

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

by

Frank Dellechiaie

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AMAX Exploration, Inc.

TABLE OF CONTENTS

	Page
SUMMARY.....	1
THERMAL FEATURES	2
CHEMISTRY.....	8
MINERAL EQUILIBRIA.....	16
SUBSURFACE TEMPERATURES.....	16
 TABLES:	
Table 1. Thermal features of the Bieber area.....	3
Table 2. Chemical analyses of the thermal feature of the Bieber area, California.....	9
Table 3. Principle anions and cations of the Bieber thermal and non-thermal waters.....	14
Table 4. A comparison of spring silica and total dissolved solids.....	15
Table 5. Gibbs Free Energies in kcal/mole for selected water samples from the Bieber area, California.....	17
 FIGURES:	
Figure 1. Location map of the Bieber Geothermal Prospect.....	2
Figure 2. The relationship between Na and Ca for the thermal and non-thermal waters of the Bieber, California, area.....	10
Figure 3. The relationship between B and Na for the thermal and non-thermal waters of the Bieber, California, area.....	11
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.....	12
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.....	13
 PLATES 1 - 7.....	 4-7
SAMPLE FORMS.....	18-29
SAMPLE LOCATION MAP.....	Pocket

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:



3. Kellogg, 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:



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.

Table 1. Thermal features of the Bieber area.

	<u>Sample Number & Name</u>	<u>T°C</u>	<u>Flow l/pm</u>	<u>Well Depth meters</u>	<u>Heat Discharge cal/sec</u>
X90044	Kellog Hot Spring West	89	189	---	2.4×10^5
X90039	Bassett Hot Spring	78	662	---	7.1×10^5
X90018	Little Hot Spring	75.5	757	---	7.8×10^5
X90035	4140 Hot Artesian Well	64	11	11	9.2×10^3
X90051	Henson Warm Well	31	946	?	2.7×10^5
X90017	Tyrrell Warm Well	30	378	24	1.0×10^5
X90023	Dixon Flat Warm Spring	28	?	---	---
X90072	Willow Creek Warm Spg.	28	757	---	1.8×10^5
X90016	Dutch Flat Warm Spring	25	4	---	7.3×10^2
X90070	Lower McBride Warm Spg.	24	378	---	6.3×10^4
X90062	Bennett Artesian W.W.	23	75	38	1.1×10^4
X90068	Knudson Warm Well	22	189	67	<u>2.8×10^4</u>
					2.4×10^6 cal/sec
					9.5×10^3 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.

