DISCHARGE AND WATER QUALITY OF SPRINGS
IN ROAN AND PARACHUTE CREEK BASINS,
NORTHWESTERN COLORADO, 1981-83

By David L. Butler

U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

Inch-pound units in this report may be expressed in the International System of Units (SI) by use of the following conversion factors:

Multiply inch-pound units	*By*	*To obtain SI units*
acre (ac)	0.4047	hectare
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer
pound (lb)	453.6	milligram
square mile (mi^2)	2.590	square kilometer

To convert temperature in degree Fahrenheit (°F) to degree Celsius (°C), use the following formula:

$$^\circ F = 1.8^\circ C+32.$$

DISCHARGE AND WATER QUALITY OF SPRINGS IN ROAN AND PARACHUTE CREEK BASINS, NORTHWESTERN COLORADO, 1981-83

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ABSTRACT

Roan and Parachute Creek basins are part of the oil-shale-rich Piceance basin in Colorado. This study of springs in Roan and Parachute Creek basins was a continuation of hydrologic investigations by the U.S. Geological Survey in important oil-shale regions. This report contains discharge, water-quality, and radiochemical data collected from 1981 to early 1983 for springs located in Roan and Parachute Creek basins. Stream discharge measurements and chemical data for two ion-mass-balance studies are included in this report.

Mean spring discharge is about 5 gallons per minute based on discharge measurements at 129 springs. Many springs have abrupt increases in discharge during or immediately after the snowmelt period, which indicates a short residence time for much of the recharge water in upland regions. Springs on the upland plateaus and ridges discharge mixed cation bicarbonate water having 216 to 713 milligrams per liter dissolved solids. Sampled springs in the canyon areas and basin-perimeter slopes have greater concentrations of sodium and sulfate than upland springs and have from 388 to 3,970 milligrams per liter dissolved solids. The only trace elements with a mean concentration greater than 10 micrograms per liter throughout the study area are barium, boron, lithium, and strontium. There is a significant difference in arsenic, barium, boron, lithium, selenium, strontium, and vanadium concentrations between samples from upland springs and samples from lowland springs.

Calcite and dolomite dissolution influence major-ion chemistry of springs in upland areas. Gypsum dissolution is a significant reaction in lower valley springs. Many springs are saturated or supersaturated with calcite, dolomite, feldspar, and clay minerals, and are undersaturated with fluoride and strontium minerals, and metal carbonates.

None of the canyon springs investigated represents discharge from the lower Green River aquifer based on chemical analyses and tritium-dating results. An ion-mass-balance study indicates lower aquifer discharge through talus material into the Carr Creek valley. Inconclusive results were obtained from a similar investigation of the West Fork Parachute Creek. Analysis of discharge and fluoride data for tributaries of Roan Creek show evidence of lower-aquifer discharge into the canyons.

Changes in spring-water quality could occur if oil-shale process water or mine water contaminated the source water of a spring. An increase in concentration of bicarbonate, fluoride, arsenic, boron, lithium, mercury, molybdenum, ammonia, and organic compounds may be observed in contaminated spring water. Because springs represent discharge from shallow, localized flow systems in Roan and Parachute Creek basins, changes in spring water quality are likely to be limited to springs located near the contamination source.

INTRODUCTION

Large oil-shale deposits exist in the Piceance basin in northwestern Colorado. Roan and Parachute Creek drainage basins (fig. 1) are located in the southern section of the Piceance basin. Current (1984) oil-shale development plus the potential for future oil-shale development throughout the study area have created a need for water studies in this region. Predevelopment hydrologic data are important requirements for oil-shale planning and development. A study of springs in Roan and Parachute Creek basins was part of a larger effort by the U.S. Geological Survey to define the hydrology of the major oil-shale areas in the western United States.

This report contains hydrologic data collected at springs in Roan and Parachute Creek basins from 1981 to 1983. The data were collected to meet three major objectives:

1. To quantify spring discharge and define areal and seasonal flow patterns. Included in this objective was relating spring discharge to available recharge and estimating residence time of the spring water in the study area.

2. To define water-quality conditions of springs in the study area prior to widespread oil-shale development. Defining water-quality conditions included quantifying concentrations of chemical constituents in the water; identifying areal patterns and relating such patterns to topography, geology, and ground-water flow systems; examining the geochemical nature of spring water; and delineating chemical constituents that may be useful for monitoring purposes.

3. To attempt to discover the relation of springs to the regional ground-water systems in Roan and Parachute Creek basins. The most important aspect of this objective was to locate springs discharging from the lower aquifer to verify some predictions of the Piceance basin ground-water model developed by the U.S. Geological Survey.

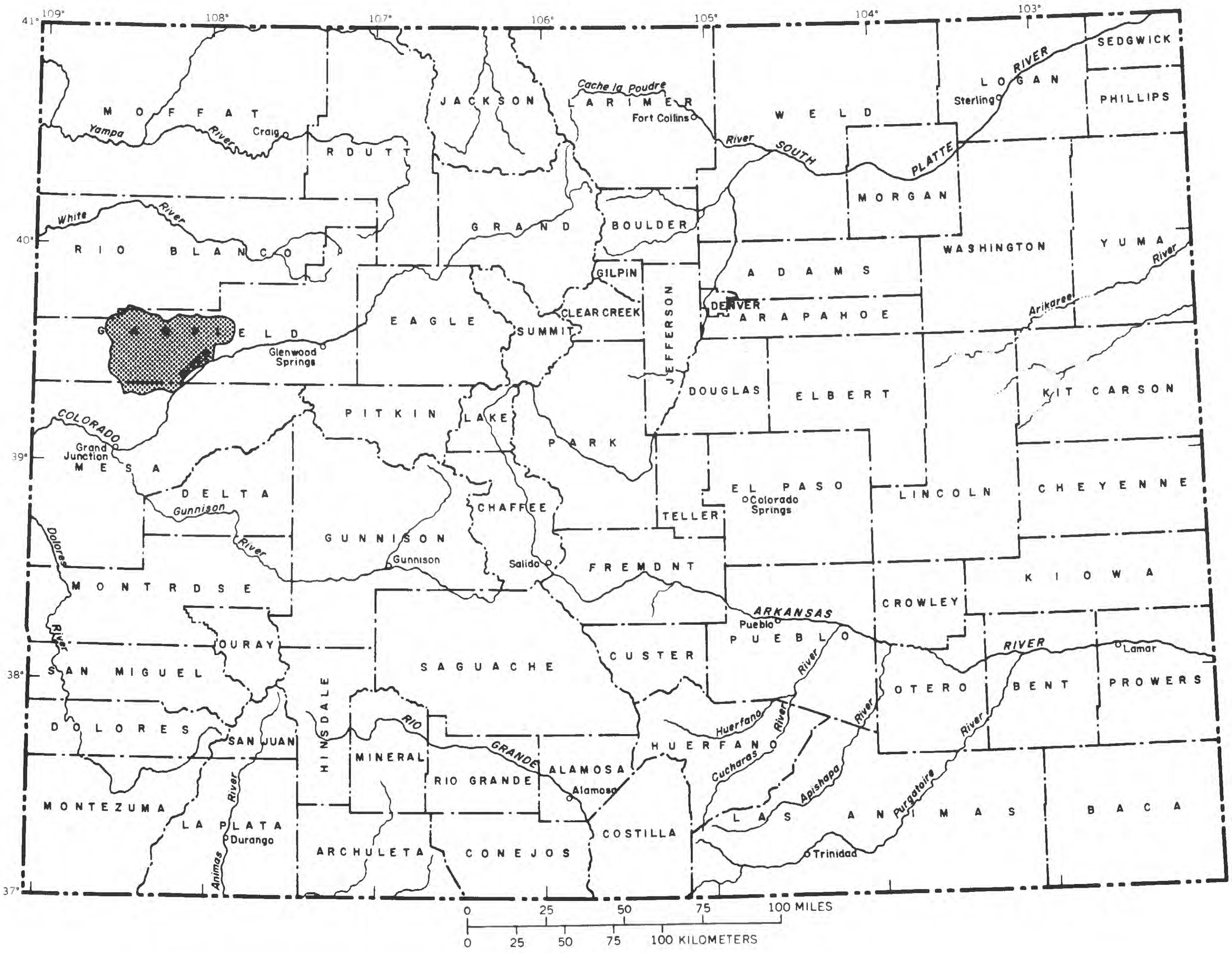


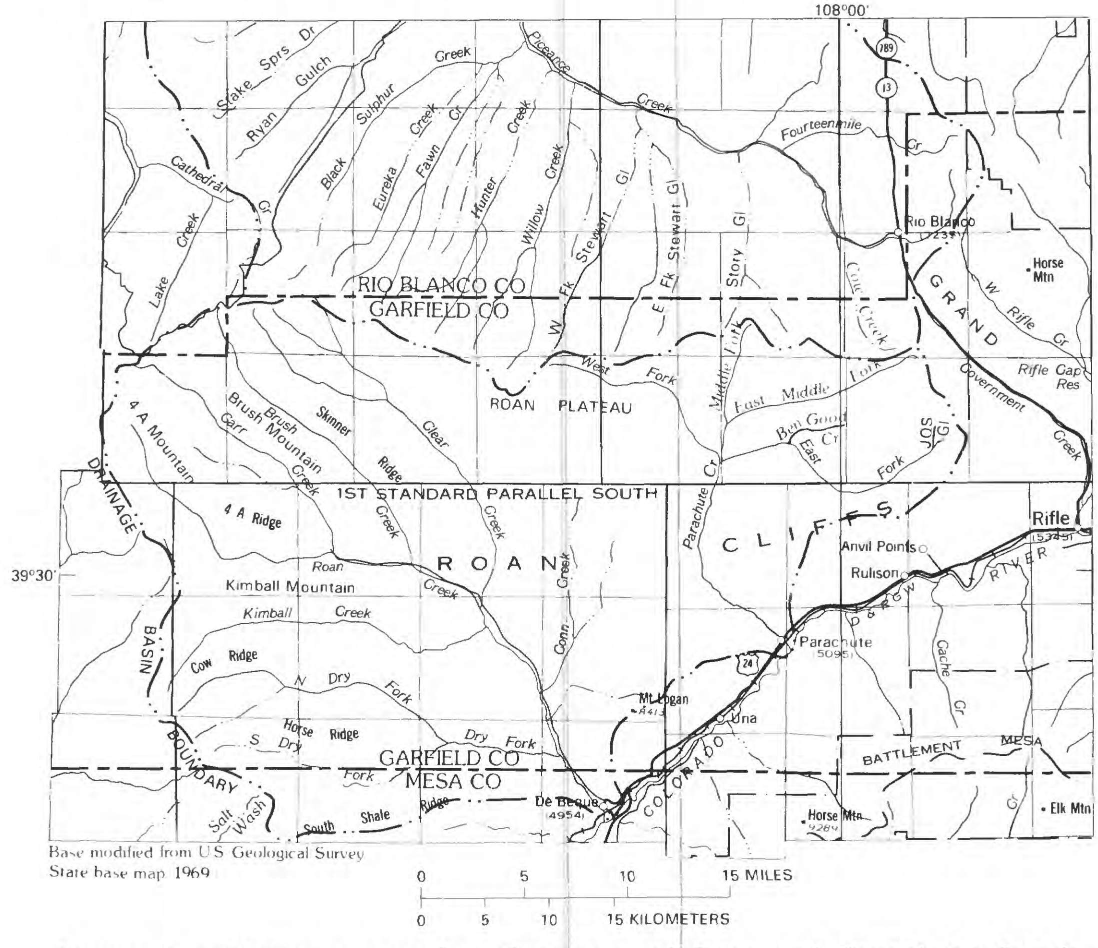
Figure 1.--Location of study area.

Physical Setting

Roan and Parachute Creeks drain the region north of the Colorado River between De Beque and Rifle. This area consists of a high plateau averaging more than 8,000 ft dissected by deep canyons. Major drainage basins are shown in figure 2. The range in elevation is from about 4,900 ft at De Beque to about 9,200 ft in the eastern part north of the Anvil Points area. Local relief of 2,000 ft or more is common in the canyons.

The study area is characterized by a continental, semiarid climate. Annual precipitation ranges from about 12 to 24 in. Deep winter snows are common on the plateaus and ridge tops.

Vegetation in the bottom land in the canyons consists of irrigated hay and pasture, sagebrush, and desert shrub. Juniper and pinyon trees, found along the lower hillsides, grade into mixed aspen and spruce forests in upland valleys. Large areas of the plateau and ridge tops consist of open grasslands or scrub oak and sagebrush that grade into the aspen and spruce forests commonly found in the upland draws and valleys. The wetter areas in the extreme western and eastern sections of the study area are dominated by forests of aspen, fir, and spruce.



Base modified from U S Geological Survey
State base map 1969

Figure 2.--Major geographic features of Roan and Parachute Creek basins and vicinity.

Ranching is the primary activity in the valleys of Roan Creek basin. Parachute Creek valley has undergone considerable change in the past few years because of the start of two large oil-shale projects. Union Oil has a mine along the downstream reach of East Fork Parachute Creek, and other parts of the project are located along Parachute Creek. The Colony project, located along the upstream reach of Middle Fork Parachute Creek, currently (1984) has suspended operations. Other energy companies have done preliminary work on shale properties in the study area, but no other large operations are currently (1984) underway. The upland areas on the Roan Plateau primarily are used as a summer range for livestock. In addition, there has been considerable gas-well drilling and mineral exploration in the study area during the past.

Geology

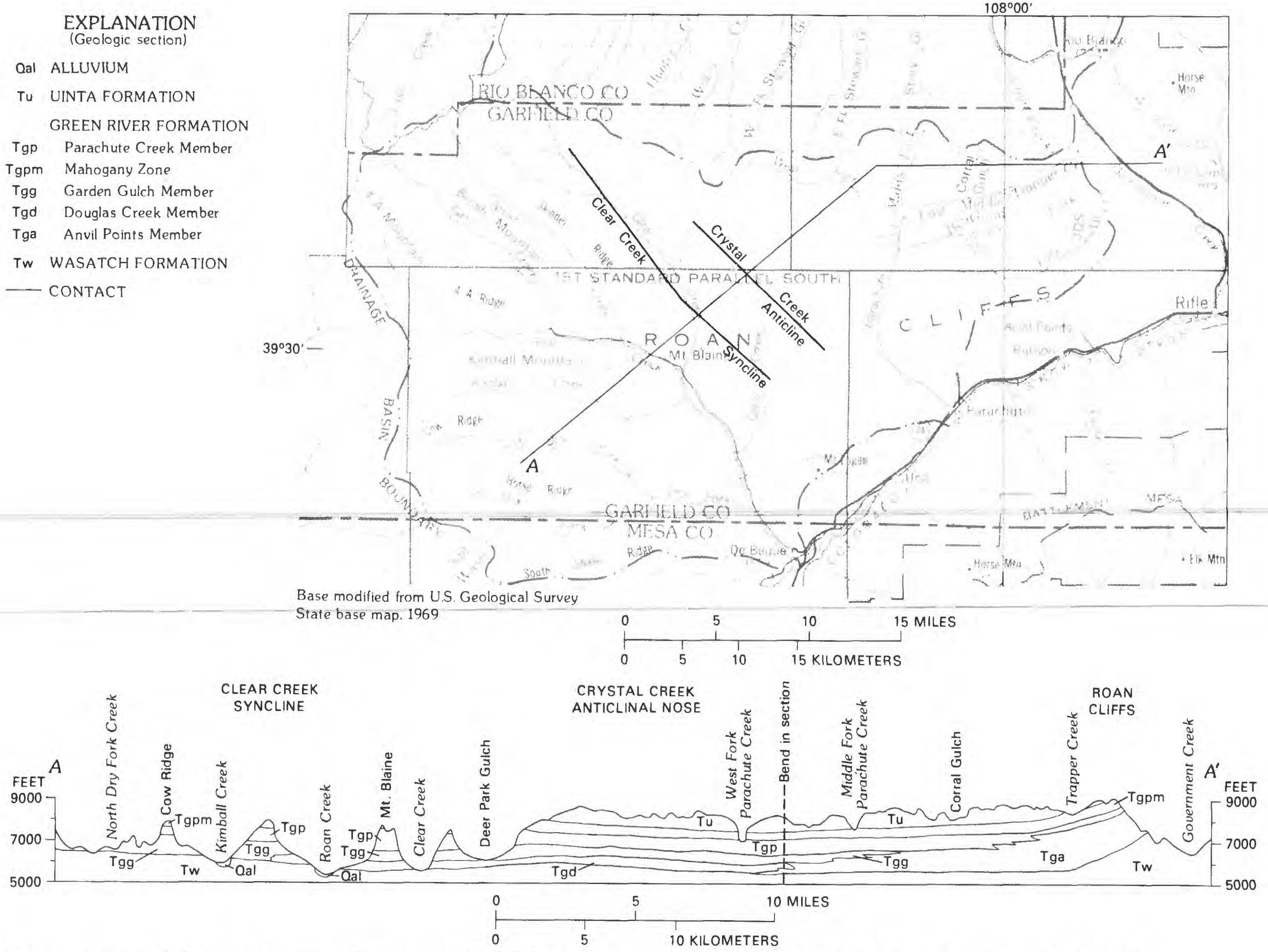
Roan and Parachute Creek basins are in the southern one-half of the Piceance basin. The basin dips gently to the north in the Roan-Parachute Creek areas. The major structural features in the study area are the Clear Creek syncline and Crystal Creek anticline. These features are shown in figure 3, along with a geologic section of the Roan and Parachute Creek basins adapted from Donnell (1961).

Quaternary deposits in the study area include thin alluvium in the major stream valleys and extensive talus, landslide, and slopewash deposits along the valley sides. The only extensive alluvial deposits are along the downstream reaches of Roan and Parachute Creeks; these deposits generally are less than 0.5 mi wide and less than 100 ft thick. Quaternary deposits were derived from material of the Wasatch, Green River, and Uinta Formations.

The Uinta, Green River, and Wasatch Formations in order of increasing age are composed of Eocene rocks derived from sediments deposited in ancestral Lake Uinta. These formations are shown in figure 4. Included in figure 4 are some of the more important zones and marker beds commonly used to describe oil-shale stratigraphy in the study area.

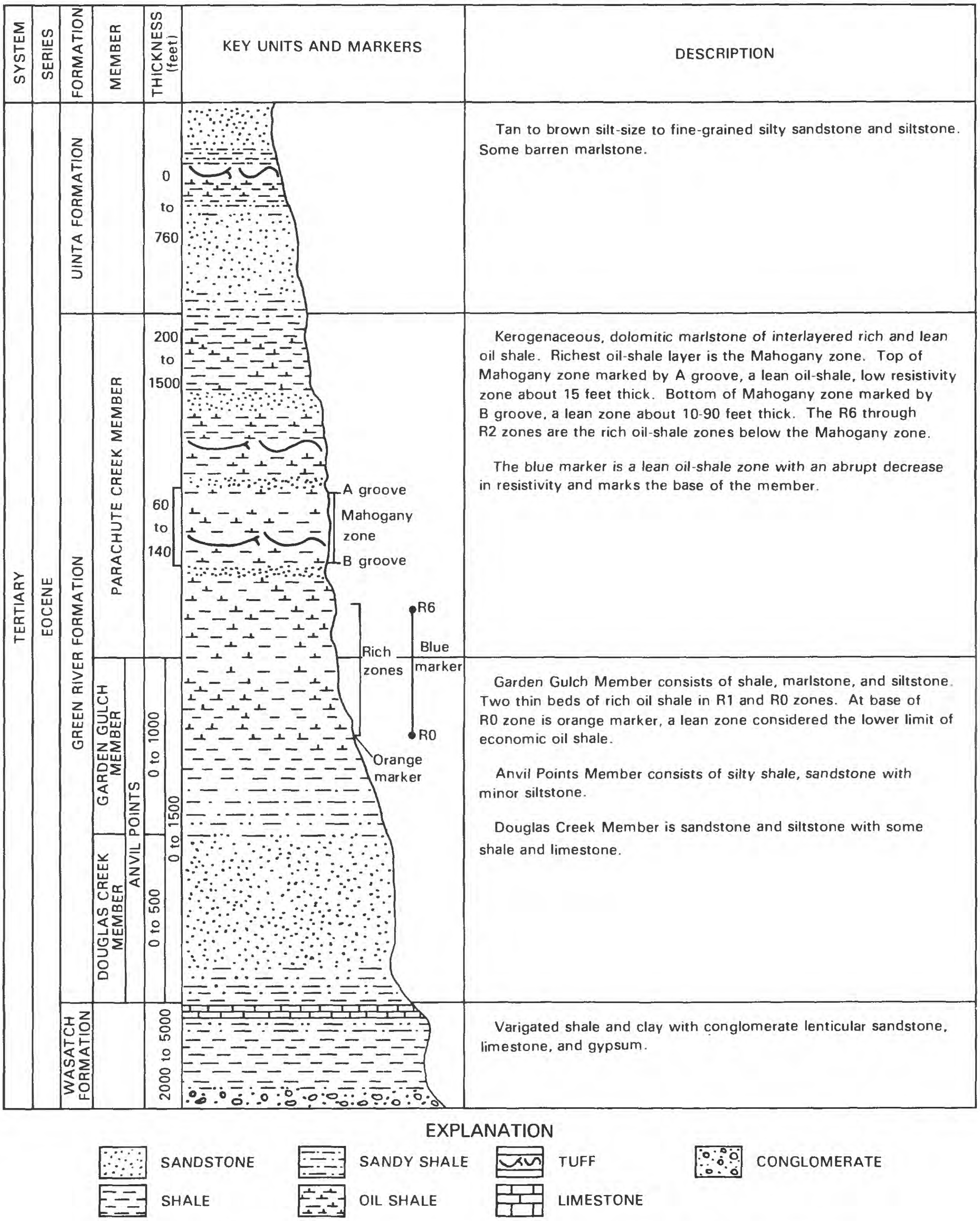
Rocks of the Eocene Uinta Formation compose the surface material of the plateau and upland areas. The formation consists of sandstone and interbedded siltstone and marlstone. The sandstone beds are fine grained and commonly cemented with calcite, so primary permeability is minimal (Coffin and others, 1971).

Below the Uinta Formation is the Green River Formation. The Green River Formation in the study area is divided into four members. The uppermost member is the Parachute Creek Member, composed of layers of rich to lean oil shale (kerogenaceous marlstone). The richest layer is called the Mahogany zone or Mahogany marker, which is 60 to 140 ft thick in the study area (Pitman and Johnson, 1978). The rich organic layers tend to be more resistant and to form ledges; the leaner layers tend to be less resistant to weathering and to erode more easily. Two important lean zones mark the top and bottom of the Mahogany zone. The upper lean zone is called the A groove and the lower lean zone the B groove (Trudell and others, 1974). There is considerable intertonguing between the upper part of the Parachute Creek Member and the Uinta Formation.



Base modified from U.S. Geological Survey State base map, 1969

Figure 3.--Major structural features and geologic section of Roan and Parachute Creek basins and vicinity (modified from Donnell, 1961).



Tan to brown silt-size to fine-grained silty sandstone and siltstone. Some barren marlstone.

Kerogenaceous, dolomitic marlstone of interlayered rich and lean oil shale. Richest oil-shale layer is the Mahogany zone. Top of Mahogany zone marked by A groove, a lean oil-shale, low resistivity zone about 15 feet thick. Bottom of Mahogany zone marked by B groove, a lean zone about 10-90 feet thick. The R6 through R2 zones are the rich oil-shale zones below the Mahogany zone.

The blue marker is a lean oil-shale zone with an abrupt decrease in resistivity and marks the base of the member.

Garden Gulch Member consists of shale, marlstone, and siltstone. Two thin beds of rich oil shale in R1 and R0 zones. At base of R0 zone is orange marker, a lean zone considered the lower limit of economic oil shale.

Anvil Points Member consists of silty shale, sandstone with minor siltstone.

Douglas Creek Member is sandstone and siltstone with some shale and limestone.

Varigated shale and clay with conglomerate lenticular sandstone, limestone, and gypsum.

Figure 4.--Generalized stratigraphic section of the Uinta, Green River, and Wasatch Formations.

Below the Parachute Creek Member are the Garden Gulch and Douglas Creek Members of the Green River Formation. The Garden Gulch Member consists of marlstone, siltstone, and shale. The Douglas Creek Member consists of sandstone and siltstone with some shale and limestone. Both members are considered relatively impermeable with little fracturing (Coffin and others, 1971). The Anvil Points Member is mapped at the surface in the southeastern part of the study area (Donnell, 1961). It is similar in composition to the Douglas Creek and Garden Gulch Members and grades into these members to the west.

The Wasatch Formation underlies the Green River Formation and forms the base of the Roan and Parachute Creek valleys. The formation is composed of varigated clay, shale, and sandstone layers and contains gypsum. The maroon claystone and siltstone in the upper part of the Wasatch Formation mark the contact with the Green River Formation.

The most detailed surface-geology map of the entire Roan and Parachute basins is found in Donnell (1961). Geologic maps of greater detail exist for some areas of the Roan and Parachute Creek basins. Six geologic maps at a 1:24,000 scale are listed in the reference section of this report: Hail (1982); Johnson (1975); Johnson (1980); Johnson (1981); O'Sullivan and others (1981); and Roehler (1973).

HYDROLOGIC SYSTEM

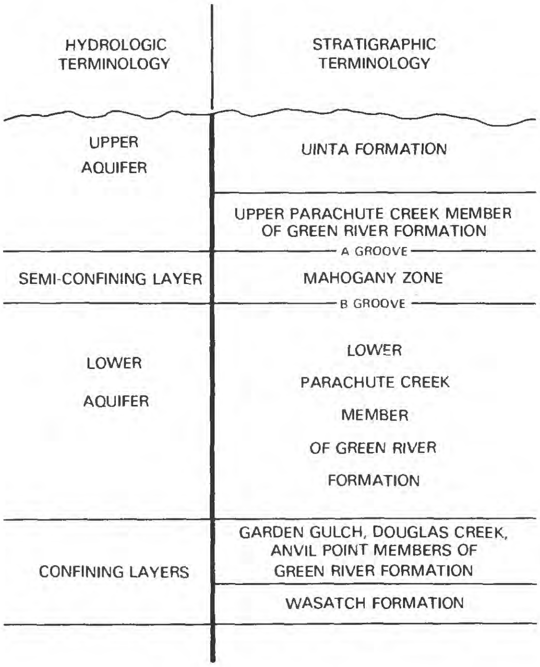
Surface Water

Roan and Parachute Creeks drain an area of about 720 mi^2. Roan and Parachute Creeks and a few of the larger tributaries normally are perennial streams; all other streams are either intermittent or ephemeral. Base flow is maintained by discharge of springs and bedrock aquifers in headwater areas, and by ground-water discharge from valley alluvial aquifers, small-scale flow systems in other Quaternary deposits, and perhaps from bedrock aquifers in the canyons.

The average daily discharge for Parachute Creek is 31 ft^3/s based on 20 years of streamflow data and 42 ft^3/s for Roan Creek based on 22 years of streamflow data. Eighty to 90 percent of the annual flow occurs during the April-June runoff period as snowmelt in upland areas. Occasionally, high stream discharge can occur in summer from intense thunderstorms, but such storms usually are local and brief.

Ground Water

The ground-water system in the Piceance basin is considered to be a two-aquifer system (Weeks and others, 1974). The upper aquifer consists of rocks in the Uinta Formation and the Parachute Creek Member of the Green River Formation above the Mahogany zone (fig. 5). Ground-water flow in the Uinta Formation is composed primarily of perched, small-scale systems. The lower aquifer is defined as the Parachute Creek Member below the Mahogany zone. The Piceance basin ground-water model developed by Taylor (1982) considers the top



HYDROLOGIC TERMINOLOGY	STRATIGRAPHIC TERMINOLOGY
UPPER AQUIFER	UINTA FORMATION
	UPPER PARACHUTE CREEK MEMBER OF GREEN RIVER FORMATION
	A GROOVE
SEMI-CONFINING LAYER	MAHOGANY ZONE
	B GROOVE
LOWER AQUIFER	LOWER PARACHUTE CREEK MEMBER OF GREEN RIVER FORMATION
CONFINING LAYERS	GARDEN GULCH, DOUGLAS CREEK, ANVIL POINT MEMBERS OF GREEN RIVER FORMATION
	WASATCH FORMATION

Figure 5.--Hydrologic and stratigraphic terminology.

of the Garden Gulch Member of the Green River Formation as the base of the aquifer system in the Green River and Uinta Formations. Recharge to the ground-water system is considered to be snowmelt above 7,000 ft (Weeks and others, 1974).

Because lean oil-shale zones such as the A and B grooves are more fractured than richer oil-shale layers (Robson and Saulnier, 1981), they are more permeable than the richer layers. Therefore, the A and B grooves may be the most significant aquifers in the Parachute Creek Member. The Mahogany zone, the thickest of the rich oil-shale layers, is considered to be a leaky confining layer (Robson and Saulnier, 1981) that allows interchange of water between aquifers.

The potentiometric surfaces generated by the flow model in Taylor (1982) indicate similar flow patterns for both aquifers in the study area. A generalized flow system for the Roan and Parachute Creek basins is shown in figure 6. Ground-water flow toward the canyons is indicated for most of the study area. The flow patterns indicate that the Clear Creek syncline, which trends from the Gilman Gulch area of Conn Creek northwesterly up the Clear Creek canyon, controls the bedrock-aquifer flow pattern in the Roan Creek drainage. The simulated potentiometric surfaces indicate that some ground-water flow along the northern edges of the Roan and Parachute Creek basins may be flowing north out of the drainage basins. Because most of the study area is located in a recharge zone, most flow between aquifers is downward (fig. 6). For more detailed descriptions of ground-water systems in the Piceance basin and the development of mathematical models, the reader is referred to Weeks and others (1974), Robson and Saulnier (1981), and Taylor (1982).

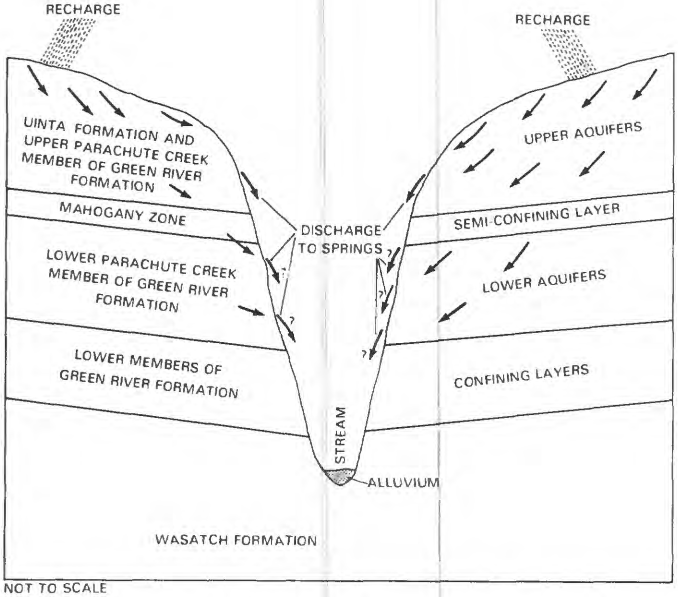


Figure 6.--Schematic diagram of ground-water flow systems.

Roan and Parachute Creeks and the bedrock aquifers of interest do not form a stream-aquifer system. Alluvial aquifers of limited extent are found in the major stream valleys. Small-scale flow systems are located above the alluvium along the sides of the valleys or in small side gulches.

PREVIOUS STUDIES

The U.S. Geological Survey conducted a hydrologic reconnaissance of Roan and Parachute Creek basins from 1976 to 1980 (Adams and others, 1985). That report contains inventory data for 286 springs and chemical analyses for 59 springs in the study area. Chemical analyses and other ground-water data from wells completed in the Uinta and Green River Formations are included in that report. Additional hydrologic information for the eastern part of the study area can be found in Patt and others (1982) and Galyean and others (1983).

Considerable hydrologic data have been collected by energy companies and consultants in the Roan and Parachute Creek areas. Only a part of these data are concerned with springs, and not all the information is available to the public. A report by the Chevron Shale Oil Co. (1982b) contains considerable hydrologic information for the Clear Creek area.

The U.S. Geological Survey has conducted hydrologic studies in the Piceance Creek basin since 1964. Some of those studies contain or discuss ground-water chemical data or spring discharge and chemical data that may be useful for comparison to or interpretation of spring data collected for this report. Early geohydrologic studies include Coffin and others (1968, 1971). More recent studies in the Piceance Creek basin include: Ficke and others (1974); Weeks and others (1974); Weeks and Welder (1975); Saulnier (1978); Colorado Division of Water Resources (1978); Welder and Saulnier (1978); and Robson and Saulnier (1981).

CLASSIFICATION OF SPRINGS AND SELECTION OF SAMPLING SITES

Upland Springs

Upland springs are considered to be all springs and seeps located above the Mahogany zone. Generally, these springs are located in small gulches and valleys on the Roan Plateau and on the ridge-top areas of the Roan Creek drainage. A block diagram showing general location of springs relative to topography and geology of the area is shown in figure 7.

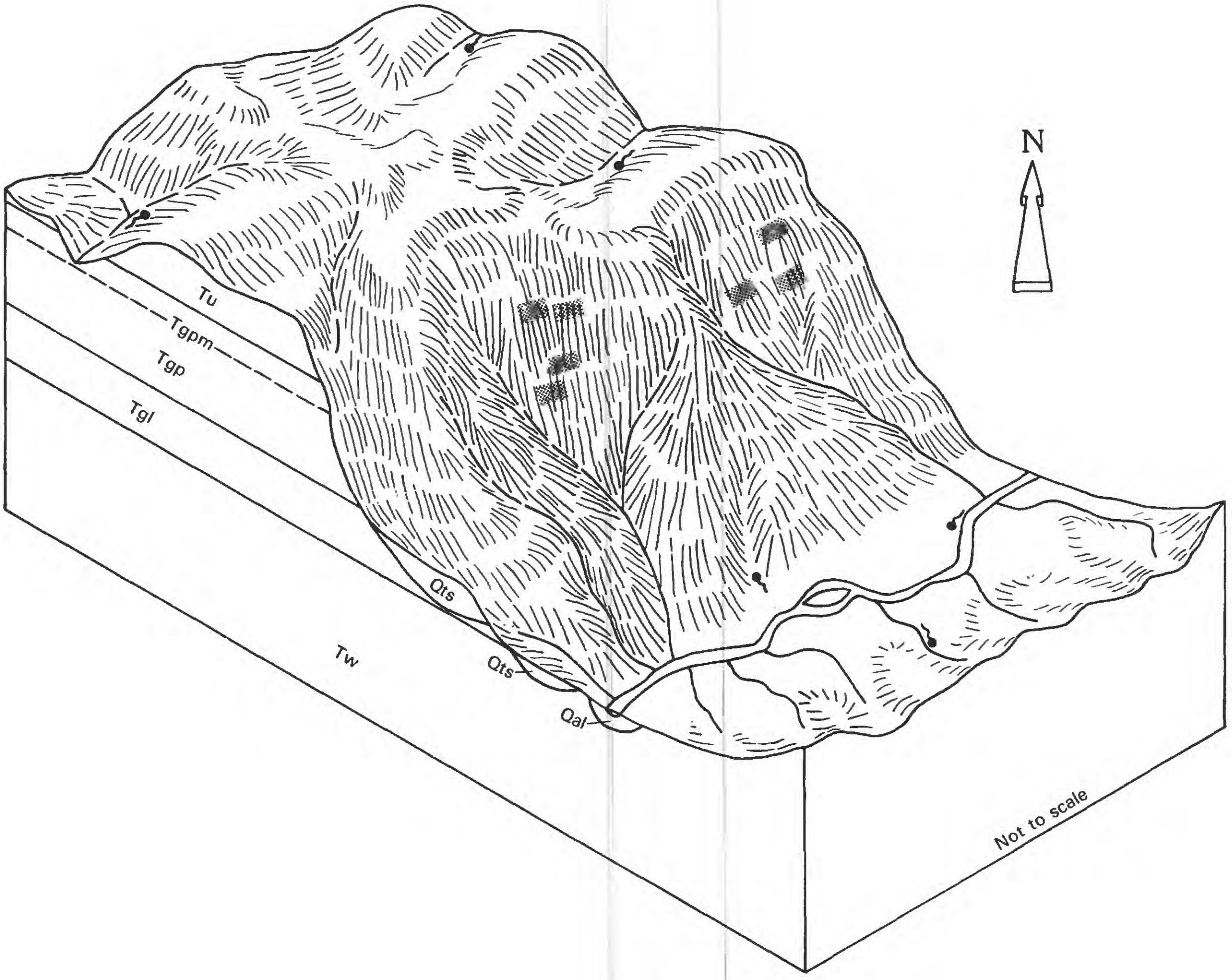
An initial reconnaissance of upland springs was conducted during 1981. Access problems prevented complete areal coverage of the study basins. The largest area excluded from the inventory of springs was the area south of East Fork Parachute Creek from basin divide westward to Parachute Creek and the headwater areas of Clear and Willow Creeks. The primary criteria for selecting an upland spring for additional data collection were accessibility, suitability for water-quality sampling, sufficient discharge for flow measurements and collection of samples, and geographical distribution.

Lowland Springs

Lowland springs are springs and seeps located below the Mahogany zone. Some lowland springs are located in the recent stream alluvium; others are located above the alluvium on hillside slopes and in small gullies within the main canyons. The generalized location of lowland springs is shown in figure 7.

Because of the paucity of lowland springs, nearly all lowland springs inventoried in the canyons were sampled for chemical analysis. Lowland springs were catagorized according to their location relative to stream alluvium. An objective of this study was to determine if there were springs discharging from the lower aquifers. Attempts were made to determine if nonalluvial springs represented localized, small-scale aquifers or discharge from bedrock aquifers.

The location of all springs inventoried and sampled for this report are plotted on plate 1. A list of the map numbers representing springs on plate 1 with corresponding location or local number, latitude, longitude, and altitude are given in table 13, located in the Supplemental Hydrologic Data section at the end of the report. Also included in table 13 is a description of site location. Upland springs are designated by major stream drainage, except in the western Roan Creek drainage, where sites are located by ridges. Lowland sites are described by stream drainage and the probable ground-water source of the spring. Map numbers on plate 1 will be used in the remainder of this report when reference to a particular spring is required.



EXPLANATION

Qal	STREAM ALLUVIUM
Qts	TALUS, SLUMP, AND LANDSLIDE DEPOSITS
Tu	UNITA FORMATION
Tgp	UPPER PART OF GREEN RIVER FORMATION, PARACUTE CREEK MEMBER
Tgpm	MAHOGANY ZONE
Tgl	LOWER PART OF GREEN RIVER FORMATION, GARDEN GULCH, DOUGLAS CREEK, AND ANVIL POINTS MEMBERS
Tw	WASATCH FORMATION
———	CONTACT
▨	WET AREAS OF CLIFFS
●~	SPRING

Figure 7.--Typical location of springs and seeps in relation to generalized topography and geology.

Spring-Numbering System

The location of springs for this report is designated by a numbering system based on the Federal system of land subdivision. These identification numbers are called "local numbers" by the U.S. Geological Survey.

An example of a local number is SC00304921CCB2 (fig. 8). The "S" denotes that the area is governed by the sixth principal meridian and "C" indicates the quadrant. Quadrants are formed by intersection of a baseline and a principal meridian. The first number (003 in the example) is the township, the second number (049) is the range, and the third number (21) is the section. The three letters indicate where within the section the spring is located: the first letter (C) is the quarter section; the second letter (C) is the quarter-quarter section; and the third letter (B) the quarter-quarter-quarter section. Letters begin in the northeast quarter and proceed counterclockwise. The location now is designated within a 10-acre tract. If two sites are in the same quarter-quarter-quarter section, sequence numbers are used to differentiate sites. For the example shown in figure 8, the sequence number is 2.

SPRING DISCHARGE

Measuring Techniques and Equipment

Measuring discharge from a developed spring was done with a 10-L (liter) bucket calibrated in 1-L increments and a stopwatch. A developed spring is one that has been modified so water is collected and diverted into a pipe that commonly drains into a tank or pan for use by livestock. Some springs are developed for domestic use. For very small discharges, a calibrated 3-L bottle was used instead of the bucket.

Measuring spring discharge at undeveloped locations usually was done with a portable, 60° V-notch weir. This is a very small weir that is installed directly into the channel. A depth scale is located on the weir, and discharge is selected from a rating table supplied by the manufacturer. The maximum discharge measurable with the weir is about 35 gal/min (about 0.08 ft^3/s). A modified 3-inch Parshall flume was used a few times for larger flows. Three 3-inch Parshall flumes were installed at undeveloped springs to facilitate repeated measurements at those sites. Additional flumes were to be installed at springs selected for flow monitoring, but project cutbacks curtailed flume installation in favor of the portable weir.

Many springs in the study area have small discharges and commonly do not have a well-defined flow of water at their initial discharge points. Sometimes it was necessary to obtain a discharge measurement at some point downstream from the initial outflow area, in some instances 300 to 600 ft downstream from the outflow point. At some sites, the measured flow represents the discharge from multiple seeps.

