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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HYDROLOGIC AND DRILL-HOLE DATA FOR TEST WELLS UE-29a#1 AND UE-29a#2, FORTYMILE CANYON, NEVADA TEST SITE

by

Richard K. Waddell, Jr.

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METRIC CONVERSIONS

The SI units (International System of Units) used in this report may be converted to inch-pound units by use of the following conversion factors:

Multiply SI unit	By	To obtain inch-pound unit
kilometer	0.6214	mile
centimeter (cm)	0.3937	inch
liter per second (L/s)	15.85	gallon per minute
meter (m)	3.281	foot
meter per hour (m/h)	3.281	foot per hour
microsiemens per centimeter at 25° Celsius (µS/cm)	1	micromhos per centimeter at 25° Celsius
milligram per liter (mg/L)[1]	1.0	part per million

[1]Approximate.

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

HYDROLOGIC AND DRILL-HOLE DATA FOR TEST WELLS UE-29a#1 AND UE-29a#2, FORTYMILE CANYON, NEVADA TEST SITE

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ABSTRACT

Test wells UE-29a#1 and UE-29a#2 were drilled in Fortymile Canyon, Nevada Test Site, as part of the U.S. Department of Energy's program to study the feasibility of constructing a high-level nuclear-waste repository beneath Yucca Mountain. The wells were designed to obtain data pertinent to characterizing the regional ground-water flow system near Yucca Mountain. Drilling of test well UE-29a#1 began September 25, 1981, and reached a total depth of 65.5 meters before being abandoned because of an irretrievable drill bit and collar down the hole. A second well, UE-29a#2, was drilled 8.9 meters from the first and reached a depth of 421.5 meters before caving problems stopped the drilling.

Hydrologic testing of UE-29a#1 consisted of three short-term pumping tests, with pumping rates ranging from 0.61 to 1.64 liters per second. These tests were stopped when the water level inside the test well declined to the pump intake. A water sample was collected in a separate episode of pumping; the water had a carbon-14 content of 75.3 percent of modern.

Test well UE-29a#2 was tested in two episodes of pumping. During the first episode, the uncased part of the well (247.3 to 354.5 meters) was pumped at rates ranging from 33.2 to 47.6 liters per second; maximum drawdown in three tests ranged from 74 to 115 meters. Temperature and tracejector logs were obtained during pumping. Water samples collected during the first episode had a carbon-14 content of 62.3 percent of modern. The second episode of testing involved pumping the upper part of the hole and obtaining temperature and tracejector logs; before installing the pump, the casing was perforated from 86.9 to 213.4 meters, and a bridge plug was installed in the casing below the perforations. The pumping rate ranged from 10.4 to 38.6 liters per second, with maximum drawdown in three separate tests ranging from 33 to 61 meters. The second episode of pumping was complicated by generator failure and clogging of the pump intake by debris from the perforating charges. The water sample had a carbon-14 content of 60.0 percent of modern. Predominant ions in all samples were sodium, calcium, and bicarbonate.

INTRODUCTION

Test wells UE-29a#1 and UE-29a#2 were drilled in Fortymile Canyon (fig. 1) as part of the Nevada Nuclear Waste Storage Investigations being conducted for the U.S. Department of Energy by several governmental agencies and contractors. Drilling and testing of these two wells were performed under the direction of U.S. Geological Survey personnel under Interagency Agreement DE-AI08-78ET44802. Only one well was planned, but drilling problems caused the first well (UE-29a#1) to be abandoned and a second one to be drilled at the same site. The test wells were drilled to obtain geologic, hydrologic, and water-chemistry data in an area of the Nevada Test Site where no nearby drill holes exist. The ground-water flow system around the site of a possible nuclear waste repository (Yucca Mountain) probably is strongly influenced by the presence of very permeable rocks in western Jackass Flats, downgradient from Yucca Mountain. Prior to drilling these test wells, no hydrologic data were available in areas upgradient from either Fortymile Wash or Yucca Mountain. The drilling site was located in Fortymile Canyon, north of Jackass Flats, in order to answer several questions concerning the hydrology and geology near the Yucca Mountain site:

1. What is the altitude of the potentiometric surface upgradient of the proposed repository? Determination of flow directions and flow rates depends on existence of reliable potentiometric data. Numerical modeling requires information on transmissivity distribution, which is reflected in the potentiometric surface.

2. What is the vertical hydraulic head gradient beneath Fortymile Canyon?

3. Does recharge occasionally occur from intermittent flow in the stream channel?

4. Is the high transmissivity of rocks beneath Fortymile Wash caused by lithology alone, or by a possible north-trending fracture zone that may exist beneath Fortymile Wash and Fortymile Canyon?

5. Does the Crater Flat Tuff occur north of Yucca Mountain, and if so, what is its lithology and volcano-tectonic setting?

6. What are the *in situ* hydrologic properties of rocks beneath the drill site? It was expected that the test well would penetrate rhyolitic lava flows, flow breccias, and bedded and nonwelded tuffaceous beds of Calico Hills. Beneath Yucca Mountain, the Calico Hills is represented mainly by bedded tuffs that are locally zeolitized. Lava flows are composed of more brittle rocks than bedded tuffs, and their hydrologic properties probably are different. Because large areas north and northwest of Jackass Flats are underlain by rhyolitic lavas, it is important to know their hydrologic properties.

7. What is the chemistry and age of the water beneath Fortymile Canyon? Fortymile Canyon and Fortymile Wash may lie along a flow line from Pahute Mesa (and perhaps Timber Mountain) to the Amargosa Desert. Do geochemical data support the hypothesis, or is another hypothesis more tenable?

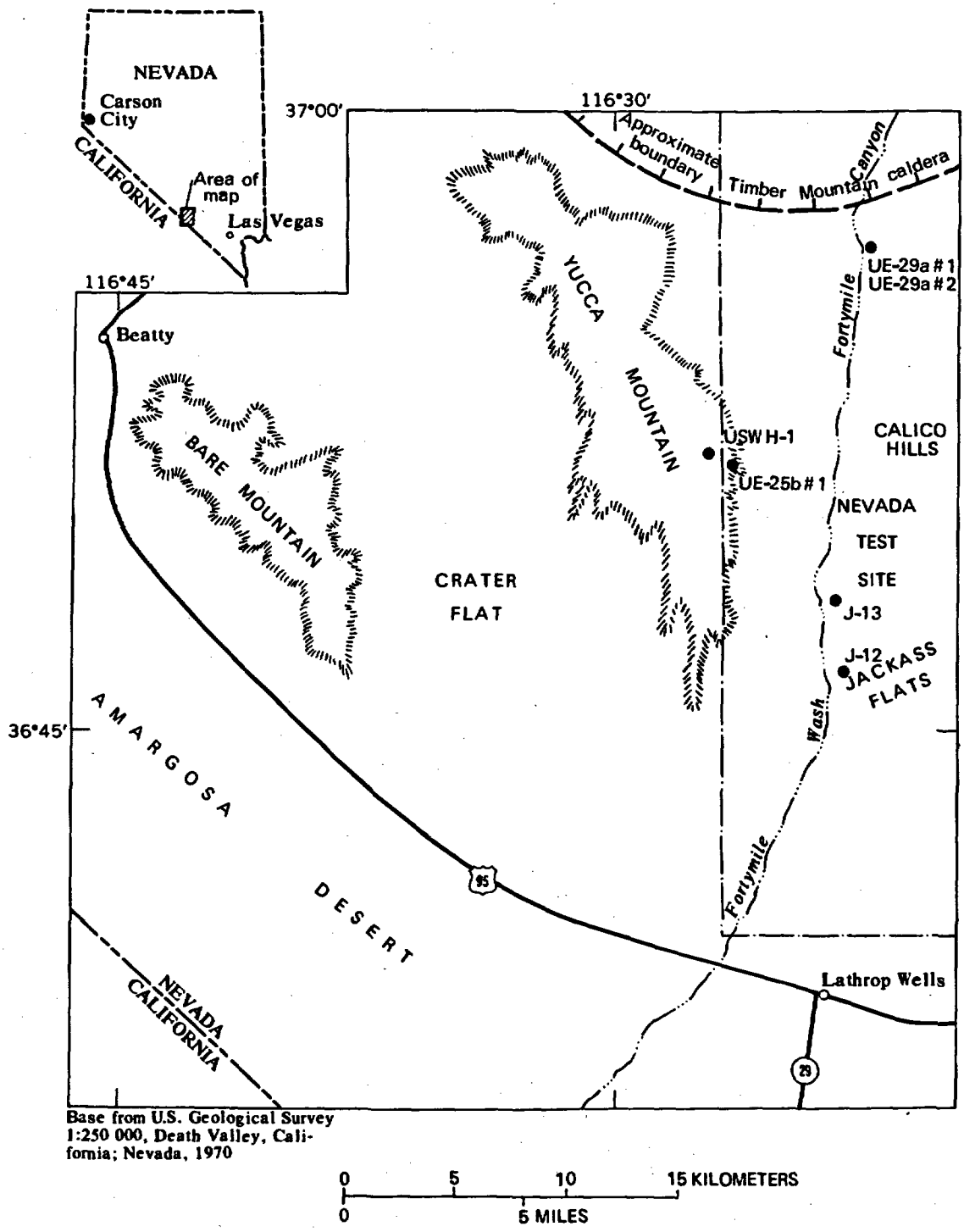

Figure 1.--Location of drilling site.

