A HYDROGEOCHEMICAL STUDY
OF THE BIEBER GEOTHERMAL PROSPECT
OF NORTH CENTRAL CALIFORNIA

by

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AMAX Exploration, Inc.

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SUMMARY

1. The Bieber geothermal prospect lies in north central California. The area contains 4 hot springs and at least 8 warm springs and/or wells.

2. Non thermal waters contain less than 200 mg/l of dissolved solids. Background SiO_2 content is about 55 mg/l. Cations and anions occur as follows:

   $HCO_3 > Cl \sim SO_4$ Na> Ca> Mg> Ca.

3. Kellog, Bassett and Little Hot Spring and 4140 Hot Artesian Well are the most interesting thermal features. They show strong chemical similarities and are also similar to Kelley Hot Spring. based on relationships between SO_4-Cl-HCO_3, Na-B, Na-Ca, SiO_2-Cl/HCO_3 SiO_2-TDS, and subsurface temperatures. These hot waters demonstrate ionic relationship:

   $SO_4 > Cl > HCO_3$ Na > Ca > K > Mg.

   Hot waters demonstrate no evidence of mixing.

4. Hot springs demonstrate similar water age based on principle ionic distribution.

5. Mineral equilibria indicates that all hot waters last equilibrated with an altered volcanic rock.

6. Hot water systems are indicated by basic pH, low levels of NH_3, Li, B, high concentrations of Cl and the Cl/F and Cl/SO_4 ratios.

7. Subsurface temperatures are considered reliable and show maximum temperatures of 130°C. Correlation between SiO_2 and alkali thermometers is poor.

8. The hydrogeochemistry of the Bieber area implies homogenous chemical and physical subsurface conditions. Waters do not indicate the necessary subsurface temperatures for electric power production. Hydrogeochemistry thus argues for a low rating as a geothermal prospect.

THERMAL FEATURES

Sixty-five water samples were collected from the Bieber area of north central California (Figure 1) during August, 1974. Sample locations are shown on the sample map at the end of this report. Spring and well temperatures range from 89°C at Kellog Hot Spring (X90045) to 7°C at Hamlin Cold Spring (X90020). Twelve wells or springs have the surface temperatures greater than 22°C. The surface temperatures of the remaining 53 water samples indicate that the background temperature of the area is 14°C. The thermal features are further described in Table 1. Heat discharge was calculated from spring flow by subtracting 14 cal/gr background enthalpy from the actual water enthalpy.

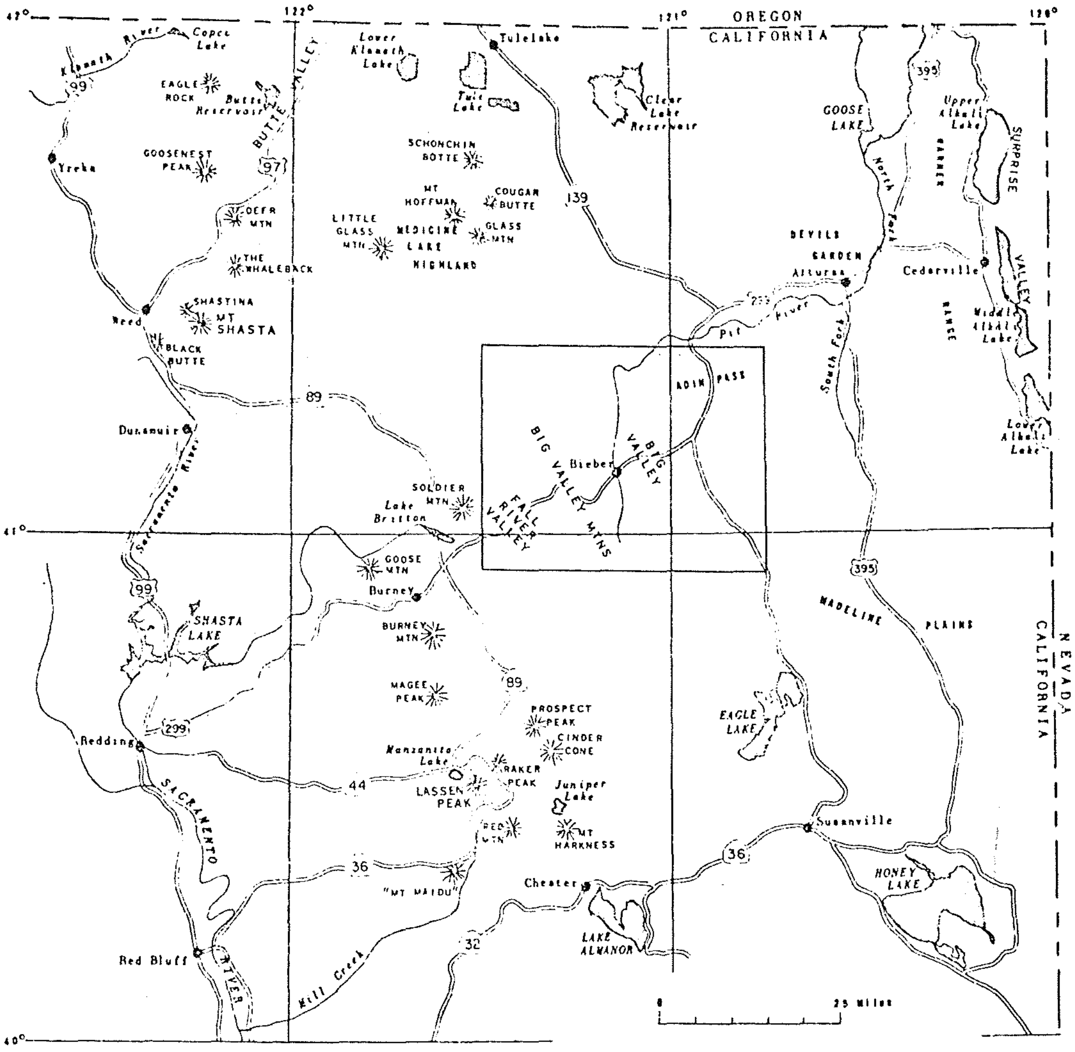

Figure 1. Location map of the Bieber Geothermal Prospect.

Table 1. Thermal features of the Bieber area.

	Sample Number & Name	T°C	Flow l/pm	Well Depth meters	Heat Discharge cal/sec
X90044	Kellog Hot Spring West	89	189	---	$2.4x10^5$
X90039	Bassett Hot Spring	78	662	---	$7.1x10^5$
X90018	Little Hot Spring	75.5	757	---	$7.8x10^5$
X90035	4140 Hot Artesian Well	64	11	11	$9.2x10^3$
X90051	Henson Warm Well	31	946	?	$2.7x10^5$
X90017	Tyrrell Warm Well	30	378	24	$1.0x10^5$
X90023	Dixon Flat Warm Spring	28	?	---	---
X90072	Willow Creek Warm Spg.	28	757	---	$1.8x10^5$
X90016	Dutch Flat Warm Spring	25	4	---	$7.3x10^2$
X90070	Lower McBride Warm Spg.	24	378	---	$6.3x10^4$
X90062	Bennett Artesian W.W.	23	75	38	$1.1x10^4$
X90068	Knudson Warm Well	22	189	67	$2.8x10^4$
					$2.4x10^6$ cal/sec
					$9.5x10^3$ BTU/sec

A complete description of each thermal feature is given in Appendix 1.

