STRUCTURAL EVOLUTION OF THE WESTERN

FRANKS BASIN, PONTOTOC COUNTY,

OKLAHOMA

BY

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LIST OF SYMBOLS

AGF	Atoka 'Growth' Fault
C	calcite cement
Ca	carbonate fragment
Ch	chert fragment
Ct	Timbered Hills (Cambrian)
DSOh	Hunton (Devonian - Silurian - Ordovician)
FCF	Franks carbonate fragment
FF	Franks fault
FFZ	Franks Fault Zone
Fm	formation
Lst	limestone
Mc	Caney (Mississipian)
MDcsw	Caney - Sycamore - Woodford (Mississipian - Devonian)
OCa	Arbuckle (Ordovician - Cambrian)
Os	Sylvan (Ordovician)
Osi	Simpson (Ordovician)
Ov	Viola (Ordovician)
P	porosity

IPat	Atokan (Pennsylvanian)
IPdm	Desmoinesian (Pennsylvanian)
IPm	Missourian (Pennsylvanian)
pCg	Tishomingo (Precambrian)
IPus	Union Valley - Springer (Pennsylvanian)
IPw	Wapanucka (Pennsylvanian)
Q	quartz
S	sandstone fragment
Ss	sandstone
Sh	shale
SOA	South Oklahoma Aulacogen
WFF	West Fitts Fault
WFB	Wesrtern Franks Basin

CHAPTER I

ABSTRACT

The Western Franks Basin is a located within the northeastern part of the Arbuckle Mountains between the Lawrence Uplift to the north and the Hunton Anticline to the south. It is bounded by the Stonewall Fault to the north and the Franks Fault Zone to the south. The two boundary faults diverge to thc east and converge to the west giving to the basin a triangular shape.

Nine structural cross-sections and three structural contour maps were constructed in order to describe and interprete the structural features and their spatial arrangement in the area. A fence diagram was drawn to display the stratigraphic relationships of the formations present in the Western Franks Basin. The construction of the cross-sections, contour maps, and fence diagram were based on the surface geology, the scout-ticket information, and the author's interpretation of the well logs. A petrographic study of a section of the Franks Conglomerate was carried out to determine the provenance of the carbonate fragments present in the unit. The petrographic study was also used to interprete the diagenetic history of the unit.These structural, sedimentologic, and petrographic data were analyzed and interpreted to reconstruct the structural evolution of the basin.

The Franks Fault was probably formed during the rifting stage of the Southern Oklahoma Aulacogen as a normal fault, and then later was rejuvenated as a strike-slip fault during the deformation stage of the Aulacogen. The Franks Fault Zone (FFZ) is characterized by a reverse separation along its three main parallel faults that dip to the south and converge at depth to form a subvertical fault. This geometry of the FFZ was interpreted as a flower structure. The reverse separation along the three branches of the Franks fault zone averages 300 feet. But the fault as a whole shows about 5000 feet reverse separation. The normal separation the Stonewall Fault is estimated to be about 5000 feet. A sudden change in thickness of the Atoka Formation from about 500 feet to the south to about 1,500 feet to the north indicated the presence of a fault named the Atoka Growth Fault which was tectonically active during the Atoka deposition. This fault trends east-west and becomes shallower toward the west where it exhibits a normal separation of about 1,000 feet, almost twice that of the eastern part. The SW-NE trending surface faults of the Hunton Anticline continue in the subsurface within the basin, and dip to the southeast. The folds of the basin mostly formed in close association with the faults.

CHAPTER II

INTRODUCTION

Statement of Purpose

The Franks Basin is a tectonic feature located in the Eastern Arbuckle Mountains, southern Oklahoma. The basin probably formed during the deformation stage of the Southern Oklahoma Aulacogen, in Pennsylvanian time. Within the basin, the Pennsylvanian deformation is marked by the presence of synorogenic clastic deposits, known as the Franks Conglomerate

The primary purpose of this investigation is to reconstruct of the structural evolution of the western part of the Franks Basin. Therefore, this study focuses on the description and interpretation of the structural geology of the basin and its spatial structural relationships with the Arbuckle Mountains and the Arkoma Basin. The Franks Graben can be considered as a transitional wedge between the strike-slip faulted Arbuckles and the Arkoma Basin that is dominated by thrusting (Figure 1). The research was undertaken not only to contribute to a better understanding of the evolution of the Franks Basin, but also to improve the understanding of the structural transition between the Arbuckle Mountains and the Arkoma Basin

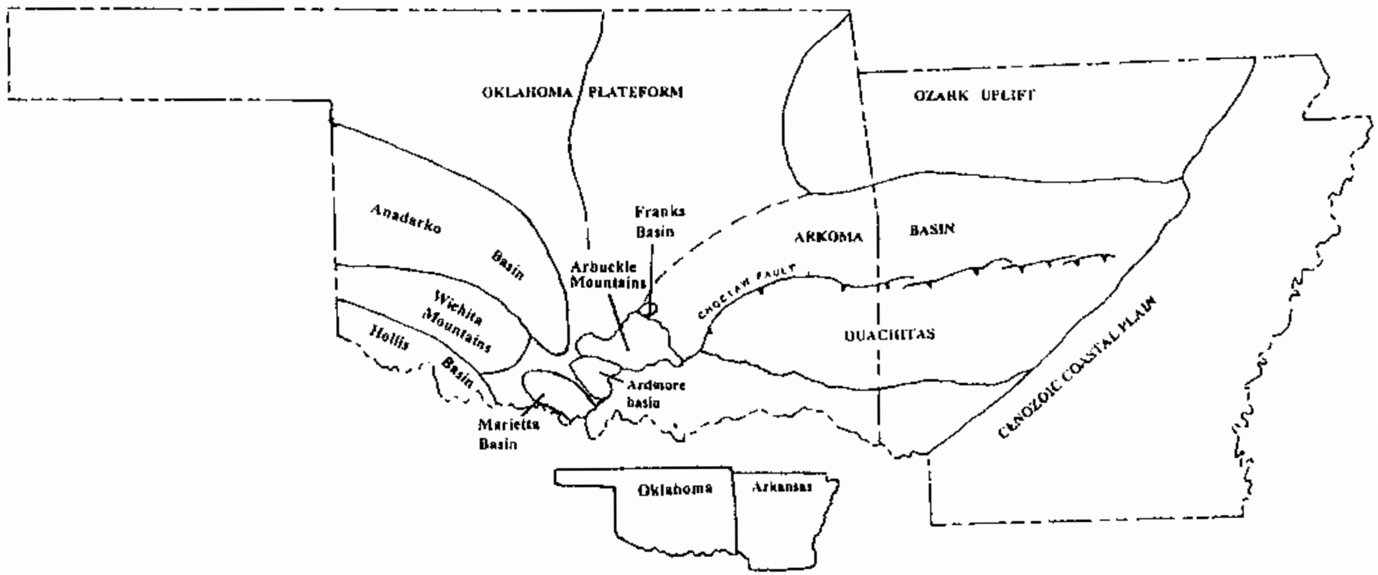


Figure 1: Tectonic setting of the Franks Basin
(Sutherland, 1988, and Arbenz, 1956)

Location of the Study area

The Arbuckle Uplift covers approximately 720 square miles in south-central Oklahoma. The study area is located in the northeastern part of the Arbuckles between the Hunton Anticline to the south and the Lawrence Uplift to the north. The study area includes Township 2 North and the Range 6 East in the south-central portion of Pontotoc County, Oklahoma (Figure 2; Plate 1).

Methods of Investigation

In order to attain the stated purposes of this study, four principal tasks were formulated and followed: data collection, literature search, analysis and interpretation of data.

First, all available wire-line well logs as well as scout-tickets were utilized to construct nine structural cross-sections and three structural contour maps. Second, the information extracted from the cross-sections and structural contour maps were used to construct the structural map of the study area. Third, a detailed petrographic study of one unit of the Franks conglomerate was conducted to determine carbonate fragment provenance and reconstruct its diagenetic history. Finally, the structural evolution of the basin and the determination of the depositional environment of one unit of the Franks conglomerate were made based on this research and information from previous investigations.

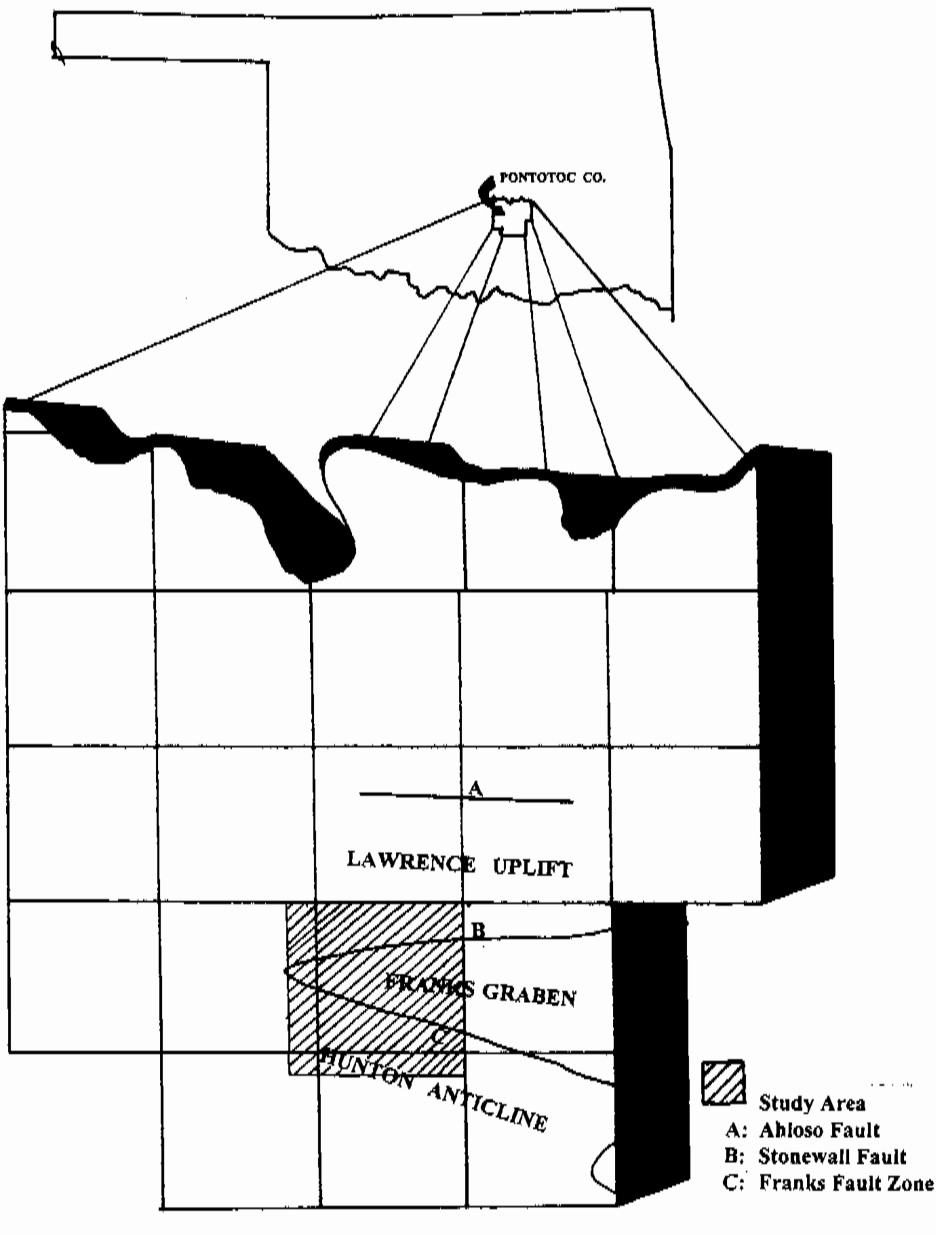


Figure 2: Location of the Study Area, Pontotoc County, Oklahoma.

Previous investigations

The area of study has been the focus of geological studies for more than 90 years. The geology of the area was first mapped by Taff (1901) who described and named the Hunton Anticline. He mentioned that:

"...In T2N R6E, near the extreme north limit of the uplift (Hunton Anticline), there is a triangular basin of Carboniferous limestone conglomerate resting unconformably across older Paleozoic rocks. The beds are steeply upturned upon the northwestern and southwestern sides, and faulting has occurred at the contact of the conglomerate with the older rocks, so that the rocks are depressed by faulting as well as folding. ..."

Reeds (1910) named the depressed area the Franks syncline, and the uplifted area to the north the Lawrence anticline. Morgan (1924) changed the previous names given by Reeds from Franks syncline to Franks Graben and Lawrence anticline to Lawrence Uplift. He also reported the presence of the Stonewall Fault and the Fitts structure. Morgan (1924) interpreted that the Stonewall Fault was first formed in pre-Boggy time. He stated that the general structure of the strata within the Graben consists of two sharp drag synclines between which is a broad westward plunging anticline.

Kuhleman (1950) mentioned that the Atoka Formation thickened eastward. Mann (1958) described the subsurface geology of the Franks Basin, in Pontotoc and Coal Counties, Oklahoma. He considered the Franks Basin as the western extension of the McAlester Basin and discussed the structural features of the graben based on 2 structural cross-sections and 3 structural contour maps. However, he did not report any subsurface faults besides the Stonewall and Franks Faults. Mann (1958) also reported that these two faults have great vertical displacement, and faulting is dominant throughout the area. He noticed that the Atoka Formation thickens eastward and it is overlapped by the Desmoinesian rocks.

Withrow (1968 and 1969) found that the Cromwell lithofacies may be used to divide the area into a northern sandy area, a central transitional area and a southern shaly area. He delineated at least four subsurface faults in the study area.

Johnson (1990) compiled the surface geology of the study area. In Township 2 North, Range 6 East, his map shows the Stonewall Fault striking westerly to the north, and the Franks fault zone striking southeasterly to the south. The two faults delimit the Franks Basin and converge to the west giving to the basin a triangular form. He mapped the younger Paleozoic (Missourian and Desmoinesian) rocks within the basin, and older Paleozoic rocks on the Hunton Anticline and Lawrence Uplift. To the south, his map shows the Hunton, Sylvan, Viola, and Simpson rocks as confined bands of rocks bounded by the Franks faults.

Regional Geology

The Franks Basin formed during the Pennsylvanian orogenies of the Southern Oklahoma Aulacogen. Its geologic history is thought to parallel that of the Arbuckle Mountains. Therefore, in order to determine the tectonic setting of the Franks Graben, the evolution of the SOA needs to be recalled so that the building of the Arbuckles can be chronologically inserted.

Southern Oklahoma Aulacogen

Aulacogens were defined by Schatsky (1946), as long-lived graben-like tectonic troughs located perpendicular to the major mountain chains. In the case of the Southern Oklahoma Aulacogen, the major mountain chain is the Ouachitas (Figure. 3). Burke and Dewey (1973), and Hoffman, Dewey, and Burke (1974) explained the tectonic origin of the aulacogens by the hot spot theory. This theory proposes that a thermal bulge formed by the heating beneath the continental plate is followed by the development of a three-rift system. The margins of two arms of the rift system develop as continental margins while the spreading of the third one parallel to the plate motion ceases at an early stage. This failed arm of a triple junction forms an aulacogen when it goes through two other stages; a sagging (subsidence), and a deformation stage.

The Southern Oklahoma Aulacogen experienced these three stages of an aulacogen formation.

Wickham (1978) described three stages of development of the Southern Oklahoma Aulacogen in detail. They are as follows:

Rifting Stage

The rifting stage uplifted the crystalline basement that is 1,000 to 2,000 Ma in age. Rifting began in Late Precambrian to Early Cambrian time. Cambrian age bimodal igneous rocks settled in the rift through the normal fault system. Two lines of evidence support the interpretation of the region as an Early Paleozoic rift system: 1)- the present distribution of rhyolite is controlled by several of the major fault zones in contrast to the

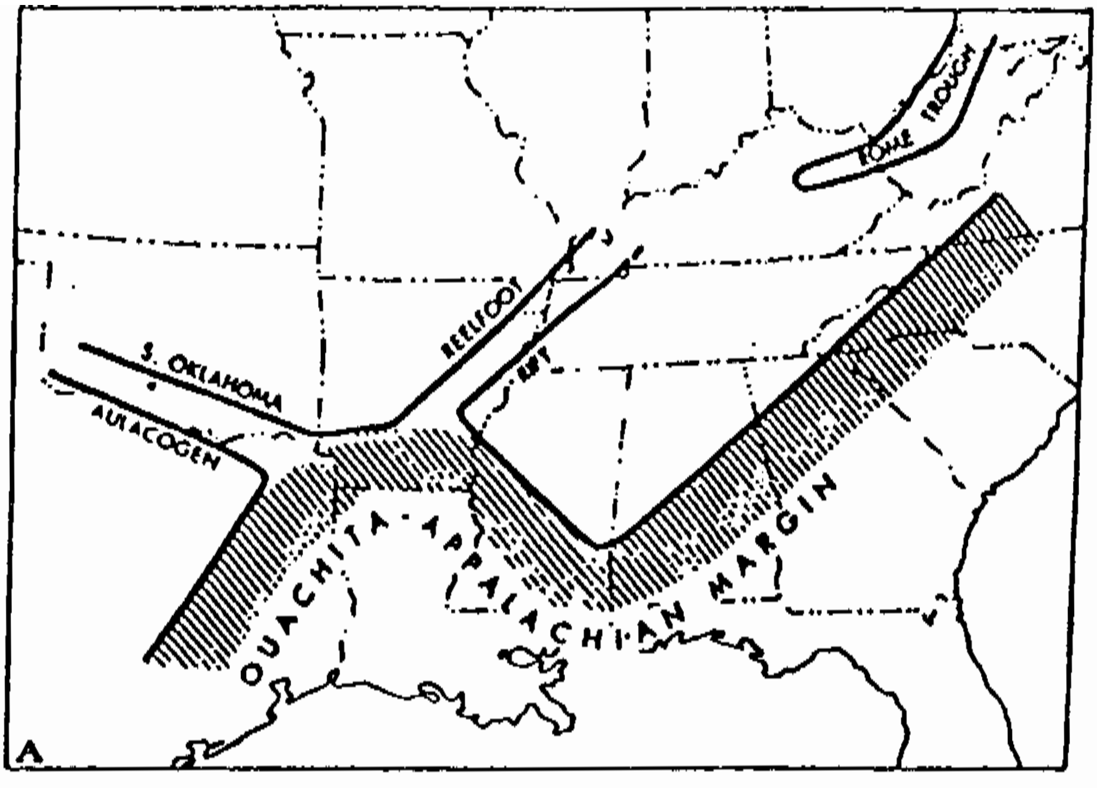


Figure 3: Location of the Southern Oklahoma Aulacogen perpendicular to the Ouachitas (Lowe, 1985)

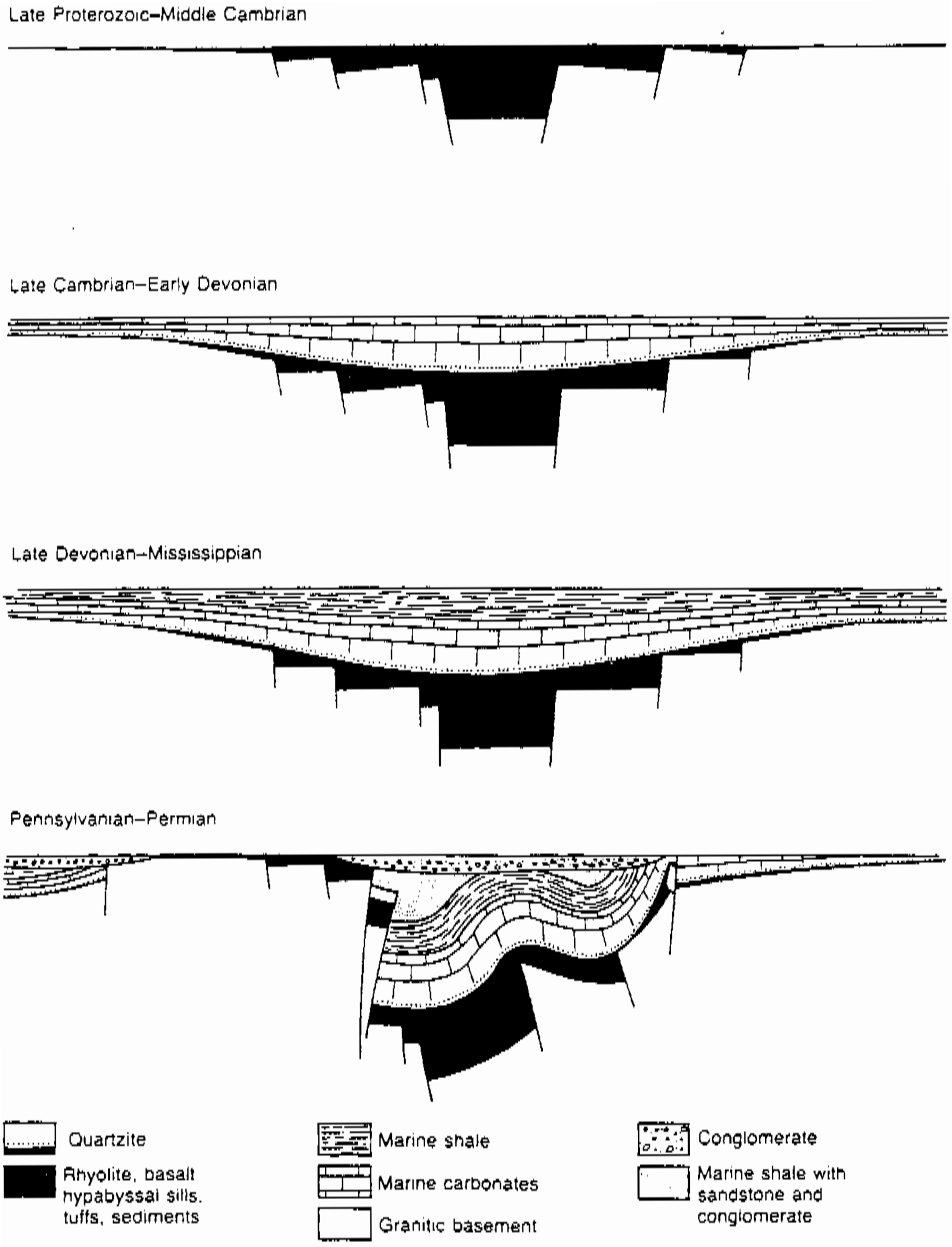


Figure 4: Schematic Transverse Sections Illustrating the Evolution of the SOA. (Ham, 1969)

overlying sedimentary rocks and 2)- the presence of intrusions of gabbro, anorthosite, and troctolite near the axis of thc aulacogen.

Downwarp Stage

During the Late Cambrian through Ordovician (downwarp or sagging stage), marine transgression and active sedimentation accelerated the subsidence in the aulacogen. Carbonates dominated deposition from the Late Cambrian through Early Mississipian (Figure 4). The first marine sediment to be deposited was thc Late Cambrian Reagan Sandstone Formation of the Timbered Hills Group. Afterward, thc Arbuckle Group, Viola Group, Sylvan Shale, Hunton Group, Woodford Formation, Caney Shale, and Springer Group were deposited.

Brown et al., (1985) suggested that the subsidence rate approximately equaled the sedimentation rate throughout the deposition of the Arbuckle and Simpson Groups. By the end of Simpson Group deposition, the aulacogen began to subside more rapidly, accompanied by the deposition of Viola Group, Sylvan Shale, and Hunton Group. In Late Devonian, the subsidence rate increased and the Woodford Shale and the Sycamore Limestone were deposited. The aulacogen continued to subside and maintain rclativcly deep water conditions into the Early Pennsylvanian.

Ham (1973) estimated the total thickness of the Cambrian to Mississipian age sediments accumulated in the Southern Oklahoma Aulacogen at 17,000 feet. Thc combination of continued subsidence and pcriodic orogcnic activity of the third stagc led to the accumulation of an additional 13,000 feet of mostly terrigenous clastic sediments during the Pennsylvanian.

Deformation Stage

The deformation stage occurred in the Pennsylvanian as the result of a plate collision between the North America Plate and a southern continent; most likely the South America Plate. Brown and Grayson (1985) stated that the orogenic activity began as early as Late Mississipian time.

Wickham (1978) suggested that the main Wichita Orogeny took place in early Atokan time. It was marked by a period of strong folding and uplift along the Amarillo-Wichita-Criner trend. The Wichitas and the Eastern Arbuckles formed during the Desmoinesian. Many of the normal faults that originated in Cambrian time and exceeded 100 km in length were reactivated in Pennsylvanian. In late Missourian and early Virgilian time, the Arbuckle Orogeny began. During that period of deformation, the folds of the Wichita system were rejuvenated and the Eastern Arbuckles were uplifted and faulted. The basinal area between these two mountain systems was compressed, folded, and faulted to become Ardmore Basin and the Arbuckle Anticline. Up to 8 km (5 miles) of displacement occurred along the bounding faults between some uplifts and the adjacent basins. In the eastern part of the aulacogen, a number of folds intersect the faults suggesting a wrench fault structural style (Figure 5).

Today, the aulacogen consists of a number of basins (Marietta, Ardmore, Anadarko), and uplifts (Muenster, Criner, Arbuckle, Wichita)

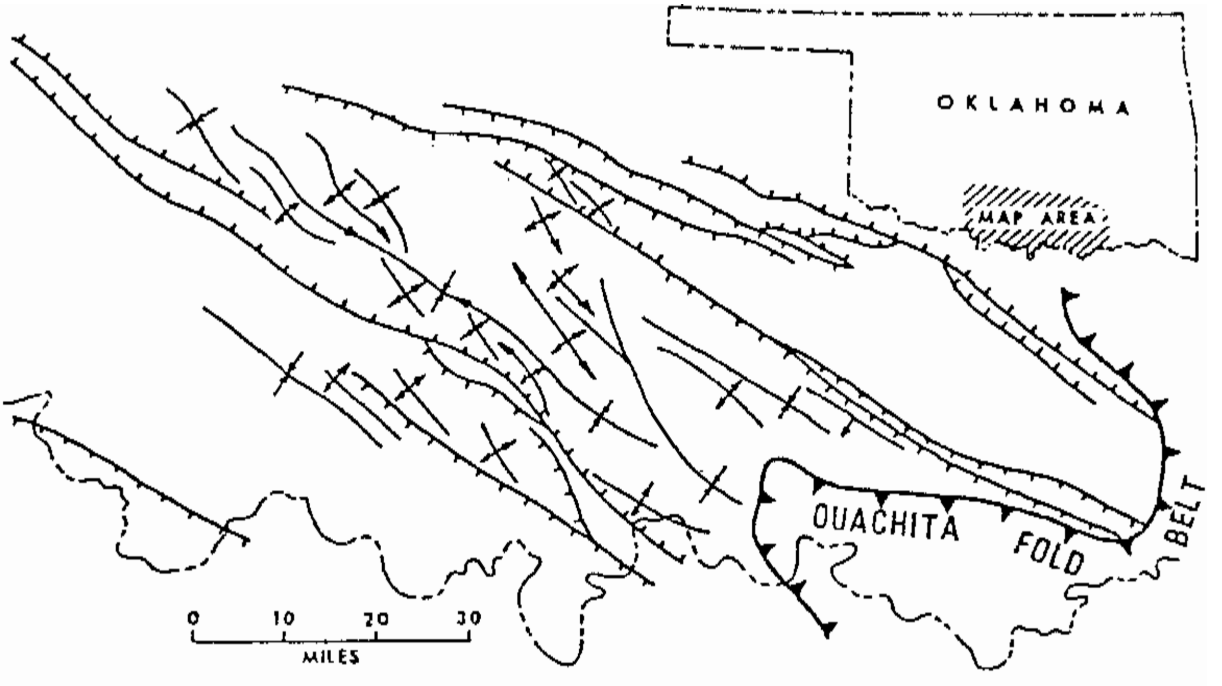


Figure 5: Structural Features of the SOA.
(Wickham, 1978)

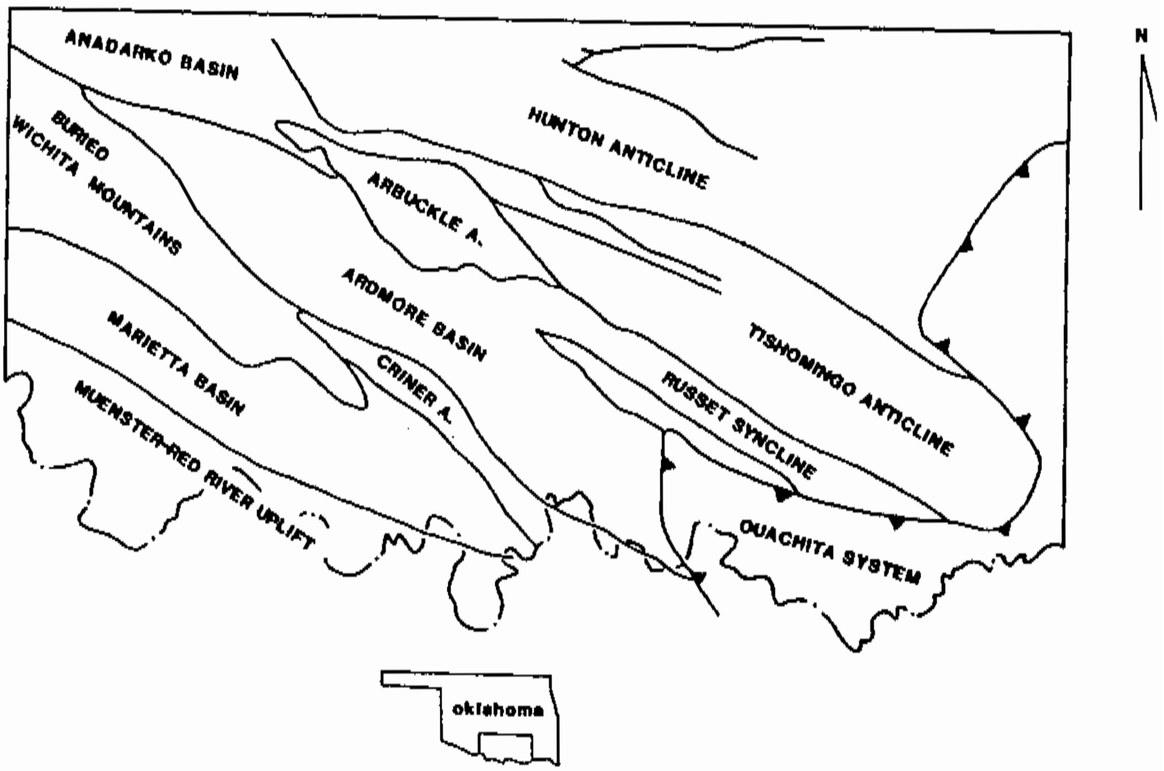


Figure 6: Location of Major Uplifts and Basins Associated with the SOA (Palladino and Jamieson, 1985).

(Figure 6). The Arbuckle Mountains are, therefore, one of the features resulting from the Pennsylvanian deformation.

Arbuckle Mountains

The Arbuckle Uplift is a tectonic feature that uplifted during the Pennsylvanian deformation stage of the Southern Oklahoma Aulacogen. Brown and Grayson (1985) stated that the two Pennsylvanian orogenies (Wichita and Arbuckle) are easily distinguishable within the Arbuckle Mountains. The orogenies led to the formation of two distinct structural provinces: the Eastern Arbuckles and the Arbuckle Anticline, (Figure 7). The Eastern Arbuckles formed during the Early Pennsylvanian Wichita Orogeny, while the Arbuckle Anticline resulted from the Arbuckle Orogeny in Late Pennsylvanian (Wickham, 1978). The line of demarcation between the two Arbuckle provinces is the Washita Valley Fault (Figure 7). The mechanism for the structural deformation of the Arbuckles is centered on the geometry and relative movement of the Washita Valley Fault. The basement rocks of both sides of the fault are chronologically distinct: the Arbuckle Anticline basement rocks is Middle and Lower Cambrian age, while the Eastern Arbuckles basement is Precambrian in age (Wickham, 1978). Figure 8 shows the Pre-Pennsylvanian stratigraphic columns in principal segments of the Arbuckle Mountains in which A represents the stratigraphic column of the Arbuckle Anticline and B is the stratigraphic column of the cratonic area adjacent to the Arbuckles.

