WATER-RESOURCES BULLETIN 13
1970

UTAH GEOLOGICAL AND MINERALOGICAL SURVEY
affiliated with
THE COLLEGE OF MINES AND MINERAL INDUSTRIES
University of Utah, Salt Lake City, Utah

MAJOR THERMAL SPRINGS OF UTAH

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The United States Geological Survey
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by
J. C. Mundorff
Hydrologist, U. S. Geological Survey

Frontispiece. View of typical hot pot near Midway, Utah. Opening is about 9 feet in diameter, and water level is 1.5 feet below rim. Top of rim is about 5 feet above ground level on left side of photograph. (Photograph by Claud H. Baker, Jr.)

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ABSTRACT

As part of a study of the springs of Utah, reconnaissance data were obtained on the thermal, chemical, and geologic characteristics of the major thermal springs of Utah. Only three of the springs have temperatures near the boiling point of water; the maximum recorded temperatures of these springs range from 185° to 189° F. All three springs are in or near areas of late Tertiary or Quaternary volcanism.

Temperatures of the thermal springs studied ranged from 68° to 189° F. Nearly all thermal springs in Utah are in or near fault zones. Very few of these springs issue from volcanic rocks, but several springs are close to areas of late Tertiary or Quaternary volcanic rocks.

Dissolved-solids contents of the springs range from as low as 214 ppm (parts per million) for a spring having a temperature of 80° F to as high as about 45,000 ppm for a spring having a temperature of 132° F. Most springs are sodium chloride in type, and all springs that contain more than 3,000 ppm of dissolved solids are of the sodium chloride type. Silica concentrations exceed 100 ppm for two of the thermal springs.

Only two springs in the State, Roosevelt and Abraham Hot Springs, are in what has been designated as potentially valuable geothermal areas by the U. S. Geological Survey.

Some thermal springs in Utah have large discharges, low dissolved-solids contents, and fairly low temperatures; these springs are valuable as water supplies for irrigation and stock use.

The main undesirable effect of the thermal springs in Utah is that they add significant amounts of water having high dissolved-solids contents to some streams and lakes. The inflow of LaVerkin Hot Springs to the Virgin River and of many thermal springs around Utah Lake results in a deterioration of the quality of the surface-water supply.

INTRODUCTION

The thermal springs of Utah have been of scientific and economic interest for more than a century. In 1843, Fremont's expedition measured a temperature of 136° F at the springs now known as Utah Hot Springs and described by Hayden (1873, p. 175) as "ten miles above Ogden City, Utah Territory, and 4 miles from Salt Lake." The use of the springs of Utah as a thermal resource has been limited mainly to the development of spas, although water from many of the thermal springs has been used for irrigation, stock, and other purposes. Thus, nearly all thermal springs in Utah have been used mainly as water resources, not as thermal resources.

Increasing attention is being directed toward thermal springs as indicators of areas in which the use of geothermal energy for generation of electric power might be economically feasible. Although thermal springs in an area indicate the existence of geothermal energy at some depth, they do not indicate the economic feasibility of development of the energy, the depth and magnitude of the source of heat, or the optimum location for subsurface exploration and possible development of the geothermal resource. Therefore, the thermal springs described in this report are not a direct indication that an area has a geothermal resource from which electric power can be produced economically; they are an indication that the area may have such a resource.

This study of thermal springs in Utah was part of an investigation of the major springs of Utah, which is included in a program of water-resources investigations being made by the U. S. Geological Survey in cooperation with the Utah Geological and Mineralogical Survey. The objective of this study was to obtain information on the location, chemical characteristics, water discharge, temperature and general geologic setting of each major thermal spring in Utah. The detailed geologic and geophysical reconnaissance necessary before possible development of any site for geothermal energy was not a part of this study.

The normal thermal equilibrium of an area may be affected by (1) the presence of an intrusive magma rising sufficiently close to the surface to heat the surrounding rock and the interstitial water, (2) the extrusion of igneous rocks (volcanism), (3) heat from radioactive elements and (4) heat that might be generated by the friction along faults. Of the probable sources of geothermal heat, intrusive or extrusive masses of magma are a requirement for hyperthermal conditions having economic value. Fault friction may be a minor source of heat for all springs shown in the vicinity of faults or for springs described as being in the vicinity of known or inferred faults.

Thermal discharges having temperatures at or near the boiling point of water indicate prospective areas in which to drill wells in exploration for geothermal energy. In the United States, prospective areas appear to be limited, with few or no exceptions, to zones in or near post-Miocene volcanism. In Utah, only three springs--Thermo, Abraham, and Roosevelt--have temperatures near the boiling point of water. The boiling point at the altitude of these springs is about 205° F. All three springs have temperatures between 185° and 189° F, and all three springs are in or near areas of late Tertiary or Quaternary volcanism. (During the past 10 years, however, Roosevelt Hot Springs have had little or no discharge, although abnormal geothermal conditions are evident in the vicinity of the springs.)

The possibilities of producing natural steam depend on the existence of a source of heat, on the presence of a permeable bed, and generally on the presence of an impermeable caprock. Detailed geologic, gravimetric, electrical, seismic, and hydrogeological reconnaissances are therefore recommended before drilling. The preliminary objective is to drill test wells to confirm the inferences from these surveys and to supply detailed information about the formations present. Such detailed information should include their most important physical properties (porosity, permeability, and density) and existing physical conditions (temperature and pressure of the fluids and nature of the percolating fluids).

Although chemical data were obtained on the major thermal springs of Utah, Doyle and Studt (*in* United Nations, 1964a, p. 195) state that chemical sampling of springs may help to indicate the type of condition likely to be met in drill holes and that many of the chemical features are superficial. Chemistry becomes more important when drill holes can be sampled and trends followed over a reasonable period. White (1957b, p. 1668) states that volcanic hot spring waters generally range from about 1,000 to 5,000 ppm in content of dissolved solids. Volcanic sodium chloride waters have the highest silica content of known natural surface waters; the silica content of volcanic springs commonly ranges from 150 to more than 500 ppm. Lithium, relative to other components, is higher in the volcanic sodium chloride springs than in any other natural water; the lithium/sodium ratio averages 0.01.

Bodvarsson and Palmason (*in* United Nations, 1964a, p. 91-98) state that a main implication of their studies in Iceland is that thermal water, which has been saturated at one temperature and is cooled by conduction losses or flashing, will keep the initial silica content reactive in spite of the temperature loss. They state that the behavior of silica implies that the following relation can be applied in order to obtain a semiquantative estimate of the base temperature:

$$25 + T_b = SiO_2 \text{ in ppm,}$$

where T_b is in degrees C.

If 340° F or 170° C is assumed to be the minimum subsurface temperature for commercial geothermal steam, then thermal springs having temperatures at or near the boiling point of water and having silica concentrations of about 200 ppm or greater would indicate a good potential for geothermal prospecting.

Nearly all thermal springs in Utah are in or very near fault zones that serve as escape routes for deeply circulated waters under artesian pressure. Although very few of these springs actually issue from volcanic rocks, several springs are close to areas of late Tertiary or Quaternary volcanic rocks.

No evidence exists to indicate that meteoric water is not the source of the spring discharges. Small amounts of volcanic, connate, magmatic, or juvenile water may be present in the discharge of some springs, but the available chemical data offer no proof.

Previous Work and Acknowledgments

Many investigators have studied one or more of the thermal springs of Utah. Waring (1965), in a summary of thermal springs of the world, listed and briefly described many of the major thermal springs in Utah. Heylmun (1966) presented a brief description of the geothermal power potential in Utah. Milligan, Marsell, and Bagley (1966) studied the "mineralized springs" in Utah; these springs included thermal springs having dissolved-solids contents ranging from as low as 292 ppm to about 46,500 ppm.

White (1957a and 1957b) and many contributors to the United Nations (1964a) have been used freely in this report as sources of information concerning general characteristics of thermal springs of the world. Many other investigators are listed in the section "Selected references."

Spring-numbering System

The spring-numbering system used in this report is shown in figure 1 and is based on the U. S. Bureau of Land Management's system of land subdivision. The spring number indicates the location of the spring by quadrant, township, range, section, and position (if known) within the section. Four quadrants are formed by the intersection of the Salt Lake Base Line and the Salt Lake Meridian. The capital letter at the beginning of the location code indicates the quadrant in which the spring is located–A the northeast quadrant, B the northwest, C the southwest and D the southeast. Numbers designating the township and range, respectively, follow the quadrant letter, and the three are enclosed in parentheses. The number after the parentheses designates the section; the lowercase letters, if shown, indicate the location of the spring within the section. The first letter denotes the quarter section (usually 160 acres), the second the quarter-quarter section (40 acres), and the third the quarter-quarter-quarter section (10 acres). The letters are assigned within the section in a counterclockwise direction beginning with "a" in the northeast quarter of the section. Letters are assigned within each quarter section and each quarter-quarter section in the same manner. The capital letter "S" completes the designation of a spring. When two or more springs are within the smallest subdivision, consecutive numbers beginning with 1 are added after the letter "S." For example, (D-3-4)27cbd-S1 indicates a spring in the southeast quarter of the northwest quarter of the southwest quarter of sec. 27, T. 3 S., R. 4 E., and shows that this is the first spring recorded in the quarter-quarter-quarter section. The capital letter D indicates that the township is south of the Salt Lake Base Line and that the range is east of the Salt Lake Meridian.

Definition of Terms

CONNATE WATER–Water that was entrapped in the interstices of rock material at the time the material was deposited.

EQUIVALENTS PER MILLION (epm)–A unit for expressing the concentration of chemical constituents in solution in terms of the interreacting values of the electrically charged particles, or ions. One equivalent per million of a positively charged ion will react with one equivalent per million of a negatively charged ion.

GEOTHERMAL GRADIENT–The rise in temperature with depth below the earth's surface. The normal temperature increase is 1° F for each increase in depth of 60-100 feet.

HOT POTS–Small pools of warm or hot water occupying shallow craters in the tops of conical or hemispherical mounds of tufa.

HOT SPRINGS–Springs whose waters have temperatures higher than 100° F.

JUVENILE WATER–"New" water that is in, or is derived from, primary magma or other matter and has not previously been a part of the hydrosphere.

MAGMA–Naturally occurring mobile rock material, generated within the earth and capable of intrusion and extrusion, from which igneous rocks are considered to have been derived by solidification.

MAGMATIC WATER–Water that is in, or is derived from, magma.

METEORIC WATER–Water that was derived from the atmosphere.

PARTS PER MILLION (ppm)–A unit for expressing the concentration of chemical constituents by weight, generally as grams of constituents per million grams of solution. In the laboratory the results are expressed in weights of solutes in a given volume of water. To express the results in parts per million, the data must be converted. For most waters, this conversion is made by assuming that a liter of water weighs 1 kilogram; thus 1 mg/l (milligram per liter) is equivalent to 1 ppm for waters having concentrations less than 7,000 ppm.

SALINE SEDIMENT–In this report, the term is regarded as synonymous with two map units used by Stokes (1964)–lakebed sediments permanently moist and with high salt content and lakebed sediments poorly drained and with enough salt to prohibit agriculture.

THERMAL SPRING–Any spring whose temperature is significantly higher (10° F) than the mean annual air temperature of the surrounding area.

VOLCANIC WATER–Water that is in, or that has separated from, magma at the surface or at relatively shallow depth.

WARM SPRINGS–Springs whose waters have temperatures higher (10° F) than the local mean annual temperatures of the atmosphere but lower than 100° F.

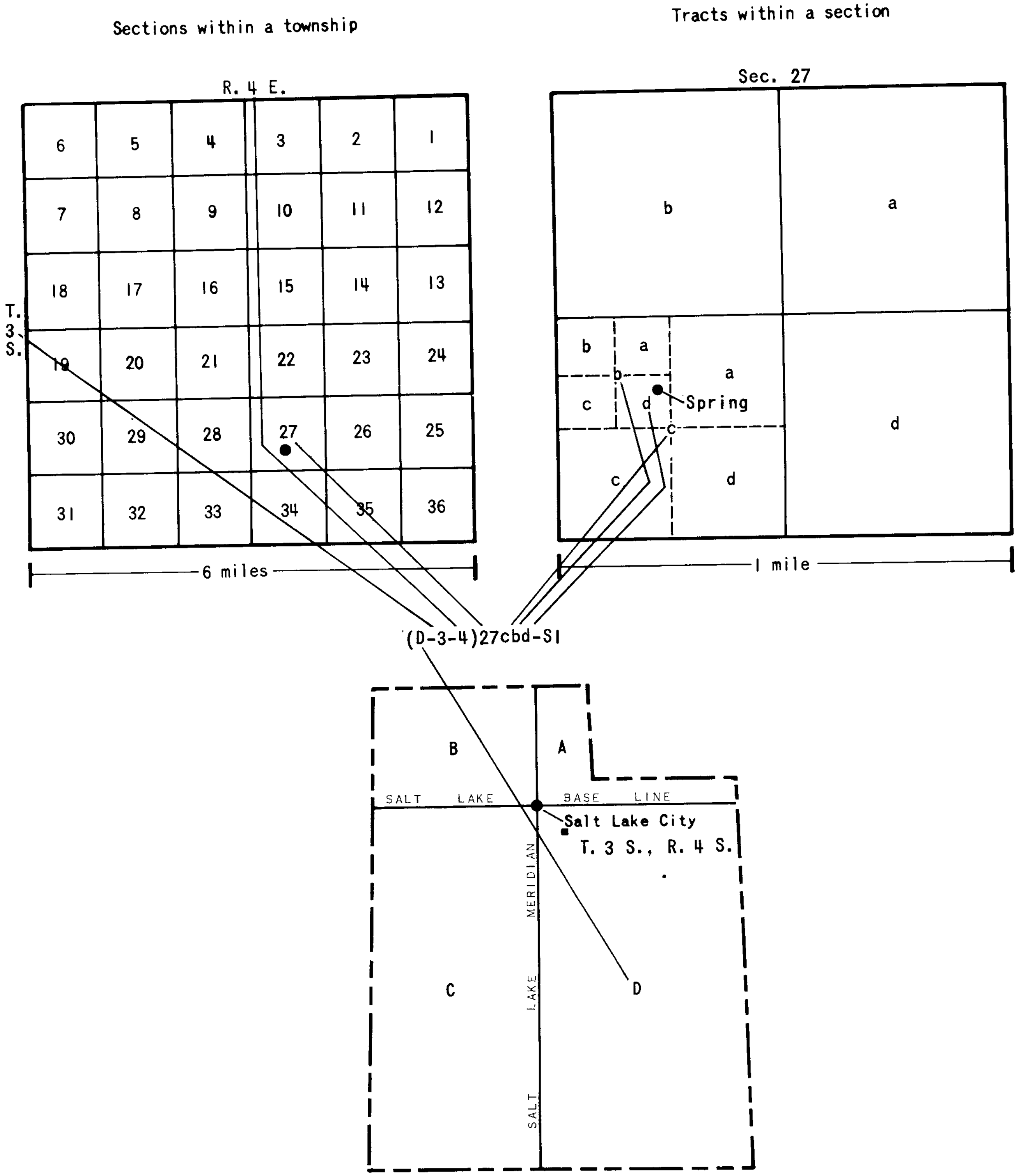


Figure 1. Diagram showing spring-numbering system.

DESCRIPTION OF THE THERMAL SPRINGS IN UTAH

All the hot springs and nearly all the major thermal springs in Utah are in the western half of the State. The occurrence of these springs in association with fault zones is obvious from figure 2.

Data on the chemical composition of the thermal spring waters are given in table 1. This table, which includes data obtained as early as 1881, does not include all available data on chemical composition. Data evaluation resulted in the exclusion of some analyses; incomplete knowledge about the availability of data undoubtedly resulted in the unintentional exclusion of other data. Except for chemical data for Blue Warm Springs, (B-13-5)29-S, data from Milligan and others (1966) are not repeated in this report. Chemical data obtained as part of this study include standard analyses for major ions and for lithium, bromide, and iodide (U. S. Geol. Survey laboratory, Salt Lake City, Utah), and spectrographic analyses for the 17 minor elements aluminum, beryllium, bismuth, cadmium, chromium, cobalt, copper, gallium, germanium, iron, lead, manganese, molybdenum, nickel, titanium, vanadium, and zinc (U.S. Geol. Survey laboratory, Sacramento, Calif.). The major ionic composition of water from selected thermal springs is shown diagrammatically on plate 1.

Ion ratios for many of the thermal springs are given in table 2. For convenience, two ratios are given for each ion pair. For example, the ratio both of lithium to sodium and of sodium to lithium are given. In much of the literature, ratios are computed to give a value such as 0.0003. The reciprocal of this number $\frac{1}{0.0003}$ gives a readily comprehended whole number, which shows that 3,300 ppm of one ion is present for each part per million of the other ion. The ion ratios are computed by weight.

The relation of equivalents per million of sodium to equivalents per million of chloride in major thermal springs in Utah is shown in figure 3. The points show little scatter about a line having a slope of 45°, except for the data from the hot springs in the central Sevier Valley (Monroe-Red Hill-Joseph) group in western Sevier County (p. 41), Radium and Thermo Springs in southeastern Beaver County (p. 43), Midway Hot Springs (p. 46), and LaVerkin Hot Springs (p. 44). The data in tables 1 and 2 indicate the increasing predominance of sodium and chloride as the dissolved-solids content of springs increases. Figure 3 shows proportionate increases of chloride with increases in sodium throughout a wide range of concentrations.

In the following pages and in tables 1 and 2 of this report, springs are listed and described in the order of their location beginning with springs in the northeast (A) quadrant of Utah, then the northwest (B), then the southwest (C), and then the southeast (D) quadrant. Discharges of most springs are given in the text in both cubic feet per second (cfs) and gallons per minute (gpm); 1 cfs equals about 450 gpm. To obviate the need for frequent mention of tables 1 and 2 and figure 2 and plate 1, these tables and figures are here given as references for the individual descriptions of the thermal springs. Geologic maps are presented in this report only for areas in the vicinity of hot springs (water temperatures 100° F or greater). Warm springs that are located within these areas are shown along with the hot springs. Areas for which geologic maps are presented in this report are shown on plate 2.

The spring names given in this report are generally the official names given on Geological Survey maps or in publications of Federal and State agencies. For several springs, no official names have been assigned or several different names have been used locally for the same spring; a name has been arbitrarily assigned to such springs. Other names that have been used locally are also given. The terms "hot" and "warm" are used as part of the spring name according to the definitions of "hot" and "warm" given in this report. The temperature of hot springs is 100° F or higher; the temperature of warm springs is lower than 100° F but higher than the mean annual air temperature in the vicinity of the spring. The only exception is for Veyo Hot Spring; the latest observed temperature of this spring was 98° F. Because of long-standing local usage, however, the name "Veyo Hot Spring" is used.

Como Warm Springs

Como Warm Springs, (A-4-3)31cab-S1, rise along a concealed fault that crosses Weber River valley about one mile east of Morgan, Morgan County (figure 4). The fault cuts limestones of Middle Paleozoic age, and the springs issue from near the base of carbonate rocks of Mississippian age. The source of the water is not known, but the relatively low temperature of the water (77° F), the low dissolved-solids content (about 600 ppm), and the point of discharge suggest that the water is of meteoric origin and is brought to the surface along a conduit formed by the fault.

The water is calcium sulfate bicarbonate in type; spectrographic analysis for 17 minor elements indicates no high concentrations of any of these elements.

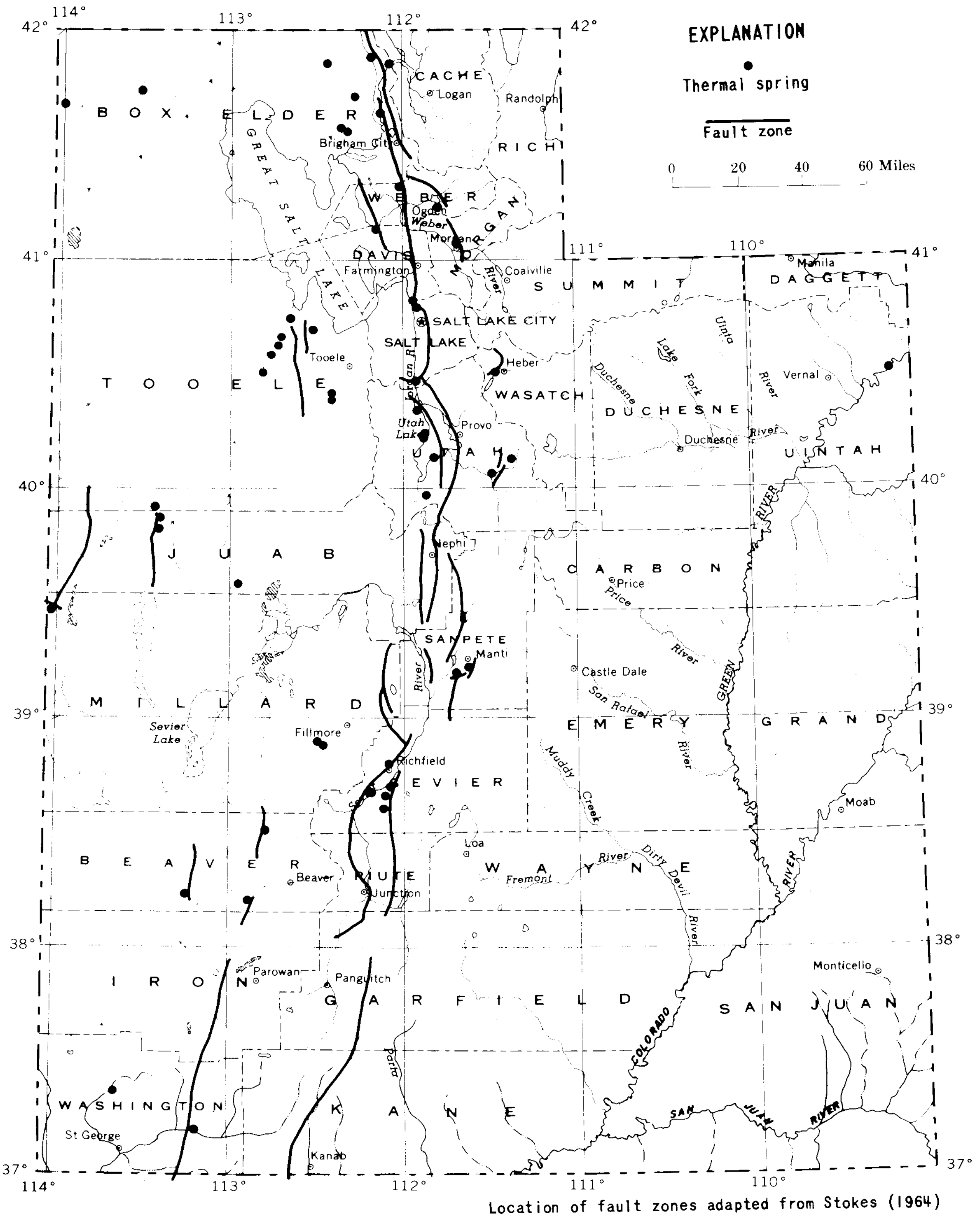


Figure 2. Map showing locations of major thermal springs and major fault zones in Utah.

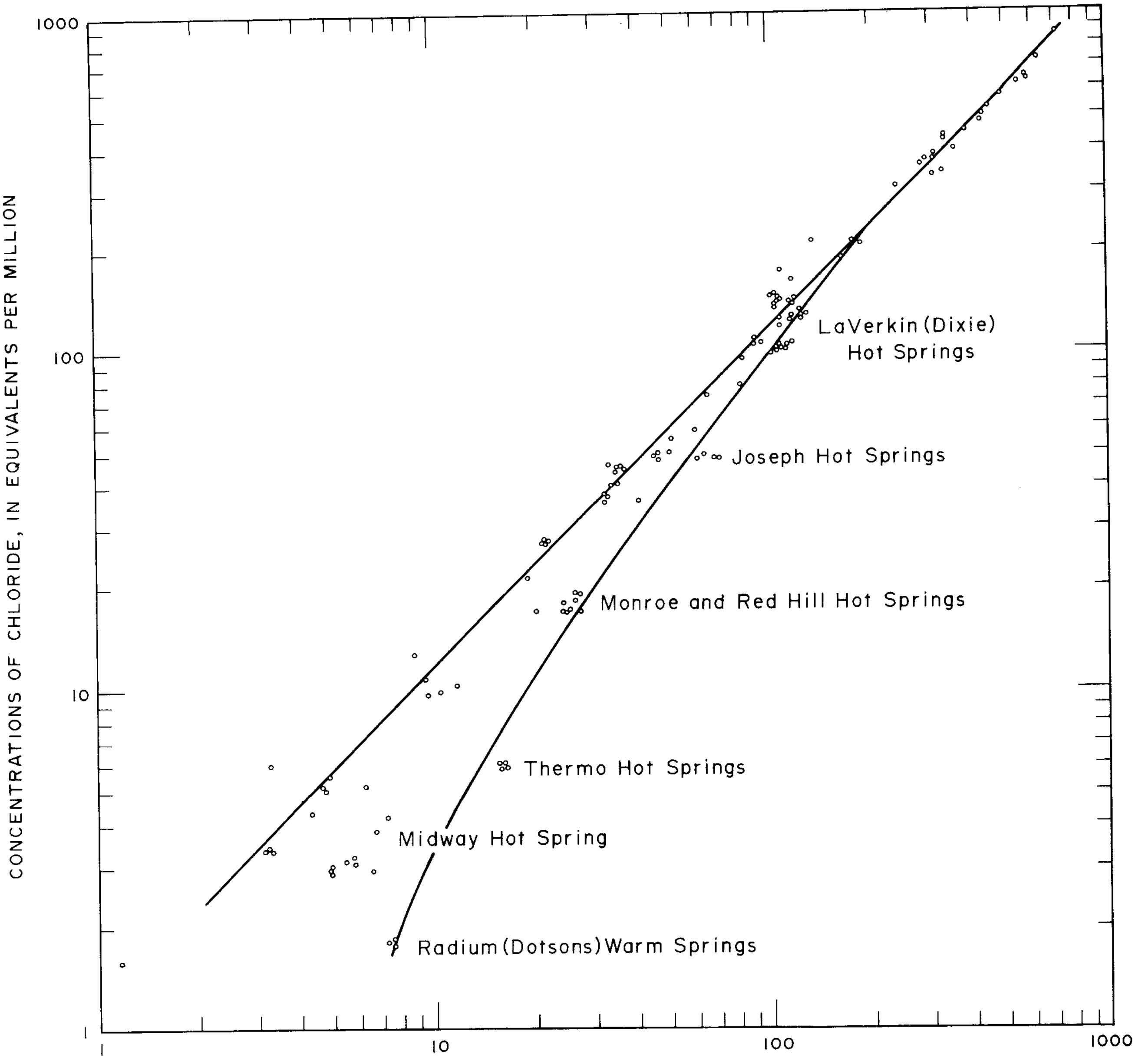


Figure 3. Graph showing relation of equivalents per million of sodium to equivalents per million of chloride in major thermal springs in Utah.

Part of the water is temporarily used in a swimming pool near the springs, but all the water ultimately enters the Weber River in the vicinity of the springs. Discharges ranging from about 2 to 20 cfs (900 to 9,000 gpm) have been measured or estimated at different times.

The source of the heat probably is the normal geothermal gradient. Circulation of water to a depth of 1,500-2,000 feet could result in temperatures that are 20° F higher than temperatures of shallow ground water in the area. These warm springs, like most other thermal springs in Utah, have no potential for geothermal development for power generation.

Table 1. Chemical analyses of thermal springs in Utah.

