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Geothermal Potential of Idaho

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GEOTHERMAL POTENTIAL OF IDAHO

by

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GEO THERMAL POTENTIAL OF IDAHO

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ABSTRACT

The first comprehensive inventory and evaluation of thermal ground water in the State of Idaho shows that such water can be expected in wells and springs almost anywhere along the margins of the Snake River Plain or in valleys south of the Plain. About one-half of the approximately 200 thermal springs in the State emerge from granitic rocks or silicic volcanic rocks along the borders of the Idaho batholith north of the Snake River Plain.

Thermal springs and wells are non-existent in the one region previously considered to have prime geothermal potential--that area of Idaho bordering Yellowstone National Park. Here, although ground-water temperatures are commonly as much as 20° F above the mean annual temperature of 37° F, lack of higher temperatures is caused by high rock permeabilities and large volumes of diluting non-thermal water.

Specific conductances of thermal water from granitic rocks averages between 300 and 400 micromhos/cm at 77° F; average conductance of thermal water from volcanic rocks is somewhat higher. Sodium and bicarbonate are the dominant ions in most water, although a few highly-mineralized springs are of the sodium-chloride type. Much of the water is high in silica and fluoride, even though concentrations of other minerals are low.

Some use of thermal water for space heating pre-dates 1900, although the only thermal water used to generate electricity flows through a small Pelton wheel. It has only been within the last few years that water has been used for individual domestic heating systems and for large commercial greenhouse operations. Power generation from geothermal water will occur only in the future, although space-heating use is expanding rapidly.

GEOHERMAL POTENTIAL OF IDAHO

INTRODUCTION

More than 200 thermal springs are scattered throughout Idaho according to published lists (N. D. Stearns and others, 1937; Waring, 1965). In addition, a large number of wells yield warm or hot water. If the usual United States criterion of 150° F above mean annual temperature is applied, much of the ground water in the State should be listed as thermal. However, in Idaho, water generally is not classified as such until temperatures reach about 80° F.

Idaho (Plate 1), in the northwestern section of the United States, is one of the least populated and most mountainous of States. More than 50 percent of the 184,000 square miles is public domain, and much is used only for range land or recreation. Until the present survey, no systematic attempt had been made to study the occurrence of thermal water.

Some of the earliest reports about the region, such as Peale (1879), mention Idaho thermal springs; later geologic reports, especially those dealing with water resources, discuss (or at least mention) thermal springs within specific areas.

In 1937, N. D. Stearns and others summarized published occurrences of thermal water plus unpublished information from the files of the U. S. Geological Survey. The current study shows that the Idaho portion of this list was very nearly complete; most additional discoveries of thermal water have been in wells drilled since that publication. A recent summary by Waring (1965) contains no information not available in the 1937 publication.

Method of Study

The current reconnaissance study, sponsored by the Idaho Bureau of Mines and Geology, began in 1967. The purpose was to delineate (1) areas of naturally-occurring thermal water, (2) amounts of such water showing at the surface, (3) temperatures and possible sources of heat, (4) chemical compositions of the water, (5) land ownership, (6) present uses of thermal water, and (7) potential uses.

Published locations have been rechecked and corrected or refined where necessary. About 85 percent of the older locations are correct; some springs had been erroneously placed because of the poor quality of then-available maps.

Most springs and wells were sampled, even if previous chemical information were available. Published and unpublished chemical analyses, where available, were compiled.

Some remote springs were not visited because of time limitations and/or because economic potential was estimated to be low.

Method of Presentation

This paper gives a summary, area by area, of the data and conclusions derived from the study. Additional information about most areas can be found in references listed at the end of this report or in files in the office of the Idaho Bureau of Mines and Geology, Moscow, Idaho, U.S.A. Revised lists of thermal areas (Table I) and typical chemical analyses (Table II) are included in this report. The older consecutive numbering system was retained for cross-reference to N. D. Stearns and others, 1937, and to Waring, 1965. Spring areas now dry are noted, but retained on the list.

Most agencies concerned with ground water in Idaho follow the well and spring numbering system used by the Water Resources Division of the U.S. Geological Survey within the State. Because the system (Plate 2) indicates location in an abbreviated form, it is used in this report to supplement the previously-used consecutive numbering system.

Throughout the text, temperatures have been given in degrees Fahrenheit for ease of comprehension. However, in the tables, temperatures are listed in degrees centigrade--a practice becoming more common in scientific publications. References have been assigned consecutive numbers, which are used to identify them as sources of information for springs and wells listed in the tables.

Acknowledgements

Unpublished data, including chemical analyses, pertinent to thermal springs in Idaho are in the files of the Water Resources Division of the U.S. Geological Survey in Boise, Idaho. Additional chemical analyses are from the U.S. Bureau of Reclamation, the Idaho Department of Reclamation, the Idaho Department of Health, and the University of Idaho.

Employees of the Water Resources Division of the U.S. Geological Survey, the U. S. Forest Service, and the Idaho Department of Reclamation supplied information about thermal areas within the State. Local residents and water-well drillers also have been helpful in determining the exact location and extent of thermal anomalies.

USE OF THERMAL WATER

Thermal water has been known in Idaho since the beginning of permanent settlement in the middle 1800's. The most common uses of the State's thermal waters during the past century have been for recreation, irrigation, and space heating.

Recreational Use

More than 30 recreational facilities located around naturally-thermal waters are operating in Idaho. Most of these resorts specialize in recreation, not the health or curative aspects of the water--although most mention it incidentally.

Perhaps the reason that so many of Idaho's thermal resorts are still operating when similar resorts in nearby States have closed is that Idaho is highly oriented toward outdoor recreation. A region that emphasizes camping, hunting, and fishing is a natural

one in which to locate cabins or campgrounds peripheral to swimming pools and hot baths. The pool at Burgdorf (Spring No. 14, Idaho County), South Fork Plunge (31, Valley County), and Paradise Hot Springs (129, Elmore County), among others, cater to outdoor enthusiasts. Non-commercial hot springs near U. S. Forest Service campgrounds are being developed to utilize the thermal water for bathing facilities.

Swimming pools near metropolitan centers draw crowds who come to spend a day or an afternoon. In southwestern Idaho, Warm Springs Resort (82, Boise County) and Givens Hot Springs (159, Owyhee County) draw swimmers and picnickers from the Boise area. Heise Hot Spring (152, Jefferson County) and Green Canyon Hot Spring (153, Madison County) are popular with residents of Idaho Falls and communities to the north. Swimmers from Pocatello patronize either Indian Hot Spring (189, Power County), or Lava Hot Springs (190, Bannock County). Lava Hot Springs is unique in that it supports a "health" resort administered by the State of Idaho.

Irrigation

The largest volumes of thermal water in Idaho are used directly to grow crops. Most of the tillable land of southern Idaho receives less than 15 inches of precipitation per year, and all large sources of water are important for irrigation.

Traditionally, thermal water has been a nuisance for irrigation because it generally must be cooled to 90° F or less before it can be placed on the ground. However, at least one farmer near Grandview (well 5S-3E-28dd, Owyhee County) has experimented, apparently successfully, with applying 131° F water directly to alfalfa. Water is pumped from the well at 154° F and cools only during open flow to the field.

The trend toward sprinkler irrigation, which cools water more rapidly than does furrow irrigation, allows an increased use of thermal water in several areas of southern Idaho. Increased well drilling for irrigation use has been an important factor in the increase of knowledge concerning Idaho's thermal water.

Space Heating--Domestic Usage

One relatively large space-heating operation continues within Idaho. Houses along Warm Springs Avenue in Boise have been heated with 170° F well water (70, Ada County) since 1890. The system supplies hot water to more than 200 customers. A history of this operation can be found in reference 63.

Sun Valley, the world-famous resort in Blaine County, was developed, in part, because of the large number of thermal springs in central Idaho. Here, in addition to the recreational use of warm water, thermal wells and springs supply heat to many of the vacation homes along Warm Springs Creek.

In southwestern Idaho, ever-increasing numbers of persons are drilling wells as a source of water for domestic heat; temperatures range from just over 118° F to more than 158° F. One area near Marsing (Owyhee County) yields thermal water containing enough methane to be collected and used for cooking fuel.

Space Heating--Agricultural Usage

Three greenhouses in Boise use thermal water for growing flowers; water has been used in such operations in the city for more than 50 years. A small greenhouse operation along the Middle Fork of the Payette River in Boise County uses spring 8N-5E-10bd for growing flowers and vegetables.

Large amounts of vegetables have been grown using thermal water for controlling greenhouse temperature only in the last several years. At this time, the principal crop is tomatoes. Two major centers exist. Several producers in Owyhee County use water at temperatures near 104° F. Another operation, in Cassia County, uses 200° F water from well 15S-26E-23dd.

Minor Uses of Thermal Water

During the pioneer era, an important use of very hot water was for scalding and cleaning in butchering operations. Although the practice has been abandoned at most springs and wells, 210° F water from spring (well) 184 in Cassia County is still used in this manner. It is reported that water from some of the springs and wells in Camas County are also used for such purposes.

Thermal water from Twin Springs (84, Boise County), which occurs 90 feet above river level, runs through a small Pelton wheel before discharging into the Boise River. This is the only thermal water in Idaho now used to generate electricity.

Water from spring 34 (Valley County) is used to keep a pond at a lumber mill from freezing during winter months. A 1,700-foot well (6N-7E-35a), (Boise County), at another lumber mill was drilled to supply water for the same purpose. However, water temperature was only 82° F, not high enough to keep the pond open.

GEOLOGY OF THERMAL ANOMALIES

Thermal water is encountered in rocks from Precambrian to Holocene age; the largest number of warm and hot springs in Idaho issue from volcanic or granitic rocks of Mesozoic or Cenozoic age. When the source of the water is other than igneous rocks, it is generally associated with normal faults, which allow for deep circulation and heating of thermal waters. Thermal waters occur in what seem to be discharge areas for both intermediate and regional flow systems as described by Toth (1963).

Although the source of thermal waters in the State typically is obscure, occurrences can be grouped into four general types relative to their associated rocks:

- (1) Water in and around Mesozoic and Tertiary plutons. Most of these occurrences are in or near areas containing large numbers of Tertiary dikes or other Tertiary intrusions; much of the country rock is altered, bleached, or silicified.
- (2) Water in or near fault zones in Tertiary volcanic rocks.
- (3) Water in or near normal faults bordering complexly-folded and faulted mountain ranges composed of pre-Tertiary sedimentary rocks.
- (4) Water moving along aquifers in Tertiary and Quaternary volcanic or sedimentary-filled basins.

Intrusive Igneous Rocks

Central Idaho is underlain dominantly by intrusive rock of the Idaho batholith (Plates 1, 3-8). Although the main part of the batholith has been dated as Cretaceous (average age, 108 m.y.; Larsen and others, 1958, p. 60), smaller batholiths occur in several areas. The most notable of these plutons are the Sawtooth batholith (Reid, 1963) and the batholithic mass along the Middle Fork of the Salmon River (Ross, 1934).

Smaller Tertiary stocks occur in several areas; and Tertiary dikes, both granitic and mafic, are plentiful throughout central Idaho (Plates 3, 5, and 7). Rocks in areas that contain large numbers of dikes are often highly altered and bleached. Thermal springs (as well as important centers of mineralization) seem to be concentrated in such zones of Tertiary intrusions. It is probable that these zones are major fault zones also, but such deformation has not been proven for most of the area.

Volcanic Rock

The Snake River Plain, a great arcuate structural trough, characterizes the topography of southern Idaho. The Plain, actually a plateau ranging from less than 2500 feet to more than 5000 feet above sea level, is underlain by great thicknesses of Cenozoic basalt (Plate 1), some sediments, and, at depth, perhaps Tertiary silicic rocks.

Early to Middle Tertiary silicic rocks crop out around the border of the Plain. They are also common in several other areas of the State, such as near Stanley (Custer County, Plate 5) and Salmon (Lemhi County, Plate 6).

Thermal anomalies are common both in regions of silicic volcanic rocks and in the western part of the Snake River Plain, which is underlain by a combination of basalts and sediments. No thermal anomalies can be measured on the eastern Snake River Plain because of the dilution effects of tremendous volumes of non-thermal water moving nearly horizontally through the basalt aquifers. However, detailed thermal studies at the National Reactor Testing Station in the center of the Plain west of Idaho Falls, indicate that small, but significant, temperature increases occur at depth (Olmstead, 1962).

Other Rocks that Yield Thermal Water

Most of south-central and southeastern Idaho south of the Snake River Plain is typified by broad, open valleys and fault-block mountains composed of pre-Tertiary meta-sedimentary rocks and some Tertiary silicic volcanic rocks (Plates 9 and 12). Similar structures and rock types persist north of the Snake River in west-central Idaho (Plate 4) and in east-central Idaho (Plate 6). Most of the valleys are filled with Tertiary or Quaternary trough sediments, which obscure the locations of presumed faults. Mansfield (1927) and Meinzer (1924b), p. 301) believes that thermal springs along these faults came into existence before the close of the Tertiary.

CHEMICAL QUALITY OF THERMAL WATER

Chemical analyses of Idaho's thermal waters show wide variations in composition (Table II) from one part of the State to another. Within a given region, thermal waters are similar to each other.

Most water, with the exception of that southeast of the Snake River Plain, has a specific conductance (a measure of the total dissolved solids) of less than 1,500 micromhos

/cm at 25° C. Water from springs in granitic rocks averages between 300 and 400 micromhos/cm at 25° C; water from volcanic rocks is somewhat higher. Spring and well waters from the limestone and the valley fill of southeastern Idaho have specific conductances as high as 18,000 micromhos/cm at 25° C.

Virtually all spring and well water is alkaline, with pH's ranging from about 7 to more than 9. Sodium and bicarbonate ions dominate in most samples; water from limestone terrains contains relatively larger amounts of calcium and magnesium ions. (Compare analyses from springs 10, 38, 129, and 167 with analyses from springs 150, 190, and 196).

Sulfate and chloride ions generally are low, except in water from valley-fill sediments in southeastern Idaho.

Silica ranges from about 20 mg/liter (spring 177) to more than 100 mg/l (springs 66 and 174). Most silica is in the 50 to 100 mg/l range. This amount of silica is not unusual in some Idaho non-thermal water either, although within a given region, thermal water tends to contain the higher amounts. Littleton and Crosthwaite (1947, p. 181) point out that "warm alkaline water percolating through...silicic volcanic rocks (or chemically similar granitic rocks)...tends to acquire silica".

SOURCES OF HEAT

One problem that has not been answered satisfactorily is the source of the heat in thermal springs and wells of Idaho.

Sources Suggested in the Literature

Many geologists in Idaho (and elsewhere) have assumed a "normal" gradient of about 1° C per 100 ft. (1.8° F per 100 ft.) of depth and have calculated a minimum depth from which water must have risen. Mansfield (1927, p. 320-321) and Meinzer (1924a, p. 26) used this procedure.

Darton (1920, p. 36-37), in a compiled list of geothermal data for the United States, explained anomalies in Idaho as "due, doubtless, to local volcanic conditions".

Piper (1923, p. 70-71) suggested three possible sources of heat to deep wells (14S-21E-34ab; 15S-21E-4b) in Cassia County:

1. Volcanism and expiring volcanism,
2. Mechanical heating caused by movement along faults; and
3. Migration of water along fault zones from depths where such high temperatures are considered "normal".

Piper's conclusion, published in reports in 1923 and 1924, is that the third hypothesis is most likely the correct one. Volcanism was eliminated because of the relative thinness of the recent flows; mechanical heating was also discarded because any recent movement along faults seems to be minor.

Meinzer (1924b, p. 295-303) believed that most of the thermal water in the southern Idaho-Utah-Nevada region is related to normal faults. He further concluded that although a large number of springs are in regions containing Cenozoic volcanic rocks, many are not closely related to such rocks and do not derive their heat directly from them. Instead, water is heated at depth by underlying magmas (some of which gave rise to the volcanic rocks).

Meinzer (1924b) also believed that the faults and related springs have been in existence since perhaps the Middle Tertiary. Mansfield (1927, p. 318) concurred that many springs of southwestern Idaho are persistent features because of associated spring deposits: "The extent and nature of these (travertine) deposits indicate the former greater activity of the springs and suggest that they were once thermal".

Stevens (1962, p. 33) suggested that higher-than-normal temperatures in wells in Canyon County were caused by "upward leakage of warm water from artesian aquifers (that) raises the temperature of the water in the shallower aquifers".

Walton (1962, p. 29-40) concluded that in the Camas Prairie, Camas County, "... the abnormal gradient... may be caused by hot water or steam that mixes with water in the valley-fill deposits".

Walker and Sisco (1964, p. Q21) believed that the character of water in thermal spring 14N-3W-19cb (Washington County) "...doubtless reflects the hot gas and water rising from depth, reaction (of the thermal water) with the formations at a higher level, and admixture of normal shallow ground water".

Ralston and Chapman (1968, p. 28) stated that the thermal water in Elmore County is heated by deep circulation, with some residual heat supplied from local Late Pleistocene and Holocene volcanic rocks.

Heat-flow Measurements

A study by Blackwell (1969) of heat-flow in the western United States shows that the rate of heat flow in much of the Precambrian metasedimentary rocks of northern Idaho and in Precambrian metasedimentary and Cretaceous granitic rocks in western Montana is higher than average; it is probably similar to the high rate of heat flow in much of the Basin-and-Range region. Data are not yet available for most of Idaho, but Blackwell's regions of known high heat flow completely surround the area of Idaho's thermal springs.

In contrast, heat-flow rates in Tertiary lavas to the west, in western and central Washington State, are nearly normal. Almost no thermal springs are found in these "normal" heat-flow areas.

Summary

In summary, most of the thermal anomalies in Idaho, and perhaps in adjoining areas in neighboring states, are ultimately related to residual heat of deep-seated Cenozoic rock bodies that give rise to overall high heat-flow rates and locally, to extra-high thermal gradients.

The major mechanism for conveying thermal meteoric water and/or steam through the heating cycle is regional (and some intermediate) flow systems modified by major normal faults. Many of the faults have been conduits (aquifers) since Middle Tertiary time. It is impossible to delineate further most of the flow systems and faults that are involved because of the lack of detailed geologic mapping in much of Idaho.

Thermal anomalies in many areas, especially those associated with large volumes of Tertiary and Quaternary valley-fill materials, are "diluted" by water in local or intermediate flow systems that is not influenced by deep-heat sources. Thermal water may be

common beneath the Snake River Plain--one of the greatest aquifers in the United States--but it is masked by large volumes of non-thermal ground water moving horizontally through permeable rocks beneath the surface of the Plain. Thermal anomalies in the Island Park caldera area west of Yellowstone National Park may be undetected for the same reason.

DESCRIPTIONS OF IDAHO GEOTHERMAL AREAS

Idaho's thermal springs and wells are better described by regions than by arbitrary county boundaries as they were in earlier reports by N. D. Stearns and others (1937) and Waring (1965). Plates 3-13, which include most of the important thermal anomalies within the State, show the relation between geology and the anomalies. The geology has been generalized both because of the scale of the maps and because of lack of detailed mapping in many areas. Individual thermal areas will be reviewed in a general northwest-to-southeast pattern. Data concerning springs and wells are shown in Table I and II.

North-central Idaho

North of the Salmon River, in a thousand square-mile area, approximately a dozen springs or groups of springs (1-12) emerge from granitic and related metamorphic rock (Plate 3). "Warmer-than-normal" seeps (60° - 68° F or more) are also reported throughout the region.

Temperatures range from 70° F to 130° F. Although the sampled springs are typified by low total dissolved solids, many serve as "salt licks" for game animals and indicate the almost total lack of salts in the soil and other water of the region.

Most of these thermal springs are remote and are in Wilderness or Primitive areas that restrict motorized traffic. The source of the heat may be at great depth. Both the political-economic outlook and the geology are unfavorable for development, and it is doubtful that any of these springs will be looked at in the near future for either space or power generation.

West-central Idaho

West-central Idaho is typified by Tertiary faulting that cuts across pre-Tertiary metamorphic rock, Cretaceous granitic rock, and Tertiary (mostly Miocene) basalt (Plate 4).

Riggins-Yellow Pine area

Springs in the Riggins-Yellow Pine area are inferred to be along faults; many springs are in high-elevation valleys filled with Tertiary sediments. In addition to the distinct springs, many of the pools in the valleys contain water that is 10° F to 18° F warmer than would be expected in the region.

