MORROWAN SANDSTONES IN SOUTH-CENTRAL TEXAS COUNTY, OKLAHOMA

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CHAPTER I

ABSTRACT

Morrowan sandstones of the Oklahoma Panhandle commonly are divided into informal stratigraphic units. The "Upper" Morrowan sandstone generally is considered to have been deposited in a fluvial setting; "Lower" Morrowan sandstones generally are interpreted as having been deposited during a shallow-marine transgression.

Interpretation of Upper Morrowan sandstones is based on evidence such as (1) quartz, feldspars, and rock fragments that range widely in grain size, (2) carbonized plant remains that are common, (3) overall fining-upward sequences, (4) strata that are finer grained upward, from granules and coarse grained sands to medium sized grains, (5) abundant medium scale crossbeds (6) lateral discontinuity of strata, and (7) absence of fossils and/or glauconite.

Interpretation of Lower Morrowan sandstones is based on (1) fairly consistent grain size, (2) abundant glauconite and fossil fragments, (3) sparse detrital clay, (4) some small scale to medium scale crossbeds, and (5) overall blanket-type geometry.

The Morrowan interval thickens to more than 600 ft. in the western half of the study area, from slightly more than 500 ft. in the southeast part of the study area. Thickness of Upper Morrowan strata varies approximately 70-80 ft. across the study area, whereas Lower Morrowan strata vary as much as 150 ft. in thickness. The top of the Morrowan interval dips gently southeastward at about 0.5 degrees. Dip is interrupted by three syndepositional faults that trend northeastward and by four small domes.

Porosity in Upper and Lower Morrowan sandstones is mostly secondary, due to enlarged pores and partly dissolved grains; minor types of porosity include intergranular porosity and microporosity within authigenic clays.

Petroleum from Upper Morrowan rocks is produced mostly from stratigraphic traps. The sandstones are encased in nonmarine shales and siltstones. Lower Morrowan reservoirs mostly are in structural traps.

CHAPTER II

INTRODUCTION

Location

The study area is in the Hugoton Embayment of the Anadarko Basin. It is in the Oklahoma Panhandle, in the south-central to southeastern part of Texas County, Oklahoma. Included in the study area are Townships 2 and 3 North, and Ranges 13 to 15 ECM (east of the Cimarron Meridian) (Figures 1 and 2).

The terms "Upper Morrow" and "Lower Morrow," used throughout the report, are not formal stratigraphic nomenclature. However, these names are used widely in the literature for reference to divisions of the Morrowan section (Figure 3) (Swanson, 1979 p. 120; Cornish, 1982, p. 74).

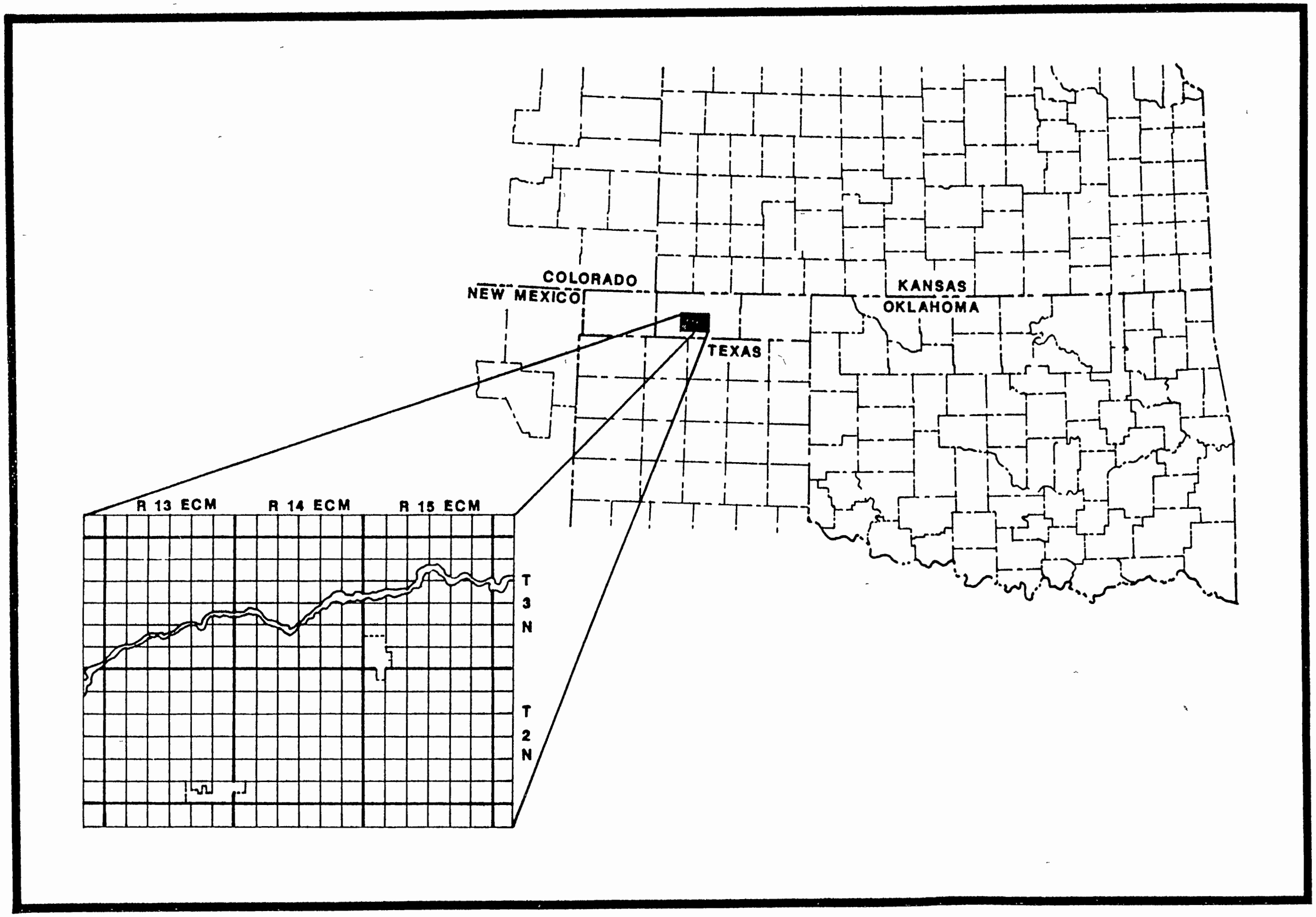

Figure 1. Location of the study area.

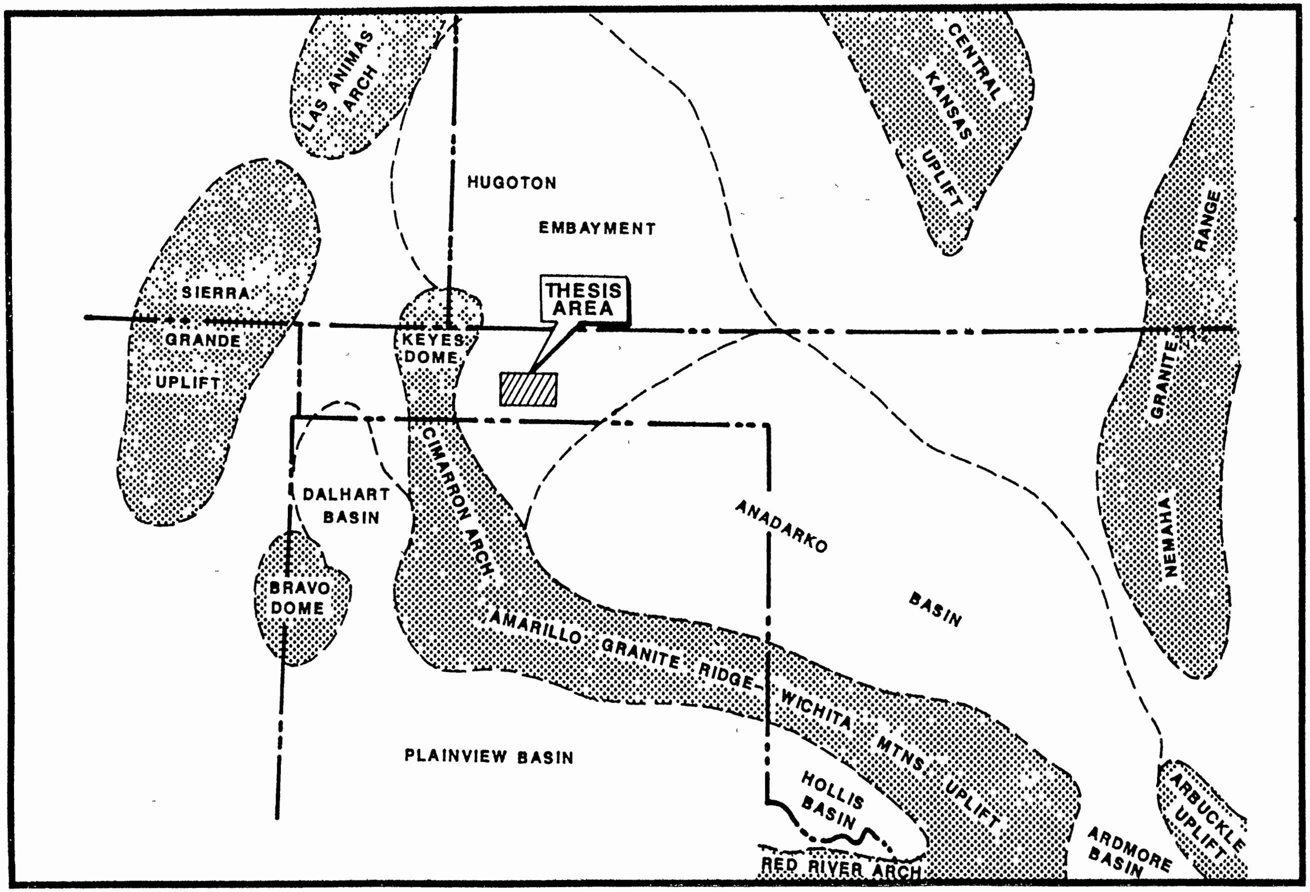

Figure 2. Location of the study area with respect to major structural features (modified from Forgotson et al., 1966, p. 519; Abels, 1959, p. 93).

