1232	+16	+1	+17	+16	
900E	1236	+12	0	+12	+14	
1000E	1241	+14	0	+14	+14	
1100E	1251	+17	-1	+16	+17	
1200E	1256	+22	-1	+21	+17	
1300E	1303	+16	-2	+14	+17	
1400E	1308	+18	-2	+16	+16	
1500E	1313	+21	-3	+18	+19	
1600E	1321	+26	-3	+23	+18	
1700E	1327	+18	-4	+14	+17	
1800E	1332	+18	-4	+14	+12	
1900E	1341	+12	-5	+7	+12	
2000E	1347	+19	-5	+14	+13	"Culture" ends - relatively
2100E	1353	+23	-6	+17	+14	undisturbed desert begins
2200E	1359	+16	-6	+10	+15	
2300E	1404	+26	-7	+19	+12	
2400E	1410	+13	-7	+6	+14	
2500E	1418	+26	-8	+16	+11	

LINE SP-5 (CONT'D)

(1)	(2)	(3)	(4)	(5)	(6)		(7)
2600E	1422	+20	-8	+12	+10		
2700E	1429	+11	-9	+2	+6		
2800E	1433	+12	-9	+3	+2		
2900E	1441	+12	-10	+2	-1		
2960E	1446	+2	-10	-8	—		
						true meters	
100W	1621	+14	-10	+4	+3	115	Paced distances; 100 ≈ 115 m
200W	1626	+15	-10	+5	+9	230	
300W	1631	+26	-9	+17	+9	345	
400W	1636	+13	-9	+4	+9	460	
450W	1758	+16	-9	+7	+1	518	
500W	1642	0	-8	-8	+4	575	
600W	1648	+26	-8	+14	+3	690	
700W	1653	+10	-8	+2	+5	805	
800W	1659	+9	-8	+1	+4	920	
900W	1706	+17	-7	+10	+5	1035	
1000W	1711	+10	-7	+3	+6	1150	
1100W	1718	+12	-7	+5	+6	1265	
1200W	1723	+15	-6	+9	+11	1380	
1300W	1729	+24	-6	+18	—	1450	25 m E of E edge of highway

LINE SP-6 ANIMAS, N.M. 14-15 MARCH 77

①	②	③	④	⑤	⑥	⑦
1300E	1127	0	—	0	0	Ref. at 1300 E. Begin 14 Mar.
1400E	1132	-5	+5	0	-1	
1600E	1139	-6	+4	-2	0	at 16/21 | 15/22
1800E	1149	-1	+4	+3	0	
2000E	1157	-3	+3	0	0	
2200E	1207	-6	+2	-4	+1	
2400E	1214	+5	+2	+7	+7	
2600E	1223	+18	+1	+19	+7	
2800E	1231	-5	0	-5	+5	
3000E	1236	0	0	0	-1	
3200E	1250	+2	-1	+1	+2	
3400E	1301	+6	-2	+4	+3	
3600E	1316	+6	-2	+4	—	End line to E
1200E	1423	+2	-3	-1	0	
1000E	1456	+4	-3	+1	+1	Ref. now at 1200 E, +2 wrt 1300E
800E	1511	+7	-3	+4	+4	+2 mV included in col. ③ for tie to 1300
600E	1518	+9	-2	+7	+6	
400E	1524	+8	-2	+6	+6	
200E	1531	+7	-2	+5	+4	
0	1538	+4	-2	+2	+5	at 17/20 | 16/21
200W	1549	+9	-2	+7	+5	
400W	1556	+8	-1	+7	+6	
600W	1602	+6	-1	+5	+3	
800W	1612	-2	-1	-3	+1	End 14 Mar

SP-6 CONT'D

15 MARCH 77

①	②	③	④	⑤	⑥	⑦
*Col. 4 includes -2 mV to tie to 800W			*			
3200W	1013	—	—	-2	+2	Ref at 3200W, 13/18 24/19
3100W	1028	-9	-1	-10	-9	
3000W	1033	-14	-1	-15	-9	
2900W	1044	0	-1	-1	-8	~~Level at 2940W~~
2800W	1051	-8	-1	-9	-4	
2700W	1056	-1	-1	-2	-5	
2600W	1103	-4	-1	-5	-3	
2500W	1109	-1	-1	-2	-3	
2400W	1120	-1	-1	-2	-1	
2300W	1125	+2	-1	+1	-1	
2200W	1130	0	-1	-1	-1	
2100W	1135	-1	-1	-2	-1	
2000W	1141	+2	-1	+1	-2	
1900W	1150	-4	-2	-6	-3	
1800W	1155	-2	-2	-4	-5	
1700W	1203	-3	-2	-5	-3	
1600W	1211	-3	-2	-5 ✓	-4	
1500W	1217	+1	-2	-1	-3	
1400W	1226	0	-2	-2	-1	
1300W	1233	+2	-2	0	-1	
1200W	1239	+1	-2	-1	0	
1100W	1245	+2	-2	0	0	
1000W	1251	+2	-2	0	0	

SP-6 CONT'D 15 MARCH 77

①	②	③	④	⑤	⑥	⑦
900W	1256	+2	-2	0	-1	
800W	1303	-1	-2	-3	+1	End line to E
3300W	1451	+23	-3	+20	+13	Begin line to W. Ref 3200W
3400W	1457	+25	-3	+22	+19	
3500W	1502	+19	-3	+16	+14	
3550W	1515	+8	-3	+5	+6	
3600W	1509	+1	-3	-2	0	
3700W	1521	+1	-3	-2	-5	
3800W	1526	-7	-3	-10	+2	
3900W	1532	+22	-3	+19	+10	
4020W	1539	+22	-3	+19	+20	
4100W	1544	+24	-3	+21	+19	
4200W	1549	+21	-3	+18	+20	
4420W	1700	+25	-3	+22	+19	
4600W	1616	+19	-3	+16	+18	
4800W	1625	+20	-3	+17	—	at 19|13 / 23|24. End line to W

LINE SP-7 ANIMAS, N.M. 17 MARCH 77

①	②	③	④	⑤	⑥	⑦
2400W	0927	0	—	0	+8	Ref. at 2400 W
2200W	0940	+1	+6	+7	+7	
2000W	0946	+9	+5	+14	+9	
1800W	0954	0	+5	+5	+9	
1600W	1002	+3	+5	+8	+5	
1400W	1008	-2	+4	+2	+3	
1200W	1014	-4	+4	0	-1	
1000W	1021	-8	+3	-5	-7	
800W	1027	-20	+3	-17	-12	
600W	1036	-18	+3	-15	-17	
400W	1043	-22	+2	-20	-15	
200W	1049	-12	+2	-10	-15	
0	1059	-17	+2	-15	-10	At $\frac{31}{6} \mid \frac{32}{5}$
200E	1104	-5	+1	-4	-8	
400E	1111	-5	+1	-4	-4	
600E	1118	-5	0	-5	-5	
750E	1122	-6	0	-6	—	Indeed; end line to E
2600W	1327	+16	0	+16	+12	
2800W	1337	+20	0	+20	+14	
3000W	1343	+5	0	+5	+14	
3200W	1351	+18	0	+18	+11	
3400W	1359	+11	0	+11	+17	

LINE SP-7 (CONT'D) 17 MAR 77

①	②	③	④	⑤	⑥	⑦
3600W	1404	+21	0	+21	+16	At gravel pits
3800W	1411	+17	0	+17	+18	
4000W	1417	+17	0	+17	+21	
4200W	1424	+28	0	+28	+19	
4400W	1430	+12	0	+12	+18	
4600W	1437	+14	0	+14	+11	
4800W	1443	+6	0	+6	—	At paved highway

LINE SP-8 ANIMAS, N.M. 18 MARCH 77

①	②	③	④	⑤	⑥	⑦
1600W	0849	0	—	0	0	Ref. at 1600W, ¼ sect., 25/30
1400W	0859	-4	+9	+5	+3	
1200W	0907	-4	+8	+4	+2	
1000W	0913	-12	+8	-4	-1	
800W	0921	-11	+7	-4	-3	
600W	0927	-8	+7	-1	-4	
400W	0938	-12	+6	-6	-4	
200W	0945	-11	+6	-5	-5	
0	0954	-9	+5	-4	-4	at ¼ sect 29/30
200E	1001	-7	+4	-3	-3	
400E	1007	-7	+4	-3	-4	
600E	1018	-10	+3	-7	-6	
800E	1027	-10	+3	-7	-7	
1000E	1034	-10	+2	-8	-9	
1200E	1041	-13	+1	-12	-11	
1400E	1048	-13	+1	-12	—	End line to E
1700W	1221	-3	0	-3	+1	
1800W	1227	+6	-1	+5	+5	
2000W	1232	+15	-1	+14	+3	
2200W	1238	-3	-2	-5	+7	
2400W	1245	+14	-2	+12	+3	
2600W	1251	+5	-3	+2	+9	50m. E. of houses