The most easily accessible thermal spring is Riggins Hot Spring (13), which is a health resort. Bergdorf Hot Spring (14) is also a resort; other springs are relatively remote, but most can be reached on improved dirt roads.

Temperatures range up to 136° F. Mineral content in the springs is low; analyses from springs 14 and 26 (Table II, part 2) seem typical. Some of the land is privately-owned and is being developed for summer homes. Thus, some of the springs might be favorably

for space-heating development. However, until some accurate method is found for determining a heat source in valley fill, random drilling would be the only likely method of exploration.

New Meadows area

One hot and three warm springs are along fault zones in the area bounding New Meadows Valley. Three of the springs are along a northward extension of the Long Valley fault, and the other spring is on the same fault as Riggins Hot Spring (Plate 4).

The best-known spring is 150° F Zims Resort (16). It flows about 100 gpm (gallons per minute) from alluvial fill near the fault contact between Tertiary basalt and granitic rocks. The two springs to the north are only slightly warm at 90° F.

Kreigbaum Hot Spring (17), in metamorphosed granitic rock, flows about 50 gpm at a temperature of 109° F. Specific conductance and geologic occurrence are similar to other New Meadows thermal springs, although Kreigbaum Hot Spring is depositing silica gel and the country rocks are bleached and silicified.

No wells are in proximity with any of these springs, so the areal extent of hot water is unknown. All springs are on private property with easy access. The geology is favorable for exploration by wells along extensions of the major faults.

Weiser River drainage

Two hot springs occur on relatively short north-trending faults in the upper reaches of the Middle Fork of the Weiser River along the west side of the West Mountain fault block. Both springs are approximately 154° F; however, Warm Spring (18) seems typical of most thermal springs in granite, whereas White Licks Hot Spring (19) has an abnormally high mineral content.

At least five other thermal anomalies occur in the 200-square-mile area to the west of these two springs. All are in Quaternary alluvium or Tertiary basalt. It is probable that more thermal water exists in the region and will be discovered through drilling.

South Fork of the Salmon River

It is difficult to count the thermal springs along the South Fork of the Salmon River because a mile-long reach is one continuous thermal-water discharge area. At least nine springs along the river (22-25, 29-33) yield water from granite. Major springs flow from fault intersections. Volume and temperature seem to increase southward. The most spectacular spring is Vulcan Hot Spring (32) which discharges more than 500 gpm at 192° F.

Northward for a mile from South Fork Plunge spring (31) thermal water discharges almost continuously. Other, smaller springs are farther to the north, on a creek to the west, and in alluvium to the east.

The area appears technically promising. Large quantities of very hot water occur in the region, and a large number of faults and shear zones should deliver thermal water to moderate depths.

Cascade (Long Valley) area

The Cascade area has seven distinct thermal anomalies (Plate 4). The hottest water

(140° F to 160° F) is at Cabarton Hot Spring (13N-4E-31cb), the southernmost of the group. This spring flows about 60 gpm from a coarse granite at the intersection of two faults.

The community of Cascade uses water from a 106° F spring (34) to supply the local swimming pool; a lumber mill also uses this water to keep its mill pond from freezing. Two thermal springs (34a, 14N-3E-5a) are now covered by Cascade Reservoir.

The 93° F spring (27) at the head of Hot Creek is used for irrigation and stock water. Badley Warm Spring (15N-4E-20d) is atypical in location because it is near the summit of a stream valley instead of in the lower reaches. However, temperature, conductance, flow, and appearance of the outlet are similar to most of the thermal springs in the region.

Long Valley, as a whole, seems favorable for testing with a drilling program. A gravity map, showing inferred faults and depth of valley fill, is available (Kinoshita, 1962) and some of the surface geology has been mapped. On the negative side of exploration is the great depth of valley fill (as much as 7,000 feet), and the lack of drill data.

Middle Fork of the Payette River (Boiling Springs) area.

Perhaps the best-studied thermal spring in Idaho is Boiling Springs (38) on the Middle Fork of the Payette River. Temperatures range from 180° F to 189° F. Although the specific conductance is only 235 micromhos/cm at 77° F (Table II, part 2), the water contains several metallic ions, including mercury (White, 1967).

Boiling Springs is only 1 of about 8 thermal springs (35-40) in the region. All flow from granitic rocks along shear zones paralleling the river. Springs along the Middle Fork of the Payette River seem to lie along an extension of the same fault that acts as a conduit for springs along the South Fork of the Salmon River (Plate 4).

This region also has good potential for releasing steam or high-temperature water to wells at reasonable depths. However, the same detriments noted for the South Fork region also apply here: the area is relatively remote and most of it is administered by the U.S. Forest Service.

Central Idaho

Most of central Idaho is classified as Wilderness or Primitive area; almost the entire northern two-thirds of the area shown on Plate 5 is inaccessible to motorized vehicles. Thermal springs flow from rocks as old as Precambrian and as young as Quaternary.

Casto region

The occurrence of thermal springs along the Middle Fork of the Salmon River and its tributaries (41-49, 54-58, 86-88, 96-98) is summarized by Ross (1934, p. 105-107):

Commonly the springs issue from cracks in rocky bluffs a few feet above the present streams...the springs contain only moderate amounts of dissolved mineral matter, in which sodium carbonate predominates. (Table II, part 3)...the water is somewhat more mineralized than that of the streams or cold springs of the region, but the character and amount of the dissolved solids are such as might well be produced by hot (meteoric) water circulating through rocks of the region.

Some of the hot springs are grouped along lines of known faulting...The others are probably also on faults of small displacement. All the living springs are close to present stream channels.

The springs that Ross (1934) describes issue from rocks of pre-Tertiary, Tertiary, and Quaternary age. The Casto region contains a major Tertiary granitic pluton, numerous Tertiary dikes, and Tertiary silicic volcanic rocks (Plate 5). Ross (1934, p. 106) points out that the faults "are relatively so recent and have displacements so large that the ascent of water along them from (great) depth...is by no means impossible". But he also notes that "if the products of the Miocene intrusion have not entirely cooled, the temperature gradient for this region may be somewhat high, and therefore the probable depth to the source of the spring water would be somewhat less".

Small amounts of thermal water are now used for bathing and some irrigation at a few "guest ranches" along the river. The Casto region probably will not be considered in a thermal-water exploration program in the near future because of the remoteness of the area.

Grand Jean area

Two springs are along or near the upper reaches of the South Fork of the Payette River west of the small resort of Grand Jean. Bonneville Hot Spring (80) yields 350 gpm of 187° F water from a fault in granite. It closely resembles Boiling Springs in temperature, yield, conductance, and mode of occurrence.

Sacajawea Hot Spring (81) is in an area that Reid (1963) shows is underlain by a Tertiary pluton. The area is similar to most thermal areas in central Idaho; as such, it may have geothermal potential. The land is public domain administered by the U.S. Forest Service.

Stanley area

Thirteen springs or groups of springs (89-95, 99-104) occur in the Stanley area. Ten of these are along the main Salmon River (Plate 5). Springs 90-94 are along a N65E trending shear zones that extends eastward from Stanley. Other springs are also along major faults or at the intersection of fault zones (Choate, 1963).

Three springs (90, 94, and 100) are now used for swimming or bathing; Sunbeam Hot Spring (93) has been so used in the past. Temperatures range from 104° F to 169° F. Mineral content is low (Table II, part 3), typical of much of central Idaho.

Almost all of the thermal springs in this region are on National Forest land. Some of the springs could be used for bathing facilities at Forest Service campgrounds; areas away from recreational lands could possibly be explored for steam.

East-central Idaho

Many small thermal springs are scattered about Salmon and Challis in east-central Idaho (51-53, 59-65, 105-108). Most have temperatures of less than 120° F and issue from small faults in or near Tertiary silicic volcanic rocks.

The general geologic aspect of the region is similar to that of southeastern Idaho: High mountains, composed of pre-Tertiary metasedimentary or Tertiary silicic volcanic rocks, are separated by broad, open valleys filled with Tertiary and Quaternary sediments

(Plate 6). Many of the mountain ranges probably are bounded by faults.

Three springs, Salmon Hot Spring (59), Sharkey Hot Spring (60), and Beardsley Hot Spring (105) are resorts that cater to the swimmer. Some springs, such as 107 and 108, are used informally for bathing.

Much of this land is administered by the U.S. Bureau of Land Management or the U. S. Forest Service. So little is known about the region that the geology and chemistry should be studied in more detail before deciding if the region is worthy of exploration.

Boise Region of Western Idaho

A large discordance marks the abrupt boundary between the Cretaceous and Tertiary granitic rock of central Idaho and the Tertiary and Quaternary basalt and sediments of the Snake River Plain (Plate 7). Thermal anomalies are common on both sides of the boundary, but seem to be more abundant and higher in temperature on the granitic side of the break.

Area of the Boise Front

The Boise Front is a several-mile wide zone that marks the break between granitic rocks and Tertiary sediments and basalt. Many of the sediments show minor faulting features; geomorphic evidence and drilling have shown that northwest-trending faults cross the entire zone.

Two springs (68 and 69) could not be located and apparently have gone dry. A third, Boise Hot Springs (70), was never a spring at all, but is the site of 500-foot-deep flowing wells drilled for space-heating purposes (Wells, 1971). In the canyons that cross the Boise Front, thermal water occurs in almost all wells at depths of 600 to 1,200 feet. Temperatures are 120° F or less. A temperature probe in well 4N-2E-17ba showed that the water reached a maximum of 110° F at about 600 feet and was cooler below that depth.

Springs 66 and 6N-1E-30 in Gem County seem to be along an extension of the Boise Front. Chemical quality of the water is different from that of the Boise hot well (Table II, part 5), but it is possible that the quality of water in the well is atypical.

A U.S. Geological Survey study of the water resources in the Boise area is in progress and should help to delineate the best zones for geothermal exploration. This area, because of its relatively-large population, will see an increase in thermal water use. Some is now tapped for private swimming pools, but at this time there is little or no individual space-heating use except for several greenhouses.

Canyon County wells

At least six wells in southern Canyon County have encountered thermal water at depths of less than 1,000 feet. All the wells (5N-3W-14dc through 1N-2W-36bd) obtain water from Tertiary sediments. Stevens (1962) suggests that local thermal gradients are high because of upward leakage of warm water from deeper aquifers.

Thermal water has potential for space heating and for agricultural use in this area of relatively small irrigated farms. Drilling has shown no distinct pattern in the anomalies but temperatures are all low and it is doubtful if the area will yield high-temperature water.

South Fork of the Payette River

Approximately a dozen widely-spaced thermal springs (72-81) occur along the 60-mile east-west lineament that marks the South Fork of the Payette River. All the springs are in granitic rocks and have similar geologic occurrences and similar specific conductances. Temperatures are higher than in many regions, the lowest is 124° F; most are greater than 140° F. The two westernmost springs have temperatures above 167° F; they may be related to Boiling Springs to the north.

Springs 73 and 78 are used to fill swimming pools at resorts. The U.S. Forest Service use springs 77 and 79 for shower facilities at campgrounds. Several other springs could be used similarly. Warm water in this area has a potential for space heating, especially in the areas of summer homes. Water from spring 8N-5E-10bd is already used to regulate temperature in a greenhouse.

Middle Fork of the Boise River

More than a dozen thermal springs occur along the lineament that marks the main Boise River and its Middle Fork tributary (Plate 7). All the springs issue from granite, in areas transected by granitic and mafic dikes. Between Twin Springs (84) and Weatherby mill (6N-9E-35a) springs average one every 2 miles. A single spring (123) is northeast of Atlanta along the same lineament.

Analysis of Twin Springs (84), Neimyer Spring (116) and spring 123 (Table II, part 5) show that chemical quality is uniform along the entire reach of the river. The 84° F water from the flowing well at Weatherby mill is considered by local residents too mineralized to drink, although total dissolved solids are similar to those in the springs.

The area seems to have geothermal potential, even though the mill well failed at obtaining hot water. It is probable that the well is east of the main heat source; it is also probable that the well was drilled on the wrong side of a barrier, possibly a fault zone, that blocks the main flow of thermal water.

Idaho City

An isolated thermal spring (82) is just south of Idaho City (Plate 7). The water is used in the swimming pool at Warm Springs Resort. Very little information is available about this locality, but the spring is in granite and seems to be similar to dozens of other thermal springs in central Idaho.

Sun Valley Region of Central Idaho

Rocks in the Sun Valley region of central Idaho include all types from pre-Tertiary metasedimentary rocks to Quaternary alluvium (Plate 8). Thermal water is common along the South Fork of the Boise River, on the Camas Prairie, along the Wood River drainage, and along Clover Creek near the Snake River.

South Fork of the Boise River

Approximately a dozen thermal anomalies (124-130, 132-136) occur along the upper reaches of the South Fork of the Boise River and its tributaries. All are in granitic rock, much of which is cut by mafic and pegmatitic dikes.

Paradise Hot Spring (129) utilizes 140° F water in a swimming pool at a resort. A mile south, Bridge Hot Spring (128) and related seeps flow more than 150 gpm, also at 140° F. A warm spring (124) and several warm wells are at Featherville. The 115° F water

at Baumgartner Hot Spring is used for bathing facilities at a Forest Service campground. Lightfoot Hot Spring (134) apparently was used at one time for domestic heating and for irrigation of a small meadow. Maximum temperature is 144° F.

Worswick Hot Springs (136) cover more than 10 acres with dozens of vents. Most temperatures are above 168° F; total flow is more than 400 gpm. The entire area, which is brecciated, bleached, and silicified, is probably at the intersection of several fault zones.

Highest temperatures along the South Fork of the Boise River are at the east and west extremities of the regions; Worswick Hot Springs would probably be the most interesting to test drill for steam. Other thermal anomalies look promising, especially those near the western end of the area.

Camas Prairie

Camas Prairie is an alluvial-filled graben bounded on one side by Cretaceous granitic rocks and on the other by Tertiary silicic volcanic rocks. Both Piper (1925) and Walton (1962) noted the thermal anomalies and sampled them (Table II, part 6). Walton showed that the thermal gradient of 5.4° F per 100 ft. is relatively uniform beneath the entire Prairie. He believes that the source of heat is steam or hot water rising from depth and diffusing through the sediments.

Some springs reportedly are used for space heating and for scalding operations, and the area may have additional geothermal potential for space heating and agricultural uses.

Wood River drainage

Six springs (140-145) are aligned roughly along the upper reaches of the Big Wood River and its tributaries. These springs line up with the prevailing fracture trends in the region, although Umpleby and others (1930) point out that they are not along a single large fracture.

The springs near Sun Valley are exceptionally high in silica, sodium, and fluoride; temperatures range from 102° F to 170° F. All of the springs, except 143, are being or have been used for recreational purposes. In addition, water from wells near Bald Mountain Hot Spring (142) is used to heat homes along Warm Springs Creek. Because this is an expanding year-around vacation area, space-heating uses will increase if thermal water can be located.

Farther south, springs 146, 147, and 1S-22E-1ba are small and relatively cool. Until more is known about their occurrence, it is impossible to say if thermal water of the area has potential beyond minor space heating.

Clover Creek near the Snake River

Near the mouth of Clover Creek, one spring (131b) and a few wells discharge warm water (113° F or less) mostly from Tertiary sediments. Many of the wells are deeper than 1,200 feet and yields are small. Water here has a deep-seated source to the northwest. Long flow paths account for the relatively cool temperatures and high mineralization (Table II, part 6).

Along upper Clover Creek, a series of parallel grabens mark the break between the Snake River Plain and mountains to the north. A small Pleistocene basalt flow partially fills Clover Creek valley; a thermal "crater lake" (171) occurs at the source of the flow.

Temperature and mineral content fluctuate because of large amounts of seepage from Clover Creek.

West of the crater lake, White Arrow Hot Spring (170), once a resort, flows more than 1,200 gpm of 149° F water. Thermal water also occurs along a boggy meadow (172) and in a nearby well more than a mile southwest of White Arrow Spring. This area, because of favorable geologic structures near upper Clover Creek and the broad thermal-water occurrence, could be one that yields steam at some reasonable depth. Lower Clover Creek near the Snake River probably has little, if any, thermal potential beyond small amounts of space heating.

Eastern Idaho north of the Snake River Plain

Two isolated thermal anomalies in Clark and one in Butte County occur along the northern boundary of the Snake River Plain.

Clark County

Two thermal springs (149 and 150) and a thermal well were used at the Lidy Hot Spring resort. The springs emerge along a north-south fault that plunges southward beneath the Snake River Plain. The country rock, Paleozoic limestone, is reflected in the high percentage of calcium in the water (Table II, part 7); Tertiary silicic volcanic rocks crop out close by.

Seven miles north of Lidy Hot Springs, spring 148 discharges several hundred gallons per minute of 84° F water from limestone. Although there is probably more thermal water in the region, it would be uneconomic to drill randomly for it. Space-heating uses will be minor because of the sparse population of the region.

Butte County

Several years ago the community of Butte City drilled a municipal well (3N-27E-9a) that yields warm water; there is no other indication of thermal water for more than 50 miles in any direction. Temperature at the static water-surface, 392 feet below ground level, is only 72° F but a temperature log of the 464-foot well shows a uniform thermal gradient of 10° F per 1.4 feet. As in Clark County, more thermal water undoubtedly exists in the region, but it will be difficult to determine suitable drilling locations.

Western Border of Yellowstone National Park

The extreme northeastern corner of Idaho, in proximity to the thermal areas of Yellowstone National Park, has been suggested as a prime geothermal target. Even though the highest temperatures in springs in the region are 55° F to 57° F, the average is considerably above the 37° F mean annual temperature of the area.

The best-known of these springs, Big Springs near Island Park, discharge almost 75,000 gpm at 56° F. Warm River Springs (151) was removed from the list of thermal (Table I) because it is less than 58° F.

Large amounts of heat could be diffused and dispersed throughout the non-thermal ground water as a result of the permeable nature of the Cenozoic volcanic rocks and relatively large amount of precipitation. Thus, the region could be favorable for geothermal prospecting, although there is little surface indication that the search would be successful.

Northeastern Idaho near Idaho Falls

Thermal-water occurrences in the Idaho Falls region can be divided into four groups: those near Newdale, those along the Snake River Canyon, those near Yandell Mountain (Plate 9), and the thermal wells at Tyhee.

Newdale area

Water from the hot spring (153) in Green Canyon southeast of Newdale has been used in a public swimming pool for many years. The 115° F spring is in a fault zone in Tertiary silicic volcanic rocks. A second thermal spring along the canyon is reported to the south.

At Newdale, four irrigation wells and a domestic well yield water ranging in temperature from 79° F to 97° F. These warm wells all lie within a half-mile wide zone that extends eastward from Newdale for about a mile.

It is doubtful that the Newdale area is worth specific geothermal exploration because of the low temperature of the water and the smallness of the anomalous area. If additional drilling extends the area of higher-temperature water, the area should be re-evaluated.

Snake River above Heise

Thermal springs and wells occur all along the northwest-trending reach of the Snake River. Heise Hot Spring (152), at the western end of the canyon, is perhaps the best known of these springs, although Alpine Hot Spring (155) was a popular resort before it was covered by Palisades Reservoir. Total dissolved solids are higher than in water from many parts of Idaho. Sodium, chloride, and sulfate ions are the most abundant (Table II, part 7).

The northwest-trending reach of the Snake River follows a major fault. More thermal water undoubtedly exists at various places along this fault, but with now-used prospecting techniques it could be difficult to locate. It would not now be economical to prospect for hot water or steam in this area, but accidental discoveries of thermal water could be used for space heating.

Yandell Mountain area

Five springs, with temperatures from 72° F to 90° F comprise Yandell Springs (157). Total discharge is in excess of 1,500 gpm from a fault in Paleozoic limestone. A second warm spring to the east (4S-38E-23dd) is depositing tufa. The entire area has no other indication of thermal water, and the geothermal potential of the area probably is small.

Well near Tyhee

Well 5S-34E-26dba drilled in 1968 near Tyhee north of Pocatello has a temperature of 106° F. Wells on three sides, less than half-a-mile away and with comparable depths, yield 70° F water, more than 27° F above mean annual temperature. The area has only small geothermal potential, although it is possible that random drilling will encounter sources of higher-temperature water.

