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Thomas L. Judge, Governor

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**BUREAU OF MINES AND GEOLOGY**  
S. L. Groff, Director

**GEOHERMAL DATA-BASE STUDY:  
MINE-WATER TEMPERATURES**

**Final Report**

**by**

**D. C. Lawson and J. L. Sonderegger**

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Montana Bureau of Mines and Geology  
Montana College of Mineral Science and Technology  
Butte, Montana**

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# GEOHERMAL DATA-BASE STUDY: MINE-WATER TEMPERATURES

## FINAL REPORT

D. C. Lawson and  
J. L. Sonderegger

### ABSTRACT

Investigation of about 1,600 mines and prospects for perennial discharge resulted in the measurement of temperature, pH, specific conductance, and discharge at 80 sites to provide information for a geothermal data base. Measurements were made in the fall, winter, and late spring or early summer to provide information about seasonal variability. None of the temperatures measured exceeded the mean annual air temperature by 15°F, but three areas were noted where discharges were anomalously warm, based upon high temperatures, slight temperature variation, and quantity of discharge.

The most promising area, at the Gold Bug mine in the Little Rockies, discharges water averaging 7.3°C (12.1°F) above the mean annual air temperature. The discharge may represent water heated during circulation within the syenite intrusive body. If the syenite is enriched in uranium and thorium, an abnormal amount of heat would be produced by radioactive decay. Alternatively, the water may move through deep permeable sedimentary strata, such as the Madison Group, and be discharged to the surface through fractures in the pluton.

### INTRODUCTION

Reconnaissance studies involving the measurement of ground-water temperatures at springs and mines are one of several methods commonly employed to establish a data base that can be used to evaluate geothermal potential (Coombs and Muffler, 1973). The U.S. Geological Survey had some data on water temperatures at depth from mines in Butte (see Robertson and others, 1976, Table 1); very few mine-water temperature measurements were available for the rest of Montana. An expanded data base of mine-water temperatures in Montana seemed likely to be useful in depicting areas for further geothermal investigation.

The major difficulty in such a study is obtaining permission to collect samples, especially if they are to be collected underground from inactive mines. The senior author has been employed by the Montana Bureau of Mines and Geology (MBMG) for more than twenty years; because he knows many of the mine owners personally, obtaining permission to enter the mines and to measure discharge characteristics was greatly simplified.

Including subdistricts, there are 250 hardrock mining areas in Montana. Approximately 1,600 mines and prospects were inspected for discharge. At only 368 of these sites could a measurable discharge be found during the fall of 1976. In some districts, water was a common mining problem, and nearly all of the mines in these districts had perennial discharge, but in other districts, all mines checked in the fall were dry. Where multiple sampling sites were available, mines that were in close proximity and in the same host rock were grouped, and the most accessible high-discharge mine was picked as the sample site, because of the severity of winter sampling conditions. No anomalously warm discharges were deleted in selecting the sampling sites. This final group consisted of 80 mines and prospects. Temperature, specific conductance, pH, and discharge were measured in the fall, winter, and spring to provide information about the seasonal variability, especially of temperature and discharge.

Sample sites ranged in altitude from about 2,900 feet (885 meters) to 9,840 feet (3,000 meters). Air temperatures while the measurements were made ranged from 90°F (32°C) to -23°F (-31°C), a difference of 113°F (63°C). Snow pack at some locations was as great as 10 feet (3 meters) during winter sampling, and a few sites were "unlocatable" because of drifts of 20 feet or more.

### ACKNOWLEDGMENTS

We thank the many mine owners and operators who granted permission for this study. Without their generous cooperation the underground measurements and many of the portal measurements could not have been obtained. We especially thank Gunnar Johnson, Bun Stark, Hugh King, the Bullock Brothers, Emmett Clary, Carl Berg, Don Jenkins, Bill Hand, Jim Young, Kester Counts, The Anaconda Company, Peter Antonioli, Vernon Smith, and Donald Cripe.

We also thank Phil Farnes of the Soil Conservation Service, Snow Survey unit, for climatological data from their stations. Bob Bergantino of the Montana Bureau of Mines and Geology provided extensive assistance with the climatic data. Dale Loucks and Don Barbula assisted with the field work and data compilation. The authors, however, are solely responsible for the assumptions and the methods used to obtain calculated values and for the interpretation of all data. Manuscript reviews by Dr. Ralph King, Dr. Richard Berg, and Joseph Donovan resulted in greater clarity and brevity of presentation.

### METHODOLOGY AND RESULTS

Water temperatures were measured with a mercury thermometer with 1°C divisions until the second winter-sampling period (1978), when a new thermometer with ½°C divisions was used. Precision for all measurements is believed to be ½°C and accuracy to be within 1°C. Both thermometers agreed within 0.3°C with a calorimeter thermometer at various temperatures.

At first the pH value of the water was tested using Dual-Tint pH paper color coded in 0.3-unit increments. Some fading was encountered, but we believe that the values are accurate to ±0.5 pH units and are generally better than ±0.3 units. In 1978, ColorpHast papers were used with complete satisfaction. These values are probably within the ±0.1 pH unit accuracy claimed by the manufacturer.

The specific conductance of the mine waters was measured using a Yellow Springs Model 33 salinity-conductivity meter, using the standard 10-foot probe lead. This meter is very rugged; the ability to null the meter compensated for thermal effects to the meter's electronics. Satisfactory results were obtained, provided that the probe was kept moist and calibration solutions were carried along to check for drift (contamination of the platinum black electrodes). Nevertheless, a few readings from middle to late September, 1976, seem to be spuriously low. The data are presented in the Appendix and are listed in fall-winter-spring sequence, with raw and corrected conductance values. Temperature corrections employed in this study were taken from the U.S. Department of Agriculture, Agriculture Handbook No. 60 (1954, p. 90).

Two different methods of discharge measurement were employed, depending upon the conditions encountered. Where possible, the discharge was confined by building a dam and causing the discharge to exit through either a 2- or 4-inch diameter plastic pipe. The time required to fill a 3-gallon bucket was measured three times with a stopwatch, and the average time was used to calculate the discharge rate. This method is generally precise to about 2 or 3 percent. If the senior author questioned whether complete containment without seepage loss or adsorption was achieved, these values are not reported to three places.

If the volume of discharge was too great or if the flow could not be contained properly to employ the bucket and stopwatch method, the discharge was calculated from measured times for a wood chip to float a measured length of the channel. For this method a straight stretch of the discharge channel 12 to 20 feet

in length and even slope (gradient) was chosen. At the top, middle, and bottom of the measured channel stretch, the width and water depth were measured at each side and the middle of the channel. Figure 1 shows a typical cross section of a drainage channel. The area of the channel (A) was approximated using equation (1)

$$A = (W/2) (D_1 + D_3) + (W/4)[(D_2 - D_1) + (D_2 - D_3)] \quad (1)$$

as shown by the dashed lines in Figure 1. The average cross-sectional area was calculated using the three sets of measurements

$$A = (A_1 + A_2 + A_3)/3 \text{ ft}^2 \quad (2)$$

Similarly the average velocity was calculated from three measurements of the time required for a small wooden chip to float the length of the measured stretch

$$v = d/[(t_1 + t_2 + t_3)/3] \text{ ft/sec} \quad (4)$$

where  $v$  is the average velocity,  $d$  is the measured channel length, and each  $t$  is an elapsed time for the chip to travel the measured channel length.

Because in most discharge channels the ratio of width to depth at the center ( $W$  to  $D_2$ ) was 10 or greater, corrections for the large amount of bottom surface relative to cross-sectional area as well as for the greater-than-average velocity of the centerline surface had to be considered. Kulin and Compton (1975, p. 63) recommended a correction term of about 0.83 for large dish-shaped sections with rough beds and a float that does not extend significantly beneath the water surface. The authors have chosen to reduce this factor to 0.75 in view of the sampling conditions. The discharge rate was calculated as

$$Q = 0.75 \times A \times v \times 448.8 \text{ gal/min} \quad (5)$$

where  $Q$  is the discharge and 448.8 is a term to convert cubic feet per second to gallons per minute. Discharge measurements made by this method are marked by an asterisk (\*) in the Appendix; we believe that all of these measurements are accurate to  $\pm 20$  percent, and that most of the measurements are within 10 percent of the true value.

All of the waters tested were acid, the pH values ranging from 3.5 (Glengarry mine, Park County) to 6.8. Of 230 determinations, 19 were less than 5.0, 150 ranged from 5.0 to 5.9, and 61 from 6.0 to 6.8. The modal pH value is 5.9 and the median pH value is 5.8. Because the first pH paper used was graduated in

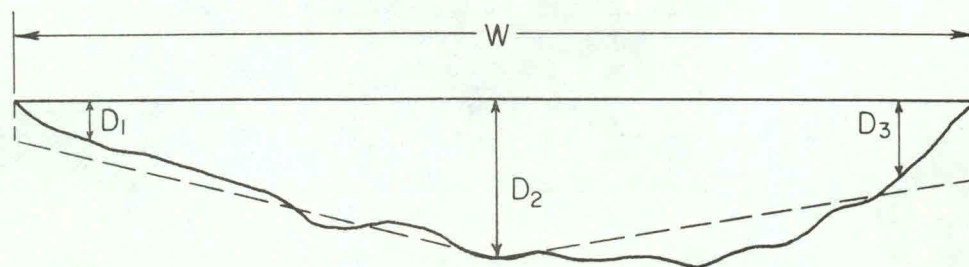


Figure 1.—Cross section of a typical discharge channel (vertical scale exaggerated).



