MED 855

SELF POTENTIAL SURVEY
DEETH PROJECT
ELKO COUNTY, NEVADA

FOR

AMAX EXPLORATION, INC.
GEOTHERMAL BRANCH

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Robert E. West

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SUMMARY:

A northeast trending negative self potential anomaly of 500 to 1000 millivolts in amplitude is coincident with Twin Buttes in the northeast quadrant of the project area. Eighty to 100 mv highs flank the southern end of this anomaly. A broad S.P. high of 50 to 100 mv trends north and then west from the Gross Ranch and is centered in approximately the same position as the Charleston road. The southern part of this high is on the west side of the Marys River where several hot springs occur. The rest of the project area has self potentials that vary from -50 to +50 mv.

The quality of the data is very good. Station to station scatter does not exceed $\pm$10 to 20 mv. Errors caused by changes in the loop resistance of the S.P. measuring circuit are negligible. The potential drift of the roving electrode during the reading of a spread is normally less than 4 mv. The average base station variation was 6.2 mv for Vasquez' crew and 7.6 mv for Harbison's crew.

Time variations in the self potential during this survey are probably less than 30 mv. This is estimated from the maximum

value of the base to base errors and in differences in S.P. values measured on opposite sides of Marys River. Base to base corrections averaged 16.6 mv and probably removed some of the time variations. A better evaluation of time variation in S.P. measurements could be made by setting up a recording S.P. dipole along the length of a spread being surveyed.

INTRODUCTION:

An S.P. survey was conducted in the titled area during the period October 27 to December 9 under the direction of Edward Vasquez, technician for Mining Geophysical Surveys, Inc. The survey and line layout was supervised by Arthur L. Lange, geophysicist for AMAX. The report is by Robert E. West, geophysicist for MGS, Inc.

The purpose of the survey is to evaluate the area for further geothermal exploration.

SURVEY PROCEDURE:

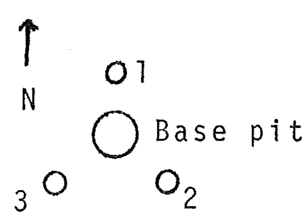
A) Equipment:

Voltage measurements were made using Fluke model 8020A and Simpson model 463 digital multimeters with LCD display. Both of these meters have 10 megaohm input resistance for DC voltage measurements. Tinker & Razor non-polarizing electrodes, models 3A (flat bottom) and 8B (cone tipped), were used. Light wire marked at 100 meter intervals stored in lengths of 3.3 km on light-weight back or chest packable reels with removable spool capability was used. Industrial grade granular copper sulfate and bottled distilled water were used in the electrodes and their storage containers.

B) Reading Procedures:

Self potential measurements are made by measuring DC voltage differences from a base station with a fixed model 3A electrode in contact with the ground to a "roving" 8B electrode that is placed in contact with the ground at 100 to 200 meters interval stations along a line. One end of the wire on the reel is attached to the base electrode. The wire is reeled out and the other end of this wire is attached to the negative end of the multimeter. A wire from the roving electrode is always attached to the positive terminal of the multimeter.

Base stations are established by excavating a central pit and three satellite pits to a depth of about one foot in a triangular pattern as shown below:



All pits were dug to fresh (natural) moisture. Pits 1, 2, and 3 are 3 to 4 feet from the base pit.

When this base station is used to start a spread of readings a copper sulfate soaked sponge is placed in the central pit and a model 3A "fat boy" electrode is placed on the sponge. This becomes the base or fixed electrode for that spread. A piece of foam and a tinfoil covered board are used to cover the pit in an attempt to reduce temperature changes in it.

Three voltage readings between the fat boy and a model 8B roving electrode placed in the satellite pits are taken and noted as 01, 02, and 03 in the field notebook along with the time at the beginning of the reading of a "spread".

