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Incoming

PACIFICORP
ELECTRIC LAKE RESISTIVITY SURVEY

BY GEO-WESTERN
JULY, 2002

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INTRODUCTION

Resistivity and Induced Polarization tests were conducted on the East side of Electric Lake during late July of 2002. Five long East-West profiles, 1000 feet apart were completed near the North end of the lake in an attempt to locate faulting or fracturing along the East flank of the lake and to determine the presence of water on such fracturing. The most Northerly line was labeled JCR-1 and is the longest at 4,100 feet, with its zero point at the West, approximately 1000 feet East of the lakeshore. The zero point on all of the five lines is on a line bearing North-South. Line length is increasingly shorter as the survey advances South until at line five the length is 2500 feet. The zero point on line five is in the lake with the current water level at station 7 (700') East. The slope east of the Lake is rather steep ranging for 20 to 25 degrees on most lines.

ELECTRODE ARRAY

The survey points had been laid out in advance of the data collection with pin flags at 50 foot interval. Because of the wide electrode separations necessary to achieve depth penetration up to 600 feet it was decided to employ the pole-pole electrode array since there was insufficient survey points beyond the West and East ends to facilitate the normal pole-dipole array. The pole-pole array requires a fixed current and potential electrode at infinite with one each current and potential electrode advancing along the profile at fixed interval. In order to collect sufficient data to develop a pseudo-section three "A" spacings were used (400-800-1200 feet) with the current electrode leading to the East. Depth penetration is considered to be roughly one half of the electrode separation. In this case 200, 400, and 600 feet which places the deepest penetration approximately 400 feet below the lake shore (8,500 feet) and about 350 feet above the mine workings. This is at the lowest point of the survey on the west end of line JCR-2.

RESISTIVITY/IP METHOD

Two conditions must be met in order to develop definable representation of vertical faulting or fracturing within survey data. The first is a relatively consistent conductivity over a broad area. The second requirement is sufficient conductive contrast within the fracture to cause an interruption in electrical continuity. Experience has shown that a fracture containing some wet clay will generally present a lower than

normal resistivity contrast while a fracture containing moving fresh water will present a higher than normal resistivity.

While taking resistivity data it is advisable to take induced polarization (IP) data. This data is a product similar to an RC circuit where current is passed through the ground generating an ion flow. Water by its self does not produce IP effect, however clay particles which surround an aquifer, either fresh or saline, will provide a capacitive effect generating small signals which can be measured at the surface. Other polarizers such as metallic sulfides or graphite will also produce IP response. All formations will respond to some small degree and these weak responses are considered to be background effect. Higher than Normal IP responses are normally used as a confirmation of resistivity intersects on fracturing or to confirm the presence of water. Some IP responses were noted in locations other than those supported by resistivity data, and while these may indicated the presence of minor fracturing, they are not noted as fracture intersects.

CULTURAL EFFECTS

Man made features, such a metal fences, buried cables, power lines or mine activity can cause problems with both resistivity and IP data. In this case where wide separation of potential electrodes required with the pole-pole array the problem could be more significant for both natural (telluric noise) and man made electrical noise. There were no metal fences noted during the survey, however a deep water well located roughly 2500 feet North of the survey created considerable electrical noise when measuring IP response, requiring repositioning of the reference Potential electrode. Resistivity data appeared not be effected by electrical noise since the signal is roughly 100 times stronger than IP responses. IP data however, was effected to a considerable degree especially by what appeared to be mine noise at the 1200 foot electrode separation. For this reason IP data were taken only at the 400 and 800 foot separations.

INSTRUMENTATION

The GEO-WESTERN HEW-200 resistity/IP portable system was used with a rechargeable power supply coupled to a DC-DC converter supplying up to 1000 volts. The transmitter delivers a commutated current at selectable pulse times. In this case a one second current pulse was used with a 50 percent duty cycle. During the off period, following a 300 millisecond delay, a 600 millisecond window was opened for measurement of the IP response.

TOPOGRAPHIC EFFECTS

As the survey advances up-slope the current electrode will always be at somewhat higher elevation than the following potential

electrode. Since data penetration is considered to be perpendicular to the plane of the two electrodes adjustments must be made in the data point locations to compensate for this error. This can be seen in the pseudo sections where the data stations appear to be farther East than the corresponding surface location.

DATA PRESENTATION

Vertical pseudo-sections were made of each line with the surface topographic profile taken from the topographic map. Using a template, data points were plotted at their appropriate locations perpendicular to the plane of the two traveling electrodes. Since IP responses were taken at only the 400 and 800 foot separations the data were insufficient to develop pseudo sections. The data therefore were plotted on a separate sheet at their surface location. For this reason anomalous responses will generally appear slightly to the West of fracture intersects indicated on the resistivity sections.

ANOMALOUS FEATURES

Anomalous features, indicated by contouring of the resistivity data in pseudo-sections are shown as follows along with supporting IP responses. Where the presence of water, either fresh (highly resistive) or saline (more conductive), these features are also indicated. If the feature corresponds to a feature shown on the mine map this is also noted.

