GEOLOGICAL SURVEY OF ALABAMA

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BULLETIN 88

A SUBSURFACE STUDY OF SOUTHEAST ALABAMA

By Donald B. Moore and Thomas J. Joiner

UNIVERSITY, ALABAMA

1969

STATE OF ALABAMA

Honorable Albert P. Brewer, Governor

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University, Alabama
August 13, 1969

Honorable Albert P. Brewer
Governor of Alabama
Montgomery, Alabama

Dear Governor Brewer:

I have the honor to transmit herewith the report entitled "A Subsurface Study of Southeast Alabama," by Donald B. Moore and Thomas J. Joiner, which has been published as Bulletin 88 of the Geological Survey of Alabama.

This report deals with the stratigraphy and structural configuration of the subsurface formations in southeast Alabama and defines areas having excellent potential for the production of oil and gas. This is an outstanding research effort and has contributed substantially to the added emphasis on oil and gas exploration in southern Alabama during the past year. This report is a joint effort on the part of the Oil and Gas Board and Geological Survey to encourage exploration and development of Alabama's natural resources.

Respectfully,

Philip E. LaMoreaux
Philip E. LaMoreaux
State Geologist

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A SUBSURFACE STUDY OF SOUTHEAST ALABAMA

By Donald B. Moore and Thomas J. Joiner

ABSTRACT

A subsurface study of Barbour, Bullock, Butler, Coffee, Conecuh, Covington, Crenshaw, Dale, Escambia, Geneva, Henry, Houston, and Pike Counties was made to evaluate the water, mineral, and petroleum resources. The study was based on available data from oil-test wells, core holes and water wells.

The easternmost limit of the salt basin in Alabama extends through Escambia County. Most of the geologic structures detected in the Lower Cretaceous Series or in younger sediments in the salt basin are the result of movement of the underlying Louann Salt of Jurassic age. East of the salt basin the influence of basement tectonics is of primary importance in evaluating structure.

Subtle structural indications and numerous facies changes which occur in the 13-county area offer possibilities as potential oil traps.

The Pollard oil field proves the existence of source and reservoir beds in Escambia County, and Covington and Conecuh Counties have good oil and gas potential. Test wells which have been drilled in other parts of the study area offer little encouragement for petroleum possibilities, but most of the area remains virtually untested, and future exploration will probably discover other commercial oil accumulations in south and southeast Alabama.

INTRODUCTION

A subsurface study of geology and structure was made in 13 counties in south and southeast Alabama to evaluate the water, mineral, and petroleum resources. The area studied included Barbour, Bullock, Butler, Coffee, Conecuh, Covington, Crenshaw, Dale, Escambia, Geneva, Henry, Houston, and Pike Counties (fig. 1).

Southeast Alabama lies within the Gulf Coastal Plain physiographic province where sediments consist of relatively unconsolidated sand, shale, clay, and limestone. The Coastal Plain sediments range in thickness from zero where they pinch out at the Fall Line, to an estimated 20,000 feet in southwest Escambia County.

The basic data used were from 230 oil test wells, 12 core holes, and numerous water wells that have been drilled. One hundred and thirty-six oil test wells were drilled in Escambia County with samples and electric logs available for study. Ninety-four oil

Figure 1.—Index map showing area of investigation.

test wells were drilled in the other 12 counties studied, but electric logs were available on only 52 of them. Electric logs of water wells were the main source of information in the northeast part of the area where Upper Cretaceous sediments are relatively shallow.

PREVIOUS WORK

Surface work which dealt with the stratigraphy, structure, and correlation of Upper Cretaceous rocks in parts of southeast Alabama was published by E. R. Applin (1947). Reconnaissance surface geologic mapping in the area was done by F. Sterns MacNeil (1946) and D. H. Eargle (1950).

Surface geologic mapping and a water and minerals resources investigation of the 13-county area was undertaken as a cooperative project of the Alabama Geological Survey and the U.S. Geological Survey in 1963. A geologic map of Barbour and Coffee Counties is now available. Geologic maps for the other counties are being prepared. Mineral resources maps of the 13 counties are also available.

GEOLOGY

BASEMENT

Basement rocks of metamorphic and igneous composition were penetrated by 15 wells drilled in the project area. Depth to basement in these wells ranges from 1,700 feet below the surface in Bullock County to 9,470 feet in Butler County.

In Houston County well 186, Union Producing Co. E. P. Kirkland No. 1, bottomed in calcareous sandstone and shale of Ordovician age at a depth of 8,100 feet.

TRIASSIC SYSTEM

Rocks of Triassic(?) age have been reported from six oil test wells in southeastern Alabama (Applin, 1951; McKee and others, 1959; and King, 1961). The wells are: 145 (Nelson Exploration Company No. 1, Smith Lumber Company, Crenshaw County); B-321 (W. B. Hinton No. 1, J. S. Creel, Barbour County); B-317 (H. A. Stebbinger No. 1, Alice S. Robertson, Barbour County); 162 (Messergill and Williams No. 1, T. R. Grubbs, Barbour County); 159 (Robert

York Trustee No. 1, S. V. Dismuke, Barbour County); and 631 (Renwar Oil Corporation No. 1, H. D. Granberry, Henry County).

Cores and cuttings from the wells show that buried Triassic(?) sedimentary rocks are composed of hard dark-red and greenish-gray and mottled micaceous shales irregularly interbedded with fine- to coarse-grained poorly sorted white, gray, and red sandstone that in places is conglomeratic and highly arkosic (Applin, 1957, p. 1486). Diabase dikes or sills were penetrated in wells B-321 and B-317.

JURASSIC SYSTEM

LOUANN SALT

The Louann Salt was encountered in six wells in southwest Alabama. This formation probably underlies the southwestern part of the area studied. The salt is clear to grayish white with anhydrite streaks.

Most of the major geologic structures in southwest Alabama are the results of deep-seated movement of the Louann Salt. The Pollard fault zone and other structures in Escambia County are probably related to salt movement. The updip limit of the Louann Salt is generally defined by a graben fault system such as the Gilbertown fault system in Choctaw County, and the Pollard fault zone in Escambia County (fig. 1).

NORPHLET FORMATION

The Norphlet Formation overlies the Louann Salt. It is composed of red and gray clays and sands, and some gravel. Frosted sand grains were noted in numerous samples. Maximum thickness of the Norphlet Formation is greater than 75 feet.

SMACKOVER FORMATION

The Smackover Formation is generally a light olive gray to brown fine-grained oolitic limestone with occasional vugular porosity. A sandstone unit in some wells in Clarke, Choctaw, and Wilcox Counties has been called Smackover equivalent by some workers, but the unit may be the Norphlet Formation. Additional work is needed to resolve the problem. The thickness of the Smackover Formation in Choctaw County is approximately 450 feet.

The Smackover Formation probably underlies Escambia County. It has been the target of much recent drilling and is a prolific producer of high grade crude oil in Choctaw County, Alabama, and in Mississippi, Louisiana, Arkansas, and Texas.

HAYNESVILLE FORMATION

The Haynesville Formation that overlies the Smackover Formation is a regressive deposit with evaporites overlain by clastics. The upper part of the formation consists of fine-grained pink and red sands and silts with some pink to red shales. The lower evaporitic sequence consists of anhydrite, salt, shale, and limestone. The evaporites do not extend east of Escambia County.

COTTON VALLEY GROUP

The Cotton Valley Group, named by the Shreveport Geological Society, includes dark-gray marine fossiliferous shale, limestone, and sandstone. At the type locality in the Cotton Valley field in northern Louisiana, it is underlain by the Haynesville Formation and overlain by red beds of the Lower Cretaceous Hosston Formation.

In Alabama, the Cotton Valley Group consists of pink and gray sands and gravel; red, purple, and green mottled shale; green waxy shale; and some carbonaceous material.

The vertical limits of this formation in Alabama are difficult to determine lithologically or electrically.

The Cotton Valley Group, consisting of dark-red and green waxy shale, coarse-grained sand and sandstone, with conglomerate fragments, was penetrated at 10,470 feet in well 40, Humble Oil and Refining Co., Mrs. Minnie E. Skinner No. 1, T. 3 N., R. 10 E., in Escambia County. There have not been enough deep wells drilled in southeast Alabama to determine the extent of the area underlain by the Cotton Valley Group.

CRETACEOUS SYSTEM

LOWER CRETACEOUS SERIES

Lower Cretaceous sediments were penetrated by 33 percent of the wells drilled in the project area. They underlie the "massive sands" of the Tuscaloosa Group of Upper Cretaceous age. Pink nodular lime and red and green shales generally occur at the top of the Lower Cretaceous throughout south Alabama. It is often difficult to determine the top of the Lower Cretaceous on electric logs, and regional correlations are dependent on sample logs. There have been few attempts to subdivide the Lower Cretaceous in southeast Alabama where the sequence is referred to as Lower Cretaceous undifferentiated. These sediments thin northward until they pinch out in the subsurface south of the Fall Line.

UPPER CRETACEOUS SERIES

TUSCALOOSA GROUP

The Tuscaloosa Group was originally ranked as the Tuscaloosa Formation, named for the city of Tuscaloosa in Tuscaloosa County, Alabama (Smith and Johnson, 1887). The formation was later divided into the Cottondale, Eoline, Coker, and Gordo Formations and raised to group status (Conant and others, 1945). In 1953, Drennen reclassified the outcropping Tuscaloosa Group in Alabama. The Coker Formation was redefined to include the Cottondale, Eoline, and Coker Formations of Conant, Eargle, and Monroe. The redefined formation is composed of a lower member, the Eoline, which includes beds formerly called Cottondale, and an upper unnamed member equivalent to the original Coker Formation. The Gordo Formation remains as originally defined. Thickness of the Tuscaloosa Group ranges from about 600 feet in the easternmost counties in southeast Alabama to more than 1,100 feet in Escambia County.

The Tuscaloosa Group undifferentiated consists typically of a lower arenaceous section, a middle argillaceous section that is normally marine, and an upper section of predominantly arenaceous to graveliferous beds. For the purposes of this report these sequences of sediment are termed "Lower," "Middle" (or Marine), and "Upper Tuscaloosa." Facies changes within the Tuscaloosa Group downdip from the surface exposures and the resulting changes in electrical characteristics hinder precise correlations of the subsurface units with the surface Coker and Gordo Formations. Murray (1961, p. 337) presents a possible correlation of the informal subsurface units with the formally named surface stratigraphic units (fig. 2).

