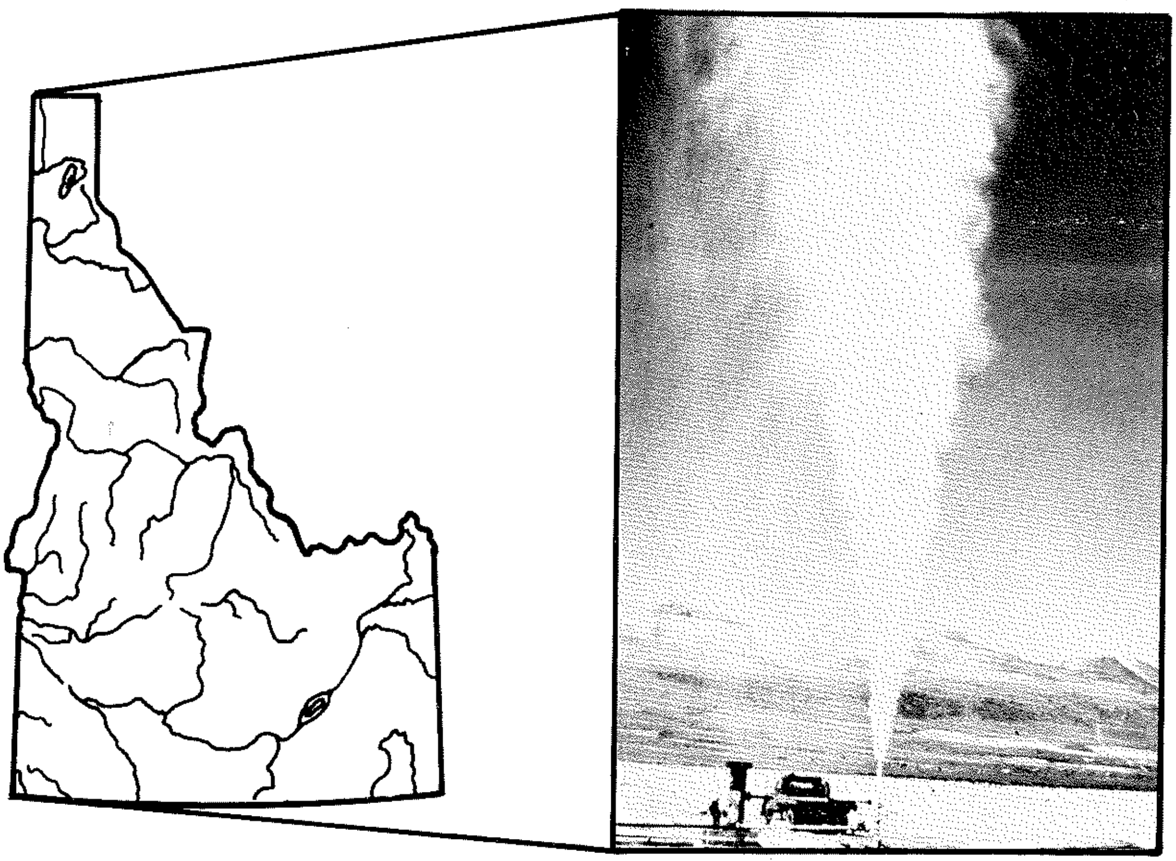
GEOTHERMAL INVESTIGATIONS IN IDAHO

PART I

GEOCHEMISTRY AND GEOLOGIC SETTING OF SELECTED THERMAL WATERS



IDAHO DEPARTMENT OF WATER ADMINISTRATION

WATER INFORMATION BULLETIN NO. 30

MAY 1973

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Geochemistry and Geologic Setting of Selected Thermal Waters

by

H. W. Young
U. S. Geological Survey

and

J. C. Mitchell
Idaho Department of Water Administration

Prepared jointly by the

U. S. Geological Survey

and

Idaho Department of Water Administration

May 1973

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GEOTHERMAL INVESTIGATIONS IN IDAHO

Part 1

Geochemistry and Geologic Setting of Selected Thermal Waters

by

H. W. Young and J. C. Mitchell

ABSTRACT

At least 380 hot springs and wells are known to occur throughout the central and southern parts of Idaho. One hundred twenty-four of these were inventoried as a part of the study reported on herein. At the spring vents and wells visited, the thermal waters flow from rocks ranging in age from Precambrian to Holocene and from a wide range of rock types — igneous, metamorphic, and both consolidated and unconsolidated sediments. Twenty-eight of the sites visited occur on or near fault zones while a greater number were thought to be related to faulting.

Measured water temperatures at the 124 wells and springs inventoried ranged from 12° to 93°C (degrees Celsius) and averaged 50°C. Estimated aquifer temperatures, calculated using the silica and the sodium-potassium-calcium geochemical thermometers, range from 5° to 370°C and averaged 110°C. Estimated aquifer temperatures in excess of 140°C were found at 42 sites. No areal patterns to the distribution of temperatures either at the surface or subsurface were found.

Generally, the quality of the waters sampled was good. Dissolved-solids concentrations range from 14 to 13,700 mg/l (milligrams per liter) and averaged 812 mg/l, with higher values occurring in the southeastern part of the State.

No hot springs or wells were found within the Yellowstone KGRA (known geothermal resource area) in northeastern Idaho. At the Frazier KGRA in Raft River Valley, water temperatures at the surface above 90°C were measured at two wells. Geochemical thermometers indicate temperatures of 135° to 145°C may exist at depths. Dissolved-solids concentrations in waters issuing from the two wells were 1,720 and 3,360 mg/l. The minerals being deposited by these waters consist chiefly of halite (NaCl) and calcite ($CaCO_3$).

Twenty-five areas were selected for future study. Of these areas, 23 were selected on the basis of estimated aquifer temperatures of 140°C or higher and two on the basis of geologic considerations.

INTRODUCTION

The search for energy resources in the United States continues in an effort to meet increasing demands for electric energy. Widespread interest in converting the natural heat of the earth into electric power, shared by the general public, governmental agencies, and the power industry, stems from the hope that this source of energy will become a viable component of existing modes of power generation. If that hope can be realized, fossil fuel can be conserved, proposed dam sites can be saved for their scenic value, and some of the fears concerning the environmental effects of using nuclear fuels can be avoided.

The recent interest in geothermal energy and the need to establish exploration leasing rights led the United States Congress to pass the Geothermal Steam Act of 1970 (Public Law 91-581, Godwin and others, 1971, p. 10-18) which makes provision for leasing, development, and utilization of geothermal resources found on Federal lands. The Idaho Geothermal Leasing Act of 1972 (sections 47-1601 to 1611, **Idaho Code**) makes similar provisions for geothermal resources found on State and school lands. As provided in the Federal act, pre-leasing land classification, including Federal, State, and private lands, was conducted on a reconnaissance level by the U. S. Geological Survey and a total of 44 KGRA's (known geothermal resource area) were designated in the nine western states (Godwin and others, 1971, p. 2). Approximately 1.8 million acres of land was included in this classification. Two of the areas in Idaho, the Yellowstone KGRA in eastern Fremont County and the Frazier KGRA in the Raft River basin (fig. 1), include about 21,800 acres and represent about 16 percent of the area in the KGRA's designated in the Pacific Northwest.

In addition to KGRA's, lands potentially valuable for geothermal exploration were also designated. A total of nearly 96 million acres in 14 states is in this category. In Idaho, nearly 15 million acres or approximately 30 percent of the State (fig. 1) was classified as potentially valuable for exploration.

Economic or beneficial present uses of Idaho's geothermal resources, although of long standing, have been of only minor importance (Ross, 1971). These uses have been primarily for irrigation and secondarily for recreation and space heating of a few homes and greenhouses.

Existing knowledge and laws have been adequate with regard to development and regulation of the resource for these minor uses. However, recognition of the possibilities for development of Idaho's geothermal resources for power, also brought the realization that little information concerning both the source of the hot water and its adequacy for power development was available. Despite this lack of information, interest in looking for geothermal areas capable of sustaining power plants is keen and private interests have requested permits from the Idaho Department of Water Administration that would allow them exploration and development rights as provided in Idaho's Geothermal Resources Act of 1972 (sections 42-4001 to 4015, **Idaho Code**).

In recognition of the needs for information noted above, the U. S. Geological Survey in cooperation with the Idaho Department of Water Administration initiated a study to

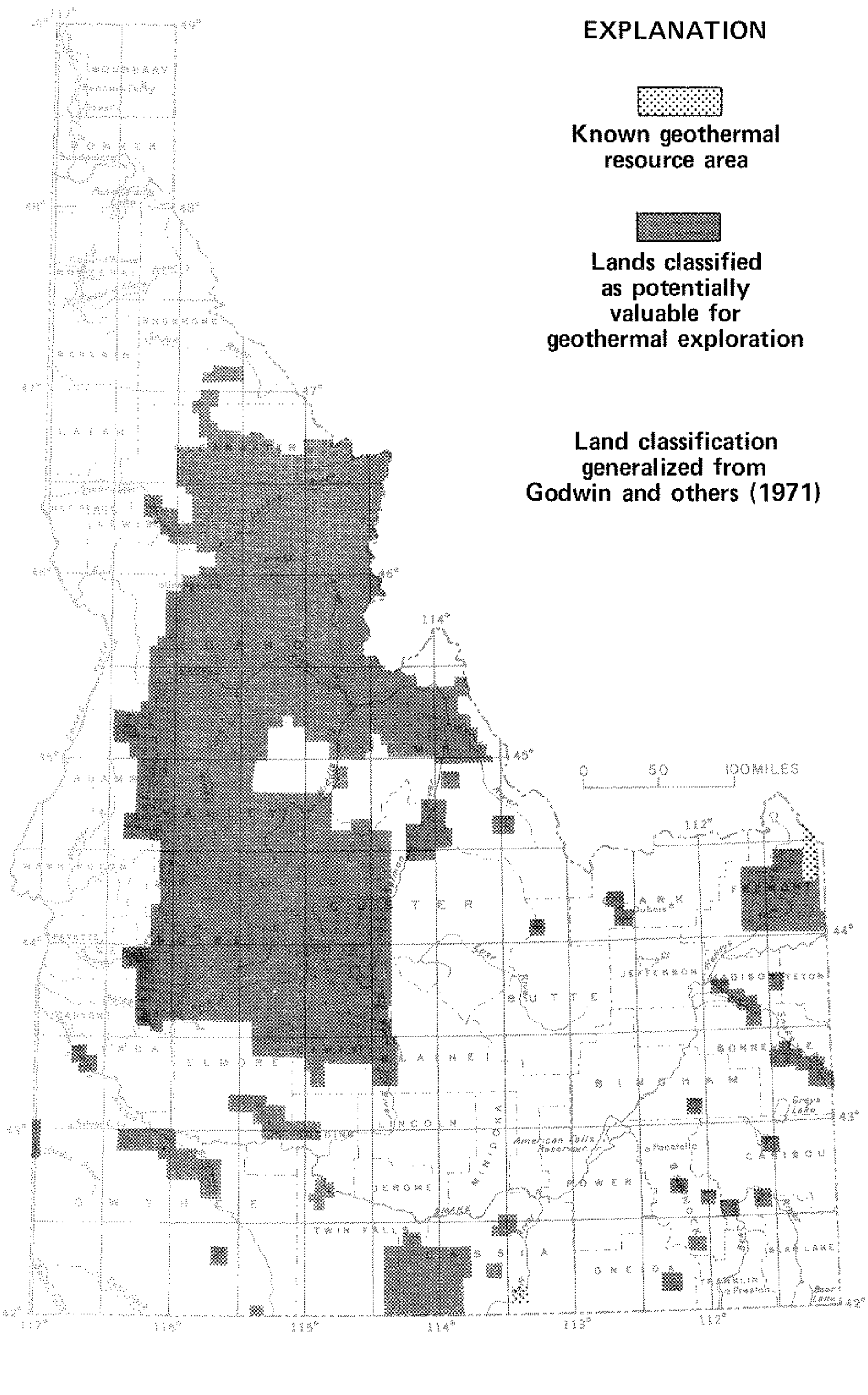


FIGURE 1. Location of known geothermal resource areas and areas classed as potentially valuable for geothermal exploration.

investigate the potential for geothermal resource development in Idaho. This report summarizes the effort in which 124 selected thermal springs and wells were visited during the spring and summer of 1972. The objectives of this progress report are: (1) to present the chemical analyses of 124 selected thermal springs and wells, estimate aquifer temperatures for them, and reconnaissance data on their geologic setting; and (2) to designate for additional study areas where: (a) estimated aquifer temperatures of 140°C or higher (a temperature of 140°C was arbitrarily selected by the authors as the minimum needed for usable water) were found, using the silica and sodium-potassium-calcium geochemical thermometers or (b) favorable geologic conditions indicate work is needed.

Previous Work

Numerous reports have briefly mentioned or described the occurrence and characteristics of thermal waters within a particular region or section of Idaho. However, only three reports (Stearns and others, 1937, Waring, 1965, and Ross, 1971) have described thermal waters throughout the State. These reports are mainly a collection of pre-existing data compiled by various workers over a time span of approximately 50-60 years. The information given in Stearns and others (1937, p. 136-151) for Idaho is essentially repeated by Waring (1965, p. 26-31). The most comprehensive of the three reports, (Ross, 1971, p. 47-67), includes data on 380 thermal springs and wells, and evaluations of the geothermal potential of some areas. Although the three reports contain much useful information applicable to this investigation, they are lacking in the water-chemistry data needed for purposes of this study.

Well- and Spring-Numbering System

The numbering system used by the U. S. Geological Survey in Idaho indicates the location of wells or springs within the official rectangular subdivision of the public lands, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range. The third segment gives the section number, followed by three letters and a numeral, which indicate the quarter section, the 40-acre tract, the 10-acre tract, and the serial number of the well within the tract, respectively. Quarter sections are lettered a, b, c, and d in counterclockwise order from the northeast quarter of each section (fig. 2). Within the quarter sections, 40-acre and 10-acre tracts are lettered in the same manner. Well 6S-5E-10ddd1 is in the SE¼ SE¼ SE¼ sec. 10, T. 6 S., R. 5 E., and was the first well inventoried in that tract. Springs are designated by the letter "S" following the last numeral; for example, 4S-13E-30adb1S.

