HYDROLOGIC AND GEOLOGIC ANALYSIS OF A WELL IN DORCHESTER COUNTY, SOUTH CAROLINA

By M. S. Reid, W. R. Aucott, R. W. Lee, and R. A. Renken

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Errata

The correct altitude of well DOR-211 is 78 feet above sea level as indicated on Plate 1. The altitude of 40 feet given in the last line of page 1 and on line 6, page 6, is incorrect. Also, the correct altitude of 78 feet was determined by leveling, not estimated from topographic maps.

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ABSTRACT

Well DOR-211 (Dorchester 211), located about 3 miles southeast of St. George, Dorchester County, South Carolina, was drilled and cored through the entire thickness of Coastal Plain sediments into the underlying basement rock at a depth of 2,067 feet. The test well was drilled in 1982 to determine the depth and thickness of sand aquifers in Dorchester County, South Carolina and to be used as an observation well. Data presented include lithologic descriptions from cores, geophysical logs, water level measurements, and water quality analyses.

INTRODUCTION

Deeply buried aquifers in the Coastal Plain of South Carolina range in depth below land surface from about 1,000 feet near Myrtle Beach to about 2,500 feet near Parris Island and Hilton Head Island. The potentiometric surface of these aquifers ranges from about 115 feet above sea level near the North Carolina-South Carolina State line to as much as 175 feet above sea level at Hilton Head Island. Water in these aquifers is confined by overlying slightly permeable clay beds. Limited hydrologic and geologic data is available to determine the characteristics of these deep aquifers and confining beds. Accordingly, a well was drilled to establish the geologic and hydraulic character of the Coastal Plain rocks where no deep well data existed. The test drilling was performed as part of the Southeastern Coastal Plain Regional Aquifer Systems Analysis Investigation.

Purpose and Scope

The purpose of this report is to present geologic and hydrologic data determined by drilling test well DOR-211. Data collected include the depth, thickness, lithology, and water chemistry of the Coastal Plain aquifers at the site. These data, presented by graphs, tables, and diagrams, will assist in regional correlations of stratigraphy and flow system characteristics.

The scope of the test-drilling project was to (1) obtain cuttings and wireline core samples for geologic and hydrologic testing and paleontological examination, (2) obtain geophysical logs to aid in the description and definition of the lithology and physical characteristics of the sediments penetrated, (3) determine water quality from discrete sand beds, and (4) determine the pressure head in the sands sampled for water quality.

Location of Area

The well is located in Dorchester County, South Carolina at 33 09'25"N latitude and 080 31'18"W longitude (fig. 1). The site is approximately 3 miles southeast of St. George and 6 miles southwest of Harleyville. The altitude at the site is 40 feet above sea level (from topographic map).

Acknowledgments

The cooperative efforts of Mr. Robert Massey, District Manager, Layne-Atlantic, and Mr. Phillip Miller, Chief Driller, made possible the excellent core recovery obtained from this well.

R. W. Davis, J. D. Hunn, and B. B. McDonald of the U.S. Geological Survey assisted during the drilling operations and described the cores and sample cuttings in the field.

The work was done under a cooperative agreement between the Water Resources Division, RASA program, and the Geologic Division of the U.S. Geological Survey.

WELL CONSTRUCTION

Drilling and Casing Procedures

Well DOR-211 (Dorchester 211) was drilled to a depth of 2,067 feet and later reamed to accommodate casing and cement after drilling, coring, geophysical logging, and water sampling were completed. The well was reamed to a diameter of 15 inches from land surface to 600 feet and 12.25 inches from 600 to 1,828 feet. A 6-inch casing was installed from land surface to 1,828 feet and finished with a 4-inch casing from 1,774 to 1,831 feet. A lead seal was swedged between the 6-inch and 4-inch casings. The well was backfilled from a depth of 1,866 to 2,067 feet and finished with a cement plug. Twenty feet of 4-inch 20-slot opening (0.020 inch), number 303 stainless steel screen was installed from 1,831 to 1,851 feet. Cement grout was placed in the annulus from land surface to a depth of 1,828 feet. A construction diagram is shown on plate 1.

Coring

Well DOR-211 was cored by the wire-lining core method from land surface to the top of pre-Cretaceous basement rock. Core was retrieved at five-foot intervals. Each length of core was measured, described, and placed in plastic tubing for preservation. From 50 feet below land surface to 1,967 feet, a total of 1,164.4 feet of core was recovered for a recovery rate of 68.4 percent.

Once the basement was reached at 1,967 feet, the wire-line core barrel was replaced with a standard 8-inch diamond core bit and a Christensen core barrel to core and retrieve samples of the hard basaltic basement rock from 1,967 to 2,073 feet.

Well Development

Temporary screens were installed opposite the zones selected for recovery testing and water-quality sampling (discussed in later sections of this report). One zone in well DOR-211 was permanently screened. All screens were gravel packed, and the gravel was placed by washing it down in tremie. The screened intervals were developed by a combination of jetting and air surging. Some intervals required backwashing in addition to surging. Development in all zones continued until the water pumped appeared to be free of drilling mud and sand, and until the specific conductance of the water stabilized. Four zones were selected for testing.

