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CHEMICAL COMPOSITION DATA AND CALCULATED AQUIFER TEMPERATURE FOR SELECTED WELLS AND SPRINGS OF HONEY LAKE VALLEY, CALIFORNIA

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CHEMICAL COMPOSITION DATA AND CALCULATED AQUIFER TEMPERATURE FOR SELECTED WELLS AND SPRINGS OF HONEY LAKE VALLEY, CALIFORNIA

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ABSTRACT

Major element, minor element, and gas composition data are tabulated for 15 springs and wells in Honey Lake Valley, California. Wendel and Amedee hot springs issue $Na-SO_4-Cl$ waters at boiling or near boiling temperatures; the remaining springs and wells issue $Na-HCO_3$ waters at temperatures ranging from 14 to 33°C. Gases escaping from the hot springs are principally nitrogen with minor amounts of methane. The geothermometers calculated from the chemical data are also tabulated for each spring.

INTRODUCTION

Wendel and Amedee hot springs have been described and analyzed numerous times (Waring, 1915; Stearns and others, 1937; Waring, 1965; and Reed, 1975). Flow rates estimated by Waring (1915) for Amedee Hot Springs (700 gallons per minute) and Wendel Hot Springs (250 gallons per minute) appear to be about the same as those observed at present. General water quality investigations of the Honey Lake area have been carried out by the California Department of Water Resources (1960). Several geothermal wells have been drilled in the area around Wendel and Amedee hot springs. The most recent tests were drilled to a depth of approximately 5,000 feet (1,524 meters) by Gulf Oil Corporation near Amedee Hot Springs in sec. 5, T. 28N., R. 16E. and near Wendel Hot Springs in sec. 25, T. 29N., R. 15E. Both wells were abandoned by Gulf; it is not known whether high temperature fluids were encountered.

PURPOSE OF SAMPLING

Both the Bureau of Reclamation and the U.S. Geological Survey were interested in detailed sampling of thermal and cold springs in the Honey Lake Valley to attempt to better define the geothermal potential of the area. To prevent duplication of effort and alienation of land owners, it was decided that the Geological Survey would sample springs and wells in the northeastern part of the valley while the Bureau of Reclamation would sample springs and wells in the northwestern part of the valley. Sample number 15, a hot well in the town of Susanville, was collected by both agencies for purposes of comparison.

The Bureau of Reclamation was interested in water quality and mixing of water from the deep reservoir. The water quality data we are releasing in this report are needed for the mixing model calculations. The stable isotope data on the samples we collected and the samples collected for us by Gary Hollinger and Lyle Williams of the Bureau of Reclamation are being analyzed in our laboratory. When available, these data will be used in formal publication.

LOCATION OF SAMPLE SITES

The locations of the sampled springs and wells are shown in figure 1. Table 1 lists the locations as determined from U.S. Geological Survey topographic maps. We attempted to sample as many springs and wells in the northeastern part of the Honey Lake Valley as we could in a three-day period from August 2 to August 4, 1976; simultaneously the Bureau of Reclamation was sampling in the northwestern part of the valley.

METHODS AND PROCEDURES

Water collected at points as close to the orifices of the springs or wells as possible was immediately pressure-filtered through a 0.1 µm (micrometer) membrane filter using compressed nitrogen as the pressure source. Filtered water samples were stored in plastic bottles which had been acid-washed to remove contaminants prior to use. Samples collected for Group II metals were acidified with concentrated hydrochloric acid to pH 2. Twenty-five milliliters of the filtered sample was diluted to 50 milliliters with distilled deionized water to prevent the