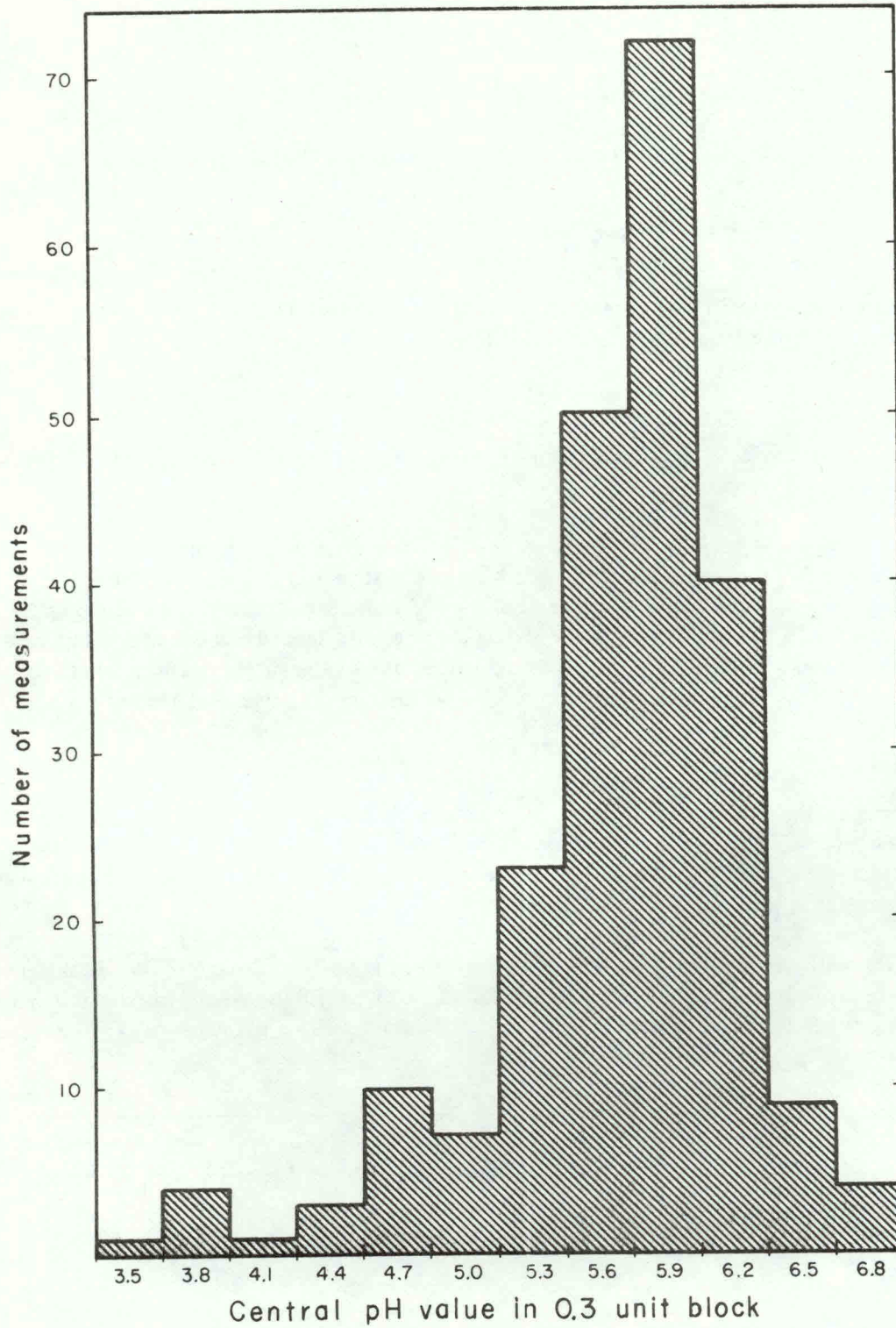


Figure 2.—Histogram depicting the frequency of pH measurements, in 0.3-unit increments.

0.3 pH unit increments, it was necessary to use the same increment size in constructing a histogram showing the frequency of the measured pH values (Fig. 2). For most of the samples, the pH is buffered by carbon dioxide, and a slight increase in pH is caused by carbonic acid attacking silicate and carbonate minerals. In the low pH waters, this effect is reversed by the oxidation of sulfide minerals.

Most of Montana's thermal springs are slightly to moderately basic (Sonderegger, Bergantino, and Miller, 1977). Consequently, should any of these discharges contain, in part, thermal water from depth, it is probable that the pH has been lowered by mixing with shallow meteoric water.

The specific-conductance measurements (232) are presented in a histogram (Fig. 3). Most of these mine discharges (70 percent) had a specific conductance of 500 micromhos per centimeter ( $\mu\text{mho}/\text{cm}$ ) or less; the modal value is in the 201-300  $\mu\text{mho}/\text{cm}$  range, and the median value is in the 301-400  $\mu\text{mho}/\text{cm}$  range. Montana's thermal springs range in specific conductance from about 200 to 2,200  $\mu\text{mho}/\text{cm}$ ; the major value of these measurements is for comparison with thermal springs in adjacent areas to estimate roughly the range of possible dilution involved.

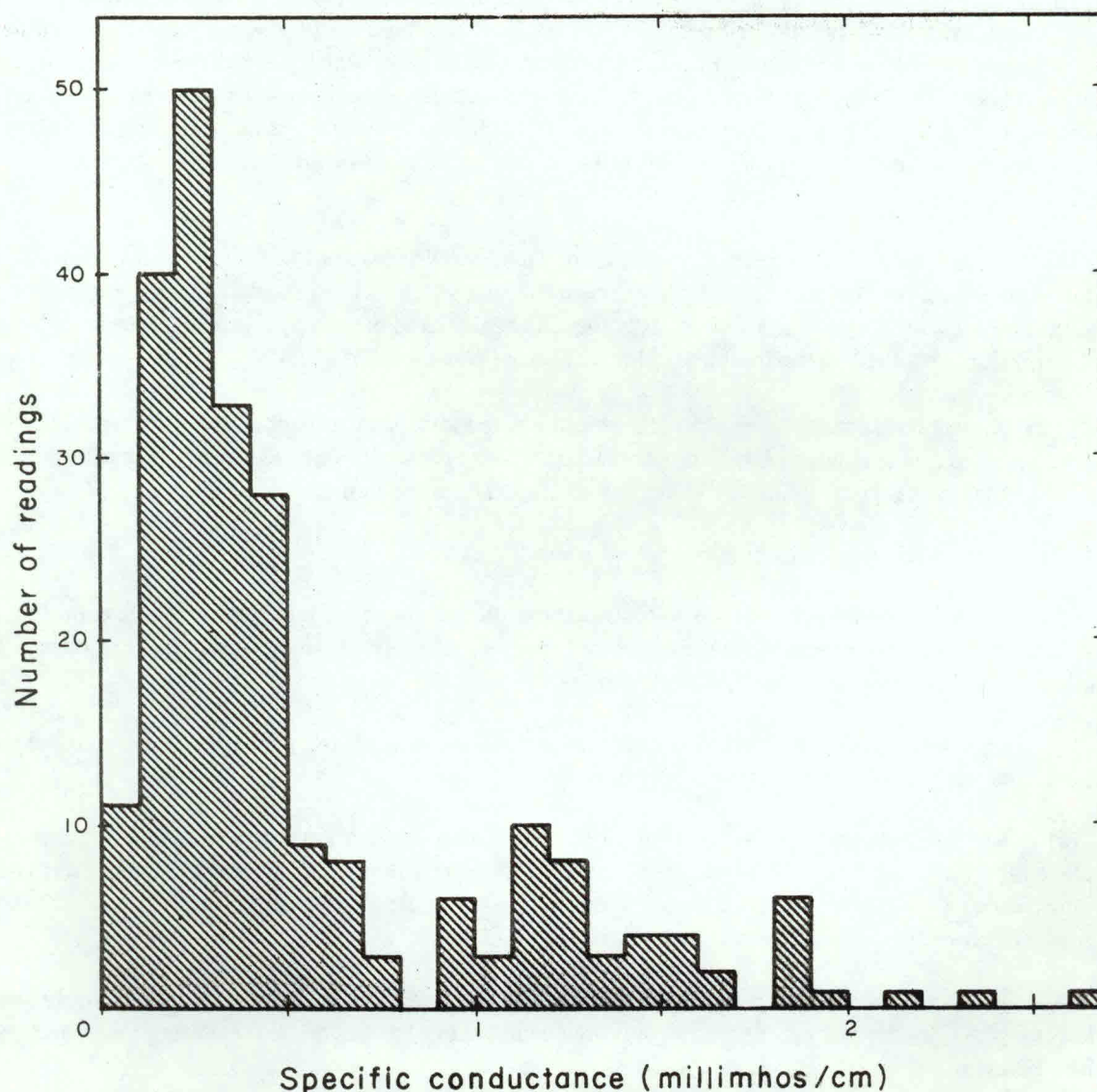


Figure 3.—Histogram depicting the frequency of specific conductance values, in 100- $\mu\text{mhos}/\text{cm}$  increments.

The temperature data were originally to be compared to a computer fit of mean annual air temperatures. The following equation in degrees centigrade ( $^{\circ}\text{C}$ ) was derived by multiple regression analysis of climatic data compiled by R. N. Bergantino from 88 weather stations in central and western Montana:

$$T = 32.0722 - 0.001427(\text{Alt.}) - 0.9233(\text{Lat.}) + 0.2039(\text{Long.}) \quad (6)$$

where Alt. is the altitude in feet, Lat. is the latitude in decimal degrees, and Long. is the longitude in decimal degrees; the standard error of estimate was  $0.957^{\circ}\text{C}$  and the adjusted standard error of estimate was  $0.974^{\circ}\text{C}$ . The scarcity of data for stations above 6,000 feet prevented us from using the equation for some data points.

An attempt to fill the data gap for high altitudes by using data from the U.S. Soil Conservation Service Snow Survey records (P. E. Farnes, pers. commun., 1978) showed that the 42-inch-depth soil temperatures ranged from  $-2$  to  $+8$  degrees Fahrenheit relative to the mean annual air temperature and did not provide sufficiently homogeneous data to warrant extending our calculations to high altitudes.

The next step was to plot the temperature data for each season against the altitude of the sampling site and to sketch an "upper normal temperature" curve. Next a composite plot was prepared depicting the observed temperature range versus altitude. A portion of this plot, which we believe includes all of the significant anomalies, is presented as Figure 4. The three sites that we believe constitute real anomalies are labeled A, B, and C, in order of their importance. An additional five sites, which probably represent the upper range of normal temperature variation but which might also be worth further investigation, are listed as D through H in their estimated order of importance.

The data for these eight mines are presented in Table 1. Discussion of the three most important sites follows a review of the setting of Montana's known thermal springs. The reader is cautioned that none of these mining sites discharges water that is  $15^{\circ}\text{F}$  above the calculated mean annual air temperature, the standard definition of a thermal spring in the United States (Waring, 1965, p. 4).

The complete data compilation is presented in the Appendix. Measurements are listed sequentially for fall, winter, and late spring to early summer seasons to aid comparison between sites. The sampling sites are listed alphabetically, by county, district, subdistrict, and mine name.

We offer the following observations about sampling factors:

- (1) Unless an annual range of variation in temperature is essential, samples should be collected during the fall, low-base-flow period before late fall rains or snow (with subsequent melting) occur. This greatly reduces the logistical problems and expense.
- (2) For winter sampling conditions, underground, no measurable temperature variation of the water was detected beyond 100 feet from the portal.
- (3) Generally, the smaller discharges showed greater annual variation in temperature. When measuring the temperatures of flows less than 5 gpm, the aspect, the length of the drift, and the time of day should be considered. Diffuse discharge (seepage) from collapsed prospects or other shallow sources can be significantly altered by ground temperature.
- (4) Discharge volumes showed a wider variation than the other parameters, particularly during winter sampling, owing to freezing, snow, and the need to move the discharge measuring point because of limited accessibility.