STA.	RESISTIVITY	IP	ATTITUDE	QUALITY	WATER	MAPPED
JCR-1						
2.3	high (level change) all spacings	high	vertical	minor		no
7.9	low (level change) all spacings	high	vertical	major	saline below 200′	yes
18.1	low at 400-800 sep. high at 600′	strong	vertical	major	fresh below 600′	no
20.2	low (level change) all spacings	high	vertical	major		yes
26.2	broad high all spacings	none	vertical	major	fresh below 500′	no
32.8	high (below 300′)	none	vertical	major	fresh below 300′	yes
36.0	high (below 400′)	strong	vertical	major	fresh	yes

below 500′

Note: The inferred fracture at station 7.9 encountered probable saline water beginning 200 feet below the surface and extending to the maximum penetration at 600 feet. Below 300 feet a broad conductive zone with erratic IP responses extends from station 4 to 15 indicating a probable zone of saturation. Very strong IP responses were encountered between the two inferred fractures at 32.8 and 36.0.

JCR-2

2.3	high (below 400′	high	vertical	minor	fresh Below 400	no
4.8	high (below 200′	high	vertical	minor	fresh	no
7.7	high (below 300′	very high	vertical	major	fresh below 300′	yes
18.1	low all spacings	high	vertical	major	saline below 400′	no
21.0	low all spacings	high	vertical	minor	saline below 400′	yes
27.7	low all spacings	high	vertical	major	saline below 400′	yes

Note: From 2.5 East to 13 East a strong resistivity high was encountered below the 400 foot level with a significant (broad IP response). This feature begins at the two fractures at 4.8 and 7.7 and extends downward along these two inferred fractures to the broad resistivity high at depth and probably indicates fresh water. From 18 East to 28.5 East a broad resistivity low is cut by three inferred fractures at 18.1, 21.0 and 27.7. These features begin at the 400 foot spacing and extend downward to the 1200 foot spacing with most of the activity below the 400′ depth. A probable zone of saline water saturation is suggested. With the exception of high IP values at the fracture intersects IP responses were rather flat across the zone.

JCR-3

4.7	high all spacings	high	vertical	minor	fresh below 200′	no

10.2	high all spacings	high	vertical	major	fresh below 200′	yes
12.9	high all spacings	high	vertical	major	fresh below 200′	no
18.4	high		vertical	minor	fresh below 300′	no
20.6	low all spacings	high	vertical	major		yes
28.5	high 400′spacings		vertical	minor		yes

Note: The very high resistivity values, especially at the 1200 foot spacing (600′depth), are consistent with those seen on line two over the West one third of the profile from station 4 to about 14. IP responses over the area are abnormally high. Coupled together these two parameters suggest a strong possibility of fresh water both below and above the lake level.

JCR-4

4.4	low all spacings	high	vertical	minor		no
9.5	low all spacings	strong IP	vertical	major		yes
18.0	high all spacings	weak IP	-80 West	major	fresh below 200′	no
21.5	high all spacings	strong IP	vertical	major	fresh below 200′	yes
24.5	high all spacings	no IP	vertical	major	fresh belwo 200′	yes

Note: the fresh water (resistivity high) features at 18.0, 21.5 and 24.3 all indicate the presence of fresh water several hundred feet above the 8,500 foot lake level.

JCR-5

16.4	low all spacings	high	vertical	minor		no
20.1	low all spacings	high	vertical	major		yes

24.9	low	high	vertical	minor	no

Note: No indications of fresh water were found on this profile.

RESULTS AND CONCLUSIONS

Resistivity and IP data taken with the Pole-Pole array, compared to the dipole-dipole system, although somewhat susceptible to sporadic electrical interference, is much less time consuming and equally useful in locating fractures where wide coil separations are required in rough terrain. Although IP data were deemed to be unreliable at the 1200 foot coil separation, due to probable mine activity, the 400 and 800 foot data was considered to be sufficient for confirmation of anomalous resistivity intersects.

With the exception of the major North-South (mapped) fault which should have been intercepted at station 24 on line JCR-3 all of the mapped locations were detected by the survey. Due to insufficient data at the West end of line JCR-5, the most Westerly of the North-South faults is not shown on the section.

The lake shore level, shown on all 5 pseudo-sections, presents a clear overview as the to whether the inferred fractures with their accompanying water will occur above or below the lake level.

The area stretching through lines JCR-1, JCR-2 and JCR-2,for a minimum distance of 3000 feet North to South, and from 4 East to 14 east for an East-West distance of 1000 feet, appears to contain considerable water. The center of this zone is cut by the inferred North-South fracture at 7.9 on line JCR-1, at 7.7 on JCR-2 and again at 10.2 on line JCR-3. This fracture is presently producing 2,500 gpm on the same fracture roughly 2,500 feet North of JCR-1. Resistivity and IP data collected over the zone appears to suggest a resistive zone at or below the 8,500 foot elevation mark, particularly at the 1200 foot separation where the data is expected to be approximately 600 feet below the surface. Three inferred fractures which are expected to contain fresh water above the 8,500 foot elevation are noted on line JCR-3 at 4.7, 10.2 and 12.9. All three are expected to contain fresh water at least 300 feet above the 8,500 foot mark and continuing to at least the 600 foot depth.

