DEPOSITIONAL ENVIRONMENTS, PETROGRAPHY, AND DIAGENESIS OF THE MIDDLE TO UPPER DEVONIAN MISENER SANDSTONE IN NORTH-CENTRAL OKLAHOMA

By

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PREFACE

The purpose of this study is to delineate factors which affect the distribution and petrologic constituency of the Misener Sandstone in north-central Oklahoma.

I would like to offer my sincere thanks to Dr. Zuhair Al-Shaieb, who served as my principle thesis advisor and offered constructive guidance with respect to petrographic and diagenetic aspects of the problem. Dr. Douglas Kent and Dr. Stan Finney also provided critical review of the work, and their participation is appreciated. Constructive discussion from Mr. Richard Fritz was also very helpful and is appreciated.

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CHAPTER I

INTRODUCTION

The present strategy for hydrocarbons in the Mid-Continent Province of the United States is determined by technological advances, economic climate, and intensity of past exploration and production in the region. The initial discovery of hydrocarbons in the area occurred late in the 19th century, and changes in the above factors have influenced the petroleum industry in terms of both the methodology used in exploration and the type of reservoir commonly targeted. The majority of large accumulations associated with structural trapping are thought to have been found, thus necessitating exploration for more subtle structural and stratigraphic hydrocarbon reservoirs.

In parts of north-central Oklahoma, the Misener Sandstone (Middle to Upper Devonian) exhibits many of the qualities associated with excellent hydrocarbon reservoirs in terms of porosity and permeability. Difficulty encountered in exploration for the Misener, however, stems from its erratic distribution and complex depositional setting.

It is apparent that the search for the Misener, as with most reservoirs, involves an element of risk, but if prolific Misener production can be located, it should provide an excellent return on the initial investment. An approach to an exploration program should be aimed at reducing the risk involved through utilization of a carefully planned strategy, and it is the intent of this study to provide information which can be applied to such an endeavor.

The thesis area includes parts of Grant County, Garfield County and Noble County in north-central Oklahoma (Figure 1). Data examined in this study were derived from scouting information, electric logs, and available cores. Data from Sunray DX Corporations's Mount Kilcrease Unit No. 1 well located in Section 36 of T5N R7E of Pontotoc County, Oklahoma, were incorporated into this study. This information is useful for reasons which will be covered in more detail in a later chapter dealing with depositional setting.

Methods and Objectives

The intent of this project is to provide useful and accurate information with respect to the distribution, depositional environment, and diagenetic overprint of the Misener Sandstone in north-central Oklahoma. In the study area, the base of the Misener, where present, is unconformable with strata of the Hunton Group (Siluro-Devonian), the Sylvan Shale (Upper Ordovician), and the Viola Limestone (Middle to Upper Ordovician). The Woodford

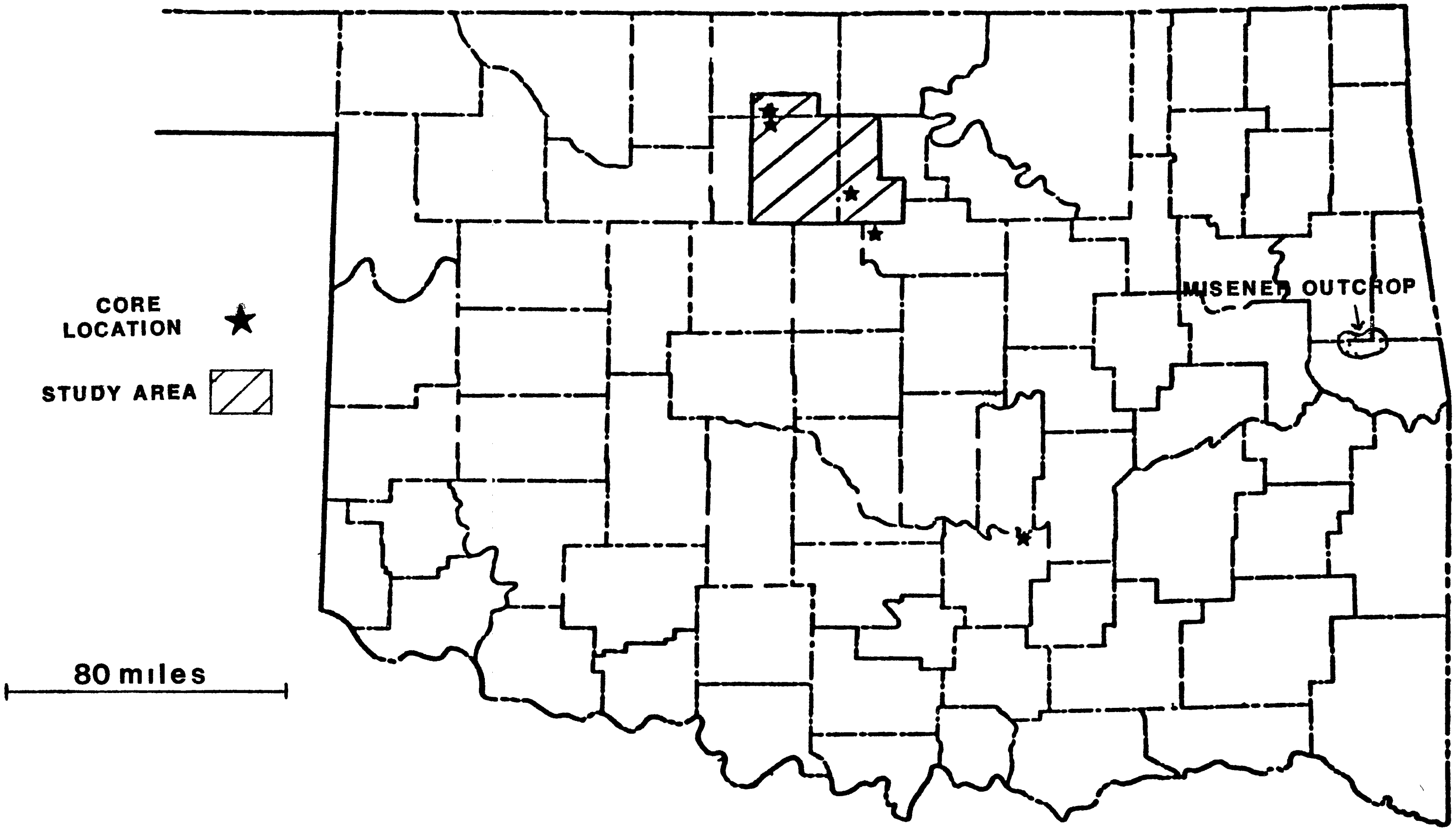


Figure 1. Location Map of the Study Area

Shale (Late Devonian to Early Mississippian) covers the Misener when it is present and the unconformity when the Misener is not present. The Misener is thought to be a basal unit of the Woodford Shale, thus the two are probably genetically related (Amsden and Klapper, 1972).

This study attempts to deal with the Misener Sandstone on a regional scale with emphasis on the following aspects of the problem:

1. Determination of the depositional environment of the Misener within the thesis area.
2. Determination of the diagenetic overprint of the Misener within the the thesis area.
3. Inferences regarding the provenance of the Misener in north-central Oklahoma.

Information gained from data analyses was applied to the construction of the following items:

1. Ten cross-sections with an index map showing the Woodford/Misener-Sylvan interval.
2. Core descriptions to aid in the determination of depositional environment.
3. A Misener sandstone distribution map.
4. Paleogeologic diagrams at times both prior to and contemporaneous with Misener deposition.
5. Inferences regarding the diagenetic overprint of the Misener Sandstone based on petrographic data.

Previous Works

The Misener trends northwest-southeast through north-central Oklahoma (Amsden and Klapper, 1972) (Figure 2). "The name 'Misener' was first applied to a sandstone in the subsurface of Creek County (Oklahoma)...and was named after Fred D. Misener, a Tulsa oil operator..." (Amsden and Klapper, 1972, p. 2323). The sand was interpreted as being an eolian deposit by White and Green (1924), who described it as a light-blue, sandy calcareous shale seen in an area from Okmulgee County to Osage County.

The Keskuk Pool in Seminole County, Oklahoma, was the subject of a paper by Rau and Ackley (1939). They characterized the Misener reservoir facies as a medium-fine to medium-grained, subrounded to rounded sandstone. They also indicate that the sand is well sorted and cemented and shows good porosity (10%) and permeability (75.9 millidarcies).

Borden and Brant (1941) characterized the Misener as a nearshore marine sand. This interpretation, based upon data from the East Tuskegee Pool in Creek County, Oklahoma, conflicts with the previously hypothesized eolian depositional processes. Borden and Brant (1941) correlated upper and lower Misener sections with the Sallisaw Formation and the Frisco Limestone (Lower Devonian), respectively, in eastern Oklahoma, and Amsden (1961) reported an Ulsterian fauna from the Misener

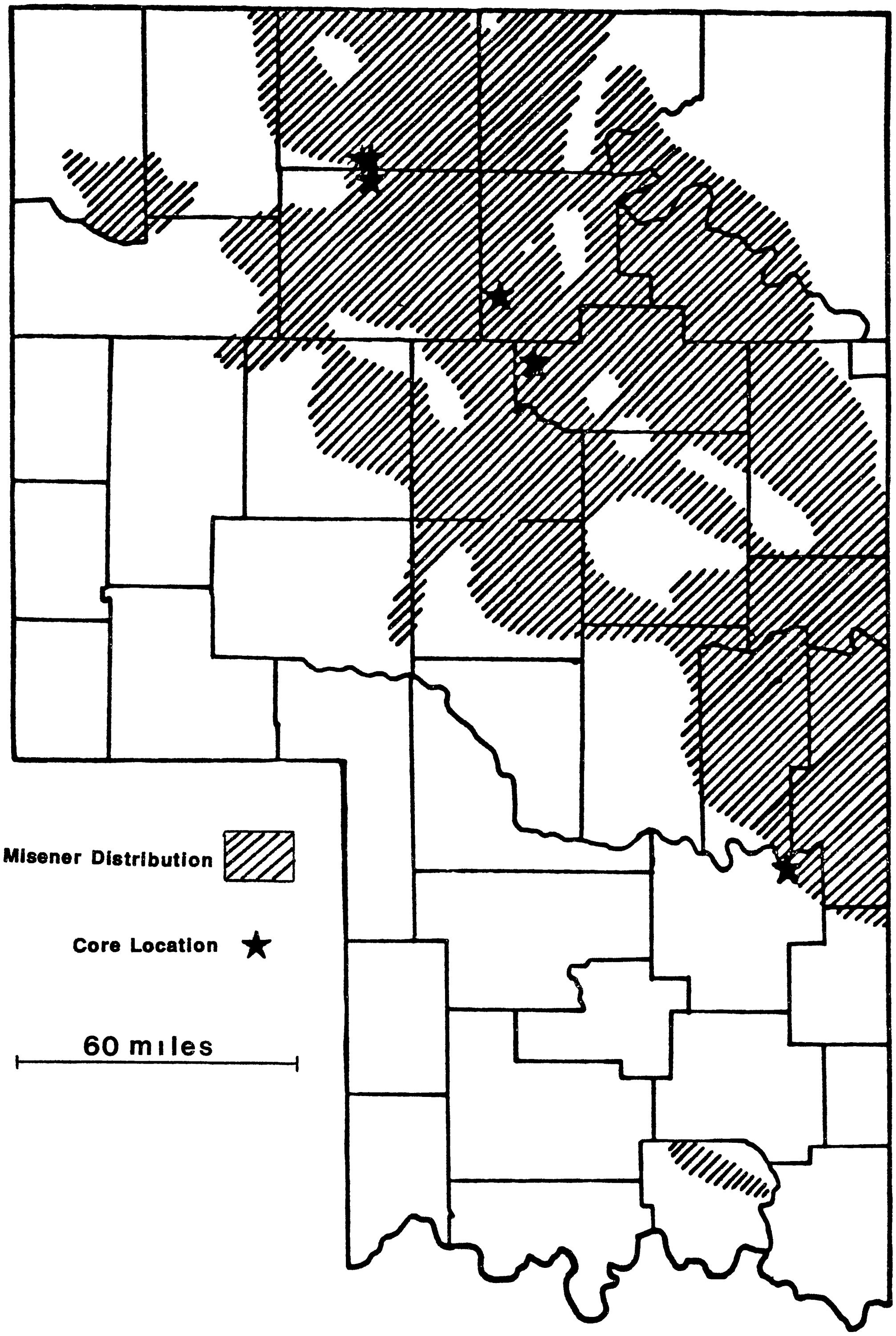


Figure 2. Distribution of the Misener Sandstone in Central Oklahoma (After Amsden and Klapper, 1972)

(Sylamore) in eastern Oklahoma. Cram (1930) assigned the name Sallisaw Sandstone to exposures of a calcareous sandstone of earliest Middle Devonian age which outcrops near Marble City, Oklahoma. Amsden (1961) then concluded that, while identification of the Ulsterian fauna was correct, the assignment of the strata to the Sallisaw was erroneous. The strata examined by Cram is actually of the Sylamore sandstone, not the Sallisaw as Cram had proposed. This mistake may have been the reasoning behind Borden and Brant's (1941) correlation scheme, which is also thought to be incorrect (Amsden and Klapper, 1972).

Amsden and Klapper (1972) correlated the Woodford/Misener sequence to the Chatanooga Shale/Sylamore Sandstone sequence of Eastern Oklahoma and Arkansas and adopted the names Woodford Shale and Misener Sandstone for these units. This nomenclature will be adhered to in this study.

Amsden and Klapper (1972) described the Misener as being composed of rounded, detrital quartz grains with a matrix of crystalline dolomite, which grades into crystalline dolomite with a few scattered quartz grains. They attributed deposition of the Misener to shallow marine processes occurring along a shoreline made up of emergent Hunton strata.

Kochick (1976) proposed four interpretations of depositional processes of the Misener in eastern Payne and northeastern Logan Counties of north-central Oklahoma. He concluded that the Misener was originally deposited as an alluvial sand that was later reworked by shallow marine processes as a transgression occurred. This provided a situation in which a lower alluvial sand could be overlain by an upper marine sand in one locality.

Baurnfiend (1980) conducted a study on the Misener in parts of Lincoln and Creek Counties. He also attributes deposition to both fluvial and shallow marine processes, although he doesn't discuss any overlapping of the two in his area. He concluded that the provenance for the sand was the emergent Cushing Ridge, which is located in his study area. Baurnfiend (1980) proposed that strata of the Ordovician Simpson Group was also the source of the sand. This idea is consistent with that of Amsden and Klapper (1972) who also condlude that erosion of the Simpson in northeastern Oklahoma provided detritus for the Misener in north-central Oklahoma.

Mansfield (1985) and Busanus (1985) recently studied the occurrence of the Misener in the Kremlin area of northern Garfield and southern Grant Counties. Mansfield attributes deposition of the Misener to shallow marine processes which were tidally influenced. Busanus (1985) proposes a depositional model in which the sand was deposited in strike valleys on an unconformity surface, which became drowned valleys as marine transgression proceeded.

The Misener in Outcrop

The Misener (Sylamore) Sandstone outcrops in Cherokee County, Oklahoma (Figure 1). As described by Huffman (1958), it is a light colored "salt and pepper" sand, made up of dark, phosphatic and light quartzitic grains and dolomite crystals. Distribution in the area is erratic, and the maximum thickness is 18 feet in Section 29 T14N R24E. Fossil fragments are common and consist of brachiopods of the genus Lingula, "spirifer" fragments, and wood fragments (Huffman, 1958).

The sand also outcrops in north-central and northwestern Arkansas and is usually one to two feet thick. The Misener in these locations was probably deposited under shallow marine conditions as evidenced by its large skeletal fragment constituency and clean, well sorted appearance (Figures 3 & 4).

Figure 3. Outcrop Photograph of the Misener Sandstone

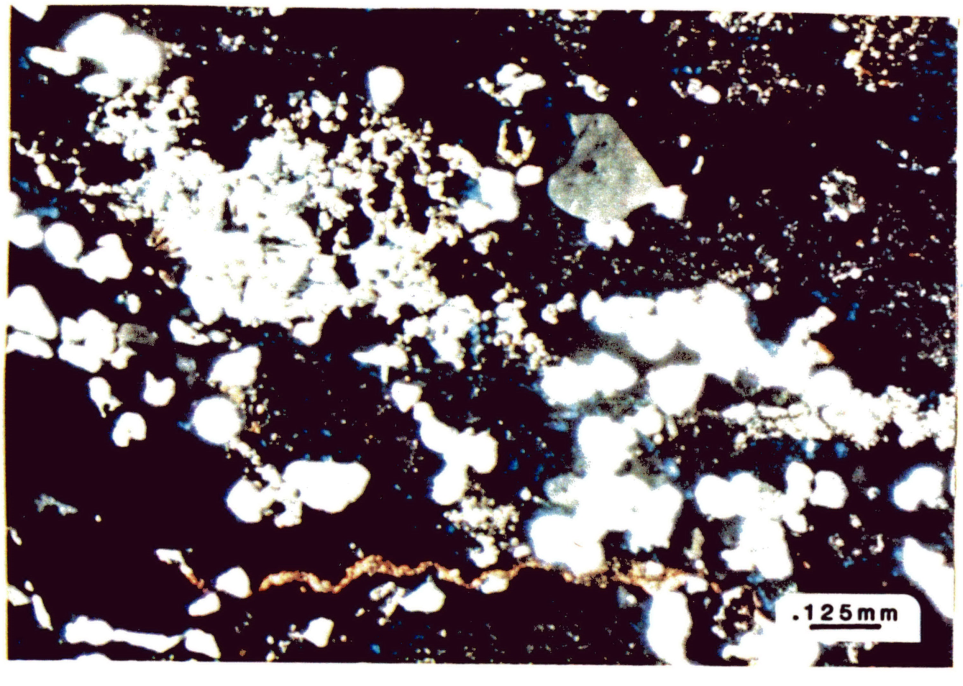


Figure 4. Photomicrograph of the Misener (Sylamore) Sandstone From Northwestern Arkansas; Cross Polarized

CHAPTER II

REGIONAL GEOLOGY

Stratigraphic Framework

The determination of the stratigraphic framework was an integral part of this study, as it aided in the interpretation of the processes which resulted in deposition of the Misener. Discussion of stratigraphic units within the study area has been limited to Kinderhookian and earlier units and concentrates on those formations which are directly related to the problem (Figure 5). Information for this chapter was obtained through the construction of stratigraphic cross-sections and from previous works.

Pre-Cambrian Rocks

Characterization of Precambrian rocks in north-central Oklahoma is difficult due to the limited number of well-bore penetrations into this section. The tendency of drillers to call any igneous rock penetrated a 'granite', has resulted in very little knowlege of the petrographic nature of the north-central Oklahoma Precambrian igneous complex (Jones, 1960).

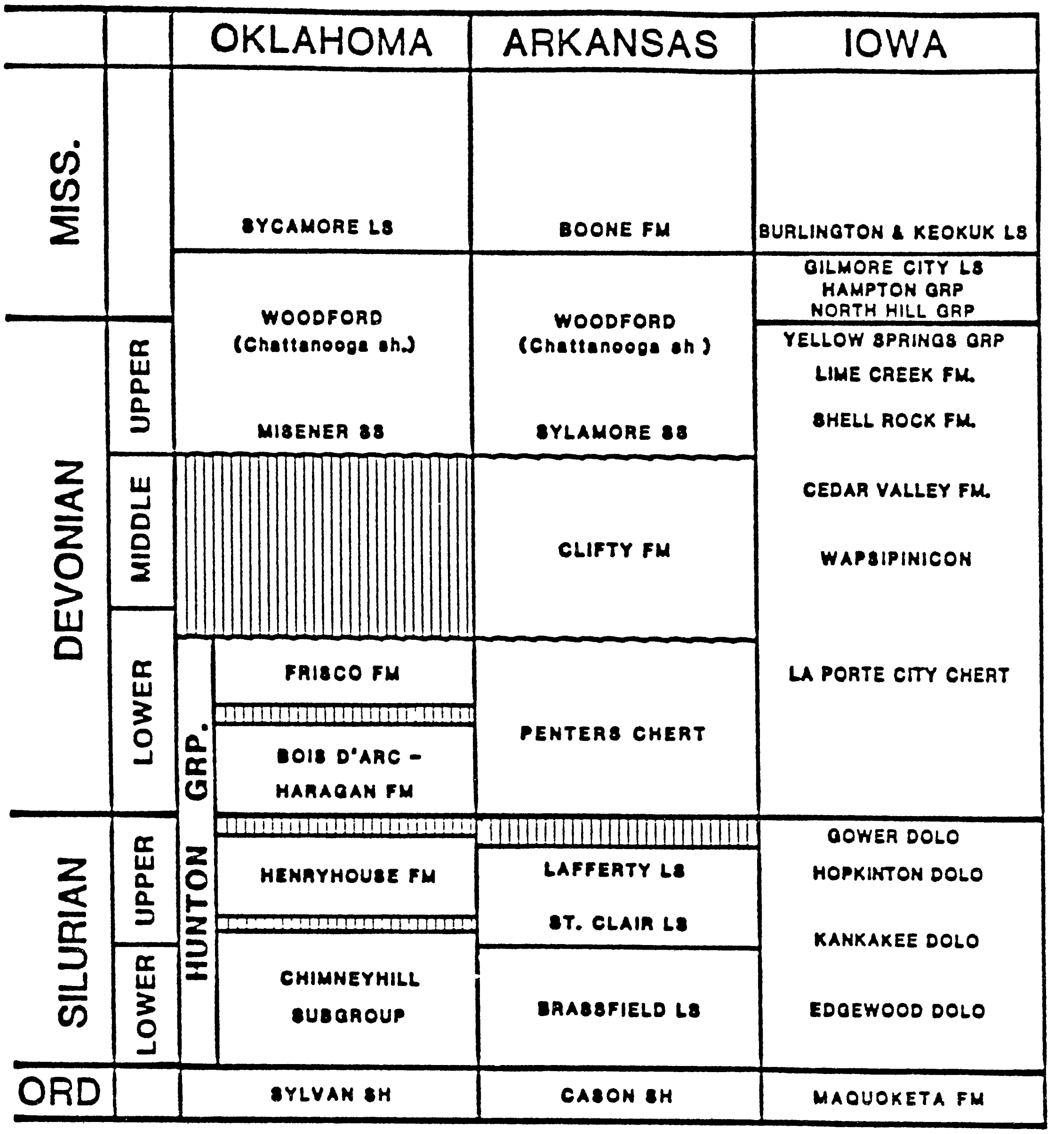


Figure 5. A Stratigraphic Column of the Formations of Interest in Oklahoma and Relationship of this Nomenclature to that of Arkansas and Iowa (After Chenoweth, 1983)

Cambrian System

Reagan Sandstone. The Reagan Sandstone, like the Precambrian rocks, has been rarely penetrated in the thesis area. In a paper by Stringer (1956), the Reagan is described as a white, fine to coarse-grained, dolomitic sandstone interbedded with gray, sandy crystalline dolomite. The base of the sand is unconformable with Precambrian rocks and it is conformably overlain by the Arbuckle Group.

Cambro-Ordovician

Arbuckle Group. The Arbuckle Group is the thickest of all pre-Desmoinesian sediments present in north-central Oklahoma. Thickness range from 500 feet or less in Osage County, to nearly 2000 feet in Canadian County (Jones, 1960). Carey (1955) characterized the top of this group in the Garber Field area as a tan to brown, porous dolomite. The Arbuckle is unconformably overlain by the Simpson Group in the thesis area.

Ordovician System

Simpson Group. The Simpson Group is present throughout the study area in the subsurface and is thought to be a source of detritus for the Misener in north-central Oklahoma. The group consists of repeating sequences of interbedded massive sandstones, thin bedded shales, and limestones. The Simpson Group includes, in ascending order, the Joins Formation, the Oil Creek Formation, the McLish Formation, the Tulip Creek Formation, and the Bromide Formation (Harris, 1957). Baurnfiend (1980) subdivides the Bromide into five members which are, in ascending order, (1) the Second Wilcox Sand (also known as the Second Bromide); (2) the Marshall Zone; (3) the First Wilcox Sand (also known as the Simpson Sand), (4) the Simpson Dolomite, and (5) the Simpson Dense".

Viola Group. The Viola Group is made up of two units, the Viola Springs Formation and the Welling Formation but will be referred to collectively as the Viola in this thesis. It has been described as a white to gray colored, coarsely crystalline limestone with scattered pink calcite crystals (Baurnfiend, 1980).

Sylvan Shale. The Sylvan Shale is light-green and commonly contains pyrite, as well as dolomitic intervals. The Sylvan is present in much of the study area, and is overlain by the Hunton Group, if the Hunton is present, and by the Misener/Woodford sequence if the Hunton has been eroded.

Siluro-Devonian

The Hunton Group is the youngest unit beneath the pre-Woodford unconformity in north-central Oklahoma. The group has been divided into five units: (1) the Chimney Hill Subgroup; (2) the Henryhouse Formation; (3) the Haragan

Formation, (4) the Bois d' Arc Formation, and (5) the Frisco Formation. Thickness of the Hunton within the thesis area is variable, and drastic changes of greater than 300 feet in thickness over a short lateral distance were observed along the western edge. This thickening trend is thought to correspond to the hingeline of the Great Basin of the Mid-Continent which was present during Hunton deposition and will be discussed further in a later section of this work (Crumme, 1969).

Middle to Upper Devonian

Misener Sandstone. The Misener was deposited on what is commonly called the pre-Woodford unconformity surface in north-central Oklahoma. Data from this study indicate that the sand was extensively altered by processes of dissolution and/or replacement of much of the original detrital constituency by carbonate cement. This replacement is not uniform, however, with variations noted in some of the individual cores which were examined. The resultant lithotypes will be discussed in the petrologic chapter of this work.

Earlier interpretations were cited in the previous works in Chapter I and will not be repeated. One should note, however, that the Misener/Woodford sequence is interpreted as being diachronous, thus occupying different positions in time with respect to lateral dimensions, as would be expected in a transgressive marine setting.