(from USGS-OFR-84-142, Waddell, 1985)

Test well UE-29a#1 was sited in Fortymile Canyon (fig. 1) as far north as possible without being within the Timber Mountain caldera, in order to be far away from existing drill holes but still provide data about the Calico Hills rhyolites and Crater Flat Tuff. The second test well, UE-29a#2, was drilled at the same site when drilling problems in UE-29a#1 caused its abandonment. This report presents the data collected during the drilling and testing of the two test wells. These data may be used to address the seven questions listed above, although drilling problems prevented acquiring all the necessary data.

This work was funded by the U.S. Department of Energy as part of the Nevada Nuclear Waste Storage Investigations. The test wells were drilled by a Department of Energy contractor, Reynolds Electrical and Engineering Co.[1]; Fenix & Scisson, Inc., another contractor, provided technical drilling and geological support.

Certain individuals deserve thanks for their contributions to these studies: D. O. Blout served as liaison between the author and the people involved in daily drilling operations; W. J. Oatfield and C. L. Washington collected and processed the water-chemistry samples; L. E. Wollitz and W. A. Evert assisted in the pumping tests; and W. D. Low processed the pumping-test data. Geologists from Fenix & Scisson, Inc. (D. O. Blout, J. M. Brandt, B. W. Cork, G. A. DePaolis, L. P. Escobar, H. E. Huckins, C. R. Kneiblher, R. G. Lahoud, and S. J. Waddell) helped in both drilling and testing operations.

DRILLING HISTORY

Test well UE-29a#1 was designed to be about 915 m deep in order to penetrate some of the Crater Flat Tuff, and to obtain additional stratigraphic and hydrologic information on this unit for comparison with data for test holes at Yucca Mountain. Depth to water was estimated to be greater than 275 m. Both pumping and packer tests were planned. Casing was to have been installed to about 50 m below the static water level.

Drilling was begun on September 26, 1981. The circulating fluid was air with a foaming agent; lithium chloride was added so that the degree of contamination by drilling fluid of water-chemistry samples could be determined. When the well had been drilled to a depth of 65.5 m, one drill collar, the bit, and associated hardware were lost in the hole. Fishing attempts were unsuccessful, and the hole was abandoned on October 6, 1981. A summary of the drilling history of test well UE-29a#1 is in the Supplemental Data section at the end of this report.

During drilling at a depth of about 25 to 30 m, discharge from the well changed from light pink and foamy to red and watery, indicating that the well was producing water. Water-level measurements and chemical evidence that the discharge water was diluted drilling water confirmed that a saturated zone had been reached. It was not known whether the water was perched (a possibility because of the proximity of two nearby intermittent stream beds) or whether it represented the regional saturated zone.

[1]Use of firm names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Because UE-29a#1 had not met any of the planned study objectives, a new test well (UE-29a#2) was begun, following the same drilling plan. The second hole was spudded about 8.9 m west northwest of UE-29a#1 on October 7, 1981.

A summary of the drilling of UE-29a#2 is contained in the Supplemental Data section at the end of this report. Drilling operations went smoothly until a depth of about 248 m was reached, although caving of the hole above this depth had occurred. While cleaning the hole, the drill string became stuck; free-point tests indicated that the pipe was stuck at a depth of 183 m. The drill string was freed 1 week after becoming stuck, and 27.3-cm-diameter casing was installed to a depth of 247.3 m. Drilling was resumed, and continued to a depth of 421.5 m. Penetration was extremely fast from a depth of 345 m to 421.5 m, reaching a maximum of about 35 m/h. Caving of the soft material hampered drilling, and the engineers and geologist decided to lower the 27.3-cm-diameter casing (previously set, but not cemented, at 247.3 m) to solve the problem caused by caving. The hole was underreamed from a depth of 248.1 to 355.1 m so the casing could be lowered. While attempting to loosen the casing, the rig was damaged. Another rig was not available for drilling, so drilling was stopped short of the planned total depth.

Construction data for test wells UE-29a#1 and UE-29a#2 are summarized in figure 2. Caliper logs show that caving occurred in the depth ranges from 85 to 100 m, from 135 to at least 160 m, and below 360 m.

TESTING RESULTS

Data collected during drilling included fluid balance, specific conductance and lithium concentration in discharge fluid, cuttings and core, numerous geophysical logs, and penetration rate. Data collected during the pumping tests conducted in December 1981 and January 1982 included rates of water-level change, discharge rates, temperature logs during pumping, tracejector data, lithium concentration, specific conductance, temperature and pH of discharge water, and water-chemistry data.

Not all data are reported here; for example, the geophysical logs are not reproduced, only listed. The data presented within the report primarily are of a hydrologic nature.

Data Collected During Drilling

Because only test well UE-29a#2 was deep enough to be thoroughly tested, data from that well are presented more completely than data from UE-29a#1.

Rate-of-penetration data are presented in figure 3. Although penetration rate is determined by many factors, relatively rapid rates generally indicate poorly consolidated rock.

Specific-conductance and lithium-concentration data are given in figures 4 and 5. Lithium concentration in the drilling fluid was maintained at approximately 20 mg/L. Lithium concentration of the ground water was estimated to be about 0.05 to 0.1 mg/L, based on analysis of water samples collected from wells J-13, USW H-1, and UE-25b#1 (fig. 1). Addition of lithium chloride