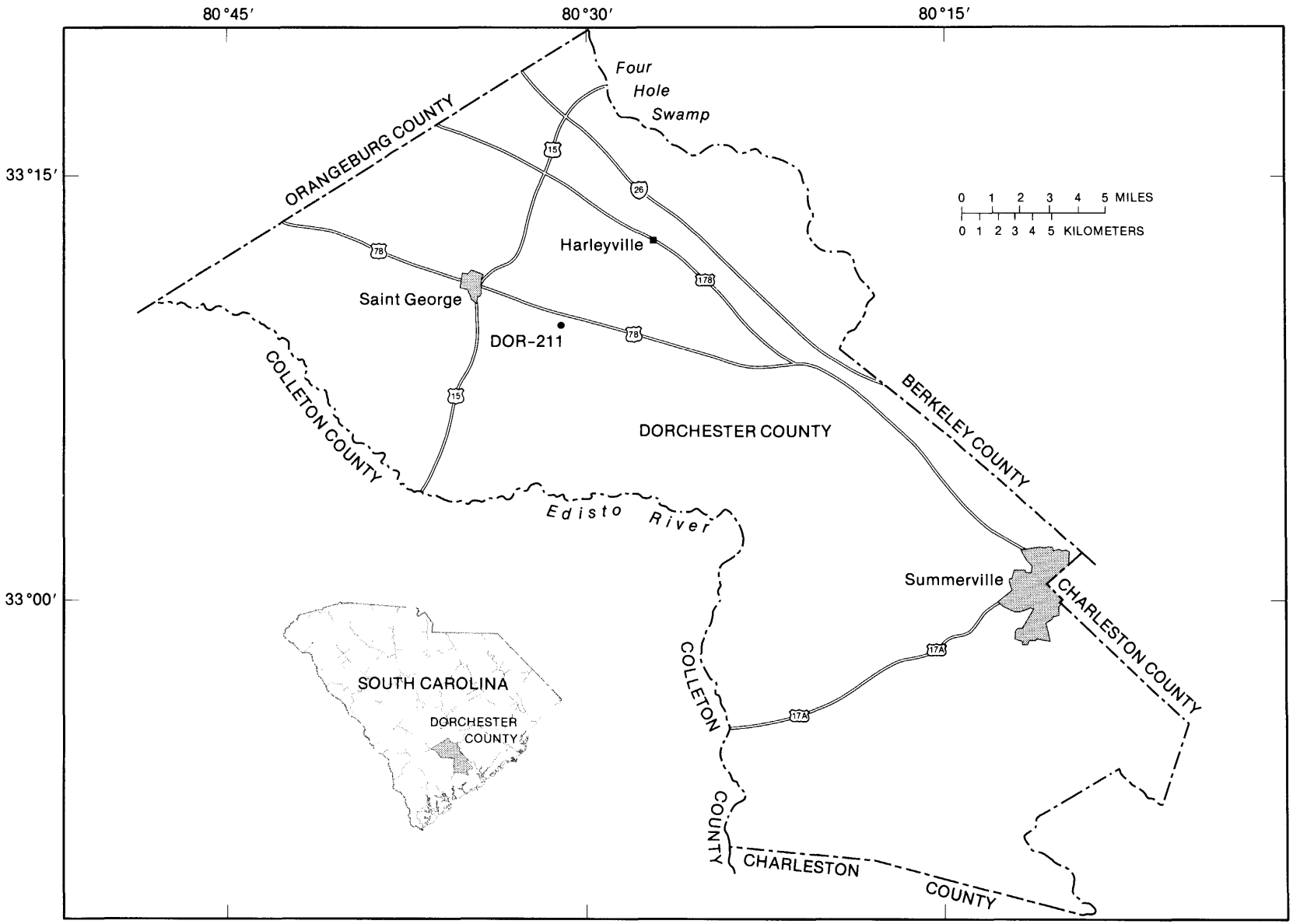

Figure 1.--Map showing the location of test well DOR-211.

HYDROGEOLOGIC DATA

Geology

Dorchester County is located in the South Carolina Coastal Plain. Coastal Plain rocks in the State consist primarily of unconsolidated to poorly consolidated sand and clay, with minor amounts of limestone. These rocks are all of Late Cretaceous age or younger, and form a generally wedge-shaped prism of sediments that thickens seaward. The Coastal Plain sediments lie on a pre-Cretaceous surface consisting of metamorphic, igneous, and consolidated sedimentary rocks.

Well DOR-211 penetrated the entire sequence of Coastal Plain rocks and 102 feet of pre-Cretaceous basaltic basement rock. Geologic units present in the well are: post-Miocene surficial deposits; Oligocene and Eocene deposits of the Cooper Group; Eocene deposits including the Santee Formation and the Fishburne (?) Formation; Paleocene deposits of the Black Mingo Formation; Upper Cretaceous deposits, including the Peedee, Black Creek, Middendorf and Cape Fear Formations. The well penetrated basaltic basement rock below the Cape Fear Formation.

Summary of Lithology in Well DOR-211

The post-Miocene surficial deposits (land surface to 10 feet below land surface) consist of sand, with phosphate and clay present.

The Cooper Group of Oligocene and Late Eocene age (10 to 80 feet) consists of sand with calcareous clay in the upper part of the interval, with the clay content increasing in the lower part.

The Santee Formation of Eocene age (80 to 250 feet) consists of limestone. Glauconite and shell fragments are present.

The Fishburne (?) Formation of Eocene age (250 to 300 feet) consists of limestone in the upper part of the interval and sand with limestone in the lower part. Glauconite is present.

The Black Mingo Formation of Paleocene age (300 to 560 feet) consists of sand, silt, and clay. Glauconite, lignite, and phosphate are present.

The Peedee Formation of Late Cretaceous age (560 to 1,088 feet) consists of sand with local sandy limestone layers in the upper part of the interval and clay changing from sandy to silty with glauconite present in the lower part.

The Black Creek Formation of Late Cretaceous age (1,088 to 1,322 feet) consists of silty clay which is calcareous and sandy. Lignite is present.

The Middendorf Formation of Late Cretaceous age (1,322 to 1,375 feet) consists of gray to yellowish-gray silty, micaceous sandy clay.

The Cape Fear Formation (1,375 to 1,965 feet) is the oldest formation of Cretaceous age penetrated. The formation consists of clayey feldspathic sand, with clay being dominant in some intervals. Fining-upward sand sequences are common. A quartz crystal measuring 5 mm was recovered in the lower 1.3 feet of the 1,910 to 1,920-foot core.

Basalt was encountered at 1,965 feet below land surface.

Geophysical Logs

A suite of geophysical logs was made of the uncased well including a standard electric log with self-potential and a 16- and 64-inch resistivity curve, focused resistivity, natural gamma, neutron porosity, gamma-gamma density, acoustic velocity, caliper, and temperature. The lithologic log and all of the geophysical logs are shown on plate 1.

X-ray Mineralogy

Selected cores from DOR-211 were tested for mineral content. The depth of the 22 cores ranges from 585 to 1,861 feet. The results of the x-ray diffractograms are shown in table 2.

HYDROLOGIC TESTING

Testing Procedures

Recovery tests were performed in well DOR-211 in four test zones: 580-600 feet, 1,326-1,346 feet, 1,765-1,785 feet and 1,828-1,848 feet; and on the completed well screened at a depth of 1,831-1,851 feet. During each test, the well screen was set in place, gravel packed, and sealed. Development was accomplished by jetting water and air into the screens, by air lift, and by pumping. After the development of each zone with air and water, a submersible pump was installed. Development continued by pumping until the water was clear and its specific conductance stable. Pumping rates were measured using a 1/2-gallon or 5-gallon bucket and a watch. A water sample was collected for each zone when the water level had stabilized. Development time varied for each zone from 56 to 220 hours. At the end of the development time, the pump was then shut down, and the water level was allowed to recover. When the water level approached land surface in zones 1,326-1,346 feet, 1,765-1,785 feet and 1,828-1,848 feet, the pump and drop pipe were removed and the well capped. Water-level measurements were made continuously throughout the recovery period using an electric tape or a calibrated pressure gauge when flow was achieved. The recovery test was terminated when a static water level was obtained. The screen line was then raised in preparation for the next zone test.

The recovery test measurements were plotted for each zone to verify the measured static water levels. In general, however, these tests do not prove to be reliable aquifer tests due to the effect of casing storage resulting in low pumping rates with respect to casing size. This effect is particularly noticeable in low yield aquifers (Schafer, 1978).