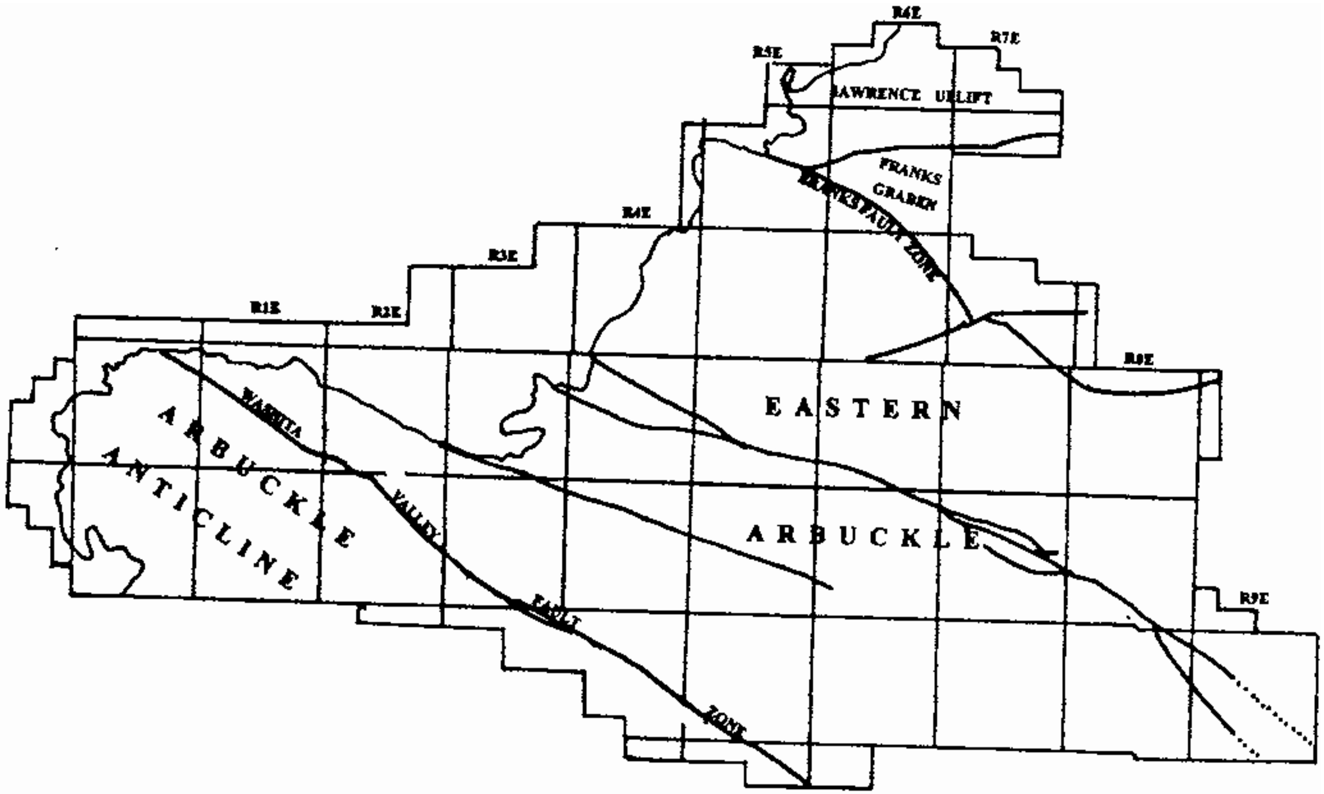


Figure 7: Structural Provinces of the Arbuckle Mountains
(simplified from Johnson, 1990)

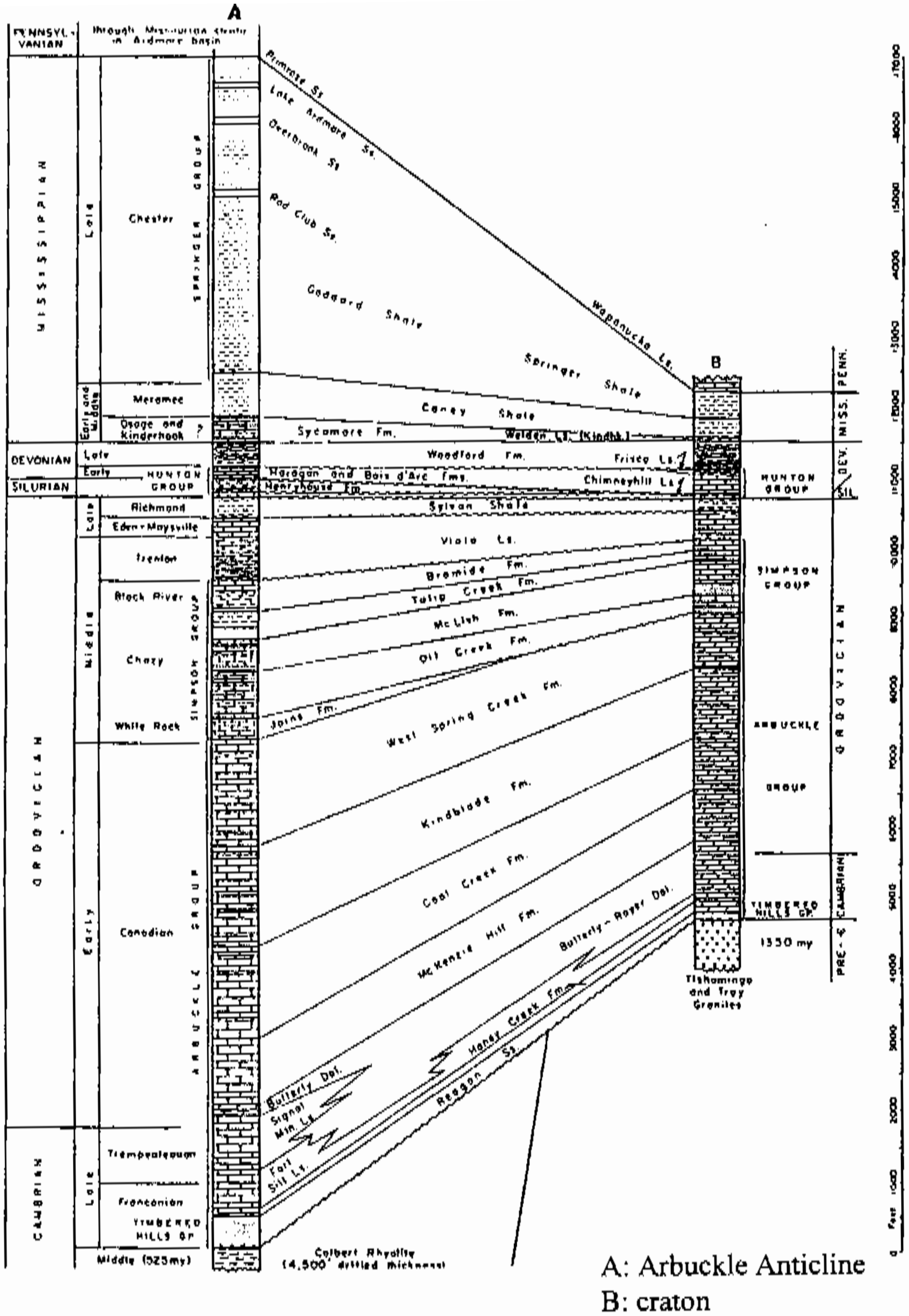


Figure 8: Pre-Pennsylvanian Stratigraphic Columns in Principal Segments of the Arbuckle Mountains (Ham, 1973).

The Pennsylvanian deformation is marked by the presence of synorogenic clastic deposits in the Arbuckle Mountains area. Four principal conglomerate sequences are present in the Arbuckles: Deese, Franks, Collings Ranch, and Vanoss. Ham (1973) reported that the Deese and Franks conglomerates contain erosional products derived from the Wichita Orogeny. He believed that the orogeny began as a broad domal folding of the Hunton Anticline in early Deese time. The Deese and Franks sediments were closely folded, locally overturned, and faulted by the Arbuckle Orogeny which produced the uplift from which the Collings Ranch and the Vanoss conglomerates were derived. This later orogeny appears to have been the most intense deformation to have affected the Arbuckle Mountain region.

Franks Basin

Johnson (1990) mapped the surface geology of the study area. He mapped the Franks fault zone parallel to the other faults present in the Arbuckle Mountains. The Missourian and basinal rocks are in abrupt contact with the older Paleozoic rocks of the Lawrence Uplift and the Hunton Anticline.

Morgan (1924) summarized the geologic evolution of the study area within the framework of geosynclinal theory. He postulated that by the end of Atoka time, the area was uplifted, peneplaned and subsequently covered by sediments associated with deposition of the Hartshorne, McAlester, and at least part of the Savanna Formations. Toward the end of Savanna time, the northeastern part of the Arbuckles experienced a period of uplift and block faulting, which resulted in the emergence of all the area with the possible exception of the Franks Basin. Before the end of Wewoka time, a general northwestward tilting of the Pennsylvanian strata in the region occurred. The period of uplift (Lawrence Uplift) and faulting was followed by peneplanation again, which eroded the western end of the Lawrence Uplift and stripped off the beds down to the lower part of the Boggy Formation. In the western end of the Franks Basin, all strata down to near the top of the Boggy were eroded. By the end of Vamoosa time, the block faults that cut the Hunton and overlapping Holdenville Formation in the northwest quarter of Section 34 T2N, R6E, west of Franks, formed by an unusual uplift of the Arbuckle axis.

Morgan (1924) named the basin Franks 'Graben' The Glossary of Geology (1987) defines a graben as an "elongate relatively depressed crustal unit or block that is bounded by faults on its long sides". Twiss and Moores (1992) defined a graben as a down-dropped block bounded on both sides by conjugate normal faults. This terminology is abandoned in this study since the geometry of the basin does not fit the definition of graben.

Lawrence Uplift

The Lawrence Uplift is bounded to the north by the Ahloso Fault and to the south by the Stonewall Fault (Baker, 1951). The area between these two faults moved upward to form an eastward plunging horst. The beds exposed on the uplift have a relatively uniform dip of 4 to 6 degrees toward the northeast. Baker (1951) concluded that the folding took place after deposition of the Wapanucka Formation which is the youngest easterly dipping unit on the uplift. The Boggy Formation overlaps all the older units (from the older to younger Caney, Springer, Union Valley, and Wapanucka) and dips gently to the west as a result of later regional tilting. The post-Boggy movement along the Ahloso Fault is indicated by the displacement of Boggy and younger units.

Morgan (1924) suggested that many of the limestone fragments found in the Boggy Formation were derived from the Hunton and Viola Groups. The Boggy lies unconformably on the Lawrence Uplift and overlaps successively older formations. However, within the Franks Graben, it was deposited in normal succession on the Savanna Sandstone.

CHAPTER III

STRATIGRAPHIC FRAMEWORK

The Franks Basin contains Paleozoic rocks ranging in age from Cambrian to Pennsylvanian as well as Quaternary alluvium (Plate 1). In general, the sediments become more clastic toward the top of the section, and coarser toward the Arbuckle Mountains. Table 1 is a composite stratigraphic column of the area.

Most of the wells drilled in the area are very shallow and bottom out in Pennsylvanian age rocks. The Van Grisso Estate Norris # 1 is the deepest well located in NE-SE-SE of section 27. It penetrated most of the Paleozoic section and spotted at the top of the Arbuckle Group. Along the Franks fault zone, the Simpson, Viola and Hunton Group rocks are exposed (Plate 1). Below these groups, a few wells either penetrate the Pennsylvanian sections down to the Cromwell Sandstone or encounter a shale dominated Pennsylvanian section (Desmoinesian rocks). These wells which are located in Sections 29 and 28 indicate the structural complexity of the south side of the basin in the Franks fault zone. At the northern edge of the Hunton Anticline, the Texaco Inc. Witherspoon #1 well in NE-SE-NE of Section 30 penetrates 372 feet of the granitic base. Two well-logs from the Lawrence Uplift; NW-NE-NW-SE of Section 3 and NE-NW-NW-NW of

ERA	SYSTEM	SERIES	GROUP	FORMATION
Paleozoic	Pennsylvanian	Missourian	Skiatook	Belle City, Francis, Seminole
		Desmoinesian	Marmaton	Holdenville, Wewoka, Wetumka, Calvin
			Cabaniss	Senora, Stuart, Thurman
			Krebs	Boggy, Savanna, McAlester, Hartshorne
		Atokan	upper Dornick Hills	Atoka
		Morrowan	lower Dornick Hills	Wapanucka, Union Valley, Springer
	Mississipian	Upper		Caney, Sycamore
		Lower		
	Devonian	Upper		Woodford
		Middle	Hunton	Bois d'Arc, Haragan, Henryhouse, Chimneyhill
		Lower		
	Silurian	Upper		
		Lower		
	Ordovician	Upper	Sylvan	Sylvan
			Viola	Fernvale, Viola Springs
			Simpson	Bromide, McLish, Oil Creek, Joins
		Lower	Arbuckle	West Spring, Kindblade, Cool Creek, McKenzie Hill
	Cambrian	Upper	Timbered Hills	Honey Creek, Reagan
Meso Proterozoic				Tishomingo Granite

Table 1: Composite Stratigraphic Column of the Study Area (modified from Johnson, 1989)

Section 11; exhibit the signatures of Siluro-Ordovician rocks (Plate 1). Within the basin, the formations that crop out are Missourian and Desmoinesian in age. A fence diagram (Plate 2) shows the stratigraphic relationships between the different rock units penetrated by the wells throughout the basin.

The Desmoinesian rocks are the focus of this investigation. They consist of interbedded sandstone, conglomerate, and shale without a correlatable marker that subdivides the interval. As a result they are considered as one package of rocks. On the wire-line logs, the top of this shale dominated section is marked by a conglomerate/sandstone signature called the base of a marker X. This coarse clastic zone is considered the base of the Missourian rocks.

Since this study is primarily concerned with the structural evolution of the western part of the Franks Basin, only a brief overview of the Cambrian to Mississipian rocks is provided. A more detailed discussion of the Pennsylvanian units is included. For a detailed stratigraphy and sedimentology of the outcrop rocks in the basin, the reader is referred to Taff (1902) and Morgan (1923 and 1924).

CAMBRIAN TO ORDOVICIAN

Arbuckle group

The Arbuckle Group is Upper Cambrian to Lower Ordovician in age. No outcrop of the Arbuckle is present within the basin, but large area of exposed Arbuckle carbonate are found on the Hunton Uplift to the south of the Franks fault zone. The Arbuckle Group appears to be the oldest rock units penetrated by the wells in the western Franks

Basin area. Total Arbuckle thickness exceeds 3,500 feet (Plate 6). The Arbuckle Group includes the Mckenzie, Cool Creek, Kindblade, West Spring Creek Formations, which are predominantly limestone, and dolomite with thin sandstone beds.

Simpson Group

The Simpson Group is Middle Ordovician in age. It outcrops in the study area as a faulted and discontinuous band within the Franks Fault Zone bordering the Hunton Anticline to the south, and in the northern part of Section 18 where it is cut by the Stonewall Fault. The Simpson Group ranges in thickness from 1,200 to 2,000 feet and contains in increasing age Joins, Oil Creek, McLish, and Bromide Formations.

The Bromide Formation contains two distinct sandstone-rich zones that are separated by a fine dolomitic limestone. The sandstones are coarse grained and well rounded and cemented with silica, dolomite, and calcite. A green shale is intercalated with the sandstone in the lower part of the formation.

The McLish Formation is composed of the dolomitic sandstone at the base that is overlain by limestone and dolomites. The sandstone is fine grained and cemented with dolomite. It is very porous and is an excellent oil reservoir.

The lower part of the Oil Creek Formation is a fine grained dolomitic sandstone, while the upper part contains mottled gray and white crystalline limestone beds alternating with gray micro-crystalline magnesium limestone, a green shale, and a dolomitic sandstone.

Viola Group (Viola Limestone)

The Viola Group outcrops on the Lawrence Uplift Sections 6, 7, and 8. It also appears in the Franks Fault Zone as a narrow band in Section 34 and the SW 1/4 of Section 35. The thickness ranges between 500 and 750 feet.

Teis & Teis (1937) described the Viola Group as being mainly finely-crystalline, light-brown limestone. It contains light-brown chert, and coarsely-crystalline dolomitic and fossiliferous zones. The Viola is also mottled white coarsely crystalline argillaceous limestone which is dolomitic and sandy near the base.

Sylvan Group (Sylvan Shale)

The Sylvan Group is Upper Ordovician in age. It lies conformably on the Viola Limestone and is overlain by the Hunton Group. The shale forms a linear outcrop that parallels the adjacent Viola exposures.

ORDOVICIAN-SILURIAN-LOWER DEVONIAN

Hunton Group

The Hunton Group is of Ordovician to Devonian in age (Al Shaieb et al, 1993). The outcrops are present as narrow bands in the Franks Fault Zone, and on the Lawrence Uplift in sec. 4, 5, 9, 10, and 11. The Hunton Group contains from oldest to youngest, Chimneyhill Subgroup, Henryhouse, Haragan, and Bois d'Arc and Frisco Formations.

The Chimneyhill Subgroup rests unconformably on the Sylvan Group, and contains the three formations in the Fitts pool; the Clarita is a pink crinoidal limestone, the Cochrane a white glauconitic limestone, and the Keel is oolitic.

Henryhouse Formation

The Henryhouse Formation rests unconformably on the Clarita Formation of the Chimneyhill Subgroup. Morgan (1924) stated that the Henryhouse is primarily shale and interbedded marly limestone and occasional resistant limestone beds

The Haragan/Bois d'Arc Formation is a gray finely-crystalline silty limestone that is cherty in areas. It appears to be absent on the Lawrence Uplift.

The Frisco Formation consists of biohermal mounds that formed the eroded surface of the pre-Frisco strata. It contains mud-rich wackstones and crinoidal grainstones/packstones (Al Shaieb et al., 1993).

UPPER DEVONIAN-MISSISSIPIAN

The Upper Devonian-Lower Mississipian rocks in the study area are represented by the Woodford Shale. The Woodford Shale is succeeded by the Mississipian Sycamore Limestone and the Caney Shale. In the construction of the structural cross-sections, Woodford, Sycamore, and Caney, Springer, and Union-Valley Formations were considered as one package of rocks, except for the cross-sections FF' and GG' (Plates 8 and 9) where a fault at the top of the Sycamore was to be enhanced. On these cross-sections, the Springer and the Union-Valley Formations were mapped as one package of rocks.

The Woodford Formation is brown shale with considerable dark brown chert. It is Upper Devonian in age. The Woodford crops out on the Lawrence Uplift where its ranges from 500 to 700 feet. In the study area, the Woodford averages about 400 feet in the wells that penetrate the formation.

The Mississippian Sycamore Formation outcrops on the Lawrence Uplift . Morgan (1924) mapped the outcrop at the northwest corner of Section 2, T2N, R6E. From that point, it extends in a general easterly direction and continues to the eastern edge of Section 12 where it turns sharply southwestward till it is cut by the Stonewall Fault. The formation is a hard limestone, slate blue on fresh exposure, and weathers to yellow. The Sycamore is only 4 to 5 feet thick. The lower part is slightly sandy in some places and grades laterally into shale.

The Caney Shale is mapped by Morgan (1924) as a small down-dropped block between two faults in the southeastern part of Section 11. It unconformably overlies the Woodford in the Fitts Pool area, where it is composed of brownish-black shale with a greasy luster. The upper part of the Caney Mississipian (Chesterian) consists of siderite ironstone concretions near the contact with the Springer.

PENNSYLVANIAN

The common rocks penetrated by most of the wells throughout the study area are Pennsylvanian in age. Therefore, a detailed discussion of the Pennsylvanian rocks is provided. From oldest to youngest, six groups of rocks of the Pennsylvanian system are present in the study area: the Lower Dornick Hills, Upper Dornick Hills, Krebs, Cabaniss, Marmaton, and Skiatook Groups.

The Springer Shale was formerly called the Pennsylvanian Caney by many workers (Teis ans Teis, 1937; Morgan, 1923 and 1924; Hyatt, 1936). It is overlain conformably by the Union-Valley Formation. Hyatt (1936) observed that the formation lies unconformably on the Caney shale although on the basis of lithology, the contact appears to be gradational. Morgan (1924) divided the formation into two parts: the lower part which consists of lighter colored blue and greenish-blue shales with occasional interbedded sandy beds, and the upper part consists of black-shales and slates with at places bands of dense, blue limestone nodules.

Lower Dornick Hills Group

The Union Valley Formation is made of two parts; the lower part is the Cromwell Sandstone, and the upper part is called the Union Valley Limestone. In the subsurface, the exact thickness of each unit can not be determined from electric logs because of the difficulty of identifying the contact between them. Based on wire-line logs, the formation has an average thickness of 200 feet. In the Fitts pool area, the Union Valley Limestone is a gray, argillaceous, glauconitic limestone that contains sponge spicules (Teis and Teis, 1937). The Cromwell Sandstone is a medium to fine-grained silty sandstone. In some places, it is very porous while in others it is tightly cemented and calcareous. The sandstone is often interbedded with gray micaceous shale and dark-gray sandy shale.

The Wapanucka Formation conformably overlies the Union Valley Formation. It is divided into two parts in the vicinity of the Fitts Pool area: a lower shale, and an upper part consisting of two limestones and interbedded shale (Teis and Teis, 1937). The lowermost limestone in the upper part contains shale and is very oolitic. The second limestone is composed of massive beds of finely crystalline light gray oolitic limestone. The Wapanucka Shale is very micaceous. The Wapanucka Formation does not crops out in the study area. The two limestones were either entirely removed by the post-Wapanucka erosion or were never deposited. The lower limestone appears in some wells drilled in the southeastern part the study area.

Upper Dornick Hills Group

The Atoka Formation unconformably overlies the Wapanucka Formation. It does not outcrop in the study area. Morgan (1924) estimated the thickness at 800 feet in the Stonewall Quadrangle. The wire-line logs of the wells in the graben show a 500 feet to more than 950 feet of Atoka Formation. Crawford # 1 in section 15 shows a large thickness of 1200 feet.

Bruce (1977 and 1979) described the Atoka Formation along the southwestern margin of the Arkoma Basin in Coal and Pontotoc counties. It contains shale and mudstone interbedded with thin sandstone and thin sandy limestone. The Atoka is a marine shelf deposit that received only minor amounts of medium clastic sediments. The sandstones present are lower foreshore beach, submerged barrier bars, or longshore bars deposited during brief stillstands or minor regressions that occurred intermittently during a general transgression.

The lenticular nature of the Atoka beds indicates a rapid deposition of the formation. The formation consists of alternating beds of calcareous sandstone, gray and black shales, and marls with some inconsistent limestone members occurring in the middle and lower part of the section.

The Atoka Formation is divided into three parts in the vicinity of the Fitts pool. The lower and middle parts consist of sandstones interbedded by micaceous shale. The sandstones are medium to coarse grained, angular and sometimes slightly glauconitic. Some are quartzitic, some tightly cemented with calcite while others are very porous. The upper part contains limestone beds with sponge spicule zones between which lies a finely crystalline limestone called the "Atoka dense" (Teis and Teis, 1937).

The fence diagram (Plate 2) shows a progressive eastward thickening and a sudden northward thickening of the Atoka Formation. The sudden north thickening occurs north of the wells Schafer Ranch # 1 in Section 19 and Marcum # 1 in Section 23. The progressive eastward thickening accounts for sedimentological processes while the sudden north thickening suggests the presence of a syndepositional normal fault.

The contacts between the three groups of the Desmoinesian Stage, Krebs, Cabaniss, and Marmaton are not discernible on the logs because of the shaliness of the section. Therefore in the cross-sections, the three groups are referred to as the Desmoinesian package.

Krebs Group

The Krebs Group contains four formations which are from the oldest to the youngest; the Hartshorne, McAlester, Savanna, and Boggy Formation. The Hartshorne sandstone rests unconformably on the Atoka Formation in the areas to the east of the study area where it is present the subsurface only.

The McAlester Formation is mapped by Morgan (1924) as a narrow band in section 35. It lies above the Hartshorne and below the Savanna Sandstone. The formation carries numerous beds of conglomerate.

The Savanna Formation is mapped also by Morgan (1924) in the southeast of section 35 and south of section 36. A 400 foot thick section about two miles southeast of the town of Franks. It consists of alternating shales and sandstones with occasional thin impure limestone. The conglomeratic beds carry fragments of oolitic and pink crinoidal limestone from Chimneyhill Formation. Other fragments resemble strata from the Viola and Arbuckle Groups.

The Boggy Formation outcrop was mapped all over the eastern portion of the study area in sections 13, 14, 23-26, east of 27, and north of 36 (Morgan, 1924). The formation consists of sandstone, shale, and limestone. The shale beds constitute by far the greatest thickness. At the top of the formation, clastic beds are quite prominent. They grade from sandstone and fine grained conglomerate at the eastern edge of the

Stonewall Quadrangle to coarse limestone conglomerate near the town of Franks where only the upper part of the formation is exposed. Don Hyatt (1936) reported an average thickness of 1,000 feet of the Boggy Formation in the Fitts pool area where the formation lies unconformably on the McAlester Formation.

Cabaniss Group

Morgan (1924) described the Thurman Sandstone as a succession of several beds of conglomerate and conglomeratic limestone in which the pebbles consist of chert and limestone. Some of the limestone fragments resemble the pink crinoidal member of the Silurian Chimneyhill Limestone and are thought to have been derived from that formation. Brown and yellowish-brown sandstones are very prominent in the formation and alternate with dark shales.

Marmaton Group

The Marmaton Group contains four formations which are from oldest to youngest: the Calvin Sandstone, Wetumka Shale, Wewoka Formation and Holdenville Formation. Only the Wewoka and Holdenville formations are exposed in the study area (Morgan, 1924).

Morgan (1924) mapped the Wewoka Formation outcrops in the Franks Graben, extending north south through the central part of the study area. He mentioned a sandstone section exposed in the section line at the extreme northeast corner of section 23, where the average thickness of the Wewoka approximates 400 feet. The top and bottom of the formation are marked by sandstone beds. The basal sandstone and other members locally grade into limestone.

Above the top sandstone of the Wewoka Formation lies the Holdenville Formation. It contains shale, sandstone, and limestone conglomerate. Morgan (1924) believed that the shale exposed in the southwestern part of section 15 and the asphaltic conglomerate at the old asphalt pit in the southern part of section 20 carry a fauna correlatable with that of the Holdenville Formation.

Skiatook Group

The Skiatook Group contains three formations which are from the oldest to youngest; the Seminole, Francis, and Belle City formations. The Francis Formation outcrops in the northwestern part of the study area in Sections 15-17, 18, 19, 20, and 21. The formation consists of from the base to the top: a limestone, a dark blue and black shales grading upward to the sandstone, a thick dark and sometimes calcareous shale with abundant limestone concretions, a coarse brown sandstone and a chert conglomerate, and a shale with thin sandstone and one conglomeratic limestone. Because the limestone concretions common to the basal shale of the Francis Formation are abundant in the southwestern part of section 15, Morgan (1924) concluded that the formation is present in the western part of the basin.

FRANKS CONGLOMERATE

Taff (1901) considered all the limestone conglomerates of the study area as one formation and named them Franks conglomerate. The name is after the town of Franks in section 34 T2N, R6E. Taff (1901) followed by Reeds (1910) and Willis (1915) placed the Franks conglomerates at the base of the Pennsylvanian section equivalent to the Wapanucka Limestone. Moore (1921) stated that the Franks and Seminole were equivalent. McCoy correlated the Franks conglomerate with the Seminole Conglomerate of Taff (1901), but with much thicker deposits. Weidman (1922), concluded that the Franks conglomerates represent a series of conglomerate beds from the Pennsylvanian and most likely the basal Permian. Morgan (1923) suggested that the Franks conglomerate represents the shoreward phase of the McAlester, Savanna, Boggy, and possibly younger formations. He suggested that the term Franks conglomerate be restricted to the Pennsylvanian strata that are fossiliferous, highly folded or faulted and non-arkosic. Johnson (1990) called Franks Conglomerate the formations of the Desmoinesian Series present in the Franks Basin including McAlester, Savanna, Boggy, Wewoka, and Holdenville.formations.

In this study, the Franks Conglomerate is considered as the conglomerate deposited in the Franks Basin during the Pennsylvanian deformation stage of the SOA (Table 2).

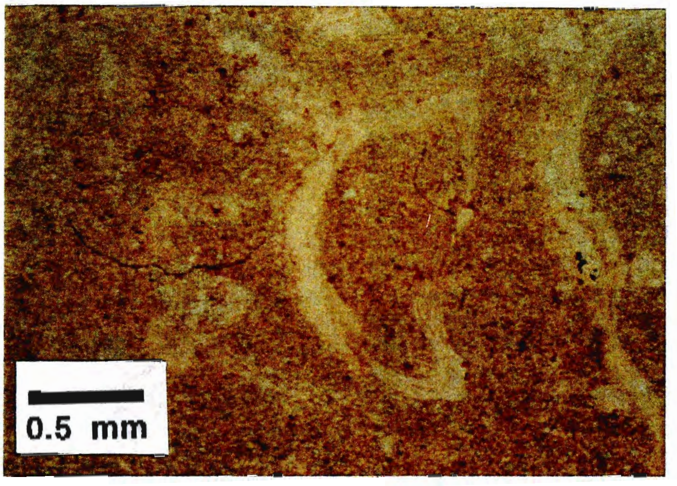
SYSTEM	STAGE	GROUP	FORMATION	TAFF (1903-4)	MOORE (1921)	McCOY (1921)	WEIDMAN (1922)	MORGAN (1923)	JOHNSON (1990)	THIS STUDY (1995)
Permian			Pontotoc Terrain: Konowa Fm			Seminole or Franks				
			Pontotoc Terrain: Stratford Fm							
Pennsylvanian	Virgilian	Wabaunsee	Vanoss Fm							
		Shawnee	Ada Fm							
		Douglas	Vamoosa Fm							
	Missourian	Skiatook	Belle City Fm							?
			Francis Fm							
			Seminole Fm		Franks					
	Desmoinesian	Marmaton	Holdenville Sh.				Franks		Franks	Franks
			Wewoka Fm							
			Wetumka Sh.							
			Calvin Ss.							
		Cabaniss	Senora Fm							
			Stuart Fm							
			Thurman Ss.							
		Krebs	Boggy Fm					Franks		
			Savanna Ss.							
			McAlester Fm							
			Hartshorne Ss.					?		?
	Atokan	Upper Dornick Hills	Atoka Fm							
	Morrowan	Lower Donick Hills	Wapanucka Fm	Franks						
			Union Valley							
Mississippian			Springer							
			Caney Sh.							
			Sycamore Lst.							

Table 2: Stratigraphic Position of the Franks Conglomerate (revised after Morgan, 1923; and Johnson, 1990)

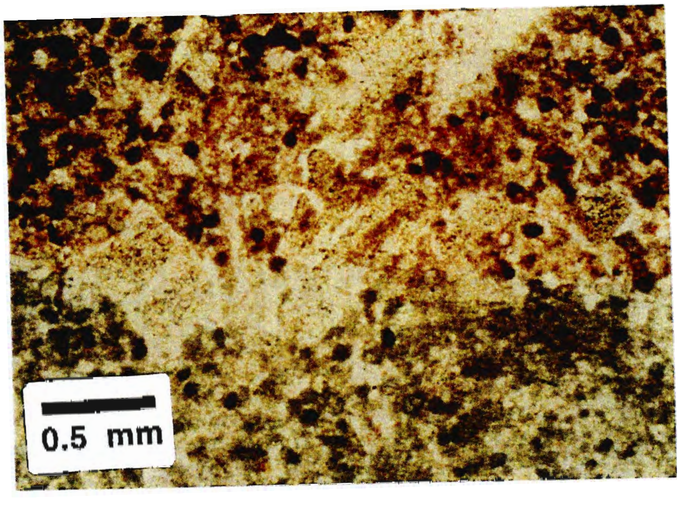
Provenance of the Carbonate Fragments

Ham (1973) mentioned that the Franks Conglomerate derived from the Arbuckle, Viola, and Hunton Groups. Morgan (1924) observed the Viola and Hunton fragments in the Boggy Formation that is one unit of the Franks Conglomerate. In this study, the petrographic study of a conglomerate unit most probably equivalent to the Boggy Formation that outcrops southwest of Section 27 was carried out to examine the provenance of the carbonate fragments found in this conglomeratic unit. Based only on both mesoscopic examination of hand samples, and microscopic examination of thin sections, it has been determined that Arbuckle, Viola, and Hunton fragments are present in the conglomerate unit examined. Therefore, the adjacent Hunton Uplift was the most probable probable source area for the conglomerate. This in turn suggests that the Hunton uplift was already formed during the deposition of the conglomerate. However, the determination of these carbonate fragments based only on the petrographic characteristics of the fragments and the sources is somewhat restrictive. Therefore, a more detailed study based on biostratigraphy is advised.

Figure 9 shows a comparative petrographic analysis and interpretation between the sources and the carbonate fragments of the Boggy Formation. Figure 10 is the measured section of the conglomerate unit measured in the area, probably equivalent to the Boggy Formation. The unit is about 140 feet thick. The source of identifiable rock fragments are shown in a column on the right side of the columnar section. However, the source of certain carbonate elements could not be determined because of lack of conspicuous petrographic evidence. A more detailed petrographic and biostratigraphic study may reveal their sources. These may also be fragments from other source rock such as Simpson Group.

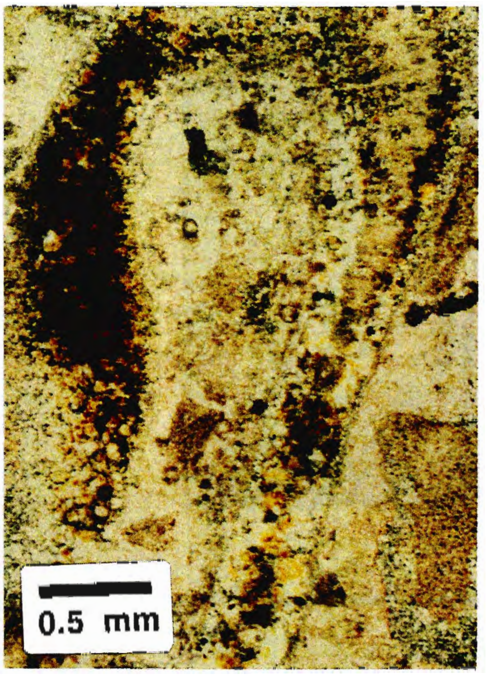


A. Hunton Sample: Sparsely fossiliferous Mudstone

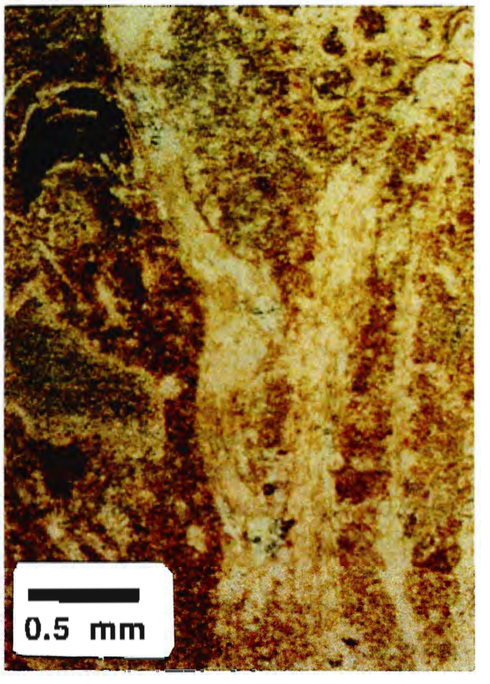


B. FCF: Echinoderm Biopelmicrite/ Wackstone (Source Hunton)

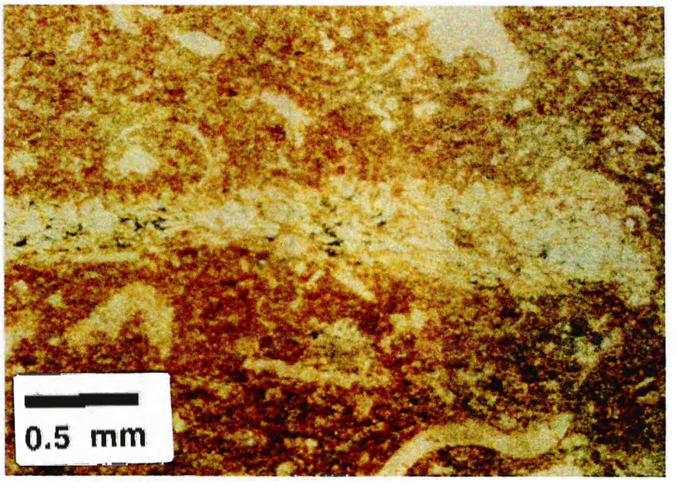
Figure 9A: Carbonate Fragment and its inferred source.



