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SEAL OF THE STATE OF COLORADO



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October 30, 1981

Dr. L.L. Mink
Idaho Operations Office
U.S. Dept. of Energy
550 2nd St.
Idaho Falls, Idaho 83401

Dear Roy:

RE: CONTRACT DE-AS07-77ET28365

Enclosed please find 5 copies of two map reports that we have prepared for the above contract.

DOE/ET/28365-12, Revised Heat Flow Map of Colorado by Ted G. Zacharakis and
DOE/ET/28365-13, Geothermal Gradient Map of Colorado by Frank N. Repplier and Robert L. Fargo.

In order that these maps might be readily to the general public extra copies were printed and they are available at no cost from the Colorado Geological Survey as Map Series 18 and Map Series 20 respectively.

Sincerely,

Richard H. Pearl
Project Coordinator

cc: Duncan Foley
Marshall Reed
Washington D.C. office

Return to
R. H. Reed
Colo. Geol. Survey

GLOO9107

GEOPHYSICAL SURVEYS AT PAGOSA SPRINGS AND GLENWOOD SPRINGS,

COLORADO

by

Department of Geophysics
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GEOPHYSICAL SURVEYS AT PAGOSA SPRINGS AND GLENWOOD SPRINGS, COLORADO

ABSTRACT

The Geophysics Department of the Colorado School of Mines has carried out surveys in the vicinity of Glenwood Springs and Pagosa Springs to assist in locating test wells to evaluate geothermal potential. At Pagosa Springs, a seismic reflection survey indicates that the main springs issue along a fault that bounds an anticline with a closure of approximately 500 feet. Electrical resistivity surveys indicate anomalously low values over an area of several square miles extending northeastward from the main hot springs. This area is also characterized by a slightly higher content of mercury in the soil than is present in surrounding areas.

At Glenwood Springs, only electrical resistivity surveys were carried out. An area of anomalously low resistivity was mapped along the Colorado River but centered beneath Lookout Mountain which lies two miles east of Glenwood Springs. The resistivity surveys show progressively better potential for the presence of a geothermal reservoir as one goes from the west end to the east end of the anomaly.

GEOPHYSICAL SURVEYS AT PAGOSA SPRINGS AND GLENWOOD SPRINGS,
COLORADO

INTRODUCTION

During the period from June to November, 1977, students and faculty from the Department of Geophysics, Colorado School of Mines, carried out various geophysical surveys at Pagosa Springs in southwestern Colorado and Glenwood Springs in western Colorado to assist in the location of boreholes intended to evaluate geothermal potential in these areas.

At Pagosa Springs, surveys included electrical resistivity, soil mercury content, and seismic reflection. At Glenwood Springs, only electrical resistivity surveys have been carried out up to the present time.

PAGOSA SPRINGS AREA

At Pagosa Springs, warm springs issue from Jurassic Mancos shale. These springs are among the hottest and have the highest flow rates in the State of Colorado. Temperature ranges from 54° to 60° C. and total discharge is approximately 700 gpm.

The town of Pagosa Springs is located on the south flank of the San Juan Uplift, which is a southern extension of the Uncompaghre Uplift. The San Juan Uplift is covered in the central, north, and eastern parts by the San Juan volcanic field

*Mancos is
K*

which includes at least ten calderas with associated flows.

The town of Pagosa Springs lies on the central-northeastern edge of a 30-35 mile long fault zone with a $N45^{\circ}W$ trend. The fault zone is about six miles wide. The town is also about 10 miles north of a six-ten mile wide north-northeast trending (Oligocene?) dikes form that intersects the fault zone at nearly right angles. The town is near the center of a semi-circle described by six Tertiary intrusives to the north, east, and south at a radius of ten miles. The nearest recognized caldera complex is 30 miles to the north.

Seismic Survey

During July, 1977, approximately seven miles of six-fold and one mile of twelve-fold reflection seismic data were collected along traverses passing through the town of Pagosa Springs as indicated on the map in Figure 1. The survey was done using a vibrator source from the Colorado School of Mines. A long north-south seismic line (Line 1) was selected to maximize the amount of geologic information provided by the survey. Regional dips of geologic units were predicted to be south or southwest away from the San Juan volcanic field. Two short crosslines (Lines 2 and 3) were shot in an east-west direction to provide some three-dimensional structural control in the vicinity of the Hot Springs. Line 2 was centered to cross the surface expression of the Pagosa Hot Springs. Because of topographic relief and urban obstacles, the line was limited to

approximately two-thirds of a mile in length. Line 3 was located 1- $\frac{1}{2}$ mile south of Pagosa Springs. It was acquired to investigate the possibility that potential thermal reservoir rocks may occur immediately south of Pagosa Springs.

The data obtained in the field were processed using standard computer routines and interpretations of the three lines are shown in Figures 2-4. Identification of geologic units is based on surface geologic control and postulated correlation to the section in the Gramps Oil Field, located 20 miles southeast of Pagosa Springs. Seismic and well log information are available at the Gramps Oil Field to provide control (Figure 5). Similarities in the seismic character of the records from Pagosa Springs and those from the Gramps Field are striking. Three marker horizons are picked; Precambrian top (PE), top of the Dakota (Kd), and the Mancos-Mesa Verde marker (Kmm). Assuming that these horizons have been correctly identified on the Pagosa Springs sections in Figures 2-4, the following interpretation may be made:

Line 1 - the north-south regional line shows that

- a) the Hot Springs is situated on the hinge line of a monoclinial fold,
- b) this hinge line is fault controlled,
- c) the axis of the hinge line trends northwest to southeast, and
- d) the south limb of the monocline dips steeply while the north limb dips gently to the north.

It is particularly important to note that the sedimentary sequence of Mesozoic rocks is predicted to have a thickness of 3500 to 4000 feet in the Pagosa Springs area.

Line 2 - the east-west line centered across the Hot Springs shows

- a) the plunge of the axis of the monoclinial fold is to the east-southeast,
- b) the warm springs appear to be located within a fault block on the highest structural position on the monoclinial axis,
- c) the disruption of data quality on the extreme left side of the section may be due to a thermal and/or chemical change of acoustic impedance properties of the rocks directly associated with the mineral springs.

The Dakota "dim-spot" is particularly noticeable. The Dakota could be the main aquifer for the geothermal system.

Line 3 - the east-west line, 1-½ miles south of Pagosa Springs illustrates

- a) the southeast plunge of the monoclinial hinge line or fold axis,
- b) fault control of the hinge axis,
- c) that the Mesozoic sequence has thickened to approximately 5000 feet.

In summary, the Pagosa Springs geothermal features are located on a southeasterly-plunging monoclinial hinge line or fold axis. The surface expression of the geothermal anomaly is located on the apex of the fold axis. The fold axis is fault controlled. A tectonic map, Figure 6, shows the structural features and maps the surface of the Dakota Formation.

Reconnaissance Resistivity Survey

A reconnaissance resistivity survey was carried out over an area of approximately 150 square miles more or less centered on the town of Pagosa Springs (see Plate 1). This survey was carried out using the dipole mapping technique. In this technique, the area to be surveyed is energized using a fixed bipole source. For the survey of the Pagosa Springs area, the source bipole was located along U. S. Highway 84 approximately a mile and a half south of Pagosa Springs. The length of the bipole source, that is, the distance between grounding electrodes, was approximately 750 meters. The source was energized with periodically reversed direct current, with the peak to peak amplitude of current supplied to the ground being approximately 360 amperes. The direction of current flow was reversed six times per minute; thus, the frequencies contained in the transmitted current wave form were sufficiently low that direct current behavior could be assumed.

The behavior of the current flow from this bipole source was mapped by making measurements of electric field intensity at numerous stations over the survey area, as indicated on Plate 1. In order to measure the electric field at a receiver station, two 100-meter lengths of wire were laid out at right angles to one another, and connected to the ground through nonpolarizing electrodes. The voltages from the two legs of the electrode setup were amplified and recorded on a graphical recorder. Signals with amplitudes as low as 50 microvolts could be measured with an accuracy of a few percent.

Values of apparent resistivity were computed from the measured currents and the measured electric fields by using standard formulas for uniform earth. Contours of values of apparent resistivity are shown on Plate 1.

For the most part, the area around Pagosa Springs is characterized by resistivities ranging from 150 to 300 ohm-meters or more. These resistivities are relatively high for a sedimentary sequence, and probably reflect the presence of relatively fresh waters in the sedimentary sequence. A striking feature of the reconnaissance resistivity survey is the region of anomalously low resistivity mapped in and immediately around the town of Pagosa Springs. The very lowest resistivity values - 31 ohm-meters - was recorded in the immediate vicinity of the Hot Springs. All of the region within the 100 ohm-meter contour can be assumed to be anomalous. This area of low resistivity probably reflects the limits of the reservoir in which thermal waters are present.

Structurally, the area of low resistivity appears to terminate abruptly along a northwest-southeast trending line along the southwestern edge of the town. The regions of lowest resistivity tend to be elongate to the northeast. It is possible that recharge of the geothermal reservoirs may take place by water flowing from northeast to southwest, and being blocked by fault boundaries as observed with the seismic survey.

A listing of the bipole mapping survey data and calculations is included in Table 1 and Table 2.

Detail Resistivity Survey

Following the reconnaissance resistivity survey, a detailed survey was carried out in the immediate vicinity of Pagosa Springs using the dipole-dipole profiling technique. This is a standard method, commonly used for locating lateral changes in resistivity along profiles. The layout of electrodes used in making a single determination of apparent resistivity is shown in Figure 7. Four electrodes are used, placed along the profile to be traversed. The two electrodes at one end of the array are used to drive current into the ground; these are indicated as electrodes C_1 and C_2 on Figure 7. The other two electrodes, P_1 and P_2 , are used to detect the voltage generated by the current flowing from the source electrodes. The distance between the current electrodes or between the receiver electrodes is used as a parameter to characterize the spacing of the electrode array, a . The inner-spacing between the two sets of electrodes is set equal to some integer multiplying the length of either one of the electrode pairs as shown in Figure 1. In making a set of measurements, the two source electrodes are fixed on location while the two receiver electrodes are moved away from the source as a sequence of measurements are made. In presenting the results of a dipole-dipole survey, data are plotted in cross-section form. The observed voltage at any receiver pair is converted to a value for apparent resistivity, and this value is plotted on a cross-section

at a point midway between the centers of the source and receiver dipoles. This method of presentation of the data has been accepted as standard, and no implication that the resistivity being measured is that at the plotting point should be made.

In making a resistivity cross-section along a traverse, many different source electrode and receiver electrode positions are occupied. To minimize the effort involved in laying out cables, in the surveys done at Pagosa Springs and Glenwood Springs, a set of multi-conductor cables with takeouts for electrode placement was used. Each cable consisted of six conductors. Takeouts were provided at intervals of 30 meters along each cable, for a total length of 150 meters. In making a set of measurements, two such cables were laid end to end along the proposed traverse. The contacts on one cable were used as current points while the contacts on the other cable were used as measuring points. The source and receiver equipment were located at the junction of the two cables. This equipment included switches which allowed selection of any pair of electrodes along either cable for use as a source dipole or receiver dipole.

With a single setup of the cables and equipment, 24 individual determinations of apparent resistivity were made without moving the equipment. Using the convention for plotting the data shown in Figure 7, for each location thus occupied, 24 apparent resistivity values corresponding to a diamond-shaped area on a cross-section are obtained.

Sets of measurements were made at 70 locations sited on 25 profiles as shown on the map in Figure 8. From one to six sets of measurements were made per profile. Because of interference from structures within the town of Pagosa Springs, many of the profiles were very short. Resistivity sections for all but one of the profiles are contained in Appendix I accompanying this report. Profile #1 was directed along an east-west line passing through the Pagosa Hot Springs. Unfortunately, because of problems that developed in making good contact through the Hot Springs' deposits, the data from Line 1 were unsatisfactory and are not included in this report.

No detailed interpretation of these profiles has yet been made. In examining the profiles, there are a number of anomalies confined to one or two measurements at a single measurement site; these are most likely caused by buried metal structures along the profile line. Such structures must be common within the town of Pagosa Springs.

The resistivity measurements of most interest are the low values such as were recorded at Location 5 on Line 2, at Location 9 on Line 3, at Location 31 on Line 9, at Location 35 on Line 11, at Location 38 on Line 12, and at Location 40 on Line 14. These areas of low resistivity are closely associated with observable and known warm water seepage. In each of these cases, areas with resistivities below 10 ohm-meters were located, with the lowest resistivities being 3 ohm-meters or less. The very large contrast between these low resistivity values and the more normal values of 50 to several hundred ohm-meters observed further away from hot springs indicates that the warm water seepage has had a

very strong effect on the properties of the rock.

Except for the few locations just mentioned, no distinctive changes in resistivity are observable on these resistivity cross-sections. Rather, it appears that resistivity changes gradually as one goes away from the Pagosa Hot Springs. This is clearly shown by the summary map for the dipole-dipole measurements in Figure 9. Here, the four individual measurements made at each setup for a 120 meter separation between dipoles were averaged together and plotted at the mid-point for the array. The lowest resistivity is immediately to the northeast of the main hot spring. Apparent resistivity increases gradually in all directions away from this minimum value to values of 100 ohm-meters or more. The location of the area of low resistivity mapped with the dipole-dipole array is the same as that mapped in the reconnaissance survey. For a 120 meter separation between dipoles, the greatest depth to which resistivity effects the measurement is probably 60 meters. In contrast, for the reconnaissance dipole measurements, where the offset distance from the source was approximately 2000 meters, the likely depth to which the rock contributes significantly to the resistivity measurement would be approximately 1000 meters. There is no marked change in the character of the resistivity anomaly for the shallow part and for the deeper part of the feature. In summary, both the shallow and deep penetration resistivity surveys indicate a well-defined zone of low resistivity which probably represents the area of the reservoir feeding the hot springs.

Soil Mercury Survey

A method used to locate geothermal reservoirs is the detection of mercury in soil or soil gas. The element mercury is not easily trapped in rocks, and tends to defuse continuously to the surface of the earth. If subsurface temperatures are unusually high, the rate of defusion is accelerated and anomalously high concentrations of mercury will occur in the soil. High concentrations of mercury may also occur if rocks with unusual amounts of mercury are present in the geologic section, or if open jointing and faulting is present to permit easy movement of mercury to the surface.

The normal concentration of mercury in soil is 10 to 100 ppb (parts per billion). In known geothermal areas, the concentration of mercury is 100 to 1000 times greater. At The Geysers in California, at Roosevelt Hot Springs in Utah, and at the Hawaii Geothermal Test Well #1 in Puna, the concentration of mercury in the soil which is levels of 1000 to 10,000 ppb. These three geothermal areas are characterized by relatively high reservoir temperatures, in the range from 250^o to 300^o C. While no definitive relationship has been established between the concentration of mercury in soil and subsurface temperature, these high mercury levels around known geothermal areas encourage one to believe such measurements can be used in exploration.

Soil samples were gathered at 40 locations in the vicinity of the Pagosa Springs resistivity anomaly, as shown in Plate 2. These samples consisted of 30 to 50 grams and were taken at a

depth of 6 to 12 inches. The material was sieved to separate the fine sand sizes for analysis. The fine sand separate was heated in a small oven to volatilize the metallic mercury present. The fumes derived from the sample were passed through a silver thimble to separate the mercury from organic compounds volatilized along with it. After heating for three minutes, the thimble was removed and it in turn was placed in the oven. On heating, the thimble released the amalgamated mercury which was then passed through a dual atomic absorption cell. The accuracy of mercury determinations made with this device is $\pm 20\%$.

Mercury contents observed in the Pagosa Springs area were for the most part unusually low. The background level to the west and north of Pagosa Springs appears to be approximately 20 ppb. In town, and generally in the area where the resistivity was anomalously low, the mercury concentration is higher, amounting to 30 or 40 ppb. This two-fold increase in mercury concentration is appropriate for a relative low temperature geothermal system.

An interesting feature of the mercury survey is the presence of a linear zone with quite high mercury concentrations southeast of town. Here, concentrations in excess of 200 ppb were measured at two locations. These high concentrations may result from the presence of a mercury-rich member of the section, or they may represent accumulation of mercury along an active fracture, or the effect of temperature. It appears that a more detailed and complete mercury survey would provide interesting information.

GLENWOOD SPRINGS AREA

There are nine major hot springs at Glenwood Springs, most of them within the city limits, flowing from both the channel and the alluvium on both sides of the Colorado River. Seven springs flow from the Leadville Limestone (Mississippian) and its surface trace beneath the river. Yampa Spring discharges 2500 gpm at a temperature of 51° C. It feeds the municipal pool which is 750 feet long and 65 to 110 feet wide. The remainder of the springs have flow rates from a few to 160 gpm, at temperatures within a few degrees of Yampa Spring. They are the most highly mineralized springs in the state, with up to 20,000 ppm dissolved solids. Sodium and chlorine make up 90% of the solutes.

Glenwood Springs is located on the southwest flank of the White River Uplift, which borders to the west and southwest with the Piceance Basin. The White River Uplift is a broad flat-topped arch which is the last of the major Laramide uplifts. The northern flank of the uplift is monoclinal, but on the west and southeast flanks the strata are steeply upturned. At Glenwood Springs, this flank is structurally complex with extensive antithetic faulting.

The stratigraphic section contains 25,000 feet of pre-Tertiary sedimentary rocks with Precambrian rocks exposed only in a few small areas in deep canyons. The section contains 6900 feet of Paleozoic rocks, 11,300 feet of Mesozoic rocks, and 6600 feet of Cenozoic rocks.

The Paleozoic is primarily a marine section with quartz sandstones, galuconitic dolomite, limestone and shale.

The carboniferous section consists of massive redbeds with shales and limestones. In the Paradox Basin to the southwest, the section above the Leadville Limestone (Mississippian) contains large amounts of salts and evaporites.

The Mesozoic section is typical of that in most of the rest of the state with thick sequences of variegated shales, conglomerates, sandstones, and minor limestones.

The Cenozoic section consists of clay, shale, sandstone, coal, conglomerates and glacial deposits capped by basalt 20 miles north in the Flat-top Mountains. In the Dotsero area, 20 miles to the east, a cindercone has been dated at 4000 years B.P. There are two other basalt flows that overlie modern topography and several other small uninvestigated piles of volcanic ash on the plateaus to the south and north. It is possible that dikes or sills were implaced at shallow depth in Glenwood Springs during this recent period of sporadic volcanism.

Reconnaissance Resistivity Survey

A reconnaissance resistivity survey was carried out over an area of approximately 80 square miles, mainly along the valleys of the Colorado and Roaring Fork Rivers (Plate 3). As at Pagosa Springs, the dipole mapping technique was used. The source bipole, which was 800 meters in length, was located along a northsouth road in Section 34, four miles south of

Glenwood Springs. The current obtained with this source varied from 40 to 60 amperes, peak to peak, during the survey.

The behavior of the electric field was mapped in the same manner as described earlier for the Pagosa Springs area. At Glenwood, considerable difficulty was encountered in making measurements anywhere except along the two river bottoms. Away from the rivers, the topography is difficult, and because measurements were made during hunting season, many gates were closed.

The pattern of apparent resistivities mapped during the reconnaissance survey is shown on Plate 3. Resistivities are approximately in order of magnitude lower than those observed during a reconnaissance survey at Pagosa Springs. The areas to the west of the Roaring Fork River and to the north of the Colorado River have the highest resistivities measured, being above 20 to 40 ohm-meters. Anomalously low resistivities were measured beneath the summit of Lookout Mountain, which lies south of the Colorado River and east of the Roaring Fork River. The lowest values were 2.0 to 2.5 ohm-meters. The low resistivity area is elongate to the west and northwest along the Colorado River in the immediate vicinity of the known hot springs.

The reconnaissance electrical data indicate that the principal reservoir for the hot springs lies immediately east of Glenwood Springs beneath Lookout Mountain, rather than beneath the river bottom where the springs now issue. However, because of the complex terrain and the possibility that the apparent

resistivity pattern is controlled by some extent by the terrain, this interpretation must be considered tentative until further electrical surveying can be done.

Detail Resistivity Survey

Detail resistivity surveys were made along the banks of the Colorado River near the hot springs at the locations indicated on Figure 10. As at Pagosa Springs the dipole-dipole method was used. Measurements were made at 62 locations on 18 profiles. The resistivity cross-sections for these 18 profiles are contained in Appendix 2.

Resistivities of 5 ohm-meters and less were measured for the short separations at locations where hot springs are known to be present. These areas of low surficial resistivity include Location 4 on Line 1, Locations 9, 10 and 11 on Line 1, Locations 24 and 25 on Line 8, and Location 44 on Line 12.

The dipole-dipole data are summarized into plan-maps in Figures 11 and 12. Average resistivities for a dipole separation of 120 meters are shown on Figure 11, while average resistivities are shown for dipole separation of 240 meters on Figure 12. The data characterize two relatively small areas of anomalously low resistivity, both located in the immediate vicinity of hot springs. The eastern-most of these two locations is at the Hot Springs Lodge, and this area has a lower resistivity than the area immediately to the west.

Both the shallow and deep resistivity surveys indicate a decreasing quality to the electrical anomaly as one goes to the west. The reconnaissance resistivity survey shows that the most likely area for the main reservoir is to the east of Glenwood Springs where no detailed measurements were made because of problems with topography.

SUMMARY

Geophysical surveys at both Pagosa Springs and Glenwood Springs provide clear evidence for limited zones supplying thermal fluids to warm springs. The geophysical data provide no additional insight with respect to the probable temperature of the reservoir than has been previously been available from geochemical studies. It is probable that optimum drilling locations for test holes lie in the centers of these areas of low resistivity. However, in a complete evaluation of the geothermal prospects of these two areas, much additional exploration effort would be needed.

At Pagosa Springs, the hot springs appear to rise at the crest of a fault-bounded anticline. The structure is very similar in character to the one at the Gramps Oil Field, located 20 miles to the south. Consideration should be given to the possibility that a hole drilled at the top of this anticline will find hydrocarbon-saturated reservoir rocks.

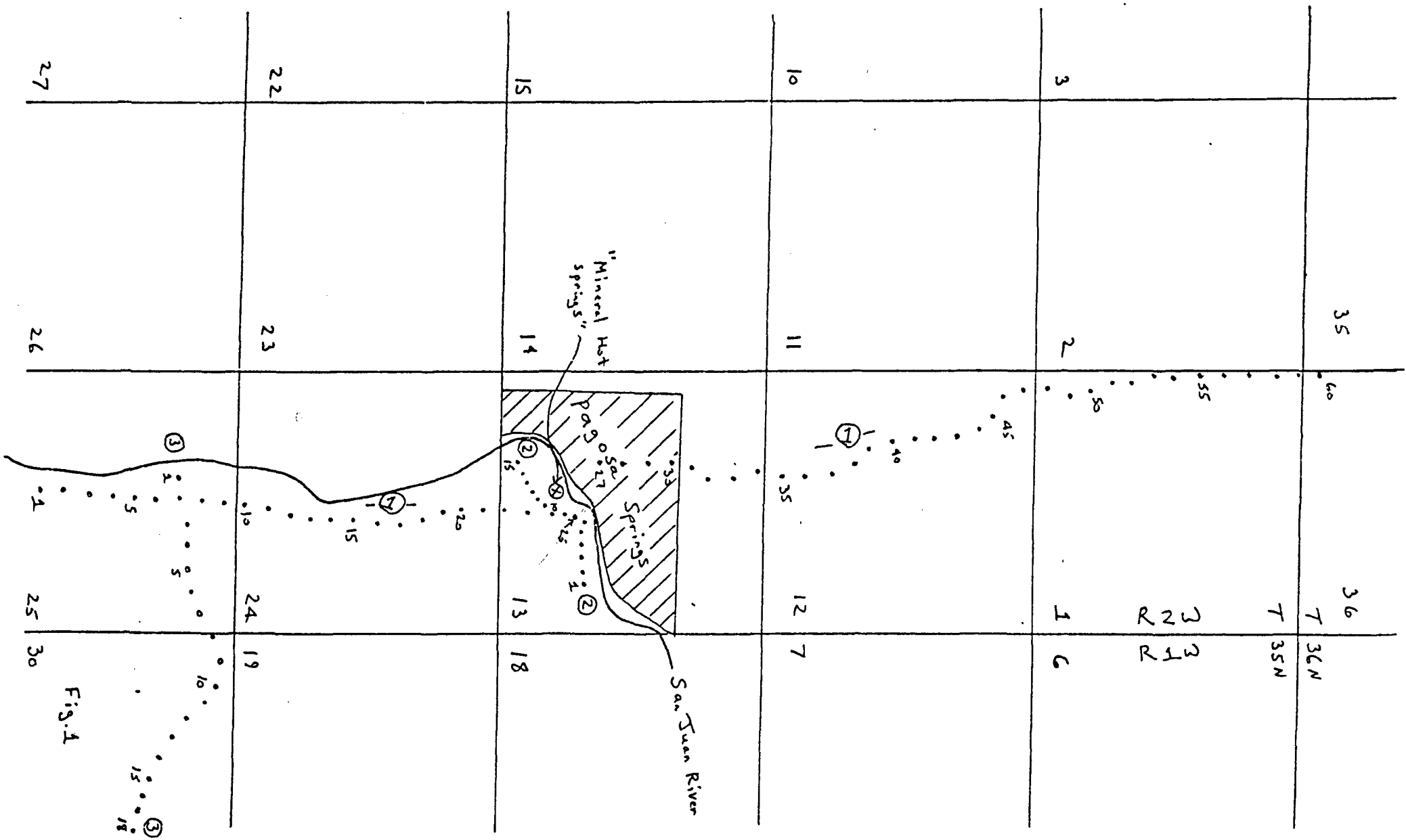


Figure 1: Locations of vibrator points occupied during seismic reflection survey at Pagosa Springs.

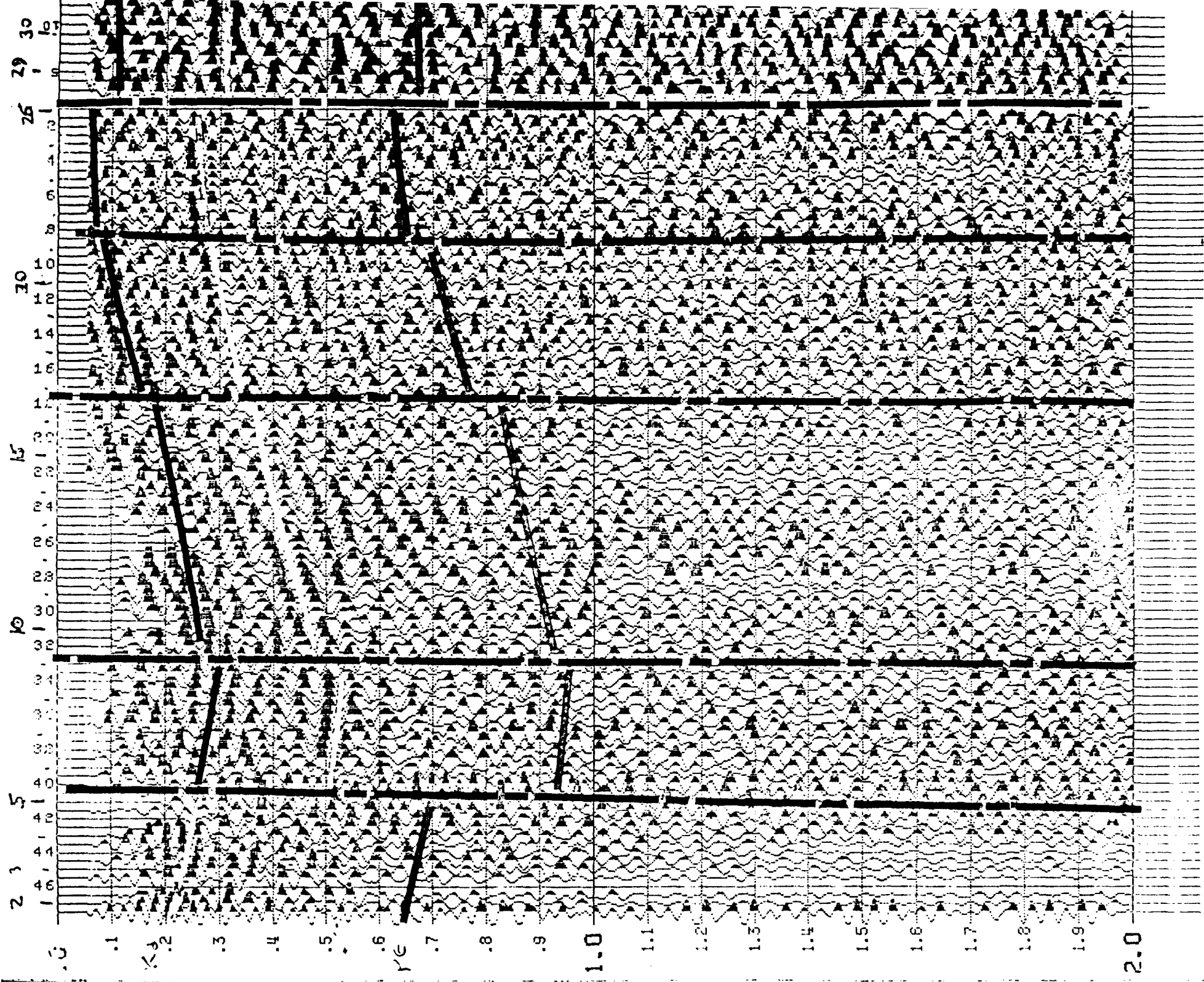
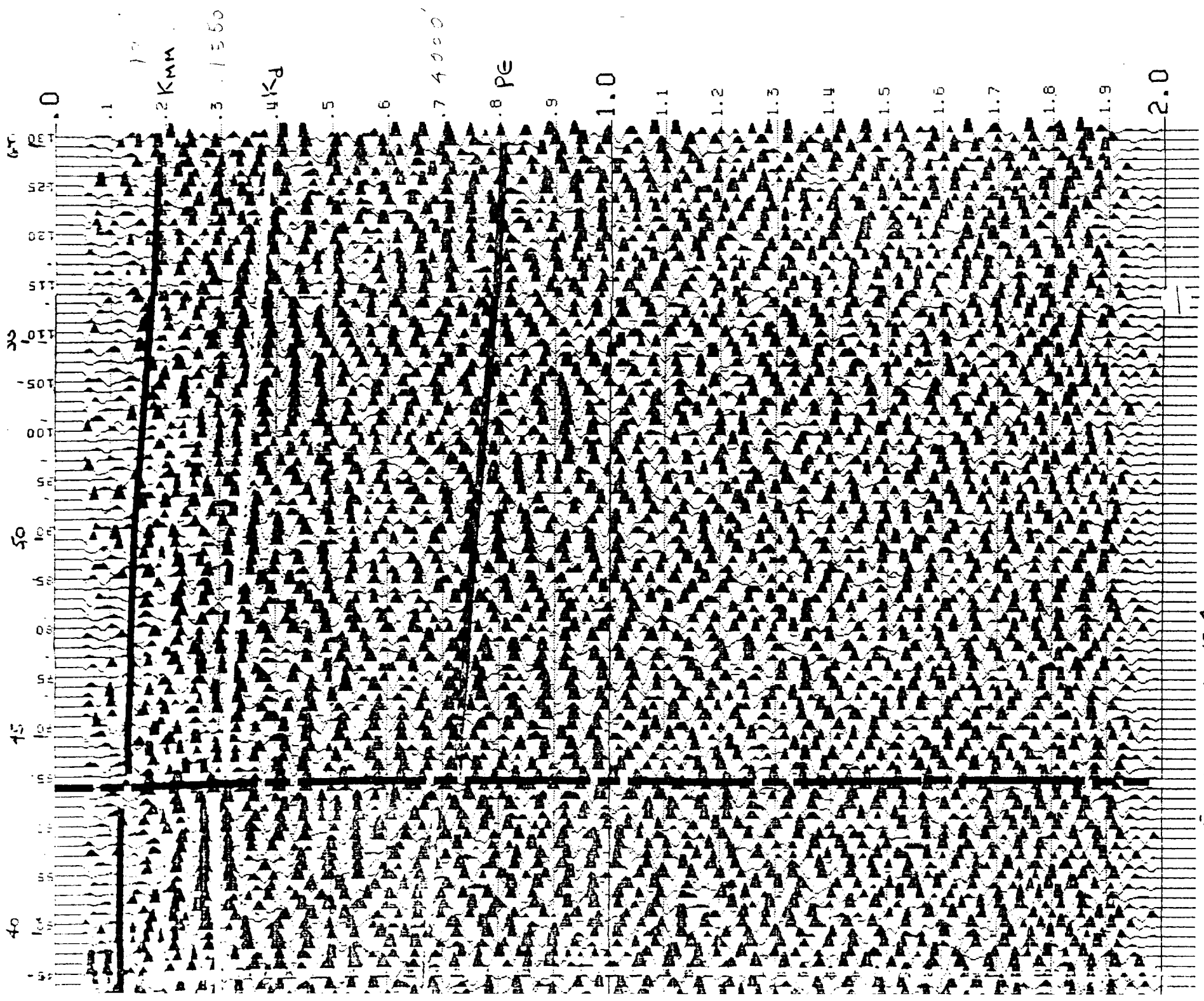
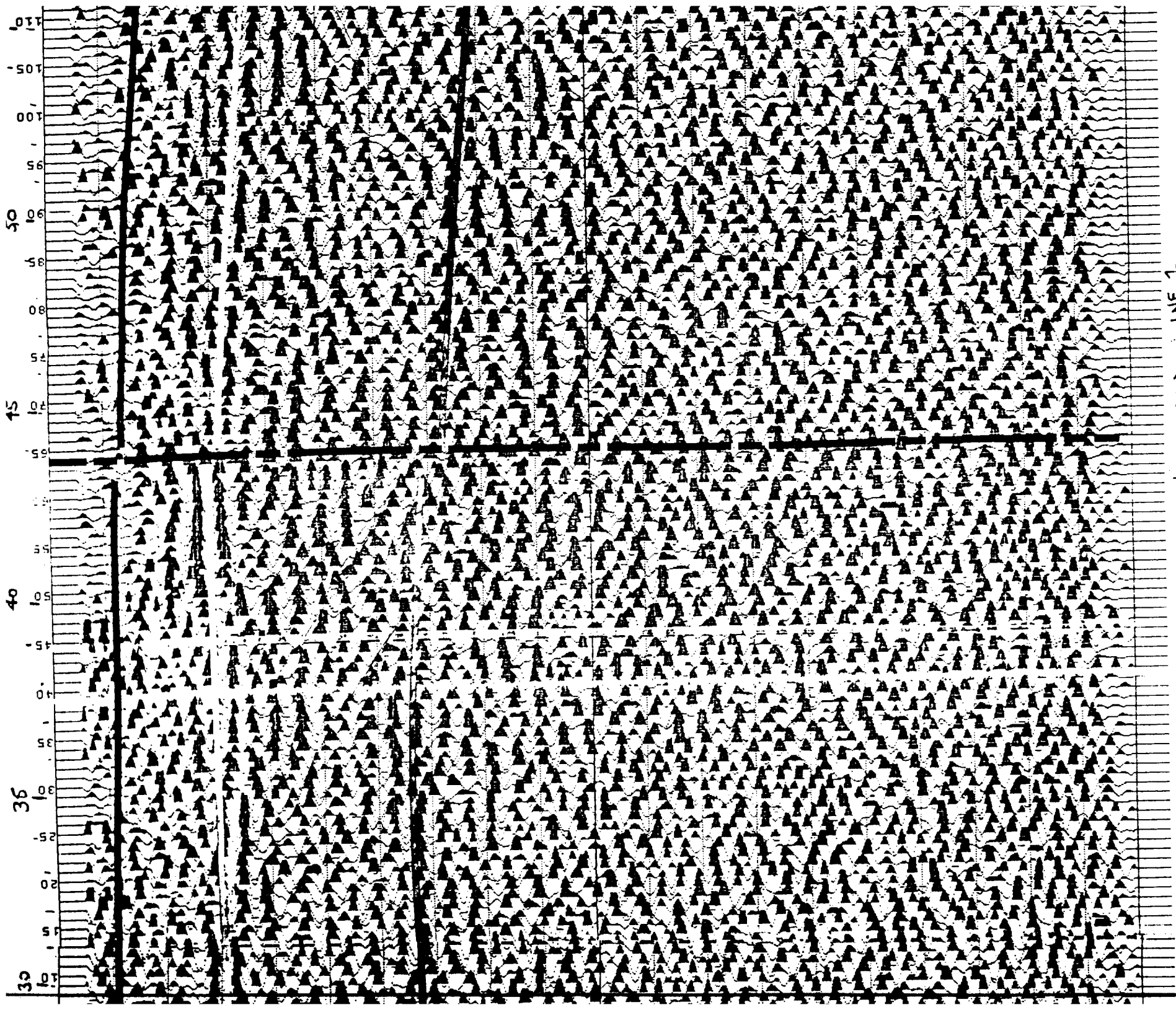


Figure 2: Seismic section along Pagosa Line 1.