Use of Metric Units

In this report, metric units are used to present concentrations of water-quality parameters determined by chemical analyses and the temperature of water. Chemical data for concentrations are given in milligrams per liter (mg/l) rather than in parts per million (ppm), the units used in earlier reports of the U. S. Geological Survey. However, numerical values for chemical concentrations given in this report would be essentially the same

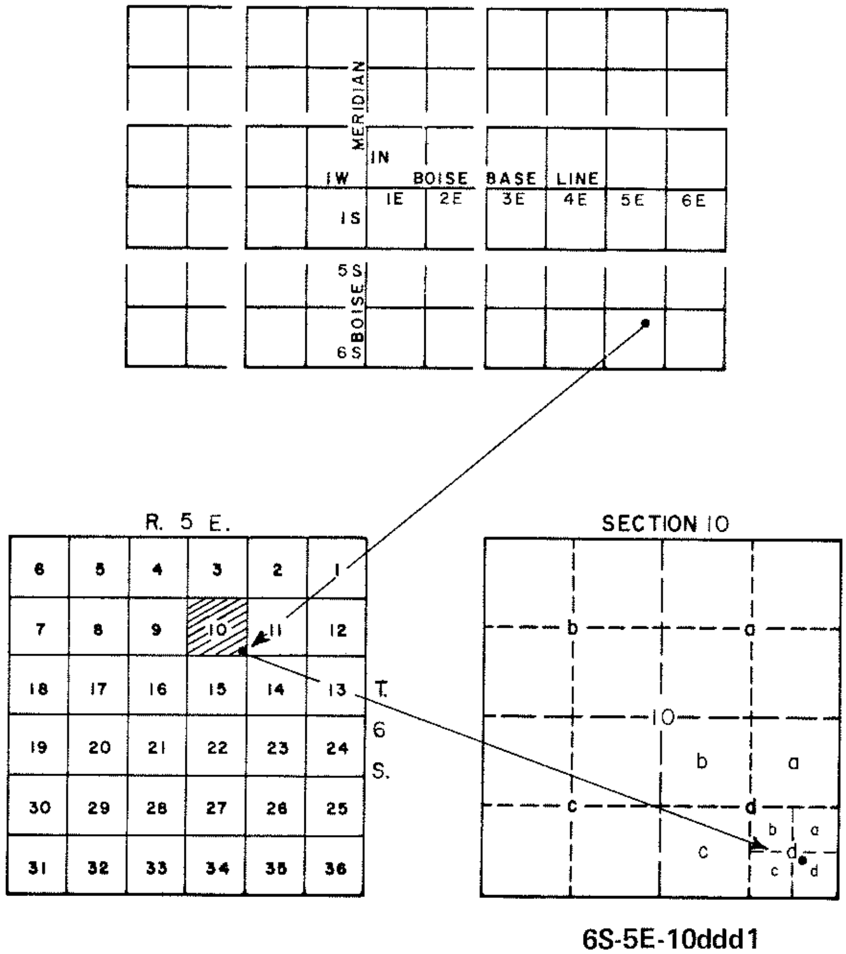


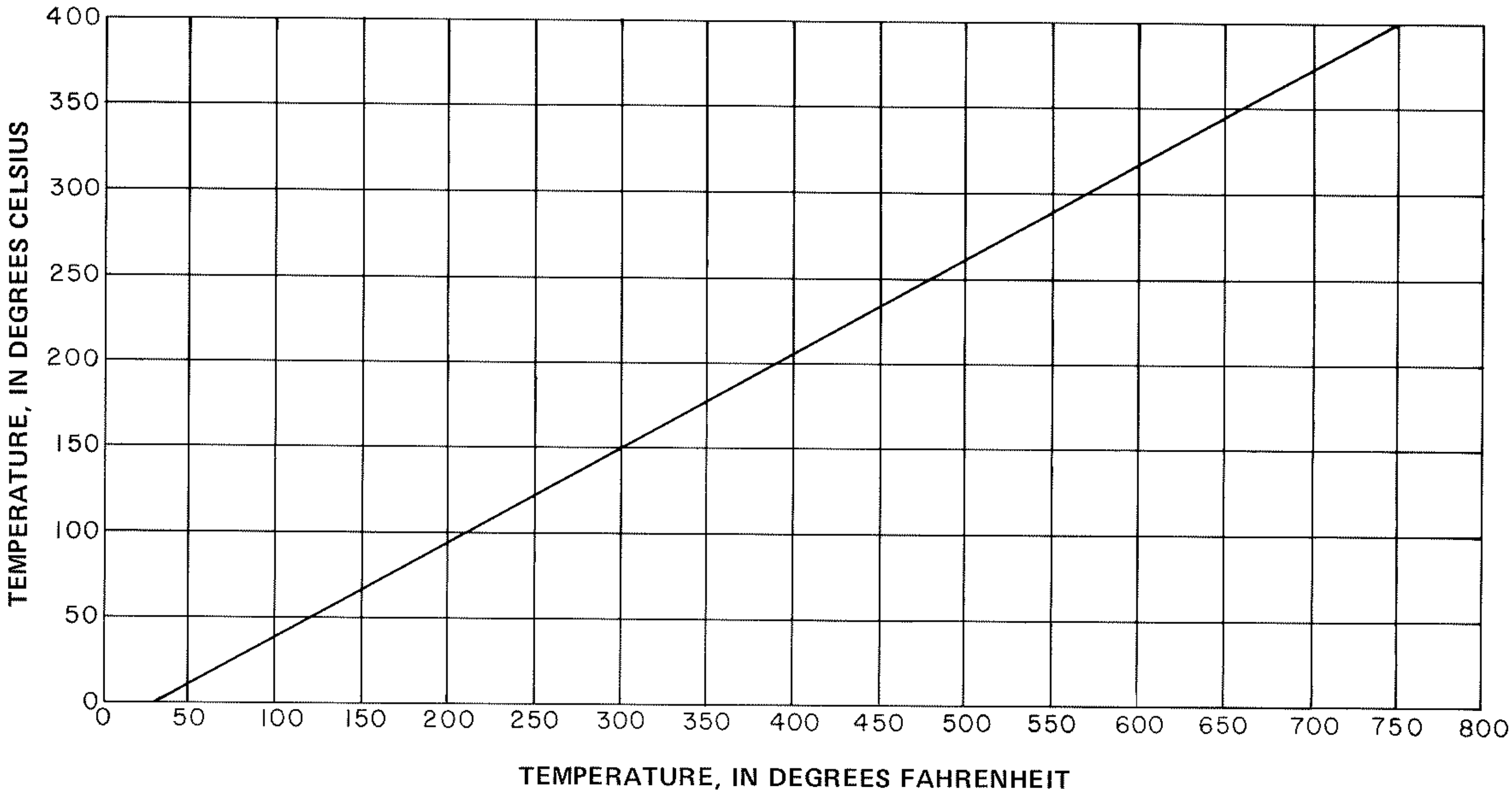
FIGURE 2. Diagram showing the well- and spring-numbering system.

whether reported in terms of milligrams per liter or parts per million. Water temperatures are presented in degrees Celsius (°C). Figure 3 shows the relation between degrees Fahrenheit and degrees Celsius.

METHODS OF DATA COLLECTION

Selection of Sampling Sites

There are at least 380 thermal springs and wells in Idaho (Ross, 1971, p. 47-64). Because the time required to visit all of these was considered excessive, only a limited number of them could be visited, examined, and water samples collected. Generally, selection of the 124 springs and wells visited was made using the following criteria: (1) location within a classified area, figure 1; (2) temperature known or reported to be above 20°C; (3) known or reported water chemistry suggestive of higher temperatures at depth; or



Conversion of degrees Celsius (°C) to degrees Fahrenheit (°F) is based on the equation, °F = 1.8°C + 32.

FIGURE 3. Temperature-conversion graph.

(4) geologic conditions suggesting an association with some inferred heat source. Where several springs or wells were closely grouped, water from the spring or well having the highest water temperature at the surface was preferentially sampled. This procedure was based on the hypothesis that the hottest waters would best reflect conditions at depth. That is, they probably would not have undergone as large a temperature decrease through conduction with the wall rock, alteration of composition by mixing with waters of intermediate levels, flashing to steam, or other alteration processes during their ascent to the surface.

Measurements of Water Quality and Quantity

Field data collected at each sampled site included measurements of pH, water temperature at the surface, and discharge. These measurements were made as close as possible to the spring vent or well discharge pipe. In some instances, only estimates of discharge could be obtained.

Water samples were collected at each spring or well for standard chemical analysis. A separate sample was collected for silica determination. This sample was diluted in the field with distilled water (one-part sample to nine-parts distilled water) to prevent silica polymerization prior to analysis.

Geologic Reconnaissance

A brief geologic reconnaissance made at each site included (1) identification of the lithology at or near the spring vent, and (2) identification of the structural setting of the site with emphasis on faulting and the intersection of fracture zones. Available geologic maps were used to aid understanding of geologic conditions in areas of interest and to determine the age of the rocks. In addition, available drillers' logs were examined to assess well construction, and aquifer or aquifers penetrated by the well.

Active deposition of silicate or carbonate minerals at or near the sample spring or well was noted where possible.

GEOLOGY OF THERMAL-WATER AREAS

General Considerations

The close association of thermal springs with main belts of present or geologically recent volcanic activity was noted by Waring (1965, p. 4). As noted by Waring, the occurrence of thermal waters is most common in extensive areas of lava flows of Tertiary and later geologic age.

Although the association of geothermal activity with specific rock types has not been established, in many areas geothermal phenomena seem more closely associated with acidic volcanic rocks of rhyolitic to dacitic composition, as well as their glassy equivalents, rather than with the more basaltic volcanic types (Healy, 1970, p. 574). The more favorable areas for exploration and development of geothermal steam are probably characterized by recent normal faulting, volcanism, and high heat flow (Grose, 1971, p. 1). Grose further states that thermal springs commonly emerge from faults along caldera margins and that some thermal water areas are indirectly associated with surface or shallow subsurface, time-related volcanism which is not evident in the immediate thermal spring area. The heat source in these areas is believed, in most cases, to come from shallow, magmatic intrusive bodies, that transfer their heat to circulating ground water.

Generalized Geologic Setting of Idaho

The State of Idaho is underlain by rocks of igneous, metamorphic, and sedimentary origins (fig. 4). These formations range in age from Precambrian to Holocene and represent a varied and complex geologic history. Large scale igneous activity has occurred throughout most of the State. Cenozoic lava flows ranging in composition from rhyolite to basalt are exposed in most of the western, central, and southern parts of the State, while Mesozoic and Cenozoic granitic rocks are the predominant rock type of large areas of central Idaho. Marine sedimentary rocks of Paleozoic age are the principal rock type of southeastern Idaho, while metamorphic rocks of Precambrian age are exposed in northern and east-central Idaho.

For purposes of this report the geology of the State of Idaho is divided into nine map units. Each unit was selected on the basis of age and lithologic considerations. The areal distribution and descriptions of these units are given in figure 4.

Although the occurrence of thermal activity and its association to a particular rock type in Idaho is obscure, known thermal anomalies are limited to the central and southern parts of the State. The occurrence and associated rock type of sampled springs and wells is discussed in the following sections.

Inventoried Springs and Wells

A brief description of the geology, including the age and lithology of the spring vent or aquifer, and where possible, the controlling structure, and the active deposition at each spring and well is given in table 1. These descriptions indicate that thermal springs and wells throughout the State issue from a great diversity of rocks types of nearly all ages. However, the lithology and age of the spring vent or aquifer may not be indicative of the aquifer from which the thermal waters originate. Many thermal springs in central Idaho occur in association with fault zones in Cretaceous and Tertiary granitic and related rocks, whereas springs and wells along the margins of the Snake River Plain occur in Cenozoic basaltic and rhyolitic lava flows and associated sedimentary rocks. In southeastern Idaho, springs and wells are primarily associated with fault zones in Paleozoic marine sedimentary rocks that may, in places, be overlain by unconsolidated valley fill.

TABLE 1

GEOLOGIC ENVIRONMENT OF SELECTED SPRINGS AND WELLS IN IDAHO

(Dash in column indicates unknown or not observed.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
ADA COUNTY								
5N 1E 35aca1	Pliocene and Pleistocene sediments	-	-	-	-	Flowing well	Savage, 1958	
4N 2E 29acd1	Pliocene and Pleistocene sediments	-	-	-	-	Flowing well; slight sulfur odor	Savage, 1958	
3N 2E 12cdd1	Pliocene and Pleistocene sediments	Northwest trending fault	Yes	Yes	-	Flowing well; sulfur odor	Savage, 1958	
ADAMS COUNTY								
White Licks Hot Springs 16N 2E 33bcc1S	Quaternary alluvium, probably less than 5 feet thick, near Miocene basalt and Cretaceous granitic rocks	-	-	Yes	Yes	Numerous spring vents; gas present in several vents; sulfur odor; temperature range 63 to 65°C	Waring, 1965	1
Zim's Resort Hot Springs 20N 1E 26ddb1S	Quaternary alluvium near Miocene basalt	Northwest trending normal fault	-	Yes	Yes	Slight sulfur odor	Hamilton, 1969	
Krigbaum Hot Springs 19N 2E 22cca1S	Cretaceous granitic rocks near Miocene basalt	Northeast trending normal fault	-	Yes	-	Two spring vents; temperature of 40 and 43°C	Newcomb, 1970	
Starkey Hot Springs 18N 1W 34dbb1S	Miocene basalt	-	-	Yes	Yes	Seven spring vents; sulfur odor; secondary calcite in basalt near spring vents	Livingston and Laney, 1920	
BANNOCK COUNTY								
5S 34E 26dab1	Pliocene and Pleistocene sediments (?)	-	-	Yes	-	Flowing well; slight sulfur odor; driller's log available	Ross, 1971	2
Lava Hot Springs 9S 38E 21ddab1S	Paleozoic quartzite and younger travertine	Fault	-	Yes	Yes	Numerous spring vents	Stearns and others, 1938	3
Downata Hot Springs 12S 37E 12cdc1S	Quaternary alluvium near Tertiary sediments	-	-	-	Yes (?)	-	Norvitch and Larson, 1970	
BEAR LAKE COUNTY								
Bear Lake Hot Springs 15S 44E 13cca1S	Paleozoic limestone	North trending fault	-	Yes	-	Numerous spring vents; sulfur odor	Dion, 1969	4
BLAINE COUNTY								
1S 17E 23aab1	Quaternary alluvium (?)	-	-	Yes	-	Flowing well; sulfur odor; driller's log available	Smith, 1959	5

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
			BLAINE COUNTY (Cont'd.)					
Guyer Hot Springs 4N 17E 15aac1S	Paleozoic limestone	Northwest trending fault (?)	Yes	Yes	Yes	Numerous spring vents; hydrogen sulfide odor; temperature range 55 to 70½$^{\circ}$C	Umpleby and others, 1930	
Clarendon Hot Springs 3N 17E 27dcb1S	Paleozoic quartzite	-	-	-	Yes (?)	Numerous spring vents; sulfur odor; temperature range 42 to 47°C	Umpleby and others, 1930	
Hailey Hot Springs 2N 18E 18dbb1S	Paleozoic limestone	-	Yes	-	Yes	Numerous spring vents; sulfur odor	Umpleby and others, 1930	
Condie Hot Springs 1S 21E 14dd1S	Quaternary alluvium near Pleistocene basalt	-	-	Yes	Yes (?)	-	Stearns and others, 1938	
1S 22E 1da1S	Quaternary alluvium near Holocene basalt and Paleozoic quartzite	-	-	Yes	Yes	Three spring vents	Ross, 1971	
			BOISE COUNTY					
Bonneville Hot Springs 10N 10E 31c1S	Cretaceous granitic rocks	-	Yes	Yes	-	Eight spring vents and numerous seeps; slight sulfur odor; temperature range 68 to 85°C; granitic rock silicified in places	Waring, 1965	6
9N 3E 25bac1S	Cretaceous granitic rocks	-	Yes	Yes	-	One vent; slight sulfur odor	Waring, 1965	7
Kirkham Hot Springs 9N 8E 32cac1S	Cretaceous granitic rocks	-	Yes	Yes	Yes	Numerous spring vents; temperature range 48 to 65°C	Waring, 1965	
8N 5E 1bcb1S	Quaternary alluvium overlying Cretaceous granitic rocks	-	-	-	-	-	Anderson, 1947	
8N 5E 10bdd1S	Cretaceous granitic rocks	-	-	-	-	-	Anderson, 1947	
			BONNEVILLE COUNTY					
1N 43E 9cbb1S	Quaternary alluvium with travertine deposits near Paleozoic limestone	Northwest trending fault	-	Yes	Yes	Six spring vents; sulfur odor; temperature range 23 to 25°C	Jobin and Shroeder, 1964	8
			BUTTE COUNTY					
3N 25E 32cdd1	Pleistocene basalt	-	-	-	-	Driller's log available	-	
3N 27E 9abb1	Pleistocene basalt and sediments	-	-	-	-	Driller's log available	Ross, 1971	