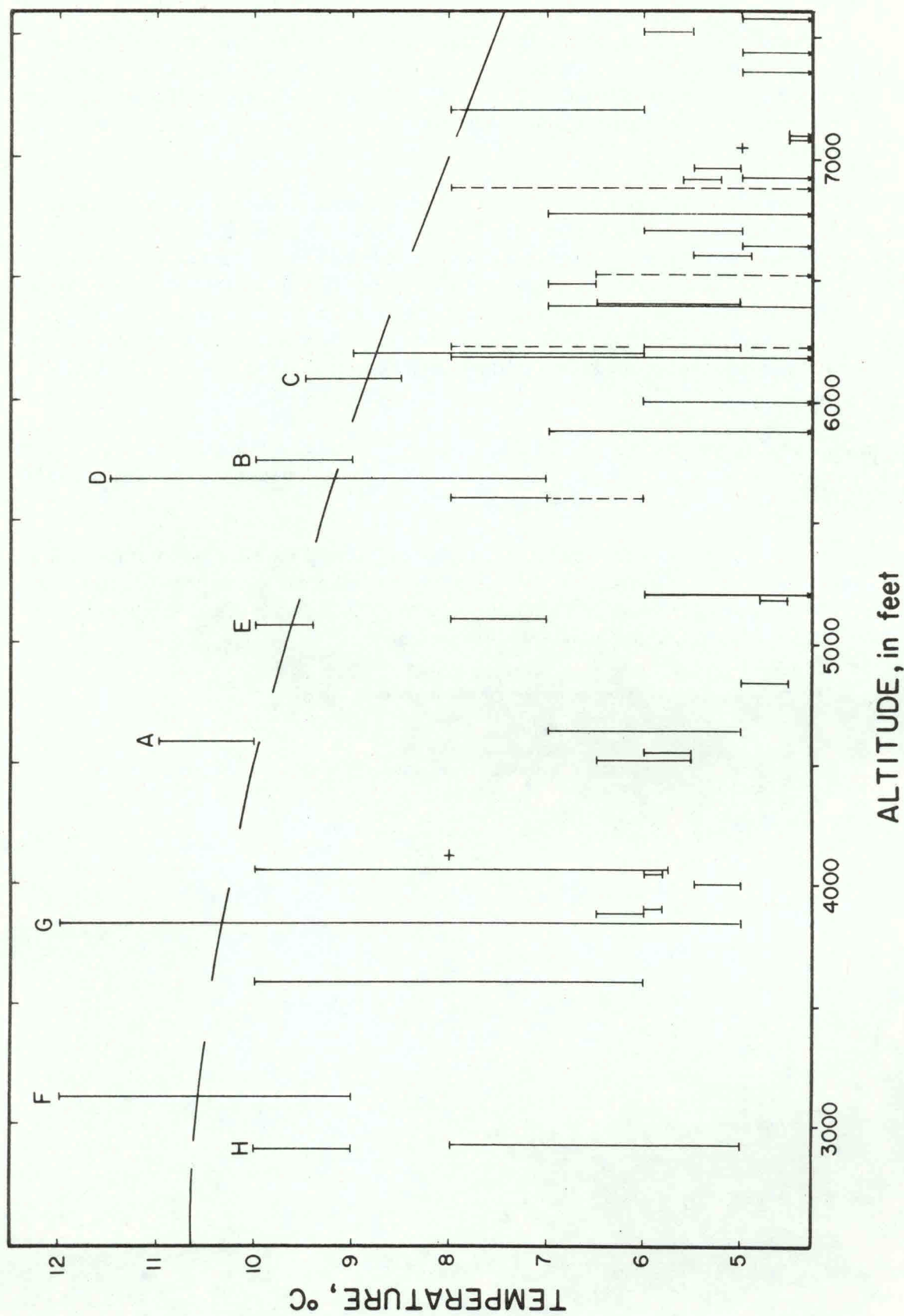


Figure 4.—Plot of measured temperatures versus altitude. Letters denote sites listed in Table 1; the dashed curved line represents the estimated normal high range for discharge temperatures; the symbol + represents a site where all measured temperatures were the same.

## DISCUSSION

Most of Montana's known thermal springs are located either on valley margins or in valleys. This is not surprising, in view of the fact that western Montana's mountain ranges and intermontane valleys are the result of epeirogenic uplift and block faulting (Perry, 1962). The present mountain ranges are blocks of the crust that have moved upward relative to adjacent blocks. Most if not all of the intermontane valleys represent downdropped blocks.

The faults that cause this physiographic separation of land into mountains and valleys must extend to great depth, as shown by the thickness of sediments filling the valley basins. These fault systems provide natural conduit systems for heated water from thousands of feet below the land surface to rise upward. Because most of the major faults bound the valleys (i.e., are at the margins of the valleys), one would expect most of the thermal springs to rise along the valley margins. A brief inspection of Witkind's map (1975) of known and suspected active faults in Montana will show that most of these faults are along valley margins. A significant percentage of the known thermal springs occurs along valleys where Witkind has denoted active faults.

Some mountain hot springs may also be related to active faults. The Elkhorn hot spring in the Pioneer Mountains, northwest of Dillon at an altitude of 7,200 feet, is on a logical extension of the unnamed fault along the Wise River Valley shown by Witkind (1975).

The purpose of this discussion is to point out that the mountainous areas, where most of the mining activity in Montana has been undertaken, are not necessarily the best areas to prospect for geothermal energy. Only where ascending thermal waters can find no outlet along the valley margins, at lower elevations, will they continue to rise and be discharged in the mountains.

Table 1.—Mine discharges at temperatures above average.

Mine name	County	Altitude (feet)	Calculated mean annual air temp., °C	Water temperature °C	Discharge (gpm)	Specific conductance (μmho/cm)	pH	ΔT (observed—calculated), °C
A. Gold Bug	Phillips	4600	3.4	11	650	633	6.2	7.6
				10	614	649	5.9	6.6
				11	90	523	5.9	7.6
B. Swansea	Lewis and Clark	5760	3.5	10	23	155	5.9	6.5
				9	30	159	5.9	5.5
				10	10.6	167	5.3	6.5
C. Iron Mountain	Beaverhead	6190	4.4	9.5	192	150	5.7	5.1
				9.0	367	190	5.6	4.6
				8.5	505	200	6.2	4.1
D. Waterlode	Madison	5080	5.55	10.0	5	254	6.2	4.45
				9.5	4	250	6.0	3.95
				9.4	3.2	258	6.1	3.85
E. Double Mac	Lincoln	3120	6.6	12	6	282	5.6	5.4
				11	5	275	5.8	4.4
				9	4.5	304	5.7	2.4
F. Nancy Lee	Mineral	3840	6.4	10	2.9	1270	5.9	3.6
				5	—	1597	6.2	-1.4
				12	8.75	1877	5.9	5.6
G. Luken Hazel (Lower)	Lincoln	2900	6.9	10	24	1235	6.2	3.1
				9	24	514	6.2	2.1
				9	25	384	6.3	2.1

## GOLD BUG MINE

The Gold Bug mine, in Phillips County, was selected as the best prospect for further study because:

(1) The difference between calculated and observed temperatures was the greatest.

(2) The amount of temperature variation recorded was small (1 °C).

(3) The discharge, although varying significantly, was sufficiently large to assure that diurnal and short-term climatic effects were not significant.

The geology of this area was mapped by Knechtel (1959); the mine is located in syenite porphyry believed to be of early Tertiary age. The sedimentary rocks around the Little Rocky Mountains have been domed up by the intrusion of the porphyry, and erosion has exposed rocks of Precambrian, Paleozoic, and Mesozoic age. Warm springs around the dome constitute a significant low-temperature resource (Sonderegger, Bergantino, and Miller, 1977); these springs discharge from zones adjacent to the Mississippian-Jurassic contact.

Alkalic magmas commonly are enriched in radioactive elements, particularly uranium and thorium (Gabelman, 1977), and the decay of these elements will release significant quantities of heat. Consequently, it is not possible, from the data available, to determine whether the water discharged at the Gold Bug mine represents water from a deeper sedimentary source such as the Madison Group or water that has circulated within the porphyry and has been heated by radioactive decay.

## SWANSEA MINE

The Swansea mine (lower adit) in Lewis and Clark County was selected as the second-best prospect for further study because:

(1) The difference between calculated and observed temperatures was the second greatest.

(2) The amount of temperature variation was small (1 °C).

(3) The discharge, although not large, was deemed adequate, and the lowest temperature (winter sampling) was accompanied by the greatest discharge.

The geology of this area has been mapped by Melson (1971); the portal was observed to be in the intrusive Silver Bell stock, which ranges in composition from quartz monzonite to granodiorite. The drift runs along the contact between the intrusive body and the host rock (Precambrian siltstone and mudstone, which are dolomitic to calcareous, and have been altered to hornfels). Geochemical soil sampling in the area (McClernan, 1974) suggests that disseminated sulfide minerals may be present.

The most probable explanation for the warm water is that (1) the Silver Bell stock was emplaced at a fairly shallow level, possibly connected by feeders to a larger parent body at depth, which is generally believed to result in greater fracturing in the host and in the outer shell of the intrusive body; (2) its emplacement was controlled by zones of structural weakness, which resulted in extensive faulting and fracturing, as shown by the fact that the contact-zone ores and gangue definitely fill open spaces (McClernan, oral commun., 1978); and (3) a deep circulation pattern for meteoric water, heated at depth, has been established. The age of the intrusion is believed to be similar to that of the Boulder batholith, roughly 76 to 72 million years before present, based upon "main series" dates presented by Tilling (1973). Because this area lies northwest of the Marysville known geothermal resource area along the trend of the Montana Lineament, it is possible that the intrusive body is of a younger age and that high heat-flow values may also be present in this area.

## IRON MOUNTAIN MINE

The Iron Mountain mine, in Beaverhead County, was placed third on the prospect list because the 1 °C range of variation and the large discharge values (192 to 505 gpm) are promising factors, although the difference between calculated and observed temperatures was the lowest of the three anomalous areas.

The geology of the area was mapped by Myers (1952); the adit sampled is south-southwest of the shaft shown on the map and is about 6 feet above the creek. Winchell (1914) reported that the main tunnel passed through 500 feet of quartz monzonite before encountering limestone. He also reported that mining was along the contact between the quartz monzonite and the limestone, which strikes east and dips 50° to the north, the dip decreasing with depth (p. 67). Winchell also noted that the ore postdates the solidification of the intrusive body, that faulting occurs along the contact, and that sulfides have been deposited within the fault gouge (p. 67-68).