Water more prevalent at depth than surface

High resistivity intersects on line JCR-4 at stations 10.0, 21.5, and 24.5 all indicate the presence of fresh water at least 200 to 300 feet above the 8,500 foot elevation.

Zonal NW fault

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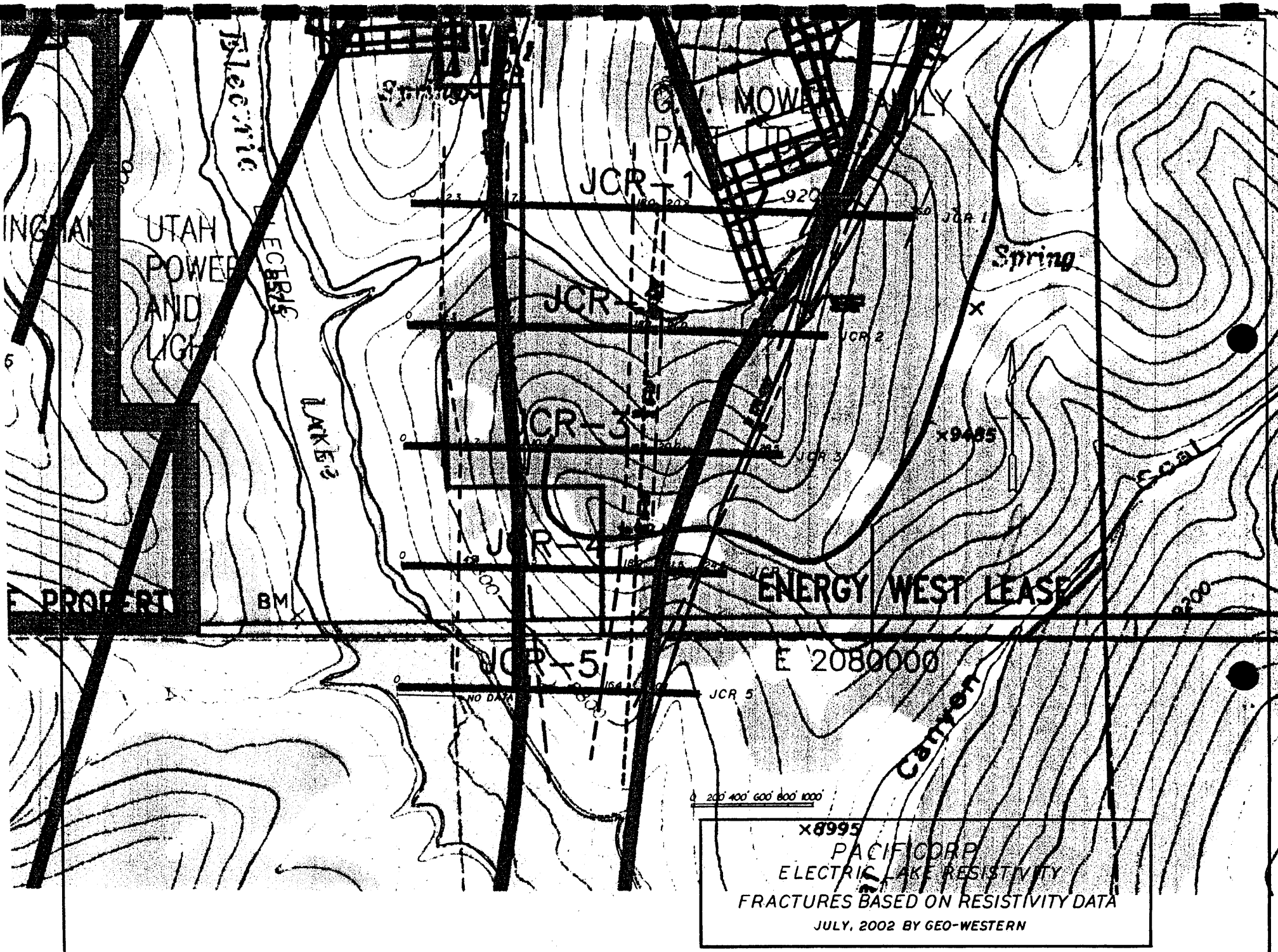
July Avg Elev Lk
WS Elev 8505



