DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1875 (SHEET 1 OF 2)

INTRODUCTION

The U.S. Geological Survey is conducting a regional water-resources investigation of the Gulf Coastal Plain, which includes all of the Mississippi Alluvial Plain of southeastern Missouri, locally known as the southeast lowlands. The purpose of the regional study is to describe and evaluate the major aquifer systems in sediments of Tertiary and younger age in parts of 10 States (Grubb, 1984). In the southeast lowlands of Missouri, the subsurface stratigraphy and structural configuration of geologic units need to be described in detail to define the major aquifer systems in the area. The purpose of this report is to describe the subsurface geologic framework for Paleozoic, Mesozoic, and Cenozoic units in the southeast lowlands of Missouri and to correlate these units to those in adjacent States using geophysical and geologic methods (index map). Geophysical logs of wells were used to determine which units are aquifers or confining beds. The drilling of the U.S. Geological Survey test well 1-X in New Madrid County, Missouri, and the subsequent interpretation of geohydrologic data from the well have provided valuable information used in the preparation of this report.

The tops of the stratigraphic units were picked from geophysical or geologic data. No attempt was made to show faults on the contour maps (sheet 2).

The Tertiary and younger sediments described in this report were deposited in a geosyncline known as the Mississippi embayment. The area covered by this report is in the northern part of the embayment and generally west of the axis of the geosyncline.

The geology and structure of the northern Mississippi embayment are being studied by other Federal and State agencies as part of the earthquake-hazards research program.

ACKNOWLEDGEMENT

A. J. Crone, U.S. Geological Survey, Geologic Division, contributed work notes used to interpret seismic-reflection profiles.

PREVIOUS INVESTIGATIONS

Previous investigations on the geohydrology and stratigraphy of the northern Mississippi embayment have been reported by Wells and Foster (1933), Farrar and McManamy (1937), Grohskopf (1955), Steams (1957), Ryling (1960), Koenig (1961), Plebuch (1961), Cushing and others (1964), Boswell and others (1965), Heyl and others (1965), Hosman and others (1968), Boswell and others (1968), Wilson and Criner (1969), Moore and Brown (1969), Davis and others (1973), Crone and Russ (1979), Crone (1981), Broom and Lyford (1981), Crone and Brockman(1982), Frederiksen and others (1982), Hamilton and Zoback (1982), McKeown (1982), and O'Connell and others (1982), Parks and others (1985).

Grohskopf (1955) described the subsurface geology of the Mississippi embayment of southeast Missouri. Paleozoic and Cretaceous units were defined in detail as was the Midway Group of the Tertiary System. The Wilcox Group of the Tertiary System was not subdivided and units in the Claiborne Group and Jackson Formation were not recognized.

The stratigraphic nomenclature, as defined by Koenig (1961), for Tertiary units in southeast Missouri was originally defined on the basis of rock outcrops on Crowleys Ridge. The Wilcox was divided on the basis of these outcrops, but the units were difficult to differentiate in the subsurface and the Claiborne Group and Jackson Formation were again not recognized.

Hosman and others (1968) recognized units of the Claiborne Group in the subsurface, but did not differentiate the units.

Moore and Brown (1969) studied the stratigraphy of the Fort Pillow Test Well in Lauderdale County, Tennessee, and on the basis of geophysical logs and correlations, spore assemblages, and lithology, they subdivided the Wilcox Group, in ascending order, into the Old Breastworks (?) Formation, the Fort Pillow Sand, and the Flour Island Formation. In addition, they named and defined the Memphis Sand as the basal unit of the Claiborne Group. The formations overlying the Memphis Sand were recognized as the Cook Mountain Formation and the Cockfield Formation. The uppermost Eocene unit was thought to be the Jackson (?) Formation.

Crone and Russ (1979) published a preliminary stratigraphic section of the U.S. Geological Survey test well 1-X in New Madrid County, Missouri, in which they subdivided the Wilcox Group into the Old Breastworks (?) Formation, the Fort Pillow Sand, and the Flour Island Formation. They tentatively identified and divided the Claiborne Group in the subsurface and suggested some revisions in stratigraphic nomenclature were warranted for parts of the Tertiary section in Missouri.