The quartz monzonite stock may have been emplaced within a zone of structural weakness. The topographic feature known as the Argenta Flats is a Quaternary alluvial fan, bounded by Tertiary terraces to the northeast and southwest. The northeastern boundary, along which Rattlesnake Creek flows, has a sharp topographic boundary forming a very steep hillside with about 100 feet of relief adjacent to the creek. The southwestern boundary, close to the town of Argenta and the mine, seems to be faceted, suggesting late Tertiary faulting. The areas northeast, northwest, and southwest of Argenta are extensively faulted (Myers, 1952; Ross, Andrews, and Witkind, 1955); this easterly flowing portion of the Rattlesnake Creek drainage seems to have been developed along an east-west boundary that constituted the southern limit of the Pioneer Mountains batholith.

The faulting and possible boundary relationship to the major intrusive body suggest that deep circulation along faults and fractures provides the major control for the ascent of warmer water from depth.

## REFERENCES CITED

- COOMBS, J., and MUFFLER, L. P. J., 1973, Exploration for geothermal resources, *in* Kruger, P., and Otte, C., editors, Geothermal energy resources, production, stimulation: Stanford University Press, p. 95-128.
- GABLEMAN, J. W., 1977, Migration of uranium and thorium—exploration significance: American Association of Petroleum Geologists, Studies in Geology No. 3, 168 p.
- KNECHTEL, M. M., 1959, Stratigraphy of the Little Rocky Mountains and encircling foothills, Montana: U.S. Geological Survey Bulletin 1072-N, 30 p.
- KULIN, G., and COMPTON, P. R., 1975, A guide to methods and standards for the measurement of water flow: U.S. Department of Commerce, National Bureau of Standards Special Publication 421, 97 p.
- McCLERNAN, H. G., 1974, Geochemical exploration of the Stemple Pass area, Lewis and Clark County, Montana: Montana Bureau of Mines and Geology Special Publication 64, 5 p.
- MELSON, W. G., 1971, Geology of the Lincoln area, Lewis and Clark County, Montana: Smithsonian Contributions to Earth Science No. 7, Smithsonian Institution Press, 29 p.
- MYERS, W. B., 1952, Geology and mineral deposits of the NW¼ Willis quadrangle and adjacent Browns Lake area, Beaverhead County, Montana: U.S. Geological Survey Open-File Report, 46 p.
- PERRY, E. S., 1962, Montana in the geologic past: Montana Bureau of Mines and Geology Bulletin 26, 78 p.
- ROBERTSON, E. C., FOURNIER, R. O., and STRONG, C. P., 1976, Hydrothermal activity in southwestern Montana, *in* Proceedings of the Second United Nations Symposium on the Development and Use of Geothermal Resources, Berkeley, University of California Press, p. 553-561.
- ROSS, C. P., ANDREWS, D. A., and WITKIND, I. J., 1955, Geologic map of Montana: U.S. Geological Survey.
- SONDEREGGER, J. L., BERGANTINO, R. N., and MILLER, M. R., 1977, Phase zero study results—Geothermal potential of the Madison Group at shallow depths in eastern Montana, *in* Montana Bureau of Mines and Geology Open-File Report 25, 16 p.
- TILLING, R. I., 1973, The Boulder batholith, Montana: Product of two contemporaneous but chemically and isotopically distinct magma series, *in* Miller, R. N., editor, Guidebook for the Butte field meeting of the Society of Economic Geologists, Butte, The Anaconda Company, p. C1-C5.
- U.S. SALINITY LABORATORY, 1954, Diagnosis and improvement of saline and alkali soils: U.S. Department of Agriculture Handbook No. 60, 160 p.
- WARING, G. A., 1965, Thermal springs of the United States and other countries of the world—a summary, revised by R. R. Blankenship and R. Bentall: U.S. Geological Survey Professional Paper 492, 383 p.
- WINCHELL, A. N., 1914, Mining districts of the Dillon quadrangle, Montana, and adjacent areas: U.S. Geological Survey Bulletin 574, 191 p.
- WITKIND, I. J., 1975, Preliminary map showing known and suspected active faults in western Montana: U.S. Geological Survey Open-File Report 75-285, 36 p.



## APPENDIX

Deposit name: IRON MOUNTAIN

District: ARGENTA

County: BEAVERHEAD

Location: Township 6 N.

Range 10 W.

Section 30

Latitude: 45°16'60"

Longitude: 112°52'33"

Map name: ARGENTA

Series: 7½ minute

Altitude of portal (ft.): 6190; of sampling point, same

Distance from portal to sampling point (ft.): 235

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/8/76	9.5	5.7	150 x <sub>f<sub>t</sub></sub> = 214	192*
2/24/78	9	5.6	195 x <sub>f<sub>t</sub></sub> = 282	367*
5/19/77	8.5	6.2	200 x <sub>f<sub>t</sub></sub> = 294	505*

Deposit name: NEW DEPARTURE

District: BLUE WING

County: BEAVERHEAD

Location: Township 7 S.

Range 11 W.

Section 26

Latitude: 45°11'43"

Longitude: 112°54'56"

Map name: BANNACK

Series: 7½ minute

Altitude of portal (ft.): 6770; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/8/76	7	—	250 x <sub>f<sub>t</sub></sub> = 382	9
2/20/78	4	6.0	300 x <sub>f<sub>t</sub></sub> = 498	4
5/19/77	4	5.6	312 x <sub>f<sub>t</sub></sub> = 518	3.6

Deposit name: GAR (COMET)

District: ELKHORN

County: BEAVERHEAD

Location: Township 4 S.

Range 12 W.

Section 26

Latitude: 45°27'25"

Longitude: 113°2'53"

Map name: POLARIS

Series: 15 minute

Altitude of portal (ft.): 8800; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/21/76	3	5.3	30 x <sub>f<sub>t</sub></sub> = 51	2.25
2/21/78	3	5.5	40 x <sub>f<sub>t</sub></sub> = 68	2
7/8/77	4	5.4	30 x <sub>f<sub>t</sub></sub> = 50	3

Deposit name: LOWER ELKHORN

District: ELKHORN

County: BEAVERHEAD

Location: Township 4 S.

Range 12 W.

Section 14

Latitude: 45°29'9"

Longitude: 113°2'53"

Map name: POLARIS

Series: 15 minute

Altitude of portal (ft.): 7520; of sampling point, same

Distance from portal to sampling point (ft.): at portal (unsafe)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/21/76	6	5.0	120 x <sub>f<sub>t</sub></sub> = 188	281*
2/24/78	5.5	5.1	120 x <sub>f<sub>t</sub></sub> = 191	278*
6/16/77	5.5	5.0	130 x <sub>f<sub>t</sub></sub> = 207	289*

Deposit name: SILVER QUEEN

District: JAKE CREEK

County: BEAVERHEAD

Location: Township 10 S.

Range 7 W.

Section 17

Latitude: 44°57'51"

Longitude: 112°29'14"

Map name: PRICE CREEK

Series: 7½ minute

Altitude of portal (ft.): 7050; of sampling point, same

Distance from portal to sampling point (ft.): 50

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/15/77	5	6.2	220 x <sub>f<sub>t</sub></sub> = 355	2.69
2/25/78	5	6.1	230 x <sub>f<sub>t</sub></sub> = 371	1.75
5/18/77	5	6.0	210 x <sub>f<sub>t</sub></sub> = 339	2.25

Deposit name: MARIETTA

District: PARK (Indian Creek subdistrict)

County: BROADWATER

Location: Township 7 N.

Range 1 W.

Section 15

Latitude: 46°21'42"

Longitude: 111°42'46"

Map name: TOWNSEND

Series: 15 minute

Altitude of portal (ft.): 7080; of sampling point, same

Distance from portal to sampling point (ft.): at adit

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/18/76	4.5	5.3	180 x <sub>f<sub>t</sub></sub> = 294	13
1/28/78	4	5.3	200 x <sub>f<sub>t</sub></sub> = 332	10
5/23/77	4	5.3	200 x <sub>f<sub>t</sub></sub> = 332	31.2

Deposit name: EAST PACIFIC

District: WINSTON (Beaver Creek subdistrict) County: BROADWATER

Location: Township 8 N. Range 1 W. Section 26

Latitude: 46°25'14" Longitude: 111°41'30"

Map name: TOWNSEND Series: 15 minute

Altitude of portal (ft.): 5880; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/22/77	4	5.8	260 x <sub>f<sub>t</sub></sub> = 432	4.5
3/24/77	4	5.9	840 x <sub>f<sub>t</sub></sub> = 1394	6
5/23/77	7	5.6	250 x <sub>f<sub>t</sub></sub> = 382	10

Deposit name: LOWER KLEINSCHMIDT

District: WINSTON County: BROADWATER

Location: Township 7 N. Range 1 W. Section 3

Latitude: 46°23'28" Longitude: 111°42'46"

Map name: TOWNSEND Series: 15 minute

Altitude of portal (ft.): 7360; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/19/76	5	5.9	335 x <sub>f<sub>t</sub></sub> = 540	23*
3/24/77	3	5.9	700 x <sub>f<sub>t</sub></sub> = 1196	20*
5/23/77	4.5	5.8	188 x <sub>f<sub>t</sub></sub> = 308	24*

Deposit name: LOWER BIG SEVEN

District: NEIHART County: CASCADE

Location: Township 14 N. Range 8 E. Section 27

Latitude: 46°56'44" Longitude: 110°41'33"

Map name: NEIHART Series: 7½ minute

Altitude of portal (ft.): 7000; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/16/76	3	4.7	280 x <sub>f<sub>t</sub></sub> = 479	142*
3/13/77	2	5.0	700 x <sub>f<sub>t</sub></sub> = 1239	86*
6/15/77	3	5.0	600 x <sub>f<sub>t</sub></sub> = 1025	100*

Deposit name: McKAY CREEK

District: NEIHART

County: CASCADE

Location: Township 14 N.

Range 8 E.

Section 16

Latitude: 46°58'28"

Longitude: 110°42'47"

Map name: NEIHART

Series: 7½ minute

Altitude of portal (ft.): 6600; of sampling point, same

Distance from portal to sampling point (ft.): caved at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/16/76	5.5	5.6	230 x <sub>f</sub> t = 366	3
1/29/78	4.9	5.5	780 x <sub>f</sub> t = 1262	2
5/29/77	5.5	5.6	790 x <sub>f</sub> t = 1257	2.5

Deposit name: SILVER DYKE

District: NEIHART

County: CASCADE

Location: Township 14 N.

Range 8 E.

Section 10

Latitude: 46°59'20"

Longitude: 110°41'33"

Map name: NEIHART

Series: 7½ minute

Altitude of portal (ft.): 6880; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/16/76	8	5.6	1250 x <sub>f</sub> t = 1860	25.5
2/3/77	2	5.6	1050 x <sub>f</sub> t = 1860	10.36
5/29/77	7	5.6	1750 x <sub>f</sub> t = 2674	28.13

Deposit name: STAR

District: NEIHART

County: CASCADE

Location: Township 14 N.

