DEEP DRILLING DATA RAFT RIVER GEOTHERMAL AREA, IDAHO

RAFT RIVER GEOTHERMAL EXPLORATION WELL #1

T. 15 S., R. 26 E., sec. 23ca Elev. 4835'

Compiled by H. R. Covington

DISCUSSION

The southern Raft River Valley near Bridge, Idaho was designated the Frazier Known Geothermal Resource Area (Frazier KGRA) in 1971 by the U.S. Geological Survey (Godwin and others, 1971), based on two shallow wells--the Bridge and Crank wells--that flow boiling water. A geochemical and geological reconnaissance of selected thermal waters in Idaho was made by the U.S. Geological Survey (USGS) in 1972 (Young and Mitchell, 1973). Geochemical thermometry of water from the Bridge and Crank wells indicated a reservoir temperature of about 150°C (300°F). In the summer of 1973 an audio frequency magnetotelluric survey in the Raft River Valley by the USGS identified a significant resistivity anomaly near Bridge.

The occurrence of boiling water in the Raft River Valley prompted the Raft River Rural Electric Cooperative, in 1971, to begin preliminary geologic investigations applicable to the development of a geothermal electrical generating facility in the valley. The U.S. Energy Research and Development Administration (ERDA) became interested in the Raft River Valley in 1973 as a result of proposals by the Raft River Rural Electric Cooperative. Preliminary engineering and feasibility studies were then begun by the Idaho National Engineering Laboratory (INEL) in the Raft River Valley as a potential site for an experimental binary-fluid geothermal power plant.

In response to Senate Subcommittee Hearings in Idaho Falls, Idaho on Geothermal Power in the Northwest during August of 1973, the USGS, in cooperation with ERDA, began an integrated geologic, geophysical, and hydrologic exploration program in southern Idaho. This program, underway by September 1973, was designed to provide a scientific framework for the evaluation of a geothermal resource and to test the applicability of various geological, geophysical, and hydrological techniques to the study of geothermal resources.

To define the geologic setting of the Bridge geothermal anomaly, geologic mapping of the Jim Sage Mountains and the Raft River Valley was carried out emphasizing structure, stratigraphy, and distribution of hydrothermal alteration (Williams and others, 1974). Cuttings from three nonproductive oil test wells drilled in the valley were also studied for initial interpretation of the subsurface geology and geophysical data.

Geophysical investigations by the USGS to further identify the boundaries of the geothermal anomaly as well as concealed structures in the Raft River basin were carried out during the summer of 1974. These studies included electrical resistivity, magnetic and gravity surveys, and seismic refraction surveys (Williams and others, 1976).

Initial shallow drilling was begun by the USGS, in cooperation with ERDA, in the spring of 1974 to measure the temperatures and flows of the near-surface cold-water aquifers. A total of thirty-four auger holes were drilled to depths of about 100 ft (30 m) (Crosthwaite, 1974), and a 400 ft (123 m) deep offset to the Bridge hot well was completed. In August of 1974, the USGS began drilling five core holes (Crosthwaite, 1976) in cooperation with the Idaho Department of Water Administration to depths ranging from 250 ft (76 m) to 1,423 ft (434 m). The purpose of the core drilling was to test geophysical interpretations of the subsurface geology and to provide hydrologic and geologic data on the shallow part of the geothermal system.

The first Raft River Geothermal Exploratory borehole (RRGE #1) site was picked by Aerojet Nuclear Company (ANC) and the USGS late in 1974. A site was chosen so that deep drilling would intersect the Bridge fault at or near the base of the Salt Lake Formation and initially confirm the existence of hot water in quantities suitable for commercial power applications.

Drilling of RRGE #1 by Reynolds Electrical and Engineering Co., Inc. (REECo) began on January 5, 1975. Drilling mud was used to a depth of 900 ft (274 m) where twenty-inch surface casing was installed. Drilling continued using water as drilling fluid to 4,477 ft (1,364 m) where core #1 was cut to 4,537 ft (1,382 m). After core was recovered the hole was drilled to 4,632 ft (1,412 m) and geophysical logging begun. Spontaneous flow began within 12 hours, and by the morning of February 2, 1,400 gal/min (88 L/sec.) boiling water was flowing out the top. The well was shut off and 13 3/8-inch casing installed to 3,720 ft (1,134 m). This cased off cooler water above the production zone and reduced the artesian flow to approximately 600 gal/min (28 L/sec), but increased the temperature from 280°F (138°C) to 295°F (146°C). The hole was then drilled to 4,989 ft (1,521 m) taking cores at 4,668 ft (1,423 m) and at the bottom. The main purpose for drilling the well beyond the production zone was to obtain geologic information on the basement complex below the valley fill. The well was completed and testing begun on April 1, 1975.