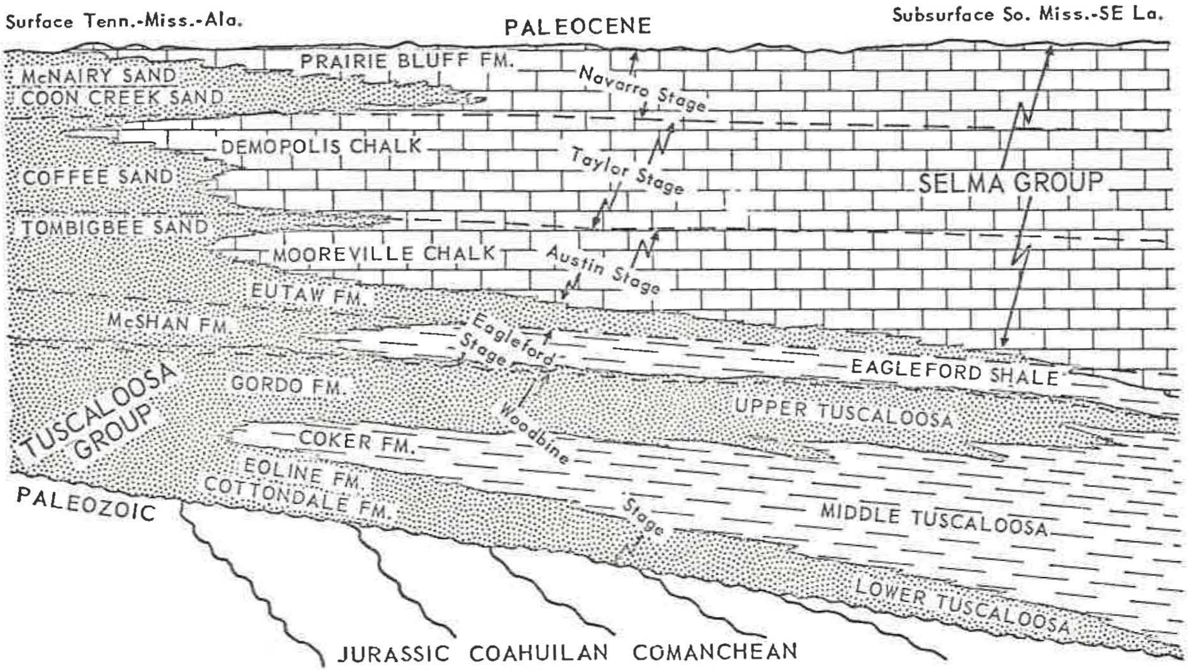

Figure 2.—Diagrammatic dip section of the Selma and Tuscaloosa Groups in eastern part of northern Gulf Coastal province showing an interpretation of (1) updip-downdip facies, (2) cyclical sequences, (3) rock-stratigraphic nomenclature which has commonly been applied in the region, and (4) supposed relationships to provincial stages (after Murray, 1961).

The Lower Tuscaloosa was penetrated by 86 percent of the wells drilled. It is the oldest geologic unit mapped in this study and is easily identified lithologically and electrically.

EUTAW FORMATION

The Eutaw Formation includes the beds between the overlying Selma Group and the underlying Tuscaloosa Group. The formation was named for the town of Eutaw in Greene County, Alabama, by Hilgard in 1860. It was later redefined by Smith and Johnson in 1887.

The Eutaw Formation is composed of fine- to medium-grained gray to greenish-gray glauconitic micaceous sandstone, and light-gray to greenish-gray silty micaceous shale. The shale beds are often calcareous and carbonaceous. The upper part of the Eutaw is the Tombigbee Sand Member, a massive calcareous glauconitic sand with indurated layers and concretionary masses. The estimated average thickness of the Eutaw Formation is 400 feet.

SELMA GROUP

The Selma Group unconformably overlies the Eutaw Formation, and is overlain unconformably by the Clayton Formation of Paleocene age. In western Alabama, the Selma Group is comprised mainly of chalk with relatively little clastic material. In central Alabama and eastward the rocks grade from predominantly chalk to fossiliferous sand and clay, and the clastic materials become coarser (Eargle, 1950).

The present classification of the Selma Group is shown in the following table:

Classification of the Selma Group
(after Eargle, 1950)

Western Alabama	Eastern Alabama
Prairie Bluff Chalk	Providence Sand Perote Member at base
Unconformity	Unconformity

Classification of the Selma Group—Continued

Western Alabama	Eastern Alabama
Ripley Formation	Ripley Formation
Demopolis Chalk	Cusseta Sand Member (at base)
Unconformity	
Mooreville Chalk Arcola Limestone Member (at top)	Blufftown Formation

The Mooreville Chalk is light gray to buff, clayey, and impervious, although on exposed surfaces it is jointed and fissile.

The Mooreville Chalk is approximately 400 feet thick and produces the gently sloping "Black Belt" topography. The beds of clayey chalk interfinger with sand and clay of the Blufftown Formation toward the east.

In Bullock County, the uppermost and the lowermost beds of the Mooreville grade into the two westward-extending tongues of the Blufftown Formation. The Blufftown Formation is composed of relatively impervious black to dark-gray carbonaceous silty and finely sandy clay with interbedded lenses of chalk and fine sand.

The Ripley Formation in central Alabama consists chiefly of light-gray calcareous micaceous very fine to medium-grained glauconitic sand, sandstone, and calcareous sandy clay, which weathers light yellow to orange red. The upper part contains several layers of light-gray to yellow hard calcareous sandstone.

The uppermost part of the Selma Group in western Alabama is the Prairie Bluff Chalk, equivalent to the upper formations of the Navarro Group of Texas, and composed of more or less sandy and clayey chalk. Eastward the formation grades laterally into the Providence Sand; first the upper part and then successively lower and lower beds of the chalk become sandy.

The top of the Selma Group was selected as a third mapping horizon. This top is easily recognized in Escambia, Covington, and Conecuh Counties, but east of these counties, correlation becomes increasingly difficult as the upper part of the chalk grades laterally into shale and finally into sand.

TERTIARY SYSTEM

In Alabama, the Tertiary formations consist of relatively unconsolidated marine sediments that are transitional in character between the clastic and largely nonmarine formations of Mississippi and the carbonate formations of the Florida peninsula. Tertiary sediments extend northward in Alabama into Sumter, Marengo, Wilcox, Butler, Crenshaw, Pike, and Barbour Counties. Downdip, these sediments thicken rapidly, attaining a thickness of 6,000 feet in Mobile County.

The Tertiary System has been extensively subdivided, especially on the surface in south Alabama. The Paleocene Series consists mainly of clay, marl, and shale in southwest Alabama. In central Alabama, these sediments become more calcareous and farther east they are predominantly limestone.

The Eocene Series, in southwest Alabama, consists mainly of sand, clayey sand, and silt, and in general, eastward, makes a transition to calcareous shale and limestone. The transition from a clastic to a carbonate facies occurs farther east in Eocene sediments than it does in the underlying Paleocene sediments.

The Oligocene Series is composed of calcareous shale, marl, and limestone in southwest Alabama. In central and eastern Alabama, limestone is the predominant lithology. Miocene and Pliocene sediments consist mainly of sand, sandstone, and gravel. The Citronelle Formation of Pliocene age, composed mainly of sand and gravel, covers much of the western part of the project area.

Most oil test wells drilled in the Coastal Plain of Alabama penetrated Tertiary sediments; therefore, a relatively large amount of subsurface data are available. However, because of the great number of facies changes occurring in the Tertiary it was beyond the scope of this project to attempt an interpretation. A separate study, investigating only the Tertiary formations of south Alabama, is suggested.

STRUCTURE

The easternmost limit of the salt basin in Alabama extends through Escambia County (fig. 1). Most of the geologic structures detected in the Lower Cretaceous Series or in younger sediments in the salt basin are the result of movement of the underlying Louann Salt of Jurassic age. Salt responds as a plastic medium at depth and will move into zones of weakness in response to sediment onloading. Anticlines and domes are formed in sedimentary beds over salt swells and domes, and collapse-type features such as grabens are formed where salt was removed. The Gilbertown, Coffeeville-West Bend, and Pollard fault zones probably developed as a result of salt flowage or solution along the periphery of the salt basin.

East of the salt basin the influence of basement tectonics is of primary importance in evaluating structure. In all of the counties included in this study, with the exception of Escambia County, basement movement such as readjustment along faults, downwarping in response to sediment load, and igneous intrusions, is largely responsible for structure in overlying sediments.

The Cartersville, Brevard, Towaliga and Goat Rock fault zones (Crickmay, 1952) projected from north of the Fall Line into south Alabama are possibly responsible for some of the facies changes which occur in southeast Alabama. The east-west facies changes in Jurassic, Cretaceous, and Tertiary sediments possibly were caused by periodic rejuvenation of the fault zones (Joiner and Moore, 1966).

Geologic formations in southeast Alabama generally strike northwest-southeast and dip south-southwest at 20 to 50 feet per mile. East of Geneva County the strike becomes more east-west and the direction of dip is nearly due south.

The structural features in Escambia County are better known than those in other counties within the project area because of the large amount of data available from oil test wells drilled in and around the Pollard oil field in the south-central part of the county. The Pollard fault system (Marsh, 1966) extends from Florida into the south-central part of Escambia County, and continues northwestward for 35 miles into Baldwin County. A smaller northeastward-trending fault system is indicated a few miles north of the Pollard oil field. Small faults with less than 50 feet of throw are indicated in wells 396, 479, 499, 467, 610, 161, and 468 in Escambia County.

A gentle structural nose along the county line between Crenshaw and Pike Counties is another structural feature of interest in southeast Alabama.

LOWER TUSCALOOSA HORIZON

The altitude of the Lower Tuscaloosa ranges from 900 feet below sea level in the northwest corner of Barbour County to 6,250 feet below sea level in the southwest corner of Escambia County (pl. 1). The data on which the structure map on plate 1 is based are given in table 1. This horizon is important in southeast Alabama because it produces oil in the Pollard oil field in central Escambia County.

The Pollard oil field was discovered in January 1952 and nearly 10,000,000 barrels of 25.6° to 30.1° A.P.I. gravity oil have been produced. The Pollard fault, which is downthrown to the north and northeast, vertically displaces the Lower Tuscaloosa horizon 250 to 300 feet. Farther west, the displacement increases to 500 feet. Most of the production is from sands in the Lower Tuscaloosa on the upthrown side of the Pollard fault, but some oil is produced on the downthrown side of the fault from sands in the Upper Tuscaloosa (Winter, 1954). A map of the field, contoured on the top of the Lower Tuscaloosa horizon, is shown in figure 3. The productive area includes approximately 740 acres in secs. 11, 12, and 13, T. 1 N., R. 8 E., and secs. 7 and 18, T. 1 N., R. 9 E. The field is roughly 3¼ miles long and three-quarters of a mile wide.

In the northeast part of T. 2 N., R. 11 E., about 10 miles east of Pollard in Escambia County, a subtle southwest plunging nose is mapped. The axis of this feature approximates an imaginary line drawn through wells 168 and 529. Gently folded, southwestward-plunging noses are also mapped northeast of well 350 in Conecuh County and along the county line between Crenshaw and Pike Counties.