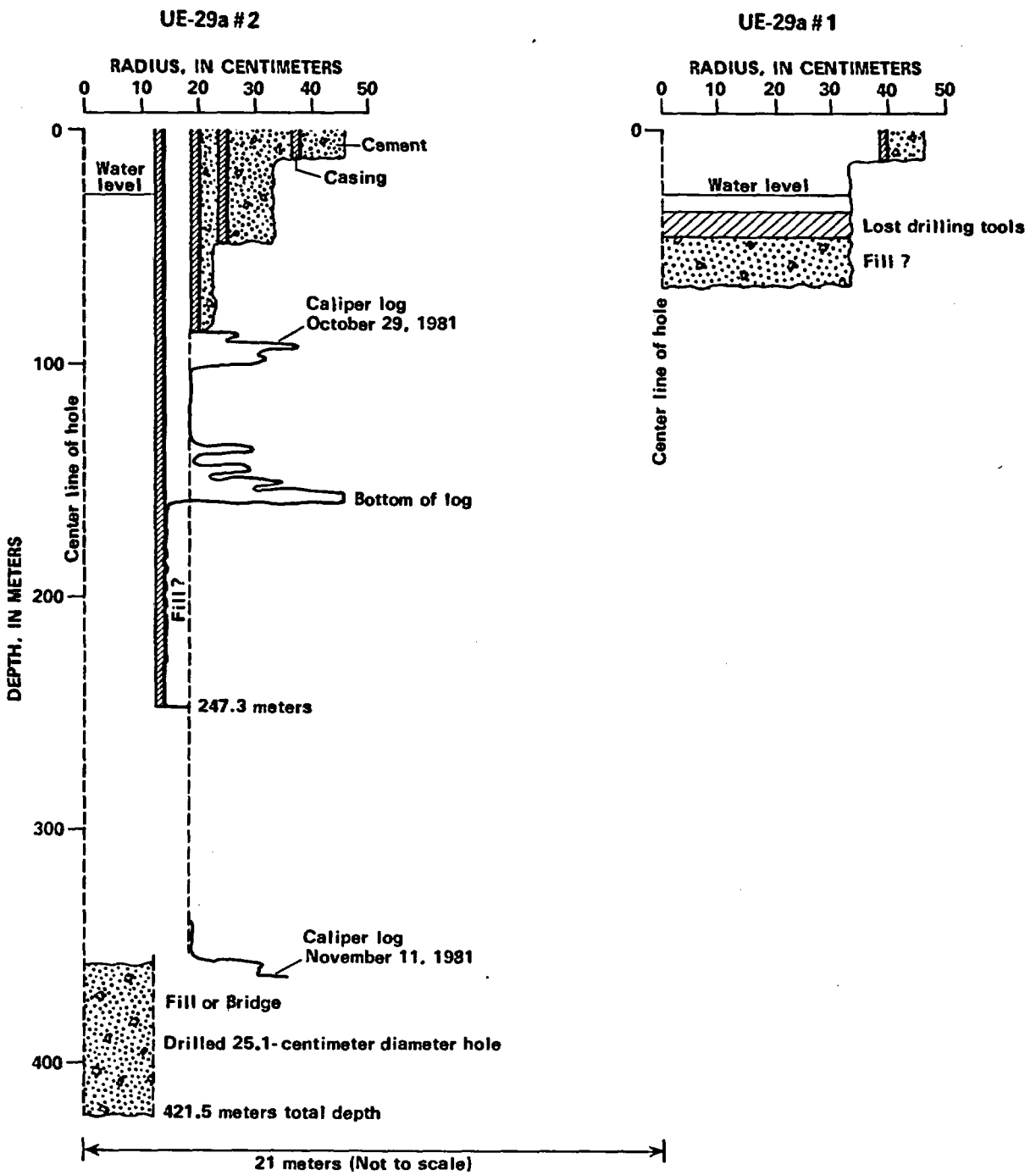

Figure 2.--Schematic diagram of test wells UE-29a#1 and UE-29a#2. (Horizontal exaggeration 240:1.)

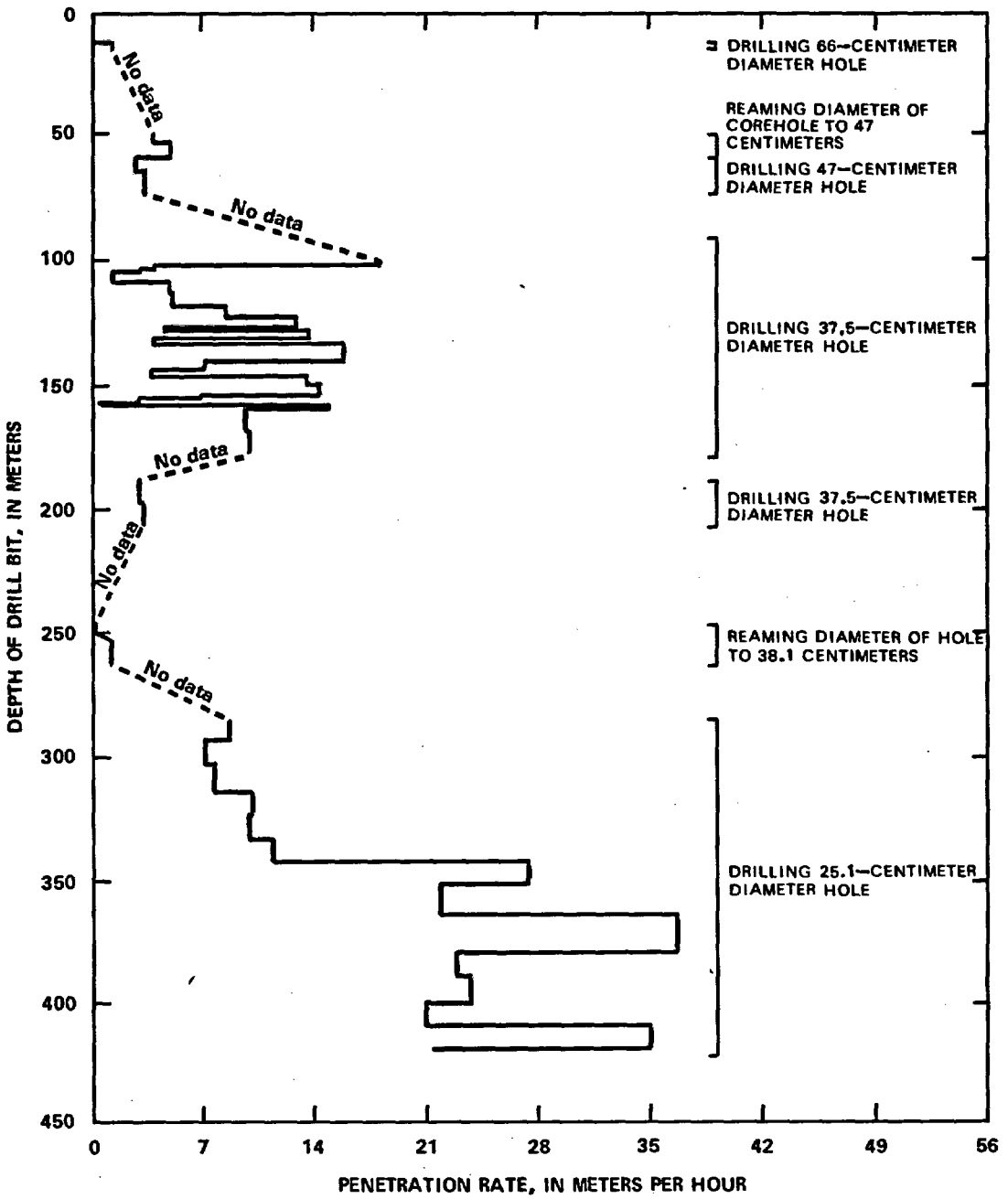

Figure 3.--Penetration rate during drilling of test well UE-29a#2.

