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CHEMICAL DATA FOR EIGHT SPRINGS IN NORTHWESTERN NEVADA

By R. H. Mariner, T. S. Presser, and W. C. Evans

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ABSTRACT

Chemical analyses of major and minor elements, deuterium and oxygen (18) composition, and gas composition data are tabulated for six hot springs and two cold springs in northwestern Nevada. The hot springs issue in areas of geothermal interest in the San Emidio Desert, Black Rock Desert, and Dixie Valley. Data for the cold springs are included to establish background silica concentrations and isotope compositions. The normal chemical geothermometers are tabulated for each spring.

INTRODUCTION

This open-file data release makes available chemical data on hot springs sampled in northwestern Nevada during 1975. The San Emidio Desert KGRA (Known Geothermal Resources Area) was designated after the sampling for our previous papers (Mariner and others, 1975, 1974) was complete. Data on several other hot and cold springs in the Black Rock Desert area are included for completeness. Sampling conditions in the San Emidio Desert are very poor; the springs are merely seeps with virtually no surface discharge. The sample from the unnamed hot spring near Trego was collected to replace a grab sample collected in 1972 which we reported in the previously listed papers. The two cold springs were sampled to determine background silica and isotope compositions. Hyder Hot Springs in Dixie Valley is included so that this data release will make available all of the chemical and isotopic data we have on the hot springs of Nevada.

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 (micrometre) 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 for heavy metal analyses were immediately acidified with concentrated nitric acid to a pH of 2 or less to insure that the metals would remain in solution. Samples collected for Group II metals were acidified with concentrated hydrochloric acid to pH 2. Ten millilitres of filtered sample were diluted to 100 millilitres with distilled deionized water to slow the polymerization of silica. Three samples of unfiltered untreated water were collected in 125-ml (millilitre) glass bottles with polyseal caps for stable isotope analysis. Samples of any gases escaping from the spring were collected in gas-tight glass syringes which were placed in a bottle of the native water for transport back to the laboratory.

Field determinations were made of barometric pressure, air temperature, water temperature, pH, alkalinity, ammonia and sulfide. Extraction of aluminum and preservation of mercury were also performed in the field. Water temperatures were determined with a thermistor probe and a maximum reading mercury-in-glass thermometer. Detailed descriptions of our sampling techniques are given in Presser and Barnes (1974). 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 determined by the iodometric titration method described by Brown, Skougstad and Fishman, (1970). Mercury was stabilized by addition of 2:1 H_2SO_4:HNO_3, 5 percent $KMnO_4$(W/V), and 5 percent $K_2S_2O_8$(W/V). Ammonia was determined by allowing the thermal spring sample to cool to ambient temperature, adding sodium hydroxide to raise the pH to approximately 12 and measuring the dissolved ammonia with an ammonia specific ion electrode. Water samples for aluminum were complexed with 8-hydroxyquinoline, buffered at pH 8.3, and extracted with methyl isobutyl ketone in the field as described by Barnes (1975).

Silica, sodium, potassium, lithium, rubidium, cesium, cadmium, cobalt, copper, iron, nickel, lead, manganese, and zinc were determined by direct aspiration on a double beam atomic absorption (A. A.) spectrophotometer in our laboratory. Detection limits in micrograms per litre ($\mu g/l$) for the direct aspiration of solutions containing the heavy metals on our instrument are cadmium (10), cobalt (50), copper (10), iron (20), lead (100), manganese (20), and zinc (10). Boron was determined in our laboratory by either the Dianthrimide method or the Carmine method (Brown and others, 1970), depending on the concentration range. Fluoride was determined in our laboratory by specific ion electrode using the method of R. B. Barnes (written commun., 1973). Chloride and sulfate were determined by the Mohr and Thorin methods, respectively, as described in Brown, Skougstad and Fishman, (1970). Specific conductances were determined in the laboratory at 25°C. Mercury was determined by a flameless atomic absorption technique (Environmental Protection Agency, 1971). The organic extract containing the aluminum complex was analyzed by A. A.

Oxygen isotope analysis was by the CO_2-equilibration method of Cohn and Urey (1938) and deuterium analysis by reaction with uranium at 800°C (Bigeleisen and others, 1952). $^{18}O/^{16}O$ and D/H measurements were made mass spectrometrically.