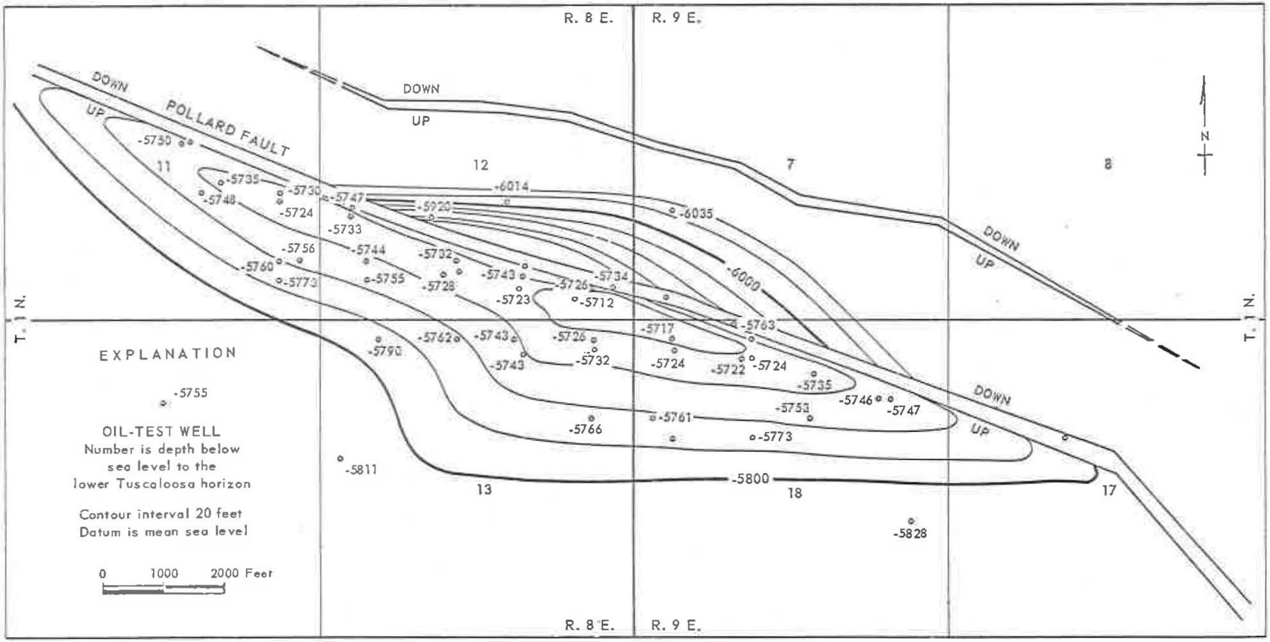

Figure 3.—Map showing structure, top of the Lower Tuscaloosa horizon, Pollard oil field (after Winter, 1954).

BASE OF SELMA GROUP MARKER

Facies changes in the upper part of the Eutaw Formation occur downdip and along strike, and the top of the formation is not a correlative unit. Therefore, a marker bed was selected near the base of the overlying Selma Group for mapping purposes. This marker persists over the entire area and normally occurs between 100 and 200 feet above the first sand of the Eutaw Formation. The elevation of this bed ranges from sea level at the northwest corner of Barbour County to 5,000 feet below sea level in the southwest corner of Escambia County (pl. 1). The data on which this structure map is based are given in table 2.

Structural features mapped on this horizon are nearly the same as those described on the Lower Tuscaloosa structure map. Vertical displacement of the marker bed along the faults in Escambia County is not as great as the displacement of the Lower Tuscaloosa because of deposition contemporaneous with faulting.

TOP OF SELMA GROUP

A structure map on the top of the Selma Group (pl. 1) exhibits the same general structural features as the structure maps for the two deeper horizons. The data on which the structure map is based are presented in table 3. Formations equivalent to the upper part of the Selma Group are exposed on the surface in Butler, Crenshaw, Pike, Bullock, and Barbour Counties. In the southwest corner of Escambia County, the elevation of the top of the Selma Group is about 3,800 feet below sea level.

The Selma Group changes from chalk in Escambia and Conecuh Counties to shale in eastern Covington County to sand in the eastern part of the project area. These changes and sparse well control make lithologic and electrical correlations across the project area very difficult.

The southwest-plunging nose along the county line between Crenshaw and Pike Counties is more pronounced on this horizon than on the deeper mapped horizons.

LOWER TUSCALOOSA - BASE OF SELMA GROUP ISOPACH

The thickness of the interval between the top of the Lower Tuscaloosa and the base of the Selma Group ranges from less than 900 feet in the east and northeast part of the project area to more than 1,300 feet in the graben fault system near Pollard in Escambia County (pl. 1). The data on which this isopach map is based are given in table 4.

A northeast-trending "thin," extending from T. 4 N., R. 10 E. in Conecuh County to the northeast corner of Butler County, and a "thick" near the eastern boundary of Escambia County are possibly indicative of structure. The "thin" is parallel to the Appalachian trend indicating that thinning was possibly caused by basement tectonics.

BASE OF SELMA GROUP TO TOP OF SELMA GROUP

The Selma Group ranges in thickness from less than 900 feet in Houston County to more than 1,300 feet in Escambia County (pl. 1). The data on which this isopach map is based are given in table 5. Thickness trends of this interval are quite different from those for the Lower Tuscaloosa to base of Selma Group interval.

The thickness of the Selma Group in Covington County averages about 1,200 feet. This is thicker than it is over most of southeast Alabama indicating that the area was possibly a subsiding basin during deposition of the Selma Group. Southeast of the thick area in Covington County, the Selma Group begins to thin toward Geneva County where it is 1,000 feet thick.

CROSS SECTIONS

Plates 2 through 7 (in pocket) are cross sections based upon electric log correlations of the formations studied in southeast Alabama. Plate 8 (in pocket) is a panel diagram which illustrates generally some of the facies changes which occur in southeast Alabama.

Cross sections A-A′ and A′-A″ extend from well 456 in western Monroe County to well 489 in northeastern Coffee County, a distance of over 100 miles (pls. 2 and 3).

The Lower Tuscaloosa horizon changes very little along this section. The most noticeable change occurs near the eastern end of the section in well 500 where fresh water in sands within the upper 175 feet is indicated by a sharp increase in resistivity values on the electric log. Well 489, the easternmost well of these two sections, was not drilled deep enough to penetrate the Lower Tuscaloosa horizon, but the fresh-water sands are probably present.

Electrical characteristics indicate that the lithology of the lower part of the Selma Group changes very little over the extent of these cross sections. However, higher than normal resistivity values near the base of the Selma Group on logs of wells 500 and 489 indicate more sand in this interval than in the same interval in wells to the west. Eastward from well 450, the lower part of the Selma Group, which typically is chalk, becomes increasingly clastic and electric logs exhibit higher resistivity values than normally recorded in chalk lithology.

A shale interval between the marker bed at the base of the Selma Group and the first sand of the Eutaw Formation thickens from 40 feet in well 719 to more than 200 feet in well 489. This change is significant because it indicates an eastward deepening of the sea during deposition of the Eutaw Formation.

A facies change that is easily detected on electric logs occurs in the upper part of the Selma Group. The electrical character on the log of well 456 is typical of this interval in southwest Alabama. A slight increase in resistivity values through this interval on logs from wells 668 and 437 indicates an eastward increase of clastic sediments. This probably marks the beginning of the change from chalk, typical of the downdip facies, to sand which occurs updip.

High resistivity values and a subdued S. P. (self potential) curve on the log of well 450 indicate that the upper part of the Selma Group is a clean sand saturated with fresh water. Data from wells east of well 450 indicate that the sand development continues eastward and thickens to as much as 500 feet in well 489. This sand is probably the downdip equivalent of the Ripley Formation which is mapped on the surface in Crenshaw, Pike, Bullock, and Barbour Counties.

A facies change in the Midway Group is shown on this cross section. In well 456, a 10-foot interval having resistivity values slightly higher than the shale base line value occurs approximately 150 feet above the top of the Selma Group. An interval 15 feet thick with about the same electrical characteristics occurs in well 668 approximately 180 feet above the top of the Selma Group. In well 437, the interval is 30 feet thick and resistivity values are higher. Eastward from well 450, this interval continues to thicken and in well 719 in Butler County it is a highly resistant bed approximately 150 feet thick. The lithology of the interval is light-gray hard dense limestone. It is probably the downdip equivalent of the Clayton limestone which is mapped on the surface in Butler, Crenshaw, Pike, and Barbour Counties.

Cross section B-B′ extends from well 719 in Butler County, southeastward across Covington County to well 417 in Coffee County (pl. 4).

The lithology of the Lower Tuscaloosa horizon changes very little along the line of this section. Resistivity curves on the electric logs indicate that sands within this horizon contain salt water.

High resistivity values throughout the sands of the Eutaw Formation in well 417 in Coffee County indicate fresh water. The Eutaw Formation is not used as a source for ground water in this area because adequate supplies are obtained from shallower aquifers.

Sands containing fresh water comprise the upper 150 feet of the Selma Group in well 719 in Butler County. The Selma Group below those fresh-water sands is composed of silty chalky shale. Downdip from well 719, the resistivity values throughout the upper part of the Selma Group in wells 326, 309, 183, and 182 are much lower than in well 719, indicating that the upper sands are changing to silty chalk, or silty calcareous shale toward south Butler County and north Covington County.

The top of the Selma Group is easily correlated from well 719 in Butler County through well 182 in Covington County. Eastward from well 182, resistivity values through the upper portion of the Selma Group become higher indicating an increase of clastic sediments. Slightly higher resistivity values in well 492 are the first evidence of an updip sandy facies in the upper part of the Selma

Group. In well 417, at the extreme eastern end of the section, the upper 400 feet of the Selma Group is predominantly sand.

Eastward from well 492, a rapid facies change occurs within the lowermost 100 feet of the Midway Group. The interval changes from a clay and limestone lithology to a massive sand which contains fresh water. Many facies changes from limestone to shale to sand can be detected in the Midway Group by detailed correlation of the electric logs.

Cross sections C-C′ and C′-C″ extend southeastward from well 449 in eastern Monroe County across Conecuh, Covington, and Geneva Counties to well 238 in Houston County (pls. 5 and 6).

The lithology of the Lower Tuscaloosa horizon changes very little between Monroe County and Houston County. The only noticeable changes are in wells 615 and 238 where sands which are normally massive contain an unusual amount of shale, and in well 2380 where fresh water occurs in sands within the Upper Tuscaloosa horizon and the Eutaw Formation. These zones contain brackish or salt water in the other wells in the section.

Correlation of the top of the Selma Group from the northeast end of the section to the southeast end is difficult because of numerous changes in lithology. A predominantly shale lithology in the Selma Group is indicated in wells 513 and 452 in Covington County. Eastward, between wells 452 and 238, the Selma Group lithology is generally a soft gray marl, or a calcareous shale. In Houston County, extremely high resistivity values throughout the upper 200 feet of the Selma Group, in well 238, indicate a fresh water-bearing sand. This sand is probably the downdip equivalent of the Ripley Formation.

Cross section D-D′ is a dip section extending from well 452 in Covington County to well 500 in Crenshaw County (pl. 7).

Fresh water is indicated in sands within the Upper Tuscaloosa horizon and the Eutaw Formation in wells 412 and 500 in Coffee and Crenshaw Counties respectively. These sands are not presently developed for fresh water because an adequate supply is available from shallower depths, but they should be considered potential aquifers for future development.

The upper part of the Selma Group changes from chalky shale downdip to porous sand updip. The facies change is vividly exhibited by the resistivity and S. P. curves on the electric logs used in this section. The log of well 452 has electrical characteristics typical of soft calcareous shale throughout the upper part of the Selma Group. Higher resistivity values recorded in well 381 indicate an increase in the amount of clastic sediments deposited in the upper part of the Selma Group, and mark the beginning of the facies change in an updip direction. Extremely high resistivity values recorded in well 412 indicate that the upper 450 feet of the Selma Group is porous fresh water-bearing sand. Higher than normal resistivity values on this log also indicate that the amount of clastic sediments in the lower part of the Selma Group is increasing in the updip direction. High resistivity values are recorded throughout the entire Selma Group in well 500 indicating that approximately 1,200 feet of sand and very silty shale were deposited.