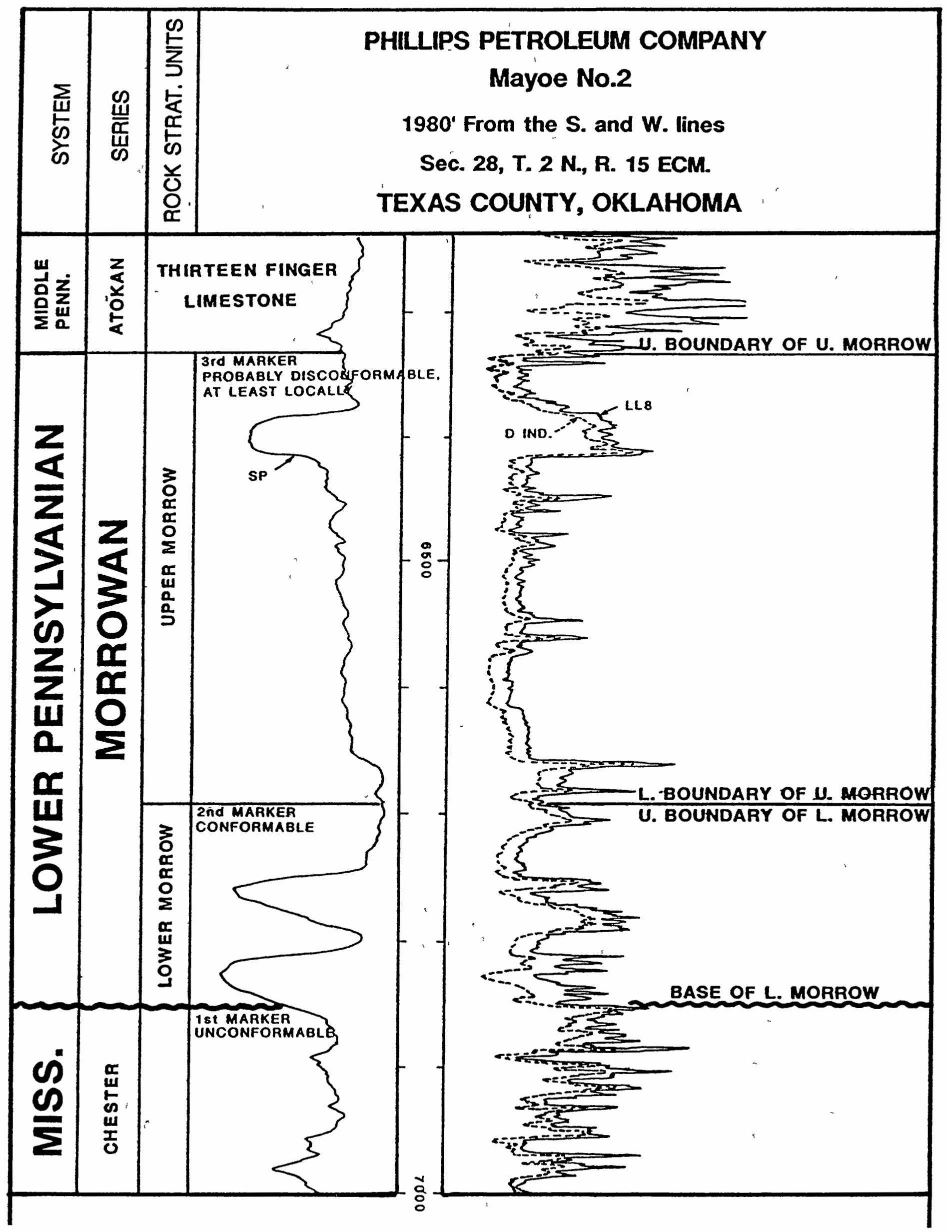

Figure 3. Type log of principal Upper Mississippian and Lower Pennsylvanian strata within the study area.

Objectives

Rocks of primary concern in this research are sandstones of the Morrowan Series (Figure 3). The sands may have been transported to the Anadarko Basin from the Amarillo-Wichita Uplift, Central Kansas Uplift, and Sierra Grande Uplift (King, 1951, p. 146; Arro, 1965, p. 28; Benton, 1972, p. 8, 9). The most accepted explanation indicates the source of sediment was the Sierra Grande Uplift (Arro, 1965, p. 28; Abels, 1959, p. 104; Swanson, 1979, p. 164) (Figure 2). At many localities in the Hugoton Embayment, Morrowan sandstones are exceptionally productive of oil and gas.

Sandstones of the Upper and Lower Morrowan generally are regarded as having been deposited in fluvial and marine environments, respectively. The majority of evidence seems to support these interpretations (Halverson and Robinson, 1989, p. 283; Cornish, 1982, p. 73; Curtis and Ostergard, 1980, p. 142; Benton, 1972, p. 3), but in exploration for Morrowan sandstones, some formidable questions arise.

1) Can the boundaries of the Upper and Lower Morrow be correlated throughout the area?

2) Can the Mississippian/Pennsylvanian unconformity be determined from wireline logs? Can it be determined from cores?

3) Are marker units within the Upper and Lower Morrow traceable for long distances?

4) If markers are extensive, can time-stratigraphic relationships of the sandstones and the bounding units be described?

5) Do cores and cuttings permit calibration of wireline logs in terms of lithofacies?

6) Do cores of the units show strong evidence as to the environments of deposition?

7) Do thin sections of the rocks show evidence as to the environments of deposition?

8) Do shales in the cores contain evidence of deposition in marine environments?

9) Can distinctive SP-resistivity-conductivity-log signatures be correlated with characteristic log signatures derived from density logs, neutron logs, and sonic logs?

Methods of Study

Dwight's production-data and Petroleum Information's data books, both oil and gas production, were the sources of information for the production map, which shows distribution of oil- and gas-production by rock-stratigraphic unit (Plate I).

Data from more than 200 wireline logs were used to make structural contour maps, isopach maps, sandstone-trend maps and sandstone-thickness maps. Structural contour maps of these marker-beds were made: (1) the base of the Keyes sandstone (Plate II); (2) a marker-bed selected to represent the top of the Lower Morrow interval (Plate III); and (3) the base of the Thirteen Finger Limestone (Plate IV) (for details on the rationale concerning selection of marker beds, refer to Appendix D).

To increase the accuracy of contour placement, particularly near the borders of the study area, information was obtained from logs of wells within a 1-mile-wide strip of land around the study area (Figure 1).

The four cores available from the vicinity of the study area were documented (Figure 4); 60 thin sections from these cores were described (Appendix B). The cores and thin sections were used mostly to describe petrography of the sandstones, and to draw inferences about the depositional settings of the Morrowan sandstones. A secondary objective of the thin-section analysis was to interpret the sequence of diagenetic events.

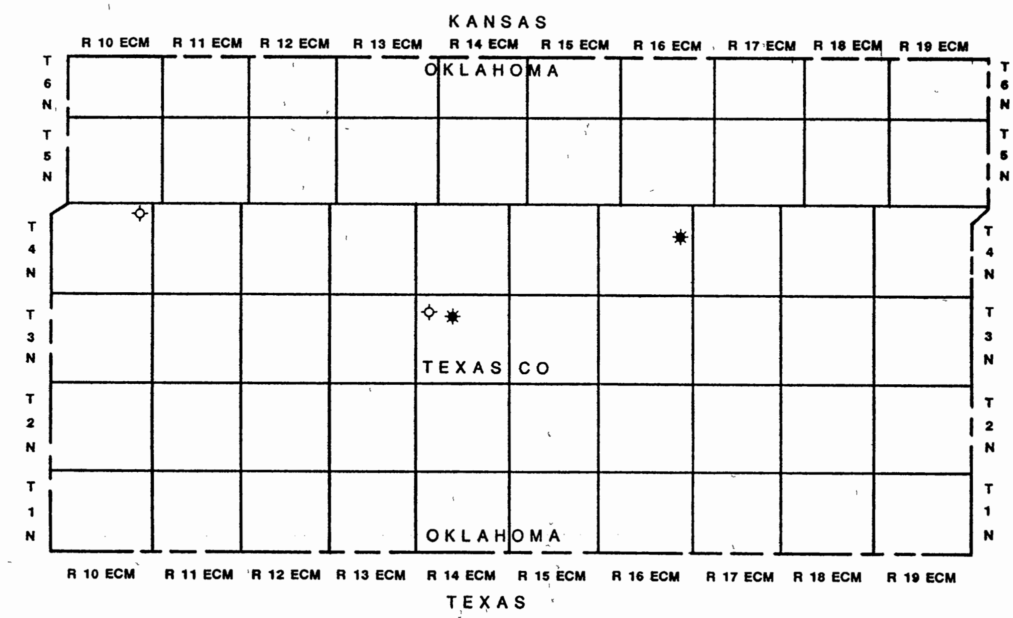

Figure 4. Locations of wells from which cores were studied.

CHAPTER III

HISTORY OF EXPLORATION

Petroleum was discovered near the study area in 1918 (Figure 5), in northern Potter County, Texas. The well, drilled on a dome mapped at the surface by C. N. Gould in 1917 (Davis and Northcutt, 1989, p. 16), initiated drilling in the Panhandle Gas Field. The Panhandle Oil Field was discovered during 1921 in Carson County, Texas. The first discovery of gas in the Hugoton Embayment, in 1922, was from a shallow Permian reservoir in Seward County, Kansas (Davis and Northcutt, 1989, p. 18). The field was extended into Texas County, Oklahoma in 1922 (Totten, 1956, p. 1947; Totten, 1961, p. 69) and in 1923 the Guymon-Hugoton gas area was discovered in southwestern Texas County, Oklahoma. These fields eventually were linked to form the Panhandle-Guymon-Hugoton Gas Field, the largest gas field in North America (Davis and Northcutt, 1989, p. 18) (Figure 6).

In May, 1943, Pure Oil Co. discovered petroleum in Morrowan rocks. Pure drilled the discovery well of the Keyes Field, the No. 1 R. E. Cox, in Section 16, T5N, R8ECM, Cimarron County, Oklahoma. Initial gas production of 19 MMCFPD was from the Keyes sandstone (Lower Morrow) at a depth of 4677-4751 feet. Lower Morrow sands at Keyes