Readings at stations are taken by digging a pit to fresh moisture, placing the roving electrode in the pit and recording the primary voltage in millivolts, its sign ($\pm$), the loop resistance in ohms, and the time of the reading. The type of terrain is noted also. The electrode face is cleaned after each reading with a whisk broom to remove soil.

If a base station is to be established in the interior of the spread being read for a future crossline, or at the end of the spread for the continuation of the line, a central pit is dug with its three satellites, and four readings are taken with the roving electrode--one in the central pit and one in each of the three satellite pits. These four readings have a station number and three sub number designations; i.e., sta 18 and 18_1, 18_2, 18_3, noting the voltage of each and resistance (one reading is sufficient).

When the spread is completed, the wire is reeled back to the starting base station of the spread and three more voltage measurements are made from the base electrode to the satellite pits and recorded along with the time to close out the loop. These measurements and the initial base measurements are used to correct for base station variation as described in the Data Reduction section.

The line or crosslines are continued by moving the base electrode to one of the established bases and a new spread is read. In this manner, potential differences are established between stations and bases throughout the survey area and some initial starting base. In this survey the initial base is sta 0, spread 1, Tie Line E, with an arbitrary value of 0.0 mv (also Line 13 at T.L. E).

C) Electrode Drift Measurements:

Small potentials (drift) build up in the electrodes in spite of their supposedly non-polarizing construction. These potentials appear to vary with temperature and other phenomena may be involved as well. We are presently using portable "standard" electrodes to observe the intensity of the electrode drift. The standards consist of at least two 8B electrodes with flat bottoms resting on a large sponge saturated with copper sulfate solution in a plastic widemouth thermos. This thermos is carried by the crew and at about one hour intervals the roving pot (cleaned) is placed in the container, and the potential difference between the roving pot and two standard pots is measured. It is assumed that the standard pots remain at a constant potential. Perhaps one should read the voltage between the two standards as well (not recorded on this survey) to see if the potential difference between the two standards remains relatively constant.

Another test is made by measuring the potential difference between the roving electrode and the base electrode while they are resting on the saturated sponge in the thermos before the survey of the spread begins and after it ends.

DATA REDUCTION:

The data were reduced by applying base station variation corrections and base to base error distributions in the following order:

1) The loop beginning and ending at station 0, spread 1, Tie Line E; proceeding south and southwest on Tie Line E to Line 1; west on Line 1 to Tie Line W; north on Tie Line W to Line 13; and east on Line 13 to the starting point.

2) Lines 2 through 12 from Tie Line E to Tie Line W.

The remainder of the data was corrected for base station variations only.

A) Base Station Variation Corrections:

The reading of the satellite holes at the base station at the start and finish of a loop established the base reading variation. All readings were corrected for this variation assuming a linear change with time, e.g., readings for 0_1, 0_2, 0_3, at 0810 are -2.1, -3.4, -1.8 for an average of -2.4; at 1230 these values are +6.8, +9.2, +4.0 for an average of +6.7. The total drift is +9.1 mv for the 4 hr 20 min of the loop and each station in the loop is corrected by a small negative amount (the drift is (+), hence the correction (-)) proportional to the time each station was read in the loop. A station read at 0937 would be corrected by -3.045 (-3.0) mv.

B) Base to Base Error Distribution:

The S.P. or voltage difference measured around a closed loop should be zero. Errors and time variations in voltage cause a non zero voltage difference. The error is distributed around the loop such that the voltage difference is zero. The method used is to number each station in order around the loop. The total number of stations is divided into the negative of the loop error to give the "correction per station". The correction for a station is given by the station number times the "correction per station".

Errors also occur when voltage measurements are made along a line between two bases with known "absolute S.P. values". This error is distributed in an identical manner to corrections for a loop except that the voltage difference between bases may not be zero.

DATA QUALITY:

We judge the quality of the S.P. data collected during this survey by the following criteria:

1) Data Scatter:

Scatter of ±10 to 20 mv generally occurs in the raw data profiles. This scatter usually occurs from station to station but, on occasion, S.P. highs or lows of the same magnitude occur up to 1 km in length. The significance of these low amplitude features is unknown.