Plates 1 through 7 are pictorial representations of some thermal features.

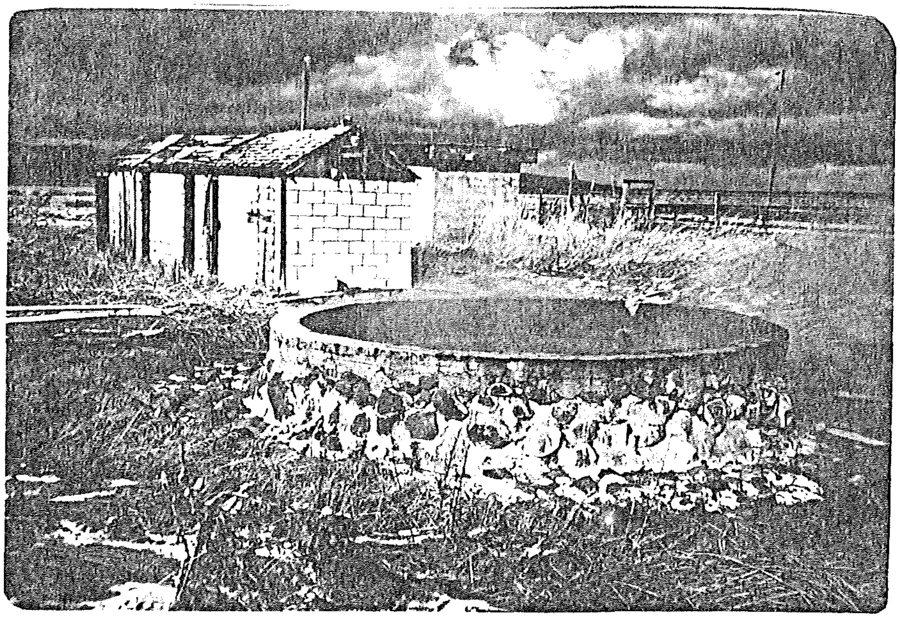

Plate 1. Kellog Hot Spring West
T = 89°C at 189 lpm

Plate 2. Bassett Hot Spring
T = 78°C at 662 lpm

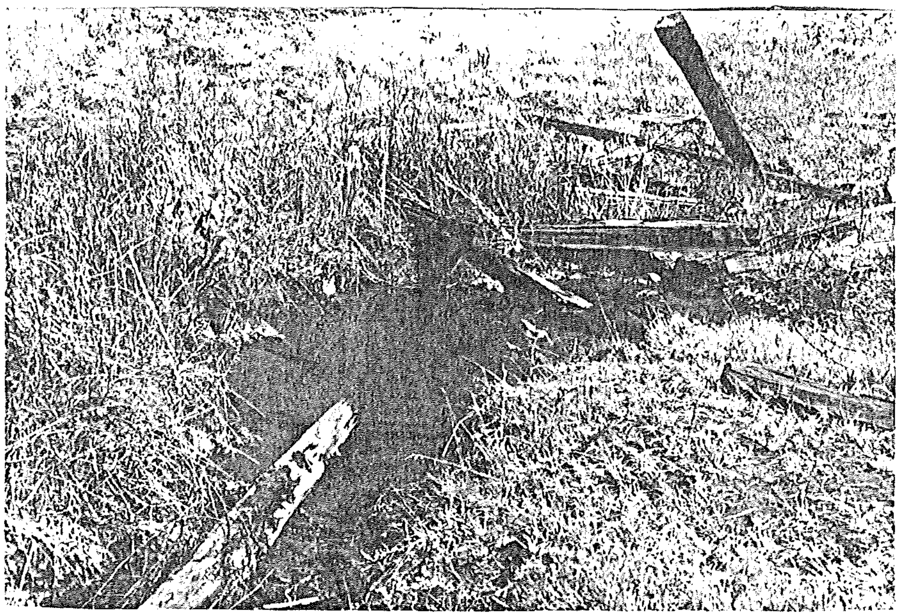

Plate 3. Little Hot Spring
T = 75.5°C at 757 lpm

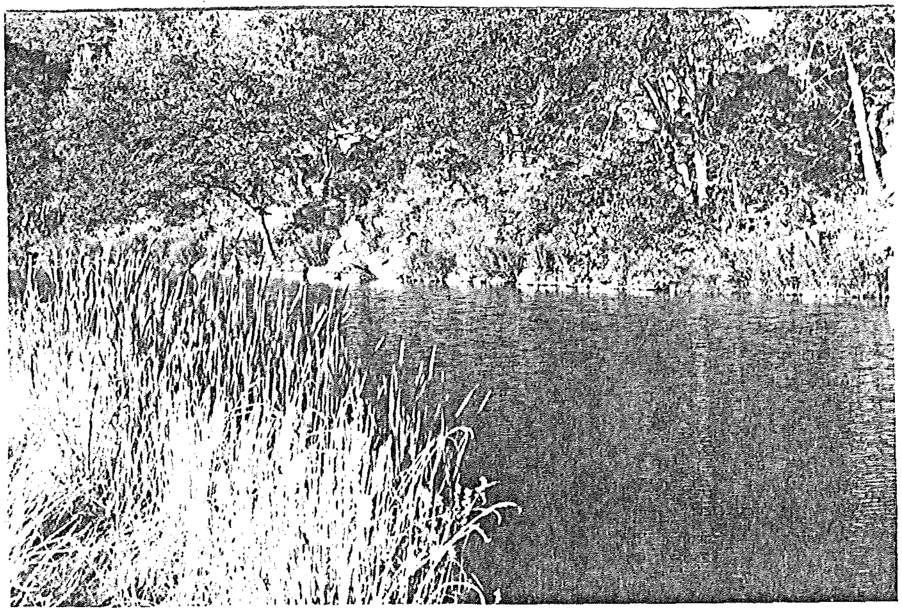

Plate 4. Dixon Flat "Hot" Spring. The pond temperature
is 28°C but the feeder spring is probably much hotter.