Location	Name of spring	Date of collection	Estimated discharge (gpm)	Temperature (F)	Silica (SiO_2)	Calcium (Ca) ppm epm	Magnesium (Mg) ppm epm	Sodium (Na) ppm epm	Potassium (K) ppm epm	Bicarbonate (HCO_3) ppm epm	Carbonate (CO_3) ppm epm	Sulfate (SO_4) ppm epm	Chloride (Cl) ppm epm	Total equivalents per million: Major cations	Total equivalents per million: Major anions	Fluoride (F)	Nitrate (NO_3)
(A-4-3) 31cab-S1	Como Warm Springs	5-18-66	9,000	77	19	109 5.44	31 2.55	34 1.48	8.4 .21	250 4.10	-	231 4.81	28 .79	9.67	9.68	2.0	0.1
(B-1-1) 14dcb-S1	Becks Hot Springs	1881	-	-	32	694	110	3,755	197		-	840	6,740			-	-
		5-19-42 2/	-	-	32	653 32.58	134 11.02	4,040 175.74	444 11.35	239 3.91	-	875 18.22	7,670 216.37	230.7	238.5	-	-
		8-29-47	-	-	35	688 34.33	136 11.19	4,100 1/ -	 -	235 3.85	-	800 16.66	7,210 203.39	-	-	-	-
		11-3 -51	-	-	36	720 35.92	125 10.28	4,050 176.17	262 6.70	227 3.72	-	879 18.30	7,260 204.80	229.1	226.8	2.3	-
		11- 9-66	450	130	32	738 36.82	135 11.10	4,120 179.22	198 5.06	229 3.75	-	927 19.30	7,310 206.22	232.2	229.3	3.2	.6
		7-26-67	60	132	32	746 37.23	131 10.78	4,250 184.88	156 3.98	221 3.62	-	985 20.51	7,470 210.73	236.9	234.8	3.3	.7
(B-1-1) 25db-S	Wasatch Hot Springs	3-16-34 2/	-	-	33	1,380 68.86	136 11.18	2,660 115.71	552 14.11	307 5.03	-	1,330 27.70	5,800 163.61	209.9	196.3	-	-
		5- -35 2/	-	-	62	469 23.40	98 8.06	1,940 84.39	163 4.16	293 4.80	-	1,020 21.24	3,390 95.63	120.0	121.7	-	-
		1- -37 2/	-	-	41	414 20.66	58 4.77	1,870 81.34	194 4.96	293 4.80	-	1,470 30.62	2,780 78.42	111.7	113.8	-	-
		3-16-40 2/	-	-	26	461 23.00	65 5.35	1,400 60.90	62 1.58	278 4.55	-	982 20.45	2,070 58.39	90.8	83.4	-	-
		5-19-42 2/	-	-	22	538 26.85	103 8.47	2,110 91.78	211 5.40	260 4.26	-	912 18.99	3,690 104.09	132.5	127.3	-	-
		11- 3-66	-	108	18	565 28.17	109 8.99	2,410 104.84	111 2.84	220 3.61	-	1,090 22.69	4,170 117.64	144.84	143.9	1.9	.9
		7-26-67	-	105	16	433 21.61	90 7.40	1,620 70.47	70 1.79	244 4.00	0	818 17.03	2,820 79.55	101.26	100.6	2.8	7.3
(B-5-3) 27c-S	Hooper Hot Springs	11- 3-51	-	140	28	523 26.09	118 9.71	2,390 103.96	283 7.23	245 4.01	-	36 .74	5,100 143.87	147.0	148.6	.6	-
		9-15-53 3/	-	140	35	535 26.70	92 7.57	2,520 109.62	285 7.28	234 3.83	-	36 .74	4,370 123.27	151.2	127.8	.7	2.0
		10- 7-53 3/	-	-	42	525 26.20	110 9.05	2,370 103.09	292 7.46	265 4.34	-	37 .77	5,180 146.12	145.8	151.2	.4	8.5
		6-20-57	-	130	34	519 25.90	85 6.99	2,420 105.27	168 4.30	297 4.87	-	40 .83	4,940 139.35	142.5	145.0	.9	-
		4-13-60	-	-	30	524 26.15	99 8.14	2,450 106.57	239 6.11	220 3.60	-	59 1.22	5,090 143.58	147.0	148.4	-	17
		11- 7-66	-	118	30	506 25.25	91 7.48	2,350 102.22	256 6.55	224 3.67	-	38 .79	4,840 136.54	141.3	141.0	1.0	1.9
(B-5-3) 28d-S	Southwest Hooper Warm Springs	9-15-53 3/	-	90	48	536 26.75	458 37.68	8,290 360.62	803 20.53	304 4.98	-	219 4.56	14,400 406.22	445.6	403.9	-	1.6
(B-6-1) 23ccd-S1	Ogden Hot Springs	4-27-43	-	-	-	355 17.71	11 .90	3,000 1/ -	 -	208 3.40	-	102 2.12	5,080 143.30	-	-	3.0	
		11- 3-51		137	53	337 16.82	8 .66	2,740 119.19	407 10.40	200 3.27	-	100 2.08	5,060 142.74	147.1	148.1	3.4	-
		11- 2-66	75	135	47	356 17.76	4.9 .40	2,730 118.76	359 9.18	192 3.15	-	106 2.21	4,940 139.36	146.10	144.7	3.7	.4
		3- 8-67	-	-	-	- -	- -	- -	- -	- -	-	- -	- -	-	-	-	-
		5-18-67	-	134	45	320 15.97	49 4.03	2,690 117.02	347 8.87	192 3.15	-	121 2.52	4,990 140.77	145.9	146.4	3.8	.9
(B-7-2) 14dca-S1	Utah Hot Springs	11-18-11	-	-	-	1,174 58.58	28 2.30	8,563 1/ -	 -	188 3.08	-	203 4.22	15,079 425.37	-	-	-	-
		11- 3-51	-	-	41	1,190 59.38	46 3.78	7,720 335.82	1,100 28.12	199 3.26	-	200 4.16	14,800 417.50	427.1	424.9	-	-
		3- 2-54	-	-	33	859 42.86	39 3.21	5,550 241.42	742 18.97	190 3.11	-	181 3.77	10,800 304.66	306.5	311.5	2.6	6.5
		4- 5-58	-	135	38	1,140 56.89	70 5.76	7,030 305.80	901 23.04	192 3.15	-	189 3.93	13,300 375.19	391.5	382.3	3.2	-
		11- 3-66	-	137	35	1,020 50.90	39 3.21	6,580 286.23	935 23.91	182 2.98	-	201 4.18	12,700 358.27	364.2	365.4	4.3	.8
		3- 8-67	-	-	-	- -	- -	- -	- -	- -	-	- -	- -	-	-	-	-
		5-18-67	-	135	34	1,040 51.90	79 6.50	6,870 298.84	932 23.83	190 3.11	-	293 6.10	13,300 375.19	381.1	384.4	4.1	2.8
(B-10-3) 30bbd-S1	Stinking Hot Springs	11-18-11	-	-	-	878 43.81	379 31.18	10,400 452.40	- -	393 6.44	-	20 .41	18,500 521.88	527.4	528.7	-	-
		10-27-51	-	118	53	898 44.81	355 29.20	11,200 487.20	658 16.82	518 8.49	-	58 1.20	20,400 575.48	578.0	585.2	0	-
		5-21-52	-	124	-	- -	- -	- -	- -	501 8.21	-	- -	22,700 640.36	-	-	-	-
		6-29-52	-	124	-	- -	- -	- -	- -	497 8.14	-	- -	21,600 609.33	-	-	-	-
		2- 6-53	-	-	-	- -	- -	- -	- -	501 8.21	-	135 2.81	22,200 626.26	-	-	-	-
		4- 5-58	-	118	48	946 47.20	297 24.4	12,600 548.10	571 14.60	324 5.31	-	111 2.31	21,600 609.33	634.2	617.0	1.9	0
		5-24-66	-	113	40	840 41.92	342 28.13	10,100 439.35	662 16.93	169 2.77	-	167 3.48	17,700 499.32	526.4	505.6	1.6	3.2
		5-17-67	-	117	41	652 32.53	431 35.45	9,780 425.43	492 12.58	426 6.98	-	152 3.16	17,200 485.21	506.0	495.4	1.8	2.1

1/ Calculated Na plus K, reported as Na.
2/ Analysis by Salt Lake City Corporation.
3/ Analysis by U.S. Bureau of Reclamation.
e Estimate.

Table 1. (continued).

					Dissolved solids				Concentration, in micrograms per liter																
Boron (B)	Lithium (Li)	Strontium (Sr)	Bromide (Br)	Iodide (I)	Residue on evaporation at 180°C	Calculated	Specific conductance (micromhos at 25°C)	pH	Aluminum Al	Beryllium Be	Bismuth Bi	Cadmium Cd	Chromium Cr	Cobalt Co	Copper Cu	Gallium Ga	Germanium Ge	Iron Fe	Lead Pb	Manganese Mn	Molybdenum Mo	Nickel Ni	Titanium Ti	Vanadium V	Zinc Zn
0.07	-	-	-	-	622	586	896	7.4	16	<0.57	<0.29	<1.4	<1.4	<1.4	<1.4	<5.7	2.9	4.6	<1.4	8.6	.29	0.8	0.6	<0.29	18
-	-	-	-	-	12,585	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	13,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	13,100	19,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	13,500	20,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.0	2.3	-	-	0.62	-	13,600	21,600	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2	-	-	-	-	-	13,900	20,800	7.4	31	<.6	<.3	<1.4	<1.4	6.9	<1.4	<5.7	20	37	<1.4	486	<.3	4.3	<.6	.7	<5.7
-	-	-	-	-	-	12,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	8,080	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	7,310	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	5,590	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	7,770	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2	.78	-	-	.26	8,680	8,590	13,700	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.9	-	-	-	-	-	6,000	9,540	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	8,600	14,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	9,310	14,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	9,980	16,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	8,350	14,300	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.0	-	-	-	.07	-	8,620	15,000	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.1	2.0	-	-	.14	-	8,230	14,300	7.6	34	<57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	46	137	<1.4	>3,000	.29	5.1	<.57	<.29	<5.7
-	-	-	-	-	-	27,800	39,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	8,650	14,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.6	6.0	-			-	8,820	-	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.6	5.4	-	-	.3	-	8,650	15,000	7.7	40	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	66	149	<1.4	>3,000	<.29	3.7	<.57	<1.7	<5.7
-	-	-	-	-	-	-	14,400	-	43	<.57	<.29	<1.4	19	<1.4	<1.4	<1.4	91	>90	<1.4	> 800	<4.3	2.6	<.57	3.1	<5.7
2.6	3.5	-	15	.39	-	8,680	14,400	7.7	69	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	54	154	<1.4	914	<.3	5.4	<.6	<.3	<5.7
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	25,200	37,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	18,900	28,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.1	9.9	28	8.2	.2	-	22,900	34,300	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.1	7.9	-	-	.24	-	21,600	34,800	7.5	51	<.57	<.29	<1.4	<1.4	26	<1.4	<5.7	80	314	<1.4	3,000	<.29	7.4	<.57	4.9	<5.7
-	-	-	-	-	-	-	34,600	-	66	<.57	<.29	<1.4	71	<1.4	<1.4	<5.7	80	214	<1.4	860	8.3	5.4	<.57	2.9	<5.7
3.3	7.5	-	34	.38	-	22,700	34,100	7.0	63	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	53[e]	460[e]	<1.4	1,100[e]	<.3	5.4[e]	<.6	<.3	<5.7
-	-	-	-	-	-	30,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	33,900	48,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	53,000	6.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	51,000	6.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	52,200	6.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.6	6.9	31	15	1.3	-	36,600	53,900	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.6	3.86	-	-	-	-	29,900	46,100	7.3	27	<.57	<.29	-	-	<1.4	<1.4	<5.7	<.3	-	<1.4	286	<.29	-	<.57	<.29	<5.7
3.2	2.8	-	35	.76	-	29,000	42,500	7.1	43	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	21	24	<1.4	217	.3	3.7	<.6	<.3	<5.7

Table 1. (continued).

Location	Name of spring	Date of collection	Estimated discharge (gpm)	Temperature (°F)	Silica (SiO_2)	Calcium (Ca) ppm / epm	Magnesium (Mg) ppm / epm	Sodium (Na) ppm / epm	Potassium (K) ppm / epm	Bicarbonate (HCO_3) ppm / epm	Carbonate (CO_3) ppm / epm	Sulfate (SO_4) ppm / epm	Chloride (Cl) ppm / epm	Total equivalents per million: Major cations	Total equivalents per million: Major anions	Fluoride (F)	Nitrate (NO_3)
(B-11-2) 29da-S	Crystal (Madsen) Hot Springs	11-18-[illegible]	-	-		901	218	16,600	-	454	-	499	27,100			-	-
						44.96	17.93	722.10	-	7.44		10.39	764.49	785.0	782.3		
		10-27-51	-	132	31	803	219	14,700	763	465	-	466	25,000			0	-
						40.07	18.01	639.45	19.50	7.62		9.70	705.25	717.0	722.6		
		6-29-52	-	124	25	-	-	13,400	-	445	-	-	22,700			-	-
						-	-	582.90	-	7.29		-	640.36	-	-		
		2-6-53	-	-	-	-	-	-	-	468	-	480	25,300			-	-
						-	-	-	-	7.67		9.99	713.71	-	-		
		11-2-66	1,800	127	26	784	186	13,600	654	371	-	444	22,600			1.9	0.9
						39.10	15.28	591.60	16.72	6.10		9.24	637.55	662.7	653.0		
(B-11-19) 11dda-S1	Unnamed hot spring	5-16-66	[illegible]	10	24	44	14	13 1/		184	0	29	9.1	-	-	-	-
						2.20	1.12			3.02		.61	.26				
(B-12-13) 19aab-S1	Warm Springs	8-12-66	450	80	14	36	8.0	27	1.7	108	2	15	57			.2	.1
						1.8	.66	1.17	.04	1.77	.07	.31	1.61	3.67	3.76		
(B-13-3) 23baa-S1	Eddy Hot Springs	11-1-66	-	109	26	212	55	2,690	118	366	-	90	4,470			1.5	2.6
						10.59	4.52	117.02	3.02	6.00		1.87	126.10	135.1	134.0		
(B-13-5) 29-S	Blue Warm Springs 4/	9-10-64	3,400	80	-	83	24	540	32	268	-	68	886			-	-
						4.1	2.0	23.5	.8	4.40		1.41	25.0	30.4	30.8		
(C-1-7) 8&9-S	Big Warm Springs	9-28-59	3,600	-	7.9	102	97	[illegible] 1/		132	22	352	4,550			-	9.7
						5.08	7.97	-		2.16	-	7.33	128.35	-	-		
		9-29-59	-	-	10	136	79	2,730	97	214	0	327	4,360			.2	13
						6.78	6.49	118.75	2.48	3.50	-	6.81	122.99	134.5	133.3		
		1-5-60	2,750	-	9.5	138	81	2,810	106	223	-	345	4,550			-	10
						6.88	6.66	122.23	2.71	3.65		7.18	128.35	138.5	139.2		
		4-12-60	2,100	-	7.1	134	80	2,850	103	174	-	351	4,670			-	12
						6.68	6.58	123.97	2.63	2.85		7.31	131.74	139.9	141.9		
		7-8-60	3,200	-	7.0	144	73	2,790	99	206	-	332	4,500			-	14
						7.18	6.00	121.36	2.53	3.37		6.91	126.94	137.1	137.2		
		10-1-60	2,700	-	15	146	73	2,830	98	194	-	349	4,590			-	9.7
						7.28	6.00	123.10	2.50	3.17		7.26	129.48	138.9	139.9		
		10-11-60	1,000	-	9.0	139	77	2,800	93	205	-	345	4,510			-	10
						6.93	6.33	121.80	2.37	3.35		7.18	127.22	137.4	137.8		
		1-10-61	2,900	-	11	142	81	2,840	100	220	-	353	4,600			-	10
						7.08	6.66	123.54	2.55	3.60		7.35	129.76	139.8	140.7		
		4-4-61	-	-	5.5	144	88	2,890	103	218	-	352	4,720			-	13
						7.18	7.23	125.71	2.63	3.57		7.33	133.15	142.8	144.0		
		5-27-66	-	65	7.9	140	85	2,750	114	207	-	318	4,420			1.0	1.4
						6.99	6.99	119.62	2.91	3.39		6.62	124.69	136.5	134.8		
(C-2-6) 16aad-S1	Grantsville Warm Springs	3-15-66	-	76	27	584	188	8,910	237	233	-	662	15,000			1.7	1.3
						29.14	15.46	387.58	6.06	3.82		13.78	423.15	438.2	440.7		
(C-4-1)11 & 12b-S	Crystal Hot Springs	1882	-	-	28	141	28	405	55	216	-	378	337			-	-
						7.03	2.30	17.61	1.40	3.54		-	-	-	-		
		5-22-3[illegible]	-	137	60	106	25	304 1/		285	-	97	598			-	-
						5.28	2.05	-	-	4.67		-	-	-	-		
		7-25-50	-	-	73	102	24	224 1/		146	-	72	560			-	-
						5.08	1.97	-	-	2.39		-	-	-	-		
		9-10-52	-	-	66	80	32	417 1/		330	-	84	616			.0	9.6
						3.99	2.63	-	-	5.40		-	-	-	-		
		5-27-58	-	-	50	142	31	330 1/		340	-	72	595			-	4.7
						7.08	2.55	-	-	5.57		-	-	-	-		
(C-5-1)25-S	Crater Hot Springs	5-27-58	-	107	27	180	49	232 1/		320	-	425	318			-	1.3
						8.98	4.03	-	-	5.24		8.85	8.97	-	-		
		6-4-58	-	110	28	191	52	235 1/		320	-	441	338			-	2.5
						9.53	4.27	-	-	5.24		9.18	9.53	-	-		
(C-5-1) 25cd-S	Saratoga Hot Springs	1933	-	-	-	148	34	273	-	281	-	388	361			-	-
						7.38	2.79	11.87		4.60		8.08	10.18	-	-		
		3-24-66	-	111	25	190	68	214 1/		313	-	451	350			-	-
						9.48	5.59			5.13		9.39	9.87	-	-		
(C-5-5) 9cba-S1	Mormon Warm Springs	9-22-64	1,000	75	20	58	24	110	11	174	-	90	179			1.0	0.4
						2.89	1.97	4.78	.28	2.85		1.87	5.05	9.92	9.76		
		5-27-66	-	77	18	56	24	109	13	172	-	89	182			1.2	.3
						2.79	1.97	4.74	.33	2.82		1.85	5.13	9.83	9.80		
		7-18-67	-	80	19	48	28	112	11	162	-	98	188			1.4	.0
						2.40	2.30	4.87	.28	2.66		2.04	5.30	9.84	9.99		
(C-5-5) 17aaa-S1	Russells Warm Springs	4-29-66	450	71	17	51	21	73	11	170	-	55	124			1.6	.2
						2.54	1.72	3.18	.28	2.79		1.15	3.50	7.72	7.44		
		5-27-66	-	72	17	53	19	74	12	175	-	55	122			1.5	.1
						2.64	1.56	3.22	.31	2.87		1.15	3.44	7.72	7.46		
		7-18-67	-	-	19	55	17	71	10	170	-	65	122			1.5	.0
						2.74	1.40	3.09	.26	2.79		1.35	3.44	7.46	7.58		

1/ Calculated Na plus K, reported as Na.
4/ Analysis from Milligan and others (1966, table 1).

Table 1. (continued).

Boron (B)	Lithium (Li)	Strontium (Sr)	Bromide (Br)	Iodide (I)	Dissolved solids: Residue on evaporation at 180°C	Dissolved solids: Calculated	Specific conductance (micromhos at 25°C)	pH	Concentration, in micrograms per liter: Aluminum Al	Beryllium Be	Bismuth Bi	Cadmium Cd	Chromium Cr	Cobalt Co	Copper Cu	Gallium Ga	Germanium Ge	Iron Fe	Lead Pb	Manganese Mn	Molybdenum Mo	Nickel Ni	Titanium Ti	Vanadium V	Zinc Zn
-	-	-	-	-	-	45,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	. -	42,200	58,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	53,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	56,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.1	4.8	-	-	.28	-	38,500	58,100	7.3	<1.4	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	11	111	<1.4	163	<.29	4.6	<.57	<.3	<5.7
					248	-	373																		
					-																				
.02	.02	-	.2	.00	-	214	406	8.5	2.7	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<.57	.29	18	<1.4	<1.4	<.29	<1.9	<.57	.7	<5.7
.69	.83	-	-	.1	-	7,850	13,600	7.9	19	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	<.29	54	<1.4	<1.4	<.29	3.1	<.57	<.3	<5.7
.2	.8	-	-	-	-	1,923	3,580	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	8,100	14,000	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.98	1.8	-	-	-	-	7,860	13,000	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.91	1.0	-	-	.05	--	8,160	13,700	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.95	-	-	-	.06	-	8,300	14,400	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.85	-	-	-	.04	-	8,060	13,200	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	.07	-	8,210	13,800	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	.06	-	8,090	13,500	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	.06	-	8,250	13,800	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	.05	-	8,430	14,300	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.70	.67	-	-	-	-	7,940	13,300	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5	-	-	-	-	-	25,800	40,400	7.5	37	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	<.29	6.6	<1.4	<1.4	3.4	7.4	<.57	2.9	197
-	-	-	-	-	-	1,680	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	1,665	-	-	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,300	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,550	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,390	2,470	7.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,390	2,140	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,440	2,230	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	1,503	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,450	2,220	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	583	981	8.0	6.0																
.16	.04	-	-	-	-	578	1,030	7.7	16	.57	2.7	-	-	49	9.4	<5.7	<.29	-	<1.4	<1.4	3.1	-	<5.7	.6	<5.7
.18	.03	-	.3	.01	-	586	1,000	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.14	.03	-	.3	.01	-	438	779	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.09	.02	-	-	-	-	440	778	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.14	.02	-	.2	.02	-	445	744	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1. (continued).

Location	Name of spring	Date of collection	Estimated discharge (gpm)	Temperature (F)	Silica (SiO_2)	Calcium (Ca) ppm / epm	Magnesium (Mg) ppm / epm	Sodium (Na) ppm / epm	Potassium (K) ppm / epm	Bicarbonate (HCO_3) ppm / epm	Carbonate (CO_3) ppm / epm	Sulfate (SO_4) ppm / epm	Chloride (Cl) ppm / epm	Total equivalents per million: Major cations	Total equivalents per million: Major anions	Fluoride (F)	Nitrate (NO_3)
(C-10-14) 33-S	Wilson Hot Springs	7-12-67	100	141	33	741	224	7,090	18	178	-	1,560	11,900			4.0	.0
						36.97	18.43	308.42	.46	2.92	-	32.48	335.70	364.3	371.1		
(C-11-14) 23c-S	Fish Springs	7-12-67	75	82	20	136	26	470	36	312	-	340	630			2.0	.0
						6.79	2.14	20.44	.92	5.11		7.08	17.77	30.3	29.96		
(C-11-14) 23db-S	do	3-26-56	-	77	-	-	-	-	-	321	-	-	-			-	-
						-	-	-	-	5.26	-	-	-	-	-		
(C-11-14) 23dc-S	do	3-26-56	-	65	-	-	-	-	-	296	-	-	-			-	-
						-	-	-	-	4.85	-	-	-	-	-		
(C-11-14) 23dd-S	do	3-26-56	-	72	-	-	-	-	-	316	-	-	-			-	-
						-	-	-	-	5.18	-	-	-	-	-		
(C-14-8) 10-S	Abraham (Crater) Hot Springs	11-12-27	-	-	-	440	-	703[1]		156	-	560	1,410			-	-
						-	-		-	-		-	-	-	-		
		5-31-66	-	-	57	361	56	812	67	153	-	733	1,550			3.0	.2
						18.01	4.60	35.32	1.71	2.51	-	15.26	43.73	59.6	61.5		
		7-13-67	250	180	59	345	68	816	48	160	-	756	1,450			4.1	.0
						17.22	5.59	35.50	1.23	2.62		15.74	40.90	59.5	59.3		
(C-15-19) 31bc-S	Gandy Warm Springs	3- 3-66	4,500	81	20	50	21	28	2.8	278	-	21	20			.7	3.6
						2.50	1.73	1.22	.07	4.56		.44	.56	5.49	5.54		
		7-12-67	9,000	80	21	50	18	29	3.7	250	-	29	26			.7	1.9
						2.50	1.48	1.26	.09	4.10		.60	.73	5.32	5.42		
(C-22-6) 26ccc-S1	Meadow Hot Springs	5-12-66	-	106	44	419	97	1,040	157	314	-	1,020	1,750			5.3	.6
						20.91	7.98	45.24	4.01	5.18		21.24	49.37	78.1	75.7		
(C-22-6) 27ddd-S1	do	4- 8-43		95	-	464	95	1,150[1]		452	-	1,040	1,830			3.9	2.0
						23.15	7.81	-	-	7.40		-	51.62	-	-		
		6-18-57	-	-	-	470	88	1,090[1]		440	-	993	1,780			-	2.7
						23.45	7.23		-	7.21		-	50.21	-	-		
		8-27-58	-	90	-	485	68	1,160[1]		436	-	1,050	1,820			-	2.8
						24.20	5.59		-	7.14		-	51.34	-	-		
		5-12-66	-	84	50	451	103	1,060	157	429	-	1,040	1,780			5.0	1.0
						22.50	8.47	46.11	4.01	7.03		21.65	50.21	81.1	78.9		
		5-22-67	-	106	47	433	114	1,020	13.8	408	-	1,130	1,800			5.5	1.6
						21.60	9.38	44.37	3.53	6.69		23.53	50.78	78.9	81.0		
(C-22-6) 35ddb-S1	Hatton Hot Springs	6-19-57	-	100	44	465	89	1,090[1]		427	-	985	1,780			-	2.4
						23.20	7.32	-	-	6.99		-	50.21	-	-		
		8-27-58	25	-	-	489	75	1,150[1]		484	-	1,040	1,810			-	2.8
						24.40	6.16	-	-	7.93		-	51.06	-	-		
(C-23-3) 26aca-S1	Richfield Warm Springs	7-30-57	-	68	14	45	38	12	4.0	298	-	27	20			.2	.8
						2.25	3.13	.52	.10	4.88		.56	.56	6.00	6.00		
		6- 6-66	700	72	11	51	35	15	3.2	280	4	29	20			.3	.1
						2.54	2.88	.65	.08	4.59	.13	.60	.56	6.13	5.88		
(C-25-3) 10dda-S1	Monroe (Cooper) Hot Springs	7-23-57	-	-	54	282	34	562	63	354	-	898	630			2.6	0
						14.07	2.79	24.44	1.61	5.80		18.70	17.77	42.9	42.3		
		9-10-57	-	169	54	288	33	555	67	416	-	833	660			3.0	0
						14.37	2.71	24.14	1.71	6.81		17.35	18.61	42.9	42.8		
		5-17-66	6	108	52	257	17	578	62	309	-	932	625			2.8	.7
						12.82	1.40	25.14	1.59	5.06		19.40	17.63	40.9	42.1		
(C-25-3) 11cac-S1	Red Hill Hot Spring	9-11-57	-	-	83	240	34	618	53	256	-	965	660			-	-
						11.97	2.80	26.88	1.35	4.19		20.10	18.61	43.0	42.9		
		5- 2-66	40	170	51	200	34	597	66	158	-	928	665			2.8	.3
						9.98	2.80	25.97	1.69	2.59		19.33	18.75	40.4	40.7		
(C-25-3) 15a-S	Monroe (Cooper) Hot Springs	5- 3-67	-	97	51	281	49	553	49	386	-	924	600			1.8	.2
						14.02	4.03	24.06	1.25	6.33		19.24	16.93	43.4	42.5		
(C-25-3) 27a-S	Johnson Warm Spring	4-19-67	10	77	32	70	15	44	1.5	175	-	163	14			1.8	.0
						3.49	1.23	1.91	.04	2.87		3.39	.39	6.66	6.65		
(C-25-4) 23-S	Joseph Hot Springs	7-23-57	-	130	85	282	36	1,440	68	426	-	1,270	1,750			2.7	-
						14.07	2.96	62.64	1.73	6.98		26.45	49.36	81.4	82.8		
		9-11-57	-	147	84	264	44	1,380	45	412	-	1,250	1,690			6.0	-
						13.17	3.61	60.03	1.15	6.75		26.03	47.67	78.0	80.4		
		5- 3-66	-	145	77	261	49	1,470	60	410	-	1,260	1,700			3.0	1.6
						13.02	4.03	63.94	1.53	6.72		26.23	47.96	82.5	80.9		
		5-15-67	-	148	76	248	46	1,490	47	396	-	1,370	1,700			4.6	.0
						12.38	3.78	64.82	1.20	6.49		28.52	47.96	82.2	83.0		
(C-26-9) 34dcb-S1	Roosevelt (McKeans) Hot Springs	11- 4-50	-	185	405	19	3.3	2,080	472	158	-	65	3,810			7.1	1.9
						.95	.27	90.48	12.07	2.57		1.35	107.48	103.8	111.4		
		9-11-57	-	131	313	22	0	2,500	488	156	-	73	4,240			7.5	11
						1.10	0	108.75	12.48	2.56		1.52	119.61	122.3	123.7		
(C-30-9) 7aca-S1	Radium (Dotsons) Warm Springs	8-21-63	-	91	31	110	24	172	18	220	3	480	65			9.8	.2
						5.48	1.97	7.48	.46	3.60		9.99	1.83	15.4	15.4		
		3-12-66	-	88	29	104	26	164	18	222	-	458	64			4.3	.1
						5.18	2.13	7.13	.46	3.64		9.54	1.81	14.9	15.0		
		7-11-67	100	89	32	88	35	169	17	228	-	435	63			4.5	.0
						4.39	2.87	7.35	.43	3.74		9.06	1.78	15.0	14.6		

1/ Calculated Na plus K, reported as Na.

Table 1. (continued).

Boron (B)	Lithium (Li)	Strontium (Sr)	Bromide (Br)	Iodide (I)	Dissolved solids: Residue on evaporation at 180°C	Dissolved solids: Calculated	Specific conductance (micromhos at 25°C)	pH	Aluminum Al	Beryllium Be	Bismuth Bi	Cadmium Cd	Chromium Cr	Cobalt Co	Copper Cu	Gallium Ga	Germanium Ge	Iron Fe	Lead Pb	Manganese Mn	Molybdenum Mo	Nickel Ni	Titanium Ti	Vanadium V	Zinc Zn
									Concentration, in micrograms per liter																
2.6	2.1	-	23	.36		21,800	31,200	7.4	74	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	20	43	<1.4	160	8.0	4.0	<.57	<.29	<5.7
.79	.33	-	1.3	.02	-	1,820	3,050	7.7	25	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	<.29	110	<1.4	1.4	9.4	2.5	<.57	1.0	110
-	-	-	-	-	-	-	3,160	7.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	3,130	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	3,100	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	3,170	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.70	.78	-	-	-	3,710	-	5,910	7.8	31	<.57	<.29	-	-	<1.4	<1.4	<5.7	<.29	-	<1.4	100	<.29	-	<.57	<.29	<5.7
.83	.63	-	1.8	.09	-	3,630	5,570	7.3	4.3	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	.29	86	5.1	130	<.29	2.7	1.4	<.29	<5.7
.09	-	-	-	-	-	305	498	7.6	4.3	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	4.6	3.4	<1.4	<1.4	1.5	1.6	<.57	1.6	197
.09	.02	-	.1	.00	-	303	485	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2	2.5	-	1.3	.03	-	4,690	7,350	7.6	629	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	57	7.4	<1.4	<1.4	<.29	2.7	<.57	<.29	143
-	-	-	-	-	-	4,810	7,350	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	4,690	7,360	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	4,850	7,270	7.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.3	1.5	-	1.3	.08	-	4,870	7,440	7.7	106	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	571	13	<1.4	<1.4	<.29	2.5	<.57	<.29	<109
4.0	3.2	-	4.0	.45	-	4,900	7,130	7.5	63	<.6	<.3	<1.4	<1.4	<20	<1.4	<5.7	25	40	<1.4	<1.4	<.3	4.0	<.6	<.3	<5.7
-	-	-	-	-	-	4,670	7,270	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	4,850	7,380	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	.5	-	-	-	-	310	548	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.04	.04	-	.1	.01	-	307	551	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	4.8	-	-	-	-	2,700	4,100	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.9	1.1	-	-	-	-	2,860	4,020	6.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.6	.51	-	.4	.03	-	2,680	4,000	7.6	4.0	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	19	5.1	<1.4	<1.4	1.2	.9	<.57	<.29	<5.7
3.4	.9	-	-	-	-	-	4,070	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.7	.57	-	.3	.06	-	2,630	4,100	7.8	6.0	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	16	11	<1.4	<1.4	1.2	1.1	<.57	<.29	<5.7
2.3	.4	-	1.6	.04	-	2,700	3,900	7.9	571	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	16	29	<1.4	346	<.29	4.1	.57	<.29	<5.7
.08	.01	-	.1	.01	-	428	623	7.4	11	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	<.29	14	<1.4	<1.4	18	1.7	<.57	1.5	<5.7
-	-	-	-	-	-	5,150	7,790	6.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.8	1.5	-	-	-	-	4,970	7,520	6.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.0	1.5	-	.9	.10	-	5,090	7,680	7.6	714	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	129	16	37	177	19	5.4	<.57	<.29	<5.7
3.7	1.9	-	3.0	.12	-	5,180	7,530	7.8	19	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	57	270	<1.4	343	25	4.6	<.6	<.3	<5.7
-	-	-	-	-	-	7,040	11,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	.27	-	3.3	.3	-	7,800	12,700	7.9	.04	-	-	-	-	-	.00	-	-	-	.00	0	-	-	0	-	0
.31	.4	1.2	.0	.01	-	1,020	1,420	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.33	.13	-	.0	.01	-	977	1,410	8.2	31	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	19	6.3	<1.4	1.4	2.1	1.4	<.57	<.29	91
.47	.11	-	.2	.00	-	956	1,390	7.4	29	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	27	110	<1.4	<1.4	<.29	2.3	<.57	<.29	<5.7

Table 1. (continued).