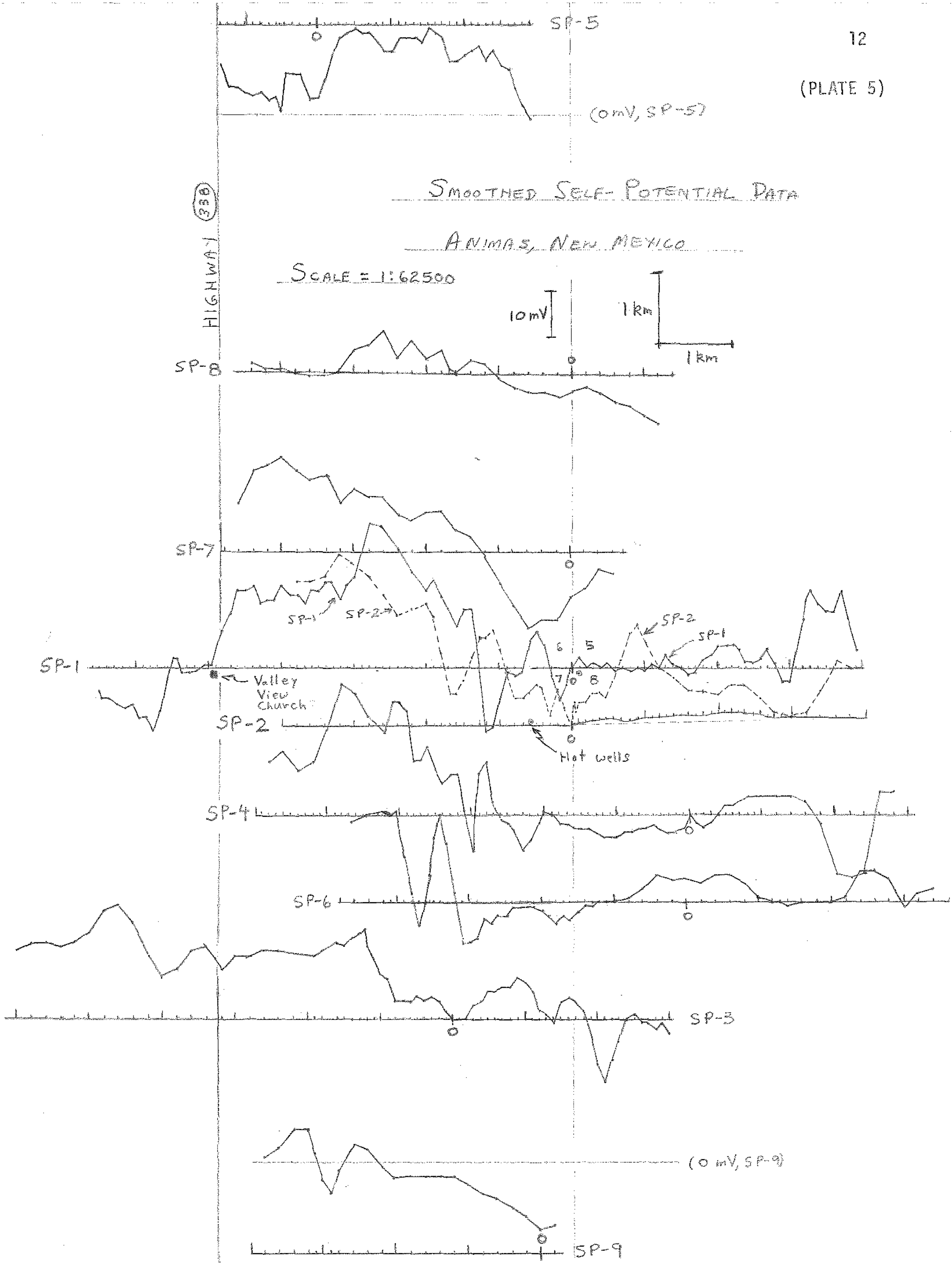
LINE SP-8 (CONT'D)

①	②	③	④	⑤	⑥	⑦
2800W	1302	+16	-3	+13	+6	
3000W	1308	+7	-4	+3	+5	
3200W	1316	+2	-4	-2	0	
3400W	1327	+3	-5	-2	-1	
3600W	1333	+5	-5	0	-1	
3800W	1340	+4	-6	-2	0	
4000W	1347	+9	-6	+3	+1	
4200W	1354	+10	-7	+3	+1	
4400W	1401	+5	-7	-2	+2	
4600W	1408	+13	-8	+5	—	End line to W.

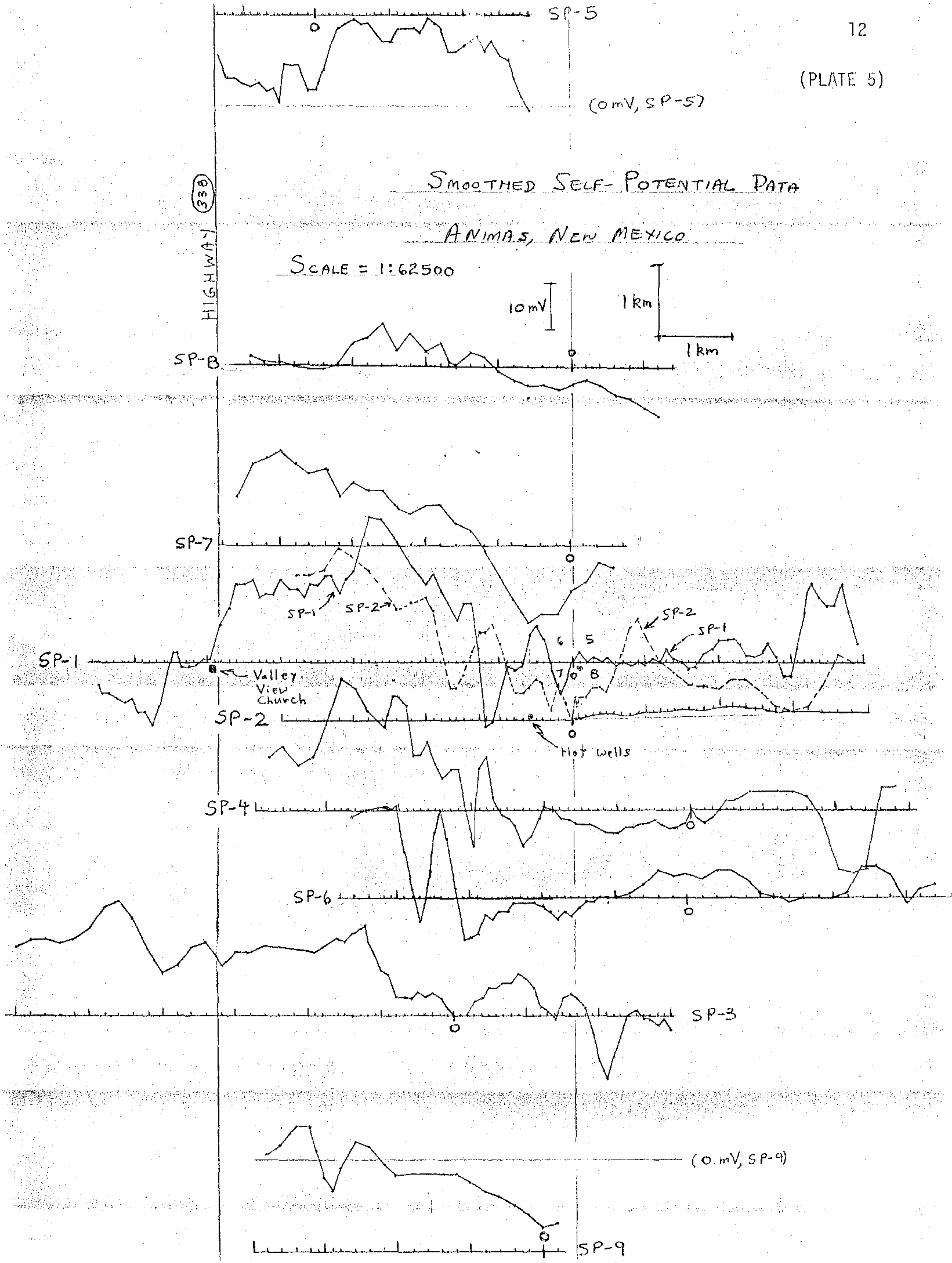
LINE SP-9 ANIMAS, N.M. 19 MARCH 77

①	②	③	④	⑤	⑥	⑦
2800W	0859	0	—	0	−2	Ref. at 2800W. Power pole 20 m W
2600W	0908	+5	−1	+4	+4	
2400W	0918	+9	−1	+8	+3	
2200W	0924	−2	−2	−4	−1	
2000W	0931	0	−2	−2	−3	
1800W	0938	+1	−3	−2	−3	
1600W	0944	−2	−3	−5	−3	
1400W	0954	+2	−4	−2	−3	
1200W	1001	+2	−4	−2	−3	
1000W	1008	+1	−5	−4	−5	
800W	1020	−5	−5	−10	−7	
600W	1027	−2	−6	−8	−8	
400W	1032	0	−6	−6	−10	
200W	1039	−8	−7	−15	−12	
0	1046	−7	−7	−14	−15	
200E	1053	−9	−8	−17	−14	
300E	1102	−4	−8	−12	—	58 m SW of 531/532
2900W	1331	+1	−11	−10	−7	Note: wells, pumps, pipes
3000W	1221	−2	−8	−10	−4	along line, 2800W-4000W
3100W	1321	+20	−11	+9	+2	
3200W	1227	+14	−8	+6	+7	
3400W	1236	+15	−9	+6	+7	
3600W	1244	+17	−9	+8	+3	
3800W	1251	+6	−10	−4	+1	
4000W	1257	+10	−10	0	—	End line to W

(PLATE 5)

