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SOUTHWESTERN APPALACHIAN STRUCTURAL SYSTEM BENEATH THE GULF COASTAL PLAIN

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ABSTRACT. The Appalachian structural system has been interpreted to extend from the outcrops in Alabama southwestward in the subsurface beneath the Gulf coastal plain and to continue westward to the Ouachita system in Arkansas. New data are interpreted to confirm that general interpretation, to indicate some modifications of previous interpretations, and to extend the area of recognition of parts of the system. Metamorphic rocks of the Piedmont province extend southwestward in the subsurface of Alabama. The subsurface Talladega Slate belt, which includes carbonate rocks comparable in structural setting with the Sylacauga Marble, trends southwestward in Alabama and curves westward into Mississippi. A belt of folded and thrust-faulted Paleozoic sedimentary rocks along the northwestern front of the system also strikes southwestward in Alabama and curves westward in Mississippi; however, structure of the belt across eastern Mississippi is problematic because of sparse wells. The fold and thrust belt in western Alabama includes at least three major structural panels, one of which is north of the previously mapped structural front. Structural style of the fold and thrust belt and also a Paleozoic stratigraphic succession similar to that of the Appalachian outcrops extend as far west as central Mississippi. A belt of slaty pelitic rocks extends northwestward from central Mississippi toward the Ouachita Mountains.

INTRODUCTION

In central Alabama, Paleozoic structures of the Appalachian system plunge southwestward beneath Mesozoic strata of the Gulf coastal plain (fig. 1). Drilling has shown that Appalachian structures extend southwestward in the subsurface. Similarly, in central Arkansas, Paleozoic structures of the Ouachita Mountains are overlapped unconformably on the east by coastal plain strata (fig. 1) and, although wells are sparse, drilling indicates that the Ouachita system extends eastward in the subsurface. Structural strike of the Appalachian and Ouachita systems points to an intersection beneath the coastal plain in Mississippi; however, data have been so sparse as to permit several interpretations. More recent drilling has provided data that suggest some modifications of previous interpretations and that extend the area of recognition of parts of the structural system. The purpose of this paper is to examine the implications of the new data. Approximately 60 wells provide subsurface information on the belt of deformed rocks in Alabama and Mississippi; more than half of those include data that have become available during the past dozen years. The interpretations of the deformed belt presented here are based on examination of samples from 52 wells, electrical logs, and published and open-file sample descriptions (app). North of the deformed belt, the southwestward-dipping homocline of the Black Warrior basin is defined by relatively numerous wells (Thomas, 1972a, pl. 8; 1972b, fig. 3). Although the available new data indicate some revisions of earlier interpretations, much more subsurface data are necessary to resolve remaining problems.

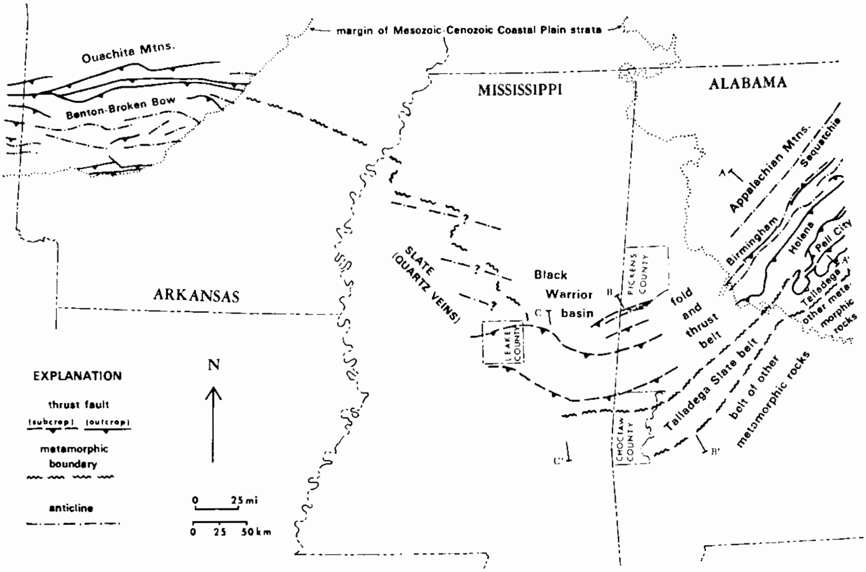

Fig. 1. Regional structural geology map of Appalachian Mountains in Alabama, Appalachian-Ouachita system beneath the Gulf coastal plain, and Ouachita Mountains. (Exposed Ouachita structure after Stone, 1966.) Note: "metamorphic boundaries" may or may not be faulted.

PREVIOUS WORK

In 1947, Mellen (p. 1801) defined the Black Warrior basin as a structure bounded on the southeast by the Appalachian Mountains and on the southwest by the buried Ouachita Mountains. Six wells in east-central Mississippi served to define the southeast-trending front of the Ouachita structural system (Mellen, 1947, fig. 1).

In 1950, King (p. 667) summarized regional geology critical to the Appalachian-Ouachita junction and outlined several possible interpretations. He called attention to important differences in Paleozoic stratigraphic successions of the Ouachitas and the Appalachians.

A subcrop area of lower Paleozoic carbonate rocks in western Alabama and eastern Mississippi has been interpreted to be an extension of the Appalachian Valley and Ridge province (McKee and others, 1956, p. 1; King, *in* Flawn and others, 1961, p. 88). A subcrop map (King, *in* Flawn and others, 1961, pl. 3) shows the southwestward extension of the Appalachian Valley and Ridge belt across Alabama and a southeasterly trending Ouachita structural front in Mississippi; however, the available data did not permit definition of individual structures. From central Mississippi eastward, the Ouachita-Appalachian belt is marked by subcrop of Cambrian-Devonian undifferentiated carbonate rocks of "Appalachian" facies (fig. 2). The deformed belt is bordered on the north by Pennsylvanian subcrop of the Black Warrior basin (fig. 2). In western Alabama the belt of lower Paleozoic carbonate rocks strikes southwest-

