EXPLORATION FOR GEOTHERMAL ENERGY IN ARIZONA BASIN AND RANGE A SUMMARY OF RESULTS AND INTERPRETATION OF HEAT FLOW AND GEOCHEMISTRY STUDIES IN SAFFORD BASIN, ARIZONA

by

James C, Witcher

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416 W. Congress, Suite #100, Tucson, Arizona 85701

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NOTICE

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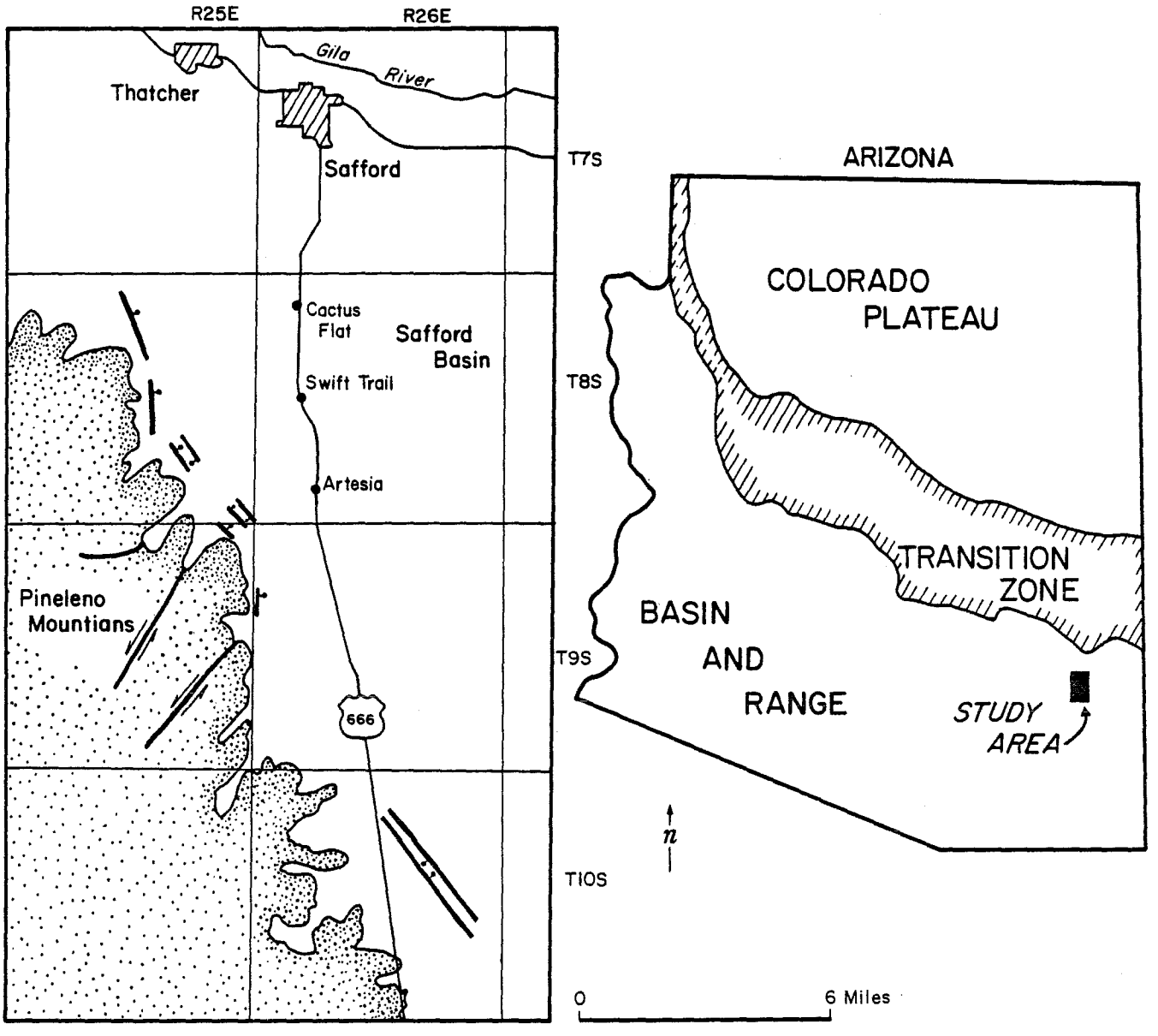
Introduction

Numerous artesian wells in the Safford basin, southeast Arizona, discharge thermal water (30 to 50°C) contained in sand and gravel aquifers stacked within and below an extensive silt and clay aquaclude. The artesian geothermal resource appears to be characterized chiefly by a conductive thermal regime in basin fill sediments, although hydrothermal convective systems apparently exist below the silt and clay in a few areas. A probable hydrothermal system is located 18 km south of Safford adjacent to U.S. 666 (Fig. 1). This system, the Artesia anomaly, is characterized by high soil mercury and high apparent heat flow (>167 mW/m^2) in a $\tilde{\sim}$ 3 km^2) area. The Artesia anomaly is the subject of this report.

Geologic Setting

The crust of southeast Arizona is highly anisotropic and is dominated by a west-northwest to northwest structural grain which is superimposed on an older northeast grain (Swan, 1982 and Silver, 1978). This anisotropicity originated during Precambrian. During the Mesozoic, probable reactivation of west-northwest structures (Titley, 1976) may have uplifted the Mogollon Highland (Coney, 1978, Turner, 1962, Elston, 1958). Significant erosion during that same period removed Paleozoic and pre-late Cretaceous rocks to expose Precambrian basement (Elston, 1958), consisting of the Pinal Schist and large granitic batholiths (Silver, 1978). The Safford area lies astride the Mesozoic Mogollon Highland.

The Pineleno Mountains, a mid-Tertiary metamorphic core complex (Davis and Coney, 1979), defines the western boundary of the Artesia area. This range reaches an altitude over 3,000 m (10,000 ft) and receives significant precipitation (>76.2 cm/yr, >30 in/yr). The impressive mountain front is dissected by several linear canyons which are deeply eroded into gneiss and



BED ROCK GEOLOGY MODIFIED FROM THORMAN, 1981.
PLEISTOCENE FAULTS MODIFIED FROM PERS. COMM. CHRIS MENGES

Pleistocene fault

Bedrock fault zone

Pre Late Miocene bedrock

Basin filling sediments

Figure 1. Location and Geologic Map

mylonitic gneiss. These canyons coincide with major northeast striking fault zones displaying minor left-lateral strike-slip movement (Thorman, 1981) (Fig. 1). Mylonitic foliation in the gneiss dips gently north to northeast near the base of the Pinaleno Mountains and it dies out rapidly into the range (Thorman, 1981).

A complete Bouguer gravity map of the region (Wynn, 1981) shows very closely spaced isogals (-135 to -175 milligals) between 0.2 and 4 km east of and parallel to the mountain front in the Artesia area. A large displacement high angle Basin and Range fault zone is interpreted from these gravity data. This fault zone forms the western boundary of the Safford basin, which may contain up to 3 km (Oppenheimer and Sumner, 1981) of post mid-Miocene basin-filling sediments (Scarborough and Pierce, 1978). Pleistocene tectonic activity along the fault zone is observed in multiple and composite fault scarps displacing Pleistocene geomorphic surfaces up to 30 m (Morrison and others, 1981). A faulting reoccurance interval of 100,000 years was estimated by Menges and others (1982).

Basin-fill stratigraphy in the Artesia area is divided into two major units, upper and lower basin fill. These units are separated approximately by a time-stratigraphic horizon showing a change in sedimentation processes and by a Pliocene to Quaternary faunal transition (Harbour, 1966).

Lower basin fill consists of three facies: (1) A conglomerate facies, (2) a clay-silt facies, and (3) an evaporite facies. The evaporite facies consists of gypsiferous clay, gypsum, anhydrite, and minor halite beds and it intertongues with the clay-silt facies, which also overlies the evaporites in the axis of the Safford basin, north and east of the Artesia area (Harbour, 1966). The lacustrine clay-silt facies is extensive and occurs to within 2 or 3 km of the Pineleno Mountain front. Nonindurated to moderately indurated sand and gravel form the conglomerate facies, which occurs along the basin margins.

It is postulated to underlie the clay-silt facies in the basin interior and is known to be interbedded with the clay-silt facies at depth along U.S. 666. This conglomerate facies hosts stacked, thermal artesian aquifers in the Safford Basin.

Upper basin fill consists of nonindurated gruslike sand with gravel lenses. It overlies a gneiss pediment and the clay-silt and conglomerate facies of lower basin fill. The upper basin fill no doubt has an important hydrologic connection with the conglomerate facies next to the mountain front. A thin, less than 20 m thick, cobble to boulder conglomerate caps the upper basin fill to form the mid-Pleistocene to Recent geomorphic surfaces.

Complex basement structure (pre late-Miocene) is inferred below basin fill (post mid-Miocene) and may have important control on potential deep (>1 km) geothermal resources. Metamorphic core complexes, such as the Pineleno Mountains, generally have a distinctive structural morphology (Coney and Davis (1979): A low angle fault zone of chloritized mylonite and mylonite breccia overlies mylonitized metamorphic rocks and gneiss. Deformed, but unmetamorphosed rock overlie the low angle fault. While a low angle fault is not observed in the Pineleno Mountains adjacent to Artesia, outcrops of mylonitic gneiss at the base of the Pineleno Mountains suggest that a fault is preserved in the Safford basin basement. A mid-Tertiary age for cataclasis of the gneiss is unconfirmed (Thorman, 1981), but low-angle Miocene faults are observed at Eagle Pass (Blacet and Miller, 1978) and near Gillespie Mountain (Thorman, 1981) on the northwest and southeast ends, respectively, of the Pineleno Mountains.

Monoclinally dipping post-Cretaceous to pre late-Miocene volcanic flows and clastic sediments deformed by listric normal faults that merge into a low angle fault are inferred beneath basin fill, in the basin adjacent to the Pineleno Mountains. Highly fractured zones near the low-angle faults may act

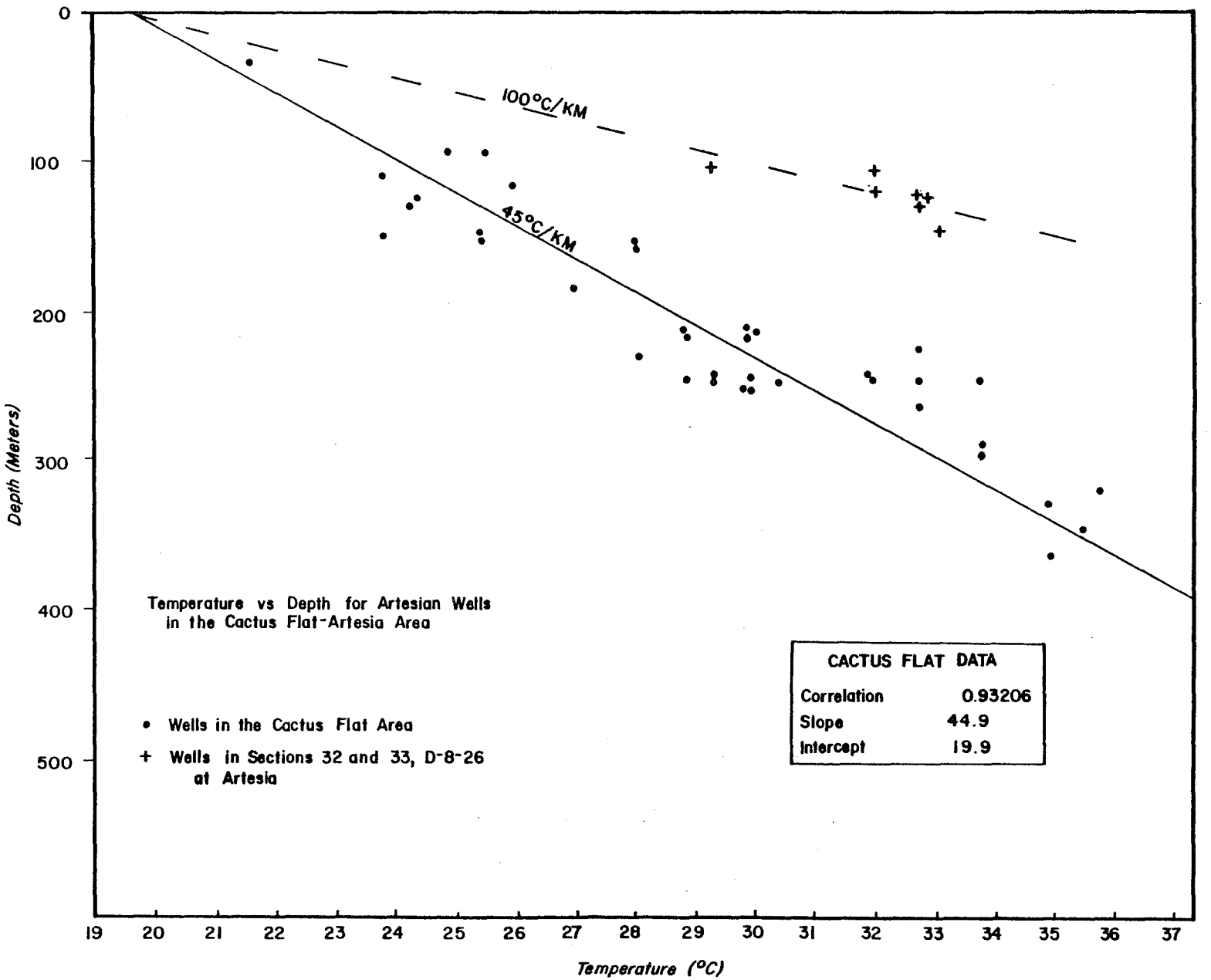


Figure 2. Temperature versus Depth of Artesian Wells

as a deep geothermal reservoir.