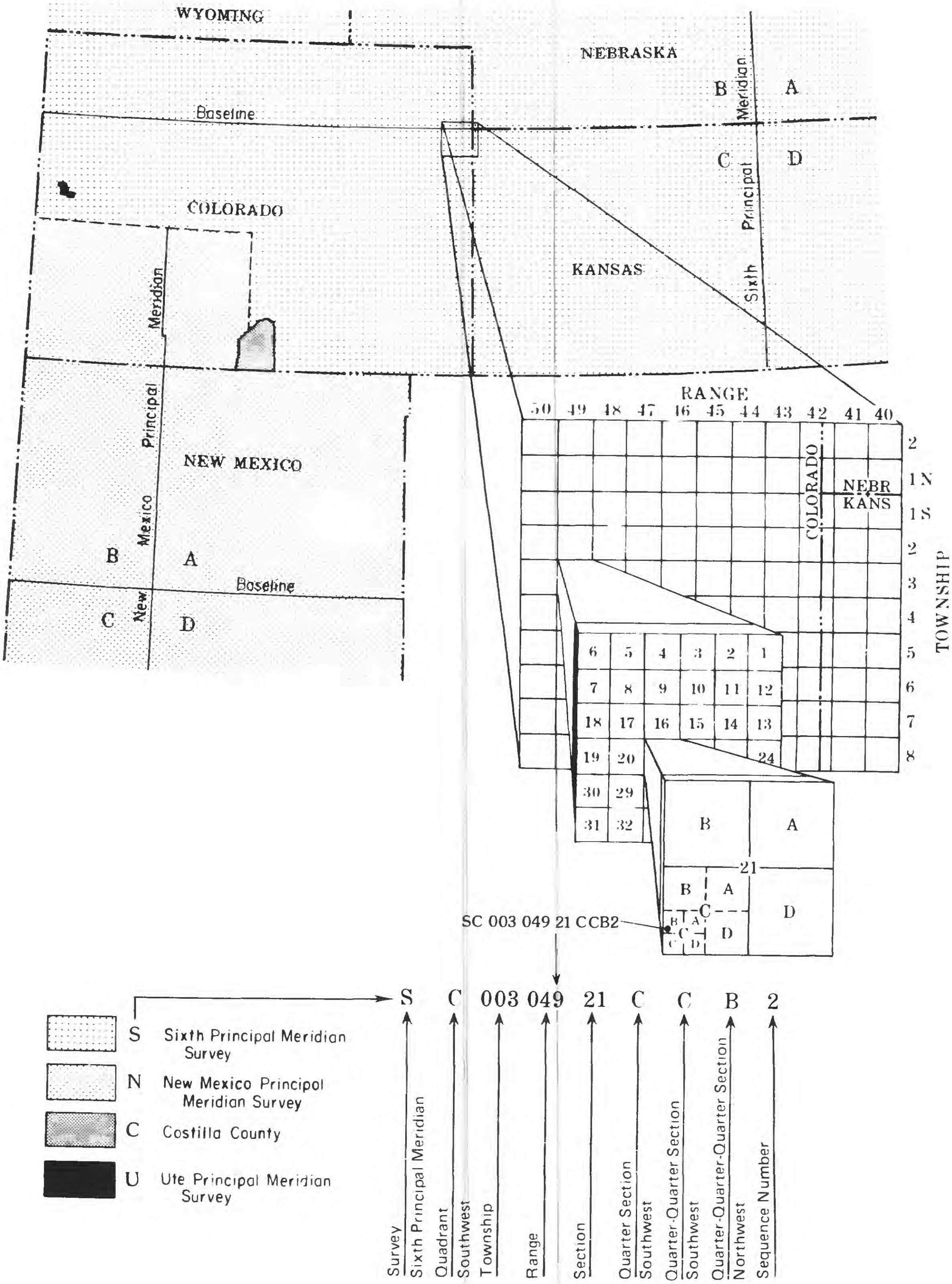


Figure 8.--System of numbering springs using township, range, and section.

Results and Conclusions

Measurements of spring discharge, temperature, pH, and specific conductance from June 1981 to March 1983 are listed in table 14 in the Supplemental Hydrologic Data section. Some entries in table 14 represent a one-time inventory visit to a spring.

Quantity and Distribution

The range in instantaneous discharge measurements for 106 upland springs was zero flow at several sites to 300 gal/min at spring 1 during May 1982. The mean discharge for upland springs was 5.5 gal/min. A mean discharge for upland springs corrected to base-flow conditions by deleting all discharge measurements made during May and June was 3.6 gal/min.

The range in instantaneous discharge measurements at 23 lowland springs was 0.14 gal/min at spring 122 during November 1982 to 75 gal/min at spring 135 during December 1981. The mean discharge at lowland springs was 11 gal/min. Excluding the much greater flows at springs 125 (30 gal/min), 37 (50 gal/min), and 135 (75 gal/min), the mean discharge was 5.2 gal/min.

In much of the study area, only large-scale distribution patterns of spring discharge were examined because of the independent nature of the shallow flow systems. The upland region of Roan and Parachute Creek basins was divided into three subareas: (1) West, which includes Skinner and 4A Ridges and Brush and Kimball Mountains; (2) central, which includes the area between Conn and Clear Creeks on the west and Parachute and Middle Fork Parachute Creeks on the east; and (3) east, the area east of Parachute Creek, including the headwaters of the Middle Fork. The western ridges and mountains had less spring discharge in a down-ridge direction. On Kimball Mountain, more springs occur on the north side than on the south side of the mountain. The mean spring discharge at base-flow conditions was 1.4 gal/min for the western subarea, 4.6 gal/min for the central subarea, and 2.2 gal/min for the eastern subarea. Greater spring discharge in the central plateau area may be the result of larger recharge areas for springs in the northern part of the plateau.

The mean discharge for the eastern subarea was calculated from data at 26 sites with spring 1 excluded. Inclusion of discharge data for spring 1 into the calculation results in a mean discharge for the east subarea of 4.4 gal/min. Spring 1 was measured downstream from a substantial seep area that forms the headwaters of the Middle Fork Parachute Creek. Spring 1 does not represent a single spring or discharge point as do many of the other measured springs in the subarea. It was believed that 2.2 gal/min was more representative of base-flow spring discharge in the eastern subarea than 4.4 gal/min.

Most of the larger lowland springs are located in stream alluvium areas, such as spring 125 (Conn Creek) and spring 135 (Kimball Creek). Large alluvial springs also exist on Clear Creek (Chevron Shale Oil Co., 1982b), and a large alluvial spring has been observed in the downstream reach of East Fork Parachute Creek. Lowland springs located on hillsides tended to have much smaller discharge than alluvial springs. One apparent exception was spring 37 located in the East Fork Parachute Creek canyon. This spring, which had a discharge of 50 gal/min in March 1983, is at the cliff base. Ben Good Creek infiltrates into the streambed above the cliff and apparently the water moves down vertical fractures in the cliff face and discharges near the base of the cliff as the spring.

Temporal Trends

Because springs in the upland parts of the study area are thought to represent shallow flow systems, significant changes in recharge to these springs should result in measurable changes in spring discharge. Data in table 1 indicate that the snowpack water content from upper-altitude locations in the Piceance basin during 1982 was nearly double the snowpack water content during 1981. Examination of spring discharge during July through November at springs where flow data were collected in both years shows an increase in discharge from 1981 to 1982. The mean spring discharge at those sites was 4.0 gal/min in 1981 and 6.4 gal/min in 1982; 38 of 49 springs had greater discharge in 1982 than 1981. A t-test performed on these data indicates the two mean values are statistically different at the 0.25 probability level. Although a large increase in available recharge did result in a measurable increase in spring discharge from 1981 to 1982, the measured difference in discharges between the 2 years would not be considered statistically significant. It is suspected that if a comparison could have been done for May and June of each year, a more significant relation between discharge of springs and recharge would be determined. It is likely that much of the upland springs' response to snowmelt occurs during May and June. The earliest measurements of flow at upland springs during 1981 were not made until July. A measured decrease in upper-aquifer spring discharge because of drought conditions was determined in the Piceance Creek drainage basin (Colorado Division of Water Resources, 1978).

During 1982, 89 springs were measured during May and June and again about 6 to 10 weeks later to document the response of springs to recharge in the upland areas of Roan and Parachute Creek basins. Eighty of the 89 springs decreased in discharge from the earlier to the later measurements. The change in discharge was about a 40-percent decrease. Six of the springs ceased flowing. A number of other springs and seeps in the study area were observed to flow for only a brief time during spring and early summer before ceasing to flow. These observations indicate a fast response of discharge from springs to snowmelt recharge, often a few weeks. A similar conclusion is indicated for upland springs in the Piceance Creek drainage basin (Colorado Division of Water Resources, 1978).

Table 1.--*Water content of snow, Roan and Parachute Creek basins and southern Piceance Creek basin, 1981-82*

Site	1981		1982	
	Water content (inches)	Date of measurement	Water content (inches)	Date of measurement
NOSR1 (9200-8800 feet)[1]	5.2	March 25	10.1	March 23
NOSR1 (8800-8400 feet)[1]	4.5	March 25	9.2	March 23
NOSR1 (8400-8000 feet)[1]	3.5	March 25	7.2	March 23
JQS Gulch[2]	6.4	April 1	11.7	April 1
Upper Cow Creek[3]	7.3	April 1	13.9	April 1
Willow Creek[4]	7.6	April 1	11.6	April 1

[1] Data collected by a private contractor for the U.S. Department of Energy on the Naval Oil Shale Reserve Number 1 (NOSR1). Values are averages for several snow-survey stations in the different altitude zones indicated in parenthesis.

[2] Data from Galyean and others (1983). Site is a climate station located in eastern Parachute Creek basin near JQS Gulch. Latitude 39°35'34", longitude 107°55'00", altitude 8,860 feet.

[3] Unpublished data collected by U.S. Geological Survey and U.S. Soil Conservation Service at a snow-survey site in southern Piceance Creek basin. Latitude 39°39'18", longitude 107°59'55", altitude 8,320 feet.

[4] Unpublished data collected by U.S. Geological Survey and U.S. Soil Conservation Service at a snow-survey site in southern Piceance Creek basin. Latitude 39°33'22", longitude 108°16'12", altitude 8,300 feet.

Most springs have a fairly similar discharge regime, with a large peak in late spring or early summer followed by a gradual decrease in flow toward the winter months. Such a pattern should exist for springs in a recharge area, but not all springs have such uniform patterns. Variance from the expected discharge regime can be seen in table 14 for springs 36, 90, and 101.

The discharge monitoring effort was severely disrupted during the second year of the study because of cutbacks in project funding. The result of that disruption was a large gap in flow-measurement data from late fall of 1981 to late May of 1982, when access to the upland areas was restricted. Better definition of spring discharge in Roan and Parachute Creek basins could be obtained by a long-term monitoring effort in order to study climatic effects on discharge of springs. More frequent measurements, especially during April through July, are needed in order to define discharge of springs during snowmelt recharge.

SPRING-WATER QUALITY

Methods of Sampling and Analysis

Two techniques were used to collect water-quality samples from springs. Where the spring was developed, samples were collected directly from the discharge pipe. At a few springs, plastic elbows were used because the pipe was submerged in a stock tank or was otherwise unusable. At undeveloped springs, the samples were collected at or close to the discharge point. At many undeveloped springs the flow was inadequate to enable direct collection of the sample into a container. A pipe was placed in or near a discharge point and dirt packed around the pipe in order to force water through the pipe so a sample could be collected. All water samples, with the exception of water for phenol, organic-carbon, and oxygen-isotope analysis, were collected in 3-L plastic bottles.

Temperature, pH, and specific conductance were measured at each spring where water-quality samples were collected. The pH meter was calibrated for the 7 to 10 pH range, and the specific-conductance meter was calibrated with a range of standards to encompass the specific conductance of the springs tested.

All samples that were to be analyzed for dissolved constituents were filtered through a 0.45-µm (micrometer) filter. Samples for cation and trace-metal analyses were acidified to a pH of 2 or less with nitric acid. Samples for nitrogen and phosphorus analyses were treated with mercuric chloride and then chilled for shipment. Samples for sulfide analysis were unfiltered and treated with 0.5 g (gram) of zinc acetate to preserve any sulfide present. Samples for cyanide analysis were unfiltered and treated with 1 or 2 sodium-hydroxide pellets to adjust the pH to 12, chilled, and shipped to the U.S. Geological Survey water-quality laboratory. Samples for phenol analysis were collected in 1-L glass bottles that were cleaned by the laboratory. One gram of copper sulfate and 1-mL (milliliter) of phosphoric acid were added to these samples, which then were chilled for shipment. Samples for dissolved organic-carbon analysis were taken from the sample for phenol analysis prior to its treatment. Samples for organic-carbon analysis were filtered using a stainless-steel filtering apparatus with silver filters. The filtrate was collected into specially cleaned 125-mL glass bottles supplied by the laboratory and then chilled for shipment. Samples for oxygen-isotope analysis were collected in 125-mL glass bottles. The bottles were overfilled until all air was purged from the sample, capped, and then sealed in wax to prevent atmospheric contamination prior to analyses at the laboratory.

All water-quality analyses were done by the water-quality laboratory. Analytical methods for determination of inorganic constituents are described in Skougstad and others (1979); for organic constituents in Goerlitz and Brown (1972); and for radiochemical constituents in Thatcher and others (1977). Because the laboratory continues to improve analytical techniques, some methods used to analyze samples for this report may not be described in the listed references. The appearance of more than one lower limit in the data indicates that a change or improvement in the analytical method for that constituent occurred during the data collection phase of the study.

Major Chemical Constituents

Analytical results for dissolved cations, anions, fluoride, silica, and dissolved solids are listed in table 15 in the Supplemental Hydrologic Data section of this report. A statistical summary for each constituent, including specific conductance, is found in table 2. Because springs on the upland areas of Roan and Parachute Creek basins represent different water sources and rock types than lowland springs, the chemical data were grouped into upland and lowland areas for discussion and analysis.

Upland Springs

Springs located on upland plateaus and ridges in the study area yield a mixed cation bicarbonate water type. Water-quality analysis diagrams for 50 springs are shown in figures 9 through 11. Mean values are plotted for springs with two or more analyses. The upland springs were divided into three geographical areas, western, central, and eastern, to facilitate plotting the chemical compositions of the springs and to examine general areal differences in water chemistry of springs. Water composition is about the same in the three areas. Most of the ion-percentage plots of the cations are within the 40 to 50 percent calcium, 25 to 35 percent magnesium, and 20 to 30 percent sodium zone. Bicarbonate commonly accounts for at least 70 percent of the anion composition. Dissolved-solids concentrations for upland springs ranged from 216 to 713 mg/L (milligrams per liter). The variance of cation concentrations indicated in table 2 seem surprisingly small for 50 springs that probably represent localized, small-scale flow systems. Sulfate had more variability among springs than the other major ions, and it also had a much greater range in concentrations (1 to 280 mg/L). Mean concentrations of fluoride (0.15 mg/L) and chloride (3.3 mg/L) were small in the upland springs and little variation in concentration was determined between springs. Silica concentrations were about 20 mg/L in spring water throughout the study area.

An analysis of variance in ion concentrations between the three geographical divisions indicated no significant difference at the 0.05 probability level (5 percent) in major constituent concentrations, with the exceptions of calcium and potassium. Specific conductance in the area east of Parachute Creek is significantly smaller at 0.05 probability level than in the western and central areas. An examination of water chemistry at a smaller scale was attempted, dividing the three major divisions (western, central, and eastern) into geographical subunits. The western area was divided by main ridges, and the central and eastern areas were divided by stream drainages. The plots of mean water composition and descriptions of these units are shown in figure 12. The cation plots for the nine upland subunits cluster about the 45-percent calcium, 30-percent magnesium, and 25-percent sodium lines. The Brush Mountain and Skinner Ridge (subunit 1) and the Middle Fork Parachute Creek (subunit 9) subunits show a greater percentage of sulfate, but those results probably are caused by greater sulfate concentrations at one spring within the subunit rather than a greater sulfate concentration throughout the subunit. The small sulfate-to-bicarbonate ratio indicated in subunit 7 (East Fork Parachute Creek) is biased by an unusually small sulfate concentration at

Table 2.--*Summary statistics for major chemical constituents, dissolved solids, and specific conductance for upland and lowland springs*

[All concentrations in milligrams per liter; specific conductance in microsiemens per centimeter; N1, total number of springs sampled; N2, total number of samples; Mean, mean concentration; SD, standard deviation; SE, standard error of the mean; Max, maximum concentration; Min, minimum concentration; 95 percent CI, 95-percent confidence interval of the mean; Expected range, the range in which 95-percent of the values are estimated to occur]

Constituent or property	N1	N2	Mean	SD	SE	Max	Min	95 percent CI	Expected range
UPLAND SPRINGS									
Calcium	50	128	64	9.6	1.4	96	39	61-66	44-82
Magnesium	50	128	27	8.6	1.2	52	11	24-29	10-44
Sodium	50	128	45	17	2.4	91	19	40-50	14-77
Potassium	50	128	.9	.6	.09	3.3	0.2	.7-1.0	0-1.7
Alkalinity	50	128	273	53	7.5	481	160	258-288	162-378
Sulfate	50	128	84	54	7.7	280	1	68-99	0-188
Chloride	50	128	3.3	2.0	.28	11	0.7	2.8-3.9	0-7.2
Fluoride	50	128	.15	.08	.01	1.6	0.0	.13-.18	0-.44
Silica	49	126	20	2.4	.34	28	16	20-21	18-22
Dissolved solids	49	126	413	110	15.6	713	216	382-444	207-619
Specific conductance	116	338	623	149	13.9	1,220	350	595-650	335-931
LOWLAND SPRINGS									
Calcium	23	36	102	56	11.8	310	50	78-126	0-217
Magnesium	23	36	99	75	15.7	330	26	66-132	0-248
Sodium	23	36	182	171	35.7	880	50	108-256	0-564
Potassium	23	35	2.4	1.2	.25	5.7	0.6	1.8-2.9	0-5.0
Alkalinity	23	36	392	72	15.0	554	240	361-423	258-548
Sulfate	23	36	627	640	134	2,400	58	349-905	0-1,985
Chloride	23	36	10	8.4	1.8	38	3.1	6.8-14	0-27
Fluoride	23	36	.40	.23	.05	1.0	.0	.30-.50	0-.77
Silica	23	36	19	3.8	.80	26	10	17-21	11-27
Dissolved solids	23	35	1,286	922	193	3,970	388	888-1684	0-3,296
Specific Conductance	24	47	1,699	1,006	205	4,900	600	1,274-2,124	0-3,769

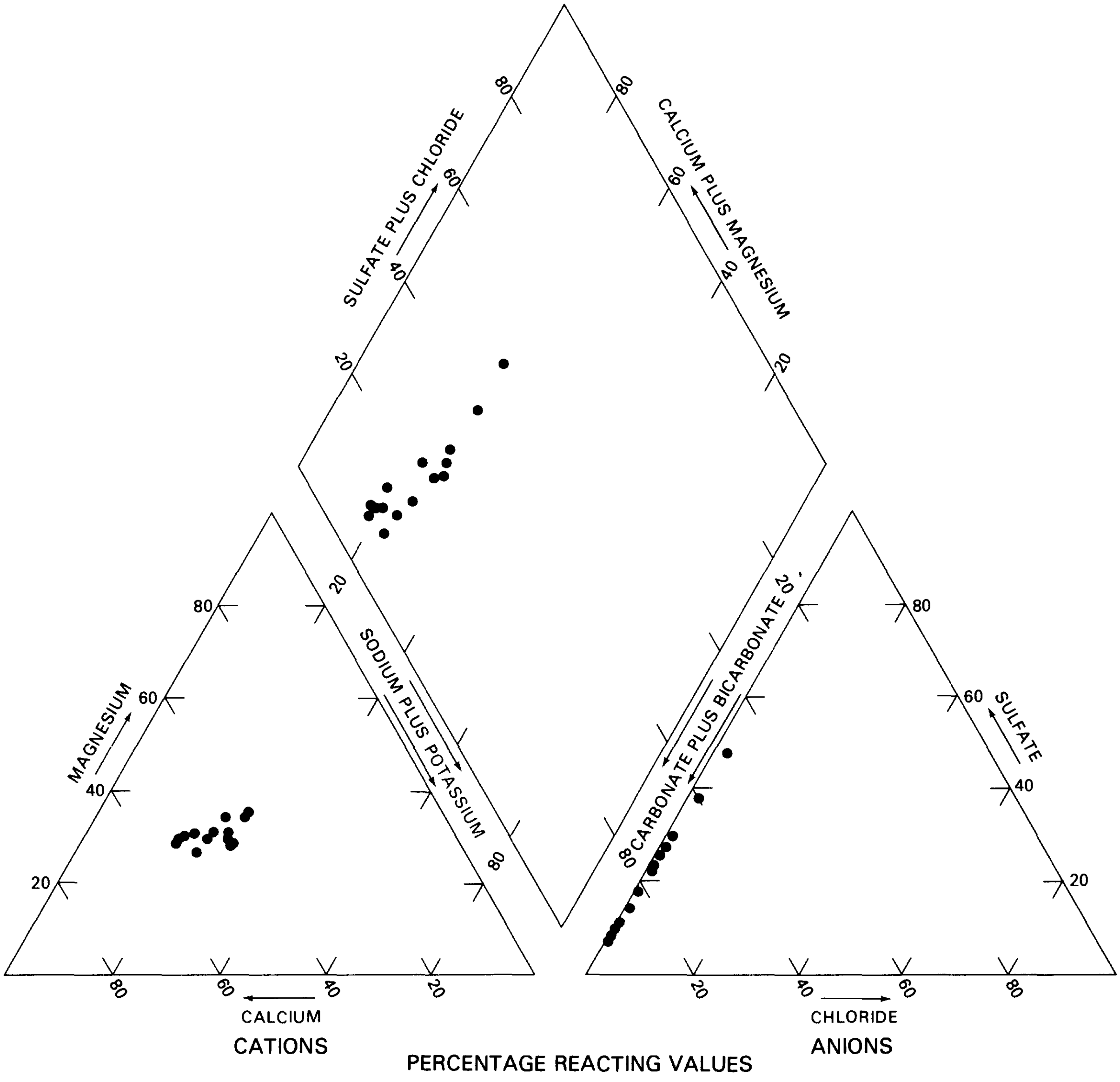


Figure 9.--Water-quality diagram for upland springs located on the ridgetop areas of Roan Creek basin.

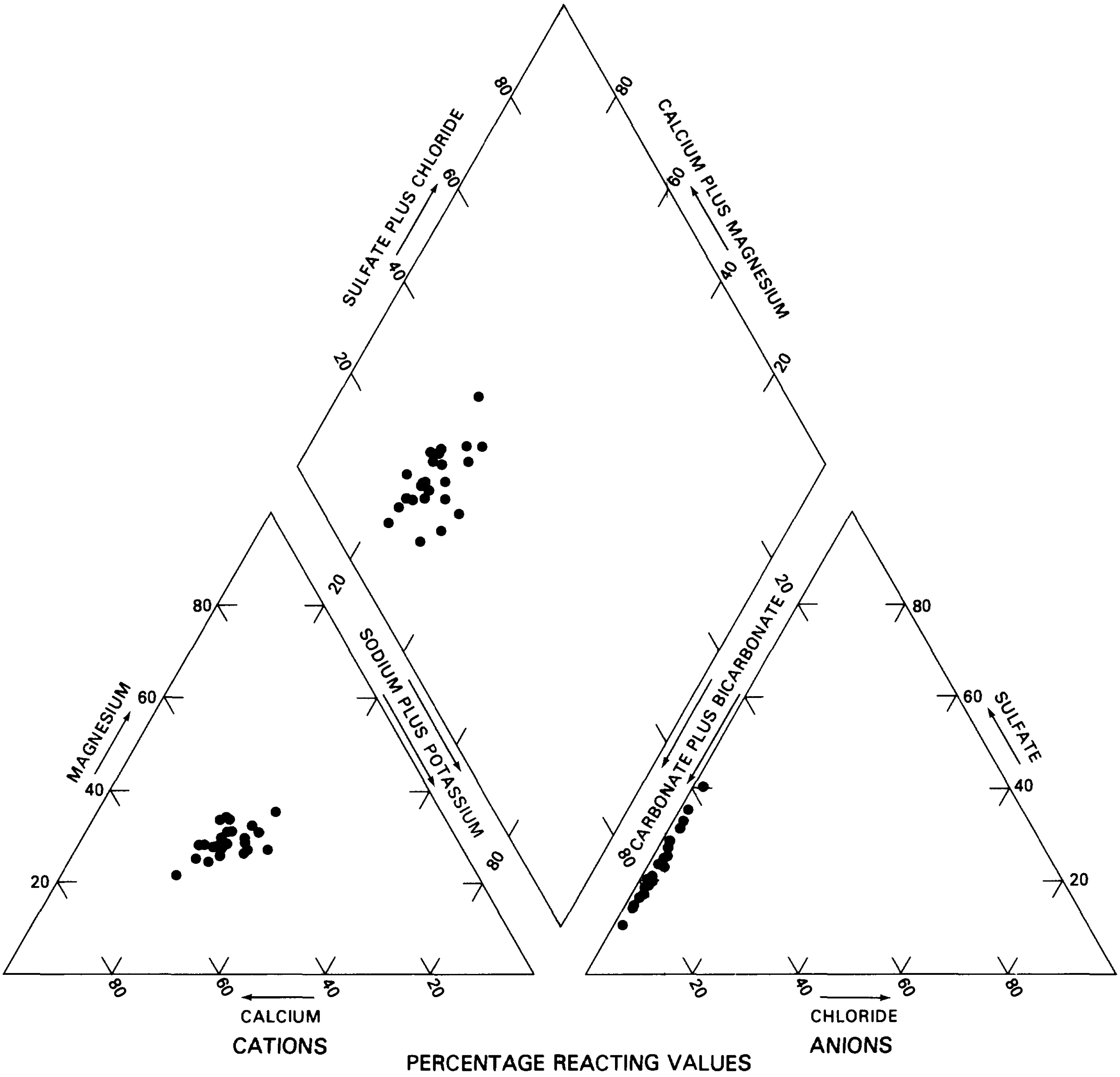


Figure 10.--Water-quality diagram for upland springs located on the plateau between Roan and Parachute Creeks.

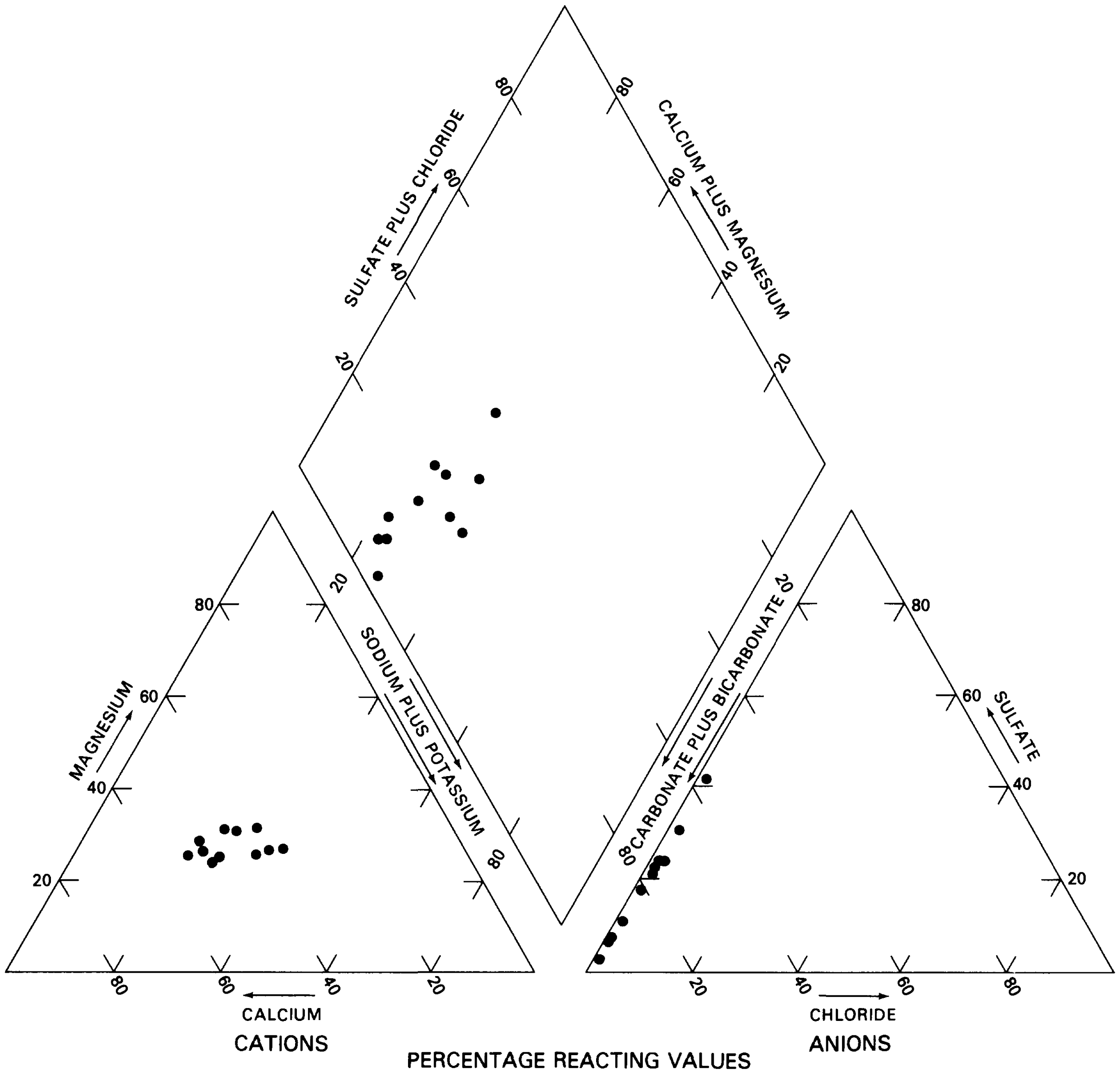
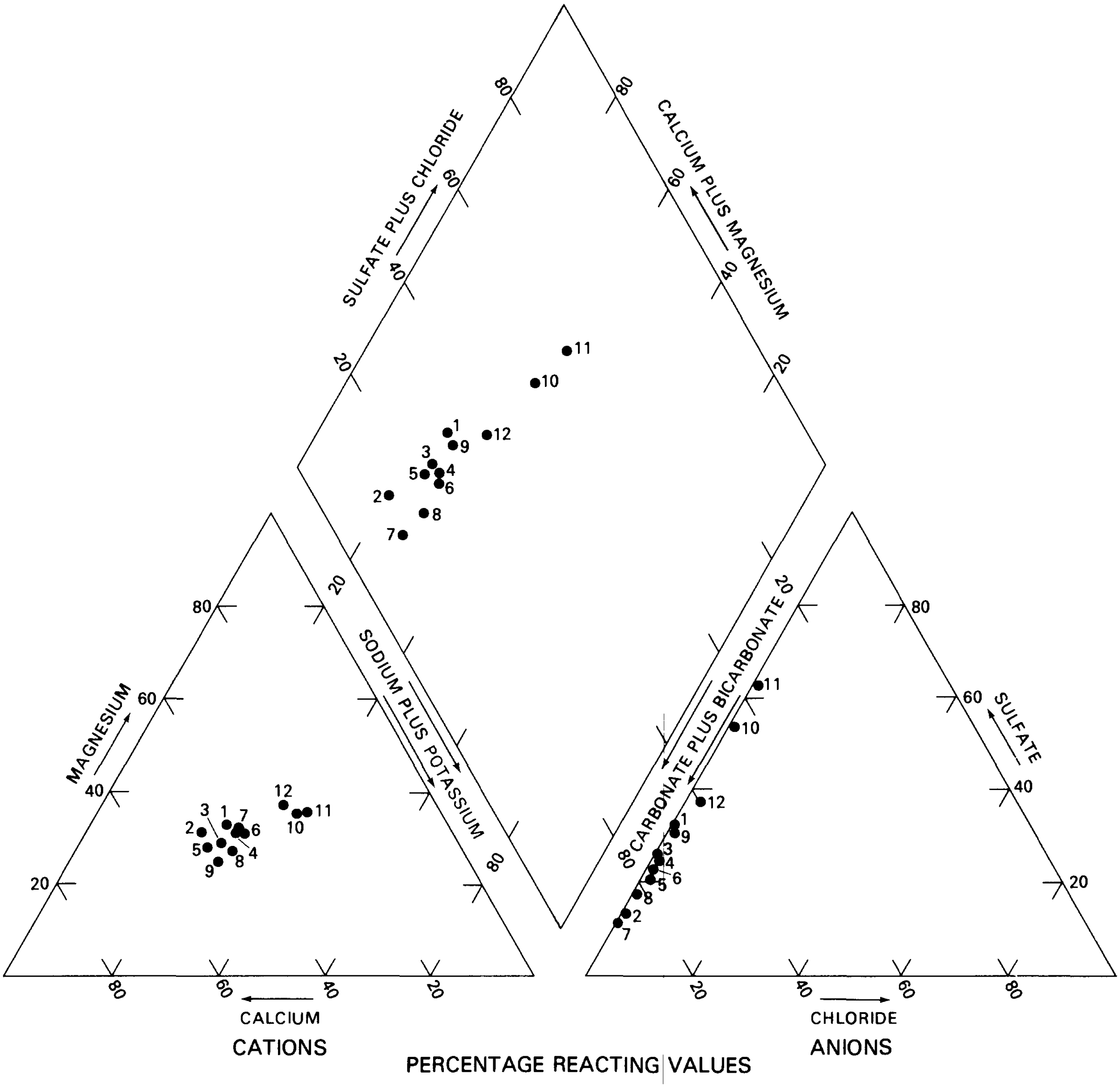


Figure 11.--Water-quality diagram for upland springs located east of Parachute Creek.



EXPLANATION

UPLAND SPRINGS LOCATED ON WESTERN RIDGES OF ROAN CREEK DRAINAGE

1 On Brush Mountain and Skinner Ridge
2 On 4A Mountain and 4A Ridge
3 On Kimball Mountain

UPLAND SPRINGS ON CENTRAL PLATEAU AREA BETWEEN ROAN AND PARACHUTE CREEKS

4 In the northern one-half of area
5 In southern one-half of area, Roan Creek drainage
6 In southern one-half of area, Parachute Creek drainage

UPLAND SPRINGS LOCATED EAST OF PARACHUTE CREEK

7 In the East Fork Parachute Creek drainage
8 In the East Middle Fork Parachute Creek drainage
9 In the Middle Fork Parachute Creek drainage

LOWLAND SPRINGS

10 Above stream alluvium and the Wasatch Formation
11 Above stream alluvium and below the Wasatch Formation contact
12 In stream valley alluvium

Figure 12.--Water-quality summary diagram for springs in various geographical areas.

one spring. Because the variance in ion concentrations between springs within subareas commonly was significant, a detailed spring-sampling program would be needed to accurately analyze variability in water chemistry of springs on a small scale in Roan and Parachute Creek basins.

Specific conductance can be an indicator of general water-quality conditions. With the exception of fluoride, all major constituents and dissolved solids have significant (probability 0.05) regression relationships with specific conductance for upland springs. Combining specific-conductance data collected by Adams and others (1985) with specific-conductance data collected for this study gives an adequate data base with which to map specific conductance. The use of a map of specific conductance with ion concentration-specific conductance relationships can give a general overview of water chemistry of springs in areas where no water analyses are available. The result of plotting all available specific-conductance data from upland springs in the study area is shown in figure 13. One pattern that is apparent in figure 13 is the large area of specific conductance less than 500 μS/cm (microsiemens per centimeter at 25 degrees Celsius) for springs in the eastern section of the study area. Smaller areas with less than 500 μS/cm specific conductance are found in the extreme southern part of the central plateau and on upper 4A Mountain and upper Kimball Mountain. It appears that areas of smaller specific conductance correspond to areas of higher altitude. Areas of larger specific conductance are located north of West Fork Parachute Creek and in the Middle Fork Parachute Creek headwaters area. The southwest side of both lower Brush Mountain and lower Skinner Ridge are zones of increased specific conductance. The area of greater specific conductance on Brush Mountain approximately corresponds to an area with considerable contortion of the Uinta and upper Green River Formations (Johnson, 1981).

Plots of water analyses for six selected springs for various times of the year and at different flow rates are shown in figure 14. Seasonal variation in water chemistry appears to vary from spring to spring. Spring 1 shows the greatest variation in water chemistry of the six springs shown in figure 14. Springs 66 and 124 are examples of springs in the study area that had little variation in major-ion chemistry. Chloride concentrations were constant at each spring. Patterns in other ion concentrations were ill defined. Review of the plots in figure 14 and of additional chemical analyses for other springs indicate that most springs in the study area had only small variations in their water chemistry during the sampling period except for a brief period in late spring. During or immediately following snowmelt, springs receive fresh recharge water that dilutes ion concentrations. Because the sampling period for this study included only about 1½ years, a longer sampling period may be needed to define more detailed seasonal patterns in water chemistry of springs.