A. Viola Sample: Echinoderm Biosparite/ Grainstone
Notice the silicified trilobite

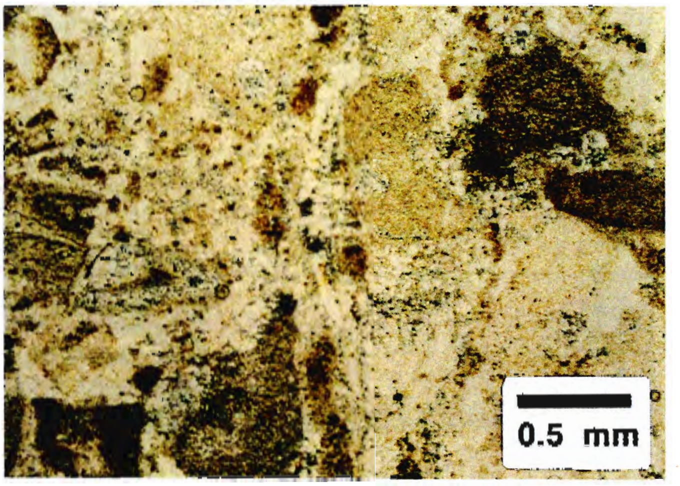


B. Viola Sample: Brachiopod Biomicrite/ Packstone
Notice the silicified brachiopod

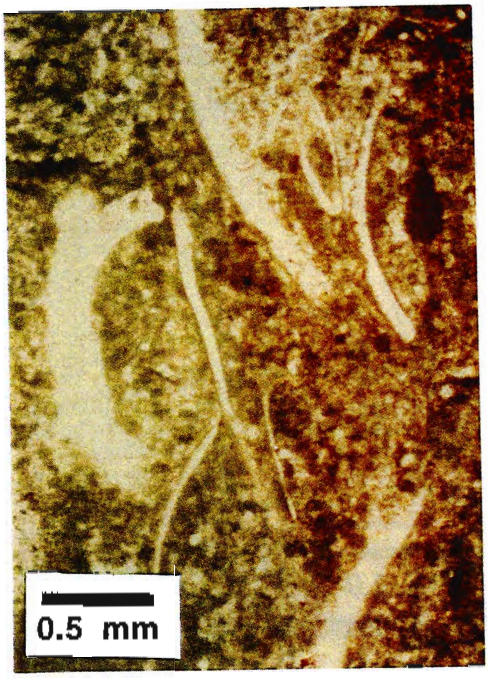


C. FCF: Brachiopod Biomicrite/wackstone
(Source: Viola)
Notice the silicified brachiopod

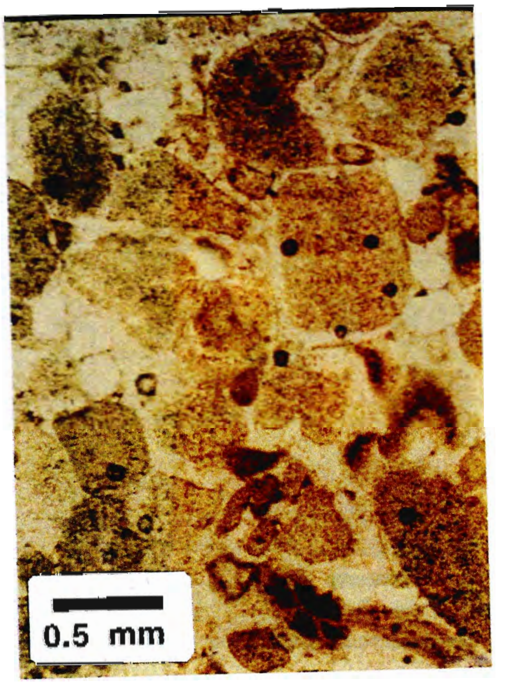
Figure 9B: Carbonate Fragment and its Inferred Source.



A. Viola Sample: Echinoderm Biosparite/Grainstone

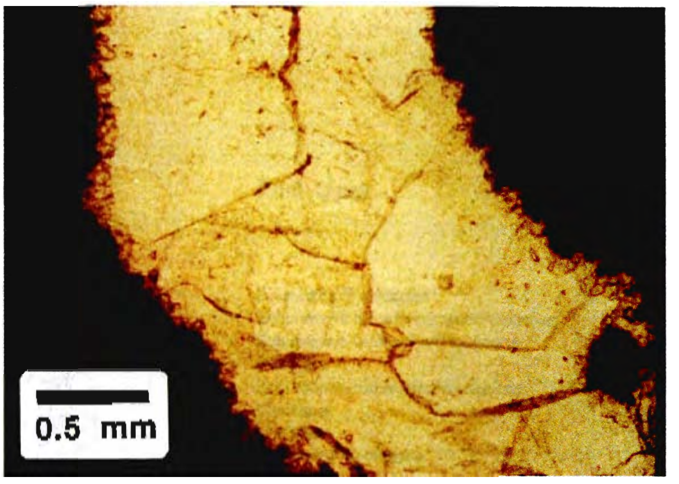


B. FCF: Biopelmicrite / Mudstone
(Source: Viola)
Notice the oriented fossils

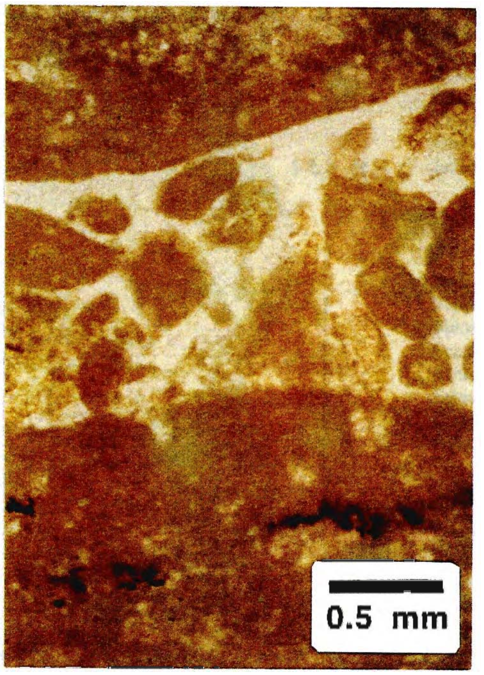


C. FCF: Echinoderm Biosparite/Grainstone-Packstone
(Source: Viola)

Figure 9B: Carbonate Fragments and their Inferred Source



A. Arbuckle Group Sample: Mudstone

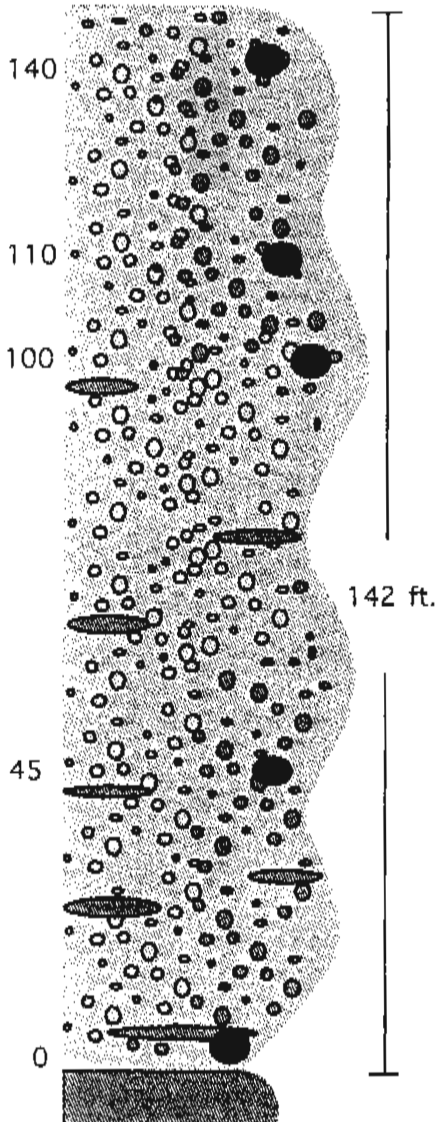


B. FCF: Intrasparite/Grainstone (Source: Arbuckle)

B. FCF: Brachiopod Intrasparite /Grainstone (Source: Arbuckle)

Figure 9C: Carbonate Fragments and their Inferred Source

Franks Conglomerate



Rock types	Source
Biomicrite/Wackstone	?
Echinoderm biomicrosparite/Packstone	?
Echinoderm biosparite/Grainstone	Viola
musdtone	?
Echinoderm biomicrite/Wackstone	?
Mudstone	Arbuckle
Mudstone	Viola
Pelmicrite/Wackstone	Hunton
Echinoderm biopelmicrite/Packstone	Hunton
Echinoderm pelsparite/Grainstone-Packstone	?
Brachiopod trilobite pelmicrosparite/Packstone	?
Biomicrite/Wackstone	?
Brachiopod bryozoan trilobite pelmicrosparite Wackstone-Packstone	Viola
Echinoderm bivalve biomicrosparite/Wackstone Packstone	Hunton
Mudstone	?
Siliceous biomicrite	?
Brachiopod biomicrite/Wackstone	?
Intrapelsparite/Grainstone	Viola
Echinoderm trilobite biomicrite/Wackstone	?
Oncolite pelmicrosparite/Packstone	Arbuckle
Intramicrosparite/Packstone-Wackstone	?
Bryozoan biomicrite/Wackstone	?
Siliceous Echinoderm biomicrosparite	Hunton
Mudstone	Hunton
Echinoderm biomicrite/Wackstone	
Echinoderm biomicrosparite/Packstone	?
Echinoderm brachiopod biomicrite/Wackstone	?
Brachiopod intrapelsparite/Packstone	Viola
Biomicrite/Wackstone	
Echinoderm ostracod biopelmicrosparite/Packstone	Viola
Biomicrite/Wackstone	?
Echinoderm pelmicrosparite/Packstone	Viola
Echinoderm trilobite biomicrite/Wackstone	?
Mudstone	Arbuckle
Pelbiomicrite/Wackstone	

Figure 10: Measured Section of the Franks Conglomerate (SW of Section 27)-Types of Carbonate Fragment Present in the Section-Inferred Sources.

Diagenesis of the Franks Conglomerate unit (Boggy Formation)

The petrographic analysis of the Boggy Formation equivalent of the Franks Conglomerate was designed to determine the mineralogical composition, textural relationship, and the diagenetic history of the unit. The unit is a poorly porous (<5 %) limestone pebble conglomerate. A south source of the carbonate fragments , which are the major constituents of the unit, is already established. Diagenetic modifications have slightly affected the conglomerate unit.

Detrital Constituents

The Franks conglomerate unit contains 70 to 80 % sedimentary rock fragment pebbles, 25% to 10 % of silty to sandy matrix, 3% to 8% of calcite cement, and 2% to 4% of pyrite and 6% to 8% of hematite.

The sedimentary rock fragments comprise the carbonate, chert, and sandstone fragments. The carbonate fragments were studied in detail during the determination of their source. They comprise 80 to 90 % of the detrital fraction. In summary, their nature ranges from mudstone to grainstone (Figure 9). Some fragments contain a considerable amount of quartz grains. They derived from the Arbuckle, Viola and Hunton Groups that were exposed on the Hunton Anticline by the time the unit was being deposited. The chert fragments are relatively abundant and comprise 10 - 15 % of the detrital constituents

(Figure 11-). The sandstone fragments are fine grained well rounded moderately sorted quartz arenite with calcite cement (Figure 12). They represent about 5 % of the detrital fraction.

Sandy and silty and micritic matrices were observed in the pebble limestone conglomerate (Figure 13). The sandy matrix represents the primary matrix of the rock. It is a fine-grained litharenite. The matrix contains quartz (10-25%), sedimentary rock fragments composed of chert and carbonate fragments (20 - 35%), fossils (5-8%), micritic matrix (25-45 %) and a microsparry or poikilotopic calcite (5-7 %). The sand grains resemble those present in the sandstone and carbonate fragments as far as roundness is concerned (Figure 14).

Zircon occurs as accessory constituent.

Diagenetic Constituents

The common diagenetic textures observed are related to a slight compaction, cementation, replacement and dissolution.

Compactional textures are almost non existent suggesting that the unit had not been subjected to a deep burial. Figure 15 shows the concavo-convex contacts between the particles of the rock. The major cement is calcite replacing the micritic matrix. It appears as microspar or poikilotopic or sparry calcite (Figure 16). In places, cement and micrite dissolve producing secondary porosity. (Figure 15). The pyrite occurs as rhombs crystals (Figure 16) often altered to hematite. Hydrocarbon stains were observed along the grain contacts (Figure 15) or in the sandy matrix.

Paragenesis

The textural relationships suggest the presence of several diagenetic episodes which are related to a slight compaction (Figure 15). With the small burial the unit was slightly compacted and the contact with freshwater led to the crystallization of calcite cement. The dissolution of both matrix and cement produced the secondary porosity. The diagenetic history of the unit is illustrated on figure 17.

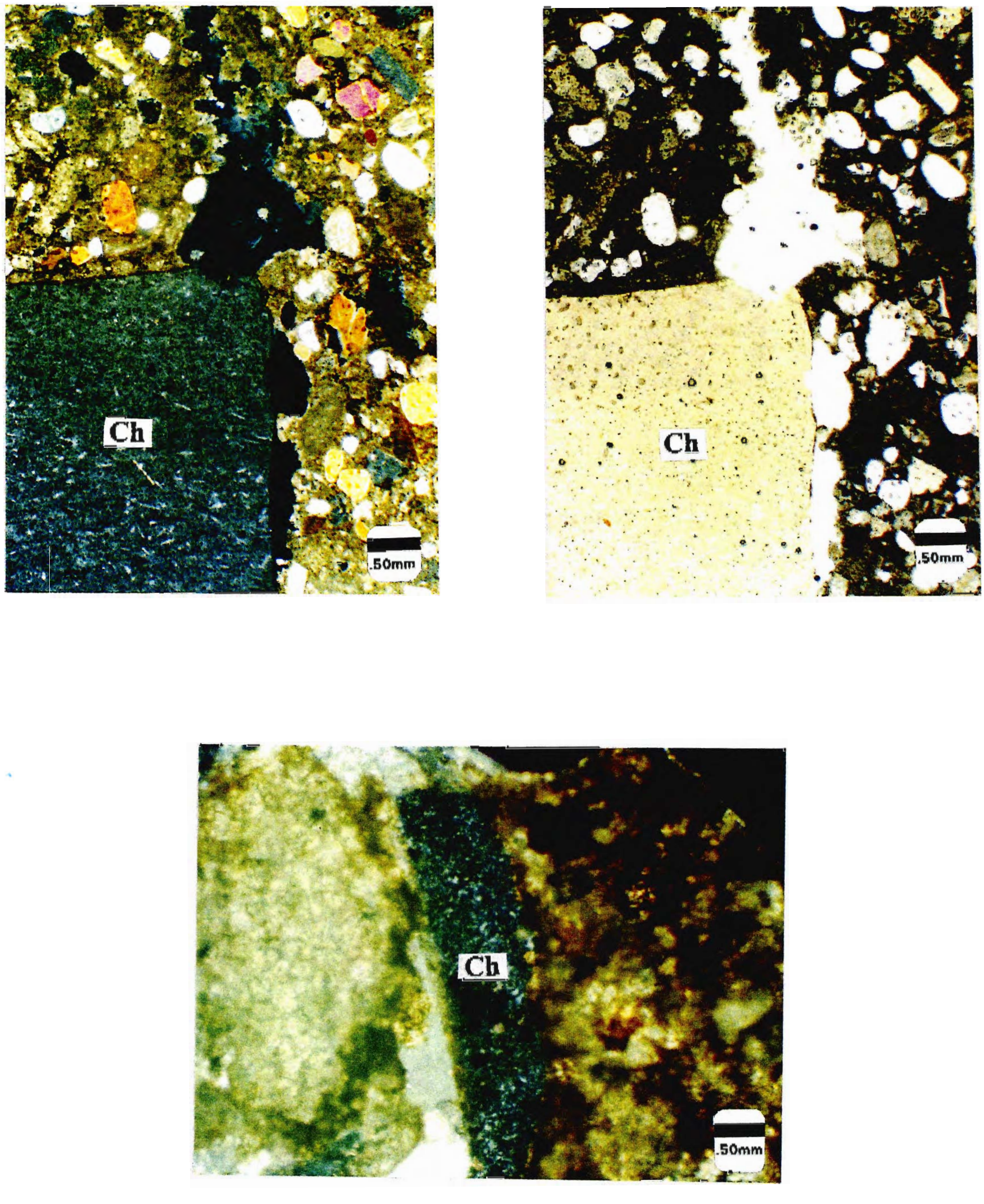
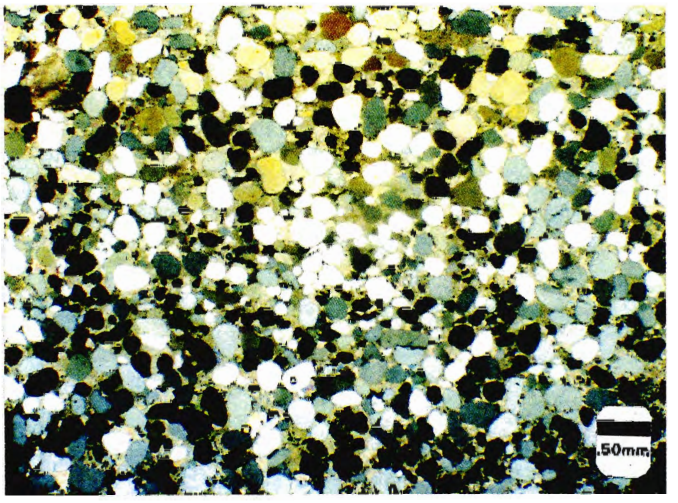
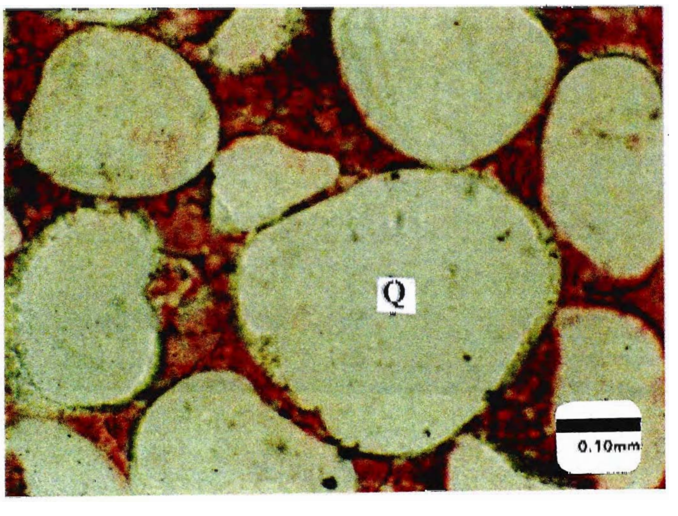


Figure 11: Chert Fragments (Ch) in the pebble limestone limestone

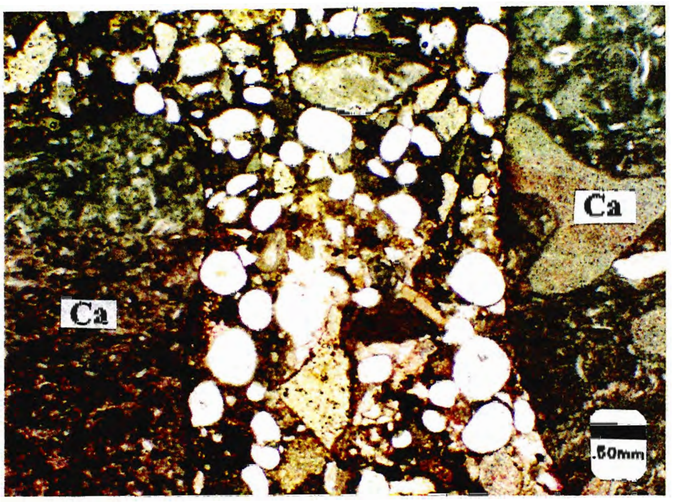


A: Quartz arenite fragment

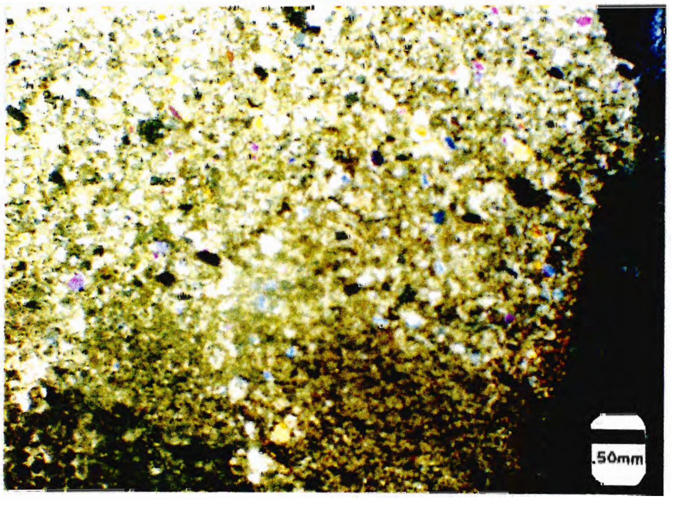


B: Stained quartz arenite discriminating the calcite cement

Figure 12: Sandstone fragment in the pebble limestone conglomerate (note the good roundness of the quartz grains)



A: Sandy matrix



B: Silty matrix

Figure 13: Different matrices of the pebble limestone conglomerate

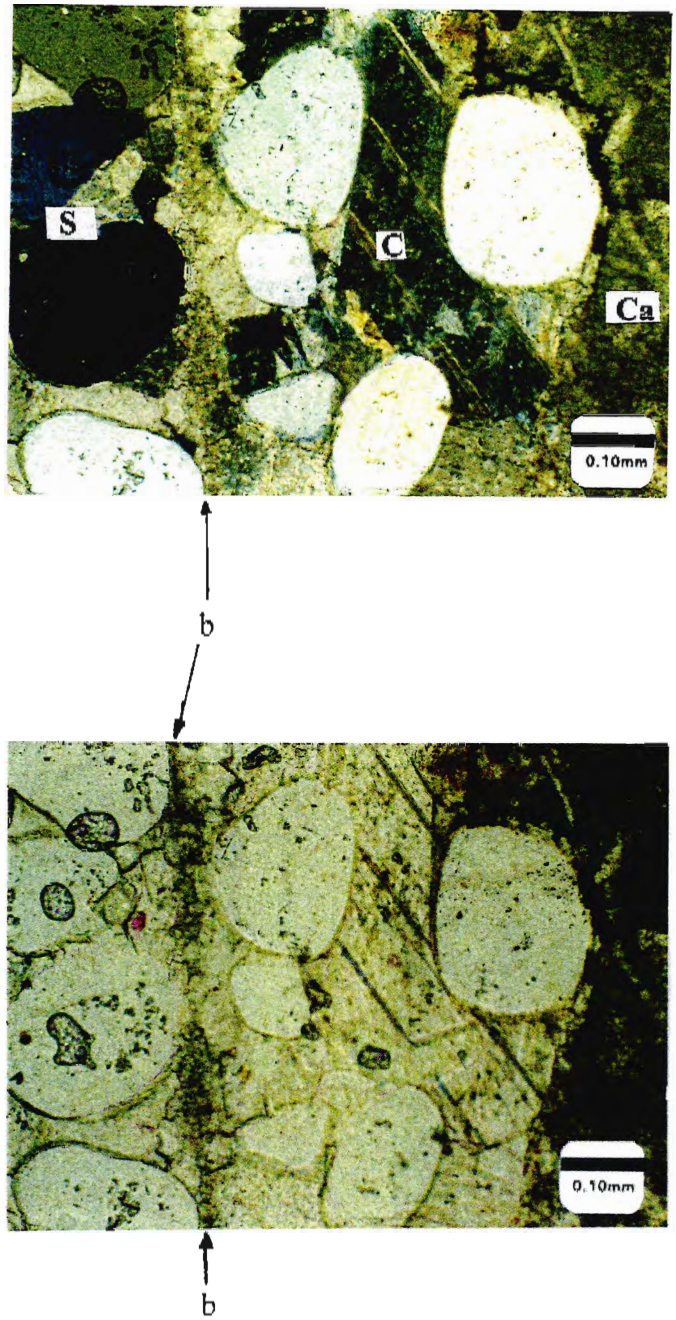


Figure 14: Resemblance of the quartz grains between the cement (C) and the sandstone fragment (S). b is the boundary between the two entities (note the poikilotopic calcite cement)

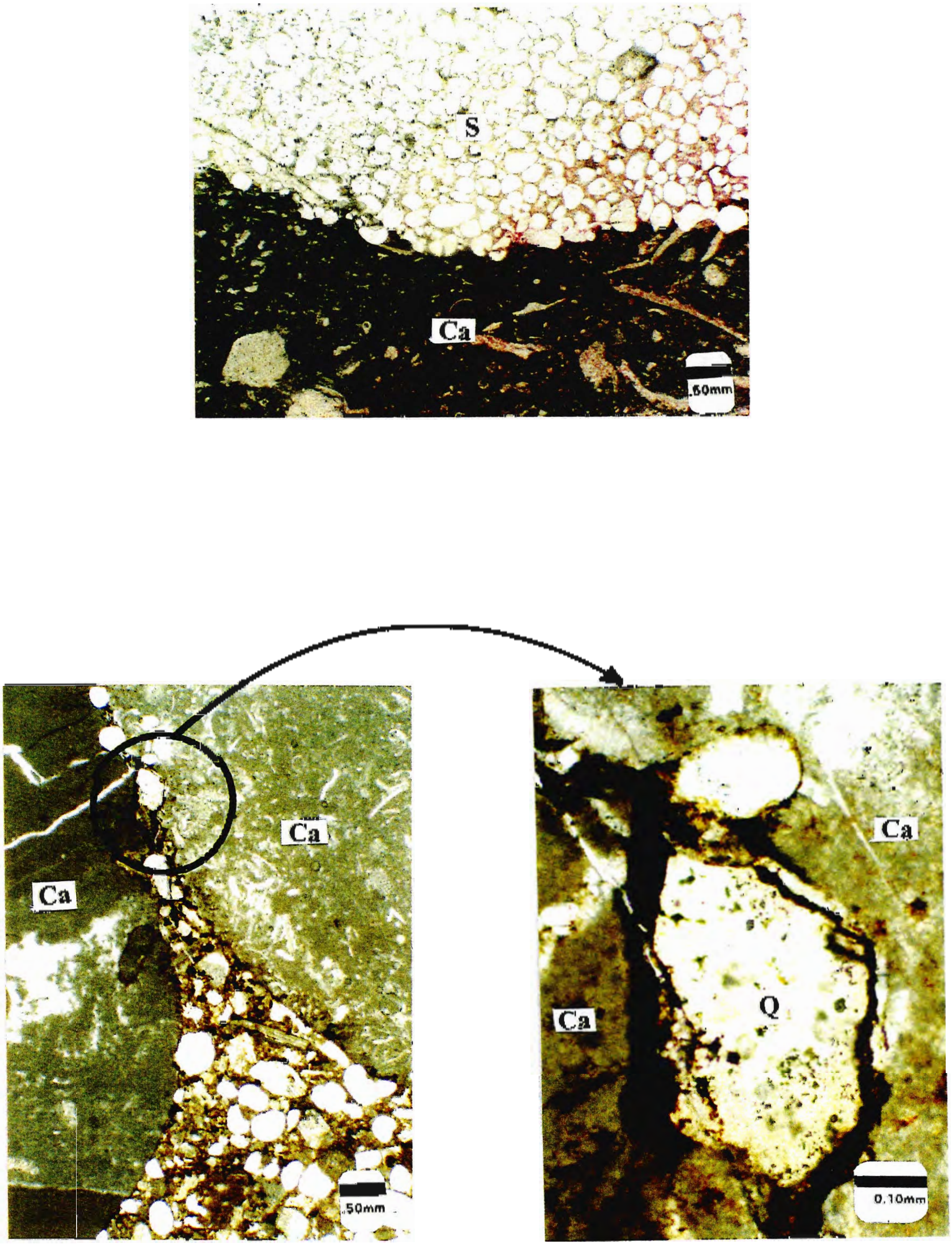
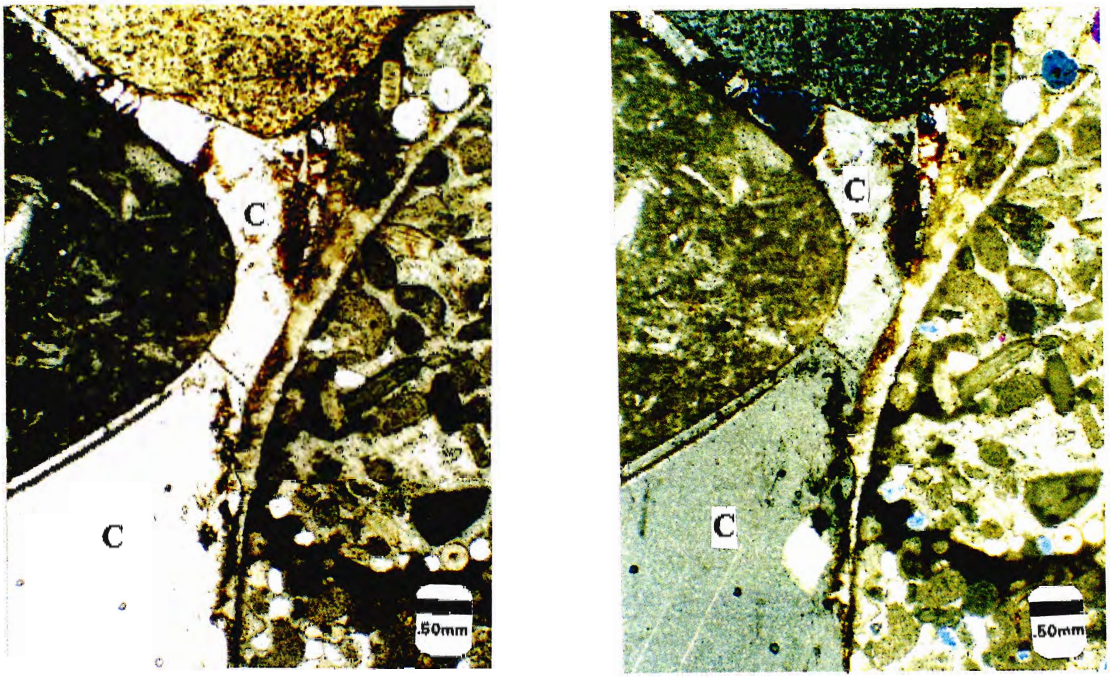
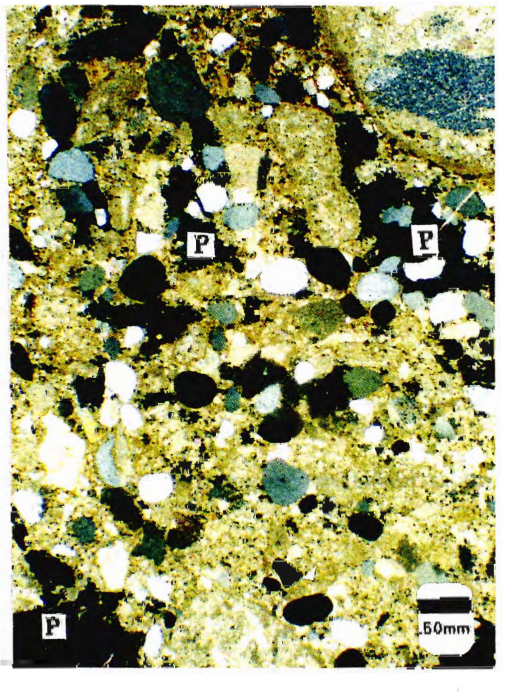


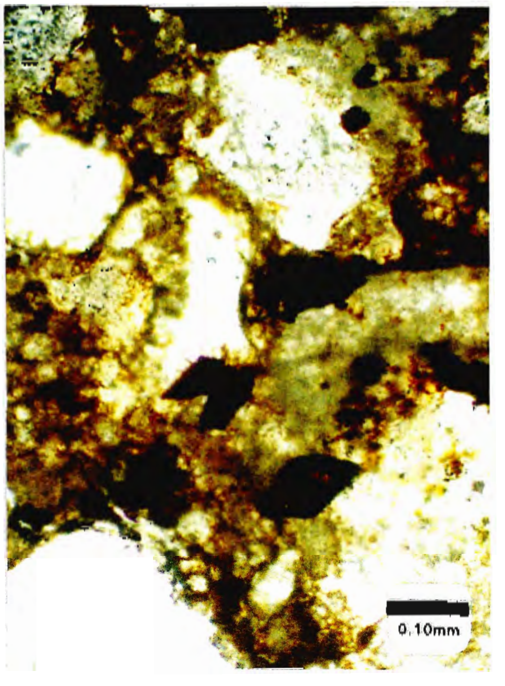
Figure 15: Concavo-convex contacts between:
A: the sandstone (S) and carbonate (Ca) fragments
B: the carbonate fragments (Ca) and the quartz grain (Q)



A: Sparry calcite



B: Microsparry calcite
(note the secondary porosity p)



C: Pyrite rhombs in alteration to hematite.