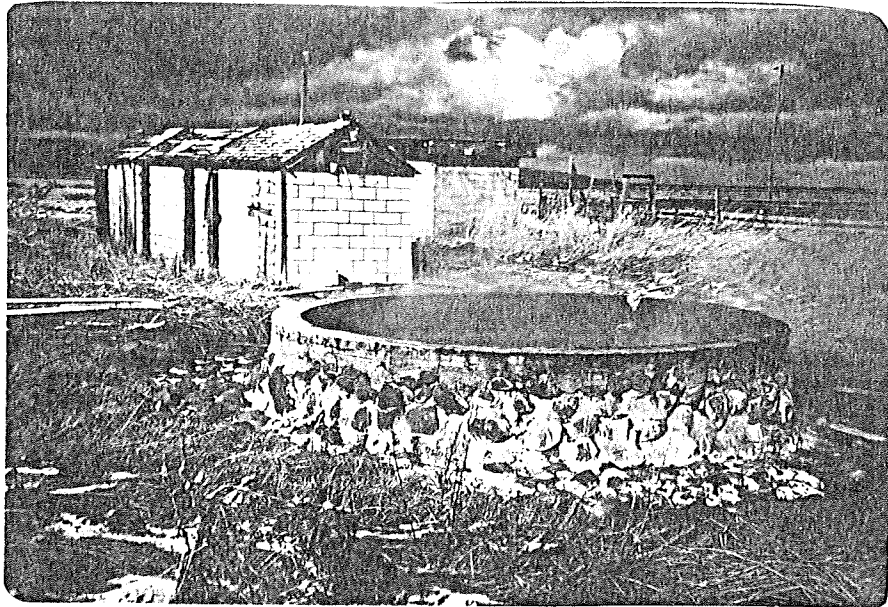


Plate 1. Kellogg Hot Spring West
T = 89°C at 189 lpm



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

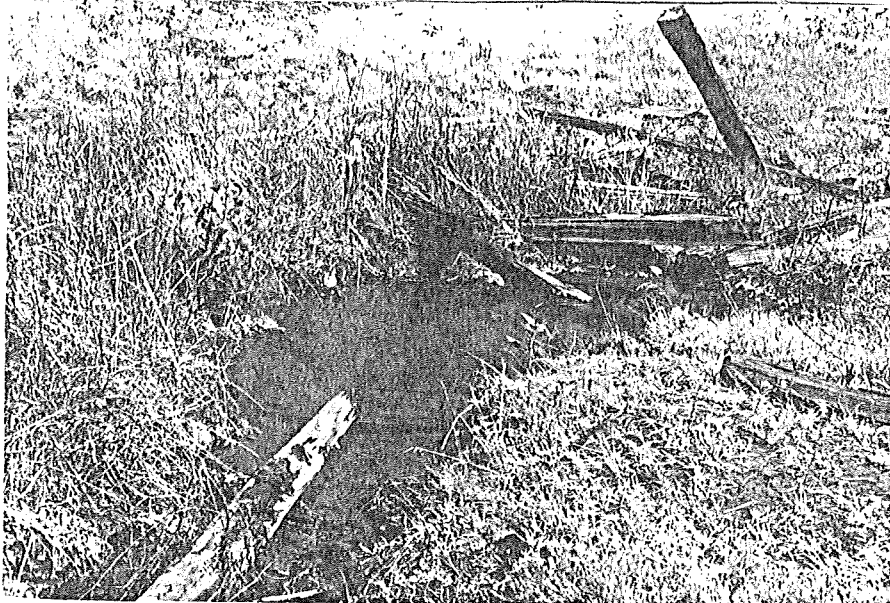


Plate 3. Little Hot Spring
T = 75.5°C at 757 lpm



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

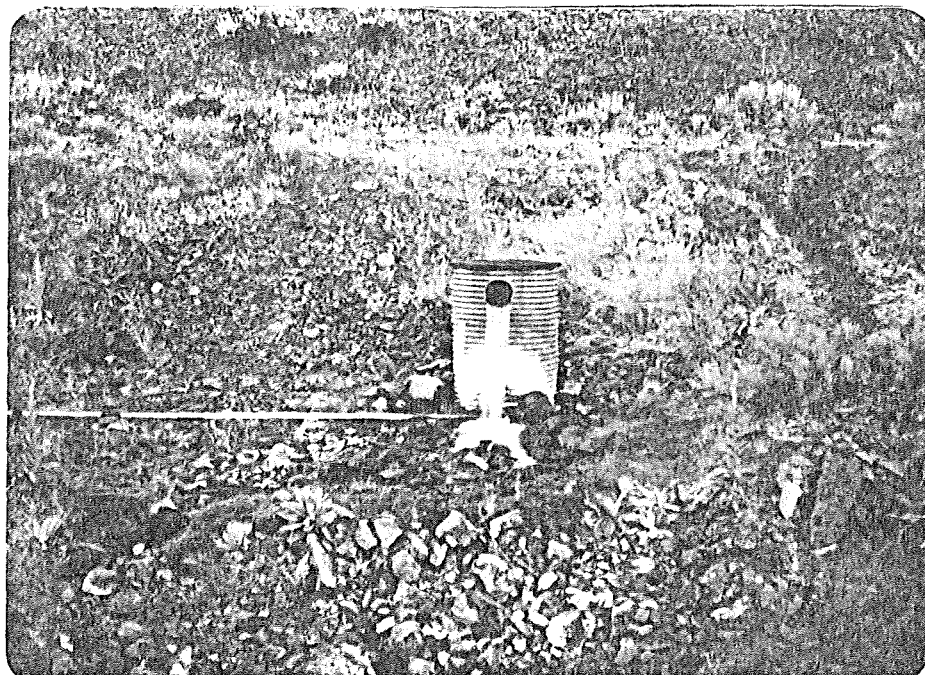


Plate 5. Willow Creek Warm Spring
T = 28°C at 757 lpm



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.

es of the thermal feature of the Bieber area, California. Units are mg/l unless otherwise noted.

st	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
	9.1	8.1	9.2	7.35	8.3	9.2	7.9	7.8	8.5	8.4	7.6	7.4
94	1.88	2.3	1.78	6.0	1.3	2.3	1.3	1.2	1.6	1.7	2.3	1.1
27	0	40	27	150	96	75	78	95	85	73	163	66
0	350	400	360	2	1	4	< 1	2	1	60	82	32
75	220	86	68	81	45	50	46	64	38	21	50	49
3.2	5.6	3.4	7.1	6.4	3.2	4.2	4.2	6.1	4.5	5.6	8.1	.7
36	40	26	2	14	9	14	14	9	13	7	22	17
.1	.3	< .1	2	3	6	3	3	2	4	3	5	7
.1	.2	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
2.3	3.2	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
40	40	40	6	2	2	2	< 1	2	< 1	2	4	< 1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
.48	.13	.51	1.14	.01	.07	.05	.05	.10	.02	0.0	.22	.04
2.38	.34	1.70	1.36	.34	.34	0	0	.34	.68	0.34	1.19	.51
821.7	420.9	802.8	327.4	193.9	171.7	173.7	216.6	173.3	178.5	341.9	176.7	176.7
78	75.5	64	31	30	28	28	25	24	23	23	22	12
662	575	11	946	378	?	757	4	378	75	75	189	40
121.7	128.9	116.7	125.7	96.9	101.8	98	113.7	89.4	110.5	110.5	126.4	82.1
33.0	59.9	33.8	185.4 *	365.5 *	282.0 *	290.5 *	279.2 *	303.0 *	336.4 *	336.4 *	247.9 *	32.1
58.9	74.6	67.6	186.3 *	75.3	60.4	61.9	87.7	65.4	86.1	86.1	82.6	81.5
.7	.6	.6	8.1	3.5	1.6	3.5	1.6	4.3	4.6	4.6	3.1	3.0
6.0	3.9	5.1	.1	.02	.05	.03	.02	.03	.04	.04	.02	.03
26.5	20.7	23.8	12.7	4.3	6.4	4.3	3.5	5.0	4.1	4.1	6.8	4.3

subsurface conditions.