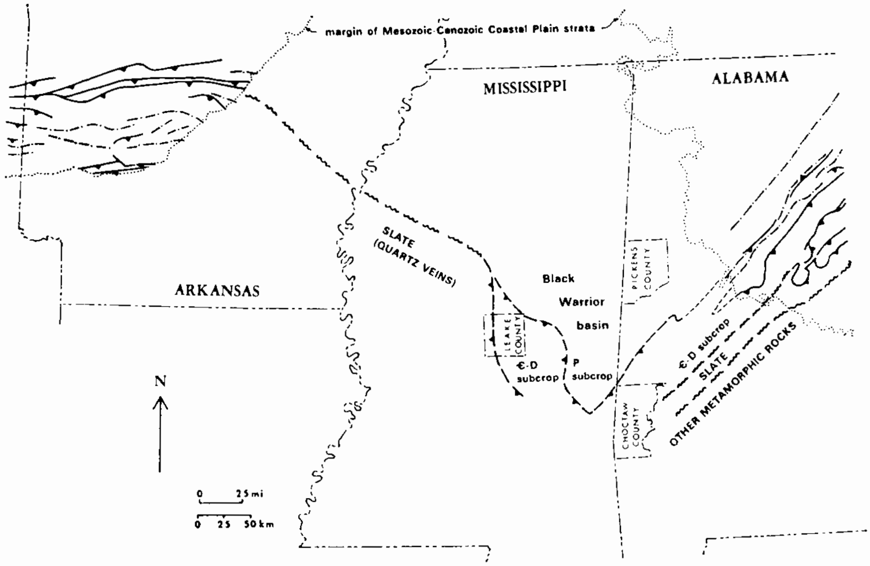

Fig. 2. Generalized regional structural geology map of Appalachian-Ouachita system beneath the Gulf coastal plain, as previously interpreted. Compiled and modified from Mellen, 1947; King, *in* Flawn and others, 1961; and Vernon, 1971. Symbols are explained on figure 1. Explanation of subcrop symbols: €-D, Cambrian through Devonian; P, Pennsylvanian.

ward, but, in central Mississippi, the boundary between Cambrian-Devonian carbonate rocks and Pennsylvanian rocks has been interpreted to strike southeastward (fig. 2). Thus, the two structural systems apparently intersect at an acute angle in eastern Mississippi. King (*in* Flawn and others, 1961, p. 85) noted that the triangular shape of the Black Warrior basin is a result of its position in a recess between the Ouachita and Appalachian structural systems.

Wells in south-central Alabama indicate subsurface continuity of metamorphic rocks of the Piedmont (fig. 2). Although no well data were available from within the belt, King (*in* Flawn and others, 1961, pl. 3) projected the Talladega Slate belt southwestward between the higher grade metamorphic rocks and the Valley and Ridge.

A subsurface belt of weakly metamorphosed clastic rocks extends northwestward from central Mississippi to the Ouachita outcrops (fig. 2). Identification of the belt has been defined in terms of slaty cleavage and other evidence of deformation of the subcrop rocks (King, *in* Flawn and others, 1961, p. 91-93). Correlation is uncertain, but part of the weakly metamorphosed clastic rocks may be equivalent to lower Paleozoic shale, sandstone, and chert of the Ouachita Mountains (King, *in* Flawn and others, 1961, p. 93). King (1950, p. 668) proposed tentatively that the "Ouachita" clastic sequence is an extension of the Appalachian Piedmont clastic facies, and that westward termination of carbonate rocks in central

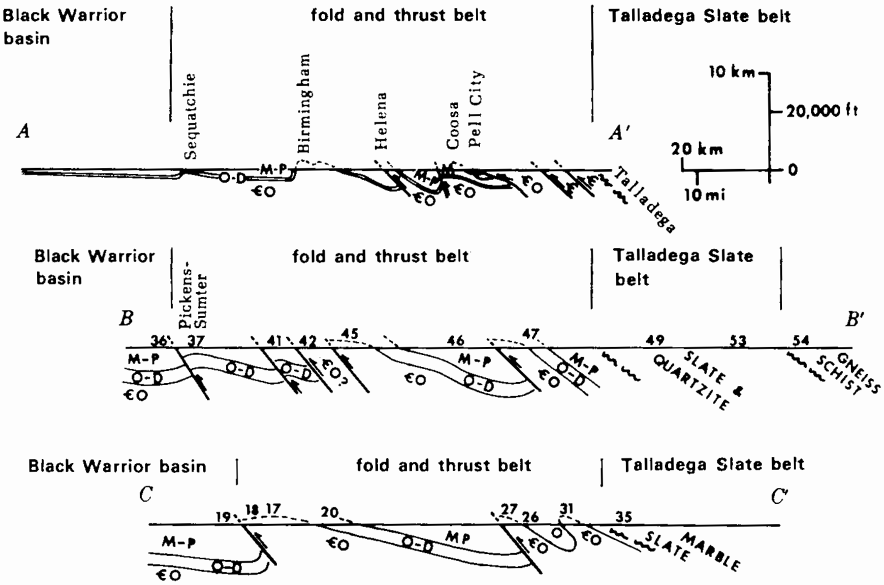

Fig. 3. Cross sections of Appalachian structural system. A-A′, exposed Appalachians; B-B′, western Alabama; C-C′, Central Mississippi deformed belt. Lines of cross section are shown on figures 1 and 4, and symbols are explained on figure 4.

Mississippi possibly reflects thrusting of the clastic facies northward over the carbonate facies. Thus, the carbonate facies was presumed to extend beneath the Ouachita surficial structures. Later interpretations have accepted that structural configuration (Vernon, 1971, p. 963); however, King (*in* Flawn and others, 1961, p. 90) considered the alternate possibility that westward termination of the carbonate subcrop was a result of facies change. The Ouachita lower Paleozoic clastic sequence must be at least partly equivalent to the carbonate facies east of central Mississippi (table 1), and the carbonate facies presumably grades westward to the Ouachita clastic sequence. The area of lower Paleozoic subcrop in central Mississippi has been named the Central Mississippi uplift, and the age of uplift has been interpreted to be later than Appalachian-Ouachita deformation (Morgan, 1970).

APPALACHIAN OUTCROPS IN ALABAMA

The Alabama outcrops encompass four tectonic units: Black Warrior basin, folded and thrust-faulted Paleozoic rocks, Talladega Slate, and other metamorphic rocks of the Piedmont (fig. 1). Northwest of the Appalachians, the Black Warrior basin is a gentle southwestward-dipping homocline. A boundary may be drawn between the Black Warrior basin on the northwest and the folded and thrust-faulted Paleozoic sedimentary rocks on the southeast. The deformed strata are defined here to include Sequatchie anticline, Birmingham anticlinorium, Helena fault, and the complex Coosa and Pell City faults (figs. 1, 3, and 4). A "structural