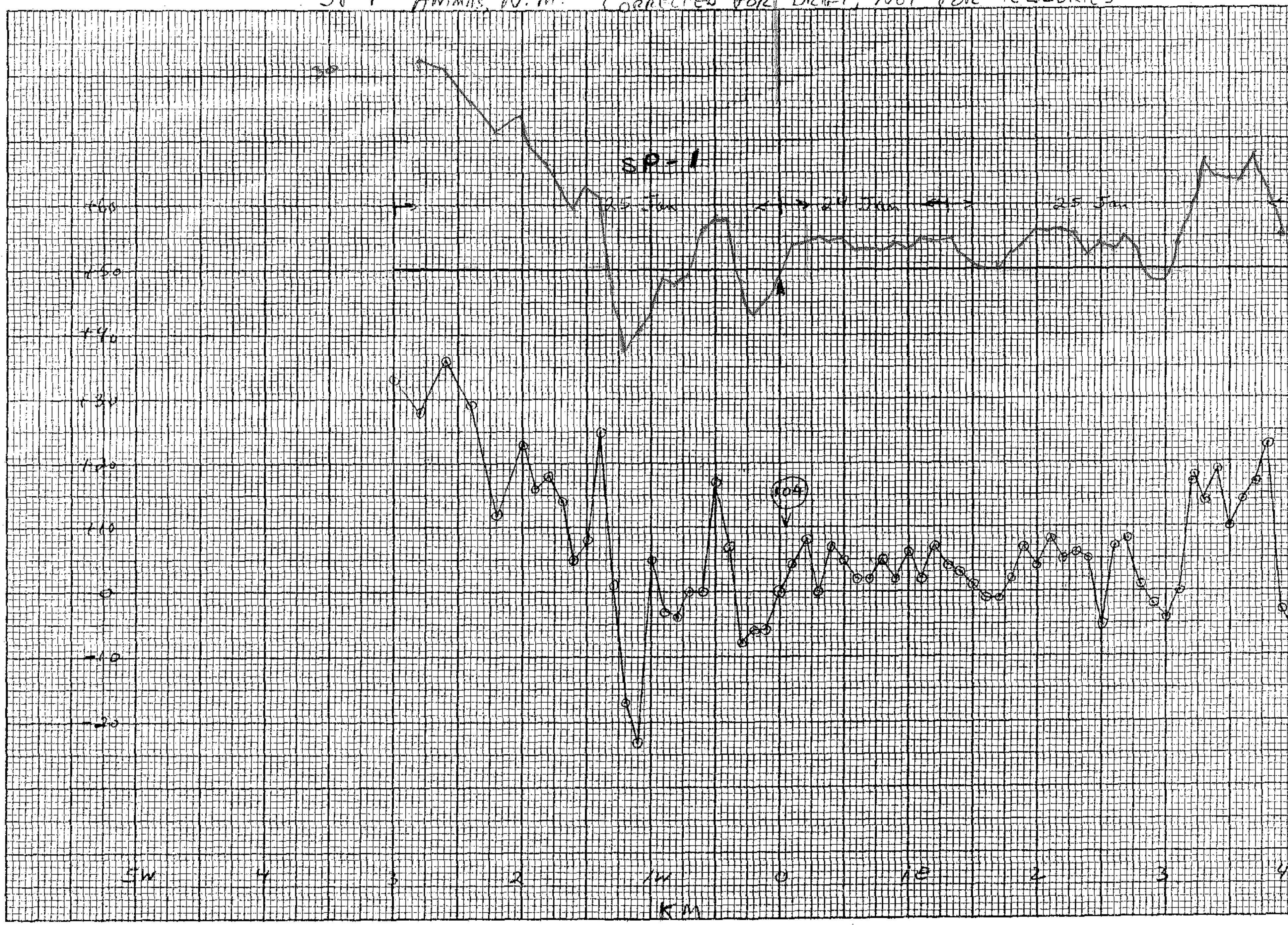

SP-5
(0 mV, SP-5)
SMOOTHED SELF-POTENTIAL DATA
ANIMAS, NEW MEXICO
SCALE = 1:62500
HIGHWAY 338
10 mV
1 km
1 km
SP-8
SP-7
SP-1
SP-2
Valley View Church
Hot wells
SP-4
SP-6
SP-3
(0 mV, SP-9)
SP-9

(PLATE 5)


SP-5
(0 mV, SP-5)
SMOOTHED SELF-POTENTIAL DATA
ANIMAS, NEW MEXICO
SCALE = 1:62500
HIGHWAY 338
10 mV
1 km
1 km
SP-8
SP-7
SP-1
SP-2
Valley View Church
Hot wells
SP-4
SP-6
SP-3
(0 mV, SP-9)
SP-9

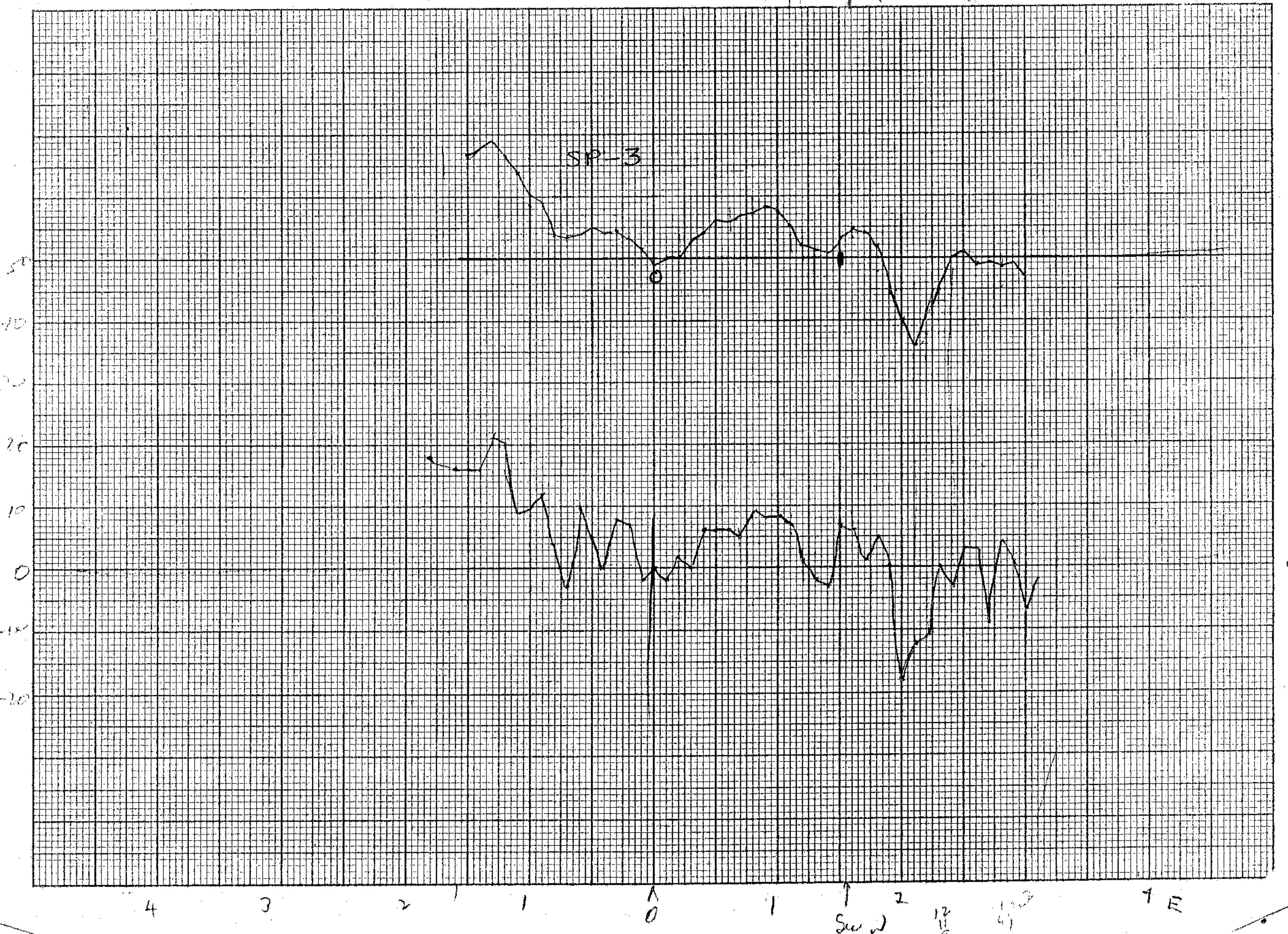
K+E 10 X 10 TO 1/2 INCH 46 1322
7 X 10 INCHES
KEUFFEL & ESSER CO.