Comparison of Predevelopment and Modern Water Levels

Static water levels for the test zones (table 3) provide some interesting data pertinent to the hydraulics of the ground-water flow system. The water levels measured from this test well are probably close to predevelopment water levels because little development has occurred in this part of South Carolina. These water levels, however, may not be typical for this part of South Carolina because of the extensiveness of clayey material present at this site in the lower half of the column compared to areas surrounding St. George such as Walterboro, Charleston, Summerville, Orangeburg, and St. Stephen.

Table 1.--Description of core samples from well DOR-211

Well Name: St. George Test Hole - DOR 211
Owner: U.S. Geological Survey
Driller: Layne-Atlantic, Savannah, Ga.
Latitude/Longitude: 330925/0803118
Altitude: 40 feet (Topo)
Total depth: 2067 feet
Lithologic description and stratigraphic determinations
by Robert A. Renken
Paleontologic descriptions by James A. Miller

Descriptions 0-50 feet, 55-105 feet, 106-250 feet, 251-300 feet, 460-510 feet, 530-590 feet, 710-730 feet, 1,420-1,430 feet, 1,650-1,660 feet based on cuttings; remainder of descriptions based predominantly on cores.

	Depth in feet below land surface
Post Miocene Series	
Surficial deposits	
Sand, grayish orange (10YR7/4), medium to coarse, fairly well sorted; some phosphate, white to black, some clay, yellow brown to ochre.	0-10
Tertiary System	
Oligocene and Late Eocene Series, undifferentiated	
Cooper Group	
Contact based on paleontology, lithology, and the occurrence of marl (silty clay)	
Sand, yellowish gray (5Y7/2), fine- to very fine-grained; clay, calcareous, 5-10% of sample, clay matrix probably washing out of cuttings; some heavy minerals; foraminifera are shallow water types but not identified; Echinocytheris clarkana (Ulrich and Bassler), McLean.	10-30
Sand, yellowish gray (5Y7/2) but somewhat coarser, subrounded to angular, highly polished; rose quartz, rare; highly phosphatic (gray to green); large agglutinated foraminifera, Textularia sp., comprised of sand grains.	30-40
Sand, coarse; with phosphatized shark's teeth.	40-50
Silt, yellowish-gray (5Y7/2), highly calcareous.	50-55
Clay, silty (marl) and limestone, yellowish gray (5Y7/2); phosphate grains are numerous under microscopic examination, possibly representing an erosional interval; some foraminifera, including Robulus limbosus (Reuss), Lagena cf. L. costa (Williamson) Reuss, Bulimina sp. present at 60-70 feet; Bulimina jacksonensis Cushman at 70-80 feet.	55-80
Eocene Series	
Santee Formation	
Contact identified on basis of lithology, paleontology, and electric log.	

Limestone, yellowish gray (5Y7/2 to 5Y8/1), crystalline texture; highly glauconitic, particularly at 80-90 feet.	80-105
Limestone, yellowish-gray (5Y7/2), crystalline, highly glauconitic.	105-106
Limestone, yellowish gray (5Y8/1), crystalline texture.	106-160
Limestone, yellowish gray (5Y8/1), very soft; clayey, increase in glauconite content at 180-190 feet.	170-190
Limestone as above with numerous shell fragments and a middle Eocene fauna, including Cytheropteron variosum Martin.	190-200
Limestone, very light gray (N8), micritic.	200-210
Limestone, very light gray (N8), crystalline to microcrystalline; glauconitic; Cytheropteron variosum Martin.	210-230
Limestone, very light gray (N8), highly glauconitic.	230-250
Eocene Series	
Fishburne (?) Formation	
Top contact questionable, identified at 240 feet on basis of log correlation with type section (Gohn and others, 1983).	
Limestone, yellowish gray (5Y8/1), micritic, soft, with some glauconite.	250-251
Limestone, yellowish gray (5Y8/1); with less micrite.	251-270
Limestone, yellowish gray (5Y8/1); with sand, quartz, coarse-grained; glauconite.	280-290
Sand, medium light gray (N6), quartz, medium to coarse, angular to subangular; with some limestone particles as above, some glauconite.	290-300
Paleocene Series	
Black Mingo Formation	
Contact identified on basis of lithology	
Clay, silty, with some thinly laminated sand lenses (upper foot of sample), medium light gray (N6) to light gray (N7); remainder of core is sand, with thinly laminated clay stringers; interbedded with sand, quartz, clayey in places, fine to very fine, angular to subangular; a few lenses of calcareous clay.	300-320
Sand, with thinly bedded interlaminated clay, silty, medium light gray (N6) to light gray (N7), calcareous; sand, quartz, fine to very fine; lignitic.	320-330
Clay, silty, medium light gray (N6); with sand, quartz, fine- to very fine-grained, subangular to angular.	330-340
Sand, medium light gray (N6) with clay, interlaminated and interbedded; micaceous; lignitic.	340-350
Clay, with sand, grayish black (N2) to dark gray (N3) to medium gray (N5), some oxidized to yellowish gray (5Y8/1), interbedded and interlaminated; sand or clay predominates at different intervals, occurring as drapes in places; sand is quartz, fine, subangular to angular, lignitic; micaceous (muscovite); some shells.	350-370
Clay, silty, noncalcareous, with sand occurring as thin laminae, light gray (N7) to medium light gray (N6) to dark gray (N3) to grayish black (N2) to olive gray (5Y4/1); sand is quartz, fine, subangular to angular; mica, lignite.	370-391

Sand, coarse- to medium-grained, quartz, angular to subangular; some silt; mica.	391-395
Sand, with clay laminae or lenses, olive gray (5Y4/1) to very light gray (N8); mica.	395-400.5
Clay, grayish black (N2) to dark gray (N3) to medium dark gray (N4) to medium gray (N5) to medium light gray (N6); with sand occurring as thin laminae; clay is highly calcareous, with some silt; shell fragments common to numerous at 403-410 feet.	400.5-410
Clay, light gray (N7) to light olive gray (5Y6/1) and silt, sandy; shell fragments.	410-420
Clay, medium gray (N5); with occasional fine sand laminae.	420-422.3
No Sample	422.3-460
Clay, medium light gray (N6), calcareous, glauconitic; lignitic; some mica.	460-480
Clay, medium gray (N5), slightly silty, calcareous, subfissile.	490-510
Clay, silty, medium dark gray (N4) to medium gray (N5), with occasional fine sand laminae or lenses; some shell fragments.	510-530
Sand, medium gray (N5), quartz, good sorting with trace of shells.	530-550
No Sample	550-560
Cretaceous System	
Gulfian Series	
Peedee Formation	
Contact selected on basis of log correlation, phosphatic nature of sand, and the occurrence of limey sand and sandy limestone (marl).	
Sand, medium gray (N5), quartz, medium- to coarse-grained; with increase in shells between 560-580 feet; highly phosphatic.	560-590
Sand, limey and limestone, sandy (marl), white (N9) to light olive gray (5Y6/1); sand is fine- to medium-grained, highly calcareous, slightly indurated.	590-595
No Sample	595-600
Sand, fine to medium, slightly calcareous, loosely consolidated; mica.	600-605
No Sample	605-610
Sand, light olive gray (5Y6/1), fine, very porous; some thin clay or silt laminae.	610-616
Clay, medium dark gray (N4) to dark olive gray (5Y4/1); some lenses or laminae of sand, fine- to medium-grained.	616-618
Sand, clayey, greenish gray (5GY6/1) to olive gray (5Y6/1) to medium gray (N4); some clay, sandy, silty; bioturbated; faintly mottled.	618-640
Clay, sandy, with some sand and clay interbeds, grayish black (N2) to dark gray (N3) to light olive gray (5Y6/1); clay beds with sand laminae predominate at base, some bioturbation; calcareous; sand is quartz, fine to very fine; shells common to numerous at 655-660 feet.	640-665