Location	Name of spring	Date of collection	Estimated discharge (gpm)	Temperature (°F)	Silica (SiO_2)	Calcium (Ca) ppm / epm	Magnesium (Mg) ppm / epm	Sodium (Na) ppm / epm	Potassium (K) ppm / epm	Bicarbonate (HCO_3) ppm / epm	Carbonate (CO_3) ppm / epm	Sulfate (SO_4) ppm / epm	Chloride (Cl) ppm / epm	Total equivalents per million: Major cations	Total equivalents per million: Major anions	Fluoride (F)	Nitrate (NO_3)
(C-30-12) 21-S	Thermo Hot Springs	10-23-39	-	-	-	-	-	-	-	370	-	460	217			-	-
						-	-	-	-	6.06		9.58	6.12				
		8-21-63	-	-	108	83	9.7	358	49	384	-	482	210			14	1.0
						4.14	.79	15.57	1.25	6.29		10.04	5.92	21.78	22.2		
(C-30-12) 28-S	do	8-21-63	-	-	103	71	9.2	367	45	314	16	469	215			4.7	1.1
						3.54	.75	15.96	1.15	5.15	.53	9.76	6.07	21.4	21.5		
		5-25-66	10	173	100	75	9.7	361	52	359	-	460	208			6.7	.1
						3.74	.80	15.70	1.33	5.88		9.58	5.87	21.6	21.3		
		7-11-67	-	170	100	76	12	364	47	374	-	460	212			14	.0
						3.79	.98	15.83	1.20	6.13		9.58	5.98	21.8	21.7		
(C-40-16) 7acb-S1	Veyo Hot Spring	3-30-66	90	90	30	59	29	32	4.4	220	-	100	30			.6	8.3
						2.94	2.39	1.39	.11	3.61		2.08	.85	6.82	6.52		
		4-20-67	-	90	32	53	28	32	3.6	230	-	90	30			.7	6.9
						2.64	2.30	1.39	.09	3.77		1.87	.85	6.42	6.47		
(C-41-13) 25-S	LaVerkin (Dixie) Hot Springs	6- 3-40	-	-	10	787	165	2,300	167	1,270	-	1,960	3,440			-	.2
						39.27	13.57	100.05	4.27	20.82		40.81	97.04	157.0	158.7		
		8-15-50	-	-	9.3	816	197	2,430 1/		1,290	-	1,940	3,580			-	-
						40.71	16.20	-	-	21.14		40.41	100.99	-	-		
		2- 5-51	-	-	30	825	169	2,340	175	1,300	-	1,970	3,600			3.1	3.2
						41.16	13.90	101.79	4.47	21.30		41.03	101.56	161.4	165.6		
		8-31-60	4,800	100	28	590	148	2,490	177	583	-	2,050	3,610			2.1	3.2
						29.44	12.17	108.31	4.52	9.55		42.70	101.83	154.4	154.1		
		3-25-66	4,500	108	28	643	128	2,530	220	721	-	1,990	3,620			2.6	.9
						32.09	10.53	110.06	5.63	11.82		41.43	102.12	158.3	155.4		
(D-3-4) 26bca-S1	Midway Hot Springs	7- 1-52	-	-	5.6	358	16	257 1/		754	-	698	121			.3	.1
						17.86	1.31	-	-	12.35		14.53	-	-	-		
(D-3-4) 26cca-S1	do	9-28-66	50	103	23	331	68	114	25	674	-	661	108			2.2	.1
						16.51	5.59	4.96	.64	11.05		13.76	3.05	27.7	27.9		
(D-3-4) 27bab-S1	do	9-13-67	-	113	27	345	83	148	16	644	0	742	132			2.5	.4
						17.22	6.83	6.44	.41	10.56		15.45	3.72	30.9	29.7		
(D-3-4) 27bac-S1	do	5-16-67	10	104	28	361	88	152	32	696	-	853	140			3.1	.0
						18.01	7.23	6.61	.82	11.41		17.76	3.94	32.7	33.1		
(D-3-4) 27bad-S1	do	9-28-66	150	103	28	389	73	151	31	728	-	820	138			2.5	.1
						19.41	6.00	6.57	.79	11.93		17.07	3.89	32.8	32.9		
(D-3-4) 27cbd-S1	do	9-28-66	0	84	21	353	72	125	28	716	-	702	115			2.1	.1
						17.61	5.92	5.44	.72	11.74		14.62	3.24	29.7	29.6		
		5-15-67	0	84	22	228	95	130	28	476	-	719	115			2.3	.1
						11.37	7.81	5.66	.72	7.80		14.97	3.24	25.5	26.0		
(D-3-4) 27cbd-S2	do	9-28-66	0	85	19	329	70	111	25	686	-	643	103			2.2	.1
						16.41	5.75	4.83	.64	11.24		13.39	2.90	27.6	27.5		
		5-15-67	0	90	17	279	74	114	26	572	-	611	105			2.4	.0
						13.92	6.08	4.96	.66	9.38		12.72	2.96	25.6	25.1		
(D-3-4) 27cbd-S3	do	5-16-67	0	83	21	329	88	163	33	584	-	805	150			2.7	.0
						16.41	7.23	7.09	.84	9.57		15.66	4.23	31.6	29.5		
(D-4-24) 16cdd-S1	Split Mountain Warm Spring	9-19-48	5,400	86	18	97	32	193 1/	193	198	-	212	291			-	1.2
						4.84	2.63	-	-	3.24		4.41	8.20	-	-		
(D-7-1) 5ccb-S1	Warm spring west shore of Utah Lake	9-11-58	-	77	15	144	58	342 1/		348	-	325	510			-	.8
						7.18	4.77	-	-	5.70		6.76	14.38	-	-		
(D-7-1) 8bbc-S1	do	9-11-58	-	75	16	88	59	342 1/		196	-	314	510			-	.8
						4.39	4.85		-	3.21		6.54	14.38	-	-		
(D-8-1) 3dda-S1	Lincoln Point Warm Springs	5-27-64	-	87	22	457	114	1,820 1/		756	-	953	2,800			-	-
						22.80	9.37		-	12.39		19.84	78.99	-	-		
		6-16-66	-	89	21	451	136	1,510	159	751	-	940	2,530			2.8	2.4
						22.50	11.19	65.68	4.07	12.31		19.57	71.37	103.4	103.2		
(D-8-5) 14d-S	Diamond Fork Warm Springs	10-20-67	450	68	17	104	32	117	8.3	264	0	390	36			1.6	.5
						5.20	2.64	5.09	.21	4.33		8.12	1.02	13.1	13.5		
(D-9-4) 18ba-S	Castilla Hot Springs	10-20-67	20	104	30	469	80	1,680	10	542	0	1,400	2,320			3.6	4.8
						23.40	6.60	73.08	2.56	8.88		29.15	65.45	105.6	103.6		
(D-10-1) 8c-S	Goshen Warm Springs	5-27-64	-	70	18	84	41	356 1/		316	-	102	558			-	2.2
						4.19	3.40	-	-	5.18		2.12	15.74	-	-		
		6-15-66	-	70	17	87	40	343	19	314	-	115	540			1.2	2.1
						4.34	3.29	14.92	.49	5.15		2.39	15.23	23.0	22.8		
(D-18-2) 13cad-S1	Livingston (Crystal) Warm Spring	2- 6-41	-	-	5.6	26	15	129 1/		421	-	86	55			.7	3.0
						1.29	1.23			6.90		-	-	-	-		
(D-19-2) 4dca-S1	Sterling Warm Spring	8-27-57		67	13	38	19	94	3.8	310	-	71	34			1.1	.1
						1.89	1.56	4.08	.09	5.08		1.47	.95	7.62	7.50		

1/ Calculated Na plus K, reported as Na.

Table 1. (continued).

Boron (B)	Lithium (Li)	Strontium (Sr)	Bromide (Br)	Iodide (I)	Dissolved solids: Residue on evaporation at 180°C	Dissolved solids: Calculated	Specific conductance (micromhos at 25°C)	pH	Aluminum Al	Beryllium Be	Bismuth Bi	Cadmium Cd	Chromium Cr	Cobalt Co	Copper Cu	Gallium Ga	Germanium Ge	Iron Fe	Lead Pb	Manganese Mn	Molybdenum Mo	Nickel Ni	Titanium Ti	Vanadium V	Zinc Zn
									Concentration, in micrograms per liter																
-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.64	1.3	.7	.0	.03	-	1,500	2,120	8.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.60	-	.8	.0	.03	-	1,460	2,100	8.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.50	.98	-	.2	.03	-	1,450	2,130	7.7	>230	<.57	<.29	<1.4	<1.4	<1.4	6.3	<5.7	<57	8.3	17	24	<.29	1.6	<.57	<.3	<5.7
.85	.85	-	.4	.04	-	1,470	2,100	7.4	<1.4	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	<.29	49	<1.4	60	<.29	3.7	<.57	<.3	<5.7
.14	.05	-	.2	.00	-	402	640	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.14	.02	-	.1	.01	-	389	600	7.6	<1.4	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	<.29	9.4	<1.4	<1.4	<.29	<.29	<.57	5.7	<5.7
-	-	-	-	-	-	9,460	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	9,610	13,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.3	-	-	-	-	-	9,760	13,800	6.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.0	-	-	-	-	-	9,390	13,500	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.8	2.0	-	1.5	.32	-	9,530	14,200	7.2	100	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	60	9.7	<1.4	<1.4	<.29	1.9	<.57	<.3	14
-	-	-	-	-	-	1,890	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.67	.28	-	.9	.01	-	1,670	2,200	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.64	-	-	-	-	-	1,810	2,410	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.83	.3	-	.5	.02	-	2,000	2,490	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.79	.36	-	.7	.01	-	1,990	2,560	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.70	.31	-	.6	.01	-	1,770	2,330	7.4	11	<.57	<.29	<1.4	<1.4	<1.4	<1.4	<5.7	12	25	<1.4	51	<.29	4.6	<.57	<.3	<5.7
.71	.3	-	.5	.01	-	1,570	2,280	7.8	12	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	<14	36	<1.4	<1.4	.3	43	<.6	<.3	<5.7
.64	.27	-	.5	.00	-	1,640	2,180	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.64	.2	-	.5	.01	-	1,510	2,120	7.9	12	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	18	13	<1.4	<1.4	<.3	3.7	<.6	<.3	<5.7
.80	.3	-	.9	.02	-	1,880	2,610	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	942	1,570	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,570	2,570	6.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	1,430	2,430	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	6,550	9,490	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.7	1.7	-	-	-	-	6,140	9,340	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.2	.10	-	.05	.03	-	837	1,180	7.6	27	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	13	49	<1.4	<3.9	.3	3.4	<.6	<.3	<5.7
1.4	1.3	-	1.5	.08	-	6,360	9,480	7.9	20	<.6	<.3	<1.4	<1.4	<1.4	<1.4	<5.7	37	14	<1.4	103	<.3	<.3	<.6	<.3	<5.7
-	-	-	-	-	-	1,320	2,310	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.21	4.13	-	-	-	-	1,320	2,320	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	635	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	.4	-	-	-	-	429	711	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Ratios, by weight, of selected constituents in thermal springs in Utah.

Location	Name of spring	Date	Dissolved solids (ppm)	Calcium/Magnesium Ca/Mg Magnesium/Calcium Mg/Ca	Sodium/Calcium Na/Ca Calcium/Sodium Ca/Na	Sodium/Potassium Na/K Potassium/Sodium K/Na	Sodium/Lithium Na/Li Lithium/Sodium Li/Na	Chloride/Sulfate Cl/SO_4 Sulfate/Chloride SO_4/Cl	Chloride/Fluoride Cl/F Fluoride/Chloride F/Cl	Chloride/Bicarbonate Cl/HCO_3 Bicarbonate/chloride HCO_3/Cl	Chloride/Bromine Cl/Br Bromine/Chloride Br/Cl	Bromine/Iodine Br/I Iodine/Bromine I/Br
(A-4-3)31cab-S1	Como	5-18-66	586	3.5	0.31	4.0	-	0.12	-	-	-	-
				.29	3.2	.25		8.3				
(B-1-1)14dcb-S1	Becks	1881	12,580	6.3	5.4	19.0	-	8.0	-	-	-	-
				.16	.19	.05		.12				
		5-19-42	13,900	4.9	6.2	9.1	-	8.8	-	32.1	-	-
				.20	.16	.11		.11		.03		
		8-29-47	13,100	5.1	6.0	-	-	9.0	-	30.7	-	-
				.20	.17			.11		.03		
		11- 3-51	13,500	5.8	5.6	15.5	-	8.3	3,160	32.0	-	-
				.17	.18	.06		.12	.0003	.03		
		11- 9-66	13,600	5.5	5.6	20.8	1,790	7.9	2,280	31.9	-	-
				.18	.18	.05	.0006	.13	.0004	.03		
		7-26-67	13,900	5.7	5.7	26.6	-	7.6	2,260	33.8	-	-
				.18	.18	.04		.13	.0004	.03		
(B-1-1)25db-S	Wasatch	3-16-34	12,800	10.1	1.9	4.8	-	4.4	-	18.9	-	-
				.10	.53	.21		.22		.05		
		May 1935	8,080	4.8	4.1	11.9	-	3.3	-	11.6	-	-
				.21	.24	.08		.30		.08		
		Jan.1937	7,310	7.1	4.5	9.6	-	1.9	-	9.5	-	-
				.14	.22	.10		.53		.11		
		3-16-40	5,590	7.1	3.0	22.6	-	2.1	-	7.4	-	-
				.14	.33	.04		.48		.14		
		5-19-42	7,770	5.2	3.9	10.0	-	4.0	-	14.2	-	-
				.19	.26	.10		.25		.07		
		11- 3-66	8,590	5.2	4.3	21.7	3,090	3.8	2,290	19.0	-	-
				.19	.23	.05	.0003	.26	.0004	.05		
		7-26-67	6,000	4.8	3.7	23.2	-	3.4	1,010	11.6	-	-
				.21	.27	.04		.29	.001	.08		
(B-5-3)27c-S	Hooper	11- 3-51	8,600	4.4	4.6	8.4	-	142	8,500	20.8	-	-
				.23	.22	.12		.007	.0001	.05		
		9-15-53	9,310	5.8	4.7	8.8	-	121	6,240	18.7	-	-
				.17	.21	.11		.008	.0002	.05		
		10- 7-53	9,980	4.8	4.5	8.1	-	140	12,950	19.5	-	-
				.21	.22	.12		.007	.0001	.05		
		6-20-57	8,350	6.1	4.7	14.4	-	124	-	5.5	-	-
				.16	.21	.07		.008		.18		
		4-13-60	8,620	5.3	4.7	10.3	-	86.3	-	23.1	-	-
				.19	.21	.10		.01		.04		
		11- 7-66	8,230	5.6	4.6	9.2	1,175	127	4,840	21.6	-	-
				.18	.21	.11	.0009	.008	.0002	.05		
(B-5-3)28d-S	Southwest Hooper	9-15-53	27,800	1.2	15.5	10.3	-	65.8	-	47.4	-	-
				.83	.06	.10		.02		.02		
(B-6-1)23ccd-S1	Ogden	4-27-43	8,650	32.3	8.5	-	-	49.8	1,690	24.4	-	-
				.03	.12			.02	.0006	.04		
		11- 3-51	8,820	42.1	8.1	6.7	456	50.6	1,490	25.3	-	-
				.02	.12	.15	.002	.02	.0007	.04		
		11- 2-66	8,650	7.3	7.7	7.6	66.5	46.6	1,340	25.7	-	-
				.14	.13	.13	.02	.02	.0008	.04		
		5-18-67	8,680	6.5	8.4	7.7	99	41.2	1,310	26.0	333	38
				.15	.12	.13	.01	.02	.0008	.04	.003	
(B-7-2)14dca-S1	Utah	11-18-11	-	41.9	-	-	-	74.3	-	80.2	-	-
				.02				.02		.01		
		11- 3-51	25,200	25.9	6.5	7.0	-	74.0	-	74.4	-	-
				.04	.15	.14		.02		.02		
		3- 2-54	18,900	22.0	6.5	7.5	-	59.7	4,150	56.8	-	-
				.05	.15	.13		.02	.0002	.02		
		4- 5-58	22,900	16.3	6.2	7.8	710	70.4	4,160	69.2	1,620	41
				.06	.16	.13	.001	.02	.0002	.02	.0006	
		11- 3-66	21,600	26.2	6.5	7.0	833	63.2	2,950	69.8	-	-
				.04	.15	.14	.001	.02	.0003	.02		
		5-18-67	22,700	13.1	6.6	7.4	916	45.3	3,240	70.0	3,910	89
				.08	.15	.14	.001	.02	.0003	.02	.0003	
(B-10-3)30bbd-S1	Stinking	11-18-11	30,400	2.3	11.8	-	-	925	-	47.1	-	-
				.43	.08			.001		.02		
		10-27-51	33,900	2.5	12.5	17.0	-	352	-	39.4	-	-
				.40	.08	.06		.003		.03		
		2- 6-53	-	-	-	-	-	164	-	44.3	-	-
								.006		.02		
		4- 5-58	36,600	3.2	13.3	22.1	1,830	194	11,370	66.7	1,440	9.4
				.31	.08	.05	.0005	.005	.00009	.01	.0002	
		5-24-66	29,900	2.5	12.0	15.3	2,620	106	11,100	105	-	-
				.40	.08	.07	.0004	.009	.00009	.01		
		5-17-67	29,000	1.5	15.0	19.9	3,370	113	-	113	491	46
				.67	.07	.05	.0003	.009		.009	.002	
(B-11-2)29da-S	Crystal	11-18-11	45,500	4.1	18.4	-	-	54.3	-	59.7	-	-
				.24	.05			.02		.02		
		10-27-51	42,200	3.7	18.3	-	-	53.6	-	54.0	-	-
				.27	.05			.02		.02		
		2- 6-53	-	-	-	-	-	52.7	-	54.0	-	-
								.02		.02		
		11- 2-66	38,500	4.2	17.3	20.7	2,830	50.9	11,900	60.9	-	-
				.24	.06	.05	.0004	.02	.00009	.02		
(B-11-19)11dda-S1	Unnamed hot spring	5-16-68	248	3.1	-	-	-	.31	-	.05	-	-
				.32				3.2		20.2		
(B-12-15)19aab-S1	Warm	8-12-66	214	4.5	.75	15.9	1,350	3.8	285	.53	285	-
				.22	1.33	.06	.0007	.26	.004	1.9	.003	
(B-13-3)23baa-S1	Uddy	11- 1-66	7,850	3.9	12.7	22.8	3,240	49.7	2,980	12.2	-	-
				.26	.08	.04	.0003	.02	.0003	.08		

Table 2. (continued).

Location	Name of spring	Date	Dis-solved solids (ppm)	Calcium/Magnesium Ca/Mg Magnesium/Calcium Mg/Ca	Sodium/Calcium Na/Ca Calcium/Sodium Ca/Na	Sodium/Potassium Na/K Potassium/Sodium K/Na	Sodium/Lithium Na/Li Lithium/Sodium Li/Na	Chloride/Sulfate Cl/SO4 Sulfate/Chloride SO4Cl	Chloride/Fluoride Cl/F Fluoride/Chloride F/Cl	Chloride/Bicarbonate Cl/HCO3 Bicarbonate/Chloride HCO3/Cl	Chloride/Bromine Cl/Br Bromine/Chloride Br/Cl	Bromine/Iodine Br/I Iodine/Bromine I/Br
(C-1-7)8&9-S	Big	9-28-59	8,100	1.05 .95	27.5 .04	-	-	12.9 .08	-	34.5 .03	-	-
		9-29-59	7,860	1.70 .59	20.1 .05	28.1 .04	1,520 .0007	13.3 .08	21,800 .00005	20.0 .05	-	-
		1- 5-60	8,160	1.70 .59	20.4 .05	26.5 .04	2,810 .0004	13.2 .08	-	20.4 .05	-	-
		4-12-60	8,300	1.70 .59	21.3 .05	27.7 .04	-	13.3 .08	-	26.8 .04	-	-
		7- 8-60	8,060	1.95 .51	19.4 .05	28.2 .04	-	13.6 .07	-	21.8 .05	-	-
		10- 1-60	8,210	2.00 .50	19.4 .05	28.9 .04	-	13.2 .08	-	23.7 .04	-	-
		10-11-60	8,090	1.80 .56	20.1 .05	30.1 .03	-	13.1 .08	-	22.0 .05	-	-
		1-10-61	8,250	1.75 .57	20.0 .05	28.4 .04	-	13.0 .08	-	20.9 .05	-	-
		4- 4-61	8,430	1.65 .61	20.1 .05	28.1 .04	-	13.4 .08	-	21.7 .05	-	-
		5-27-66	7,940	1.6 .62	19.6 .05	24.1 .04	4,100 .0002	13.9 .07	4,425 .0002	21.4 .05	-	-
(C-2-6)16aad-S1	Grantsville	3-15-66	25,800	3.1 .32	15.3 .07	37.6 .03	-	22.7 .04	8,820 .0001	64.4 .02	-	-
(C-4-1)12b-S	Crystal	1882	1,680	5.0 .20	2.9 .35	7.4 .14	-	.89 1.1	-	1.6 .62	-	-
		5-22-34	1,665	4.2 .24	2.9 .35	-	-	6.2 .16	-	2.1 .47	-	-
		7-25-50	1,300	4.2 .24	2.2 .45	-	-	7.8 .13	-	3.8 .26	-	-
		9-10-52	1,550	2.5 .40	-	-	-	7.3 .14	-	1.9 .53	-	-
		5-27-58	1,390	4.6 .22	-	-	-	8.3 .12	-	1.8 .56	-	-
(C-5-1)25-S	Crater	5-27-58	1,390	3.7 .27	-	-	-	.75 1.3	-	1.0 1.0	-	-
		6- 4-58	1,440	3.7 .27	-	-	-	.77 1.3	-	1.1 .91	-	-
(C-5-1)25cd-S	Saratoga	1933	1,500	4.4 .23	1.8 .56	-	-	.93 1.1	-	1.3 .77	-	-
		3-24-66	1,450	2.8 .36	-	-	-	.78 1.3	-	1.1 .91	-	-
(C-5-5)9cba-S1	Morgans	9-22-64	583	2.4 .42	1.9 .53	10.0 .10	-	2.0 .50	179 .005	1.0 1.0	-	-
		5-27-66	578	2.3 .43	1.9 .53	8.4 .12	2,720 .0004	2.0 .50	151 .007	1.1 .91	-	-
		7-18-67	586	1.7 .59	2.3 .43	10.2 .09	3,730 .0003	1.9 .53	134 .007	1.2 .83	627 .0015	30
(C-5-5)17aaa-S1	Russells	4-29-66	438	2.4 .42	1.4 .71	6.6 .15	-	2.3 .43	-	.72 1.4	-	-
		5-27-66	440	2.8 .36	1.4 .71	6.2 .16	3,750 .0003	2.2 .45	81 .012	.70 1.4	-	-
		7-18-67	445	3.2 .31	1.3 .77	7.1 .14	3,550 .0003	1.9 .53	81 .012	.72 1.4	610 .0016	10
(C-10-14)33-S	Wilson	7-12-67	21,800	3.3 .30	9.6 .10	39.4 .02	3,380 .0003	7.6 .13	2,980 .0003	66.9 .01	517 .0019	63.9
(C-11-14)23c-S	Fish	7-12-67	1,820	5.2 .19	3.5 .28	13.1 .08	1,420 .0007	1.9 .53	315 .003	2.0 .50	485 .0020	65
(C-14-8)10c-S	Abraham	11-12-27	3,170	-	-	-	-	2.5 .40	-	9.0 .11	-	-
		5-31-66	3,710	6.4 .15	2.2 .45	12.1 .08	1,040 .0009	2.1 .48	517 .019	10.1 .10	-	-
		7-13-67	3,630	5.1 .20	2.4 .42	17.0 .06	1,300 .0008	1.9 .53	354 .028	9.1 .11	806 .0012	20
(C-15-19)31bc-S	Gandy	3- 3-66	305	2.4 .42	.56 1.8	10 .10	-	.95 1.0	-	.07 1.4	-	-
		7-12-67	303	2.8 .36	.58 1.7	7.8 .13	1,450 .0006	.9 1.1	37 .027	.10 1.0	260 .038	-
(C-22-6)26ccc-S1	Meadow	5-12-66	4,690	4.3 .23	2.5 .40	6.6 .15	416 .002	1.7 .59	330 .003	5.6 .18	1,350 .0007	43
(C-22-6)27ddd-S1	do	4- 8-43	4,810	4.9 .20	-	-	-	1.8 .56	-	4.0 .25	-	-
		6-18-57	4,690	5.3 .19	-	-	-	1.8 .56	-	4.0 .25	-	-
		8-27-58	4,850	7.1 .14	-	-	-	1.7 .59	-	4.2 .24	-	-
		5-12-66	4,870	4.4 .23	2.4 .42	6.8 .15	707 .001	1.7 .59	356 .003	4.1 .24	1,370 .0007	16.2
		5-22-67	4,900	3.8 .26	2.4 .42	73.9 .01	319 .003	1.6 .62	327 .003	4.4 .23	450 .022	8.9
(C-22-6)35ddb-S1	Hatton	6-19-57	4,670	5.2 .19	-	-	-	1.8 .56	-	4.2 .24	-	-
		8-27-58	4,850	6.5 .15	-	-	-	1.7 .59	-	3.7 .27	-	-
(C-23-3)26aca-S1	Richfield	7-30-57	310	1.2 .83	.26 3.8	3.0 .33	24 .042	.74 1.3	100 .010	.07 14.3	-	-
		6- 6-66	307	1.5 .67	.29 3.4	4.7 .21	375 .003	.69 1.4	67 .015	.14 7.1	200 .050	10

Table 2. (continued).

Location	Name of spring	Date	Dis-solved solids (ppm)	Calcium/Magnesium Ca/Mg; Magnesium/Calcium Mg/Ca	Sodium/Calcium Na/Ca; Calcium/Sodium Ca/Na	Sodium/Potassium Na/K; Potassium/Sodium K/Na	Sodium/Lithium Na/Li; Lithium/Sodium Li/Na	Chloride/Sulfate Cl/SO_4; Sulfate/Chloride SO_4/Cl	Chloride/Fluoride Cl/F; Fluoride/Chloride F/Cl	Chloride/Bicarbonate Cl/HCO_3; Bicarbonate/Chloride HCO_3/Cl	Chloride/Bromine Cl/Br; Bromine/Chloride Br/Cl	Bromine/Iodine Br/I; Iodine/Bromine I/Br
(C-25-3)10dda-S1	Monroe	7-23-57	2,700	8.3	2.0	8.9	117	0.70	242	1.8	-	-
				.12	.50	.11	.008	1.4	.004	.55		
		9-10-57	2,860	8.9	2.1	12.5	1,040	.68	-	1.4	-	-
				.11	.48	.08	.0009	1.5		.71		
		5-17-66	2,680	15.1	2.2	9.3	1,130	.67	222	2.0	1,560	13.3
				.07	.45	.11	.0008	1.5	.004	.50	.0006	
(C-25-3)11cac-S1	Red Hill	5- 2-66	2,630	5.9	3.0	9.0	1,050	.72	238	4.2	2,220	5.0
				.17	.33	.11	.0009	1.4	.004	.24	.0004	
(C-25-3)15a-S	Monroe	5- 3-67	2,700	5.7	2.0	11.3	1,380	.65	333	1.6	375	40.0
				.18	.50	.09	.0007	1.5	.003	.62	.026	
(C-25-3)27a-S	Johnson	4-19-67	428	4.7	.63	29.3	4,400	.09	7.8	.08	140	10.0
				.21	1.6	.03	.0002	1.1	.13	1.2	.007	
(C-25-4)23-S	Joseph	7-23-57	5,150	7.8	5.1	21.1	180	1.4	648	4.1	-	-
				.13	.20	.05	.005	.71	.002	.24		
		10-11-57	4,970	6.0	5.2	30.1	-	1.4	282	4.1	-	-
				.17	.19	.03		.71	.004	.24		
		5- 3-66	5,090	5.3	5.6	18.1	98.0	1.3	567	4.1	1,890	9.0
				.19	.18	.05	.01	.77	.002	.24	.0005	
		5-15-67	5,180	5.4	6.0	31.7	784	1.2	370	4.3	570	25
				.18	.17	.03	.012	.83	.003	.23	.002	
(C-26-9)34dcb-S1	Roosevelt	11- 4-50	7,040	5.6	109	4.4	-	58.6	-	24.1	-	-
				.18	.009	.23		.02		.04		
		9-11-57	7,800	-	114	5.1	-	58.1	-	27.2	-	-
					.008	.20		.02		.04		
(C-30-9)7aca-S1	Radium	8-21-63	1,020	4.6	1.6	9.6	860	.14	6.6	.68	-	-
				.22	.62	.10	.011	7.1	.15	1.5		
		3-12-66	977	4.0	1.6	9.1	1,260	.14	14.9	.40	-	-
				.25	.62	.11	.0008	7.1	.07	2.5		
		7-11-67	956	2.5	1.9	10.0	1,540	.14	14.0	.28	315	-
				.40	.53	1.0	.0006	7.1	.07	3.6	.003	
(C-30-12)21-S	Thermo	10-23-39	-	-	-	-	-	.47	-	.59	-	-
								2.1		1.7		
		8-21-63	1,500	8.6	4.3	7.3	275	.44	15.0	.55	-	-
				.12	.23	.14	.004	2.3	.07	1.8		
(C-30-12)28-S	do	8-21-63	1,460	7.7	5.2	8.2	-	.46	46.0	.68	-	-
				.13	.19	.12		2.2	.02	1.5		
		5-25-66	1,450	7.7	4.8	6.9	368	.45	31.0	.58	1,040	.67
				.13	.21	.14	.003	2.2	.03	1.7	.0010	
		7-11-67	1,470	6.3	4.8	7.7	428	.46	15.1	.57	530	10
				.16	.21	.13	.002	2.2	.07	1.8	.002	
(C-40-16)6cdb-S1	Veyo	3-30-66	402	2.0	.54	7.3	640	.30	50.0	.14	150	0.2
				.50	1.8	.14	.002	3.3	.02	7.1	.007	
		4-20-67	389	1.9	.60	8.9	1,600	.33	42.9	.13	300	10
				.53	1.7	.11	.0006	3.0	.02	7.7	.003	
(C-41-13)25-S	LaVerkin	6-3-40	9,460	4.8	2.9	13.8	-	1.8	-	2.7	-	-
				.21	.34	.07		.55		.37		
		2- 5-51	9,760	4.8	2.8	13.4	-	1.9	-	2.8	-	-
				.21	.36	.07		.52		.36		
		3-25-66	9,530	5.0	3.9	11.5	1,260	1.8	1,390	5.0	2,410	4.7
				.20	.27	.09	.0006	.55	.0007	.20		
(D-3-4)26bca-S1	Midway	7- 1-52	1,890	22.4	-	-	-	.17	-	.16	-	-
				.04				5.9		6.2		
(D-3-4)26cca-S1	do	9-28-66	1,670	4.9	.34	4.6	407	.16	49.1	.16	120	90
				.20	2.9	.22	.002	6.2	.02	6.2	.008	
(D-3-4)27bac-S1	do	5-16-67	2,000	4.1	.42	4.8	507	.16	45.1	.20	280	25
				.24	2.4	.21	.002	6.2	.02	5.0	.003	
(D-3-4)27bad-S1	do	9-28-66	1,990	5.3	.39	4.9	419	.17	55.2	.19	197	70
				.19	2.6	.20	.002	5.9	.02	5.3	.005	
(D-3-4)27cbd-S1	do	9-28-66	1,770	4.9	.28	4.5	403	.16	54.8	.16	192	60
				.20	3.6	.22	.002	6.2	.02	6.2	.005	
		5-15-67	1,570	2.4	.57	4.6	433	.16	50.0	.24	230	50
				.42	1.7	.22	.002	6.2	.02	4.2	.004	
(D-3-4)27cbd-S2	do	9-28-66	1,640	4.7	.33	4.4	411	.16	46.8	.15	206	-
				.21	3.0	.23	.002	6.2	.02	6.7	.005	
		5-15-67	1,510	3.8	.41	4.4	570	.17	43.8	.18	210	50
				.26	2.4	.23	.002	5.9	.02	5.5	.005	
(D-3-4)27cbd-S3	do	5-16-67	1,880	3.7	.50	4.9	543	.19	55.5	.26	167	45
				.27	2.0	.20	.002	5.3	.02	3.8	.006	
(D-4-24)16cdd-S1	Split Mountain	9-19-48	942	3.0	-	-	-	1.4	242	1.5	-	-
				.33				.71	.04	.67		
(D-7-1)5ccb-S1	Warm spring, west shore of Utah Lake	9-11-58	1,570	2.5	-	-	-	1.6	-	1.5	-	-
				.40				.62		.67		
(D-7-1)8bbc-S1	do	9-11-58	1,430	1.5	-	-	-	1.6	-	2.6	-	-
				.67				.62		.38		
(D-8-1)3dda-S1	Lincoln Point	5-27-64	6,550	4.0	-	-	-	2.9	-	3.7	-	-
				.25				.34		.27		
		6-16-66	6,140	3.3	3.3	9.4	-	8.2	-	3.4	-	-
				.30	.30	.11		.12		.29		
(D-8-5)14d-S	Diamond Fork	10-20-67	837	3.2	1.1	14.1	1,170	.09	22.5	.14	-	-
				.31	.91	.07	.0008	.11	.04	7.1		
(D-9-4)18ba-S	Castilla	10-20-67	6,360	5.9	3.6	16.8	1,290	1.7	644	4.3	-	-
				.17	.27	.06	.0007		.002	.23		
(D-10-1)8c-S	Goshen	5-27-64	1,320	2.0	-	-	-	5.5	-	1.8	-	-
				.50				.18		.55		
		6-15-66	1,320	2.2	3.9	18.1	-	4.7	-	1.7	-	-
				.45	.26	.05		.21		.59		
(D-18-2)13cad-S1	Livingston	2- 6-41	635	1.7	5.0	-	-	.64	-	.13	-	-
				.59	.20			1.6		7.7		
(D-19-2)4dca-S1	Sterling	8-27-57	429	2.0	-	-	-	.48	-	.11	-	-
				.50				2.1		9.1		

Becks Hot Springs

Becks Hot Springs, (B-1-1)14dcb-S1, are about a half mile south and one mile east of the northwest corner of the area enclosed by the Salt Lake City corporate boundary and are in Salt Lake County. The springs issue from near the contact between valley fill of Quaternary age and limestones of Paleozoic age (figure 5). The contact zone and apparent conduit for the thermal waters is the Warm Springs fault. Volcanic rocks of Tertiary age are exposed about 2.5 miles southeast of the springs but are not believed to be a source of heat. Circulation of meteoric water to depths of several thousand feet and contact with saline sediments probably result in the temperatures of about 130° F and the dissolved-solids content of about 13,000 ppm. Some mixing of deeply circulated brines and shallow dilute ground water may occur.