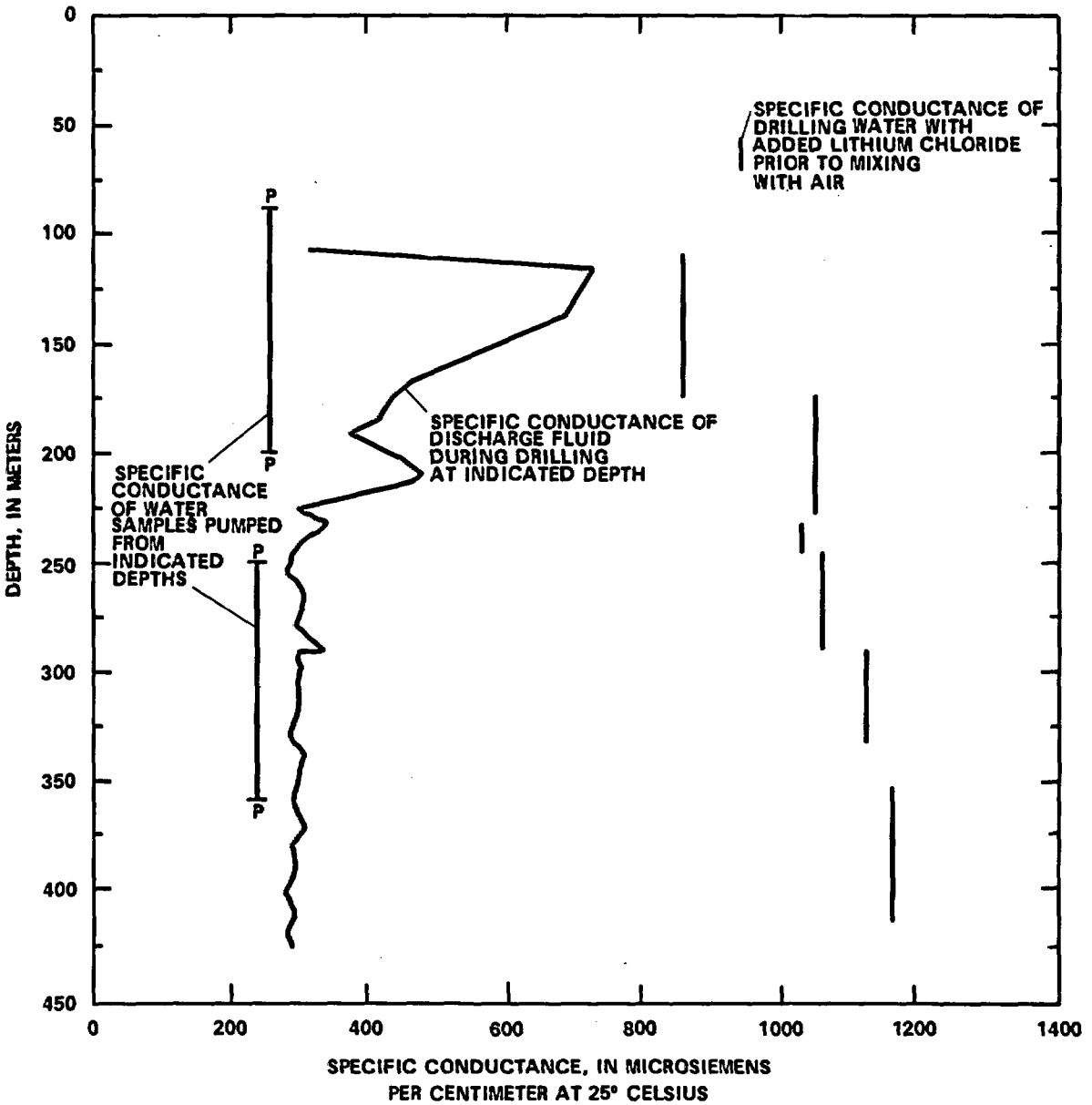

Figure 4.--Variation in specific conductance of discharge fluid with depth during drilling of test well UE-29a#2.

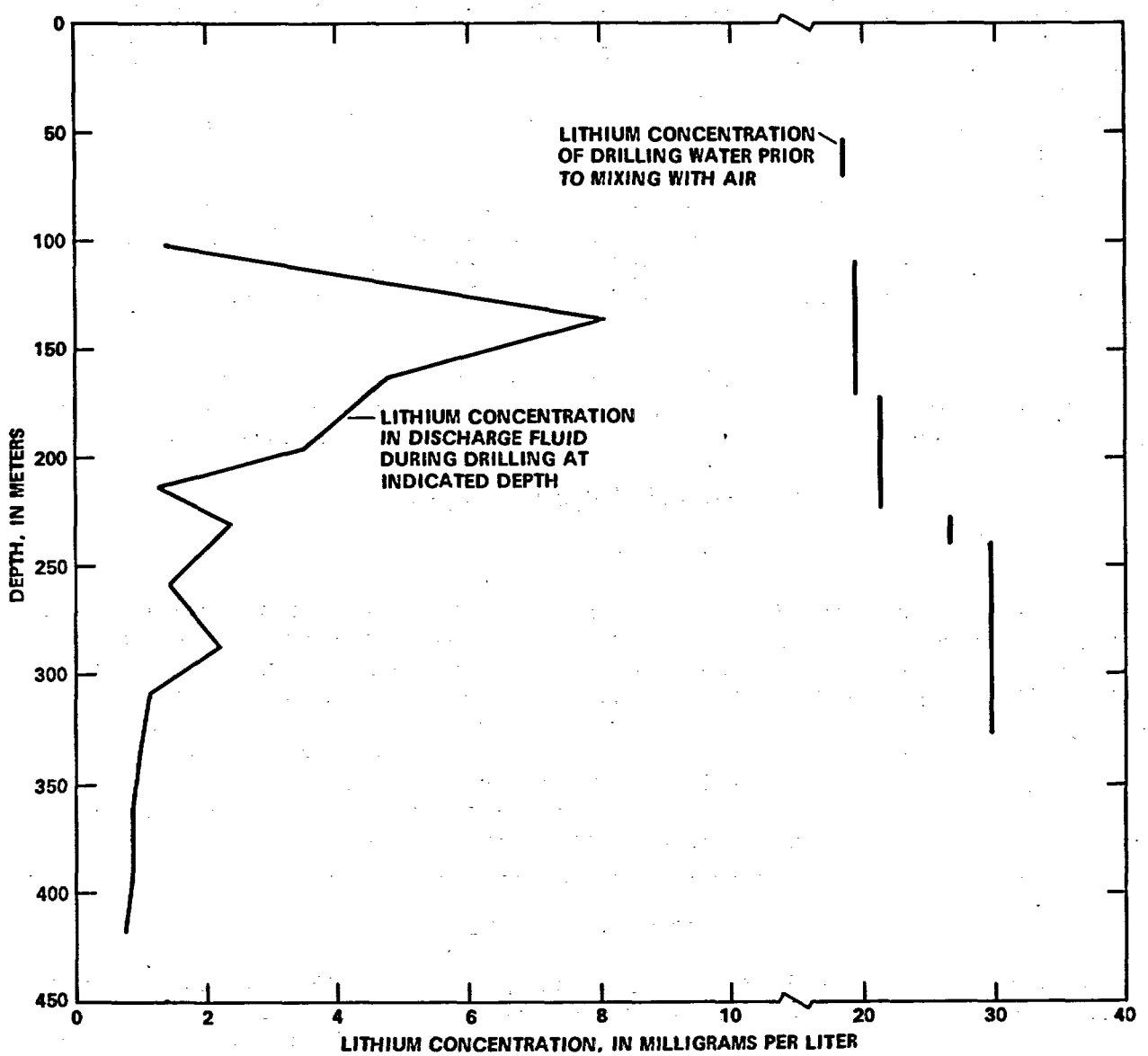

Figure 5.--Variation in lithium concentration of discharge fluid with depth during drilling of test well UE-29a#2. (Note scale change for concentrations greater than 10 milligrams per liter.)

and soap to the drilling water raised its specific conductance to approximately 1,000 µS/cm. The water used in drilling (obtained from well J-13) had a specific conductance of 250 to 300 µS/cm prior to addition of the lithium chloride and soap. Ground water at the site was expected to have a specific conductance in the same range.

Cuttings were collected at 3-m intervals throughout most of the drilling and at every 1.5 m in the upper 15 m, above the alluvium/volcanic-rock contact. Cores were collected in the following depth intervals: 50.3 to 59.7 m, 207.9 to 212.1 m, and 247.5 to 250.2 m. Recovery ranged from 10 to 100 percent. These samples are stored at the U.S. Geological Survey's core library in Mercury, Nev.

An abbreviated lithologic log based on descriptions of cuttings and core (W. J. Carr, U.S. Geological Survey, written commun., 1983) is shown in table 1. Subsurface stratigraphy is complex and not well known, and depths of several contacts are not well known because of the limited quantity of core available.

A list of geophysical logs is presented in table 2. Depth coverage is incomplete because of difficulty in keeping the hole cleared of rock. Copies of these logs also are maintained at the core library in Mercury, Nev.

Data Collected During Pumping

Test Well UE-29a#1

Three pumping tests (A, B, and C) were performed in test well UE-29a#1 using a low-capacity, air-driven pump. Discharge rate from this pump was greatly affected by the lift and, therefore, changed during the tests. During test A, it was evident that total drawdown was determined by the depth of the pump; the pump was lowered for tests B and C. Data from these tests are presented in figure 6 and table 3. Discharge data were not collected during the first test because the flow meter did not function well without back pressure. A gate valve downstream from the meter was used during subsequent tests. A sample for water-chemistry determinations was collected in a separate episode of pumping. These data are presented in table 4.

Test Well UE-29a#2

Pumping tests of UE-29a#2 are designated T1 through T6. The first series of tests includes two short tests (T1 and T2), a 13-day break, and a 2½-day test (T3) of the depth interval from 247.3 m (bottom of casing) to 354.5 m, which was the depth to top of the fill. The casing was not cemented in place. The first two tests were conducted primarily for the purpose of cleaning the hole and designing the third test. Details of these tests are given in table 5; drawdown, recovery, and discharge-rate data are presented in figure 7; and tracejector and temperature data are presented in figure 8. The apparent large discharge values at depths less than 255 m probably were caused by a decrease in hole diameter from 17 to 12.7 cm, near the lower end of the casing.

