UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Sample Description and Stratigraphic Correlation of the New Madrid Test Well-1-X, New Madrid County, Missouri

by

Anthony J. Crone

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INTRODUCTION

The New Madrid test well is a research well drilled by the U.S. Geological Survey as part of a continuing series of studies designed to evaluate the earthquake hazards in the northern Mississippi Embayment. The well, drilled in the fall of 1978 reached a total depth of 2316 ft in fractured carbonate rocks of Paleozoic age. At that depth, large volumes of artesian water and caving problems forced a premature completion of the well.

The primary purpose of the well was to collect data on the current tectonic-stress field in the northern embayment; however, the well also provided a unique opportunity to carefully study the stratigraphy in an area where the subsurface geology is poorly understood. More complete stratigraphic information permits better regional correlations, thus providing a clearer picture of the structural and tectonic evolution of the northern Mississippi Embayment. In addition, the geophysical logs and stratigraphic information gathered from the well allowed accurate identification of the key reflecting horizons from nearby seismic reflection profiles (Crone and Russ, 1979; Hamilton and Zoback, 1979).

The test well is located about 21 km south-southwest of the town of New Madrid and about 12 km east-southeast of the town of Portageville on Missouri State Highway 162 in New Madrid County (SW 1/4 SE 1/4 SE 1/4 sec 32, T. 21 N., R. 14 E.) (fig. 1). The ground elevation at the well site is 284 ft (86.5 m) above mean sea level. The geophysical logs and the samples are referenced to the kelly bushing on the drill rig which had an elevation of about 288.5 ft (87.9 m). In this report, measurements associated with the drilling of the well are cited in English units to maintain consistency with standard drilling useage.

The well was drilled with a truck-mounted rotary drilling rig. Depending on the characteristics of the formations being penetrated, various intervals were drilled with a drilling fluid of either water, air, or bentonite mud. Three strings of casing were run in the well: 140 ft of 12 1/2 in. diameter surface casing, an intermediate string of 9 5/8 in. casing to 1400 ft, and a string of 6 5/8 in. casing to 2060 ft. A complete suite of geophysical logs was useful for accurately identifying formation boundaries and for making regional correlations.

CORING AND SAMPLING PROGRAM

An ambitious program of coring and sampling was originally scheduled for the New Madrid well to collect as much detailed stratigraphic, paleontologic, and palynologic information as possible, but as drilling proceeded, the program had to be modified. However, with few exceptions, generally good samples were collected at about 5-ft intervals throughout the entire depth of the well. Samples of cuttings, compensated for lag time, were collected directly from the flowline attached to the well head. A driller's log was maintained to record any significant on-site observations and to provide a preliminary set of sample

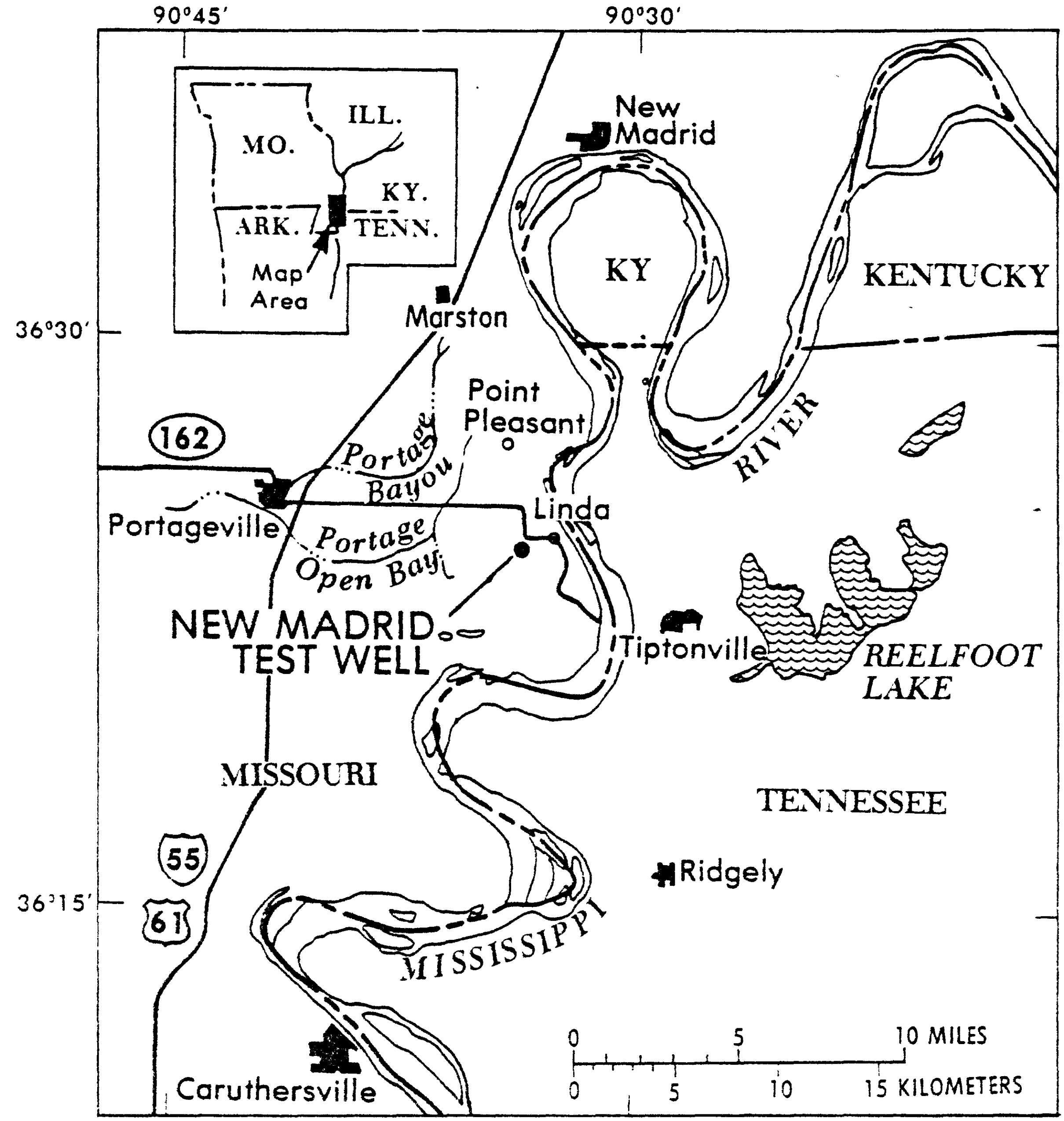

Figure 1.--Location of the New Madrid test well.

descriptions (Crone and Russ, 1979). The unconsolidated nature of the Cretaceous and Tertiary sediments, particularly the silts and clays, made it difficult to clean and wash the cuttings without disaggregating and destroying the samples. Because of this problem, some descriptions of the finer-grained intervals in this report rely on color and textural information from the driller's log which was obtained from fresh samples at the drill site.

The coring program in the test well was generally plagued by very poor recovery with two notable exceptions: nearly all of the Porters Creek Clay was successfully cored with high recovery rates providing excellent samples for faunal and floral studies, and several intervals of the McNairy Sand, which were extensively cemented by pyrite, yielded good cores. The depth control on the cores is generally very accurate (table 1). As soon as it became obvious that the coring program would be plagued by recovery problems, samples of cuttings were collected while still coring so that at least some samples were available for lithologic descriptions.