Datum 7000ft
 $V_R = 3000 \text{ ft/s}$

6 Fold Vibroseis
 Acquired July 1977
 Processed August 1977



LINE 1
6 Fold Vibracis
Resins July 1971
Process August 1971

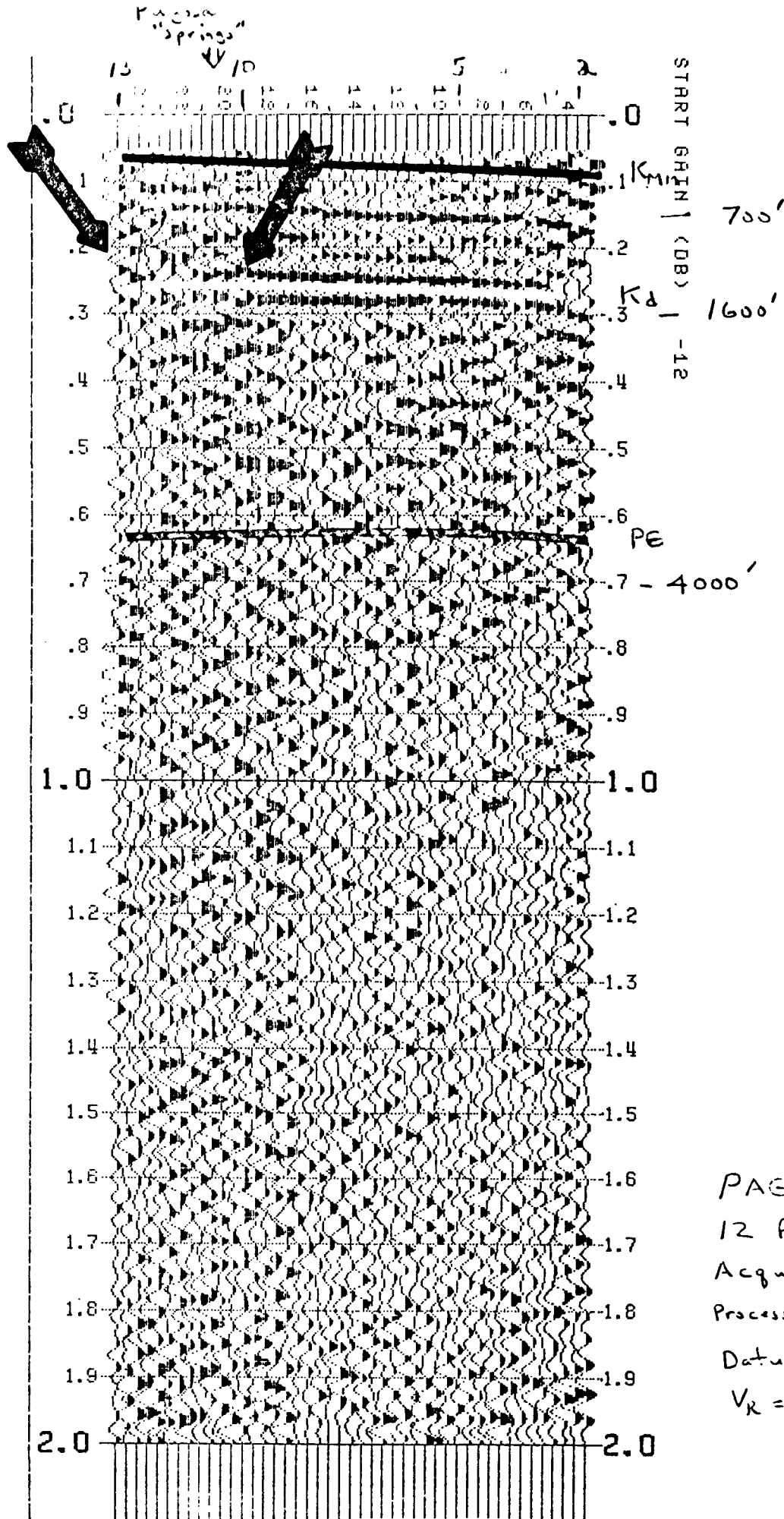
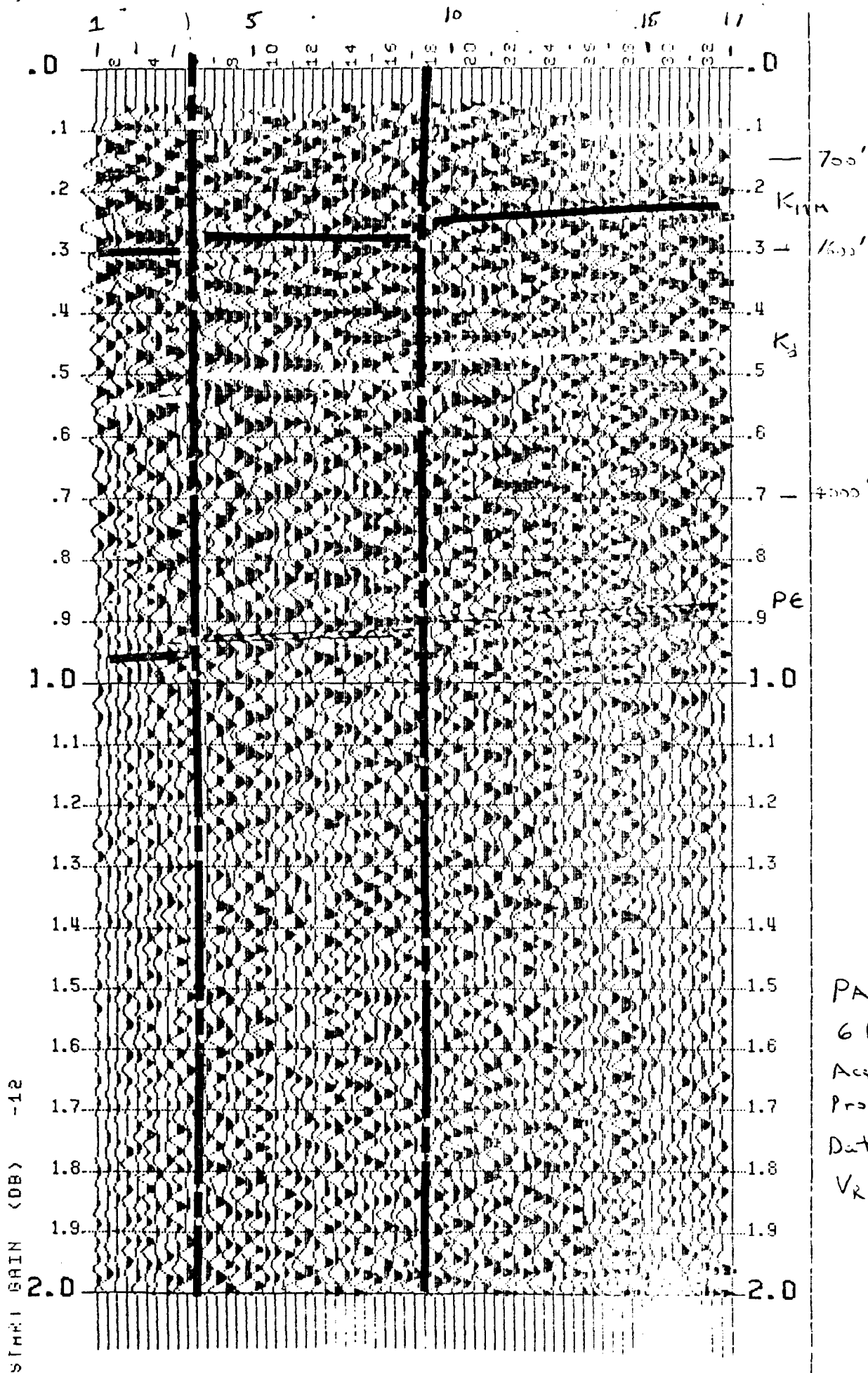


Figure 3: Seismic section along Pagosa Line 2.



PAGOSA LINE 3
 6 fold - Vibroseis
 Acquired July 31, 1977
 Processed August, 1977
 Datum 7000 ft
 $V_R = 2000 \text{ ft/s}$

Figure 4: Seismic section along Pagosa Line 3.

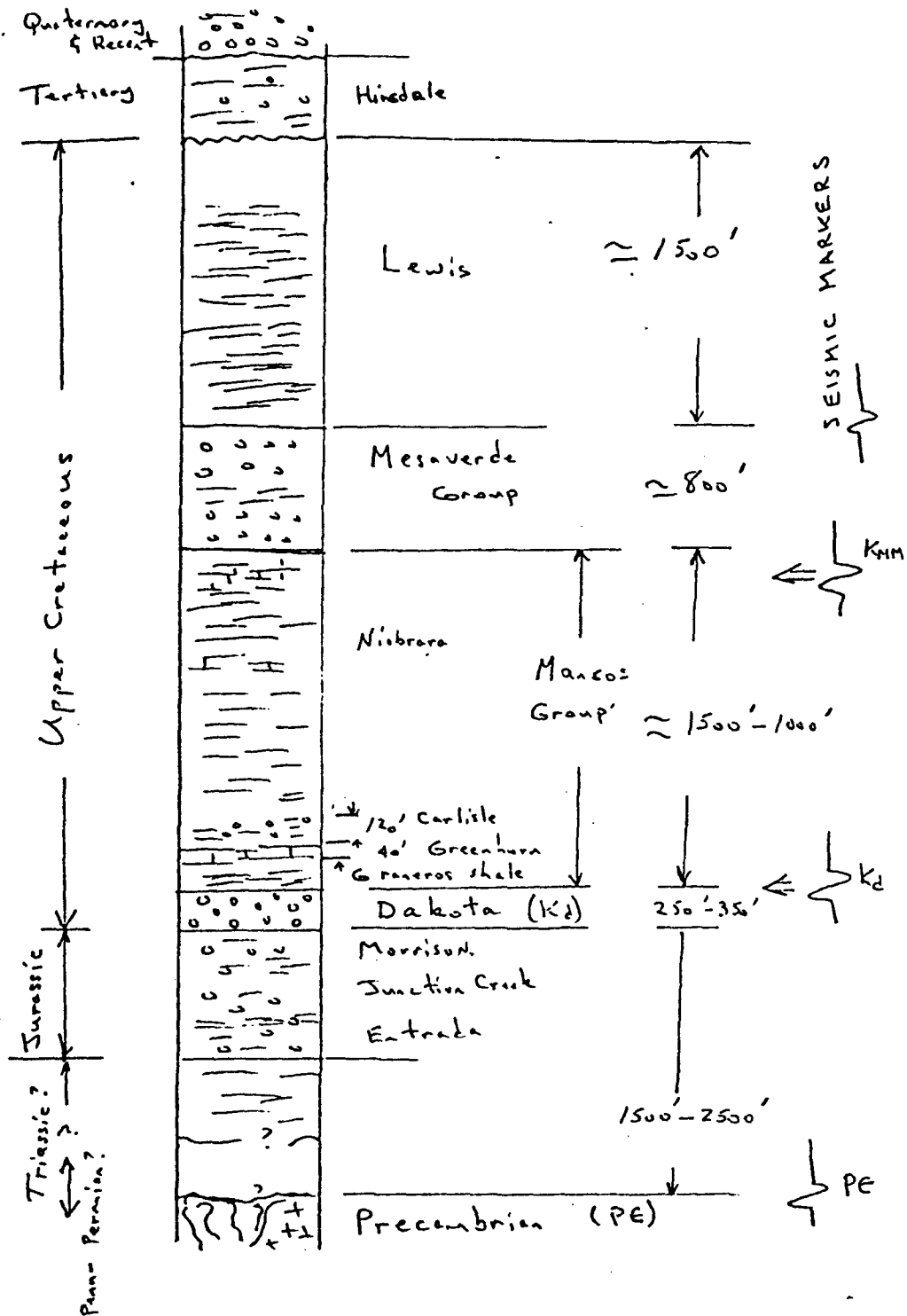


Figure 5: Schematic stratigraphic section from the Gramps Oil Field at Chromo.

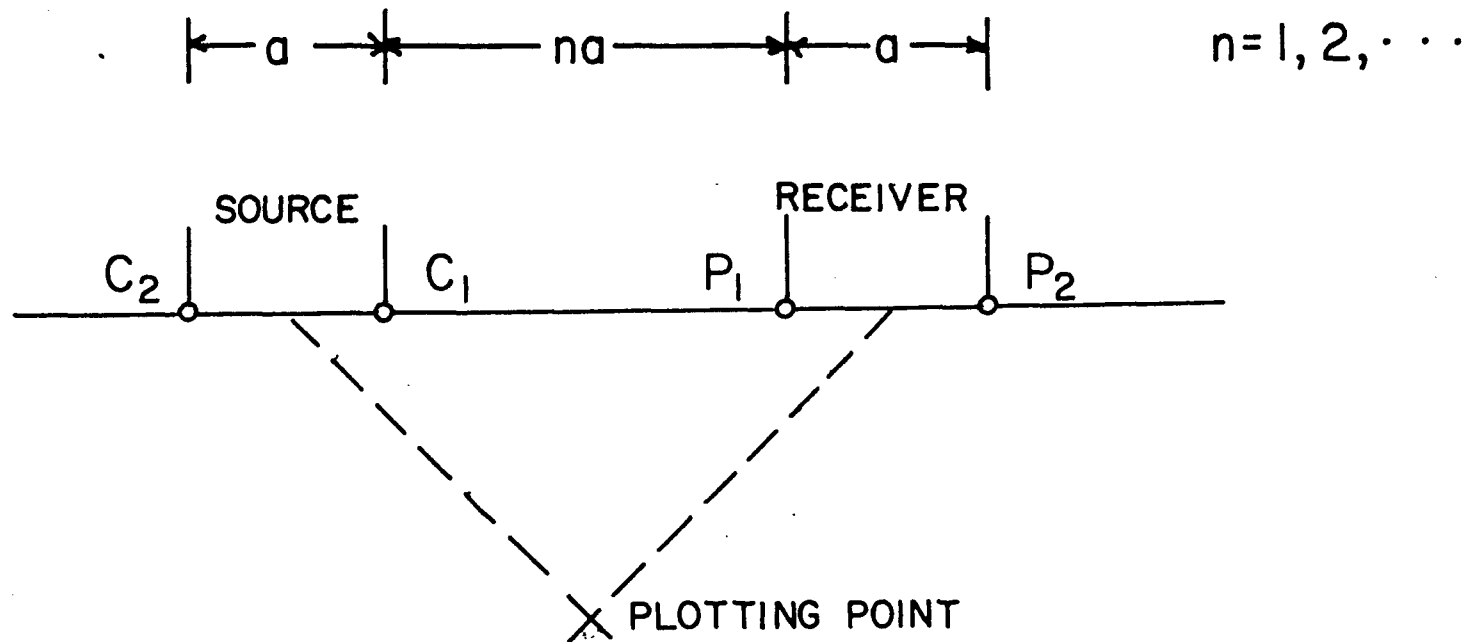


Figure 7: Dipole-dipole array showing where resistivities are plotted to make a resistivity cross-section.

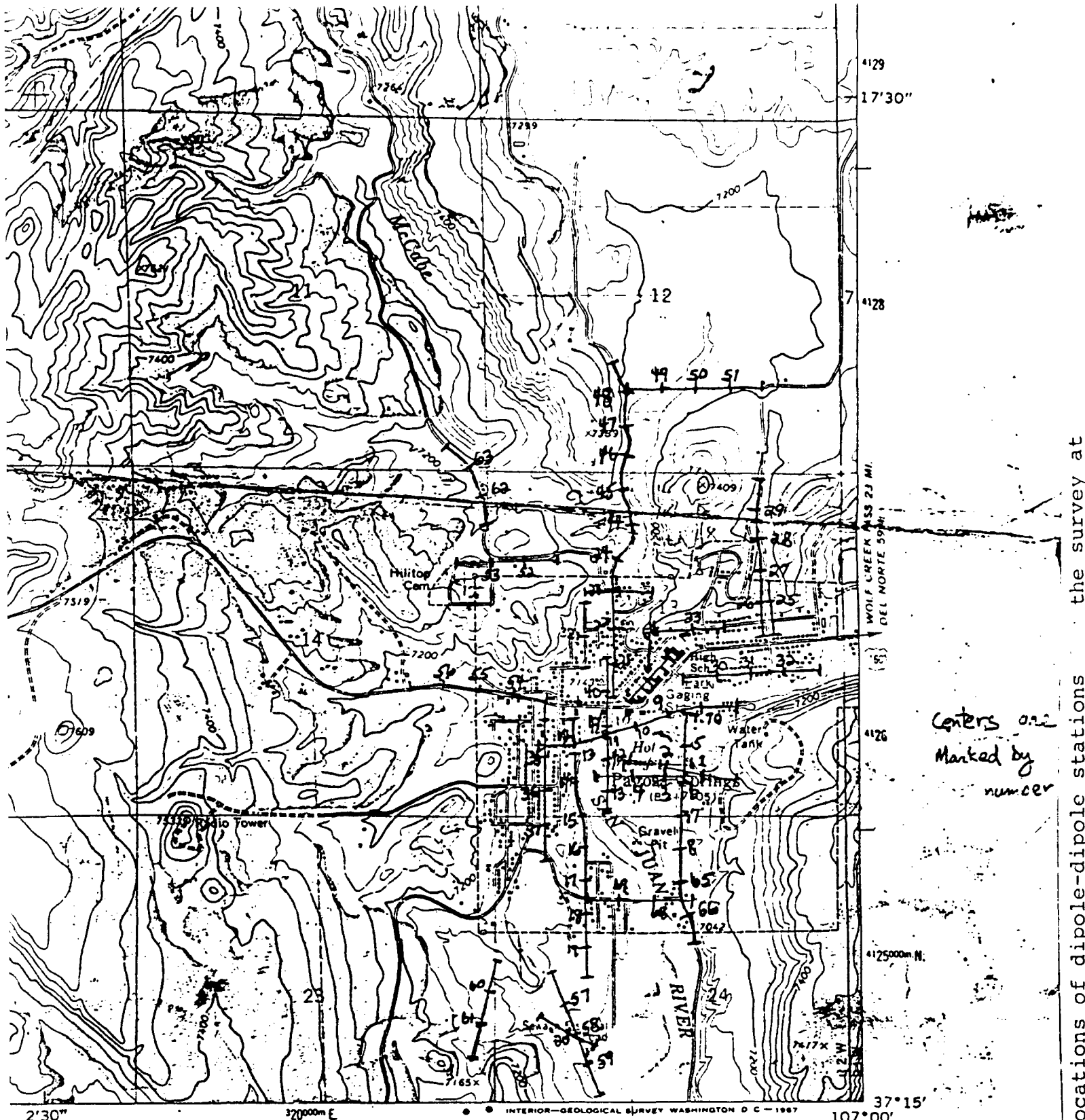


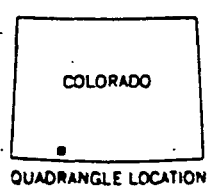
Figure 8: Locations of dipole-dipole stations the survey at

LE

2'30" 320000m E 107°00' 37°15'

ROAD CLASSIFICATION

- Medium-duty: Light-duty
- Unimproved dirt
- U. S. Route



34 on map
 7-10
 5-6-7
 26-27

PAGOSA SPRINGS, COLO.
 N3715—W10700/7.5

CHRONO 1:50,000

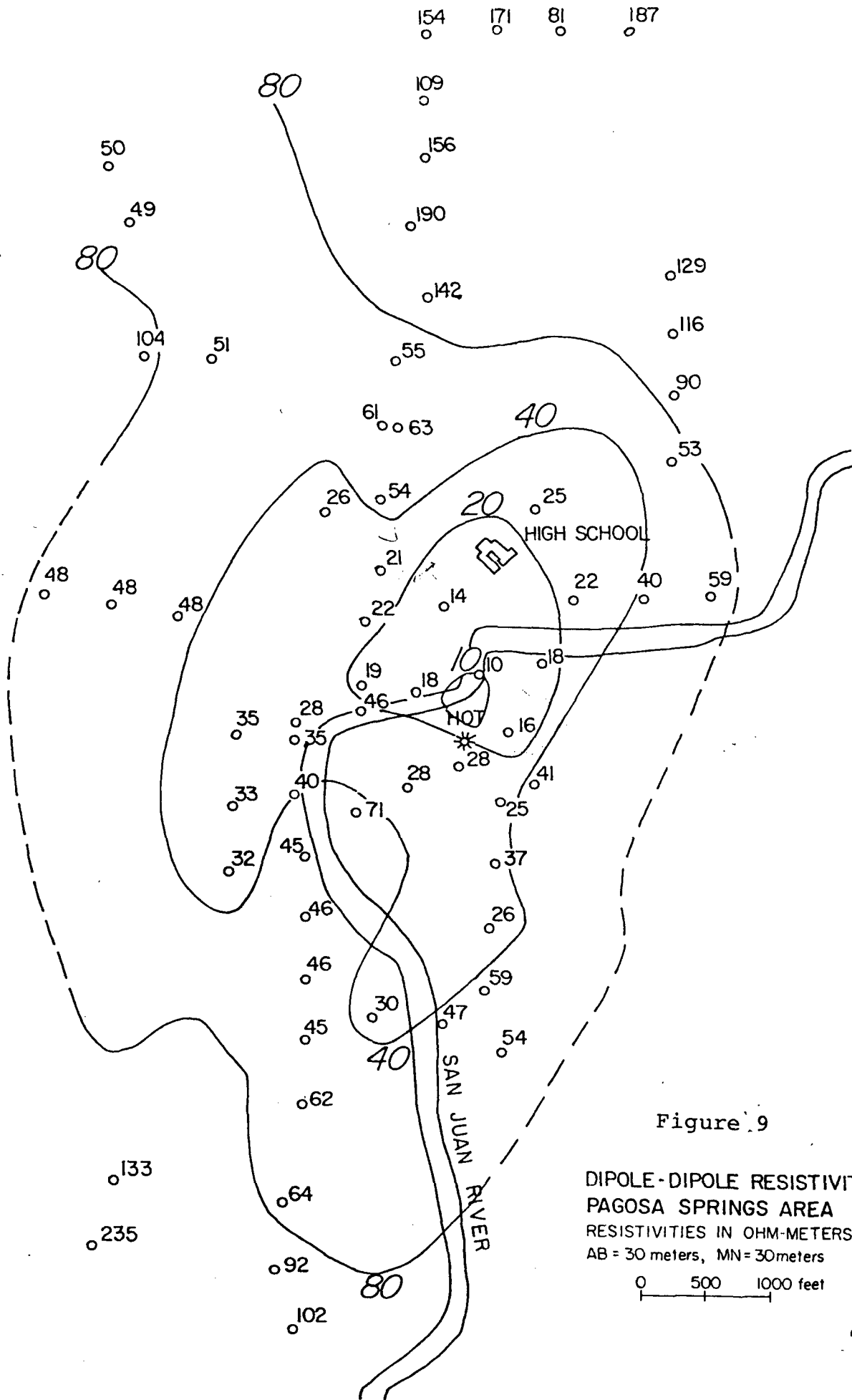


Figure 9

DIPOLE-DIPOLE RESISTIVITY MAP
 PAGOSA SPRINGS AREA
 RESISTIVITIES IN OHM-METERS FOR N=4
 AB = 30 meters, MN = 30 meters

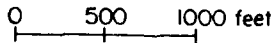




Figure 10: Locations of dipole-dipole stations at Glenwood Springs.

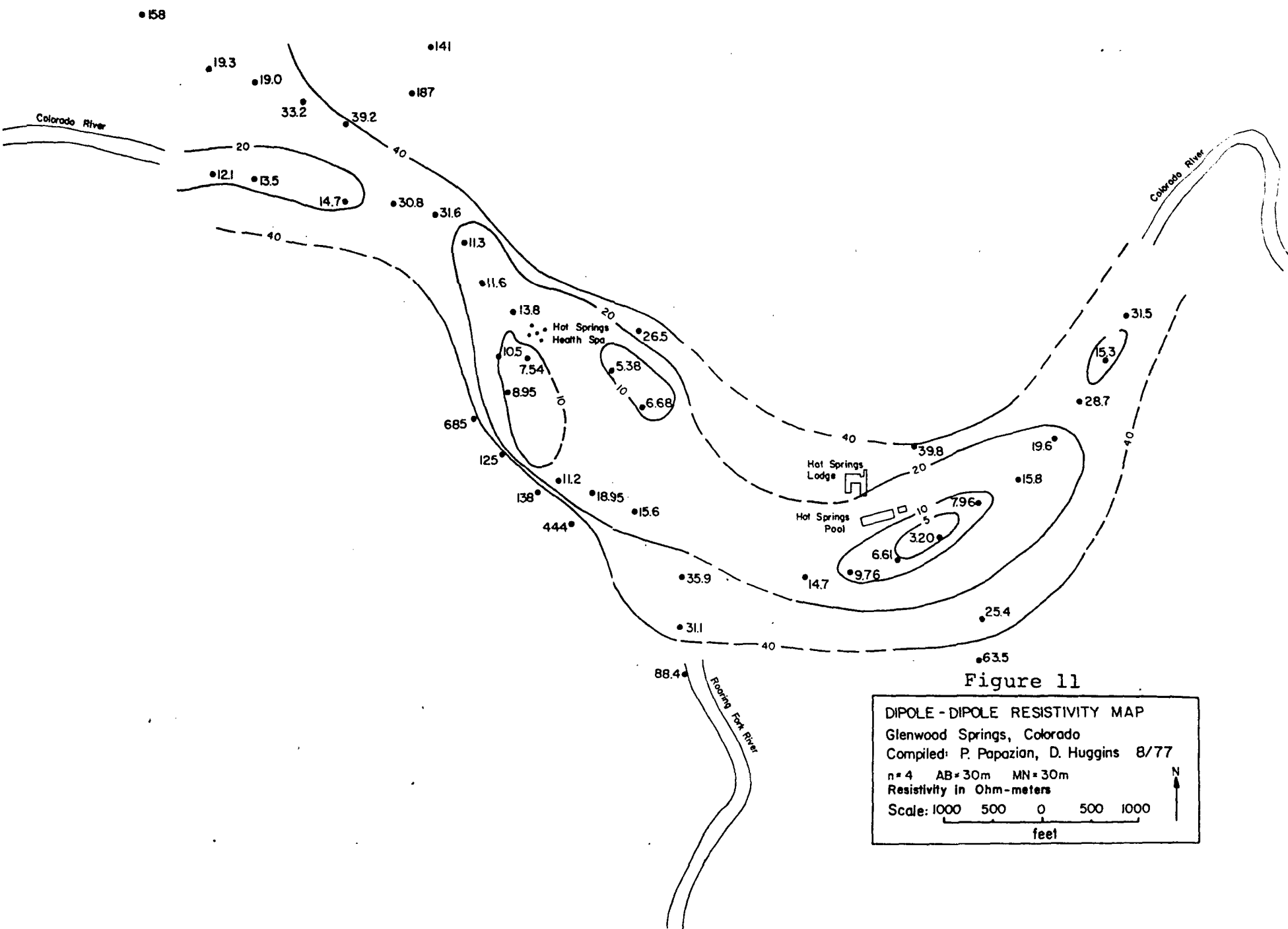


Figure 11

DIPOLE - DIPOLE RESISTIVITY MAP
 Glenwood Springs, Colorado
 Compiled: P. Papazian, D. Huggins 8/77
 n = 4 AB = 30m MN = 30m
 Resistivity in Ohm-meters
 Scale: 1000 500 0 500 1000
 feet

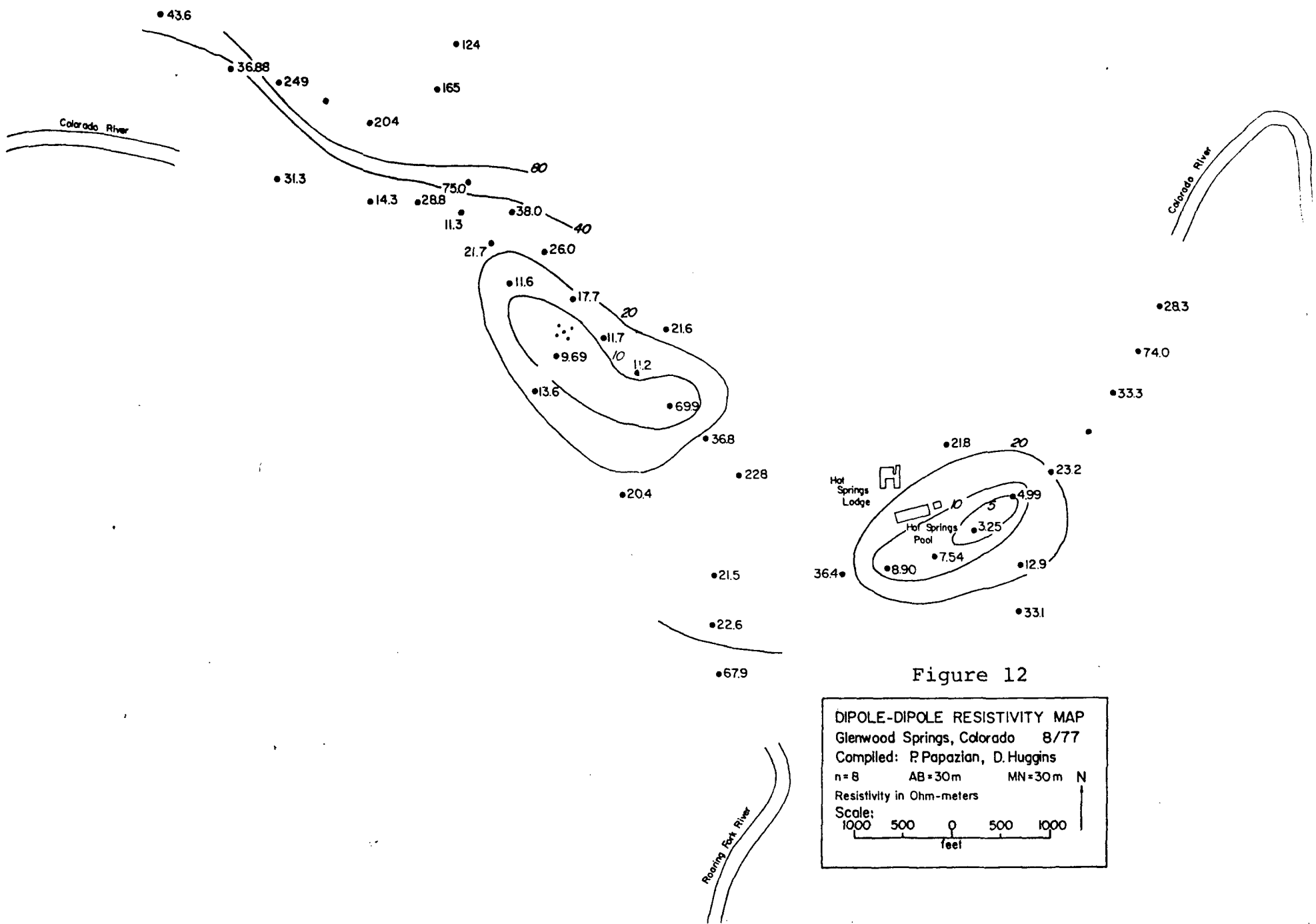


Figure 12

DIPOLE-DIPOLE RESISTIVITY MAP
 Glenwood Springs, Colorado 8/77
 Compiled: P. Papazian, D. Huggins
 n = 8 AB = 30m MN = 30m N
 Resistivity in Ohm-meters
 Scale:
 1000 500 0 500 1000
 feet

PAGOSA SPRINGS MERCURY ANALYSIS

1.	16.0 ppb	23.	15.0 ppb
2.	19.5 ppb	24.	29.5 ppb
3.	34.0 ppb	25.	33.5 ppb
4.	12.0 ppb	26.	41.0 ppb
5.	44.5 ppb	27.	32.0 ppb
6.	15.0 ppb	28.	43.0 ppb
7.	21.5 ppb	29.	37.5 ppb
8.	71.5 ppb	30.	13.5 ppb
8a.	19.0 ppb	31.	22.0 ppb
9.	27.0 ppb	32.	17.0 ppb
9a.	29.0 ppb	33.	17.5 ppb
10.	24.5 ppb	34.	31.0 ppb
11.	12.0 ppb	35.	25.5 ppb
12.	10.0 ppb	36.	23.0 ppb
13.	20.5 ppb	37.	225.0 ppb
14.	8.0 ppb	38.	26.0 ppb
15.	10.5 ppb	39.	38.0 ppb
16.	11.5 ppb	40.	23.0 ppb
17.	31.0 ppb	41.	24.5 ppb
18.	33.0 ppb	41a.	70.5 ppb
19.	17.5 ppb	42.	215.0 ppb
20.	19.0 ppb		
21.	26.5 ppb		
22.	11.5 ppb		

Key to Table I

- n: Index Number for Receiver Station
- Rx: Distance from Transmitter to Receiver Station, Northerly Component
- Ry: Distance from Transmitter to Receiver, Easterly Component
- R1: Radial Distance From One End of Transmitter to Receiver Station, Kilometers
- R2: Distance from the Other End of the Source to a Receiver Station in Kilometers
- D: Angle Included Between the Radaii R1 and R2 from Receiver Station to the Transmitter
- B1, B2: Bearings of the Two Lines Used to Detect Components of the Electric Field
- E1, E2: Observed Electric Field Components Along the Two Measuring Lines at a Receiver Station, In Microvolts per Meter

Table 1: Observed data, dipole mapping survey.

