U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-2284

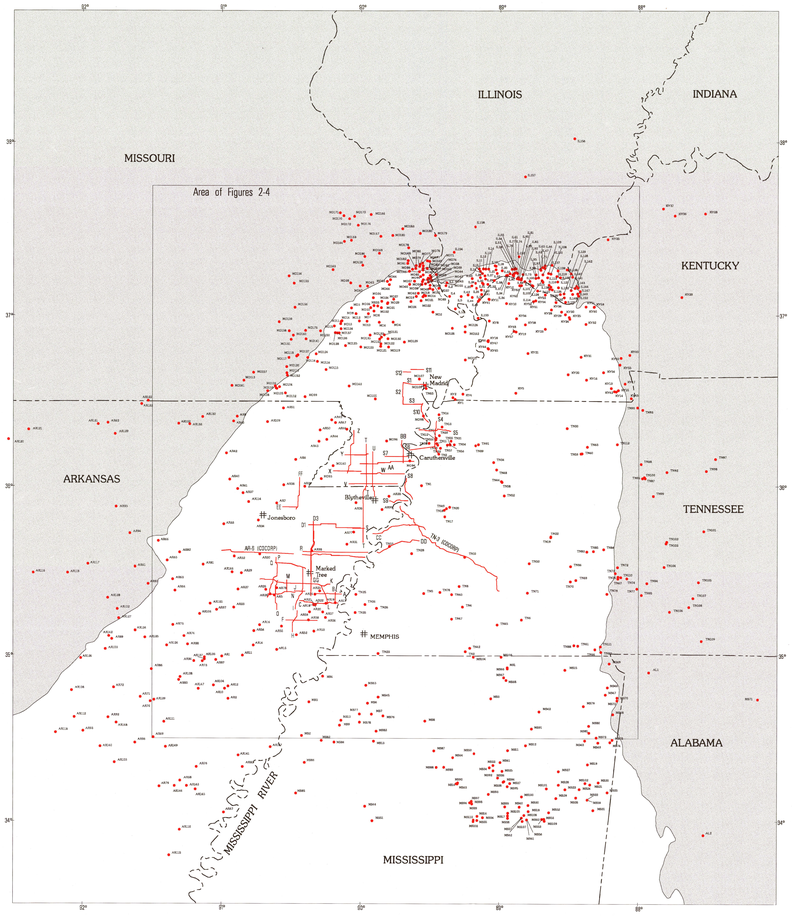

Figure 1. Drill holes and core holes (red dots) in the study area. Drill-hole and core-hole numbers are listed in table 1. U.S. Geological Survey vibroseis lines (thin and Wheeler, 1994) and COCORP AR6 and TN3 vibroseis lines are shown in red. Gray area is the region of Paleozoic bedrock geology outside the Mississippi Embayment.

INDEX MAP SHOWING AREA OF FIGURE 1 (RED AREA)

INTRODUCTION

The Mississippi Embayment regional seismic hazard (Fuller, 1912; Nuttli, 1973, 1982, 1983), associated with the New Madrid seismicity (Nuttli, 1982), is attributed to displacement on seismogenic structures primarily within the failed Reelfoot rift (Burke and Dewey, 1973; Ervin and McGinnis, 1975; Hildenbrand, 1977; Johnston and Shedlock, 1992). Hildenbrand and others (1977) and Hildenbrand (1985) used potential field data to show the northeastward trend of the buried rift and the existence of related intrusive bodies. The Mississippi Valley graben (Hildenbrand and others, 1977; Kane and others, 1981; Hildenbrand, 1985; Wheeler and others, 1993), also referred to as the Reelfoot graben (Hildenbrand and Hendricks, 1995), is here considered to be the structural expression of the Reelfoot rift at the Precambrian basement surface.

Structure contours on subcrop maps can be important tools in improving our understanding of seismogenic Reelfoot rift structures as well as the structural and stratigraphic history of the Mississippi Embayment region. The maps presented here differ from earlier structure contour and subcrop maps of the upper Mississippi Embayment region (Grohskopf, 1955; Stearns, 1982; Schwalb, 1982; Buschbach, 1988; Sims, 1990; Henderson, 1991; Buschbach and Kolata, 1991; Dart and Sargent, 1992) because they are computer generated, are based on larger data sets, generally cover a larger area, combine drill-hole and seismic-reflection data, and incorporate some data not previously available. This text briefly discusses the contour and subcrop map data, the contouring method used, and some of the structure contour and subcrop geologic features shown on the maps.