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
				CAMAS COUNTY				
Wardrop Hot Springs 1N 13E 32abb1S	Quaternary alluvium near Pleistocene basalt and Cretaceous granitic rocks	-	-	-	Yes	Numerous spring vents	Walton, 1962	5
Worswick Hot Springs 3N 14E 28ca1S	Cretaceous granitic rocks	-	Yes	Yes	-	Numerous spring vents; granitic rock silicified in places; possible intersection of faults	Umpleby, 1913	
Elk Creek Hot Springs 1N 15E 14ada1S	Cretaceous granitic rocks near contact with Oligocene silicic volcanic rocks	-	-	Yes	-	Five spring vents and numerous seeps; temperature range 43 to 53½°C	Walton, 1962	
1S 12E 31cbc1	Quaternary alluvium	-	-	-	-	Flowing well	Walton, 1962	
1S 13E 27ccb1	Quaternary alluvium	-	Yes	-	-	Flowing well; driller's log available	Walton, 1962	
Barron's Hot Springs 1S 13E 34bcc1S	Quaternary alluvium near Pleistocene basalt and Cretaceous granitic rocks	-	-	Yes	Yes	Numerous spring vents; temperature range 62 to 71°C	Walton, 1962	
				CANYON COUNTY				
2N 2W 34abc1	Pliocene and Pleistocene sediments	-	-	-	-	Sulfur odor; driller's log available	Savage, 1958	
				CARIBOU COUNTY				
6S 41E 19baa1S	Quaternary travertine	West trending fault (Pelican fault)	-	Yes	Yes	Ten spring vents; slight sulfur odor; temperature range 34 to 42°C	Mansfield, 1927	9
Soda Springs 9S 41E 12add1S	Holocene travertine near Pleistocene basalt	North trending thrust fault	-	Yes	Yes	Numerous spring vents; slight sulfur odor; temperature range 24 to 31°C	Armstrong, 1969	
				CASSIA COUNTY				
15S 26E 23bbc1	-	-	-	Yes	Yes (?)	Flowing well; slight sulfur odor	Stearns and others, 1938	10
15S 26E 23ddc1	Pleistocene sediments	-	-	Yes	Yes (?)	Flowing well; driller's log available	Nace and others, 1961	10
11S 25E 11cca1	Precambrian quartzite	North trending fault	Yes	Yes	-	Flowing well; sulfur odor; driller's log available	Crosthwaite, 1957	
14S 21E 34bdc1	Pliocene silicic volcanic rocks	-	-	Yes	-	Flowing well; sulfur odor; driller's log available	Piper, 1923	

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
			CASSIA COUNTY (Cont'd.)					
Oakley Warm Spring 14S 22E 27dcb1S	Precambrian quartzite	-	-	-	Yes (?)	Slight sulfur odor	Anderson, 1931	
15S 24E 22ddb1	-	-	-	Yes	-	Flowing well	Ross, 1971	
			CLARK COUNTY					
Warm Springs 11N 32E 25aac1S	Quaternary alluvium near Paleozoic limestone	-	-	-	-	Twelve spring vents; temperature range 26 to 29°C; travertine deposits near spring vents	Stearns and others, 1939	
Lidy Hot Springs 9N 33E 2bbc1S	Miocene and Pliocene silicic volcanic rocks	North trending fault	-	Yes	Yes (?)	Travertine deposits near spring vents	Stearns and others, 1939	
			CUSTER COUNTY					
8N 17E 32bca1S	Quaternary alluvium near Tertiary silicic volcanic rocks	-	-	Yes	Yes	Numerous spring vents; hydrogen sulfide odor; temperature range 40 to 54°C; secondary quartz in volcanic rocks near spring vents	Waring, 1965	11
14N 19E 34daa1	-	-	-	-	-	Flowing well	-	
Sunbeam Hot Springs 11N 15E 19c1S	Cretaceous granitic rocks	-	Yes	Yes	Yes	Numerous spring vents; slight hydrogen sulfide odor; temperature range 65 to 76°C	Choate, 1962	
Sullivan Hot Springs 11N 17E 27bdd1S	Contact between Oligocene silicic volcanic rocks and Paleozoic dolomite and argillite	-	-	Yes	Yes	Hydrogen sulfide odor	Ross, 1937	
Barney Hot Springs 11N 25E 23cab1S	Quaternary alluvium	-	-	-	Yes	-	Waring, 1965	
Stanley Hot Springs 10N 13E 3cab1S	Quaternary alluvium near Cretaceous granitic rocks	Northeast trending fault	-	Yes	Yes	Six spring vents and numerous seeps; hydrogen sulfide odor; temperature range 31 to 41°C	Choate, 1962	
Slate Creek Hot Springs 10N 16E 30a1S	Paleozoic argillite	-	-	Yes	Yes	Eight spring vents; hydrogen sulfide odor; temperature range 32 to 50°C	Ross, 1937	
			ELMORE COUNTY					
5S 8E 34bdc1	Pliocene and Pleistocene sediments (?)	-	-	Yes	Yes	Flowing well; hydrogen sulfide odor	Ralston and Chapman, 1968	12

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
			ELMORE COUNTY (Cont'd.)					
Neinmeyer Hot Springs 5N 7E 24b1S	Cretaceous granitic rocks	-	Yes	-	Yes (?)	Thirteen spring vents; gas present at one vent; temperature range 68 to 76°C	Waring, 1965	
Dutch Frank's Spring 5N 9E 7b1S	Cretaceous granitic rocks	-	Yes	Yes	Yes (?)	Numerous spring vents; gas present at one vent; temperature range 53 to 65°C	Waring, 1965	
Paradise Hot Springs 3N 10E 33bd1S	Cretaceous granitic rocks	-	-	-	Yes	Several spring vents	Waring, 1965	
3S 8E 36cda1	Pliocene and Pleistocene sediments (?)	-	-	-	-	Flowing well	Dion and Griffiths, 1967	
Latty Hot Springs 3S 10E 31ddb1S	Pleistocene basalt	Northwest trending fault	-	-	-	-	Malde and others, 1963	
4S 8E 36bba1	Pliocene and Pleistocene sediments	-	-	-	-	Slight hydrogen sulfide odor; driller's log available	Ralston and Chapman, 1968	
4S 9E 8ab1	Pliocene and Pleistocene sediments and basalt	-	-	Yes	-	Flowing well; driller's log available	Ralston and Chapman, 1968	
5S 10E 7acd1	Pliocene and Pleistocene sediments (?)	-	-	-	-	Flowing well; slight sulfur odor	Ralston and Chapman, 1968	
5S 10E 32bdb1	Pliocene and Pleistocene sediments (?)	-	-	Yes	-	Flowing well; sulfur odor; driller's log available	Ralston and Chapman, 1968	
			FRANKLIN COUNTY					
Maple Grove Hot Springs 13S 41E 7aca1S	Paleozoic quartzite (?)	North trending fault	-	Yes	Yes	Numerous spring vents; slight sulfur odor	Dion, 1969	13
14S 39E 36ada1	Quaternary alluvium (?)	-	-	-	-	Slight sulfur odor	Dion, 1969	13
Wayland Hot Springs 15S 39E 8bdc1S	Quaternary alluvium with travertine deposits	Northwest trend-fault	-	Yes	Yes	Numerous spring vents	Dion, 1969	13
15S 39E 17bcd1	Quaternary alluvium with travertine deposits	Northwest trending fault	-	Yes	Yes	Flowing well near Squaw Hot Springs	Dion, 1969	13
			FREMONT COUNTY					
Ashton Warm Springs 9N 42E 23dab1S	Pleistocene basalt	-	-	-	-	-	Stearns and others, 1939	14

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
				FREMONT COUNTY (Cont'd.)				
Big Springs 14N 44E 34bbb1S	Quaternary obsidian (rhyolite)	-	-	-	-	Numerous spring vents; temperature range 10½ to 12°C	Hamilton, 1965	
Lily Pad Lake 10N 45E 35abc1S	Tertiary rhyolite ash flows	-	-	-	-	Assumed numerous small seeps; no inflow or outflow channels	Hamilton, 1965	
7N 41E 35cdd1	Tertiary silicic volcanic rocks (?)	-	-	Yes	-	-	-	
				GEM COUNTY				
Roystone Hot Springs 7N 1E 8dda1S	Quaternary alluvium near Miocene basalt	-	-	-	-	Five spring vents	Newcomb, 1970	15
7N 1E 9cdc1S	Quaternary alluvium near Miocene basalt	-	-	-	-	-	Newcomb, 1970	
				GOODING COUNTY				
4S 13E 28ab1	-	-	-	Yes	-	Flowing well	Stearns and others, 1938	
White Arrow Hot Springs 4S 13E 30adb1S	Quaternary alluvium near Pliocene basalt	-	-	Yes	Yes	Four spring vents	Malde and others, 1963	
5S 12E 3aaa1	Pliocene sediments and basalt	-	-	Yes	-	Flowing well; driller's log available	Malde and others, 1963	
				IDAHO COUNTY				
Weir Creek Hot Springs 36N 11E 13b1S	Cretaceous granitic rocks	-	Yes	-	-	Six spring vents; temperature range 44 to 47½°C	Waring, 1965	
Jerry Johnson Hot Springs 36N 13E 18a1S	Cretaceous granitic rocks	-	-	Yes	-	Eight spring vents; temperature range 41 to 48°C	Waring, 1965	
Red River Hot Springs 28N 10E 3d1S	Cretaceous granitic rocks	-	Yes	-	-	Nine spring vents; temperature range 37 to 55°C	Waring, 1965	
Riggins Hot Springs 24N 2E 14dac1S	Quaternary alluvium, probably less than 5 feet thick, overlying Paleozoic and Mesozoic gneiss	North trending normal fault	-	Yes	Yes	Four spring vents and numerous seeps	Hamilton, 1969	
Burgdorf Hot Springs 22N 4E 1bdc1S	Quaternary alluvium near Cretaceous granitic rocks	-	-	Yes	Yes	Two spring vents	Waring, 1965	

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
				JEFFERSON COUNTY				
Heise Hot Springs 4N 40E 25dcb1S	Tertiary silicic volcanic rocks	Northwest trending fault	-	Yes	-	Sulfur odor; extensive travertine deposits	Stearns and others, 1938	8
				LEMHI COUNTY				
Big Creek Hot Springs 23N 18E 22c1S	Cretaceous granitic rocks, altered, strong lineations (?)	-	Yes	Yes	Yes (?)	Fifteen spring vents; slight sulfur odor; temperature range 82 to 93°C; travertine deposits below present spring vents	Waring, 1965	16
Salmon Hot Springs 20N 22E 3abd1S	Contact between Oligocene basalt and older tuffaceous rocks	Northeast trending fault	-	Yes	-	Three spring vents	Forrester, 1956	17
Sharkey Hot Springs 20N 24E 34ccc1S	Oligocene silicic volcanic rocks	Northwest trending fault	-	Yes	-	Silica deposition along fault trace above spring vent	Anderson, 1957	17
16N 21E 18adc1S	Quaternary alluvium, probably less than 5 feet thick, near Precambrian quartzite	-	-	Yes	-	-	Ross, 1963	18
				MADISON COUNTY				
Green Canyon Hot Springs 5N 43E 6bca1S	Tertiary silicic volcanic rocks	-	-	Yes	-	Travertine deposits below spring vents	Waring, 1965	
				ONEIDA COUNTY				
14S 36E 27cda1S	Quaternary alluvium with travertine deposits	-	-	Yes	Yes	One spring vent	Burnham and others, 1969	19
Pleasantview Warm Springs 15S 35E 3aab1S	Quaternary alluvium	-	-	Yes	-	Numerous spring vents	Burnham and others, 1969	19
Woodruff Hot Springs 16S 36E 10bbc1S	Paleozoic limestone	Northwest trending fault (?)	-	Yes	-	Nine spring vents; temperature range 27 to 32°C	Burnham and others, 1969	19
12S 34E 36bcb1S	Paleozoic limestone	-	-	-	-	Numerous spring vents	Piper, 1924	
				OWYHEE COUNTY				
4S 2E 32bcc1	Pliocene sediments and basalt, and Tertiary silicic volcanic rocks (?)	-	-	-	Yes	Flowing well; sulfur odor	Ralston and Chapman, 1969	20
5S 3E 26bcb1	Pliocene sediments and basalt, and Tertiary silicic volcanic rocks (?)	-	Yes (?)	Yes	Yes	Flowing well	Ralston and Chapman, 1969	20

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
			OWYHEE COUNTY (Cont'd.)					
6S 3E 2ccc1	Pliocene sediments and basalt	-	Yes	Yes	-	Flowing well; sulfur odor; driller's log available	Ralston and Chapman, 1969	20
6S 5E 10ddd1	Pliocene sediments	-	-	Yes	-	Flowing well; driller's log available	Littleton and Crosthwaite, 1957	20
6S 5E 29dcc1	Pliocene sediments	-	-	-	-	Flowing well; slight sulfur odor; driller's log available	Litteton and Crosthwaite, 1957	20
6S 6E 12ccd1	Pliocene sediments	-	-	-	-	Driller's log available	Ralston and Chapman, 1969	20
7S 5E 7abb1	Pliocene silicic volcanic rocks	-	-	Yes	-	Flowing well; driller's log available	Ralston and Chapman, 1969	20
Indian Bathtub Hot Springs 8S 6E 3bdd1S	Contact between Pliocene basalt and overlying tuffaceous rocks	-	-	Yes	-	Numerous seeps along contact; temperature range 37½ to 39°C	Littleton and Crosthwaite, 1957	20
Murphy Hot Springs 16S 9E 24bb1S	Pliocene silicic volcanic rocks	Fault	-	-	-	Two spring vents	Waring, 1965	21
1N 4W 12dbb1	Pliocene sediments	-	-	-	Yes	Flowing well; hydrogen sulfide odor; driller's log available	Ralston and Chapman, 1969	
1S 2W 7ccb1	Pliocene sediments	-	-	Yes	-	Flowing well; slight sulfur odor	Ralston and Chapman, 1969	
4S 1E 34bad1	Pliocene basalt and Tertiary silicic volcanic rocks	-	-	Yes	-	Flowing well; sulfur odor; driller's log available	Ralston and Chapman, 1969	
5S 1E 24ad1	Tertiary silicic volcanic rocks	-	-	Yes	-	Flowing well; slight sulfur odor; driller's log available	Ralston and Chapman, 1969	
5S 2E 1bbc1	Pliocene sediments and basalt (?)	-	-	Yes	Yes	Flowing well; sulfur odor	Ralston and Chapman, 1969	
7S 6E 9bad1	Tertiary silicic volcanic rocks	-	-	Yes	-	Flowing well; sulfur odor	Ralston and Chapman, 1969	
Indian Hot Springs 12S 7E 33c1S	Tertiary silicic volcanic rocks	Northwest trending fault	Yes	-	Yes	Numerous spring vents; sulfur odor	Waring, 1965	
			POWER COUNTY					
Indian Springs 3S 31E 18dab1S	Paleozoic limestone	Northwest trending fault	-	Yes	-	Seven spring vents	Stearns and others, 1938	
10S 30E 13cdc1S	Paleozoic limestone	-	-	-	-	Numerous spring vents; temperature range 34 to 38°C	Ross, 1971	

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No Fig. 6
				TWIN FALLS COUNTY				
Miracle Hot Springs 8S 14E 31acb1S	Quaternary alluvium near Pliocene basalt and older silicic volcanic rocks	-	-	Yes	Yes	-	Malde and others, 1972	
8S 14E 33cba1	Pliocene and Pleistocene sediments and basalt (?)	-	-	Yes	-	Flowing well	Stearns and others, 1938	
11S 19E 33ddd1	Pliocene silicic volcanic rocks	-	-	-	-	Driller's log available	Crosthwaite, 1969a	
Nat-Poo-Paw Warm Springs 12S 17E 31bab1S	Quaternary alluvium near Tertiary silicic volcanic rocks	-	-	Yes	-	-	Crosthwaite, 1969b	
12S 18E 1bba1	Pliocene silicic volcanic rocks	-	-	-	-	Flowing well	Crosthwaite, 1969a	
Magic Hot Springs 16S 17E 31ac1S	Pliocene silicic volcanic rocks	-	-	Yes	Yes	Four spring vents; slight sulfur odor	Ross, 1971	
				VALLEY COUNTY				
Vulcan Hot Springs 14N 6E 11bda1S	Cretaceous granitic rocks	-	Yes	-	Yes	Thirteen spring vents; hydrogen sulfide odor; temperature range 84 to 87°C; debris around some vents appears to be silicified	Waring, 1965	22
Hot Creek Springs 15S 3E 13bbc1S	Quaternary alluvium near Miocene basalt and Cretaceous granitic rocks	-	-	Yes	Yes	Hydrogen sulfide odor	Newcomb, 1970	
Molly's Hot Springs 15N 6E 14acc1S	Cretaceous granitic rocks	-	-	Yes	-	Seven spring vents; temperature range 58 to 59°C	Waring, 1965	
14N 3E 36abd1	Quaternary alluvium near Cretaceous granitic rocks	Northwest trending fault	-	Yes	-	-	Newcomb, 1970	
Cabarton Hot Springs 13N 4E 31cab1S	Cretaceous granitic rocks	Northwest trending fault	-	Yes	Yes	Numerous springs vents; temperature range 56 to 70½°C	Newcomb, 1970	
Boiling Springs 12N 5E 22bbc1S	Cretaceous granitic rocks	Northeast trending fault	Yes	Yes	Yes	Numerous spring vents; temperature range 80 to 86°C	Waring, 1965	
				WASHINGTON COUNTY				
14N 3W 3ddc1	Miocene basalt	-	-	-	-	Flowing well; driller's log available	Newcomb, 1970	1
13N 3W 8ccc1	Miocene basalt	-	-	Yes	-	Flowing well; driller's log available	Walker and Sisco, 1964	1

TABLE 1 (Cont'd.)

