GL00634

SELF-POTENTIAL SURVEYS

RINCON AND RADIUM HOT SPRINGS AREAS

DONA ANA COUNTY, NEW MEXICO

Interim Report

by

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INTRODUCTION

Self-potential surveys have often been used as one component of an exploration program for high-temperature geothermal resources. More recent work indicates that the method may apply equally well to exploration for low- and moderate-temperature resources. Self-potential (SP) surveys have been initiated in the Rincon and Radium Springs areas of Dona Ana County, New Mexico to evaluate radon anomalies observed in an earlier study (Witcher, 1990), to further explore for geothermal resource potential, and to continue to evaluate the applicability of the self-potential method for low- to moderate-temperature geothermal resource delineation.

The SP data reported here are interim survey results which will be extended in future survey efforts. Quantitative interpretation of the data will be forthcoming when the field survey results are completed and when interpretation algorithms can be modified.

GEOLOGY
(Jim will address this)

RINCON RADON SURVEY
(brief summary)

SELF-POTENTIAL METHOD IN GEOTHERMAL EXPLORATION

Background

Self-potential (spontaneous-potential or SP) surveys have often been used in the exploration for high-temperature geothermal resources. The method is relatively simple and inexpensive, and often gives encouragement for the presence of a thermal resource. SP responses occur as a wide variety of amplitudes, shapes, and multiple anomalies, and may be positive or negative in polarity (Corwin and Hoover, 1979). Zablocki (1976) has documented the association of SP anomalies with cooling magma on Kilauea Volcano, and mapped a large positive anomaly associated with the Puna geothermal resource in the Kilauea East Rift Zone (Zablocki, 1977).

The physical basis for self-potential anomalies has been examined by several authors. Corwin and Hoover (1979) describe the thermoelectric coupling effect and the electrokinetic coupling (streaming potential) effects which give rise to most anomalies associated with geothermal fluid flow. Fitterman (1979) presented an analysis of self-potential anomalies due to streaming potential effects in the vicinity of a vertical contact. Sill (1983) presented a unifying theory for the numerical modeling of self-potential data using primary physical flows, either heat or fluid.

Corwin and Hoover (1979) report a 50 millivolt (mV) negative anomaly associated with Leach Hot Springs, Nevada and a 150 mV (peak to peak) dipolar anomaly associated with the Cerro Prieto geothermal field, Baja California. Sill and Johng (1979) mapped a dipolar anomaly with a 100 mV low over the production zone at Roosevelt Hot Springs, Utah. At Monroe-Red Hill (Utah) deep circulation along a fault zone gives rise to a low temperature geothermal resource and a modest dipolar anomaly (-45 mV minimum, 25 mV maximum) as mapped by Mase et al (1978).

A recent study by Thanassoulas and Lazou (1990) reports SP results over the low enthalpy Lagadas geothermal field in Greece. The authors completed a total of 63 line km of SP profiles in an area of 40 sq km, observing SP values which typically ranged form -15 to +15 mV and anomaly minima of -55 mV which are associated with the geothermal field. At Lagadas the maximum temperatures observed to date are 37 C, at depths of 315 m.

A detailed SP survey at the Newcastle, Utah geothermal area (Ross et al, 1990) delineated a 108 mV negative anomaly which corresponds to the buried intersection of the Antelope Range Fault and northwest trending faults mapped in bedrock. Heat flow and resistivity data support the interpretation of the negative SP source as the probable upflow zone for thermal fluids which are now being produced from an outflow plume. With observed temperatures as high as 130 C and an anomalous heat flow loss estimated at 12.4 Mw, this resource may have some potential for binary power production.

RINCON SELF-POTENTIAL SURVEY

Survey Procedure

A radial or "spoke" survey technique was utilized so that many potential measurements could be measured directly with respect to a central stationary electrode, thereby minimizing cumulative errors which could result from looping between intersecting profiles. When it became necessary to extend the survey, the potentials of the individual reference electrodes were determined with respect to the primary base station and added to the new observed reading. A Fluke high-impedance digital voltmeter and copper-copper sulfate porous pot electrodes were used to measure naturally occurring earth voltages through a 1220 m (4000 ft) lightweight single conductor copper wire.

The surveys reported here were conducted September 24-28 1990 following a major weekend rainfall and a wet monsoon season. As a result the near surface soil moisture content was high, and electrode holes were only watered near the end of the survey period, and then only to verify questionable readings or at very dry pot locations. As a result noise levels were low and voltage reproducibility was excellent (generally +/- 2 mV) for most repeat readings.

Survey Results

The location of the survey area is shown in Figure 1. The topography of the area includes 500 feet of relief, locally steep hillsides, cliffs and incised drainages (Figure 3). The survey control, shown as Figure 4, included several profiles which radiate from the primary base station, R1-0, and secondary reference stations at stations R1S-3800S, R1S-2000S, and R1N-1400N. The observed voltage readings were corrected for potential drift between the reference and traveling electrode, and then plotted and contoured to form the map shown as Figure 5. All voltages are measured with respect to a zero value assigned to the primary base station. A total of 45,000 line feet of SP profile was completed during the survey. A basic station spacing of 200 feet was used for most of the survey, but this was decreased to 100 feet in several areas of high gradient.

Inspection of the map indicates the choice of 0 or background value to be reasonably appropriate, for only low gradients occur near the 0 contour, and this contour meanders across the non-anomalous portions of the survey area. Self-potential values between -20 mV and +20 mV are generally considered non-anomalous, and may result from local soil differences, infiltration and telluric current flow through differing subsurface resistivities.

A -58 mV anomaly occurs in the northeastern portion of the survey area. This anomaly is quite coherent, open to the north, and only partially defined. The location of the SP anomaly corresponds to a two station radon anomaly, and the joint occurrence of radon and SP anomalies strongly suggest that thermal fluids are present at depths less than 500 feet. Additional survey work is needed to fully define this anomaly.