CONTOUR AND SUBCROP DATA

Figure 1 shows the locations of 651 upper Mississippi Embayment drill holes and core holes that were completed in Paleozoic or Precambrian rocks (table 1; Dart, 1990, 1992, 1993, 1994). Seismic-reflection data (fig. 1) from COCORP (Geothermal Consortium for Reflection Profiling) vibroseis lines AR-6 and TN-3, Wheeler vibroseis lines, and subcrop geologic data from these drill holes and core holes are from published and unpublished sources (Dart, 1992). The U.S. Geological Survey vibroseis lines are either industry lines purchased by the U.S. Geological Survey or U.S. Geological Survey contracted lines (Ebasa and Wheeler, 1994).

The data used to create the Paleozoic surface structure contour map (fig. 2) are basement and subsurface stratigraphic depths from 578 of the 651 drill holes and core holes, 308 shot-point locations along 31 U.S. Geological Survey vibroseis lines (Hamilton and McKeown, 1988; McKeown and others, 1990; Crone, 1992; McKeown, written commun., 1993; Crone, written commun., 1993) and bedrock elevations from 562 locations outside the Mississippi Embayment. Paleozoic bedrock and subcrop geologic data (fig. 3) are from 257 drill holes and core holes and state geologic maps of bedrock outcrops (Miller and others, 1966; Williams and others, 1967; Mississippi Geological Survey, 1969; Haley and others, 1976; Missouri Division of Geology, 1979; McDowell and others, 1981; Stohr and others, 1988).

The structure contour map of the Precambrian surface (fig. 4) is a composite of new and previously published basement contours (Buschbach, 1988; Sims, 1990; Buschbach and Kolata, 1991; and Sargent, 1992). The new basement contours of the central part of the map area were combined with previously published basement contours of the surrounding region. The data used to create the new basement contours are depths to Precambrian basement from 13 drill holes and core holes and basement-reflection depths at 170 shot-point locations along 33 U.S. Geological Survey vibroseis lines (Hamilton and McKeown, 1988; McKeown and others, 1990; Crone, 1992; McKeown, written commun., 1993; Crone, written commun., 1993) and at 16 shot-point locations along COCORP vibroseic lines AR-6 and TN-3 (Thomas, 1989; Nelson and Zhang, 1991; fig. 1). Precambrian basement depths from the drill holes and core holes are from published and unpublished sources (Dart, 1992). Paleozoic and Precambrian basement reflection depths from the U.S. Geological Survey and COCORP vibroseis lines (figs. 2 and 4) were derived from calculated interval velocities at selected shot-point locations. These interval velocities were calculated using standard velocity-depth analysis and the standard Dix equation. Paleozoic and Precambrian bedrock elevations (figs. 2, 3, and 4) and Paleozoic bedrock geologic data (fig. 3) are from 1:24,000-scale topographic maps and state geologic maps (Miller and others, 1966; Williams and others, 1967; Mississippi Geological Survey, 1969; Haley and others, 1976; Missouri Geological Survey, 1979; McDowell and others, 1981; Stohr and others, 1988). The bedrock elevations were taken from the topographic maps at 10 km intervals.

CONTOURING METHOD

The structure contour maps (figs. 2 and 4) were generated from the available drill-hole- and seismic-reflection-depth and bedrock-elevation data using a PC-based computer graphics program (Golden Software, Inc., 1988). The contouring program calculates a regularly spaced grid of interpolated contour values from the irregularly spaced depth and elevation data using a data-search and -sampling method where the search radius, the number of subdividing depth- and elevation-data values sampled, and the number of columns and rows in the regularly spaced grid are user specified.

In order to determine the best combination of user-specified variables that would generate structure contours that most accurately represent the actual geologic topography, a number of contouring tests were made using hypothetical-surface contour data. Combinations of user-specified variables tested included Kriging, Inverse distance, and Minimum curvature interpolation algorithms and Octant, Normal, Quadrant, and All data-search and Type-of-contour (Golden Software, Inc., 1988) with different data search radii for various size grids (ex. 6 rows or 50 columns x 50 rows) of interpolated contour values. The best results, that is, the least simulated that contours generated from the Kriging interpolation algorithm and the Octant data-search method combined with a data-search radius equal to 0.5" would best represent the configuration of the hypothetical test surface. The optimum grid size in Arkansas, Louisiana, and Mississippi was 50 columns x 50 rows. The new Paleozoic and Precambrian structure contour maps (figs. 2 and 4) were generated using these parameters.