Spring or Well Identification Number	Age and Rock Type of Aquifer(s) or Spring Vent(s)	Structure	Active Deposition Siliceous	Active Deposition Carbonates	Gas	Remarks	Principal Reference for Geologic Setting	Area No. Fig. 6
			WASHINGTON COUNTY (Cont'd.)					
11N 6W 10cca1	Miocene basalt	-	-	-	Yes	Flowing well; hydrogen sulfide odor; driller's log available	Newcomb, 1970	23
11N 3W 7bdb1S	Quaternary alluvium, probably less than 5 feet thick, overlying Miocene basalt	Northwest trending fault	-	Yes	-	Two spring vents and numerous seeps; temperature range 54 to 87°C	Newcomb, 1970	23
14N 3W 19cbd1S	Quaternary alluvium near Miocene basalt	-	-	Yes	-	-	Newcomb, 1970	
14N 2W 6bba1S	Quaternary alluvium near Miocene basalt	-	-	Yes	Yes	Numerous spring vents; sulfur odor; temperature range 63 to 70°C	Newcomb, 1970	
13N 4W 13bac1	Miocene basalt	-	-	Yes	-	Flowing well; driller's log available	Walker and Sisco, 1964	

Although nearly one-fifth of the sampled springs issue from known faults, a few of which are shown in figure 4, a greater number are thought to be associated with faulting. Also, some of the wells sampled are known to intersect fault zones. Determination of the geologic structure at many of the springs and wells was not possible from the brief field examination, or from existing geologic maps.

Active deposition of minerals from water discharged by thermal springs and wells occurs throughout the State. Minerals deposited include gypsum, halite, and various carbonates, and silicates. Carbonate deposits were identified using diluted hydrochloric acid while siliceous deposits were identified by hardness and visual examination.

GEOCHEMICAL THERMOMETERS

Summary of Geochemical Thermometers Available

In recent years the concentrations of certain chemical constituents dissolved in thermal waters have been used to estimate water temperatures in the thermal aquifer. However, these geochemical thermometers are useful only if the geothermal system is of the more common hot-water type rather than of the vapor-dominated or steam type, none of which is known to occur in Idaho.

Geochemical thermometers that are useful in describing and evaluating geothermal systems (excluding the sodium-potassium-calcium thermometer) have been summarized by White (1970). Part of his summary is as follows:

"Chemical indicators of subsurface temperatures
in hot-water systems.

Indicator	Comments
1) - SiO_2 content	Best of indicators; assumes quartz equilibrium at high temperature, with no dilution or precipitation after cooling.
2) - Na/K	Generally significant for ratios between 20/1 to 8/1 and for some systems outside these limits; see text.
3) - Ca and HCO_3 contents	Qualitatively useful for near-neutral waters; solubility of $CaCO_3$ inversely related to subsurface temperatures; see text and ELLIS (1970).
4) - Mg; Mg/Ca	Low values indicate high subsurface temperature, and vice versa.

5) - ***	***
6) - Na/Ca	High ratios may indicate high temperatures (MAHON, 1970) but not for high-Ca brines; less direct than 3?
7) - $Cl/HCO_3 + CO_3$	Highest ratios in related waters indicate highest subsurface temperatures (FOURNIER, TRUESDELL 1970) and vice versa.
8) - Cl/F	High ratios may indicate high temperature (MAHON, 1970) but Ca content (as controlled by pH and CO_3^{2-} contents) prevents quantitative application.
9) - ***	***
10) - Sinter deposits	Reliable indicator of subsurface temperatures (now or formerly) $>180^{o}C$.
11) - Travertine deposits	Strong indicator of low subsurface temperatures unless bicarbonate waters have contacted limestone after cooling."

The general principles and assumptions on which the use of geochemical thermometers (White, 1970) is based are: (1) the chemical reactions controlling the amount of a chemical constituent taken into solution by hot water are temperature dependent; (2) an adequate supply of these chemical constituents is present in the aquifer; (3) chemical equilibrium has been established between the hot water and the specific aquifer minerals which supply the chemical constituents; (4) hot water from the aquifer flows rapidly to the surface; and (5) the chemical composition of the hot water does not change as it ascends from the aquifer to the surface.

The fact that these principles and assumptions more often than not can not readily be verified in a field situation requires that the concept of geochemical thermometers be applied with caution and in full recognition of the uncertainties involved. With that understanding, geochemical thermometers provide a useful point of departure for reconnaissance screening and provisional evaluation of thermal areas.

Silica Geochemical Thermometer

The silica method of estimating aquifer temperatures (Fournier and Rowe, 1966) appears to be the most accurate and useful proposed to date. Experimental evidence has established that the solubility of silica in water is most commonly a function of temperature and the silica species being dissolved.

Practical use of the silica geochemical thermometer assumes that there is equilibration of dissolved silica with quartz minerals in high-temperature aquifers and that the equilibrium composition is largely preserved in the silica-bearing thermal waters during their ascent to the surface. White (1970) stated that while equilibrium is generally attained at high aquifer temperatures, silica may precipitate rapidly as waters cool to about 180°C and, therefore, the silica method commonly fails to predict actual aquifer temperatures much above 180°C. The rate of precipitation of silica decreases rapidly as the temperature cools below 180°C.

White (1970) also cautioned against using the silica geochemical thermometer in acid waters which have a low chloride concentration, because at temperatures near or below 100°C these waters are actively decomposing silicate minerals and thereby releasing highly soluble amorphous SiO_2. In this case, the basic assumption of equilibration with quartz would be rendered invalid.

Dilution effects caused by mixing of thermal with non-thermal waters can be a cause of erroneous temperature estimates. Cool ground waters containing low silica concentrations that mix with thermal waters rich in silica would effectively lower the silica concentration of the thermal water and a lower aquifer temperature would be indicated. Generally, as with the other geochemical thermometers described below, the possible effect of both dilution and enrichment of thermal waters on the temperature calculated using any geochemical thermometer must be considered.

The Sodium-Potassium and Sodium-Potassium-Calcium Geochemical Thermometers

The sodium-potassium (Na/K) geochemical thermometer plots the log of the atomic ratios of Na/K against the reciprocal of the absolute temperature. White (1970) stated that ratios are of general significance only in the ratio range between 8/1 and 20/1. He also reported that Na/K temperatures are not significant for most acid waters, although a few acid-sulfate-chloride waters yield reasonable temperatures. Fournier and Truesdell (1973) point out that Ca enters into silicate reactions in competition with Na and K and the amount of Ca in solution is greatly dependent upon carbonate equilibria. Calcium concentration from carbonates decreases as temperature increases, and may increase or decrease as the partial pressure of carbon dioxide increases, depending on pH considerations. Therefore, the Na/K ratio should not be used for purposes of geochemical thermometry when partial pressures of carbon dioxide are large, as higher carbon dioxide partial pressures may permit more Ca to remain in solution and consequently a smaller Na/K ratio. Fournier and Truesdell (1973) suggest that this ratio should not be used when the $\sqrt{M_{Ca}}/M_{Na}$ (square root of molar concentration of calcium/molar concentration of sodium) is greater than 1.

The sodium-potassium-calcium (Na-K-Ca) geochemical thermometer devised by Fournier and Truesdell (1973) is a method of estimating aquifer temperatures based on the molar concentrations of Na, K, and Ca in natural thermal waters. Accumulated evidence suggests that thermal, calcium-rich waters do not give reasonable temperature estimates using Na/K atomic ratios alone, and that the Ca concentration must be given consideration.

Fournier and Truesdell (1973) showed that molar concentrations of Na-K-Ca for most geothermal waters cluster near a straight line when plotted as the function $\log K^* = \log (Na/K) + \beta \log (\sqrt{Ca}/Na)$ versus the reciprocal of the absolute temperature, where β is either 1/3 or 4/3, depending upon whether the waters equilibrated above or below about 100°C and where K^* is an equilibrium constant. For most waters they tested, the Na-K-Ca method gave better results than the Na/K method. It is generally believed that the Na-K-Ca geochemical thermometer will give better results for calcium-rich environments provided calcium carbonate has not been deposited after the water has left the aquifer. Where calcium carbonate has been deposited, the Na-K-Ca geochemical thermometer may give anomalously high aquifer temperatures. Fournier and Truesdell (1973) caution against using the Na-K-Ca geochemical thermometer in acid waters that are low in chloride.

ANALYSES OF DATA

The chemical analyses of thermal spring and well waters sampled for this investigation are given in table 2. The aquifer temperatures estimated by the silica method were obtained by applying the silica concentration in table 2 to the plot of silica concentration versus temperature curves from Fournier and Truesdell (1970, fig. 1, curve A, p. 530). These calculated values of temperature are given in table 3.

Likewise, values of Na, K, and Ca concentrations from table 2 were used to calculate aquifer temperatures and these values are also given in table 3. Values of the various atomic ratios calculated for each sampled spring or well are given in the remainder of table 3. The estimated aquifer temperatures that are given in table 3 are also shown in figure 5.

Most thermal waters in Idaho are low in dissolved solids with concentrations in sampled waters ranging from 14 to 13,700 mg/l. Thermal waters in the southeastern part of Idaho are higher in dissolved solids than thermal waters in other parts of the State. Waters which are high in dissolved solids generally give high Na-K-Ca temperatures relative to silica temperatures (table 3) whereas waters low in dissolved solids give high silica temperatures relative to low Na-K-Ca temperatures.

Measured temperatures of sampled waters ranged from 12°C in northern Fremont County to 93.0°C in Cassia and Lemhi Counties and averaged 50°C for all sampled springs and wells. Examination of the temperature data collected does not reveal any correlation of temperature with location, rock type, or structure.

SUMMARY OF FINDINGS

1. A total of 124 thermal springs and wells was visited and described in Idaho in 1972. At each site, water samples were collected and analyzed, and the geology briefly examined.

2. Of the 124 springs and wells visited, 16 were in the Basin and Range

TABLE 2

CHEMICAL ANALYSES OF THERMAL WATERS FROM SELECTED SPRINGS AND WELLS IN IDAHO

(Chemical constituents in milligrams per liter)

Analyses by: U. S. Geological Survey

Spring or Well Identification Number	Reported Well Depth Below Land Surface (feet)	Sample Collection Date	Discharge (gpm)	Temperature (°C)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (Calculated)	Dissolved Solids (tons per ac-ft)	Hardness as $CaCO_3$	Hardness Non-carbonate	Specific Conductance	pH (field)	Alkalinity as $CaCO_3$	Percent Sodium	Sodium Absorption Ratio	Area No. Fig. 6
ADA COUNTY																										
5N 1E 35aca1		5-31-72	22	40.0	33	4.3	0	49	3.2	112	1	23	0.03	4.9	11	0.05	193	0.26	11	0	285	7.5	94	89	7.4	
4N 2E 29acd1	1,195	5-31-72	-	47.0	46	4.5	.3	55	2.4	145	2	21	.02	4.4	10	.06	225	.31	14	0	311	7.1	122	89	7.1	
3N 2E 12cdd1	400	5-31-72	-	75.0	78	2	0	75	1.3	141	4	23	.01	9.3	24	.08	299	.41	9	0	386	7.3	122	95	13	
ADAMS COUNTY																										
White Licks Hot Springs 16N 2E 33bcc1S		6-29-72	30	65.0	110	39	.3	420	17	71	0	660	.05	150	8.8	.07	1,440	1.96	99	40	2,030	7.6	58	88	18	1
Zim's Resort Hot Springs 20N 1E 26ddb1S		6-29-72	-	65.0	64	12	.1	190	3.6	47	9	330	.03	32	2.3	.07	666	.91	30	0	940	8.5	54	92	15	
Krigbaum Hot Springs 19N 2E 22cca1S		6-29-72	40	43.0	73	5.3	.2	140	3.3	81	9	190	.03	26	2.8	.05	490	.67	14	0	668	8.8	81	94	16	
Starkey Hot Springs 18N 1W 34dbb1S		6-27-72	130	56.0	56	4.5	0	86	1.6	60	6	150	.03	14	.9	.05	369	.50	12	0	502	8.6	58	94	12	
BANNOCK COUNTY																										
5S 34E 26dab1	582	7-27-72	15	40.5	20	70	25	150	21	478	0	95	0	87	3.2	.02	706	.96	280	0	1,170	7.7	392	52	3.9	2
Lava Hot Springs 9S 38E 21dda1S		8-15-72	-	44.5	32	120	32	170	39	542	0	110	.04	190	.7	.38	962	1.31	430	0	1,580	6.6	445	43	3.6	3
Downata Hot Springs 12S 37E 12cdc1S		5-17-72	[a]490	43.0	29	43	15	20	9.1	214	0	18	0	20	.4	.5	262	.36	170	0	413	6.7	176	19	.7	
BEAR LAKE COUNTY																										
Bear Lake Hot Springs 15S 44E 13cca1S		5- 9-72	-	47.5	35	210	55	180	61	256	0	800	.01	79	7.1	.56	1,560	2.12	750	540	2,040	6.6	210	32	2.9	4
BLAINE COUNTY																										
1S 17E 23aab1	260	6-21-72	15	70.5	100	22	1.3	330	19	766	0	60	.04	83	13	.06	1,010	1.37	60	0	1,500	6.4	628	89	19	5
Guyer Hot Springs 4N 17E 15aac1S		7-11-72	[a]1,000	70.5	86	2.9	0	84	2.1	51	25	72	.02	11	16	.06	324	.44	7	0	421	8.0	83	95	14	
Clarendon Hot Springs 3N 17E 27dcb1S		7-11-72	100	47.0	80	2.2	.1	81	1.7	29	30	68	.01	11	15	.06	303	.41	6	0	400	8.2	74	96	15	
Hailey Hot Springs 2N 18E 18dbb1S		7-11-72	70	[b]59.0	85	2	0	68	1.5	88	0	51	.02	10	12	.07	273	.37	5	0	337	8.7	72	96	13	
Condie Hot Springs 1S 21E 14dd1S		8- 8-72	346	52.0	28	56	11	63	17	360	0	28	.01	14	1.7	.05	396	.54	190	0	653	7.3	295	40	2	
1S 22E 1da1S		8- 8-72	[a]20	44.0	26	60	12	48	8.9	294	0	63	.03	6.5	2.3	.03	371	.5	200	0	591	7.3	241	33	1.5	
BOISE COUNTY																										
Bonneville Hot Springs 10N 10E 31c1S		8-18-72	363	85.0	100	2.2	.1	67	2.9	58	21	52	.03	7.2	17	.02	306	.42	6	0	377	8.1	83	94	13	6

TABLE 2 (Cont'd.)