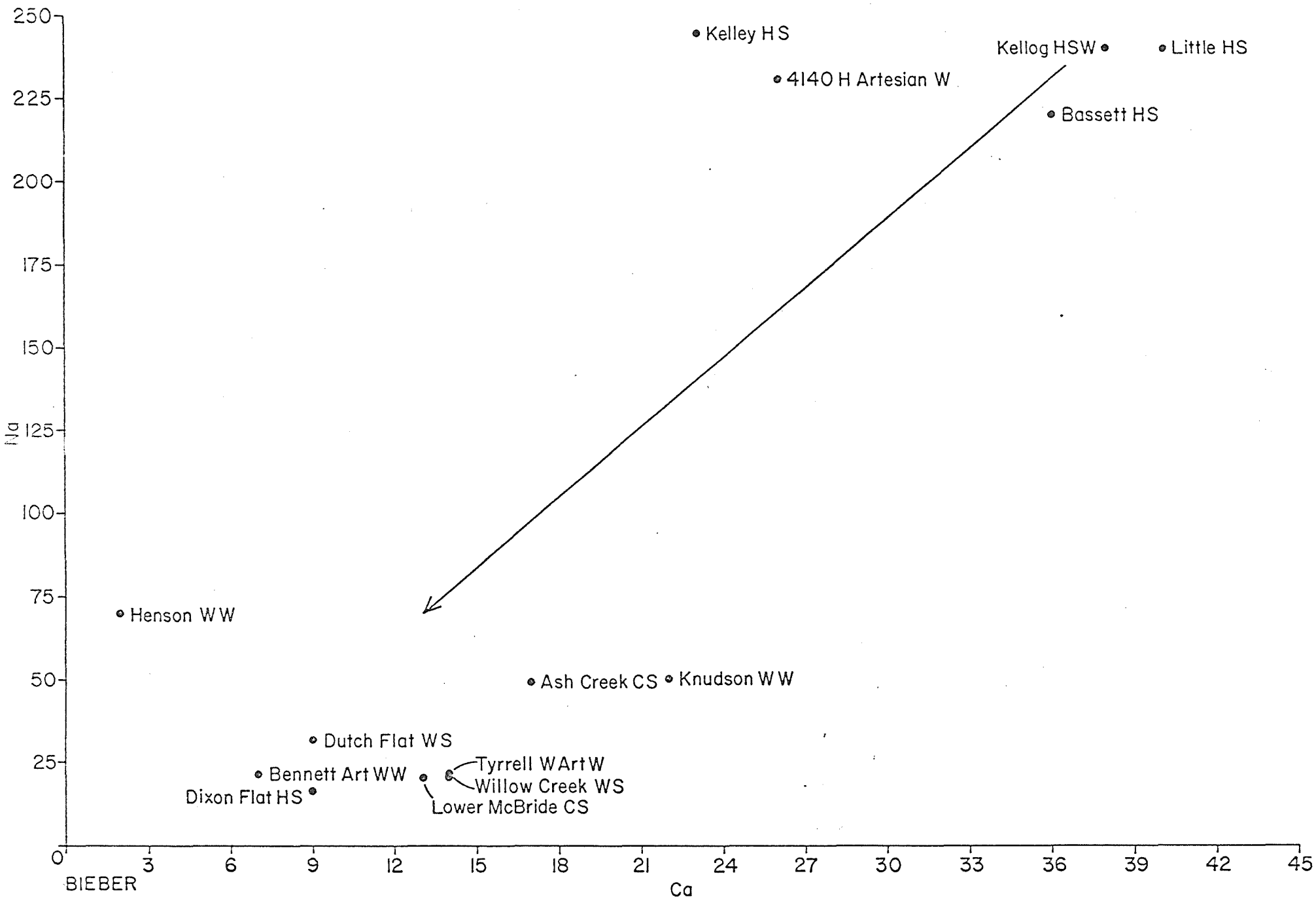


Figure 2. The relationship between Na. and Ca for the thermal and non-thermal waters of the Bieber, California, area.