PALEOZOIC AND PRECAMBRIAN MAPS

Paleozoic structure contours (fig. 2) define a gently dipping to very gently sloping, southwest plunging, generally featureless erosional surface. Within the Mississippi Embayment as much as 1,200 meters of Upper Cretaceous and Tertiary sediments unconformably overlie this surface. The aerial extent of the younger sedimentary fill, defined by the 150-meter contour (fig. 2), defines the horseshoe shape of the upper Mississippi Embayment. It should be noted that the northward-oriented cusp approximately 15 km southeast of Marked Tree, Arkansas (fig. 2), is an artifact of the computer contouring.

Paleozoic subcrop geologic units, as much as 6,000 meters of Upper Cambrian through Middle Pennsylvanian sedimentary rock overlie the Precambrian basement (fig. 4). Precambrian rock samples from several deep drill holes in the study area show the composition of the crystalline basement to be mainly granite porphyry and gneiss (Dart, 1992). Precambrian igneous bedrock outcrops in the northeast corner of the study area (figs. 3 and 4) are granite and granite porphyry intrusives and volcanic, rhyolitic ash-flow tuffs with minor amounts of felsic rhyolite and trachyandesite (Hays, 1981; Tolman and Robertson, 1969; Anderson, 1979). The Upper Cambrian, Upper Cambrian and Lower Ordovician Knox Group, Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian subcrops overlying the Precambrian surface (fig. 3) are mostly limestone and dolomite with lesser amounts of sandstone, shale, and conglomerate (Hayes and Knight, 1961; Grabau, 1964; Martin and others, 1961; Sperling, 1961; table 2). On figure 3, the Upper Cambrian through Middle Ordovician sedimentary rock subcrop is referred to as the Paleozoic surface are undifferentiated as to formation name or rock type.

Extensive structural erosion prior to the deposition of Upper Cretaceous sediments entirely removed strata younger than Middle Pennsylvanian from the Mississippi Embayment region (Grohskopf, 1955; Stearns, 1982). Subcrop geologic units of Upper Cambrian through Middle Pennsylvanian age define the Paleozoic surface (fig. 3) has the appearance of a southeast plunging anticline. Grohskopf (1955) referred to this antiformal structure in the Pascola arch. The Upper Cambrian core of the Pascola Arch subcrops in a subcircular pattern on the axis of the anticline (fig. 3). Here, Bonneterre, Davis, and Derby-Doerun dolomite and shale of the Mississippi embayment: U.S. Geological Survey Professional Paper 448-B, 28 p.

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Table 1. Upper Mississippi embayment drill holes and core holes that were completed in Paleozoic or Precambrian rocks (Dart, 1992)

[Abbreviations: MGS, Missouri Geological Survey]; C.C.C. (Civilian Conservation Corps).]

