PETROLOGICAL, SEDIMENTOLOGICAL, AND GEOPHYSICAL CHARACTERISTICS

OF THE MISENER/SYLAMORE SANDSTONE (UPPER DEVONIAN) OF THE

MIDCONTINENTAL UNITED STATES

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by

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ABSTRACT

PETROLOGICAL, SEDIMENTOLOGICAL, AND GEOPHYSICAL CHARACTERISTICS OF THE MISENER/SYLAMORE SANDSTONE (UPPER DEVONIAN) OF THE MIDCONTINENTAL UNITED STATES

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The Upper Devonian Misener Sandstone (subsurface in Kansas and Oklahoma) and its surface equivalent, the Sylamore Sandstone (surface exposure in eastern Oklahoma and northern Arkansas), are the basal formations of the Woodford/Chattanooga Group. The sandstone body is found throughout the Central United States, including the states of Colorado, Kansas, Oklahoma, Arkansas, Illinois, Missouri, and Tennessee. The Misener/Sylamore is erratically distributed on the post-Hunton/pre-Chattanooga unconformity in topographic lows. The thickness of the rock body is controlled by paleotopography and ranges from absent to a reported maximum of 26 meters.

The Misener/Sylamore consists within the area of investigation mostly of quartzose sandstone, dolostone, and shale. At places, the sequence is interbedded with Woodford/Chattanooga type Shale. Three lithofacies were recognized within the rock body. These include: Arenite, Wacke, and Shale. These lithofacies represent depositional environments that are related to water depth and distance from shore. The arenite was deposited closest to shore or in shallowest water, and the shale was deposited further from shore in the deepest water.

The detrital components of the Misener/Sylamore sequence include: monocrystalline quartz , clay, phosphatic particles, glauconite, conodonts, fish bone fragments, and trace amounts of feldspars, rock fragments (chert, metamorphic quartz, dolomite), tourmaline, and zircon. Diagenesis began with either poikilotopic carbonate, syntaxial silica, or pyrite, followed by dolomitization (pore filling and recrystallization, stylolitization, creation of secondary porosity, and migration of hydrocarbons.

The Misener/Sylamore is a nearshore marine transgressive lag deposit, with the sediments being reworked during the transgression of the Woodford/Chattanooga sea. This reworking would make the sediments within the Misener/Sylamore palimpsest, and some of the sedimentary features relict.

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INTRODUCTION

The Misener Sandstone (subsurface in Oklahoma and Kansas) and its surface equivalent the Sylamore Sandstone (surface in Oklahoma, Arkansas, and Missouri) are the basal formations of the Woodford/Chattanooga Shale of the Midcontinental United States. According to Keroher (1966), the name "Misener" was first applied to a sandstone that occurred on top of the Viola Limestone in an oil pool near the town of Beggs, Oklahoma, and was named for a Tulsa oil operator, Fred D. Misener. Keroher (1966) also reported that the original reference using the name "Sylamore" was that of Penrose (1891), and applied to sandstone exposed at an undefined location along Sylamore Creek, Stone County, Arkansas. The age of the basal unit ranges from late Middle Devonian to Early Mississippian. Because the sandstone is related to the transgressive event that led to the widespread deposition of the Woodford/Chattanooga, it is a time transgressive unit that is older to the south and younger to the north (Swanson and Landis, 1962; Freeman and Schumacher, 1969; Amsden and Klapper, 1972).

The Woodford/Chattanooga Shale is an important hydrocarbon source rock in the Midcontinent. The hydrocarbons generated in the shale in part migrated into the Misener. Initial production in one Misener well was reported at 1,000 barrels of oil per day (choked) with an estimated production of 2,000 barrels per day open flow (Brown, 1988). Beyond the economic importance of the Misener is the geologist's understanding of the processes which led to deposition of the Misener. If the genesis of the Misener is well understood, then the proper methods of exploration should prove successful in finding Misener reservoirs. One problem related to the origin of the Misener is its erratic deposition in post-Hunton/pre-Chattanooga lows (White, 1926; Amsden and Klapper, 1972; Francis, 1988). Another problem which inhibits environmental determination is the lack of sedimentological structures within the Misener/Sylamore interval. This has led to environmental interpretations which range from eolian (White, 1926) to marine storm deposits (Francis, 1988). Previous studies of the Misener/Sylamore have been limited geographically, and usually cover only one or two counties. Because of the lack of abundant cores and the small extent of outcrops, previous work focused on mapping the subsurface distribution.

Therefore, this investigation will be of larger areal extent than previous studies (samples from Oklahoma, Kansas, and Arkansas), and relate deposition of the Misener/Sylamore to conditions which resulted in the Woodford/Chattanooga sequence.

PREVIOUS WORKS

Penrose (1891) first described the Sylamore Sandstone from outcrops in the Batesville District of Arkansas. The rock body is described as yellow, brown, or gray earthy usually associated with green or black shaley layers. Iron staining is common and small flat ferruginous concretions were also present. Distribution of the sandstone body is irregular, and ranged from zero to 40 feet (13m).

White and Green (1924) first applied the term "Misener Sand" to a sandstone horizon below the Chattanooga Shale. They described it as lenticular and "spotty" in its distribution. At that time, samples of the Misener were difficult to obtain but those available were described as light blue sandy calcareous shale with pyrite.

White (1926) studied well cuttings and subsurface distribution of rocks (including the Misener) in northeastern Oklahoma, and outcrops of the Sylamore in eastern Oklahoma and concluded that the Misener/Sylamore is early Mississippian because of stratigraphic relations. In north-central Oklahoma the Misener is interpreted as an eolian deposit because of elongate subsurface patterns, although it may have been deposited in shallow water or along beaches near the Ozark region. It is postulated that the Devonian ended with erosion and levelling of the surface, and what little sediments were left formed sand dunes along with a thin veil of sand that is later preserved by the advance of the Chattanooga seas. The sandstone usually was less than two feet thick (<1 m), but thicker where it filled depressions.

Cram (1930) studied well cuttings and subsurface distribution of rocks in Cherokee and Adair counties, Oklahoma, and declared that the age of the Misener is Mississippian because it graded upward into the Chattanooga, and therefore must be an introductory phase of deposition. There the Misener ranged in thickness from a maximum of 30 feet (10 m) to absent.

A study of outcrops in the Arkansas Paleozoic area by Croneis (1930) yielded a Mississippian age for the Sylamore because of its relationship to the Chattanooga and fossil evidence from Missouri. The sandstone is described as massive, either porous and friable or tightly cemented. Thickness of the Sylamore generally ranged from two to five feet (1-2 m), but is up to 75 feet (25 m) thick along the White River, and absent in other localities. The upper contact is conformable with the Chattanooga, or unconformable with the Boone Chert.

Rau and Ackley (1939) used well cuttings and subsurface distribution to describe the geology of the Keokuk (hydrocarbon) pool in Seminole County, Oklahoma. They did not speculate about the depositional environment of the Misener, but stated that it has been a "... bone of contention ..." among geologists, and could possibly be marine. The sandstone is described as being dolomitic and cherty at some places. A chert bed that normally occurs on top of the Hunton and below the Misener can also be found within the Misener. The thickness of the Misener in the area averaged 14.5 feet (5 m), with a range of from three to 33 feet (1-11m) within the pool. It was suggested that after Hunton deposition there was an emergence of northeastern and north-central Oklahoma.

Borden and Brant (1941) examined well cuttings and mapped the subsurface of the

East Tuskegee (hydrocarbon) pool in Creek County, Oklahoma. The Misener was assumed to be Mississippian in age, and the depositional environment is inferred to be a nearshore marine setting. The Misener, which unconformably overlies the Sylvan Shale and Viola Limestone, is massive and fined upward grading into the Chattanooga. The lower part of the Misener is probably time equivalent with the Sallisaw Formation (refer to Plate 1) although the upper part is coeval with the Sylamore Sandstone (Plate 1). The thickness of the Misener ranged from less than one foot up to 30 feet (<1-10 m).

Imbt (1941) described the geology of the Zenith (hydrocarbon) pool in Stafford County, Kansas. The age of the Misener is Mississippian and the depositional environment is interpreted as nearshore marine in erosional lows. The presence of marine limestone and pebble-sized grains were evidence for marine deposition and against an aeolian origin. The writer declared two sand bodies in the Misener that were separated at places by a fossiliferous, cherty to noncherty limestone.

Silurian and Devonian strata in Central Kansas (in well cuttings and subsurface mapping) were studied by Taylor (1946) and the Misener is declared to be Devonian, although it is probably not the same age everywhere. The sandstone was deposited on a widespread pre-Mississippian/post-Hunton erosional surface and is irregularly distributed. The Misener contains shale and limestone, and unconformably overlies rocks as old as Simpson, along with younger Viola, Sylvan, and Hunton.

Swanson and Landis (1962) examined Chattanooga Shale outcrops in north-central Arkansas and concluded that conodonts and stratigraphic relationships indicated that the Sylamore is a time transgressive unit that ranged in age from Late Devonian to Early

Mississippian (figure 1). The depositional environment is interpreted as a marine setting, with the Sylamore being the shoreward facies relative to the further offshore deposition of the Chattanooga (figure 2). Evidence for this interpretation is the interfingering of Chattanooga and the Sylamore, with pods of Chattanooga occurring within the Sylamore. The thickness is generally a few inches but ranged up to one foot thick (<1 m). The Ozark area was the source of the sediments that formed the Sylamore.

Freeman and Schumacher (1969) studied 18 outcrops in northern Arkansas and stated that conodonts indicated the Sylamore is time transgressive and ranged from Middle Devonian to Lower Mississippian. The sandstone was deposited as part of the Chattanooga transgressive seas, and was interrupted by several minor regressions which caused biostratigraphic gaps.

Hilpman (1969) examined 27 cores, sample logs from 2,500 wells, and cuttings from 50 wells in a study of Devonian rocks in Kansas. Conodonts yielded an age for the Misener of Late Devonian to Early Mississippian (Tournaisian) and indicated time transgression. The sandstone ranges from quartz arenite to a pyritic conglomerate, shows bedding when shale is present, but otherwise appears massive. The Misener is erratically distributed up to fifty feet thick (16 m) on an erosional surface, unconformably overlies rocks from Ordovician to Late Devonian age, and generally reflects the lithology from which it was derived. The Misener is conformably overlain by the Chattanooga Shale, and its lateral facies equivalents are the Sedalia Dolomite, and Gilmore City Limestone (oolitic). The Misener was deposited by the Chattanooga seas transgressing from the southeast and by Late Devonian to Early Mississippian (Kinderhookian) time was being

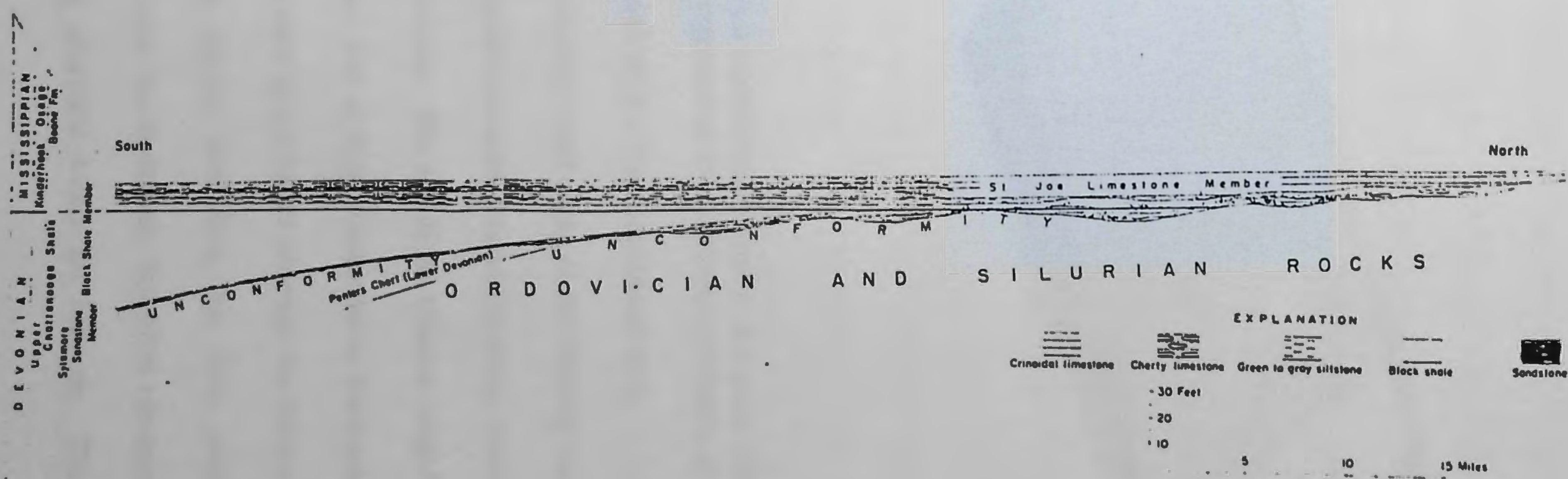


Figure 1- Diagram showing stratigraphic relationships of some Paleozoic rocks in north-central Arkansas. Note that the Sylamore is time transgressive (Swanson & Landis, 1962).

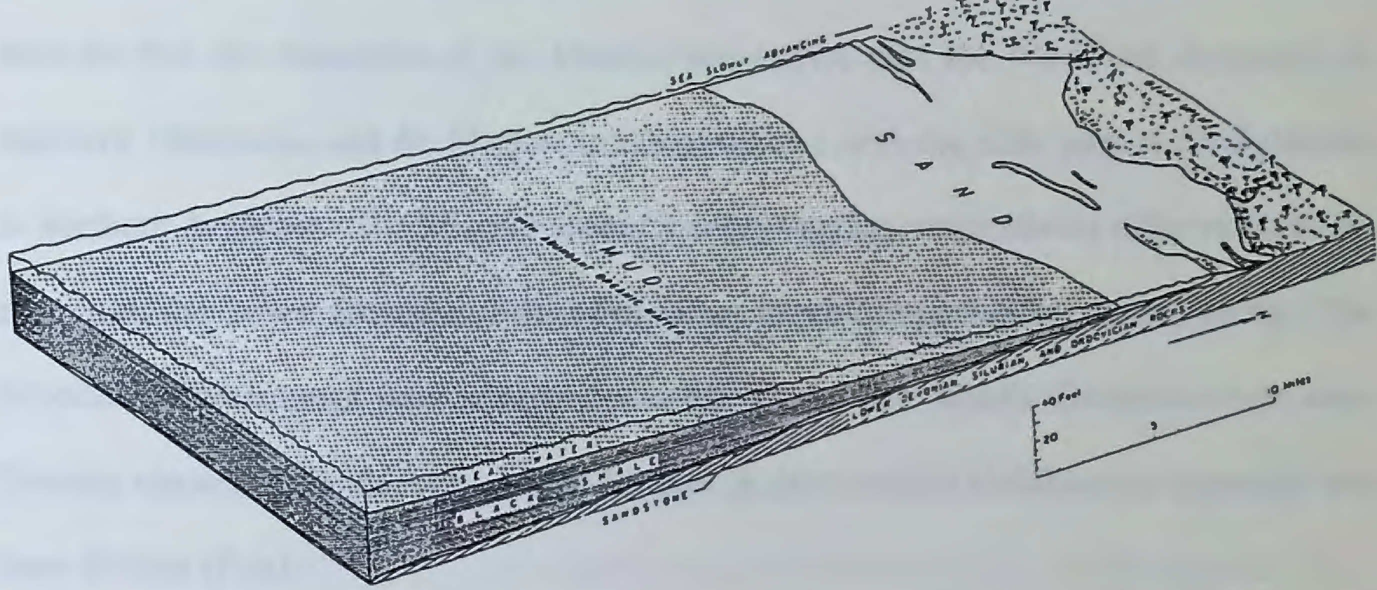


Figure 2- Depositional model from Swanson & Landis (1962), for the Late Devonian. The Sylamore is represented as the shoreward facies of the Chattanooga.

deposited on the flanks of the Transcontinental arch.

The most commonly cited study of the Misener was done by Amsden and Klapper (1972). This investigation centered around five cores, subsurface mapping, and sample logs in north-central Oklahoma. The age of the Misener ranged from Middle to Late Devonian (Givetian-Famennian) and is time transgressive (indicated by conodont studies). Two depositional settings were given for the Misener; the thicker units were deposited in shallow water as nearshore marine sand bars that were parallel to shoreline; the thinner discontinuous units were beach deposits that filled topographic lows. There were no well-defined sedimentary structures within the Misener. The composition of the sandstone ranged from rounded quartz grains floating in a dolomitic matrix to abundant quartz with small amounts of dolomite, and is interbedded with a Woodford-type shale. Conodonts indicate that the deposition of the Misener was coeval with the Woodford deposition in southern Oklahoma, and the Misener is age correlative with the older part of the Sylamore in northern Arkansas. The Misener unconformably overlies progressively older strata to the east from the Lower Devonian Frisco Formation to pre-Simpson (Ordovician) strata. The Woodford/Chattanooga seas advanced westerly in the late Middle Devonian over east-flowing streams. The thickness of the Misener in north-central Oklahoma is typically less than 20 feet (7 m).

Kochick (1976) examined one core, described thirty thin sections, and generated subsurface maps using electric logs and drilling reports, of the Misener in Payne and Lincoln counties, Oklahoma. The depositional setting is postulated as alluvial channel deposits with the upper part of the Misener being reworked by the advancing Woodford seas; elsewhere the Misener was deposited in a marine environment. The long, sinuous bodies of sand were deposited in topographic lows. The thickness of the Misener ranges from absent to more than 50 feet (16 m), but is usually less than ten feet (3 m) thick.

Bauerfiend (1980) inspected well cuttings from 30 wells, thin sections, X-ray diffraction patterns, and electric logs for subsurface mapping of the Misener in Lincoln and Creek counties, Oklahoma. A fluvial origin is postulated for the Misener in the northeast based on mapped features (channelized deposition), bell-shaped electric log curve, and the lack of glauconite and dolomite; to the southwest the environment was originally fluvial then a tidal flat, based on mapped features accompanied by the presence of dolomite and glauconite. The thickness of the sandstone ranges in the area from absent to 73 feet (24 m), with an average thickness of six feet (2 m). The Woodford Shale is postulated to have been deposited in a restricted, shallow water environment.

Fourteen outcrops of the Sylamore Sandstone in northeastern Oklahoma and northern Arkansas (with 51 thin sections) were studied by Pittenger (1981). Conodonts yielded an age of late Middle to Late Devonian. The depositional environment is described as nearshore, shallow, restricted moderate energy marine transgressive sandstone based on grain size distribution, presence of phosphate, glauconite, fossils and burrows. The Sylamore is commonly massive, has a thin basal conglomerate of chert, low angle bidirectional cross-bedding (found at one location). The Sylamore unconformably overlies rocks from Ordovician to Devonian and interfingers with the overlying Chattanooga Shale. The Ozark Dome was positive and the source of Sylamore sediments, yet not of high enough relief to yield highly immature sediments.

Terry (1981) described fourteen outcrops of Devonian strata in the Batesville District of northeastern Arkansas. The age of the Sylamore is early Late Devonian based on conodonts. The depositional environment is postulated to be a transgressive beach sandstone in the Chattanooga sea which reworked older exposed rocks, with an east-west depositional strike and southward dip. The sandstone has the following characteristics: 1) erratic distribution filling erosional lows, 2) massive, 3) rare graded bedding at a few places with prominent bedding surfaces, 4) sharp upper contacts, and 5) interfingers with the Chattanooga Shale. The Sylamore unconformably overlies rocks that range in age from Ordovician to Lower Devonian, and when not conformably overlain by the Chattanooga it is unconformably overlain by the St. Joe or Boone Formation. The maximum thickness of the Sylamore is 17.5 feet (6 m), with an average thickness of four feet (1-2 m).

Horner and Craig (1982) examined eighteen outcrops of the Sylamore in north-central Arkansas and concluded that the age is Late Devonian to Early Mississippian based on conodont studies. The Sylamore is postulated to have been deposited as the nearshore, shallow water facies of the transgressing Chattanooga Sea. The sandstone occurs interbedded with and at the base of the Chattanooga Shale, and is glauconitic, and phosphatic. At places where the Chattanooga is absent, the Sylamore is a thin phosphatic sandstone at the base of the St. Joe member of the Boone Formation.

Misener in the West Kremlin field (Garfield County, Oklahoma) was studied by Mansfield and Breckon (1985). The sedimentary features indicated a shallow water marine environment that was wave-tide-influenced. The sandstone is classified either as a dolomite-cemented quartz arenite or a quartz-bearing dolomite. The Misener ranges up to 60 feet (20 m) thick in the West Kremlin field.

Cameron (1986) scrutinized nine thin sections from one core, and created subsurface maps from electric logs of the Misener in Grant and Garfield counties, Oklahoma. The presence of conodonts, glauconite, fish fragments, brachiopods, and textural characteristics of the Misener indicated a marine environment with erratic distribution controlled by topography. The Misener ranges from a quartzose dolomite to quartz sandstone with dolomitic cement (the dolomite is secondary replacement of primary lime mud), with glauconite, and pyrite. The Misener is the thickest where the Sylvan Shale is thin or absent.

Walker (1986) used five cores, one outcrop, and electric logs with subsurface maps to study the Misener in north-central Oklahoma. Multiple depositional models ranging from estuarine to open marine shoreline and tidal channel were proposed to explain rock types.

Subsurface mapping techniques were used to study the Misener in Grant and Garfield counties, Oklahoma, by Bockhorst (1987). The depositional environment is interpreted to be alluvial deposits (probably based on subsurface morphology), that were later dolomitized and reworked by transgressive Woodford seas. The Misener was deposited in erosional lows as shown by isopach and structural maps.

Pogue (1987) utilized four conventional cores (thin sections and X-Ray radiographs) and 626 wireline logs (for subsurface mapping) to study the Misener in Grant and Garfield counties, Oklahoma. The Misener was deposited on an erosional surface during the early phases of the Woodford Sea transgression, as a fluvial deltaic system (suggested by subsurface distribution) with transport from northeast. The further transgression of the Woodford Sea influenced preservation and redeposited the Misener in paleotopographic lows. The sandstone shows small-scale ripples, bioturbation, flaser bedding, and a gradational upper contact with interfingering of the Woodford. The Misener unconformably overlies Ordovician to Lower Devonian rocks, and is conformably overlain by the Woodford. Cuestas probably influenced Misener distribution as did features such as the Chautauqua arch, Ozark uplift, and Anadarko foredeep. The Misener is finer grained and more dolomitic at the base with a shale break separating the upper unit which is coarser grained and less dolomitic. The sandstone ranges from absent to 58 feet (19 m).

Probably the most complete work on the Misener of north-central Oklahoma was the study of Francis (1988) who utilized 11 conventional cores (with 70 thin sections) and electric logs for subsurface mapping in Grant and Garfield counties, Oklahoma. A conodont study yielded an Upper Devonian age. The presence of graded bedding and glauconite in cores as well as the subsurface distribution indicated a marine depositional environment with storm-related episodic deposition, and low-energy marine shale separating events. Subsurface distribution is either as pods or ribbons. The thickness generally is less than 20 feet (7 m), but ranges from absent to 80 feet (26 m).

Prezbindowski et al. (1989) studied the Misener in north-central Oklahoma and used petrographic and sedimentologic evidence to interpret a marine depositional environment. The Misener is described as a dolomitic quartz arenite which fined upward, interfingered with shale, and was deposited on an erosional surface with shale, phosphate, and sandstone clasts at the basal contact.

The Misener was examined by Shelton et al. (1989) who used cores and sequence stratigraphy to determined that the sand was deposited in either a shallow marine, tidal ridge, estuarine, or tidal flat. Many cores showed overall shallowing upward in phosphatic sands and sandy dolomites. This overall shallowing is part of the two major transgressive/regressive episodes during the Devonian which also affected Woodford deposition.

Smith and Smith (1989) used closely spaced, ground-based geomagnetic studies to map the subsurface occurrence of the Misener in Grant and Garfield counties, Oklahoma. They suggested that the Misener consisted of storm surge deposits that were aligned adjacent to paleostructural highs. These highs were influenced by basement anomalies which are shown by magnetic, seismic, and drilling data.

Newell et al. (1991) described geologic features of the Zenith field in central Kansas. There the Misener is described as a north-northeast trending elongate body that included a limestone referred to as the "Misener Limestone" (figure 3). The somewhat parallel lobes of the Misener may have been deposited by currents or waves travelling to the south-southeast. The Misener Limestone was deposited in restricted intertidal to supertidal waters.

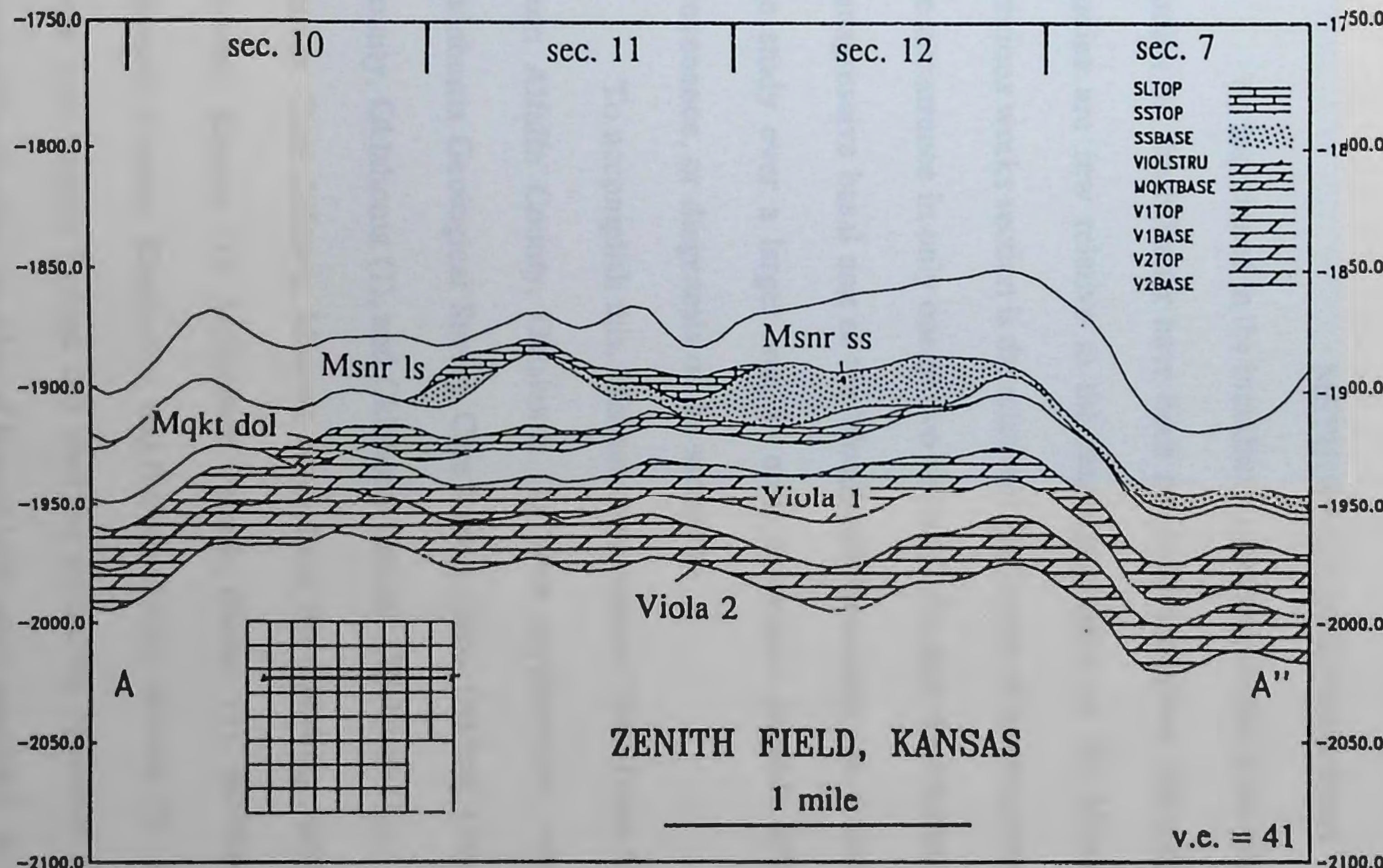


Figure 3- East-west cross section of the Zenith field showing stratigraphic relationships of the Misener Sandstone, Misener Limestone, and units directly below (Newell et al., 1991).

METHODS OF INVESTIGATION

As mentioned in the introduction, and manifested in the previous works section, most studies on the Misener have been based on subsurface mapping. The Sylamore outcrop studies are few relative to the mapping projects of the Misener. Also evident in the previous works section is the relatively small scale of investigations, many of which covered the occurrence in only one or two counties. Because the Misener/Sylamore is the proposed transgressive basal unit of the Woodford/Chattanooga sea, it seems appropriate to conduct the study over a larger area, in order to observe possible differences in sedimentation, provenance, or diagenesis of the sandstone.

To accomplish this, Misener cores obtained from Grant County, Oklahoma (4), and from Alfalfa County, Oklahoma (1), were supplemented with cores examined at the Oklahoma Geological Survey Core Library from: Garfield County, Oklahoma (2); Noble County, Oklahoma (1), and Oklahoma County, Oklahoma (1), . At the Kansas Geological Survey Core Library, Misener cores from the following locations were studied: Reno County, Kansas (1); Sedgewick County, Kansas (1), McPherson County, Kansas (2), Edwards County, Kansas (1), and Harvey County, Kansas (3). In Arkansas, at the Beaver Dam near Eureka Springs one road cut containing Sylamore was studied, and Sylamore blocks (float) along the edge of Beaver Lake were examined. In addition, the United States Army Core of Engineers provided a small diameter core (used in assessing the Beaver Dam site) for examination. The 18 cores and outcrops were sampled, and 179 standard and large thin sections were made of the samples. The thin sections were described using a petrographic microscope, with almost half being point counted (500 point) for mineralogical composition. Macroscopic core description colors were described using the GSA Rock-Color Chart (Goddard et al., 1948). Supplemental information (core analysis) concerning the porosity and permeability on three Grant County cores was provided by Gearhart (Halliburton) Industries Petrophysical Laboratory.

LOCATION OF CORES STUDIED

Figures 4a, 4b, 4c, and 4d show the location, by county, of the cores utilized for this study. The numbers associated with each core/sample correspond to the same number on the figures. The cores examined from Kansas include: 1) Western Petroleum- Hoffman 1, Edwards County; 2) Mabee-Shell- Friesen 5, McPherson County; 3) Mabee-Shell- Nikkel 5B, McPherson County; 4) Amerada- Wilson 1, Reno County; 5) Derby- Sperling 1, Harvey County; 6) Shaffer- Steele 1, Harvey County; 7) Shell- Duerkson 1, Harvey County; and 8) Commonwealth- Farber 1A, Sedgewick County. The cores utilized from Oklahoma are: 9) Park Avenue Exploration- Jane 1-25, Alfalfa County; 10) W.H. Davis- Cox 1, Grant County; 11) D&J Oil- Daisy 1-17, Grant County; 12) D&J Oil- Sunflower 1-8, Grant County; 13) D&J Oil- Wade 1-8, Grant County; 14) FCD- Mary A1, Garfield County; 15) FCD- Roberts 1-18, Garfield County; 16) Federal Petroleum- Wolleson 1, Noble County; and 17) Tenneco- Swen 1-16, Oklahoma County. The road cut, shallow core, and lakeside float of the Sylamore Sandstone described is from Carroll County, Arkansas (18).

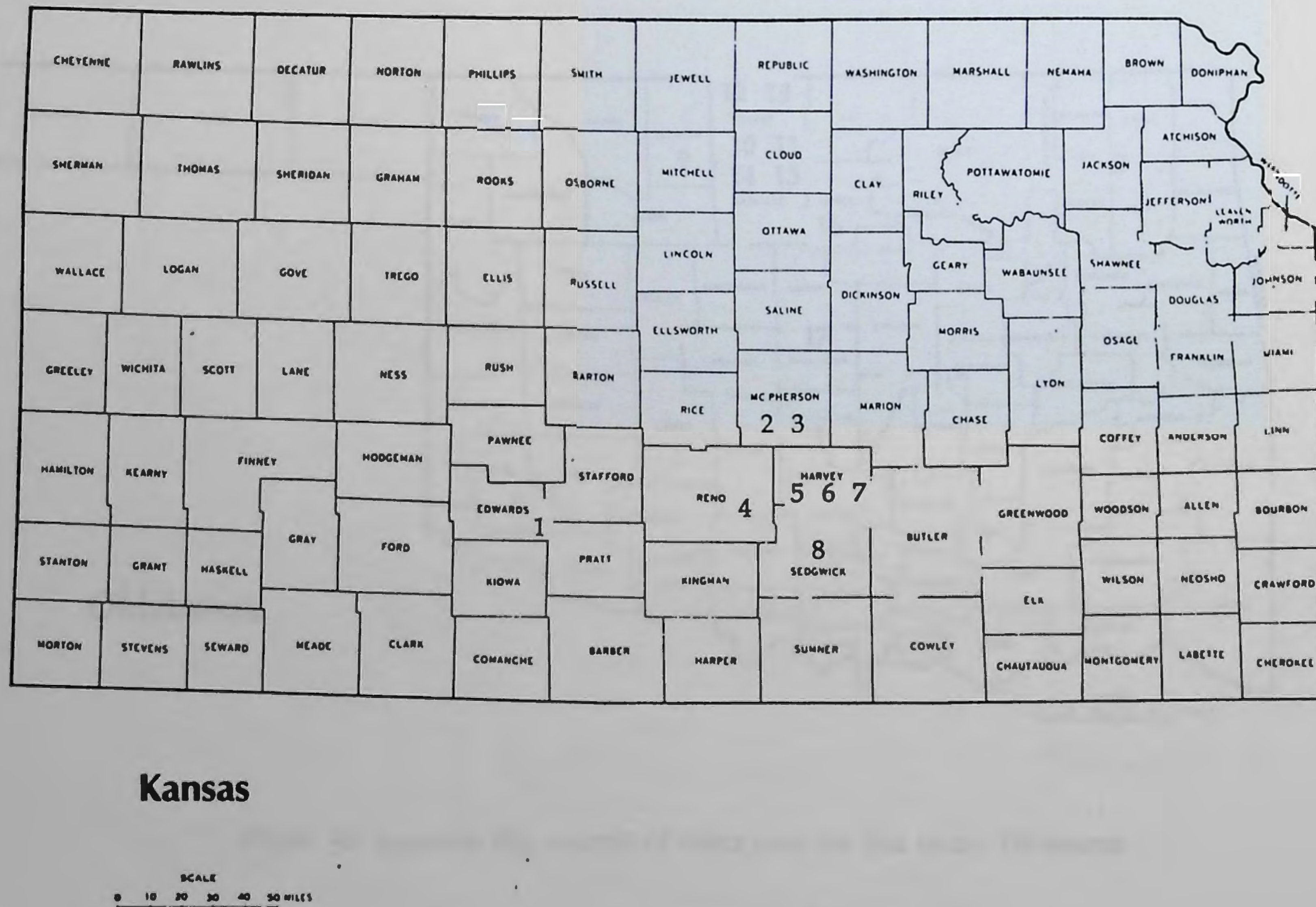


Figure 4a- Location (by county) of cores used for this study: Kansas

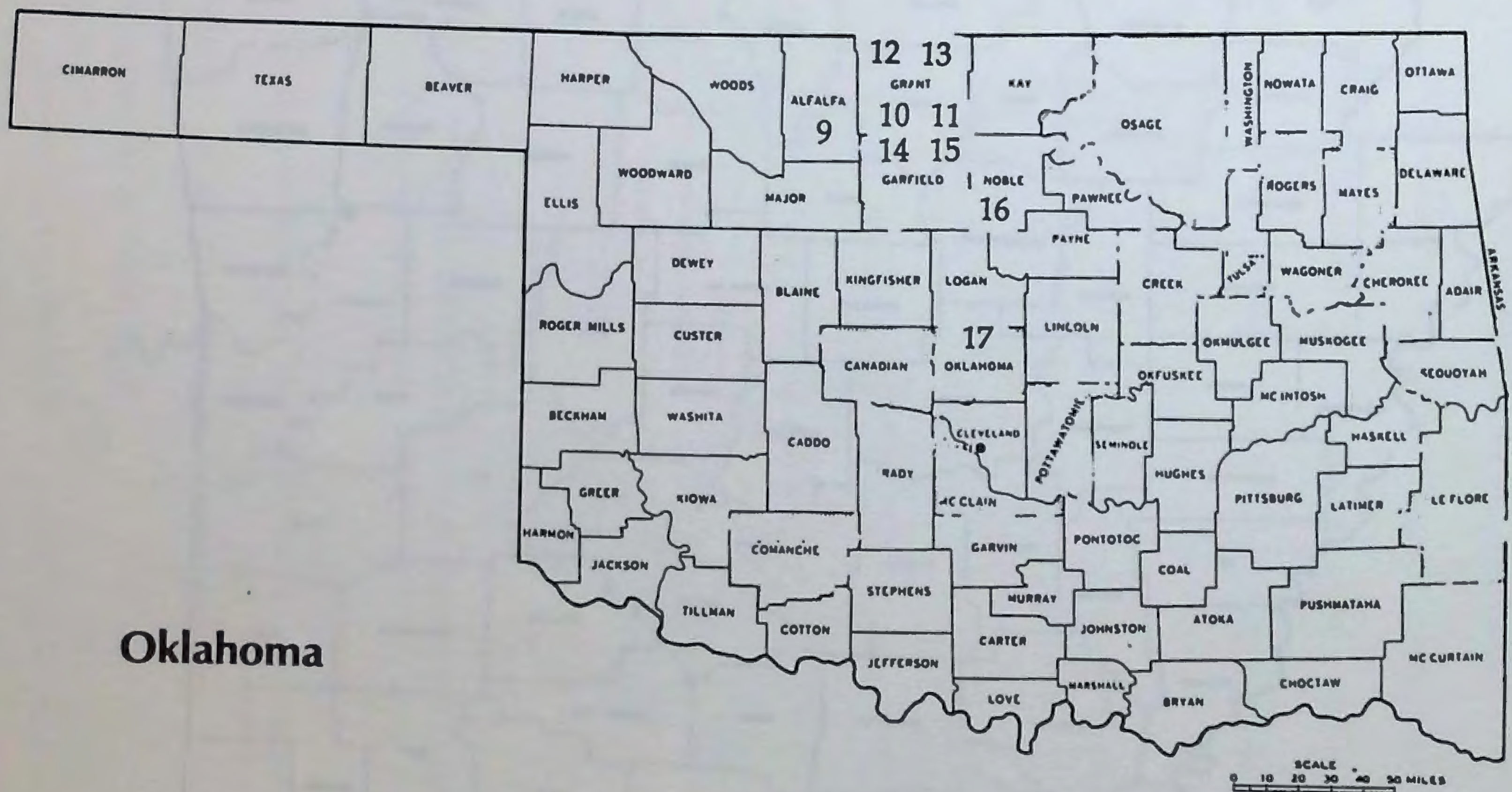


Figure 4b- Location (by county) of cores used for this study: Oklahoma

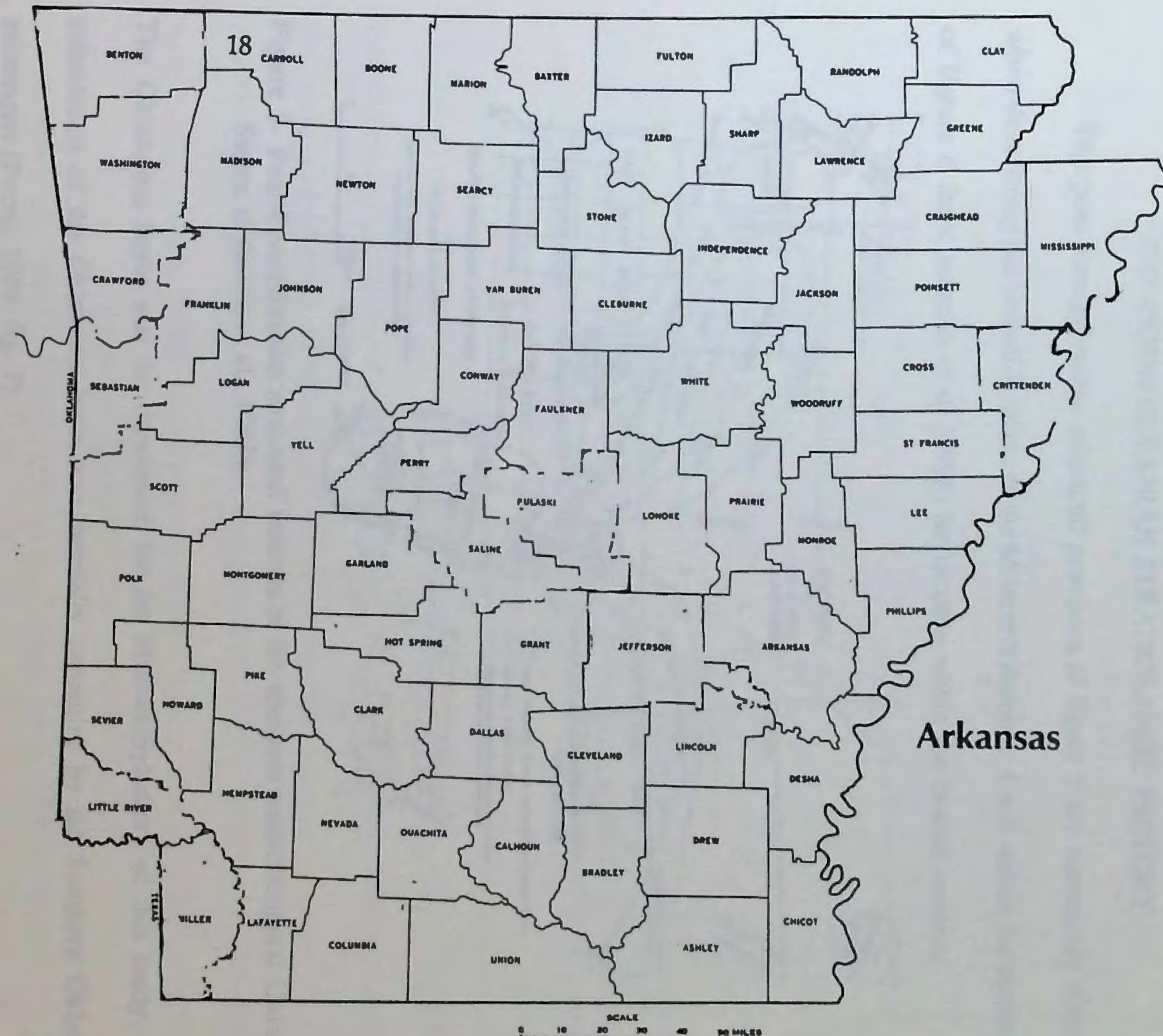


Figure 4c- Location (by county) of cores used for this study: Arkansas

PRE-PENNSYLVANIAN STRATIGRAPHIC HISTORY

The post-Pennsylvanian structural provinces of figure 5 are commonly referred to when describing the basinal location of the Misener/Sylamore. I will utilize the terminology of Figure 6 from Johnson et al. (1988) for location within the basinal context.

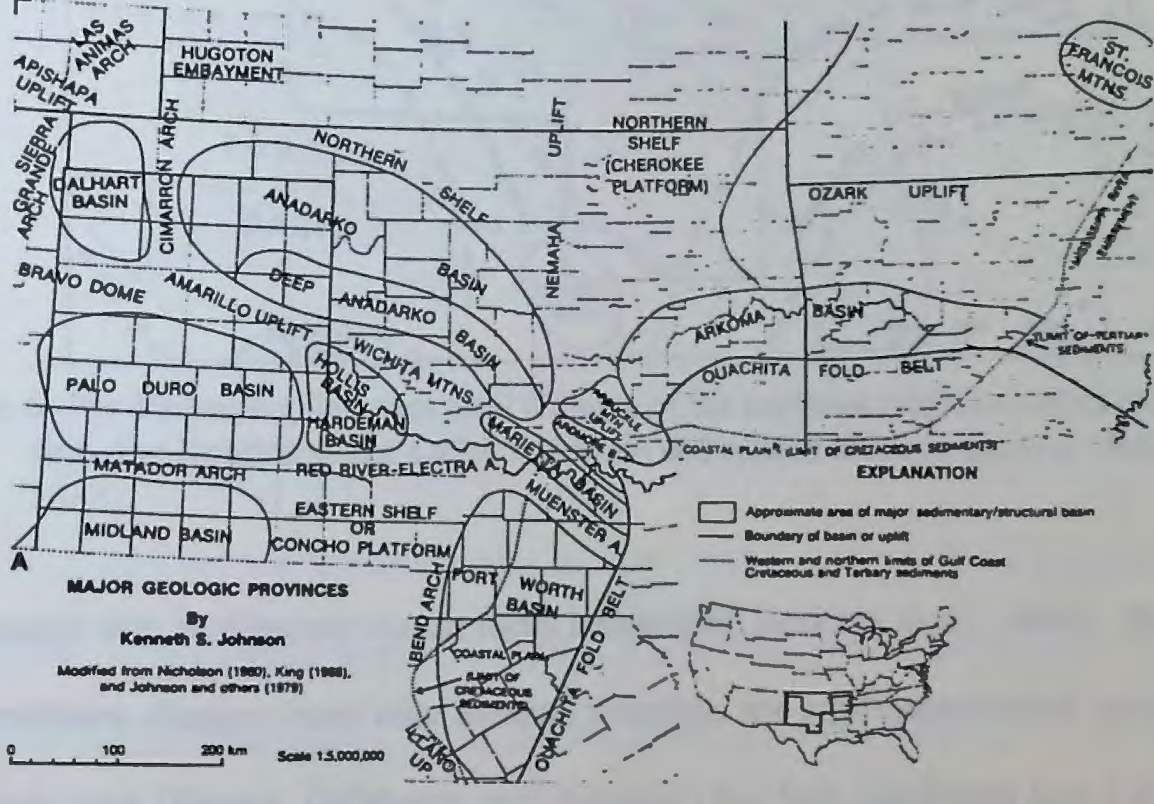


Figure 5- Post-Pennsylvanian structural features of the southern midcontinental United States (Johnson et al., 1988).

The Oklahoma basin was the depocenter for the Misener/Sylamore of this study. The subsidence of the Oklahoma basin was thermally controlled by the Southern Oklahoma aulacogen (Perry, 1989, fig. 7).

Pre-Pennsylvanian rocks of the Oklahoma basin are laterally persistent and ubiquitous, and consist primarily of shallow-marine carbonate rocks (limestone and

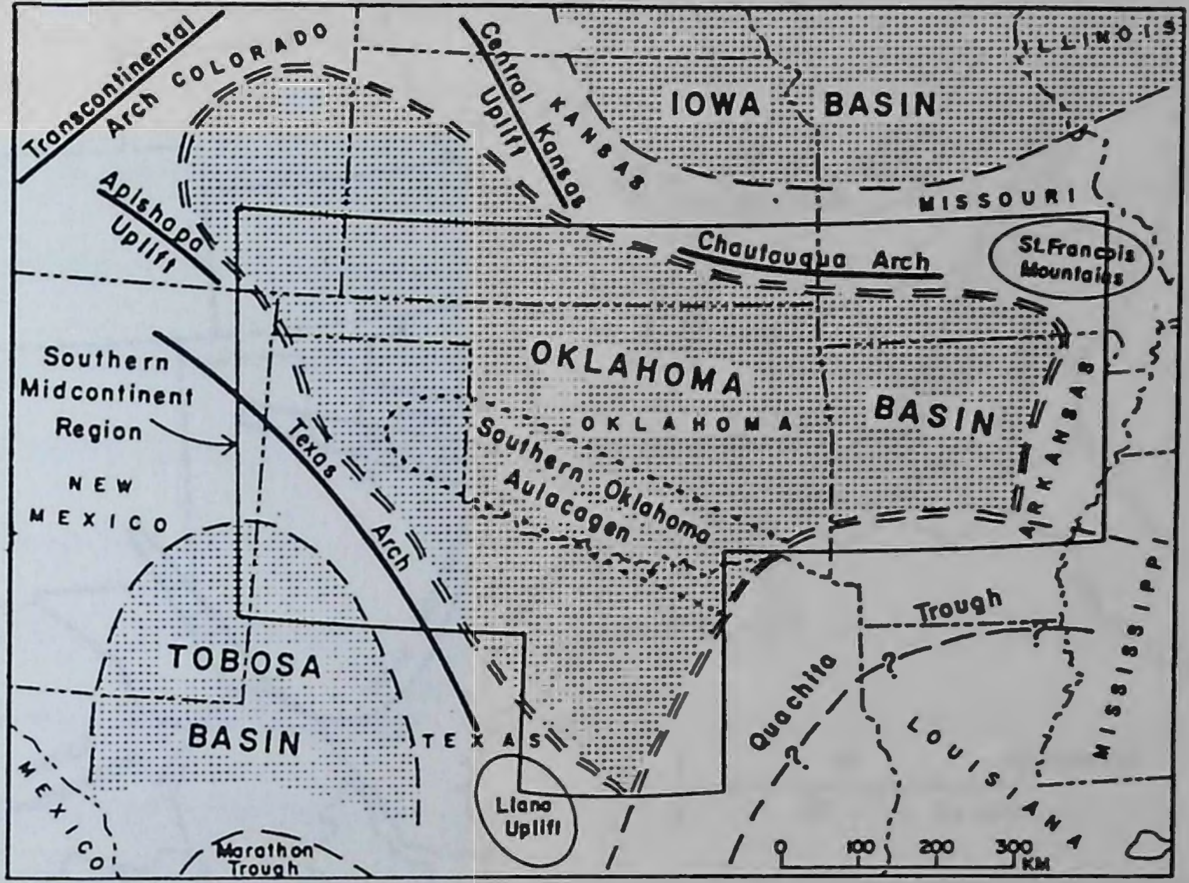


Figure 6- Pre-Pennsylvanian structural features of the southern midcontinental United States showing location of the Oklahoma basin and related tectonic features (Johnson et al., 1988).

dolostone) with terrigenous clastic rocks interbedded (Johnson et al., 1988). Stratigraphic nomenclature changes from state to state, therefore, the pre-Pennsylvanian stratigraphy of the study area (Kansas, Oklahoma, and Arkansas) has been condensed into a depositional history using the events outlined in Johnson et al. (1988), along with the sequence terminology of Sloss (1988). A regional stratigraphic correlation chart is shown in Plate 1.

Proterozoic through Middle Cambrian (Sauk I)

Basement rocks of the Proterozoic through Early Cambrian time crop out prominently in three areas; The St. Francois Mountains in southeast Missouri, and the Wichita and Arbuckle mountains of southern Oklahoma. Only rocks from the St. Francois Mountains can be considered a source for the Misener because the Arbuckle and Wichita

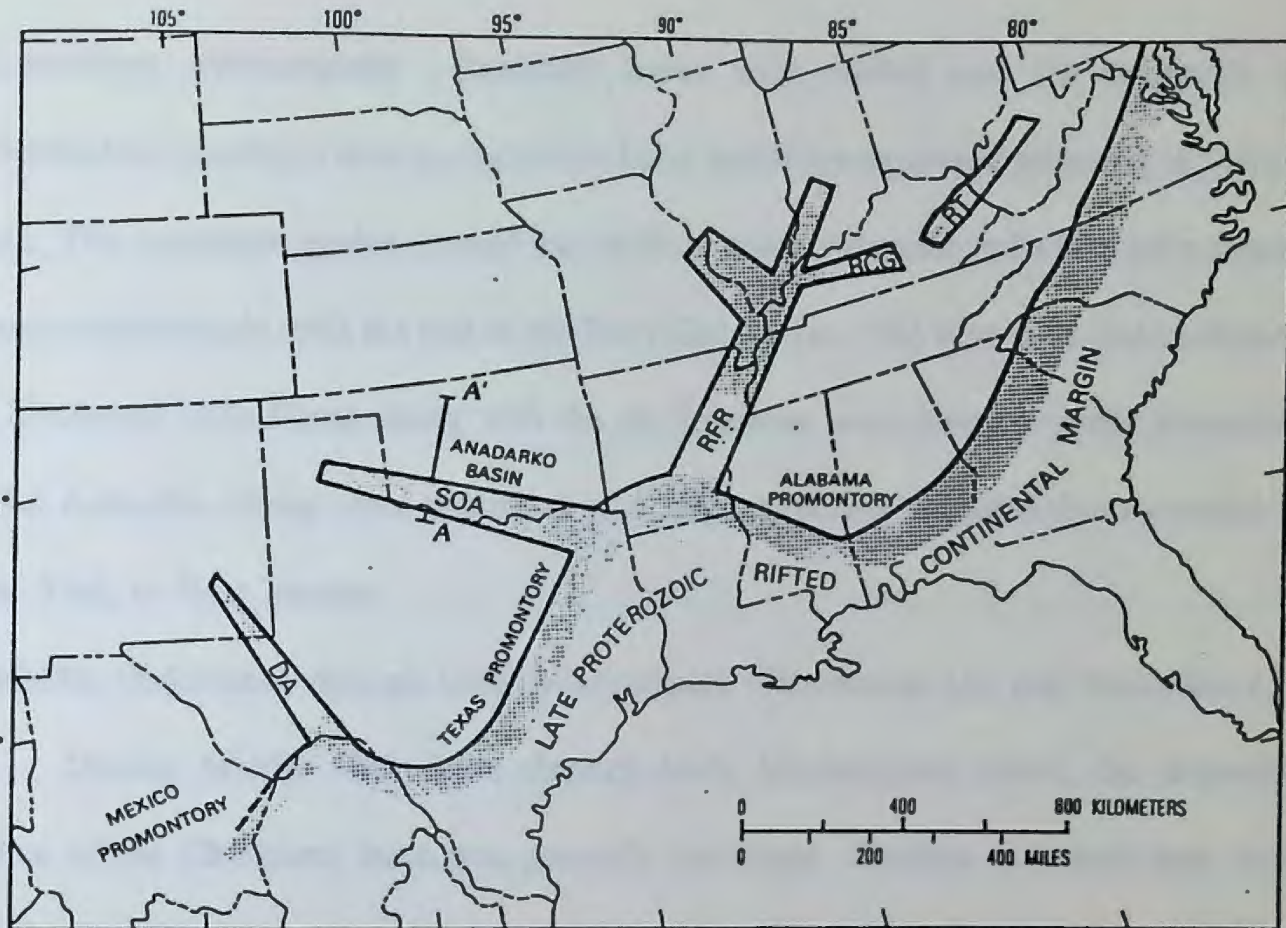


Figure 7- Late Proterozoic rift margin of the southern United States (Perry, 1989).
DA- Delaware aulacogen; RCG- Rough Creek graben; RFR- Reelfoot rift; RT- Rome trough; SOA- southern Oklahoma aulacogen.