DATA SUMMARY

Drilling period:	January 5-April 1, 1975	
Total depth:	4,989 ft	1,521 m
Artesian flow:	600 gal/min.	28 L/sec.
Max. temp.:	295°F	146°C
Production zones:	3,720-4,700 ft	1,134-1,432 m
Production casing:	3,720 ft	1,134 m
Bridge fault:	4,495-4,585 ft	1,370-1,397 m

TOP OF FORMATION

Tertiary-Salt Lake:	450 ft	137 m
Precambrian-Upper Narrows Schist:	4,585 ft	1,397 m
Precambrian-Elba Quartzite:	4,700 ft	1,432 m
Precambrian-Quartz monzonite:	4,960 ft	1,512 m

CORE

Core #1: 4,477-4,537 ft (1,364-1,382 m) Salt Lake Formation
- 20 ft (6 m) Green-speckled cellular silica, considerably fractured and slickensided. Probably a major fault zone. Parent material probably sandstone and siltatone.
- 40 ft (12 m) Dark-gray calcareous claystone, and light-gray, probably tuffaceous sandstone, cut by vertical fractures, some fractures, some fractures filled with calcite.

Core #2: 4,668-4,680 ft (1,423-1,426 m) Upper Narrows Schist
- Gray to dark-gray quartzite and graphitic biotite schist, with minor amounts of dolomitic cement, scattered pyrite, and vugs with calcite and quartz crystals. Fractures contained massive quartz and quartz crystals.

Core #3: 4,987-4,989 ft (1,520-1,521 m) Quartz Monzonite
- Gneissic, light to dark greenish gray. 50 percent feldspar, 30 percent quartz, 20 percent chlorite, trace of pyrite and magnetite. Fractures with slickensides and calcite, iron staining.

GEOPHYSICAL LOGS

Log	Date	Run	Logged Interval feet	Logged Interval meters
Caliper - four arm	1-9-75	one	18-898	5-274
Caliper - four arm	2-9-75	three	900-4,616	275-1,407
Caliper - four arm	4-6-75	four	3,000-5,002	914-1,524
Compensated Neutron-Formation Density	2-2-75	one	880-4,619	268-1,408
Compensated Neutron-Formation Density	4-6-75	three	3,623-4,992	1,104-1,521
Gamma	2-2-75	one	880-4,619	268-1,408
Gamma	4-6-75	three	3,623-4,992	1,104-1,521
Compensated Sonic	1-9-75	one	30-896	9-273
Compensated Sonic	2-2-75	two	880-4,618	268-1,408
Compensated Sonic	4-6-75	three	3,592-4,998	1,095-1,523
Temperature	2-2-75	two	500-4,619	152-1,408

EXPLANATION

Quaternary--Raft Formation: Massive beds of light-colored clay and silt and thin-bedded calcareous quartzose silt and sand that is crossbedded locally. Conglomerate or gravel occurs at the base of the formation in many places (Trimble, and Carr, 1976). The Raft Formation in the Raft River Basin is primarily gravel containing clasts of Tertiary volcanic rock, Paleozoic limestone, and Precambrian quartzite derived from the surrounding mountains. These gravels are interbedded with light-colored calcareous silts and sands. The Raft Formation-Salt Lake Formation contact in the well is an arbitrary contact based on downward decrease in overall gravel content.

Tertiary--Salt Lake Formation: Gray to light-green thin-bedded to massive, tuffaceous siltstone and sandstone with minor beds of conglomerate. In the western part of the Raft River Basin the Salt Lake Formation is divided by a volcanic member at Jim Sage Mountain into upper and lower members Williams and others (1976).

Upper member (Tsu) is gray to light-green tuffaceous siltstone and sandstone, and minor buff to gray conglomerate

Volcanic member at Jim Sage Mountain (Tsj) consists of rhyolite flows separated in many places by a vitrophyre breccia. The flows are black glassy and red-brown porphyritic-aphanitic calc-alkali rhyolite containing phenocrysts of oligoclase-andesine and pigeonite. The vitrophyre breccia consists of black glass clasts a few cm to 2 m in diameter in a yellow and orange matrix of hydrated glass (Williams, and others, 1976).

Lower member (Tsl) is gray and white thin-bedded to massive tuffaceous sandstone with light-green interbeds of claystone and siltstone and minor conglomerate.

Precambrian--Upper Narrows Schist: Dark-brown to gray, fine- to medium-grained biotite schist and fine-grained gneiss that contains quartz or quartz-feldspar lenses (Compton, 1972).

Precambrian--Elba Quartzite: White, tan or locally pale-green quartzite with muscovite-quartz schist between some beds (Compton, 1972).