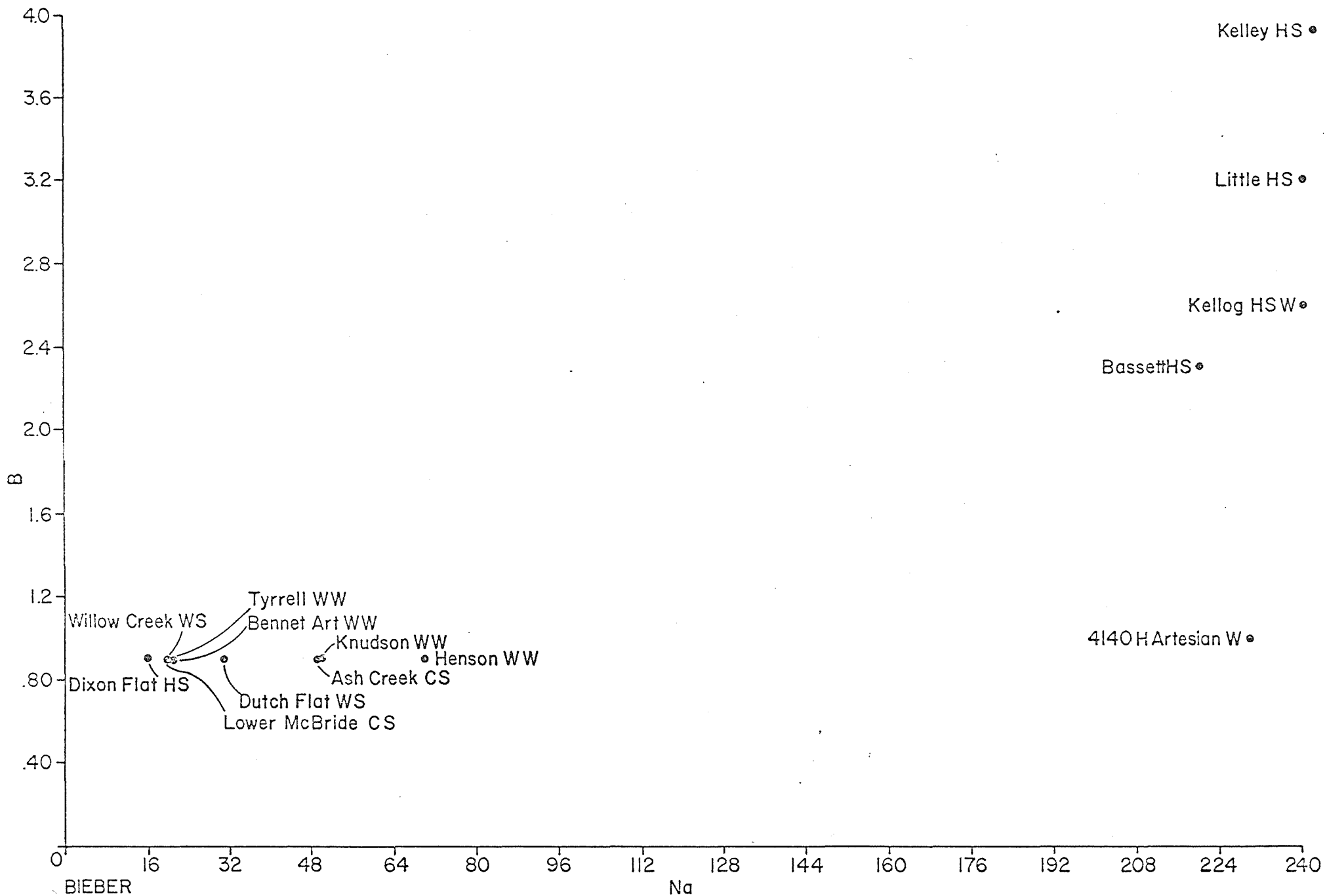


Figure 3. The relationship between B and Na for the thermal and non-thermal waters of the Bieber, California, area.

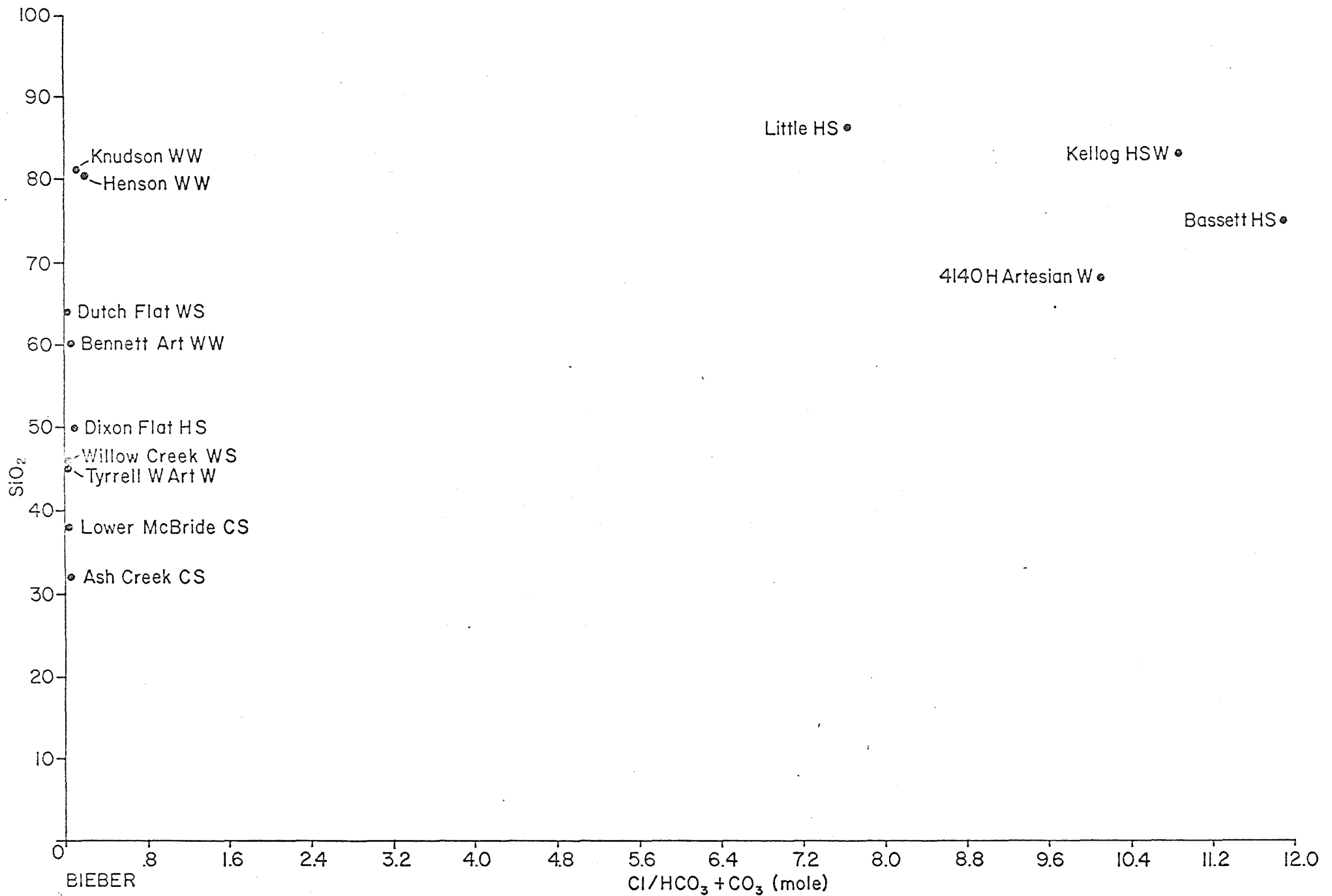


Figure 4. The relationship between SiO₂ and the Cl/HCO₃+CO₃ ratio for the thermal and non-thermal waters of the Bieber, California, area.