Mountains are Pennsylvanian features. During Proterozoic time, granitic igneous material was either extruded or emplaced at shallow depths. Epizonal comagmatic granites related to rhyolites cover vast areas. There are also small amounts of low-rank metasedimentary rocks, and possibly up to 30,000 feet (9,800 m) of relatively undisturbed Proterozoic layered rocks in southwest Oklahoma. Basaltic rocks occur as dikes and sills but represent a small percentage of the total volume. Crustal thinning and resulting rifting during the Cambrian resulted in emplacement of rocks composed of granite, rhyolite, gabbro, and basalt, which occur from southern Oklahoma to the Texas Panhandle.

Middle Cambrian through Early Ordovician (Sauk II, Sauk III)

During Middle to Late Cambrian, transgressive seas progressed north and west across the southern Midcontinent. Basement rocks were eroded and the sediments were redistributed, creating a time transgressive basal sandstone deposited primarily in low-lying areas. The sandstone grades upward into shallow water carbonate rocks that were deposited almost continuously until the end of the Early Ordovician. The limestone and sandstone of the Timbered Hills Group along with the six limestone units (two are partly dolomitized) of the Arbuckle Group were deposited on a large carbonate platform that extended from New York to New Mexico.

Middle Ordovician through Early Mississippian (Tippecanoe I,II, and Kaskaskia I,II)

During Middle Ordovician through Early Mississippian times, the depositional regime of the Oklahoma basin was generally consistent. Shallow carbonate seas with an abundant benthic fauna were disrupted at some places by the influx of fine-moderately coarse clastic material that was introduced from the east. Two major Devonian epeirogenic events, broad upwarpings with maximum uplift along the flanks of the Oklahoma basin, interrupted the depositional cycles. The first was the pre-Frisco-Sallisaw uplift, the second was the pre-Woodford/Chattanooga uplift. These upwarpings led to removal of some pre-Devonian strata, primarily along the edge of the basin. The Oklahoma basin consists of five major stratigraphic units from the Middle Ordovician through the Lower Mississippian; the Simpson Group (Tippecanoe I), the Viola Group (Tippecanoe I), the Sylvan/Cason Shale (Tippecanoe I and locally II), the Hunton Group (Tippecanoe I and II, early Kaskaskia I), and the Woodford Shale/Chattanooga Group (Kaskaskia I and II). Shallow-water marine carbonate rocks are predominant in the Viola and Hunton groups. Deposition of these carbonate rocks was disrupted by the introduction of terrigenous clastics during the

Simpson, Sylvan/Cason, and Woodford/Chattanooga events. The Simpson Group (Middle to Upper Ordovician) contains large percentages of sand, silt, and clay size detritus, including multicycle sand grains (exemplified by such strata as the Saint Peter Sandstone). The amount of carbonate content changes throughout the group. The Viola and Simpson groups are characteristic of poorly aerated, shallow-water deposits. The Sylvan/Cason Shale is gray and grades vertically into increasingly dolomitic shale. The Upper Ordovician base of the Hunton Group is an oolitic facies that is widely distributed within the Oklahoma basin. This oolitic limestone is overlain by low mud content skeletal limestone of the Chimneyhill Sub-group. The volume of terrigenous clastic material increased during the Late Silurian (Henryhouse Formation) and Early Devonian (Haragan-Bois d'Arc formations). In the northern and western parts of the Anadarko basin Upper Ordovician through Lower Devonian strata are moderately to intensely dolomitized. After deposition of Lower Devonian (Gedinnian) strata, the area was uplifted and eroded, and transgression of the Kaskaskia I seas deposited the Frisco, Sallisaw, Penters Chert, and Clifty formations. Widespread erosion marked the Middle Devonian of the Midcontinent, and transgression of the Woodford/Chattanooga seas (Kaskaskia I) began deposition of the time transgressive Misener/Sylamore Sandstone and concurrently the Woodford/Chattanooga Shale. Figures 8 and 9 show the surface exposures of the formations upon which the Misener/Sylamore and Woodford/Chattanooga were deposited in Kansas and Oklahoma. Woodford/Chattanooga rock ranges from a black, radioactive, organic rich anoxic facies in parts of the area, to red and green oxygenated facies in others.

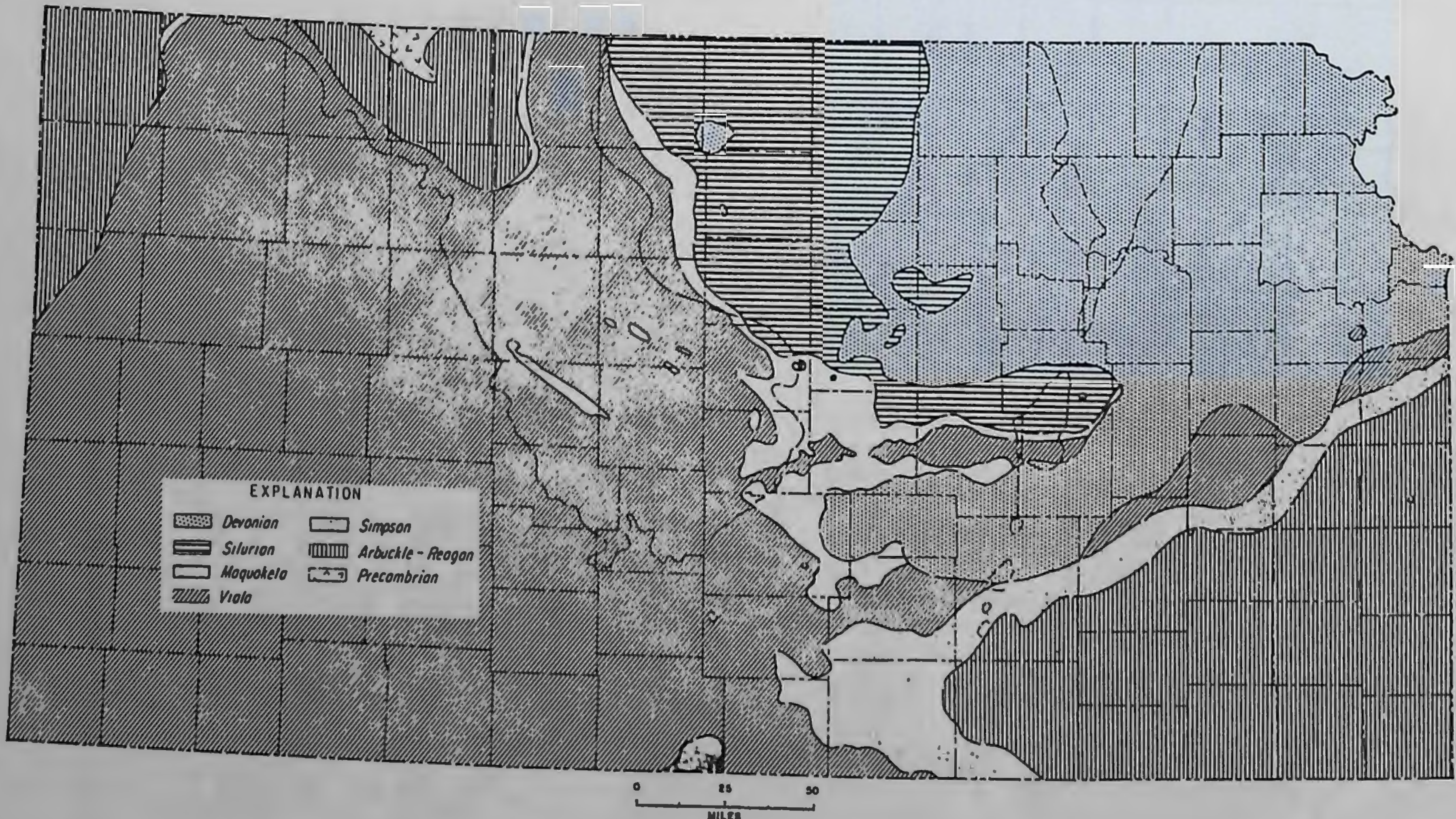


Figure 8- Map showing distribution of pre-Chattanooga rocks in Kansas (Merriam, 1963).

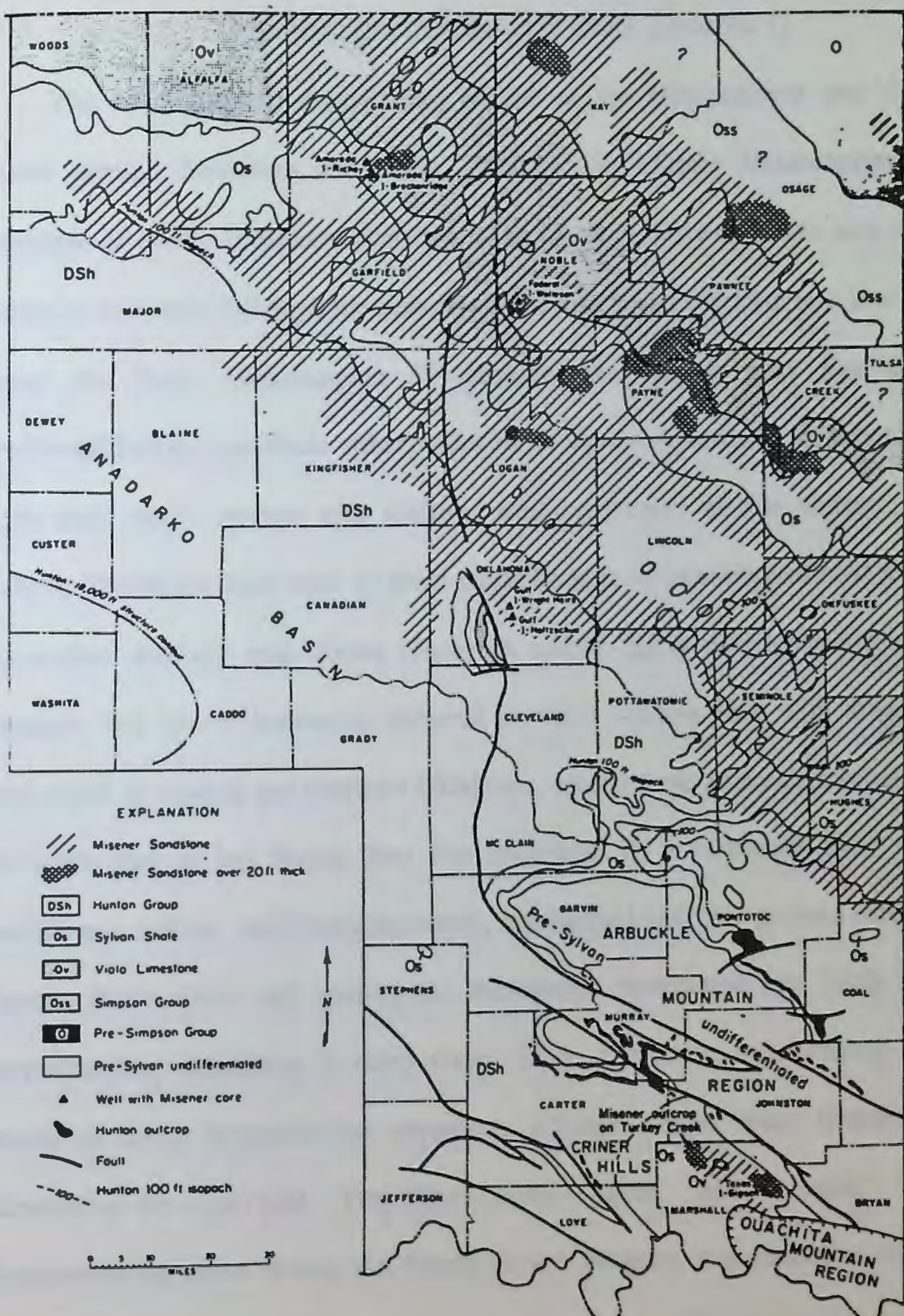


Figure 9- Pre-Woodford rocks of north-central Oklahoma (Amsden & Klapper, 1972).

Mississippian (Kaskaskia II, early Absaroka I)

The Mississippian depositional regime of the Midcontinent was dominated by shallow marine limestone and shale. During the Middle Mississippian widespread deposition of cherty limestone occurred. The Ozark uplift and Texas arch were positive features at this time, although the majority of the area was a platform or a low-energy shelf. During the Early Mississippian (Tournaisian) the euxinic seas that deposited the Woodford/Chattanooga Shale either withdrew or were oxygenated. At this time vast parts of the area were covered with shallow, well-oxygenated marine waters. Central and southern Oklahoma lack most of these strata because of post-depositional erosion. Later Tournaisian through mid-Visean (Early to middle Early Mississippian) deposition of limestone and cherty limestone occurred in warm shallow seas with abundant oxygen. Local uplift in central and southern Oklahoma, eroded these strata shortly after deposition. The latter part of the Visean also was dominated by a carbonate shelf which formed fossiliferous, oolitic, and cherty limestone, interbedded with fine grained siliciclastic rocks. Eustatic fluctuations and epeirogenic movements interrupted late Early Mississippian (Serpukhovian) deposition in many areas. Shale, limestone, and marginal sandstone are present in lower Serpukhovian sequences, although deeper water limestone and shale characterize the upper part. Post-Mississippian uplift and erosion affected the aforementioned strata during the Pennsylvanian orogeny, and created a widespread pre-Pennsylvanian unconformable surface at the Mississippian/Pennsylvanian boundary.

GEOLOGIC SETTING

It was during the Devonian that forests, insect-like arthropods, sharks, and land-living vertebrates first appeared (Stokes, 1982). The evolution of fish during this time led to the dominance of bony and cartilaginous fish by the Late Devonian, and competition along with changing environments drove certain lobe-finned fishes onto land, leading to the earliest amphibians (Stokes, 1982). Stokes (1982) noted that the development of vascular tissue (which conducts sap and nutrients), cellulose and lignin (made possible large, upright trees), and true leaves and root systems during the Devonian allowed for rapid spread of vegetation on the continents. By the close of the Devonian the plants had adapted well enough to create the first forests (i.e. New York State), and by the Early Mississippian these floral elements had spread to the continental interiors (prior to that being limited to stream valleys and shores) so that the coal swamps of the Carboniferous were possible (Stokes, 1982). Invertebrates were dominated by stable and abundant levels of corals, bryozoans, brachiopods, gastropods, coiled cephlapods, and bivalves, whereas the trilobites, inarticulate brachiopods, and graptolites were on the decline (Stokes, 1982).

The tectonic events that are important in considering the setting during the deposition of the Misener/Sylamore are the Antler orogeny (western United States) and the Acadian orogeny (eastern North America, figure 10). According to Ziegler (1989), the Antler orogeny began in Late Devonian (Frasnian) and continued through Early Carboniferous (Namurian). Westward movement of the North American plate during the Devonian to

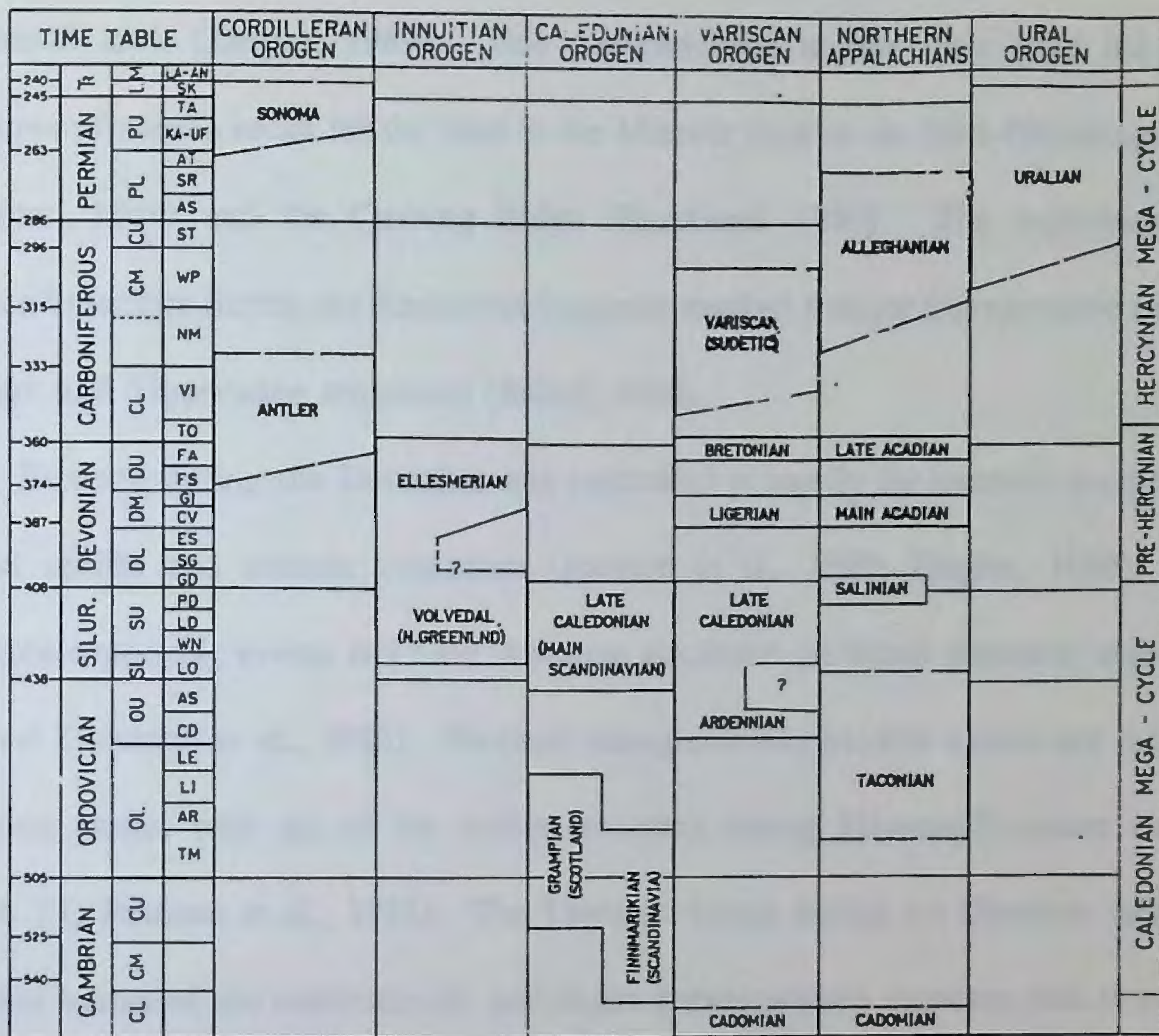


Figure 10- Correlation chart of Paleozoic tectonic events (Ziegler, 1989).

Early Mississippian led to vulcanism, eastward thrusting, and deformation of the Antler basin (Oldow et al., 1989), manifesting itself as the Klamath and Sierra Nevada mountains in Nevada and California. The Acadian orogeny can be divided into two pulses; the main pulse was late Early to Middle Devonian (Emsian to Givetian), and the late Acadian pulse was Late Devonian to Early Mississippian (Famennian to Tournaisian, Ziegler, 1989). The Acadian orogeny affected rocks as old as the Precambrian when multiple terrane docking events thrust the rocks westward (Rast, 1989). The compressional tectonics that led to deformations in the west (Antler) and in the east (Acadian) also influenced the Midcontinent by reactivating regional features such as the Ozark and Nashville domes, and the Transcontinental arch (Ziegler, 1989). This compressional regime may have led to local exposures of source rocks for the sand in the Misener such as the Ellis-Chautaugua arches (Hilpman, 1969) and the Cushing Ridge (Baurfiend, 1980). The deposition of the Misener/Sylamore during the Kaskaskia Sequence marked a major transgressive event after the Sauk and Tippecanoe sequences (Balley, 1989).

Eustacy during the Devonian was controlled primarily by tectonic events such as thermal uplifts and oceanic vulcanism (Johnson et al., 1985; Ziegler, 1989). Middle Devonian evaporitic events and Late Devonian glaciation (in South America) also affected sea level (Johnson et al., 1985). Fourteen transgressive/regressive cycles are recorded in Devonian strata, with six of the cycles occurring during Misener/Sylamore deposition (Figure 11, Johnson et al., 1985). The Taghanic Onlap during the Givetian followed an erosional hiatus of the midcontinent, and began a transgressive sequence that is evident in North America and Western Europe (Johnson, 1985). It was during this transgression that deposition of the Misener/Sylamore and Woodford/Chattanooga began.

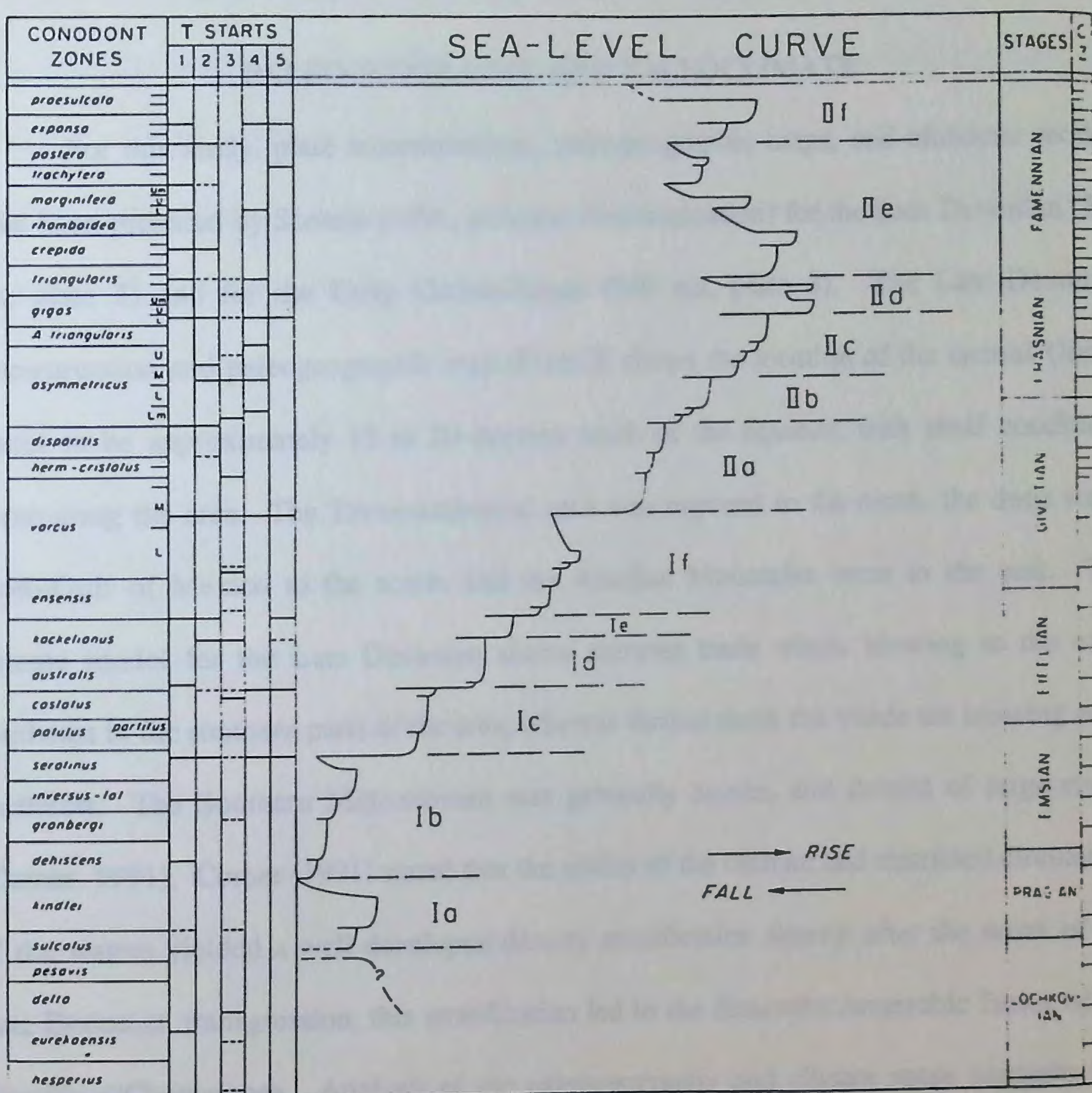


Figure 11- Eustatic curve for the Devonian, including conodont zones (Johnson et al., 1985).

PALEOGEOGRAPHY AND PALEOCLIMATE

For this study, plate reconstructions, paleogeographic maps, and climactic models have been prepared by Scotese (1991, personal communication) for the Late Devonian (363 ma, plate 2) and for the Early Carboniferous (340 ma, plate 3). The Late Devonian reconstruction and paleogeographic map (Plate 2) shows the location of the central United States to be approximately 15 to 20 degrees south of the equator, with shelf conditions dominating the area. The Transcontinental arch was exposed to the north, the deep water proto-Gulf of Mexico to the south, and the Acadian Mountains were to the east. The climate model for the Late Devonian shows summer trade winds blowing to the east-southeast in the southern parts of the area, whereas further north the winds are blowing east-northeast. The Southern Midcontinent was generally barren, and devoid of large rivers (Comer, 1991). Comer (1991) stated that the aridity of the climate and restricted circulation of the waters yielded a well developed density stratification shortly after the onset of the Late Devonian transgression; this stratification led to the disaerobic/anaerobic facies of the Woodford/Chattanooga. Analysis of the paleogeography and climate maps suggests that there was an absence of deep water near the eastern part of the study area. Hurricanes normally form in deep water and move to the west and north. The lack of deep water to the near east (due to onset of the Appalachian orogeny) would inhibit the occurrence of hurricanes, across the study area (Otto-Bliesner, 1992, personal communication). Marsaglia and Klein (1983) also suggest that hurricanes were probably scarce on the western side of

North America during the Devonian, but winter storms affected the area. The plate reconstruction and paleogeography for the Early Carboniferous (Plate 3) shows a slight clockwise rotation of North America, and that the Transcontinental arch was flooded. The climate model for the Early Carboniferous suggests that summer winds blew north-northwest over the study area. Conditions that possibly inhibited the formation of hurricanes during the Late Devonian persisted through the Early Carboniferous.

LITHOLOGY

Simpson Group- Middle Ordovician

The Simpson Group observed in this study is a quartzose sandstone interbedded with thin shale. The sandstone is white (N9) to light gray (N7), with the shale being very pale green (10 G 8/2). The terrigenous components range from clay to medium sand size (<.004-0.26mm); and are typically fine sand size (0.13mm). The particles are well to moderately sorted and well cemented (with minor silica). The unit is either massive or interbedded with shale. In the one well which Simpson is described, the upper contact with the Misener is not present.

Viola Group- Upper Ordovician

The composition of the Viola Group ranges from a fossiliferous dolostone to solution breccia with fossiliferous dolostone. The color of the dolostone and breccia is variegated and ranges from white (N9), very pale green (10 G 8/2), pale yellowish brown (10 YR 6/2), moderate brown (5 YR 3/4), dusky brown (5 YR 3/4), dark reddish brown (10 R 3/4), to dark gray (N3). The breccia contains fragments from clay to pebble size (<.004-40mm), is poorly sorted and poorly cemented. The dolostone is typically fossiliferous, massive to parallel bedded, cherty at places, with stylolites common. Where the upper contact with the Misener is present, it is generally sharp and undulose. The Viola appeared weathered in several of the cores.

Sylvan Shale- Upper Ordovician

The Sylvan Shale identified in this study is a dolomitic shale. The color is generally grayish green (10GY 5/2) to moderate green (5 G 5/6), with minor dusky brown (5 YR 2/2). The grain size ranges from clay to fine (<.004-.13mm) with phosphatic nodules up to pebble size (10-20mm). The shale is generally massive, with rare laminations. The upper contact is sharp and undulose, and in one core, the contact is bored and filled with sand from the overlying Misener.

Chattanooga/Woodford Group: Misener/Sylamore Formation
Middle-Upper Devonian

The Misener/Sylamore Member observed in this study consists of three different rock types; 1) quartzose sandstone, 2) dolostone (detrital dolostone grains), and 3) shale. Quartzose sandstone is the dominant lithology, but containes beds and laminations of shale and dolostone.

The thickness of the quartzose sandstone ranges from several centimeters up to 10 meters. The colors of the sandstone are: white (N9), very pale green (10 G 8/2), moderate green (5 G 5/6), grayish green (5 G 5/2), moderate yellow (5 Y 5/6), pale yellowish brown (10 YR 6/2), moderate brown (5 YR 3/4), dusky brown (5 YR 2/2), light brownish gray (5 YR 6/1), brownish gray (5 YR 4/1), light gray (N7), medium gray (N5), dark gray (N3), and black (N1). When observed in outcrop, parts of the Sylamore are dusky brown (5 YR 2/2) due to iron staining. Light to heavy oil staining colors intervals of the Misener are pale yellowish brown (10 YR 6/2) to dark gray (N3), respectively.

The detrital grains range from clay to pebble size (<0.004-20mm), and are typically fine to medium (0.13-0.26mm). The sorting ranges from very well to very poor (phi <0.05-

>2.0), and bimodal sorting is evident in some samples, overall the sandstone is well sorted. Cementation is well to poor (friable), with silica being the dominant cement, with minor calcite, dolomite, and clay matrix. The sandstone is generally massive, with a salt and pepper appearance due to the presence of fine to medium (0.13-0.26mm) phosphatic particles (plates 4 and 5). At places, dolomitic layers ranging from wavy beds centimeters thick up to several m thick are interbedded with the sandstone. Shale layers occur from thin lamina to one to two m thick within the sandstone. Stylolites and phosphatic clasts are common. Graded bedding, scour and fill and slump features are rare. Bioturbation is heavy to absent. The contact with the underlying unit is generally sharp and undulose, and incorporated subangular to rounded lithoclasts up to pebble size (20-30mm) from eroded underlying units (plate 6). The contact of the Misener Sandstone and the underlying Sylvan Shale is bored, with sand filling the borings into the Sylvan (plate 7). Internal contacts within the sandstone range from gradational with the dolostone to sharp (sometimes undulose) with shales. The upper contact with the Woodford/Chattanooga shale is typically sharp and planar. A layer of pyrite, within the sandstone, up to five cm thick is common at the upper contact. In several cores from Grant County, Oklahoma, glauconite is abundant just below the pyrite layer, and this layer is several cm thick (plate 7).

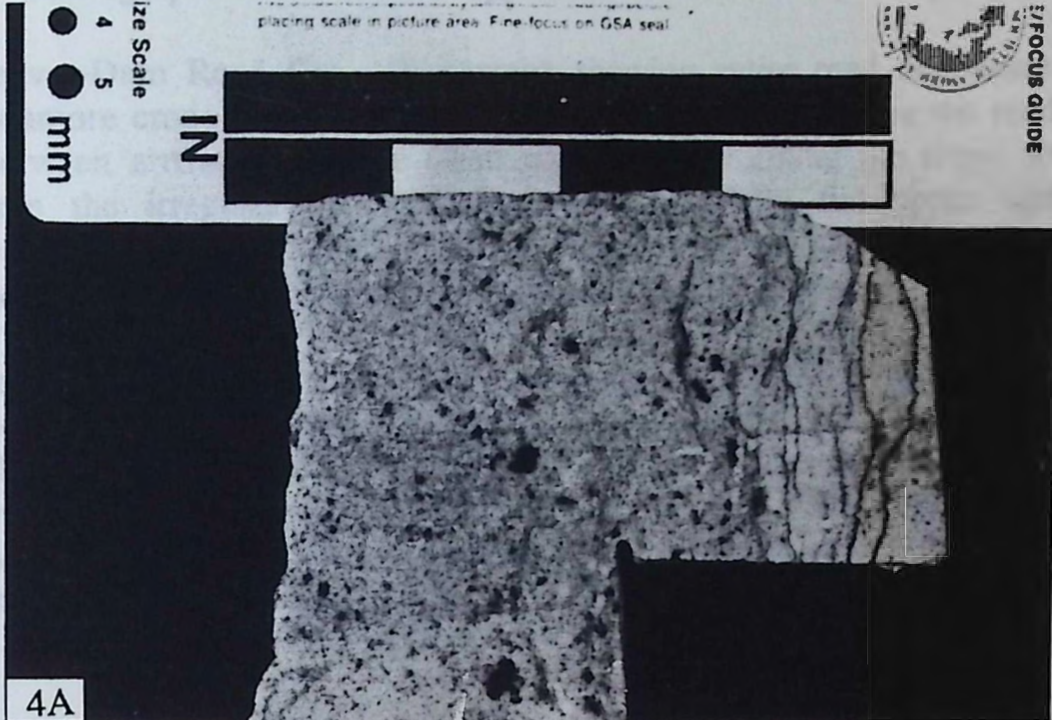
Dolostone within the Misener/Sylamore member ranges from wavy beds a few centimeters thick to massive beds up to 10 m thick. The color of the dolostone is: pale yellowish brown (10 YR 6/2), light brownish gray (5 YR 6/1), light gray (N7), and dark gray (N3). The size of the dolostone ranges from 0.05-0.25mm, and is typically euhedral to subhedral. The dolostone contains quartz, and minor amounts of glauconite. The quartz

PLATE 4

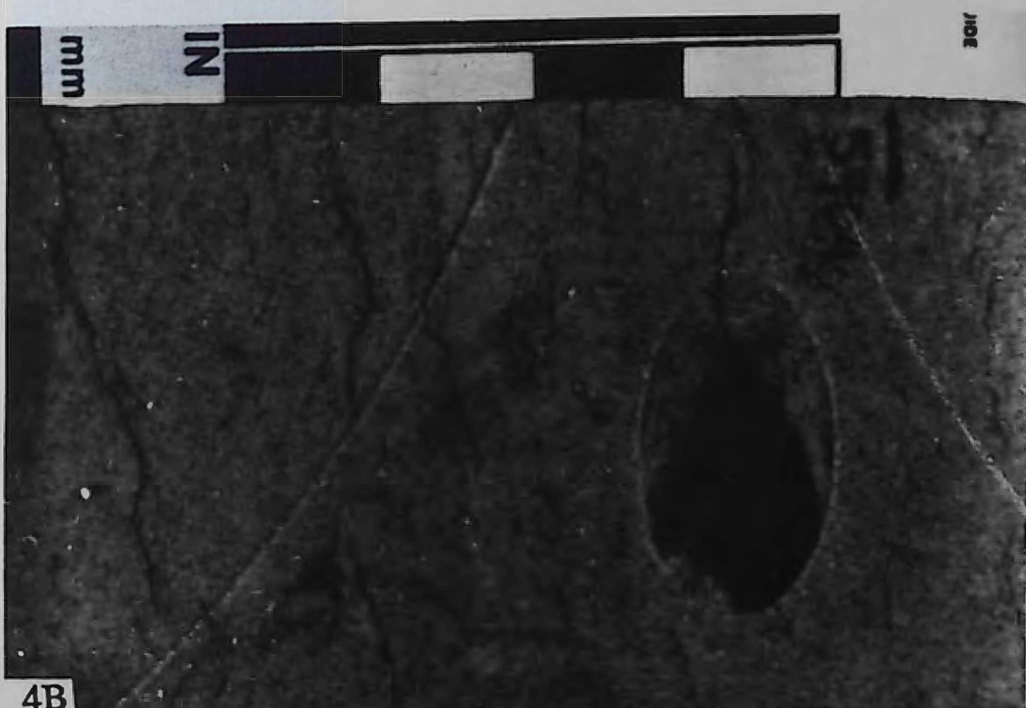
Photographs showing massive to speckled look of the Misener.

4A. W.H. Davis- Cox 1: 5931′. Massive appearance of the Misener with phosphatic grains giving a salt and pepper appearance. Note layer towards bottom which is lighter colored and lacks phosphate grains. This lower layer has more dolomite. Scale shown in photograph. Top of core is to right of photo.

4B. D&J Oil- Wade 1-8: 5904′. Massive appearance of the Misener with wispy stylolites. Scale shown in photograph. Top of core is to right of photo.



4A



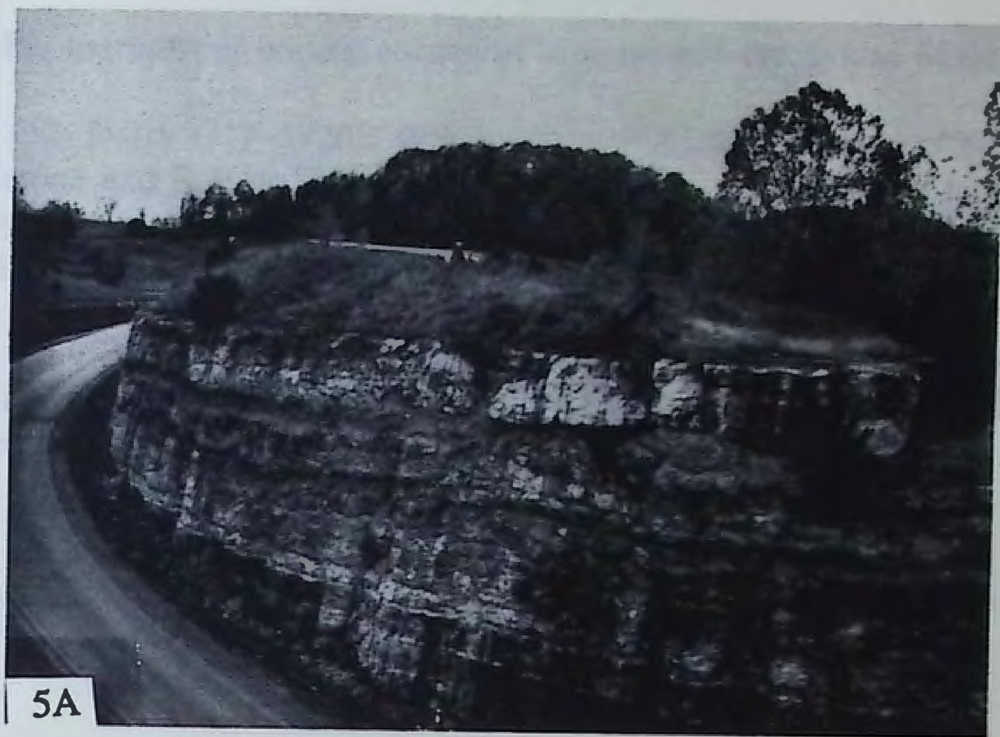
4B

PLATE 5

Photographs of the massive appearance of the outcrop of Sylamore.

5A. Beaver-Dam Road Cut. Photograph showing entire road cut where the Sylamore crops out. The Sylamore is the rock body capping the road cut (between arrows), with the Chattanooga Shale forming the slope above. Note the irregular bottom surface and essentially flat upper surface, suggesting that the Sylamore fills topographic lows. The thickness of the Sylamore between the arrows is approximately 1.6 meters.

5B. Beaver Dam- Road Cut. Close up photograph of the Sylamore interval (between arrows). Note the bedding planes (arrows) within the Sylamore where bioturbation, cementation, and staining are the only apparent distinguishing features separating the internal layers. The slope above the Sylamore is the Chattanooga Shale. The Sylamore in the photograph is approximately 1.3 meters thick.



5A

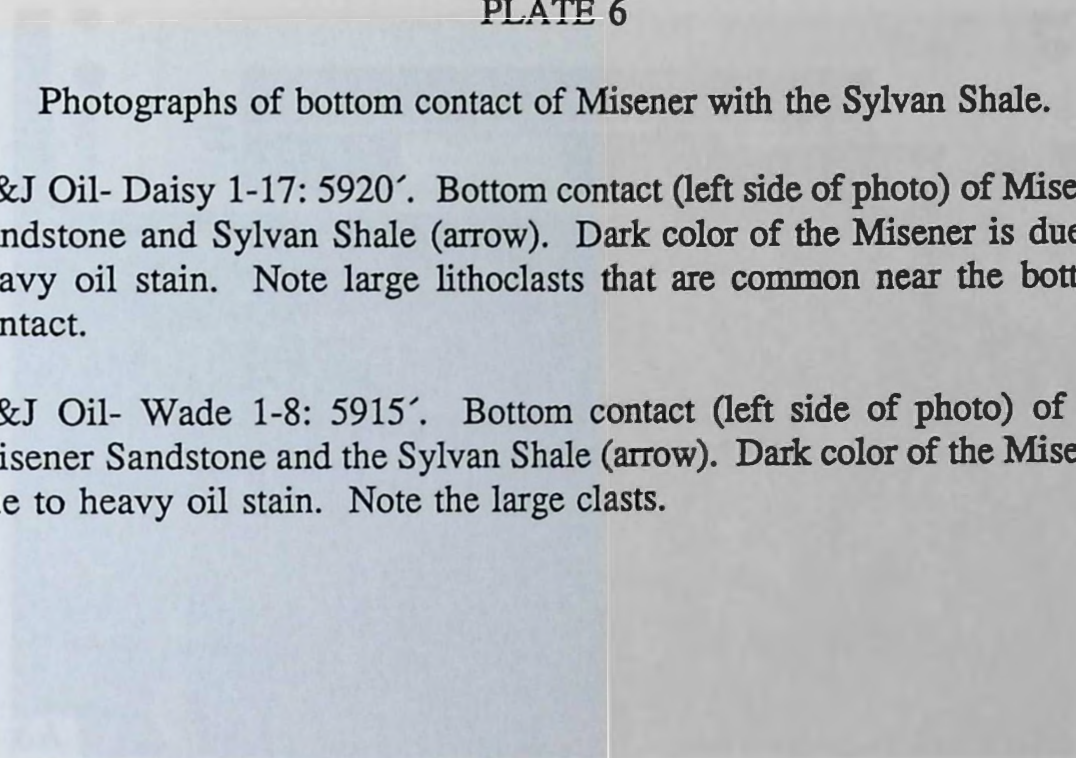
5B

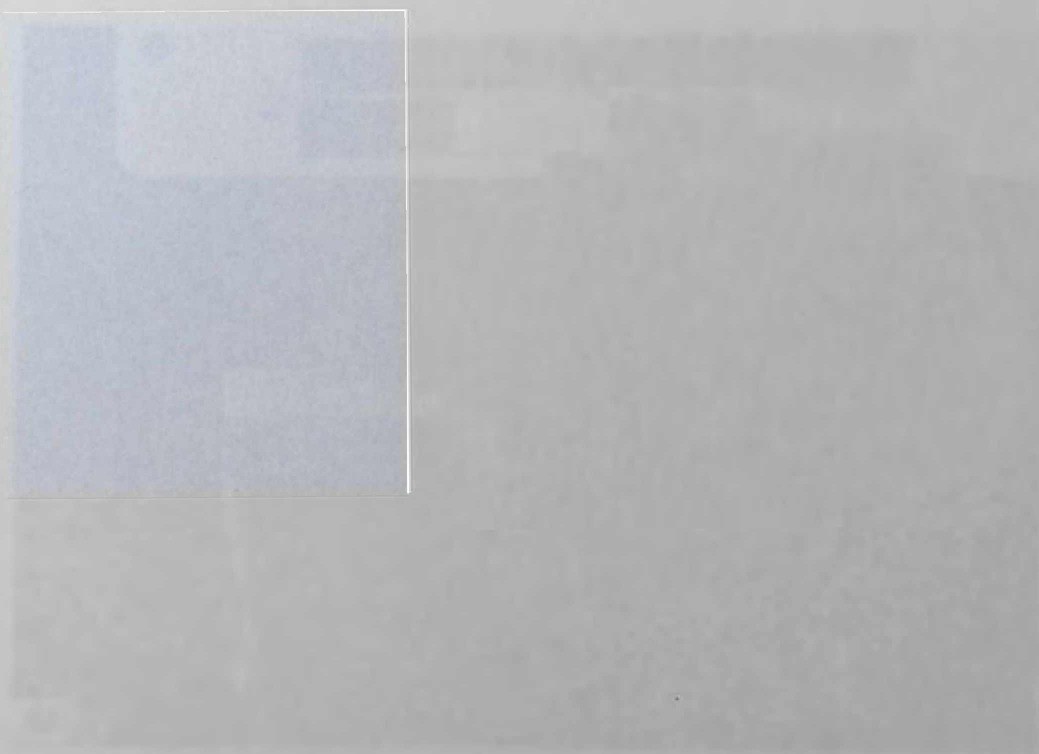
PLATE 6

Photographs of bottom contact of Misener with the Sylvan Shale.

6A. D&J Oil- Daisy 1-17: 5920´. Bottom contact (left side of photo) of Misener Sandstone and Sylvan Shale (arrow). Dark color of the Misener is due to heavy oil stain. Note large lithoclasts that are common near the bottom contact.

6B. D&J Oil- Wade 1-8: 5915´. Bottom contact (left side of photo) of the Misener Sandstone and the Sylvan Shale (arrow). Dark color of the Misener due to heavy oil stain. Note the large clasts.



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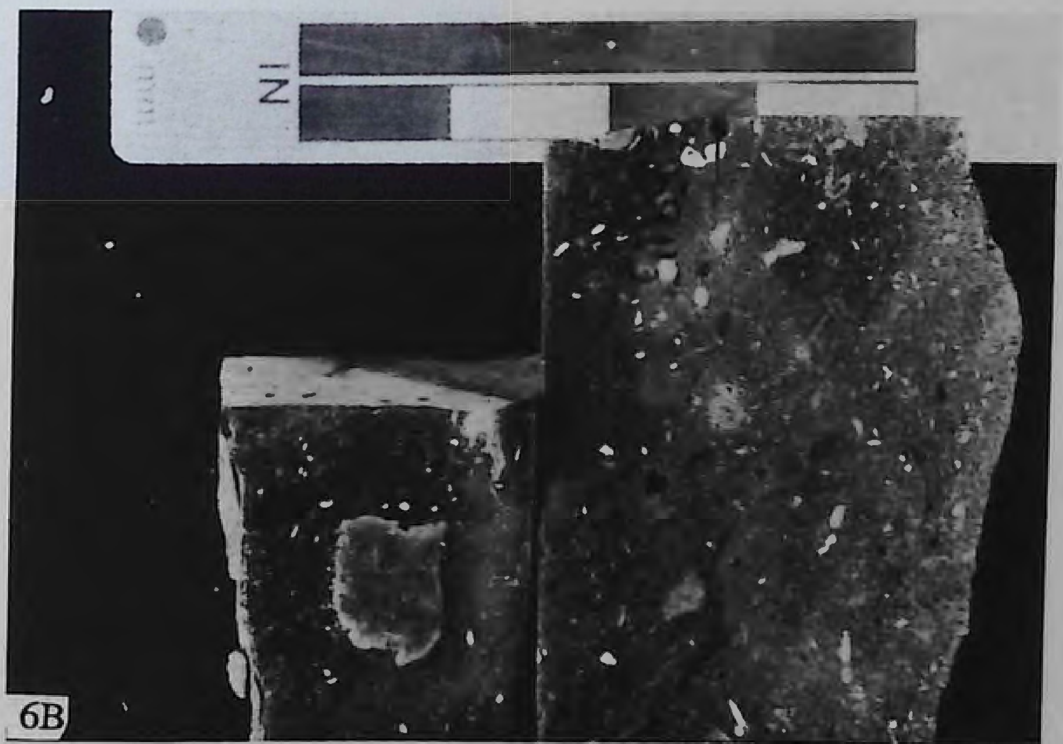
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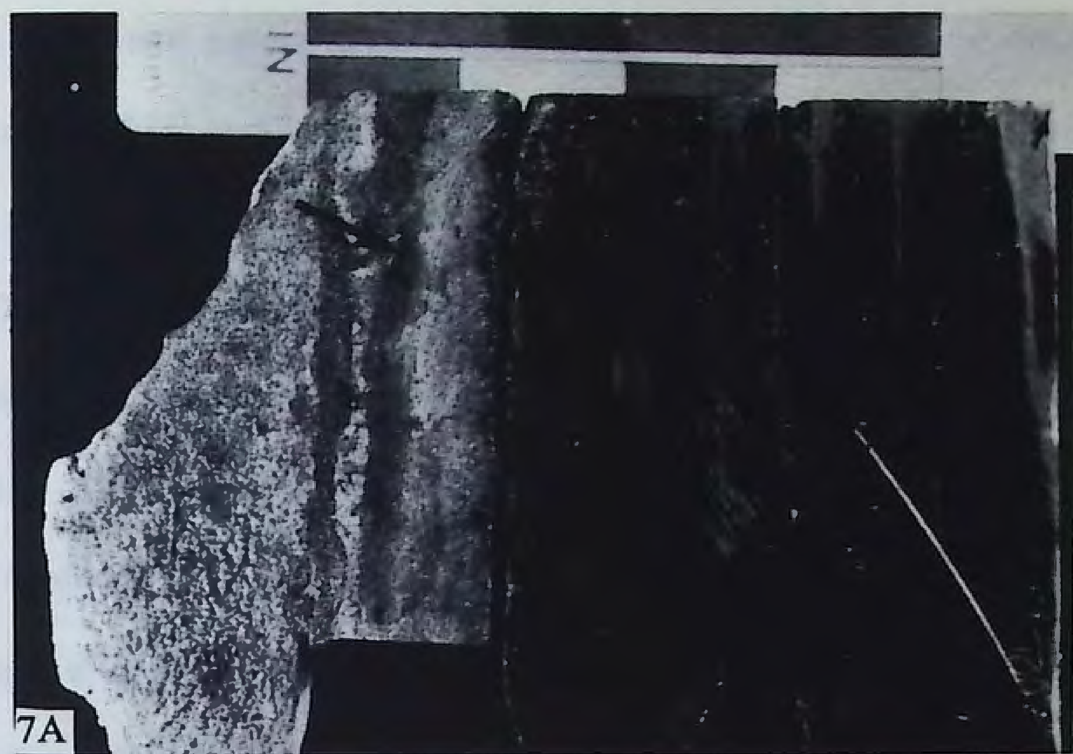
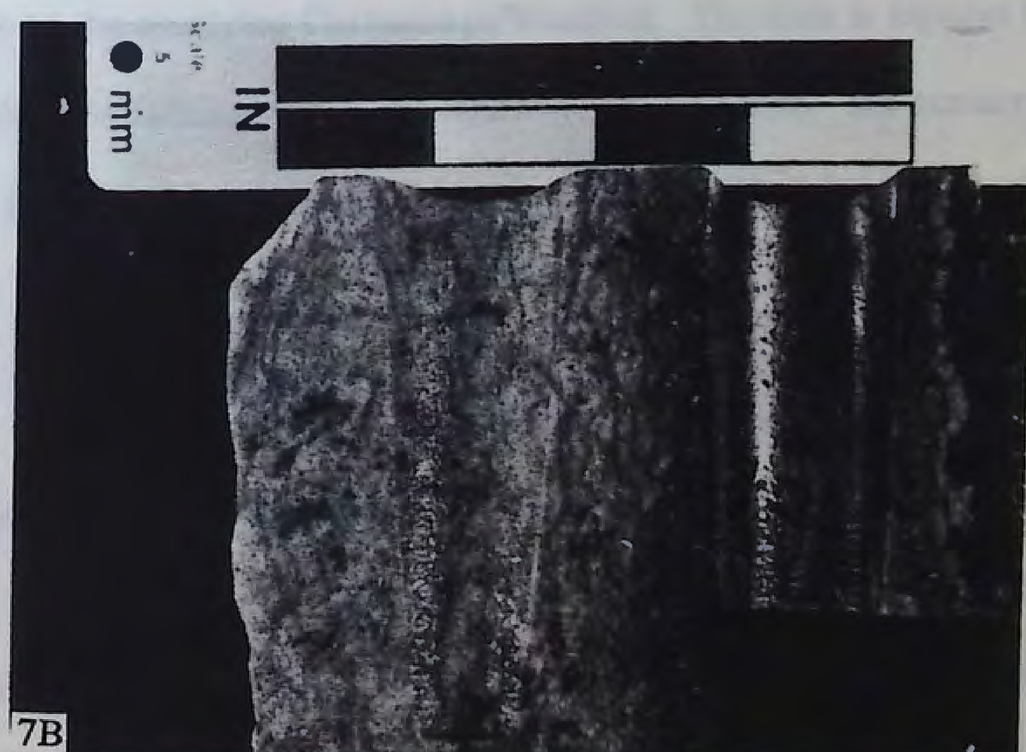
PLATE 7

Photographs of the upper contact between the Misener and the Woodford Shale.

