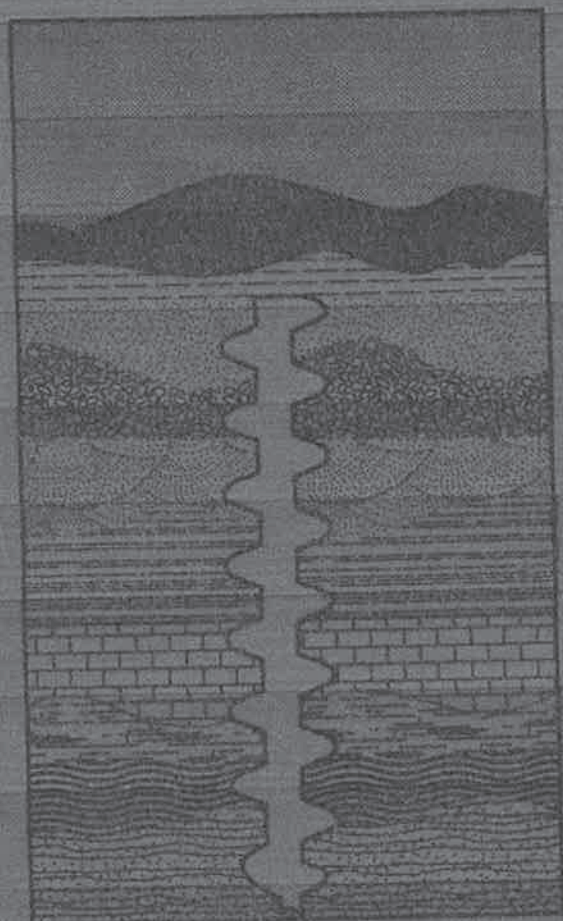
000132



GSi/water

GEOTHERMAL SURVEYS, INC.

Ground Water Exploration and Development

99 PASADENA AVE
SOUTH PASADENA
CALIFORNIA 91030
GSi
(213) 255-4511
GEOTHERMAL
SURVEYS, INC

INVESTIGATIONS OF GROUND WATER FLOW DIRECTIONS IN THE SOUTHWESTERN EXTENSION OF THE INDIAN WELLS VALLEY, CALIFORNIA

Mark P. Muir
J.H. Birman, R. G. 994

Geothermal Surveys, Inc.
99 Pasadena Avenue
South Pasadena, California 91030

Prepared for:

Eastern Kern County Resource Conservation District
P.O. Box 492
Inyokern, California 93527

February 10, 1986

CONTENTS

CONTENTS (cont'd.)

INTRODUCTION

In December 1985, the Eastern Kern County Resources Conservation District commissioned Geothermal Surveys, Inc. (GSI) to perform a geohydrological investigation of the southwest extension of Indian Wells Valley, Kern County, California (Figure 1).

The objective of this project is to help define the ground water flow divide between water flowing northeast towards Inyokern and water flowing southwest towards Red Rock Canyon. This will provide planners with a greater understanding of the ground water recharge in the Ridgecrest-Inyokern area.

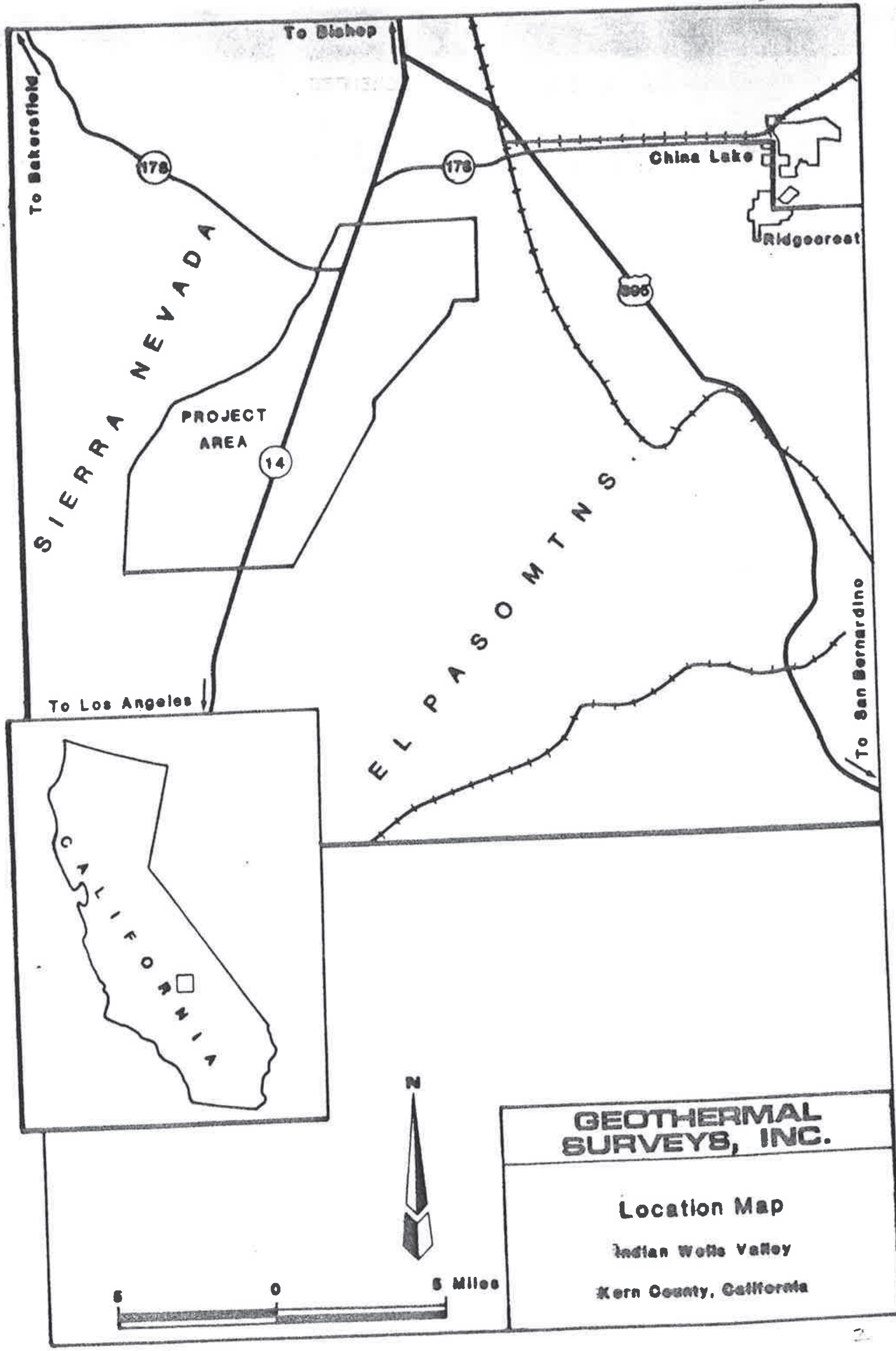
All surface drainage is to the northeast towards Inyokern. Analysis of water levels in wells suggests that a ground water flow divide is located near Sage Canyon (Dutcher and Moyle, 1973, Plate 2). However, this analysis was based on data from only 4 wells and was considered tenuous.

Research for this project consisted of the installation of a network of 57 ground temperature monitoring stations, 2 temperature surveys, and an analysis of the results supplemented with information derived from the pertinent geologic and geohydrologic literature.

Field work for this study was accomplished in December 1985 and January 1986. An initial reconnaissance of the project area and a field review with a Bureau of Land Management archaeologist to obtain approval of sites in environmentally or archaeologically sensitive areas were performed on December 30-31, 1985. Installation of the temperature monitoring stations was begun on January 7, 1986 and completed on January 12. All drilling was performed by Permanent Dead Man Company of Bakersfield, California. Temperature surveys were conducted on January 13-14 and January 22-24.