A major negative anomaly trends north-northwest from the RAD-8 drill hole area to the northwestern portion of the survey area, and appears to continue beyond the northwest limit of the present survey. The length of the strongly anomalous zone (<-50 mV) exceeds 4000 feet, but is broken by a 500 foot area of higher potentials. The largest anomaly was observed near the RAD-8 drill site where a value of -113 mV was observed on profile R2N. A later detailed profile to assess the response of the 295 foot deep, one inch pipe, (Figure 6) indicates that the drill pipe gives rise to a +40 mV anomaly, probably detracting from the minima observed 116 feet away on profile R2N. Low values of -120 and -122 mV were also observed 80 feet NW and 50 feet SE of the drill site. The drill hole, sited on a radon anomaly and with geologic interpretation, is also located very near the SP anomaly minimum. Temperatures of 85 C were observed in this hole at a depth of 295 feet, an estimated 100 feet above the water table. The correspondence of anomalous radon values, SP minima, and high subsurface temperatures all indicate this area is an upflow zone for thermal fluids, probably along a structural intersection.

Four other SP minima are observed along this trend (Figure 5), and the trend of SP lows corresponds in general to high radon values. It appears that thermal fluids are rising along a northwest trending fracture zone. More work is needed to better define the northwestern portion of this significant anomaly.

Profiles R4W and R4WA cross a single point radon high near a northwest trending fault. The largest SP values of the survey, +23 and +24 mV were noted here. This may be a high associated with a -25 mV low mapped 500 to 1000 feet to the north, and thus be a dipolar expression arising from a fault contact (resistivity change), or could also be the expression of thermal fluids. This is a lower priority target area which warrants further study.

RADIUM SPRINGS SURVEY

A single 4000 foot SP profile was completed near Radium Springs. This profile was completed to determine if a more complete SP survey should be conducted in the area on a later field trip. The southwestern end of the profile, the reference station, is located approximately 3000 feet northeast of the developed Radium Springs area (Figure 7.) The profile crosses near drill hole RAD-2, a fractured rhyolite outcrop, and a weak radon anomaly (Figure 8). A substantial anomaly, shown as Figure 9, was observed northeast of the rhyolite outcrop. Insufficient work has been done to estimate the extent, orientation, and magnitude of the anomaly, but the magnitude probably exceeds -25 mV. Additional work is planned in this area.

DISCUSSION

Self-potential surveys have in general confirmed the anomalous areas defined by radon surveys in the Rincon and Radium Springs areas. Complete confirmation that the radon and SP anomalies result from moderate temperature geothermal fluids will require further drill testing. Based on the results of drill holes RAD-3, -7, and -8 in the Rincon area, and SP studies in other geothermal areas (discussed earlier) there seems to be little doubt that this is the case.

Several features of the SP method make it well suited for evaluating radon anomalies and other indications of a geothermal resource. These include low cost, quick turnaround of results (which allows for on site survey planning), and high spatial resolution of data in anomalous areas. Quantitative interpretation of the data adds to the value, but this is most effective when enhanced by other data which relate to electrokinetic or thermoelectric coupling parameters.

From the resource point of view, previously unknown thermal resources are indicated by both the radon and SP data in the Rincon and Radium Springs areas. It is important for future energy planning and for regional development planning that we evaluate the quality of these resources. The Rincon area is well sited near a major highway, railroad siding, and community, for direct heat utilization. Projected water table temperatures near or above 100 C indicate some possibility that this resource may lie at the lower range of economic electric power production, as described by Nichols et al. (1986). Additional drilling, temperature gradient surveys, and collection of thermal fluid samples are needed to evaluate this possibility. The Radium Springs anomaly is located near a major greenhouse (8.4 acres) which uses geothermal fluids for heating, and planned expansion of this facility will require additional geothermal fluids.

SUMMARY AND RECOMMENDATIONS

Self-potential surveys at Rincon and Radium Springs confirm the presence of anomalous areas indicated by radon soil gas studies. In view of existing drill hole results, it appears that both methods are mapping the presence of rising thermal fluids. The SP method provides an independent, low cost method for better resolving the target areas, and additional SP work should be completed at the Rincon and Radium Springs areas, and other high priority geothermal target areas in the southern Rio Grande Rift.

Additional drill testing is required to better evaluate the resource in the RAD-8 area. A 500 to 1000 foot drill hole, drilled with blowout prevention and gas monitoring equipment, would provide a much better evaluation of the enthalpy of the resource. The temperature gradient should be logged, and fluid samples collected for fluid chemistry and geothermometry to establish probable reservoir temperatures. Additional drilling will be required to evaluate SP/radon anomalies to the northwest and northeast. Additional SP surveys should be completed prior to siting these temperature gradient holes. Additional geophysical surveys (electrical resistivity) may be advisable prior to siting any deep production well tests, should these be indicated by promising results of earlier work.

