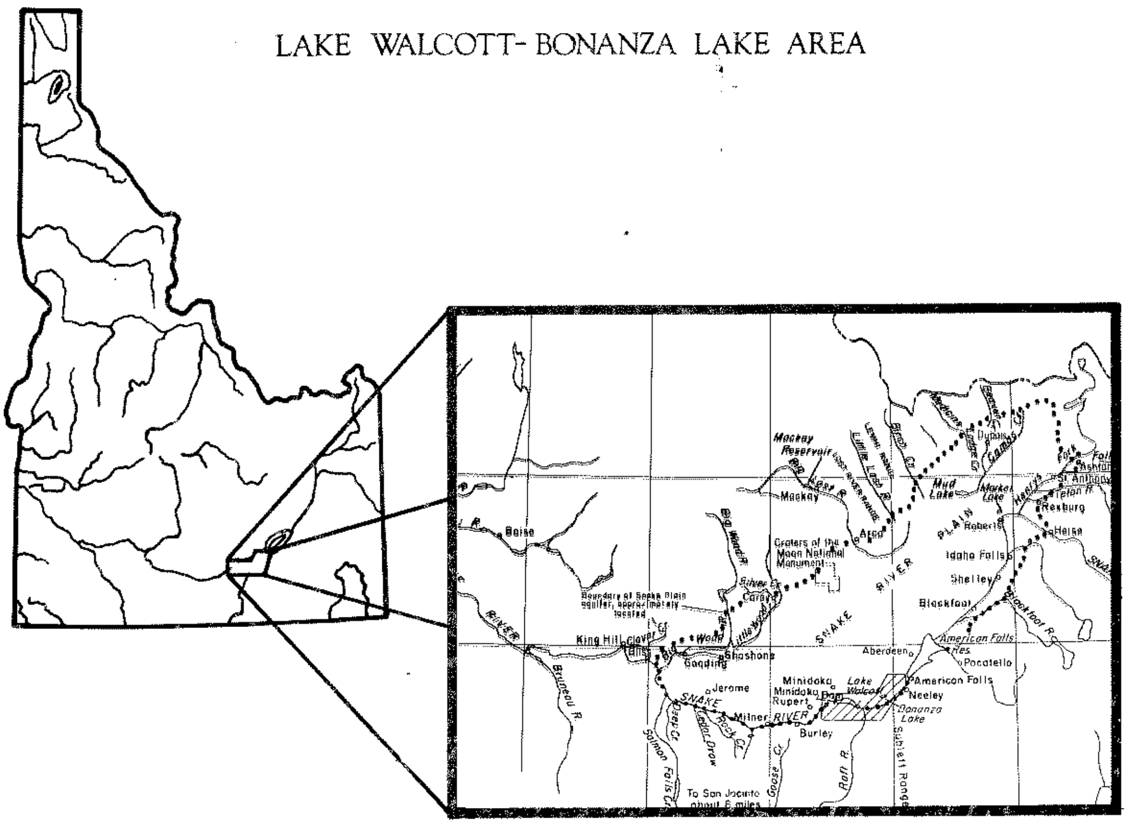
# A PROGRESS REPORT ON RESULTS OF TEST-DRILLING AND GROUND-WATER INVESTIGATIONS OF THE SNAKE PLAIN AQUIFER, SOUTHEASTERN IDAHO

## PART 3

LAKE WALCOTT-BONANZA LAKE AREA




IDAHO DEPARTMENT OF WATER RESOURCES

WATER INFORMATION BULLETIN NO. 38

AUGUST 1974

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Part 3

Lake Walcott-Bonanza Lake Area

by

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Prepared by the United States Geological Survey

in cooperation with the

Idaho Department of Water Resources

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## PREFACE

The Snake Plain aquifer, as defined by Mundorff, Crosthwaite, and Kilburn (1964, p. 142), is a series of basalt flows and intercalated pyroclastic and sedimentary materials that underlies the Snake River Plain east of Bliss (fig. 1). The aquifer is about 9,500 square miles (24,600 square kilometers) in areal extent and yielded about a million acre-feet (1.233 cubic kilometers) of water to wells in 1969. Approximately 6½-million acre-feet (8 cubic kilometers) of water is recharged annually to this aquifer by seepage loss from the Snake River and its tributaries, by underflow from tributary valleys, by the downward percolation of water applied for irrigation, and by precipitation on the Plain. Water is discharged from the aquifer through springs and by pumping for irrigation, municipal, industrial, stock, and domestic use. Although the aquifer has been extensively studied and its general extent and properties are known, it is so large and thick that data on the distribution of the basalt flows and interbedded sedimentary deposits that control the movement of ground water have not been obtained at several places of great current importance. Also, there are large areas where the position of the water table and the potential yield of the aquifer are not known.

The Idaho Department of Water Administration (now the Idaho Department of Water Resources) has the responsibility of administering the water resources of Idaho and for this reason it is vitally interested in basic data descriptive of the water resources of the Snake River Plain. Because the U. S. Bureau of Reclamation is actively developing the water resources available in various parts of the Plain, it needs basic data which will be useful in selecting areas suitable for development and in evaluating effects of development. The U. S. Geological Survey has a responsibility for collecting basic data and for appraising the water resources of Idaho. Because of their common interests, and in recognition of the need for information about the water resources of the Snake Plain aquifer, these three agencies entered into a cooperative agreement whereby the U. S. Geological Survey and U. S. Bureau of Reclamation initiated, in July 1969, a 4-year investigative project whose goal is to satisfy the objectives described below.

The objectives of this investigation are to obtain (1) information descriptive of elevations and fluctuations of the water table, water-table gradients, and the distribution of transmissivity, in areas of the Snake Plain aquifer where data are lacking; (2) details of stratigraphic and hydrologic properties at localities selected as being suitable for pumping large quantities of ground water in exchange for surface water[1/]; (3) hydrologic details in the eastern part of this aquifer, where the greatest amount of recharge occurs, so as to correlate better the distribution of recharge to areas of spring discharge; and (4) water-level and stratigraphic data in the area of the Mud Lake-Market Lake ground-water "barrier" so as to better define recharge relations and large water-level differentials occurring in and around this barrier. In addition, it is expected that all the data collected will be integrated into a

[1/] The U. S. Bureau of Reclamation is investigating means of providing total water management in the upper Snake River basin. This includes evaluating the feasibility of diverting surface water from presently irrigated land to areas of inadequate surface-water supply or to areas of no surface-water supply and replacing the diverted water with ground water.

digital model of the Snake Plain aquifer so that the long-term effects of development of the aquifer can be better predicted.

To provide for timely release of the data collected during the project, a series of progress reports describing the work accomplished during each phase of the project has been prepared. The Mud Lake region was discussed in part 1 of this report series. Observation wells south of Arco and west of Aberdeen were discussed in part 2. Part 1 of these progress report series is entitled "Mud Lake region, 1969-70." Part 2 is entitled "Observation wells south of Arco and west of Aberdeen." The present report (part 3) describes the work accomplished in the Lake Walcott-Bonzana Lake area in the south-central part of the Snake River Plain during the period June to December 1970. In June 1972 at the end of the third year of this project, work was discontinued because of a lack of funds available to the Bureau of Reclamation.

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# RESULTS OF TEST—DRILLING AND GROUND—WATER INVESTIGATIONS

# OF THE SNAKE PLAIN AQUIFER, SOUTHEASTERN IDAHO

## Part 3

## Lake Walcott-Bonanza Lake Area

by

E. G. Crosthwaite

## ABSTRACT

Direct-current resistivity soundings and exploratory drilling suggest that the basalt of the Snake River Group is relatively thin in the area along the Snake River that is topographically suitable for pumping large quantities of ground water in exchange for surface water. The formations underlying the Snake River Group appear to have low permeability and probably would not yield large amounts of water. Previous studies have indicated that the southern edge of the Snake Plain aquifer extended to the Snake River. Data presented in this report implies that, in general, the southern boundary should, in fact, be several miles north of the river.

## INTRODUCTION

Little is known about the geology and hydrology of the southern Snake River Plain between Minidoka Dam, which impounds Lake Walcott, and American Falls (figs. 1 and 2). The area between Minidoka Dam and Bonanza Lake is only a few to a few tens of feet (a few meters) above the level of Lake Walcott and the Snake River. Topographic considerations imply that the area just north of the Snake River would be a convenient place to withdraw large volumes of ground water for discharge to the Snake River if geologic and hydrologic conditions were favorable. The ground water could be used either to replace surface water diverted from users with surface-water rights or to supplement streamflow during years of deficient stream runoff.

Several wells within 5 miles (8 kilometers) southeast of Minidoka yield large supplies of water for irrigation and, between Minidoka and American Falls, several wells supply water to livestock. In addition, a few shallow wells in Lake Channel withdraw water from alluvial deposits for domestic and irrigation use. Except for the wells in Lake Channel, most of the

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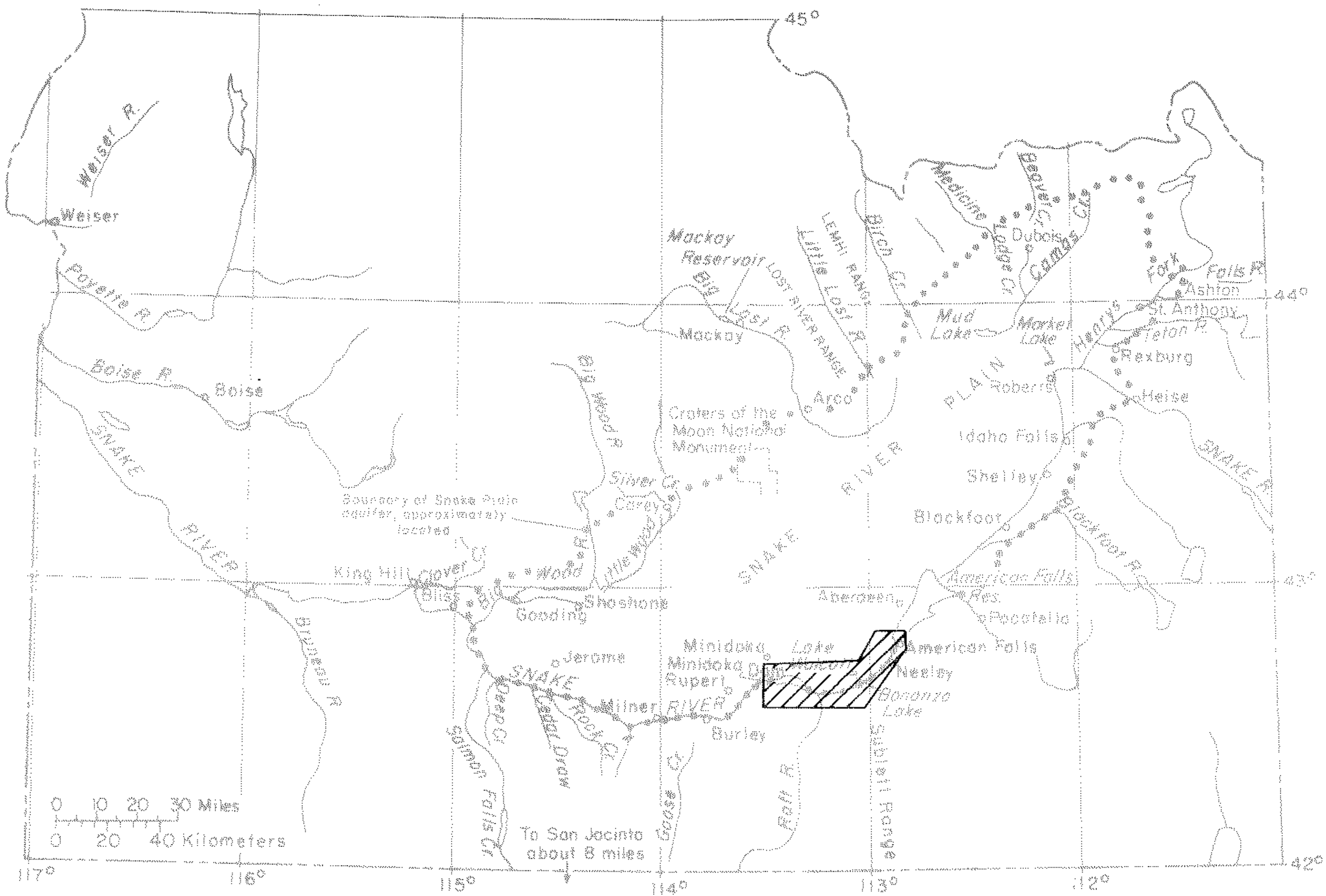