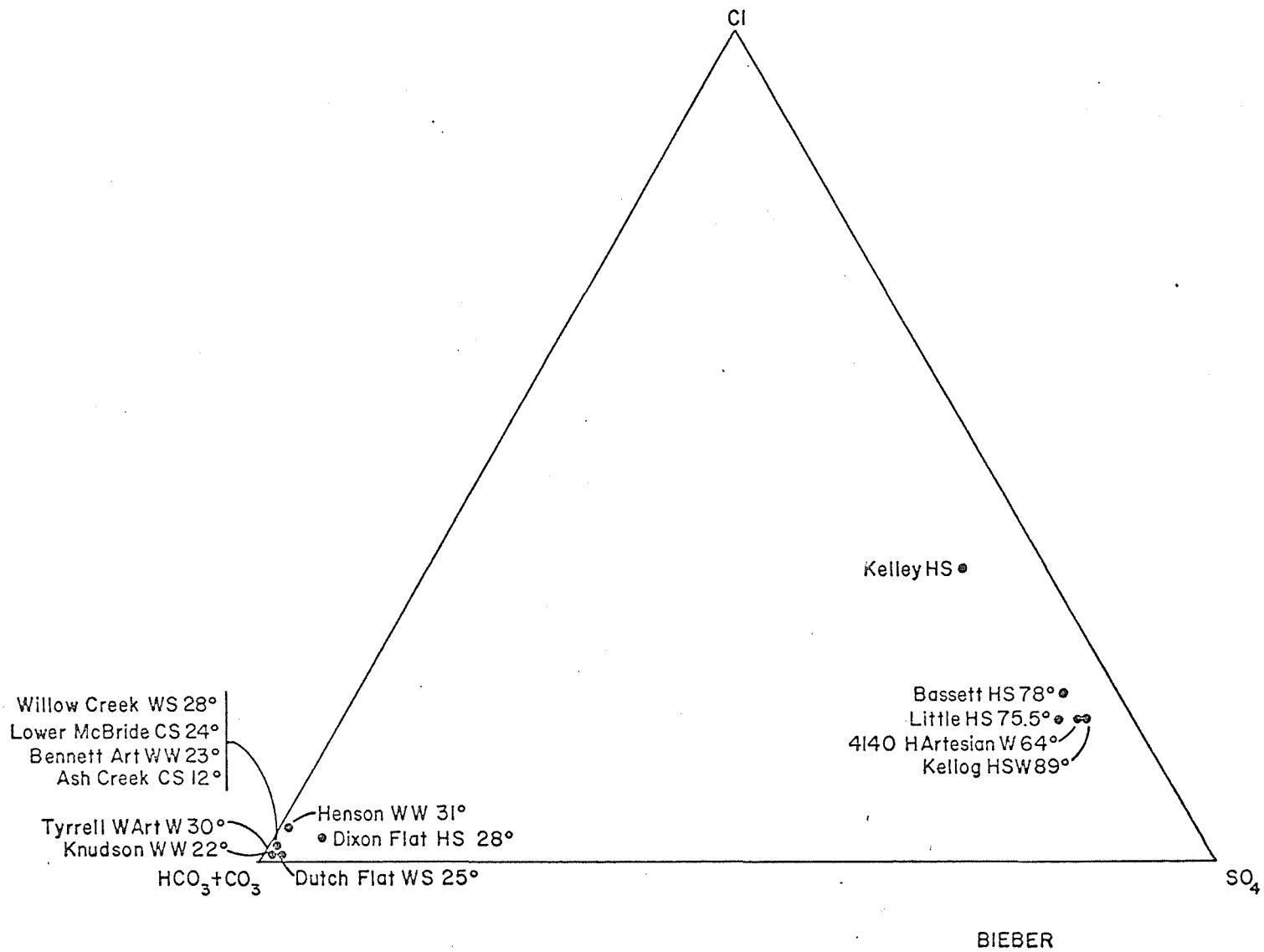


Figure 5. The relationship between HCO_3+CO_3 , SO_4 and Cl for the thermal and non-thermal waters of the Bieber, California, area.