Table 1.--*Generalized lithologic log, test well UE-29a#2*

[Modified from W.J. Carr, U.S. Geological Survey, written commun., 1983; log is based on cuttings, geophysical logs, and three cored intervals]

Depth (meters)	Description of lithology
0- 12±	Alluvium, grayish-brown, containing abundant green, white rhyolite and altered rhyolite fragments.
12± -57.3	Rhyolite, predominantly reddish-brown, white, clayey, hydrothermally altered, brecciated. Probably Rhyolite of Fortymile Canyon (informal).
57.3- 65±	Tuff, light tan to orange-pink and yellow-green, massive, with light purplish-gray lithic fragments, including phenocryst-poor lava with fine flow-banding; very few phenocrysts. Core (50.3 to 59.7 meters) is locally broken by small faults and fractures; clayey, zeolitic, secondary silica, and iron stains.
65±-189	Rhyolite(?), white to pink, light green and reddish-brown, hydrothermally altered; few phenocrysts; probably rhyolite lava of Calico Hills (informal).
189-total depth	Rhyolite, similar to that in depth interval from 65 to 189 meters, but white to purplish-gray, massive at top; flow banding observed in lower core; contains about 5 percent white altered feldspar, minor quartz, and biotite. Partly silicified, a little clay and minor slickensides on some fractures. Core shows numerous fractures at 247.5 to 249.3 meters. Dark gray to purple from 248.4 to 356.6 meters; resistivity 400 to 600 ohm-meters from 247 to 341 meters as contrasted to less than 100 ohm-meters through much of the rest of the hole. Color becomes light gray again at 355 meters. More hydrothermally altered from about 370 meters to total depth (421.5 meters). Color red to pinkish-brown and white from 405 to 421.5 meters. Probably rhyolite lava of Calico Hills.

Table 2.--*Type and depth interval of geophysical logs, test well UE-29a#2*

Log	Depth interval (meters)
Caliper	76.2-155.1
	234.7-359.4
	231.6-362.1
	234.7-353.6
	0 -353.0
Density, dual proximity	83.5-136.5
Density, borehole-compensated	239.9-362.7
Epithermal neutron	234.7-361.2
Gamma ray	79.3-156.4
Nuclear annular investigation	6.1-189.0
Spontaneous potential and resistivity	82.3-155.1
	242.3-363.6
Magnetometer	91.4-156.4
	246.9-361.5
3-D velocity (0.91-meter spacing)	240.2-359.7
(1.83-meter spacing)	242.2-360.3
Vibroseis	16.2-144.8
	243.8-358.1
Temperature (natural)	0 -156.4
(while pumping)	0 -224.0
(while pumping)	0 -224.6
(while pumping)	120.7-355.1
Tracejector (while pumping)	91.4-217.9
(while pumping)	173.7-210.3
(while pumping)	240.2-334.5

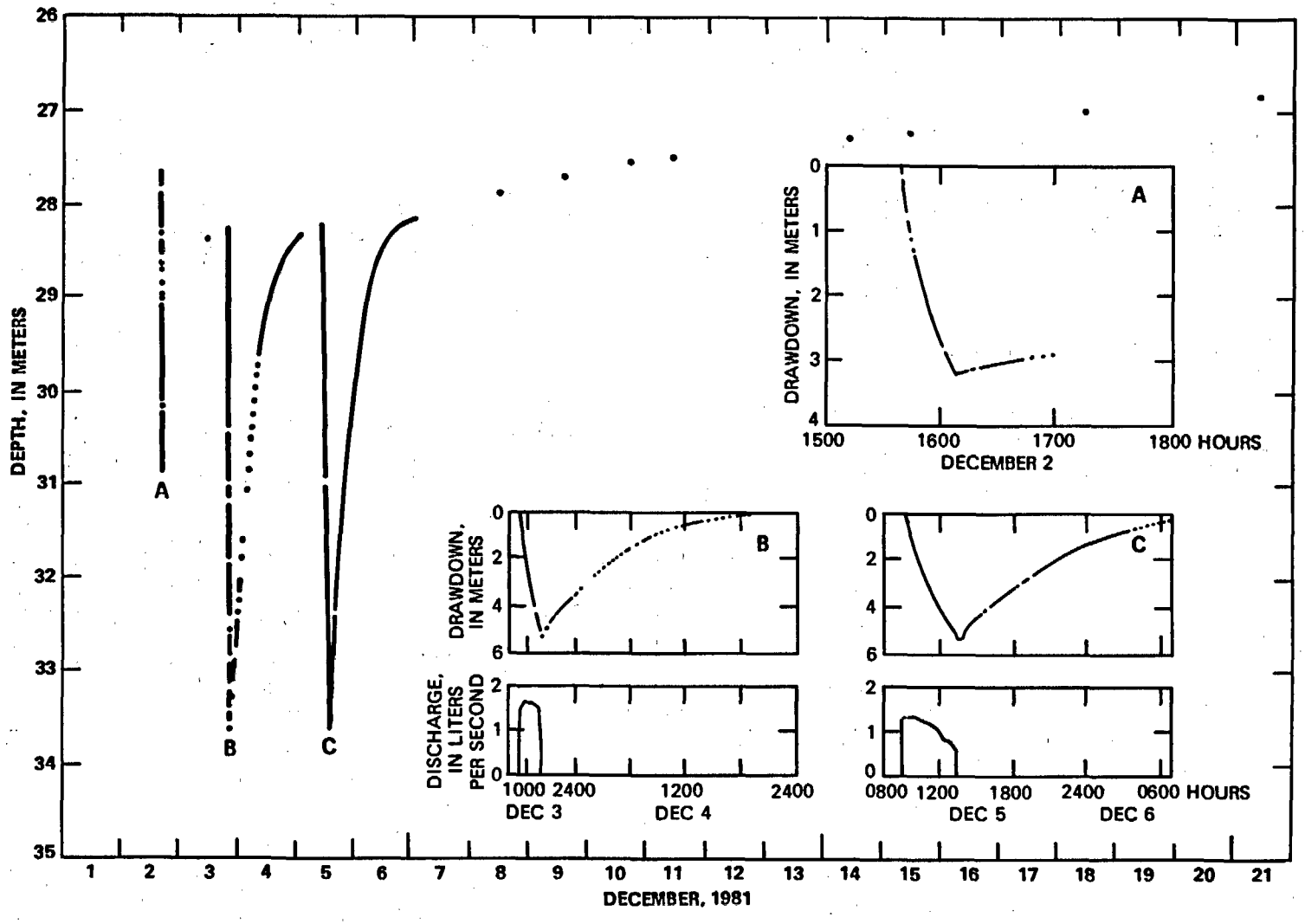

Figure 6.--Water-level changes for three pumping tests of test well UE-29a#1. (Insets give more detailed history of drawdown, recovery, and pumping rates.)

Table 3.--*Pumping-test data, test well UE-29a#1*

Test	Date	Time	Duration (hours)	Depth interval (meters)	Depth of pump intake (meters)	Pumping rate (liters per second)	Maximum drawdown (meters)
A	12/02/81	1538 to 1616 hours	0.6	27.6 to 45.7	33.5	Unknown	3.2
B	12/03/81	1752 to 2039 hours	2.8	28.2 to 45.7	36	1.26 to 1.64	5.4
C	12/05/81	0849 to 1347 hours	5.0	28.2 to 45.7	36	0.61 to 1.34	5.4

Table 4.--*Results of chemical and isotopic analyses of water samples*
[Analyses by U.S. Geological Survey; mg/L, milligrams per liter; pCi/L, picocuries per liter; µS/cm, microsiemens per centimeter at 25°Celsius]

Constituent, property, or isotope	Test well UE-29a#1 01/29/82	Test well UE-29a#2 01/08/82[1]	Test well UE-29a#2 01/15/82[2]
Calcium (mg/L)	23	10	10
Sodium (mg/L)	39	44	44
Potassium (mg/L)	4.0	1.1	1.3
Magnesium (mg/L)	.27	.20	.30
Lithium (mg/L)	.080	.10	.11
Strontium (mg/L)	.067	.039	.033
Bicarbonate (mg/L)	56.7	56.1	54.9
Sulfate (mg/L)	19	22	21
Chloride (mg/L)	11	11	8.8
Fluoride (mg/L)	.8	1.0	.9
Nitrate (mg/L)	11.5	9.3	9.7
pH (units)	7.4	7.2	7.0
Specific conductance (µS/cm)	270	240	258
Carbon-14 (percent of modern)	75.3	62.3	60.0
Tritium (pCi/L)	200	37	37
δD[3]	-92.0	-93.5	-93.0
$\delta^{18}O$[3]	-12.4	-13.0	-13.1
$\delta^{13}C$[4]	12.6	12.6	13.1

[1]Pumped interval from bottom of casing (247.3 meters) to top of fill (354.5 meters).
[2]Pumped through perforations in casing from 86.9 to 213.4 meters.
[3]per mil deviation from Standard Mean Ocean Water.
[4]per mil deviation from Peedee belemnite standard.