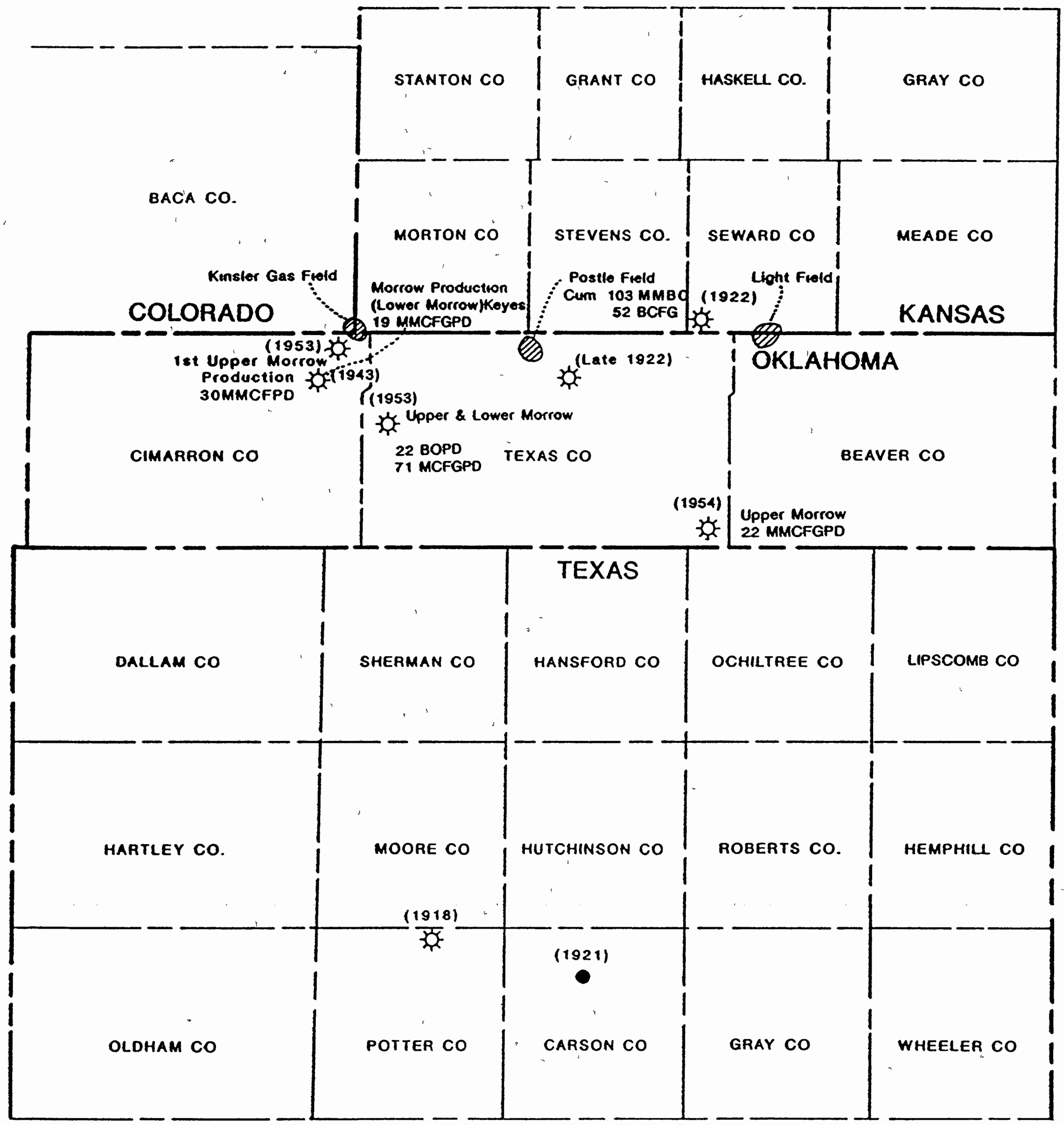

Figure 5. Locations of wells significant in discovery and enlargement of oil and gas fields in southwestern Kansas, Oklahoma Panhandle, and Texas Panhandle.

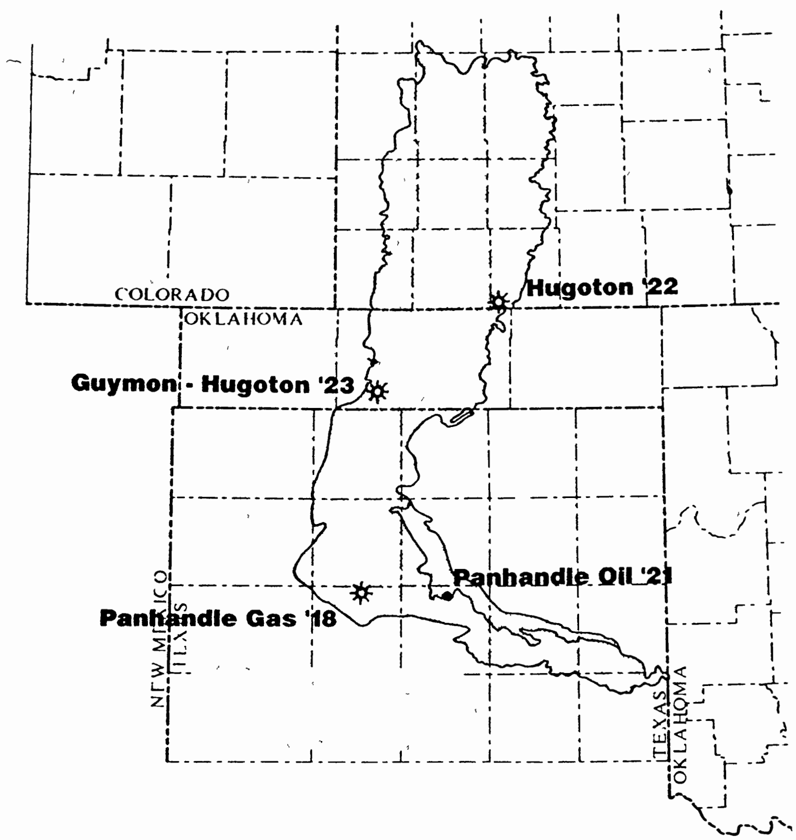

Figure 6. The current extent of the Panhandle-Guymon-Hugoton Gas Field. Symbols (☼) gas well; (●) oil well. (From Davis and Northcutt, 1989, p. 16.)

Field had produced 500 billion CFG and 1.7 million BO as of 1985 (Davis and Northcutt, 1989, p. 19). The first production of oil and gas from Upper Morrowan sandstone was in May, 1953. Coltexo Corp. drilled the No. 1 Purdy in Section 20, T6N, R9ECM, also in the Keyes Field; initial potential was 30 MMCFPD (Wagner, 1961, p. 241).

During the 1950's there were many discoveries of oil and gas in the Oklahoma Panhandle and Texas Panhandle. The Northwest Eva Field, discovered in 1953 by the Union Carbon No. 1 Kelly, is a few miles northwest of the study area. Located in Section 2, T4N, R10ECM, the initial potential of 22 BOPD and 71 MCFPD (Figure 5) predominantly was from Upper Morrowan sandstones and partially from the Lower Morrowan Keyes sandstone (Williams, 1961, p. 251, 252). At this location oil and gas were produced mostly from stratigraphic traps in Upper Morrowan sandstones. Traps in the Lower Morrow Keyes sandstone are structural (Williams, 1961, p. 251-252).

The Camrick Gas Field was discovered in 1954 by Texas Company's No. 1 J. H. Cook well in Section 27, T1N, R19ECM (Figure 5). Initial potential was 22,250 MCFPD (Dempsey, 1961, p. 245). The Camrick Field has produced 1 trillion CFG and 14 million BO as of the end of 1985 (Davis and Northcutt, 1989, ps. 19, 20). Production is from stratigraphically trapped, discontinuous, lenticular Upper Morrowan sandstones.

The Postle Field, discovered in northern Texas Co. in 1958, has produced 103 million BO and 52 billion CFG from Upper Morrowan sandstones. This field and the Camrick Field are interpreted as having been deposited in a large deltaic plain (Davis and Northcutt, 1989, p. 20).

Discoveries continued through the 1950's and 1960's; more than 16 major fields were found in the Oklahoma Panhandle. Currently, exploratory drilling in the Anadarko Basin is primarily restricted to the deeper basin; however, much development drilling is continuing in the Hugoton Embayment.

CHAPTER IV

PREVIOUS STUDIES

From evidence based on fusilinid foraminifera, M. L. Thompson defined the Morrowan stratigraphic sequence of shales, sandstones and limestones to the Morrowan Series based on fusilinid identification (Dobervich and Parker, 1958, p. 5). Morrowan strata were correlated throughout the Oklahoma and Texas Panhandles, southeastern Colorado, and western Kansas by Maher, who used Thompson's descriptions, and faunal identifications by Henbest (Dobervich and Parker, 1958, p. 5).

Stratigraphic units described by Maher were the basis for definition of the Morrowan section in the Anadarko Basin/Hugoton Embayment (Dobervich and Parker, 1958, p. 5).

The term "Hugoton Embayment" was introduced in 1948 for that area previously referred to as the "Dodge City Embayment" (Maher and Collins, 1948, p. 813-816). Reasons for proposing the new terminology were that the axis of the basin extends near Hugoton and the thickest Carboniferous rocks are near Hugoton.

Study of diagenesis of Lower Morrowan sandstones resulted in interpretation of two basic types of sandstone: nearshore clean, well sorted, nonglauconitic, noncalcareous quartzose sand deposited in a high energy environment, and a seaward facies of the first type. The seaward facies has glauconite, more calcareous cement, and is less well sorted; locally shale is the dominant rock (Adams, 1954, p. 1568, 1569). Much of the porosity in Upper Morrowan sandstones is secondary, such as moldic pores and enlarged intergranular pores formed from partially dissolved grains. These types of porosity are results of diagenetic dissolution (Walker, 1986, p. 52-56; Rader, 1990, p. 54) as well as formation of clay (microporosity).

Morrowan rocks include light to medium gray shales as well as gray-green shales with carbonaceous material (Dobervich and Parker, 1958, p. 5). Shales are interbedded with discontinuous sandstones and limestones (Totten, 1956, p. 1955; Abels, 1959, p. 96; Worden, 1959, p. 125; Pate, 1959, p. 49). In general, Morrowan sandstones are gray to tan and arkosic, with decreasing amounts of feldspar eastward (Abels, 1959, p. 99), fine to coarse grained, poorly sorted, subangular to subrounded, and glauconitic with calcareous cement.

Upper Morrowan sandstones are angular to subangular, with unweathered feldspars and detrital cementing material. These rocks have been interpreted as having had local, low-lying sources (Barrett, 1964, p. 5). Possible other sources include the Central Kansas Uplift, the Sierra Grande Uplift and the Amarillo-Wichita Mountains (Arro, 1965, p. 28).

The Lower Morrowan interval has been interpreted as having been deposited in a sea that advanced from southeast to northwest (Davis, 1964, p. 8). Sediments "filled in" or "leveled out" the irregular topography on Mississippian rocks, of which most relief had been developed before (or to a lesser degree, early in) deposition of Morrowan sediments (Dobervich and Parker, 1958, p. 7; Arro, 1965, p. 28 and 29; Forgotson et al., 1966, p. 532). Lower Morrowan sands were spread into, within and among valleys by marine processes. These sandstones are predominantly fine to medium grained, fossiliferous, and glauconitic, with siliceous and calcitic cements (Barrett, 1964, p. 3, 4).

Morrowan sandstones have been mapped locally in many areas near the present study area. Some such areas are the Kinsler Field in Morton County, Kansas, Baca County, Colorado, and Cimarron County, Oklahoma (Davis, 1964) (Figure 5), the Light Field in Beaver County, Oklahoma and Seward County, Kansas (Barby, 1960), (Figure 5) and the southeastern part of Texas County, Oklahoma (Curtis and Ostergard, 1980). Numerous regional studies of Morrowan strata have been published (for example, Swanson, 1979, and Barrett, 1964).

CHAPTER V

GEOLOGIC SETTING

The Anadarko Basin is bounded on the south by the anticlinorium composed of the Arbuckle Mountains, Wichita Mountains, and the Amarillo Uplift (Figure 2). The axis of the basin is only about 30 mi. north of the anticlinorium, but the comparatively gentle northern flank of the basin extends as far as southwestern Nebraska; the northwesternmost part of the basin forms the Hugoton Embayment (Figure 2). In Oklahoma and southern Kansas the Nemaha Range is the eastern limit of the Anadarko Basin, whereas the Sierra Grande Uplift, the Las Animas Arch, the Keyes Dome and the Cimarron Arch are positive elements that make up the western boundary (Figure 2).

