HYDROGEOLOGIC DATA FROM A TEST WELL NEAR PONTE VEDRA, NORTHEAST ST. JOHNS COUNTY, FLORIDA

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ABSTRACT

A 2,035-foot test well was drilled in northeast St. Johns County, Florida, to obtain hydrogeologic and water chemistry data. Drill cuttings and water samples were collected, and water-level measurements and lithologic and geophysical logs were made. The deposits to a depth of 313 feet consist of sand, clayey sand, phosphatic sandy clay, coquina, sandy limestone, and dolomite. Below 313 feet, the deposits consist of limestone, dolomitic limestone, and dolomite, which comprise the Floridan aquifer system in the area.

Water levels measured through the drill stem as drilling progressed from 373 to 1,980 feet ranged from 24 feet above land surface at a depth of 548 feet to 33.0 feet above land surface at a depth of 1,790 feet. After the lower saline water-bearing zone was penetrated at a depth of 1,983 feet, water level decreased to 4.9 feet below land surface. Water levels measured in the annular space ranged from 23.7 feet above land surface at a depth of 548 feet to 33.1 feet at a depth of 1,790 feet. Flow of the test well ranged from about 72 gallons per minute at a depth of 338 feet to 2,340 gallons per minute at a depth of 1,703 feet.

Chloride concentrations of drill stem samples from a depth of 343 to 1,023 feet ranged from 12 to 31 milligrams per liter. Below the 1,023-foot depth, chlorides increased to as much as 270 milligrams per liter at 1,025 feet, varied between 12 and about 38 milligrams per liter from 1,093 feet to 1,973 feet, and reached a maximum of 16,210 milligrams per liter at 2,023 feet. Water temperatures of drill stem samples ranged from 23 to 27 degrees Celsius.

INTRODUCTION

Purpose and Scope

Little information is available on the hydrogeology of the saline-water zones of the Floridan aquifer system below a depth of 1,500 feet and the interconnection of these zones with the overlying freshwater zones in the northeast Florida area. Information on water levels, the location of the freshwater-saltwater interface, and on water chemistry is necessary to determine the relation between withdrawals of water from the freshwater zones and saltwater intrusion. The information will aid in assessing the availability of potable water from the Floridan aquifer system.

The U.S. Geological Survey, in cooperation with the St. Johns River Water Management District and St. Johns County, is investigating the hydrogeology and water chemistry of the deep zones of the Floridan aquifer system. An essential part of this investigation is the drilling, testing, and instrumentation of a network of five to seven deep test wells. This report contains geologic and hydrologic data collected during construction of a test well drilled near Ponte Vedra, northeast St. Johns County. The well will be used to monitor ground-water levels and water chemistry. The information from the test well will help determine the depth and change of position of the freshwater-saltwater interface. The Ponte Vedra Test Well is the third well drilled under this program.

Acknowledgments

The authors wish to express their appreciation to the Governing Board and staff of the St. Johns River Water Management District and to the Board of County Commissioners and staff of St. Johns County for their support of this investigation. Particular acknowledgment is given to Douglas Munch, Director, Resource Evaluation Division, St. Johns River Water Management District, and to J. L. Harrington, County Administrator, and Gene Burns, Department of Public Works, St. Johns County.

WELL CONSTRUCTION

The location of the test well is shown in figure 1. Construction of the well took place from August to October 1985. As shown in figure 2, the well was drilled to a depth of 2,035 feet below land surface. It was drilled to a depth of 345 feet by the standard mud-rotary method, then a 12-inch diameter steel casing was installed from land surface to a depth of 335 feet and grouted from the bottom of the hole to the surface. The remainder of the hole, 345 to 2,035 feet, was drilled by the reverse-air rotary method. A 6-inch diameter steel casing was installed from land surface to a depth of 1,980 feet and grouted from that depth to land surface. The interval from 1,980 to 2,035 feet was left open to the formation.

GEOLOGIC DATA

Drill cuttings were collected at intervals of about 5 to 10 feet and at changes in lithology (table 1). The deposits to a depth of 313 feet consist of sand, clayey sand, phosphatic sandy clay, coquina, sandy limestone, and dolomite (fig. 3). These materials range in age from Miocene (Hawthorn Formation) to Holocene. The deposits below 313 feet consist of fragmented and granular limestone, dolomitic limestone, and massive to finely crystalline dolomite of Paleocene to Eocene age. The formations, which comprise the Floridan aquifer system in northeast Florida according to Miller (1986), in ascending order, are the Cedar Keys Formation of Paleocene age and the Oldsmar Formation, Avon Park Formation, and Ocala Limestone of Eocene age.

Geophysical logs were made during construction of the well. Logs included in this report are electric (long and short normal resistivity, spontaneous potential and focused resistivity), caliper and natural gamma, neutron porosity, gamma-gamma density, fluid resistivity, temperature, and acoustic velocity (figs. 4-11).

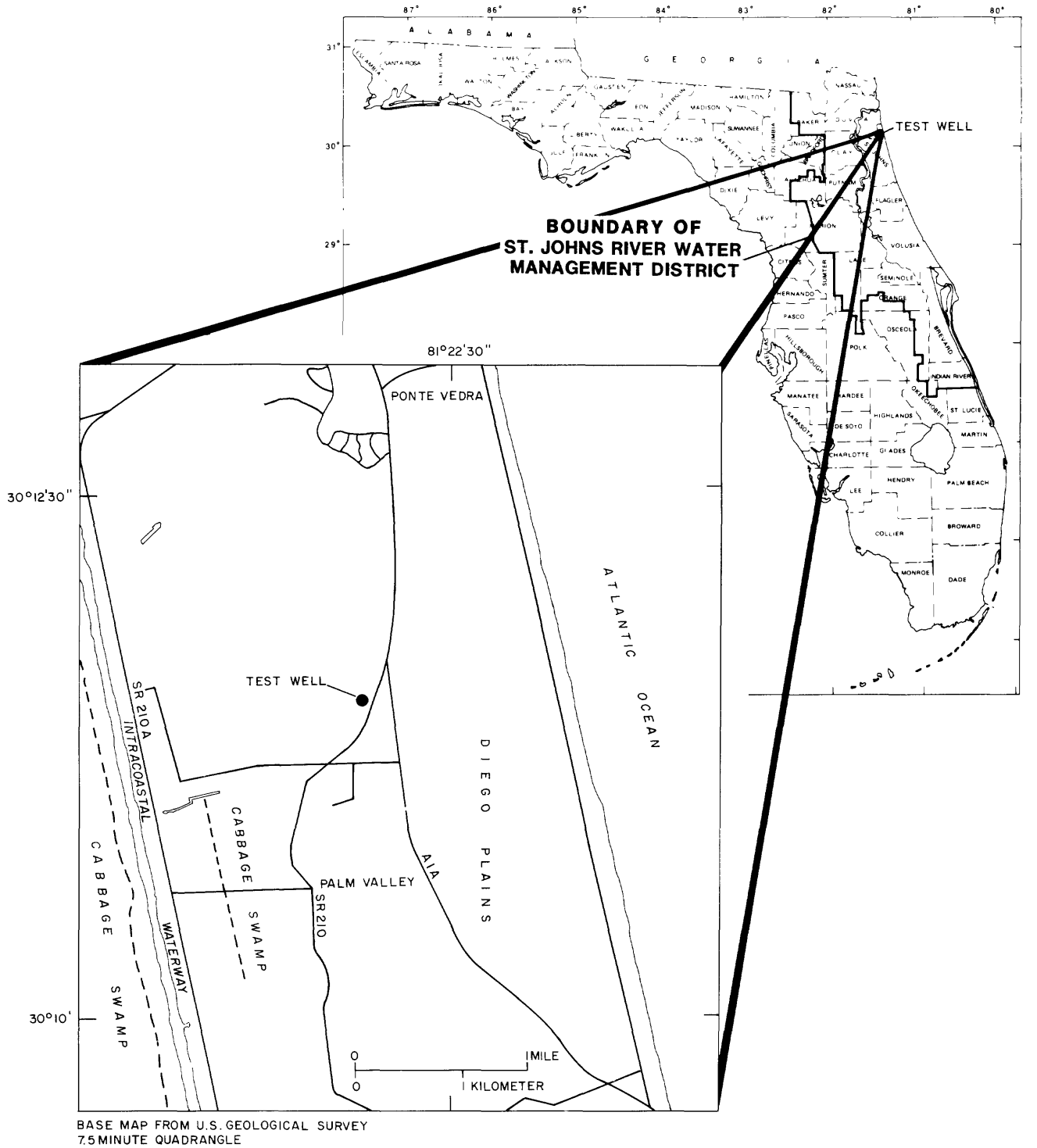

Figure 1.--Location of test well.

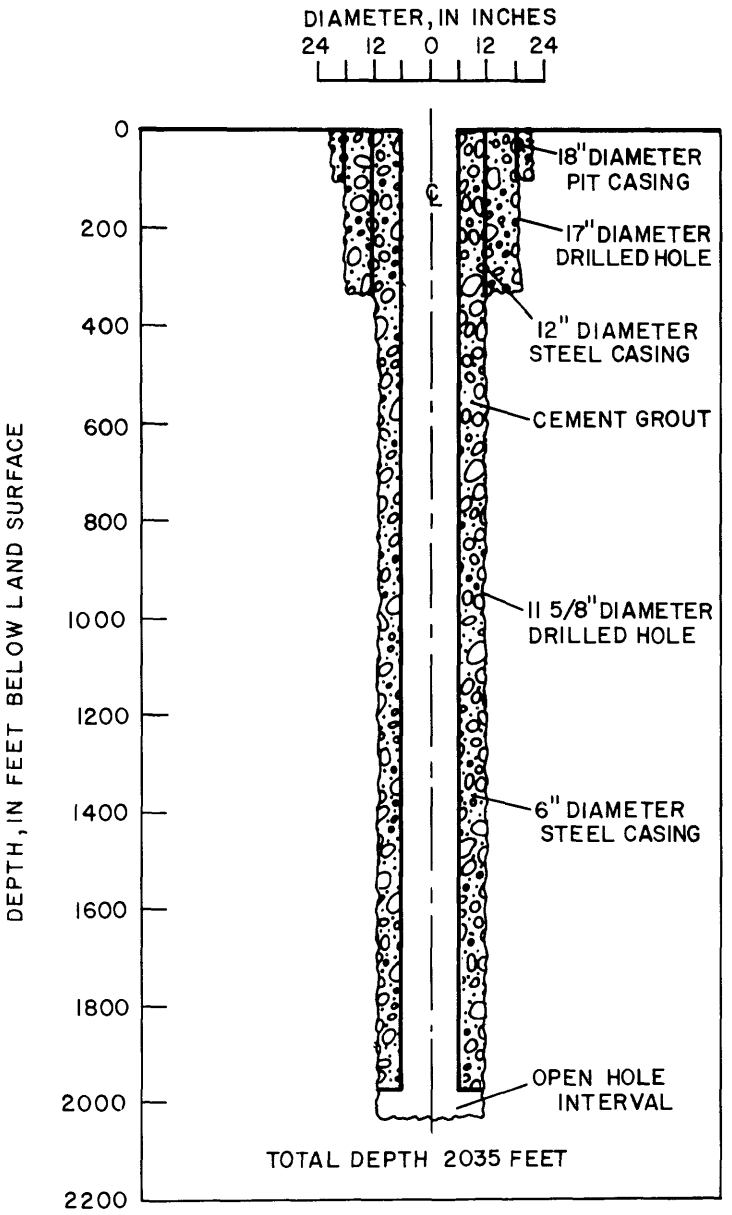

Figure 2.--Schematic diagram of well construction.