Southwestern Idaho

Thermal water occurs north and east of Mountain Home in southwestern Idaho. In addition, in parts of northern Owyhee County it is almost impossible not to drill a ther-

mal well (Plate 10). Two isolated springs are farther south in the County.

Mountain Home area

Two thermal springs (131a, Plate 8; and 131, Plate 10) and almost a dozen thermal wells yield water in an area north and east of Mountain Home. Near the mountains the distribution of hot artesian water is controlled by a series of subparallel northwest-trending faults. They allow both the downward flow of cold recharge water and the upward flow of hot water and possibly steam (Ralston and Chapman, 1968).

An artesian well drilled into spring 131 did not increase water flow. The well ceased flowing when new irrigation wells were drilled near by; pumping tests show mutual interference between these wells. At least four of the wells, which are 600 to 1,000 feet deep, yield 135° F to 153° F water.

Near the mountain front, water from wells in basalt is being used both for space-heating of homes and for irrigation. This area probably has more potential for such use, but the problem of well interference will have to be resolved. Wells in Tertiary sediments at some distance from the mountains yield cooler, more mineralized water from greater depths, indicating that the southern area is of less interest for geothermal exploration.

Bruneau-Oreana area

In studies of the Bruneau region, Piper (1924) and Littleton and Crosthwaite (1957) showed that Tertiary sediments comprise the major thermal-water aquifer. A few faults are evident at the surface (Plate 10) and may act as thermal water conduits, but faults are not the major thermal-water aquifer.

Some of the springs (160-162) that Piper (1924) described are now dry because of the large pumpage near them. It should be noted that wells listed in Table I for Owyhee County are only representative; many more wells, both irrigation and domestic, exist in the region.

Most wells are more than 1,000 feet deep; many yield large volumes of water by artesian flow. Temperatures range from "just warm" to more than 167° F. Highest-temperature water is near Oreana and Grand View. Chemical analyses (Table II, part 8) show water high in sodium, bicarbonate, silica, and fluoride.

The area has definite potential for space heating of residences and greenhouses as shown by the successful operations farther west near Givens Hot Springs (159). It is possible that steam might be discovered in the area, but the problem is one of selecting drilling sites. None of the wells in the region, some of which are as much as 3,000 ft. deep, has encountered steam or water near the boiling point.

Area near Givens Hot Springs

The thermally-anomalous area around Givens Hot Springs is geologically similar to the area between Bruneau and Oreana and is probably a continuation of it (Plate 10); however, very little is known about the hydrogeology of the intervening area. Water quality also is similar to water in the Bruneau-Oreana region (Table II, part 8). Maximum temperature of water near Givens Hot Springs is about 113° F, similar to water temperatures

near Bruneau, but cooler than many of those in the Oreana area.

Development of thermal-water resources for space heating is just beginning in the area. Most water will be low temperature, it is possible that high-temperature water or steam does not exist in the area now being exploited.

Southern Owyhee County

Two isolated thermal springs, Indian Hot Spring (169a) and Murphy Hot Spring (169b) are in southern Owyhee County. The main spring at Indian Hot Spring yields more than 3,000 gpm at 158° F; the vents are along a fault that disrupts basalts and Tertiary silicic volcanic rocks.

Murphy Hot Springs resort utilizes thermal water for swimming and bathing. Thermal water also may be used for space heating in the near future. The water is exceptionally low in total dissolved solids (Table II, part 8); silica is the only dissolved matter of importance.

Both of these areas may have geothermal potential, but more information about the occurrence and chemistry is needed to evaluate them properly.

South-central Idaho, near Twin Falls

Thermal-water occurrences near Twin Falls can be separated into five localities: (1) Thousand Springs area, (2) east of Hollister, (3) between Rock Creek and Big Cedar Canyon, (4) near Idavada, and (5) along Goose and Trapper Creeks.

Thousand Springs area

Three closely-spaced thermal springs (173-175) are across the Snake River from Thousand Springs, a major discharge point for non-thermal water from the Snake River Plain aquifer (Plate 11). All three springs are used as recreational sites. Several warm wells have also been developed, but recent drilling attempts to increase the flow of water at 136° F Banbury Hot Spring (175) have encountered only hot mud.

The major constituents of the water are silica, sodium, and bicarbonate ions. Carbonate and fluoride are also high (Table II, part 9). An extensive drilling program would be needed to outline the extent and temperature of the thermal anomaly because of the large volume of non-thermal water in the area.

Hollister area

Thermal water originally flowed from three springs east of Hollister. One, Nat-Suh-Pa Hot Springs (177) is a resort; the other two springs have gone dry. Wells have defined the areal extent of the thermal water (Crosthwaite, 1969b). Temperatures are mostly about 95° F; although 140° F water is reported from a 900-foot well in the southern part of the area. The high percentage of calcium ions in the water reflects that Paleozoic limestone as well as Tertiary silicic volcanic rocks may be a source (Table II, part 9) of the water.

The Hollister area may have limited geothermal value for space heating. As with other areas, additional irrigation drilling will give more information than can be used for re-evaluation.

Rock Creek to Big Cedar Canyon

A long, thin band of thermal water persists along the north and east flanks of the Rock Creek hills along a line from Rock Creek through Artesian City (178) through Poulton Warm Spring (179) to the mouth of Big Cedar Canyon. Warmest water (110° F) flows from well 12S-19E-12cd near Artesian City. In the east-west trending segment of the thermally anomalous area, water averages about 95° F. Water becomes cooler to the southeast so that near the mouth of Big Cedar Creek, water temperatures average 77° F or less. Water levels are declining in the entire area, and some sections have been closed to further drilling because of excessive drawdowns in wells.

Thermal water near Artesian City could be used for space heating, but the area, at this time, seems to offer few incentives for exploration for higher-temperature water.

Area east of Idavada

Magic Hot Spring (16S-17E-30cb), seven air miles east of Idavada, a railroad siding on the Idaho-Nevada State line, is probably more closely related to near-by springs in Nevada than it is to springs in Idaho. Its potential for geothermal exploitation is unknown.

Spring 180 was removed from Table I because of this low temperature. Thoroughbred Spring (181) is only 70° F. Both are remote, removed from other thermal water, and are used only for watering livestock.

Trapper and Goose Creeks area

Two wells (14S-21E-34ab; 15S-12E-4b) on Trapper Creek and several on Goose Creek yield 113° F water. One 880-foot well was reported to contain 160° F water (Piper, 1924). The water is high in silica, but low in most other dissolved material (Table II, part 9).

At the present time, there is only limited demand for space heating in these relatively remote canyons. Although warm water seems to occur along both creeks, there is not enough drill data to predict locations likely to yield high-temperature water or steam.

South-central Idaho, near Burley

Thermal spring and wells occur mostly along the borders of Basin-and-Range-type valley in south-central Idaho. Although thermal springs are scattered throughout the region, many of the anomalies have been discovered by drilling.

Oakley Warm Spring

Two springs and a well at Oakley Warm Spring (182) yield a few gallons per minute from a fault in silicic volcanic rocks; the 115° F water is used in a swimming pool. Silica, bicarbonate, and sodium ions are high (Table II, part 10), but other mineral matter is relatively unimportant.

These springs are several miles away from the next-closest thermal water along Goose and Trapper Creeks, but they may be similar in geologic occurrence. Oakley Warm Spring is relatively isolated and has only a small flow. These conditions together with the lack of drill data suggest possibilities for increased development are not promising.

Albion Basin

Two thermal areas (185 and 186) are in Marsh Creek canyon near Albion Basin. Until 1968, Bridger Hot Spring (185) at the intersection of two major faults, yielded 120° F water from several natural vents and six shallow wells. Then, a 447-foot well that initially flowed 1,080 gpm at 145° F was drilled. After a year of pumping, the water-level was 20 feet below ground surface and the springs ceased to flow. It is possible that high temperature water or steam exists at depth, but, if this well is any indication, water volume is limited.

Raft River Valley

Four or more thermal springs occur in the headwaters of the Raft River and its tributaries and two others are in the main Raft River valley. Additional thermal water has been discovered by drilling. Most of the water flows from alluvium or valley-fill sediments, although it may rise close to the surface along faults.

None of the water is warmer than 102° F, with the exception of water from two wells (temperatures: 200° F and 210° F) to be discussed below. Most of the ground-water temperatures in the Raft River area are between 48° F and 55° F, close to regional mean annual temperatures; however, unpublished U.S. Geological Survey data show that in certain areas, large quantities of water have temperatures of 63° F to 68° F.

Perhaps the most spectacular thermal anomalies in Idaho are the waters in two wells (184 and 15S-26E-23dd) in the southern end of the Raft River valley. Both wells yield boiling water from about 400 feet; surface elevations are between 4,800 and 5,000 feet above sea level.

Flow from well 184 was listed at 120 gpm in the early 1930's (H. T. Stearns and others, 1938). Nace and others (1961, p. 133) report a flow of 59 gpm, but give no date of measurement. Flow was approximately 60 gpm in the summer of 1969. H. T. Stearns and others (1938, p. 170) believe that "The well flows because of its high temperatures and the included steam. The high temperature of the water at the surface suggests that it is superheated not far below the bottom of the well."

The second boiling well (15S-26E-23dd) is now used in a greenhouse that grows tomatoes. Nace and others (1961) list the flow at 26 gpm. These two wells are more than a mile apart and there are no wells directly between them. Other near-by wells all have temperatures below 104° F.

Southern Raft River valley seems to be one of the most likely places to drill for steam in the entire State of Idaho. The area near the two boiling wells is the most obvious location, but it is possible that other sites, especially near the valley margins, could also yield steam. Most of the wells along the River are in the center of the valley; only a few wells have been drilled near the mountains, but most of these wells have water temperatures at least slightly above that which normally would be expected. The basin has been closed to future water-well drilling because artesian pressures have declined excessively in the last few years. Thus, no additional drill data will become available in the near future.

Rockland Valley

The 90° F water at Indian Spring Natatorium (189) issues from a fault in Paleozoic limestone. Two springs, yielding just under 1,000 gpm each, supply the public swimming

pool and are used for irrigation. A well one-half-mile to the east yields 81° F water; another well, a few hundred yards from the spring, but on the west side of the fault, discharges only non-thermal water.

A second spring, 10S-30E-24ba, flows about 300 gpm of 100° F water from an intermittent stream channel on the western side of Rockland Valley.

No detailed study has been made of the ground-water regime of this valley, so it is not known if thermal wells have been drilled in it. Without any more knowledge than is available now, Rockland Valley can be classified as unfavorable for geothermal prospecting.

Southeastern Idaho

Thermal springs are widely scattered in southeastern Idaho (Plate 13). They differ considerably in chemical content, temperature, and occurrence. In addition to the active thermal springs in the region, many of the cool, mineralized springs may have been thermal in the geologic past (Mansfield, 1927).

The numerous vents at Lava Hot Springs (190) yield more than 1,500 gpm of water that ranges in temperature from 100° F to 144° F. The water issues from tufa along a deep canyon of the Portneuf River. H. T. Stearns and others (1938, p. 172) think that a breccia near one spring "...suggests that the hot water is rising along deep faults".

Two groups of thermal springs (191, 13S-40E-7ac) are about a mile apart along Bear River where it enters Oneida Narrows. The northern springs (191) have a temperature of 126° F; the southern one, Maple Grove Hot Spring, is at 170° F.

At the southern end of Oneida Narrows near Preston, two highly-mineralized springs, Battle Creek Hot Spring (15S-39E-8b) and Vincent Hot Springs (15S-39E-17a), add more than 1,000 gpm to the flow of Bear River. Temperatures are 172° F and 180° F, respectively. Three miles to the northeast (14S-39E-36), the ground on the south side of the Bear River reportedly "steams" during much of the year.

A resort at Downata Hot Spring (191a) utilizes 111° F water. Although it issues from Tertiary valley fill, the water probably moves up from depth along faults. A second small thermal spring, one-quarter mile away, is used to water livestock.

At Soda Springs (193) and Steamboat Springs (9S-41E-18), warm waters 75° F to 88° F are depositing tufa. The Soda Springs "geyser" is actually a controlled artesian well drilled on a spring. The geologic map of the Soda Springs 15-minute quadrangle (Armstrong, 1969) shows that the springs were more active in the past; large portions of the valleys are filled with spring-deposited tufa.

Pleasantview Warm Springs (194) and Price's Hot Spring (195) are highly mineralized and discharge several tons of salt per day into the drainage basin of the Malad River.

A single thermal spring (196) along the east side of Bear Lake has been used for swimming and bathing, although the 118° F water gives off a hydrogen-sulfide odor and is depositing free sulfur.

Chemical analyses of eight springs in southeastern Idaho are given in Table II, part 11. As a group, these springs are the most mineralized in Idaho. Some of the springs on Bear and Malad Rivers contribute so many salts to the streams that they constitute a

serious problem (Milligan and others, 1967). Only Downata Hot Spring (191) contains small amounts of dissolved minerals.

Some of the thermal areas in southeastern Idaho, especially those near Preston, seem to have geothermal potential. Temperatures are high (180° F), and relatively large amounts of thermal water occur over several miles. The region is populous enough to have a use for space heating.

Most of the areas need additional study to determine if exploration for hot water or steam is feasible.

CONCLUSIONS

The preceeding discussion presents only the most basic facts and inferences about Idaho's thermal springs and wells. Some additional data are available about most of the thermal anomalies, but no single anomaly has been studied as an entity. Only a few have been studied partially, generally as an incidental part of another project.

Idaho is still a developing State. It has been settled for little more than a century; the major industries are agriculture, lumber, mining, and tourism. Only thermal anomalies that have been inexpensive to develop have been exploited--primarily for recreation or for irrigation.

Within the last 5 to 10 years, however, Idahoans have learned that naturally-occurring thermal water can be an economic asset, not just an oddity to be used in a swimming pool or cooled for irrigation. Individuals that once complained about water that was too hot to place on crops are now using it to heat homes or greenhouses. Wells are being drilled not for water, but for heat contained in the water.

Large amounts of thermal water are known, but most are low temperature; only two wells have discovered boiling water or steam. The present view of Idaho's geothermal resources may be distorted, however, because it is primarily the low temperature anomalies, often in regions geologically unfavorable for steam, that have been exploited. Virtually all drilling has been for water for irrigation which, by necessity, must be cool enough to place on crops and must underlie farmable land. The areas that seem to have the most potential for producing steam are, for the most part, different from those now drilled.

At the present time and in the foreseeable future, Idaho's most important use of the heat in thermal water is for space heating. Power generation using natural steam does not seem feasible in the next few years. Idaho does have, however, five incentives that make prospecting for steam look attractive.

First, Idaho lacks most conventional fuels. The few indigenous coal fields are low in grade, remote, and structually unfavorable for mining. Oil and gas test holes have proved disappointing, although exploration continues. Idaho does have hydroelectric power, but many sites are completely developed. Most of the still-existing dam sites may not be utilized because of increasing public pressure to preserve "wild" rivers in their natural states. Idaho Power, which serves most of southern Idaho, even now is a partner in the new Jim Bridger coal generating plant in southern Wyoming.

Second, Idaho can use large blocks of additional inexpensive power. Irrigation is increasing, often with pumping lifts as high as 700 feet. The continually-expanding phosphate industry of southeastern Idaho needs additional power to produce fertilizers and phosphoric acid from raw rock. Additional inexpensive power would also be an incentive for other types of industrial growth.

Third, chemical and geologic data, even with limited study, indicate that several areas may have potential to produce steam suitable for power generation. Chemical data show that much of the higher-temperature water is surprisingly low in mineral content when compared to other thermal waters throughout the world. For example, the following analysis is typical of water from granitic rocks in most areas north of the Snake River Plain; dozens of springs show analyses that differ from it only slightly:

silica	62	ppm	sulfate	14	ppm
calcium	4	ppm	chloride	9	ppm
magnesium	0.3	ppm	fluoride	12.1	ppm
sodium	60	ppm	nitrate	0.2	ppm
potassium	1.3	ppm			
carbonate	22	ppm	specific conductance		
bicarbonate	59	ppm	315 micromhos/cm at 25° C		
pH	9.2		total dissolved solids		
			224 ppm		

Steam prospecting is favorable also because the State is geologically young in many areas. Tertiary and Quaternary volcanic rocks (a few less than 1,600 year old) are common. Many parts of central Idaho are underlain by batholiths, stocks, and smaller intrusive rock bodies that may be as young as Miocene. Geologically-young faults and fault zones are in proximity with these igneous rocks--a combination that is favorable for natural-steam occurrence the world over.

Fourth, increased drilling for thermal water to be used for space heating will not be restricted to shallow holes in irrigated areas. Probably steam will be discovered as the more promising anomalies are drilled for hot water. With the additional data from such programs, steam wells for power could appear more practical.

The fifth incentive is political. On December 24, 1970, a Federal bill was signed that allows for exploration and leasing of Federally-owned lands with geothermal potential. Because such large areas of Idaho, many of them with known thermal anomalies, are under Federal management, this new law will be a major incentive for increasing exploration for steam within the State.

In summary: Idaho is in the infancy of geothermal exploitation. As of now relatively shallow holes have been drilled on low-temperature anomalies, most for the water. Although geothermal power generation probably is not practical within the near future, Idaho has incentives that should make the State attractive to prospecting for geothermal energy. Space-heating use of naturally hot water, both for agriculture and for domestic use, is increasing and should continue to expand at an accelerated rate.

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APPENDIX

PLATES

Plate 1.	Location map of Idaho
Plate 2.	Well-numbering system used in Idaho
Plate 3.	Thermal springs in north-central Idaho
Plate 4.	Thermal springs and wells in west-central Idaho
Plate 5.	Thermal springs in central Idaho
Plate 6.	Thermal springs in east-central Idaho
Plate 7.	Thermal springs and wells in the Boise region of western Idaho
Plate 8.	Thermal springs and wells in the Sun Valley region of central Idaho
Plate 9.	Thermal springs and wells in the Idaho Falls region of eastern Idaho
Plate 10.	Thermal springs and wells in southwestern Idaho
Plate 11.	Thermal springs and wells near Twin Falls, south-central Idaho
Plate 12.	Thermal springs and wells near Burley, south-central Idaho
Plate 13.	Thermal springs in southeastern Idaho

TABLES

Table I.	Thermal springs and wells in Idaho
Table II.	Chemical analyses of Idaho thermal waters

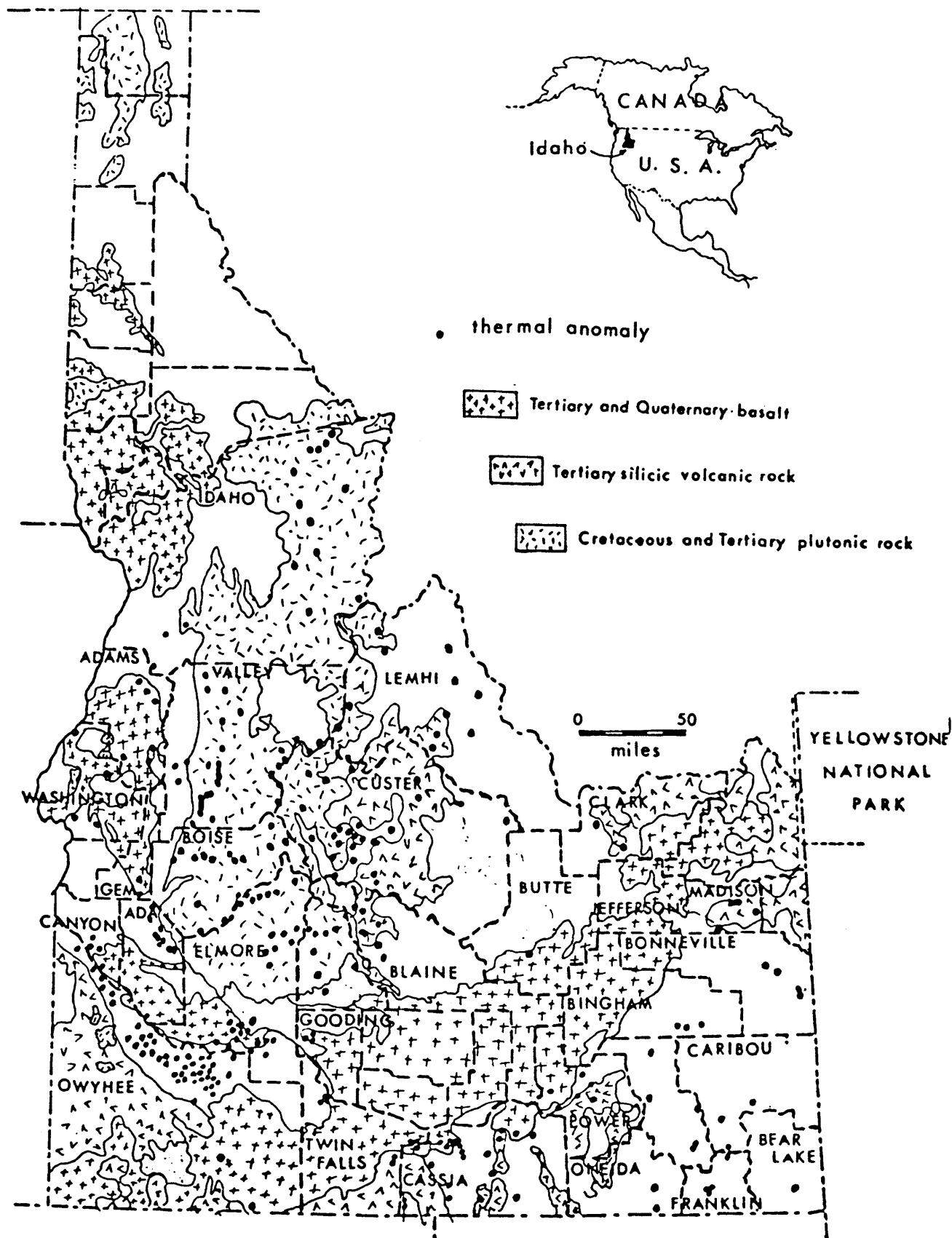


Plate 1. Location map of Idaho. Only names of counties with known thermal anomalies are shown.