Thermal Artesian Wells

Surface discharge temperatures of artesian wells, south of Safford along U.S. 666, are plotted against their respective depths (Fig. 2). The wells, exclusive of those in sections 32 and 33, Township 8 South, Range 26 East, show a linear increase in temperature with depth (4.5°C per 100 m). At least five separate, vertically stacked aquifers confined by clay and silt provide water to these wells (Witcher, 1979).

From studies of several deep (> 300 m) mineral exploration holes 18 km north of Safford, Reiter and Shearer (1979) reported an average heat flow (79.5 mWm^2), which is typical for the southern Basin and Range Province. Because basin fill in this area has thermal conductivities less than 1.88 W/mK, a 45°C/km gradient is normal for a conductive heat flow of 7.9 mWm^2.

Unusually warm wells occur in sections 32 and 33, Township 8 South, Range 26 East. These wells have estimated temperature gradients exceeding 100°C/km (Fig. 2). Unfortunately, no wells exist south of this anomaly.

Ground Water Chemistry and Use of Geothermometers

Nonthermal (<30°) ground water in the area has sodium bicarbonate to sodium sulfate-bicarbonate chemistry with total dissolved solids (TDS) less than 1,000 milligrams per liter (mg/l). Thermal waters (>30°C) have sodium sulfate to sodium chloride-sulfate chemistry with TDS ranging between 1,000 and 9,000 mg/l. Witcher (1981) showed that the chloride-sulfate versus bicarbonate ratio has a logarithmic relationship to lithium concentration, which suggests that thermal and nonthermal water chemistry evolves from contact with differing lithology through equilibria and ion exchange processes (Fig. 3). The clay-silt facies provides a source for sulfate, chloride and lithium.

Silica concentrations are highest in nonthermal sodium bicarbonate water.

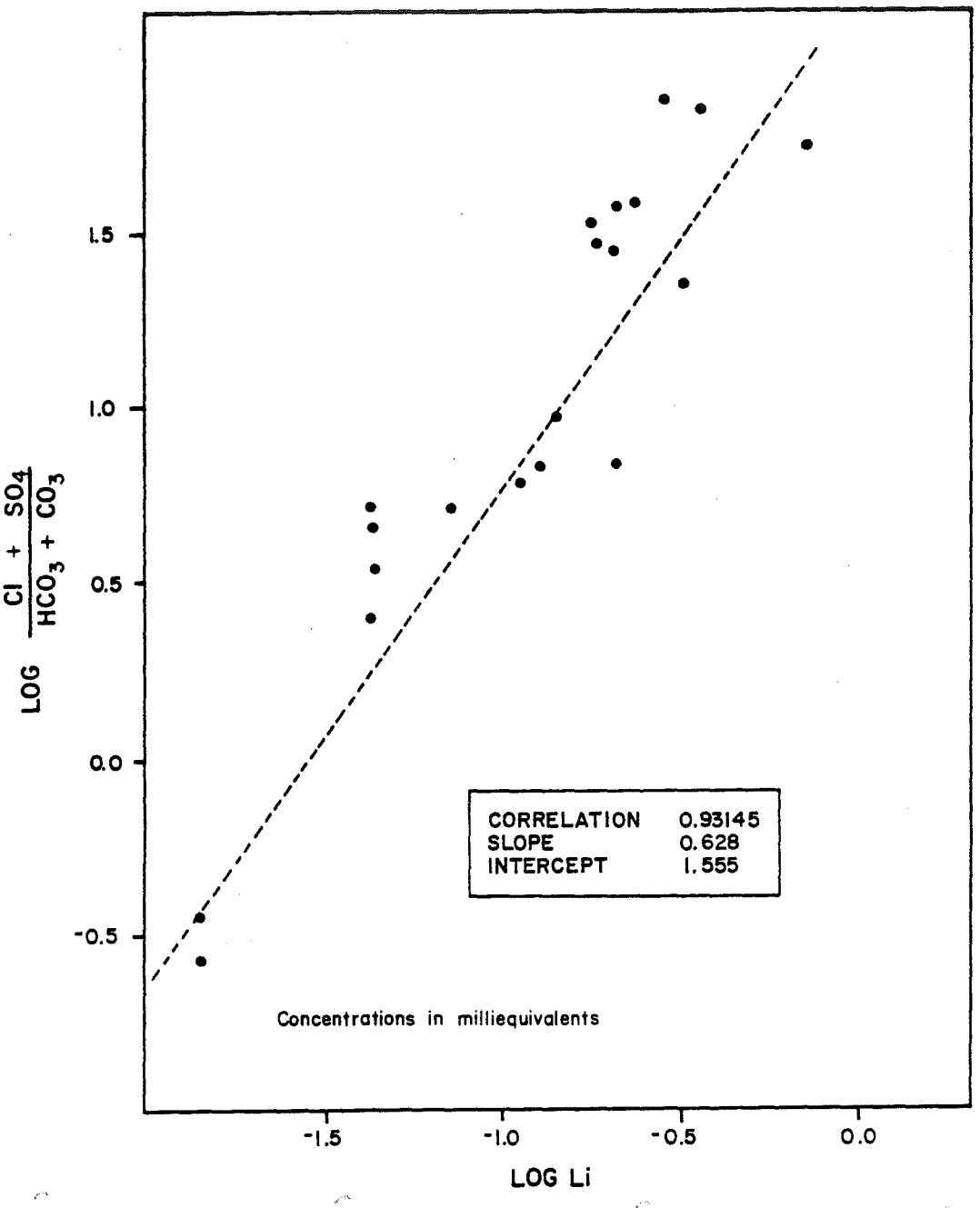


Figure 3. Chloride-Sulfate and Carbonate Ratio versus Lithium

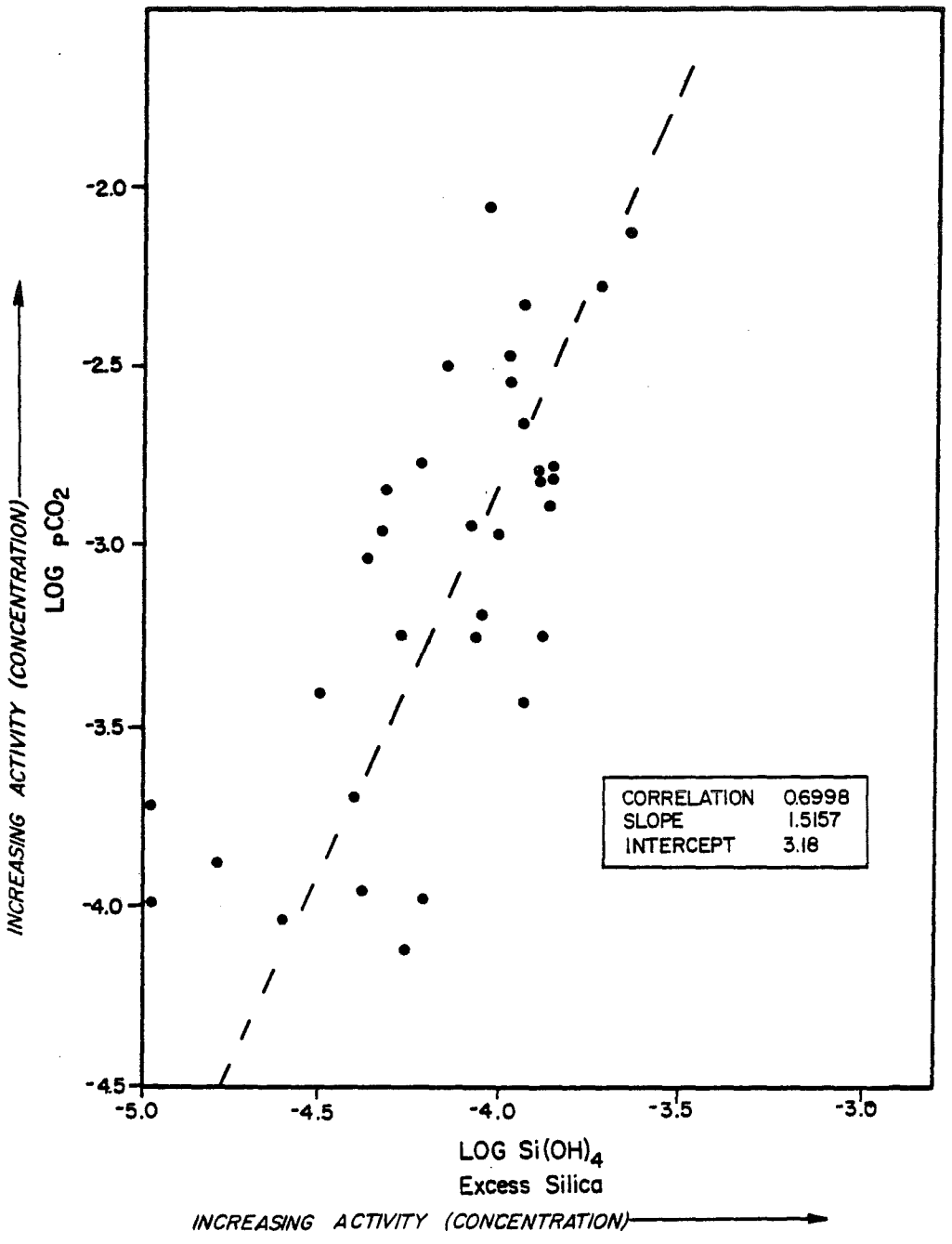


Figure 4. Dissolved Carbon Dioxide versus Excess Silica

Several studies of low-temperature ($< 50^{o}C$) ground waters in contact with felsic rocks or sediment derived from these rocks have shown that silica concentration is a function of dissolved carbon dioxide (Garrels and Mackenzie, 1967; Paces, 1972):

$$\underset{\text{solid}}{\text{Alumino-silicate}} + H_2CO_3 \rightarrow \text{cations} + HCO_3^- + Si(OH)_4 + \underset{\text{solid}}{\text{Kaolinite}}$$

where $H_2CO_3 = CO_{2(g)} + H_2O$

$Si(OH)_4$ is dissolved silica

Comparison of calculated dissolved carbon dioxide concentration with silica concentration in all Artesia-Cactus Flat area waters suggests that a steady state disequilibrium between dissolved silica and alumino-silicates plus quartz has a more dominant influence on silica concentration than does temperature dependent equilibrium with quartz alone (Witcher, 1981). Figure 4 shows carbon dioxide concentrations compared to excess silica concentrations. Excess silica is determined by subtracting analyzed and pH-corrected silica from a theoretical temperature-dependant equilibrated solution with either quartz, chalcedony, or cristobalite. The species selected for this calculation is the one which least exceeds the analyzed silica.