We gratefully acknowledge the assistance and cooperation of Mr. L. Marquardt and Mr. R. Dodge of the Eastern Kern County Resource Conservation District. Mr. G. Thomsen of the Ridgecrest office of the Bureau of Land Management was very helpful in working with us to obtain the necessary permits.

Figure 1


To Bishop
To Bakersfield
178
178
China Lake
Ridgecrest
395
SIERRA NEVADA
PROJECT AREA
14
EL PASO MTNS
To San Bernardino
To Los Angeles
CALIFORNIA
N
5
0
5 Miles
GEOTHERMAL SURVEYS, INC.
Location Map
Indian Wells Valley
Kern County, California

REFERENCES

Austin, C.F. and Durbin, W.F., 1985, Coso: Example of a complex geothermal reservoir: Naval Weapons Center Technical Publication 6658, 96 p.

Dibblee, T.W., Jr., 1967, Areal geology of the Western Mojave Desert, California: U.S. Geological Survey Professional Paper 522, 153 p.

Dutcher, L.C. and Moyle, W.R., 1973, Geologic and hydrologic features of Indian Wells Valley, California: U.S. Geological Survey, Water Supply Paper 2007, U.S. Government Printing Office, Washington D.C., 30 p.

Hulin, C.D., 1925, Geology and ore deposits of the Randsburg Quadrangle, California: California Mining Bureau Bulletin 95, 152 p.

Jennings, C.W., Burnett, J.L., and Troxel, B.W., compilers, 1962, Geologic map of California: Olaf P. Jenkins Edition, California Division of Mines and Geology, Trona and Bakersfield Sheets; scale 1:250,000.

Kunkle, F. and Chase, G.F., 1969, Geology and ground water in Indian Wells Valley, California: U.S. Geological Survey, Water Resources Division, Open File Report, Menlo Park, California, 84 p.

Lipinski, P., 1980, Map of Indian Wells Valley, California, showing change in water level, 1963-73, and hydrographs of selected wells: U.S. Geological Survey, Open File Map 80-342.

Moyle, W.R., Jr., 1963, Data on water wells in Indian Wells Valley area: Inyo, Kern and San Bernardino Counties, California: State of California, Department of Water Resources, Bulletin No. 91-9, 243 p.

Olivér, H.W., Chapman, R.H., Biehler, S., Robbin, S.L., Hanna, W.F., Grislom, A. Beyer, L.A., and Silver, E.A., 1980, Gravity map of California and its continental margin: California Division of Mines and Geology; scale 1:750,000.

Oliver, H.W., (ed.), 1980, Interpretation of the gravity map of California and its continental margin: California Division of Mines and Geology Bulletin 205, 52 p.

Roquemore, G.R. and Zellmer, J.T., 1983, Ground cracking associated with 1982 magnitude 5.2 Indian Wells Valley Earthquake: California Geology, pages 197-200.

St. Amand, P., 1985, Water supply of the Indian Wells Valley, California: Naval Weapons Center Technical Publication 6404, 71 p.

U.S. Geological Survey, 1961, Topographic Map of Western United States; Bakersfield sheet; Trona Sheet; scale 1:250,000.

U.S. Geological Survey, 15 minute Topographic Quadrangles (California) Cross Mountain; Inyokern; Onyx; and Saltdale; scale 1:62,500.

Zbur, R.T., 1963, A geophysical investigation of Indian Wells Valley, California: U.S. Naval Ordnance Test Station, China Lake, Naval Weapons Center Technical Publication 2795, 98 p.

TOPOGRAPHIC SETTING

The project area is in a southwest trending extension of Indian Wells Valley. This extension is approximately 15 miles long and 7 miles wide at its maximum and has an average elevation of about 3,100 ft. It is bounded to the north by the Sierra Nevada, which rise along a steep front to elevations greater than 6,000 ft. To the south, the El Paso Mountains rise to an elevation of 5,244 ft. (Black Mountain).

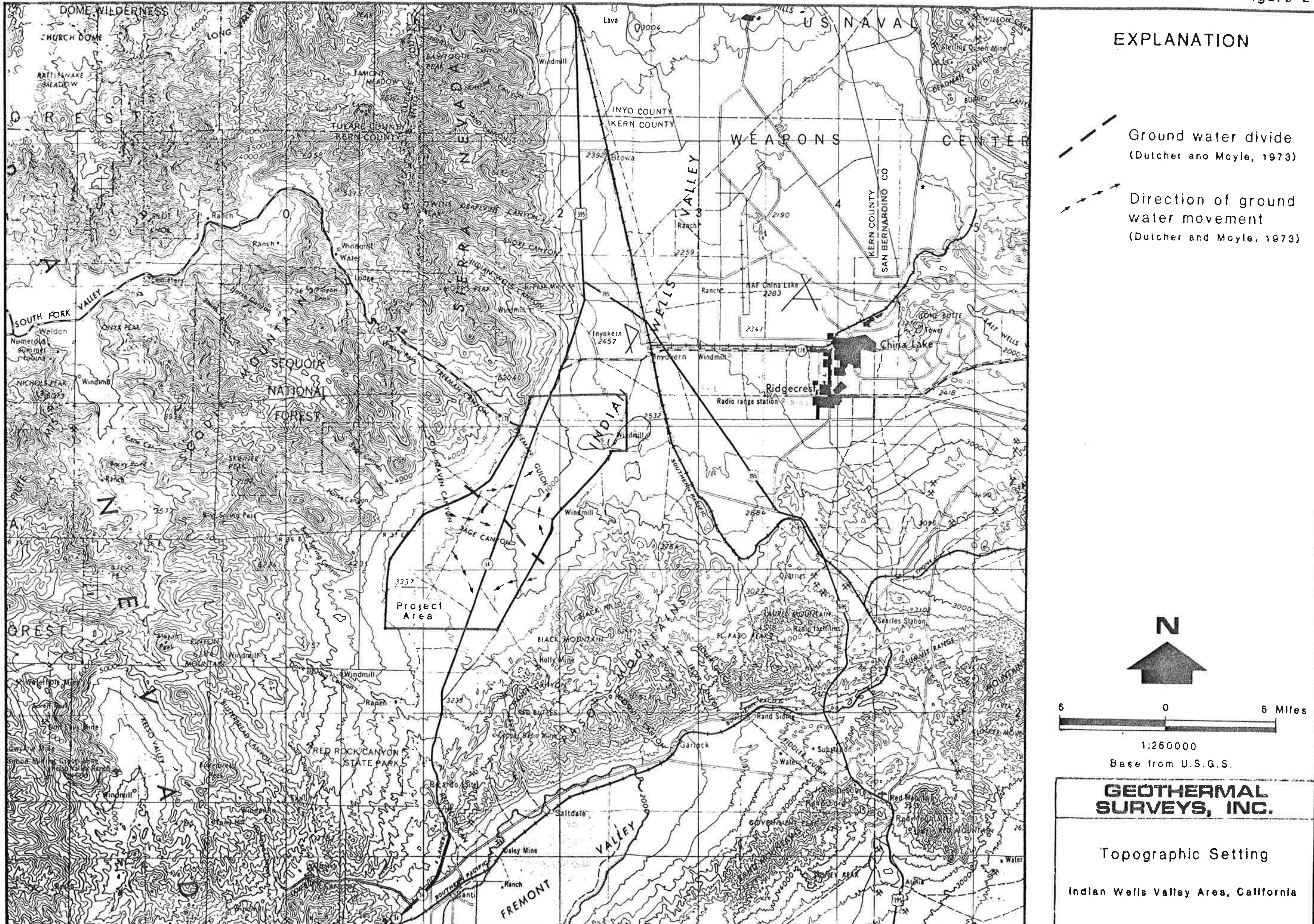
Streams in the area are intermittent. Most drain to the northeast towards China Lake, but those in the extreme southwest part of the valley drain south through Red Rock Canyon into Fremont Valley.

Topographic coverage of the project area is provided by the following USGS Topographic Quadrangles.