The area of concern in this research is in the Hugoton Embayment. The embayment lies between the Las Animas Arch, to the northwest, and the Central Kansas Uplift, to the northeast (Figure 2). The study area is only a few miles east of the Cimarron Arch and the smaller but prominent Keyes Dome (Figure 2).

In general, the uplifts cited above and others shown in Figure 2, and correspondingly the Anadarko Basin and Hugoton Embayment, were active as long ago as the

Mississippian Period (Huffman, 1959, p. 2546; Stewart, 1975, p. 130; Wilson, 1975, p. 248). Evidence of recurrent movement of these structural elements in the Late Paleozoic and Mesozoic is detectable by inspection of regional areal geology (for example, see Miser and others, 1954).

The major episodes of tectonic activity on the southern margin of the Anadarko Basin were the Wichita disturbance, Late Mississippian through Early Pennsylvanian (Morrowan), and the Arbuckle orogeny, Late Pennsylvanian (King, 1951, p. 146, 147; Huffman, 1959, p. 2544, 2545).

CHAPTER VI

STRUCTURAL SETTING

Overall dip of Morrowan strata is about 0.5 degrees southeastward across most of the study area (Plates II-IV). Structural features include three small domes (Plate II); at the top of the Morrowan interval two are expressed as noses and only one as a dome (Plate IV). Regional dip also is interrupted by three down-to-the-northwest faults and one down-to-the-southeast fault that trend 30-40 degrees east of north and two possible minor down-to-the southeast faults and one minor down-to-the-west fault (Plates II, III, and IV). Faulting began during Mississippian time and continued into the Morrowan (Forgotson, et al., 1966, p. 521).

Observation of structural contour maps of the three marker beds shown on Figure 3, (1) the base of the Lower Morrowan sandstone (Plate II), (2) the top of the limestone/sandstone marker (Plate III), and (3) the base of the Thirteen Finger Limestone (Plate IV), reveals evidence about relative timing of faults. At the lowest marker (D) (Figure 7; Plate II), the most western fault shows displacement of more than 95 ft., at the top of the Lower Morrowan section (B) (Figure 7; Plate III)

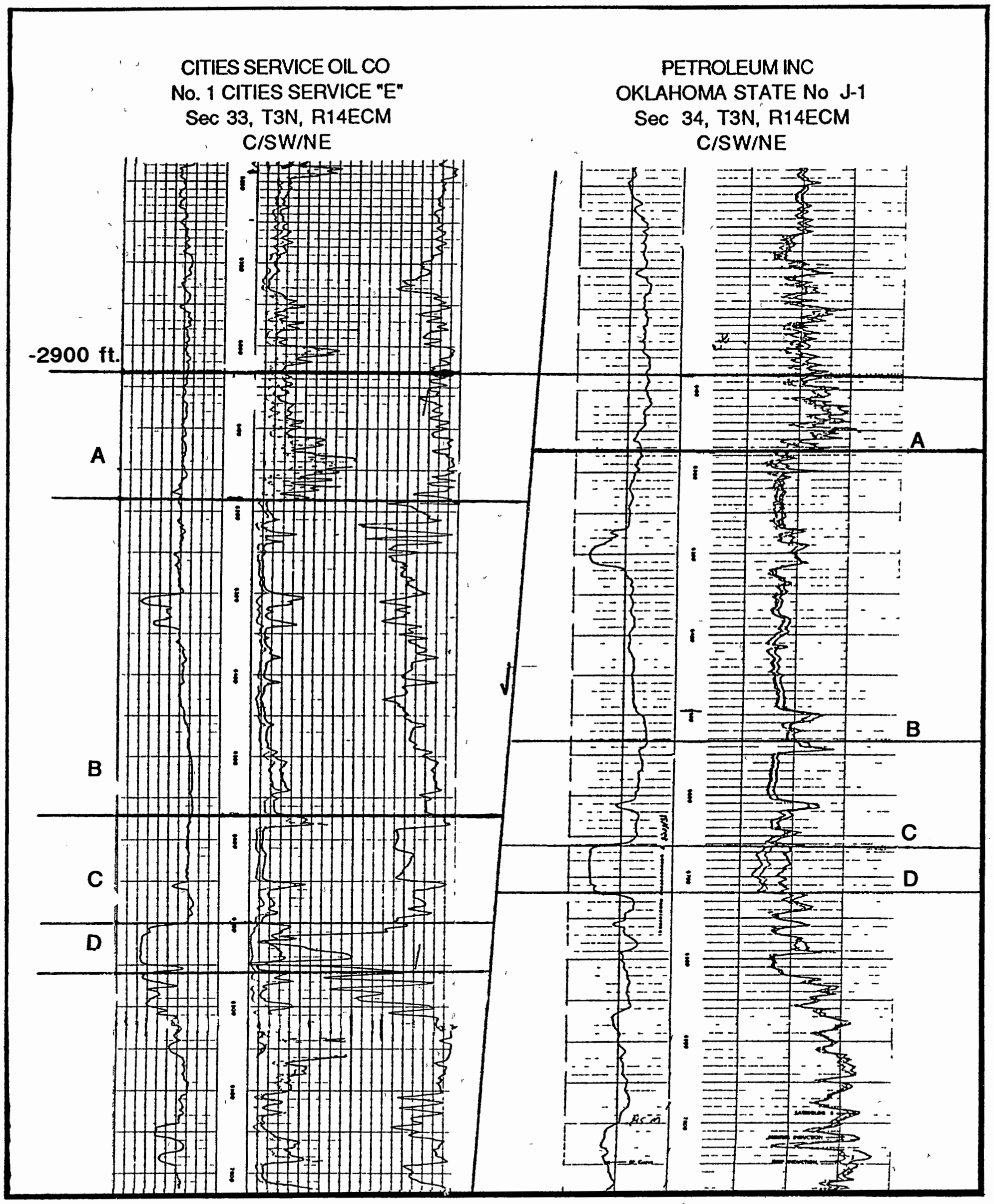

Figure 7. Logs of two wells located 1 mile apart. Displacement of markers decreases upward; well on down-thrown side of fault has slightly more than 90 ft. of displacement at marker D; displacement at marker A is little more than 60 ft. Location is shown as 1-1′ on Plates II, III, and IV.

displacement is almost 90 ft.; and at marker (A), Figure 7; Plate IV) it is slightly more than 60 ft. This evidence tends to suggest that some faulting continued through Morrowan time, but decreased in intensity.

Morrowan faulting probably was syndepositional. Evidence includes (1) the progressive upward decrease in vertical displacement, (2) the added strata in section (Plates XIII, XIX, (in orange) and Figure 7), (3) and the large increase in Lower Morrowan sandstone thickness on the down-thrown side of the westernmost fault. Part of this thickness is also attributed to pre-Morrowan erosion. The thickening of Lower Morrowan strata (Plates VI, VIII) can be explained in a few ways: (1) alluvial valley filled with back-stepping marine sediments; valley was cut during lowstand of sea level toward close of Mississippian time, (2) alluvial valley fill; erosional channel could have been related genetically to displacement along a fault, prior to deposition of the Lower Morrowan sandstone, or (3) deposition of Lower Morrowan sandstones on a down-dropped block.

CHAPTER VII

STRATIGRAPHY

In the northwestern part of the Anadarko Basin of Oklahoma, the units generally called "Morrow," are believed to be of Morrowan age (Figure 3). The Morrow probably is unconformable upon Mississippian rocks.

Within the study area, the youngest Mississippian rocks are considered to be Chesteran, primarily (Benton, 1972, p. 2). The Chesteran Series ranges from more than 600 feet thick, in portions of Beaver County, Oklahoma to zero on the Keyes dome (Barby, 1956, p. 15).

Mississippian System

Chesteran Series

Chesteran rocks primarily are fossiliferous limestones. They contain abundant ooliths, crinoid stems, bryozoans, brachiopods and ostracods (Curtis and Ostergard, 1980, p. 118; Barrett, 1964, p. 3). Interbedded with the mottled limestones are gray to green-gray and brown fissile shales (Abels, 1959, p. 96). These limestone units can be classified using Dunham's classification as oolitic bioclastic grainstones, crinoid-bryozoan wackestones, and crinoid-bryozoan packstones (Asquith, 1984, p. 87).

Pennsylvanian System

Morrowan Series

"Lower Morrow" Sequence

The lowermost rock units of the Pennsylvanian System are Morrowan. The upper boundary of the "Lower Morrow" interval is herein defined as a selected sandstone/limestone marker generally in contact with an overlying shale (Figure 3); the base of the "Lower Morrow" is defined as the base of the Keyes sandstone (see Appendix D; Figure 3). The Lower Morrow interval is composed predominantly of shales with thin discontinuous sandstone and limestone units (Barrett, 1964, p. 3). These units record an overall transgressive sequence with many disconformities (Sonnenberg, 1990, p. 207).

Sandstones. Throughout the general area the Lower Morrowan sandstone units are more widespread than Upper Morrowan sandstone units. Grain sizes range from very fine to medium, and sorting from poor to fair. These sandstones are gray to white and locally are argillaceous (Barrett, 1964, p. 4). Curtis and Ostergard (1980, p. 118) concluded that the entire lower section of Morrowan rocks is generally more marine than the upper section. This detailed description is consistent with Barrett's except that they described the rocks as having more glauconite. Arro (1965, p. 21-22) described Lower Morrowan sandstones from north-central and northwestern Texas County, Oklahoma simply as finer grained and better sorted than Upper Morrowan sandstones from the same area.

Shales. Shales in the Lower Morrow section generally are dark, rich in organic material, pyritic (Arro, 1965, p. 21) slightly calcareous, (Curtis and Ostergard, 1980, p. 118) micaceous, and locally glauconitic (Barrett, 1964, p. 4).

Limestones. Limestones of the Lower Morrowan section commonly are more argillaceous than Mississippian limestones (Totten, 1956, p. 1955). Most of these strata are sandy, buff to tan, and locally dolomitic. Some of the limestones are hard, microcrystalline, and gray to brown. Lower Morrowan limestones contain 2% glauconite, on the average (Barrett, 1964, p. 4). Deposition of the sediments was across the truncated Chesteran terrain (Swanson, 1979, p. 117-118; Cornish, 1982, p. 74).

"Upper Morrow" Sequence

The Upper Morrowan section is bounded on the bottom by the same sandstone/limestone - shale contact that marks the upper boundary of the Lower Morrow (Figure 3). The top is defined as the base of the Thirteen Finger Limestone (Figure 3) (Swanson, 1979, p. 119; Dobervich and Parker, 1958, p. 9) (see also Appendix D).

The Upper Morrowan interval is the record of sediments deposited primarily within a fluvial setting (Benton, 1972, p. 3). Parker (with Dobervich, 1958, p. 9) stated that in the central part of the northern Texas Panhandle, Upper Morrowan rocks are similar over a large region. The rock is a section of fissile, gray to dark gray shales interbedded with few lenticular sandstones and a few discontinuous limestones.