The silica and Na-K-Ca geothermometers (Fournier and Rowe, 1966 and Fournier and Truesdell, 1973) are not applicable in the Artesia area within the assumptions governing their use (Fournier, White, and Truesdell, 1974); also the unusually warm waters in sections 32 and 33, Township 8 South, Range 26 East have chemistry that is indistinct from that of other waters in the Artesia area.

The following shallow (<1 km) ground water flow and chemical evolution model may apply in the Artesia area. Meteoric water recharging aquifers near the Pineleno Mountain front has a high dissolved carbon dioxide content which attacks alumino-silicate minerals to form sodium-bicarbonate water. As ground

water flows deeper into and laterally through sand and gravel zones confined by clay and silt, evaporite and carbonate minerals in the clay dissolve and ion exchange with clay minerals occurs to transform the sodium bicarbonate water into sodium sulfate-chloride water.

Soil Mercury

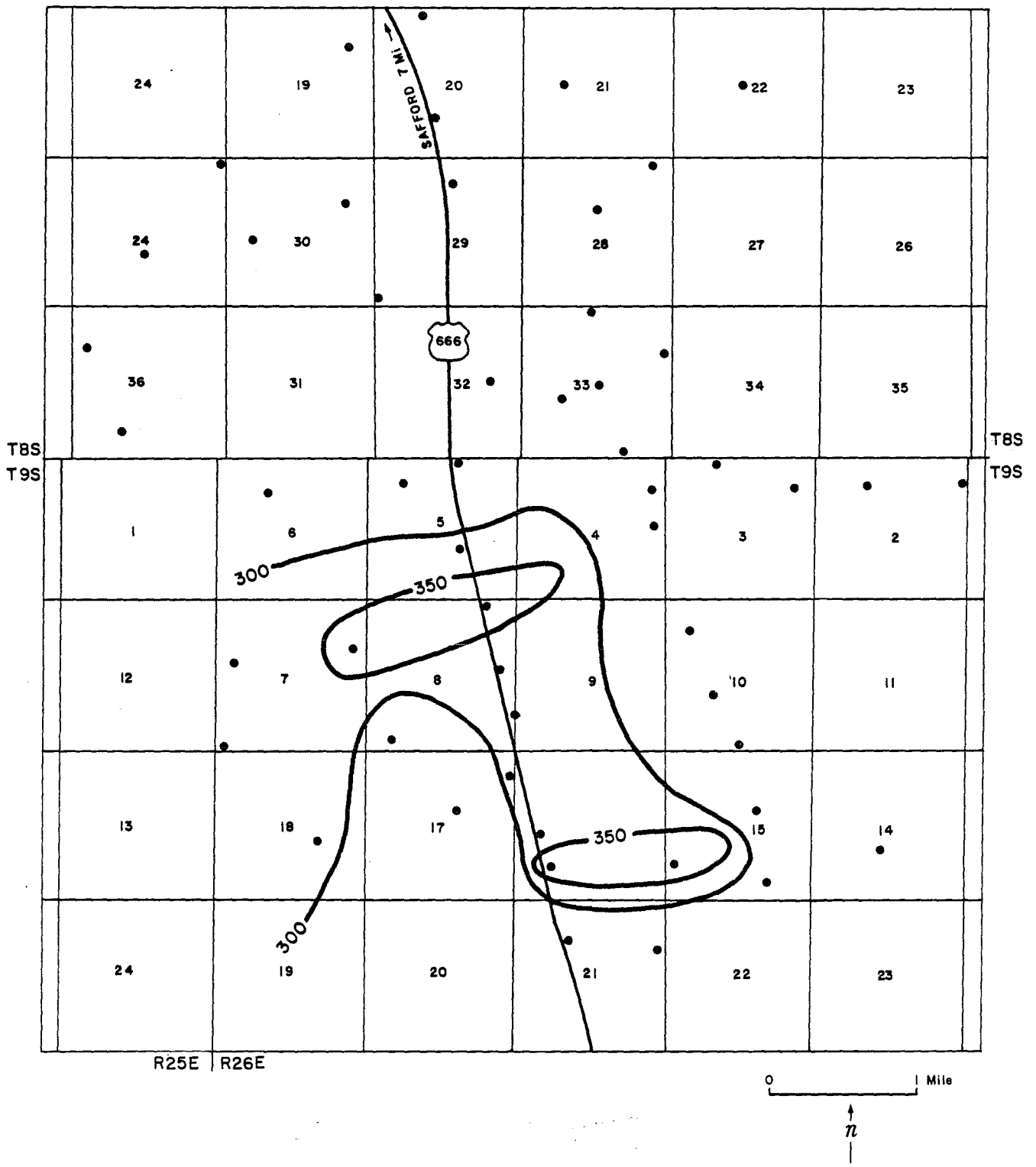
Soil mercury anomalies are frequently associated with high temperature hydrothermal systems (>150°C). Matlick and Buseck (1975) and Capuano and Bamford (1978) have used soil mercury sampling with success over high temperature systems to define structure which controls fluid flow. Mercury gas leaks upward along these structures where it is measured in near surface soil.

A soil mercury survey was conducted south of the area having anomalous temperature wells in order to delineate the extent of the anomaly, to identify potential structure control of a probable convective system, and to test the applicability of soil mercury on a probable low temperature (<100°C) geothermal system in a southern Basin and Range geologic setting. A soil mercury survey was selected because it is inexpensive and rapid to perform.

Two soil samples were collected at each sampling site, approximately 3 m apart and 10 cm deep, were placed in 3 x 5 ziplock plastic bags. Samples were laboratory dryed and screened through an -80 mesh stainless steel sieve. The fines were analyzed for mercury by using atomic absorption. Agreement between samples at each location was ±42 ppb.

Background mercury concentration in the study area was 225 ppb ±99, which is relatively high and it may reflect the geologic setting. Unusually high soil mercury content is defined by values exceeding 303 ppb, which is the mean plus one standard deviation. No correlation exists among different stratigraphic-geomorphic surfaces in the survey area.

High concentrations of mercury occur south of Artesia and adjacent to



● Sample location
Concentration in parts per billion (ppb)

Figure 5. Soil Mercury Anomaly

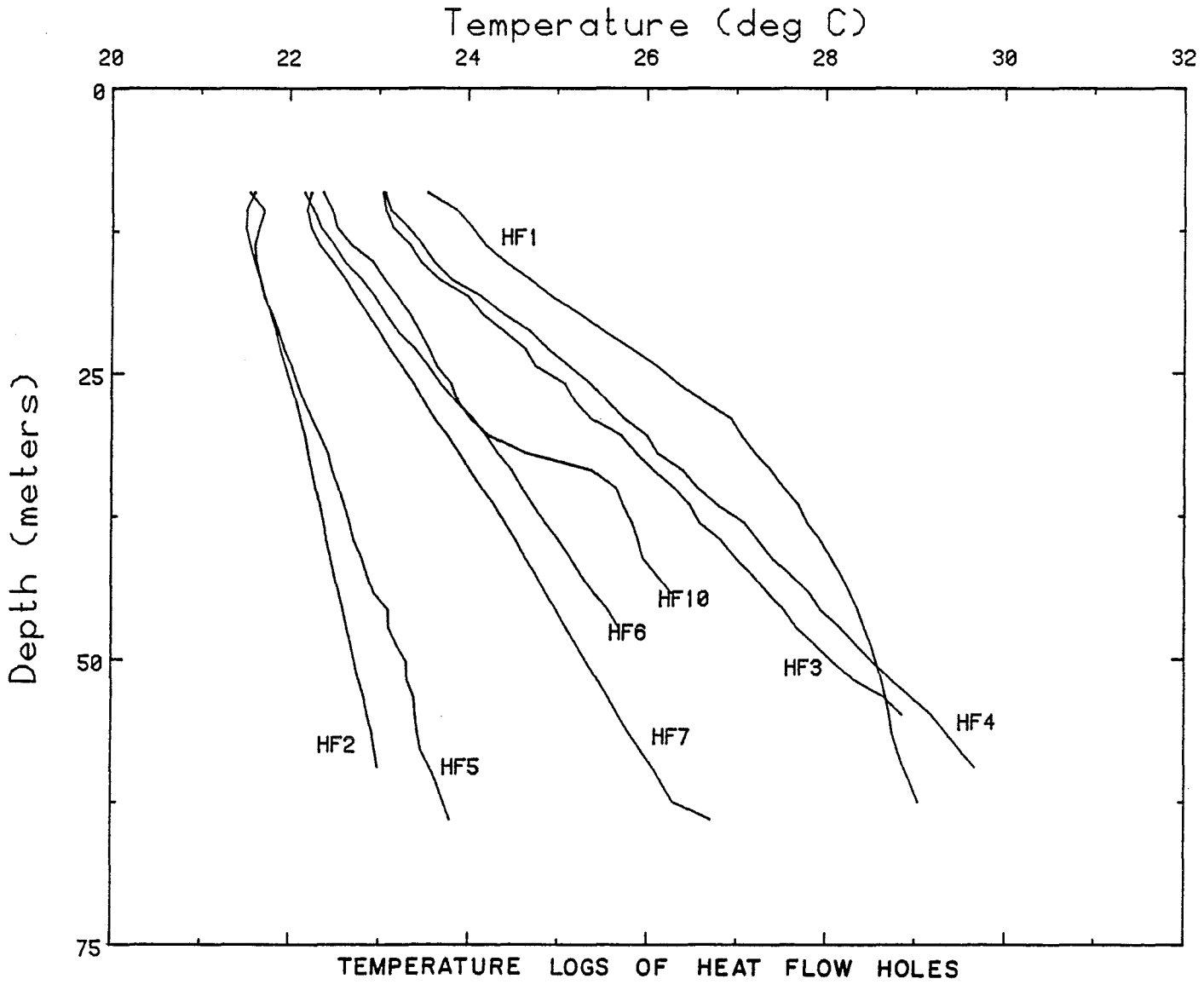


Figure 6. Temperature versus Depth of Heat Flow Holes

the area with anomalous temperature wells (Fig. 5). Two east-northeast trending closures with mercury exceeding 350 ppb are within a general northwest trending zone of high soil mercury (>303 ppb). Highest mercury concentrations are 380 ppb.

Temperature Gradient and Heat Flow Studies

An array of eight temperature gradient/heat flow holes, centered on the soil mercury anomaly, were drilled to a maximum depth of 64 m. The heat flow study was designed to confirm the existance of a geothermal anomaly inferred from the soil mercury survey and indicated by the adjacent anomalous wells, and to obtain data that may have use for modeling the extent of and natural heat loss from the system.

Shallow drills holes (<61 m) were selected to avoid intersection with possible artesian aquifers and because limited drill footage is least expensive. The holes were drilled with a small Simco 4000 tracked air drill, commonly used for mining evaluation and engineering studies. Drilling was accomplished with air, or air and foam, using a drag bit. Formation samples were collected at 10 ft (3 m) intervals.

Holes were completed by installing a 1 inch (2.5 cm) PVC, 200 psi pipe capped at the bottom and filled with clean water. A thick mixture of gel mud and cement filled the hole annulus around the PVC casing. A 3-m-long iron pipe with a lockable cap was set around the PVC at the surface and filled with cement.