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

DATA

Table 1 gives the name, location, and a brief description of the springs. The chemical, isotope, and gas compositions of the respective springs are listed in tables 2, 3, and 4. Springs in the San Emidio Desert all "issue" moderately saline waters of near neutral pH (6.6 - 6.7) at temperatures near boiling. Unfortunately these springs also have very low flow rates. As expected for springs issuing so close to one another, the chemical compositions of samples from the San Emidio Desert are very similar. These sodium-chloride waters range from 1,400 to 1,500 milligrams per litre (mg/l) in sodium and from 2,300 to 2,500 mg/l in chloride. Isotopically the water is similar to Great Boiling Spring in deuterium concentration; however, it is heavier in deuterium than the fresh waters or the hot spring near Trego. The oxygen isotope shift is similar for all the hot springs. Gases escaping from the hot spring near Trego and the unnamed hot spring 2 in the San Emidio Desert are principally nitrogen (93 and 62 percent, respectively). The spring in the San Emidio Desert also issues some carbon dioxide (25 percent) and methane (11 percent).

Estimated aquifer temperatures (table 5) based on the concentrations of silica, sodium, potassium, and calcium indicate temperatures of 180° to $190^{\circ}C$ for the thermal reservoir associated with the hot springs in the San Emidio Desert. However the very low flow rates make the estimated reservoir temperatures qualitative at best for reasons detailed in Fournier, White, and Truesdell (1974). Lower temperatures are estimated for the springs in the Black Rock Desert and Dixie Valley.

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Table 1.--Location and description of springs sampled in Pershing and Washoe Counties, Nevada, during 1975

Spring name	Location	Date of collection	Description
		Pershing County	
Unnamed hot spring near Trego-------	Lat. $40^{\circ}46'$ N., long. $119^{\circ}7'$ W.	August 21, 1975	Intermittent gas discharge, estimated flow approximately 150 lpm.
Unnamed cold spring in the Selenite Range------------	Lat. $40^{\circ}37'$ N., long. $119^{\circ}15'$ W.	August 21, 1975	Fresh water, developed as source for cattle tank.
Hyder (Hydra) Hot Springs-----------	SW¼ sec. 28, T. 25 N., R. 38E.	September 20, 1975	Large carbonate mound, gassy spring, travertine terraces, large flow (>100 lpm).
		Washoe County	
Unnamed hot spring San Emidio Desert 1---------------	sec. 9 and 16, T. 29N., R. 23E.[1/]	August 20, 1975	Clear gassy spring, estimated flow <3 lpm.
Unnamed hot spring San Emidio Desert 2---------------	sec. 9 and 16, T. 29N., R. 23E.[1/]	August 20, 1975	Clear gassy spring, estimated flow <3 lpm.
Unnamed hot spring San Emidio Desert 3---------------	sec. 9 and 16, T. 29N., R. 23E.[1/]	August 20, 1975	Boiling spring, estimated flow <1 lpm.
Unnamed hot spring near Great Boiling Spring---------	SW¼ NW¼ sec. 10, T. 32N., R. 23E.	August 20, 1975	Spring rises in excavation on north side of graded road from Gerlach to Soldier Meadows, estimated flow rate 100 lpm.
San Emidio Spring-------------------	NE¼ sec. 31, T. 28N., R. 23E.	August 20, 1975	Fresh water, seep spring.

[1/] All three springs are located within a 200-metre strip near the vegetation line on the eastern side of the San Emidio Desert.

Table 2.--Chemical analysis of sampled thermal and fresh water springs in Pershing and Washoe Counties, Nevada

[Concentrations in milligrams per litre; dashes indicate the absence of data]

Spring name	Temperature (°C)	pH	Specific conductance (Micromhos)	Silica (SiO_2)	Sodium (Na)	Potassium (K)	Lithium (Li)	Calcium (Ca)	Magnesium (Mg)	Alkalinity (as HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Boron (B)	Ammonia (as N)	Cesium (S)	Rubidium (Rb)	Manganese (Mn)	Iron (Fe)	Aluminum (Al)	Sulfide (as H_2S)
Pershing County																					
Unnamed hot spring near Trego------------	84½	7.93	2,120	79	430	8.6	0.26	11	0.2	162	180	500	4.1	5.0	0.57	<0.1	0.06	<0.01	<0.02	0.021	1.0
Unnamed cold spring in the Selenite Range-----------------	14	7.15	471	29	33	5.0	.03	49	11	177	28	51	<.1	.22	---	<.1	<.02	---	---	---	---
Hyder Hot Springs------	78	6.77	1,500	63	390	20	1.6	41	10	926	120	45	8.6	4.1	1.4	.3	.15	.02	<.02	.004	<1
Washoe County																					
Unnamed hot spring San Emidio Desert 1---	79	6.69	6,850	240	1,400	110	2.1	140	1.5	92	230	2,300	5.0	6.3	---	.4	.92	.08	.13	---	7.6
Unnamed hot spring San Emidio Desert 2---	89	6.57	6,880	205	1,400	110	2.2	160	2.2	102	220	2,300	5.1	6.5	1.6	.4	.86	.13	.12	.004	9.6
Unnamed hot spring San Emidio Desert 3---	95	6.63	7,570	215	1,500	120	2.5	160	2.3	129	240	2,500	5.2	7.2	---	.4	.90	.15	.05	---	---
Unnamed hot spring near Great Boiling Spring----------------	89½	7.62	6,350	145	1,400	86	1.5	58	1.0	68	350	2,050	4.8	7.1	.88	.2	.62	.01	<.02	.011	<.5
San Emidio Spring------	15	9.7	260	34	25	8.3	<.01	18	7.9	120	19	16	.29	.12	---	<.1	<.02	---	---	---	---