Sandstones. Sandstones of the Upper Morrow generally are coarser grained than those of the Lower Morrow. They are nonfossiliferous and arkosic, and range from fine grained to granular. At many places the sandstone is poorly sorted, locally is conglomeratic, and at some places the rock contains fragments of carbonized wood or other carbonaceous debris (Kasino and Davies, 1979, p. 173). The sandstone units fine upward from very coarse grained/granular to medium grained and fine grained (Swanson, 1979, p. 122).

Shales. At many places, the shales are fossiliferous, carbonaceous and pyritic; locally they are rich in glauconite and calcareous cement (Barrett, 1964, p. 4).

Limestones. Limestones in the Upper Morrow are less extensive, finer grained and more sandy than limestones in the Lower Morrow (Curtis and Ostergard, 1980, p. 118).

Atokan Series

Thirteen Finger Limestone

The Atokan Thirteen Finger Limestone generally is dark brown to gray but at some places it ranges from white to black. Interbedded with strata of limestone are black, splintery, bituminous shales. The Thirteen Finger Limestone is crystalline to chalky and dolomitic; locally is contains fossil fragments and chert (Munson, 1989, p. 5; Benton 1972, p. 4).

CHAPTER VIII

DIAGENESIS

Introduction

The principal reason for analysis of thin sections was to gather information for interpretation of depositional environments of the Upper and Lower Morrowan sandstones, as well as to interpret the diagenetic history of the sandstones. Also examined were thin sections of shales and limestones that bound the sandstones. Descriptions of all thin sections are included in Appendices B and C.

In the discussion that follows, photomicrographs show exemplary constituents of Morrowan rocks. Photomicrographs are in pairs; the upper one was made under plane-polarized light, the lower under crossed nicols. Also, a code follows the caption of each photomicrograph. This code denotes which thin section is shown: ST4 signifies Cities Service No. 4 Stonebraker "AN", ST101 is the code for Cities Service No. 101 Stonebraker "A", FF signifies Shell No. 1-13 Finfrock, and KY is the code for Gulf No. 1 C. C. Kelly. The number following the code is the index number of the thin section, the description of which is in Appendices B, C, and D.

Upper Morrowan Rocks

Cities Service No. 4 Stonebraker "AN"

Upper Morrowan rocks in the core from the No. 4 Stonebraker "AN" mostly are subarkoses and sublithchertwackes; sublitharenites, sublithwackes, and quartz arenites are minor components.

Detrital Constituents

The major constituents are monocrystalline quartz and clay matrix (Figure 8). Minor detrital constituents (generally less than 5% of the total rock) include polycrystalline quartz, feldspars, chert and other rock fragments, muscovite and zircon. Except for feldspar and chert, minor detrital constituents were recorded in trace amounts.

On the average, monocrystalline quartz is the most common detrital constituent; it makes up approximately 60% of the rock. Grains generally are poorly sorted and subrounded to subangular. Extinction of grains commonly is straight, but a few grains show slight undulose extinction, suggesting that the rocks have been compacted strongly by faulting or folding (Al-Shaieb, 1992). Some grains have pressure-solution features at grain boundaries (Figure 9).

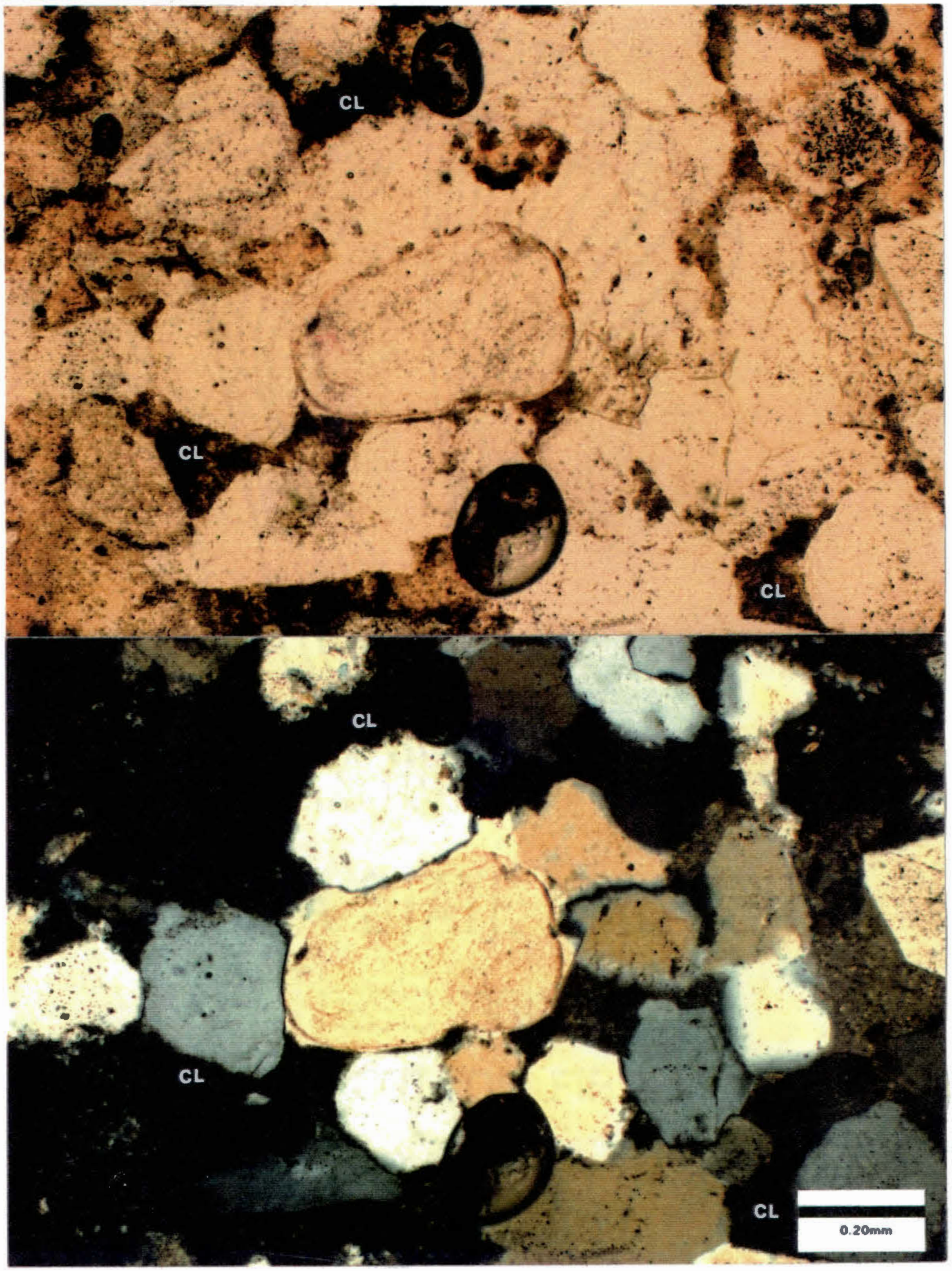

Figure 8. Abundant quartz grains and detrital clays (CL) (ST4-8).

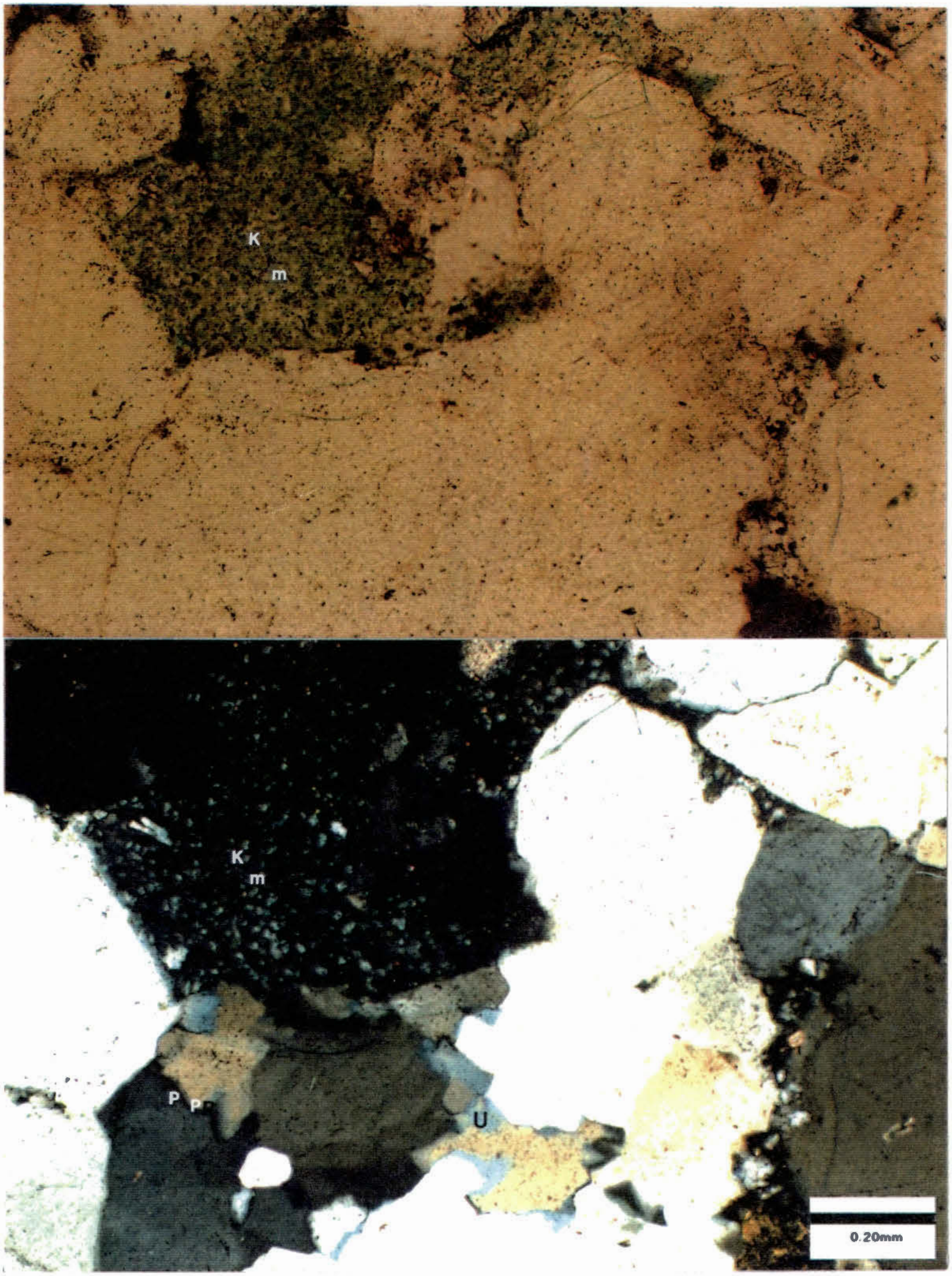

Figure 9. Undulose extinction (U) of quartz grains and pressure features (P) at grain boundaries. Kaolinite (K) with internal microporosity (m) in upper left of figure (ST4-9).