SUMMARY

Gentle noses and abrupt changes in thickness and rate of dip on the regional maps are possibly indicative of small structures. More test drilling and geophysical work is needed to evaluate the region in detail.

The Pollard oil field proves the existence of source and reservoir beds in Escambia County, and new oil fields will be discovered in this county. Covington and Conecuh Counties have good oil and gas producing potential, particularly from sediments of Jurassic age. Test wells which have been drilled in other parts of the study area offer little encouragement for petroleum production at this time, but most of the area remains virtually untested. Future exploration will discover other commercial oil accumulations in south and southeast Alabama.

Sands in the Eutaw Formation and upper Tuscaloosa horizon are potential fresh-water aquifers in Crenshaw, Coffee, and Houston Counties where they are not presently being developed. In view of the nation's increasing demand for water, these potential sources should be evaluated for quantity and quality.

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TABLES

Table 1.—*Elevation of the top of the Lower Tuscaloosa*

Permit No. - State Oil and Gas Board permit number
Elevation - feet below mean sea level

Permit No.	Elevation	Permit No.	Elevation	Permit No.	Elevation
		Barbour County			
162	-1345				
B-321	-1860				
		Bullock County			
86	- 750				
92	-1100				
24-A	-1264				
		Butler County			
326	-3175				
308	-3245				
		Coffee County			
412	-2638				
542	-2852				
417	-2920				
		Conecuh County			
204	-3880	560	-4474	549	-2902
350	-3387	675	-3591	472	-3838
469	-4013	397	-4042	390	-4084
410	-4129	132	-4417		
		Covington County			
309	-3379	183	-3504	492	-3156
182	-3404	381	-3079	513	-4062
452	-3839	17	-4402		
		Crenshaw County			
145	-2646				
500	-2377				
		Escambia County			
669	-5972	413	-5684	22	-4800
550	-5805	491	-5837	90	-4938
567	-6012	396	-5032	149	-5034
645	-5454	610	-5325	478	-5066
521	-6096	467	-5385	477	-4969
470	-6052	506	-5478	475	-5147
483	-5860	420	-5486	59	-5216
586	-5808	556	-5506	529	-5360
497	-5781	508	-5957	424	-5502
341	-6270	726	-6139	524	-5469
360	-5876	340	-6267	461	-5444
476	-6007	351	-6250	435	-5431
221	-6107	359	-6265	171	-4429

Table 1.—*Elevation of the top of the Lower Tuscaloosa*—Continued

Permit No.	Elevation	Permit No.	Elevation	Permit No.	Elevation
		Escambia County—Continued			
559	-5298	510	-5855	37	-4553
464	-5362	352	-5920	716	-4637
763	-5827	349	-5921	168	-4874
530	-5794	468	-4851	391	-5063
376	-5982	50	-4803	496	-5189
463	-5991	161	-5058	541	-5247
1168	-5215	197	-5831	398	-4447
479	-5375	362	-5866	583	-4722
499	-5412	327	-5827	522	-4989
436	-5480	582	-6075	485	-5623
462	-6074	429	-6193	431	-5527
602	-5986	525	-5020	1273	-6208
157	-5517	588	-5918	58	-5531
764	-5719	176	-4760		
		Geneva County			
S-3	-3584	169	-3805	555	-3611
591	-3613	130	-3634	514	-3554
817	-3565	439	-3080	615	-3212
		Henry County			
631	-2635				
392	-2698				
		Houston County			
426	-2875				
186	-3163				
238	-2887				
		Pike County			
184	-2174				
118	-2367				

Table 2.—*Elevation of the base of the Selma Group*

Permit No. - State Oil and Gas Board permit number
Elevation - feet below mean sea level

Permit No.	Elevation	Permit No.	Elevation	Permit No.	Elevation
		Barbour County			
B-321	- 796				
162	- 466				
		Bullock County			
1311	- 450 est.	92	- 350	86	- 62
1325	- 508 est.				
		Butler County			
719	-1644				
326	-2134				
308	-2158				
		Coffee County			
412	-1650	417	-1925	489	-1440
S-4	-2470	542	-1867		
		Conecuh County			
204	-2761	560	-3369	549	-1740
350	-2347	675	-2538	472	-2798
469	-2954	397	-2988	390	-3027
410	-3084	132	-3057		
		Covington County			
309	-2335	183	-2444	492	-2130
182	-2357	381	-2087	513	-2980
452	-2762	17	-3269		
		Crenshaw County			
145	-1642				
500	-1426				
		Escambia County			
550	-4545	529	-4225	424	-4365
524	-4325	567	-4809	461	-4293
645	-4207	435	-4258	521	-4716
171	-3318	470	-4729	37	-3427
483	-4600	716	-3525	586	-4558
168	-3744	391	-3907	341	-4896
496	-4029	360	-4630	541	-4087
476	-4745	398	-3292	221	-4851
583	-3503	559	-4087	522	-3761
464	-4147	485	-4385	747	-5027
431	-4330	763	-4632	530	-4545
376	-4750	463	-4748	1168	-4019
479	-4153	499	-4200	436	-4262

Table 2.—*Elevation of the base of the Selma Group*—Continued

Permit No.	Elevation	Permit No.	Elevation	Permit No.	Elevation
		Escambia County—Continued			
462	-4688	602	-4662	1273	-4855
764	-4518	413	-4496	396	-3870
610	-4104	467	-4152	506	-4301
420	-4711	556	-4640	508	-4604
726	-4790	340	-4834	351	-4843
359	-4856	352	-4704	349	-4678
468	-3693	50	-3671	161	-3856
197	-4627	362	-4612	582	-4754
429	-4825	525	-3838	157	-4266
58	-4382	176	-3628	22	-3664
90	-3792	149	-3896	478	-3927
477	-3836	475	-4002	59	-4072
		Geneva County			
S-3	-2575	169	-2828	555	-2623
591	-2643	130	-2678	S-1	-2683
514	-2584	S-2	-2631	817	-2616
439	-2155	615	-2286		
		Henry County			
631	-1723				
392	-1788				
		Houston County			
426	-1950				
186	-2263				
238	-1995				
		Pike County			
184	-1238				
118	-1428				

Table 3.—*Elevation of the top of the Selma Group*

Permit No. - State Oil and Gas Board permit number
Elevation - feet below mean sea level

Permit No.	Elevation	Permit No.	Elevation	Permit No.	Elevation
		Butler County			
719	- 435				
326	- 895				
308	- 914				
		Coffee County			
412	- 411	489	- 218	542	- 603
417	- 662	S-4	-1241		
		Conecuh County			
204	-1591	469	-1769	560	-2161
397	-1787	549	- 562	390	-1828
350	-1193	410	-1881	675	-1394
132	-1872	472	-1626	103	-2006
		Covington County			
309	-1058	381	- 815	183	-1176
513	-1732	492	- 879	452	-1515
182	-1107	17	-2036		
		Crenshaw County			
145	- 416				
500	- 177				
		Escambia County			
669	-3487	176	-2404	550	-3478
22	-2426	1281	-3613	90	-2577
567	-3612	149	-2645	645	-3083
478	-2685	521	-3424	477	-2590
470	-3459	475	-2725	59	-2778
586	-3685	529	-2908	497	-3639
424	-2990	341	-3548	524	-3037
461	-2967	476	-3530	435	-2927
221	-3635	171	-2098	559	-2907
37	-2211	747	-3604	716	-2298
168	-2501	763	-3633	391	-2616
530	-3642	496	-2707	376	-3510
541	-2784	463	-3493	398	-2051
1168	-2840	583	-2235	479	-2977
522	-2491	499	-2986	485	-3103
436	-3031	431	-3007	462	-3283
602	-3415	1273	-3430	1310	-3451
588	-3314	764	-3368	413	-3526
491	-3422	396	-2693	610	-2835
467	-2920	506	-3021	420	-3262

Table 3.—*Elevation of the top of the Selma Group*—Continued

Permit No.	Elevation	Permit No.	Elevation	Permit No.	Elevation
		Escambia County—Continued			
556	-3248	508	-3187	726	-3358
340	-3343	351	-3377	359	-3409
510	-3391	352	-3370	349	-3329
468	-2500	50	-2432	161	-2624
197	-3317	362	-3390	327	-3478
582	-3330	429	-3374	525	-2590
157	-2963	58	-3054	464	-3020
		Geneva County			
S-3	-1332	169	-1772	555	-1546
591	-1581	130	-1663	S-1	-1675
514	-1531	S-2	-1599	817	-1587
439	-1142	615	-1288		
		Houston County			
426	- 967				
186	-1352				
238	-1073				
		Pike County			
184	- 24				
118	- 217				

Table 4.—*Thickness of the interval between the base of the Selma Group and the top of the Lower Tuscaloosa*

Permit No. - State Oil and Gas Board permit number

Permit No.	Thickness (feet)	Permit No.	Thickness (feet)	Permit No.	Thickness (feet)
		Butler County			
719	-1113				
326	-1041				
308	-1087				
		Coffee County			
412	- 988				
542	- 985				
		Conecuh County			
204	-1119	560	-1105	549	-1162
350	-1040	675	-1053	472	-1040
469	-1059	397	-1045	390	-1057
410	-1045	132	-1060		
		Covington County			
309	-1044	381	- 992	183	-1060
513	-1082	492	-1026	452	-1077
182	-1047	17	-1133		
		Crenshaw County			
145	-1004				
500	- 951				
		Escambia County			
550	-1260	351	-1407	359	-1409
352	-1216	645	-1247	349	-1243
521	-1380	468	-1158	470	-1323
483	-1260	161	-1202	197	-1204
362	-1254	341	-1374	360	-1246
582	-1321	476	-1262	429	-1368
559	-1211	221	-1256	525	-1182
157	-1251	464	-1215	58	-1149
176	-1132	763	-1195	22	-1136
530	-1192	90	-1146	376	-1232
149	-1144	463	-1243	478	-1139
1168	-1196	477	-1133	479	-1222
475	-1145	499	-1212	59	-1144
436	-1218	529	-1135	462	-1386
424	-1137	602	-1324	524	-1144
1273	-1336	461	-1151	435	-1173
588	-1226	171	-1111	37	-1126
716	-1111	168	-1130	396	-1162
		391	-1156	610	-1221
496	-1160	467	-1233	541	-1160
506	-1177	398	-1155	420	- 775

Table 4.—*Thickness of the interval between the base of the Selma Group and the top of the Lower Tuscaloosa*—Continued

Permit No.	Thickness (feet)	Permit No.	Thickness (feet)	Permit No.	Thickness (feet)
		Escambia County—Continued			
583	-1219	556	- 866	522	-1228
508	-1353	485	-1238	726	-1349
431	-1197	340	-1433		
		Geneva County			
S-3	-1009	514	- 970	169	- 977
555	- 988	817	- 949	591	- 970
439	- 925	130	- 956	615	- 926
		Henry County			
631	- 912				
392	- 910				
		Houston County			
426	- 925				
186	- 900				
238	- 892				
		Pike County			
184	- 936				
118	- 939				