"Pre-Woodford Shale". This unit is thought to be correlative with the Misener in north-central Oklahoma. It was noted in two wells in T20N R6W and is characterized as a comparatively low-radioactivity, calcareous shale, and is thought to have been deposited in karst features on the Hunton subcrop.

Upper Devonian to Lower Mississippian

Woodford Shale. The Woodford Shale is a black to dark gray shale which is relatively hard and contains pyrite and chert. The Woodford blankets much of the surface which was exposed during Acadian tectonism and has an unconformable basal contact with the Hunton Group, Sylvan Shale, Viola Limestone, and Simpson Group in the study area, but is conformable with the Misener sandstone.

Mississippian

Kinderhook Limestone Member. The Kinderhook Limestone is the basal limestone member of the Mississippi Limestone Formation. The basal section of this lime is characterized by one and sometimes two limestone beds which are easily picked on well logs. The Mississippi Limestone is described as a series of interbedded argillaceous limestones and interbedded calcareous shales (Pulling, 1976).

Ten stratigraphic cross-sections were constructed across the study area to aide in establishing a stratigraphic framework and in making well to well correlations. Orientation and labeling of these cross sections are exhibited in Plate I, an index map of the study area. The datum for these cross sections is the base of the Kinderhook limestone, and the Viola limestone is the base of the interval of interest of the cross sections. It should be noted that cross section A - A' extends to the north of the study area, but was included in this work because it shows a less incised channel morphology than cross sections to the south.

An attempt was made to use log suites which included gamma ray and resistivity logs which penetrated the top of the Viola limestone, as these are most useful in correlation from well to well. This was possible in the majority of the wells, however, eleven of the 117 log suites utilized do not penetrate the Viola Limestone and seven do not have resistivity logs.

Southwest to Northeast Cross Sections

Cross section A-A' (Plate II) contains nine logs from wells located in the northern and northwestern parts of the study area. This cross section indicates a thinning of the Sylvan Shale to the northeast. The Misener is present in two wells at the expense of the Sylvan Shale, and the thickening of the Woodford/Misener interval relative to thinning of the Sylvan in these wells supports the hypothesis that the Misener was deposited on topographic lows in this area.

Cross section B-B' (Plate III) is located to the south and east of cross section A-A' and passes through the Kremlin area. The striking feature of this cross section is the development of a thick Misener interval which appears to be a channel fill type of sand. This cross section, like A-A', shows that the Misener thickens at the expense of the Sylvan Shale. It differs from A - A', however, in that it expressed a much more incised channel. This may relate to input of erosive energy from the northeast and west at a greater rate near the Kremlin area than was present to the north.

Cross sections C-C' and C'-C" (Plates IV & V) extend across the south-central part of the study area. The Misener is present as a continuous, thin unit (8-10') across much of the Sylvan subcrop and thickens, again at the expense of the Sylvan, near the Viola subcrop. Cross section C'-C" extends well onto the Viola subcrop with detection of the Misener in the Billings area. This sand is also 8-10' thick, but appears to exist coincident with a thinning of the overlying Woodford shale's thickness.

Cross sections D-D' and D'-D" (Plates VI & VII) also indicate Misener occurrence at the expense of the Sylvan Shale. The erosional processes appear to be most pronounced in cross section D-D' as it progresses across the Sylvan subcrop along the southern edge of the study area. It is evident that erosion exposed the Viola as far west as Thetis Energy's Wehling No. 12-1 well in section 12 of T20N R6W. The corresponding thickening of the Woodford/Misener interval is dominantly expressed in the Woodford possibly indicating a limited sand supply for this system. Cross section D'-D" extends well onto the Viola subcrop, and the presence of the Misener near Perry is characterized by an increase in the Woodford/Misener interval, indicating a possible channel cut surface on the Viola which was not detected in cross section C'-C".

Northwest to Southeast Cross Sections

Cross sections E-E' and E'-E" (Plates VIII & IX) are located in the west-central part of the study area predominantly within the Sylvan subcrop. The Misener is present in many of the wells as a thin, discontinuous sand occurring at the expense of the Sylvan Shale. As the Kremlin area is encountered, a narrow, thick Misener is detected. Cross section E-E' intersects with cross section B-B', in the Kremlin area, and supports the channel-like morphology which was interpreted for the Misener in cross section B-B'. A thinner Misener is encountered at the intersection of cross sections D-D' and E'-E" and has been discussed previously. The Sylvan thickness is variable in these cross sections, due to thinning over structural highs of the Viola, which indicates that a thinner Sylvan might not always coincide with a thicker Woodford/Misener sequence.

Cross section F-F' and F'-F" (Plates X & XI) are located in the eastern part of the thesis area. Cross section F-F' passes through the East Kremlin Field and indicates a well developed Misener which is geometrically similar to that encountered in the West Kremlin area in cross sections B-B' and E-E'. These cross sections also show Misener development at the expense of the Viola, and F'-F" shows evidence of a thick development of Misener near Perry which is similar to that seen near the Kremlin area.

It is apparent that relationships which were shown through the construction of these cross sections is helpful in the interpretation of processes which were responsible for deposition of the Misener.

Structural and Tectonic Framework

The Acadian Orogeny is thought to have played an important role in shaping the topography upon which the Misener-Woodford sequence was deposited in north-central Oklahoma. This tectonic event began in the last epochs of the Silurian , increasing in magnitude until Middle and Late Devonian time (Barrett, 1963). Regional tilting of only a few degrees in much of northern and eastern Oklahoma resulted, and truncation of strata of Silurian and pre-Silurian Age occurred (Barrett, 1963). A channel cut surface is thought to have existed contemporaneous with deposition of the Misener/Woodford sequence in much of Oklahoma and Arkansas, with both erosionally and structurally related lows serving as sites which were conducive to Misener deposition.

Such an interpretation is favored by Baurnfiend (1980) and Kochick (1976), both of whom interpreted a possible combination of fluvial and shallow marine processes as modes of deposition of the Misener in their thesis areas.

Further support for this interpretation is provided by Chenoweth (1983) who delineates an emergent surface to the northeast of the study area. "The Ellis-Chautaugua-Ozark-Pascola uplift originated in Middle Ordovician time (Adler, 1971) but was submerged, except for the St. Francois Mountains, during Middle Devonian time. A strong renewal and deep erosion of this feature occurred prior to Late Devonian deposition. At least several hundred feet of Late Ordovician, probably some Silurian, and Middle Devonian rocks were removed" (Chenoweth, 1983, p. 250). Figure 6 is a geologic map of the pre-Woodford unconformity surface in the southern Mid-Continent Region which reflects the extent of erosion as a result of regional tilting (Chenoweth, 1983).

To the west of the study area, the region which is presently known as the Anadarko basin is interpreted as having been a topographic and possibly structural high (Amsden, 1975). "Pre-Woodford stream channels are postulated to have run easterly along the part of the basin that is presently regarded as the 'deep' Anadarko" (Chenoweth, 1983, p. 253).

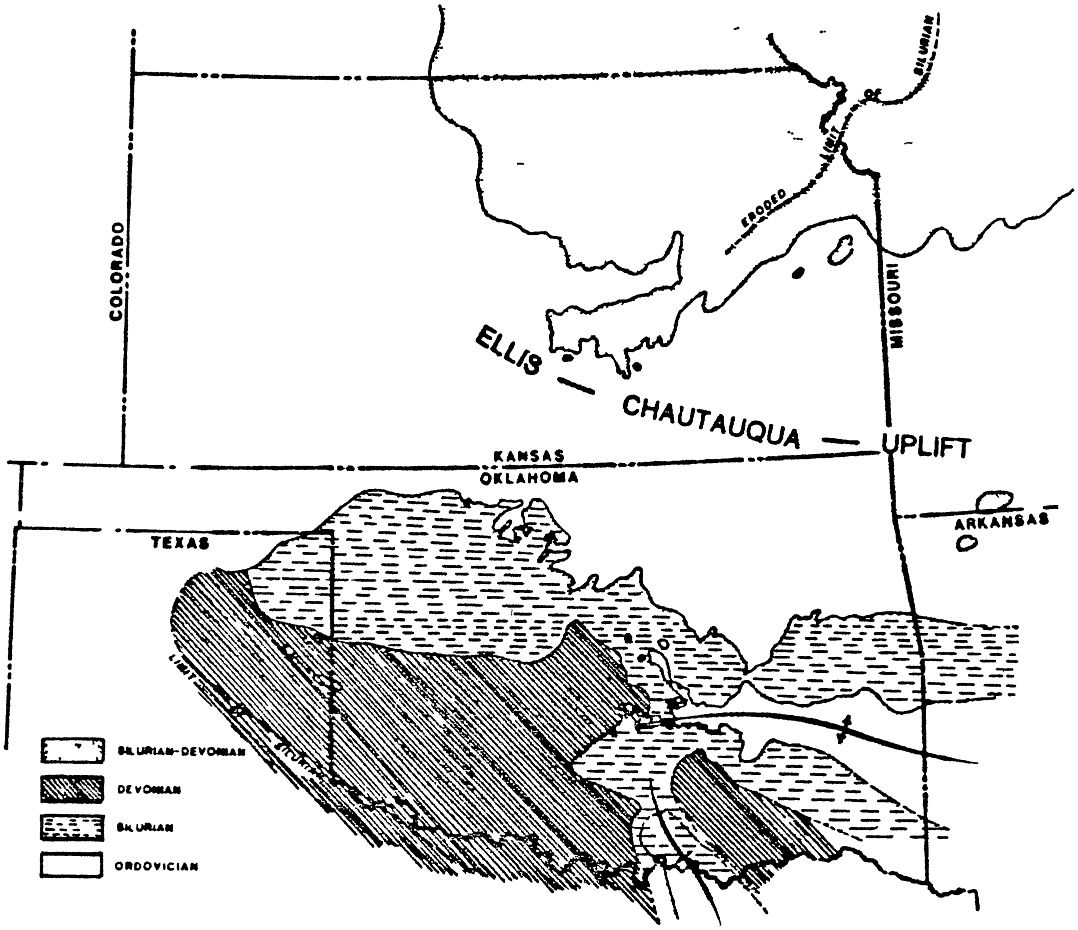


Figure 6. Geologic Map of the Pre-Woodford Unconformity Surface in the Southern Mid-Continent Region of the United States (After Chenoweth, 1983)

Consideration of the above information could allow one to hypothesize that the area selected for this study represented a depressed, northwest-southeast trending site upon which erosional processes were most pronounced (due to the subcrop of the Sylvan Shale), prior to deposition of the Misener-Woodford Sequence.

Regional tectonic provinces in Oklahoma are outlined in Figure 7. The study area is roughly bisected from North to South by the Nemaha Ridge and is bordered to the east by the Central Oklahoma Platform and to the west by the East shelf of the Anadarko basin. The Seminole-Cushing Ridge is located to the southeast.

The structural setting is depicted in a structural contour map on the top of the Viola Limestone (Figure 8). This map reveals regional dip to the southwest and local features include a large, faulted anticline upon which the Garber field has been established. Production in this area is predominantly from strata which are shallower than those with which this study is concerned. Faulting noted within the study area is thought to be related to the Nemaha Ridge, which is a basement feature extending northward into Kansas. Other structural features in the area are relatively small, both in terms of lateral extent and closure, but may be important components of potentially economic Misener reservoirs.

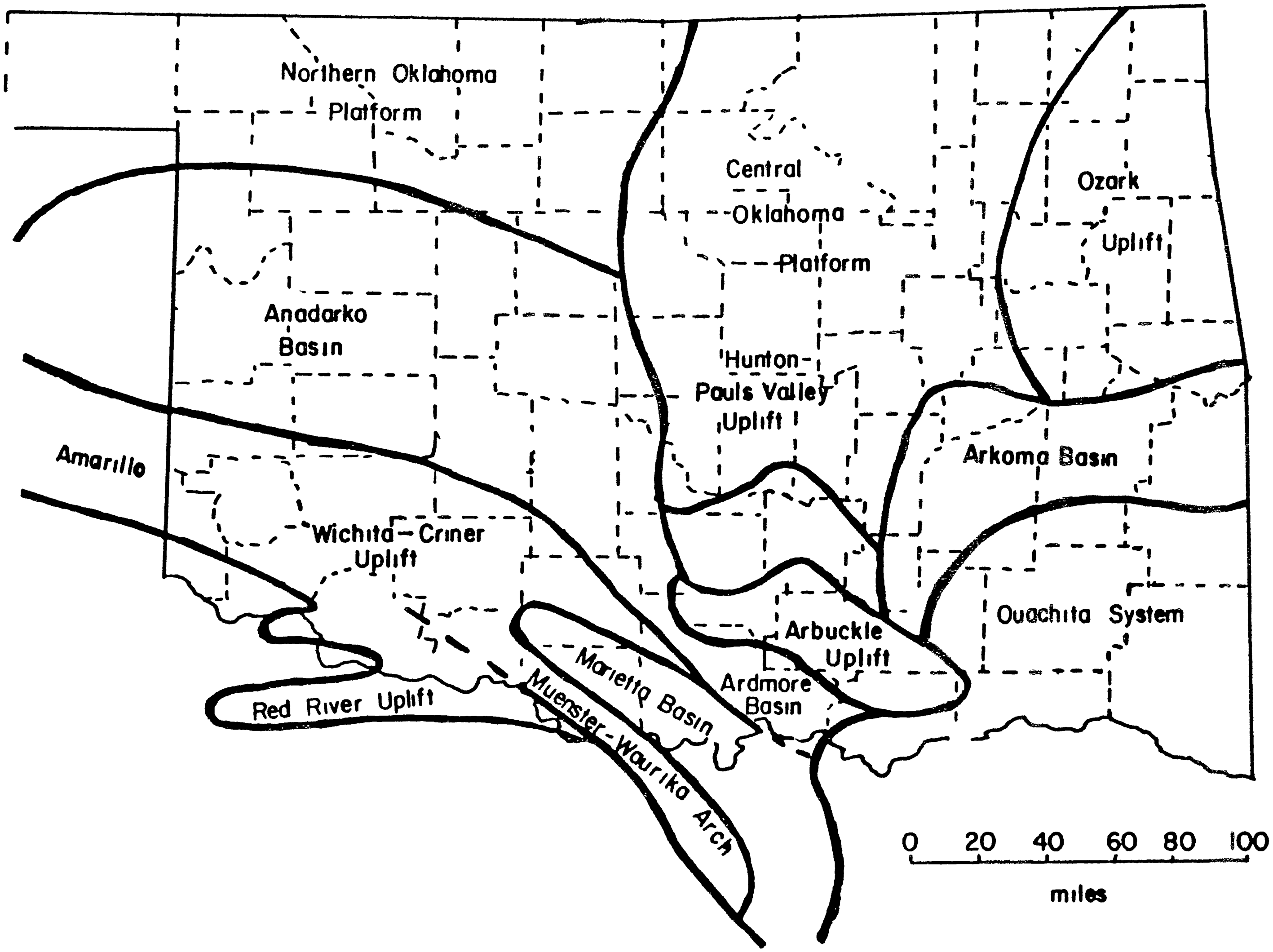


Figure 7. Major Geologic Provinces (After Al-Shaieb and Shelton, 1977)

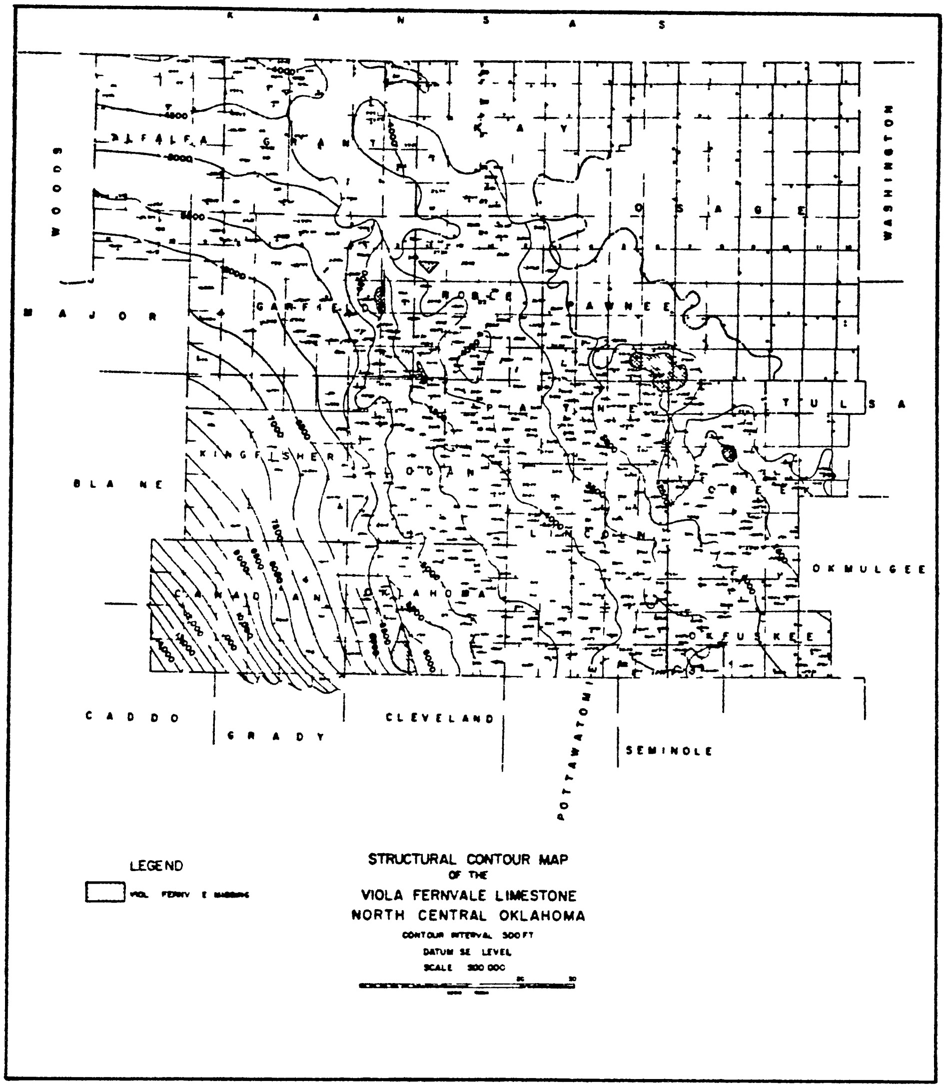


Figure 8. Structural Map of Much of North-Central Oklahoma Utilizing the Top of the Viola-Fernvale Limestone Unit as a Mapping Horizon (After Jones, 1960)

CHAPTER III

PETROLOGY

Lithologies

The Misener sandstone cores contain a consistent assemblage of detrital and diagenetic constituents. The problems encountered in a petrologic study of the sand are thought to be related to variations in the depositional setting which are reflected in the diagenetic overprint. Since detrital constituency is dominated by quartz, a standard Folkian QRF plot would not be satisfactory in studying variations in relative amounts of constituents. Therefore, it was determined that variation in the Misener is related to variations in percentages of detrital constituents versus secondary carbonate cement and a graph expressing this relationship has been prepared (Figure 9). This diagram delineates three lithologic types which characterize the Misener:

(1) Quartz arenite with varying amounts of dolomite

(2) Dolomite with varying amounts of detritus

(3) A combination of (1) and (2)

One should note, however, that changes between these

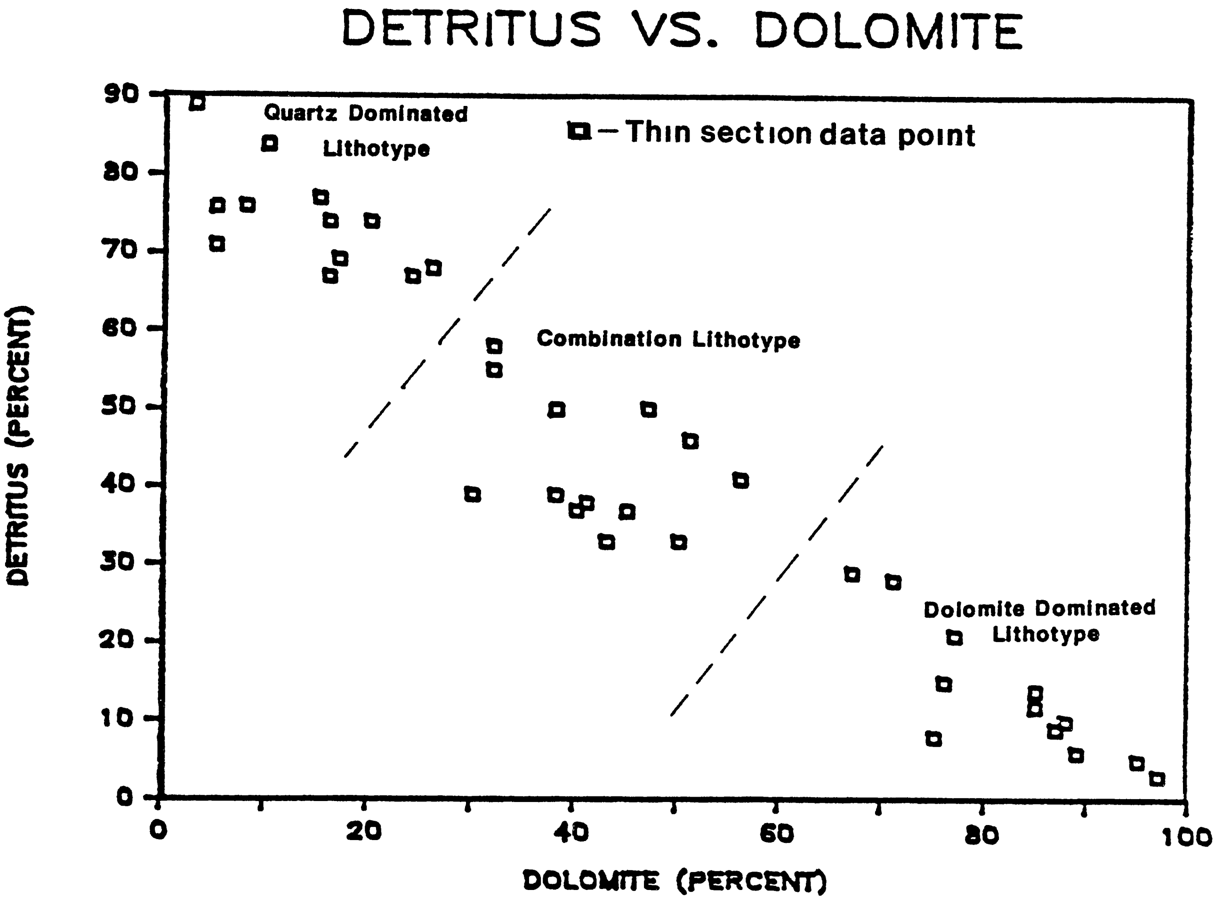


Figure 9. Graphical Relationship of Detritus Vs. Dolomite in the Misener Sandstone

three categories is transitional. Such relationships among lithotypes will be discussed in the diagenesis chapter of this work.

A petrolog and core description have been prepared for each of the cores utilized in this study. They are contained in the appendix.

The quartz arenites are generally fine to very fine grained and well sorted. The quartz grains are rounded and contain numerous quartz overgrowths. This lithotype contains varying amounts of detrital clay matrix up to eleven percent. Figures 10 and 11 are an example of this lithotype, which is present in the Gungoll and Associates Alice No. 3-12 core, the Amerada Richey No. 1 core, the Amerada Breckenridge No. 1 core, and the Gomoco Lawler No. 2-25 core.

The dolomites are commonly poorly crystalline and contain scattered quartz grains which exhibit varying degrees of corrosion on their edges. Detrital matrix and carbonaceous material appear to be displaced and may have inhibited crystal growth of the dolomite, which is usually subhedral to anhedral. This lithotype is noted in the Gomoco Lawler No. 2-25 core, the Amerada Richey No. 1 core, and the Amerada Breckenridge No. 1 core (Figures 12 and 13).