Discrete temperatures ($\pm 0.01^{\circ}C$) were measured at 5 ft intervals (1.52 m) in these holes. Figure 6 shows the results of temperature logging. All holes except HF1 and HF10 show a conductive (linear) gradient. The temperature profile of HF1 is concave downward and may indicate upward seepage of water, possibly from a leaky artesian aquifer at about 60 m depth. HF1 may have penetrated a fault zone because it is the only hole that encounted zones of

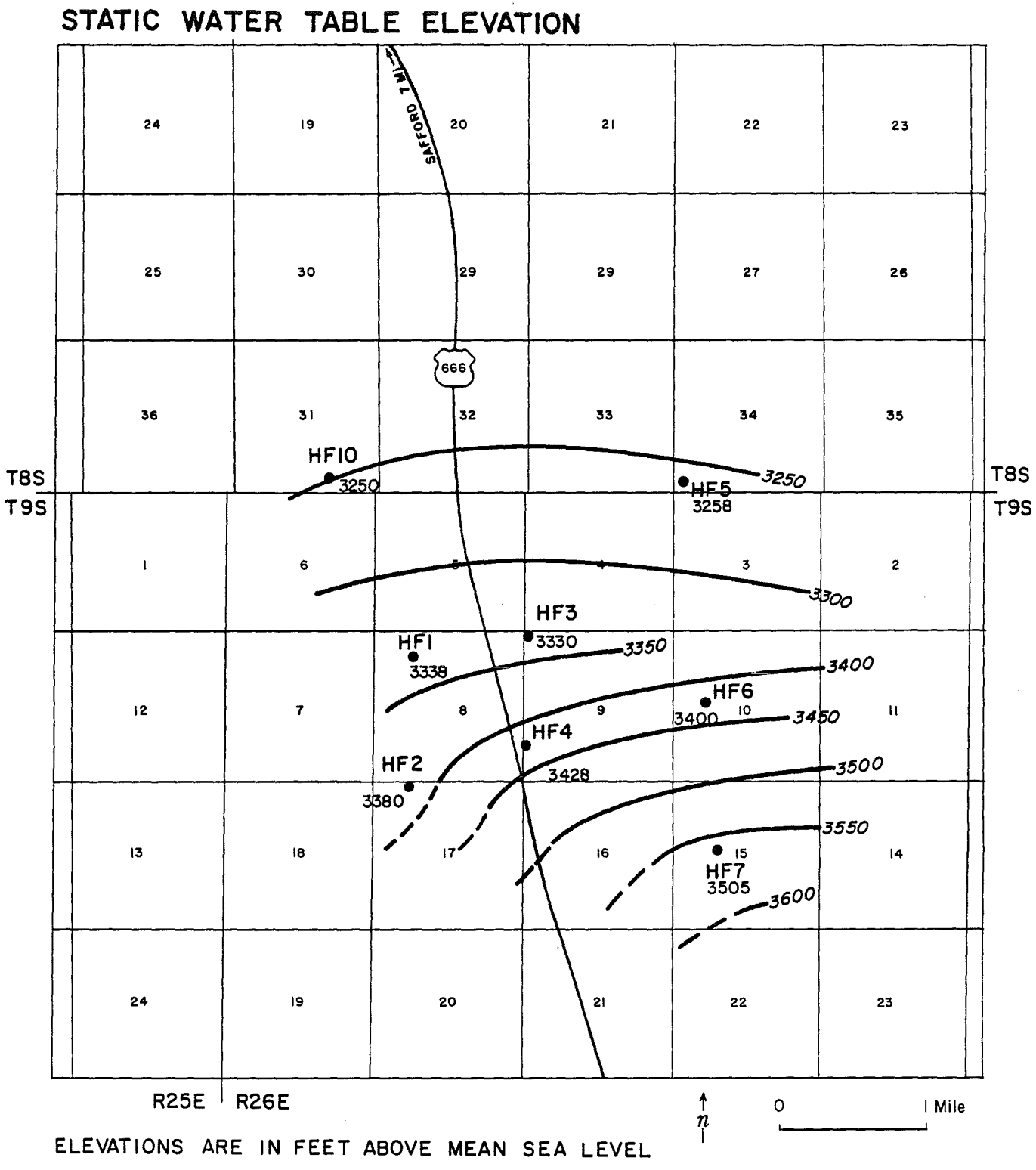


Figure 7. Map of Static Water Table

Table 1A. Bulk Thermal Conductivity and Lithology of Sand/Gravel Samples

Drill Hole	Depth Interval Feet (meters)	Bulk Conductivity (k_B) 1×10^{-3} cal/cm sec ^{o}C (W/mK)	Lithologic Description
HF1	70-80 (21.3-24.4)	6.86 (2.87)	Sandy granule to pebble conglomerate: uncemented, clayey, poorly sorted, feldspathic litharenite.
HF1	150-160 (45.7-48.8)	7.31 (3.06)	Very fine to coarse sandstone: uncemented, clayey, poorly sorted, subarkose.
HF2	80-90 (24.4-27.4)	6.85 (2.87)	Pebbly medium to very coarse sandstone: uncemented, clayey, poorly sorted, litharkose.
HF2	150-160 (45.7-48.8)	6.73 (2.82)	Pebbly very fine to very coarse sandstone: uncemented, clayey, poorly sorted, litharkose.
HF3	160-170 (48.8-51.8)	6.27 (2.62)	Sandy granule to pebble conglomerate: uncemented, clayey, poorly sorted, feldspathic litharenite.
HF4	160-170 (48.8-51.8)	7.72 (3.23)	Pebbly medium to very coarse sandstone: uncemented, poorly sorted, biotite, magnetite, litharkose.
HF5	90-100 (27.4-30.5)	5.76 (2.41)	Coarse to very coarse sandstone: uncemented, well sorted, litharenite.
HF6	60-70 (18.3-21.3)	6.90 (2.89)	Sandy granule to pebbly conglomerate: uncemented, clayey, poorly sorted, feldspathic litharenite.
HF10	60-70 (18.3-21.3)	6.26 (2.62)	Fine to very fine sandstone: uncemented, clayey, moderately sorted, subarkose.
	Mean	6.74 ± 0.59 (2.82 ± 0.25)	Note: lithics in these samples consist predominantly of granitic clasts, less than 25% andesite porphyry clasts and schist fragments. Sample HF5 (90-100 feet) contained more than 40% schist fragments.

Table 1B. Bulk Thermal Conductivity and Lithology of Clay/Silt Samples

Drill Hole	Depth Interval	Bulk Thermal Conductivity (K_B)	Lithologic Description
	Feet	1×10^{-3} cal/cm sec ^{o}C	
	(meters)	(W/mK)	
HF3	100-110	3.88	Claystone
	(30.5-33.5)	(1.62)	
HF5	120-130	4.14	Sandy siltstone to claystone
	(36.6-39.6)	(1.73)	
HF6	130-140	4.62	Sandy siltstone
	(39.6-42.7)	(1.93)	
HF7	80-90	4.92	Sandy siltstone
	(24.4-27.4)	(2.06)	
HF7	170-180	5.63	Sandy to pebbly siltstone
	(51.8-54.9)	(2.36)	
	Mean	4.64 ± 0.69	
		1.94 ± 0.29)	

indurated sand and gravel. These zones may indicate paleosols (caliche) or cementation resulting from ground-water flow across a physio-chemical boundary. HF10 encountered the only significant quantity of water during drilling, which accounts for the observed thermal disturbance. During logging, another well located 150 m from HF10 was pumping 29°C water.

All temperature logs except HF10 show a slight decrease in gradient below about 30 to 45 m depth. This decrease indicates a small thermal conductivity change attributable to the hole penetrating water saturated sediments at that depth (water table). A map of the static water table (Fig. 7) is interpreted from gradient changes. Ground water flow is from south to north and all wells but HF1 and HF10 apparently encounter mostly low permeability sediments as indicated by a lack of noticable water during drilling and the conductive gradients.

Representative formation samples from these holes were measured for thermal conductivity, using a divided bar apparatus. Conductivities were measured at Southern Methodist University in Dave Blackwell's heat-flow lab. Lithologic descriptions of samples and bulk thermal conductivities are listed in Table 1A and 1B

Two suites of basin fill are represented in Table 1A and 1B. Mean bulk thermal conductivities of the two categories of sediments, the silt/clay and the sand/conglomerate, were corrected for porosity in order to get a formation thermal conductivity (Sass and others 1971). The following equation was used for porosity corrections: $K_F = (K_P^{\phi})\ (K_B^{1-\phi})$

where K_F = formation thermal conductivity

K_B = bulk thermal conductivity of rock

K_P = thermal conductivity of pore medium

ϕ = fractional porosity

Because no geophysical logs were performed on these holes, and core samples were not taken, detailed porosity information is not available. However,

Table 2. Data Used For Heat Flow Calculations

Drill Hole	Thermal Conductivity(K_F) (1×10^{-3} cal/cm sec ^oC (W/mK)	Gradient ^oC/km	Depth Interval Feet (meters)	Lithology	Heat Flow 1×10^{-6} cal/cm^2 sec (mW/m^2)
HF1	$4.24 \pm .37$	187.49 ± 17.69	65-95	sand/gravel	7.95 ± 1.51
	$(1.77 \pm .15)$		(19.8-29.0)		(332.63 ± 63.18)
	$4.24 \pm .37$	43.42 ± 13.26	145-205	sand/gravel	$1.84 \pm .77$
	$(1.77 \pm .15)$		(44.2-62.5)	(indurated zones)	(76.99 ± 32.22)
HF2	$4.24 \pm .37$	31.73 ± 5.55	65-195	sand/gravel	$1.35 \pm .37$
	$(1.77 \pm .15)$		(19.8-59.4)		(56.48 ± 15.48)
HF3	$3.27 \pm .49$	134.78 ± 49.50	70-130	silt/clay	4.41 ± 2.52
	$(1.37 \pm .21)$		(21.3-39.6)		(184.51 ± 105.44)
	$4.24 \pm .37$	123.74 ± 19.08	140-170	sand/gravel	5.25 ± 1.33
	$(1.77 \pm .15)$		(42.7-51.8)		(219.66 ± 55.65)
HF4	$4.24 \pm .37$	122.12 ± 19.99	135-195	sand/gravel	5.18 ± 1.37
	$(1.77 \pm .15)$		(41.1-59.4)		(216.73 ± 57.32)
HF5	$3.27 \pm .49$	44.41 ± 10.99	85-135	silt/clay	$1.45 \pm .63$
	$(1.37 \pm .21)$		(25.9-41.1)		(60.67 ± 26.36)
HF6	$3.27 \pm .49$	94.46 ± 13.76	80-150	silt/clay	$3.09 \pm .98$
	$(1.37 \pm .21$		(24.4-45.7)		(129.29 ± 41.00)
HF7	$3.27 \pm .49$	78.18 ± 5.91	150-205	silt/clay	$2.56 \pm .60$
	$(1.37 \pm .21)$		(45.7-62.5)		(107.11 ± 25.10)
HF10	$4.24 \pm .37$	70.86 ± 21.90	70-90	sand/gravel	3.00 ± 1.28
	$(1.77 \pm .15)$		(21.3-27.4		(125.52 ± 53.56)