Spring or Well Identification Number	Reported Well Depth Below Land Surface (feet)	Sample Collection Date	Discharge (gpm)	Temperature (°C)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (Calculated)	Dissolved Solids (tons per ac-ft)	Hardness as $CaCO_3$	Hardness Non-carbonate	Specific Conductance	pH (field)	Alkalinity as $CaCO_3$	Percent Sodium	Sodium Absorption Ratio	tio Area No. Fig. 6
BOISE COUNTY (Cont'd.)																										
9N 3E 25bac1S		8- 4-72	20	80.0	120	4.5	0	130	4.8	160	0	79	0.02	34	13	0.04	464	0.63	11	0	600	8.1	131	94	17	7
Kirkham Hot Springs 9N 8E 32cac1S		7-14-72	a250	65.0	69	1.9	.1	66	1.3	46	21	45	.02	3	15	.06	245	.33	5	0	322	7.8	73	95	13	
8N SE 1bcb1S		6- 8-72	a2	40.0	48	2.4	.1	66	.9	85	1	42	.01	5.1	3.1	.25	216	.29	6	0	317	8.8	71	95	11	
8N 5E 10bdd1S		8-18-72	70	55.0	59	1.9	0	68	1.1	40	30	38	.02	5.6	14	.04	237	.32	5	0	336	8.6	83	96	14	
BONNEVILLE COUNTY																										
1N 43E 9cbb1S		8-10-72	a70	25.0	11	440	96	1,110	120	1,200	0	390	.04	1,900	1.7	.05	4,650	6.32	1,500	510	7,950	6.3	984	59	12	8
BUTTE COUNTY																										
3N 25E 32cdd1	360	8- 9-72	12	41.0	55	74	24	72	21	322	0	170	.02	21	3.2	.12	599	.81	280	19	898	6.3	264	34	1.9	
3N 27E 9abb1	475	8- 9-72	-	b35.0	33	64	24	31	7.7	315	0	56	.02	22	.8	.98	398	.54	260	0	648	7.2	258	20	.8	
CAMAS COUNTY																										
Wardrop Hot Springs 1N 13E 32abb1S		6-20-72	193	66.0	73	1.4	0	54	3	51	37	12	.03	5.1	4.1	.07	215	.29	4	0	252	8.0	103	94	13	5
Worswick Hot Springs 3N 14E 28ca1S		7-10-72	466	81.0	96	1.8	0	69	1.9	51	28	35	.02	5	15	.07	277	.38	5	0	328	7.3	88	96	14	
Elk Creek Hot Springs 1N 15E 14ada1S		6-21-72	a15	53.5	63	2.3	0	87	1.4	82	15	48	.02	25	19	.06	302	.41	5	0	441	8.2	92	96	17	
1S 12E 31cbc1	400	6-20-72	15	31.0	36	.6	0	32	.3	31	26	3.3	.04	2.1	.8	.03	116	.16	2	0	150	9.2	69	97	11	
1S 13E 27ccb1	190	6-20-72	4	35.0	76	3.2	.1	92	1.3	216	0	6.4	.04	12	11	.04	308	.42	8	0	413	7.4	177	95	14	
Barron's Hot Springs 1S 13E 34bcc1S		6-20-72	31	70.0	77	3.6	.1	99	2.5	226	0	13	.04	15	14	.08	337	.46	10	0	471	7.3	185	94	14	
CANYON COUNTY																										
2N 2W 34abc1	318	6- 9-72	a700	51.0	38	3.5	.1	110	.8	279	0	59	.04	11	4.1	.13	384	.52	9	0	589	7.5	229	97	19	
CARIBOU COUNTY																										
6S 41E 19baa1S		8-15-72	a1,300	42.0	24	660	260	94	240	2,500	0	980	.05	40	1.9	.04	3,530	4.8	2,700	670	4,590	6.8	2,050	6	.8	9
Soda Springs 9S 41E 12add1S		8-15-72	-	31.0	29	640	170	12	23	2,290	0	800	.07	4.9	.5	.03	3,120	4.24	3,000	1,110	3,990	6.3	1,880	1	.1	
CASSIA COUNTY																										
15S 26E 23bbc1	414	5-18-72	58	93.0	90	53	.4	560	22	55	0	57	0	900	5.7	.54	1,720	2.34	130	89	3,050	7.4	45	88	21	10
15S 26E 23ddc1	540	5-18-72	60	b90.0	97	130	.4	1,110	35	36	0	61	.01	1,900	14	.57	3,360	4.57	330	300	6,090	7.7	30	87	27	10
11S 25E 11cca1	447	7-26-72	2,090	60.0	60	8.2	.5	110	3.9	125	0	59	0	55	14	0	372	.51	23	0	574	7.7	103	90	10	
14S 21E 34bdc1		7-26-72	a50	43.0	47	14	1.1	44	9.6	144	0	15	.01	7	1.3	.01	210	.29	39	0	282	8.0	118	65	3	
Oakley Warm Spring 14S 22E 27dcb1S		10-26-72	a10	47.0	70	2.7	0	87	2.2	43	29	22	.03	53	8	.04	295	.4	7	0	421	9.6	84	95	15	
15S 24E 22ddb1	500	7-25-72	100	38.0	44	37	9.3	70	3.1	169	0	33	.03	80	2.9	.56	365	.5	130	0	606	7.4	139	53	2.7	
CLARK COUNTY																										
Warm Springs 11N 32E 25aac1S		8-28-72	1,920	29.0	17	54	19	9.9	2.9	209	0	62	.02	5.3	1	.12	274	.37	210	42	457	7.0	171	9	.3	

Spring or Well Identification Number	Reported Well Depth Below Land Surface (feet)	Sample Collection Date	Discharge (gpm)	Temperature (°C)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (Calculated)	Dissolved Solids (tons per ac-ft)	Hardness as $CaCO_3$	Hardness Non-carbonate	Specific Conductance	pH (field)	Alkalinity as $CaCO_3$	Percent Sodium	Sodium Absorption Ratio	Area No. Fig. 6
CLARK COUNTY (Cont'd.)																										
Lidy Hot Springs 9N 33E 2bbc1S		8-25-72	[a]250	[b]50.0	34	87	16	27	15	179	0	190	0.03	8	6	0.02	471	0.64	280	140	691	6.3	147	16	0.7	
CUSTER COUNTY																										
8N 17E 32bca1S		7-12-72	[a]25	51.0	43	21	5.5	100	13	234	0	94	.02	26	8.4	.06	425	.58	72	0	651	6.7	192	71	5.1	11
14N 19E 34daa1	3,000	7-12-72	50	40.0	23	55	21	45	7.6	226	0	130	.01	4	1.1	.1	398	.54	220	38	625	7.3	185	30	1.3	
Sunbeam Hot Springs 11N 15E 19c1S		7-12-72	444	76.0	91	1.5	0	85	2.4	119	0	54	.02	12	15	.06	320	.44	4	0	413	8.5	98	96	19	
Sullivan Hot Springs 11N 17E 27bdd1S		7-12-72	70	41.0	38	49	11	170	15	554	0	26	.02	57	1.8	.06	640	.87	170	0	1,070	7.0	454	66	5.7	
Barney Hot Springs 11N 25E 23cab1S		7-13-72	170	[b]28.5	18	37	20	9	1.5	181	0	35	.03	4	.5	.25	215	.29	170	26	364	7.8	148	10	.3	
Stanley Hot Springs 10N 13E 3cab1S		7-12-72	110	41.0	55	2.2	.1	60	.5	30	28	31	.01	5	14	.05	211	.29	6	0	293	8.8	71	95	11	
Slate Creek Hot Springs 10N 16E 30a1S		7-11-72	185	50.0	86	8.1	.1	83	4.5	110	0	110	.02	7	8.7	.03	362	.49	21	0	437	8.0	90	87	8.0	
ELMORE COUNTY																										
5S 8E 34bdc1	1,320	7- 5-72	2	34.0	58	9.1	1	320	11	797	0	6.5	.04	59	2.2	.04	859	1.17	27	0	1,340	7.7	654	94	27	12
Neinmeyer Hot Springs 5N 7E 24b1S		8-17-72	349	76.0	100	1.1	.1	67	1.8	5	51	31	.03	2.9	10	.02	267	.36	3	0	295	8.5	89	96	16	
Dutch Frank's Spring 5N 9E 7b1S		8-17-72	[a]300	65.0	72	2.2	.2	57	1.2	17	40	30	.03	2.4	10	.02	223	.3	6	0	268	8.6	81	94	9.9	
Paradise Hot Springs 3N 10E 33bd1S		8-29-72	-	56.0	69	1.5	.1	50	1	45	35	17	.03	2.6	3.1	.04	200	.27	4	0	232	9.2	94	96	11	
3S 8E 36cda1	600	8-14-72	[a]700	68.0	86	1.5	0	87	.8	74	50	14	.04	4.5	17	.06	297	.4	4	0	382	8.5	144	98	20	
Latty Hot Springs 3S 10E 31ddb1S		7- 5-72	-	[b]55.0	100	.4	0	54	1.7	90	33	10	.04	2.7	7	.07	248	.34	1	0	243	8.4	117	98	29	
4S 8E 36bba1	1,900	6- 6-72	8	38.0	86	3.2	.2	160	3.7	447	0	5.4	.05	10	3	.06	491	.67	10	0	703	7.8	364	96	22	
4S 9E 8ab1	1,003	8-29-72	-	62.0	85	.9	0	82	.8	81	41	14	.03	3.2	16	.05	283	.38	2	0	387	9.2	135	98	24	
5S 10E 7acd1	1,300	6-19-72	-	32.0	42	2.5	0	79	.9	115	16	12	.03	6.1	20	.03	235	.32	6	0	367	8.5	121	96	14	
5S 10E 32bdb1	935	6-22-72	54	37.5	46	2.5	.2	130	.9	270	8	2.5	.03	29	13	.06	365	.5	6	0	590	7.9	235	97	22	
FRANKLIN COUNTY																										
Maple Grove Hot Springs 13S 41E 7aca1S		5-10-72	350	76.0	55	89	24	490	110	491	0	260	.04	630	1.1	.07	1,900	2.58	320	0	3,160	7.3	403	70	12	13
14S 39E 36ada1	40	5-11-72	-	44.5	80	25	7.1	360	24	524	0	15	.05	320	10	1.5	1,110	1.51	92	0	1,890	7.3	430	8.7	16	13
Wayland Hot Springs 15S 39E 8bdc1S		5- 9-72	[a]900	77.0	80	160	16	3,100	660	699	0	50	.06	5,400	12	.81	9,830	13.4	470	0	16,400	7.0	573	84	63	13

TABLE 2 (Cont'd.)

Spring or Well Identification Number	Reported Well Depth Below Land Surface (feet)	Sample Collection Date	Discharge (gpm)	Temperature (°C)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (Calculated)	Dissolved Solids (tons per ac-ft)	Hardness as $CaCO_3$	Hardness Non-carbonate	Specific Conductance	pH (field)	Alkalinity as $CaCO_3$	Percent Sodium	Sodium Absorption Ratio	Area No. Fig. 6
FRANKLIN COUNTY (Cont'd.)																										
15S 39E 17bcd1	22	5-10-72	25	82.0	130	250	23	4,300	880	733	0	54	0.08	7,700	7	1.6	13,700	18.6	720	120	22,200	7.8	601	84	70	13
FREMONT COUNTY																										
Ashton Warm Springs 9N 42E 23dab1S		8-28-72	[a]2	41.0	110	1.1	.1	36	1.6	92	0	4.7	.05	2.9	2.2	.24	205	.28	3	0	166	7.6	75	94	8.8	14
Big Springs 14N 44E 34bbb1S		8-28-72	92,000	12.0	47	5.6	.6	14	3	46	0	3.2	.03	2.5	3.1	.05	102	.14	16	0	102	6.4	38	60	1.5	
Lily Pad Lake 10N 45E 35abc1S		8-30-72	-	[b]17.5	.1	2.6	.4	.5	1	11	0	2.2	.03	1.1	.1	.44	14	.02	8	0	19	7.2	9	10	.1	
7N 41E 35cdd1	350	8- 9-72	-	36.0	75	28	6.3	78	8.6	240	0	33	.02	24	5.4	.79	380	.52	96	0	538	7.9	197	61	3.5	
GEM COUNTY																										
Roystone Hot Springs 7N 1E 8dda1S		11-24-72	[a]20	[b]55.0	120	8.7	.6	160	7.7	187	0	110	.04	62	16	0	577	.78	24	0	799	7.5	153	91	14	15
7N 1E 9cdc1S		8- 4-72	-	45.0	94	15	2.4	99	5.3	169	0	57	.02	30	8	.67	397	.54	47	0	529	7.6	139	80	6.3	
GOODING COUNTY																										
4S 13E 28ab1	160	6-21-72	-	[b]47.0	92	9.8	1.2	100	5.9	278	0	19	.05	8.2	12	.49	373	.51	30	0	497	7.0	207	85	7.9	
White Arrow Hot Springs 4S 13E 30adb1S		5-26-72	826	65.0	97	1.2	0	91	1.6	141	22	15	.03	6.6	12	.11	316	.43	3	0	407	7.5	152	98	23	
5S 12E 3aaa1	692	6-19-72	-	43.0	62	1.6	.1	90	.8	83	42	19	.03	8.4	19	.17	284	.39	4	0	413	8.6	138	97	19	
IDAHO COUNTY																										
Weir Creek Hot Springs 36N 11E 13b1S		8-23-72	[a]40	47.5	49	3.3	0	29	.5	21	22	15	.03	2.1	2.2	.03	134	.18	8	0	148	8.5	54	88	4.4	
Jerry Johnson Hot Springs 36N 13E 18a1S		8-23-72	[a]300	48.0	49	2.7	.2	37	.4	24	25	25	.04	1.9	1.6	.03	155	.21	8	0	186	8.7	61	91	5.9	
Red River Hot Springs 28N 10E 3d1S		8-21-72	35	55.0	76	2.7	0	81	1.6	36	36	44	.01	4.4	23	.04	286	.39	6	0	380	8.6	89	95	14	
Riggins Hot Springs 24N 2E 14dac1S		8- 1-72	[a]50	42.0	72	6.2	.1	160	3.4	11	25	300	.02	8	2.1	.02	582	.79	16	0	812	8.6	51	95	17	
Burgdorf Hot Springs 22N 4E 1bdc1S		8- 1-72	162	45.0	73	2.3	0	49	.8	19	41	18	.02	3	2	.03	199	.27	6	0	218	8.1	84	94	8.9	
JEFFERSON COUNTY																										
Heise Hot Springs 4N 40E 25dcb1S		7-27-72	[a]60	[b]49.0	30	450	82	1,500	190	1,100	0	740	.04	2,400	3.1	.1	5,940	8.08	1,500	560	8,840	6.7	902	66	17	8
LEMHI COUNTY																										
Big Creek Hot Springs 23N 18E 22c1S		7-13-72	[a]75	93.0	150	5.3	.2	220	14	488	0	53	.05	29	15	.07	727	.99	14	0	1,010	7.5	400	94	26	16
Salmon Hot Springs 20N 22E 3abd1S		8-24-72	145	45.0	33	23	11	190	28	565	0	34	.04	50	1.8	.03	649	.88	100	0	1,060	6.3	463	75	8.2	17

TABLE 2 (Cont'd.)