DESCRIPTION OF SAMPLES FROM THE NEW MADRID TEST WELL

A systematic description of the samples from the New Madrid test well combined with data from the geophysical logs provides detailed information about the stratigraphy and lithologies encountered in the well (Maher, 1959). Conventional techniques for the examination of drill cuttings were used to describe the lithology of the individual samples, but due to variable lag times and other complicating factors, the samples provided only approximate formation boundaries. The formation contacts in the test well were chosen primarily on the basis of characteristic deflections on the geophysical logs in conjunction with lithologic data from the samples (table 1). The formation boundaries from the geophysical logs are probably accurate to within a few feet and are more easily recognized than the boundaries indicated by the samples. In addition, the geophysical logs can be confidently correlated with similar logs from other wells in the northern Mississippi Embayment to establish reliable regional correlations.

Table 1.--Description of samples and related information from the New Madrid test well

Depth to Formation Tops

(numbers in parentheses are referred to sea level)

Jackson Formation	135?(+153)
Claiborne Group	
Cockfield Formation	270(+18)
Cook Mountain Formation	415(-127)
Memphis Sand	593(-305)
Wilcox Group	
Flour Island Formation	1048(-760)
Fort Pillow Sand	1186(-898)
Old Breastworks Formation (?)	1339?(-1051)
Midway Group	
Porters Creek Clay	1377?(-1089)
Clayton Formation	1691(-1403)
McNairy Sand (and Owl Creek Formation?)	1703(-1415)
Paleozoic bedrock	2023(-1735)

Cored Intervals

(unless otherwise indicated, complete core recovered from listed intervals)

1415-1435	
1450-1460	
1467-1511.5	
1515-1531:	recovered 2.5 ft
1534-1560	
1561-1581	
1582-1610	
1626-1656	
1658-1688	
1689-1697	
1698-1701	
1703-1704	
1769-1782	
1788-1791	
1797-1799	
1814-1816	
1817-1823:	recovered 2 ft
1835-1838:	recovered 1.5 ft
1852-1862:	recovered 2 ft
1898-1902	
2021.5-2022.5	
2022.5-2026:	recovered 1.5 ft
2026-2027.5:	recovered 1 ft
2060-2083?:	recovered 1 ft
2083?-2106:	recovered 1 ft

Depth (ft)	Description
0-10	Clay, light-gray to light brown-gray, silty, non-calcareous; lignite common; very rare detrital glauconite; locally mottled orange from iron oxide; contains floating very fine to coarse sand-sized grains of quartz and rock fragments.
10-120	Sand, light-brown to white-brown, fine- to very coarse grained, quartzose, subangular to rounded; lignite common; igneous, metamorphic, and sedimentary rock fragments comprise up to 15 percent of samples; chert common; trace silicified crinoid columnals and bryozoan(?) fragments; contains lenses and beds of gravel with grains up to 6 mm in size.
120-135	Gravel, light buff-brown to light-gray, angular to rounded; good sorting; lignite common; contains quartz, chert, silicified limestone, feldspars, igneous and metamorphic rock fragments.
135-250	Sand, light steel-gray to white-gray, medium- to very fine grained, silty, argillaceous, quartzose, angular to rounded; lignite common; rare pale-green detrital glauconite; locally laminated; interbedded with silt, light gray-white to "off-white", argillaceous, lignitic; trace mica; slightly calcareous. No samples from 140-145 and 150-165.
250-270	Sand, light white-gray, medium- to very coarse grained, quartzose, subangular to rounded; lignite abundant with twigs and woody fragments; locally cemented with pyrite; rock fragments and chert common.
270-299	Silty clay and clayey silt, light gray-white to light brown-gray, slightly calcareous; abundant black, vitreous to earthy lignite and finely disseminated carbonaceous material; some brown coloration may be staining from organic material.
299-313	Sand, light-gray to light brownish-gray, medium- to fine-grained, quartzose; locally cemented with pyrite; grading to silt toward base.
313-345	Silt, light-gray to brownish-gray, argillaceous, slightly calcareous; finely disseminated organic material produces "salt and pepper" appearance; contains few interbeds of sand.

Depth	Description
345-375	Silt, light white-gray, calcareous, argillaceous, sandy; lignite common; "salt and pepper" appearance; contains scattered grains of orange-brown, hard, limonitic material near base.
375-399	Lignite, dark-gray to black, earthy to vitreous, silty; some fragments have woody texture; interbedded with silt, medium- to dark-gray; stained with organics.
399-403	Silt, medium- to dark-gray and brownish-gray, argillaceous, sandy; abundant lignite.
403-415	Sand, light gray-brown to white-buff, medium- to fine-grained, angular to subrounded; lignite common; trace of coarser grains.
415-419	Silt, light-gray to buff, argillaceous; interbedded with lignite, black to dark-gray, soft, earthy to vitreous luster; remnants of woody texture.
419-426	Sand, light-gray to light-buff, medium- to fine-grained, quartzose, angular to subrounded; few coarser grains; lignite common.
426-459	Silt, gray to light-gray, argillaceous, sandy, slightly calcareous; with lignite, black to dark peat-brown, dull.
459-524	Clay, light-gray to slightly buff-gray, soft, silty, waxy luster; lignite common to abundant; rare pale-green detrital glauconite grains; few floating sand grains.
524-593	Silty clay, light-gray to buff-gray, sandy; trace lignite; rare pale mint-green detrital glauconite grains; increase in sand near base.
593-634	Sand, white to gray-white, medium- to coarse-grained, quartzose, subangular to rounded; trace lignite; trace pyrite; trace feldspars and igneous rock fragments; becoming slightly silty near base.
634-651	Silt, light white-gray to light buff-gray, argillaceous, soft, sandy, noncalcareous; trace mica; contains finely disseminated organic material.

Depth	Description
651-692	Sand, light gray-white, medium- to coarse-grained, quartzose, subangular to rounded; polished grains common; black, vitreous lignite common with some fragments larger than 1 cm in diameter; pyrite cementing aggregates of grains common.
692-696	Lignite, black, soft, earthy to vitreous luster; remnants of woody texture; locally is extensively replaced by pyrite.
696-814	Sand, medium- to fine-grained, quartzose, angular to subrounded; occasional coarse- to very coarse-sand-size grains; black lignite with woody texture and vitreous luster common to abundant; trace pyrite; rare, silt-size, pale mint-green detrital glauconite; trace dark-gray rock fragments becoming more common in lower part.
814-817	Lignite, black to slightly brownish-black, soft, earthy to vitreous, slightly silty.
817-906	Sand, fine- to coarse-grained, quartzose, subangular to rounded; locally grades to very coarse sand and fine gravel; well-rounded, polished grains common; lignite common to abundant; rock fragments common; trace pyrite that locally cements grains into aggregates; rare silt-size, bleached, detrital glauconite.
906-909	Lignite, black to dark-brown, soft, vitreous to earthy; trace of woody texture in some fragments.
909-1048	Sand, light-buff to white-gray, fine- to very coarse-grained, quartzose, subangular to rounded, unconsolidated; black to dark-brown lignite rare to common; pyrite rare to common; dark-gray chert and igneous(?) rock fragments locally abundant; rare mica; very rare silt-size detrital glauconite.
1048-1065	Clay, medium-gray to tan-gray, silty, noncalcareous; trace black to dark-brown, woody, soft lignite; trace fine mica.
1065-1186	Silt, medium-gray to buff-gray, argillaceous, sandy, micaceous; trace lignite; interbedded with sand, medium-gray to slightly yellowish-gray, fine- to very fine-grained, silty, argillaceous, micaceous; trace black, woody lignite; trace pyrite; very rare silt-sized, bleached detrital glauconite.