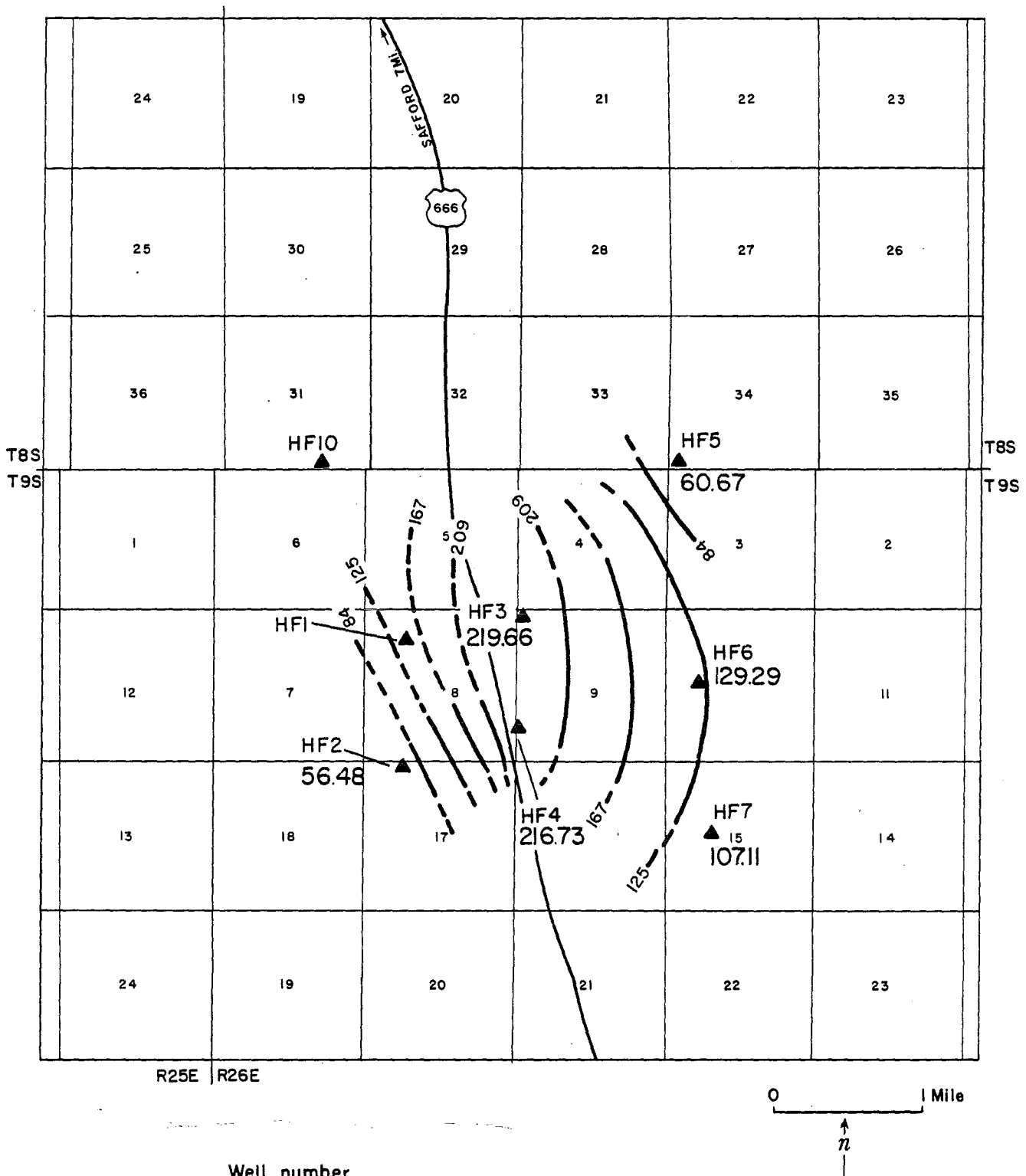


Figure 8. Map of Heat Flow

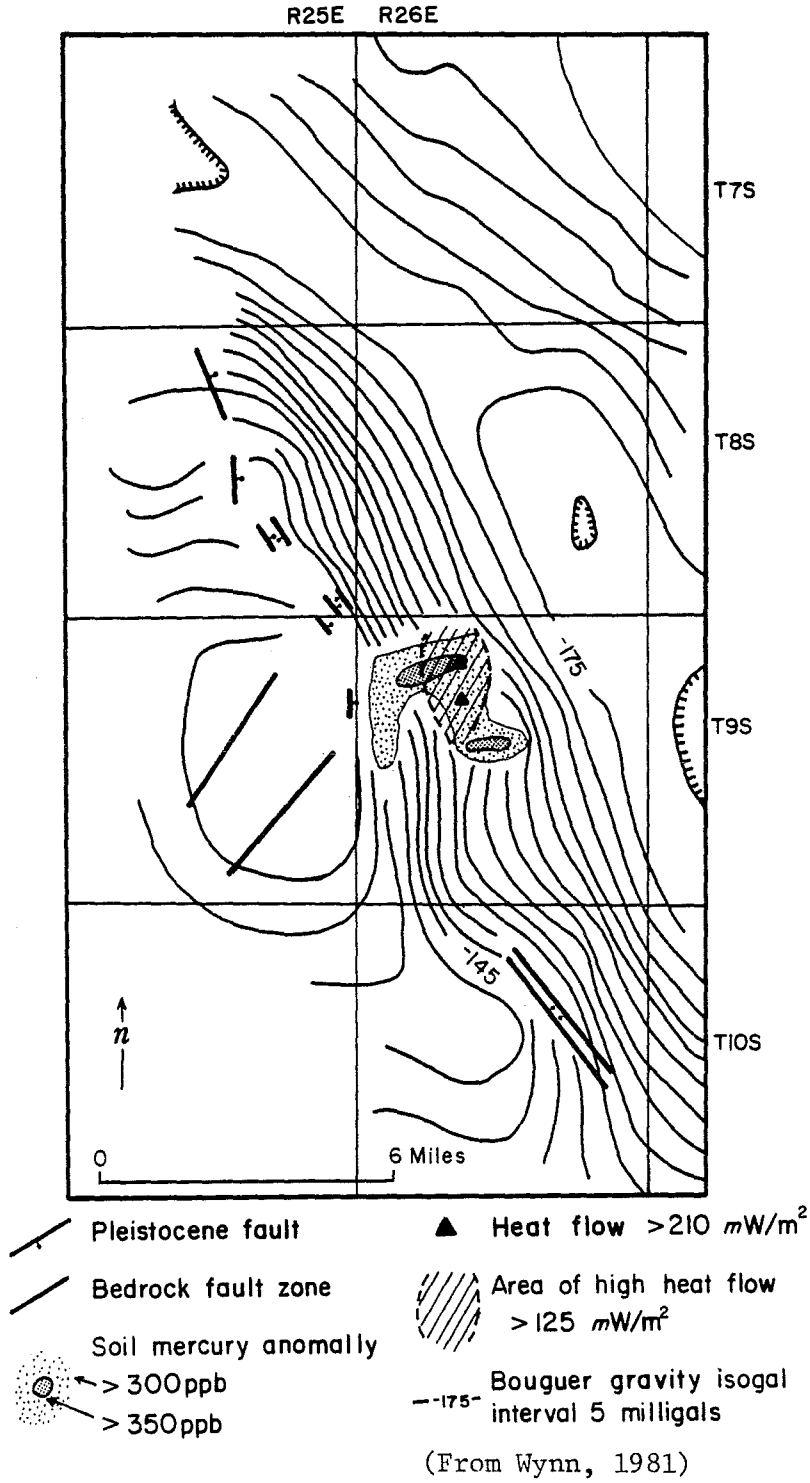


Figure 9. Comparison of Mapped Structure, Bouguer Gravity, Soil Mercury Anomalies and Heat Flow

porosities computed from geophysical logs in the shallowest unconsolidated clay, sand and gravel in the Tucson basin, Arizona, range from 26 to 34 percent (Davidson, 1973). A 30 percent porosity and a 0.6025 W/mK thermal conductivity for water were used for the porosity corrections.

Table 2 lists the information used in making the heat flow calculations for each drill hole, while Figure 8 is a contour map of these data. Heat flows range from 56.48 m W/m^2 in HF1 to 219.66 m W/m^2 in HF3. The computations are estimated or apparent heat flows because of uncertianty in formation porosity and in thermal conductivity of the pore medium above the water table. Also, no topographic correction was applied to holes HF7 and HF10. The other holes do not require this correction.

Synthesis

A north-northwest trending heat flow high (> 167 m Wm^2) overlies a high soil mercury anomaly (>300 ppb) of the same trend. The highest apparent value (219.66 m W/m^2) coincides with a 350 ppb soil mercury closure with east-northeast trend (Fig. 9). These anomalies overlie a major Basin and Range fault zone interpreted from complete Bouguer gravity data. An inferred structural intersection of northeast-trending basement faults with the high angle basin-bounding fault zone coincides with the soil mercury and heat flow anomalies. Also, the highest soil mercury anomalies trend east-northeast suggesting structure control with that orientation. Repetitious Pleistocene faulting on the Basin and Range fault zone may have created and sustained open fracture permeability at depth. All the above factors point toward a hydrothermal convection system possibly controlled by basement structure.

Projection of temperature gradients to depths greater than the drill hole is speculative; however, reconnaissance dipole-dipole resistivity profiling indicates 450 to 950 m of relatively impermeable silt, clay and evaporite sediments (Phoenix Geophysics, 1979; Witcher, 1981). Tentative

INFERRED
SUBSURFACE MODEL OF SAFFORD BASIN
bedrock structure (pre-Late Miocene)
below basin fill is highly speculative
(not to scale)

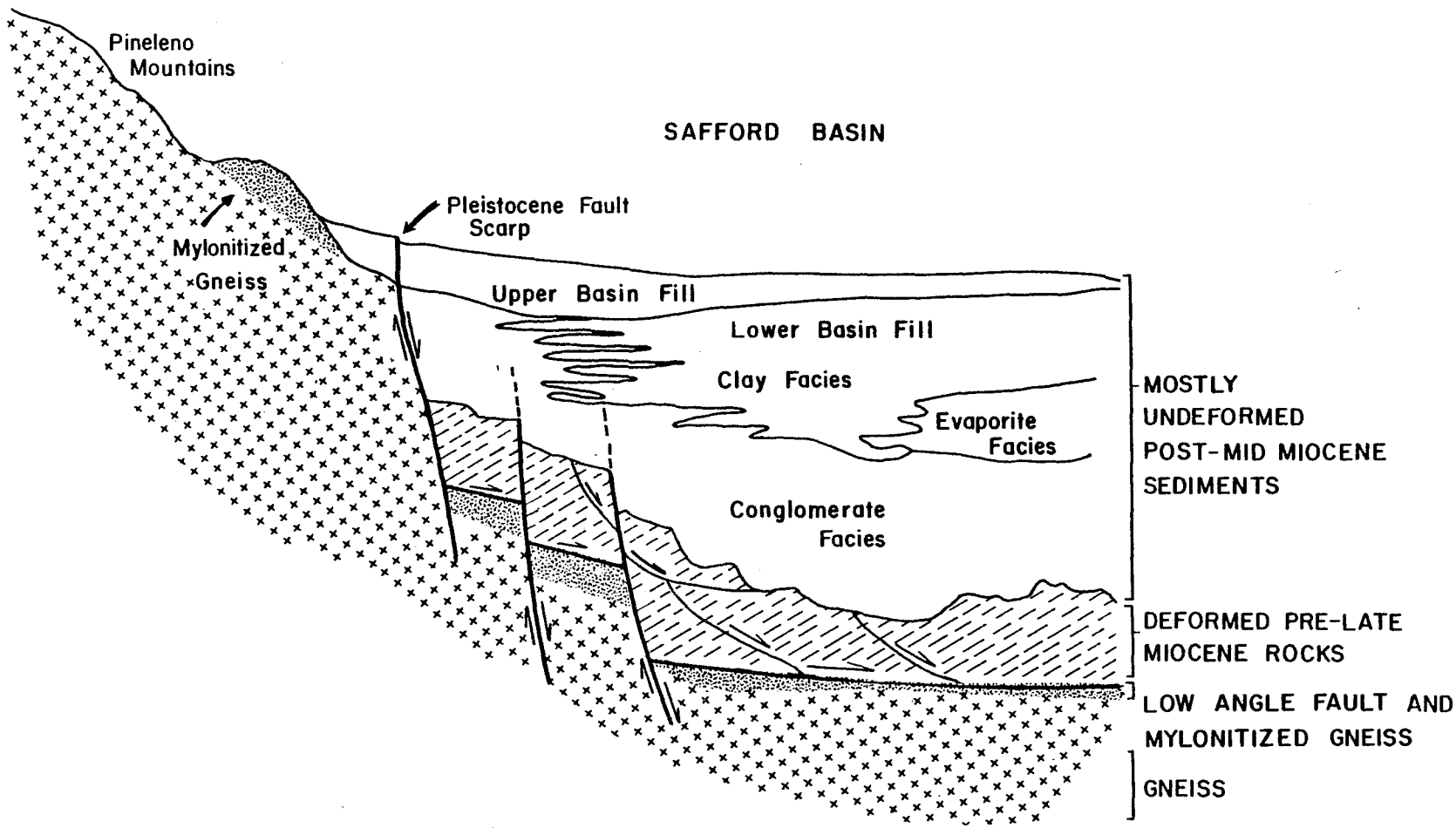


Figure 10.

projection of a 120°C/km gradient to 500 m gives a 78°C temperature when using 18°C as the mean surface temperature.

A deep (>1 km) intermediate temperature (100 - 150°C) resource is possible beneath the area with anomalous heat flow. Two exploration targets are inferred. The most accessible potential reservoir is in the conglomerate facies below the clay and silt facies. The other reservoir target, which is highly speculative, may lie in a complex basement structural setting (Fig. 10). Because the Pineleno Mountains are a metamorphic core complex, a low angle fault, overlain by highly deformed pre-Basin and Range tectonism (pre-late Miocene) rocks, is tentatively inferred in the Safford basin basement. Such a fault zone may contain significant fracture permeability and may receive recharge from the Pineleno Mountains via northeast trending basement fault zones. This latter model is essentially a "Raft River" type system, which occurs in a similar metamorphic core complex tectonic setting in Idaho (Covington 1980).