Table 5.--*Pumping-test data, test well UE-29a#2*

Series	Test	Beginning time	Ending time	Duration (hours)	Depth interval (meters)	Depth of pump intake (meters)	Pumping rate (liters per second)	Maximum drawdown (meters)
1	T1	12/23/81 0530 hours	12/23/81 0900 hours	3.5	247.3- 354.5	103.8	35.4 to 48.9	74.3
1	T2	12/23/81 2000 hours	12/24/81 0900 hours	13	247.3- 354.5	223.4	39.0 to 47.6	112.9
1	T3	01/05/82 1840 hours	01/07/82 0916 hours	62.6	247.3- 354.5	223.4	33.2 to 44.5	114.5
2	T4	01/12/82 2102 hours	01/12/82 2133 hours	.5	86.9- 213.4	223.2	37.5 to 38.6	36.8
2	T5	01/12/82 2205 hours	01/12/82 2235 hours	.5	86.9- 213.4	223.2	32.0 to 38.6	33.0
2	T6	01/13/82 1004 hours	01/16/82 0018 hours	62.1	86.9- 213.4	223.2	10.4 to 32.9	61.0

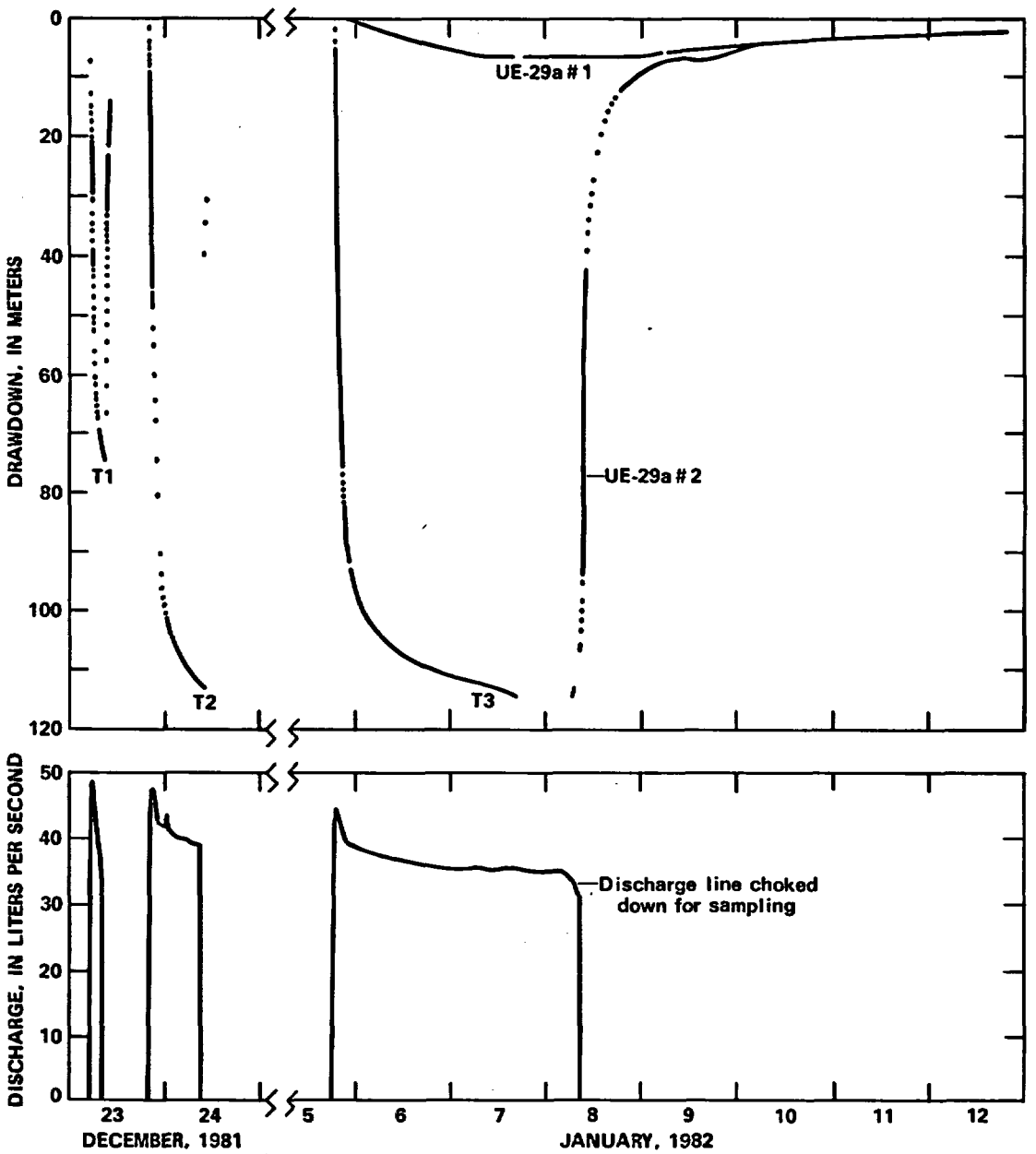

Figure 7.--Drawdown, recovery, and discharge data for the first series of pumping tests of test well UE-29a#2. [Interval pumped was from 247.3 meters (bottom of uncemented casing) to 354.5 meters (top of fill).]

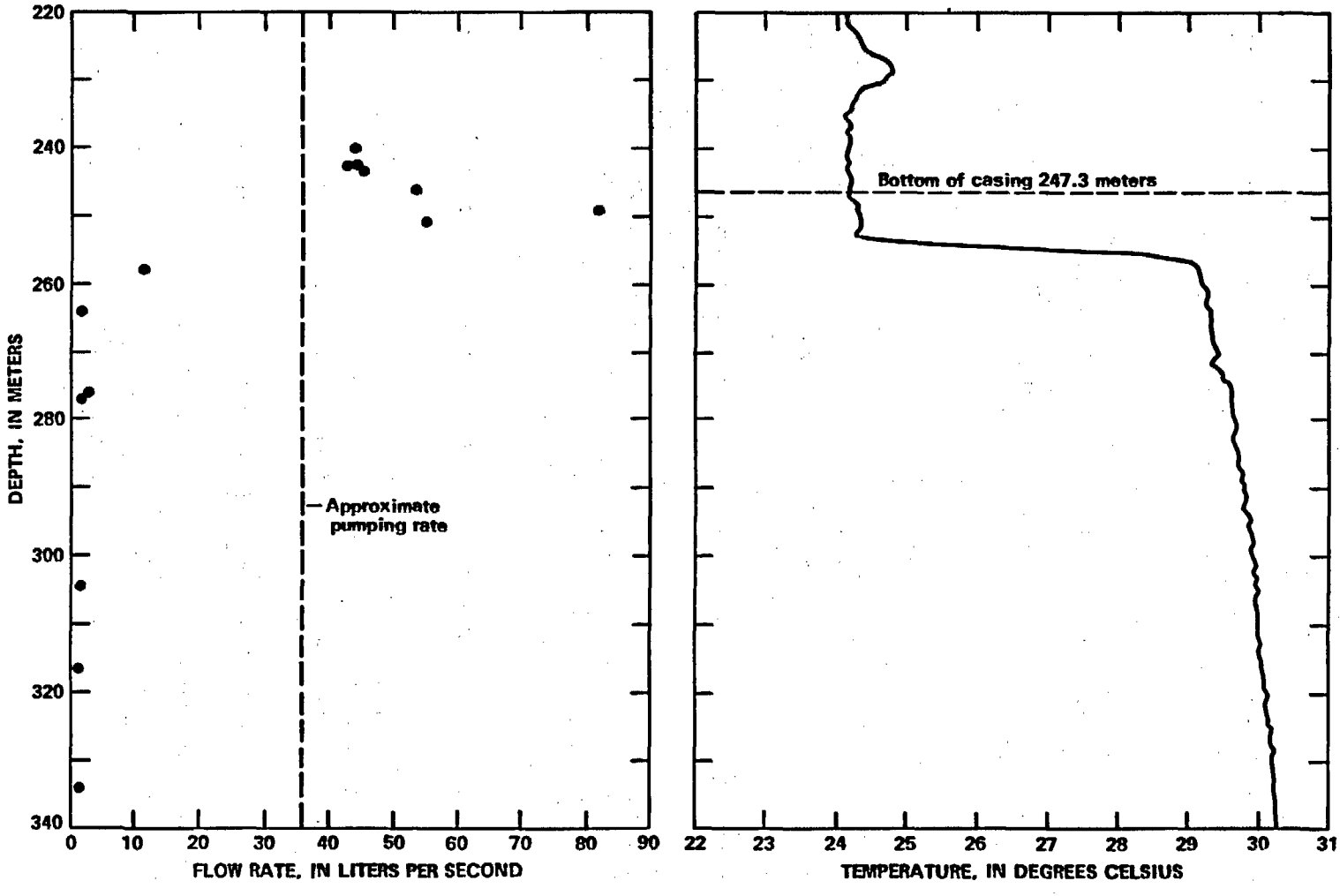

Figure 8.--Results of tracejector and temperature surveys run during the third pumping test, test well UE-29a#2.