Depth	Description
1186-1264	Sand, light-gray to white-gray, very fine- to coarse-grained, quartzose, silty, argillaceous, micaceous, angular to subrounded; lignite common; trace pyrite; coarser grains tend to be polished and more rounded.
1264-1339	Sand, medium- to very coarse-grained, quartzose, angular to rounded; lignite common; pyrite and mica common to rare; rare silt-size, pale-green, detrital glauconite; better sorted than overlying sand.
1339-1377	Silt and silty clay, medium- to light-gray and yellow-gray, sandy, micaceous, noncalcareous; pyrite common; lignite common; light-green, white, and brown clay noted in drillers log.
1377-1405	Silty clay, light yellow-gray and dark steel-gray, micaceous, laminated, noncalcareous; locally grades to very fine sand; abundant fine disseminated black and dark-brown organic material; locally burrowed with light-gray silt filling burrows.
1405-1415	No samples.
1415-1460	Clay, steel-gray to dark-gray, micaceous, hard, noncalcareous; slightly silty in upper part; hackly to conchoidal fracture; abundant black finely disseminated organic matter; locally mottled with light-gray.
1460-1467	No samples.
1467-1511 1/2	Clay, steel-gray, micaceous, hard, noncalcareous; conchoidal to hackly fracture; locally mottled with yellow-buff color; locally contains minor silt; trace fish-scale fragments and microfossils; fine disseminated black organic material common; irregular patches of microcrystalline pyrite that selectively replaces organic material are common.
1511 1/2-1515	No core recovery.
1515-1531	Clay, steel-gray to slightly yellowish-gray, silty, micaceous; calcareous and noncalcareous microfossil and macrofossil fragments common.
1531-1534	No core recovery.

Depth	Description
1534-1569	Clay, steel-gray to dark-gray, micaceous, hard, calcareous, fossiliferous; trace of silt; trace black organic material; fish scales, microfossils and macrofossil fragments common.
1569-1577	No core recovery.
1577-1610	Clay, steel-gray, micaceous, hard, slightly silty, slightly calcareous; microfossil and macrofossil fragments common; concentrations of mica and possibly remains of calcareous microfossils produce light gray laminae; trace pyrite with iron oxide halos.
1610-1626	No recovery - faulty core catcher.
1626-1673	Clay, steel-gray to light-gray, hard, micaceous, silty, calcareous; locally becoming dark-gray; microfossil and macrofossil fragments common.
1673-1691	Clay, olive-gray to light green-gray, hard, silty, micaceous, calcareous, fossiliferous, glauconitic; becoming subfissile; dark-green pelletal and botryoidal glauconite abundant and locally composing 20-30 percent of sediment; microcrystalline pyrite associated with glauconite; microfossils very abundant.
1691-1703	Marl, greenish-white, very fossiliferous, very glauconitic, lithified; contains up to 60 percent glauconite some of which is locally oxidized to yellow-brown; trace microcrystalline pyrite; locally grades into gray-white, glauconitic limestone; interbedded with clay, green-gray, silty, calcareous, very glauconitic, fossiliferous.
1703-1720	No samples.
1720-1750	Sand, medium- to very fine-grained, quartzose, micaceous, angular; black woody lignite common; trace fine-crystalline pyrite; few rounded coarse sand-size grains; mica flakes up to 1 mm in size; trace dark-gray chert; rare light-buff to yellow-gray siderite.
1750-1769	No samples.
1769-1792	Silt, medium- to dark-gray, micaceous, argillaceous, sandy, carbonaceous, laminated; abundant carbonized wood that is locally replaced and cemented by pyrite

Depth	Description
	and bornite(?); pyrite locally oxidized; contains laminae and lenses of gray-white, fine-grained sand.
1792-1812	Sand, gray to white, medium- to fine-grained, quartzose, micaceous, carbonaceous, argillaceous; fair sorting; trace fine-crystalline pyrite; interlaminated with sand, white, medium- to fine-grained, quartzose, glauconitic, well-sorted; trace mica; rare buff to yellow-gray siderite.
1812-1814	No samples.
1814-1816	Silt, medium- to dark-gray, argillaceous, sandy; irregularly interlaminated with sand, white, medium- to fine-grained, quartzose; trace glauconite; locally contains large carbonized wood fragments which are completely cemented and partially replaced by pyrite, chalcopyrite, bornite(?) and calcite.
1816-1817	No sample.
1817-1847	Sand, white- to yellow-gray, medium- to fine-grained, quartzose, micaceous; trace glauconite, trace pyrite: locally cemented with calcite; contains abundant carbonized wood fragments; locally contains subangular to rounded clasts of gray silt; interbedded with silt, light- to dark-gray, argillaceous, sandy, micaceous, carbonaceous; trace glauconite; rare buff to yellow-gray siderite.
1847-1852	No samples.
1852-1859	Clay, dark-gray to steel-gray, soft, micaceous, laminated, noncalcareous, slightly silty; locally sandy; contains carbonized wood fragments which are partially replaced by pyrite.
1859-1872	Sand, white-gray, medium- to fine-grained, quartzose, angular to subrounded, micaceous; trace glauconite; slightly calcareous; trace pyrite.
1872-1885	No samples.
1885-1908	Clay, steel-gray, soft, laminated, slightly silty, slightly calcareous; locally micaceous; trace pyrite: interbedded and interlaminated with sand, white, fine- to very fine grained, quartzose, micaceous; rare buff to yellow-gray siderite.

Depth	Description
1908-1933	Sand, white-gray, medium- to coarse-grained, quartzose; trace mica; trace glauconite; carbonized wood common and often partially replaced by pyrite; rare siderite as above.
1933-1943	Silt, steel-gray, argillaceous, sandy, micaceous; interbedded with sand, as above; rare siderite as above.
1943-1995	Sand, medium- to coarse-grained, quartzose, micaceous, silty; glauconite common; slightly calcareous; trace of milky quartz and reddish-pink feldspars; pyrite common to abundant; trace buff to yellow-gray siderite.
1995-2004	Clay, medium- to dark-gray, silty, micaceous; slightly calcareous; trace soft, white clay; trace lignite(?).
2004-2023	Sand, light-gray to yellow-brown, medium- to fine-grained, micaceous; glauconite common; trace white and brown chert; fragments of light-gray, microcrystalline dolomite becoming common to abundant near base.
2023-2028	Dolomite, medium- to dark-gray, fine- to coarse-crystalline, dense; trace disseminated pyrite; healed and partially healed joints and fractures common; locally recrystallized to coarse-crystalline, white dolomite; in upper part interbedded with limestone, medium to dark-gray, fine-crystalline to aphanitic; rare sand grains; disseminated organic material common; contains irregular laminations of black, silty limestone; no hydrocarbon residue detected.
2028-2060	Dolomite, medium- to dark-gray and white, coarse-crystalline, dense; trace disseminated pyrite; trace yellow-buff, fine-crystalline dolomite.
2060-2063	No samples.
2063-2064(?)	Dolomite, dark-gray, fine-crystalline, vuggy; locally mottled with white, recrystallized dolomite; vugs up to 2 cm in diameter lined with dolomite rhombohedrons; trace very fine-crystalline pyrite on rhombohedrons.