Name	Size	Contour Interval	Date
Dove Spring, CA	7 1/2 min.	40 ft.	1972
Freeman Junction, CA	7 1/2 min.	20 ft.	1972
Inyokern SE, CA	7 1/2 min	20 ft	1972
Horse Canyon, CA	7 1/2 min	40 ft.	1972
Saltdale NW, Ca.	7 1/2 min	40 ft.	1967

Included on this map are the location of a ground water flow divide and the directions of ground water flow inferred by Dutcher and Moyle (1973, Plate 2) based on water level data from wells.

Figure 2



Topographic Setting

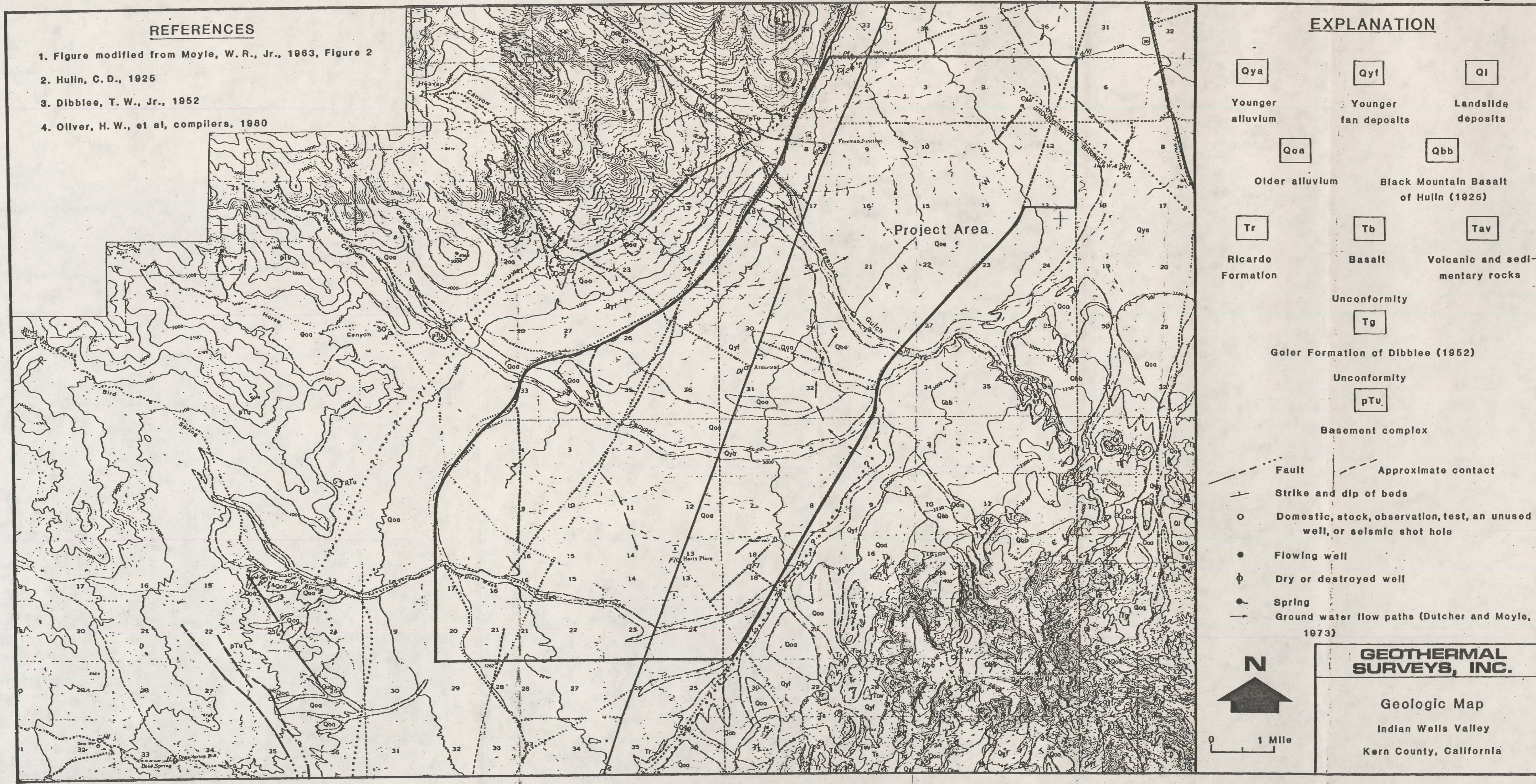
Indian Wells Valley Area, California

GEOLOGIC SETTING

Geologic Units	Description[1]
Qya	Younger alluvium. Unconsolidated clay and moderately to well sorted sand, and gravel.
Qyf	Younger fan deposits. Unconsolidated, poorly to moderately sorted gravel, sand, silt, and mud flow debris.
Ql	Landslide deposits. Common in the El Paso Mountains.
Qoa	Older alluvium. Unconsolidated, generally weathered gravel, sand, silt and clay.
Qbb	Black Mountain Basalt of Hulin (1925)[2]. Flows of extrusive olivine basalt, vesicular to dense.
Tr	Ricardo Formation. Moderately to highly compacted siltstone, sandstone, limestone, clay, shale, opal-chert, conglomerate, and tuff.
Tb	Basalt. Lava flows and instrusions into the Ricardo and other Pliocene formations.
Tav	Volcanic and sedimentary rocks. Andesite flow breccia in Ricardo Formation.
Tg	Goler Formation of Dibblee (1952)[3]. Arkosic sandstone, clay, shale, and conglomerate.
pTu	Basement complex. Undifferentiated plutonic, hypabyssal, and metamorphic rocks of pre-Tertiary age.

Structural Unit	Description
Sierra Nevada Fault Zone	A major normal fault zone that forms the boundary between the Sierra Nevada and the Indian Wells Valley.
Northwest-southeast trending faults	Northwest-southeast trending normal faults and fault zones (such as the Little Lake Fault) that occur throughout Indian Wells Valley.
Northeast-southwest trending fault zone	Northeast-southwest trending fault zone along the northwest edge of the El Paso Mountains inferred from seismic data[4].

Figure 3



REFERENCES
1. Figure modified from Moyle, W. R., Jr., 1963, Figure 2
2. Hulin, C. D., 1925
3. Dibblee, T. W., Jr., 1952
4. Oliver, H. W., et al, compilers, 1980
Project Area
Freeman Junction
Harts Place
EXPLANATION
Qya Younger alluvium
Qyf Younger fan deposits
Ql Landslide deposits
Qoa Older alluvium
Qbb Black Mountain Basalt of Hulin (1925)
Tr Ricardo Formation
Tb Basalt
Tav Volcanic and sedimentary rocks
Unconformity
Tg Goler Formation of Dibblee (1952)
Unconformity
pTu Basement complex
Fault
Approximate contact
Strike and dip of beds
Domestic, stock, observation, test, an unused well, or seismic shot hole
Flowing well
Dry or destroyed well
Spring
Ground water flow paths (Dutcher and Moyle, 1973)
N
0 1 Mile
GEOTHERMAL SURVEYS, INC.
Geologic Map
Indian Wells Valley
Kern County, California

SURFACE DRAINAGE IN AND AROUND THE SOUTHWESTERN EXTENSION OF INDIAN WELLS VALLEY, CALIFORNIA

Drainage Basin	Area (sq. mi.)	Average Precipitation (in./yr.)	Average Precipitation (ac-ft/yr).
Sierra Nevada	105	10[1]	56,000
El Paso Mountains	16	5[1]	4,300
Valley (includes project area)	89	5[2]	23,700
Total	210		84,000

According to one study[3], 2 - 2 1/2% of the precipitation that falls in the drainage basin of the main portion of Indian Wells Valley is incorporated into the ground water. Applying this value to the drainage basin for the project area suggests that about 2,000 acre-ft/year enters the ground water of this part of the valley. This should be considered only an estimate, which may be conservative. We consider it a useful first attempt subject to more detailed analysis as new information becomes available.