Table 1.--Lithologic log of test well

[Depth to base, in feet below measuring point, which is 7.0 feet above land surface]

Description	Thickness (feet)	Depth to base (feet)
Sand and clay, medium gray with greenish cast; 80 percent fine-grained well-sorted quartz sand, iron-stained in part; 20 percent medium greenish-gray clay binder. Woody material prominent. Trace of fine gravel, rose quartz.	10	17
Shell hash, gray-white mottled. Samples consist of medium to large broken pelecypod and gastropod fragments. Aggregates of fine-grained sand in a dark-gray clay matrix prominent. Clay increases to 20 percent in 40 to 50-foot interval.	40	57
Shell, silt, and sand, gray-white mottled; 40 percent broken shell fragments as above; 35 percent light-gray calcareous silt matrix; 25 percent fine- to very coarse-grained subrounded to well-rounded quartz sand. Fine quartz gravel prominent. Trace of black coarse-grained phosphate.	10	67
As above with increase in gravel to 20 percent, corresponding decrease in silt.	20	87
Sand, quartz, light-gray, medium- to very coarse-grained, subrounded to rounded, 10 percent light-gray calcareous silt binder. Trace of coarse-grained black phosphate. Sand coarse- to very coarse-grained in 100 to 110-foot interval.	23	110
Sand and silt, dark greenish-gray; as 80 to 100-foot interval with increase in calcareous silt to 20 percent, corresponding decrease in sand. Lenses of olive-green clay prominent in 130 to 140-foot interval.	30	140
Sand and silt, dark greenish gray; 60 percent medium- to very coarse-grained rounded to subrounded quartz sand; 40 percent dark greenish-gray calcareous silt matrix. Trace of coarse-grained black phosphate.	10	150
Sand, quartz, light gray with greenish cast, coarse to very coarse-grained, rounded to subrounded. Light greenish-gray silt binder prominent. Trace of dark-brown to black phosphate; shell fragments. Dark-green clay lenses prominent in 160 to 170-foot interval.	50	200
Sand and clay, light olive-green; 75 percent coarse-grained well-sorted rounded to subrounded quartz sand; 25 percent dark olive-green clay binder. Dark-brown to black coarse-grained phosphate prominent. Trace of shell fragments.	50	250

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Sand and clay, phosphatic, dark olive-green with brown cast; 40 percent fine- to medium-grained angular to subrounded quartz sand; 30 percent fine- to medium-grained light to dark-brown phosphate; 30 percent dark olive-green silty clay matrix. Gamma-ray log shows high phosphate concentration occurs at 240 to 255 feet. Both quartz sand and phosphate are coarse to very coarse-grained in the 260 to 270-foot interval, where a low gamma-ray count probably indicates a sand bed.	40	290
Limestone, sandy, phosphatic, light olive-green; 65 percent light greenish-gray well indurated dolomitic limestone matrix; 20 percent fine- to medium-grained dark-brown to black phosphate; 15 percent fine- to medium-grained subrounded to rounded quartz sand. Phosphate and sand are disseminated in the limestone.	10	300
Mixed sample; 80 percent limestone as above; 20 percent coarse-grained phosphatic sand, consisting of rounded quartz sand and black phosphate up to pea-gravel size.	5	305
Silt, phosphatic, light olive-green; 60 percent loosely consolidated dolomitic silt matrix; 25 percent medium- to very coarse-grained light- to dark-brown phosphate; 15 percent medium- to very coarse-grained rounded to subrounded quartz sand.	5	310
Dolomite, light olive-green, very fine crystalline, well indurated. Trace of fine-grained light- to dark-brown phosphate, fine-grained rounded quartz sand. Phosphate very prominent in 315 to 320-foot interval.	10	320
Limestone, white, fossiliferous, pelletal, porous, semi-indurated to well indurated; 40 percent white micrite matrix; 30 percent limestone pellets of medium to coarse sand size; 30 percent bryozoan fragments and large foraminifera (Lepidocyclina sp.). Trace of pelecypod fragments. Partially dolomitized in 340 to 345-foot interval.	25	345
Limestone, white, fossiliferous, very highly porous, well indurated. Estimated porosity, 30 percent. Mostly Lepidocyclina and Heterostegina sp., bryozoan fragments, and minor coarse pellets of limestone; 25 percent white hard micrite binder. Composed mostly of pellets in 350 to 355-foot interval. Recrystallized in 355 to 360-foot and 370 to 375-foot intervals. Very hard in 370 to 375-foot interval.	35	380

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, white, very fossiliferous, very porous; 85 percent bryozoan fragments and large foraminifera; 15 percent fine crystalline limestone loosely binding fossil remains. Estimated porosity 40 percent. Gyroidina crystalriverensis in 395 to 400-foot interval. Trace of very light gray coarse crystalline calcite in 385 to 390-foot and 405 to 410-foot intervals.	30	410
Limestone, white, pelletal, fossiliferous; 65 percent small to medium pellets of micrite; 35 percent white hard micritic limestone matrix. Bryozoan fragments and large foraminifera abundant. Trace of light-gray very coarse crystalline calcite. Estimated porosity, 20 percent.	10	420
Limestone as 380 to 410-foot interval. Most fossil remains are large foraminifera (Lepidocyclina and Heterostegina sp.).	20	440
Limestone as 410 to 420-foot interval. Asterocyclina sp. rare in 455 to 460-foot interval. Sphaerogypsina globula common in 460 to 465-foot interval.	25	465
Limestone as 420 to 440-foot interval.	5	470
Limestone as 410 to 420-foot interval. Contains Asterocyclina georgiana.	10	480
Limestone, white, pelletal; 60 percent fine pellets of micrite; 40 percent soft white micrite matrix. Large foraminifera abundant. Estimated porosity, 10 percent.	5	485
Limestone, white with tan cast, pelletal, cuts as thin plates; 70 percent fine pellets of micrite and miliolid foraminifera, both partly altered to tan dolomite; 30 percent tan dolomitized micrite matrix. Trace of dark green amorphous glauconite, large foraminifera. Estimated porosity, 30 percent.	15	500
Limestone as 410 to 420-foot interval.	5	505
Limestone as 485 to 500-foot interval with large foraminifera prominent. Less dolomitized, more coarsely pelletal in 515 to 530-foot interval. Soft in 530 to 535-foot interval. Very few foraminifera in 550 to 535-foot interval.	50	555
Limestone, off-white, very fine crystalline, hard, dense, massive, low porosity; casts and molds of miliolid and large foraminifera prominent.	5	560

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Dolomite, light tan, fine crystalline, hard, massive, low porosity. Sacchroidal texture in 565 to 570-foot interval.	10	570
Limestone, white, finely pelletal; 50 percent fine pellets of white micrite; 50 percent soft to hard white micrite matrix. Low porosity. Trace of bryozoan fragments, large foraminifera.	10	580
Limestone, tan, medium crystalline, coarsely pelletal, porous. Estimated porosity, 30 percent. Trace of Dictyoconus sp.	5	585
Limestone as 570 to 580-foot interval but hard, dense.	10	595
Limestone, tan, coarsely pelletal, consists of a microcoquina of Dictyoconus sp. and other large foraminifera, loosely bound with tan fine to coarse crystalline limestone cement. Highly porous. Estimated porosity, 35 percent.	5	600
Limestone as above with white micrite filling most spaces between pellets. Estimated porosity, 15 percent.	10	610
Limestone, tan, pelletal, fossiliferous; 40 percent medium to large micrite pellets; 40 percent white micrite matrix, partly recrystallized to tan dolomite; 20 percent large Dictyoconus, Heterostegina, and microechinoids. Low porosity. Fossils sparse in 515 to 520-foot interval.	10	620
Limestone, off-white, coarsely pelletal, highly porous. Estimated porosity, 30 percent. 65 percent Dictyoconus sp., other large foraminifera, and coarse micrite pellets; 35 percent white micrite binder.	15	635
Limestone, light brown, coarsely pelletal, highly porous. Estimated porosity, 35 percent. 50 percent large to small foraminifera and fine to coarse limestone pellets in 50 percent micrite matrix. All of rock is recrystallized to brown fine to coarse crystalline dolomitic limestone. Decrease in porosity to about 20 percent in 645 to 650-foot interval.	15	650
Limestone, foraminiferal, tan, well indurated, low porosity; 75 percent miliolid foraminifera; 25 percent matrix of light-brown fine crystalline dolomitic limestone. Cone-shaped Dictyoconus sp. prominent. Highly vuggy in 660 to 665-foot interval. Black disseminated organic material prominent in 665 to 670-foot interval. Large flat Dictyoconus sp. account for 20 percent of rock in 670 to 690-foot interval.	45	695

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, cream, fine pelletal; 70 percent fine pellets of white micrite and miliolid foraminifera; 30 percent soft cream micrite binder. Soft, with trace of black organic material in 695 to 700-foot interval.	10	705
Limestone, tan, foraminiferal, low porosity; 60 percent miliolid foraminifera and white micrite pellets; 40 percent microcrystalline tan dolomitic limestone matrix. Cone-shaped Dictyoconus sp. very prominent in 715 to 720-foot interval.	15	720
Limestone as 695 to 705-foot interval, well indurated, with micrite binder light-brown to tan.	25	745
Limestone, white, pelletal; 75 percent fine pellets of white micrite and miliolid foraminifera; 25 percent white micrite binder. Trace of cone-shaped Dictyoconus sp. Porosity estimated at 15 percent. Rock becomes medium to coarse pelletal in 755 to 760-foot interval. Trace of apple-green glauconite in 760 to 765-foot interval. Recrystallized in 770 to 780-foot interval.	35	780
Limestone, white, coarsely pelletal, friable, highly porous. Estimated porosity, 30 percent. Consists of loosely cemented coarse pellets of white micrite and large foraminifera. Cement is clear medium crystalline calcite.	10	790
Limestone, medium gray, very fine crystalline to microcrystalline, hard, low porosity. Dark-green glauconite, large foraminifera common, enclosed in hard limestone matrix.	5	795
Limestone, white, hard, low porosity; 50 percent miliolid foraminifera and fine pellets of white micrite; 50 percent white to cream microcrystalline limestone matrix.	5	800
Limestone, pelletal, white, highly porous (estimated porosity 25 percent). Consists of fine white micrite pellets and small foraminifera loosely cemented by cream coarse crystalline calcite.	10	810
Limestone, dark-brown, low porosity; 60 percent fine crystalline dark-brown limestone matrix; 40 percent white miliolid and other small foraminifera scattered in matrix.	10	820
Limestone as 800 to 810-foot interval but well cemented.	30	850