Figure 16: Different cements in the pebble limestone conglomerate

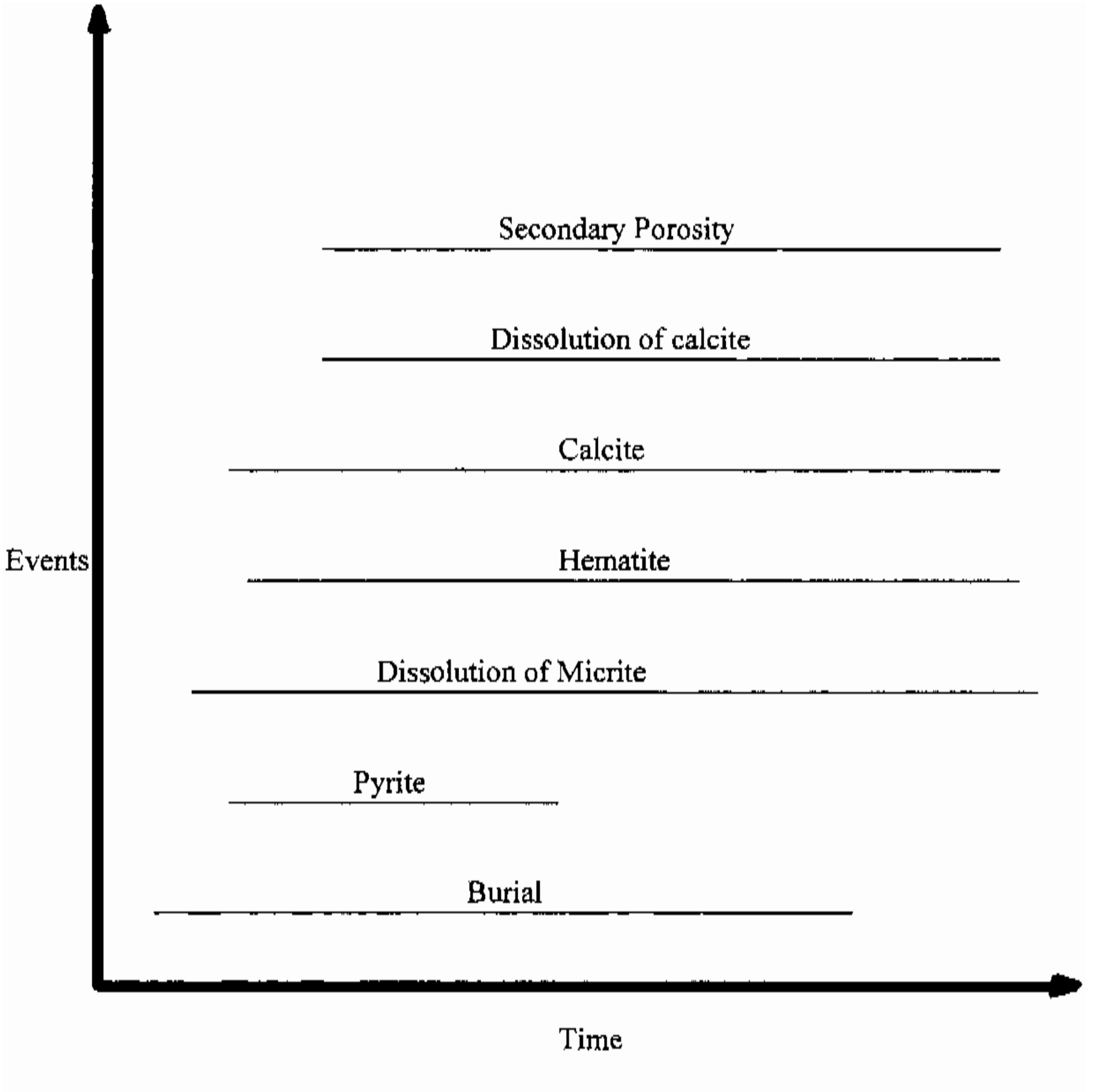


Fig 17: Diagenetic History of the Pebble limestone conglomerate unit (Boggy Formation)

CHAPTER IV

STRUCTURAL GEOLOGY

The Franks Basin is a structural wedge within the northern part of the Arbuckle Mountains; it is located between the Lawrence Uplift to the north and the Hunton Anticline to the south. This study is primarily aimed at a better understanding of the structural evolution of the western part of the basin located mostly in T2N R6E in the Stonewall Quadrangle.

Morgan (1924) mapped the Stonewall Quadrangle and recognized the Stonewall Fault, the Franks Basin, the Franks Faults Zone, and the Fitts structure. He suggested that the general structure of the strata within the basin consists of two sharp drag synclines and a broad westward plunging anticline. Hyatt (1936) constructed many cross-sections through the Fitts pool. His cross-sections show a high-angle normal fault in competent beds and flattening in shales (Wapanucka, Union Valley, Caney) in sections 25, 26, 35, and 36 of the study area (Figure 18). Mann (1958) constructed three structural contour maps in the area (tops of Hunton, Viola, and Wapanucka), but he did not map any fault within the basin except in the western end of the Fitts Structure. In the western portion of the basin, his structural maps show an anticlinal structure faulted by the Franks

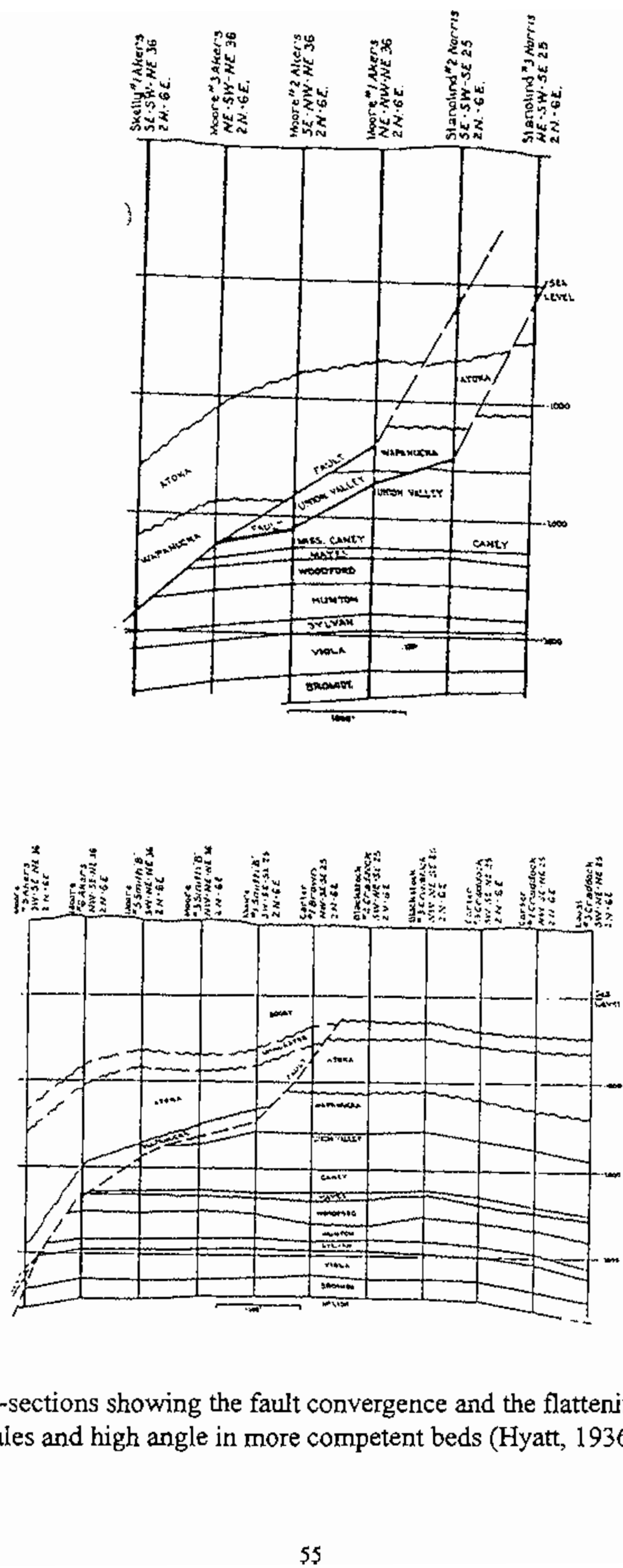
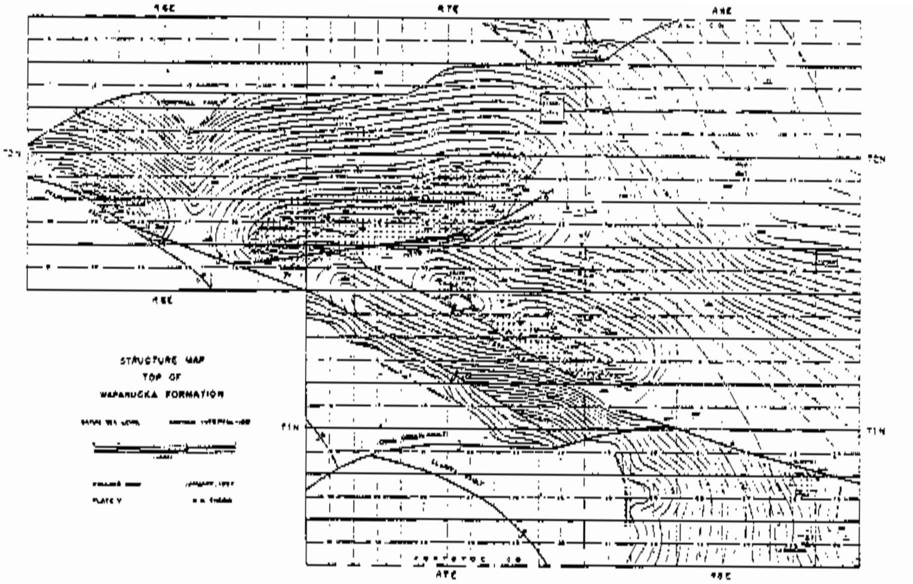


Figure 18: Cross-sections showing the fault convergence and the flattening of fault plane in shales and high angle in more competent beds (Hyatt, 1936)

fault zone and separated from the Fitts Structure by a large saddle (Figure 19A). Withrow (1968, and 1969) constructed a structural contour map on top of the Cromwell Sandstone. Besides the two bounding faults of the basin, he reported five faults merging from the Franks fault and propagating north or northeast within the basin (Figure 19B).

During this study, nine structural cross-sections (Plate 1 and Plates 3-11) and three structural contour maps (Plates 12-14) were constructed to determine the geometry of the structural features present in the study area. The cross-sections are based on well log data and the surface geology of Johnson (1990), and the formation tops are based on scout tickets and the author's interpretation of well data. Since the area contains only few deep wells (Norris Heirs # 2, SW-NE-SE, Section 26; Norris Estate # 1, NE-SE-SE, Section 27; Cherokee # 1, SW-SW-SE, Section 26; J. Norris Estate # 1, NE-SW-NE, Section), the thickness of many formations have been based on thickness obtained in the well logs of these wells. Since the public seismic profiles were not available in the area, the cross-sections are strictly based on well data and were constructed to illustrate the geometry of the structural features in the basin. The construction of the structural contour maps to the north of the basin are based on the cross-sections.

Three structural blocks separated by faults are easily distinguished in the cross-sections. The structural blocks are the Hunton Anticline to the south, the Lawrence Uplift to the north, and the Franks Basin between the two uplifted areas.



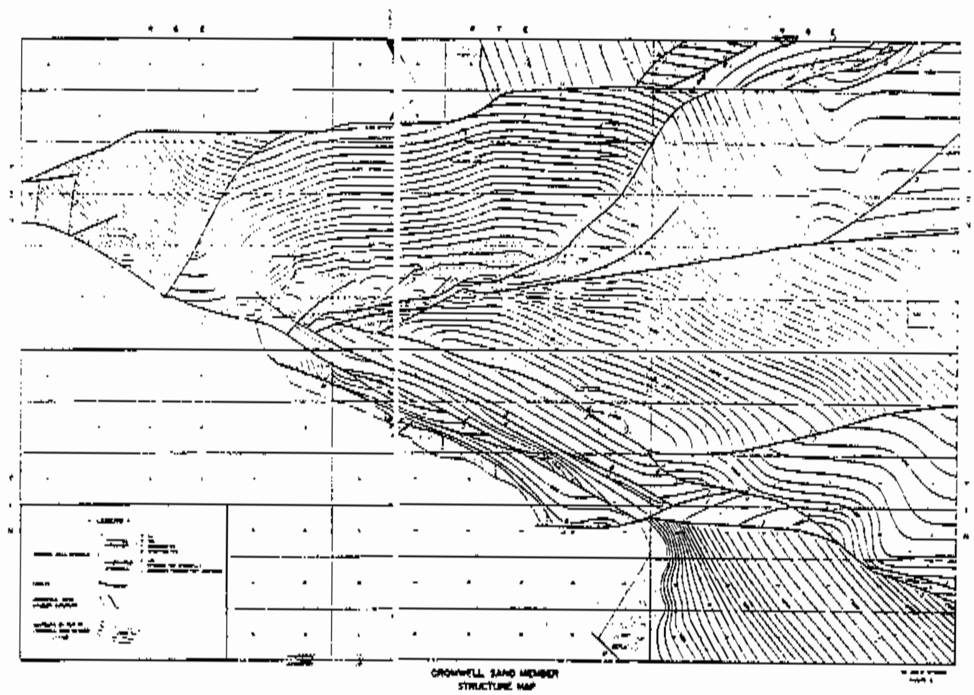


Figure 19: Structural contour maps of Mann (1958), and Withrow (1968 and 1969)

The subsurface faults of the Western Franks Basin are displayed on plates (7-9, and 11). Figure 20 is a south-north cross-section that displays the structural blocks and the features of the study area. The structural map (Figure 21) shows the structural features present in the study area.

FAULTS

Surface faults

The main surface faults exposed at the surface are the Stonewall Fault to the north and the Franks fault zone to the south and few faults in the Hunton Anticline (Figure 21). Their surface traces are drawn from the geologic map of the Arbuckles (Johnson, 1990). The two boundary faults, Stonewall Fault and Franks fault zone diverge eastward and converge westward giving the Franks Basin a triangular shape.

Stonewall Fault

The Stonewall Fault bounds the Franks Basin to the north (Plate 1). It strikes northeasterly and juxtaposed the older Paleozoic rocks of the Lawrence Uplift with the younger basinal deposits.

On the cross-sections A-A', B-B', C-C', D-D', E-E', and G-G' (Plates 3-6 and 9), the fault is shown as a high angle normal fault dipping approximately 80 toward the south

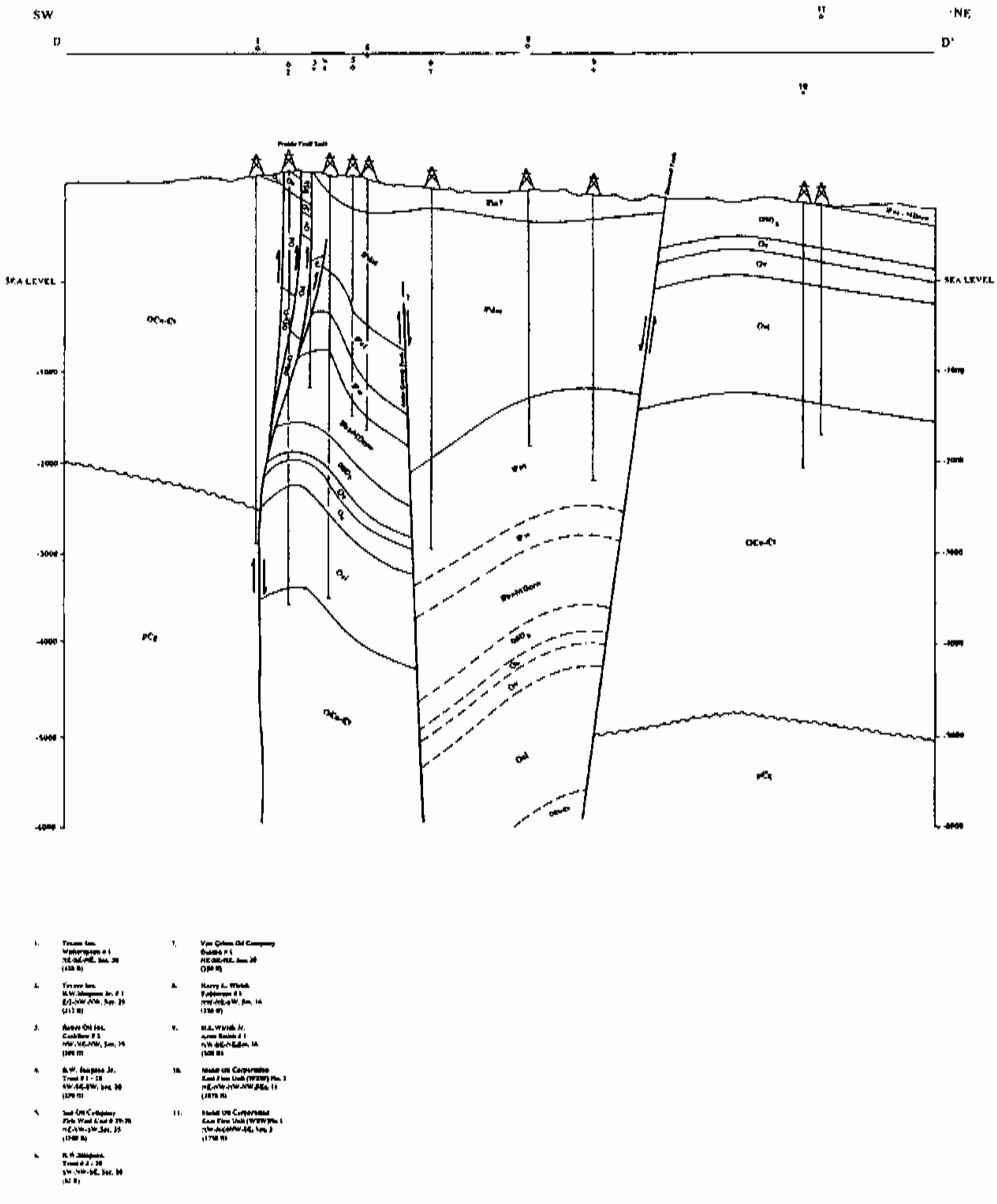
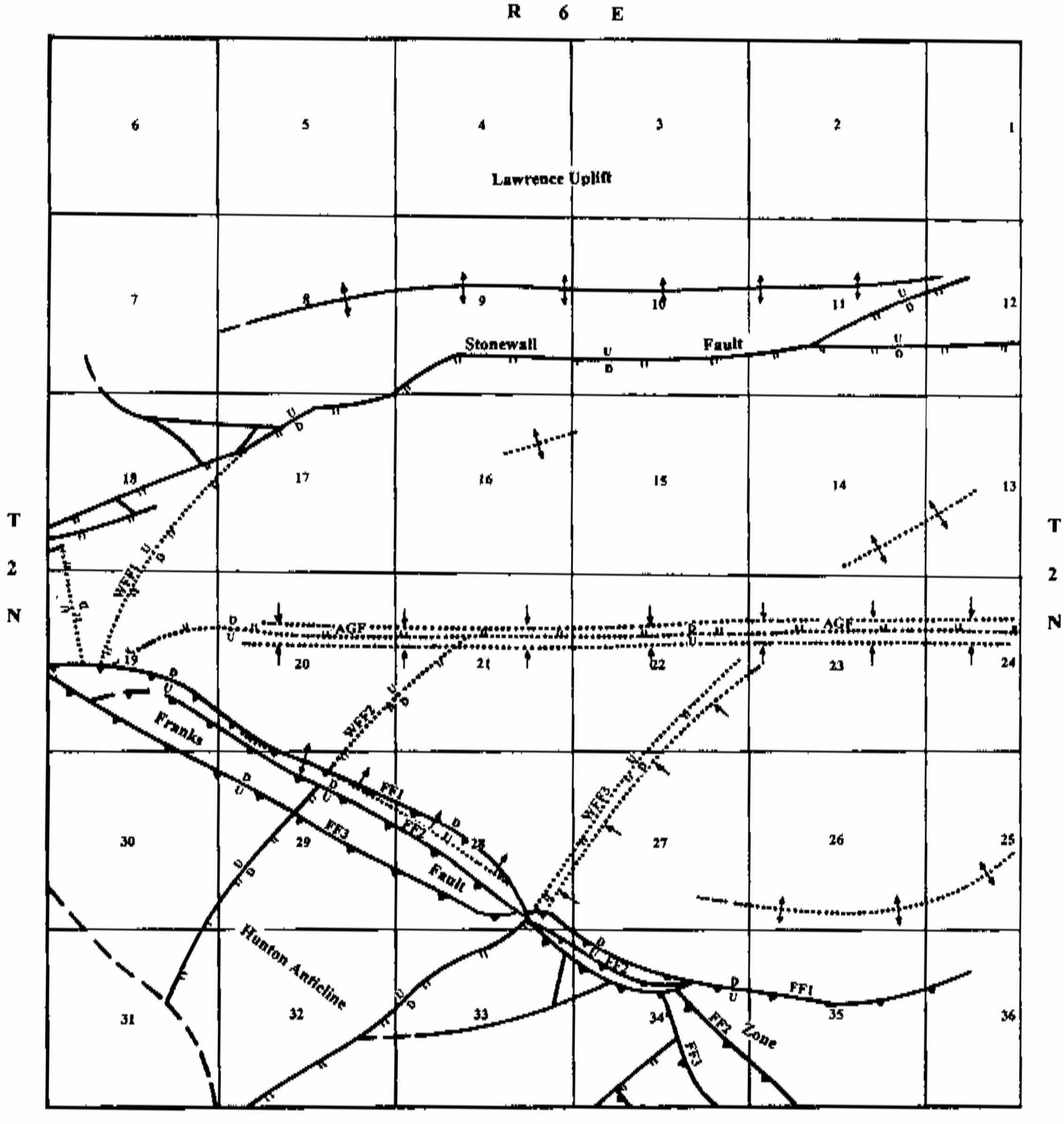


Figure 20: South-North Structural Cross-Section Showing the Three Structural Blocks and the Geometry of the Structures of the Western Franks Basin



EXPLANATION

- Surface structural feature
  - Normal fault
  - Inferred fault
  - Anticline
- Subsurface structural feature
  - Normal fault
  - Anticline
  - Anticline associated with fault
  - Syncline associated with fault

AGF : Atoka growth fault

WFF : West Fitts Fault

FF : Franks Fault

Figure 21: Schematic Structural Map of the Western Franks Graben, showing the structures exposed at the surface and encountered in the subsurface

with a great separation. The basin side of the fault represents the hanging-wall and the Lawrence side is the footwall. The estimation of the dip is arbitrary because no well to the south of the surface trace of the fault penetrates the fault in the subsurface. The closest well to the south adjacent to the fault has a total depth of only 1952 feet. Therefore, the fault plane has to be to the north of this well (Plate 4).

On the surface fault brings Missourian and Desmoinesian basinal units of the hanging-wall in abrupt contact with Ordovician and Silurian units of the Lawrence Uplift in the footwall. On all the cross-sections, the older Paleozoic rock units present on the footwall are uplifted forming the Lawrence Uplift. On the other side representing the hanging-wall, the correlative strata are downthrown in the way that today's surface geology shows an abrupt contact between the Missourian/Desmoinesian and Ordovician. In addition, the shallowness of the wells within the basin rendered impossible the accurate position of the displaced older Paleozoic units. Therefore, the thickness of the pre-Atoka formations obtained from the deepest wells were used in the hanging-wall side in order to estimate the normal separation. As a result, the westernmost south-north cross-section (Plate 3) shows a normal separation of 5750 feet and the two east cross-sections (Plates 4 and 5) show a normal separation that averages 4625 feet. Therefore, the separation along the Stonewall fault increases westward. The amount of normal separation approximates 5,000 feet.

A small fault splay from the Stonewall fault in section 11 (Plate 1) can be interpreted in two different ways according to the surface pattern of the two faults, a)-they are joined on the surface and in subsurface only at the point where they intersect in section 11 and diverge eastward, or b)-they are joined both at depth and at the intersection point and diverge eastward and upward. The first interpretation is favored here because the small fault does not parallel the main fault after its emergence point (Plate 7).

Franks Fault Zone

The Franks Fault was first mapped by Morgan (1924) as a fault bounding the Franks Basin to the south. The southern boundary of the basin is shown on the geologic map of the area (Johnson, 1990) as thin bands of Ordovician and Silurian rocks bounded by faults, which are usually referred to as the Franks fault zone (FFZ).

Within the Franks fault zone, few electric logs show the older Paleozoic rocks interpreted as Arbuckle and Simpson Groups overlying the Wapanucka Formation, which is thicker than the normal section found on the other well-logs. This suggests a repetition of the Wapanucka Formation due to faulting that brought the older Paleozoic rocks over the Wapanucka Formation. On the cross-sections A-A' and D-D' (Plates 3 and 6), the Franks fault zone contains three faults which are from north to south FF.1, FF.2, and FF.3. When The surface traces of FF.1 and FF.2 are joined to the point where they are interpreted as penetrated by the wells, they appear to be dipping to the south at a high angle. On the cross-section D-D', the only available well to the south of the FFZ (Witherspoon # 1; NE-SE-NE, Section 30) does not penetrate any of these faults at depth. This suggests that the three faults converge at depth to form one subvertical fault that cuts through the Arbuckle Group rocks and the Proterozoic granitic basement. The involvement of the basement indicates a thick-skinned deformation This interpretation of the subsurface geometry of the FFZ was carried on all the other cross-sections cutting where the FFZ is present. All three faults of the FFZ show a reverse separation. However, the separation between the basinal deposits or the Paleozoic rocks and along the FFZ units could not be determined because the rock units exposed on the upthrown block (mostly Arbuckle Group) are not penetrated by any wells within the Franks Graben in the downthrown block. The only major rock boundary on the upthrown block is the contact between the Arbuckle Group and the Proterozoic basement. On the downthrown side of the FFZ, this contact is well below the total depth of any wells drilled to date. Nevertheless, the separation of 4,700 feet was quite accurately determined on the cross-section D-D' (Figure 20 or Plate 6) where the top of the Arbuckle Group is shown on both sides of the FFZ.

Within the Franks fault zone and between the small fault blocks of rocks, this separation is very small. In fact, There is not a big age gap between the rocks exposed in each block of the FFZ. They become younger basinward: the Arbuckle Group is exposed on the southernmost block and the Hunton on the northernmost block. This suggests that these rocks are silvers between the faults and the three faults should join to one major fault at depth (Plates 3-6).

The fact that the Franks fault zone is penetrated by the wells drilled in the southernmost part of the study area, suggests that the fault does not extend to south. Therefore, the 4,700 feet separation along the Franks fault zone to the north is reasonable. This large separation of rocks observed between the basin and the FFZ/Hunton Anticline area is an evidence of the uplift of the Hunton Anticline, along the fault zone. In short, the FFZ consists of a relatively narrow fault blocks of rock which join to a subvertical principal displacement zone at depth. These characteristics fit very well to the characteristics of a strike-slip fault zone as summarized by Biddle and Christie-Blick, (1985). Figure 22 shows a generalized sketch of the southern part of the cross-sections A-A' to D-D', showing some similarities with the idealized profile of a flower structure of Biddle and Blick (1985). Therefore, this study suggests that the Franks fault zone had experienced a substantial strike-slip movement during the deposition of basinal rocks of the Franks Basin.

The surface geology (Plate 1) shows the FFZ as small and elongate bands of rocks confined to the basin-Hunton Anticline boundary. These bands of rocks have a preferential southeast-northwest direction. The confinement of the bands of rocks to the basin boundary, their elongate shape along a preferential direction, and the bounding of the bands by the faults suggest that they have been horizontally displaced. The sense of the motion can be inferred from the surficial arrangement of the rocks throughout the region. On the geologic map of Johnson (1990), the Hunton and Simpson group units outcrop to the east of the Hunton Anticline where they are highly faulted along the north boundary of the anticline. To the west, these formations do not crop out. This suggests a southeast source of the of the faulted blocks of rocks present in the study area, indicating a northwest horizontal displacement along a pre-existing fault that formed prior to the northwest motion. This can be justified by the northwest structural trends present in the

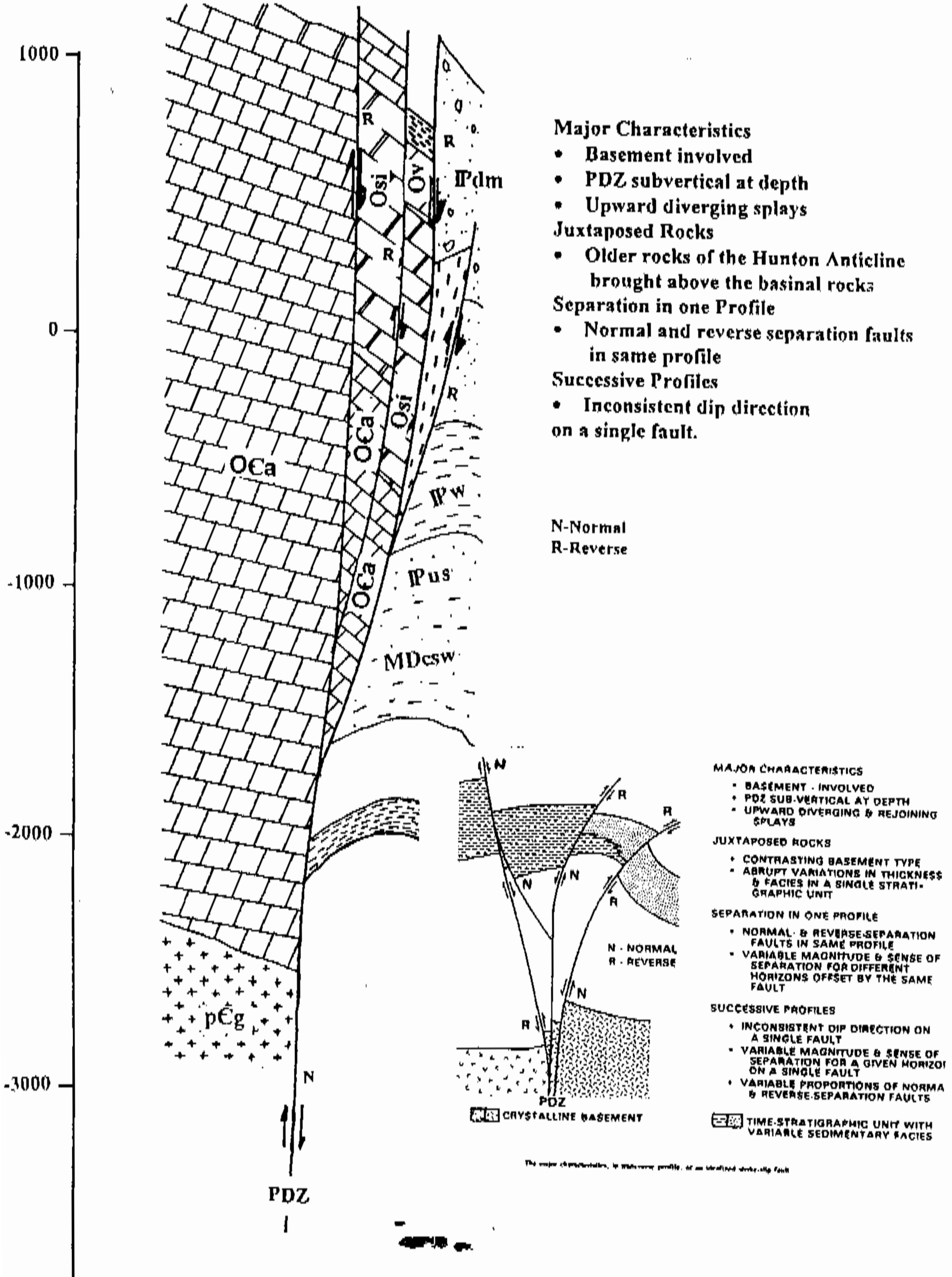


Figure 22: Major Characteristics in transverse Profile of the Flower Structure of the Franks Fault Zone. Note the similarities with the characteristics of the idealized profile of Biddle and Blick (1985).

SOA (Figure 6). This horizontal motion of blocks of rock determines the strike-slip nature of the reactivation of a pre-existing fault.

The strike-slip faults are defined by Biddle and Blick (1985) as linear or curvilinear principal displacement zones (Figure 23). Curving along the strike-slip fault zones is common because significant lateral displacement can not be accommodated where there are discontinuities or abrupt changes in fault orientation without pervasive deformation within one or both of the juxtaposed blocks (Biddle and Blick, 1985). Most prominent strike-slip faults involving igneous and metamorphic basement rocks as well as supracrustal sedimentary rocks are termed wrench faults, particularly in the literature of petroleum geology (Wilcox, Harding, Seely, 1973; Biddle and Blick, 1985). Figure 24 shows the map view of the FFZ. The curvilinear faults in the fault zone diverge and merge laterally forming faulted blocks of rock. To the southeast, there is a set of curved fault splays that crudely resembles a horsetail splay which is a term used for splaying faults at the termination of the strike-slip fault zone (Figure 24). The curvilinearity of the FFZ and the presence of a horsetail structure also points toward the strike-slip nature of the FFZ.