N	R1X	RY	R1	R2	Cos ² D	B1	E1	B2	E2
1,	-1.555,	1.495,	2.157,	2.687,	.99564,	49.,	348.0,	346.,	102.6,
2,	-1.858,	-1.604,	2.455,	2.317,	.97251,	80.,	-416.0,	346.,	123.2,
3,	-1.827,	1.236,	2.206,	2.695,	.99233,	340.,	-244.0,	70.,	82.0,
4,	-1.444,	-1.900,	-2.384,	-2.134,	.99571,	75.,	-211.2,	170.,	81.6,
5,	-1.475,	0.952,	1.756,	2.233,	.98800,	63.,	-67.7,	343.,	115.2,
6,	-1.382,	0.606,	1.509,	1.953,	.97723,	275.,	-896.0,	185.,	-410.4,
7,	-1.413,	0.009,	1.413,	1.699,	.94803,	183.,	-636.0,	273.,	63.5,
8,	-3.913,	-1.808,	4.311,	4.303,	.99106,	85.,	-20.5,	355.,	58.4,
9,	-3.722,	-2.629,	4.557,	4.441,	.99213,	250.,	28.7,	340.,	43.0,
10,	-3.851,	-3.845,	-5.442,	-5.228,	.99498,	237.,	-20.5,	327.,	33.8,
12,	-4.191,	-5.727,	7.097,	6.796,	.99750,	4.,	10.2,	274.,	-8.2,
13,	-4.253,	-6.641,	7.886,	7.553,	.99815,	67.,	16.4,	161.,	-8.4,
14,	-4.283,	-7.554,	-8.664,	-8.324,	.99860,	-80.,	9.1,	170.,	5.3,
16,	-4.574,	-9.641,	10.671,	10.277,	.99920,	86.,	96.0,	356.,	4.4,
17,	-5.487,	-10.875,	12.181,	11.796,	.99936,	90.,	3.7,	360.,	1.1,
19,	-1.907,	1.501,	2.427,	-2.933,	.99473,	115.,	-215.2,	25.,	-71.8,
20,	-1.660,	0.847,	1.864,	2.320,	.98576,	255.,	266.4,	165.,	4.1,
21,	-1.981,	0.958,	2.200,	2.646,	.98856,	0.,	-186.4,	270.,	232.0,
22,	-2.166,	1.075,	2.418,	2.865,	.99046,	110.,	137.6,	200.,	-112.8,
23,	-2.351,	0.773,	2.475,	2.869,	.98759,	90.,	123.2,	180.,	-92.0,
24,	-1.765,	0.433,	1.817,	2.193,	.97607,	90.,	237.6,	0.,	128.8,
25,	-1.913,	0.007,	1.913,	2.183,	.96900,	270.,	-148.0,	0.,	160.0,
26,	-2.129,	1.359,	2.526,	3.005,	.99329,	280.,	-115.2,	10.,	-29.4,
27,	-2.432,	1.384,	2.798,	3.260,	.99353,	270.,	-110.4,	0.,	42.6,
28,	-2.135,	1.668,	2.709,	3.214,	.99556,	260.,	-64.1,	173.,	31.4,
29,	-2.382,	1.810,	2.992,	3.491,	.99608,	90.,	148.0,	180.,	14.6,
30,	-1.759,	2.094,	2.735,	3.283,	.99825,	77.,	26.6,	167.,	90.2,
31,	-1.672,	2.649,	3.133,	3.699,	.99948,	270.,	-87.2,	0.,	-67.8,
32,	-2.061,	2.433,	3.189,	3.735,	.99862,	90.,	60.3,	180.,	53.8,
33,	-2.302,	2.421,	3.341,	3.877,	.99828,	70.,	48.5,	160.,	49.2,
34,	-1.950,	2.069,	2.843,	3.381,	.99779,	165.,	-105.6,	255.,	114.8,
35,	-1.333,	1.878,	2.303,	2.863,	.99864,	50.,	54.8,	160.,	229.6,
36,	-1.037,	1.896,	2.161,	2.732,	.99953,	70.,	-156.0,	340.,	108.8,
37,	-1.055,	2.112,	2.361,	2.934,	.99977,	77.,	-45.2,	369.,	57.4,
38,	-1.351,	2.094,	2.492,	3.057,	.99917,	75.,	-65.1,	345.,	140.8,
39,	-1.265,	2.439,	2.748,	3.320,	.99977,	260.,	129.6,	350.,	186.4,
40,	-1.092,	2.581,	2.803,	3.378,	.99997,	270.,	-71.1,	0.,	-104.8,
41,	-0.820,	2.149,	2.300,	2.876,	1.00000,	250.,	-18.5,	380.,	-117.6,
42,	-0.543,	3.890,	3.928,	4.492,	.99962,	90.,	-80.8,	180.,	154.4,
43,	-1.283,	1.390,	1.892,	2.434,	.99593,	290.,	-177.6,	200.,	91.2,
44,	-1.172,	1.199,	1.677,	2.215,	.99438,	270.,	-363.2,	180.,	225.6,
45,	-0.919,	1.446,	1.713,	2.280,	.99859,	345.,	228.0,	165.,	1037.6,
46,	-1.043,	1.668,	1.967,	2.534,	.99894,	90.,	123.0,	180.,	287.2,
47,	-2.753,	0.155,	2.757,	3.034,	.98474,	90.,	63.0,	0.,	297.6,
48,	-2.802,	-0.048,	2.802,	3.042,	.98392,	90.,	23.1,	0.,	313.6,
49,	-2.839,	-1.166,	3.069,	3.103,	.98265,	270.,	5.4,	0.,	279.2,

Table 1 (Cobtinued)

N	X	Y	R1	R2	Cos ² D	B1	E1	B2	E2
50,	-3.469,	-0.715,	3.542,	3.673,	.99792,	270.,	0.8,	180.,	-43.0,
51,	-3.080,	1.236,	3.319,	3.730,	.99344,	80.,	30.8,	350.,	121.6,
52,	-3.858,	-1.279,	4.064,	4.447,	.99488,	140.,	27.8,	50.,	-25.9,
53,	-3.080,	1.847,	3.591,	4.057,	.99605,	180.,	13.7,	90.,	-91.2,
54,	-3.648,	2.489,	4.416,	4.897,	.99768,	145.,	114.8,	55.,	-52.6,
55,	-3.987,	2.421,	4.664,	5.128,	.99754,	335.,	21.4,	65.,	-55.5,
56,	-4.765,	2.057,	5.190,	5.603,	.99723,	150.,	29.6,	60.,	-28.9,
57,	-5.635,	1.686,	5.882,	6.245,	.99728,	315.,	4.5,	45.,	-17.8,
58,	-4.524,	-1.081,	6.413,	6.917,	.99738,	135.,	12.2,	45.,	-10.3,
59,	-6.919,	0.575,	6.943,	7.206,	.99738,	135.,	9.4,	45.,	-18.5,
60,	-2.858,	2.214,	3.615,	4.115,	.99726,	180.,	6.2,	270.,	101.8,
61,	-1.759,	3.409,	3.836,	4.408,	.99987,	360.,	70.4,	90.,	-35.2,
62,	-1.993,	4.180,	4.631,	5.205,	.99995,	360.,	101.7,	90.,	-14.8,
63,	-2.228,	4.822,	5.312,	5.886,	.99997,	180.,	-46.6,	90.,	-11.7,
64,	-2.320,	5.433,	5.908,	6.483,	.99999,	155.,	-37.0,	65.,	13.4,
65,	2.358,	6.483,	6.899,	7.474,	1.00000,	345.,	21.4,	255.,	-16.8,
66,	-2.358,	7.446,	7.810,	8.386,	.99999,	345.,	-18.9,	255.,	10.6,
67,	-2.672,	8.155,	8.582,	9.157,	1.00000,	345.,	8.0,	53.,	2040.0,
68,	-3.500,	8.254,	8.965,	9.541,	1.00000,	315.,	10.0,	45.,	3.4,
69,	-3.543,	9.057,	9.725,	10.301,	1.00000,	15.,	8.9,	285.,	4.6,
70,	3.296,	10.013,	10.542,	11.117,	1.00000,	350.,	3.7,	260.,	3.4,
71,	-3.456,	11.032,	11.561,	12.136,	1.00000,	345.,	5.9,	255.,	-0.9,
72,	-3.820,	11.902,	12.500,	13.075,	1.00000,	25.,	-4.8,	205.,	1.7,
73,	0.321,	2.365,	2.387,	2.908,	.99565,	25.,	262.4,	113.,	14.3,
74,	0.963,	3.168,	3.311,	3.786,	.99576,	0.,	71.8,	90.,	61.5,
75,	1.624,	4.081,	4.392,	4.835,	.99682,	15.,	33.4,	195.,	22.6,
76,	1.846,	4.785,	5.129,	5.574,	.99766,	10.,	21.0,	280.,	16.2,
77,	2.278,	6.199,	6.604,	7.052,	.99859,	0.,	13.7,	270.,	-13.5,
78,	2.618,	7.353,	7.805,	8.255,	.99900,	0.,	8.9,	270.,	-8.2,
79,	3.019,	8.353,	8.882,	9.329,	.99921,	30.,	5.7,	210.,	2.1,
80,	3.482,	8.915,	9.571,	10.008,	.99927,	25.,	3.4,	295.,	-2.0,
81,	4.315,	9.588,	10.514,	10.932,	.99932,	140.,	1.2,	50.,	3.4,
82,	5.056,	10.001,	11.206,	11.606,	.99934,	140.,	0.5,	50.,	2.9,
83,	6.050,	10.483,	12.104,	12.479,	.99937,	220.,	-2.3,	130.,	1.5,
84,	7.062,	11.625,	13.602,	13.967,	.99948,	330.,	-1.1,	240.,	-1.2,
85,	0.772,	-1.968,	2.114,	-1.538,	.99997,	60.,	64.6,	150.,	65.9,
86,	0.673,	-2.480,	2.570,	1.997,	.99967,	350.,	377.6,	260.,	137.6,
87,	0.834,	-2.480,	2.616,	2.041,	.99996,	342.,	56.2,	252.,	-74.5,
88,	1.013,	-4.746,	4.853,	4.284,	.99981,	30.,	25.2,	300.,	93.6,
89,	2.136,	-5.209,	5.630,	5.054,	.99999,	198.,	-25.9,	288.,	55.8,
90,	3.433,	-5.468,	6.456,	5.894,	.99980,	45.,	-26.6,	315.,	45.7,
91,	3.673,	6.721,	7.659,	7.090,	.99993,	180.,	34.1,	270.,	4.1,
92,	4.945,	-7.345,	8.854,	8.296,	.99987,	150.,	-29.3,	240.,	6.0,
93,	4.976,	-8.277,	9.658,	9.092,	.99993,	180.,	-8.2,	90.,	-23.8,
94,	4.476,	9.030,	10.078,	9.506,	.99998,	0.,	10.6,	270.,	14.5,
95,	4.013,	-10.166,	10.929,	10.354,	1.00000,	8.,	9.0,	98.,	-5.4,
96,	4.673,	-10.894,	11.854,	11.279,	1.00000,	210.,	1.4,	300.,	3.9,
97,	0.771,	3.248,	3.338,	3.910,	.99984,	180.,	123.2,	270.,	2.6,
98,	-0.709,	4.100,	4.161,	4.728,	.99975,	168.,	-50.9,	258.,	-12.7,
99,	-0.432,	5.847,	5.863,	6.418,	.99969,	190.,	-46.3,	280.,	-0.5,

Table 1 (Continued)

N	X	Y	R1	R2	Cos ² θ	B1	E1	B2	E2
100,	-1.466,	1.322,	1.974,	2.468,	.99501,	155.,	-7.3,	65.,	7.4,
101,	-1.418,	1.010,	1.741,	2.211,	.99077,	155.,	68.6,	65.,	93.6,
102,	-1.899,	1.010,	2.151,	2.582,	.99048,	155.,	23.4,	65.,	18.9,
103,	-1.779,	0.240,	1.795,	2.107,	.97432,	160.,	59.8,	250.,	-50.1,
104,	-2.356,	1.466,	2.775,	3.222,	.99484,	204.,	-2.1,	295.,	32.8,
105,	-2.476,	2.188,	3.304,	3.791,	.99781,	323.,	51.4,	55.,	-20.2,
106,	-2.332,	2.476,	3.401,	3.906,	.99861,	160.,	-14.4,	260.,	25.0,
107,	-2.500,	2.933,	3.854,	4.366,	.99914,	118.,	78.0,	218.,	25.0,
110,	-2.885,	3.894,	4.846,	5.368,	.99963,	180.,	49.9,	283.,	-43.7,
111,	-2.837,	4.543,	5.356,	5.887,	.99984,	140.,	33.0,	210.,	31.2,
112,	-3.269,	5.168,	6.115,	6.646,	.99987,	13.,	-1.3,	270.,	-0.8,
113,	-3.558,	4.952,	6.097,	6.621,	.99978,	100.,	34.3,	160.,	7.0,
114,	-4.495,	4.567,	6.408,	6.906,	.99951,	60.,	2.6,	145.,	1.7,
115,	-5.337,	4.471,	6.962,	7.438,	.99937,	0.,	-0.8,	88.,	1.6,
116,	-6.394,	4.471,	7.802,	8.255,	.99932,	272.,	-2.6,	175.,	3.1,
117,	-2.740,	2.043,	3.418,	3.885,	.99722,	180.,	0.8,	87.,	0.7,
118,	-3.365,	-2.788,	4.371,	4.228,	.99266,	95.,	-61.4,	5.,	26.8,
119,	-3.894,	-3.990,	5.576,	5.371,	.99583,	192.,	3.0,	275.,	1.4,
200,	-0.577,	-0.457,	0.736,	0.771,	.74380,	339.,	-2560.0,	240.,	-168.0,
201,	0.529,	1.707,	1.787,	2.237,	.98885,	170.,	144.0,	90.,	-216.0,
202,	1.130,	1.611,	1.967,	2.314,	.98113,	170.,	76.0,	90.,	192.0,
203,	1.731,	1.755,	2.465,	2.734,	.98371,	308.,	60.0,	214.,	56.0,
204,	1.226,	3.101,	3.335,	3.751,	.99527,	282.,	41.6,	195.,	54.4,
205,	0.769,	3.053,	3.148,	3.604,	.99630,	284.,	39.2,	204.,	55.2,
206,	0.313,	2.428,	2.448,	2.935,	.99621,	300.,	-32.0,	220.,	176.0,
300,	0.505,	-3.654,	3.689,	3.165,	.99926,	86.,	-97.6,	0.,	12.0,
301,	0.409,	0.649,	0.767,	1.301,	.99666,	17.,	616.0,	6.,	2696.0,
302,	-0.962,	-4.351,	4.456,	4.016,	.99727,	77.,	39.2,	343.,	30.4,
303,	0.096,	1.899,	1.901,	2.406,	.99590,	155.,	-116.0,	36.,	304.0,
304,	0.865,	2.284,	2.442,	2.982,	1.00000,	351.,	112.0,	230.,	88.0,
305,	-0.793,	3.173,	3.271,	3.808,	.99986,	270.,	-60.0,	180.,	-76.0,
306,	-0.697,	3.774,	3.838,	4.370,	.99975,	273.,	-18.4,	181.,	-52.8,
307,	3.053,	2.812,	4.151,	3.982,	.99204,	6.,	13.6,	266.,	35.2,
308,	-3.894,	-4.062,	5.628,	5.418,	.99593,	270.,	20.0,	168.,	4.8,
309,	-0.457,	2.380,	2.423,	2.957,	.99950,	90.,	73.6,	0.,	94.4,
310,	0.024,	2.788,	2.789,	3.298,	.99822,	22.,	112.0,	246.,	84.8,
311,	0.769,	3.486,	3.569,	4.032,	.99729,	328.,	20.0,	208.,	-45.6,

Key to Table II

N: Station Index Number

X: North Component of Distance Between Source and Receiver in Kilometers

Y: East Component of the Distance Between The Source and Receiver In Kilometers

R1: Distance from One End of the Source to a Receiver Station, in Kilometers

R2: Distance from the Other End of the Source to a Receiver Station in Kilometers

ρ_a : Apparent Resistivity Computed from the Magnitude of the Observed Electric Field, in ohm-meters

Table 2: Apparent resistivity values computed for dipole mapping survey

N	X	Y	R1	R2	ρ_a
1	-1.555	1.495	2.157	2.687	181.36
2	-1.858	-1.604	2.455	2.317	335.63
3	-1.827	-1.236	2.206	2.695	126.60
4	-1.444	-1.900	2.386	2.134	121.88
5	-1.475	0.952	1.756	2.243	32.66
6	-1.382	-0.606	1.509	1.953	179.92
7	-1.413	-0.005	1.413	1.699	109.02
8	-3.913	-1.808	4.311	4.304	299.70
9	-3.722	-2.629	4.557	4.444	270.43
10	-3.851	-3.845	5.442	5.228	305.80
12	-4.191	-5.727	7.097	6.796	196.94
13	-4.253	-6.641	7.886	7.553	372.93
14	-4.283	-7.554	8.684	8.324	266.06
16	-4.574	-9.641	10.671	10.277	4316.31
17	-5.487	-10.875	12.181	11.796	263.28
19	-1.907	1.501	2.427	2.933	142.86
20	-1.660	0.847	1.864	2.320	85.14
21	-1.981	0.958	2.200	2.646	150.84
22	-2.166	1.075	2.418	2.865	116.98
23	-2.351	0.773	2.475	2.869	113.50
24	-1.765	0.433	1.817	2.193	86.01
25	-1.913	0.007	1.913	2.183	87.41
26	-2.129	1.359	2.526	3.005	85.66
27	-2.432	1.384	2.798	3.260	115.14
28	-2.135	1.668	2.709	3.214	59.62
29	-2.382	1.810	2.992	3.491	168.33
30	-1.759	2.094	2.735	3.283	79.23
31	-1.672	2.649	3.133	3.698	133.47
32	-2.061	2.433	3.189	3.735	104.44
33	-2.302	2.421	3.341	3.877	102.62
34	-1.950	2.069	2.843	3.381	147.57
35	-1.333	1.878	2.303	2.863	113.06
36	-1.037	1.896	2.161	2.732	82.65
37	-1.055	2.112	2.361	2.934	32.12
38	-1.351	2.094	2.492	3.057	99.74
39	-1.265	2.439	2.748	3.320	189.74
40	-1.092	2.581	2.803	3.378	111.49
41	-0.820	2.149	2.300	2.876	54.64
42	-0.543	3.890	3.928	4.492	396.72
43	-1.283	1.390	1.892	2.434	62.07
44	-1.172	1.199	1.677	2.215	96.65
45	-0.919	1.446	1.713	2.280	189.61
46	-1.043	1.668	1.967	2.534	105.74
47	-2.753	0.155	2.757	3.034	342.39
48	-2.802	-0.048	2.802	3.042	384.41
49	-2.839	-1.166	3.069	3.103	494.88
50	-3.469	-0.715	3.542	3.673	113.83

Table 2 (Continued)

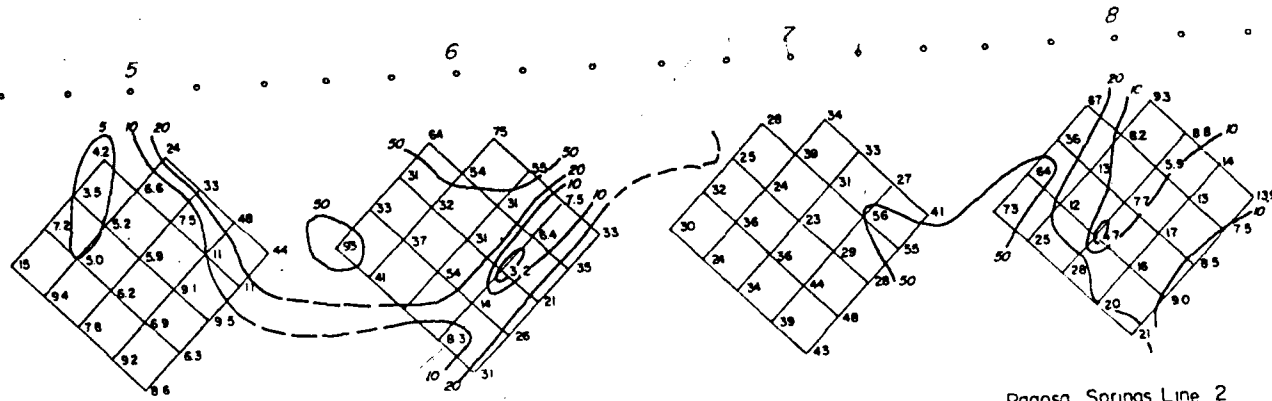
N	R	Y	R1	R2	<i>R_a</i>
51	-3.080	1.236	3.319	3.730	208.05
52	-3.858	1.279	4.064	4.447	115.90
53	-3.080	1.847	3.591	4.057	180.19
54	-3.648	2.489	4.416	4.897	437.14
55	-3.987	2.421	4.664	5.128	245.35
56	-4.765	2.057	5.190	5.603	246.43
57	-5.635	1.684	5.882	6.245	167.30
58	-6.524	1.081	6.613	6.917	220.85
59	-6.919	0.575	6.943	7.206	349.17
60	-2.858	2.214	3.615	4.115	196.03
61	-1.759	3.409	3.836	4.408	166.31
62	-1.993	4.180	4.631	5.205	368.85
63	-2.228	4.822	5.312	5.886	254.90
64	-2.320	5.433	5.908	6.483	282.75
65	-2.358	6.483	6.899	7.474	305.52
66	-2.358	7.446	7.810	8.386	347.64
67	-2.672	8.155	8.582	9.157	43178.18
68	-3.500	8.254	8.965	9.541	253.05
69	-3.543	9.057	9.725	10.301	304.25
70	-3.296	10.013	10.542	11.117	193.44
71	-3.456	11.032	11.561	12.136	300.98
72	-3.820	11.902	12.500	13.075	412.14
73	0.321	2.365	2.387	2.908	156.27
74	0.963	3.168	3.311	3.786	145.53
75	1.624	4.081	4.392	4.835	38.42
76	1.846	4.785	5.129	5.574	146.97
77	2.278	6.199	6.604	7.052	220.67
78	2.618	7.353	7.805	8.255	225.39
79	3.019	8.353	8.882	9.329	98.25
80	3.482	8.915	9.571	10.008	135.76
81	4.315	9.588	10.514	10.932	167.68
82	5.056	10.001	11.206	11.606	169.09
83	6.050	10.483	12.104	12.479	205.06
84	7.062	11.625	13.602	13.967	174.08
85	0.772	-1.968	2.114	1.538	16.19
86	0.673	-2.480	2.570	1.997	141.03
87	0.834	-2.480	2.616	2.041	34.67
88	1.013	-4.746	4.853	4.284	280.46
89	2.136	-5.209	5.630	5.054	282.45
90	3.433	-5.468	6.456	5.894	382.76
91	3.673	-6.721	7.659	7.090	420.02
92	4.945	-7.345	8.854	8.296	584.13
93	4.976	-8.277	9.658	9.092	635.40
94	4.476	-9.030	10.078	9.506	512.93
95	4.013	-10.166	10.929	10.354	383.35
96	4.673	-10.894	11.854	11.279	194.39
97	-0.771	3.248	3.338	3.910	176.46
98	-0.709	4.100	4.161	4.728	140.09
99	-0.432	5.847	5.863	6.418	332.63

Table 2 (Continued)

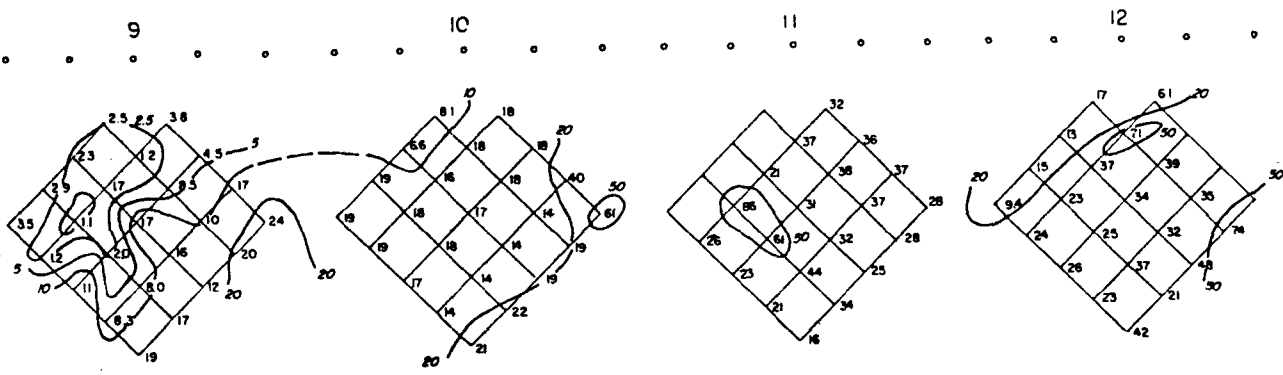
N	X	Y	R1	R2	P_c
100	-1.466	1.322	1.974	2.468	3.83
101	-1.418	1.010	1.741	2.211	31.11
102	-1.899	1.010	2.151	2.582	14.86
103	-1.779	0.240	1.795	2.107	26.16
104	-2.356	1.466	2.775	3.222	32.44
105	-2.476	2.188	3.304	3.791	86.12
106	-2.332	2.476	3.401	3.906	50.75
107	-2.500	2.933	3.854	4.366	179.92
110	-2.885	3.894	4.846	5.368	322.15
111	-2.837	4.543	5.356	5.887	304.41
112	-3.269	5.168	6.115	6.646	11.56
113	-3.558	4.952	6.097	6.621	324.16
114	-4.495	4.567	6.408	6.906	32.58
115	-5.337	4.471	6.962	7.438	23.26
116	-6.394	4.471	7.802	8.255	81.03
117	-2.740	2.043	3.418	3.885	1.79
118	-3.365	-2.788	4.371	4.229	312.65
119	-3.894	-3.990	5.576	5.371	30.63
200	-0.577	-0.457	0.736	0.771	69.68
201	0.529	1.707	1.787	2.237	69.60
202	1.130	1.611	1.967	2.314	81.09
203	1.731	1.755	2.465	2.734	67.71
204	1.226	3.101	3.335	3.751	120.23
205	0.749	3.053	3.148	3.604	101.61
206	0.313	2.428	2.448	2.935	115.89
300	0.505	-3.654	3.689	3.165	128.18
301	-0.409	0.649	0.767	1.301	102.70
302	-0.962	-4.351	4.456	4.016	135.38
303	0.096	1.899	1.901	2.406	123.43
304	-0.845	2.284	2.442	2.982	63.62
305	-0.793	3.173	3.271	3.808	137.74
306	-0.697	3.774	3.838	4.370	123.91
307	-3.053	-2.812	4.151	3.982	135.41
308	-3.894	-4.062	5.628	5.418	176.54
309	-0.457	2.380	2.423	2.957	74.43
310	0.024	2.788	2.789	3.298	171.53
311	0.769	3.486	3.569	4.032	114.54

APPENDIX 1

RESISTIVITY CROSS-SECTIONS FROM PAGOSA SPRINGS

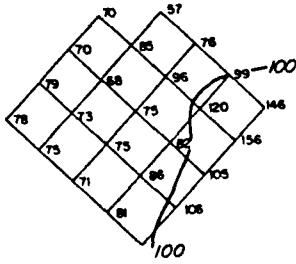


Pagosa Springs Line 2
 ← N to S →
 6/28/77



Pagosa Springs Line 3
 ← W to E →
 6/28/77

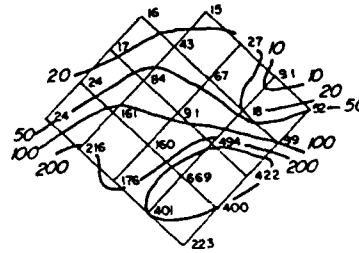
20



PAGOSA SPRINGS LINE 5

— W to E —
7/1/77

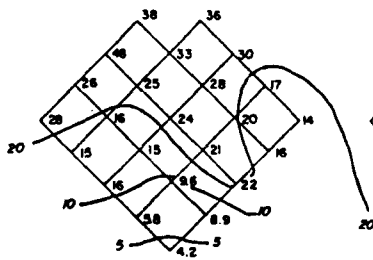
25



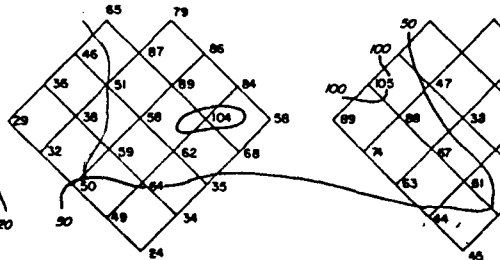
PAGOSA SPRINGS LINE 7

— N to S —
7/2/77

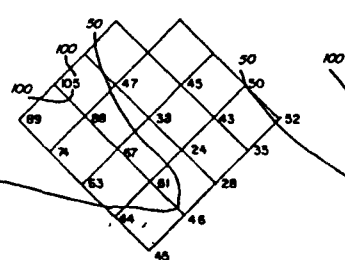
21



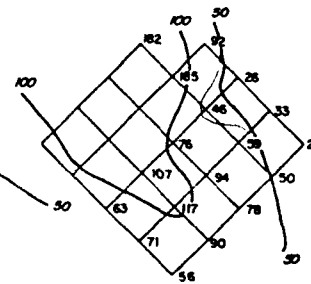
22



23

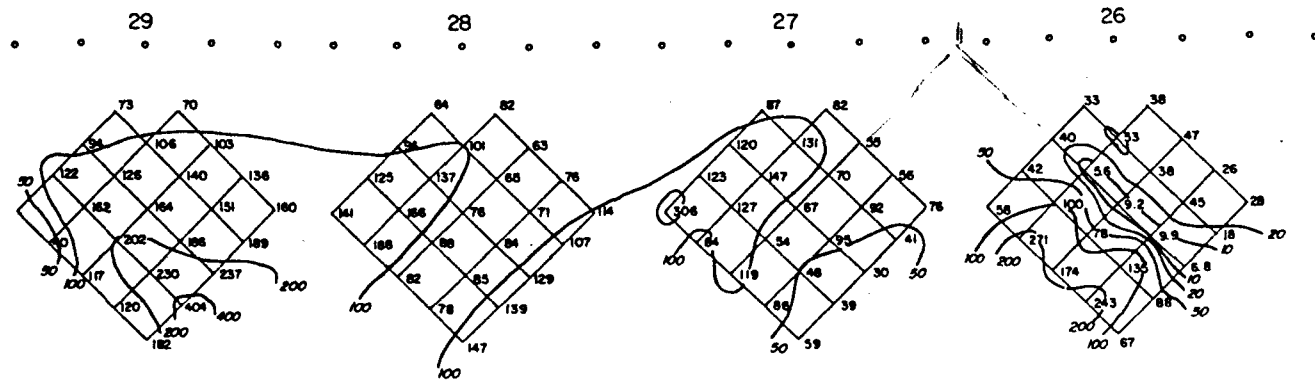


24



Pagosa Springs Line 6

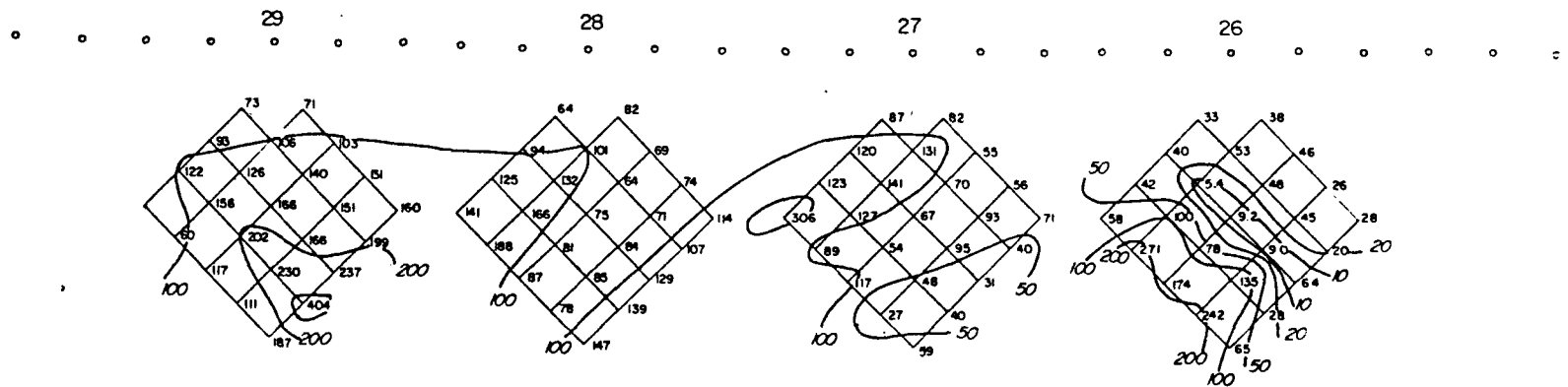
— N to S —
7/1/77



Pagosa Springs Line 8

← N to S →

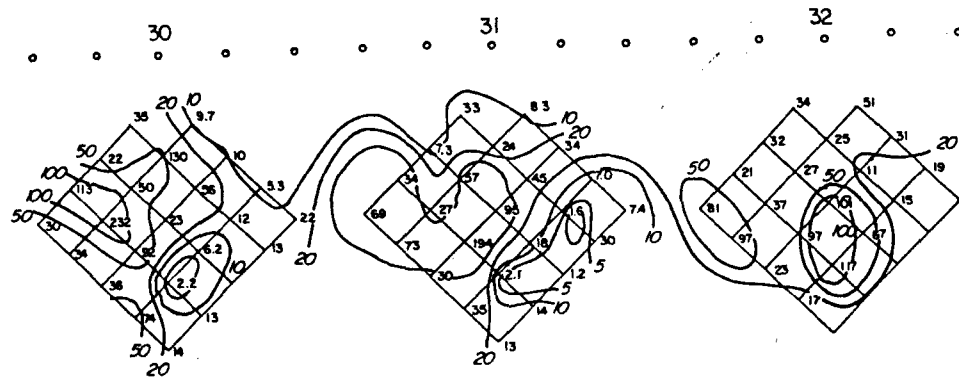
7/2/77



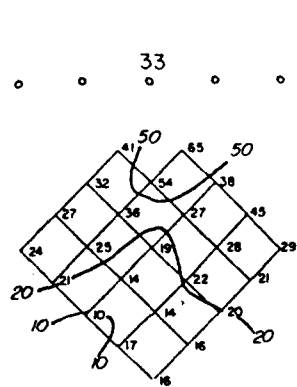
PAGOSA SPRINGS LINE 8

← N to S →

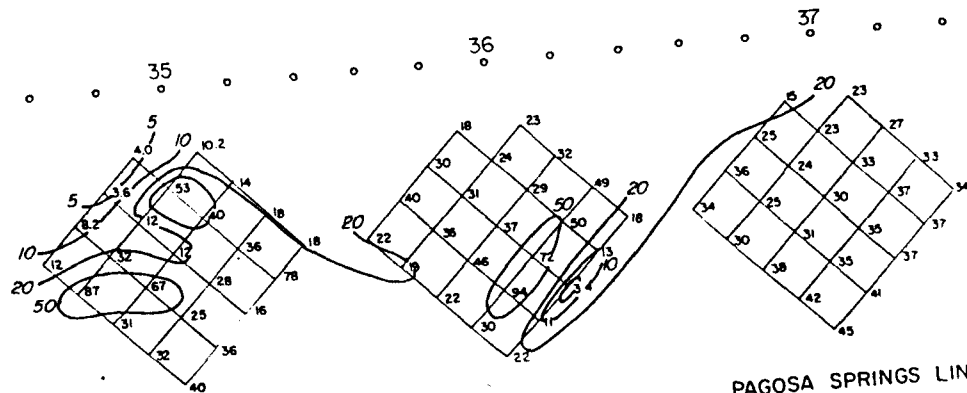
7/2/77



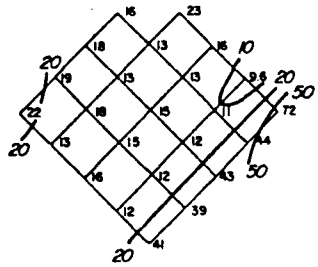
PAGOSA SPRINGS LINE 9
 — W to E —
 7/4/77



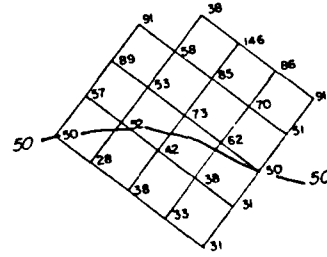
PAGOSA SPRINGS LINE 10
 — W to E —
 7/4/77