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

<u>Sample Number & Name</u>	<u>Anions</u>	<u>Cations</u>	<u>Inferred Water Age</u>
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~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~SO ₄	Na>Ca>K>Mg	Young
X90016 Dutch Flat Warm Spg.	HCO ₃ >SO ₄ ~Cl	Na>Ca>K>Mg	Young
X90070 Lower McBride C. Spg.	HCO ₃ >Cl~SO ₄	Na>Ca>K~Mg	Young
X90062 Bennett Art. Warm Well	HCO ₃ >Cl~SO ₄	Na>Ca>K>Mg	Young
X90068 Knudson Warm Well	HCO>Cl~SO ₄	Na>Ca>K>Mg	Young
X90066 Ash Creek Cold Spring	HCO>Cl~SO ₄	Na>Ca>Mg>Ca	Young

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

<u>Sample Number & Name</u>	<u>T°C</u>	<u>SiO₂</u>	<u>TDS</u>	<u>TDS/SiO₂</u>
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 Flat Warm Spring X90016	Lower McBride Warm Spring X90070	Bennett Art. Warm Well X90062	Knudson Warm Well X90068	Ash Creek Cold Spring X90066
T°C	89	78	75.5	64	31	30	28	28	25	24	23	22	12
TDS	894.2	821.7	920.9	802.8	327.4	193.9	171.7	173.7	216.6	173.3	178.5	341.9	176.7
Carbonates			Calcite .1 Aragonite .02				Dolomite 1.3 Calcite .5 Aragonite .4 Huntite .3 Magnesite .1						
Silicates	Tremolite 32.0 Talc 14.5 Diposide 7.5 Crysotil 6.9 Fayalite 2.8 Wallasto 1.4 Clinenst .1 Quartz .03	Tremolite 31.0 Talc 14.0 Diposide 7.0 Crysotil 6.3 Fayalite 2.8 Wallasto 1.0 Quartz .1	Tremolite 15.9 Talc 8.6 Fayalite 2.8 Diposide 2.1 Quartz .7 Calcedony Qtz. .3 Magadite .2	Tremolite 27.7 Talc 13.0 Diposide 5.8 Crysotil 5.1 Fayalite 2.9 Quartz .3 Wallasto .3	Talc 2.1 Quartz 1.4 Chalcedony Qtz. .8 Cristobalite .6 Silcaam .1	Tremolite 11.7 Talc 9.1 Greenalite 1.5 Fayalite 1.2 Quartz 1.1 Chalcedony Qtz. .5 Cristobalite .2	Tremolite 28.7 Talc 16.9 Crysotil 7.8 Greenalite 5.1 Diopside 4.4 Fayalite 3.4 Sepiolite 1.4 Quartz 1.0 Chalcedony Qtz. .4 Clinenst .3 Cristobalite .1	Talc 5.7 Tremolite 3.7 Quartz 1.1 Calcedony Qtz. .5 Cristobalite .3 Silicaam .06	Talc 4.9 Tremolite 1.5 Quartz 1.4 Chalcedony Qtz. .8 Cristobalite .5 Silicaam .06	Tremolite 13.3 Talc 9.9 Greenalite 2.8 Fayalite 1.4 Quartz 1.0 Crysotil .7 Chalcedony Qtz. .5 Diposide .2	Tremolite 11.8 Talc 9.6 Greenalite 2.9 Quartz 1.3 Fayalite 1.2 Chalcedony Qtz. .7 Cristobalite .5	Talc 5.0 Quartz 1.6 Tremolite 1.4 Chalcedony Qtz. 1.0 Cristobalite .7 Silicaam .3	

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

SE 1/4 NW 1/4 Sec. 4 T 38N R: 10E; Km/mi. of

Lat.: Long.: Sampler: F. Dellechiaie

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 Discharge: 10 (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 hard Type of piping

Bubbling 0 Artesian Head

Boiling 0 Rock Data:

Vegetation 0 Type (surface) basalt

Fluid issues from plastic pipe Color dark gray

 Grain size medium

 Megascopic Minerals Qtz, Olivine,

Salt: Type 0 Pyroxene, calcite fillings

Quantity

Color Alteration: no

Form Rx Type (at depth)

Sinter: Type 0 Water used for 0

Quantity Immediate area used for: camping

Color National Forest land

Form Quality of sample: (Exc), Good, Poor

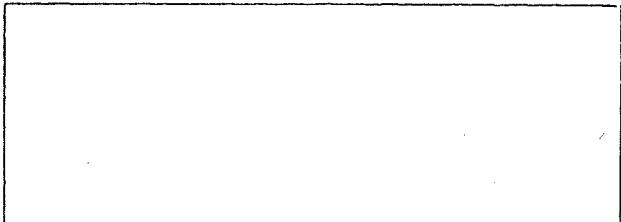
Probable cause of manifestation natural hydro flow

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

SW 1/4 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 Discharge: ? gpm/Lpm

Ground Temp. °C Well Data: Depth 220

Air Temp. Bore 6"

Odor H2S Pump Type sub

Fluid Color clear Level of water in bore 18"

Fluid Taste 0 Type of piping steel casing

Bubbling 0 Artesian Head

Boiling 0 Rock Data:

Vegetation 0 Type (surface) bslt (float)

Fluid issues from steel pipe Color

 Grain size

 Megascopic Minerals

Salt: Type 0

Quantity

Color Alteration:

Form Rx Type (at depth)

Sinter: Type 0 Water used for home & farm

Quantity Immediate area used for:

Color

Form 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

NE 1/4 NW 1/4 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 Discharge: + 20 gpm/Lpm

Ground Temp. °C Well Data: Depth 124'

Air Temp. Bore 6" (?)