SP-1 ANIMAS, N. M. CORRECTED FOR DRIFT; NOT FOR TELLURICS

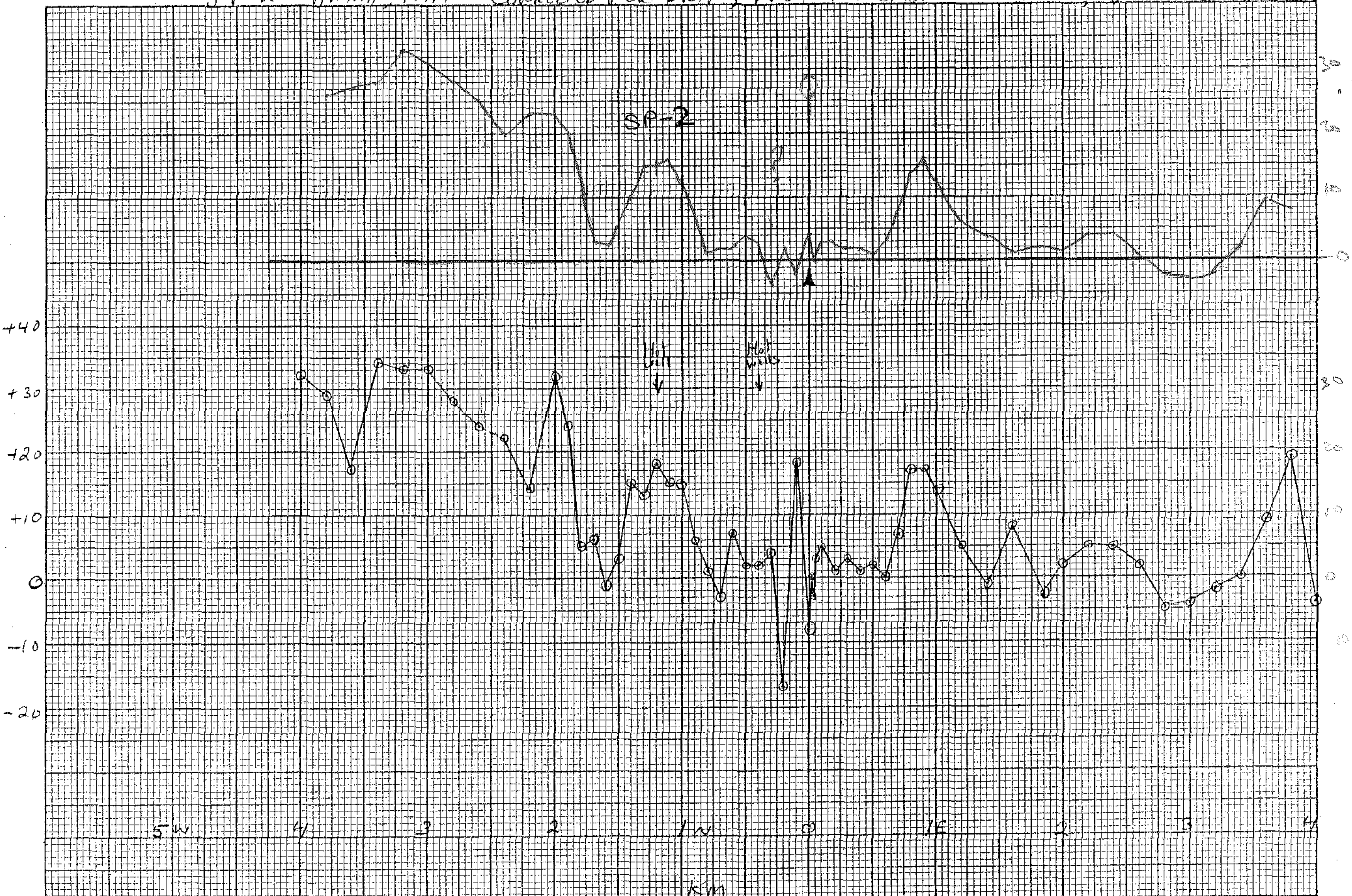


K+E 10 X 10 TO ½ INCH 46 1322
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