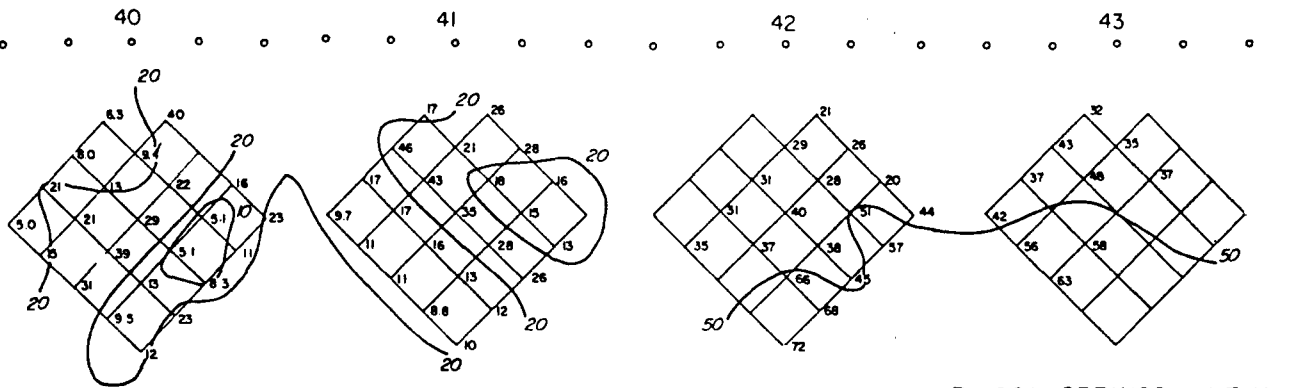
PAGOSA SPRINGS LINE 11
 — N to S —
 7/5/77



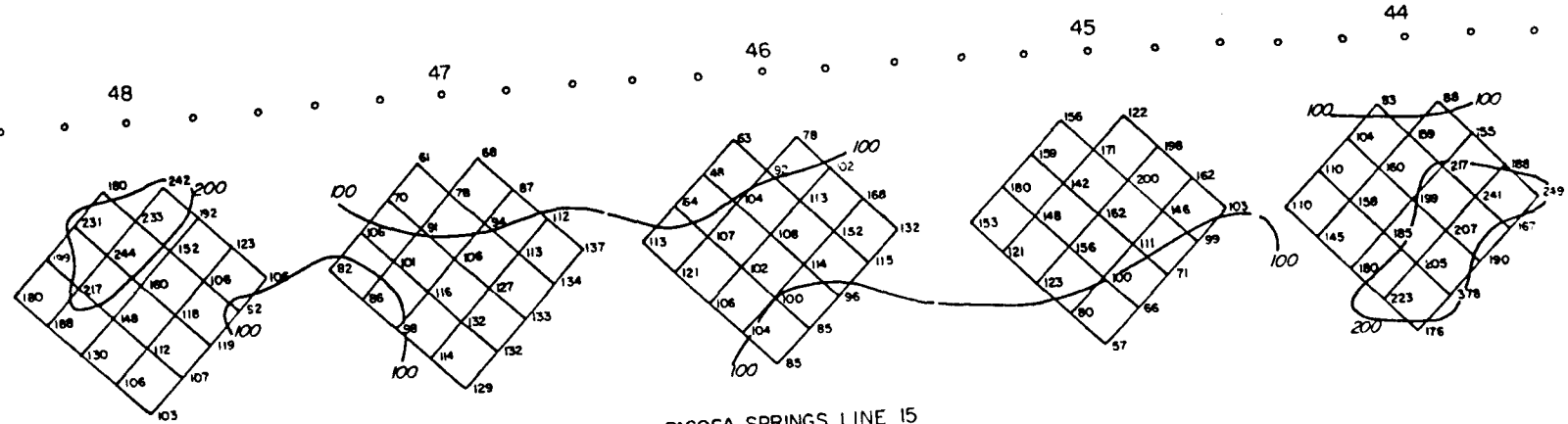
PAGOSA SPRINGS LINE 12
 —N to S—
 7/5/77



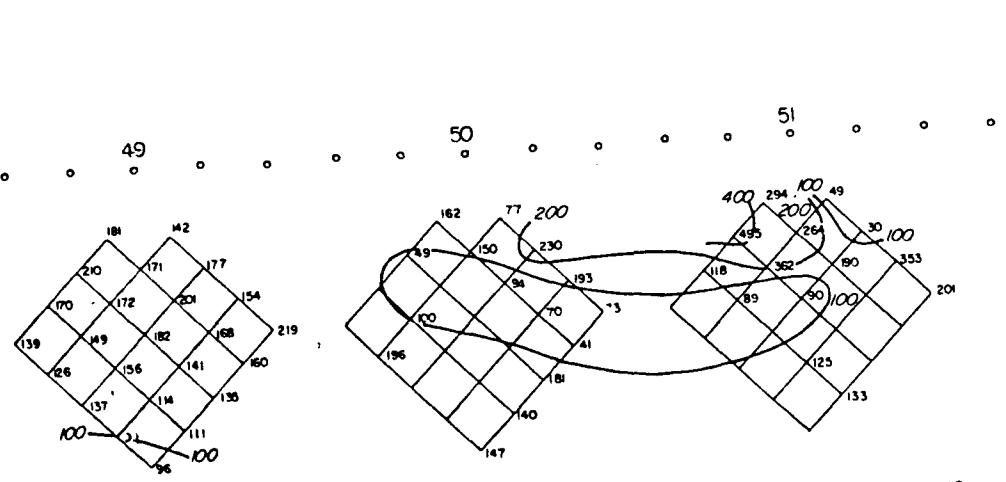
PAGOSA SPRINGS LINE 13
 —W to E—
 7/5/77



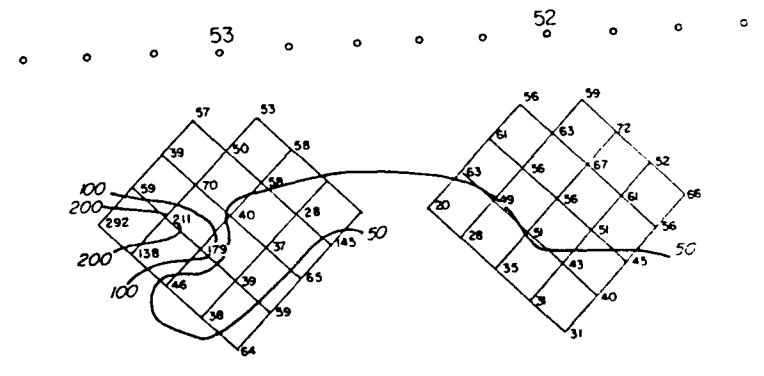
PAGOSA SPRINGS LINE 14
 —N to S—
 7/6/77



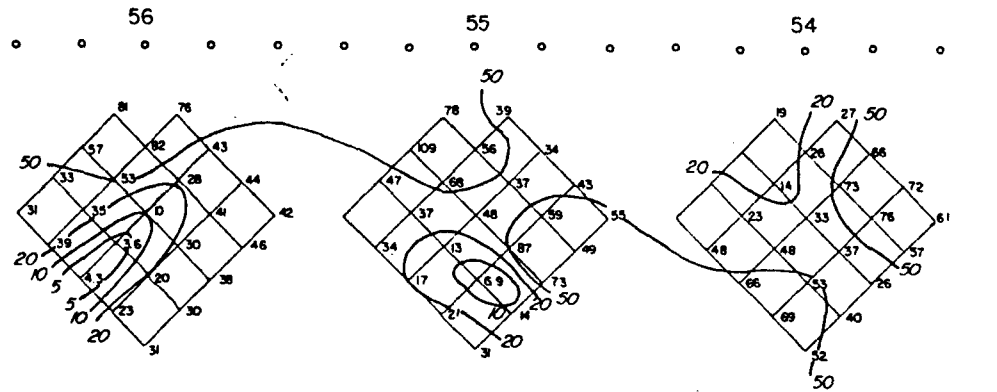
PAGOSA SPRINGS LINE 15
 - N to S -
 11/7/77



PAGOSA SPRINGS LINE 16
 - W to E -
 11/7/77

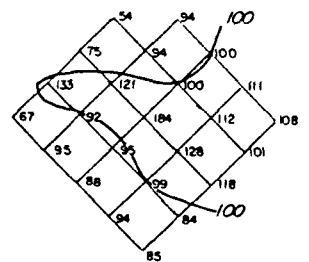
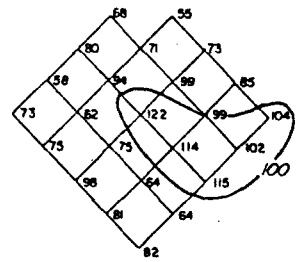
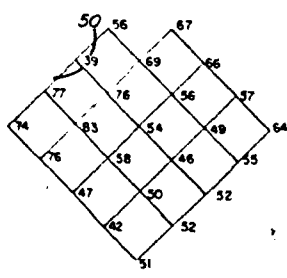


PAGOSA SPRINGS LINE 17
 W to E
 11/8/77



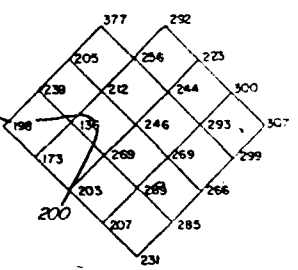
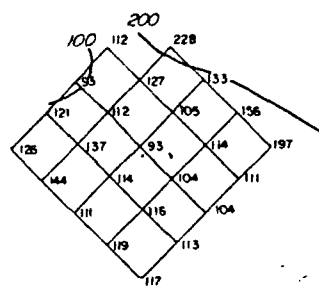
PAGOSA SPRINGS LINE 18
W to E
1/8/77

57 58 59



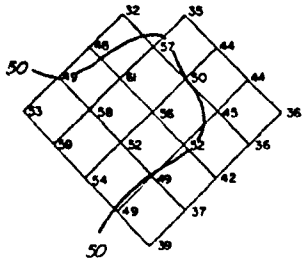
PAGOSA SPRINGS LINE 19
— NW to SE —
7/9/77

60 61

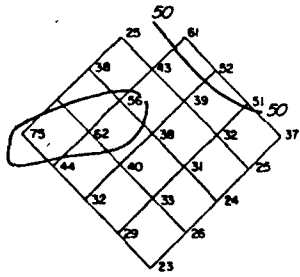


PAGOSA SPRINGS LINE 20
N to S
7/9/77

63

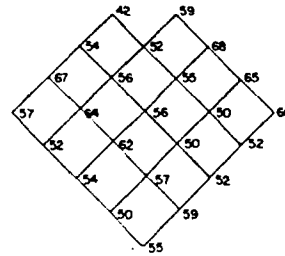


62

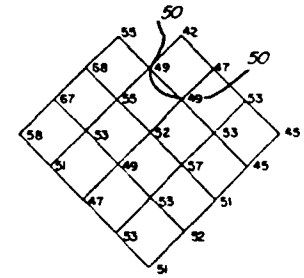


PAGOSA SPRINGS LINE 21
N to S
7/11/77

65

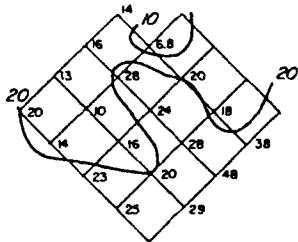


66



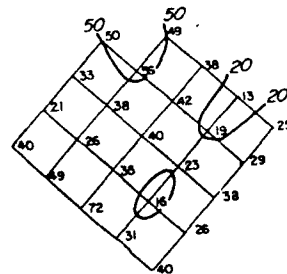
PAGOSA SPRINGS LINE 23
N to S
7/11/77

67

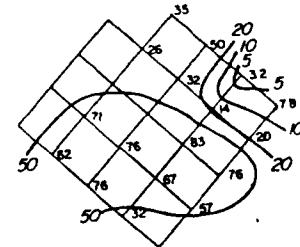


PAGOSA SPRINGS LINE 24
— W to E —
7/12/77

69



68

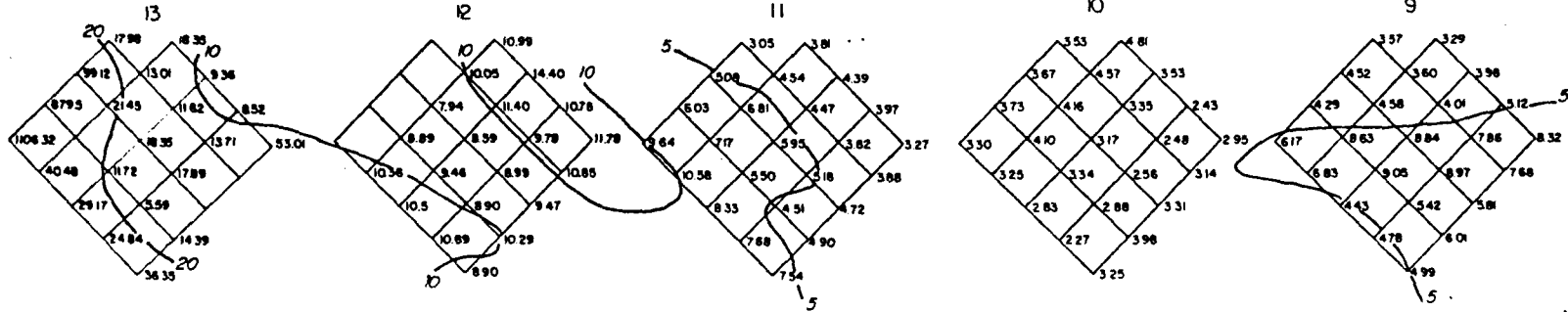


PAGOSA SPRINGS LINE 25
— W to E —
7/12/77

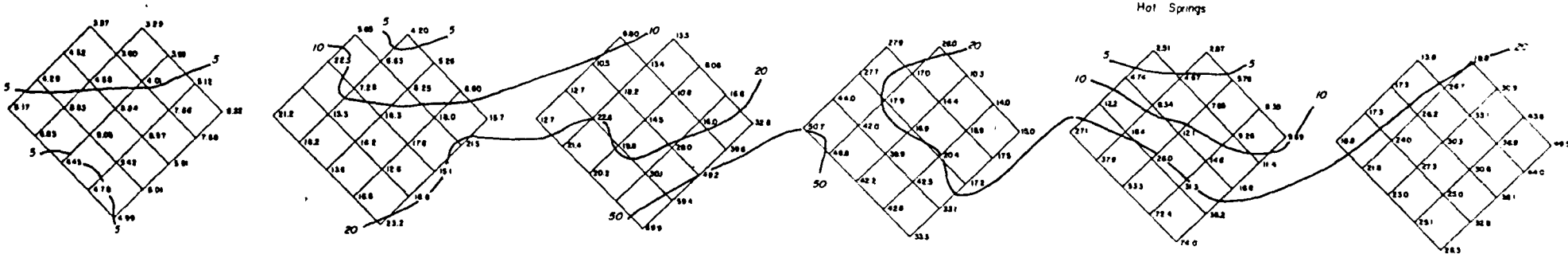
APPENDIX II

RESISTIVITY CROSS-SECTIONS FROM GLENWOOD SPRINGS

GLENWOOD SPRINGS



GLENWOOD SPRINGS



Center: 9
Date: 7/20/77

← W Bearing E →
Line: 1 Center: 8
Date: 7/20/77

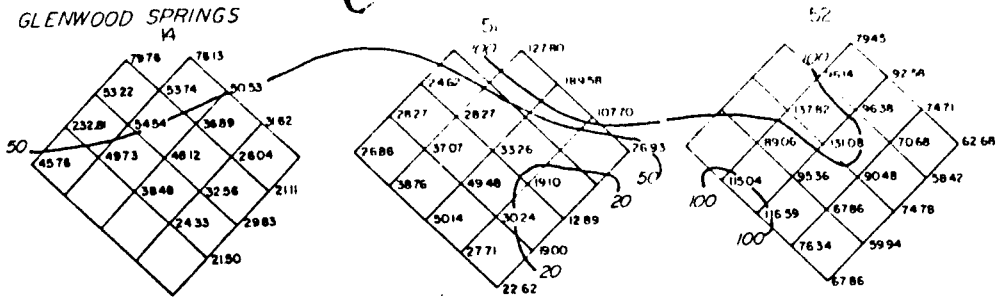
Center: 1
Date: 7/18/77

← W Bearing E →
Line: 1 Center: 3
Date: 7/19/77

Center: 4
Date: 7/19/77

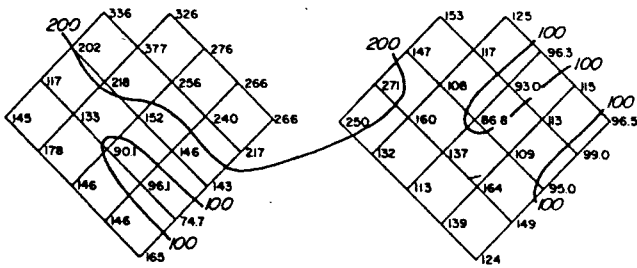
← W Bearing E →
Line: 1 Center: 5
Date: 7/19/77

GLENWOOD SPRINGS



← N BEARING S →
 LINE 4 CENTER: 52
 SURVEY: GLENWOOD
 DATE: 8/16/77
 INITIALS: D.H.

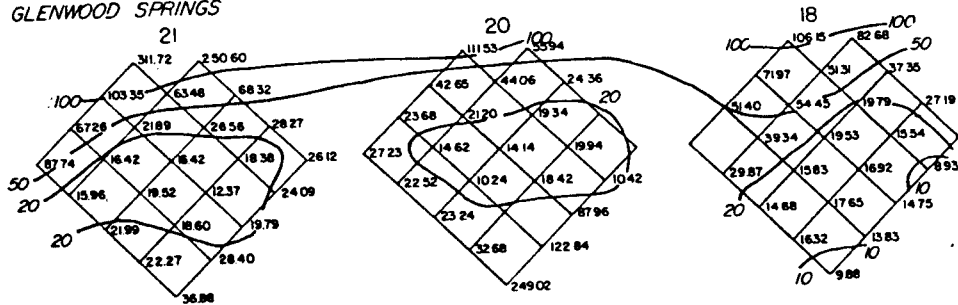
GLENWOOD SPRINGS



CENTER: 15
 DATE: 7/25/77

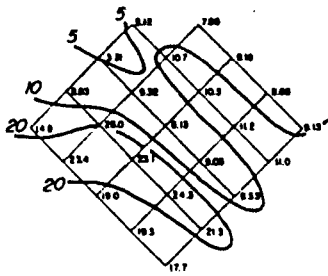
← S BEARING N →
 LINE: 5 CENTER: 16
 SURVEY: GLENWOOD
 DATE: 7/25/77
 INITIALS: P.P.

GLENWOOD SPRINGS

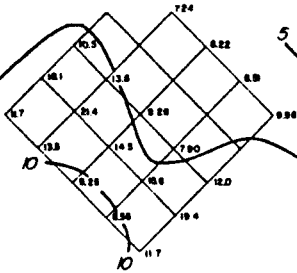


← W BEARING E →
 LINE: 7 CENTER: 18
 SURVEY: GLENWOOD
 DATE: 7/26/77
 INITIALS: D.H.

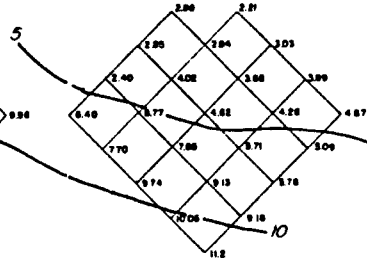
GLENWOOD SPRINGS



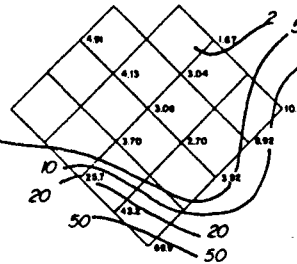
Center 27
Date 7/30/77



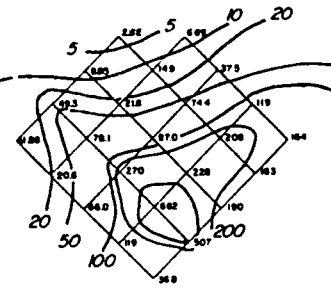
← W Bearing E →
Line: B Center: 26
Date 7/30/77



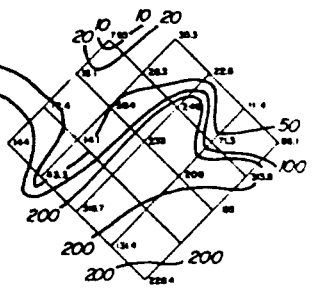
Center 25
Date 7/30/77



← W Bearing E →
Line: B Center: 24
Date 7/29/77

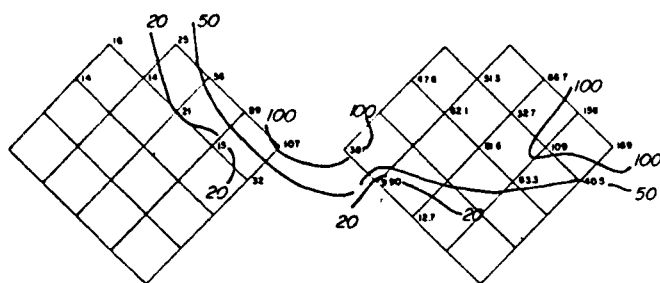


Center 23
Date 7/29/77

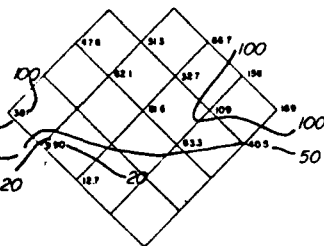


← W Bearing E →
Line: B Center: 22
Date 7/29/77

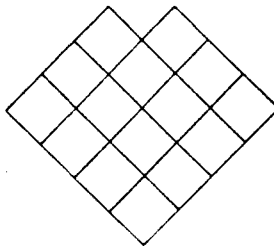
GLENWOOD SPRINGS



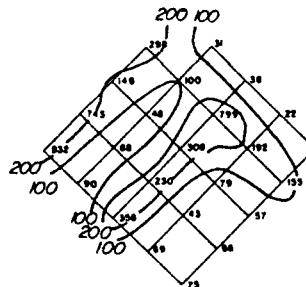
Center 32
Date 8/9/77



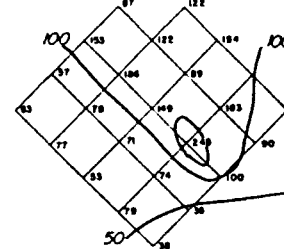
← W Bearing E →
Line: B Center: 31
Survey: Glenwood
Date: 8/9/77
Initials: DH



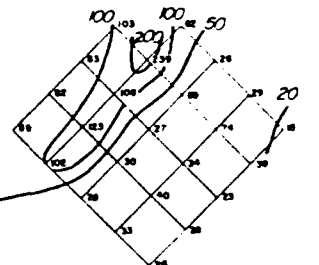
Center: No center here



← W Bearing E →
Line: B Center: 30

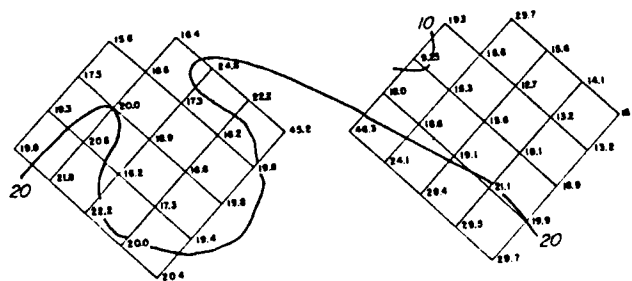


Center: 29
Date: 8/8/77



← W Bearing E →
Line: B Center: 28
Date: 8/8/77

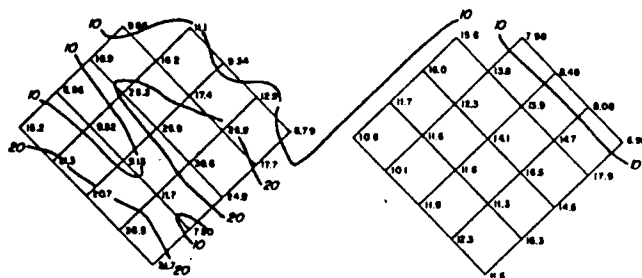
GLENWOOD SPRINGS



Center 34
Date 8/10/77

← W Bearing E →
Line: 9 Center: 33
Date 8/10/77

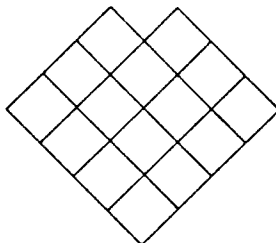
GLENWOOD SPRINGS



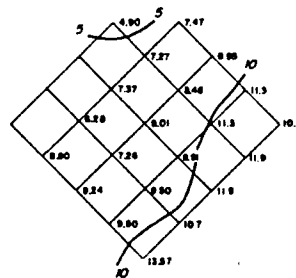
Center: 39
Date: 8/11/77

← W Bearing E →
Line: 11 Center: 38
Date: 8/11/77

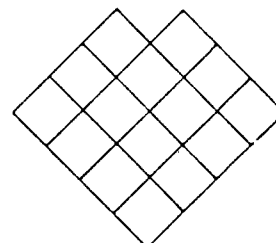
Hot Spring Area



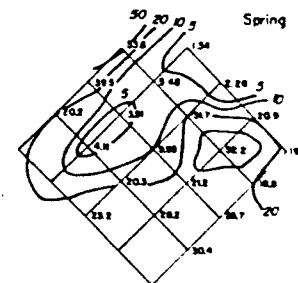
Center: No center here



← W Bearing E →
Line: 10 Center: 36
Date: 8/11/77

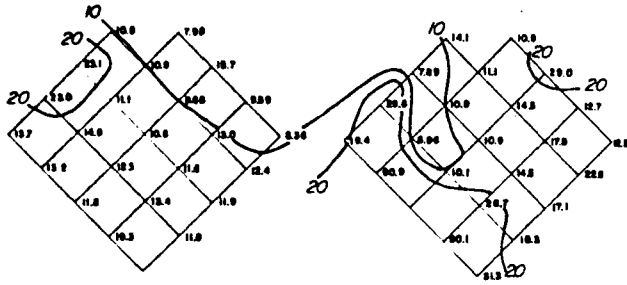


Center: No center here



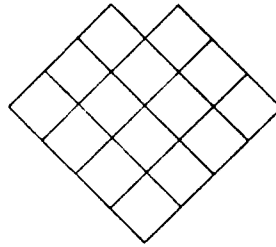
← W Bearing E →
Line: 9 Center: 35
Date: 8/10/77

GLENWOOD SPRINGS

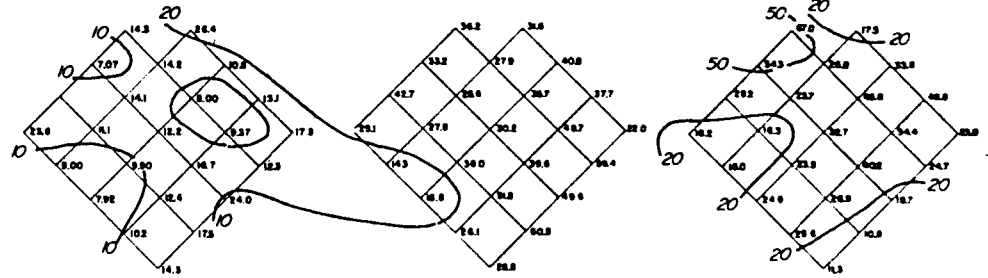


Center: 49
Date 8/16/77

← W Bearing E →
Line: 11 Center: 48b
Survey: Glenwood
Date: 8/16/77
Initials: PP.



Center: No center here

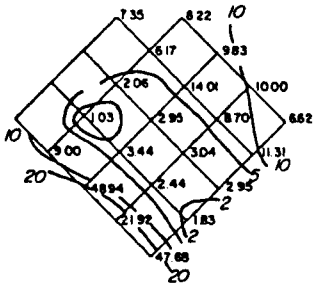


← W Bearing E →
Line: 11 Center: 42
Date: 8/11/77

Center: 41
Date: 8/11/77

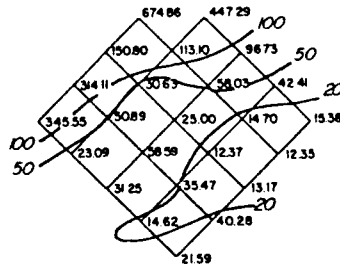
← W Bearing E →
Line: 11 Center: 4C
Date: 8/11/77

GLENWOOD SPRINGS



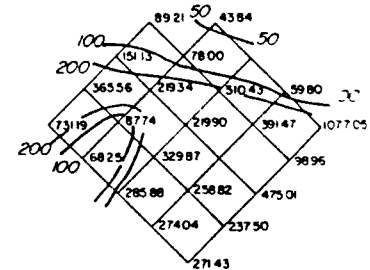
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LINE: 12 CENTER: 44
SURVEY: GLENWOOD
DATE: 8/12/77
INITIALS: D.H.

GLENWOOD SPRINGS



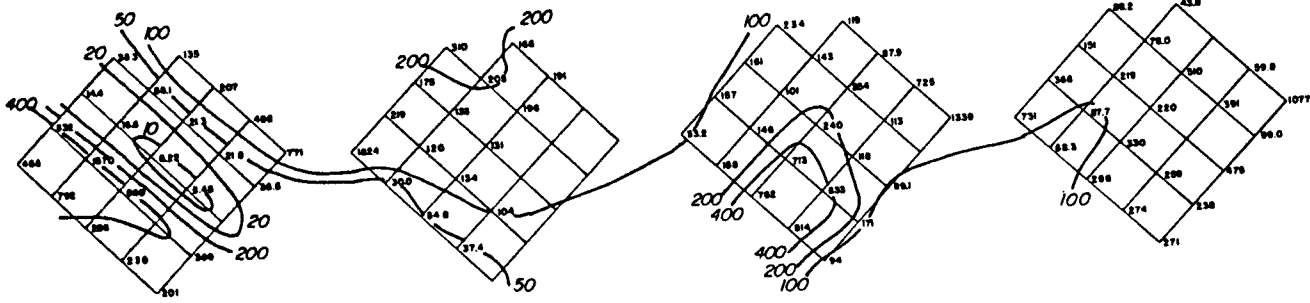
← NW BEARING SE →
LINE: 15 CENTER: 50
SURVEY: GLENWOOD
DATE: 8/16/77
INITIALS: D.H.

GLENWOOD SPRINGS



← W BEARING E →
LINE: 16 CENTER: 53
SURVEY: GLENWOOD
DATE: 8/17/77
INITIALS: D.H.

GLENWOOD SPRINGS



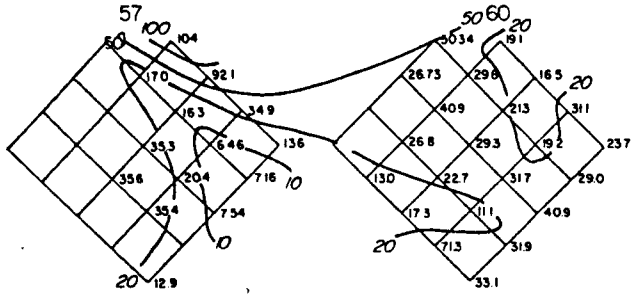
Center: 56
Date: 8/17/77

← NW Bearing SE →
Line: 16 Center: 55
Survey: Glenwood
Date: 8/17/77
Initials: D.H.

Center: 54
Date: 8/17/77

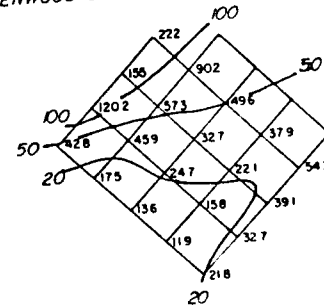
← NW Bearing SE →
Line: 16 Center: 53
Date: 8/17/77

GLENWOOD SPRINGS



← N BEARING S →
LINE: 17 CENTER: 60
SURVEY: GLENWOOD
DATE: 8/20/77
INITIALS: P.P.

GLENWOOD SPRINGS



← W BEARING E →
LINE: 18 CENTER: 58
SURVEY: GLENWOOD
DATE: 8/18/77
INITIALS: D.H.

Pagosa
Hot Spring

12 7
13 18

Axis of
Monocline

11 12
13 14
25 26
41 42

73
71
64
82
87
82

Fault?

Hot.
Spring

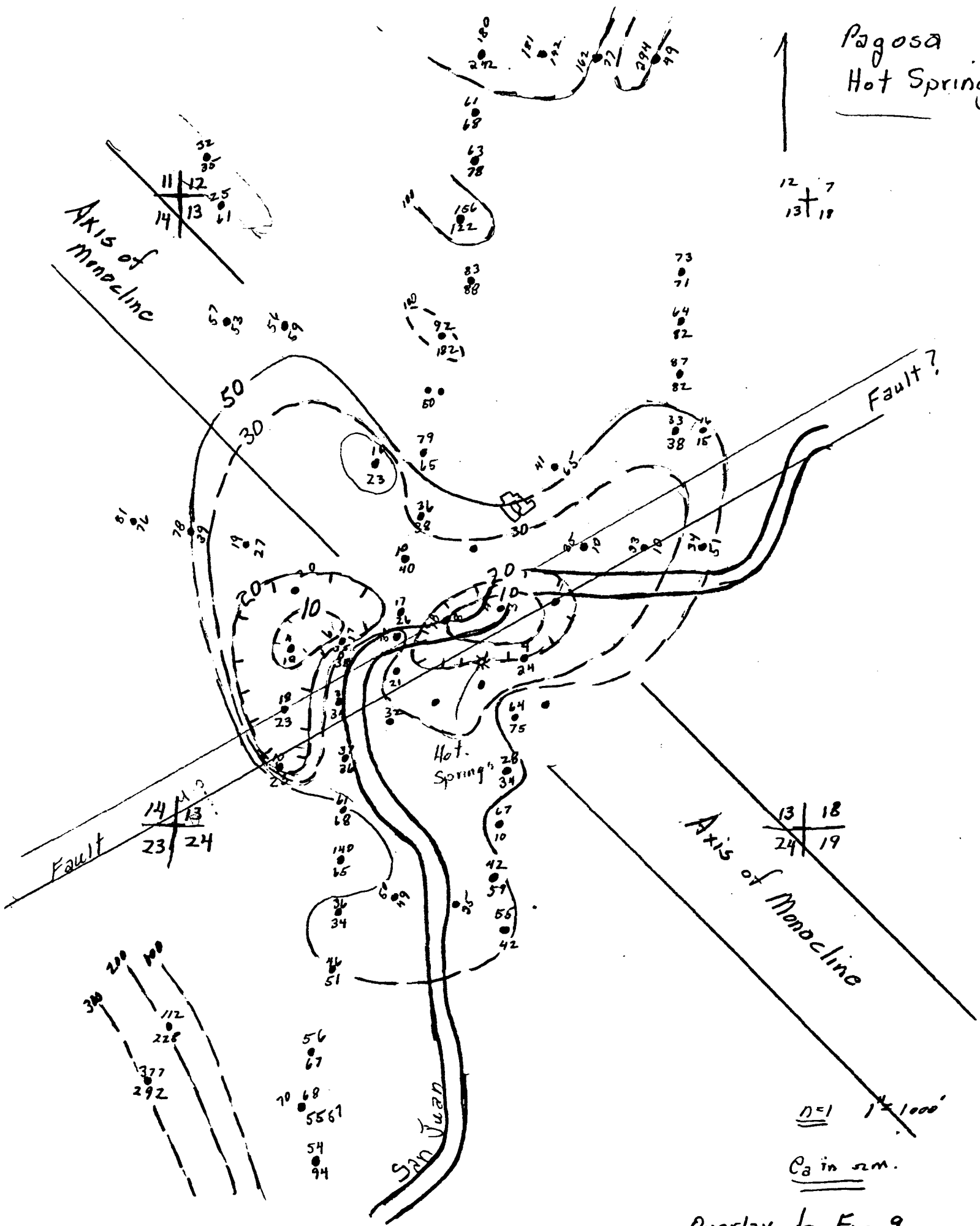
14 13
23 24

13 18
24 19
Axis of Monocline

n=1 1/2 1000'

Ca in sm.