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, white, coarsely pelletal, highly porous. Estimated porosity, 35 percent. Friable, consists of coarse pellets of white micrite and large foraminifera loosely cemented by white micrite binder.	10	860
Limestone as 820 to 850-foot interval with cone-shaped Dictyoconus sp. very prominent.	10	870
Limestone, white, foraminiferal, coarsely pelletal, friable, highly porous. Estimated porosity, 35 percent. Consists mostly of cone-shaped Dictyoconus sp., with minor coarse pellets of white micrite, loosely cemented by white fine crystalline calcite.	5	875
Limestone, dark-brown, medium crystalline, low porosity, with 15 percent white small to large foraminifera scattered throughout. Foraminifera increase to 40 percent in 880 to 885-foot interval.	15	890
Limestone as 860 to 870-foot interval.	5	895
Limestone as 870 to 875-foot interval.	10	905
Limestone as 820 to 850-foot interval with 20 percent white micrite matrix. Coarse micrite pellets and large foraminifera prominent in 915 to 935-foot interval.	30	935
Limestone, white, micritic, hard, with fine micrite pellets and small foraminifera prominent. Trace of small vugs, large foraminifera. Cone-shaped Dictyoconus sp. prominent in 990 to 995-foot interval.	60	995
Limestone, pelletal, white, highly porous. Estimated porosity, 40 percent. Consists of fine pellets of white micrite and small foraminifera loosely cemented by white micrite binder. Porosity decreases to about 15 percent in 1,000 to 1,005-foot interval because of micrite filling pore spaces.	10	1,005
Limestone, tan, pelletal, soft, low porosity; 60 percent fine white micrite pellets and small foraminifera; 40 percent tan fine crystalline calcite binder.	5	1,010
Limestone as 1,000 to 1,005-foot interval. Add trace of white algal balls.	5	1,015
Limestone, dark-brown, fine crystalline, hard, low porosity. White miliolid foraminifera prominent, scattered through brown limestone.	5	1,020
Limestone as 1,005 to 1,010-foot interval with cone-shaped Dictyoconus sp. prominent.	5	1,025

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, very dark brown to dull black, interbedded, low porosity. Black limestone has silty texture, brown is fine crystalline.	5	1,030
Dolomite, medium brown, fine to medium crystalline, hard, massive, low porosity, with isolated vugs common. Minor black mottling in 1,035 to 1,040-foot interval.	10	1,040
Limestone as 1,005 to 1,010-foot interval. Very well indurated.	5	1,045
Limestone as 1,000 to 1,005-foot interval. Much soft micrite filling pores in 1,050 to 1,055-foot and 1,070 to 1,085-foot interval causes decrease in porosity to about 20 percent. Porosity is estimated at 35 to 40 percent over remainder of interval.	35	1,080
Dolomite, calcareous, very dark brown, fine to medium crystalline, hard, massive, low porosity, with a few isolated vugs.	5	1,085
Dolomite, tan, hard, massive, very fine crystalline, low porosity, trace of isolated small vugs.	5	1,090
Dolomite as 1,080 to 1,085-foot interval but light brown.	5	1,095
Dolomite, tan, coarse crystalline, sacchroidal, massive, hard, low porosity, with trace of isolated vugs.	20	1,115
Limestone, white, micritic, low porosity, with trace of large foraminifera.	5	1,120
Limestone as 1,045 to 1,050-foot interval. Soft in 1,125 to 1,130-foot interval.	15	1,135
Limestone, light brown, medium to coarse crystalline, hard, low porosity, dolomitic, with white fine micrite pellets and miliolid foraminifera prominent. Trace of dark-green glauconite. Vuggy in 1,140 to 1,145- and 1,155 to 1,160-foot intervals.	30	1,165
Limestone, white with numerous black specks (algal remains), micritic, hard, low porosity. Largely recrystallized to clear fine crystalline calcite in 1,175 to 1,180-foot interval.	15	1,180
Limestone, light-gray, coarse crystalline (recrystallized), low porosity, with a few scattered vugs.	5	1,185
No Sample	5	1,190
Limestone as 1,180 to 1,185-foot interval.	5	1,195
Limestone as 1,175 to 1,180-foot interval.	5	1,200
Limestone as 1,165 to 1,175-foot interval.	10	1,210

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, white, micritic, low porosity, massive. Trace of fossil casts and molds.	5	1,215
No Sample	5	1,220
Limestone as 1,210 to 1,215-foot interval. Trace of apple-green glauconite in 1,225 to 1,230-foot interval.	10	1,230
Limestone, white, fossiliferous, hard, low porosity; 60 percent casts and molds of fossils, chiefly bryozoa with some pelecypods; 40 percent white micrite matrix. Trace of scattered very fine-grained black glauconite.	10	1,240
Limestone, white, micritic, low porosity; small foraminifera and dark-green glauconite prominent. Pyrite common in 1,250 to 1,255-foot interval. Largely recrystallized to coarse crystalline light gray calcite in 1,275 to 1,280-foot interval.	40	1,280
Dolomite, dark-gray, very fine to fine crystalline, hard, massive, low porosity, with light-green disseminated glauconite prominent. Trace of isolated vugs.	5	1,285
Limestone, dolomitized, white and dark-gray mottled; 55 percent white micritic limestone, low porosity; 45 percent dark-gray coarse crystalline sacchroidal dolomite, replacing micrite as blebs and stringers. Micrite is fossiliferous (mostly small foraminifera) in 1,295 to 1,300-foot interval.	15	1,300
Limestone, light-gray, pelletal; 75 percent coarse pellets of white micrite and broken bryozoan fragments; 25 percent matrix of white micrite with abundant dark-green glauconite. Trace of vuggy porosity. Dark-gray recrystallized glauconitic limestone prominent in 1,310 to 1,315- and 1,330 to 1,335-foot intervals. Very well indurated, very low porosity, little glauconite in 1,320 to 1,330-foot interval.	40	1,340
Limestone, medium gray, pelletal, low porosity; 55 percent fine to medium pellets of white micrite and bryozoan fragments; 45 percent dark-gray recrystallized limestone matrix. Very fine-grained dark-green glauconite prominent in matrix. Stringers of dark-gray recrystallized limestone prominent in 1,345 to 1,350-foot interval.	10	1,350

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, medium-gray, micritic, hard, low porosity, with light- to dark-green glauconite, bryozoan fragments prominent. Trace of pyrite. Pelletal (coarse pellets of white micrite) in 1,355 to 1,360-foot interval. Dark-gray coarse recrystallized limestone prominent in 1,360 to 1,365-foot interval, increases to 40 percent of rock in 1,370 to 1,375-foot interval.	30	1,380
Limestone, light-gray, pelletal, porous. Estimated porosity, 20 percent. 65 percent fine white micrite pellets, bryozoan fragments, and small foraminifera; 35 percent white to light-gray micrite binder. Trace of very fine-grained dark-green glauconite. Large foraminifera very prominent in 1,385 to 1,395-foot interval. Highly glauconitic in 1,400 to 1,405-foot interval.	25	1,405
Limestone, medium-gray, pelletal, highly porous. Estimated porosity, 30 percent. 60 percent fine white micrite pellets and fine bryozoan fragments; 40 percent medium gray recrystallized limestone matrix. Fine-grained glauconite prominent.	15	1,420
Limestone, dolomitic, tan, medium to coarse crystalline, low porosity, with white bryozoan fragments prominent, dark-green glauconite common. Small foraminifera and isolated vuggy porosity common in 1,430 to 1,435-foot interval.	15	1,435
Dolomite, tan with minor black spots, fine crystalline, hard, massive, low porosity.	5	1,440
Dolomite, cream, medium crystalline, sacchroidal, massive, low porosity, with trace of pinpoint vugs. Becomes light-brown with vuggy zones in 1,450 to 1,465-foot interval. Coarse crystalline with estimated 25 percent porosity in 1,465 to 1,470-foot interval.	35	1,475
Limestone, light-gray, pelletal, low porosity; 70 percent fine white micrite pellets, bryozoan fragments and small foraminifera; 30 percent white micrite matrix, partly recrystallized to medium crystalline light-gray calcite.	5	1,480
Limestone, medium-gray, pelletal, low porosity; 55 percent fine white micrite pellets and small bryozoan fragments; 45 percent fine crystalline (recrystallized) light-gray to light-brown limestone matrix, with dark-gray spots prominent.	5	1,485

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Dolomite, light gray with brown tint, medium to coarse crystalline, low porosity, with minor vugs and black spots prominent. Zones of very coarse crystalline porous dolomite prominent in 1,490 to 1,495-foot interval.	10	1,495
Limestone as 1,480 to 1,485-foot interval.	10	1,505
Limestone, white, micritic, low porosity; about 20 percent recrystallized to fine crystalline clear calcite "floating" in micrite. Fine white micrite pellets prominent. Trace of very fine-grained dark-green glauconite. Decrease in recrystallized calcite to trace, increase in glauconite to prominent in 1,535 to 1,540-foot interval.	45	1,550
Limestone, white, pelletal, low porosity; 70 percent fine white micrite pellets, bryozoan fragments, and small foraminifera; 30 percent white micrite matrix. Fine-grained light- to dark-green glauconite common. Trace of pelecypods.	25	1,575
Dolomite, medium-gray, fine crystalline, hard, massive, low porosity, with small black spots common.	5	1,580
Dolomite, light-gray, fine crystalline, hard, massive, low porosity, sacchroidal.	5	1,585
Limestone, white, micritic, soft, low porosity, with trace of pyrite and fine- to medium-grained dark-green glauconite.	15	1,600
Dolomite, light-brown, medium crystalline, sacchroidal, low porosity, with fine-grained glauconite, black algal (?) flakes prominent.	5	1,605
Limestone as 1,585 to 1,600-foot interval. Partly recrystallized to cream very fine crystalline soft dolomite in 1,610 to 1,615-foot interval.	10	1,615
Dolomite, cream, calcareous, very fine crystalline, hard, massive, low porosity. Trace of black algal (?) flakes. A few white large discoid foraminifera in 1,620 to 1,625-foot interval.	10	1,625
Limestone as 1,585 to 1,600-foot interval. Tan recrystallized limestone prominent in 1,630 to 1,640-foot interval.	15	1,640
Limestone, white, micritic, hard, low porosity, with dark-gray chert accounting for 40 percent of sample. Chert is replacing limestone.	15	1,655

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, white, micritic, soft, low porosity, with very fine-grained light-green glauconite prominent. Hard, with light-gray chert prominent in 1,665 to 1,670-foot interval. Increase in glauconite to 15 percent in 1,675 to 1,685-foot interval.	30	1,685
Limestone, medium-gray with greenish tint, micritic, soft, low porosity; 65 percent white, soft to cream, indurated micritic limestone matrix; 35 percent very fine to fine-grained dark-green glauconite.	5	1,690
Limestone, white, micritic, hard, massive, low porosity; very fine-grained light- to dark-green glauconite prominent. Trace of coarse pyrite aggregates, pelecypod casts and molds.	20	1,710
Limestone, light-gray, pelletal, hard, low porosity; 80 percent fine white micrite pellets and rare bryozoan fragments; 20 percent white micrite matrix, partly recrystallized to medium crystalline clear calcite. Very fine-grained light-green glauconite prominent. Echinoid fragments, small foraminifera common in 1,720 to 1,725-foot interval.	20	1,730
Limestone, light-gray with tan cast, hard, micritic, low porosity, with tan recrystallized calcite, small foraminifera and very fine-grained dark-green glauconite prominent. Trace of white gypsum in 1,745 to 1,755-foot interval. Trace of oyster fragments, large aggregates of apple-green glauconite in 1,755 to 1,760-foot interval.	35	1,765
Limestone, white, pelletal, hard, micritic, low porosity; 75 percent fine white micrite pellets and small foraminifera; 25 percent light-gray hard micrite matrix. Trace of very fine-grained dark-green glauconite. Soft with no glauconite in 1,770 to 1,780- and 1,800 to 1,805-foot intervals. Porous (estimated porosity, 20 percent) in 1,785 to 1,795-foot interval.	45	1,810
Limestone, cream, micritic, hard, low porosity, with fine- to coarse-grained apple-green glauconite prominent. Trace of dark-gray highly glauconitic limestone lenses with much disseminated pyrite.	10	1,820
Limestone, tan, fine pelletal, hard, low porosity; 80 percent miliolid foraminifera and fine white micrite pellets; 20 percent tan microcrystalline micrite matrix.	10	1,830