**FIGURE 1. Map of southern Idaho showing the Snake River Plain and area covered by this report.**

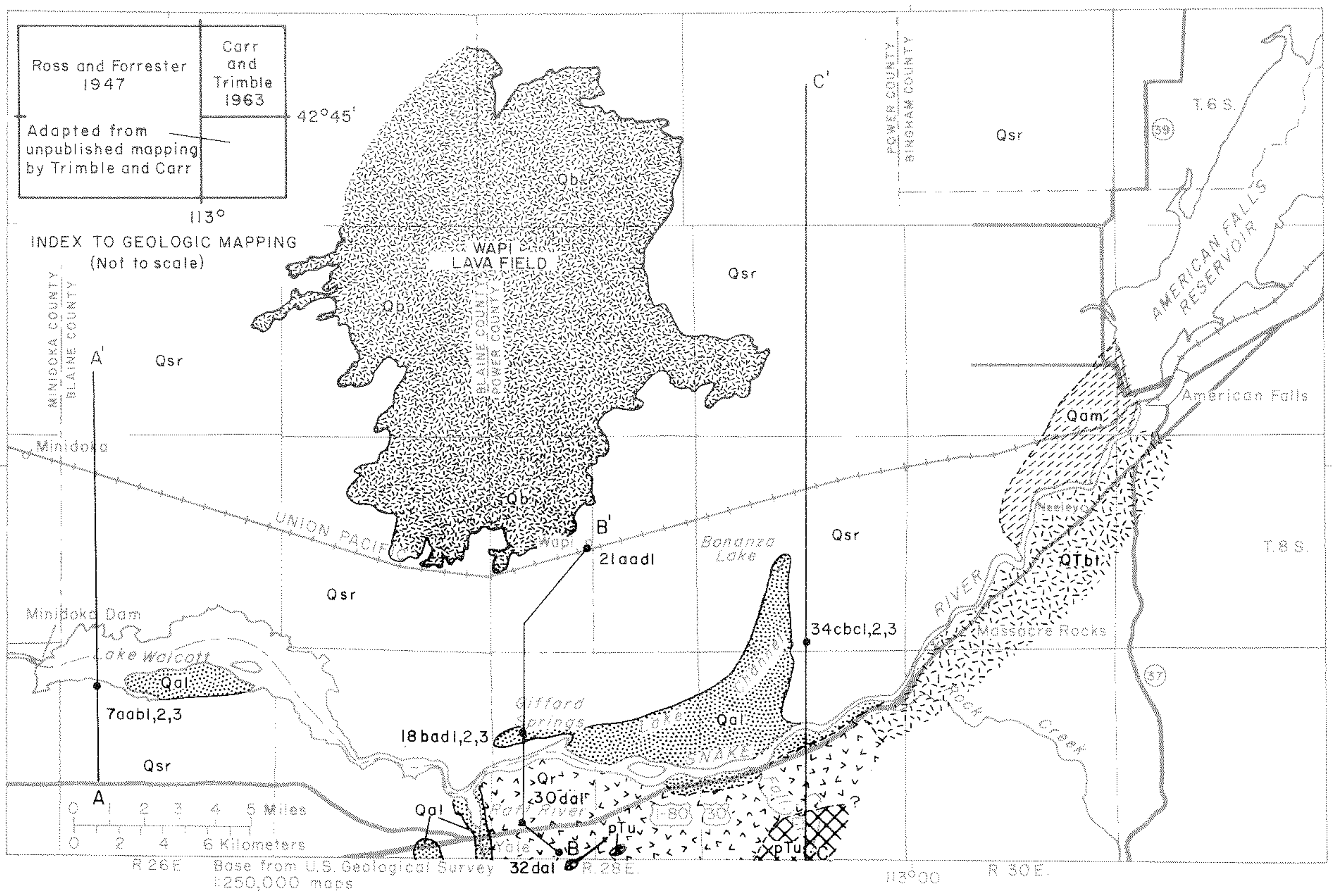



**FIGURE 2. Generalized geologic sketch map of the study area.**

EXPLANATION

| | | |
|---|---|---|
| Qal — Alluvium | Holocene | QUATERNARY |
| Qb — Basalt | Holocene | QUATERNARY |
| Qam — American Falls Lake Beds | Pleistocene | QUATERNARY |
| Qsr — Basalt of Snake River Group | Pleistocene | QUATERNARY |
| Qr — Raft Formation | Pleistocene | QUATERNARY |
| QTb — Basalt, basaltic tuff, older alluvium, and silicic tuffs, undivided | Pleistocene and Pliocene | QUATERNARY AND TERTIARY |
| pTu — Predominately rock of Pleozoic age | | PRE-TERTIARY |

Contact

21aadl
Well and number used in this report

A——A'
Line of resistivity profile
(Profiles shown on figures 5, 6, and 7)

wells produce from basalt.

To learn more about the hydrology and the thickness and extent of the basalt in the area and, thereby, the potential for producing large quantities of ground-water from the basalt, direct-current resistivity (electrical) soundings were made along three lines several miles in length and an exploratory hole was drilled on or near each line of resistivity soundings. This report presents the results of these field studies and evaluates, insofar as the data permit, the possibilities for development of large-scale ground-water supplies in the area.

The direct current resistivity soundings were made along three north-south lines; one line in the western part of the area, one near the central part, and one in the eastern part (fig. 2). The profile compiled from resistivity soundings in the western part of the area is 12 miles (19 kilometers) long and the results were interpreted to a depth of about 4,000 feet (1,200 meters), (fig. 5). The middle profile is about 8 miles (13 kilometers) long and the interpretation also was to a depth of about 4,000 feet (1,200 meters), (fig. 6). The eastern profile is 22 miles (35 kilometers) long and the interpretation extends to a depth of about 15,000 feet (4,500 meters), (fig. 7).

An exploratory hole was drilled on or near each of the resistivity lines to gather data on the geologic and hydrologic conditions in the area and as an aid to interpretation of the electrical resistivity soundings. The holes were drilled to shallow depth by air rotary methods and then core-dilled to the total depth. Two 3/4-inch (19 millimeters) pipe piezometers were installed at selected depths in each hole and the holes backfilled with sand and fine gravel. Neat-cement grout was placed at selected intervals to isolate the piezometers so that water levels in different hydrologic units can be monitored. Wells logs, construction diagrams, and other pertinent data are given in the appendix.

## General Features

Much of the area investigated consists of a gently rolling basalt surface of the Snake River Group that is mantled by windblown sand. Sandy loam mantles the basalt near Minidoka and northwest of American Falls. Lake Channel (fig. 2), a valley that is tributary to the Snake River in the east central part of the area, was cut by the overflow of flood water from Lake Bonneville (Trimble and Carr, 1961, p. 1,745) and, consequently, now is floored with sand, gravel, and boulders. The flood waters cut an escarpment which extends from the Snake River northward to Bonanza Lake and southwestward from the lake to near Gifford Springs. Between American Falls and Lake Channel, the Snake River flows in a canyon about 200 feet (60 meters) deep. Downstream from Lake Channel, the land surface rises gently northward from the river to the nearly bare basalt of the Wapi lava field, a rise of about 200 feet in 5 miles (60 meters in 8 kilometers). Downstream from American Falls on the south side of the river, the canyon wall decreases slowly in height to where, just beyond the mouth of Raft River, the river channel is incised only a few feet below the level of the plain. West of the mouth of Raft River, the terrain on both sides of the river is typical of the Snake River Plain. South of the Snake River near the mouth of Lake Channel, the steeply rolling mountains of the Sublett Range rise 2,000 to 3,000 feet (600 to 900 meters) above the general level of the Snake River Plain.

Minidoka Dam, which impounds Lake Walcott, backs water up the channel of Snake River to within about 10 miles (16 kilometers) of American Falls. The only perennial streams in the area, besides the Snake River, are Raft River, Fall Creek and Rock Creek, all of which enter Snake River from the south. Lake Channel contains Bonanza Lake and several small ponds, all of which appear to be at or near the elevation of the water table. Several springs discharge from basalt to the Snake River (all from the north side) at, near, or below river level, and all but two of the smallest ones are upstream from the mouth of Raft River. A small warm spring whose temperature is 28° C (82° F) discharges from alluvium overlying the Raft Formation in the NE¼ SW¼ sec. 19, T. 9 S., R. 28 E.

## Previous Work

Stearns, and others, (1938, p. 151-154) describe the springs between American Falls and Minidoka Dam and give the records of their discharge for the period 1925-28. Their records indicate that the discharge of the springs increased after the completion of the American Falls Dam in 1927 and the estimated total discharge in 1928 was about 70 cfs (cubic feet per second), (2 cubic meters per second). They also published a geologic map of part of the area (Stearns and others, 1938, pl. 6).

Meisler (1958) made a reconnaissance study of the general area covered by this report. He summarized the geology in the Bonanza Lake area and suggested that a perched water table was the source of the springs discharging to the Snake River.

Stearns and Isotoff (1956, p. 19-34) mapped the geology in detail in a small area along the Snake River near Massacre Rocks. Later Carr and Trimble (1963) mapped the American Falls quadrangle in detail and slightly modified the stratigraphy of Stearns and Isotoff. Trimble and Carr (oral commun., 1971) have also mapped the Rockland Valley quadrangle immediately south of the American Falls quadrangle. The geologic mapping of Carr and Trimble was in the extreme eastern part of the area of this report and is useful in correlating the geologic formations in the area of this report with those studied by Trimble and Carr. For that reason, their stratigraphy for the Tertiary and Quaternary rocks is shown in figure 3. Mundorff (1967) reported on the hydrology and geology of the American Falls Reservoir area. His work indicates that leakage from the reservoir is small and that the reservoir level could be raised 10 to 15 feet (3 to 5 meters) without a significant increase in leakage. A generalized geologic map compiled from the above sources and the State geologic map (Ross and Forrester, 1947) is shown in figure 2. Walker and others (1970) recently reappraised the

# EXPLANATION

**QUATERNARY**

**Upper Pleistocene to Recent**

Qal

**Alluvium undifferentiated**

Qam

**American Falls lake beds**

Tan and light-gray to pinkish-brown locally calcareous quartz sand and silt, gray to green clay, and a persistent layer of white blocky very diatomaceous clay. A layer of pebble gravel at the base is generally absent where the formation overlies basalt. About 80 feet thick.

**Middle or Upper Pleistocene**

Qsb

**Sunbeam formation**

Tan calcareous quartz silt and fine sand, poorly to locally well-bedded, with a few lenses of gravel. Probably includes some $Ql_2$ and Qal.

Qb

**Big Hole basalt**

Several flows of gray to black vesicular olivine basalt. In the areas west of Aberdeen and southwest of American Falls, the basalt is locally covered by unmapped loess and sand dunes, generally less than 20 feet thick.

$Ql_1$ | $Ql_2$

**Loessial deposits**

Uniform light-tan slightly indurated calcareous silt.

$Ql_1$, loess west of American Falls Reservoir mantling Qb.

$Ql_2$, loess southeast of American Falls, generally at altitudes above 4,750 feet. Age relations of $Ql_1$ and $Ql_2$ unknown.