Depth	Description
2064(?)-2083	No samples.
2083-2110	Dolomite, gray to white, fine- to coarse-crystalline; pyrite locally abundant; locally stained yellow-orange from iron oxide.
2110-2315	Dolomite, gray to white, fine- to coarse-crystalline, dense; pyrite and chalcopyrite(?) locally abundant; locally contains doubly terminated authigenic quartz crystals up to 4 mm long; minor intercrystalline porosity; contains several fractured zones that produce artesian water.

STRATIGRAPHY OF THE NEW MADRID WELL AND CORRELATION WITH THE FORT PILLOW TEST WELL

The detailed stratigraphic relationships of the post-Paleozoic sediments in the northern Mississippi Embayment are, at present, only partially understood. This is due, in large part, to the limited number of well in the area that have good quality geophysical logs and detailed lithologic information. The New Madrid test well is important because it provides this type of essential stratigraphic information in a portion of southeast Missouri where virtually no data existed previously. The paleontologic and palynologic data from the test well help to define important time-stratigraphic boundaries (N. O. Frederiksen, written communication) that are then useful in recognizing regional facies relationships.

The Fort Pillow test well (fig. 2) in Lauderdale County, Tenn., is a key stratigraphic control point in the northern Mississippi Embayment because a set of good quality electrical logs from the well has been combined with detailed lithologic, paleontologic, and palynologic information (Moore and Brown, 1969). Data from the Fort Pillow well permitted Moore and Brown (1969) to refine the Eocene subsurface stratigraphy in western Tennessee and allowed them to divide the Wilcox Group into the Old Breastworks Formation, the Fort Pillow Sand, and the Flour Island Formation. The test well was designated the typical locality for these three formations by them.

On the basis of geophysical logs and sample descriptions (fig. 3; table 1), the Cretaceous and Tertiary stratigraphy in the New Madrid test well can be easily correlated with the Fort Pillow well, even though the formations are considerably thinner to the north (table 2). The post-Paleozoic sediments have a cumulative thickness of over 3100 ft in the Fort Pillow well but, in the New Madrid well, they are only about 2000 ft thick. The Upper Cretaceous Series in the Fort Pillow well is subdivided, in ascending order, into the Coffee Sand, Demopolis Formation, Coon Creek Formation, McNairy Sand and possibly the Owl Creek Formation whereas only the McNairy Sand is definitely recognized in the New Madrid well.

The depositional environment of the McNairy Sand in the New Madrid well is uncertain because of conflicting evidence. The abundant carbonized wood fragments indicate either non-marine deposition or at least a major terrestrial source area nearby. However, the presence of glauconite which can be observed in intact core samples suggests a distinctly marine depositional environment (Pettijohn, 1957; Grim, 1968). Some of the glauconite may be reworked from older deposits, but it is doubtful that all of it is reworked because many of the grains do not appear to be abraided and there is no known substantial supply of glauconite from nearby source areas. The preferred explanation to reconcile this apparently conflicting evidence is that the McNairy Sand in the vicinity of the test well was deposited under shallow marine conditions adjacent to the shoreline where abundant terrestrial organic debris could be washed

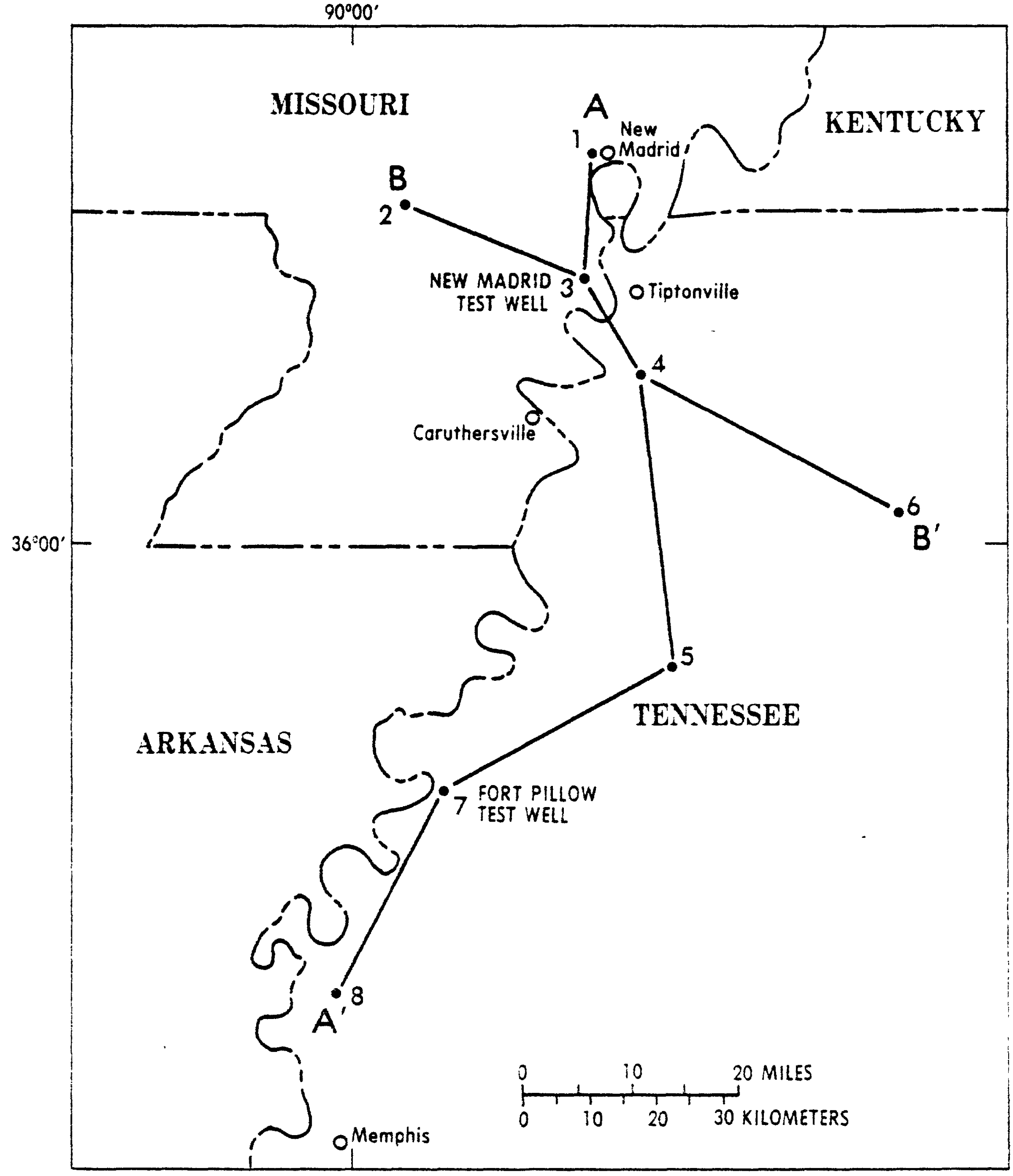

Figure 2.--Location of the Fort Pillow test well and regional geologic sections. Solid dots with numbers show locations of wells used to construct stratigraphic cross-sections A-A' and B-B'. Well numbers are keyed to Table 3.