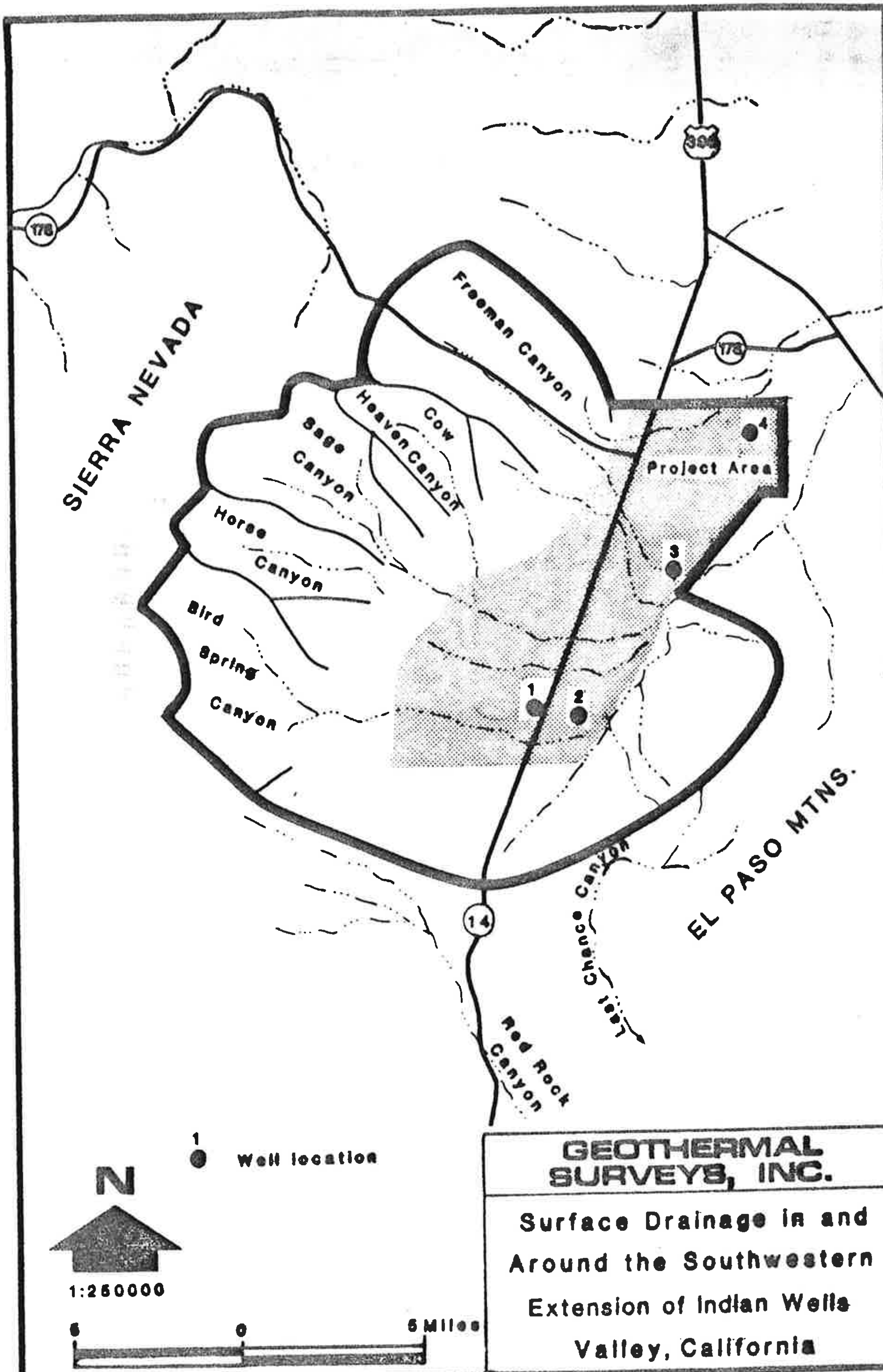
Table 1

DATA ON WELLS AND GROUND WATER LEVELS[4]

Well	Total Depth of Well (ft)	Depth to Water (ft)	Elevation of Ground Water Surface (ft)
1	400	280	2800
2	600	211	2814
3	300	170	2705
4	305.6	292	2347

1. St. Amand, P., 1985, Table 1.
2. This rate is the same as that shown for Inyokern in St. Amand, P., 1985, Figure 6. This is likely a good approximation of the precipitation in the field area.
3. St. Amand, P., 1985, p. 20.
4. Moyle, W. R., 1963.

Figure 4



GEOTHERMAL SURVEYS, INC.

Surface Drainage in and Around the Southwestern Extension of Indian Wells Valley, California

APPLICATION

Number of Probes Installed: 57

Depth of Sensors: 10 feet

Dates of Probe Installation: January 7-12, 1986

Comments

For a brief description of the use of temperature measurements in ground water studies, please refer to Appendix A.

The project area, about 58 square miles, is crudely rectangular and measures approximately 12 miles in length by a maximum of 6 miles in width. Within the project area, probes were installed in a rough grid pattern with average probe spacing on the order of 1 mile.

All probe holes were drilled by auger by Permanent Dead Man Company of Bakersfield, California.

Most probe holes were drilled in silt and sand. Some also contained gravel with clasts up to 25 cm.

No ground water was encountered in any of the probe holes.

STATISTICS

Date of Reading	No. of Probes	Temperature Range (°C)	Mean (°C)	Standard Deviation (°C)	Skewness
1/13-14/86	57	16.93-19.95	18.14	0.77	-1.17
1/22-24/86	57	16.49-19.62	17.62	0.85	-1.43