7A. D&J Oil- Wade 1-8: 5900′6″. Upper contact of the Misener Sandstone and the overlying Woodford Shale. Note the dark and massive appearance of the Woodford, followed by the pyrite layer (between arrows), then the glauconite rich bottom (G). Scale is shown in photograph. Top of core is to right of photo.

7B. D&J Oil- Daisy 1-17: 5909′. Upper contact of the Misener and the Woodford. The pyrite layer (between arrows) is followed by a glauconite rich layer (G). Scale is shown in photograph. Top of core is to right of photo.


IN
7A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either floats in a dolomitic matrix, or forms discrete layers within the dolostone. Shale layers up to one-two meters thick, are commonly interbedded with the dolostone. The dolostone ranges from parallel to wavy laminated/bedded to massive. Bioturbation is heavy to absent, and stylolites are common. The contacts with the shale are generally sharp and parallel. The contacts with the sandstone range from sharp to gradational.

Shale intervals within the Misener/Sylamore are several centimeters to one-two meters thick. The color of the shale is: moderate green (5 G 5/6), grayish green (5 G 5/2), moderate brown (5 YR 3/4), dusky brown (5 YR 2/2), dark reddish brown (10 R 3/4), medium gray (N5), and dark gray (N3). The detrital grains within the shale range from clay to coarse size (<0.004-0.5mm), and are generally well sorted. Bioturbation is commonly absent, with rare slight burrowing. The shale contains pyrite and is typically similar in appearance to the overlying Chattanooga/Woodford. The shale is massive to parallel and wavy bedded and laminated with the sandstone and dolostone. The contacts are primarily sharp and planar. Load structures are present, but are rare at the contact of the sandstone and shale.

Chattanooga/Woodford Group: Chattanooga/Woodford Formation
Upper Devonian-Lower Mississippian

The Chattanooga/Woodford Shale observed in this study ranges in thickness from one to 30 m. The color of the shale is typically dusky brown (5 YR 2/2)-dark reddish brown (10 R 3/4)-black (N1), with minor moderate green (5 G 5/6), dusky yellowish green (10 GY 3/2), moderate olive brown (5 Y 4/4), and dark gray (N3). The clastic components are clay to fine size (<0.004-0.13mm), and generally well sorted. The dark brown to black color of the shale reflects its high organic content. The shale is typically massive (mudstone/claystone) and commonly discrete thin laminae of pyrite. Burrowing is observed in the lighter colored shale in Kansas, but is otherwise absent. The lower contact with the Misener/Sylamore is sharp.

TERRIGENOUS (EXTRABASINAL) COMPONENTS

The detrital particles are predominantly subrounded to well rounded, with moderate to high sphericity. The average grain size ranges from coarse to very fine sand size, sorting is well to poor, with bimodal grain size distribution evident in some samples (plate 8). Therefore, the maturity of the samples ranged from immature to supermature.

Monocrystalline Quartz

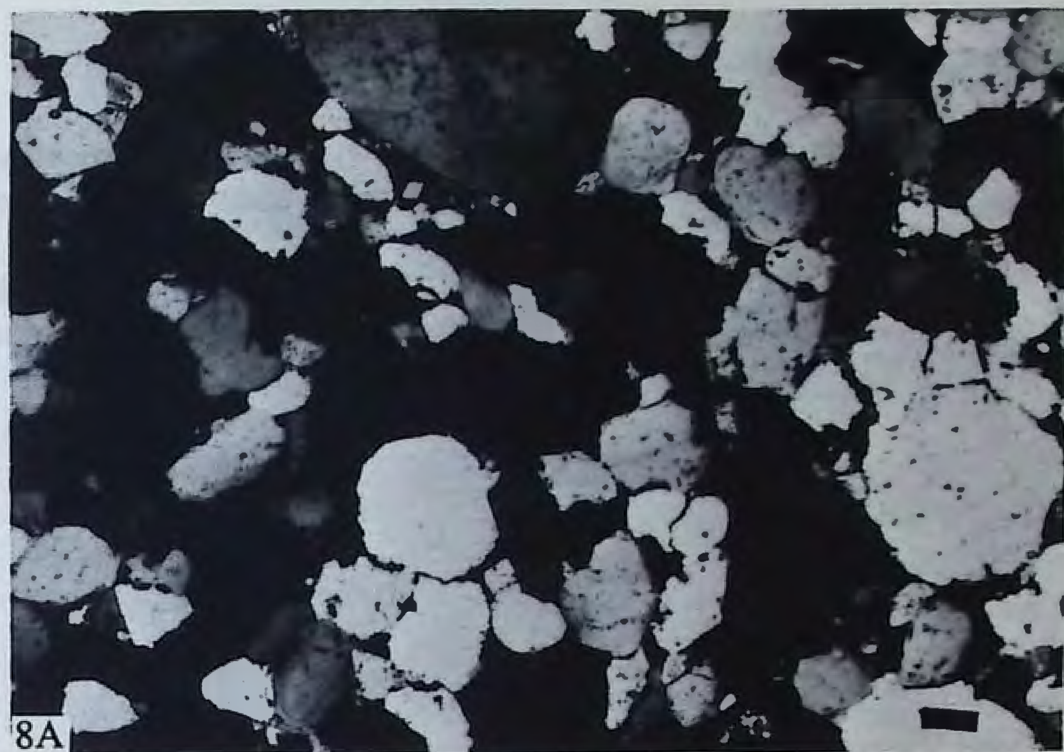
The dominant detrital component is monocrystalline quartz, with sharp to slightly undulose extinction ranging from a small percent to almost the entire sample (plate 8). The average size of the monocrystalline quartz ranges from very fine to coarse grained sand size (0.07-0.5mm). Inclusions within the quartz are rare, and consist of tourmaline, zircon, and fluid inclusions aligned into linear trains (plate 9). Previous writers (eg. Amsden & Klapper, 1972; Bauerfiend, 1980; Pittenger, 1981, Shelton et al. 1989) have suggested that the source of the quartz for the Misener was the Ordovician Simpson Group. Evidence cited by the investigators included the presence of linear bubble trains in the quartz crystals within the sandstones of the Simpson and the Misener. These features mark healed fractures typical of plutonic quartz (Wolff, 1991; Schieber, 1991; personal communications), and therefore are not good links between the Simpson Group and the Misener. Quartz within the Misener is typically subrounded to well rounded, indicating a probable multicycle history. The rounding of the quartz, combined with the exposure of the Simpson Group at the Ozark dome (Shelton et al., 1989), Chautauqua arch (Cameron, 1986), and Cushing

PLATE 8

Photomicrographs of rocks showing monocrystalline quartz and bimodal sorting.

8A. Shaffer- Steele 1: 3348′. Poorly sorted sample showing predominance of monocrystalline quartz. Scale bar 0.25mm, 4x, crossed-nicols.

8B. D&J Oil- Sunflower 1-8: 5921′6″. Sample showing bimodal grain distribution, consisting primarily of monocrystalline quartz with syntaxial silica overgrowths. Note dolomite (d) and degraded oil (arrow) filling pores, and conodont fragment (c) in upper right part of photo. Scale bar 0.25mm, 4x, plane light.



8A

8B

PLATE 9

Photomicrographs of rocks containing inclusions within quartz.

9A. Tenneco- Swen 1-16: 6461.5′. Well sorted sample showing quartz with tourmaline inclusion (arrow). Scale bar 0.25mm, 10x, plane light.

9B. D&J Oil- Sunflower 1-8: 5920.5′. Well sorted sample with silica overgrowths evident. Note linear bubble trains within quartz grain in center of photo (arrow). Scale bar 0.25mm, 10x, plane light.


9A


9B

ridge (Bauerfiend, 1980), during Late Devonian strongly suggests Simpson Group provenance.

Polycrystalline quartz

Traces of sedimentary chert fragments and metamorphic quartz are present in some rocks (plate 10). The chert fragments are typically subrounded to well rounded and silt to medium sand size (0.05-0.26mm); and range from only a few grains to absent. The metamorphic fragments are also subrounded to well rounded, and range in size from very fine sand to pebble sized gravel (0.07-20.0mm). Some of the metamorphic fragments were identified as metaigneous by Wolff (1991, personal communication). Pettijohn et al. (1987) stated that quartz arenites (multicycle sands) usually contain well rounded chert grains.

Feldspar

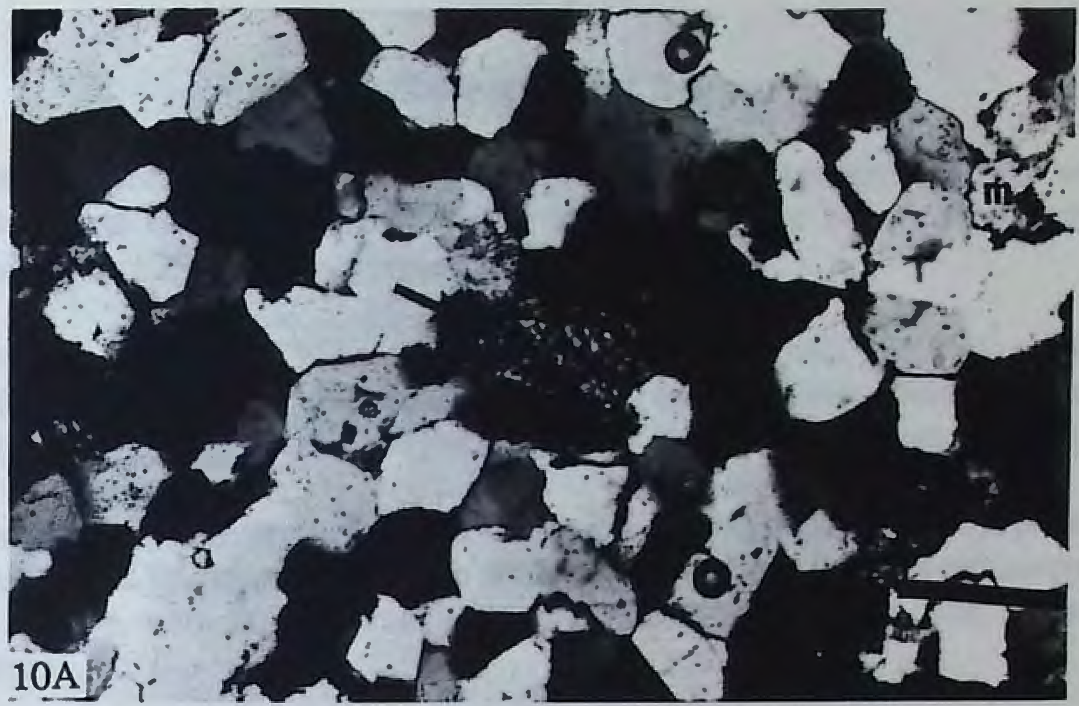
Feldspar is present in very small amounts, typically less than one percent. Potassium feldspar is far more prevalent than plagioclase feldspar, and is usually subrounded to well rounded and of very fine to fine (0.07-0.13mm) grain size (plate 11). The potassium feldspar is generally pristine, showing little evidence of chemical weathering, or post-depositional diagenesis. The well rounded feldspar grains, and the pristine appearance (both potassium and plagioclase) probably indicate a weathering and transport history that was dominated by mechanical processes; because feldspars usually do not survive many erosion/deposition events, the small percentages indicate multicycle history. Bauerfiend (1980), who performed X-ray diffraction analysis on both Misener and Simpson sand samples, reported potassium and plagioclase feldspar content from two to four percent within the Simpson. The smaller percentage of feldspar within the Misener relative

PLATE 10

Photomicrographs of rocks with chert and metamorphic rock fragments.

10A. Western- Hoffman 1: 4543′. Well sorted sample with well rounded, chert in the center (arrow). Metamorphic rock fragment (m) visible in upper right corner. Scale bar 0.25mm, 10x, crossed-nicols.

10B. Commonwealth- Farber 1A: 3535′. Poorly sorted sample with metamorphic rock fragment (m) to left of photograph. Note well rounded plagioclase feldspar grain (arrow) in middle of photo. Scale bar 0.25mm, 10x, crossed-nicols.


m
10A


m
10B

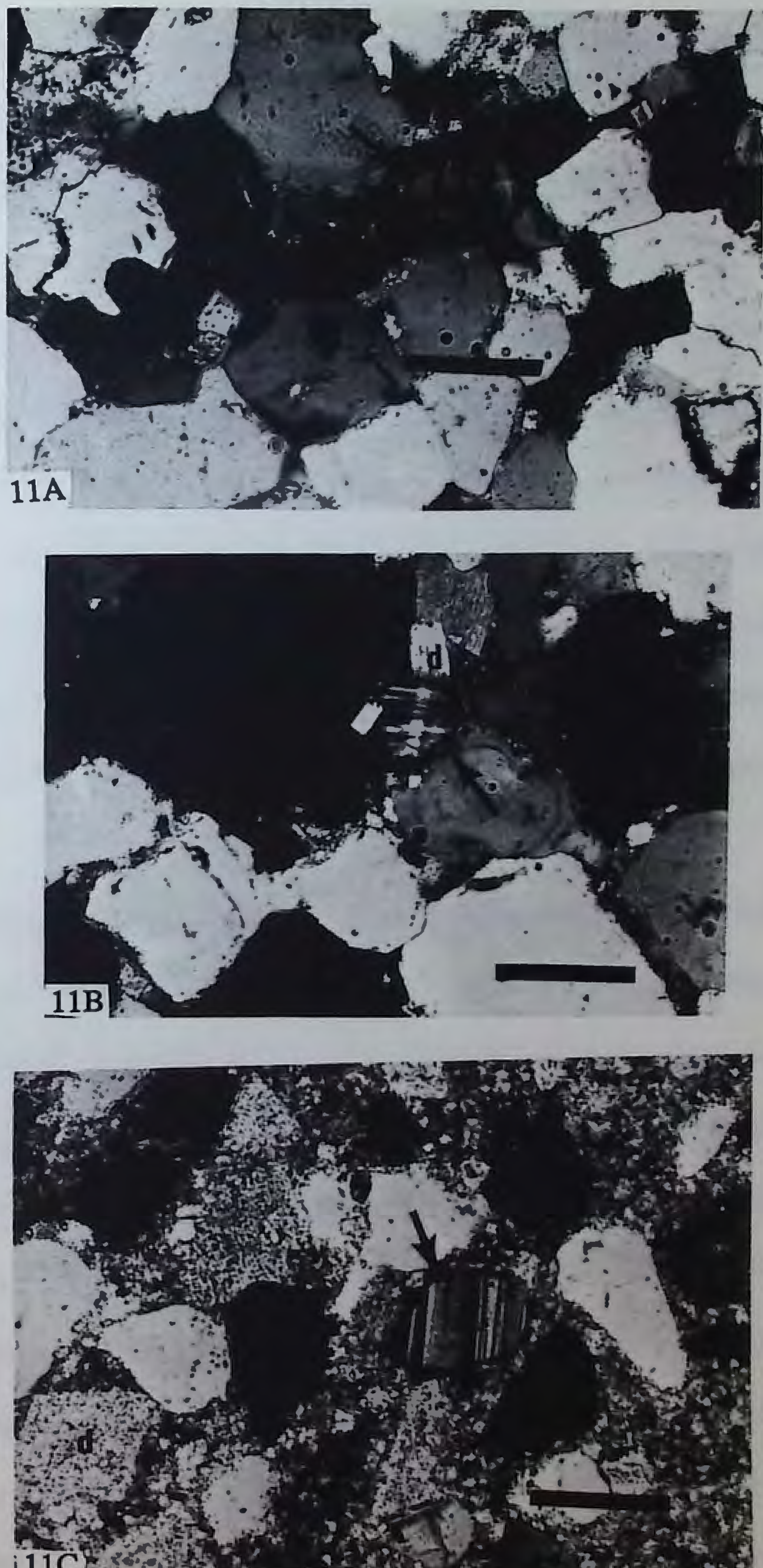
PLATE 11

Photomicrographs of feldspars

11A. Shell- Duerkson 1: 3486′8″. Sample showing potassium feldspar with microcline twinning (arrow) that is well rounded but not heavily altered. Scale bar 0.25mm, 10x, crossed-nicols.

11B. Shaffer- Steele 1: 3348′. Poorly sorted rock with well rounded, pristine potassium feldspar with microcline twinning (arrow). Note dolomite rhombs (d) forming adjacent to feldspar. Scale bar 0.25mm, 10x, crossed-nicols.

11C. Mabee-Shell- Friesen 5: 3750′. Dolomitic sample with well rounded, pristine plagioclase feldspar (arrow) with albite twinning. Note dolomite replacement of sample, with large rhombs (d) to left. Scale bar 0.25mm, 10x, crossed-nicols.


11A
d
11B
d
11C

to the Simpson suggests that the feldspar content was reduced by multicycle erosion and deposition events. Post-depositional alteration of some of the feldspars will be discussed in the diagenesis section.

Mica

Mica is extremely rare in the rocks examined, being absent from almost all samples except those described from the contact between the Chattanooga and Misener in Oklahoma (plate 12). Muscovite mica is present in trace amounts just below the contact of the Chattanooga and the Misener, in Garfield County, Oklahoma. It is possible that the rare occurrence of mica within the Misener/Sylamore sequence reflects the multicycle nature of the rock body, with the numerous erosion and transportation events destroying the mica grains. Mica was not mentioned as a constituent by previous investigators.

Phosphate

Phosphatic material is a common detrital component, typically making up less than five percent of a sample. The grains are usually larger than the surrounding quartz, and range in size from very fine sand to pebble sized gravel (0.07-20mm, plate 13). Pebble size-phosphate delineates bedding surfaces in samples and outcrop. Where the phosphatic placers occur within the Misener/Sylamore sequence, the layer may mark either storm reworking, or other high energy events such as transgressive events. Horner and Craig (1982) proposed that phosphate concentrated along bedding surfaces within the Syalamore is possibly storm related, and that the phosphate was derived from Ordovician phosphate-bearing strata, a conclusion supported by Francis (1988). An opposing theory was put forth by Walker (1986), who suggested that the phosphate came from upwelling waters to the

PLATE 12

Photomicrographs of rocks containing mica.

12A. FCD- Mary A1: 6385′. Sample showing muscovite mica (arrow) near upper contact of Misener/Woodford. Scale bar 0.25mm, 10x, plane light.

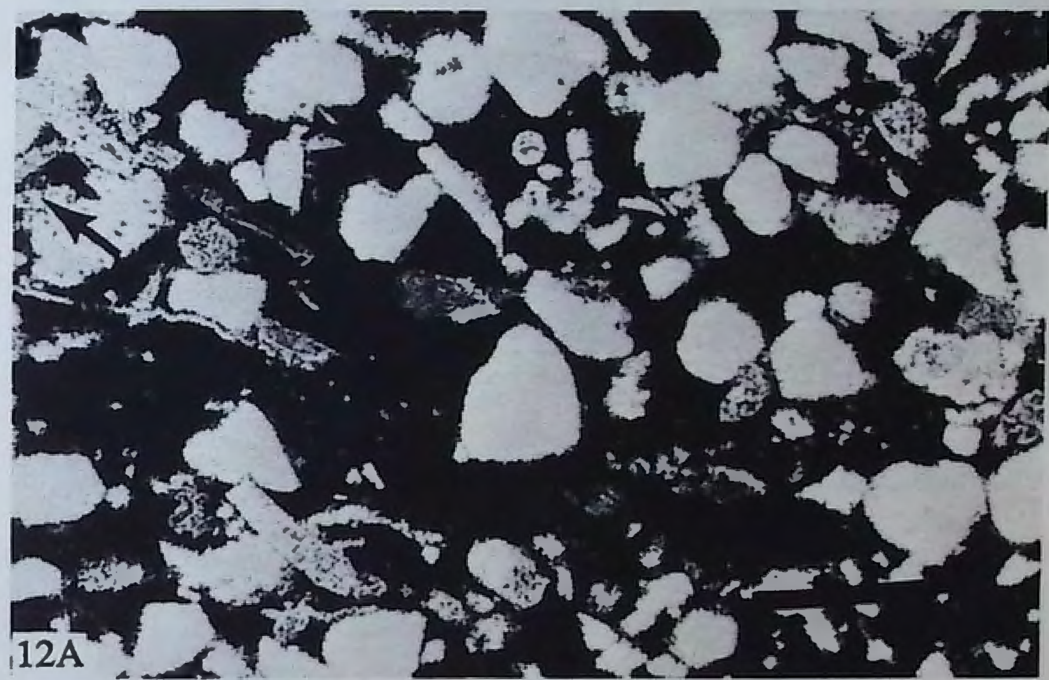
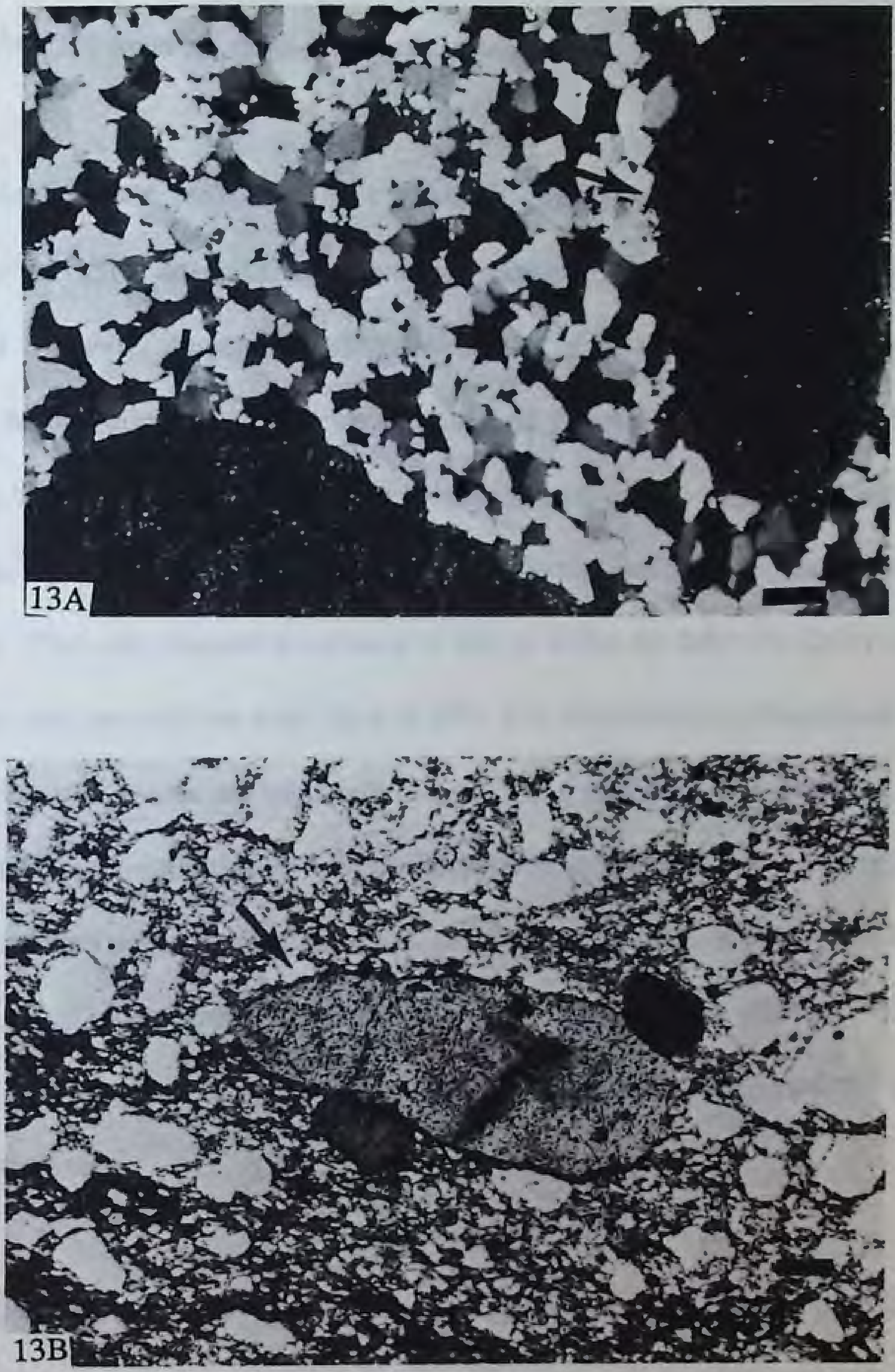

12A

PLATE 13

Photomicrographs of rocks with phosphate.

13A. D&J Oil- Wade 1-8: 5915′9″. Reworked phosphatic rock that is well rounded and gravel-size (arrows) within fine grained quartz. Scale bar 0.25mm, 4x, crossed-nicols.

13B. Amerada- Wilson 1: 3603′. Sample showing rounded phosphatic particle (probable fish bone, arrow) surrounded by fine grained detritus. Scale bar 0.25mm, 4x, plane light.


13A
13B

south. The phosphatic material observed in this study is rounded, suggesting that it is reworked/eroded material from phosphatic strata.

Clay

Mineralogical analysis of the clay size fragments (<0.004mm) was not done for the majority of samples; however, 22 samples were analyzed by X-ray diffraction the D&J Oil-Sunflower 1-8 well. Appendix 3 shows the results of the analyses. The predominant clay is illite. Minor amounts of montmorillonite and chlorite were also detected. The clay occurs as discrete layers or mixed with other detrital components. In Garfield County, Oklahoma, the clay is interlayered with detrital dolomite that has been diagenetically altered (plate 14). The only unusual occurrence of clay is within the D&J Oil- Daisy 1-17. In that well a two and one half cm shale layer at 5911 ft is interpreted as a flocculated shale (plate 14). Flocculated shales are the result of comingling of marine and terrestrial waters, and the subsequent precipitation of clays, which settle to the sea floor. The resulting shale shows a random orientation of the clays, or "flocculated" texture. This core lies south of the other three cores from Grant County, which indicates the probable existence of a terrestrial water source to the south. No other investigator reported the presence of flocculated shale.

Heavy Minerals

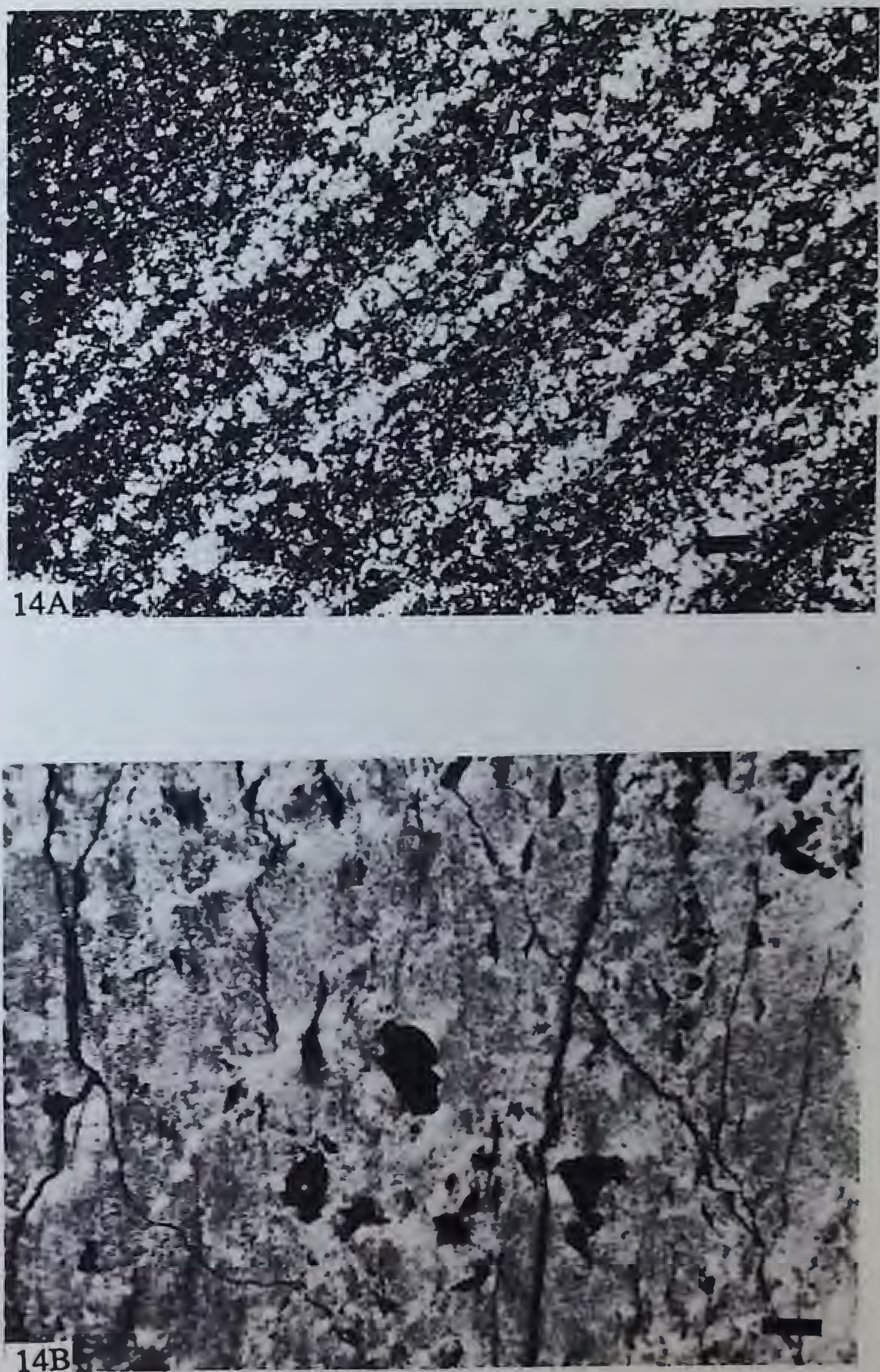
The only accessory minerals are Tourmaline and Zircon, and typically make up much less than one percent of the sample. They are well rounded, and very fine to fine (0.07-0.13mm) sand size (plate 15) tourmaline and zircon. These two minerals are very resistant and should be expected in a mature sandstone (Pettijohn et al., 1987).

PLATE 14

Photomicrographs of Shale/Mudstone rocks.

14A. FCD- Mary A1: 6393′. Carbonaceous Woodford Shale interbedded with euhedral diagenetic dolomite. Scale bar 0.25mm, 4x, crossed-nicols.

14B. D&J Oil- Daisy 1-17: 5911′. Mudstone within Misener showing flocculated texture characteristic of marine/terrestrial waters mixing. Scale bar 0.25mm, 4x, crossed-nicols.



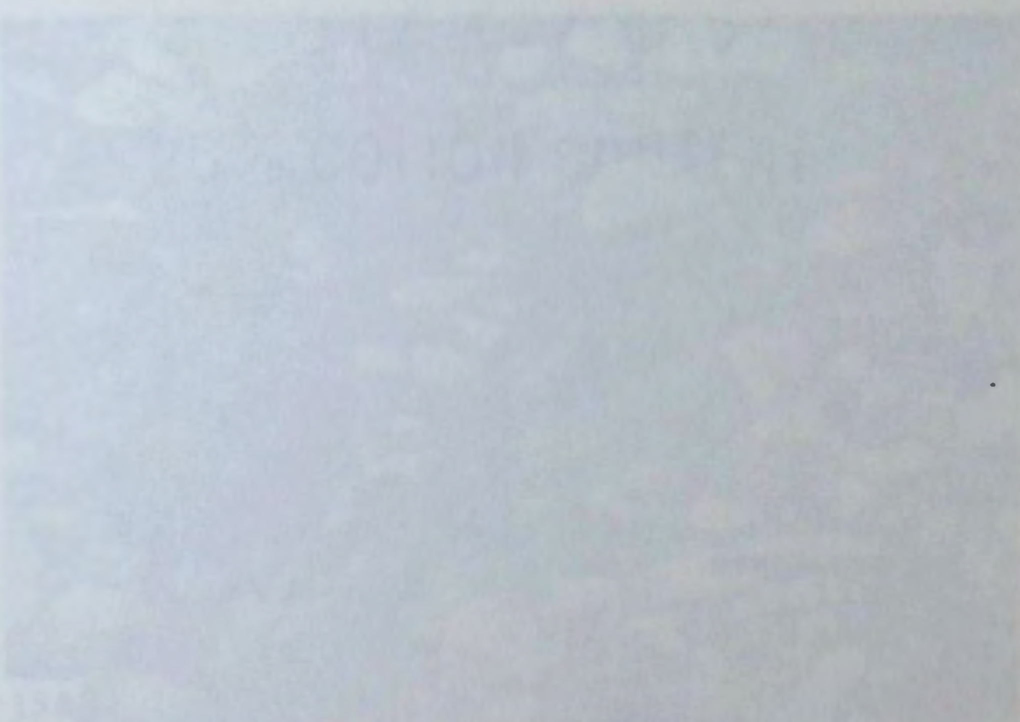
14A

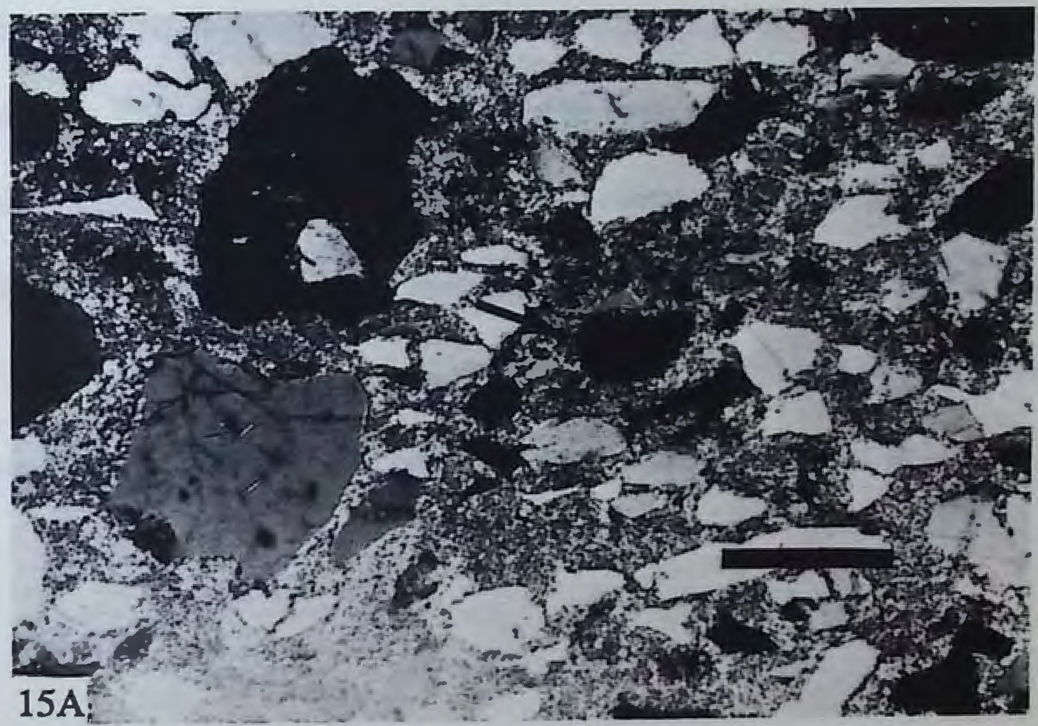
14B

PLATE 15

Photomicrographs of rocks with detrital heavy minerals.

15A. Western- Hoffman 1: 4541´6˝. Poorly sorted sample with angular to rounded grains in clay matrix. Note detrital tourmaline grain (arrow). Scale bar 0.25mm, 10x, crossed-nicols.




15A

Pittenger (1981) separated heavy minerals from samples of the Sylamore and reported that the heavy mineral assemblage consisted only of trace amounts of zircon and tourmaline.

Carbonate

Carbonate is present in the form of dolomite, ferroan dolomite, and calcite. The majority of the carbonate is diagenetic alteration of detritus. The detrital particles ranged in size from very fine to pebble sand size (0.07-20mm, plate 16). The grains were subround to well rounded. This detrital dolomite should be expected as the underlying strata contains abundant carbonate. Amsden & Klapper (1972) reported primary dolomite in some of the samples. Francis (1988) reported large amounts of detrital dolomite, and Walker (1986) suggested that the dolomite is entirely secondary. The samples examined for this investigation suggest pervasive secondary dolomitization of detrital dolomite.

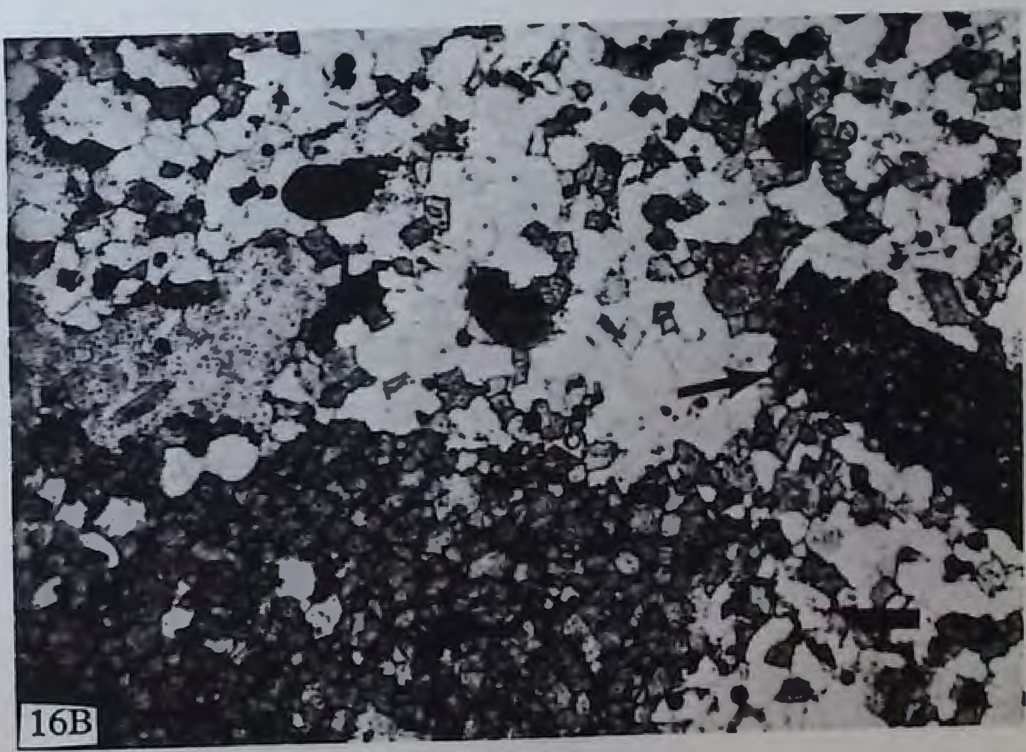
PLATE 16

Photomicrographs of samples with detrital dolomite.

16A. FCD- Roberts 1-18: 6438′. Dolostone fragment (arrow) surrounded by quartz. Scale bar 0.25mm, 4x, plane light.

16B. W.H. Davis- Cox 1: 5918. Well rounded detrital dolostone (arrow) surrounded by similar size quartz grains. Scale bar 0.25mm, 10x, crossed-nicols.


16A


16B

INTRABASINAL COMPONENTS

Glauconite

Glauconite is found in all but one of the wells examined, but generally represented only a few grains per thin section. The mineral is typically pellet shaped, moderate green (5 G 5/6), and ranged in size from very fine to fine (0.07-0.13mm) in size (plate 17). In the three D&J wells from Grant County, Oklahoma, just below the Woodford/Misener contact, glauconite is concentrated in a layer several centimeters thick. The only well which lacked glauconite is the Shaffer- Steele #1 well in Harvey County, Kansas. Glauconite is also not present in any of the samples from the Beaver Dam area in Carroll County, Arkansas. Glauconite was also identified by Amsden & Klapper (1972), Kochick (1976), Pittenger (1981), Terry 1981), Horner & Craig (1982), and others within their respective study areas. Glauconite is indicative of slightly reducing marine conditions at depths of from 50 to 500 m, and small sedimentation rates (Odin and Matter, 1981). The lack of glauconite in the Shaffer well and the Beaver Dam area might indicate shallower, less reducing water.

Conodonts

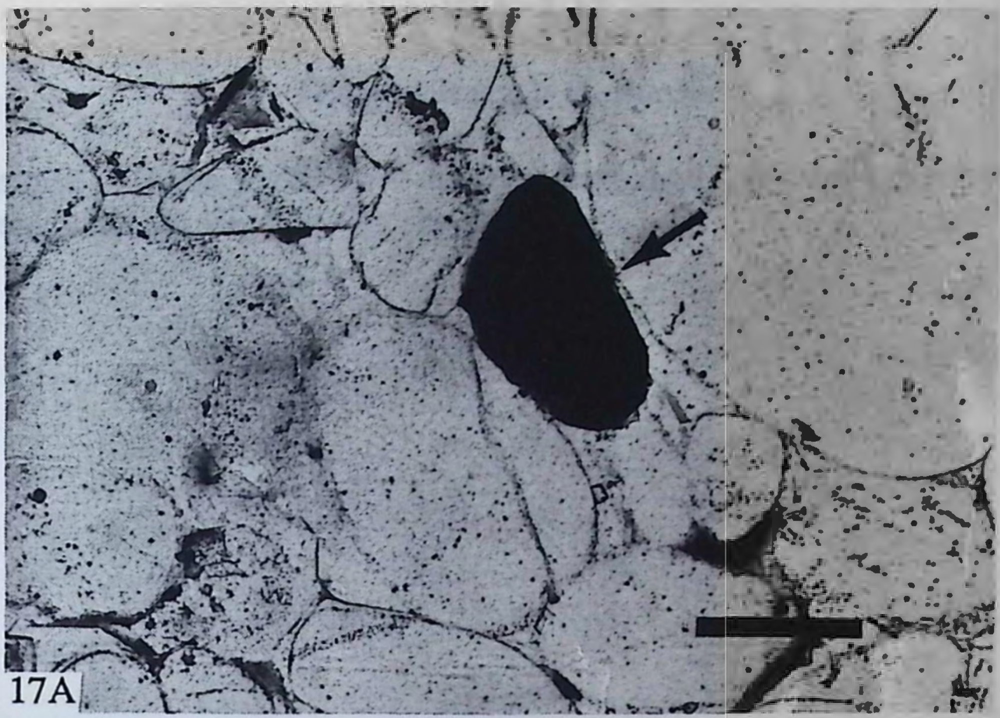
Conodonts are present in most samples (plate 18). For this study conodonts were not examined, but ample conodont identification exists from previous work. The conodonts were usually broken, indicating transport. In several samples in Kansas, conodonts were very abundant. The conodonts are usually very fine to fine (0.07-0.13mm), pale yellowish

PLATE 17

Photomicrographs of glauconite.

17A. D&J Oil- Daisy 1-17: 5914'. Sample showing glauconite (arrow) surrounded by quartz grains of similar size. Scale bar 0.25mm, 10x, plane light.

17B. D&J Oil- Sunflower 1-8: 5921'1". Glauconite (arrow) with oxidation rim surrounded by quartz. Note Phosphatic grain to left. Scale bar 0.25mm, 10x, plane light.



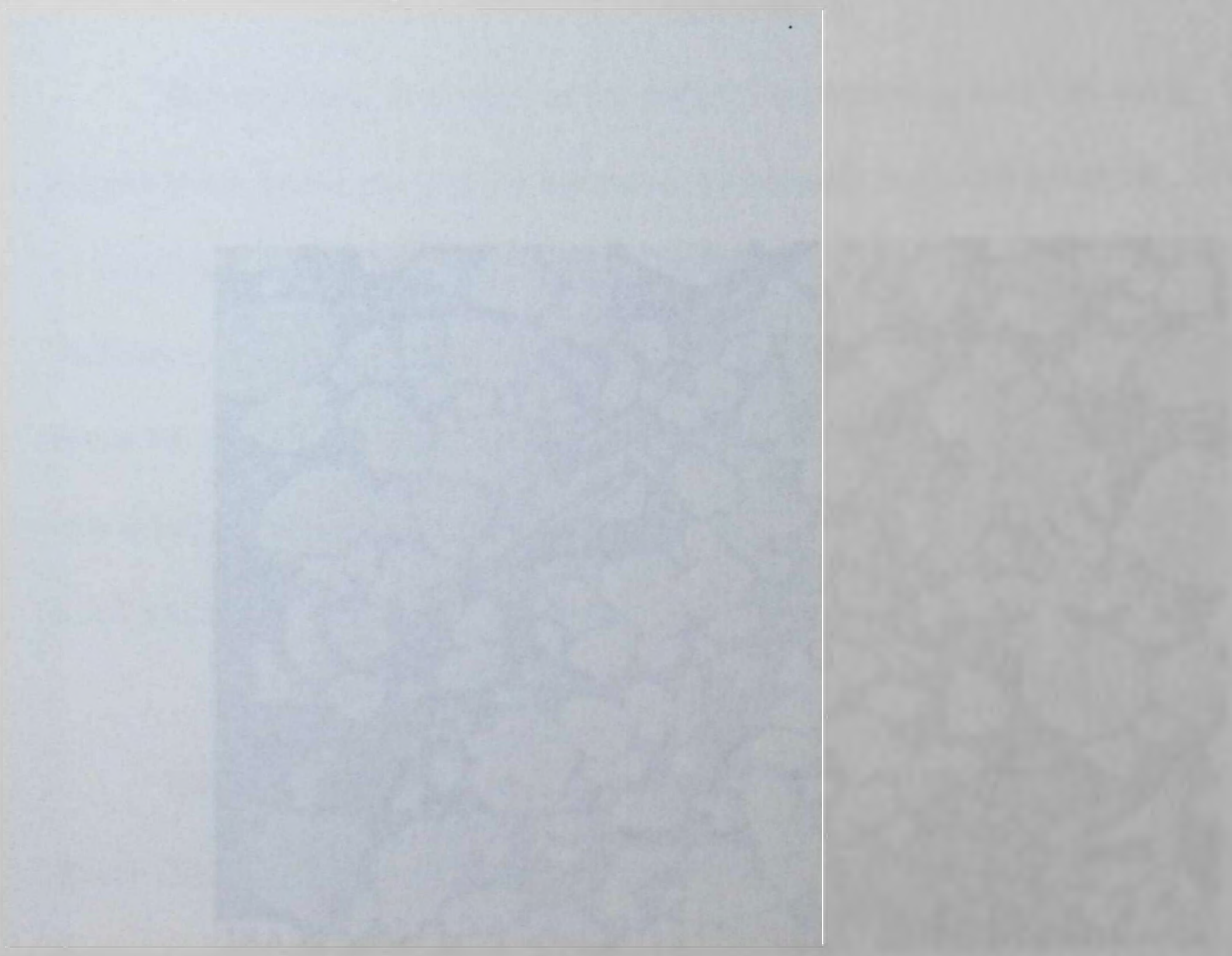
17A

17B

PLATE 18

Photomicrograph of conodonts

18A. Amerada- Wilson 1: 3596'2". Abundant conodont fragments (arrow) within Misener. Scale bar 0.25mm, 4x, plane light.




18A

brown (10 YR 6/2) to moderate brown (5 YR 3/4), and randomly dispersed throughout the sample. Conodonts are not present in thin section samples from the Beaver Dam area, Carroll County, Arkansas. The lack of these fossils may be linked with the absence of glauconite in the samples, possibly reflecting nearshore conditions that would be unsuitable for the formation of glauconite and conodont habitation.

Ichnofossils

Bioturbation is present in the majority of samples seen in this study. The intensity ranges from absent to slightly burrowed, to intensely burrowed (plate 19). Bioturbation is a function of not only the fauna present, but also of the rate of sedimentation. Sedimentation rates for the Misener/Sylamore were comparatively small, as indicated by the presence of glauconite, and intensely bioturbated sediments. Ichnofossils have been identified by previous workers (Pittenger, 1981, and Pogue, 1987), and will be discussed in a following section.

Fish Fragments

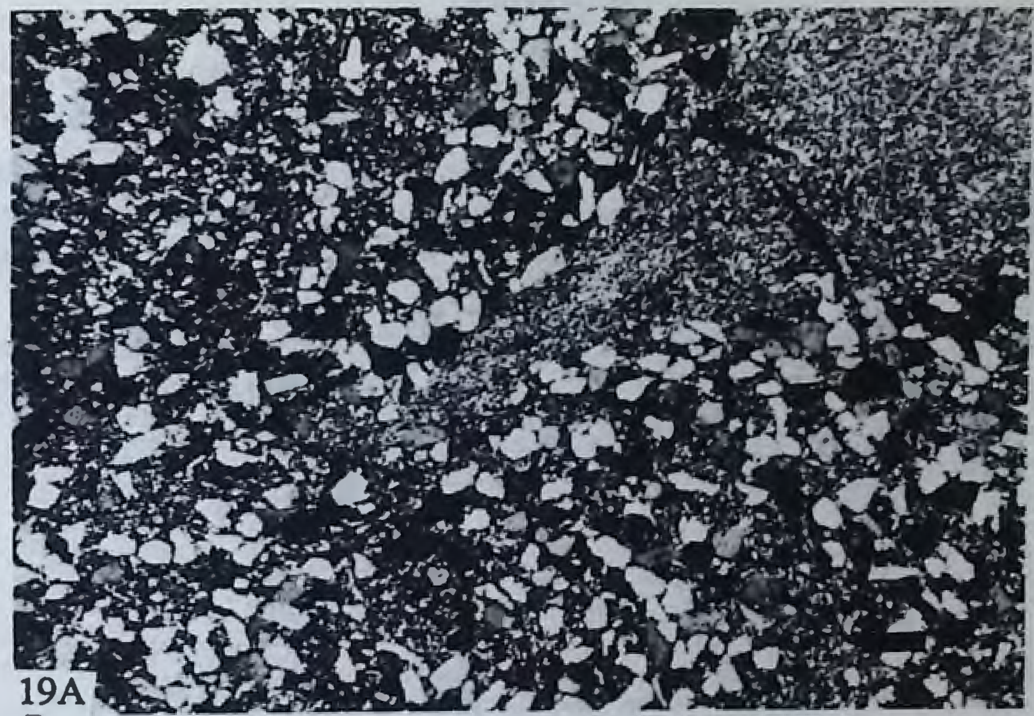
Phosphatic fish bones, scales, and teeth are observed in the majority of the samples (plate 20). The fish particles are gernerally larger than the surrounding grains, ranging from medium to coarse sand size (0.26-0.5mm), broken, and randomly oriented within the sample. The color of the fish particles ranged from pale yellowish brown (10 YR 6/2) to dusky brown (5 YR 2/2). The presence of the fish particles indicates a marine setting, and the disjointed nature of the bones and scales indicates transport. Croneis (1930), Pittenger (1981), Mansfield and Breckon (1985), also reported the occurrence of unidentified fish scales, teeth, and bones in the rock body.

PLATE 19

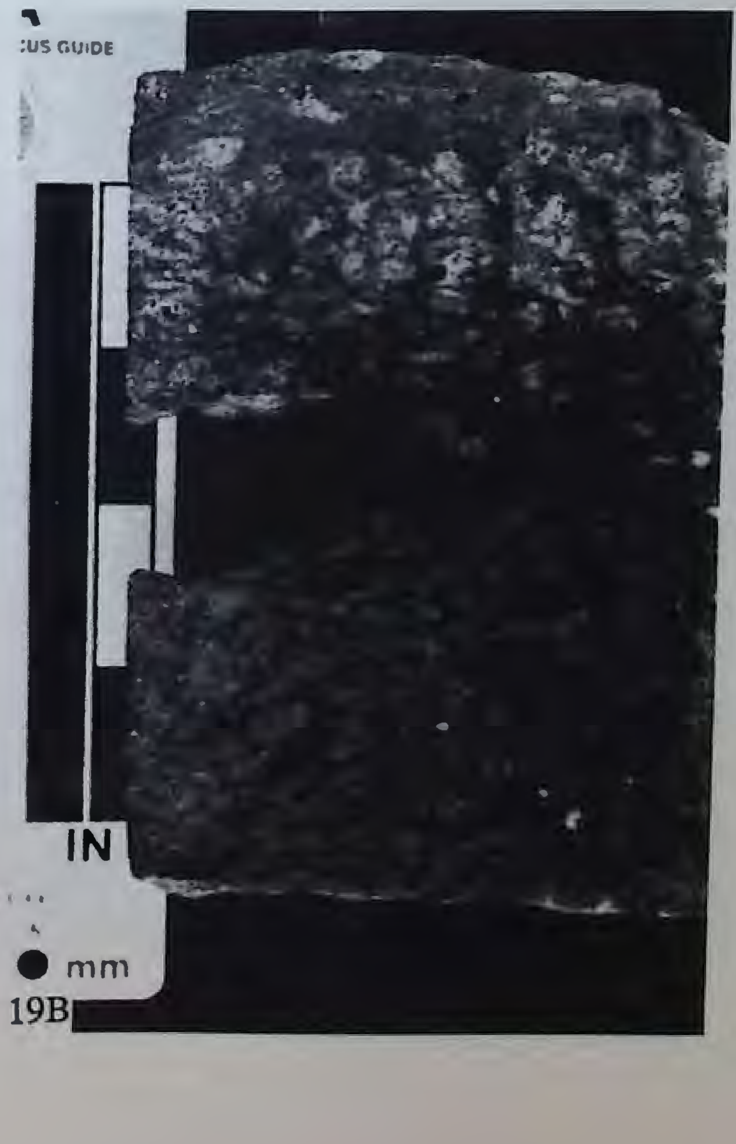
Photographs of rocks showing bioturbation

19A. Western- Hoffman 1: 4539′. Photomicrograph of branching burrow (arrows) within Chattanooga. This is a burrowing within the Chattanooga was rarely observed. Scale bar 0.25mm, 4x, crossed-nicols.