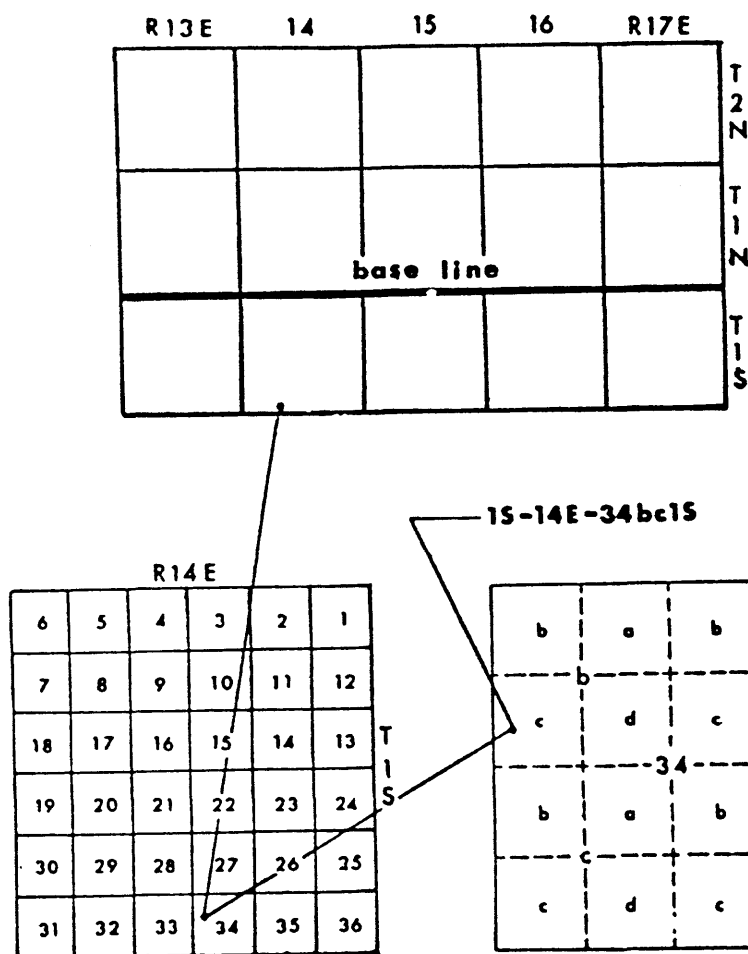


Plate 2. Well-numbering system used in Idaho. The system indicates the locations of wells and springs within the official rectangular subdivision of the public lands of the United States. In this State, all lands are referenced to the Boise Meridian and base line. The first two segments of a number designate the township and range (1S-14E). The third segment gives the section number followed by two or three letters (1S-14E-34bc). Quarter sections are lettered a, b, c, and d, in counterclockwise order, from the northeast quarter of each section. Within each quarter section, the 40-acre tracts are labeled in the same manner. On some locations, the 40-acre tracts may be divided into 10-acre tracts in the same way. Thus, spring 1S-14E-34bc1S is in the SW1/4 of the NW1/4 of Section 34, Township 1 south, Range 14 east, Boise Meridian and base line and is the first spring visited in that tract.

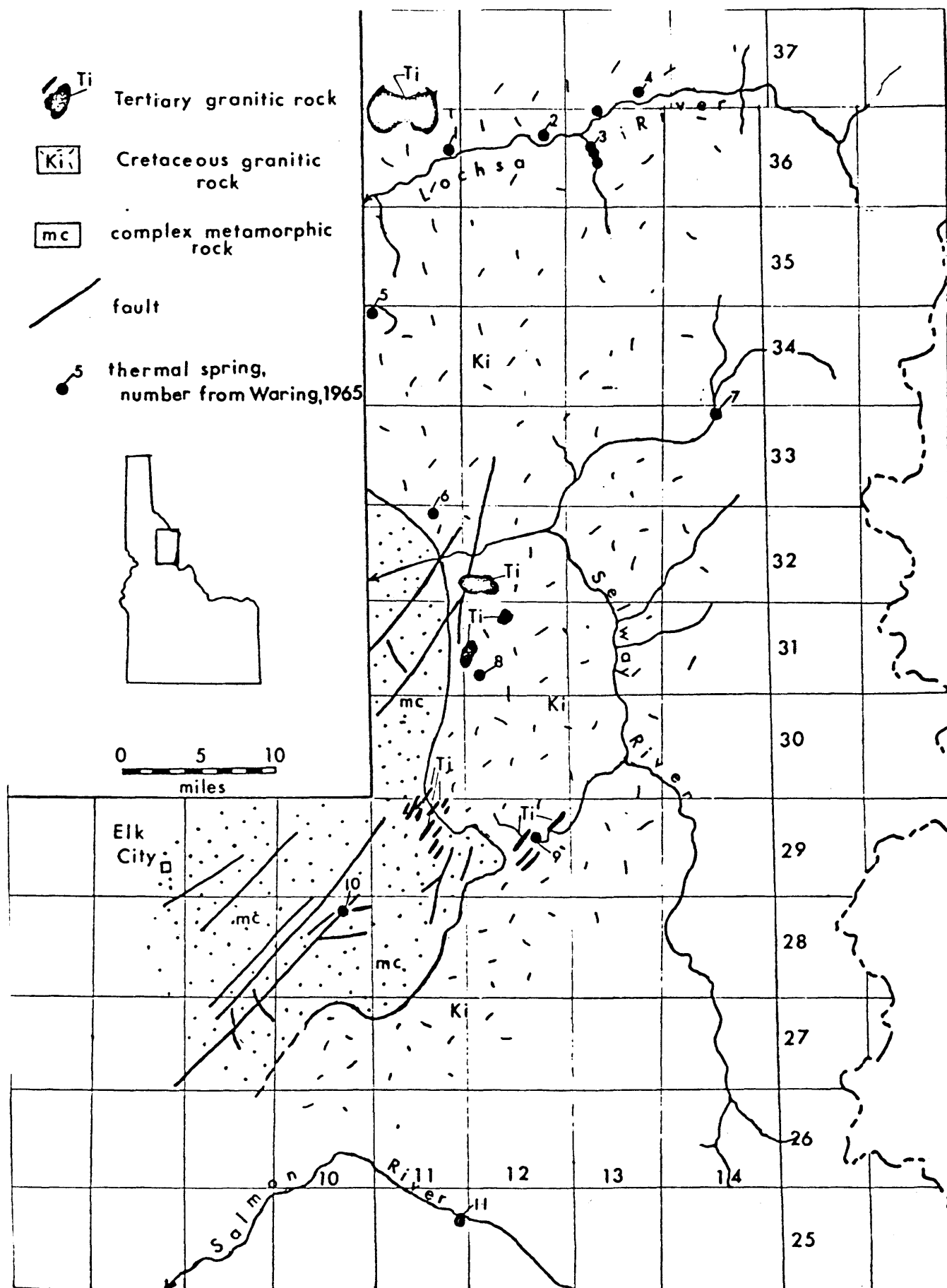


Plate 3. Thermal springs in north-central Idaho.

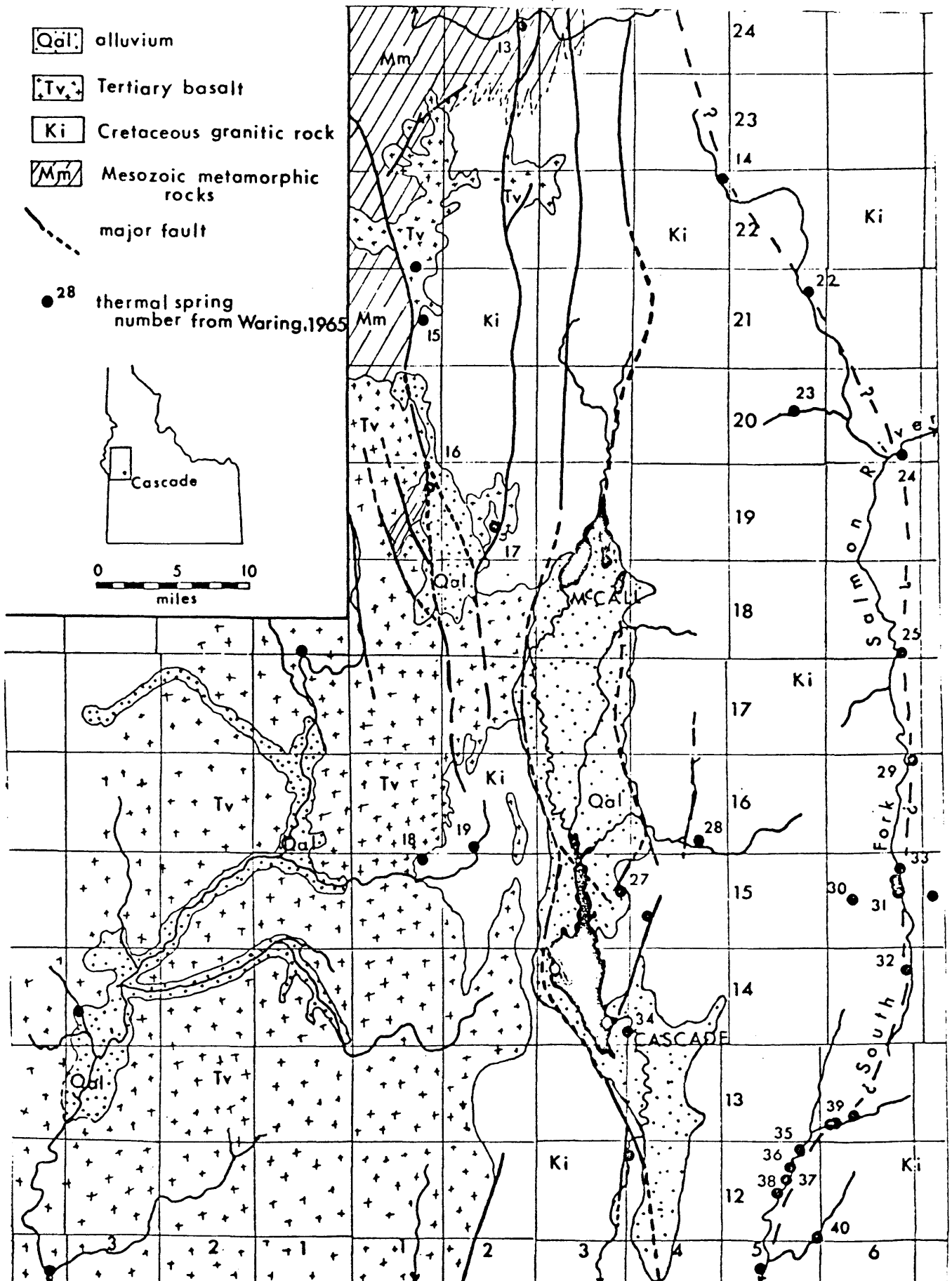
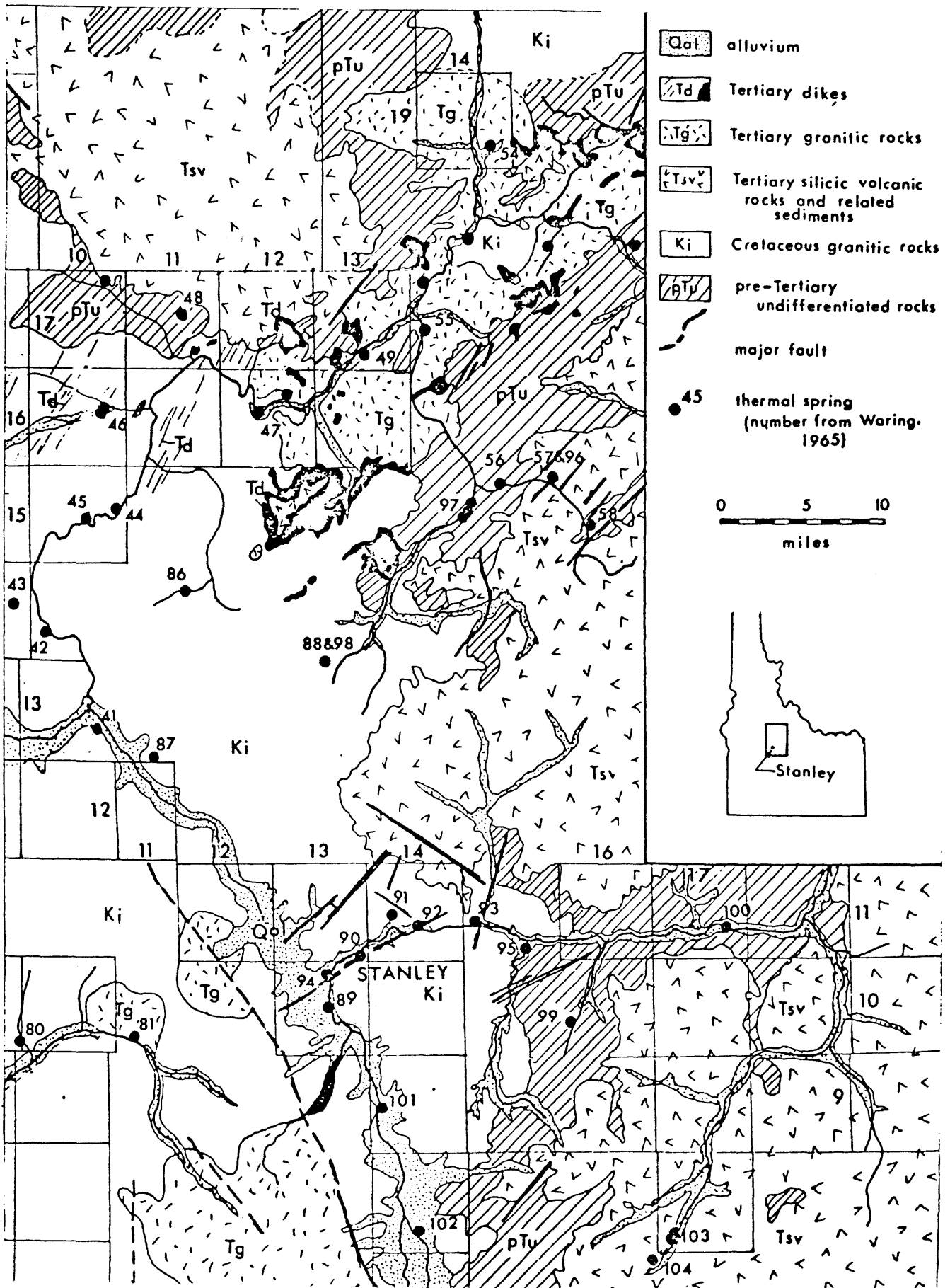


Plate 4. Thermal springs and wells in west-central Idaho.



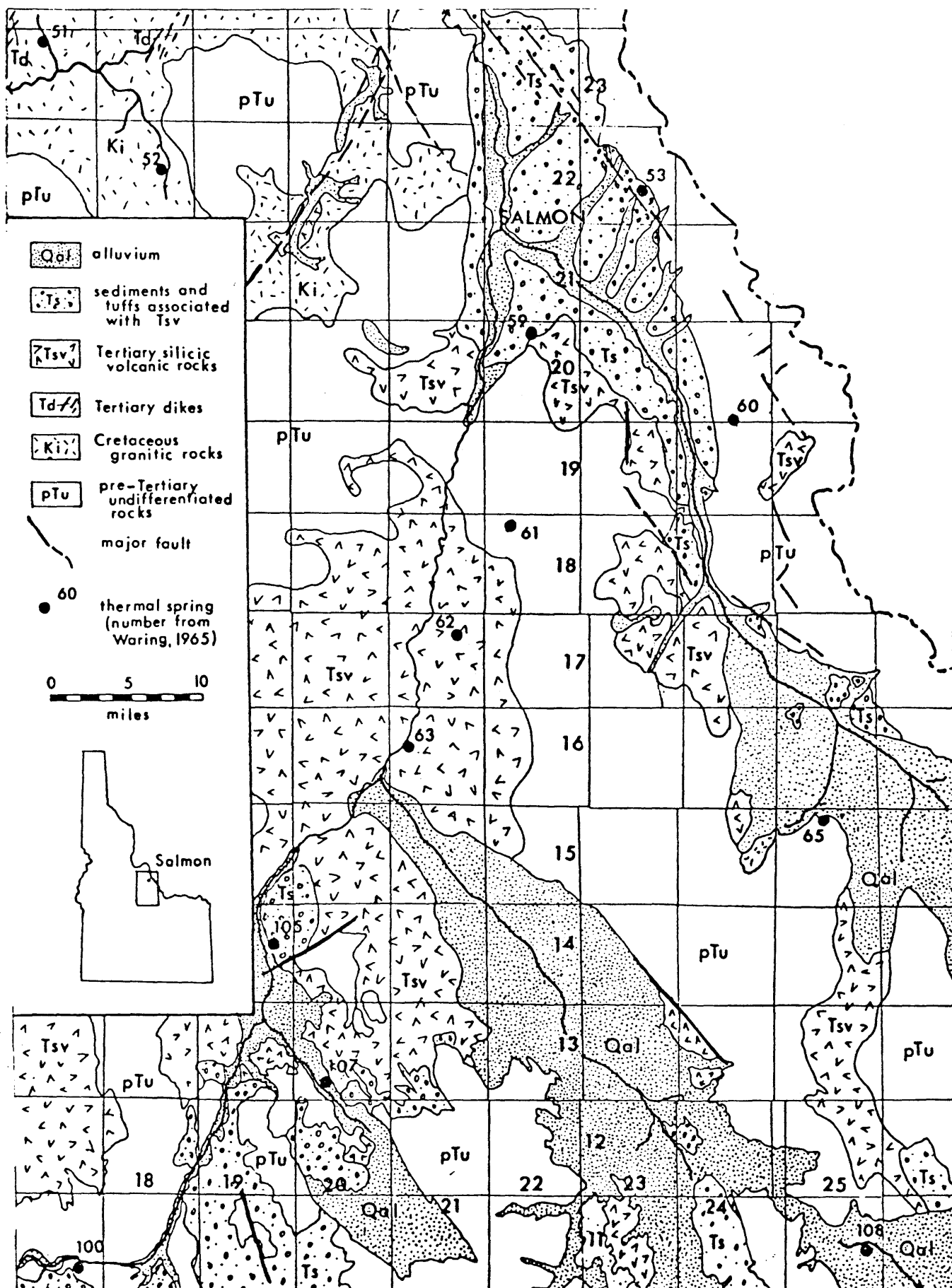


Plate 6. Thermal springs in east-central Idaho.