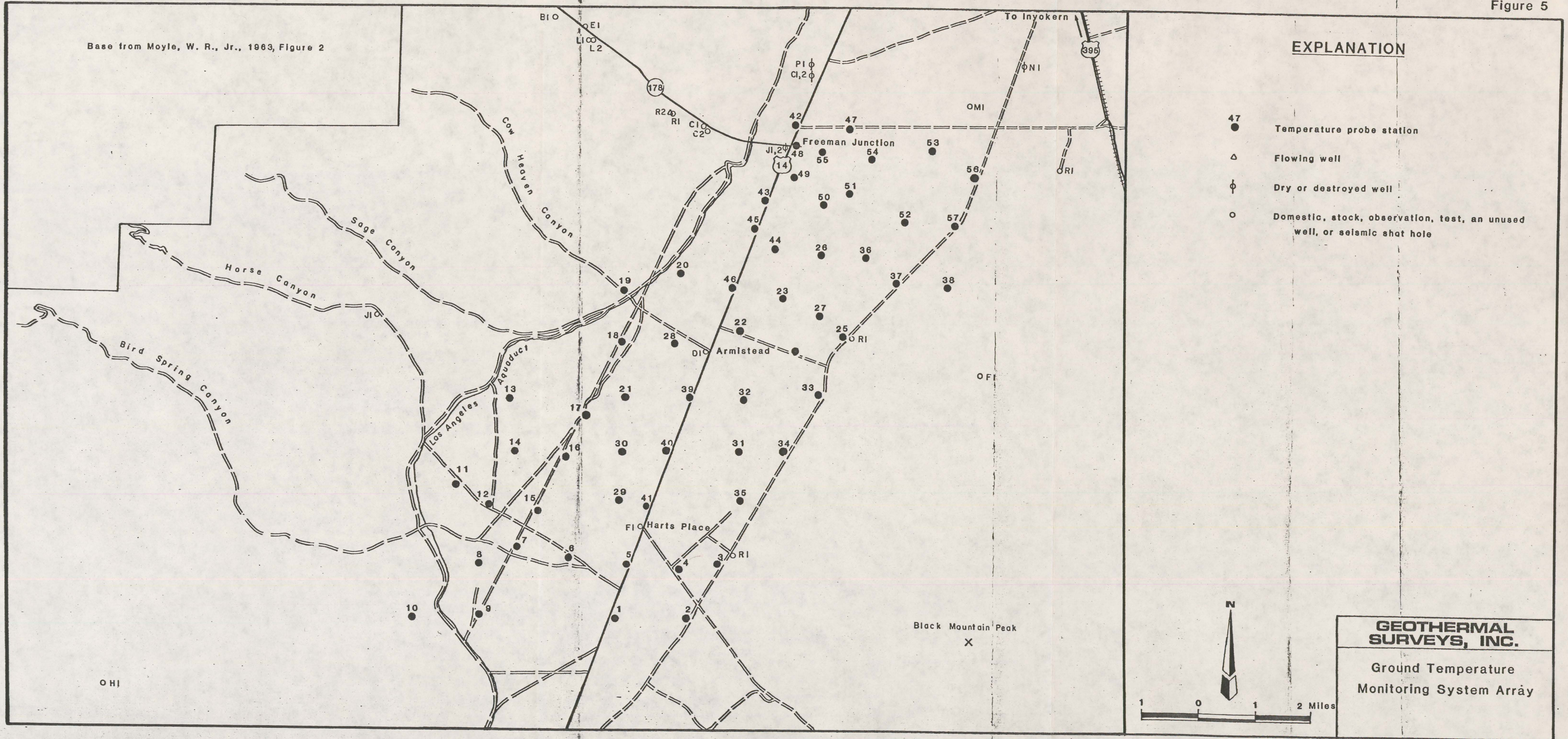


Figure 5

GEOTHERMAL SURVEYS, INC.

Ground Temperature Monitoring System Array

TEMPERATURE SURVEY

January 13-14, 1986

Number of probes: 57

Maximum Temperature: 19.95 degrees C.

Minimum Temperature: 16.93 degrees C.

Average Temperature: 18.14 $\pm$ 0.77 degrees C.

Skewness: -1.17

Interpretation

South of Armistead, cooler temperatures occur in a well defined zone that includes areas where stream channels enter the valley, particularly those from the Sierra Nevada, and in a broad band that extends through the central part of the valley. Higher temperatures occur along the valley margins between major stream channels.

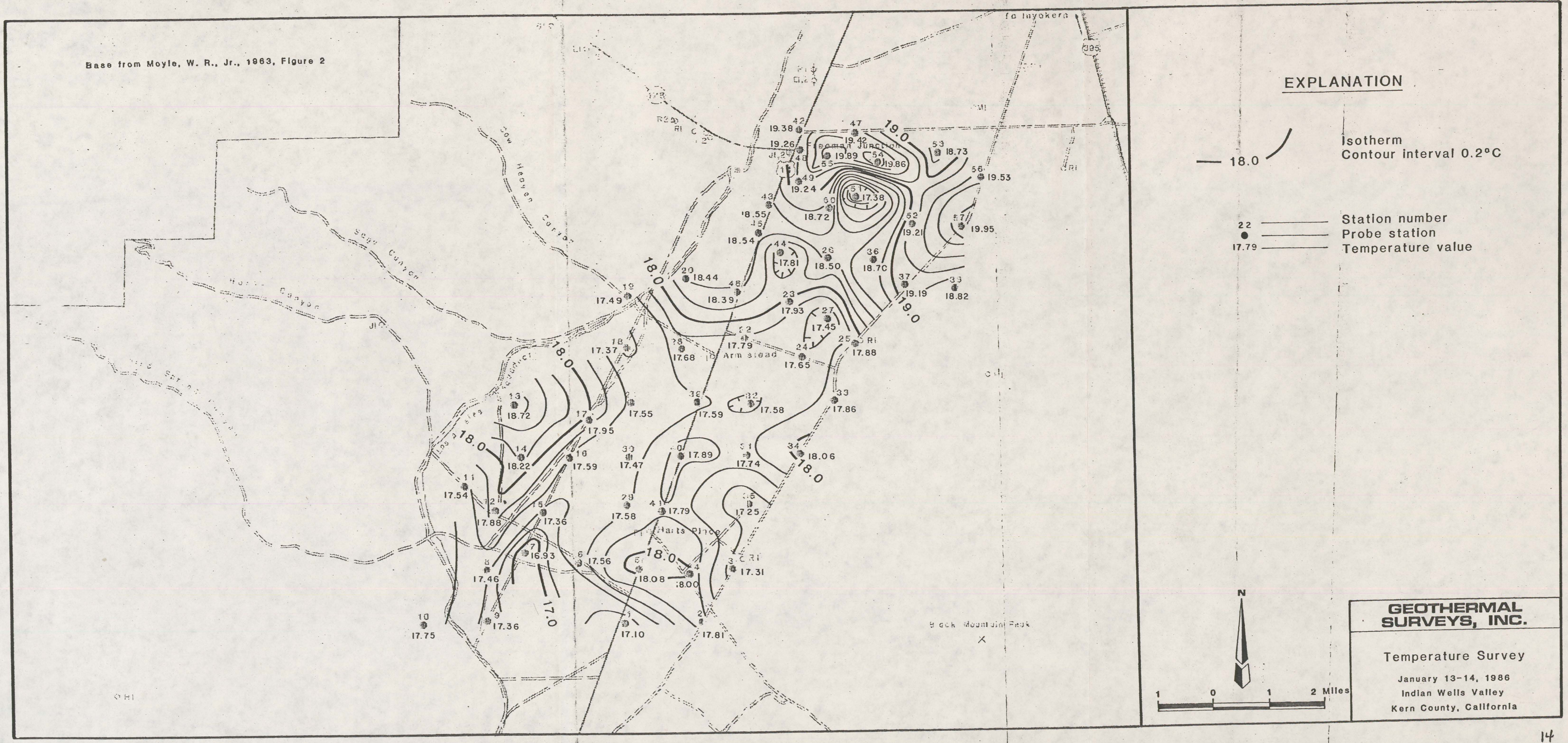
The shape of the low temperature zone suggests that ground water from Horse and Bird Spring Canyons flows into the valley and then either south towards Red Rock Canyon or east across the valley.

It appears that a ground water divide exists near the mouth of Sage and Cow Heaven Canyons (in the area defined by Stations 18, 21, 39 and 28). It affects the discharge from these canyons such that some ground water may flow to the northeast and some may flow down a prominent thermal trough to join the discharge from Bird Spring and Horse Canyons.

Ground water from the El Paso Mountains may flow near Station 35 and then either north or west.

North of Armistead, temperatures and the temperature gradient tend to increase to the northeast. Isothermal contour lines tend to be oriented perpendicular to the valley axis rather than parallel as in the southern half. This suggests the presence of a ground water flow barrier trending northwest-southeast across the valley near the location of Freeman Gulch.

Within the project area, ground water discharging from Freeman Canyon probably flows to the southeast. Additional ground water from Freeman Canyon may discharge north of West Bowman Road in an area not covered by temperature surveys.


Base from Moyle, W. R., Jr., 1963, Figure 2
to Inyokern
395
Freeman Junction
Armstead
Harts Place
Black Mountain Peak
19.0
18.0
17.0
EXPLANATION
18.0
Isotherm
Contour interval 0.2°C
22
17.79
Station number
Probe station
Temperature value
N
1 0 1 2 Miles
GEOTHERMAL SURVEYS, INC.
Temperature Survey
January 13-14, 1986
Indian Wells Valley
Kern County, California

TEMPERATURE SURVEY

January 22-24, 1986

Number of Probes: 57

Maximum Temperature: 19.62 degrees C

Minimum Temperature: 16.49 degrees C

Average Temperature: 17.65 $\pm$ 0.85 degrees C

Skewness: -1.43

Interpretation

Temperatures in this survey averaged about 0.5° C cooler than those in the survey of January 13-14. As the temperature change at a depth of 10 feet lags about 2 months behind that at the surface, these results reflect decreasing ambient temperatures in Fall, 1985.