Crone (1981) used the same stratigraphic section as defined for the Fort Pillow test well in Lauderdale County, Tennessee, to correlate with the U.S. Geological Survey test well 1-X in New Madrid County, Missouri.

Frederiksen and others (1982) studied the biostratigraphy and paleoecology of samples collected from the U.S. Geological Survey test well 1-X in New Madrid County, Missouri, and published a stratigraphic section identifying the subdivided Wilcox Group, subdivided Claiborne Group, and the Jackson Formation.

Correlation of stratigraphic units in southeast Missouri and adjacent areas using borehole geophysical techniques has been made by Steams (1957), Ryling (1960), Plebuch (1961), Boswell and others (1965), Hosman and others (1968), Moore and Brown (1969), Davis and others (1973), and Crone (1981). Seismic-reflection profiles have been used for correlations by Crone and Russ (1979), Crone and Brockman (1982), and Hamilton and Zoback (1982). The correlation and mapping of Tertiary and younger units in this report were done on the basis of geophysical log interpretations.

Paleozoic and younger units underlying southeast Missouri are described in the stratigraphic section (presented on this sheet) that is modified from Frederiksen and others (1982). The correlation of Tertiary units underlying the northern Mississippi embayment in Arkansas, Kentucky, Missouri, and Tennessee is summarized in the correlation chart presented on this sheet.

PALEOZOIC ERATHEM AND CRETACEOUS SYSTEM (MESOZOIC)

The contacts between strata of the Paleozoic Erathem and Cretaceous System (Mesozoic), and Cretaceous and Tertiary Systems are easily recognizable on geologic logs, geophysical logs, and seismic-reflection profiles. These contacts were used to define the regional and local altitude, dip, and general thickness of the units.

Undifferentiated Paleozoic rocks underlie all of the southeast lowlands of Missouri and the Mississippi embayment and crop out on Crowleys Ridge and at the Ozark escarpment (index map). Paleozoic rocks are penetrated only by a few wells in the middle of the embayment, therefore the depth below land surface and dip of these strata have been estimated on most of the maps and sections. The units are composed chiefly of dolomite and are easily differentiated on geologic and geophysical logs and seismic-reflection profiles from the overlying sand and clay of the Cretaceous System. The top of the Paleozoic rocks may be a weathered or unconformable surface.

The Cretaceous System overlying the Paleozoic rocks is comprised of the McNairy Sand and Owl Creek Formations. The McNairy Sand primarily is sand with some interbedded clay units that may be continous enough to be mapped in the subsurface. The sand generally is fine grained, white, glauconitic and used as a source of water for public and municipal supplies. The Owl Creek Formation is mainly silt or clay and is not differentiated from the McNairy Sand in this report. The contact between the Cretaceous and overlying Tertiary System generally is distinctive on most geologic and geophysical logs.

CENOZOIC ERATHEM

The Tertiary System has been subdivided in this report using the stratigraphic nomenclature as defined by Moore and Brown (1969), Crone and Russ (1979), and Frederiksen and others (1982). The Old Breastworks (?) Formation is included in the Midway Group as described by Frederiksen and others (1982, p. 31) and has not been differentiated on the sections or maps.

MIDWAY GROUP

The Midway Group is comprised of the Clayton Formation, and Porters Creek Clay, tentatively, the Old Breastworks (?) Formation. The Clayton Formation contains glauconitic clay and marl and was not differentiated in the sections or maps because it does not appear as a distinct unit on geophysical logs; however, it is easy to recognize in the subsurface in geologic samples. The thickness of the unit ranges from 0 to 20 feet in the subsurface.

The Porters Creek Clay is very distinct on geologic and geophysical logs as a massive clay unit, which is a regional confining unit. Total thickness may exceed 650 feet in southern Missouri.