UNCONFORMITY

Qr

**Raft formation**

Tan to light-gray calcareous bedded quartz silt and fine sand containing a few beds of greenish-gray clay; commonly contains hard calcareous nodules. Lower part locally contains basaltic and rhyolitic ash, gravel lenses, and one or more persistent lime-cemented layers, 1 to 3 feet thick. In this area, the formation is a few feet to about 150 feet thick.

UNCONFORMITY

**QUATERNARY(?)**

**Pleistocene(?)**

Qlb / Qlc

**Little Creek formation**

UNCONFORMITY

Qlb, basalt member, a single flow of dark-gray dense to locally porous fine-grained basalt with little visible olivine. Commonly has a streaky flow-banded appearance, and is locally diktytaxitic. Normally 5 to 25 feet thick, but locally as much as 60 feet thick in areas of valley filling.

Qlc, tuff member, yellowish-tan to reddish-brown basaltic tuffaceous sandstone, and dark-gray to tan lapilli tuff and tuff-breccia, mainly basaltic but with some rhyolitic pyroclastic material, particularly in lower part. Lenses of conglomerate are common in the Ferry Hollow area. 10 to 75 feet thick.

UNCONFORMITY

**TERTIARY**

**Middle Pliocene**

Tw

**Walcott tuff**

Upper member, mainly black dense glassy obsidian welded tuff with locally abundant spherulites and lithophysae, and a local zone of pink hard to friable tuff at top. Lower member, parallel-bedded pure white rhyolitic tuff. Entire formation is 15 to 50 feet thick.

Twn

**Walcott tuff and Neeley formation undifferentiated**

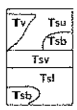
Tn

**Neeley formation**

Light-tan to orange-brown fine- to coarse-grained rhyolitic tuff, commonly poorly bedded; lenses of pebbles, fragments of pumice, and a few beds of pure white marl. At the base is a gravel containing pebbles and cobbles mostly of Paleozoic rocks and vitric-crystal tuff of the Starlight formation. About 30 to 150 feet thick.

UNCONFORMITY

**Lower or Middle Pliocene**




**Starlight formation**

Mainly rhyolitic tuff containing some interstratified marl, welded tuff, gravel and tuff-breccia, and locally numerous flows of basalt and layers of basaltic tuff and tuff-breccia.

Tsu, upper member, white to gray bedded rhyolitic tuff, and minor tuff-breccia and white marl. Deposition of the upper part is contemporaneous with intrusion of a vitrophyre, Tv, that is locally a breccia incorporated in the ash beds. In lower part are intercalated a few flows of basalt, Tsb, and some brown basaltic tuff.

Tsv, vitric-crystal tuff member, light-gray to tan vitric-crystal tuff, generally friable in lower part, compact and welded in upper part. Locally includes an upper zone of dark-gray to brown glassy welded tuff. Contains small pumice fragments and conspicuous crystals of quartz, many doubly terminated, sanidine, and a little biotite and plagioclase. 10 to 75 feet thick.

Tsl, lower member, white to gray and red rhyolitic bedded tuff and tuffaceous sandstone, interbedded locally with marl beds, brown and gray cindery basaltic tuff and tuff-breccia, and dense basalt, Tsb.

Tv, vitrophyre, dark-gray to black flow-banded glass with conspicuous phenocrysts of plagioclase and sanidine. Commonly shows steeply dipping flow banding and contacts, and is primarily an intrusive rock, although as a breccia it is locally incorporated in tuff beds of the upper part of the upper member of the Starlight formation. In an area 0.5 mile northeast of American Falls, it is highly altered and includes fragments and pebbles of older rocks.

Tsb, basalt, dark-gray dense fine-grained basalt and minor basaltic andesite, commonly with a few small yellowish spots of altered olivine. A few flows have well-developed platy structure or contain scattered large plagioclase crystals. Basalt in the lower part of the lower member of the formation is locally porphyritic and visibly ophitic. May include a few beds of Tsl.

MAJOR UNCONFORMITY

**PRE-TERTIARY**

Pt

**Pre-Tertiary rocks undifferentiated**

**FIGURE 3. Tertiary and Quaternary stratigraphy of the American Falls quadrangle. (From Carr and Trimble, 1963, pl. 1.)**

water resources of the Raft River basin. Their report is useful in correlating the geology near the mouth of the Raft River with the rock units of this report.

## Well Numbering System

The well-numbering system used by the U. S. Geological Survey in Idaho indicates the locations of wells within the official rectangular land subdivision, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range. The third segment gives the section number, followed by three letters and a numeral, which indicate the quarter section, the 40-acre (16.2 hectares) tract, the 10-acre (1.6 hectares) tract, and the serial number of the well within the tract, respectively. Quarter sections are lettered a, b, c, and d in counterclockwise order from the northeast quarter of each section (fig. 4). Within the quarter sections, 40-acre (16.2 hectares) and 10-acre (1.6

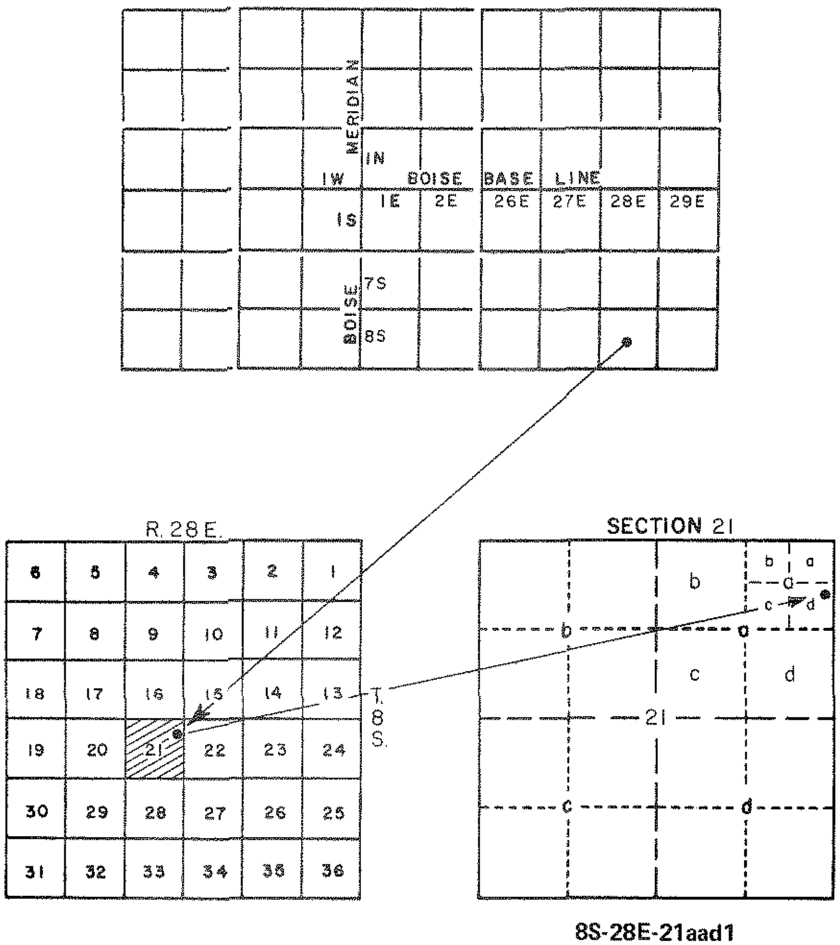



FIGURE 4. Diagram showing well-numbering system.

hectares) tracts are lettered in the same manner. Well 8S-28E-21aad1 is in the SE¼ NE¼ NE¼ sec. 21, T. 8 S., R. 28 E., and was the first well inventoried in that tract.

Each exploratory well in this report contains either two or three piezometers and each piezometer is considered as a well. The well or piezometer that monitors the water level in the shallowest formation at a well site is considered as well No. 1, the piezometer that monitors the water level in the next deepest zone is well No. 2, and in the deepest zone is well No. 3.

## Factors for Converting English Units to

## International System (SI) Units

The International System of Units is being adopted for use in reports prepared by the U. S. Geological Survey. To assist readers of this report in understanding and adapting to the new system, many of the measurements reported herein are given in both units. The factors listed below are presented as an aid to conversion from one system of units to another.

| Multiply English units | By | To obtain SI units |
|---|---|---|
| | **Length** | |
| inches (in) | 25.4 | millimeters (mm) |
| | .0254 | meters (m) |
| feet (ft) | .3048 | meters (m) |
| miles (mi) | 1.609 | kilometers (km) |
| | **Area** | |
| acres | 4047 | square meters ($m^2$) |
| | .4047 | hectares (ha) |
| | .4047 | square hectometer ($hm^2$) |
| | .004047 | square kilometers ($km^2$) |
| square miles ($mi^2$) | 2.590 | square kilometers ($km^2$) |
| | **Volume** | |
| gallons (gal) | 3.785 | liters (l) |
| | 3.785 | cubic decimeters ($dm^3$) |
| | $3.785 \times 10^{-3}$ | cubic meters ($m^3$) |
| million gallons ($10^6$ gal) | 3785 | cubic meters ($m^3$) |
| | $3.785 \times 10^{-3}$ | cubic hectometers ($hm^3$) |
| cubic feet ($ft^3$) | 28.32 | cubic decimeters ($dm^3$) |
| | .02832 | cubic meters ($m^3$) |
| cfs-day ($ft^3$/s-day) | 2447 | cubic meters ($m^3$) |
| | $2.447 \times 10^{-3}$ | cubic hectometers ($hm^3$) |
| acre-feet (acre-ft) | 1233 | cubic meters ($m^3$) |
| | $1.233 \times 10^{-3}$ | cubic hectometers ($hm^3$) |
| | $1.233 \times 10^{-6}$ | cubic kilometers ($km^3$) |
| | **Flow** | |
| cubic feet per second ($ft^3$/s) | 28.32 | liters per second (l/s) |
| | 28.32 | cubic decimeters per second ($dm^3$/s) |

(continued on next page)

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| Multiply English units | By | To obtain SI units |
|---|---|---|
| | **Flow** | |
| | .02832 | cubic meters per second ($m^3/s$) |
| gallons per minute (gpm) | .06309 | liters per second (l/s) |
| | .06309 | cubic decimeters per second ($dm^3/s$) |
| | $6.309 \times 10^{-5}$ | cubic meters per second ($m^3/s$) |
| million gallons per day (mgd) | 43.81 | cubic decimeters per second ($dm^3/s$) |
| | .04381 | cubic meters per second ($m^3/s$) |
| | **Mass** | |
| ton (short) | .9072 | tonne (t) |


### Acknowledgments

The U. S. Bureau of Reclamation supplied well data, including drillers' logs, core samples, and water-level measurements for the three wells drilled as part of this study. A. A. R. Zohdy and W. D. Stanley, U. S. Geological Survey, did the direct-current resistivity surveys and supplied the electrical interpretations of the geologic cross sections. D. R. Mabey, and D. E. Trimble, both of the U. S. Geological Survey, contributed to the geologic interpretation through informal correspondence.


## RESULTS OF GEOPHYSICAL WORK AND EXPLORATORY DRILLING

The direct-current resistivity soundings and exploratory drilling suggested that, in general, the basalt of the Snake River Group is relatively thin, particularly in that part of the area that is topographically suitable for large-scale ground-water withdrawals. The formations underlying the basalt consist of fine-grained sediments and rhyolitic tuff which appear to be unsuitable for large production wells. Following is a discussion of the profiles compiled from electrical soundings and exploratory well drilling.

### Western Resistivity Profile

Figure 5, a resistivity profile compiled from resistivity soundings, shows that low resistivity material occurs at depth and this material is overlain by several groups of rocks having distinctive and successively higher resistivities. Exploratory well 9S-26E-7aab3 was drilled and cored to aid in verifying the stratigraphy suggested by the resistivity soundings and to determine the position of water table in the water-bearing zones.