Overlay to Fig. 9
Subject Point



Pagasa
Hot Spring

Axis of
Morpholine

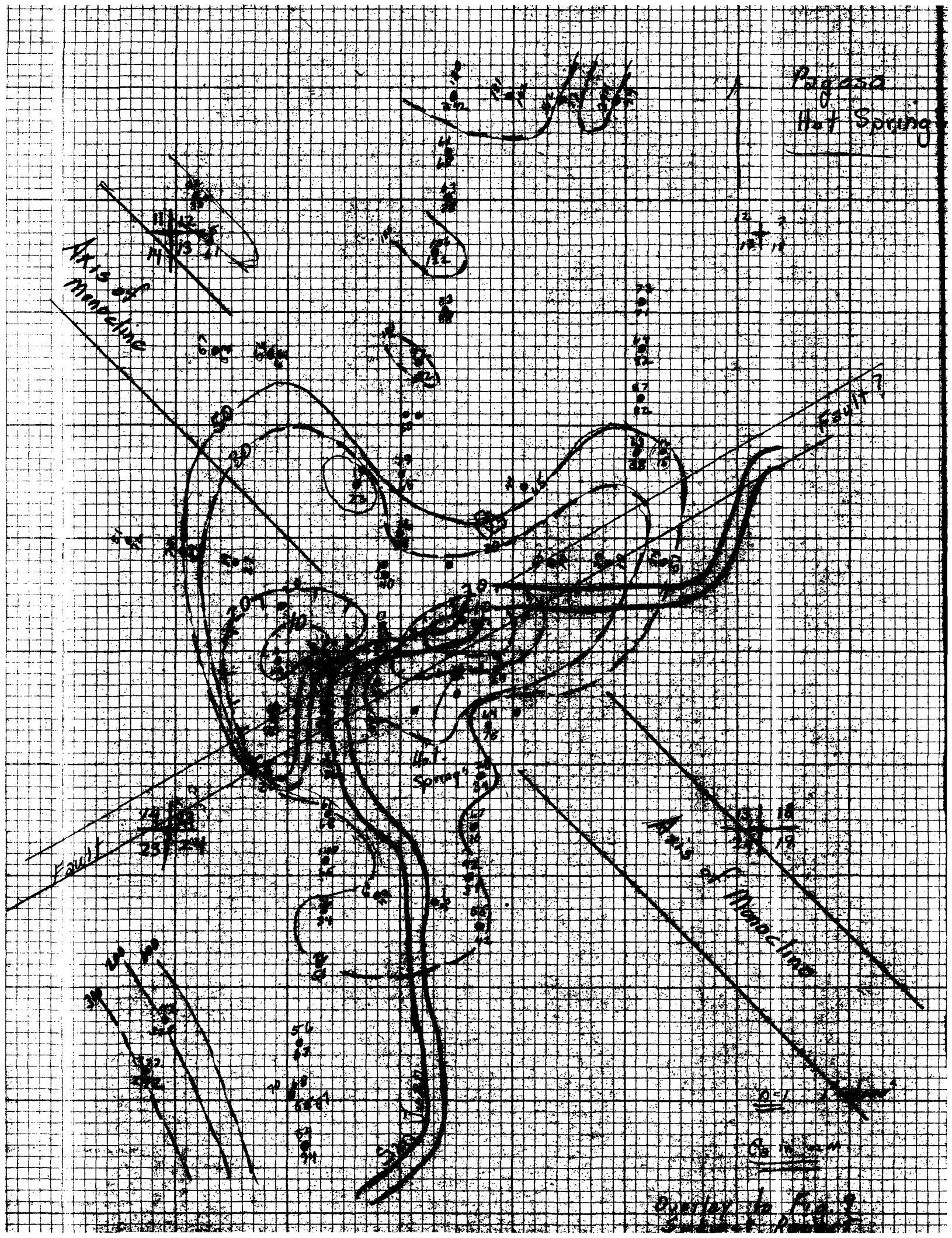
Fault

Hot
Spring

Fault

Axis
of
Morpholine

Quarter to Area



Colorado Geothermal News

Published by Colorado Geological Survey

1313 Sherman Street, Rm. 715, Denver, CO 80203 (303) 839-2611

OCTOBER, 1981

SUCCESSFUL PAGOSA SPRINGS DISTRICT HEATING SYSTEM TO BE DEDICATED

According to Bill Ray, Pagosa Springs City Manager, the Pagosa Springs District Heating System, which will start operation this fall, will be dedicated sometime during the middle of October. This project is one of, if not the major, successful U.S.D.O.E. geothermal project and its story deserves to be retold.

The project started a little over 3 years ago in 1978, when the City was awarded a Program of Opportunity Notice (PON) Grant from D.O.E. for \$935,000.00. Additional funding has raised total D.O.E. contribution to \$1,110,000.0 (See later story about additional funds).

In 1979 three wells were drilled behind the county courthouse on the north bank of the San Juan River. After testing it was determined that only two of the wells had adequate flow and temperatures. These two wells having an average depth of 285 feet will produce 1800 gallons per minute (gpm) of 142 F waters.

The system is capable of delivering a total of 56,700,000 B.T.U.'s of heat energy (equivalent to 9,450 barrels of oil) annually. This winter thermal energy will be supplied to 65 customers at a cost of \$3.35/Million B.T.U.'s of heat energy, approximately 40% of the equivalent cost of natural gas. The area being served by the district heating system extends along U.S. 160 from the U.S. Forest Service Building on the east, through the downtown area, to the west side of town.

Bill Ray further states that the City will soon be applying to the Colorado Division of Housing for a grant to upgrade and retrofit 5 low income housing units on the southside of town.

As stated above this project is one of the major successes of the U.S. Dept. of Energy's geothermal energy hydrothermal energy program and is a very good example of the direction the nation should be going in its energy independence drive. The Pagosa Springs project demonstrates visibly the need for federal government assistance in developing low to moderate temperature geothermal projects. It would have been impossible for the community of Pagosa Springs to have funded and constructed this district heating system on its own. Unfortunately we will be seeing less and less of these successful projects in the future with the curtailment of the federal geothermal program.

The citizens and officials of Pagosa Springs as well as the U.S. Dept. of Energy can be very proud of their efforts in bringing this program to a successful conclusion.

TWO COLORADO COMMUNITIES RECEIVE GRANTS FROM U.S. DEPT. OF ENERGY

Tom Stroud, U.S. Dept. of Energy, Denver, recently announced that the Cities of Ouray and Pagosa Springs have been awarded grants for 1981-1982 under the Small-Scale Appropriate Energy Technology Grants Program. Ouray will receive \$10,000.00 to fund a feasibility study for the development and use of geothermal energy within the city. Pagosa Springs will receive \$44,000.00 to be used towards the cost of extending the district heating distribution system into a low income area on the southside of the city. (See above related article). Congratulations to both communities.

STATE-FEDERAL GEOTHERMAL COMMERCIALIZATION REVIEW MEETING

The Colorado Geothermal Commercialization Team attended the joint State-Federal Commercialization Team meeting Sept. 9-10 at Custer State Park, South Dakota. Representatives from commercialization teams in New Mexico, Colorado, Utah, Wyoming, Montana, North Dakota and South Dakota attended. The purpose of this meeting is for the individual states to report on the progress of their program to the Dept. of Energy. The individual teams reported on the growth of geothermal energy within their state during the time their team has been in existence. It was very encouraging to see the amount of development that has occurred in the seven states over the last 3 years.

In addition to the state reports, talks were presented by knowledgeable and experienced persons on alternative funding sources for district heating projects. In this time of reduced federal funding for geothermal development any community wishing to develop a district heating system will have to look for alternative sources of financing.

A discussion was held regarding the future of the Geothermal Commercialization Project. Mike Tucker, U.S. D.O.E. Project Manager, stated that the individual states should be starting to plan for phasing out the project or to locate other sources of funding. He stated that D.O.E. will not be providing any more funds after the present project year funds are expended. For Colorado this means that the project will probably terminate sometime during the summer of 1982.

GEOTHERMAL DEVELOPMENT UPDATE

Redstone Corp. Glenwood Springs: Jay Dick, of Chaffee Geothermal, consultant to Redstone Corp. has told Geothermal News, that they have successfully drilled and completed a 155 ft. deep well which preliminary testing has determined produces 1200 gallons per minute of 122 F waters. Plans call for the waters to be used to heat an existing new 40,000 sq. ft. office building and in the future to heat planned town homes, and commercial area. Keck Consulting Services, Denver, will be hydrologically testing the well in two weeks.

Wright Water Engineers, Glenwood Springs: Wright Water Engineers have drilled their well, located on the south bank of the Colorado River, near the downtown area, to a depth of 345 feet. Waters having a temperature of 126 F were encountered in the Leadville limestone aquifer. Wright Water Engineers are presently determining if the well should be drilled deeper.

Alamosa City Well: Energy Services Inc., consultants to the city, report that the drill site is being prepared in anticipation that drilling will commence sometime between Oct. 1 and 10th. GRC Colo. Well Co., Rangely will be the drilling contractor.

COLORADO RESOURCE ASSESSMENT TEAM BUSY DURING SUMMER OF 1981

During this past summer the Colorado Resource Assessment Team conducted a wide range of resource assessment programs at the following thermal area: Ranger and Cement Creek Hot Springs northwest of Gunnison; Hartsel Hot Springs in South Park; Hot Sulphur Springs; and the Steamboat Springs and Routt Hot Springs in northwest Colorado. Electrical resistivity surveys were run in all of these areas. In addition temperature gradients were measured in a number of drill holes throughout western Colorado. A program in cooperation with the U.S. Geological Survey, Water Resources Division, was initiated to evaluate thermal mine drainage waters in Ouray, Lake City and Cripple Creek areas. This program consisted of locating all thermal mine drainage then sampling the waters for temperature, pH, conductivity, discharge, and dissolved mineral matter. A program of measuring the soil-helium-gas content in the Steamboat Springs area was conducted by the U.S. Geological Survey. The results of this program in conjunction with the temperatures measured in 1 meter deep drill holes helped to further define the extent of the Steamboat Springs thermal resource. In addition to the field work, office work continued on the preparation of a state geothermal gradient map based on oil well bottom hole temperatures. A map was also prepared during the summer depicting temperatures of the ground waters of Colorado. The gradient map and the ground-water temperature map will be published by the Colorado Geological Survey in the near future.

HEAT PUMP PAMPHLET DELAYED

As reported in the August issue of Colorado Geothermal News a pamphlet describing ground-water heat pumps in Colorado was to have been available for free distribution. Many persons have written in requesting this pamphlet. Unfortunately, due to unforeseen printing delays, the pamphlet has not yet been printed. It is anticipated that it will be published by the middle of Oct. Copies of it will be sent to all persons, companies, agencies, etc. who receive the newsletter.

GEOTHERMAL RESOURCES COUNCIL MEETINGS

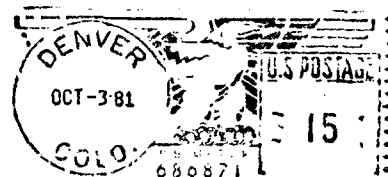
The Rocky Mountain Section of the G.R.C. will hold its monthly meeting at noon Oct. 22nd at the Quality Motel, 1840 Sherman St., Denver. The speaker will be Ron DiPippo, Brown University, who will speak on World Wide Geothermal Electric Production. For reservations call Valorie Smith at 771-0900 x 366.

The Geothermal Resources Council's annual meeting will be held at the Hilton Shamrock Hotel, Houston, Texas Oct 25-29. Four days of papers and talks on all facets of geothermal energy exploration, development and utilization will be presented. For more information and registration contact Geothermal Resources Council headquarters P.O. Box 98, Davis CA (916) 758-2360.

The Colorado Geothermal News is published by the Colorado Geological Survey with funding from the U.S. Dept. of Energy. The Colorado Geological Survey is solely responsible for any and all statements expressed or implied in the newsletter. For more information about articles in the newsletter or to receive copies please contact the Colorado Geothermal Commercialization Team at the address below.

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JUNE, 1981

DEVELOPMENTS IN GLENWOOD SPRINGS

The Redstone Corp. is presently building a 40,000 square foot office building on the north bank of the Colorado River near the Colorado Dept. of Highways office building. The Corp., who would like to heat this building with thermal waters, is having a feasibility study made to determine if adequate amounts of thermal waters are available.

Wright Water Engineers plans on drilling a 600 ft. deep thermal water well in the very near future on the south bank of the Colorado River approximately 1 block east of the railroad station. Thermal waters from this well will be used to heat a 2,000 square ft office building which Wright Water Engineers will construct on the site.

PAGOSA SPRINGS HEATING DISTRICT UPDATE

Bill Ray, City Manager of Pagosa Springs, stated that bids have been received for construction of the distribution system. The District plans on awarding the bid at a meeting on June 1st. Ray noted that the city drilled two successful production wells last summer. The combined yield of these two wells is approximately 1,800 gallons per minute with a temperature of 144°F. Unfortunately Ray noted that one unsuccessful well was drilled, which reduced their budget; therefore the distribution system for the south side of the San Juan River has been omitted. Ray stated that some of the residents having old wells on their property will be tying into the new system as it is cheaper than maintaining the old wells. Maintenance sometimes exceeds \$2,000/year. A local restaurant has volunteered to be a "guinea pig" for retrofitting materials. All data from line points will be constantly monitored and transmitted to a computer for printout. The grand opening of the system is scheduled for early October.

GEOHERMAL PROGRAM AVAILABLE

Any professional, civic, or other group desiring to learn more about Geothermal energy and the geothermal resources of Colorado and their potential should contact the Geothermal Commercialization Office at (303) 866-2611. The Commercialization office has available a professionally prepared slide show that they will be most willing to present.

ALAMOSA ENERGY FAIR

On June 6 and 7, 1981 the Sunshine Fair will be held in Alamosa Colo. at Cole Park. The Geothermal Commercialization Team will attend this fair and distribute information on geothermal energy and its uses.

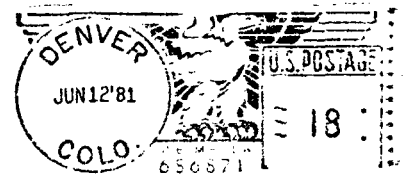
JUNE GEOTHERMAL RESOURCES COUNCIL PROGRAM

The June program of the Rocky Mountain Section, Geothermal Resources Council will be given by Jo Chanaud, Colo. Technical Reference Center, Boulder. The program will be titled "Information Retrieval for Geothermal Resources". For information or reservation call Aldona Rayton 363-7205 by June 24, 1981.

NEW SOURCE OF THERMAL WATERS REPORTED

Charles Steel, Mineral County Land Use Administrator, reported that a water well drilled recently southwest of Creede encountered hot waters at a depth of 65 ft. As the well owner was looking for cold waters thermal waters were cased off the well drilled deeper.

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COLORADO

GEOTHERMAL NEWS

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FEBRUARY, 1982

OPPORTUNITY AT GLENWOOD SPRINGS

The U.S. Bureau of Reclamation is considering several options for diverting and treating the hot saline waters at Glenwood Springs, as part of the Colorado River Water Quality Improvement Project. The Bureau is open to proposals from private industry to utilize the heat available from the springs during the desalinization process. Inquiries or proposals should be directed to Nick Mezei, U.S. Bureau of Reclamation, 764 Horizon Drive, Grand Junction, CO, 81501 (303) 243-4992.

DRILLING

U.S. Dept. of Energy and Sandia National Laboratories have indicated that a 90 percent reduction in the corrosion of drill pipes in geothermal wells may be obtained by adding nitrogen to drilling fluids. This determination was made with the assistance of E.G.&G. Energy Measurements Group. A nitrogen/water mist drilling fluid was compared with a chemically treated air/water mist in drilling a northern New Mexico geothermal well. By using the inert gas in deep drilling, pipe could last 10 times longer, which could amount to \$2,000/day in savings.

Sandia is now studying the feasibility of a portable well site nitrogen generator, to avoid the prohibitive cost of transporting liquid nitrogen. This work is being done as part of D.O.E.'s Geothermal Drilling and Well Completion Technology Development Program managed by Sandia Labs. (from Geothermal Energy Magazine).

USER TARGETING

The Colorado Geothermal Commercialization Project has hired an independent consultant, Ms Barbara Coe, to study industries that could most effectively use geothermal energy in the state. Major industries studied have included manufacturing, mining, tourism, and agriculture. Both co-located and potentially relocatable businesses are being considered.

Preliminary results indicate that although a large variety of manufacturing processes could use geothermal energy, the most likely candidates are:

Food and kindred products

Lumber and forest products

Furniture and fixtures

Chemicals

Stone, clay and concrete products.

Leather goods

NEW PUBLICATION

The Colorado Geothermal Resource Assessment Project has announced the publication and availability of Map Series 21, Groundwater Temperature Map of Colorado, by F.N. Repplier, M.M. Relf and R.K. Columbia, Scale 1:1,000,000. Copies of this map may be obtained for \$0.75 mailed, free over the counter at Rm. 715, 1313 Sherman St., Denver, CO 80203. Payment to accompany order.

GEOHERMAL DISTRICT HEATING GUIDE AVAILABLE

Oregon Institute of Technology, has recently published a 75 page guide to district heating using geothermal energy. This guide is designed to aid developers in the preliminary evaluation of the feasibility of district heating using heat produced from geothermal fields. The analysis is accomplished through five analysis steps: 1) estimating geothermal heat production; 2) procedures for identifying district heating market areas and estimating their peak heating loads and annual energy uses; 3) preliminary design considerations for district heating systems; 4) analysis of economic aspects of district heating systems; and 5) evaluation of district heating feasibility.

Any Colorado municipality wishing to borrow this report for a short period of time may do so by contacting the Colorado Geothermal Commercialization Project Office, Rm. 715, 1313 Sherman St., Denver 80203, (303) 866-2611.

"Colorado Geothermal Newsletter" is published to disseminate information to the public concerning the potential and application of geothermal energy in Colorado and is mailed free of charge. If you know of anyone who would like to be included on the mailing list or would like additional information, contact the Colorado Geothermal Commercialization Project, Colorado Geological Survey, Rm. 715, 1313 Sherman St., Denver, Colorado 80203 (303)866-2611.

Program Coordinator: Richard H. Pearl
Geologist: Kevin P. McCarthy

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JULY-AUGUST

HEAT AND COOLING WITH GROUNDWATER HEAT PUMPS

Groundwater is not given much consideration as an energy resources, yet due to the heat adsorption properties of water being higher than any other natural material, it is a natural source of energy. The most efficient method of extracting heat contained in water is with heat pumps.

A heat pump is a mechanical device that removes heat from one place and delivers it to another place. A heat pump works on the principal that a fluid adsorbs heat when it evaporates to a gas and gives off heat when it condenses back into a liquid.

Most heat pumps that we are familiar with, refrigerators and air conditioners are air-to-air heat pumps. These pumps are very efficient when the air temperature is high. However once the air temperature drops below 40°F then the efficiency of the heat pumps drops off. Therefore for a heat pump to be used for heating purposes in the winter a source of heat is needed whose temperature is above 45°F. One such source is groundwater. Studies have shown that the groundwater temperatures in those parts of the country needing winter heating are usually above 50°F. In Colorado groundwater temperatures varies from a low of 50°F to a high of 65°F and are very stable, usually not varying more than one degree throughout the year.

Water-to-air pumps normally work in the following manner. Groundwaters are pumped to a heat exchanger coil where the heat from the waters are adsorbed by a low boiling liquid such as freon. The liquid evaporates becoming a hot gas. The gas is then compressed, making it even hotter. The dense hot gas is pumped into the building heat exchanger where it is allowed to condense back into a liquid. In so doing it gives off heat, heating the cool building air being blown through the heat exchanger. This warm air is then distributed throughout the building being heated. The pressure on the refrigerant is relieved and the cycle starts over again. For cooling purposes the heat pump cycle is run in the reverse direction with heat energy being removed from the home and delivered to the groundwater.

Economic analysis have shown that groundwater heat pumps are cost effective. In almost all instances, groundwater heat pump annual operating costs are equal to or are less than the annual operating cost of natural gas forced air heating systems. When compared to other heating systems they are much more economical. If air conditioning operating costs are included then groundwater heat pump costs are far cheaper than any other form of energy.

More information may be obtained about groundwater heat pumps from the the Colorado Geothermal Commercialization Project, Rm. 715, 1313 Sherman St., Denver, CO 80203, or National Water Well Association, 500 West Wilson Bridge Rd. Worthington, Ohio, 43085.

ALAMOSA PROJECT UPDATE

According to Terry Huntley, City Manager and Leroy Payne, Project Manager; after review of comprehensive geological and geophysical data officials of the City of Alamosa have decided to proceed with the drilling of the exploratory/production well being funded under the U.S.D.O.E. User Coupled Drilling Program. Pending receipt of D.O.E. permission and the necessary permits from the Colorado Div. of Water Resources it is anticipated that drilling will start by the middle of Sept. and be completed by the first of January, 1982. The well will be drilled at a site adjacent to the City's industrial park on the south side of Alamosa and west of the airport. As currently planned the well will be drilled to a depth of approximately 7,000 ft. and it is anticipated that waters of approximately 200°F will be encountered.

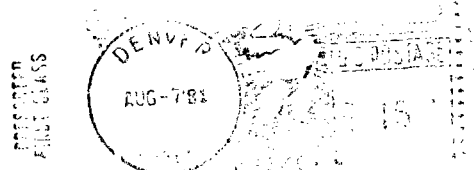
ENERGY COORDINATING COUNCIL FORMED

A new recently enacted law (Senate Bill 23) calls for the establishment of the Colorado Energy Coordinating Council. This Council, which is to be composed of members of the legislature, governors appointments, energy related business, and a consumer representative, has many charges but the primary ones are: 1) Inventory all state agencies and activities which directly or indirectly affect the research, development, or implementation of energy policy of Colorado; 2) To review and recommend legislation pertaining to energy-related activities; and 3) To inventory, study, and analyze all federal agencies, programs, activities, and policies in Colorado which directly or indirectly affect the research, development, or implementation of energy policy of Colorado.

The Council is to give advice and information and make recommendations to the Governor and general assembly concerning cooperation of state government energy activities and the cooperation of state and local governments with businesses, industries, and consumers to achieve orderly energy development and substantial energy conservation.

The Council will be holding hearing during the summer and fall of 1981 as must report to the general assembly by December 31, 1981, and again by December 31, 1982. Activities of the Council as they relate to geothermal energy development in Colorado will be reported in later issues of the Colorado Geothermal News.

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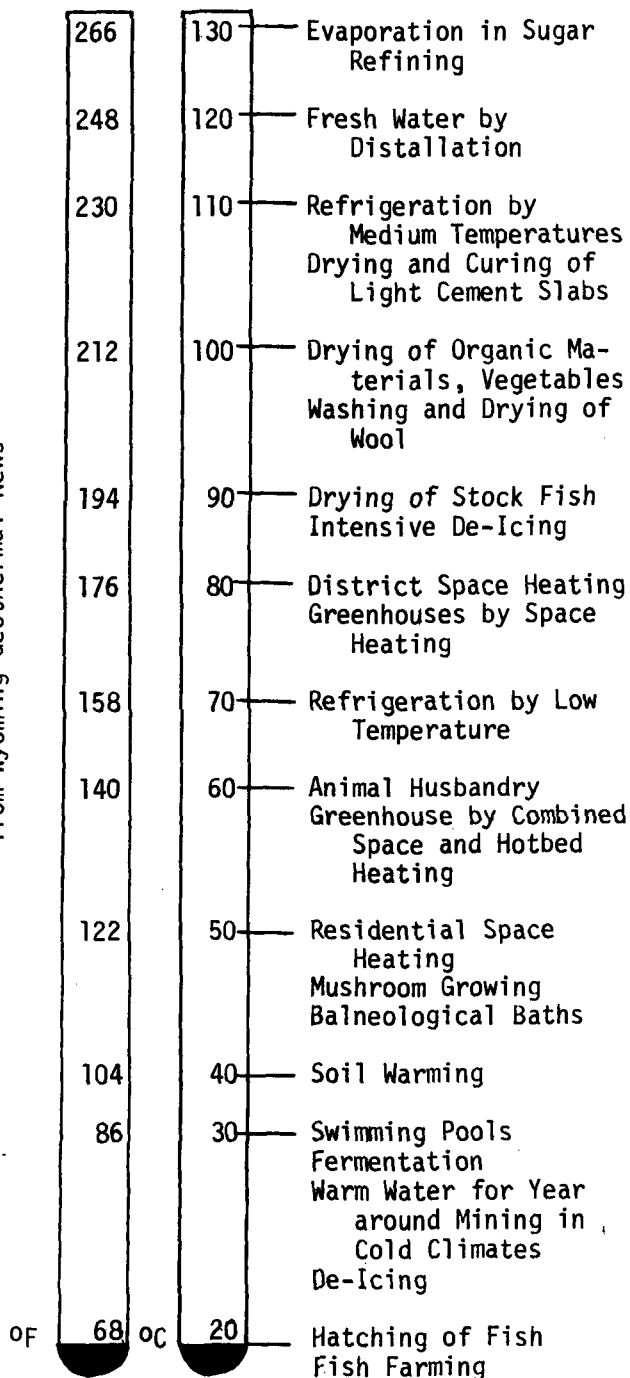
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MAY, 1981

from Wyoming Geothermal News



ENERGY DEVELOPMENT IN THE 1980'S

A. U.S. Dept. of Energy seminar stressing government and industry cooperation for energy development was held April 21 - 23 in Denver. The Geothermal workshop, held on the first afternoon, featured a distinguished panel including Barbara Coe, Western Energy Planners, Ltd., Bill Dolan, AMAX Geothermal, Stan Green, Utah Div. of Water Rights; George Gault, economic development consultant to City of Ouray, Colorado; and Jay Dick, Chaffee Geothermal. Impediments to geothermal development were discussed, and suggestions made to D.O.E. regarding legislative and institutional revisions.

STATE-FEDERAL GEOTHERMAL MEETING IN GLENWOOD SPRINGS

A meeting of the Federal-State Resource Assessment Teams will be held in Glenwood Springs May 5-7, 1981. Papers will be presented by each state team on their research, and its accomplishments and failures. This meeting is unique in that it is one of the few held by the Resource Assessment Program and it will allow the various state teams to discuss in depth with each other common areas of interest. The Colorado Resource Assessment and Commercialization Teams will be attending.

VERSATILITY OF GEOTHERMAL ENERGY

The thermometers at the left were adapted from the Wyoming Geothermal News, and illustrate the many possibilities for direct use of geothermal resources.

GEOTHERMAL WELL PERMIT APPLICATIONS

An application was received from Alamosa Mushroom Farm, Inc. by the Colorado Oil and Gas Conservation Commission, for authorization to drill a 2,500 ft exploration well in T. 38 N, R. 10 E., Sec. 26 E1/2, SE1/4 in Alamosa County.

BIBLIOGRAPHY OF GEOTHERMAL REPORTS IN COLORADO

The Colorado Geological Survey announces the recent publication of Bulletin 44, Bibliography of Geothermal Reports in Colorado by Richard H. Pearl, Ted Zacharakis, Frank Replier and Kevin P. McCarthy. Bulletin 44, the first compilation of all reports pertaining to the geothermal resources of Colorado, lists all reports published up until 1980 by author and subject index. Copies of Bulletin 44 may be obtained from the Colo. Geological Survey, Rm. 715, 1313 Sherman St., Denver, Colorado 80203 for \$5.00 + \$1.00 mailing fee. Make all checks payable to the Colo. Geological Survey.

FINANCIAL ASSISTANCE PROGRAMS AVAILABLE FOR GEOTHERMAL DEVELOPMENT

Following is a brief summary of several federal financial assistance programs currently available for potential developers of geothermal resources. Recent Federal cutbacks may have eliminated or modified many of these programs. For more information about these programs please contact the respective federal agency.

DEPARTMENT OF AGRICULTURE: Farmers Home Administration--

Business and Industrial Loans: \$11,000-\$33,000,000 loans, applicants must provide min. of 10%. Contact (202) 477-3479.

Community Facilities Loans: Rural State and Local Agencies, Tribes and non-profit corp.; Amounts \$1,600 to \$18,000,000. Contact (202) 447-7667.

DEPARTMENT OF COMMERCE: Economic Development Administration--

Business Development Assistance Loans: Private sector; Amounts: \$260,000 to \$5,200,000. Contact (202) 377-2607.

DEPARTMENT OF INTERIOR: Bureau of Indian Affairs--

Eligible Parties: Native American organizations and individuals: Amounts; \$100 to 1,000,000. Contact (202) 343-5875.

SMALL BUSINESS ADMINISTRATION-Small Business Loans

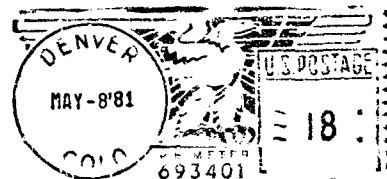
Independently owned and operated small business: Amounts; \$1,000 to \$500,000. Contact (202) 653-6570.

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GEOTHERMAL NEWS

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RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
DIRECTOR

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING -- 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 866-2611

March 3, 1983

Ms. Susan Prestwich
U.S. Department of Energy
550 Second Street
Idaho Falls, ID 83401

Dear Susan:

Re: DOE/ET/28365

Being mailed to you under separate cover are five (5) copies of the final technical report for the above contract. A camera ready copy of this report will also be mailed to NTIS. The preparation of this report completes all work on the project.

Sincerely,

Richard H. Pearl
Project Coordinator

bn

cc: Leon Lehr
Duncan Foley
Marshall Reed

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

February 15, 1983

MEMORANDUM

TO: Richard H. Pearl

FROM: Carl A. Ruscetta, Technical Program Coordinator

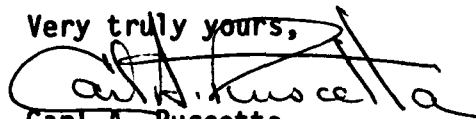
SUBJECT: Review of Draft: Final Technical Report, Geothermal Reservoir Assessment and Confirmation Program for Direct Heat Applications in Colorado. DOE Contract No. DE-AS07-77ET-28365.

Dear Mr. Pearl:

Please find enclosed a marked copy of the subject final report draft. D. Foley and I have reviewed this draft and find no problems with technical content or format. A number of minor typographical errors were detected and marked for your convenience. Thank you for the opportunity to review this draft. I have also reviewed the status of report deliverables against the subject contract, including your list of pertinent reports published or in press, contained in the final report draft. The publication of the two reports contained in your listing now in press and the Final Technical Report would, in our opinion, constitute completion of the work detailed in the subject contract as modified. I also note that monthly progress reports on file at ESL are complete through January, 1983.

Dr. Foley and I would also like to take this opportunity to congratulate you personally, and the Colorado State Team, for a job well done. It has been a pleasure to work with you.

Very truly yours,



Carl A. Ruscetta
Technical Program Coordinator

CAR:jp

cc: D. Foley
S. Prestwich/DOE, ID

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

November 30, 1982

Mr. Richard H. Pearl
Colorado Geological Survey
1313 Sherman Ave., Rm 715
Denver, CO 80203

Dear Dick:

Enclosed please find reviewed copies of the Shaws and Steamboat area reports. As usual, I have made many comments that you are free to reject if you wish. Jon Zeisloft looked briefly at the Shaws report, and I have included his comments with mine.

I discussed the presentation of the resistivity data in both reports with Howard Ross, and have made several notations on the pseudosections based on his comments. He has a fair number of misgivings about the data and their presentation. One comment he made is that all the faults seem to be drawn at the same angle, usually about 45° along the diagonal with low resistivity. Resistivity model catalogs suggest that in many cases the actual dip of the fault may be opposite to the dip of the low resistivity zone on the pseudosection. I wonder, given the uncertainty of the data in some cases and the uncertainty of the interpretations in other cases, if it might be best to put the pseudosections into the appendices with tables and identify Ted as the author? This would give him credit for the specific section, and absolve you of having to resolve many problems now that Ted is gone. I am sorry that it is too late to do modeling of the data, as this could resolve many of the problems.

I have, as per usual, kept copies of these reviews, so I can explain in more detail any of my quizzical comments. Please call with any questions you have.

Sincerely,



Duncan Foley

DF:jp

enclosure

STATE OF COLORADO



RICHARD D. LAMM
GOVERNOR

R
12/12/82
JOHN W. ROLD
DIRECTOR

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING — 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 866-2611

December 8, 1982

Ms. Susan Prestwich
Idaho Operations Office
U.S. Department of Energy
550 2nd
Idaho Falls, ID 83401

RE: CONTRACT NO DE-AS07-77ET28365

Dear Susan:

Being sent to you under separate cover are five copies of our latest report titled "Geothermal Resources Assessment of Canon City, Colorado Area" by Ted Zacharakis and myself.

Sincerely,

Richard H. Pearl
Richard H. Pearl
Project Coordinator

vt

cc: Leon Lehr
Duncan Foley
Marshal Read

X²/28

STATE OF COLORADO



RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
DIRECTOR

**COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES**

715 STATE CENTENNIAL BUILDING — 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 866-2611

February 24, 1983

Ms. Susan Prestwich
U.S. Department of Energy
530 2nd Street
Idaho Falls, ID 83401

RE: DOE/ET-28365

It gives me great pleasure to inform you that being sent to you under separate cover is our final site specific report titled "Geothermal Resource Assessment of Ranger Warm Spring, Colorado," by Zacharakis, myself and Ringrose. With the exception of the final Technical Report, which you should receive within a month, this completes all work on the project.

I want to take this opportunity to express the State of Colorado's, this office's and my appreciation to the U.S. Department of Energy and your office for funding this project. I can't begin to describe the benefits that we here in Colorado have received from the project. In summary, I think the main benefit that Colorado has received is that we now have a sound and firm foundation from which the development of our low to moderate temperature geothermal resources can go forward in the future. Also, there is now a good group of highly trained professionals working in the private sector who are actively involved in developing geothermal resources.

To be associated with a government program that was so successful and professionally conducted is very rewarding, especially when there is so much publicity about government programs that are complete failures. I am very sorry and disappointed that this program has never received the recognition that it richly deserves. Please pass on my compliments to the rest of your staff and contractors for an outstanding job.

Sincerely,

Richard H. Pearl
Project Coordinator

vt

cc: Leon Lehr
Duncan Foley
Marshal Reed

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

February 15, 1983

MEMORANDUM

TO: Richard H. Pearl

FROM: Carl A. Ruscetta, Technical Program Coordinator

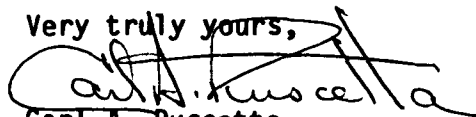
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Dear Mr. Pearl:

Please find enclosed a marked copy of the subject final report draft. D. Foley and I have reviewed this draft and find no problems with technical content or format. A number of minor typographical errors were detected and marked for your convenience. Thank you for the opportunity to review this draft. I have also reviewed the status of report deliverables against the subject contract, including your list of pertinent reports published or in press, contained in the final report draft. The publication of the two reports contained in your listing now in press and the Final Technical Report would, in our opinion, constitute completion of the work detailed in the subject contract as modified. I also note that monthly progress reports on file at ESL are complete through January, 1983.