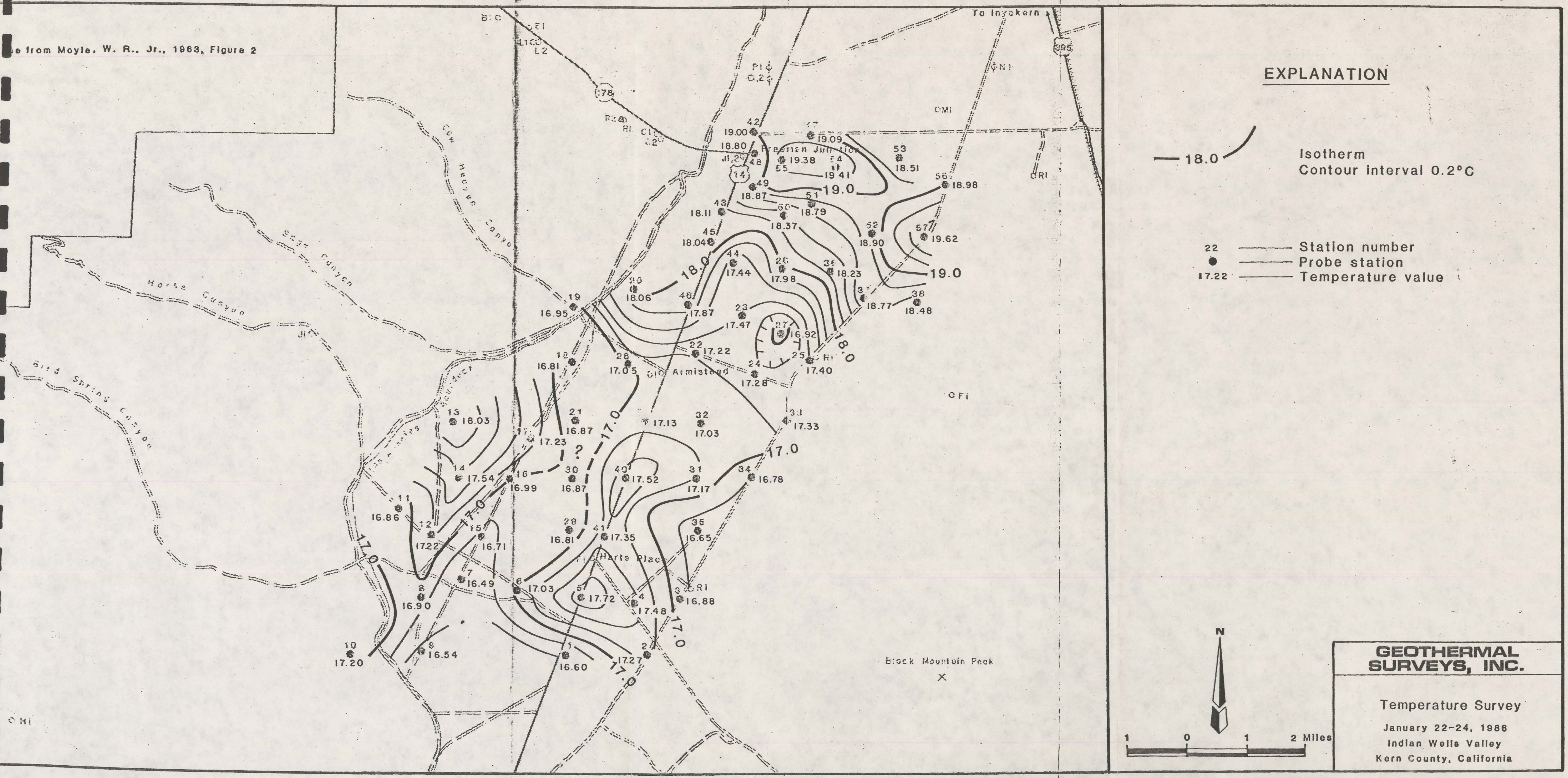
The general pattern is similar to that observed in the first survey.

The thermal drift (difference in temperature at a station between two readings) at Station 51 is +1.41° C. As all other stations experienced a negative thermal drift, it is likely that at least one of the measurements at Station 51 was in error. The temperature at Station 51 correlates much better with surrounding temperatures in this survey than in the previous one, suggesting that the reading in the first survey is in error.

Our interpretation of ground water flow paths and directions is unaffected by the possibility of a reading error at Station 51.

There may be some flow northeastward between Stations 52 and 54 toward Station 53.

References made to ground water flow in these discussions are intended to describe the principal zones of more active ground water movement. Ground water occurs pervasively within the project area and moves in accordance with the indicated directions.


from Moyle, W. R., Jr., 1963, Figure 2
To Inyokern
395
178
14
Cow Heaven Canyon
Sage Canyon
Horse Canyon
Bird Spring Canyon
Freeman Junction
Armistead
Harts Place
Black Mountain Peak
19.0
18.0
17.0
?
EXPLANATION
18.0
Isotherm
Contour interval 0.2°C
22
17.22
Station number
Probe station
Temperature value
N
1 0 1 2 Miles
GEOTHERMAL SURVEYS, INC.
Temperature Survey
January 22-24, 1986
Indian Wells Valley
Kern County, California

GROUND WATER FLOW DIRECTIONS
INFERRED FROM THE TEMPERATURE SURVEYS

Our interpretation of the general paths of ground water flow in the project area as inferred from analysis of the temperature surveys is presented in Figure 8. The important points to note are:

- A ground water flow divide appears to occur near the mouth of Cow Heaven Canyon between water flowing to the southwest and water flowing to the northeast toward Inyokern. From the data currently available, it is impossible to determine if the southwest flowing water continues south and discharges into Fremont Valley through Red Rock Canyon or whether it crosses the valley to the base of the El Paso Mountains and then turns north toward Inyokern, perhaps along a fault zone.

- Most inferred ground water flow paths do not follow active surface channels. The major exceptions to this are at Freeman Gulch and, perhaps, at Little Dixie Wash north of its intersection with Freeman Gulch.