Clay, silty to sandy, light olive gray (5Y6/1) to medium light gray (N6), calcareous; basal part of core faintly bedded with sand laminae; muscovite.	665-680
Sand, medium dark gray (N4) to olive gray (5Y4/1); mica; shell fragments.	680-682
Clay, medium gray (N5) to dark gray (N3); with some sand and silt occurring as occasional thin laminae; clay, waxy when scratched, calcareous; shell fragments; mica, Heterohelix sp. at 700 feet.	682-710
Silt, clayey, very finely sandy; with Robulus sp., other foraminifera common; trace of phosphate.	710-720
Silt, clayey, rare phosphate, glauconite; trace of foraminifera and ostracoda, including Brachycythere rhomboidalis (Berry).	720-730
Clay, silty, olive black (5Y2/1) to medium dark gray (N4), massive, calcareous; ostracoda and foraminifera common, Robulus sp. at 730-740, Brachycythere sphenoides (Ruess) and Globotruncana ventricosa White at 740-750; shark's teeth; quartz sand, rare; clay faintly laminated with silt and fine quartz at 745-750.	730-750
Clay, olive gray (5Y4/1) to olive black (5Y2/1) to dark gray (N3) to light gray (N7); massive, waxy when scratched; with silt and fine sand occurring as occasional, indistinct, thin-bedded laminae; calcareous.	750-780
Clay, silty to sandy at base, medium dark gray (N4) to medium light gray (N6), highly calcareous to calcareous; increasing sand content downwards; sand is quartz, fine to very fine, angular to subangular; trace of phosphate, mica; some pyrite; foraminifera and ostracoda common, including Veenia arachanoides (Berry) and Brachycythere sphenoides (Ruess).	780-790
Sand, interlaminated with clay, medium gray (N5); sand predominant lithology; some sand lenses, quartz, fine- to coarse-grained; clay is calcareous.	790-820
No Sample	820-824
Clay, dark gray (N3) to medium dark gray (N4) to light gray, calcareous, with silty sand occurring as thin laminae and rare lenses; sand is very light gray (N8), quartz, very fine to fine, angular to subrounded.	824-836, 850-885
No Sample	885-895
Clay, silty, medium gray (N5), and some silt, clayey, calcareous; with sand, quartz, fine to very fine, occurring as occasional to frequent laminae; numerous shell fragments; bioturbated in upper 5 feet.	895-940
Clay, silty, medium dark gray (N4) to medium gray (N5); less sandy laminae than previous section; rare ostracoda and foraminifera.	940-970
Clay, silty, calcareous, with fine sand occurring as thin laminae; numerous shell fragments between 980-990 feet.	970-1,000

Clay, silty, medium gray (N5) to medium light gray (N6) to greenish gray (5GY6/1); with sand as thin laminae; Haplocytheridea? sp. aff. H.? plummeri (Alexander); very fine sand at 1,000-1,010 feet; mica at 1,010-1,011 feet.	1,000-1,030
No Sample	1,030-1,040
Sand, medium light gray (N6), very fine; some clay; shell fragments; rare mica.	1,040-1,052
Clay, silty, medium gray (N5), with some silt and fine-grained sand occurring as thin laminae; shell fragments common to numerous in places; bedding locally indistinct.	1,055-1,088
Black Creek Formation	
Contact selected on basis of electric log correlation, occurrence of lignite in float, and overall lithic character. Contact considered gradational with Peedee Formation.	
Sand, silty, light olive gray (5Y6/1), very fine- to medium-grained, massive, calcareous.	1,088-1,100
Sand, light olive gray (5Y6/1) to dark greenish gray (5GY4/1) to greenish gray (5GY6/1), calcareous, massive; in places interlaminated with clay; some clay laminae are bioturbated and intermixed with the sand; sand is quartz, clear, fine, angular to subangular; shell fragments in upper 5 feet; lignite and mica in float.	1,100-1,140
No Sample	1,140-1,145
Clay, silty, greenish gray (5GY6/1) to medium gray (N5); with interbedded to interlaminated sand, amount decreasing with depth.	1,145-1,170
Clay, silty, medium gray (N5) to medium light gray (N6) to dark greenish gray (5GY4/1) to grayish black (N2); with occasional interbedded and interlaminated sand, quartz, fine; rare shell material.	1,170-1,210
Clay, silty, medium gray (N4); rare sand laminae; sand is quartz, clear, subangular to angular; some shell material.	1,210-1,245
No Sample	1,245-1,270
Clay, silty, medium light gray (N5) to medium gray (N4), some interbedded silt, clayey; little sand; finely broken, thin-walled (delicate) shell material.	1,270-1,305
Clay, silty, medium light gray (N6) to light gray (N7), calcareous, massive; basal two feet consists of very light gray (N8) to light gray (N7) to olive gray (5Y4/1) clay, mottled, noncalcareous, grading to sand at base; trace of lignite in float.	1,305-1,322
Middendorf (?) Formation	
Contact questionably identified on basis of lithology, absence of lignite, and noncalcareous nature. Contact considered gradational with Black Creek.	
Sand, silty, very light gray (N8) to light gray (N7), quartz, fine- to coarse-grained, milky to clear, subangular to angular; trace of mica.	1,322-1,342
Clay, silty, yellowish gray (5Y8/1) to light gray (N7) to very light gray (N8), massive; grades downward to slightly sandy clay, noncalcareous, fine- to medium-grained, matrix supported.	1,342-1,355