2) Loop Resistances:

The maximum loop resistance measured during the survey was 83,800 ohms. This causes less than 1 percent error in the S.P. measurements. The majority of the loop resistances were less than 10,000 ohms.

3) Electrode Drift:

A spot check of electrode drift measurements for the survey show no consistent correlation occurs for the change in voltages measured between the roving electrode and the two standard electrodes from the beginning to the end of a spread on Vasquez' crew. However, the potential difference measured between the roving pot and standard electrode A (B-A) increased from around 0 mv on 10/27/79 to over 50 mv on 11/12/79 and then decreased to 20 to 30 mv. A similar change did not occur in measurements with standard electrode C (B-C) which remained near 0 mv. This indicates that changes occurred in standard electrode A that may have been greater than any changes in the roving electrode.

Similar checks for Harbison's crew did show correlation between similar voltage changes (D-F & D-G, roving electrode D). They were almost always the same sign and the magnitude was usually less than 4 mv. This suggests that changes in the roving electrode cause voltage changes during the reading of a spread that are 4 mv or less.

The change in voltage between the roving electrode and base pot on the sponge saturated with copper sulfate solution during the reading of a spread almost always has the same sign as the change in voltage between the base pot in the pit and the roving electrode in the satellite pits. The magnitude of these changes show some similarity but they are not the same. This suggests that the change in voltage measured at a base station is partially but not completely related to changes in the electrodes. Part of the voltage change also occurs because the electrode is placed in the ground.

4) Base Station Variations:

The average of the absolute value of the base station variations for Vasquez' crew was 6.2 mv for 73 spreads. Nineteen percent of the variations were negative. The maximum variation was 29.1 mv.

The average of the absolute value of the base station variations for Harbison's crew was 7.6 mv for 45 spreads. 35% of the variations were negative. The maximum variation was 34.4 mv.

5) Base to Base Errors:

The loop error on Tie Line E, Line 1, Tie Line W and Line 13 was 24.6 mv. Base to base errors for Lines 2 through 12 from Tie Line E to Tie Line W were:

LINE #	BASE TO BASE ERROR (mv)
2	35.9
3	-10.9
4	9.7
5	22.0
6	15.8
7	-21.8
8	12.5
9	-16.3
10	-10.4
11	20.8
12	- 6.7

The average of the base to base errors for Lines 2 through 12 is 4.6 mv and the standard deviation is 18.7 mv. The average of the absolute values of the errors is 16.6 mv.

6) Other Errors:

Only Line 13 was run across Marys River to tie the stations on the west side of the river to those on the east side. Elsewhere, lines were run east from Tie Line E and west from Tie Line E2 to the Marys River but not across it. Thus no base to base error distribution could be made. The following table gives the S.P. value on each side of the river for lines run there:

LINE NUMBER	S.P. ON WEST SIDE (mv)	S.P. ON EAST SIDE (mv)	DIFFERENCE (mv)
15	12.0	25.7	-13.7
14	54.6	23.4	-31.2
13	Tied	Tied	0.0
12	70.5	64.6	5.9
11	87.7	53.3	34.4
10	60.1	57.2	2.9
9	63.7	38.5	25.2

PRODUCTION:

Crew Days (full and partial)	60 days
Hours in Field	546.75 hrs
Line Km	267 km
Total Cost	$31,637.88