Spring or Well Identification Number	Reported Well Depth Below Land Surface (feet)	Sample Collection Date	Discharge (gpm)	Temperature (°C)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (Calculated)	Dissolved Solids (tons per ac-ft)	Hardness as $CaCO_3$	Hardness Non-carbonate	Specific Conductance	pH (field)	Alkalinity as $CaCO_3$	Percent Sodium	Sodium Absorption Ratio	Area No. Fig. 6
LEMHI COUNTY (Cont'd.)																										
Sharkey Hot Springs 20N 24E 34ccc1S		8-24-72	8	[b]52.0	91	7.3	0.6	270	17	470	0	160	0.02	51	12	0.08	840	1.14	21	0	1,270	7.4	386	93	26	17
16N 21E 18adc1S		8-24-72	[a]20	46.0	37	11	1.4	160	11	339	0	66	.04	26	7	.06	486	.66	33	0	757	7.4	278	88	12	18
MADISON COUNTY																										
Green Canyon Hot Springs 5N 43E 6bca1S		8- 9-72	-	[b]44.0	25	140	32	3.9	3.6	167	0	330	.01	1.7	1.6	.13	621	.84	480	340	846	6.8	137	2	.1	
ONEIDA COUNTY																										
14S 36E 27cda1S		5-16-72	44	25.0	19	240	79	1,200	210	958	0	25	0	2,100	.4	.95	4,350	5.92	920	140	7,590	6.5	786	69	17	19
Pleasantview Warm Springs 15S 35E 3aab1S		5-16-72	3,810	25.0	21	110	33	280	29	331	0	110	0	470	.7	1.5	1,220	1.66	410	140	2,190	6.8	271	58	6	19
Woodruff Hot Springs 16S 36E 10bbc1S		5-11-72	-	27.0	29	130	45	910	87	454	0	58	.03	1,600	.6	1.4	3,090	4.2	510	140	5,370	7.3	372	76	18	19
12S 34E 36bcb1S		5-17-72	189	24.0	33	56	19	15	4.3	226	0	18	0	35	.3	.73	295	.40	220	33	479	6.7	185	13	.4	
OWYHEE COUNTY																										
4S 2E 32bcc1	2,704	6- 6-72	30	42.0	94	4.1	.7	150	8.8	390	0	7.1	.08	15	7.7	.05	479	.65	13	0	689	8.2	320	93	18	20
5S 3E 26bcb1	3,000	6-12-72	[a]280	84.5	110	1.8	0	90	1.5	74	38	74	.02	14	30	.06	416	.57	4	0	522	7.6	124	98	24	20
6S 3E 2ccc1	1,940	6-12-72	489	55.0	92	1.3	0	90	3.9	149	29	25	.02	17	17	.05	369	.05	3	0	506	8.1	171	97	28	20
6S 5E 10ddd1	1,667	6-14-72	4	38.5	70	2.5	.1	120	4.5	165	21	24	.04	15	28	.12	366	.50	6	0	549	8.6	170	96	22	20
6S 5E 29dcc1	1,560	6-14-72	3	34.0	100	6.8	0	92	7	140	0	56	.07	15	15	.03	361	.49	17	0	459	8.0	115	89	9.7	20
6S 6E 12ccd1	990	6-15-72	-	37.0	100	10	.5	170	14	460	0	3.6	.06	18	5.6	.06	548	.75	27	0	833	7.3	377	89	14	20
7S 5E 7abb1	1,625	6-14-72	-	39.0	81	6.3	.1	50	7.2	96	1	18	.04	8.3	9.7	.33	230	.31	16	0	278	8.1	80	81	5.4	20
Indian Bathtub Hot Springs 8S 6E 3bdd1S		7- 3-72	458	39.0	76	5.9	.4	54	7.3	124	2	15	.04	8	8.8	.79	242	.33	16	0	287	8.2	105	82	5.8	20
Murphy Hot Springs 16S 9E 24bb1S		5-23-72	[a]70	51.0	83	.6	0	50	2.0	67	1	4.7	.1	2.3	3.6	.64	163	.22	2	0	137	7.1	57	94	11	21
1N 4W 12dbb1	640	6-13-72	410	35.5	40	2.2	0	110	.3	214	0	8.6	.01	28	7.9	.04	302	.41	5	0	483	7.2	176	98	20	
1S 2W 7ccb1	1,700	6- 5-72	169	45.5	32	1.9	0	120	1.2	187	12	45	.01	19	11	.04	334	.45	5	0	545	8.7	173	98	24	
4S 1E 34bad1	2,960	6- 6-72	-	75.0	83	1.1	.2	98	.7	108	33	40	.03	12	12	.05	333	.45	4	0	454	7.9	144	98	23	
5S 1E 24ad1	3,120	7-24-72	1,060	66.0	82	1.2	.1	100	.8	105	31	45	.23	13	14	.04	339	.46	3	0	459	7.9	138	98	24	
5S 2E 1bbc1	1,800	6- 7-72	30	49.5	68	1.5	0	87	.6	60	54	20	.02	11	5.8	.04	277	.38	4	0	394	8.2	139	98	20	
7S 6E 9bad1	910	6-15-72	153	50.0	93	1.6	0	99	2.8	72	40	27	.06	9.7	22	.05	331	.45	4	0	446	8.2	126	97	22	
Indian Hot Springs 12S 7E 33c1S		6- 2-72	1,730	69.0	75	1.5	0	75	.6	67	30	24	.04	8.4	14	.06	262	.36	4	0	360	8.0	105	97	17	
POWER COUNTY																										
Indian Springs 8S 31E 18dab1S		7-27-72	1,540	32.0	20	76	19	110	10	254	0	19	.02	220	.7	.13	600	.82	270	60	1,100	7.5	208	46	2.9	
10S 30E 13cdc1S		7-27-72	418	38.0	22	92	33	62	14	160	0	23	.02	250	.8	.02	576	.78	370	230	1,110	7.6	131	26	1.4	
TWIN FALLS COUNTY																										
Miracle Hot Springs 8S 14E 31acb1S		5-24-72	[a]350	54.0	93	2.2	0	120	1.5	63	54	29	.03	35	20	.50	388	.53	5	0	560	9.0	142	97	22	

TABLE 2 (Cont'd.)

Spring or Well Identification Number	Reported Well Depth Below Land Surface (feet)	Sample Collection Date	Discharge (gpm)	Temperature (°C)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (Calculated)	Dissolved Solids (tons per ac-ft)	Hardness as $CaCO_3$	Hardness Non-carbonate	Specific Conductance	pH (Field)	Alkalinity as $CaCO_3$	Percent Sodium	Sodium Absorption Ratio	Area No. Fig. 6
TWIN FALLS COUNTY (Cont'd.)																										
8S 14E 33cba1	210	5-24-72	60	59.0	97	1.1	0	100	1.5	88	38	26	0.03	27	15	0.54	351	0.48	3	0	479	8.5	135	98	26	
11S 19E 33ddd1	620	5-25-72	1,930	33.0	63	27	3.9	17	8.6	118	0	12	.04	15	.3	1	209	.28	83	0	266	6.6	97	28	.8	
Nat-Poo-Paw Warm Springs 12S 17E 31bab1S		7-25-72	30	36.0	19	34	14	43	11	266	0	18	.01	8	1.9	.02	280	.38	140	0	469	7.6	218	37	1.6	
12S 18E 1bba1	775	7-25-72	543	38.0	67	18	2	16	6	95	0	9.3	.26	8	.6	.63	176	.24	53	0	198	7.6	78	36	1	
Magic Hot Springs 16S 17E 31ac1S		5-23-72	385	45.5	23	30	8.9	13	4.5	162	0	15	.03	3.8	.3	.42	180	.24	110	0	281	6.4	133	19	.5	
VALLEY COUNTY																										
Vulcan Hot Springs 14N 6E 11bda1S		8- 2-72	[a]500	87.0	120	1.8	.1	94	3	120	0	43	.02	17	24	.05	362	.49	5	0	451	8.5	98	96	18	22
Hot Creek Springs 15N 3E 13bbc1S		8- 2-72	798	[b]34.0	60	1.3	.1	60	.6	17	45	16	.02	16	2.6	0	210	.29	4	0	279	9.8	89	97	14	
Molly's Hot Springs 15N 6E 14acc1S		8- 2-72	[a]20	59.0	87	2	0	70	1.5	48	30	17	.02	10	17	.03	258	.35	5	0	326	7.7	89	96	14	
14N 3E 36abd1	50	8- 3-72	-	42.5	45	1.6	0	58	.4	62	22	17	.04	15	3.8	.09	194	.26	4	0	275	9.2	87	97	13	
Cabarton Hot Springs 13N 4E 31cab1S		8- 3-72	[a]70	70.5	78	1.7	0	100	1.9	70	26	46	.02	49	11	.05	348	.47	4	0	511	7.7	101	97	21	
Boiling Springs 12N 5E 22bbc1S		8- 3-72	165	85.0	94	1.9	.1	71	1.7	81	24	12	.02	12	13	.04	270	.37	5	0	331	8.8	106	95	14	
WASHINGTON COUNTY																										
14N 3W 3ddc1	925	6-28-72	-	25.5	70	2.6	.2	73	6.8	157	16	15	.04	3.8	1	.04	266	.36	7	0	309	8.7	155	91	12	1
13N 3W 8ccc1	963	6-28-72	-	28.0	84	8.7	.8	73	23	225	0	14	.04	3.1	.7	.04	318	.43	25	0	338	8.3	185	74	6.4	1
11N 6W 10cca1	400	6-28-72	1/3	70.0	170	2.7	0	160	5.1	92	19	150	.03	55	4.6	.07	612	.83	7	0	698	8.2	107	96	27	23
11N 3W 7bdb1S		6-30-72	10	87.0	170	27	.7	300	19	198	0	270	.31	190	2.9	.06	1,080	1.47	70	0	1,480	6.8	162	87	16	23
14N 3W 19cbd1S		6-27-72	58	50.0	55	8	.8	80	1.9	81	1	110	.05	15	.8	.30	314	.43	23	0	406	8.5	68	87	7.2	
14N 2W 6bba1S		6-28-72	431	70.0	72	17	.1	200	3.8	24	20	200	.09	140	1.9	.06	667	.91	43	0	1,000	7.8	53	90	13	
13N 4W 13bac1	1,350	6-28-72	-	28.0	73	3.5	.2	86	.7	188	20	14	.03	3.2	.7	.04	294	.4	10	0	375	8.5	188	95	12	

[a] Discharge estimated.

[b] Measured temperature is probably lower than at point of discharge.

TABLE 3

ESTIMATED AQUIFER TEMPERATURES AND ATOMIC RATIOS OF SELECTED CHEMICAL CONSTITUENTS

Spring or Well Identification Number	Discharge (gpm)	Water Temperature at Surface (°C)	Aquifer Temperatures from Geochemical Thermometers °C (rounded to 5°C) [a]Silica	[b]Sodium-Potassium-Calcium	Atomic Ratios: Sodium/Potassium (Na/K)	Calcium/Bicarbonate (Ca/HCO$_3$)	Magnesium/Calcium (Mg/Ca)	Sodium/Calcium (Na/Ca)	Chloride/Bicarbonate plus Carbonate (Cl/HCO$_3$ + CO$_3$)	Chloride/Fluoride (Cl/F)	$\sqrt{\text{Calcium}}$/Sodium $\sqrt{(Ca)}$/Na	Area Number Fig. 6
ADA COUNTY												
5N 1E 35aca1	22	40.0	85	85	26.0	0.058	-	19.9	0.075	0.239	0.154	
4N 2E 29acd1	-	47.0	95	80	39	.047	0.11	21.3	.051	.236	.14	
3N 2E 12cdd1	-	75.0	125	80	98.1	.022	-	65.4	.11	.208	.068	
ADAMS COUNTY												
White Licks Hot Springs 16N 2E 33bcc1S	30	65.0	145	145	42	.836	.013	18.8	3.64	9.13	.054	1
Zim's Resort Hot Springs 20N 1E 26ddb1S	-	65.0	115	85	89.8	.389	.014	27.6	.981	7.46	.066	
Krigbaum Hot Springs 19N 2E 22cca1S	40	43.0	120	95	72.1	.1	.062	46	.496	4.98	.06	
Starkey Hot *Springs* 18N 1W 34dbb1S	130	56.0	110	70	91.4	.114	-	53.3	.364	8.34	.09	
BANNOCK COUNTY												
5S 34E 26dab1	15	40.5	65	185	12.1	.223	.589	3.74	.313	14.6	.203	2
Lava Hot Springs *9S 38E 21dda1S*	-	*44.5*	*80*	*210*	*7.41*	*.337*	*.439*	*2.47*	*.603*	*145*	*.234*	3
Downata Hot Springs 12S 37E 12cdc1S	[c]490	43.0	80	60	3.74	.306	.575	.811	.161	26.8	1.19	
BEAR LAKE COUNTY												
Bear Lake Hot Springs 15S 44E 13cca1S	-	47.5	85	230	5.02	1.25	.432	1.49	.531	5.96	.292	4
BLAINE COUNTY												
1S 17E 23aab1	15	70.5	135	160	29.5	.044	.097	26.1	.186	3.42	.052	5
Guyer Hot Springs 4N 17E 15aac1S	[c]1,000	70.5	130	90	68	.087	-	50.5	.248	.368	.074	
Clarendon Hot Springs 3N 17E 27dcb1S	100	47.0	125	85	81	.115	.075	64.2	.318	.393	.066	
Hailey Hot Springs 2N 18E 18dbb1S	70	[d]59.0	130	85	77.1	.035	-	59.3	.196	.447	.076	
Condie Hot Springs 1S 21E 14dd1S	346	52.0	80	90	6.3	.237	.324	1.96	.067	4.41	.431	
1S 22E 1da1S	[c]*20*	*44.0*	*75*	*65*	*9.17*	*.311*	*.33*	*1.39*	*.038*	*1.51*	*.586*	

TABLE 3 (Cont'd.)

Spring or Well Identification Number	Discharge (gpm)	Water Temperature at Surface (°C)	Aquifer Temperatures from Geochemical Thermometers °C (rounded to 5°C) [a]Silica	[b]Sodium-Potassium-Calcium	Atomic Ratios: Sodium / Potassium (Na/K)	Calcium / Bicarbonate (Ca/HCO_3)	Magnesium / Calcium (Mg/Ca)	Sodium / Calcium (Na/Ca)	Chloride / Bicarbonate plus Carbonate ($Cl/HCO_3 + CO_3$)	Chloride / Fluoride (Cl/F)	$\sqrt{\text{Calcium}}$ / Sodium ($\sqrt{(Ca/Na)}$)	Area Number Fig. 6
					BOISE COUNTY							
Bonneville Hot Springs 10N 10E 31c1S	363	85.0	135	140	39.3	0.058	0.075	53.1	0.156	0.227	0.08	6
9N 3E 25bac1S	20	80.0	150	140	46.1	.043	-	50.4	.366	1.4	.059	7
Kirkham Hot Springs 9N 8E 32cac1S	[c]250	65.0	115	80	86.3	.063	.087	60.6	.077	.107	.076	
8N 5E 1bcb1S	[c]2	40.0	100	65	125	.043	.069	47.9	.102	.882	.085	
8N 5E 10bdd1S	70	55.0	110	75	105	.072	-	62.4	.137	.214	.074	
					BONNEVILLE COUNTY							
1N 43E 9cbb1S	[c]70	25.0	35	190	15.6	.558	.36	4.36	2.72	599	.069	8
					BUTTE COUNTY							
3N 25E 32cdd1	12	41.0	105	90	5.83	.35	.534	1.7	.112	3.52	.434	
3N 27E 9abb1	-	[d]35.0	85	55	6.85	.309	.618	.844	.12	14.7	.937	
					CAMAS COUNTY							
Wardrop Hot Springs 1N 13E 32abb1S	193	66.0	120	155	30.6	.042	-	67.2	.099	.667	.08	5
Worswick Hot Springs 3N 14E 28ca1S	466	81.0	135	95	61.8	.054	-	66.8	.108	.179	.071	
Elk Creek Hot Springs 1N 15E 14ada1S	[c]15	53.5	115	80	106	.043	-	65.9	.442	.705	.063	
1S 12E 31cbc1	15	31.0	85	50	181	.029	-	93	.063	1.41	.088	
1S 13E 27ccb1	4	35.0	120	70	120	.023	.052	50.1	.096	.585	.071	
Barron's Hot Springs 1S 13E 34bcc1S	31	70.0	125	90	67.3	.024	.046	47.9	.114	.574	.07	
					CANYON COUNTY							
2N 2W 34abc1	[c]700	51.0	85	55	234	.019	.047	54.8	.068	1.44	.062	
					CARIBOU COUNTY							
6S 41E 19baa1S	[c]1,300	42.0	70	370	.666	.402	.649	.248	.028	11.3	.993	9
Soda Springs 9S 41E 12add1S	-	31.0	80	35	.887	.425	.438	.033	.004	5.25	7.66	
					CASSIA COUNTY							
15S 26E 23bbc1	58	93.0	135	145	43.3	1.47	.012	18.4	28.2	84.6	.047	10
15S 25E 23ddc1	60	[d]90.0	135	140	53.4	5.5	.005	14.8	90.8	72.7	.038	10
11S 25E 11cca1	2,090	60.0	110	90	48	.10	.1	23.4	.757	2.11	.095	
14S 21E 34bdc1	[c]50	43.0	95	95	7.79	.148	.129	5.48	.084	2.89	.309	
Oakley Warm Spring 14S 22E 27dcb1S	[c]10	47.0	115	90	67.3	.096	-	56.2	1.26	3.55	.069	

TABLE 3 (Cont'd.)