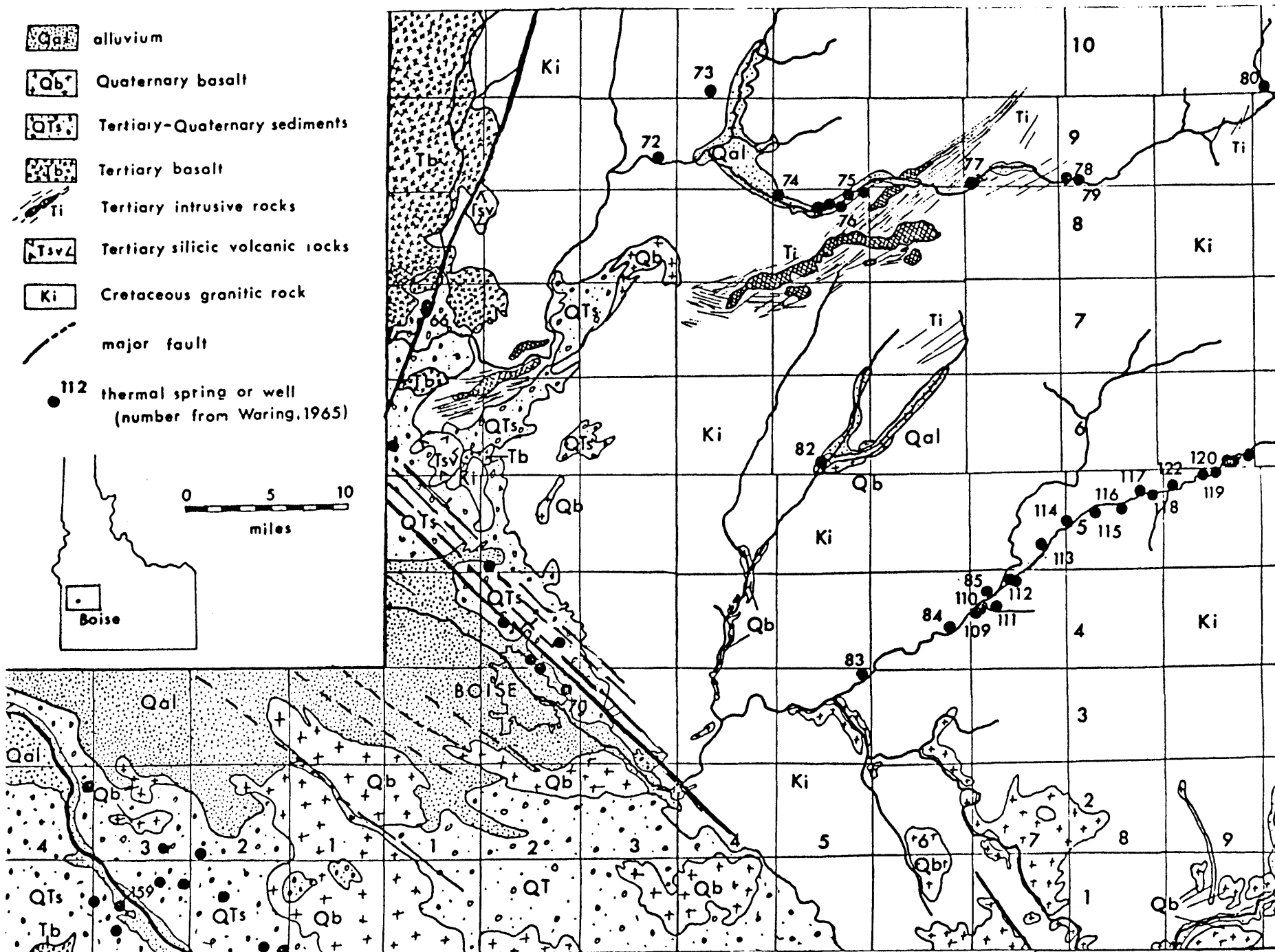
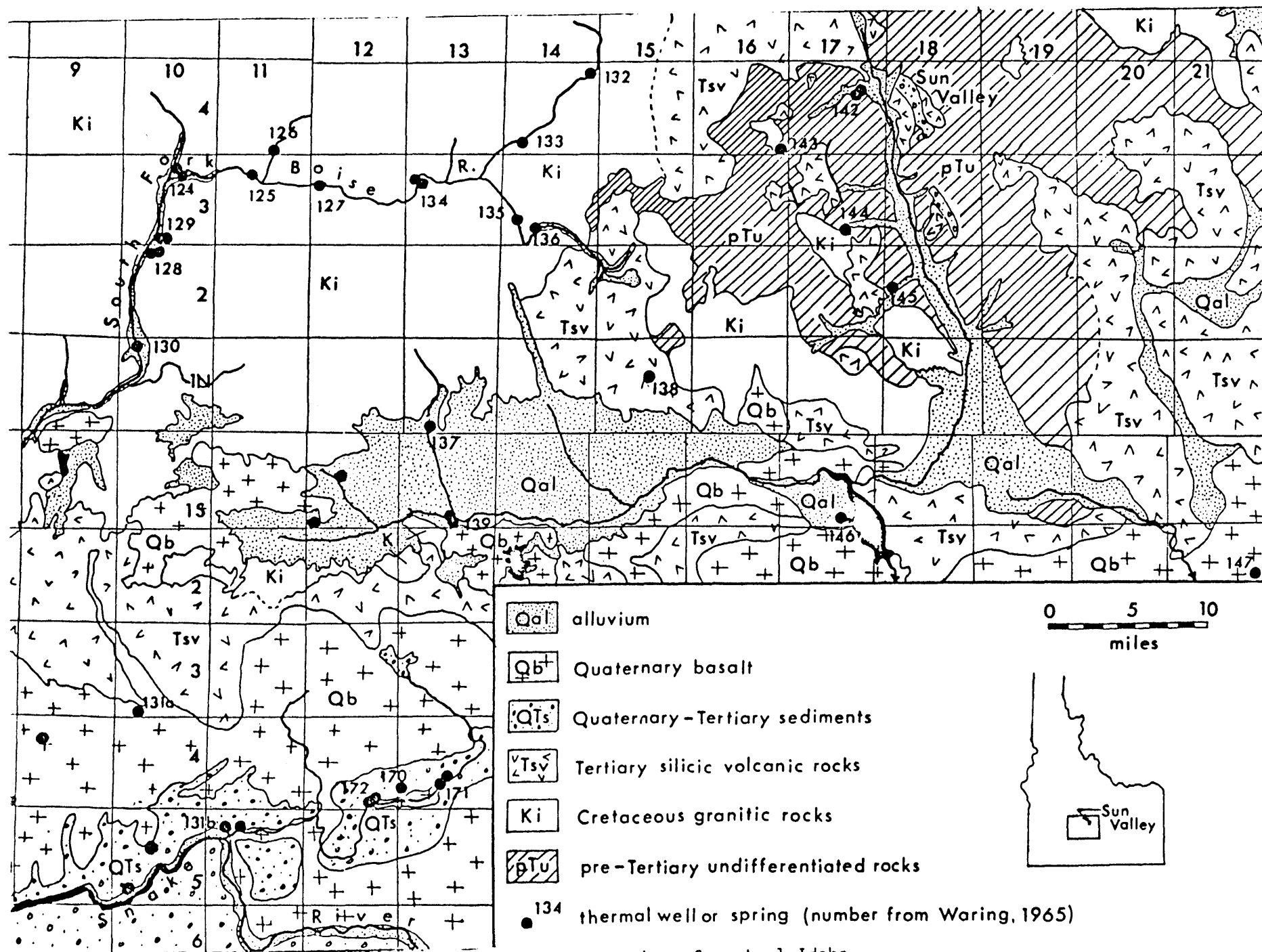


Plate 7. Thermal springs and wells in the Boise region of western Idaho.



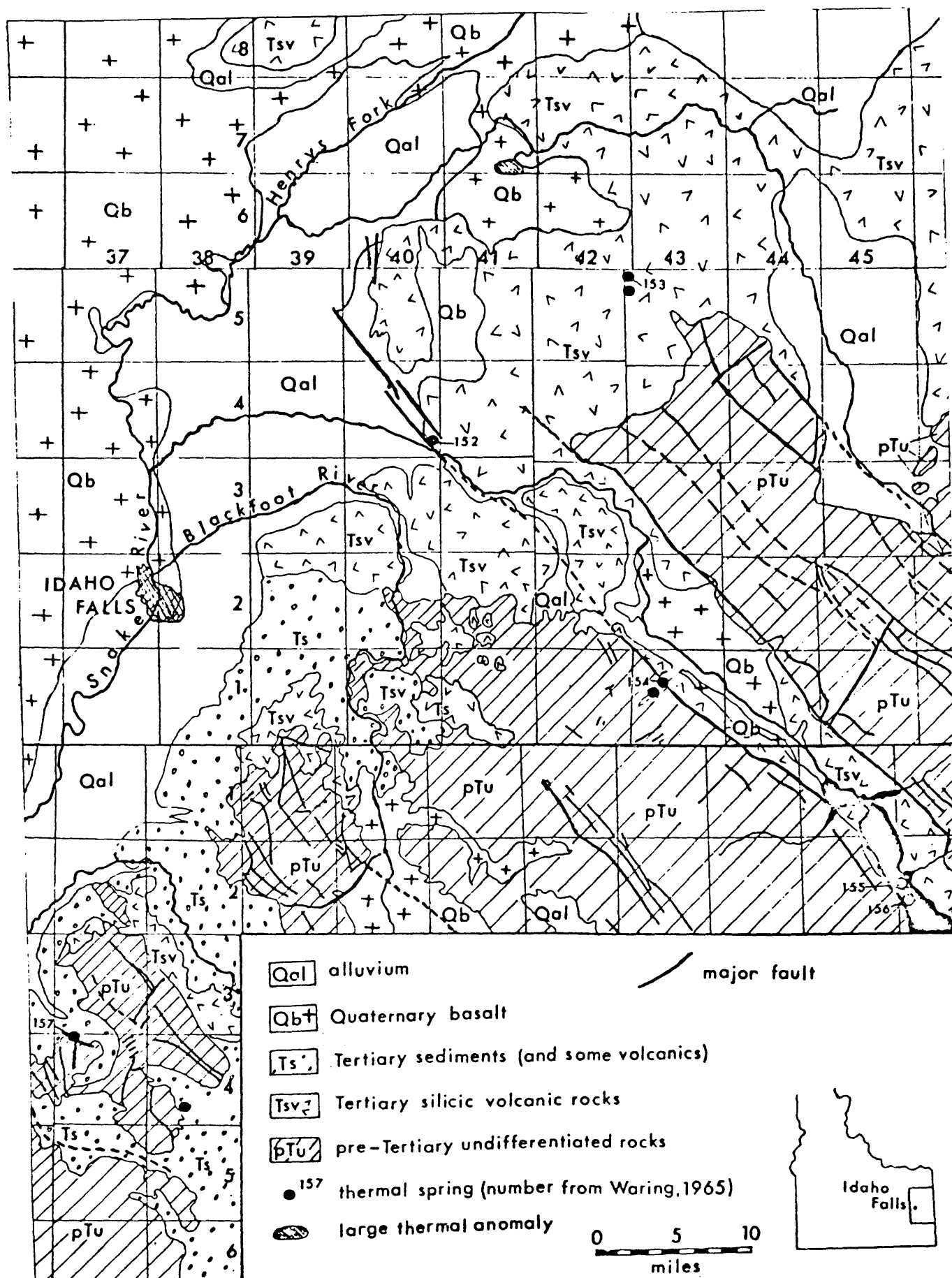


Plate 9. Thermal springs and wells in the Idaho Falls region of eastern Idaho.

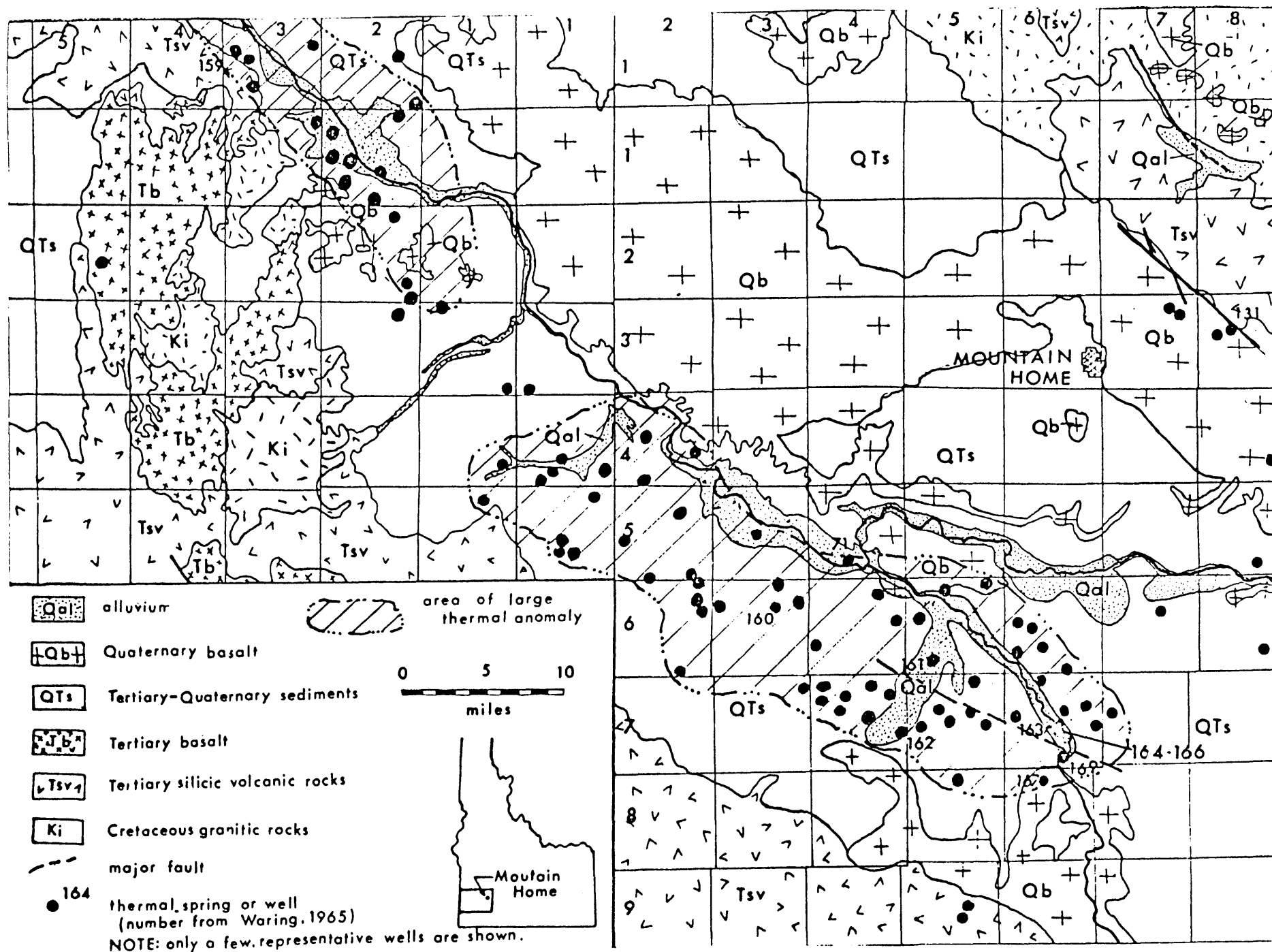


Plate 10. Thermal springs and wells in southwestern Idaho.

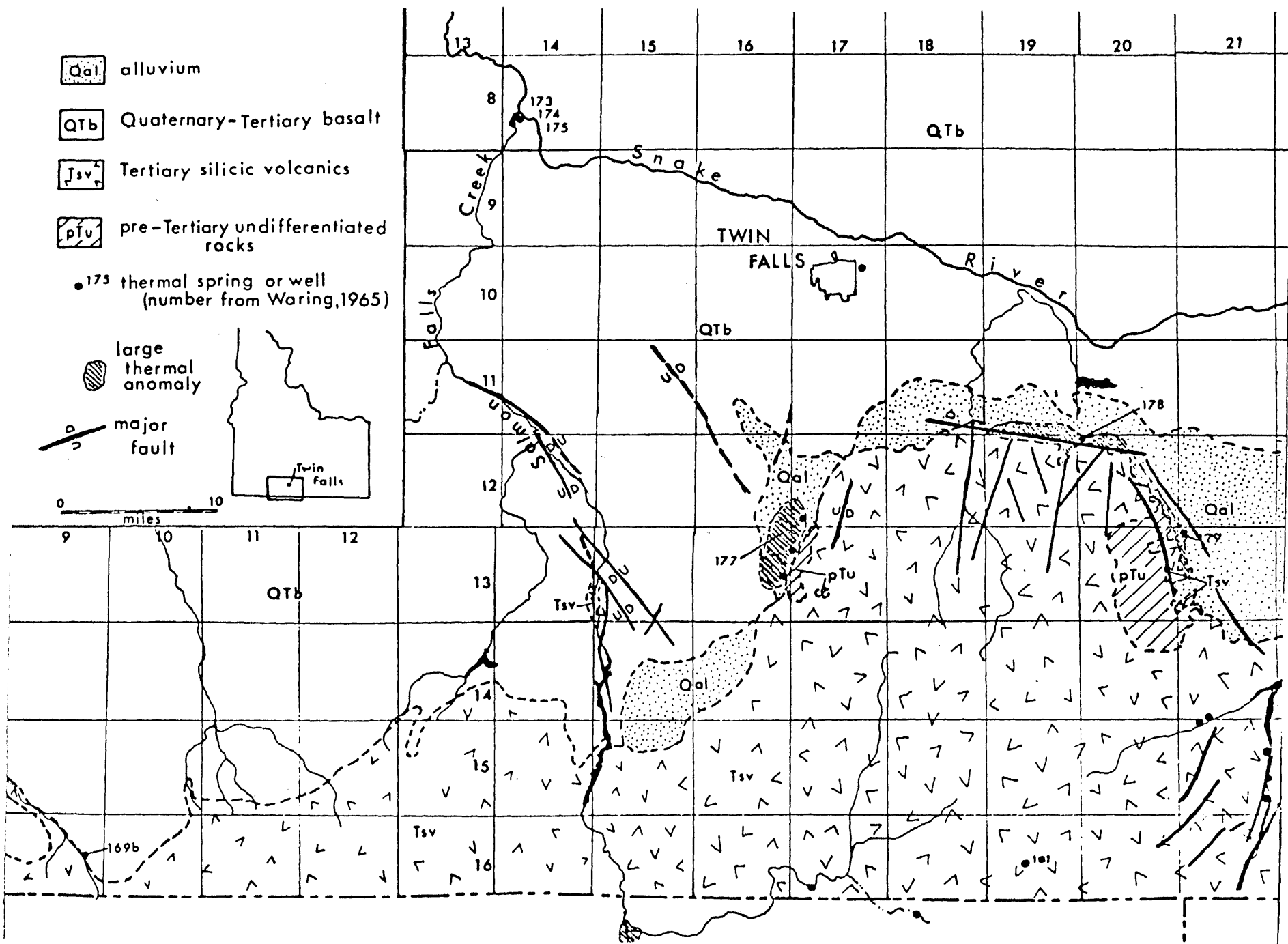


Plate 11. Thermal springs and wells near Twin Falls, south-central Idaho.