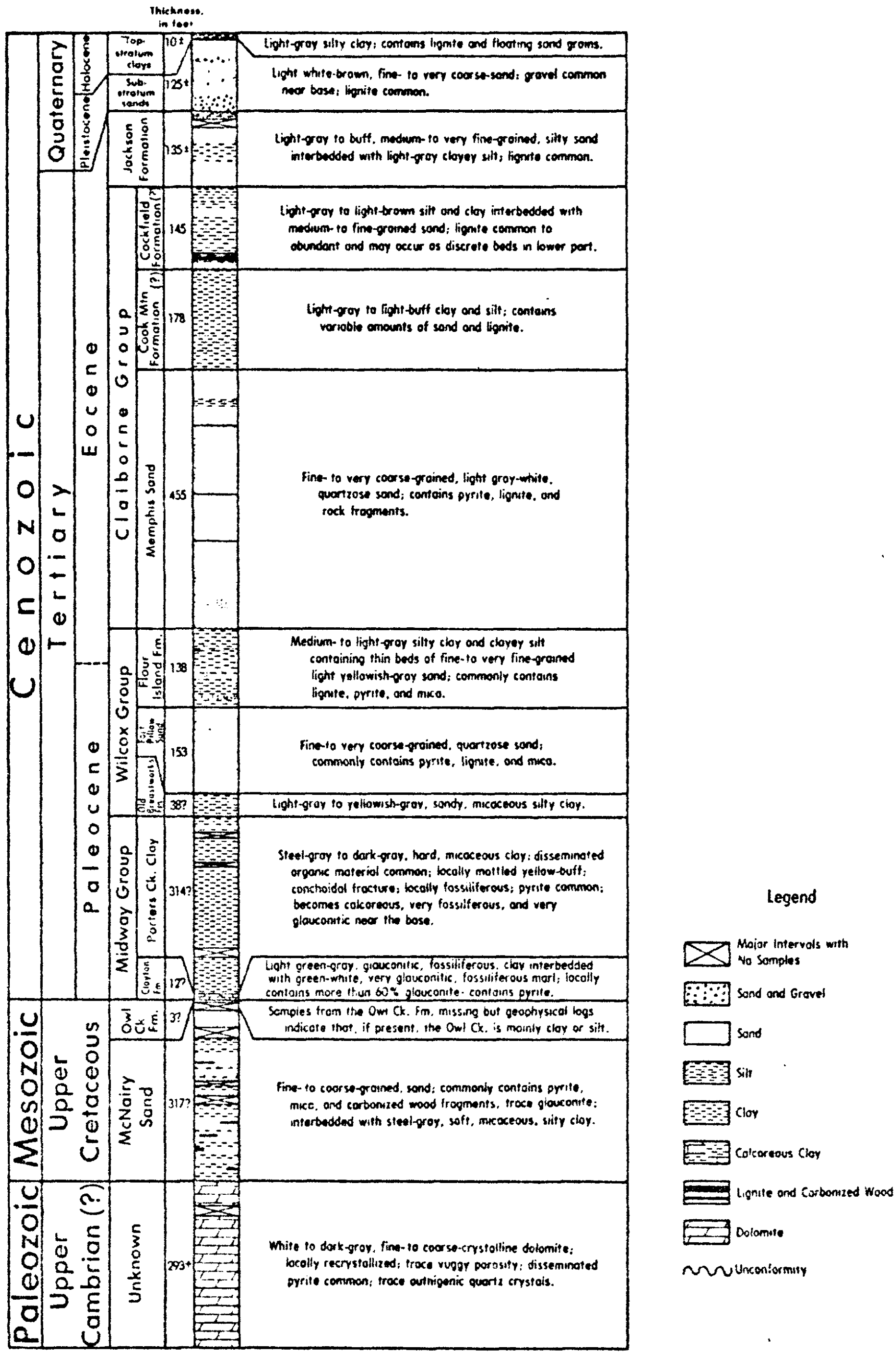

Figure 3.--Columnar section of the New Madrid test well.

Table 2.--Comparison of thickness of Cretaceous and Tertiary sediments.
[thickness in feet]

	Fort Pillow test well (Moore and Brown, 1969)	New Madrid test well (this report)
Claiborne Group		
Cockfield Fm.	202?	145
Cook Mountain Fm.	198?	178
Memphis Sand	699	455
Wilcox Group		
Flour Island Fm.	196	138
Fort Pillow Sand	163	153
Old Breastworks Fm.	280	38?
Midway Group		
Porters Creek Clay and Clayton Fm.	404	326
McNairy Sand (and Owl Creek Fm. if present)	791*	320

*In the Fort Pillow well, the thickness shown for the McNairy Sand includes the thickness of the Upper Cretaceous Coon Creek and Demopolis Formations, and the Coffee Sand.

into the sea and incorporated into the marine sediments. Fluctuations in the shoreline probably resulted in periods of time when marine deposition dominated while at other times non-marine conditions prevailed. This interpretation is consistent with the paleogeographic reconstructions of both Stearns (1957) and Pryor (1960).

The overlying Paleocene Midway Group is lithologically similar in both wells but is considerably thinner in the New Madrid well. The base of the Midway Group is readily identified by the fossiliferous, glauconitic marl of the Clayton Formation, but the upper boundary is much more difficult to recognize and may be represented by a gradational contact between the Porters Creek Clay and the overlying sediments of the Wilcox Group.

Detailed log correlations show that the subdivisions of the Wilcox Group in the Fort Pillow well can be traced in the subsurface to the New Madrid well in southeastern Missouri (Russ and Crone, 1979). It remains uncertain whether the Old Breastworks Formation, the basal formation of the Wilcox Group in the Fort Pillow well, can be definitely identified in the New Madrid well (fig. 4). In the New Madrid well, the light-gray to yellowish-gray, lignitic, silty clay described in the samples between 1339 ft and 1405 ft is lithologically similar to the Old Breastworks Formation at the type locality. This interval of silty clay occupies the appropriate stratigraphic position between the overlying Fort Pillow Sand and the hard, steel-gray clays below which typify the Porters Creek Clay. Also, the geophysical logs suggest that a thin section of the Old Breastworks Formation may be present in the New Madrid well. Tentatively, a 38-ft thick interval between 1339 and 1377 ft is assigned to the Old Breastworks Formation. Palynologic studies, currently in progress, will hopefully resolve some of the uncertainty in this correlation.

The Fort Pillow Sand in the New Madrid well is represented by 153 ft of fine- to coarse-grained sand between the depths of 1186 ft and 1339 ft. This fresh-water aquifer, equivalent to the "1400-foot" sand of Klaer (1940) and Stearns (1957), is typically recognized by its high resistivity on electrical logs (fig. 4).

The 138-ft-thick sequence of gray silt, clay, and fine-grained sand that overlies the Fort Pillow Sand is correlated with the Flour Island Formation in the Fort Pillow well. On electrical logs, the argillaceous character of the Flour Island Formation results in a more positive self-potential curve and lower resistivity than the fresh-water sands above and below it.