Sand, light gray (N7) to very light gray (N8), quartz, fine- to coarse-grained, massive; mica common; trace of sandy silt laminae.	1,355-1,375
Cape Fear Formation	
Top of formation based on cyclic nature of stratification (coarse-grained sand grading upward to medium- and fine-grained sand, in turn, grading upwrd to silt and clay). Cycles are repetitive, though not necessarily complete, and are similar to sand-mud couplets described by Heron, Swift, and Dill (1968).	
Sand, very light gray (N8) to light gray (N7) to medium light gray (N6), fining upward to sandy silt, then to clay; several repetitive fining-upward cycles occur within this interval; sand is quartz, clear to milky, fine to coarse, angular to subangular; some grains are stained pink to yellow; some feldspar; clay mottled in places; trace of mica.	1,375-1,401
Sand, yellowish gray (5Y8/1) to light olive gray (5Y6/1) to light gray (N7) to very light gray (N8), fine- to coarse-grained; grades upward to silty sand, then to silty clay at top; contact with overlying sand is sharp.	1,401-1,405
Sand, yellowish gray (5Y8/1), fine- to coarse-grained; grading upward to silty sand, then sandy silt, and finally to silty clay at top; sand is quartz; some pink-stained grains; feldspathic; basal foot of core consists of silt, clayey, somewhat sandy.	1,405-1,420
Sand, light olive gray (5Y6/1), quartz, some yellow to pink, coarse, subangular to angular, clear to milky; some fledspar.	1,420-1,430
No Sample	1,430-1,440
Sand, yellowish gray (5Y8/1) to light gray (N7), fine- to medium-grained, (uppermost foot of core is fine- to coarse-grained), quartz, milky to clear; some feldspar; trace of mica. With exception of size differences, sand appears structureless.	1,440-1,470
Sand, fining upward to clayey silt and silty clay, light gray (N7) to medium light gray (N6) to medium gray (N5) to light olive gray (5Y6/1) to greenish gray (5Y6/1) to dark reddish brown where oxidized or mottled at base; two complete fining-upward cycles noted; uppermost foot of core consists of sand, silty, coarse- to fine-grained, marks the beginning of the next fining-upward cycle; clay bedding ranges from massive to thin beds emphasized by local alternating color bands; some feldspar.	1,470-1,495
Sand, medium light gray (N6) to medium gray (N5) to light gray (N7), oxidized and mottled to moderate reddish brown (10R4/6) to moderate red (5R4/6); fining upward to silty clay which comprises upper 12 feet of core; lower 9 feet is sand, coarse- and medium-grained at base, fining upward to medium- and fine-grained, quartz, clear to milky, iron-stained in part, some feldspar.	1,495-1,516

Sand, fining upward to clayey silt and silty clay, yellowish gray (5Y8/1) to light gray, oxidized and mottled to very pale orange (10YR8/2) to moderate reddish brown (10R4/6) to dark reddish brown (10R3/4) to grayish red (10R4/2) to brownish gray (5YR6/1); clay, silty, mottled, very slightly calcareous, comprises upper 18 feet of core; sand, quartz, fine- to very coarse-grained, with some feldspar, comprises lower 12 feet of core.	1,516-1,546
Sand, fining upward to silty clay, light gray (N7) mottled to dark reddish brown (10R3/4); sand is quartz, coarse- and medium-grained at base of interval, fining upward to medium- and fine-grained; trace of feldspar, mica.	1,546-1,555
Sand, very pale orange (10YR8/2) to grayish yellow (5Y8/4) to yellowish gray (5Y7/2), fining upward to silty clay, moderate reddish brown (10R4/6) to pinkish gray (5Y8/1) to light brownish gray (5YR6/1) to light brown (5YR5/6), somewhat sandy in places; sand comprises 1,569-1,578 foot interval, is quartz, very coarse to fine; some feldspar and mica; clay is mottled, micaceous.	1,555-1,578
Sand, very light gray (N8) to light gray (N7) to yellowish gray (5Y8/1) to very pale orange (10YR8/2) (1,590-1,617); fining upward to clay, somewhat silty in places, light olive gray (5Y5/2) to light gray (N7) to grayish red (10R4/2) to dark reddish brown (10R3/4) to very light gray (N8) to light gray (N7) to yellowish gray (5Y8/1) (1,580-1,590); sand is quartz, fine- to very coarse-grained, some granule-sized, with feldspar and mica.	1,578-1,617
Sand, fining upward to clay; sand is quartz, coarse- to fine-grained, with feldspar and mica.	1,617-1,621
Clay, sandy, and silty sand, light brownish gray (5YR6/1).	1,621-1,622
No Sample	1,622-1,625
Sand, light brownish gray (5YR6/1) to yellowish gray (5Y8/1), coarse- to fine-grained; some sandy clay at top of cored section.	1,625-1,632
No Sample	1,632-1,635
Sand, light olive gray (5Y6/1) to light gray (N7) to light brownish gray (5YR6/1), oxidized to moderate reddish brown (10R4/6); fining upward to clayey sand, then to sandy clay, and finally to silty clay, light gray (N7) to light brownish gray (5YR6/1) to moderate reddish brown (10R4/6) to dark reddish brown (10R3/4); sand is quartz, fine- to very coarse-grained, with some granule-size material and feldspar; clay is mottled, with some mica.	1,635-1,650
Sand, pale yellowish-brown (10YR6/2), quartz, some feldspar, fine to very coarse, angular to subangular; some silt.	1,650-1,660