19B. D&J Oil- Sunflower 1-8: 5911′6″. Photograph of heavily burrowed Misener interval. Scale shown in photograph. Top of core is top of photo.



19A



19B

PLATE 20

Photomicrographs of samples which contain fish fragments.

20A. Park Avenue Exploration- Jane 1-25: 5918´. Phosphatic fish fragments (arrows) surrounded by quartz and dolomite. Scale bar 0.25mm, 4x, plane light.

20B. Shell- Duerkson 1: 3486´4˝. Phosphatic fish fragments (arrows). Scale bar 0.25mm, 4x, crossed-nicols.

20A

20B

Bivalves

Rare phosphatic inarticulate brachiopod shells and one mollusc shell are seen in the samples (plate 21). The shells are disarticulated and broken, larger than the surrounding grains, generally medium to coarse sand size (0.26-0.5mm), white (N9), and pale yellowish brown (10 YR 6/2) to dusky brown (5 YR 2/2). Amsden and Klapper (1972), Horner and Craig (1982), and Walker (1986) all reported brachiopods within their samples.

Spores

Spores, which are common within the Woodford/Chattanooga interval, are also present within shaley parts of the Misener section in Kansas (plate 22). The spores are flattened within the Woodford/Chattanooga interval, but retain a subrounded appearance within the Misener. The size of the spores is usually around 0.26mm, and the color of the spores is (bright) moderate red (5 R 4/6).

PLATE 21

Photomicrographs of samples with brachiopod and mollusc shells.

21A. Derby- Sperling 1: 3485′. Phosphatic inarticulate brachiopod shell (arrow). Scale bar 0.25mm, 4x, crossed-nicols.

21B. Amerada- Wilson 1: 3605′. Sample with punctate brachiopod (arrow) replaced by dolomite. Scale bar 0.25mm, 4x, crossed-nicols.

21C. Mabee-Shell- Friesen 5: 3479′5″. Mollusc fragment (arrow) surrounded by quartz. Scale bar 0.25mm, 4x, crossed-nicols.

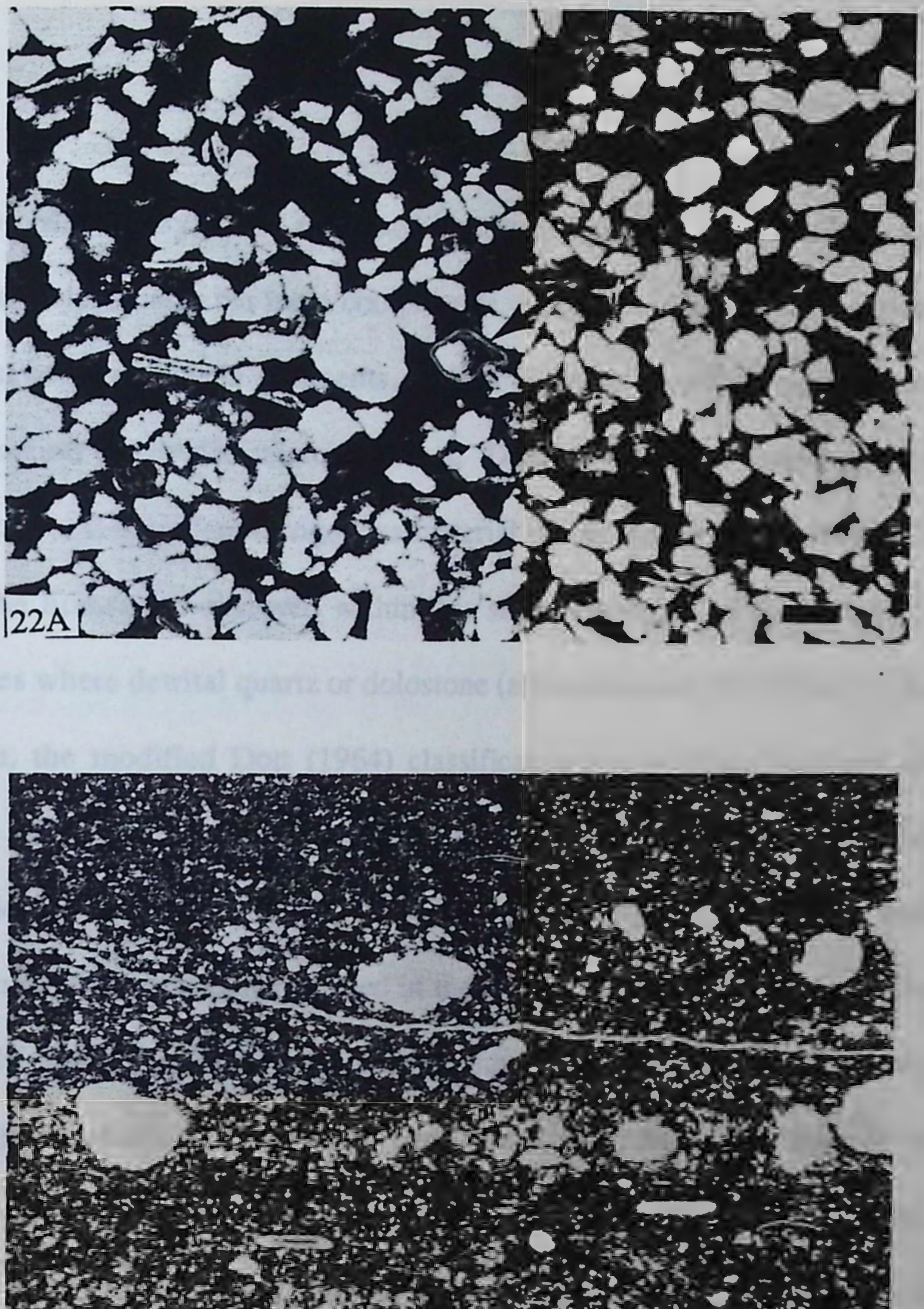

21A
21B
21C

PLATE 22

Photomicrographs of samples with spores.

22A. Shaffer- Steele 1: 3347′. Poorly sorted sample near the contact of the Misener and Chattanooga with spores (arrow) similar in appearance to those found within the Chattanooga. Scale bar 0.25mm, 4x, plane light.

22B. Commonwealth- Farber 1A: 3534′. Chattanooga Shale with flattened spores (arrows). Scale bar 0.25mm, 4x, plane light.


22A
22B

LITHOFACIES

The Misener/Sylamore represents a mature sandstone with multicycle quartz grains and detrital dolostone as the main components. Other constituents that are generally found within first or second cycle sediments, such as feldspars or rock fragments, constitute only a small fraction of the detrital components. Detrital clay and reworked phosphatic grains are the next most abundant terrigenous material within the Misener/Sylamore. In order to describe the lithofacies observed within this study, two types of classification were used. For samples where detrital quartz or dolostone (at least silt size, >0.004mm) is the dominant constituent, the modified Dott (1964) classification scheme from Pettijohn et al. (1987, figure 12) is used. For samples where clay-sized detritus (<0.004mm) is abundant, the classification given by Potter et al. (1980, figure 13) is utilized. Quartz, clay, and dolostone were the most important minerals used in the classification process. If the detrital particles were mostly clay, the sample is classified as either a: 1) Mudstone- 33-65 percent clay, beds >10mm; 2) Mudshale- 33-65 percent clay, laminae <10mm; 3) Claystone- 66-100 percent clay, beds >10mm; or 4) Clayshale- 66-100 percent clay, laminae <10mm. Quartz, dolostone, and phosphate then determine whether the rock will be classified as a quartz arenite (>95 percent quartz) or sublitharenite or litharenite (>5 percent dolostone or phosphate). If a quartz arenite, sublitharenite, or lithic arenite contained detrital clay (5-15 percent), these rocks were modified with the term 'argillaceous'. Other modifiers include: fossiliferous, phosphatic, calcareous, and pyritiferous. If the detrital clay within the sample

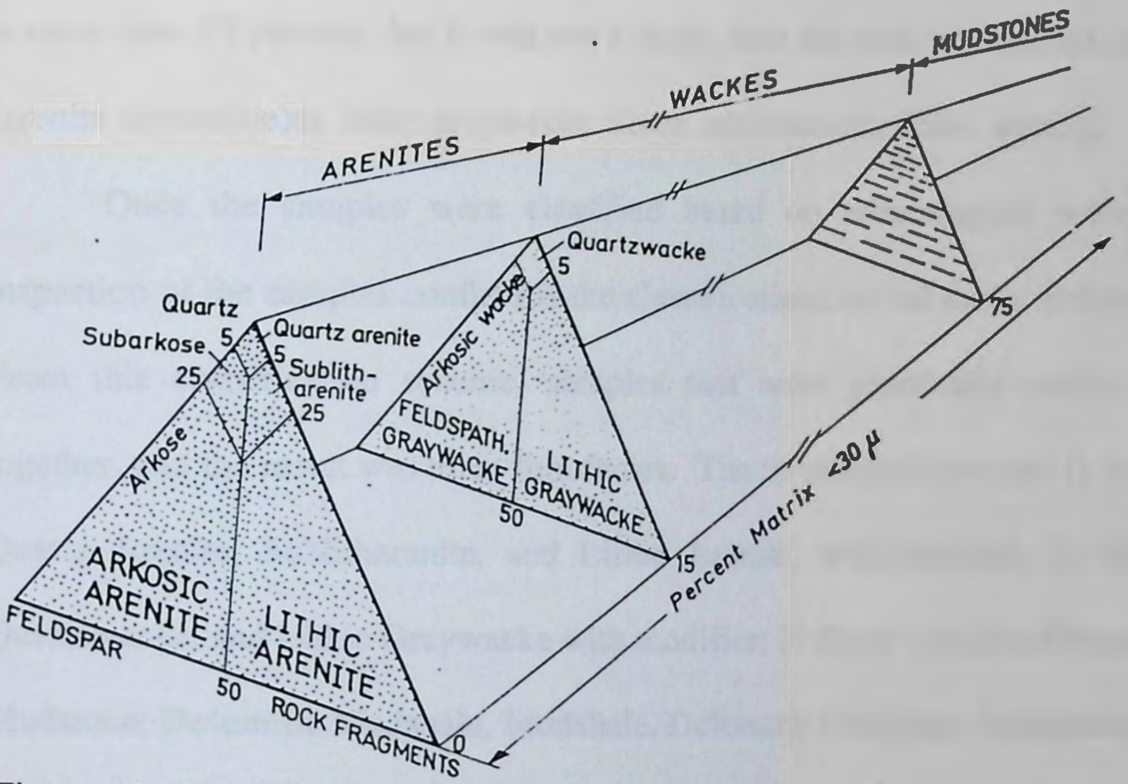


Figure 12- Classification scheme used for rocks with terrigenous components dominantly sand size (Pettijohn et al., 1987).

METAMORPHOSED			INDURATED		NONINDURATED		Field Adjective	Percentage clay-size constituents
			Laminae	Beds	Laminae	Beds		
Degree of metamorphism HIGH ← LOW			Less than 10 mm	Greater than 10 mm	Less than 10 mm	Greater than 10 mm		
PHYLLITE AND/OR MICA SCHIST	QUARTZ SLATE	QUARTZ ARGILLITE	LAMINATED SILTSTONE	BEDDED SILTSTONE	LAMINATED SILT	BEDDED SILT	Gritty	0-32
	SLATE	ARGILLITE	MUDSHALE	MUDSTONE	LAMINATED MUD	BEDDED MUD	Loamy	33-65
			CLAYSHALE	CLAYSTONE	LAMINATED CLAYMUD	BEDDED CLAYMUD	Fat or Slick	66-100

Figure 13- Classification scheme used for rocks with terrigenous components dominated by clay size (Potter et al., 1984).

is more than 15 percent, but it was not a shale, then the rock is classified as a quartzwacke (arenite derivative)or lithic graywacke (from sublitharenite/lithic arenite).

Once the samples were classified based on mineralogical percentages, further inspection of the samples confirmed the classifications, or led to the addition of modifiers. From this classification scheme, samples that were genetically similar were grouped together, and the result was three lithofacies. The three lithofacies are: 1) Arenite- includes Quartz Arenite, Sublitharenite, and Lithic Arenite, with modifier; 2) Wacke- includes Quartzwacke, and Lithic Graywacke with modifier; 3) Shale- includes Dolomitic Mudstone, Mudstone, Dolomitic Mudshale, Mudshale, Dolomitic Claystone, Claystone, and Clayshale with modifier.

Minor detrital components that occur in the Arenite, and Wacke lithofacies are: phosphate (up to 10 percent), plagioclase and potassium feldspar, chert, metamorphic quartz, zircon, tourmaline. Intrabasinal components that are common within the Arenite and Wacke lithofacies are: glauconite, conodonts, fish particles, brachiopods, and rare molluscs.

Arenite Facies

Monocrystalline quartz and detrital dolostone are the primary components. Samples are generally well to moderately sorted, moderately to well cemented with syntaxial silica cement (dominant), poikilotopic calcite, and pore filling dolomite (plate 23). The grains are typically subrounded to well rounded. Clay is present both as detrital material and secondary precipitate (<15%). When the dolostone or phosphate content exceeds five percent, the sample is classified either as a sublitharenite (plate 24), or lithic arenite (plate 25). Pyrite occurs as a secondary pore filling mineral from trace amounts to a few percent.

PLATE 23

Photomicrographs of Arenite lithofacies.

23A. Mabee-Shell- Nikkel 5B: 3468′6″. Quartz Arenite with minor amounts of detrital clay, pyrite, and conodont debris. Scale bar 0.25mm, 4x, plane light.

23B. Beaver Dam- Float (layer #2). Quartz Arenite with almost no other mineralogical constituents. Scale bar 0.25mm, 4x, crossed-nicols.

23C. D&J Oil- Wade 1-8: 5908′. Quartz Arenite with abundant porosity (primary and secondary), and minor amounts of phosphatic material. Scale bar 0.25mm, 4x, crossed-nicols.

23D. W.H. Davis- Cox 1: 5931′. Quartz Arenite with dolomite (arrows) filling pores. Note also phosphatic material. Scale bar 0.25mm, 4x, crossed-nicols.

23E. Tenneco- Swen 1-16: 6459′. Quartz Arenite with poikilotopic calcite (arrow) and detrital clay. Scale bar 0.25mm, 4x, crossed-nicols.

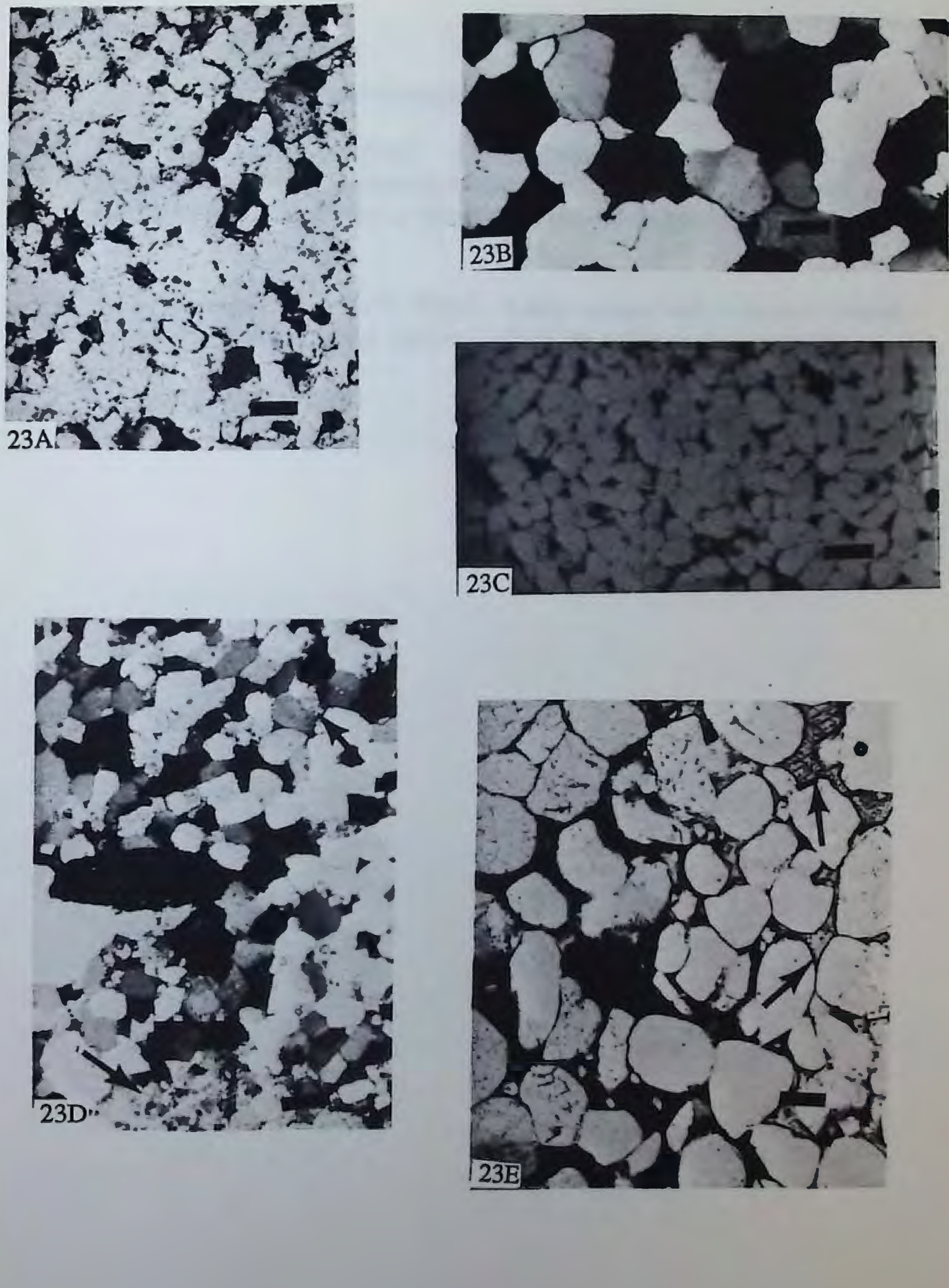
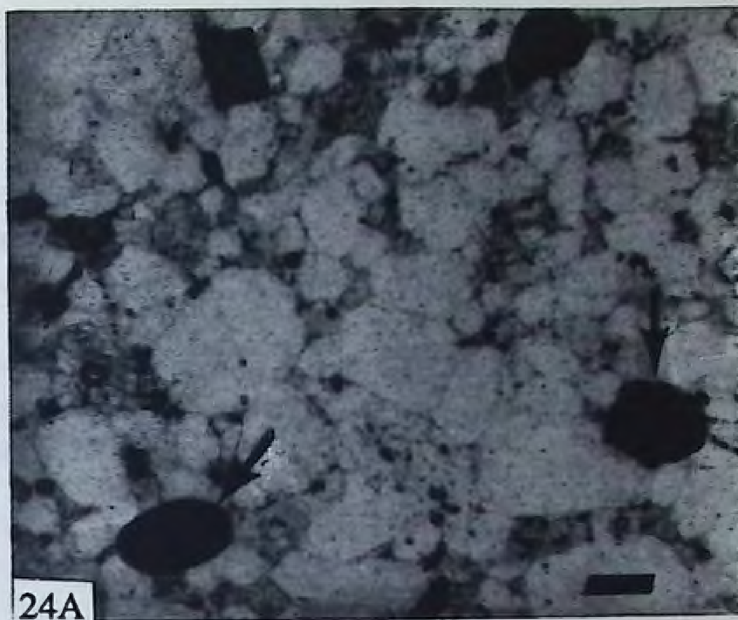

23A
23B
23C
23D
23E

PLATE 24

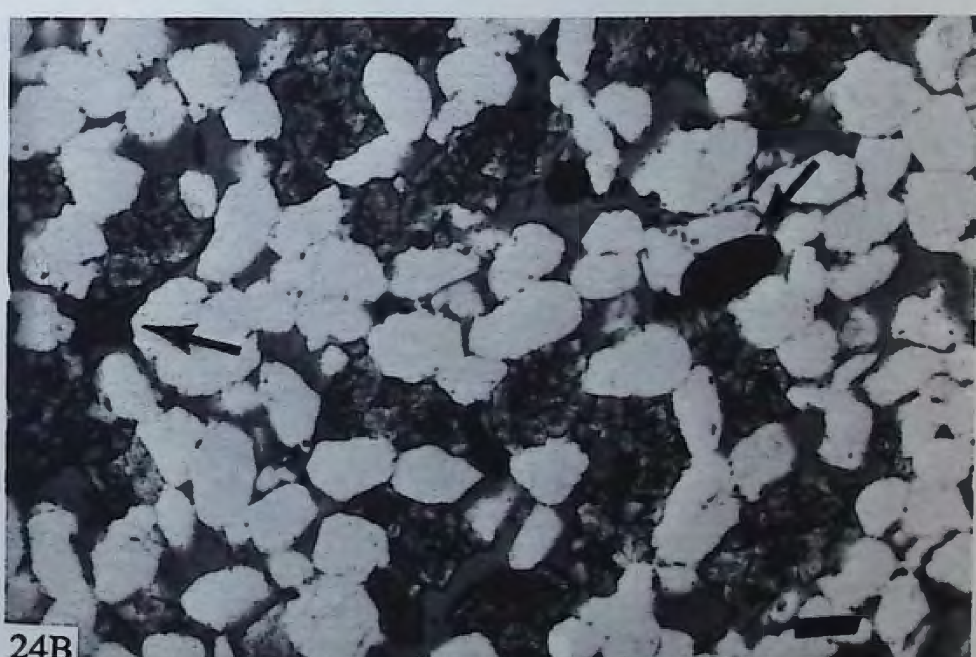
Photomicrographs of Arenite lithofacies.

24A. W.H. Davis- Cox 1: 5930′. Sublitharenite with dolomite filling pores. Phosphate (arrows) present in sufficient amounts to classify this rock as a Sublitharenite rather than a Quartz Arenite. Scale bar 0.25mm, 4x, plane light.

24B. Park Avenue- Jane 1-25: 5923′. Lithic arenite with abundant detrital dolostone, and phosphate (arrows). Scale bar 0.25mm, 4x, plane light.



24A



24B

PLATE 25

Photomicrographs of Arenite lithofacies.

25A. FCD- Roberts 1-18: 6399′. Lithic arenite consisting of detrital dolomite and quartz grains. Note the euhedral character of the dolomite. Scale bar 0.25mm, 4x, plane light.

25B. W.H. Davis- Cox 1: 5928′. Lithic arenite showing two layers of detrital dolostone separated by layer of abundant quartz (arrow). Scale bar 0.25mm, 4x, crossed-nicols.


25A
25B

Features that can be observed in thin section include burrowing, graded bedding, and stylolites. The porosity ranges from very low to just over 20 percent.

Wacke Facies

Wackes have more than 15 percent detrital clay (normalized), yet not enough to be classified as a shale (plate 26). Identification of the clay-sized detritus was not done throughout the area, but X-ray diffraction results from one well (D&J Oil- Sunflower 1-8, appendix 3) indicate the presence of illite, montmorillonite, and chlorite.

The terrigenous components consits primarily of monocrystalline quartz and detrital dolostone. The quartz and dolostone grains are angular to well rounded. Muscovite and biotite, and spores are extremely rare; if present, these sedimentary particles occurred near the contact with the Woodford/Chattanooga. Pyrite ranges from a small percent (pore filling) to over 10 percent (cement).

Sedimentary features observed include graded beds, stylolites, and burrows. The porosity is generally less than five percent.

Shale Facies

The percentage of detrital components determined either a Mudstone/Mudshale (33-65% clay size grains) or Claystone/Clayshale (66-100% clay size detritus, plates 27 and 28). The presence of beds thicker than 10 mm resulted in a Mudstone/Claystone designation. The presence of laminae thinner than 10 mm resulted in a Mudshale/Clayshale designation. X-ray diffraction of samples from D&J Oil- Sunflower 1-8 indicate that the clay is mainly illite.

Monocrystalline quartz and dolostone are the dominant detrital minerals.

PLATE 26

Photomicrographs of Wacke lithofacies.

26A. D&J Oil- Wade 1-8: 5900.8′. Wacke lithofacies showing monocrystalline quartz in a clay matrix. Note that the quartz ranges from angular to well rounded. Scale bar 0.25mm, 4x, crossed-nicols.

26B. Western- Hoffman 1: 4541′6″. Wacke lithofacies with angular to well rounded monocrystalline quartz in a clay matrix. Scale bar 0.25mm, 4x, crossed-nicols.

26C. Mabee-Shell- Friesen 5: 3479′. Wacke lithofacies with abundant conodont detritus (arrows). Scale bar 0.25mm, 4x, plane light.

26D. Shaffer- Steele 1: 3350′. Wacke lithofacies with abundant monocrystalline quartz, but less clay matrix than first two samples from above. Scale bar 0.25mm, 4x, plane light.

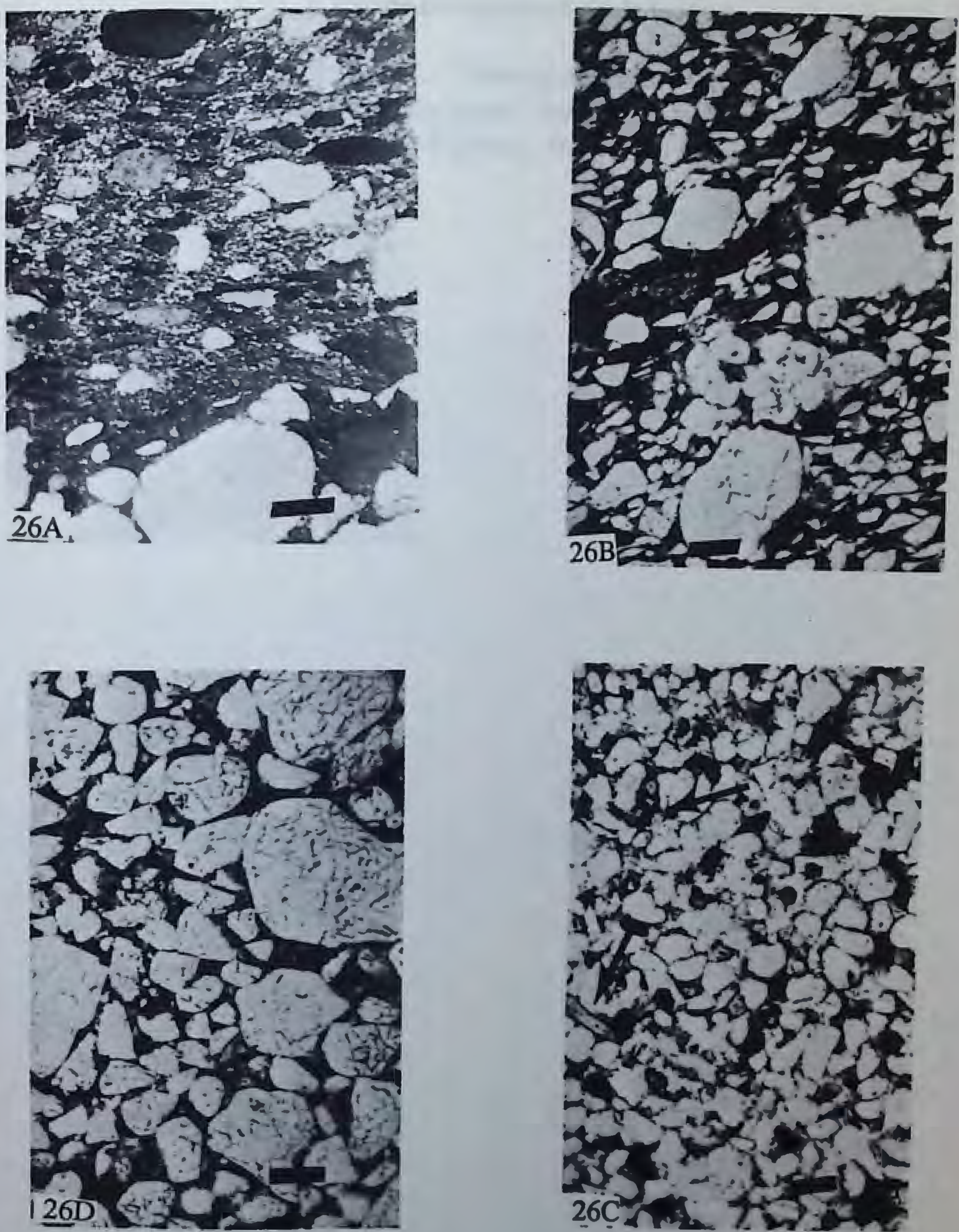

26A
26B
26D
26C

PLATE 27

Photomicrograph of Shale facies.

27A. FCD- Roberts 1-18: 6392′. Photomicrograph of Shale facies showing interbedded clay and dolomite layers. Note distinctive euhedral to subhedral dolomite crystals. Scale bar 0.25mm, 4x, crossed-nicols.

27A

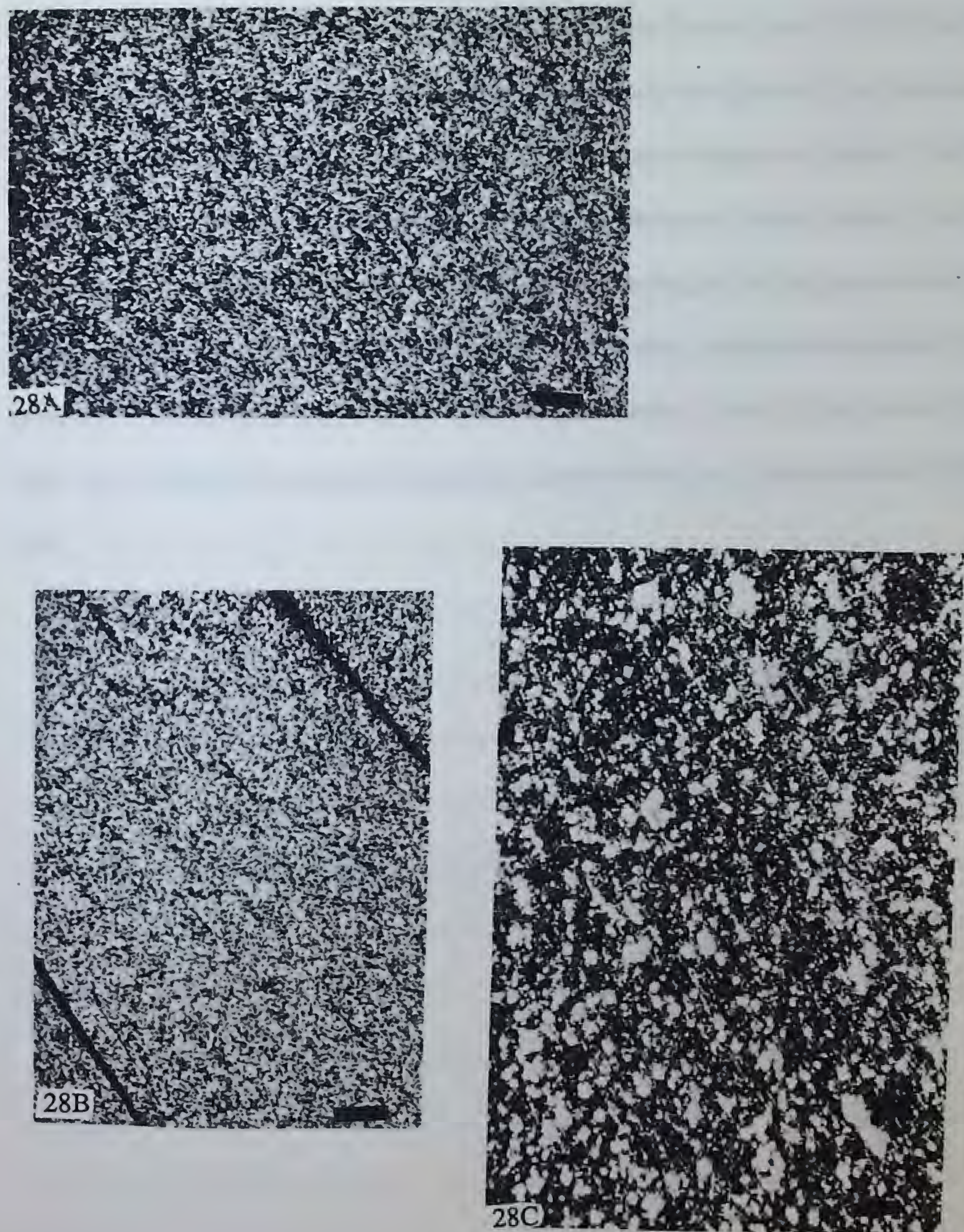
PLATE 28

Photomicrographs of Shale lithofacies.

28A. Amerada- Wilson 1: 3595'6". Photomicrograph of a member of the Shale lithofacies- Mudstone, with minor amounts of pyrite. Note fine grained and massive nature of the sample. Scale bar 0.25mm, 4x, crossed-nicols.

28B. Tenneco- Swen 1-16: 6454'6". Photomicrograph of Shale lithofacies member- Claystone, with minor amounts of pyrite. Note increased amounts of clay sized detritus relative to the above sample. Scale bar 0.25mm, 4x, crossed-nicols.

28C. Commonwealth- Farber 1A: 3534'8". Photomicrograph of Mudshale member of the Shale lithofacies. Scale bar 0.25mm, 4x, crossed-nicols.


28A
28B
28C

Polycrystalline quartz (metamorphic and sedimentary), feldspar, and phosphate, are rare to absent. The larger clastic grains are typically silt to very fine sand size (0.05-0.07mm) and angular to subrounded. Intrabasinal components include rare glauconite, and unidentified conodonts and spores. Pyrite is common as a syngenetic or diagenetic mineral. The shale is generally brown to black because of the large percentage of organic matter in the rock. In Kansas, the organic content of the shale is less, resulting in red or green colored rock. These shales probably reflect a more aerobic environment, a conclusion supported by the presence of more burrowing than the brown to black shales. A thin (2.5 cm) layer of green shale with a random orientation (flocculated texture) of the clay is present in the D&J Daisy well.

ENVIRONMENTS OF DEPOSITION

The Misener/Sylamore Sandstone is the basal formation of the Woodford/Chattanooga Group. In order to fully understand the environments of deposition of the Misener/Sylamore, the environment in which the Woodford/Chattanooga was deposited must be determined. The Woodford/Chattanooga and equivalents are widespread over the North American Craton. Type II kerogen within the Woodford/Chattanooga rock body (Olson, 1982, Ulmishek and Klemme, 1990) indicates a mixed input of marine and terrestrial organic input. These observations suggest a marine origin, probably far from shore. Anoxic facies within the Woodford/Chattanooga may indicate stratification within the water column, possibly density stratification that would restrict oxygen flow to the bottom and allow accumulation of abundant organic material, without aerobic degradation. The shale was deposited on the craton, which would probably preclude deposition in bathyal depths. The exclusion of bathyal depths, coupled with the type II kerogen suggest that the Woodford/Chattanooga was probably deposited in depths no less than tens of meters or middle shelf.

The presence of glauconite, conodonts, and fish fragments, all offer evidence of depositon of the Misener/Sylamore in a marine environment. Sorting and grain size of the rock body indicate a depositional environment that ranged from moderate to high energy. Low energy intervals within the Misener/Sylamore are marked by the accumulation of Woodford/Chattanooga type organic shale. Deposition of the Misener/Sylamore was coeval with the Woodford/Chattanooga (Amsden & Klapper, 1972), therefore, the Misener/Sylamore is probably the nearshore facies marking the transgression of the Woodford/Chattanooga sea, a conclusion also reached by Swanson and Landis (1962), and Freeman and Schumacher (1969).

Each of the three Misener/Sylamore lithofacies can be related by position relative to shoreline or water depth. The Shale lithofacies (Woodford/Chattanooga) represents the lowest energy or deepest water, and the Arenite lithofacies represents the highest energy, deposition can be related on a continuum between these two end points.

Arenite Facies

The low percentage of detrital clay within the Arenite lithofacies suggests at least moderate energy, enough to carry the clay further out to sea. Cross bedding is not observed within the facies. The lack of cross stratification can be interpreted in two different ways: 1) the sedimentation rate was so small that bioturbation mixed the sediments and destroyed any cross-beds formed by nearshore current, wave, or tidal action, or 2) the sediments were below wave base and not deposited by current, wave, or tidal forces, but rather are the products of episodic deposition. The latter explanation appears more plausible due to the presence of glauconite within the rock, which requires mildly reducing conditions to form, and would not survive a nearshore, higher energy environment. The exception seen in the samples is from the outcrop of the Sylamore in Carroll, County, Arkansas. There, glauconite and conodonts were not present suggesting that the sandstone was deposited nearer to shore; however, the sedimentary structure remained the same ranging from massive to bioturbated bedding. Ichnofossils identified by previous investigators (Pittenger, 1981;

Pogue, 1987) suggested nearshore deposition for the Misener/Sylamore. Pittenger (1981) noted the presence of Teichichnus. Pogue (1987) listed Skolithos and Cruziana as the two ichnofossils present. Skolithos reflects an intertidal/lagoonal-upper shoreface envionment; Cruziana (including Teichichnus) occurs in lower shoreface-shelf-slope environments (Potter et al., 1984). Further evidence of a nearshore setting for parts of the Misener comes from Francis (1988), who noted that conodont assemblages from his study area indicate a nearshore, high energy, marine setting. The Arenite lithofacies is interpreted as the nearshore facies, and is probably eqivalent to Walker's (1986) open marine shoreline facies.

Wacke Facies

The presence of detrital clay suggest that the Wacke lithofacies was deposited in deeper, less energetic waters, seaward of the Arenite. The presence of terrigenous grains that are sand size within a clay matrix suggests that there was enough energy to deliver the larger sediments, yet not so much as to remove the finer fraction. The Wacke lithofacies has similar characteristics to Walker's (1986) estuarine environment (muddy sand), but is probably not a restricted nearshore environment.

Shale Facies

Shale, and shale interbedded with fine grained detrital dolostone are believed to be the deepest facies (as aforementioned), probably deposited on the middle-shelf. The grain size of the terrigenous detritus is typically less than 0.13mm. This small particle size indicates a low energy environment either far from the provenance, or in a restricted, possibly even shallow water, setting. It is more probable that the Shale facies represents a deeper water (middle shelf) setting because of the type II kerogen present. The zenith of the Woodford/Chattanooga sea trangsression is marked by the ubiquitous deposition of the black shales over the North American craton.

The flocculated shale within one well is an exception to the postulated deeper water environment. This shale probably reflects a minor regression where the shoreline was close enough to the depositional site to allow mixing of marine and fluvial waters. The aerobic shales in Kansas (green and red colors) probably indicates shallow water conditions and an aerated water column within the Chattanooga Shale that prevented the preservation of the organic matter.

DEPOSITIONAL SYSTEM

Modern analogs of the deposition of the Misener/Sylamore and the Woodford/Chattanooga are difficult to find because of the absence of present-day vast euxinic epeiric seas on stable cratons with passive margins (Comer, 1991). This lack of recent examples complicates interpretation. The Misener/Sylamore is generally agreed to have been deposited in a marine setting, with distribution of the unit as sinuous elongate bodies or pods. These two depositional features are where the consensus of environments stop. Since the Misener/Sylamore is distributed in elongate bodies, and contains moderate to shallow water depth ichnofossils (Pittenger, 1981, Pogue, 1987) and conodonts (Francis, 1988), the logical choice for a depositional system would be either a estuary, barrier bar, marine bar, sand wave, sand ribbon, or sand ridge.

Reineck and Singh (1987) list some of the features of an estuarine deposit to be: 1) flocculated shale, 2) ripples and megaripples, 3) large-small-scale cross bedding, 4) flaser bedding, 5) wavy bedding, and 6) shell beds. Clifton (1982) described estuarine sands as well sorted with fine sand and mud, ripples, crossbedding, flaser bedding, bioturbation, lag deposits at the bottom consisting primarily of shells, and fining upward sequences. No cross beds, ripple beds, flaser beds, or shell placers were observed within the Misener/Sylamore interval. Flocculated shale was described only once. The presence of glauconite and conodonts suggest deposition further offshore than would be expected with an estuarine deposit.

Reineck and Singh (1987) stated that the vertical sequence of barrier bars consists of back bar restricted, lagoonal sediments overlain by sand and shelly layers with low to heavy bioturbation, above which are crossbedded sands and finally aeolian deposits. McCubbin (1982) also reported barrier bar lithologies consisting of lagoonal facies, swash and hummocky cross-stratification, large scale trough and tabular cross bedding, ripple marks, and bioturbation. However, no lagoonal sediments, cross beds, ripple marks, or aeolian sands occur within the Misener/Sylamore investigated.

Bouma et al. (1982) described the characteristics of a marine bar as: 1) a basal transgressive lag deposit, 2) shelly layers, 3) ripple marks, 4) cross bedding, and 5) overall coarsening upward sequences. Ripple marks, cross bedding, shelly layers, were not observed within the Misener/Sylamore, and the amount of fine material increases upwards. However, the Misener/Sylamore does contain a basal lag deposit, which is common for transgressive sequences (Baum & Vail, 1988).

Quaternary sand waves from Georges Bank, USA, that are up to 10 km long and up to 20 m high were described by Bouma et al. (1982). Reineck and Singh (1987) stated that small sized ripples, megaripples, sand and shale laminations, and bioturbation are all associated with sand waves. Smith (1989) observed planar and trough cross bedding, hummocky cross-stratification, parallel bedding, and rhythmites within sandwaves from a Lower Permian shelf sequence in South Africa. Ripple marks and trough and planar cross bedding were not observed within the Misener/Sylamore. The size of the sandwaves is, however, on the same scale as some of the Misener fields, which can be several km long and less than a 1-2 km wide. Reineck and Singh (1987) described sand ribbons as linear bed forms on gravelly to sandy sea floors at moderate to shallow depths. They reported that the dimensions of the sand ribbons can be as long as 15 km and as much as 200 m wide, but generally are less than one meter in height. The sand ribbons represent gravelly tidal lag deposits and usually have shell layers (Reineck & Singh, 1987). In this study, the Misener/Sylamore attains thicknesses of more than 17 m, and fills erosional lows.

Well sorted sand, silty sand, and shell debris are all features observed by Yang (1989) during an analysis of Holocene sand ridges in the East China and southern Yellow seas. Reading (1986) also concluded that well sorted, medium-fine-grained sands with shell fragments made up sand ridges, along with large-small-scale cross bedding, parallel laminations, and mud drapes and rip up clasts. Reported lengths of sand ridges were as much as 65 km, their width reached 5 km, and they were as much as 40 m high (Reineck and Singh, 1987). The dimensions of these sand ridges are similar to those of the Misener/Sylamore bodies. However, cross bedding, mud drapes and rip up clasts, and abundant shell debris are not significant components of the Misener/Sylamore of this study.

The largest obstacle to defining a depositional system for the Misener/Sylamore is the lack of internal stratification. Internal homogeneity (massiveness) is common, and hinders interpretation. If massive bedding is primary, then the accumulation may be due to rapid sedimentation (Reineck and Singh, 1987). However, if the massive beds resulted from post-depositional events, then it may lend insight into the setting for the Misener/Sylamore. Post-depositional processes which may lead to the disruption of internal bedding include: bioturbation, water escape and fabric collapse during compaction, or gasses escaping from the sediment below (Reineck and Singh, 1987). The initial porosity and permeability of the sediments was high, making it improbable that gas escaping causes sediment disruption. It is also possible that tectonic disturbances or storm events churned the sediments, thus destroying their internal structure. The setting of the deposition of the Misener/Sylamore was on a stable craton, making it unlikely that tectonic disturbances were consistant enough to disturb the fabric of the sediment.

If the massive beds were caused by storm related rapid deposition, then hummocky cross-stratification would likely be present. Bourgeois (1980) described an Upper Cretaceous transgressive sequence containing hummocky cross-stratification; the Misener/Sylamore is a transgressive sequence yet it does not show hummocky bedding. Although no hummocky cross-stratification is identified within the samples for this study, escape trails and layers of phosphate pebbles may mark storm events. Francis (1988) listed hummocky cross-stratification as a sedimentary feature during a study of the Misener in north-central Oklahoma. Bourgeois (1980) also noted the presence of a basal conglomerate, trough-cross-bedded sandstone, within the transgressive sequence in southwestern Oregon. The Misener/Sylamore does not have a basal conglomerate, although it often contains gravel sized sand at the base, and no trough cross-bedding was observed.

Diaz and Maldonado (1990) described modern sand bodies deposited by storm events, and showed how the sand body distribution was affected by seafloor topography. Mapping of the Misener/Sylamore has shown that the sediments filled topographic lows (Francis, 1988), therefore, accumulation was affected by subsea topography. This accumulation in low areas also suggests that the sediments were not positive features on the sea floor, therefore they were not likely to have been sand waves or ribbons.

The lack of consistent internal stratification within the Misener/Sylamore does not rule out the aforementioned depositional systems. It may be that the sedimentation rate was so small (as manifested by presence of glauconite) so as not to preserve the primary sedimentary features. The sedimentary features seen in the Misener/Sylamore for this study are therefore probably the result of slow sedimentation rates, coupled with biological and or mechanical reworking of existing sediments. It must be noted that several previous investigators observed cross-stratification, although it was not ubiquitous.

It is therefore proposed that the lack of consistency of features with depositional systems aforementioned indicates that the Misener/Sylamore probably does not lend itself in a simple way to any conventional interpretation. If the depositional system was dominant, then strong facies relationships should be evident both laterally, and with respect to distance from shore. The Misener/Sylamore and its stratigraphic equivalents are found over a large area from West Texas to Tennessee and into Illinois. This study focused on the rocks in Arkansas, Oklahoma, and Kansas, and the lack of internal stratification, components (monocrystalline quartz, detrital dolomite, phosphate, fish fragments, glauconite), thin nature, and erratic distribution is fairly consistant throughout the three states. This consistancy indicates that depositional environment (setting) and provenance, as opposed to depositional system was the dominant force.

It is therefore proposed that the Misener/Sylamore can not easily be related to a conventional depositional system, but better attributed to a transgressive depositional setting upon a submerged, unconformable, surface (figure 14). This conclusion agrees with those reached by Swanson and Landis (1962), Freeman and Schumacher (1969), Comer (1991), and with what should be expected of a transgressive sequence as outlined by Baum and Vail (1988).

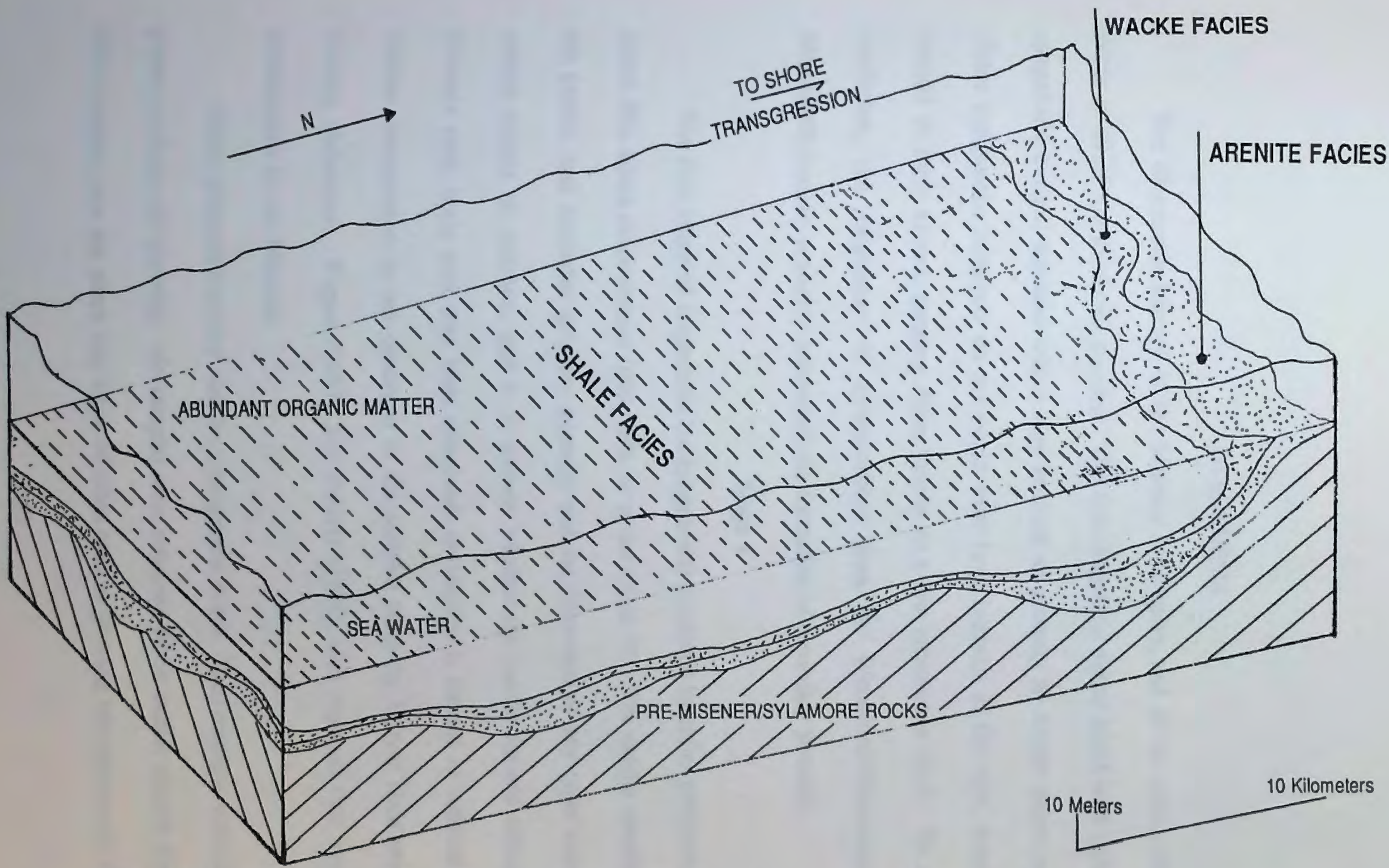


Figure 14- Interpretation of depositional conditions of Misener/Sylamore and Woodford/Chattanooga (modified after Swanson & Landis, 1962).

DIAGENESIS

The diagenetic history of the Misener is complex, and all the stages listed do not occur at all of the locations studied. The first diagenetic events listed were quite possibly syngenetic events, because where they occlude all porosity no further stages are present. These syngenetic minerals do not occur over large intervals of the rock, rather they are limited in their extent, ranging from patchy to a few centimeters thick. To add to the confusion, the migration of hydrocarbons from the Woodford/Chattanooga to the Misener/Sylamore probably enhanced the formation of secondary porosity.

Stage 1

The first stage of diagenesis (or syngenesis) is marked by either poikilotopic calcite (plate 29), silica cementation (plate 30), or pyrite (plate 31). The calcite usually supports the grains, and occludes primary porosity and the formation of any other cement. The calcite occurs in patches, and it is unclear whether the calcite formed throughout the Misener rock body and was later dissolved, or whether it formed in isolated intervals. Calcite cementation is not observed in the samples from the Beaver Dam area, Carroll County, Arkansas. Pogue (1987) and Francis (1988), also reported first stage calcite cementation in the Misener.

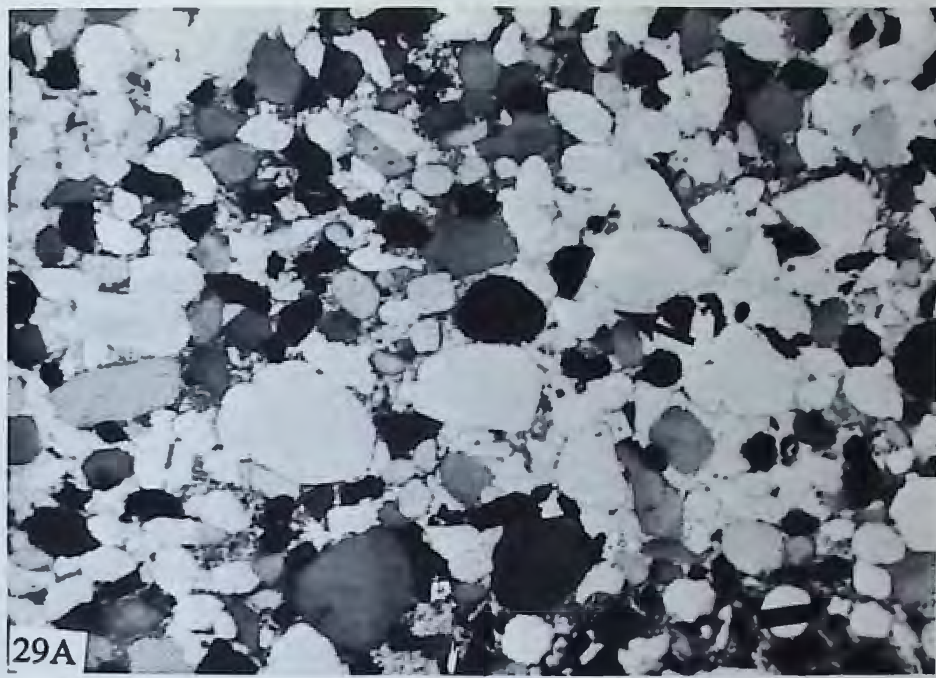
Silica cementation may also be a syngenetic event. The cement is syntaxial, and at places occludes all porosity. No samples were observed where calcite cement formed after silica cement, nor are there any signs of silica cement growing into previously existing

PLATE 29

Photomicrographs of samples with poikilotopic carbonate cement.

29A. D&J Oil- Wade 1-8: 5901´. Poikilotopic calcite cement (arrow) within Misener near upper contact with Woodford. Scale bar 0.25mm, 4x, crossed nicols.