Range 8 E.

Section 29

Latitude: 46°56'44"

Longitude: 110°44'2"

Map name: NEIHART

Series: 7½ minute

Altitude of portal (ft.): 5600; of sampling point, same

Distance from portal to sampling point (ft.): locked (at portal)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/16/76	8	6.5	460 x <sub>f</sub> t = 684	60*
2/3/77	6	6.2	600 x <sub>f</sub> t = 941	30
5/29/77	8	5.6	980 x <sub>f</sub> t = 1458	24

Deposit name: UPPER BIG SEVEN

District: NEIHART

County: CASCADE

Location: Township 14 N.

Range 8 E.

Section 28

Latitude: 46°56'44"

Longitude: 110°42'47"

Map name: NEIHART

Series: 7½ minute

Altitude of portal (ft.): 7040; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/20/77	3.75	5.4	1180 x <sub>f<sub>t</sub></sub> = 1976	26*
3/13/77	3	5.3	1230 x <sub>f<sub>t</sub></sub> = 2102	25*
6/15/77	3.75	5.3	950 x <sub>f<sub>t</sub></sub> = 1591	28*

Deposit name: BERTHA (GIES) MINE

District: WARM SPRINGS (Gilt Edge subdistrict)

County: FERGUS

Location: Township 17 N.

Range 20 E.

Section 22

Latitude: 47°13'10"

Longitude: 109°9'18"

Map name: JUDITH PEAK

Series: 15 minute

Altitude of portal (ft.): 5100; of sampling point, same

Distance from portal to sampling point (ft.): 870

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/13/76	8	6.5	242 x <sub>f<sub>t</sub></sub> = 360	12
2/13/77	8	6.2	290 x <sub>f<sub>t</sub></sub> = 432	9.2
5/30/77	7	5.6	780 x <sub>f<sub>t</sub></sub> = 1192	10.2

Deposit name: MARRIETTA NO. 1

District: WARM SPRINGS (Gilt Edge subdistrict)

County: FERGUS

Location: Township 17 N.

Range 20 E.

Section 27

Latitude: 47°12'18"

Longitude: 109°9'18"

Map name: JUDITH PEAK

Series: 15 minute

Altitude of portal (ft.): 4660; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/16/77	6	5.4	180 x <sub>f<sub>t</sub></sub> = 282	135*
1/30/78	5	5.3	190 x <sub>f<sub>t</sub></sub> = 306	120*
5/30/77	7	5.3	170 x <sub>f<sub>t</sub></sub> = 260	164*

Deposit name: JOSEPHINE  
 District: PHILIPSBURG (Flint Creek subdistrict) County: GRANITE  
 Location: Township 7 N. Range 13 W. Section 29  
 Latitude: 46°19'55" Longitude: 113°15'10"  
 Map name: FRED BURR LAKE Series: 7½ minute  
 Altitude of portal (ft.): 6650; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
10/14/76	5	5.6	130 x <sub>f</sub> t = 210	11*
1/24/78	5	5.7	135 x <sub>f</sub> t = 218	23*
7/17/77	5	5.3	80 x <sub>f</sub> t = 129	25*

Deposit name: YOUNG AMERICAN  
 District: PHILIPSBURG County: GRANITE  
 Location: Township 7 N. Range 13 W. Section 33  
 Latitude: 46°19'3" Longitude: 113°13'55"  
 Map name: FRED BURR LAKE Series: 7½ minute  
 Altitude of portal (ft.): 6960; of sampling point, same  
 Distance from portal to sampling point (ft.): 20

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
10/14/76	5	5.6	110 x <sub>f</sub> t = 177	0.75
2/15/78	5	5.0	110 x <sub>f</sub> t = 177	0.4
7/15/77	5.5	5.7	120 x <sub>f</sub> t = 191	0.5

Deposit name: CRYSTAL  
 District: BASIN (Cataract subdistrict) County: JEFFERSON  
 Location: Township 7 N. Range 5 W. Section 20  
 Latitude: 46°20'38" Longitude: 112°15'12"  
 Map name: BASIN Series: 15 minute  
 Altitude of portal (ft.): 7660; of sampling point, same  
 Distance from portal to sampling point (ft.): 60

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
9/22/77	4.8	3.8	700 x <sub>f</sub> t = 1136	17.86
2/9/78	4.5	3.9	710 x <sub>f</sub> t = 1162	14.28
5/24/77	4.8	3.8	690 x <sub>f</sub> t = 1119	19*

Deposit name: MORNING MINE  
 District: BASIN (Cataract subdistrict) County: JEFFERSON  
 Location: Township 7 N. Range 5 W. Section 18  
 Latitude: 46°21'28" Longitude: 112°16'27"  
 Map name: BASIN Series: 15 minute  
 Altitude of portal (ft.): 7880; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/22/77	2.5	6.2	50 x <sub>f</sub> t = 87	4.31
2/9/78	2	6.3	60 x <sub>f</sub> t = 106	3.33
5/24/77	2.5	6.3	55 x <sub>f</sub> t = 96	6.25

Deposit name: PROSPECT SW¼ of SE¼  
 District: BASIN (Cataract subdistrict) County: JEFFERSON  
 Location: Township 7 N. Range 5 W. Section 29  
 Latitude: 46°19'48" Longitude: 112°15'12"  
 Map name: BASIN Series: 15 minute  
 Altitude of portal (ft.): 6520; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/22/77	6.5	6.2	240 x <sub>f</sub> t = 372	3.5
2/9/78	2.5	6.3	255 x <sub>f</sub> t = 444	2
5/24/77	6.5	6.2	240 x <sub>f</sub> t = 372	3.06

Deposit name: ELKHORN COMMUNITY SPRING  
 District: ELKHORN County: JEFFERSON  
 Location: Township 6 N. Range 3 W. Section 11  
 Latitude: 46°17'11" Longitude: 111°56'33"  
 Map name: CLANCY Series: 15 minute  
 Altitude of portal (ft.): 6640; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/10/76	5	5.9	165 x <sub>f</sub> t = 266	6
2/19/77	4	5.3	195 x <sub>f</sub> t = 324	5
5/18/77	4	5.6	172 x <sub>f</sub> t = 286	5.41

Deposit name: CAPE NOME  
 District: BARKER County: JUDITH BASIN  
 Location: Township 16 N. Range 9 E. Section 31  
 Latitude: 47°6'13" Longitude: 110°38'1"  
 Map name: BARKER Series: 7½ minute  
 Altitude of portal (ft.): 6180; of sampling point, same  
 Distance from portal to sampling point (ft.): 165

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/15/76	4.5	5.9	80 x <sub>f</sub> t = 131	1.3
2/27/78	2	5.8	95 x <sub>f</sub> t = 168	0.26
5/29/77	8	5.8	130 x <sub>f</sub> t = 193	0.5

Deposit name: CARTER-DAVIS  
 District: BARKER County: JUDITH BASIN  
 Location: Township 15 N. Range 9 E. Section 6  
 Latitude: 47°5'23" Longitude: 110°37'47"  
 Map name: BARKER Series: 7½ minute  
 Altitude of portal (ft.): 6220; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/15/76	6	5.9	225 x <sub>f</sub> t = 353	60
3/12/77	5	5.9	230 x <sub>f</sub> t = 371	10
5/29/77	5	5.6	235 x <sub>f</sub> t = 379	31

Deposit name: LOWER TIGER DRIFT  
 District: BARKER County: JUDITH BASIN  
 Location: Township 15 N. Range 9 E. Section 6  
 Latitude: 47°5'23" Longitude: 110°37'47"  
 Map name: MIXES BALDY Series: 7½ minute  
 Altitude of portal (ft.): 6220; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/15/76	8	3.8	150 x <sub>f</sub> t = 223	2.25
3/12/77	0	5.8	130 x <sub>f</sub> t = 248	.25
5/29/77	7	4.1	345 x <sub>f</sub> t = 527	.25



Deposit name: UPPER TIGER MINE

District: BARKER

County: JUDITH BASIN

Location: Township 15 N.

Range 9 E.

Section 5

Latitude: 47°5'23"

Longitude: 110°36'31"

Map name: MIXES BALDY

Series: 7½ minute

Altitude of portal (ft.): 6520; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/15/76	4	5.9	270 x <sub>f<sub>t</sub></sub> = 448	21
2/27/78	3.5	5.8	1080 x <sub>f<sub>t</sub></sub> = 1820	18
5/29/77	3.5	5.3	1110 x <sub>f<sub>t</sub></sub> = 1870	25.7

Deposit name: SWANSEA

District: GOULD-STEMPLE (Poorman subdistrict)

County: LEWIS AND CLARK

Location: Township 13 N.

Range 7 W.

Section 18

Latitude: 46°53'6"

Longitude: 112°32'20"

Map name: SWEDE GULCH

Series: 7½ minute

Altitude of portal (ft.): 5760; of sampling point, same

Distance from portal to sampling point (ft.): at portal (unsafe)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/18/76	10	5.9	110 x <sub>f<sub>t</sub></sub> = 155	23*
2/11/77	9	5.9	110 x <sub>f<sub>t</sub></sub> = 159	30
5/28/77	10	5.3	118 x <sub>f<sub>t</sub></sub> = 167	10.58

Deposit name: ANACONDA

District: HEDDLESTON (Blackfoot subdistrict)

County: LEWIS AND CLARK

Location: Township 15 N.

Range 6 W.