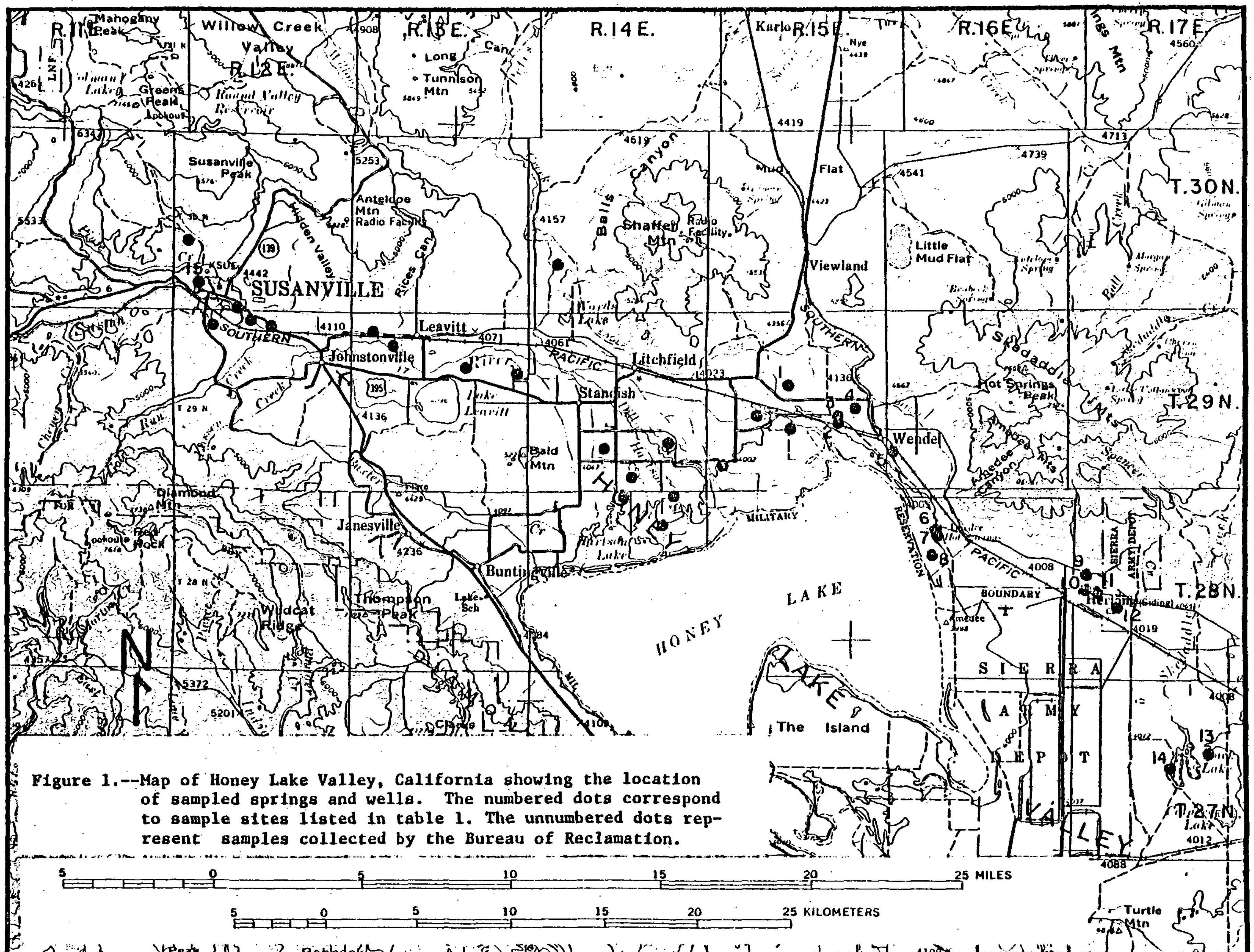

Figure 1.--Map of Honey Lake Valley, California showing the location of sampled springs and wells. The numbered dots correspond to sample sites listed in table 1. The unnumbered dots represent samples collected by the Bureau of Reclamation.

Table 1.--Location of sampled springs or wells

[Numbers in the sample column correspond to locations shown in figure 1]