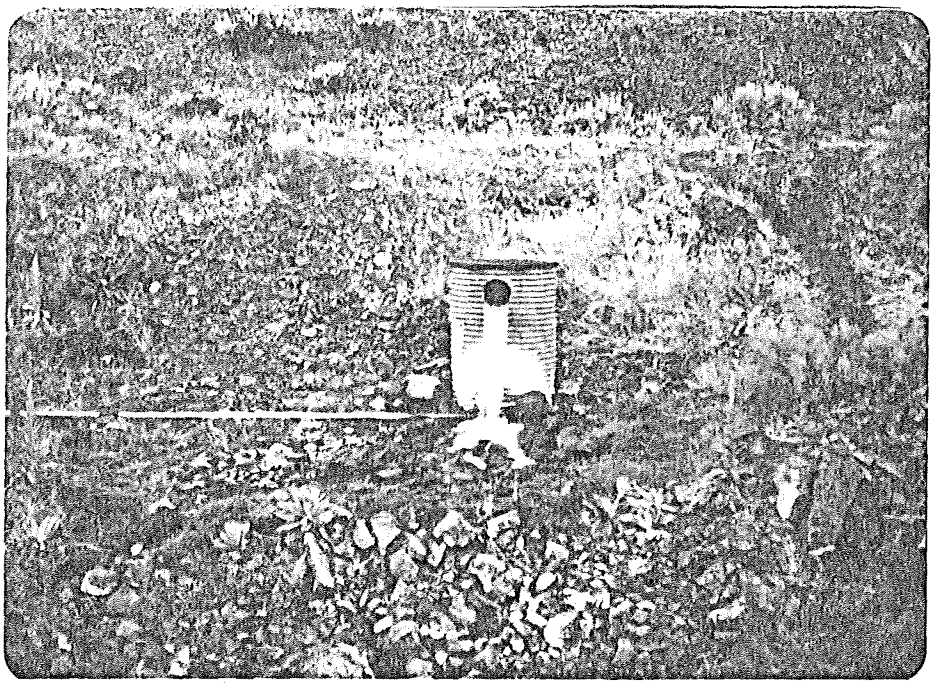

Plate 5. Willow Creek Warm Spring
T = 28°C at 757 lpm

Plate 6. Dutch Flat Warm Spring
T = 25°C at 4 lpm

Plate 7. Lower McBride Warm Spring
T = 24°C at 378 lpm

CHEMISTRY

The non-thermal waters of the Bieber area generally contain less than 200 mg/l of dissolved solids. Water pH is near neutral. Bicarbonate is the principle ion with lessor amounts of sodium, calcium, magnesium and chloride. Cold waters generally contain about 55 mg/l of SiO_2 although 75 mg/l is not uncommon. Ash Creek Cold Spring X90066 was selected to represent average background chemistry for the area (Table 1).

Thermal waters range from near neutral to basic. The hottest waters contain sulfate as the principle anion, while bicarbonate predominates in warm waters (Tables 2 and 3). Hot thermal water contains more than 80 mg/l of chloride indicating hot water systems at depth. Fluoride concentrations are low and range from 0.14 to 2.4 mg/l. Boron concentrations range from 1.0 mg/l to 3.2 mg/l in the hottest waters. The silica concentrations in hot springs are above background but do not exceed 86 mg/l. Ammonia and sulfide concentrations are in tune with a low temperature hot water system. Thermal waters are dilute and do not exceed 921 mg/l of total dissolved solids.

Figures 2, 3, 4 and 5 are geochemical plots of the thermal and non-thermal waters of the Bieber area and Kelley Hot Spring. These figures demonstrate that Kellog, Bassett and Little Hot Springs and 4140 Hot Artesian Well are very similar chemically. These similarities indicate equivalent reservoir rocks, subsurface temperatures and depth to the respective reservoirs. These similarities also evidence the lack of mixing in the aforementioned hot waters, i.e. if mixing did occur the waters would contain differing cold water fractions and data points would show a broad scatter on these diagrams. It would be too fortuitous that the mixing fractions for all the hot springs are identical. The remaining warm waters shown on these diagrams are strongly mixed with surface waters.

Silica and total dissolved solids are compared in Table 4. Note that silica does not vary proportionately with surface water temperature. Total dissolved solids do increase with surface water temperature. The TDS/SiO_2 ratios comprise two groups, one for hot waters and one for warm waters. TDS/SiO_2 ratios for hot waters are tightly grouped between 10.7 and 11.8 while the warm waters exhibit ratios between 3.0 and 4.6. The TDS/SiO_2 ratios indicate that hot waters are similar.

Table 2. Chemical analyses of the thermal feature of the Bieber area, California. Units are mg/l unless otherwise noted.

	Kellog Hot Spg. West X90044	Bassett Hot Spring X90039	Little Hot Spring X90018	4140 Hot Art. W. X90035	Henson Warm Well X90051	Tyrrell Warm Art. W. X90017	Dixon Flat Warm Spring X90023	Willow Creek Warm Spring X90072	Dutch Flat Warm Spring X90016	Lower McBride Warm Spring X90070	Bennett Art. Warm Well X90062	Knudson Warm Well X90068	Ash Creek Cold Spring X90066
pH	9.0	9.1	8.1	9.2	7.35	8.3	9.2	7.9	7.8	8.5	8.4	7.6	7.4
Cl	86	94	90.0	80.0	6.0	1.3	2.3	1.3	1.2	1.6	1.7	2.3	1.1
F	2.40	1.88	2.3	1.78	.25	0.16	0.19	0.16	.18	.17	.22	0.18	0.14
HCO_3	27	27	40	27	150	96	75	78	95	85	73	163	66
CO_3	0	0	0	0	0	0	0	0	0	0	0	0	0
SO_4	400	350	400	360	2	1	4	< 1	2	1	1	2	1
SiO_2	83	75	86	68	81	45	50	46	64	38	60	82	32
Na	240	220	240	230	70	21	16	20	31	20	21	50	49
K	5.6	3.2	5.6	3.4	7.1	6.4	3.2	4.2	6.1	4.5	5.6	8.1	.7
Ca	35	36	40	26	2	14	9	14	9	13	7	22	17
Mg	< .1	.1	.3	< .1	2	3	6	3	2	4	3	5	7
Li	.1	.1	.2	.1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
B	2.6	2.3	3.2	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cu	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
Mo μg/l	60	40	40	40	6	2	2	< 1	2	< 1	2	4	< 1
Zn	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	1
Fe	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
NH_3	.22	.48	.13	.51	1.14	.01	.07	.05	.10	.02	0.0	.22	.04
H_2S	2.04	2.38	.34	1.70	1.36	.34	.34	0	.34	.68	0.34	1.19	.51
TDS	894.2	821.7	420.9	802.8	327.4	193.9	171.7	173.7	216.6	173.3	178.5	341.9	176.7
T°C	89	78	75.5	64	31	30	28	28	25	24	23	22	12
Flow(lpm)	189	662	575	11	946	378	?	757	4	378	75	189	40
$TSiO_2$ °C	127	121.7	128.9	116.7	125.7	96.9	101.8	98	113.7	89.4	110.5	126.4	82.1
TNa/K °C	59.9	33.0	59.9	33.8	185.4 *	365.5 *	282.0 *	290.5 *	279.2 *	303.0 *	336.4 *	247.9 *	32.1
TNa-K-Ca °C	77.5	58.9	74.6	67.6	186.3 *	75.3	60.4	61.9	87.7	65.4	86.1	82.6	81.5
Cl/SO_4	.6	.7	.6	.6	8.1	3.5	1.6	3.5	1.6	4.3	4.6	3.1	3.0
Cl/HCO_3	5.5	6.0	3.9	5.1	.1	.02	.05	.03	.02	.03	.04	.02	.03
Cl/F	19.0	26.5	20.7	23.8	12.7	4.3	6.4	4.3	3.5	5.0	4.1	6.8	4.3

* Does not reflect true subsurface conditions.