Section 28

Latitude: 47°1'40"

Longitude: 112°22'7"

Map name: ROGERS PASS

Series: 7½ minute

Altitude of portal (ft.): 6200; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/16/76	9	4.7	290 x <sub>f<sub>t</sub></sub> = 420	2.5
2/11/77	6	4.6	1000 x <sub>f<sub>t</sub></sub> = 1569	14.5
5/28/77	7	4.8	620 x <sub>f<sub>t</sub></sub> = 947	4.46

Deposit name: MIKE HORSE

District: HEDDLESTON (Blackfoot subdistrict) County: LEWIS AND CLARK

Location: Township 15 N. Range 6 W. Section 28

Latitude: 47°1'40" Longitude: 112°22'7"

Map name: ROGERS PASS Series: 7½ minute

Altitude of portal (ft.): 5680; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
9/16/76	8.5	5.9	800 x <sub>f<sub>t</sub></sub> = 1174	128*
2/11/77	7	5.6	1200 x <sub>f<sub>t</sub></sub> = 1834	12*
5/28/77	11.5	5.6	1700 x <sub>f<sub>t</sub></sub> = 2309	103*

Deposit name: LITTLE ANNIE

District: CABINET County: LINCOLN

Location: Township 27 N. Range 31 W. Section 27

Latitude: 48°4'27" Longitude: 115°34'40"

Map name: HOWARD LAKE Series: 7½ minute

Altitude of portal (ft.): 5620; of sampling point, 5621.5

Distance from portal to sampling point (ft.): 150

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/9/77	4	4.6	150 x <sub>f<sub>t</sub></sub> = 249	1
12/10/77	4	4.6	150 x <sub>f<sub>t</sub></sub> = 249	0.9
7/23/76	4	4.4	145 x <sub>f<sub>t</sub></sub> = 241	1.25

Deposit name: SILVER BUTTE (OLD WILLIAMS CLAIM)

District: CABINET County: LINCOLN

Location: Township 25 N. Range 30 W. Section 7

Latitude: 47°56'18" Longitude: 115°30'50"

Map name: GOAT PEAK Series: 7½ minute

Altitude of portal (ft.): 4840; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
10/16/77	5	5.4	60 x <sub>f<sub>t</sub></sub> = 97	0.5
12/11/77	4.5	5.8	70 x <sub>f<sub>t</sub></sub> = 115	0.5
7/22/76	4.5	5.3	58 x <sub>f<sub>t</sub></sub> = 95	0.75

Deposit name: DOUBLE MAC  
 District: LIBBY (SNOWSHOE) County: LINCOLN  
 Location: Township 29 N. Range 32 W. Section 12  
 Latitude: 48°17'27" Longitude: 115°38'0"  
 Map name: LITTLE HOODOO MOUNTAIN Series: 7½ minute  
 Altitude of portal (ft.): 3120; of sampling point, 3130.5  
 Distance from portal to sampling point (ft.): 1050

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/9/77	11	5.8	200 x <sub>f<sub>t</sub></sub> = 275	5
12/10/77	9	5.7	210 x <sub>f<sub>t</sub></sub> = 304	4.5
7/12/76	12	5.6	210 x <sub>f<sub>t</sub></sub> = 282	6

Deposit name: LUKEN HAZEL (LOWER)  
 District: LIBBY (SNOWSHOE) County: LINCOLN  
 Location: Township 29 N. Range 31 W. Section 5  
 Latitude: 48°18'18" Longitude: 115°35'25"  
 Map name: LITTLE HOODOO MOUNTAIN Series: 7½ minute  
 Altitude of portal (ft.): 2900; of sampling point, same  
 Distance from portal to sampling point (ft.): at caved portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
7/12/76	10	6.2	875 x <sub>f<sub>t</sub></sub> = 1235	24
2/10/77	9	6.2	355 x <sub>f<sub>t</sub></sub> = 514	24
6/24/77	9	6.3	265 x <sub>f<sub>t</sub></sub> = 384	25

Deposit name: INDEPENDENCE  
 District: TOBACCO RIVER County: LINCOLN  
 Location: Township 37 N. Range 26 W. Section 22  
 Latitude: 48°57'21" Longitude: 114°57'51"  
 Map name: KSANKA PEAK Series: 7½ minute  
 Altitude of portal (ft.): 6390; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
7/21/76	5	5.8	95 x <sub>f<sub>t</sub></sub> = 153	.66
3/5/77	0	5.9	130 x <sub>f<sub>t</sub></sub> = 248	.25
6/24/77	7	5.6	120 x <sub>f<sub>t</sub></sub> = 173	.5

Deposit name: ROCK LAKE BARITE

District: TOBACCO RIVER

County: LINCOLN

Location: Township 35 N.

Range 26 W.

Section 6

Latitude: 48°49'32"

Longitude: 115°0'22"

Map name: EUREKA SOUTH

Series: 7½ minute

Altitude of portal (ft.): 2920; of sampling point, same

Distance from portal to sampling point (ft.): 150

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
7/14/76	8	5.7	225 $x_{f_t} = 335$	0.1
12/11/77	5	5.8	260 $x_{f_t} = 419$	0.5
6/23/77	7	5.6	250 $x_{f_t} = 382$	0.9

Deposit name: MADISON ASBESTOS MINE

District: none

County: MADISON

Location: Township 12 S.

Range 2 E.

Section 25

Latitude: 44°45'34"

Longitude: 111°25'33"

Map name: HEBGEN DAM

Series: 15 minute

Altitude of portal (ft.): 7720; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
10/11/76	5	5.6	140 $x_{f_t} = 226$	50
3/13/77	(completely dry)	—	— $x_{f_t} = —$	—
7/19/77	(completely dry)	—	— $x_{f_t} = —$	—

Deposit name: B & H MINE

District: BISMARCK

County: MADISON

Location: Township 3 S.

Range 4 W.

Section 7

Latitude: 45°35'24"

Longitude: 112°8'32"

Map name: WATERLOO

Series: 15 minute

Altitude of portal (ft.): 8160; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
10/2/76	5	5.9	240 $x_{f_t} = 387$	32*
12/15/77	4	5.7	780 $x_{f_t} = 1295$	23*
5/20/77	4	5.6	800 $x_{f_t} = 1328$	23*

Deposit name: PETE &amp; JOE (UPPER)

District: BISMARK

County: MADISON

Location: Township 3 S.

Range 4 W.

Section 8

Latitude: 45°35'24"

Longitude: 112°07'17"

Map name: WATERLOO

Series: 15 minute

Altitude of portal (ft.): 9280; of sampling point, same

Distance from portal to sampling point (ft.): 30

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/2/76	5.5	5.6	100 x <sub>f<sub>t</sub></sub> = 159	56.9
12/15/77**	2.5	5.8	140 x <sub>f<sub>t</sub></sub> = 244	0.5
7/18/77	2.5	5.9	130 x <sub>f<sub>t</sub></sub> = 226	1

\*\*Likely blockage in tunnel after 10/2/76.

Deposit name: PROSPECT NW¼ of SE¼

District: BISMARK

County: MADISON

Location: Township 3 S.

Range 4 W.

Section 7

Latitude: 45°35'24"

Longitude: 112°08'32"

Map name: WATERLOO

Series: 15 minute

Altitude of portal (ft.): 8460; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/23/77	3	5.6	130 x <sub>f<sub>t</sub></sub> = 222	1.25
2/7/78	2	5.7	135 x <sub>f<sub>t</sub></sub> = 239	1
7/18/77	3	5.6	130 x <sub>f<sub>t</sub></sub> = 222	4.8

Deposit name: PROSPECT SW¼ of SE¼

District: BISMARK

County: MADISON

Location: Township 3 S.

Range 4 W.

Section 7

Latitude: 45°35'24"

Longitude: 112°08'32"

Map name: WATERLOO

Series: 15 minute

Altitude of portal (ft.): 8640; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/23/77	2	5.6	110 x <sub>f<sub>t</sub></sub> = 195	18.2
2/7/78	2	5.7	110 x <sub>f<sub>t</sub></sub> = 195	10
7/18/77	2	5.6	100 x <sub>f<sub>t</sub></sub> = 177	22.2

Deposit name: WATERLODE  
 District: NORRIS (Little Hot Springs subdistrict) County: MADISON  
 Location: Township 3 S. Range 1 E. Section 19  
 Latitude: 45°33'40" Longitude: 111°46'18"  
 Map name: NORRIS Series: 15 minute  
 Altitude of portal (ft.): 5080; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/31/76	10	6.2	180 x <sub>f<sub>t</sub></sub> = 254	5
2/26/78	9.4	6.1	180 x <sub>f<sub>t</sub></sub> = 258	3.25
5/18/77	9.5	6.0	175 x <sub>f<sub>t</sub></sub> = 250	4

Deposit name: STRAWBERRY MINE  
 District: PONY County: MADISON  
 Location: Township 2 S. Range 3 W. Section 14  
 Latitude: 45°39'45" Longitude: 111°56'9"  
 Map name: HARRISON Series: 15 minute  
 Altitude of portal (ft.): 6480; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/23/77	7	5.9	730 x <sub>f<sub>t</sub></sub> = 1115	21.4
2/27/78	6.5	6.0	730 x <sub>f<sub>t</sub></sub> = 1130	14.3
5/21/77	6.5	5.9	720 x <sub>f<sub>t</sub></sub> = 1115	33.3

Deposit name: WILLOW CREEK MINE  
 District: PONY County: MADISON  
 Location: Township 2 S. Range 3 W. Section 15  
 Latitude: 45°39'45" Longitude: 111°57'22"  
 Map name: HARRISON Series: 15 minute  
 Altitude of portal (ft.): 7640; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/23/77	4	6.2	140 x <sub>f<sub>t</sub></sub> = 232	1.25
2/27/78	3	6.3	145 x <sub>f<sub>t</sub></sub> = 248	0.75
5/21/77	4	6.2	140 x <sub>f<sub>t</sub></sub> = 232	2

Deposit name: ATLANTIC &amp; PACIFIC MINE

District: POTOSI

County: MADISON

Location: Township 2 S. Range 3 W. Section 21

Latitude: 45°38'53" Longitude: 111°58'36"

Map name: HARRISON Series: 15 minute

Altitude of portal (ft.): 7680; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/23/77	4	4.3	750 $x f_t = 1245$	2.33
2/27/78	4	4.6	740 $x f_t = 1228$	1
5/21/77	4	4.5	730 $x f_t = 1212$	2.5

Deposit name: RED PINE

District: SHERIDAN (Indian Creek subdistrict)

County: MADISON

Location: Township 4 S. Range 4 W. Section 3

Latitude: 45°31'1" Longitude: 112°4'50"

Map name: WATERLOO Series: 15 minute

Altitude of portal (ft.): 7600; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/3/76	5	5.4	70 $x f_t = 113$	238*
5/20/77	5	5.3	70 $x f_t = 113$	284*
6/28/77	5	5.4	70 $x f_t = 113$	268*

Deposit name: UNCLE SAM

District: SHERIDAN (Mill Creek subdistrict)

County: MADISON

Location: Township 4 S. Range 3 W. Section 17

Latitude: 45°29'16" Longitude: 111°59'53"

Map name: COPPER MOUNTAIN Series: 7½ minute

Altitude of portal (ft.): 7570; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/3/76	5	5.9	250 $x f_t = 403$	4.9*
5/20/77	2.5	6.5	355 $x f_t = 617$	3.3*
6/28/77	4.5	6.2	330 $x f_t = 540$	4.1*

Deposit name: BELLE MINE  
 District: VIRGINIA CITY (Alder Gulch subdistrict) County: MADISON  
 Location: Township 6 S. Range 3 W. Section 35  
 Latitude: 45°16'8" Longitude: 111°55'60"  
 Map name: VIRGINIA CITY Series: 15 minute  
 Altitude of portal (ft.): 6000; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/18/77	6	6.5	1000 x <sub>f<sub>t</sub></sub> = 1569	1
2/7/78	4	6.6	1000 x <sub>f<sub>t</sub></sub> = 1660	0.5
6/4/77	6	6.4	970 x <sub>f<sub>t</sub></sub> = 1522	1.5