Table 1.--Lithologic log of test well--Continued

Description	Thickness (feet)	Depth to base (feet)
Limestone, white with tan cast, hard, micritic, massive, low porosity, very fine crystalline, with silty appearance due to recrystallization of micrite.	40	1,870
Dolomite, tan, medium crystalline, calcareous, hard, low porosity, massive. Very fine crystalline in 1,880 to 1,885-foot interval.	20	1,890
Limestone as 1,820 to 1,830-foot interval. Micrite matrix white in 1,890 to 1,895-foot interval. Dark brown algal mats prominent in 1,905 to 1,910-foot interval.	25	1,915
Limestone, white, soft, pelletal, low porosity, consists of 75 percent very fine micrite pellets and small foraminifera loosely bound by 25 percent soft white micrite matrix.	10	1,925
Limestone, cream, micritic, massive, hard, low porosity. Dark-brown algal mats, medium-brown fine crystalline dolomite stringers prominent in 1,925 to 1,930-foot interval. Black clay (cavity filling) prominent in 1,930 to 1,935- and 1,945 to 1,950-foot intervals. Miliolid foraminifera abundant in 1,945 to 1,950-foot interval.	30	1,955
Limestone, light gray with tan cast, micritic, hard, low porosity; 50 percent white micritic limestone; 50 percent very fine to fine crystalline tan limestone, representing recrystallized micrite. Dark-brown algal flakes abundant. Trace of black woody material in 1,970 to 1,975-foot interval.	20	1,975
Limestone, light gray, micritic, hard, dense, massive, low porosity. Trace of pinpoint vugs, black fine organic material.	15	1,990
Dolomite, very dark gray with minor dark brown mottling, hard, massive, fine crystalline, low porosity. Becomes medium crystalline in 2,010 to 2,020-foot interval. 2,010 to 2,015-foot interval is about 30 percent light gray chert. Dolomite is light olive color in 2,020 to 2,025-foot interval.	40	2,030
Dolomite, light-gray, microcrystalline, hard, massive, dense, low porosity.	10	2,040 (T.D.)

Total depth of well is 2,042 feet below measuring point, or 2,035 feet below land surface. Land surface is estimated to be 7 feet above sea level.

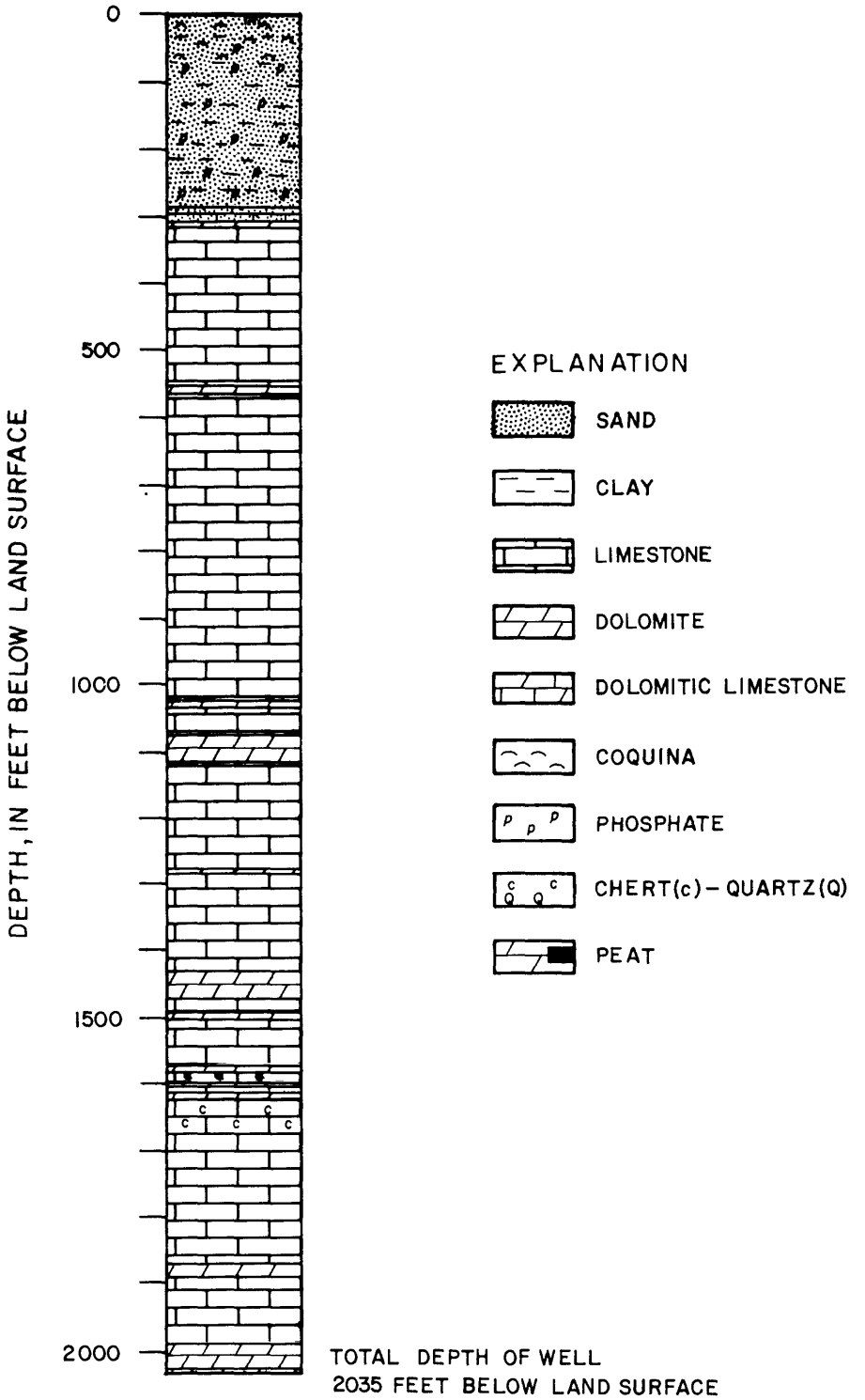

Figure 3.--Lithology at test well site.

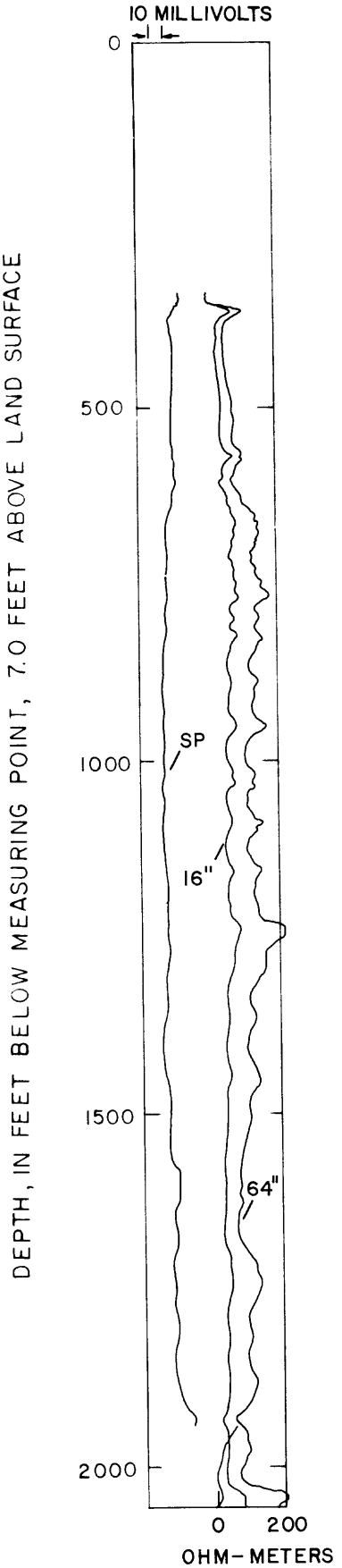

Figure 4.--Electric log; long and short normal resistivity, and spontaneous potential.

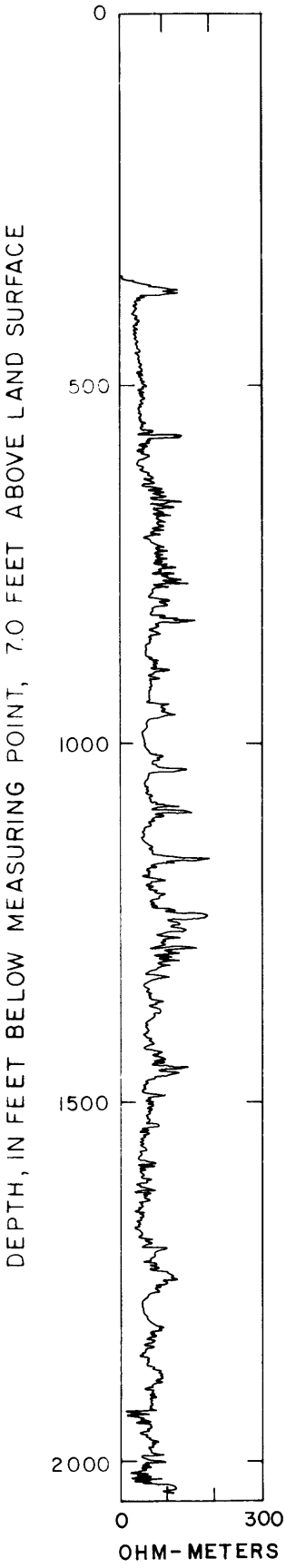

Figure 5.--Electric log (focused resistivity).