The Old Breastworks (?) Formation at the base of the Wilcox Group in Tennessee, was tentatively assigned to the top of the underlying Midway Group and tentatively extended to Missouri. Frederiksen and others (1982, p. 31) states "the Old Breastworks (?) Formation in the New Madrid test well, and presumably also in,the Fort Pillow well, may belong to the Midway Group rather than the Wilcox Group to which the formation was assigned by Moore and Brown (1969). The presence of this silty clay is questioned by Crone (1981) in the New Madrid test well 1-X, and if it exists, may be less than 38 feet thick. The Old Breastworks (?) Formation was not differentiated in this report because it is not easily distinguished from the underlying Porters Creek Clay in the Midway Group or overlying Fort Pillow Sand in the Wilcox Group. If the Old Breastworks (?) Formation is present in Missouri, it would only be found in the U.S. Geological Survey test well 1-X (well 11) and at Steele, Missouri (well 15).

WILCOX GROUP

The basal unit of the Wilcox Group is identified as the Fort Pillow Sand consisting of the massive sand interval above the Midway Group and below the Flour Island Formation. The thickness of this unit ranges from 0 to more than 400 feet thick in southeast Missouri. The Fort Pillow Sand is an important unit that some municipalities and public water supplies use as a source of water.

The upper unit of the Wilcox Group overlying the Fort Pillow Sand is identified as the Flour Island Formation. It is a unit of mixed sand, silt, and clay in varying proportions but changes into a sandy clay in the northern part of the Mississippi embayment. The unit is upper Paleocene and lower Eocene, as shown by Frederiksen and others (1982).

CLAIBORNE GROUP

The basal unit of the Claiborne Group is the Memphis Sand. It may contain a distinct massive sand bed with clay layers interbedded. Many wells that originally were thought to be completed in the Wilcox Group actually were completed in the Memphis Sand.

The Cook Mountain Formation, a clay unit, overlies the Memphis Sand. It generally is a distinct clay but becomes sandy in the north. The contact at the top of this unit is questionable in some areas but may be distinct in geophysical logs near the Mississippi River.

The uppermost unit present in the Claiborne Group, the Cockfield Formation, is a sandy clay unit. The contacts are distinct on geophysical logs only when a distinct clay section of the Cook Mountain underlies it and the Jackson Formation overlies it. Where no distinct contact separates the Cockfield and the Jackson Formations, the strata are referred to as the Jackson through Cockfield undivided.

JACKSON FORMATION

The Jackson Formation overlies the Cockfield Formation and generally is a silty sand with silt interbedded. It is only present along and near the Mississippi River in Missouri and is not known to crop out in southeast Missouri.

ALLUVIUM

The alluvium covers the entire southeast lowlands of Missouri, except where older units crop out on Crowleys Ridge. The alluvium in southeast Missouri has been mapped in detail by Fisk (1944) and Luckey (1985). Luckey (1985) indicates the thickness of the alluvium ranges from 0 to more than 250 feet thick. Thickness varies where ancient river channels were filled with younger sediments. The base of the alluvium may be recognized by the presence of coarse sand, gravel, and cobble.

GEOLOGIC SECTIONS OF STRATIGRAPHIC UNITS

The geologic sections shown on sheet 1 are drawn parallel and perpendicular to the axis of the Mississippi embayment (index map). Generally, only spontaneous potential (SP), resistivity (R), and gamma-ray (G) logs, as listed in the table of geophysical-log data were used, except where geologic logs were used to estimate a contact. The contacts of the stratigraphic units were chosen on the basis of log deflections, lithology, and estimates of vertical position. The U.S. Geological Survey test well 1-X in New Madrid County was used as a typical section for correlation with other wells. Lithologic changes presented a problem in estimating formation boundaries due to changes in depositional environment. The normal dip of the overlying or underlying beds and average bed thickness were used to estimate contacts between units when no other method was available. The faults shown on the correlations were interpreted from the sections, seismic-reflection profiles of Hamilton and Zoback (1982), work notes provided by A. J. Crone (U.S. Geological Survey, written commun., 1983), or inferred from other published literature.

The dashed contact lines show estimates of contacts. The geophysical logs were manually reduced in scale and represent only general characteristics of the original log.