Odor Pump Type electric

Fluid Color clear Level of water in bore surf

Fluid Taste none (hard) Type of piping iron - plastic

Bubbling 0 Artesian Head yes

Boiling 0 Rock Data:

Vegetation 0 Type (surface)

Fluid issues from drilled art Color

well Grain size

 Megascopic Minerals

Salt: Type 0

Quantity

Color Alteration:

Form Rx Type (at depth)

Sinter: Type 0 Water used for house

Quantity Immediate area used for: residence

Color

Form Quality of sample: Exc!, Good, Poor

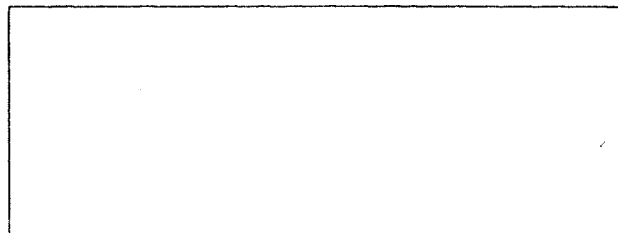
Probable cause of manifestation well

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

SW $\frac{1}{4}$ SW $\frac{1}{4}$ 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 Discharge: 50 gpm/Lpm

Ground Temp. °C Well Data: Depth

Air Temp. Bore

Odor H₂S Pump Type

Fluid Color clear Level of water in bore

Fluid Taste S= hardness Type of piping

Bubbling minor Artesian Head

Boiling 0 Rock Data:

Vegetation 0 Type (surface) valley fill

Fluid issues from cement pool Color

 Grain size

 Megascopic Minerals

Salt: Type clorides, sulfates

Quantity major

Color white Alteration:

Form acicular Rx Type (at depth)

Sinter: Type travertine Water used for 0

Quantity minor Immediate area used for: cattle lumber

Color white

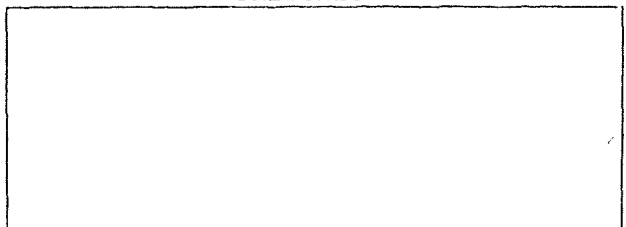
Form massive Quality of sample: Exc, Good, Poor

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 Color lt-dk gray weathers to lt. basalt on gentle slope (gray granular material)
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

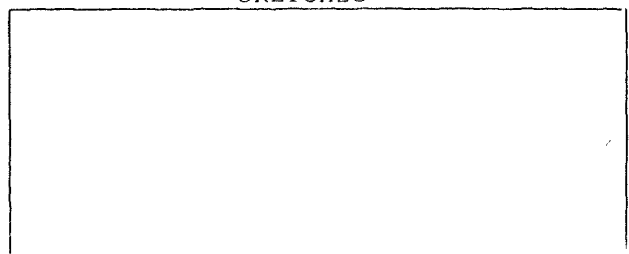
Probable cause of manifestation deep fault

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

NW 1/4 SE 1/4 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 Discharge: 100 (natural) gpm/Lpm

Ground Temp. °C _____ Well Data: Depth 80'

Air Temp. _____ Bore 4" 20' casing

Odor none Pump Type Electric centrif

Fluid Color clear Level of water in bore 20'

Fluid Taste 0 Type of piping iron

Bubbling 0 Artesian Head yrs

Boiling 0 Rock Data: _____

Vegetation some green algae Type (surface) basalt

Fluid issues from _____ Color _____

_____ Grain size _____

_____ Megascopic Minerals _____

Salt: Type 0 _____

Quantity _____

Color _____ Alteration: _____

Form _____ Rx Type (at depth) _____

Sinter: Type 0 Water used for _____

Quantity _____ Immediate area used for: _____

Color _____

Form _____ 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

SE 1/4 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 Discharge: ? gpm/Lpm

Ground Temp. °C Well Data: Depth

Air Temp. Bore

Odor Pump Type

Fluid Color Level of water in bore

Fluid Taste Type of piping

Bubbling Minor (very) Artesian Head

Boiling 0 Rock Data:

Vegetation algae Type (surface) bslt

Fluid issues from base of Color

basaltic hillside along flt Grain size

 Megascopic Minerals

Salt: Type 0

Quantity

Color Alteration:

Form Rx Type (at depth)

Sinter: Type 0 Water used for recreation

Quantity Immediate area used for: farming

Color

Form Quality of sample: Exc., Good, Poor

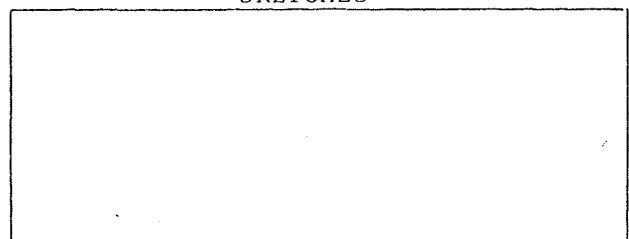
Probable cause of manifestation Flt intercepting warm water at depth

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

NW 1/4 NE 1/4 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 Discharge: 3 gpm/Lpm

Ground Temp. °C Well Data: Depth 35'

Air Temp. Bore 4

Odor Mild S= Pump Type artesian

Fluid Color 0 Level of water in bore to top

Fluid Taste CO2 H2S hard Type of piping rusty iron

Bubbling highly CO2 'ed Artesian Head

Boiling 0 Rock Data:

Vegetation vegetation Type (surface) valley fill

Fluid issues from steel pipe Color

 Grain size

 Megascopic Minerals

Salt: Type chloride sulfates

Quantity minor

Color white tan Alteration:

Form acicular - massive Rx Type (at depth)