	OUACHITA MTNS., ARKANSAS	MISSISSIPPI	APPALACHIAN MTNS., ALABAMA
MISSISSIPPIAN — PENNSYLVANIAN	**ATOKA FORMATION** shale; sandstone; coal in upper part. 5800 m. (19000 ft.) **JOHNS VALLEY SHALE** shale; erratic boulders; sandstone. 300 m. (1000 ft.) **JACKFORK GROUP** sandstone; shale; siliceous shale. 2100 m. (7000 ft.) **STANLEY GROUP** shale; siliceous shale; sandstone; tuff in lower part. 3650 m. (12000 ft.) **ARKANSAS NOVACULITE** 290 m. (950 ft.)	**POTTSVILLE FM.** sandstone; shale; conglomerate; coal. 3050 m. (10000 ft.) **PARKWOOD FM.** sandstone; shale. 600 m. (2000 ft.) **FLOYD SHALE** shale; sandstone in lower part. 260 m. (850 ft.) **FORT PAYNE-TUSCUMBIA** chert; cherty limestone. 75 m. (250 ft.) **ARKANSAS NOVACULITE** 340 m. (1100 ft.)	**POTTSVILLE FORMATION** sandstone; shale; conglomerate; coal. 2750 m. (9000 ft.) **PARKWOOD FM.** sandstone-shale facies on southwest. 800 m. (2600 ft.) **BANGOR LS.** limestone facies on northeast. 210 m. (700 ft.) **FLOYD SHALE** 520 m. (1700 ft.) **HARTSELLE SANDSTONE** 45 m. (150 ft.) **PRIDE MTN. FM.** shale; sandstone. 120 m. (400 ft.) **TUSCUMBIA LIMESTONE** cherty limestone. 60 m. (200 ft.) **FORT PAYNE CHERT** chert; siliceous limestone. 45 m. (150 ft.) **MAURY SHALE** green shale. 3 m. (10 ft.)
DEVONIAN			**CHATTANOOGA SHALE** black shale. 8 m. (25 ft.) —hiatus—
SILURIAN	**MISSOURI MTN. SHALE** 90 m. (300 ft.) **BLAYLOCK SANDSTONE** 450 m. (1500 ft.)	**UN-NAMED** siliceous limestone; claystone; dolostone. black shale and limestone on southwest. 210 m. (700 ft.)	**RED MTN. FORMATION** sandstone; shale; limestone; hematite. 150 m. (500 ft.)
MIDDLE & UPPER ORDOVICIAN	**POLK CREEK SHALE** black shale; sandstone. 50 m. (175 ft.) **BIGFORK CHERT** 210 m. (700 ft.) **WOMBLE SHALE** black shale; sandstone; limestone. 580 m. (1900 ft.)	**CHICKAMAUGA GROUP** limestone; dolostone; sandy limestone-dolostone and sandstone at base. black shale tongue near top pinches out eastward. sandstone at top on north. 900 m. (3000 ft.)	**CHICKAMAUGA GROUP** limestone; local chert conglomerate at base. 270 m. (900 ft.)
CAMBRIAN-LOWER ORDOVICIAN	**BLAKELY SANDSTONE** shale; sandstone; chert. 210 m. (700 ft.) **MAZARN SHALE** black shale; sandstone; limestone. 300 m. (1000 ft.) **CRYSTAL MTN. SS.** 260 m. (850 ft.) **COLLIER SHALE** black shale; limestone; chert. 150 m. (500 ft.) —no older rocks exposed—	**KNOX GROUP** dolostone; cherty dolostone. —no older rocks drilled—	**KNOX GROUP** dolostone; cherty dolostone. 900 m. (3000 ft.) **CONASAUGA FORMATION**

front" between the Appalachian Plateau and the Appalachian Valley and Ridge has been defined along the northwest limb of the Birmingham anticlinorium (Rodgers, 1950, fig. 1); thus, the Sequatchie anticline lies within the Appalachian Plateau. However, that structural front does not seem amenable to subsurface identification, and the "fold and thrust belt" is used here as a single tectonic unit (figs. 1 and 3). Southeast of the fold and thrust belt, the Talladega Slate belt includes slate, phyllite, quartzite, and marble (Carrington, *in* Deininger and others, 1964, p. 15). The Talladega belt is bordered on the southeast by higher grade rocks (phyllite, schist, gneiss, granite, quartzite, and marble) of the Piedmont province (Deininger and others, 1964).

DISCUSSION

In the following discussion, the different tectonic elements of the Appalachian system are called: (1) fold and thrust belt, (2) Talladega Slate belt, (3) belt of other metamorphic rocks, and (4) Black Warrior basin northwest of the fold and thrust belt. Because of lateral variations in availability of data and in apparent structural style, the following subdivisions along strike are useful to this discussion:

A. exposed Appalachians (in Alabama),
B. western Alabama (subcrop),
C. Eastern Mississippi "angle" (deep re-entrant in structural front as shown by King, *in* Flawn and others, 1961, pl. 3),
D. Central Mississippi deformed belt (area of lower Paleozoic subcrop, defined by Morgan, 1970, as Central Mississippi uplift),
E. Western Mississippi slate belt (area of metasedimentary rocks that extend northwestward from the Central Mississippi deformed belt toward the Ouachita Mountains), and
F. exposed Ouachitas (in Arkansas).

BELT OF OTHER METAMORPHIC ROCKS

The area of the Piedmont southeast of the Talladega Slate belt contains a variety of metamorphic rock types. Mica schist, granite gneiss, and granite have been penetrated in several wells in southern Alabama (fig. 4); however, no specific rock units of the exposed Piedmont have been identified in the subsurface. Presence of characteristic rock types indicates that the general identity of the belt of other metamorphic rocks extends southwestward at least to Clarke County, Ala.

TABLE 1

Generalized Paleozoic stratigraphic columns (compiled and modified from Butts, 1926; Flawn and others, 1961; Sterling, Stone, and Holbrook, 1966; Stone, 1966; Thomas, 1972a; 1972b). Thicknesses are an approximate maximum for each area. Because maxima of different formations do not coincide geographically, total sedimentary thickness at any locality is less than the sum of the formation maxima for each area. Thicknesses of most units in Mississippi are from the Black Warrior basin, because formation thickness is generally undetermined within the Central Mississippi deformed belt.