Table 5.—*Thickness of Selma Group*

Permit No. - State Oil and Gas Board permit number

Permit No.	Thickness (feet)	Permit No.	Thickness (feet)	Permit No.	Thickness (feet)
		Butler County			
719	-1209				
326	-1239				
308	-1244				
		Coffee County			
412	-1239	417	-1263	489	-1241
S-4	-1254	542	-1263		
		Conecuh County			
204	-1171	560	-1208	549	-1178
350	-1154	675	-1144	472	-1172
469	-1185	397	-1210	390	-1199
410	-1203	132	-1185		
		Covington County			
309	-1277	183	-1268	492	-1252
182	-1251	381	-1272	513	-1251
452	-1250	17	-1233		
		Crenshaw County			
145	-1226				
500	-1242				
		Escambia County			
340	-1491	550	-1067	351	-1468
359	-1449	645	-1124	352	-1334
521	-1293	349	-1352	468	-1193
483	-1092	161	-1232	197	-1310
341	-1348	362	-1222	582	-1424
221	-1216	429	-1451	559	-1189
525	-1248	464	-1128	157	-1303
747	-1423	58	-1328	176	-1224
530	- 903	22	-1238	376	-1240
90	-1215	463	-1255	149	-1245
1168	-1179	478	-1242	479	-1176
477	-1246	499	-1214	475	-1275
436	-1231	59	-1294	462	-1408
529	-1317	602	-1247	524	-1335
461	-1326	588	-1378	435	-1331
171	-1220	37	-1216	716	-1228
396	-1177	168	-1243	610	-1269
391	-1291	467	-1232	496	-1322
506	-1281	541	-1303	420	-1450
398	-1241	556	-1392	583	-1268

Table 5.—*Thickness of Selma Group*—Continued

Permit No.	Thickness (feet)	Permit No.	Thickness (feet)	Permit No.	Thickness (feet)
		Escambia County—Continued			
508	-1419	522	-1270	726	-1434
485	-1282	431	-1323		
		Geneva County			
S-3	-1243	169	-1056	555	-1077
591	-1062	130	-1015	S-1	-1008
514	-1053	S-2	-1032	817	-1029
439	-1000	615	- 988		
		Houston County			
426	- 978				
186	- 913				
238	- 869				
		Pike County			
184	-1215				
118	-1211				

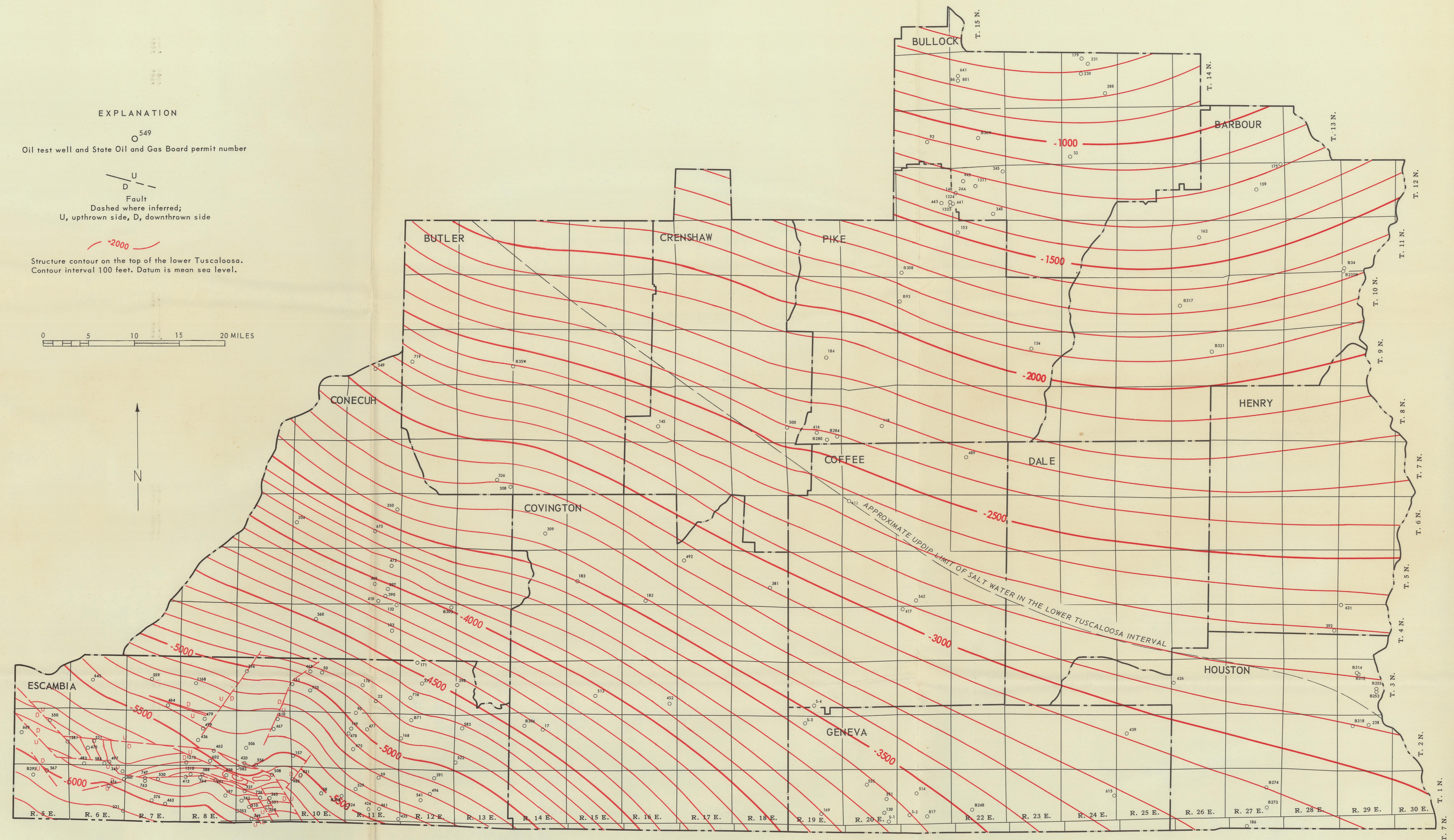

FIGURE 3. MAP SHOWING TOP OF LOWER TUSCALOOSA.

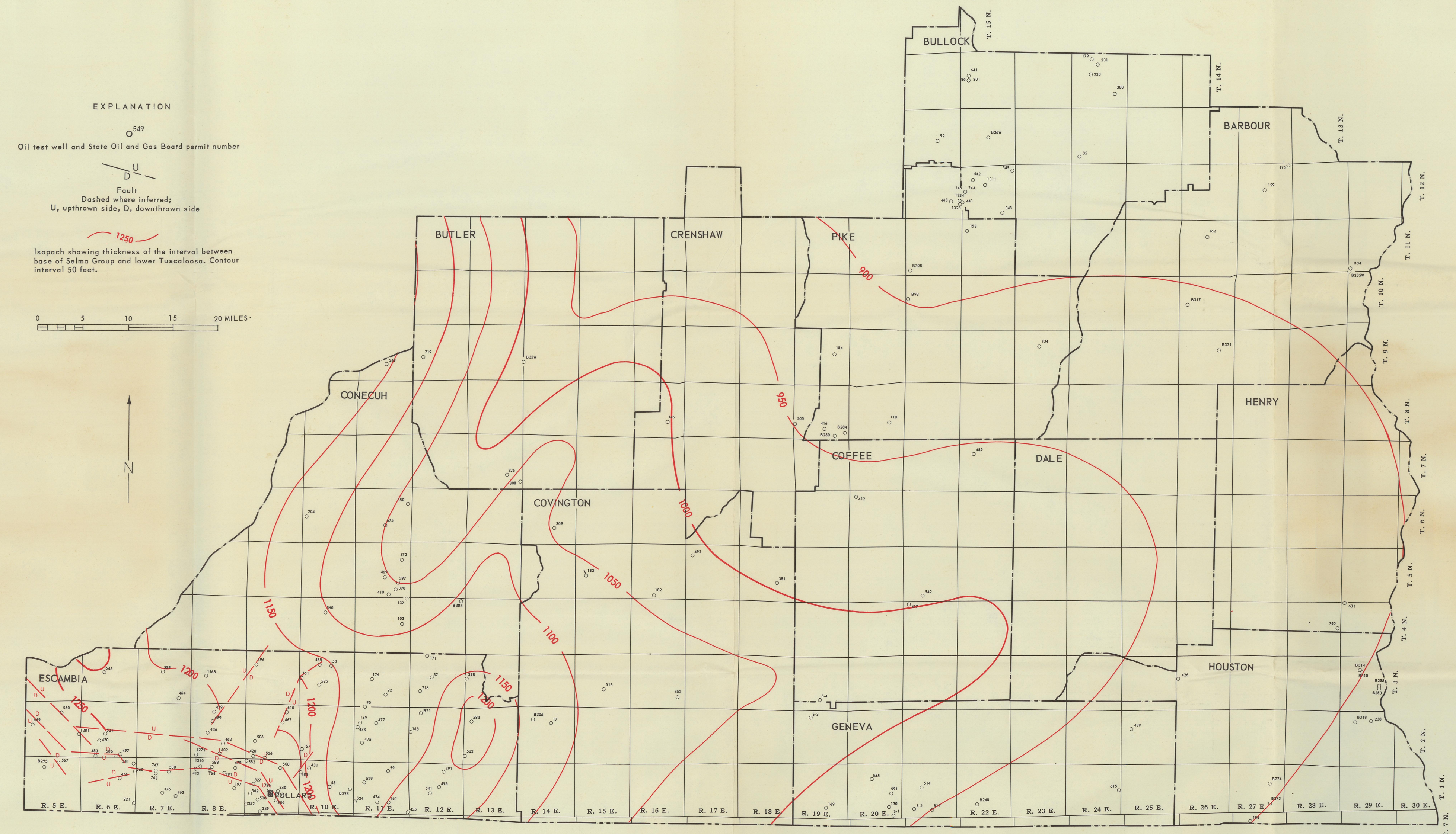

FIGURE 5. MAP SHOWING THICKNESS OF INTERVAL BETWEEN BASE OF SELMA GROUP AND LOWER TUSCALOOSA.