Lowland Springs

The lowland springs group included 19 sampled springs located in the valleys of Roan and Parachute Creek drainage basins plus four sampled springs (springs 9, 10, 86, and 137) located on basin perimeter slopes that are not located in either drainage. These four springs are included because of their stratigraphic location near the contact of the Green River and Wasatch

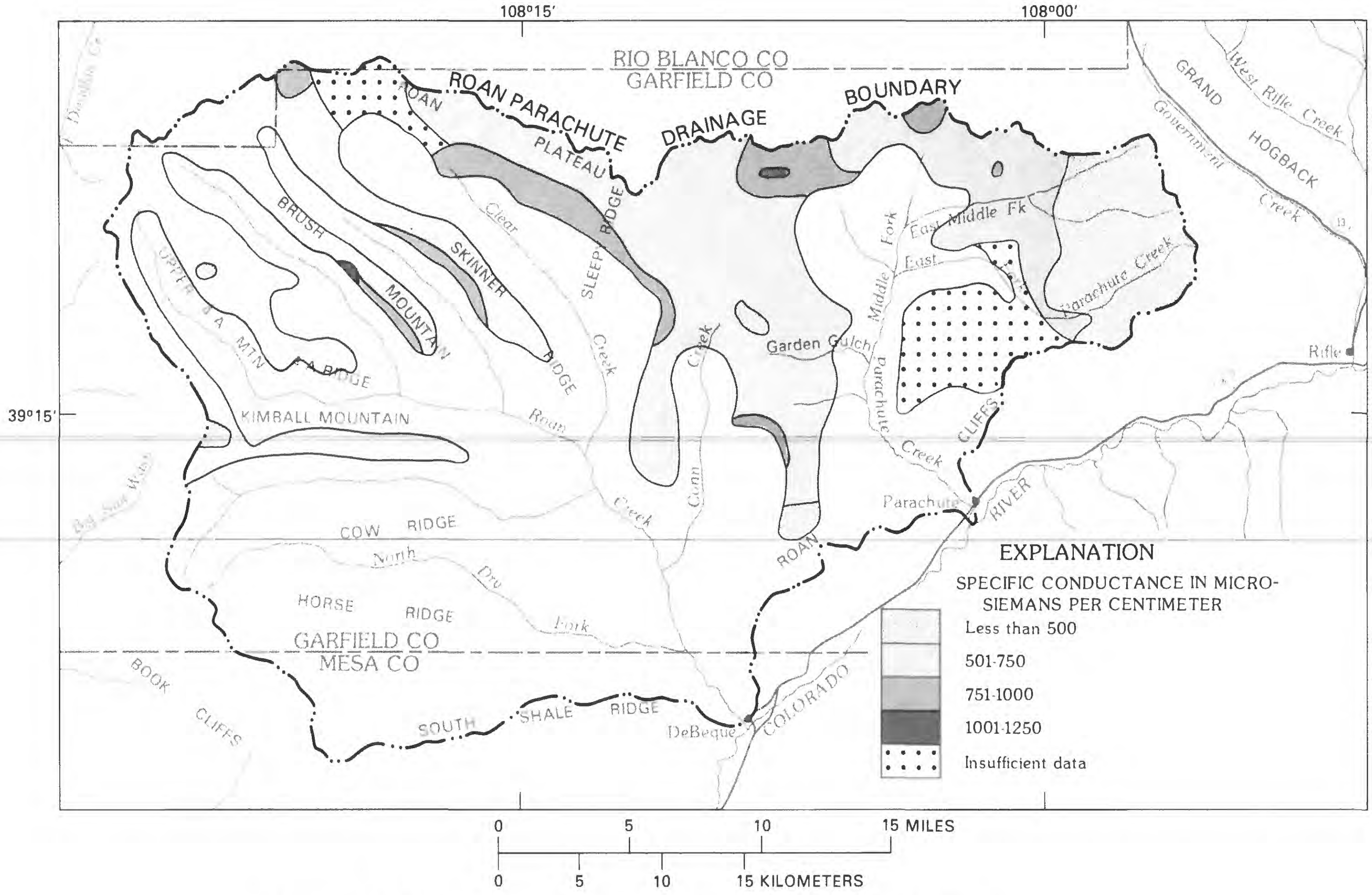
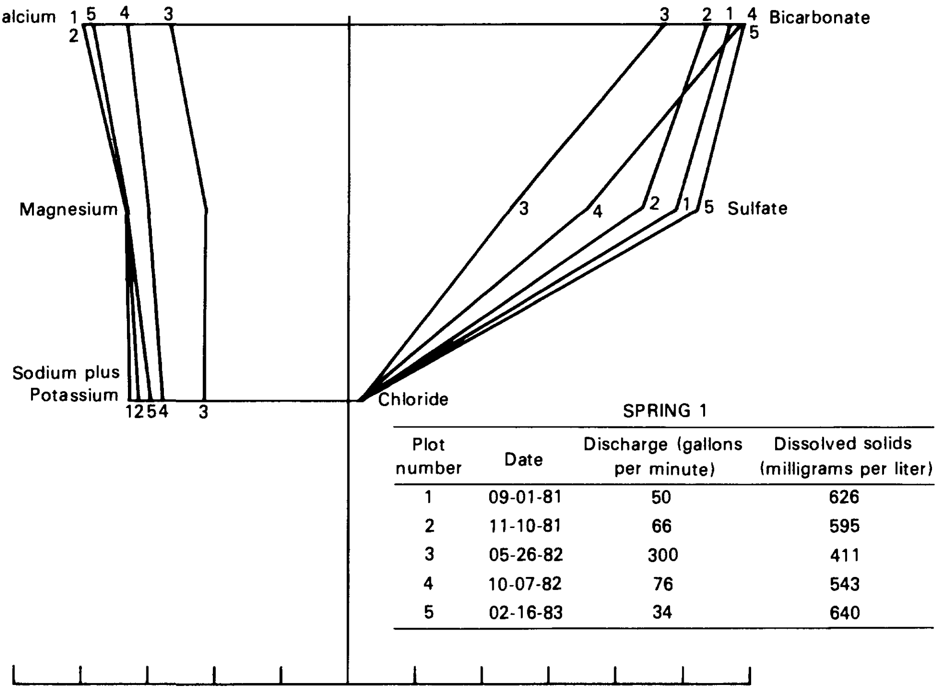
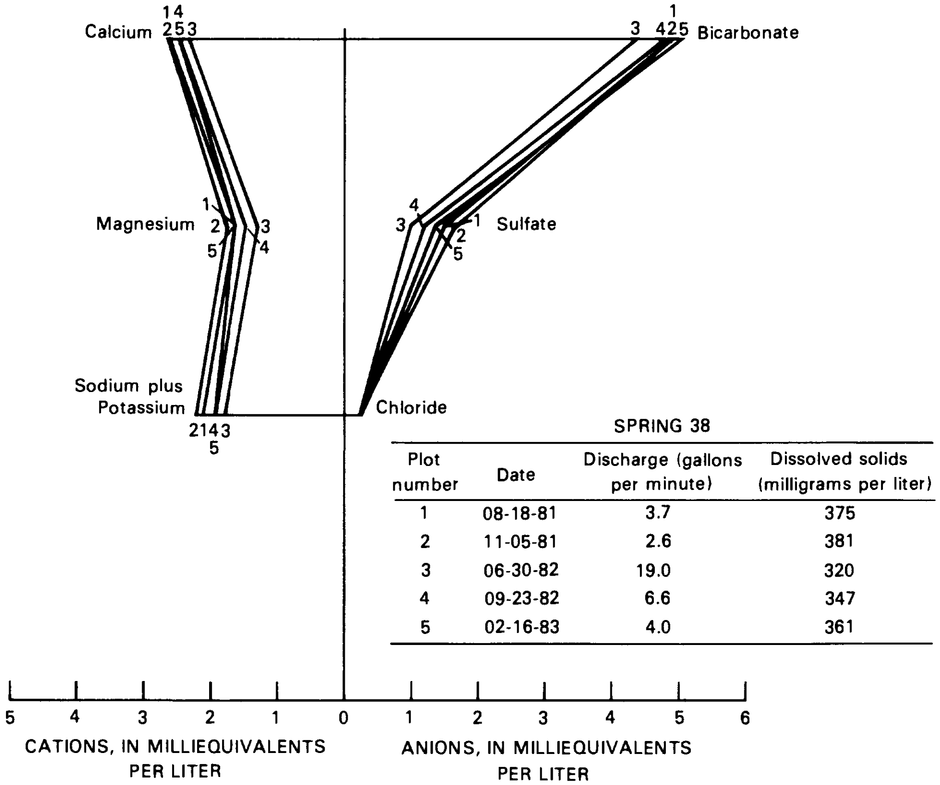


Figure 13.--Specific conductance of upland springs.



SPRING 1

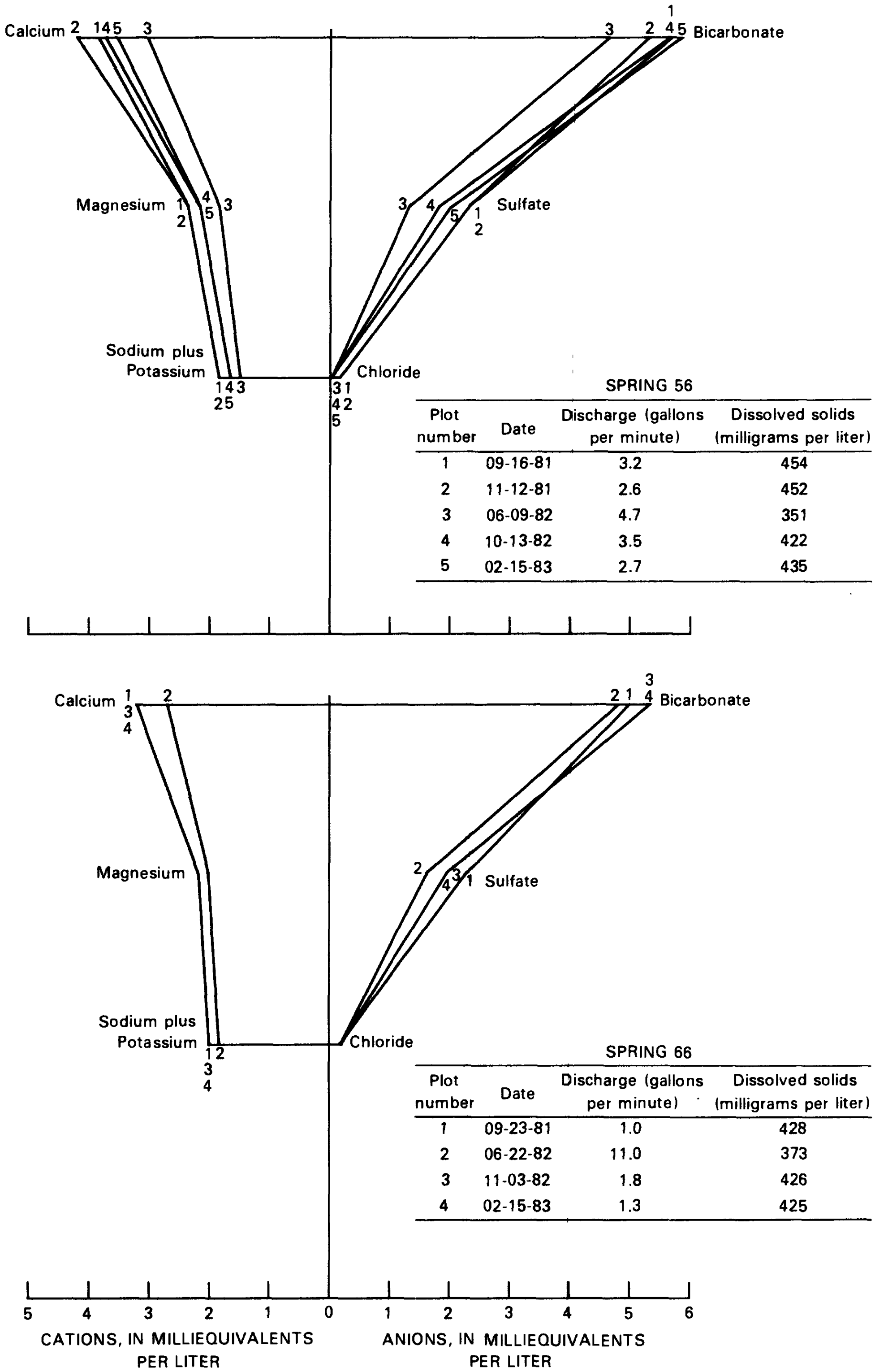
Plot number	Date	Discharge (gallons per minute)	Dissolved solids (milligrams per liter)
1	09-01-81	50	626
2	11-10-81	66	595
3	05-26-82	300	411
4	10-07-82	76	543
5	02-16-83	34	640



SPRING 38

Plot number	Date	Discharge (gallons per minute)	Dissolved solids (milligrams per liter)
1	08-18-81	3.7	375
2	11-05-81	2.6	381
3	06-30-82	19.0	320
4	09-23-82	6.6	347
5	02-16-83	4.0	361

Figure 14.--Seasonal variation of water chemistry at six springs.



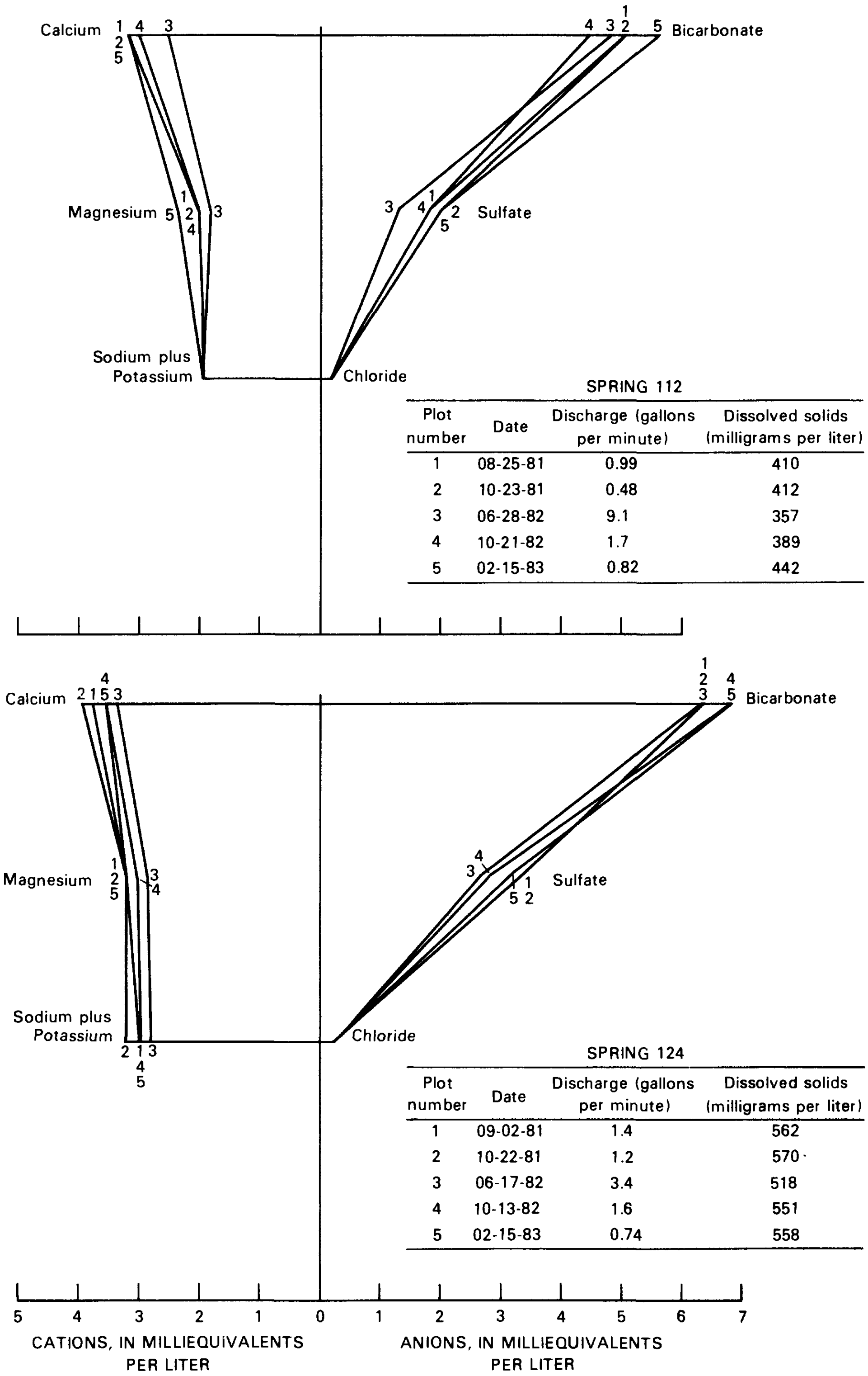
SPRING 56

Plot number	Date	Discharge (gallons per minute)	Dissolved solids (milligrams per liter)
1	09-16-81	3.2	454
2	11-12-81	2.6	452
3	06-09-82	4.7	351
4	10-13-82	3.5	422
5	02-15-83	2.7	435

SPRING 66

Plot number	Date	Discharge (gallons per minute)	Dissolved solids (milligrams per liter)
1	09-23-81	1.0	428
2	06-22-82	11.0	373
3	11-03-82	1.8	426
4	02-15-83	1.3	425

Figure 14.--Seasonal variation of water chemistry at six springs--Continued.



SPRING 112

Plot number	Date	Discharge (gallons per minute)	Dissolved solids (milligrams per liter)
1	08-25-81	0.99	410
2	10-23-81	0.48	412
3	06-28-82	9.1	357
4	10-21-82	1.7	389
5	02-15-83	0.82	442

SPRING 124

Plot number	Date	Discharge (gallons per minute)	Dissolved solids (milligrams per liter)
1	09-02-81	1.4	562
2	10-22-81	1.2	570
3	06-17-82	3.4	518
4	10-13-82	1.6	551
5	02-15-83	0.74	558

Figure 14.--Seasonal variation of water chemistry at six springs--Continued.

Formations. Lowland springs have a large range and variation in concentration for all the cations except potassium, for the anions sulfate and bicarbonate (reported as alkalinity), and for dissolved solids (table 2). Specific conductance ranged from 600 to 4,900 µS/cm. Lowland springs are mixed cation and anion water types as indicated by the chemical-composition plots in figure 15. The cations generally plotted in the 20 to 40 percent calcium, 30 to 40 percent magnesium, and 30 to 40 percent sodium parts of the diagram. Anion percentages ranged from more than 80 percent sulfate at several springs to 80 percent bicarbonate at several other springs. Chloride seldom accounted for more than 5 percent of the anion content.

Lowland springs were grouped by alluvial and nonalluvial sources, and the nonalluvial sources were further grouped according to the stratigraphic location of the spring. Plots 10, 11, and 12 of ion percentages of the mean chemical composition of the three groups are shown in figure 12. Dissolved solids in alluvial spring water average about one-half the dissolved solids in other lowland spring water. Alluvial spring samples have slightly less sodium relative to calcium plus magnesium and a greater bicarbonate-to-sulfate ratio than nonalluvial source springs. Nonalluvial source springs were grouped according to their location relative to the Wasatch Formation-Green River Formation contact. Those two spring groups had similar chemical compositions with slightly increased sulfate percentage for the springs located below the contact. The nonalluvial source springs are located along valley hillsides and slopes and may represent small-scale flow systems; therefore, stratigraphic location may not be a very important factor in determining chemistry of the spring.

Two springs located in lowland areas had unusual chemical compositions when compared to other springs sampled. The two outlier points on the cation diagram in figure 15 represent analyses from springs 44 and 122. Spring 44 is the 65 percent magnesium and 7 percent calcium plot and represents a sample of melt water from ice collected from the lower cliffs of the Green River Formation in the West Fork Parachute Creek valley. The chemical composition may have been altered by freezing and thawing cycles. The other outlier is the 62 percent sodium and 9 percent calcium point from spring 122, the Mt. Callahan spring near Parachute. The analysis of spring 122 also is the outlier point on the combined diagram in figure 15 (62 percent sodium plus potassium, 81 percent sulfate plus chloride). This is the only spring sampled where the percent sodium was greater than 50. The tritium results discussed later in the report in the tritium section indicate that water from spring 122 may be from a deeper or slower circulation aquifer system.

Independent, small-scale flow systems can display remarkable differences in water quality within short distances. An example of such differences was discovered in a gulch in upper Roan Creek basin at the base of Brush Mountain. Springs 108 and 109 are less than ¼-mi apart and at virtually the same altitude, yet spring 108 had a mean dissolved solids of 1,185 mg/L and spring 109 a mean dissolved solids of 3,510 mg/L. Sulfate concentration was 5 times greater and cation concentrations 2 to 3 times greater at spring 109 than at spring 108. The springs are located in landslide-slope wash deposits at the lower end of a gulch that extends about a mile above the springs. Spring 108

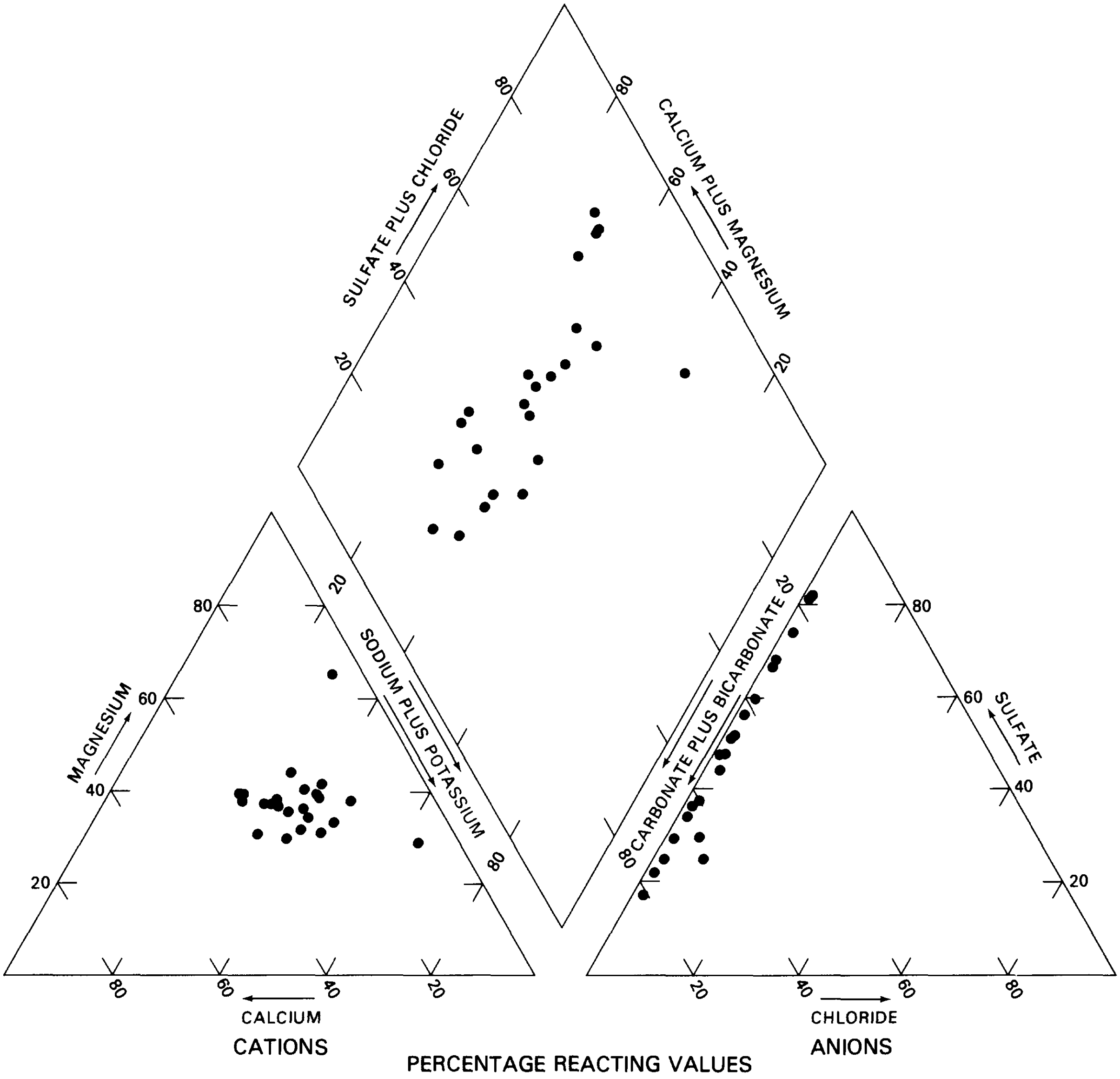


Figure 15.--Water-quality diagram for lowland springs.

issues from a single discharge point, and spring 109 consists of a salt encrusted seep area. Spring 108 has the appearance of a fracture type spring and may represent a faster flow system than spring 109, where slower ground-water movement enables more dissolution of soluble salts.

Average dissolved solids is about three times greater at lowland springs than at upland springs in Roan and Parachute Creek basins. Except for silica, all major-constituent mean concentrations are greater at lowland springs. Silica concentrations are not significantly different between the two spring groups. Mean fluoride concentrations are only 0.2 mg/L greater in lowland springs. Nearly 80 percent of the increase in dissolved solids between lowland and upland springs can be accounted for by increases in sodium sulfate. Plots of lowland-spring groups (numbers 10 to 12 in fig. 12) have a shift toward increased percent sodium, less percent calcium, and a marked shift toward greater percent sulfate than upland-spring plots (numbers 1 to 9). Gypsum ($CaSO_4$) is present in the Wasatch Formation and soluble sodium salts are likely to be present in the cements and clays of the lower members of the Green River Formation and the Wasatch Formation. A significant quantity of clay is reported in the lower members of the Green River Formation (Robb and Smith, 1974).

Dissolved Trace Elements

Data Results and Statistical Summary

Trace element results for samples collected from 1981-83 are reported in table 16 in the Supplemental Hydrologic Data section at the back of this report. An inorganic water-quality constituent that is reported in units of micrograms per liter instead of milligrams per liter is included in this section.

A significant number of trace-element concentrations are qualified as "less than" values (table 16). A significant number of concentrations are also reported as zero, but the true concentration can be between zero and the analytical detection limit. Qualified and zero values are referred to as censored values. By mid-1982, the laboratory no longer reported zeroes in trace-element results.

Another problem commonly associated with the analysis of trace-element data is a nonnormal distribution of the values. The data commonly have a large positive skew, which indicates that a large number of values occur at the smaller concentrations with an abrupt decrease in frequency toward increasing concentrations. Calculation of means or statistical testing using censored, nonnormal data can introduce considerable error in the analysis. An excellent discussion of such computational error can be found in Miesch (1967).

A logarithm transform of nonnormal distributed data commonly will result in an approximate normal distribution or in a log-normal distribution. The antilogs of the mean and standard deviation of the transformed values are the geometric mean and geometric deviation. For log-normal distributions, a geometric mean is considered a better estimate of central tendency than a mean calculated from original values. For a data set with no censored values, the calculation of a geometric mean to estimate mean trace-element concentration would be sufficient. A method devised by Cohen (1959) and described in Miesch (1967) can be used to estimate population means and variances using censored data. The method is based on the degree of censoring or detection ratio, the number of uncensored values to the total number of values, and the mean and variance of the uncensored values. Cohen's (1959) method requires use of a lower limit or detection limit. Because of changes in analytical methods used during the sampling phase of the study, seven elements listed in tables 3 and 4 had two lower limits.

A second method was used to estimate means for censored data that is based on relative ranks of the values. After converting qualified values to 0.7 times the value (for example, <10 becomes 7), all the data are ordered by value with zeroes and the remarked data listed first. Using statistical computer programs (Helwig and Council, 1979), a normal-rank score is computed for each value and then converted to units of standard deviation. The logarithm of concentration of nonzero values is regressed against standard deviation, and the intercept of the resulting line is the geometric mean and the slope is the geometric deviation. This method is less sensitive to variable detection limits than Cohen's (1959) method. Most geometric means listed in tables 3 and 4 were calculated using the ranking procedure, but for many elements with only one lower-limit value, the means calculated by the two methods agree well. The standard error of the mean listed in the tables is the antilog of the standard error of the transformed data. It should be emphasized that the methods used to calculate estimates of central tendency are designed only to decrease computational error and are not designed to correct for sampling and analytical error.

It may be desirable to estimate an arithmetic mean for trace-element constituents for comparison purposes with data in the literature. Miesch (1967) describes a method devised by Sichel (1952) to estimate an arithmetic mean, called a Sichel t-estimate, on log-normally distributed data. These values are listed under the "AM" column in tables 3 and 4. For some constituents, such as boron and strontium that have no censored values and approximate a normal distribution, the t-estimator is equivalent to the simple arithmetic mean of the original data.

Discussion of Results

Background concentrations of aluminum, beryllium, cadmium, chromium, cobalt, copper, iron, lead, mercury, and nickel in many springs in Roan and Parachute Creek basins are equal to or less than analytical detection limits. A concentration of 570 μg/L of aluminum in a sample from spring 43 has the appearance of sampling or analytical problems, as no other spring sampled had a concentration of aluminum greater than 20 μg/L. That sample also had unusually large barium and manganese concentrations for springs in the study area, and there are no known natural causes of increased metal concentrations in that spring. A cadmium value of 26 μg/L from spring 112 on Kimball

Table 3.--*Statistical summary of dissolved trace-element data for upland springs*

[All concentrations in micrograms per liter; N, number of values; NC, number of censored values; DR, detection ratio, = $\frac{N-NC}{N}$; GM, geometric mean; GD, geometric deviation; SE, standard error of the mean; Max, maximum reported concentration; Min, minimum reported concentration; Expected range, the range where 95 percent of the values are estimated to occur; AM, the Sichel t-estimate of the arithmetic mean; -, statistics not calculated if inadequate number of uncensored values]

Constituent	N	NC	DR	GM	GD	SE	Max	Min	Expected range	AM
Aluminum	73	25	0.66	8.3	2.08	1.10	570	0	1.9-35.7	10.8
Arsenic	110	0	1.00	4.1	1.63	1.05	13	1	1.5-10.9	4.6
Barium	107	0	1.00	84.1	1.28	1.02	300	47	51.3-138	86.5
Beryllium	61	39	.36	.5	1.69	1.07	3	<.5	.2-1.4	.6
Boron	125	1	.99	25.3	1.61	1.04	130	0	9.8-65.5	28.1
Cadmium	97	94	.03	-	-	-	26	<1	-	-
Chromium	72	64	.11	-	-	-	20	0	-	-
Cobalt	25	25	.00	-	-	-	<3	<3	-	-
Copper	97	34	.65	2.1	2.58	1.10	12	0	.3-14.0	3.3
Iron	97	60	.38	5.0	2.11	1.08	46	<3	1.1-22.3	6.6
Lead	97	52	.46	1.7	3.05	1.13	10	0	.2-15.8	3.1
Lithium	105	1	0.99	12.9	1.52	1.04	33	<4	5.6-29.7	14.1
Manganese	98	39	.60	2.2	4.32	1.16	210	<1	.1-41.1	6.3
Mercury	72	69	.04	-	-	-	.4	0	-	-
Molybdenum	110	53	.52	7.3	1.80	1.06	31	<1	2.3-23.7	8.7
Nickel	36	18	.50	1.1	2.01	1.13	6	<1	.3-4.4	1.4
Selenium	85	13	.85	1.2	1.85	1.07	5	0	.4-4.1	1.4
Strontium	113	0	1.00	912	1.47	1.04	2,000	380	422-1970	982
Vanadium	110	2	.98	12.7	1.48	1.04	27	1	5.8-27.8	13.7
Zinc	98	30	.69	6.0	2.93	1.12	450	<3	.7-51.5	10.6

Table 4.--*Statistical summary of dissolved trace-element data for lowland springs*

[All concentrations in micrograms per liter; N, number of values; NC, number of censored values; DR, detection ratio, = $\frac{N-NC}{N}$; GM, geometric mean; GD, geometric deviation; SE, standard error of the mean; Max, maximum reported concentration; Min, minimum reported concentration; Expected range, the range where 95 percent of the values are estimated to occur; AM, the Sichel t-estimate of the arithmetic mean; -, statistics not calculated if inadequate number of uncensored values]

Constituent	N	NC	DR	GM	GD	SE	Max	Min	Expected range	AM
Aluminum	18	2	0.89	10.0	1.33	1.07	20	<10	5.6-18	10.4
Arsenic	31	5	.84	1.6	1.79	1.11	4	< 1	.5-5.1	1.9
Barium	27	6	.78	43.4	1.69	1.11	110	21	15-124	51.2
Beryllium	5	4	.20	-	-	-	1	< 1	-	-
Boron	33	0	1.00	111	2.43	1.17	590	30	19-656	162
Cadmium	18	14	.22	.8	1.59	1.12	2	< 1	-	.9
Chromium	16	11	.31	7.7	1.28	1.07	10	0	-	7.9
Cobalt	5	4	.20	-	-	-	< 3	< 1	-	-
Copper	18	4	.78	1.5	2.13	1.20	10	< 1	.3-6.8	2.0
Iron	25	13	.48	8.1	5.77	1.42	760	< 3	.2-270	35
Lead	20	8	.60	1.3	2.25	1.20	10	< 1	.3-6.6	1.8
Lithium	32	0	1.00	55.1	2.45	1.17	660	17	9.2-330	81.5
Manganese	28	8	0.71	3.6	4.35	1.33	50	< 1	.2-68.1	10.4
Mercury	18	18	.00	-	-	-	<.1	.0	-	-
Molybdenum	30	3	.90	18.7	1.90	1.13	100	8	5.2-67.3	22.8
Nickel	4	0	1.00	2.2	1.94	1.47	4	1	.6-8.3	2.7
Selenium	27	0	1.00	3.7	2.07	1.15	20	1	.9-15.9	4.8
Strontium	34	0	1.00	1,486	1.66	1.09	5,200	710	538-4,095	1,679
Vanadium	29	4	.86	3.9	2.22	1.16	13	.7	.8-19.2	5.7
Zinc	25	5	.80	8.0	2.33	1.19	39	<3	1.5-43.4	11.4

Mountain could indicate a sample contamination problem. A sample from spring 141 on South Dry Fork had an iron concentration of 760 µg/L, which is an order of magnitude greater than any other iron concentration listed in table 16 (in the Supplemental Hydrologic Data section). That sample may have been contaminated by iron from the pipe used to collect the sample. The following list of elements either were present in significant concentrations or had significant variation in concentration to warrant further discussion:

1. Arsenic--An analysis of variance using the F-test indicates a significant difference (0.01 probability level) in concentration of arsenic between upland and lowland springs. The reason for greater arsenic concentrations in upland springs is unknown. Desborough and Pitman (1974) suggest that arsenic is present in sulfides in the Parachute Creek Member. Greater concentrations of arsenic were detected in springs on the western ridges of the study area.

2. Barium--Concentrations of barium were significantly greater (probability level of 0.05) in upland springs than in lowland springs. No concentrations exceeded 150 µg/L except for one sample, 300 µg/L at spring 43. No apparent large-scale spatial differences in barium concentrations between upland springs were found.

3. Boron--Mean boron concentrations were five times greater in lowland springs than in upland springs. The maximum reported value for boron from an upland spring was 130 µg/L at spring 32; however, boron seldom exceeded 50 µg/L in upland-spring samples. Springs on the Roan Plateau and on the western ridges of Roan Creek had a marked uniformity in boron concentrations. Boron commonly is associated with sedimentary rocks and evaporite minerals.

4. Lithium--Concentrations of lithium were significantly greater (probability level 0.01) in lowland springs than in upland springs in Roan and Parachute Creek basins. Larger lithium concentrations were associated with greater dissolved-solids concentrations in spring water in both upland and lowland areas. Absorption of lithium on clays may account for the more lithium in the lowland springs. No spatial trends in lithium data between major areas of the uplands springs were determined.

5. Manganese--Mean concentrations of manganese were small for springs throughout the study area, and many samples had less than 10 µg/L manganese. However, there are several samples with manganese exceeding 40 µg/L from randomly scattered springs throughout the study area. The maximum manganese concentration of 210 µg/L determined for spring 116 on 4A Mountain does not agree with an earlier manganese sample from that spring of 26 µg/L.

6. Molybdenum--Concentrations of molybdenum were significantly greater (probability level 0.05) in lowland springs than in upland springs. Greater molybdenum concentrations are apparent in spring water on the western ridges of Roan Creek drainage for upland areas. Several samples from springs in the western area have molybdenum concentrations of 20 to 30 µg/L. The maximum concentration of molybdenum, 100 µg/L, was from spring 44; that sample represents ice from the lower cliffs of Parachute Creek Member in West Fork Parachute Creek Valley in which water sources are unclear and alterations to chemical composition are possible.

7. Selenium--Mean selenium concentration was about three times greater for lowland springs than for upland area springs. Two samples exceeded 10 µg/L, one from spring 122 (12 µg/L) and one from spring 129 (20 µg/L). Both springs may represent water from the lower members of the Green River Formation or the upper part of the Wasatch Formation.

8. Strontium--Strontium concentrations exceeding 2,000 µg/L were common in lowland springs, especially in nonalluvial source springs. Mean strontium concentration was significantly smaller (probability level 0.01) in upland springs. Strontium is common in carbonate sediments (Hem, 1970) and in the Piceance Creek drainage basin is a significant element in the Uinta Formation ground water (Robson and Saulnier, 1981). Concentrations of strontium were less in upland springs of Roan and Parachute Creek basins than in springs in the Piceance Creek drainage basin. This difference can be attributed to shorter flow path and residence time for springs in the Roan and Parachute part of the Piceance basin, resulting in less dissolution of strontium. Average strontium concentrations are less in springs on the western ridges of Roan Creek drainage than in springs on the central and eastern plateau areas in the study area. Trends of increasing strontium to the north in the central Roan Plateau and to the northwest in the area east of Parachute Creek are apparent.

9. Vanadium--Vanadium concentrations were significantly greater (probability level 0.05) in upland springs than in lowland springs in the study area. Within the upland region, vanadium concentrations are significantly less in the eastern area than in the western or central areas. Reasons for these differences are not understood. A substantial negative correlation exists between vanadium and strontium concentrations. Vanadium concentrations of 20 to 30 µg/L were determined in six upland-spring samples from western and central locations.

10. Zinc--Zinc was not present in large concentrations in springs in the study area. Galvanized-steel pipes used at some springs may have contributed zinc to water samples. This contamination was somewhat random in occurrence. A maximum concentration of 450 µg/L of zinc was reported from spring 90 in a sample collected during September 1981. Three subsequent samples from spring 90 had zinc concentrations of <3, <3, and 36 µg/L. Three samples from other springs with zinc concentrations of 50 to 100 µg/L were not verified by other zinc analyses from those springs. Readers are advised to use the larger zinc concentrations shown in table 16 with caution in any additional analysis of the data.

Dissolved Nitrogen and Phosphorus

Analytical data for dissolved nitrogen and phosphorus species are listed in table 15 in the Supplemental Hydrologic Data section. A statistical summary of the data is tabulated in table 5. Because some of the data contain censored values or were not normally distributed, computational techniques previously described in this report were used to estimate central tendency, variance, and arithmetic mean.

Table 5.--*Statistical summary of dissolved nitrogen and phosphorus data for upland and lowland springs*

[All concentrations in milligrams per liter; N, number of values; NC, number of censored values; DR, detection ratio, = $\frac{N-NC}{N}$; GM, geometric mean; GD, geometric deviation; SE, standard error of the mean; Max, maximum reported concentration; Min, minimum reported concentration; Expected range, the range where 95 percent of the values are estimated to occur; AM, the Sichel t-estimate of the arithmetic mean; -, statistics not calculated if inadequate number of uncensored values]

Constituent	N	NC	DR	GM	GD	SE	Max	Min	Expected range	AM
UPLAND SPRINGS										
Organic nitrogen	36	0	1.0	0.42	1.55	1.08	0.90	0.15	0.18-1.0	0.46
Ammonia	69	23	.67	.06	1.77	1.07	.17	.02	.02- .20	.08
Organic plus ammonia nitrogen	36	0	1.0	.52	1.44	1.06	.94	.24	.25-1.1	.56
Nitrite	36	9	.75	.02	1.46	1.07	.06	.00	.01- .05	.02
Nitrite plus nitrate	127	1	.99	.70	2.13	1.07	3.3	.07	.16-3.2	.92
Phosphorus	69	0	1.0	.04	1.72	1.07	.16	.01	.02- .13	.05
Orthophosphate	36	5	.86	.04	2.36	1.15	.11	.00	.01- .20	.05
LOWLAND SPRINGS										
Organic nitrogen	6	0	1.0	0.60	2.15	1.37	2.57	0.28	0.13-2.8	0.79
Ammonia	17	11	.35	.04	2.58	1.30	.23	.05	.02- .07	.06
Organic plus ammonia nitrogen	16	0	1.0	.87	1.96	1.18	3.2	.42	.23-3.3	1.08
Nitrite	15	13	.13	.01	2.56	1.28	.04	.00	-	.02
Nitrite plus nitrate	35	3	.91	.61	3.89	1.22	11	.11	.04-9.2	1.48
Phosphorus	17	0	1.0	.02	1.78	1.15	.05	.01	.01- .06	.02
Orthophosphate	15	13	.13	-	-	-	.02	.00	-	-

Ammonia and nitrite were present in small concentrations in springs throughout the study area. Therefore, nearly all the inorganic nitrogen present was in the oxidized nitrogen state as nitrate. The nitrite plus nitrate determination can effectively be considered entirely as nitrate. The geometric means of nitrate concentration between upland and lowland springs are not significantly different. However, the large variance in the nitrate data for the lowland sites results in a significantly greater estimate of arithmetic mean than for upland springs. A sample from spring 129 had 11 mg/L nitrate, and two samples from spring 108 had 6.1 and 5.5 mg/L of nitrate. Both springs are located in small gulches in Roan Creek valley. Reasons for the large nitrate concentrations at the two springs are unknown. Four springs located on the western ridgetops of Roan Creek drainage have mean nitrate concentrations of about 2 to 3 mg/L. Because nitrate concentrations were quite variable between springs within short distances, distinct spatial trends were not readily apparent.

The mean organic plus ammonia nitrogen concentrations were greater for lowland area springs. Lowland springs had a larger variability among springs than upland springs with respect to organic nitrogen. Springs 108 and 129, which had the greatest concentrations of nitrate in samples also had the maximum organic plus ammonia nitrogen concentrations (2.7 and 3.2 mg/L). No differences in organic plus ammonia nitrogen concentrations were apparent in the upland springs.

Dissolved phosphorus and orthophosphate concentrations were minimal in spring samples from the study area. Mean concentrations were near analytical detection limits, and concentrations in only a few analyses exceeded 0.10 mg/L.

Miscellaneous Constituents

Water-quality constituents discussed in this section include sulfide, bromide, iodide, cyanide, organic carbon, phenols, and oxygen 18/16 isotope ratio. Analytical results for those constituents in spring samples are given in table 15 in the Supplemental Hydrologic Data section. A statistical summary of the data can be found in table 6.

Mean sulfide, bromide, and iodide concentrations were not significant in springs of Roan and Parachute Creek basins. Sulfide may be present in slightly greater concentrations in lowland springs than in upland springs. The maximum sulfide concentration was 0.8 mg/L in a sample from spring 125, an alluvial spring on Conn Creek. Sulfide odor was noticed at a few springs. Bromide concentrations were 0.1 mg/L or less at most springs. More than 80 percent of the iodide values were censored. Apparently a change in analytical methods for iodide at the laboratory from 1981 to 1982 resulted in an increase in reporting limits from 0.01 to 0.25 mg/L.