The discharge of Becks Hot Springs is commonly greatest in early spring and least in late fall but is somewhat variable from month to month and from year to year. U. S. Geological Survey personnel estimated the flow to be about 450 gpm on November 9, 1966, and about 60 gpm on July 26, 1967; dissolved-solids content changed very little–13,600 ppm on November 9 and 13,900 on July 26.

Water temperature has remained stable during the past 90 years. Gilbert (1928, p. 33) states, "On July 5, 1877, I obtained 126° [F at Becks Hot Springs], and on August 30, 1917, Mr. Sterling B. Talmage found 133° [F]." Temperature observations during 1966-67 were 130° and 132° F. The source of the heat probably is the geothermal gradient.

Hayden (1871, p. 171) gives an interesting early description of Becks Hot Springs: "About three miles north of the city are the Hot Springs, which are well worth the examination of the traveler. The water boils up from beneath beds of limestone at the base of the mountains, and it is only necessary to thrust the hand into it to ascertain that is is boiling hot. Meat is readily cooked in it, and eggs will be ready for the table in three minutes. The dense column of steam that rises perpetually will always point out the locality of the springs. Quite a large volume of water issues forth, forming a stream four or five feet in width and six inches in depth. It flows into a beautiful lake not far distant to the west, called Hot Spring Lake. This lake is supposed to be supplied to some extent with water from hot springs beneath the surface. Still the hot water is not sufficient to prevent the existence of some kinds of excellent fish, among them fine large trout... Hot, warm, and cold springs frequently issue from the ground only a few yards apart."

Hague and Emmons (1877, p. 438) state, "At the point of the projecting spur of the Wahsatch, just north of Salt Lake City, a warm sulphur spring gushes out of the Wahsatch limestones, sending down a little stream, some 6 feet wide, of sulphurous waters, into the little arm of the lake called Hot Spring Lake. These waters, like most of the springs around the lake, contain chloride of sodium as their principal mineral ingredient. Between this point and the city is another warm spring in the limestone, whose waters contain some sulphuretted hydrogen."

Richardson (1906, p. 44) writes, "In the northern part of Salt Lake City several thermal springs occur... The hot springs issue at a temperature of about 130° [F] from the Wasatch limestone at the western end of the spur of the mountains, with a discharge of about three-fourths second-foot [cfs], and flow into Hot Springs Lake. The warm springs issue from unconsolidated deposits at the base of the spur about 2 miles southeast of the hot springs... The temperature is 118° [F] at the spring..."

Taylor and Leggette (1949, p. 39) quote the *Salt Lake Herald* of August 26, 1888: "Use of the springs [Becks Hot Springs] for bathing and medicinal purposes is increasing. The hot springs discharge something over 200 gallons per minute. The temperature is given as 129° F. A partial analysis shows a content of more than 10,000 parts per million of dissolved mineral matter, of which over 70 percent is sodium chloride (common salt)."

Hot Springs Lake no longer exists; the area of the former lake is now crossed by Interstate Highway 15. Becks Hot Springs are no longer used for bathing resorts.

The water from Becks Hot Springs is sodium chloride in type. Spectrographic analysis shows that the cobalt concentration (6.9 μg/l (micrograms per liter)) and the manganese concentration (486 μg/l) were high relative to many other thermal springs in Utah.

Wasatch Hot Springs

Wasatch Hot Springs, (B-1-1)25db-S, are about one mile north-northwest of Temple Square in Salt Lake City, Salt Lake County. The springs, like Becks Hot Springs, issue along the Warm Springs fault at the contact between rocks of Quaternary and Paleozoic age (figure 5). During the past 45 years, several short tunnels have been constructed in an effort to increase spring discharge; and other construction in

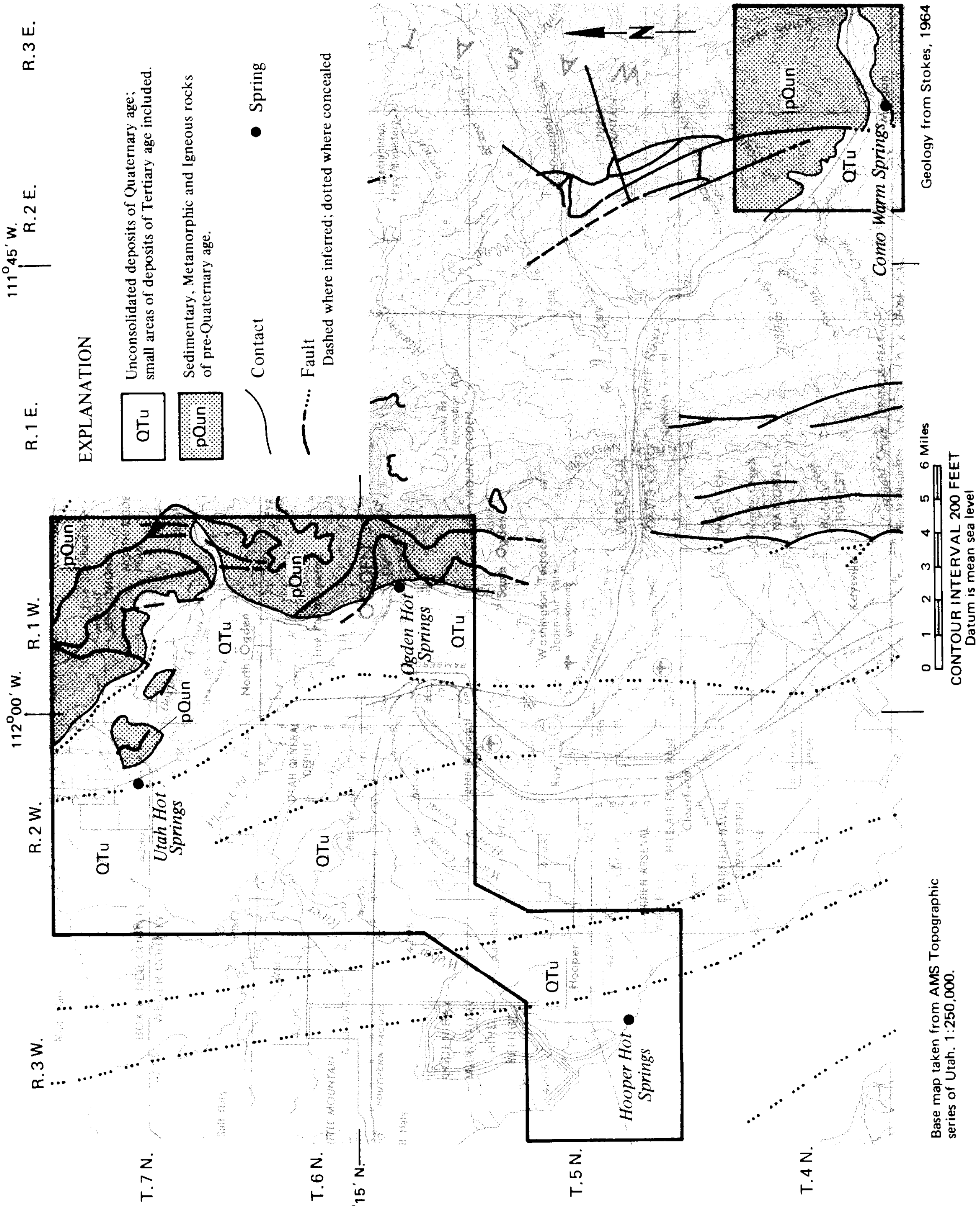


Figure 4. Map showing generalized geology in the vicinity of Como, Hooper, Ogden, and Utah Springs.

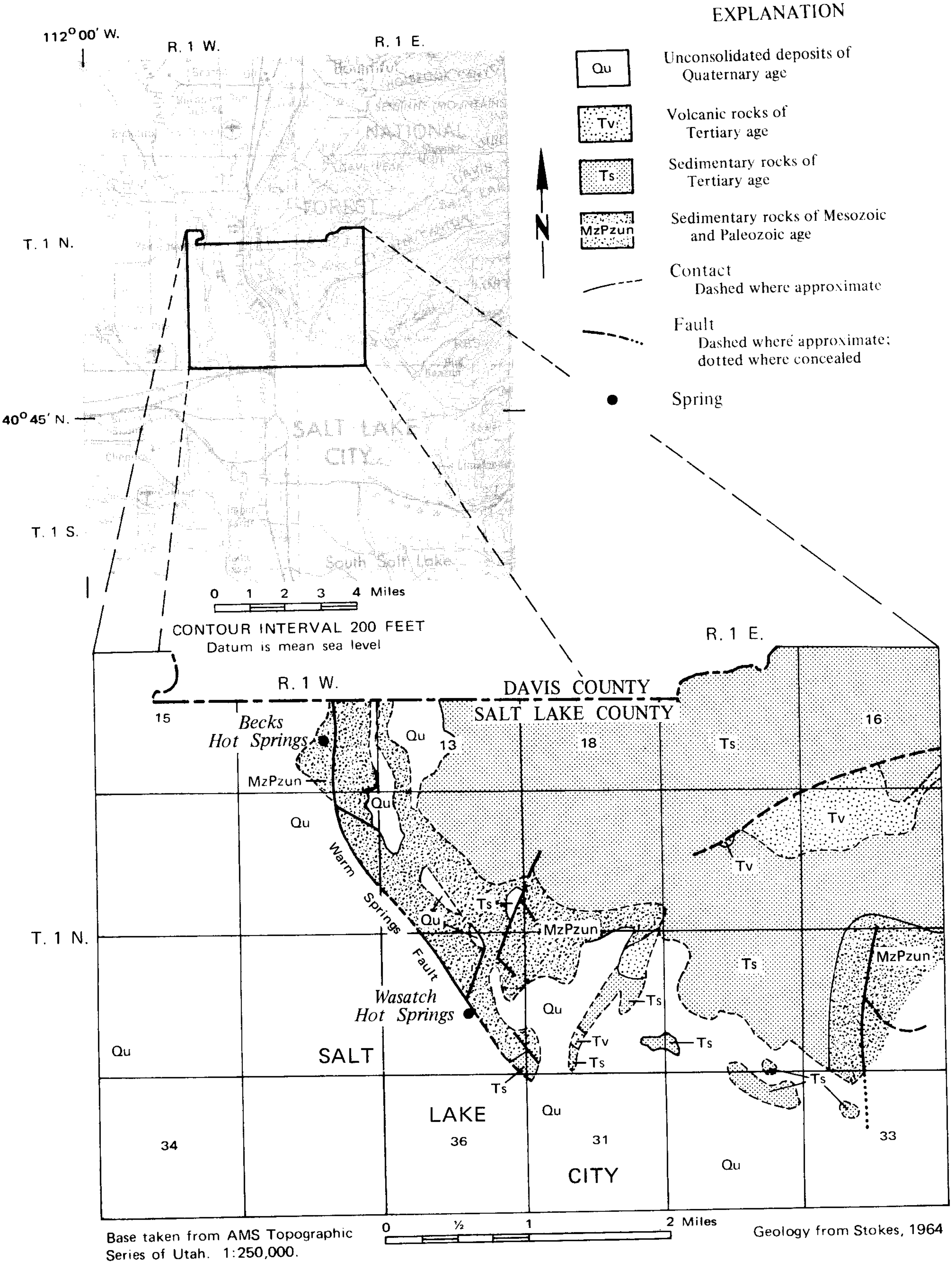


Figure 5. Map showing generalized geology in the vicinity of Becks and Wasatch Hot Springs.

the immediate vicinity of the springs has affected spring discharge. Therefore, comparisons of variations in spring discharge and in chemical characteristics of the water may not be valid. Taylor and Leggette (1949, p. 40) show that observed flow from springs at "Wasatch Springs Plunge" ranged from 0.69 to 2.27 cfs (310 to 1,020 gpm) during the period 1920-36. Milligan and others (1966, table 1) reported a discharge of 0.7 cfs during the summer of 1964. Concurrent observations of discharge and chemical characteristics of the springs are inadequate for establishment of the relation between discharge and chemistry of the water, but the dissolved-solids content appears to increase as spring discharge decreases. Dissolved-solids content was nearly 13,000 ppm at very low discharges during the severe drought in 1934. Since then, the data available show dissolved-solids content as ranging from about 5,600 to about 8,600 ppm. The data suggest that fairly constant amounts of deep, highly mineralized water mixes with variable amounts of shallower, less mineralized water.

The temperature of Wasatch Hot Springs was 105° F on July 26, 1967, and was 132° F at the nearby Becks Hot Springs on the same date. Dissolved solids were 6,000 and 13,900 ppm, respectively. The water is of the sodium chloride type at both springs, and sulfate concentrations are similar. The lower temperature and lower dissolved-solids content of water from Wasatch Hot Springs probably results from a proportionately greater amount of less deeply circulated ground water that enters the system in the vicinity of these springs. Although a small area of volcanic rocks is about one mile east of the Wasatch Hot Springs, the source of the heat is believed to be the geothermal gradient.

Figure 6 is an aerial photograph showing the area near Wasatch and Becks Hot Springs.

Hooper Hot Springs

Hooper Hot Springs, (B-5-3)27c-S, are in Davis County, about 10 miles southwest of Ogden on the east shore of Great Salt Lake. The springs issue from valley fill of Quaternary age (figure 4). The springs are about a quarter of a mile west of an inferred fault in the fill and are at the east edge of the mudflats of Great Salt Lake (figure 7). In addition to the main Hooper Hot Springs, several small springs and seeps are in the immediate vicinity and some extend northwestward through the mudflats.

On September 15, 1953, chemical data were obtained at Hooper Hot Springs and at Southwest Hooper Warm Springs, (B-5-3)28d-S, which are about three-eights of a mile west of the main spring. Temperature of Hooper Hot Springs was 140° F and dissolved-solids content was 9,310 ppm. Temperature of Southwest Hooper Warm Springs was 90° F and dissolved-solids content was 27,800 ppm. The water was of the sodium chloride type at both springs. Calcium concentrations were about the same at both springs, but magnesium and potassium concentrations were much greater at Southwest Hooper Warm Springs. Large differences are probable in the chemistry of the several small springs and seeps in the vicinity. The highly saline deposits of the fill and possible mixing of deeply circulated waters with variable amounts of highly mineralized shallow ground water probably result in a complex water-chemistry condition in a small area. Estimated discharges of Hooper Hot Springs have ranged from 5 to 30 gpm.

Data obtained infrequently between 1951 and 1966 show that the dissolved-solids content of Hooper Hot Springs ranged from about 8,000 to 10,000 ppm. Spectrographic analysis of a sample obtained on November 7, 1966, showed nothing unusual except that the concentration of manganese was equal to or greater than 3,000 μg/l, and the concentration of germanium was 46 μg/l.

Infrequent observations of temperature between 1951 and 1966 show a temperature range of 118°-140° F at Hooper Hot Springs. The cause of the heat probably is the geothermal gradient; no intrusive or volcanic rocks of late Tertiary or Quaternary age are known to occur within many miles of the springs.

If the source of heat and the dissolved-solids content of the deeply circulated waters are assumed to be the same for both Hooper Hot Springs and Southwest Hooper Warm Springs, the data obtained on September 15, 1953, can be used as the basis for some rough approximations. If the water from Hooper Hot Springs were mixed with an equal amount of water having a temperature of 55° F and having a dissolved-solids content of about 50,000 ppm (about one-fifth that of Great Salt Lake), then the resultant water would have a temperature of 90° F and a dissolved-solids content of 27,800 ppm, such as was observed at Southwest Hooper Warm Springs in 1953.

Ogden Hot Springs

Ogden Hot Springs, (B-6-1)23ccd-S1, are at the mouth of Ogden Canyon, about a quarter of a mile east of the east boundary of the City of Ogden, Weber County. The springs rise in the Wasatch fault

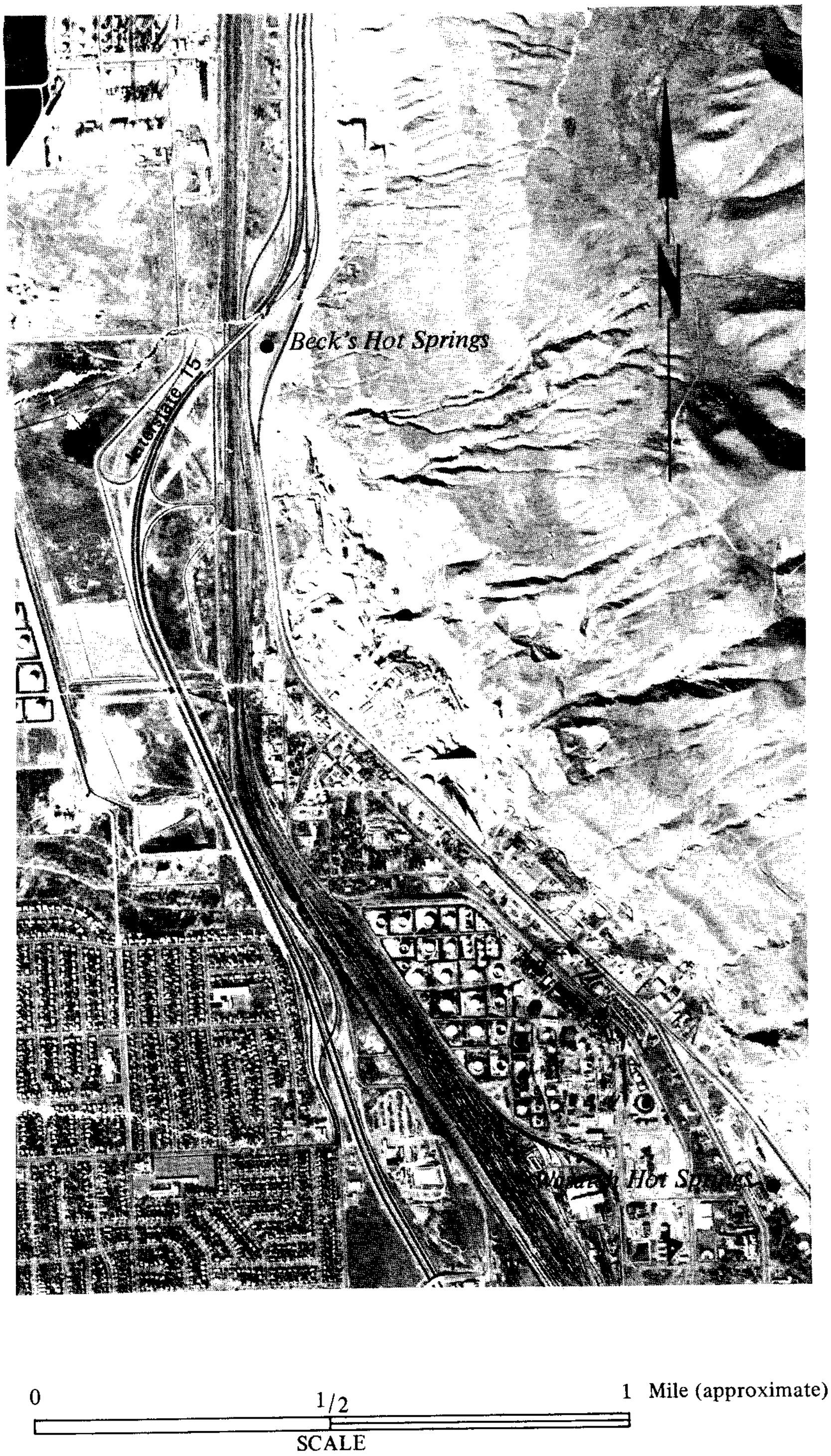


Figure 6. Aerial photograph of the area surrounding Becks and Wasatch Hot Springs. (Photograph by U. S. Geological Survey, November 1965.)

zone (figure 4) in rocks of Precambrian age. The immediate vicinity of the springs is mantled with talus or thin valley fill.

Hayden (1873, p. 175) observed one spring at the "mouth of Ogden Canon, near Ogden City, Utah Territory" having a temperature of 121° F. A temperature of 150° F was reported for the spring once but nearly all temperature observations have been about 135° F. As for nearly all thermal springs in Utah, the cause of heat probably is the geothermal gradient. As the water descends to depths of several thousand feet, its temperature is raised 60°-80° F. No igneous rocks of late Tertiary or Quaternary age occur within many miles of Ogden Hot Springs.

On October 31, 1940, U. S. Geological Survey personnel estimated the discharge of the springs to be 100 gpm, but most records show that the spring discharge is about 35 gpm. The probable source of the water is meteoric water circulating through metamorphic rocks of Precambrian age.

The dissolved-solids content of Ogden Hot Springs ranged from 8,650 to 8,820 ppm during 1943-67; the water is of the sodium chloride type. Concentration of manganese is high, and concentration of germanium is somewhat higher than for most thermal springs in Utah. The chemical and thermal characteristics of Ogden Hot Springs are similar to those for Hooper Hot Springs, which are about 15 miles to the southwest.

Utah (Bear River) Hot Springs

Utah (Bear River) Hot Springs, (B-7-2)14dca-S1, are in the extreme southeast corner of Box Elder County, about eight miles northwest of Ogden. The springs issue in an area of complex faulting (figure 4) in rocks of Cambrian age. Gilbert (1928, p. 32) stated that these springs rise along the outer base of Pleasant View spur, one of several fault-block spurs that are associated with the Wasatch Range. The relation between these springs and the main Wasatch fault zone, however, is not known in detail.

The temperature of Utah Hot Springs has remained constant during the past 125 years. The temperature was 136° F in 1843, 136° F in 1871, and 135°-137° F in 1966-67. Late Tertiary or Quaternary igneous activity is not evident within many miles of the springs. The source of the heat probably is the geothermal gradient, which results in the heating of deeply circulating meteoric waters.

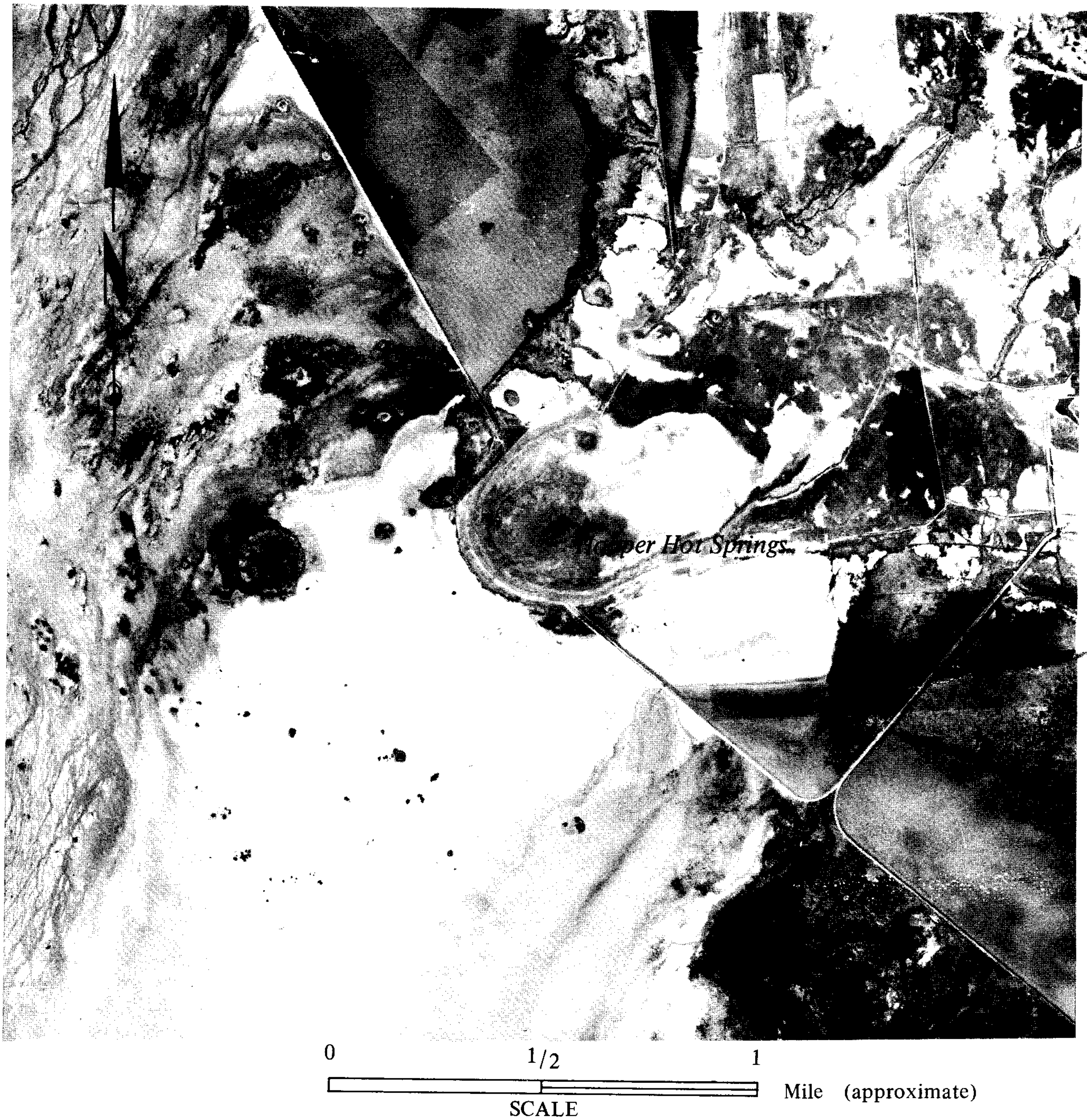


Figure 7. Aerial photograph of the area surrounding Hooper Hot Springs. Mudflats of Great Salt Lake occupy the southwest half of the area shown. The springs are on the margin of the mudflats. (Photograph by U. S. Geological Survey, November 1965.)

Utah, Ogden, and Hooper Hot Springs are within an area having a 10-mile radius, and all three springs have temperatures ranging from 130° to 140° F. The temperature similarity suggests a similarity in depth of water circulation or a common igneous source of heat at unknown depth.

Most observations indicate that the discharge of Utah Hot Springs is fairly constant at about 500 gpm, although discharges ranging from 250 to 700 gpm have been reported. The water was used as a bathing resort many years ago but is no longer used for that purpose. During recent years, the water has been used for heating of buildings near the springs. Figure 8 is an aerial photograph showing the area around Utah Hot Springs.