Map number	Operator/
AL17	Cities Service Co.
AL21	Champlin Refining Co./Galloway Coal Co. #1
AR1	Coulehl Corp./Coulehl #1 H.E. Bunch and others
AR2	Coulehl Corp./Coulehl #2 Bunch
AR3	Quanta Lmb/#1 D. Griffith
AR4	Quanta Lmb/#1 Griffith
AR5	Quanta Lmb/#1 Co./Robinson #1
AR6	Quanta Lmb/#1 Co./Robinson #1
AR7	Quanta Lmb/#1 Griffith
AR8	Quanta Lmb/#1 Griffith
AR9	Quanta Lmb/#1 Griffith
AR10	Quanta Lmb/#1 Griffith
AR11	Quanta Lmb/#1 Griffith
AR12	Quanta Lmb/#1 Griffith
AR13	Quanta Lmb/#1 Griffith
AR14	Quanta Lmb/#1 Griffith
AR15	Quanta Lmb/#1 Griffith
AR16	Quanta Lmb/#1 Griffith
AR17	Quanta Lmb/#1 Griffith
AR18	Quanta Lmb/#1 Griffith
AR19	Quanta Lmb/#1 Griffith
AR20	Quanta Lmb/#1 Griffith
AR21	Quanta Lmb/#1 Griffith
AR22	Quanta Lmb/#1 Griffith
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AR41	Quanta Lmb/#1 Griffith
AR42	Quanta Lmb/#1 Griffith
AR43	Quanta Lmb/#1 Griffith
AR44	Quanta Lmb/#1 Griffith
AR45	Quanta Lmb/#1 Griffith
AR46	Quanta Lmb/#1 Griffith
AR47	Quanta Lmb/#1 Griffith
AR48	Quanta Lmb/#1 Griffith
AR49	Quanta Lmb/#1 Griffith
IL1	Unknown
IL2	Unknown
IL3	Unknown
IL4	Unknown
IL5	Unknown
IL6	Unknown
IL7	Unknown
IL8	Unknown
IL9	Unknown
IL10	Unknown
IL11	Unknown
IL12	Unknown
IL13	Unknown
IL14	Unknown
IL15	Unknown
IL16	Unknown
IL17	Unknown
IL18	Unknown
IL19	Unknown
IL20	Unknown
IL21	Unknown
IL22	Unknown
IL23	Unknown
IL24	Unknown
IL25	Unknown
IL26	Unknown
IL27	Unknown
IL28	Unknown
IL29	Unknown
IL30	Unknown
IL31	Unknown
IL32	Unknown
IL33	Unknown
IL34	Unknown
IL35	Unknown
IL36	Unknown
IL37	Sergent/#1 A. Eddleman
IL38	U.S. War Dept./Lock and Dam 53
IL41	Sergent/#1 J. Stroman
IL42	Clarke Oil Co./#1 G. Moses
IL44	Mound City Ice Plant Well
IL49	Unknown/Mound City Well
IL50	Vick Oil Co./#1 Boyd
IL51	Unknown/Mound City Warehouse Co.
IL53	Sergent/#1 A. Bruce
IL54	Evansville/#1 Barnett
IL57	Sergent/#1 T. Lewis
IL58	Sergent/#1 P. Fisher
IL59	Sergent/#1 Mansfield
IL61	Kelsey/ #1 J. Bowen
IL65	Elizabeth/#1 B. Brewer
IL66	Sergent/#1 Hall, Bennett and Farmer
IL67	Kelsey/#1 Mc. Kingston
IL71	Kelsey/#1 J. Weaver
IL72	Kelsey/#1 J. Mathews
IL73	Richey/#1 T. Washburn
IL74	Richey/#1 Ed Hall
IL75	Sergent/#1 Ed Hall
IL78	Sergent/D. Ernest #1
IL79	Sergent/#1 J. Bowen
IL81	Hop Rock Oil Co./#1 Semple
IL82	City of Salem #1
IL83	Arkansas Oil Ventures (Svardoff Oil Co.)/#1 Doggett
IL84	Magnolia Petroleum Co./#1 Stigge
IL85	Ohio Oil Co./#1 Mary Ann Clarke
IL86	Ohio Oil Co./#1 Herbert Nortis
IL87	Hunt Oil Co./#1 J. Thomas
IL88	Texas Company/#1 Ida Fox
IL89	Sun Consolidated Petroleum Co./#1 McCollum
IL90	Vaistory Development Co./#1 A.E. Clayton
IL91	Transcontinental Oil Co./#1 L. Novak
IL92	Co./#1 Chambers Estate
IL93	Sergent/#1 Mrs. Ethel and Taylor Brothers
IL94	H.P. Taubman/#1 T. Poff
IL95	W.N. Gregory/#1 W.N. Gregory
IL96	Sergent/#1 Mrs. Ethel and W.A. Yost
IL97	Sergent/#1 Mansion LT/241 A. Berry
IL98	Hagler Petroleum Co./#1 K.E. Thompson
IL99	John Hollinger Brothers/#1 L. Miller
IL100	Jackson Development Co./#1 Johnson and Berger
IL101	Sergent/#1 Mansion LT/241
IL102	Stiles Production Co./#1 G. Dowell
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IL112	City of Cotterell/ Water Well
IL113	City of Cotterell/ Treworgy #3 Water Well
IL114	Sergent/#1 Mansion LT/241
IL115	City of Mammoth Springs/Water Well
IL116	Ben Eaglesmith/Nichols Farm
IL117	Norman O'Neil Mansion
IL118	Mrs. Ethel Sergent/#1 Mansion LT/241
IL119	Moran Exploration, Inc./#1 Reaper
IL120	Sergent/#1 Mansion LT/241-1
IL121	Sergent/#1 Mansion LT/241
IL122	Ft. Pillow Test Well
IL123	Ft. Pillow Test Well
IL124	Ft. Pillow Test Well
IL125	Ft. Pillow Test Well
IL126	Ft. Pillow Test Well
IL127	Ft. Pillow Test Well
IL128	Ft. Pillow Test Well
IL129	Ft. Pillow Test Well
IL130	Ft. Pillow Test Well
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IL140	Ft. Pillow Test Well
IL141	Ft. Pillow Test Well
IL142	Ft. Pillow Test Well
IL143	Ft. Pillow Test Well
IL144	Ft. Pillow Test Well
IL145	Ft. P