Forty-six of 50 cyanide concentrations were either zero or <0.01 mg/L. The maximum concentration of 0.02 mg/L was at spring 43, which also had some unusual metal concentrations. Dissolved-organic carbon (DOC) results indicate 2 to 5 mg/L DOC in most springs throughout the study area, and no spring sampled had a DOC greater than 10 mg/L. Phenol concentrations represent a

Table 6.--*Statistical summary of miscellaneous-constituent data for upland and lowland springs*

[All concentrations in milligrams per liter except for phenols (micrograms per liter) and oxygen 18/16 isotope ratio (parts per thousand). All constituents total phase except bromide, iodide, and organic carbon, which are dissolved species; N, number of values; NC, number of censored values; DR, detection ratio, = $\frac{N-NC}{N}$; GM, geometric mean; GD, geometric deviation; SE, standard error of the mean; Max, maximum reported concentration; Min, minimum reported concentration; Expected range, the range in which 95 percent of the values are estimated to occur; AM, the Sichel t-estimate of the arithmetic mean; -, statistics not calculated because of inadequate number of uncensored values]

Constituent	N	NC	DR	GM	GD	SE	Max	Min	Expected range	AM
					UPLAND SPRINGS					
Sulfide	46	29	0.37	0.07	2.44	1.14	0.6	0.0	0.0- .4	.11
Bromide	36	28	.22	.06	1.76	1.10	.2	.0	.0- .2	.07
Iodide	36	29	.19	.01	1.36	1.05	.02	.00	.00- .02	.01
Cyanide	36	32	.11	-	-	-	.02	.00	-	-
Organic carbon	47	0	1.0	2.80	1.44	1.05	9.6	1.6	1.4- 5.8	3.00
Phenols	44	13	.70	1.88	3.46	1.21	27	0	0-23	4.00
Oxygen 18/16[1]	21	0	1.0	-16.3	.38	.08	-15.6	-17.0	-17.1 to -15.5	-
					LOWLAND SPRINGS					
Sulfide	17	6	0.65	0.22	3.19	1.32	0.8	0.0	0.0- 2.2	0.42
Bromide	14	3	.79	.11	1.19	1.05	.13	.08	.08- .16	.11
Iodide	14	12	.14	-	-	-	<.25	.00	-	-
Cyanide	14	14	.00	-	-	-	.00	.00	-	-
Organic carbon	13	0	1.0	3.54	1.67	1.15	9.4	1.3	1.3- 9.9	4.04
Phenols	11	4	.64	1.77	4.66	1.59	29	0	0-38	5.20
Oxygen 18/16[1]	3	0	1.0	-16.3	.69	.40	-15.5	-16.7	-	-

[1] Statistics are arithmetic mean, standard deviation, standard error on untransformed data.

gross or total phenol concentration and do not differentiate specific phenolic compounds or groups. Phenol concentrations exceeded 10 μg/L in five spring samples. Occasional large phenol concentrations in ground water of the region are not unexpected because of substantial organic content in rocks of the area. The maximum phenol concentration reported was 29 μg/L from spring 131 on North Dry Fork. A sample collected during 1981 from spring 88 on the central Roan Plateau had 27 μg/L phenols. The phenol data had a large skew and variance, which results in considerably greater estimates of arithmetic means than of geometric means.

Oxygen-isotope ratio is the ratio of the heavier, stable oxygen-18 isotope to the common oxygen-16 isotope. The oxygen-isotope data represent a difference of the isotope ratio of the sample from the isotope ratio of a standard called standard mean ocean water (Freeze and Cherry, 1979). The values are expressed in parts per thousand. Larger negative values indicate greater depletion of oxygen-18 in the water relative to the standard. Once oxygen-18 has moved through the soil zone into an aquifer, it becomes a property of that water, so sources and mixing zones in ground-water systems can be studied using isotope analysis. Deeply circulating water is likely to be enriched in oxygen-18 because of reaction losses of oxygen-16, so values of the isotope ratio are less negative than isotope ratios of shallow waters. The isotope data given in table 15 (in the Supplemental Hydrologic Data section) were collected in conjunction with tritium sampling. Values ranged from -15.5 to -17.0 parts per thousand in 24 spring samples. These values are comparable to oxygen-isotope values for shallow ground waters in high-altitude recharge areas in Colorado (H.C. Claassen, U.S. Geological Survey, oral commun., 1984). The data are presented to define oxygen-isotope values in shallow waters in the study area. These data could be helpful in future hydrologic studies of the Piceance basin if isotope data are collected from alluvial and deeper ground water.

MINERAL SATURATION OF SPRING WATER

Relations of water chemistry to geologic terrain can be examined through use of chemical-equilibria calculations that can be used to determine mineral-saturation information from chemical analyses of spring samples. Effects on water quality caused by outside inputs to the system and estimates of maximum limits on concentrations of trace elements can be derived from mineral-saturation data.

The computer program WATEQF (Plummer and others, 1978) was used for calculation of distribution and activity of selected inorganic aqueous species. The program also calculates the state of saturation of the water with respect to certain minerals. An excellent discussion of principles of solution-mineral equilibria is presented in Garrels and Christ (1965).

The saturation index (SI) used from WATEQF is equal to the log of the ion activity product divided by the mineral equilibrium constant. If SI was in the range -0.1 to +0.1, the sample was designated as saturated or at equilibrium with that mineral; if less than -0.1, the sample was designated undersaturated; SI greater than 0.1 was designated supersaturated. A summary of SI values for selected minerals for spring analyses from Roan and Parachute Creek basins is given in table 7. Mineral selection was based on possible precipitation controls for various aqueous species and on mineralogic information for the Piceance basin found in Desborough and Pitman (1974), Milton (1977), and Robb and Smith (1974). Soil composition data from Kimball (1981) and Dean and Ringrose (1979) also were considered during mineral selection process.

Mineral saturation, predominant ion species, chemical reactions, and ion-concentration limits are discussed for the following list of chemical constituents or groups of constituents:

1. Calcium magnesium bicarbonate system--Calcite and dolomite are present in cements of the Uinta Formation and are common minerals of the Green River Formation. Carbon dioxide (CO_2) charged water infiltrates the weathered zone and then the unweathered zone. The resultant dissolution of calcite and dolomite produces calcium, magnesium, and bicarbonate ions in solution. Calculated CO_2 partial pressures in spring samples commonly were greater than atmospheric CO_2. This indicates significant CO_2 was present throughout the flow system and aided in mineral dissolution. It is apparent that most springs represent ground-water systems with sufficient flow-path length and residence time to reach saturation or supersaturation with calcite and dolomite (table 7). Carbonate deposits sometimes were observed near spring discharge points. Because no other major sources of calcium and magnesium are present in the rocks of shallow flow systems of upland areas, calcium and magnesium concentrations have become restricted to a narrow range in the spring water. Mineral saturation and ion exchange had a limiting effect on calcium and magnesium concentrations. A few springs in the valleys had greater calcium concentrations because of gypsum dissolution. Bicarbonate concentrations could increase significantly if nahcolite were present in the flow system, but that mineral probably has been leached from the shallower zones and is present in significant quantities only at deeper zones of the Green River Fomation. From WATEQF species distribution calculations, the predominant ion species of calcium was Ca^{2+} with $CaSO_4$ of secondary importance. The primary ion species of magnesium was Mg^{2+}, but the $MgSO_4$ and $MgHCO_3^+$ species account for about 20 percent of the total magnesium. Bicarbonate was predominantly in the HCO_3^- form; cation complexes accounting for about 10 percent of total bicarbonate.

Table 7.--*Number of samples from upland and lowland springs saturated or supersaturated with respect to selected minerals*

[N, number samples; SAT, number of samples saturated; SSAT, number of samples supersaturated]

Mineral	Chemical formula	Upland Springs			Lowland Springs		
		N	SAT	SSAT	N	SAT	SSAT
Adularia	$KAlSi_3O_8$	55	8	42	18	1	15
Albite	$NaAlSi_3O_8$	55	4	2	18	4	3
Analcime	$NaAlSi_2O_6 \cdot H_2O$	55	0	0	18	0	0
Barite	$BaSO_4$	102	7	89	27	0	27
Calcite	$CaCO_3$	125	18	95	38	3	32
Chalcedony	SiO_2	123	1	122	38	7	21
Dolomite	$CaMg(CO_3)_2$	125	7	88	38	2	32
Fluorite	CaF_2	125	0	0	37	0	0
Gibbsite	$Al(OH)_3$	55	14	33	18	1	13
Gypsum	$CaSO_4 \cdot 2H_2O$	125	0	0	38	1	0
Illite	$K_{.6}Mg_{.25}Al_{2.3}Si_{3.5}O_{10}(OH)_2$	55	0	55	18	0	18
Kaolinite	$Al_2Si_2O_5(OH)_4$	55	0	55	18	0	18
Muscovite	$KAl_3Si_3O_{10}(OH)_2$	55	0	55	18	0	18
Ca-Montmorillonite	$Ca_{.17}Al_{2.33}Si_{3.67}O_{10}(OH)_2$	55	0	55	18	0	18
Nahcolite	$NaHCO_3$	125	0	0	38	0	0
Quartz	SiO_2	123	0	123	38	0	38
Siderite	$FeCO_3$	93	0	0	27	1	0
Strontianite	$SrCO_3$	110	0	0	34	3	2
Witherite	$BaCO_3$	103	0	0	28	0	0
Rhodochrosite	$MnCO_3$	93	0	0	25	0	0

2. Sodium and potassium--Albite and analcime dissolution and cation exchange on clay minerals are likely sodium sources in spring water. Hem (1970) states that sodium may be present as an impurity in calcite cements. The larger sodium concentrations in lowland springs may be due to clay available for cation exchange and perhaps nahcolite in the slump and landslide debris derived from Green River Formation. Nearly all the sodium in solution was present as Na^+ ions. Potassium sources in Roan and Parachute Creek basin springs were potassium feldspar (adularia) and clay minerals. More soluble sources of silica cause supersaturation of potassium-silicate minerals in springs and maintain small potassium concentrations.

3. Sulfate and chloride--Sulfur was present in the oxidized form SO_4^{2-} in springs of the study area. The presence of moderate sulfate concentrations and oxidized nitrogen as nitrate indicates oxidizing conditions are prevalent in spring systems. Because sulfate minerals seldom are reported in the Uinta or upper part of the Green River Formations, the sulfur source is not clear. Robson and Saulnier (1981) suggest upward leakage of reduced sulfur from pyrite sources in the Parachute Creek Member may produce sulfate in Uinta springs in Piceance Creek drainage basin when reduced sulfur is exposed to recharge waters. It is not likely that this process is occurring in the Roan and Parachute Creek area. Gypsum dissolution in the Wasatch Formation accounts for increased sulfate concentrations in many lowland springs. Only one sample was saturated with gypsum, indicating the mineral is still actively being dissolved, despite large sulfate concentrations in some lowland springs. About 80 to 90 percent of oxidized sulfur was in the SO_4^{2-} form, with minor contributions from several cation and metal complexes. If a spring analysis reported measurable sulfide, nearly all reduced sulfur is in the HS^- form. The calculated molality of HS^- usually was about three orders of magnitude less than sulfate molality.

Some upland springs with large-dissolved solids concentrations tend to have greater sulfate to bicarbonate ratios and slightly increased percent of sodium. Those springs may represent discharge from a longer flow-path system in the upper aquifer system.

Although no chloride minerals are present in areas where springs are located, much of the the chloride in spring water probably is derived from trace chloride in the minerals present. Chloride concentrations in precipitation near the study area are much smaller than concentrations in spring samples. Because chloride is a conservative ion in the ground water of concern, its concentration gradually will increase down gradient from continued dissolution of trace chloride. Several upland springs suspected of discharging from longer flow systems in the upper aquifer had slightly larger chloride concentrations.

4. Silica--Quartz, chalcedony, and potassium feldspar are reported to be common minerals in Piceance basin. Most springs were saturated or supersaturated with chalcedony and potassium feldspar, and all springs were supersaturated with quartz. The presence of more soluble amorphorus silica may explain why silica concentrations exceeded quartz solubility (Hem, 1970). Silica concentrations appear to be at a steady state because additional silica dissolution from amorphous silica is offset by precipitation of silica minerals. Species distribution calculations by WATEQF indicate silica to be primarily in the aqueous H_4SiO_4 form.

5. Aluminum--Aluminum bearing minerals illite, kaolinite, muscovite (potassium mica), and calcium montmorillonite were all supersaturated in spring water. The more soluble gibbsite was undersaturated in 8 upland and 4 lowland samples. Dawsonite ($NaAlCO_3(OH)_2$) is not in the WATEQF program, but calculations of 20 randomly selected analyses indicate it also was supersaturated in springs. Equilibrium constants and ion activities produced by WATEQF can be used to calculate an equilibrium concentration or limit for aluminum (or for the metal of interest) with respect to a selected mineral. Equilibrium concentrations for aluminum using gibbsite as the controlling precipitate were in the 2 to 20 μg/L range. If kaolinite was used as the precipitate, then aluminum limits were less than 1 μg/L at many springs. Kimball (1981) describes sampling problems that can produce unrealistically large dissolved aluminum concentrations and apparent mineral supersaturation. The analytical sensitivity of 10 μg/L for samples collected for this study was too large to accurately describe aluminum mineral saturation. The complexes $Al(OH)_2^+$ and $Al(OH)_4^-$ were the primary aluminum species in the samples tested by the WATEQF program.

6. Barium--Nearly all spring samples were saturated or supersaturated with barite and undersaturated with the more soluble witherite. Neither mineral is reported to be very common in Piceance basin. Using barite as a controlling precipitate reaction, barium limits of about 10 to 40 µg/L for upland springs and 2 to 20 µg/L for lowland springs were indicated from equilibrium calculations. Greater sulfate activities are a likely explanation for the smaller mean barium concentrations at lowland springs in the study area.

7. Boron--Boron concentration in ground water is likely to be a function of availability rather than of equilibrium controls. Milton (1977) reports boron containing minerals in the Green River Formation, but their solubility is unknown. The predominate boron species in the spring samples is aqueous H_3BO_3.

8. Cadmium--Although not present in significant concentrations in spring samples, cadmium and a few other constituents are included in this discussion to obtain concentration limits for selected heavy metals. Using the equilibrium constant for otavite ($CdCO_3$) and CO_3^{2-} activities, cadmium (as Cd^{2+}) equilibrium concentration limits in the 50 to 300 µg/L range are indicated for spring water. Chemical analyses of spring samples show cadmium concentrations of about 1 µg/L; thus $CdCO_3$ was undersaturated in spring water. An influx of soluble cadmium into a spring's water source could result in concentrations of the element well in excess of background concentrations.

9. Fluoride--Fluorite is a likely controlling precipitate mineral for fluoride ion, and its presence is reported in mineralogic studies of the Piceance basin. All spring samples were undersaturated with fluorite (table 7). At the calcium activities commonly found in spring samples, saturation concentrations of 2 to 3 mg/L were indicated for fluoride. Analytical concentrations of fluoride in the samples were an order of magnitude less than equilibrium concentrations.

10. Iron--Spring water in equilibrium with siderite would have iron concentrations of about 150 to 1,500 µg/L. Concentration limits greater than 1,000 µg/L iron were limited to a few springs where measured pH was less than 7.5. Only one sample was saturated with siderite, and that sample was suspected of being contaminated. Siderite is a rare mineral in Piceance basin and not a likely source of iron in spring water. Pyrite is common in oil shale of the Green River Formation, but pyrite is not a likely iron source for springs in the study area. Iron may be present in iron-oxide cements of Uinta Formation sandstone and siltstone. Assuming slightly oxidizing conditions in springs, the primary iron species were Fe^{2+}, $FeSO_4$, and $FeOH^+$. Although calculation of iron limits from siderite equilibria depends only on pH and $CO_3{}^{2-}$ activity, a fully accurate description of iron species distribution and saturation of iron minerals in natural waters needs consideration of oxidation-reduction reactions and actual values of eh (redox potential), if valid field measurements could be made.

11. Lead--Using thermodynamic data from Robie and others (1978) and activities of $CO_3{}^{2-}$, OH^-, and $SO_4{}^{2-}$, lead limits were calculated with respect to cerussite ($PbCO_3$). Assuming all lead was represented by the aqueous species Pb^{2+}, $PbOH^+$, and $PbSO_4$, equilibrium lead concentrations of about 2 to 15 µg/L were calculated for spring samples. A majority of the samples were undersaturated with lead using cerrusite as the controlling precipitate.

12. Lithium--Nearly all lithium was in the Li^+ aqueous form in samples from the springs. The primary control of lithium concentration was likely to be availability. Robson and Saulnier (1981) report large lithium concentrations associated with large bicarbonate concentrations in Piceance Creek drainage basin. Lithium concentrations in springs of Roan and Parachute Creek basins were greater in valley locations where it may be more available as a trace element in clays of the Wasatch and lower part of the Green River Formations.

13. Manganese--Manganese limits in spring water generally were in the 150 to 500 µg/L range calculated from rhodochrosite equilibrium. A few springs having pH near 7.0 had equilibrium concentrations of about 1,000 µg/L. All spring samples were undersaturated with respect to rhodochrosite, and manganese concentrations commonly were 10 to 20 times less than the calculated limits. The primary aqueous species of manganese were Mn^{2+} and $MnHCO_3{}^-$.

14. Strontium--Strontium limits generally ranged from 2,000 to 20,000 µg/L for water at equilibrium with strontianite. All upland-spring samples were undersaturated with strontianite, but five samples from lowland springs were saturated or supersaturated with strontium. Those five samples had a pH of 8.3 to 8.5, which results in an increase in CO_3^{2-} activity and less Sr^{2+} activity to attain equilibrium with strontianite. Springs having a pH of about 7 with a CO_3^{2-} activity typical of the area could exceed 20 mg/L strontium at equilibrium. Strontium minerals are seldom reported in Piceance basin mineralogy. The source of strontium may be as an impurity in carbonate minerals.

15. Zinc--Zinc was not in the WATEQF program, but zinc limits with respect to smithsonite ($ZnCO_3$) can be estimated. Calculations indicated that most springs in the study area were undersaturated with zinc by 1 to 3 orders of magnitude with limits of 700 to 7,000 µg/L as Zn^{2+}. Complexes such as $ZnSO_4$ and $ZnOH^+$ would increase maximum zinc solubility. It appears zinc concentration would be more a function of availability rather than mineral-solubility controls.

A geochemical flow path model from precipitation recharge water to deep circulation water in the lower aquifer would necessitate additional chemical information from wells in Roan and Parachute Creek basins. With current data, only the part of the flow path from precipitation to shallow zone waters represented by springs could be examined. Additional samples from the upper aquifer near or at the A groove and well samples from the lower aquifer would be needed to develop a geochemical flow-path model of the ground-water system.

Solubility of many trace elements, including the heavy metals, could be enhanced in spring water by a decrease in pH or removal of carbonate. Some element solubilities in natural waters can be increased because of ion complexing by increasing the pH. Initial decreases in pH of a spring are likely not to occur due to the buffering capacity of spring waters in the study area. An external input that could produce a pH change in spring water would probably contain significant concentrations of other ionic species that may have large effects on chemical equilibria. Shallow zone springs in Roan and Parachute Creek basins have the capacity to retain dissolved trace metals in solution in concentrations well in excess of currently determined background concentrations.

TRITIUM SAMPLING

Theory

Tritium is a radioactive isotope of hydrogen having two neutrons and one proton in its nucleus. The isotope has a half-life of 12.3 years and has both natural and manmade sources. Prior to 1953, background tritium concentrations in ground water probably were about 2 to 4 tritium units (TU). One TU is equal to 3.2 pCi/L (picocuries per liter). With the advent of atmospheric testing of nuclear bombs during 1953, tritium concentrations in the atmosphere, precipitation, and recharge to groundwater substantially increased compared to natural concentrations.

Tritium sampling has become a useful tool for hydrologic studies. One use is dating ground water, because any water with tritium concentrations exceeding 5 to 10 TU is of post 1953 age. Interpretation of tritium data may make it possible to distinguish various ages in post-1953 water in simple situations. Tritium could be useful in detecting mixing patterns of distinct water types. Because tritium is unaffected by reactions other than decay, it is useful as a tracer. Tritium dating could aid in determining ground-water velocity in recharge areas. Peak tritium concentrations in ground water may correlate to tritium concentrations in precipitation if long-term records on tritium concentrations in precipitation were available.

Methods of Sampling and Analysis

Samples for tritium analysis were collected in 125-mL glass bottles. The bottles were overfilled until all air was purged from the sample. Tritium samples from snowpack were collected using a snow corer and filling a 3-L plastic bottle with packed snow. The sample then was collected from the melt water, which represented a composite of several snow cores. All samples were sealed in wax to prevent atmospheric contamination prior to analyses at the laboratory.

All samples were analyzed by U.S. Geological Survey laboratories. Two analytical methods were used depending on the detection limit requested. Initial tritium samples collected during 1981 were analyzed at a detection limit of 200 pCi/L. That method of analysis uses the liquid scintillation-counting procedure with no sample enrichment. The method is described in detail in Thatcher and others (1977). All additional tritium samples were analyzed using gas-counting equipment. The use of such equipment, without sample enrichment, decreases the detection limit to about 30 pCi/L, and individual samples may be successfully counted to even lesser concentrations.

Results and Conclusions

Analytical results for tritium samples collected at 32 springs from 1981 to 1983 are given in table 8. Four additional samples are listed in table 8. One of the additional samples represents a flowing well located along Willow Creek in the Piceance Creek drainage basin. The flowing well is completed in

Table 8.--*Analytical results for tritium samples collected at 32 springs and 4 miscellaneous locations*

[Concentrations in picocuries per liter]

Site number (plate 1)	Local identifier	Date	Tritium, total
		SPRINGS	
1	SC00409531DAA1	09-01-81	<200
3	SC00409635DBD1	09-01-81	<200
9	SC00509319DBD1	07-29-81	<200
10	SC00509329DBA1	07-29-81	48
21	SC00509420ABB1	08-19-81	<200
25	SC00509423CCC1	08-18-81	190
		09-23-82	170
		02-16-83	180
34	SC00509505ABA1	09-01-81	<200
36	SC00509514BCD1	08-19-81	<200
38	SC00509536BAD1	08-18-81	<200
52	SC00509720DBA1	09-16-81	<200
56	SC00509725BCD1	09-16-81	<200
		07-28-82	120
58	SC00509727DCA1	09-08-81	<200
66	SC00509913CAB1	08-24-82	100
		11-03-82	83
		02-15-83	89
76	SC00510023DCC1	08-13-81	110
77	SC00510027BCA1	08-05-82	120
78	SC00510027DAD1	08-13-81	<200
90	SC00609704DCA1	09-08-81	<200
95	SC00609712AAB1	09-02-81	<200
96	SC00609714BCC1	09-02-81	<200
101	SC00609723ADC1	09-02-81	130
		07-28-82	120
		10-13-82	130
		02-15-83	130
106	SC00609826AAA1	09-08-81	<200
108	SC00609922CCD1	12-07-82	100
109	SC00609922CCD2	07-21-82	62
		12-07-82	89
112	SC00609932CCB1	08-19-82	180
		10-21-82	45
		02-15-83	180
116	SC00610016CAD1	08-13-81	<200
118	SC00610034CBC1	08-25-81	<200
122	SC00709610BDD1	11-17-82	24
127	SC00709713BAC1	09-02-81	<200
133	SC00710005BCC1	08-25-81	<200
137	SC00710127ADC1	08-25-81	68
		10-21-82	190
139	SC00809916DCD1	11-23-82	<10
141	SC00810012DCB1	11-23-82	86

Table 8.--*Analytical results for tritium samples collected at 32 springs and 4 miscellaneous locations*--Continued

Site location	Altitude, feet	Type of sample	Date	Tritium, total
MISCELLANEOUS LOCATIONS				
Precipitation gage 1 mile northwest of spring 90, central Roan plateau. Latitude: 39°33'39" Longitude: 108°13'50"	8,600	Snowpack	03-11-82	28
Weather station near Douglas Pass, 5.5 miles west-northwest of spring 82. Latitude: 39°28'26" Longitude: 108°45'44"	9,000	Snowpack	04-15-82	78
Well SC00509704BBD1, southern Piceance Creek basin, 1.6 miles northeast of spring 49. Latitude: 39°38'50" Longitude: 108°17'22"	7,778	Ground water, lower aquifer	07-27-82	<10
Weather station 0.25 miles west of spring 25, East Fork Parachute Creek basin. Latitude: 39°35'29" Longitude: 107°54'59"	8,840	Precipitation	12-16-81 to 01-20-82	48

the lower aquifer and was sampled because of the need to define tritium concentrations in the lower aquifer. No wells were available to sample that represent lower-aquifer water in the Roan and Parachute Creek basins. Two of the additional sites are U.S. Geological Survey snowcourse sites where snowpack samples were collected for tritium analysis. One snowcourse site is on the Roan-Parachute Creek drainage divide at headwaters of Willow Creek; the other site is northeast of Douglas Pass, just to the west of the study area. The fourth miscellaneous sample is a composite precipitation sample collected at a U.S. Geological Survey climatic station located in the upper East Fork Parachute Creek basin 0.25 mi west of spring 25.

Initial tritium samples were collected at 24 springs during the summer of 1981. The analytical method selected to analyze these samples proved to have too large a detection limit, and all results were reported as <200 pCi/L.

Five of the samples were reanalyzed at a smaller detection limit, and definitive values were obtained. Prohibitive cost prevented reanalysis of more samples. All subsequent tritium samples were analyzed using gas-counting equipment so that tritium concentrations as small as about 10 pCi/L could be detected. The tritium concentrations listed in table 8 were not decay corrected for the time between sample collection and analysis. Such corrections would be about 1 or 2 percent and were not necessary for this study.

Eight of the spring samples collected for tritium analysis represent lowland springs. The large differences in water quality between springs 108 and 109 were discussed previously; tritium results for the two springs do not indicate large differences in age, as both were post-1953 waters. Explanations for the disparity in water chemistries may be the result of rock and soil differences between the springs or in different types of flow paths, rather than in a large difference in residence time. Large concentrations of dissolved solids at spring 122 indicate that the spring might represent deeper circulation or slower moving ground water than other springs in the study area. A tritium value of 24 pCi/L indicates that a large percentage of the water from the spring was post-1953 age. Of the tritium samples analyzed at the lesser detection limit, only spring 139, located in South Dry Fork drainage, had a concentration less than 10 pCi/L. That spring represents pre-1953 age ground water. The spring is on a hillside slope of older terrace and slopewash deposits that are stratigraphically located on the Wasatch Formation. Spring 139 probably represents an older local flow system or bedrock discharge from the Wasatch Formation. Other dating techniques are needed to estimate the age of pre-1953 waters.

Seven upland springs definitely were post-1953 age waters, but using the data available it was not possible to define age in terms of weeks, months, or years. Seventeen upland springs had a single tritium sample with a concentration reported as <200 pCi/L; no conclusions about age of these springs can be made. Tritium in the Roan Plateau snow sample collected during March 1982 did not correlate with tritium in samples collected in July from springs 56 and 101, the nearest springs sampled. Similar results were obtained when tritium in the Douglas Pass snow sample was compared to tritium in spring samples collected in the western area. There was little variation in tritium concentrations between the three samples at spring 25, the four samples at spring 101, or the three samples collected at spring 66. Apparently no samples for tritium analysis were collected soon enough after snowmelt infiltration to detect any effects of recent recharge water mixing with the spring water.

Reasons for the unusual change in tritium concentration at spring 112 during October 1982 are unknown. A large fluctuation in tritium should indicate a major change in source or flow path of spring water, but discharge and chemical data do not indicate any anomalous event occurring at the spring.

Water from the lower Green River aquifer should have pre-1953 tritium concentrations. That conclusion was verified by the sample from the flowing well. The determination of actual age of the lower-aquifer water would require additional age-dating techniques. Mixing of shallow-zone water of post-1953 age with deep water of pre-1953 age may be detected by tritium sampling if adequate information exists on tritium concentrations in the unmixed waters.

SPRINGS AND THE GROUND-WATER SYSTEM

Upper Aquifer

The upper aquifer consists of the upper part of the Uinta Formation and the upper part of the Parachute Creek Member of the Green River Formation above the Mahogany zone. The aquifer is very incised by major drainages and tributary creeks in the study area and is not a continuous aquifer. Some upland springs drain small-scale, perched ground water in confined sandstone layers of the Uinta Formation. Other upland springs may be contact springs, the result of downward moving water in the Uinta Formation reaching less permeable marlstone layers in the upper part of the Green River Formation. In many areas the contact is not distinct and there is considerable intertonguing of the formations; therefore, identifying true contact springs is difficult. Upland springs also drain the upper part of the Parachute Creek Member. These springs probably are the result of fracture systems conducting water to the land surface. Springs in the Piceance Creek drainage basin are related to a northwest trending fracture system (Colorado Division of Water Resources, 1978), but it is not known if that fracture system continues into Roan and Parachute Creek basins. Because of extensive fracturing, the A groove, at the base of the upper aquifer, may be a consistent water-yielding zone, but no springs or seeps could be studied from that layer.

It was not attempted to classify upper-aquifer springs by geologic unit. Because the units are areally discontinuous yet hydrologically connected locally, no distinct chemical, radiochemical, or discharge characteristics could be discerned between the units.

Lower Aquifer

The lower aquifer consists of the lower part of the Parachute Creek Member of the Green River Formation below the Mahogany zone. A Piceance basin model predicts lower-aquifer discharge into the canyons of Roan and Parachute Creeks and their tributaries (Taylor, 1982). That prediction has been difficult to verify with direct evidence. Efforts were made during this study to locate springs discharging from the lower aquifer in the study area.

A reconnaissance for springs was conducted in major stream valleys, gulches, and talus areas. As shown earlier in this report (fig. 7), springs typically were found in valley alluvium and in small gulches eroded into slump, slopewash, or talus deposits of the Green River and Wasatch Formations. The springs were sampled to compare spring chemistry with lower-aquifer water chemistry. The sources of chemical data for the lower-aquifer water in the study area and in the Piceance Creek area were referenced in the previous studies section. Chemical analyses of spring water collected at sites in the canyons of the study area and from basin perimeter slopes did not resemble lower-aquifer water.

In the Piceance basin, large fluoride concentrations in a water sample is an excellent indicator of lower-aquifer water. The fluoride concentrations were too small in lowland spring samples for the water to be representative of lower-aquifer discharge. In addition, boron and sodium concentrations were too small and sulfate concentrations were too large in the spring samples for the water to be solely from lower-aquifer discharge. The springs located above the stream alluvial deposits may represent local flow systems in Quaternary deposits derived from the Green River and Wasatch Formations. The dissected topography partitions the lower aquifer into hydrologically disconnected units in the Roan and Parachute Creek basins. The quantity of lower-aquifer discharge into any single canyon could be quite small. A small discharge from the lower-aquifer in a canyon spring could easily be masked by water from other sources.

Four springs (springs 9, 10, 86, and 137) that were sampled are located on basin-perimeter slopes near the Green River-Wasatch contact. Chemical data for these springs indicate these springs represent local flow systems in talus slopes of the Green River Formation below the Roan Cliffs. In the canyons, springs 108, 109, 122, 129, and 140 are located in the vicinity of the Green River-Wasatch contact. Springs 108, 109, 122, and 140 appear to represent local flow systems in material of the lower members of the Green River Formation or of the upper part of the Wasatch Formation. Spring 129 was the only spring that could definitely be placed at the base of the Parachute Creek Member. It issues from a distinct fracture in the bottom of a deep, narrow, steep-walled gully. The gradient of the gulch bottom steepens at the spring location, where the gulch bottom is in contact with the Parachute Creek Member. The chemical analysis of this spring had larger nitrate, selenium, and molybdenum concentrations compared to other lowland springs. However, the major-ion chemistry and the small fluoride concentration were not indicative of lower-aquifer water.

In many canyons, wet areas are visible on cliff faces, but the sources of the water were not readily distinguishable. Potential sources include seepage from the bedrock aquifers, surface and spring waters from sources above the rim seeping down the cliff face, and precipitation recharge water mixed with other upper-zone aquifer ground water flowing down vertical fractures in the cliff faces. Attempts to correlate wet zones on cliffs with a particular stratigraphic layer probably are not useful unless the bedrock seepages can be differentiated from other water sources. Close inspection of some wet spots indicate that a few appeared to be seepage faces from bedrock ground-water discharge, but verifying that observation was very difficult. Access to these wet zones was very limited, and they were impossible to sample unless they were frozen. Melted ice samples collected in Cascade Canyon and in the East Fork Parachute Creek valley from cliffs of the Parachute Creek Member had specific-conductance values less than 300 µS/cm. Those values were too small to represent any ground water in the study area. The ice may have been composed of precipitation moving down fractures in the cliff faces and possibly mixing with other source waters. Another possibility is that freeze and thaw cycles of the ice may have precipitated salts from the water and altered its chemistry. Melt water from a third ice sample collected in the West Fork Parachute Creek canyon had a specific conductance of 2,850 µS/cm; therefore, a chemical analysis was done on that sample. Results of the analysis will be discussed later in this report.

Wasatch Formation

Springs 138 and 139, located in the South Dry Fork valley, may represent ground-water discharge from the Wasatch Formation. The springs' stratigraphic location can be placed in the upper part of the Wasatch Formation. Both springs are characterized by large dissolved solids and sulfate concentrations and greater percent sodium compared to other lowland springs. The tritium result for spring 139 indicates it is pre-1953 age water. Because of the incised terrain, these springs probably represent small-scale, localized aquifers in the Wasatch Formation.

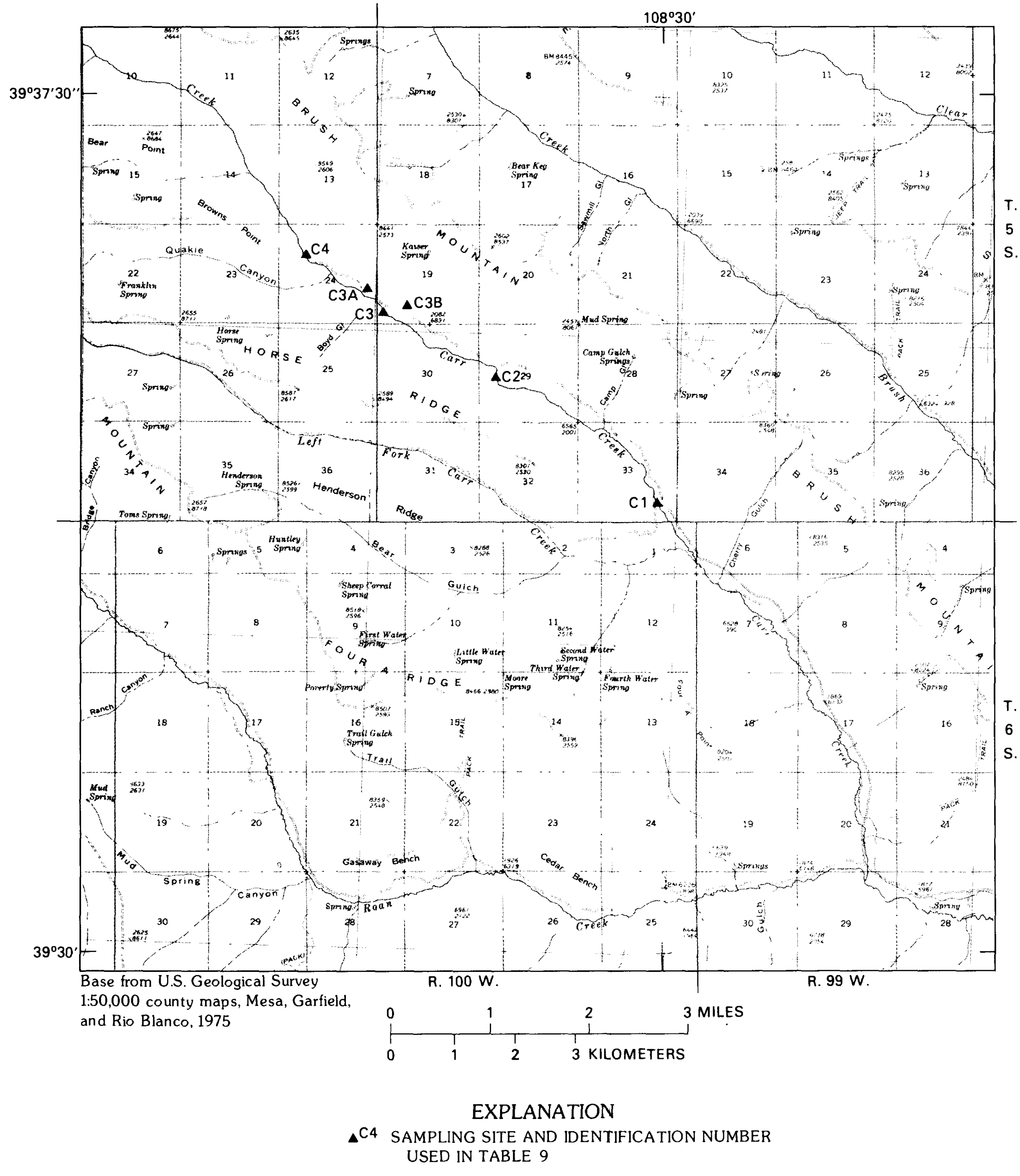
Ion-Mass-Balance Studies

Discharge from the lower aquifer may flow under talus slopes and into valley and stream alluvium. A gain and loss study on streams in the canyons may not permit any conclusions regarding discharge from the lower aquifer if ground-water inflow sources into the stream cannot be delineated. Chemical samples were collected in conjunction with the streamflow measurements in order to use ion-mass-balance calculations to determine chemical concentrations of gaining streamflow components. A substantial downstream increase in boron, fluoride, lithium, and molybdenum concentrations in a gaining stream may indicate discharge from the lower aquifer. Downstream increases of dissolved boron and lithium concentrations occur in Roan Creek (Adams and others, 1985) because the stream alluvium is in contact with the Wasatch Formation, a significant source of those ions. If study reachs are selected where stream alluvium is not in contact with the Wasatch Formation, the affect the Wasatch has on stream chemistry should be lessened.

Two stream reaches, one on Carr Creek, the other on West Fork Parachute Creek, were selected for this type of study during late 1982. The primary considerations for stream selection were access, perennial flow, and stratigraphic location of the stream channel in the lower part of the Green River Formation.

Carr Creek

Discharge was measured and water-quality samples collected during November 1982 at four sites on Carr Creek (fig. 16). Additional samples also were collected at surface-water sites C3A and C3B in small gullies on the Brush Mountain side of the valley. The reach of Carr Creek from sites C4 to C1 flows through valley-fill alluvium material that is about 0.25 to 0.5 mi wide and probably less than 100-ft deep. The valley bottom is stratigraphically located in the Green River Formation in the reach measured. The geologic map of the Henderson Ridge area (Roehler, 1973) shows a syncline from upper Quakie Canyon plunging east-southeast to southeast down Carr Creek valley to about the confluence with Left Fork Carr Creek. The presence of this syncline could direct bedrock ground-water flow toward the Carr Creek valley in this area.



Base from U.S. Geological Survey
1:50,000 county maps, Mesa, Garfield,
and Rio Blanco, 1975

EXPLANATION

▲C4 SAMPLING SITE AND IDENTIFICATION NUMBER USED IN TABLE 9

Figure 16.--Location of sampling sites on Carr Creek.

Discharge and chemical data collected during November 1982 are listed in table 9. Discharge increased downstream in Carr Creek, with the largest gain in flow occurring between sites C3 and C2, where the alluvium is the most extensive. Water chemistry was relatively unchanged from sites C4 to C2, but had a distinct change from sites C2 to C1.

Concentrations of selected constituents in the gaining water in each section calculated by ion-mass-balance differences are listed in table 10. There was no observed surface flow into Carr Creek in the study reach, thus, this gaining stream water represents discharge from the alluvium to the creek. Noticeable increases in boron, lithium, fluoride, and molybdenum were calculated in the gaining water for the reach between sites C2 and C1 compared to the upstream reaches. These increases may indicate the presence of a small quantity of lower-aquifer discharge into the Carr Creek alluvium.

The calculated ion concentrations in table 10 are dependent on the accuracy of the discharge measurements. The calculated concentrations could vary 10 to 20 percent for reasonable errors in discharge. However, if discharge errors were reasonably consistent at all sites the relative magnitudes of the ion concentrations between the three stream reaches would not be greatly affected.

Samples from the Camp Gulch Springs on Brush Mountain had greater sulfate, chloride, and strontium concentrations than Carr Creek upstream from site C2. This spring water flows off the mountain, infiltrates talus slopes, and recharges the stream alluvium. Inflow of upland waters into the alluvium between sites C2 and C1 could account for some of the calculated increase in sulfate, chloride, and strontium. Inflow of upland waters would not increase boron, fluoride, lithium, or molybdenum concentrations in Carr Creek unless these elements were dissolving into the water during movement through or over the talus and colluvial materials. However, the distance from the Brush Mountain cliffs to the alluvium is short and dissolution of these ions from talus material probably is insignificant.

Sites C3A and C3B (fig. 16) represent sampling locations on small (about 0.01 ft^3/s) surface flows in gullies off Brush Mountain. Neither creek flows to Carr Creek at the surface because both infiltrate into the stream alluvium. Surface flow off Brush Mountain above these gullies is evidenced by ice masses on the cliffs at the heads of the gullies. The source of these surface waters at the time of year the sampling was conducted (November) would be upland springs. A comparison of the chemical analyses of samples from sites C3A and C3B with chemical data for the Kaiser Spring (Adams and others, 1985) on Brush Mountain (fig. 16) indicate notable differences in sodium, sulfate, boron, fluoride, and strontium concentrations between the water at sites C3A and C3B and from the spring. Fluoride concentrations were 10 times greater and boron concentrations about 5 times greater at sites C3A and C3B than at the spring. These increases in fluoride and boron concentrations from the cliff to the edge of the alluvium were not likely to occur in such a short distance unless other water sources were present. Small discharge from the lower aquifer seeping through the talus materials and into the gulches could increase fluoride and boron concentrations in creeks in the gulches.