The surface and subsurface geometries of the Franks Fault Zone (Figure 22 and 24) characterize it as a strike-slip fault zone with a thick-skinned deformation. Although the surface and subsurface the geometry of the FFZ does not conform strictly the

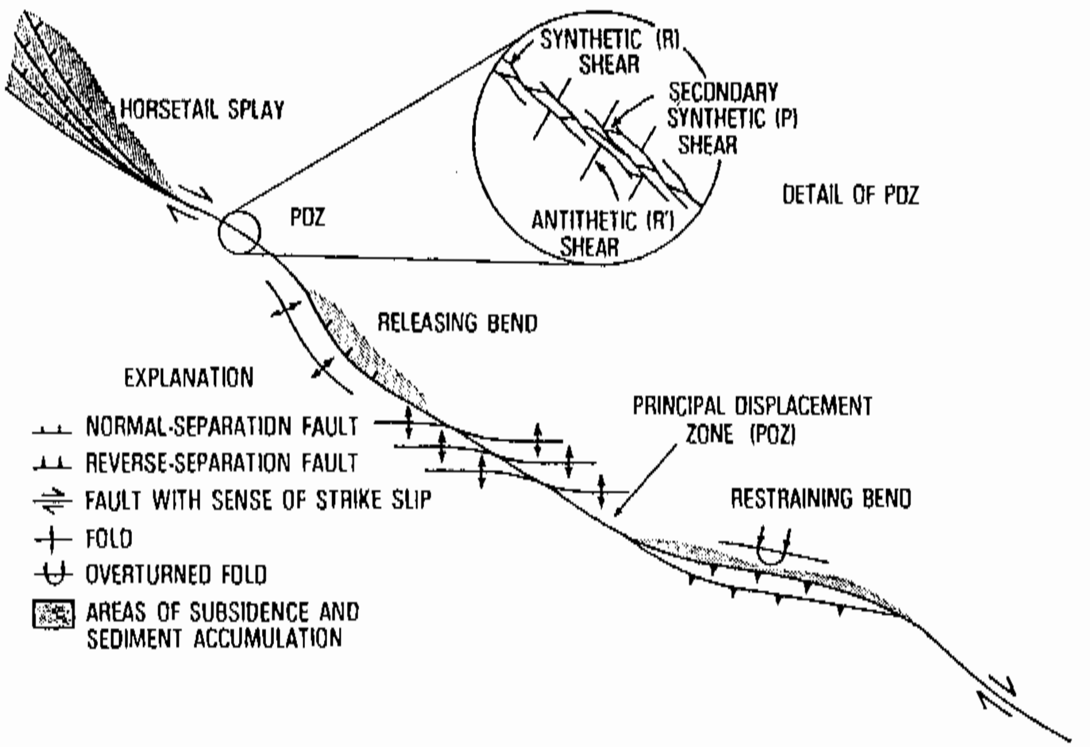


Figure 23: Spatial Arrangement in Map View of Structures Associated with an Idealized Right-Slip Fault (Biddle and Blick, 1985).

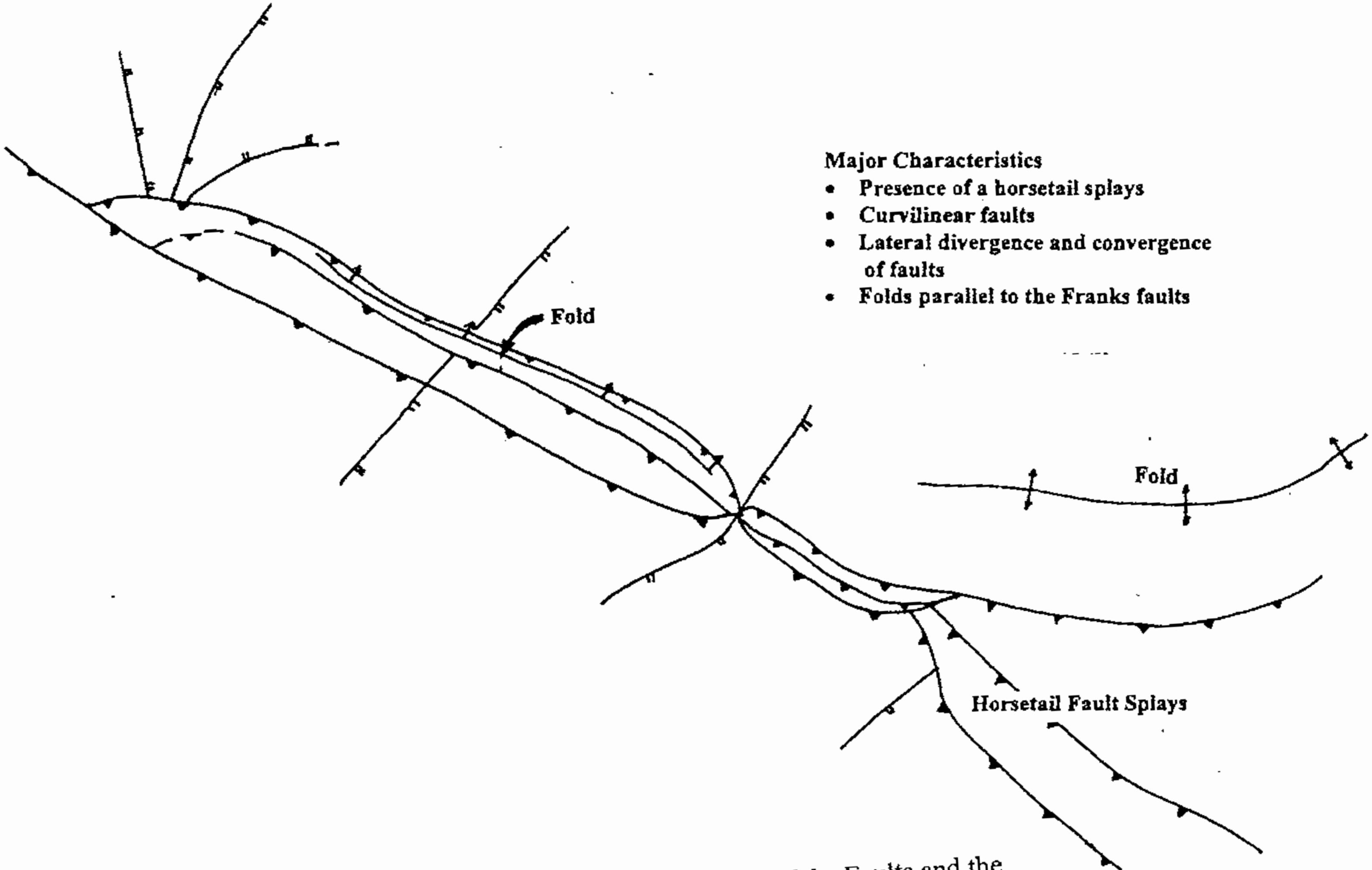


Figure 24: Map View of the FFZ Showing the Curvilinearity of the Faults and the Associated Structures.

idealized map and cross-section view of Biddle and Blick (1985), there are enough similarities that a reasonable conclusion can be stated. The differences are probably due to the fact that rocks are heterogeneous, the structural development occurs sequentially rather than instantaneously. Moreover, every strike-slip fault zone has its unique history of development.

Subsurface Faults

Structural cross-sections and structural contour maps revealed the presence of subsurface faults within the basin. These faults generally trend in two directions, and can be grouped as east-west trending faults and southwest-northeast trending faults (Figure 21). Two northeasterly striking east-dipping normal faults bound the West Fitts pool. They are henceforth called West Fitts Faults. There is only one east -west trending subsurface fault; it is named here the Atoka 'growth' fault because of the considerable difference in thickness of the Atoka Formation on both sides of the fault. A subsurface fault appears in the core of the Fitts Structure on the contour map constructed on the top of the Wapanucka Formation (Plate 13).

West Fitts Faults

On the structural contour maps, the West Fitts Faults appear to be the continuation of the southwest-northeast trending faults that are exposed on the Hunton Anticline in sections 31/29 and 32/33. The western fault is named West Fitts Fault 1 (WFF 1), the middle one WFF.2, and the eastern one WFF.3 (Figure 21).

The WFF.1 curves progressively in sections 19 and 17 and finally joins the Stonewall Fault. This fault is shown on the structural contour maps and the fence diagram. The wells G. C. Mayhue # 1 NW-SE-NW, Section 19 and Schafer # 2 NW-NE-NE Section 19 drilled to the west of the fault shows about 750 feet thick of a shaley section (Wapanucka) overlain by a sandy to conglomeratic section. On the well logs Schafer #1 SW-NW, Section 19 and B. D. Denton # 1 C-NW-NW, Section 19 west of the previous wells, the shaley section does not exist, but the conglomeratic section lies on the Union-Valley Formation. The Atoka Formation is totally absent in these wells. However, the base of a marker X considered as the top of the Desmoinesian (base of Missourian) is present on these logs. This indicated the presence of a subsurface fault that does not cut the Missourian. This fault is termed the West Fitts Fault 1 WFF1.

The WFF 2 and WFF 3 are present to the south of the AGF (Figure 21). There is no evidence of their continuation to the north of the AGF. This may be due to lack of sufficient well control to the north. The WFF 2 runs through the West Fitts pool and exhibits a small displacement of about 350 feet (Plate 11). The WFF 3 marks the boundary between the Fitts pool area and the West Fitts pool area. It shows a displacement of about 1,000 feet.

The closest wells to these faults WFF.1, WFF.2, and WFF.3 do not penetrate them at depth. This suggests that they can be considered as high angle faults mostly-down-to-the east. The non-availability of the public seismic lines rendered difficult to determine the direction of dip on these faults. However based on the well-log data, they can be considered as dipping to the southeast. This suggests that they show normal separation.

Therefore, the West Fitts Faults are interpreted as high-angle southeast-dipping normal faults.

The cross-section I-I' (Plate 11) shows the base of the Desmoinesian cut by the West Fitts Faults WFF 2 and WFF 3. These faults do not reach the marker X, interpreted as the base of the Missourian. This suggests that these faults were active during the Early Desmoinesian time. The total absence of the Atoka Formation on the west side of WFF.1 suggests a non deposition or a complete erosion of the formation due to an uplift of the western part of the basin. Therefore, the WFF1 was probably active until near the end of the Desmoinesian time.

Atoka "Growth" Fault

The east-west striking north-dipping fault is portrayed on the structural contour maps (Plates 12, 13, and 14). It is present throughout the basin and either intersects the WFF 1 or merges into the FFZ in section 19. The WFF 2 and WFF 3 may intersect the fault in sections 21 and 22. The structural contour maps constructed on the top of the Union-Valley and Wapanucka Formations (Plates 13 and 14) show a distinct trace of the fault throughout the basin. However, the top data of these formations were inferred from the structural cross-sections because of the shallowness of the wells to the north of the fault. In contrast, the contour map on top of the Atoka Formation (Plate 12) does not show the trace of the fault in the eastern part of the basin. This suggests that the fault becomes shallower westward.

The cross-sections A-A', B-B', C-C', D-D' E-E', G-G', and H-H' (Plates 3, 5-7, 9, and 11) depict a considerable difference in thickness of the Atoka Formation on both sides of the fault. To the north, the thickness approximates 1,500 feet which is at least twice the thickness to the south side. This is an evidence that the fault was active during the deposition of the Atoka Formation. The fault is ,therefore, a "growth" fault and is named the Atoka "Growth" Fault (AGF). It is a syndepositional fault and shows a normal separation, with a slight northerly dip. Since the fault is not cut by any of the wells in its vicinity for at least 2,500 feet at depth, it was drawn as a high angle fault. Sutherland (1988) also observed the change in thickness of the Atoka Formation in the Arkoma Basin, where syndepositional faults were formed during the deposition of the middle Atoka. The southern part of the Arkoma Basin displays marked increases in thickness of the Atoka on the down-thrown sides of the east-trending syndepositional normal faults. There, the upper Atoka is not cut by the normal fault (Figure 25). Oakes (1967) reported that some southwest-trending faults of the Arkoma Basin cut the Boggy, but they do not cut the post-Boggy rocks.

On the cross-sections BB' CC' and HH' (Plates 4, 5, and 10), the fault penetrates only the base of the Atoka Formation and the displacement approximates 500 feet. In contrast, the amount of displacement on the cross-sections AA' and DD', west of the previous cross-sections, is about 1,000 feet for the top of the Atoka and 1,700 feet for the base of the Atoka and the older formations (Plates 2 and 6). This suggests an uplift of the

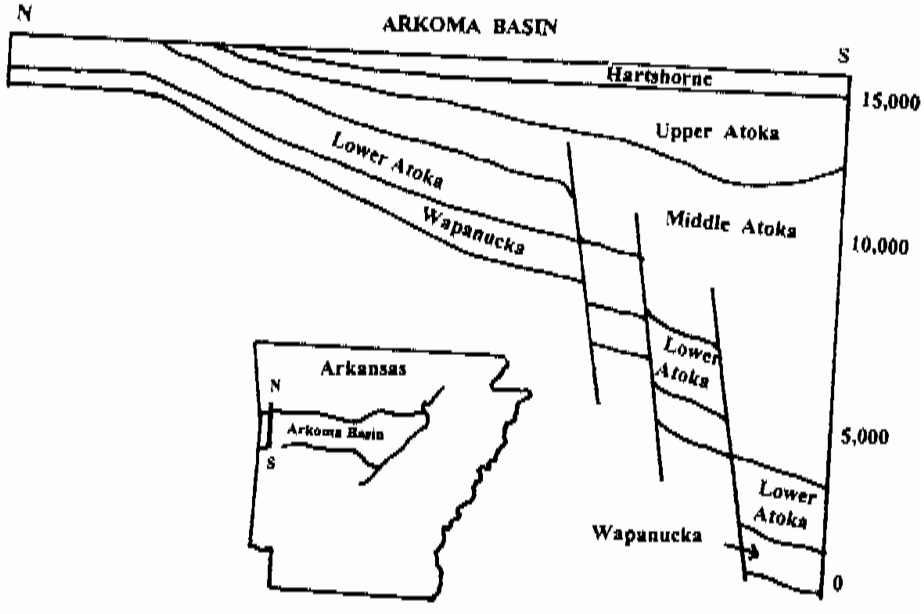


Figure 25: North-South Cross-Section of the Arkoma Basin Depicting Growth Faults that Controlled Sedimentation during Deposition of Middle Atoka Formation (Sutherland, 1988).

western part of the basin that reactivated the western end of the AGF. The AGF either formed during the early Atoka time or before the Atoka time and was reactivated during the deposition of the Atoka Formation prior to the uplift of the western study area.

To the north of the AGF, the cross-sections A-A' and D-D' (Plates 3, and 6) show a thick section of the Desmoinesian deposits. However, the fault does not cut the marker X interpreted as the base of the Missourian. This also points toward an uplift of the western part of the graben, which probably occurred during the Desmoinesian time prior to the deposition of the Missourian.

FOLDS

In addition to many faults present in the study area, there are several folds which were mostly formed in close structural association with the faults. The anticline in the southeastern part of the basin is a prominent fold. It has been long recognized as the Fitts Structure. The anticlinal axial trace strikes northeast in Sections 25 and 26 where it curves to parallel the general trend of the FFZ (Figure 21). The well log Norris Heirs # 2; SW-NE-SE, Section 26, presents a missing section of the middle and bottom parts of the Sycamore Formation. This is diagnostic of the presence of a normal fault that dips to the north. On cross-section F-F' (Plate 8), this well is close to the crest of the fold, and the other wells in the vicinity do not show any missing section. The formations older than Caney on the well J. Norris Estate # 1; NE-SW-NE, Section 26, located to the north of the Norris Heirs # 2 well progressively become deeper indicating the presence of a fault at depth. The fault probably progradcd upward until the Caney Formation where it dies out. The upward progradation of the fault probably bent the younger formations forming an anticline qualifying the fold as a forced anticline.

Besides the Fitts Structure, two anticlinal features are present in the basin, one on each side of the AGF (Plates 3, 4, 5, 6, 7, and 9. These folds are well portrayed on the south-north cross-sections A-A', B-B', and C-C' (Plates 3, 4, and 5). They become broader to the east (Plate 4). Their flanks converge toward the AGF to form a faulted syncline. In the West Fitts pool, the hinge of the anticline lies underneath the FFZ (Plate 6). The axial point of the anticline on each cross-section was projected at surface and plotted on the schematic structural map (Figure 21). The line obtained by joining these points determined an anticlinal axial trace that parallels the FFZ.

All the formations up to probably the lower Desmoinesian are highly folded and faulted. This suggests that the deformation causing this folding ended close to the end of the Desmoinesian time during the Arbuckle Orogeny since the Missourian rocks are only very slightly folded.

CHAPTER V

DEVELOPMENT OF THE WESTERN FRANKS BASIN

Although it is defined as a graben by Morgan (1924), the Franks Basin is not a graben because its geometry does not fit to the general definition of a graben (Twiss and Moores, 1992). A graben is generally defined by "down-dropped block bounded on both sides by conjugate normal faults".In case of the Franks Basin, the Franks fault zone is a strike-slip fault bounding the basin to the south; whereas the Stonewall Fault is a normal fault bounding the basin to the north. On the other hand, these two faults converge to the west giving a typical triangular form to the basin. However, this triangular form does not fit the elongate form of a graben defined in the glossary of geology (1987).

The reconstruction of the structural evolution of the Franks Basin is based on the description and analysis of the sedimentologic and structural data and their logical interpretations. An interpretation of sequential development of the Western Franks Basin is shown on plate 15.

The Franks Fault Zone is parallel to the other prominent faults of the Arbuckle Mountains such as Sulphur, Reagan, and Washita Valley fault zones (Figures 6 and 7). Therefore, it probably formed during the rifting stage of the Southern Oklahoma Aulacogen. Together with the other faults, it controlled Cambrian-Ordovician sedimentation during the sagging stage, which lasted until the Pennsylvanian when the formation of the Ouachita fold-thrust belt was well underway marking the start of the deformation stage of the aulacogen.

The Stonewall Fault may be also considered to have formed during the rifting stage of the Southern Oklahoma Aulacogen. However, it may also be formed at the time with the extensional faults of that which displaced the lower Atokan (Spiro) and Wapanucka rocks in the Arkoma Basin. Since it shows no evidence of reactivation and its trend is parallel to the trend of the extensional faults, it probably formed during the middle Atoka time together with the other extensional faults of the Arkoma Basin. As the thrusting prograded north-northwest in the Ouachitas, some of these faults were overridden by the approaching thrust sheet whose leading edge was the Choctaw Fault. Roberts (1994) summarized the Paleozoic tectono-stratigraphic history of the southern edge of the North America continent (Figure 26). According to him, the extensional block faulting formed during Mississipian-Morrowan. It caused the subsidence that forced the translation of the shelf edge far to the north and created the deep Arkoma Basin. However, the extensional faulting is post lower Atokan in the Wilburton Gas Field area (Cemen and others, 1995; Akhtar and others, 1994).

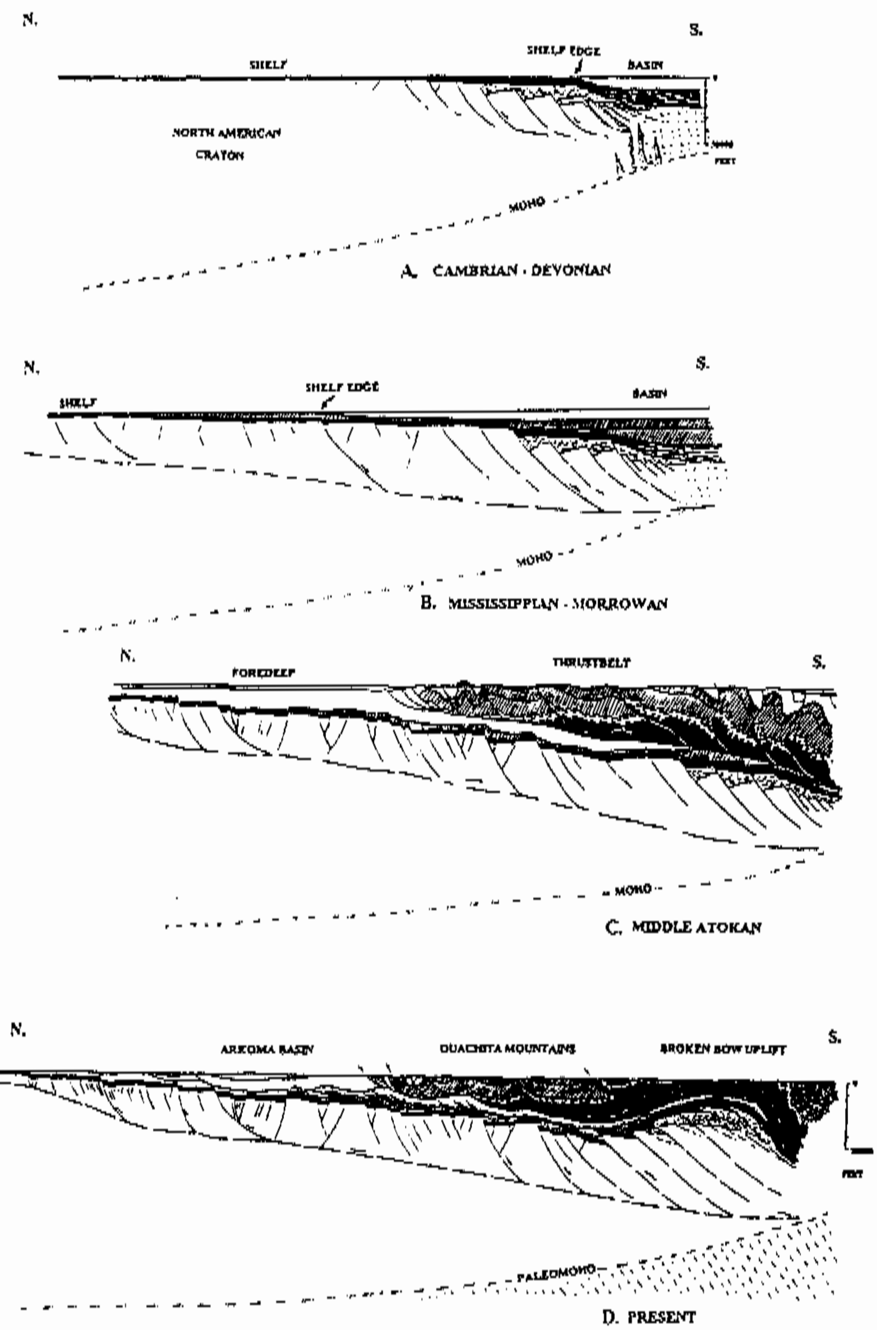
The major steps in the structural evolution of the Western Franks Graben are illustrated on plate 15 and are summarized as follows:

Pre-Pennsylvanian stage of sedimentation yielding to the deposition of Cambrian through Mississipian deposits. These sediments are underlain by massive Precambrian granites. The Franks fault probably formed during the rifting stage as a normal fault.

The Franks fault probably continued its movement sporadically during the sagging stage of the aulacogen (Plate 15).

The Lower Pennsylvanian stage of the Wichita Orogeny triggered the epeirogenic rise of the Hunton anticline. The Strike-slip motion of the Franks Fault probably started, during the Wichita Orogeny. Morrowan and Lower Atokan sediments were deposited probably over the region and subsequently got eroded from the Lawrence Uplift and the Hunton Anticline, but were preserved in the Franks basin to the north (Plate 15).

During the Atoka time, the Stonewall Fault and the Atoka 'Growth' Fault formed in response to extension, and the strike-slip motion along the Franks fault zone continued (Plate 15).



A: Cambrian-Devonian stable margin
B: Mississipian -Morrowan extensional block faulting of the shelf
C: Middle Atokan thrusting
Late Pennsylvanian -Early Permian basement duplex formation.

Figure 26: Paleozoic Tectono-Stratigraphic Evolution of the Southern Edge of the North American Craton (Roberts, 1994).

The formation of the Stonewall Fault led to the formation of the Lawrence Uplift whereas the AGF was growing as the Atoka Formation was being deposited. The Stonewall Fault and the AGF can be related to the lower Atokan normal faults that effected the Spiro sandstone in the Arkoma Basin.

During the early Desmoinesian time, the strike-slip motion continued to form the uplifting of the Hunton Anticline, yet there is no evidence for normal faulting along the Stonewall Fault and the AGF. The Boggy equivalent of the Franks Conglomerate shed from the Hunton Anticline. The conglomerate was derived from the Arbuckle, Viola, and Hunton groups, and settled in the Franks Basin overlapping the older formations with a well developed unconformity. Morgan (1924) mentioned that the Stonewall Fault is covered to the east by the Boggy Formation. He concluded that the Stonewall Fault was formed prior to the deposition of the Boggy Formation, near to the end of the Savanna time. In the Arkoma Basin, Sutherland (1988) observed that the Boggy is more complexly and sharply folded and faulted than the Stuart Formation.

During the middle to late Desmoinesian to early Missourian time, the study area underwent a strong folding and faulting due to the Arbuckle Orogeny. The movement along the Stonewall triggered the erosion of all the formations down to the Sylvan and Viola Groups. The strike-slip motion along the Franks Fault Zone possibly continued.

CHAPTER VI

PETROLEUM GEOLOGY

The Franks Basin is a hydrocarbon producing basin. The western part of the Fitts pool and the west Fitts pool are the producing pools in the area of study (Figure 27). Hydrocarbons are produced from the formations ranging from the shallow McAlester Sandstone of Pennsylvanian age to the Oil Creek Sandstone of the Ordovician age.

Fitts Pool

Prior to 1917, John Fitts, for whom the Fitts pool was named, led the search for oil in the Franks Basin. In 1929, the first well drilled by McCraw and Whitney in Sec. 35; T1N R8E completed, and tested some oil in the Wapanucka limestone at 1,860 feet. The Fitts pool is the outstanding pool in the entire basin with respect to structure and production.

Structurally, The Fitts pool is a faulted anticline called Fitts structure striking northeast. In the study area, it occupies sections 24, 25, 35, and 36 of T2N R6E. On cross-section FF' (Figure 28), the structure appears to be a forced anticline because of the

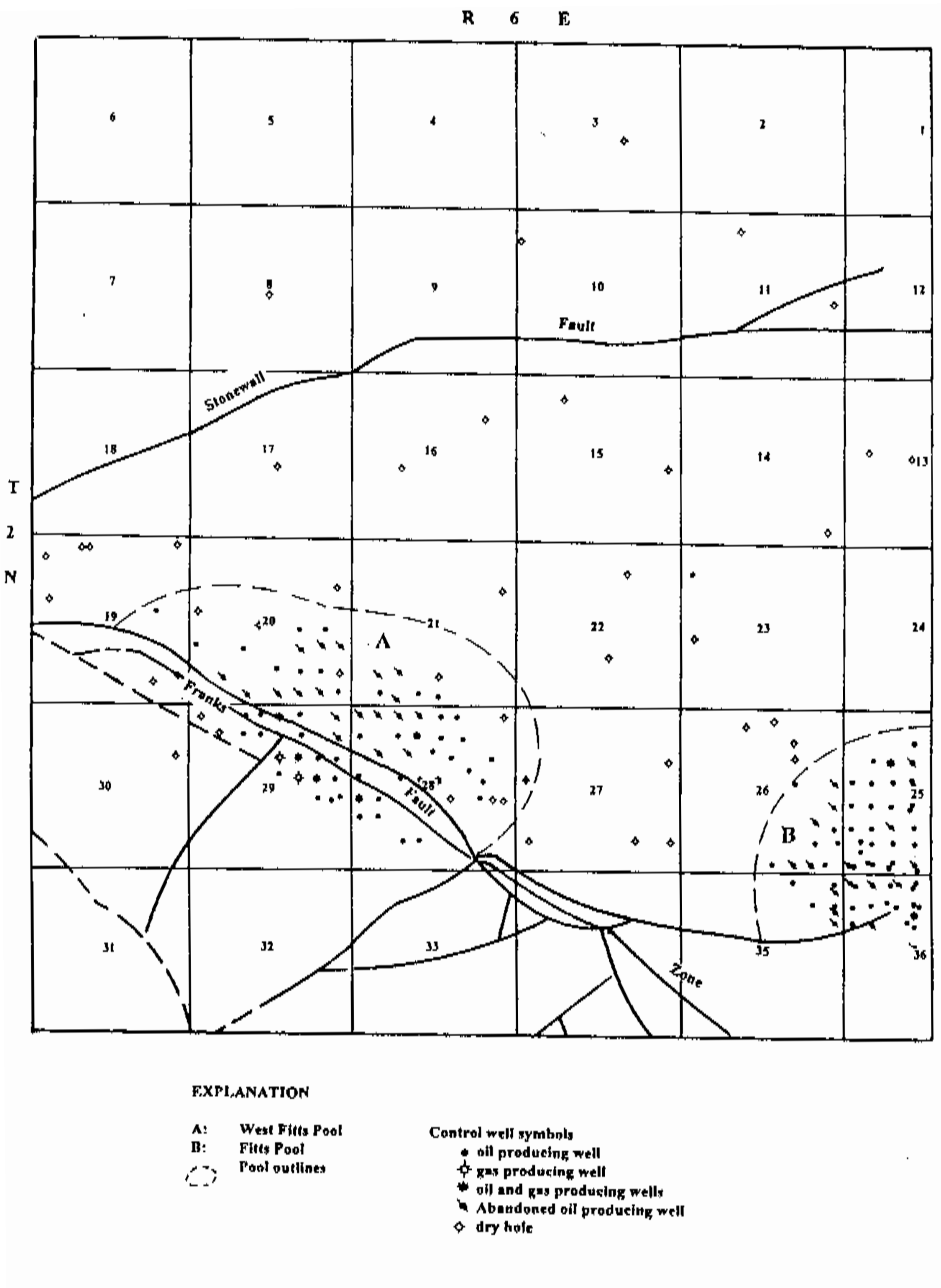


Figure 27: Pool Map of the Western Franks Basin

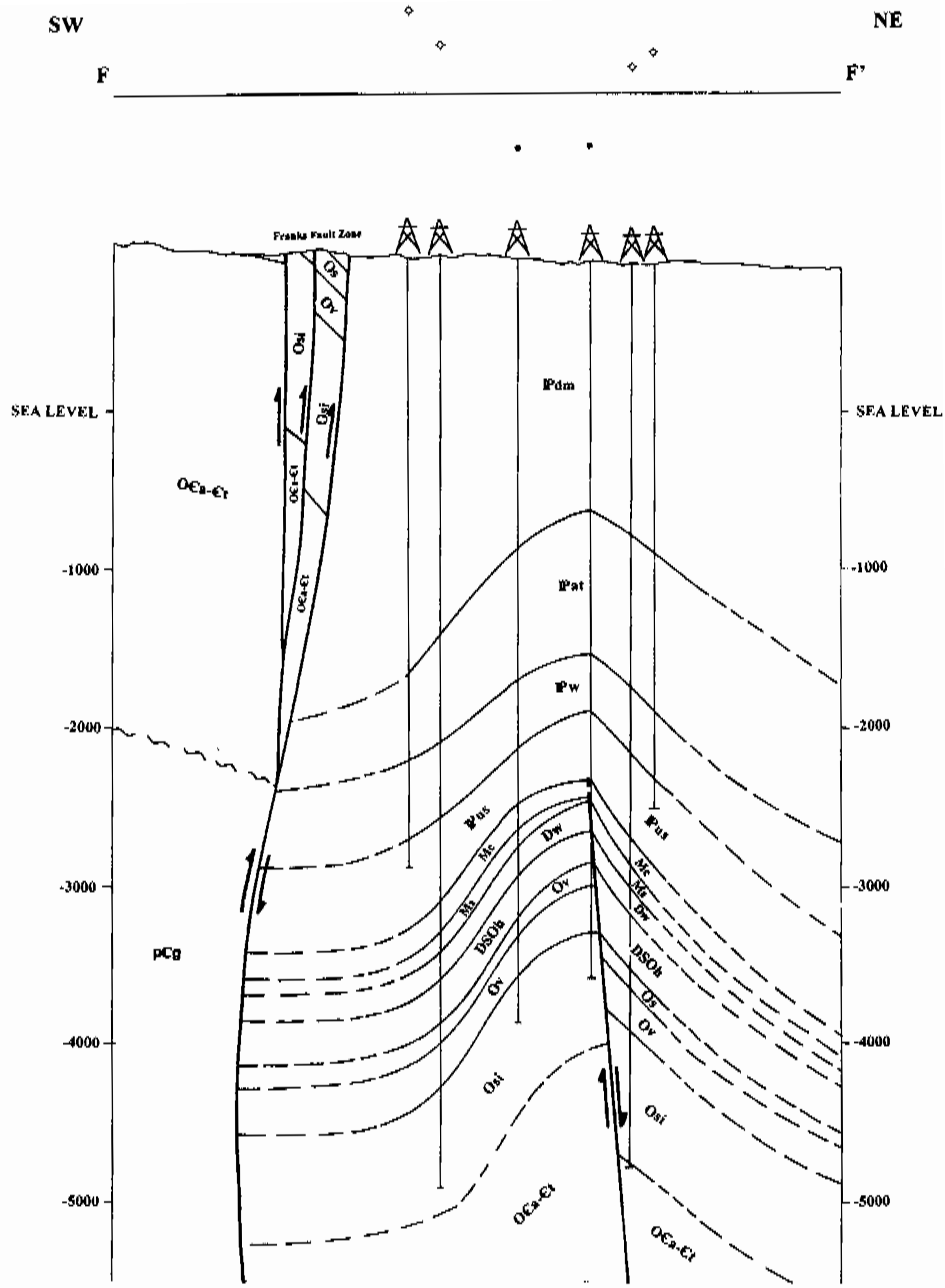


Figure 28: Structural Cross-Section Showing the Forced Anticline of the Fitts Structure.

existence of a normal fault in its core. On the Structural contour map drawn on top of Wapanucka Formation (plate 11), the fault strikes southwest-northeast.

The first commercial well in the Franks Basin was W. A Delaney's Harden no. 1, in the NE SW 1/4 Sec. 30, T2N, R7E. the well was completed in February 1933 in the Gilcrease Sandstone of the Atoka Formation for 30 million cubic feet of gas per day and produced from 1,165 to 1,185 foot interval. This well did not arouse much interest and the presence of gas was attributed to a sand lens condition. In July 1933, the production of 75 barrels of oil per day from the lower Hunton (Chimneyhill) limestone made the Fitts pool a major Oklahoma oil field.

Production in Ordovician rocks was discovered by W. A. Delaney's Craddock No. 2, in NE NE NE of Sec. 25 T2N R6E, in June 1934, which flowed 300 barrels of oil per day from the Bromide. A structure of some magnitude and a large oil reserve were definitely proved with wells producing from the Fernvale-Viola Limestone, the Bromide Formation, and five sandstone zones in the McLish Formation.

During the development that followed, oil was found in formations ranging from the shallow McAlester sandstone of Pennsylvanian age to the Oil Creek sandstone of Ordovician age. Included are the following formations: McAlester, Atoka (Gilcrease zone), Union-Valley (Cromwell), Hunton (Bois d'Arc and Chimneyhill), Fernvale-Viola, Bromide McLish, and Oil Creek. Of these, the basal McLish sandstone ("Wilcox")has been the most productive horizon.