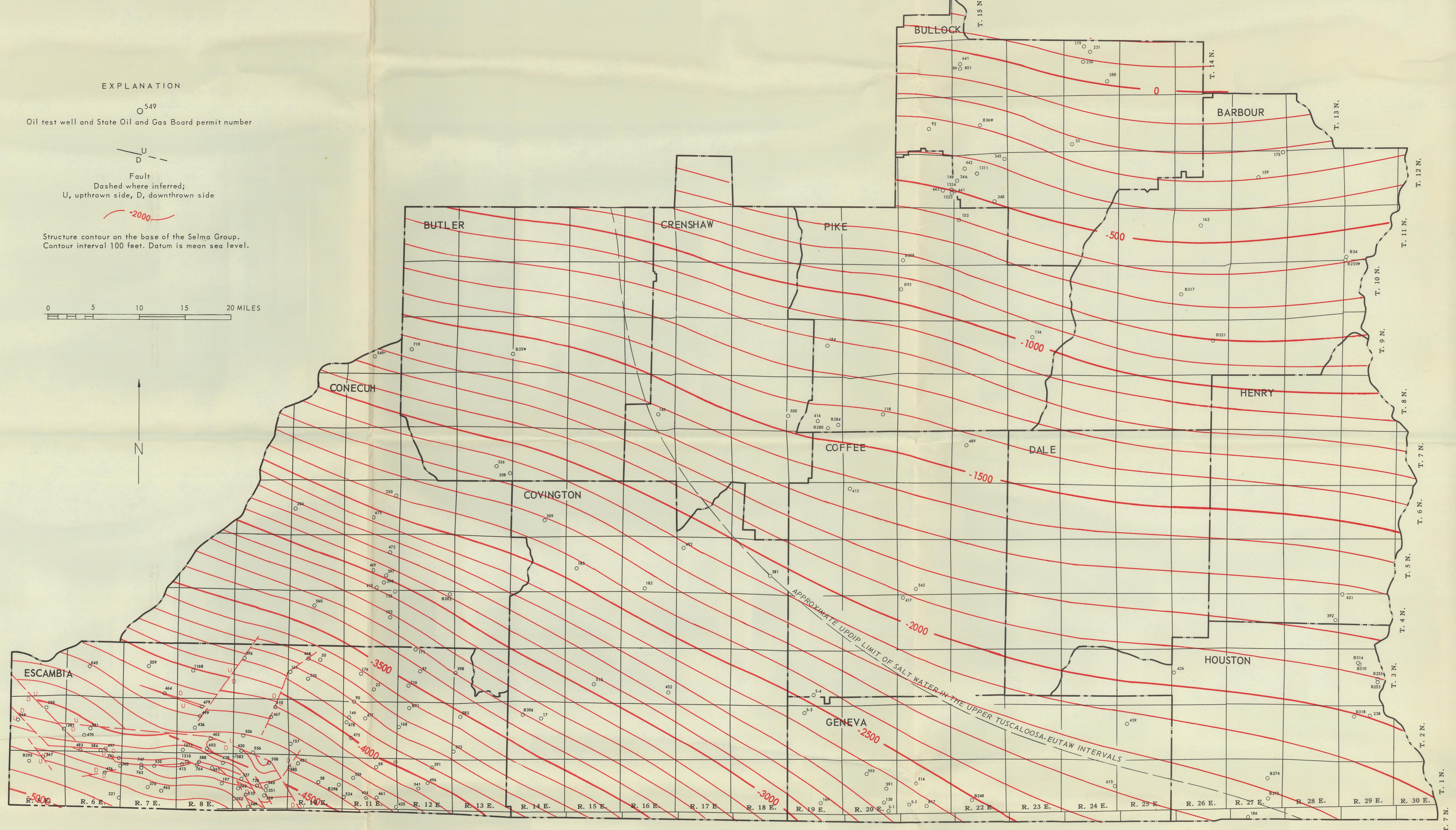

FIGURE 6. MAP SHOWING BASE OF SELMA GROUP.

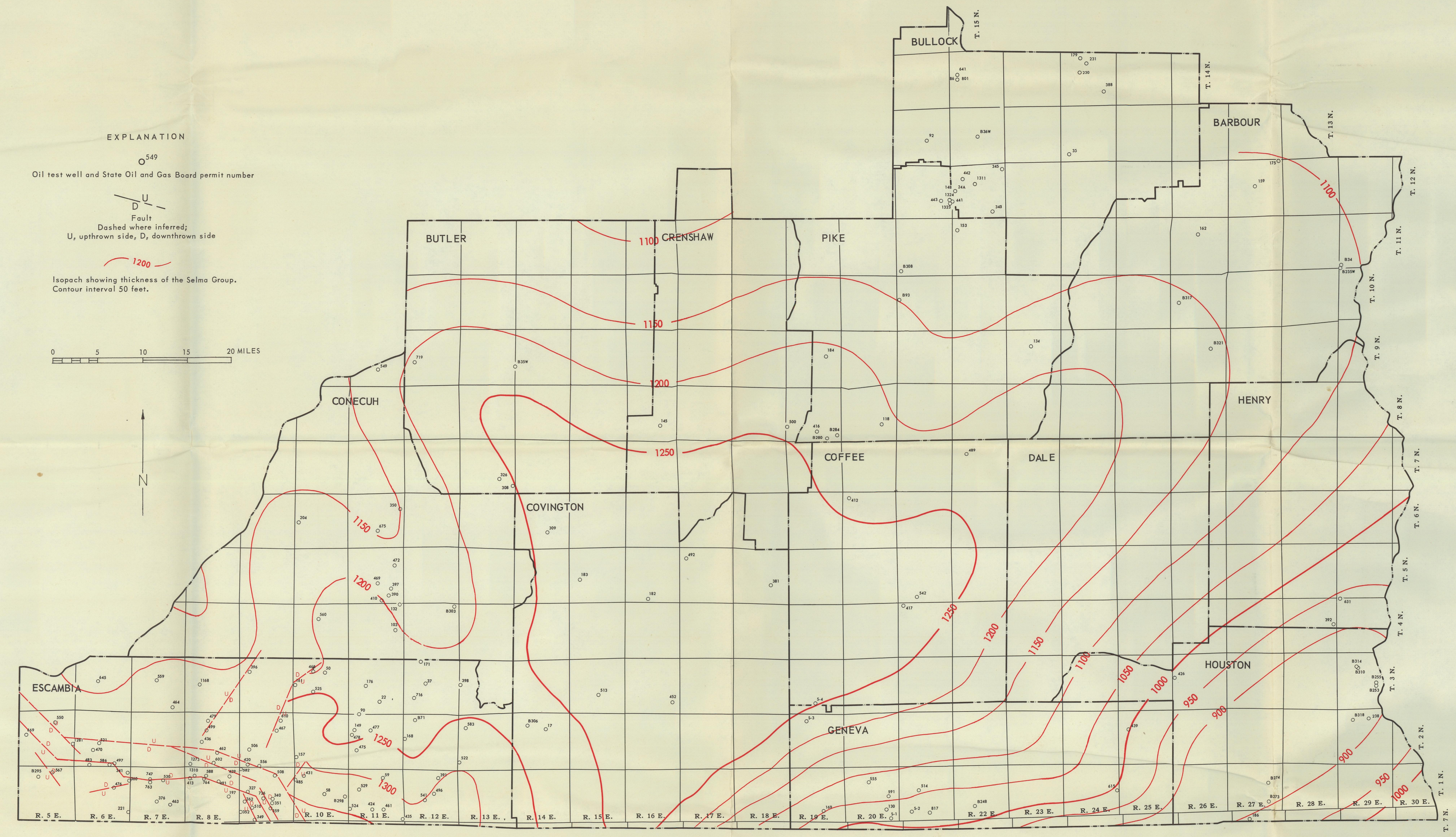

FIGURE 8. MAP SHOWING THICKNESS OF SELMA GROUP.

FIGURE 7. MAP SHOWING TOP OF SELMA GROUP.

SUBSURFACE GEOLOGY OF SOUTHEAST ALABAMA

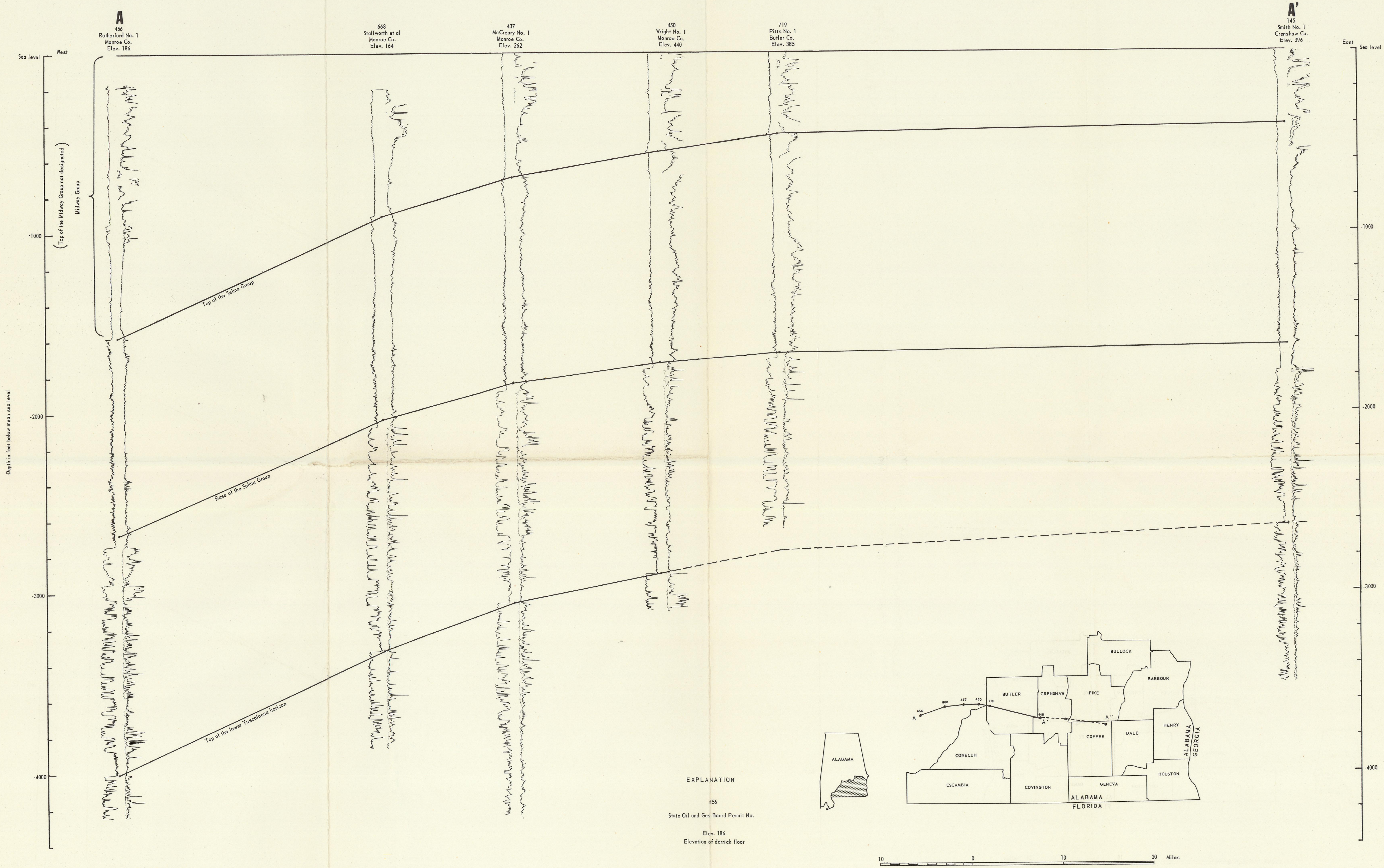

PLATE 2. CROSS SECTION A–A'