The Raft Formation crops out along the Snake River from the mouth of Raft River to beyond American Falls. The electrical resistance of the deepest formation (labeled A) in figure 5 and the altitude of its upper surface suggests that it is correlative with the Raft

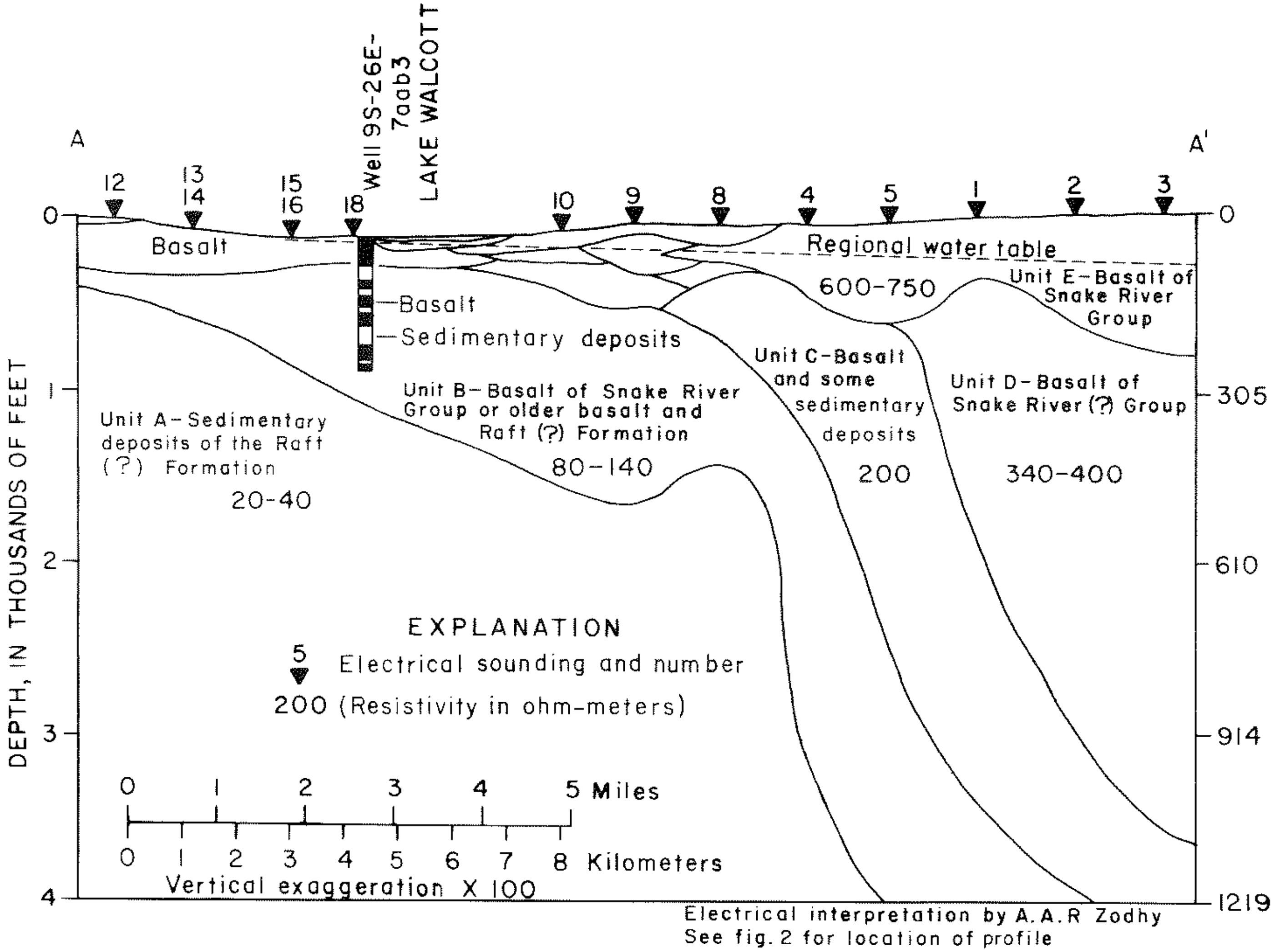


FIGURE 5. Resistivity profile A—A'.

Formation. The Raft Formation is composed of light-colored beds of massive silt and clay and stratified silt and sand (Carr and Trimble, 1963, p. G21). Figure 5 implies that unit A exceeds 3,500 feet (1,000 meters) in thickness. It is doubtful that all of unit A is Raft Formation. The exploratory well showed that the material with a resistance of 80-140 ohm-meters is interbedded basalt and sediments (labeled B in fig. 5). About three-fifths of this unit is basalt and about two-fifths is clay, silt, and fine sand. On the basis of the resistivity soundings, the material with about 200 ohm-meter resistivity is interpreted to be mostly basalt with several thin interbedded sedimentary beds (labeled C). Trimble (written commun., 1973) suggests that units B and C comprise the Raft Formation with intertongued layers of basalt of the Snake River Group and older basalts. This interpretation is reasonable because both the Raft Formation and at least a part of the older basalts of the Snake River Group are of the same age. The sediments probably pinch out to the north but data are not available to verify this statement. A limited amount of resistivity data suggests that basalts similar to the basalts of the Snake River Group have resistivities of 300 to more than 1,000 ohm-meters. On that basis, the remainder of the material shown in figure 5 (D and E) is basalt of the Snake River Group or similar basalt even though there is a small but significant resistivity contrast between the two units. The contrast may be due to a contrast in water quality with the deeper water being slightly more conductive. Also, the possibility of some interbedded sediments in the basalt labeled D should not be discounted.

To summarize, all the basalt shown in figure 5 is interpreted to be a part of the Snake River Group with a large amount of interbedded sediments in the lower, older part. Sediments become less abundant in the younger basalts and are a minor part of the section in the youngest basalts. The sediments in units B and C appear to be a part of the Raft Formation that was deposited when drainage from the Raft River basin was blocked by basalt flows.

Piezometers were set at 152, 227, and 785 feet (46.3, 69.2, and 239.3 meters) below land surface in exploratory hole 9S-26E-7aab to monitor water levels in the intervals 68 to 153, 170 to 550, and 620 to 804 feet (20.7 to 46.6, 51.8 to 167.6, and 189.0 to 245.1 meters), respectively. The water level in the shallowest zone is about 60 feet (18 meters) below land surface. (The upper piezometer monitors the water level in the open hole.) The water level in the next deeper piezometer is a few tenths of a foot (a few centimeters) lower. Small differences in head have been observed in the water-bearing zones at the National Reactor Testing Station (P. H. Jones, written commun., 1961), and thus it would not be unusual to expect small head differences in this area; especially when the basalt flows are separated by beds of fine-grained sediments. However, this explanation may not be the reason for the difference in water levels in the two piezometers. The well is about 150 feet (45 meters) from the shore of Lake Walcott. The lake is perched above the water table and the surface of the lake is about 55 feet (17 meters) higher than the water table. There is some evidence that water leaks through the bottom and sides of the lake (Crosthwaite and Scott, 1956, p. 15) and that vertical leakage from the lake could cause the upper water level to be higher than that in the next underlying water-bearing zone.

The water level in the deepest piezometer is about 10 feet (3 meters) below land surface or about 50 feet (15 meters) above the main water table as measured in the other two piezometers. This high artesian pressure indicates that a confining bed of large areal extent occurs at some intermediate depth between 227 and 785 feet (69.2 and 239.3 meters). The gradient of the regional water table in the general vicinity of the well site ranges from 3 to 5 feet per mile (0.6 to 1 meter per kilometer). Thus, the confining bed would have to extend outward from the well site for at least 10 miles (16 kilometers) for water to enter the underlying water-bearing zone and develop a head 50 feet (15 meters) higher than the regional water table. Furthermore, it should be noted that the confining layer probably leaks water upward to the overlying aquifers, thus causing a considerable loss in head in the lower aquifer. If this actually happens, then the confining layer necessarily must have a much larger areal extent than indicated above.

The well penetrates six series of basalt flows and five series of sedimentary beds. Sediments make up about 45 percent of the section below the water table. If the water levels in each basalt series were monitored with piezometers, it is likely that six different water levels would be found. Thus, each of the three piezometers monitor water levels that are naturally integrated and the resultant level in each is a composite of the water level in several water-bearing zones.

## Middle Resistivity Profile

Figure 6 is a resistivity profile compiled from resistivity soundings and a few logs of shallow wells. At the south end of the profile, the electrically resistant limestones and sandstones of Paleozoic age crop out in low hills near the south side of the Snake River and abut the low resistivity material interpreted to be in the Raft Formation. Exploratory well 9S-28E-18bad penetrated sediments, from land surface to a depth of 506 feet (154 meters), which correlate with the Raft Formation. At electrical sounding 27, the Raft appears to be on the order of 1,600 feet (500 meters) thick but this interpreted thickness may be greater than the actual thickness as is suggested by the correlation of sounding 23 with well 9S-28E-18bad. Carr and Trimble (1963, p. G22) found the Raft Formation to be more than 200 feet (60 meters) thick in the American Falls quadrangle near the extreme eastern edge of the area of this report.

The electrical soundings made at site 23 indicated rhyolite or basalt and sediments at a depth of about 600 feet (180 meters). The exploratory well penetrated rhyolitic welded crystal tuff at 506 feet (154 meters) and continued in this material to the total depth of 1,014 feet (309 meters). This unit may be the latitic(?) ashflow tuff that, according to Trimble (written commun., 1973), is widespread along the east side of the Raft River Valley. Walker and others (1970, figs. 1 and 7) include the ashflow tuff of Raft River Valley as the lower part of the Salt Lake Formation. However, correlation of all or part of the unit with the crystal tuff member near the middle of the Starlight Formation (early or middle