The combination lithotype is characterized by lack of dominance of either detrital or secondary constituents. It is made up of quartz which is analogous to that seen in the

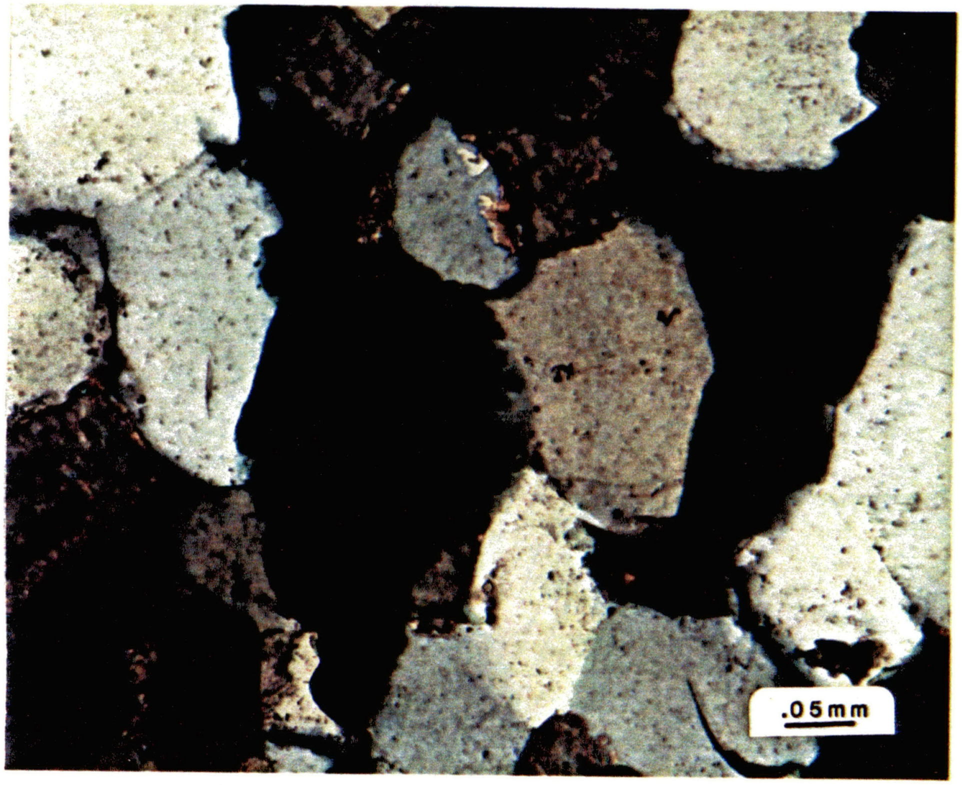


Figure 10. Photomicrograph of the Quartz Arenite Lithotype of the Misener Sandstone;Cross Polarized

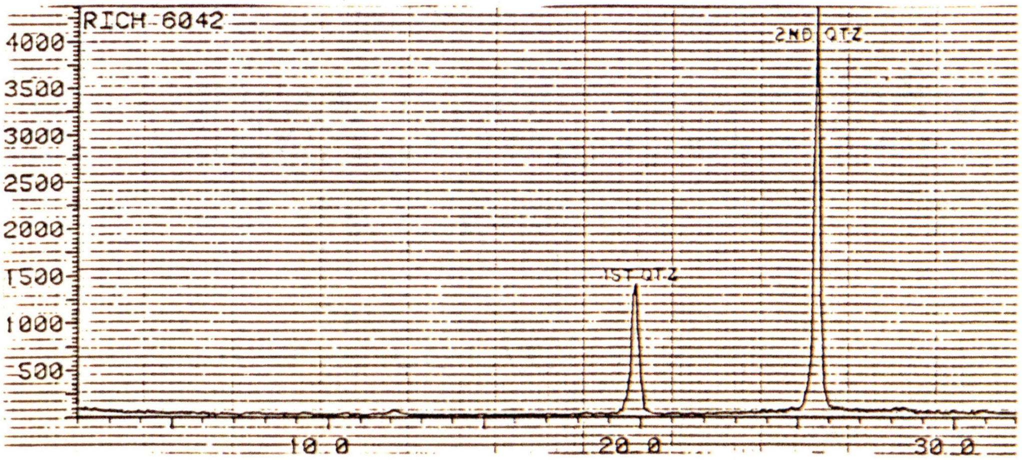


Figure 11. Associated X-Ray Diffraction Data

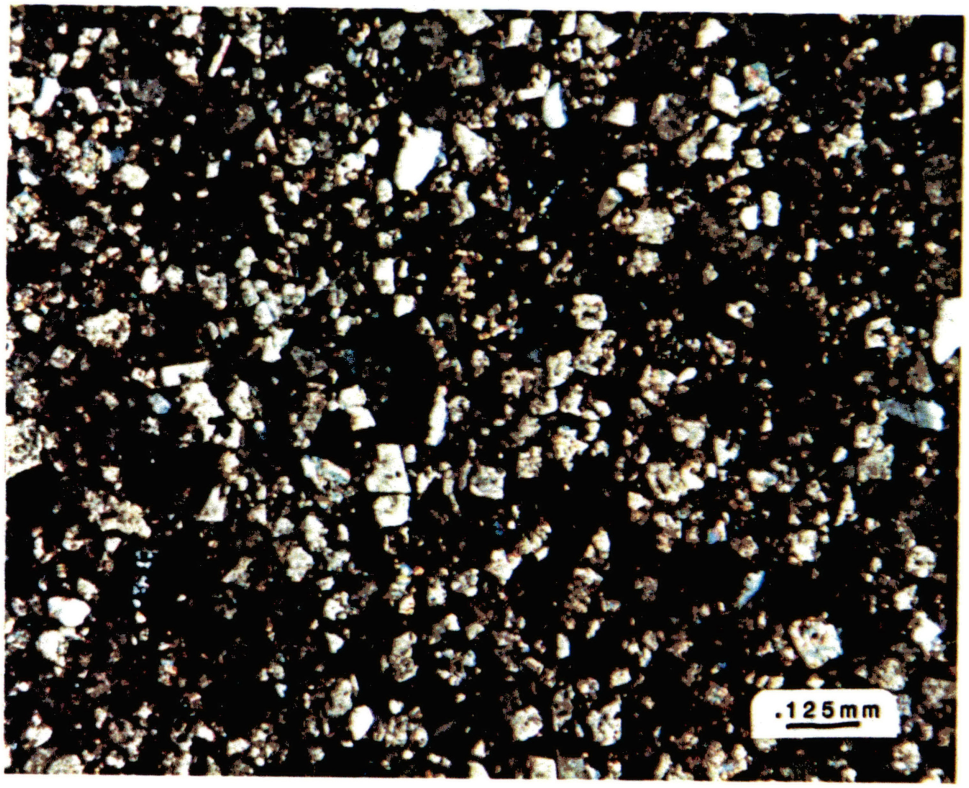


Figure 12. Photomicrograph of the Dolomitic Lithotype of the Misener Sandstone; Cross Polarized

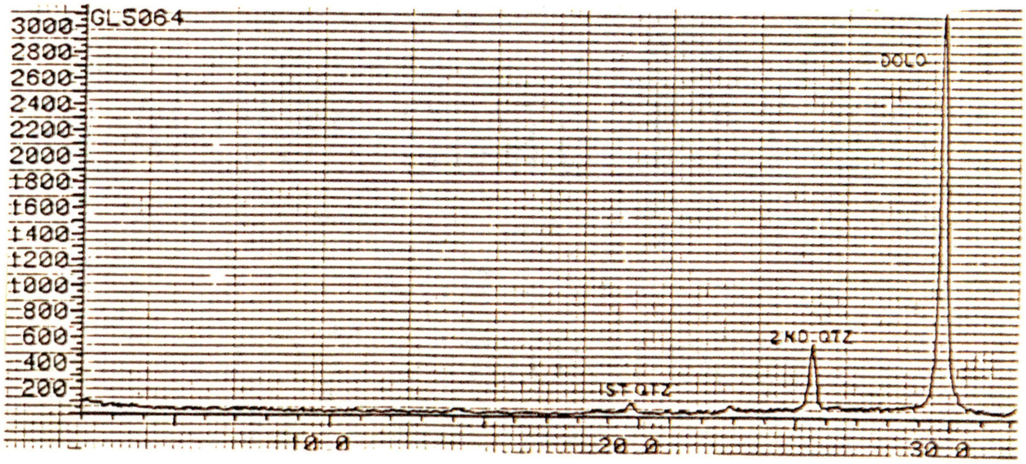


Figure 13. Associated X-Ray Diffraction Data

quartz arenites. The dolomite, however, is dominantly euhedral. These well formed rhombs are thought to be related to less interference of crystal growth as well as the presence of numerous quartz grains which provided a more rigid framework within which the dolomite crystals could precipitate. The Federal No. 1 Wolleson core, the Gomoco Lawler No. 2-25 core, and the Gungoll and Associates Alice No. 3-12 core show examples of this lithology which is represented in Figures 14 and 15.

Table I is a listing of constituent percentages for the previously described lithotypes.

Detrital Constituents

Quartz

Monocrystalline quartz comprises the majority of the Misener Sandstone lithotypes. Quartz grains range from coarse silt to fine sand grain size (.05-.15mm), are well rounded to subrounded, and in some cases, contain inclusions consisting of bubble trains of aqueous or gas filled varieties. Syntaxial quartz overgrowths are common in the Misener, and corrosion of the overgrowths and the quartz grains occurs when they are in contact with carbonate cement or enlarged secondary pore spaces (Figure 16). Polycrystalline quartz comprises no more than trace percentages in thin sections, and grain size is very fine sand (.06-.125mm).

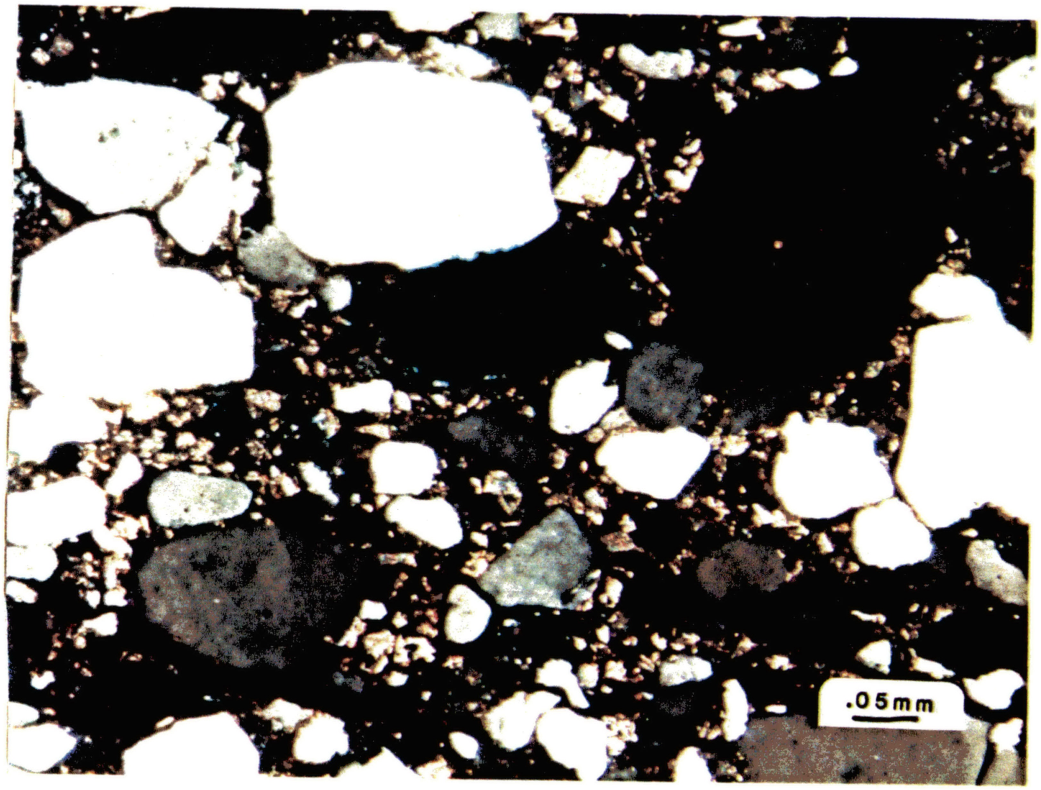


Figure 14. Photomicrograph of the Combination Lithotype of the Misener Sandstone; Cross Polarized

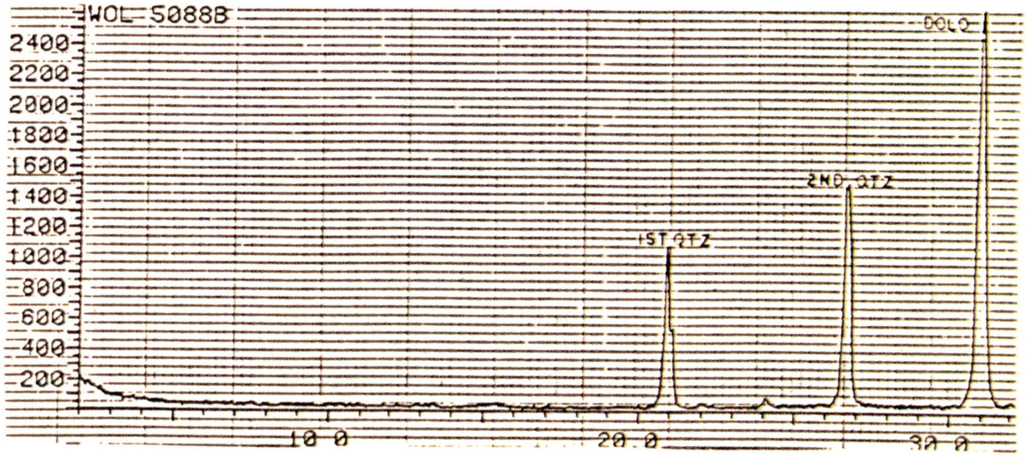


Figure 15. Associated X-Ray Diffraction Data

TABLE I

CONSTITUENT AVERAGES FOR LITHOTYPES

Well	No.	Depth	Qtz.	Dol.	RkFr.	Glac.	SkGr.	Cmt.	Mtx	Por
RICH	1	6039	64	17	1	3	2	4	0	8
RICH	2	6042	84	3	1	1	1	4	3	3
RICH	3	6058	2	88	1	2	1	1	4	0
RICH	4	6062	57	26	1	2	2	3	7	2
RICH	5	6063	60	24	1	2	2	2	3	6
BRK	6	6252	12	56	0	2	5	2	22	1
BRK	7	6258	55	32	1	1	2	7	.1	1
BRK	8	6264	9	77	2	3	1	1	0	1
BRK	9	6265	4	71	.1	1	.1	2	23	1
BRK	10	6266	65	20	.1	1	2	3	6	2
BRK	11	6270	31	30	30	1	2	1 1	5	.1
GL	12	5044	70	10	2	1	1	2 1	11	2
GL	13	5045	11	76	1	2	2	3 1	0	5
GL	14	5047	3	97	.1	.1	.1	0	0	0
GL	15	5062	38	51	1	1	2	1 1	5	1
GL	16	5053	5	95	0	.1	.1	.1	0	.1
GL	17	5058	43	47	1	1	1	4	5	1
GL	18	5052	12	67	1	1	1	4	15	1
GL	19	5059	2	87	1	1	.1	3	6	1
GL	20	5072	3	85	1	0	0	0	9	1
GL	21	5091	8	85	.1	0	0	1	6	0
GL	22	5094	3	88	.1	0	0	0	3	5
GL	23	5099	3	75	.1	0	0	17	5	0
WOL	24	5085	26	38	.1	3	5	5	5	18
WOL	25	5088	26	41	.1	2	3	5	7	16
WOL	26	5091	19	50	.1	3	4	4	7	16
WOL	27	5096	25	40	.1	3	3	3.1	6	20
WOL	28	5100	20	43	.1	3	3	2 1	7	22
WOL	29	5103	20	45	.1	3	5	3	9	16
WOL	30	5105	37	38	.1	3	3	5	7	7
ALICE	31	6301	46	5	2	5	8	9	12	13
ALICE	32	6302	69	5	.1	.1	3	12 1	4	7
ALICE	33	6304	60	8	.1	4	5	5	7	11
ALICE	34	6306	57	16	.1	3	4	4	10	6
ALICE	35	6310	60	16	.1	3	4	3	0	7
ALICE	36	6315	40	32	.1	3	4	5	8	8
ALICE	37	6316	60	15	.1	3	5	4	9	4

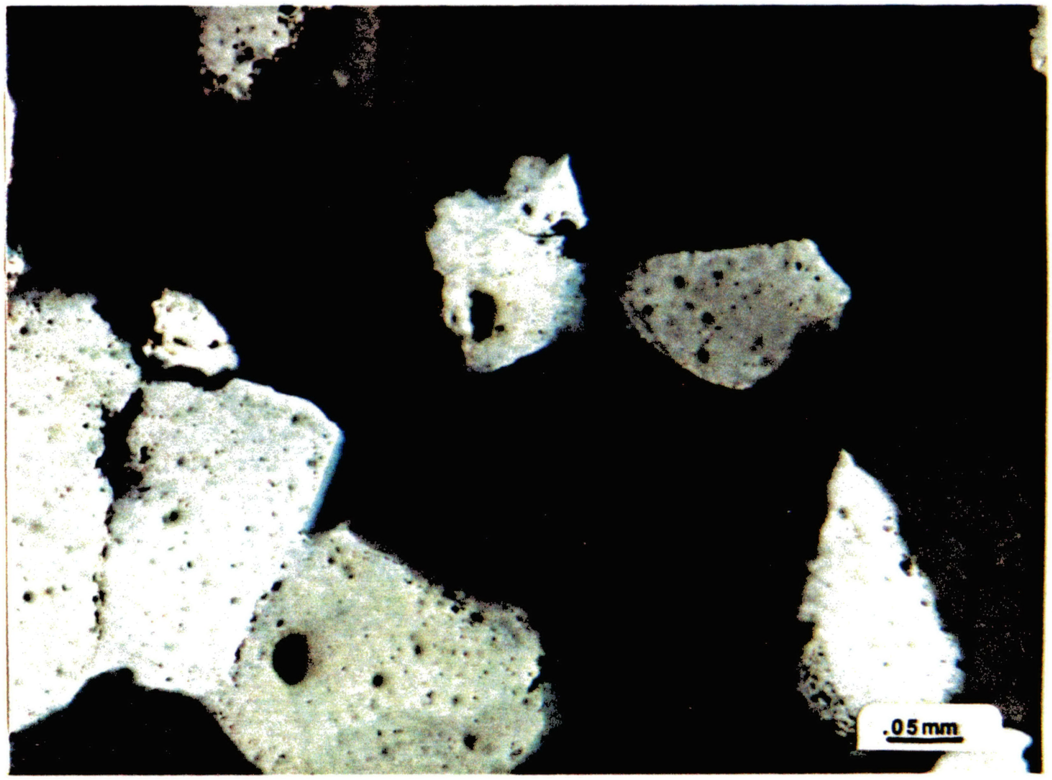


Figure 16. Photomicrograph of Quartz Grains and Associated Silica Overgrowths in the Misener Sandstones; Cross Polarized

Fossils

Fossils are present in amounts varying from 0 to 8 percent and are well preserved in most cases. Replacement of original material by both apatite and collophane is noted in most plant and invertebrate fossils in the Misener, and is thought to have occurred prior to deposition. Some fossils, however, have been replaced by dolomite, chert, and pyrite, to varying degrees, and are thought to have been deposited "in situ". Fossil types include brachiopods, conodonts, and large stemlike plant fossils (Figure 17). Grain sizes are variable and shapes are irregular due to the morphologies of the fossils.

Glauconite

Glauconite is present in all of the Misener thin sections examined and ranges from a trace to 5 percent of the total rock. Much of the illitic pseudomatrix present in the Misener is thought to have originated as green glauconite which was altered to brown glauconite before the transformation to pseudomatrix (Figures 18 & 19). This alteration is thought to be evidence of compactional overburden stresses which are related to burial.

Rock Fragments

Chert, metamorphic rock fragments, and phosphatic clasts commonly range from 0 to 2 percent but make up 30

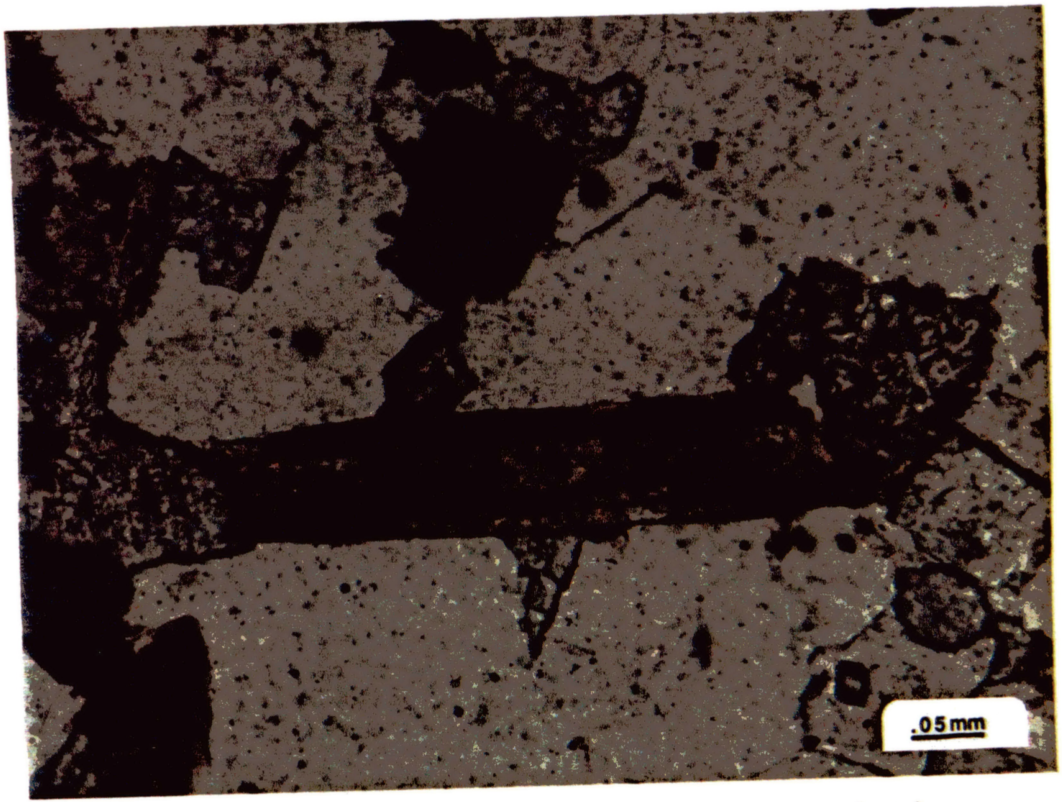


Figure 17. Photomicrograph of Characteristic Fossil Fragment in the Misener Sandstone; Cross Polarized

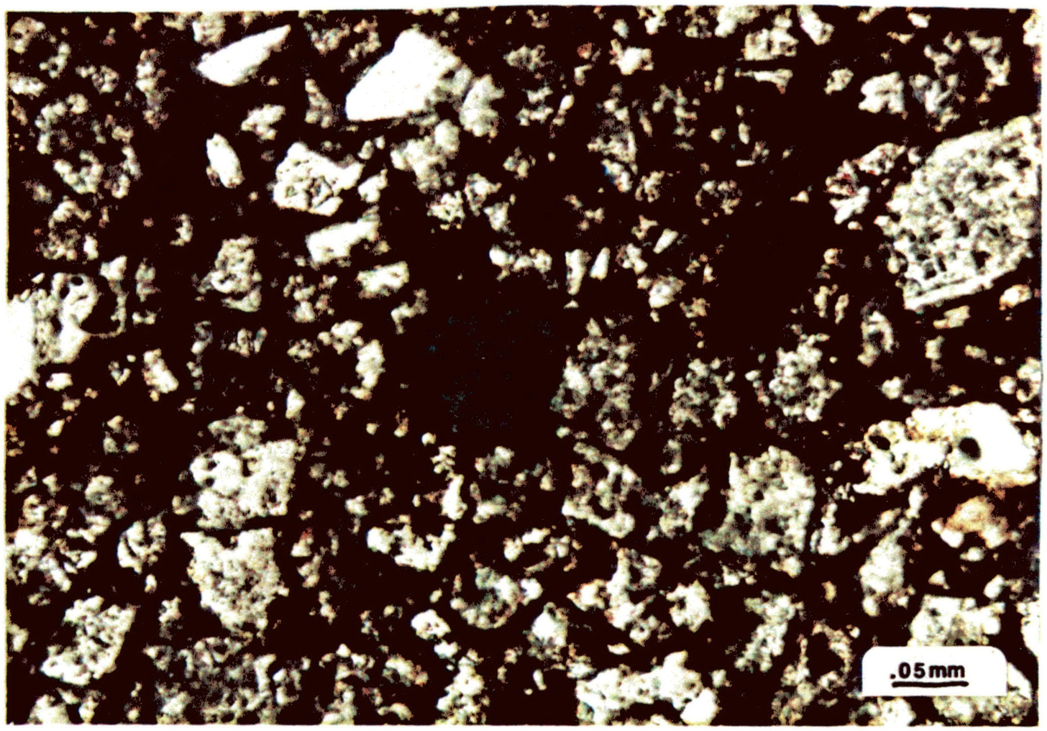


Figure 18. Photomicrograph of Green Glauconite; Plane Polarized

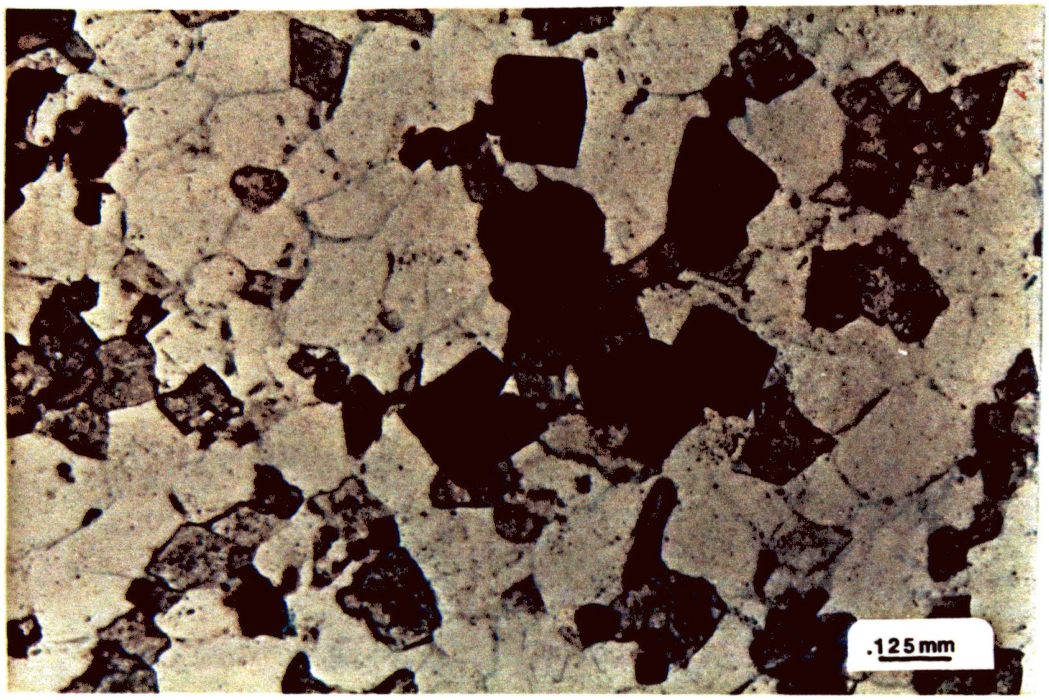


Figure 19. Photomicrograph of Breakdown of Green Glauconite to Brown Glauconite; Plane Polarized

percent of the Misener in a basal conglomeratic unit in Amerada's Breckenridge No. 1 core. Their grain size is similar to that of quartz, except in the conglomeratic unit, where they occur from coarse to granule size (Figure 20).