Regional correlations of the New Madrid test well confirm that sediments of the Claiborne Group extend into southeastern Missouri in the subsurface (Russ and Crone, 1979). The Memphis Sand and the Cook Mountain Formation are definitely identified but the presence of the Cockfield Formation is problematical.

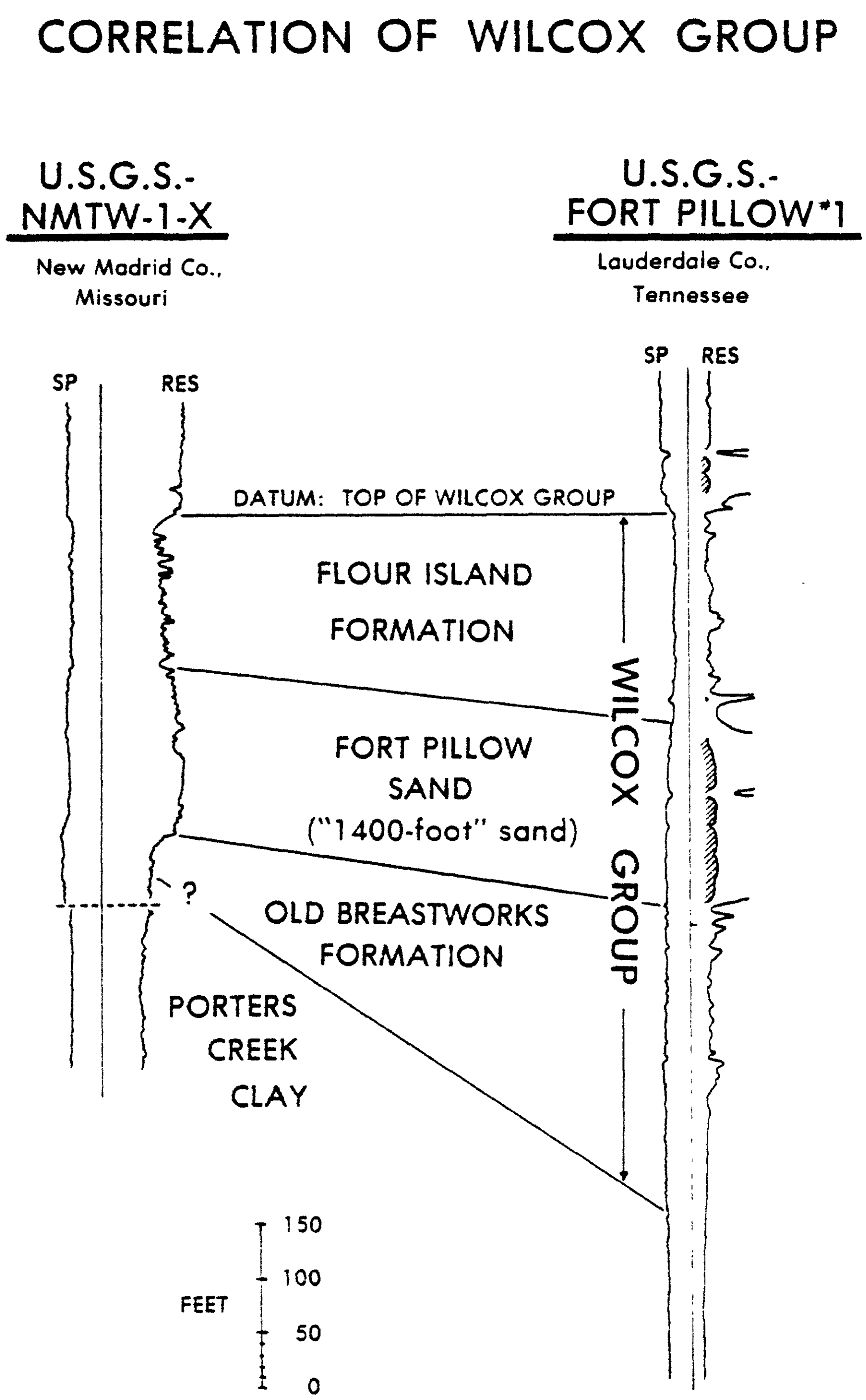

Figure 4.--Correlation of the Wilcox Group in the New Madrid and Fort Pillow test wells. Locations of the wells are shown in figure 2. Hachured areas of log show zones of high resistivity which caused off-scale excursions. Dashed horizontal line in New Madrid test well log is the break between run 1 and run 2. Formation contacts queried where uncertain.

The Memphis Sand, the basal formation of the Claiborne Group in the northern Mississippi Embayment, is an important aquifer that is also informally known as the "500-foot" sand (Stearns, 1957; Moore and Brown, 1969). In the New Madrid well, 455 feet of medium- to very coarse grained sand between the depths of 593 ft and 1048 ft is correlated with the Memphis Sand. The Memphis Sand in the well was slightly artesian but no measurements of the hydrostatic head were made.

Sharp breaks in both the self-potential and resistivity curves mark the contact between the Memphis Sand and the overlying silts and clays of the Cook Mountain Formation (fig. 5). The upper boundary of the Cook Mountain Formation is less distinct and subject to interpretation, but if the contact tentatively identified by Moore and Brown (1969) is traced to the New Madrid well, about 178 ft of the formation is indicated.

The presence of the Cockfield Formation in the New Madrid well is uncertain but is suggested by well-log correlations. The contact between the Cockfield Formation and the overlying Jackson Formation could not be firmly established in the Fort Pillow well (Moore and Brown, 1969) and is equally as difficult to recognize in the New Madrid well. A slight change in the character of the self-potential curve and marked changes in the character of the gamma-ray and resistivity logs at a depth of 270 feet in the New Madrid well (Crone and Russ, 1979) suggest a prominent lithologic change that may coincide with the Jackson Formation-Claiborne Group contact. If this is the contact then the Cockfield Formation is about 145 ft thick.

Pollen analysis has definitely recognized Jackson-age sediments in the New Madrid well (N. O. Frederiksen, written communication), but reworking of older pollen and uphole contamination make it difficult to select a specific lower boundary. As mentioned, the logs suggest a possible lower contact at 270 ft indicating perhaps 135 ft of Jackson Formation in the well. Although the thickness remains uncertain, the pollen analyses are significant because they show that the Jackson Formation, exposed along the bluffs in western Kentucky (Finch, 1971a; Finch, 1971b) and western Tennessee, does indeed extend in the subsurface into southeastern Missouri.

REGIONAL GEOLOGIC SECTIONS

Two geologic cross-sections were constructed to visually demonstrate some of the major regional stratigraphic and structural relationships in the northern embayment area. The locations of the sections are shown on figure 2 and the control wells are listed in table 3.