Dr. Foley and I would also like to take this opportunity to congratulate you personally, and the Colorado State Team, for a job well done. It has been a pleasure to work with you.

Very truly yours,



Carl A. Ruscetta
Technical Program Coordinator

CAR:jp

cc: D. Foley
S. Prestwich/DOE, ID

RECEIVED

SEP 12 1977

GEOHERMAL ENERGY
BRANCH

CONTRACT BETWEEN

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY

and

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

THIS AGREEMENT, entered into the 29th day of August, 1977, effective as of the 27th day of June, 1977, by and between the UNITED STATES OF AMERICA (hereinafter referred to as the "Government"), acting through the ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION (hereinafter referred to as "ERDA"), and the COLORADO GEOLOGICAL SURVEY, an agency of the State of Colorado, Department of Natural Resources, existing under the laws of the State of Colorado, with principal offices in Denver, Colorado (hereinafter referred to as the "Contractor");

WITNESSETH THAT:

WHEREAS, ERDA desires to have the Contractor perform certain research work, as hereinafter provided; and

WHEREAS, this agreement is authorized by the Energy Reorganization Act of 1974 (P. L. Law 93-438), and other applicable laws;

NOW, THEREFORE, the parties hereto agree as follows:

ARTICLE I - THE RESEARCH TO BE PERFORMED

The Contractor shall, to the best of its ability, furnish personnel, facilities, equipment, materials, supplies, and services, except such as are furnished by the Government, necessary for the performance of the research provided for in Appendix A hereto, and shall perform the research and report thereon pursuant to the provisions of this contract. It is understood that Appendix A, a guide to the performance of this contract, may be deviated from by the Contractor subject to the specific requirements of this contract.

ARTICLE II - THE PERIOD OF PERFORMANCE

The period of performance under this contract shall commence on June 27, 1977 and expire on June 26, 1978. Performance may be extended for additional periods by the mutual written agreement of the parties.

472.2

ARTICLE III - CONSIDERATION

(a) In full consideration of the Contractor's performance hereunder, ERDA shall furnish the equipment, supplies, materials, and services, if any, listed in Article A-II(b), and pay the Contractor the sum of One Hundred Fifty-Four Thousand One Hundred Thirty Dollars (\$154,130.00), hereinafter called the "Support Ceiling", which sum shall be subject to adjustment as hereinafter provided.

(b) Payments to the Contractor shall equal the "Cumulative Support Cost" of the performance of this contract, as the term "Cumulative Support Cost" is defined in Article B-XXVIII; Provided, however, and notwithstanding any other provisions of this contract, that the Government's monetary liability under this contract shall not exceed the Support Ceiling specified in (a) above. ERDA shall not pay more than the Support Ceiling or an amount equal to the Cumulative Support Cost, whichever is less. The Contractor shall be obligated to perform under this contract throughout the agreed-upon period of performance, and to bear all costs which ERDA has not agreed to pay; Provided, however, that the Contractor shall have the right to cease to perform the research provided for in this contract, upon written notice to ERDA to that effect, at any time when or after the Cumulative Support Cost equals or exceeds the Support Ceiling.

(c) The Support Ceiling specified in (a) above may be increased unilaterally by ERDA by written notice to the Contractor and may be increased or decreased by written agreement of the parties (whether or not by formal modification to this contract). In the event the stated period of contract performance is extended, the Support Ceiling may be revised to reflect any increased ERDA support for the extended period or periods.

(d) Upon termination, or expiration of the total period of performance, the Contractor shall promptly refund to ERDA (or make such disposition as ERDA may in writing direct) any sums paid by ERDA to the Contractor under this contract, through direct payment or under letter of credit, in excess of the Cumulative Support Cost incurred in performance under the contract.

ARTICLE IV - GOVERNMENT PROPERTY

The following items of property procured or fabricated by the Contractor are hereby listed as "Government property":

None

ARTICLE V - ADDITIONAL CONTRACT PROVISIONS

Appendix B attached hereto and made a part hereof, sets forth additional general contract provisions of this contract.

IN WITNESS WHEREOF, the parties hereto have executed this document
as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY THE ENERGY RESEARCH AND DEVELOPMENT
ADMINISTRATION

By /s/ R. E. Simonds
R. E. Simonds, Director
Contracts and Procurement Division
Idaho Operations Office
Contracting Officer

Contractor

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR

By /s/ David W. Walker
for Executive Director

Colorado Geological Survey
John W. Rold, Director

DEPARTMENT
OF Natural Resources

/s/ John W. Rold

APPROVALS

ATTORNEY GENERAL J. D. MacFarlane CONTROLLER Dan S. Whittemore

By /s/ A. H. Jewell, Jr. By /s/ not legible
A. H. Jewell, Jr.
Assistant Soliciter General
General Legal Services

Contract No. EG-77-S-07-1678

CONTRACTOR: State of Colorado
Colorado Geological Survey

APPENDIX A

For the Contract Period June 27, 1977 through June 26, 1978

Article A-I RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) The scope of the work under this contract is unclassified, and the Contractor under this agreement with the Energy Research and Development Administration will perform research consisting of the following:

1. The Contractor will accomplish a preliminary synthesis of data presently available concerning the distribution of low and moderate temperature geothermal reservoirs in the State of Colorado potentially suitable for direct heat applications. Data gathered during this review will be provided to the USGS GEOTHERM data base.
2. The Contractor, in cooperation with the U. S Geological Survey, the U. S. Forest Service, and representatives of U. S. ERDA-Division of Geothermal Energy, will select individual sites for detailed site assessment studies. The Contractor will manage these studies which may include:
 - a. Geological and hydrological mapping.
 - b. Geophysical investigations.
 - c. Heat flow drilling and measurements.
3. The Contractor will subcontract for preliminary environmental assessments and reports on non-Forest Service land as required by ERDA-DGE Environmental Reporting Procedures.
4. In cooperation with the other parties to the Colorado low temperature reservoir assessment and confirmation project, the Contractor will recommend sites for confirmation during follow-on work, if any.

(b) The scope of work shall include such other studies, investigations, and services as may be mutually agreed upon.

A-II WAYS AND MEANS OF PERFORMANCE

(a) Items for which support will be provided as indicated in A-III below:

1. Salaries and Wages - Professional	\$36,930.00	
Other	<u>1,000.00</u>	\$37,930.00
2. Vehicle lease and operation		4,500.00
3. Travel and per diem		6,300.00
4. Materials, equipment and supplies		5,000.00
5. Publication expense		500.00
6. Subcontract actions		
a. Contract geophysics	40,000.00	
b. Test drilling and aquifer testing	46,307.00	
c. Chemical water analysis	1,500.00	
d. Environmental impact statement	<u>8,400.00</u>	
		96,207.00
7. Indirects (10% overhead on salaries of professionals)		<u>3,693.00</u>
	Total	<u>\$154,130.00</u>

(b) Items, if any, significant to the performance of this contract, but excluded from computation of Support Cost and from consideration in proportioning costs:

None

(c) Time or effort of Principal Investigator(s) including indirect costs and fringe benefits contributed by the Contractor but excluded from computation of Support Cost and consideration in proportioning costs:

\$7,000.00

Article A-III FUNDING

The total estimated cost of items under A-II(a) above, for the contract period stated in this Appendix A, is \$154,130.00. ERDA will pay 100% of the actual costs of these items incurred during the contract period stated in this Appendix A, subject to the provisions of Article III and Article B-XXVIII. The estimated ERDA Support Cost for the contract period stated in this Appendix A is \$154,130.00.

The estimated ERDA Support Cost is funded as follows:

- (a) Estimated unexpended balance from prior period(s) \$ 0
- (b) New funds for the current period \$154,130.00

Article A-IV ADMINISTRATION AND REPORTS

- (a) Principal Investigator - Richard H. Pearl

ERDA Program Manager - Clayton R. Nichols - ERDA HQ.
 Division of Geothermal Energy

The Principal Investigator shall direct the work as outlined in discussions and in periodic letters from the Program Manager.

- (b) Reports

1. General - General reporting requirements for ERDA/DGE contractors are presented in ERDA-76/72, "Requirements and Procedures for Reporting Geothermal Information", dated July 1976. Reports should be prepared for this contract as follows:

	<u>Frequency</u>	<u>Draft to Program Manager for Concurrence</u>	<u>Distribution Program Manager</u>	<u>TIC</u>
Administrative Letter Report	-----	N/A	10	N/A
Technical Progress Report	-----	3 weeks after end of report- ing period	10	1 camera- ready copy

	<u>Frequency</u>	<u>Draft to Program Manager for Concurrence</u>	<u>Distribution Program Manager TIC</u>	
Final Report	Completion of contract effort	3 weeks after end of reporting period	10	1 camera- ready copy
Topical Reports	As required	As agreed with Program Manager	10	1 camera- ready copy

2. Reports Formats

The following will apply to all technical progress reports, topical reports and final reports:

- (a) The cover page will be supplied by ERDA/DGE unless the Contractor intends to use its corporate cover.
- (b) Reports under this contract will all carry the number prescribed by the Program Manager. Report numbers will be assigned sequentially.
- (c) The distribution category for reports prepared under this contract will be UC-66A as defined on page 16 of ERDA-76/72.

3. Content of Reports

Administrative Letter Reports -- Progress memo to Program Manager on personnel and fiscal matters, including such information as rate of expenditures, equipment ordering/availability/receipt, loss or gain of personnel, etc.

Technical Progress Reports -- Full account of progress, problems encountered, plans for future reporting periods, and an assessment of prospects for future progress, identifying clearly all facts with both positive and negative impact on expectations for completely achieving task objectives on schedule and within contract funds, should include, as appropriate, accounts of activities aimed at utilization of task results.

Final Report -- Comprehensive report of objectives, results and conclusions of task effort, should identify accomplishments, problems encountered and solutions applied, conclusions reached and recommendations for applications of results. It shall also include a summary of the available geological, geochemical, geophysical, hydrological, and environmental data relevant to the distribution of the low and moderate temperature geothermal resources in Colorado. The report will contain a prioritized list of candidate sites for reservoir confirmation studies during follow-on work, if any. A map will be prepared in cooperation with NOAA which will graphically portray the distribution of the resource. The report should be in sufficient detail that the work could be duplicated by others.

01/07/78-20

SUPPLEMENTAL AGREEMENT

THIS SUPPLEMENTAL AGREEMENT, entered into the 20th day of March 1978, by and between the UNITED STATES OF AMERICA (hereinafter called the "Government"), acting through the DEPARTMENT OF ENERGY (hereinafter called "DOE")(formerly the Energy Research and Development Administration "ERDA"), and the COLORADO GEOLOGICAL SURVEY, an agency of the State of Colorado, Department of Natural Resources with its principal office at Denver, Colorado (hereinafter called the "Contractor");

WITNESSETH THAT:

WHEREAS, on August 29, 1977, effective as of the 27th day of June 1977, the Government and the Contractor entered into Contract No. EG-77-S-07-1678 for the Contractor to perform certain research work; and

WHEREAS, the parties desire to modify said contract as hereinafter provided; and

WHEREAS, DOE certifies that this Supplemental Agreement is authorized by and executed under Section 302(c)(5) and (15) of the Federal Property and Administrative Services Act of 1949, as amended, and the Department of Energy Organization Act of 1977 (Public Law 95-91), and other applicable laws;

NOW, THEREFORE, said contract is hereby amended as follows:

- A. ARTICLE I, "THE RESEARCH TO BE PERFORMED," is amended by adding a new paragraph as follows:

"Appendix A1, attached to this Supplemental Agreement and made a part hereof, provides for the research to be performed by the Contractor during the contract period specified therein."

- B. ARTICLE II, "THE PERIOD OF PERFORMANCE," is amended as follows:

"The period of performance for the work performed under this Supplemental Agreement shall commence on January 1, 1978 and expire on December 31, 1978. The period of time for performing the research work under Appendix A1 may be extended for additional periods by the mutual written agreement of the parties."

C. ARTICLE III, CONSIDERATION," paragraph (a) is hereby revised to increase the contract Support Ceiling to a total of Three Hundred Eighteen Thousand Seven Hundred Fifty-One Dollars (\$318,751.00).

Except only to the extent modified by this Supplemental Agreement or to the extent rendered inconsistent herewith, all of the terms and provisions of said contract EG-77-S-07-1678 shall remain unchanged and continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY THE DEPARTMENT OF ENERGY

By

R. E. Simonds
R. E. Simonds, Director
Contracts and Procurement Division
Idaho Operations Office
Contracting Officer

Contractor

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR

By

Robert D. Siek
Title Robert D. Siek
Deputy Director

(Name typed)

Colorado Geological Survey
John W. Rold, Director

DEPARTMENT
OF Natural Resources

APPROVALS

ATTORNEY GENERAL J. D. MacFARLANE

CONTROLLER

DAN S. WHITTEMORE

By

J. D. MacFarlane

By

Dan S. Whittemore

A. H. Jewell, Jr.
A. H. JEWELL, JR.
Assistant Solicitor General
General Legal Services

020678

CONTRACTOR: State of Colorado
Colorado Geological Survey

APPENDIX A1

For the Contract Period January 1, 1978 through December 31, 1978

Article A-I RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) The scope of the work under this contract is unclassified, and the Contractor under this agreement with DOE is now performing and shall complete the following research:

1. The Contractor shall accomplish a preliminary synthesis of data presently available concerning the distribution of low and moderate temperature geothermal reservoirs in the State of Colorado potentially suitable for direct heat applications. Data gathered during this review will be provided to the USGS GEOTHERM data base.
2. The Contractor, in cooperation with the U. S Geological Survey, the U. S. Forest Service, and representatives of U. S. DOE-Division of Geothermal Energy, will select individual sites for detailed site assessment studies. The Contractor will manage these studies which may include:
 - a. Geological and hydrological mapping.
 - b. Geophysical investigations.
 - c. Heat flow drilling and measurements.
3. The Contractor will subcontract for preliminary environmental assessments and reports on non-Forest Service land as required by DOE-DGE Environmental Reporting Procedures.
4. In cooperation with the other parties to the Colorado low temperature reservoir assessment and confirmation project, the Contractor will recommend sites for confirmation during follow-on work, if any.

(b) In connection with the above work the Contractor shall perform specific reservoir conformation studies consisting of the following:

1. Test drill wells 300-600 meter in depth.
2. Perform following hydrological assessment:

- a. Aquifer testing
- b. Isotope determination
- c. Recharge areas and rates
- d. Affect on water resources of area

3. Furnish reports as set forth in Article A-IV (b) below:

(c) All subcontracts and consultant agreements will require the prior written approval of the Contracting Officer.

A-II WAYS AND MEANS OF PERFORMANCE

(a) Items for which support will be provided as indicated in A-III below:

1. Salaries and Wages -		
Professional	\$37,752.00	
Other	<u>6,156.00</u>	\$43,908.00
2. Vehicle lease and operation		6,750.00
3. Travel and per diem		9,244.00
4. Materials, equipment & supplies		7,400.00
5. Publication expense		3,500.00
6. Subcontract actions		
a. Contract geophysics	\$ 8,000.00	
b. Test drilling and aquifer testing	163,000.00	
c. Chemical water analysis	1,500.00	
d. Environmental impact statement	<u>4,279.00</u>	176,779.00
7. Indirects (10.265% overhead on salaries of professionals)		<u>3,875.00</u>
	TOTAL	<u>\$251,456.00</u>

(b) Items, if any, significant to the performance of this Appendix A1, but excluded from computation of Support Cost and from consideration in proportioning costs:

None

(c) Time or effort of Principal Investigator(s) including indirect costs and fringe benefits contributed by the Contractor but excluded from computation of Support Cost and consideration in proportioning costs:

None

Article A-III FUNDING

The total estimated cost of items under A-II(a) above, for the contract period stated in this Appendix A1, is \$251,456.00. DOE will pay 100% of the actual costs of these items incurred during the contract period stated in this Appendix A1, subject to the provisions of Article III and Article B-XXVIII. The estimated DOE Support Cost for the contract period stated in this Appendix A1 is \$251,456.00.

The estimated DOE Support Cost is funded as follows:

- | | |
|---|---------------------|
| (a) Estimated unexpended balance from prior period(s) | \$ <u>86,835.00</u> |
| (b) New funds for the current period | <u>\$164,621.00</u> |

Article A-IV ADMINISTRATION AND REPORTS

- (a) Principal Investigator - Richard H. Pearl

DOE Program Manager - Clayton R. Nichols - DOE HQ.
Division of Geothermal Energy

The Principal Investigator shall direct the work as outlined in discussions and in periodic letters from the Program Manager or his representative.

- (b) Reports

1. General - General reporting requirements for DOE/DGE contractors are presented in ERDA-76/72, "Requirements and Procedures for Reporting Geothermal Information", dated July 1976. Reports should be prepared for this contract as follows:

	<u>Frequency</u>	<u>Draft to Program Manager for Concurrence</u>	<u>Distribution</u>	
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Administrative Letter Report	-----	N/A	10	N/A
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Topical Reports	As required	As agreed with Program Manager	10	1 camera- ready copy

2. Reports Formats

The following will apply to all technical progress reports, topical reports and final reports:

- (a) The cover page will be supplied by DOE/DGE unless the Contractor intends to use its corporate cover.
- (b) Reports under this contract will all carry the number prescribed by the Program Manager. Report numbers will be assigned sequentially.
- (c) The distribution category for reports prepared under this contract will be UC-66A as defined on page 16 of ERDA-76/72.

3. Content of Reports

Administrative Letter Reports -- Progress memo to Program Manager on personnel and fiscal matters, including such information as rate of expenditures, equipment ordering/availability/receipt, loss or gain of personnel, etc.

Technical Progress Reports -- Full account of progress, problems encountered, plans for future reporting periods, and an assessment of prospects for future progress, identifying clearly all facts with both positive and

negative impact on expectations for completely achieving task objectives on schedule and within contract funds, should include, as appropriate, accounts of activities aimed at utilization of task results.

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M.a.a.

DEPARTMENT OF ENERGY
PROCUREMENT/FINANCIAL ASSISTANCE REQUEST-AUTHORIZATION

1. TO: Contract Negotiation Branch ID

2. FROM INITIATING OFFICE: Energy & Technology Div., Office of Geothermal Energy

3. INITIAL: [] UPDATE: [] 4. PROCUREMENT: [] FINANCIAL ASSISTANCE: []

5. PR NUMBER: _____ 6. PR CORRECTION LETTER: _____ 7. RELATED PR NUMBER: _____

ACTION IDENTIFICATION

3. TITLE: Low Temperature Resource Assessment of Colorado

9. UNSOLICITED PROPOSAL NO: _____ 10. PROJECT NO: _____ 11. CFDA NO: _____

12. PRODUCT OR SERVICE: * AG3X 13. SUPPORT SERVICES: YES [] NO [X] 14. CONSULTANT AWARD: YES [] NO [X]

15. CONTROLLED DELIVERABLE: * A6Y 16. REPORT/DRAWING REQ: YES [X] NO [] IF YES, ATTACH DETAILS.

17. CLASSIFICATION OF MATERIALS/WORK: U U-UNCLASSIFIED C-CONFIDENTIAL S-SECRET T-TOP SECRET

18. GOVERNMENT PROPERTY: N F-FURNISHED P-PURCHASED N-NOT INVOLVED IF CODE F OR P, ATTACH DETAILS.

AWARD PLANNING

19. AWARD AS ORDER UNDER BIN: _____ IF CODE T, ATTACH DETAILS.

20. DESIRED AWARD DATE: 01 01 79 21. KIND OF AWARD ACTION: * 1Q 22. TYPE OF AWARD: * X IF CODE T, ATTACH DETAILS.

23. IF MULTI-YEAR AWARD, INDICATE NUMBER OF YEARS: _____ 24. TYPE SOLICITATION INSTRUMENT: * _____

25. EXTENT OF COMPETITION: * _____ IF COMPETITIVE, ATTACH TECHNICAL EVALUATION PLAN. IF NON-COMPETITIVE, ATTACH JUSTIFICATION. REF: 50E-PR 9-3,805.51 or 9-4,909(f).

26. SOURCE SELECTION PROCEDURE: _____ 1-A-E 2-SEB 3-OTHER 4-NONE

27. FOR A-E, SHOW ESTIMATED CONSTRUCTION COST IN DOLLARS: _____

AWARDEE

IF COMPETITIVE, HAS LIST OF SOURCES BEEN ATTACHED? YES [] NO [] IF NON-COMPETITIVE, COMPLETE 28-31.

28. NAME: Colorado Geologic Survey 29. ADDRESS: 715 State Centennial Blvd.

30. DIVISION: Dept. of Natural Resources 1313 Sherman St., Denver, CO 80203

31. GOCO/LAB: D A-GOCO/LAB B-GOCO/NON-LAB C-NON-GOCO/LAB D-NOT APPLICABLE

FINANCIAL

AWARD VALUE		DOLLAR AMOUNT
32. GOV'T SHARE		<u>\$200,000</u>
33. TOTAL		<u>\$200,000</u>
34. CONSIDERATION IN KIND, LOAN, OR LOAN GUARANTEE DATA REPORTED ON PR-799C: []		
35. PROJECT PERIOD: FROM	<u>01 01 79</u>	THRU <u>12 31 79</u>
	MONTH DAY YEAR	MONTH DAY YEAR

CURRENT FY FUNDS COMMITTED		
36. B&R NUMBER	37. FUND CLASS	38. DOLLAR AMOUNT
<u>AE1002020</u>		<u>\$200,000</u>
-----		-----
-----		-----

39. FROM PR-799B (PART A) _____

40. TOTAL THIS PR: \$200,000

41. FUNDING PERIOD: FROM 01 01 79 THRU 12 31 79
MONTH DAY YEAR MONTH DAY YEAR

42. APPROPRIATION SYMBOL: 89 X 0210.91

43. ALLOTMENT SYMBOL: ID 90-91

44. OBJECT CLASS: 250

PROJECT MANAGER

45. NAME: Leland L. Mink

46. SIGNATURE: _____

47. DATE: _____ 48. OFFICE CODE: _____

49. FTS TELEPHONE NUMBER: 583-0638

PROGRAM OFFICIAL

50. NAME: R. E. Wood

51. SIGNATURE: _____

52. DATE: _____

CERTIFYING OFFICIAL

53. NAME: F. S. Smith

I HEREBY CERTIFY THAT THE FUNDS CITED IN ITEM 40 ARE AVAILABLE.

54. SIGNATURE: _____

55. DATE: _____

* SEE BACK OF FORM FOR CODES

STATE OF COLORADO



RECEIVED

WILLIAM D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

715 STATE CENTENNIAL BUILDING - 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 839-2611

October 31, 1978

Dr. L. R. Mink
U.S. Department of Energy
Division of Geothermal Energy
Idaho Operations Office
550 2nd Street
Idaho Falls, ID 83401

Dear ^{Roy} Mr. Mink:

Following is a summary of work required to be done in 1978 as outlined in Contract ET-77-S-07-1678 and a proposal and budget for work that we would like to do during 1979 as part of the State Coupled Program.

1. The contractor has been working with Mr. J. Swanson of the USGS on the GEOTHERM file. Water quality data for thermal wells and springs here in Colorado has been coded and submitted to Mr. Swanson. This data was entered into the computer and printed out. The print-outs have been returned to this office for editing.

The contractor is preparing a major report assessing the potential of low temperature geothermal resources in Colorado. This report will attempt to delineate the size and extent of each individual resource area in Colorado. In addition the estimated amount of heat contained in the system will be estimated. This report will soon be sent out for review by colleagues. It is hoped that the completed report will be sent to DOE/DGE by the first of the year.

2. The Contractor picked two sites for detailed site assessment work - Pagosa Springs and Glenwood Springs.

Geological and hydrological mapping, geophysical investigations, and heat flow drilling and measurements were done in the vicinity of these two communities. In addition a 1,500 foot production-type well was drilled at Pagosa Springs.

3. Preliminary environmental assessments and reports of Pagosa Springs and Glenwood Springs were contracted for through the University of Denver's Research Institute. The report for Pagosa Springs was submitted and accepted by the Washington Office of DGE/DOE. The Glenwood Springs report is in the final stages of preparation.

GEOLOGY

STORY OF THE PAST . . . KEY TO THE FUTURE

- (a) All conditions of this subsection were met during drilling of the well at Pagosa Springs.

Modification of proposed research under contract EG-77-S-07-1678.

1. While not specifically spelled out, it was proposed that a production-type well would be drilled at Glenwood Springs during 1979. In light of the fact that the reservoir conditions are not completely understood we propose that more work be done and that the well be postponed until some time in the future.

PROPOSED NEW WORK

1. In order that geothermal development may progress in Colorado in an orderly manner we propose that a complete geophysical evaluation of the San Luis Valley plus other areas in Colorado be started next year. In order that this evaluation might be done properly it is believed that it should be a long term (2-3 year) on-going project. It is proposed that the U.S. Geological Survey undertake this project. To that end we have initiated contact with the representatives of the U.S. Geological Survey, Branch of Regional Geophysics (Don Hoover, and Frank Friscknecht) and they were receptive to the idea and are now discussing the matter with the Reston, Virginia office.

2. The Colorado Division of Corrections is now in the process of building a new maximum security penitentiary 5 miles east of Canon City (approximately 40 miles west of Pueblo, Colorado). We have talked with representatives of the Division of Corrections and they told us that they could use all the hot waters that we could provide them with. Therefore, a program of resource definition in the Canon City area is recommended leading to the drilling of a well some time in 1980. The following thermal waters have been found in and adjacent to Canon City: Canon City Hot Springs; a deep well on the north edge of Canon City, and a deep well at Florence 11 miles east of Canon City.

Officials from the City of Alamosa, located in the San Luis Valley, visited with Jack Salisbury during the summer of 1978 regarding the possibility of developing a geothermal resource for heating purposes within the city.

It is proposed that detailed geophysical, geological, hydrogeological investigations be undertaken during 1979 in and adjacent to both Canon City and Alamosa to fully delineate the size and extent of the geothermal resources. It is planned that this work will lead to drilling of exploratory wells during 1980.

3. We also propose to initiate geophysical studies around some of the other thermal systems in Colorado. For year 1979 we propose that regional geophysical studies be done in the Waunita Hot Springs - Ranger Hot Springs area northeast of Gunnison.

4. We would also like to do a small amount of geophysical work at both Glenwood Springs and Pagosa Springs to try and further define the limits of those systems.

5. Depending upon decisions reached by Coury and Associates regarding the use of the production well drilled in 1978 at Pagosa Springs, it is planned that a minor amount of work will be done to this well.

(a) At the present time the well is shut in. Gradient temperatures will be measured in this well some time later this spring. If the gradient measurements and geophysical surveys indicate that a heat source might be found at a greater depth we would like the option to reenter the well and deepen it.

6. After all the above work is contracted for and if any monies remain it is proposed to initiate a program of heat flow drilling and measurement. Marshall Reiter, New Mexico Bureau of Mines and Geology and Ed Decker, University of Wyoming, have measured heat flow rates at a number of locations here in Colorado. It is proposed that their unpublished data will be acquired and analyzed to determine where more holes, if any, should be drilled. It is proposed that, providing money remains, to drill heat flow holes in and adjacent to Canon City and Alamosa to help delineate the location of the resources in those two areas.

Sincerely,



Richard H. Pearl, Chief
Ground Water Investigations Section

RHP/vt

1979 BUDGET

Salaries:

Project Chief	\$22,193	
Geophysicist	20,872	
Draftsman/Secretary	<u>3,000</u>	\$46,065

Travel: (Per Diem, Meetings and Conf.)	<u>\$ 7,000</u>	\$ 7,000
--	-----------------	----------

Equipment and Supplies:

Vehicle Rent	\$ 5,000	
Vehicle Operation	2,000	
Publication expense	2,000	
Supplies and equipment	<u>10,000</u>	\$19,000

Geophysics, heat flow drilling, and further work at Pagosa Springs	<u>\$83,935</u>	\$83,935
---	-----------------	----------

Overhead (22% or subject to negotiation)	<u>\$44,000</u>	44,000
		<u>\$200,000.</u>

RHP/vt

RECEIVED

APR 3 1979

GEOTHERMAL ENERGY
BRANCH

11.2.2
Modification No. A002
Supplemental Agreement to
Contract No. DE-AS07-77ET28365

SUPPLEMENTAL AGREEMENT

THIS SUPPLEMENTAL AGREEMENT, entered into the 23rd day of March 1979 (effective as of the 1st day of January 1979), by and between the UNITED STATES OF AMERICA (hereinafter called the "Government"), acting through the DEPARTMENT OF ENERGY (hereinafter called "DOE") (formerly the Energy Research and Development Administration "ERDA"), and the COLORADO GEOLOGICAL SURVEY, an agency of the State of Colorado, Department of Natural Resources with its principal office at Denver, Colorado (hereinafter called the "Contractor");

WITNESSETH THAT:

WHEREAS, on August 29, 1977, effective as of the 27th day of June 1977, the Government and the Contractor entered into Contract No. EG-77-S-07-1678 for the Contractor to perform certain research work; and

WHEREAS, the parties desire to modify said contract as hereinafter provided; and

WHEREAS, DOE certifies that this Supplemental Agreement is authorized by and executed the Department of Energy Organization Act of 1977 (Public Law 95-91), and other applicable laws;

NOW, THEREFORE, said contract is hereby amended as follows:

- A. The contract designation number of "EG-77-S-07-1678" is hereby changed to "DE-AS07-77ET28365."
- B. ARTICLE I, "THE RESEARCH TO BE PERFORMED," is amended by adding a new paragraph as follows:

"Appendix A2, attached to this Supplemental Agreement and made a part hereof, provides for the research to be performed by the Contractor during the contract period specified therein."

- C. ARTICLE II, "THE PERIOD OF PERFORMANCE," is amended as follows:

"The period of performance for the work performed under this Supplemental Agreement shall commence on January 1, 1979 and expire on December 31, 1979. The period of time for performing the research work under Appendix A2 may be extended for additional periods by the mutual written agreement of the parties."

012679
br-MM-A-1

CONFORMED COPY

Modification No. A002 (Cont'd)
Supplemental Agreement to
Contract No. DE-AS07-77ET28365

D. ARTICLE III, "CONSIDERATION", paragraph (a), is hereby revised to increase the contract Support Ceiling by \$100,000.00 to a new total of Four Hundred Eighteen Thousand Seven Hundred Fifty-One Dollars (\$418,751.00).

Except only to the extent modified by this Supplemental Agreement or to the extent rendered inconsistent herewith, all of the terms and provisions of said Contract No. DE-AS07-77ET28365, as previously amended, shall remain unchanged and continue in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Supplemental Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY THE DEPARTMENT OF ENERGY

By /s/ Lois D. Anderson
Lois D. Anderson
Contracts Management Division
Idaho Operations Office
Contracting Officer

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR

By /s/ Robert D. Siek

for Title Executive Director

Harris D. Sherman
(Name typed)

Colorado Geological Survey
John W. Rold, Director

DEPARTMENT
OF Natural Resources

/s/ John W. Rold

APPROVALS

ATTORNEY GENERAL J. D. MacFarlane

CONTROLLER Dan S. Whittemore

By /s/ A. H. Jewell, Jr.
Assistant Solicitor General

By /s/ Dan S. Whittemore

012679 General Legal Services -2-

CONTRACTOR: STATE OF COLORADO

APPENDIX A2

For the Contract Period January 1, 1979 through December 31, 1979.

Article A-I RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) (1) Cooperate with the US Geological Survey in geophysical investigation of the San Luis Valley and/or other areas of Colorado with geothermal potential. The work in the San Luis Valley should include site specific geological, geophysical and hydrological studies in the Alamosa area.

(2) Conduct geothermal resource evaluation of the Canyon City area for potential non-electric uses.

(3) Initiate geophysical studies in areas of Colorado where geothermal interest exists. These areas may include, but are not limited to Waunita Hot Springs-Ranger Hot Springs area, Glenwood Springs and Pagosa Springs.

(4) Complete the testing and analysis of the Pagosa Springs Well. This work should be coordinated with Coury and Associates, and the City of Pagosa Springs with respect to the recently awarded PON.

(b) All subcontracts and consultants agreements will require the prior written approval of the Contracting Officer.

Article A-II WAYS AND MEANS OF PERFORMANCE

(a) Items for which support will be provided as indicated in Article A-III below:

1. Salaries and Wages		
Professional	\$ 43,000.00	
Other	<u>3,000.00</u>	\$ 46,000.00
2. Vehicle Lease & Operation		7,000.00
3. Travel and Per Diem		7,000.00
4. Materials, Expendable Equipment and Supplies		10,986.00

Article A-II WAYS AND MEANS OF PERFORMANCE (Cont'd)

5. Publication Expense	2,000.00
6. Subcontract Actions	
a. Geophysics	20,000.00
b. Heat flow drilling	52,500.00
c. Pagosa Springs (testing)	11,500.00
TOTAL DIRECT COST	<u>\$156,986.00</u>
7. Overhead (D.O.I. negotiated 27.4% of TOTAL DIRECT COST)	\$ <u>43,014.00</u>
	<u>\$200,000.00</u>

(b) Items, if any, significant to the performance of this Appendix A2, but excluded from computation of Support Cost and from consideration in proportioning costs:

None

(c) Time or effort of principal Investigator(s) including indirect costs and fringe benefits contributed by the Contractor but excluded from computation of Support Cost and consideration in proportioning costs:

Salary of Richard H. Pearl, Chief, Ground Water Investigation Section will be contributed by the State of Colorado.

Article A-III - FUNDING

(a) The total estimated cost to DOE for performance of all work under Article A-II above is \$200,000.00. An amount of \$100,000.00 is hereby obligated for the period from January 1, 1979 through December 31, 1979 to start the work. The balance of \$100,000.00 will be obligated when and if such funds become available. The Contractor shall perform the research set forth under Article A-I until 90% of the \$100,000.00 is costed and committed. At this time if additional funds have not been authorized, the Contractor shall discontinue work and notify DOE that work has been stopped until additional funds are authorized. If additional funds will not be authorized, DOE will notify the Contractor in writing within 30 days and at that time the Contractor shall submit a final report for the work that has been performed. DOE will pay 100% of the actual costs enumerated in Article A-II subject to the provisions contained in this article, Article III, and Article XXVIII.

Article A-IV ADMINISTRATION AND REPORTS

(a) Principal Investigator - Richard H. Pearl

DOE Program Manager - Gerald Brothy, DOE-HQ
Division of Geothermal Energy

The Principal Investigator shall direct the work as outlined in discussions and in periodic letters from the Program Manager or his representative.

(b) Reports

(1) General - General reporting requirements for DOE/DGE contractors are presented in ERDA-76/72, "Requirements and Procedures for Reporting Geothermal Information," dated July 1976. Reports should be prepared for this contract as follows:

	<u>Frequency</u>	<u>Draft to Program Manager for Concurrence</u>	<u>Distribution Program Manager</u>	<u>TIC</u>
Technical Progress Report	Quarterly	3 weeks after end of reporting period	10	1 Camera Ready Copy
Final Report	Completion of contract effort	3 weeks after end of reporting period	10	1 Camera Ready Copy
Topical Reports	As required	As agreed with Program Manager	10	N/A

(2) Reports Formats

The following will apply to all technical progress reports, topical reports and final reports:

(i) The cover page will be supplied by DOE/DGE unless the Contractor intends to use its corporate cover.

Article A-IV ADMINISTRATION AND REPORTS (Cont'd)

- (ii) Reports under this contract will all carry the number prescribed by the Program Manager. Report numbers will be assigned sequentially.
- (iii) The distribution category for reports prepared under this contract will be UC-66A as defined on Page 16 of ERDA-76/72.