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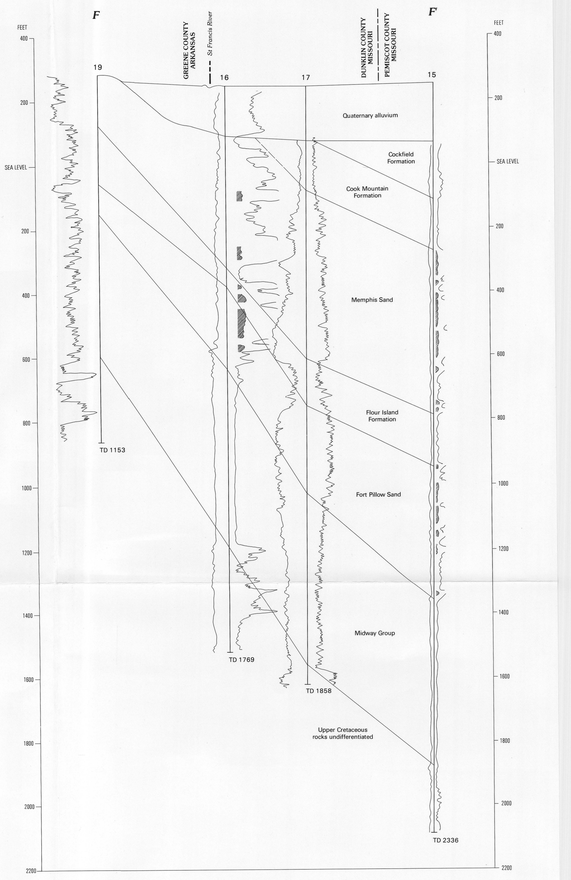
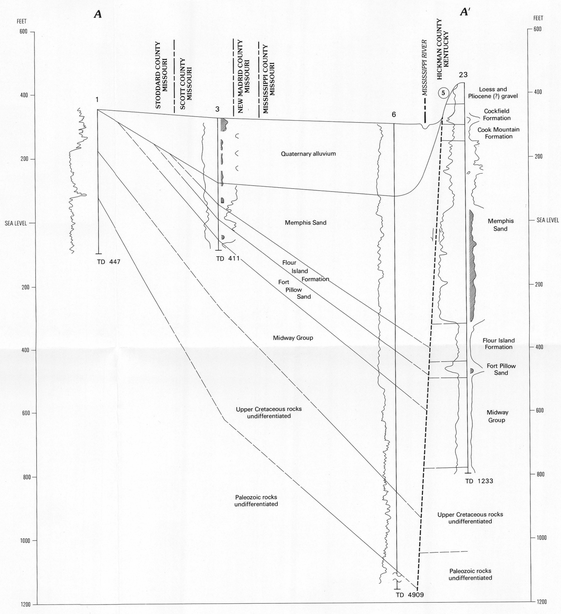
Stratigraphic Section of Subsurface Units in Southeast Missouri (modified from Frederiksen and others, 1982)