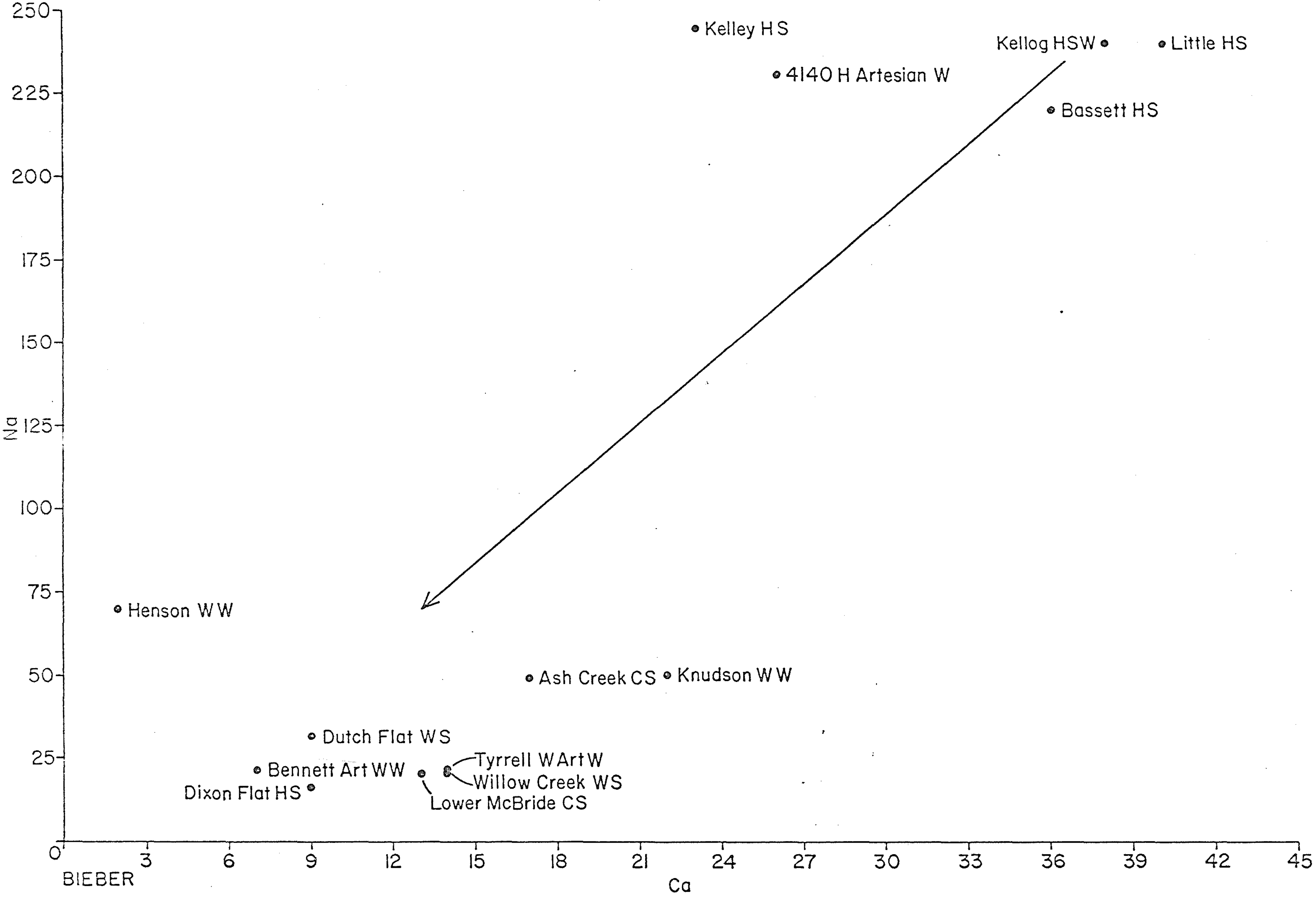

Figure 2. The relationship between Na and Ca for the thermal and non-thermal waters of the Bieber, California, area.

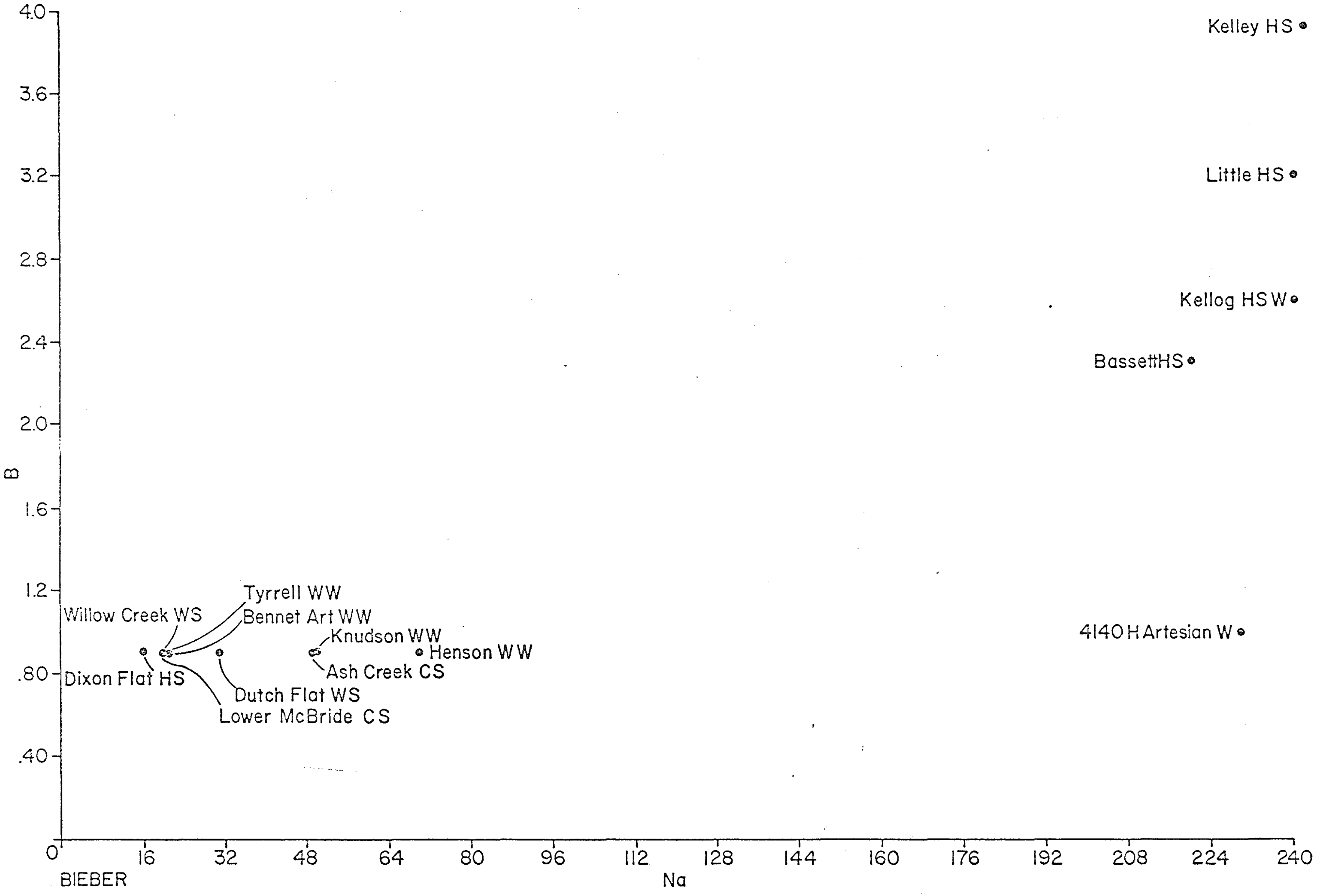

Figure 3. The relationship between B and Na for the thermal and non-thermal waters of the Bieber, California, area.