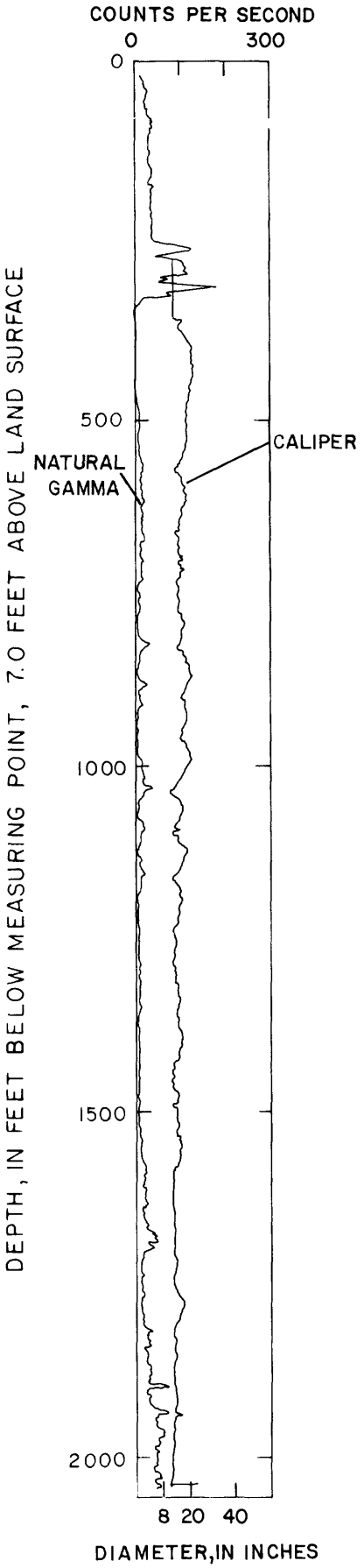

Figure 6.--Caliper and natural gamma log.

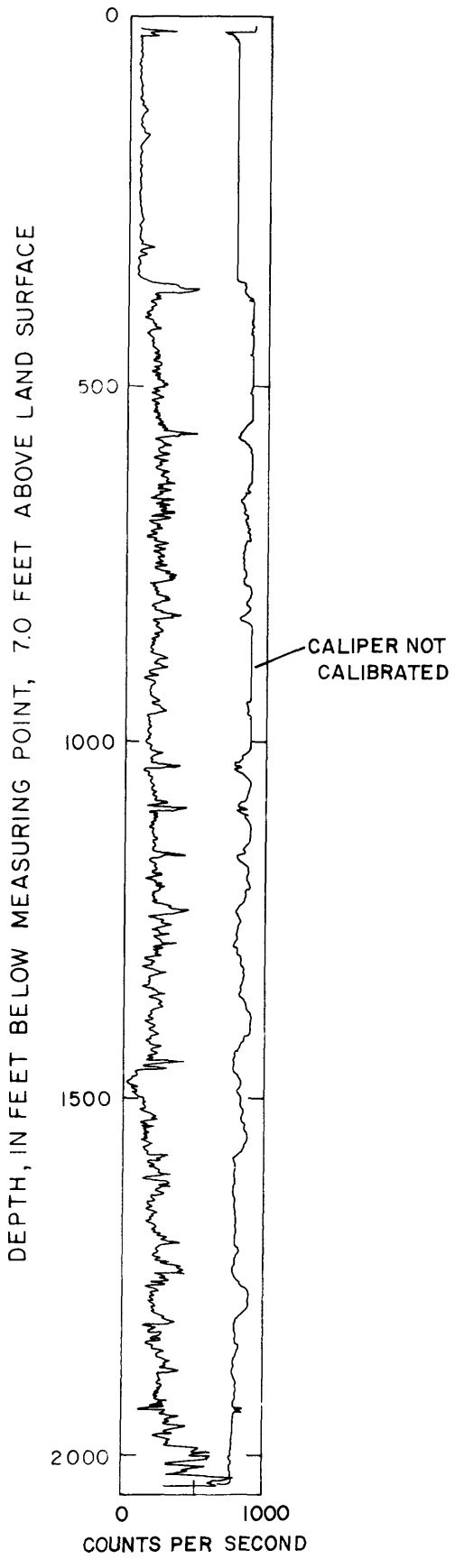

Figure 7.--Neutron porosity log.

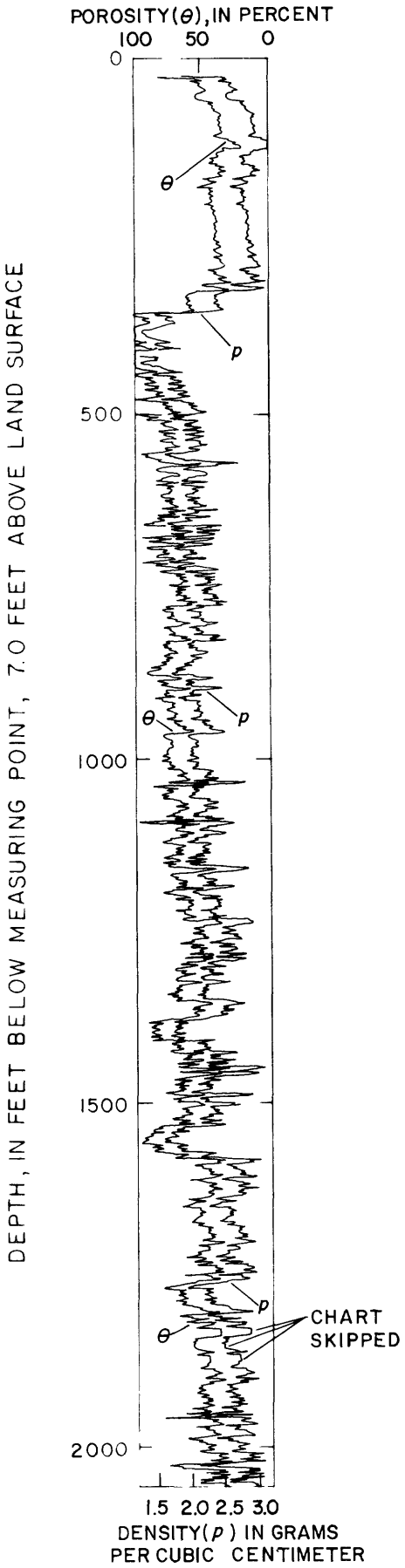

Figure 8.--Gamma-gamma density log.

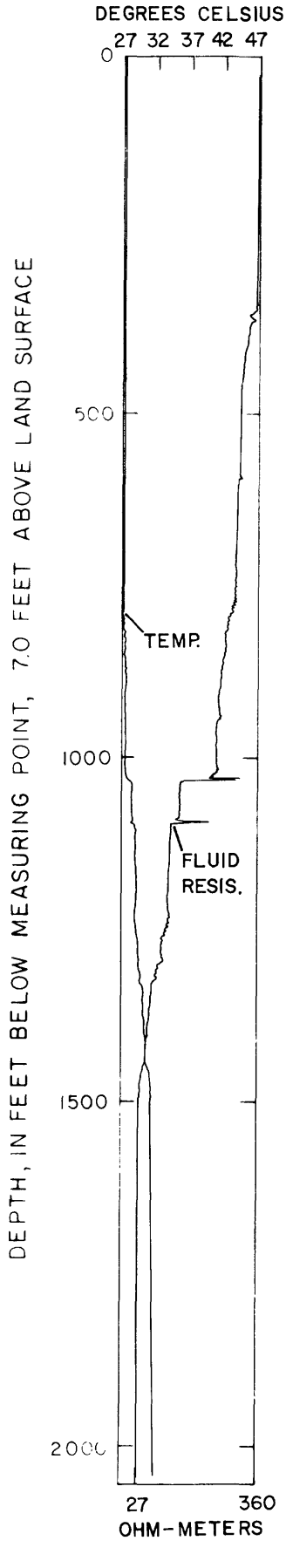

Figure 9.--Fluid resistivity log.

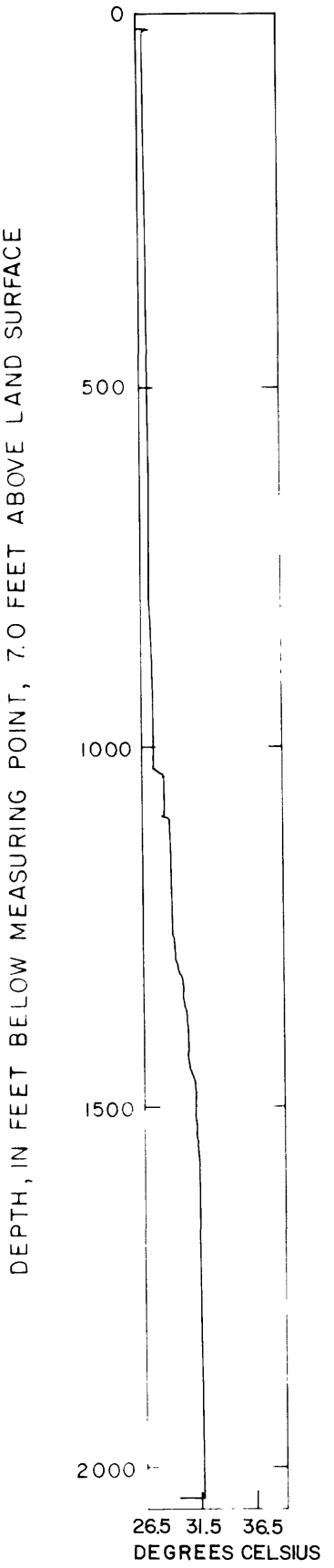

Figure 10.--Temperature log.

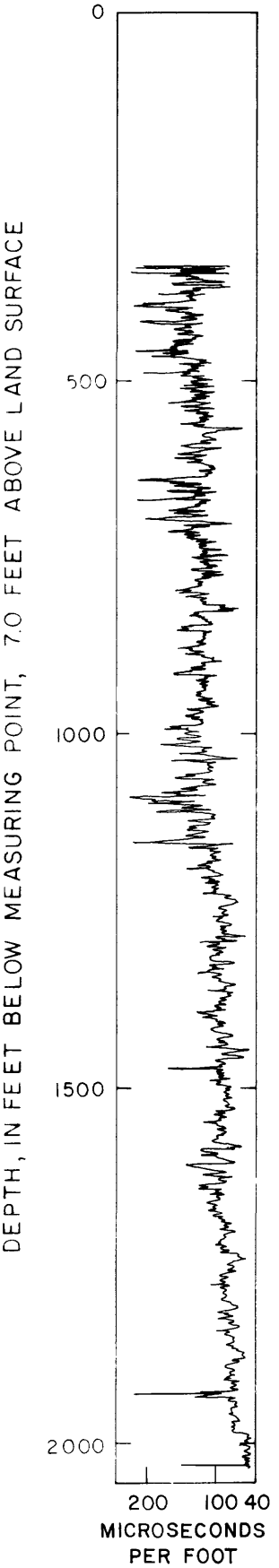

Figure 11.--Acoustic velocity log.

HYDROLOGIC DATA

Water Levels

Water levels were measured in the drill stem positioned near or at the bottom of the drill hole and in the annular space between the drilled hole and the drill stem as drilling progressed from 373 to 2,035 feet below land surface (fig. 12). The altitude of land surface at the test site was about 5 to 7 feet above sea level. Water levels measured through the drill stem represent artesian pressures at or near the bottom of the borehole. Annulus water levels represent a composite artesian pressure of the open-hole interval below the surface casing.

Water levels measured through the drill stem as drilling progressed from 373 to 1,980 feet ranged from 24 feet above land surface at a depth of 548 feet to 33.0 feet above land surface at a depth of 1,790 feet. After the lower saline water-bearing zone was penetrated at a depth of 1,983 feet, water level decreased to 4.9 feet below land surface. Water levels measured in the annular space ranged from 23.7 feet above land surface at a depth of 548 feet to 33.1 feet at a depth of 1,790 feet. After the well was completed, water level in the monitored interval (1,980 to 2,035 feet below land surface) was about 5 feet above sea level. Water-level data were not adjusted for density differences between freshwater and mineralized water in the drill stem during drilling and in the completed well.