ERATHEM	SYSTEM	SERIES	GROUP	FORMATION	DESCRIPTION OF UNIT (U.S. Geological Survey test well 1-X, New Madrid County, Missouri)
CENOZOIC	Quaternary	Holocene		Alluvium	Light gray silty clay, contains lignite and floating sand grains
		Pleistocene			Light white brown fine to very coarse-grained sand, gravel common near base, lignite common
	Tertiary	Eocene	Claiborne	Jackson Formation	Light gray to buff, medium to very fine grained silty sand interbedded with light gray clayey silt, lignite common
				Cockfield Formation	Light gray to light brown silt to fine-grained sand, lignite common to abundant and may occur as discrete beds in lower part
				Cook Mountain Formation	Light gray to light buff clay and silt, contains variable quantities of sand and lignite
				Memphis Sand	Fine to very coarse-grained, light gray white quartzose sand, contains pyrite, lignite and rock fragments
		Paleocene	Wilcox	Flour Island Formation	Medium to light gray silty clay and clayey silt containing thin beds of fine to very fine-grained light yellowish-gray sand, commonly contains lignite, pyrite, and mica
				Fort Pillow Sand	Fine to very coarse-grained, quartzose sand, commonly contains pyrite, lignite, and mica
			Midway	Old Breastworks (?) Formation	Light gray to yellowish gray, sandy, micaceous silty clay
				Porters Creek Clay	Steel gray to dark gray, hard micaceous clay, locally mottled yellow buff, conchoidal fracture, locally fossiliferous, pyrite common, becomes calcareous, very fossiliferous, and very glauconitic near the base
				Clayton Formation	Light green, gray, glauconitic, fossiliferous clay interbedded with green white very glauconitic fossiliferous marl, locally contains more than 60 percent glauconite
MESOZOIC	Cretaceous			Owl Creek Formation	Samples missing, but geophysical logs indicate that, if present, the unit is mainly clay or silt
				McNairy Sand	Fine to coarse-grained, glauconitic sand, commonly contains pyrite, mica, and carbonized wood fragments, trace glauconite interbedded with steel gray soft micaceous silty clay
PALEOZOIC	Ordovician				This system was not recognized in the test well, however, geologic logs from other wells indicate dolomitic rocks are common
	Cambrian				White to dark gray, fine to coarse crystalline dolostone, locally recrystallized, trace vuggy porosity, disseminated pyrite common, trace authingenic quartz crystals

Correlation chart of the Tertiary System in Arkansas, Kentucky, Missouri, and Tennessee

ERATHEM	SYSTEM	SERIES	GROUP	ARKANSAS	KENTUCKY	MISSOURI	TENNESSEE
CENOZOIC	Tertiary	Eocene	Claiborne	Undifferentiated	Jackson Formation	Jackson Formation	Jackson Formation
				Cockfield Formation	Cockfield Formation	Cockfield Formation	Cockfield Formation
				Cook Mountain Formation	Cook Mountain Formation	Cook Mountain Formation	Cook Mountain Formation
				Sparta Sand	Sparta Sand	Memphis Sand	Memphis Sand
				Cane River Formation	Tallahatta Formation		
				Carrizo Sand			
		Paleocene	Wilcox	Undifferentiated	Wilcox Formation	Flour Island Formation	Flour Island Formation
						Fort Pillow Sand	Fort Pillow Sand
			Midway	Porters Creek Clay	Porters Creek Clay	Old Breastwork (?) Formation	Old Breastwork Formation
						Porters Creek Clay	Porters Creek Clay
				Clayton Formation	Clayton Formation	Clayton Formation	Clayton Formation

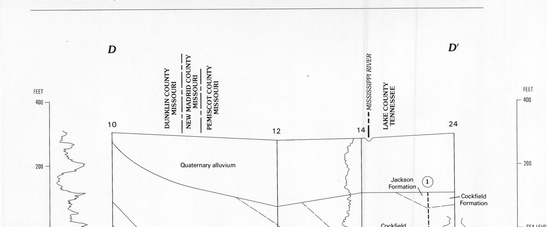




GEOPHYSICAL-LOG DATA

[Logging agency or company: DGⅅLS, Missouri Division of Geology and Land Survey; USGS, U.S. Geological Survey; USBM, U.S. Bureau of Mines; NRC, U.S. Nuclear Regulatory Commission. Log type: G, gamma ray; SP, spontaneous potential; R, resistivity]