Feldspar

Feldspar grains were noted in many of the thin sections and were present in trace amounts. Microcline and albite are the only two feldspar types found, characterized by cross-hatched and albite twinning respectively. These grains are commonly coarse silt sized, with some grains as large as very fine sand. Feldspar grains are often corroded along the edges, with dissolution affecting the entire grain in rare cases (Figure 21).

Detrital Matrix

Detrital matrix exists in varying amounts in the Misener and is dominantly illitic (Figures 22 & 23). Chlorite is a possible constituent of the matrix, but was not definitely identified. Present percentages of matrix may not be representative of original values, as much of the core examined indicates a dolomite dominated rock which is thought to have originally been dominated by detrital matrix. Existing percentages of the clay fraction range from 0 to 23 percent of the rock.

Carbonaceous material is noted in many samples and is

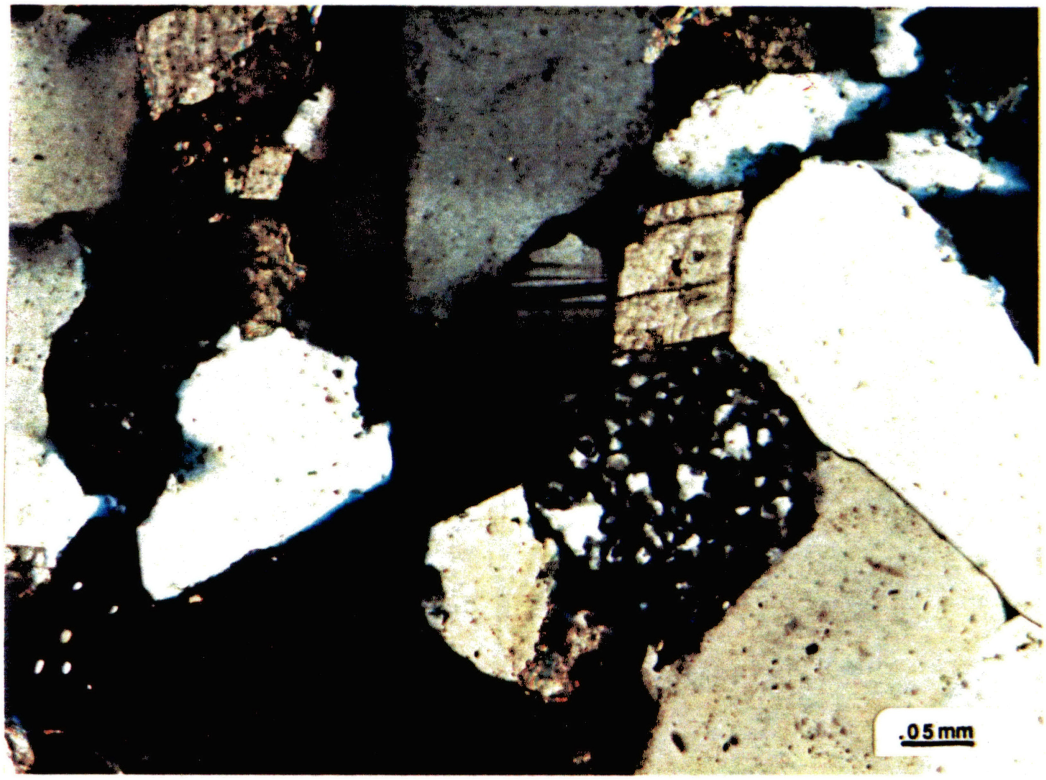


Figure 20. Photomicrograph of a Chert Rock Fragment in the Misener Sandstone; Cross Polarized

Figure 21. Photomicrograph of a Partially Dissolved Feldspar Grain (F) in the Misener Sandstone; Plane Polarized

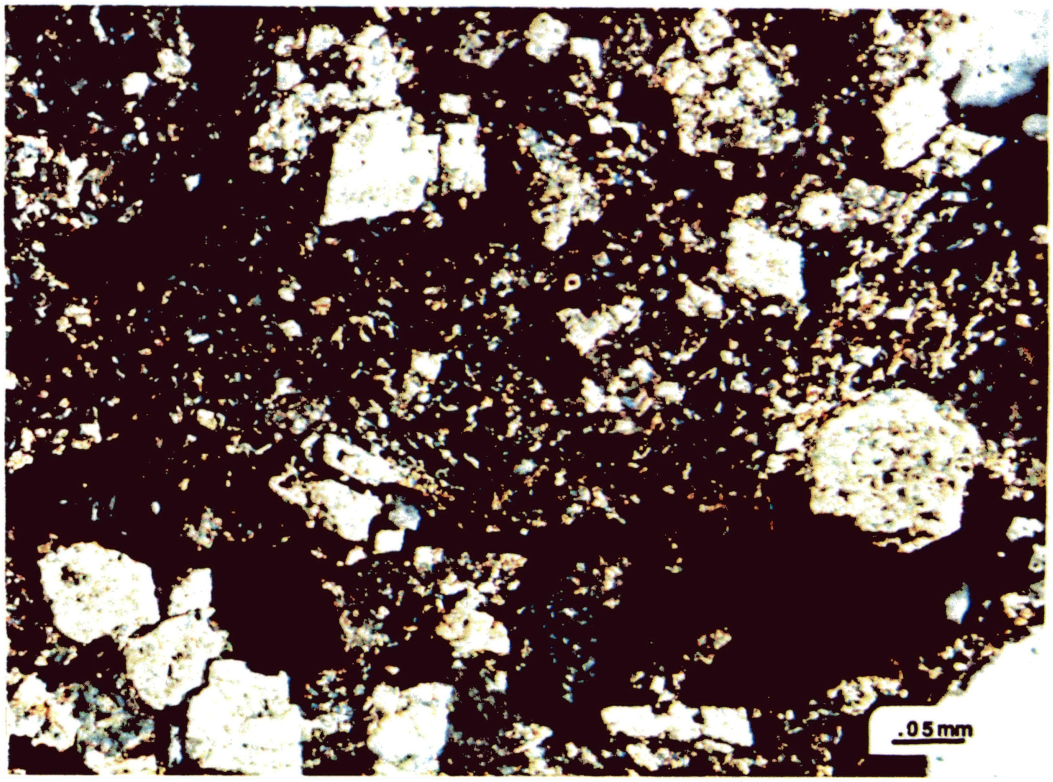


Figure 22. Photomicrograph of Illitic Pseudomatrix; Cross Polarized

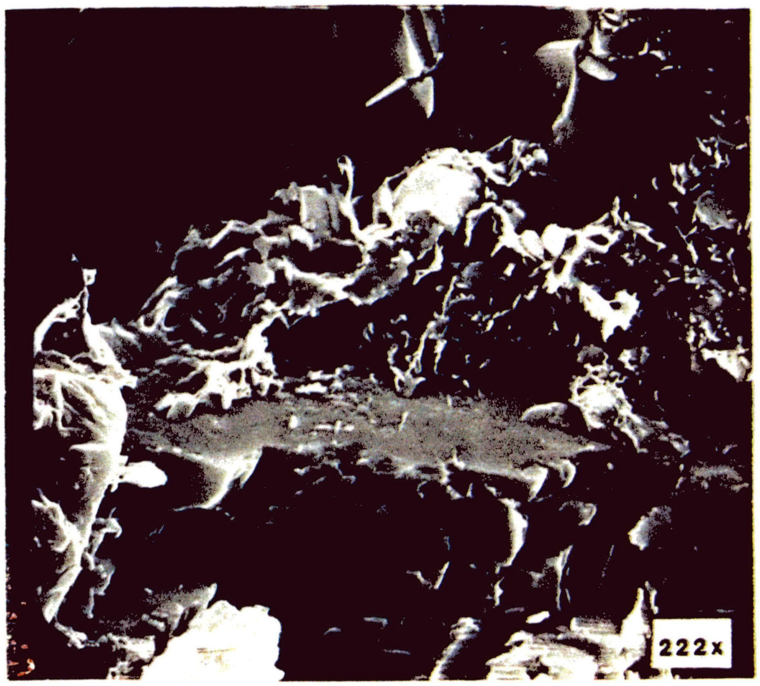


Figure 23. SEM Photomicrograph of Illitic Clay in the Misener Sandstone

black in color. This material is genetically associated with other detrital matrix components and is often concentrated along organic stylolitic seams (Figure 24). It is often replaced by pyrite and in dolomitic samples is sometimes displaced or incorporated into the dolomite, as is the detrital illitic matrix.

Diagenetic Constituents

Silica

The precipitation of silica cement has taken place in two separate phases in the Misener. The first is thought to have occurred shortly after burial as syntaxial quartz overgrowths. These overgrowths comprise up to 2 percent of the quartz rich samples, but are not common in the dolomite dominated lithotypes.

As previously noted, overgrowths present in thin section often reveal signs of corrosion if the quartz grain and overgrowth are next to dolomite or secondary pore spaces. Overgrowths may also cause a rounded quartz grain to appear angular if a well developed dust rim between the grain and the overgrowth is not present. Some well rounded quartz grains do, however, exhibit a well defined dust rim allowing accurate determination of sphericity (Figures 25 & 26).

Chert and chalcedony are present in many of the thin sections as a secondary cement. They comprise 17 percent

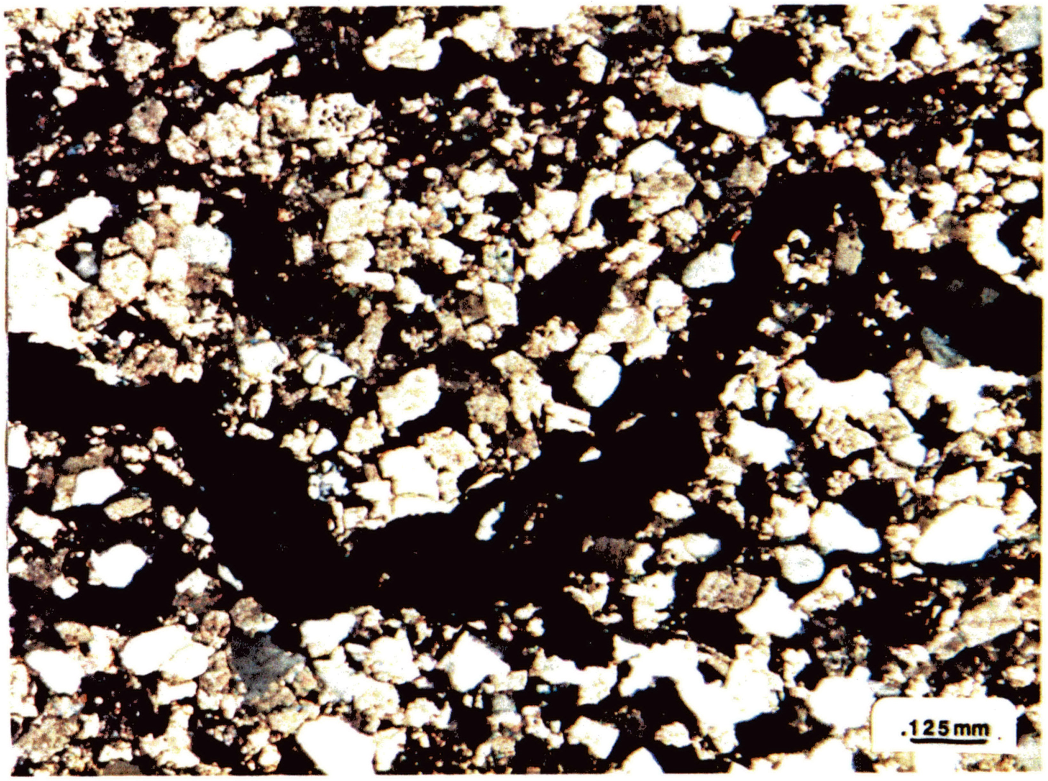


Figure 24. Photomicrograph of Carbonaceous Material Concentrated Along a Stylolitic Seam; Cross Polarized

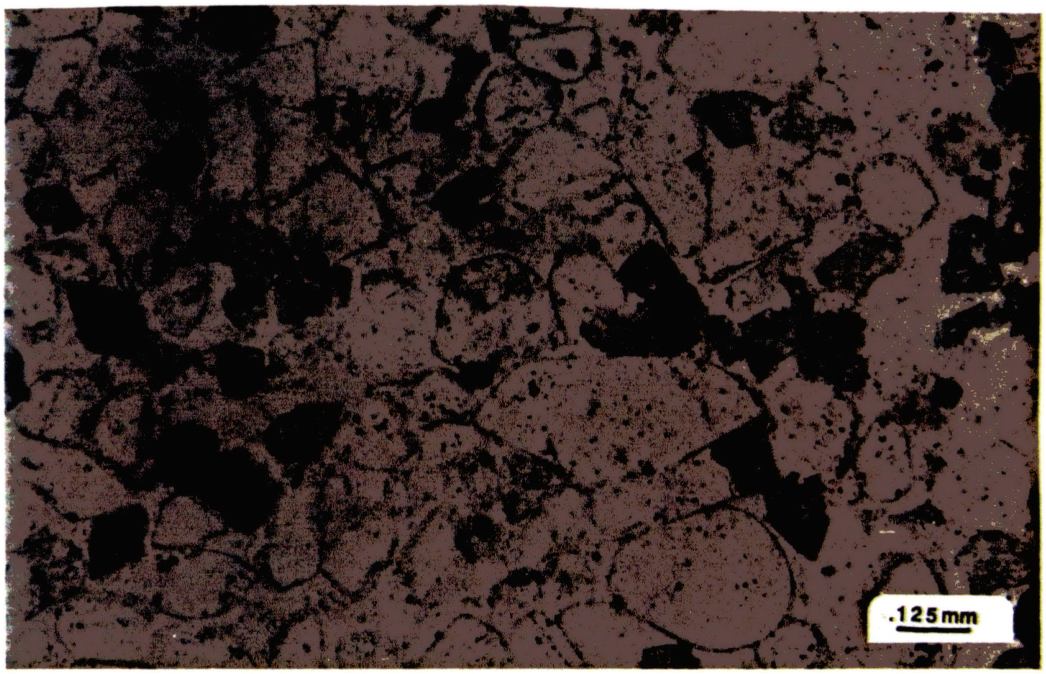


Figure 25. Photomicrograph of Quartz Overgrowths; Plane Polarized

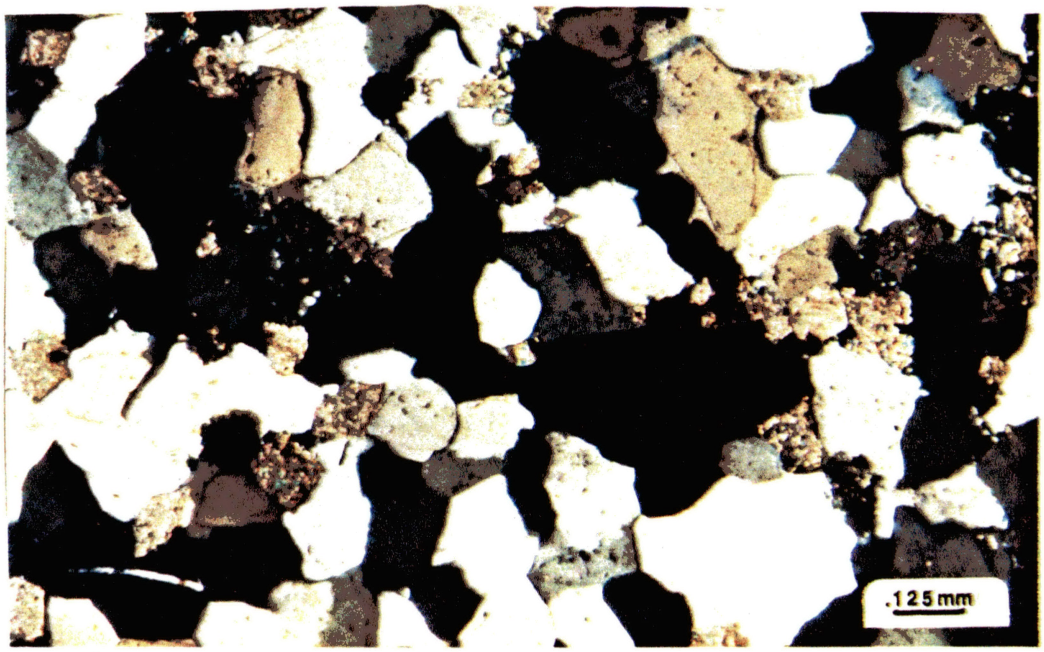


Figure 26. Photomicrograph of Quartz Overgrowths, Arrow Indicates Dust Rims on the Original Well Rounded Grains; Cross Polarized

of a sample taken from the Gungoll Alice 3-12 core at a depth of 6203 (-5085) feet, although most occurrences are less than 4 percent. Chert often precipitates as a replacement fabric or pore filling. In most cases, carbonate has been replaced, possibly indicating a switch from alkaline to acidic formation fluids. Chert is usually precipitated at high concentrations of SiO , with formation of larger and more crystalline chalcedony occurring as SiO concentration decreases (Figure 27).

Carbonate

Ferroan dolomite is the most abundant secondary cement in the Misener. Percentages vary among the three lithotypes, but it is present in all of the samples examined.

Dolomite is thought to have formed at the expense of all detrital constituents, but detrital matrix and pseudomatrix have been most affected (Figures 28 & 29). As stated earlier, crystallinity of the dolomite is dependent on the amount of matrix that was originally present in the sample, as well as the percentage of quartz grains which may provide a stable framework conducive to euhedral crystallinity. If the quartz percentage is small and the original detrital matrix percentage is thought to have been large, than the dolomite exhibits a displacive/replacive texture, and may even appear to be detrital. It is the opinion of this author, however, that

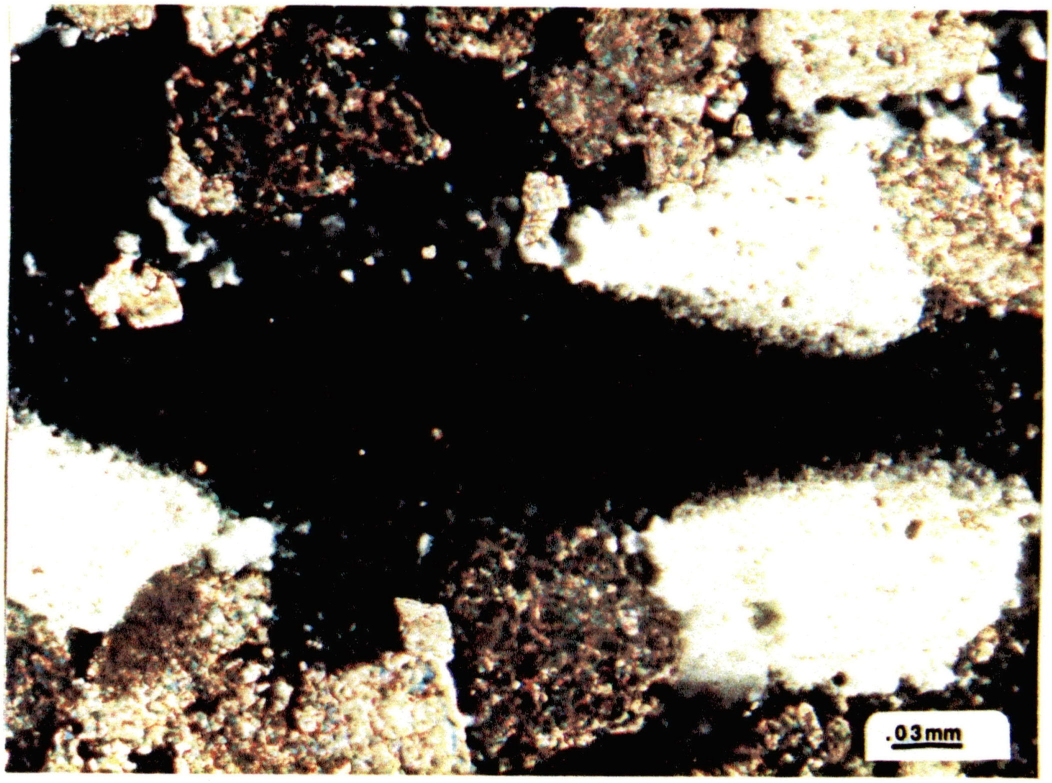


Figure 27. Photomicrograph of Chert as a Secondary Cement in the Misener Sandstone; Cross Polarized

Figure 28. SEM Photomicrograph of Euhedral Dolomite

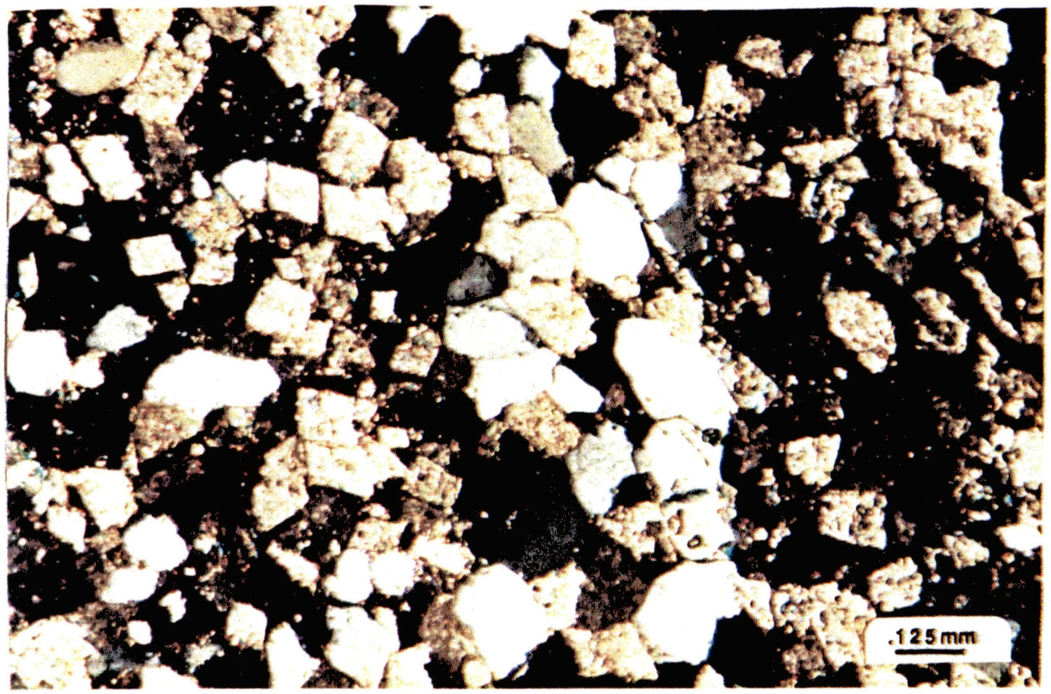


Figure 29. Photomicrograph of Anhedral to Subhedral Dolomite; Cross Polarized

the dolomite present in the Misener is secondary.

Remnants of calcite cement were detected in some thin sections and a sample from 6203 ft. in the Alice core contains a mosaic of poikilotopic calcite cement. Calcite was also detected during SEM analysis and is seen lining a quartz overgrowth (Figure 30).

Pyrite

Pyrite cementation is thought to be both an early feature related to pressure solution along stylolitic seams and a late feature which is probably related to hydrocarbon migration. This will be explained in the diagenesis chapter of this work. Late pyrite is present as small aggregates replacing all other constituents, as a poikilotopic cement, and exhibiting a cubic morphology (Figures 31 & 32). Thin section percentages of pyrite range from 0 to 4.