Table 9.--*Discharge and water-quality data for Carr Creek ground-water inflow study*

[ft, feet; NGVD, National Geodetic Vertical Datum; ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25° Celsius; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; dashes indicate no data]

Site number (fig. 16)	Station name	Latitude	Longitude	Sequence number	Date of sample	Time	Altitude of land surface (feet above NGVD)	Streamflow, instantaneous (ft^3/s)	Specific conductance (µS/cm)
C4	Carr Creek above Quakie Canyon	39°36'06"	108°34'04"	01	11-29-82	1400	6,900	1.0	590
C3A	SC00510024DAD1	39°35'48"	108°33'19"	01	11-29-82	1500	6,810	.01	725
C3	Carr Creek above Altenbern Ranch	39°35'37"	108°33'09"	01	11-29-82	1230	6,790	1.5	620
C3B	SC00509919CDB1	39°35'39"	108°32'54"	01	11-29-82	1520	6,850	[1].01	760
C2	Carr Creek below Altenbern Ranch	39°35'06"	108°31'54"	01	11-29-82	1100	6,700	2.8	665
C1	Carr Creek above Left Fork Carr Creek	39°33'58"	108°30'05"	01	11-29-82	0900	6,310	3.2	720

Site number (fig. 16)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium-adsorption ratio	Potassium, dissolved (mg/L as K)	Alkalinity, laboratory (mg/L as $CaCO_3$)
C4	8.4	4.0	246	47	31	43	27	1.2	1.9	268
C3A	8.4	.0	282	50	38	68	34	1.8	.7	324
C3	8.3	6.5	257	50	32	42	26	1.2	1.6	271
C3B	8.4	.5	267	44	38	80	39	2.2	.7	317
C2	8.5	6.0	251	49	31	42	27	1.2	1.8	282
C1	8.5	3.0	286	50	39	55	29	1.4	2.3	309

Table 9.--*Discharge and water-quality data for Carr Creek ground-water inflow study*--Continued

Site number (fig. 16)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, nitrate plus nitrate dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Aluminum, dissolved (µg/L as Al)
C4	70	1.9	0.3	19	376	0.70	--	--	--
C3A	99	3.5	1.0	26	482	.23	<0.060	0.030	10
C3	69	2.0	.3	19	379	.67	--	--	--
C3B	100	3.7	.9	25	484	--	--	--	--
C2	69	2.3	.4	17	382	1.2	--	--	--
C1	89	2.8	.5	17	442	.56	--	--	--

Site number (fig. 16)	Arsenic dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Mercury dissolved (µg/L as Hg)
C4	3	47	50	--	--	--	--	24	--	--
C3A	5	54	130	<10	1	3	<1	33	1	<.1
C3	3	57	60	--	--	--	--	26	--	--
C3B	--	--	150	--	--	--	--	--	--	--
C2	3	65	70	--	--	--	--	26	--	--
C1	3	59	100	--	--	--	--	36	--	--

Site number (fig. 16)	Molybdenum, dissolved (µg/L as Mo)	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
C4	17	2	590	--	<3
C3A	20	1	910	6.1	15
C3	17	2	600	--	4
C3B	--	--	1,000	--	--
C2	18	2	580	--	5
C1	21	2	660	--	4

[1] Estimated.

Table 10.--*Calculated concentration of selected dissolved chemical constituents in ground water discharging from the alluvium to Carr Creek.*

Discharge and Constituents	Stream reach		
	Sites C4-C3	Sites C3-C2	Sites C2-C1
Discharge change, in cubic feet per second	+0.5	+1.3	+0.4
Dissolved solids, in milligrams per liter	391	394	844
Sodium, in milligrams per liter	40	42	146
Sulfate, in milligrams per liter	67	69	230
Chloride, in milligrams per liter	2.2	2.7	6.3
Fluoride, in milligrams per liter	.3	.5	1.2
Boron, in micrograms per liter	80	82	310
Lithium, in micrograms per liter	30	26	106
Molybdenum, in micrograms per liter	17	19	42
Strontium, in micrograms per liter	620	557	1,220

Using chemical data of water from wells completed in the lower aquifer in upper Clear Creek basin (Chevron Oil Shale Co., 1982b), average concentrations of fluoride, boron, and lithium in the lower aquifer in the Carr Creek area can be estimated. Using these ion concentrations for the lower aquifer and the calculated ion concentrations in the gaining water in Carr Creek reach, the contribution from the lower aquifer was estimated. The percentage of the gaining water in Carr Creek attributed to inflow from the lower aquifer was 7 percent based on fluoride data, 8 percent based on boron data, and 10 percent based on lithium data. These approximations assume there are no other important sources of fluoride, boron, and lithium in the Carr Creek study area.

West Fork Parachute Creek

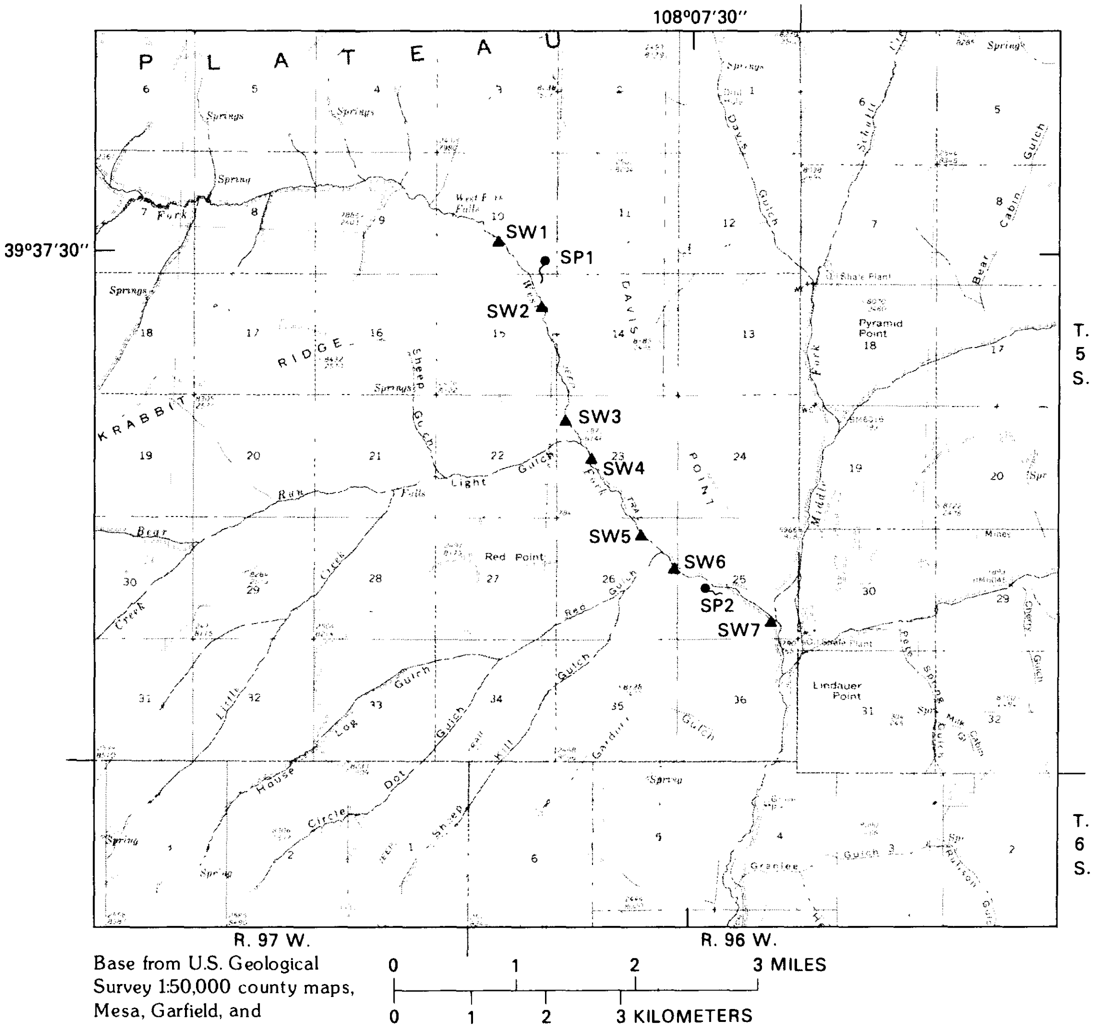
Discharge was measured and a chemical sample collected at seven sites on the West Fork Parachute Creek during December 1982; the sampling sites are shown in figure 17, and the chemical and discharge results are given in table 11. The stream gained water between sites SW1 and SW3 and lost water from sites SW3 to SW6. The stream is located in a narrow, steep-walled valley and the alluvium seldom is more than 0.25-mi wide. Alluvial material is more extensive where Light and Red Gulches intersect the West Fork Parachute Creek valley between sites SW3 and SW6. The greater alluvium may explain the water loss in the creek between sites SW3 and SW6. Surface flow was not observed in Light or Red Gulches at their confluence with the West Fork. In the last mile of the study reach, between sites SW6 and SW7, the stream regained the water lost upstream. The canyon narrows in one reach immediately downstream from site SW6 and the stream alluvium becomes limited in extent. The base of the alluvium may rest on the Wasatch Formation or clay zones in the alluvial deposits may create a less permeable layer that directs ground water back into the stream. The presence of springs and seeps in the narrow reach indicated ground-water discharge from the alluvium was occuring in that reach.

There was no variation in chemical composition of the stream from sites SW1 to SW6. Major increases in sodium, bicarbonate, chloride, boron, and lithium and slight increases in fluoride and molybdenum were noted from sites SW6 and SW7. Calculated concentrations of the ground water discharging from the alluvium are tabulated in table 12 for the gaining reaches. Site SP2 (spring 46 on plate 1) is a spring in the seep area between sites SW6 and SW7. Chemical analysis of SP2 compared reasonably well to the calculated ion concentrations of the gaining water in this reach. It is not known why chloride concentrations increased by the magnitude indicated at the seep area.

The magnitudes of calculated ion concentration for the alluvial water discharging into the stream between sites SW6 and SW7 provide little evidence for inflow of water from the lower aquifer to West Fork Parachute Creek. The results were somewhat unexpected because the West Fork Parachute Creek would more likely receive water from the lower aquifer than Carr Creek, based on the areal extent of the lower aquifer in each area.

Site SP1 (spring 44 on plate 1) represents an ice sample collected in the West Fork Parachute Creek valley between sites SW1 and SW2 at the junction of the talus slope with cliffs of the lower part of the Parachute Creek Member. The sample was obtained to determine if any of the ice accumulations seen on the cliffs represent seepage zones from the lower aquifer. The analytical results from the melt water did not aid in this determination. The water was a magnesium sodium sulfate water with a large molybdenum concentration and moderate boron and fluoride concentrations. The sulfate concentration is far too large to be representive of unaltered ground water of the Uinta Formation or Parachute Creek Member of the Green River Formation in the study area. Calcite precipitation during freezing and thawing cycles may have enriched magnesium relative to calcium and sulfate relative to bicarbonate in the ice. Determination of a water source or sources for the ice was not possible based on that one chemical analysis.

Environmental impact statements for the Chevron Oil Shale Project on Clear Creek (Chevron Oil Shale Co., 1982a, b) contain ground-water data for the aquifers and flow and chemical data for streams in that area. Based on streamflow data for 1980 and 1981, one reach of Clear Creek gains about 10 to



Base from U.S. Geological Survey 1:50,000 county maps, Mesa, Garfield, and Rio Blanco, 1975

EXPLANATION

▲SW1 SURFACE-WATER SITE AND IDENTIFICATION NUMBER USED IN TABLE 11

●SP1 SPRING OR SEEP AND IDENTIFICATION NUMBER USED IN TABLE 11

Figure 17.--Location of sampling sites on West Fork Parachute Creek.

Table 11.--*Discharge and water-quality data for West Fork Parachute Creek ground-water inflow study*

[Ft³/s, cubic feet per second; gpm, gallons per minute; μS/cm, microsiemens per centimeter; °C, degress centigrade; mg/L, milligrams per liter; μg/L, micrograms per liter]

Site number (fig. 17)	Station name	Latitude	Longitude	Sequence number	Date of sample	Time	Altitude of land surface (feet above NGVD)	Streamflow, instantaneous (ft^3/s)	Flow rate, instantaneous (gpm)	Specific conductance (μS/cm)
SW1	West Fork Parachute Creek below West Fork Falls	39°37'36"	108°09'15"	01	12-15-82	0930	6,760	1.6	--	730
SW2	West Fork Parachute Creek at site 2	39°37'05"	108°08'50"	01	12-15-82	1100	6,430	1.9	--	725
SW3	West Fork Parachute Creek above Light Gulch	39°36'19"	108°08'38"	01	12-15-82	1200	6,190	2.1	--	720
SW4	West Fork Parachute Creek below Light Gulch	39°36'03"	108°08'25"	01	12-15-82	1245	6,160	1.5	--	710
SW5	West Fork Parachute Creek above Red Gulch	39°35'30"	108°07'57"	01	12-15-82	1330	6,000	1.3	--	705
SW6	West Fork Parachute Creek below Red Gulch	39°35'16"	108°07'39"	01	12-15-82	1400	5,940	1.2	--	720
SW7	West Fork Parachute Creek at mouth	39°34'54"	108°06'44"	01	12-15-82	1500	5,810	2.1	--	875
SP1	SC00509610DDD1	39°37'24"	108°08'45"	01	12-15-82	1030	6,960	--	--	2,850
SP2	SC00509625CBA1	39°35'24"	108°07'21"	01	12-15-82	1430	5,920	--	E10	1,000

Site number (fig. 17)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Percent sodium	Sodium-adsorption ratio	Potassium, dissolved (mg/L as K)	Alkalinity, laboratory (mg/L as $CaCO_3$)
SW1	8.5	.0	285	59	33	54	29	1.4	.8	298
SW2	8.5	.0	282	58	33	54	29	1.4	.8	291
SW3	8.5	.0	272	54	33	55	31	1.5	.8	286
SW4	8.5	.0	277	56	33	55	30	1.5	.8	282
SW5	8.5	.0	270	53	33	55	31	1.5	.8	289
SW6	8.4	.5	269	53	33	55	31	1.5	1.3	288
SW7	8.4	2.5	289	54	37	88	40	2.3	2.0	328
SP1	8.5	.0	1,378	56	300	240	28	2.8	1.5	320
SP2	8.1	6.0	341	60	46	99	39	2.4	2.8	377

Table 11.--*Discharge and water-quality data for West Form Parachute Creek ground-water inflow study*--Continued

Site number (fig. 17)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, Nitrite dissolved (mg/L)	Nitrogen, nitrate plus nitrate dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, Ammonia and organic dissolved (mg/L as N)
SW1	95	2.9	.2	17	442	--	.15	--	--
SW2	95	3.0	.2	17	437	--	.14	--	--
SW3	95	3.0	.2	17	431	--	.15	--	--
SW4	96	3.0	.2	17	431	--	.14	--	--
SW5	96	3.0	.2	17	433	--	.15	--	--
SW6	100	4.4	.3	17	438	--	.29	--	--
SW7	110	33	.4	17	539	--	.52	--	--
SP1	1,500	13	1.0	23	2,330	<.020	3.5	.230	2.8
SP2	140	33	.7	18	627	--	.82	--	--

Site number (fig. 17)	Phosphorus, dissolved (mg/L as P)	Phosphate ortho, dissolved (mg/L as P)	Arsenic dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Lithium dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Zinc, dissolved (µg/L as Zn)
SW1	--	--	2	91	40	--	10	--	4	<1	1,100	4
SW2	--	--	2	88	40	--	9	--	4	<1	1,100	3
SW3	--	--	2	92	40	--	9	--	4	<1	1,100	4
SW4	--	--	2	91	30	--	8	--	4	<1	1,100	5
SW5	--	--	2	88	40	--	9	--	4	<1	1,100	8
SW6	--	--	4	87	40	--	14	--	6	1	1,000	3
SW7	--	--	3	79	130	--	24	--	12	1	1,100	5
SP1	.050	<.010	3	100	300	30	30	20	100	--	2,400	20
SP2	--	--	3	58	150	--	37	--	19	2	1,100	8

Table 12.--*Calculated concentration of selected dissolved chemical constituents in ground water discharging from the alluvium to West Fork Parachute Creek*

[-, ion concentration not calculated for losing reach]

Discharge and Constituents	Stream reach					
	SW1-SW2	SW2-SW3	SW3-SW4	SW4-SW5	SW5-SW6	SW6-SW7
Discharge change, in cubic feet per second	+0.3	+0.2	-0.6	-0.2	-0.1	+0.9
Dissolved solids, in milligrams per liter	430	375	-	-	-	680
Sodium, in milligrams per liter	54	64	-	-	-	132
Sulfate, in milligrams per liter	95	95	-	-	-	123
Chloride, in milligrams per liter	3.5	3.0	-	-	-	70
Fluoride, in milligrams per liter	.2	.2	-	-	-	.5
Boron, in micrograms per liter	40	40	-	-	-	250
Lithium, in micrograms per liter	4	9	-	-	-	37
Molybdenum, in micrograms per liter	4	4	-	-	-	20
Strontium, in micrograms per liter	1,100	1,100	-	-	-	1,100

12 ft^3/s. Ion-mass-balance calculations using fluoride data indicate part of the increase of water on Clear Creek might be discharge from the lower aquifer into the canyon.

Discharge and chemical data were collected on the major tributaries of Roan Creek during November 1983 for support of the U.S. Geological Survey's ground-water modeling effort in the study area. Analyses of stream discharge and fluoride data show there are unaccounted gains of water in Brush and Clear Creeks and that part of this water may be attributed to lower-aquifer discharge into those canyons.

SPRING MONITORING AND OIL SHALE DEVELOPMENT

Monitoring of shallow aquifers near an oil-shale mine or process facility for ground-water contamination may be feasible by sampling of nearby springs. If springs were located near the area of concern, monitoring efforts would be less costly than if wells had to be drilled for the same purpose. However, springs in Roan and Parachute basins, especially in upland areas, represent small-scale, short flow-path systems in a very incised plateau. A spring would only be useful for monitoring the affects of mining on ground water if it were located in the immediate vicinity of the potential problem area.

Pumping a well completed in a shallow aquifer in the Uinta Formation or upper part of the Parachute Creek Member of the Green River Formation could affect flow at nearby springs. Perched-water zones could be dewatered quite easily, resulting in springs issuing from that aquifer ceasing to flow.

A change in major-ion chemistry of a spring might be indicated by monitoring only specific conductance. The presence of mine-drainage water or shale-processing and retort waters in the water source of a spring could result in increased specific conductance and in increases of sodium, bicarbonate, and fluoride in excess of natural concentrations determined during this study. A mixing of significant quantities of deep ground water with spring water could increase fluoride concentrations noticeably in spring samples. The natural direction of ground-water movement is downward in the study area so any mixing of deep water with the shallow zone spring water could be caused by man.

Arsenic, lithium, mercury, molybdenum, and selenium are enriched in oil shales (U. S. Environmental Protection Agency, 1977). The elements arsenic, boron, mercury, molybdenum, and selenium have been identified as the most likely trace elements discussed in this report to be found in significant quantities in retorted shales and retort water (U.S. Environmental Protection Agency, 1977). The presence of certain elements in oil-shale waste products will depend on the shale-processing methods used. Because springs in the study area have small background concentrations for the constituents listed above, the presence of leachate or process water in shallow ground water could increase those element concentrations. Mine-drainage water is likely to have large concentrations of arsenic, barium, boron, fluoride, lithium, and molybdenum based on chemical information in ground-water studies in the Piceance basin. Mixing of mine-drainage water with water sources for nearby surface springs may cause noticeable increases in concentrations of some trace elements in spring water.

Ammonia could be present in significant concentrations in oil-shale processing wastewater and it also could be present in spoil-pile leachates under certain conditions (Slawson, 1979). Infiltration of water with large concentrations of ammonia into the shallow ground water might affect the nitrogen concentration in a nearby spring. An increase in ammonia in the spring would occur, though it is likely the nitrogen would begin oxidizing to the nitrite and nitrate forms, resulting in increases in concentration of those constituents.

Dissolved organic carbon, phenols, and cyanide are likely to be present in wastewater from oil-shale retorting and processing. Contamination of spring water with retort waters could result in a large increase in DOC, phenols, and cyanide. Background concentrations of those constituents are small in the springs sampled for this study. Therefore, DOC, phenols, and cyanide could be useful constituents for monitoring water-quality of springs near an oil-shale facility.

SUMMARY

A study of springs was conducted from 1981 to 1983 in Roan and Parachute Creek basins to collect and interpret hydrologic information. The study area, part of the oil-shale rich Piceance basin, currently (1984) has one shale project in operation and has potential for widespread oil-shale mining. Description of chemical and discharge characteristics of springs will help define the hydrologic system, which is necessary for planning and developing the oil-shale resources.

Discharge was measured at 129 springs located in the study basins and on nearby basin perimeter areas. Mean spring discharge was about 5 gal/min, with a range in instantaneous measurements from zero to 300 gal/min. Larger recharge areas for springs in the central plateau resulted in greater mean springflow in that upland part of the study area.

Upland springs discharge from small-scale, short flow-path aquifers and often responded briefly to recharge during or immediately after the snowmelt period. Increased discharge from springs in 1982 was the result of increased water content of the winter snowpack. Long-term monitoring of spring discharge would be needed to relate discharge changes to climatic trends.

Upland spring waters contained from 216 to 713 mg/L dissolved solids and are a mixed cation bicarbonate water. Lesser mean calcium concentrations were found in spring samples from the eastern part of the study area. Accurate definition of ion concentration spatial trends on a small scale needs a dense sampling network because of the variation in spring chemistry within short distances. A generalized map of specific conductance of spring discharge shows an area of lesser specific conductance for the upland areas east of Parachute Creek on the Naval Oil-Shale Reserve and small areas of generally larger specific-conductance values north of West Fork Parachute Creek and on parts of Brush Mountain and Skinner Ridge.

Variation in major-ion chemistry was greater between lowland area springs, where specific conductance values ranged from 600 to 4,900 µS/cm. These waters were of mixed water types. Anion composition ranged from more than 80 percent sulfate at several springs to 80 percent bicarbonate at other springs. Mean dissolved solids of alluvial springs was about one-half the mean dissolved solids of springs from other sources in the canyons. Increased dissolved solids usually can be associated with increased sulfate concentrations because of dissolution of gypsum in the downstream reaches of valleys.

Background concentrations of many trace elements in spring water were about equal to or less than analytical detection limits. Arsenic, barium, boron, lithium, molybdenum, selenium, strontium, and vanadium commonly were present in measurable concentrations in spring samples. Mean concentrations for barium, strontium, and vanadium were the only trace-element concentrations significantly greater than detection limits. Springs on the uplands have significantly greater arsenic, barium, and vanadium concentrations and significantly smaller boron, lithium, molybdenum, selenium, and strontium concentrations than the lowland springs. In the upland parts of the study area, springs on the western ridges of Roan Creek drainage tended to have more molybdenum and vanadium than other upland area springs.

Inorganic nitrogen generally is present in the oxidized nitrate form in both upland and lowland springs. Nitrate concentrations commonly were less than 1 mg/L in upland-spring samples, but a few samples from western-area springs had concentrations of 2 to 3 mg/L. Nitrate concentrations in lowland springs were quite variable; concentrations ranged from 0.1 to 11 mg/L. Concentrations of other inorganic nitrogen species and phosphorus species usually were less than 0.1 mg/L. Cyanide, bromide, iodide, and sulfide concentrations usually were at or less than detection limits. Phenols were quite common in springs, and five samples had more than 10 μg/L of total phenol.

Calcite and dolomite dissolution in the Uinta Formation and upper part of the Parachute Creek Member of the Green River Formation is a primary factor affecting chemistry of upland-spring water. Those minerals were saturated or supersaturated in many samples from springs. Albite and analcime dissolution and cation exchange contribute sodium to the water. Sulfate sources in upper-aquifer spring water are not apparent. Sulfate concentrations are greatly increased in some lowland-spring water from gypsum dissolution, and saturation indices indicated the mineral is actively dissolving if present. Equilibrium calculations indicated that springs are saturated or supersaturated with aluminosilicate minerals and barium and generally are undersaturated with fluoride, strontium, and several heavy metals.

Tritium results for samples analyzed at small detection limits indicate post-1953 age water issuing from almost all springs in the study area. The single exception was a sample collected at a spring on South Dry Fork. A sample from a well completed in the lower aquifer contained pre-1953 age water based on the tritium concentration. Available data are inadequate to correlate tritium concentrations in springs with tritium in recharge water in order to estimate a residence time of spring water.

A comparison of lower-aquifer chemical analyses from the Piceance basin with chemical analyses from springs in Roan and Parachute Creek basins in conjunction with tritium dating indicates none of the springs sampled represents direct lower-aquifer discharge. The presence of a small quantity of lower-aquifer water in a spring could easily be masked by water from other sources. Results from two ion-mass-balance studies on streams indicated there is some evidence of lower-aquifer inflow into Carr Creek valley; results from the West Fork Parachute Creek study were not definitive. An analysis of discharge and water quality data from other streams in Roan Creek drainage show evidence of lower-aquifer inflow into the canyons.

Springs in Roan and Parachute Creek basins represent discharge from localized, small-scale flow systems located in incised terrain. Only springs located in the immediate vicinity of an oil-shale project will be useful for monitoring the shallow aquifers near the project. Dewatering a local aquifer in the Uinta Formation or the upper part of the Parachute Creek Member could affect flow at nearby springs. Mixing of wastewater from shale processing with source water for a spring may result in increased specific conductance at the spring. The most probable change in major-constituent chemistry would be an increased concentration of bicarbonate. Constituents that may be concentrated in waste water include fluoride, arsenic, boron, mercury, molybdenum, cyanide, organic carbon, and phenols. An increase in concentration of any of those constituents in excess of background concentrations in a spring may indicate the presence of wastewater. Ammonia may be a by-product in retort waters. Mixing of retort waters with spring water could noticeably affect ammonia and nitrate concentrations. Mixing of deep ground water from mine dewatering with the shallow aquifer water could increase fluoride, boron, and lithium concentrations in spring water. Because springs generally are undersaturated with many trace elements, heavy-metal concentrations could increase in excess of background concentrations if a metal source became available.

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SUPPLEMENTAL HYDROLOGIC DATA

Table 13.--*Location information for springs*

[Altitude in feet; upland sites include springs and seeps located above Mahogany zone and represent ground water from the Uinta Formation and upper Parachute Creek Member; lowland sites are springs and seeps located below the Mahogany zone and represent small-scale ground-water systems in alluvium and non-alluvial areas and perhaps ground water from the Wasatch Formation]

Site number (on plate 1)	Local identifier	Latitude	Longitude	Altitude	Site location
1	SC00409531DAA1	39°39'30"	108°05'24"	7,640	Upland, headwaters Parachute Creek
2	SC00409535DBB1	39°39'04"	108°01'20"	8,130	Upland, East Middle Fork Parachute Creek
3	SC00409635DBD1	39°39'21"	108°07'57"	7,790	Upland, headwaters Parachute Creek
4	SC00409735CDC1	39°39'02"	108°14'52"	8,130	Upland, upper West Fork Parachute Creek
5	SC00409833DBD1	39°39'15"	108°23'27"	7,980	Upland, northern Clear Creek
6	SC00409835DCC1	39°39'03"	108°21'20"	8,030	Upland, northern Clear Creek
7	SC00410032DAD1	39°39'15"	108°37'57"	8,740	Upland, upper Brush Mountain
8	SC00509319DAC1	39°35'47"	107°51'59"	7,040	Lowland, below Roan Cliffs in talus/slump material
9	SC00509319DBD1	39°35'49"	107°52'07"	7,120	Lowland, below Roan Cliffs in talus/slump material
10	SC00509329DBA1	39°35'03"	107°50'59"	6,560	Lowland, below Roan Cliffs in talus/slump material
11	SC00509403ACC1	39°38'41"	107°55'40"	8,580	Upland, East Middle Fork Parachute Creek
12	SC00509407AAA1	39°38'08"	107°58'36"	8,020	Upland, East Middle Fork Parachute Creek
13	SC00509408BBD1	39°37'56"	107°58'14"	8,120	Upland, East Middle Fork Parachute Creek
14	SC00509414BAD1	39°37'06"	107°54'39"	8,850	Upland, East Middle Fork Parachute Creek
15	SC00509415AAC1	39°37'13"	107°55'19"	8,745	Upland, East Middle Fork Parachute Creek
16	SC00509415CDC1	39°36'31"	107°55'52"	8,580	Upland, East Middle Fork Parachute Creek
17	SC00509416ACD1	39°36'53"	107°56'37"	8,350	Upland, East Middle Fork Parachute Creek
18	SC00509416BDC1	39°36'54"	107°56'57"	8,320	Upland, East Middle Fork Parachute Creek
19	SC00509418DAC1	39°36'42"	107°58'43"	8,240	Upland, East Middle Fork Parachute Creek
20	SC00509419BCC2	39°36'04"	107°59'31"	8,260	Upland, East Middle Fork Parachute Creek
21	SC00509420ABB1	39°36'17"	107°57'51"	8,270	Upland, East Middle Fork Parachute Creek
22	SC00509420BAD1	39°36'14"	107°58'19"	8,240	Upland, East Middle Fork Parachute Creek
23	SC00509422CCD1	39°35'34"	107°56'03"	8,810	Upland, East Fork Parachute Creek
24	SC00509423CCA1	39°35'40"	107°55'00"	8,940	Upland, East Fork Parachute Creek
25	SC00509423CCC1	39°35'37"	107°55'00"	8,840	Upland, East Fork Parachute Creek

Table 13.--*Location information for springs*--Continued

Site number (on plate 1)	Local identifier	Latitude	Longitude	Altitude	Site location
26	SC00509423DBB1	39°35'55"	107°54'30"	8,900	Upland, East Fork Parachute Creek
27	SC00509424CBB1	39°35'56"	107°53'57"	8,920	Upland, East Fork Parachute Creek
28	SC00509428BDC1	39°35'07"	107°56'57"	8,670	Upland, East Fork Parachute Creek
29	SC00509434DDD1	39°33'39"	107°55'12"	8,760	Upland, East Fork Parachute Creek
30	SC00509435BDB1	39°34'25"	107°54'41"	9,000	Upland, East Fork Parachute Creek
31	SC00509502BAA1	39°39'04"	108°01'19"	7,955	Upland, East Middle Fork Parachute Creek
32	SC00509502BCA1	39°38'46"	108°01'38"	7,680	Upland, East Middle Fork Parachute Creek
33	SC00509503ADA1	39°38'43"	108°01'53"	7,880	Upland, East Middle Fork Parachute Creek
34	SC00509505ABA1	39°38'59"	108°04'23"	7,910	Upland, headwaters Parachute Creek
35	SC00509510CBC1	39°37'35"	108°02'52"	7,770	Upland, East Middle Fork Parachute Creek
36	SC00509514BCD1	39°36'56"	108°01'34"	7,870	Upland, East Middle Fork Parachute Creek
37	SC00509522DDC1	39°35'36"	108°02'01"	7,180	Lowland, Ben Good Creek alluvium
38	SC00509536BAD1	39°34'30"	108°00'09"	8,110	Upland, East Fork Parachute Creek
39	SC00509604ACD1	39°38'41"	108°10'15"	7,810	Upland, West Fork Parachute Creek
40	SC00509605CCD1	39°38'13"	108°11'56"	7,800	Upland, West Fork Parachute Creek
41	SC00509605DDB1	39°38'19"	108°11'11"	7,790	Upland, West Fork Parachute Creek
42	SC00509606DCB1	39°38'24"	108°12'31"	7,940	Upland, West Fork Parachute Creek
43	SC00509608BBD1	39°38'01"	108°11'54"	7,800	Upland, West Fork Parachute Creek
44	SC00509610DDD1	39°37'24"	108°08'45"	6,960	Lowland, ice deposit from cliff, West Fork Parachute Creek
45	SC00509617BAB1	39°37'20"	108°11'45"	7,840	Upland, West Fork Parachute Creek
46	SC00509625CBA1	39°35'08"	108°07'21"	5,920	Lowland, alluvium,West Fork Parachute Creek
47	SC00509633CCB1	39°34'00"	108°10'56"	8,020	Upland, West Fork Parachute Creek
48	SC00509706CAB1	39°38'32"	108°19'18"	8,010	Upland, Clear Creek
49	SC00509708CBD1	39°37'34"	108°18'28"	8,150	Upland, Clear Creek
50	SC00509710CCD1	39°37'22"	108°16'12"	8,040	Upland, West Fork Parachute Creek
51	SC00509712AAA1	39°38'07"	108°13'04"	7,750	Upland, West Fork Parachute Creek
52	SC00509720DBA1	39°35'53"	108°17'49"	8,150	Upland, Clear Creek
53	SC00509721CBD1	39°35'46"	108°17'21"	8,070	Upland, Clear Creek
54	SC00509724DCC1	39°35'35"	108°13'35"	8,020	Upland, West Fork Parachute Creek
55	SC00509725ABB1	39°35'30"	108°13'33"	8,040	Upland, West Fork Parachute Creek

Table 13.--*Location information for springs*--Continued

Site number (on plate 1)	Local identifier	Latitude	Longitude	Altitude	Site location
56	SC00509725BCB1	39°35'13"	108°14'08"	8,220	Upland, West Fork Parachute Creek
57	SC00509727BAB1	39°35'27"	108°16'03"	8,170	Upland, Clear Creek
58	SC00509727DCA1	39°34'48"	108°15'34"	8,040	Upland, Clear Creek
59	SC00509729ADA1	39°35'17"	108°17'33"	7,930	Upland, Clear Creek
60	SC00509735BCA1	39°34'21"	108°15'06"	8,050	Upland, Clear Creek
61	SC00509801DDD1	39°38'07"	108°19'49"	7,910	Upland, Clear Creek
62	SC00509810DAD1	39°37'31"	108°22'02"	7,800	Upland, Clear Creek
63	SC00509834BDB1	39°34'23"	108°22'41"	7,660	Upland, Skinner Ridge
64	SC00509905ADC1	39°38'38"	108°31'07"	8,005	Upland, Skinner Ridge
65	SC00509906ACB1	39°38'44"	108°32'33"	8,200	Upland, Skinner Ridge
66	SC00509913CAB1	39°36'44"	108°27'17"	7,850	Upland, Skinner Ridge
67	SC00509917BDC1	39°36'50"	108°31'45"	8,010	Upland, Brush Mountain
68	SC00509919ACB1	39°36'08"	108°32'40"	8,140	Upland, Brush Mountain
69	SC00509924CDB1	39°35'48"	108°27'25"	7,830	Upland, Skinner Ridge
70	SC00509927DAB1	39°35'04"	108°29'00"	8,020	Upland, Brush Mountain
71	SC00509928ACB1	39°35'13"	108°30'18"	8,000	Upland, Brush Mountain
72	SC00509928ACB2	39°35'14"	108°30'19"	8,010	Upland, Brush Mountain
73	SC00509934DAA1	39°34'10"	108°28'34"	7,960	Upland, Brush Mountain
74	SC00510001CDA1	39°38'18"	108°33'53"	8,300	Upland, Brush Mountain
75	SC00510012ABD1	39°37'55"	108°33'48"	8,350	Upland, Brush Mountain
76	SC00510023DCC1	39°35'36"	108°34'55"	8,240	Upland, Upper 4A Mountain
77	SC00510027BCA1	39°35'18"	108°36'22"	8,470	Upland, Upper 4A Mountain
78	SC00510027DAD1	39°34'57"	108°35'35"	8,445	Upland, Upper 4A Mountain
79	SC00510034DDD1	39°33'48"	108°35'35"	8,430	Upland, Upper 4A Mountain
80	SC00510035DAC1	39°34'02"	108°34'34"	8,380	Upland,Upper 4A Mountain
81	SC00510036BBA1	39°34'32"	108°34'13"	7,360	Lowland, alluvium, Left Fork Carr Creek
82	SC00510124DDD1	39°36'13"	108°39'58"	8,280	Upland, headwaters Roan Creek
83	SC00609406CBA1	39°33'14"	107°56'02"	8,880	Upland, East Fork Parachute Creek
84	SC00609406DCB1	39°32'59"	107°55'38"	8,810	Upland, East Fork Parachute Creek
85	SC00609501DAD1	39°33'03"	107°56'21"	8,830	Upland, East Fork Parachute Creek

Table 13.--*Location information for springs*--Continued

Site number (on plate 1)	Local identifier	Latitude	Longitude	Altitude	Site location
86	SC00609528BAC1	39°29'58"	108°00'18"	5,610	Lowland, colluvium/slopewash deposits, south of Roan Cliffs
87	SC00609702CBD2	39°32'58"	108°11'29"	8,190	Upland, West Fork Parachute Creek
88	SC00609703DAC1	39°33'05"	108°12'03"	8,240	Upland, West Fork Parachute Creek
89	SC00609704ADA1	39°33'19"	108°12'55"	8,445	Upland, West Fork Parachute Creek
90	SC00609704DCA1	39°32'49"	108°13'18"	8,220	Upland, Conn Creek
91	SC00609705BBD1	39°33'23"	108°14'52"	8,150	Upland, Clear Creek
92	SC00609706DAB1	39°33'06"	108°15'20"	8,040	Upland, Clear Creek
93	SC00609707DAD1	39°32'08"	108°15'08"	8,050	Upland, Conn Creek
94	SC00609711BCA1	39°32'24"	108°11'31"	8,210	Upland, Parachute Creek
95	SC00609712AAB1	39°32'36"	108°09'41"	8,080	Upland, Parachute Creek
96	SC00609714BCC1	39°31'26"	108°11'39"	8,220	Upland, Parachute Creek
97	SC00609715BAA1	39°31'46"	108°12'24"	8,260	Upland, Conn Creek
98	SC00609715CDC1	39°30'58"	108°12'31"	8,220	Upland, Conn Creek
99	SC00609719DCD1	39°30'08"	108°15'27"	7,760	Upland, Conn Creek
100	SC00609722ACA1	39°30'37"	108°12'04"	8,230	Upland, Conn Creek
101	SC00609723ADC1	39°30'33"	108°10'53"	8,190	Upland, Parachute Creek
102	SC00609724BDD1	39°30'31"	108°10'14"	8,150	Upland, Parachute Creek
103	SC00609726DBB1	39°29'37"	108°11'08"	8,100	Upland, Conn Creek
104	SC00609736DCA1	39°29'01"	108°09'54"	8,110	Upland, Parachute Creek
105	SC00609813DBD1	39°31'47"	108°16'29"	7,820	Upland, Clear Creek
106	SC00609826AAA1	39°30'36"	108°17'20"	7,720	Upland, Clear Creek
107	SC00609902AAC1	39°33'10"	108°24'11"	7,810	Upland, Skinner Ridge
108	SC00609922CCD1	39°30'47"	108°25'58"	6,170	Lowland, landslide/slump deposits, Roan Creek valley
109	SC00609922CCD2	39°30'45"	108°26'01"	6,160	Lowland, landslide/slump deposits, Roan Creek valley
110	SC00609930BAD1	39°30'35"	108°29'07"	6,060	Lowland, Roan Creek alluvium
111	SC00609931DBB1	39°29'22"	108°28'57"	8,060	Upland, Kimball Mountain
112	SC00609932CCB1	39°29'10"	108°28'18"	8,060	Upland, Kimball Mountain
113	SC00609933CDA1	39°29'07"	108°26'53"	7,960	Upland, Kimball Mountain
114	SC00610011DCC1	39°32'34"	108°31'10"	8,115	Upland, 4A Ridge
115	SC00610016ABC1	39°32'20"	108°33'23"	8,290	Upland, 4A Ridge