Well site	Gulf Coast NASA log number	County	Company	Well name	Elevation of land surface above sea level (feet)	Total depth of well (feet)	Log interval (feet)	Log type used for geophysical correlations
				MISSOURI				
1	MOST03	Stoddard	DGⅅLS	NRC test No. 1	354	447	0–447	G
2	MOMS02	Mississippi	Little Egypt	Delaney No. 1	315	1,050	0–882	G
3	MOSC01	Scott	City of Sikeston	Test No. 4	325	411	0–411	SP,R
4	MOST01	Stoddard	Stoddard County Exploration Co.	Higgins No. 1	348	1,860	0–213	G
5	MOST02	Stoddard	Marr	Barnett No. 1	300	4,579	546–4,519	SP,R
6	MOMS01	Mississippi	Hercules Oil	Big Oak No. 1	293	4,909	0–4,905	G
7	MONM03	New Madrid	Cordova-Union	Phillips No. 1	302	2,563	185–2,340	SP,R
8	MODU01	Dunklin	Knight	Stewart No. 1	380	871	0–871	SP,R,G
9	MONM01	New Madrid	USBM	Oliver No. 1	269	3,728	183–1,313	SP,R
10	MODU02	Dunklin	City of Campbell	Water Well	305	945	0–945	G
11	MONM02	New Madrid	USGS	Test 1–X	284	2,318	149–2,027	SP,R
12	MOPE02	Pemiscot	Strake	Russell No. 1	266	4,740	383–2,152	SP,R
13	MODU04	Dunklin	City of Kennett	Water Well No. 2	267	1,630	293–1,340	R
14	MOPE03	Pemiscot	City of Caruthersville	Water Well No. 4	276	800	5–749	G
15	MOPE01	Pemiscot	City of Steele	Water Well No. 2	255	2,336	188–2,336	SP,R
16	MODU03	Dunklin	City of Cardwell	Water Well No. 1	247	1,769	35–1,769	SP,R
17	MODU05	Dunklin	City of Hornersville	Water Well No. 1	246	1,858	161–1,858	SP,R
				ARKANSAS				
18	ARCL01	Clay	Gallatin Drilling	J. Callaway No. 1	265	1,350	300–1,350	SP,R
19	ARGN01	Greene	Lafe Water Association	Water Well	292	1,153	0–1,153	G
20	ARMS05	Mississippi	Ground Water Association, Inc.	Water Well	245	1,195	1–1,195	G
21	ARCR02	Craighead	Quinton Little	Little No. 1	270	8,686	510–8,682	SP,R
				KENTUCKY				
22	KYBA01	Ballard	Higrade Concrete and Wickliffe	Water Well	470	1,170	0–585	G
23	KYHI01	Hickman	USGS	Jack Roberts Test Well No. 2	430	1,233	0–1,233	SP,R,G
				TENNESSEE				
24	TNLK01	Lake	Frazier-Benz	Sam Hayes No. 1	293	2,263	286–2,263	SP,R
25	TNDY01	Dyer	Henderson Oil	Field Well No. 1	260	2,300	200–2,300	SP,R



EXPLANATION

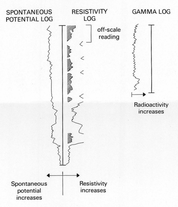
(4) **Contact**—Dashed where estimated

Fault—Arrows indicate direction of movement. Number indicates source of data for location and movement. Dashed where estimated
1–Inferred from profile S-6, Hamilton and Zoback (1982)
3–Inferred from profiles S-3 and S-10, Hamilton and Zoback (1982)
4–Interpreted from site 12 (table of geophysical log data) and Public Water-Supply District 1 geological log at Pascola, Missouri
5–Inferred from geologic data
6–From Parks and others, 1985 (p.12)
7–Inferred from profiles S-3 and S-10, Hamilton and Zoback (1982)