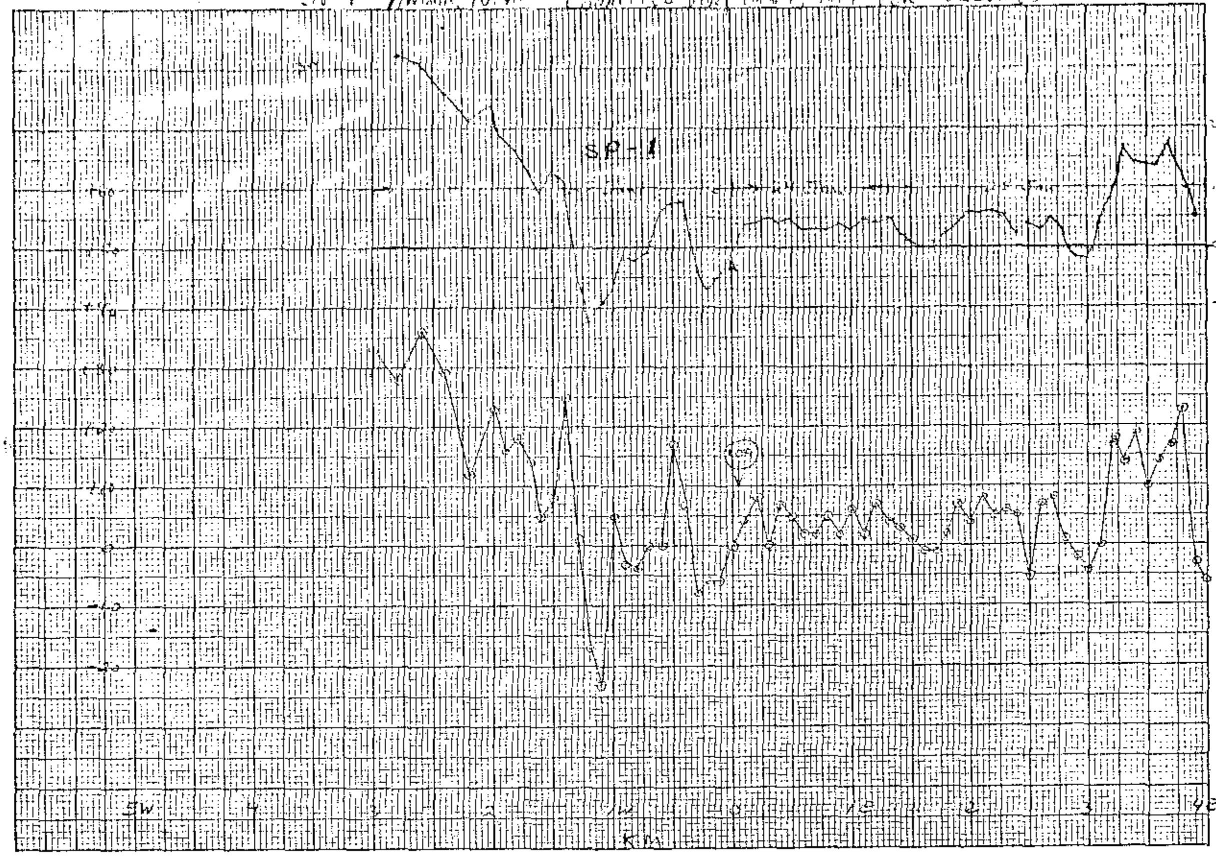
SP-3



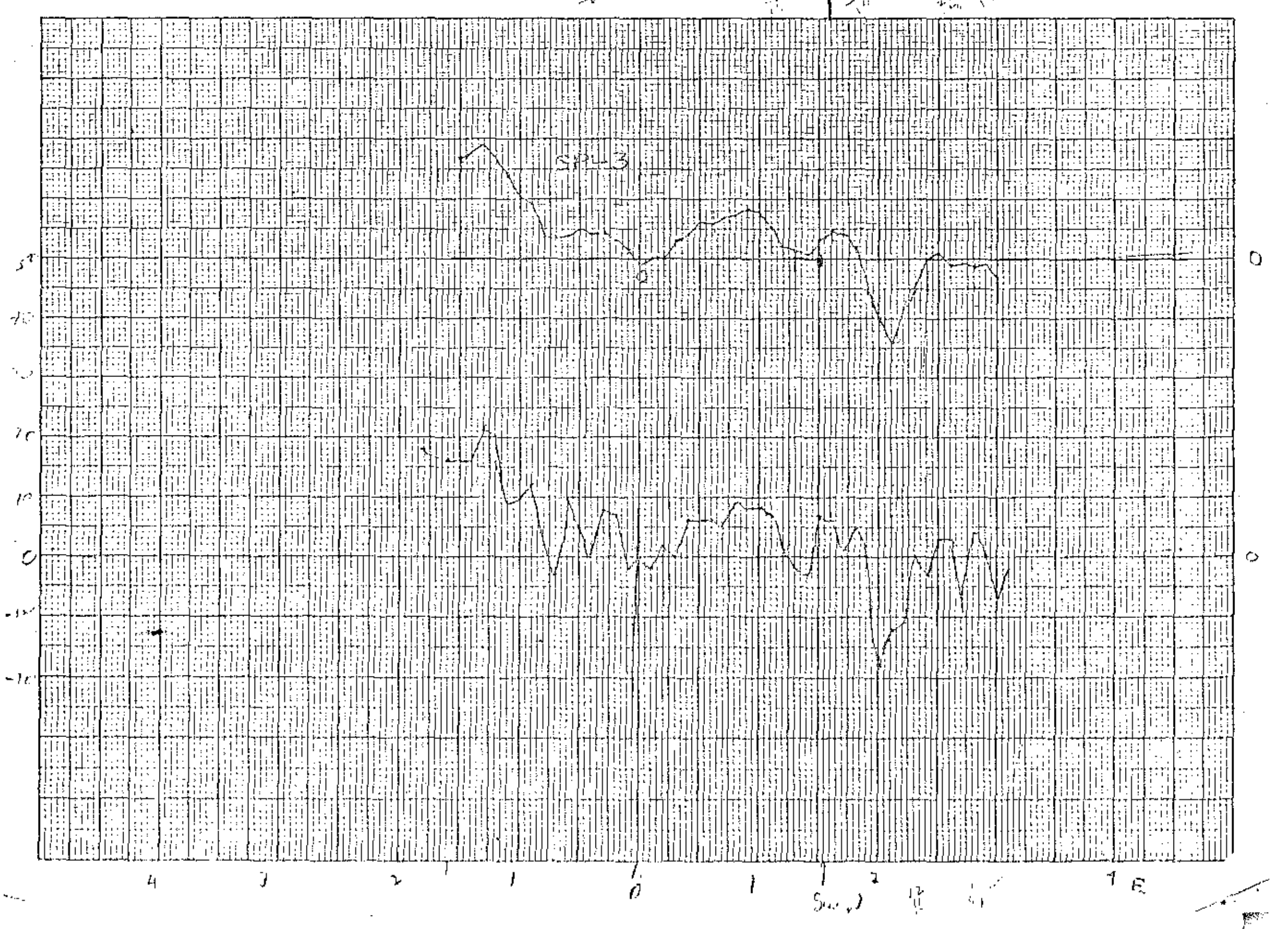
SP-2 ANIMAS, N.M. CORRECTED FOR DRIFT, NOT TELLURICS. REF. TO 0, SP-1 26 JAN 77

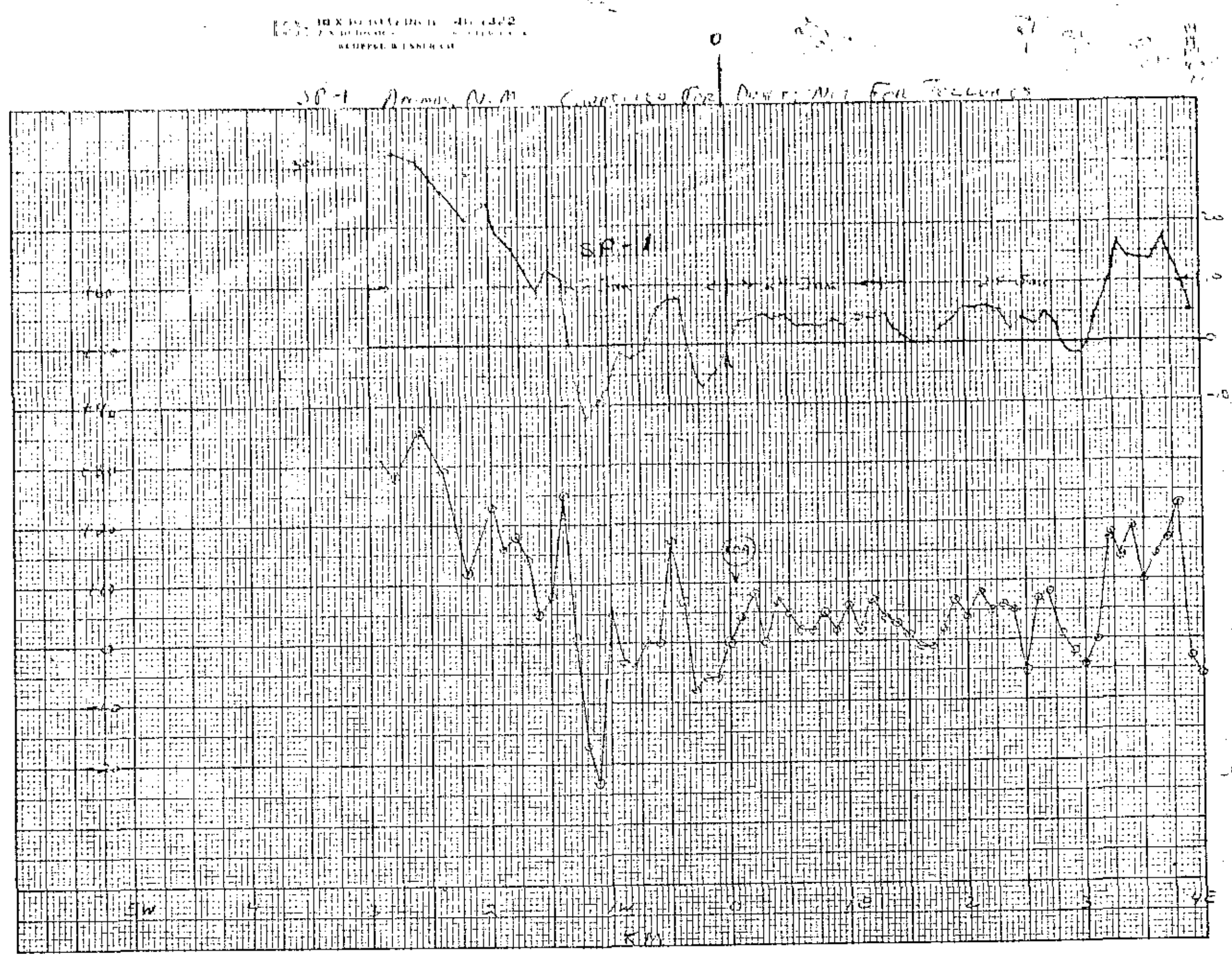


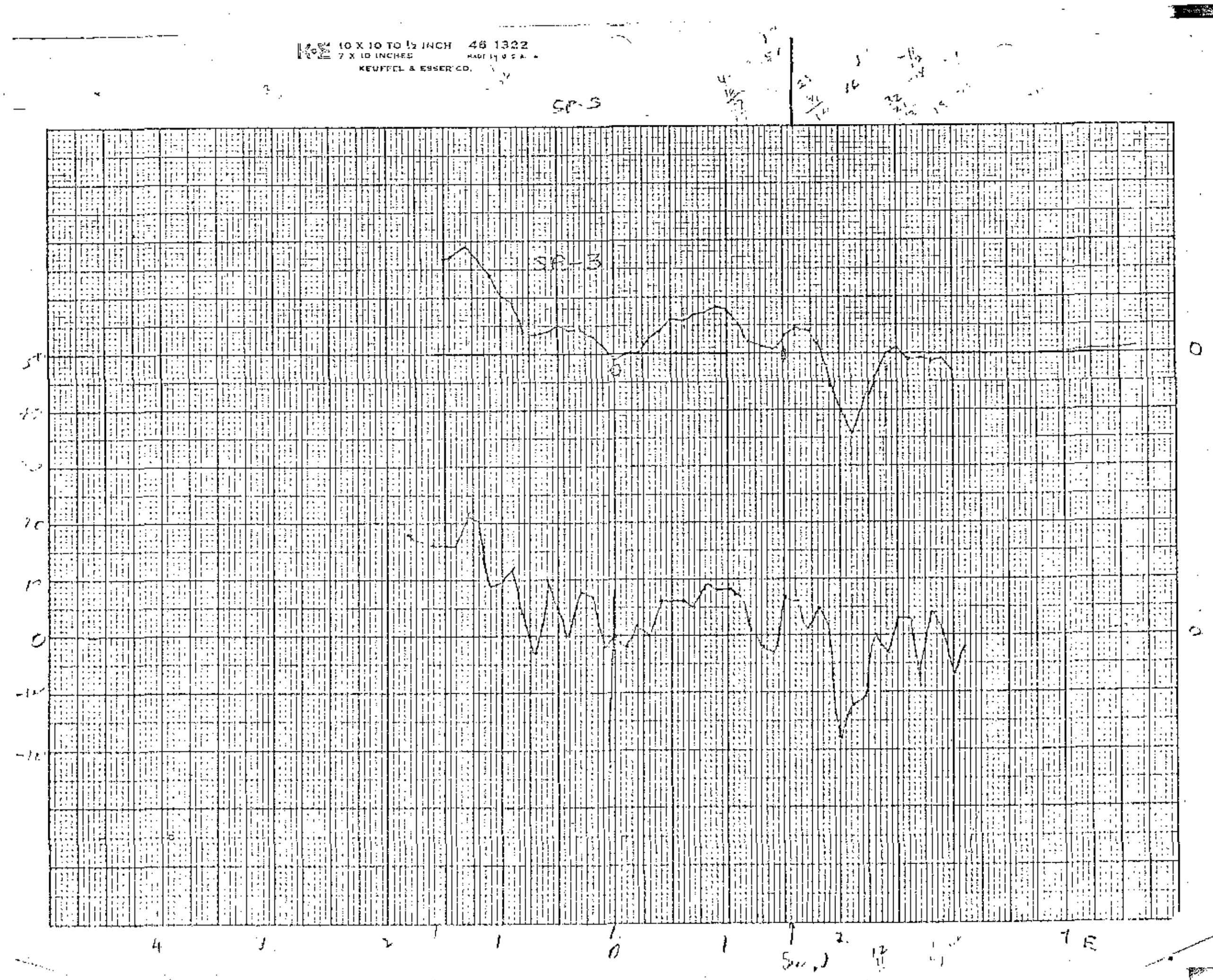
SP-1 Animas N.M. Corrected For Drift: Not For Terrain