Conclusions

A combination of soil mercury and shallow temperature gradient surveys is a viable exploration method in southern Arizona to delineate potential hydrothermal convection systems. Prior to running these surveys, a thorough evaluation of available geohydrologic, geophysical and geologic data is recommended to identify areas that may have convective thermal regimes. Also, these data are useful to interpret results of mercury and heat flow studies.

The Na-K-Ca geothermometer probably has little value in large basins containing significant lacustrine and playa deposits due to ion exchange and the high solubility of gypsum and halite. The pH and carbonate species need careful measurement when obtaining hydrochemical samples for geothermal studies. Clarification of equilibria control on silica concentration, using pH and carbonate geochemical information, is apparently required to successfully use

silica geothermometry in evaluation of geothermal potential in southern Arizona basins.

Drillers' logs, lithologic logs and Bouguer gravity data are very useful in evaluation of Arizona basins. Clay and silt distribution in the subsurface has prime importance because the clay and silt frequently form confining layers overlying thermal aquifers. In addition they have high temperature gradients due to low thermal conductivities. As a result of high gradients, significant low temperature ($< 100^{o}C$) resources may occur within and below the silt and clay. Bouguer gravity data are useful for structure and relative basin fill thickness determinations. Reconnaissance electrical resistivity surveys are most useful to map silt, clay and evaporite strata where well data are absent.

In conclusion, exploration for low to intermediate temperature (30 to $150^{o}C$) geothermal resources in easily accessible areas near potential users may find resources which will help keep future energy costs low, conserve potable ground water, and insure economic productivity in the developed areas of southern Arizona. Due to extensive ground water development, these areas often have available a great amount of hydrologic and subsurface geologic information, useful for geothermal surveys.

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Appendix 1

Temperature Logs Of Drill Holes

WELL HFI DATE 2/8/82 ELEVATION 3430

LOCATION D-9-26-8 BAC LOGGING SYSTEM UNSU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC
30	88.70	23.54		SAND
35	87.61	23.87	216.5	"
40	87.05	24.04	111.5	"
45	86.58	24.19	98.4	"
50	85.85	24.41	144.4	"
55	84.94	24.69	183.7	"
60	84.16	24.94	164.0	"
65	83.18	25.25	203.4	"
70	82.32	25.52	177.2	"
75	81.36	25.83	203.4	"
80	80.47	26.12	190.3	"
85	79.72	26.36	157.5	"
90	78.92	26.63	177.2	SAND
95	77.99	26.94	203.4	SAND, GRAVEL, "ROCK", INTERBEDDED 5' LAYERS
100	77.64	27.06	78.7	"
105	77.19	27.21	98.4	"
110	76.66	27.39	118.1	"
115	76.25	27.53	91.9	"
120	75.79	27.69	104.9	"
125	75.49	27.79	65.6	"
130	75.07	27.94	98.4	"
135	74.72	28.06	78.7	"
140	74.40	28.17	72.2	"
145	74.14	28.27	65.6	"
150	73.88	28.36	59.1	"
155	73.67	28.43	45.9	"
160	73.46	28.51	52.5	"
165	73.28	28.57	39.4	"
170	73.14	28.62	32.8	"
175	73.02	28.67	32.8	"
180	72.90	28.71	26.3	"
185	72.80	28.74	19.7	"
190	72.62	28.80	39.4	"
195	72.44	28.87	45.9	"
200	72.23	28.95	52.5	"
205	72.00	29.03	52.5	SAND, GRAVEL, "ROCK", INTERBEDDED 5' LAYERS
210				
215				
BOTTOM 206	72.00	29.03		

WELL HF2 DATE 2/8/82 ELEVATION 3495

LOCATION D-9-26-17BBA LOGGING SYSTEM NMSU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC.
30	95.58	21.55		AIR?
35	95.00	21.71	104.9	MEDIUM SAND
40	95.25	21.65	-39.4	"
45	95.39	21.60	-32.8	"
50	95.33	21.62	13.1	"
55	95.15	21.67	32.8	"
60	94.96	21.72	32.8	"
65	94.76	21.78	39.4	"
70	94.56	21.84	39.4	"
75	94.38	21.89	32.8	"
80	94.16	21.95	39.4	"
85	93.94	22.01	39.4	"
90	93.73	22.07	39.4	"
95	93.57	22.12	32.8	"
100	93.41	22.17	32.8	"
105	93.26	22.21	26.3	"
110	93.11	22.25	26.3	"
115	92.96	22.29	26.3	"
120	92.81	22.34	32.8	"
125	92.65	22.38	26.3	"
130	92.54	22.41	32.8	MEDIUM SAND
135	92.39	22.46	32.8	GRAVEL, PEBBLES
140	92.24	22.50	26.3	SAND
145	92.06	22.55	32.8	"HARD ROCK"
150	91.90	22.60	32.8	SAND
155	91.75	22.64	26.3	"
160	91.60	22.69	32.8	"HARD ROCK"
165	91.46	22.73	26.3	"
170	91.30	22.77	26.3	SAND
175	91.13	22.83	39.4	"
180	90.98	22.87	26.3	"
185	90.82	22.92	32.8	"
190	90.69	22.95	19.7	SAND
195	90.58	22.99	26.3	"HARD ROCK"
200				
205		65-195'	MEAN	31.37°C/km ±5.55
210				
215				
BOTTOM 195	90.58	22.99		

WELL HF3 DATE 2/8/82 ELEVATION 3430

LOCATION D-9-26-9BBB LOGGING SYSTEM NMSU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC
30	90.41	23.04		SAND, SILT, CLAY
35	90.32	23.07	19.7	"
40	90.04	23.15	52.5	"
45	89.38	23.34	124.7	"
50	89.00	23.46	78.7	"
55	88.30	23.67	137.8	"
60	87.21	24.00	216.5	"
65	86.68	24.16	104.9	SAND, SILT, CLAY
70	85.89	24.40	157.5	SILT, CLAY
75	85.12	24.64	157.5	"
80	84.76	24.75	72.2	"
85	83.72	25.08	216.5	"
90	83.37	25.19	72.2	"
95	82.81	25.37	118.1	"
100	81.73	25.71	223.1	"
105	81.21	25.88	111.6	"
110	80.59	26.08	131.2	"
115	79.88	26.31	150.9	"
120	79.39	26.48	111.6	"
125	79.03	26.59	72.2	"
130	78.31	26.83	157.5	SILT, CLAY
135	77.85	26.99	104.9	COARSE SAND, PEBBLES WATER?
140	77.30	27.18	124.7	"
145	76.78	27.35	111.6	"
150	76.25	27.53	118.1	"
155	75.86	27.67	91.9	"
160	75.24	27.88	137.8	"
165	74.67	28.08	131.2	"
170	74.03	28.31	150.9	"
175	73.05	28.65	223.1	"
180	72.49	28.85	131.2	COARSE SAND, PEBBLES
185				
190				
195				
200				
205				
210				
215				
BOTTOM 184	72.19	28.96		

WELL HF4 DATE 2/8/82 ELEVATION 3510

LOCATION D-9-26-9-CBC LOGGING SYSTEM NMBU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC.
30	30.32	23.06		MEDIUM SAND
35	90.08	23.13	45.9	"
40	89.47	23.32	124.7	"
45	88.93	23.48	104.9	"
50	88.49	23.61	85.3	"
55	87.81	23.81	131.2	"
60	86.69	24.15	223.1	"
65	85.92	24.39	157.5	"
70	84.96	24.69	196.9	"
75	84.31	24.89	131.2	"
80	83.56	25.13	157.5	"
85	82.79	25.37	157.5	"
90	82.22	25.55	118.1	"
95	81.65	25.74	124.7	"
100	80.85	26.00	170.6	"
105	80.47	26.12	78.7	"
110	79.57	26.41	190.3	"
115	79.11	26.57	104.9	"
120	78.44	26.79	144.4	"
125	77.56	27.09	196.9	"
130	77.10	27.24	98.4	"
135	76.63	27.40	104.9	"
140	76.02	27.61	137.8	"
145	75.45	27.81	131.2	"
150	75.08	27.94	85.3	"
155	74.45	28.16	144.4	"
160	73.92	28.34	118.1	"
165	73.40	28.53	124.7	"
170	72.83	28.73	131.2	"
175	72.20	28.96	150.9	MEDIUM SAND
180	71.59	29.18	144.4	COARSE SAND
185	71.14	29.34	104.9	"
190	70.71	29.50	104.9	"
195	70.27	29.66	104.9	COARSE SAND
200				
205				
210				
215				
BOTTOM 197	70.17	29.70		

WELL HF5 DATE 2/8/82 ELEVATION 3360

LOCATION D-8-26-34 ccc LOGGING SYSTEM NMSU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC.
30	95.41	21,60		SAND
35	95,72	21,51	-59.1	CLAY
40	95,74	21,50	-6.6	"
45	95,58	21,55	32.8	"
50	95.39	21,60	32.8	"
55	95,16	21,67	45.9	"
60	94,99	21,71	26.3	"
65	94,70	21,80	65.6	"
70	94.46	21,87	45.9	"
75	94,19	21,94	45.9	"
80	93,93	22,02	52.5	CLAY
85	93,68	22,09	45.9	SILTY CLAY
90	93,43	22,16	45.9	SAND
95	93,10	22,25	59,1	"
100	92,78	22,34	59,1	"
105	92,49	22,43	59,1	"
110	92,32	22,48	32.8	SILTY CLAY
115	92,08	22,55	45.9	"
120	91,85	22,61	39,4	"
125	91,64	22,67	39,4	"
130	91,41	22,72	32.8	"
135	91,17	22,81	59,1	SILTY CLAY
140	90,96	22,87	39,4	"HARD ROCK"
145	90,73	22,94	45.9	SILTY CLAY
150	90,49	23,10	104,9	"
155	90,16	23,11	6.6	"
160	89,87	23,20	59,1	"
165	89,49	23,31	72.8	"
170	89,49	23,31	0	"
175	89,21	23,39	52.5	"
180	89,16	23,41	13,1	"
185	89,08	23,43	13,1	"
190	88,96	23,47	26,3	"
195	88,61	23,57	65.6	"
200	88,36	23,65	52.5	"
205	88,12	23,72	45.9	"
210	87,89	23,79	45.9	SILTY CLAY
215				
BOTTOM 213	87,83	23,81		

WELL HF6 DATE 2/8/82 ELEVATION 3535

LOCATION D-9-26-10 BDC LOGGING SYSTEM NMSU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC.
30	93.42	22.16		SILT, CLAY
35	93.04	22.27	72.8	SILT, CLAY
40	92.78	22.34	45.9	SAND, GRAVEL
45	92.27	22.49	98.4	"
50	91.86	22.61	78.7	"
55	91.20	22.80	124.7	"
60	90.70	22.95	98.4	"
65	90.28	23.07	78.7	"
70	89.81	23.21	91.9	"
75	89.20	23.40	124.7	SAND GRAVEL
80	88.70	23.55	98.4	SILT, CLAY
85	88.21	23.69	91.9	"
90	87.65	23.86	111.5	"
95	87.04	24.05	124.7	"
100	86.53	24.20	98.4	"
105	86.13	24.33	85.3	"
110	85.59	24.49	104.9	"
115	85.24	24.60	72.2	"
120	84.84	24.72	78.7	"
125	84.41	24.86	91.7	"
130	83.93	25.01	98.4	"
135	83.53	25.14	85.3	"
140	83.14	25.26	78.7	"
145	82.70	25.40	91.9	"
150	82.21	25.56	104.9	"
155	81.82	25.68	78.7	SILT, CLAY
160				
165				
170				
175				
180				
185				
190				
195				
200				
205				
210				
215				
BOTTOM 155	81.82	25.68		