Deposit name: (Mine name unknown.) NW¼ of SE¼  
 District: VIRGINIA CITY (Alder Gulch subdistrict) County: MADISON  
 Location: Township 7 S. Range 3 W. Section 14  
 Latitude: 45°13'31" Longitude: 111°55'58"  
 Map name: VARNEY Series: 15 minute  
 Altitude of portal (ft.): 6920; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/18/77	5.6	5.6	178 x <sub>f<sub>t</sub></sub> = 282	1
2/26/78	5.2	5.8	180 x <sub>f<sub>t</sub></sub> = 289	0.5
5/20/77	5.6	5.6	180 x <sub>f<sub>t</sub></sub> = 285	1.25

Deposit name: MARIETTA  
 District: VIRGINIA CITY (Barton Gulch subdistrict) County: MADISON  
 Location: Township 7 S. Range 3 W. Sections 15 and 22  
 Latitude: 45°13'8" Longitude: 111°57'6"  
 Map name: VARNEY Series: 15 minute  
 Altitude of portal (ft.): 7800; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/4/76	4	5.9	390 x <sub>f<sub>t</sub></sub> = 647	20
2/26/78	4.8	5.7	185 x <sub>f<sub>t</sub></sub> = 300	40
9/18/77	5.0	5.6	178 x <sub>f<sub>t</sub></sub> = 287	40



Deposit name: EASTERN PACIFIC  
 District: VIRGINIA CITY (Brown's Gulch subdistrict) County: MADISON  
 Location: Township 7 S. Range 3 W. Section 9  
 Latitude: 45°14'24" Longitude: 111°58'23"  
 Map name: VARNEY Series: 15 minute  
 Altitude of portal (ft.): 7440; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/3/76	5	6.2	570 $x_{f_t} = 919$	17*
2/26/78	4	5.0	270 $x_{f_t} = 448$	23*
6/12/77	4	5.3	228 $x_{f_t} = 378$	26*

Deposit name: NELLIE BLY  
 District: VIRGINIA CITY (Highland subdistrict) County: MADISON  
 Location: Township 7 S. Range 3 W. Sections 1 and 12  
 Latitude: 45°14'54" Longitude: 111°54'40"  
 Map name: VARNEY Series: 15 minute  
 Altitude of portal (ft.): 6400; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/4/76	5	5.9	830 $x_{f_t} = 1339$	10
2/26/78**	5.5	5.7	310 $x_{f_t} = 493$	6.25
6/4/77	6.5	5.6	315 $x_{f_t} = 488$	9.2

\*\*Snow absorbance, 2/26/78, may have had greater discharge.

Deposit name: BELLE OF THE CASTLE (NORTH)  
 District: CASTLE MOUNTAIN County: MEAGHER  
 Location: Township 8 N. Range 8 E. Section 2  
 Latitude: 46°28'59" Longitude: 110°41'21"  
 Map name: CASTLE TOWN Series: 7½ minute  
 Altitude of portal (ft.): 6920; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/17/76	5	5.9	110 $x_{f_t} = 177$	2
1/6/77	4	5.7	190 $x_{f_t} = 315$	1.5
5/24/77	4	5.6	185 $x_{f_t} = 307$	2

Deposit name: BELLE OF THE CASTLE (SOUTH)  
 District: CASTLE MOUNTAIN County: MEAGHER  
 Location: Township 8 N. Range 8 E. Section 2  
 Latitude: 46°28'59" Longitude: 110°41'21"  
 Map name: CASTLE TOWN Series: 7½ minute  
 Altitude of portal (ft.): 6880; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/17/76	4.5	5.6	100 x <sub>f<sub>t</sub></sub> = 164	1.8
1/6/77	4	5.7	130 x <sub>f<sub>t</sub></sub> = 216	2.0
5/24/77	4	5.7	120 x <sub>f<sub>t</sub></sub> = 199	2.2

Deposit name: YELLOWSTONE  
 District: CASTLE MOUNTAIN County: MEAGHER  
 Location: Township 8 N. Range 8 E. Section 11  
 Latitude: 46°28'7" Longitude: 110°41'21"  
 Map name: CASTLE TOWN Series: 7½ minute  
 Altitude of portal (ft.): 6700; of sampling point, same  
 Distance from portal to sampling point (ft.): 900

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/17/76	5	5.9	280 x <sub>f<sub>t</sub></sub> = 452	8
2/18/77	6	6.3	150 x <sub>f<sub>t</sub></sub> = 235	4
5/10/77	5.5	6.8	130 x <sub>f<sub>t</sub></sub> = 207	15

Deposit name: NANCY LEE  
 District: KEYSTONE County: MINERAL  
 Location: Township 18 N. Range 26 W. Section 31  
 Latitude: 47°16'36" Longitude: 114°57'29"  
 Map name: PLAINS Series: 15 minute  
 Altitude of portal (ft.): 3840; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (pipe discharge)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
7/28/76	10	5.9	900 x <sub>f<sub>t</sub></sub> = 1270	2.9
2/9/77**	5	6.2	990 x <sub>f<sub>t</sub></sub> = 1597	—
6/17/77	12	5.9	1400 x <sub>f<sub>t</sub></sub> = 1877	8.75

\*\*Could not get accurate discharge; pipe shut off to prevent icing road.

Deposit name: BRYAN  
 District: PACKER CREEK County: MINERAL  
 Location: Township 20 N. Range 31 W. Section 28  
 Latitude: 47°27'52" Longitude: 115°32'58"  
 Map name: SALTESE Series: 15 minute  
 Altitude of portal (ft.): 4550; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/16/77	6	5.6	280 x <sub>f<sub>t</sub></sub> = 439	3
1/25/78	5.5	5.7	270 x <sub>f<sub>t</sub></sub> = 430	2.5
6/16/77	6	5.6	280 x <sub>f<sub>t</sub></sub> = 439	4

Deposit name: HEMLOCK  
 District: PACKER CREEK County: MINERAL  
 Location: Township 19 N. Range 31 W. Section 2  
 Latitude: 47°26'8" Longitude: 115°30'28"  
 Map name: SALTESE Series: 15 minute  
 Altitude of portal (ft.): 3600; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/16/77	10	5.9	700 x <sub>f<sub>t</sub></sub> = 988	0.5
1/26/78	6	5.9	680 x <sub>f<sub>t</sub></sub> = 1067	0.41
6/14/77	8	5.9	680 x <sub>f<sub>t</sub></sub> = 1012	1

Deposit name: LITTLE ANACONDA  
 District: SPRING GULCH County: MINERAL  
 Location: Township 18 N. Range 26 W. Section 35  
 Latitude: 47°16'36" Longitude: 114°52'24"  
 Map name: PLAINS Series: 15 minute  
 Altitude of portal (ft.): 5200; of sampling point, same  
 Distance from portal to sampling point (ft.): 12

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/13/76	5.5	6.2	220 x <sub>f<sub>t</sub></sub> = 350	2.9
12/10/76	0	5.9	180 x <sub>f<sub>t</sub></sub> = 344	0.5
6/16/77	6	5.9	600 x <sub>f<sub>t</sub></sub> = 941	1

Deposit name: MEADOW MOUNTAIN

District: PACKER CREEK County: MINERAL

Location: Township 20 N. Range 31 W. Section 36

Latitude: 47°27'0" Longitude: 115°29'8"

Map name: HAUGAN Series: 15 minute

Altitude of portal (ft.): 4040; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/27/76	6	6.3	165 x <sub>f</sub> t = 259	7.2
1/26/78	5.8	6.4	165 x <sub>f</sub> t = 260	10.5
5/17/77	6	6.3	170 x <sub>f</sub> t = 267	13.6

Deposit name: MEADOW MOUNTAIN MINES

District: PACKER CREEK County: MINERAL

Location: Township 20 N. Range 31 W. Section 35

Latitude: 47°27'0" Longitude: 115°30'25"

Map name: SALTESE Series: 15 minute

Altitude of portal (ft.): 4000; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/16/77	5.5	5.8	280 x <sub>f</sub> t = 445	0.50
1/25/78	5	5.9	270 x <sub>f</sub> t = 436	0.75
6/16/77	5.5	5.8	270 x <sub>f</sub> t = 430	1

Deposit name: WABASH

District: PACKER CREEK County: MINERAL

Location: Township 20 N. Range 31 W. Section 36

Latitude: 47°27'0" Longitude: 115°29'8"

Map name: HAUGAN Series: 15 minute

Altitude of portal (ft.): 3880; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/16/77	6.5	5.7	250 x <sub>f</sub> t = 387	3.6
1/25/78	6	5.8	260 x <sub>f</sub> t = 408	3.0
6/16/77	6	5.7	250 x <sub>f</sub> t = 392	4.5

Deposit name: ROCK ISLAND

District: ROCK ISLAND

County: MINERAL

Location: Township 19 N. Range 29 W. Section 4

Latitude: 47°0'0" Longitude: 114°38'21"

Map name: HAUGAN

Series: 15 minute

Altitude of portal (ft.): 5120; of sampling point, 5121.3

Distance from portal to sampling point (ft.): 130

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/27/76	4.8	6.7	70 x <sub>f</sub> t = 114	1.7
1/26/78	4.5	6.8	80 x <sub>f</sub> t = 131	2.0
5/17/77	4.8	6.7	75 x <sub>f</sub> t = 122	2.25

Deposit name: HIDDEN TREASURE

District: CLINTON

County: MISSOULA

Location: Township 12 N. Range 16 W. Section 19

Latitude: 46°46'51" Longitude: 113°39'34"

Map name: CLINTON

Series: 7½ minute

Altitude of portal (ft.): 4060; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
10/13/76	5.5	5.8	190 x <sub>f</sub> t = 302	144
2/9/77	10	6.0	160 x <sub>f</sub> t = 226	67
5/28/77	10	5.9	198 x <sub>f</sub> t = 279	53

Deposit name: EMIGRANT

District: EMIGRANT

County: PARK

Location: Township 7 S. Range 9 E. Section 7

Latitude: 45°14'28" Longitude: 110°40'4"

Map name: GARDINER

Series: 15 minute

Altitude of portal (ft.): 8400; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/29/76	5	4.7	145 x <sub>f</sub> t = 234	73
12/15/77	4.5	4.7	240 x <sub>f</sub> t = 393	10.5
7/19/77	5	4.7	365 x <sub>f</sub> t = 589	22

Deposit name: GALENA QUEEN

District: EMIGRANT

County: PARK

Location: Township 7 S.

Range 9 E.

Section 4

Latitude: 45°15'21"

Longitude: 110°37'36"

Map name: EMIGRANT

Series: 15 minute

Altitude of portal (ft.): 7600; of sampling point, same

Distance from portal to sampling point (ft.): at portal (unsafe)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/29/76	3	5.6	80 x <sub>f<sub>t</sub></sub> = 137	48
12/15/77	3.5	5.4	260 x <sub>f<sub>t</sub></sub> = 438	10.4
6/14/77	3.5	5.3	250 x <sub>f<sub>t</sub></sub> = 421	12.5

Deposit name: BLACK WARRIOR

District: NEW WORLD (COOKE CITY)

County: PARK

Location: Township 9 S.