Precambrian--Quartz Monzonite: Gneissic, light to dark greenish-gray with a trace of pyrite and magnetite.

Formational contacts and lithologic changes within the Salt Lake Formation are based solely on the well cuttings and may not correspond exactly to changes in the geophysical logs. Cuttings and core were examined and described at the well site by P. L. Williams and H. R. Covington during drilling and lithologic breaks assigned without the benefit of geophysical logs. Sample depth control was maintained, through the use of a carbide lag, by Core Laboratories, Inc.

Geophysical logging was carried out by Schlumberger Well Services. Calibration of individual logs change from run to run and were adjusted to a single calibration for this publication. The Temperature log used was run fourteen hours after circulation of drilling fluid in the hole and so shows a cooler bottom hole temperature than was observed several days later. Interruptions in the geophysical log data indicate depth intervals for which there is no commercially run geophysical logs or no geophysical logs provided.

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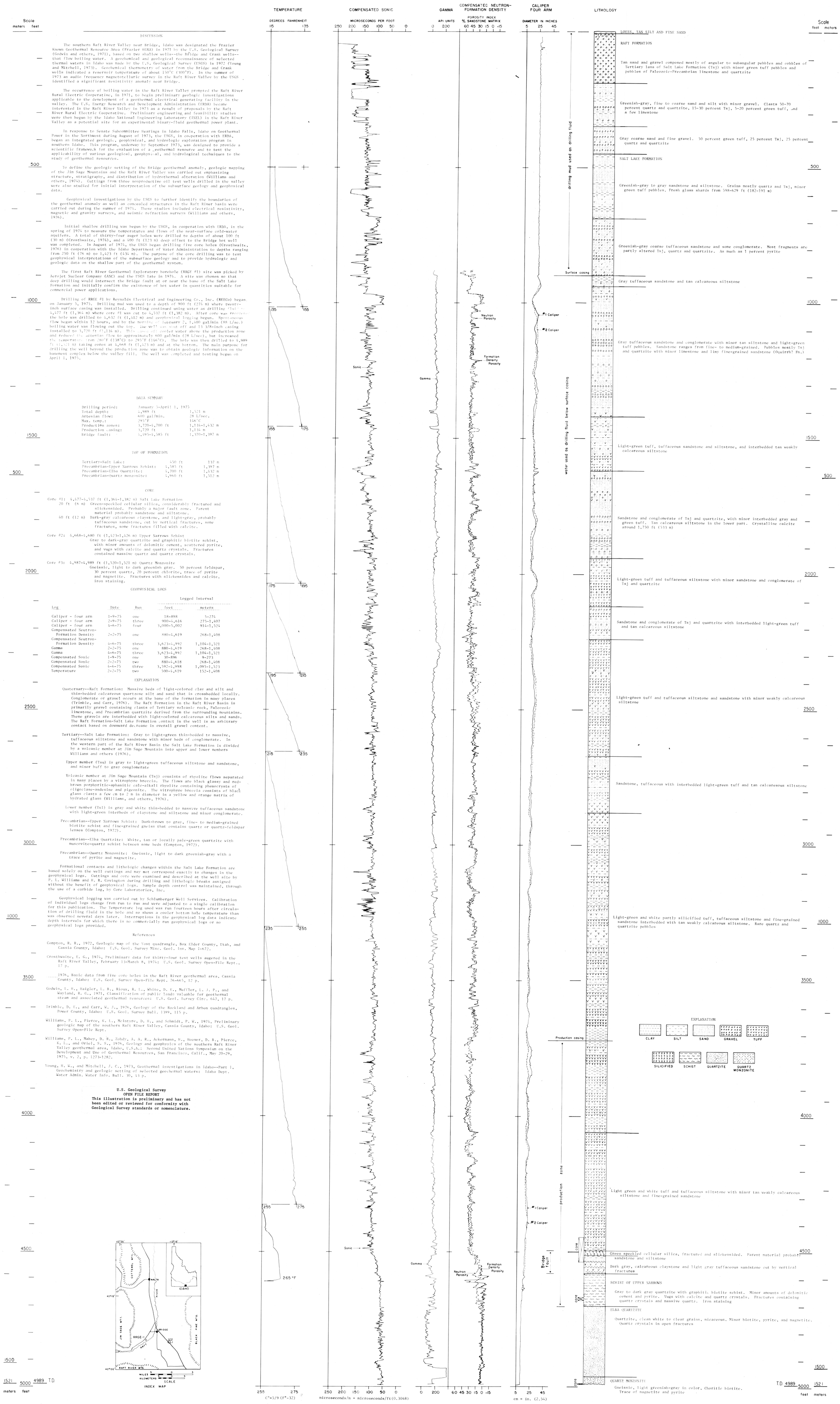
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