Table 13.--*Location information for springs*--Continued

Site number (on plate 1)	Local identifier	Latitude	Longitude	Altitude	Site location
116	SC00610016CAD1	39°31'53"	108°33'35"	8,360	Upland, 4A Ridge
117	SC00610031CDD1	39°29'04"	108°35'45"	8,405	Upland, Kimball Mountain
118	SC00610034CBC1	39°29'17"	108°32'53"	8,210	Upland, Kimball Mountain
119	SC00610034CDB1	39°29'08"	108°32'35"	8,140	Upland, Kimball Mountain
120	SC00610035CAD1	39°29'13"	108°31'17"	8,110	Upland, Kimball Mountain
121	SC00610036CAA1	39°29'25"	108°30'13"	8,070	Upland, Kimball Mountain
122	SC00709610BDD1	39°27'08"	108°05'45"	6,170	Lowland, talus slopes, Parachute Creek valley
123	SC00709701DCA1	39°28'10"	108°10'03"	8,150	Upland, Parachute Creek
124	SC00709702DCB1	39°28'14"	108°11'09"	8,050	Upland, Conn Creek
125	SC00709705BDB1	39°28'37"	108°14'49"	5,880	Lowland, Conn Creek alluvium
126	SC00709712BAD1	39°27'50"	108°10'11"	8,150	Upland, Parachute Creek
127	SC00709713BAC1	39°27'03"	108°10'15"	8,240	Upland, Parachute Creek
128	SC00709714ADC1	39°26'47"	108°10'54"	8,330	Upland, Conn Creek
129	SC00709802CAB1	39°28'27"	108°18'03"	6,200	Lowland, slopewash deposits, Roan Creek valley
130	SC00709926CCB1	39°24'46"	108°25'02"	6,220	Lowland,slump/ terrace deposits, North Dry Fork valley
131	SC00709926CCB2	39°24'46"	108°25'02"	6,220	Lowland, slump/terrace deposits, North Dry Fork valley
132	SC00709927ACD1	39°25'08"	108°25'31"	6,190	Lowland, North Dry Fork alluvium
133	SC00710005BCC1	39°28'38"	108°35'07"	8,270	Upland, Kimball Mountain
134	SC00710008DDB1	39°27'27"	108°34'16"	6,870	Lowland, Kimball Creek alluvium
135	SC00710009ACD1	39°27'41"	108°33'12"	6,797	Lowland, Kimball Creek alluvium
136	SC00710026DCB1	39°24'45"	108°31'12"	6,840	Lowland, Middle Dry Fork alluvium
137	SC00710127ADC1	39°25'08"	108°38'37"	7,190	Lowland, talus/slopewash deposits, west of study area
138	SC00809915DAC1	39°21'24"	108°24'47"	6,020	Lowland, Wasatch Formation/slopewash?, South Dry Fork valley
139	SC00809916DCD1	39°21'10"	108°26'06"	6,180	Lowland, Wasatch Formation?, South Dry Fork valley
140	SC00809927ADB1	39°20'02"	108°24'44"	7,070	Lowland, talus slopes, South Dry Fork valley
141	SC00810012DCB1	39°22'15"	108°29'58"	6,645	Lowland, terrace/slump deposits, South Dry Fork

Table 14.--*Inventory data for springs*

[E, estimated; gal/min, gallons per minute; µS/cm, micromsiemens per centimeter; °C, degrees centigrade]

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
1	SC00409531DAA1	81-08-04		--	1,020	7.6	8.0
		81-09-01	1200	E50	900	8.0	7.5
		81-10-06		56	--	--	--
		81-11-10	1200	66	915	8.1	8.0
		82-05-26	1215	300	640	8.1	6.5
		82-07-20	1140	84	805	8.0	9.0
		82-10-07	1400	76	870	7.9	7.5
		83-02-16	0845	34	920	8.4	3.5
2	SC00409535DBB1	82-05-28	1000	4.30	540	8.2	6.0
		82-07-20	1450	1.10	580	7.9	9.5
3	SC00409635DBD1	81-08-04		0.40	615	7.2	16.0
		81-09-01	1030	0.23	670	7.9	16.0
		82-05-26	1000	2.30	630	7.8	7.0
		82-07-20	1100	0.44	675	7.9	13.5
		83-02-16	0830	0.00	--	--	--
4	SC00409735CDC1	81-11-12	1230	0.43	670	7.4	6.5
		82-06-08	1030	0.43	690	8.2	7.5
		82-07-27	1030	0.32	700	7.5	10.5
		82-10-26	1000	0.40	685	8.1	7.5
5	SC00409833DBD1	82-06-14	1400	4.70	725	7.6	7.0
		82-07-27	1610	0.00	--	--	--
6	SC00409835DCC1	82-06-14	1300	2.40	620	8.2	7.5
		82-07-27	1545	0.00	--	--	--
7	SC00410032DAD1	82-06-22	1600	3.40	550	8.3	6.0
		82-08-11	0910	1.40	600	8.2	9.0
8	SC00509319DAC1	82-04-27	1015	9.30	1,080	7.5	6.0
9	SC00509319DBD1	81-07-29	1430	1.84	1,070	7.1	10.0
		82-04-27	0930	2.40	1,040	7.5	8.5
10	SC00509329DBA1	81-07-29	1230	9.05	950	7.1	10.5
		81-11-04	0930	8.60	890	7.0	10.5
		82-04-27	1100	--	890	7.5	--
		82-09-23	1500	8.00	910	7.4	11.0
11	SC00509403ACC1	82-05-28	1340	4.30	395	7.8	4.5
		82-10-07	0930	4.70	550	8.3	6.5
12	SC00509407AAA1	81-07-22		--	438	6.9	7.0
13	SC00509408BBD1	82-05-28	1215	28	385	7.8	5.5
		82-07-20	1615	0.00	--	--	--

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
14	SC00509414BAD1	82-06-30	1745	5.20	460	7.6	6.0
		82-10-07	1000	1.60	520	8.0	8.0
15	SC00509415AAC1	81-06-30		--	530	7.9	24.0
16	SC00509415CDC1	82-06-30	1720	3.80	420	7.8	6.0
		82-10-07	1030	2.90	460	8.1	7.0
17	SC00509416ACD1	81-06-30		--	490	7.1	9.0
		82-06-30	1700	35	485	8.0	14.0
		82-10-07	1100	9.00	550	8.3	8.0
18	SC00509416BDC1	81-06-30		--	500	7.4	10.0
		81-08-19	1615	--	510	7.9	12.0
19	SC00509418DAC1	81-07-21		--	430	--	7.0
20	SC00509419BCC2	81-07-21		1.13	480	--	10.0
21	SC00509420ABB1	81-06-30		--	500	--	10.0
		81-08-19	1115	0.70	595	7.8	8.0
		82-06-30	1615	1.30	450	7.3	6.5
		82-10-07	1125	1.40	525	7.8	8.0
22	SC00509420BAD1	81-06-30		--	515	7.5	12.0
		82-06-30	1630	1.60	500	7.3	7.5
		82-10-07	1140	1.70	530	7.7	9.0
23	SC00509422CCD1	81-07-21		1.67	435	--	9.0
24	SC00509423CCA1	81-06-30		--	478	7.4	11.0
		81-07-21		2.60	390	--	7.0
25	SC00509423CCC1	81-08-18	1430	2.64	395	7.2	8.0
		81-11-04	1100	3.00	460	6.9	7.5
		82-06-30	1245	13	355	7.4	7.0
		82-09-23	1100	5.10	445	7.5	8.5
		83-02-16	1000	2.00	470	8.2	5.0
26	SC00509423DBB1	81-07-20		1.57	470	--	9.0
27	SC00509424CBB1	81-06-30		--	475	7.8	7.5
		82-06-30	1230	33	430	7.6	5.0
		82-09-23	1030	8.00	505	7.8	6.5
28	SC00509428BDC1	81-06-30		--	395	7.5	10.0
		82-06-30	1315	4.00	350	7.4	5.5
		82-09-23	1130	1.30	400	7.9	8.0
29	SC00509434DDD1	81-06-29		--	490	7.4	14.5
		82-06-30	1015	4.10	460	7.7	8.0
		82-09-23	0930	<0.10	--	--	--

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (μS/cm)	pH (standard units)	Temperature (°C)
30	SC00509435BDB1	81-06-29		--	524	7.4	12.0
		82-06-30	1000	1.50	360	7.8	5.5
		82-09-23	0915	<0.10	--	--	--
31	SC00509502BAA1	82-05-28	1030	E50	430	8.2	5.5
		82-07-20	1430	0.00	--	--	--
32	SC00509502BCA1	82-07-20	1515	1.10	910	7.5	9.0
33	SC00509503ADA1	82-05-26	1600	22	655	8.3	7.0
		82-07-20	1400	0.00	--	--	--
34	SC00509505ABA1	81-08-04		0.79	660	--	11.0
		81-09-01	1330	0.70	640	7.7	10.0
		81-10-06		0.73	--	--	--
		81-11-10	1130	0.90	675	7.6	5.5
		82-05-26	1200	8.80	575	7.9	5.0
		82-07-20	1130	3.10	625	7.7	8.0
		82-10-07	1330	2.00	670	7.7	7.5
35	SC00509510CBC1	82-05-26	1430	13	620	8.2	6.5
		82-07-20	1330	1.40	760	7.7	10.0
36	SC00509514BCD1	81-07-21		1.09	550	--	9.0
		81-08-19	0830	1.08	530	7.5	9.0
		81-11-10	1400	1.10	550	8.1	7.0
		82-06-30	1530	2.00	490	7.4	7.0
		82-09-23	1345	0.63	560	7.9	9.5
		83-02-16	0930	1.20	570	8.3	4.5
37	SC00509522DDC1	83-03-02	1130	50	600	8.4	6.5
38	SC00509536BAD1	81-08-18	1730	3.66	605	7.3	9.5
		81-11-05	1230	2.60	575	7.5	7.0
		82-06-30	1445	19	510	7.5	7.0
		82-09-23	1230	6.60	570	8.3	9.5
		83-02-16	0945	4.00	580	8.3	5.0
39	SC00509604ACD1	82-05-26	1045	E5.00	820	8.2	7.5
		82-07-20	1015	7.70	880	8.4	9.5
40	SC00509605CCD1	81-08-06		4.50	840	8.1	--
		82-06-09	1400	7.60	925	8.1	8.0
		82-07-27	1215	4.50	935	7.6	11.5
41	SC00509605DDB1	81-08-06		5.30	860	8.1	17.0
42	SC00509606DCB1	81-08-05		--	715	7.8	8.0
		82-06-09	1300	0.16	900	8.3	9.0
		82-07-27	1130	<0.10	970	8.1	10.0
43	SC00509608BBD1	81-09-16	1130	11	1,115	7.4	12.0
44	SC00509610DDD1	82-12-15	1030	--	2,850	8.5	0.0

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
45	SC00509617BAB1	82-06-09	1430	11	625	7.9	6.5
		82-07-27	1200	7.10	690	7.7	9.5
46	SC00509625CBA1	82-12-15	1430	E10	1,000	8.1	6.0
47	SC00509633CCB1	82-06-15	1200	11	540	7.6	6.5
		82-08-04	1400	4.50	580	7.9	8.0
48	SC00509706CAB1	81-08-06		12	650	7.7	8.0
		82-06-14	1130	10	680	8.0	7.0
		82-07-27	1500	9.70	660	7.8	8.5
49	SC00509708CBD1	81-08-06		--	600	7.5	8.0
		81-09-16	1500	E10	610	7.4	8.0
		81-11-20	1200	15.4	615	7.5	7.5
		82-06-14	1100	14	600	8.3	6.5
		82-07-27	1430	9.70	625	7.7	11.5
50	SC00509710CCD1	81-08-06		E25	555	7.9	11.5
		81-09-16	1630	E5.00	570	8.0	10.5
		82-06-09	1130	40	530	8.3	8.0
		82-07-27	1315	20	570	8.2	10.0
51	SC00509712AAA1	81-11-12	1130	2.80	725	7.4	6.5
		82-06-09	1215	2.90	670	8.0	6.5
52	SC00509720DBA1	81-08-11		1.38	995	7.1	10.0
		81-09-16	1400	2.53	1,000	7.4	10.0
		81-11-20	1045	0.21	995	7.4	8.5
		82-06-14	1500	0.23	960	7.5	7.5
		82-07-28	0700	0.13	1,000	7.6	8.0
		83-02-15	1410	<0.10	990	7.6	5.0
53	SC00509721CBD1	81-08-11		--	730	7.6	7.0
54	SC00509724DCC1	81-08-06		1.40	630	--	--
		82-06-09	1530	10	565	7.8	7.0
		82-07-28	0830	4.50	595	8.0	8.0
55	SC00509725ABB1	81-08-06		3.40	650	7.6	8.0
56	SC00509725BCB1	81-08-06		2.90	540	7.6	8.0
		81-09-16	1230	3.17	705	7.3	8.0
		81-11-12	1400	2.60	705	7.7	5.5
		82-06-09	1600	4.70	575	7.7	6.0
		82-07-28	0815	4.00	640	7.8	7.0
		82-10-13	1400	3.50	700	8.1	6.0
		83-02-15	1330	2.70	700	7.8	4.5
57	SC00509727BAB1	82-06-14	1630	21	620	8.1	7.0
		82-07-27	1800	9.70	660	7.7	7.0

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (μS/cm)	pH (standard units)	Temperature (°C)
58	SC00509727DCA1	81-08-11		--	725	7.9	7.0
		81-09-08	1545	E5.00	700	7.7	9.0
		82-06-09	1700	40	655	8.0	6.5
		82-07-27	1820	22	740	7.6	7.0
59	SC00509729ADA1	81-08-11		2.80	770	7.3	6.0
		82-06-14	1530	4.60	690	7.9	5.5
		82-07-28	0720	4.70	760	7.8	8.0
60	SC00509735BCA1	81-11-12	1500	4.70	790	7.8	6.0
		82-06-09	1630	8.80	690	7.8	6.0
		82-07-28	0800	7.50	720	7.9	8.0
		82-10-13	1330	6.30	760	8.1	6.5
		83-02-15	1400	4.70	790	7.6	4.5
61	SC00509801DDD1	81-08-06		16	660	7.7	7.5
		81-09-16	1600	14	775	7.8	9.0
		81-11-20	1300	14	750	7.9	7.0
		82-06-14	1145	25	795	7.7	7.0
		82-07-27	1515	16	770	7.8	8.5
		82-10-26	1045	11	780	8.0	7.5
		83-02-15	1430	E10	780	7.9	6.0
62	SC00509810DAD1	81-11-20		E1.00	890	8.0	4.0
63	SC00509834BDB1	82-06-22	1300	1.30	600	7.8	7.5
		82-08-24	1300	0.30	620	8.5	19.0
64	SC00509905ADC1	81-09-23	1200	E10	730	--	9.5
		82-06-22	1000	75	615	7.9	8.5
		82-08-11	1400	17	605	8.0	11.5
		82-11-03	1100	E5.00	640	8.2	5.0
65	SC00509906ACB1	82-06-22	1400	18	730	7.7	6.5
		82-08-11	1330	5.40	750	7.8	7.5
66	SC00509913CAB1	81-09-23	1330	0.99	675	--	7.5
		82-06-22	1100	11	600	7.8	6.0
		82-08-24	1100	3.20	650	8.2	7.0
		82-11-03	1300	1.80	655	8.1	6.0
		83-02-15	1100	1.30	680	7.9	5.0
67	SC00509917BDC1	82-06-24	0900	17	635	8.0	8.5
68	SC00509919ACB1	81-07-31		0.45	710	--	12.0
		82-06-22	1530	1.20	690	7.9	8.5
		82-08-11	1020	0.20	660	8.0	11.0
69	SC00509924CDB1	82-06-22	1130	1.30	960	8.0	6.0
		82-08-24	1130	0.40	950	8.3	7.0

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
70	SC00509927DAB1	81-07-31		--	650	--	22.0
		82-06-24	1000	6.50	570	7.9	6.5
		82-08-11	1130	2.90	605	7.8	9.5
71	SC00509928ACB1	81-07-31		0.48	1,195	--	10.0
		81-11-13	1200	0.40	1,120	7.7	6.5
		82-08-11	1115	0.20	900	7.8	10.0
72	SC00509928ACB2	81-07-31		0.26	1,220	--	15.0
		82-06-24	0935	0.64	790	7.9	7.5
		82-08-11	1110	1.30	915	7.8	10.0
		82-10-12	1030	0.20	960	8.1	7.5
73	SC00509934DAA1	82-06-24	1030	0.50	755	8.1	8.0
		82-08-11	1150	0.20	755	8.3	20.0
74	SC00510001CDA1	81-09-23		--	--	--	7.0
75	SC00510012ABD1	81-07-31		1.35	470	-	10.0
		81-11-13	1100	0.32	485	7.6	3.5
		82-06-24	0815	5.70	440	8.2	5.5
		82-08-11	1000	2.30	455	7.6	7.0
		82-10-12	0930	1.70	470	8.1	5.0
		83-02-15	1030	0.41	505	8.1	3.5
76	SC00510023DCC1	81-08-13	1600	1.22	660	7.6	7.0
		82-06-24	1200	--	625	7.9	8.0
		82-08-05	0930	3.40	595	8.0	8.0
77	SC00510027BCA1	81-11-13	1600	1.10	630	7.3	5.0
		82-06-24	1230	2.80	610	7.8	5.5
		82-08-05	1000	2.00	575	7.8	6.0
78	SC00510027DAD1	81-08-13	1430	0.50	540	7.1	9.5
		82-06-24	1300	2.00	530	7.8	6.0
		82-08-05	1030	1.00	575	7.8	8.0
		82-10-12	1300	0.50	555	7.6	8.0
79	SC00510034DDD1	81-11-13	1530	0.79	740	7.8	5.5
		82-06-24	1320	5.40	625	8.1	6.0
		82-08-05	1100	1.60	680	7.9	7.0
80	SC00510035DAC1	82-06-24	1400	0.90	530	7.7	9.0
		82-08-05	1120	1.10	585	7.6	13.0
81	SC00510036BBA1	81-08-13	1800	--	560	7.8	6.0
82	SC00510124DDD1	81-07-31		--	550	--	14.0

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
83	SC00609406CBA1	81-06-29		--	560	7.7	14.0
		81-08-18	1230	E5.00	510	7.7	10.0
		81-11-04	1530	6.00	500	7.5	7.0
		82-06-30	1050	7.00	410	7.5	6.5
		82-09-23	0945	5.80	470	7.9	8.5
84	SC00609406DCB1	81-06-29		0.09	535	7.7	21.0
85	SC00609501DAD1	81-06-29		--	560	8.0	18.0
86	SC00609528BAC1	82-04-20	1330	4.30	1,250	7.6	7.0
87	SC00609702CBD2	81-10-22	1300	0.50	520	7.5	5.5
		82-06-15	1345	1.20	465	7.8	5.0
		82-08-04	1320	0.62	530	7.8	8.0
88	SC00609703DAC1	81-08-11		7.90	485	8.2	12.0
		81-09-08	1000	--	480	7.8	9.0
		82-06-15	1100	34	460	7.8	6.0
		82-08-04	1430	12	495	8.0	7.5
89	SC00609704ADA1	82-06-15	1045	0.40	455	7.8	6.5
		82-07-28	1245	<0.10	--	--	--
90	SC00609704DCA1	81-08-11		2.20	550	7.7	7.0
		81-09-08	1100	1.53	560	7.5	7.5
		81-10-22	1200	1.70	540	7.5	6.5
		82-06-15	1015	2.40	525	8.0	6.5
		82-08-04	1530	1.80	585	8.0	7.0
		82-10-13	1200	1.90	600	8.3	6.5
		83-02-15	1320	2.40	580	8.0	6.0
91	SC00609705BBD1	81-08-06		--	730	7.2	9.0
		81-09-08	1500	E2.00	700	7.8	9.0
		82-06-14	1730	30	655	7.8	6.0
		82-07-28	0915	12	685	8.0	7.0
92	SC00609706DAB1	82-06-15	0930	9.70	615	8.0	7.0
		82-07-28	1000	2.70	710	7.8	8.5
93	SC00609707DAD1	81-08-11		--	680	7.8	11.0
		81-09-08	1230	E2.00	680	8.1	19.0
		82-06-14	1800	6.20	635	7.9	6.0
		82-07-28	1030	4.10	680	8.0	10.0
94	SC00609711BCA1	81-08-06		--	530	--	9.0
		81-09-02	1330	E4.00	535	8.3	9.5
		82-06-15	1400	27	420	8.1	8.5
		82-07-28	1300	12	480	8.3	12.5

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
95	SC00609712AAB1	81-08-12		0.37	635	7.4	10.0
		81-09-02	1400	0.38	660	7.8	10.0
		82-06-15	1300	3.70	600	8.0	6.5
		82-08-04	1340	2.40	645	7.9	9.0
		83-02-15	1300	0.86	660	7.8	6.5
96	SC00609714BCC1	81-08-06		--	--	--	8.0
		81-09-02	1230	0.40	585	7.9	8.0
		81-10-22		0.70	570	7.6	5.0
		82-06-15	1515	5.50	520	7.8	5.5
		82-07-28	1320	5.50	540	7.8	5.5
97	SC00609715BAA1	81-08-12		0.75	560	8.0	10.0
		82-06-15	1430	10	550	8.1	6.5
		82-08-04	1300	4.10	580	8.2	9.5
98	SC00609715CDC1	81-08-12		--	530	6.8	7.0
		82-06-15	1500	40	490	8.1	6.0
		82-08-04	1200	8.30	530	8.0	7.0
99	SC00609719DCD1	81-08-11		--	775	8.0	15.0
		82-06-15	0830	2.90	780	7.6	8.0
		82-07-28	1200	1.50	760	7.7	11.5
100	SC00609722ACA1	81-08-12		--	538	7.4	7.0
101	SC00609723ADC1	81-08-12		1.51	655	7.3	11.0
		81-09-02	1130	3.66	670	7.5	10.5
		81-10-22	1110	1.80	650	7.2	9.0
		82-06-15	1530	4.70	575	7.8	7.0
		82-07-28	1330	4.40	620	7.5	9.0
		82-10-13	1000	2.50	635	8.0	8.5
		83-02-15	1240	1.80	675	7.7	4.5
102	SC00609724BDD1	81-08-12		--	500	7.6	9.5
		82-06-17	1230	10	490	7.9	7.0
		82-08-04	1110	3.00	515	7.8	9.0
103	SC00609726DBB1	81-08-12		0.50	595	7.4	10.0
		82-06-17	1200	27	535	7.6	6.5
		82-08-04	1030	4.70	600	7.7	11.0
104	SC00609736DCA1	81-10-22	1045	1.50	510	7.2	10.0
		82-06-17	1100	9.60	530	8.1	6.5
		82-08-04	1000	7.70	520	7.7	9.0

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (μS/cm)	pH (standard units)	Temperature (°C)
105	SC00609813DBD1	82-06-15	0730	12	740	7.7	7.0
		82-07-28	1045	5.20	780	7.9	9.5
106	SC00609826AAA1	81-08-11		0.79	690	7.6	10.0
		81-09-08	1330	0.79	690	7.5	10.0
		82-06-15	0815	1.40	680	7.7	6.5
		82-07-28	1115	0.80	705	7.6	9.0
107	SC00609902AAC1	82-06-22	1215	6.00	940	8.0	8.0
		82-08-24	1230	1.20	985	7.9	11.0
108	SC00609922CCD1	82-06-03	1100	5.50	1,750	7.5	10.0
		82-07-21	0930	3.30	1,720	7.5	9.5
		82-12-07	0915	5.70	1,575	7.7	9.5
109	SC00609922CCD2	82-06-03	1130	E3.00	3,725	7.9	10.5
		82-07-21	1000	1.80	3,780	7.3	11.0
		82-12-07	0930	2.00	4,000	7.4	8.5
110	SC00609930BAD1	82-01-19	0930	12	1,290	8.1	8.0
		82-11-19	0900	7.90	1,240	7.8	10.0
111	SC00609931DBB1	81-07-30		1.06	730	--	11.0
112	SC00609932CCB1	81-07-30		1.67	670	--	12.0
		81-08-25	1430	0.99	640	7.3	12.5
		81-10-23	1200	0.48	640	7.5	9.0
		82-06-28	1130	9.10	590	7.8	7.5
		82-08-19	1100	3.50	645	7.6	10.5
		82-10-21	1130	1.70	650	7.9	8.5
		83-02-15	0900	0.82	725	8.0	3.0
113	SC00609933CDA1	82-06-28	1200	0.10	615	8.1	9.5
		82-08-19	1130	<0.10	--	--	--
114	SC00610011DCC1	82-06-24	1515	2.30	540	7.7	6.5
		82-08-05	1245	0.95	585	7.8	8.5
115	SC00610016ABC1	82-06-24	1440	1.70	450	8.0	6.0
		82-08-05	1230	1.30	490	7.9	6.0
		82-10-12	1345	1.30	475	8.0	5.0
		83-02-15	0925	1.40	500	8.1	5.0
116	SC00610016CAD1	81-08-13	1200	0.57	660	7.6	12.0
		81-11-13	1430	0.49	675	7.7	6.0
		82-06-24	1430	2.30	645	7.7	8.5
		82-08-05	1215	0.70	660	8.0	12.5

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
117	SC00610031CDD1	82-06-28	0915	4.10	495	7.9	6.5
		82-08-19	0930	0.90	550	7.7	9.0
118	SC00610034CBC1	81-07-30		1.02	660	--	6.0
		81-08-25	1300	0.70	605	7.8	7.0
		81-10-23	1100	0.40	570	7.8	5.5
		82-06-28	1030	7.90	520	7.8	5.0
		82-08-19	1020	2.80	580	7.9	6.0
119	SC00610034CDB1	81-07-30		0.21	590	--	11.0
120	SC00610035CAD1	81-07-30		0.47	560	--	14.0
121	SC00610036CAA1	82-06-28	1100	0.10	605	8.0	14.0
		82-08-19	1045	0.00	--	--	--
122	SC00709610BDD1	82-04-20	1030	0.30	4,900	8.0	5.5
		82-11-17	1000	0.14	4,650	8.4	4.5
123	SC00709701DCA1	81-08-12		--	600	7.4	11.0
124	SC00709702DCB1	81-08-12		1.50	860	7.8	10.0
		81-09-02	1030	1.36	865	8.1	9.0
		81-10-22	1030	1.20	830	7.3	9.0
		82-06-17	1300	3.40	820	7.9	7.0
		82-08-04	0945	2.10	860	7.6	9.5
		82-10-13	0915	1.60	850	8.3	8.0
		83-02-15	1215	0.74	890	7.9	5.0
125	SC00709705BDB1	82-11-16	1100	30	970	7.8	6.5
126	SC00709712BAD1	82-06-17	0940	10	540	7.8	6.5
		82-08-04	0920	2.70	490	7.6	9.5
127	SC00709713BAC1	81-08-12		0.40	438	7.8	15.0
		81-09-02	0945	--	450	8.3	10.0
		82-06-17	0915	19	510	7.8	5.5
		82-08-04	0900	8.30	530	7.7	6.5
128	SC00709714ADC1	82-06-17	0845	3.60	465	7.8	6.0
		82-08-04	0845	2.30	485	7.6	10.0
129	SC00709802CAB1	82-12-07	1300	5.20	2,400	8.3	10.0
130	SC00709926CCB1	82-02-03	1330	<3.00	1,790	7.8	8.5
131	SC00709926CCB2	82-02-03	1340	7.20	1,740	7.6	9.0
		82-11-23	1215	3.80	1,675	8.0	9.0
132	SC00709927ACD1	82-02-03	1400	6.10	1,550	7.5	7.0
		82-11-23	1245	6.90	1,420	7.6	7.5

Table 14.--*Inventory data for springs*--Continued

Site number (plate 1)	Local identifier	Date	Time	Flow rate (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)
133	SC00710005BCC1	81-07-30		0.59	665	--	9.0
		81-08-25	1100	0.43	665	7.1	10.0
		81-10-23	1015	0.40	680	7.7	7.5
		82-06-28	0945	3.00	670	7.7	7.0
		82-08-19	1000	1.30	705	7.7	9.0
		82-10-21	1000	0.70	665	8.1	8.0
		83-02-15	0820	--	690	8.3	--
134	SC00710008DDB1	81-12-17	1015	7.60	810	8.1	6.0
135	SC00710009ACD1	81-12-17	1000	E75	900	7.8	7.5
136	SC00710026DCB1	81-12-15	1300	E3.00	990	8.4	2.0
		82-11-23	1400	6.00	890	7.9	0.0
137	SC00710127ADC1	81-07-30		3.10	1,140	--	8.5
		81-08-25	0830	--	1,140	7.3	8.5
		81-10-01		3.70	--	--	--
		81-10-23	0900	4.00	1,160	7.6	8.0
		82-06-28	0830	11	1,250	7.8	7.0
		82-08-19	0830	5.80	1,190	7.6	8.5
		82-10-21	0830	4.00	1,100	7.8	8.0
138	SC00809915DAC1	82-07-21	1300	5.40	2,225	7.4	11.0
139	SC00809916DCD1	81-12-15	0900	0.66	2,275	8.1	8.5
		82-07-09	1230	5.00	2,400	7.6	10.5
		82-11-23	1000	4.00	2,250	7.5	9.5
140	SC00809927ADB1	81-12-17	1300	E1.50	2,340	8.5	3.0
		82-07-09	0915	0.60	2,250	8.0	10.0
141	SC00810012DCB1	81-12-15	1015	5.30	1,440	7.7	9.5
		82-07-09	1015	4.60	1,500	7.4	10.0
		82-11-23	0930	4.40	1,500	7.5	9.5

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*

[E, estimated; gal/min, gallons per minute; µS/cm, microsiemens per centimeter; °C, degrees centigrade; mg/L, milligrams per liter; µg/L, micrograms per liter]

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
1	SC00409531DAA1	81-09-01	1200	E50	900	8.0	7.5	364	79	40	74
		81-11-10	1200	66	915	8.1	8.0	367	80	40	71
		82-05-26	1215	300	640	8.1	6.5	241	53	26	51
		82-10-07	1400	76	870	7.9	7.5	320	68	36	64
		83-02-16	0845	34	920	8.4	3.5	359	77	40	69
3	SC00409635DBD1	81-09-01	1030	.2	670	7.9	16.0	285	66	29	40
		82-05-26	1000	2.3	630	7.8	7.0	254	59	26	39
4	SC00409735CDC1	81-11-12	1230	.4	670	7.4	6.5	261	60	27	52
		82-06-08	1030	.4	690	8.2	7.5	274	63	28	51
		82-10-26	1000	.4	685	8.1	7.5	271	62	28	52
9	SC00509319DBD1	81-07-29	1430	1.8	1,070	7.1	10.0	378	72	48	110
10	SC00509329DBA1	81-07-29	1230	9.1	950	7.1	10.5	306	63	36	85
		81-11-04	0930	8.6	890	7.0	10.5	314	66	36	83
		82-09-23	1500	8.0	910	7.4	11.0	321	69	36	85
18	SC00509416BDC1	81-08-19	1615	--	510	7.9	12.0	214	54	19	27
21	SC00509420ABB1	81-08-19	1115	.7	595	7.8	8.0	224	58	19	31
		82-06-30	1615	1.3	450	7.3	6.5	192	50	16	27
25	SC00509423CCC1	81-08-18	1430	2.6	395	7.2	8.0	183	48	15	29
		81-11-04	1100	3.0	460	6.9	7.5	193	51	16	31
		82-06-30	1245	13	355	7.4	7.0	144	39	11	23
		82-09-23	1100	5.1	445	7.5	8.5	188	50	15	30
		83-02-16	1000	2.0	470	8.2	5.0	188	50	15	30

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
1	SC00409531DAA1	81-09-01	31	1.7	1.5	280	.0	230	5.9	.2	.00
		81-11-10	30	1.7	.8	270	--	210	5.3	.2	--
		82-05-26	32	1.5	1.1	237	--	110	4.1	.2	--
		82-10-07	30	1.6	1.0	290	--	170	5.1	.2	--
		83-02-16	30	1.6	.7	293	<.5	250	5.1	.2	--
3	SC00409635DBD1	81-09-01	23	1.1	.6	230	.0	87	3.4	.2	.00
		82-05-26	25	1.1	.4	266	--	74	3.5	.1	--
4	SC00409735CDC1	81-11-12	30	1.4	.6	260	--	97	4.3	.2	--
		82-06-08	29	1.4	.6	280	--	89	4.5	.2	--
		82-10-26	29	1.4	.6	289	--	90	4.2	.2	--
9	SC00509319DBD1	81-07-29	39	2.5	1.2	420	.0	170	5.2	.0	.10
10	SC00509329DBA1	81-07-29	38	2.2	1.2	380	.3	110	3.6	.3	.10
		81-11-04	37	2.1	1.0	380	--	100	3.8	.3	--
		82-09-23	37	2.1	1.1	392	--	110	3.4	.2	--
18	SC00509416BDC1	81-08-19	22	.8	.5	240	.2	18	1.0	.1	.20
21	SC00509420ABB1	81-08-19	23	.9	.6	260	.2	21	1.0	.1	.10
		82-06-30	23	.9	.7	225	--	21	1.3	.1	--
25	SC00509423CCC1	81-08-18	26	1.0	.5	230	.2	1.0	.7	.1	.00
		81-11-04	26	1.0	.4	240	--	5.0	1.2	.1	--
		82-06-30	26	.9	.6	183	--	8.0	1.1	<.1	--
		82-09-23	26	1.0	.6	230	--	10	1.0	<.1	--
		83-02-16	26	1.0	.5	241	<.5	11	1.0	<.1	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Iodide, dis-solved (mg/L as I)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Nitro-gen, organic, dis-solved (mg/L as N)
1	SC00409531DAA1	81-09-01	.000	22	605	625	.55	.020	.57	.160	.32
		81-11-10	--	21	--	592	--	--	.46	--	--
		82-05-26	--	18	--	407	--	--	.86	--	--
		82-10-07	--	20	--	540	--	--	.49	.060	--
		83-02-16	--	19	--	639	--	--	.26	<.060	--
3	SC00409635DBD1	81-09-01	.000	24	414	393	.68	.020	.70	.110	.30
		82-05-26	--	19	--	380	--	--	1.0	--	--
4	SC00409735CDC1	81-11-12	--	18	--	415	--	--	.90	--	--
		82-06-08	--	19	--	424	--	--	1.0	--	--
		82-10-26	--	19	--	430	--	--	.70	<.060	--
9	SC00509319DBD1	81-07-29	.010	23	646	690	1.60	.040	1.6	.140	.28
10	SC00509329DBA1	81-07-29	.010	21	503	555	1.40	.030	1.4	.150	.39
		81-11-04	--	20	--	539	--	--	1.2	--	--
		82-09-23	--	21	--	562	--	--	1.2	--	--
18	SC00509416BDC1	81-08-19	.000	18	300	284	.29	.030	.32	.120	.17
21	SC00509420ABB1	81-08-19	.000	20	277	309	.25	.020	.27	.090	.15
		82-06-30	--	18	--	270	--	--	.21	--	--
25	SC00509423CCC1	81-08-18	.000	22	273	258	.53	.020	.55	.120	.45
		81-11-04	--	23	--	272	--	--	.47	--	--
		82-06-30	--	20	--	213	--	--	.53	--	--
		82-09-23	--	22	--	268	--	--	.59	--	--
		83-02-16	--	21	--	274	--	--	.58	<.060	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dis-solved (mg/L as N)	Phos-phorus, dis-solved (mg/L as P)	Phos-phate, ortho, dis-solved (mg/L as P)	O-18/ O-16, (parts per thou-sand)	Carbon, organic, dis-solved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (μg/L)
1	SC00409531DAA1	81-09-01	.48	.050	.050	-17.0	3.2	.00	0
		81-11-10	--	--	--	--	--	--	--
		82-05-26	--	--	--	--	--	--	--
		82-10-07	--	.090	--	--	--	--	--
		83-02-16	--	.030	--	--	2.8	--	3
3	SC00409635DBD1	81-09-01	.41	.030	.040	-16.8	2.0	.00	--
		82-05-26	--	--	--	--	--	--	--
4	SC00409735CDC1	81-11-12	--	--	--	--	--	--	--
		82-06-08	--	--	--	--	--	--	--
		82-10-26	--	.060	--	--	--	--	--
9	SC00509319DBD1	81-07-29	.42	.030	.000	-16.7	2.2	.00	0
10	SC00509329DBA1	81-07-29	.54	.010	.000	-16.7	1.3	.00	3
		81-11-04	--	--	--	--	--	--	--
		82-09-23	--	--	--	--	--	--	--
18	SC00509416BDC1	81-08-19	.29	.040	.030	--	2.3	.00	--
21	SC00509420ABB1	81-08-19	.24	.060	.040	-15.9	1.8	.00	12
		82-06-30	--	--	--	--	--	--	--
25	SC00509423CCC1	81-08-18	.57	.050	.050	-16.0	4.6	.00	6
		81-11-04	--	--	--	--	--	--	--
		82-06-30	--	--	--	--	--	--	--
		82-09-23	--	--	--	--	--	--	--
		83-02-16	--	.040	--	--	2.2	--	4

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
32	SC00509502BCA1	82-07-20	1515	1.1	910	7.5	9.0	289	64	31	81
33	SC00509503ADA1	82-05-26	1600	22	655	8.3	7.0	215	50	22	53
34	SC00509505ABA1	81-09-01	1330	.7	640	7.7	10.0	259	60	26	45
		81-11-10	1130	.9	675	7.6	5.5	264	61	27	44
		82-05-26	1200	8.8	575	7.9	5.0	222	51	23	40
36	SC00509514BCD1	81-08-19	0830	1.1	530	7.5	9.0	225	58	19	38
		81-11-10	1400	1.1	550	8.1	7.0	222	56	20	38
		82-06-30	1530	2.0	490	7.4	7.0	201	52	17	29
		82-09-23	1345	.6	560	7.9	9.5	225	58	19	35
		83-02-16	0930	1.2	570	8.3	4.5	231	59	20	36
37	SC00509522DDC1	83-03-02	1130	50	600	8.4	6.5	244	54	26	50
38	SC00509536BAD1	81-08-18	1730	3.7	605	7.3	9.5	216	53	20	49
		81-11-05	1230	2.6	575	7.5	7.0	228	55	22	53
		82-06-30	1445	19	510	7.5	7.0	191	48	17	43
		82-09-23	1230	6.6	570	8.3	9.5	205	50	19	46
		83-02-16	0945	4.0	580	8.3	5.0	209	50	20	47
40	SC00509605CCD1	82-06-09	1400	7.6	925	8.1	8.0	385	81	44	74
43	SC00509608BBD1	81-09-16	1130	11	1,115	7.4	12.0	410	96	41	87

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab, (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
32	SC00509502BCA1	82-07-20	38	2.1	.5	367	<.5	110	3.2	.4	--
33	SC00509503ADA1	82-05-26	35	1.6	1.2	210	--	97	3.6	.2	--
34	SC00509505ABA1	81-09-01	28	1.3	.8	240	.1	82	11	.1	.00
		81-11-10	27	1.2	.6	270	--	90	4.1	.2	--
		82-05-26	28	1.2	.6	220	--	67	3.8	.1	--
36	SC00509514BCD1	81-08-19	27	1.1	.5	240	.0	59	3.0	.1	.00
		81-11-10	27	1.1	.5	230	--	63	3.1	.2	--
		82-06-30	24	.9	.5	226	--	37	2.9	.1	--
		82-09-23	25	1.1	.5	250	--	48	3.0	.1	--
		83-02-16	25	1.1	.5	255	--	54	3.1	.1	--
37	SC00509522DDC1	83-03-02	31	1.4	.6	290	--	58	3.1	.5	--
38	SC00509536BAD1	81-08-18	33	1.5	.5	240	.0	76	3.9	.2	.00
		81-11-05	34	1.6	.4	240	--	77	4.1	.2	--
		82-06-30	33	1.4	.6	220	--	48	3.6	.2	--
		82-09-23	33	1.5	.5	239	--	57	3.7	.1	--
		83-02-16	33	1.5	.5	246	<.5	66	3.7	.1	--
40	SC00509605CCD1	82-06-09	30	1.7	.6	367	--	180	4.0	.2	--
43	SC00509608BBD1	81-09-16	31	1.9	3.2	380	.0	210	3.8	.1	.00

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Iodide, dis-solved (mg/L as I)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Nitro-gen, organic, dis-solved (mg/L as N)
32	SC00509502BCA1	82-07-20	--	27	--	539	--	--	<.10	--	--
33	SC00509503ADA1	82-05-26	--	--	--	--	--	--	.73	--	--
34	SC00509505ABA1	81-09-01	.000	21	403	394	.43	.020	.45	.130	.23
		81-11-10	--	19	--	408	--	--	.53	--	--
		82-05-26	--	19	--	336	--	--	.73	--	--
36	SC00509514BCD1	81-08-19	.000	20	351	346	.64	.020	.66	.110	.29
		81-11-10	--	19	--	338	--	--	.58	--	--
		82-06-30	--	19	--	294	--	--	.64	--	--
		82-09-23	--	20	--	335	--	--	.49	--	--
		83-02-16	--	19	--	346	--	--	.58	<.060	--
37	SC00509522DDC1	83-03-02	--	19	--	387	--	--	.11	.100	.60
38	SC00509536BAD1	81-08-18	.000	22	376	375	.92	.020	.94	.100	.46
		81-11-05	--	21	--	377	--	--	.86	--	--
		82-06-30	--	20	--	314	--	--	1.3	--	--
		82-09-23	--	21	--	342	--	--	1.1	--	--
		83-02-16	--	20	--	356	--	--	.96	<.060	--
40	SC00509605CCD1	82-06-09	--	21	--	626	--	--	.38	--	--
43	SC00509608BBD1	81-09-16	.000	24	747	697	.33	.030	.36	.150	.71