The second series of tests (T4 through T6) was designed similarly to the first series; however, prior to the tests, the bottom string of casing was perforated from 86.9 to 213.4 m, using approximately 33 shots per 10 m. To determine if water moved around a bridge plug to be installed near the bottom of the casing, a wireline tool containing sodium bromide was lowered to a depth of 260 m and signaled to release the salt; discharge water subsequently was analyzed for bromide. A removable bridge plug, with a pressure recorder mounted below the bridge plug, was set at a depth of 245.4 m (center of plug). The pump and a perforated (92 to 220 m) access line then were installed.

Details of the tests are presented in table 5; drawdown, recovery, and discharge data are presented in figure 9; temperature and tracejector logs during T6 are presented in figure 10. The logging tools were run inside perforated tubing adjacent to the discharge line; because of the constriction, measured rates are less than pump discharge. Bromide appeared in the discharge water shortly after pumping started.

During T6, the generator supplying power to the pump failed and had to be replaced. During rewiring, two wires were inadvertently switched, so the pump ran backwards. The first tracejector log was run during this period of low discharge; when upward flow in the borehole was discovered, the tracejector test was aborted; at this time, water levels in UE-29a#1 were rising rather than declining. Later, the pump leads were correctly wired, causing an increase in the discharge rate; a new tracejector log then was obtained.

Throughout the second series of tests, maximum discharge rates always were less than during the first series, even though power consumption was the same. When the pump was removed, pieces of the perforating charges and wiring were found in the pump intake and pump. These pieces probably were caught in the perforations and subsequently were sucked into the pump intake, clogging it; therefore, the efficiency of the pump was decreased. In future tests where extensive perforating is performed, it may be advisable to clean the hole with a casing scraper before installing the pump.

Samples for determination of water chemistry were collected at the ends of T3 and T6. Data for these analyses are presented in table 4.

After the pump and bridge plug were removed, a wireline sample was used to obtain samples from four different depths. These samples were analyzed for temperature, dissolved-oxygen concentration, pH, and bromide concentration. Results are given in table 6.

Data Collected After Testing Was Completed

Unperforated tubing with an inside diameter of 3.5-cm was worked a few meters into the material at the bottom of UE-29a#2 to provide future access in case the hole caved, and to obtain hydraulic-head information in the fill to compare with heads measured in the open hole (annulus). Results of water-level measurements in UE-29a#1 and the open hole and tubing in UE-29a#2 are presented in table 7.

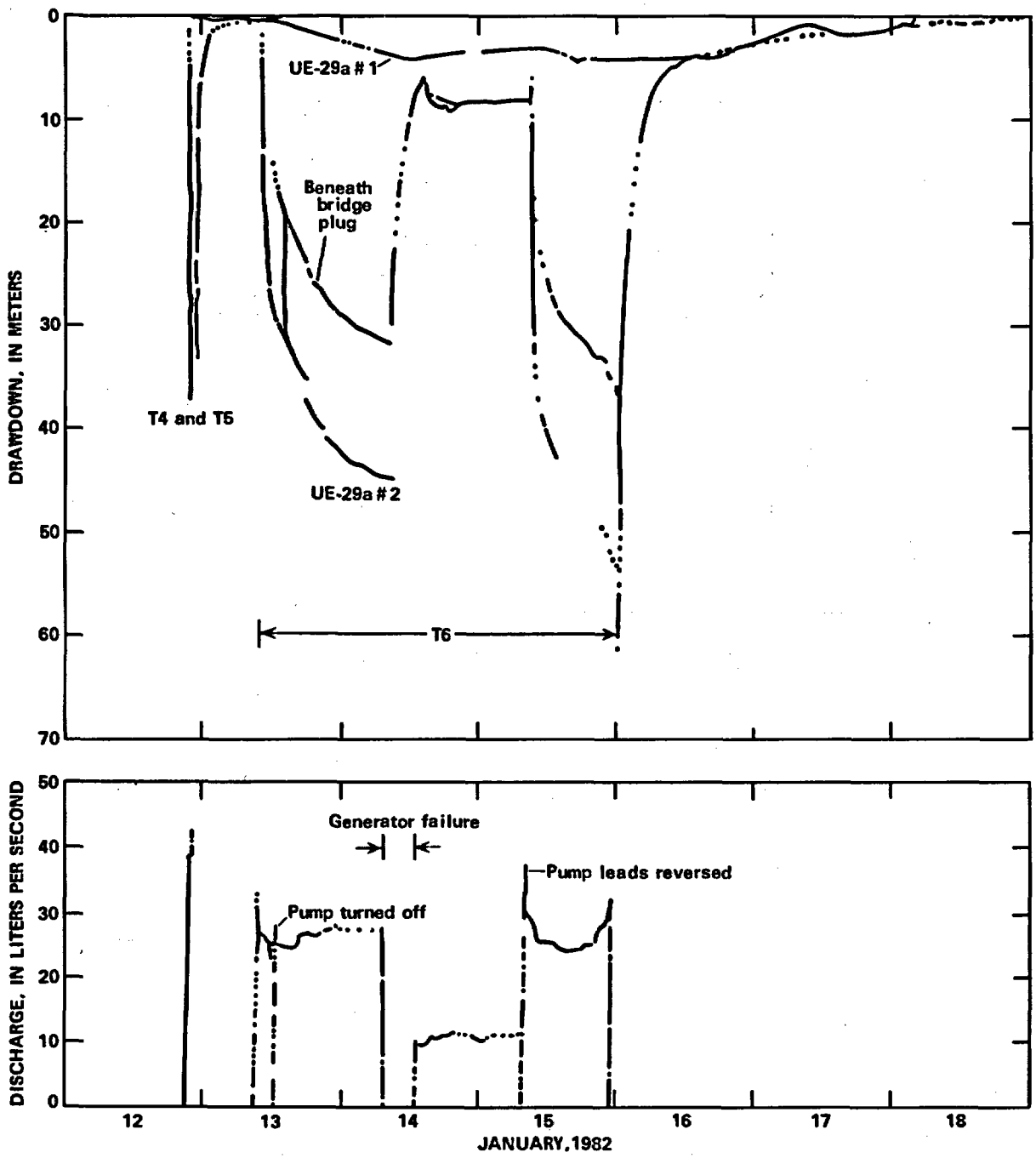

Figure 9.--Drawdown, recovery, and discharge data for second series of pumping tests of test well UE-29a#2. (Pumping was through perforations in the casing.)