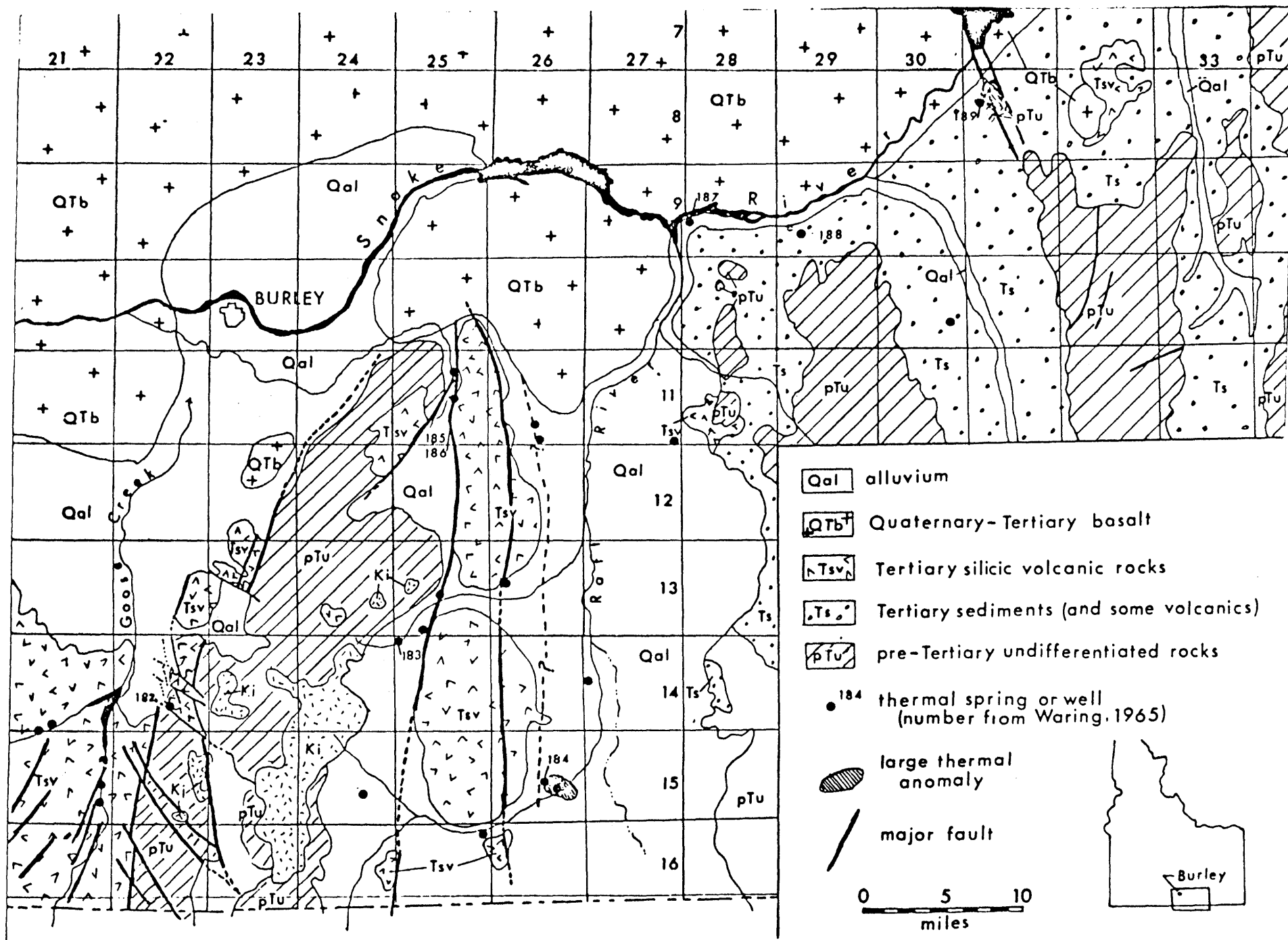


Plate 12. Thermal springs and wells near Burley, south-central Idaho.

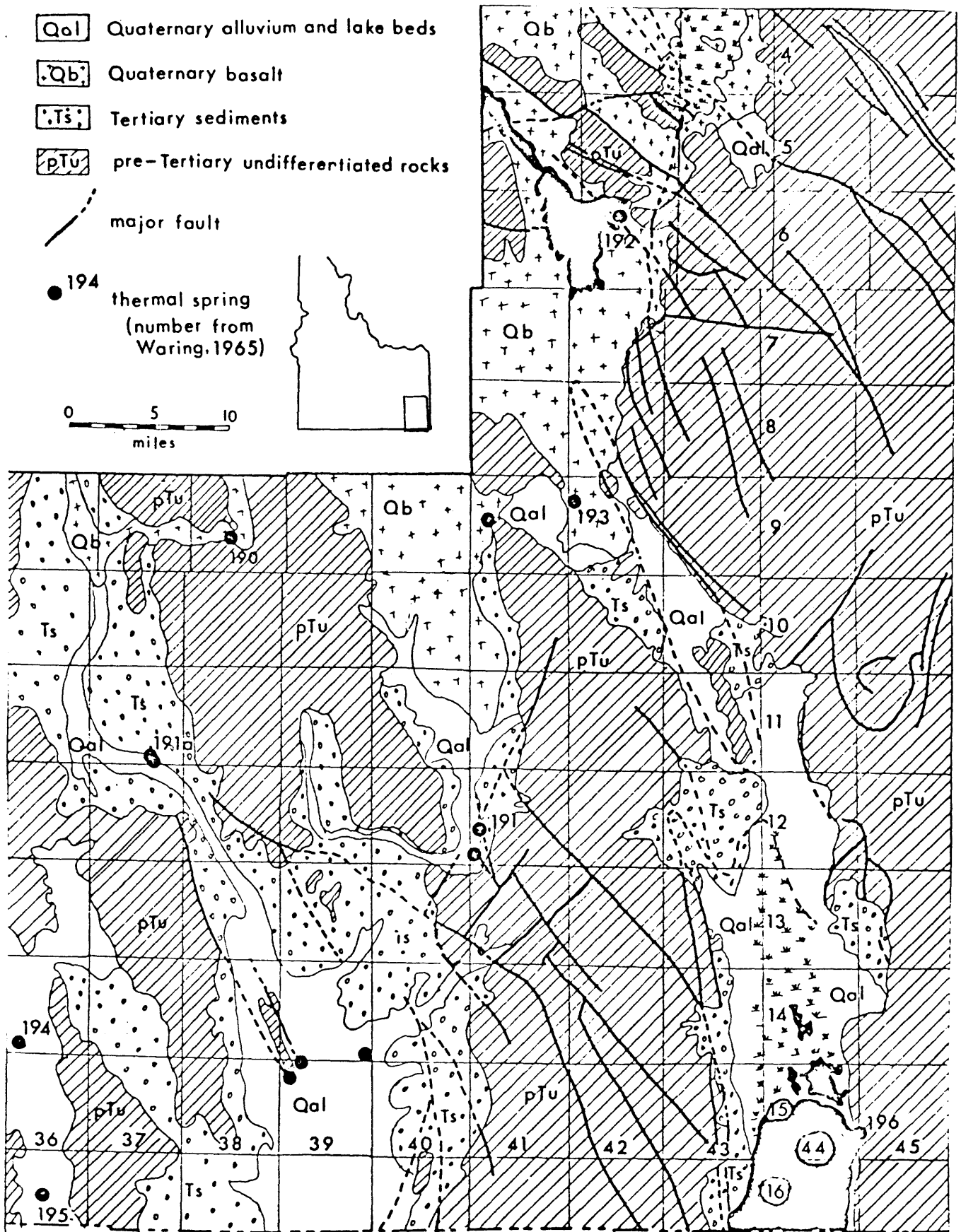


Plate 13. Thermal springs in southeastern Idaho.

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO

S or W: spring or well; DISCHARGE: (f) flowing well yield unknown; GEOLOGY AND REMARKS: Age of rocks: Q = Quaternary, T = Tertiary, pT = pre-Tertiary; Types of rock: al = alluvium, d = dikes, g = granite, b = basalt, sv = silicic volcanics, s = sediments, u = undifferentiated rock types, ls = limestone, qtzite = quartzite; Condition of rocks: cm = cemented, sl = silicified, br = brecciated; Notes: A = chemical analyses (see Table II), H = space heating, G = greenhouse, B = bathing facilities, R = resort, P = swimming pool, X = covered by reservoir, (678') = depth of well.

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
				Idaho County					
1	36N-11E-13b	s	Weir Creek H.S.	61	3	47	50	145	granite
2	36N-12E-15a	s	Colgate Licks	61	3	41	50	280	granite
3	36N-13E-18a	s	Jerry Johnson H.S.	61, 24	3	44-49	400	185	granite
---	36N-13E-18a	s	----	--	3	41-43	100	170	cm Qal near granite
4	36N-13E-5a	s	----	61	3	27	200	---	granite
---	37N-13E-26dd	s	----	--	3	20	40	480	granite
5	34N-10E-6b	s	Stanley H.S.	61	3	--	--	---	granite
6	32N-11E-4b	s	Stuart H.S.	61	3	--	35	---	granite
7	33N-14E-4a	s	----	61	3	--	--	---	granite
8	31N-11E-24d	s	Marten H.S.	61	3	--	--	---	granite
9	29N-12E-14b	s	Running Springs	61	3	--	--	---	Qal near granite
10	28N-10E-2d	s	Red River H.S.	61	3	54-63	20	355	gn, R, A
11	25N-11E-13dd	s	Barth H.S.	61	3	--	200	---	granite
12	24N-4E-7	s	----	61	-	48	10	---	granite
13	24N-2E-14da	s	Riggins H.S.	61	4	42-50	50	---	granite
14	22N-4E-1b	s	Burgdorf H.S.	61, 22	4	45	100	210	granite, R, A
---	21N-1E-2bd	s	Boulder Creek Resort	--	4	29	50	235	Tb near granite, B

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
15	21N-1E-23ab	s	Frank Garcie	61	4	32	61	595	gn, P
16	20N-1E-26da	s	Zims Resort	61, 22, 24	4	63-66	--	640	Qal near Tb, R
17	19N-2E-22cc	s	Krigbaum H.S.	61, 22	4	43	50	610	fault in gn
18	15N-1E-2bd	s	----	61	4	68	50	---	granite
19	16N-2E-33bc	s	White Licks H.S.	61	4	68	35	1,575	Qal near granite, B
---	18N-1W-34ac	s	Starkey H.S.	--	4	--	--	---	Tb, R
<u>Washington County</u>									
20	17N-5W-27	-	----	61, 23	-	--	--	---	Tb, X
---	14N-3W-19cb	s	J. Wiggins	59	4	49	--	371	Qal near Tb, A
21	12N-5W-33db	s	----	61, 62	-	--	--	---	Ts
---	11N-4W-14	s	----	--	4	--	--	---	Tb
---	11N-4W-33	w	W. Brummett	--	-	38	--	---	Tb, (1394')
<u>Valley County</u>									
22	21N-5E-11d	s	----	61	4	--	100	---	granite
23	20N-5E-15d	s	----	61	4	--	--	---	granite
24	20N-7E-35a	s	----	61	4	32-58	100	---	Qal near granite
25	18N-6E-35c	s	----	61	4	47	10	260	granite
26	18N-8E-17a	s	----	61	4	35	--	343	sl granite, A
27	15N-3E-13bb	s	Hot Creek Spring	61	4	34	25	278	Qal near granite and Tb, A
28	16N-4E-35cb	s	----	61, 22	4	49	100	330	br granite
---	15N-4E-20d	s	Badley H.S.	61, 22	4	38	40	202	granite, P(a)
29	16N-6E-1b	s	----	61	4	--	--	---	granite
---	16N-6E-14c	s	----	--	4	--	--	---	granite
30	15N-6E-20ba	s	Trail Creek H.S.	61	4	50	75	240	granite
31	15N-6E-14cd	s	South Fork Plunge	61	4	54	--	280	granite, P, A

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
32	14N-6E-11ba	s	Vulcan H.S.	61	4	89	450	340	sl granite
33	15N-6E-14ab	s	Molly's Spring	61	4	61	75	300	granite
---	14N-7E-18c	s	----	--	4	--	--	---	Qal
34	14N-3E-36ab	s	City of Cascade	61	4	38	10	270	Qal, P, A
34a	14N-3E-26d	s	----	61	4	--	--	---	Qal, P(a), X
---	14N-3E-5a	s	----	--	4	--	--	---	Qal, X
---	13N-4E-31cb	s	Cabarton H.S.	--	4	64-70	80	480	granite
35	12N-5E-2da	s	----	61	4	--	--	---	granite
36	12N-5E-11bb	s	----	61	4	38	15	---	granite
37	12N-5E-10dd	s	----	61	4	32	15	---	granite
38	12N-5E-22bc	s	Boiling Springs	61, 67	4	84-88	150	325	granite, A
39	13N-6E-29da	s	Bull Creek Springs	61	4	--	--	---	granite
40	12N-5E-36db	s	Silver Creek Plunge	61	4	39	450	245	granite, A
---	11N-5E-29cd	s	----	--	4	43-49	50	285	granite
41	13N-10E-23c	s	----	61	5	--	10	---	granite
42	14N-10E-30c	s	----	61	5	--	--	---	granite
43	14N-9E-13a	s	----	61	5	37-43	10	---	granite
44	15N-10E-24bb	s	Sheepeater H.S.	61	5	--	25	---	granite
45	15N-10E-21d	s	----	61	5	--	--	---	granite
46	16N-10E-14db	s	----	--	5	--	--	---	granite with Td
47	16N-12E-20a	s	----	61	5	--	40	---	granite
48	17N-11E-15a	s	----	61	5	--	50	---	granite
---	17N-10E-11b	s	----	--	5	--	--	---	granite
49	17N-13E-27a	s	Cox H.S.	61, 45	5	--	--	---	Tg
---	17N-14E-6d	s	Hospital H.S.	--	5	--	--	---	Tg
<u>Lemhi County</u>									
50	25N-17E-17d	s	----	61, 24	-	43	10	---	granite

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
51	23N-17E-10b	s	Owl Creek H.S.	61	6	--	25	---	granite
52	23N-18E-22a	s	Big Creek H.S.	61	6	--	--	---	granite
53	23N-22E-22a	s	----	61	6	80	--	---	fault in Ts
54	19N-14E-26dd	s	Warm Springs	61, 45	5	--	40	---	Tg
---	18N-14E-22bb	s	----	45	5	--	--	---	gn
55	17N-14E-19bd	s	----	61, 45	5	--	10	---	Tg
56	15N-14E-10a	s	----	61, 45	5	27-64	400	---	fault in Tsv, A
57	15N-15E-1a	s	----	61	5	--	--	---	fault in Tsv
58	15N-16E-16	s	----	61, 45	5	50	200	---	fault in Tsv
59	20N-27E-3ca	s	Salmon H.S.	61, 1	6	--	400	---	fault in tuff
60	20N-24E-34dd	s	Sharkey H.S.	61, 2	6	--	200	---	pT ls
61	18N-22E-6	s	----	61	6	--	200	---	pT qtz
62	17N-21E-4	s	----	61	6	--	100	---	Tsv
63	16N-21E-18ad	s	----	61	6	--	100	---	Tsv
64			Unknown — may also be spring 62 or 63						
65	15N-26E-21db	s	----	61	6	31	3	---	Qal near pTu
<u>Gem County</u>									
66	7N-1E-8dd	s	Health Spa (Roystone) H.S.	61	7	66-74	75	680	fault in Tb, R, A
---	7N-1E-9d	s	----	--	7	--	--	---	Qal near Tb
---	6N-1E-30	s	----	--	7	26	1	358	QTs
<u>Canyon County</u>									
---	5N-3W-14dc	w	W. Doty	--	-	46	--	---	QTs, (174')
---	1N-4W-12db	w	C. Collis	--	7	36	--	---	QTs, (640')

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific conduct. (μmhos @ 25°C)	Geology and Remarks
---	1S-2W-5ca	w	L. Givens	--	10	38	--	---	Qts, (855')
---	2S-3W-22cb	w	R. E. Balley	55	7	27	--	509	Qts, (832'), A
---	1N-3W-12ba	w	E. Tiego	55	7	32	--	554	Qts, (1265'), A
---	1N-2W-16cb	w	H. Tiego	55	7	26	--	1,070	Qts, (375'), A
---	1N-2W-36bd	w	Reynold Irr. Dist.	55	7, 10	2	--	595	Qts, (71'), A
67 and 68				Ada County					
69			Unknown	-- most likely gone dry					
			Unknown	-- most likely gone dry					
70	3N-2E-12cd	w	Boise Water Corp.	61, 21, 48, 49, 63	7	77	--	380	fault in Qts, H, A
---	5N-1E-26dcd	w	B. Stadler	68	7	30	900	280	Qts, (688'), P
---	5N-1E-35aca	w	J. Jeker	68	7	43	(f)	280	Qts, (—)
---	4N-2E-4bcd	w	G. Huffaker	68	7	31	--	300	Qts, (956')
---	4N-2E-17ba	w	----	--	7	43	--	---	Qts + Qb (1700')
---	4N-2E-17cbb	w	J. Barnes	68	7	34	--	380	Qts + Qb, (1240'), P
---	4N-2E-22bcd	w	J. Turteling	68	7	43	--	280	Qts, (595')
---	4N-2E-22cbb	w	J. Turteling	68	7	43	--	---	Qts, (600')
---	4N-2E-28abb	w	V. Nibler	68	7	48	--	300	Qts, (1200')
---	4N-2E-28cbb	w	Milstead Florests	68	7	48	190	290	Qts, (1240'), G
---	4N-2E-29ae	w	Edwards Florests	68	7	48	337	285	Qts, (1295'), G
---	4N-2E-29ad	w	W. F. Church	68	7	47	--	280	Qts, (1420')
71	5S-4E-29a	s	----	61	10	43	100	---	Qts
---	5S-3E-14bb	w	----	--	10	--	--	---	Qts, (—)
				Boise County					
72	9N-3E-25bae	s	----	61	7	79	30	540	granite

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
73	10N-4E-33cbc	s	----	61	7	76	100	375	granite, R, A
74	8N-5E-6db	s	Hot Springs Campground	61	7	46-51	8	330	granite, both sides of river, H?
---	8N-5E-1bc	s	----	--	7	--	--	---	granite
75	8N-5E-2d	s	----	61	7	--	80	---	granite
---	8N-5E-10ad	s	----	--	7	--	--	---	granite
---	8N-5E-10bd	s	----	--	7	56	55	325	granite, G
76	8N-5E-1bc	s	----	61	7	--	10	---	granite
77	9N-7E-31d	s	Pine Creek Camp- ground	61	7	61	200	330	granite with Td, B
78	9N-8E-31a	s	Haven Lodge	61	7	58	75	360	granite, R
79	9N-8E-32c	s	Kirkham H.S.	61	7	49-64	250	302	sl granite, B
80	10N-10E-31c	s	Bonneville H.S.	61	5, 7	86	350	350	sl granite, B
81	10N-11E-30a	s	Sacajawea H.S.	61	5	68	100	360	Tg
82	6N-5E-33ac	s	Warm Springs Resort	61, 6, 31	7	43	300	305	Qal near granite, P
83	3N-6E-1b	s	Nevin Spring	61	7	--	200	---	Qal (silted by reservoir)
84	4N-6E-24bc	s	Twin Springs	61	7	67	350	230	granite, A
85	4N-7E-1a	s	Basset H.S.	61	7	--	--	---	granite
<u>Custer County</u>									
86	14N-11E-1d	s	----	61	5	--	4	---	granite
87	12N-11E-2b	s	----	61	5	--	200	---	granite
88	14N-13E-33a	s	----	61	5	--	3	---	granite
89	10N-13E-12bc	s	----	61	5	--	200	---	granite
90	10N-13E-25dc	s	----	61, 8	5	57	--	328	granite, A
91	11N-14E-21dd	s	Basin Creek Campground	61, 8	5	59	--	345	granite, A

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge 9gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
92	11N-14E-21dd	s	----	61, 8	5	59	--	---	granite
93	11N-15E-19c	s	Sunbeam H.S.	61, 8, 46	5	76	200	409	granite, P(a), A
94	10N-13E-3ca	s	Stanley H.S.	61, 8	5	49	400	300	Qal near granite, P, A
95	11N-15E-34d	s	Robinson Bar H.S.	61, 8, 46	5	53	40	359	Qal near granite, R, A
96				Same as spring 57					
97	15N-14E-10 & 13	s	Loon Creek H.S.	61, 45	5	46-58	700	---	pTu, A
98				Same as spring 58					
99	10N-16E-19d	s	Slate Creek H.S.	61	5	51	200	448	pTu, A
100	11N-17E-27d	s	Sullivan H.S.	61, 46	5, 6	41	200	1,120	pTu, P, A
101	9N-14E-19a	s	----	61	5	41	--	---	granite
102	8N-14E-27a	s	Pierson Spring	61, 43, 46	5	49	300	---	granite, P
103	8N-17E-30 & 31	s	----	61	5	21-49	450	---	Tsv
104	7N-17E-6a	s	----	61	5	24-43	300	---	Tsv
105	14N-19E-23dd	s	Beardsley H.S.	61, 46	6	51	1,500	---	fault between Tsv & pTu, A
106				Temperature 14°C -- removed from list					
107	12N-20E-10cb	s	----	61, 27	6	--	100	---	Qal near Tsv
108	11N-25E-23ca	s	Barney H.S.	61, 27	6	32	150	500	Qal near Tsv & pTu
				<u>Elmore County</u>					
110	4N-7E-8bc	s	Sheep Creek Bridge H.S.	61	7	61	15	218	granite
111	4N-7E-7d	s	Reed H.S.	61	7	--	--	---	granite
112	5N-7E-34cc	s	Smith Cabin H.S.	61	7	--	--	---	granite
113	5N-7E-34db	s	Loftus H.S.	61	7	49	30	198	granite
114	5N-7E-26cc	s	Crevice H.S.	61	7	--	2	---	granite
115	5N-7E-26da	s	Vaughn Spring	61	7	--	100	---	granite