TD 1350 **Well depth**—Total depth of well, in feet below land surface

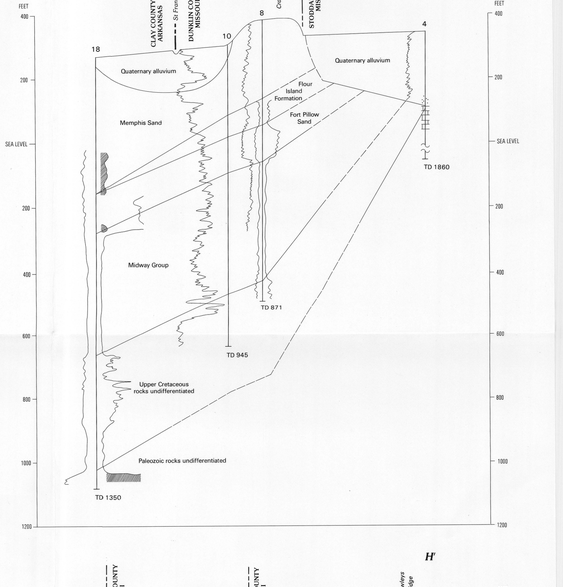
VERTICAL SCALE GREATLY EXAGGERATED

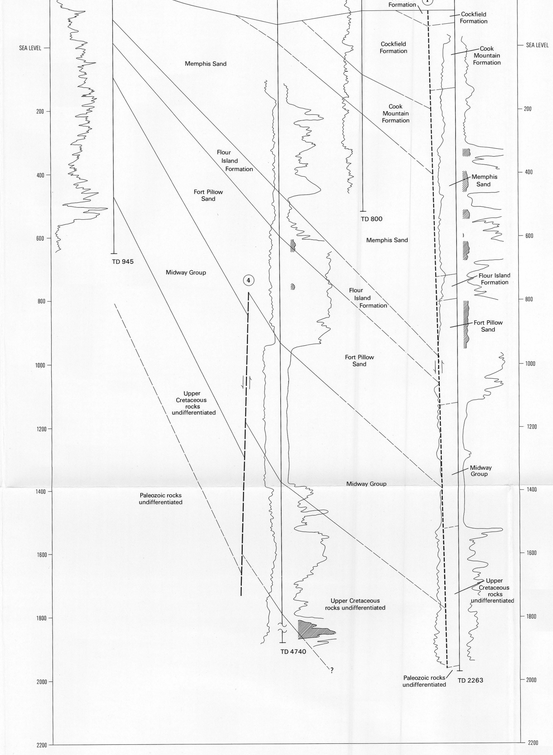
SAMPLE LOG TYPES

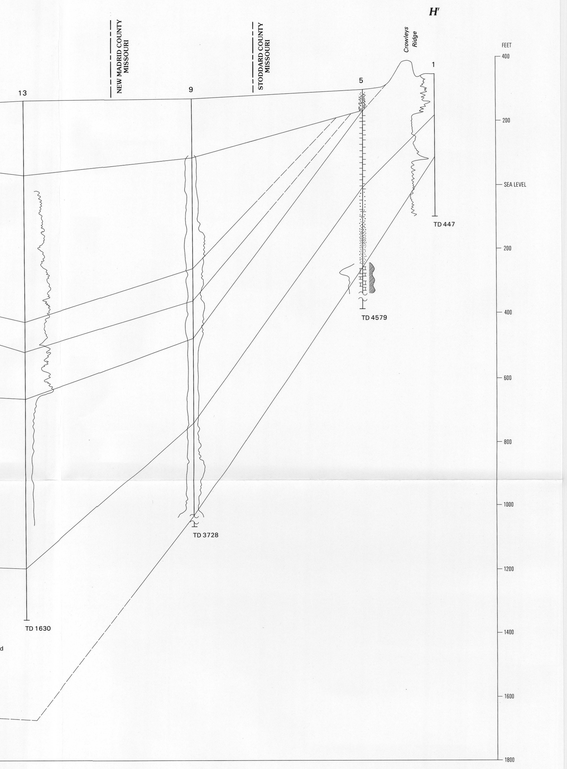


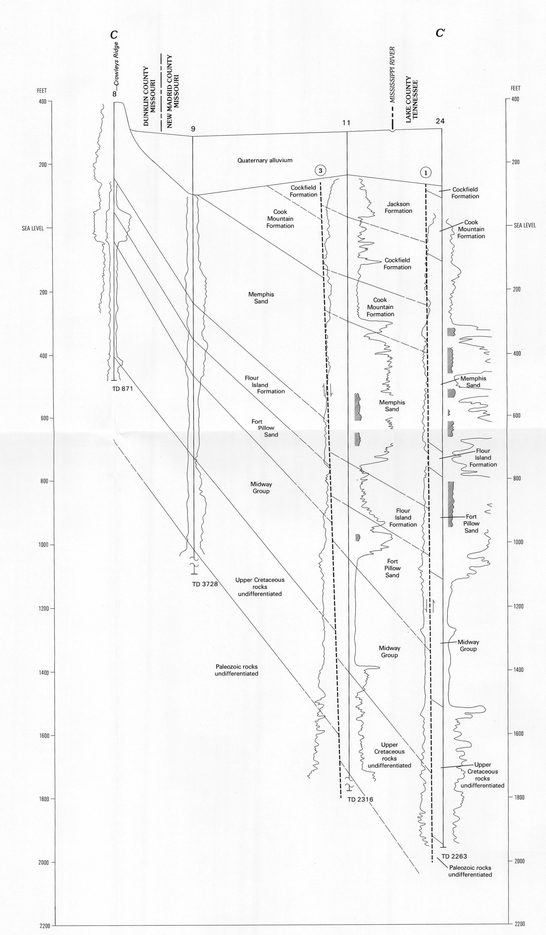
LITHOLOGY