Respectfully submitted,

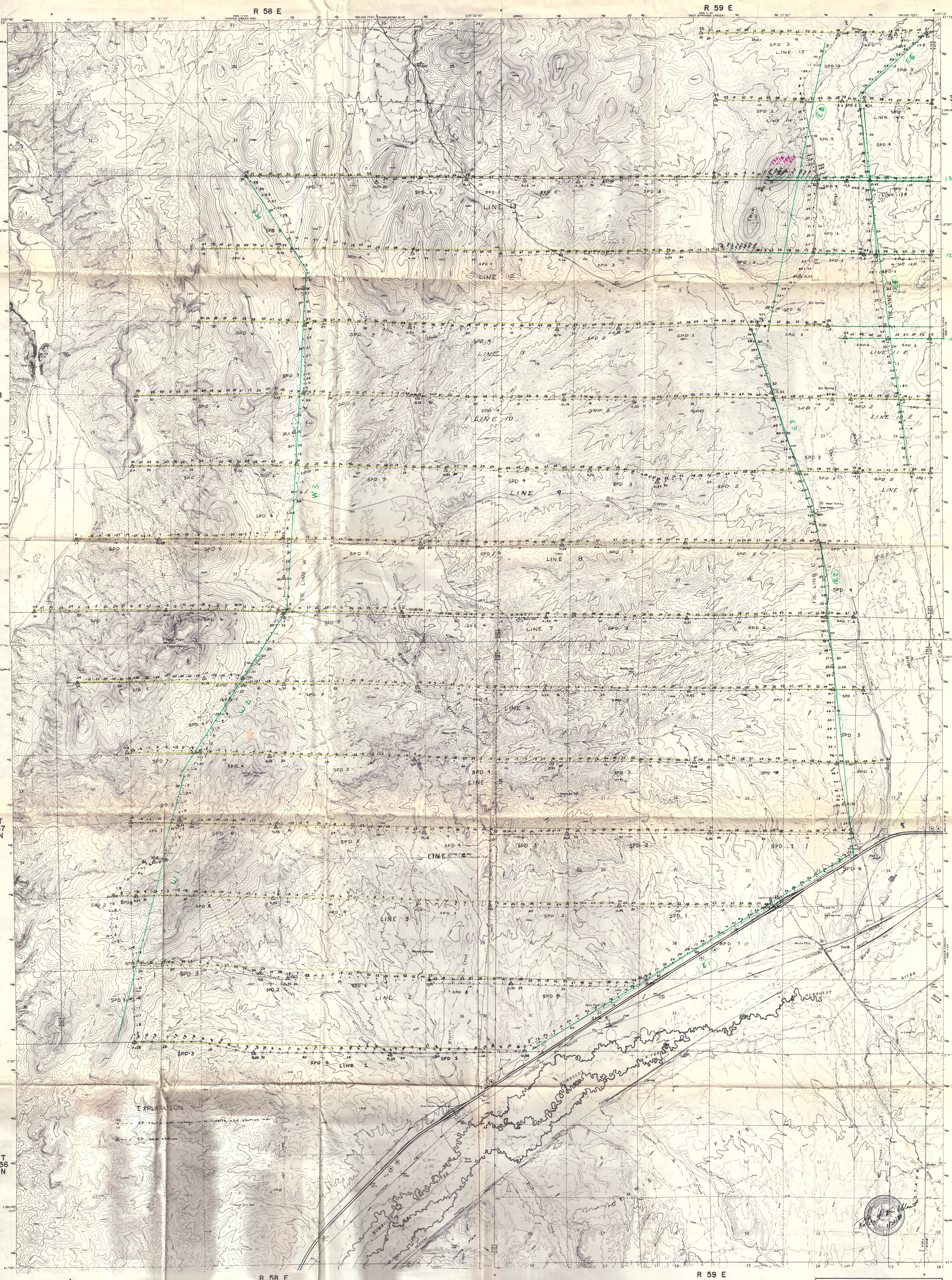
Robert E. West

Robert E. West
Geophysicist

Registered Professional Engineer (Geophysics)
CERTIFICATE NO. 11338
ROBERT E. WEST
Date Signed 1/22/80
ARIZONA, U.S.A.

January 22, 1980

Tucson, Arizona



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GEOTHERMAL BRANCH

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CORRECTED S.P. DATA