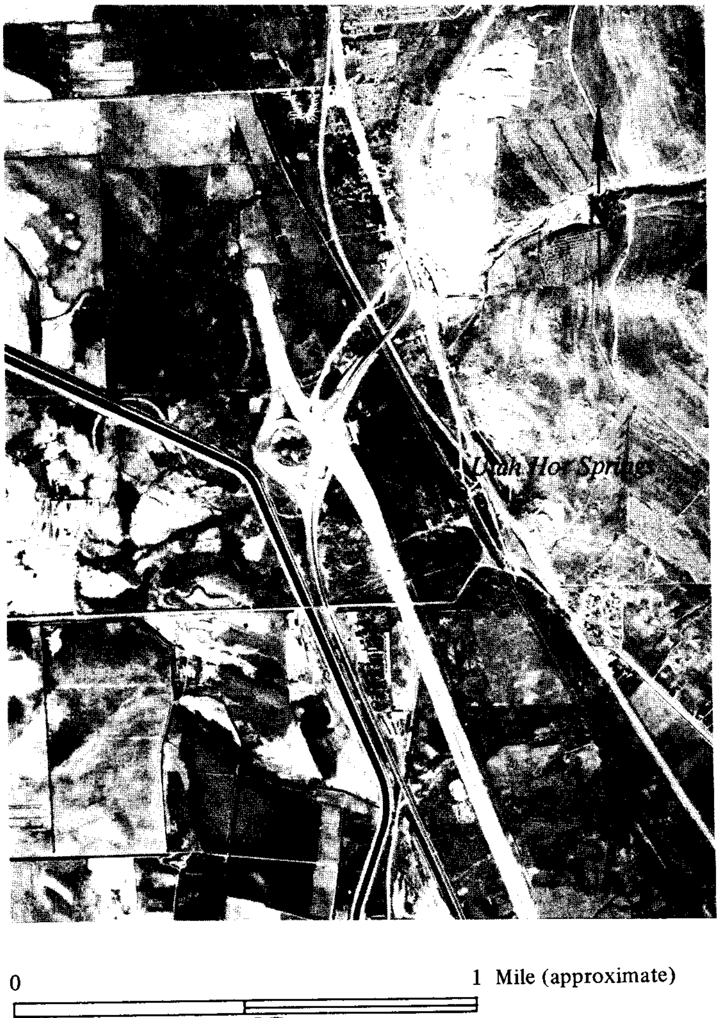


Figure 8. Aerial photograph of the area surrounding Utah Hot Springs. (Photograph by U. S. Geological Survey, November 1965.)

Observed dissolved-solids content of the springs ranged from 18,900 to 25,200 ppm. The water is strongly sodium chloride in type. Movement of the water through saline sediments is probable. Manganese concentrations are high, and germanium concentrations are fairly high in water from Utah Hot Springs, as they are in water from Hooper and Ogden Hot Springs.

Stinking Hot Springs

Stinking Hot Springs, (B-10-3)30bbd-S1, are about six miles southwest of Bear River City, Box Elder County. The springs discharge from limestones of Mississippian age at the base of the south end of Little Mountain (figure 9). The water rises along one of the faults in these limestones. The springs derive their name from the presence of hydrogen sulfide gas.

Measured spring temperatures during the period 1951-67 ranged from 113° to 124° F. The absence of evidence of igneous activity of late Tertiary or Quaternary age indicates that the probable cause of heat is the geothermal gradient. If the spring discharge were undiluted by shallow ground water, circulation of meteoric water to a depth of about 5,000 feet could result in the observed temperatures. Estimated discharges of the springs have ranged from 5 to 45 gpm.

Stinking Hot Springs are some of the most mineralized thermal springs in Utah. Dissolved-solids content in 1911 was 30,400 ppm and in 1967 was 29,000 ppm; observations during the intervening period show concentrations in the same general range but as high as 36,600 ppm. The water is of the sodium chloride type. Lithium and bromide concentrations are fairly high; iodide concentrations are especially high compared with those of other thermal springs in Utah.

The location of Stinking Hot Springs at the south end of Little Mountain and at the north margin of the saline marshes and mudflats along Great Salt Lake is shown in figure 10. The highly saline characteristics of both the surface and the

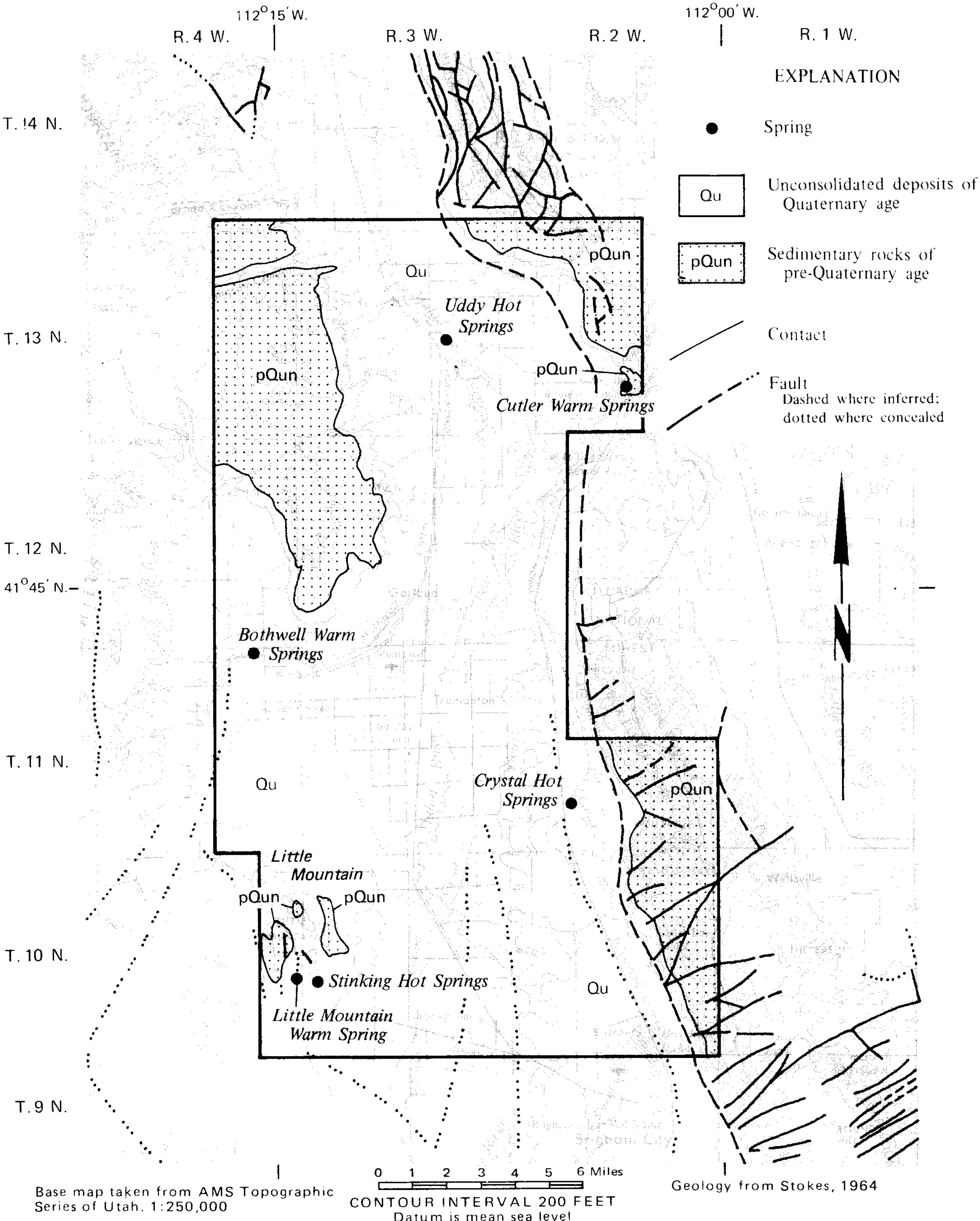


Figure 9. Map showing generalized geology in the vicinity of Stinking, Little Mountain, Crystal (Madsens), Cutler and Uddy Springs.

subsurface material through which the water moves results in the high dissolved-solids content of the spring water.

Crystal (Madsens) Hot Springs

Crystal (Madsens) Hot Springs, (B-11-2)29da-S, are in Box Elder County, about 10 miles north of Brigham City. The springs issue from rocks of Paleozoic age (figure 9) along the Wasatch fault zone. The temperature of the springs has remained fairly constant during the past 125 years. Fremont reported the temperature of these springs as 134° F in 1843, and Gilbert reported temperatures varying from 121° to 132° in 1872 (Lee and others, 1915, p. 108). Temperatures reported by U. S. Geological Survey personnel were 132° F in 1951, 124° F in 1952, and 127° F in 1966. As for most other thermal springs in Utah, the location of these hot springs is a major fault zone, the absence of evidence of nearby igneous activity of late Tertiary or Quaternary age, and the moderate temperature of the water suggest that the geothermal gradient is the cause of the high temperature of the water. Estimates of spring discharge have ranged from about 500 to about 1,800 gpm during a period of many years.

The dissolved-solids content of Crystal Hot Springs is higher than that for any other hot spring in Utah (table 1). The water is of the sodium chloride type; approximately 95 percent of the dissolved solids, by weight, are sodium and chloride.

The source of most of the spring discharge is believed to be deeply circulating water from the mountainous area east of the Wasatch fault zone. The high dissolved-solids content of the water probably results from the upward movement of the water through several thousand feet of unconsolidated valley fill in the immediate vicinity of the fault zone and from mixing of originally dilute deep water with highly concentrated interstitial brines in the unconsolidated sediments. A nearby slightly thermal spring has a temperature of 63° F, and a dissolved-solids content of about 1,500 ppm. This spring apparently rises along the same fault as do Crystal Hot Springs; the depth of water circulation is much less than for Crystal Hot Springs and does not appear to reach the saline deposits or the concentrated interstitial water that contributes to Crystal Hot Springs.

Figure 11 is an aerial photograph showing the general setting of the springs. The Wasatch Front is to the east and the Bear River is to the west. The springs form Salt Creek, which empties into the Bear River about six miles south of the springs.

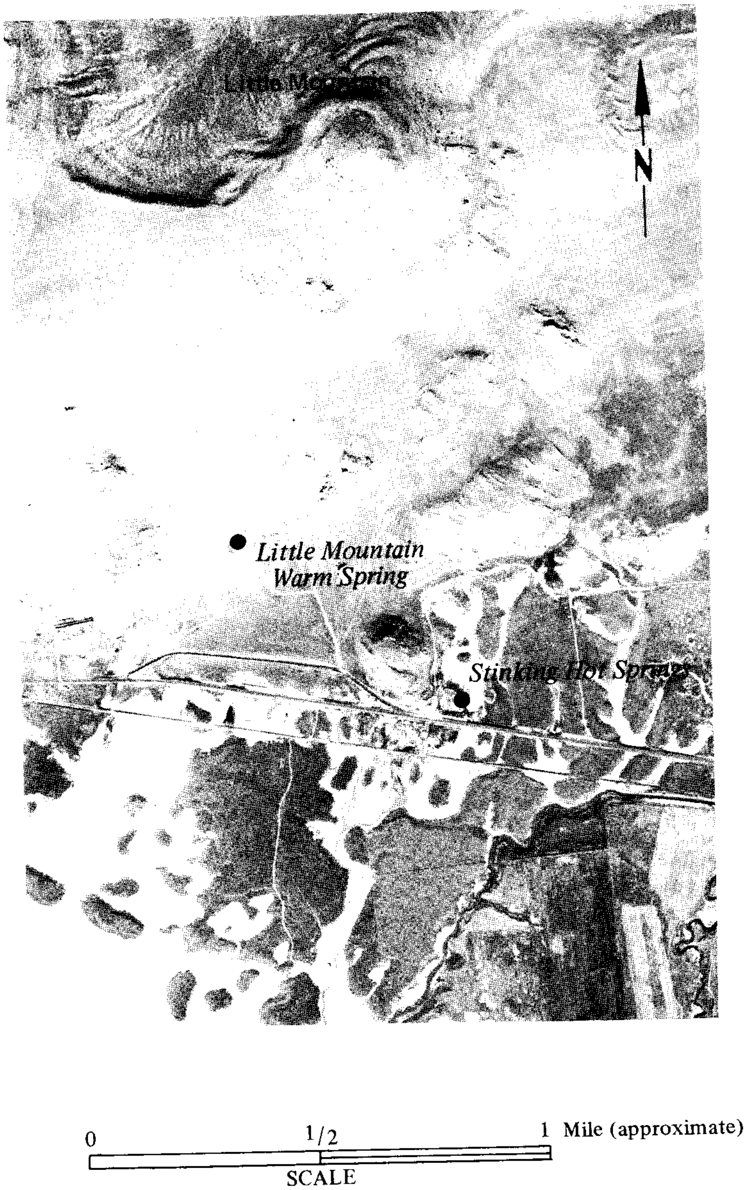


Figure 10. Aerial photograph of the area surrounding Stinking Hot Springs and Little Mountain Warm Spring. (Photograph by U. S. Geological Survey, November 1965.)

Warm Spring

Probably hundreds of springs and seeps occur in and along Grouse Creek and Raft

River Mountains of northwest Utah, but Warm Spring, (B-12-15)19aab-S1, in Box Elder County, is one of the few known thermal springs in northwest Utah. Carpenter (1913) stated that this spring has a perennial flow of about 2 cfs (900 gpm). Observations since then indicate that the discharge may fluctuate between 1 and 2 cfs (450 and 900 gpm).

Warm Spring issues from shattered quartzite of Precambrian age and from valley fill of Quaternary age at the base of Dennis Hill, a small mountain composed of Precambrian rocks. The altitude of the spring is about 5,720 feet; the altitude two miles north of the spring is 7,400 feet. A fault may extend under the valley fill in the vicinity of the spring.

A temperature of 80° F was measured at Warm Spring in 1966. If the source of the water is a high bedrock area immediately north of the spring, circulation of the water to a depth of only about 1,000 feet below the altitude of the surface of the valley fill could result in the temperature of 80° F; the geothermal gradient probably is the source of heat.

The dissolved-solids content of Warm Spring (214 ppm) is lower than that for any other thermal spring observed in Utah. The water is calcium bicarbonate chloride in type.

The extremely low dissolved-solids content, the relatively low temperature, and the absence of known intrusives or extrusives of Tertiary or Quaternary age within many miles of the spring indicate that the water is of local meteoric origin and probably is not circulated to any great depth below the altitude of the spring.

Uddy Hot Springs

Uddy Hot Springs, (B-13-3)23-S, are about one mile southwest of Plymouth, Box Elder County. The springs are a group of springs that issue from Paleozoic limestones at the small escarpment between the flood plain and the higher levels of the Malad River valley. Outcrops of limestone of Paleozoic age are within a few miles to the west and to the northeast of the springs (figure 9). The springs may issue in the vicinity of a fault concealed beneath the valley fill of Quaternary age.

The temperature of the water at different points of issue ranges from about 90° to 110° F. Reported discharge of the springs has ranged from about 2 to 8 cfs (900 to 3,600 gpm).

The dissolved-solids content of the water was moderately high (7,850 ppm), and the water is of the sodium chloride type. About 90 percent, by weight, of the dissolved solids is sodium chloride.

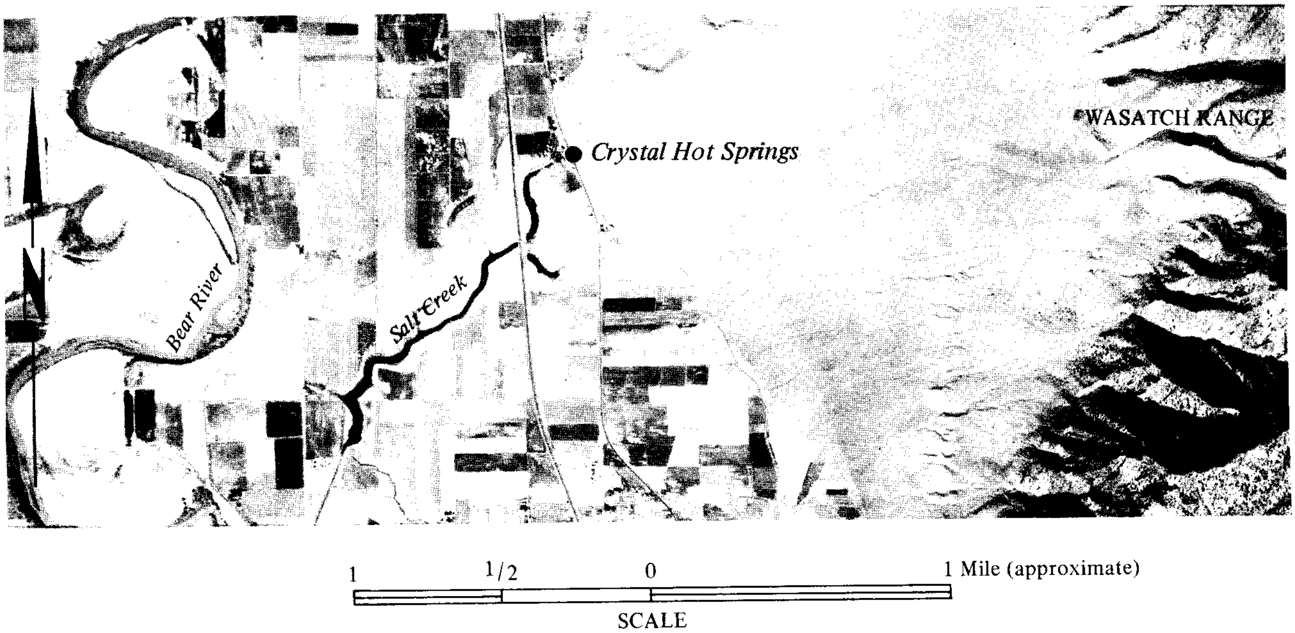


Figure 11. Aerial photograph of the area surrounding Crystal (Madsens) Hot Springs. (Photograph by U.S. Geological Survey, October 1956.)

No igneous rocks of late Tertiary or Quaternary age are known to occur within many miles of the springs; the source of the heat probably is the geothermal gradient. Circulation of meteoric water to a depth of several thousand feet probably results in heating of the water. The moderately high dissolved-solids content may result from solution of minerals during circulation of the water and from mixing of the deeply circulated water with brines at unknown depth.

Blue Warm Springs

Blue Warm Springs, (B-13-5)29-S, are about 17 miles northwest of Tremonton, Box Elder County. The springs apparently issue from rocks of Paleozoic age. Weathered limestone was observed in an excavation at the springs (B. L. Bridges, U. S. Soil Conservation Service, oral communication, 1969), and faulted rocks of Paleozoic age crop out about one mile southeast of the springs. Volcanic rocks of late Tertiary age crop out about five miles northwest of the springs. The springs are at the head of Blue Creek Reservoir (figure 12) and are submerged when the reservoir is filled to maximum storage capacity.

The temperature of the water ranges from about 80° to 86° F. Deep circulation of meteoric water and emergence of the water from a fault beneath the valley fill may explain the location and temperature of the springs; the source of heat probably is the geothermal gradient. The significance of volcanic rocks of late Tertiary age within five miles of the springs is not known.

The dissolved-solids content probably ranges from about 1,800 to 2,000 ppm; the water is of the sodium chloride type. Milligan and others (1966, table 1) reported that the dissolved-solids content of Blue Warm Springs was 1,923 ppm, the specific conductance was 3,580 micromhos per centimeter, and the discharge was 7.6 cfs (3,400 gpm) on September 10, 1964. On February 20, 1968, U. S. Geological Survey personnel measured specific conductance of 3,150, 3,020, 3,460, and 3,340 micromhos per centimeter at four different points in the spring area; the measured discharge from the spring area was 8.4 cfs (3,780 gpm). The source of the dissolved solids is not known.

Warm Springs along the West Side of the Stansbury Mountains

From Big Warm Springs, (C-1-7)8-S and (C-1-7)9-S, on the north to springs known locally as Iosepa Springs, (C-3-8)10-S and (C-3-8)15-S, on the south are several warm springs along the western flank of the Stansbury Mountains. Included are Burnt Springs, (C-2-7)6-S, Muskrat Spring, (C-2-8)13dcb-S1, and Horseshoe Springs, (C-2-8)26dab-S1, which are not, however, considered to be major thermal springs. All these springs are in Tooele County. A fault buried beneath unconsolidated sediments of Quaternary age is indicated by the series of springs. Although outcrops of volcanic rocks of early Tertiary age occur a few miles east of Iosepa Springs, the source of the heat is believed to be the geothermal

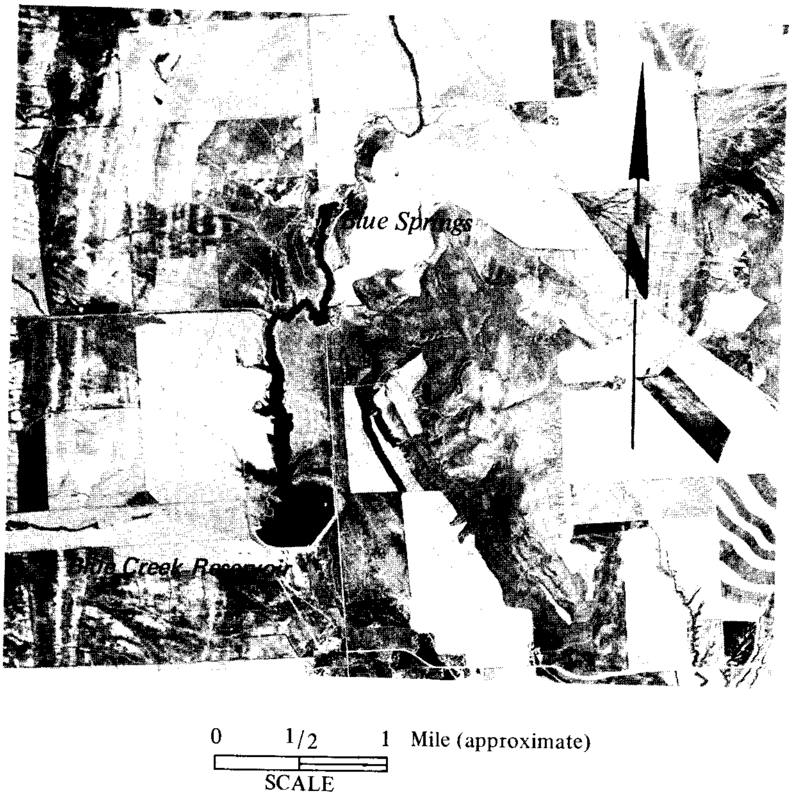


Figure 12. Aerial photograph of the area surrounding Blue Warm Springs. (Photograph by Army Map Service, May 1953.)

gradient. Spring temperatures range from about 61° to 75° F. If some or most of the spring discharge is meteoric water that infiltrates faulted rocks of Paleozoic age at altitudes of 6,000-9,000 feet in the nearby Stansbury Mountains, downward movement of the water to the altitude of the springs (4,200-4,300 feet) could result in the observed temperatures.

Dissolved-solids content of the springs ranges from about 2,000 ppm for Muskrat Spring to about 8,500 ppm for Big Warm Springs. The water is of the sodium chloride type. Most of the dissolved-solids content probably results from solution of saline minerals of the unconsolidated sediments of Quaternary age and possibly from small additions of concentrated interstitial brines in these sediments. Estimated and measured discharges of Big Warm Springs have ranged from about 7 to 10 cfs.

The similar temperatures and chemical characteristics of the series of springs suggest that they have similar depths of circulation and similar sources of dissolved solids.

Grantsville Warm Springs

Grantsville Warm Springs, (C-2-6)16aad-S1, are about three miles northwest of Grantsville, Tooele County. The springs discharge from lakebed sediments of Quaternary age on the mudflats of Great Salt Lake. The combined discharge of the several small springs which compose Grantsville Warm Springs is about 400 gpm. Temperature of the water ranges from about 75° to about 90° F. Volcanic rocks of early Tertiary age crop out about five miles southwest of the springs but probably are not directly related to the source of heat for the water; the source of heat probably is the geothermal gradient. A buried fault in the vicinity of the springs probably is the escape route of water that infiltrates the faulted rocks of Paleozoic age at altitudes of 5,000-8,000 feet in the Stansbury Mountains. If the water descends to depths of 3,000-5,000 feet below the upland surface before moving upward along a fault, the observed temperatures would result.

Dissolved-solids content of the water is high—about 25,000 ppm. Solution of saline deposits that overlie the buried fault and some mixing with concentrated interstitial brines probably result in the high dissolved-solids content of the water. The water is of the sodium chloride type; about 96 percent of the dissolved-solids content, by weight, is sodium chloride. Spectrographic analysis for 17 minor elements show that only zinc is high relative to other thermal springs.

Crystal Hot Springs

Crystal Hot Springs, (C-4-1)11-S and (C-4-1)12b-S, are about 20 miles south of Salt Lake City, Salt Lake County. The springs issue from unconsolidated valley fill at the south end of Jordan Valley (figure 13); the water may rise through the fill along a fault. Volcanic rocks of Tertiary age underlie the fill and crop out about three miles southwest of the springs.

Richardson (1906, p. 48) states, "About 4 miles southwest of the town of Draper, in sec. 12, T. 4 S., R. 1 W., at some distance from the base of the mountains, there are four warm-water lakes that are fed by springs, some of which are said to be quite hot. The westernmost of the group is the largest and covers an area of about five acres. The temperature is reported to remain at about 70° [F] the year around." Taylor and Leggette (1949, p. 36) state, "A group of springs in the NE¼ sec. 11 and NW¼ sec. 12, T. 4 S., R. 1 W., Salt Lake Base and Meridian, yield hot water and are known as Crystal Hot Springs... The natural discharge from the lower group was 1.44 cubic feet per second on June 30, 1934. The temperatures of three of the springs in the higher, or easterly, group on June 30, 1934, were 112°, 132°, and 137° F." Heylmun (1966, p. 15) reports that "up to 60 gpm" issue from Crystal Hot Springs and that most temperatures observed have been less than 100° F. Milligan and others (1966, p. 28) report that the combined flow of the springs was estimated as 45 gpm in August 1964 and as 60 gpm in September 1964; temperatures were found to range from 122° to 137° F—the same as observed by Taylor and Leggette (1949) in 1934.

The volcanic rocks of Tertiary age that underlie the alluvium at depths of about 700 feet in the vicinity of Crystal Hot Springs are probably the source of most of the heat, although additional heat probably is derived from the geothermal gradient.

Dissolved-solids content of the springs has ranged from about 1,300 to 1,700 ppm since the first analysis was reported for a sample obtained in

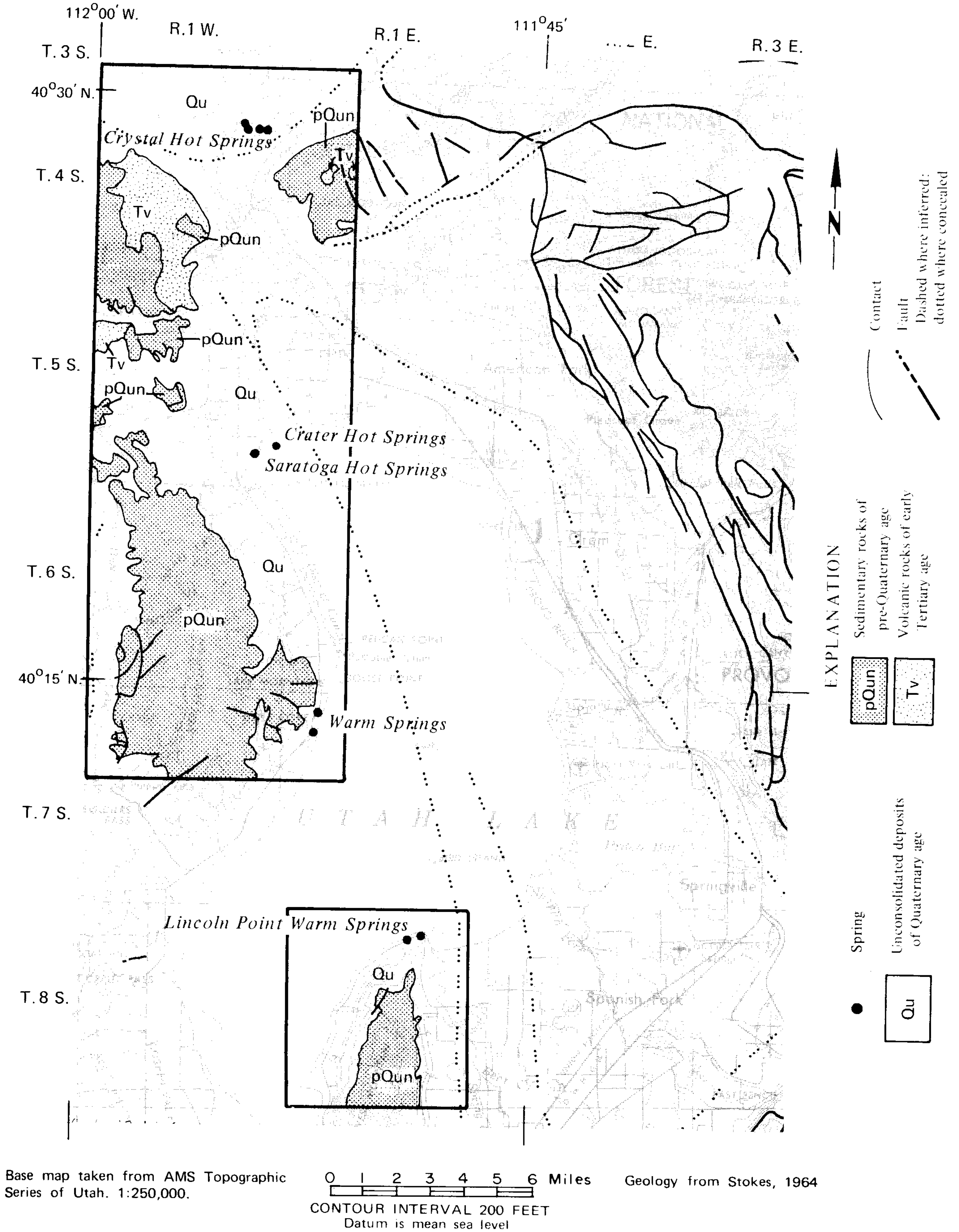


Figure 13. Map showing generalized geology of thermal springs in the vicinity of Utah Lake.

1882. The water, which is meteoric in origin, is of the sodium chloride type, although calcium and bicarbonate are present in appreciable amounts.

Several small warm springs issue in secs. 22, 23, and 26, T. 4 S., R. 1 W., in the vicinity of the Jordan Narrows and about 2-4 miles south of Crystal Hot Springs. These small warm springs have temperatures of less than 80° F and dissolved-solids contents that are much less than that of Crystal Hot Springs.