UTAH POWER AND LIGHT
Electric
LAKES
PROPERTY
BM
JCR-1
JCR-2
JCR-3
JCR-4
JCR-5
JCR 1
JCR 2
JCR 3
JCR 5
NO DATA
Spring
Canyon
Coal
ENERGY WEST LEASE
E 2080000
×9485
×8995
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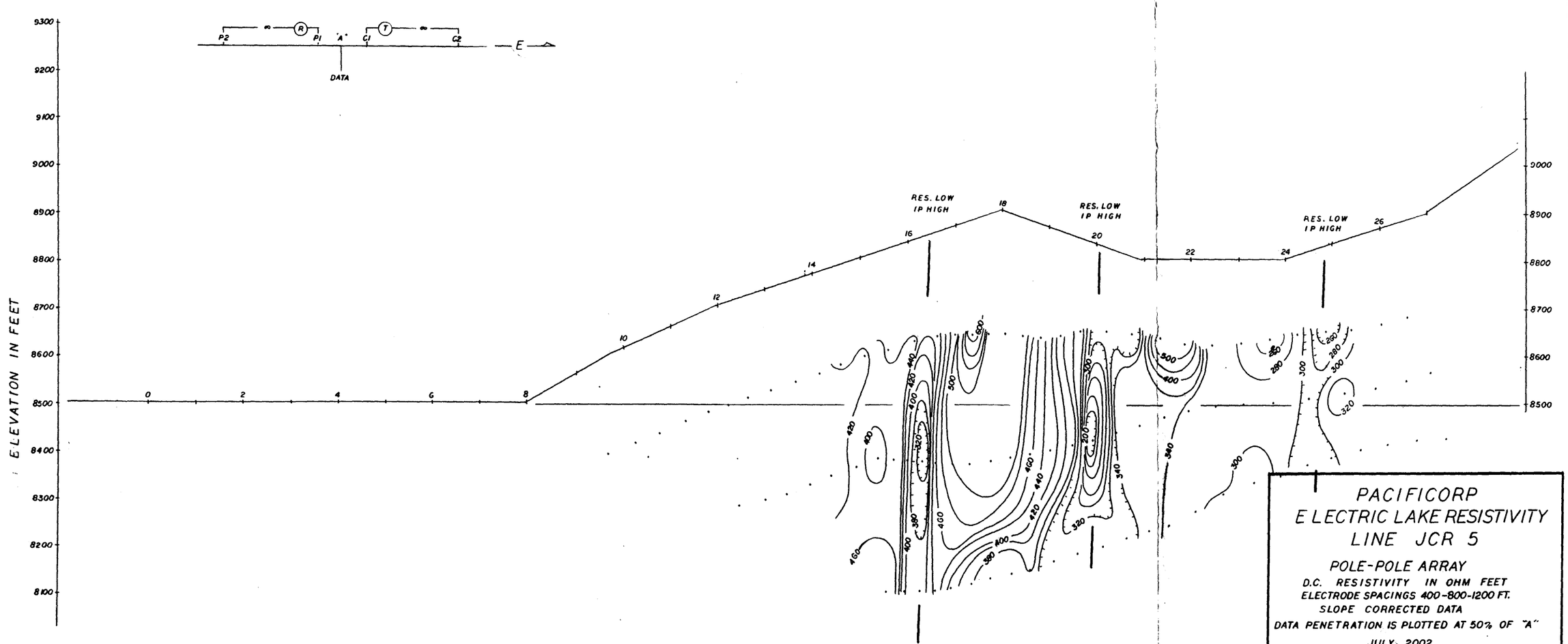
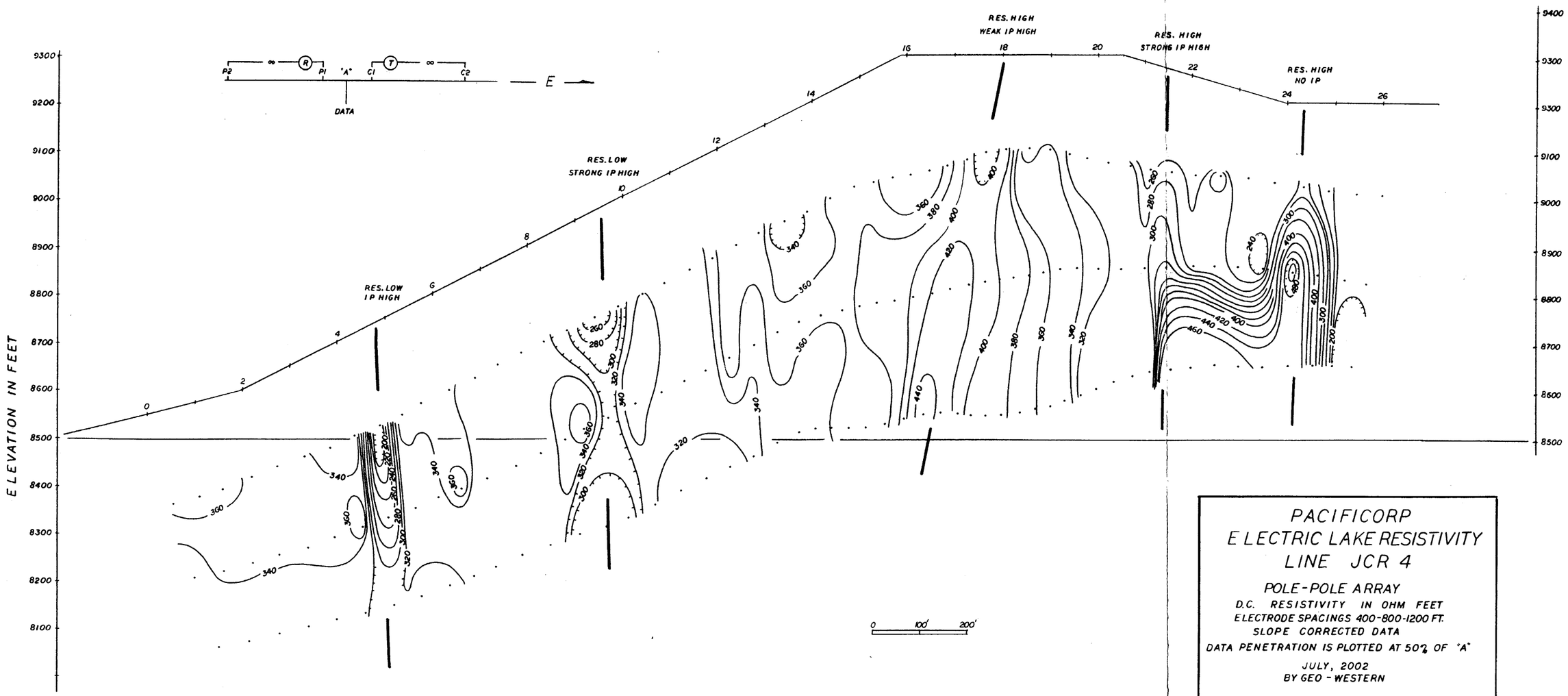
PACIFICORP
ELECTRIC LAKE RESISTIVITY
FRACTURES BASED ON RESISTIVITY DATA
JULY, 2002 BY GEO-WESTERN