29B. Commonwealth- Farber 1A: 3541´. Well sorted and well rounded quartz grains "floating" within poikilotopic calcite cement (arrow). Scale bar 0.25mm, 4x, crossed-nicols.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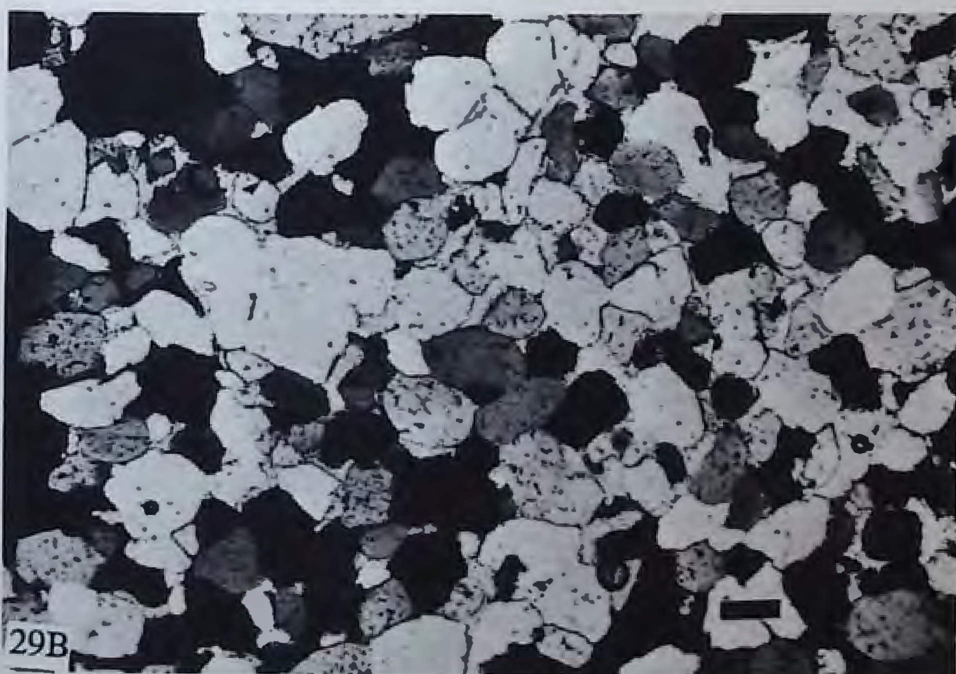
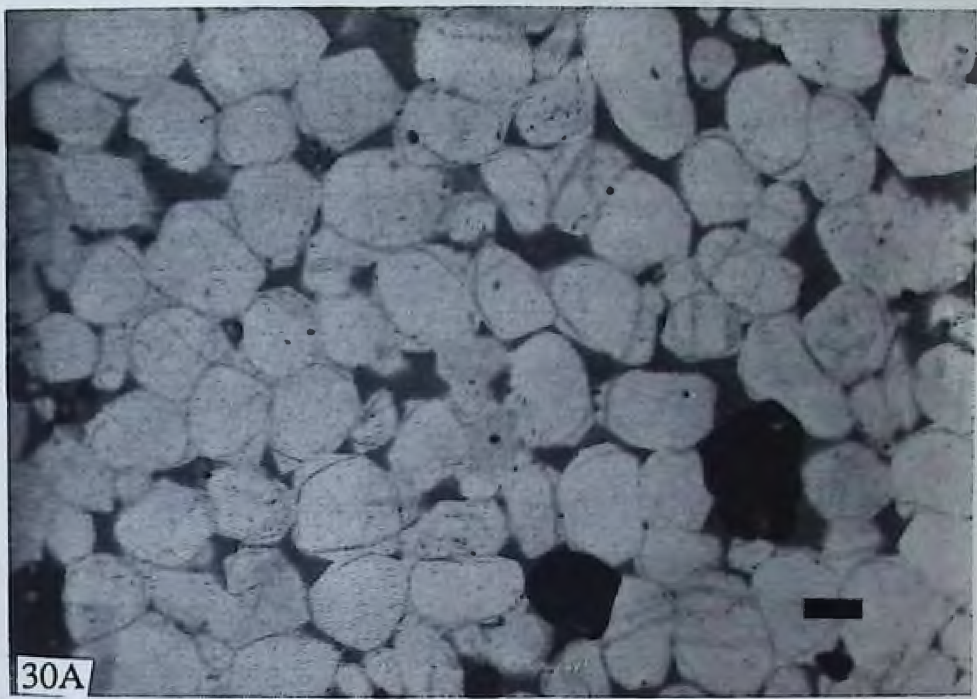

29B

PLATE 30

Photomicrographs of silica cementation.

30A. D&J Oil- Sunflower 1-8: 5917′3″. Syntaxial silica overgrowths preserving primary porosity and making straight pore walls. Scale bar 0.25mm, 4x, plane light.

30B. Shaffer- Steele 1: 3349′. Silicified carbonate mud with quartz grains. Scale bar 0.25mm, 4x, crossed-nicols.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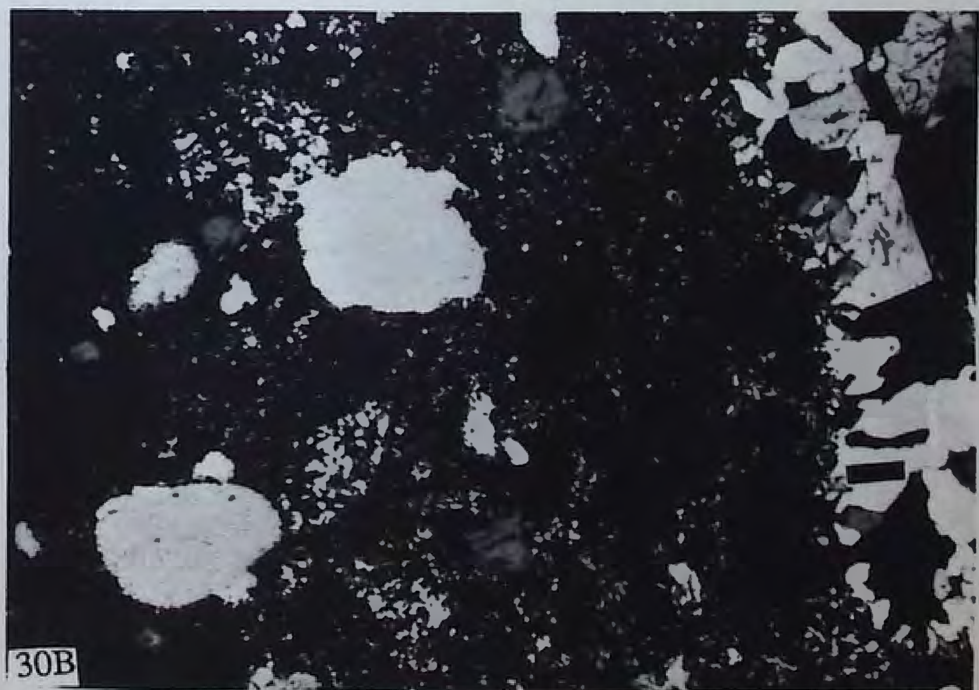

30B

PLATE 31

Photomicrographs of rocks with pyrite.

31A. Shell- Duerkson 1: 3486'2". Pyrite cement (arrows) at contact between Misener and Chattanooga. Scale bar 0.25mm, 4x, crossed-nicols.

31B. Beaver Dam- Float (2). Abundant quartz with syntaxial silica overgrowths. Pyrite fills pores (arrows). Scale bar 0.25mm, 4x, plane light.

31A

31B

calcite. Typically, the silica forms euhedral overgrowths on the quartz grains, with the boundaries evident. The overgrowths leave straight pore walls and obvious primary porosity. In Kansas, there is evidence of silica replacement of carbonate mud (plate 30), a phenomenon also described by Newell et al. (1991).

Pyrite is a syngenetic feature, but is most concentrated at the contact between the Misener and Woodford (plate 31). The pyrite at the contact with the Woodford/Chattanooga acts as a cement. It is possible that the onset of reducing conditions that marked the Woodford/Chattanooga deposition were recorded in the pyrite layer at the top of the Misener/Sylamore. It is also possible that the pyrite reflects the movement of fluids from the Woodford/Chattanooga to the Misener/Sylamore. Schieber (1991, personal communication) noted that pyrite typically occurs at the contacts of sandstone and shale because of the aforementioned fluid movement.

Stage 2

Dolomite and ferroan dolomite crystallization followed silica cementation (plate 32). The euhedral dolomite rhombs usually fill primary pore space, and by the process of thin film dissolution, are replacing quartz. In samples where the dolomite is abundant (eg. Federal Petroleum- Wolleson 1; FCD's-Mary and Roberts wells) petrographic observations suggest that the diagenetic dolomite is altering detrital dolostone, making for euhedral crystals that obscure eroded or rounded edges of the detrital grains. One argument against the hypothesis of primary dolomite within dolomite rich samples is the occurrence of euhedral silica overgrowths on quartz grains "floating" within dolomite. If the dolomite is primary, it should occlude any silica cementation. If the quartz grains were transported,

PLATE 32

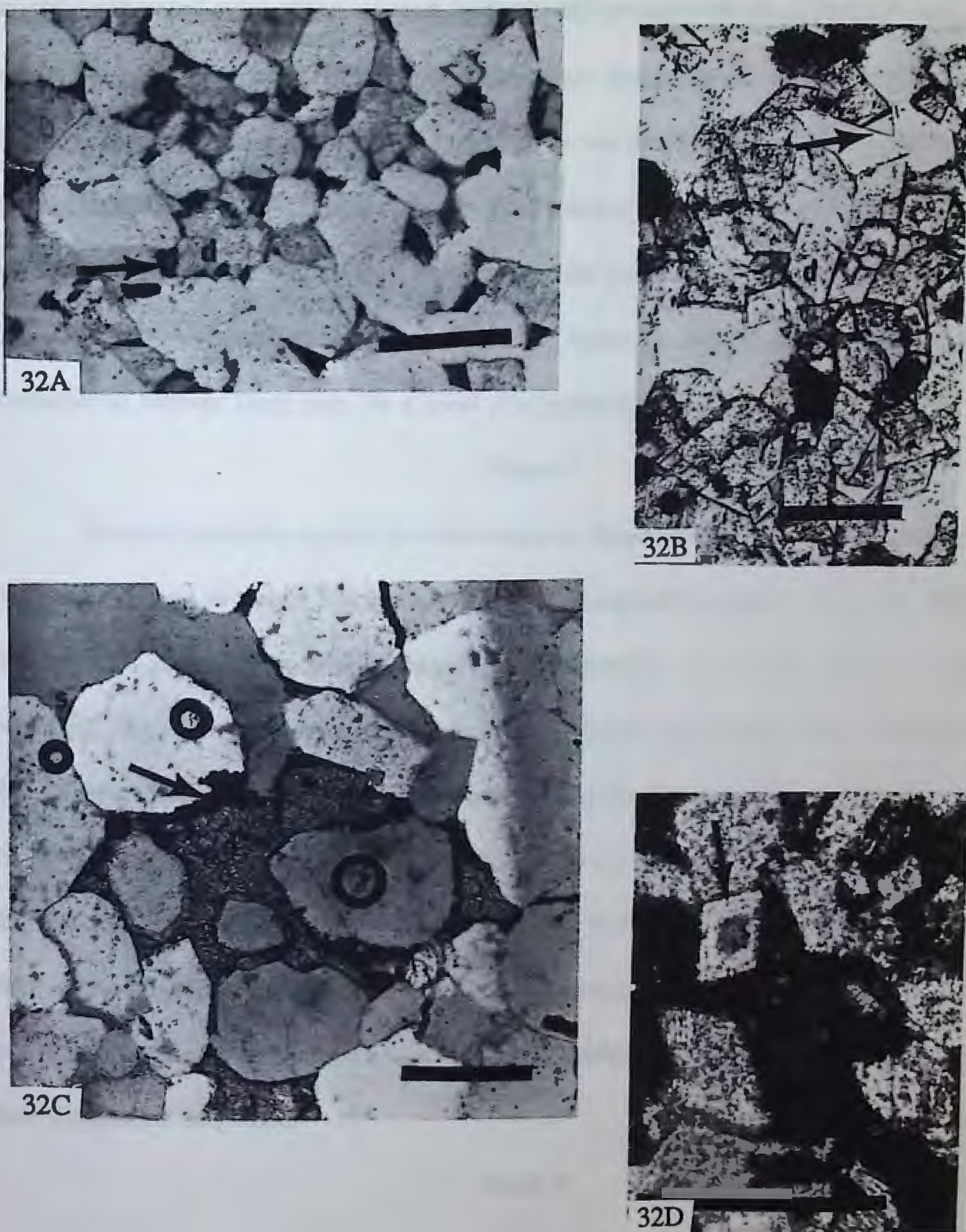
Photomicrographs of diagenetic dolomite.

32A. D&J Oil- Wade 1-8: 5914'8". Quartz (with syntaxial overgrowths) forming framework. Later stage euhedral dolomite (d) filling pores and replacing quartz. Note degraded oil lining pores (arrow). Scale bar 0.25mm, 10x, plane light.

32B. Federal Petroleum- Wolleson 1: 5083'. Quartz with syntaxial silica overgrowths (arrow) "floating" in euhedral dolomite (d) matrix. note straight pore walls in upper right corner of photo. Scale bar 0.25mm, 10x, plane light.

32C. Commonwealth- Farber 1A: 3541'. Sample showing silica cementation (s), followed by pore filling dolomite (d), and late stage pyrite (arrow) filling in remainder of pore. Scale bar 0.25mm, 10x, plane light.

32D. Federal Petroleum- Wolleson 1: 5093'4". Sample showing rare occurrence of zoned dolomite (arrow). Scale bar 0.25mm, 20x, crossed-nicols.


32A
32B
32C
32D

already cemented with silica, eroded, and rounded overgrowths should be common, which is not the case. Francis (1988) reported abundant detrital dolostone that was later altered by diagenetic dolomite formation. Dolomite is not detected in the samples from Beaver Dam, Carroll County, Arkansas. It is unclear whether the lack of dolomite is related to the absence of glauconite and conodonts, or it is the result of subarial exposure. Pittenger (1981) reported secondary dolomite within the Sylamore, which suggests that the lack of dolomite at Beaver Dam may be a local phenomenon.

Stage 3

Pressure solution marks the next stage of diagenesis (plate 33). The formation of pressure solution released silica which, in turn, cemented the grains above and below the feature, creating a permeability barrier. The stylolites are usually lined with organic material, clay, and can occur in swarms. The stylolites dissolve the detrital minerals, and the aforementioned diagenetic minerals, indicating that the stylolites formed after calcite, silica, and most of the dolomite. The stylolites do not have any trapped oil. indicating that they formed before the migration of hydrocarbons. This suggests that stylolites were formed prior to the migration of hydrocarbons. The stylolites can occur at bedding planes, but more commonly within homogeneous rock. No other worker noted the formation of stylolites in their diagenetic sequence.

Stage 4

Secondary porosity (plate 34) formed late in diagenesis, but it is unclear whether it preceded or followed hydrocarbon generation. The lack of earlier stage diagenetic cements within the diagenetic porosity suggests that it was formed after the earlier

PLATE 33

Photographs of rocks with stylolites.

33A. D&J Oil- Daisy 1-17: 5914′. Photomicrograph of stylolite lined by organic material, and dissolution of detrital and diagenetic minerals. Scale bar 0.25mm, 4x, plane light.

33B. W.H. Davis- Cox 1: 5916′4″. Stylolite swarm within fairly homogeneous rock. Lighter areas of rock are where dolomite content increases. Scale shown on photograph

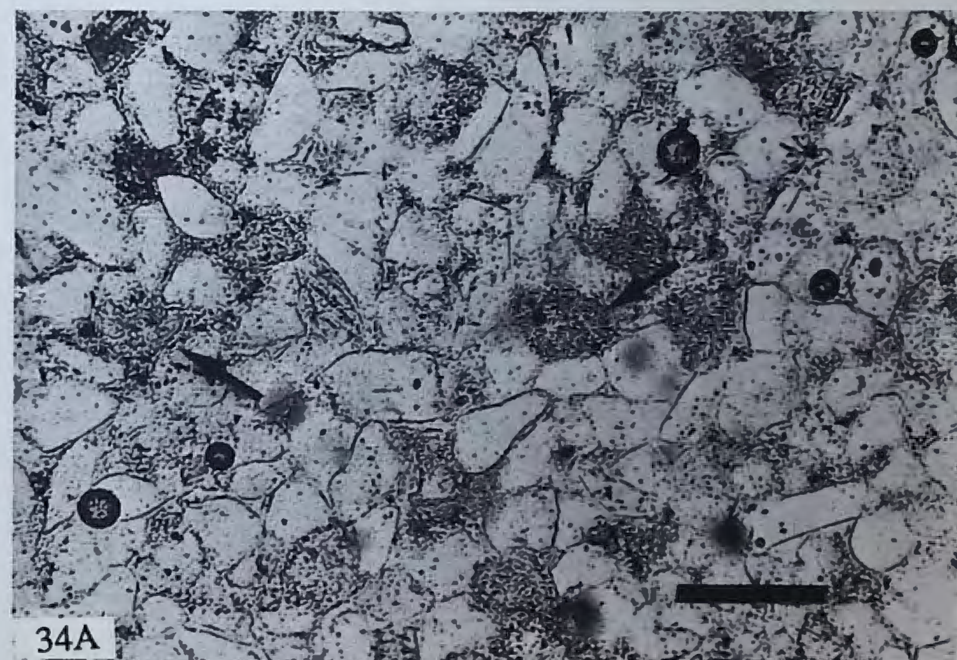
33A

33B

PLATE 34

Photomicrographs samples with secondary porosity.

34A. Western- Hoffman 1: 4548′. Secondary porosity identified by ghost grain outlines (arrows) which under polarized light show minor authigenic clay. Scale bar 0.25mm, 10x, plane light.



34A

cementation. Surdam et al. (1989) discusses the organic acid front which precedes hydrocarbon migration, which he concludes aids in the creation of secondary porosity. This phenomenon therefore suggests that secondary porosity formation should precede hydrocarbon migration in the diagenetic order.

Stage 5

The migration of hydrocarbons is the last stage in the diagenetic sequence. The evidence for late hydrocarbon migration is that there is no apparent oil inclusions within the earlier stage diagenetic cements. In the D&J wells from Grant County, degraded oil exists in the lower part of the core. The process which degraded the oil also contributed to the oxidation of glauconite, which changes from green to brown in the affected zones (plate 17). Walker (1986) listed the migration of hydrocarbons as a late stage of diagenesis within his study area.

AGE OF THE MISENER/SYLAMORE

For this study, biostratigraphic analysis was not done, however, previous workers have supplied a sufficient database. The conodont zones listed by Amsden and Klapper (1972) reflect the time transgressive nature of the Misener in north-central Oklahoma from Middle Devonian (Polygnathus varcus zone) to late Upper Devonian (upper Polygnathus triangularis zone). Francis (1988) also noted similar conodont occurrences, and suggested that two of the species present, Ancyrodella africana and Icriodus subterminus, were indicative of a nearshore, high energy, marine setting. Freeman and Schumaker (1969) listed biostratigraphic zones from Middle Devonian (Polygnathus varcus) through Early Mississippian (Siphonodella isosticha) in Arkansas. Terry (1977), and Pittenger (1981), were in agreement with Freeman and Schumaker (1969), with regards to conodont zones. Hilpman (1969) examined conodonts in Kansas, and found a range from early Late Devonian through Early Mississippian.

LIMITATIONS OF STUDY

One limitation of the study is the paucity of cores taken through the Woodford/Chattanooga and Misener/Sylamore interval. This scarcity of cores, coupled with the resulting limited collection of cores at the Kansas and Oklahoma Geological Survey (core libraries) restricts access to the Misener/Sylamore from the subsurface. When cores are donated to state surveys it is usually because the exploration company has lost interest in the prospect (or hasn't the storage space). The hydrocarbon producing potential of the cores observed from the state surveys is unkown, but probably very low. This would tend to bias the samples towards non-productive Misener/Sylamore intervals, thereby affecting the final conclusions. The four cores from Grant County, Oklahoma, and one from Alfalfa County, Oklahoma were all from hydrocarbon producing wells. The coring operation itself is also a biased process because only the competent rocks survive. The sampling therefore was not random. Although the sampling is biased, and the thickness of the Misener cores and Sylamore outcrops studied ranges from less than one ft/0.32 m to more than 50 ft/16.4 m, the features are remarkably consistent.

CONCLUSIONS

1. The deposition of the Misener/Sylamore has no present-day analogues, making it difficult to relate to a traditional system. The rock body is widespread, thin, and relatively consistant both compositionally and sedimentologically. The occurrence of the rocks at the base of the Late Devonian transgressive event suggests that the Misener/Sylamore can best be described as the result of sediment accumulation in erosional lows (lag deposit) as the Woodford/Chattanooga seas advanced.

2. Classification of the samples based on the components yielded three lithofacies: 1) Arenite; 2) Wacke; and 3) Shale. These three lithofacies represent depositional environments ranging from nearshore (Arenite) to middle shelf (Shale).

3. The Misener/Sylamore consists of quartzose sandstone, lithic sandstone (primarily detrital dolostone), and a shale that is usually very similar to Woodford/Chattanooga-type shale. The three lithotypes are interbedded with contacts from sharp (planar and undulose) to gradational. The thickness of each rock type ranges from several in/5-10 cm up to tens of ft/3-10 m. The lower contact is generally sharp and undulose, and lithoclasts from underlying units are usually incorporated in the quartzose matrix above the contact. The upper contact with the Woodford/Chattanooga is sharp and

planar, with shale just below the contact appearing similar to the Woodford/Chattanooga Shale. Phosphatic pebbles (reworked from older sediments) define bedding surfaces, possibly marking either storm or transgressive events. The rocks are generally massive with differing amounts of bioturbation. Cross stratification was not observed within the samples described.

4. The detrital components of the Misener/Sylamore are primarily monocrystalline quartz and detrital dolostone, with minor amounts of polycrystalline quartz (chert and metamorphic rock fragments), and reworked phosphate. Potassium and plagioclase feldspar, zircon, and tourmaline, were present in trace amounts, with biotite and muscovite being very rare. The rounding and sphericity of the monocrystalline quartz indicates a multicycle history for the grains.

5. The intrabasinal components of the Misener/Sylamore consist of minor amounts of glauconite, conodonts, ichnofossils, and fish fragments; brachiopods, molluscs, and spores were present in trace amounts. The glauconite, fish fragments, and conodonts indicate a marine environment for the deposition of the Misener/Sylamore.

6. The sequence of syngenetic/diagenetic events is: 1) poikilotopic calcite, syntaxial silica and silicification of carbonate mud, and pyrite formation; 2) dolomite and iron dolomite forming, and altering detrital dolostone; 3) stylolitization; 4) creation of secondary porosity, enhanced by the migration

of organic acids preceding the migration of hydrocarbons; and 5) migration of hydrocarbons. The interpretation of the dolomite as being a combination of detrital and diagenetic is critical in eliminating an evaporitic tidal flat as a possible depositional environment/system. Not all of the stages occurred in all locations.

7. The consensus on the age of the Misener/Sylamore based on conodonts is Middle Devonian to Early Mississippian. The Misener/Sylamore is time transgressive, being older to the south.

8. The location of the central United States with relation to the Acadian orogeny (east of the study area) probably hindered the formation of hurricanes near the study area during the Late Devonian to Early Mississippian.

SUGGESTIONS FOR FURTHER STUDY

In order to more fully understand the regional occurrence of the Misener/Sylamore it would be useful to study cores or outcrops over a wider area (including Missouri, Colorado, Tennessee, and Illinois). The obervations could be compared to those made in this and previous studies, to gain a better understanding of the influence of local provenance versus depositional environment. A study using isotopic analysis of the dolomites and cathodluminescence may better develop a better understanding of the timing of diagenesis. For petroleum exploration purposes a seismic project that utilized three dimensional time slices mapped on the unconformity may show paleo-lows where Misener/Sylamore accumulations are likely.

APPENDICES

I. Core Descriptions/Thin Section Data

II. Petrophysical Data

III. X-Ray Diffraction Results (Sunflower 1-8)

IV. Lithofacies Classification

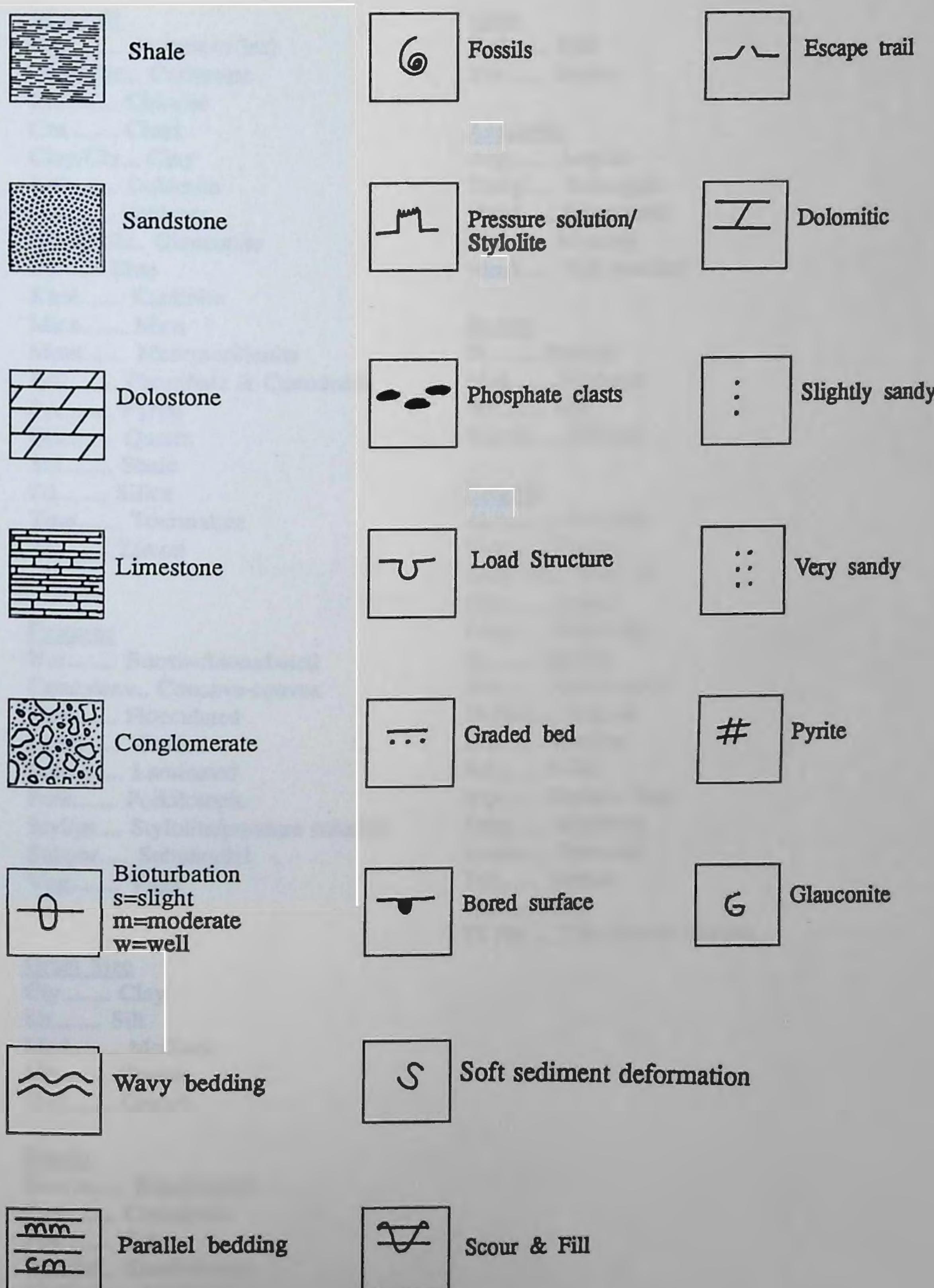
List of core utilized

#	COMPANY	WELL NAME	LOCATION
1	Western Petroleum	Hoffman 1	Edwards Co., KS
2	Mabee-Shell	Friesen 5	McPherson Co., KS
3	Mabee-Shell	Nikkel 5B	McPherson Co., KS
4	Amerada	Wilson 1	Reno Co., KS
5	Derby	Sperling 1	Harvey Co., KS
6	Shaffer	Steele 1	Harvey Co., KS
7	Shell	Duerkson 1	Harvey Co., KS
8	Commonwealth	Farber 1A	Sedgewick Co., KS
9	Park Avenue Ex.	Jane 1-25	Alfalfa Co., OK
10	William H. Davis	Cox 1	Grant Co., OK
11	D&J Oil	Daisy 1-17	Grant Co., OK
12	D&J Oil	Sunflower 1-8	Grant Co., OK
13	D&J Oil	Wade 1-8	Grant Co., OK
14	FCD	Mary A1	Garfield Co., OK
15	FCD	Roberts 1-18	Garfield Co., OK
16	Federal Petroleum	Wolleson 1	Noble Co., OK
17	Tenneco	Swen 1-16	Oklahoma Co., OK
18	Beaver Dam	Core/Road Cut/ Float	Carroll Co., Ark

APPENDIX 1

Core Descriptions/Thin Section Data

LEGEND


Shale
Fossils
Escape trail
Sandstone
Pressure solution/
Stylolite
Dolomitic
Dolostone
Phosphate clasts
Slightly sandy
Limestone
Load Structure
Very sandy
Conglomerate
Graded bed
Pyrite
Bioturbation
s=slight
m=moderate
w=well
Bored surface
Glauconite
Wavy bedding
Soft sediment deformation
mm
cm
Parallel bedding
Scour & Fill

Abbreviations

Minerals
Acc........ Accessory(ies)
Carb/Car... Carbonate
Chl........ Chlorite
Cht........ Chert
Clay/Cly... Clay
Dol........ Dolomite
Fld........ Feldspar
Glauc/Glc.. Glauconite
Ill........ Illite
Kaol....... Kaolinite
Mica....... Mica
Mont....... Montmorillonite
P/C........ Phosphate & Conodonts
Pyr........ Pyrite
Qtz........ Quartz
Shl........ Shale
Sil........ Silica
Tour....... Tourmaline
Zir........ Zircon

Features
Bur........ Burrow/bioturbated
Conc.conv.. Concave-convex
Floc....... Flocculated
Gded....... Graded
Lam........ Laminated
Poik....... Poikilotopic
Styl/ps.... Stylolite/pressure solution
Subpar..... Subparallel
Vug........ Vugs

Grain Size
Cly........ Clay
Slt........ Silt
Med........ Medium
Crs........ Coarse
Gvl........ Gravel

Fossils
Brachs..... Brachiopods
Con........ Conodonts
Fsh........ Fish
Fossilif... Fossiliferous
Molluscs... Molluscs

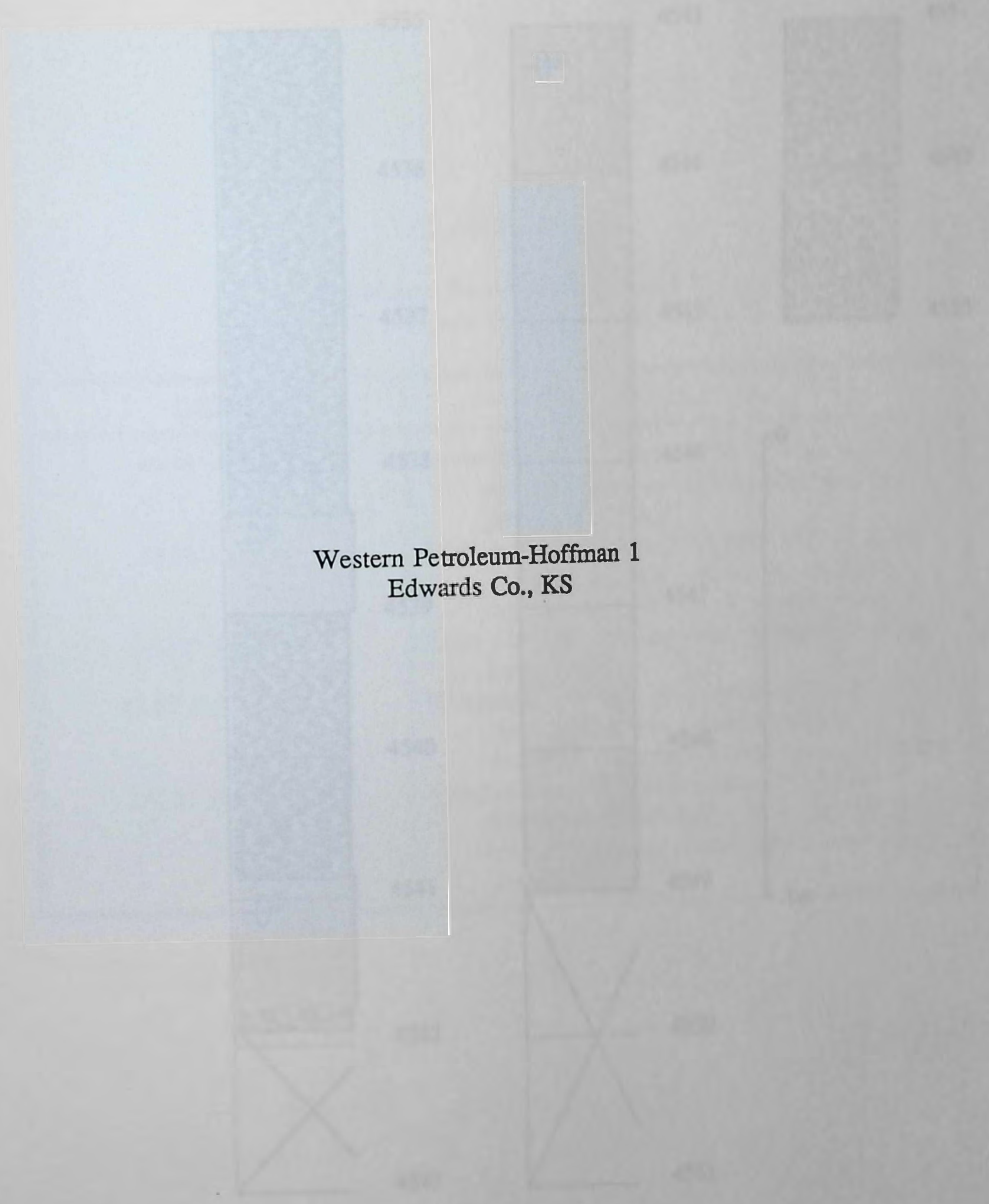
Color
Red........ Red
Brn........ Brown

Angularity
Ang........ Angular
Sbang...... Subangular
Sbrnd...... Subrounded
Rnd........ Rounded
wlrnd...... Well rounded

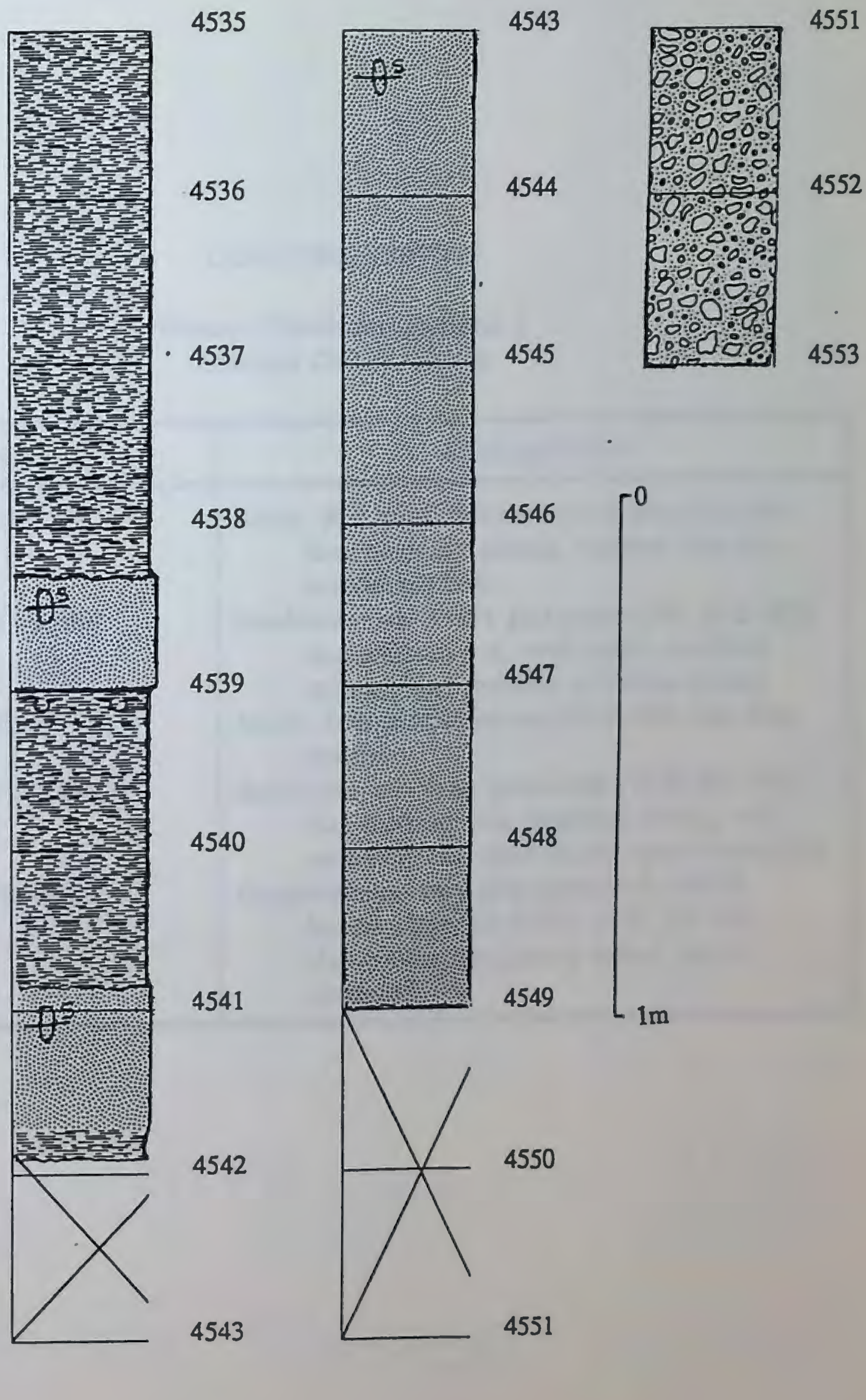
Sorting
Pr......... Poor(ly)
Mod........ Moderate
Wl......... Well
Bimod...... Bimodal

General
Abun....... Abundant
Cntc....... Contact
Dead Oil... Dead Oil
Detr....... Detrital
Frags...... Fragments
Ig......... Igneous
Met........ Metamorphic
Organic.... Organic
Ran........ Random
Rel........ Relict
Rep........ Replace (ing)
Separ...... Separating
Syntax..... Syntaxial
Tex........ Texture
Tr......... Trace
TS Phi..... Thin Section Porosity

Western Petroleum-Hoffman 1
Edwards Co., KS



Western Petroleum-Hoffman 1
Edwards Co., KS



CORE DESCRIPTION

Western Petroleum- Hoffman 1
Edwards County, Kansas

DEPTH	DESCRIPTION
4535'-4538'1"	Shale- dark reddish brown (10 R 3/4), clay-fine size, moderate sorting, massive, rare thin parallel silt beds
4538'1"-4539'	Sandstone- white-very pale green (N9- 10 G 8/2), fine-medium size, well sorted, moderate cement, load structure at bottom contact
4539'-4540'11"	Shale- dark reddish brown (10 R 3/4), clay-fine, massive
4540'11"-4549'(?)	Sandstone- moderate green-white (5 G 5/6- N9), clay-medium size, moderate sorting, well cemented, rare shale streak, wavy lamination
4551'(?)-4553'	Conglomerate- very pale green-dark reddish brown-white (10 G 8/2- 10 R 3/4- N9), clay-cobble size, poorly sorted, poorly cemented

WESTERN PETROLEUM: HOFFMAN 1, EDWARDS COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
4537.0	Chatt		laminated	clay,dol	mod
4538.0	Chatt		laminated (wvy)	clay	mod
4539.0	Chatt		laminated	clay	mod
4541.6	Misener	float-straight	laminated	clay	mod
4543.0	Misener	point-conc.conv	ran-laminated	sil,dol,clay	mod
4546.0	Misener	float-conc.conv	random	silica,dol	mod
4548.0	Misener	float-conc.conv	random	sil,dol,clay	mod
4549.0	Misener	float-conc.conv	random	silica	mod
4551.0	?(Carb)			carb	

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
4537.0	Chatt	cly-v fine	slt	0	1	60	39
4538.0	Chatt	cly-fine	cly	0	10	30	60
4539.0	Chatt	cly-fine	cly	0	10	15	75
4541.6	Misener	cly-med	fine	0	55	5	40
4543.0	Misener	cly-med	v fine	0	78	2	20
4546.0	Misener	cly-fine	v fine	0	95	3	2
4548.0	Misener	cly-fine	fine	0	93	2	5
4549.0	Misener	cly-fine	fine	0	96	2	2
4551.0	?(Carb)	slt-v fine		0	0	100	0

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
4537.0	Chatt	ang-sbrnd	low-high		red;bur
4538.0	Chatt	ang-rnd	low-high		red;
4539.0	Chatt	ang-wlrnd	low-high		red;bur
4541.6	Misener	ang-wlrnd	low-high	immature	tr tour;abun ang frags
4543.0	Misener	ang-wlrnd	low-high	immature	tr tour;dol rep qtz
4546.0	Misener	sbang-wlrnd	mod-high	submature	tr zir,tour,cht;dol rep qtz
4548.0	Misener	sbang-wlrnd	mod-high	submature	tr zir,cht;dol rep qtz
4549.0	Misener	sbang-wlrnd	low-high	submature	tr zir,tour,cht;ps;dol rep qtz
4551.0	?(Carb)	ang-sbrnd	low-high		spong spic;press soln

WESTERN PETROLEUM: HOFFMAN 1, EDWARDS COUNTY, KANSAS

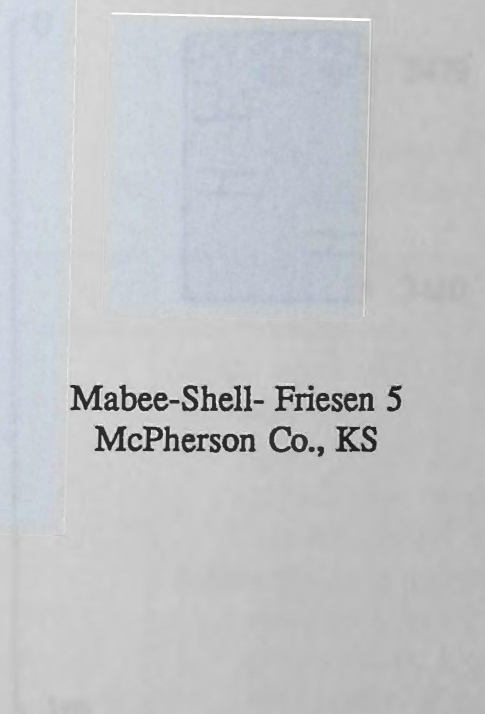
Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
4537.0	Chatt	1.0	39.0	1.0	0.0	1.0	0.0	39.0	0.0	15.0	5.0
4538.0	Chatt	1.0	31.0	1.0	3.0	1.0	1.0	60.0	0.0	0.0	2.0
4539.0	Chatt	1.0	24.0	1.0	10.0	1.0	0.0	63.0	0.0	0.0	0.0
4541.6	Misener	1.0	53.0	1.0	0.0	1.0	3.0	40.0	0.0	0.0	1.0
4543.0	Misener	10.0	51.0	1.0	0.0	0.0	2.0	25.0	0.0	10.0	1.0
4546.0	Misener	15.0	69.0	1.0	0.0	0.0	2.0	5.0	0.0	7.0	1.0
4548.0	Misener	15.0	71.0	1.0	0.0	0.0	1.0	8.0	0.0	3.0	1.0
4549.0	Misener	15.0	69.0	1.0	0.0	1.0	1.0	10.0	0.0	3.0	1.0
4551.0	?(Carb)	10.0	10.0	0.0	0.0	0.0	2.0	0.0	0.0	68.0	10.0

WESTERN PETROLEUM: HOFFMAN 1, EDWARDS COUNTY, KANSAS

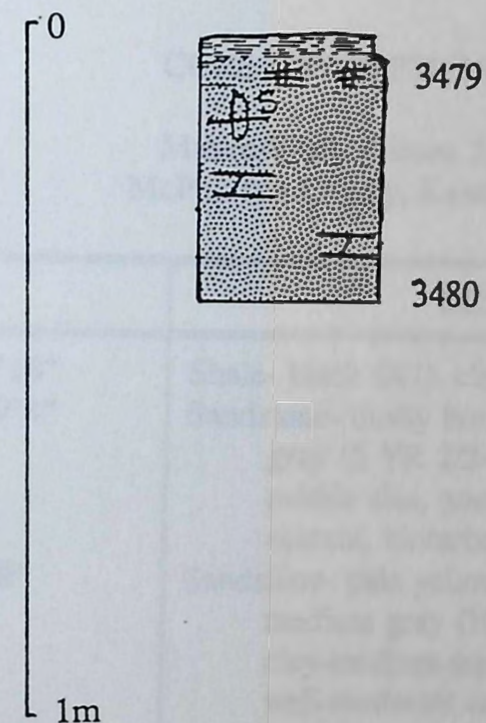
Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
4537.0	Chatt	1.0	39.0	1.0	0.0	1.0	0.0	39.0	0.0	15.0	5.0
4538.0	Chatt	1.0	31.0	1.0	3.0	1.0	1.0	60.0	0.0	0.0	2.0
4539.0	Chatt	1.0	24.0	1.0	10.0	1.0	0.0	63.0	0.0	0.0	0.0
4541.6	Misener	1.0	53.0	1.0	0.0	1.0	3.0	40.0	0.0	0.0	1.0
4543.0	Misener	10.0	51.0	1.0	0.0	0.0	2.0	25.0	0.0	10.0	1.0
4546.0	Misener	15.0	69.0	1.0	0.0	0.0	2.0	5.0	0.0	7.0	1.0
4548.0	Misener	15.0	71.0	1.0	0.0	0.0	1.0	8.0	0.0	3.0	1.0
4549.0	Misener	15.0	69.0	1.0	0.0	1.0	1.0	10.0	0.0	3.0	1.0
4551.0	?(Carb)	10.0	10.0	0.0	0.0	0.0	2.0	0.0	0.0	68.0	10.0



Mabee-Shell- Friesen 5
McPherson Co., KS

Mabee-Shell- Friesen 5
McPherson Co., KS



CORE DESCRIPTION

Mabee-Shell- Friesen 5
McPherson County, Kansas

DEPTH	DESCRIPTION
3478'9"-3478'10"	Shale- black (N1), clay-silt size, massive
3478'10"-3479'4"	Sandstone- dusky brown-moderate yellow-light gray (5 YR 2/2- 5 Y 7/6- N7), clay-pebble size, poorly sorted, moderate cement, bioturbation, abundant pyrite
3479'4"-3480'	Sandstone- pale yellowish brown-moderate brown-medium gray (10 YR 6/2- 5 YR 3/4- N5), clay-medium size, well-moderate sorting, well-moderate cemented, weathered appearance

MABEE-SHELL: FRIESEN 5, McPHERSON COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3479.0	Misener	point-conc.conv	random	clay,dol,pyr	pr
3479.5	Misener	point-conc.conv	random	silica,dol	mod
3480.0	Misener	float-conc.conv	ran-laminated	dol,sil	wl

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3479.0	Misener	cly-gvl	fine	5	80	5	10
3479.5	Misener	cly-med	fine	0	96	1	3
3480.0	Misener	fine-med	fine	0	100	0	0

Thin Section Data: Grain Shape and Comments

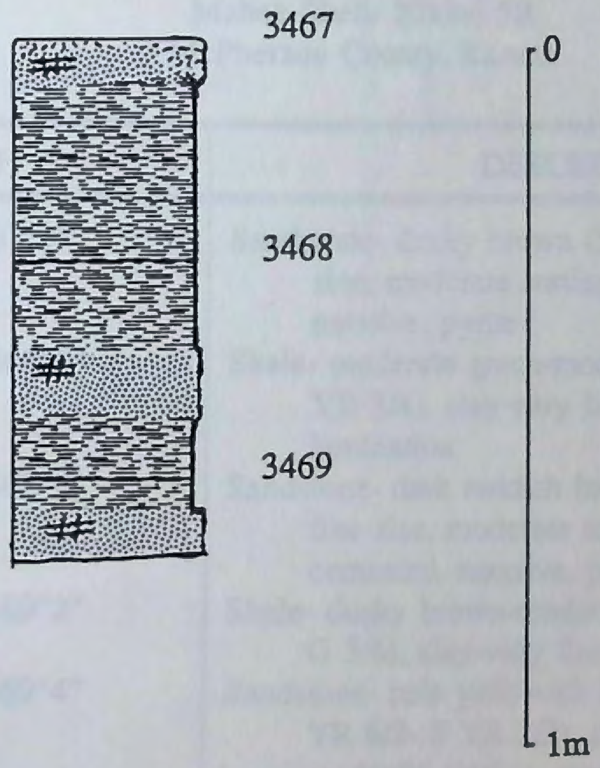
Depth	Formation	Angularity	Sphericity	Maturity	Comments
3479.0	Misener	ang-wlrnd	low-high	immature	dol rep qtz
3479.5	Misener	ang-wlrnd	mod-high	submature	fossilif;dol rep qtz
3480.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr met qtz,cht;dol rep qtz

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3479.0	Misener	1.0	78.0	1.0	0.0	0.0	7.0	5.0	0.0	5.0	3.0
3479.5	Misener	2.0	66.0	1.0	0.0	1.0	7.0	5.0	0.0	17.0	1.0
3480.0	Misener	10.0	40.0	1.0	0.0	3.0	5.0	0.0	0.0	40.0	1.0

Mabee-Shell- Nikkel 5B
McPherson Co., KS

Mabee-Shell- Nikkel 5B
McPherson Co., KS



CORE DESCRIPTION

Mabee-Shell- Nikkel 5B
McPherson County, Kansas

DEPTH	DESCRIPTION
3467'-3467'2"	Sandstone- dusky brown (5 YR 2/2), clay-fine size, moderate sorting, moderate cemented, massive, pyrite
3467'2"-3468'5"	Shale- moderate green-moderate brown (5 G 5/6-5 YR 3/4), clay-very fine size, thin parallel lamination
3468'5"-3468'8"	Sandstone- dark reddish brown (10 R 3/4), clay-fine size, moderate sorting, moderate cemented, massive, pyrite
3468'8"-3469'2"	Shale- dusky brown-moderate green (5 YR 2/2- 5 G 5/6), clay-very fine size, thin laminations
3469'2"-3469'4"	Sandstone- pale yellowish brown-dusky brown (10 YR 6/2- 5 YR 2/2), clay-fine size, moderate sorting, moderate cement, wavy laminations

MABEE-SHELL: NIKKEL 5B, McPHERSON COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3467.0	Misener	point-conc.conv	random	pyr,sil,dol	mod
3468.0	Chatt		laminated	clay	mod
3468.6	Misener	float-conc.conv	random	sil,pyr,clay	mod

Thin Section Data: Grain Size

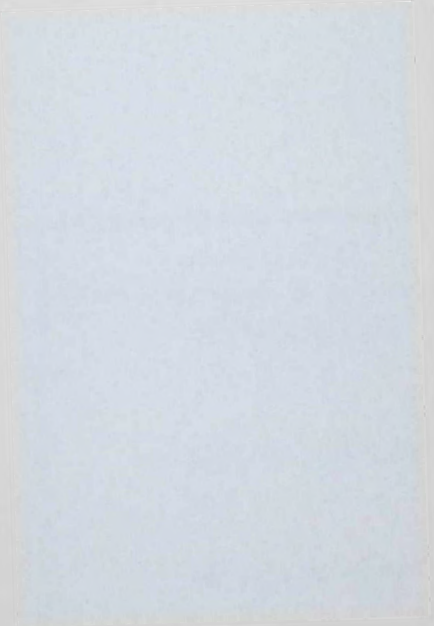
Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3467.0	Misener	cly-fine	v fine	0	86	1	13
3468.0	Chatt	cly-v fine	cly	0	2	13	85
3468.6	Misener	cly-fine	v fine	0	94	1	5

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
3467.0	Misener	sbang-wlrnd	low-high	immature	tr tour,zir,cht;spores
3468.0	Chatt	ang-wlrnd	mod-high		spores
3468.6	Misener	sbang-wlrnd	mod-high	submature	tr cht;fossilif