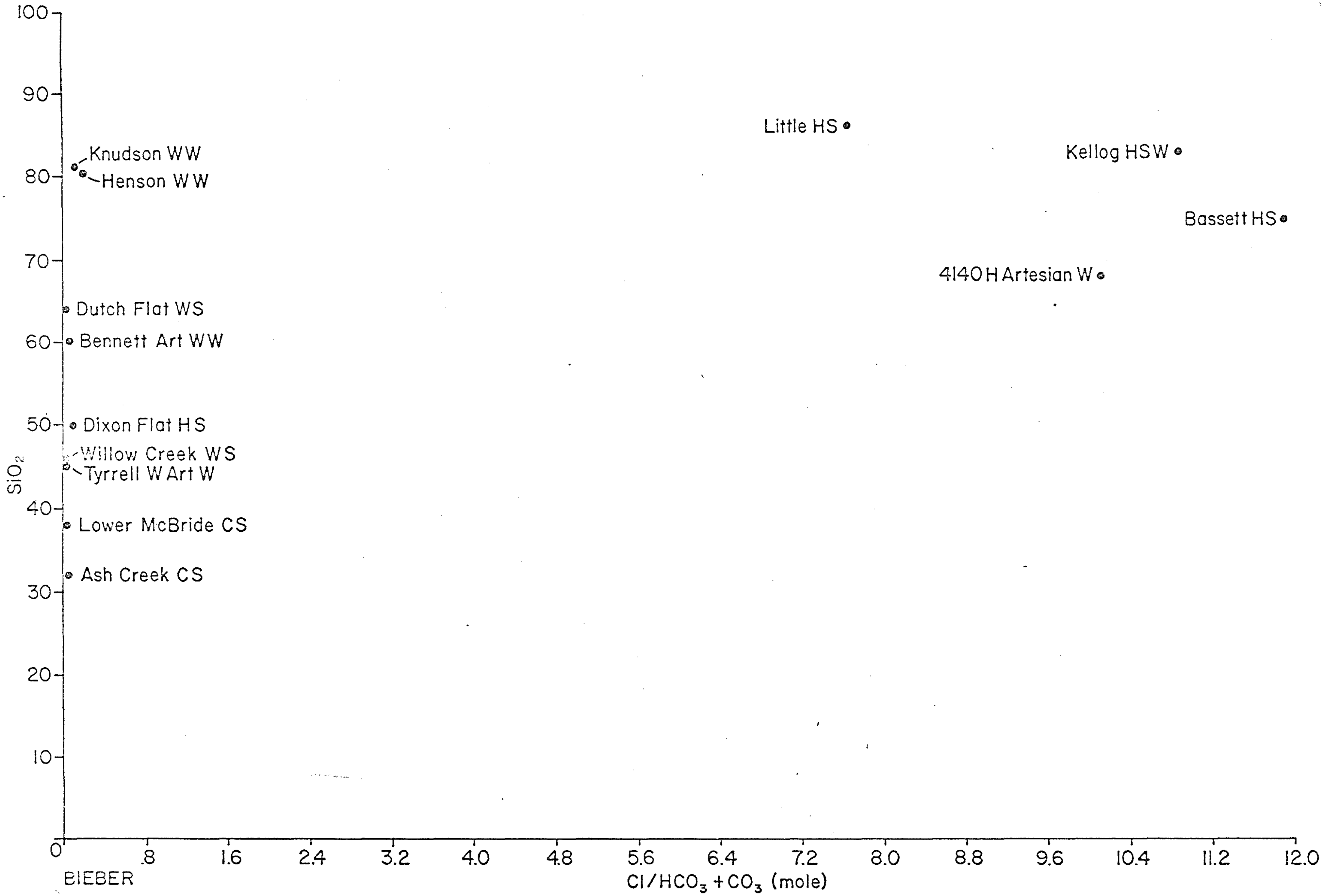

Figure 4. The relationship between SiO_2 and the Cl/HCO_3+CO_3 ratio for the thermal and non-thermal waters of the Bieber, California, area.

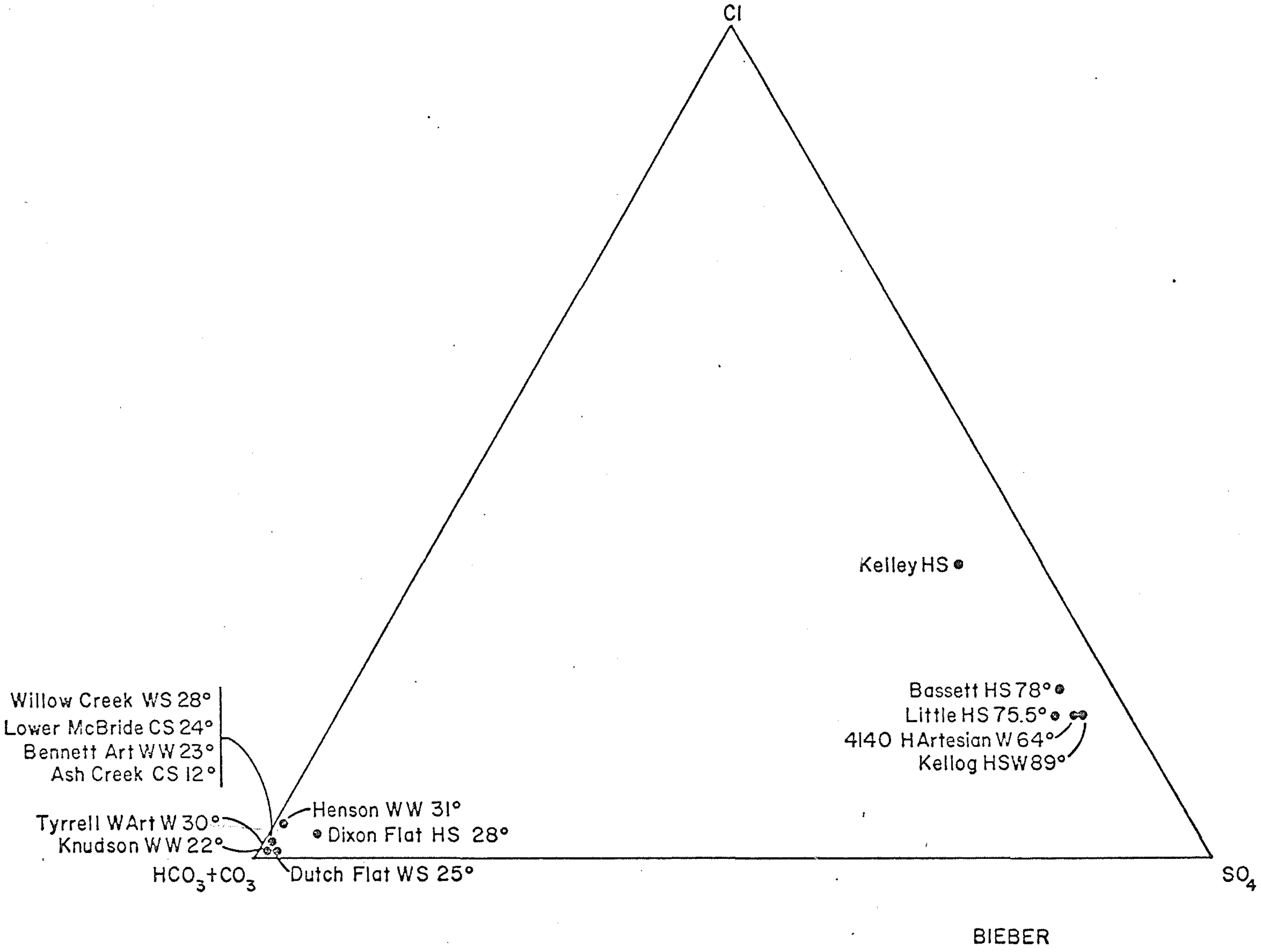

Figure 5. The relationship between HCO_3+CO_3, SO_4 and Cl for the thermal and non-thermal waters of the Bieber, California, area.