Geologic section A-A' (fig. 6) runs roughly down the axis of the embayment and shows the gradual updip thinning of the entire post-Paleozoic section. The electrical logs show that the major Upper Cretaceous and Tertiary stratigraphic units identified in the Fort Pillow well (well 7) can be correlated thoroughout the northern

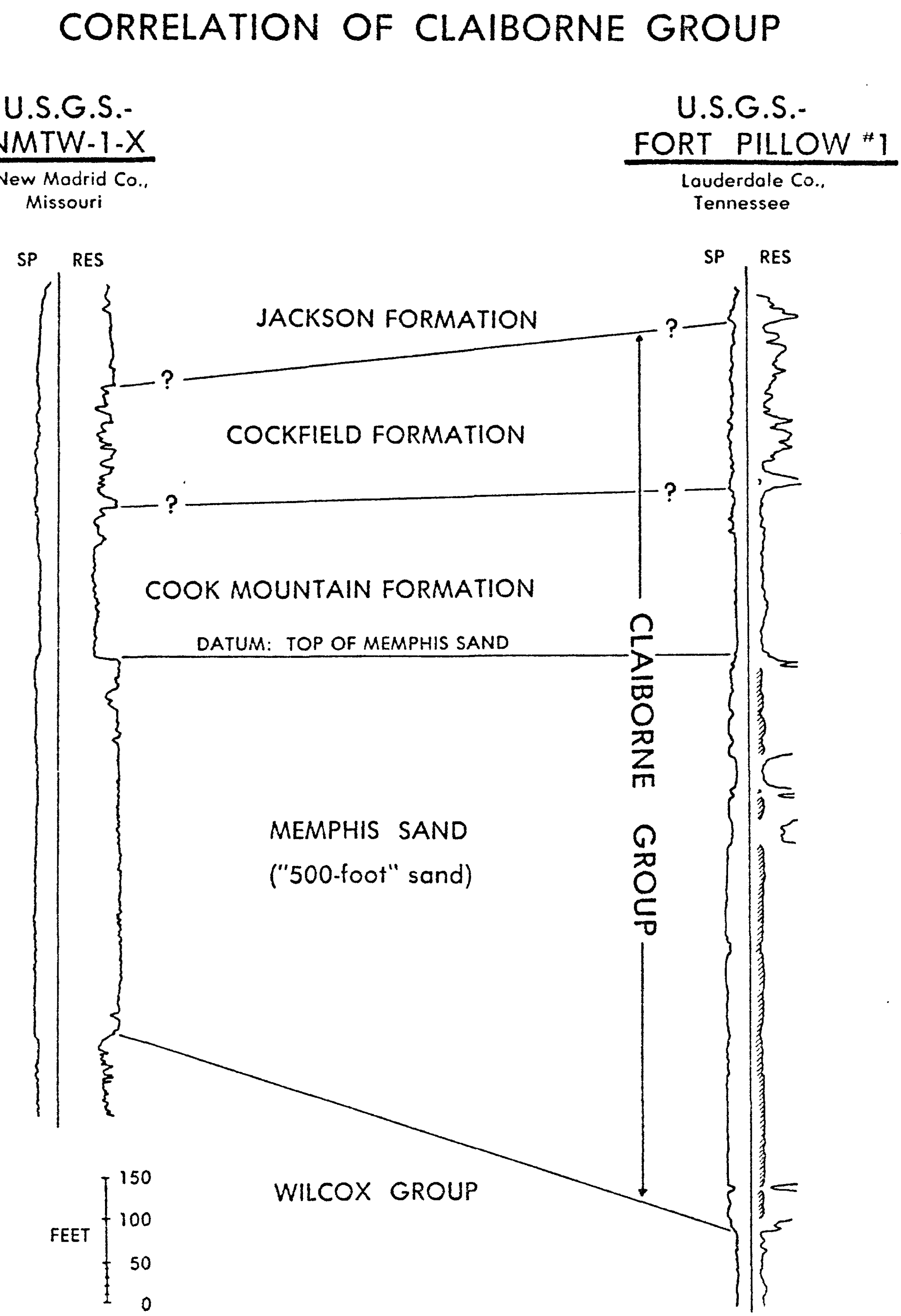

Figure 5.--Correlation of the Claiborne Group in the New Madrid and Fort Pillow test wells. Locations of the wells are shown in figure 2. Hachured areas of log show zones of high resistivity which caused off-scale excursions. Formation contacts queried where uncertain.

Table 3.--Well control for stratigraphic sections.

Well Number on figure 2	Company or Driller	Well Name	Location
1.	Cordova - Union	#1 E. Phillips	New Madrid Co., Missouri
2.	U.S. Bureau of Mines	#1 Oliver	New Madrid Co., Missouri
3.	U.S. Geological Survey	New Madrid test well 1-X	New Madrid Co., Missouri
4.	Corley, Geiselman, and Benz	#1 J. E. Vaughn	Lake Co., Tennessee
5.	Raymond Gear	#1 T. A. Lee	Lauderdale, Co., Tennessee
6.	L. M. Watson	#1 Vance Holt	Gibson Co., Tennessee
7.	U.S. Geological Survey	Fort Pillow test well	Lauderdale Co., Tennessee
8.	U.S. Geological Survey-Tennessee Department Conservation	USGS SH:TL8	Shelby Co., Tennessee

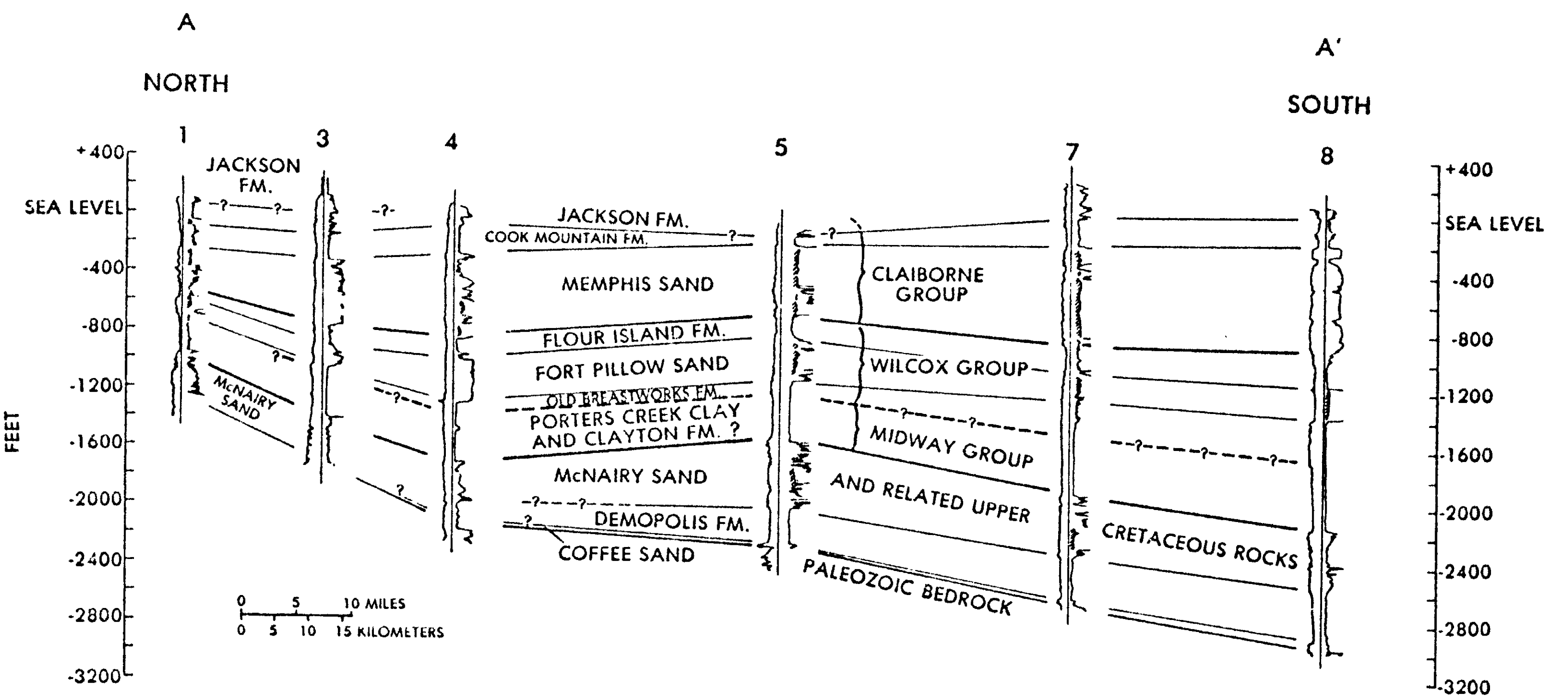

Figure 6.--Stratigraphic cross-section A-A'. Location of cross-section shown on figure 2. Well numbers are keyed to table 3. Hachured areas of logs show zones of high resistivity which caused off-scale excursions. Formation contacts queried where uncertain.