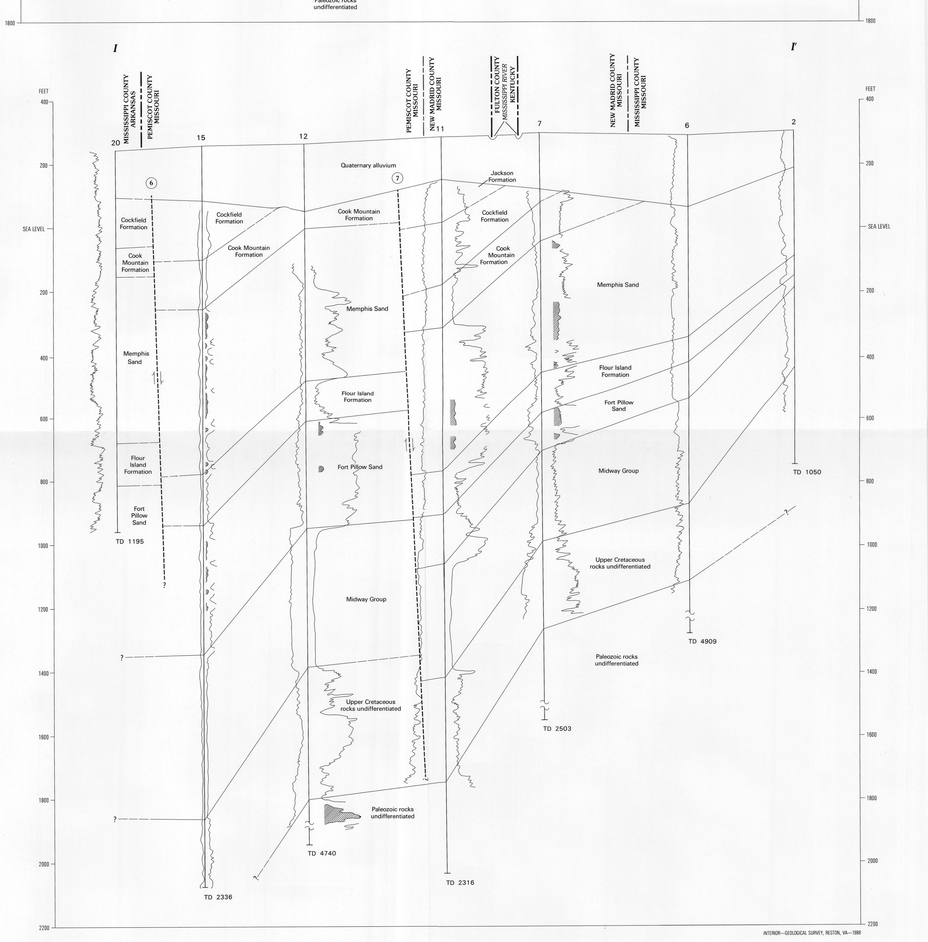
Sand | Silt, clay | Gravel | Bedrock











Geologic sections of stratigraphic units in southeast Missouri

SUBSURFACE GEOLOGY OF PALEOZOIC, MESOZOIC, AND CENOZOIC UNITS IN SOUTHEAST MISSOURI

By
T.O. Mesko

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