Artesian Flow

The artesian flow of the test well with and without the drill stem in the hole was measured periodically during drilling (fig. 13). The flow (drill stem in the hole) increased from about 72 gal/min at a depth of 338 feet to 2,340 gal/min at a depth of 1,703 feet. The maximum flow measured (without the drill stem in the hole) was about 3,330 gal/min at a depth of 2,035 feet.

During drilling, down-hole traverses were made with a flow meter in the open-hole intervals of 335 to 818 feet, 335 to 1,381 feet, and 335 to 2,035 feet (figs. 14-16). Traverses were made with the well naturally flowing at 1,500 gal/min, 2,800 gal/min, and 3,500 gal/min, respectively, and with the well shut-in at the 335- to 1,381-foot and 335- to 2,035-foot intervals.

Water Chemistry

Figures 17, 18, and 19 show the specific conductance, chloride concentrations, and temperature of drill stem and annulus water samples as drilling progressed from 342- to 2,035-foot depths. Specific conductance ranged from 450 to 46,000 μmho/cm at 25 °C in the drill stem samples and from 525 to 2,060 μmho/cm in the annulus samples. Chloride concentrations of drill stem samples ranged from 12 to 16,210 mg/L. Chloride concentrations of drill stem samples ranged from 12 to 31 mg/L from a depth of 343 to 1,023 feet and then increased to 270 mg/L at 1,025 feet. Chloride concentrations ranged from 100 to 270 mg/L to a depth of 1,083 feet. Below 1,083 feet, chloride concentrations ranged from 12 mg/L to 38 mg/L to a depth of 1,983 feet. From a depth of 1,983 feet to 2,035 feet, chloride increased from 38 mg/L to a maximum of 16,210 mg/L. The water temperature from the drill stem samples ranged from 23 to 27 °C, generally increasing with depth.

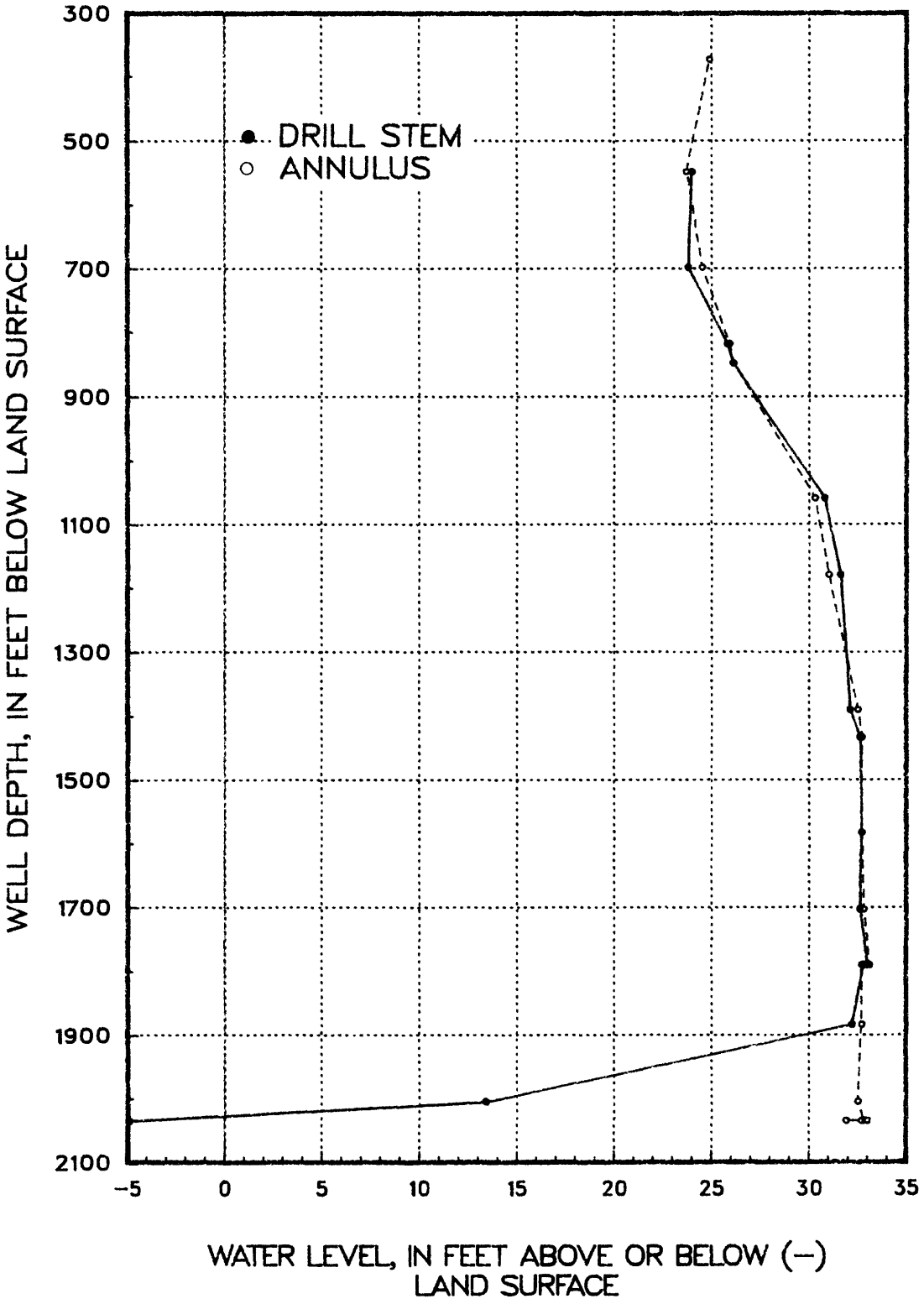

Figure 12.--Water levels in drill stem and in annulus during drilling of test well.

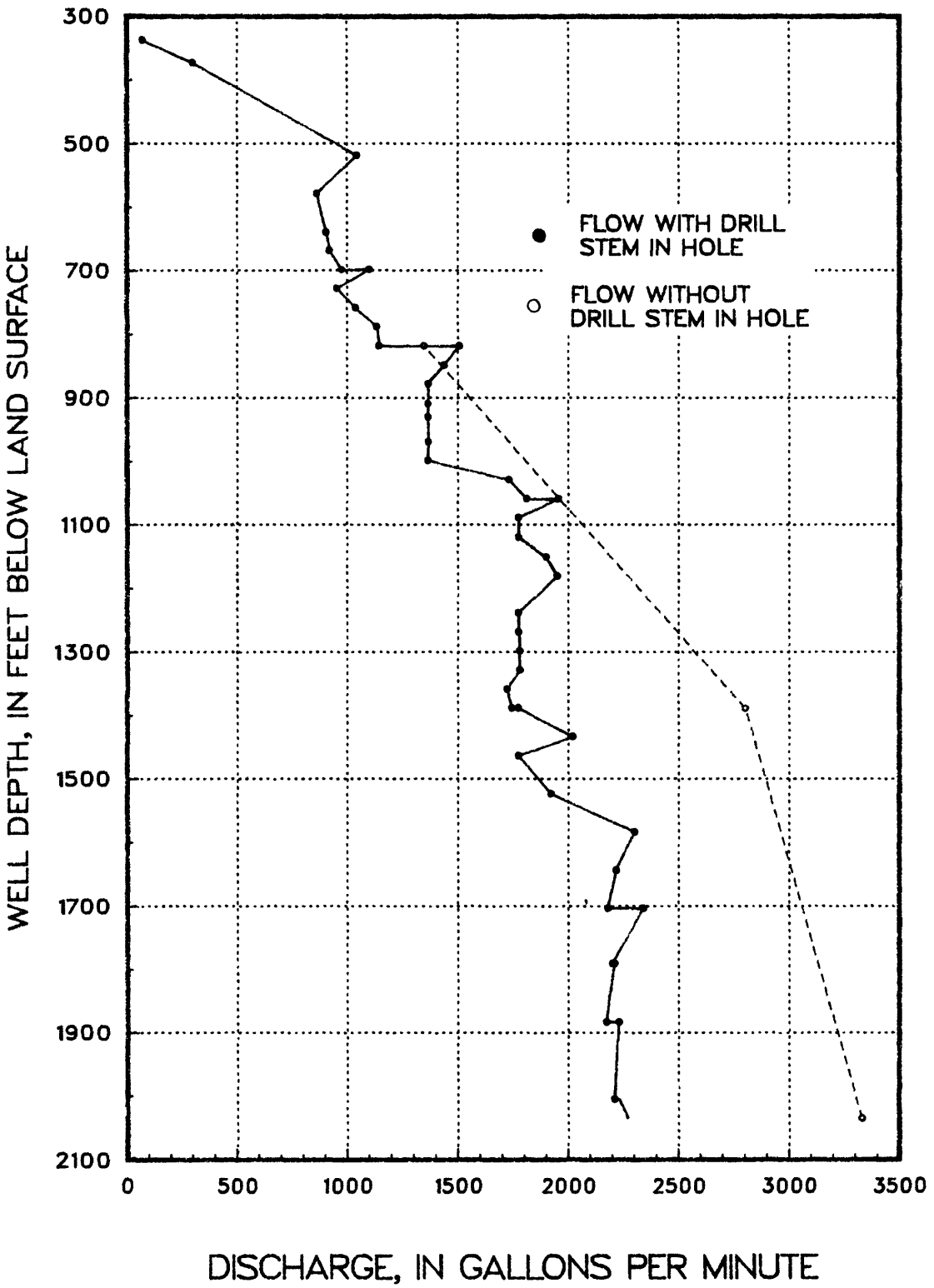

Figure 13.--Artesian flow of test well during drilling.