Table 3. Principle anions and cations of the Bieber thermal and non-thermal waters.

Sample Number & Name		Anions	Cations	Inferred Water Age
X90044	Kellog Hot Spring West	$SO_4 > Cl > HCO_3$	Na>Ca>K>Mg	Old
X90039	Bassett Hot Spring	$SO_4 > Cl > HCO_3$	Na>Ca>K>Mg	Old
X90018	Little Hot Spring	$SO_4 > Cl > HCO_3$	Na>Ca>K>Mg	Old
X90035	4140 Hot Artesian Well	$SO_4 > Cl > HCO_3$	Na>Ca>K>Mg	Old
X90051	Henson Warm Well	$HCO_3 > Cl > SO_4$	Na>K>Ca>Mg	Young
X90017	Tyrrell Warm Art. Well	$HCO_3 > Cl \sim SO_4$	Na>Ca>K>Mg	Young
X90023	Dixon Flat Hot Spring	$HCO_3 > SO_4 > Cl$	Na>Ca>Mg>K	Young
X90072	Willow Creek Warm Spg.	$HCO_3 > Cl \sim SO_4$	Na>Ca>K>Mg	Young
X90016	Dutch Flat Warm Spg.	$HCO_3 > SO_4 \sim Cl$	Na>Ca>K>Mg	Young
X90070	Lower McBride C. Spg.	$HCO_3 > Cl \sim SO_4$	Na>Ca>K~Mg	Young
X90062	Bennett Art. Warm Well	$HCO_3 > Cl \sim SO_4$	Na>Ca>K>Mg	Young
X90068	Knudson Warm Well	$HCO_3 > Cl \sim SO_4$	Na>Ca>K>Mg	Young
X90066	Ash Creek Cold Spring	$HCO_3 > Cl \sim SO_4$	Na>Ca>Mg>Ca	Young

Table 4. A comparison of spring silica and total dissolved solids.

Sample Number & Name		T°C	SiO_2	TDS	TDS/SiO_2
X90044	Kellog Hot Spring West	89	83	894.2	10.8
X90039	Bassett Hot Spring	78	75	821.7	11.0
X90018	Little Hot Spring	75.5	86	920.9	10.7
X90035	4140 Hot Artesian Well	64	68	802.8	11.8
X90051	Henson Warm Well	31	81	327.4	4.0
X90017	Tyrrell Warm Art. Well	30	45	193.9	4.3
X90023	Dixon Flat Hot Spring	28	50	171.7	3.4
X90072	Willow Creek Warm Spg.	28	46	173.7	3.8
X90016	Dutch Flat Warm Spg.	25	64	216.6	3.4
X90070	Lower McBride C. Spg.	24	38	173.3	4.6
X90062	Bennett Art. Warm Well	23	60	178.5	3.0
X90068	Knudson Warm Well	28	82	341.9	4.2
X90066	Ash Creek Cold Spring	12	32	176.7	5.5

MINERAL EQUILIBRIA

Computer program Solmneq calculated the degree of saturation or undersaturation for various hypothetical minerals. Gibbs free energies (kcal/mole) are interpreted as follows:

negative values = undersaturation

0 = equilibrium

positive values = saturation.

The saturated silicate minerals are listed in Table 5. Saturated minerals for the hot waters (X90044, X90039, X90018 and X90035) are similar. This data indicates waters were last in equilibrium with a metamorphosed volcanic rock. Quartz is the most saturated silica mineral in all samples thus indicating the validity of quartz subsurface temperatures for the hot waters.

SUBSURFACE TEMPERATURES

Chemical evidence previously discussed indicates that X90044, X90039, X90018 and X90035 are primary unmixed thermal waters. Subsurface temperatures indicated by quartz and the Na-K-Ca thermometers are thus considered valid. Quartz subsurface temperatures (Table 2) do not exceed 130°C. Na-K-Ca temperatures do not exceed 90°C except for Henson Warm Well (X90051) which is highly mixed.

Table 5. Gibbs Free Energies in kcal/mole for selected water samples from the Bieber area, California. Positive values imply saturation.

	Kellog Hot Spring West X90044		Bassett Hot Spring X90039		Little Hot Spring X90018		4140 Hot Artesian Well X90035		Henson Warm Well X90051		Tyrell Warm Art. Well X90017		Dixon Flat Hot Spring X90023		Willow Creek Warm Spring X90072		Dutch Warm S X90016
T°C	89		78		75.5		64		31		30		28		28		25
TDS	894.2		821.7		920.9		802.8		327.4		193.9		171.7		173.7		216.6
Carbonates					Calcite	.1							Dolomite	1.3			
					Aragonite	.02							Calcite	.5			
													Aragonite	.4			
													Huntite	.3			
													Magnesite	.1			
Silicates	Tremolite	32.0	Tremolite	31.0	Tremolite	15.9	Tremolite	27.7	Talc	2.1	Tremolite	11.7	Tremolite	28.7	Talc	5.7	Talc
	Talc	14.5	Talc	14.0	Talc	8.6	Talc	13.0	Quartz	1.4	Talc	9.1	Talc	16.9	Tremolite	3.7	Tremol
	Diposide	7.5	Diposide	7.0	Fayalite	2.8	Diposide	5.8	Chalcedony Qtz.	.8	Greenalite	1.5	Crysotil	7.8	Quartz	1.1	Quartz
	Crysotil	6.9	Crysotil	6.3	Diposide	2.1	Crysotil	5.1	Cristobalite	.6	Fayalite	1.2	Greenalite	5.1	Calcedony Qtz.	.5	Chalce
	Fayalite	2.8	Fayalite	2.8	Quartz	.7	Fayalite	2.9	Silcaam	.1	Quartz	1.1	Diopside	4.4	Cristobalite	.3	Cristo
	Wallasto	1.4	Wallasto	1.0	Calcedony Qtz.	.3	Quartz	.3			Chalcedony Qtz.	.5	Fayalite	3.4			Silica
	Clinenst	.1	Quartz	.1	Magadite	.2	Wallasto	.3			Cristobalite	.2	Sepiolite	1.4			
	Quartz	.03											Quartz	1.0			
													Chalcedony Qtz.	.4			
													Clinenst	.3			
													Cristobalite	.1			

alifornia. Positive values imply saturation.

Henson Warm Well X90051		Tyrell Warm Art. Well X90017		Dixon Flat Hot Spring X90023		Willow Creek Warm Spring X90072		Dutch Flat Warm Spring X90016		Lower McBride Warm Spring X90070		Bennett Art. Warm Well X90062		Knudson Warm Well X90068		Ash Creek Cold Spring X90066	
31		30		28		28		25		24		23		22		12	
27.4		193.9		171.7		173.7		216.6		173.3		178.5		341.9		176.7	
				Dolomite	1.3												
				Calcite	.5												
				Aragonite	.4												
				Huntite	.3												
				Magnesite	.1												
lc	2.1	Tremolite	11.7	Tremolite	28.7	Talc	5.7	Talc	4.9	Tremolite	13.3	Tremolite	11.8	Talc	5.0		
artz	1.4	Talc	9.1	Talc	16.9	Tremolite	3.7	Tremolite	1.5	Talc	9.9	Talc	9.6	Quartz	1.6		
alcedony Qtz.	.8	Greenalite	1.5	Crysotil	7.8	Quartz	1.1	Quartz	1.4	Greenalite	2.8	Greenalite	2.9	Tremolite	1.4		
istobalite	.6	Fayalite	1.2	Greenalite	5.1	Calcedony Qtz.	.5	Chalcedony Qtz.	.8	Fayalite	1.4	Quartz	1.3	Chalcedony Qtz.	1.0		
lcaam	.1	Quartz	1.1	Diopside	4.4	Cristobalite	.3	Cristobalite	.5	Quartz	1.0	Fayalite	1.2	Cristobalite	.7		
		Chalcedony Qtz.	.5	Fayalite	3.4			Silicaam	.06	Crysotil	.7	Chalcedony Qtz.	.7	Silicaam	.3		
		Cristobalite	.2	Sepiolite	1.4					Chalcedony Qtz.	.5	Cristobalite	.5				
				Quartz	1.0					Cristobalite	.2						
				Chalcedony Qtz.	.4					Diposide	.2						
				Clinenst	.3												
				Cristobalite	.1												