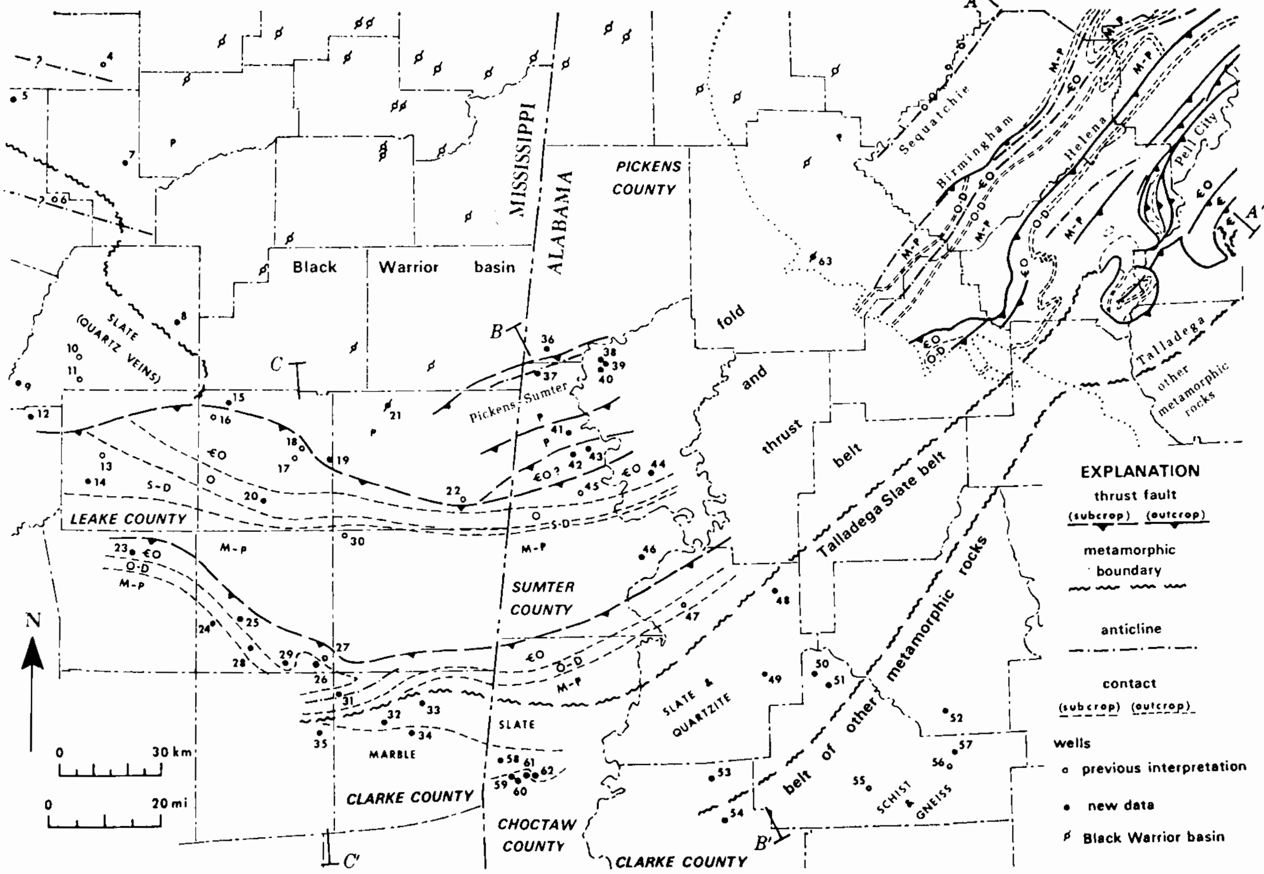

Fig. 4. Structural geology map of Appalachian system beneath the Gulf coastal plain. Explanation of subcrop and outcrop symbols: Є, Cambrian; ЄO, Cambrian and Lower Ordovician (subcrop Knox Group); O, Middle and Upper Ordovician (Chickamauga); O-D, Middle Ordovician through Devonian; S-D, Silurian and Devonian; M-P, Mississippian and Pennsylvanian; P, Pennsylvanian (Pottsville). Numbered wells are listed in appendix; wells in Black Warrior basin are identified on published maps (Thomas, 1972a, pl. 8; 1972b, figs. 2 and 3). Wells designated as "new data" include older wells for which new or supplementary information is available in addition to more recently drilled wells. Note: "metamorphic boundaries" may or may not be faulted.

TALLADEGA SLATE BELT

The subsurface Talladega Slate belt includes mainly black slate with interbeds of quartzite and quartz-pebble conglomerate. The lithology suggests a metamorphic equivalent of the Mississippian-Pennsylvanian rocks of the fold and thrust belt outcrops; that interpretation parallels Carrington's (1972) identification of metasedimentary rocks and formations at the southwestern end of the exposed Talladega Slate belt in Alabama. Although the exposed Talladega includes multiple structural slices and stratigraphic sequences (Carrington, 1972), such details cannot now be identified in the subsurface. The subsurface slate belt strikes southwesterly across western Alabama and apparently curves to westerly strike in Mississippi (fig. 4).

The southwestern part of the slate belt includes a carbonate unit composed of pink and gray dolomite. The carbonate sequence locally includes thin intervals of red slate, black and gray pelite, and black and gray chert. Parts of the succession include chlorite schist and green phyllitic rock that contains chlorite. In Alabama, the carbonate rocks are bordered on the south (wells 59, 60, and 61) by chlorite schist, phyllite, and vein quartz. The lithologic association and the position within the structural system suggest that this subsurface carbonate unit constitutes a marble belt analogous to the Sylacauga Marble of the Alabama outcrops. The subsurface marble belt apparently extends from Choctaw County, Ala. westward into Clarke County, Miss. (fig. 4). The overall lithology suggests equivalence to the Cambrian-Ordovician carbonate succession (table 1).

FOLD AND THRUST BELT

Stratigraphy.—Identification of the Appalachian fold and thrust belt in the subsurface is based on subcrop distribution of rock types. Previously published maps have generally shown two stratigraphic subdivisions of subcrop rocks: a Cambrian through Devonian undifferentiated carbonate unit and a Mississippian-Pennsylvanian clastic sequence (fig. 2). More detailed stratigraphic subdivision is feasible (table 1), and identification of such subdivisions provides for a more detailed subcrop map (fig. 4).

Western Alabama.—In western Alabama, the subsurface structural boundary between the fold and thrust belt and the Black Warrior basin was drawn previously along the northwest side of an area of Cambrian-Devonian subcrop (fig. 2). The structural front was interpreted as extending southwestward from the Birmingham anticlinorium into the Eastern Mississippi "angle" (King, *in* Flawn and others, 1961, pl. 3), and the western Alabama subcrop has been shown as an extension of the exposed Appalachians (fig. 2). That interpretation now seems confirmed by well 46 (in eastern Sumter County) which penetrated Pottsville sandstone and shale within the area formerly known to contain only Cambrian-Devonian carbonate rocks (fig. 4). The geographic position of the Pottsville subcrop indicates that the area of Cambrian-Devonian subcrop must be divided into at least two strips (fig. 4). The subcrop distribution is compatible with an interpretation of two southeast-dipping panels separated by a thrust fault (figs. 3 and 4).