Detrital matrix is the second most common constituent; it averages 12.8% overall. Dominantly the material is pseudomatrix of compacted clay particles; the pseudomatrix occludes much of the original pore space.

Authigenic Constituents

Authigenic constituents predominantly are cements, clays, and slight amounts of pyrite and organic material.

Siliceous cement, as syntaxial overgrowths, makes up at least 2% of the rock. Overgrowths generally are detectable by dust rims, which outline the original grains (Figure 10). Of the carbonate cements, calcite is dominant (4.3% on the average); dolomite is minor (average 0.5%) (Figure 11).

Authigenic clays include kaolinite, illite and chlorite. Kaolinite is most abundant (average: 3%). Kaolinite (Figure 9) and illite are pore-filling. Chlorite is present only as pore-lining traces.

Organic matter is abundant in the thin sections. It is in stylolitic laminae, residual from pressure dissolution of inorganic material (Figure 12).

Porosity

Total average recorded porosity is only 2%; however some parts of the rock have porosity of as much as 10%. Porosity is mostly secondary, in the forms of enlarged intergranular pores and micropores within

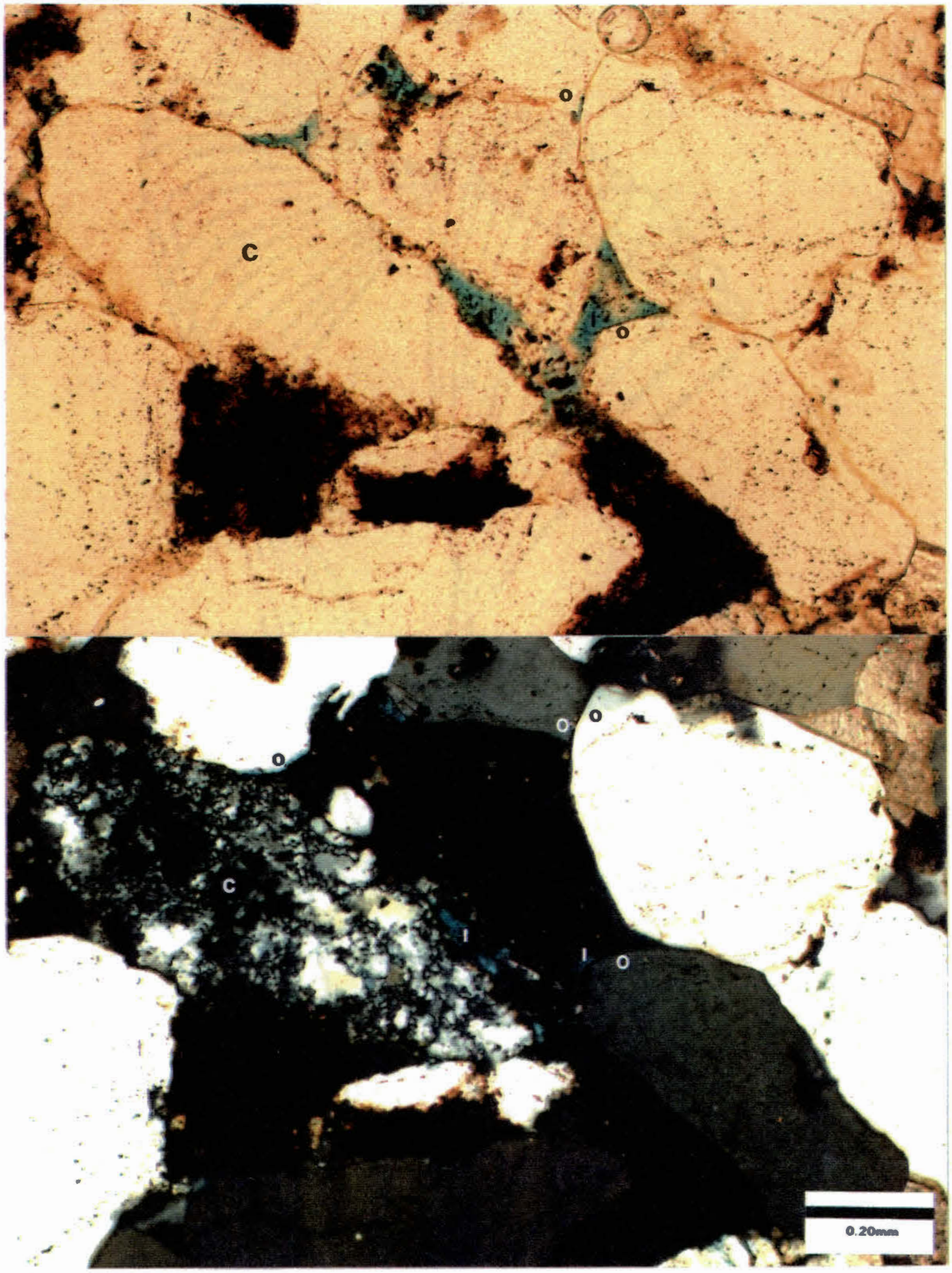

Figure 10. Photomicrographs show quartz grains with well developed overgrowths (O), as shown by dust rims; also chert fragment (C) and some primary (intergranular) porosity (I) (ST4-17).

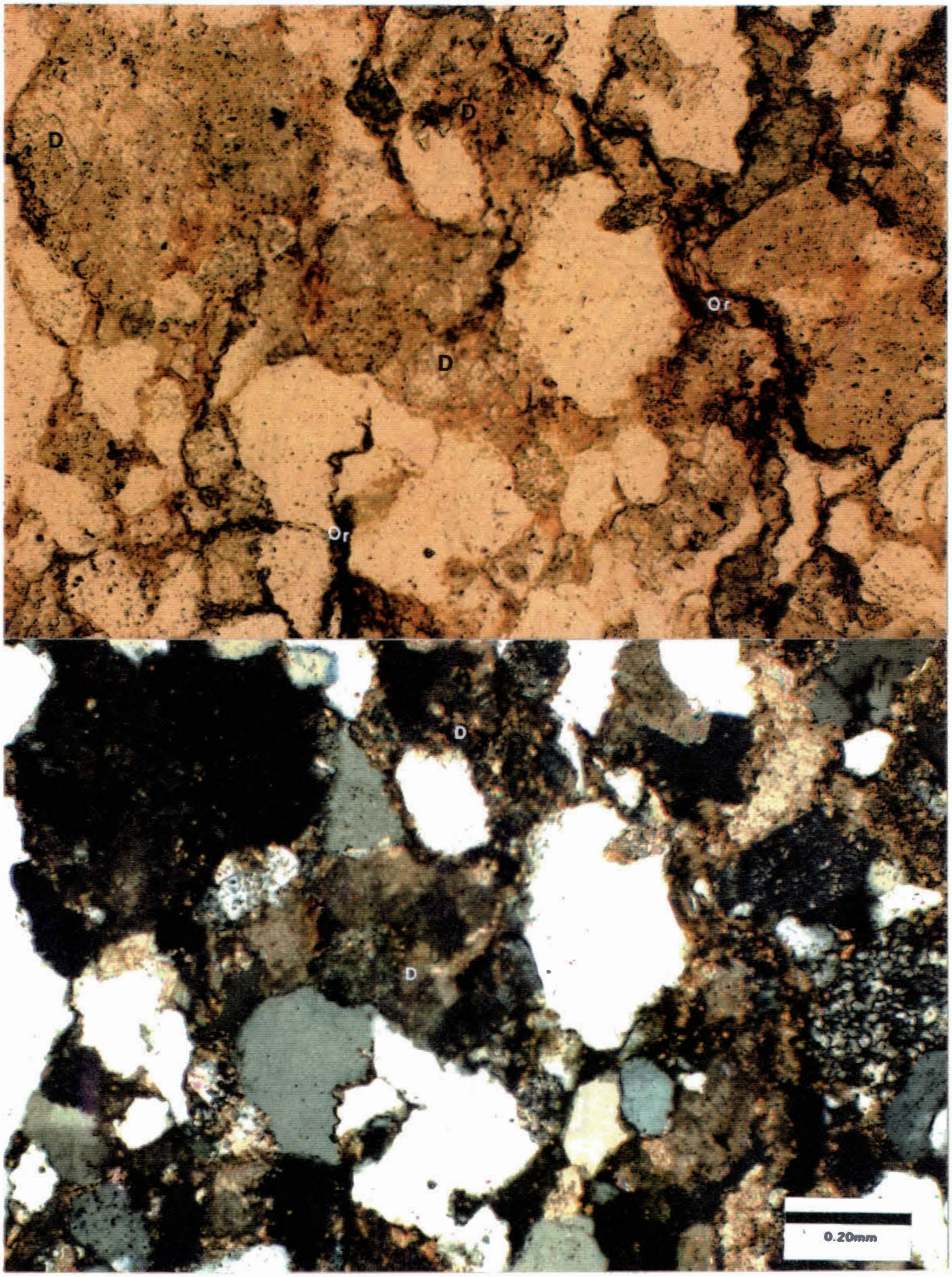

Figure 11. Dolomite rhombohedra (D) within calcite-dominated cement; also wisps of organic material (Or) (ST4-16).