GEOCHEMICAL

SAMPLE FORMS

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1053 Sample No. X 90066 Date 8/2/74 Time 13:45

Name: ASH CREEK CAMPGROUND C. S. Location: Co. Lassen State CA

SE¼ NW¼ Sec. 4 T 38N R: 10E ; Km/mi. of

Lat.: Long.: Sampler: F. Dellechaie

Elevation: 4880 Quad. Adin 15

Sample Type:X Spring (p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 12

Ground Temp. °C

Air Temp.

Odor 0

Fluid Color 0

Fluid Taste hard

Bubbling 0

Boiling 0

Vegetation 0

Fluid issues from plastic pipe

Salt: Type 0

Quantity

Color

Form

Sinter: Type 0

Quantity

Color

Form

Discharge: 10 [✓ gpm]/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) basalt

Color dark gray

Grain size medium

Megascopic Minerals QTz, Olivine, Pyroxene, calcite fillings

Alteration: no

Rx Type (at depth)

Water used for 0

Immediate area used for: camping National Forest land

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation natural hydro flow

Property owned by state

Previous and/or Current Leases

Comments: sign says water unsafe to drink?

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1055 Sample No. X 90068 Date 8/3/74 Time 15:00

Name: KNUDSON WARM WELL Location: Co. Lassen State CA

SW¼ Sec. 21 T 38N R: 9E ; Km/mi. of

Lat.: Long.: Sampler: John E. Deymonaz

Elevation: 4320 Quad. Adin

Sample Type: Spring (p), [✓ well (p)], creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 22

Ground Temp. °C

Air Temp.

Odor H2S

Fluid Color clear

Fluid Taste 0

Bubbling 0

Boiling 0

Vegetation 0

Fluid issues from steel pipe

Salt: Type 0

Quantity

Color

Form

Sinter: Type 0

Quantity

Color

Form

Discharge: ? gpm/Lpm

Well Data: Depth 220

Bore 6"

Pump Type sub

Level of water in bore 18"

Type of piping steel casing

Artesian Head

Rock Data:

Type (surface) bslt (float)

Color

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for home & farm

Immediate area used for:

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation well

Property owned by A. L. Knudson Box 209 Adin, Calif. SEND RESULTS!

Previous and/or Current Leases

Comments:

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1049 Sample No. X 90062 Date 8/2/74 Time 13 15

Name: BENNETT ART. WARM WELL Location: Co. Modoc State CA

NE¼ NW¼ Sec. 28 T 39N R: 10E ; Km/mi. of

Lat.: Long.: Sampler: G.S. and F. Dellechaie

Elevation: 4200 Quad. Adin

Sample Type: Spring (p), [✓ well (p)], creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 23

Ground Temp. °C

Air Temp.

Odor

Fluid Color clear

Fluid Taste none (hard)

Bubbling 0

Boiling 0

Vegetation 0

Fluid issues from drilled art well

Salt: Type 0

Quantity

Color

Form

Sinter: Type 0

Quantity

Color

Form

Discharge: ± 20 [✓ gpm]/Lpm

Well Data: Depth 124'

Bore 6" (?)

Pump Type electric

Level of water in bore surf

Type of piping iron - plastic

Artesian Head yes

Rock Data:

Type (surface)

Color

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for house

Immediate area used for: residence

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation well

Property owned by Ibyl J. Bennett

Previous and/or Current Leases

Comments: ~1924 drilled

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1031 Sample No. X 90044 Date 8/1/74 Time 11:20

Name: KELLOGG H. S. WEST Location: Co. Lassen State CA

SW¼ SW¼ Sec. 14 T 38N R: 8E ; Km/mi. of

Lat.: Long.: Sampler: F. Dellechaie

Elevation: 4220 Quad. Bieber 15'

Sample Type: [✓ Spring] (p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 89

Ground Temp. °C

Air Temp.

Odor H_2S

Fluid Color clear

Fluid Taste S= hardness

Bubbling minor

Boiling 0

Vegetation 0

Fluid issues from cement pool

Salt: Type clorides, sulfates

Quantity major

Color white

Form acicular

Sinter: Type travertine

Quantity minor

Color white

Form massive

Discharge: 50 gpm/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) valley fill

Color

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for 0

Immediate area used for: cattle lumber

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation deep fault

Property owned by ?

Previous and/or Current Leases

Comments:

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1003 Sample No. X 90016 Date 8/3/74 Time 1500

Name: DUTCH FLAT WARM SPRING Location: Co. Modoc State CA

Center Sec. 34 T 40N R: 9E ; Km/mi. of

Lat.: Long.: Sampler: John E. Deymonaz

Elevation: 4320 Quad. Canby

Sample Type: [✓ Spring] (p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 25 Discharge: 1 gpm/Lpm

Ground Temp. °C Well Data: Depth

Air Temp. Bore

Odor 0 Pump Type

Fluid Color 0 Level of water in bore

Fluid Taste 0 Type of piping

Bubbling 0 Artesian Head

Boiling 0 Rock Data:

Vegetation plants, grass, algae Type (surface) basalt

Fluid issues from fracture in basalt on gentle slope Color lt-dk gray (gray granular material) weathers to lt.

Grain size

Megascopic Minerals

Salt: Type 0

Quantity

Color Alteration:

Form Rx Type (at depth)

Sinter: Type 0 Water used for cattle

Quantity Immediate area used for: farming

Color

Form Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation deep fault

Property owned by Owen Kresge Box 236 Adin, CA 96006 SEND RESULTS!

Previous and/or Current Leases

Comments: Roll 9#5

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1004 Sample No. X 90017 Date 8/1/74 Time 20:30

Name: TYRRELL ART WARM WELL Location: Co. Modoc State CA

NW¼ SE¼ Sec. 35 T 40N R: 9E ; 5 Km/mi. N of Adin

Lat.: Long.: Sampler: G.S. and John Deymonez

Elevation: 4360 Quad. Canby

Sample Type: Spring (p), [✓ well (p)], creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 30

Ground Temp. °C

Air Temp.