Sand, pinkish gray (5R8/1) to yellowish gray (5Y8/1) to light brownish gray (5YR6/1) to light brown (5YR5/6) to moderate yellowish brown (10YR5/4) to dark yellowish orange (10YR6/6) to light gray (N7) to very light gray (N8); fining upward to silty clay in uppermost part of interval; sand is quartz, fine- to coarse-grained, some granule-size grains at base, some feldspar; some sandy clay in places.	1,660-1,676.5
Sand, yellowish gray (5Y8/1) oxidized to dark yellowish orange (10YR6/6), fine to very coarse, with some granule-size sand present, fining upward to clay, mottled.	1,676.5-1,682.5
No Sample	1,682.5-1,690
Clay, silty, moderate brown (5YR4/4) to yellowish gray (5Y8/1), highly oxidized, micaceous; sandy in places; burrows evident.	1,690-1,703.5
No Sample	1,703.5-1,710
Sand, yellowish gray (5Y8/1), quartz, fine- to very coarse-grained, with some gravel, feldspar, mica; fines upward to clay as above.	1,710-1,720
Sand, yellowish gray (5Y8/1) to light olive gray to light brownish gray (5YR6/1) oxidized to greenish orange (5YR7/2) to grayish orange (10YR7/4) to pale red (10R6/2) to moderate yellowish brown (10YR5/4); coarse to fine, some very coarse and granule-size material present at certain intervals.	1,720-1,731
Sand, very pale orange (10YR8/2), pale red (5R6/2), light brown (5YR6/4), moderate brown (5YR4/4), pale yellowish brown (10YR6/2), and grayish orange (10YR7/4), quartz, fine to very coarse, some gravel in places, highly oxidized, some feldspar; clay and silt in matrix.	1,745-1,802
Clay, silty, pale red (5R6/2) to grayish orange pink (5R7/2), highly oxidized; grades downward to bed of sand, fine- to medium-grained, that is in turn underlain by silty clay, highly oxidized, micaceous.	1,802-1,810
Silt, sandy, clayey, very light gray (N8), pinkish gray (5YR8/1) to grayish pink (5YR7/2) to pale reddish brown (10R5/4); and clay, silty, slightly sandy.	1,810-1,820
Sand, fining upward to clay, very pale orange (10YR8/2) to pale yellowish brown (10YR6/2) to grayish orange pink (5YR7/2); sand is medium- to coarse-grained at base, grading upward to a medium- to fine-grained sand; clay is silty, highly oxidized in sections.	1,820-1,825
Sand, light greenish gray (5GY8/1) to yellowish gray (5Y8/1) to moderate reddish orange (10R6/6) to moderate reddish brown (10R4/6) to pale reddish brown (10R5/4) to dark yellowish orange (10YR6/6), quartz, fine- to very coarse-grained, some feldspar; silt and clay form matrix in places; highly oxidized; trace of mica.	1,825-1,866
Clay, silty, highly oxidized, light olive gray (5Y6/1) to yellowish gray (5Y8/1) to pale red (10R6/2), in sharp contact with overlying sand, but grades into underlying sand.	1,866-1,875

Sand, moderate orange pink (10R7/4) to pinkish gray (10R8/1), quartz, very coarse- to medium-grained at base, fining upward to coarse- to fine-grained, subrounded; quartz grains seem to have greater iron-staining than previously noted; some feldspar; bedding is flat to very gently inclined. 1,875-1,892.5

No Sample 1,892.5-1,900

Sand, fining upward to silt, white (N9) to very light gray (N8), in turn, fining upward to silty clay, yellowish gray (5Y8/1) to greenish gray (5GY8/1) mottled to moderate reddish brown (10YR4/6) to dark reddish brown (10R3/4); clay is highly oxidized; sand is quartz, fine- to medium-grained, well sorted, angular to subrounded; iron-stain streaks cut horizontally across core; less feldspar than above; some mica; bedding is flat to gently inclined. 1,900-1,909

Sand, white (N9) to yellowish gray (5Y8/1) to very light gray (N8) to yellowish gray (5Y8/1), locally oxidized to light brownish gray (5YR6/1), quartz, fine- to coarse-grained; some mica. 1,909-1,923.5

No Sample 1,923.5-1,930

Unnamed Clay

Contact identified on distinctive lithology change.

Clay, silty, light brownish gray (5YR6/1), light olive gray (5Y6/1), bluish gray (5Y8/1), light gray (N7) to moderate brown (5YR4/4), mottled and oxidized in places, waxy. 1,930-1,962.5

Saprolite (?)

Clay, silty, and weathered bedrock, very light gray (N8) to grayish yellow green (5GY7/2) to dusty yellow (5Y6/4). 1,962.5-1,965

Pre-Cretaceous System

Bedrock - Base of Coastal Plain

Basalt 1,965-1,967

Not Described 1,967-2,067

Summary	From	To	Thickness
Post-Miocene Series			
Surficial deposits	0	10	10
Tertiary System			
Oligocene - Late Eocene Series, undifferentiated			
Cooper Formation	10	80	70
Eocene Series			
Santee Formation	80	240	160
Fishburne (?) Formation	240	300	60
Paleocene Series			
Black Mingo Formation	300	560	260
Cretaceous System			
Peedee Formation	560	1,088	528
Black Creek Formation	1,088	1,322	234
Middendorf (?) Formation	1,322	1,375	53
Cape Fear Formation	1,375	1,930	555
Unnamed clay	1,930	1,962.5	32.5
Saprolite (?)	1,962.5	1,965	2.5
Pre-Cretaceous System			
Basalt	1,965		
Total depth	2,067		

Table 2.--Mineralogy from selected cores of USGS Test Well, DOR-211

DEPTH	QUARTZ	KSPAR	ALBITE	CALCITE	PYRITE	KAOLIN	SMECT	MUSC	OTHER MINERALS	CORE DESCRIPTIONS
585'	S	M	-	M	-	TR	TR	TR	DRILLING MUD	FROM CUTTINGS, SAND, MICACEOUS, LARGE GRAINS
1200'	M	-	-	S	L	TR	-	TR	--------	FINE-GRAINED, DARK, LAMINATED LS., WITH SHELL FRAGMENTS
1331'	S	L	TR	TR	-	S	TR	L	DRILLING MUD	MICACEOUS SAND AND SILT
1351'	S	-	-	-	-	M	TR	-	--------	FINE SAND-SILT-CLAY WITH DARK MINERAL
1359'	S	L	-	TR	-	S	TR	L	--------	MICACEOUS SAND AND CLAY WITH LARGE CLASTS
1417'	S	L	M	TR	-	L	L	TR	--------	FINE MICACEOUS SAND WITH FELDSPAR AND CLAY
1470'	S	M	L	L	-	L	L	TR	--------	SL. CEMENTED QUARTZ SAND AND CLAY WITH LARGE WHITE MICROCLINE CLASTS
1512'	S	S	-	TR	-	M	TR	TR	TR MIXED-LAYER CLAY	COARSE MICACEOUS QUARTZ SAND WITH ORTHOCLASE CLASTS AND CLAY
1524'	S	M	S	TR	-	L	L	TR	--------	MICACEOUS SAND, RUTILATED QUARTZ, CLAY, SILT
1530'	S	M	L	TR	-	L	L	TR	--------	FINE MICACEOUS, RED-GREEN MOTTLED SILTY SAND AND CLAY WITH CALCITE AND ORTHOCLASE
1541'	S	L	S	TR	-	TR	TR	L	TR MIXED-LAYER CLAY	FINE TO VERY FINE MICACEOUS SAND AND CLAY
1573'	S	S	M	TR	-	L	TR	TR	TR MIXED-LAYER CLAY	FINE MICACEOUS SAND AND CLAY WITH LARGE BB-SIZE CLASTS, MICROCLINE
1576'	S	S	L	L	TR	TR	L	TR	DRILLING MUD	COARSE SAND WITH CLAY, RED AND GREEN MOTTLES, PINK AND GREENISH CLASTS, ORTHOCLASE
1627'	S	S	TR	TR	TR	TR	M	TR	DRILLING MUD	COARSE SAND AND CLAY, RED AND GREEN MOTTLES, PINK AND GREENISH CLASTS, ORTHOCLASE
1681'	S	L	TR	TR	-	M	L	TR	TR-MIXED-LAYER CLAY	SAND AND CLAY WITH PEA SIZE FELDSPAR CLASTS AMBER, MICROCLINE
1717'	S	S	L	TR	-	L	L	TR	TR MIXED-LAYER CLAY	MICACEOUS SAND AND CLAY WITH COARSE FELDSPAR GRAINS, MICROCLINE
1723'	S	M	TR	L	-	L	TR	TR	TR MIXED-LAYER CLAY	FINE SAND AND CLAY WITH MICA AND ORTHOCLASE
1753'	S	M	TR	L	TR	M	TR	TR	TR DOLOMITE	SAND AND CLAY WITH LARGE RED AND WHITE CLASTS, RUTILATED QUARTZ GRAINS, MICROCLINE, GOETHITE
1781'	S	L	TR	TR	-	L	TR	TR	--------	MEDIUM SAND AND CLAY WITH LARGE WHITE CLASTS OF MICROCLINE
1798'	S	M	L	L	TR	M	TR	TR	TR ILLITE	SAND, CLAY, AND MICA WITH DARK MINERAL, MICROCLINE CLASTS WITH TRACE CALCITE
1841'	S	M	L	TR	-	L	TR	TR	TR ILLITE	MICACEOUS SAND AND CLAY, MICROCLINE
1861'	S	L	TR	TR	TR	L	TR	TR	TR ILLITE	MEDIUM MICACEOUS SAND AND CLAY, ORTHOCLASE