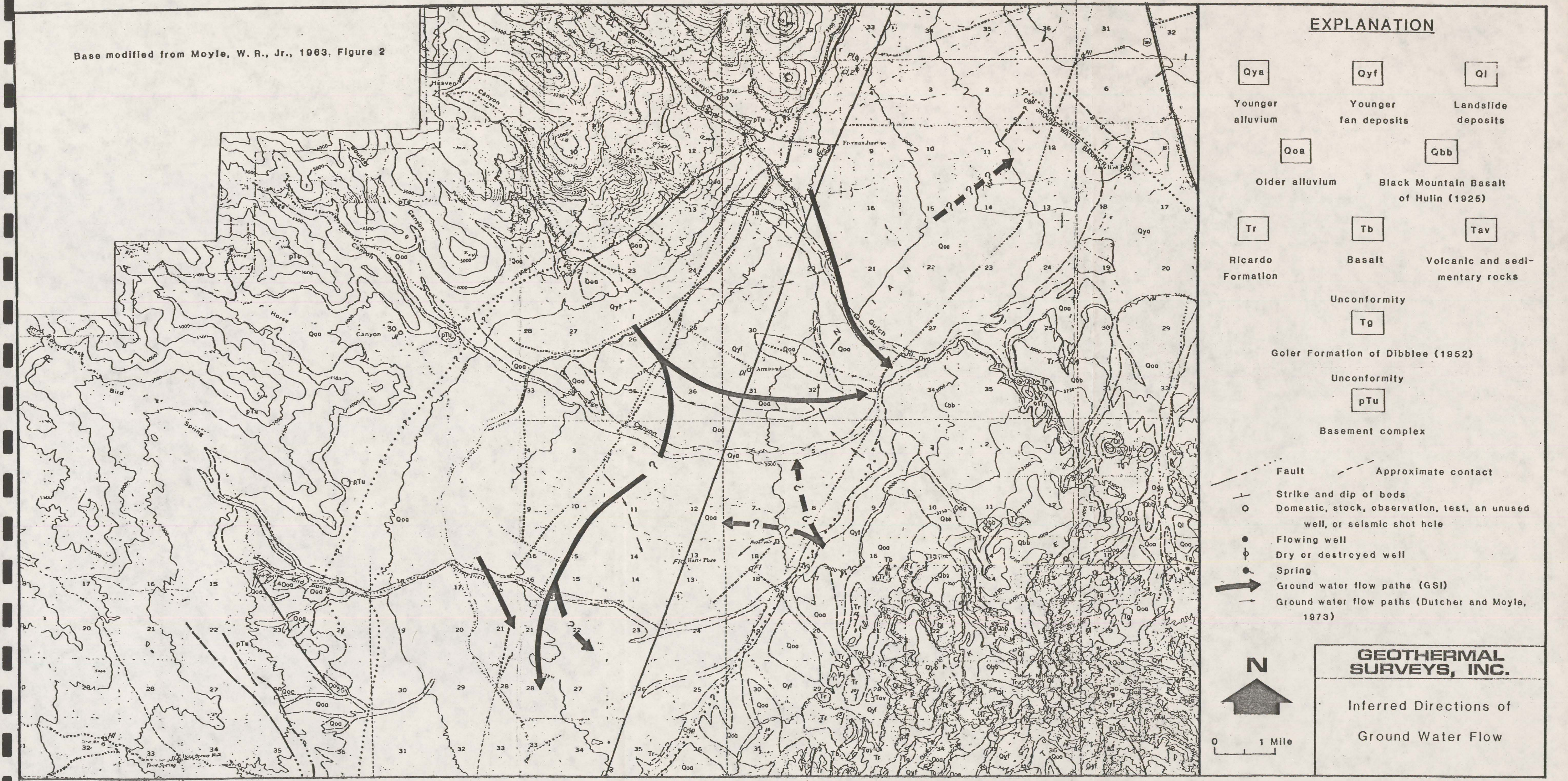
- Much of the ground water from Freeman Canyon probably follows Freeman Gulch. Some additional ground water from the canyon may flow to the north of West Bowman Road in an area not covered by our temperature probes.

- A northeast oriented flow path may exist several miles east of Freeman Junction. It may be related to a fault in the area that has been inferred from seismic data (Dutcher and Moyle, 1973, Plate 1).

- No well defined flow path has been found extending into the project area from the El Paso Mountains.

- The ground water flow paths and the position of the ground water divide that we derive from the thermal survey are similar in major respects to those published by the U. S. Geological Survey (Dutcher and Moyle, 1973, Plate 2).

Figure 8



Base modified from Moyle, W. R., Jr., 1963, Figure 2
EXPLANATION
Qya
Younger alluvium
Qyf
Younger fan deposits
Ql
Landslide deposits
Qoa
Older alluvium
Qbb
Black Mountain Basalt of Hulin (1925)
Tr
Ricardo Formation
Tb
Basalt
Tav
Volcanic and sedimentary rocks
Unconformity
Tg
Goler Formation of Dibblee (1952)
Unconformity
pTu
Basement complex
Fault
Approximate contact
Strike and dip of beds
Domestic, stock, observation, test, an unused well, or seismic shot hole
Flowing well
Dry or destroyed well
Spring
Ground water flow paths (GSI)
Ground water flow paths (Dutcher and Moyle, 1973)
N
0 1 Mile
GEOTHERMAL SURVEYS, INC.
Inferred Directions of Ground Water Flow
Heaven Canyon
Horse Canyon
Bird Spring Pass
Bird Spring Canyon
Freeman Canyon
Freeman Junction
Gulch
GROUND WATER BARRIER
Armitage
Hart's Place
Reservoir
Black Mountain

CONCEPTUAL MODEL

Figure 9 is a diagrammatic sketch of one possible configuration of the potentiometric surface extending through the project area from Fremont Valley in the southwest to north of West Bowman Road in the northeast. Significant elements are the ground water divide, approximately at Sage Canyon, and a barrier to ground water flow beginning near Freeman Canyon and extending to the northeast.

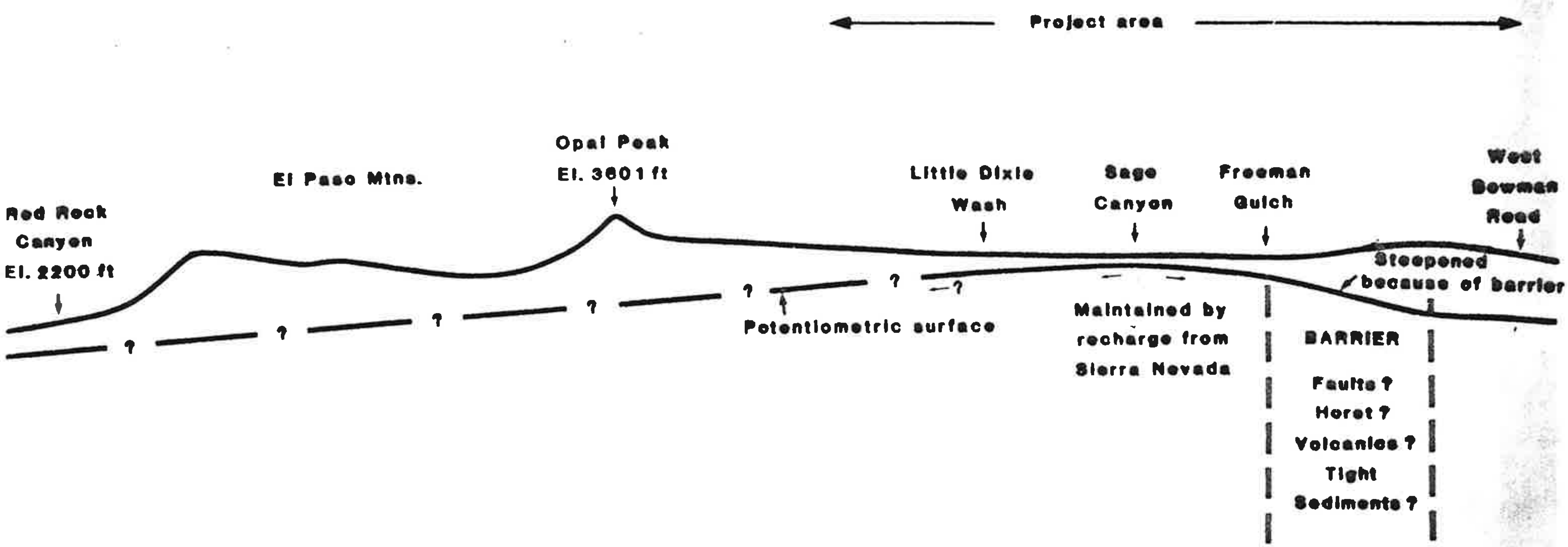
As indicated in this sketch, ground water may flow southwest from the divide toward Fremont Valley and northeast from the divide toward China Lake.

The barrier, inferred from warmer temperatures, may consist of a fault zone, buried volcanics, a fault-bounded upraised segment of bedrock (horst), a buried bedrock spur, or tight sediments. Its effect would be to steepen the potentiometric surface toward China Lake.

We considered the possibility that the warmer temperatures in the northeast could result from a topographic effect caused by the Freeman Canyon alluvial fan. However, because the thermal configuration does not conform to the topography of the fan, we do not think this is the explanation.

No records are available to prove whether the ground water is confined. We think that it is not significantly confined because of the generally coarse nature of the alluvium exposed in the project area. Therefore, the potentiometric surface should reasonably represent the ground water table.

It is important to note that, though we prefer this model based on all the currently available data, this is just one of several possible models of the potentiometric surface that can be derived from the combination of water level data and the results of the temperature survey.



GEOTHERMAL SURVEYS, INC.