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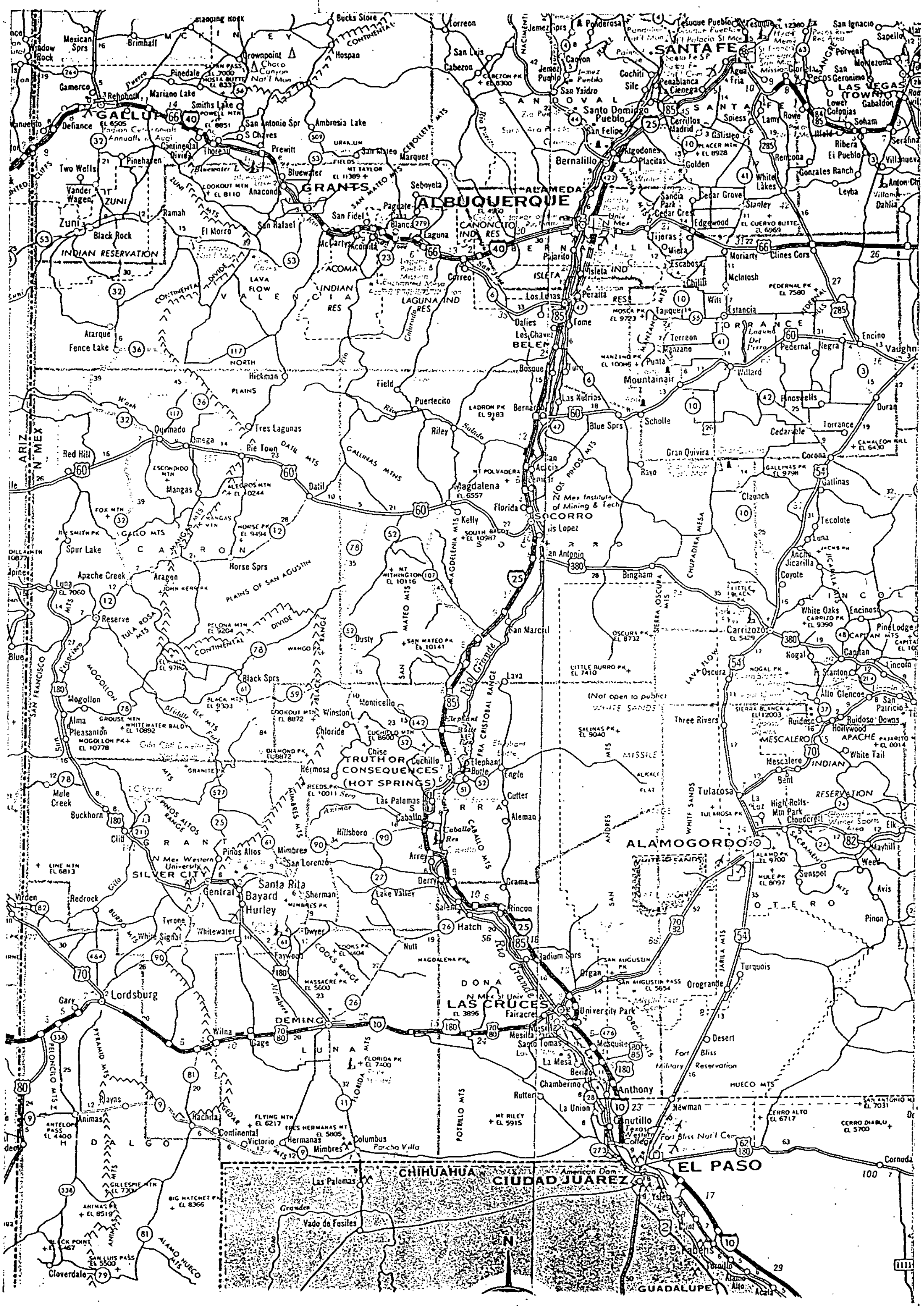