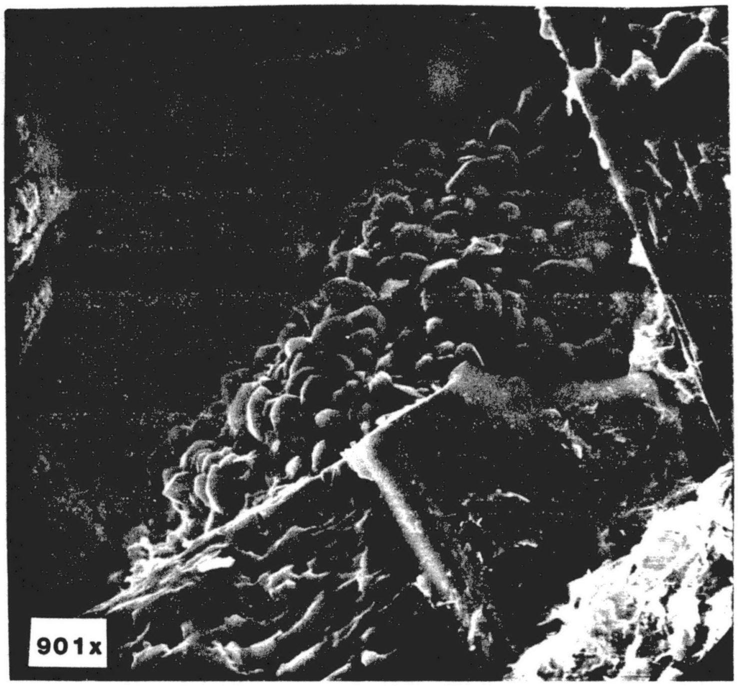


Figure 30. SEM Photomicrograph of Secondary Euhedral Calcite

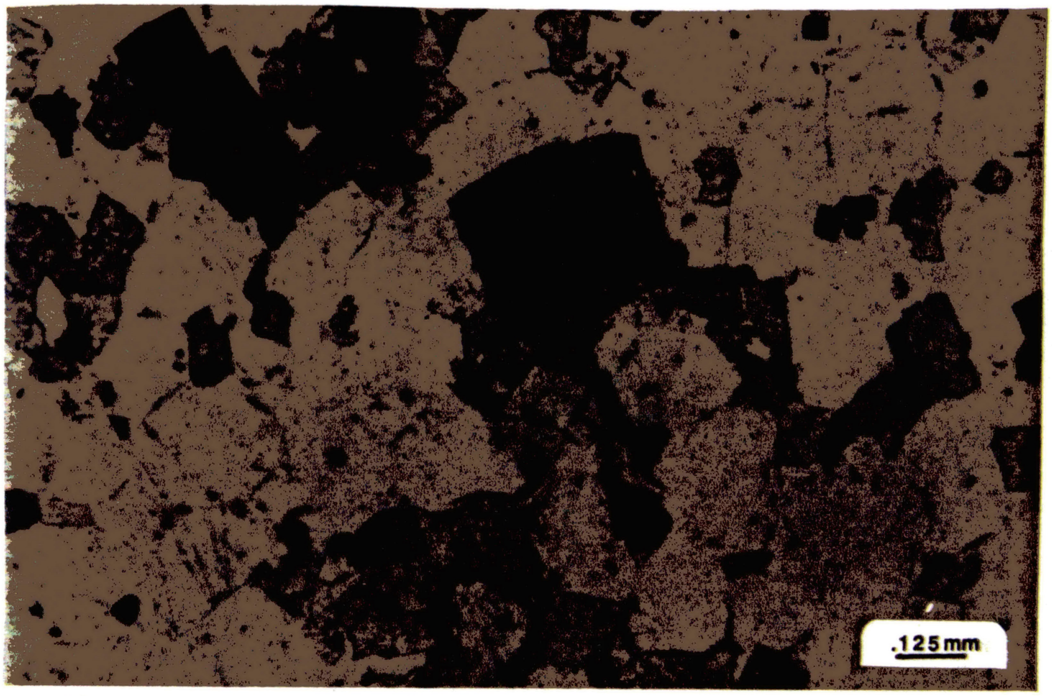


Figure 31. Photomicrograph of Pyrite Exhibiting Cubic Morphology; Plane Polarized

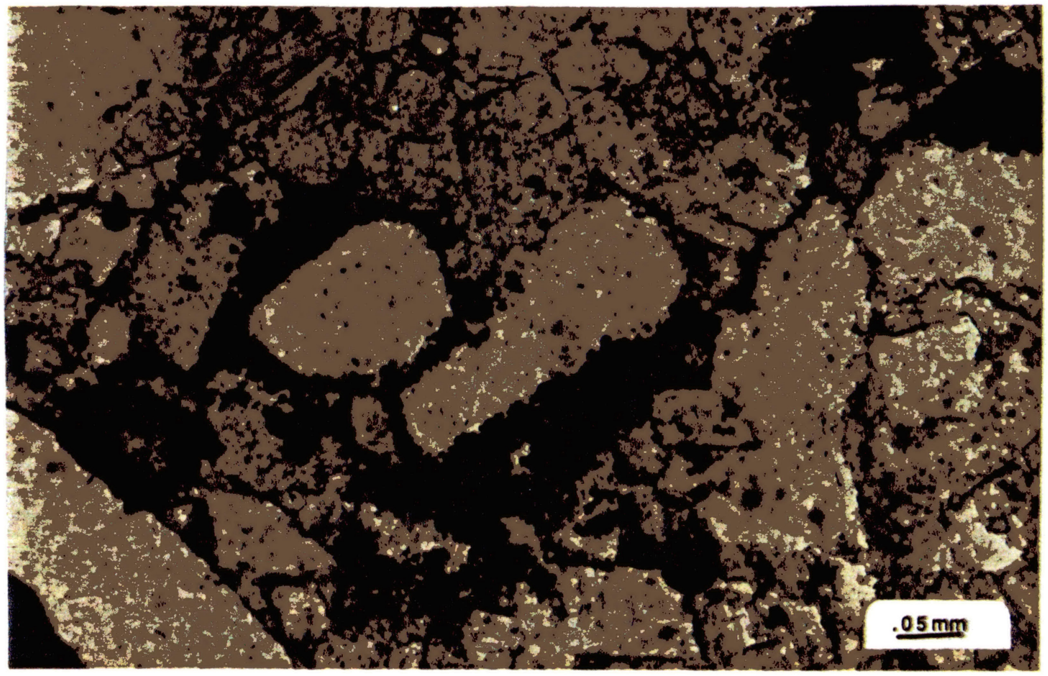


Figure 32. Photomicrograph of Pyrite Exhibiting Aggregate Morphology; Plane Polarized

CHAPTER IV

DIAGENESIS AND POROSITY

Diagenesis

The following is an analysis of the diagenetic history of the Misener Sandstone which represents a well based interpretation with respect to data utilization.

Figure 33 is a paragenetic sequence of the diagenetic history of the Misener Sandstone. Some of the steps may have occurred exclusively in certain lithotypes of the Misener, and, thus, should be used with discretion when applyied to specific cores or samples.

The Misener is interpreted to have been deposited in three lithofacies: a quartz rich sandstone, an immature or muddy sandstone, and a mudstone containing scattered quartz grains. The postulation of these lithotypes is an integral part of diagenetic interpretation, as variations in the paragenetic sequence of the samples which were examined are predominantly attributed to the original lithologic variation.

Carbonate cement is thought to have precipitated in the mature and immature sandstone lithotypes shortly after deposition. An acidic environment probably ensued, however, as

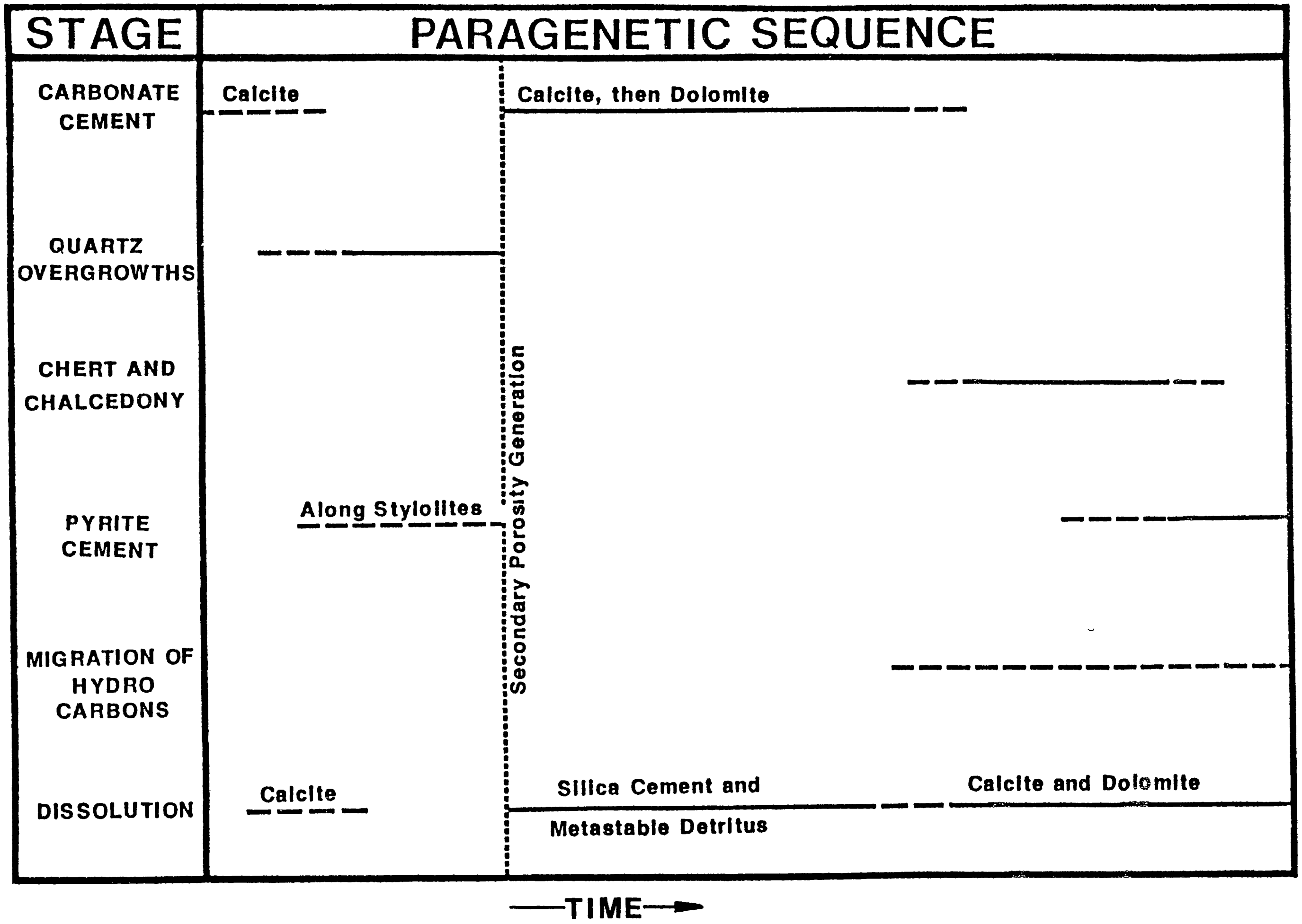


Figure 33. Paragenetic Sequence of the Misener Sandstone

organic materials underwent early bacterial degradation and decay, resulting in the near complete dissolution of the early calcite.

Acidic conditions were also conducive to precipitation of silica cement in the form of syntaxial quartz overgrowths in the sandstone facies of the Misener. In many quartz arenitic lithotype samples, this cement is still present as the dominant post-depositional feature. Pyrite may have also formed along pressure solution seams. Anaerobic bacterial reduction of sulfates to sulfides and release of iron from compacted glauconite and dissolution of matrix could have been conducive to pyrite precipitation.

Dolomite of the sandstone facies of the Misener displays a high order of crystallinity, is often zoned due to alternating periods of growth and non-precipitation, is ferroan, and has an overall clean, limpid appearance.

Dolomite noted in the mudstone lithotype is also ferroan, but is commonly less crystalline, possibly because it replaced sediments dominated by a clay sized fraction. This dolomite shows an early crystal interference and more common incorporation of detrital materials. The lack of a stable quartz framework may have limited the crystallinity of this dolomite which is dominantly anhedral and dirtier than its sandstone counterpart.

The proposed model for early dolomitization involves the mixing of fresh water (>5%) and seawater (<95%) under transgressive marine conditions (Figure 34). Diffusion and exchange of ionic species through the sandstone lithofacies may have been accomplished more readily in the immature sandstones due to a greater amount of detrital matrix which could be leached, opening pore spaces which were maintained by the quartz framework. Sands which were extensively cemented by silica (quartz overgrowths), often do not contain large percentages of secondary dolomite due to a lack of readily soluble metastable components.

Ferroan dolomite may have derived much of its iron form the breakdown of green glauconite to brown glauconite, which was then converted to illitic pseudomatrix (Figure 35). This mechanism, as well as the dissolution of detrital illitic dominated matrix, may have released iron and magnesium ions which were needed in the precipitation of ferroan carbonate cement, much of which still exists in the Misener.

Ferroan dolomite could have developed to a minor extent under deeper burial conditions. Dolomite of this type exhibits baroque or curved crystal faces and is somewhat less euhedral than earlier dolomite. Although the two processes of dolomitization are distinctive with respect to mode of formation, they are thought to have occurred as a continual phase of carbonate cementation in the diagenetic history of the Misener.

The Misener is thought to have maintained carbonate dominant parameters until higher temperatures associated

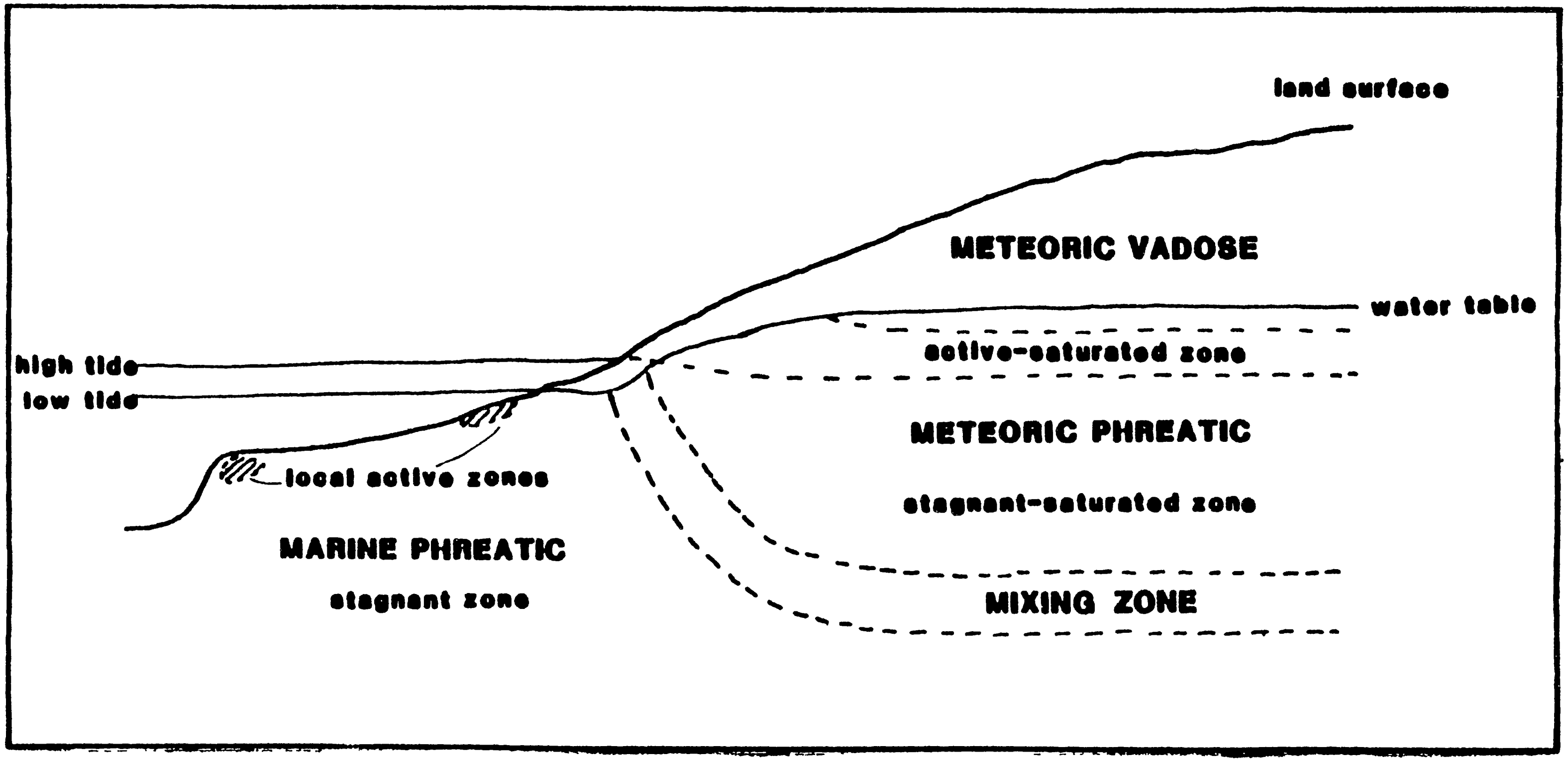


Figure 34. The Mixing Model of Dolomitization (After Longman, 1980)

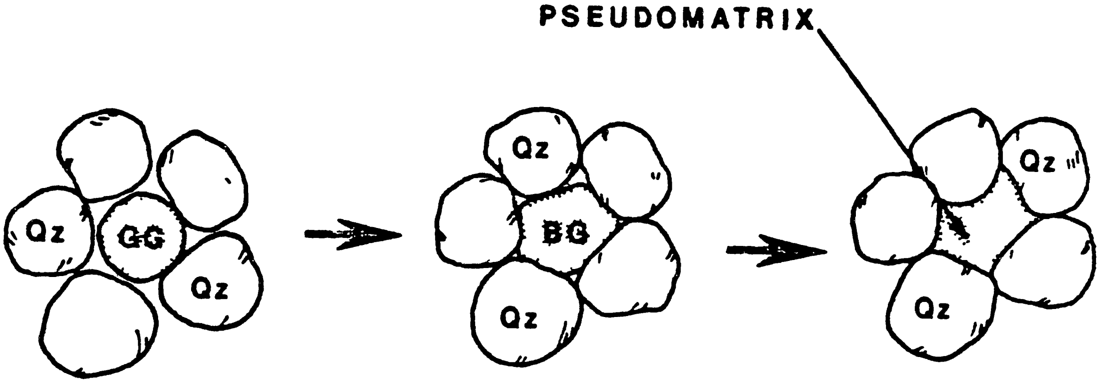


Figure 35. Ductile Deformation of a Glauconite Pellet During Compaction to Form Pseudomatrix

with deeper burial caused the thermal maturation of organic materials in adjacent shales, and possibly within the Misener itself. A renewed release of CO into formation fluids is postulated just prior to hydrocarbon expulsion from the shales. This could have increased the acidity of the system, resulting in dissolution of carbonates as proposed by Al-Shaieb and Shelton (1981).

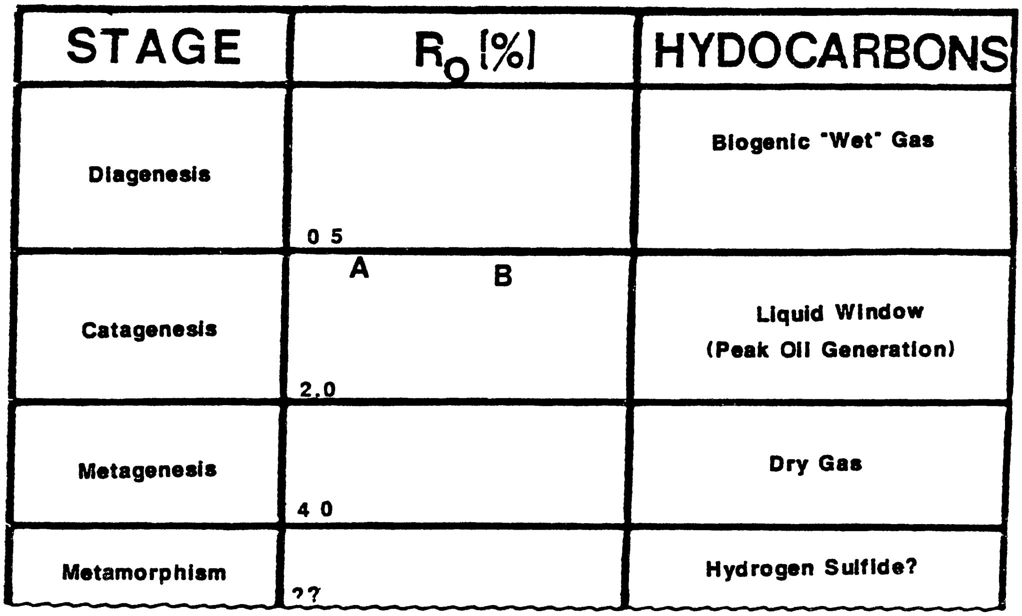
$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \qquad 4\text{-}1$$

$$H_2CO + CaCO_3 \rightleftharpoons 2HCO_3^- + Ca^{++} \qquad 4\text{-}2$$

Vitrinite reflectance data indicate that the Woodford shale within the thesis area probably reached maximum thermal maturity during Permian time, following which roughly 1900 feet of sediments were removed in north-central Oklahoma. The values derived indicate that the Woodford was in the lower stages of the liquid window (oil generative stage) of catagenesis, thus supporting that at least some of the Woodford's hydrocarbon generative potential was triggered (Cardott, 1985) (Figure 36).

A late stage of silica cement, in the form of chert and chalcedony, replaced and neomorphosed dolomite in much of the Misener. This replacement/precipitation stage probably took place just after dissolution of carbonate cement, during which time the environment was acidic.

Pyrite cementation, as described in the petrology chapter of this study, was the last step in the diagenetic



STAGE	R_o [%]	HYDOCARBONS
Diagenesis	0.5	Biogenic "Wet" Gas
Catagenesis	A B 2.0	Liquid Window (Peak Oil Generation)
Metagenesis	4.0	Dry Gas
Metamorphism	??	Hydrogen Sulfide?

Figure 36. Graphical Representation of Vitrinite Reflectance Data of the Woodford Shale in North-Central Oklahoma From A) Jefferson-Williams No. 1 Ebert, Sec.1-22N-4W; and B) Bobby J. Darnell No. 1 Kindschi, Sec. 14-19N-2W; Ro=0.57 (Data from Cardott, 1985)

history of the Misener (Figure 37). Iron needed for the formation of pyrite was probably available due to the dissolution of ferrous dolomite, and sulfur may have entered the system as hydrocarbon expulsion and migration progressed, assuming that the hydrocarbons were heteroatomic.

Porosity

Porosity types detected in the Misener are preserved primary porosity and secondary porosity.

Preserved Primary Porosity

This porosity type is not a common feature in the Misener. It usually occurs in quartz dominated samples. The pores exhibit a triangular shape related to interlocking of detrital quartz grains, but their original size has been reduced by syntaxial quartz overgrowths (Figure 38).

Secondary Porosity

Porosity of this type was derived from dissolution of both detrital and secondary constituents at various stages of the paragenetic sequence. Leaching of detrital matrix may have occurred contemporaneous with dolomitization, however actual identification of this feature is difficult. Porosity may have resulted exclusively from the dissolution of dolomite, which may have originally replaced

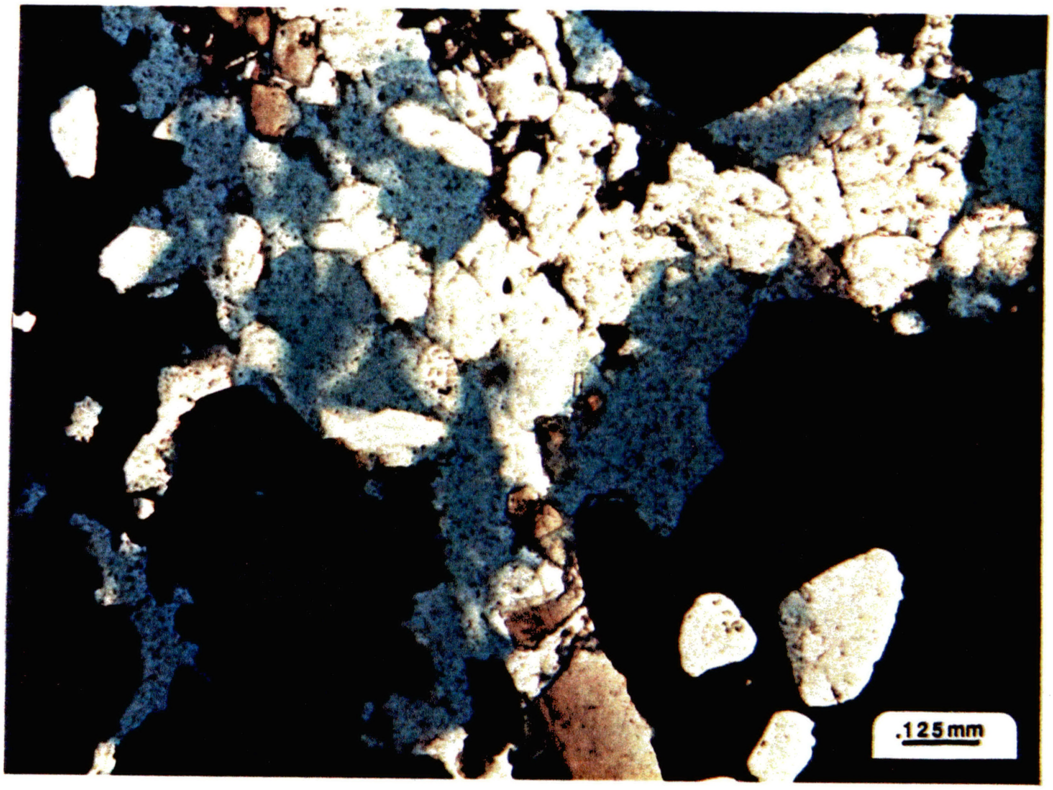


Figure 37. Photomicrograph of Pyrite Cement Exhibiting a Displacive/Replacive Poikilotopic Texture; Plane Polarized

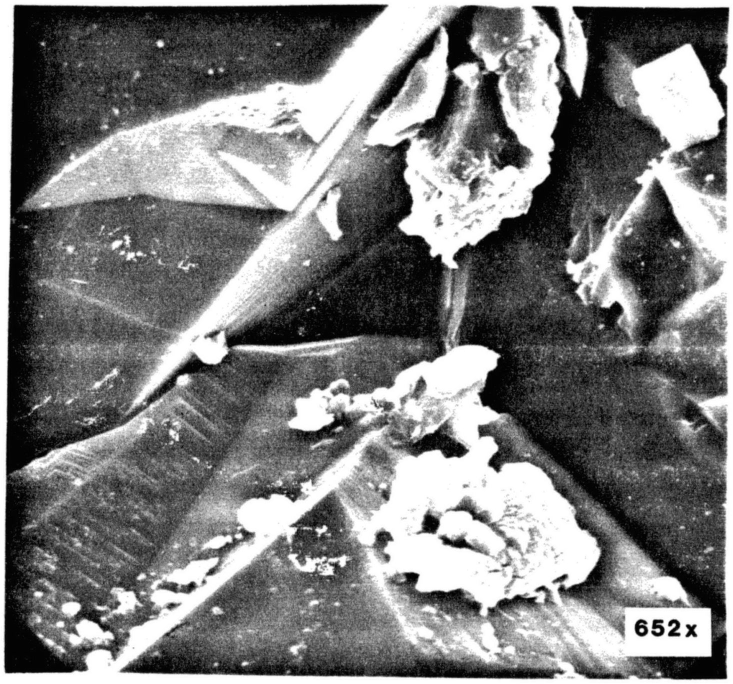


Figure 38. SEM Photomicrograph of Preserved Primary Porosity

the matrix prior to formation of porosity. Much of the secondary porosity is attributed to dissolution of dolomite as was outlined in the earlier diagenetic steps. Enlarged intergranular and intercrystalline pore spaces have resulted and are best preserved in Misener units that are thought to have originally been immature sandstones (Figure 39). These rocks lack intense silica cementation, probably due to inhibition by detrital matrix. This matrix was subsequently replaced by dolomite, which was then dissolved, thus creating much of the preserved pore space. Porosity derived in this way can reach values in excess of 20 percent, as seen in Federal's No. 1 Wolleson core.