Saratoga Hot Springs

Saratoga Hot Springs, (C-5-1)25cd-S, issue from unconsolidated deposits of Quaternary age along the shore at the northwest corner of Utah Lake (figure 13). Hot springs, known locally as Crater Hot Springs, (C-5-1)25-S, issue beneath the surface of Utah Lake about half a mile east of Saratoga Hot Springs. Both springs are in Utah County. Richardson (1906, p. 49) reported that the springs used by the Saratoga resort had a temperature of 111° F in 1904. Infrequent observations since then show that the temperature has remained between 100° and 111° F. Volcanic rocks of Tertiary age crop out about five miles north of these springs but are not believed to be a source of heat for the water; the source of the heat probably is the geothermal gradient. Deep circulation of meteoric water probably results in the heating of the water. A northwest-trending fault along the west margin of Utah Lake is believed to control the location of the springs along the northwest side of Utah Lake.

A. B. Purton (written communication, 1934) reported that he measured the discharge of the largest of the usually submerged Crater Hot Springs during a low stage of the lake in 1933; the discharge was 0.43 cfs. The total discharge of all thermal springs in and along the northwest part of Utah Lake is not known but probably is only a few cubic feet per second.

Dissolved-solids content of Saratoga and Crater Hot Springs ranges from about 1,400 to 1,500 ppm; the water is of a calcium sodium sulfate chloride type. As with most thermal springs in Utah, silica concentration is low.

The water from Saratoga Hot Springs is presently used for a bathing resort.

Morgans and Russells Warm Springs

Morgans, (C-5-5)9cba-S1, and Russells, (C-5-5)17aaa-S1, Warm Springs are about 12 miles southwest of Tooele, in Tooele County. These springs issue from valley fill of Quaternary age at the base of an outcrop of rocks of late Paleozoic age. The isolated outcrop rises to an altitude about 300 feet higher than that of the springs. The springs are in Rush Valley and are about midway between crests of the Oquirrh Mountains on the east and the Stansbury Mountains on the west.

Observed spring temperatures during 1964-67 ranged from 75° to 80° F at Morgans Warm Springs. Observed temperatures at Russells Warm Springs were 71° and 72° F during the spring of 1966; a temperature of 100° F was reported during July 1967, but this temperature may reflect surface heating when air temperatures exceeded 100° F.

Spring discharges at both springs are somewhat variable. At Morgans Warm Springs, discharges ranging from about 500 to 1,000 gpm have been reported. At Russells Warm Springs, discharges ranging from less than 100 to about 600 gpm have been reported.

The dissolved-solids content of Morgans Warm Springs is about 580 ppm and of Russells Warm Springs is about 440 ppm. Water from Morgans Warm Springs is of the sodium chloride type, and water from Russells Warm Springs is of the sodium calcium chloride bicarbonate type. The higher mineralization of Morgans Warm Springs is due mainly to additional sodium chloride. Spectrographic analyses of samples obtained from Morgans Warm Springs during 1964 and 1966 show that the cobalt concentration (49 micrograms per liter for the latter sample) was higher than that observed for any other thermal spring in Utah.

The relatively low temperatures of the water, the low dissolved-solids content, and the relatively high discharge suggest that meteoric water circulates to depths of 3,000-4,000 feet in the surrounding mountains and is warmed by the geothermal gradient. A fault buried beneath the valley fill in the vicinity of the springs probably is the channel through which the water moves upward into the fill. The springs issue at the edge of a depression that forms the lowest part of Rush Valley.

Fish Springs Group

The Fish Springs group is in Juab and Tooele Counties, about 55 miles northwest of Delta. Wilson Hot Springs, (C-10-14)33-S, Big Spring, (C-11-14)3-S, and Fish Springs, (C-11-14)23-26-S, are included in the Fish Springs group in this report. The actual spring locations are difficult to determine accurately because of the terrain, and some sources describe Wilson Hot Springs as (C-11-14)3-S and Big Spring as (C-11-14)2-S. The physical setting of the Fish Springs group is shown in figure 14. Big Spring is about one mile southeast of Wilson Hot Springs, and the center of the Fish Springs is about three miles south-southeast of Big Spring.

Wilson Hot Springs consist of several springs that issue along a northeast-trending line that extends about half a mile into the Great Salt Lake Desert from the base of the Fish Springs Range. The springs issue from soft tufa mounds formed on valley fill of Quaternary age. The springs probably rise along a fault buried beneath the valley fill. Fish Springs Range, which is composed of faulted sedimentary rocks of Paleozoic age (figure 15), extends southward from Wilson Hot Springs and has altitudes more than 4,000 feet higher than those of the springs along the northeast base of the mountains. In July 1967, the temperature of the hottest measured spring in the group was 141° F at the edge of the pool and 168° F in the center of the pool; the estimated discharge was 100 gpm. The dissolved-solids content of these springs, which issue at the southern margin of Great Salt Lake Desert, is about 22,000 ppm; about 83 percent of the dissolved solids, by weight, is sodium chloride.

The discharge of Wilson Hot Springs probably is meteoric water that has circulated to depths of several thousand feet through the fault system of the Fish Springs Range. As the heated water moves up through highly saline lakebed sediments, either large quantities of salts are dissolved or relatively dilute hot water mixes with concentrated interstitial brines of the sediments. If a geothermal gradient of 1° F for each 100 feet of depth is assumed, circulation to a depth of about two miles would be required if the water does not cool as it moves upward and does not mix with cool shallow water. In this area, however, the geothermal gradient may be abnormally high. Volcanic rocks of late Tertiary age crop out about eight miles southeast and about 10 miles southwest of the springs, and a large intrusive igneous body of late Tertiary age crops out about 15 miles northeast of the springs. Although these igneous rocks probably are not the direct source of the heat, they may indicate the possibility that the geothermal gradient is as high as 1° F for each 50 feet or less of depth in the area surrounding the springs.

Both Big Spring, (C-11-14)3-S, and Fish Springs, (C-11-14)23-26-S, appear to be associated with the same fault zone, but not necessarily the same fault, that results in Wilson Hot Springs. The discharges of Big and Fish Springs have much lower temperatures than those for Wilson Hot Springs. Temperatures of these two springs range from about 65° to 82° F, and the dissolved-solids content is about 1,800 ppm for Fish Springs. The water is of the sodium chloride type; only about 60 percent of the dissolved solids, by weight, is sodium chloride compared to about 83 percent sodium chloride in Wilson Hot Springs. The total discharge of all springs in the Fish Springs group probably varies from less than 40 cfs to more than 60 cfs seasonally and from year to year. The relatively low temperature and dissolved-solids content of Fish Springs indicate that the water does not circulate to great depths and that the water does not have appreciable exposure to a saline environment, as compared to the water issuing from Wilson Hot Springs.

Abraham (Crater) Hot Springs

Abraham (Crater) Hot Springs, (C-14-8)10-S and (C-14-8)15-S, are in Juab County, about 18 miles north-northwest of Delta. These springs issue from a tufa mound about 15 feet high and several hundred feet in diameter on the floor of the Sevier Desert along the east side of a Quaternary basalt flow having a maximum extent of about six miles from east to west and about nine miles from north to south (figure 15).

Gilbert (1890, p. 332-333) reported that "A basaltic mesa five miles across in either direction is half divided by a valley opening to the northeast... At its head this valley is a mile wide, and is floored by red scoriae. In it stands a rough tower about 160 feet high with a truncated and obscurely crateriform summit... The tower, Fumarole Butte, marks the position of the volcanic vent... About the outer edge of the summit are thirty to forty crevices from which warm, moist air gently flows... In different openings I found the temperatures 62°, 70°, 72°,

Figure 14. Aerial photograph of the area surrounding the Fish Springs group. (Photograph by Army Map Service, June 1953.)

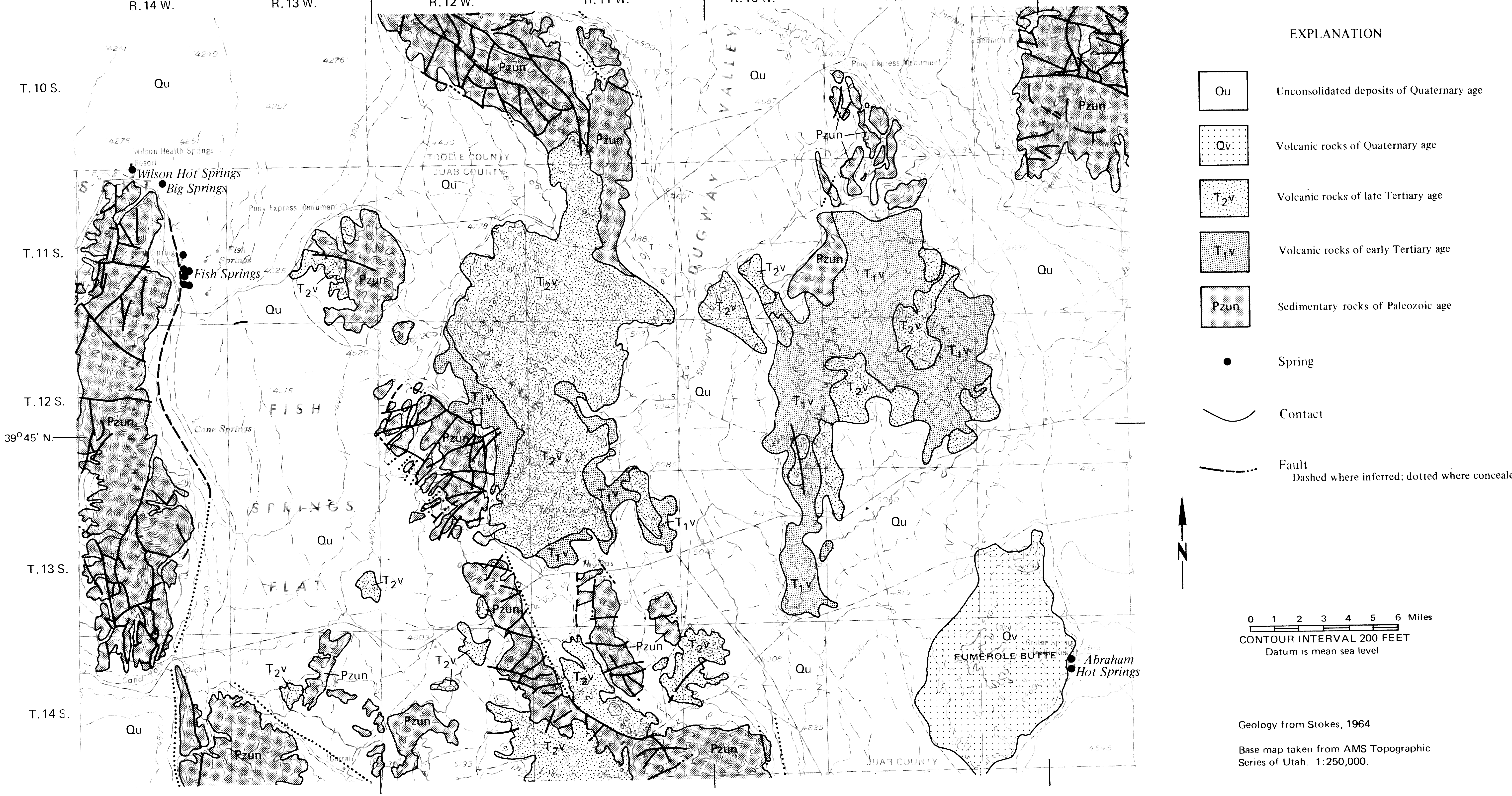


Figure 15. Map showing generalized geology in the vicinity of and between Fish Springs and Abraham (Crater) Hot Springs.

Figure 16. Aerial photograph of the area surrounding Abraham (Crater) Hot Springs. (Photograph by Army Map Service, June 1953.)

and 73.5° Fahr., all above the atmospheric mean for the locality, which is approximately 55°. At the time of observation the outer air had a temperature of 30°, and was dry... It can hardly be doubted that this thermal manifestation testifies to a residuum of volcanic heat in the old flue."

Water temperatures near the center of the spring area are about 180° F. In August 1964, one small spring had a temperature of 189° F and a discharge of about 20 gpm. In July 1967, temperatures were 180° F in the center of the spring area; springs near the margins of the area had temperatures of 162° and 148° F. In July 1967, the total discharge from all springs was estimated to be only about 250 gpm. Because the springs occur over a fairly large area, accurate information on discharge is difficult to obtain. In April 1938, U. S. Geological Survey personnel estimated the total discharge to be between about 700 and 900 gpm (H. E. Thomas, written communication, 1938). Other estimates of discharge have ranged as high as 5,000 gpm. The water probably is meteoric in origin and has circulated to relatively great depth. The water may have been heated by a high geothermal gradient or by contact with a cooling volcanic body. Conduits in the volcanic flow or concealed faults in the vicinity of the springs may furnish the avenues for deep circulation and emergence of the water.

The water is of the sodium chloride type, although calcium and sulfate are present in significant amounts. Calcium, in equivalents per million, is about half that of sodium, and sulfate is about a third that of chloride. Dissolved-solids content ranges from about 3,200 to 3,800 ppm. Although the spring area has been prospected for manganese (Callaghan and Thomas, 1939), spectrographic analyses indicate that this element is not especially abundant in the water.

Abraham Hot Springs is not important as a water resource; the water is unsuitable for most uses because of its chemical characteristics. The absence of boiling temperatures, the low silica concentrations, and the large water discharge during some periods indicate that test drilling would be necessary to determine if temperature increase with depth is sufficient to sustain an economically feasible geothermal development. A large water discharge suggests large loss of heat by rapidly circulating water during long periods of time; thus the subsurface temperature of the heat reservoir may be much cooler than it would have been if water discharge were small.

Gandy Warm Springs

Gandy Warm Springs, (C-15-19)31bc-S, are in extreme northwest Millard County, about three miles from the Utah-Nevada State line. These springs issue along the southern base of a hill that is several hundred feet higher than the springs and that consists of faulted limestones of Cambrian age. The major springs issuing from the limestone appear to be centered along vertical joints in the limestone.

Meinzer (1911, p. 131) reported that the water temperature from the largest vents was 81.5° F. Other U. S. Geological Survey personnel reported temperatures of 81° F in 1955, 1964, and 1966.

Milligan and others (1966, p. 15) reported that a flow of 21 cfs is perennial. Hood and Rush (1965, table 9), however, estimated the flow to be 8 cfs on November 3, 1964; and on July 12, 1967, U. S. Geological Survey personnel estimated the flow to be less than 20 cfs.

The dissolved-solids content of the springs is only about 300 ppm. The water is of the calcium magnesium bicarbonate type and is of excellent quality; it is used to irrigate a few hundred acres in the vicinity of Gandy.

The heating undoubtedly is caused by the normal geothermal gradient. Circulation of meteoric water to a depth of only about 2,000 feet could result in the observed temperatures. The large discharge of the spring and the low dissolved-solids content suggest rapid movement of the water and little loss of heat as the water moves to the point of issue.

Meadow and Hatton (Black Rock, Wiwepa) Hot Springs

Meadow, (C-22-6)26ccc-S1 and (C-22-6)27ddd-S1, and Hatton (Black Rock, Wiwepa), (C-22-6)35ddb-S1, Hot Springs are about five miles northwest of Kanosh and about five miles southwest of Meadow in Millard County. These springs issue from valley-fill deposits of Tertiary or Quaternary age. Basalt flows of Quaternary age are only about three miles north of the springs; basalt flows of late Tertiary age are about three miles west of the springs and in the vicinity of Black Rock Volcano about three miles south of the springs (figure 17).

Temperature of the water of Meadow Hot Springs was 84° F in May 1966 and was 106° F in May 1967; a discharge of 60 gpm was estimated in 1957. Hatton Hot Springs have not flowed for several years; the temperature of the water was 100° F in 1957.

Chemical data obtained during the past 25 years at Meadow Hot Springs show that the dissolved-solids content has ranged from 4,690 to 4,900 ppm and that the water is of the sodium chloride type. In equivalents per million, calcium is about half that of sodium, and sulfate is about half that of chloride. The germanium content of a sample obtained in May 1966 was fairly high (571 μg/l), but the germanium content of two other samples obtained during 1966 and 1967 was not especially high. Bromide (400 μg/l), iodide (450 μg/l), and cobalt (20 μg/l) were fairly high in a sample obtained in May 1967. Silica concentration did not exceed 50,000 μg/l in any sample analyzed.

Some heat undoubtedly is furnished by the nearby volcanic flows of late Tertiary and Quaternary age. The dissolved-solids content of water at Meadow and Hatton Hot Springs (4,670-4,900 ppm) is somewhat similar to that of the ground water in the

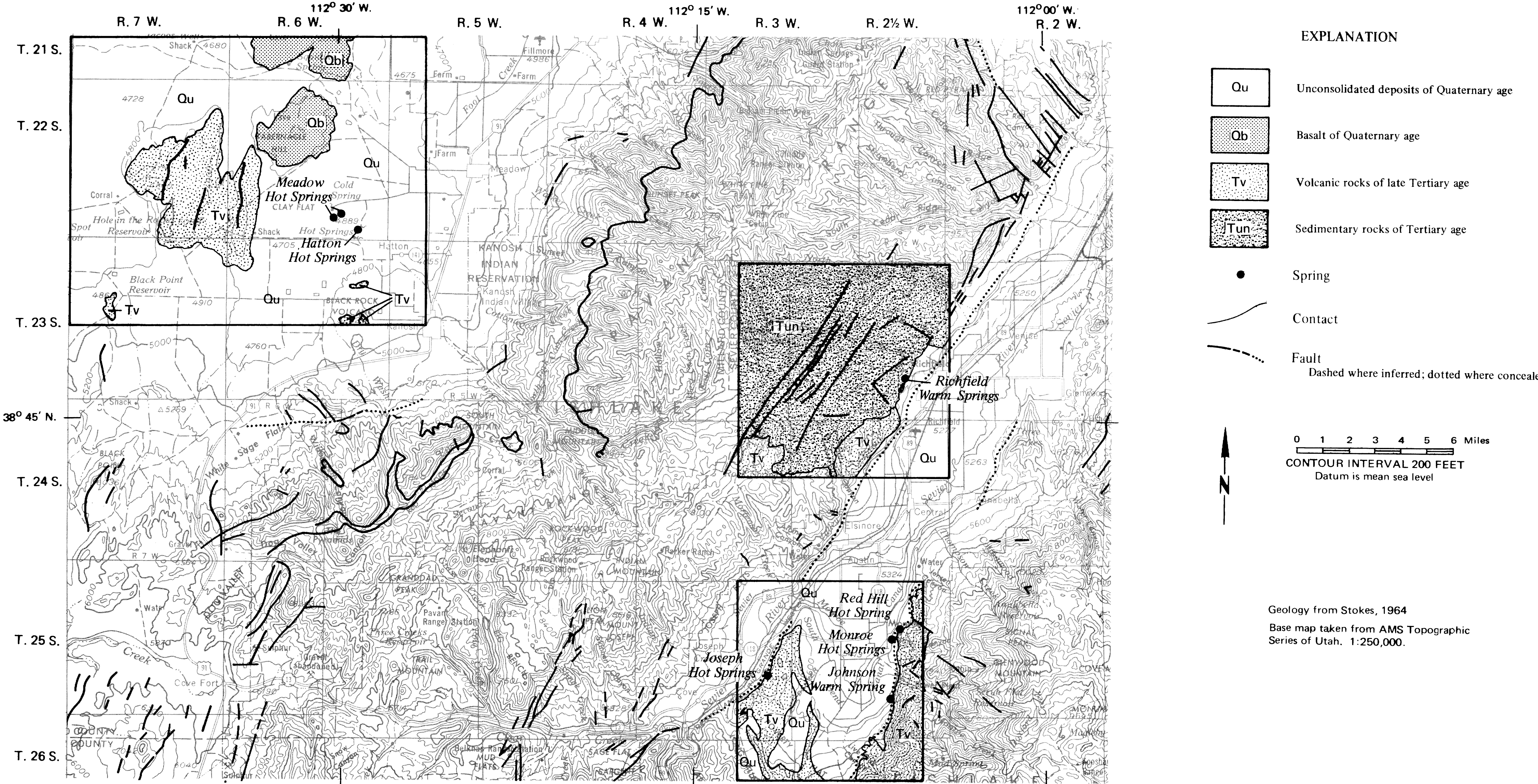


Figure 17. Map showing generalized geology in the vicinity of Meadow and Hatton Hot Springs, Richfield Warm Springs, and central Sevier Valley group.

general area of the springs. Water from a well about five miles northeast of the springs has a dissolved-solids content of 6,970 ppm, water from two wells about three miles southwest of the springs has dissolved-solids contents of 4,430 and 4,490 ppm, and water from a well about three miles south of the springs has a dissolved-solids content of 8,050 ppm. The depths of these wells range from 100 to 527 feet. If ground water similar to that found in the described wells were in contact with the volcanic flows or were circulated to a depth of 3,000 feet, water having the chemical and thermal characteristics of the hot springs would result.

Despite the proximity of volcanic rocks of late Tertiary and Quaternary age, the immediate area of the springs appears to be of questionable geothermal potential. The relatively low temperature of the spring water, the low silica content, and the similarity in chemical quality of the spring water and the ground water in a fairly large surrounding area are not favorable indicators of a large increase in temperature at fairly shallow depth.

Richfield Warm Springs

Richfield Warm Springs, (C-23-3)26aca-S1, are about half a mile west of Richfield in Sevier County. These springs issue at a fault contact between alluvium and sandstones of Tertiary age in the Elsinore fault zone along the west side of the Sevier River valley (figure 17). Numerous faults occur in the eastern part of the Pavant Range, which is immediately west of the springs. Volcanic rocks of late Tertiary age crop out about two miles south of the springs and extend for many miles southwestward along the west side of the Sevier River valley; similar outcrops are common along the east side of the valley.

Richardson (1907, p. 58) reported that spring discharge was 1,440 gpm and that water temperature was 74° F. In June 1966, discharge was 700 gpm and water temperature was 72° F. Dissolved-solids content of the springs is low—about 300 ppm; the water is of the magnesium calcium bicarbonate type.

The presence of numerous faults in the mountains one to five miles west of the springs, the large discharge of the springs and the low dissolved-solids content indicate that the spring discharge is meteoric water that descends not more than 2,000-3,000 feet and is heated slightly by the geothermal gradient. The altitude in some areas of possible infiltration is more than 2,000 feet higher than that of the springs. The geothermal gradient within the mountains is sufficient to raise the temperature of the water 15°-20° F. The springs probably issue where water moving out of the mountain mass is intercepted by the Elsinore fault zone. The springs are a main source of municipal water supply for the city of Richfield.

Central Sevier Valley Group

The central Sevier Valley group of springs issue along the east side of the Sevier River valley, about 10 miles south of Richfield in Sevier County. Monroe (Cooper) Hot Springs, (C-25-3)10dda-S1 and (C-25-3)15a-S; Red Hill Hot Spring, (C-25-3)11cac-S1; Johnson Warm Spring, (C-25-3)27a-S; and Joseph Hot Springs, (C-25-4)23-S, are included in the central Sevier Valley group in this report. Monroe and Red Hill Hot Springs and Johnson Warm Spring issue from the Sevier fault; Joseph Hot Springs issue from the Dry Wash fault about five miles west of the Sevier fault (figure 17). Volcanic rocks of late Tertiary age occur within one mile of all except Johnson Warm Spring.

Monroe Hot Springs issue from a single tufa mound that extends for about half a mile along the mountain front; the width of the mound is about 600 feet from the mountain front to the base, and the height is 75-100 feet. The springs issue from seepage zones and from fissures and cracks that have been enlarged by local residents to increase the spring yield. Discharge is at two major points—one near the center of the mound and the other at the base. The largest spring on the mound discharges about 50 gpm; water temperature was 148° F on February 13, 1967. The other large spring discharges about 40 gpm from the base of the mound; water temperature was 106° F. Several small springs discharge from the surface of the mound. The total discharge of Monroe Hot Springs was about 150-200 gpm on February 13, 1967. In addition to the visible discharge from the springs, some water evaporates directly from the mound surface; saturated areas high on the mound above the spring areas and extending to the mountain front indicate that artesian pressure is forcing water to the surface of the mound.

Red Hill Hot Spring issues from a tufa mound about 600 feet long, 200-300 feet wide, and about 50 feet high. The only spring that issues from the mound discharges as much as 150 gpm from a crevice in the north-central part of the mound. The water temperature was 167° F on February 13, 1967; a temperature of 169° F was reported for "Monroe Hot Springs" (Carpenter and Young, 1963, p. 17), but this temperature actually was for Red Hill Hot Spring.

Johnson Warm Spring issues along the Sevier fault about two miles south of Monroe Hot Springs. Richardson (1907, p. 58) reported a flow of 180 gpm and a temperature of 80° F. In April 1967, U.S. Geological Survey personnel reported a flow of 10 gpm and a temperature of 77° F.

Both Monroe and Red Hill Hot Springs have dissolved-solids contents ranging from about 2,600 to 2,900 ppm and are of the sodium sulfate chloride type. Johnson Warm Spring has a much lower dissolved-solids content and is of the calcium sulfate type. One of the small springs in the Monroe Hot Springs showed a high manganese content (346 μg/l). Johnson Warm Spring had one of the highest molybdenum contents (18 μg/l) of all thermal springs in Utah.

Joseph Hot Springs issue from tufa deposited by the springs over the Dry Wash fault. Extensive areas of volcanic rocks crop out immediately east of the fault. Water temperatures of 145° and 148° F were measured in 1966 and 1967. Discharge of the springs probably averages 30 gpm. Dissolved-solids content of Joseph Hot Springs ranges between about 5,000 and 5,200 ppm—nearly double that of Monroe and Red Hill Hot Springs. The water is of the sodium chloride type. The concentration of calcium is about the same for Monroe, Red Hill, and Joseph Hot Springs; sulfate is somewhat greater in Joseph Hot Springs than in Monroe and Red Hill Hot Springs. In Joseph Hot Springs, chloride (in equivalents per million) is nearly double that of sulfate; but in Monroe and Red Hill Hot Springs, chloride and sulfate are about equal (in equivalents per million).

The presence of volcanic rocks of late Tertiary age along the faults from which Monroe, Red Hill and Joseph Hot Springs issue indicates that these rocks probably contribute to the heating of the water. They may be a direct source of heat for some of the water, and the volcanic activity that resulted in these rocks may have resulted in an abnormally high geothermal gradient. The depth of circulation and the amount of dilution by cool shallow ground water are not known. The major faults certainly furnish the avenues of escape for the water that enters the earth's surface at altitudes much higher than those of the springs, but the depth of circulation in the fault zone is unknown.

Roosevelt (McKeans) Hot Springs

Roosevelt (McKeans) Hot Springs, (C-26-9)34dcb-S1, are in Beaver County, about 12 miles northeast of Milford and about 20 miles northwest of Beaver. Lee (1908, p. 20) reported that the largest of the springs in Roosevelt Hot Springs had a discharge of about 10 gpm, and that the temperature at the pipe leading from the spring was 190° F. He also stated that much of the silica contained in solution as the boiling water issued from the rocks was deposited as the water cooled. U. S. Geological Survey personnel reported a discharge of 1 gpm and a temperature of 185° F in November 1950 and reported a temperature of 131° F in September 1957. In May 1966 the spring was dry and appeared not to have discharged for several years.

Intrusive rocks of Tertiary age crop out immediately east of the former springs, and volcanic rocks of late Tertiary age crop out less than two miles southeast of the springs (figure 18). The springs issued from a fault zone along the west side of the Mineral Mountains. The heating of the water, probably of meteoric origin, may have been caused by contact with volcanic rocks or by an abnormally high geothermal gradient in the area where both intrusive and extrusive rocks of Tertiary age are common.

Lee (1908, p. 20 and 50) reported a dissolved-solids content of only 645 ppm and a discharge of 10 gpm. In 1950 the dissolved-solids content was 7,040 ppm at a measured discharge of 1 gpm. In 1957 the dissolved-solids content was 7,800 ppm. Lee's data show that the water was of the sodium sulfate chloride type; silica concentration (101 ppm) exceeded that of any single ion. In 1950 and 1957, the highly mineralized water was sodium chloride in type; silica content was very high (405 and 313 ppm). The analysis of a sample obtained in 1957 shows fairly high concentrations of boron and fluoride. The source of the dissolved solids is not known. If Lee's data are reliable, the spring discharge showed about a tenfold increase in dissolved-solids content with a tenfold decrease in discharge during a 50-year period. Lee (1908, p. 20) states that "the water contains a large amount of mineral in solution, as shown by the analysis in table 9"; but the data in table 9 of Lee's report do not show an especially "large amount of mineral in solution."

The very high silica concentrations indicate a possibility of marked increase in temperature with depth. The lack of spring flow during the past 10 years and the lack of information on the possible presence of a reservoir rock indicate that the geothermal potential of the area can be evaluated only by intensive subsurface exploration.

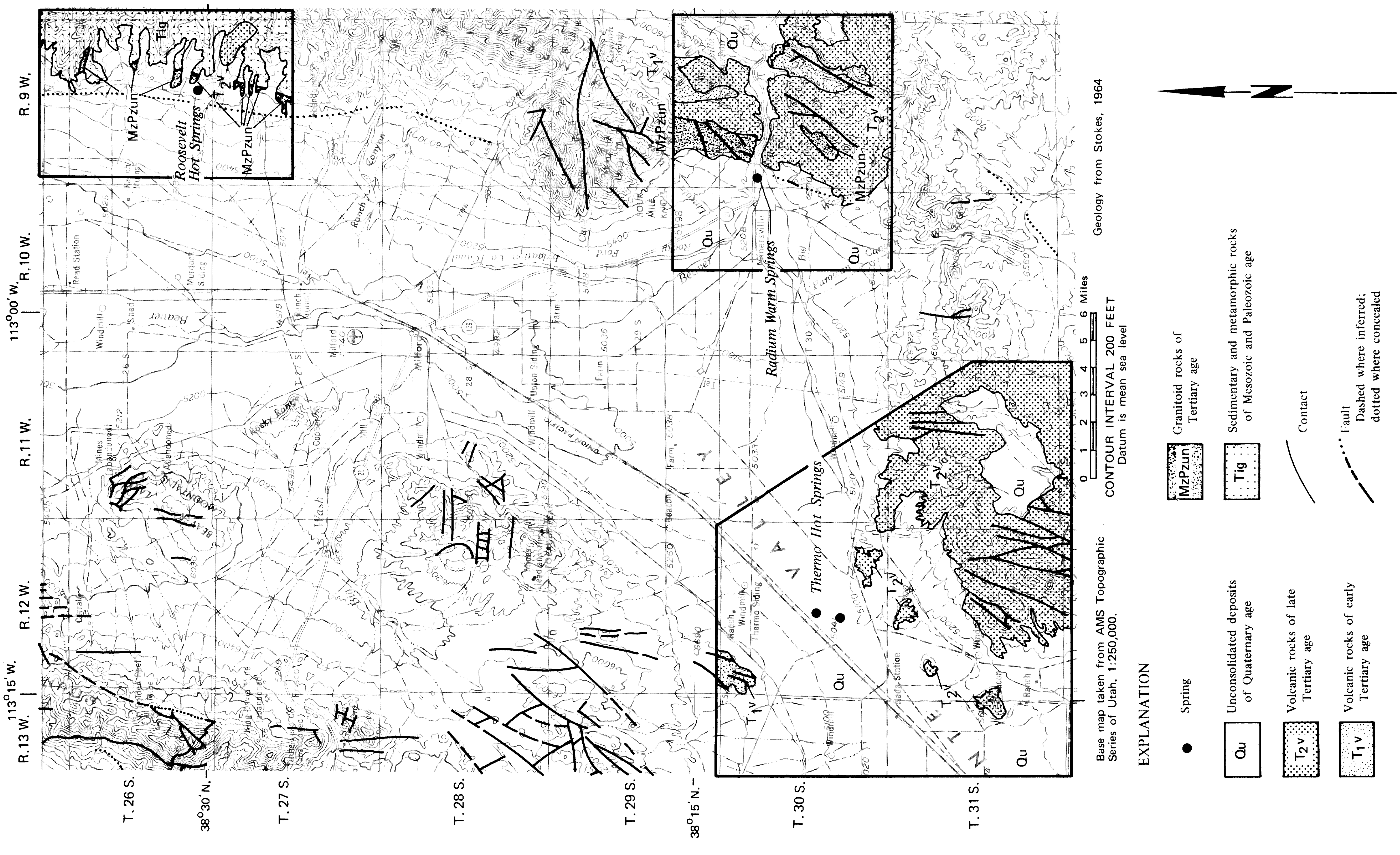


Figure 18. Map showing generalized geology in the areas surrounding Roosevelt (McKeans), Radium (Dotsons), and Thermo Springs.