West Fitts Pool

The West Fitts pool was discovered in 1937. It is located in Sections. 20, 21, 28, and 29, T2N R6E, and represents the largest pool in the study area. Production is entirely from the Cromwell sandstone. The structural contour map on the top of Union-Valley Formation (Figure 21) shows the Franks Fault Zone as the controlling factor in trapping the oil. The structure of the West Fitts pool is revealed on the cross-sections AA', BB', DD' and EE' (Plates 3, 4, 6, and 7) as an anticlinal structure whose axis underneath the Franks Fault zone parallels it. The contour maps (Plates 12, 13, and 14) show that the pool is bounded by the FFZ to the south, the WFF.1 to the west, the WFF.3 to the east, and the AGF to the north.

Future Hydrocarbon Potential

The pool map of the study area (Figure 27) shows that there is no structure in the area that has not been subjected to drilling. Among the few scattered wells to the north of the Atoka 'Growth' Fault, only one produces probably from a lenticular sands. This gives little hope for large discoveries from stratigraphic traps. However, because of the overlap relationships exhibited by the Desmoinesian rocks, it is conceivable that lenticular sands yet undeveloped lie on the flanks of the structures. There is also a very slight possibility that wells drilled to the south of FF 1 in Sections 36 and 35 might encounter hydrocarbons trapped against the fault. In general, the wells drilled in the study area are very shallow; most of them reach only the Union-Valley Formation. Therefore, there might be a possibility of discovery in the deeper formations.

CHAPTER VII

SUMMARY

In the study area, the age of the rock units either exposed on the surface or penetrated in the subsurface ranges from Proterozoic to Late Pennsylvanian (Missourian). Overlying the Precambrian basement are the Arbuckle, Simpson, Viola, Sylvan, Hunton, Lower and Upper Dornick Hills, Krebs, Cabaniss, Marmaton, and Skiatook Groups.

The study area contains several faults, they are from south to north the strike-slip fault zone represented by the Franks Fault zone, the West Fitts Faults, the Atoka Growth Fault, and the Stonewall Fault. The folds present in the study area formed in close structural association with the faults.

The Franks fault zone was formed during the rifting stage of the Southern Oklahoma Aulacogen. The strike-slip motion along the fault started as early as the early Atokan time during the Wichita Orogeny.

The Stonewall Fault and the Atoka growth fault were probably formed during the middle Atokan time together with the other extensional faults of the Arkoma Basin.

The presence of the older Paleozoic on the top of younger Paleozoic rocks in the FFZ determine the reverse separation nature of the Franks faults dipping at a high angle toward the south. This reverse separation is caused by the strike-slip movement along the fault.

The faults of the Franks fault zone converge at depth to form a subvertical fault giving to the FFZ a characteristic of a strike-slip fault zone.

The reverse separation along the Franks fault zone is about 4,700 feet and the normal separation along the Stonewall Fault is about 5,000 feet. The normal separation along the Atoka 'growth' fault is about 1,500 feet to the west and 500 feet to the east

The Atoka Formation is absent in the western corner of the study area in section 19, justifying the presence of the WFF1 and the uplift of the western part of the Western Franks Basin. The western part of the study area was probably uplifted near the end of the Desmoinesian time.

The fragments of the Arbuckle, Viola, and Hunton Groups are present in the Franks Conglomerate (Boggy Formation), attesting the exposure of these rocks on the Hunton Anticline during the Desmoinesian time.

The diagenetic history of a Franks conglomerate unit revealed that the unit has not been subjected to a deep burial. The presence of sandy and silty matrices with micritic matrix and calcite cement suggests a transitional depositional environment under marine and continental influences.

The West Fitts pool and the western end of the Fitts pool are the producing pools in the area. The production comes from the Cromwell Sandstone in the West Fitts pool, and from the McAlester Formation down to the Oil Creek Formation in the West Fitts pool.

The West Fitts Structure is an anticline lying underneath the Franks fault zone. Only the north flank of the anticline is well developed. The Fitts Structure is a forced anticline. Deeper formations in the West Fitts pool are the future targets in the WFG.

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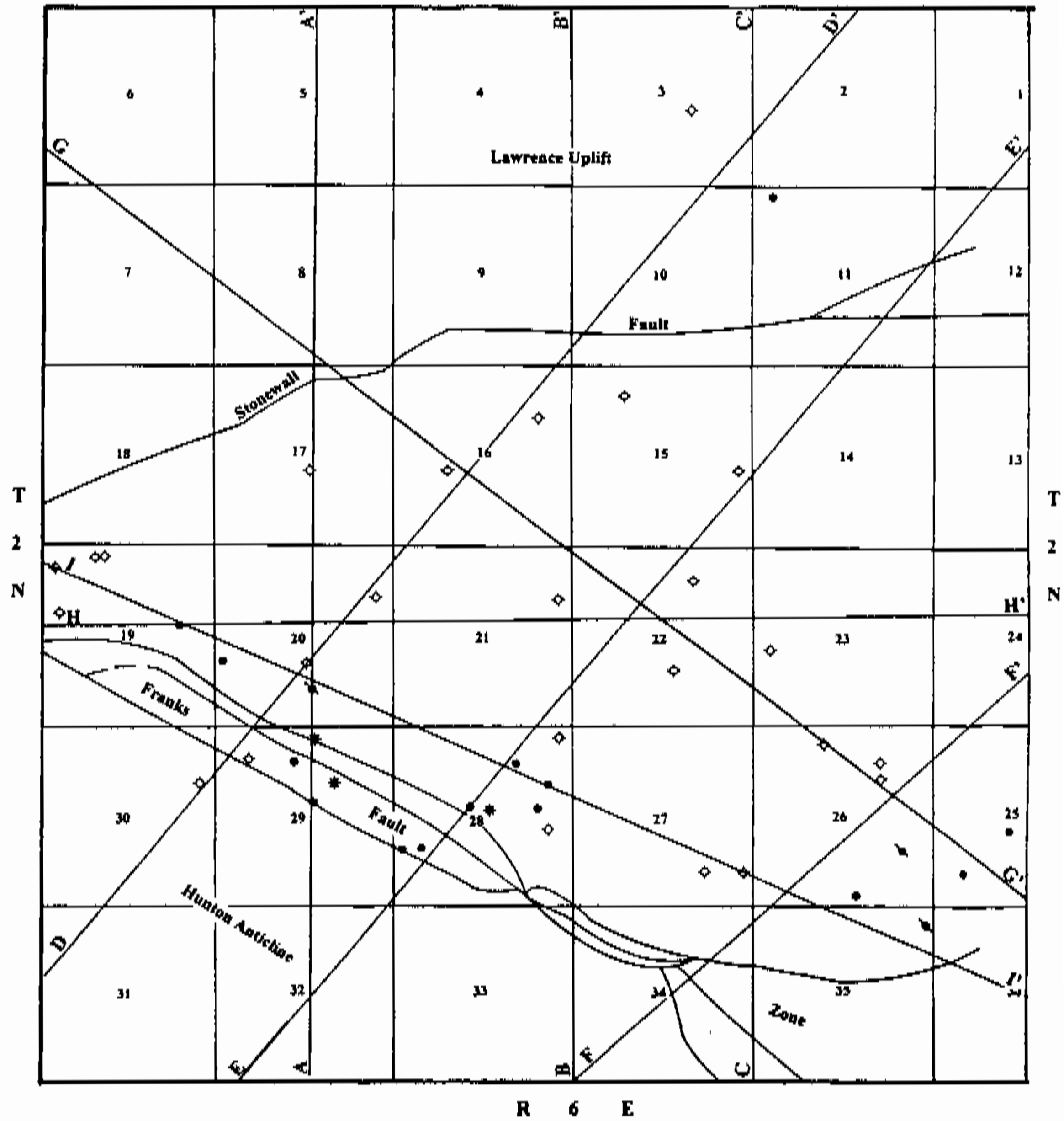
APPENDIX 1

BASE MAP OF THE STUDY AREA, SHOWING THE LINES OF CROSS-SECTIONS AND THE WELLS PROJECTED



APPENDIX 2 : LIST OF WELL LOG DATE T2N R6E

S.NO.	OPERATOR	WELL	LOCATION	SECTION	FIELD	TOTAL DEPTH (ft)	TOP DESMOIN-ESIAN (ft)	TOP ATOKA (ft)	TOP WAPANUCKA (ft)	TOP UNION VALLEY (ft)
1	Mobil Oil Corporation	East Fitts Unit (WSW) No 1	NW-NE-NW-SE	3	-	-1704	-	-	-	-
2	Mobil Oil Corporation	East Fitts Unit (WSW) No 2	NE-NW-NW-NW	11	East Fitts	-2054	-	-	-	-
3	H.L. Wirick	Stinchcomb # 1	SE-SW-NW	13	-	-2012	-	-1365	-	-
4	H.L. Wirick	Crawford # 1	NE-NE-SE	15	-	-2733	-	-1414	-	-
5	Pontotoc Operation inc.	Lasalle # 1	SW-NE-NW	15	-	-1957	695	-1365	-	-
6	H.L. Wirick Jr.	Artie Smith # 1	NW-SE-NE	16	W/C	-2234	689	-1178	-	-
7	Harry L. Wirick	Feddersen # 1	NW-NE-SW	16	Wildcat	-1851	627	-1313	-	-
8	W.L. Wirick	Mayhue # 1	NW-NW-SE	17	-	-2022	623	-1223	-	-
9	Anderson-Prichand Oil	B.D. Denton # 1	C-NW-NW	19	Wildcat	-2681	875	-	655	-625
10	Philip Boyle, Inc.	Schafer # 2	NW-NE-NW	19	Wildcat	-1124	769	-	-31	-736
11	Philip Boyle, Inc.	Schafer # 1	SW-NW	19	Wildcat	-1581	998	-	718	608
12	H.L. Wirick, Jr.	Schafer Ranch # 1	SW-SE-NE	19	W. Fitts	-1350	860	-129	-669	-987
13	Stanol Ind.Oil & Gas	G.C. Mayhue # 1	NW-NE-NW	19	Wildcat	-1244	119	-	19	-771
14	Vern Jones Oil & Gas	McDaniel # 1-19	NW-SE-SE	19	W. Fitts	-2756	420	-	-	-
15	Simpson-Roodhouse	Montpelier # 1	SW-SW-NW	20	W. Fitts	-3283	764	-566	-1386	-1806
16	K.M.Hamilton Oil & Gas	Leslie - Lynn - Winn # 2	SW-NW-SW	20	W. Fitts	-1831	988	-43	-723	-1063
17	R.W.Simpson Jr.	Trust # 1 - 20	SW-SE-SW	20	W. Fitts	-3539	921	116	-389	-809

S.NO.	OPERATOR	WELL	LOCATION	SECTION	FIELD	TOTAL DEPTH (ft)	TOP DESMOIN-ESIAN (ft)	TOP ATOKA (ft)	TOP WAPANUCKA (ft)	TOP UNION VALLEY (ft)
18	Van Grisso Oil Company	Denton # 1	NE-SE-NE	20	W. Fitts	-2986	800	-1975	-	-
19	R.W. Simpson	Trust # 4 - 20	SW-NW-SE	20	NW Fitts	-1698	767	-483	-1208	-1523
20	Mack M. Braly	Mayhue # A - 3	SE-SE-SE	20	W.Fitts	-1914	928	-692	-1382	-1722
21	R.W. Simpson Jr.	Montpelier # 3	NW-SW-SE	20	W.Fitts	-1530	810	-230	-855	-1330
22	Company Clark & Cowden	Montpelier # 2	SE-SW-SE	20	W.Fitts	-1647	824	-347	-1067	-1417
23	K.M.Hamilton Oil & Gas	Hamilton # 1 - A	NE-SE-NE	21	NW Fitts	-2463	-	-1623	-	-
24	Boyle Oil Company	Meharg # 1	SW-SW-SE	21	W.Fitts	-2400	523	-1177	-1697	-2197
25	H.L Wirick, Jr.	Parks # 1	SW-NW-NE	22	-	-1927	-	-1574	-	-
26	H.L. Wirick, Jr.	Gill # 1	SW-NW-SE	22	Wildcat	-1414	-	-1109	-	-
27	W.A. Delaney, Jr.	Marcum # 1	NW-NW-SW	23	Wildcat	-2993	-	-1775	-2385	-2815
28	Sun Oil Company	Fitts West Unit # 29-20	NE-SW-SW	25	Fitts	-3668	-	-561	-1405	-1731
29	Texfel Petroleum Corp.	Fitts West Unit # 12-13	NE-NE-SW	25	Fittstown	-3554	-	-	-	-
30	D.D. Feldman Oil & GAs	Norris Estate # 1	NE-SW-NE	26	Wildcat	-4818	-	-801	-1741	-2189
31	Philip Boyle Inc.	Ebey # 1	SE-NW-NE	26	Fitts	-2488	-	-875	-1998	-2293
32	Amerada Petroleum Corp.	Norris Heirs # 2	SW-NE-SE	26	Fitts Pool	-3570	-	-620	-1550	-1890
33	Texakoma Oil & GAs	Cherokee # 1	SW-SW-SE	26	Fittstown	-3869	-	-857	-1687	-2113
34	Philip Boyle INc.	Ada Norris Berry # 1	NE-NE-NW	26	Wildcat	-2700	-	-1377	-2052	-2490
35	Van Grisso Oil	Norris Estate # 1	NE-SE-SE	27	Wildcat	-4907	-	-1382	-2098	-2592
36	Ascot Oil Incorp.	McElroy # 1	NE-SW-SE	27	Fittstown	-2938	-	-1676	-2186	-2676
37	Zebra Production	Cya Fred # 1	NE-NE-NE	28	W.Fitts	-2535	1052	-1296	-1918	-2338
38	C.W.Roodhouse	Fee # 1	SW-NW-NE	28	W.Fitts	-2188	922	-808	-1578	-1968
39	Fleet Oil Corp.	Life # 1	C-N1/2of SE-NW	28	W.Fitts	-1799	977	-623	-1323	-1623
40	C.W. Roodhouse	Hunter # 3	SW-SE-NE	28	W.Fitts	-2431	-	-1003	-1763	-2133

S.NO.	OPERATOR	WELL	LOCATION	SECTION	FIELD	TOTAL DEPTH (ft)	TOP DESMOIN-ESIAN (ft)	TOP ATOKA (ft)	TOP WAPANUCKA (ft)	TOP UNION VALLEY (ft)
41	Pontotoc Production	# 15-7 W.Fitts Sand Unit	SW-SW-NE	28	W.Fitts	-2094	867	-793	-1440	-1853
42	C.W. Roodhouse	Hunter # 2	C-N 1-2 NW-SE	28	W.Fitts	-2222	-	-816	-1476	-2976
43	MacMillan Petroleum	Close # 1	NW-NE-SE	28	Wildcat	-2428	-	-1141	-1346	-2166
44	C.W. Roodhouse	Close # 1	C-N1/2-NE-SE	28	Wildcat	-2319	-	-1195	-1895	-2205
45	J.T.R. Energy Inc.	Cashflow # 16	NE-SE-SW	28	W.Fitts	-1716	-	-	-165	-1675
46	Robco Oil Inc.	Cashflow # 21	SE-NW-SW	28	W.Fitts	-1702	-	-	-362	-1442
47	Robco Oil Inc.	Cashflow # 12	SW-NW-SW	28	W.Fitts	-1533	-	-	-613	-810
48	Robco Oil Inc.	Cashflow # 9	NW-NW-SW	28	W.Fitts	-1721	-	-	435	-1415
49	Pontotoc Production Co.	W.Fitts sand unit # 15-3	SE-SE-NW	28	W.Fitts	-1966	968	-637	-1317	-1717
50	Pontotoc Production Co.	W.F.S.U. # 12-7	NW-NW-NE	29	W.Fitts	-1504	986	-204	-874	-1264
51	Pntotoc Production Co.	P.P.C # 1	NE-SE-NE	29	W.Fitts	-1599	536	-	446	-334
52	Pontotoc Production Co.	P.P.C. # 5	SW-SW-NE	29	Fittztown	-1504	-	-	-761	-1256
53	Kaiser-Francis Oil Co.	Hunter # 1 - 28	SE-SE-NE	29	W.Fitts	-1511	907	-164	-874	-1174
54	Robco Oil Inc.	Cashflow # 2	NW-NE-NW	29	W. Fitts	-1213	-	-	-	-812
55	Texaco Inc.	R.W. Simpson Jr. # 1	E/2-NW-NW	29	Wildcat	-3620	-	-	-	-
56	Texaco Inc.	Witherspoon # 1	NE-SE-NE	30	R.Wildcat	-2928	-	-	-	-
57	Skelly Oil Company	Smith # 2	NE-NE-NE	35	Fittspool	-2952	-	-821	-1561	-1946

VITA

Claudine Eloumou

Candidate for the Degree of

Master of Science

Thesis STRUCTURAL EVOLUTION OF THE WESTERN FRANKS BASIN, PONTOTOC COUNTY, OKLAHOMA

Major Field: Geology

Biographical:

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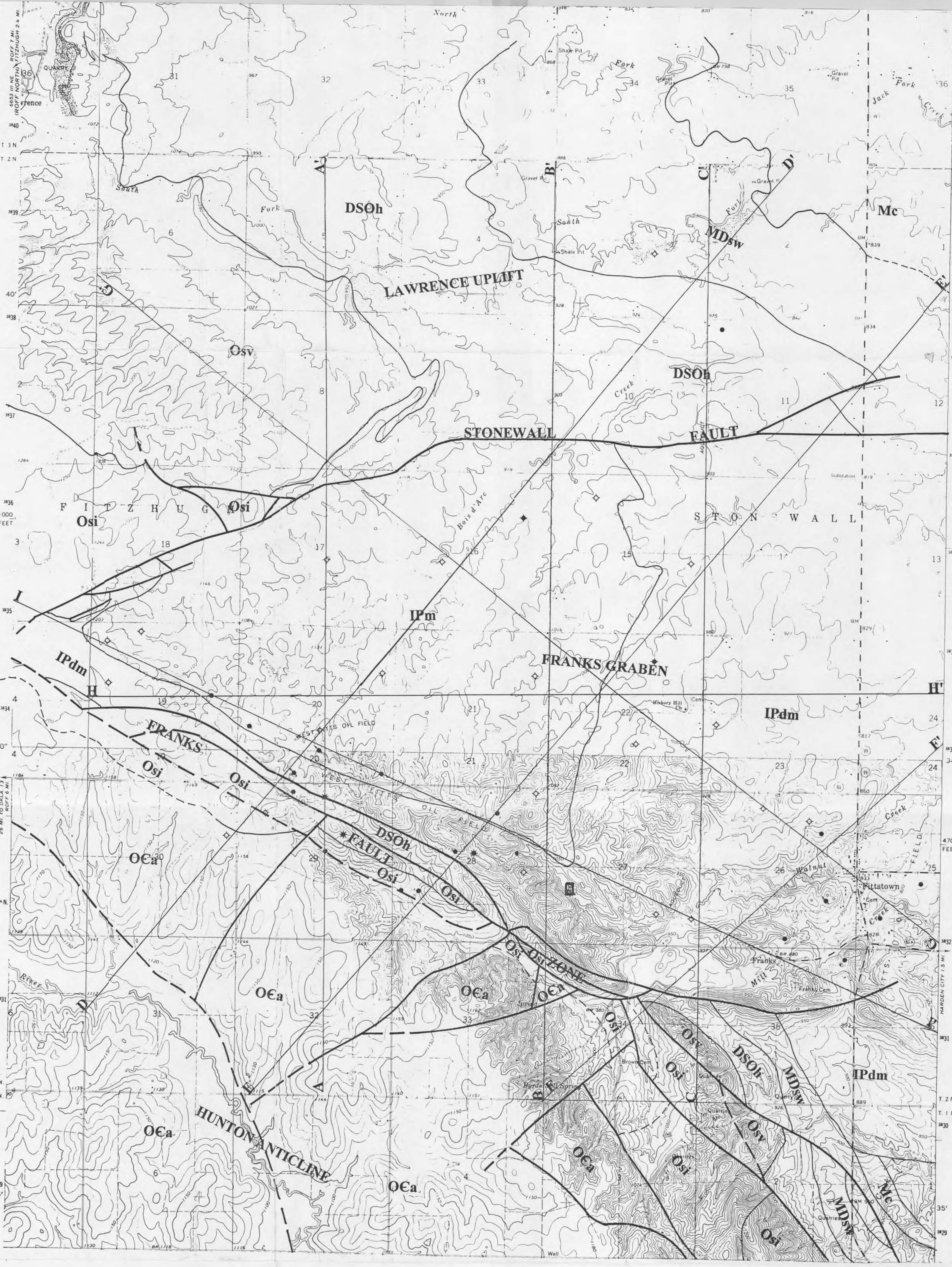
Experience: Raised in Yaounde, the capital of Cameroon; Summer jobs in a bank (SGBS), BP Oil Company, and in a High School (Ndi Samba); employed in University of Yaounde 1 as a teaching assistant; employed in NHC (National Hydrocarbon Corporation) Cameroon.

Professional Membership: AAPG (American Association of Petroleum Geologists).



EXPLANATION

IPm:	Missourian (Pennsylvanian)
IPdm:	Desmoinesian (Pennsylvanian)
Mc:	Caney (Mississipian)
MDsw:	Sycamore (Mississipian)
	Woodford (Devonian)
Osv:	Sylvan-Viola (Ordovician)
DSOh:	Hunton (Devonian-Silurian-Ordovician)
Osi:	Simpson (Ordovician)
O€a:	Arbuckle (Ordovician-Cambrian)

A — A' Lines of cross-sections

Sampling location

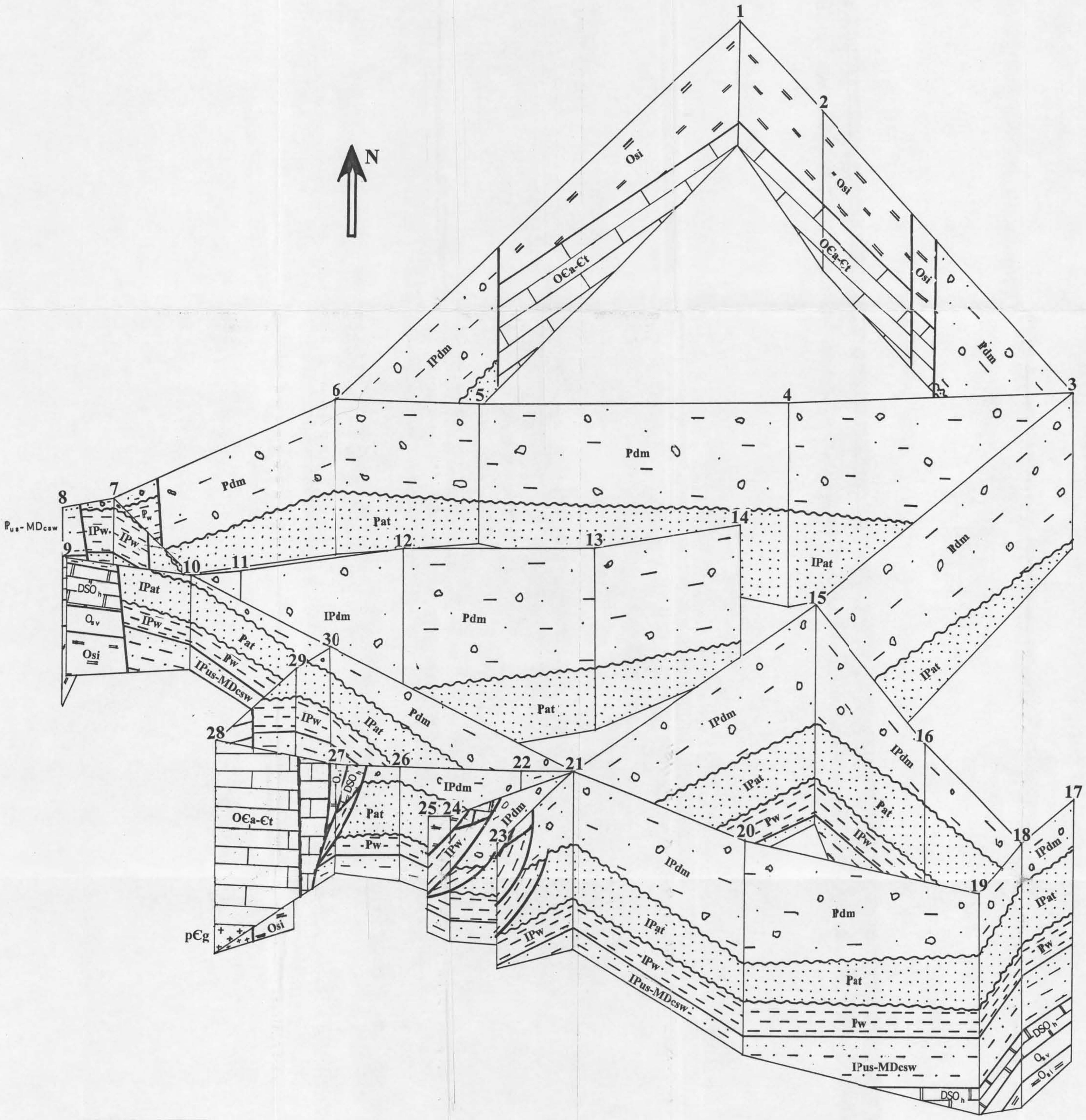
GEOLOGIC MAP
OF THE STUDY AREA
(from Johnson, 1990)

0 — 4000

Scale in feet

Western Franks Graben — Plate 1

Claudine Eloumou — *M.S. 1995*



EXPLANATION

IPdm	:	Desmoinesian (Pennsylvanian)
IPat	:	Atoka (Pennsylvanian)
IPw	:	Wapanucka (Pennsylvanian)
IPus - MDcsw	:	Union Valley - Springer (Pennsylvanian) Caney - Sycamore (Mississipian) Woodford (Mississipian - Devonian)
DSOh	:	Hunton (Devonian - Silurian - Ordovician)
Osv	:	Sylvan - Viola (Ordovician)
Osi	:	Simpson (Ordovician)
O€a - €t	:	Arbuckle (Ordovician - Cambrian) Timbered Hills (Cambrian)
p€g	:	Tishomingo granite (Precambrian)

1. Mobil Oil Corporation
   East Fitts Unit (WSW) No. 1
   NW-NE-NW-SE-3

2. Mobil Oil Corporation
   East Fitts Unit (WSW) No. 1
   NE-NW-NW-NW

3. H. L. Wirick
   Stinchcomb # 1
   SE-SW-NW-13

4. H. L. Wirick
   Crawford # 1
   NE-NE-SE-15

5. Harry L. Wirick
   Feddersen # 1
   NW-NE-SW-16

6. W. L. Wirick
   Mayhue # 1
   NW-NW-SE-17

7. Philip Boyle, Inc.
   Schafer # 2
   NW-NE-NW-19

8. Anderson-Prichard
   B.D. Denton # 1
   C-NW-NW-19

9. Philip Boyle, Inc.
   Schafer # 1
   SW-NW-19

10. H. L. Wirick, Jr.
    Schafer Ranch # 1
    SW-SE-NE-19

11. Simpson-Roodhouse
    Montpelier # 1
    SW-SW-NW-20

12. Van Crisso Oil
    Denton # 1
    NE-SE-NE-20

13. K. M. Hamilton
    Hamilton # 1-A
    NE-SE-NE-21

14. H. L. Wirick, Jr.
    Parks # 1
    SW-NW-NE-22

15. W. A. Delaney, Jr.
    Marcum # 1
    NW-NW-SW-23

16. D. D. Feldman
    Norris Estate # 1
    NE-SW-NE-26

17. Texfel Petroleum
    Fitts West Unit # 12-13
    NE-NE-SW-25

18. Sun Oil C
    Fitts West unit # 29-20
    NE-SW-SW-25

19. Skelly Oil Co.
    Smith # 2
    NE-NE-NE-35

20. Ascot Oil Inc.
    McElroy # 1
    NE-SW-SE-27

21. C. W. Roodhouse
    Huner # 3
    SW-SE-NE-28

22. Pontotoc Production
    W. Fitts Sand # 15-7
    SW-SW-NE-28

23. J. T. R. Energy
    Cashflow # 16
    NE-SE-SW-28

24. Robco Oil Inc.
    Cashflow # 12
    SW-NW-SW-28

25. Robco Oil Inc.
    Cashflow # 21
    SE-NW-SW-28

26. Kaiser-Francis
    Hunter # -38
    SE-SE-NE-29

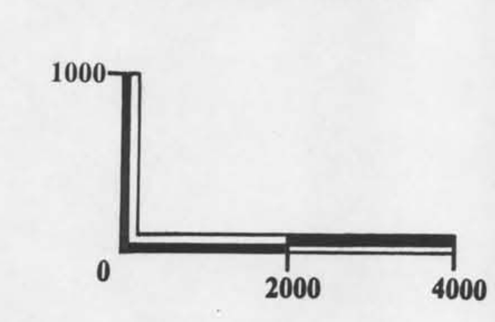
27. Pontotoc Production
    P. P. C. # 5
    SW-SW-NE-29

28. Texaco Inc.
    Witherspoon # 1
    NE-SE-NE-30

29. R. W. Simpson Jr.
    Trust # 1-20
    SW-SE-SW-20

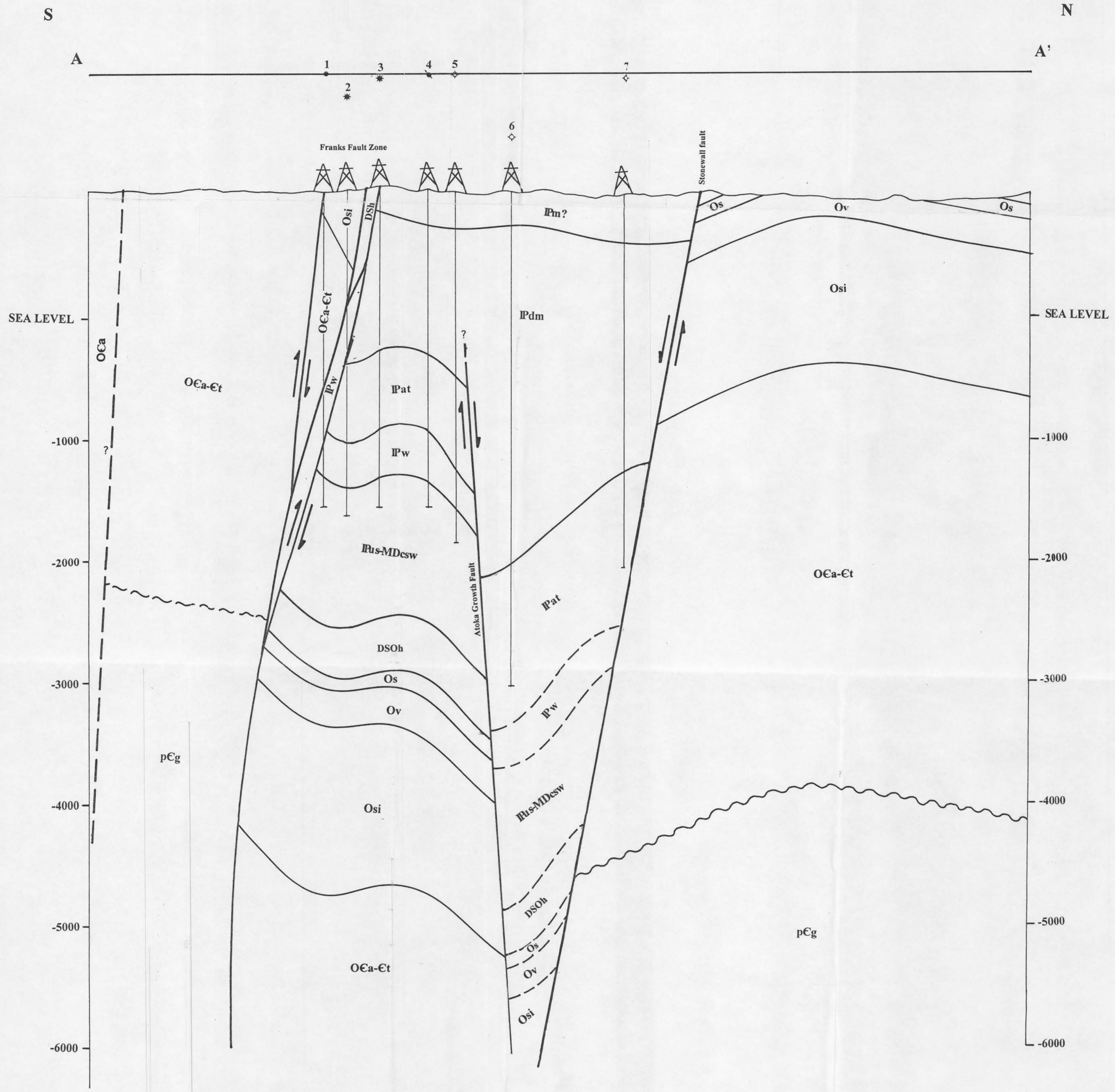
30. R. W. Simpson Jr.
    Montpelier # 2
    NW-SW-SE-20

FENCE DIAGRAM
showing stratigraphic relationships between the rock units



Western Franks Graben — Plate 2

Claudine Eloumou — *M.S. 1995*

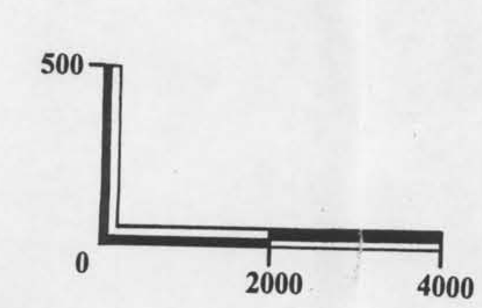


EXPLANATION

Pm	:	Missourian (Pennsylvanian)
Pdm	:	Desmoinesian (Pennsylvanian)
Pat	:	Atoka (Pennsylvanian)
Pw	:	Wapanucka (Pennsylvanian)
Pus - MDcsw	:	Union Valley-Springer (Pennsylvanian)
		Caney-Sycamore (Mississipian)
		Woodford (Mississipian - Devonian)
DSO_h	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvan (Ordovician)
Ov	:	Viola (Ordovician)
Os_i	:	Simpson (Ordovician)
O€a-€t	:	Arbuckle (Ordovician - Cambrian)
		Timbered Hills (Cambrian)
p€g	:	Tishomingo granite (Precambrian)