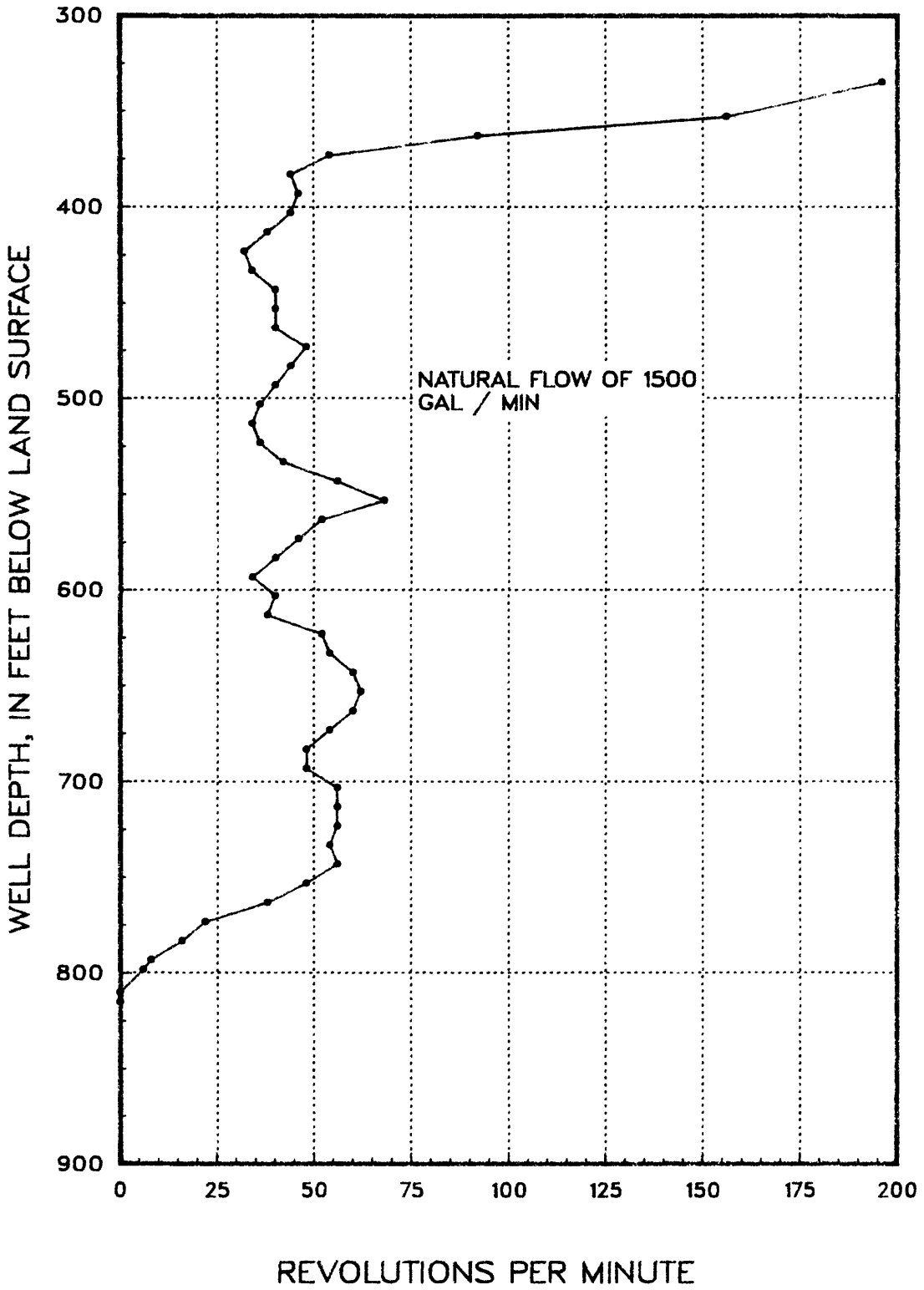

Figure 14.--Flow-meter traverse in test well, open-hole interval 335 to 818 feet below land surface.

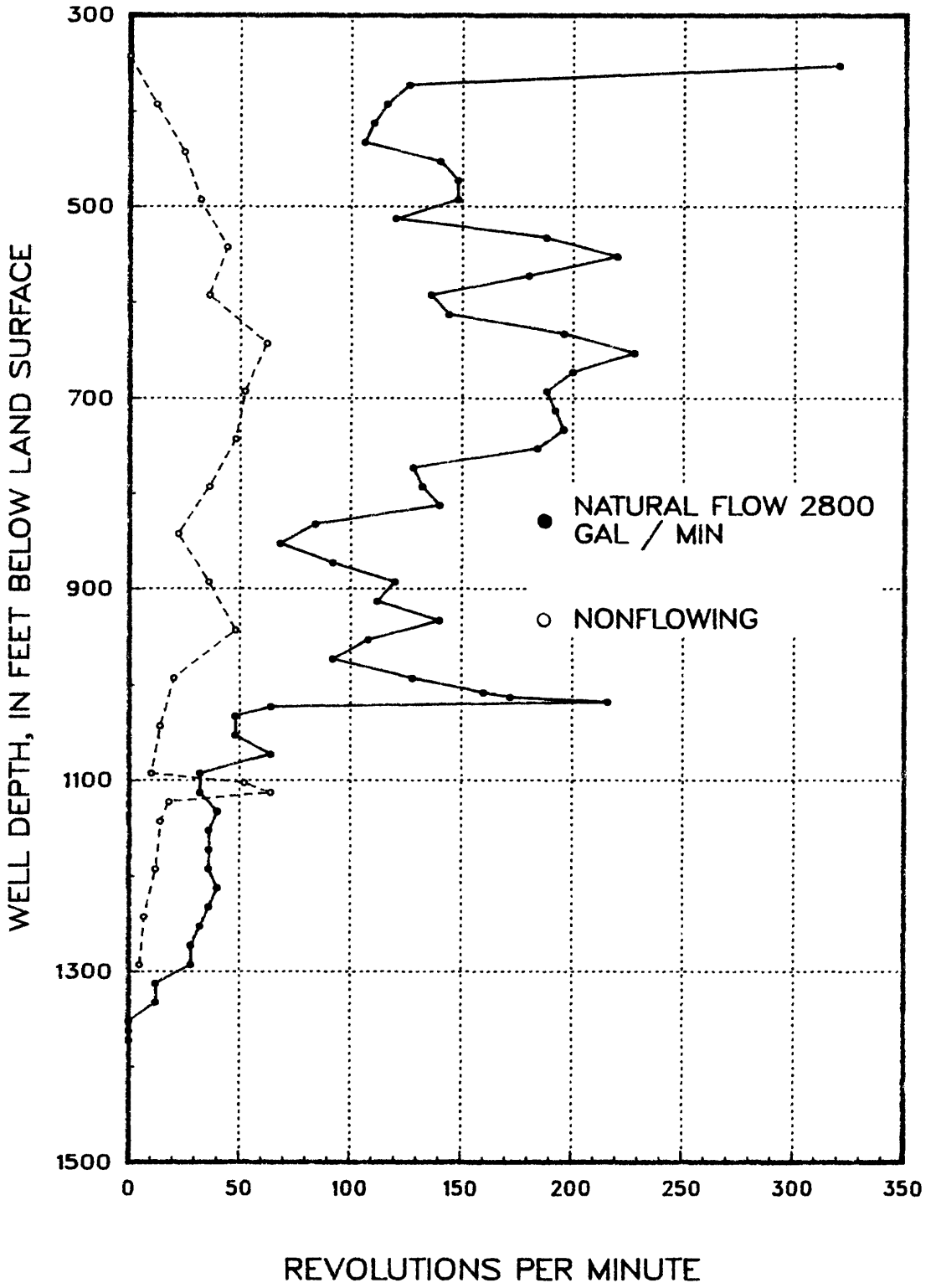

Figure 15.--Flow-meter traverses in test well, open-hole interval 335 to 1,381 feet below land surface.

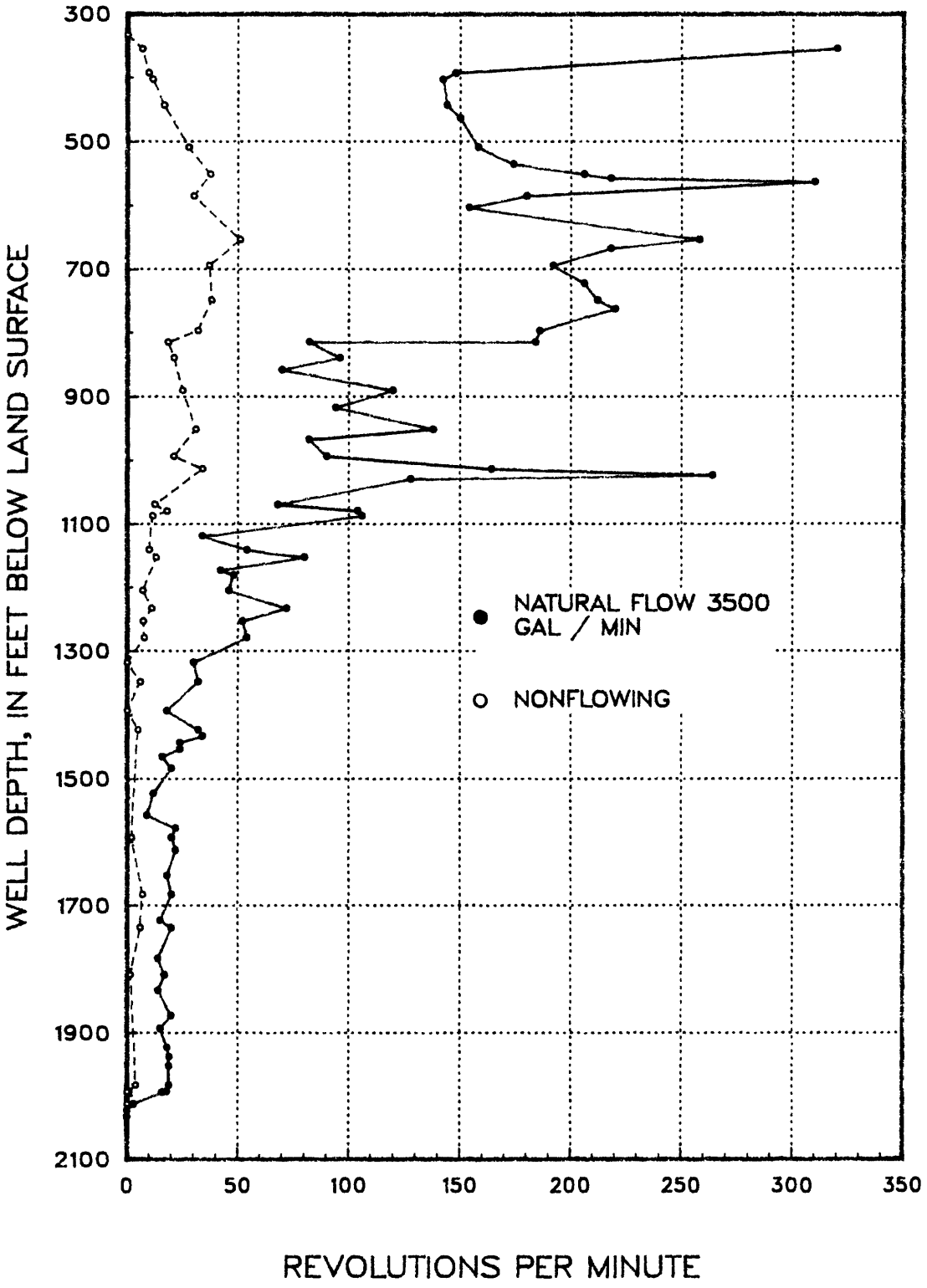

Figure 16.--Flow-meter traverses in test well, open-hole interval 335 to 2,035 feet below land surface.