Recent wells in western Alabama demonstrate the presence of at least one major structure, Pickens-Sumter anticline (Thomas and Bearce, 1969, p. 38), north of the previously mapped position of the Appalachian front. In southern Pickens and northern Sumter counties, Ala., three wells (wells 36, 37, and 41) define an asymmetric anticline or thrust block (figs. 3 and 4). The top of Devonian strata in well 37 at the crest of the anticline is more than 1800 m (6000 ft) structurally higher than in well 36 on the northwest limb (figs. 3 and 4). On the southeast, Devonian strata in well 41 are 490 m (1600 ft) structurally lower than in well 37. On the east, well 40 bottomed in Pottsville sandstone and shale more than 950 m (3100 ft) structurally lower than well 37. Farther west in Mississippi, well 21 bottomed in Pottsville strata more than 3300 m (10,800 ft) lower than well 37. The structure may be mapped as a rather simple, asymmetric, doubly plunging anticline (Thomas, 1972b, fig. 3). But, the anticline may be double-crested and have a shallow medial syncline through the location of well 40 (Thomas and Bearce, 1969, p. 38). Seismic data (Schneeflock, in preparation) indicate that the steep northwest flank of the anticline is faulted and confirm that the anticline is double-crested. The lower southeastern crest of the anticline also may be faulted (figs. 3 and 4). Fold geometry required by well data suggests a southwesterly strike—a direction that leads toward the northeast corner of the Central Mississippi deformed belt (fig. 4).

New data are interpreted to show that the western Alabama fold and thrust belt includes at least three major structures, but lack of subsurface data prevents an interpretation of continuity of any one of those structures to any specific structure in the exposed Appalachians (fig. 4). However, the structural style of the fold and thrust belt evidently is continuous southwestward at least to the state line. Projection of strike of the exposed Sequatchie anticline suggests possible subsurface continuity southwestward to the Pickens-Sumter anticline; however, the Sequatchie anticline apparently flattens and ends southwestward in the Alabama outcrop. If strike curves more westerly, the Birmingham anticlinorium may be continuous with the Pickens-Sumter anticline. However, the most likely possibility appears to be that the Pickens-Sumter anticline ends northeastward before connecting with any particular structure in the exposed Appalachians, and probably no single frontal structure persists along strike from the exposed Appalachians to western Alabama.

Stratigraphic indications of structural history suggest similarity of the Pickens-Sumter anticline to the Birmingham anticlinorium rather than to the Sequatchie anticline. Relation of thickness and facies distribution to structural position (see Cooper, 1964, for discussion of applicable principles) suggests folding of the Pickens-Sumter anticline contemporaneously with Mississippian sedimentation (Thomas, 1972a, p. 5). Stratigraphic data have been interpreted to show that deformation of the Birmingham anticlinorium was contemporaneous with sedimentation during parts of the Paleozoic, particularly Mississippian and Silurian (Thomas, 1968, p. 2133; Thomas, Bearce, and Drahovzal, 1970, p. 704; Bearce, 1973, p. 698). In contrast, the Sequatchie anticline in the exposed Appalachians shows no clear stratigraphic indication of Mississippian folding (Thomas, 1972a, p. 5).

Central Mississippi Deformed Belt.—The Central Mississippi uplift (Morgan, 1970, p. 92) encompasses an area in which several wells have penetrated lower Paleozoic carbonate rocks. Use of greater detail in stratigraphic subdivision (table 1) reveals a subcrop distribution pattern that suggests at least two south- to southwest-dipping panels of Paleozoic rocks (figs. 3 and 4). Presumably the structures are either thrust fault blocks or asymmetric anticlines which are steep on their northern sides. The evident complexity of the internal structure of the uplift suggests the name, Central Mississippi deformed belt (Thomas, 1972b, p. 85, fig. 3). Silurian rocks are identified on the basis of fossils (King, *in* Flawn and others, 1961, p. 355); the other units are identified on the basis of lithology. The strip of Mississippian-Pennsylvanian subcrop, mapped across the middle of the belt, has not been drilled within the area of the uplift (fig. 4); presence of the strip is inferred from subcrop distribution of other rock units and analogy with western Alabama.

On the south edge of the Central Mississippi deformed belt, just north of the Talladega Slate belt, well 31 (Clarke County, Miss.) has penetrated a unique stratigraphic succession. Beneath the Mesozoic, a thick dolostone interval is physically underlain by sandstone and sandy dolostone, and that is succeeded downward by limestone. That succession has been interpreted as being in the lower part of the Knox Group (Williams, 1969); however, no similar rock succession is known in the lower Knox elsewhere in the area. The succession may be interpreted as dolostone of the Knox Group, underlain by sandstone and sandy dolostone of the basal Chickamauga, and limestone of the Chickamauga Group. That intriguing possibility requires an overturned panel of Cambrian and Ordovician rocks (fig. 3).

Eastern Mississippi "Angle".—Structure of the Eastern Mississippi "angle" remains problematic. Only a few wells have been drilled within the "angle", and all have penetrated carbonaceous sandstone and shale of the Pottsville. Earlier maps show the "angle" as lying between the southwest-trending fold and thrust belt of western Alabama and the southeast-trending Central Mississippi deformed belt (fig. 2). However, that interpretation predates discovery of the Pickens-Sumter anticline, which lies across part of the open northern end of the "angle" (figs. 1 and 4).

Several alternative interpretations appear possible:

1. Strike of structures other than the Pickens-Sumter anticline may converge to define the "angle" as previously mapped (fig. 5). The Pickens-Sumter anticline thus extends across part of the open end of the "angle" and is not parallel with other structures in the fold and thrust belt. Gravity data show northeast-trending anomalies in the area around the northwest corner of Clarke County, Miss. (Morgan, 1970, p. 91). However, the Talladega Slate belt, particularly the marble, suggests a westerly strike south of the fold and thrust belt (fig. 5). The required configuration is one of parallel structures on the north (Pickens-Sumter) and the south (Talladega) separated by divergent structures within the fold and thrust belt.

2. Apparent similarity of multiple structural panels of Paleozoic rocks both west (central Mississippi) and east (western Alabama) of the