Spring or Well Identification Number	Discharge (gpm)	Water Temperature at Surface (°C)	Aquifer Temperatures from Geochemical Thermometers °C (rounded to 5°C) [a]Silica	[b]Sodium-Potassium-Calcium	Atomic Ratios: Sodium/Potassium (Na/K)	Calcium/Bicarbonate (Ca/HCO_3)	Magnesium/Calcium (Mg/Ca)	Sodium/Calcium (Na/Ca)	Chloride/Bicarbonate plus Carbonate ($Cl/HCO_3 + CO_3$)	Chloride/Fluoride (Cl/F)	$\sqrt{\text{Calcium}}$/Sodium ($\sqrt{(Ca/Na)}$)	Area Number Fig. 6
					CASSIA COUNTY (Cont'd.)							
15S 24E 22ddb1	100	38.0	95	45	38.4	0.333	0.414	3.3	0.815	14.8	0.316	
					CLARK COUNTY							
Warm Springs 11N 32E 25aac1S	1,920	29.0	60	25	5.81	.393	.58	.32	.044	2.84	2.7	
Lidy Hot Springs 9N 33E 2bbc1S	[c]250	[d]50.0	85	65	3.06	.74	.303	.541	.077	.714	1.25	
					CUSTER COUNTY							
8N 17E 32bca1S	[c]25	51.0	90	185	13.1	.137	.432	8.3	.191	1.66	.166	11
14N 19E 34daa1	50	40.0	70	60	10.1	.371	.629	1.43	.03	1.95	.598	
Sunbeam Hot Springs 11N 15E 19c1S	444	76.0	135	130	60.2	.019	-	98.8	.174	.429	.052	
Sullivan Hot Springs 11N 17E 27bdd1S	70	41.0	85	100	19.3	.135	.37	6.05	.177	17	.15	
Barney Hot Springs 11N 25E 23cab1S	170	[d]28.5	60	15	10.2	.311	.891	.424	.038	4.29	2.45	
Stanley Hot Springs 10N 13E 3cab1S	110	41.0	105	45	204	.112	.075	47.5	.147	.191	.09	
Slate Creek Hot Springs 10N 16E 30a1S	185	50.0	130	90	31.4	.112	.02	17.9	.11	.431	.125	
					ELMORE COUNTY							
5S 8E 34bdc1	2	34.0	110	145	49.5	.017	.181	61.3	.127	14.4	.034	12
Neinmeyer Hot Springs 5N 7E 24b1S	349	76.0	135	125	63.3	.335	.15	106	.088	.155	.057	
Dutch Frank's Spring 5N 9E 7b1S	[c]300	65.0	120	70	80.8	.197	.15	45.2	.072	.129	.094	
Paradise Hot Springs 3N 10E 33bd1S	-	56.0	115	75	85	.051	.11	58.1	.056	.449	.089	
3S 8E 36cda1	[c]700	68.0	130	70	185	.031	-	101	.062	.142	.051	
Latty Hot Springs 3S 10E 31ddb1S	-	[d]55.0	135	135	54	.007	-	235	.038	.207	.043	
4S 8E 36bba1	8	38.0	130	125	73.5	.011	.103	87.2	.038	1.79	.041	
4S 9E 8ab1	-	62.0	130	80	174	.017	-	159	.045	.107	.042	
5S 10E 7acd1	-	32.0	90	65	149	.033	-	55.1	.08	.163	.073	
5S 10E 32bdb1	54	37.5	95	70	246	.014	.132	90.7	.179	1.2	.044	
					FRANKLIN COUNTY							
Maple Grove Hot Springs 13S 41E 7aca1S	350	76.0	105	235	7.58	.276	.444	9.6	2.21	307	.07	13
14S 39E 36ada1	-	44.5	125	170	25.5	.073	.468	25.1	1.05	17.1	.05	13

TABLE 3 (Cont'd.)

Spring or Well Identification Number	Discharge (gpm)	Water Temperature at Surface (°C)	Aquifer Temperatures from Geochemical Thermometers °C (rounded to 5°C) [a]Silica	[b]Sodium-Potassium-Calcium	Atomic Ratios: Sodium/Potassium (Na/K)	Calcium/Bicarbonate (Ca/HCO_3)	Magnesium/Calcium (Mg/Ca)	Sodium/Calcium (Na/Ca)	Chloride/Bicarbonate plus Carbonate ($Cl/HCO_3 + CO_3$)	Chloride/Fluoride (Cl/F)	$\sqrt{Calcium}$/Sodium ($\sqrt{Ca}/Na$)	Area Number Fig. 6
					FRANKLIN COUNTY (Cont'd.)							
Wayland Hot Springs 15S 39E 8bdc1S	c900	77.0	125	270	7.99	0.348	0.165	33.8	13.3	241	0.015	13
15S 39E 17bcd1	25	82.0	155	270	8.31	.519	.152	30.	18.1	589	.013	13
					FREMONT COUNTY							
Ashton Warm Springs 9N 42E 23dab1S	c2	41.0	145	90	38.3	.018	.15	57.1	.054	.706	.106	14
Big Springs 14N 44E 34bbb1S	92,000	12.0	95	65	7.94	.185	.177	4.36	.094	.432	.614	
Lily Pad Lake 10N 45E 35abc1S	-	d17.0	<35	20	.85	.36	.254	.335	.172	5.89	11.7	
7N 41E 35cdd1	-	36.0	120	85	15.4	.178	.371	4.86	.172	2.38	.246	
					GEM COUNTY							
Roystone Hot Springs 7N 1E 8dda1S	c20	d55.0	150	150	35.3	.071	.114	32.1	.571	2.08	.067	15
7N 1E 9cdc1S	-	45.0	135	85	31.8	.135	.264	11.5	.305	2.01	.142	
					GOODING COUNTY							
4S 13E 28ab1	-	d47.0	135	100	28.8	.054	.202	17.8	.051	.366	.114	
White Arrow Hot Springs 4S 13E 30adb1S	826	65.0	135	115	96.7	.013	-	132	.07	.295	.044	
5S 12E 3aaa1	-	43.0	115	70	191	.029	.103	98.1	.115	.237	.051	
					IDAHO COUNTY							
Weir Creek Hot Springs 36N 11E 13b1S	c40	47.5	100	35	98.6	.239	-	15.3	.083	.512	.227	
Jerry Johnson Hot Springs 36N 13E 18a1S	c300	48.0	100	35	157	.171	.122	23.9	.066	.636	.161	
Red River Hot Springs 28N 10E 3d1S	35	55.0	120	80	86.1	.114	-	52.3	.104	.103	.074	
Riggins Hot Springs 24N 2E 14dac1S	c50	42.0	120	95	80	.858	.027	45	.378	2.04	.057	
Burgdorf Hot Springs 22N 4E 1bdc1S	162	45.0	120	55	104	.184	-	37.1	.085	.804	.112	
					JEFFERSON COUNTY							
Heise Hot Springs 4N 40E 25dcb1S	c60	d49.0	80	205	13.4	.623	.3	5.81	3.75	415	.051	8

TABLE 3 (Cont'd.)

Spring or Well Identification Number	Discharge (gpm)	Water Temperature at Surface (°C)	Aquifer Temperatures from Geochemical Thermometers °C (rounded to 5°C) aSilica	bSodium-Potassium-Calcium	Atomic Ratios: Sodium/Potassium (Na/K)	Calcium/Bicarbonate (Ca/HCO_3)	Magnesium/Calcium (Mg/Ca)	Sodium/Calcium (Na/Ca)	Chloride/Bicarbonate plus Carbonate (Cl/HCO_3 + CO_3)	Chloride/Fluoride (Cl/F)	$\sqrt{\text{Calcium}}$/Sodium $\sqrt{(Ca/Na)}$	Area Number Fig. 6
					LEMHI COUNTY							
Big Creek Hot Springs 23N 18E 22c1S	c75	93.0	160	175	26.7	0.017	0.062	72.4	0.102	1.04	0.038	16
Salmon Hot Springs 20N 22E 3abd1S	145	45.0	80	205	11.5	.062	.788	14.4	.152	14.9	.092	17
Sharkey Hot Springs 20N 24E 34ccc1S	8	d52.0	135	175	27	.024	.135	64.5	.187	2.28	.036	17
16N 21E 18adc1S	c20	46.0	85	165	24.7	.049	.21	25.3	.132	1.99	.075	18
					MADISON COUNTY							
Green Canyon Hot Springs 5N 43E 6bca1S	-	d44.0	70	5	1.84	1.28	.377	.049	.018	.569	11	
					ONEIDA COUNTY							
14S 36E 27cda1S	44	25.0	65	230	9.72	.381	.542	8.72	.377	2,810	.047	19
Pleasantview Warm Springs 15S 35E 3aab1S	3,810	25.0	65	175	16.4	.506	.494	4.44	2.44	360	.136	19
Woodruff Hot Springs 16S 36E 10bbc1S	-	27.0	80	190	17.8	.436	.57	12.2	6.06	1,430	.046	19
12S 34E 36bcb1S	189	24.0	85	35	5.93	.377	.559	.467	.267	62.5	1.81	
					OWYHEE COUNTY							
4S 2E 32bcc1	30	42.0	135	165	29	.016	.281	63.8	.066	1.04	.049	20
5S 3E 26bcb1	c280	84.5	145	90	102	.037	-	87.2	.214	.25	.054	20
6S 3E 2ccc1	489	55.0	135	150	39.2	.013	-	121	.164	.536	.046	20
6S 5E 10ddd1	4	38.5	115	145	45.4	.023	.066	83.7	.139	.287	.048	20
6S 5E 29dcc1	3	34.0	135	165	22.4	.074	-	23.6	.184	.536	.103	20
6S 6E 12ccd1	-	37.0	135	175	20.6	.033	.082	29.6	.067	1.72	.068	20
7S 5E 7abb1	-	39.0	125	190	11.8	.1	.026	13.8	.147	.459	.182	20
Indian Bathtub Hot Springs 8S 6E 3bdd1S	458	39.0	120	185	12.6	.072	.112	16	.109	.487	.163	20
Murphy Hot Springs 16S 9E 24bb1S	c70	51.0	125	160	25.5	.014	-	87.2	.058	.342	.094	21
1N 4W 12dbb1	410	35.5	85	40	624	.016	-	87.2	.225	1.9	.049	
1S 2W 7ccb1	169	45.5	80	85	170	.015	-	110	.164	.926	.042	
4S 1E 34bad1	-	75.0	125	75	238	.016	.3	155	.146	.536	.039	
5S 1E 24ad1	1,060	66.0	125	80	213	.017	.137	145	.164	.498	.04	
5S 2E 1bbc1	30	49.5	115	65	247	.038	-	101	.165	1.02	.051	
7S 6E 9bad1	153	50.0	135	130	60.1	.034	-	108	.148	.236	.046	
Indian Hot Springs 12S 7E 33c1S	1730	69.0	120	60	213	.034	-	87.2	.148	.322	.059	

TABLE 3 (Cont'd.)

Spring or Well Identification Number	Discharge (gpm)	Water Temperature at Surface (°C)	Aquifer Temperatures from Geochemical Thermometers °C (rounded to 5°C) [a]Silica	[b]Sodium-Potassium-Calcium	Atomic Ratios: Sodium/Potassium (Na/K)	Calcium/Bicarbonate (Ca/HCO_3)	Magnesium/Calcium (Mg/Ca)	Sodium/Calcium (Na/Ca)	Chloride/Bicarbonate plus Carbonate (Cl/HCO_3 + CO_3)	Chloride/Fluoride (Cl/F)	$\sqrt{Calcium}$/Sodium $\sqrt{(Ca/Na)}$	Area Number Fig. 6
					POWER COUNTY							
Indian Springs 8S 31E 18dab1S	1,540	32.0	65	70	18.7	0.456	0.412	2.52	1.49	168.0	0.288	
10S 30E 13cdc1S	418	38.0	70	70	7.53	.875	.591	1.17	2.69	167	.562	
					TWIN FALLS COUNTY							
Miracle Hot Springs 8S 14E 31acb1S	[c]350	54.0	135	85	156	.053	-	95.1	.511	.938	.045	
8S 14E 33cba1	60	59.0	135	110	113	.019	-	158	.367	.965	.038	
11S 19E 33ddd1	1,930	33.0	115	70	3.36	.348	.238	1.1	.219	26.8	1.11	
Nat-Poo-Paw Warm Springs 12S 17E 31bab1S	30	36.0	65	80	6.65	.195	.679	2.2	.052	2.26	.492	
12S 18E 1bba1	543	38.0	115	65	4.54	.288	.183	1.55	.145	7.14	.963	
Magic Hot Springs 16S 17E 31ac1S	385	45.5	70	45	4.91	.282	.489	.755	.04	6.79	1.53	
					VALLEY COUNTY							
Vulcan Hot Springs 14N 6E 11bda1S	[c]500	87.0	150	135	53.3	.023	.092	91	.244	.38	.052	22
Hot Creek Springs 15N 3E 13bbc1S	798	[d]34.0	110	60	170	.116	.127	80.5	.439	3.3	.069	
Molly's Hot Springs 15N 6E 14acc1S	[c]20	59.0	130	85	79.4	.063	-	61	.219	.315	.073	
14N 3E 36abd1	-	42.5	95	45	247	.039	-	63.2	.306	2.12	.079	
Cabarton Hot Springs 13N 4E 31cab1S	[c]70	70.5	125	100	89.5	.037	-	103.0	.874	2.39	.047	
Boiling Springs 12N 5E 22bbc1S	165	85.0	135	90	71	.036	.087	65.1	.196	.495	.07	
					WASHINGTON COUNTY							
14N 3W 3ddc1	-	25.5	115	180	18.3	.025	.127	48.9	.038	2.04	.08	1
13N 3W 8ccc1	-	28.0	130	240	5.4	.059	.152	14.6	.024	2.37	.147	1
11N 6W 10cca1	1/3	70.0	170	140	53.4	.045	-	103	.85	6.41	.037	23
11N 3W 7bdb1S	10	87.0	170	165	26.9	.208	.043	19.4	1.65	35.1	.063	23
14N 3W 19cbd1S	58	50.0	105	65	71.6	.15	.165	17.4	.315	10	.128	
14N 2W 6bba1S	431	70.0	120	80	89.5	1.08	.01	20.5	5.43	39.5	.075	
13N 4W 13bac1	-	28.0	120	50	209	.028	.094	42.8	.026	2.45	.079	

a Using curve A (equilibrium with quartz) Fournier and Truesdell, 1970.

b Fournier and Truesdell, 1973.

c Discharge estimated.

d Measured temperature is probably lower than temperature at point of discharge.

physiographic province (Fenneman, 1931) of southeastern Idaho, 5 were in the Middle Rocky Mountain physiographic province of eastern Idaho, 24 were in the eastern Snake River Plain, and 37 in the western Snake River Plain of the Columbia Plateau physiographic province of south-central and southwestern Idaho and 42 were in the Northern Rocky Mountain phsiographic province of central Idaho. No thermal waters were found north of the Lochsa River in northern Idaho.