(3) Content of Reports

Technical Progress Reports -- Full account of progress, problems encountered, plans for future reporting periods, and an assessment of prospects for future progress, identifying clearly all facts with both positive and negative impact on expectations for completely achieving task objectives on schedule and within contract funds, should include, as appropriate, accounts of activities aimed at utilization of task results.

Topical Report - A special technical report prepared when a project has reached a point at which a major milestone or a significant phase has been completed, when unexpected results have been achieved, when it is logical to summarize results achieved, or when a new scientific or technological finding is deemed to warrant prompt publication.

Final Report -- Comprehensive report of objectives, results and conclusions of task effort, should identify accomplishments, problems encountered and solutions applied, conclusions reached and recommendations for applications of results. It shall also include a summary of the available geological, geochemical, geophysical, hydrological, and environmental data relevant to the distribution of the low and moderate temperature geothermal resources in Colorado. The report will contain a prioritized list of candidate sites for reservoir confirmation studies during follow-on work, if any. A map will be prepared in cooperation with NOAA which will graphically portray the distribution of the resource. The report should be in sufficient detail that the work could be duplicated by others.

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-437
(1-78)

(See Instructions on Reverse)

FORM APPROVED
OMB NO. 38R-0190

1. IDENTIFICATION Geophysical Investigation in Parts of Colorado	2. OBLIGATION INSTRUMENT: PR Unnumbered Contract No. DE-AS07-77ET28365
---	---

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. <input type="checkbox"/> Management Plan 2. <input type="checkbox"/> Milestone Schedule & Status Report 3. <input type="checkbox"/> Cost Plan 4. <input type="checkbox"/> Manpower Plan 5. <input type="checkbox"/> Contract Management Summary Report 6. <input type="checkbox"/> Project Status Report 7. <input type="checkbox"/> Cost Management Report 8. <input type="checkbox"/> Manpower Management Report 9. <input type="checkbox"/> Conference Record 10. <input type="checkbox"/> Hot Line Report		1. <input type="checkbox"/> Notice of Energy RD&D Project (SSIE) 2. <input checked="" type="checkbox"/> Technical Progress Report 3. <input checked="" type="checkbox"/> Topical Report 4. <input checked="" type="checkbox"/> Final Technical Report C. PMS/MINI-PMS 1. Cost Performance Report <input type="checkbox"/> Format 1 WBS <input type="checkbox"/> Format 2 Functional <input type="checkbox"/> Format 3 Baseline <input type="checkbox"/> Format 5 Problem Analysis 2. <input type="checkbox"/> Cost/Schedule Status Report 3. <input type="checkbox"/> Management Control System Description 4. <input type="checkbox"/> Summary System Description 5. <input type="checkbox"/> WBS Dictionary	Q A Y

FREQUENCY CODES: A - As Required C - Contract Change F - Final (End of Contract) M - Monthly O - One Time (Soon After Contract Award)	Q - Quarterly S - Semi-Annually X - Mandatory for Delivery with Proposals/Bid Y - Yearly or Upon Contract Renewal
---	--

4. SPECIAL INSTRUCTIONS

The Colorado Geological Survey will mail one camera-ready copy of the "Final Report" to TIC upon completion of the work.

5. ATTACHED HEREWITH:

Report Distribution List
 WBS/Reporting Category

6. PREPARED BY (Signature and date): /s/ J. E. Detmer 2/8/79	7. REVIEWED BY (Signature and date): /s/ Clayton R. Nichols 2/8/79
--	--

STATE OF COLORADO GENERAL SERVICES ADMINISTRATION FEDERAL PROCUREMENT REG. (41 CFR) 1-16.101		AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT		PAGE 1 OF 2
1. AMENDMENT/MODIFICATION NO. A003		2. EFFECTIVE DATE 6/21/79	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401		CODE	6. ADMINISTERED BY (If other than block 5) AGENCY 01-11 -00 CONTROL # 6213	
7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Bldg. - 1313 Sherman Street Denver, Colorado 80203 Attn: Richard H. Pearl		CODE FACILITY CODE	8. GL # <input type="checkbox"/> AMENDMENT OF SOLICITATION NO. DATED _____ (See block 9) <input checked="" type="checkbox"/> MODIFICATION OF CONTRACT/ORDER NO. AS07-77ET28365 (formerly EG-77-S-07-1678) DATED _____ (See block 11)	
9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS <input type="checkbox"/> The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.				
10. ACCOUNTING AND APPROPRIATION DATA (If required)				
11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS (a) <input type="checkbox"/> This Change Order is issued pursuant to _____ The Changes set forth in block 12 are made to the above numbered contract/order. (b) <input type="checkbox"/> The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12. (c) <input checked="" type="checkbox"/> This Supplemental Agreement is entered into pursuant to authority of <u>Public Law 95-91 and other applicable laws.</u> It modifies the above numbered contract as set forth in block 12.				
12. DESCRIPTION OF AMENDMENT/MODIFICATION 1. Article III, Consideration, paragraph (a) is hereby revised to increase the Support Ceiling by \$100,000.00 from \$418,751.00 to \$518,751.00. 2. Article A-III, Funding, of Appendix A2 to Modification No. A002 is hereby increased from \$100,000.00 to \$200,000.00. 3. The contractor is authorized to use approximately \$10,000.00 from \$20,000.00 earmarked for Geophysical Work under Mod. No. A002, to hire three students to run soil mercury surveys from designated areas in the State of Colorado to be determined by contractor. Geophysics NOT BEING DONE				
Except as provided herein, all terms and conditions of the documents referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.				
13. <input type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT <input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN <u>2</u> COPIES TO ISSUING OFFICE				
14. NAME OF CONTRACTOR/OFFEROR BY <u>John W. Rold</u> (Signature of person authorized to sign)		17. UNITED STATES OF AMERICA BY <u>R. E. Simonds</u> (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print) John W. Rold Director and State Geologist		16. DATE SIGNED 7/5/79	18. NAME OF CONTRACTING OFFICER (Type or print) R. E. Simonds, Director Contracts Management Division	
			19. DATE SIGNED JUN 28 1979	

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day first above written.

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR

[Signature]
For Harris D. Sherman
EXECUTIVE DIRECTOR.

~~Contractor _____~~

~~Position _____~~

~~Social Security Number or Employer ID _____~~

DEPARTMENT Natural Resources
OF _____

APPROVALS

ATTORNEY GENERAL J. D. MacFARLANE

CONTROLLER DAN S. WHITTEMORE

[Handwritten initials]

[Signature]
A. H. JEWELL, JR.
Assistant Solicitor General
General Legal Services

By *[Signature]*

R. Skidmore M. 2.2

STANDARD FORM 30, JULY 1966 GENERAL SERVICES ADMINISTRATION FED. PROC. REG. (41 CFR) 1-16.101		AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT		PAGE 1 OF 1
1. AMENDMENT/MODIFICATION NO. <u>MOOS- MOO4</u>		2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
5. ISSUED BY U.S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401		6. ADMINISTERED BY (If other than block 5)		
7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl		8. AMENDMENT OF SOLICITATION NO. <input type="checkbox"/> AMENDMENT OF SOLICITATION NO. DATED _____ (See block 9) <input checked="" type="checkbox"/> MODIFICATION OF CONTRACT/ORDER NO. <u>DE-AS07-77ET28365</u> (Formerly EG-77-S-07-1678) DATED <u>8/29/79</u> (See block 11)		
9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS <input type="checkbox"/> The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.				
10. ACCOUNTING AND APPROPRIATION DATA (If required)				
11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS (a) <input type="checkbox"/> This Change Order is issued pursuant to _____ The Changes set forth in block 12 are made to the above numbered contract/order. (b) <input type="checkbox"/> The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12. (c) <input checked="" type="checkbox"/> This Supplemental Agreement is entered into pursuant to authority of <u>mutual agreement of the parties.</u> It modifies the above numbered contract as set forth in block 12.				
12. DESCRIPTION OF AMENDMENT/MODIFICATION As requested in letter dated October 4, 1979, the completion date for the research being performed under Modification No. A002 is hereby extended from December 31, 1979, to March 1, 1980.				
Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.				
13. <input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT <input type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN _____ COPIES TO ISSUING OFFICE				
14. NAME OF CONTRACTOR/OFFEROR BY _____ (Signature of person authorized to sign)		17. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print) J. P. Anderson, Chief Contract Administration Branch	19. DATE SIGNED 11-5-79	

RECEIVED
NOV 16 1979

ENERGY & TECHNOLOGY
DIVISION

M. 2. 2

STATE OF COLORADO



RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING - 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 839-2611

January 18, 1980

Dr. L. L. Mink
Division of Geothermal Energy
U. S. Department of Energy
Idaho Operations Office
550 2nd Street
Idaho Falls, Idaho 83401

Re: Contract No. DE-AS07-77-ET28365

Dear Roy:

Enclosed please find a copy of a contract for your review and approval between this office and Geophysics Fund, Inc. for a geophysical appraisal of the San Luis Valley.

Have you followed up yet on the request that I made earlier regarding our obtaining excess government property? I would like to get started on obtaining this property as soon as possible so that we could have it by the start of the field season this spring.

Sincerely,

Richard H. Pearl, Chief
Ground Water Investigations Section

RHP:sd

cc: Joe Lee

Approved 2/8/80

DEPARTMENT OR AGENCY NUMBER 34-11-00
CONTRACT ROUTING NUMBER

CONTRACT

THIS CONTRACT, made this 16th day of January, 1980, by and between the State of Colorado for the use and benefit of the Department of Natural Resources Colorado Geological Survey hereinafter referred to as the State, and Geophysics Fund, Inc., 917 18th St., Golden, Colorado 80401 hereinafter referred to as the contractor,

WHEREAS, authority exists in the Law and Funds have been budgeted, appropriated and otherwise made available and a sufficient unencumbered balance thereof remains available for payment in Fund Number 1001, G/L Account Number 5038X, Contract Encumbrance Number _____; and

WHEREAS, required approval, clearance and coordination has been accomplished from and with appropriate agencies; and

WHEREAS, ³ the Colorado Geological Survey is conducting investigations of the geothermal resources of several areas in Colorado leading to the development of those resources; and

WHEREAS, the Colorado Geological Survey, as part of this investigation, wishes to evaluate the geothermal resources of the San Luis Valley of Colorado; and

WHEREAS, the successful completion of this investigation necessitates the collection, collation, and interpretation of published and unpublished geophysical data; and

WHEREAS, the Contractor has unique capabilities and has developed the expertise to collect and interpret said data; and

WHEREAS, the Contractor has access to the sophisticated equipment and highly qualified personnel required to collect and interpret said data; and

WHEREAS, the Colorado Geological Survey and the Contractor agree that the collection and interpretation require a degree of flexibility in the methodology and time spent on each phase.

NOW THEREFORE, it is hereby agreed that

1. ⁴ This contract shall cover professional services rendered by the Contractor and shall include interim letters and a final report detailing results of findings. The final report shall include tabulations and photos of field data, interpretations of layer thickness, velocities, apparent resistivities, interpretation of structural conditions, cross sections, and a description of the interpretive methods.

Interim letter reports shall be submitted by May 15, 1980 and September 1, 1980. The text and all maps and illustrations of the final report, which shall be completed and submitted by December 31, 1980, shall be camera ready.

2. The cost of this contract shall not exceed nine thousand nine hundred fifty-five and no/100 dollars (\$9,955.00), and will be paid in the following manner:

20% payment upon full execution of this contract	\$1,991.00
30% progress payments:	
Upon acceptance of first interim report	2,986.00
Upon acceptance of second interim report	2,987.00
20% upon acceptance of final report	1,991.00
	<u>\$9,955.00</u>

3. Field investigations and collection will be towards defining the geophysical conditions of that part of the San Luis Valley north of the Rio Grande River and south of Villa Grove, Colorado. Details of the project will be established in meetings between representatives of the Colorado Geological Survey and the Contractor.

4. The Colorado Geological Survey shall have the first right, if it so wishes, to publish the Contractor's findings as part of its professional publication series. Any publication printed shall acknowledge the Contractor as the source of the data.

5. The Contractor shall have the right to publish its findings in professional journals or other suitable media. Any publication shall contain the following statement: Done in cooperation with State of Colorado, Department of Natural Resources, Colorado Geological Survey. A preprint copy of any papers proposed to be published shall be furnished the Colorado Geological Survey.

6. Dr. Phillip R. Romig, Vice President of Geophysics Fund, Inc., will be classified as the Principal Investigator of the project by the Contractor.

7. The Contractor shall absolve and hold the Colorado Geological Survey harmless from all liability from any and all such damage, loss, or costs incurred or sustained by the Contractor resulting from operations associated with this contract.

8. Scope of work as outlined by Geophysics Fund, Inc. in their letter (Attachment A) dated December 7, 1979, to the Colorado Geological Survey shall guide and direct the project. Attachment A is appended hereto and made a part hereof.

9. The Contractor is an independent contractor and as such is not entitled to any benefits of the State Personnel system.

10. This contract will be in effect until March 1, 1981, or completion of the project, whichever comes first.

CONTROLLER'S APPROVAL

1. This contract shall not be deemed valid until it shall have been approved by the Controller of the State of Colorado or such assistant as he may designate. This provision is applicable to any contract involving the payment of money by the State.

FUND AVAILABILITY

2. Financial obligations of the State payable after the current fiscal year are contingent upon funds for that purpose being appropriated, budgeted and otherwise made available.

BOND REQUIREMENT

3. If this contract involves the payment of more than ten thousand dollars for the construction, erection, repair, maintenance, or improvement of any building, road, bridge, viaduct, tunnel, excavation or other public work for this State, the contractor shall, before entering upon the performance of any such work included in this contract, duly execute and deliver to and file with the official whose signature appears below for the State, a good and sufficient bond or other acceptable surety to be approved by said official in a penal sum not less than one-half of the total amount payable by the terms of this contract. Such bond shall be duly executed by a qualified corporate surety, conditioned for the due and faithful performance of the contract, and in addition, shall provide that if the contractor or his subcontractors fail to duly pay for any labor, materials, team hire, sustenance, provisions, provender or other supplies used or consumed by such contractor or his subcontractor in performance of the work contracted to be done, the surety will pay the same in an amount not exceeding the sum specified in the bond, together with interest at the rate of eight per cent per annum. Unless such bond, when so required, is executed, delivered and filed, no claim in favor of the contractor arising under this contract shall be audited, allowed or paid. A certified or cashier's check or a bank money order made payable to the Treasurer of the State of Colorado may be accepted in lieu of a bond.

MINIMUM WAGE

4. Except as otherwise provided by law, if this contract provides for the payment of more than five thousand dollars and requires or involves the employment of laborers or mechanics in the construction, alteration or repair of any building or other public work, (except highways, highway bridges, underpasses and highway structures of all kinds) within the geographical limits of the State, the rate of wage for all laborers and mechanics employed by the contractor or any subcontractor on the building or public work covered by this contract shall be not less than the prevailing rate of wages for work of a similar nature in the city, town, village or other civil subdivision of the State in which the building or other public work is located. Disputes respecting prevailing rates will be resolved as provided in 8-10-101, C.R.S. 1973, as amended.

DISCRIMINATION AND AFFIRMATIVE ACTION

5. The contractor agrees to comply with the letter and spirit of the Colorado Antidiscrimination Act of 1957, as amended, and other applicable law respecting discrimination and unfair employment practices (24-34-301, CRS 1973, as amended), and as required by Executive Order, Equal Opportunity and Affirmative Action, dated April 16, 1975. Pursuant thereto, the following provisions shall be contained in all State contracts or sub-contracts.

During the performance of this contract, the contractor agrees as follows:

(1) The contractor will not discriminate against any employee or applicant for employment because of race, creed, color, national origin, sex, marital status, religion, ancestry, mental or physical handicap, or age. The contractor will take affirmative action to insure that applicants are employed, and that employees are treated during employment, without regard to the above mentioned characteristics. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer, recruitment or recruitment advertising; lay-offs or terminations; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth provisions of this non-discrimination clause.

(2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, national origin, sex, marital status, religion, ancestry, mental or physical handicap, or age.

(3) The contractor will send to each labor union or representative of workers with which he has collective bargaining agreement or other contract or understanding, notice to be provided by the contracting officer, advising the labor union or workers' representative of the contractor's commitment under the Executive Order, Equal Opportunity and Affirmative Action, dated April 16, 1975, and of the rules, regulations, and relevant Orders of the Governor.

(4) The contractor and labor unions will furnish all information and reports required by Executive Order, Equal Opportunity and Affirmative Action of April 16, 1975, and by the rules, regulations and Orders of the Governor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the office of the Governor or his designee for purposes of investigation to ascertain compliance with such rules, regulations and orders.

(5) A labor organization will not exclude any individual otherwise qualified from full membership rights in such labor organization, or expel any such individual from membership in such labor organization or discriminate against any of its members in the full enjoyment of work opportunity, because of race, creed, color, sex, national origin, or ancestry.

(6) A labor organization, or the employees or members thereof will not aid, abet, incite, compel or coerce the doing of any act defined in this contract to be discriminatory or obstruct or prevent any person from complying with the provisions of this contract or any order issued thereunder; or attempt, either directly or indirectly, to commit any act defined in this contract to be discriminatory.

(7) In the event of the contractor's non-compliance with the non-discrimination clauses of this contract or with any of such rules, regulations, or orders, this contract may be cancelled, terminated or suspended in whole or in part and the contractor may be declared ineligible for further State contracts in accordance with procedures, authorized in Executive Order, Equal Opportunity and Affirmative Action of April 16, 1975 and the rules, regulations, or orders promulgated in accordance therewith, and such other sanctions as may be imposed and remedies as may be invoked as provided in Executive Order, Equal Opportunity and Affirmative Action of April 16, 1975, or by rules, regulations, or orders promulgated in accordance therewith, or as otherwise provided by law.

(8) The contractor will include the provisions of paragraphs (1) through (8) in every sub-contract and sub-contractor purchase order unless exempted by rules, regulations, or orders issued pursuant to Executive Order, Equal Opportunity and Affirmative Action of April 16, 1975, so that such provisions will be binding upon each sub-contractor or vendor. The contractor will take such action with respect to any sub-contracting or purchase order as the contracting agency may direct, as a means of enforcing such provisions, including sanctions for non-compliance; provided, however, that in the event the contractor becomes involved in, or is threatened with, litigation with the subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the State of Colorado to enter into such litigation to protect the interest of the State of Colorado.

COLORADO LABOR PREFERENCE

6. Provisions of 8-17-101, & 102, CRS 1973 for preference of Colorado labor are applicable to this contract if public works within the State are undertaken hereunder and are financed in whole or in part by State funds.

GENERAL

7. The laws of the State of Colorado and rules and regulations issued pursuant thereto shall be applied in the interpretation, execution and enforcement of this contract. Any provision of this contract whether or not incorporated herein by reference which provides for arbitration by any extra-judicial body or person or which is otherwise in conflict with said laws, rules and regulations shall be considered null and void. Nothing contained in any provision incorporated herein by reference which purports to negate this or any other special provision in whole or in part shall be valid or enforceable or available in any action at law whether by way of complaint, defense or otherwise. Any provision rendered null and void by the operation of this provision will not invalidate the remainder of this contract to the extent that the contract is capable of execution.

8. The signatories hereto aver that they are familiar with 18-8-301, et seq., (Bribery and Corrupt Influences) and 18-8-401, et seq., (Abuse of Public Office), C.R.S. 1973, as amended, and that no violation of such provisions is present.

9. The signatories aver that to their knowledge, no state employee has any personal or beneficial interest whatsoever in the service or property described herein.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day first above written.
COLORADO GEOLOGICAL SURVEY

John W. Rold, Director
Contractor _____
Position _____

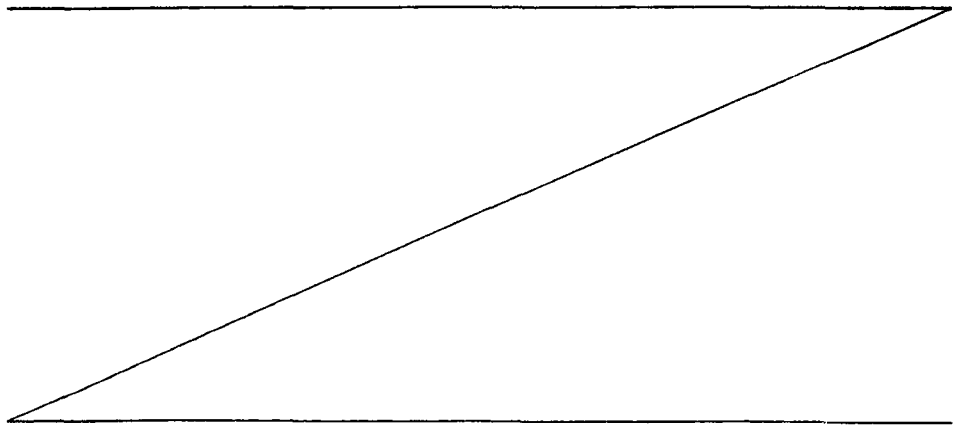
Social Security Number
or Employer I.D.

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR
By _____
EXECUTIVE DIRECTOR, Harris D. Sherman
DEPARTMENT OF Natural Resources

APPROVALS

ATTORNEY GENERAL _____ CONTROLLER _____

By _____ By _____



UPPER SAN LUIS VALLEY PROJECT

BUDGET ESTIMATE

Salaries and Benefits:

Project Geophysicist		
8½ months @ \$600/mo.		\$5,100.
2 Mos. @ \$1,200/mo.		2,400.
Project Supervisor		500.
	Subtotal	<u>8,000.</u>

Direct Expenses:

Travel		
3 trips @ \$150.		450.
Computer Charges		300.
Miscellaneous (Xerox, etc.)		300.
	Subtotal	<u>1,050.</u>

Indirect Cost:

10% of Salaries and Direct		<u>905.</u>
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Total		\$9,955.
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December 7, 1979

Mr. Richard C. Pearl
Colorado Geological Survey
1313 Sherman
Denver, CO 80203

Dear Mr. Pearl:

During the past few years several organizations have sponsored geological and geophysical surveys in the San Luis Valley, Colorado. The Colorado Geological Survey has sponsored several programs related to geothermal energy. The U. S. Geological Survey and related federal agencies have studied ground water distribution and aquifer characteristics. The Colorado School of Mines Geophysics field camp has been collecting geophysical data throughout the Valley. The proposed San Marcos project has provided detailed information about a small region near San Luis. Several oil companies have conducted preliminary exploration programs, and wildcat drilling is underway. As a result of this recent activity, additional information has been and is being accumulated that will make it possible to construct better interpretations of the overall structure of the Valley.

Under the sponsorship of the U. S. Geological Survey, the Department of Geophysics at the Colorado School of Mines is currently collecting, processing and interpreting geophysical data from the southern half of the San Luis Valley. The purpose of that study is to attempt to better describe the structural and stratigraphic relationships in the Valley south of Alamosa. Clearly the San Luis Valley is composed of several geologic provinces or regimes. However, these are more properly subdivisions of one major geologic/tectonic feature. It would seem to be more efficient and productive to conduct a parallel, coordinated study of the entire San Luis Valley.

Therefore, the Geophysics Fund, Inc. herein proposes to conduct a regional study of the San Luis Valley north of Alamosa. The purpose of the study would be to collect, organize and interpret all available geophysical data covering that portion of the Valley. The Geophysics Fund, Inc. study would be coordinated with the Colorado School of Mines study of the lower portion of the Valley so that duplication of effort would be minimized and sharing of data would be maximized. The study would also be coordinated with the Colorado School of Mines field camp so that data collected therein during May and June, 1980, would be used to the maximum extent possible.

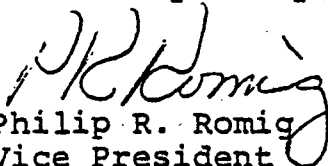
The study would begin as soon as possible, preferably during January, 1980. Initial accumulation and assimilation of data would be accomplished and a first interim letter report prepared by

May 15, 1980. Collection of any additional data and preliminary interpretation of all data would be completed, and a second interim letter report would be presented by September 1, 1980. The final report would be completed and delivered by December 31, 1980. The Geophysics Fund, Inc. is a non-profit corporation, and as such all results and reports are in the Public Domain and must be considered non-proprietary.

The program would be under the direct supervision of Dr. Philip R. Romig, Vice President, Geophysics Fund, Inc. The person actually conducting the study would work half-time on the project for the calendar year and would also be a graduate student in geophysics at the Colorado School of Mines. This would insure close cooperation with the CSM study of the lower San Luis Valley. The total cost of the project would be \$9,955.00; a budget estimate is outlined on the attached sheet.

Please feel free to call me if you have questions or need additional information.

Yours very truly,



Philip R. Romig
Vice President

PRR:dn

enc.

cc: R. Major

JAN 25 1980

RECEIVED
JAN 28 1980
GEOTHERMAL ENERGY
BRANCH

State of Colorado
Colorado Geological Survey
Department of Natural Resources
715 State Centennial Building
1313 Sherman Street
Denver, Colorado 80203

ATTENTION: Richard H. Pearl, Chief
Ground Water Investigations Section

SUBJECT: MODIFICATION NO. A002 TO CONTRACT NO. DE-AS07-77ET28365

Gentlemen:

As requested in your letter dated November 5, 1979, to L. L. Mink,
the attached revised budget for Modification No. A002 is approved.

Very truly yours,

/s/ J. P. Anderson

J. P. Anderson
Contracting Officer
Chief, Contract Administration Branch
Contracts Management Division

Attachment

bcc w/attach:
M. A. Widmayer
E. G. Jones

RECORD NOTE: Approvals and comments
from RDB and FMD are
attached.

CAB
JOLee:mh
1/25/80

CAB
JPAnderson

REVISED 1979 BUDGET

Monies on hand 1/1/79	\$ 22,262.10	
Monies budgeted for 1979	<u>200,000.00</u>	
	222,262.10	
Salaries:		
Geologists and Geophysicist	\$32,234.55	
Sec./Draftsperson	3,303.76	
		<u>\$35,538.31</u>
Vehicle operation		3,000.00
Travel (P.D. rates are \$40.00/day)		5,300.00
Publication		12,473.09
Per. Equipment		
Computer Program	\$ 2,000.00	
Geophysical equip.	9,000.00	
Map file	1,500.00	
Soil mercury detector	4,579.15	
		<u>\$17,079.15</u>
Expendable equip. and supplies		10,000.00
Geophysics		
Grad. Student	9,000.00	
Summer Student	12,241.09	
		<u>\$21,241.09</u>
Gradient Drilling		110,000.00
Pagosa Spgs (Misc. bill from drlg. program)		446.10
Overhead		<u>7,184.36</u>
TOTAL		<u>\$222,262.10</u>

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. A005	2. EFFECTIVE DATE 3/7/80	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
5. ISSUED BY U.S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401	CODE	6. ADMINISTERED BY (If other than block 5) AGENCY 04-11 CONTROL # 66-88 5038X	CODE

7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl	CODE	FACILITY CODE	8. AMENDMENT OF SOLICITATION NO. <input type="checkbox"/> DATED _____ (See block 9) <input checked="" type="checkbox"/> MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-77ET28365 (Formerly EG-77-S-07-1678) DATED 8/29/79 (See block 11)
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9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

The above referenced solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers is extended, is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above referenced contract/order.

(b) The above referenced contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above referenced contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

A. This contract is hereby changed from a "Special Research Support Agreement" to a "Special Research Contract." Wherever the words "Special Research Support Agreement" are used, they shall mean "Special Research Contract."

B. ARTICLE I, "THE RESEARCH TO BE PERFORMED," is amended by adding a new paragraph as follows:

"Appendix A5, attached to this modification and made a part hereof, provides for the research to be performed by the Contractor during the contract period specified therein."

C. ARTICLE II, "THE PERIOD OF PERFORMANCE," is amended as follows:

"The period of performance for the work performed under this Supplemental Agreement shall commence on March 1, 1980, and expire on February 28, 1981. The period of time for performing the research work under Appendix A5 may be extended for additional periods by the mutual written agreement of the parties."

--continued

Except as provided herein, all terms and conditions of the documents referenced in block 8, as hereinafter changed, remain unchanged and in full force and effect.

13. <input type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT		<input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN <u>3</u> COPIES TO ISSUING OFFICE	
14. NAME OF CONTRACTOR/OFFEROR BY <u>John W. Rold</u> (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY <u>J. P. Anderson</u> (Signature of Contracting Officer)	15. NAME AND TITLE OF SIGNER (Type or print) John W. Rold, Director & State Geologist	16. DATE SIGNED
15. NAME AND TITLE OF SIGNER (Type or print) J. P. Anderson, Chief Contract Administration Branch		17. DATE SIGNED	18. DATE SIGNED

Modification No. A005 (Cont'd)
Supplemental Agreement to
Contract No. DE-AS07-77ET28365

- D. ARTICLE III, "CONSIDERATION," paragraph (a), is hereby revised to increase the contract Support Ceiling by \$199,995 to a new total of Seven Hundred Eighteen Thousand Seven Hundred Forty-Six Dollars (\$718,746.00) summarized as follows:

Original Contract	\$154,130.00
Modification No. A001	164,621.00
Modification No. A002	100,000.00
Modification No. A003	100,000.00
Modification No. A005	<u>199,995.00</u>
TOTAL	<u>\$718,746.00</u>

- E. ARTICLE VI, "DATE OF INCURRENCE OF COSTS," is added to read as follows:

"ARTICLE VI - DATE OF INCURRENCE OF COSTS"

The Contractor shall be entitled to reimbursement for costs incurred in an amount not to exceed \$50,000 on or after March 1, 1980, which, if incurred after this modification had been entered into, would have been reimbursable under the provisions of this modification."

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day first above written.

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR

For  EXECUTIVE DIRECTOR, Harris D. Sherman

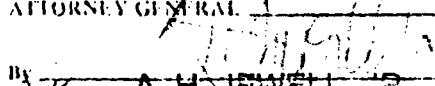
DEPARTMENT OF Natural Resources

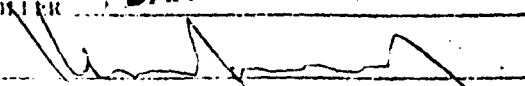
~~Contractor _____
Position _____
Social Security Number or Employer ID _____~~

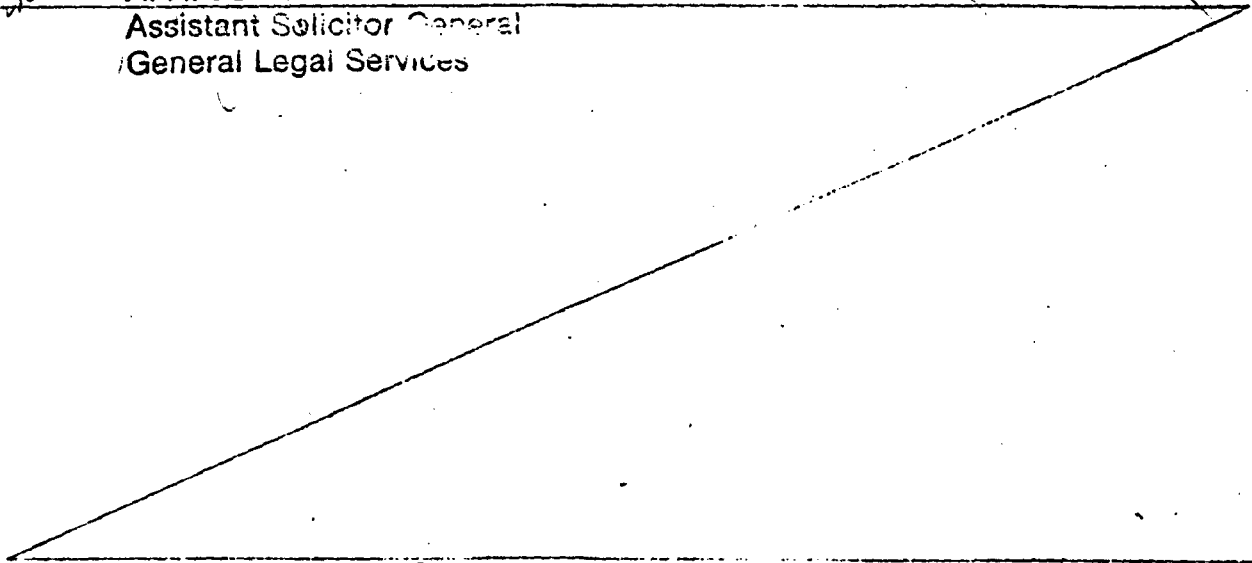
J. D. MacFARLANE
ATTORNEY GENERAL

APPROVALS

DAN S. WHITTEMORE
CONTROLLER


By A. H. JEWELL, JR.
Assistant Solicitor General
General Legal Services


By



CONTRACTOR: STATE OF COLORADO

APPENDIX A5

For the contract period March 1, 1980 through February 28, 1981.

Article A-1 - RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) The Contractor shall perform the following research:

- Task 1 - In the Canon City area a resistivity survey and a seismic profile will be conducted. A report detailing the findings of the investigation will be prepared.
- Task 2 - In the San Luis Valley an electrical resistivity survey and a seismic survey will be run in the vicinity of Shaw Hot Springs. All available geophysical information will be collected for the northern portion of the valley. A report detailing these findings will be prepared.
- Task 3 - In the Idaho Springs area, a reconnaissance study will be conducted and will include investigation into the geologic, hydrologic, and geophysical conditions of the area. A resistivity survey will be conducted in the vicinity of the hot springs. A report detailing these findings will be prepared.
- Task 4 - In Duray a reconnaissance study will be conducted and consist of a thorough appraisal of the geological, hydrological, and geophysical conditions of the area.
- Task 5 - Reconnaissance studies similar to task 4 will be conducted in the Animas Valley in the Tripp-Trimble-Pinkerton Hot Springs areas.
- Task 6 - This task will consist of acquiring available thermal gradient measurements from existing wells in the State of Colorado.
- Task 7 - A state-wide assessment of groundwater temperatures will be continued; the Contractor will perform a compilation of tables and a preparation of a preliminary field map of state-wide temperatures. Bottomhole temperatures from water wells and oil and gas wells in Eastern Colorado will be obtained.
- Task 8 - Acquisition and interpretation of any available geophysical data from the State of Colorado will be pursued on an as-available basis.
- Task 9 - Soil mercury surveys will be performed at Hot Sulphur, Cement Creek - Ranger Hot Springs, and Waunita Hot Springs.
- Task 10 - Continued assistance will be given to NOAA, in the preparation of a State Geothermal Map, and to the USGS in the update of their GEOTHERM files of geothermal information.