Conceptual Model

Figure 9

DISCUSSION

The results of this project indicate some interesting new aspects regarding the geohydrology of the project area and its possible correlation with facets of the local geology. These results also support and refine the major points of a model of the local potentiometric surface developed by the U.S. Geological Survey (Dutcher and Moyle, 1973).

Ground water from Bird Spring and Horse Canyons, and perhaps from Cow Heaven and Sage Canyons, appears to flow southerly through the valley following a well defined thermal trough whose course is independent of the surface drainage pattern. It may be that the ground water is following a buried drainage system in which surface water formerly flowed to the south.

Evidence that an earlier drainage system in and around the project area may have flowed into Fremont Valley is found at Last Chance Canyon and Goler Gulch in the El Paso Mountains. These streams appear to be antecedent to the development of the mountains and may have had their original headwaters in the canyons of the Sierra Nevada.

There is insufficient information to determine the eventual destination of this ground water. It may discharge into Fremont Valley through Red Rock Canyon. Alternatively, south of the project area, it may turn east to the base of the El Paso Mountains and then north toward China Lake, perhaps along a fault zone inferred to occur along the mountain front (please refer to Figure 3).

The drainage basins contributing water to this southerly flow constitute a large proportion, 50% or greater, of the total Sierra Nevada catchment area. Thus, it is likely that the amount of water involved constitutes a similar proportion of the total ground water recharge received from the Sierra Nevada. Using the previously derived (page 9) value of 2,000 acre-feet per year of recharge and assuming that the bulk of this is contributed from the Sierra Nevada leads to a value on the order of 1,000 acre-feet per year of ground water that may be flowing to the south.

The northern part of the project area is thermally more complex than the southern part. The temperature surveys suggest the presence of a ground water barrier extending southeast across the valley from the mouth of Freeman Canyon toward Black Mountain. The exact nature of this barrier is unknown. It may consist of a fault zone, buried volcanics, a horst, a buried bedrock spur, or tight sediments.

EVIDENCE REGARDING THE NATURE OF THE GROUND WATER BARRIER

Evidence for a fault zone from Freeman Canyon to Black Mountain:

- Northwest trending faults have been mapped locally.
- Freeman Canyon is the largest of the local Sierra Nevada Canyons and the only one to head into a pass (Walker Pass) at its upper end.
- A fault up Freeman Canyon may connect into the Pinyon Peak Fault.
- Freeman Gulch trends to the southeast toward Black Mountain rather than northeast down the steeper face of the alluvial fan.
- The eruptive center for the Black Mountain Basalt is in line with this trend.

Evidence for buried volcanics:

- The evidence listed above in support of a fault zone can also be used to infer the presence of buried volcanics.
- The Black Mountain Basalt extends beyond the general mountain front of the El Paso Mountains into the valley near Freeman Gulch. The current northwest edge of the basalt does not appear to be the original flow margin. These suggest that the volcanics extend into the valley at depth.
- The shape of the southwest extension of Indian Wells Valley (widening to the southwest) suggests that it is a downdropped basin that is deepest several miles southwest of Armistead.

Evidence for a buried bedrock spur:

- The El Paso Mountains project further into the valley near Freeman Gulch than at any other point.

Evidence for a buried horst:

- The evidence listed above in support of a fault zone can also be used to infer the presence of a buried horst.

Evidence for the presence of tight sediments:

- No direct evidence exists for the presence of tight sediments.

RECOMMENDATIONS

Based on the results of the present survey, we recommend the following:

- Improve the water budget for the southwest extension of Indian Wells Valley. Assess the ground water recharge from each of the major drainage basins.

- Assess the potential for discharge of ground water from Indian wells Valley into Fremont Valley through Red Rock Canyon. Use presently available data supplemented with a field reconnaissance of the geology.

- If the potential discharge into Fremont Valley appears to be significant, extend the temperature survey southwest to the head of Red Rock Canyon to help define the major ground water flow paths. This will be relatively easy as the sleeves for the present thermal survey are still in place. The surveys could be overlapped without the need to redrill the existing stations.

- Investigate the northeastern ground water barrier using geophysical techniques, either seismic refraction or gravity surveying, to help determine the existence, nature, and dimensions of the inferred ground water barrier.

- Reassess the water budget based on the results of this additional research.

- If the District wishes to develop the ground water in the survey area, we would recommend and prioritize sites for test wells followed by production well drilling and construction.

APPENDIX A

THE THERMAL TECHNIQUE

The thermal method for locating ground water and tracing its movement is based on the principles that: Water moving through the ground changes the temperature of its surroundings by acting as a heat source or a heat sink. If the water is shallow, it can also attenuate or modify the surface ambient temparature cycles.

In application, the sensors do not have to be within the body of the water in order to detect it. The technique maps the thermal effects in the materials overlying or surrounding the moving fluid.

Geothermal Surveys, Inc. uses thermal probes containing thermistors calibrated to 0.01 degrees Centigrade as sensing elements. They are installed in a predetermined areal pattern at depths sufficient to exceed the reach of the diurnal ambient cycle, but within the reach of the annual ambient cycle.

The electrical resistance of a thermistor is a function of temperature and is measured in the field using a Wheatstone Bridge. To ensure accuracy and repeatability, readings are taken only after the probe has reached thermal equilibrium with the surrounding material. The data are computer reduced using coefficients derived from the calibration of the individual thermistors.

After the data are converted, the resulting temperatures are plotted as profiles or contoured as isotherms on base maps. The temperature configuration permits delineation of zones of differential fluid migration and areas of concealed bedrock or other barriers.

APPENDIX B

Temperature Survey Data

Station	Temperature Jan. 13-14, 1986 (degrees C)	Temperature Jan. 22-24,1986 (degrees C)	Temperature Drift (degrees C)
1	17.10	16.60	-0.50
2	17.81	17.27	-0.54
3	17.31	16.88	-0.43
4	18.00	17.48	-0.52
5	18.08	17.72	-0.36
6	17.56	17.03	-0.53
7	16.93	16.49	-0.44
8	17.46	16.90	-0.46
9	17.36	16.54	-0.82
10	17.75	17.20	-0.55
11	17.54	16.86	-0.68
12	17.88	17.22	-0.66
13	18.72	18.03	-0.69
14	18.22	17.54	-0.68
15	17.36	16.71	-0.65
16	17.59	16.99	-9.60
17	17.95	17.23	-0.72
18	17.37	16.81	-0.56
19	17.49	16.95	-0.54
20	18.44	18.06	-0.38
21	17.55	16.87	-0.68
22	17.79	17.22	-0.57
23	17.93	17.47	-9.46
24	17.65	17.28	-0.37
25	17.88	17.40	-0.48
26	18.50	17.98	-0.52
27	17.45	16.92	-0.53
28	17.68	17.05	-0.63
29	17.58	16.81	-0.77
30	17.47	16.87	-0.60
31	17.74	17.17	-0.57
32	17.58	17.03	-0.55
33	17.86	17.33	-0.53
34	18.06	16.78	-1.28
35	17.25	16.65	-0.60
36	18.70	18.23	-0.47
37	19.19	18.77	-0.42
38	18.82	18.48	-0.34
39	17.59	17.13	-0.46
40	17.89	17.52	-0.37
41	17.79	17.35	-0.44
42	19.38	19.00	-0.38
43	18.55	18.11	-0.44
44	17.81	17.44	-0.37
45	18.54	18.04	-0.50

Appendix B: Temperature Survey Data (cont'd.)

Station	Temperature Jan. 13-14, 1986 (degrees C)	Temperature Jan. 22-24,1986 (degrees C)	Temperature Drift (degrees C)
46	18.39	17.87	-0.52
47	19.42	19.09	-0.33
48	19.26	18.80	-0.46
49	19.24	18.87	-0.37
50	18.72	18.37	-0.35
51	17.38	18.79	-1.41
52	19.21	18.90	-0.31
53	18.73	18.51	-0.22
54	19.86	19.41	-9.45
55	19.89	19.38	-0.51
56	19.53	18.98	-0.55
57	19.95	19.62	-0.33