Range 14 E.

Section 15

Latitude: 45°2'56"

Longitude: 109°58'16"

Map name: COOKE CITY

Series: 15 minute

Altitude of portal (ft.): 9720; of sampling point, same

Distance from portal to sampling point (ft.): caved at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/26/76	3.5	5.8	250 x <sub>f<sub>t</sub></sub> = 421	.55
3/1/78	2	5.9	270 x <sub>f<sub>t</sub></sub> = 478	.45
7/20/77	2	6.5	325 x <sub>f<sub>t</sub></sub> = 575	1

Deposit name: GLENGARRY

District: NEW WORLD (COOKE CITY)

County: PARK

Location: Township 9 S.

Range 14 E.

Section 2

Latitude: 45°4'40"

Longitude: 109°57'5"

Map name: COOKE CITY

Series: 15 minute

Altitude of portal (ft.): 9320; of sampling point, same (unsafe)

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/26/76	3	3.5	690 x <sub>f<sub>t</sub></sub> = 1179	143*
3/1/78	3	6.3	840 x <sub>f<sub>t</sub></sub> = 1436	67*
7/20/77	3	6.2	850 x <sub>f<sub>t</sub></sub> = 1453	56*

Deposit name: GOLD DUST

District: NEW WORLD (COOKE CITY)

County: PARK

Location: Township 9 S.

Range 14 E.

Section 11

Latitude: 45°3'48"

Longitude: 109°57'5"

Map name: COOKE CITY

Series: 15 minute

Altitude of portal (ft.): 9240; of sampling point, same (at portal)

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/26/76	3	6.2	300 x <sub>f<sub>t</sub></sub> = 513	12
3/18/77**	0.5	5.9	480 x <sub>f<sub>t</sub></sub> = 902	—
7/20/77	3	6.2	850 x <sub>f<sub>t</sub></sub> = 1453	20

\*\*Frozen up around portal; no accurate discharge measurement possible.

Deposit name: LITTLE DAISY

District: NEW WORLD (COOKE CITY)

County: PARK

Location: Township 9 S.

Range 14 E.

Section 14

Latitude: 45°2'56"

Longitude: 109°57'5"

Map name: COOKE CITY

Series: 15 minute

Altitude of portal (ft.): 9840; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/1/77	2	6.3	450 x <sub>f<sub>t</sub></sub> = 796	4.5
3/1/78	2	6.4	440 x <sub>f<sub>t</sub></sub> = 779	3.8
7/19/77	2	6.3	440 x <sub>f<sub>t</sub></sub> = 779	5.3

Deposit name: PROSPECT NE¼ of NW¼

District: NEW WORLD (COOKE CITY)

County: PARK

Location: Township 9 S.

Range 14 E.

Section 12

Latitude: 45°3'48"

Longitude: 109°55'53"

Map name: COOKE CITY

Series: 15 minute

Altitude of portal (ft.): 9840; of sampling point, same

Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/19/77	5	5.9	60 x <sub>f<sub>t</sub></sub> = 97	1
2/11/78**	—	—	— x <sub>f<sub>t</sub></sub> = —	—
5/21/77	5	6.0	50 x <sub>f<sub>t</sub></sub> = 81	1.5

\*\*Snowdrifts ≅ 20 feet; could not find portal.

Deposit name: PROSPECT CENTER of NE¼  
 District: NEW WORLD (COOKE CITY) County: PARK  
 Location: Township 9 S. Range 14 E. Section 10  
 Latitude: 45°3'48" Longitude: 109°58'16"  
 Map name: COOKE CITY Series: 15 minute  
 Altitude of portal (ft.): 9600; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
9/1/77	2.5	5.6	240 x <sub>f<sub>t</sub></sub> = 417	1
2/11/78**	—	—	— x <sub>f<sub>t</sub></sub> = —	—
8/26/76	2.5	5.6	230 x <sub>f<sub>t</sub></sub> = 400	1.33

\*\*Snowdrifts > 20 feet; could not find portal.

Deposit name: PROSPECT NW¼ of SW¼  
 District: NEW WORLD (COOKE CITY) County: PARK  
 Location: Township 9 S. Range 15 E. Section 18  
 Latitude: 45°2'54" Longitude: 109°54'35"  
 Map name: COOKE CITY Series: 15 minute  
 Altitude of portal (ft.): 8960; of sampling point, same (unsafe portal)  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/26/76	7.5	6.2	80 x <sub>f<sub>t</sub></sub> = 121	0.5
3/1/78	3	5.9	390 x <sub>f<sub>t</sub></sub> = 666	0.20
7/20/77	3	5.9	400 x <sub>f<sub>t</sub></sub> = 684	0.25

Deposit name: GOLD BUG MINE  
 District: LITTLE ROCKIES (Landusky subdistrict) County: PHILLIPS  
 Location: Township 25 N. Range 24 E. Section 22  
 Latitude: 47°54'25" Longitude: 108°37'11"  
 Map name: ZORTMAN Series: 7½ minute  
 Altitude of portal (ft.): 4600; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (locked)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (µmho/cm)	Flow (gpm)
8/12/76	11	6.2	460 x <sub>f<sub>t</sub></sub> = 633	650*
2/16/77	10	5.9	460 x <sub>f<sub>t</sub></sub> = 649	614*
5/11/77	11	5.9	380 x <sub>f<sub>t</sub></sub> = 523	90*



Deposit name: BEAVER MINE

District: LITTLE ROCKIES (Zortman subdistrict) County: PHILLIPS

Location: Township 25 N. Range 25 E. Section 5

Latitude: 47°56'60" Longitude: 108°31'59"

Map name: ZORTMAN Series: 7½ minute

Altitude of portal (ft.): 4520; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/12/76	6.5	6.2	148 x <sub>f</sub> t = 229	20
2/17/77	6	5.9	180 x <sub>f</sub> t = 282	14
5/11/77	5.5	5.9	170 x <sub>f</sub> t = 270	14.1

Deposit name: FLORA DAWN

District: FINN County: POWELL

Location: Township 12 N. Range 8 W. Section 20

Latitude: 46°46'49" Longitude: 112°37'45"

Map name: FINN Series: 7½ minute

Altitude of portal (ft.): 5600; of sampling point, same

Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/18/76	8	5.9	320 x <sub>f</sub> t = 476	105*
2/8/77	7	5.8	330 x <sub>f</sub> t = 504	94*
6/23/77	7.8	5.9	330 x <sub>f</sub> t = 494	125*

Deposit name: BROKEN HILL

District: BLUE CREEK County: SANDERS

Location: Township 27 N. Range 34 W. Section 10

Latitude: 48°7'4" Longitude: 115°57'44"

Map name: HERON Series: 7½ minute

Altitude of portal (ft.): 3900; of sampling point, same

Distance from portal to sampling point (ft.): 20 (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/24/76	6	5.6	35 x <sub>f</sub> t = 55	35.6
12/11/77	5.8	5.6	95 x <sub>f</sub> t = 150	2.86
6/25/77	6	5.7	100 x <sub>f</sub> t = 157	35.8

Deposit name: EDDY CREEK

District: PLAINS

County: SANDERS

Location: Township 20 N.

Range 28 W.

Section 14

Latitude: 47°29'32"

Longitude: 115°07'35"

Map name: ST. REGIS

Series: 15 minute

Altitude of portal (ft.): 4120; of sampling point, 4134

Distance from portal to sampling point (ft.): 1400 back

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/26/76	8	5.8	100 x <sub>f<sub>t</sub></sub> = 149	9
1/25/78	8	6.0	170 x <sub>f<sub>t</sub></sub> = 253	10
6/17/77	8	5.9	170 x <sub>f<sub>t</sub></sub> = 253	11.1

Deposit name: GRACE (PROSPECT)

District: BASIN CREEK

County: SILVER BOW

Location: Township 1 N.

Range 7 W.

Section 22

Latitude: 45°49'20"

Longitude: 112°27'21"

Map name: PIPESTONE PASS

Series: 7½ minute

Altitude of portal (ft.): 7200; of sampling point, same

Distance from portal to sampling point (ft.): none

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
7/7/76	8	5.9	72 x <sub>f<sub>t</sub></sub> = 107	3
1/31/78	6	6.0	75 x <sub>f<sub>t</sub></sub> = 118	2
5/31/77	8	5.9	80 x <sub>f<sub>t</sub></sub> = 119	2.25

Deposit name: MOUAT

District: NYE

County: STILLWATER

Location: Township 5 S.

Range 15 E.

Section 20

Latitude: 45°23'5"

Longitude: 109°54'0"

Map name: MT. WOOD

Series: 15 minute

Altitude of portal (ft.): 7100; of sampling point, same

Distance from portal to sampling point (ft.): main portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/3/77	4.5	6.2	300 x <sub>f<sub>t</sub></sub> = 491	27.3
12/15/77	1.5	5.9	360 x <sub>f<sub>t</sub></sub> = 651	17.9
7/22/77	4.5	6.2	170 x <sub>f<sub>t</sub></sub> = 278	23.3

Deposit name: BENBOW (NORTH PORTAL)  
 District: STILLWATER County: STILLWATER  
 Location: Township 5 S. Range 16 E. Section 31  
 Latitude: 45°21'21" Longitude: 109°47'53"  
 Map name: MT. WOOD Series: 15 minute  
 Altitude of portal (ft.): 8200; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
9/3/77	4.5	6.2	170 x <sub>f<sub>t</sub></sub> = 278	20.6
12/15/77	1.5	6.3	175 x <sub>f<sub>t</sub></sub> = 316	18.75
7/22/77	4.5	6.2	170 x <sub>f<sub>t</sub></sub> = 278	23.3

Deposit name: INDEPENDENCE  
 District: INDEPENDENCE County: SWEET GRASS  
 Location: Township 7 S. Range 12 E. Section 15  
 Latitude: 45°13'18" Longitude: 110°13'6"  
 Map name: CUTOFF MTN. Series: 15 minute  
 Altitude of portal (ft.): 9400; of sampling point, same  
 Distance from portal to sampling point (ft.): at portal (caved)

Date Mo./Day/Yr.	Water temp. (°C)	pH	Specific conductance (μmho/cm)	Flow (gpm)
8/28/76	3.5	5.6	40 x <sub>f<sub>t</sub></sub> = 67	1.25
4/10/77**	—	—	— x <sub>f<sub>t</sub></sub> = —	—
7/21/77	2.75	—	220 x <sub>f<sub>t</sub></sub> = 386	1.11

\*\*Could not find portal in snowdrifts.

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