Figure 1. Location map, Rincon and Radium Springs

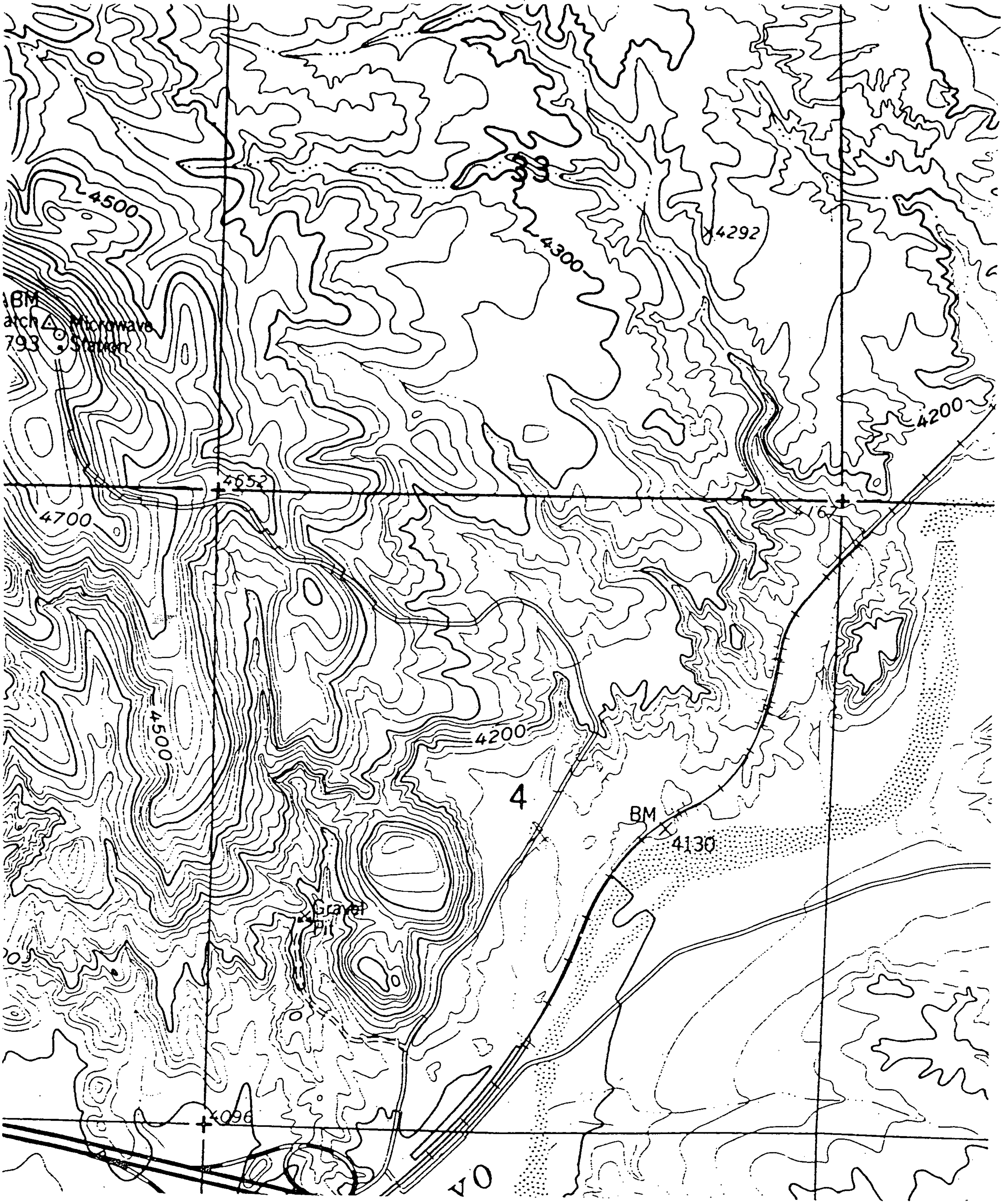


Figure 3. Topographic base map, Rincon Survey Area
scale: 1:12,000

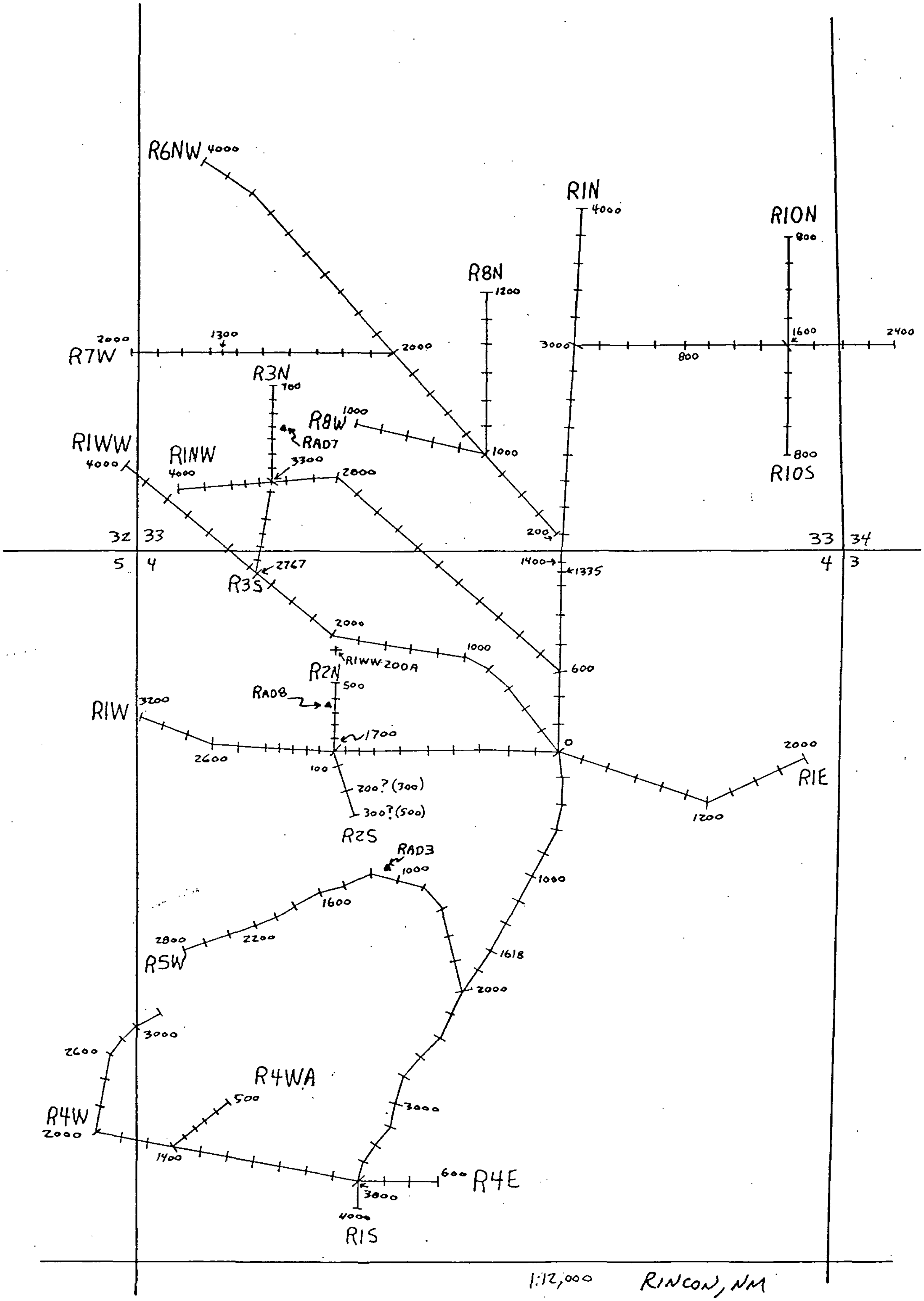


Figure 4. Self-potential survey control map, Rincon area.