PACIFICORP
ELECTRIC LAKE RESISTIVITY
LINE JCR 5

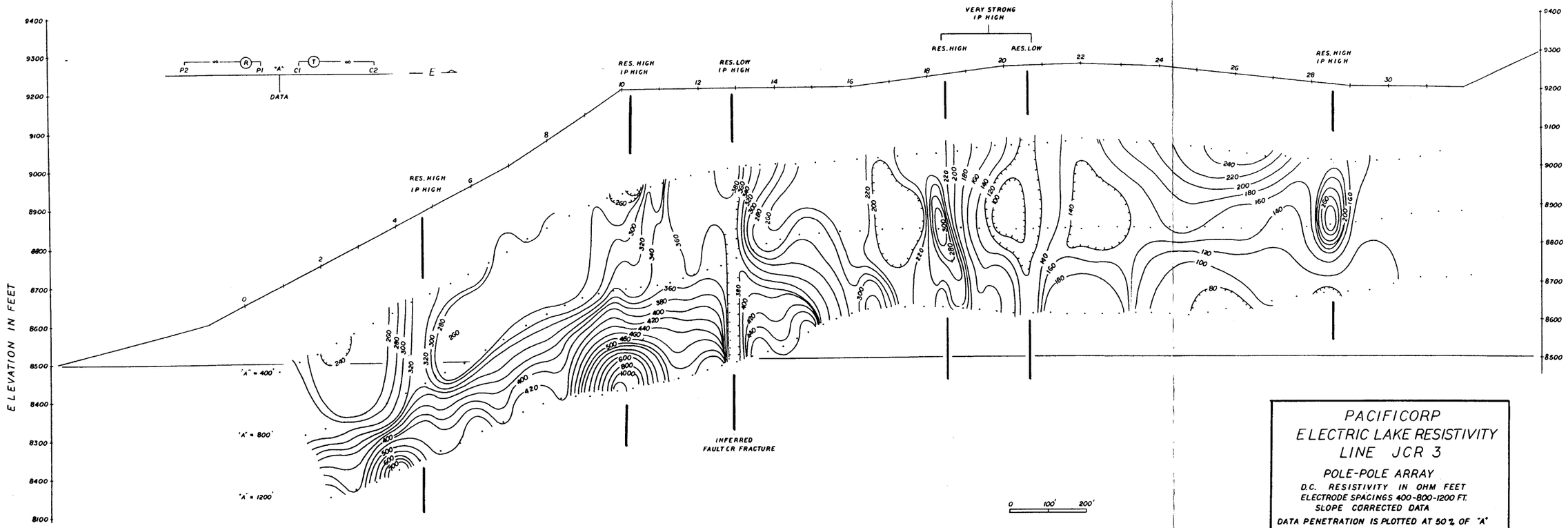
POLE-POLE ARRAY
D.C. RESISTIVITY IN OHM FEET
ELECTRODE SPACINGS 400-800-1200 FT.
SLOPE CORRECTED DATA
DATA PENETRATION IS PLOTTED AT 50% OF "A"
JULY, 2002
BY GEO-WESTERN



PACIFICORP
ELECTRIC LAKE RESISTIVITY
LINE JCR 4

POLE-POLE ARRAY
D.C. RESISTIVITY IN OHM FEET
ELECTRODE SPACINGS 400-800-1200 FT.
SLOPE CORRECTED DATA
DATA PENETRATION IS PLOTTED AT 50% OF "A"