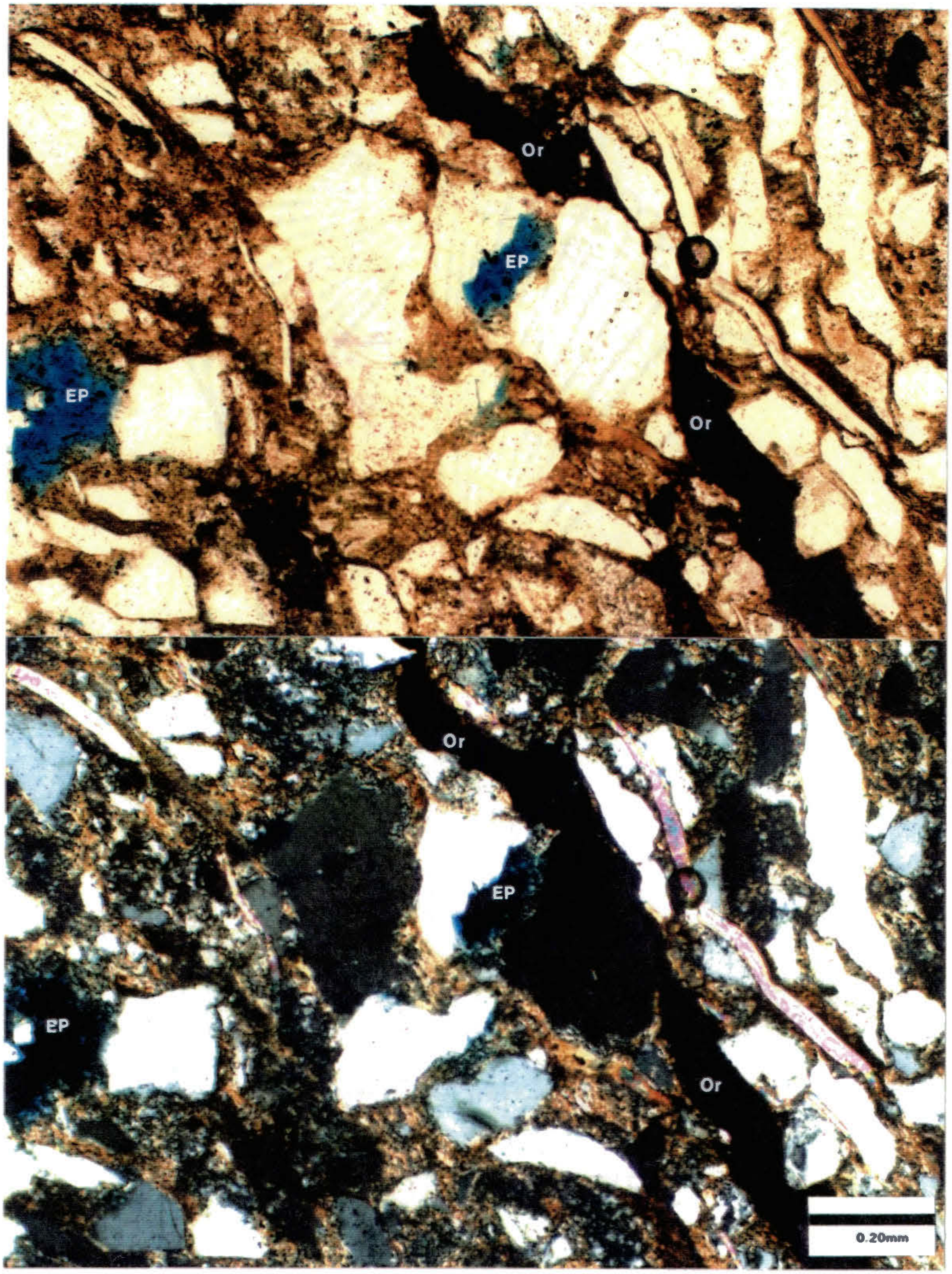

Figure 12. Organic material (Or) in a stylolite, and enlarged intergranular pores (EP) (ST4-4).

authigenic clays (Figures 12 and 9 respectively). Primary porosity is intergranular and quite sparse (Figure 10).

Cities Service No. 101 Stonebraker "A"

Upper Morrowan sandstones in the core from the No. 101 Stonebraker "A" are subarkose, subarkosic wacke, feldspathic lithwacke, quartz wacke and sublitharenite.

Detrital Constituents

The main detrital constituents of sandstone in the No. 101 Stonebraker "A" are monocrystalline quartz and clay matrix. Minor detrital constituents generally are less than 2 to 3% of the total rock; they are polycrystalline quartz, feldspars, chert and other rock fragments, muscovite, zircon, traces of glauconite, and traces of collophane (phosphate), which commonly is cement in fragments of siltstone.

On the average, monocrystalline quartz composes 50% of the sandstone. Grains are poorly to very poorly sorted and subrounded to subangular.

Detrital matrix is the second most common constituent of the sandstone, 11.3% on the average. Mostly it is pseudomatrix of compacted particles of clay.

The trace amounts of glauconite are accompanied by traces of collophane.

Authigenic Constituents

Authigenic constituents predominantly are cements and clays, with pyrite and organic material.

Siliceous cement as syntaxial overgrowths makes up at least 1% of the rock; it is revealed by dust rims in the original grains (Figure 13). Poikilotopic calcite cement is 20% of the rock, on the average; primarily it is owing to dissolution of grains and replacement by calcite, as well as being partly initial calcite cement, precipitated early in diagenesis. Some grains are almost completely replaced by calcite (Figure 13). Dolomite cement is only in very slight amounts.

Authigenic clays mostly are kaolinite and illite, which commonly are pore-filling.

Organic matter is present only in trace amounts.

Porosity

Total average porosity is only 0.7% with a maximum of 1.4%. Porosity mostly is secondary, as enlarged primary porosity (Figure 13), and to a lesser degree, microporosity within authigenic clays.

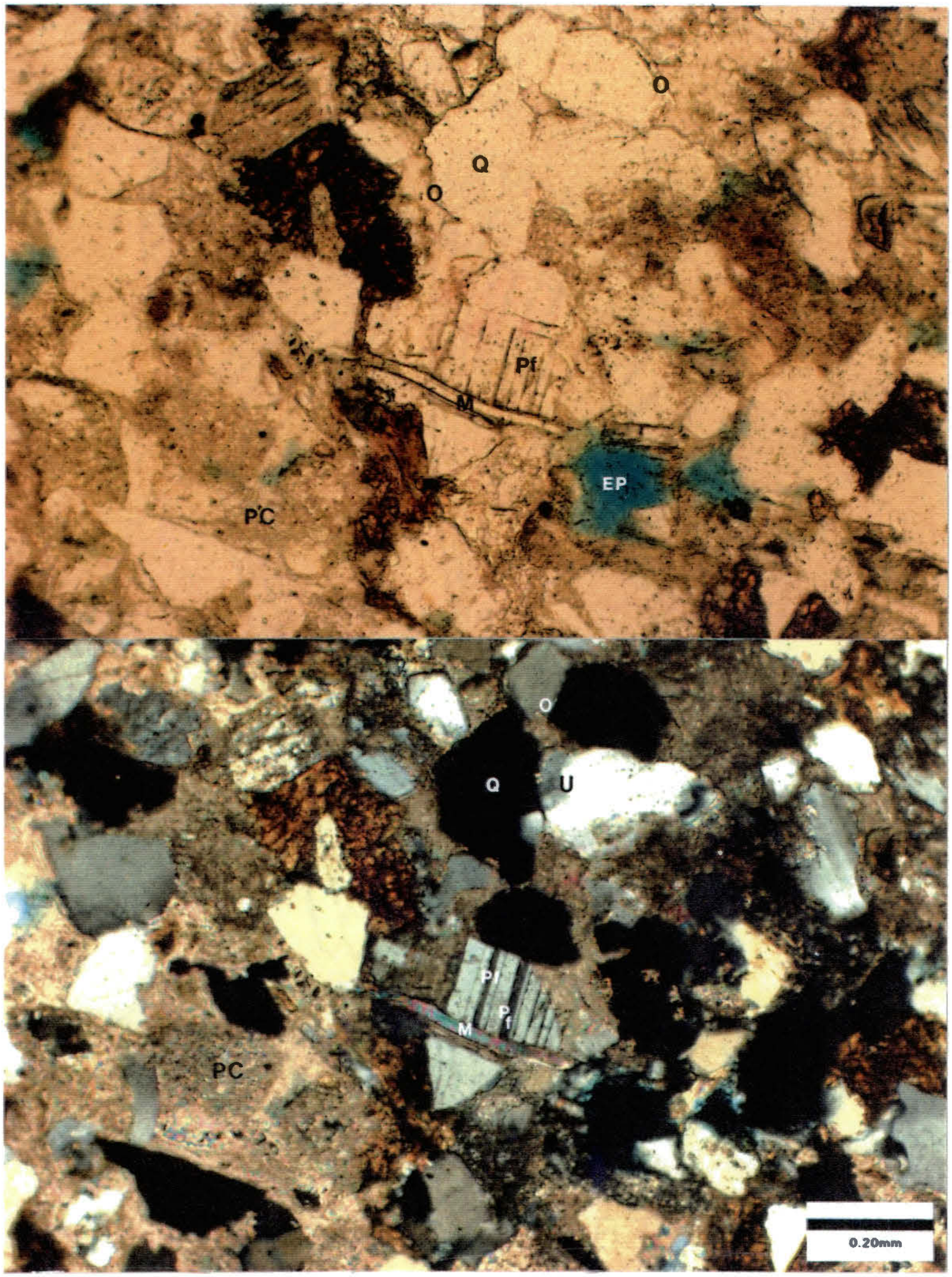

Figure 13. Quartz (Q), plagioclase feldspar (Pf), muscovite (M), detrital illite, enlarged intergranular porosity (EP), quartz overgrowths, and poikilotopic calcite cement (PC). Note the undulose (U) extinction of some of the quartz grains (ST101-27).

Lower Morrowan Rocks

Shell Oil No. 1-13 Finfrock

Lower Morrowan rocks in the core from the No. 1-13 Finfrock mostly are sublitharenites and quartz arenites; however, two thin-section samples were wackes.

Detrital Constituents

Most detrital constituents are monocrystalline quartz, glauconite and fossil fragments. Minor detrital constituents (generally less than 2 to 3% of the rock) include muscovite, chert and other rock fragments, feldspars, collophane-cemented pebbles, and zircon.

Monocrystalline quartz, the most common detrital constituent, makes up more than 50% of the rock, on the average, ranging from 31% to 71%. Grains are poorly to moderately sorted and rounded to subangular (grains in two samples are well sorted). The grains show straight to slightly undulose extinction (Figure 14).

Glauconite is abundant, 5% of this rock on the average, ranging from less than 1% to more than 12% (Figure 15). Glauconite characteristically is bright green, with some having been partially dissolved (Figure 15). The glauconite grains are mostly rounded or slightly oval; similar grains, in the Cromwell Sandstone of southern Oklahoma have been interpreted as being *in situ* fecal pellets (Stout, 1991, p. 97).