Article A-II - WAYS AND MEANS OF PERFORMANCE

(a) The estimate research budget is as follows:

1. SALARIES:

Geophysicist	\$24,255.00	
Geologist	20,961.00	
Geologist (6 mos.)	9,055.00	
Secretary	4,450.00	
Draftsman	4,450.00	
Summer Student IV	3,474.00	
Summer Student IV	3,474.00	
Summer Student II	2,700.00	
Summer Student II	2,700.00	
Summer Student II	2,700.00	
Part time Student II	655.00	
Summer Student (H.S. \$4.50/hr.)	<u>2,160.00</u>	
TOTAL SALARIES		\$81,034.00

2. FRINGE BENEFITS ON STAFF SALARIES: 7,776.00

3. TRAVEL:

Geophysicist - Per Diem (40x81)	\$ 3,240.00	
Geologist - Per Diem (40x81)	3,240.00	
Geologist - Per Diem (40x30)	1,200.00	
Vehicle mileage for Assessment Team Rate of (\$.15/mile)	2,600.00	
Attend meetings called by DOE	2,000.00	
Professional Society meetings	1,500.00	
Training courses:	2,000.00	
Summer Students Travel:		
Summer students travel expenses	10,500.00	
Vehicles for summer students	10,000.00	
Vehicle mileage for summer Student rate of (\$.15/mile)	<u>2,250.00</u>	
TOTAL TRAVEL EXPENSES		\$38,530.00

4. PERMANENT EQUIPMENT:

Two-way radios to be used by geophysical crew	\$ 300.00	
Temperature probe:	<u>5,000.00</u>	

TOTAL PERMANENT EQUIPMENT 5,300.00

Article A-II - WAYS AND MEANS OF PERFORMANCE (Cont'd)

5. PUBLICATION COSTS:		16,000.00
6. EXPENDABLE EQUIPMENT:		
Plastic Pipe and rent of auger	\$ 2,000.00	
Expendable equipment and supplies	5,000.00	
Black Iron Pipe (2" x 1700')	<u>4,000.00</u>	
TOTAL EXPENDABLE EQUIPMENT		11,000.00
7. SUBCONTRACTS FOR GEOPHYSICAL DATA:		15,000.00
8. ACQUISITION OF PRIVATE COMPANY DATA:		<u>6,260.00</u>
TOTAL DIRECT COSTS		<u>180,900.00</u>
9. OVERHEAD OF 20% ON 66.6% OF \$180,900:		<u>24,095.00</u>
TOTAL		<u>\$204,995.00</u>

(b) No allowance has been made in Article A-II for paying overhead on direct cost for the period from March 1, 1980 through June 30, 1980, as no overhead was allowed in the "Indirect Cost Negotiation Agreement" between the U.S. Department of Interior and the Colorado Department of Natural Resources for the period from July 1, 1969 through June 30, 1980. The maximum allowable overhead rate for the period from June 1, 1980, through February 28, 1981, shall be 20% of \$120,479.00. If the negotiated overhead rate is less than 20%, the above budget shall be adjusted downward accordingly.

(c) Items, if any, significant to the performance of this Appendix A2, but excluded from computation of Support Cost and from consideration in proportioning costs:

None

(d) Time or effort of principal Investigator(s) including indirect costs and fringe benefits contributed by the Contractor but excluded from computation of Support Cost and consideration in proportioning costs:

Salary of Richard H. Pearl, Chief, Ground Water Investigation Section will be contributed by the State of Colorado.

Article A-III - FUNDING

The total estimated cost of items under A-II(a) above, for the contract period stated in this Appendix A5, is \$204,995.00. The amount obligated by this Modification No. A005 is \$199,995.00. The balance of \$5,000.00 for purchase of the temperature probe will be authorized when and if funds are available.

Article A-IV - ADMINISTRATION AND REPORTS

(a) Principal Investigator - Richard H. Pearl

DOE Program Officer - M. A. Widmayer
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

The Principal Investigator shall direct the work as outlined in discussions and in periodic letters from the Program Officer or her representative.

(b) Reports

Reports are to be furnished in accordance with attached DOE Form CF-537.

U. S. DEPARTMENT OF ENERGY
REPORTING REQUIREMENTS CHECKLIST

Form CR-537
 (1-78)

(See Instructions on Reverse)

FORM APPROVED
 OMB NO. 38R-0190

1. IDENTIFICATION Confirmation of Geothermal Resources in State of Colorado	2. OBLIGATION INSTRUMENT: Modification No. A005 Contract No. DE-AS07-77ET28365
---	---

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. <input type="checkbox"/> Management Plan		1. <input checked="" type="checkbox"/> Notice of Energy RD&D Project (SSIE)	O
2. <input type="checkbox"/> Milestone Schedule & Status Report		2. <input checked="" type="checkbox"/> Technical Progress Report	Q
3. <input type="checkbox"/> Cost Plan		3. <input checked="" type="checkbox"/> Topical Report	Y
4. <input type="checkbox"/> Manpower Plan		4. <input checked="" type="checkbox"/> Final Technical Report	F
5. <input checked="" type="checkbox"/> Contract Management Summary Report	M		
6. <input checked="" type="checkbox"/> Project Status Report	M		
7. <input type="checkbox"/> Cost Management Report			
8. <input type="checkbox"/> Manpower Management Report			
9. <input checked="" type="checkbox"/> Conference Record	A		
10. <input checked="" type="checkbox"/> Hot Line Report	A		
		C. PMS/MINI-PMS	
		1. Cost Performance Report	
		<input type="checkbox"/> Format 1 WBS	
		<input type="checkbox"/> Format 2 Functional	
		<input type="checkbox"/> Format 3 Baseline	
		<input type="checkbox"/> Format 5 Problem Analysis	
		2. <input type="checkbox"/> Cost/Schedule Status Report	
		3. <input type="checkbox"/> Management Control System Description	
		4. <input type="checkbox"/> Summary System Description	
		5. <input type="checkbox"/> WBS Dictionary	

FREQUENCY CODES:

A - As Required	Q - Quarterly
C - Contract Change	S - Semi-Annually
F - Final (End of Contract)	X - Mandatory for Delivery with Proposals/Bid
M - Monthly	Y - Yearly or Upon Contract Renewal
O - One Time (Soon After Contract Award)	

4 SPECIAL INSTRUCTIONS

Submit all reports to the DOE Program Officer at Idaho Operations Office (ID) as indicated below:

A.5 and 6 - Six copies are due at ID within fifteen days after end of the calendar month.

B.1 - Two copies are due at ID within fifteen days after Cooperative Agreement Award.

B.2 - Six copies are due at ID within fifteen days after end of the calendar quarter.

B.3 - Six copies are due not less than forty-five days prior to completion of the yearly term.

B.4 - Submit in draft forty-five days prior to completion date of Cooperative Agreement. After thirty days for DOE review, submit eleven copies including one camera-ready copy.

5. ATTACHED HEREWITH:

<input type="checkbox"/> Report Distribution List	<input type="checkbox"/>
<input type="checkbox"/> WBS/Reporting Category	<input type="checkbox"/>

6. PREPARED BY (Signature and date): <i>Margaret A. Widmayer 1/5/80</i>	7. REVIEWED BY (Signature and date): <i>J. A. Lee 1-11-80</i>
--	--

M.2.2

JUN 18 1980

RECEIVED

JUN 18 1980

GEO THERMAL ENERGY
BRANCH

State of Colorado
Colorado Geological Survey
Department of Natural Resources
715 State Centennial Building
1313 Sherman Street
Denver, Colorado 80203

ATTENTION: Richard Pearl

SUBJECT: CONTRACT NO. DE-AS07-77ET28365

Gentlemen:

You are authorized to use a maximum of \$13,413 from funds obligated under Modifications Nos. A002 and A005 to install cement plugs in two thermal gradient wells at Pagosa Springs, Colorado, which were drilled under the subject contract.

As discussed during telephone conversations among J. O. Lee and M. A. Widmayer of DOE and Dick Pearl of Colorado Geological Survey, there is approximately \$18,000 available from the support ceiling under Modification No. A002. The Colorado Geological Survey (CGS) is authorized to spend \$13,413 from these remaining funds and advise DOE what CGS plans to do with the balance of \$4,587.

We understand that you may have underestimated the cost of capital equipment under Modification No. A005. Please let us know the actual cost of equipment and DOE will determine whether it can fund the additional cost.

If you have any questions, please contact J. O. Lee of my staff.

Very truly yours,

Original signed by
J. P. Anderson

J. P. Anderson
Contracting Officer
Chief, Contract Operations Branch
Contracts Management Division

bcc: M. A. Widmayer

COB
JOLee:mh
6/17/80

RDB
MAWidmayer

COB
JPAnderson

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. A006 2. EFFECTIVE DATE 6-25-80 3. REQUISITION/PURCHASE REQUEST NO. 07-80 FT 315,504 4. PROJECT NO. (If applicable)

5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401 6. ADMINISTERED BY (If other than block 5) M.2.2

7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 ATTN: Richard Pearl

8. AMENDMENT OF SOLICITATION NO. DE-AS07-77ET28365 DATED (See block 9)

MODIFICATION OF CONTRACT/ORDER NO. (Formerly EG-77-S-07-1678) DATED 8/29/79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of offers is extended, is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning a copy of this amendment (b) By acknowledging receipt of this amendment on each copy of the offer submitted or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter contains reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) This Change Order is issued pursuant to _____

The Changes set forth in block 12 are made to the above numbered contract/order.

(b) The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.

It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

A. ARTICLE III - CONSIDERATION, Paragraph (a), is hereby revised to increase the contract Support Ceiling by \$5,000.00 to a new total of Seven Hundred Twenty-Three Thousand Seven Hundred Forty-Six Dollars (\$723,746.00) summarized as follows:

Original Contract	\$ 154,130.00
Modification No. A001	164,621.00
Modification No. A002	100,000.00
Modification No. A003	100,000.00
Modification No. A005	199,995.00
Modification No. A006	5,000.00
Total	\$ 723,746.00

Except as provided herein, all terms and conditions of the document referenced in block 3, as hereinafter changed, remain unchanged and in full force and effect.

CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR: State of Colorado 17. UNITED STATES OF AMERICA

BY: [Signature] BY: [Signature]

Signature of person authorized to sign Signature of Contracting Officer

15. NAME AND TITLE OF SIGNER (Type or print): John W. Rold, Director & State Geologist 16. DATE SIGNED: 5/15/80

18. NAME OF CONTRACTING OFFICER (Type or print): J. P. Anderson, Chief Contract Administration Branch 19. DATE SIGNED: [Signature]

B. ARTICLE IV - GOVERNMENT PROPERTY, is revised to read as follows: The following items of property procured or fabricated by the contractor are hereby listed as "Government Property:"

Map File	\$ 1,500
Soil Mercury Detector	4,579
Temperature Probe	5,000
Scintrex Rax Eight	9,000

U. S. DEPARTMENT OF ENERGY

PROCUREMENT/FINANCIAL ASSISTANCE REQUEST-AUTHORIZATION

1. TO J. P. Anderson, Chief, Contract Administration Branch

2. FROM INITIATING OFFICE R. E. Wood, Director, Energy Technology Division

3. INITIAL: [X] UPDATE: [] 6. PROCUREMENT: [] FINANCIAL ASSISTANCE: []
5. OR NUMBER: _____ 6. PR CORRECTION LETTER: _____ 7. RELATED PR NUMBER: _____

ACTION IDENTIFICATION

8. TITLE: Geothermal Assessment in Colorado
Awarding Capital Equip. Funds to existing contract and scope of work

9. UNSOLICITED PROPOSAL NO: _____ 10. PROJECT NO: _____ 11. CFOA NO: _____
12. PRODUCT OR SERVICE: A63X 13. SUPPORT SERVICES: YES [] NO [X] 14. CONSULTANT AWARD: YES [] NO [X]
15. CONTROLLED DELIVERABLE: A6Y 16. REPORT/DRAWING REQ: YES [X] NO [] IF YES, ATTACH DETAILS.
17. CLASSIFICATION OF MATERIALS/WORK: _____ U - UNCLASSIFIED C - CONFIDENTIAL S - SECRET T - TOP SECRET
18. GOVERNMENT PROPERTY: P F - FURNISHED P - PURCHASED N - NOT INVOLVED IF CODE F OR P, ATTACH DETAILS.

AWARD PLANNING

19. AWARD AS ORDER UNDER BIN: DE-FC07-77ET28365 IF CODE T, _____
20. DESIRED AWARD DATE: 04 01 80 21. KIND OF AWARD ACTION: _____ 22. TYPE OF AWARD: _____ ATTACH DETAILS.
23. IF MULTI-YEAR AWARD, INDICATE NUMBER OF YEARS: _____ 24. TYPE SOLICITATION INSTRUMENT: _____
25. EXTENT OF COMPETITION: _____ IF COMPETITIVE, ATTACH TECHNICAL EVALUATION PLAN. IF NON-COMPETITIVE, ATTACH JUSTIFICATION. REF: DOE-PR 9-3,305.51 or 9-4,709(?).
26. SOURCE SELECTION PROCEDURE: _____ 1 - A-E 2 - SEB 3 - OTHER 4 - NONE
27. FOR A-E, SHOW ESTIMATED CONSTRUCTION COST IN DOLLARS: _____

AWARDEE

IF COMPETITIVE, HAS LIST OF SOURCES BEEN ATTACHED? YES [] NO [X] IF NON-COMPETITIVE, COMPLETE 28 - 31.
28. NAME: Colorado Geological Survey 29. ADDRESS: 715 State Centennial Building
30. DIVISION: Dept of Natural Resources 1313 Sherman Street
31. GOCO/LAB: _____ A - GOCO/LAB B - GOCO/NON-LAB C - NON-GOCO/LAB D - NOT APPLICABLE Denver, CO 80203

FINANCIAL

AWARD VALUE
2. GOV'T SHARE \$ 5,000
3. TOTAL \$ 5,000
4. CONSIDERATION IN KIND, LOAN, OR LOAN
GUARANTEE DATA REPORTED ON PR-799C: []
5. PROJECT PERIOD: FROM 04 01 80 THRU 02 28 81
MONTH DAY YEAR MONTH DAY YEAR

CURRENT FY FUNDS COMMITTED		
36. BAR NUMBER	37. FUND CLASS	38. DOLLAR AMOUNT
<u>35 AM 15</u>		<u>\$ 5,000 Capital Equip</u>
-----	-----	-----
-----	-----	-----

6. FROM PR-799B (PART A) _____
7. TOTAL THIS PR \$ 5,000
8. FUNDING PERIOD: FROM 04 01 80 THRU 02 28 81
MONTH DAY YEAR MONTH DAY YEAR
9. APPROPRIATION SYMBOL: _____
10. ALLOTMENT SYMBOL: _____
11. OBJECT CLASS: _____

* SEE BACK OF FORM FOR CODES

PROJECT MANAGER

45. NAME: Roy Mink
46. SIGNATURE: Roy Mink
47. DATE: 3 27 80 48. OFFICE CODE: _____
MONTH DAY YEAR
49. FTS TELEPHONE NUMBER: _____

PROGRAM OFFICIAL

50. NAME: R. E. Wood
51. SIGNATURE: R. E. Wood
52. DATE: 3 27 80
MONTH DAY YEAR

CERTIFYING OFFICIAL

53. NAME: F. S. Smith
I HEREBY CERTIFY THAT THE FUNDS CITED IN ITEM 40 ARE AVAILABLE.
54. SIGNATURE: _____
55. DATE: _____
MONTH DAY YEAR

STANDARD FORM 30, JULY 1966 GENERAL SERVICES ADMINISTRATION FED. PROC. REG. (41 CFR) 1-16.101		AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT		PAGE	OF
1. AMENDMENT/MODIFICATION NO. A007		2. EFFECTIVE DATE		3. REQUISITION/PURCHASE REQUEST NO. 07-81ET28365.501	
4. PROJECT NO. (If applicable)		5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401		6. ADMINISTERED BY (If other than block 5)	
7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl		8. AMENDMENT OF SOLICITATION NO. DATED _____ (See block 9)		MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-77ET28365 DATED 8-29-79 (See block 11)	
9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS <input type="checkbox"/> The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.					
10. ACCOUNTING AND APPROPRIATION DATA (If required) AM 15-10 89X0224.91 Increase obligations and consideration by \$173,676 to revised total of \$897,422					
11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS (a) <input type="checkbox"/> This Change Order is issued pursuant to _____ The Changes set forth in block 12 are made to the above numbered contract/order. (b) <input type="checkbox"/> The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12. (c) <input checked="" type="checkbox"/> This Supplemental Agreement is entered into pursuant to authority of <u>mutual agreement of the parties.</u> It modifies the above numbered contract as set forth in block 12.					
12. DESCRIPTION OF AMENDMENT/MODIFICATION 1. ARTICLE I - "THE RESEARCH TO BE PERFORMED," is amended by adding a new paragraph as follows: "Appendix A7, attached to this modification and made a part hereof, provides for the research to be performed by the Contractor during the contract period specified therein." 2. ARTICLE II - "THE PERIOD OF PERFORMANCE," is amended as follows: "The period of performance for the work performed under this Supplemental Agreement shall commence on March 1, 1981, and expire on February 28, 1982. The period of time for performing the research work under Appendix A7 may be extended for additional periods by the mutual written agreement of the parties."					
CONTINUED.....					
Except as provided herein, all terms and conditions of the documents referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.					
13. <input type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT <input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN <u>3</u> COPIES TO ISSUING OFFICE					
14. NAME OF CONTRACTOR/OFFEROR BY <u>A.L. Hornbaker</u> (Signature of person authorized to sign)			17. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print) A.L. Hornbaker Acting Director		16. DATE SIGNED 7/28/81	18. NAME OF CONTRACTING OFFICER (Type or print) William C. Drake		19. DATE SIGNED 8/10/81

Modification No. A007 (Cont'd)
Supplemental Agreement to
Contract No. DE-AS07-77ET28365

3. ARTICLE III, "CONSIDERATION," paragraph (a) is hereby revised to increase the contract Support Ceiling by \$173,676 to a new total of Eight Hundred Ninety-Seven Thousand Four Hundred Twenty-Two Dollars (\$897,422) summarized as follows:

Original Contract	\$154,130
Modification No. A001	164,621
Modification No. A002	100,000
Modification No. A003	100,000
Modification No. A005	199,995
Modification No. A006	5,000
This Modification No. A007	173,676
Total	<u>\$897,422</u>

- E. ARTICLE VII, "DATE OF INCURRENCE OF COSTS," is added to read as follows:

"ARTICLE VII - DATE OF INCURRENCE OF COSTS

This Contractor shall be entitled to reimbursement for costs incurred in an amount not to exceed \$50,000 on or after March 1, 1981, which, if incurred after this modification had been entered into, would have been reimbursable under the provisions of this modification."

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day first above written.

STATE OF COLORADO
RICHARD D. LAMM, GOVERNOR

By *D. Monte Pascoe*
EXECUTIVE DIRECTOR, D. Monte Pascoe

~~Contractor~~

~~Position~~

DEPARTMENT
OF Natural Resources

~~Social Security Number or Employer ID~~

APPROVALS

~~ATTORNEY GENERAL~~

~~CONTROLLER~~

~~By~~

~~By~~

CONTRACTOR: STATE OF COLORADO

APPENDIX A7

For the contract period March 1, 1981 through February 28, 1982.

Article A-I - RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) The Contractor shall perform the following research

Task 1. Resistivity Surveys

Resistivity surveys will be run at the following areas: Steamboat-Routt Hot Springs; Hot Sulphur Springs; Ranger Hot Springs, and Wagon Wheel Gap Hot Springs. The resulting surveys will be analyzed along with other existing geoscience data for each area in order to develop an interpretation of the geothermal potential at each site. A map of the resistivity profile lines, generated data, and an interpretation of the survey results will be compiled for each site and included in the final report for this contract modification work.

Task 2. Heat Flow Map

A heat flow map of a scale of 1:1,000,000 will be produced for the State of Colorado using all available heat flow data for the State. The map will be part of the final product for this contract modification work, however the Colorado Geological Survey will be responsible for publication and distribution of the map as a survey document.

Task 3. Ground Water Temperature Map

A ground water temperature map at a scale of 1:500,000 will be produced showing location, well depth, and bottomhole temperature for all available well information in the State of Colorado. This map will be published as a Colorado Geological Survey document, as well as being part of the final product for this scope of work.

Task 4. Temperature Gradient Map

A temperature gradient map at a scale of 1:500,000 will be produced using all available temperature gradient information generated for the eastern portion of Colorado during FY 1980, and all temperature gradient measurements and calculations for the rest of the state. The map will be part of the final product for this contract modification work, and will be published as a Colorado Geological Survey document.

Task 5. Temperature Profile Measurements

Holes of opportunity will be used, as available, to acquire temperature profile information. Temperature gradients will be determined from profile information and included in the data base for Task 4.

Task 6. Geophysical Characteristic Evaluation

As part of the geoscience data base for Colorado, a series of state-wide compilation maps at appropriate scales (1:500,000) will be made. Maps will depict gravity, magnetic, fracture lineaments, and other available geophysical data. Accompanying these maps will be a report discussing in detail the integrated interpretation of these data as they related to geothermal exploration in the state.

Task 7. Evaluation of Thermal Waters in Mining Districts

Waters from select mining districts near Ouray in Southwest Colorado will be sampled and analyzed for chemical content. A preliminary determination will be made of the thermal potential in and around the mining areas as compared to water geochemistry. Findings will be presented as part of the final report for this year's effort.

Task 8. Reporting Requirements

All reporting requirements as set forth in DOE Form 537 will be executed. In addition, all programmatic meetings arranged between DOE-ID and Colorado Geological Survey will be attended.

Task 9. Information Dissemination

All requests for information regarding geothermal resources in Colorado will be responded to the best abilities of the CGS Resource Team. Any requests beyond the capabilities of the CGS Resource Team will be forwarded to the Colorado Commercialization Team or to the UURI User-Assistance Program. Copies of the Geothermal Resources of Colorado map will be distributed free of charge.

Article A-II - WAYS AND MEANS OF PERFORMANCE

(a) The estimate research budget is as follows:

Personnel:

	<u>Base Salary</u>	<u>Fringe Benefits</u>	<u>Total</u>
Geophysicist	\$26,740	\$3,742	\$ 30,482
Geologist	23,104	3,298	26,402
Geologist B	19,799	2,895	22,694
Draftsperson	14,960	2,305	17,265
Summer Student Gr. 55			7,464
TOTAL SALARIES			<u>\$104,307</u>
Total Travel			\$ 23,420
Expendable Equipment and Supplies			\$ 5,000
Subcontracts: Geology			6,000
Publication Costs			5,250
Word Processor Costs			7,200
Water Analysis			2,000
Total Direct Costs			\$153,177
Overhead (15%* on all direct costs after July 1, 1981)		\$17,499	
Rent of Office Space (\$10.00 sq. ft/year)		3,000	
TOTAL ESTIMATED COSTS			<u>\$173,676</u>

* This is a ceiling rate; actual rate reimbursable will be that negotiated with the U. S. Department of Interior.

- (b) Items, if any, significant to the performance of this Appendix A2, but excluding from computation of Support Cost and from consideration in proportioning costs:

None.

- (c) Time or effort of Principal Investigator(s) including indirect costs and fringe benefits contributed by the Contractor but not excluded from computation of Support Cost and consideration in proportioning costs:

Salary and Fringe Benefits of Richard H. Pearl, Chief, Ground Water Investigation Section will be contributed by the State of Colorado. \$17,376.

Article A-III - FUNDING

The total estimated cost of items under A-II(a) above, for the contract period stated in this Appendix A7, is \$173,676. The amount obligated by this Modification No. A007 is \$173,676.

(a) Principal Investigator - Richard H. Pearl

DOE Program Officer - Susan Prestwich
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401
Telephone: (208) 526-1147

The Principal Investigator shall direct the work as outlined in discussions and in periodic letters from the Program Officer or his representative.

(b) Reports

Reports are to be furnished in accordance with attached DOE Form CR-537.

**U. S. DEPARTMENT OF ENERGY
REPORTING REQUIREMENTS CHECKLIST**

DOE Form CR-537
(1-78)

(See Instructions on Reverse)

FORM APPROVED
OMB NO. 38R-0190

1. IDENTIFICATION Geothermal Resource Assessment in Colorado	2. OBLIGATION INSTRUMENT: Modification No. A007 to Contract No. DE-AS07-77ET28365
--	---

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. <input type="checkbox"/> Management Plan 2. <input type="checkbox"/> Milestone Schedule & Status Report 3. <input type="checkbox"/> Cost Plan 4. <input type="checkbox"/> Manpower Plan 5. <input checked="" type="checkbox"/> Contract Management Summary Report 6. <input checked="" type="checkbox"/> Project Status Report 7. <input type="checkbox"/> Cost Management Report 8. <input type="checkbox"/> Manpower Management Report 9. <input type="checkbox"/> Conference Record 10. <input type="checkbox"/> Hot Line Report	M M	1. <input type="checkbox"/> Notice of Energy RD&D Project (SSIE) 2. <input type="checkbox"/> Technical Progress Report 3. <input checked="" type="checkbox"/> Topical Report 4. <input checked="" type="checkbox"/> Final Technical Report C. PMS/MINI-PMS 1. Cost Performance Report <input type="checkbox"/> Format 1 WBS <input type="checkbox"/> Format 2 Functional <input type="checkbox"/> Format 3 Baseline <input type="checkbox"/> Format 5 Problem Analysis 2. <input type="checkbox"/> Cost/Schedule Status Report 3. <input type="checkbox"/> Management Control System Description 4. <input type="checkbox"/> Summary System Description 5. <input type="checkbox"/> WBS Dictionary	A Y

FREQUENCY CODES:

A - As Required	Q - Quarterly
C - Contract Change	S - Semi-Annually
F - Final (End of Contract)	X - Mandatory for Delivery with Proposals/Bid
M - Monthly	Y - Yearly or Upon Contract Renewal
O - One Time (Soon After Contract Award)	

4. SPECIAL INSTRUCTIONS

A.5., A.6. - Copies are due within fifteen days after end of the calendar month.

B.3. - Submit in draft after completion of work as indicated in Statement of Work. After DOE approval is received, submit copies as required on attached "Report Distribution List."

B.4. - Submit 2 copies in draft forty-five days prior to completion date of contract term. After DOE approval is received, submit in final including one camera-ready copy.

5. ATTACHED HEREWITH:

<input checked="" type="checkbox"/> Report Distribution List	<input type="checkbox"/>
<input type="checkbox"/> WBS/Reporting Category	<input type="checkbox"/>

6. PREPARED BY (Signature and date):	7. REVIEWED BY (Signature and date):
--------------------------------------	--------------------------------------



ID F-129 (Rev. 08-79)
 Ref. DOE 13302
 (use with DOE CR-537)

U.S. DEPARTMENT OF ENERGY
 IDAHO OPERATIONS OFFICE
REPORT DISTRIBUTION LIST

<p>Contract No. DE-AS07-77ET28365 Modification No. A007</p>	<p>Milestone Schedule & Status Report Management Plan Contract Management Summary Report Cost Plan Manpower Summary Report Project Status Report Manpower Management Report Cost Management Report Notice of Energy RD&D Project (ISIE) Conference Record Hot Line Report Technical Progress Report (TSIE) Final Technical Report Topical Report Management Control System Status Report Cost/Schedule Status Report Summary System Description WBS Dictionary</p>
---	---

Addressees	Number of Report Copies									
U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401										
Attn: L. L. Mink, Program Manager Energy & Technology Division				2	2				2	12
Attn: Nell W. Fraser, Director Contracts Management Division				1	1				1	1
Attn: E. G. Jones, Director Financial Management Division				1	1					
Bob Gray U. S. Department of Energy, DGE MS 3344, Federal Building 12th and Penn. N.W. Washington, DC 20461				2	2				2	2
Duncan Foley UURI 420 Chipeta Way, Suite 120 Salt Lake City, UT 84108				1	1				1	1

Special Instructions

M. A. Widmeyer

M. 2. 2

FEB 27 1981

State of Colorado
Colorado Geological Survey
715 State Centennial Building
1313 Sherman Street
Denver, CO 80203

ATTENTION: Richard Pearl

SUBJECT: MODIFICATION NO. A007 - CONTRACT NO. DE-AS07-77ET28365

Gentlemen:

You are hereby authorized effective March 1, 1981, to begin work and incur costs up to a maximum of \$50,000 under proposed Modification No. A007 to the subject contract pending execution of the formal modification. Work is to be performed in accordance with the attached Statement of Work.

The resulting modification will include the following article:

"Date of Incurrence of Costs - The Contractor shall be entitled to reimbursement for costs incurred in an amount not to exceed \$50,000 on or after March 1, 1981, which, if incurred after this modification had been entered into, would have been reimbursable under the provisions of this modification."

In the event the State of Colorado and the Government are unable to reach agreement and a modification is not executed, the Government shall not be liable for any obligations arising out of this letter.

Please indicate your acceptance of this action by signing in the space indicated below and returning one copy to this office.

RECEIVED

MAR 03 1981

GEOTHERMAL ENERGY
BRANCH

022581
7E-A16

FEB 27 1981

State of Colorado
Page 2

If you have any questions, please contact Kent R. Hastings of my staff at
telephone 298-526-1839.

Very truly yours,

Wm. C. Drake

William C. Drake
Contracting Officer
R&D Contracts Branch
Contracts Management Division

Attachment

ACCEPTED:

Name _____

Title _____

Date _____

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. M008	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO. 07-82ET28365.501	4. PROJECT NO. (If applicable)
5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401	CODE	6. ADMINISTERED BY (If other than block 5)	CODE

7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl	CODE	FACILITY CODE	8. AMENDMENT OF SOLICITATION NO. DATED _____ (See block 9) MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-77ET28365 <input checked="" type="checkbox"/> DATED 8-29-79 (See block 11)
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9 THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers is extended, is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10 ACCOUNTING AND APPROPRIATION DATA (If required)

No Change in Funding.

11 THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) This Supplemental Agreement is entered into pursuant to authority of **mutual agreement of the parties.**
It modifies the above numbered contract as set forth in block 12.

12 DESCRIPTION OF AMENDMENT/MODIFICATION

ARTICLE II - THE PERIOD OF PERFORMANCE, is amended to extend the term of the contract through August 31, 1982.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13 <input type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT		<input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 2 COPIES TO ISSUING OFFICE	
14 NAME OF CONTRACTOR/OFFEROR BY John W. Rold (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY Kent R. Hastings (Signature of Contracting Officer)	15 NAME AND TITLE OF SIGNER (Type or print) John W. Rold Director and State Geologist	16. DATE SIGNED 11/20/81
18. NAME OF CONTRACTING OFFICER (Type or print) Kent R. Hastings		19. DATE SIGNED 11/16/81	

COLORADO

CONTRACT

5/26 Copy FOR SUE &

KEWT

Added Pearl summary
of deliverables to
contract summaries.

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

MEMORANDUM

March 5, 1982

TO: Richard H. Pearl
Colorado Geological Survey
1313 Sherman Ave. Room 715
Denver, CO 80203

FROM: Carl A. Ruschetta, Technical Program Coordinator

SUBJECT: Deliverable Status on DOE Contract DE-AS07-77ET28365
(Formerly EG-77-S-07-1678)

At the request of Susan Prestwich, DOE/ID, please find enclosed copies of the Modifications and Deliverables summary prepared by ESL for the subject contract. These summaries are being made for each of the state coupled resource assessment contracts to aid DOE in the orderly closing-out of this program during FY82.

I note that many contracts and modifications, as written, list various tasks that are to be performed as part of the contracted research but do not always identify a specific deliverable that should result from that research. In some cases a specific product (such as a reconnaissance report or a map) is obviously required; in other cases the work accomplished for a specific task will be combined with other results and appear in a summary or general report.

In the case of the Colorado contract, I have listed the various tasks as listed in the original contract and modifications 001 thru 008. Checking thru the ESL library and publication bibliographies (Colorado Geol. Survey Bulletin 44 and the Glenwood Springs Proceedings, Volume II), I have attempted to match published reports with specific contract tasks and thus catalog the deliverables received to date, against the contract requirements.

Please review this listing and let me know if I have missed any deliverables and/or provide references for the data specified in each task that has, or perhaps will, appear in a general or summary report.

Richard H. Pearl

-2-

March 5, 1982

I feel that the Colorado team has done a good job of reporting their excellent work and meeting contract requirements for timely submission of periodic reports. I also wish to thank you and your team for the fine cooperation and assistance you have extended to me in the conduct of the RA program.

Best regards,

A handwritten signature in black ink, appearing to read "Carl A. Ruscetta". The signature is fluid and cursive, with a large initial "C" and "R".

Carl A. Ruscetta

CAR:nlr
Enclosures
cc D. Foley
S. Prestwich

M 212
R 8/31

AUG 23 1982

State of Colorado
Colorado Geological Survey
Department of Natural Resources
715 State Centennial Building
1313 Sherman Street
Denver, Colorado 80203

ATTENTION: Richard Pearl

SUBJECT: MODIFICATION NO. M009 TO CONTRACT NO. DE-AS07-77ET28365

Gentlemen:

We are enclosing three copies of the subject modification which have been signed on behalf of DOE. Please have all three copies signed by an authorized official and return two fully executed copies to this office. The third fully executed copy is for your retention.

Should you have any questions, please contact me on 208/526-1510.

Very truly yours,

Original Signed By:
Kent R. Hastings

Kent R. Hastings
Contracting Officer
R&D Contracts Branch
Contracts Management Division

3 Enclosures

bcc: S. M. Prestwich ←

R&DCB
KRHastings:db
8/23/82

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. M009	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO. 07-82ET28365.502	4. PROJECT NO. (If applicable)
5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401	CODE	6. ADMINISTERED BY (If other than block 5)	CODE

7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl	CODE	FACILITY CODE	8. AMENDMENT OF SOLICITATION NO. <input type="checkbox"/>	DATED _____ (See block 9)
(Street, city, county, state, and ZIP Code)			<input checked="" type="checkbox"/> MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-77ET28365	DATED 8/29/79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers is extended, is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

No Change in Funding.

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) This Supplemental Agreement is entered into pursuant to authority of Mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

ARTICLE II - THE PERIOD OF PERFORMANCE, is amended to extend the term of the contract through December 31, 1982.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. <input type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT	<input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN <u>2</u> COPIES TO ISSUING OFFICE		
14. NAME OF CONTRACTOR/OFFEROR BY _____ (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print) Kent R. Hastings	19. DATE SIGNED 8/23/82

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. M009		2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO. 07-82ET28365.502	4. PROJECT NO. (If applicable) X3/1
5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401		CODE	6. ADMINISTERED BY (If other than block 5) CODE	
7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl		CODE	FACILITY CODE	8. AMENDMENT OF SOLICITATION NO. _____ DATED _____ (See block 9) MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-77ET28365 DATED 8/29/79 (See block 11)
9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS <input type="checkbox"/> The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.				
10. ACCOUNTING AND APPROPRIATION DATA (If required) No Change in Funding.				
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12. DESCRIPTION OF AMENDMENT/MODIFICATION ARTICLE II - THE PERIOD OF PERFORMANCE, is amended to extend the term of the contract through December 31, 1982.				
Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.				
13. <input type="checkbox"/> CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT <input checked="" type="checkbox"/> CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 2 COPIES TO ISSUING OFFICE				
14. NAME OF CONTRACTOR/OFFEROR BY <i>John W. Rold</i> (Signature of person authorized to sign)		17. UNITED STATES OF AMERICA BY <i>Kent R. Hastings</i> (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print) John W. Rold Director and State Geologist	16. DATE SIGNED 8/24/82	18. NAME OF CONTRACTING OFFICER (Type or print) Kent R. Hastings	19. DATE SIGNED 8/23/82	

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1/18/82

1. AMENDMENT/MODIFICATION NO. M010	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO. 07-83ET28365.501	4. PROJECT NO. (If applicable)
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5. ISSUED BY U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401	6. ADMINISTERED BY (If other than block 5)
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7. CONTRACTOR NAME AND ADDRESS State of Colorado Colorado Geological Survey Department of Natural Resources 715 State Centennial Building 1313 Sherman Street Denver, Colorado 80203 Attn: Richard Pearl	8. AMENDMENT OF SOLICITATION NO. MODIFICATION OF CONTRACT/ORDER NO. DE-AS07-77ET28365 DATED 8/29/79
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10. ACCOUNTING AND APPROPRIATION DATA (If required)

No Change in Funding.

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(c) This Supplemental Agreement is entered into pursuant to authority of Mutual agreement of the Parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

ARTICLE II - THE PERIOD OF PERFORMANCE, is amended to extend the term of the contract through March 31, 1983.

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13. CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 2 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR BY <i>[Signature]</i> (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY <i>[Signature]</i> (Signature of Contracting Officer)
---	---

15. NAME AND TITLE OF SIGNER (Type or print) John W. Rold Director and State Geologist	16. DATE SIGNED 12/30/82	18. NAME OF CONTRACTING OFFICER (Type or print) Kent R. Hastings	19. DATE SIGNED 12/22/82
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