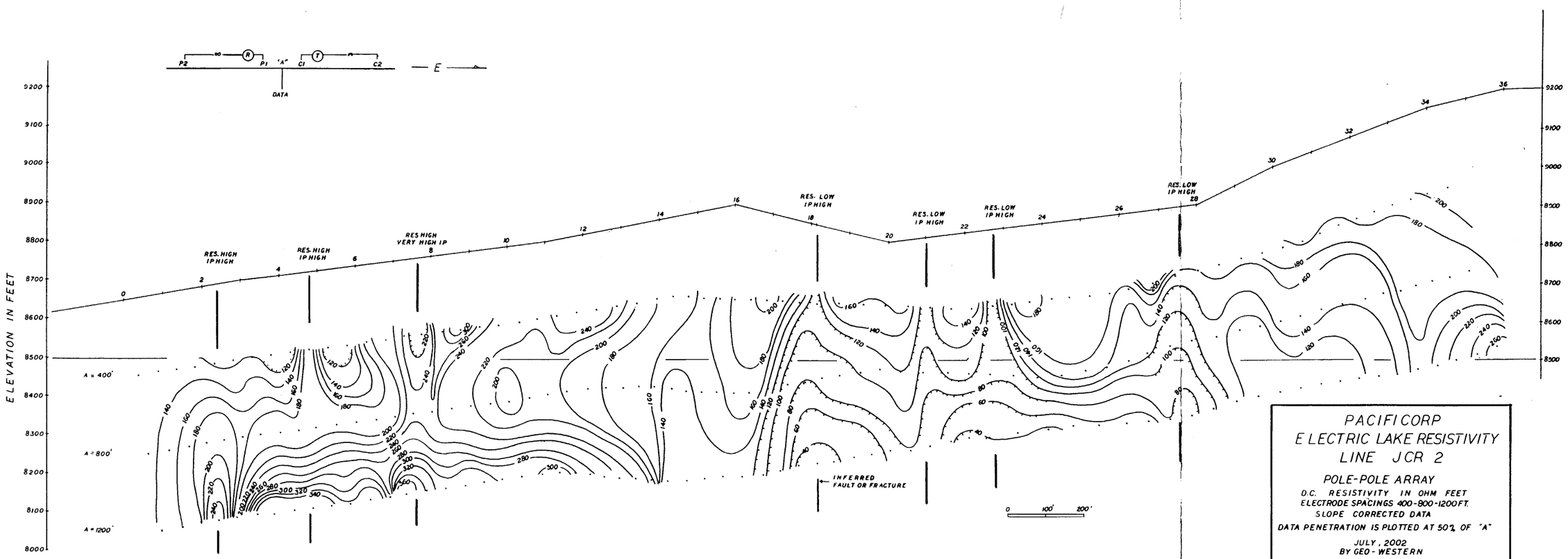
JULY, 2002
BY GEO-WESTERN



PACIFICORP
ELECTRIC LAKE RESISTIVITY
LINE JCR 3

POLE-POLE ARRAY
D.C. RESISTIVITY IN OHM FEET
ELECTRODE SPACINGS 400-800-1200 FT.
SLOPE CORRECTED DATA
DATA PENETRATION IS PLOTTED AT 50% OF "A"