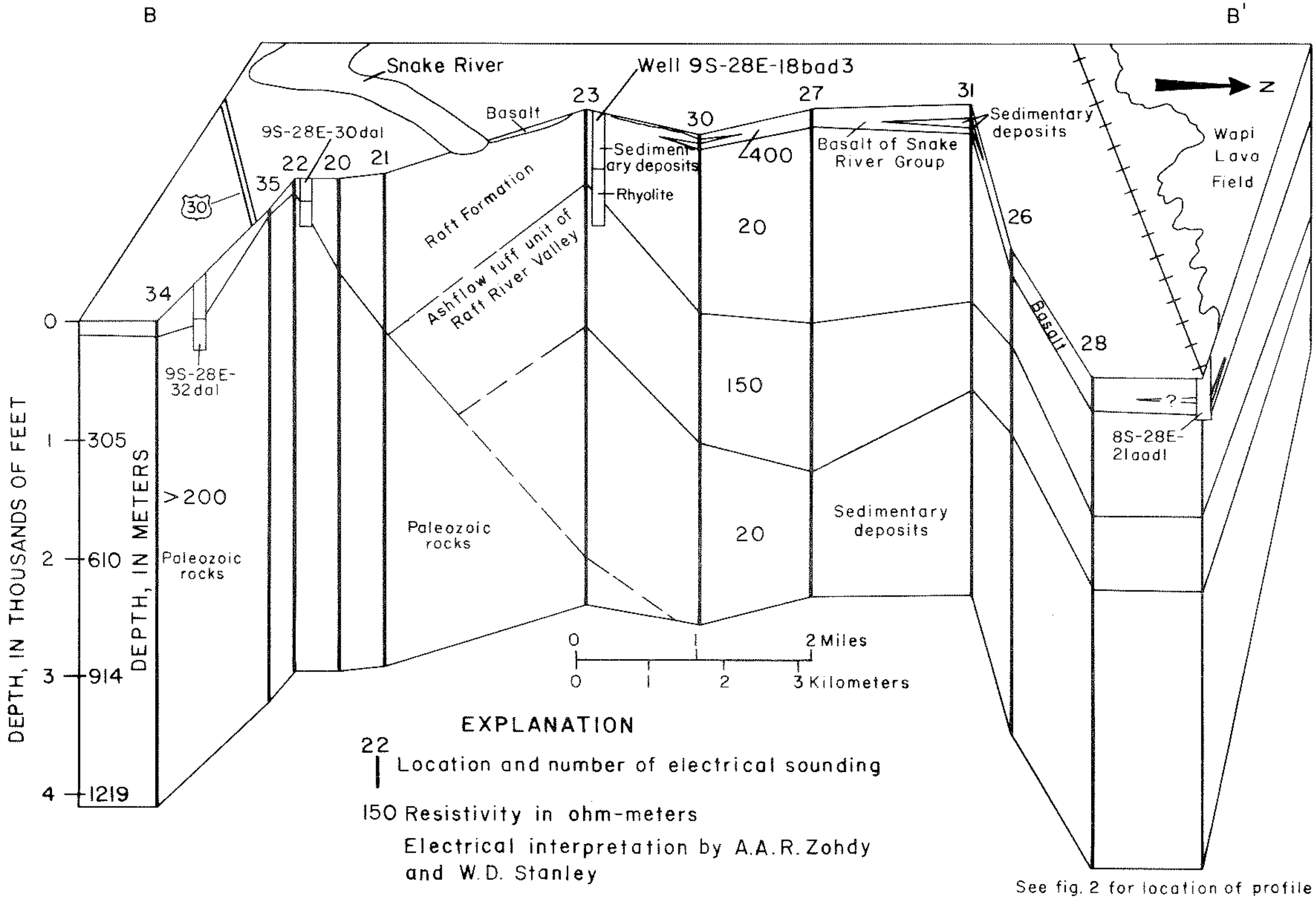


**FIGURE 6. Resistivity profile B—B'.**

Pliocene age) of Carr and Trimble (1963, p. G9) should not be discounted. On the basis of the electrical soundings, the ashflow unit is on the order of 1,200 feet (370 meters) thick at site 23 but thins to the north to about 700 or 800 feet (200 or 250 meters) thick. The low resistivity material (20 ohm-meters) below the ashflow tuff unit may be some part of the Starlight Formation. In the American Falls quadrangle, the Starlight Formation consists of a white to gray, bedded, rhyolitic-friable-tuff with many interstratified basalt flows and minor basaltic tuff and breccia (Carr and Trimble, 1963, p. G8).

The stratigraphy implied by the electrical soundings agrees with that found in the exploratory well. Several formations which Carr and Trimble found in the American Falls area were not identified in the exploratory well below a depth of about 500 feet (150 meters). These include the Neeley Formation, the Walcott Tuff, the Little Creek Formation, and the Massacre Volcanics, and possibly the Starlight Formation. This suggests nondeposition or erosion from middle Pliocene to middle Pleistocene time.

The formation of greatest interest is the basalt of the Snake River Group. The electrical soundings and a few well logs show that the basalt is absent on the south side of the Snake River, very thin immediately north of the river, and thickens northward to about 275 feet (85 meters) at the north end of the profile. The basalt between the river and the exploratory well filled a shallow valley cut in the Raft Formation by the Snake River. Gifford Springs (fig. 2) issues from this flow. North of the exploratory well (9S-28E-18bad), two or three basalt flows separated in part by sedimentary deposits can be identified in well logs and the electrical soundings. Well logs indicate that these or similar flows and sediments extend 6 to 8 miles (10 to 12 kilometers) west and northwest from the profile.

Piezometers were set at 25, 420, and 554 feet (7.6, 158.5, and 168.9 meters) in well 9S-28E-18-bad. The piezometer set at 25 feet (7.6 meters) is outside the 6-inch (152 millimeters) casing and monitors the water level in the shallow aquifer which extends to a depth of 150 feet (45.7 meters). Six-inch (152 millimeters) casing extends to 150 feet (45.7 meters) and the well is uncased from 150 to 280 feet (45.7 to 85.3 meters). The piezometer set at 420 feet (158.5 meters) monitors the water level in the zone from 318 to 505 feet (96.9 to 153.9 meters). The other piezometer monitors the water level in the zone from 525 to 1,014 feet (160 to 309 meters). The water level in the upper piezometer is about 7 feet (2 meters) higher than the water level in some ponds in depressions in the valley-filling basalt about one-half mile (0.8 kilometer) south of the well and is about 9 feet (2.7 meters) above the normal operating level of Lake Walcott. This implies that the ground water in the upper 150 feet (45 meters) of the formation is moving south or southwest toward Lake Walcott. The water level in the next deepest piezometer is 1 to 2 feet (0.3 to 0.6 meters) above land surface, and, thus, ground water in the lower part of the Raft Formation is under artesian pressure. Meisler (1958, p. 17, and fig. 4) suggested that a perched water table might be present in the Bonanza Lake area. The data at this site does not confirm Meisler's suggestion, but on the other hand, it does not disprove the suggestion because the well is not constructed to monitor water levels in the interval from 150 to 280 feet (45 to 85 meters).

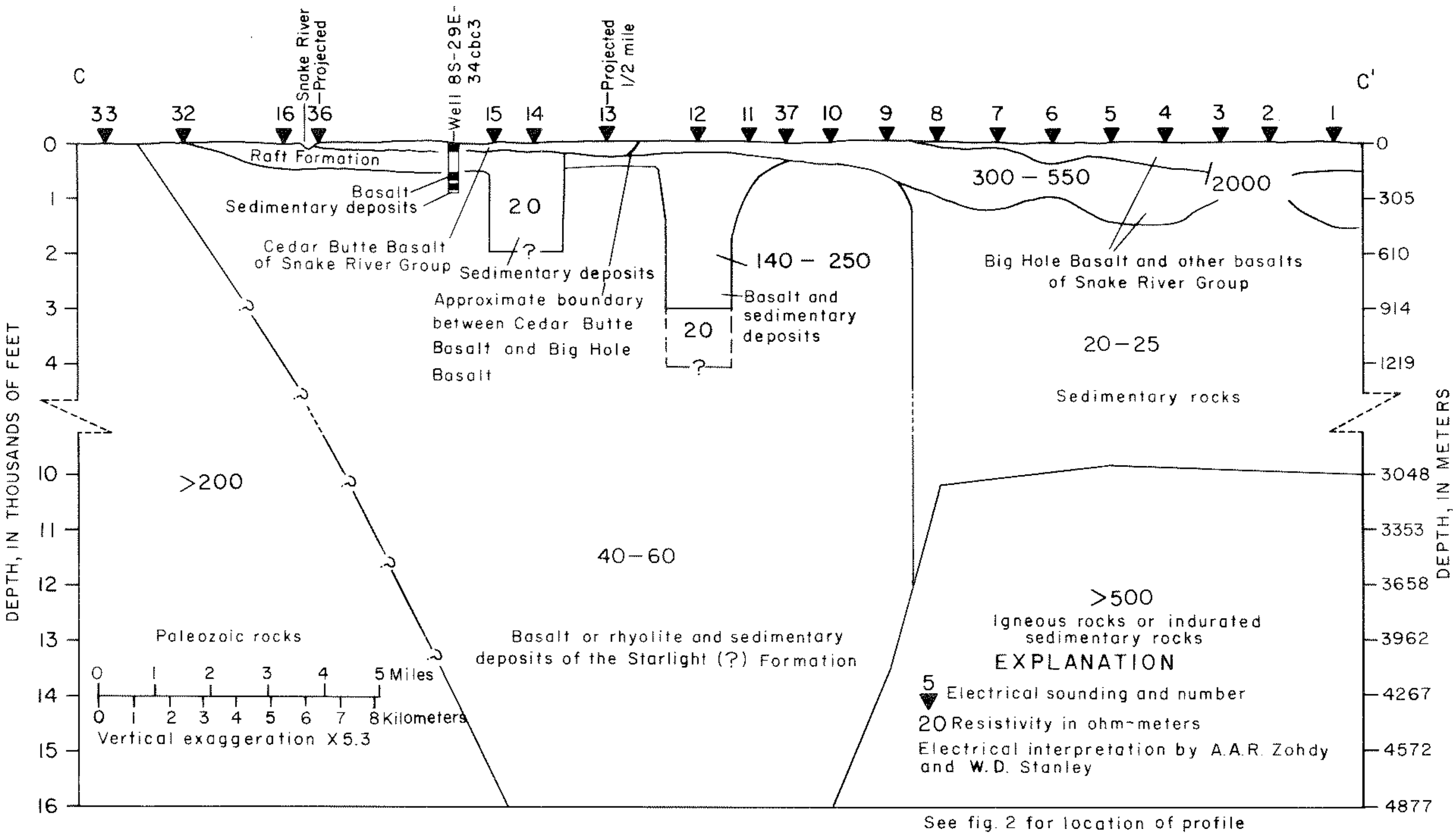


**FIGURE 7. Resistivity profile C—C'.**

The water level in the deepest piezometer is about 55 feet (17 meters) below land surface and thus the crystal tuff unit contains water under artesian pressure.

### Eastern Resistivity Profile

Figure 7 implies some unexpected geology and, therefore, a few general comments are in order. The relatively deep narrow valleys beneath electrical sounding sites 12 and 14 exceed in depth any valley of the modern Snake River in the Snake River Plain. The valleys appear to be cut in a thick sequence of volcanic rocks and sediments. This thick sequence may be faulted up relative to the position of the rocks of Paleozoic age on the south and igneous or Paleozoic rocks on the north. On the other hand, the thick sequence may be in depositional contact with the Paleozoic rocks on the south because the inferred contact between the two units is not very steep. According to D. R. Mabey (written commun., 1973), the southern part of the resistivity profile is approximately coincident with a gravity high that extends north from the Sublett Range. This gravity high suggests a buried ridge separating deep depressions to the east and west. Although the interpretation of resistivity soundings do not indicate the presence of a ridge in this area, there is resistivity evidence of complex subsurface geology. Until more geophysical work is done in the area, the interpretation of the resistivity data should be considered tentative.

At the north end of the profile, the basement of igneous or well-indurated sedimentary rocks appear to be at a depth of about 10,000 feet (3,000 meters). The resistivity data imply that 8,000 to 9,000 feet (2,500 to 2,700 meters) of sediments overlie the basement. With the exception of the Paleozoic rocks at the south end of the profile, the lithology of the material below a depth of 1,000 to 2,000 feet (300 to 600 meters) cannot be interpreted with any degree of confidence.

However, the upper 1,000 to 2,000 feet (300 to 600 meters) of material shown in the profile can be discussed with some confidence. At the south end of the section, small scattered exposures of rhyolite tuff indicate that the Starlight Formation of Carr and Trimble lies on rocks of Paleozoic age. The Raft Formation overlies both the Paleozoic rocks and the Starlight Formation. Formations between the Starlight and the Raft have not been identified at the surface along the line of the profile, but they are exposed a few miles (a few kilometers) east of the profile. The exploratory well (8S-29E-34cbc) drilled by the Bureau of Reclamation penetrated interbedded basalts and sediments from a depth of 500 to 1,028 feet (152 to 313 meters) which are probably equivalent to the Raft, Little Creek, and Starlight Formations. The Raft Formation crops out near the Snake River and extends northward to at least the southern-most buried valley shown on the section. In the exploratory hole, the Raft is at least 420 feet (128 meters) thick (see following paragraph). Basalt of the Snake River Group overlies the Raft Formation from the Snake River northward. At the exploratory well, the basalt is 77 feet (23.5 meters) thick. Northward, the basalt becomes thicker and the electrical data suggests that it is about 1,500 feet (450 meters) thick at the north end of the profile.