1/Detectable amounts of cadmium, cobalt, and lead were not found in any of the spring waters. Detectable amounts of copper, nickel, mercury, and zinc were found in several springs: copper (0.01 mg/l) in San Emidio 1 and 2, (0.02 mg/l) in Hyder Hot Springs; nickel (0.02 mg/l) in San Emidio 1; mercury (0.0006 mg/l) in San Emidio 2 and (0.0002 mg/l) in Trego; zinc (0.01 mg/l) in San Emidio 3.

Table 3.--Deuterium and oxygen (18) compositions of thermal and fresh waters[1/]

[Dashes indicate the absence of data]

Spring name	δD(‰)	$\delta^{18}O$(‰)	Oxygen shift[2/]
Pershing County			
Unnamed hot spring near Trego--	-127.6	-14.87	+2.33
Unnamed cold spring in the Selenite Range--------	-119.3	-15.26	+0.90
Hyder Hot Springs--------------	---	---	---
Washoe County			
Unnamed hot spring San Emidio Desert 1----------	-105.3	-11.54	+2.87
Unnamed hot spring San Emidio Desert 2----------	-108.3	-12.05	+2.73
Unnamed hot spring San Emidio Desert 3----------	-106.4	-11.61	+2.94
Unnamed hot spring near Great Boiling Spring----	-106.5	-11.65	+2.91
San Emidio Spring--------------	-110.2	-14.24	+.78

[1/]Deuterium and oxygen (18) analyses were done by L. D. White and S. J. Grigg.

[2/]Oxygen shift relative to meteoric water line, $\delta D = 8\ \delta^{18}O + 10$.

Table 4.--Chemical composition of gases escaping from hot springs

[Analyses in volume percent]

Spring name	Oxygen (O2) + Argon (Ar)	Nitrogen (N_2)	Methane (CH_4)	Carbon dioxide (CO_2)
Pershing County				
Unnamed hot spring near Trego---	2.6	93	2.8	1.2
Hyder Hot Springs---------------	4.0	12	0.85	83
Washoe County				
Unnamed hot spring San Emidio Desert 2-----------	2.3	62	11	25

Table 5.--Estimated aquifer temperatures (°C)[1/]

Spring name	Spring temperature (°C)	Quartz (conductive)	Quartz (adiabatic)	Chalcedony	Amorphous silica	Na-K-1/3Ca	Na-K-4/3Ca
Pershing County							
Unnamed hot spring near Trego----	84½	124	122	92	2	124	129
Unnamed cold spring in the Selenite Range----------	14	78	82	[2/]46	-34	166	47
Hyder Hot Springs----------------	78	113	112	84	-5	154	126
Washoe County							
Unnamed hot spring San Emidio Desert 1------------	79	193	178	173	68	188	190
Unnamed hot spring San Emidio Desert 2------------	89	182	170	160	58	187	185
Unnamed hot spring San Emidio Desert 3------------	95	185	172	164	61	189	191
Unnamed hot spring near Great Boiling Spring------	89½	159	151	132	34	183	210
San Emidio Spring----------------	15	85	88	[2/]29	-48	214	80

[1/]The quartz geothermometer has been described by Fournier and Rowe (1966) while the Na-K-Ca geothermometer has been described by Fournier and Truesdell (1973). The equations used to calculate the reservoir temperatures were provided by R. O. Fournier. Calculations were carried out with a modified version of the computer program SOLMNEQ (Kharaka and Barnes, 1973).

[2/]Assuming equilibrium with alpha-cristobalite would indicate aquifer temperatures of 28°C and 12°C, respectively, for the cold spring in the Selenite Range and San Emidio Spring.