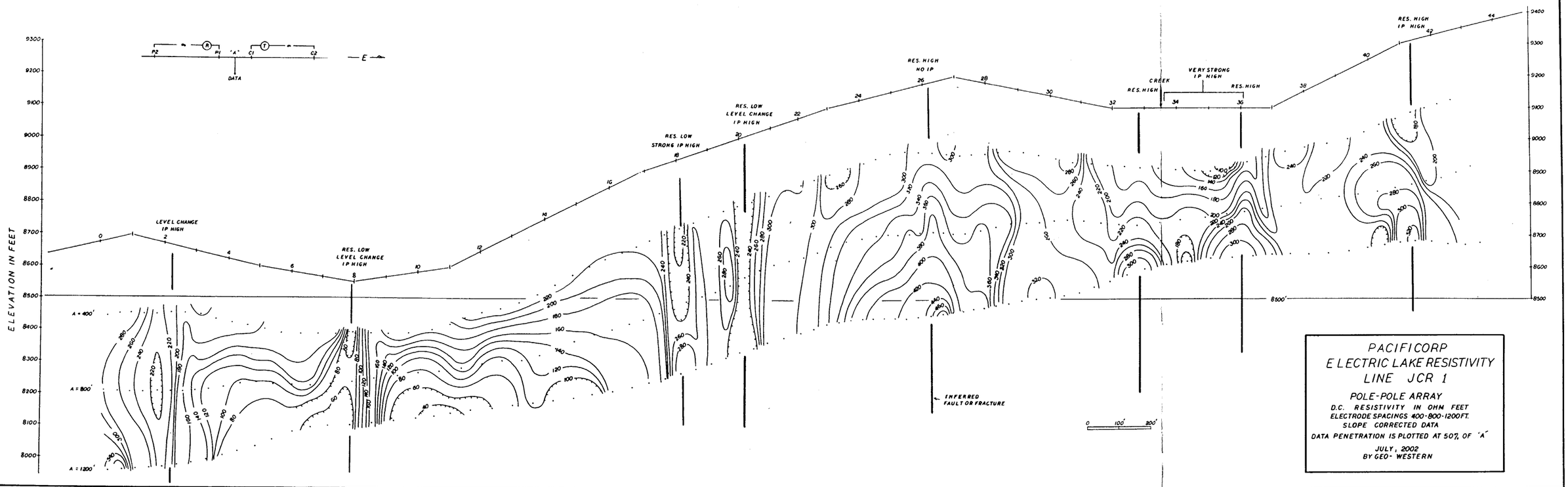
JULY, 2002
BY GEO-WESTERN



PACIFICORP
ELECTRIC LAKE RESISTIVITY
LINE JCR 2

POLE-POLE ARRAY
D.C. RESISTIVITY IN OHM FEET
ELECTRODE SPACINGS 400-800-1200 FT.
SLOPE CORRECTED DATA
DATA PENETRATION IS PLOTTED AT 50% OF "A"

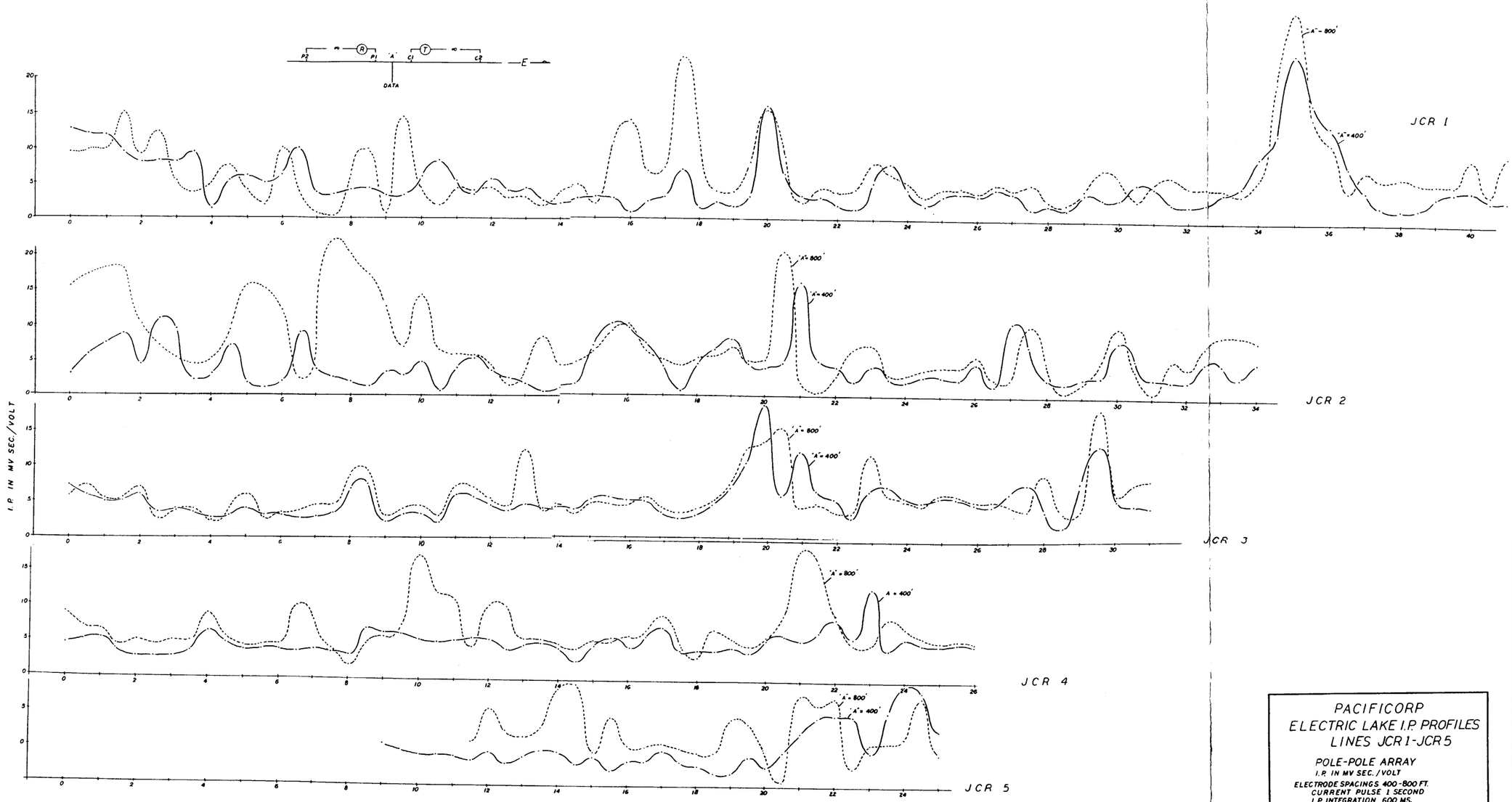
JULY, 2002
BY GEO-WESTERN



PACIFICORP
ELECTRIC LAKE RESISTIVITY
LINE JCR 1

POLE-POLE ARRAY
D.C. RESISTIVITY IN OHM FEET
ELECTRODE SPACINGS 400-800-1200FT.
SLOPE CORRECTED DATA
DATA PENETRATION IS PLOTTED AT 50% OF 'A'