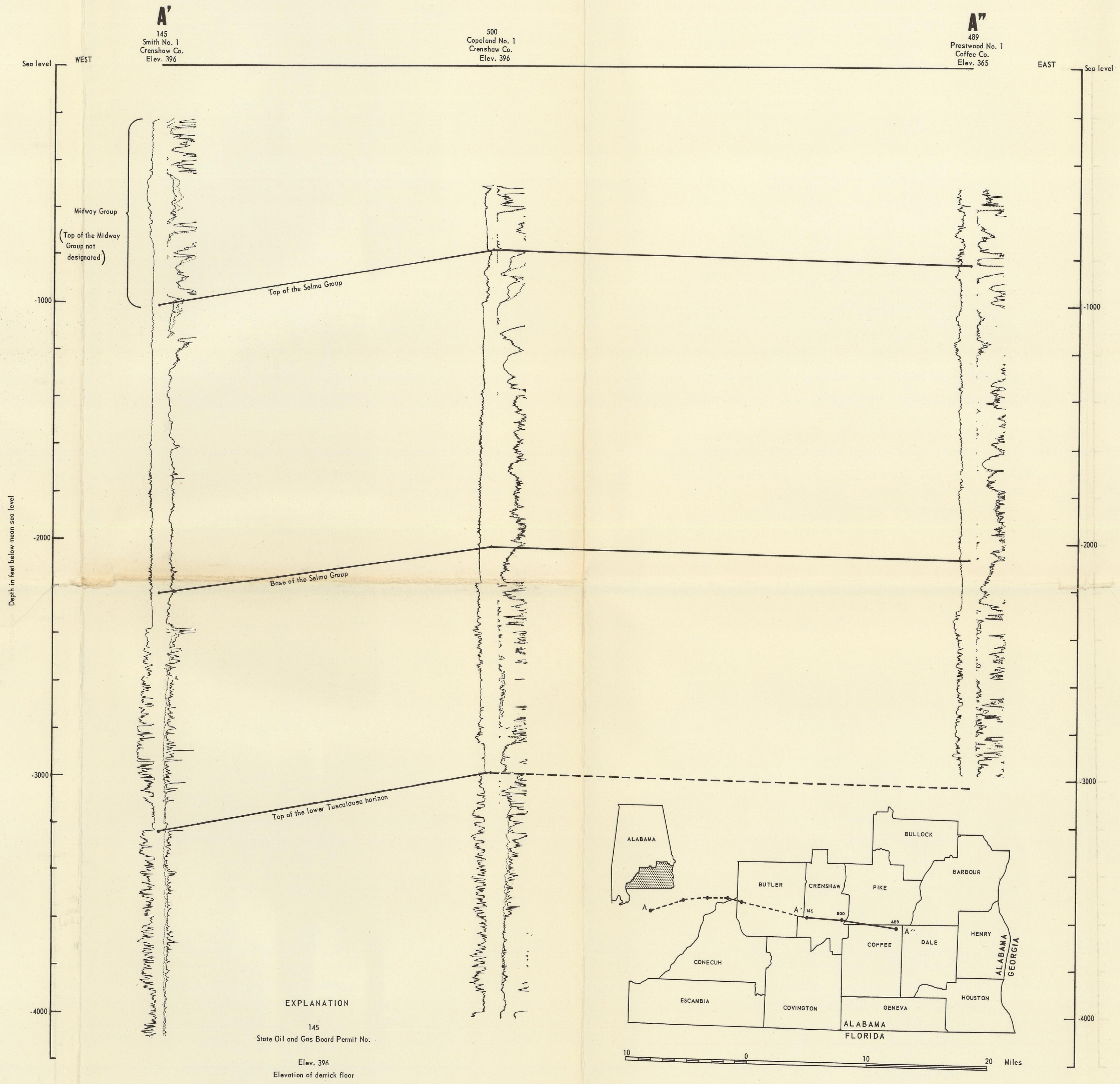

PLATE 3. CROSS SECTION A'–A''

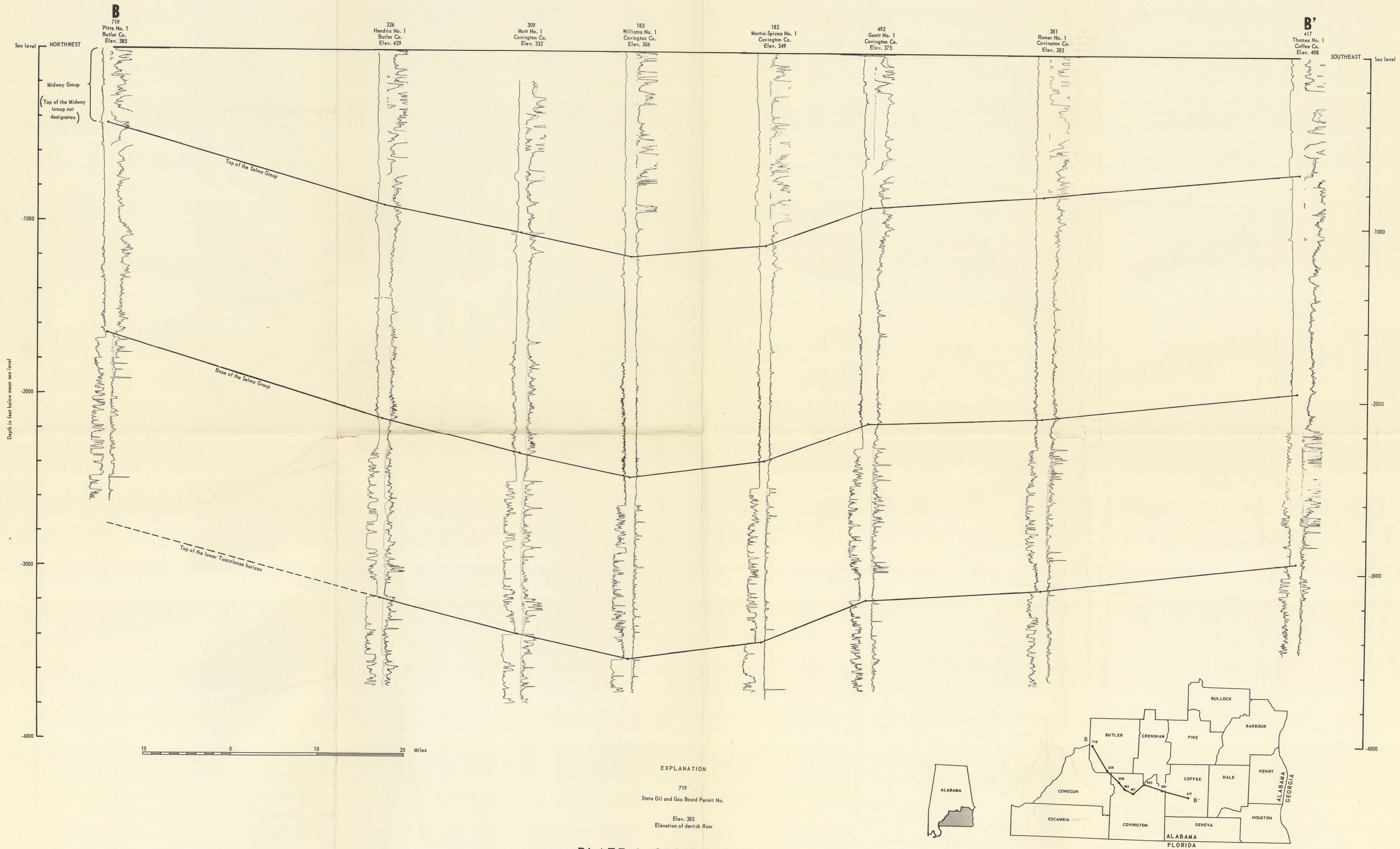

PLATE 4. CROSS SECTION B-B'

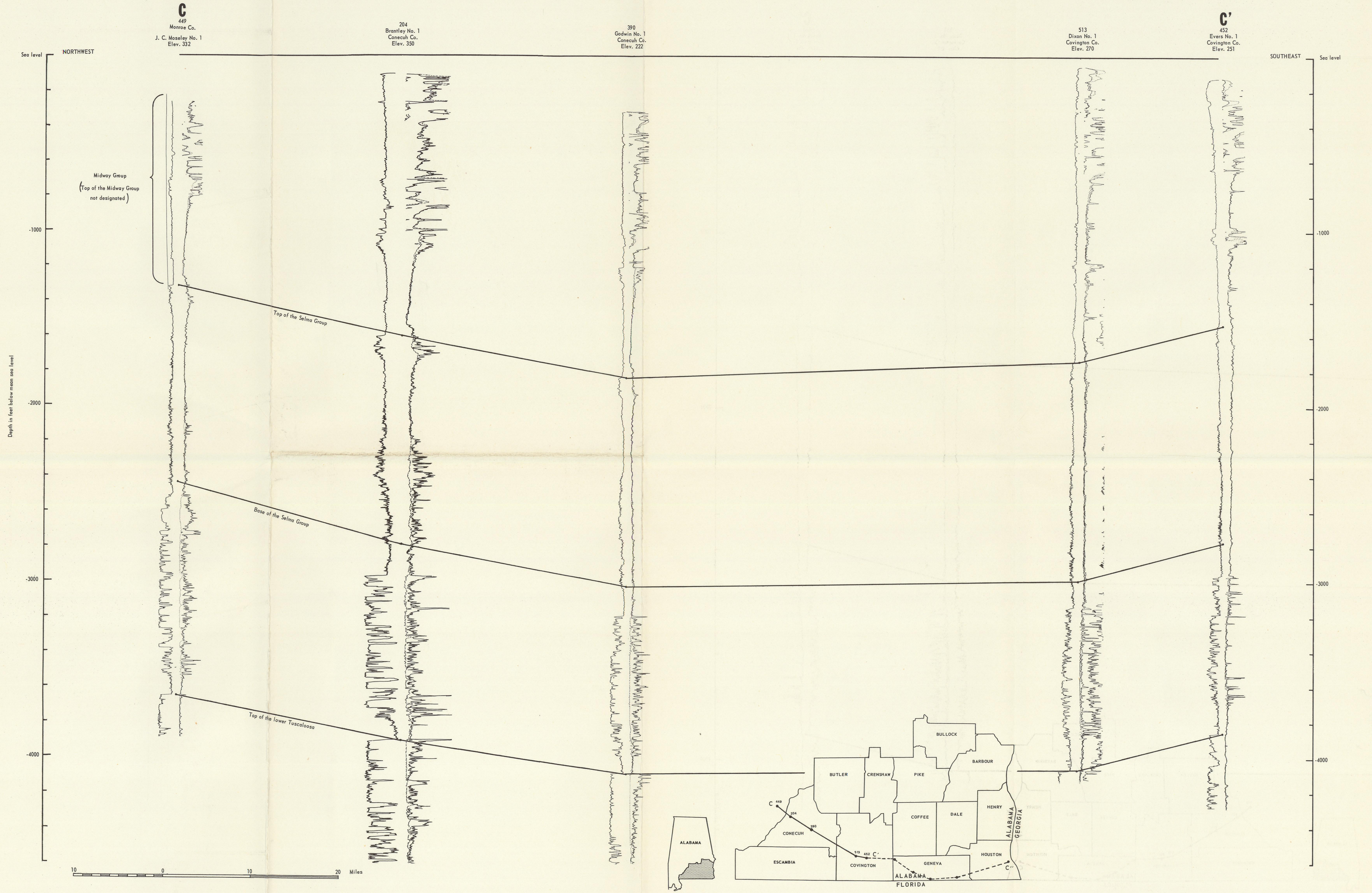

PLATE 5. CROSS SECTION C-C''