1. Pontotoc Production Co.
   P.P.C. # 5
   SW-SE-NE, Sec. 29
2. Pontotoc Production Co.
   P.P.C. # 1
   NE-SE-NE, Sec. 29
   (750 ft)
3. Pontotoc Producton Co.
   W.F.S.U. # 12-7
   NW-NW-NE, Sec. 29
   (125 ft)
4. R.W.Simpson Jr.
   Montpelier # 3
   NW-SW-SE, Sec. 20
5. R.W.Simpson
   Trust # 4 - 20
   SW-NW-SE, Sec. 20
6. Van Crisso Oil Co.
   Denton # 1
   NE-SE-NE, Sec. 20
   (2000 ft)
7. Philip Boyle, Inc.
   Schafer # 1
   SW-NW, Sec. 19

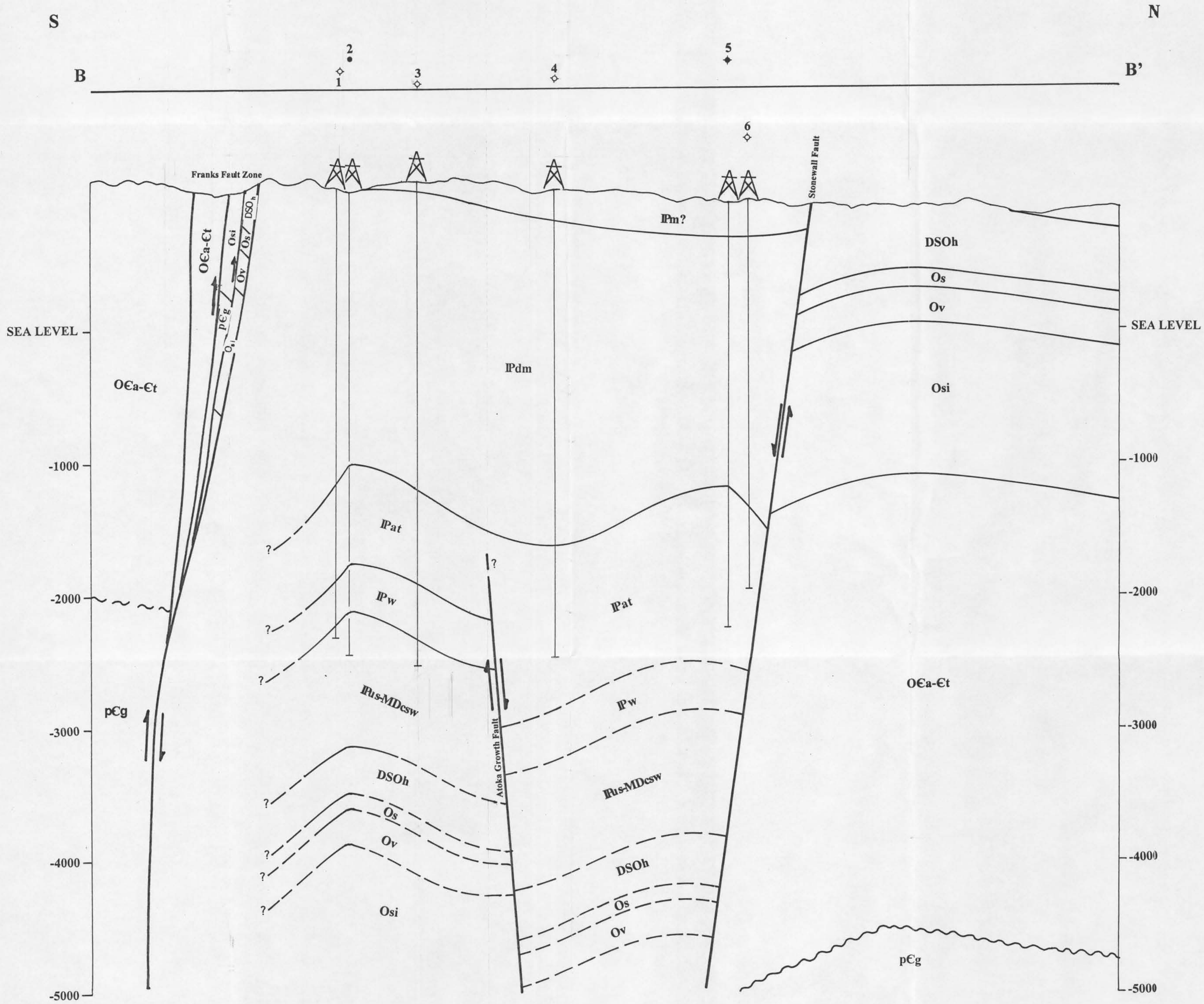
SOUTH - NORTH
Structural Cross-Section
A - A'



Scale in feet

Western Franks Graben — Plate 3

Claudine Eloumou — M.S. 1995



EXPLANATION

Pm	:	Missourian (Pennsylvanian)
Pdm	:	Desmoinesian (Pennsylvanian)
Pat	:	Atoka (Pennsylvanian)
Pw	:	Wapanucka (Pennsylvanian)
Pus - MDcsw	:	Union Valley-Springer (Pennsylvanian)
		Caney-Sycamore (Mississipian)
		Woodford (Mississipian - Devonian)
DSO_h	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvan (Ordovician)
Ov	:	Viola (Ordovician)
Os_i	:	Simpson (Ordovician)
O€a - €t	:	Arbuckle (Ordovician - Cambrian)
		Timbered Hills (Cambrian)
p€g	:	Tishomingo granite (Precambrian)

1. C.W.Roodhouse
Close # 1
C-N1/2-NE-SE, Sec. 28
(375 ft)

2. C.W.Roodhouse
Fee # 1
SW-SE-NE, Sec. 28
(625 Ft)

3. Zebra Production
Cya Fred # 1
NE-NE-NE, Sec. 28
(125 ft)

4. K.M.Hamilton Oil & Gas
Hamilton # 1 - A
NE-SE-NE, Sec. 21
(250 ft)

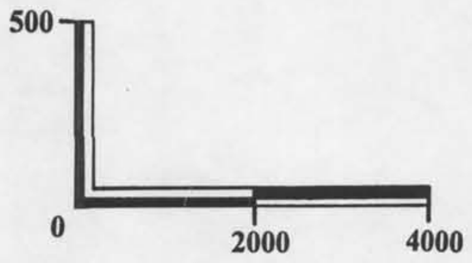
5. H.L. Wirick Jr.
Artie Smith # 1
NW-NE-SW, Sec. 16
(500 ft)

6. Pontotoc Operation Inc.
Lasalle # 1,
SE-NE-NW, Sec. 15
(1000 ft)

SOUTH - NORTH

Structural Cross-Section

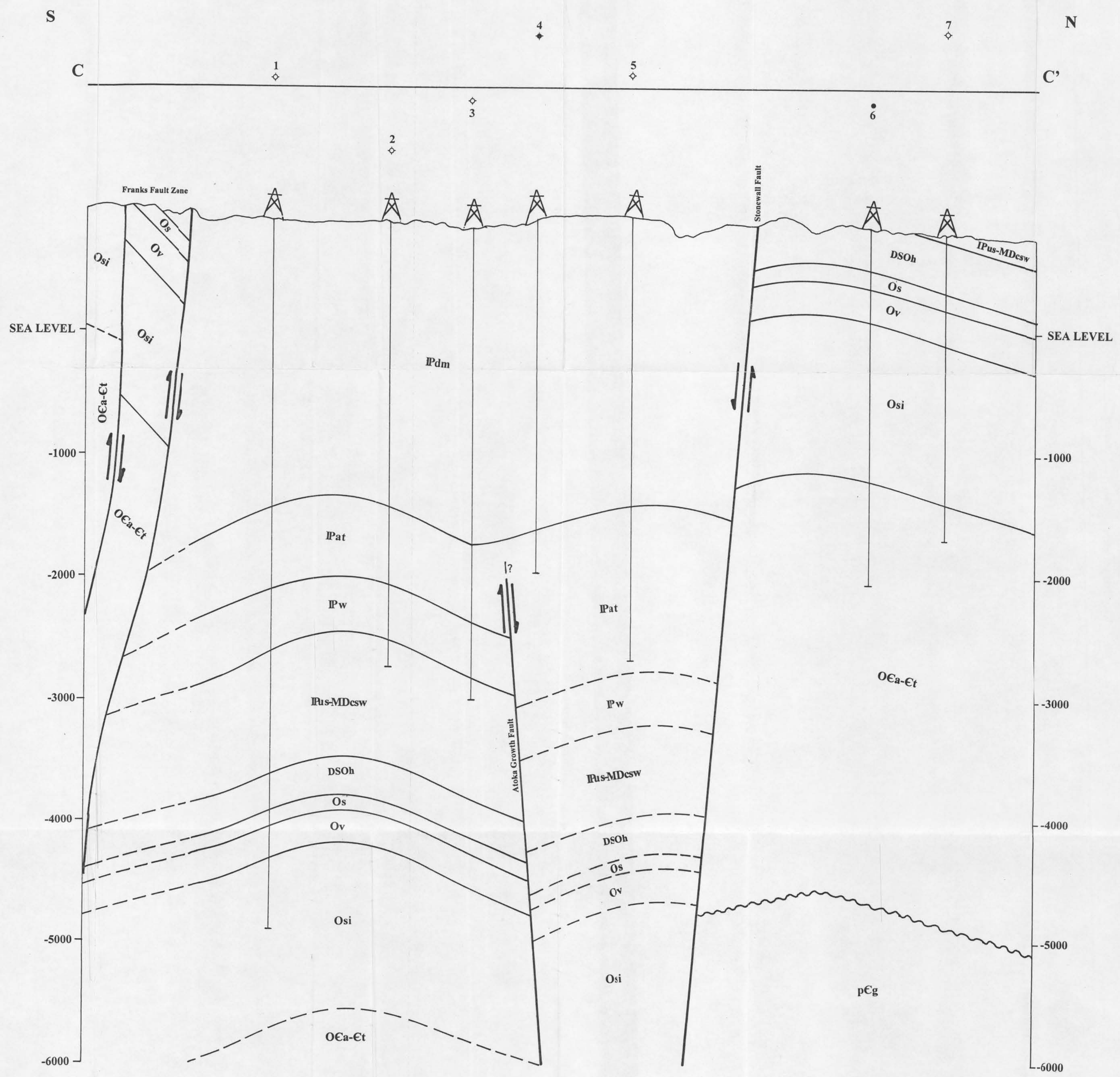
B - B'



Scale in feet

Western Franks Graben — Plate 4

Claudine Eloumou — M.S. 1995



EXPLANATION

Pdm : Desmoinesian (Pennsylvanian)
Pat : Atoka (Pennsylvanian)
Pw : Wapanucka (Pennsylvanian)
Pus - MDcsw: Union Valley-Springer (Pennsylvanian)
Caney-Sycamore (Mississipian)
Woodford (Mississipian - Devonian)
DSO_h : Hunton (Devonian - Silurian - Ordovician)
Os : Sylvan (Ordovician)
Ov : Viola (Ordovician)
Os_i : Simpson (Ordovician)
O€a - €t : Arbuckle (Ordovician) Timbered Hills (Cambrian)
P€g : Tishomingo granite(Cambrian - Precambrian)

1. Van Grisso Oil
Norris Estate # 1
NE-SE-SE, Sec. 27
(250 ft)

2. Philip Boyle Inc.
Ada Norris Berry # 1
NE-NE-NW, Sec. 26
(2000 ft)

3. W.A.Delaney, Jr.
Marcum # 1
NW-NW-SW,Sec. 23
(375 ft)

4. H.L. Wirick, Jr.
Parks # 1
SW-NW-NE, Sec. 22
(1625 ft)

5. H.L. Wirick
Crawfprd # 1
NE-NE-SE, Sec. 15
(375 ft)

6. Mobil Oil Corporation
East Fitts Unit (WSW) # 2
NE-NW-NW-NW, Sec. 11
(435 ft)

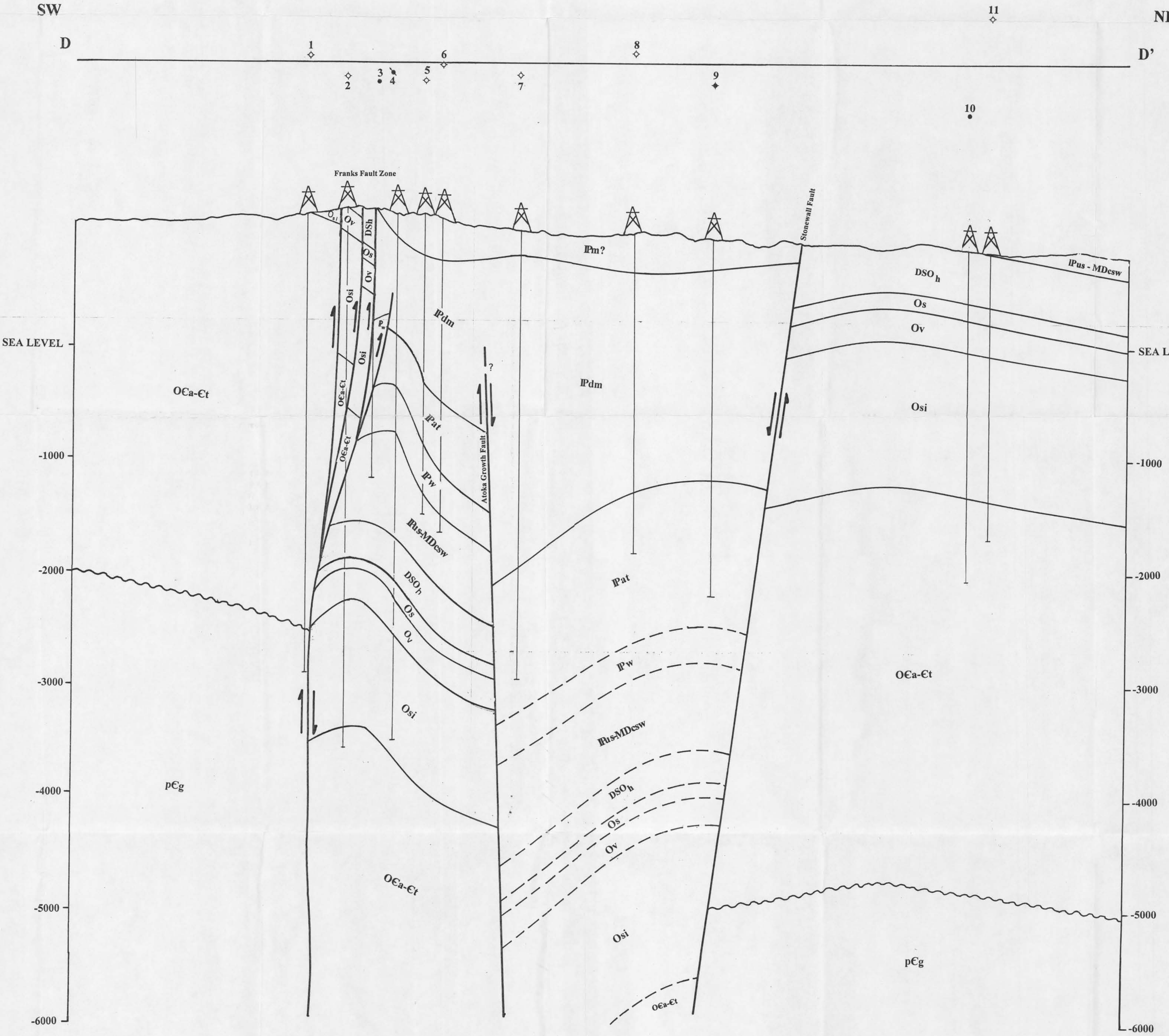
7. Mobil Oil Corporation
East Fitts Unit (WSW) No. 1
NW-NE-NW-SE, Sec. 3
(1815 ft)

SOUTH - NORTH
Structural Cross-Section
C - C'

500
0
2000
4000
Scale in feet

Western Franks Graben — Plate 5

Claudine Eloumou — M.S. 1995



EXPLANATION

IPm	:	Missourian (Pennsylvanian)
IPdm	:	Desmoinesian (Pennsylvanian)
IPat	:	Atoka (Pennsylvanian)
IPw	:	Wapanucka (Pennsylvanian)
IPus - MDcsw	:	Union Valley-Springer (Pennsylvanian) Caney-Sycamore (Mississipian) Woodford (Mississipian - Devonian)
DSO_h	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvan (Ordovician)
Ov_i	:	Viola (Ordovician)
OS	:	Simpson (Ordovician)
OЄa - Єt	:	Arbuckle (Ordovician - Cambrian) Timbered Hills (Cambrian)
pЄg	:	Tishomingo granite (Precambrian)

1. Texaco Inc.
   Witherspoon # 1
   NE-SE-NE, Sec. 30
   (125 ft)

2. Texaco Inc.
   R.W.Simpson Jr. # 1
   E/2-NW-NW, Sec. 29
   (312 ft)

3. Robco Oil Inc.
   Cashflow # 2
   NW-NE-NW, Sec. 29
   (500 ft)

4. R.W. Simpson Jr.
   Trust # 1 - 20
   SW-SE-SW, Sec. 20
   (250 ft)

5. Sun Oil Company
   Fitts West Unit # 29-20
   NE-SW-SW,Sec. 25
   (1500 ft)

6. R.W.Simpson,
   Trust # 4 - 20
   SW-NW-SE, Sec. 20
   (62 ft)

7. Van Crisso Oil Company
   Denton # 1
   NE-SE-NE, Sec. 20
   (250 ft)

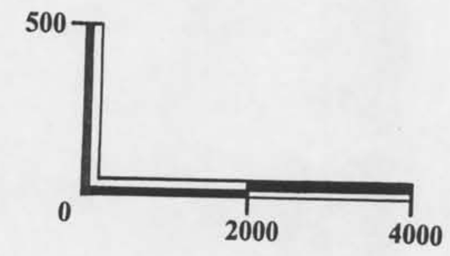
8. Harry L. Wirick
   Feddersen # 1
   NW-NE-SW, Sec. 16
   (250 ft)

9. H.L.Wirick Jr.
   Artie Smith # 1
   NW-SE-NE,Sec. 16
   (500 ft)

10. Mobil Oil Corporation
    East Fitts Unit (WSW) No. 2
    NE-NW-NW-NW,SEc. 11
    (1875 ft)

11. Mobil Oil Corporation
    East Fitts Unit (WSW)No 1
    NW-NE0NW-SE, Sec. 3
    (1750 ft)

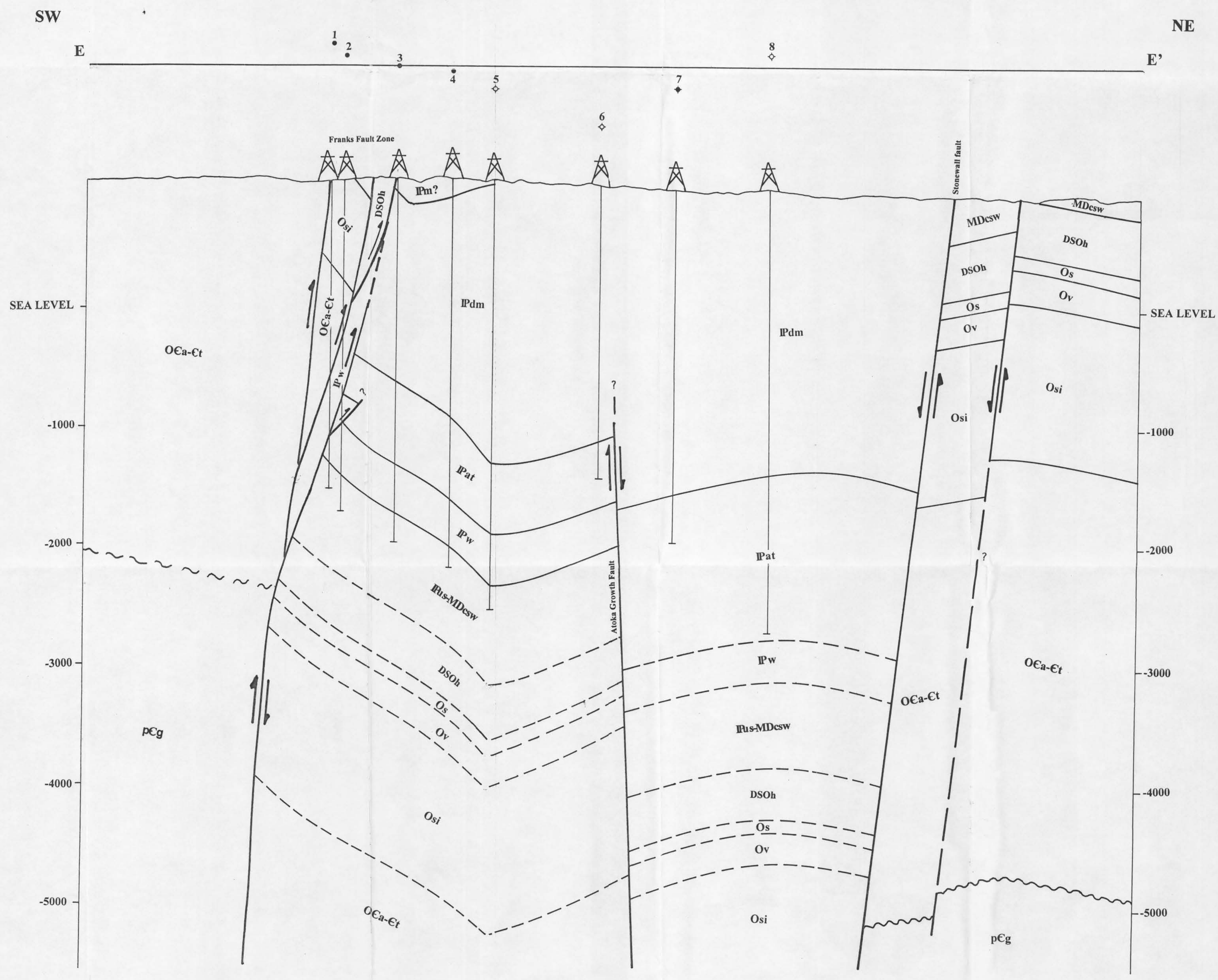
SOUTH WEST - NORTH EAST
Structural Cross-Section
D - D'



Scale in feet

Western Franks Graben — Plate 6

Claudine Eloumou — M.S. 1995



EXPLANATION

Pm	:	Missourian (Pennsylvanian)
Pdm	:	Desmoinesian (Pennsylvanian)
Pat	:	Atoka (Pennsylvanian)
Pw	:	Wapanucka (Pennsylvanian)
Pus - MDcsw	:	Union Valley-Springer (Pennsylvanian)
		Caney-Sycamore (Mississipian)
		Woodford (Mississipian - Devonian)
DSO_h	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvan (Ordovician)
Ov	:	Viola (Ordovician)
Os_i	:	Simpson (Ordovician)
O€a-€t	:	Arbuckle (Ordovician - Cambrian)
		Timbered Hills (Cambrian)
p€g	:	Tishomingo granite (Precambrian)

1. Robco Oil Inc.
Cashflow # 12
SW-NW-SW, Sec. 28
(625 ft)

2. Robco Oil Inc.
Cashflow # 21
SE-NW-SW, Sec. 28
(375 ft)

3. Pontotoc Production Co.
W.Fitts sand Unit # 15-3
SE-SE-NW, Sec. 28

4. C.W.Roodhouse
Fee # 1
SW-NW-NE, Sec. 28
(125 ft)

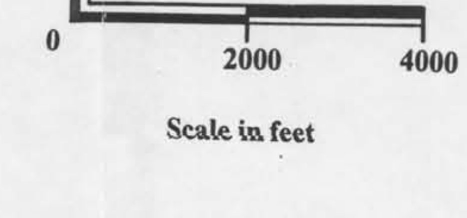
5. Zebra Production
Cya Fred # 1
NE-NE-NE, Sec. 28
(750 ft)

6. H.L.Wirick Jr.
Gill # 1
SW-NW-SE, Sec. 22
(2000 ft)

7. H.L.Wirick, Jr.
Parks # 1
SW-NW-NE, Sec. 22
(625 ft)

8. Pontotoc Operation Inc.
Lasalle # 1
SW-NE-NW, Sec. 15
(375 ft)

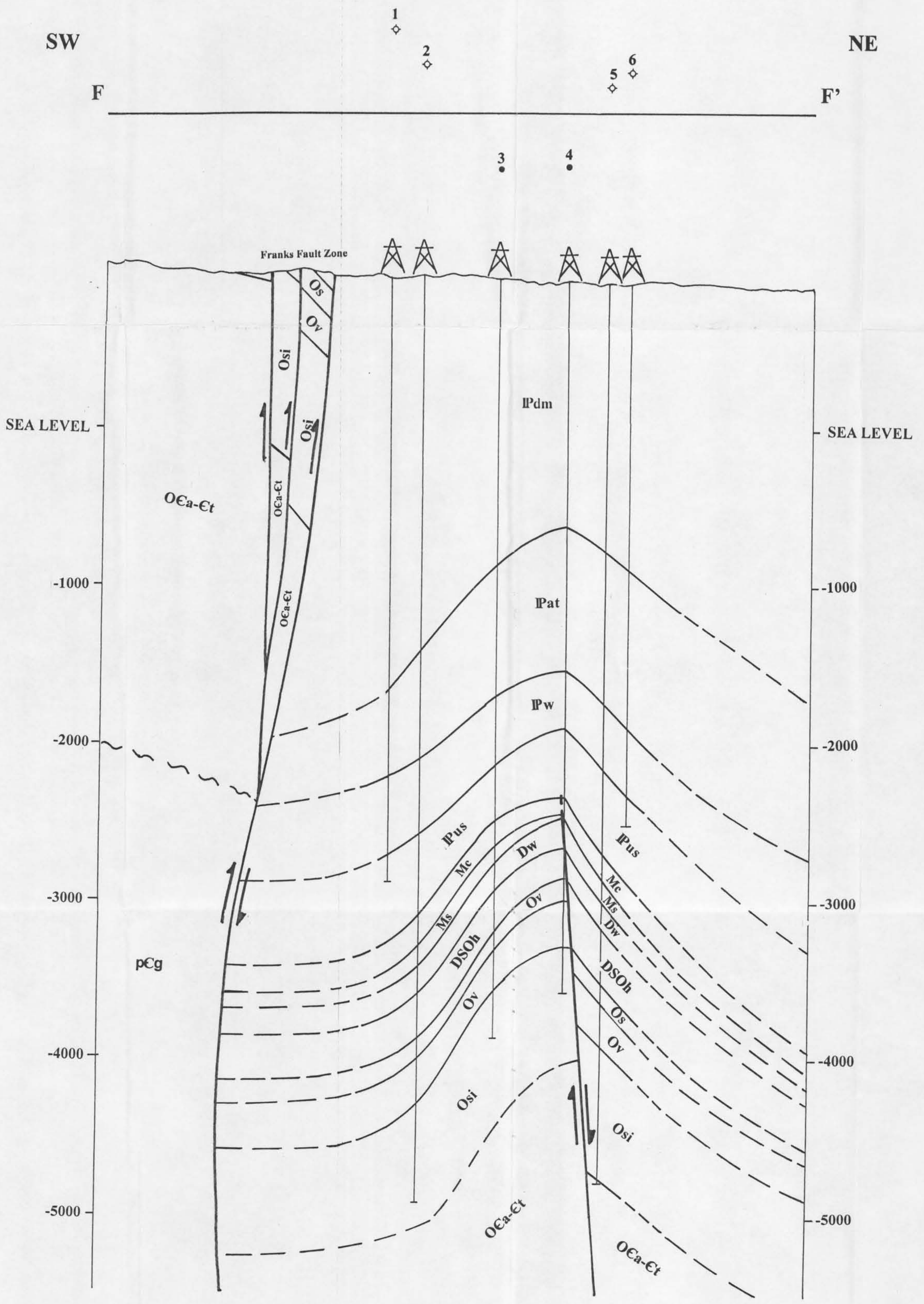
SOUTH WEST - NORTH EAST
Structural Cross-Section
E - E'



Scale in feet

Western Franks Graben — Plate 7

Claudine Eloumou — M.S. 1995



EXPLANATION

IPdm	:	Desmoinesian (Pennsylvanian)
IPat	:	Atoka (Pennsylvanian)
IPw	:	Wapanucka (Pennsylvanian)
IPus	:	Union Valley - Springer (Pennsylvanian)
Mc	:	Caney (Mississipian)
Ms	:	Sycamore (Mississipian)
Dw	:	Woodford (Devonian)
DSOh	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvian (Ordovician)
Ov	:	Viola (Ordovician)
Osi	:	Simpson (Ordovician)
O€a - €t		Arbuckle (Ordovician - Cambrian) Timbered Hills (Cambrian)
p€g		Tishomingo granite (Precambrian)

1. Ascot Oil Incorp.
McElroy # 1
NE-SW-SE, Sec. 27
(2125 dt)

2. Van Grisso Oil
Norris Estate # 1
NE-SE-SE, Sec. 27
(2000 ft)

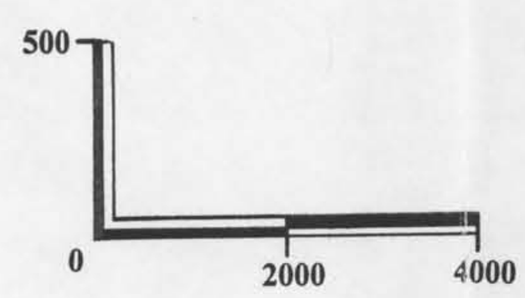
3. Texakoma Oil and Gas
Cherokee # 1
SW-SW-SE, Sec. 26
(1250 ft)

4. Amerada Petroleum Corp.
Norris Heirs # 2
SW-NE-SW, Sec. 26
(1250 ft)

5. D.D.Feldman Oil & Gas
Norris Estate,# 1
NE-SW-NE, Sec. 26
(625 ft)

6. Philip Boyle Inc.
Ebey # 1
SE-NW-NE, Sec. 26
(1000 ft)

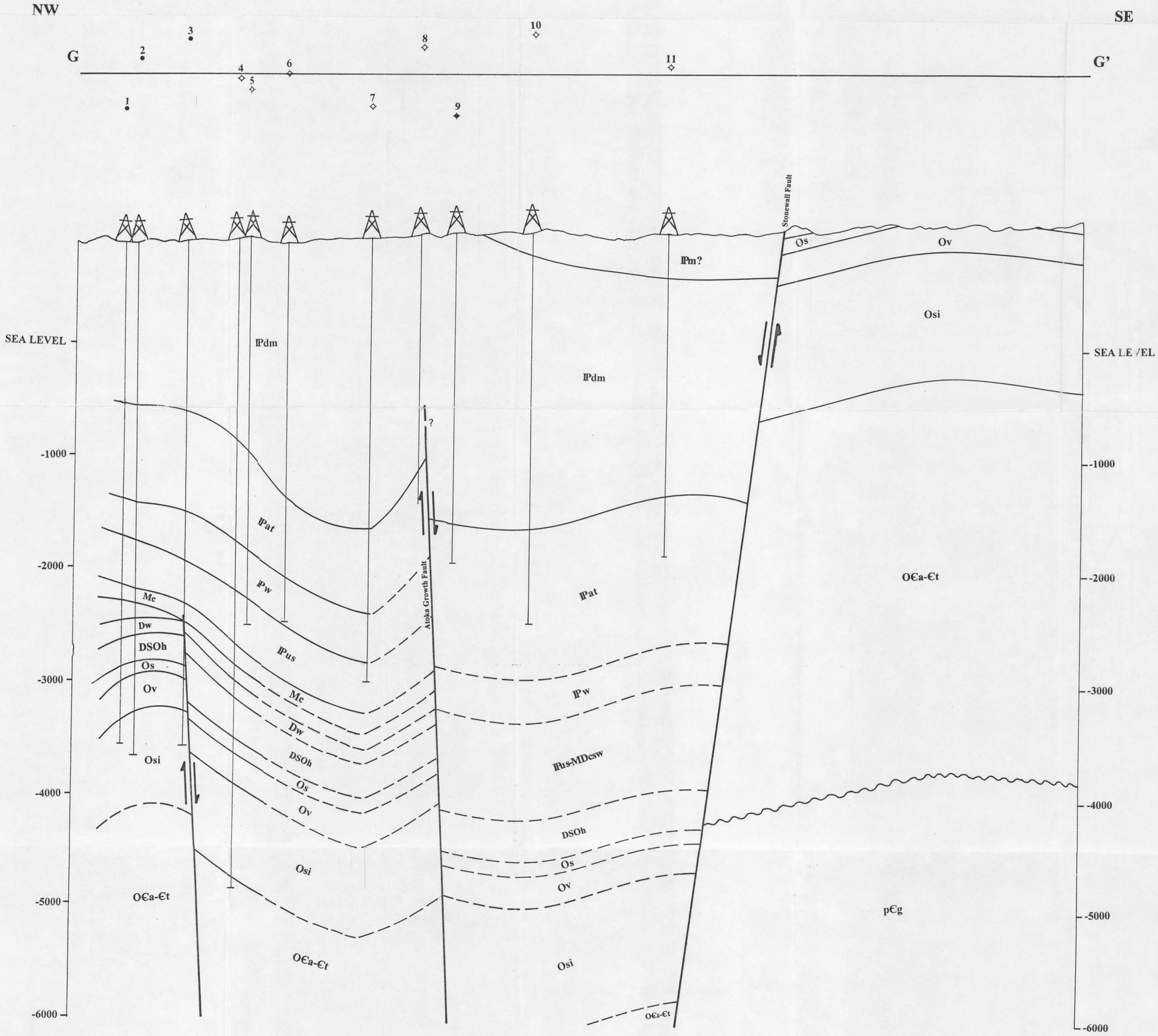
SOUTH WEST - NORTH EAST
Structural Cross-Section
F - F'



Scale in feet

Western Franks Graben — Plate 8

Claudine Eloumou — M.S. 1995



EXPLANATION

ℙm : Missourian (Pennsylvanian)
ℙdm : Desmoinesian (Pennsylvanian)
ℙat : Atoka (Pennsylvanian)
ℙw : Wapanucka (Pennsylvanian)
ℙus : Union Valley - Springer (Pennsylvanian)
Mc : Caney (Mississipian)
Ms : Sycamore (Mississipian)
Dw : Woodford (Devonian)
DSOh : Hunton (Devonian - Silurian - Ordovician)
Os : Sylvian (Ordovician)
Ov : Viola (Ordovician)
Osi : Simpson (Ordovician)
O€a - €t : Arbuckle (Ordovician - Cambrian)
Timbered Hills (Cambrian)
p€g : Toshimingo granite (Precambrian)