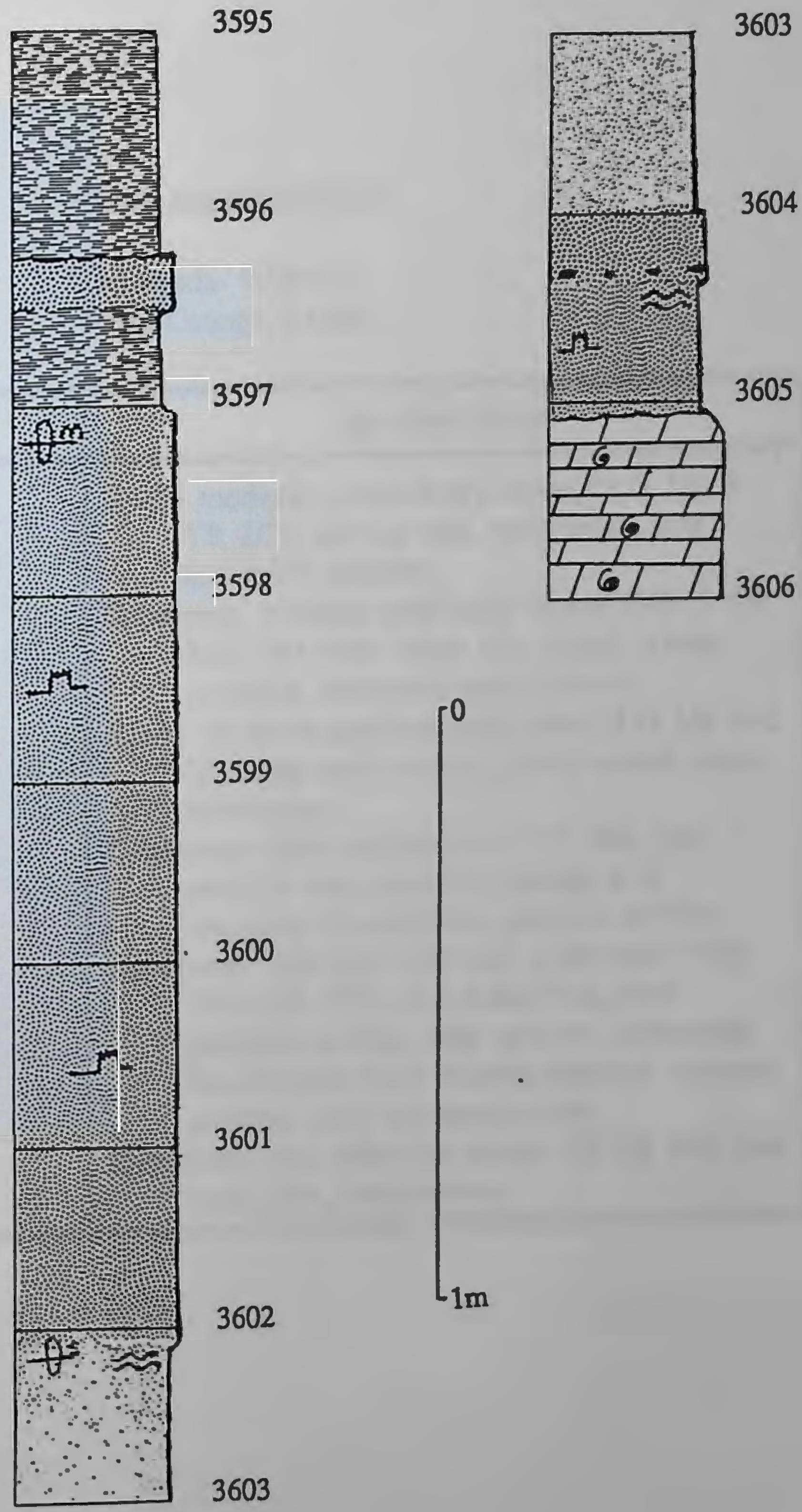
Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3467.0	Misener	1.0	69.0	1.0	0.0	1.0	10.0	3.0	0.0	5.0	10.0
3468.0	Chatt	1.0	15.0	0.0	0.0	0.0	1.0	78.0	0.0	0.0	5.0
3468.6	Misener	10.0	63.0	2.0	0.0	1.0	10.0	5.0	1.0	3.0	5.0



Amerada- Wilson 1
Reno Co., KS

Amerada- Wilson 1
Reno Co., KS



CORE DESCRIPTION

Amerada- Wilson 1
Reno County, Kansas

DEPTH	DESCRIPTION
3595'-3596'2'	Shale- moderate green-dusky brown (5 G 5/6- 5 YR 2/2), clay-silt size, well sorted, thin laminated-massive
3596'2"-3596'6"	Sandstone- medium gray-dusky brown (N5- 5 YR 2/2), clay-very coarse size, poorly sorted, moderate cemented, wavy contact
3596'6"-3597'	Shale- moderate green-grayish green (5 G 5/6- 5 G 5/2), clay-medium size, poorly sorted, wavy laminations
3597'-3602'1"	Sandstone- light-medium gray (N7- N5), clay-medium size, moderate sorting, well cemented, bioturbation, pressure solution
3602'1"-3605'2"	Sandstone- light gray-very pale green-white (N7- 10 G 8/2- N9), clay-coarse size, poor-moderate sorting, very well-well cemented, bioturbation, wavy bedded-massive, pressure solution, large phosphate clasts
3605'2"-3606'	Dolostone- pale yellowish brown (10 YR 6/2), fine crystalline, fossiliferous

AMERADA: WILSON 1, RENO COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3595.6	Chatt		laminated	clay	wl
3596.2	Misener	float-conc.conv	ran-laminated	clay,poik carb	pr
3599.0	Misener	float-conc.conv	random	dol,silica	mod
3602.0	Misener	point-conc.conv	random	dol,silica	mod
3603.0	Misener	float-straight	laminated	clay,dol	pr
3604.4	Misener	point-conc.conv	random	cht/sil,dol	pr
3605.0	Misener	float-conc.conv	laminated	poik carb,sil carb	mod
3606.0	?(Carb)				

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3595.6	Chatt	cly-slt	cly	0	0	5	95
3596.2	Misener	cly-v crs	med	0	80	1	19
3599.0	Misener	cly-med	fine	0	98	0	2
3602.0	Misener	cly-fine	fine	0	97	1	2
3603.0	Misener	cly-crs	med/silt	0	60	20	20
3604.4	Misener	cly-crs	med	0	95	2	3
3605.0	Misener	v fine-crs	fine	0	100	0	0
3606.0	?(Carb)	slt-fine		0	95	5	0

Thin Section Data: Grain Shape and Comments

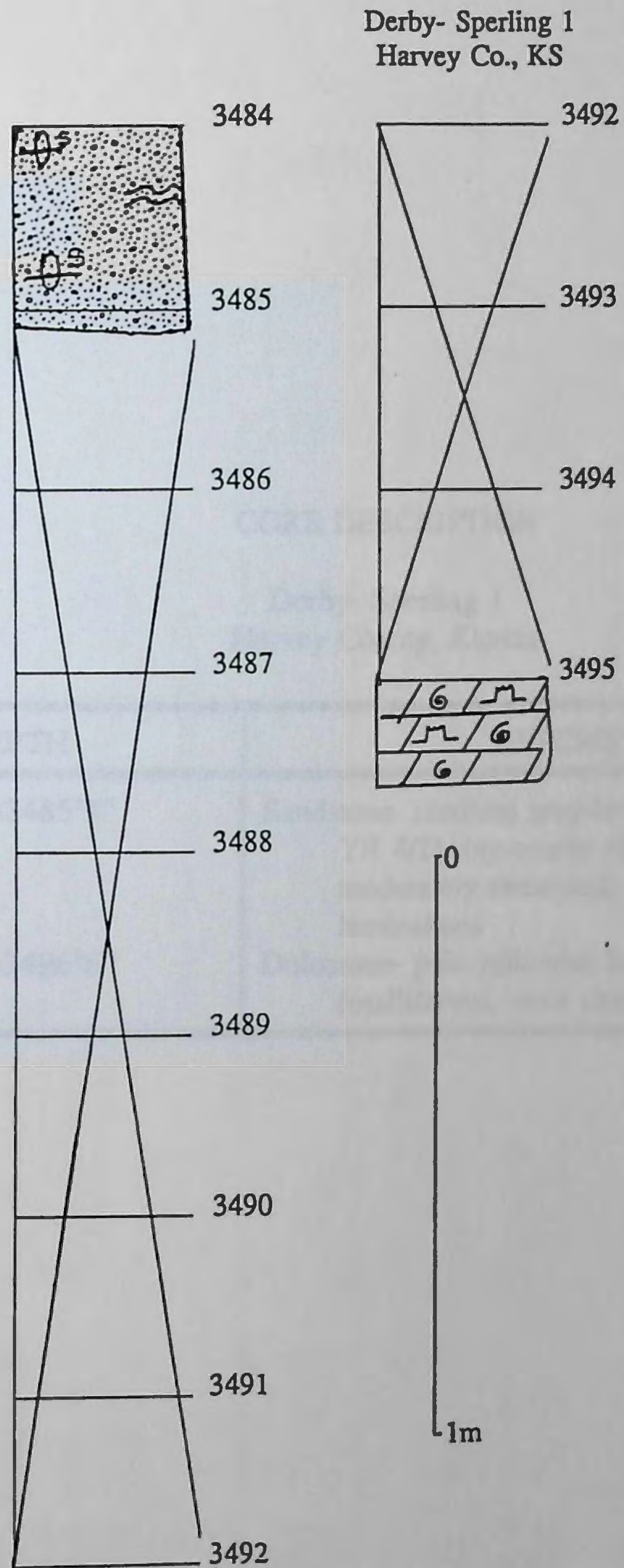
Depth	Formation	Angularity	Sphericity	Maturity	Comments
3595.6	Chatt	ang-sbang	mod-high		
3596.2	Misener	ang-wlrnd	low-high	immature	tr cht,met qtz;fossilif
3599.0	Misener	sbang-wlrnd	mod-high	mature	pyr bur;tr cht;dol rep qtz
3602.0	Misener	sbrnd-rnd	mod-high	supermature	tr tour,cht;dol rep qtz
3603.0	Misener	ang-wlrnd	low-high	immature	tr cht;dol rep qtz
3604.4	Misener	ang-wlrnd	low-high	submature	poik carb;bur;dol rep qtz
3605.0	Misener	sbrnd-wlrnd	mod-high	supermature	poik carb
3606.0	?(Carb)	sbrnd-wlrnd	mod-high		styl, fossilif

AMERADA: WILSON 1, RENO COUNTY, KANSAS

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3595.6	Chatt	1.0	40.0	0.0	0.0	0.0	0.0	54.0	0.0	0.0	5.0
3596.2	Misener	1.0	59.0	1.0	0.0	0.0	10.0	19.0	0.0	10.0	0.0
3599.0	Misener	1.0	58.0	1.0	0.0	1.0	1.0	2.0	0.0	32.0	5.0
3602.0	Misener	1.0	59.0	1.0	0.0	0.0	1.0	2.0	0.0	34.0	2.0
3603.0	Misener	1.0	54.0	1.0	0.0	1.0	2.0	20.0	0.0	20.0	2.0
3604.4	Misener	5.0	69.0	1.0	0.0	1.0	10.0	3.0	0.0	10.0	1.0
3605.0	Misener	3.0	49.0	1.0	0.0	1.0	5.0	0.0	0.0	40.0	1.0
3606.0	?(Carb)	1.0	5.0	0.0	0.0	0.0	0.0	2.0	0.0	90.0	2.0

Derby- Sperling 1
Harvey Co., KS


Derby- Sperling 1
Harvey Co., KS
3484
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CORE DESCRIPTION

Derby- Sperling 1
Harvey County, Kansas

DEPTH	DESCRIPTION
3484'-3485'2"	Sandstone- medium gray-brownish gray (N5- 5 YR 4/1),clay-coarse size, poorly sorted, moderately cemented, bioturbation, wavy laminations
3496'-3496'6"	Dolostone- pale yellowish brown (10 YR 6/2), fossiliferous, trace chert, multiple stylolites

DERBY: SPERLING 1, HARVEY COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3484.0	Misener	float-conc.conv	random	clay,dol	pr
3485.0	Misener	float-conc.conv	ran-laminated	clay,poik carb	pr
3494.0	Carb ?			carb	

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3484.0	Misener	cly-crs	med/fine	0	50	10	40
3485.0	Misener	cly-crs	fine	0	70	2	28
3494.0	Carb ?	slt-fine		0	98	2	0

Thin Section Data: Grain Shape and Comments

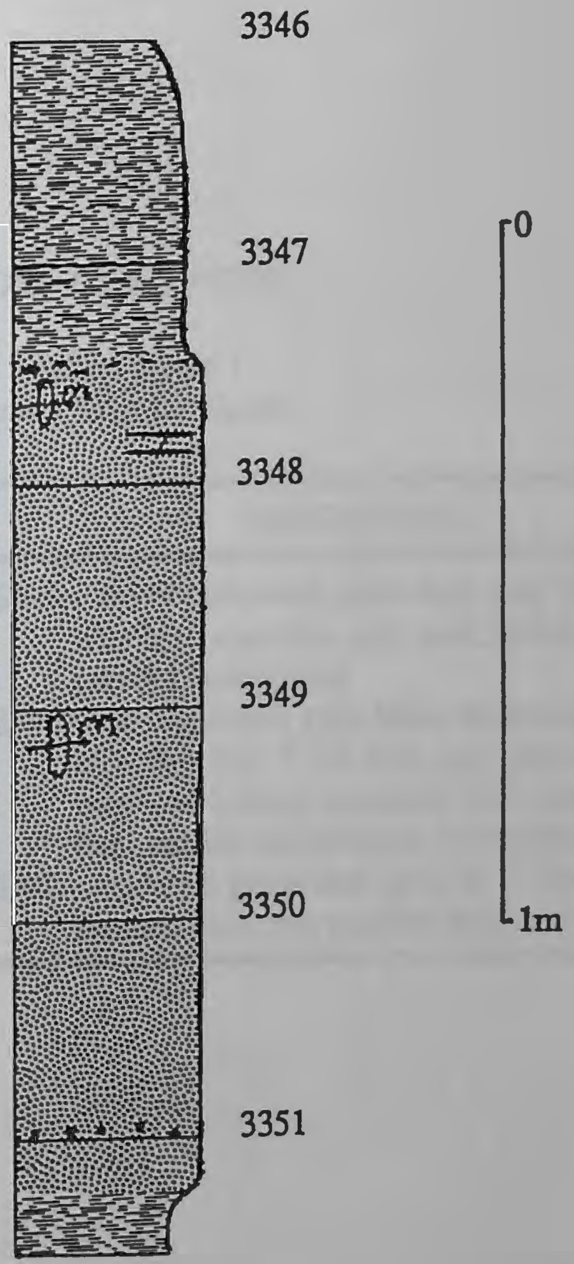
Depth	Formation	Angularity	Sphericity	Maturity	Comments
3484.0	Misener	ang-wlrnd	low-high	immature	tr tour;dol rep cly mat
3485.0	Misener	ang-wlrnd	low-high	immature	dol rep qtz/cly mat
3494.0	Carb ?	sbang-wlrnd	low-high		relic tex;fossilif;ps

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3484.0	Misener	1.0	51.0	1.0	0.0	1.0	3.0	10.0	0.0	30.0	3.0
3485.0	Misener	1.0	62.0	1.0	0.0	0.0	3.0	3.0	0.0	25.0	5.0
3494.0	Carb ?	1.0	10.0	1.0	0.0	1.0	0.0	0.0	0.0	87.0	0.0

Shaffer- Steele 1
Harvey Co., KS

Shaffer- Steele 1
Harvey Co., KS



CORE DESCRIPTION

Shaffer- Steele 1
Harvey County, Kansas

DEPTH	DESCRIPTION
3346'-3347'6"	Shale- dusky yellowish green-dark gray (10 GY 3/2- N3), clay-fine size, well sorted, thin parallel laminations
3347'6"-3351'3"	Sandstone- light-dark gray-black-brownish gray (N7- N3- N1- 5 YR 4/1), clay-gravel size, poor-well sorted, moderate-well cemented, faint parallel laminations, bioturbation
3351'3"-3351'8"	Shale- moderate green-dark gray (5 G 5/6- N3), clay-silt size, thin parallel laminations, pyrite

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3347.0	Chatt		laminated	clay	wl
3347.6	Misener	float-conc.conv	ran-laminated	clay,dol	pr
3347.9	Misener	float-conc.conv	laminated	dol,clay	mod
3348.0	Misener	point-conc.conv	random	sil,dol,clay	pr
3349.0	Misener	point-straight	random	cht	wl
3350.0	Misener	float-conc.conv	random	sil,clay,dol	pr

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3347.0	Chatt	cly-fine	cly	0	1	10	89
3347.6	Misener	cly-gvl (gded)	med	10	75	5	10
3347.9	Misener	cly-crs (gded)	fine/med	0	83	12	3
3348.0	Misener	cly-crs	med	0	88	2	10
3349.0	Misener	fine-med	med	0	100	0	0
3350.0	Misener	cly-crs	med	0	83	2	15

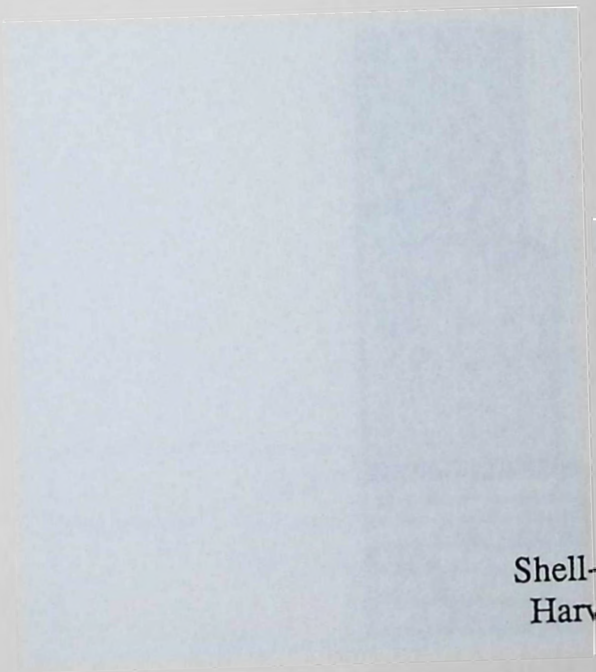
Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
3347.0	Chatt	ang-rnd	mod-high		spores;red/brn;tr cht
3347.6	Misener	ang-wlrnd	low-high	immature	fossilif (molluscs,brach,con)
3347.9	Misener	ang-wlrnd	low-high	immature	tr tour;dol rep qtz
3348.0	Misener	sbrnd-wlrnd	mod-high	immature	dol rep qtz
3349.0	Misener	sbrnd-wlrnd	mod-high	supermature	cht rep tex;late dol;vug
3350.0	Misener	sbang-wlrnd	mod-high	immature	tr tour;dol rep qtz

SHAFFER: STEELE 1, HARVEY COUNTY, KANSAS

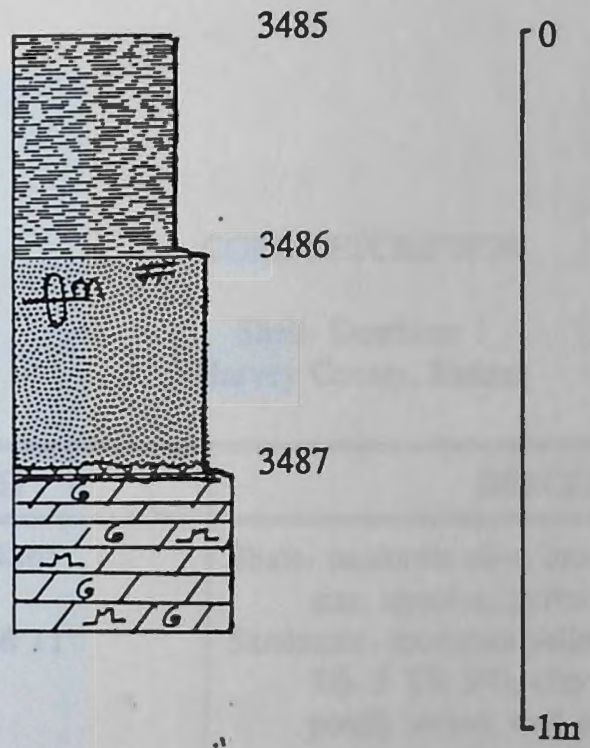
Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3347.0	Chatt	1.0	11.0	0.0	0.0	0.0	5.0	79.0	0.0	0.0	4.0
3347.6	Misener	2.0	47.0	1.0	0.0	0.0	10.0	10.0	0.0	25.0	5.0
3347.9	Misener	5.0	32.0	1.0	0.0	0.0	1.0	5.0	0.0	55.0	1.0
3348.0	Misener	10.0	59.0	0.0	0.0	0.0	4.0	10.0	0.0	15.0	2.0
3349.0	Misener	12.0	82.0	0.0	0.0	0.0	1.0	0.0	0.0	4.0	1.0
3350.0	Misener	15.0	54.0	1.0	0.0	0.0	2.0	15.0	0.0	10.0	3.0



Shell- Duerkson 1
Harvey Co., KS

Shell- Duerkson 1
Harvey Co., KS



CORE DESCRIPTION

Shell- Duerkson 1
Harvey County, Kansas

DEPTH	DESCRIPTION
3485'-3486'	Shale- moderate olive brown (5 Y 4/4), clay-fine size, massive, pyrite
3486'-3486'11"	Sandstone- moderate yellow-moderate brown (5 Y 7/6- 5 YR 3/4), clay-pebble size,moderate-poorly sorted, well cemented, pyrite at upper contact
3487'-3487'8"	Dolostone- pale yellowish brown-moderate brown (10 YR 6/2- 5 YR 3/4), fossiliferous, stylolites

SHELL OIL: DUERKSON 1, HARVEY COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3486.0	Chatt		laminated	clay	mod
3486.2	Misener	float-conc.conv	random	pyr,clay,sil	mod
3486.4	Misener	float-conc.conv	ran-laminated	cly,sil,dol	pr
3486.8	Misener	point-conc.conv	random	sil,dol	pr
3487.0	Carb ?			Dolostone	wl

Thin Section Data: Grain Size

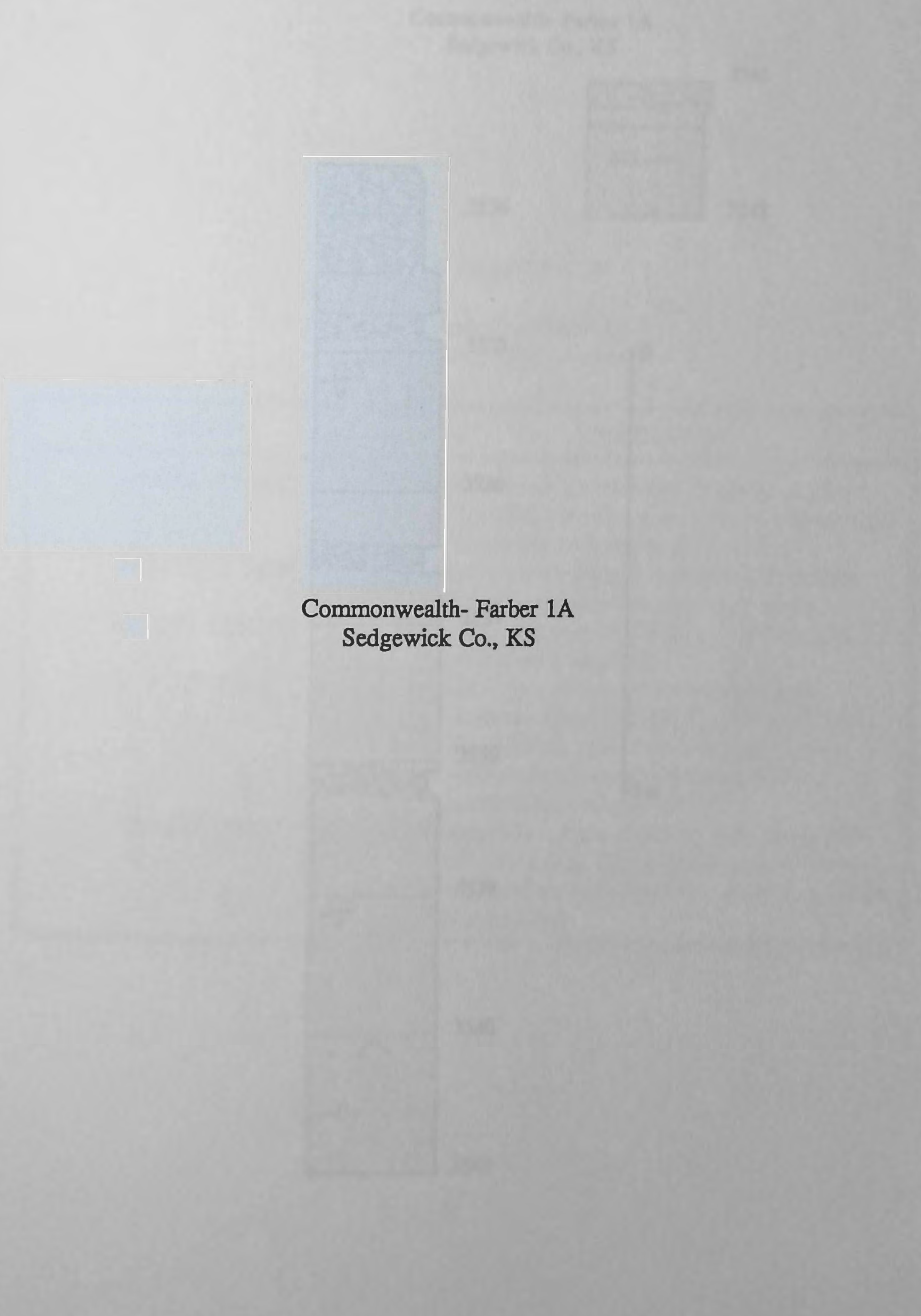
Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3486.0	Chatt	cly-fine	cly	0	3	7	90
3486.2	Misener	cly-med	fine	0	80	5	15
3486.4	Misener	cly-gvl	med	4	60	5	31
3486.8	Misener	cly-gvl	fine	10	86	1	3
3487.0	Carb ?	v fine-fine		0	100	0	0

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
3486.0	Chatt	ang-wlrnd	low-high		spores;organic
3486.2	Misener	sbang-wlrnd	low-high	immature	tr zirile;dol rep qtz
3486.4	Misener	ang-wlrnd	low-high	immature	sil cmt (both cht & syntax)
3486.8	Misener	sbrnd-wlrnd	mod-high	submature	tr tour,cht;dol rep qtz
3487.0	Carb ?	sbrnd-wlrnd	mod-high		rel tex;fossilif;

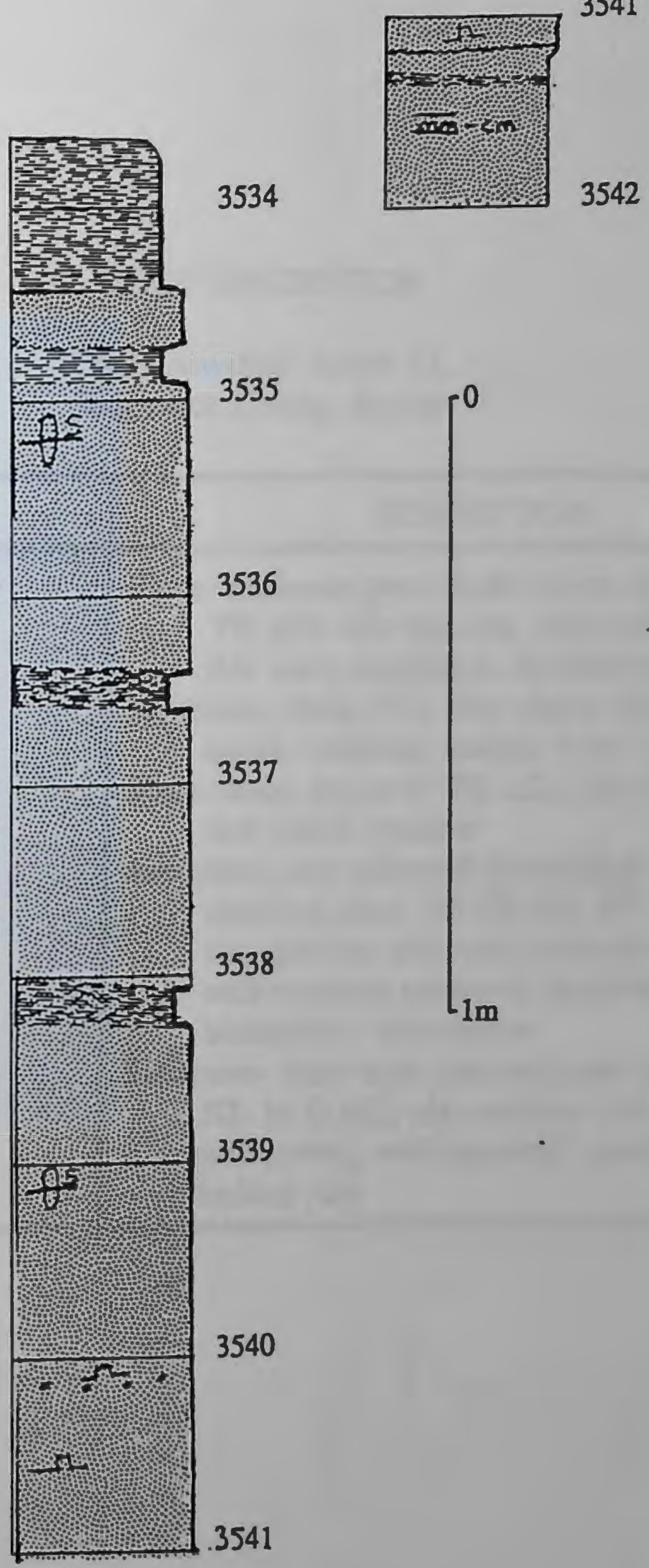
Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3486.0	Chatt	1.0	7.0	1.0	0.0	0.0	1.0	85.0	0.0	0.0	5.0
3486.2	Misener	2.0	76.0	1.0	0.0	0.0	5.0	8.0	0.0	1.0	7.0
3486.4	Misener	2.0	51.0	1.0	0.0	1.0	10.0	10.0	0.0	20.0	5.0
3486.8	Misener	5.0	79.0	1.0	0.0	1.0	5.0	2.0	0.0	5.0	2.0
3487.0	Carb ?	8.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	87.0	0.0



Commonwealth- Farber 1A
Sedgewick Co., KS

Commonwealth- Farber 1A
Sedgewick Co., KS



CORE DESCRIPTION

Commonwealth- Farber 1A
Sedgewick County, Kansas

DEPTH	DESCRIPTION
3533'6"-3534'5"	Shale- moderate green-dusky brown (5 G 5/6- 5 YR 2/2), clay-fine size, well sorted, massive-thin wavy lamination, bioturbation
3534'5"-3534'8"	Sandstone- black (N1), clay-coarse size, poorly sorted, moderate cement, wavy contact
3534'8"-3534'10"	Shale- dusky brown (5 YR 2/2), clay-fine size, well sorted, massive
3534'10"-3541'2"	Sandstone- pale yellowish brown-light gray-moderate green (10 YR 6/2- N7- 5 G 5/6), clay-medium size, well-moderate sorting, well-moderate cemented, massive-thin laminations, bioturbation
3541'2'-3542'	Sandstone- white-light gray-very pale green (N9-N7- 10 G 8/2), clay-medium size, moderate-well sorting, well cemented, massive-parallel bedded (shl)

COMMONWEALTH: FARBER 1-A, SEDGEWICK COUNTY, KANSAS

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
3534.0	Chatt		laminated	clay	wl
3534.6	Chatt cntc	float-conc.conv	laminated(wvy)	clay	pr
3534.8	Chatt		laminated	clay	wl
3535.0	Misener	strt-conc.conv	random	silica	wl
3536.0	Misener	point-conc.conv	random	dol,silica	wl
3539.4	Misener	point-conc.conv	random	silica,clay	mod
3540.0	Misener	point-conc.conv	random	silica	wl
3541.0	Misener	point-conc.conv	random	silica	mod
3541.4	Simpson	point-conc.conv	random	silica	wl
3542.0	Simpson	float-conc.conv	laminated	silica,clay	mod

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
3534.0	Chatt	cly-fine	cly	0	3	17	80
3534.6	Chatt cntc	cly-crs	med/cly	0	35	5	60
3534.8	Chatt	cly-fine	cly	0	3	27	70
3535.0	Misener	vfine-med	fine	0	100	0	0
3536.0	Misener	fine-med	fine	0	100	0	0
3539.4	Misener	cly-med	fine	0	94	1	5
3540.0	Misener	fine-med	med	0	100	0	0
3541.0	Misener	cly-med	fine	0	97	1	2
3541.4	Simpson	slt-fine	v fine	0	95	5	0
3542.0	Simpson	cly-med	fine	0	88	2	10

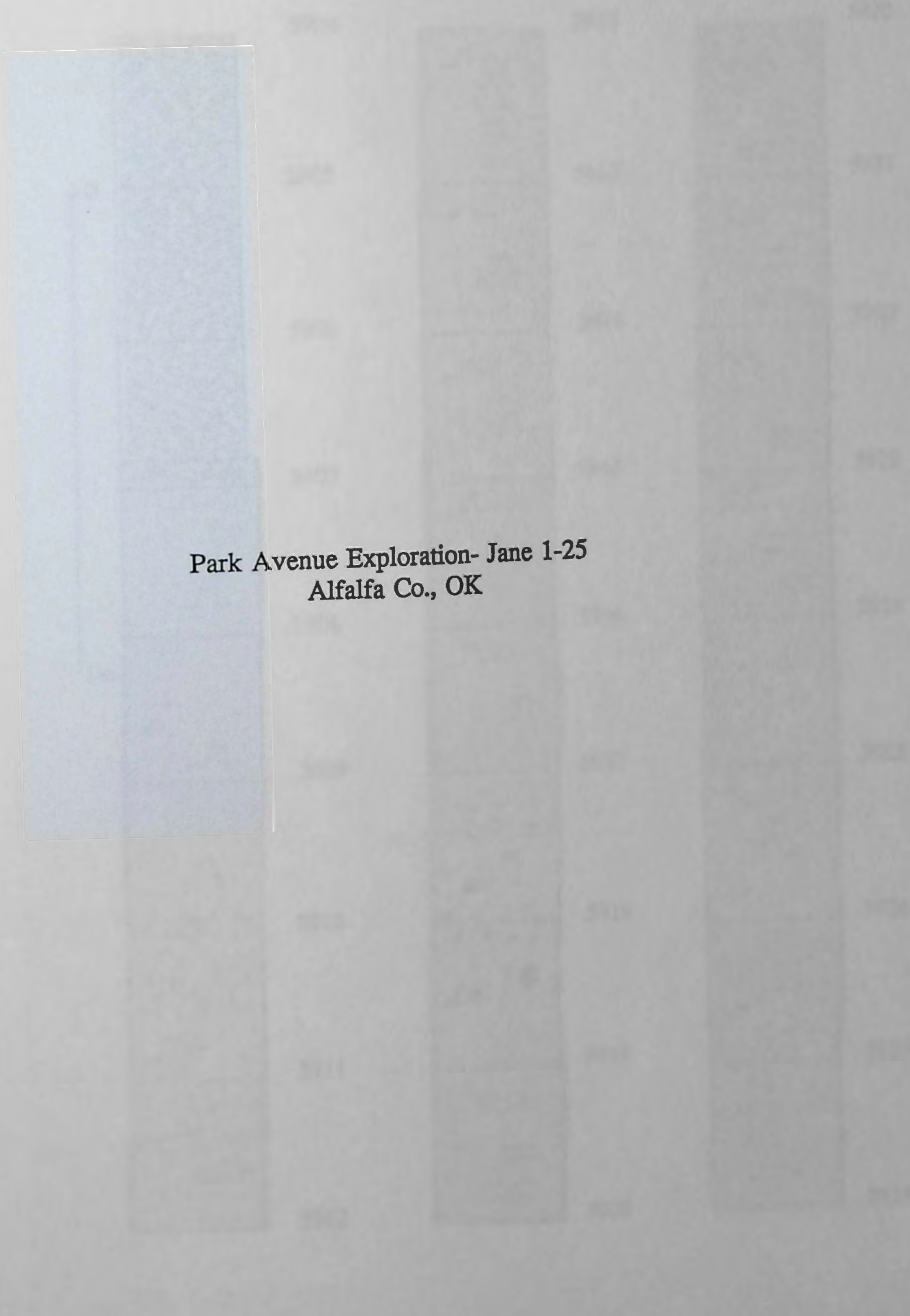
COMMONWEALTH: FARBER 1-A, SEDGEWICK COUNTY, KANSAS

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
3534.0	Chatt	ang-wlrnd	low-high		spores;organic
3534.6	Chatt cntc	ang-wlrnd	low-high	immature	spores;organic shl;dol rep qtz
3534.8	Chatt	ang-wlrnd	low-high		spores;organic
3535.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr tour;dol rep qtz
3536.0	Misener	sbrnd-wlrnd	mod-high	supermature	dol rep qtz
3539.4	Misener	sbang-wlrnd	mod-high	submature	tr zirile,cht;dol rep qtz
3540.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr tour;dol rep qtz
3541.0	Misener	ang-wlrnd	low-high	submature	tr cht;dol rep qtz
3541.4	Simpson	ang-wlrnd	mod-high	supermature	tr tour,zirile,cht;ps
3542.0	Simpson	ang-wlrnd	low-high	immature	tr zirile;ps;

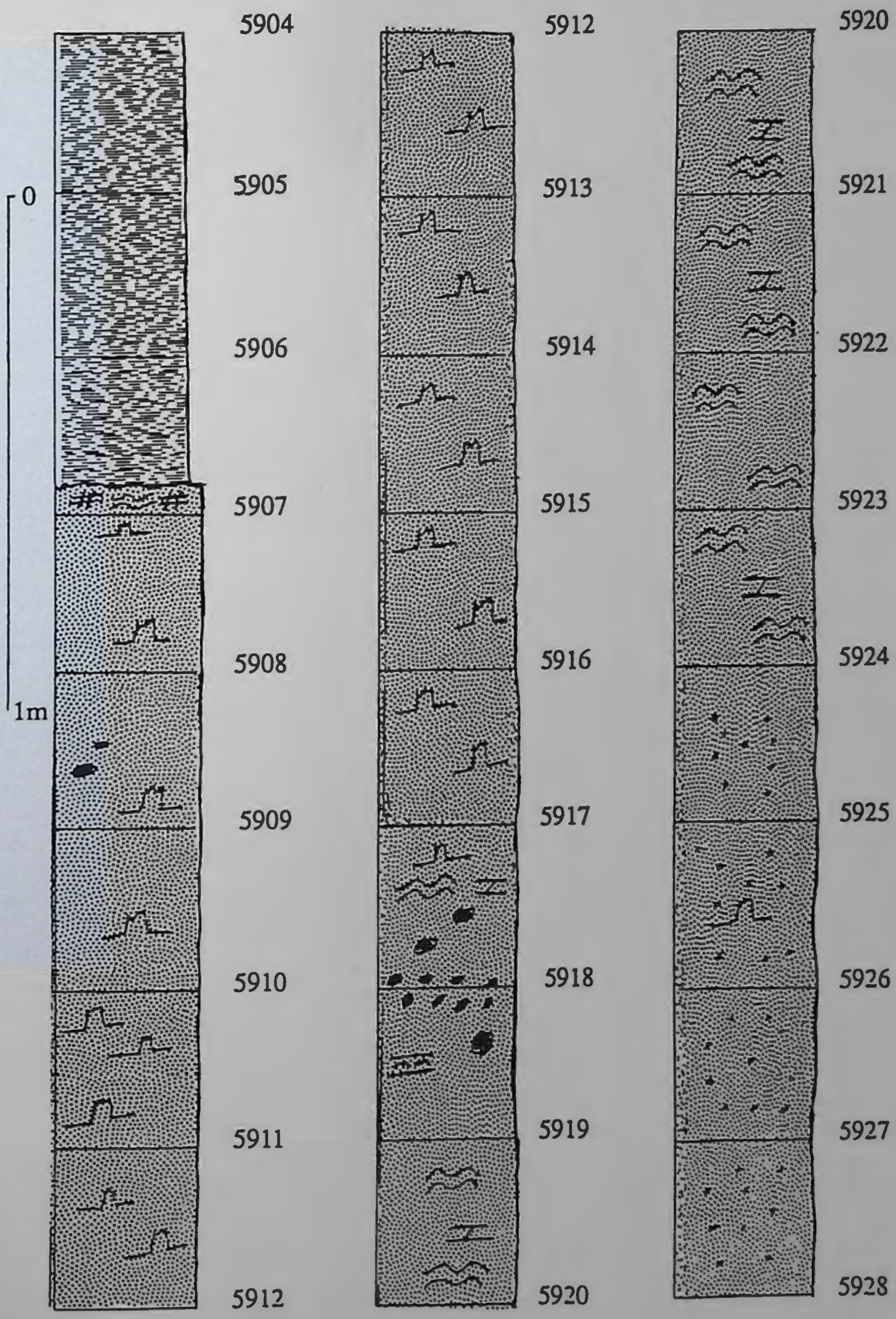
Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
3534.0	Chatt	1.0	19.0	1.0	0.0	1.0	2.0	66.0	0.0	0.0	10.0
3534.6	Chatt cntc	1.0	37.0	1.0	0.0	1.0	2.0	50.0	0.0	2.0	7.0
3534.8	Chatt	1.0	30.0	1.0	0.0	0.0	5.0	58.0	0.0	0.0	5.0
3535.0	Misener	2.0	88.0	1.0	0.0	1.0	5.0	0.0	0.0	2.0	1.0
3536.0	Misener	5.0	73.0	1.0	0.0	1.0	3.0	2.0	0.0	15.0	0.0
3539.4	Misener	7.0	88.0	1.0	0.0	2.0	3.0	5.0	0.0	1.0	0.0
3540.0	Misener	12.0	76.0	1.0	0.0	0.0	3.0	0.0	0.0	5.0	3.0
3541.0	Misener	15.0	70.0	1.0	0.0	1.0	3.0	4.0	0.0	5.0	1.0
3541.4	Simpson	7.0	80.0	4.0	0.0	1.0	1.0	5.0	0.0	0.0	2.0
3542.0	Simpson	7.0	74.0	4.0	0.0	0.0	2.0	12.0	0.0	0.0	1.0

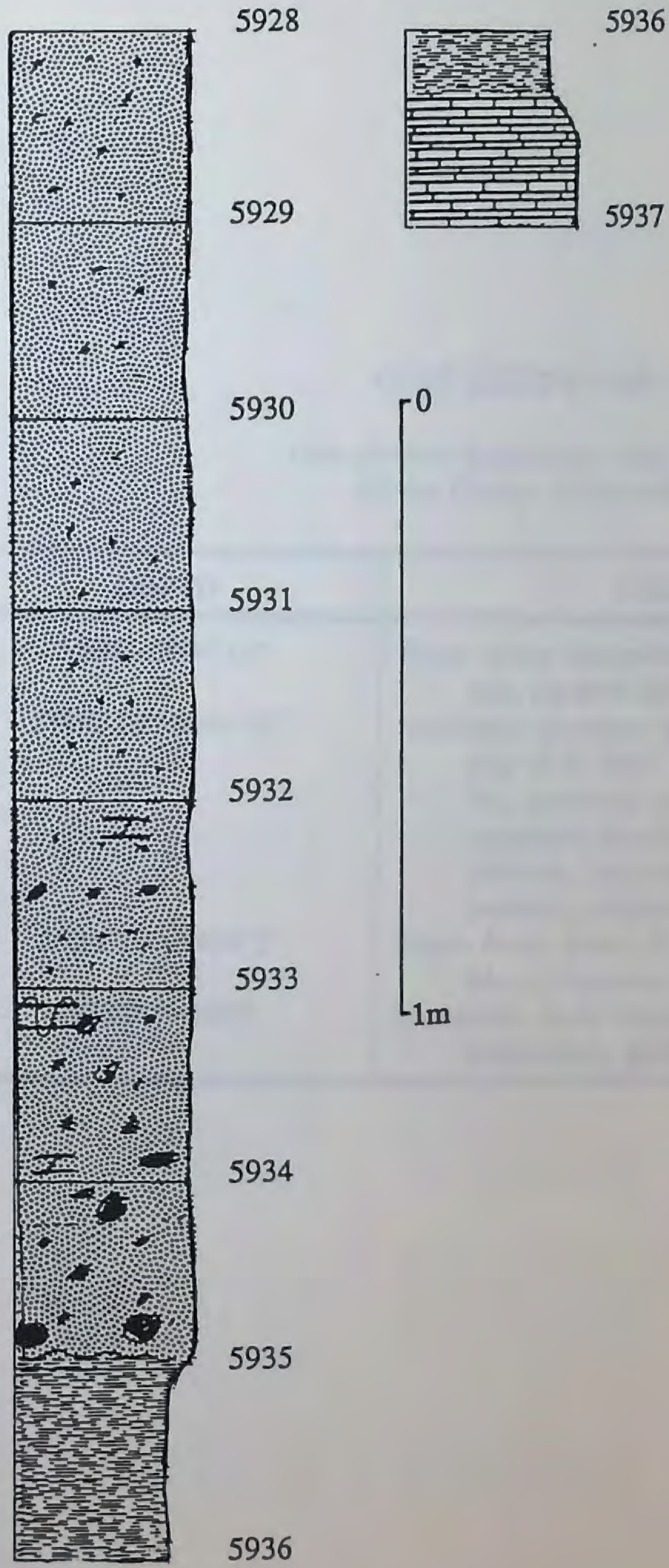


Park Avenue Exploration- Jane 1-25
Alfalfa Co., OK

Park Avenue Exploration- Jane 1-25
Alfalfa Co., OK



Park Avenue Exploration- Jane 1-25
Alfalfa Co., OK



CORE DESCRIPTION

Park Avenue Exploration- Jane 1-25
Alfalfa County, Oklahoma

DEPTH	DESCRIPTION
5904'-5906'10"	Shale- dusky brown-black (5YR 2/2- N1), clay-silt size, massive-thin lamination, pyrite
5906'10"-5934'10"	Sandstone- moderate yellow-dusky brown-light gray (5 Y 7/6-5 YR 2/2- N7), fine-cobble size, poor-well sorting, moderate-well cemented, massive-wavy bedded, pressure solutions, abundant phosphate and fish particles, cobbles at bottom contact
5934'10"-5936'2"	Shale- dusky brown (5 YR 2/2), clay-pebble size, thin laminations, phosphate nodules at top
5936'2"-5937	Limestone- dusky brown-white (5 YR 2/2- N9), fossiliferous, parallel bedded

PARK AVENUE EXPLORATION: JANE 1-25, ALFALFA COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
5910.0	Misener	point-conc.conv	random	silica	mod
5911.0	Misener	point-suture	random	silica	mod
5918.0	Misener	point-conc.conv	laminated	silica & dol	pr
5923.0	Misener	point-conc.conv	laminated	silica & dol	mod
5928.0	Misener	point-conc.conv	laminated	silica & dol	pr
5931.0	Misener	point-conc.conv	laminated	silica & dol	mod
5932.0	Misener	point-conc.conv	random	silica & dol	pr
5934.0	Misener	point-conc.conv	random	silica & dol	mod

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
5910.0	Misener	fine-crs	med	0	100	0	0
5911.0	Misener	fine-crs	med	0	100	0	0
5918.0	Misener	fine-gvl	med	30	69	1	0
5923.0	Misener	fine-crs	med	0	100	0	0
5928.0	Misener	fine-gvl	crs	2	98	0	0
5931.0	Misener	fine-crs	med	0	100	0	0
5932.0	Misener	fine-gvl	crs	30	70	0	0
5934.0	Misener	fine-v crs	crs	0	100	0	0

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
5910.0	Misener	rnd-wlrnd	mod-high	supermature	fsh & con;ps
5911.0	Misener	rnd-wlrnd	low-high	mature	met ig frag;ps
5918.0	Misener	rnd-wlrnd	mod-high	submature	gded bd
5923.0	Misener	rnd-wlrnd	low-high	mature	fsh & con;ps
5928.0	Misener	sbrnd-wlrnd	mod-high	submature	fsh & con;bur;
5931.0	Misener	rnd-wlrnd	mod-high	supermature	tr tour;fsh
5932.0	Misener	rnd-wlrnd	low-high	submature	detr dol;met qtz;foss;
5934.0	Misener	rnd-wlrnd	mod-high	supermature	poik carb;met qtz;tr tour

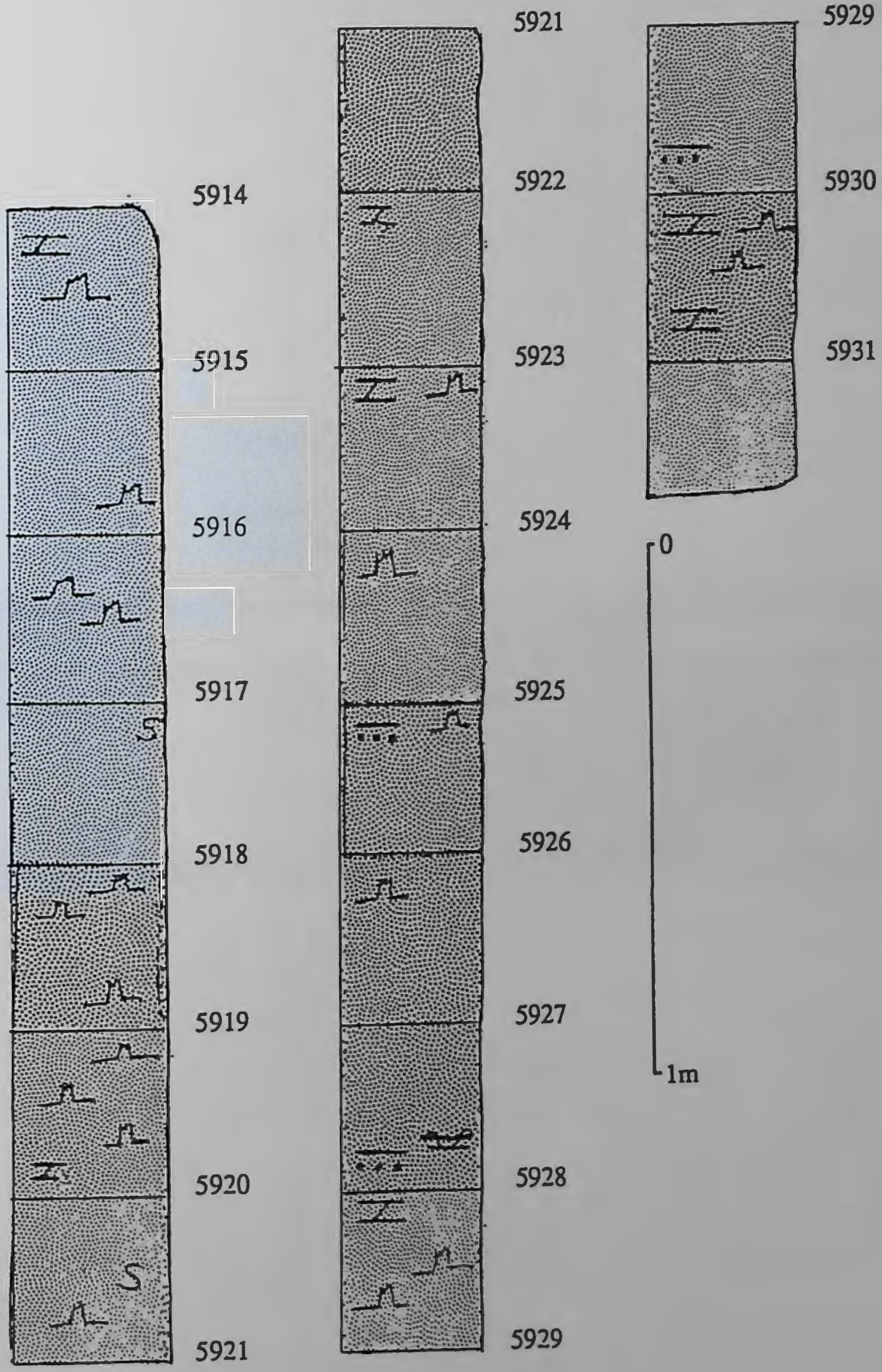
PARK AVENUE EXPLORATION: JANE 1-25, ALFALFA COUNTY, OKLAHOMA

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
5910.0	Misener	16.0	80.0	0.0	0.0	1.0	2.0	0.0	0.0	1.0	0.0
5911.0	Misener	5.0	89.0	1.0	0.0	0.0	4.0	0.0	0.0	0.0	1.0
5918.0	Misener	17.0	35.0	0.0	0.0	1.0	7.0	0.0	0.0	40.0	0.0
5923.0	Misener	20.0	42.0	0.0	0.0	1.0	1.0	0.0	0.0	36.0	0.0
5928.0	Misener	15.0	36.0	0.0	0.0	1.0	3.0	0.0	0.0	45.0	0.0
5931.0	Misener	20.0	65.0	0.0	0.0	1.0	4.0	0.0	0.0	10.0	0.0
5932.0	Misener	15.0	45.0	0.0	0.0	0.0	5.0	0.0	0.0	35.0	0.0
5934.0	Misener	15.0	42.0	0.0	0.0	0.0	3.0	0.0	0.0	40.0	0.0

William H. Davis- Cox 1
Grant Co., OK

William H. Davis- Cox 1
Grant Co., OK



CORE DESCRIPTION

William H. Davis- Cox 1
Grant County, Oklahoma

DEPTH	DESCRIPTION
5914'-5931'8"	Sandstone- light brownish gray-brownish gray (5 YR 6/1- 5 YR 4/1), clay-pebble size, poor-well sorting, moderate-very well cemented, thin wavy bedding (dol), graded bedding, scour and fill, pressure solution