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
116	5N-7E-24a	s	Neinmeyer H.S.	61	7	76	300	291	granite, A
117	5N-8E-10d	s	Pool Creek H.S.	61	7	--	---	---	granite
118	5N-8E-12a	s	----	61	7	--	---	---	granite
119	5N-9E-7b	s	Dutch Frank's Sp.	61	7	66	1,200	220	granite
120	5N-9E-4b	s	Granite Creek Sp.	61	7	58	200	250	granite
121			Same as spring 120						
---	6N-9E-35a	w	Weatherby Mill	--	7	28	(f)	280	granite, (1750')
122	6N-10E-30c	s	----	61	7	54	30	---	granite
123	6N-11E-3bbc	s	----	61	7	38	50	300	granite, A
124	3N-10E-10b	s	----	61	8	--	--	---	granite
---	3N-10E-10ab	w	----	61	8	--	--	---	granite, (—)
125	3N-11E-9b	s	----	61	8	--	--	---	granite
126	4N-11E-34db	s	----	35-58	8	35-50	150	230	Qal near granite with Td
127	3N-12E-7dc	s	Baumgartner Canyon	61	8	43-49	40	260	granite, P, B
128	2N-10E-5ab	s	Bridge H.S.	61	8	52-59	100	240	Qal near granite
128a	2N-10E-5aa	s	----	--	8	59	50	245	granite
129	3N-10E-33bd	s	Paradise H.S.	61	8	60	45	245	Qal, R. A
129a	3N-10E-33ac	s	----	--	8	48-53	55	235	granite
130	1N-10E-5	s	----	61, 4, 15, 37	8	73	--	---	Qal, X
131	3S-8E-17dd	s	Hot Springs	61, 41, 47, 48	10	70	--	279	fault in Qb, A
---	3S-8E-17dd	w	----	--	10	70	--	280	fault in Qb, (900')
---	3S-7E-2ac	w	R. Ford	41	10	31	--	240	Qb, (520')
---	3S-8E-36ca	w	Ross #1	41	8, 10	38	--	300	Qb, (585'), A
---	3S-8E-36bc	w	Ross #2	41	8, 10	68	(f)	300	QB + QTs, (600'), A
131a	3S-10E-31	s	Latty H.S.	61, 41	8	63	--	---	Qb
---	4S-8E-36bb	w	El Paso Station 11	41	8, 10	44	--	530	QTs + Qb, (1906'), A
---	4S-9E-8ab	w	Walker #1	41	10	60	--	310	QTs + Qb, (1175'), A
---	5S-8E-34bc	w	Old Resort	41	8	33	--	1,150	QTs, (>1000'), A

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
---	5S-10E-21aa	w	Stevens	41	8	28	--	---	QTs + Qb, (300'), A
---	5S-10E-32bd	w	Campinland	41	8	38	--	500	QTs, (>1000'), A
---	5S-11E-7bc	w	Texaco - King Hill	41	8	30	--	300	QTs, (1300'), A
131b	5S-12E-3ab	w	----	61	8	36	(f)	---	QTs + Qb, (506')
<u>Camas County</u>									
132	4N-14E-1c	s	----	61	8	--	10	---	granite
133	4N-14E-32a	s	----	61	8	--	21	---	granite
134	3N-13E-7a	s	Lightfoot H.S.	61	8	43-63	30	355	br granite
134a	3N-13E-7a	s	----	--	8	56	15	355	granite
135	3N-14E-30a	s	Preis H.S.	61, 37	8	41	10	340	Id in granite
136	3N-14E-28a	s	Worswick H.S.	61, 44, 57	8	51-83	500	325	sl granite
137	1N-13E-22ab	s	Wardrop H.S.	61, 40, 60	8	--	--	325	Qal near granite, A
138	1N-15E-14ad	s	Elk Creek H.S.	61, 40, 60	8	--	--	---	contact granite & Tsv, A
139	1S-13E-34bc	s	Barron's Spring	61, 40, 60	8	--	--	---	Qal near Tsv, A
---	1S-12E-15bc	s	----	40, 60	8	--	--	---	Qal
---	1S-12E-31cb	w	F. Tracy	60	8	85	10	---	Qal, (400')
---	1S-13E-27cc	w	E. Mizer	40, 60	8	35	67	415	Qal, (190'), A
<u>Blaine County</u>									
140	6N-16E-33c	s	Russian John H.S.	61, 57	-	39	45	---	Qal
141	5N-16E-10c	s	Easley Warm Spring	61, 57	-	37	90	---	cm Qal near pTu
142	4N-17E-14b	s	Bald Mtn. H.S.	61, 58	8	77	450	---	pTu, R, A
---	4N-17E-14	w	----	--	8	--	--	---	several wells, H
143	4N-16E-36d	s	----	61, 37, 58	8	--	450	---	pTu
144	3N-17E-27d	s	Clarendon H.S.	61, 22, 57, 58	8	52	100	---	pTu, R, A

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°)	Geology and Remarks
145	2N-18E-18d	s	Hailey H.S.	61, 22, 58	8	58	45	---	pTu, R, A
146	1S-17E-23aa	s	Hot Springs Landing	61, 53	8	36	130	---	Qb
147	1S-21E-13c	s	Condie H.S.	61, 53	8	44	450	---	Qb
---	1S-22E-1ba	s	----	--	-	27	--	---	Qb
<u>Butte County</u>									
---	3N-27E-9a	w	Butte City	--	-	22-42	--	---	Qb, (464')
<u>Clark County</u>									
148	11N-32E-25a	s	Warm Spring	61, 52	-	30	3,000	415	pT ls
149	10N-33E-34d	s	----	61, 50	-	--	--	---	fault in pT ls
150	9N-33E-2c	s	Lidy H.S.	61, 18, 50, 52	-	48	300	678	fault in pT ls, R(a), A
---	9N-33E-11b	w	Lidy H.S. Resort	--	-	--	--	---	pT ls
<u>Fremont County</u>									
151	Removed from list — temperature about 11°C								
<u>Jefferson County</u>									
152	4N-40E-25dc	s	Heise H.S.	61, 18, 50, 53	9	50	50	5,500	fault in Tsv, R

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
<u>Madison County</u>									
153	5N-43E-6bd	s	Green Canyon H.S.	61, 50	9	46	170	700	Tsv, P
---	5N-42E-7	s	----	--	9	--	--	---	Tsv
---	7N-41E-34dcd	w	Village of Newdale	--	9	29	--	---	Qb
---	7N-41E-34add	w	H. Harris	--	9	32	--	430	Qb
---	7N-41E-35cd	w	----	--	9	36	--	490	Qb
<u>Bonneville County</u>									
154	1N-43E-8dc	s	Fall Creek Mineral Springs	61, 51	9	23	200	2,600	pTu-tufa mound
155	2S-46E-19b	s	Alpine H.S.	61	9	49-66	25	---	Qal near Tsv, X, A
156	2S-45E-13 & 24	s	----	61, 36, 51	9	31-62	--	---	Qal near Tsv, X
157	3S-37E-31db	s	Yandell Springs	61, 63	9	22-32	1,500	550-250	fault in pT ls
---	4S-38E-28dd	s	----	--	9	--	--	---	tufa in Qal
<u>Owyhee County</u>									
158				Same as spring 159					
159	1N-3W-21ba	s	Givens H.S.	61, 6, 13, 25, 37, 48	7-10	49	35	582	Qal, R, A
---	1N-3W-20da	w	----	7	10	38	--	---	QTs + Qb
---	1N-3W-21bb	w	----	7	10	38	--	---	QTs + Qb
---	1N-4W-12ac	w	----	7	10	40	--	---	QTs + Qb. A
---	1S-2W-7bc	w	J. Mueller	7	10	21	(f)	---	QTs + Qb

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
---	1S-2W-7ca	w	J. Mueller	7	10	38	(f)	---	QTs + Qb, (900'), A
---	1S-2W-18bc	w	R. Barly	7	10	20	(f)	---	QTs + Qb, (592')
---	1S-2W-18dcc	w	Cotner	7	10	28	--	---	QTs + Qb
---	1S-2W-19bc	w	D. Hall	7	10	27	--	---	QTs + Qb, (300')
---	1S-2W-29ad	w	----	7	10	30	5	---	QTs + Qb
---	1S-2W-34cb	w	L. H. New	7	10	39	(f)	---	QTs + Qb, (300')
---	1S-2W-34cb	w	L. H. New	7	10	39	(f)	---	QTs + Qb, (1300')
---	1S-3W-1da	w	P. Mueller	7	10	40	(f)	---	QTs + Qb, (1200')
---	1S-3W-1dd	w	P. Mueller	7	10	34	(f)	---	QTs + Qb, (900')
---	2S-2W-23	s	T. Blackstock	68	10	27	5	100	Tb, A
---	2S-2W-36a	w	Newt Wright	7	10	28	(f)	---	QTs + Qb, (1230')
---	2S-2W-36ba	w	----	7	10	32	--	---	QTs + Qb, A
---	3S-1W-4dc	w	----	7	10	27	--	---	QTs + Qb
---	3S-1W-36dda	w	----	7	10	21	--	---	QTs + Qb
---	3S-1E-31ddc	w	----	7	10	22	7	---	QTs + Qb
---	4S-1E-34ab	w	Forman	7	10	77	(f)	---	QTs + Qb, A
---	4S-2E-19ac	w	----	7	10	81	(f)	---	QTs + Qb, A
---	5S-1E-29aa	w	W. Bockman	7	10	47	--	---	QTs + Qb, (600')
---	-21cb	w	W. Bockman	7	10	64	(f)	---	QTs + Qb, A
---	-24ac	w	----	7	10	66	(f)	---	QTs, A
---	5S-2E-2aa	w	O. Field	20	10	52	72	---	QTs, (1745'), A
---	-13ad	w	E. Ratliff	20	10	26	5	---	QTs, (1748')
---	5S-3E-22aa	w	C. E. Wilson	20	10	31	--	---	QTs, (60')
---	-28bc	w	Whitted	7	10	65	--	---	QTs, A
---	6S-3E-4ab	w	C. E. Wilson	20	10	34	3	---	QTs, (1400')
---	-4bc	w	B. Whitson	20	10	37	20	---	QTs, (1400')
---	-5ad	w	W. A. Thurber	20	10	37	10	---	QTs
---	-9ac	w	B. Whitson	20	10	37	30	---	QTs, (1400')
---	-10bb	w	B. Whitson	20	10	34	15	---	QTs, (1400')
---	-11ca	w	Smith & Hinton	20	10	34	5	---	QTs

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
---	-11cc	w	Smith & Hinton	20	10	34	20	---	QTs, (1423')
---	-13ab	w	Smith & Hinton	20	10	38	50	---	QTs, (1350+)
---	-13ad	w	Smith & Hinton	20	10	37	15	---	QTs
160	6S-3E-14	s	----	61	10	--	50	---	Qa1, (now dry?)
---	6S-3E-14bc	w	Smith & Hinton	20	10	29	3	---	QTs, (1341')
---	6S-5E-10dd	s	E. Black	20	10	39	5	---	QTs, (1667')
---	-24bc	w	G. Hutchinson	20	10	29	20	---	QTs, (1095')
---	-24cā	w	G. Craig	20	10	40	--	---	QTs, (1325')
---	-24db	w	W. I. Turner	20	10	33	--	---	QTs, (1170')
---	-24dd	w	Bruneau Village	20	10	34	25	---	QTs, (976')
---	-29dc	w	P. Davis	20	10	34	3	---	QTs, (1560')
161	-32a	s	Rosebrier Spring	61, 20, 47	10	38	5	---	Qa1, now dry
---	6S-6E-19cc	w	A. C. Machley	20	10	40	15	---	QTs, (913')
---	7S-4E-12bd	w	F. Faria	20	10	42	1,400	---	QTb, (1105')
---	-13dc	w	L. Lahtimer	20	10	40	1,000	---	Tsv, (1000')
---	-24bd	w	J. E. Sullivan	20	10	39	750	---	QTb, (900')
---	-24dc	w	A. M. Glidden	20	10	38	60	---	QTb, (470')
162	-24	s	Conner Spring	61, 22, 39	10	37	135	---	QTs, now dry, A
---	7S-5E-7ab	w	J. Agenbroad	20	10	38	4,000	---	QTb, (1625'), A
---	-7da	w	G. Deming	20	10	36	215	---	QTb, (1134')
---	-7bd	w	G. Deming	20	10	31	130	---	QTs, (720')
---	7S-5E-8bb	w	A. Harley	20	10	23	10	---	QTs, (580')
---	-8bc	w	R. Harley	20	10	29	100	---	QTs, (600')
---	-9dd	w	J. Agenbroad	20	10	33	200	---	QTb + Tsv, (1700')
---	-18bc	w	A. Black	20	10	33	750	---	QTb, (517')
---	-19cc	w	E. Underdahl	20	10	36	--	---	QTb + Tsv, (750')
---	-28ac	w	F. King	20	10	33	--	---	QTb + Tsv, (1003')
---	7S-6E-4ac	w	E. Black	20	10	27	10	---	QTs, (1040')
---	-4dc	w	E. Black	20	10	42	200	---	QTs, (680')
---	-7aa	w	J. E. Turner	20	10	32	20	---	QTs, (1086')

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
---	-9ba	w	E. Black	20	10	51	630	---	QTs. (960'), A
---	-16cd	w	H. L. Bean	20	10	38	35	---	QTs + QTb, (350')
---	-18bb	w	D. Sawyers	20	10	27	--	---	QTs, (1480')
---	-21db	w	S. Okimeko	20	10	40	760	---	QTs, (611'), A
---	-22aa	w	G. Pinkston	20	10	47	900	---	QTb, (580')
164	-22c	s	----	61, 39	10	44	35	---	QTs
165	-22d	s	Trammel's H.S.	61, 39	10	46	1,000	---	Qal, A
---	-23ca	w	A. Bilbao	20	10	46	250	---	QTb, (450')
163	-24d	s	Bruneau H.S.	61, 39, 47, 48	10	41	1,200	275	QTs
---	7S-6E-2bba	w	B. Bilbao	20	10	39	680	---	QTb, (365')
---	-27aa	w	E. Bertschy	20	10	47	765	---	QTb, (350')
166	-34d	s	----	61, 39	10	37	1,000	300	Qal
167	8S-6E-3ba	s	Indian bathtub	61, 39	10	38	2,000	275	tuff beneath Qb, A
168	8S-6E-3aa	s	----	61, 39	10	39	55	275	tuff beneath Qb
169	7S-6E-26cc	s	----	61, 39	10	44	--	270	Qal
169a	13S-7E-5a	s	Indian H.S.	61	-	70	2,700	360	Tb + Tsv + quartz cobble Qal
169b	16S-9E-24b	s	Murphy H.S.	61	-	50	--	136	Tb + Tsv, A
Gooding County									
170	4S-12E-30a1	s	White Arrow H.S.	61, 53	8	65	1,200	380	Ts
171	4S-13E-29ad	s	Hot Sulfur Lake	61, 53	8	27	80	---	Qb, temp. fluctuates
---	4S-13E-28ab	w	----	--	8	--	--	---	Qal
172	4S-12E-36b	s	Tschannen W.S.	61, 53	8	43	--	---	Qal
---	4S-12E-35ad	w	----	--	8	--	--	---	Ts

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
<u>Twin Falls County</u>									
173	8S-14E-30a	s	----	61, 53	11	54	5	---	QTs
174	8S-14E-31ac	s	Miracle H.S.	61, 53	11	54	300	520	QTs, P, A
---	8S-14E-30c	s	----	--	-	--	4	---	QTs
175	8S-14E-33c	s	Banbury H.S.	61, 47, 53	11	55	600	330	QTs, R, A
---	8S-14E-33	w	Banburg H.S.	61, 53	-	55	--	---	QTs, many wells
176	9S-13E-14 + 23	s	Not found — may have gone dry						
177	12S-17E-31bab	s	Nat-Soo-Pah W.S.	61, 11, 14	11	37	--	456	Qal near Tsv, P, A
---	13S-16E-12abb	s	----	11	11	--	--	---	Qal, now dry
---	13S-16E-12abb	w	City of Hollister	11	11	--	--	444	Qal, A
---	13S-16E-12daa	w	Ora Jones	--	11	60	--	---	fault, 49°C @ 720', 60°C @ 850'
---	13S-16E-12dd	s	Goat Springs	--	11	49	--	---	Qal, now dry
---	12S-16E-36db	w	----	11	11	34	--	440	Qal, several wells, A
---	13S-17E-6bc	w	Ora Jones	11	11	36	--	418	Tsv, flowed for 60 yrs, A
---	16S-17E-30cb	s	Magic H.S.	--	11	45	--	281	Tsv, R, A
---	11S-19E-31cd	w	----	--	11	29	--	---	Qal above Tsv
---	-31ddd	w	----	--	11	29	--	---	Qal above Tsv
---	11S-19E-32bd	w	----	--	11	29	--	---	Qal above Tsv
---	-33dd	w	----	10	11	33	--	251	Qal above Tsv, A
---	-35ccd	w	----	--	11	29	--	---	Qal above Tsv
---	-36dac	w	----	--	11	28	--	---	Qal above Tsv
---	11S-20E-34cc	w	----	10	11	32	--	326	Qal above Tsv, A

TABLE, I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Location	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
<u>Cassia County</u>									
---	12S-18E-1bb	w	----	10	11	38	(f)	186	Qa1 above Tsv, A
---	12S-19E-2ad	w	----	--	11	35	--	---	Qa1 above Tsv
---	-3ad	w	----	--	11	31	--	---	Qa1 above Tsv
---	-4ad	w	----	--	11	28	--	---	Qa1 above Tsv
---	-5cbd	w	----	--	11	37	--	---	Qa1 above Tsv
---	-6ddb	w	----	--	11	37	--	---	Qa1 above Tsv
---	-6cd	w	----	--	11	37	--	211	Qa1 above Tsv, A
---	-7aca	w	----	--	11	27	--	---	Qa1 above Tsv
---	12S-20E-2ddd	w	----	--	11	23	--	---	Qa1 above Tsv
---	-3ca	w	----	--	11	34	--	---	Qa1 above Tsv
178	-5cc	w	Artesian City	61, 10	11	34	--	(f)	Qa1 above Tsv, spring now dry, A
---	12S-20E-6bc	w	----	10	11	39	--	---	Qa1 above Tsv
---	12S-20E-11ad	w	----	--	11	30	--	---	Qa1 above Tsv
---	12S-21E-5b & c	w	----	10	11	24	--	---	Qa1 above pT ls, (numerous wells)
179	12S-21E-6aa	s	Poulton W.S.	61, 10, 38	11	22	--	---	Qa1 above pT ls, A
---	13S-21E-8b	w	----	10	11	24	--	---	Qa1 above pT ls, (numerous wells)
180	Removed from list — temperature - 16°C								
181	16S-19E-21c	s	Thoroughbred S.	61, 38	11	21	--	---	Tsv
---	15S-21E-4b	w	Trapper Creek #1	61, 10, 38	11, 12	71	700	---	pTu, (880'), A
---	14S-21E-34ab	w	Nelson Well	61, 10, 38	11, 12	44	900	---	pTu, (983'), A
182	14S-22E-27cd	s	Oakley W.S.	61, 10, 38	12	46	10	---	pT qtzite, P, A
---	13S-25E-22bc	w	----	--	12	30	--	---	Qa1, fault?, A
---	13S-25E-32	w	----	--	12	29	--	---	Qa1, fault?
---	13S-26E-17	w	Ward Spring	--	12	30	90	240	fault in pTu