WELL HF7 DATE 2/8/82 ELEVATION 3690

LOCATION D-9-26-15 BDC LOGGING SYSTEM NMSU A1

CABLE RESISTANCE (K OHM) 0.06

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC
30	93.13	22.24		COARSE SAND
35	93.31	22.19	-32.8	"
40	93.19	22.23	26.3	"
45	92.81	22.33	65.6	"
50	92.32	22.48	98.4	"
55	91.84	22.62	91.9	"
60	91.43	22.74	78.7	"
65	90.98	22.87	85.3	COARSE SAND
70	90.54	23.00	85.3	CLAY
75	90.13	23.12	78.7	"
80	89.66	23.26	91.9	"
85	89.23	23.39	85.3	"
90	88.86	23.50	72.2	CLAY
95	88.46	23.62	78.7	SAND
100	87.96	23.77	98.4	"
105	87.53	23.90	85.3	"
110	87.12	24.02	78.7	SAND
115	86.69	24.15	85.3	CLAY
120	86.25	24.29	91.9	SAND
125	85.85	24.41	78.7	SAND
130	85.48	24.53	78.7	CLAY
135	85.10	24.64	72.2	"
140	84.74	24.76	78.7	"
145	84.40	24.86	65.6	"
150	84.01	24.98	78.7	CLAY
155	83.69	25.09	72.2	SILT, SANDY CLAY
160	83.31	25.21	78.7	"
165	82.94	25.32	72.2	"
170	82.57	25.44	78.7	"
175	82.20	25.56	78.7	"
180	81.84	25.67	72.2	"
185	81.48	25.79	78.7	"
190	81.08	25.92	85.3	"
195	80.67	26.06	91.9	"
200	80.31	26.17	72.2	"
205	79.96	26.29	78.7	"
210	79.67	26.71	275.6	SILT, SANDY CLAY
215				
BOTTOM 211	79.66	26.72		

WELL HF10 DATE 2/8/82 ELEVATION 3345

LOCATION D-8-26-310CD LOGGING SYSTEM NMSU A1

CABLE RESISTANCE (K OHM) 006

DEPTH (FEET)	RESISTANCE (K OHMS)	TEMPERATURE °C	GRADIENT °C/KM	DRILLERS LOG, REMARKS, ETC.
30	92.71	22.37		IRRIGATION WELL 300 FEET
35	92.35	22.47	65.6	NORTHEAST OF HF10 PUMPING
40	92.16	22.52	32.8	29°C WATER
45	91.61	22.68	104.9	SILT, CLAY
50	90.75	22.93	164.0	SILT, CLAY
55	90.33	23.06	85.3	SAND, GRAVEL
60	89.84	23.21	98.4	"
65	89.38	23.34	85.3	"
70	89.02	23.45	72.2	"
75	88.66	23.56	72.2	"
80	88.34	23.65	59.1	"
85	87.81	23.81	104.9	"
90	87.57	23.88	45.9	"
95	87.12	24.02	91.9	"
100	86.44	24.23	137.8	"
105	85.09	24.64	269.0	"
110	82.75	25.38	485.6	" WATER
115	81.92	25.65	177.2	"
120	81.67	25.73	52.5	"
125	81.36	25.83	65.6	"
130	81.14	25.90	45.9	"
135	81.00	25.95	32.8	"
140	80.49	26.11	104.9	"
145	80.03	26.27	104.9	SAND, GRAVEL
150				
155				
160				
165				
170				
175				
180				
185				
190				
195				
200				
205				
210				
215				
BOTTOM 149.6	79.78	26.35		

Appendix 2

Copies Of Well Completion Reports

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE. TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR NAME OF LESSOR IF FEE LEASE~~ SLO # 23-60553 (SP. LAND USE) DWR# 55-501484 (EXEMPT WELL)	WELL NUMBER HF1 — FIELD & RESERVOIR ARTESIA
LOCATION NL 1100 WL 1400	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY SW 1/4, NE 1/4, NW 1/4 SEC 8 T. 9 S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, OR GR.)	ELEVATION OF CASING ~~HD. FLANGE~~
10 DEC. 1981	14 DEC. 1981	N/A	3430 FEET	3431 FEET

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
206	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0 - 206	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	~4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	206 FEET		NONE

TUBING RECORD N/A — LINER RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.	SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A — ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL	AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE	N/A STATIC TEST SHUT IN WELL HEAD		ANALYSES OF FLUIDS & GASES N/A								
			TOTAL MASS FLOW DATA N/A					SEPARATOR DATA N/A			
	TEMP. °F	PRES. PSIG.	LBS/HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT/HR	STEAM LBS/HR	PRES. PSIG.	TEMP. °F

CERTIFICATE: I, THE UNDERSIGNED, UNDER THE PENALTY OF PERJURY, STATE THAT I AM THE GEOLOGIST OF THE ABGMT (COMPANY), AND THAT I AM AUTHORIZED BY SAID COMPANY TO MAKE THIS REPORT; AND THAT THIS REPORT WAS PREPARED UNDER MY SUPERVISION AND DIRECTION AND THAT THE FACTS STATED THEREIN ARE TRUE, CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

14 MAY 1982
DATE

James C. Witcher
SIGNATURE JAMES C. WITCHER

PERMIT NO. 781

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE. TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN TRACT NUMBER~~ ~~OR NAME OF LESSOR IF FEE LEASE~~ SLO# 23-60553 (SP. LAND USE) DWR# 55-501485 (EXEMPT WELL)	WELL NUMBER HF2 — FIELD & RESERVOIR ARTESIA
LOCATION NL 100 WL 1200	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY NE 1/4, NW 1/4, NW 1/4, SEC 17, T. 9 S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, ~~RKB~~, RT, OR GR.) FEET	ELEVATION OF CASING ~~RD. FLANGE~~ FEET
9 DEC. 1981	10 DEC. 1981	N/A	3495	3496

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
200	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0-200	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	~4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	195 FEET		NONE

TUBING RECORD N/A — LINER RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.	SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A — ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL	AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE N/A — STATIC TEST SHUT IN WELL HEAD — ANALYSES OF FLUIDS & GASES N/A

TOTAL MASS FLOW DATA N/A — SEPARATOR DATA N/A

TEMP. °F	PRES. PSIG.	LBS./HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT./HR	STEAM LBS/HR	PRES. PSIG.	TEMP. °F

CERTIFICATE: I, THE UNDERSIGNED, UNDER THE PENALTY OF PERJURY, STATE THAT I AM THE GEOLOGIST OF THE ABGMT (COMPANY), AND THAT I AM AUTHORIZED BY SAID COMPANY TO MAKE THIS REPORT; AND THAT THIS REPORT WAS PREPARED UNDER MY SUPERVISION AND DIRECTION AND THAT THE FACTS STATED THEREIN ARE TRUE, CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

14 MAY 1982
DATE

James C. Witcher
SIGNATURE JAMES C. WITCHER

PERMIT NO. 786

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE. TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR NAME OF LESSOR IF FEE LEASE~~ BLM#AZ-040-1-B-49 (NOT. INTENT) DWR#55-501486 (EXEMPT WELL)	WELL NUMBER HF3 FIELD & RESERVOIR ARTESIA
LOCATION NL 100 WL 100	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY NW1/4, NW1/4, NW1/4 Sec 9, T. 9 S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, OR (GR)) FEET	ELEVATION OF CASING ~~HD. FLANGE~~ FEET
1 DEC. 1981	2 DEC. 1981	N/A	3430	3431

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
200	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0-200	

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	~4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200PSI	184 FEET		NONE

TUBING RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.

LINER RECORD N/A

SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE	N/A STATIC TEST SHUT IN WELL HEAD		ANALYSES OF FLUIDS & GASES N/A								
			TOTAL MASS FLOW DATA N/A					SEPARATOR DATA N/A			
	TEMP. °F	PRES. PSIG.	LBS./HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT./HR	STEAM LBS./HR	PRES. PSIG.	TEMP. °F

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14 MAY 1982
DATE

James C. Witcher
SIGNATURE JAMES C. WITCHER

PERMIT NO. 782

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE., TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR NAME OF LESSOR IF FEE LEASE~~ BLM # AZ-040-1-G-49 (NOT. INTENT) DWR # 55-501487 (EXEMPT WELL)	WELL NUMBER HF4 FIELD & RESERVOIR ARTESIA
LOCATION SL 1500 WL 100	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY SW 1/4, NW 1/4, SW 1/4, SEC 9, T. 9S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, OR (GR)) FEET	ELEVATION OF CASING ~~HD. FLANGE~~ FEET
20 DEC 1981	30 DEC. 1981	N/A	3510	3511

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
210	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0 - 210	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	N 4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	197 FEET		NONE

TUBING RECORD N/A

LINER RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.	SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL	AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE N/A

STATIC TEST SHUT IN WELL HEAD — TEMP. °F | PRES. PSIG.

ANALYSES OF FLUIDS & GASES N/A

TOTAL MASS FLOW DATA N/A — LBS./HR | TEMP. °F | PRES. PSIG. | ENTHALPY | ORIFICE

SEPARATOR DATA N/A — WATER CUFT/HR | STEAM LBS/HR | PRES. PSIG. | TEMP. °F

CERTIFICATE: I, THE UNDERSIGNED, UNDER THE PENALTY OF PERJURY, STATE THAT I AM THE GEOLOGIST OF THE ABGMT (COMPANY), AND THAT I AM AUTHORIZED BY SAID COMPANY TO MAKE THIS REPORT; AND THAT THIS REPORT WAS PREPARED UNDER MY SUPERVISION AND DIRECTION AND THAT THE FACTS STATED THEREIN ARE TRUE, CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DATE 14 MAY 1982

SIGNATURE James C. Witcher

PERMIT NO. 783

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AV., TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR PARTY OR LEASE~~ BLM # AZ-040-1-G-49 (NOT. INTENT) DWR # 55-501408 (EXEMPT WELL)	WELL NUMBER HF5 FIELD & RESERVOIR ARTESIA
LOCATION SL 100 WL 300	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY SW 1/4, SW 1/4, SW 1/4, SEC 34, T. 8 S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, OR GR) FEET	ELEVATION OF CASING ~~HD. FLANGE~~ FEET
9 DEC. 1981	9 DEC. 1981	N/A	3360	3361

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
213	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0-213	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	N 4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	213 FEET		NONE

TUBING RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.

LINER RECORD N/A

SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE	N/A STATIC TEST SHUT IN WELL HEAD		ANALYSES OF FLUIDS & GASES N/A								
			TOTAL MASS FLOW DATA N/A					SEPARATOR DATA N/A			
	TEMP. °F	PRES. PSIG.	LBS./HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT./HR	STEAM LBS./HR	PRES. PSIG.	TEMP. °F

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14 MAY 1982
DATE

James C. Witcher
SIGNATURE JAMES C. WITCHER

PERMIT NO. 780

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE. TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR PATENT OR LEASE~~ BLM# AZ-040-1-G-49 (NOT. INTENT) DWR # 55-501489 (EXEMPT WELL)	WELL NUMBER HF6 FIELD & RESERVOIR ARTESIA
LOCATION NL 2400 WL 1200	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY SW 1/4, SE 1/4, NW 1/4, SEC 10, T. 9S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, OR (GR)) FEET	ELEVATION OF CASING ~~HD. FLANGE~~ FEET
4 DEC. 1981	4 DEC. 1981	N/A	3535	3536

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
200	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0-200	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	~4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	155 FEET		NONE

TUBING RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.