EXPLANATION

XRD Relative Peak Intensity:

S Strong
M Medium
L Low
TR Trace

SAMPLING AND CHEMICAL ANALYSES OF WATER

Sampling Procedures

Four zones were chosen for obtaining water samples and head measurements. In addition, water samples and head measurements were made of the completed well. The zones were chosen based on an evaluation of the electric and lithologic logs (pl. 1). Sampling was done to determine the chemical character of the water in the sands. Water level measurements were made to determine the effectiveness of the silty clay and clay confining beds.

The general water sampling technique used consisted of making a temporary well by setting a 20-foot length of 4-inch screen opposite the sand selected, gravel packing the interval, and sealing the gravel pack with heavy mud. The deepest zones were sampled first, then the screen was pulled up to the next zone, allowing the hole to collapse beneath the zone being tested.

Each zone was developed by washing and jetting with clear water while pumping with air. After the mud cake was washed out and water native to the zone was being produced, a submersible pump was installed and development continued until the water temperature and conductivity stabilized. Pumping then was stopped and the water level allowed to recover. Pumping was restarted and water samples taken.

Chemical Analyses of Water

The analyses of the water samples taken from well DOR-211 are shown in table 3. Water samples collected were analyzed by laboratories of the U.S. Geological Survey in Doraville, Ga.; Arvada, Colo.; and Reston, Va. Samples were collected and analyzed by established procedures (Skougstad and others, 1979). Temperature, pH, bicarbonate and carbonate were determined in the field (Wood, 1976). The pH values were measured ±0.02 units and are reported to two decimal places accordingly. Ion chromatography was used to determine the major anions (Erdmann and others, 1982), although the reported phosphate (PO_4) value is from the standard nutrient method. Samples for trace metals were field prepared for inductively coupled plasma atomic emission spectroscopy (ICP) analysis (plasma-jet analyzer) by filtration through 0.45 µm pore size filters. Dissolved gas samples were collected in an evacuated glass tube (Hobba and others, 1977) preliminary to gas chromatographic analyses. The stable and radioactive isotope samples, and radiochemical samples were collected according to previously established methods within the Geological Survey (Busby and others, 1983).

The four zones sampled were: zone 1, 1,828-1,848 feet; zone 2, 1,765-1,785 feet; zone 3, 1,326-1,346 feet; and zone 4, 580-600 feet. The completed well was sampled at the 1,831-1,851-foot interval.

Water chemistry shows that zone 4 had the lowest concentrations of bicarbonate, calcium, sodium, chloride, silica and dissolved solids. Zone 1 and zone 4 showed the lowest concentration of iron.

Table 3.--Zone water levels, test well DOR-211

Zone tested (feet below land surface)	Development (hours)	Average yield (gpm)	Recovery (hours)	Static water level (feet with reference to land surface) Altitude: 78.03 feet	Water level date
580-600	109	20	20	-15.04	11/3/82
1,326-1,346	115	1.5	20	*+12.0	10/26/82
1,765-1,785	220	1.5	16	+61.4	10/15/82
1,828-1,848	56	8.3	11	+83.0	10/5/82
**1,831-1,851		3-4		+81.1	12/15/82

*Probably incomplete recovery

**Completed well

Table. 4--Chemical data from test well DOR-211

Major Water Chemistry

Well	Sampling depth interval (feet)	Temperature (deg C)	Specific conductance (μMHOS)	pH field (units)	Bicarbonate fet-fld (mg/L as HCO_3)	Carbonate fet-fld (mg/L as as CO_3)	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate dissolved (mg/L as SO_4)	Fluoride dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids residue at 180 deg. C dissolved (mg/L)
DOR 211*	1831-1851	26.6	1290	9.2	340	47	2.6	0.34	340	4.0	144	111	1.12	18	846
DOR 211-1	1828-1848	31.7	1360	8.5	420	10	2.3	0.41	320	2.8	138	102	2.59	18	788
-2	1765-1785	26.3	1280	8.5	460	11	3.2	0.89	330	3.6	144	298	2.25	17	783
-3	1326-1346	26.6	1810	7.7	1130.0	----	6.9	1.5	530	6.3	91.2	5.64	1.92	17	1160
-4	580-600	24.0	278	9.0	150.0	12	2.0	0.48	59	3.0	6.20	27.5	1.90	13	180
E.P.A. Drinking Water Standards											280	250	1.70		

Trace Metals

Well	Barium, dissolved (μg/L as Ba)	Beryllium, dissolved (μg/L as Be)	Boron, dissolved (μg/L as B)	Cadmium, dissolved (μg/L as Cd)	Cobalt, dissolved (μg/L as Co)	Copper dissolved (μg/L as Cu)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Manganese, dissolved (μg/L as Mn)	Molybdenum, dissolved (μg/L as Mo)	Strontium, dissolved (μg/L as Sr)	Vanadium, dissolved (μg/L as V)	Zinc, dissolved (μg/L as Zn)	Aluminum, dissolved (μg/L as Al)	Lithium, dissolved (μg/L as Li)	Selenium, dissolved (μg/L as Se)	Mercury, dissolved (μg/L as Hg)
DOR 211*	99	<1.0	630	<1	<3	<10	20	40	3	30	89	<6	<4	30	16	<1	<0.1
DOR 211-1	27	1.0	2800	1	3	10	3	10	18	30	67	6	4	70	18	<1	<0.1
-2	100	<1.0	2800	<1	<3	<10	86	20	15	50	96	<6	<4	110	21	<1	0.2
-3	270	<1.0	3400	<1	<3	<10	1200	<10	66	50	220	<6	10	20	41	<1	0.1
-4	23	1.0	170	1	3	10	3	10	1	10	35	6	4	<10	5	<1	<0.1
E.P.A. Drinking Water Standards	1000			10		1000	300	50	50				5000				