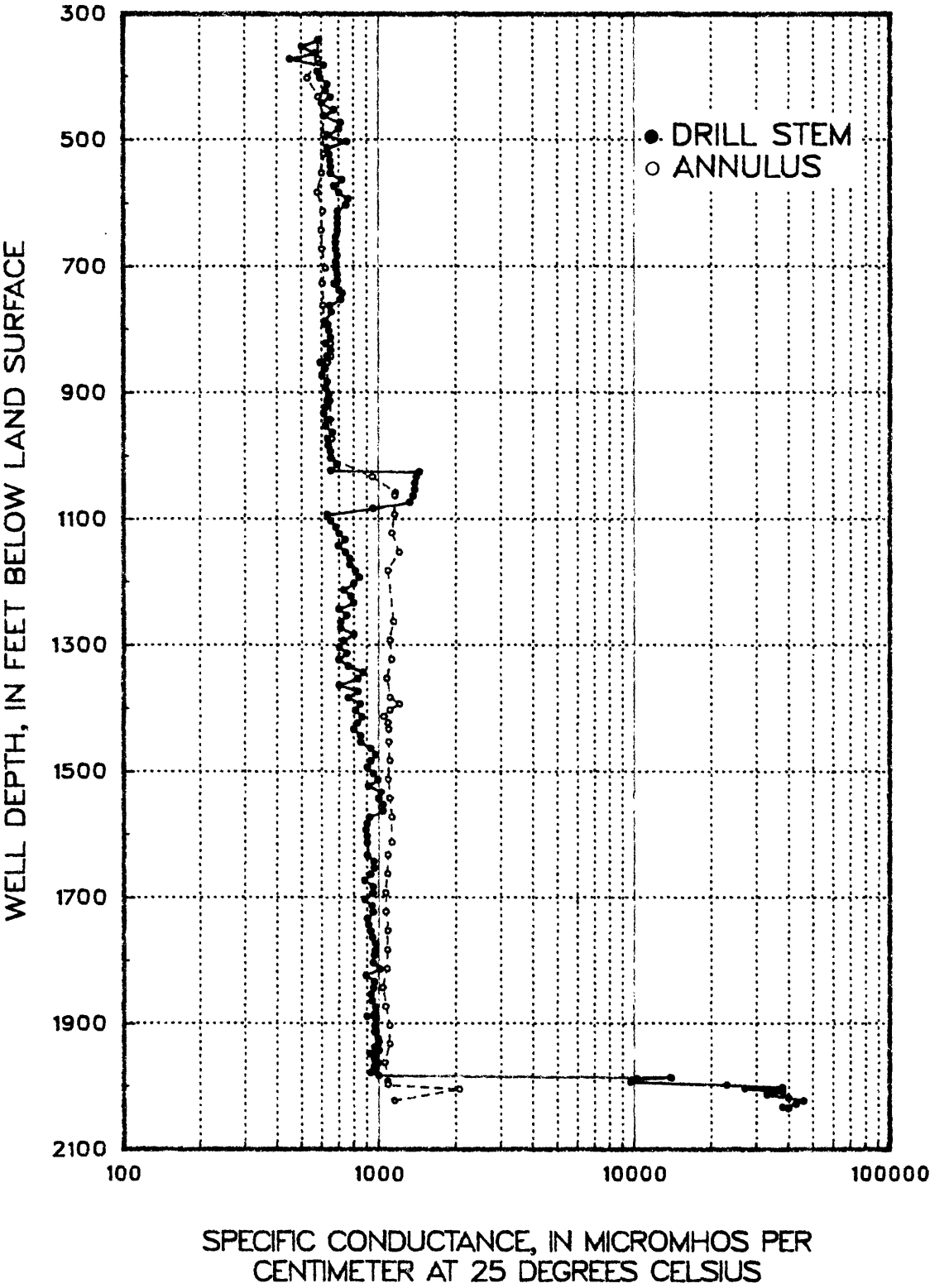

Figure 17.--Specific conductance of water obtained from the drill stem and the annulus as the test well was drilled from 342 to 2,035 feet.

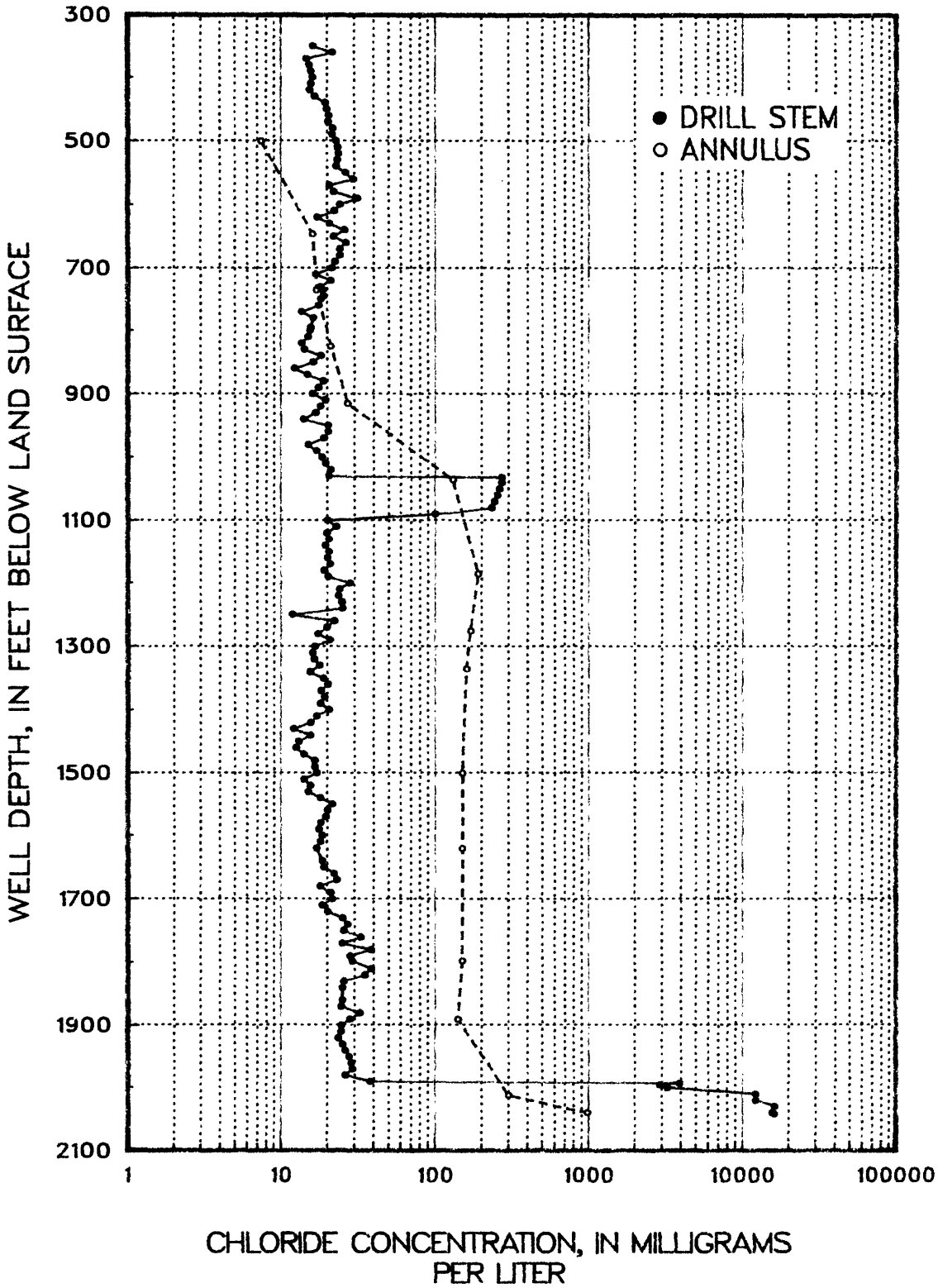

Figure 18.--Chloride concentrations of water obtained from the drill stem and annulus as the test well was drilled from 342 to 2,035 feet.

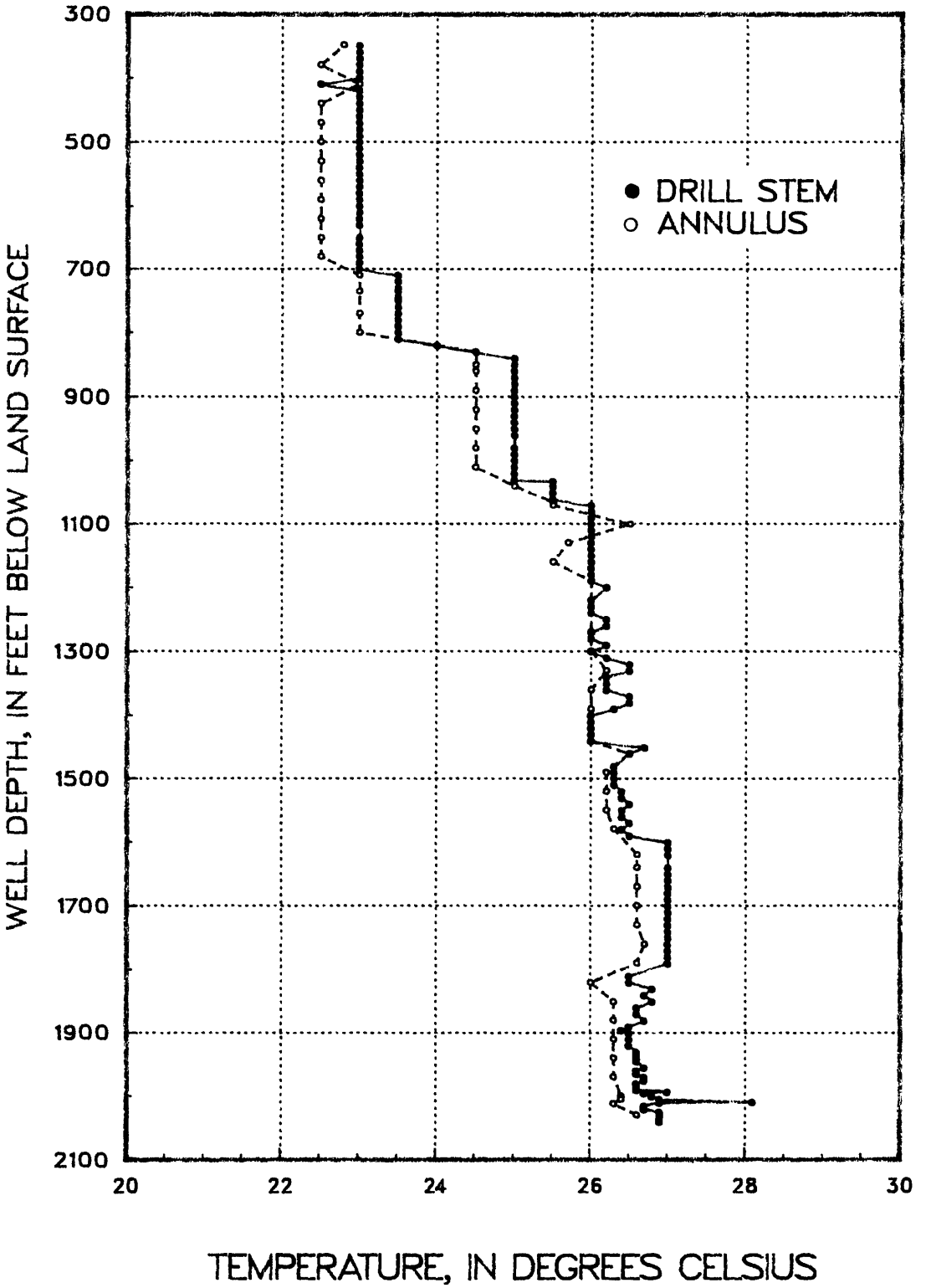

Figure 19.--Temperature of water obtained from the drill stem and annulus as the test well was drilled from 342 to 2,035 feet.

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