WILLIAM H. DAVIS: COX #1, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
5914.0	Misener	point-conc.conv	random	silica	mod
5915.0	Misener	point-conc.conv	random	silica	wl
5916.0	Misener	point-conc.conv	random	silica	mod
5917.0	Misener	point-conc.conv	random	silica	mod
5918.0	Misener	point-conc.conv	random	silica	mod
5919.0	Misener	point-conc.conv	random	silica	mod
5920.0	Misener	point-conc.conv	random	silica	pr
5921.0	Misener	point-conc.conv	laminated(gded)	silica	pr
5922.0	Misener	point-conc.conv	random	silica	pr
5923.0	Misener	point-conc.conv	laminated(gded)	silica	pr
5924.0	Misener	point-conc.conv	random	silica	pr
5926.0	Misener	point-conc.conv	random	silica	pr
5927.0	Misener	point-conc.conv	random	silica	pr
5928.0	Misener	point-conc.conv	laminated	dol	mod
5929.0	Misener	point-conc.conv	laminated	dol	pr
5930.0	Misener	point-conc.conv	laminated(gded)	silica	mod
5931.0	Misener	point-conc.conv	laminated(gded)	silica & dol	mod

WILLIAM H. DAVIS: COX #1, GRANT COUNTY, OKLAHOMA

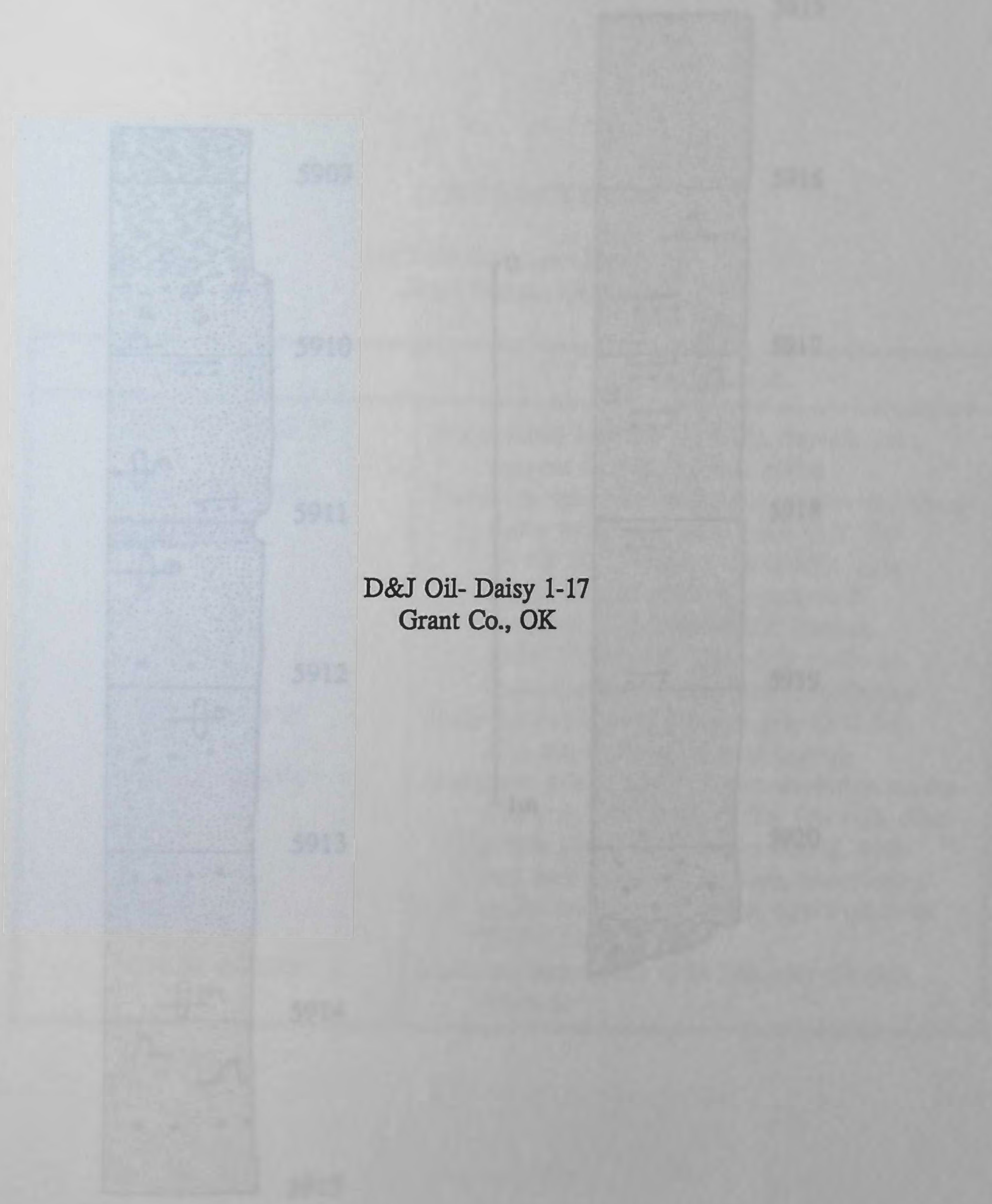
Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
5914.0	Misener	v fine/v crs	fine	0	100	0	0
5915.0	Misener	slt-med	fine	0	98	2	0
5916.0	Misener	slt-crs	fine	0	98	2	0
5917.0	Misener	slt-crs	fine	0	98	2	0
5918.0	Misener	slt-crs	med	0	98	2	0
5919.0	Misener	slt-crs	fine	0	98	2	0
5920.0	Misener	cly-crs	fine	0	93	2	5
5921.0	Misener	cly-crs	med	0	96	2	2
5922.0	Misener	cly-crs	fine	0	93	0	5
5923.0	Misener	cly-crs	fine	0	97	2	1
5924.0	Misener	cly-vcrs	fine	0	97	2	1
5926.0	Misener	cly-gvl	crs	2	95	2	1
5927.0	Misener	cly-gvl	crs	1	96	2	1
5928.0	Misener	slt-gvl	fine	1	97	2	0
5929.0	Misener	cly-crs	fine	0	96	2	2
5930.0	Misener	slt-crs	med	0	98	2	0
5931.0	Misener	slt-crs	fine	0	98	2	0

WILLIAM H. DAVIS: COX #1, GRANT COUNTY, OKLAHOMA

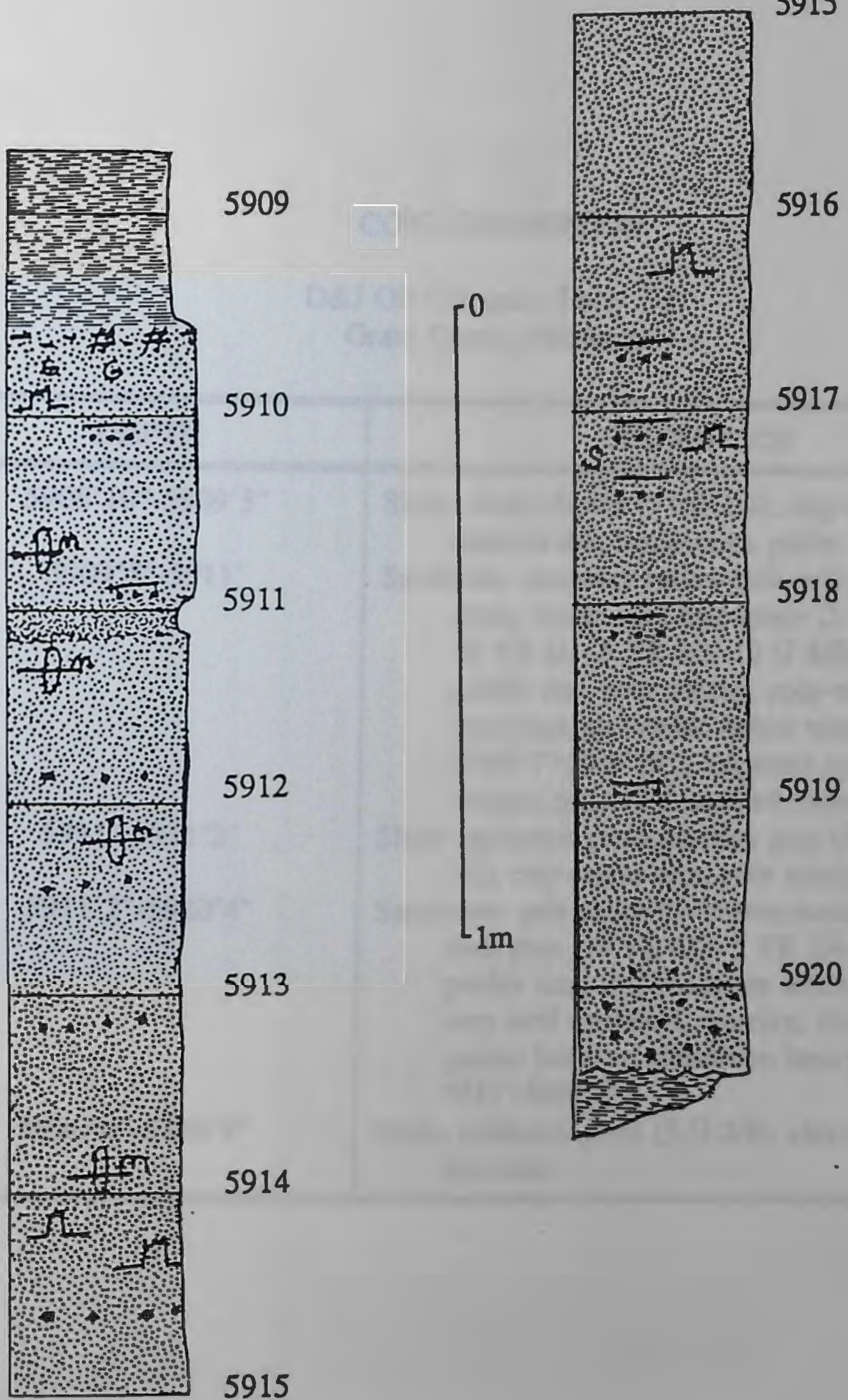
Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
5914.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr fld;fsh & con;dol rep qtz
5915.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con;ps
5916.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht,fld;fsh & con;ps
5917.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc;fsh & con
5918.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con
5919.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;met qtz;fsh & con;ps
5920.0	Misener	sbrnd-wlrnd	mod-high	immature	tr cht,met qtz,glc;fsh & con
5921.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con;ps;gded bd
5922.0	Misener	sbrnd-wlrnd	mod-high	immature	tr cht,tour;fsh & con;ps
5923.0	Misener	sbang-wlrnd	low-high	mature	tr fld,cht;bur w/ pyr;ps
5924.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht,tour;fsh & con
5926.0	Misener	sbrnd-wlrnd	mod-high	submature	tr cht,fld,met qtz;fsh & con
5927.0	Misener	sbrnd-wlrnd	mod-high	submature	tr cht,met qtz;fsh & con
5928.0	Misener	sbang-wlrnd	mod-high	mature	tr cht,fld;dol rep qtz;ps
5929.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;bur w/ pyr;ps
5930.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con
5931.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht,met qtz;fsh & con;ps



D&J Oil- Daisy 1-17
Grant Co., OK

D&J Oil- Daisy 1-17
Grant Co., OK



CORE DESCRIPTION

D&J Oil Company- Daisy 1-17
Grant County, Oklahoma

DEPTH	DESCRIPTION
5908'10"-5909'5"	Shale- dusky brown (5 YR 2/2), clay-silt size, massive-thin laminations, pyrite
5909'5"-5911'	Sandstone- moderate yellow-pale yellowish brown-dusky brown-very pale green (5 Y 7/6- 10 YR 6/2- 5 YR 2/2- 10 G 8/2) , clay-pebble size, poor sorting, poor-well cemented, glauconitic below contact (5909'7"-5909'10"), abundant pyrite at contact, massive to mottled, bioturbation
5911'-5911'2"	Shale- moderate green-medium gray (5 G 5/6- N5), clay-coarse size, poor sorting,
5911'2"-5920'4"	Sandstone- pale yellowish brown-moderate brown-dark gray (10 YR 6/2- 5 YR 3/4- N3), clay-pebble size, well-moderate sorting, well-very well cemented, massive, bioturbation, graded bedding, phosphate, heavy oil from 5919'-5920'4"
5920'4"-5920'5"	Shale- moderate green (5 G 5/6), clay-silt size, dolomitic

D&J OIL: DAISY 1-17, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
5909.3	Wood/Mis	point-conc.conv	random-lam	pyrite	pr (bimod)
5909.4	Wood/Mis	point-conc.conv	random	pyrite-clay	pr (bimod)
5909.6	Wood/Mis	point-conc.conv	random-subpar	clay	pr (bimod)
5909.9	Wood/Mis	point-conc.conv	random	clay-poik carb	pr (bimod)
5910.1	Misener	point-conc.conv	random	silica-poikcarb	pr (bimod)
5911.1	Misener	point	random(floc)		mod
5911.2	Misener	point-conc.conv	random	silica-clay	pr (bimod)
5912.0	Misener	point-conc.conv	random-subpar	silica-clay-car	pr (bimod)
5913.0	Misener	point-conc.conv	random	silica-clay	pr (bimod)
5914.0	Misener	point-conc.conv	random	silica	mod
5915.0	Misener	point-conc.conv	random	silica	wl (bimod)
5915.4	Misener	point-conc.conv	random	silica	wl
5916.1	Misener	point-conc.conv	random	silica	wl (bimod)
5917.0	Misener	point-conc.conv	random	silica	mod
5918.0	Misener	point-conc.conv	random	silica	mod
5919.0	Misener	point-conc.conv	random	silica	mod
5920.0	Misener	point-conc.conv	random	silica	mod

D&J OIL: DAISY 1-17, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
5909.3	Wood/Mis	cly-crs	med/fine	0	90	2	8
5909.4	Wood/Mis	cly-gvl	med/fine	2	75	3	20
5909.6	Wood/Mis	cly-crs	med/fine	0	78	2	20
5909.9	Wood/Mis	cly-crs	med/fine	0	88	2	10
5910.1	Misener	cly-crs	med/fine	0	97	2	1
5911.1	Misener	cly-crs	cly	0	5	5	90
5911.2	Misener	cly-gvl	med/fine	1	88	2	9
5912.0	Misener	cly-gvl	med/fine	1	92	2	5
5913.0	Misener	cly-gvl	med/fine	2	86	2	10
5914.0	Misener	cly-gvl	crs	1	95	2	2
5915.0	Misener	silt-crs	med/fine	0	98	2	0
5915.4	Misener	fine-crs	fine	0	100	0	0
5916.1	Misener	cly-crs	med/fine	0	98	1	1
5917.0	Misener	cly-gvl	fine	2	95	2	1
5918.0	Misener	fine-gvl	fine	2	98	0	0
5919.0	Misener	fine-gvl	fine	2	98	0	0
5920.0	Misener	silt-gvl	fine	2	96	2	0

D&J OIL: DAISY 1-17, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
5909.3	Wood/Mis	ang-wlrnd	low-high	immature	tr tour;fsh & con
5909.4	Wood/Mis	ang-wlrnd	low-high	immature	tr tour;fsh & con
5909.6	Wood/Mis	ang-wlrnd	low-high	immature	tr tour;fsh & con;ps
5909.9	Wood/Mis	sbrnd-wlrnd	mod-high	immature	tr fld,cht;fsh & con
5910.1	Misener	sbrnd-wlrnd	mod-high	submature	tr glc,cht;fsh & con
5911.1	Misener	ang-wlrnd	low-high	immature	con;flocculated
5911.2	Misener	sbrnd-wlrnd	mod-high	submature	tr glc,cht;fsh & con
5912.0	Misener	sbrnd-wlrnd	mod-high	submature	tr glc,cht,pyr;fsh & con
5913.0	Misener	sbang-wlrnd	low-high	immature	tr glc,cht;fsh&con;dol rep qtz
5914.0	Misener	sbrnd-wlrnd	mod-high	submature	tr glc;fsh & con;ps
5915.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con;
5915.4	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,fld;fsh & con
5916.1	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht;fsh & con
5917.0	Misener	sbrnd-wlrnd	mod-high	submature	tr glc,cht;fsh & con
5918.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con;
5919.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht;fsh & con;dead oil
5920.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht,fld;fsh & con

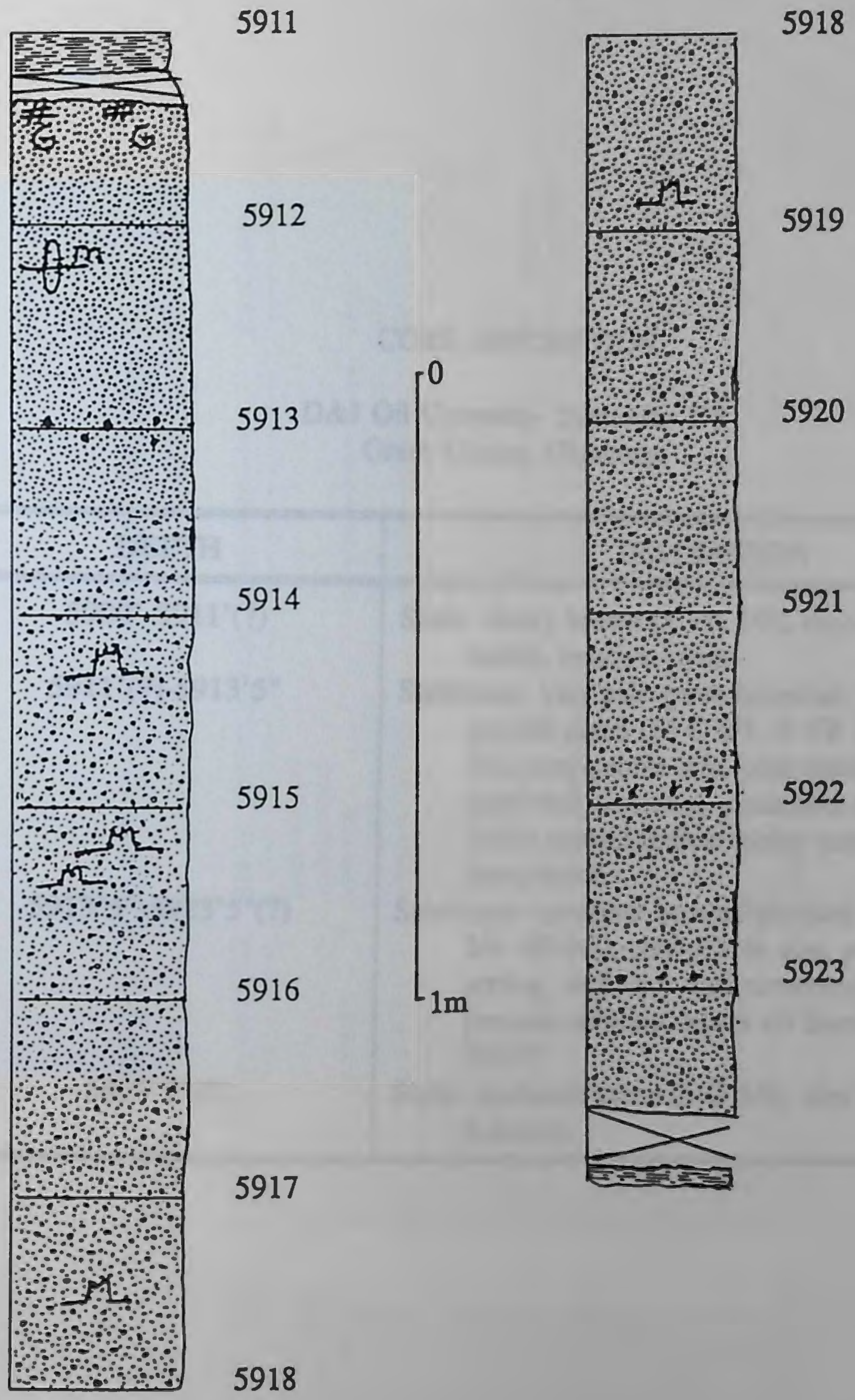
D&J OIL: DAISY 1-17, GRANT COUNTY, OKLAHOMA

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
5909.3	Wood/Mis	.6	34.0	0.0	0.0	0.0	2.6	25.0	0.0	0.0	37.8
5909.4	Wood/Mis	1.2	47.8	1.0	.2	.2	4.6	24.4	0.0	0.0	20.6
5909.6	Wood/Mis	6.4	69.4	.4	0.0	0.0	1.8	19.6	0.0	0.0	.2
5909.9	Wood/Mis	3.0	67.0	0.0	0.0	.2	1.8	12.8	0.0	15.0	0.0
5910.1	Misener	6.0	84.0	.2	0.0	0.0	2.4	.6	0.0	6.8	0.0
5911.1	Misener	0.0	9.0	0.0	0.0	0.0	1.4	83.6	0.0	0.0	6.0
5911.2	Misener	10.0	76.8	.2	0.0	0.0	2.2	10.4	0.0	.4	0.0
5912.0	Misener	6.4	77.6	.2	.2	0.0	2.6	11.2	0.0	1.8	0.0
5913.0	Misener	6.4	66.0	.2	0.0	0.0	4.4	9.2	0.0	13.4	.4
5914.0	Misener	5.0	84.4	0.0	0.0	0.0	6.8	2.4	0.0	.6	.8
5915.0	Misener	13.2	81.2	0.0	.2	.2	2.2	1.0	0.0	2.0	0.0
5915.4	Misener	1.8	95.2	0.0	0.0	0.0	1.6	0.0	0.0	1.4	0.0
5916.1	Misener	10.4	84.8	0.0	0.0	0.0	2.0	.4	0.0	2.2	.2
5917.0	Misener	9.4	81.6	0.0	0.0	0.0	2.8	.4	0.0	5.8	0.0
5918.0	Misener	9.4	69.6	0.0	0.0	.2	8.8	.2	0.0	11.8	0.0
5919.0	Misener	18.2	69.2	.2	0.0	0.0	3.4	0.0	0.0	9.0	0.0
5920.0	Misener	13.2	62.2	0.0	0.0	0.0	8.4	0.0	0.0	16.2	0.0

D&J Oil- Sunflower 1-8
Grant Co., OK

D&J Oil- Sunflower 1-8
Grant Co., OK



CORE DESCRIPTION

D&J Oil Company- Sunflower 1-8
Grant County, Oklahoma

DEPTH	DESCRIPTION
5900'-5911'(?)	Shale- dusky brown (5 YR 2/2), clay-silt size, well sorted, massive, pyrite
5911'(?)-5913'5"	Sandstone- very pale green-brownish gray-grayish green (10 G 8/2- 5 YR 4/1- 5 G 5/2), clay-pebble size, poor-moderate sorting, poor-well cemented, glauconite concentrated below contact (below pyrite zone), bioturbation
5913'5"-5923'5"(?)	Sandstone- moderate brown-light-dark gray (5 YR 3/4- N7-N3), clay-pebble size, poor-bimodal sorting, well-very well cemented, massive, pressure solution, heavy oil from 5921'5"-5923'7"
5923'5"(?)	Shale- moderate green (5 G 5/6), clay-silt, dolomitic

D&J OIL: SUNFLOWER 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
5908.9	Woodford		laminated		
5910.6	Woodford		laminated		
5911.6	Misener	point-conc.conv	random	silca,carbonate	mod
5912.5	Misener	float-conc.conv	random-subpar	clay	pr
5913.4	Misener	point-conc.conv	random(gded)	silica,carb	pr
5914.6	Misener	float-straight	random	silica,carb	mod (bimod)
5915.8	Misener	point-straight	random	silica,carb	mod (bimod)
5916.4	Misener	point-conc.conv	random	silica,carb	mod (bimod)
5917.3	Misener	point-conc.conv	random	silica	mod
5918.1	Misener	point-sutured	random	silica	pr (bimod)
5918.6	Misener	point-conc.conv	random	silica,carb	mod (bimod)
5919.6	Misener	point-sutured	laminated(gded)	silica,carb	pr
5920.1	Misener	point-conc.conv	random	silica	mod (bimod)
5920.5	Misener	straight-suture	random	silica	mod
5920.7	Misener	point-conc.conv	random	silica	mod (bimod)
5921.1	Misener	point-conc.conv	random	silica	mod (bimod)
5921.6	Misener	point-conc.conv	random	silica	mod (bimod)
5922.1	Misener	point-conc.conv	random	silica	mod (bimod)
5923.0	Misener	point-conc.conv	random	silica	mod (bimod)
5924.0	Misener	point-sutured	random	silica	pr
5925.3	Sylvan		mass		

D&J OIL: SUNFLOWER 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
5908.9	Woodford	cly-silt	cly	0	0	10	90
5910.6	Woodford	cly-silt	cly	0	0	15	85
5911.6	Misener	cly-med	fine	0	90	7	3
5912.5	Misener	cly-crs	fine	0	60	5	35
5913.4	Misener	cly-crs	med	0	90	8	2
5914.6	Misener	cly-crs	crs/fine	0	95	4	1
5915.8	Misener	cly-med	med/fine	0	86	12	2
5916.4	Misener	cly-crs	med/fine	0	94	5	1
5917.3	Misener	cly-crs	crs	0	95	4	1
5918.1	Misener	cly-crs	med/fine	0	80	17	3
5918.6	Misener	cly-crs	med/fine	0	98	1	1
5919.6	Misener	cly-gvl	fine	10	85	4	1
5920.1	Misener	cly-crs	med/fine	0	98	1	1
5920.5	Misener	cly-crs	fine	0	70	27	3
5920.7	Misener	cly-crs	med/v fine	0	96	3	1
5921.1	Misener	cly-crs	med/fine	0	98	1	1
5921.6	Misener	cly-crs	crs/v fine	0	95	4	1
5922.1	Misener	cly-crs	med/fine	0	98	3	1
5923.0	Misener	cly-crs	med/v fine	0	97	1	2
5924.0	Misener	cly-gvl	crs	2	90	7	1
5925.3	Sylvan	cly-slt	cly	0	0	5	95

D&J OIL: SUNFLOWER 1-8, GRANT COUNTY, OKLAHOMA

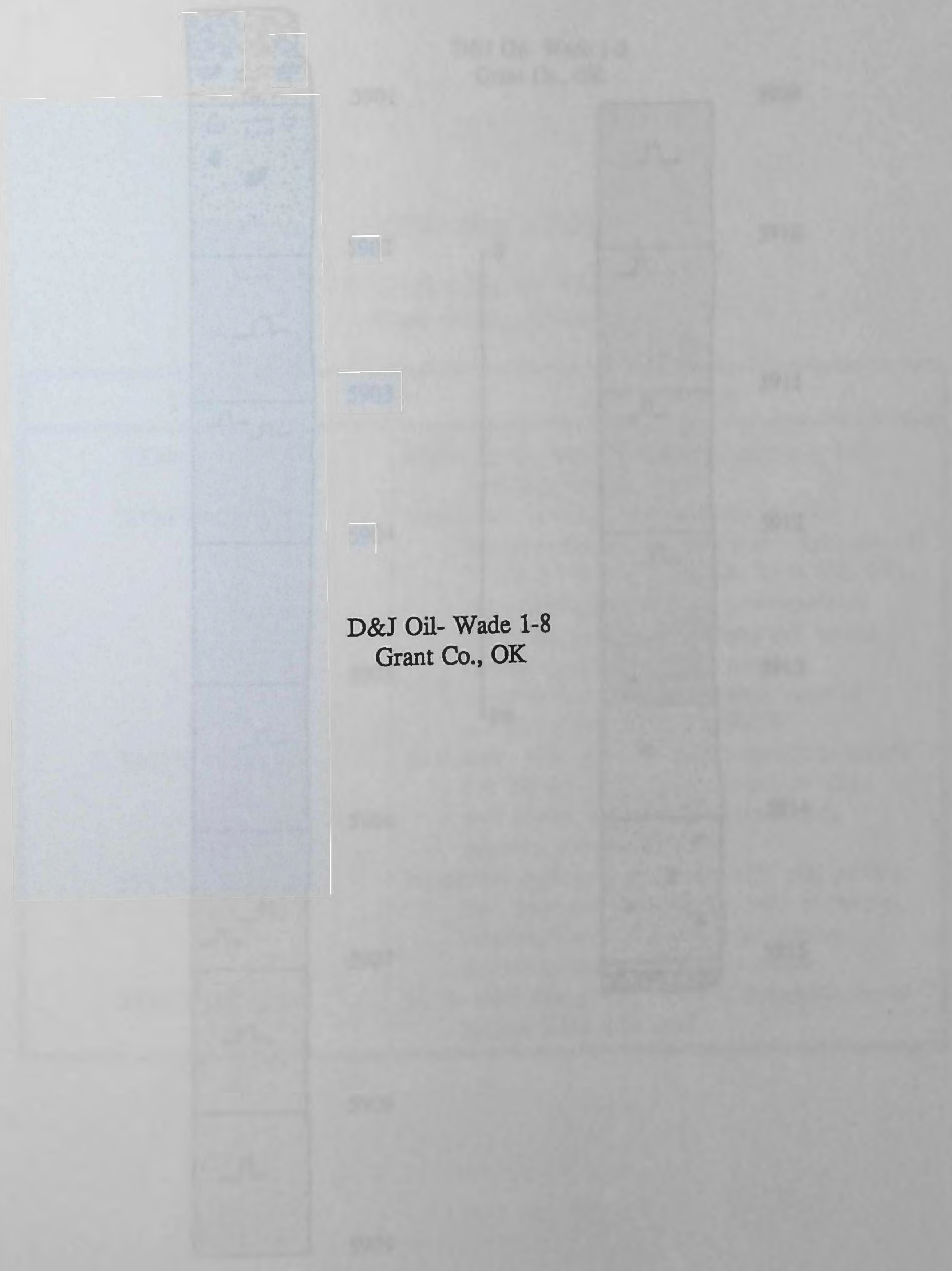
Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
5908.9	Woodford				qtz,dol,pyr,ill,kaol,chl,mont
5910.6	Woodford				qtz,dol,pyr,mica,ill,mont
5911.6	Misener	rnd-wlrnd	mod-high	submature	tr glc,fld,cht;poik carb
5912.5	Misener	ang-rnd	low-high	immature	tr glc,fld;ill,mont,chl
5913.4	Misener	rnd-wlrnd	mod-high	submature	tr glc;poik carb;tour
5914.6	Misener	rnd-wlrnd	mod-high	supermature	tr tour;
5915.8	Misener	sbang-wlrnd	mod-high	mature	tr cht;ps
5916.4	Misener	sbang-wlrnd	mod-high	mature	tr glc,cht;
5917.3	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,
5918.1	Misener	sbang-wlrnd	mod-high	submature	tr glc,fld;
5918.6	Misener	rnd-wlrnd	mod-high	supermature	tr glc;
5919.6	Misener	sbang-wlrnd	low-high	submature	tr cht;
5920.1	Misener	sbang-wlrnd	low-high	submature	tr fld;dead oil
5920.5	Misener	sbrnd-wlrnd	mod-high	mature	tr fld,cht;dead oil
5920.7	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,fld,cht;ps
5921.1	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,fld,cht;
5921.6	Misener	sbang-wlrnd	mod-high	submature	tr fld;dead oil;
5922.1	Misener	rnd-wlrnd	mod-high	supermature	tr glauc,cht;dead oil
5923.0	Misener	rnd-wlrnd	mod-high	supermature	tr cht;dead oil;ps
5924.0	Misener	rnd-wlrnd	mod-high	submature	tr fld,cht;dead oil
5925.3	Sylvan				qtz,dol,pyr,ill,mont,fld,chl

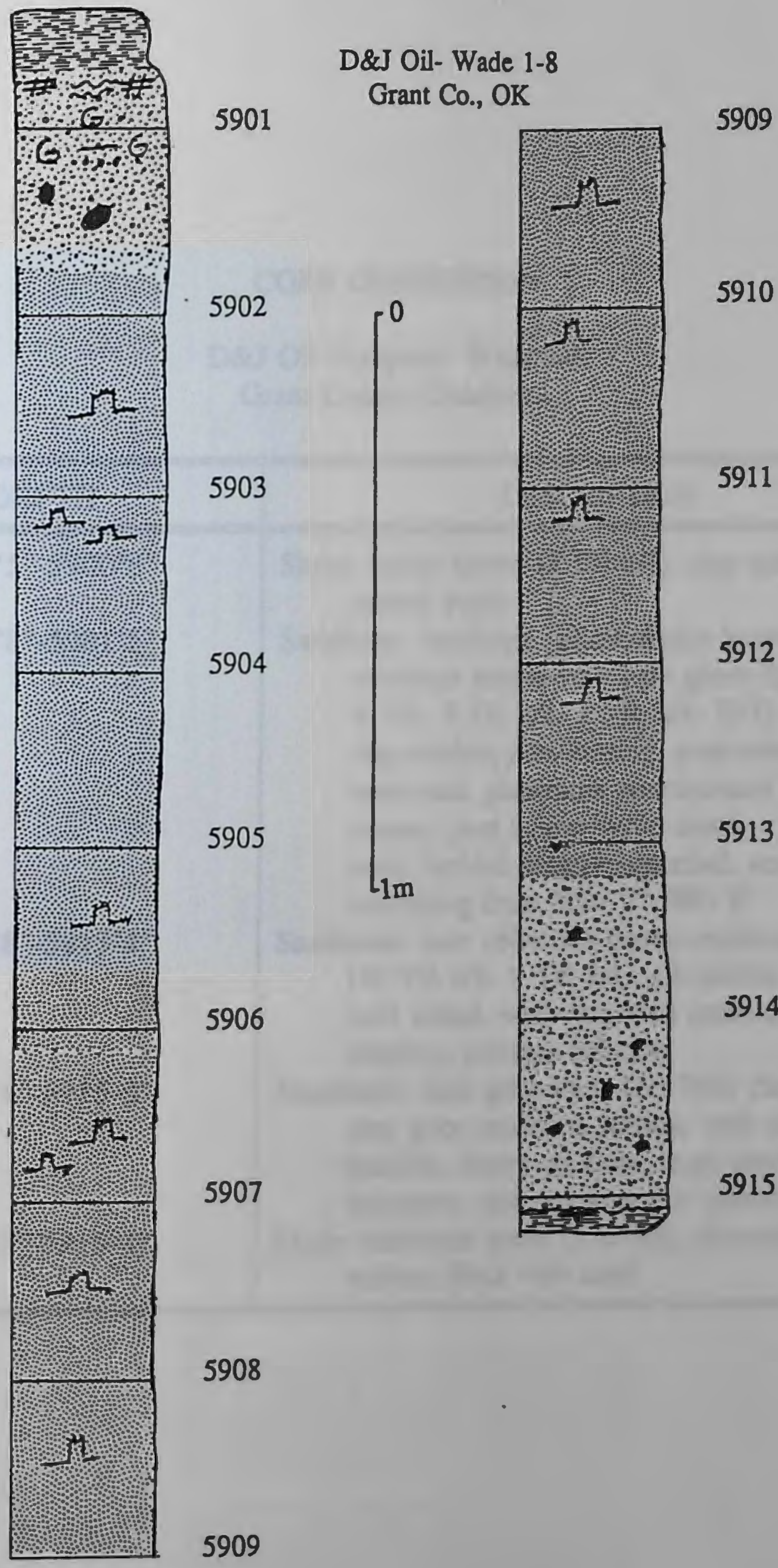
D&J OIL: SUNFLOWER 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
5908.9	Woodford										
5910.6	Woodford										
5911.6	Misener	.2	89.2	0.0	0.0	0.0	1.4	0.0	0.0	9.2	0.0
5912.5	Misener	0.0	68.6	0.0	0.0	0.0	2.8	25.6	0.0	.2	2.8
5913.4	Misener	5.8	89.2	.2	0.0	0.0	2.4	1.2	.2	.8	.2
5914.6	Misener	15.4	78.2	.6	0.0	.6	3.2	0.0	0.0	1.6	.4
5915.8	Misener	13.2	78.6	.4	0.0	.2	2.6	1.2	0.0	3.8	0.0
5916.4	Misener	14.2	82.2	.4	0.0	0.0	1.2	.2	0.0	1.4	.4
5917.3	Misener	13.8	83.0	.2	0.0	0.0	2.6	.2	0.0	0.0	.2
5918.1	Misener	16.8	77.8	0.0	0.0	0.0	2.2	0.0	.2	3.8	0.0
5918.6	Misener	10.6	83.8	0.0	0.0	0.0	2.2	0.0	0.0	3.0	.4
5919.6	Misener	14.0	76.0	.8	0.0	.2	4.6	0.0	0.0	4.4	0.0
5920.1	Misener	17.4	77.6	0.0	0.0	.4	2.0	0.0	0.0	2.6	0.0
5920.5	Misener	6.6	78.4	0.0	0.0	.2	2.8	1.8	.2	10.0	0.0
5920.7	Misener	13.6	78.4	0.0	0.0	0.0	3.0	0.0	0.0	4.8	.2
5921.1	Misener	17.2	74.4	0.0	0.0	0.0	2.6	0.0	0.0	5.8	0.0
5921.6	Misener	17.2	72.6	0.0	0.0	.2	2.6	0.0	0.0	7.4	0.0
5922.1	Misener	22.0	66.6	0.0	0.0	0.0	1.6	0.0	0.0	9.8	0.0
5923.0	Misener	19.0	74.0	.2	0.0	.4	1.4	0.0	0.0	5.0	0.0
5924.0	Misener	15.4	61.2	.8	0.0	.2	7.6	0.0	0.0	14.8	0.0
5925.3	Sylvan										



D&J Oil- Wade 1-8
Grant Co., OK


D&J Oil- Wade 1-8
Grant Co., OK
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CORE DESCRIPTION

D&J Oil Company- Wade 1-8
Grant County, Oklahoma

DEPTH	DESCRIPTION
5900'5"-5900'8"	Shale- dusky brown (5 YR 2/2), clay-silt, well sorted, pyrite
5900'8"-5901'8"	Sandstone- moderate yellow-dusky brown-moderate brown-very pale green-light gray (5 Y 7/6- 5 YR 2/2- 5 YR 3/4- 10 G 8/2- N7), clay-cobble, poor sorting, poor-moderate cemented, glauconite concentrated below contact (just below pyrite zone), wavy bedded-massive, mottled, zone of reworking from 5901'3"-5901'8"
5901'8"-5913'4"	Sandstone- pale yellowish brown-moderate brown (10 YR 6/2- 5 YR 3/4), silt-pebble size, well sorted, well-very well cemented, massive, pressure solution
5913'4"-5915'3"	Sandstone- dark gray-white (N3-N9), clay-pebble size, poor-moderate sorting, well cemented, massive, heavy oil stain, large detrital dolostone, and metamorphic quartz
5915'3"-5915'4"	Shale- moderate green (5 G 5/6), dolomitic, bored surface filled with sand

D&J OIL: WADE 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
5900.8	Misener	point-conc.conv	lam	pyr,dol	pr
5901.0	Misener	point-conc.conv	random	carbonate/clay	pr
5902.0	Misener	point-conc.conv	random	silica	wl
5903.0	Misener	point-conc.conv	random	silica	wl
5904.0	Misener	point-conc.conv	random	silica	wl
5905.0	Misener	point-conc.conv	random	silica	wl
5906.0	Misener	point-conc.conv	random	silica	wl
5906.9	Misener	point-conc.conv	random	silica	wl
5908.0	Misener	point-conc.conv	random	silica	wl
5909.0	Misener	point-conc.conv	random	silica	wl
5910.0	Misener	point-conc.conv	random-subpar	silica	wl
5911.0	Misener	point-conc.conv	random	silica	wl
5911.9	Misener	point-conc.conv	random	silica	mod
5912.6	Misener	point-conc.conv	random	silica	wl
5913.5	Misener	point-conc.conv	random-subpar	silica	pr
5914.8	Misener	point-conc.conv	random	silica	pr

D&J OIL: WADE 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
5900.8	Misener	clay-gvl	crs	1	95	1	3
5901.0	Misener	cly-crs	crs	0	95	1	4
5902.0	Misener	v fine-med	fine	0	100	0	0
5903.0	Misener	v fine-med	fine	0	100	0	0
5904.0	Misener	silt-med	fine	0	98	2	0
5905.0	Misener	silt-med	fine	0	98	2	0
5906.0	Misener	silt-med	fine	0	98	2	0
5906.9	Misener	silt-med	fine	0	98	2	0
5908.0	Misener	silt-med	fine	0	98	2	0
5909.0	Misener	silt-med	fine	0	98	2	0
5910.0	Misener	silt-med	fine	0	98	2	0
5911.0	Misener	silt-med	fine	0	98	2	0
5911.9	Misener	silt-crs	fine	0	98	2	0
5912.6	Misener	silt-med	fine	0	98	2	0
5913.5	Misener	silt-gvl	fine	5	93	2	0
5914.8	Misener	clay-gvl	med	2	94	2	2
5914.8	Misener	silt-gvl	fine	1	97	2	0

D&J OIL: WADE 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
5900.8	Misener	sbrnd-wlrnd	mod-high	submature	tr glc;con
5901.0	Misener	sbrnd-wlrnd	mod-high	submature	poik dol;fsh & con
5902.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht;fsh & con
5903.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht;fsh & con
5904.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con;ps
5905.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;fsh & con;dol rep qtz
5906.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc;fsh & con;dol rep qtz
5906.9	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc,cht;fsh&con;dol rep qtz
5908.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr glc;fsh & con;dol rep qtz
5909.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr pyr;fsh & con;dol rep qtz;
5910.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr tour;fsh & con:dol rep qtz
5911.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr tour;fsh & con;dol rep qtz
5911.9	Misener	sbrnd-wlrnd	mod-high	supermature	fsh & con;dol rep qtz
5912.6	Misener	sbrnd-wlrnd	low-high	supermature	tr glc,fld;fsh&con;dol rep qtz
5913.5	Misener	sbrnd-wlrnd	low-high	supermature	tr glc;fsh & con;dol rep qtz
5914.8	Misener	sbrnd-wlrnd	low-high	supermature	tr glc,cht;fsh&con;dol rep qtz
5914.8	Misener	sbrnd-wlrnd	mod-high	submature	tr cht;fsh & con;dol rep qtz

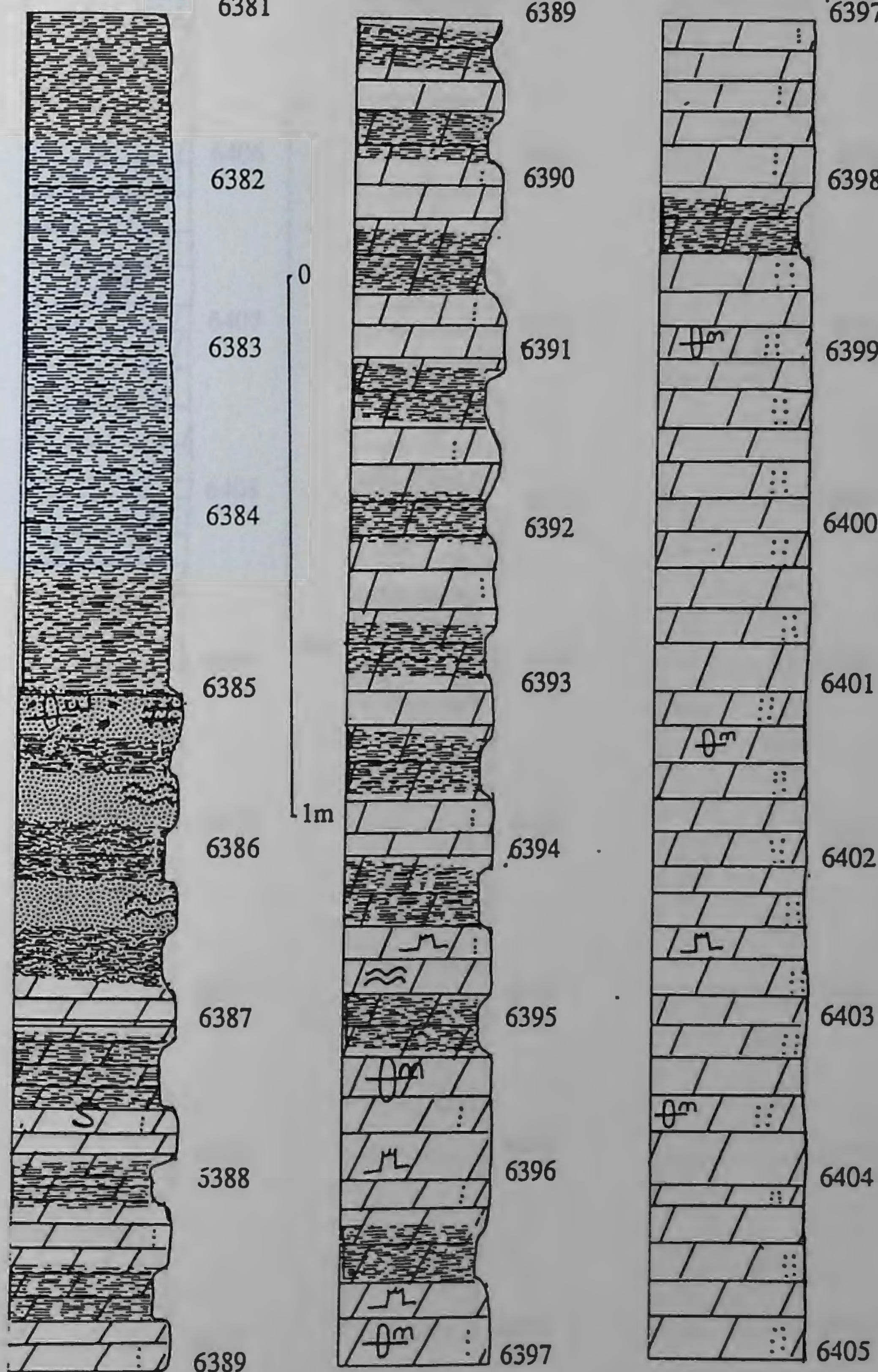
D&J OIL: WADE 1-8, GRANT COUNTY, OKLAHOMA

Thin Section Data: Composition

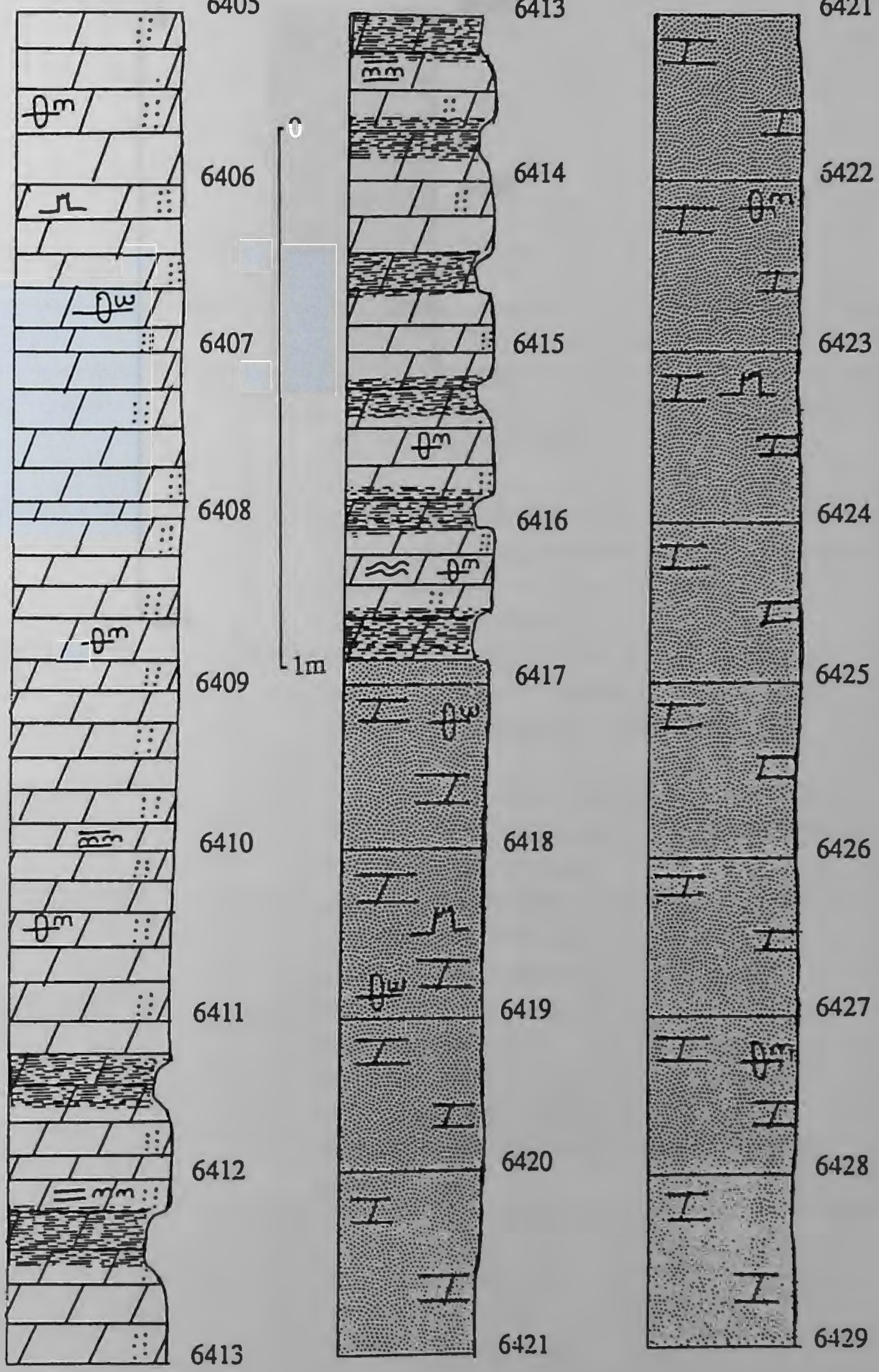
Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
5900.8	Misener	.8	60.2	0.0	0.0	0.0	2.4	7.6	0.0	4.6	24.4
5901.0	Misener	1.4	71.4	0.0	0.0	.8	1.8	1.4	0.0	23.8	0.0
5902.0	Misener	.2	96.6	0.0	0.0	0.0	.8	0.0	0.0	0.0	2.4
5903.0	Misener	15.2	82.6	.2	0.0	0.0	2.0	0.0	0.0	0.0	0.0
5904.0	Misener	13.6	84.2	.4	0.0	.2	1.6	0.0	0.0	0.0	0.0
5905.0	Misener	16.2	81.0	0.0	0.0	.4	2.2	0.0	0.0	.2	0.0
5906.0	Misener	14.2	82.2	.4	0.0	0.0	2.4	0.0	0.0	.6	0.0
5906.9	Misener	18.0	78.0	.2	0.0	0.0	2.0	0.0	0.0	1.6	.2
5908.0	Misener	15.8	78.6	.2	0.0	0.0	2.2	0.0	0.0	3.0	.2
5909.0	Misener	11.0	80.0	0.0	0.0	.2	.8	0.0	0.0	7.8	0.0
5910.0	Misener	14.2	77.8	0.0	0.0	.2	1.4	0.0	0.0	6.4	0.0
5911.0	Misener	13.2	78.0	.2	0.0	.2	1.2	0.0	0.0	7.2	0.0
5911.9	Misener	17.4	75.8	.2	0.0	.2	2.8	0.0	0.0	3.4	.2
5912.6	Misener	12.8	80.8	0.0	0.0	0.0	2.0	0.0	0.0	4.4	0.0
5913.5	Misener	12.0	65.4	0.0	0.0	0.0	7.8	.6	0.0	7.6	6.6
5914.8	Misener	7.4	57.2	.4	0.0	.4	7.0	0.0	0.0	27.6	0.0
5914.8	Misener	14.0	71.0	0.0	0.0	0.0	1.2	0.0	0.0	13.8	0.0

FCD- Mary A1
Garfield Co., OK

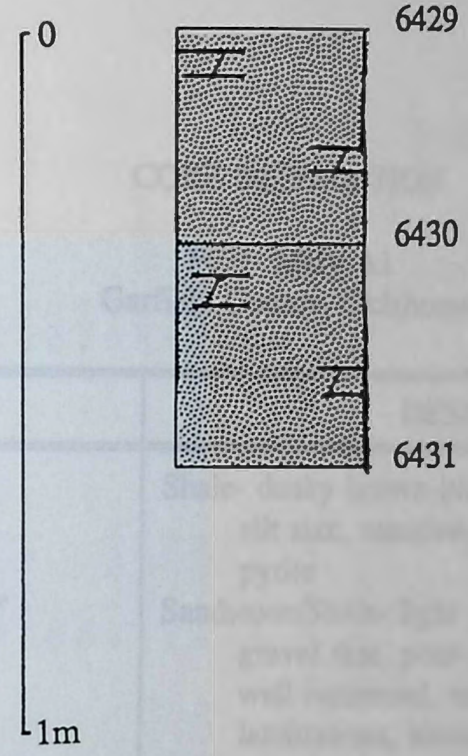
FCD- Mary A1
Garfield Co., OK



FCD- Mary A1
Garfield Co., OK



FCD- Mary A1
Garfield Co., OK



CORE DESCRIPTION

FCD- Mary A1
Garfield County, Oklahoma

DEPTH	DESCRIPTION
6381'-6385'	Shale- dusky brown-black (5 YR 2/2- N1), clay-silt size, massive-thin laminations, fissile, pyrite
6385'-6386'9"	Sandstone/Shale- light gray-black (N7- N1), clay-gravel size, poor-moderate sorting, moderate-well cemented, massive-thin wavy laminations, bioturbation
6386'9"-6398'5"	Dolostone/Shale- light gray-black (N7- N1), fine crystalline, clay-fine grain, thin parallel to subparallel laminations, slight-moderate bioturbation
6398'5"-6411'3"	Dolostone- light gray-pale yellowish brown (N7-10 YR 6/2), fine crystalline, quartz, rare parallel lamination, bioturbation
6411'3"-6416'10"	Dolostone/Shale- dark-light gray (N3-N7), fine crystalline, clay-medium size, quartz, parallel-wavy laminations, bioturbation
6416'10"-6431'	Sandstone/Dolostone- pale yellowish brown-light-dark gray (10 YR 6/2- N7- N3), fine crystalline, clay-medium size, moderate-well sorting, well cemented, massive, moderate-well bioturbated, heavy oil (dark gray)