SP-3




SP-1
KM


KEUFFEL & ESSER CO.
SP-3

ANIMAS SP

STA	MST TIME	DRIFT Δ ADD	V_{obs} mv	$V_{corr.}$	Survey Ref adjust		
LINE A	19 Mr 79						
A 0	1340	0.	0.	0.			
a	1340	0.	-6.8	-6.8			
200	1350	0.	-5.0	-5.0			
400	1400	-.1	0.0	-.1			
600	1410	-.1	+4.0	+4.1			
¼SON (800)	1415	-.1	-2.0	-2.1			
1000	1425	-.1	+3.0	-3.1			
1200	1435	+.1	+7.5	+7.6			
1400	1445	+.2	0.0	+.2			
+ (1600)	1450	+.2	-5.5	+5.7			
1800	1500	+.2	-3.0	-3.2			
2000	1508	+.2	-3.0	-3.2			
2200	1517	+.2	-1.0	-1.2			
¼S (2400)	1529	-.2	-2.0	-2.2			
2600	1600	-.3	+14.0	-14.3			
2800	1606	-.3	-5.0	-5.3	<	← Tie with C	
a'	1730	-.5	+6.3	-6.8			
		ADD					
DRIFT:	1340 – 1400	0.					
TIME	1400 – 1444	-.1					
÷5	1445 – 1529	-.2					
	1530 – 1614	-.3					
	1615 – 1700	-.4					
	1700 – 1730	+.5					
LINE B	20 Mr 79				Subt. 3.5 mv		
0	0930		0.				
b	0930		+4.8				
A 0	0938	-.33	3.8	3.47	0.		
200	0950	-.83	2.7	1.87	-1.6		
400	0956	-1.1	1.6	0.5	-2.9		
600	1001	-1.3	7.4	6.1	+2.6		
¼S 805	1007	-1.5	0.5	-1.0	-4.5		
1000	1014	-1.8	11.5	9.7	+6.2		
1200	1020	-2.1	3.8	1.7	-1.7		
1400	1026	-2.3	8.9	6.6	3.1		
1610	1033	-2.6	7.1	4.5	1.0		
1800	1040	-2.9	9.2	6.3	2.0		
SOTH 2000*	1047	-3.19	9.0	5.8	2.3		
b	1121	-4.6	+9.4	+4.80	1.3		

DRIFT 9.4 – 4.8 = 4.6

1120 – 0930 = 110 min 2.49 mv/hr

STA	MST TIME	+.2/hr DRIFT Δ ADD	V obs.	V corr	V adjusted
LINE C	20 Mr 79				
0	12.20		0	0	-8.5
0b	12.20		+2.3		
200	12.31	-.04	-.6	-.6	-9.1
400	12.40	-.07	-2.6	-2.7	-11.2
600	1300	-.13	{+2.0	1.9	-6.6 }
"	1528		+3.8}	3.2	-5.3 }
800	1549		+3.0	2.3	-6.2
1000	1556		+4.2	3.5	-5.0
1200 ([illegible])	1603		-.3	-1.	-9.5
1400	1608		+2.3	1.5	-7.0
1600	1615		0.	-.8	-9.3
1620 (2800 m A)	1618	-.79	+4.0	+3.2 =	-5.3
0b	1653	-.9	-1.4	-2.3	
LINE D		+1.65/hr			
0	1653		0	0 =	-8.5
0b	16.53		+1.4		
	18.35		-1.4	+1.4	-7.1
200	17.12		3.8	4.3	-4.2
[illegible]	17.18		1.9	2.6	-5.9
600	17.23		-4.9	-4.1	-12.6
800	17.28		-2.0	-1.0	-9.5
1000	17.33		+5.0	6.4	-2.1
[illegible]	17.39		-10.9	-9.6	-18.1
1400	17.44		-2.0	-0.6	-9.1
1600	17.50		-7.5	-5.9	-14.4
1800	17.56		5.2	6.9	-1.6
[illegible]	18.00		-.5	1.3	-7.2
LINE E		-2.23/hr		0 =	-7.0
0	10.45		0.	0.	-7.0
0b	10.45		-10.5		
	14.20	-8.0	-2.5	-10.5	-17.5
200	10.58		-4.4	-4.9	-11.9
400	11.05		0.	-0.7	-7.7
600	11.15		4.4	3.3	-3.7
800	11.20		9.5	8.2	+1.2
1000	11.26		21.4	19.9	12.9
1200	11.31		3.4	1.9	-5.1
1300	11.55		-10.9	-13.5	-20.5

45-608 EYE-EASE
45-708 20/20 BUFF
NATIONAL

LINE E CONT'D STA	TIME	DRIFT Δ ADD	V_{obs}	V_{corr}	$V_{adj'd}$		
1400	11.40		−1.2	−3.2	−10.2		
"	12.01		−1.1	−3.9	−10.9		
1600	12.20		1.3	−2.2	−9.2		
1675	13.42		−9.7	−16.3	−23.3		
1800	12.28		+7.5	3.7	−3.3		
2000	12.33		+8.5	4.5	−2.5		
2200	12.44		−6.5	−10.9	−17.9		
2400	12.47		−9.9	−14.4	−21.4		
2600	12.53		−6.9	−11.7	−18.7		
2800	12.59		−9.5	−14.5	−21.5		
3000	13.03		−.7	−5.8	−12.8		
3200+	13.08		−12.6	−17.9	−24.9		
LINE F					Sub. −24.9		
0b	15.20	Sub 2.23/hr	3.8		−24.9		
0b	16.30		6.4	3.8	−21.1		
200	15.25		−5.0	−5.2	−30.1		
400	15.30		+5.5	5.1	−19.8		
600	15.37		18.0	17.4	−7.5		
750+	15.43		1.3	0.4	−24.5		
1000	15.50		8.7	7.6	−17.3		
1200	15.55		9.0	7.7	−17.2		
1400	16.00		16.2	14.7	−10.2		
1500+	16.05		16.0	14.3	−10.6		

GORENIN SP

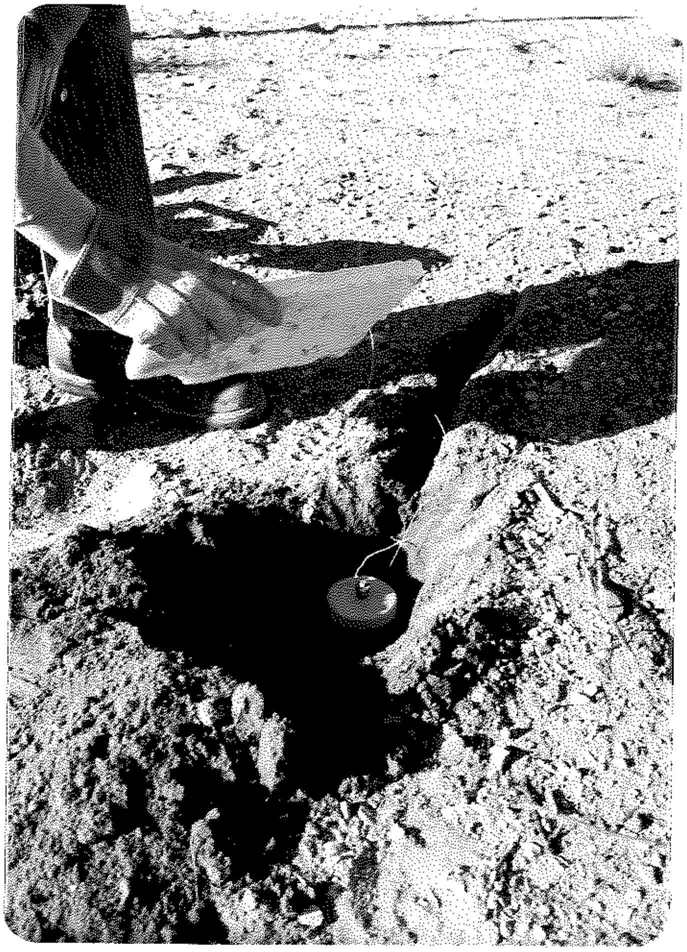
LINE SP-1 STA	mV (find)	Adj -3	Adj -7 (-10 tot)
0	3	0.	-7.
100E	0	-3.	-10.
200	4		-6.
300	-4		-14.
400	3		-7.
500	1		-9.
600	-2		-12.
700	-2		-12.
800	1		-9.
900	-2		-12.
E 1km	2	-1.	-8.
1.1	-2		-12.
1.2	3		-7.
1.2	0	-3.	-10.
		Adj -6	(-13 total)
1. E	5	-1.	-8.
1.3	4	-2.	-9.
1.4	2.		-11.
1.5	0		-13.
1.58	-3		-16.
1.6	-2.		-15.
1.7	-2.		-15.
1.8	1.		-12.
1.9	6.		-7.
2.0	3		-10.
2.1	7.		-6.
2.2	4		-9.
2.3	5.		-8.
2.4	4.		-9.
2.5	-6.		-19.
2.6	+6.		-7.
2.7	7.		-6.
2.8	0		-13.
2.9	-3		-16.
3.0	-5.		-18.
3.225	17.		+4.
3.1	-1		-14.
3.2	+16.		+3.
3.3	16.		+3.
3.4	18		+5.
3.5	9		-4.

SP-1 STA	mV (find)	Adj -6
3.6 E	13.	0.
3.7	16	+3.
3.8	22.	+9.
3.9	-4.	-17.
4.0	-7.	-20.
0.1 W	-6.	-19.
.2	-6.	-17.
.3	-8.	-21.
.4	7.	-6.
.5	17	+4.
.6	0.	+13.
.7	0.	-13.
.8	-4.	-17.
.9	-3.	-16.
1.0	5.	-8.
1.1	-23.	-36.
1.2	-17.	-30.
1.3	11.	-2.
1.4	25.	+12.
1.5	9.	-4.
1.6	5.	-8.
1.7	14	+1.
1.8	18	+5.
1.9	16.	+3.
2.0	23.	+10.
2.2	12	-1.
2.4	27	+16.
2.6	36	+23
2.8	28	+15.
3.0 W	23	+20.