Odor none

Fluid Color clear

Fluid Taste 0

Bubbling 0

Boiling 0

Vegetation some green algae

Fluid issues from

Salt: Type 0

Quantity

Color

Form

Sinter: Type 0

Quantity

Color

Form

Discharge: 100 (natural) [✓ gpm]/Lpm

Well Data: Depth 80'

Bore 4" 20' casing

Pump Type Electric centrif

Level of water in bore 20'

Type of piping iron

Artesian Head yrs

Rock Data:

Type (surface) basalt

Color

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for

Immediate area used for:

Quality of sample: [✓ Exc.], Good, Poor

Probable cause of manifestation fault ridge to south

Property owned by

Previous and/or Current Leases

Comments:

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1010 Sample No. X 90023 Date 8/ /74 Time 1600

Name: DIXON FLAT "HOT" SPRING Location: Co. Lassen State CA

SE¼ Sec. 28 T 37N R: 6E ; Km/mi. of

Lat.: Long.: Sampler: John E. Deymonaz

Elevation: 3330 Quad. Fall river

Sample Type: [✓ Spring] (p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 28

Ground Temp. °C

Air Temp.

Odor

Fluid Color

Fluid Taste

Bubbling Minor (very)

Boiling 0

Vegetation algae

Fluid issues from base of basaltic hillside along flt

Salt: Type 0

Quantity

Color

Form

Sinter: Type 0

Quantity

Color

Form

Discharge: ? gpm/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) bslt

Color

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for recreation

Immediate area used for: farming

Quality of sample: Exc., [✓ Good], Poor

Probable cause of manifestation Flt intercepting warm water at depth

Property owned by June Vestal Box 247 Mc Carther, CA 96056 Send Results!

Previous and/or Current Leases

Comments: Roll 8#35

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1022 Sample No. X 90035 Date 8/1/74 Time 1506

Name: 4140 HOT ARTESIAN HOT WELL Location: Co. Lassen State CA

NW¼ NE¼ Sec. 12 T 38N R: 8E ; Km/mi. of

Lat.: Long.: Sampler: F. Dellechaie

Elevation: 4140 Quad. Bieber

Sample Type: Spring (p), [✓ well (p)], creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 64

Ground Temp. °C

Air Temp.

Odor Mild S=

Fluid Color 0

Fluid Taste CO_2 H_2S hard

Bubbling highly Co_2 'ed

Boiling 0

Vegetation vegetation

Fluid issues from steel pipe

Salt: Type chloride sulfates

Quantity minor

Color white tan

Form acicular - massive

Sinter: Type 0

Quantity

Color

Form

Discharge: 3 gpm/Lpm

Well Data: Depth 35'

Bore 4

Pump Type artesian

Level of water in bore to top

Type of piping rusty iron

Artesian Head

Rock Data:

Type (surface) valley fill

Color

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for 0

Immediate area used for: farming

Quality of sample: Exc., [✓ Good], Poor

Probable cause of manifestation artesian well

Property owned by ?

Previous and/or Current Leases

Comments:

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1026 Sample No. X 90039 Date 8/1/74 Time 13:30

Name: BASSETT HOT SPRING Location: Co. Lassen State CA

NW¼ SE¼ Sec. 12 T 38N R: 8E ; Km/mi. of

Lat.: Long.: Sampler: F. Dellechaie

Elevation: 4150 Quad. Bieber

Sample Type: [✓ Spring](p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 78

Ground Temp. °C

Air Temp.

Odor mild H_2S

Fluid Color clear

Fluid Taste hard S=

Bubbling minor

Boiling 0

Vegetation algae

Fluid issues from cracks in SS

Salt: Type clorides & sulfates

Quantity minor

Color white

Form massive

Sinter: Type calcite

Quantity minor

Color white

Form massive

Discharge: 175 gpm/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) SS

Color gray, white

Grain size medium

Megascopic Minerals QTZ

Alteration: highly

Rx Type (at depth)

Water used for drinking, heating

Immediate area used for: ranching

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation deep fault

Property owned by G. Packwood

Previous and/or Current Leases

Comments:

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1057 Sample No. X 90070 Date 8/1/74 Time

Name: LOWER Mc BRIDE WARM SPRINGS Location: Co. Lassen State CA

NW & SW¼ NW¼ Sec. 28 T 37N R: 10E ; Km/mi. of

Lat.: Long.: Sampler: John E. Deymonaz & G.S.

Elevation: 5000 Quad. Adin

Sample Type: [✓ Spring] (p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 24

Ground Temp. °C 21.5

Air Temp.

Odor

Fluid Color clear

Fluid Taste none

Bubbling 0

Boiling 0

Vegetation some green algae

Fluid issues from several seeps and fissures

Salt: Type 0

Quantity

Color

Form

Sinter: Type 0

Quantity

Color

Form

Discharge: 100(total) [✓ gpm]/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) andesite - basalt

Color

Grain size

Megascopic Minerals scoriaceous numerous ves. fillings and fractures

Alteration: some surf

Rx Type (at depth)

Water used for cattle

Immediate area used for: ranch

Quality of sample: [✓ Exc.], Good, Poor

Probable cause of manifestation exposure of aquifer along ridge front (fault)

Property owned by

Previous and/or Current Leases

Comments:

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1005 Sample No. X 90018 Date 8/2/74 Time 10:30

Name: LITTLE HOT SPRING Location: Co. Modoc State CA

SW¼ Sec. 9 T 39N R: 5E ; Km/mi. of

Lat.: Long.: Sampler: John E. Deymonez

Elevation: 3550 Quad. J

Sample Type: [✓ Spring] (p), well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 75.5

Ground Temp. °C 46

Air Temp.

Odor minor H_2S

Fluid Color

Fluid Taste slight sulfide

Bubbling moderate

Boiling

Vegetation minor green filiment algae a gray algae

Fluid issues from cobbly soil at base of hill along flt?

Salt: Type sulfates?

Quantity minor

Color white

Form amorphous

Sinter: Type

Quantity

Color

Form

Discharge: 200 gpm/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) bslt

Color dk gray

Grain size Plagioclase up to 5mm

Megascopic Minerals Plagioclase, magnetite chlorite

Alteration: minor chlorite

Rx Type (at depth)

Water used for livestock

Immediate area used for: farming

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation flt intercepting heat source at depth

Property owned by

Previous and/or Current Leases

Comments: Roll 8 #28, 29, 30 temp. same as when measured 15 years ago. Does not vary seasonally

SKETCHES

AMAX GEOTHERMAL GEOCHEMICAL SAMPLE FORM

Spring No. CA 1059 Sample No. X 90072 Date 8/3/74 Time 2000

Name: WILLOW CK. WARM SPRING Location: Co. Lassen State CA

SE¼ Sec. 28 T 37N R: 10E ; Km/mi. of

Lat.: Long.: Sampler: John E. Deymonaz

Elevation: 5120 Quad. Adin

Sample Type: [✓ Spring (p)], well (p), creek, river, soil, salt, sinter, travertine, gas, rock, snow.

Description:

Water Temp. °C 28

Ground Temp. °C

Air Temp.

Odor 0

Fluid Color 0

Fluid Taste 0

Bubbling 0

Boiling 0

Vegetation 0

Fluid issues from galvanized steel pipe sunk into rocky hillside along Willow Cr.

Salt: Type sulfate

Quantity moderate

Color white

Form amorphous

Sinter: Type 0

Quantity

Color

Form

Discharge: 200 gpm/Lpm

Well Data: Depth

Bore

Pump Type

Level of water in bore

Type of piping

Artesian Head

Rock Data:

Type (surface) bslt

Color dk gray

Grain size

Megascopic Minerals

Alteration:

Rx Type (at depth)

Water used for drinking

Immediate area used for: recreation

Quality of sample: [✓ Exc], Good, Poor

Probable cause of manifestation possible flt running thru valley

Property owned by U. S. Forest Service

Previous and/or Current Leases

Comments: Roll 9 #8

SKETCHES