In Pontotoc County, the Mount Kilcrease Unit No. 1 core exhibits excellent porosity in thin section. Dissolution of glauconite, phosphate, and other detrital constituents appears to be the dominant process of porosity development (Figure 40).

Secondary porosity developed along stylolitic seams in dolomitic Misener units is rare.

Some of the dolomite dominated samples exhibited up to 5 percent intercrystalline porosity.

It is thought that a general relationship of porosity to lithotype exists in the Misener. Units which are dominated by dolomite usually contain poor (<5%) porosity, and units containing nearly even mixture of detritus and dolomite or a dominance of quartz may exhibit the best reservoir potential in terms of porosity.

Figure 39. Photomicrograph of Enlarged Secondary Pore Spaces; Plane Polarized

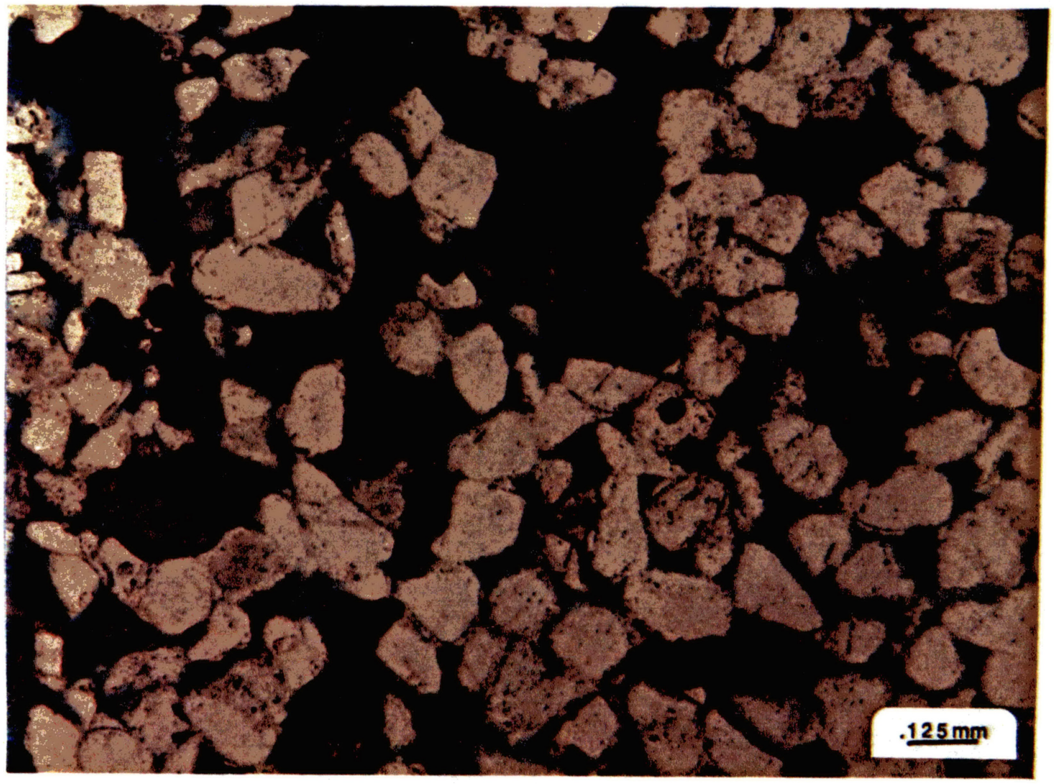


Figure 40. Photomicrograph of Secondary Porosity in the Mount Kilcrease Unit No. 1 Core in Pontotoc County, Oklahoma; Plane Polarized

A classification based on these parameters has been developed indicating that porosity is present in all three lithotypes, but it is best developed in the quartz dominated and combination lithotypes (Figure 41). As can be seen, data used for this diagram were derived from the five cores in the thesis area and from the Sunray DX Mount Kilcrease Unit No. 1 core which is located in the NW/4 of Section 36, T5N, R7E, Pontotoc County, Oklahoma. This core is quartz dominated and exhibits a higher percentage of glauconite and phosphate relative to quartz than those cores from north-central Oklahoma. Much of the porosity in this core appears to have formed through dissolution of glauconite and, to a lesser extent phosphate. A petrolog and description for this core have been included in the Appendix.

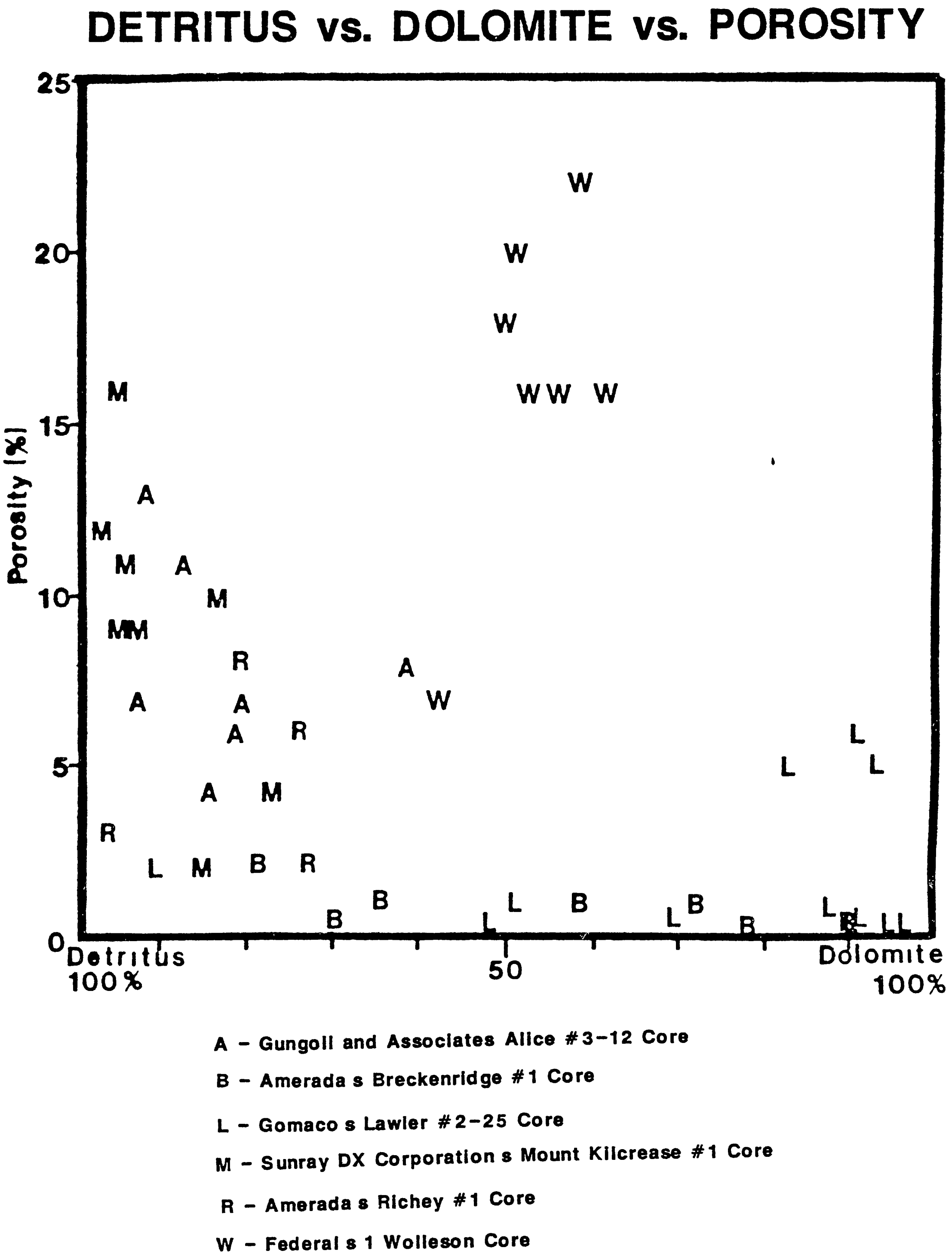


Figure 41. Graphical Comparison of Porosity to the Relationship Between Detritus and Dolomite

CHAPTER V

DEPOSITIONAL SETTING

The interpretation of the mode of deposition of a stratigraphic unit requires a complete examination of the data base. Interpretations of various types of data have been performed and the compiled lines of evidence were collectively analyzed. The following interpretation is based on this analysis.

As was discussed earlier, the Acadian Orogeny is thought to have resulted in the emergence of a topographic high to the northeast of the study area. The entire region is thought to have been subaerially exposed and fluvial erosional processes removed Hunton and pre-Hunton strata in much of north-central Oklahoma.

The drainage direction for this surface was to the southwest, however, a topographic high and much thicker Hunton unit was present along the western edge of the study area. The drastic thickening and topographic character of the Hunton along the western edge is thought to have developed from the faulting of the hingeline of the Great Basin of the Mid-Continent which existed during Siluro-Devonian time (Crumme, 1969).

Drainage from this topographic high was probably from west to east, and a convergence of the two drainage patterns just east of the hingeline apparently resulted in a trough like feature which was drained from northwest to southeast.

Figure 42 is a schematic paleogeologic diagram of the unconformity surface during the initial stages of erosion in north-central Oklahoma. The drainage patterns have been superimposed on the diagram and are representative of directions of drainage more so than actual channels. Figure 43 represents the later stages of erosion and the beginnings of transgression over the thesis area. The important idea that these diagrams convey relates to the timing of introduction of significant amounts of sand into the area.

Several hundred feet of carbonate and shale had to be eroded prior to erosion and transport of an appreciable amount of sand because the Simpson Group is present beneath Hunton, Sylvan, and Viola strata. The fluvial systems were probably originally dominated by a suspended load of clay-sized detritus, but after further erosion the streams were probably loaded with sand from the Simpson Group. Deposition of the sand may not have occurred until transgression had already begun, which would indicate that deposition was dominantly carried out by nearshore processes.

Baurnfiend (1980) points out that the Cushing Ridge was probably emergent at this time and was extensively

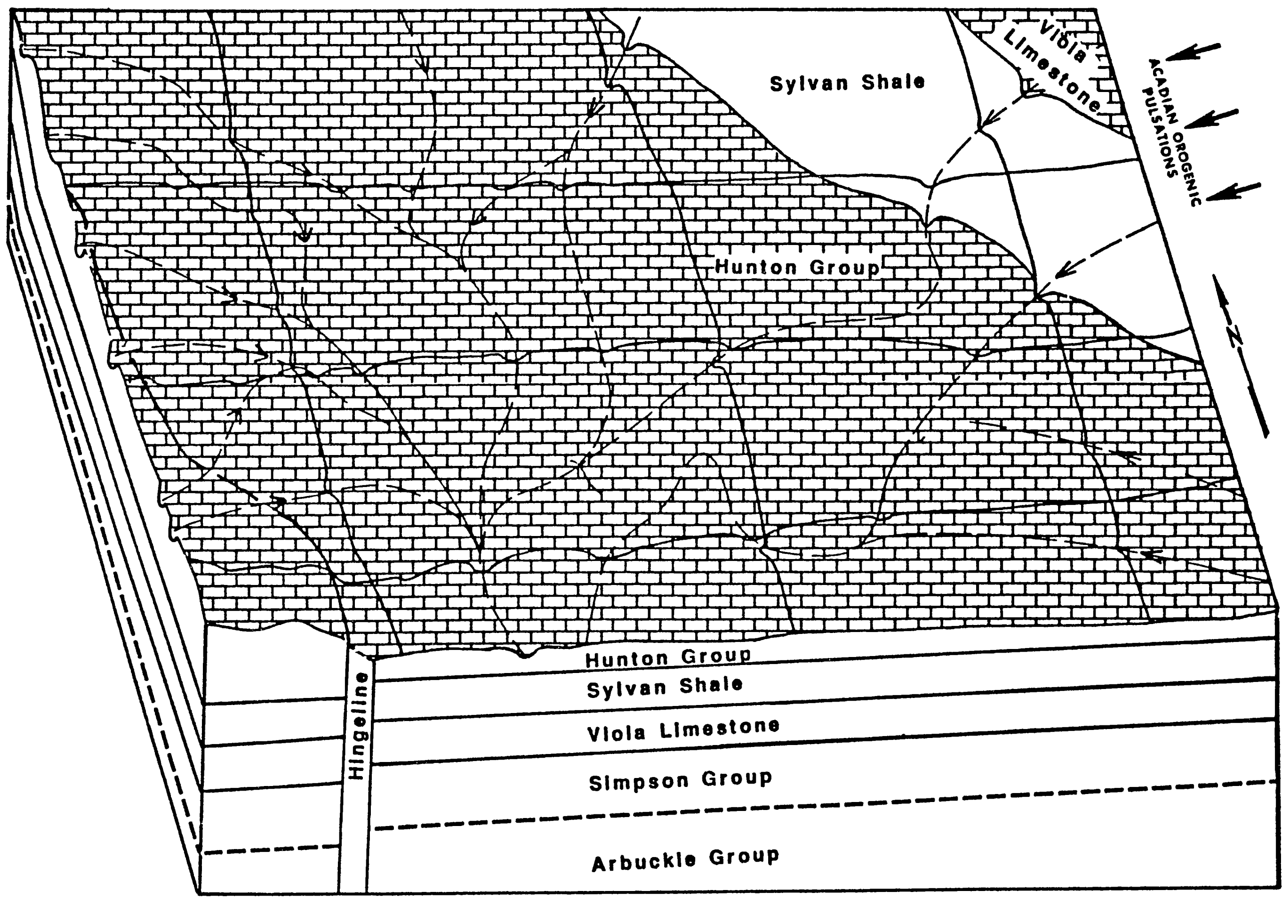


Figure 42. Schematic Paleogeologic Diagram of North-Central Oklahoma During the Initial Stages of Post-Acadian Orogenesis

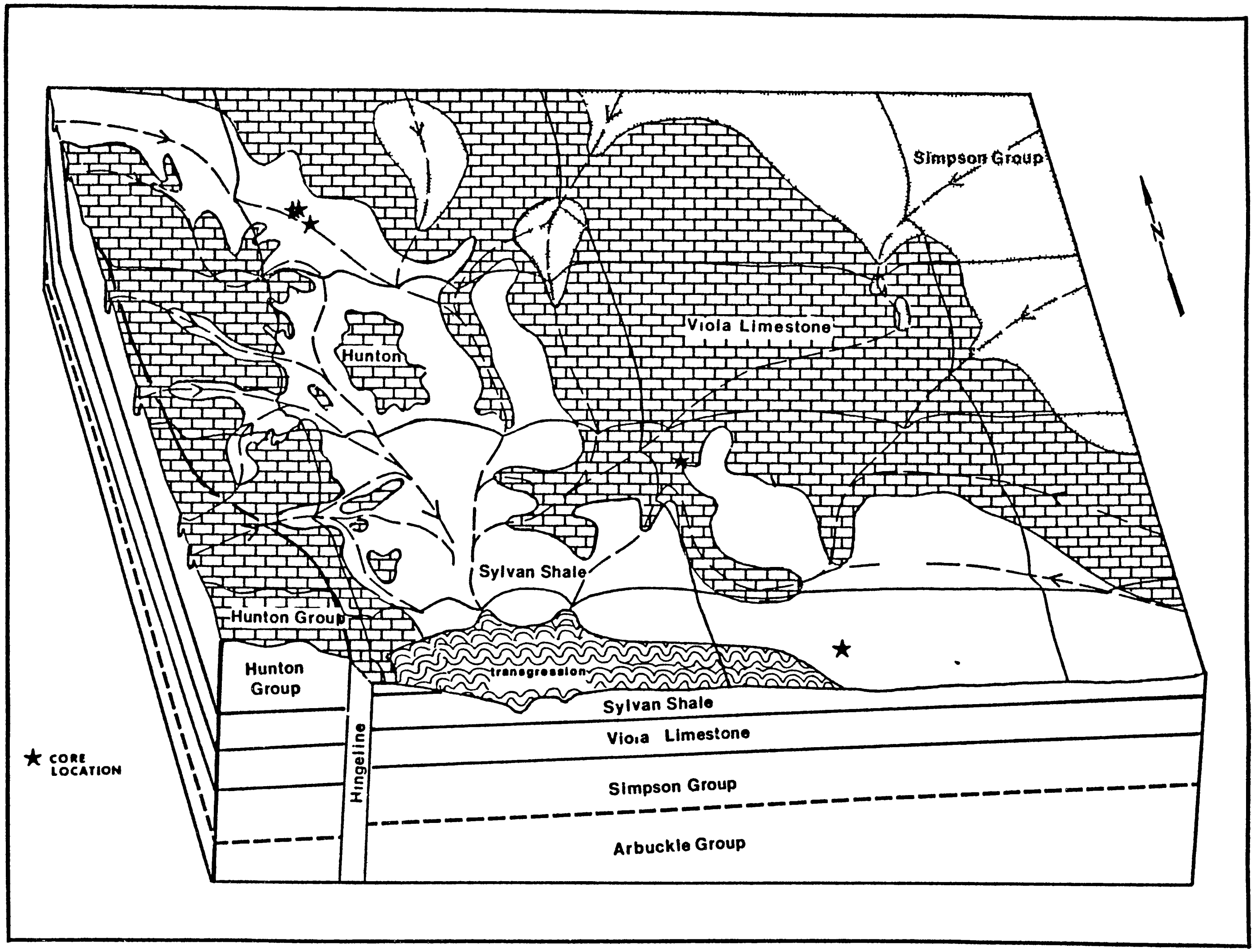


Figure 43. Schematic Paleogeologic Diagram of North-Central Oklahoma During the Transition From Subaerial Erosional Processes to Shallow Marine Transgression and Deposition of the Misener Sandstone

eroded. This would account for the east to west drainage component seen in the southeast sections of the study area. Fluvial deposition and preservation of sand bodies may have occurred in this area because the more proximal uplift which was possibly eroded at a faster rate. Such fluvial facies were not noted, however, in the cores utilized in this thesis.

Cross sections in the area support the idea that the unconformity surface was incised by channels during subaerial erosion. The geometry of the Misener in these cross sections is bimodal consisting of a channel fill morphology up to fifty feet thick, and a laterally extensive unit with a thickness of up to fifteen feet.

Core data indicate that the percentage of quartz in the original sediment may govern the lithotype which is currently present. The presence of glauconite and numerous fossil fragments of both plant and invertebrate origin support the interpretation of a shallow marine mode of deposition. The mixing model for dolomitization also occurs under shallow marine conditions, but may not be a good model for the mode of deposition, because it occurs shortly after deposition. This model indicates, however, that sea level changes were occurring shortly after deposition.

Earlier interpretations have pointed to eolian, shallow marine, or fluvial depositional models for the Misener, and some support a combination of these processes.

It is the opinion of this author, however, that deposition of the Misener sandstone in north-central Oklahoma occurred predominantly under three shallow marine settings:

1) Estuarine marine deposits
2) Open marine shoreline deposits
3) Open marine tidal channel deposits

It is thought that marine transgressive processes reworked sediments already present in fluvial channels and deposited them, along with incoming sediments, in shallow marine tidal channel and tidal flat facies. This would account for the bi-directional orientation of Misener sandstone bodies, as indicated on a Misener sandstone distribution map (Plate XII). Some sections of the shoreline may have been partially enclosed inlets in which estuarine deposits could have formed as well. A brief characterization of each of the three processes follows.

Estuarine Marine Deposits

Estuarine deposits are influenced by both marine and fluvial processes, and the resultant sediments may contain varying amounts of sand and mud. The sand may be introduced mostly from the ocean, while the mud is contributed primarily by river discharge. Commonly, the mud and well sorted sand are interlayered in sharply contrasting strata, although intense bioturbation may mix the components into a muddy sand or sandy mud (Clifton, 1982). It is evident that all three of the previously described lithotypes noted in the cores examined could have been deposited under these conditions, but the thicker, uniform sand units observed in Federal's Wolleson No. 1 and Gungoll's Alice No. 3-12 cores would probably indicate deposition on a more open coastline.

It should be noted that an estuarian setting may have both shoreline and tidal channel components, as does an open marine shoreline. The presence of greater percentages of mud and lower percentages of open marine fauna may be helpful in the distinction of a semi-enclosed shoreline from an open shoreline.

Open Marine Shoreline Deposits

Shoreline sands are predominantly clean, well sorted, fine grained units containing occasional thin clay or silt laminae. They exhibit a nearly uniform grain size and are usually more affected by early silica cementation to a larger extent than associated tidal channel sands. These units are similar in comparison with estuarine deposits, except that the presence of mud is not as prolific. Horizontal, parallel laminations are common sedimentary structures, as well as low angle cross laminations (Weimer, et. al., 1982).

Open Marine Tidal Channel Deposits

Tidal channel sandstones are commonly very fine grained, well sorted and clean (Weimer, 1982). These units contain small to medium scale cross beds and burrowing is common. A pattern of alternating scour and deposition is common to this setting, and may separate it from the other modes of deposition. Such scouring was noted in Amerada's Breckenridge and Richey cores near Kremlin.

The interaction of the above processes is common in the sedimentary record and may account for the variability noted in individual Misener cores. Figure 44 is a depiction of these models of deposition and delineates the types of deposition which may characterize the Misener in north-central Oklahoma.

A final point of interest in this interpretation deals with the presence of phosphatized fossils, ooids, and grains in the Misener. Such constituents may be indicative of an upwelling component to the system which was located farther offshore. Debris from this system may have been carried into shallow areas during storms and intermixed with the sand. This feature is well evidenced in Sunray's Mount Kilcrease Unit No. 1 core in Pontotoc County, Oklahoma, where phosphatic materials make up more than 20 percent of some samples, and in Misener samples from Arkansas, north-central and eastern Oklahoma.

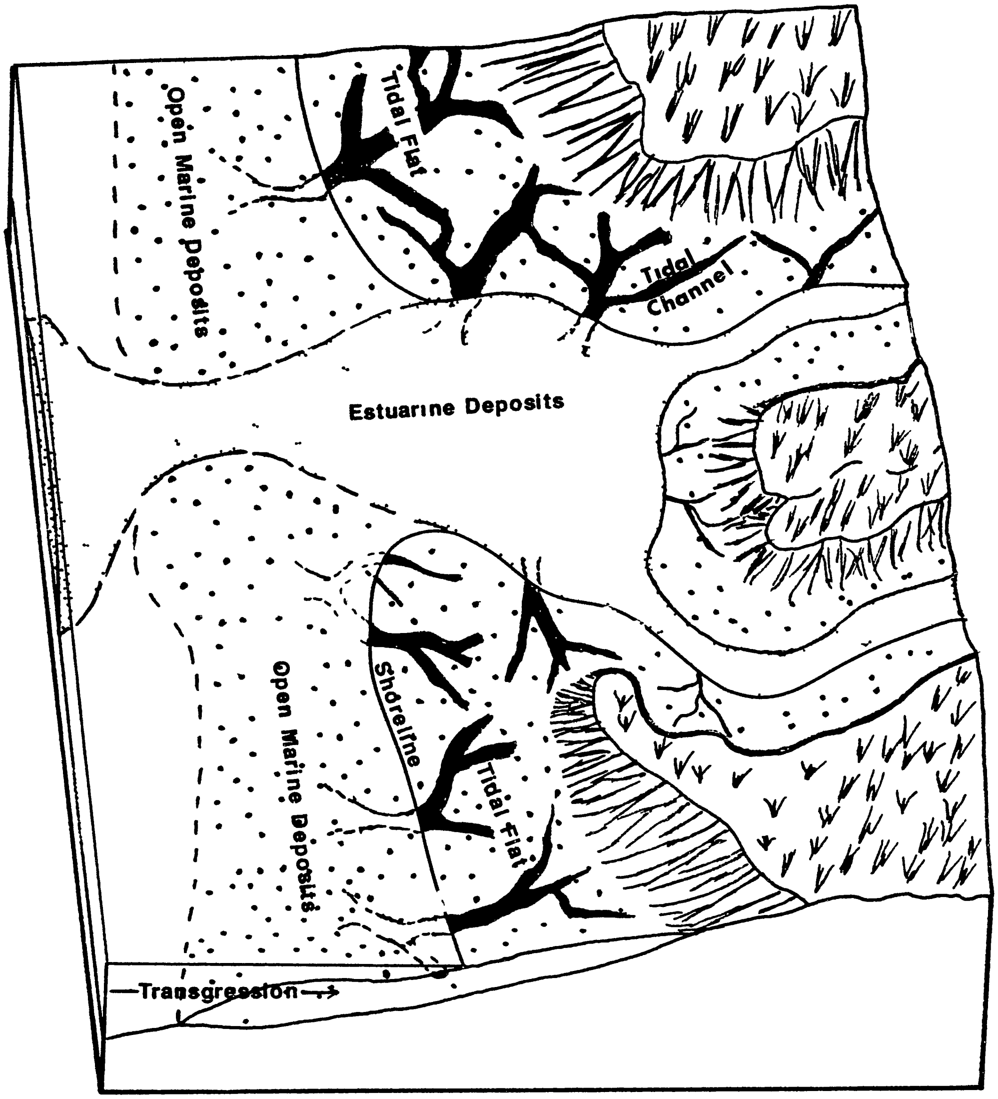


Figure 44. Proposed Depositional Model for the Misener Sandstone in North-Central Oklahoma

CHAPTER VI

CONCLUSIONS

Several conclusions can be derived from the analyses made in this study.