3. The kinds and age of rocks supplying water to the springs and wells inventoried are summarized below:

Rock type and age

Sedimentary and metamorphic rocks of Precambrian and Paleozoic age	
Springs	12
Wells	1
Total	13

Silicic volcanic and associated sedimentary rocks of Paleocene to Holocene (?) age	
Springs	12
Wells	31
Total	43

Basalt of Pliocene to Holocene age	
Springs	2
Wells	2
Total	4

Granitic rocks of Cretaceous and Miocene age	
Springs	19
Wells	0
Total	19

Basalt of Miocene and Pliocene age	
Springs	1
Wells	4
Total	5

Surficial deposits of Pleistocene and Holocene age	
Springs	30
Wells	6
Total	36

4. Twenty-eight of the springs and wells visited occurred on or near known fault zones, while a greater number are thought to be related to faulting.

5. The quality of the spring and well waters sampled was, except in a few instances, remarkably good. Dissolved-solids concentrations ranged from 14 to 13,700 mg/l and averaged 812 mg/l. In the southeastern part of the State, where waters were much more heavily mineralized, dissolved-solids concentrations are as much as 13,700 mg/l and average 3,510 mg/l.

6. Measured temperatures of the water at the springs and wells ranged from 12^{o} to 93^{o}C and averaged 50^{o}C. No areal pattern for the distribution of measured temperatures was found.

7. Estimated aquifer temperatures for the waters sampled ranged from 5^{o} to 370^{o}C as estimated by the sodium-potassium-calcium geochemical thermometer and from less than 35^{o} to 170^{o}C as estimated by the silica geochemical thermometer. Estimated temperatures, using both thermometers, showed agreement within

25°C for 42 of the 124 sampled sites. Estimated aquifer temperatures in excess of 140°C were found at 42 of the sites sampled. Generally, for waters high in dissolved solids, the Na-K-Ca geochemical thermometer indicated higher aquifer temperatures than did the silica geochemical thermometer, whereas for waters low in dissolved solids, the silica geochemical thermometer indicated highest temperatures.

8. Deposition of minerals from thermal waters included gypsum, halite, and various carbonates and silicates.

9. Although it was thought that thermal water would be found in or near the Yellowstone KGRA in Idaho, an intensive search of this area failed to reveal the existence of any true thermal waters.

10. Within the Frazier KGRA in southern Idaho, surface temperatures of 93° and 90°C (measured temperature of 90°C is probably lower than temperature at point of discharge) were found at two wells. Estimated aquifer temperatures for water from these two wells are calculated to range from 135° to 145°C. Dissolved-solids concentrations were 1,720 and 3,360 mg/l and the minerals being deposited were chiefly halite and calcite.

FUTURE STUDIES

Selection of areas in which further work will be concentrated in Idaho by the U. S. Geological Survey and the Idaho Department of Water Administration will be based on the data reported herein and on the following considerations:

1. Of the 124 springs and wells inventoried, estimated aquifer temperatures of 140°C or higher are indicated for 42 of the springs and wells listed in table 3. Figure 6 gives the location of the 23 areas in which these springs and wells were found. Two areas shown in figure 6 were selected on the basis of geologic considerations only.

2. Geophysical surveys (gravity and aeromagnetometer) that include most of the areas noted above are available. These surveys, made by the U. S. Geological Survey, will be studied and interpreted as an aid to narrowing down the number of areas to be first studied.

3. Evaluation of the known geology in terms of the structure, lithology and age of the rocks, and the geologic history of the 25 areas shown in figure 6.

4. Areas found to have such things as existing geophysical surveys, detailed geologic maps, available additional hot springs and wells from which water samples can be obtained for analysis, topography suitable for making additional geophysical surveys and for heat studies, and ready accessibility to men and equipment will be in priority over other areas equally promising.

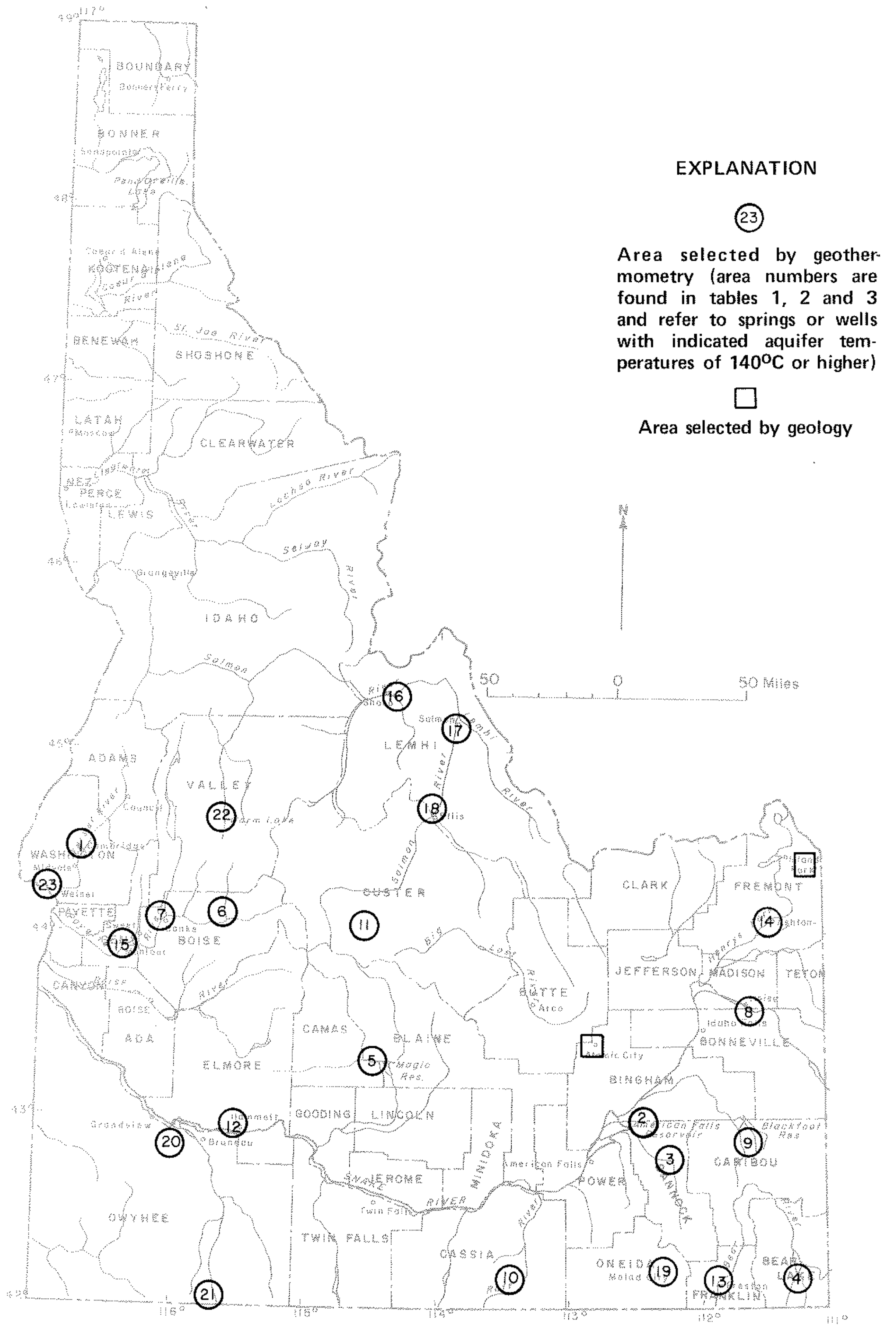


FIGURE 6. Areas selected for future study.

The data collected in the areas selected for immediate study will be aimed toward delineation of the surface area encompassed by the geothermal anomaly, and a preliminary description of the hydrology of the area. Methods used to help delineate the surface expression of the apparent anomaly in an area and the hydrology of the area will include, where possible:

1. Calculation of aquifer temperatures by geochemical thermometers using water samples collected from springs and wells.

2. Analysis of data obtained from heat studies. These heat studies will consist of a series of temperature measurements made at one-meter depths over the suspected area of the anomaly.

3. Geophysical surveys (gravity and aeromagnetometer) and other surveys as needed.

4. Examination and analysis of topographic, climatologic, hydrologic, and geologic maps and well logs to provide such things as information on ways and means of recharge to and discharge from the anomaly, the permeability of rocks in the recharge area, and at depth, and the subsurface structure.

5. Analyses of water samples collected in and around the area for oxygen and hydrogen isotopes. These isotopes are used to indicate the age of ground water and thereby lead to further understanding of the movement of water in the subsurface.

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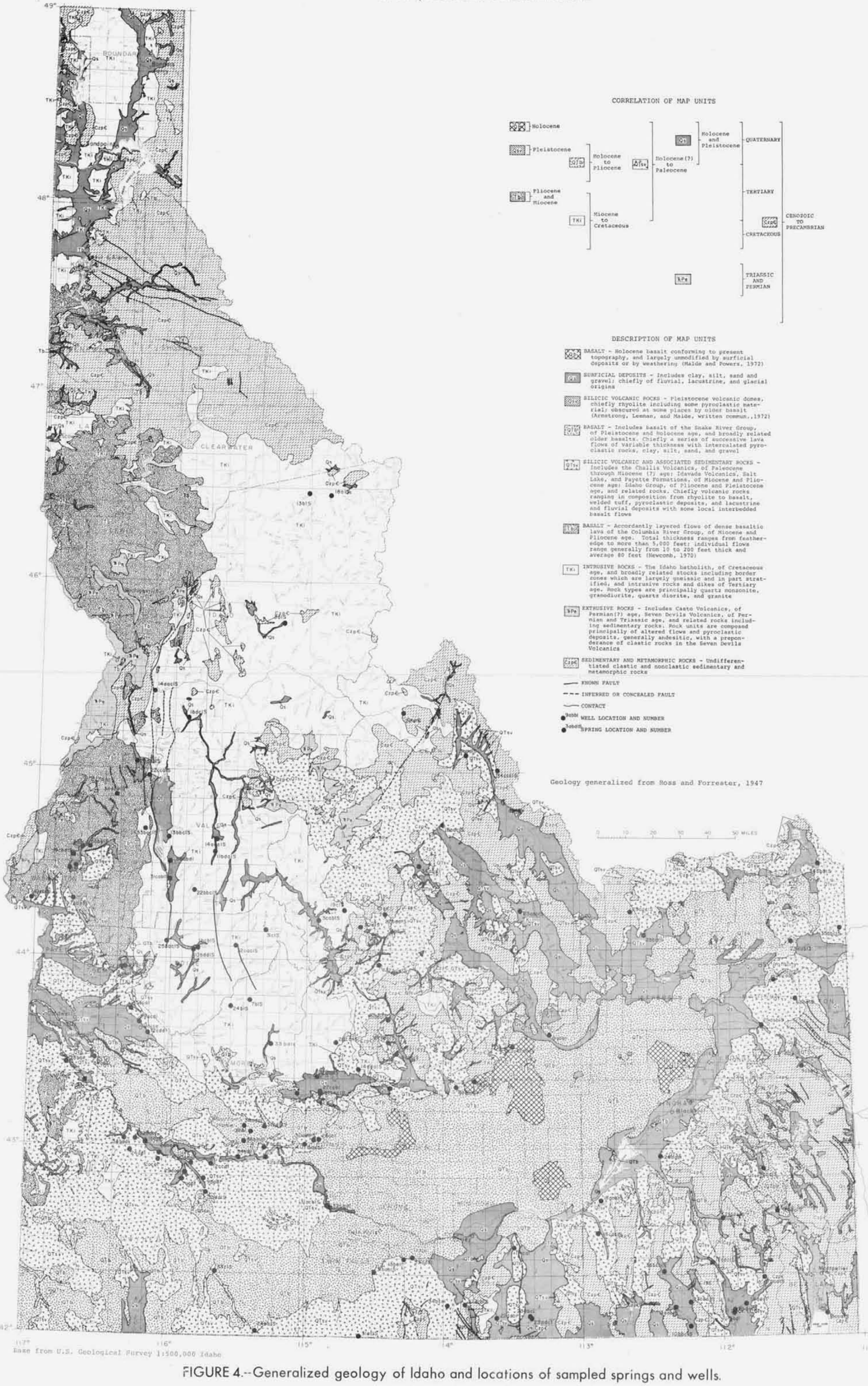

FIGURE 4.--Generalized geology of Idaho and locations of sampled springs and wells.

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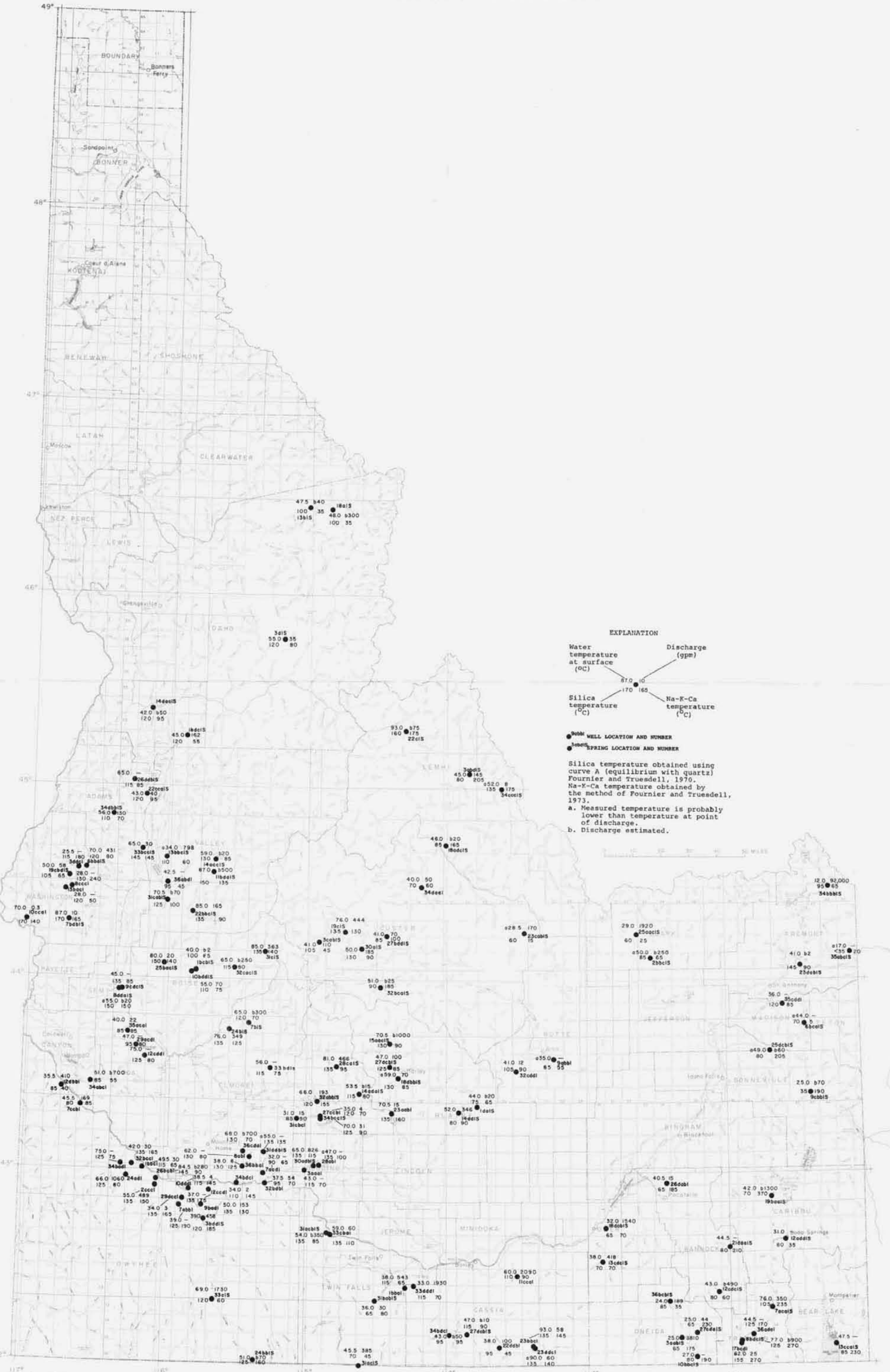

FIGURE 5.--Estimated aquifer temperatures for sampled springs and wells.