LINER RECORD N/A

SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE N/A STATIC TEST SHUT IN WELL HEAD

ANALYSES OF FLUIDS & GASES N/A

TOTAL MASS FLOW DATA N/A

SEPARATOR DATA N/A

TEMP. °F	PRES. PSIG.	LBS./HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT./HR	STEAM LBS./HR	PRES. PSIG.	TEMP. °F

CERTIFICATE: I, THE UNDERSIGNED, UNDER THE PENALTY OF PERJURY, STATE THAT I AM THE GEOLOGIST OF THE ABGMT (COMPANY), AND THAT I AM AUTHORIZED BY SAID COMPANY TO MAKE THIS REPORT; AND THAT THIS REPORT WAS PREPARED UNDER MY SUPERVISION AND DIRECTION AND THAT THE FACTS STATED THEREIN ARE TRUE, CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

14 MAY 1982
DATE

James C. Witcher
SIGNATURE JAMES C. WITCHER

PERMIT NO. 784

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE, TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR PATENT OR RECORD OF PRIV LEASE~~ BLM # AR-040-1-B-49 (NOT. INTENT) DWR # 55-501490 (EXEMPT WELL)	WELL NUMBER HF 7 — FIELD & RESERVOIR ARTESIA
LOCATION NL 2400 WL 1500	COUNTY GRAHAM
SEC. TWP-RANGE OR BLOCK & SURVEY SW 1/4, SE 1/4, NW 1/4, SEC 15, T. 9S., R 26E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, OR GR.) FEET	ELEVATION OF CASING ~~HD. FLANGE~~ FEET
7 DEC. 1981	7 DEC. 1981	N/A	3690	3691

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
213	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0-213	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	~4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	211 FEET		NONE

TUBING RECORD N/A — LINER RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.	SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A — ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL	AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE N/A — STATIC TEST SHUT IN WELL HEAD — ANALYSES OF FLUIDS & GASES N/A

TOTAL MASS FLOW DATA N/A — SEPARATOR DATA N/A

TEMP. °F	PRES. PSIG.	LBS./HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT./HR	STEAM LBS/HR	PRES. PSIG.	TEMP. °F

CERTIFICATE: I, THE UNDERSIGNED, UNDER THE PENALTY OF PERJURY, STATE THAT I AM THE GEOLOGIST OF THE ABGMT (COMPANY), AND THAT I AM AUTHORIZED BY SAID COMPANY TO MAKE THIS REPORT; AND THAT THIS REPORT WAS PREPARED UNDER MY SUPERVISION AND DIRECTION AND THAT THE FACTS STATED THEREIN ARE TRUE, CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DATE 14 MAY 1982

SIGNATURE James C. Witcher — JAMES C. WITCHER

PERMIT NO. 785

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

GEOTHERMAL RESOURCE WELL

DESIGNATE TYPE OF COMPLETION:

NEW WELL ☐ WORK OVER ☐ DEEPEN ☐ PLUG BACK ☒ SAME RESERVOIR ☐ DIFFERENT RESERVOIR ☐ DRY STEAM ☐ HOT WATER ☐ DRY ☒

DESCRIPTION OF WELL AND LEASE

OPERATOR ARIZONA BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY (ABGMT)	ADDRESS 845 N. PARK AVE. TUCSON, ARIZONA 85719
FEDERAL, STATE ~~OR INDIAN LEASE~~ NUMBER ~~OR NAME OF LESSOR IF FEE LEASE~~ SLO# 23-60553 (SP. LAND USE) DWR# 55-501497 (EXEMPT WELL)	WELL NUMBER HF10 FIELD & RESERVOIR ARTESIA
LOCATION 5L 100 EL 1600	COUNTY GRAHAM
SEC., TWP-RANGE OR BLOCK & SURVEY SE 1/4, SW 1/4, SE 1/4, SEC 31, T. 8 S., R. 26 E.	

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, ~~RKB~~, RT, OR GR.) FEET	ELEVATION OF CASING ~~HD. PLANGE~~ FEET
15 DEC. 1981	15 DEC. 1981	N/A	3345	3346

TOTAL DEPTH	P.B.T.D.	AIRDRILLED (INTERVAL)	FLUIDDRILLED (INTERVAL)
160	200 FEET		

PRODUCING INTERVAL (S) FOR THIS COMPLETION	ROTARY TOOLS USED (INTERVAL)	CABLE TOOLS USED (INTERVAL)
NONE - COMPLETED AS HEAT FLOW HOLE	0-160	N/A

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO	N/A	N/A

TYPE OF ELECTRICAL, TEMPERATURE, CEMENT BOND OR OTHER LOGS RUN (CHECK LOGS FILED WITH THE COMMISSION)	DATE FILED
TEMPERATURE	MAY 1982

CASING RECORD

CASING (REPORT ALL STRINGS SET IN WELL-CONDUCTOR, SURFACE, INTERMEDIATE, PRODUCING, ETC.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (LB./FT.)	DEPTH SET	SACKS CEMENT	AMT. PULLED
SURFACE	4 IN.	~4 IN.	IRON PIPE	10 FEET		NONE
TEMP. LOG	4 IN.	1 IN.	PVC 200 PSI	150 FEET		NONE

TUBING RECORD N/A

SIZE IN.	DEPTH SET FT.	PACKER SET AT FT.

LINER RECORD N/A

SIZE IN.	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN (FT.)

PERFORATION RECORD N/A

NUMBER PER FT.	SIZE & TYPE	DEPTH INTERVAL

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD N/A

AMT. & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE	N/A STATIC TEST SHUT IN WELL HEAD		ANALYSES OF FLUIDS & GASES N/A								
			TOTAL MASS FLOW DATA N/A					SEPARATOR DATA N/A			
	TEMP. °F	PRES. PSIG.	LBS./HR	TEMP. °F	PRES. PSIG.	ENTHALPY	ORIFICE	WATER CUFT./HR	STEAM LBS./HR	PRES. PSIG.	TEMP. °F

CERTIFICATE: I, THE UNDERSIGNED, UNDER THE PENALTY OF PERJURY, STATE THAT I AM THE GEOLOGIST OF THE ABGMT (COMPANY), AND THAT I AM AUTHORIZED BY SAID COMPANY TO MAKE THIS REPORT; AND THAT THIS REPORT WAS PREPARED UNDER MY SUPERVISION AND DIRECTION AND THAT THE FACTS STATED THEREIN ARE TRUE, CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

14 MAY 1982
DATE

James C. Witcher
SIGNATURE JAMES C. WITCHER

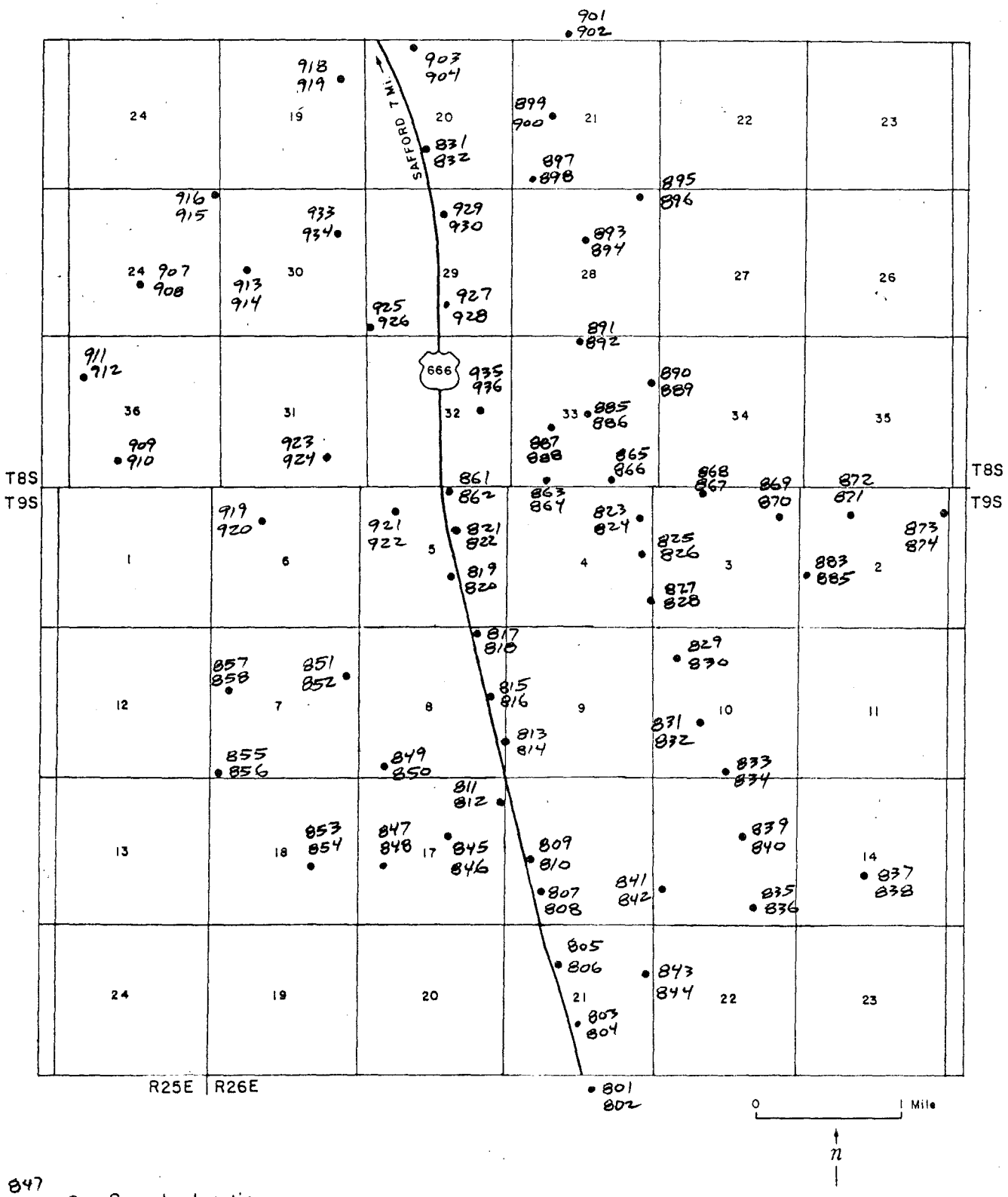
PERMIT NO. 779

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG
FILE ONE COPY
FORM NO. G-1

(COMPLETE REVERSE SIDE)

Appendix 3

Mercury Soil Data


SAFFORD TWL
666
T8S
T9S
R25E
R26E
0
1 Mile
N
847
848
Sample location
LAST THREE DIGITS OF SAMPLE NUMBER

TUCSON OFFICE

ROCKY MOUNTAIN GEOCHEMICAL CORP.

2561 EAST FORT LOWELL ROAD · TUCSON, ARIZONA 85716 · PHONE: (602) 795-9780

Certificate of Analysis

RMGC Numbers:

Local Job No.: 80-56-16T

Foreign Job No.:

Invoice No.: T10163

Date: January 20, 1981

Client: Bureau of Geology & Mineral Techmology
Geothermal Group
2045 N. Forbes Blvd.
Suite 106
Tucson, Arizona 85705

Client Order No.:

Report On: 136 samples

Submitted by: J.C. Witcher

Date Received: December 8, 1980

Analysis: Hg

Analytical Methods: Determined by Atomic Absorption.

Remarks:

cc: Enc: 1
RMGC/SLC
file

SJA/lr

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

Sample Number	Hg ppb	Sample Number	Hg ppb
417801	285	417826	190
02	285	27	285
03	285	28	190
04	190	29	190
05	190	417830	190
06	190	31	190
07	665	32	190
08	475	33	95
09	285	34	190
417810	380	35	95
11	380	36	190
12	285	37	190
13	380	38	190
14	285	39	285
15	380	417840	285
16	285	41	950
17	380	42	190
18	380	43	95
19	285	44	190
417820	380	45	190
21	285	46	95
22	285	47	95
23	285	48	190
24	285	49	95
417825	285	417850	285

Sample Number	Hg ppb	LOCATION
417851	285	
52	475	
53	285	
54	380	
55	285	
56	285	
57	380	
58	280	
59	280	
417860	380	
61	95	
62	190	
63	190	
64	190	
65	190	
66	190	
67	190	
68	95	
69	285	
417870	285	
71	285	
72	190	
73	190	
74	190	
417875	190	D-9-26-1 BAA
417876	190	D-9-26-1 BAA
77	285	D-9-26-1 AAA
78	190	D-9-26-1 AAA
79	380	D-9-26-12 DAD
417880	380	D-9-26-12 DAD
81	285	D-9-26-1 DDD
82	190	D-9-26-1 DDD
83	190	
84	285	
85	190	
86	190	
87	190	
88	190	
89	285	
417890	190	
91	190	
92	190	
93	285	
94	285	
95	190	
96	95	
97	190	
98	95	
99	760	
417900	190	

Client Bureau of Geology Date January 20, 1981 RMGC Job No. 80-56-16T

Sample Number	Hg ppb	Location
417901	285	
02	190	
03	190	
04	190	
05	285	D-8-25-26 BCC
06	190	D-8-25-26 BCC
07	285	
08	190	
09	190	
417910	190	
11	285	
12	190	
13	285	
14	285	
15	190	
16	190	
17	95	
18	190	
19	285	
417920	190	
21	95	
23	95	
24	95	
417925	95	

Sample Number	Hg ppb
417926	95
27	190
28	190
29	190
417930	190
31	95
32	95
33	190
34	95
35	95
417936	190

By Shirley J. Aiken

Shirley J. Aiken

ROCKY MOUNTAIN GEOCHEMICAL CORP.

SALT LAKE CITY, UTAH • RENO, NEVADA • TUCSON, ARIZONA