On the basis of the electrical data and the log of well 8S-29E-34cbc3 (see appendix) Trimble (written commun., 1973) states that the basalt from 3 to 80 feet (1 to 24 meters) is Cedar Butte Basalt of the Snake River Group and that the sediments from 80 to 500 feet (24 to 152 meters) are in the Raft Formation. Likely, the sediments and basalt from 678 to 818 feet (206.7 to 249.1 meters) also are in the Raft Formation and are intertonguing with basalt of the Snake River Group, although the possibility exists that the basalt from 770 to 818 feet (234.7 to 249.3 meters) is part of the Little Creek Formation (Massacre Volcanics of Stearns and Isotoff, 1956) rather than being in the Snake River Group. The silt, sand, and ash from 818 to 856 feet (249.3 to 260.9 meters) could be the Little Creek Formation, because of the ash, and the rocks below 856 feet (260.9 meters) could represent the Starlight Formation.

Piezometers were set at 703 to 861 feet (214.3 and 262.4 meters) below land surface in exploratory hole 8S-29E-34cbc to monitor water levels in the interval 673 to 818 and 826 to 1,028 feet (205.1 to 249.3 and 251.8 to 313.3 meters), respectively. The upper part of the hole is open from 170 to 313 feet (51.8 to 95.4 meters). Water level measurements made in 1971, about one year after drilling ceased, showed that the water level in the open hole at this time was at about 139 feet (42.4 meters) below land surface, in the shallowest piezometer it was at about 152 feet (46.3 meters) below land surface, and in the deepest piezometer it was at about 73 feet (22.3 meters) below land surface. The water level in the open hole is at about the same elevation as in some ponds in Lake Channel a little more than a mile west of the well. The elevation of Bonanza Lake, ponds in Lake Channel, and water levels in the exploratory hole and in wells north and northeast of the exploratory hole indicate that a water table slopes to the south in this part of the Snake River Plain. The ground water occurs in alluvium in Lake Channel and in the Raft Formation beneath the alluvium and basalt in the general area of Lake Channel and the exploratory hole.

The water level in the shallowest piezometer has ranged from 7½ feet to 14 feet (2.3 to 4.3 meters) below the water level in the open hole during the period April 1971 to July 1973. The position of the water level in the piezometer supports Meisler's suggestion that the upper water table is perched (Meisler, 1958, p. 17 and fig. 4). If this is true, then the piezometer probably monitors a water table which occurs in sediments and basalt underlying Snake River basalt.

The water level in the deepest piezometer is higher than the other water levels monitored at the site but, because this piezometer is plugged, it does not either reflect nor monitor water levels in the deeper water-bearing zones.

From the data at hand, it appears that the Snake River basalt is above the regional water table from the vicinity of Bonanza Lake southward to the Snake River. Water moving southwest through the basalt east and northeast of Lake Channel maintains a perched water table on the Raft Formation. The regional water table is a few feet below the perched water table.

## EVALUATION OF THE DATA

Well logs and geophysical data show that in the area of Lake Channel, Wapi, and Gifford Springs, the basalt of the Snake River Group probably is not adequate to provide large sustained yields to irrigation wells. However, a few miles north and northeast of Wapi and Bonanza Lake, large sustained yields are being obtained from several irrigation wells.

North of Lake Walcott and for several miles west of Wapi, the data are not adequate to assess the probable success of large irrigation wells, but this part of the report area may be suitable for moderate well yields of 500 to 1,000 gpm (30 to 60 liters per second). That part of the area south of Lake Walcott and west of Raft River may also yield moderate quantities of water.

The data indicate that the southern boundary of the Snake Plain aquifer may be arbitrarily approximated by a straight line drawn from Minidoka Dam to American Falls. It is recognized that the true boundary of the aquifer is not a straight line but for general mathematical, analog, or digital model analysis, this straight boundary is probably adequate. Location of this boundary is important in that boundary effects may cause a significant part of the drawdown of water level in the vicinity of any large-scale ground-water withdrawals. Thus, the boundary effect must be considered in locating a large well field.

The alluvial deposits and the valley-filling basalt in Lake Channel will probably yield adequate irrigation supplies to properly constructed wells for local use but would have limited potential for providing supplies for use outside Lake Channel.

The test drilling accomplished indicates that the formations older than the basalt of the Snake River Group do not have a significant ground-water potential. Also, most of the Raft Formation is composed of fine-grained material having a low permeability. The rhyolitic material in the Starlight Formation appears to have few fractures through which water can move and its intergranular permeability is low. The interbedded basalts and sediments likewise appear to have low permeability.

In summary, the exploratory wells and electrical resistivity data indicate that the area is not suitable for the withdrawal of large quantities of ground water for irrigation.

## REFERENCES


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# APPENDIX

Tables of logs and well construction details of the wells constructed by the U. S. Bureau of Reclamation and used in this report are presented in the following pages.

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Lake Walcott State Idaho

Well No. 9S 26E 7aab (Site #18) Location NW¼NE¼NE¼, sec. 7, T. 9 S., R. 26 E., Cassia County

Total Depth 804.5' Begun 7/10/70 Completed 10/19/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 58.57' (above/below) Meas. Pt. Top of 4" casing Date 11/18/70

Elevation (ground) 4199.95' W. L. Meas. Pt. 0.61 Feet (above/below) Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By L. Hampton Geophysical Log Gamma Gamma, Gamma, Neutron Drilled By Jensen Construction Co.

**Drilling Data / Pump Tests / Water Samples**

Well drilling data

Air rotary
0' to 68'

Wire line core
68' to 804.5'

Specs:
100C-1104
Contract:
14-06-100-6772

Water level data

Standing water level 59.18' below ground surface 11/18/70

W.S. Elev. 4140.77

Piezometer water levels 11/18/70

| No. | M.P. to water | Water elev |
|---|---|---|
| A | 10.62 | 4189.64 |
| B | 61.16 | 4140.05 |
| C | 60.98 | 4140.77 |

**Description of Well Completion**

Hole size data

5.5" 0' to 68'
4" 68' to 330'
3" 330' to 804.5'

Casing data

4" 0' to 68'
3" 0' to 240'
Elev. top of 4" casing 4199.34

68' bottom of 5½" hole and 4" casing

Piezometer C
147.5' ℄ of 5' perforations
152.5' bottom piezometer C
153' grout
168' sand
170' gravel

Piezometer B
222' ℄ of 5' perforations
227' bottom piezometer B
240' bottom 3" casing
330' bottom 4" hole

Piezometer data

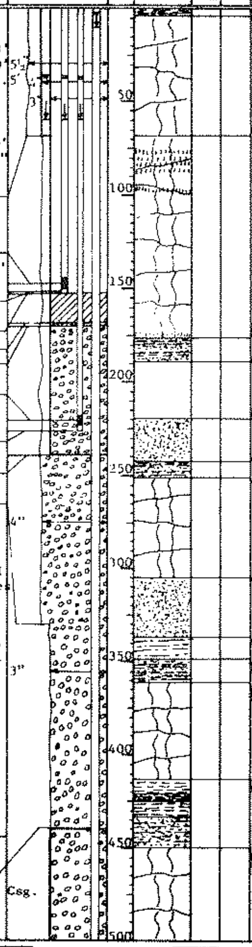
1-1" I.D. and 2-3/4" I.D. B.I piezometer pipes installed as shown below; 5' of perforations begin 2½' above bottom of each pipe.

| No. | Elev. |
|---|---|
| A | 4200.26 |
| B | 4201.21 |
| C | 4201.75 |

C B A

440' top of Nx drill rod

**Well Diagram / Depth / Log**




**Classification and Physical Condition**

0.0' to 4.0' - SILT & CLAY; topsoil and clay.

4.0' to 67.8' - BASALT; black (4' to 40'), red (40' to 50'), and dark gray (50' to 67.8'); fractured at 11.6', 17.3', and 66.0'.

67.8' to 177.0' - BASALT; medium light gray to medium gray; porphyritic with 5% to 10% plagioclase laths to 3mm; generally fresh except at tops and bottoms of each interflow; slightly to highly vesicular; slightly to highly jointed with joint spacing 0.1' to 2.0'; most joints filled with clay; 120' to 160' clay increases, also obsidian and scoria.

177.0' to 188.9' - SAND & CLAYSTONE; light brown sand and light gray claystone; predominantly quartz sand, angular to subrounded; no cement; friable, with few feldspar and dark minerals; slightly sandy (fine quartz sand) clay; weak, nearly horizontal bedding.

188.9' to 219.7' - NO SAMPLE.

219.7' to 242.8' - SAND; medium light gray to light brownish-gray; fine to coarse; quartz with minor basaltic and granitic rock fragments; angular to subangular; some grains stained with limonite.

242.8' to 250.8' - SAND, CLAY, ASH, & SILTSTONE; very light gray to light gray; fine to coarse basaltic sand; weak, horizontal bedding; cavities in ash filled with limonite.

250.8' to 304.9' - BASALT; medium light gray, grayish red-purple, and medium light gray; dense to moderately vesicular; slightly to moderately jointed with joint spacing 0.1' to 4.0', some joints lined with limonite.

304.9' to 337.1' - SAND & SANDSTONE; pale red to light gray; medium to fine; predominantly quartz with few dark minerals, rhyolite and basalt grains; angular to subrounded; strong cross bedding in red sand.

337.1' to 348.0' - SILTSTONE; very light gray; slightly sandy; friable.

348.0' to 361.0' - CLAY; light bluish-gray; with few medium to fine sand.

361.0' to 413.1' - BASALT; medium light gray to medium gray; porphyritic with about 20% plagioclase laths to 3mm; dense to slightly vesicular, normally fresh with green staining in some vesicles; slightly jointed with joint spacing to 4.0'.

413.1' to 448.5' - CLAY & SILT; light gray to light bluish-gray; interbedded clay and silt; slightly sandy silt; faint horizontal bedding.
413.1 to 422.0 - clay 425.0 to 433.5 - clay
422.0 to 425.0 - silt 433.5 to 448.5 - silt

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

CLAY SAND BASALT
SILT GRAVEL

PROJECT Snake Plain Recharge WELL NO. 9S 26E 7aab Site #18



BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Lake Walcott State Idaho

Well No. 9S 26E 7aab (Site #18) Location NW¼NE¼NE¼, sec. 7, T. 9 S., R.26 E., Cassia County

Total Depth 804.5' Begun 7/10/70 Completed 10/19/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 58.57' (above/below) Meas. Pt. Top of 4" casing Date 11/18/70

Elevation (ground) 4199.95' W. L. Meas. Pt. 0.61 Feet (above/below) Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By L. Hampton Geophysical Log Gamma Gamma, Gamma, Neutron Drilled By Jensen Construction Co.

**Description of Well Completion**

Note
130' Nx drill rod and core barrel left in hole from 440' to 571'
550' grout

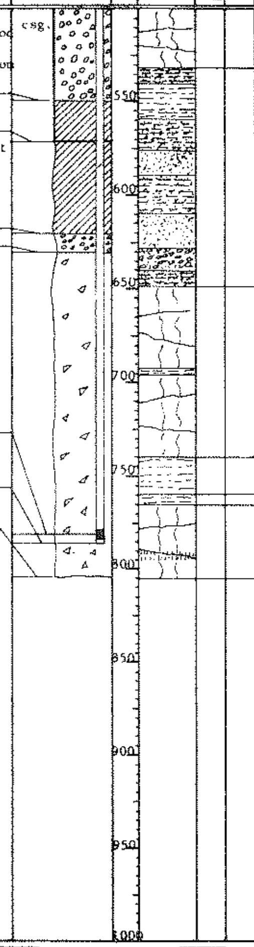
571' bottom Nx core barrel left in hole

620' gravel
630' top of caved material

Note
630' to bottom caved full

Piezometer A
780 ℄ of 5' perforations
785.2' bottom piezometer A
804.5' bottom 3" hole

**Well Diagram / Depth / Log**




**Classification and Physical Condition**

448.5' to 530.8' - BASALT; medium gray to greenish-black, porphyritic with about 20% plagioclase laths to 2mm in gray zone and fine textured with about 10% plagioclase laths in green zone; dense to moderately vesicular with most vesicles filled with clusters of colorless to white mineralization that alters greenish; slightly to moderately jointed with joint spacing 1' to 3', joints filled with mineralization.