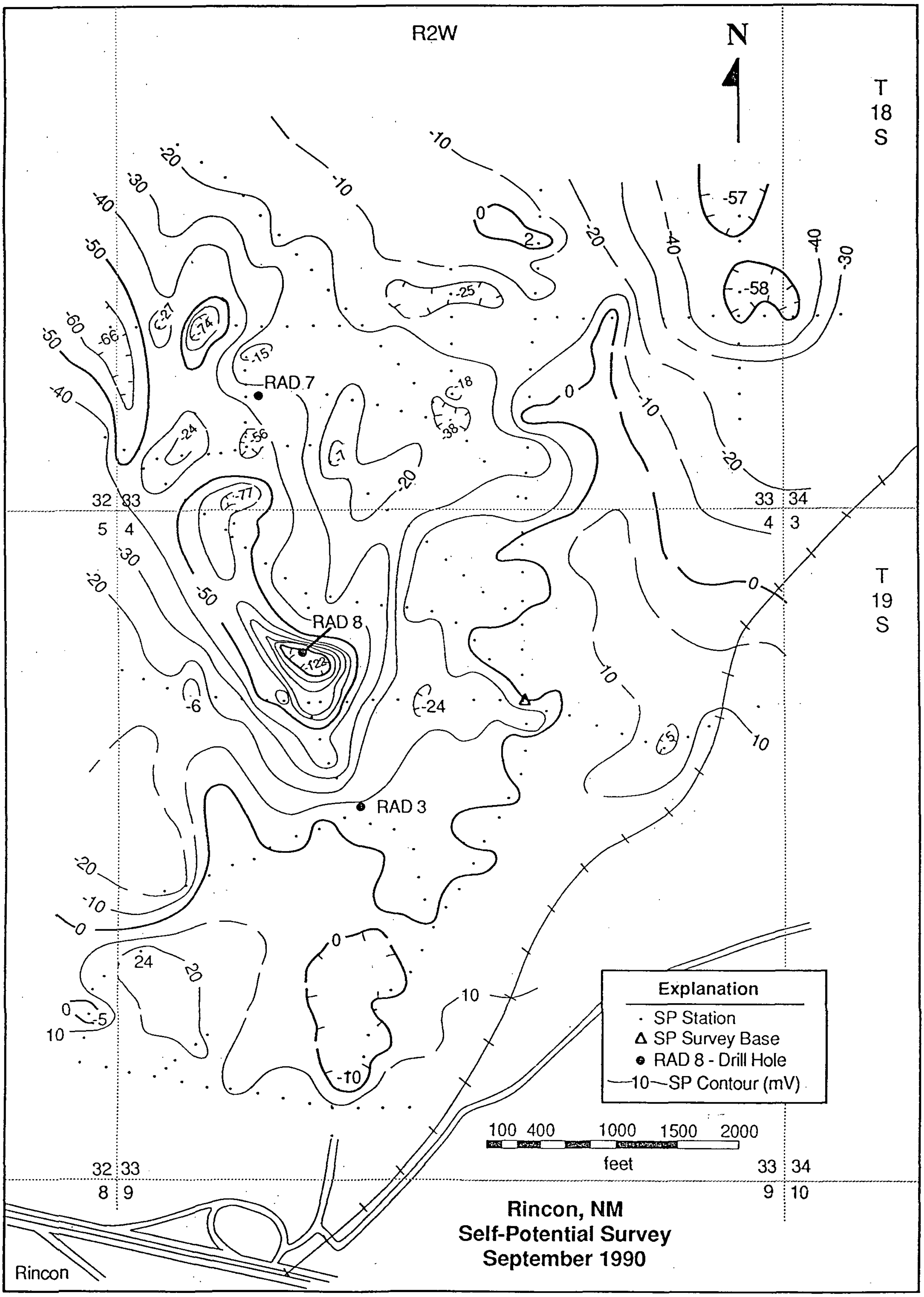
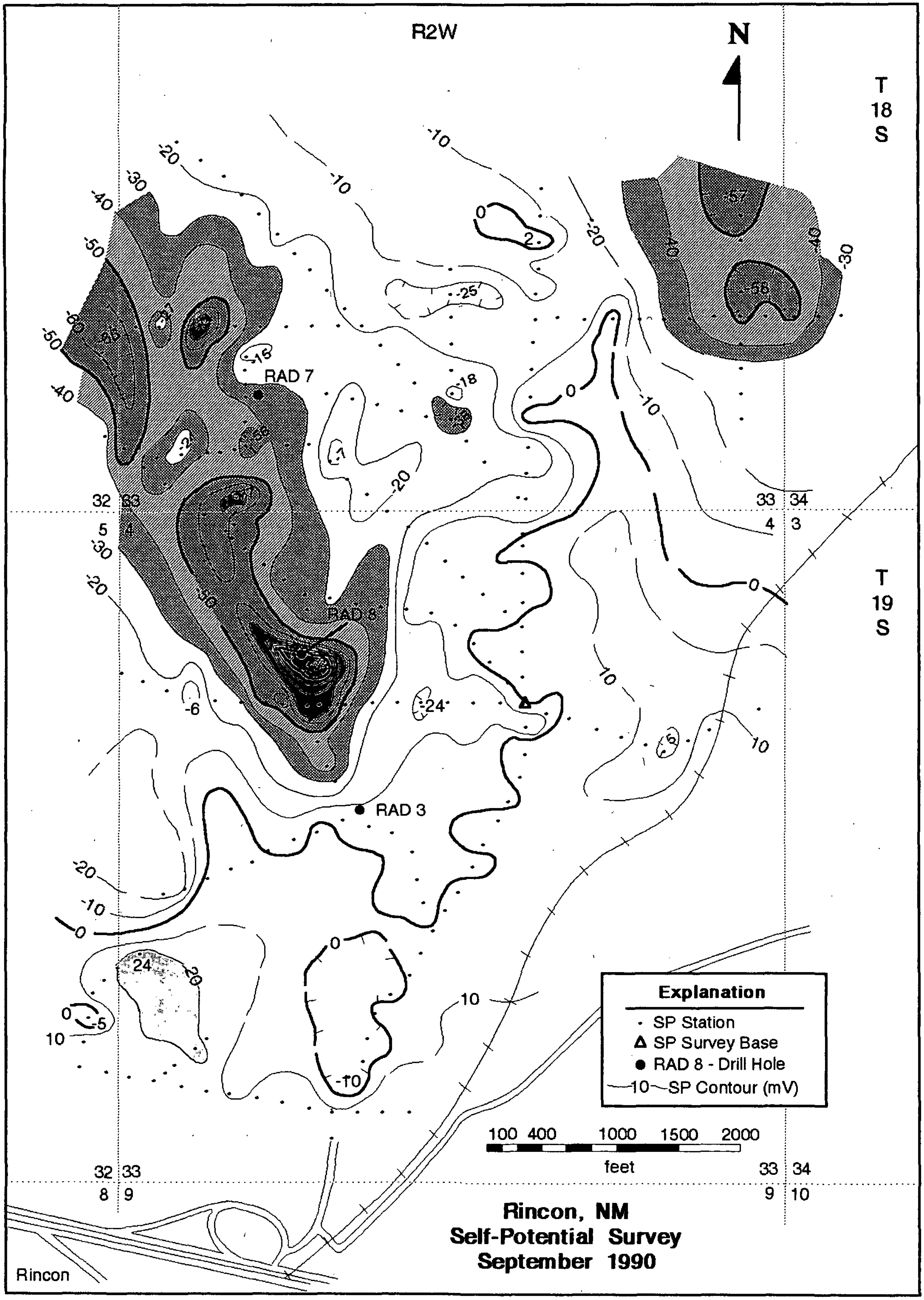