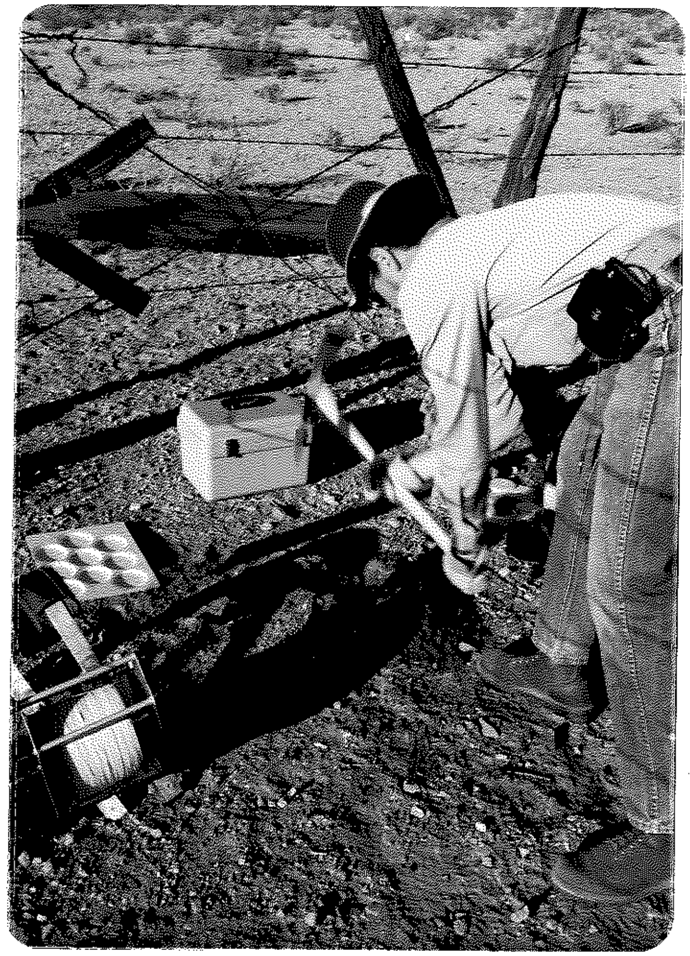
ANIMAS
JP Survey

77-3-17

ANIMAS
SP survey



77-1-31



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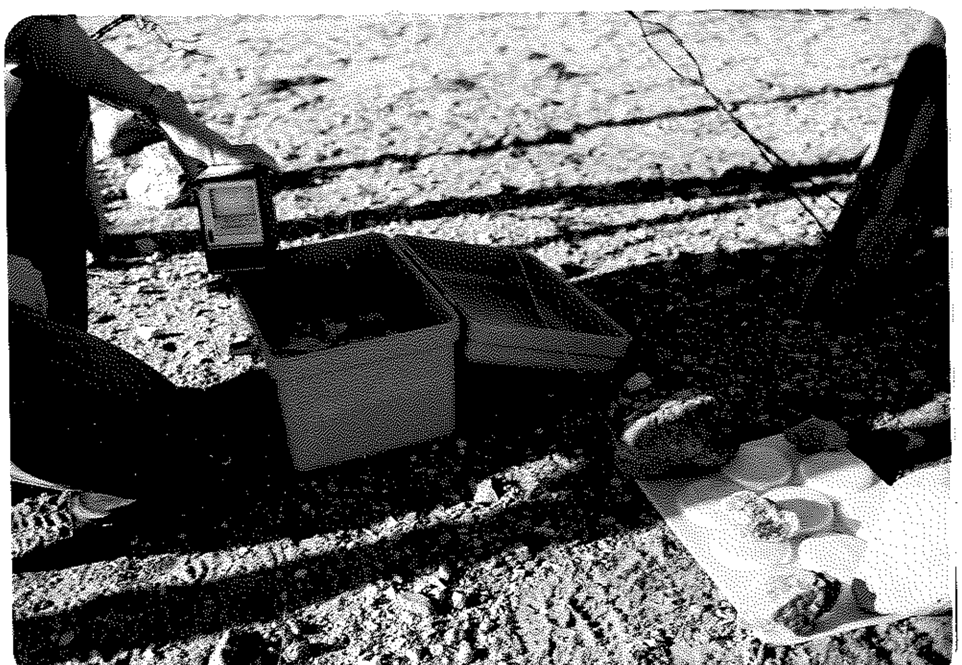

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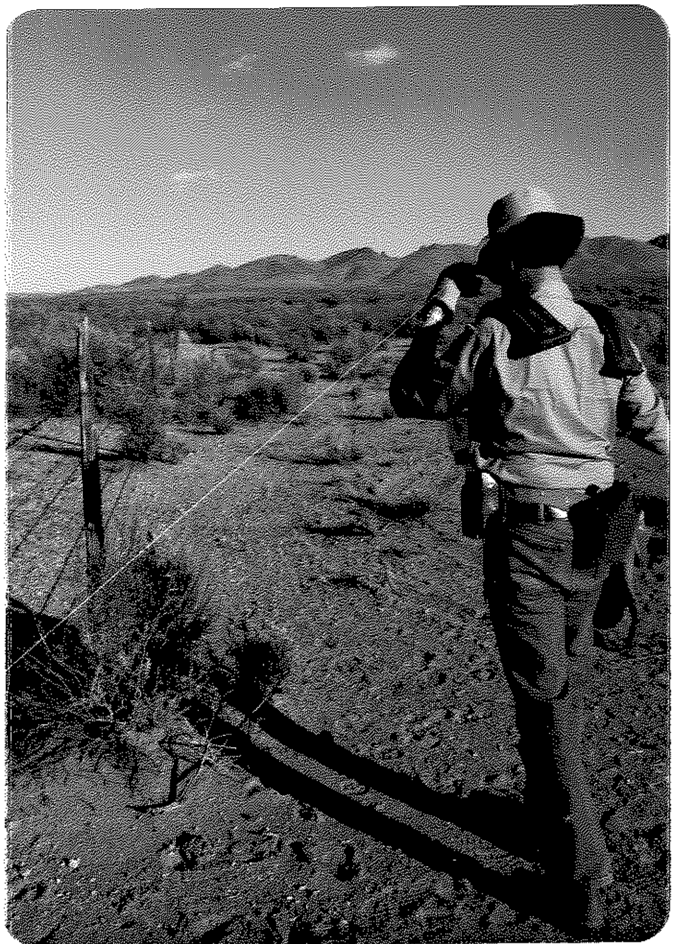
ANIMAS
S.P. SURVEY

