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RESISTIVITY AND SELF POTENTIAL SURVEY BALTAZOR-McGEE GEOTHERMAL PROSPECTS HUMBOLDT COUNTY, NEVADA

FOR

EARTH POWER PRODUCTION COMPANY

mining geophysical surveys inc

RESISTIVITY AND

SELF POTENTIAL SURVEY

BALTAZOR-McGEE GEOTHERMAL PROSPECTS

HUMBOLDT COUNTY, NEVADA

FOR

EARTH POWER PRODUCTION COMPANY

PROJECT 1002

mining
geophysical surveys inc

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SUMMARY:

Anomalous resistivity and self potential characteristics along the eastern edge of the Pueblo Mts just west of the Baltazor Hot Springs may represent an occurrence of thermal fluids in fault zones. Other resistivity-SP contacts and low resistivity-SP trends may also be associated with thermal fluid migration. These trends all appear to parallel the NE and NNE'ly striking structures expressed on the geologic map provided by EPPCo.

RESISTIVITY

A N40°E striking resistivity contact east of Baltazor Hot Springs may reflect the contact between Tertiary volcanics to the east and a deep alluvial basin. A linear trend of low resistivity material at depth east of the contact could reflect thermal trends under the volcanics. The hot springs occur in a broad basin of low resistivity material where local zones of lower resistivities could represent thermal activity.

In the McGee Mountain area a low resistivity layer at depth is believed to reflect the water table below 750'. Variations in the resistivity below the water table may reflect variations in gravel compaction or thermal trends. A slight increase in the resistivity at the west end of the line is believed to indicate Tertiary volcanics of the McGee Mts.

It is apparent that both porous gravels and volcanic rocks below the water table, as well as thermal activity, produce low resistivity environments.

SELF POTENTIAL

The main SP anomaly in the Baltazor area (SP Lines 1, 2, 3, 4, and 5) is an 80 to 100 millivolt low that trends NE'ly through the northwestern ends of Lines 1 and 2 (see plan map and profiles). This anomaly occurs SE of and parallel to normal faulting along the eastern edge of the Pueblo Mts (see EPPC's geologic map) and coincides with low resistivity rocks located on resistivity Lines 1 and 2. The SP low does not extend southwest to Line 3 and is open to the northeast.

Line 4 enters and leaves the SP low crossed by Lines 1 and 2. This causes the high amplitude SP changes on Line 4. No similar trends are seen on Line 5 to the southeast.

The remainder of the SP data in this area varies between 40 and 110 mv. No consistent anomalous trends can be traced from line to line. Single station SP anomalies occur but these features may be caused by scatter in the data.

In the McGee area (SP Lines 6, 7, and 8) a series of SP highs and lows occurs on Line 8 and may continue to the western half of Line 7. Scatter in the data makes these SP features more obscure on Line 7. They probably do not continue to Line 6. The resistivity data (Line 4) on the western half of SP Line 7 suggests layered rocks with a possible resistivity contact to the west between volcanic rocks and alluvium.

A +70 mv gradient in the SP occurs in the eastern half of Line 7. This gradient coincides with faulting in this area. A similar gradient increases the SP 30 mv on west side of Line 6. This gradient coincides with the geologic contact between sediments (Tstc) and alluvium (QTal).

Corwin and Hoover (1978)[1] report that although SP anomalies have been recorded in 13 geothermal areas around the world, anomaly shapes show no consistent pattern. However, short-wavelength high amplitude SP anomalies and steep gradients often appear to be related to faults that may be related to shallow thermal fluids in the fault zone. The SP low on Lines 1 and 2 (eastern edge of Pueblo Mts) associated with the low resistivity zone could be caused by this mechanism. The anomalies in the McGee area are more obscure and there is no direct correlation between the SP and resistivity data.

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[1] The Self Potential Method in Geothermal Exploration. Robert F. Corwin and Donald B. Hoover, GEOPHYSICS, V44 #4, Feb 1979, p 226

INTRODUCTION:

During the period of January 31 through February 21 a resistivity and SP survey was performed on the titled property. The field survey was under the direction of Peter D. Tucker, technician; the report and interpretation by Robert E. West and W. Gordon Wieduwilt, geophysicists for Mining Geophysical Surveys, Inc.