Springs and wells	Location
1 Shallow well (4 km NW of Wendel Hot Spring)----------	NW¼SE¼sec. 16, T. 29N., R. 15E.
2 Wendel Hot Spring------------------------------------	NE¼SW¼sec. 23, T. 29N., R. 15E.
3 Shallow well at Wendel Hot Spring--------------------	NW¼SE¼sec. 23, T. 29N., R. 15E.
4 Warm spring (2 km NE of Wendel Hot Spring)-----------	SW¼NW¼sec. 24, T. 29N., R. 15E.
5 Observation well (1 km SE of Wendel)-----------------	SE¼SW¼sec. 30, T. 29N., R. 16E.
6 Amedee Hot Springs #1 (north vent)-------------------	NE¼NW¼sec. 8, T. 28N., R. 16E.
7 Amedee Hot Springs #2 (middle vent)------------------	NW¼NE¼sec. 8, T. 28N., R. 16E.
8 Amedee Hot Springs #3 (south vent)-------------------	NE¼SW¼sec. 8, T. 28N., R. 16E.
9 Artesian well #1-------------------------------------	NW¼SE¼sec. 8, T. 28N., R. 17E.
10 Artesian well #2------------------------------------	NW¼NE¼sec. 19, T. 28N., R. 17E.
11 Artesian well #3------------------------------------	S½NE¼sec. 19, T. 28N., R. 17E.
12 Irrigation well (CV Ranch)--------------------------	NE¼SW¼sec. 20, T. 28N., R. 17E.
13 Windmill east of Duck Lake--------------------------	sec. 14, T. 27N., R. 17E.
14 Irrigation well at Duck Lake------------------------	NE¼NW¼sec. 22, T. 27N., R. 17E.
15 Hot well at Roosevelt Plunge------------------------	NE¼NE¼sec. 6, T. 29N., R. 12E.

polymerization of silica; these samples were used for silica analysis. Samples of any gases escaping from the spring were collected in gas-tight syringes which were placed in a bottle of the native water for transport back to the laboratory.

Field determinations were made of water temperature, pH, alkalinity, and sulfide. Water temperatures were determined with a thermistor probe and a maximum reading mercury-in-glass thermometer. The pH was measured directly in the spring (using the method of Barnes, 1964). Alkalinity was measured immediately after the sample was withdrawn from the spring. Sulfide (total sulfides as H_2S) was precipitated as zinc sulfide from the hot sample and titrated by the iodometric method. Detailed descriptions of our sampling techniques are given in Presser and Barnes (1974).

Sodium, potassium, lithium, calcium, magnesium, and silica were determined by direct aspiration on a double beam atomic absorption (A. A.) spectrophotometer in our laboratory. Silica was also determined by the molybdate blue method as described in Brown, Skougstad, and Fishman (1970). Boron was determined by the Carmine method and sulfate by the Thorin method (Brown and others, 1970). Fluoride was determined by specific ion electrode using the Orion TISAB buffer. Chloride was determined by either the Mohr titration or the colorimetric Ferric Thiocyanate method depending on the concentration range (Brown and others, 1970; ASTM, 1974).

Gases were analyzed by gas chromatography as soon as possible after returning to the laboratory. Linde Molecular Sieve 13X was used to separate and quantify (O_2 + Ar), N_2, and CH_4, while Poropak Q was used for CH_4, C_2H_6, and CO_2. The columns were run at room temperature with helium as the carrier gas. The gases were detected by thermal conductivity.

DATA

The temperature, pH, and chemical composition of the sampled springs and wells are presented in table 2. The water of the hot springs at Amedee and Wendel are higher in sulfate, chloride, fluoride, boron, and sodium but lower in magnesium than the adjacent springs and wells. Generally the hot springs (>37°C) issue $Na-SO_4-Cl$ waters while the warm and cold waters are $Na-HCO_3$ in character. Gas samples collected from Wendel and Amedee hot springs consist principally of nitrogen with minor amounts of methane (table 3). Water-rock equilibrium temperatures using various geothermometers are listed in table 4. The equations used to calculate these geothermometers are given in Fournier (1975). There is good

Table 2.--Chemical composition of springs and wells

[Concentrations are in milligrams per liter]