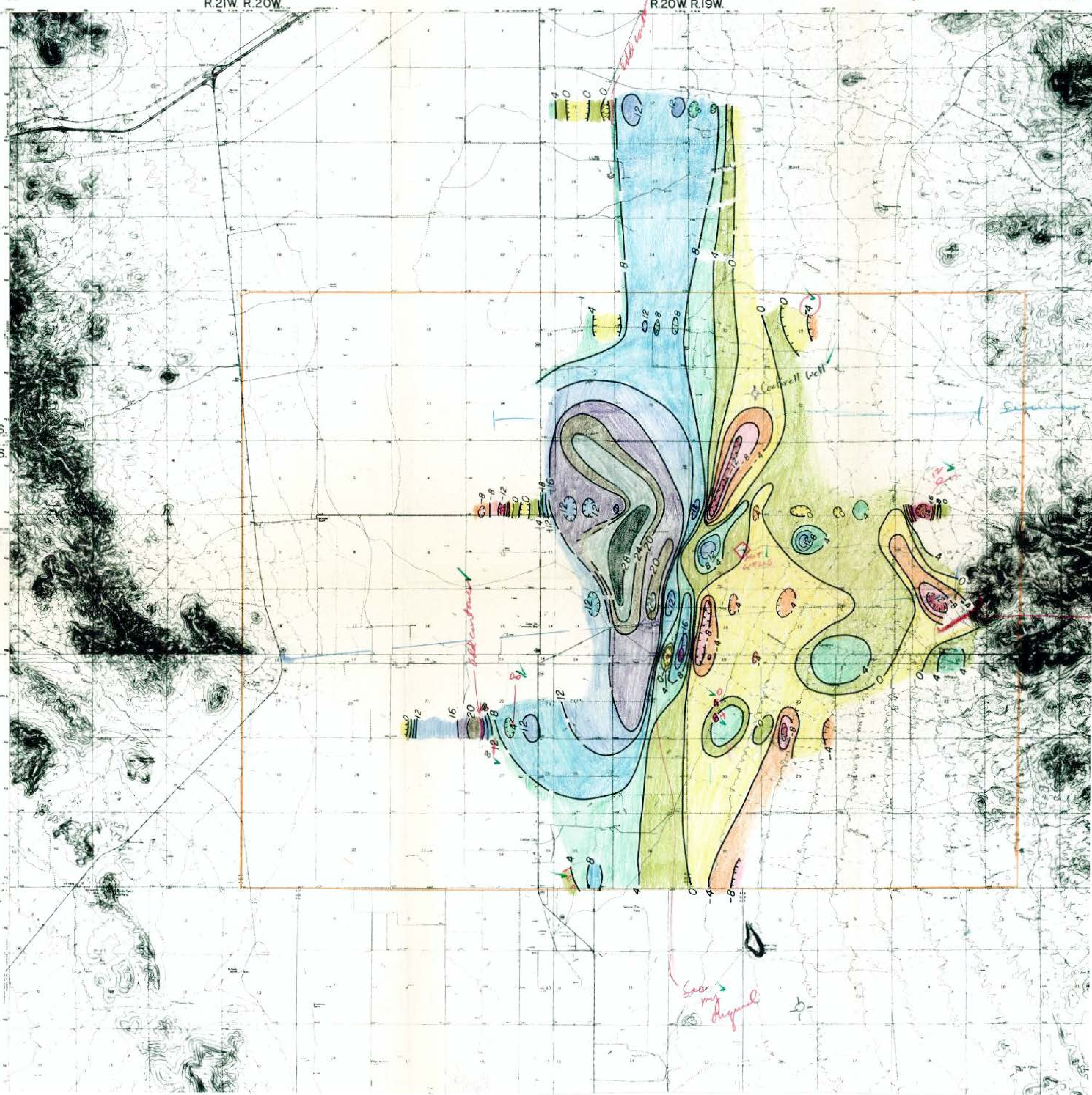


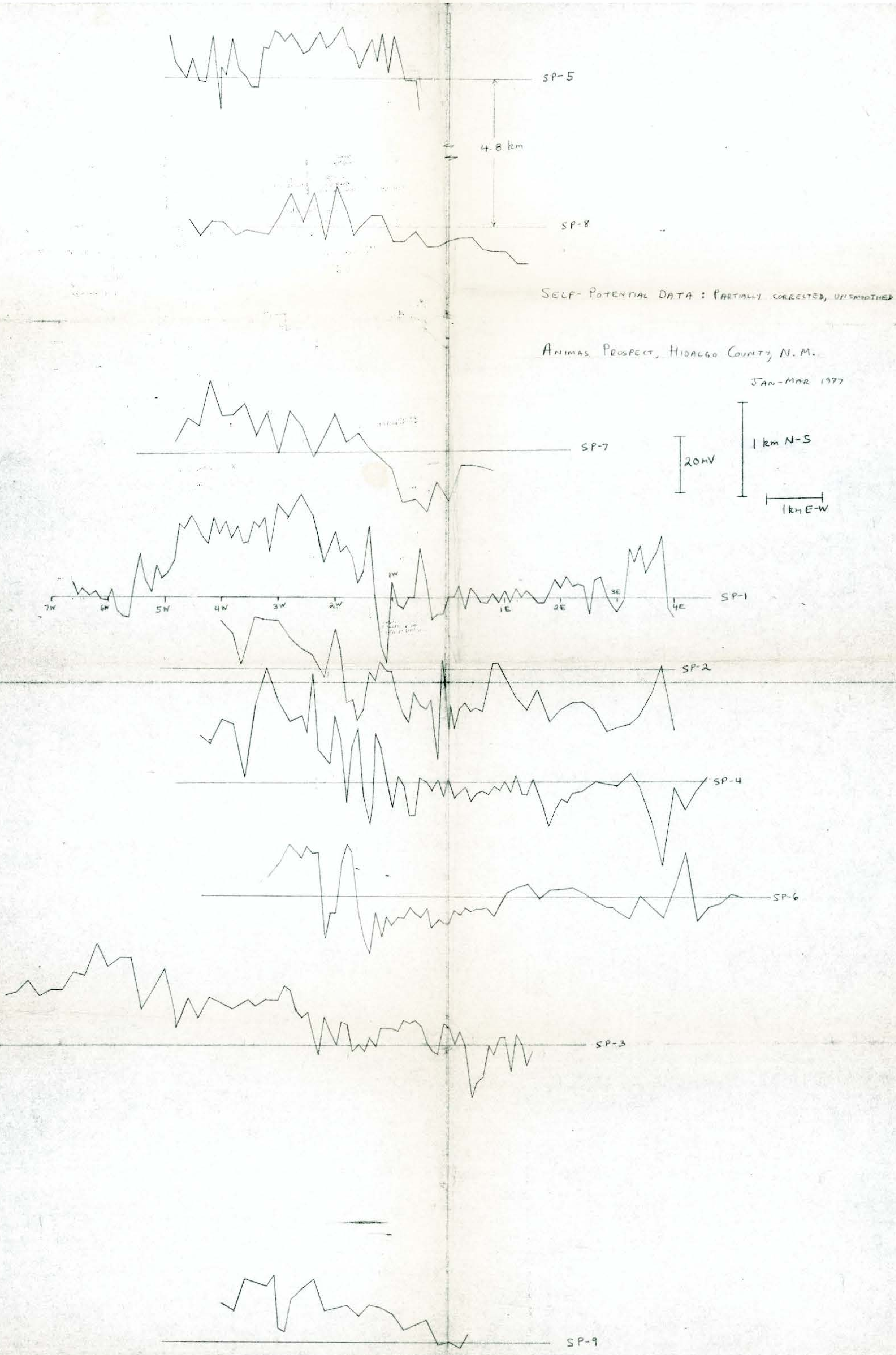
77-1-34

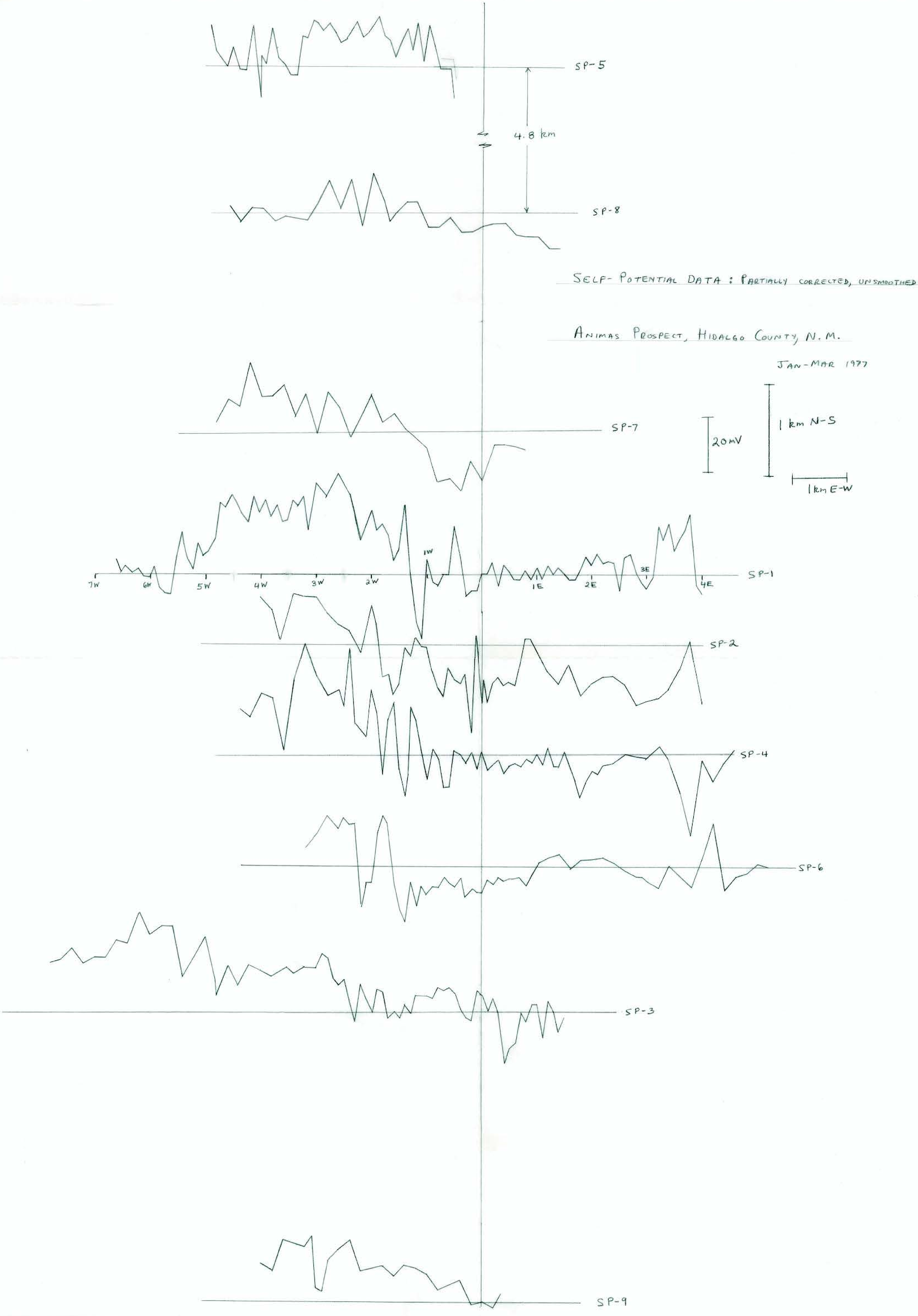
77-1-36

77-1-35

ANIMAS Self Potential 1977




SP-5
4.8 km
SP-8
SELF-POTENTIAL DATA: PARTIALLY CORRECTED, UNSMOOTHED
ANIMAS PROSPECT, HIDALGO COUNTY, N.M.
JAN-MAR 1977
SP-7
20mV
1 km N-S
1km E-W
7W
6W
5W
4W
3W
2W
1W
1E
2E
3E
4E
SP-1
SP-2
SP-4
SP-6
SP-3
SP-9


SP-5
4.8 km
SP-8
SELF-POTENTIAL DATA: PARTIALLY CORRECTED, UNSMOOTHED
ANIMAS PROSPECT, HIDALGO COUNTY, N.M.
JAN-MAR 1977
20mV
1 km N-S
1 km E-W
SP-7
SP-1
7W
6W
5W
4W
3W
2W
1W
1E
2E
3E
4E
SP-2
SP-4
SP-6
SP-3
SP-9