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphate, ortho, dissolved (mg/L as P)	O-18/ O-16, (parts per thousand)	Carbon, organic, dissolved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (µg/L)
32	SC00509502BCA1	82-07-20	--	--	--	--	--	--	--
33	SC00509503ADA1	82-05-26	--	--	--	--	--	--	--
34	SC00509505ABA1	81-09-01	.36	.010	.030	-16.8	3.4	.00	--
		81-11-10	--	--	--	--	--	--	--
		82-05-26	--	--	--	--	--	--	--
36	SC00509514BCD1	81-08-19	.40	.070	.070	-16.4	3.2	.00	5
		81-11-10	--	--	--	--	--	--	--
		82-06-30	--	--	--	--	--	--	--
		82-09-23	--	--	--	--	--	--	--
		83-02-16	--	.060	--	--	--	--	--
37	SC00509522DDC1	83-03-02	.70	.010	--	--	--	--	--
38	SC00509536BAD1	81-08-18	.56	.060	.070	-16.5	8.0	.00	--
		81-11-05	--	--	--	--	--	--	--
		82-06-30	--	--	--	--	--	--	--
		82-09-23	--	--	--	--	--	--	--
		83-02-16	--	.050	--	--	2.8	--	1
40	SC00509605CCD1	82-06-09	--	--	--	--	--	--	--
43	SC00509608BBD1	81-09-16	.86	.160	.110	--	3.1	.02	2

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
44	SC00509610DDD1	82-12-15	1030	--	2,850	8.5	0.0	1378	56	300	240
46	SC00509625CBA1	82-12-15	1430	E10	1,000	8.1	6.0	341	60	46	99
49	SC00509708CBD1	81-09-16	1500	E10	610	7.4	8.0	255	67	21	38
50	SC00509710CCD1	81-09-16	1630	E5.0	570	8.0	10.5	217	52	21	48
		82-06-09	1130	40	530	8.3	8.0	217	54	20	40
51	SC00509712AAA1	81-11-12	1130	2.8	725	7.4	6.5	290	66	30	60
		82-06-09	1215	2.9	670	8.0	6.5	271	62	28	55
52	SC00509720DBA1	81-09-16	1400	2.5	1,000	7.4	10.0	397	74	51	91
		81-11-20	1045	.2	995	7.4	8.5	390	73	50	87
		82-06-14	1500	.2	960	7.5	7.5	370	68	48	87
		83-02-15	1410	<.1	990	7.6	5.0	383	70	50	90
56	SC00509725BCB1	81-09-16	1230	3.2	705	7.3	8.0	311	78	28	41
		81-11-12	1400	2.6	705	7.7	5.5	324	82	29	42
		82-06-09	1600	4.7	575	7.7	6.0	245	60	23	34
		82-10-13	1400	3.5	700	8.1	6.0	288	72	26	39
		83-02-15	1330	2.7	700	7.8	4.5	290	71	27	39
58	SC00509727DCA1	81-09-08	1545	E5.0	700	7.7	9.0	302	66	33	45
60	SC00509735BCA1	81-11-12	1500	4.7	790	7.8	6.0	332	73	36	47
		82-06-09	1630	8.8	690	7.8	6.0	302	66	33	45
		82-10-13	1330	6.3	760	8.1	6.5	323	73	34	48
		83-02-15	1400	4.7	790	7.6	4.5	326	69	37	50

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
44	SC00509610DDD1	82-12-15	28	2.8	1.5	320	--	1,500	13	1.0	--
46	SC00509625CBA1	82-12-15	39	2.4	2.8	377	--	140	33	.7	--
49	SC00509708CBD1	81-09-16	24	1.1	2.1	260	.0	71	3.0	.1	.00
50	SC00509710CCD1	81-09-16	32	1.5	1.6	270	.0	47	1.4	.1	.00
		82-06-09	29	1.2	.7	257	--	43	2.3	.1	--
51	SC00509712AAA1	81-11-12	31	1.6	.3	300	--	110	3.3	.4	--
		82-06-09	31	1.5	.4	310	--	79	3.0	.4	--
52	SC00509720DBA1	81-09-16	33	2.0	.7	480	.0	130	3.8	.1	.00
		81-11-20	33	2.0	.8	460	--	110	3.3	.1	--
		82-06-14	34	2.0	.6	445	--	89	3.4	.2	--
		83-02-15	34	2.1	.6	481	--	100	3.7	.1	--
56	SC00509725BCB1	81-09-16	22	1.0	.6	280	.1	110	3.0	.1	.00
		81-11-12	22	1.0	.6	270	--	110	3.0	.2	--
		82-06-09	23	1.0	.7	231	--	67	2.6	.1	--
		82-10-13	23	1.0	.9	281	--	88	2.9	.1	--
		83-02-15	23	1.0	.5	288	<.5	99	2.7	.1	--
58	SC00509727DCA1	81-09-08	24	1.2	1.3	320	.0	87	2.6	.1	.00
60	SC00509735BCA1	81-11-12	24	1.2	.4	310	--	110	3.3	.2	--
		82-06-09	25	1.2	.4	283	--	87	3.2	.2	--
		82-10-13	24	1.2	.6	318	--	110	3.2	.1	--
		83-02-15	25	1.2	.5	328	--	110	3.1	.1	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifer	Date of sample	Iodide, dis- solved (mg/L as I)	Silica, dis- solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis- solved (mg/L)	Solids, sum of consti- tuents, dis- solved (mg/L)	Nitro- gen, nitrate, dis- solved (mg/L as N)	Nitro- gen, nitrite, dis- solved (mg/L as N)	Nitro- gen, NO_2+NO_3, dis- solved (mg/L as N)	Nitro- gen, ammonia, dis- solved (mg/L as N)	Nitro- gen, organic, dis- solved (mg/L as N)
44	SC00509610DDD1	82-12-15	--	23	--	2,330	--	<.020	3.5	.230	2.6
46	SC00509625CBA1	82-12-15	--	18	--	627	--	--	.82	--	--
49	SC00509708CBD1	81-09-16	.000	28	385	391	.67	.020	.69	.170	.55
50	SC00509710CCD1	81-09-16	.000	22	353	358	.33	.030	.36	.130	.44
		82-06-09	--	21	--	335	--	--	.21	--	--
51	SC00509712AAA1	81-11-12	--	20	--	471	--	--	.39	--	--
		82-06-09	--	20	--	435	--	--	.40	--	--
52	SC00509720DBA1	81-09-16	.000	25	575	666	--	<.020	.22	.100	.50
		81-11-20	--	25	--	627	--	--	.15	--	--
		82-06-14	--	25	--	590	--	--	.19	--	--
		83-02-15	--	23	--	628	--	--	.26	.060	--
56	SC00509725BCB1	81-09-16	.000	18	449	448	--	<.020	1.4	.160	.60
		81-11-12	--	18	--	447	--	--	1.2	--	--
		82-06-09	--	18	--	345	--	--	1.4	--	--
		82-10-13	--	18	--	416	--	--	1.1	<.060	--
		83-02-15	--	17	--	430	--	--	1.1	<.060	--
58	SC00509727DCA1	81-09-08	.000	17	392	448	.55	.030	.58	.050	.61
60	SC00509735BCA1	81-11-12	--	16	--	473	--	--	.98	--	--
		82-06-09	--	16	--	421	--	--	1.4	--	--
		82-10-13	--	17	--	478	--	--	.94	<.060	--
		83-02-15	--	16	--	484	--	--	.86	<.060	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphate, ortho, dissolved (mg/L as P)	O-18/ O-16, (parts per thousand)	Carbon, organic, dissolved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (µg/L)
44	SC00509610DDD1	82-12-15	2.8	.050	<.010	--	--	--	--
46	SC00509625CBA1	82-12-15	--	--	--	--	--	--	--
49	SC00509708CBD1	81-09-16	.72	.050	.080	--	1.6	<.01	0
50	SC00509710CCD1	81-09-16	.57	.080	.090	--	1.6	<.01	0
		82-06-09	--	--	--	--	--	--	2
51	SC00509712AAA1	81-11-12	--	--	--	--	--	--	--
		82-06-09	--	--	--	--	--	--	--
52	SC00509720DBA1	81-09-16	.60	.010	.030	-16.6	2.7	<.01	0
		81-11-20	--	--	--	--	--	--	--
		82-06-14	--	--	--	--	--	--	--
		83-02-15	--	.010	--	--	--	--	--
56	SC00509725BCB1	81-09-16	.76	.020	.040	-16.7	2.5	<.01	0
		81-11-12	--	--	--	--	--	--	--
		82-06-09	--	--	--	--	--	--	--
		82-10-13	--	.040	--	--	--	--	--
		83-02-15	--	.030	--	--	2.6	--	2
58	SC00509727DCA1	81-09-08	.66	.050	.030	-16.3	2.6	<.01	6
60	SC00509735BCA1	81-11-12	--	--	--	--	--	--	--
		82-06-09	--	--	--	--	--	--	--
		82-10-13	--	.020	--	--	--	--	--
		83-02-15	--	.030	--	--	--	--	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
61	SC00509801DDD1	81-09-16	1600	14	775	7.8	9.0	325	75	33	52
		81-11-20	1300	14	750	7.9	7.0	327	74	34	50
		82-06-14	1145	25	795	7.7	7.0	321	72	34	56
		82-10-26	1045	11	780	8.0	7.5	336	76	35	54
		83-02-15	1430	E10	780	7.9	6.0	331	74	35	53
64	SC00509905ADC1	81-09-23	1200	E10	730	--	9.5	309	72	31	50
		82-06-22	1000	75	615	7.9	8.5	229	50	25	44
		82-11-03	1100	E5.0	640	8.2	5.0	274	63	28	41
66	SC00509913CAB1	81-09-23	1330	1.0	675	--	7.5	270	65	26	45
		82-06-22	1100	11	600	7.8	6.0	237	55	24	42
		82-11-03	1300	1.8	655	8.1	6.0	272	64	27	47
		83-02-15	1100	1.3	680	7.9	5.0	267	62	27	47
71	SC00509928ACB1	81-11-13	1200	.4	1,120	7.7	6.5	430	86	52	76
72	SC00509928ACB2	82-06-24	0935	.6	790	7.9	7.5	327	68	38	58
		82-10-12	1030	.2	960	8.1	7.5	424	87	50	74
75	SC00510012ABD1	81-11-13	1100	.3	485	7.6	3.5	221	57	19	21
		82-06-24	0815	5.7	440	8.2	5.5	195	50	17	19
		82-10-12	0930	1.7	470	8.1	5.0	224	58	19	22
		83-02-15	1030	.4	505	8.1	3.5	225	57	20	22

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
61	SC00509801DDD1	81-09-16	26	1.3	2.2	310	.0	110	2.6	.1	.00
		81-11-20	25	1.2	1.0	300	--	110	3.2	.1	--
		82-06-14	28	1.4	1.0	305	--	120	3.2	.2	--
		82-10-26	26	1.3	.8	326	--	120	2.9	.1	--
		83-02-15	26	1.3	.7	322	<.5	120	2.8	.1	--
64	SC00509905ADC1	81-09-23	26	1.3	.9	250	.2	140	5.0	.2	.00
		82-06-22	30	1.3	.6	251	--	74	3.2	.2	--
		82-11-03	25	1.1	.8	254	--	110	3.8	.2	--
66	SC00509913CAB1	81-09-23	27	1.2	.6	250	.2	110	5.6	.1	.10
		82-06-22	28	1.2	.7	242	--	78	4.2	.1	--
		82-11-03	27	1.3	.5	263	--	100	4.7	.1	--
		83-02-15	28	1.3	.6	264	<.5	100	5.0	.1	--
71	SC00509928ACB1	81-11-13	28	1.6	.8	290	--	280	11	.2	--
72	SC00509928ACB2	82-06-24	28	1.4	.7	275	--	140	7.0	.2	--
		82-10-12	28	1.6	.7	305	--	230	9.6	.2	--
75	SC00510012ABD1	81-11-13	17	.6	.4	230	--	34	1.3	.1	--
		82-06-24	17	.6	.5	211	--	15	1.2	.2	--
		82-10-12	18	.7	.4	242	--	21	1.5	.1	--
		83-02-15	18	.7	.4	247	<.5	24	1.3	.1	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Iodide, dissolved (mg/L as I)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, nitrate, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, organic, dissolved (mg/L as N)
61	SC00509801DDD1	81-09-16	.020	21	499	491	1.50	.020	1.5	.150	.51
		81-11-20	--	21	--	475	--	--	1.2	--	--
		82-06-14	--	19	--	490	--	--	.70	--	--
		82-10-26	--	22	--	508	--	--	1.2	<.060	--
		83-02-15	--	20	--	501	--	--	1.0	.060	--
64	SC00509905ADC1	81-09-23	.010	17	450	472	.93	.030	.96	.150	.41
		82-06-22	--	18	--	367	--	--	.94	--	--
		82-11-03	--	16	--	416	--	--	1.0	<.060	--
66	SC00509913CAB1	81-09-23	.010	19	414	427	1.10	.020	1.1	.130	.35
		82-06-22	--	18	--	368	--	--	.98	--	--
		82-11-03	--	19	--	421	--	--	.97	<.060	--
		83-02-15	--	19	--	420	--	--	1.0	.080	--
71	SC00509928ACB1	81-11-13	--	18	--	699	--	--	3.0	--	--
72	SC00509928ACB2	82-06-24	--	19	--	497	--	--	3.2	--	--
		82-10-12	--	19	--	655	--	--	3.3	.070	--
75	SC00510012ABD1	81-11-13	--	17	--	288	--	--	.69	--	--
		82-06-24	--	18	--	248	--	--	.99	--	--
		82-10-12	--	18	--	286	--	--	.78	.070	--
		83-02-15	--	17	--	290	--	--	.77	<.060	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dis-solved (mg/L as N)	Phos-phorus, dis-solved (mg/L as P)	Phos-phate, ortho, dis-solved (mg/L as P)	O-18/ O-16, (parts per thou-sand)	Carbon, organic, dis-solved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (µg/L)
61	SC00509801DDD1	81-09-16	.66	.040	.020	--	2.1	<.01	0
		81-11-20	--	--	--	--	--	--	--
		82-06-14	--	--	--	--	--	--	--
		82-10-26	--	.070	--	--	--	--	--
		83-02-15	--	.030	--	--	2.4	--	1
64	SC00509905ADC1	81-09-23	.56	.030	.020	--	3.9	<.01	1
		82-06-22	--	--	--	--	--	--	--
		82-11-03	--	.050	--	--	--	--	--
66	SC00509913CAB1	81-09-23	.48	.050	.030	--	3.5	<.01	1
		82-06-22	--	--	--	--	--	--	--
		82-11-03	--	.050	--	--	--	--	--
		83-02-15	--	.050	--	--	3.5	--	10
71	SC00509928ACB1	81-11-13	--	--	--	--	--	--	--
72	SC00509928ACB2	82-06-24	--	--	--	--	--	--	--
		82-10-12	--	.080	--	--	--	--	--
75	SC00510012ABD1	81-11-13	--	--	--	--	--	--	--
		82-06-24	--	--	--	--	--	--	--
		82-10-12	--	.040	--	--	--	--	--
		83-02-15	--	.040	--	--	3.2	--	5

Table 15.--Analytical data for inorganic and nutrient constituents for springs--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
76	SC00510023DCC1	81-08-13	1600	1.2	660	7.6	7.0	299	73	28	35
77	SC00510027BCA1	81-11-13	1600	1.1	630	7.3	5.0	276	69	25	29
78	SC00510027DAD1	81-08-13	1430	.5	540	7.1	9.5	255	64	23	26
		82-06-24	1300	2.0	530	7.8	6.0	250	62	23	27
		82-10-12	1300	.5	555	7.6	8.0	264	66	24	27
79	SC00510034DDD1	81-11-13	1530	.8	740	7.8	5.5	322	76	32	45
81	SC00510036BBA1	81-08-13	1800	--	560	7.8	6.0	251	54	28	37
83	SC00609406CBA1	81-08-18	1230	E5.0	510	7.7	10.0	227	61	18	28
86	SC00609528BAC1	82-04-20	1330	4.3	1,250	7.6	7.0	417	69	59	150
87	SC00609702CBD2	81-10-22	1300	.5	520	7.5	5.5	246	62	22	33
		82-06-15	1345	1.2	465	7.8	5.0	196	50	17	24
88	SC00609703DAC1	81-09-08	1000	--	480	7.8	9.0	211	56	17	29
		82-06-15	1100	34	460	7.8	6.0	191	50	16	26
90	SC00609704DCA1	81-09-08	1100	1.5	560	7.5	7.5	237	58	22	37
		81-10-22	1200	1.7	540	7.5	6.5	230	56	22	42
		82-06-15	1015	2.4	525	8.0	6.5	219	51	22	38
		82-10-13	1200	1.9	600	8.3	6.5	248	61	23	40
		83-02-15	1320	2.4	580	8.0	6.0	238	57	23	39
91	SC00609705BBD1	81-09-08	1500	E2.0	700	7.8	9.0	292	67	30	45
93	SC00609707DAD1	81-09-08	1230	E2.0	680	8.1	19.0	289	64	31	39
94	SC00609711BCA1	81-09-02	1330	E4.0	535	8.3	9.5	217	55	19	36
95	SC00609712AAB1	81-09-02	1400	.4	660	7.8	10.0	282	68	27	43
		83-02-15	1300	.9	660	7.8	6.5	274	65	27	43

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
76	SC00510023DCC1	81-08-13	20	.9	.3	320	.2	42	1.4	.1	.20
77	SC00510027BCA1	81-11-13	19	.8	.4	300	--	35	1.2	.1	--
78	SC00510027DAD1	81-08-13	18	.7	.2	250	.0	46	1.1	.0	.20
		82-06-24	19	.8	.4	243	--	38	1.3	.2	--
		82-10-12	18	.7	.4	263	--	49	1.7	.1	--
79	SC00510034DDD1	81-11-13	23	1.1	.9	330	--	98	3.6	.2	--
81	SC00510036BBA1	81-08-13	24	1.0	1.1	260	--	58	2.0	.3	.10
83	SC00609406CBA1	81-08-18	21	.8	.6	240	.2	29	1.8	.1	.10
86	SC00609528BAC1	82-04-20	44	3.3	2.5	400	--	320	11	.7	--
87	SC00609702CBD2	81-10-22	23	.9	.8	230	--	34	1.5	.1	--
		82-06-15	21	.8	.5	226	--	20	1.5	.3	--
88	SC00609703DAC1	81-09-08	23	.9	.7	160	.0	37	1.6	.1	.00
		82-06-15	23	.8	.7	220	--	27	1.6	.1	--
90	SC00609704DCA1	81-09-08	25	1.1	.6	220	.0	66	10	.1	.00
		81-10-22	28	1.2	1.0	230	--	71	2.4	.2	--
		82-06-15	27	1.2	.6	239	--	54	2.4	1.6	--
		82-10-13	26	1.1	.7	251	--	64	2.4	.1	--
		83-02-15	26	1.1	.6	252	<.5	62	2.3	.1	--
91	SC00609705BBD1	81-09-08	25	1.2	1.3	290	.0	110	3.1	.1	.00
93	SC00609707DAD1	81-09-08	23	1.0	1.5	320	.0	62	3.0	.1	.00
94	SC00609711BCA1	81-09-02	27	1.1	1.1	230	.1	56	2.5	.1	.00
95	SC00609712AAB1	81-09-02	25	1.2	.5	240	.1	78	4.1	.2	.00
		83-02-15	25	1.2	.4	297	--	67	3.3	.1	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifer	Date of sample	Iodide, dis-solved (mg/L as I)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Nitro-gen, organic, dis-solved (mg/L as N)
76	SC00510023DCC1	81-08-13	.000	22	392	397	.48	.020	.50	.090	.43
77	SC00510027BCA1	81-11-13	--	20	--	360	--	--	.52	--	--
78	SC00510027DAD1	81-08-13	.000	20	329	338	1.40	.020	1.4	.130	.64
		82-06-24	--	21	--	319	--	--	2.7	--	--
		82-10-12	--	20	--	347	--	--	2.4	<.060	--
79	SC00510034DDD1	81-11-13	--	20	--	474	--	--	.84	--	--
81	SC00510036BBA1	81-08-13	.000	19	345	357	.17	.000	.17	.080	.33
83	SC00609406CBA1	81-08-18	.000	23	250	311	.91	.030	.94	.140	.46
86	SC00609528BAC1	82-04-20	--	18	--	871	--	--	--	--	--
87	SC00609702CBD2	81-10-22	--	20	--	312	--	--	.40	--	--
		82-06-15	--	20	--	270	--	--	.51	--	--
88	SC00609703DAC1	81-09-08	.010	21	277	261	.26	.030	.29	.020	.33
		82-06-15	--	--	--	--	--	--	--	--	--
90	SC00609704DCA1	81-09-08	.000	20	346	350	.60	.020	.62	.030	.30
		81-10-22	--	20	--	353	--	--	.94	--	--
		82-06-15	--	20	--	334	--	--	1.3	--	--
		82-10-13	--	21	--	364	--	--	1.1	<.060	--
		83-02-15	--	20	--	356	--	--	1.0	<.060	--
91	SC00609705BBD1	81-09-08	.000	18	443	451	.30	.030	.33	.040	.34
93	SC00609707DAD1	81-09-08	.010	19	416	414	.10	.040	.14	.070	.23
94	SC00609711BCA1	81-09-02	.000	23	336	332	.07	.000	.07	.040	.41
95	SC00609712AAB1	81-09-02	.000	19	410	388	.71	.010	.72	.040	.90
		83-02-15	--	19	--	404	--	--	1.2	<.060	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphate, ortho, dissolved (mg/L as P)	O-18/ O-16, (parts per thousand)	Carbon, organic, dissolved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (µg/L)
76	SC00510023DCC1	81-08-13	.52	.050	.080	-16.5	2.4	.01	3
77	SC00510027BCA1	81-11-13	--	--	--	--	--	--	--
78	SC00510027DAD1	81-08-13	.77	.080	.100	-16.4	2.5	.01	2
		82-06-24	--	--	--	--	--	--	--
		82-10-12	--	.090	--	--	--	--	--
79	SC00510034DDD1	81-11-13	--	--	--	--	--	--	--
81	SC00510036BBA1	81-08-13	.41	.030	.020	--	2.9	.00	0
83	SC00609406CBA1	81-08-18	.60	.080	.060	--	2.2	.00	0
86	SC00609528BAC1	82-04-20	--	--	--	--	--	--	--
87	SC00609702CBD2	81-10-22	--	--	--	--	--	--	--
		82-06-15	--	--	--	--	--	--	--
88	SC00609703DAC1	81-09-08	.35	.020	.010	--	1.9	<.01	27
		82-06-15	--	--	--	--	--	--	6
90	SC00609704DCA1	81-09-08	.33	.030	.060	-15.8	1.9	<.01	0
		81-10-22	--	--	--	--	--	--	--
		82-06-15	--	--	--	--	--	--	--
		82-10-13	--	.020	--	--	--	--	--
		83-02-15	--	.040	--	--	2.2	--	6
91	SC00609705BBD1	81-09-08	.38	.060	.060	--	2.7	<.01	2
93	SC00609707DAD1	81-09-08	.30	.060	.060	--	3.1	<.01	4
94	SC00609711BCA1	81-09-02	.45	.050	.000	--	1.8	.00	1
95	SC00609712AAB1	81-09-02	.94	.030	.000	-16.5	2.3	.00	--
		83-02-15	--	.050	--	--	--	--	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (μS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
96	SC00609714BCC1	81-09-02	1230	.4	585	7.9	8.0	248	61	23	38
101	SC00609723ADC1	81-09-02	1130	3.7	670	7.5	10.5	269	66	25	43
		81-10-22	1110	1.8	650	7.2	9.0	276	67	26	45
		82-06-15	1530	4.7	575	7.8	7.0	213	52	20	35
		82-10-13	1000	2.5	635	8.0	8.5	265	66	24	43
		83-02-15	1240	1.8	675	7.7	4.5	268	64	26	43
104	SC00609736DCA1	81-10-22	1045	1.5	510	7.2	10.0	216	55	19	31
		82-06-17	1100	9.6	530	8.1	6.5	206	51	19	30
106	SC00609826AAA1	81-09-08	1330	.8	690	7.5	10.0	253	58	26	62
		82-06-15	0815	1.4	680	7.7	6.5	248	56	26	62
108	SC00609922CCD1	82-06-03	1100	5.5	1,750	7.5	10.0	617	85	98	170
		82-12-07	0915	5.7	1,575	7.7	9.5	624	86	99	170
109	SC00609922CCD2	82-06-03	1130	E3.0	3,725	7.9	10.5	1,699	250	260	380
		82-12-07	0930	2.0	4,000	7.4	8.5	2,139	310	330	390
110	SC00609930BAD1	82-01-19	0930	12	1,290	8.1	8.0	390	50	64	140
		82-11-19	0900	7.9	1,240	7.8	10.0	402	50	67	150
112	SC00609932CCB1	81-08-25	1430	1.0	640	7.3	12.5	255	62	24	46
		81-10-23	1200	.5	640	7.5	9.0	260	63	25	44
		82-06-28	1130	9.1	590	7.8	7.5	216	50	22	45
		82-10-21	1130	1.7	650	7.9	8.5	256	61	25	46
		83-02-15	0900	.8	725	8.0	3.0	280	64	29	47

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide dis-solved (mg/L as Br)
96	SC00609714BCC1	81-09-02	25	1.1	.7	200	.1	80	1.9	.1	.00
101	SC00609723ADC1	81-09-02	26	1.2	.4	200	.1	150	4.1	.2	.00
		81-10-22	26	1.2	.4	190	--	150	4.5	.1	--
		82-06-15	26	1.1	.3	182	--	110	3.4	.1	--
		82-10-13	26	1.2	.3	216	--	130	3.9	.1	--
		83-02-15	26	1.2	.3	217	<.5	140	3.8	.1	--
104	SC00609736DCA1	81-10-22	24	.9	1.0	220	--	50	4.1	.2	--
		82-06-17	24	.9	1.8	226	--	43	2.8	.1	--
106	SC00609826AAA1	81-09-08	35	1.8	.6	290	.0	95	11	.1	.10
		82-06-15	35	1.8	.6	289	--	81	6.3	.1	--
108	SC00609922CCD1	82-06-03	37	3.0	2.8	494	--	470	11	.7	--
		82-12-07	37	3.0	2.5	519	.5	460	10	.6	.10
109	SC00609922CCD2	82-06-03	33	4.1	5.4	474	--	2,000	8.2	.3	--
		82-12-07	28	3.7	5.7	554	.6	2,400	7.7	.3	.12
110	SC00609930BAD1	82-01-19	44	3.1	3.1	420	--	260	13	.5	--
		82-11-19	45	3.3	2.9	444	<.5	270	7.2	.4	<.01
112	SC00609932CCB1	81-08-25	28	1.3	.6	250	--	92	3.7	.1	.00
		81-10-23	27	1.2	.9	250	--	94	4.2	.2	--
		82-06-28	31	1.4	.6	239	--	62	3.4	.2	--
		82-10-21	28	1.3	.6	223	--	89	4.0	.1	--
		83-02-15	27	1.3	.5	282	<.5	99	4.1	.2	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Iodide, dis-solved (mg/L as I)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Nitro-gen, organic, dis-solved (mg/L as N)
96	SC00609714BCC1	81-09-02	.000	19	362	346	.26	.000	.26	.040	.38
101	SC00609723ADC1	81-09-02	.000	23	444	435	.36	.000	.36	.040	.85
		81-10-22	--	24	--	432	--	--	.62	--	--
		82-06-15	--	21	--	352	--	--	.50	--	--
		82-10-13	--	23	--	421	--	--	.55	<.060	--
		83-02-15	--	22	--	430	--	--	.68	<.060	--
104	SC00609736DCA1	81-10-22	--	20	--	312	--	--	2.8	--	--
		82-06-17	--	19	--	303	--	--	1.8	--	--
106	SC00609826AAA1	81-09-08	.010	19	421	447	.10	.020	.12	.040	.26
		82-06-15	--	19	--	425	--	--	.33	--	--
108	SC00609922CCD1	82-06-03	--	18	--	1,154	--	--	6.1	--	--
		82-12-07	<.250	19	1,180	1,160	--	<.010	5.5	<.060	--
109	SC00609922CCD2	82-06-03	--	15	--	3,208	--	--	2.1	--	--
		82-12-07	<.250	15	4,050	3,797	--	<.010	.58	<.060	--
110	SC00609930BAD1	82-01-19	--	21	811	805	--	--	1.7	--	--
		82-11-19	<.250	22	821	837	--	<.020	1.7	<.060	--
112	SC00609932CCB1	81-08-25	.000	22	409	410	1.70	.000	1.7	.050	.66
		81-10-23	--	21	--	402	--	--	2.2	--	--
		82-06-28	--	20	--	347	--	--	2.2	--	--
		82-10-21	--	20	--	380	--	--	1.8	.080	--
		83-02-15	--	19	--	433	--	--	1.9	.070	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dis-solved (mg/L as N)	Phos-phorus, dis-solved (mg/L as P)	Phos-phate, ortho, dis-solved (mg/L as P)	O-18/ O-16, (parts per thou-sands)	Carbon, organic, dis-solved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (μg/L)
96	SC00609714BCC1	81-09-02	.42	.030	.000	-16.2	2.3	.00	--
101	SC00609723ADC1	81-09-02	.89	.050	.000	-16.1	2.5	.00	0
		81-10-22	--	--	--	--	--	--	--
		82-06-15	--	--	--	--	--	--	<1
		82-10-13	--	.050	--	--	--	--	--
		83-02-15	--	.060	--	--	2.7	--	2
104	SC00609736DCA1	81-10-22	--	--	--	--	--	--	--
		82-06-17	--	--	--	--	--	--	--
106	SC00609826AAA1	81-09-08	.30	.040	.070	-16.6	2.6	<.01	2
		82-06-15	--	--	--	--	--	--	--
108	SC00609922CCD1	82-06-03	--	--	--	--	--	--	--
		82-12-07	2.7	.050	<.010	--	6.1	<.01	3
109	SC00609922CCD2	82-06-03	--	--	--	--	--	--	--
		82-12-07	1.7	.020	<.010	--	4.9	<.01	4
110	SC00609930BAD1	82-01-19	--	--	--	--	--	--	--
		82-11-19	1.0	.010	<.010	--	3.3	<.01	<1
112	SC00609932CCB1	81-08-25	.71	.070	.060	--	4.0	.00	0
		81-10-23	--	--	--	--	--	--	--
		82-06-28	--	--	--	--	--	--	--
		82-10-21	--	.070	--	--	--	--	--
		83-02-15	--	.050	--	--	5.2	--	3

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
115	SC00610016ABC1	82-10-12	1345	1.3	475	8.0	5.0	233	60	20	23
		83-02-15	0925	1.4	500	8.1	5.0	216	55	19	22
116	SC00610016CAD1	81-08-13	1200	.6	660	7.6	12.0	282	68	27	41
		81-11-13	1430	.5	675	7.7	6.0	288	69	28	39
		82-06-24	1430	2.3	645	7.7	8.5	298	73	28	42
118	SC00610034CBC1	81-08-25	1300	.7	605	7.8	7.0	261	68	22	35
		81-10-23	1100	.4	570	7.8	5.5	255	66	22	34
122	SC00709610BDD1	82-04-20	1030	.3	4,900	8.0	5.5	1,143	110	210	880
		82-11-17	1000	.1	4,650	8.4	4.5	1,167	120	210	870
124	SC00709702DCB1	81-09-02	1030	1.4	865	8.1	9.0	343	74	38	70
		81-10-22	1030	1.2	830	7.3	9.0	354	77	39	72
		82-06-17	1300	3.4	820	7.9	7.0	315	68	35	65
		82-10-13	0915	1.6	850	8.3	8.0	331	71	37	69
		83-02-15	1215	.7	890	7.9	5.0	335	71	38	68
125	SC00709705BDB1	82-11-16	1100	30	970	7.8	6.5	423	83	52	64
127	SC00709713BAC1	81-09-02	0945	--	450	8.3	10.0	194	56	13	21
129	SC00709802CAB1	82-12-07	1300	5.2	2,400	8.3	10.0	1,104	210	140	210
130	SC00709926CCB1	82-02-03	1330	<3.0	1,790	7.8	8.5	666	102	100	190
131	SC00709926CCB2	82-02-03	1340	7.2	1,740	7.6	9.0	663	100	100	180
		82-11-23	1215	3.8	1,675	8.0	9.0	615	92	93	170

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
115	SC00610016ABC1	82-10-12	18	.7	.3	246	--	21	2.6	.1	--
		83-02-15	18	.7	.4	246	--	19	1.6	.1	--
116	SC00610016CAD1	81-08-13	24	1.1	.2	310	.2	29	1.6	.1	.00
		81-11-13	23	1.0	.6	330	--	41	2.5	.2	--
		82-06-24	23	1.1	1.7	337	--	28	2.3	.2	--
118	SC00610034CBC1	81-08-25	23	1.0	.5	250	.6	73	2.9	.1	.00
		81-10-23	22	1.0	.5	240	--	80	3.1	.1	--
122	SC00709610BDD1	82-04-20	63	11	4.8	490	--	2,300	38	.5	--
		82-11-17	62	11	4.7	531	.5	2,400	34	.5	.12
124	SC00709702DCB1	81-09-02	31	1.7	.9	320	.0	160	4.4	.2	.00
		81-10-22	31	1.7	.9	320	--	160	4.7	.2	--
		82-06-17	31	1.6	.7	317	--	130	4.3	.2	--
		82-10-13	31	1.7	.9	342	--	140	4.2	.2	--
		83-02-15	31	1.7	.8	340	<.5	150	4.2	.2	--
125	SC00709705BDB1	82-11-16	25	1.4	2.4	419	.8	140	7.1	.6	<.01
127	SC00709713BAC1	81-09-02	19	.7	3.3	200	.1	47	1.2	.1	.00
129	SC00709802CAB1	82-12-07	29	2.8	4.2	376	.5	1,100	11	.6	.08
130	SC00709926CCB1	82-02-03	38	3.3	2.6	410	--	620	7.8	.3	--
131	SC00709926CCB2	82-02-03	--	3.1	--	440	--	590	7.6	.3	--
		82-11-23	38	3.0	2.1	447	<.5	550	8.4	.3	.13

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Iodide, dis-solved (mg/L as I)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Nitro-gen, organic, dis-solved (mg/L as N)
115	SC00610016ABC1	82-10-12	--	22	--	297	--	--	1.3	.070	--
		83-02-15	--	21	--	286	--	--	1.4	<.060	--
116	SC00610016CAD1	81-08-13	.000	26	402	382	.52	.020	.54	.130	.42
		81-11-13	--	22	--	401	--	--	1.0	--	--
		82-06-24	--	24	--	402	--	--	.91	--	--
118	SC00610034CBC1	81-08-25	.000	19	378	377	1.30	.000	1.3	.030	.85
		81-10-23	--	19	--	369	--	--	1.3	--	--
122	SC00709610BDD1	82-04-20	--	12	--	3,852	--	--	.13	--	--
		82-11-17	<.250	12	4,010	3,973	--	<.020	.16	<.060	--
124	SC00709702DCB1	81-09-02	.000	18	538	561	.55	.010	.56	.050	.48
		81-10-22	--	19	--	566	--	--	.78	--	--
		82-06-17	--	18	--	512	--	--	1.1	--	--
		82-10-13	--	18	--	547	--	--	.82	<.060	--
		83-02-15	--	17	--	554	--	--	.77	<.060	--
125	SC00709705BDB1	82-11-16	<.250	20	632	622	--	<.020	.96	.060	.54
127	SC00709713BAC1	81-09-02	.000	22	290	285	.02	.060	.08	.070	.81
129	SC00709802CAB1	82-12-07	<.250	14	1,960	1,919	--	<.010	11	<.060	--
130	SC00709926CCB1	82-02-03	--	19	--	1,288	--	--	.20	--	--
131	SC00709926CCB2	82-02-03	--	18	1,340	--	--	--	.50	--	--
		82-11-23	<.250	19	1,250	1,205	--	<.020	.20	<.060	--

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dis- solved (mg/L as N)	Phos- phorus, dis- solved (mg/L as P)	Phos- phate, ortho, dis- solved (mg/L as P)	O-18/ O-16, (parts per thou- sand)	Carbon, organic, dis- solved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (µg/L)
115	SC00610016ABC1	82-10-12	--	.070	--	--	--	--	--
		83-02-15	--	.020	--	--	--	--	--
116	SC00610016CAD1	81-08-13	.55	.100	.110	-15.6	5.0	.01	14
		81-11-13	--	--	--	--	--	--	--
		82-06-24	--	--	--	--	--	--	7
118	SC00610034CBC1	81-08-25	.88	.050	.060	-16.3	2.6	.00	1
		81-10-23	--	--	--	--	--	--	--
122	SC00709610BDD1	82-04-20	--	--	--	--	--	--	--
		82-11-17	.60	.010	<.010	--	--	<.01	4
124	SC00709702DCB1	81-09-02	.53	.030	.000	--	1.9	.00	--
		81-10-22	--	--	--	--	--	--	--
		82-06-17	--	--	--	--	--	--	--
		82-10-13	--	.020	--	--	--	--	--
		83-02-15	--	.040	--	--	3.0	--	9
125	SC00709705BDB1	82-11-16	.60	.030	<.010	--	4.1	<.01	7
127	SC00709713BAC1	81-09-02	.88	.100	.040	-15.7	9.6	.00	8
129	SC00709802CAB1	82-12-07	3.2	.020	<.010	--	9.4	<.01	--
130	SC00709926CCB1	82-02-03	--	--	--	--	--	--	--
131	SC00709926CCB2	82-02-03	--	--	--	--	--	--	--
		82-11-23	.70	.020	.020	--	3.8	<.01	29

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Flow rate, instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
132	SC00709927ACD1	82-02-03	1400	6.1	1,550	7.5	7.0	616	96	91	150
		82-11-23	1245	6.9	1,420	7.6	7.5	551	83	83	140
133	SC00710005BCC1	81-08-25	1100	.4	665	7.1	10.0	289	69	28	47
		81-10-23	1015	.4	680	7.7	7.5	283	65	29	48
		82-06-28	0945	3.0	670	7.7	7.0	256	61	25	42
		82-10-21	1000	.7	665	8.1	8.0	277	66	27	47
		83-02-15	0820	--	690	8.3	--	271	62	28	46
134	SC00710008DDB1	81-12-17	1015	7.6	810	8.1	6.0	344	67	43	51
135	SC00710009ACD1	81-12-17	1000	E75	900	7.8	7.5	350	64	46	71
136	SC00710026DCB1	81-12-15	1300	E3.0	990	8.4	2.0	438	86	54	61
		82-11-23	1400	6.0	890	7.9	.0	398	75	51	63
137	SC00710127ADC1	81-08-25	0830	--	1,140	7.3	8.5	437	79	58	110
		81-10-23	0900	4.0	1,160	7.6	8.0	444	80	59	110
		82-10-21	0830	4.0	1,100	7.8	8.0	413	76	54	100
138	SC00809915DAC1	82-07-21	1300	5.4	2,225	7.4	11.0	701	130	91	240
139	SC00809916DCD1	81-12-15	0900	.7	2,275	8.1	8.5	896	160	120	240
		82-11-23	1000	4.0	2,250	7.5	9.5	912	150	130	250
140	SC00809927ADB1	81-12-17	1300	E1.5	2,340	8.5	3.0	988	180	130	200
141	SC00810012DCB1	81-12-15	1015	5.3	1,440	7.7	9.5	539	98	71	120
		82-12-23	0930	4.4	1,500	7.5	9.5	610	110	80	130

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Per-cent sodium	Sodium ad-sorp-tion ratio	Potas-sium, dis-solved (mg/L as K)	Alka-linity, lab, (mg/L as $CaCO_3$)	Sulfide, total (mg/L as S)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)
132	SC00709927ACD1	82-02-03	35	2.7	2.3	430	--	490	6.9	.3	--
		82-11-23	36	2.7	2.0	423	.6	440	7.3	.3	.13
133	SC00710005BCC1	81-08-25	26	1.2	.7	280	.6	93	4.3	.1	.00
		81-10-23	27	1.3	.7	280	--	90	4.4	.2	--
		82-06-28	26	1.2	.6	264	--	69	3.3	.2	--
		82-10-21	27	1.3	.6	268	--	91	4.3	.1	--
		83-02-15	27	1.3	.6	282	--	88	4.4	.1	--
134	SC00710008DDB1	81-12-17	24	1.2	.9	290	--	130	19	.2	--
135	SC00710009ACD1	81-12-17	31	1.7	1.1	330	--	170	4.0	.3	--
136	SC00710026DCB1	81-12-15	23	1.3	1.8	340	--	230	3.6	.3	--
		82-11-23	26	1.4	1.9	368	<.5	170	3.3	.2	<.01
137	SC00710127ADC1	81-08-25	35	2.3	1.6	350	.5	280	4.8	.2	.10
		81-10-23	35	2.3	1.5	350	--	300	4.9	.3	--
		82-10-21	34	2.2	1.7	265	--	300	4.8	.2	--
138	SC00809915DAC1	82-07-21	43	4.0	2.7	382	--	820	8.3	.4	--
139	SC00809916DCD1	81-12-15	37	3.6	3.2	440	.5	880	11	.3	--
	SC00809916DCD1	82-11-23	37	3.7	3.1	467	<.5	20	9.6	.2	.13
140	SC00809927ADB1	81-12-17	31	2.8	2.1	240	.4	1,000	10	.1	--
141	SC00810012DCB1	81-12-15	33	2.3	1.7	410	.4	420	4.9	.2	--
		82-11-23	32	2.6	1.6	431	<.55	470	6.5	.2	.13