Springs and wells	Temperature ($^{\circ}$C)	pH	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Lithium (Li)	Alkalinity (as HCO_3)[1]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Boron (B)	Dissolved constituents[2]
Shallow well (4 km NW of Wendel Hot Spring)------------	22½	9.00	49	2.7	0.2	60	1.9	0.01	130	20	8	0.22	<1.0	272
Wendel Hot Spring---------------------	95½	8.26	125	20	<.1	280	8.0	.11	53	340	185	4.2	5.6	1,021
Shallow well at Wendel Hot Spring--------------------------	94½	[3] 8.78	86	12	<.1	190	5.5	.06	83	220	120	2.9	3.5	723
Warm spring (2 km NE of Wendel Hot Spring)--------------	27	8.20	34	10	4.3	43	5.5	<.01	118	21	12	.15	<1.0	248
Observation well (1 km SE of Wendel)----------------------	28	8.22	43	6.2	2.2	56	8.5	.01	115	28	18	.15	<1.0	277
Amedee Hot Springs #1 (north vent)------------------------	76	8.49	100	16	<.1	235	5.5	.08	49	280	160	4.6	3.7	853
Amedee Hot Springs #2 (middle vent)-----------------------	92	8.41	100	16	<.1	235	6.0	.08	48	290	160	4.6	3.8	863
Amedee Hot Springs #3 (south vent)------------------------	96	8.36	98	15	<.1	235	5.7	.08	57	280	155	4.6	3.8	854
Artesian well #1----------------------	15	9.00	29	4.2	.9	57	2.6	.01	118	22	12	.15	<1.0	246
Artesian well #2----------------------	23	8.44	32	5.3	1.0	47	1.8	<.01	99	20	11	.17	<1.0	217
Artesian well #3----------------------	26½	8.23	38	5.4	2.0	39	4.6	<.01	97	16	9	.13	<1.0	211
Irrigation well (CV Ranch)------------	26	8.12	34	3.3	1.6	43	3.3	<.01	97	17	10	.12	<1.0	209
Windmill east of Duck Lake------------	14	8.18	63	27	13	120	9.7	.04	369	28	43	1.5	<1.0	674
Irrigation well at Duck Lake----------	18	7.73	54	44	13	25	8.5	.03	267	8	3	.54	<1.0	423
Hot well at Roosevelt Plunge----------	33	8.07	57	20	3.1	18	4.2	<.01	122	5	2	<.1	<1.0	231

[1] Total alkalinity as bicarbonate.

[2] Dissolved constituents are a total of the major element concentrations in milligrams per liter.

[3] pH measured at 32°C.

Table 3.--Compositions of gases escaping from thermal springs

[Composition in volume percent]

Spring and wells	Nitrogen (N_2)	Carbon dioxide (CO_2)	Methane (CH_4)	Oxygen (O_2) + Argon (Ar)	Hydrogen (H_2)
Wendel Hot Spring----------	95.6	0.4	2.5	1.9	---
Amedee Hot Springs #2-----	88.4	1.1	1/ 6.7	2.7	0.4

1/ Includes a trace of ethane.

Table 4.--Calculated aquifer temperatures based on water composition

[Measured and calculated temperatures are in degrees Celsius (°C). Aquifer temperatures were calculated with the computer program SOLMNEQ (Kharaka and Barnes, 1973).]

Springs and wells	Measured temperature (°C)	Quartz	Chalcedony [1/]	Alpha-cristobalite [1/]	Na-K	Na-K-1/3Ca	Na-K-4/3Ca
Shallow well (4 km NW of Wendel Hot Spring)	22½	101	61	42	80	125	82
Wendel Hot Spring	95½	144	113	89	73	128	104
Shallow well at Wendel Hot Spring	94½	126	75	54	74	127	98
Warm spring (2 km NE of Wendel Hot Spring)	27	85	52	33	214	175	85
Observation well (1 km SE of Wendel)	28	95	62	43	238	194	116
Amedee Hot Springs #1 (north vent)	76	139	98	75	60	119	94
Amedee Hot Springs #2 (middle vent)	92	137	94	72	66	123	97
Amedee Hot Springs #3 (south vent)	96	132	91	69	63	121	97
Artesian well #1	15	78	40	22	108	137	82
Artesian well #2	23	82	48	29	94	125	64
Artesian well #3	26½	89	57	38	204	175	92
Irrigation well (CV Ranch)	26	85	52	33	155	159	93
Windmill east of Duck Lake	14	113	83	61	162	162	94
Irrigation well at Duck Lake	18	105	75	54	391	206	62
Hot well at Roosevelt Plunge	33	108	77	56	310	186	53

[1/] Corrected for dissociation of H_4SiO_4.

agreement between the reservoir temperature estimated from the chalcedony and Na-K-4/3Ca geothermometers at Wendel and Amedee hot springs. The calculated aquifer temperatures for the shallow well at Wendel Hot Springs may be in doubt because the well does not flow. Mixing model calculations require interpretation and therefore were not included in this data report.

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