embayment at least as far north as the town of New Madrid (well 1), even though the total thickness of the sediments is reduced by one-half.

Section B-B' (fig. 7) is nearly perpendicular to the embayment axis and shows the obvious synclinal character of the embayment. The present axis of the syncline is located near well 4 and approximately coincides with the modern course of the Mississippi River (Cushing and others, 1964, p. B21). During Late Cretaceous time the depositional axis was east of its present location (Stearns and Armstrong, 1955). The influence of this eastern axis is seen by the gradual southeasterly thickening of Upper Cretaceous sediments, particularly between wells 4 and 6. By the time the Wilcox Group was deposited in late Paleocene and early Eocene, the axis had shifted to the west, close to its present location (Stearns and Armstrong, 1955). This westward shift in the early Tertiary is indicated by the thinning of the Wilcox Group to the northwest and southeast of well 4. The correlations also suggest that the axis that was established during deposition of the Wilcox Group did not shift significantly during deposition of the Claiborne Group. However, the correlations in the Claiborne Group are generally more tenuous, and in well 6, they are especially weak because of lack of data.

CONCLUSIONS

The New Madrid test well is an important subsurface control point in the northern Mississippi Embayment where reliable well control is sparse. Detailed lithologic and paleontologic studies of samples from the well, combined with a complete suite of geophysical logs, have refined stratigraphic boundaries and have allowed regional correlations to be confidentally established.

The correlations show that the Upper Cretaceous Series in the New Madrid well consists of only the McNairy Sand; the other Upper Cretaceous formations described in southwestern Tennessee cannot be traced throughout the northern Mississippi Embayment.

Detailed correlations have refined the Eocene stratigraphy in southeast Missouri. The subdivisions of the Wilcox Group defined in the Fort Pillow test well can be extended northward to the New Madrid well. The Flour Island Formation and the Fort Pillow Sand are easily recognized, but the presence of the basal unit, the Old Breastworks Formation remains uncertain. Also, correlations show that the Claiborne Group and Jackson Formation occur in the subsurface in southeastern Missouri. The Memphis Sand and overlying Cook Mountain Formation of the Claiborne Group are definitely present, but a third unit, the Cockfield Formation is only tentatively identified.

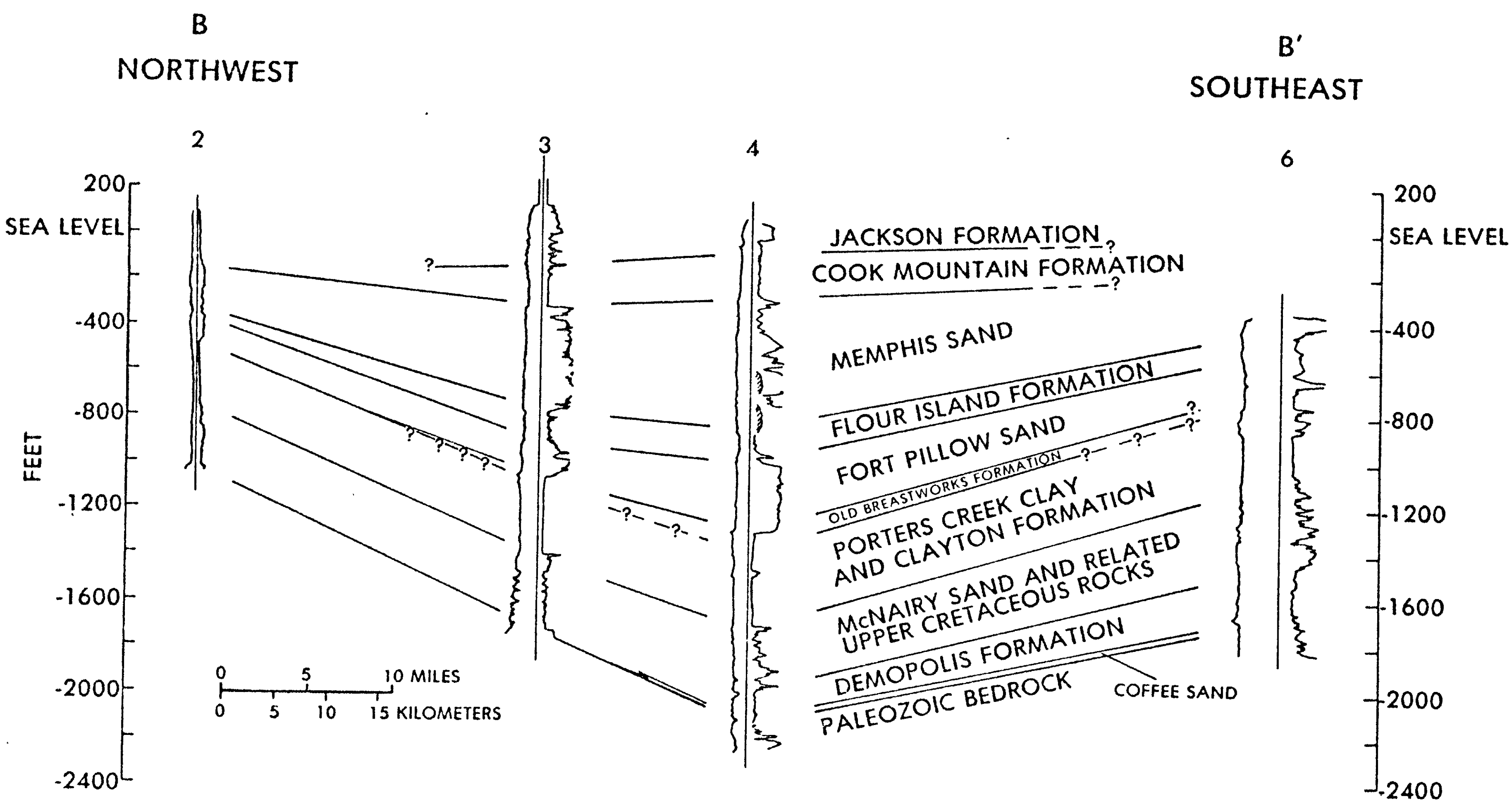

Figure 7.--Stratigraphic cross-section B-B'. Location of cross-section shown on figure 3. Hachured areas of log show zones of high resistivity which caused off-scale excursions. Formation contacts queried where uncertain.

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