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Iodide, dis-solved (mg/L as I)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Nitro-gen, organic, dis-solved (mg/L as N)
132	SC00709927ACD1	82-02-03	--	19	1,150	1,115	--	--	.41	--	--
		82-11-23	<.250	19	1,020	1,030	--	<.020	.24	<.060	--
133	SC00710005BCC1	81-08-25	.010	20	437	436	.99	.000	.99	.070	.57
		81-10-23	--	21	--	427	--	--	1.0	--	--
		82-06-28	--	19	--	379	--	--	1.6	--	--
		82-10-21	--	20	--	418	--	--	.85	.070	--
		83-02-15	--	18	--	417	--	--	.69	<.060	--
134	SC00710008DDB1	81-12-17	--	23	--	508	--	--	.60	--	--
135	SC00710009ACD1	81-12-17	--	23	559	578	--	--	.42	--	--
136	SC00710026DCB1	81-12-15	--	23	660	665	--	--	.86	--	--
		82-11-23	<.250	22	592	608	--	<.020	.98	<.060	--
137	SC00710127ADC1	81-08-25	.000	25	794	771	.14	.000	.14	.050	.52
		81-10-23	--	26	--	793	--	--	.19	--	--
		82-10-21	--	24	--	721	--	--	.23	<.060	--
138	SC00809915DAC1	82-07-21	--	13	--	1,536	--	--	.78	--	--
139	SC00809916DCD1	81-12-15	--	10	--	1,691	--	--	1.5	--	--
	SC00809916DCD1	82-11-23	<.250	11	1,760	1,757	--	<.020	1.5	<.060	--
140	SC00809927ADB1	81-12-17	--	18	--	1,687	--	--	<.10	--	--
141	SC00810012DCB1	81-12-15	--	19	--	982	--	--	<.10	--	--
		82-11-23	<.250	20	1,090	1,080	--	<.020	.10	.060	.44

Table 15.--*Analytical data for inorganic and nutrient constituents for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Nitrogen ammonia + organic, dis-solved (mg/L as N)	Phos-phorus, dis-solved (mg/L as P)	Phos-phate, ortho, dis-solved (mg/L as P)	O-18/ O-16, (parts per thou-sand)	Carbon, organic, dis-solved (mg/L as C)	Cyanide, total (mg/L as CN)	Phenols, total (μg/L)
132	SC00709927ACD1	82-02-03	--	--	--	--	--	--	--
		82-11-23	.60	.010	<.010	--	3.9	<.01	--
133	SC00710005BCC1	81-08-25	.64	.040	.020	-16.0	3.3	.00	0
		81-10-23	--	--	--	--	--	--	--
		82-06-28	--	--	--	--	--	--	--
		82-10-21	--	.050	--	--	--	--	--
		83-02-15	--	.020	--	--	--	--	--
134	SC00710008DDB1	81-12-17	--	--	--	--	--	--	--
135	SC00710009ACD1	81-12-17	--	--	--	--	--	--	--
136	SC00710026DCB1	81-12-15	--	--	--	--	--	--	--
		82-11-23	.60	.010	<.010	--	4.5	<.01	--
137	SC00710127ADC1	81-08-25	.57	.020	.010	-15.5	1.8	.00	1
		81-10-23	--	--	--	--	--	--	--
		82-10-21	--	.040	--	--	--	--	--
138	SC00809915DAC1	82-07-21	--	--	--	--	--	--	--
139	SC00809916DCD1	81-12-15	--	--	--	--	--	--	--
	SC00809916DCD1	82-11-23	.60	.020	<.010	--	3.4	<.01	<1
140	SC00809927ADB1	81-12-17	--	--	--	--	--	--	--
141	SC00810012DCB1	81-12-15	--	--	--	--	--	--	--
		82-11-23	.50	.020	<.010	--	3.1	<.01	<1

Table 16.--*Trace-element concentrations for springs*

[µg/L, micrograms per liter]

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
1	SC00409531DAA1	81-09-01	1200	10	3	110	--	30	<1	10	--
		81-11-10	1200	--	3	85	--	30	--	--	--
		82-05-26	1215	--	3	--	--	30	--	--	--
		82-10-07	1400	<10	3	87	<1	40	<1	<10	--
		83-02-16	0845	10	3	79	<1	40	<1	<10	--
3	SC00409635DBD1	81-09-01	1030	10	2	90	--	30	<1	0	--
4	SC00409735CDC1	81-11-12	1230	--	--	--	--	20	--	--	--
		82-06-08	1030	--	1	93	1	20	<1	--	<3
		82-10-26	1000	<10	1	100	<1	30	<1	<10	--
9	SC00509319DBD1	81-07-29	1430	10	1	40	--	70	<1	10	--
10	SC00509329DBA1	81-07-29	1230	10	2	40	<1	110	2	10	<3
		81-11-04	0930	--	2	--	--	110	--	--	--
		82-09-23	1500	<10	2	47	<1	120	<1	<10	--
18	SC00509416BDC1	81-08-19	1615	0	5	80	--	20	<1	0	--
21	SC00509420ABB1	81-08-19	1115	0	3	90	--	20	<1	0	--
		82-06-30	1615	--	3	75	<1	20	<1	--	<3
25	SC00509423CCC1	81-08-18	1430	0	4	80	--	10	<1	0	--
		81-11-04	1100	--	--	--	--	20	--	--	--
		82-06-30	1245	--	3	62	<1	20	<1	--	<3
		82-09-23	1100	<10	4	84	<1	30	<1	<10	--
		83-02-16	1000	10	4	80	<1	20	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis-solved (μg/L as Cu)	Iron, dis-solved (μg/L as Fe)	Lead, dis-solved (μg/L as Pb)	Lithium, dis-solved (μg/L as Li)	Manga-nese, dis-solved (μg/L as Mn)	Mercury, dis-solved (μg/L as Hg)	Molyb-denum, dis-solved (μg/L as Mo)	Nickel, dis-solved (μg/L as Ni)
1	SC00409531DAA1	81-09-01	0	<10	2	18	28	.0	<10	--
		81-11-10	--	--	--	--	--	--	<10	--
		82-05-26	--	--	--	12	3	--	5	--
		82-10-07	1	4	<1	27	5	.2	5	<1
		83-02-16	1	4	1	17	1	<.1	3	1
3	SC00409635DBD1	81-09-01	1	<10	1	11	1	.0	<10	--
4	SC00409735CDC1	81-11-12	--	--	--	--	--	--	--	--
		82-06-08	<10	<3	<10	14	<1	--	<10	--
		82-10-26	1	13	<1	16	<1	<.1	3	<1
9	SC00509319DBD1	81-07-29	1	10	2	31	2	.0	12	--
10	SC00509329DBA1	81-07-29	1	15	1	29	2	.0	18	--
		81-11-04	--	--	--	--	--	--	20	--
		82-09-23	1	<3	<1	27	1	<.1	11	3
18	SC00509416BDC1	81-08-19	1	<10	1	10	7	.0	<10	--
21	SC00509420ABB1	81-08-19	1	15	1	9	3	.0	<10	--
		82-06-30	<10	4	<10	9	<1	--	<10	--
25	SC00509423CCC1	81-08-18	1	<10	1	14	2	.0	<10	--
		81-11-04	--	--	--	--	--	--	--	--
		82-06-30	<10	<3	<10	8	1	--	<10	--
		82-09-23	2	<3	<1	10	1	<.1	3	1
		83-02-16	1	<3	1	8	<1	<.1	1	<1

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
1	SC00409531DAA1	81-09-01	1	1,900	10	<3
		81-11-10	.1	2,000	--	--
		82-05-26	1	1,100	12	<12
		82-10-07	1	1,700	9.2	10
		83-02-16	1	1,900	11	4
3	SC00409635DBD1	81-09-01	1	1,000	10	7
4	SC00409735CDC1	81-11-12	--	--	13	--
		82-06-08	--	830	12	7
		82-10-26	1	840	13	6
9	SC00509319DBD1	81-07-29	4	780	5.0	11
10	SC00509329DBA1	81-07-29	3	730	5.0	10
		81-11-04	2	710	--	--
		82-09-23	3	710	7.2	3
18	SC00509416BDC1	81-08-19	0	700	8.0	19
21	SC00509420ABB1	81-08-19	0	840	11	37
		82-06-30	--	700	8.0	<3
25	SC00509423CCC1	81-08-18	0	940	11	4
		81-11-04	--	--	--	--
		82-06-30	--	720	9.0	4
		82-09-23	<1	930	13	10
		83-02-16	1	970	17	5

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
32	SC00509502BCA1	82-07-20	1515	--	--	--	--	130	--	--	--
33	SC00509503ADA1	82-05-26	1600	--	--	--	--	50	--	--	--
34	SC00509505ABA1	81-09-01	1330	10	3	70	--	20	<1	0	--
		81-11-10	1130	--	--	--	--	10	--	--	--
36	SC00509514BCD1	81-08-19	0830	0	3	120	--	10	<1	0	--
		81-11-10	1400	--	--	--	--	10	--	--	--
		82-06-30	1530	--	3	97	<1	20	<1	--	<3
		82-09-23	1345	<10	3	120	<1	20	<1	<10	--
		83-02-16	0930	10	3	120	<1	10	<1	<10	--
37	SC00509522DDC1	83-03-02	1130	--	1	110	--	100	--	--	<1
38	SC00509536BAD1	81-08-18	1730	0	5	80	--	10	<1	0	--
		81-11-05	1230	--	--	--	--	20	--	--	--
		82-06-30	1445	--	5	67	1	20	<1	--	<3
		82-09-23	1230	<10	4	74	<1	30	<1	<10	--
		83-02-16	0945	10	5	74	<1	20	<1	<10	--
40	SC00509605CCD1	82-06-09	1400	--	1	47	1	40	<1	--	<3
43	SC00509608BBD1	81-09-16	1130	570	2	300	--	60	<1	0	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis-solved (µg/L as Cu)	Iron, dis-solved (µg/L as Fe)	Lead, dis-solved (µg/L as Pb)	Lithium, dis-solved (µg/L as Li)	Manga-nese, dis-solved (µg/L as Mn)	Mercury, dis-solved (µg/L as Hg)	Molyb-denum, dis-solved (µg/L as Mo)	Nickel, dis-solved (µg/L as Ni)
32	SC00509502BCA1	82-07-20	--	--	--	27	--	--	--	--
33	SC00509503ADA1	82-05-26	--	--	--	--	--	--	--	--
34	SC00509505ABA1	81-09-01	3	<10	1	15	1	.0	<10	--
		81-11-10	--	--	--	--	--	--	--	--
36	SC00509514BCD1	81-08-19	1	<10	1	11	3	.0	<10	--
		81-11-10	--	--	--	--	--	--	--	--
		82-06-30	<10	25	<10	8	1	--	<10	--
		82-09-23	3	<3	<1	11	<1	<.1	4	1
		83-02-16	1	<3	<1	8	<1	<.1	2	1
37	SC00509522DDC1	83-03-02	--	6	--	23	3	--	8	2
38	SC00509536BAD1	81-08-18	1	<10	1	17	2	.1	<10	--
		81-11-05	--	--	--	--	--	--	--	--
		82-06-30	<10	11	<10	14	5	--	<10	--
		82-09-23	2	<3	<1	14	<1	<.1	4	4
		83-02-16	1	4	<1	20	2	<.1	3	2
40	SC00509605CCD1	82-06-09	<10	<3	<10	17	12	--	<10	--
43	SC00509608BBD1	81-09-16	3	20	3	8	87	.0	10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (μg/L as Se)	Strontium, dissolved (μg/L as Sr)	Vanadium, dissolved (μg/L as V)	Zinc, dissolved (μg/L as Zn)
32	SC00509502BCA1	82-07-20	--	1,500	1.9	--
33	SC00509503ADA1	82-05-26	--	--	--	--
34	SC00509505ABA1	81-09-01	1	1,400	10	6
		81-11-10	--	--	--	--
36	SC00509514BCD1	81-08-19	1	1,500	13	65
		81-11-10	--	--	--	--
		82-06-30	--	1,200	11	3
		82-09-23	1	1,400	14	4
		83-02-16	1	1,500	17	<3
37	SC00509522DDC1	83-03-02	--	1,500	5.9	<3
38	SC00509536BAD1	81-08-18	1	1,500	13	4
		81-11-05	--	--	--	--
		82-06-30	--	1,200	14	43
		82-09-23	1	1,300	14	10
		83-02-16	1	1,400	16	<3
40	SC00509605CCD1	82-06-09	--	1,000	<6.0	4
43	SC00509608BBD1	81-09-16	0	1,100	10	5

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (μg/L as Al)	Arsenic, dissolved (μg/L as As)	Barium, dissolved (μg/L as Ba)	Beryllium, dissolved (μg/L as Be)	Boron, dissolved (μg/L as B)	Cadmium, dissolved (μg/L as Cd)	Chromium, dissolved (μg/L as Cr)	Cobalt, dissolved (μg/L as Co)
44	SC00509610DDD1	82-12-15	1030	--	3	100	--	300	--	--	<1
46	SC00509625CBA1	82-12-15	1430	--	3	58	--	150	--	--	--
49	SC00509708CBD1	81-09-16	1500	20	1	150	--	20	<1	0	--
50	SC00509710CCD1	81-09-16	1630	20	3	130	--	20	<1	0	--
51	SC00509712AAA1	81-11-12	1130	--	2	81	--	30	--	--	--
		82-06-09	1215	--	2	74	1	30	<1	--	<3
52	SC00509720DBA1	81-09-16	1400	10	4	63	--	50	<1	0	--
		81-11-20	1045	--	4	61	--	40	--	--	--
		82-06-14	1500	--	3	59	<1	50	<1	--	<3
		83-02-15	1410	10	4	59	1	50	<1	<10	--
56	SC00509725BCB1	81-09-16	1230	20	4	89	--	30	<1	0	--
		81-11-12	1400	--	--	--	--	20	--	--	--
		82-06-09	1600	--	4	73	1	20	1	--	<3
		82-10-13	1400	10	4	84	<1	30	<1	<10	--
		83-02-15	1330	10	5	82	1	30	<1	<10	--
58	SC00509727DCA1	81-09-08	1545	0	5	100	--	30	<1	10	--
60	SC00509735BCA1	81-11-12	1500	--	5	77	--	20	--	--	--
		82-06-09	1630	--	4	68	1	30	1	--	<3
		82-10-13	1330	10	4	75	<1	30	<1	<10	--
		83-02-15	1400	10	4	77	1	30	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis- solved (µg/L as Cu)	Iron, dis- solved (µg/L as Fe)	Lead, dis- solved (µg/L as Pb)	Lithium, dis- solved (µg/L as Li)	Manga- nese, dis- solved (µg/L as Mn)	Mercury, dis- solved (µg/L as Hg)	Molyb- denum, dis- solved (µg/L as Mo)	Nickel, dis- solved (µg/L as Ni)
44	SC00509610DDD1	82-12-15	--	30	--	30	20	--	100	4
46	SC00509625CBA1	82-12-15	--	--	--	37	--	--	19	--
49	SC00509708CBD1	81-09-16	1	<10	2	<4	41	.0	<10	--
50	SC00509710CCD1	81-09-16	1	<10	1	6	38	.0	10	--
51	SC00509712AAA1	81-11-12	--	--	--	9	--	--	<10	--
		82-06-09	<10	<3	<10	13	2	--	<10	--
52	SC00509720DBA1	81-09-16	0	<10	1	27	<1	.0	<10	--
		81-11-20	--	--	--	--	--	--	<10	--
		82-06-14	<10	<3	<10	24	<1	--	20	--
		83-02-15	2	46	2	24	<1	<.1	11	<1
56	SC00509725BCB1	81-09-16	2	<10	1	11	<1	.0	<10	--
		81-11-12	--	--	--	--	--	--	--	--
		82-06-09	<10	5	<10	15	2	--	<10	--
		82-10-13	<1	<3	<1	13	<1	<.1	5	<1
		83-02-15	1	5	<1	22	1	<.1	4	3
58	SC00509727DCA1	81-09-08	5	<10	0	6	11	.0	<10	--
60	SC00509735BCA1	81-11-12	--	--	--	11	--	--	<10	--
		82-06-09	<10	5	<10	14	2	--	10	--
		82-10-13	2	<3	2	10	<1	<.1	7	<1
		83-02-15	1	4	<1	19	2	<.1	6	1

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
44	SC00509610DDD1	82-12-15	--	2,400	--	20
46	SC00509625CBA1	82-12-15	2	1,100	--	8
49	SC00509708CBD1	81-09-16	0	840	4.0	<3
50	SC00509710CCD1	81-09-16	0	930	12	<3
51	SC00509712AAA1	81-11-12	<1	1,200	8.0	--
		82-06-09	--	1,000	<6.0	5
52	SC00509720DBA1	81-09-16	1	2,000	11	<3
		81-11-20	<1	1,900	10	--
		82-06-14	--	1,800	8.0	5
		83-02-15	1	1,800	13	35
56	SC00509725BCB1	81-09-16	1	980	15	<3
		81-11-12	--	--	14	--
		82-06-09	--	760	15	8
		82-10-13	1	860	16	<3
		83-02-15	1	900	18	<3
58	SC00509727DCA1	81-09-08	1	1,200	16	<3
60	SC00509735BCA1	81-11-12	1	1,000	14	--
		82-06-09	--	870	15	6
		82-10-13	2	950	16	8
		83-02-15	1	1000	20	6

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
61	SC00509801DDD1	81-09-16	1600	10	2	140	--	30	<1	0	--
		81-11-20	1300	--	2	90	--	20	--	--	--
		82-06-14	1145	--	2	120	<1	30	<1	--	<3
		82-10-26	1045	<10	5	86	<1	30	<1	<10	--
		83-02-15	1430	10	3	86	<1	30	<1	<10	--
64	SC00509905ADC1	81-09-23	1200	0	4	120	--	30	<1	0	--
		82-06-22	1000	--	5	81	<1	50	<1	--	<3
		82-11-03	1100	<10	4	100	1	30	<1	<10	--
66	SC00509913CAB1	81-09-23	1330	0	5	87	--	30	<1	0	--
		82-06-22	1100	--	5	80	<1	40	<1	--	<3
		82-11-03	1300	10	5	89	1	40	<1	<10	--
		83-02-15	1100	10	7	88	<1	40	<1	<10	--
71	SC00509928ACB1	81-11-13	1200	--	--	86	--	40	--	--	--
72	SC00509928ACB2	82-06-24	0935	--	8	67	<1	50	<1	--	<3
		82-10-12	1030	10	8	84	1	50	<1	<10	--
75	SC00510012ABD1	81-11-13	1100	--	--	62	--	20	--	--	--
		82-06-24	0815	--	4	52	<1	20	<1	--	<3
		82-10-12	0930	10	4	60	1	20	<1	10	--
		83-02-15	1030	10	4	62	<1	20	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis-solved (µg/L as Cu)	Iron, dis-solved (µg/L as Fe)	Lead, dis-solved (µg/L as Pb)	Lithium, dis-solved (µg/L as Li)	Manga-nese, dis-solved (µg/L as Mn)	Mercury, dis-solved (µg/L as Hg)	Molyb-denum, dis-solved (µg/L as Mo)	Nickel, dis-solved (µg/L as Ni)
61	SC00509801DDD1	81-09-16	2	<10	1	13	23	.0	<10	--
		81-11-20	--	--	--	15	--	--	<10	--
		82-06-14	<10	<3	<10	11	10	--	<10	--
		82-10-26	<1	4	1	19	<1	<.1	3	1
		83-02-15	<1	4	1	18	19	<.1	1	2
64	SC00509905ADC1	81-09-23	2	<10	0	14	64	.0	<10	--
		82-06-22	<10	3	10	16	10	--	20	--
		82-11-03	2	12	<1	15	21	<.1	5	<1
66	SC00509913CAB1	81-09-23	1	<10	0	14	<1	.0	<10	--
		82-06-22	<10	<3	<10	18	2	--	<10	--
		82-11-03	1	8	<1	18	2	<.1	7	<1
		83-02-15	1	<3	<1	21	<1	<.1	7	<1
71	SC00509928ACB1	81-11-13	--	--	--	--	--	--	--	--
72	SC00509928ACB2	82-06-24	<10	4	<10	25	<1	--	20	--
		82-10-12	2	<3	<1	30	<1	<.1	31	<1
75	SC00510012ABD1	81-11-13	--	--	--	--	--	--	--	--
		82-06-24	<10	4	<10	14	<1	--	<10	--
		82-10-12	<1	14	<1	9	4	<.1	4	<1
		83-02-15	1	10	<1	5	20	<.1	3	<1

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
61	SC00509801DDD1	81-09-16	0	1600	9.0	<3
		81-11-20	1	1600	10	--
		82-06-14	--	1400	9.0	<3
		82-10-26	1	1600	13	3
		83-02-15	1	1600	11	18
64	SC00509905ADC1	81-09-23	2	1100	13	<3
		82-06-22	--	1100	9.0	4
		82-11-03	2	930	7.1	9
66	SC00509913CAB1	81-09-23	2	870	14	<3
		82-06-22	--	760	14	<3
		82-11-03	2	870	12	13
		83-02-15	2	860	18	4
71	SC00509928ACB1	81-11-13	--	1000	18	--
72	SC00509928ACB2	82-06-24	--	710	18	8
		82-10-12	3	900	17	<3
75	SC00510012ABD1	81-11-13	--	450	13	--
		82-06-24	--	380	15	6
		82-10-12	1	440	14	22
		83-02-15	1	450	18	4

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
76	SC00510023DCC1	81-08-13	1600	0	10	90	--	30	<1	0	--
77	SC00510027BCA1	81-11-13	1600	10	8	84	--	20	--	--	--
78	SC00510027DAD1	81-08-13	1430	0	6	80	--	60	<1	0	--
		82-06-24	1300	--	5	73	<1	20	<1	--	<3
		82-10-12	1300	10	5	80	1	20	<1	<10	--
79	SC00510034DDD1	81-11-13	1530	--	8	89	--	20	--	--	--
81	SC00510036BBA1	81-08-13	1800	0	9	70	--	60	<1	0	--
83	SC00609406CBA1	81-08-18	1230	10	6	70	--	20	<1	0	--
86	SC00609528BAC1	82-04-20	1330	--	--	--	--	180	--	--	--
87	SC00609702CBD2	81-10-22	1300	--	5	--	--	20	--	--	--
		82-06-15	1345	--	3	78	1	10	<1	--	<3
88	SC00609703DAC1	81-09-08	1000	10	2	100	--	10	<1	0	--
		82-06-15	1100	--	--	--	--	10	--	--	--
90	SC00609704DCA1	81-09-08	1100	10	4	82	--	20	<1	0	--
		81-10-22	1200	--	--	--	--	20	--	--	--
		82-06-15	1015	--	4	68	<1	20	<1	--	<3
		82-10-13	1200	10	4	82	1	20	<1	20	--
		83-02-15	1320	10	4	85	1	20	<1	<10	--
91	SC00609705BBD1	81-09-08	1500	0	5	86	--	20	<1	0	--
93	SC00609707DAD1	81-09-08	1230	0	5	150	--	20	<1	0	--
94	SC00609711BCA1	81-09-02	1330	10	3	110	--	20	<1	10	--
95	SC00609712AAB1	81-09-02	1400	10	4	63	--	20	<1	0	--
		83-02-15	1300	10	5	61	<1	30	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis-solved (µg/L as Cu)	Iron, dis-solved (µg/L as Fe)	Lead, dis-solved (µg/L as Pb)	Lithium, dis-solved (µg/L as Li)	Manga-nese, dis-solved (µg/L as Mn)	Mercury, dis-solved (µg/L as Hg)	Molyb-denum, dis-solved (µg/L as Mo)	Nickel, dis-solved (µg/L as Ni)
76	SC00510023DCC1	81-08-13	3	<10	0	16	<1	.0	15	--
77	SC00510027BCA1	81-11-13	--	--	--	10	--	--	<10	--
78	SC00510027DAD1	81-08-13	3	<10	0	11	1	.0	12	--
		82-06-24	<10	6	<10	12	<1	--	20	--
		82-10-12	3	<3	<1	11	<1	<.1	11	<1
79	SC00510034DDD1	81-11-13	--	--	--	12	--	--	<10	--
81	SC00510036BBA1	81-08-13	3	<10	1	18	<1	.0	<10	--
83	SC00609406CBA1	81-08-18	2	<10	1	10	9	.0	<10	--
86	SC00609528BAC1	82-04-20	--	--	--	60	--	--	--	--
87	SC00609702CBD2	81-10-22	--	--	--	--	--	--	<10	--
		82-06-15	<10	<3	<10	14	<1	--	<10	--
88	SC00609703DAC1	81-09-08	1	<10	2	11	2	.0	<10	--
		82-06-15	--	--	--	--	--	--	--	--
90	SC00609704DCA1	81-09-08	1	<10	2	12	4	.0	<10	--
		81-10-22	--	--	--	--	--	--	--	--
		82-06-15	<10	<3	<10	14	<1	--	<10	--
		82-10-13	<1	<3	1	17	<1	<.1	4	<1
		83-02-15	1	5	1	13	<1	.4	3	2
91	SC00609705BBD1	81-09-08	4	11	0	8	36	.0	<10	--
93	SC00609707DAD1	81-09-08	2	<10	1	11	30	.0	<10	--
94	SC00609711BCA1	81-09-02	1	<10	3	8	9	.0	<10	--
95	SC00609712AAB1	81-09-02	0	<10	4	7	1	.0	20	--
		83-02-15	1	<3	1	8	<1	<.1	6	<1

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
76	SC00510023DCC1	81-08-13	1	870	14	<3
77	SC00510027BCA1	81-11-13	<1	710	14	--
78	SC00510027DAD1	81-08-13	1	520	15	99
		82-06-24	--	520	14	7
		82-10-12	1	530	14	21
79	SC00510034DDD1	81-11-13	1	710	15	--
81	SC00510036BBA1	81-08-13	1	630	11	<3
83	SC00609406CBA1	81-08-18	1	570	13	27
86	SC00609528BAC1	82-04-20	--	1,200	3.0	<12
87	SC00609702CBD2	81-10-22	0	920	--	--
		82-06-15	--	700	11	<3
88	SC00609703DAC1	81-09-08	1	750	12	5
		82-06-15	--	--	--	--
90	SC00609704DCA1	81-09-08	1	900	14	450
		81-10-22	--	--	--	--
		82-06-15	--	900	12	<3
		82-10-13	1	900	13	<3
		83-02-15	1	900	16	36
91	SC00609705BBD1	81-09-08	2	910	15	4
93	SC00609707DAD1	81-09-08	2	970	27	4
94	SC00609711BCA1	81-09-02	1	840	13	5
95	SC00609712AAB1	81-09-02	1	830	19	9
		83-02-15	1	800	24	3

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
96	SC00609714BCC1	81-09-02	1230	0	4	76	--	20	<1	0	--
101	SC00609723ADC1	81-09-02	1130	10	4	90	--	20	<1	10	--
		81-10-22	1110	--	4	--	--	10	--	--	--
		82-06-15	1530	--	3	69	<1	20	<1	--	<3
		82-10-13	1000	20	3	86	1	30	<1	10	--
		83-02-15	1240	10	5	86	<1	20	<1	<10	--
104	SC00609736DCA1	81-10-22	1045	--	--	--	--	20	--	--	--
		82-06-17	1100	--	4	64	<1	20	<1	--	<3
106	SC00609826AAA1	81-09-08	1330	10	5	90	--	20	<1	0	--
		82-06-15	0815	--	4	86	<1	30	<1	--	<3
108	SC00609922CCD1	82-06-03	1100	--	1	--	--	460	--	--	--
		82-12-07	0915	10	1	27	--	480	<1	<10	--
109	SC00609922CCD2	82-06-03	1130	--	1	--	--	590	--	--	--
		82-12-07	0930	20	<1	<100	--	590	<1	10	--
110	SC00609930BAD1	82-01-19	0930	--	2	29	--	--	--	--	--
		82-11-19	0900	10	2	29	--	240	<1	<10	--
112	SC00609932CCB1	81-08-25	1430	10	8	80	--	40	26	0	--
		81-10-23	1200	--	--	--	--	40	--	--	--
		82-06-28	1130	--	8	71	<1	40	<1	--	<3
		82-10-21	1130	10	7	83	3	40	<1	<10	--
		83-02-15	0900	<10	7	85	<1	40	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis-solved (μg/L as Cu)	Iron, dis-solved (μg/L as Fe)	Lead, dis-solved (μg/L as Pb)	Lithium, dis-solved (μg/L as Li)	Manga-nese, dis-solved (μg/L as Mn)	Mercury, dis-solved (μg/L as Hg)	Molyb-denum, dis-solved (μg/L as Mo)	Nickel, dis-solved (μg/L as Ni)
96	SC00609714BCC1	81-09-02	2	<10	0	12	<1	.0	<10	--
101	SC00609723ADC1	81-09-02	1	<10	4	12	13	.0	10	--
		81-10-22	--	--	--	--	--	--	<10	--
		82-06-15	<10	<3	<10	16	<1	--	<10	--
		82-10-13	1	7	2	15	5	<.1	5	<1
		83-02-15	2	7	<1	17	8	<.1	3	1
104	SC00609736DCA1	81-10-22	--	--	--	--	--	--	--	--
		82-06-17	<10	<3	<10	10	<1	--	<10	--
106	SC00609826AAA1	81-09-08	1	15	3	6	2	.0	<10	--
		82-06-15	<10	<3	<10	8	<1	--	<10	--
108	SC00609922CCD1	82-06-03	--	--	--	110	<1	--	44	--
		82-12-07	2	<3	1	100	1	<.1	45	--
109	SC00609922CCD2	82-06-03	--	--	--	640	50	--	20	--
		82-12-07	1	50	1	660	40	<.1	18	--
110	SC00609930BAD1	82-01-19	--	<10	--	32	3	--	40	--
		82-11-19	1	<3	<1	35	<1	<.1	31	--
112	SC00609932CCB1	81-08-25	3	<10	5	13	<1	.0	<10	--
		81-10-23	--	--	--	--	--	--	--	--
		82-06-28	<10	<3	<10	11	<1	--	10	--
		82-10-21	3	<3	1	18	4	<.1	14	2
		83-02-15	2	6	1	16	2	<.1	11	1

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
96	SC00609714BCC1	81-09-02	2	820	14	6
101	SC00609723ADC1	81-09-02	3	1,100	1.0	13
		81-10-22	3	1,100	--	--
		82-06-15	--	820	11	<3
		82-10-13	3	970	15	4
		83-02-15	3	1,000	16	<3
104	SC00609736DCA1	81-10-22	--	--	--	--
		82-06-17	--	520	17	4
106	SC00609826AAA1	81-09-08	3	810	17	8
		82-06-15	--	770	15	<3
108	SC00609922CCD1	82-06-03	10	1,500	1.9	6
		82-12-07	8	1,500	3.9	9
109	SC00609922CCD2	82-06-03	7	3,800	<1.0	20
		82-12-07	2	5,200	12	20
110	SC00609930BAD1	82-01-19	--	1,000	6.0	--
		82-11-19	3	1,100	9.4	5
112	SC00609932CCB1	81-08-25	5	1,300	19	<3
		81-10-23	--	--	--	--
		82-06-28	--	500	17	5
		82-10-21	4	580	17	7
		83-02-15	4	630	19	21

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
115	SC00610016ABC1	82-10-12	1345	<10	5	130	1	20	<1	<10	--
		83-02-15	0925	10	6	130	<1	20	<1	<10	--
116	SC00610016CAD1	81-08-13	1200	0	13	100	--	30	<1	0	--
		81-11-13	1430	--	11	88	--	20	--	--	--
		82-06-24	1430	--	12	140	<1	30	<1	--	<3
118	SC00610034CBC1	81-08-25	1300	10	7	90	--	20	<1	0	--
		81-10-23	1100	--	--	--	--	20	--	--	--
122	SC00709610BDD1	82-04-20	1030	--	<1	--	--	140	--	--	--
		82-11-17	1000	10	<1	<100	--	150	1	10	--
124	SC00709702DCB1	81-09-02	1030	10	4	66	--	40	<1	0	--
		81-10-22	1030	--	5	--	--	30	--	--	--
		82-06-17	1300	--	5	61	<1	30	<1	--	<3
		82-10-13	0915	20	4	66	<1	40	<1	10	--
		83-02-15	1215	10	5	63	1	40	<1	<10	--
125	SC00709705BDB1	82-11-16	1100	10	3	88	--	100	<1	<10	--
127	SC00709713BAC1	81-09-02	0945	10	3	100	--	0	<1	0	--
129	SC00709802CAB1	82-12-07	1300	10	1	<100	--	440	<1	<10	--
130	SC00709926CCB1	82-02-03	1330	--	--	--	--	110	--	--	--
131	SC00709926CCB2	82-02-03	1340	--	2	21	<1	--	<1	--	<3
		82-11-23	1215	<10	2	22	--	100	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis- solved (μg/L as Cu)	Iron, dis- solved (μg/L as Fe)	Lead, dis- solved (μg/L as Pb)	Lithium, dis- solved (μg/L as Li)	Manga- nese, dis- solved (μg/L as Mn)	Mercury, dis- solved (μg/L as Hg)	Molyb- denum, dis- solved (μg/L as Mo)	Nickel, dis- solved (μg/L as Ni)
115	SC00610016ABC1	82-10-12	<1	4	<1	10	<1	<.1	7	1
		83-02-15	2	<3	<1	6	<1	<.1	7	6
116	SC00610016CAD1	81-08-13	5	25	1	15	26	.0	20	--
		81-11-13	--	--	--	10	--	--	10	--
		82-06-24	<10	13	<10	13	210	--	20	--
118	SC00610034CBC1	81-08-25	3	<10	4	12	1	.0	16	--
		81-10-23	--	--	--	--	--	--	--	--
122	SC00709610BDD1	82-04-20	--	--	--	300	20	--	25	--
		82-11-17	1	60	1	310	10	<.1	23	--
124	SC00709702DCB1	81-09-02	2	<10	3	20	2	.0	10	--
		81-10-22	--	--	--	--	--	--	<10	--
		82-06-17	<10	5	<10	19	<1	--	<10	--
		82-10-13	1	3	<1	28	<1	<.1	8	<1
		83-02-15	1	3	1	33	2	<.1	6	3
125	SC00709705BDB1	82-11-16	2	<3	1	44	7	<.1	24	--
127	SC00709713BAC1	81-09-02	1	<10	4	6	2	.0	<10	--
129	SC00709802CAB1	82-12-07	3	40	1	180	10	<.1	51	--
130	SC00709926CCB1	82-02-03	--	--	--	--	--	--	--	--
131	SC00709926CCB2	82-02-03	<10	<10	<10	45	<1	<.1	20	--
		82-11-23	1	13	<1	61	1	<.1	19	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
115	SC00610016ABC1	82-10-12	1	410	11	<3
		83-02-15	1	400	16	13
116	SC00610016CAD1	81-08-13	1	570	21	12
		81-11-13	1	540	19	--
		82-06-24	--	560	25	19
118	SC00610034CBC1	81-08-25	2	540	16	5
		81-10-23	--	--	--	--
122	SC00709610BDD1	82-04-20	12	2,900	<1.0	20
		82-11-17	9	2,700	5.9	10
124	SC00709702DCB1	81-09-02	2	1,200	13	9
		81-10-22	2	1,100	--	--
		82-06-17	--	1,100	13	<3
		82-10-13	2	1,100	15	6
		83-02-15	2	1,200	15	<3
125	SC00709705BDB1	82-11-16	3	1,200	13	6
127	SC00709713BAC1	81-09-02	0	520	10	6
129	SC00709802CAB1	82-12-07	20	2,600	3.2	20
130	SC00709926CCB1	82-02-03	--	--	--	--
131	SC00709926CCB2	82-02-03	3	1,700	<6.0	<3
		82-11-23	2	1,600	1.5	39

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Time	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)
132	SC00709927ACD1	82-02-03	1400	--	2	32	<1	--	2	--	3
		82-11-23	1245	10	2	28	--	100	<1	<10	--
133	SC00710005BCC1	81-08-25	1100	10	7	90	--	30	<1	0	--
		81-10-23	1015	--	8	--	--	30	--	--	--
		82-06-28	0945	--	7	78	<1	30	<1	--	<3
		82-10-21	1000	<10	7	84	1	40	<1	<10	--
		83-02-15	0820	10	7	77	<1	30	<1	<10	--
134	SC00710008DDB1	81-12-17	1015	--	--	--	--	50	--	--	--
135	SC00710009ACD1	81-12-17	1000	--	4	55	--	70	--	--	--
136	SC00710026DCB1	81-12-15	1300	--	--	44	--	40	--	--	--
		82-11-23	1400	10	3	36	--	40	<1	<10	--
137	SC00710127ADC1	81-08-25	0830	10	3	30	--	30	<1	0	--
		81-10-23	0900	--	3	--	--	30	--	--	--
		82-10-21	0830	10	3	29	1	30	<1	<10	--
138	SC00809915DAC1	82-07-21	1300	--	--	--	--	90	--	--	--
139	SC00809916DCD1	81-12-15	0900	10	<1	<100	--	130	--	--	--
		82-11-23	1000	10	<1	<100	--	130	1	10	--
140	SC00809927ADB1	81-12-17	1300	10	1	<100	--	40	--	--	--
141	SC00810012DCB1	81-12-15	1015	--	1	21	--	50	--	--	--
		82-11-23	0930	10	2	21	--	50	<1	<10	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Copper, dis- solved (µg/L as Cu)	Iron, dis- solved (µg/L as Fe)	Lead, dis- solved (µg/L as Pb)	Lithium, dis- solved (µg/L as Li)	Manga- nese, dis- solved (µg/L as Mn)	Mercury, dis- solved (µg/L as Hg)	Molyb- denum, dis- solved (µg/L as Mo)	Nickel, dis- solved (µg/L as Ni)
132	SC00709927ACD1	82-02-03	<10	<10	10	35	<1	<.1	20	--
		82-11-23	1	<3	1	51	<1	<.1	19	--
133	SC00710005BCC1	81-08-25	12	<10	5	15	6	.0	25	--
		81-10-23	--	--	--	--	--	--	20	--
		82-06-28	<10	<10	<10	15	1	--	20	--
		82-10-21	2	<3	4	18	<1	<.1	24	6
		83-02-15	3	18	1	12	2	<.1	18	<1
134	SC00710008DDB1	81-12-17	--	--	--	--	--	--	--	--
135	SC00710009ACD1	81-12-17	--	<10	--	20	1	--	--	--
136	SC00710026DCB1	81-12-15	--	<10	--	17	2	--	--	--
		82-11-23	<1	<3	1	32	<1	<.1	14	--
137	SC00710127ADC1	81-08-25	3	<10	5	34	3	.0	<10	--
		81-10-23	--	--	--	--	--	--	<10	--
		82-10-21	<1	<3	2	35	27	<.1	8	1
138	SC00809915DAC1	82-07-21	--	--	--	60	--	--	--	--
139	SC00809916DCD1	81-12-15	--	40	<1	40	<10	--	18	--
		82-11-23	1	20	<1	40	10	<.1	19	--
140	SC00809927ADB1	81-12-17	--	40	<1	80	<10	--	13	--
141	SC00810012DCB1	81-12-15	--	--	--	21	--	--	<10	--
		82-11-23	1	760	<1	36	28	<.1	12	--

Table 16.--*Trace element concentrations for springs*--Continued

Site number (on plate 1)	Local identifier	Date of sample	Selenium, dissolved (µg/L as Se)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
132	SC00709927ACD1	82-02-03	3	1,600	<6.0	<3
		82-11-23	2	1,400	2.7	9
133	SC00710005BCC1	81-08-25	1	750	17	88
		81-10-23	1	790	--	--
		82-06-28	--	650	16	13
		82-10-21	2	730	18	20
		83-02-15	1	720	21	29
134	SC00710008DDB1	81-12-17	--	--	--	--
135	SC00710009ACD1	81-12-17	--	900	7.0	--
136	SC00710026DCB1	81-12-15	--	1,000	6.0	--
		82-11-23	2	900	10	13
137	SC00710127ADC1	81-08-25	3	1,200	7.0	7
		81-10-23	2	1,100	--	--
		82-10-21	3	1,000	2.5	<3
138	SC00809915DAC1	82-07-21	--	1,700	--	--
139	SC00809916DCD1	81-12-15	9	2,200	1.0	--
		82-11-23	6	2,300	.7	10
140	SC00809927ADB1	81-12-17	1	3,200	2.0	--
141	SC00810012DCB1	81-12-15	4	1,500	1.0	--
		82-11-23	3	1,600	3.2	6

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