1. Texfel Petroleum Corp.
Fitts West Unit # 12-13
NE-NE-SW, Sec. 25
(875 ft)

2. Sun Oil Company
Fitts West Unit # 29-20
NE-SW-SW, Sec. 25
(375 ft)

3. Amerada Petroleum Corp.
Norris Heirs # 2
SW-NE-SE, Sec. 26
(813 ft)

4. D.D.Feldman Oil & Gas
Norris Estate # 1
NE-SW-NE, Sec. 26
(125 ft)

5. Philip Boyle Inc.
Ebey # 1
SE-NW-NE, Sec. 26
(375 ft)

6. Philip Boyle Inc.
Ada Norris Berry # 1
NE-NE-NW, Sec. 26

7. W.A.Delaney Jr.
Marcum # 1
NW-NW-SW, Sec. 23
(625 ft)

8. H.L. Wirick , Jr.
Gill # 1
SW-NE-SE, Sec. 22
(500 ft)

9. H.L.Wirick Jr.
Parks # 1
SW-NW-NE,Sec. 22
(1000 ft)

10. K.M.Hamilton Oil & Gas
Hamilton # 1 - A
NE-SE-NE, Sec. 21
(875 ft)

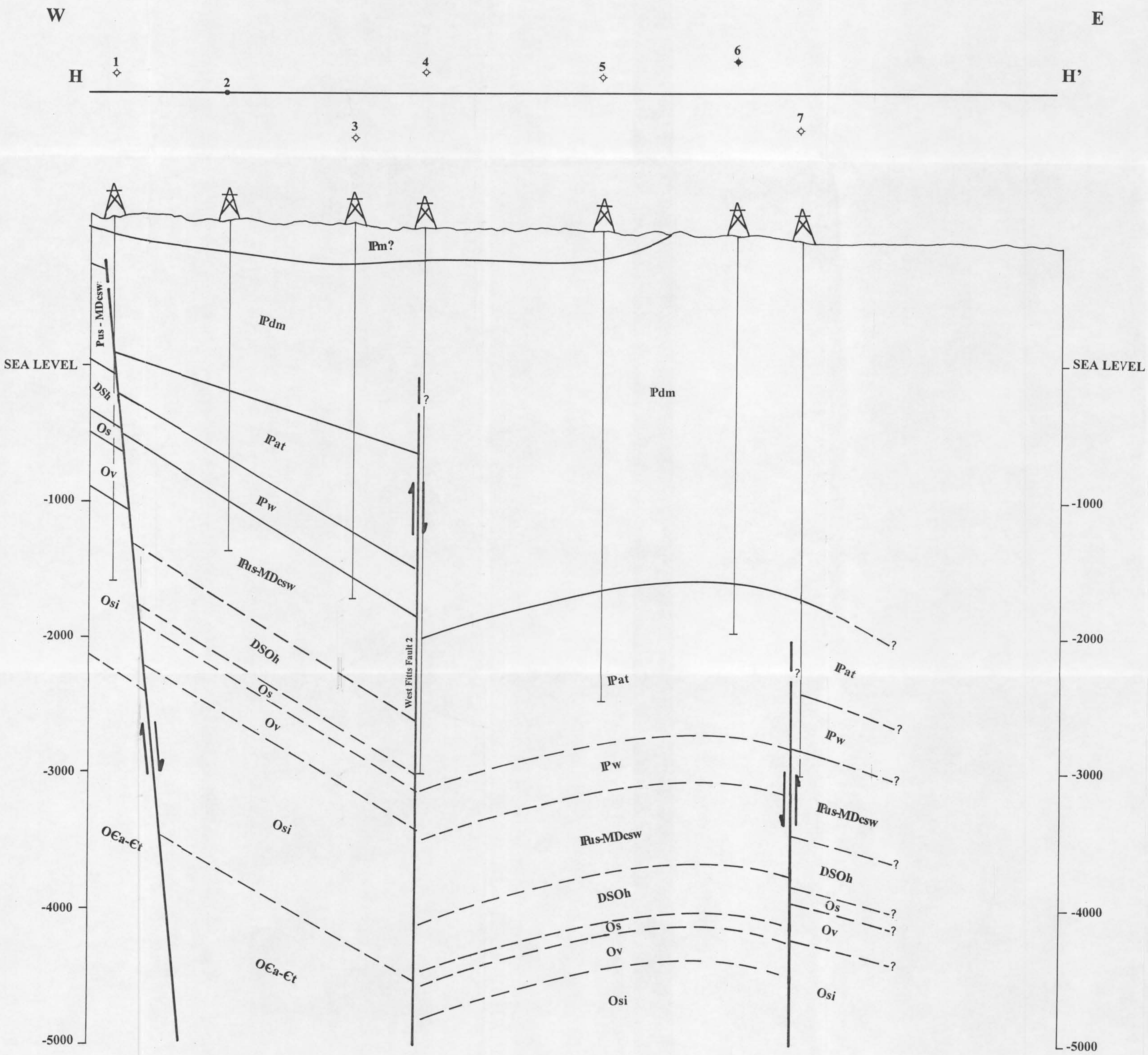
11. Harry L. Wirick
Fedderson # 1
NW-NE-SW, Sec. 16
(125 ft)

SOUTH WEST - NORTH EAST
Structural Cross-Section
G - G'

500
0
2000
4000
Scale in feet

Western Franks Graben — Plate 9

Claudine Eloumou — M.S. 1995

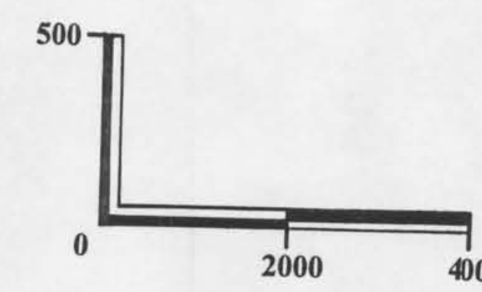


EXPLANATION

Pm	:	Missourian (Pennsylvanian)
Pdm	:	Desmoinesian (Pennsylvanian)
Pat	:	Atoka (Pennsylvanian)
Pw	:	Wapanucka (Pennsylvanian)
Pus - MDcsw	:	Union Valley-Springer (Pennsylvanian) Caney-Sycamore (Mississipian) Woodford (Mississipian - Devonian)
DSO_h	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvan (Ordovician)
Ov	:	Viola (Ordovician)
Os_i	:	Simpson (Ordovician)
O€a - €t	:	Arbuckle (Ordovician - Cambrian) Timbered Hills (Cambrian)
p€g	:	Tishomingo granite (Precambrian)

1. Philip Boyle Inc.
   Schafer # 1
   SW-NE, Sec. 19
   (625 ft)
2. H.L.Wirick Jr.
   Schafer Ranch # 1
   SW-SE-NW, Sec. 19
3. R.W.Simpson,
   Trust # 4 - 20
   SW-NW-SE, Sec. 20
   (1250 ft)
4. Van Crisso Oil Company
   Denton # 1
   NE-SE-NE, Sec. 20
   (625 ft)
5. K.M.Hamilton Oil & Gas
   Hamilton # 1 - A
   NE-SE-NE, Sec. 21
   (500 ft)
6. H.L.Wirick, Jr.
   Parks # 1,
   SW-NW-NE, Sec. 22
   (875 ft)
7. W.A.Delaney Jr.
   Marcum # 1
   NW-NW-SW, Sec. 23
   (1000 ft)

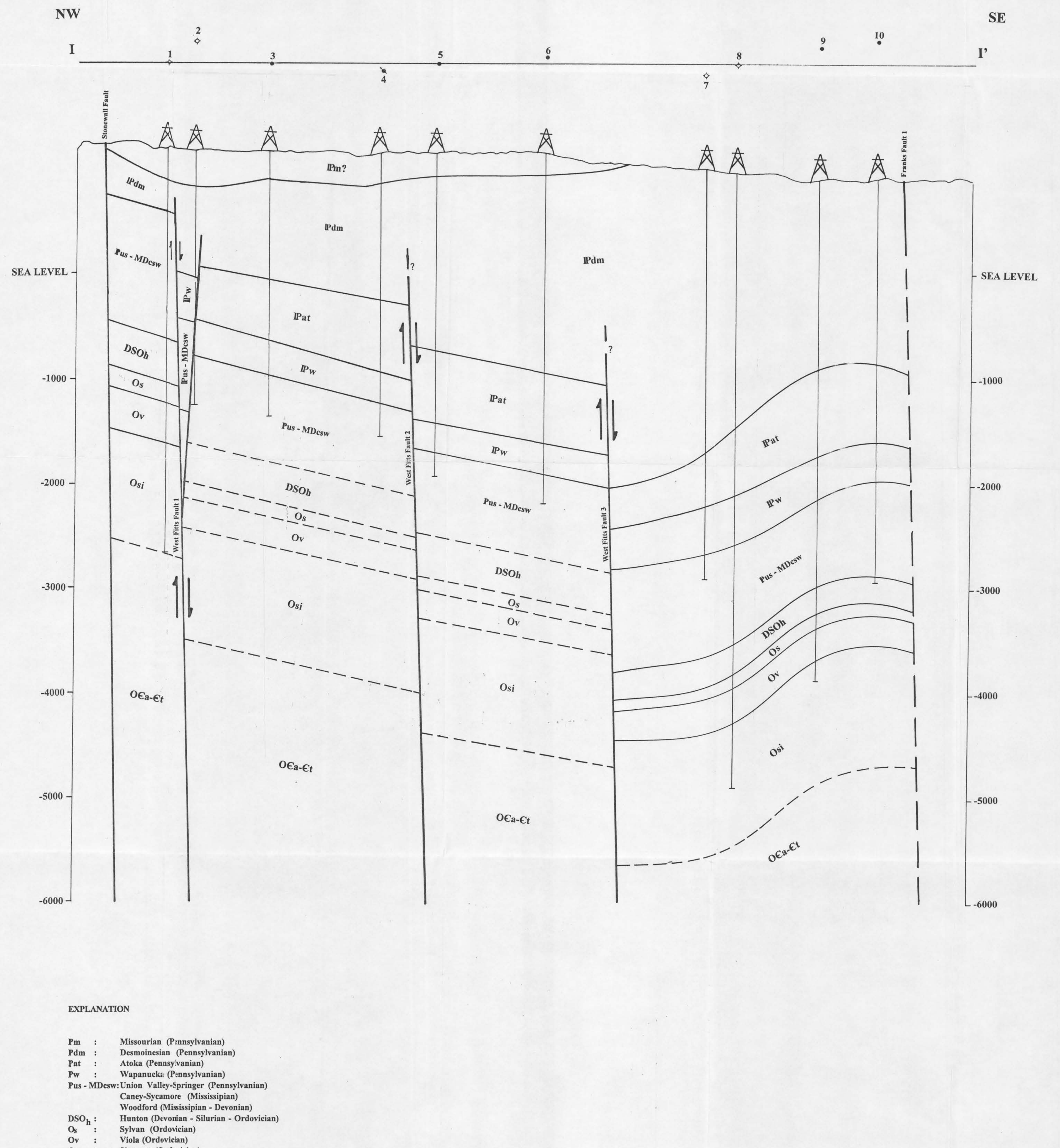
WEST - EAST
Structural Cross-Section
H - H'



Scale in feet

Western Franks Graben — Plate 10

Claudine Eloumou — M.S. 1995



EXPLANATION

Pm	:	Missourian (Pennsylvanian)
Pdm	:	Desmoinesian (Pennsylvanian)
Pat	:	Atoka (Pennsylvanian)
Pw	:	Wapanucka (Pennsylvanian)
Pus - MDcsw	:	Union Valley-Springer (Pennsylvanian)
		Caney-Sycamore (Missisipian)
		Woodford (Missisipian - Devonian)
DSO_h	:	Hunton (Devonian - Silurian - Ordovician)
Os	:	Sylvan (Ordovician)
Ov	:	Viola (Ordovician)
Os_i	:	Simpson (Ordovician)
O€a - €t	:	Arbuckle (Ordovician - Cambrian)
		Timbered Hills (Cambrian)
p€g	:	Tishomingo granite (Precambrian)

1. Anderson-Prichand Oil
B.D.Denton # 1
C-NW-NW, Sec. 19

2. Philip Boyle Inc.
Schafer # 2
NW-NE-NW, Sec. 19
(875 ft)

3. H.L.Wirick, Jr.
Schafer Ranch # 1
SW-SE-NE, Sec. 19

4. Company Clark & Cowden
Montpelier # 2
SE-SW-SE, Sec. 20
(250 ft)

5. R.W.Simpson,
Montpelier # 3
NW-SW-SE, Sec. 20

6. C.W.Roodhouse
Fee # 1
SW-NW-NE, Sec. 28
(250 ft)

7. Ascot Oil incorp.
McElroy # 1
NE-SW-SE, Sec. 27
(385 ft)

8. Van Grisso Oil
Norris Estate # 1
NE-SE-SE, Sec. 27

9. Texakoma Oil & Gas
Cherokee # 1
SW-SW-SE, Sec. 26
(625 ft)

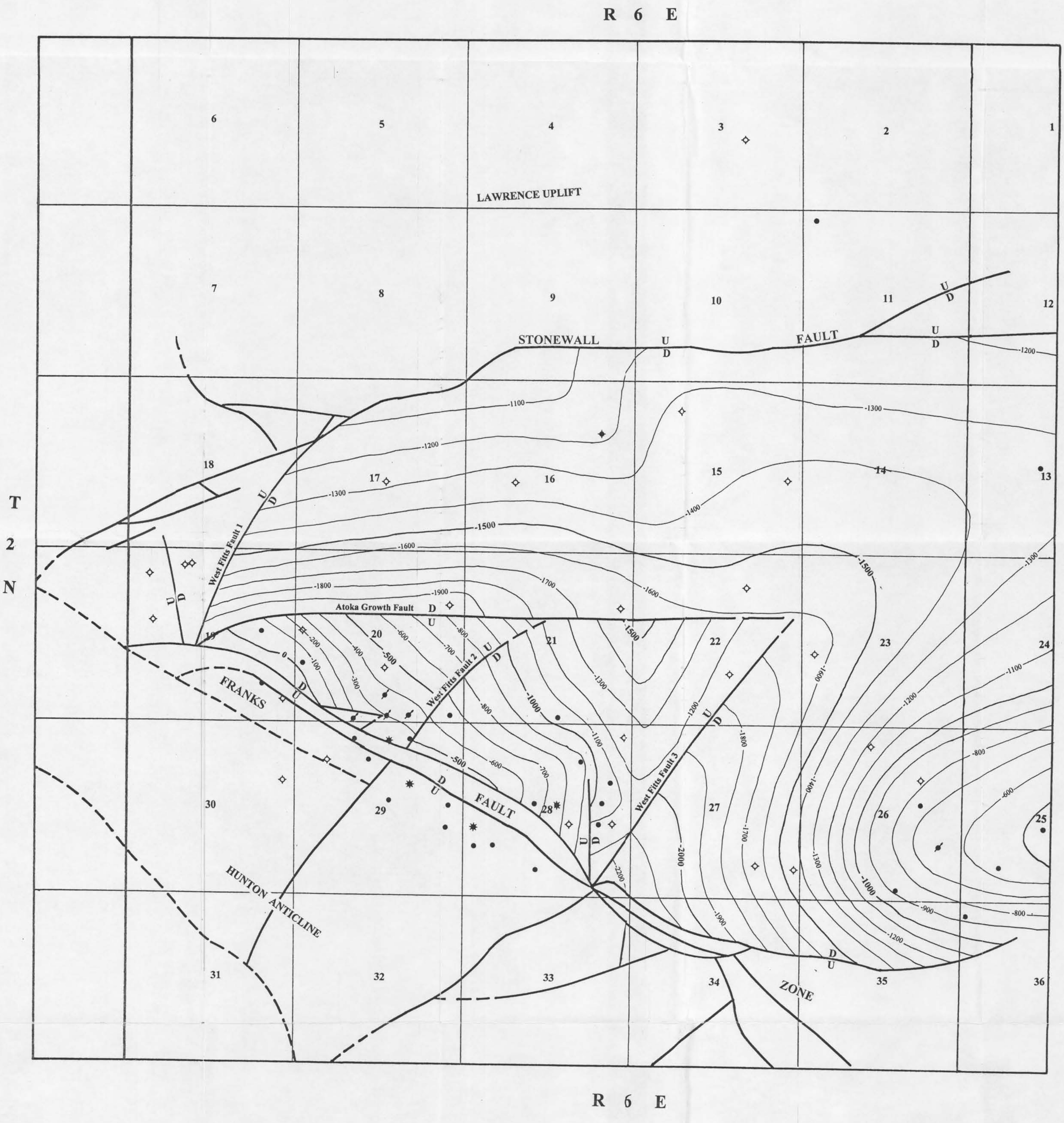
10. Skelly Oil Company
Smith # 2
NE-NE-NE, Sec. 35
(875 ft)

NORTHWEST-SOUTHEAST
Structural Cross-sections

Scale in feet

Western Franks Graben — Plate 11

Claudine Eloumou — *M.S. 1995*



STRUCTURAL CONTOUR MAP

TOP OF

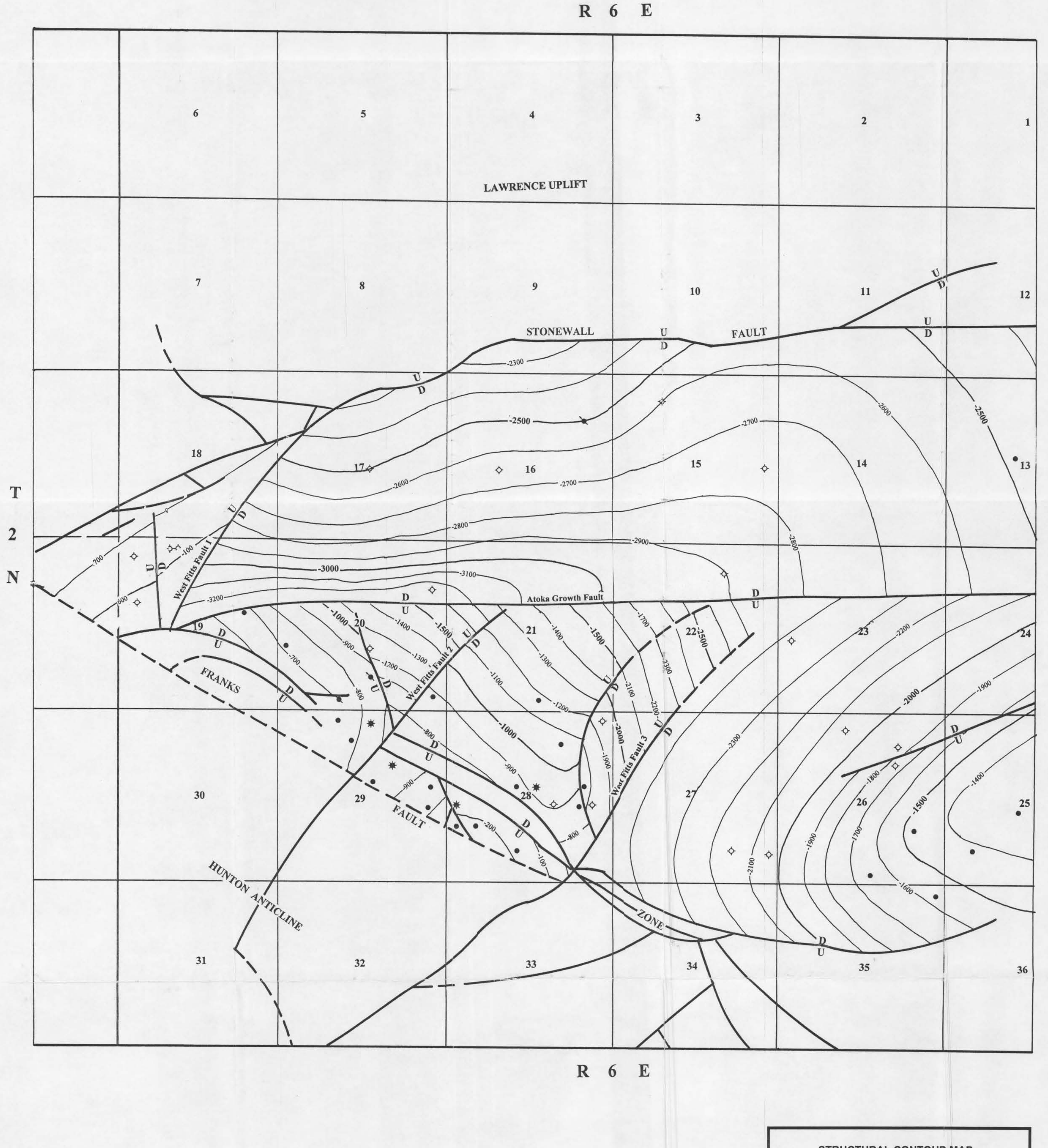
ATOKA FORMATION

0 4000

Scale in feet

Contour Interval = 100 ft.

Western Franks Graben	Plate 12
Claudine Eloumou	M.S. 1995



STRUCTURAL CONTOUR MAP

TOP OF

WAPANUCKA FORMATION

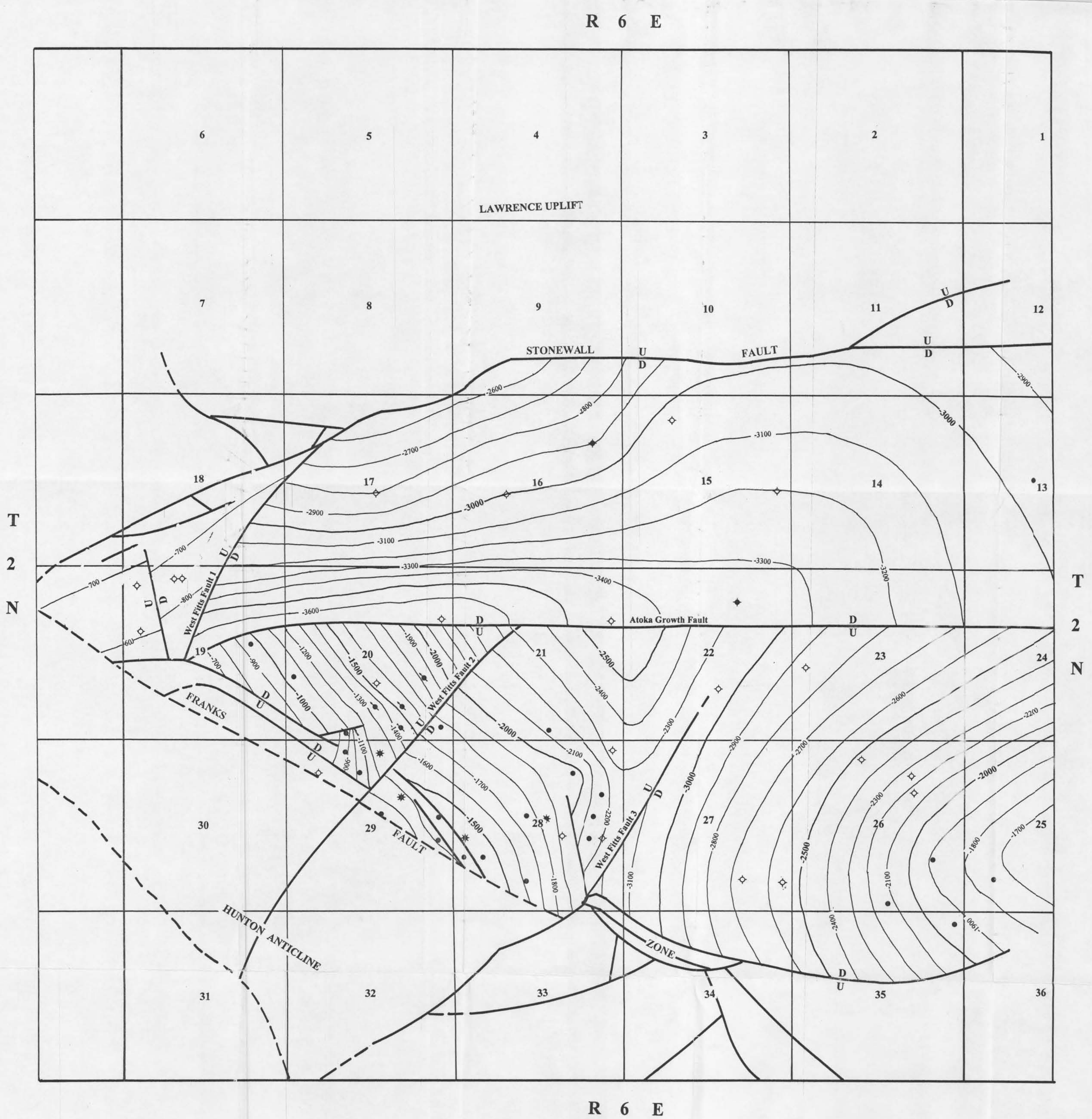
0 — 4000

Scale in feet

Contour Interval = 100 ft.

Western Franks Graben — Plate 13

Claudine Eloumou — M.S. 1995



STRUCTURAL CONTOUR MAP

TOP OF

UNION-VALLEY FORMATION

0 4000

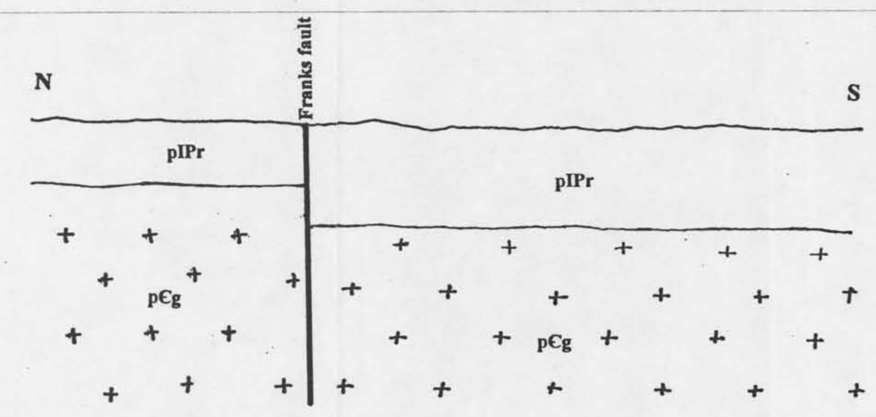
Scale in feet

Contour Interval = 100 ft.

Western Franks Graben	Plate 14
Claudine Eloumou	M.S. 1995

SCHEMATIC DIAGRAM OF THE STRUCTURAL EVOLUTION OF THE WESTERN FRANKS GRABEN

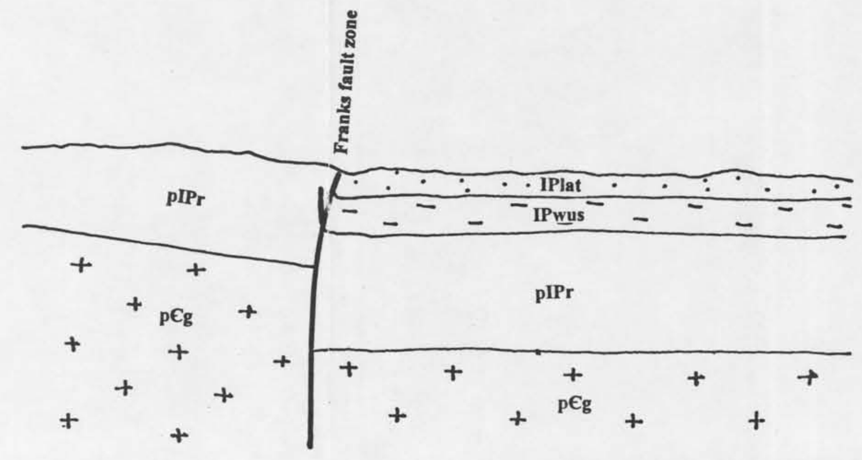
PRE-PENNSYLVANIAN



* Franks fault formed as a normal fault during the rifting stage and probably continued its movement sporadically during the sagging stage of the Southern Oklahoma Aulacogen.

PENNSYLVANIAN

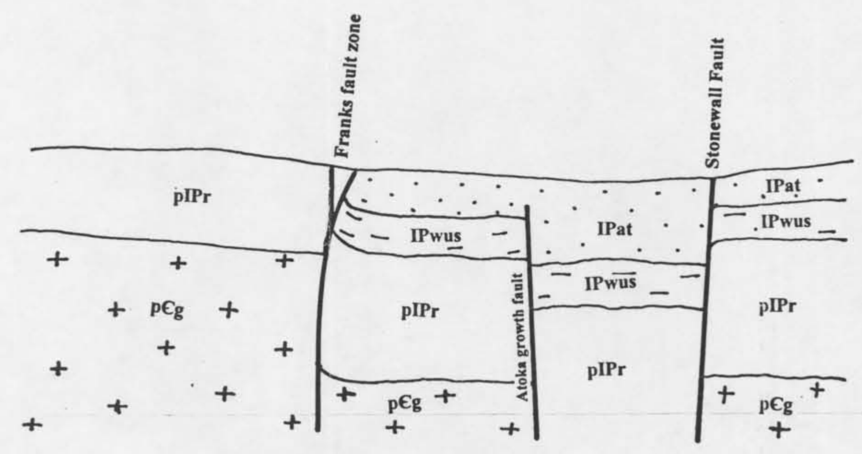
- **Morrowan-Lower Atokan**



* Rise of the Hunton Anticline and subsequent reactivation of the Franks fault.
* Start of the strike-slip motion of the franks fault.
* Deposition of the lower Atokan sediments.

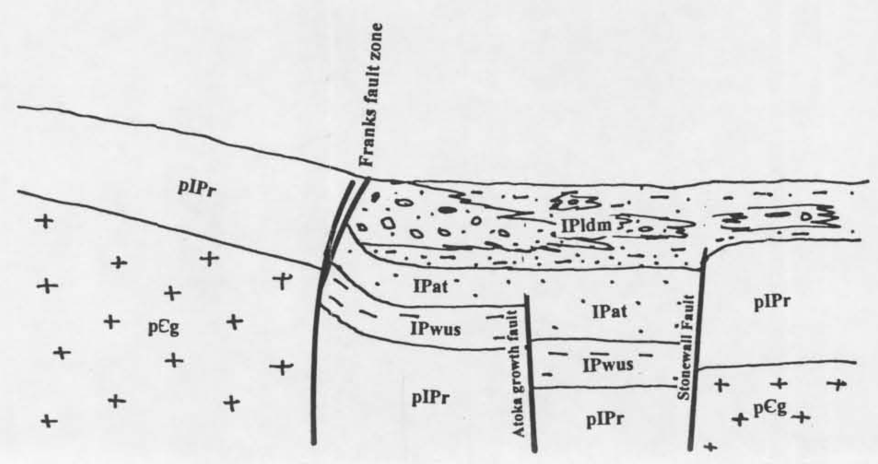
WICHITA OROGENY

- **Middle and Late Atokan**



* Syndepositional Atoka growth fault (AGF).
* Continued strike-slip motion along the Franks fault.
* The Stonewall Fault formed as a normal fault to the north and caused the formation of the Lawrence Uplift.

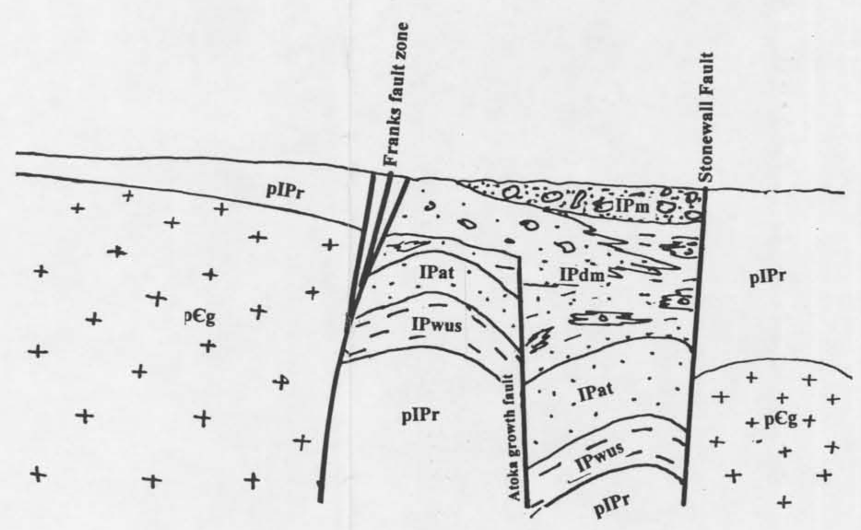
- **Early Desmoinesian**



* Deposition of the Boggy Formation overlapping the pre-Desmoinesian formations to the north and perhaps, to the south of the Franks fault .
* Probable continuation of strike-slip motion along the Franks fault.
* No evidence for normal faulting along the Stonewall fault.

ARBUCKLE OROGENY

- **Middle-Late Desmoinesian**



* Normal faulting along the Stonewall Fault and subsequent erosion of all the formations on the upthrown block (Lawrence Uplift) down to the Sylvan-Viola.
* Strong folding of the Western Franks Graben caused by the Arbuckle Orogeny.
* Strike-slip motion along the Franks fault zone continued.
* Uplift of the Hunton Anticline continued to the south.
* Deposition of the Missourian rocks.

OUACHITA OROGINY

EXPLANATION

IPm:	Missourian (Pennsylvanian)
IPldm:	Lower Desmoinesian (Pennsylvanian)
IPdm:	Desmoinesian (Pennsylvanian)
IPlat:	Lower Atoka (Pennsylvanian)
IPat:	Atoka (Pennsylvanian)
IPwus:	Wapanucka-Union Valley-Springer (Pennsylvanian)
pIPr:	Pre-Pennsylvanian rocks
p€g:	Tishomingo granite (Precambrian)

SCHEMATIC DIAGRAM SHOWING THE STRUCTURAL EVOLUTION OF THE WESTERN FRANKS GRABEN

Western Franks Graben — Plate 15

Claudine Elounou — S. 1995