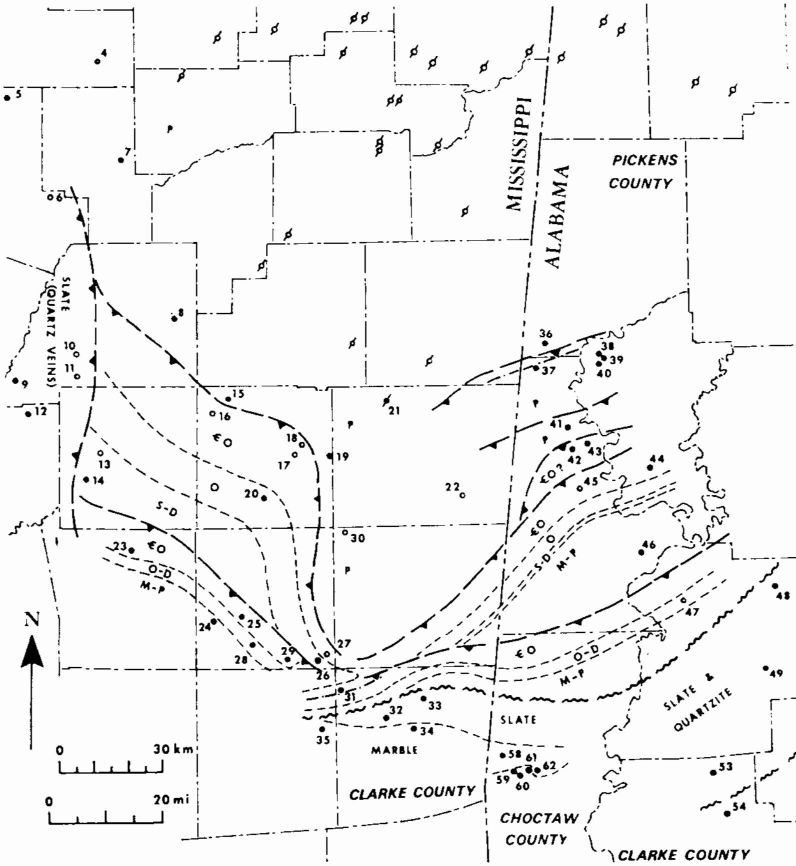

Fig. 5. Structural geology map of Appalachian system; alternate interpretation: fold and thrust belt structures converge in Eastern Mississippi "angle". Symbols are explained on figure 4.

Eastern Mississippi "angle" suggests similar structural style on both sides of the "angle". Absence of subcrop panels of lower Paleozoic rocks within the "angle" might be caused by a re-entrant bounded on both sides by strike-slip faults (fig. 6). Lateral terminations of central Mississippi and western Alabama structures possibly outline the apparent "angle".

3. Similarities of structural style in western Alabama and in central Mississippi, as well as indications of westerly strike in eastern Mississippi, suggest a simple continuation along strike from the exposed Appalachians to central Mississippi (fig. 4). Wells within the "angle" are so sparse and are spaced so as to leave the possibility that lower Paleozoic carbonate subcrop strips do cross the area. Alternatively, the "angle" may indicate a north-trending deep depression across the structural system; possibly structures on both east and west plunge beneath the area of Pottsville strata in the depression (fig. 7). Definition of structures both

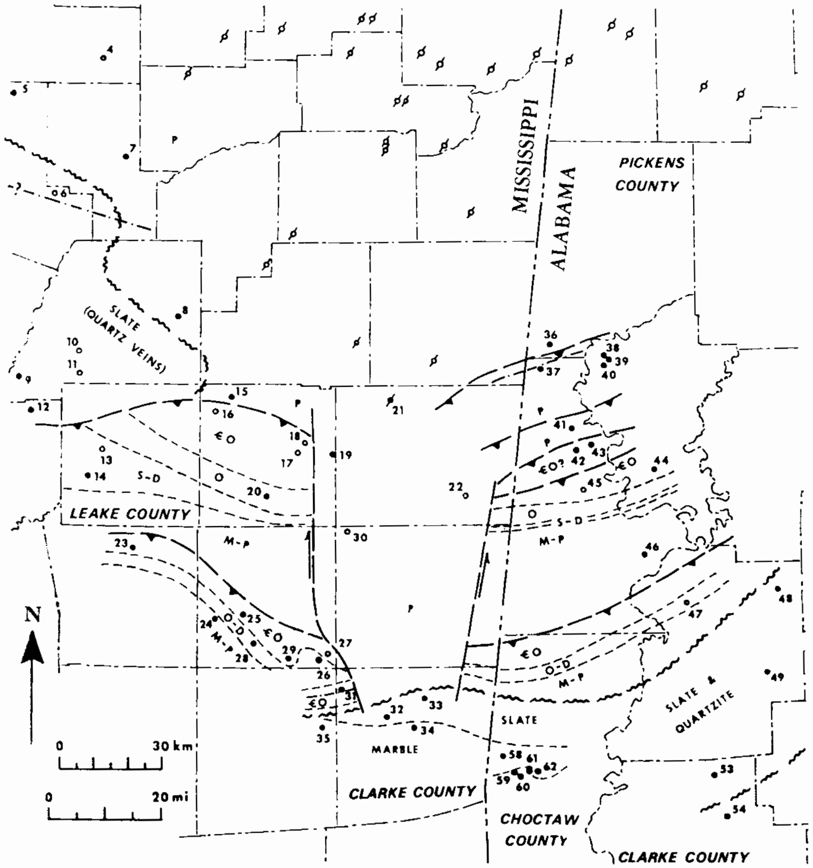

Fig. 6. Structural geology map of Appalachian system; alternate interpretation: strike-slip faults bound Eastern Mississippi "angle". Symbols are explained on figure 4.

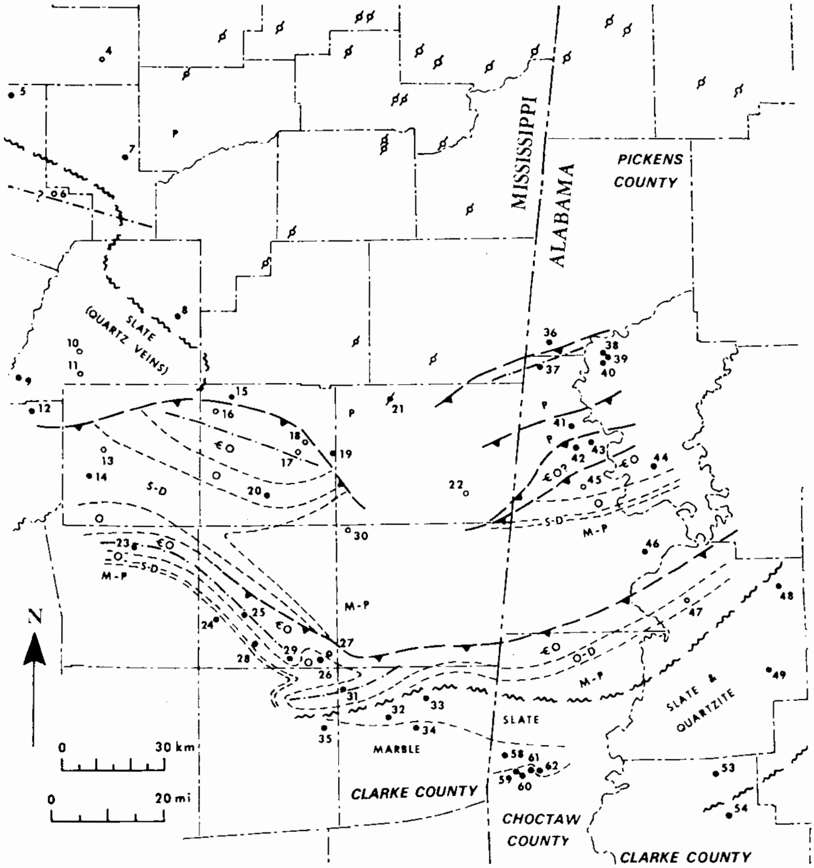

Fig. 7. Structural geology map of Appalachian system; alternate interpretation: fold and thrust belt structures plunge into structural depression in Eastern Mississippi "angle". Symbols are explained on figure 4.

east and west of the Eastern Mississippi "angle" suggests that the southwest-trending structural system of western Alabama curves westward across eastern Mississippi and continues into the central Mississippi deformed belt (figs. 1 and 4).