530.8' to 647.0' - CLAY, SILT, SAND, & GRAVEL; light gray clay and silt, and light brownish-gray sand; plastic, slightly sandy clay, friable silt with about 10% fine sand; sand is predominantly medium, subangular to subrounded; 70% quartz and 30% dark minerals; gravel is basaltic, subrounded to rounded; 5-30mm.
530.8' to 539.0' - clay
539.0' to 558.1' - silt
558.1' to 575.7' - clay
575.7' to 588.0' - sand
588.0' to 608.3' - clay
608.3' to 628.0' - sand
628.0' to 640.0' - sand with few gravel
640.0' to 647.0' - clay

647.0' to 739.0' - BASALT; predominantly medium dark gray with some greenish-black; generally fine textured with few plagioclase laths up to 1mm; slightly vesicular except for moderately vesicular in upper and lower 2 feet with some vesicles filled with medium bluish-gray material; slightly jointed with joint spacing 0.1' to 4'; baked siltbed at 685' and a baked greenish-gray hard claybed from 692' to 695'.

739.0' to 757.8' - SILT; light olive gray; loose, friable.

757.8' to 764.5' - CLAY; dark greenish-gray; plastic.

764.5' to 804.5' - BASALT; medium light gray; porphyritic with less than 10% plagioclase laths to 5mm; slightly to highly vesicular; slightly to highly jointed with joint spacing 0.2' to 1.8'+; one gray plastic claybed 778.3' to 779.1'.

Note
Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

CLAY SAND BASALT
SILT GRAVEL

PROJECT Snake Plain Recharge WELL NO. 9S 26E 7aab Site #18

# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Gifford Springs State Idaho

Well No. 9S 28E 18bad (site #19) Location SE¼NE¼NW¼, sec. 18, T. 9 S., R. 28 E., Power County

Total Depth 1013.7' Begun 7/30/70 Completed 11/4/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 13.94' (below) Meas. Pt. Top of Piezometer C Date 12/3/70

Elevation (ground) 4216.80' W. L. Meas. Pt. 1.21 Feet (above) Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By G. King Geophysical Log Gamma Gamma, Gamma, Temp, Neutron, Caliper, Electric Drilled By Jensen Construction Co.

**Drilling Data / Pump Tests / Water Samples**

Well drilling data

Air rotary
0' - 150'

Wire line core
150' - 1013.7'

Specs:
100C-1104
Contract:
14-06-100-6772

Water level data

Standing water level--12.73' below land surface--12/3/70

W.S. Elev 4204.07

Piezometer water levels 12/3/70:

| No. | M.P. to Water | Water Elev. |
|---|---|---|
| A | 68.92 | 4149.71 |
| B | 2.55 | 4215.55 |
| C | 13.94 | 4204.07 |

**Description of Well Completion**

Hole size data

8" 0' - 150'
4" 150' - 645'
3" 645' - 1013.7'

Casing data

6" - 0' - 150'
elev. top 6" casing 4216.94

25' - bottom piezometer C

150' bottom 8" hole and 6" casing

Piezometer data

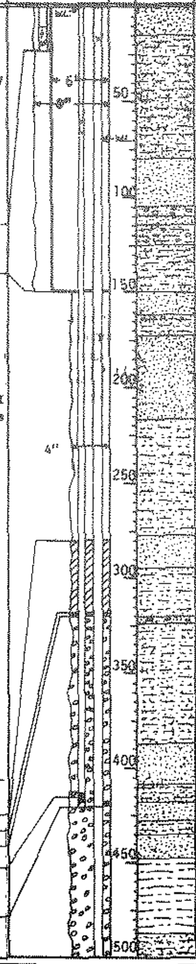
2-1" I.D. and 1-3/4" I.D., B.I piezometer pipes installed as shown below; piezometer C installed outside of and welded to 6" casing; 5' of perforations begin 2½' above bottom of each pipe.

| No. | Elev. |
|---|---|
| A | 4218.10 |
| B | 4218.63 |
| C | 4216.01 |

C B A

280' - grout
318' - sand
320' - gravel
piezometer B
415 ℄ of 5' perforations
420' bottom piezometer B

**Well Diagram / Depth / Log**




**Classification and Physical Condition**

0.0' to 15.0' - SAND; fine to medium; quartz, feldspar, mica, and few dark grains; angular to subangular.

15.0' - 80.0' - SILT & SAND; predominantly silt and very fine sand with few fine to coarse sand; quartz, feldspar, mica, and few dark grains; angular to subangular; poorly sorted.

80.0' - 115.0' - SAND & GRAVEL; predominantly very fine to very coarse sand with minor gravel to 10mm; quartz, feldspar, mica, olivine, and dark mineral sand, and limestone and siltstone gravel; angular to subangular; poorly sorted; some tabular gravel.
80' to 105' - Sand
105' to 110' - sand and gravel
110' to 115' - sand

115.0' to 125.0' - SILT, SAND, & GRAVEL; silt, sand very fine to very coarse, and gravel to 10mm dia.; quartz, feldspar, and minor dark-grained sand, with siltstone gravel; angular to subangular; poorly sorted.

125.0' to 150.0' - SILT; silt with minor very fine sand.

150.0' to 162.9' - SAND; pale yellowish-brown; medium to very fine; quartz, feldspar, and few dark minerals; iron staining; angular to subangular.

162.9' to 172.9' - SAND & SILT; moderate orange to very pale orange; very fine sand to silt; few to no dark minerals; firm.

172.9' to 216.0' - SAND; pale yellowish-brown; predominantly fine to very fine with few coarse grains; quartz, feldspar, and few dark minerals and angular basalt; subrounded.

216.0' to 276.7' - SAND & SILT; very pale orange, moderate orange-pink, and pale yellowish-brown; very fine sand to silt; quartz, feldspar, and very few dark minerals; subrounded.

276.7' to 293.9' - SAND; pale yellowish-brown; fine with few coarse grains; quartz, feldspar, and few dark minerals and angular basalt.

293.9' to 319.5' - SAND & SILT; pale yellowish-brown; very fine sand to silt; few dark minerals.

319.5' to 323.7' - SAND & GRAVEL; grayish-orange to very pale orange; very fine to very coarse sand with siltstone gravel up to 30 mm; quartz, felspar, and few dark minerals; angular to subangular; some bedding.

323.7' to 386.7' - SAND & SILT; grayish-orange to very pale orange; very fine sand to silt; very few dark minerals; ~~subangular~~; firm.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

SILT
SAND
GRAVEL
RHYOLITE
WELDED TUFF

PROJECT Snake Plain Recharge WELL NO. 9S 28E 18bad Site #19





# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Gifford Springs State Idaho

Well No. 9S 28E 18bad (Site #19) Location SE¼NE¼NW¼, sec. 18, T. 9 S., R. 28 E., Power County

Total Depth 1013.7' Begun 7/30/70 Completed 11/4/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 13.94' (below) Meas. Pt. Top of Piezometer C Date 12/3/70

Elevation (ground) 4216.80' W. L. Meas. Pt 1.21 Feet (above) Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By G. King Geophysical Log Gamma Gamma, Gamma, Temp, Neutron, Caliper, Electric Drilled By Jensen Construction Co.

**Description of Well Completion**

505' gravel
518' sand
520' gravel

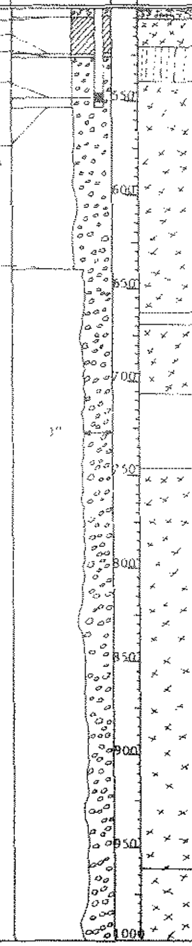
piezometer A
549' ℄ of 5' perforations

554' bottom of piezometer A

640' bottom of 4" hole

1013.7' bottom of 3" hole

**Well Diagram / Depth / Log**




**Classification and Physical Condition**

(Continued from page 1)

386.7' to 407.5' - SAND; grayish-orange to very pale orange; fine to very fine, with few basaltic gravels up to 8mm; quartz, about 50% feldspar, and about 20% dark minerals; angular to subangular.

407.5' to 416.7' - SAND & SILT; dusky yellow to yellowish-gray; very fine sand to silt; quartz, feldspar; angular to subangular.

416.7' to 427.0' - SAND; very pale orange to grayish-orange; medium to very fine; quartz, feldspar, and about 10% dark minerals; angular to subangular.

427.0' to 434.4' - SAND & SILT; very pale orange; very fine sand to silt; firm.

434.4' to 446.8' - SAND; grayish-orange; fine; quartz, feldspar, and about 20% dark minerals; angular to subangular.

446.8' to 487.2' - SILT; moderate orange-pink to very pale orange.

487.2' to 506.2' - SAND & SILT; grayish-orange; medium to fine sand and silt with few gravels up to 5mm; sand bonded 492' to 494'.

506.2' to 521.5' - RHYOLITE; black (top) to medium bluish-gray (bottom); groundmass of black spheres with 3 to 6mm dia. feldspar and quartz phenocrysts; dense; massive to slightly jointed; joints lined with clay.

521.5' to 539.0' - WELDED TUFF; pale purple; feldspar and quartz phenocrysts; dense; moderately jointed; joints lined with clay.

539.0' to 663.4' - RHYOLITE; dark reddish-brown to grayish-red; porphyritic, aphanitic groundmass with about 10% to 20% whitish to clear feldspar and quartz phenocrysts to 6mm; mostly dense, locally slightly vesicular; massive to slightly jointed; joints lined with clay and whitish, noncarbonate mineralization; badly broken locally; some limonite staining.

663.4' to 669.3' - NO SAMPLE.

669.3' to 706.2' - RHYOLITE; grayish-red; porphyritic, aphanitic groundmass with about 10% whitish to clear feldspar and quartz phenocrysts to about 6mm; generally dense; massive to moderately jointed; joints lined with mineralization.

706.2' to 746.2' - NO SAMPLE.

746.2' to 961.9' - RHYOLITE; generally grayish-red; locally dusky red; porphyritic, aphanitic groundmass with about 50% whitish to clear feldspar and quartz phenocrysts to 6mm; dense; locally broken; massive to slightly jointed; joints lined with clay; shows flow structure locally.

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log

SILT
SAND
GRAVEL
RHYOLITE
WELDED TUFF

PROJECT Snake Plain Recharge WELL NO. 9S 28E 18bad Site #19

# LOG OF WELL

Project: Snake Plain Recharge | Feature: Exploration Drill Hole—Gifford Springs | State: Idaho

Well No.: 9S 28E 18bad (site #19) | Location: SE¼NE¼NW¼, sec. 18, T. 9 S., R. 28 E., Power County

Total Depth: 1013.7' | Begun: 7/30/70 | Completed: 11/4/70 | Drilling Method: Air Rotary Wire Line Core

Static Water Level: 13.94' ~~(above)~~ (below) Meas. Pt.: top of piezometer C | Date: 12/3/70

Elevation (ground): 4216.80 | W. L. Meas. Pt.: 1.21 Feet (above) ~~(below)~~ Ground

Yield: No test | Drawdown: -- | Other Data: Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By: G. King | Geophysical Log: Gamma Gamma, Gamma, Temp, Neutron, Caliper, Electric | Drilled By: Jensen Construction Co.

| Drilling Data Pump Tests Water Samples | Description of Well Completion | Well Diagram | Depth | Log | Core Recov. | Samp Type | Classification and Physical Condition |
|---|---|---|---|---|---|---|---|
| | | | | | | | (Continued from page 2) |
| | | | | | | | 961.9' to 1013.7' - RHYOLITE; medium bluish-gray; porphyritic, aphanitic groundmass with about 10% whitish feldspar and quartz phenocrysts to 6mm; dense; massive to slightly jointed; joints filled with clay. |

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log

SILT
SAND
GRAVEL
RHYOLITE
WELDED TUFF

PROJECT: Snake Plain Recharge

WELL NO: 9S 28E 18bad Site #19

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 3

# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Lake Channel State Idaho

Well No 8S 29E 34cbc (Site #20) Location NW¼NW¼SW¼, sec. 34, T. 8 S., R. 29 E., Power County

Total Depth 1028.1' Begun 8/19/70 Completed 11/20/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 151.31' ~~(above)~~ (below) Meas. Pt. Top of 4" casing Date 12/3/70

Elevation (ground) 4387.90' W. L. Meas. Pt. 0.00 Feet (above) ~~(below)~~ Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By G. King Geophysical Log Gamma Gamma, Gamma, Neutron Drilled By Jensen Construction Co.