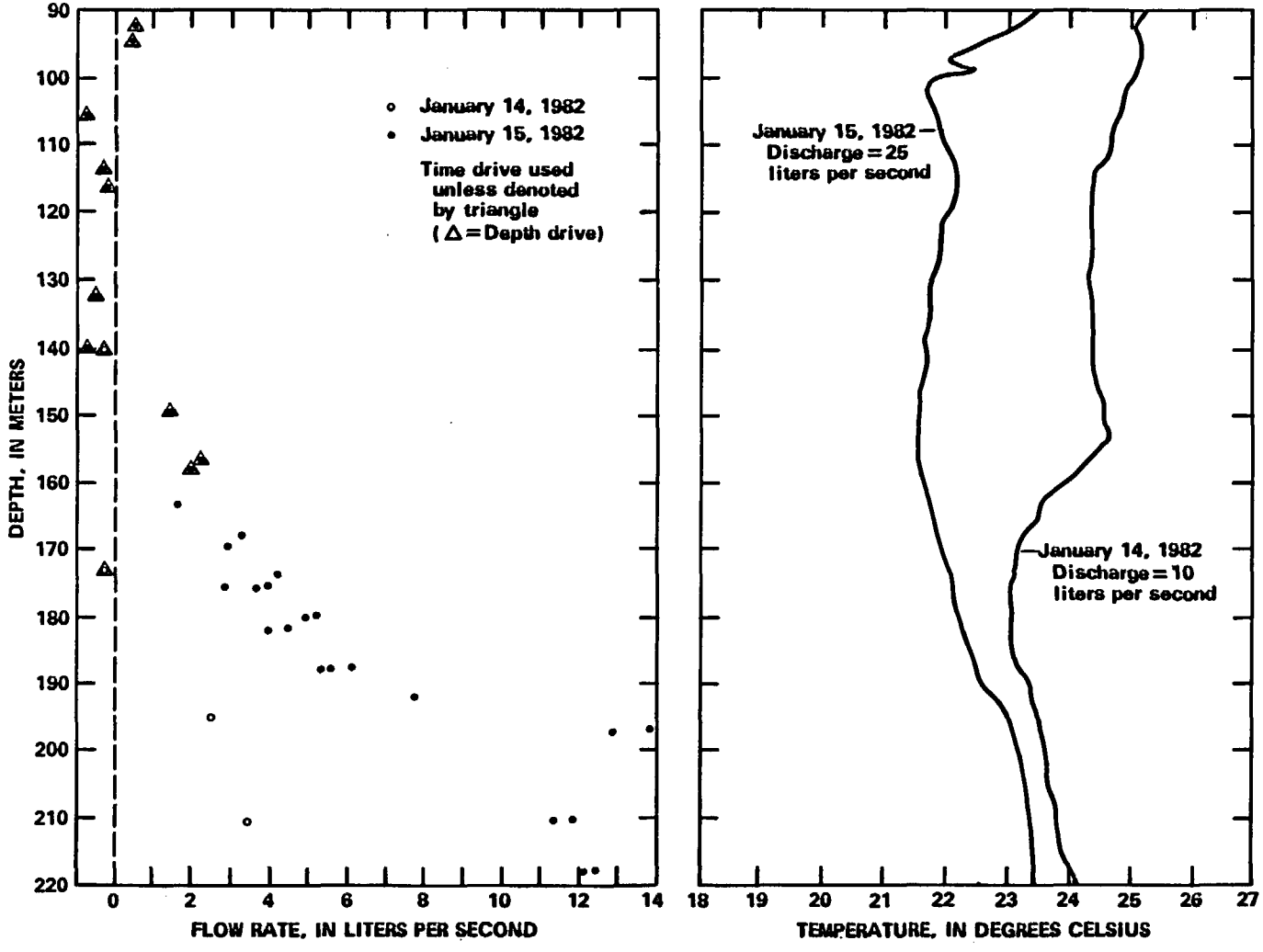

Figure 10.--Results of tracejector and temperature surveys run during the sixth pumping test, test well UE-29a#2.

Table 6.--*Results of analyses of water samples obtained by wireline sampler in test well UE-29a#2*

Depth (meters)	pH (units)	Temperature (degrees Celsius[1])	Dissolved oxygen (milligrams per liter)	Bromide (milligrams per liter)
205.85	7.07	19.0	3.6	0.23
251.65	7.11	19.0	4.8	.24
274.50	7.40	20.0	1.9	.80
304.80	7.57	19.0	2.0	.43

[1]Measured at the surface; therefore, probably cooler than at indicated depths.

Table 7.--*Depth to water, test wells UE-29a#1 and UE-29a#2*

[Datum is land surface 1,215.15 meters above sea level]

	Test well		
	UE-29a#1	UE-29a#2	
	Open hole (meters)	Annulus (meters)	Tubing (meters)
June 21, 1982----------	24.05	28.37	28.31
December 1, 1982----------	24.01	28.65	28.45
October 5, 1983----------	22.85	28.31	27.18
February 19, 1984----------	23.39	27.95	27.59

SUMMARY

Test wells UE-29a#1 and UE-29a#2 were drilled in Fortymile Canyon, Nevada Test Site, for the purpose of obtaining geologic and hydrologic data in an area devoid of other test wells. Drilling difficulties caused the abandonment of UE-29a#1; drilling problems and a rig accident caused cessation of drilling of UE-29a#2 before the desired total depth was reached. However, the saturated zone was penetrated at a much shallower depth than expected, and many of the desired hydrologic data were obtained.

Six pumping tests (two long-term and four short-term) were performed, and water samples were collected during two series of tests in UE-29a#2. Two short-term, slow pumping-rate tests were performed in UE-29a#1; a water sample was collected in a subsequent period of pumping for which no drawdown data were collected.

The pumping test in UE-29a#1 tested hydraulic properties of part of the Fortymile Rhyolite(?) which is hydrothermally altered. The two series of tests in UE-29a#2 tested properties of some of the rhyolite lavas of Calico Hills.

The dominant ions in the water are sodium and bicarbonate; calcium and sulfate are the next most dominant ions. The carbon-14 contents range from 60.0 to 75.3 percent of modern, decreasing with depth.

SUPPLEMENTAL DATA

Hole History for Test Well UE-29a#1

[Abridged from Fenix & Scisson, Inc., hole history]

Surface coordinates[1]: N. 243,147.8 meters, E. 178,483.1 meters. Surface elevation: 1,215.15 meters. Drill rig: Ideco 525. Drill hole and casing sizes:

Hole		Casing	
Depth (meters)	Diameter (centimeters)	Depth (meters)	Inside diameter (centimeters)
0-11.6	91.4	0-10.7	76.2 (cemented to surface)
11.6-65.5	66.0		

Circulating medium: Air foam and lithium chloride (about 20 milligrams per liter of lithium).

Drilling record: Spudded--9-25-81;
Reached total depth (65.5 meters)--9-29-81;
Lost tools--9-30-81;
Abandoned--10-6-81.

Remarks: One 19.7-centimeter drill collar, 2 cross-over subs, one 66.0-centimeter flange-type bit (total length 11.2 meters), and 0.8 meter of fishing equipment left in hole below 33.5 meters.

Well-site geologists: D. O. Blout, L. P. Escobar, R. G. Lahoud, and S. J. Waddell (all employees of Fenix & Scisson, Inc.).

[1]Nevada Coordinate System, relative to Mount Diablo.

Hole History for Test Well UE-29a#2.

[Abridged from Fenix & Scisson, Inc., hole history]

Surface coordinates: N. 243,152.4 meters, E. 178,475.5 meters. Surface elevation: 1,215.15 meters. Drill rig: Ideco 525. Drill hole and casing sizes:

Hole		Casing	
Depth (meters)	Diameter (centimeters)	Depth (meters)	Outside diameter (centimeters)
0-12.2	91.4	0-11.9	76.2 (cemented to surface)
12.2-48.8	66.0	0-48.8	50.8 (cemented to surface)
48.8-89.9	47.0	0-86.6	40.6 (cemented to surface)
89.9-248.1	37.5	0-247.3	27.3
248.1-355.1	38.1		
355.1-421.5	25.1		

Circulating media: Polymer from 0 to 89.9 meters; air foam from 89.9 to 421.5 meters; all fluids contained lithium chloride (about 20 milligrams per liter of lithium).

Drilling record: Spudded--10-07-81;
Drilled to 248 meters--10-24-81; hole caving; drill string became stuck below 183 meters;
Drill string freed--10-29-81;
Casing set at 247.3 meters--11-09-81;
Drilled to 421.5 meters--11-13-81; hole caving;
Underreamed from 248.1 to 355.1 meters--11-15-81 to 11-21-81;
Attempted to free 27.3-centimeter-diameter casing--11-21-81; rig damaged;
Hole completed--12-03-81.

Remarks: 27.3-centimeter-diameter casing parted at 56.4 meters.

Well-site geologists: D. O. Blout, J. M. Brandt, B. W. Cork, G. A. DePaolis, H. E. Huckins, C. R. Kneiblher, and S. J. Waddell (all employees of Fenix & Scisson, Inc.).

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