WESTERN MISSISSIPPI SLATE BELT

Within the Western Mississippi slate belt, between the Central Mississippi deformed belt and the exposed Ouachitas, the stratigraphic sequence has not been clearly defined. Rocks within the belt include clay shale, silty shale, siltstone, and sandstone. Parts of the succession are carbonaceous and seem lithologically comparable with Upper Mississippian and Pennsylvanian strata farther east in the Black Warrior basin. Other parts of the succession contain black siliceous claystone and dark-gray and black chert which appear lithologically similar to interbeds in the Stanley and Jackfork groups of the exposed Ouachitas (Thomas, 1972b, p. 103). Possibly some of the shale and chert belongs to the lower Paleozoic part of the Ouachita sequence. Insufficient depth of penetration in a single well and lack of variety in the succession have precluded indentification of useful stratigraphic subdivisions.

The belt is characterized by slaty cleavage of the pelitic rocks, although cleavage is not consistently distinct throughout the belt. Within the general area of the belt, some rocks are not slaty; possibly these are infolded into the mass of slaty rocks. Much of the belt is also marked by abundant quartz veins. Both the slaty cleavage and the quartz veins appear similar to structural characteristics of rocks in the exposed Ouachita core zone (Miser, 1959, p. 37). Evidently, Ouachita structural style extends from the outcrop in Arkansas along a southeast-trending belt to the northern front of the Central Mississippi deformed belt (fig. 1). King (*in* Flawn and others, 1961, p. 93) proposed that the slaty rocks are on an eastward extension of the Benton-Broken Bow anticlinorium or of the thrust sheets of the Ouachita system.

Because wells are sparse, the boundary between the Western Mississippi slate belt and undeformed rocks on the northeast can be defined only approximately (fig. 8). Between the belt of slate and the area of undeformed rocks of the Black Warrior basin, several wells (wells 4, 7, 8, and 15) have cored Pottsville beds which have dips of 15 degrees or more.

Junction of the Western Mississippi slate belt with the Central Mississippi deformed belt is not clearly defined; however, the slate belt apparently extends north of the known western part of the deformed belt (fig. 8). The southern limits of the Western Mississippi slate belt are unknown, and similarly the relation of the western end of the Central Mississippi deformed belt to the slate belt is not established. The slate belt rocks have been interpreted as being thrust over the carbonate rocks in central Mississippi (King, 1950, p. 668; Vernon, 1971, fig. 6); but, alternatively, the western end of the belt of carbonate rocks possibly is marked by a facies change (King, *in* Flawn and others, 1961, p. 90). Distribution of black shale interbeds in the Ordovician and Silurian limestone succession in central Mississippi suggests a facies change from the carbonate sequence westward to the "Ouachita" black shale facies across central Mississippi (Thomas, 1972b, p. 103). Possibly the Central Mississippi deformed belt, which is clearly defined in the carbonate facies, extends westward across the facies boundary into the black shale succession, where the structures are an indistinguishable part of the Western Mississippi slate belt. Lack of data on the south precludes an answer to the question of whether or not the Western Mississippi slate belt extends south of the Central Mississippi deformed belt to join the Talladega Slate belt.

The relationship between the apparently southeast-trending front of the Western Mississippi slate belt and the strike of individual structures within the belt is not presently defined; however, parallelism of the front and the structural strike generally is implied. Both the exposed Ouachitas and the Central Mississippi deformed belt, as interpreted here (fig. 1), have essentially east-west strike; therefore, if strike within the Western Mississippi slate belt is southeast, the structure curves or intersects at a sharp angle at both ends of the slate belt. Alternatively, the southeast-trending structural front at the eastern margin of the Ouachitas possibly defines not the strike of individual structures but, rather, a line along which east-plunging structures flatten and terminate (figs. 1 and 8). That interpreted configuration is designed to be analogous to the northern arc of the Pennsylvania Appalachian salient where northeast-striking frontal folds flatten northeastward beneath the Pocono Plateau (USGS, 1932; Wood and Bergin, 1970, fig. 1).

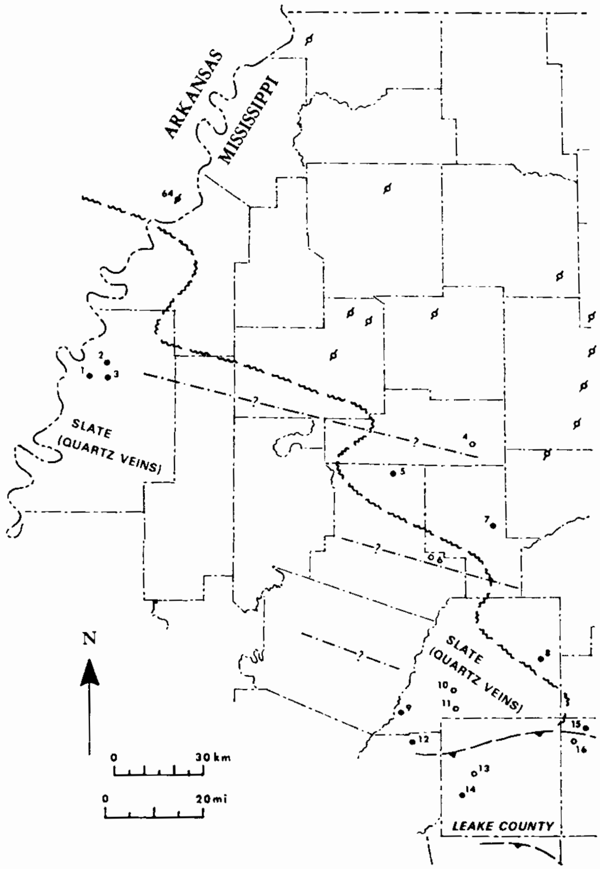

Fig. 8. Structural geology map of Western Mississippi slate belt assuming that dominant structures are eastward-flattening folds. Symbols are explained on figure 4.

CONCLUSIONS

The Appalachian structural system has been interpreted to extend southwestward from the outcrops in Alabama beneath the Gulf coastal plain and to continue westward and connect with the Ouachita system. New data provide the basis for extending the area of recognition of parts of the system and for refining specific structural details. The Appalachian system encompasses a frontal belt of folded and thrust-faulted Paleozoic sedimentary rocks and interior belts of slate and other metamorphic rocks. Structural strike evidently curves from southwestward in Alabama to westward in Mississippi. A belt of low-grade metasedimentary rocks defines a structural continuation northwestward across western Mississippi toward the Ouachita Mountains.