**Drilling Data / Pump Tests / Water Samples**

Well drilling data

Air rotary
0' to 170'
Wire line core
170' to 1028.1'

Specs:
100C-1104
Contract:
14-06-100-6772

Water level data

Standing water level 151.31' below ground surface 12/3/70
W.S. elev. 4236.59'

Piezometer water levels 12/3/70

| No. | M.P. to water | Water elev. |
|---|---|---|
| A | 58.86 | 4330.10 |
| B | 152.58 | 4236.76 |

**Description of Well Completion**

Hole size data

6" 0' to 170'
4" 170' to 899'
3" 899' to 1028.1'

Casing data

4" 0' to 170'
3" 313' to 898'
elev. top 4" casing, 4387.90'

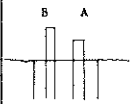
Casing shot perforated at the following intervals:
665' to 675'
697' to 702'
818' to 825'
852' to 858'

170' bottom 6" hole and 4" casing

Piezometer data

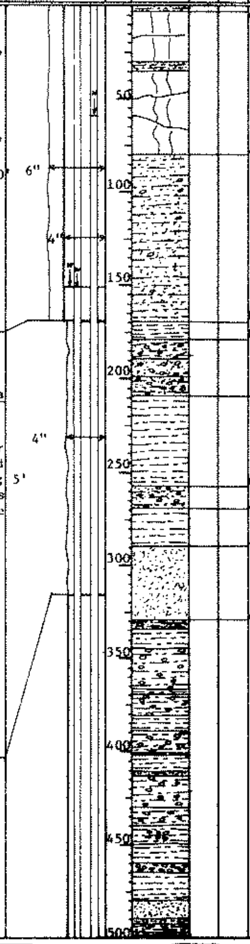
1 1" I.D. and 1 3/4" I.D., B.I. piezometer pipes installed as shown below; 5' of perforations begin 2½' above bottom of each pipe

| No. | Elev. |
|---|---|
| A | 4388.96 |
| B | 4389.34 |




313' top 3" casing

**Well Diagram / Depth / Log / Core Recov / Samp Type**




**Classification and Physical Condition**

0.0' to 3.0' - SILT & SAND; silt to medium sand with basaltic gravel; quartz and feldspar; angular to subangular; organic material.

3.0' to 80.0' - BASALT; medium gray to medium light gray; porphyritic with aphanitic groundmass and olivine phenocrysts; vesicular; 30' to 35' silt, fine sand, and few gravel.

80.0' to 170.0' - SILT & SAND; predominantly silt and very fine sand with fine to medium sand, and few basalt gravels in some zones; quartz, feldspar, and few dark minerals; angular to subangular.

170.0' to 178.5' - CLAY; pale yellowish-brown.

178.5' to 208.5' - SILT, SAND, & GRAVEL; yellowish-brown silt and sand, and grayish-yellow to yellowish-brown and yellowish-green gravel; medium to very coarse sand and gravel to 50mm; quartz, feldspar, chert, limestone, and dark minerals; subrounded to angular; poorly sorted.

178.5' to 188.5' - silt and gravel
188.5' to 198.5' - sand and gravel
198.5' to 208.0' - silt and gravel
208.0' to 208.5' - sand

208.5' to 256.9' - SILT; pale yellowish-brown.

256.9' to 268.6' - GRAVEL & SILT; pale yellowish-brown silt with black chert, very light gray quartzite, and medium bluish-gray limestone gravel to about 30mm; angular to subangular.

268.6' to 288.6' - SILT; moderate yellowish-brown.

288.6' to 328.6' - SAND; medium to very coarse; quartz, feldspar, and about 40% dark chert grains; angular to subangular; poorly sorted.

328.6' to 500.5' - SILT, SAND, & GRAVEL; yellowish-brown silt and sand, and yellowish-brown, black, and olive gray gravel; fine to very coarse sand and gravel to 75mm; quartz, feldspar, limestone, chert, quartzite, and scoria; angular to subangular; clay lens as noted.

328.6' to 334.2' - silt and gravel
334.2' to 343.6' - silt
343.6' to 365.8' - silt and gravel
365.8' to 368.6' - silt
368.6' to 380.0' - silt and gravel
380.0' to 388.3' - silt
388.3' to 400.2' - silt and gravel
400.2' to 401.2' - clay
401.2' to 409.6' - silt
409.6' to 412.4' - sand
412.4' to 448.6' - silt and gravel
448.6' to 458.6' - silt
458.6' to 464.2' - gravel
464.2' to 478.6' - silt
478.6' to 488.6' - sand
488.6' to 496.1' - silt and gravel

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

CLAY | SAND | BASALT
SILT | GRAVEL | ASH

PROJECT Snake Plain Recharge WELL NO. 8S 29E 34cbb Site #20

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 3

# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Lake Channel State Idaho

Well No 8S 29E 34cbc (Site #20) Location NW¼NW¼SW¼, sec. 34, T. 8 S., R. 29 E., Power County

Total Depth 1028.1' Begun 8/19/70 Completed 11/20/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 151.31' ~~(above)~~ (below) Meas. Pt. Top of 4" casing Date 12/3/70

Elevation (ground) 4387.90' W. L. Meas. Pt. 0.00 Feet (above) ~~(below)~~ Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By G. King Geophysical Log Gamma Gamma, Gamma, Neutron Drilled By Jensen Construction Co.

**Drilling Data / Pump Tests / Water Samples**

**Description of Well Completion**

665' to 675' shot perforations in casing in order to grout and seal off 699

665' grout
673' sand
675' gravel

Piezometer B
699' ℄ of 5' perforations

704' bottom piezometer B

697' to 702' shot perforations in casing

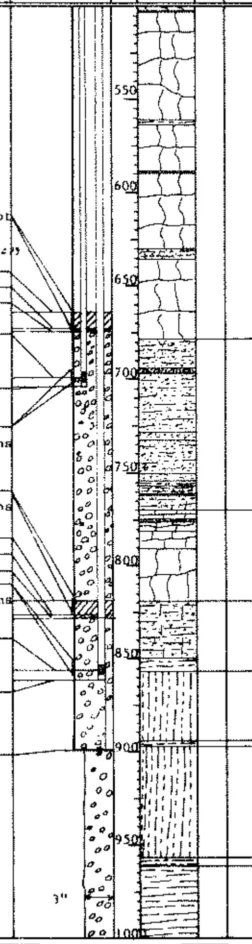
818' to 825' shot perforations in casing
818' grout
826' sand
828' gravel
852' to 858' shot perforations in casing

Piezometer A
856' ℄ of 5' perforations

861' bottom piezometer A

899' bottom 4" hole and 3" casing

**Well Diagram / Depth / Log / Core Recov / Samp Type**




**Classification and Physical Condition**

(Continued from page 1)

496.1' to 498.3' - sand
498.3' to 500.5' - silt

500.5' to 678.0' - BASALT; black, gray, and brown; aphanitic with whitish plagioclase laths; dense to moderately vesicular, some vesicles filled or lined with clay or calcite; massive to slightly jointed, some joints lined with clay; upper 2 feet well weathered; thin lenses of brown silt as noted.

500.5' to 502.7' - basalt
502.7' to 503.6' - silt
503.6' to 562.0' - basalt
562.0' to 563.8' - silt
563.8' to 588.7' - basalt
588.7' to 590.0' - silt
590.0' to 630.3' - basalt
630.3' to 636.0' - basalt, silt, and clay
636.0' to 678.0' - basalt

678.0' to 770.0' - SAND, SILT, & GRAVEL; moderate brown, orange, and gray; silt, very fine to very coarse sand and gravel to 20mm; quartz, feldspar, chert, and few dark minerals; subrounded to angular.

678.0' to 693.8' - sand and silt
693.8' to 696.7' - sand and gravel
696.7' to 728.2' - silt and sand
728.2' to 732.8' - sand
732.8' to 750.8' - sand and silt
750.8' to 753.7' - sand
753.7' to 756.7' - silt
756.7' to 761.8' - silt and sand
761.8' to 762.2' - sand and gravel
762.2' to 770.0' - silt and sand

770.0' to 818.6' - BASALT; gray, black, and dusky red; aphanitic to fine equigranular; dense to moderately vesicular, some vesicles filled or lined with calcite or clay; massive to moderately jointed, joints lined with clay; thin lens of brown to olive silt as noted.

770.0' to 774.8' - basalt
774.8' to 776.3' - silt
776.3' to 780.7' - basalt
780.7' to 781.0' - silt
781.0' to 818.6' - basalt

818.6' to 856.6' - SILT, SAND, AND ASH; grayish-brown, moderate reddish-brown, moderate brown, and dark yellowish-brown; silt with few sand and ash; baked on upper part; shards rather than grains.

856.6' to 894.5' - TUFF or ASH; bluish-white.

894.5' to 897.1' - CLAY; moderate orange-pink; waxy.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

CLAY | SAND | BASALT
SILT | GRAVEL | ASH

PROJECT Snake Plain Recharge WELL NO 8S 29E 34cbb Site #20

BUREAU OF RECLAMATION - REGION 1 SHEET 3 OF 3

# LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole--Lake Channel State Idaho

Well No. 8S 29E 34cbc (Site #20) Location NE¼NW¼SW¼, sec. 34, T. 8 S., R. 29 E., Power County

Total Depth 1028.1' Begun 8/19/70 Completed 11/20/70 Drilling Method Air Rotary Wire Line Core

Static Water Level 151.31' (below) Meas. Pt. Top of 4" casing Date 12/3/70

Elevation (ground) 4387.90' W. L. Meas. Pt. 0.00 Feet (above) Ground

Yield No test Drawdown -- Other Data Geologist's detailed log, driller's logs, inspector's reports, and geophysical logs

Logged By G. King Geophysical Log Gamma Gamma, Gamma, Neutron Drilled By Jensen Construction Co.

| Drilling Data Pump Tests Water Samples | Description of Well Completion | Well Diagram | Depth | Log | Core Recov. | Samp. Type | Classification and Physical Condition |
|---|---|---|---|---|---|---|---|
| | 1028.1 bottom 3" hole | | 1050 | | | | (Continued from page 2)<br>897.1' to 956.1' - TUFF or ASH; light bluish-gray, grayish orange-pink, light gray, moderate reddish-orange and pale red-purple to moderate brown, brownish-gray, and moderate yellowish-brown; ash with fine basalt gravel, locally bedded with clay.<br>956.1' to 961.1' - SILT; pale brown.<br>961.1' to 1005.7' - CLAY; very pale orange, pale yellowish-brown, pale olive, pale greenish-yellow, and moderate greenish-yellow; waxy, locally may contain some silt; banding or bedding in some zones.<br>1005.7' to 1028.1' - BASALT; grayish-black; aphanitic to fine equigranular; dense to slightly vesicular with upper vesicles filled or lined with whitish calcite; massive to slightly jointed. |

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log

CLAY SILT SAND GRAVEL BASALT ASH

PROJECT Snake Plain Recharge WELL NO. 8S 29E 34cbb Site #20