Four resistivity profiles and approximately 20 line miles of SP coverage were requested by EPPC. The line locations for this work are as laid out by EPPC in maps sent to MGS, Inc. dated January 10, 1980. The resistivity profiles were surveyed using a dipole-dipole electrode configuration with dipole spacings of 1500'. The SP survey used 200 meter stations with detail at 100 meters or less where gradients of 50 mv or more were observed.

RESISTIVITY DATA INTERPRETATION:

The resistivity survey occurs in two areas: a) 3 lines in the Baltazor Hot Springs area, b) a fourth line surveyed along an E-W road east of McGee Mtn (Painted Hills Mine) about 10 miles SW of the Hot Springs.

In the Baltazor Hot Springs area (Lines 1, 2, 3) a resistivity contact strikes N40°E, separating relatively high resistivity rock to the east from low resistivity alluvium(?) to the west. The hot springs lie west of this contact. The contact is complex and data suggests that a dike or horizontal cylinder-like zone of low resistivity rock lies east of and parallel to the contact at a depth of 1500' $\pm$500'. The relatively high resistivity rock east of a second resistivity contact near C_7, Line 1 likely reflects the near surface Tertiary and possibly Jurassic rocks of Black Mountain.

The low resistivity characteristics west of the main contact suggest a deep alluvial material with shallow water table. Resistivity contacts along the west edge of the lines may reflect the Tertiary volcanics of the Pueblo Mts. On Line 3 the high resistivity surface layer to 750' west of the main contact may reflect the weathered zone above the water table.

The resistivity on Line 4, east of McGee Mtn, reflects a three-layer cross section with the surface layer of 13 ohmmeters extending to 750' (water table?). From 750' to depth (7500'$\pm$) a middle layer of low resistivity material of 3 - 4 ohmmeters is indicated. Below this depth the resistivity could vary considerably from 1 ohmmeter to 400 ohmmeters; hence a lower layer is questionable. The middle layer shows lateral variations in resistivity with a suggestion of a lower resistivity zone of 1 ohmmeter $\pm$1 ohmmeter in the vicinity of electrode C_5. The slightly higher resistivities of 10 ohmmeters at the west end of the line suggest a weak indication of a contact occurring in the vicinity of electrode C_1. This contact may reflect the Tertiary volcanic rocks to the west in contact with the deep alluvial(?) basin east of C_1. The basin characteristics extend east past electrode C_{10}.

Assuming the effect of high temperature is to lower the resistivity, then areas of relatively low resistivities in the basin are of interest. These areas are:

1) 10 ohmmeters$\pm$ in the buried linear trend just east of the main contact;

2) on Line 1 5 ohmmeters in a surface layer to a depth of 750' occurs west of the main contact;

3) on Line 2 3-4 ohmmeters in a trend west of the main contact (hatchured area), and

4) on Line 3 <6 ohmmeters below 750' west of the main contact.

While the low resistivity trends can be related to thermal sources, they may also reflect a water(saline?) saturated alluvial occurrence as well.

SURVEY PROCEDURE:

RESISTIVITY

The resistivity measurements are made in the D. C. mode of operation using an EGC model R20A receiver with a capability of reading the primary voltage from 150 microvolts to 100 volts full scale. Meter accuracy is $\pm$5% of full scale. An EGC model P-45A transmitter and power supply with a capability of transmitting a maximum of 10 amps of current to the ground was the signal source.

The transmitter has an analog meter accuracy of $\pm$3% full scale. A system of measurements which uses a time cycle of 2.0 seconds "on" and 2.0 seconds "off" - 2.0 seconds "on" and 2.0 seconds "off" (current reversed) was employed.

Throughout the survey a conventional inline dipole-dipole array of six or seven current electrodes (one spread) were used, with the dipole length "a" equal to 1500' meters. Measurements were made from dipole separation factors "n" of 1/2 and 1 to 6. The potential electrodes occupied positions on both sides of the current-electrode spread, thereby providing a line coverage of approximately nine times the dipole length for a standard line of seven electrodes. The total length of line is determined by the number of spreads employed.

Data was recorded in field notes from meter readings during the current "on" part of the cycle. The current in amperes and primary voltage in millivolts were observed for at least two full cycles, with the average value entered in the field notes. Where low signal levels were encountered and "telluric" noise caused variations in the primary voltage, the primary voltage signal was observed for a greater number of cycles. On Line 4 (resistivity) the consistent "noise" at low signal levels made reading the analog voltmeter difficult, and a Beckman model TECH300 digital voltmeter with an accuracy of $\pm$0.5% was substituted. The primary voltage was monitored and recorded for a number of cycles separating the (+) and (-) phases and averaging these separately. The signal was obtained by dividing the difference by 2. The apparent resistivity is calculated in units of ohmmeters and plotted in quasi-section to facilitate presentation of data at all separations. The plotted data presents a reasonably smooth pattern of varying resistivities, suggesting no serious interference from noise. The repeat stations show reciprocity and indicate good quality data.