R2W
N
T 18 S
T 19 S
RAD 7
RAD 8
RAD 3
32 33
5 4
33 34
4 3
32 33
8 9
33 34
9 10
Explanation
SP Station
SP Survey Base
RAD 8 - Drill Hole
10 SP Contour (mV)
100 400 1000 1500 2000
feet
Rincon
Rincon, NM
Self-Potential Survey
September 1990

Figure 5.



Rincon, NM
Self-Potential Survey
September 1990

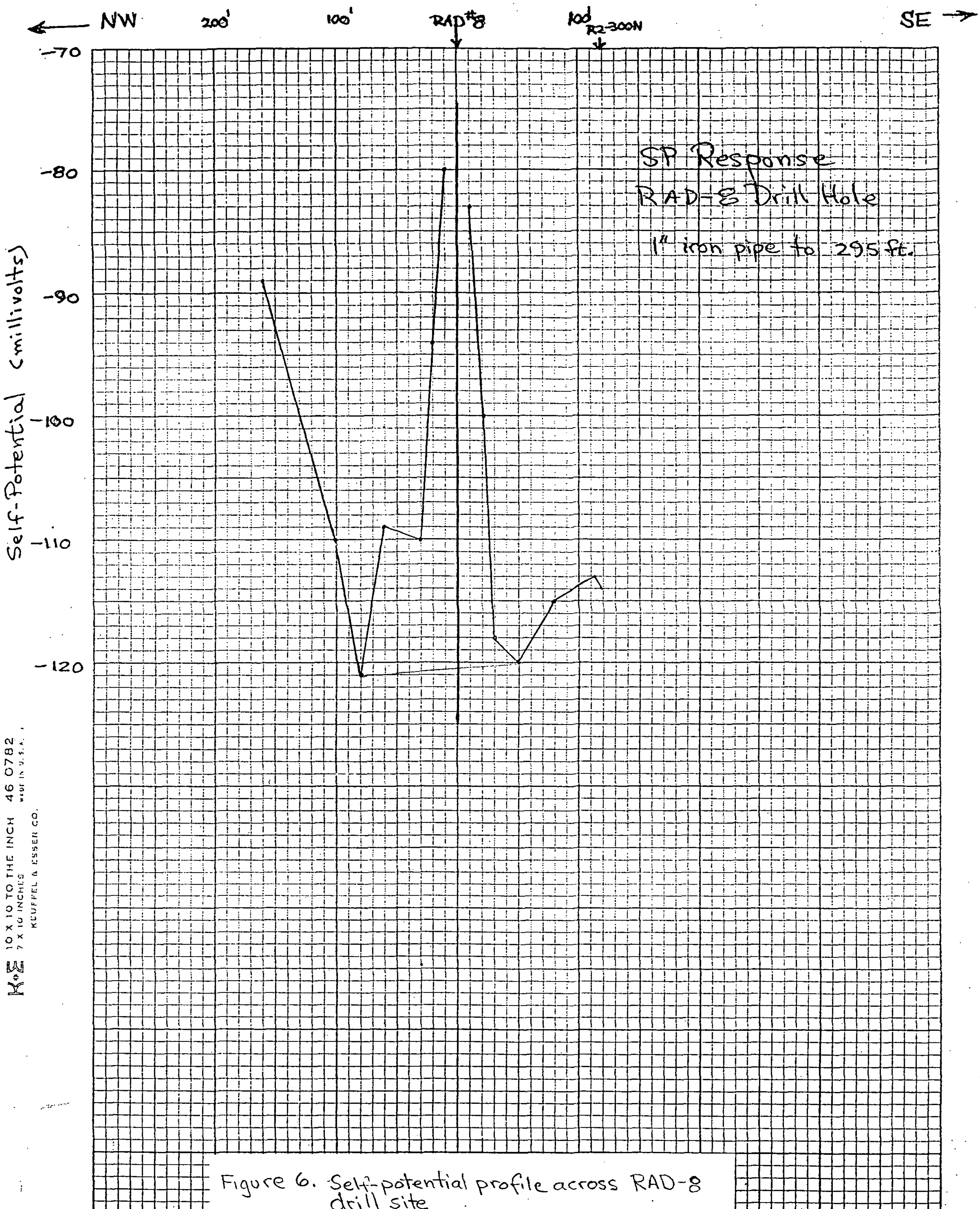


Figure 6. Self-potential profile across RAD-8 drill site

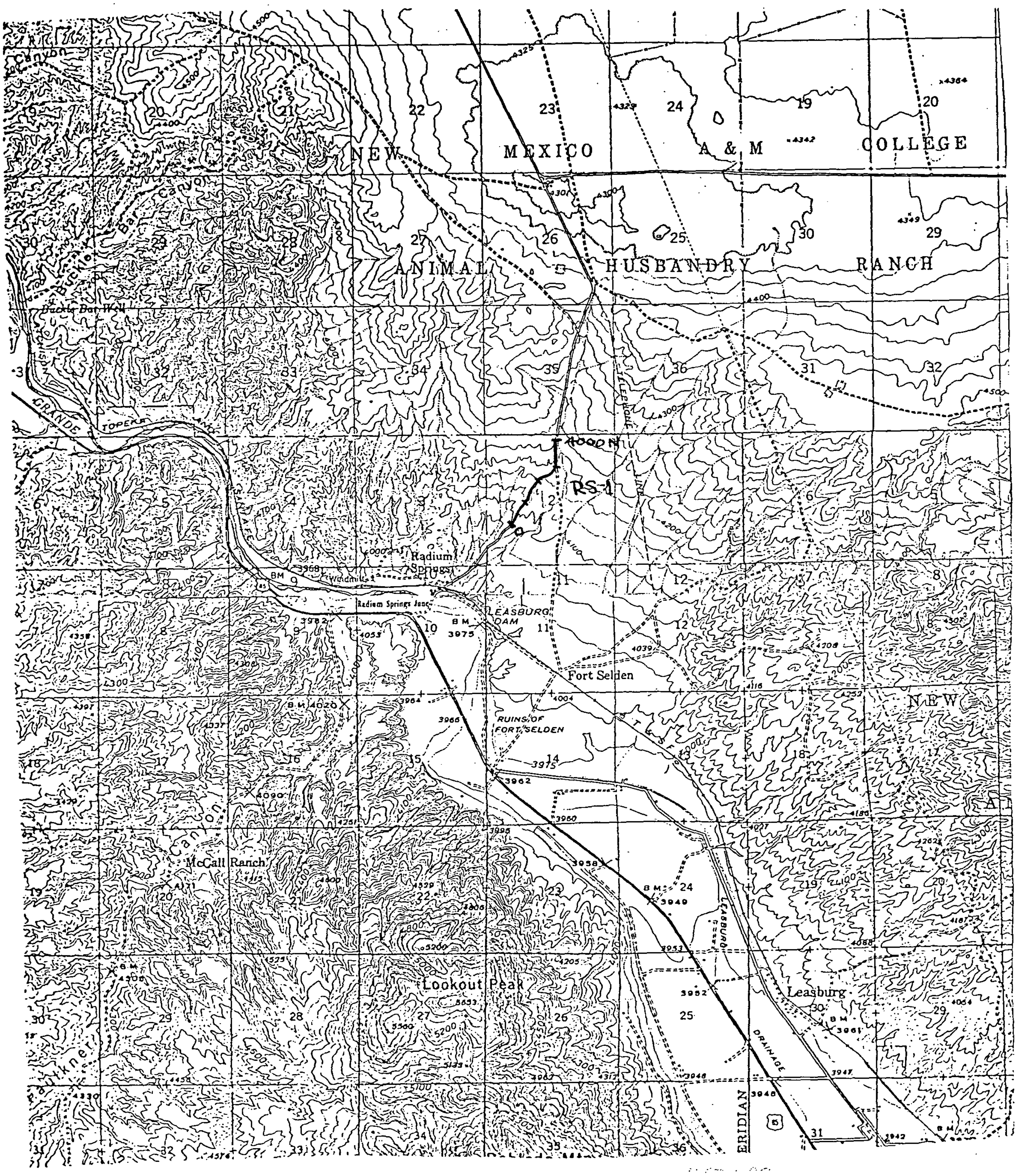


Figure 7. Topographic base map and profile location, Radium Springs area, Doña Ana County, New Mexico. Scale: 1:62,500.