1. Samples of the Misener sandstone of north-central Oklahoma which were examined during this study indicate deposition under shallow marine conditions as marine transgression supplanted subaerial erosion on the sub-Woodford unconformity surface. Fluvial facies were not detected in the data, but this does not rule out their possible existence.

2. Three depositional settings are hypothesized for the Misener:

    1) Estuarine marine deposition
    2) Open marine shoreline deposition
    3) Open marine tidal channel deposition

3. Constituents and features of core data support the proposed depositional models and include: bioturbation, small to medium scale trough cross bedding, horizontal tabular bedding, and the presence of glauconite and marine invertebrate fossils.

4. Three lithotypes were identified during the examination of Misener cores:

1) Quartz arenite with varying amounts of dolomite

2) Dolomite with varying amounts of detritus

3) A combination of 1) and 2)

5. Dolomitization of siliclastic detritus is the major secondary feature in the Misener and is thought to have formed predominantly as a result of the mixing of fresh water and marine water shortly after deposition.

6. Provenance of the Misener sandstone in north-central Oklahoma is probably related to the erosion and redeposition of Simpson Group constituents.

7. The majority of the porosity detected in the Misener is secondary and was probably formed from the dissolution of carbonate prior to hydrocarbon migration.

8. Relationships among percentages of porosity, detritus, and dolomite indicate that the best porosity development occurs in units characterized by 1) detritus dominated constituency with appreciable amounts of glauconite and phosphate, which exhibit dissolution features; 2) mixed constituency of detritus and dolomite with the presence of porosity due to dissolution of carbonate.

REFERENCES CITED

Adler, F. J., 1971, Future Petroleum Provinces of the Mid-Continent Region 7 in I.H. Cram, ed., Future Petroleum Provinces of the United States-Their Geology and Potential: Amer. Assoc. Pet. Geol. Mem. 15, V. 2, pp. 985-1120.

Al-Shaieb, Z., and Shelton, J. W., 1977, Evaluation of uranium potential in selected Pennsylvanian and Permian units and igneous rocks in southwestern and southern Oklahoma: U. S. Department of Energy, Open-File Report GJBX-35(78), 248p.

Al-Shaieb, Z., and Shelton, J. W., 1981, Migration of Hydrocarbons and Secondary Porosity in Sandstones: Amer. Assoc. Petr. Geol. Bull., Vol. 65, No. 11, pp. 2433-2436.

Amsden, T.W., and Klapper, G., 1972, Misener Sandstone (Middle to Upper Devonian), North-Central Oklahoma: Amer. Assoc. Pet. Geol. Bull., V. 67, No. 6, pp. 979-1001.

Amsden, Thomas W., 1975, Hunton Group (Late Ordovician, Silurian, and Early Devonian),in the Anadarko Basin of Oklahoma, O.G.S. Bull. 121, Univ. of Okla., Norman.

Amsden, Thomas W., 1980, Hunton Group in the Arkoma Basin of Oklahoma, O.G.S. Bull. 129, Univ. of Okla., Norman.

Barrett, Ed, 1963, The Geologic History of Oklahoma - An Out-line, O.K.C. Geol. Surv. Bull.

Baurnfeind, Paul E., 1980, "The Misener Sandstone in Portions of Lincoln and Creek Counties, Oklahoma", Shale Shaker, Vol. 30, No. 8.

Borden, J.L., and Brant, R.A., 1941, East Tuskegee Pool, Creek County, Oklahoma in Stratigraphic Type Oil Fields: Amer. Assoc. Pet. Geol. Mem. ??, p. 436.

Busanus, J. W., 1985, Misener Strike-Valley Sandstone Reservoirs, Grant and Garfield Counties, Oklahoma (abs): Amer. Assoc. Pet. Geol. Bull., V. 69, p. 1316.

Cardott, B.J., and Lambert, M., 1985, Thermal Maturation of the Woodford Shale, Anadarko Basin, Oklahoma: Amer. Assoc. Petr. Geol. Bull. Vol. , pp. 1982-1998.

Carey, L. W., 1954, The Subsurface Geology of the Garber area; Garfield County, Oklahoma: Shale Shaker, V. 5, No. 6, pp. 5-29.

Chenoweth, P. A., 1984, Southern Mid-Continent Responses to Acadian Orogeny in Limestones of the Mid-Continent: Tulsa Geol. Soc. Spec. Publ. No. 2, pp. 247-257.

Clifton, H. Edward, 1982, Estuarine Deposits in Sandstone Depositional Environments: Amer. Assoc. Petr. Geol. Mem. 31, pp. 179-189.

Crumme, George W., 1969, The Geomorphology of the Pre-Woodford Unconformity Surface in the Mid-continent and its Relation to Oil Production: Unpublished Research Paper, Tulsa University.

Harris, R. W., 1957, Ostracoda of the Simpson Group of Oklahoma: Okla. Geol. Surv. Bull. 75, pp. 94-101.

Huffman, G. G., 1958, Geology of the South and West Flanks of the Ozark Uplift, Northeastern Oklahoma: Okla. Geol. Surv. Bull, 77.

Jones, C. L., Jr., 1960, Subsurface Geology of Western Payne County, Oklahoma: Shale Shaker, V. 7, No. 8, p. 3; Shale Shaker Digest, V. 2, pp. 258-273.

Kochick, T. P., 1976, Petroleum Geology of the Misener Sandstone in parts of Payne and Lincoln Counties, Oklahoma: Unpublished M.S. thesis, Oklahoma State University.

Krauskopf, Konrad B., 1979, Introduction to Geochemistry, McGraw-Hill Book Co., New York.

Longman, M. W., 1980, Carbonate textures from nearsurface diagenetic environments: Amer. Assoc. Petr. Geol. Bull., Vol. 64, No. 4, pp. 461-487.

Manni, Federica M., 1985, Depositional Environment, Diagenesis, and Unconformity Identification of the Chimneyhill Subgroup, in the Western Anadarko Basin and Northern Shelf, Oklahoma, Oklahoma State Univ. Thesis, Master of Science.

Mansfield, C. F., 1986, Personal Communication, Stillwater, Oklahoma.

Rascoe, B., and Adler, F. J., 1983, Permo-Carboniferous Hydrocarbon Accumulations, Mid-Continent, U.S.A.: Amer. Assoc. Pet. Geol. Bull., V. 67, No. 6, pp. 979-1001

Rau, H. L., and Ackley, K. A., 1939, Geology and Development of the Keskuk Pool, Seminole and Pottawatomie Counties, Oklahoma: Amer. Assoc. Pet. Geol. Bull., V. 23, No. 2, pp. 220-245.

Stringer, C. P., Jr., 1956, Subsurface Geology of Western Payne County, Oklahoma: Shale Shaker, V. 7, No. 8, p. 3.

Weimer, Robert J., Howard, James D., and Lindsay, Donald R., 1982, Tidal Flats and Associated Tidal Channels in Sandstone Depositional Environments: Amer. Assoc. Petr. Geol. Mem. 31, pp. 191-245.

White, L. H., 1926, Subsurface Distribution and Correlation of the Pre-Chattanooga ("Wilcox" sand) series of northeastern Oklahoma: Okla. Geol. Surv. Bull. 40, p. 22.

APPENDIX

WELL: Amerada Petroleum Corporation
W. E. Breckenridge No. 1

LOCATION: NW SE 33-25N-6W, Grant County

CORE INTERVAL

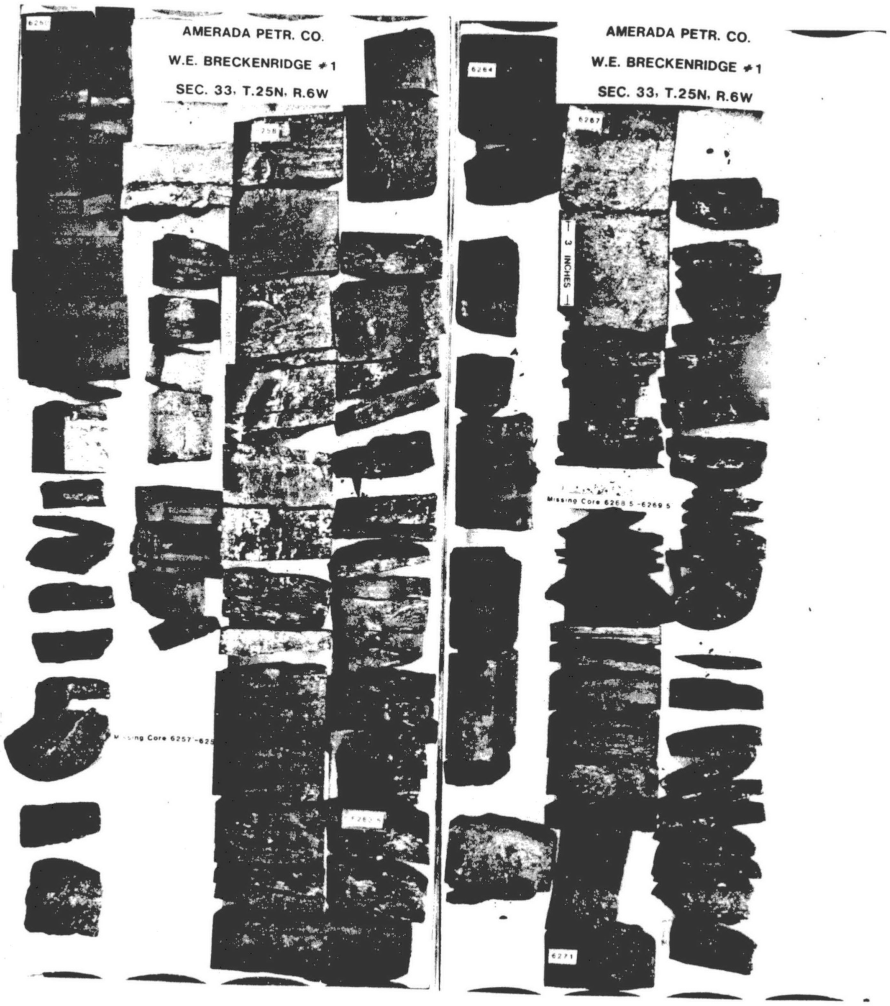
This core is located in the same section as the Amerada Richey No. 1 core and exhibits many similar features. The shale units present are sandwiched between the three sand units and are black, hard, and fissile. These shale units strongly resemble the Woodford shale located above the core.

The top of the upper unit is at a depth of 6252 (-5167) and the unit is thought to be 6 feet thick although some of the lower core is missing. This unit is gray to black in color and ranges in grain size from silt to fine sand. Quartz, glauconite, pyrite, and fossil fragments were detected. Features included flowage, stylolites, and discrete parallel laminae. The next 7 feet of the core is a shaly unit containing silty laminations which are less than one inch thick.

The middle sand unit is encountered at a depth of 6265 (-5180) feet and is four feet thick. This unit contains dolomite rhombohedra which are detectable with a binocular microscope. Quartz and other detrital constituents are less common and horizontal planar laminae have been disrupted by bioturbation. The shale unit below the second sand unit is 2 feet thick. It is similar to the upper shale unit and contains much pyrite.

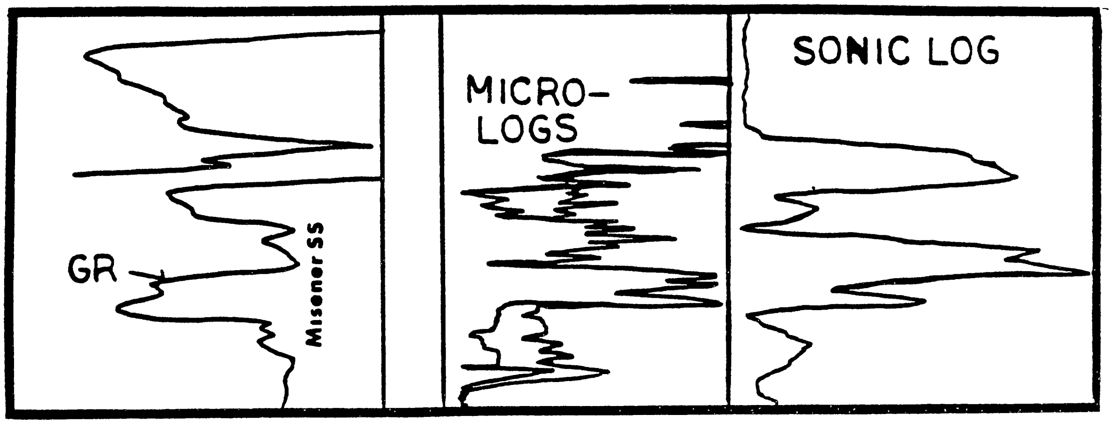
The lowermost sand unit is only 1.5 feet thick and contains a conglomeratic unit at its base which is 2 inches thick. This unit is similar to the basal unit in the Richey core and contains very fine grained quartz, coarse to pebble sized clay, chert, and phosphatic clasts, pyrite, glauconite, and fossil fragments. This unit is present form 6270 to 6271.5 (-5185 to -5186.5) feet and is underlain by 3 feet of black, fissile shale which is similar in appearance to the upper two shale units.

Thin section analyses indicate no more than 2 percent porosity in these units. More porous intervals may be present, but core analysis data is needed to better determine porosity.


AMERADA PETR. CO.
W.E. BRECKENRIDGE #1
SEC. 33, T.25N, R.6W
6284
AMERADA PETR. CO.
W.E. BRECKENRIDGE #1
SEC. 33, T.25N, R.6W
6267
3 INCHES
Missing Core 6268.5 -6269.5
6271
Missing Core 6257 -625

WELL LOG CHARACTERISTICS

The gamma ray curve indicates three units within the Misener interval which are relatively clean. Suppression of the gamma ray signature through the middle unit may be due to its higher content of illitic detrital matrix. The micro-resistivity logs exhibit positive seperation in the upper and lower units which is evidence of permeability and porosity due to a build up of mudcake on the borehole wall. The sonic log indicates potential porosity in the upper and lower zones, but little porosity in the middle (dolomitic) zone. This would be expected, as core examination indicated a similar relationship.



WELL: Henry H. Gungoll and Assoc.
Alice No. 3-12

LOCATION: C W/2 E/2 SW SW 12-24N-6W, Garfield County

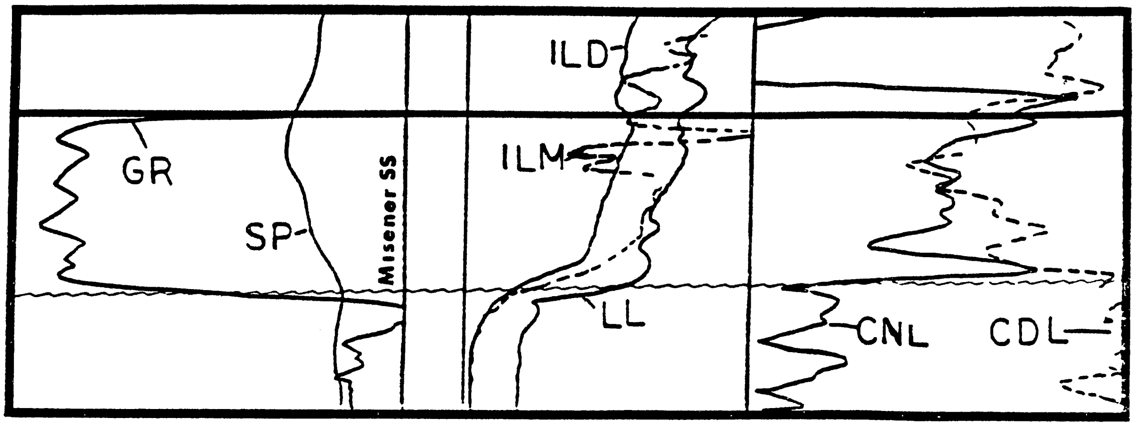
CORE INTERVAL

Wireline log data indicate that the Misener is present at a depth of 6300 (-5182) feet and is 18 feet thick at this location. This is in agreement with the core thickness and core report which were obtained for this study.

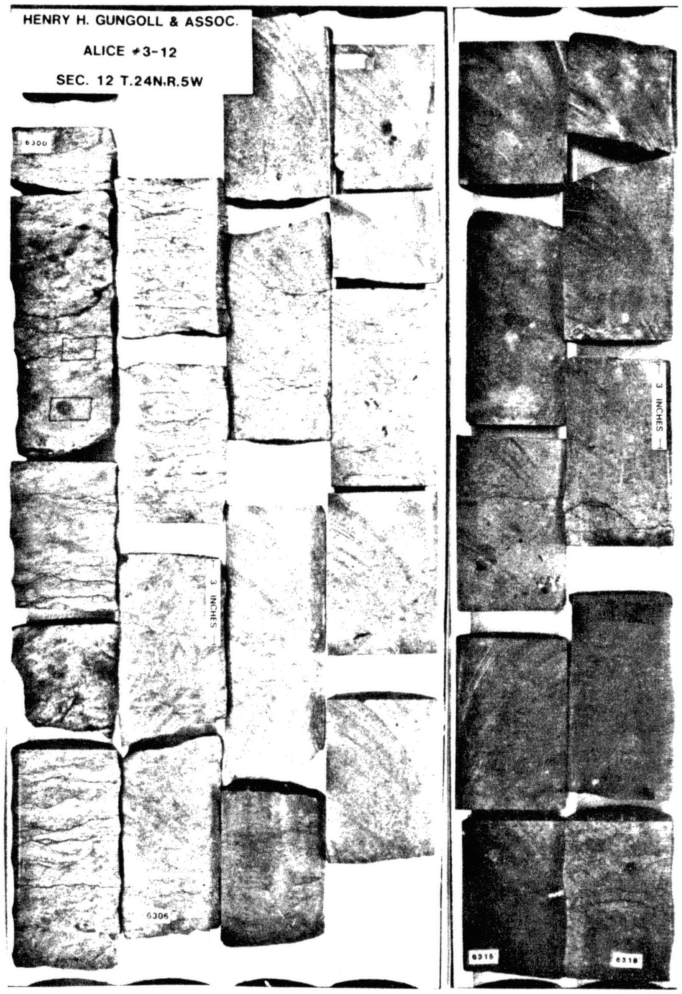
The sand in this core is light brown in color and is fine grained with fair to good sorting. Data obtained from the core analysis report indicates a porosity range of 6.8 to 12.5 percent, water saturation values ranging from 25.6 to 34.8 percent, and permeability values from 1.3 to 26.0 millidarcies.

Constituents included quartz, glauconite, clay materials, carbonate, silica, and pyrite cements. The lithology is sandstone throughout the core and features which were noted include soft sediment deformation, stylolites, clay clasts, pyrite nodules, bioturbation, phosphate nodules, and brachiopod shell fragments. This core is characterized as being the most homogeneous sand unit used in this study.

WELL LOG CHARACTERISTICS



The well developed gamma ray and resistivity profiles, as well as suppression of the SP curve, indicate a clean, possibly hydrocarbon bearing Misener. The neutron-density curves are characteristic of a quartz dominated lithotype with well developed porosity.


HENRY H. GUNGOLL & ASSOC.
ALICE #3-12
SEC. 12 T.24N.R.5W
6300
3 INCHES
6305
3 INCHES
6315'
6318'

WELL: Federal Petroleum Corporation
1 Wolleson

LOCATION: NE 22-21N-2W, Noble County

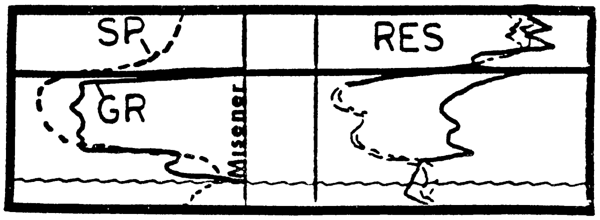
CORE INTERVAL

The top of the Misener is encountered at a depth of 5083 (-4953) feet and is 22 feet thick. The base of the Misener is represented by a green shale which is 6 inches thick. The upper part of the Viola limestone was also cored in this well and is a milky white to gray fossiliferous limestone.

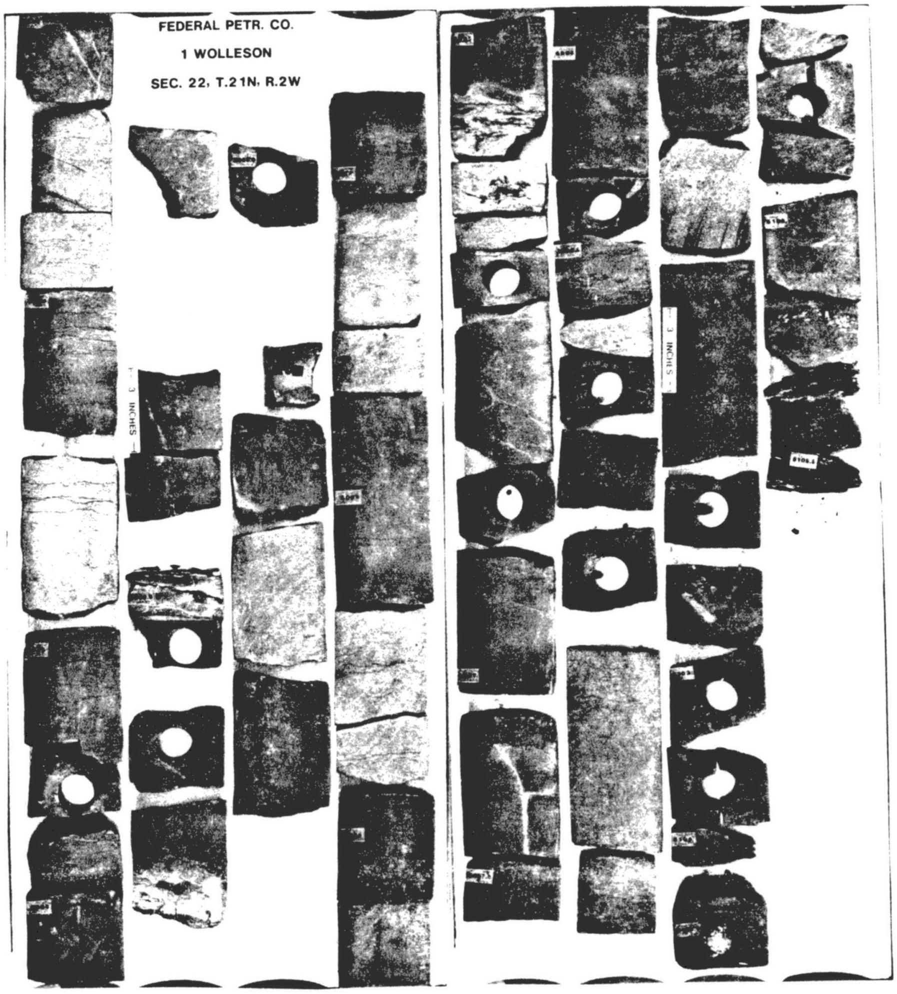
Lithology of the Misener is characterized as a continuous sand unit exhibiting stylolitic organic rich seams related to compactional overburden. Soft sediment deformation is evidenced by faulting and flowage of discrete horizontal planar bedding laminae. Two thin (4 to 6 inches) tightly cemented zones were detected at depths of approximately 5089.5 ( ) feet and at 5095.5 ( ) feet in the core. Thin section analysis indicates that these are silica cemented intervals with no porosity. The color of the core is gray with shades of brown and the grain size ranges from very fine to fine with predominantly good sorting.

Quartz, clay clasts, plant and invertebrate fossils, glauconite, carbonate, and phosphate were detected. Porosity of this unit was determined through thin section point counts and ranges from 7 to 22 percent.

WELL LOG CHARACTERISTICS



Well developed gamma ray and SP curves indicate a clean Misener unit with porosity and permeability and, in conjuction with the wet resistivity profile, the log suite is characteristic of a saltwater saturated interval


FEDERAL PETR. CO.
1 WOLLESON
SEC. 22, T.21N, R.2W
3 INCHES
3 INCHES

WELL: Amerada Petroleum Corporation
W. A. Richey No. 1

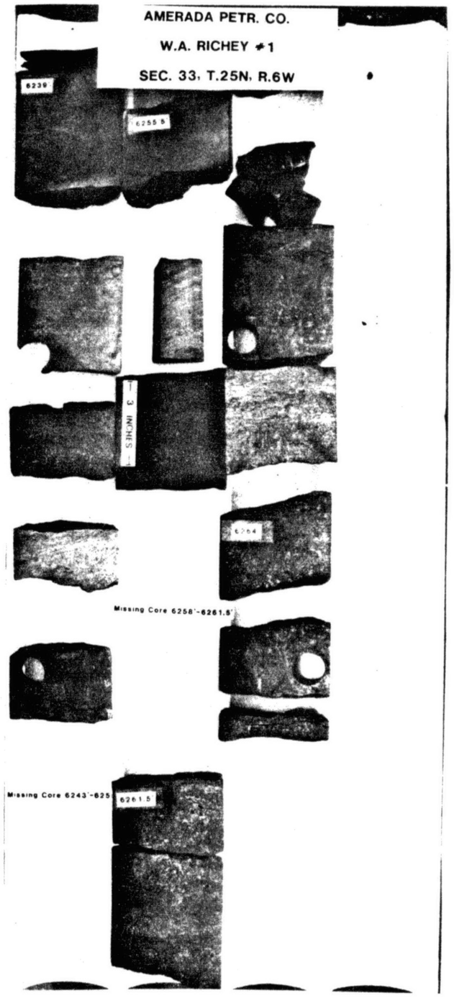
LOCATION: C N/2 SW NW 33-25N-6W, Grant County

CORE INTERVAL

This core contains approximately 10 feet of Misener sandstone which represents three distinct sand units. The upper unit is encountered at a depth of 6239 (-5155) feet and is approximately 4 feet thick. The unit is gray in color, very fine to fine grained, an shows fair to good sorting. Quartz, glauconite, pyrite, an fossil fragments were detected, as well as evidence of flowage and bioturbation. Thin section analysis indicates a porosity of 3 percent throughout this unit. The next 12.5 feet of core are not present and wireline logs indicate a shale lithology.