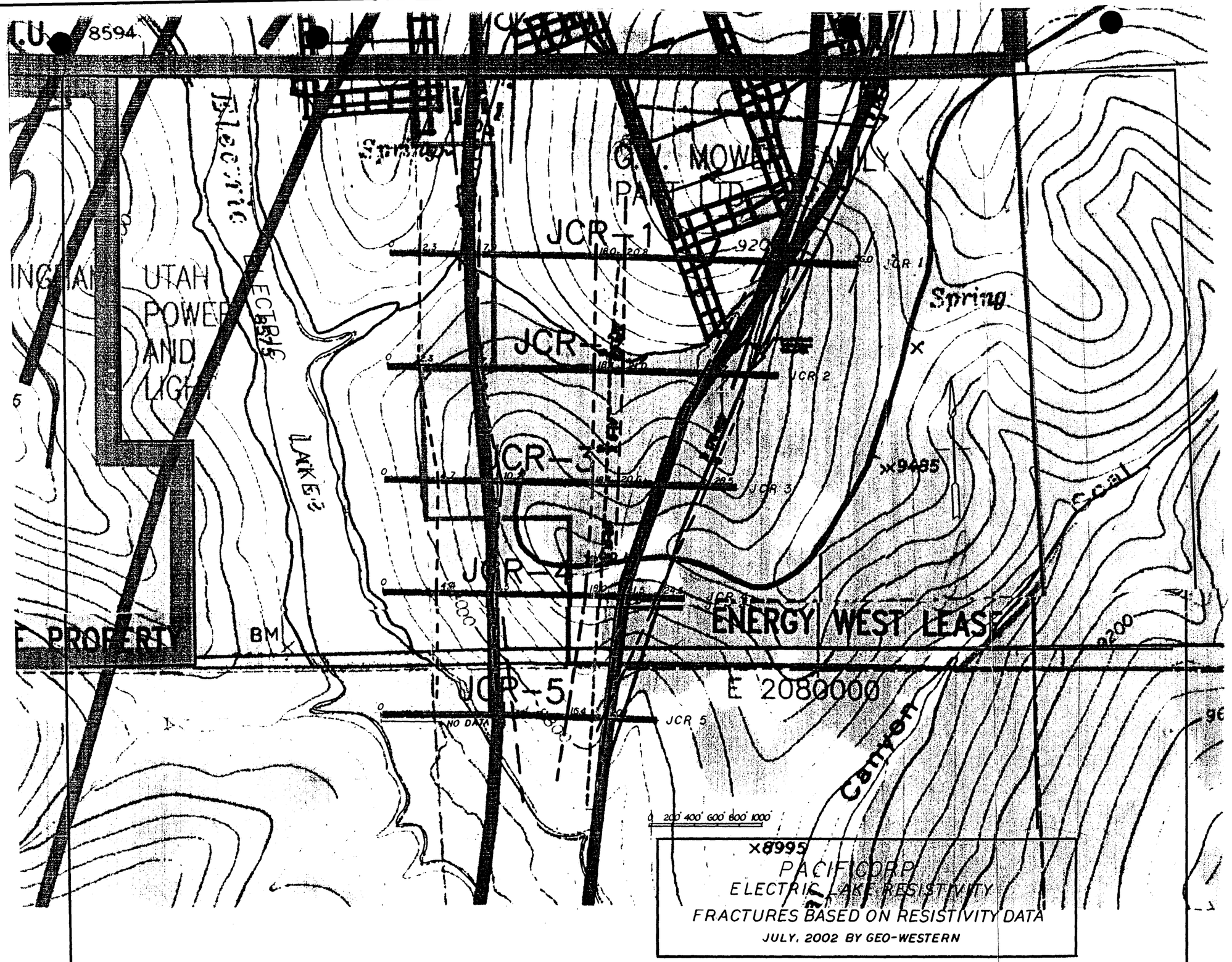
JULY, 2002
BY GEO- WESTERN



PACIFICORP
ELECTRIC LAKE I.P. PROFILES
LINES JCR1-JCR5

POLE-POLE ARRAY
I.P. IN MV SEC./VOLT
ELECTRODE SPACINGS 400-800 FT.
CURRENT PULSE 1 SECOND
I.P. INTEGRATION 600 MS.

JULY, 2002
BY GEO-WESTERN



8594
Electric
Springs
G. W. MOWER FAMILY PART LTD
JCR-1
JCR-2
JCR-3
JCR-4
JCR-5
JCR 1
JCR 2
JCR 3
JCR 5
NO DATA
UTAH POWER AND LIGHT
ELECTRIC
LAKES
Spring
x9485
Coal
ENERGY WEST LEASE
PROPERTY
BM
E 2080000
Canyon
0 200' 400' 600' 800' 1000'
x8995
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