SELF POTENTIAL

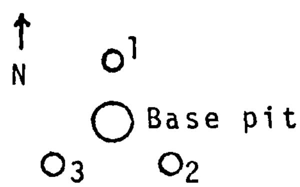
A) Equipment:

Voltage measurements were made using a Beckman TECH300 digital multimeter with LCD display. This meter has 22 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 mixed with 50% everclear (95% ethyl alcohol) 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 terminal 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 0-1, 0-2, and 0-3 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 voltage in millivolts, its sign (±), and the time of the reading. 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 number designations; i.e., sta 18-0 and 18-1, 18-2, 18-3, noting the voltage of each (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, Line 1, with an arbitrary value of 0.0 mv for the Baltazor area. Lines in the McGee area are not tied to one another and only relative SP values along individual lines can be related to one another.

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 (electrodes B and C) 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 (A) and two standard pots is measured. It is assumed that the standard pots remain at a constant potential.

Another test is made by measuring the potential difference between the roving electrode and the base electrode (D) 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 for the Baltazor area by applying base station variation corrections over the entire coverage and base to base error distributions in the following order:

The loop beginning at Line 1, spread 1, station 0 proceeding southeast to Line 1, spread 1, sta 15.6 and then southwest on Line 5 to sta 13.6 on spread 1. The loop beginning at Line 1, spread 1, sta 0 proceeding southwest on Line 4 to sta 10.2 of spread 1 then southeast on Line 2 to sta 14.7 of spread 1. The last station of these two loops is the same (Line 5, spread 1, sta 13.6 and Line 2, spread 1, sta 14.7) and the average of the two values obtained by applying base station variation corrections was used to obtain distribution correction. Finally, the loop from sta 10.2, Line 4, spread 1, southwest on Line 4 to sta 29 of spread 1, and then southeast on Line 3 to sta 18 of spread 1 and then northeast on Line 5 to sta 14.8 of spread 2. The remainder of the data was corrected for base station variations and adjusted to agree with distribution corrected values obtained for the loops.

The data for the McGee Mountain area were only corrected for base station variation.

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 SP 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 SP 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 SP data collected during this survey by the following criteria:

1) Data scatter:

Maximum scatter of $\pm$10 to 20 mv occurs in some areas.

2) Electrode drift:

Spot checks of electrode drift measurements show similar voltage changes (electrodes A-B, A-C, A-D, roving electrode A, base electrode D, reference electrodes B and C). Changes in voltages A-B and A-C from base to base were almost always the same sign as the base station variations (10 out of 12 times). However, the amplitudes of these changes were not always the same. For the 6 base to base checks studied, the base to base variation averaged +12.73 mv, A-B averaged 5.9 mv and A-C averaged 5.23 mv. Since several readings of A-B and A-C are made during the loop, the linearity of the changes can be tested. While the base to base change of these readings has the same sign as the base to base variation, they are not linear and voltages A-B and A-C generally both increase and decrease during the base to base readings.

The average value of the measurements between the roving and base electrodes (A-D) was 8.42 mv for the 6 loops. It was always the same sign as the base to base variations.

These measurements suggest that base station variations caused by electrode drift of the base and roving pot are not completely caused by changes within the electrodes but are partially caused by changes occurring while the electrodes are in the ground. Since the measurements of A-B and A-C do not completely account for the base to base variation, these measurements cannot be used to make base to base variation corrections.

3) Base station variations:

The average of the absolute value of the base station variations was 8.21 mv for 16 spreads. 12% of the spreads had negative variations. The maximum variation was 21.1 mv.

4) Base to base errors:

Three loops were run to Line 5, spread 1, sta 13.6 (also Line 2, spread 1, sta 14.7 and Line 5, spread 2, sta 14.8). The three values obtained (corrected for base station variations were 71.2 mv, 51.2 mv, and 36.4 mv. The maximum difference was 34.8 mv. These errors were removed by the distribution correction.

Based on these criteria and our experience in SP surveys, we judge the data quality to be satisfactory for this survey.

Respectfully submitted,

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