Sinter: Type 0 Water used for 0

Quantity Immediate area used for: farminç

Color

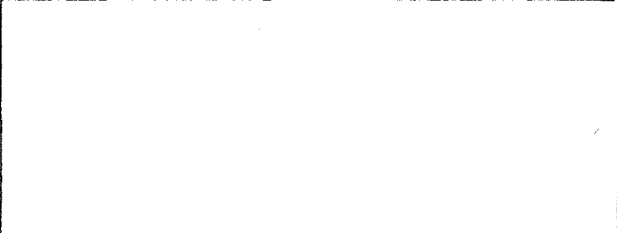
Form Quality of sample: Exc., Good, Poor

Probable cause of manifestation artesian well

Property owned by 2

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 Discharge: 175 gpm/Lpm

Ground Temp. °C Well Data: Depth

Air Temp. Bore

Odor mild H₂S Pump Type

Fluid Color clear Level of water in bore

Fluid Taste hard S= Type of piping

Bubbling minor Artesian Head

Boiling 0 Rock Data:

Vegetation algae Type (surface) SS

Fluid issues from cracks in Color gray, white

SS Grain size medium

 Megascopic Minerals QTZ

Salt: Type chlorides & sulfates

Quantity minor

Color white Alteration: highly

Form massive Rx Type (at depth)

Sinter: Type calcite Water used for drinking, heating

Quantity minor Immediate area used for: ranching

Color white

Form massive Quality of sample: (Exc), Good, Poor

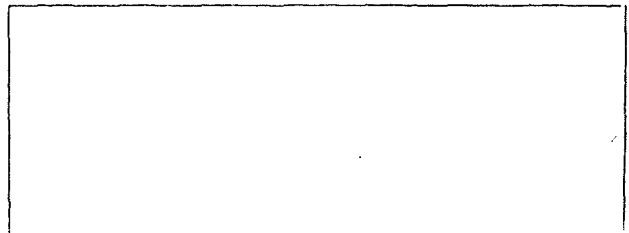
Probable cause of manifestation deep fault

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 & SW 1/4 NW 1/4 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 Discharge: 100 (total) gpm/Lpm

Ground Temp. °C 21.5 Well Data: Depth _____

Air Temp. _____ Bore _____

Odor _____ Pump Type _____

Fluid Color clear Level of water in bore _____

Fluid Taste none Type of piping _____

Bubbling 0 Artesian Head _____

Boiling 0 Rock Data: _____

Vegetation some green algae Type (surface) andesite - basalt

Fluid issues from several Color _____

seeps and fissures Grain size _____

Megascopic Minerals scoriaceous numerous

Salt: Type 0 ves. fillings and fractures

Quantity _____

Color _____ Alteration: some surf

Form _____ Rx Type (at depth) _____

Sinter: Type 0 Water used for cattle

Quantity _____ Immediate area used for: ranch

Color _____

Form _____ Quality of sample: (Exc.), Good, Poor

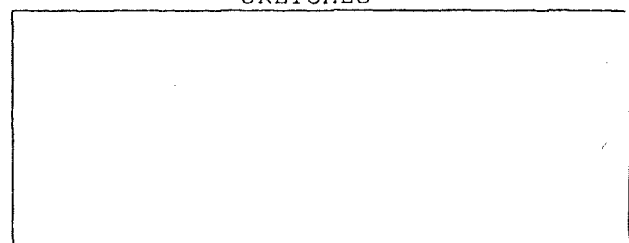
Probable cause of manifestation exposure of aquifer along ridge front (fault)

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

SW 1/4 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 Discharge: 200 gpm/Lpm

Ground Temp. °C 46 Well Data: Depth

Air Temp. Bore

Odor minor H₂S Pump Type

Fluid Color Level of water in bore

Fluid Taste slight sulfide Type of piping

Bubbling moderate Artesian Head

Boiling minor green filament algae Rock Data:

Vegetation a gray algae Type (surface) bslt

Fluid issues from cobbly soil Color dk gray

at base of hill along Grain size Plagioclase up to 5mm

flt? Megascopic Minerals Plagioclase, magnetite

Salt: Type sulfates? chlorite

Quantity minor

Color white Alteration: minor chlorite

Form amorphous Rx Type (at depth)

Sinter: Type Water used for livestock

Quantity Immediate area used for: farming

Color

Form Quality of sample: (Exc), Good, Poor

Probable cause of manifestation flt intercepting heat source at depth

Property owned by

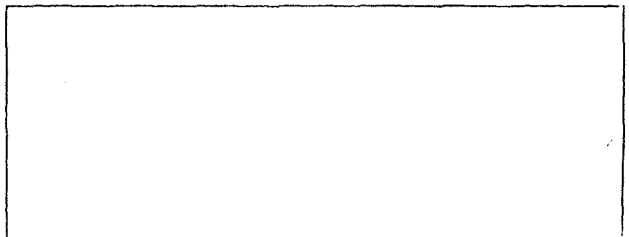
Previous and/or Current Leases

Comments: Roll 8 #28, 29, 30 temp.

SKETCHES

same as when measured 15 years

ago. Does not vary seasonally



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

SE 1/4 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 Discharge: 200 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 0 Type (surface) bslt

Fluid issues from galvanized Color dk gray

steel pipe sunk into rocky Grain size

hillside along Willow Cr. Megascopic Minerals

Salt: Type sulfate

Quantity moderate

Color white Alteration:

Form amorphous Rx Type (at depth)

Sinter: Type 0 Water used for drinking

Quantity Immediate area used for: recreation

Color

Form 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