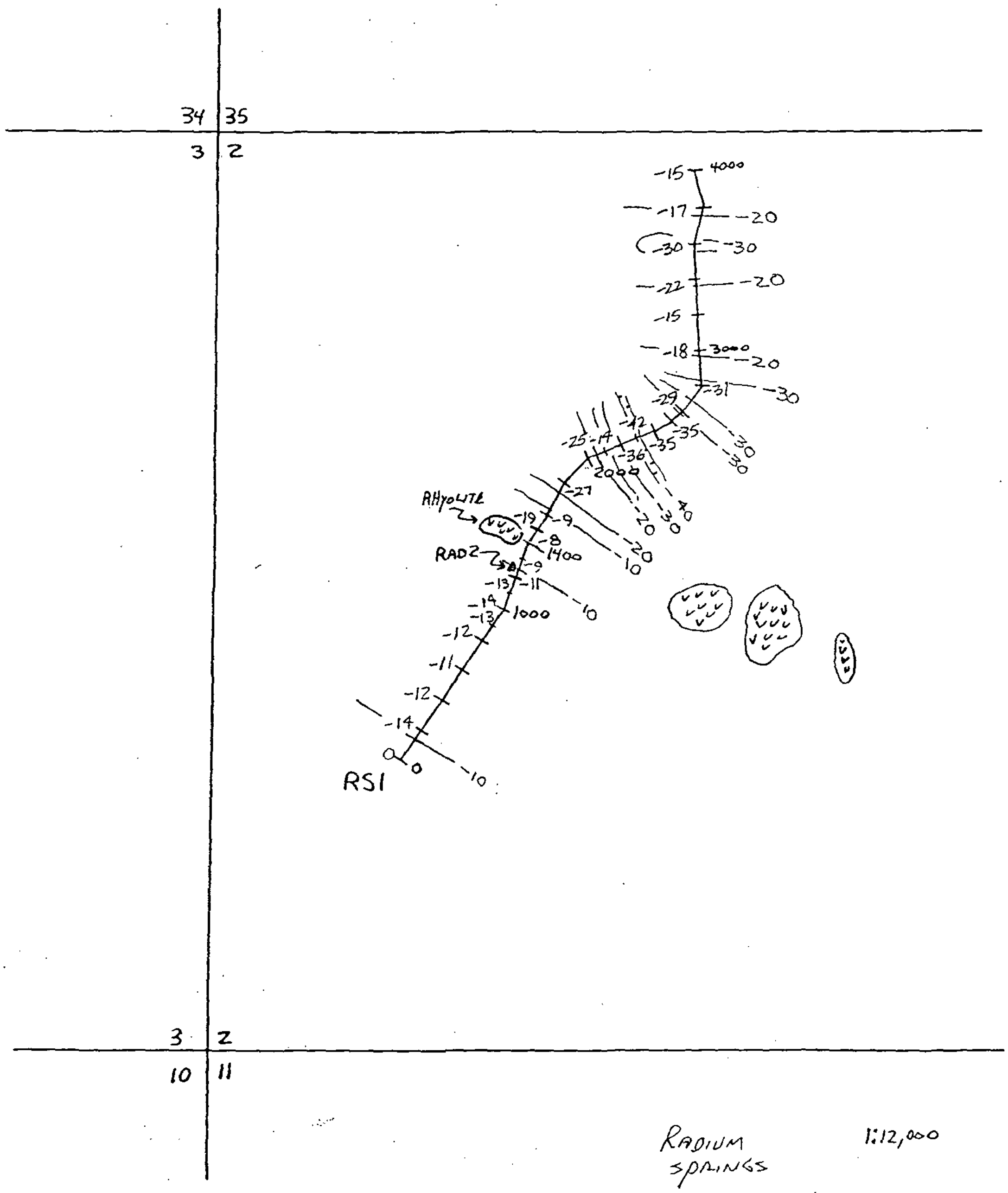


Figure 8. Self-potential traverse location and contour map, Radium Springs area, Doña Ana County, New Mexico.

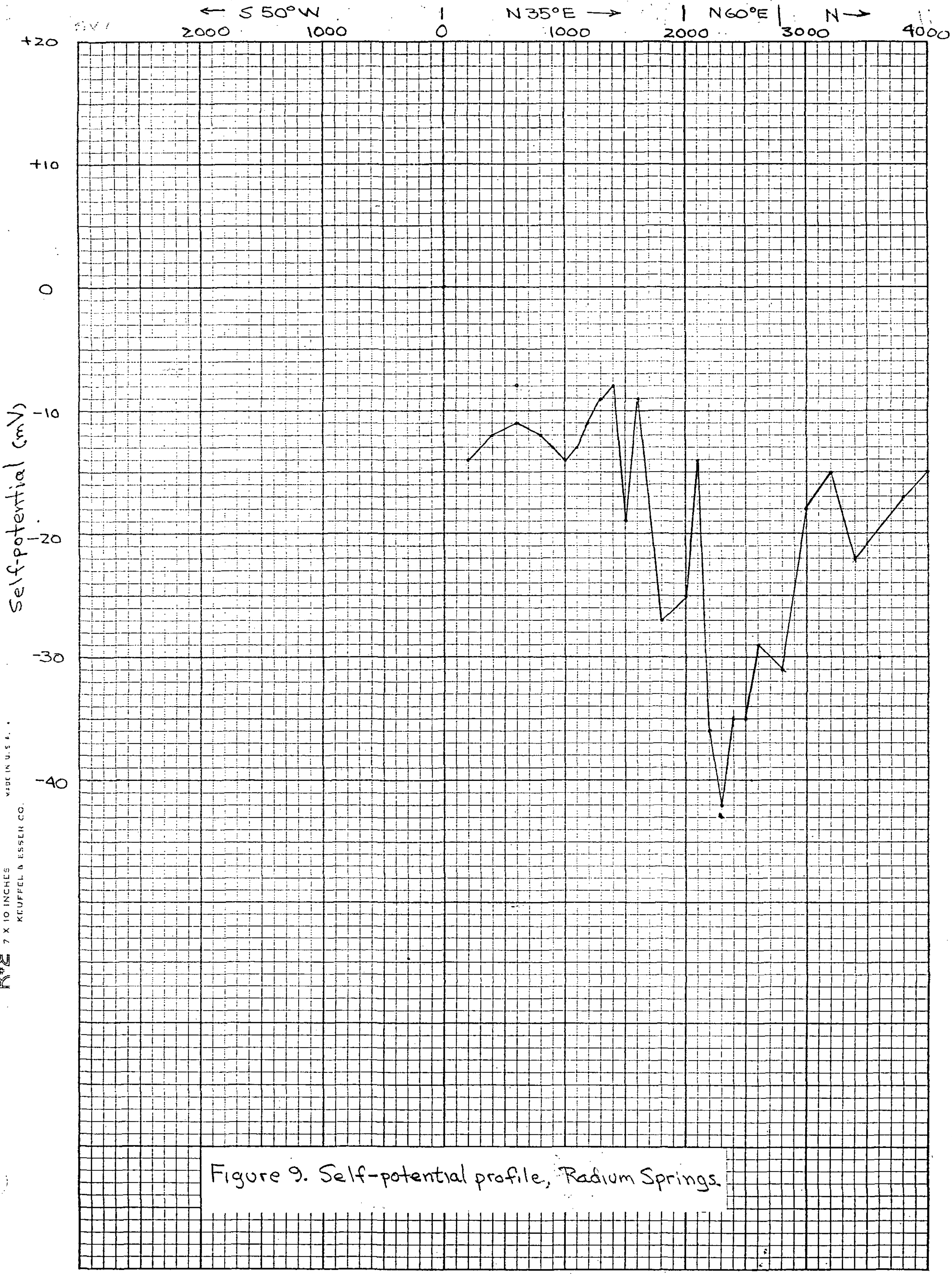


Figure 9. Self-potential profile, Radium Springs.