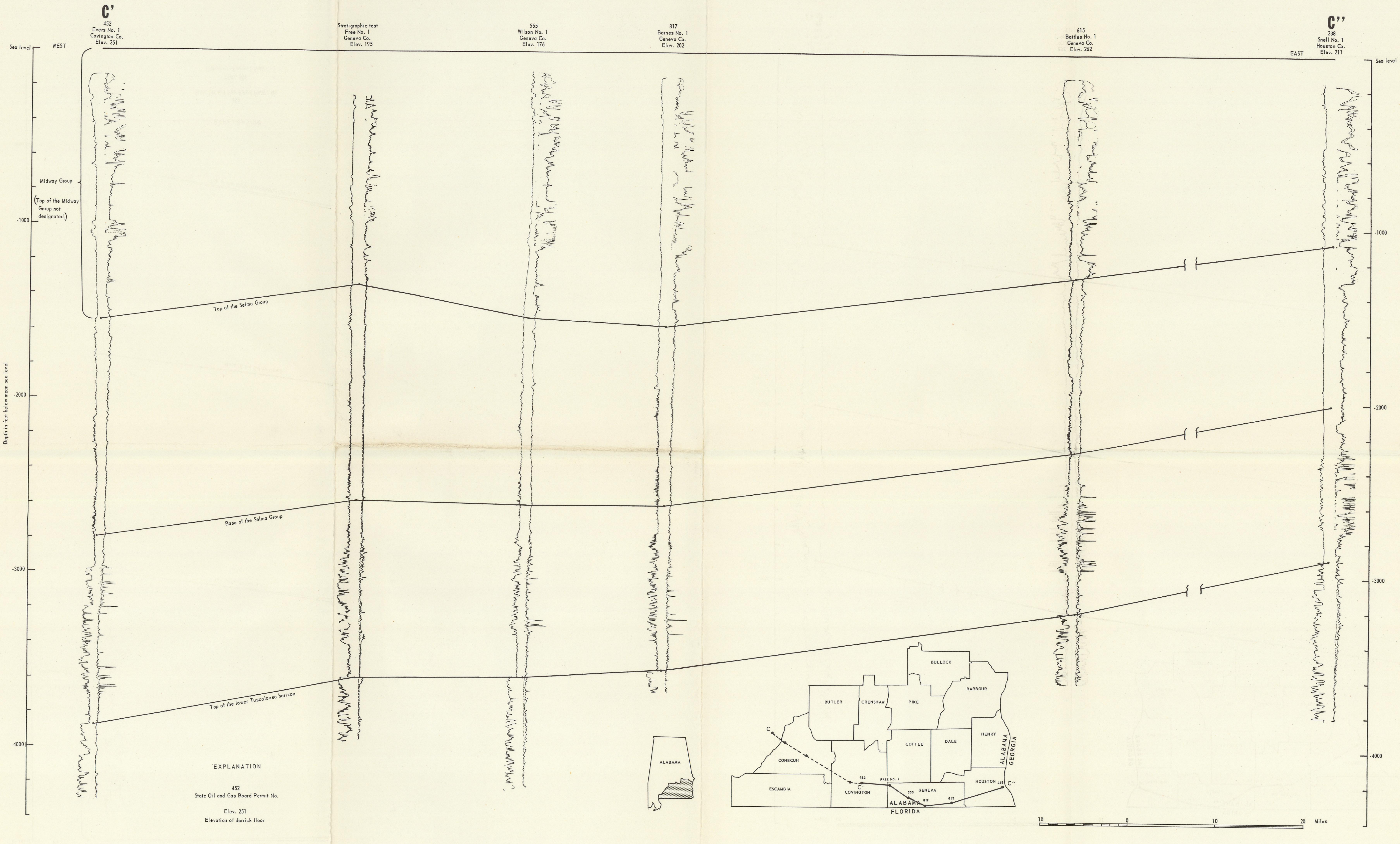

PLATE 6. CROSS SECTION C'-C''

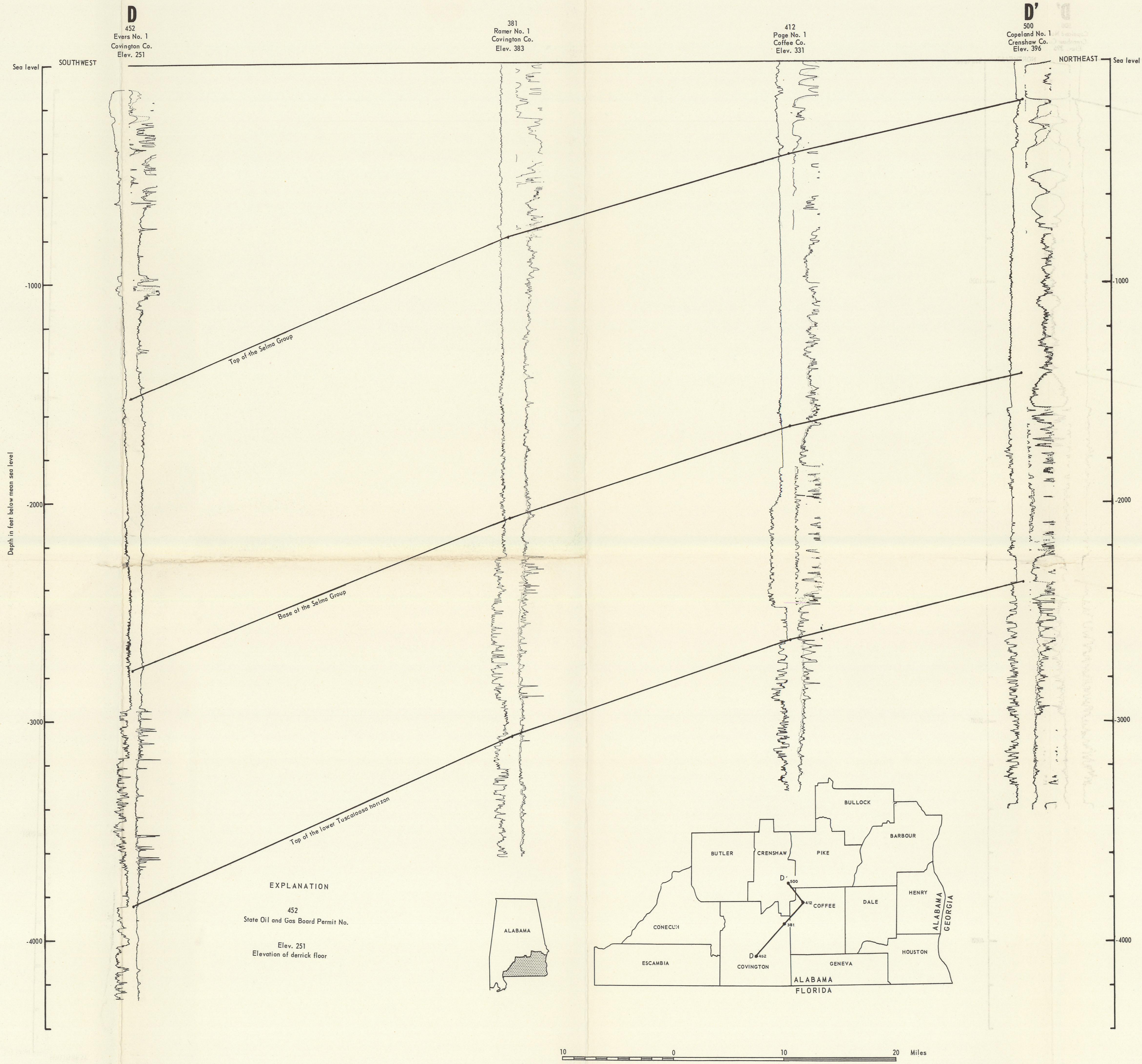

PLATE 7. CROSS SECTION D - D'

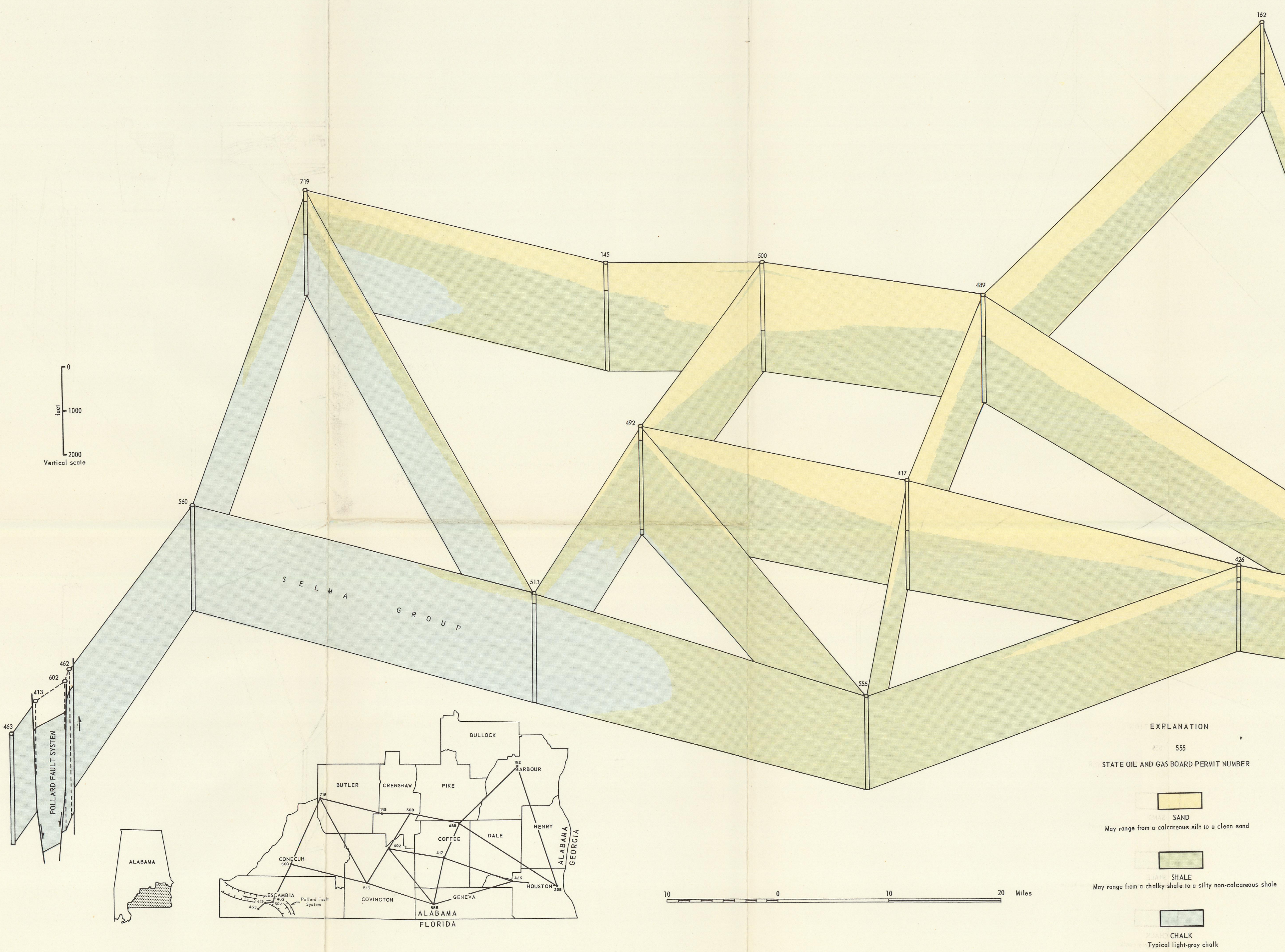

PLATE 8. GENERALIZED SUBSURFACE FACIES CHANGES IN SOUTHEAST ALABAMA

(SELMA GROUP)