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific conduct. (μmhos @ 25°C)	Geology and Remarks
183	14S-25E-6b	s	Sears Spring	61	12	29	200	260	fault in pTu
---	15S-24E-22	s	Durfee Spring	--	12	36	5	475	Qa1, P(a)
---	15S-24E-22d	w	----	--	12	34	--	562	Qa1, (500'), A
---	15S-26E-23bb	w	Bridge Spring	33	12	93	26	2,920	Qa1, (414'), A
184	15S-26E-23dd	w	----	61, 33, 53	11	99	60	6,010	Qa1, A
---	15S-26E-24bc	w	----	33	11	24	--	2,800	Qa1
---	11S-27E-5ba	w	----	--	11	29	--	655	Qa1, A
---	11S-27E-34dd	w	----	--	11	39	--	1,100	Qa1, A
---	11S-27E-36ad	w	----	--	11	22	--	499	Qa1, (249'), A
185	11S-25E-11ba	s	Bridger H.S.	61, 32, 53	11	43	--	---	fault in Tsv, now dry
---	11S-25E-11bb	w	----	--	11	63	--	---	Tsv, (447')
186	11S-25E-22	s	----	61, 32, 53	11	37	2	---	fault in Tsv
<u>Power County</u>									
187	9S-28E-19ca	s	Broken Arrow Ranch	61, 53	12	28	750	560	Qa1
188	Removed from list — temperature 17°C								
189	8S-31E-18d	s	Indian Spring	61, 53	12	32	2,000+	900	pT 1s
---	8S-31E-18d	w	----	--	12	27	300	---	pT 1s
---	8S-31E-17	w	----	--	12	32	--	---	pT 1s
---	10S-30E-24ba	s	----	--	12	38	500	860	Qa1 above pT 1s
<u>Bannock County</u>									
---	5S-34E-26dba	w	R. L. Brown	--	-	41	200	950	Qa1 near Ts, (581')
190	9S-38E-21 &22	s	Lava H.S.	61, 53	13	38-62	1,350	1,280	Qb & pTu, R, A

TABLE I. THERMAL SPRINGS AND WELLS IN IDAHO
(Continued)

No.	Location	S or W	Name or Owner	Number in List of References	Shown on Figure	Temp. (°C)	Discharge (gpm)	Specific Conduct. (μmhos @ 25°C)	Geology and Remarks
190a	--	s	----	61	-	--	--	---	went dry in 1968
191a	12S-37E-12cc	s	Downata H.S.	61	13	44	470	432	Ts, P, A
---	12S-37E-12cd	s	Bowen Ranch	--	13	--	--	---	Ts
<u>Caribou County</u>									
191	12S-40E-31d	s	----	61, 37	13	52	--	---	Ts
192	9S-42E-8	s	----	61, 26, 35	13	28	--	---	tufa near Qb.
193	8S-42E-7	s	Soda Springs	61, 26, 35	13	24-31	--	---	Qal + tufa
---	9S-41E-18	s	Steamboat Springs	26	13	31	--	---	pTu
<u>Oneida County</u>									
194	15S-35E-3a	s	Pleasantview W.S.	61, 37	13	29	--	---	Qal near pTu
195	16S-36E-23	s	Price's H.S.	61, 37, 29	13	33	--	2,800	Qal, in river, A
<u>Franklin County</u>									
---	13S-40E-7ac	s	Maple Grove H.S.	--	13	77	--	3,110	fault in pTu, A
---	14S-39E-36	s	----	--	-	--	--	---	Qal, "steaming ground"
---	15S-39E-8b	s	Battle Creek H.S.	29	13	78	900	12,300	tufa in Qal, A
---	15S-39E-17a	s	Vincent H.S.	29	13	82	180	18,500	Qal, H, A
<u>Bear Lake County</u>									
196	15S-44E-13c	s	Bear Lake H.S.	61, 26	13	48	--	---	pTu, P

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS

[Chemical constituents in milligrams per liter]

No.	Location	Date of Collection	Source of Data (No. in references)	Temperature (°C)	Silica (SiO ₂)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO ₃)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Specific Conductance (E.C.) (micromhos @ 25°C)	Total Dissolved Solids (T.D.S.)	pH
Part 1 — North-Central Idaho																		
10	28N-10E-2d	8-55	68	55	65	2	0.2	85	1.3	36	32	40	5	21.0	0.1	372	274	9.4
Part 2 -- West-Central Idaho																		
14	22N-4E-1	8-55	68	48	58	2	0.2	47	0.5	41	19	17	3	2.3	0.2	217	181	9.6
--	14N-3W-19cb	5-62	59	49	---	8	0.5	74	3.1	2	56	105	16	---	Tr	317	238	8.5
26	18N-8E-17a	9-58	68	35	60	3	0.0	63	1.8	12	58	45	10	6.4	0.0	343	257	8.7
27	15N-3E-13bb	11-55	68	34	65	1	0.0	---	---	44	20	---	16	2.4	0.3	278	218	9.6
31	15N-6E-14cd	8-55	68	55	62	4	0.3	60	1.3	22	59	14	9	12.	0.2	284	224	9.3
34	14N-3E-36ab	11-55	68	38	46	1	0.0	---	---	22	63	---	17	3.8	0.2	272	203	9.4
38	12N-5E-22bb	-53	67	88	81	2	0.0	74	1.9	106	12	12	14	---	---	325	---	9.2
38	12N-5E-22bb	10-55	68	84	80	1	0.0	72	8.0	25	87	10	11	9.7	0.1	322	260	9.2
40	12N-5E-36db	10-55	68	39	53	2	0.4	52	5.1	12	70	20	6	7.5	0.2	254	197	9.0

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
<u>Part 3 — Central Idaho</u>																		
56	15N-14E-10a	-22	45	64	55	4	0.8	74		22	59	53	14	----	Tr	-----	280	----
58	15N-15E-1a	-22	45	50	52	4	0.6	64		29	30	32	11	----	Tr	-----	229	----
90	11N-13E-36b	9-54	68	57	75	1	0.3	72	2.4	38	20	32	6	16.0	0.0	328	239	9.6
91	11N-14E-21d	9-54	68	59	95	2	0.2	75	3.2	44	50	45	6	14.0	0.1	345	274	9.6
93	11N-14E-19c	9-54	68	73	91	1	0.3	89	3.8	29	60	51	2	16.0	0.0	409	291	9.4
93	11N-14E-19c	-25	46	--	84	4	0.7	79		40	44	51	6	----	Tr	-----	-----	----
94	10N-13E-3ca	9-54	68	49	64	2	0.2	64	2.2	23	81	74	9	10.0	0.0	300	216	9.6
95	11N-15E-27d	9-54	68	44	95	2	0.3	77	3.6	37	33	58	7	10.0	0.1	359	294	9.5
95	11N-15E-27d	-25	46	--	87	3	0.4	65		41	28	49	6	----	Tr	-----	-----	----
97	15N-14E-10+13	-25	45	49	60	4	0.6	75		23	55	49	14	----	Tr	-----	-----	----
99	10N-16E-19d	9-54	68	51	95	6	0.4	92	5.6	23	81	74	9	10.0	0.0	448	352	9.0
100	11N-17E-27d	9-54	68	41	35	50	9.7	191	19.	0	578	40	58	3/0	0.0	1,120	684	7.3
<u>Part 4 — East-Central Idaho</u>																		
105	14N-19E-23dd	-25	46	51	30	48	10.0	162		0	436	128	21	----	Tr	-----	-----	----

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
<u>Part 5 — Boise Region of Western Idaho</u>																		
66	7N-1E-8dd	8-55	68	66	111	8	0.2	159	8.0	0	201	118	64	1.0	0.4	803	580	8.1
--	6N-1E-30	8-55	68	26	61	37	10.0	22	5.1	0	188	22	8	0.0	0.4	358	242	7.5
--	2N-3W-22cb	5-64	55	27	---	40	11.	55	6.5	--	242	62	8	0.6	0.0	509	354	8.2
--	1N-3W-12ba	7-56	55	32	---	13	4.0	100	14.	13	308	6	8	----	1.0	554	355	8.6
--	1N-2W-k6cb	7-56	55	26	---	92	34.	69	7.	0	134	225	96	----	26.	1,070	684	7.7
--	1N-2W-36bd	7-56	55	26	---	12	6.	81	4.	8	207	25	12	----	4.	455	291	8.4
70	3N-2E-12cd	----	49	78	59	2	2.0	----	----	--	----	16	6	18.5	0.7	-----	290	9.2
73	10N-14E-33c	10-55	68	76	90	2	0.0	86	0.8	12	126	25	16	8.8	0.1	391	307	8.7
84	4N-6E-24bc	7-55	68	67	90	2	0.0	52	0.8	37	22	22	2	4.8	0.0	230	217	9.4
116	5N-7E-24a	7-55	68	76	105	1	0.1	67	1.8	47	14	30	1	10.0	0.1	291	245	9.5
123	6N-11E-36bc	7-55	68	38	78	3	0.4	65	1.6	21	41	39	6	14.0	0.1	300	234	9.6
<u>Part 6 — Sun Valley Region of Central Idaho</u>																		
129	3N-10E-33ba	7-55	68	60	72	1	0.0	56	1.2	39	32	17	4	4.0	0.0	283	203	9.5
137	1N-13E-32ab	-24	40	--	76	2	1.0	56		48	24	12	8	----	Tr	-----	-----	----
138	1N-15E-14ad	-24	40	--	66	3	0.8	85		26	59	44	26	----	Tr	-----	-----	----
---	1S-13E-27cc	-24	40	34	70	2	1.3	91		5	207	7	12	----	Tr	-----	-----	----
---	1S-13E-27cc	9-57	60	35	78	4	0.0	96	1.4	0	211	5	11	9.0	0.6	415	309	8.0

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
139	1S-13E-34bc	-24	40	--	75	4	1.6	104		10	229	15	15	----	Tr	-----	-----	----
142	1N-17E-14bc	-13	58	71	148	9	0.8	96	0.0	14	60	72	11	15.	----	-----	320	9.4
144	3N-17E-27d	-13	58	52	75	2	0.0	82	0.0	10	44	67	13	12.	----	-----	300	8.4
145	2N-18E-18d	-13	58	58	124	7	0.0	80	0.0	50	----	60	6	----	----	-----	-----	----
---	5S-8E-34bc	7-67	41	33	24	1	0.1	284	17.2	74	530	10	67	----	----	1,150	-----	7.8
---	5S-10E-21aa	7-67	41	28	30	2	0.2	131	3.6	0	241	27	42	----	----	500	-----	8.6
---	5S-10E-32bd	7-67	41	38	19	10	0.3	142	1.2	0	295	16	48	----	----	500	-----	8.5
---	5S-11E-7bc	7-67	41	30	15	2	0.2	78	1.6	Tr	151	10	20	----	----	300	-----	8.8
<u>Part 7 — Idaho Falls Region of Eastern Idaho</u>																		
150	9N-33E-2c	9-56	68	48	37	87	15.0	28	16	0	117	184	9	2.0	0.0	678	476	7.3
155	2S-46E-19b	8-39	68	56	45	526	93.	1532	189	0	920	1052	2412	2.8	0.8	-----	6,404	----
<u>Part 8 — Southwestern Idaho</u>																		
131	3S-8E-17dd	7-57	68	70	88	1	0.0	90	1.2	56	58	14	5	13.0	0.1	379	286	9.4
---	3S-7E-2ae	7-67	41	32	26	2	0.3	58	2.0	37	68	93	20	----	----	230	-----	8.8
---	3S-8E-36ca1	7-67	41	38	27	2	0.3	85	1.6	34	131	37	19	----	----	300	-----	9.0
---	3S-8E-36ca2	7-67	41	68	35	2	0.4	85	1.6	34	103	18	17	----	----	300	-----	9.3
---	4S-8E-36bb	7-67	41	44	31	2	0.3	147	4.0	34	215	22	27	----	----	530	-----	8.3

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
---	4S-9E-8ab	7-67	41	66	40	2	0.4	82	1.6	34	103	49	36	----	----	310	-----	9.3
---	2S-5W-23	5-56	68	27	46	11	1.3	6	3.8	0	58	2	1	0.3	0.2	100	109	7.5
159	1N-3W-21ba	5-57	68	49	75	1	0.0	126	1.4	35	150	31	23	14.0	0.2	582	392	9.2
---	1N-4W-12ac	1-68	7	40	---	8	8.0	10	-----	189	14	4	1.9	2.4	-----	-----	280	8.4
---	1S-2W-7cc	3-68	7	46	---	---	-----	110	-----	190	50	15	22.2	-----	-----	-----	330	8.6
---	2S-2W-36ba	4-68	7	32	---	16	-----	12	-----	61	92	10	0.5	-----	-----	-----	222	7.1
---	4S-1E-34ab	3-68	7	77	---	15	10.	85	-----	195	47	2	2.3	0.8	-----	-----	235	8.6
---	4S-2E-19ac	4-68	7	81	---	1	0.2	84	-----	---	25	5	9.2	0.2	-----	-----	320	10.0
---	5S-1E-21cb	4-68	7	63	---	14	1.0	36	-----	102	24	5	1.7	0.9	-----	-----	252	9.2
---	5S-1E-24ac	4-68	7	66	---	3	8.0	14	-----	155	39	15	1.6	1.2	-----	-----	250	8.8
---	5S-2E-2aa	11-53	7	52	---	2	0.5	91	-----	141	22	12	14.0	0.4	-----	-----	291	9.4
---	5S-3E-28bc	3-68	7	65	---	32	23.	75	-----	146	8	5	20.6	-----	-----	-----	190	8.0
162	7S-4E-24d	-22	39	38	90	5	0.6	52	---	0	107	44	8	-----	0.5	-----	249	-----
165	7S-6E-22c	-22	39	46	78	10	1.9	48	---	14	85	18	7	-----	Tr	-----	243	-----
167	8S-6E-3	-22	39	37	66	5	1.0	58	---	24	66	21	10	-----	Tr	-----	248	-----
---	5S-2E-2aa	11-53	20	52	81	2	0.5	91	1.0	37	104	22	12	14.	0.4	395	291	9.4
---	7S-5E-7ab	11-53	20	39	88	7	1.2	52	7.5	0	100	20	9	10.	0.7	286	240	7.0
---	7S-6E-9ba	11-53	20	49	118	4	1.4	109	---	25	127	31	12	22.	0.2	461	370	9.1
---	7S-6E-21db	11-53	20	40	86	8	1.4	63	---	0	114	21	10	12.	0.8	302	236	8.2
---	7S-6E-22aa	11-53	20	47	75	9	1.2	51	6.1	0	110	17	9	10.	1.3	287	237	7.2

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
169b	16S-9E-24b	6-56	68	51	85	1	0.0	31	2.6	6	55	4	3	3.2	0.6	136	162	8.5
169b	16S-9E-24b	10-50	68	--	84	1	0.0	----	-----	2	58	3	3	3.5	-----	-----	158	8.4
Part 9 — South-Central Idaho near Twin Falls																		
174	8S-14E-31bc	1-51	68	53	104	1	1.9	107		45	72	29	26	16.	0.6	459	366	-----
175	8S-14E-33bc	3-52	68	59	---	---	-----	-----	-----	49	65	26	26	10.	-----	455	330	9.2
177	12S-17E-31bab	7-56	68	37	22	33	14.	41	10	0	270	16	5	1.9	0.1	456	275	7.7
---	12S-16E-36db	3-61	11	33	---	33	12.6	42	13.3	0	262	16	7	2.2	0.0	440	255	7.6
---	13S-16E-12ab	11-60	11	37	---	34	10.6	43	11.7	0	250	15	6	-----	0.0	444	246	7.7
---	13S-17E-6bc	5-61	11	36	---	28	13.	44	11.7	0	252	15	5	-----	0.0	418	241	7.6
---	16S-17E-30bc	8-56	68	45	25	32	9.0	13	2.9	0	163	12	1/2	0.4	0.1	281	175	7.8
---	10S-17E-14cd	7-54	10	29	45	45	10	-----	-----	0	128	65	32	0.6	1.2	-----	236	7.7
---	11S-19E-21da	7-54	10	27	71	22	3.9	21		0	108	9	12	0.4	0.6	399	191	7.5
---	11S-19E-33dd	9-52	10	33	59	25	4.1	15	8.0	0	118	11	13	0.4	1.6	251	195	7.6
---	11S-20E-34cc	9-52	10	32	28	43	8.9	11	7.4	0	186	13	5	0.7	0.6	326	209	7.5
---	12S-18E-1bb	3-52	10	38	60	17	2.1	17	5.4	0	90	6	9	0.6	4.8	186	168	7.6
---	12S-19E-6cd	9-52	10	27	77	19	3.6	19		0	93	8	12	-----	1.9	211	186	-----
178	12S-20E-5cc	9-52	10	28	18	29	8.2	22		0	160	10	9	-----	0.6	294	175	-----
179	13S-21E-6aa	4-22	38	22	62	29	8.6	17		12	119	13	6	-----	-----	-----	206	-----

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
---	14S-21E-34ab	3-22	38	45	79	5	1.4	41		23	61	12	5	----	Tr	-----	198	----
---	14S-21E-4b	3-22	38	41	45	9	1.5	43		3	98	17	11	----	Tr	-----	180	----
---	15S-21E-25dc	3-22	38	42	64	4	1.2	106		46	159	22	17	----	Tr	-----	344	----
<u>Part 10 — South-Central Idaho near Burley</u>																		
182	14S-22E-27dd	12-21	38	46	78	3	0.9	84		19	69	26	52	----	0.2	-----	308	----
182	14S-22E-27dd	9-56	68	49	76	2	0.0	87	2.5	16	67	23	54	6.8	0.1	415	295	9.4
---	11S-27E-5ba	9-66	68	29	78	26	7.2	100	-----	0	230	14	90	3.4	0.9	655	-----	7.6
---	11S-27E-34dd	8-65	68	39	59	27	9.5	212	4.6	2	270	17	20	4.9	0.1	1,100	678	8.3
---	11S-27E-36ad	5-66	68	22	66	---	-----	16	-----	0	216	-----	-----	-----	-----	499	-----	7.7
---	13S-25E-22bc	9-66	68	30	18	22	5.4	19	-----	0	94	13	22	1.4	0.8	-----	238	7.3
---	15S-24E-22dd	8-65	68	34	42	34	8.5	70	3.0	0	152	29	80	3.6	0.0	562	346	7.7
---	15S-26E-23bb	6-49	33	93	82	52	1.7	530		--	58	59	820	8.9	0.0	2,920	1,580	----
184	15S-26E-23dd	6-49	33	99	84	125	3.3	1070		--	45	64	1800	6.0	1.0	6,010	3,180	----
<u>Part 11 — Southeastern Idaho</u>																		
190	9S-38-E-21+22	3-52	68	40	29	100	34.	127	30.	0	493	78	147	0.4	1.2	1,280	776	----
191a	12S-37E-12	7-57	68	48	32	44	13.	24	9.0	0	218	20	19	0.3	0.0	432	266	7.7
195	16S-36E-10	10-47	68	32	34	234	122.	1570		0	588	66	2780	0.0	30.0	8,760	5,130	----
195	16S-36E-10	9-64	29	33	---	170	135.	1000	105	5	192	317	4504	-----	-----	8,680	7,940	7.7
195	16S-36E-10	8-64	29	33	---	200	200.	2200	180	1	170	60	2961	-----	-----	8,855	5,810	7.4

TABLE II. CHEMICAL ANALYSES OF IDAHO THERMAL WATERS
(Continued)

No.	Location	Date	Ref.	(°C)	(SiO ₂)	(Ca)	(Mg)	(Na)	(K)	(CO ₃)	(HCO ₃)	(SO ₄)	(Cl)	(F)	(NO ₃)	Specific Conductance	(T.D.S.)	pH
---	13S-41E-7ac	7-57	68	77	58	94	22.	532	80	0	488	293	600	1.1	0.6	3,110	1,910	6.9
---	15S-39E-8b	7-64	29	78	---	310	305.	3550	660	5	410	30	4681	----	----	12,300	9,010	7.7
---	15S-39E-17a	7-64	29	82	---	445	335.	4200	910	0	372	39	6880	----	----	18,500	13,190	7.3
196	15S-44E-13c	-14	26	48	26	213	221.	149	41	--	1030	797	92	----	----	-----	-----	----