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APPENDIX

List of wells, locations, and data sources

Map Number*	Well	County	Location	Data Source**
	Mississippi			
1	Holmans-Russell No. 1 Thomas	Bolivar	18-T24N-R7W	SE 1
2	Phillips Petroleum No. 1 Knowlton-Perthshire	Bolivar	2-T24N-R7W	SE 1
3	Central Oil No. 1 Tuminello	Bolivar	14-T24N-R7W	SE
4	Lockhart No. 1 Fite	Grenada	25-T22N-R6E	E 1
5	Billups-Serio No. 1 Heath	Carroll	29-T21N-R4E	S 1
6	Texas No. 1 Whitehead	Carroll	22-T18N-R5E	SE 1
7	Gulf Refining No. 1 Parker	Montgomery	22-T19N-R7E	SE 1
8	Shell Oil No. 1 Wheeles	Attala	5-T14N-R9E	SE 1
9	Occidental Petroleum No. 1 Burrell	Attala	28-T13N-R4E	SE
10	Stanolind Oil and Gas No. 1 Steed	Attala	4-T13N-R6E	SE 1
11	Continental Oil No. 1 Sudduth	Attala	28-T13N-R6E	SE 1
12	Union Producing No. 1 Vanarsdale Unit	Madison	30-T12N-R5E	SE
13	Carter Oil No. 1 Denkman	Leake	31-T11N-R7E	SE 1,2
14	Occidental Petroleum No. 1 Reimers	Leake	23-T10N-R6E	E
15	Continental Oil No. 1 Fortenberry	Neshoba	13-T12N-R10E	SE 1
16	Slick Oil-Plains Production No. 1 Breazeale	Neshoba	28-T12N-R10E	SE 1
17	Pure Oil No. 1 Rea	Neshoba	36-T11N-R12E	SE 1
18	Pure Oil No. 1 Jones	Neshoba	19-T11N-R13E	SE 1
19	Elliott No. 1 Eakes	Neshoba	36-T11N-R13E	SE 1

Map Number*	Well	County	Location	Data Source**
20	South Natural Gas No. 1 Smith	Neshoba	1-T9N-R11E	SE 1
21	Pure Oil No. 1 Henry	Kemper	15-T12N-R15E	SE
22	Lamb-Galt No. 1 Phillips	Kemper	2-T9N-R17E	E
23	Southeastern Drilling No. 1 Eley	Scott	19-T8N-R8E	SE 1
24	State Exploration No. 1 Johnson	Newton	21-T6N-R10E	E 3,4
25	Texas No. 1 Everett	Newton	17-T6N-R11E	E 3,4
26	Sun Oil No. 1 Wall	Newton	28-T5N-R13E	SE 1,2
27	Sun Oil No. 1 Citizens National Bank	Newton	23-T5N-R13E	SE 1
28	Louisiana Land and Exploration No. 1 Nicholson Unit	Newton	10-T5N-R11E	SE
29	Wyatt No. 1 Horne	Newton	27-T5N-R12E	SE
30	Magnolia Petroleum No. 1 Culpepper	Lauderdale	4-T8N-R14E	SE 1
31	State Exploration-Wyatt No. 1 Coit	Clarke	19-T4N-R14E	SE 5
32	Sun Oil No. 1 Board of Supervisors G	Clarke	16-T3N-R15E	SE
33	Sun Oil No. 1 Longbell Petroleum	Clarke	34-T4N-R16E	SE
34	Sun Oil No. 1 Culpepper-Kirkland Unit	Clarke	29-T3N-R16E	SE
35	Pan American Petroleum No. 1 Masonite	Jasper	27-T3N-R13E	SE
	Alabama			
36	Sonat-Geochemical Surveys No. 1 Lee	Pickens	26-T24N-R3W	E 6
37	Sonat-Geochemical Surveys No. 1 Hagerman	Sumter	9-T23N-R3W	E 6
38	Glasco No. 1 Grantham	Greene	5-T23N-R1W	S 6
39	Glasco No. 1 Williams	Greene	9-T23N-R1W	S 6
40	Glasco No. 1 Norwood	Greene	17-T23N-R1W	SE 6
41	Pan American Petroleum No. 1 Hill	Sumter	5-T21N-R2W	SE 6
42	Southern Natural Gas No. 1 Coggins	Sumter	28-T21N-R2W	E 6
43	Southern Natural Gas No. 1 Roberts	Sumter	23-T21N-R2W	E 6
44	Johnston No. 1 Willis	Greene	11-T20N-R1E	S 6
45	Marott No. 1 Larkin	Sumter	34-T20N-R2W	SE 1,6
46	Elliott No. 1 Perolio	Sumter	29-T18N-R1E	SE 6
47	Johnston No. 1 Peteet	Marengo	3-T16N-R2E	S 1,6
48	Hughes-Oglesby No. 1 Alexander	Marengo	29-T17N-R5E	E 6
49	Currey Oil No. 1 Glass	Marengo	1-T14N-R4E	SE
50	Henderson No. 1 Strother Brothers	Wilcox	4-T14N-R6E	SE 6
51	Geochemical Surveys No. 1 Strother Brothers	Wilcox	14-T14N-R6E	SE 6
52	Rudman-Marr No. 2 Buchanan	Dallas	7-T13N-R10E	SE 6
53	Murphy Oil No. 1 Johnson	Clarke	5-T11N-R3E	SE
54	American Petrofina No. 1 Harrigan	Clarke	10-T10N-R3E	SE 6
55	Gulf Refining No. 1 Sellers	Wilcox	13-T11N-R7E	SE 1,6
56	Seaboard Oil No. 1 McConnico	Wilcox	32-T12N-R10E	SE 1,6
57	Seaboard Oil No. 1 Rollins	Wilcox	16-T12N-R10E	SE 1,6
58	Placid Oil No. A-1 Land	Choctaw	18-T12N-R4W	SE 6
59	Justiss-Mears Oil No. 1 Jackson-Harrell	Choctaw	33-T12N-R4W	SE 6
60	Placid Oil No. 1 Land 3-9	Choctaw	3-T11N-R4W	SE 6
61	Placid Oil No. 1 Bolinger	Choctaw	36-T12N-R4W	SE 6
62	Placid Oil No. 1 Jackson	Choctaw	31-T12N-R3W	SE 6
63	Reichhold Chemicals No. 1	Tuscaloosa	3-T21S-R9W	E 6
	Arkansas			
64	Ambassador Oil No. 1 Thompson Unit	Phillips	11-T3S-R4E	7

* Well locations are identified by map number on figures 4 and 8.

** Data sources:

S—sample description by author; E—electrical and other geophysical logs.

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2. Thomas, 1972b
3. Dinkins, 1968
4. Oxley, Minihan, and Ridgway, 1968
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