Table 4.--Chemical data from test well DOR-211-continued

Nutrients and Trace Constituents

Well	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia + organic dis. (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Phosphate, dissolved (mg/L as P)	Phosphorus, dissolved (mg/L as P)	Carbon, organic dissolved (mg/L as C)	Sulfide total (mg/L as S)	Nitrate dissolved (mg/L as NO_3)	Iodide, dissolved (mg/L as I)	Bromide, dissolved (mg/L as Br)
DOR 211*	0.38	0.32	0.70	<0.10	<0.06	0.06	1.1	<0.5	<0.05	0.030	0.56
DOR 211-1	--	<0.29	0.6	<0.10	<0.06	0.05	0.8	<0.5	0.13	0.030	0.54
-2	0.17	--	0.23	<0.10	<0.06	0.07	1.8	0.6	<0.05	0.030	0.65
-3	0.07	0.53	0.6	<0.10	<0.06	0.03	1.5	<0.5	<0.05	0.12	0.36
04	0.11	0.19	0.3	<0.10	<0.06	0.04	0.5	<0.5	<0.05	0.010	<0.10

Radiochemistry, Isotopes, and Dissolved Gases

Well	Carbon 14 percent modern	C-13/C-12 stable isotope ratio (per mil)	H-2/H-1 stable isotope ratio (per mil)	O-18/O-16 stable isotope ratio (per mil)	Tritium (total T.U.)	Carbon dioxide dissolved calculated (mg/L as CO_2)
DOR 211*	6.6	-9.8	-26.0	-4.6	2	0.4
DOR 211-1	<0.7	-9.6	-27.0	-4.6	3	2.2
-2	8.4	-9.1	-24.0	-4.4	2	2.3
-3	5.0	-5.7	-24.5	-4.6	4	34
-4	2.5	-8.8	-26.0	-4.7	2	0.3

The measurement of pH and concentration of sulfate were lowest in zone 3; concentrations of carbonate and potassium were lowest in zone 1. The completed well showed the lowest concentrations of magnesium and fluoride.

Zone 3 showed the highest concentrations of bicarbonate, calcium, magnesium, sodium, potassium, iron and dissolved solids. The highest concentration of sulfate was in zone 2. Zone 1 showed the highest concentration of fluoride. Measurement of pH and concentration of carbonate were highest in the finished well. The concentration of chloride was highest in the completed well and in zone 2, while the highest concentration of silica was in zone 1 and the completed well.

The pH ranges from 7.7 to 9.2 indicating relatively basic water in all sampling zones.

Of the trace metals, the concentrations of beryllium, cadmium, cobalt, copper, vanadium and selenium were relatively low or not detectable throughout the sampling zones and the finished well. Zone 4 showed the lowest concentrations of barium, boron, manganese, molybdenum, strontium, aluminum and lithium. Zone 3 showed the lowest concentration of lead. The lowest concentration of zinc was in the finished well and zone 2. The concentrations of mercury, being fairly constant, were lowest in the finished well, zone 1, and zone 4.

Zone 3 showed the highest concentrations of barium, boron, manganese, strontium, zinc and lithium. The concentrations of aluminum and mercury were highest in zone 2. The highest concentration of molybdenum was in zone 2 and zone 3. The completed well showed the highest concentration of lead.

The waters from the completed well and zone 4 meet the regulations for the Environmental Protection Agency Drinking Water Standards.

SUMMARY

This report contains the data collected from a test well drilled in 1982 in Dorchester County, South Carolina.

Well DOR-211 penetrated surficial deposits of post-Miocene age, and deposits of the Cooper Group (Oligocene and Eocene age), Santee Formation and Fishburne (?) Formation (Eocene age), Black Mingo Formation (Paleocene age), Peedee, Black Creek, Middendorf and Cape Fear Formations (Cretaceous age) before reaching basement at 1,967 feet below land surface. Beds of sand, clay, silt and limestone were penetrated. Glauconite, shell fragments, lignite, phosphate, and feldspar are present.

Data from the wells include description of the core samples, geophysical logs, zone water levels, chemical analysis of the water sampled, and results of tests for mineral content.

The well was drilled to determine the depth and thickness of sand aquifers in Dorchester County, South Carolina.

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APPENDIX

Preliminary Analysis of "Basement" Rocks in USGS DOR-211 Test Well (6/82) St. George, S.C.

Sample Depth:

1967 ft.	Basalt and Diabase: Fine-grained mafic rock with pyroxene and minor olivine in groundmass of feldspar microlites and altered glass(?). The pyroxene is probably both hypersthene and augite and comprises about 25% of the whole rock. Olivine is present in minor amounts (less than 2%) and only as small grains. Small phenocrysts of zoned plagioclase are apparently above An_{30}-An_{40}. Plagioclase microlites are of similar composition and form an interlocking ophitic texture. Small portions of the groundmass are altered to a yellow-green fibrous mineral, possibly chlorite.
1996 ft.	Altered basalt: Similar in composition to sample at 1967 except that over 50% is altered to high-birefringence, fine-grained mineral. Plagioclase microlites are unaltered but phenocrysts are largely replaced. No mafic minerals remain although relict grain boundaries suggest they were present. The rock has scattered, filled vesicles and thin veins of the alteration material.
2037 ft.	Altered basalt: Almost identical to sample at 1996 ft. except that the microlites show signs of alteration in their cores. Bulk sample is light gray and shows signs of crude layering. The vesicles and alteration suggest the interval from 1996 to 2037 ft. may be the top of a flow.
2063 ft.	Unaltered basalt: Fine-grained mafic rock with pyroxene and olivine in a groundmass of crudely aligned feldspar microlites. The dominant mafic mineral is pyroxene which is both hypersthene and augite. Olivine is present in minor amount as small grains and some opaque minerals are present. The mafics comprise about 30% of the rock mass. Calcic plagioclase occurs as poorly aligned microlites and in phenocrysts. Orthopyroxene also occurs on phenocrysts but it generally eroded by alteration. Alteration is minimal (relative to samples above) and is generally restricted to the larger grains. Carbonate minerals (calcite?) have

2063 ft. (cont'd) replaced the groundmass in some areas and the groundmass between the microlites is dark and fuzzy in plain light. This sample shows the first signs of flow texture in aligned microlites. No vesicles are present and the whole rock is dark gray and dense.

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