Radium (Dotsons) Warm Springs

Radium (Dotsons) Warm Springs, (C-30-9) 7aca-S1, issue from a seepage zone about 300 feet long along the south bank of the Beaver River about one mile east of Minersville in Beaver County. The springs issue from alluvium, but the source of the water probably is the faulted sedimentary rocks of Paleozoic age immediately northeast of the springs. Large areas of pyroclastic rocks of late Tertiary age are within one mile of the springs (figure 18).

Lee (1908, p. 21) reported that the discharge of the springs was 57 gpm and the temperature of the water was 97° F. On July 11, 1967, U. S. Geological Survey personnel measured a water temperature of 89° F and estimated that the total discharge from the spring zone was 100 gpm.

Chemical data obtained during 1963-67 show that the dissolved-solids content ranged from 956 to 1,020 ppm, that the water was of the sodium calcium sulfate type, that fluoride concentrations were moderately high, and that silica concentrations were low.

The altitude of the faulted mountains within a few miles of the springs is 2,000-3,000 feet higher than that of the springs. The presence of volcanic rocks of late Tertiary age in the vicinity of the springs suggests that the source of heat may be either volcanic or an abnormally high geothermal gradient in the zone of faulted sedimentary rocks adjacent to the volcanics. The spring discharge undoubtedly is meteoric water that infiltrates the faulted or porous rocks at higher altitudes a few miles from the springs; the water descends 2,000-3,000 feet through these rocks, is warmed, and issues along a fault zone in the immediate vicinity of the springs.

Thermo Hot Springs

Gilbert (*in* Howell, 1875, p. 257) stated that "Another group of hot springs, . . . is located . . . sixteen miles west of Minersville [Beaver County]. These springs, [(C-30-12)21-S and (C-30-12)28-S], are situated in the open desert, on two parallel ridges having a north and south trend, placed *en echelon*, about twenty rods apart, each eight or ten rods in width and 20 feet high, with a total length of about one and a half miles. These ridges have been formed mainly by the drifting sand, held together by the moisture and consequent vegetation, as no sinter nor tufa seems to be deposited by the springs. The highest temperature noted was 185° [F]." In contrast to Gilbert's report of sand ridges and the absence of tufa, Lee (1908, p. 22) reported that "The springs occur in two conspicuous mounds built up from the surface of the plain by silica deposited from the spring waters." U. S. Geological Survey personnel reported in July 1967 that the springs issue along the sides and top of calcareous travertine mounds. The southern mound, which has the most active spring, is about half a mile long, 200-250 feet wide, and 10-20 feet higher than the desert floor. The southern mound is mainly clay covered and has travertine along the sides. The hottest spring was on the south mound and had a temperature of 170° F. The two sets of observations, which were made nearly a century apart, indicate that the sand ridges observed by Gilbert have become partly indurated by calcium carbonate or silica that precipitated from the spring water. The observations of Lee (1908), however, indicate that appreciable chemical precipitation must have occurred by 1908. Perhaps older travertine deposits had been buried by drifting sand shortly before Gilbert's observations.

The springs issue from the alluvium in Escalante Valley, but the source of the water probably is rainfall on the faulted mountains northwest or southeast of the springs. A fault buried beneath the alluvium may control the location of the springs. Volcanic rocks of late Tertiary age crop out in the mountains within a few miles south of the springs (figure 18). The source of the heat probably is an abnormally high geothermal gradient that results from late Tertiary volcanism.

The dissolved-solids content of the water ranged from 1,470 to 1,500 ppm. The water is sodium sulfate in type although both bicarbonate and chloride anions are present in significant amounts. Silica concentration was fairly high—100 to 108 ppm. Results of spectrographic analyses were somewhat erratic; one sample showed unusual concentrations of aluminum, copper, and lead, but another sample obtained a year later at the same spring showed nothing unusual.

Discharge from the entire spring area was estimated to be about 200 gpm in July 1967.

Veyo Hot Spring

Veyo Hot Spring, (C-40-16)6cdb-S1, is about 18 miles north-northwest of St. George in Washington County. This spring is no longer accessible to direct observation; a swimming pool has been constructed over the spring. In July 1967, the owner reported that the spring discharge was 120 gpm and the water temperature was 98° F. He also reported that when he started to develop the spring, it discharged horizontally from sand and gravel. The spring issues along the base of a nearly vertical canyon incised in basalts of Quaternary age and in sedimentary rocks of Cretaceous age that underlie the basalt. The vicinity of the spring is nearly surrounded by basalt flows of Quaternary age (figure 19).

The source of the spring discharge may be meteoric water that infiltrates the intensely fractured and thus permeable basalt. The water may be heated by the residual heat of the basalt as it descends to the contact of the basalt with underlying rocks of Cretaceous age. The source of the water also could be meteoric water that infiltrates the Cretaceous rocks beyond the area of basalt flow. The water may be heated as it moves from the Cretaceous rocks through the Quaternary basalt from which it ultimately discharges.

In 1966 and 1967, two samples of water were obtained that are believed to represent actual spring discharge; the dissolved-solids content was only about 400 ppm, and the water was calcium magnesium bicarbonate in type.

LaVerkin (Dixie) Hot Springs

LaVerkin (Dixie) Hot Springs, (C-41-13)25-S, are about 18 miles east-northeast of St. George in Washington County. These springs issue from the bed and banks of the Virgin River near the mouth of a canyon. The springs issue from limestone of Paleozoic age along the Hurricane fault (figure 19). Basalt flows of Quaternary age are exposed over an area of several square miles west, southwest and southeast of the springs. The springs' location and the surrounding physical setting are shown in figure 20. Gregory (1950, p. 197) reports that LaVerkin Hot Springs "are related genetically to the nearby Hurricane fault and possibly also to the concealed igneous masses that gave rise to the lavas on the adjoining cliffs. These springs issue from cavities in the Kaibab limestone in the canyon wall and in the stream bed of the Virgin River at places where strong joints and faults of small throw provide outlet for deep-seated water. The water from the several springs ranges in temperature from 108° to 132° F and flows at the rate of about 1,000 gallons per minute." The water probably is meteoric in origin.

On August 1, 1963, the Virgin River was dry immediately upstream from the springs; U. S. Geological Survey personnel measured the water discharge of the Virgin River immediately downstream from the short reach in which the springs issue at 10.2 cfs or about 4,600 gpm. Survey personnel reported discharges of 10.0 cfs in September 1956, 10.6 cfs in August 1960 and 10 cfs in 1966. Milligan and others (1966, table 1) reported a discharge of 11.6 cfs on August 21, 1964. The discharge of the springs apparently is much greater than that reported by Gregory (1950).

Measured temperatures during the period 1960-66 ranged from 100° to 108° F. Gregory (1950) reported a temperature range of 108°-132° F. Thus the minimum temperature reported by Gregory is the maximum temperature observed during 1960-66. The source of the temperature range reported by Gregory is not known, but that range is the same as that reported by Stearns and others (1937, p. 183). The observations that resulted in a reported temperature of 132° F may have been made as early as the 1880's. Either the original temperature observations were inaccurate or the springs have cooled significantly during the past 80 years. If the interest in the springs were assumed to be restricted to the potential for generation of electric power, however, the difference between 100° and 132° F is of no significance. The large discharge (10 cfs or more), the high dissolved-solids content (9,000-10,000 ppm), and the very low silica content (about 10-30 ppm) indicate a poor potential for geothermal development despite the presence of basalt flows within a few miles of the springs. The source of the heat that warms the water probably is an abnormally high geothermal gradient that resulted from volcanic activity during Quaternary time.

The major significance of the springs is their adverse effect on the quality of water in the Virgin River, especially during periods of low flow in the stream. The spring discharge has a high dissolved-solids content, is of the sodium chloride type, and has a fairly high boron concentration (about 5 ppm); the source of the dissolved solids is not known. In equivalents per million, calcium and magnesium combined are less than half that of sodium, and sulfate is less than half that of chloride. At the gaging station on the Virgin River at Virgin, which is about five miles upstream from LaVerkin Hot Springs, the average discharge during a 57-year period of record is about 200 cfs; during many years, daily mean discharges of less than 100 cfs are common. Data on the chemical quality of the Virgin River at Virgin indicate that the annual weighted-average dissolved-solids content is in the 400-600 ppm range. If LaVerkin Hot Springs contribute about 10 cfs of water having a dissolved-solids content of about 10,000 ppm to the Virgin River when the stream has a discharge of 100 cfs and a dissolved-solids content of 500 ppm, the dissolved-solids content of the

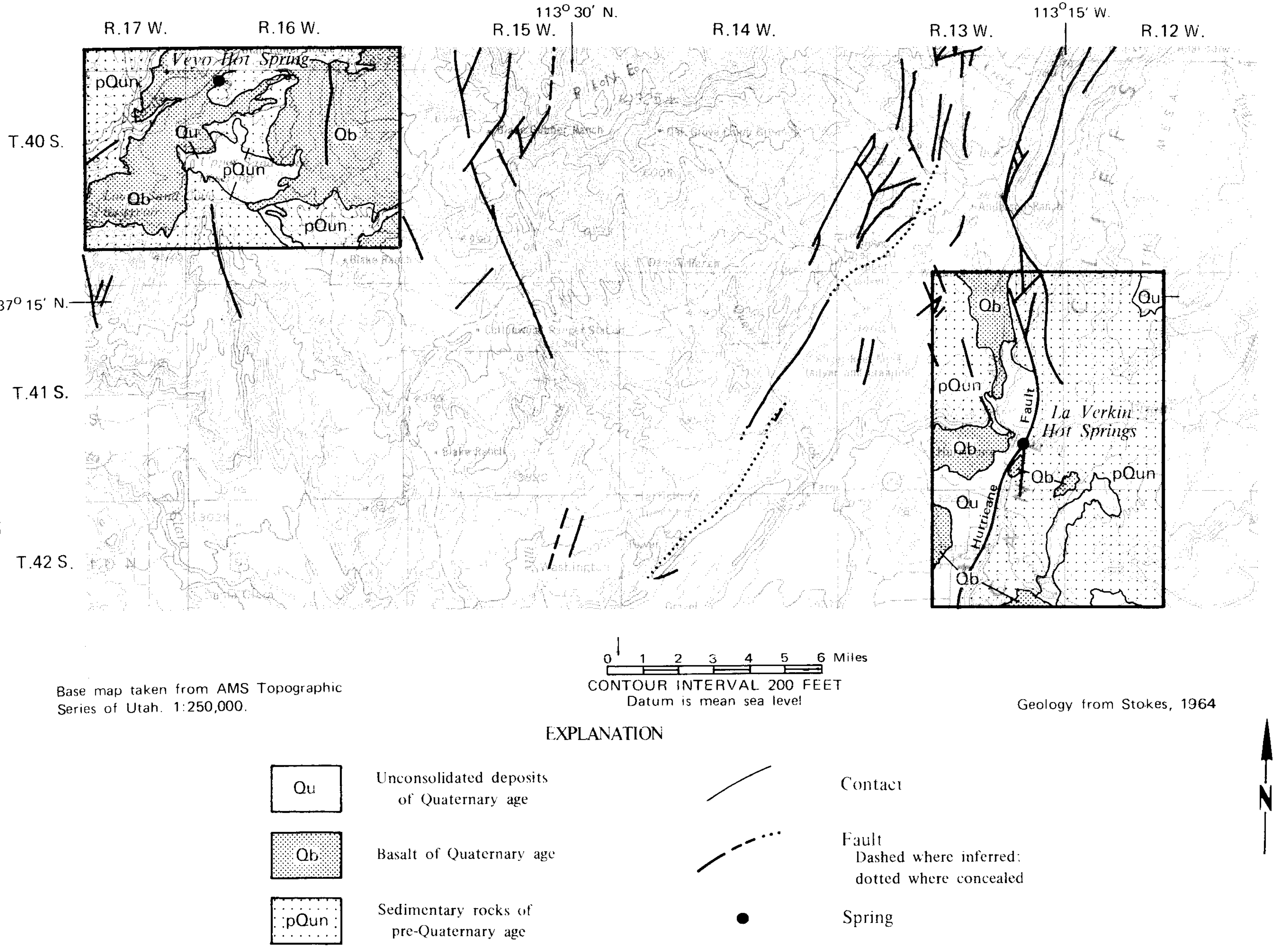


Figure 19. Map showing generalized geology of the areas surrounding Veyo and LaVerkin (Dixie) Hot Springs.

stream is almost tripled. The average annual dissolved-solids discharge of LaVerkin Hot Springs is about the same as that for the entire Virgin River basin upstream from the springs (a drainage area of about 950 square miles).

Midway Hot Springs

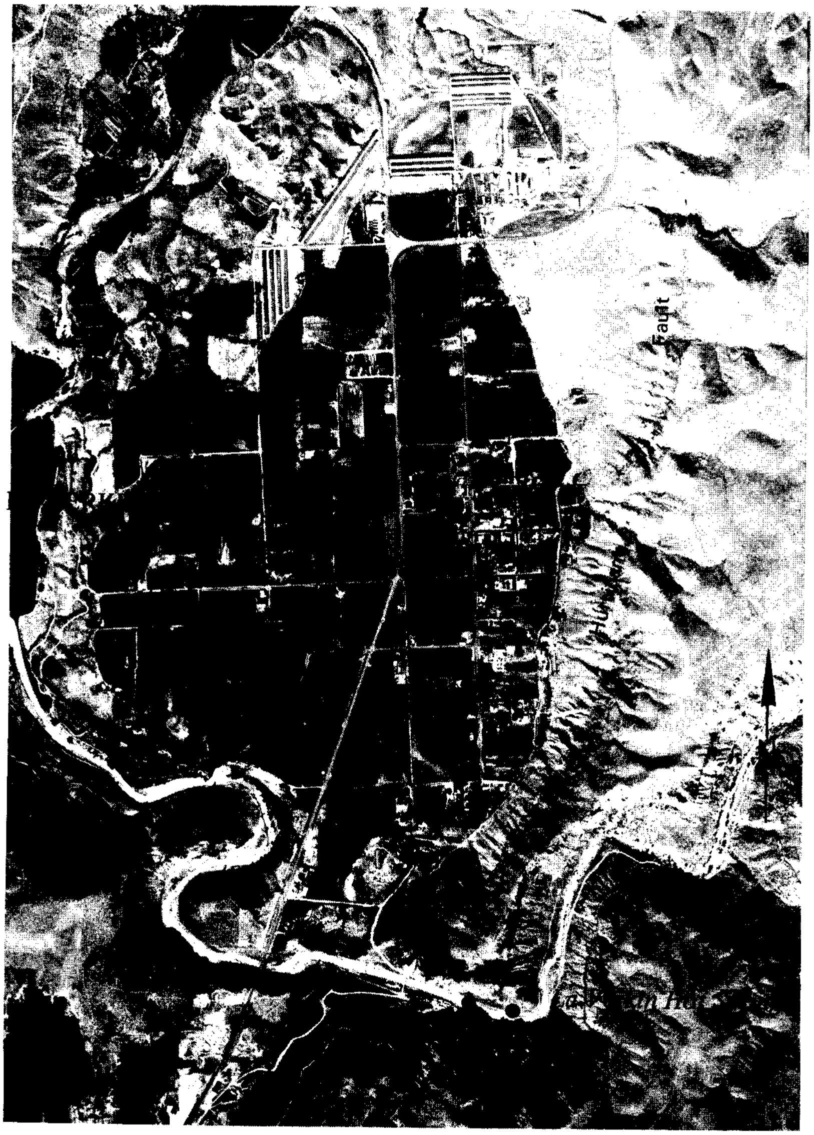
Midway Hot Springs, (D-3-4)26-S, (D-3-4)27-S, and (D-3-4)34-S, are about four miles west of Heber City in Wasatch County. This group of springs issues from calcareous tufa that covers an area of about 4.5 square miles and locally is at least 70 feet thick (Baker, 1968, p. D63). The tufa is underlain by alluvium of undetermined thickness; the thermal waters apparently rise through the alluvium from a bedrock source. The general geology of a large area surrounding the springs is shown in figure 21; the tufa deposits are not shown in this figure. Volcanic breccias crop out about three miles east of the springs area, and volcanic flows are exposed about five miles northeast of the springs. Granitoid rocks of Tertiary age crop out less than two miles north of the springs area. Areal distribution of the tufa deposits is shown in figure 22, which is generalized from Baker (1968, p. D66)

Howell (1875, p. 256) reported "A large area, a mile or two in extent, is covered to a depth of several feet with a deposit of calcareous tufa. Springs are frequent over this whole area, and the majority have built for themselves quite extensive craters of the same material....probably the largest of the whole group has a crater 65 feet high, and [is] from 150 to 200 feet broad at its base. Copious streams of water, having a temperature of 108° F, were flowing over the sides in several places..." This spring has been developed for use by a spa; at present (1968) the water surface is several feet below the rim of the crater.

Total water discharge from the spring area, including water tapped from "hot pots" by spas and water evaporated from the thermal-water surface of nonflowing craters, is not known. Measured discharges from springs and estimates of withdrawals by spas indicate that the discharge of thermal water is at least 10 cfs.

Water temperatures in nonflowing hot pots from which water is not tapped by spas ranges from about 55° to 95° F. Temperature of the water in the craters tapped by spas ranged from 100° to 104° F. Temperatures of the flowing thermal springs range from about 85° to 115° F. In general, the statement of Howell (1875, p. 256) that "the temperature of the water from the different springs was in proportion to the amount escaping" still appears to be valid.

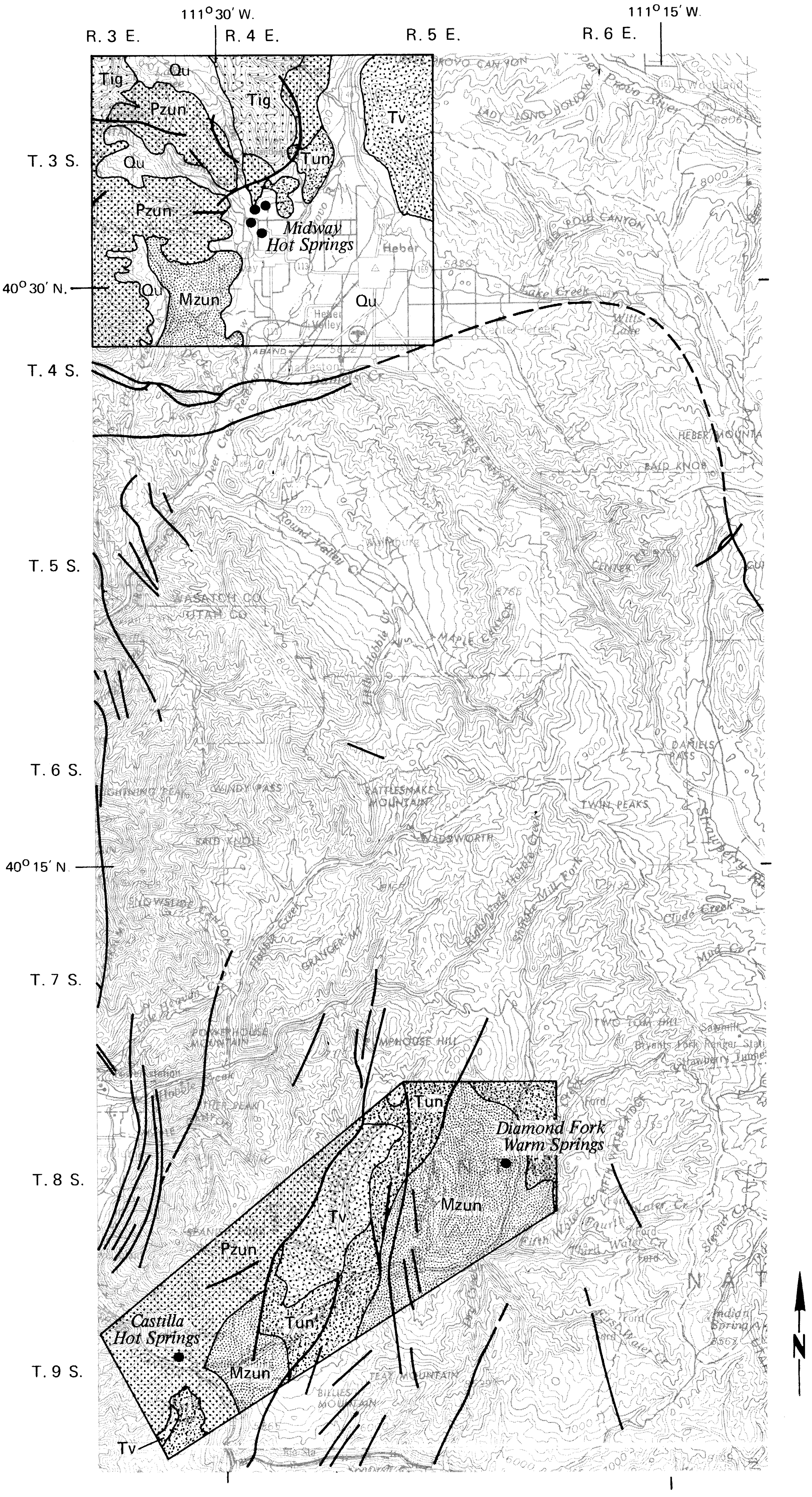
The source of the thermal water probably is meteoric water that infiltrates the surface of the Wasatch Range north



0 1/2 1 Mile (approximate)

SCALE

Figure 20. Aerial photograph of the area surrounding LaVerkin (Dixie) Hot Springs. (Photograph by Commodity Stabilization Service, September 1967.)



Base map taken from AMS Topographic Series of Utah. 1:250,000.

0 1 2 3 4 5 6 Miles

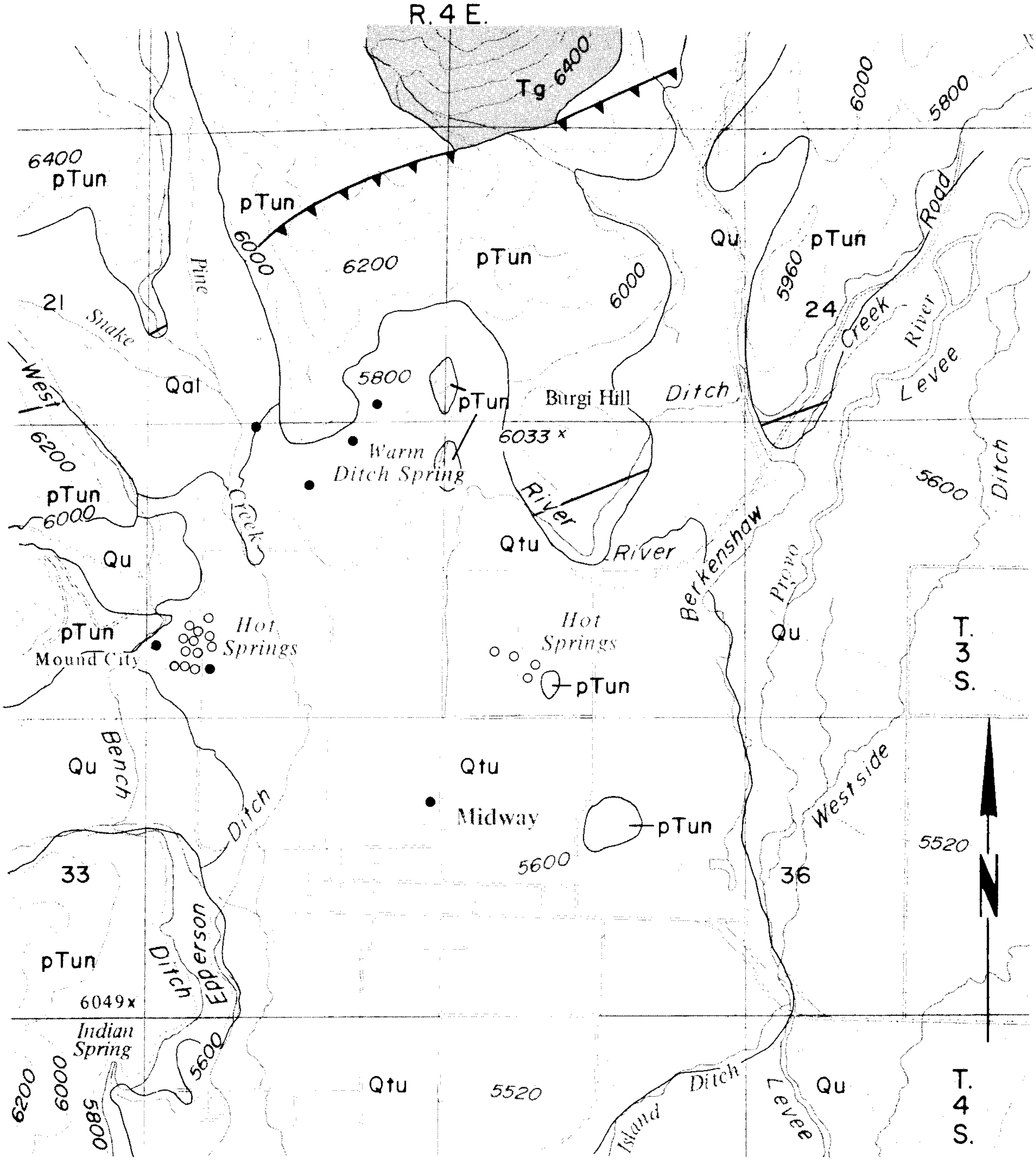
CONTOUR INTERVAL 200 FEET
Datum is mean sea level

Geology from Stokes, 1964

EXPLANATION

Symbol	Description
Qu	Unconsolidated deposits of Quaternary age
Tv	Volcanic rocks of early Tertiary age
Tig	Granitoid rocks of Tertiary age
Tun	Sedimentary rocks of Tertiary age
Mzun	Sedimentary rocks of Mesozoic age
Pzun	Sedimentary rocks of Paleozoic age
●	Spring
	Contact
	Fault. Dashed where inferred

Figure 21. Map showing generalized geology in the vicinity of Midway, Diamond Fork, and Castilla Springs.



Geology from Baker, 1968

Base map taken form USGS 7.5' Quadrangle, Heber, Utah.

1000 0 1000 2000 Feet

CONTOUR INTERVAL 200 FEET

Datum is mean sea level

EXPLANATION

Symbol	Explanation
●	Flowing thermal spring
○	Nonflowing "hot pot"
Qtu	Tufa deposits of Quaternary age
Qu	Unconsolidated deposits of Quaternary age
Tg	Granodiorite of Tertiary age
pTun	Sedimentary rocks of pre-Tertiary age
———	Contact
———	Fault
▲▲▲	Thrust fault Teeth on upper plate

Figure 22. Map showing generalized geology, including tufa deposits, in the vicinity of Midway Hot Springs.

and west of the springs, is heated by the geothermal gradient as it descends along faults or through solution channels to depths of a few thousand feet, and issues under artesian pressure from faults in the bedrock underlying the alluvium and tufa. The altitude of the northern end of the tufa sheet in secs. 22 and 23 (figure 22) is about 6,000 feet; the altitude of the highest springs or hot pots is about 5,780 feet. A fault or fracture system, now filled or sealed by tufa, in the immediate vicinity of the northern end of the tufa sheet may explain the presence of the tufa sheet at an altitude appreciably greater than that of any existing spring, hot pot or crater.

Dissolved-solids content of the different springs and hot pots ranges from about 1,500 to 2,000 ppm. The waters are of the calcium sulfate type. In equivalents per million, sulfate only slightly exceeded bicarbonate in some of the samples; in other samples sulfate was 50 percent greater than bicarbonate. Silica concentration was less than 30 ppm in all samples.

Lincoln Point Warm Springs and Other Springs in Vicinity of South Part of Utah Lake

Lincoln Point Warm Springs, (D-8-1)2-S and (D-8-1)3-S, and other thermal springs in and around Utah Lake in Utah County issue from valley fill of Quaternary age (figure 13). Saratoga Hot Springs, at the north edge of Utah Lake, which have appreciably higher temperature and lower dissolved-solids content than do the warm springs at the south end of Utah Lake, were described in a preceding section. The temperature range for thermal springs at the south end of the lake is from about 70° to 90° F.

The thermal springs around Utah Lake have been studied for many years. The interest in these springs is mainly in their effect on the chemical quality of Utah Lake, not in their thermal characteristics and potential for geothermal development. Using data obtained largely from the U. S. Bureau of Reclamation, Milligan and others (1966, p. 32-36) described the springs around Utah Lake. The following four paragraphs are quoted from their report:

"...there are numerous mineralized springs in the Goshen Bay area as well as along the west side of West Mountain and on Lincoln Point. Additional contributions of mineralized spring waters come by way of White Lake.... The outflows from White Lake are the waters accumulated from the winter flows of the Goshen Warm Springs and other springs plus any return flows from irrigation, all collected in White Lake, then released to Goshen Bay and exchanged for pumping rights from the lake to irrigate lands on the west side of Goshen Bay....