FCD: MARY A1, GARFIELD COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
6385.0	Wood/Mis	float-conc.conv	ran-laminated	cly,pyr,dol	mod
6385.5	Misener	float-conc.conv	laminated	sil,cly,dol	pr
6390.0	Misener	float-straight	random	dol,cly	mod
6393.0	Mise/Wood	float-straight	laminated	cly,dol	mod
6397.0	Misener	float	random	dol	mod
6402.0	Misener	float	random	dol	mod
6406.0	Misener	float-straight	random	sil,dol	mod
6413.0	Mise/Wood	float	laminated	clay,dol	mod (gded)
6421.0	Misener	point-conc.conv	random	sil,dol	wl
6422.3	Misener	point-conc.conv	random	sil,dol	mod
6428.0	Misener	point-conc.conv	random	sil,dol	mod
6430.0	Misener	point-conc.conv	random	sil,dol	mod

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
6385.0	Wood/Mis	cly-med	cly/med	0	45	5	50
6385.5	Misener	cly-gvl	med	2	58	2	38
6390.0	Misener	cly-fine	v fine	0	15	5	80
6393.0	Mise/Wood	cly-fine	cly	0	2	13	85
6397.0	Misener	cly-fine	v fine	0	2	8	90
6402.0	Misener	cly-fine	fine	0	13	2	85
6406.0	Misener	v fine-med	fine	0	100	0	0
6413.0	Mise/Wood	cly-med	cly	0	5	5	90
6421.0	Misener	v fine-fine	v fine	0	100	0	0
6422.3	Misener	cly-med	fine	0	96	1	3
6428.0	Misener	cly-med	fine	0	96	1	3
6430.0	Misener	cly-med	fine	0	95	1	4

FCD: MARY A1, GARFIELD COUNTY, OKLAHOMA

Thin Section Data: Grain Shape and Comments

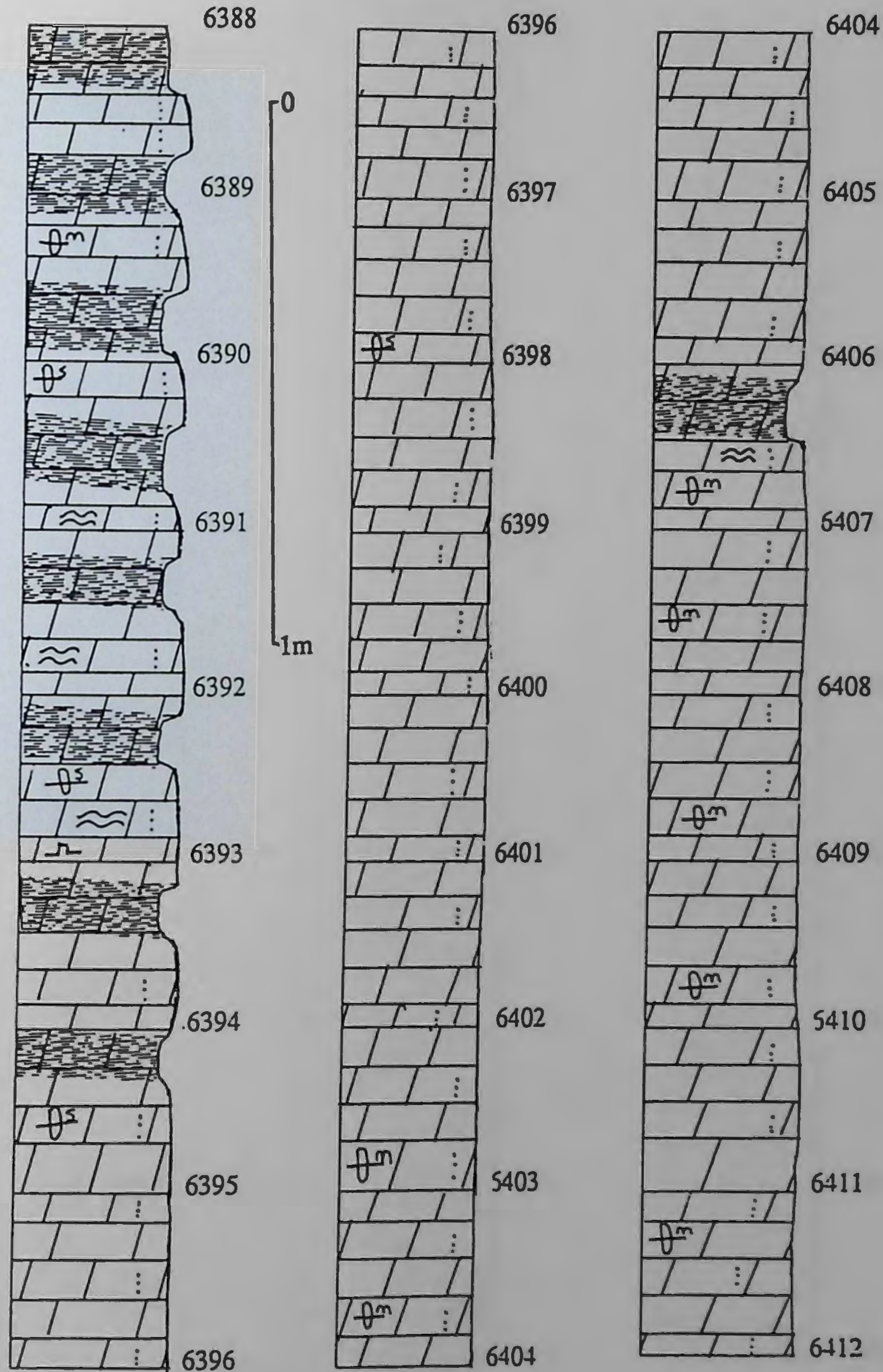
Depth	Formation	Angularity	Sphericity	Maturity	Comments
6385.0	Wood/Mis	ang-wlrnd	low-high	immature	spores;organic
6385.5	Misener	ang-wlrnd	low-high	immature	tr tour,cht;organic;ps
6390.0	Misener	sbrnd-wlrnd	mod-high	immature	tr zir;dol rep cly/qtz
6393.0	Mise/Wood	ang-wlrnd	mod-high	immature	organic;dol rep cly
6397.0	Misener	ang-wlrnd	mod-high	immature	bur;dol rep qtz
6402.0	Misener	sbang-wlrnd	mod-high	immature	tr tour,cht;dol rep qtz;styl
6406.0	Misener	sbrnd-wlrnd	mod-high	supermature	dol separ qtz cmt
6413.0	Mise/Wood	ang-wlrnd	mod-high	immature	dol rep cly
6421.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;dol rep qtz
6422.3	Misener	sbrnd-wlrnd	low-high	submature	tr cht;dol rep qtz
6428.0	Misener	sbrnd-wlrnd	mod-high	submature	tr cht;dol rep qtz
6430.0	Misener	sbrnd-wlrnd	mod-high	submature	tr tour,cht;dol rep qtz/cly

FCD: MARY A1, GARFIELD COUNTY, OKLAHOMA

Thin Section Data: Composition

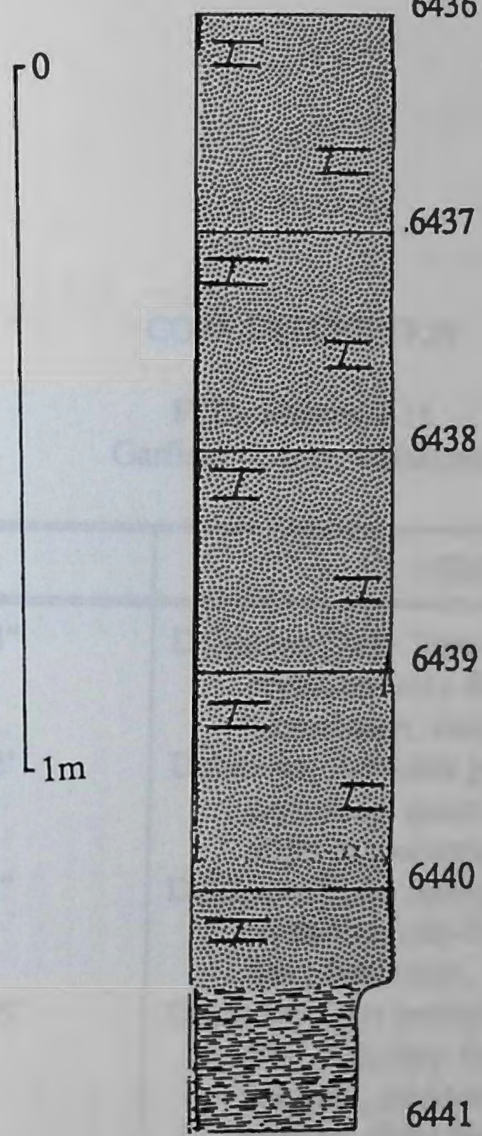
Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
6385.0	Wood/Mis	1.0	47.0	1.0	2.0	1.0	5.0	30.0	0.0	3.0	10.0
6385.5	Misener	1.0	60.0	1.0	0.0	1.0	5.0	25.0	0.0	3.0	4.0
6390.0	Misener	1.0	20.0	1.0	0.0	2.0	5.0	10.0	0.0	56.0	5.0
6393.0	Mise/Wood	1.0	15.0	1.0	1.0	2.0	0.0	45.0	0.0	30.0	5.0
6397.0	Misener	1.0	10.0	0.0	0.0	2.0	4.0	5.0	0.0	76.0	2.0
6402.0	Misener	5.0	15.0	1.0	0.0	2.0	5.0	10.0	0.0	59.0	3.0
6406.0	Misener	4.0	40.0	1.0	0.0	2.0	5.0	0.0	0.0	44.0	4.0
6413.0	Mise/Wood	1.0	10.0	1.0	0.0	1.0	3.0	50.0	0.0	30.0	3.0
6421.0	Misener	10.0	51.0	1.0	0.0	2.0	3.0	0.0	0.0	30.0	3.0
6422.3	Misener	10.0	46.0	1.0	0.0	2.0	5.0	3.0	0.0	30.0	3.0
6428.0	Misener	5.0	73.0	1.0	0.0	1.0	5.0	3.0	0.0	10.0	2.0
6430.0	Misener	5.0	66.0	1.0	0.0	2.0	5.0	3.0	0.0	15.0	3.0

FCD- Roberts 1-18
Garfield Co., OK



FCD- Roberts 1-18
Garfield Co., OK

FCD- Roberts 1-18
Garfield Co., OK



CORE DESCRIPTION

FCD- Roberts 1-18
Garfield County, Oklahoma

DEPTH	DESCRIPTION
6388'-6394'4"	Dolostone/Shale- light-dark gray (N7- N3), fine crystalline clay-fine size, slight to moderate bioturbation, wavy lamination
6394'4"-6412'	Dolostone- light-dark gray (N7-N3), fine crystalline, quartz, massive-thin lamination, slight to moderate bioturbation
6412'-6419'2"	Dolostone/Shale- light-dark gray (N7-N3), fine crystalline, clay-fine size, thin parallel to wavy lamination, slight bioturbation
6419'2"-6440'6"	Sandstone- light brownish gray-dark gray (5 YR 6/1- N3), very fine-coarse size, abundant dolomite, moderate sorting, well cemented, massive, slight bioturbation, heavy oil stain (dark gray)
6440'6'-6441	Shale- moderate green (5 G 5/6), dolomitic, massive

FCD: ROBERTS 1-18, GARFIELD COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
6392.0	Misener	float	laminated(wvy)	cly,dol	wl
6397.2	Misener	float	random	dol	wl
6399.0	Misener	float	random	dol	wl
6404.0	Misener	float	laminated(wvy)	dol	wl
6406.0	Misener	float-conc.conv	random	dol,sil	mod
6415.0	Mise/Wood	float-conc.conv	laminated	dol,cly	mod
6419.0	Mise/Wood	float-conc.conv	laminated(wvy)	dol,cly	mod
6421.0	Misener	float-conc.conv	random	dol,sil	wl
6427.0	Misener	float-conc.conv	random	sil,dol	wl
6436.3	Misener	point-conc.conv	random	sil,dol	wl
6438.0	Misener	point-conc.conv	random	sil,dol	mod
6440.0	Misener	point-conc.conv	random	sil,dol,pyr	mod
6440.4	Misener	point-conc.conv	random	sil,dol	mod

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
6392.0	Misener	cly-v fine	cly	0	2	5	20
6397.2	Misener	slt-v fine	v fine	0	95	5	0
6399.0	Misener	slt-fine	v fine	0	99	1	0
6404.0	Misener	slt-fine	v fine	0	95	5	0
6406.0	Misener	slt-med	fine	0	98	2	0
6415.0	Mise/Wood	cly-fine	cly	0	5	20	75
6419.0	Mise/Wood	cly-fine	cly	0	5	20	75
6421.0	Misener	v fine-fine	fine	0	100	0	0
6427.0	Misener	v fine-fine	fine	0	100	0	0
6436.3	Misener	v fine-fine	fine	0	100	0	0
6438.0	Misener	v fine-crs	fine	0	100	0	0
6440.0	Misener	v fine-crs	fine	0	100	0	0
6440.4	Misener	v fine-crs	fine	0	100	0	0

FCD: ROBERTS 1-18, GARFIELD COUNTY, OKLAHOMA

Thin Section Data: Grain Shape and Comments

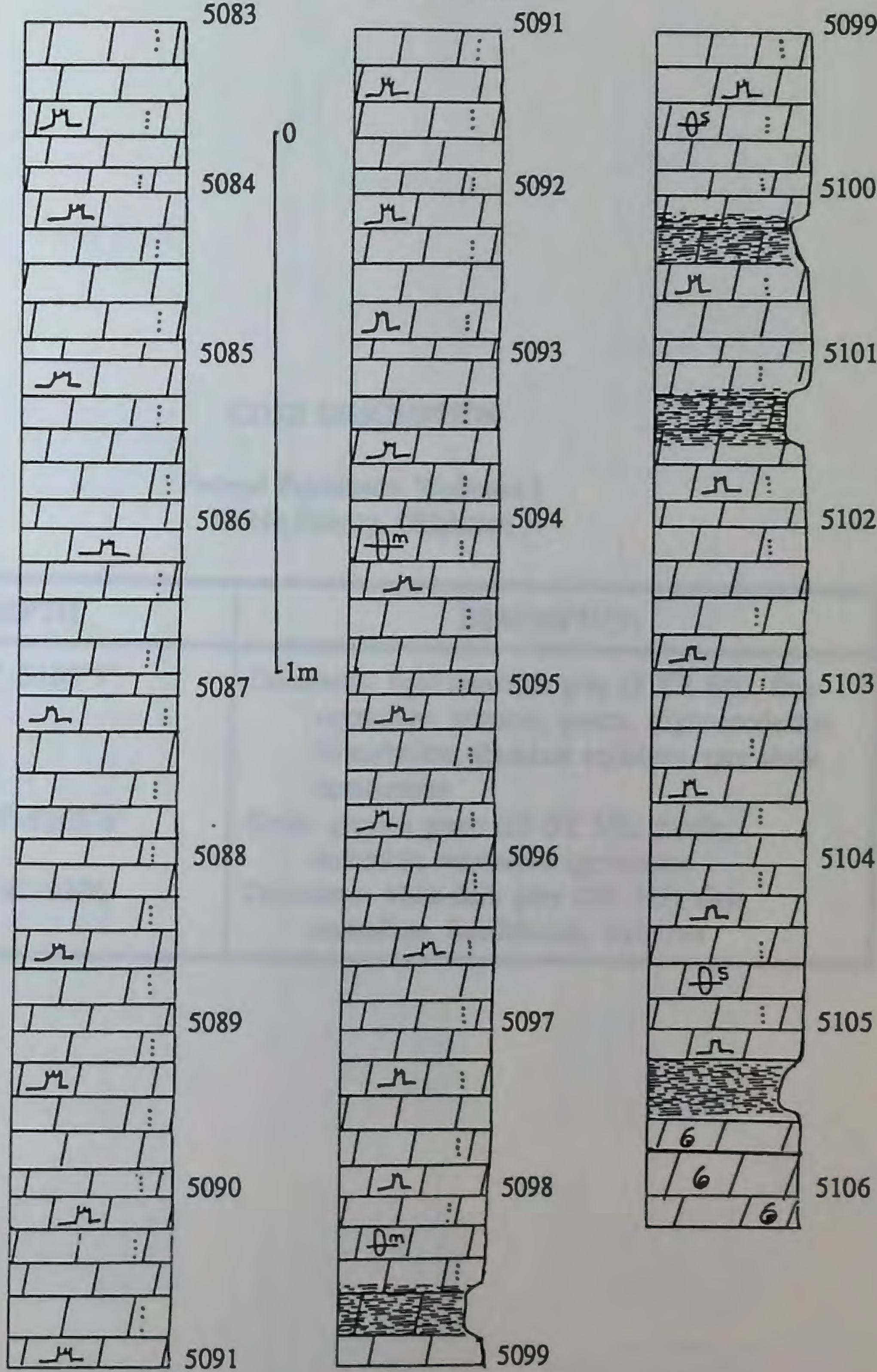
Depth	Formation	Angularity	Sphericity	Maturity	Comments
6392.0	Misener	sbang-wlrnd	mod-high	immature	dol rep cly
6397.2	Misener	sbang-wlrnd	mod-high		styl
6399.0	Misener	sbang-wlrnd	mod-high		dol rep qtz
6404.0	Misener	sbang-wlrnd	low-high		styl
6406.0	Misener	sbang-wlrnd	low-high	submature	tr cht;dol rep qtz;ps
6415.0	Mise/Wood	ang-rnd	mod-high		organic shl
6419.0	Mise/Wood	ang-rnd	mod-high		organic shl;styl
6421.0	Misener	sbrnd-wlrnd	mod-high	supermature	bur;dol rep qtz
6427.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht;dol rep qtz
6436.3	Misener	sbrnd-wlrnd	mod-high	supermature	tr cht,met qtz;ps
6438.0	Misener	sbrnd-wlrnd	mod-high	submature	detrital dol;ps
6440.0	Misener	sbrnd-wlrnd	low-high	submature	tr cht,met qtz;dol rep qtz;ps
6440.4	Misener	sbrnd-wlrnd	mod-high	submature	tr cht;

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
6392.0	Misener	1.0	7.0	0.0	0.0	1.0	2.0	20.0	0.0	73.0	3.0
6397.2	Misener	1.0	7.0	0.0	0.0	1.0	5.0	2.0	0.0	77.0	2.0
6399.0	Misener	10.0	7.0	1.0	0.0	1.0	3.0	1.0	0.0	76.0	1.0
6404.0	Misener	1.0	7.0	1.0	1.0	1.0	3.0	2.0	0.0	83.0	1.0
6406.0	Misener	12.0	20.0	0.0	0.0	1.0	4.0	1.0	0.0	61.0	1.0
6415.0	Mise/Wood	1.0	10.0	1.0	1.0	1.0	2.0	25.0	0.0	58.0	3.0
6419.0	Mise/Wood	1.0	7.0	0.0	0.0	1.0	2.0	40.0	0.0	44.0	5.0
6421.0	Misener	10.0	30.0	1.0	0.0	1.0	2.0	1.0	0.0	53.0	2.0
6427.0	Misener	5.0	40.0	1.0	0.0	1.0	2.0	1.0	0.0	49.0	1.0
6436.3	Misener	10.0	53.0	1.0	0.0	1.0	5.0	2.0	0.0	25.0	3.0
6438.0	Misener	5.0	66.0	1.0	0.0	1.0	5.0	1.0	0.0	20.0	1.0
6440.0	Misener	5.0	58.0	1.0	0.0	1.0	7.0	1.0	0.0	20.0	7.0
6440.4	Misener	5.0	60.0	1.0	0.0	1.0	5.0	2.0	0.0	25.0	1.0

Federal Petroleum- Wolleson 1
Noble Co., OK

Federal Petroleum- Wolleson 1
Noble Co., OK



FEDERAL PETROLEUM: WOLLESON 1, NOBLE COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
5083.0	Misener	float-conc.conv	random	dol,sil	wl
5088.0	Misener	float-conc.conv	random	dol,sil	wl
5093.4	Misener	float-conc.conv	random	dol,sil(cht)	wl
5098.0	Misener	float-conc.conv	random	dol,sil	mod
5099.6	Misener	float-conc.conv	random	dol,sil	wl
5105.2	Misener	float-conc.conv	ran-laminated	dol,sil	pr
5107.0	Carb ?			Dolostone	

Thin Section Data: Grain Size

Well name	Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
	5083.0	Misener	v fine-fine	v fine	0	100	0	0
	5088.0	Misener	v fine-fine	v fine	0	100	0	0
	5093.4	Misener	v fine-med	fine	0	100	0	0
	5098.0	Misener	cly-fine	v fine	0	94	1	5
	5099.6	Misener	slt-fine	v fine	0	99	1	0
	5105.2	Misener	cly-gvl	v fine	10	87	1	2
	5107.0	Carb ?						

Thin Section Data: Grain Shape and Comments

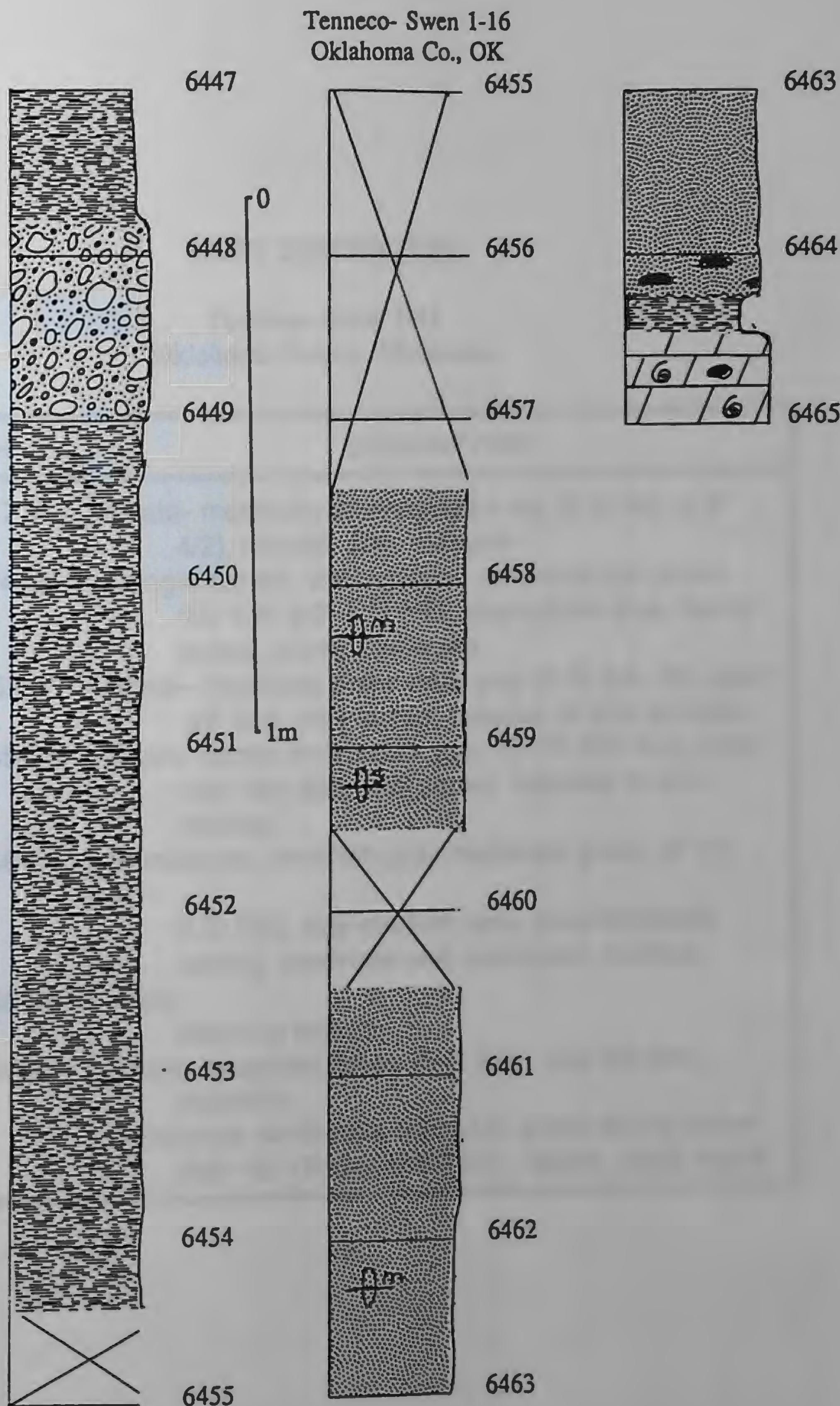
Depth	Formation	Angularity	Sphericity	Maturity	Comments
5083.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr tour,cht;dol rep qtz,styl
5088.0	Misener	sbrnd-wlrnd	mod-high	supermature	tr tour,cht;dol rep qtz,styl
5093.4	Misener	sbrnd-wlrnd	mod-high	supermature	bur;cht cmt;zoned dol;
5098.0	Misener	sbrnd-wlrnd	low-high	submature	bur;dol rep qtz/cly;styl
5099.6	Misener	sbrnd-wlrnd	mod-high	supermature	bur;dol rep qtz
5105.2	Misener	sbrnd-wlrnd	mod-high	submature	tr tour,cht;dol rep qtz
5107.0	Carb ?				rel tex;fossilif;

FEDERAL PETROLEUM: WOLLESON 1, NOBLE COUNTY, OKLAHOMA

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
5083.0	Misener	15.0	10.0	1.0	0.0	1.0	5.0	2.0	0.0	64.0	2.0
5088.0	Misener	15.0	15.0	1.0	0.0	1.0	5.0	2.0	0.0	59.0	2.0
5093.4	Misener	15.0	30.0	1.0	0.0	1.0	5.0	0.0	0.0	46.0	2.0
5098.0	Misener	10.0	30.0	1.0	0.0	1.0	3.0	2.0	0.0	52.0	1.0
5099.6	Misener	5.0	15.0	1.0	0.0	1.0	3.0	3.0	0.0	68.0	4.0
5105.2	Misener	5.0	40.0	1.0	0.0	1.0	6.0	2.0	0.0	43.0	2.0
5107.0	Carb ?	0.0	2.0	0.0	0.0	0.0	0.0	2.0	0.0	96.0	0.0

Tenneco- Swen 1-16
Oklahoma Co., OK


Tenneco- Swen 1-16
Oklahoma Co., OK
6447
6448
6449
6450
6451
6452
6453
6454
6455
0
1m
6455
6456
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6460
6461
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6464
6465

CORE DESCRIPTION

Tenneco- Swen 1-16
Oklahoma County, Oklahoma

DEPTH	DESCRIPTION
6447-6447'8"	Shale- moderate green-grayish red (5 G 5/6- 5 R 4/2), clay-silt size, massive
6447'8"-6449'	Conglomerate- white-grayish red-moderate green (N9-5 R 4/2- 5 G 5/6), clay-cobble size, poorly sorted, poorly cemented
6449'-6452'9"	Shale- moderate green-dark gray (5 G 5/6- N3, clay-silt size, well sorted, massive to thin laminae
6452'9"-6454'4"	Shale- dusky brown-dark gray (5 YR 2/2- N3), clay-very fine size, well sorted, massive to thin laminae
6457'6"-6464'4"	Sandstone- brownish gray-moderate green (5 YR 4/1- 5 G 5/6), clay-medium size, poor-moderate sorting, moderate-well cemented, mottled,
6464'4"-6464'8"	shale clasts at bottom
6464'8"-6465'	Shale- moderate green (5 G 5/6), clay-silt size, dolomitic
	Dolostone- white-pale yellowish brown-dusky brown (N9- 10 YR 6/2- 5 YR 2/2), fossils, large clasts

TENNECO: SWEN 1-16, OKLAHOMA COUNTY, OKLAHOMA

Thin Section Data: Grain Texture and Cement

Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
6448.0	Gran Wsh?	float-straight	random	clay	pr
6453.0	Woodford		laminated	clay	mod
6454.6	Woodford		laminated	clay	mod
6458.0	Misener	point-conc.conv	random	sil,dol,cly	mod
6459.0	Misener	float-conc.conv	random	sil,dol,cly	mod
6461.5	Misener	float-conc.conv	random	cly,sil,dol	mod
6462.0	Misener	float-conc.conv	random	cly,sil,dol	pr
6462.8	Misener	float-conc.conv	random	sil,cly,dol	mod
6463.0	Misener	float-conc.conv	random	sil,cly,dol	mod

Thin Section Data: Grain Size

Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
6448.0	Gran Wsh?	cly-gvl	med	40	10	5	45
6453.0	Woodford	cly-v fine	cly	0	2	20	78
6454.6	Woodford	cly-v fine	cly	0	3	17	80
6458.0	Misener	cly-med	med	0	97	1	2
6459.0	Misener	cly-med	med	0	94	1	5
6461.5	Misener	cly-med	med	0	87	1	12
6462.0	Misener	cly-gvl	med	2	87	1	10
6462.8	Misener	cly-med	med	0	94	2	4
6463.0	Misener	cly-med	med	0	93	1	6

Thin Section Data: Grain Shape and Comments

Depth	Formation	Angularity	Sphericity	Maturity	Comments
6448.0	Gran Wsh?	ang-wlrnd	low-high	immature	cht,met qtz
6453.0	Woodford	ang-sbang	mod-high		organic
6454.6	Woodford	ang-sbang	low-high		tr cht;organic
6458.0	Misener	sbrnd-wlrnd	mod-high	submature	tr tour,cht;bur;dol rep qtz;ps
6459.0	Misener	ang-wlrnd	low-high	submature	tr cht;poik carb;bur;
6461.5	Misener	sbang-wlrnd	low-high	immature	poik carb;bur
6462.0	Misener	sbang-wlrnd	low-high	immature	tr tour,cht;poik carb;bur
6462.8	Misener	sbang-wlrnd	mod-high	submature	tr cht;poik carb;bur;ps
6463.0	Misener	sbang-wlrnd	low-high	immature	tr cht;poik carb;bur;

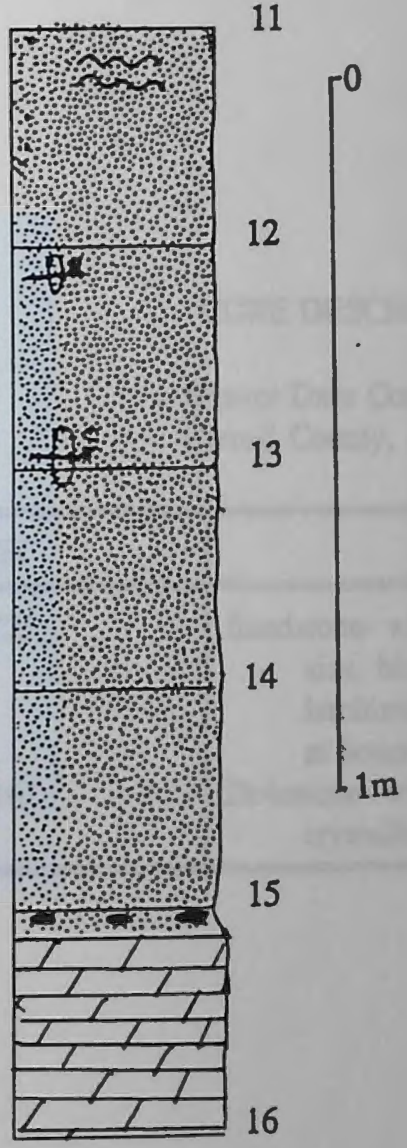
TENNECO: SWEN 1-16, OKLAHOMA COUNTY, OKLAHOMA

Thin Section Data: Composition

Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
6448.0	Gran Wsh?	1.0	51.0	1.0	0.0	2.0	0.0	35.0	0.0	10.0	0.0
6453.0	Woodford	1.0	20.0	1.0	0.0	1.0	0.0	74.0	0.0	0.0	3.0
6454.6	Woodford	1.0	18.0	1.0	1.0	1.0	1.0	76.0	0.0	0.0	2.0
6458.0	Misener	10.0	79.0	0.0	0.0	0.0	3.0	2.0	0.0	5.0	1.0
6459.0	Misener	10.0	75.0	0.0	0.0	1.0	3.0	5.0	0.0	5.0	1.0
6461.5	Misener	10.0	72.0	0.0	0.0	1.0	3.0	12.0	0.0	1.0	1.0
6462.0	Misener	10.0	73.0	0.0	0.0	1.0	3.0	10.0	0.0	2.0	1.0
6462.8	Misener	10.0	77.0	1.0	0.0	1.0	3.0	4.0	0.0	3.0	1.0
6463.0	Misener	10.0	75.0	0.0	0.0	1.0	4.0	6.0	0.0	3.0	1.0

Beaver Dam- Core/Road Cut/Float
Carroll Co., Ark

Beaver Dam- Core
Carroll Co., Ark

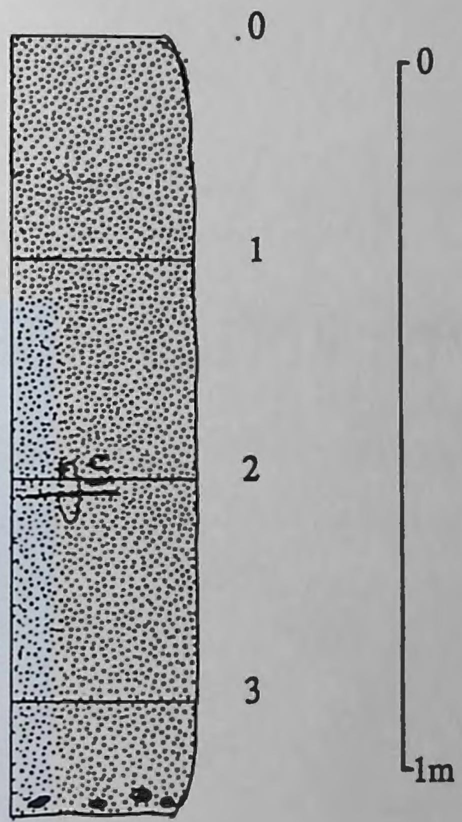


CORE DESCRIPTION

Beaver Dam Core BE-19
Carroll County, Arkansas

DEPTH	DESCRIPTION
11'-15'2"	Sandstone- white-light gray (N9-N7), clay-medium size, bimodal sorting, well cemented, wavy laminations, bioturbation, phosphate clasts at bottom
15'2"-16'	Dolostone- white-light gray (N9-N7), fine crystalline, weathered appearance

Beaver Dam- Float
Carroll Co., Ark

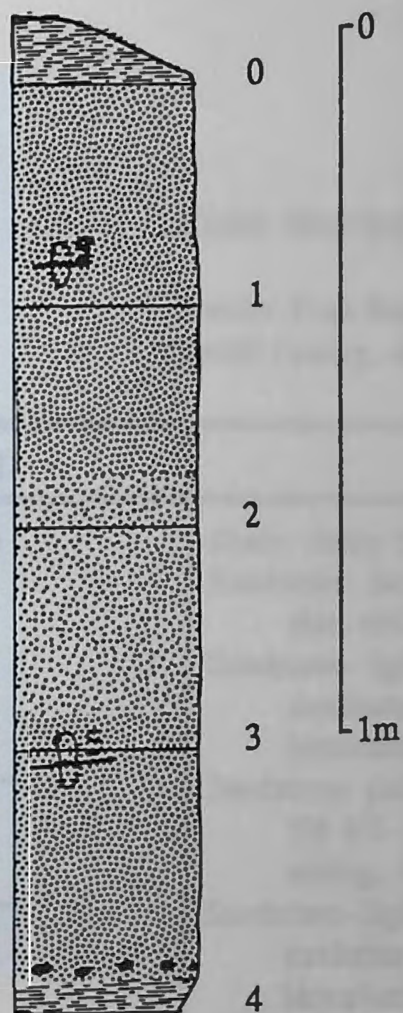


CORE DESCRIPTION

Beaver Dam Float
Carroll County, Arkansas

DEPTH	DESCRIPTION
0-6"	Sandstone- pale yellowish brown-light gray (10 YR 6/2- N7), fine-medium size, bimodal sorting, well cemented, massive
6"-3'6"	Sandstone- light gray (N7), fine-coarse size, bimodal sorting, well cemented, bioturbation, phosphate clasts at bottom contact

Beaver Dam- Road Cut
Carroll Co., Ark



CORE DESCRIPTION

Beaver Dam Road Cut
Carroll County, Arkansas

DEPTH	DESCRIPTION
Surface	Shale- dusky brown (5 YR 2/2), fissile, pyrite
0-6"	Sandstone- dusky brown (5 YR 2/2), fine-medium size, well sorted, poorly cemented, massive
6"-1'4"	Sandstone- light gray (N7), clay-medium, moderate sorting, well cemented, bioturbation
1'4"-2'3"	Sandstone- pale yellowish brown-light gray (10 YR 6/2- N7), fine-medium size, bimodal sorting, well cemented, massive
2'3"-3'8"	Sandstone- light gray (N7), clay-gravel size, poor-moderate sorting, well cemented, bioturbation, phosphate clasts at bottom
3'8"-4'	Shale- dusky brown (5 YR 2/2), clay-silt, massive

BEAVER DAM, CARROLL COUNTY, ARKANSAS

Thin Section Data: Grain Texture and Cement

Sample	Depth	Formation	Grain/grain contact	Grain orientation	Cementation	Sorting
Core 19.0	15.0	Sylamore	point-conc.conv	random	silica	wl (bimod)
Float	2.0	Sylamore	strt-conc.conv	random-subpar	silica	mod
Float	3.0	Sylamore	point-conc.conv	random	silica	wl (bimod)
Float	4.0	Sylamore	point-conc.conv	random	silica	wl (bimod)
Road Cut	1.0	Sylamore	point-conc.conv	random	silica	wl
Road Cut	2.0	Sylamore	point-conc.conv	random	silica	mod
Road Cut	3.0	Sylamore	point-conc.conv	random	silica	wl (bimod)
Road Cut	4.0	Sylamore	point-conc.conv	laminated	silica	pr

Thin Section Data: Grain Size

Sample	Depth	Formation	Range of grain size	Avg grain size	% gravel	% sand	% silt	% clay
Core 19.0	15.0	Sylamore	cly-med	med/fine	0	98	1	1
Float	2.0	Sylamore	fine-crs	med	0	100	0	0
Float	3.0	Sylamore	fine-med	med/fine	0	100	0	0
Float	4.0	Sylamore	fine-crs	med/fine	0	100	0	0
Road Cut	1.0	Sylamore	fine-med	med	0	100	0	0
Road Cut	2.0	Sylamore	cly-med	med	0	98	1	1
Road Cut	3.0	Sylamore	fine-med	med/fine	0	100	0	0
Road Cut	4.0	Sylamore	cly-gvl	med	4	94	1	1

Thin Section Data: Grain Shape and Comments

Sample	Depth	Formation	Angularity	Sphericity	Maturity	Comments
Core 19.0	15.0	Sylamore	sbrnd-wlrnd	mod-high	submature	no carb or glauc
Float	2.0	Sylamore	rnd-wlrnd	mod-high	supermature	no carb or glauc
Float	3.0	Sylamore	sbrnd-wlrnd	mod-high	supermature	no carb or glauc
Float	4.0	Sylamore	sbrnd-wlrnd	mod-high	supermature	no carb or glauc
Road Cut	1.0	Sylamore	sbrnd-wlrnd	mod-high	supermature	no carb or glauc
Road Cut	2.0	Sylamore	sbrnd-wlrnd	mod-high	submature	no carb or glauc
Road Cut	3.0	Sylamore	sbrnd-wlrnd	mod-high	supermature	no carb, glauc, phos
Road Cut	4.0	Sylamore	sbrnd-wlrnd	low-high	submature	no carb or glauc

BEAVER DAM, CARROLL COUNTY, ARKANSAS

Thin Section Data: Composition

Sample	Depth	Formation	TS Phi	% Qtz	% Fld	% Mica	% Glauc	% P/C	% Clay	% Acc	% Carb	% Pyr
Core 19.0	15.0	Sylamore	15.0	83.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Float	2.0	Sylamore	1.0	97.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Float	3.0	Sylamore	15.0	83.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Float	4.0	Sylamore	10.0	88.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Road Cut	1.0	Sylamore	5.0	92.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	1.0
Road Cut	2.0	Sylamore	3.0	95.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0
Road Cut	3.0	Sylamore	10.0	89.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Road Cut	4.0	Sylamore	5.0	90.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	1.0

APPENDIX II

Petrophysical Data

Petrophysical Data

Well name	Depth	Formation	Grain density g/cc	Permeability mD	Boyles Law porosity %
Daisy 1-17	5909.3	Wood/Mis			
Daisy 1-17	5909.4	Wood/Mis	2.90	.124	3.00
Daisy 1-17	5909.6	Wood/Mis	2.66	.455	8.60
Daisy 1-17	5909.9	Wood/Mis	2.67	.418	8.90
Daisy 1-17	5910.1	Misener	2.66	.130	4.60
Daisy 1-17	5911.1	Misener			
Daisy 1-17	5911.2	Misener	2.66	3.203	12.20
Daisy 1-17	5912.0	Misener	2.66	3.836	11.80
Daisy 1-17	5913.0	Misener	2.69	.486	8.50
Daisy 1-17	5914.0	Misener	2.69	.238	4.60
Daisy 1-17	5915.0	Misener	2.66	210.600	12.30
Daisy 1-17	5915.4	Misener	2.64	.024	1.80
Daisy 1-17	5916.1	Misener	2.66	373.600	13.10
Daisy 1-17	5917.0	Misener	2.70	130.800	11.10
Daisy 1-17	5918.0	Misener	2.69	166.400	12.80
Daisy 1-17	5919.0	Misener	2.69	90.120	10.40
Daisy 1-17	5920.0	Misener	2.64	24.110	9.40

Petrophysical Data

Well name	Depth	Formation	Grain density g/cc	Permeability mD	Boyles Law porosity %
Sunflower 1-8	5908.9	Woodford	2.56		2.20
Sunflower 1-8	5910.6	Woodford	2.78		2.10
Sunflower 1-8	5911.6	Misener	2.67	.044	3.40
Sunflower 1-8	5912.5	Misener	2.68	.395	7.50
Sunflower 1-8	5913.4	Misener	2.66	2.212	5.90
Sunflower 1-8	5914.6	Misener	2.65	441.900	8.70
Sunflower 1-8	5915.8	Misener	2.66	242.600	10.00
Sunflower 1-8	5916.4	Misener	2.66	521.100	12.50
Sunflower 1-8	5917.3	Misener	2.66	250.900	12.60
Sunflower 1-8	5918.1	Misener	2.66	314.400	11.20
Sunflower 1-8	5918.6	Misener	2.66	272.600	8.40
Sunflower 1-8	5919.6	Misener	2.66	82.230	7.90
Sunflower 1-8	5920.1	Misener	2.59	109.700	9.90
Sunflower 1-8	5920.5	Misener			
Sunflower 1-8	5920.7	Misener	2.66	379.600	12.60
Sunflower 1-8	5921.1	Misener	2.67	279.200	12.80
Sunflower 1-8	5921.6	Misener	2.58	10.420	8.10
Sunflower 1-8	5922.1	Misener	2.58	8.383	9.10
Sunflower 1-8	5923.0	Misener	2.54	17.630	6.80
Sunflower 1-8	5924.0	Misener	2.61	11.980	6.80
Sunflower 1-8	5925.3	Sylvan	2.75		5.60

Petrophysical Data

Well name	Depth	Formation	Grain density g/cc	Permeability mD	Boyles Law porosity %
Wade 1-8	5900.8	Misener			
Wade 1-8	5901.0	Misener	2.67	1.074	8.10
Wade 1-8	5902.0	Misener	2.65	.066	2.60
Wade 1-8	5903.0	Misener	2.66	88.990	10.10
Wade 1-8	5904.0	Misener	2.66	86.550	10.70
Wade 1-8	5905.0	Misener	2.66	169.300	12.40
Wade 1-8	5906.0	Misener	2.66	234.700	13.20
Wade 1-8	5906.9	Misener	2.66	293.000	13.40
Wade 1-8	5908.0	Misener	2.66	201.800	12.80
Wade 1-8	5909.0	Misener	2.67	107.400	10.20
Wade 1-8	5910.0	Misener	2.67	183.500	11.90
Wade 1-8	5911.0	Misener	2.68	161.300	11.30
Wade 1-8	5911.9	Misener	2.70	295.000	14.00
Wade 1-8	5912.6	Misener	2.66	220.600	13.10
Wade 1-8	5913.5	Misener	2.65	13.470	8.50
Wade 1-8	5914.8	Misener	2.61	16.920	7.60
Wade 1-8	5914.8	Misener	2.67	.215	5.80

APPENDIX III

X-ray diffraction results- Sunflower 1-8

Bulk X-ray Diffraction results - Sunflower 1-8

DEPTH	QTZ	K-FLD	CAL	DOL	ANK	SID	PYR	MONT	ILL	KAO	CHL
5908.9	32	5	2	14	0	1	6	0	34	0	5
5910.6	24	0	0	10	0	0	33	0	33	0	0
5911.6	89	2	7	0	1	0	0	2	0	0	0
5912.5	78	0	0	0	2	2	0	4	11	0	3
5913.4	94	0	0	0	2	2	0	2	0	0	0
5914.6	96	0	0	0	1	1	0	2	0	0	0
5915.8	98	0	0	0	1	1	0	0	0	0	0
5916.4	96	0	0	1	1	1	0	0	0	0	0
5917.3	99	0	0	0	1	0	0	0	0	0	0
5918.1	100	0	0	0	0	0	0	0	0	0	0
5918.6	96	0	0	1	1	1	0	0	0	0	0
5919.6	92	0	0	2	3	3	0	0	0	0	0
5920.1	96	0	0	3	1	1	0	0	0	0	0
5920.5	88	4	0	6	1	1	0	0	0	0	0
5920.7	95	0	0	3	1	1	0	0	0	0	0
5921.1	94	0	0	5	0	0	0	0	0	0	0
5921.6	88	2	0	8	1	1	0	0	0	0	0
5922.1	93	0	0	6	1	1	0	0	0	0	0
5923.0	93	0	0	5	1	1	0	0	0	0	0
5924.0	84	0	2	11	1	2	0	0	0	0	0
5925.3	35	9	0	12	0	4	0	3	28	0	10

Qtz- Quartz
Ank- Ankerite
Ill- Illite
K-Fld- Potassium Feldspar
Sid- Siderite
Kao- Kaolinite
Cal- Calcite
Pyr- Pyrite
Chl- Chlorite
Dol- Dolomite
Mont- Montmorillonite

APPENDIX IV

Lithofacies Classification

BEAVER DAM, CARROLL COUNTY, ARKANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Sample	Depth	Formation	Arenite	Wacke	Shale
Core 19.0	15.0	Sylamore	X		
Float	2.0	Sylamore	X		
Float	3.0	Sylamore	X		
Float	4.0	Sylamore	X		
Road Cut	1.0	Sylamore	X		
Road Cut	2.0	Sylamore	X		
Road Cut	3.0	Sylamore	X		
Road Cut	4.0	Sylamore	X		

WILLIAM H. DAVIS: COX #1, GRANT COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
5914.0	Misener	X		
5915.0	Misener	X		
5916.0	Misener	X		
5917.0	Misener	X		
5918.0	Misener	X		
5919.0	Misener	X		
5920.0	Misener	X		
5921.0	Misener	X		
5922.0	Misener	X		
5923.0	Misener	X		
5924.0	Misener	X		
5926.0	Misener	X		
5927.0	Misener	X		
5928.0	Misener	X		
5929.0	Misener	X		
5930.0	Misener	X		
5931.0	Misener	X		

D&J OIL: DAISY 1-17, GRANT COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
5909.3	Wood/Mis		X	
5909.4	Wood/Mis		X	
5909.6	Wood/Mis		X	
5909.9	Wood/Mis		X	
5910.1	Misener	X		
5911.1	Misener			X
5911.2	Misener	X		
5912.0	Misener	X		
5913.0	Misener	X		
5914.0	Misener	X		
5915.0	Misener	X		
5915.4	Misener	X		
5916.1	Misener	X		
5917.0	Misener	X		
5918.0	Misener	X		
5919.0	Misener	X		
5920.0	Misener	X		

SHELL OIL: DUERKSON 1, HARVEY COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3486.0	Chatt			X
3486.2	Misener		X	
3486.4	Misener		X	
3486.8	Misener	X		
3487.0	Viola			

COMMONWEALTH: FARBER 1-A, SEDGEWICK COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3534.0	Chatt			X
3534.6	Chatt			X
3534.8	Chatt			X
3535.0	Misener	X		
3536.0	Misener	X		
3539.4	Misener	X		
3540.0	Misener	X		
3541.0	Misener	X		
3541.4	Simpson			
3542.0	Simpson			

MABEE-SHELL: FRIESEN 5, McPHERSON COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3479.0	Misener		X	
3479.5	Misener		X	
3480.0	Misener	X		

WESTERN PETROLEUM: HOFFMAN 1, EDWARDS COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
4537.0	Chatt			X
4538.0	Chatt			X
4539.0	Chatt			X
4541.6	Misener		X	
4543.0	Misener		X	
4546.0	Misener	X		
4548.0	Misener	X		
4549.0	Misener	X		
4551.0	Viola			

FCD: MARY A1, GARFIELD COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
6385.0	Wood/Mis		X	
6385.5	Misener		X	
6390.0	Misener	X		
6393.0	Mis/Wood			X
6397.0	Misener	X		
6402.0	Misener	X		
6406.0	Misener	X		
6413.0	Mis/Wood			X
6421	Misener	X		
6422.3	Misener	X		
6428.0	Misener	X		
6430.0	Misener	X		

MABEE-SHELL: NIKKEL 5B, McPHERSON COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3467.0	Misener		X	
3468.0	Chatt			X
3468.6	Misener	X		

FCD: ROBERTS 1-18, GARFIELD COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
6392.0	Misener			X
6397.2	Misener	X		
6399.0	Misener	X		
6404.0	Misener	X		
6406.0	Misener	X		
6415.0	Mis/Wood			X
6419.0	Mis/Wood			X
6421	Misener	X		
6427.0	Misener	X		
6436.3	Misener	X		
6438.0	Misener	X		
6440.0	Misener	X		
6440.4	Misener	X		

DERBY: SPERLING 1, HARVEY COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3484.0	Misener		X	
3485.0	Misener		X	
3494.0	Viola			

SHAFFER: STEELE 1, HARVEY COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3347.0	Chatt			X
3347.6	Misener		X	
3347.9	Misener	X		
3348.0	Misener	X		
3349.0	Misener	X		
3350.0	Misener		X	

D&J OIL: SUNFLOWER 1-8, GRANT COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
5908.9	Woodford			X
5910.6	Woodford			X
5911.6	Misener	X		
5912.5	Misener		X	
5913.4	Misener	X		
5914.6	Misener	X		
5915.8	Misener	X		
5916.4	Misener	X		
5917.3	Misener	X		
5918.1	Misener	X		
5918.6	Misener	X		
5919.6	Misener	X		
5920.1	Misener	X		
5920.5	Misener	X		
5920.7	Misener	X		
5921.1	Misener	X		
5921.6	Misener	X		
5922.1	Misener	X		
5923.0	Misener	X		
5924.0	Misener	X		
5925.0	Sylvan			

TENNECO: SWEN 1-16, OKLAHOMA COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
6448.0	Gran Wsh			
6453.0	Woodford			X
6454.6	Woodford			X
6458.0	Misener	X		
6459.0	Misener	X		
6461.5	Misener		X	
6462.0	Misener	X		
6462.8	Misener	X		
6463.0	Misener	X		

D&J OIL: WADE 1-8, GRANT COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
5900.8	Misener		X	
5901.0	Misener	X		
5902.0	Misener	X		
5903.0	Misener	X		
5904.0	Misener	X		
5905.0	Misener	X		
5906.0	Misener	X		
5906.9	Misener	X		
5908.0	Misener	X		
5909.0	Misener	X		
5910.0	Misener	X		
5911.0	Misener	X		
5911.9	Misener	X		
5912.6	Misener	X		
5913.5	Misener	X		
5914.8	Misener	X		
5915.9	Misener	X		

AMERADA: WILSON 1, RENO COUNTY, KANSAS

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
3595.6	Chatt			X
3596.2	Misener		X	
3599.0	Misener	X		
3602.0	Misener	X		
3603.0	Misener		X	
3604.4	Misener	X		
3605.0	Misener	X		
3606.0	Viola			

FEDERAL PETROLEUM: WOLLESON 1, NOBLE COUNTY, OKLAHOMA

Thin Section: Sample Lithofacies

Increasing Water Depth →

Depth	Formation	Arenite	Wacke	Shale
5083.0	Misener	X		
5088.0	Misener	X		
5093.4	Misener	X		
5098.0	Misener	X		
5099.6	Misener	X		
5105.2	Misener	X		
5107.0	Viola			

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