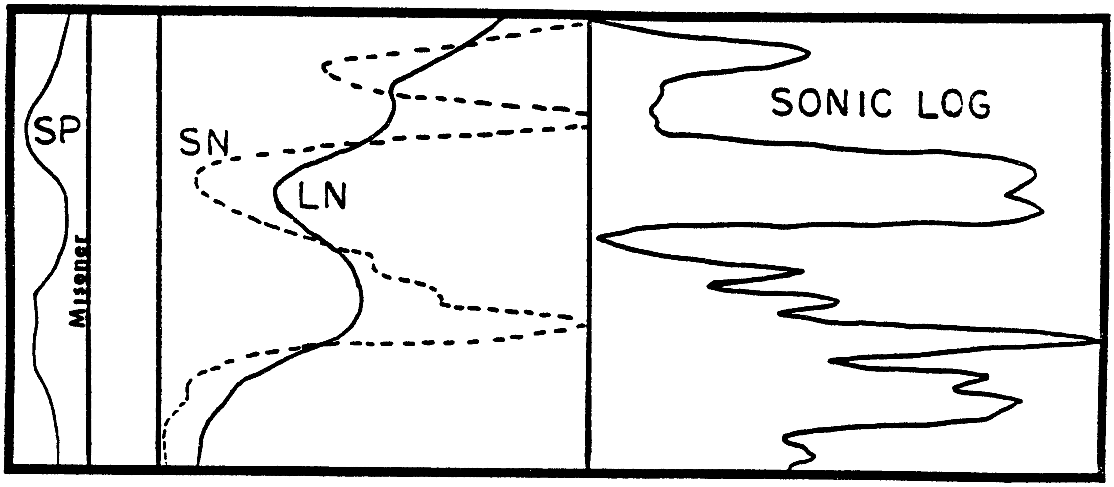
The next unit was penetrated at a depth of 6255.5 (-5171.5) feet and is thought to be approximately 2.5 feet thick. This unit is characterized by a darker gray color than the first one and it contains parallel bedding laminae and possible ripples. The grain size detected ranged from coarse silt to clay with scattered fine grained quartz. Sorting is thought to be good to fair. Quartz grains and dolomite were detected. This unit has no porosity and is tightly cemented by dolomite, both of which were detected in thin section.

The next four feet of core was also missing, and detection of the lowermost third unit occurs at a depth of 6261 (-5177) feet. This sandstone is 3.5 feet thick as is similar in appearance to the uppermost sand unit in the core. The unusual feature of this part of the core is seen at its base, which is represented by a 2 inch thick conglomeratic unit made up of pebble sized phosphatic, pyritic, and chert clasts scattered in the very fine to fine grained quartz grains which are seen throughout this unit. Plant and invertebrate fossils are also common to the lower sand and a green shale which is only a few inches thick was detected at 6263. Thin section porosity values from this interval are 2 percent and 6 percent.


AMERADA PETR. CO.
W.A. RICHEY #1
SEC. 33, T.25N, R.6W
6239
6255.5
3 INCHES
6264
Missing Core 6258'-6261.5'
Missing Core 6243'-625
6261.5'

WELL LOG CHARACTERISTICS

This log suite is indicative of the segregated nature of the Misener units as noted in the core. Suppression of the SP, a high resistivity profile, and a sonic log signature indicating porosity development all point to a possible hydrocarbon bearing Misener in the upper and lower units which are dominantly of the combination lithotype.



WELL: Gomoco Incorporated
Lawler No. 2-25

LOCATION: 25-19N-6W, Payne County

CORE INTERVAL

This is the most lithologically variable core utilized in this study. The total Misener interval as determined with wireline logs and scout information is 51 feet thick, but the sand units are interbedded with shale beds. It also appears that wireline depths are four feet deeper than core depths and an adjustment has been made which adheres to the core depths. The core is not a complete representation of the Misener section, but does contain representative samples of the units present in the borehole.

The upper section of the Misener is encountered at 5034 (-3934) feet. The unit is 19 feet thick and the lower 10 feet are present in the core.

This unit is gray in color an contains very fine grained well sorted sand in the lower 7 feet which grades upward into fine grained sand which is less well sorted. The lower 5 feet are characterized by horizontal bedding laminae and soft sediment deformation features. This interval is capped by a black shale which is 6 inches thick. The upper half of the unit is more intensely bioturbated and is also capped by a black shale which represents the top of the core. Quartz, rock fragments, clay clasts, glauconite, dolomite and pyrite were all noted in thin sections of the core.

Thin section analyses indicate porosity ranging from trace amounts near the base of the upper interval to 11 percent at the top.

The next 3.5 feet of the core are thought to be missing due to washout of a loosely compacted shale unit as indicated by the caliper log.

The lower sand units of this well appear to be interbedded with thin shale beds as indicated by the erratic nature of the gamma ray log. This unit is 15.5 feet thick and ranges in depth from 5056.5 to 5072 (-3956.5 to -3972) feet. These depths correspond to log depths of 5060.5 to 5076 feet.

The upper three feet of this unit represent a sandstone exhibiting parallel laminae. The sand is gray in color, contains very fine to fine grained quartz which coarsens upward, and is well sorted. Rock fragments, clay clasts, detrital matrix, glauconite, dolomite, pyrite, and fossil fragments are present.

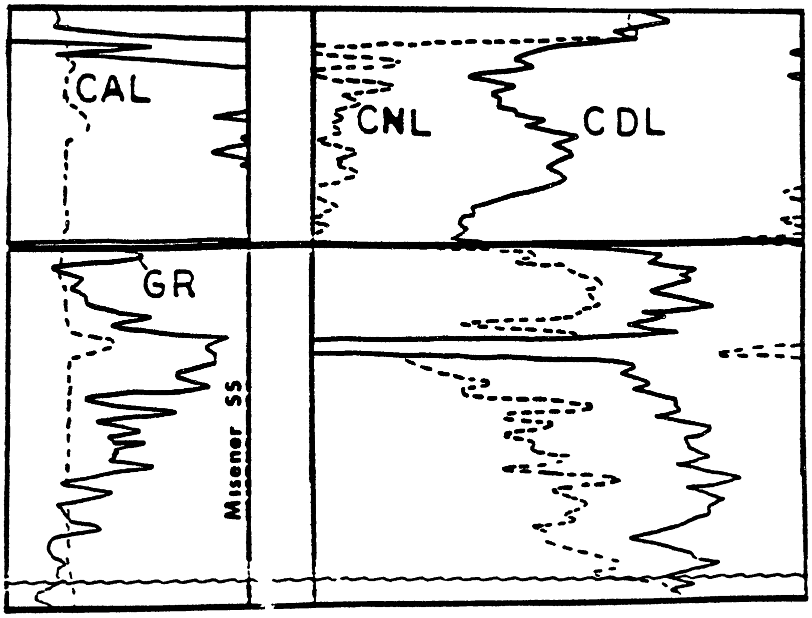
The next five feet of the core represent a shale unit which is hard and black with scattered silt sized quartz grains. The shale is underlain by a sand unit which is 4 feet thick. This interval lacks sedimentary structures, but is similar in constituency to the upper most interval of the core. Grain size is very fine and both carbonate and clay clasts are present. Thin section porosity values range from a trace to 1 percent.

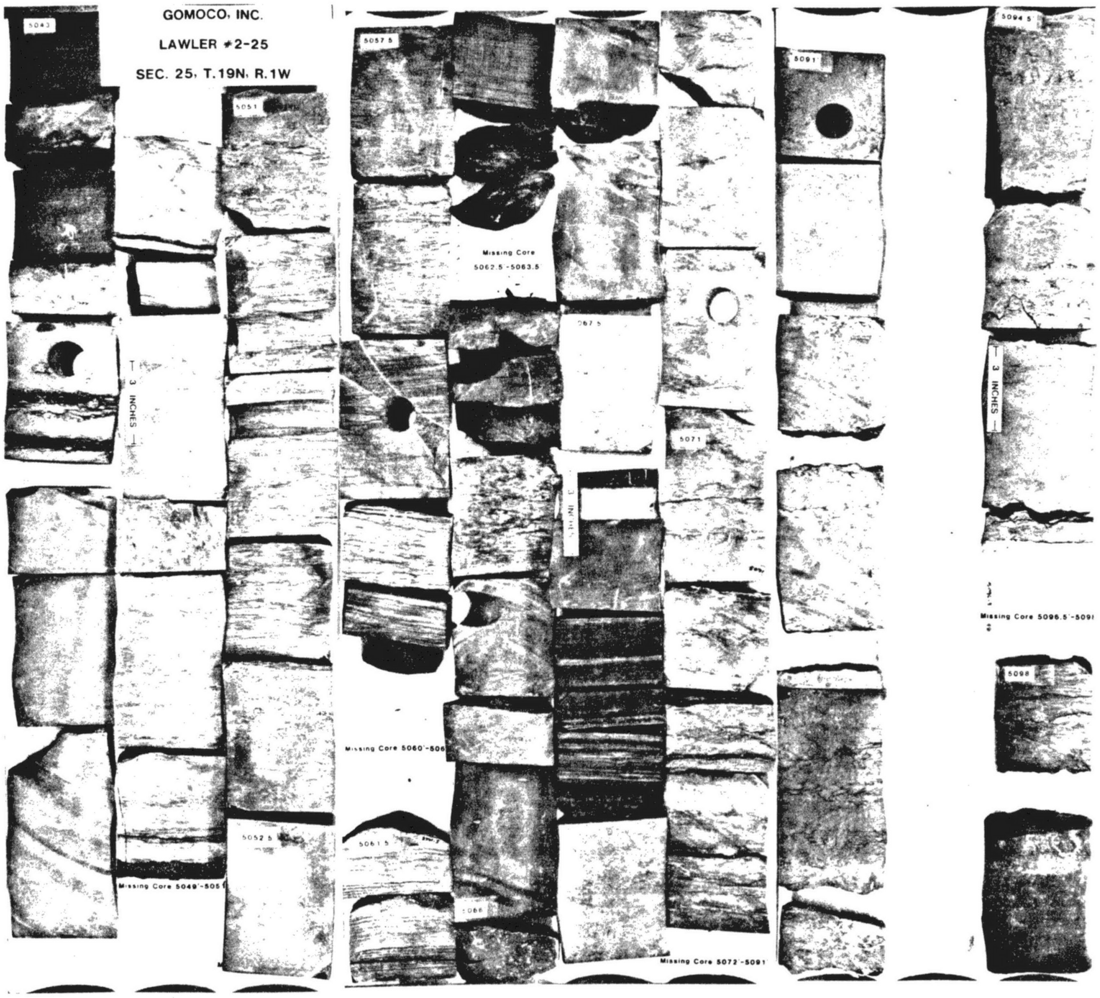
The next 4 feet of the core represent a silty shale unit containing horizontal laminae. The interval is grayish black in color and is underlain by four feet of bioturbated sand which also shows evidence of soft sediment deformation. Rock fragments, clay and carbonate clasts are absent from this interval, but it is otherwise similar to the overlying units.

The next 19 feet of the interval apparently were not cored, as the top of the next unit is at a depth of 5091 (-3991) feet which corresponds to a log depth of 5095 feet. This interval is 8 feet thick and is intensely bioturbated, with the base showing evidence of stylolitization and soft sediment deformation. The color of this interval is gray and it contains what appear to be very fine grained, well sorted constituents. Quartz is present, but not dominant, and rare feldspar grains were detected. Rock fragments, fossil fragments, glauconite, and dolomite are also present in the core.

Thin section analysis has revealed that this lowermost unit is a dolomite containing scattered remnant detrital constituents and porosity values up to 5 percent were detected at a depth of 5094.5 (-3994.5) feet. The classification of the core as dolomite also applies to parts of the middle and upper units as indicated in the lithology of the petrolog.

WELL LOG CHARACTERISTICS




GOMOCO, INC.
LAWLER #2-25
SEC. 25, T.19N, R.1W
5043
3 INCHES
Missing Core 5049'-505
5051
5052.5
5057.5
Missing Core 5060'-506
5061.5
Missing Core
5062.5'-5063.5'
5066
067.5
3 INCHES
5071
Missing Core 5072'-5091'
5091'
5094.5'
3 INCHES
Missing Core 5096.5'-509
5098

The 'ratty' nature of the gamma ray curve in the lower portion of the Misener interval indicates a large percentage of mud in the system. The upper unit appears to be a cleaner, more continous interval. This overall signature could be interpreted as a lower muddy estuarine unit proximal to a tidal channel, which is overlain by another tidal channel system which has scoured into the lower unit. Compensated neutron and density curves indicate a lithology which is possibly carbonate dominated, containing varying amounts of porosity throughout.

WELL: Sunray DX Corporation
Mt. Kilcrease Unit No. 1

LOCATION: 36-7N-5E, Pontotoc County

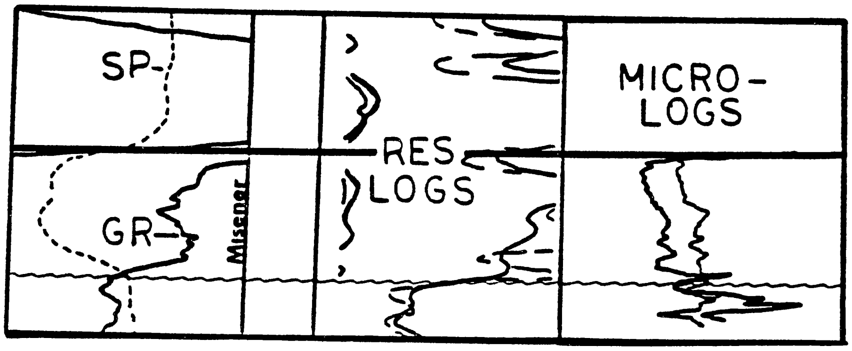
CORE INTERVAL

The top of the Misener Sandstone was penetrated by the drill bit at a depth of 3881.5 (-3068.5) feet, and the unit extends to a depth of 3899 (-3086) feet. This data and the well log curve signature data have been included in this study in order to allow a comparison of the Misener in southern Oklahoma to the Misener in north-central Oklahoma.

Sedimentary structures and features noted in this core are similar to those noted in north-central Oklahoma. The major difference appears to be an increase in the percentage of glauconite, phosphate, and phosphatic fossil fragments relative to quartz, and a decrease in the percentage of carbonate cement.

The interpretation follows that the Misener deposited in this location may have been more strongly affected by an upwelling environment, thus accounting for the presence of more phosphate grains, phosphatic fossil fragments, and glauconitic fecal pellets in the Misener.

WELL LOG CHARACTERISTICS



This log suite exhibits an interesting relationship between the SP and gamma ray logs through the Misener interval. Core data indicate that this is a quartz arenite to sublitharenite with large percentages of glauconite, in comparison to cores from north-central Oklahoma. The build up of the SP indicates porosity and permeability, while the substantial radioactive response of the gamma ray log to the sand is thought to relate to the glauconite instead of the usual case where shaliness causes a response.

The resistivity logs indicate a potential hydrocarbon bearing sand (when considered with the other logs), and the micro-resistivity logs exhibit positive separation through the Misener which is evidence of porosity and permeability, due to a mud cake build up on the borehole wall.

2

VITA

Lawrence Price Walker

Candidate for the Degree of

Master of Science

Thesis: DEPOSITIONAL ENVIRONMENTS, PETROGRAPHY, AND DIAGENESIS OF THE MIDDLE TO UPPER DEVONIAN MISENER SANDSTONE IN NORTH-CENTRAL OKLAHOMA

Major Field: Geology

Biographical:

Personal Data: Born in Yukon, Oklahoma, January 23, 1962, the son of Jesse L. and Betty Walker. Married to Patricia E. Grove on October 13, 1984.

Education: Graduated from Konawa High School, Konawa, Oklahoma, in May, 1980; received Bachelor of Science Degree in Arts and Sciences from Oklahoma State University in July 1984; completed requirements for the Master of Science degree at Oklahoma State University in December, 1986

Professional Experience: Summer Geophysicist, Exxon Company U.S.A., May, 1985, to August 1985; Graduate Research Assistant, Oklahoma State University, March, 1985, to May, 1986.

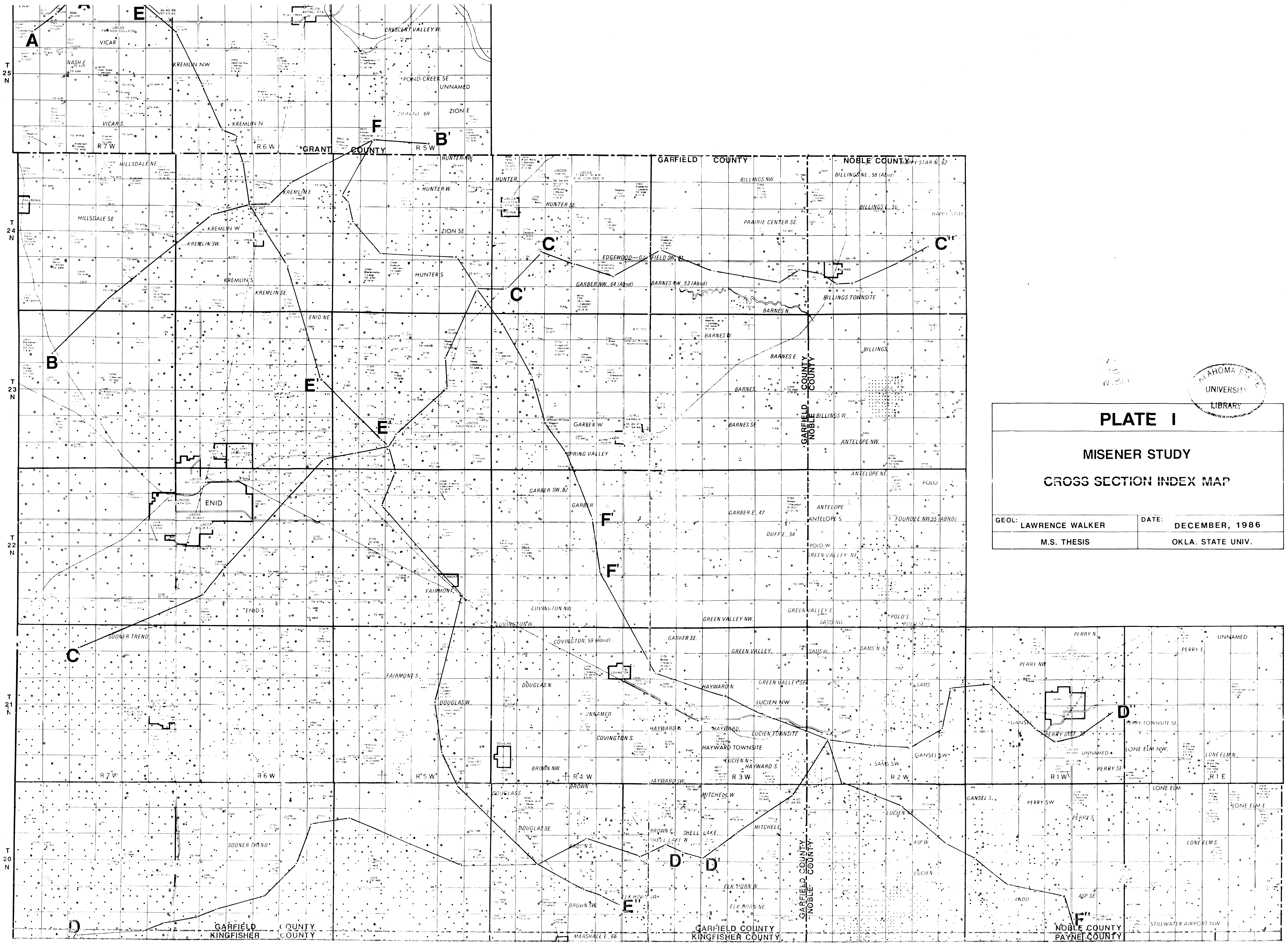


PLATE I

MISENER STUDY

CROSS SECTION INDEX MAP

GEOL: LAWRENCE WALKER	DATE: DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE II

SOUTHWEST - NORTHEAST
STRATIGRAPHIC CROSS SECTION A-A'
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL: LAWRENCE WALKER	DATE: DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE III

SOUTHWEST - NORTHEAST
STRATIGRAPHIC CROSS SECTION B - B´
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL LAWRENCE WALKER	DATE DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE IV

SOUTHWEST - NORTHEAST
STRATIGRAPHIC CROSS SECTION C-C`
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL LAWRENCE WALKER	DATE DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE V

SOUTHWEST - NORTHEAST
STRATIGRAPHIC CROSS SECTION C′-C″
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL LAWRENCE WALKER
DATE DECEMBER, 1986
M.S. THESIS
OKLA. STATE UNIV.

PLATE VI

SOUTHWEST - NORTHEAST

STRATIGRAPHIC CROSS SECTION D-D′

DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL: LAWRENCE WALKER	DATE: DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE VII

SOUTHWEST - NORTHEAST

STRATIGRAPHIC CROSS SECTION D′- D″

DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL. LAWRENCE WALKER	DATE DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE VIII

NORTHWEST - SOUTHEAST

STRATIGRAPHIC CROSS SECTION E-E'

DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL: LAWRENCE WALKER	DATE: DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE IX

NORTHWEST - SOUTHEAST
STRATIGRAPHIC CROSS SECTION E´-E˝
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL LAWRENCE WALKER	DATE DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV

PLATE X

NORTHWEST - SOUTHEAST
STRATIGRAPHIC CROSS SECTION F-F'
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL LAWRENCE WALKER	DATE DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

PLATE XI

NORTHWEST - SOUTHEAST
STRATIGRAPHIC CROSS SECTION F'-F''
DATUM: BASE OF KINDERHOOK LIMESTONE

GEOL. LAWRENCE WALKER	DATE DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.

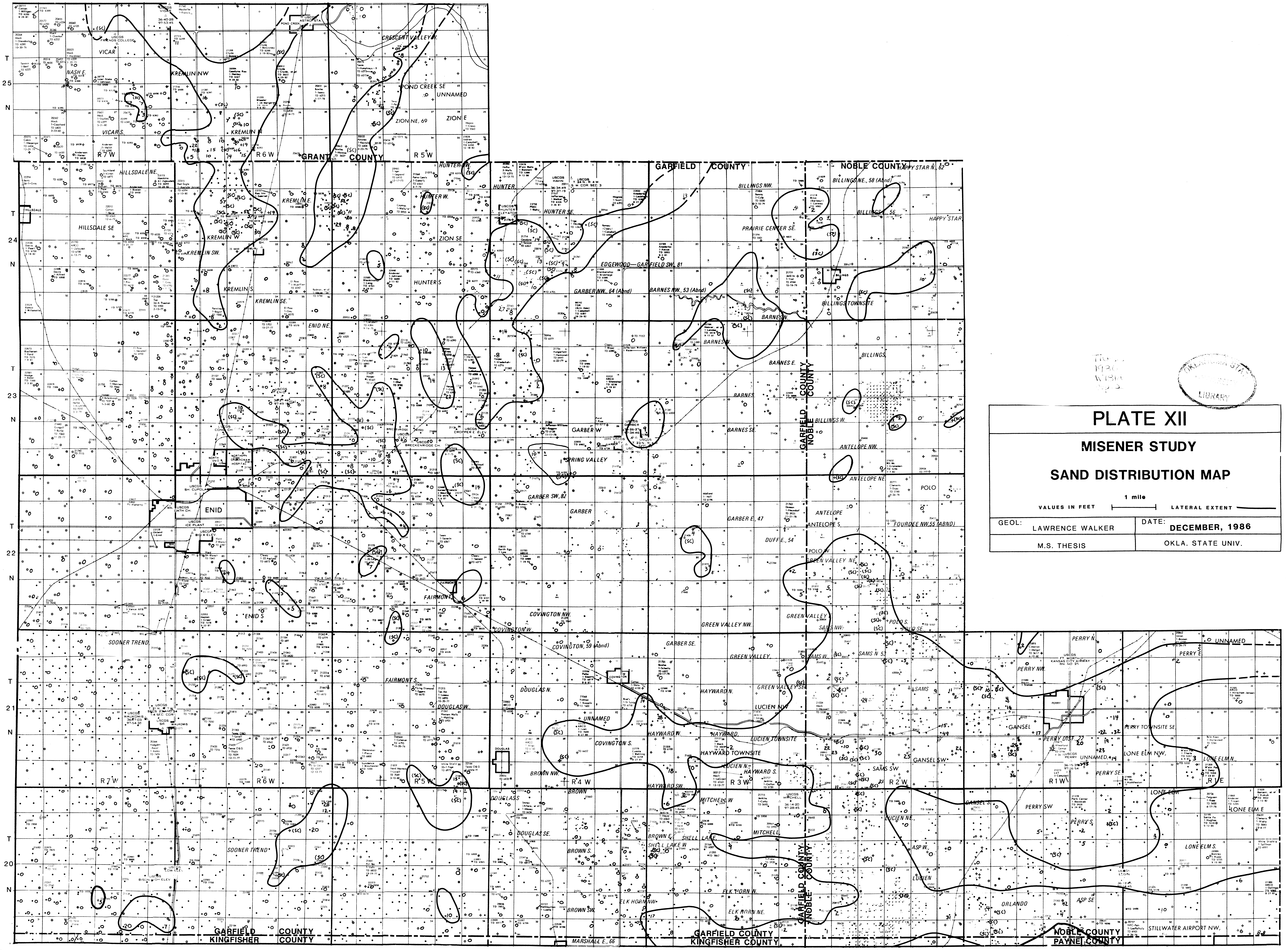


PLATE XII

MISENER STUDY

SAND DISTRIBUTION MAP

1 mile

VALUES IN FEET

LATERAL EXTENT

GEOL: LAWRENCE WALKER	DATE: DECEMBER, 1986
M.S. THESIS	OKLA. STATE UNIV.