"The U. S. Bureau of Reclamation estimates of other mineralized spring inflows to Utah Lake are based on data of earlier investigations and on measurements and estimates obtained during 1960 and 1961 when the lake was at a low level.... During the late fall and winter of 1960 the springs on Lincoln Point were measured by current meter. The combined measured flow from these springs was reported to be about 2.8 cfs or 2,000 acre-feet per year...

"...The north bay of Bird Island has at least one large thermal and mineralized spring on the right bank that keeps a considerable portion of the bay clear of the usual suspended sediments in the lake water. Water in the area of this spring has been sampled by the U. S. Bureau of Reclamation and found to have a temperature of 86° F and EC [electrical conductivity] of 14,800 micromhos....

"The Bureau of Reclamation has estimated the total inflows to Utah Lake from White Lake and from springs in and around the lake.... This inflow of about 19,000 acre-feet per year is about 3 percent of the average computed lake inflow. It is believed that this estimate of spring inflow is conservative, particularly in view of the unmeasurable thermal springs in the Saratoga, Bird Island, and Lincoln Point areas. While contributing only 3 to 5 percent of the total inflow to Utah Lake, if those sources have a weighted average of 2,000 to 2,500 ppm dissolved solids, they are bringing 20 to 25 percent of the dissolved mineral[s] into the lake."

Chemical data obtained by the U. S. Geological Survey show that one of the Lincoln Point Warm Springs–(D-8-1)3dda-S1–had temperatures of 87° and 89° F and dissolved-solids contents of 6,550 and 6,140 ppm on May 27, 1964, and June 16, 1966, respectively. Milligan and others (1966, p. 35) show a general range of dissolved-solids contents of 3,000-8,000 ppm for mineral springs of Lincoln Point, Bird Island, and Goshen Bay east side.

Data obtained by the U.S. Geological Survey at two warm springs–(D-7-1)5ccb-S1 and (D-7-1)8bbc-S1–south of Goose Point on the west shore of Utah Lake showed temperatures of 77° and 75° F and dissolved-solids contents of 1,570 and 1,430 ppm. The dissolved-solids content of these springs is about the same as that of Saratoga Hot Springs; the water type, however, is definitely sodium chloride whereas that of Saratoga Hot Springs is of a calcium sodium sulfate chloride type.

Although the thermal springs in and around Utah Lake show a fairly wide range in temperature and in chemical characteristics, all probably are related to a major fault system extending generally north through the Utah Lake area. Variable depths of meteoric water circulation and variable lithologies probably result in the differences in water temperatures and chemistry. The available evidence indicates that the geothermal gradient results in heating of the water to temperatures 15°-50° F greater than the temperature of shallow ground water in the area. A few small volcanic flows of early Tertiary age crop out several miles west and northwest of the lake, but these flows do not appear to be related to either the temperature or the chemistry of the springs in and around Utah Lake.

Diamond Fork Warm Springs

Diamond Fork Warm Springs, (D-8-5)14d-S, are about 17 miles east of Spanish Fork in Utah County. These springs issue from conglomerates of Mesozoic age along Diamond Fork (figure 21). Temperature of the water was 68° F and dissolved-solids content was about 837 ppm on October 20, 1967. The water is of the calcium sodium sulfate type; the odor of hydrogen sulfide is noticeable. The relatively low temperature and dissolved-solids content of these springs suggest that meteoric water enters the surface in the mountains at altitudes 2,000-3,000 feet higher than that of the springs, descends through fractures or voids to about the altitude of the springs, and issues from fissures in the conglomerate along Diamond Fork. The normal geothermal gradient causes the temperature of the spring discharge to be 10°-15° F warmer than that of shallow ground water in the vicinity.

Reported discharge of the springs has ranged from about 350 to 700 gpm. On October 20, 1967, the discharge of the largest spring was about 450 gpm.

Castilla Hot Springs

Castilla Hot Springs, (D-9-4)18ba-S, are about nine miles southeast of Spanish Fork in Utah County. These springs issue from sandstones of Paleozoic age in Spanish Fork Canyon near the northeast end of a fault shown by Mecham and Bitter (1959). Volcanic rocks of early Tertiary age crop out about one and a half miles south and about three miles northeast of the springs (figure 21).

Wheeler (1875, p. 151) reported a water temperature of 111° F; Peale (1886, p. 185) reported 145° F; Milligan and others (1966, table 1) reported 108° F in 1964; and U. S. Geological Survey personnel reported 104° F in 1967.

Data are lacking on spring discharge until recently. Observations during the latter part of the 19th century and early part of the 20th century indicate that the spring discharge was much greater then than now. Milligan and others (1966, p. 31) state that the spring discharge was 1.0 cfs (about 450 gpm) in 1960 but that by 1966 "the springs have almost dried up." On October 20, 1967, the discharge was about 20 gpm.

The dissolved-solids content of the springs was 6,360 ppm in 1967. The water was of the sodium chloride type. Equivalents per million of calcium was about one-third that of sodium, and equivalents per million of sulfate was less than half that of chloride. The odor of hydrogen sulfide is noticeable at the springs. The source of the dissolved solids is not known.

The cause of the heat probably is the geothermal gradient which may be abnormally high in the surrounding area. The springs are surrounded by mountains having altitudes as great as 10,000 feet; the altitude at the springs is about 4,900 feet. Water that may descend through faults or joint systems from altitudes of 7,000 to 10,000 feet could be heated to the observed temperatures at the altitude of the springs. The volcanic rocks south and east of the springs are not believed to be directly related to the thermal characteristics of the springs.

Goshen Warm Springs

Goshen Warm Springs, (D-10-1)8c-S, are about two miles east of Goshen and about three miles south-southwest of Santaquin in Utah County. These springs issue from detritus along a fault that passes through the spring area and probably is the conduit for the springs. Volcanic rocks of Tertiary age are widely exposed in the vicinity of the spring area.

Richardson (1906, p. 55) reported that spring discharge was 5 cfs. Measurements and estimates since then indicate that the spring discharge has not changed appreciably during the last 60 years. The water is probably of meteoric origin.

The dissolved-solids content of the springs was 1,320 ppm in 1964 and in 1966. The water type was strongly sodium chloride. Water temperature during 1964 and 1966 was 70° F.

The volcanic rocks in the vicinity are not believed to be a direct source of heat. The geothermal gradient may be somewhat greater than normal, and circulation of water to depths of less than 2,000 feet would result in the observed temperatures.

Little Mountain Warm Spring

Little Mountain Warm Spring, (B-10-4)24-S, issues at the south end of Little Mountain in Box Elder County (figure 10). A temperature of 90° F has been reported. Carpenter (1913, p. 42) shows that the dissolved-solids content of the spring was 30,440 ppm. The water type was strongly sodium chloride. The dissolved-solids content and the water type are similar to those for Stinking Hot Springs, (B-10-3)30bbd-S1, which are only about one mile southeast of Little Mountain Warm Spring. Although Little Mountain Warm Spring is about 35° F cooler than Stinking Hot Springs, the same fault system and source of dissolved solids probably are responsible for the thermal and chemical characteristics of both springs. The water probably is meteoric in origin. The yield of the spring is not known.

Bothwell (Salt Creek) Warm Springs

Bothwell (Salt Creek) Warm Springs, (B-11-4)2-S, are about 20 miles northwest of Brigham City in Box Elder County. These springs issue from a small outcrop of fissured limestone of Paleozoic age. Temperature of the springs ranges from about 70° to 75° F. The dissolved-solids content is about 2,000 ppm. Discharge of the springs is large and has been reported as ranging from about 5 to more than 30 cfs. The discharge shows marked fluctuations annually, and these fluctuations indicate that the water is of meteoric origin. The low temperatures indicate that no great depth of circulation is involved; the source of heat probably is the geothermal gradient. The mixing of small amounts of hot, highly mineralized water with large amounts of cool, shallow water having low dissolved-solids contents is a possibility.

Cutler Warm Springs

Cutler Warm Springs, (B-13-2)27d-S, are about 10 miles northeast of Tremonton in Box Elder County. These springs issue from limestones of Paleozoic age along the bed and banks of the Bear River; the springs are about one mile east of the main Wasatch fault (figure 9). The location of the springs in the bed and banks of the river makes it difficult to obtain accurate data on the temperature and chemical quality of the springs. Water temperatures are in the 70°-80° F range. Milligan and others (1966, table 1) obtained a water sample from one of the springs that had a temperature of 76° F and a dissolved-solids content of about 5,000 ppm at a discharge of 0.7 cfs. On February 2, 1968, U. S. Geological Survey personnel obtained a sample from one of the springs that had a temperature of 73° F and a dissolved-solids content of about 2,000 ppm. The water is strongly sodium chloride in type regardless of the dissolved-solids content. The reason for the fairly uniform temperature but wide range of observed dissolved-solids content is not known. The water is probably of meteoric origin. The source of heat probably is the geothermal gradient.

"Sulphurdale Hot Springs"

The term "Sulphurdale Hot Springs", (C-26-6)7-S, occasionally appeared in the literature researched. Such a spring was not found during an intensive field search in the northeast part of Beaver County. Perhaps a report of Lee (1908, p. 19-20) resulted in a later assumption that such springs existed. He presented the results of analysis of a highly mineralized water (10,810 ppm of dissolved solids) having a sulfate concentration of 7,600 ppm and a total iron concentration of 1,360 ppm. No temperature data were given. He was careful to state, however, that because of the mining operations the water should be classed as mine drainage. Thus, although the analysis and description appeared in the "Springs" section of his report, he did not regard the flow as a true spring. A large area of basalt flow of Quaternary age occurs within about two miles of the sulfur deposits that were mined during the early 1900's. The chemistry of the water and the resulting sulfur deposits may be related to the volcanic activity. No information is available on the thermal and chemical characteristics of the possible springs or seeps before the beginning of sulfur mining in the area.

Split Mountain Warm Spring

Split Mountain Warm Spring, (D-4-24)16cdd-S1, issues from limestones of Mississippian age along the right bank of the Green River at the mouth of Mitten Canyon, about 15 miles east of Vernal in Uintah County. Data obtained by U. S. Geological Survey personnel in 1948 show a temperature of 86° F, a dissolved-solids content of 942 ppm, and an estimated discharge of at least 12 cfs (5,400 gpm). The spring may be related to an extension of the Yampa fault; the source of heat probably is the geothermal gradient. Estimated discharges have ranged from 6 to 20 cfs; the water is of meteoric origin and is warmed by the geothermal gradient.

Livingston (Crystal) Warm Springs

Livingston (Crystal) Warm Springs, (D-18-2)13cad-S1, issue from Flagstaff Limestone of Tertiary age about two miles south of Manti in Sanpete County. G. B. Robinson, Jr., (written communication, 1967) believes that a fault or fault system is present; a series of other thermal and non-thermal springs issues south of Livingston Warm Springs and along the trend of the probable fault. Measurements made by Robinson show that the discharge was 425 gpm and the temperature was 72° F on October 20, 1965; 370 gpm and 72° F on January 27, 1966; and 380 gpm and 73° F on April 27, 1966. The dissolved-solids content was about 600 ppm, and the water type was sodium bicarbonate. Waring (1965, p. 43) reported temperatures of 62° and 73° F and a discharge of 285 gpm at two main springs. Meteoric water probably circulates to depths of less than 2,000 feet and is warmed by the geothermal gradient.

Sterling (Peacock, Nine Mile) Warm Spring

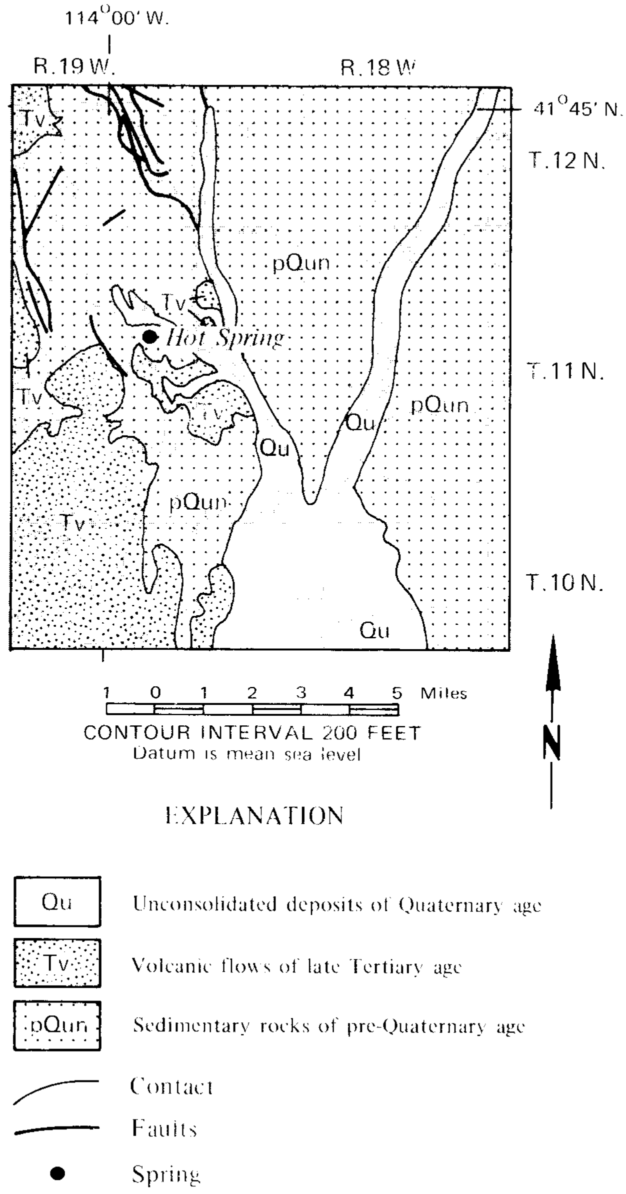
Sterling (Peacock, Nine Mile) Warm Spring, (D-19-2)4dca-S1, issues about one mile south of Sterling in Sanpete County, in the vicinity of a fault at the contact of the Green River Formation and Flagstaff Limestone of Tertiary age. Richardson (1907, p. 59) reported a discharge of 900 gpm and a temperature of 72° F. Robinson (1968, p. 26) reported a discharge of 1,260 gpm on August 19, 1965; 490 gpm on December 6, 1965; and 460 gpm on February 3, 1966. Water temperature was 72° F on all three dates. The large annual fluctuation in discharge, the relatively low temperature, and the low dissolved-solids content (about 430 ppm) suggest the circulation of meteoric water to depths of less than 2,000 feet and the warming of the water by the geothermal gradient. The water was of the sodium bicarbonate type.

Unnamed Hot Spring

A thermal spring, (B-11-19)11dda-S1, about two miles northwest of Etna and about two miles east of the Nevada-Utan State line, in the northwest corner of Box Elder County, having a temperature of 107° F and an estimated discharge of 75-100 gpm was reported by Don Price and J. W. Hood (oral communication, 1968). The water had a dissolved-solids content of 248 ppm and was of the calcium bicarbonate type. A large area of volcanic rocks of late Tertiary age is immediately south of the spring (figure 23). These rocks may contribute directly to the heating of the water or may result in a high geothermal gradient in the vicinity of the spring.

Potential for Development of Thermal Springs in Utah

Thermal springs of Utah are listed in the order of decreasing temperatures in table 3. Few springs in Utah have temperatures near the boiling point of water. Thermal discharges–liquid or steam–having temperatures at or near the boiling point of water



Base map taken from AMS Topographic Series of Utah. 1:250,000

Geology from Stokes, 1964

Figure 23. Map showing generalized geology in the vicinity of hot spring in northwestern part of Box Elder County.

Table 3. Thermal springs of Utah listed in order of decreasing temperatures.

Spring and location	Maximum observed temperature or general temperature range (°F)
Abraham (Crater) Hot Springs, (C-14-8)10-S and 15-S	189
Thermo Hot Springs, (C-30-12)21-S and 28-S	185
Roosevelt (McKeans) Hot Springs, (C-26-9)34dcb-S1	185-131
Red Hill Hot Spring, (C-25-3)11cac-S1	169
Wilson Hot Springs, (C-10-14)33-S	168
Monroe Hot Springs, (C-25-3)10dda-S1 and 15a-S	148
Joseph Hot Springs, (C-25-4)23-S	148
Hooper Hot Springs, (B-5-3)27c-S	140-118
Crystal Hot Springs (Salt Lake County), (C-4-1)11-S and 12b-S	137-122
Utah Hot Springs, (B-7-2)14dca-S1	137
Ogden Hot Springs, (B-6-1)23ccd-S1	135
Crystal (Madsens) Hot Springs, (B-11-2)29da-S	134-121
Becks Hot Springs, (B-1-1)14dcb-S1	133
Stinking Hot Springs, (B-10-3)30bbd-S1	124-113
Midway Hot Springs, (D-3-4)26-S, 27-S, and 34-S	115-85
Castilla Hot Springs, (D-9-4)18ba-S	111-104
Saratoga Hot Springs, (C-5-1)25cd-S	111-100
Uddy Hot Springs, (B-13-3)14-S and 23-S	100-90
LaVerkin (Dixie) Hot Springs, (C-41-13)25-S	108-100
Unnamed hot spring, (B-11-19)11dda-S1	107
Meadow Hot Springs, (C-22-6)26ccc-S1 and 27ddd-S1	106-84
Wasatch Hot Springs, (B-1-1)25db-S	105
Veyo Hot Spring, (C-40-16)7acb-S1	98
Radium (Dotsons) Warm Springs, (C-30-9)7aca-S1	97
Little Mountain Warm Spring, (B-10-4)24-S	90
Grantsville Warm Springs, (C-2-6)16aad-S1	90-75
Lincoln Point Warm Springs, (D-8-1)2-S and 3-S	89
Split Mountain Warm Spring, (D-4-24)16cdd-S1	86
Blue Warm Springs, (B-13-5)29-S	86-80
Big, (C-11-14)3-S, and Fish, (C-11-14)23-26-S, Springs	82-65
Gandy Warm Springs, (C-15-19)31bc-S	81
Warm Spring, (B-12-15)19aab-S1	80
Morgans, (C-5-5)9cba-S1, and Russells, (C-5-5)17aaa-S1, Warm Springs	80-71
Como Warm Springs, (A-4-3)31cab-S1	77
Warm spring, west shore of Utah Lake, (D-7-1)5ccb-S1	77
Johnson Warm Spring, (C-25-3)27a-S	77
Cutler Warm Springs, (B-13-2)27d-S	76-73
Warm spring, west shore of Utah Lake, (D-7-1)8bbc-S1	75
Bothwell (Salt Creek) Warm Springs, (B-11-4)2-S	75-70
Big Warm Springs, (C-1-7)8-S and 9-S	75-68
Richfield Warm Springs, (C-23-3)26aca-S1	74
Livingston (Crystal) Warm Springs, (D-18-2)13cad-S1	73
Sterling (Peacock, Nine Mile) Warm Spring, (D-19-2)4dca-S1	72
Goshen Warm Springs, (D-10-1)8c-S	70
Diamond Fork Warm Springs, (D-8-5)14d-S	68

generally indicate the areas in which exploration of geothermal energy is most likely to be economically productive.

The U. S. Geological Survey has designated the areas near Roosevelt (C-26-9)34dcb-S1, and Abraham (C-14-8)10-S and 15-S, Hot Springs as potentially valuable geothermal areas. Roosevelt Hot Springs have been dry for several years. Data obtained during historical times, however, show that temperatures as high as 185° F and silica concentrations of more than 400 ppm have been measured. The two surface indicators–temperature and silica concentration–give no assurance that the site is suitable for commercial development. Abraham Hot Springs discharge water with a maximum recorded temperature of 189° F, but the maximum recorded silica content is 59 ppm. Detailed geologic and geophysical reconnaissance is a prerequisite to drilling for geothermal development at both sites.

Some thermal springs, such as Gandy Warm Springs, (C-15-19)31bc-S, and Warm Spring (B-12-15)19aab-S1, have fairly large discharge and low dissolved-solids content. Such springs are useful as water supplies for irrigation and stock use.

Many thermal springs in Utah have been of economic importance as the source of hot mineralized water for spas. Wasatch, Becks, Midway, Castilla, Saratoga, Veyo, and other thermal springs have served as such sources.

In addition to the springs described in this report, many small springs in Utah have temperatures that are 10°-15° F greater than the mean annual air temperature or the temperature of shallow ground water in the vicinity of the springs. Such springs were not regarded as of sufficient importance as either water resources or thermal resources for inclusion in this report.

SUMMARY

Utah has many thermal springs, nearly all of which appear to be related to faults or fault zones. A statewide surficial reconnaissance of these springs suggests that intensive geological and geophysical investigation for the generation of electrical power by geothermal energy may be justified at a few sites. Roosevelt and Abraham Hot Springs in particular are considered to be in potentially valuable geothermal areas.

Some of the thermal springs in Utah are valuable water supplies for agricultural and recreational uses. A few of the thermal springs are used for the heating of buildings.

The main undesirable effect of the thermal springs in Utah is that they add significant amounts of water having high dissolved-solids contents to some streams and lakes. The inflow of LaVerkin Hot Springs to the Virgin River and of many thermal springs around Utah Lake, for example, results in a deterioration of the quality of the surface-water supply.

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UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

103 Utah Geological Survey Building
University of Utah
Salt Lake City, Utah 84112

THE UTAH GEOLOGICAL AND MINERALOGICAL SURVEY since 1949 has been affiliated with the College of Mines and Mineral Industries at the University of Utah. It operates under a director with the advice and counsel of an Advisory Board appointed by the Board of Regents of the University of Utah from organizations and categories specified by law.

The survey is enjoined to cooperate with all existing agencies to the end that the geological and mineralogical resources of the state may be most advantageously investigated and publicized for the good of the state. The *Utah Code, Annotated, 1953 Replacement Volume 5, Chapter 36, 53-36-2,* describes the Survey's functions.

Official maps, bulletins, and circulars about Utah's resources are published. (Write to the Utah Geological and Mineralogical Survey for the latest list of publications available).

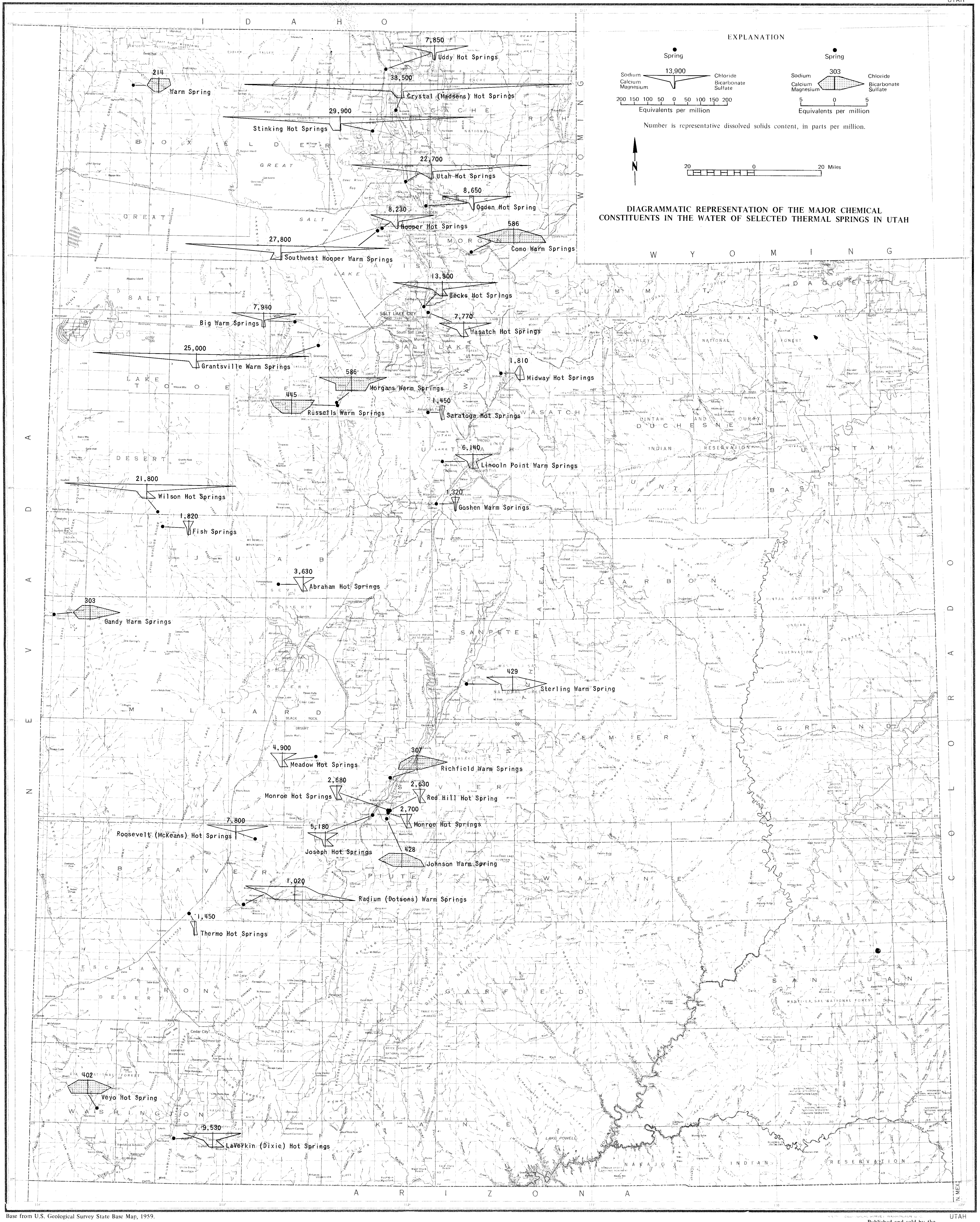
THE LIBRARY OF SAMPLES FOR GEOLOGIC RESEARCH. A modern library for stratigraphic sections, drill cores, well cuttings, and miscellaneous samples of geologic significance has been established by the Survey at the University of Utah. It was initiated by the Utah Geological and Mineralogical Survey in cooperation with the Departments of Geology of the universities in the state, the Utah Geological Society, and the Intermountain Association of Petroleum Geologists. This library was made possible in 1951 by a grant from the University of Utah Research Fund and by the donation of collections from various oil companies operating in Utah.

The objective is to collect, catalog, and systematically file geologically significant specimens for library reference, comparison, and research, particularly cuttings from all important wells driven in Utah, and from strategic wells in adjacent states, the formations, faunas, and structures of which have a direct bearing on the possibility of finding oil, gas, salines or other economically or geologically significant deposits in this state. For catalogs, facilities, hours, and service fees, contact the office of the Utah Geological and Mineralogical Survey.

THE SURVEY'S BASIC PHILOSOPHY is that of the U. S. Geological Survey, i.e., our employees shall have no interest in Utah lands. For permanent employees this restriction is lifted after a 2-year absence; for consultants employed on special problems, there is a similar time period which can be modified only after publication of the data or after the data have been acted upon. For consultants, there are no restrictions beyond the field of the problem, except where they are working on a broad area of the state and, here, as for all employees, we rely on their inherent integrity.

DIRECTORS:

William P. Hewitt, 1961-
Arthur L. Crawford, 1949-1961



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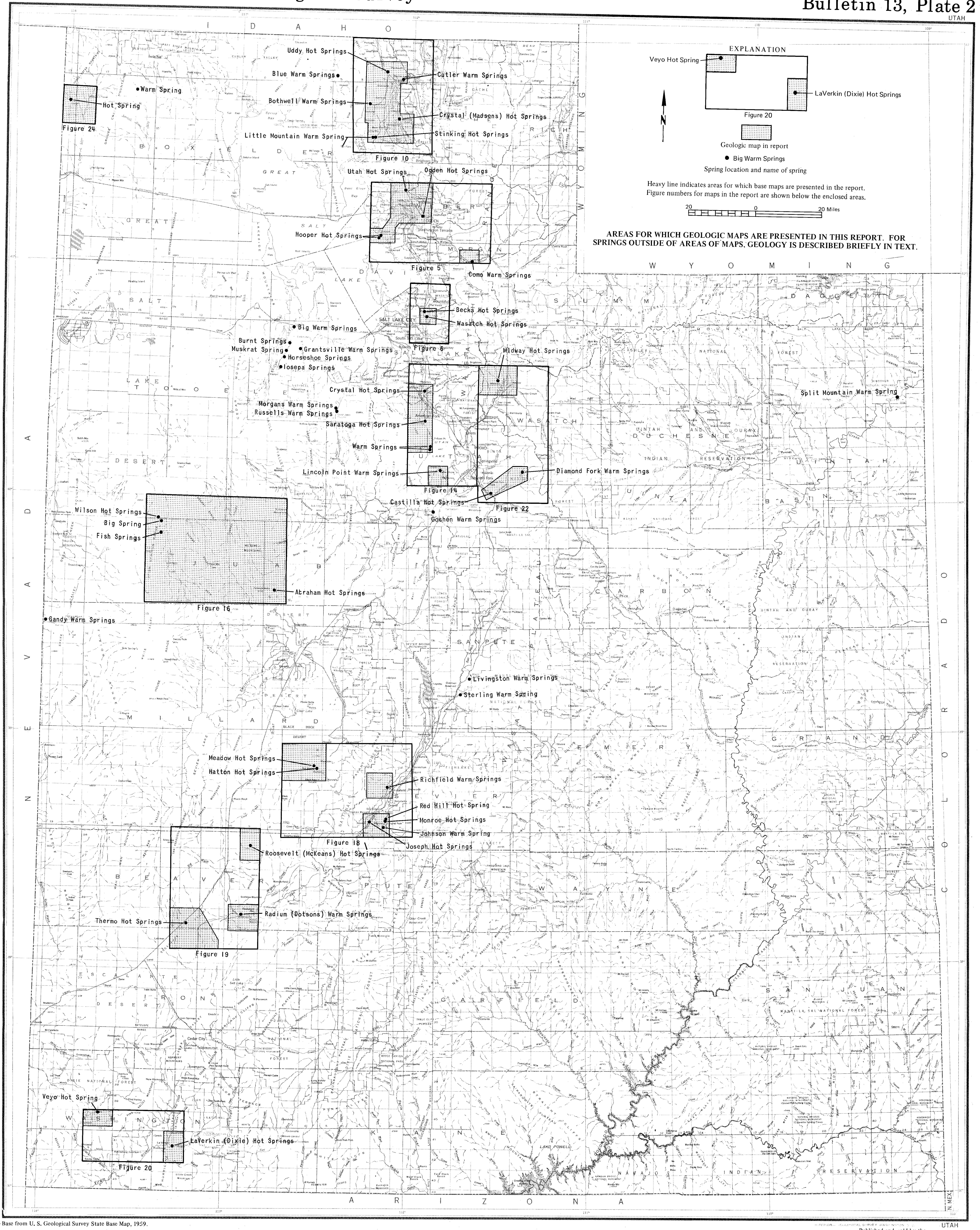

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