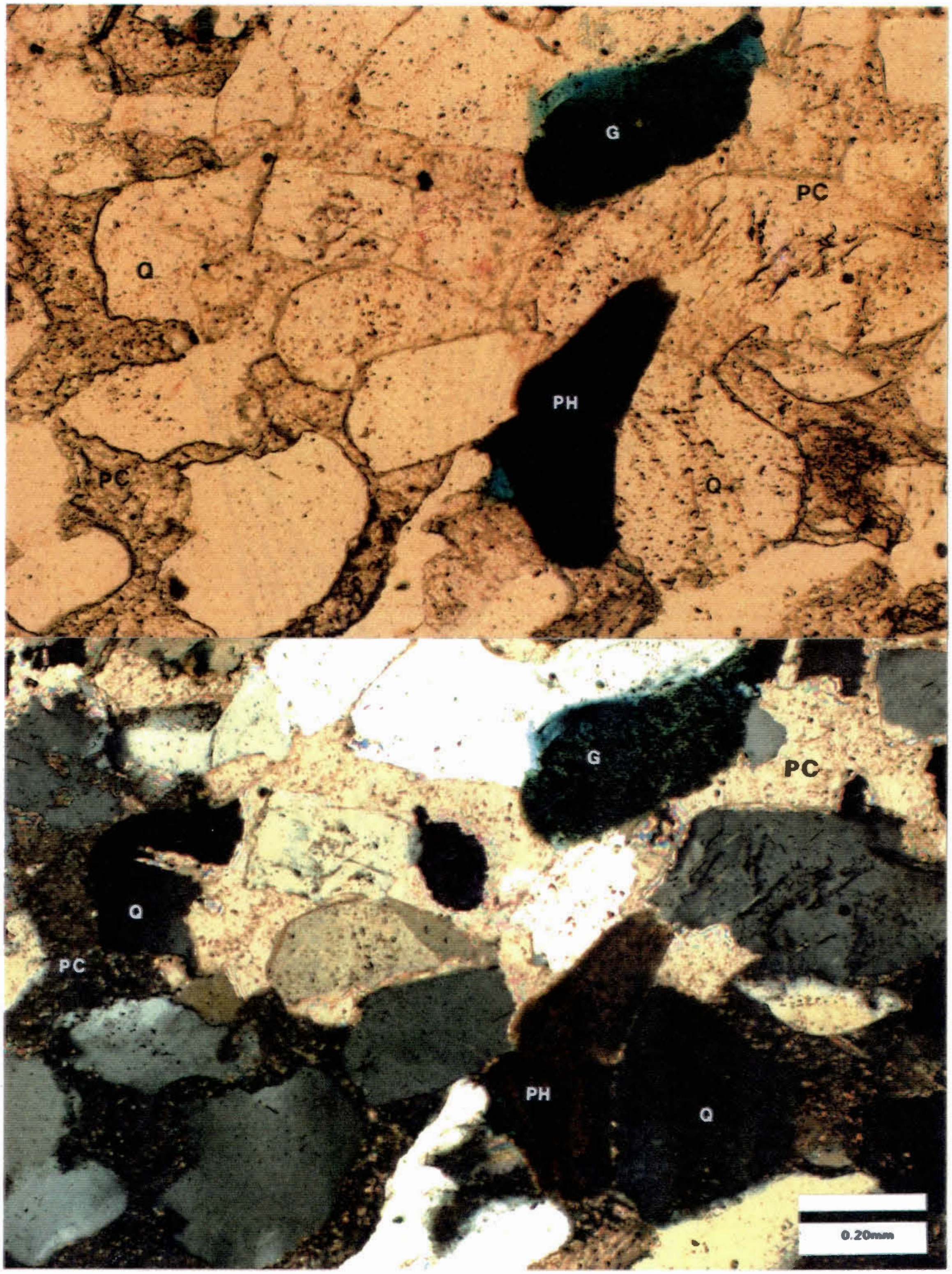

Figure 14. Dominant quartz (Q), which has straight to slightly undulose extinction, with glauconite (G) and phosphatic clay (PH) in poikilotopic calcite cement (PC) (FF-46).

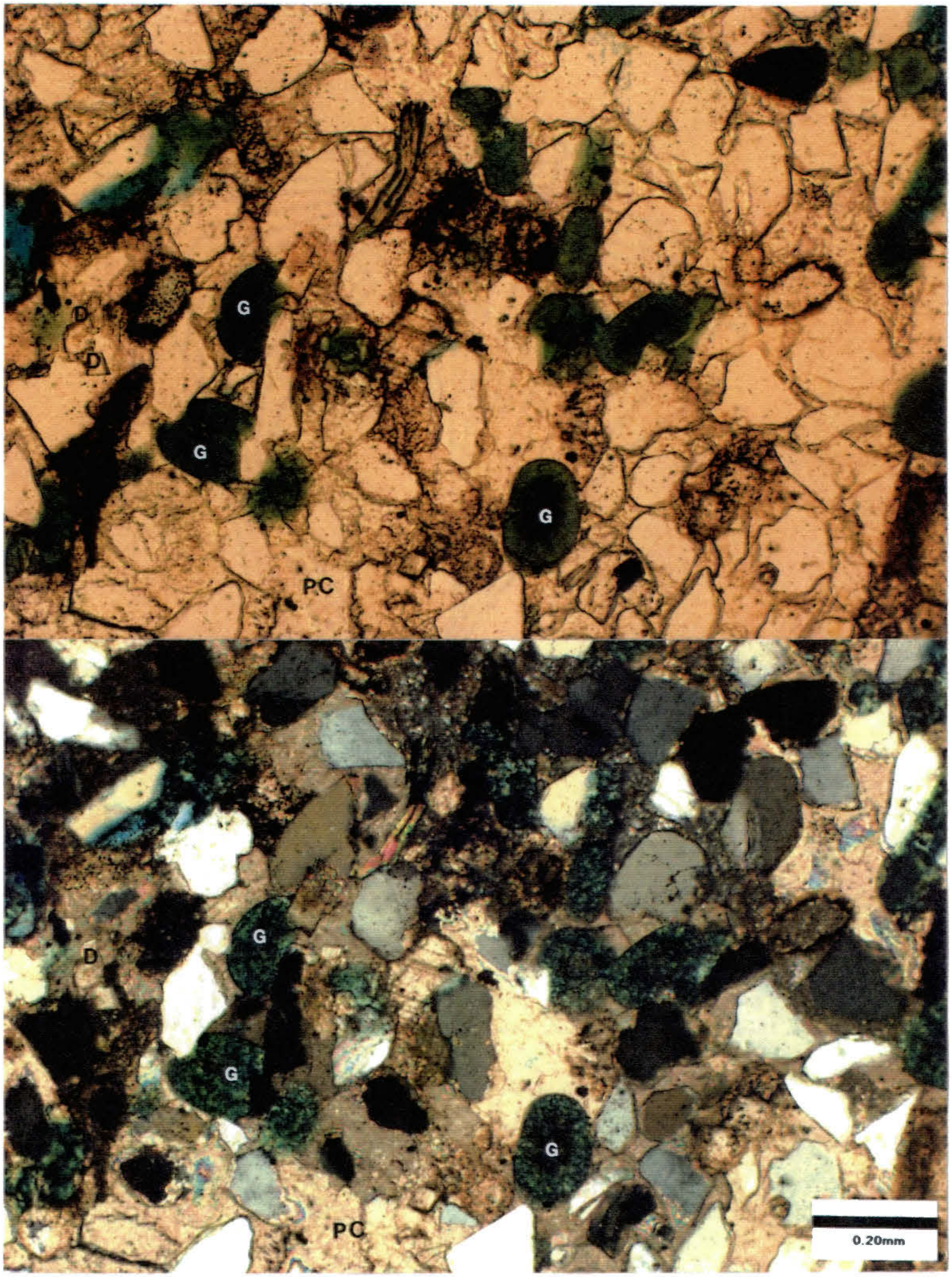

Figure 15. Abundant glauconite (G) (some of which is partially dissolved) in predominantly calcite cement (PC) (slight amount of dolomite (D) in far left) (FF-37).

Fossil fragments are also in most samples. They average 3% of the rock, and in one sample compose 22% of the rock. Fossil fragments chiefly are echinoderm-plate fragments (Figure 16) and fragments of bryozoa (Figure 17).

Authigenic Constituents

Authigenic constituents mostly are cements and clays; pyrite and traces of organic material are minor components.

Siliceous cement as syntaxial overgrowths makes up at least 2% of the rock; it is marked by dust rims that show boundaries of the original grains (Figure 18). Much angularity of grains is due to quartz overgrowths, which crystallized around host grains (Figure 18). Poikilotopic calcite cement is dominant (Figures 14, 15, and 16), about 20% on the average and maximally 45%. Dolomite cement is in small amounts (Figure 15).

Authigenic clays mostly are kaolinite and illite, with small amounts of chlorite. Kaolinite (Figure 18) and illite are primarily pore-filling. Kaolinite and illite average 5% and 2% per sample, respectively. Chlorite is sparse, and has been suggested as being due to replacement of glauconite (Ostergren, 1992).

Organic matter is present only as traces, preserved as stylolites in areas of pressure dissolution.

Porosity

Total average porosity is 3.7%, with a maximum of 18%. Porosity mostly is secondary, as enlarged primary porosity, partly or completely dissolved grains, shrunken detrital glauconite, microporosity within authigenic clays, and microporosity preserved in the cements (Figure 19).

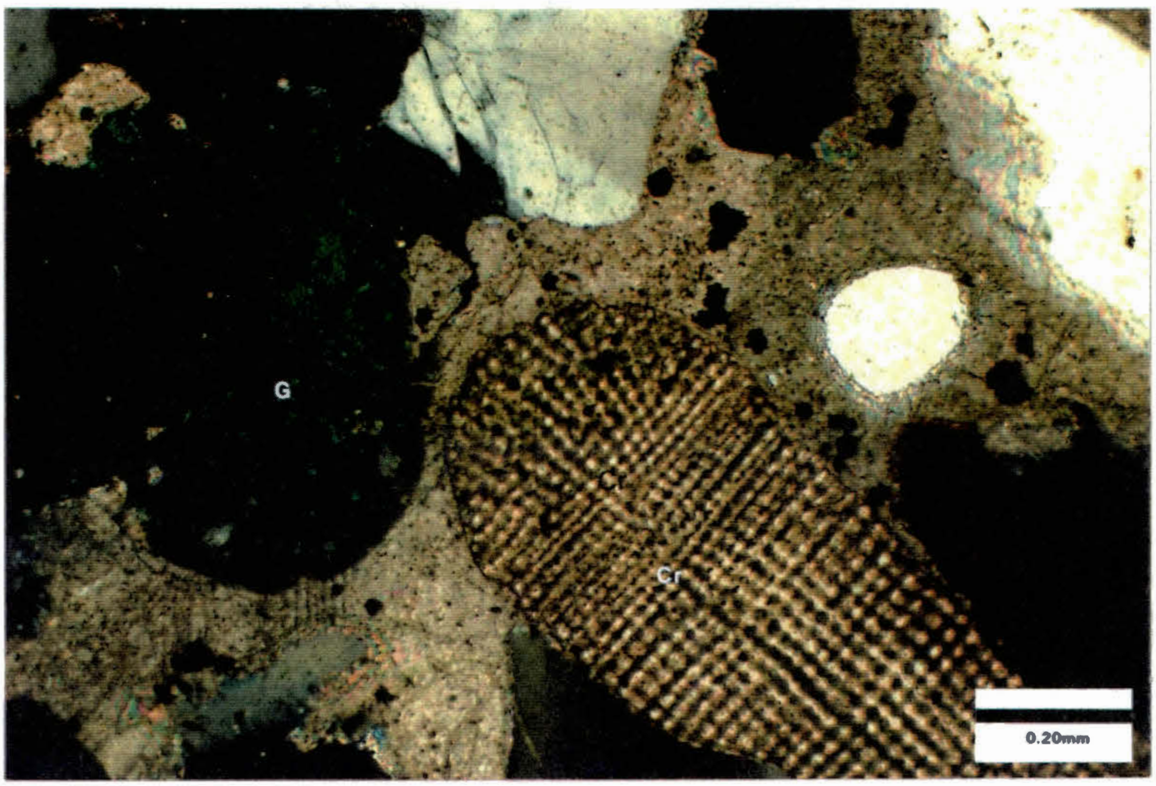

Figure 16. Glauconite (G) and crinoid-plate fossil fragment (Cr) in poikilotopic calcite cement (FF-41).

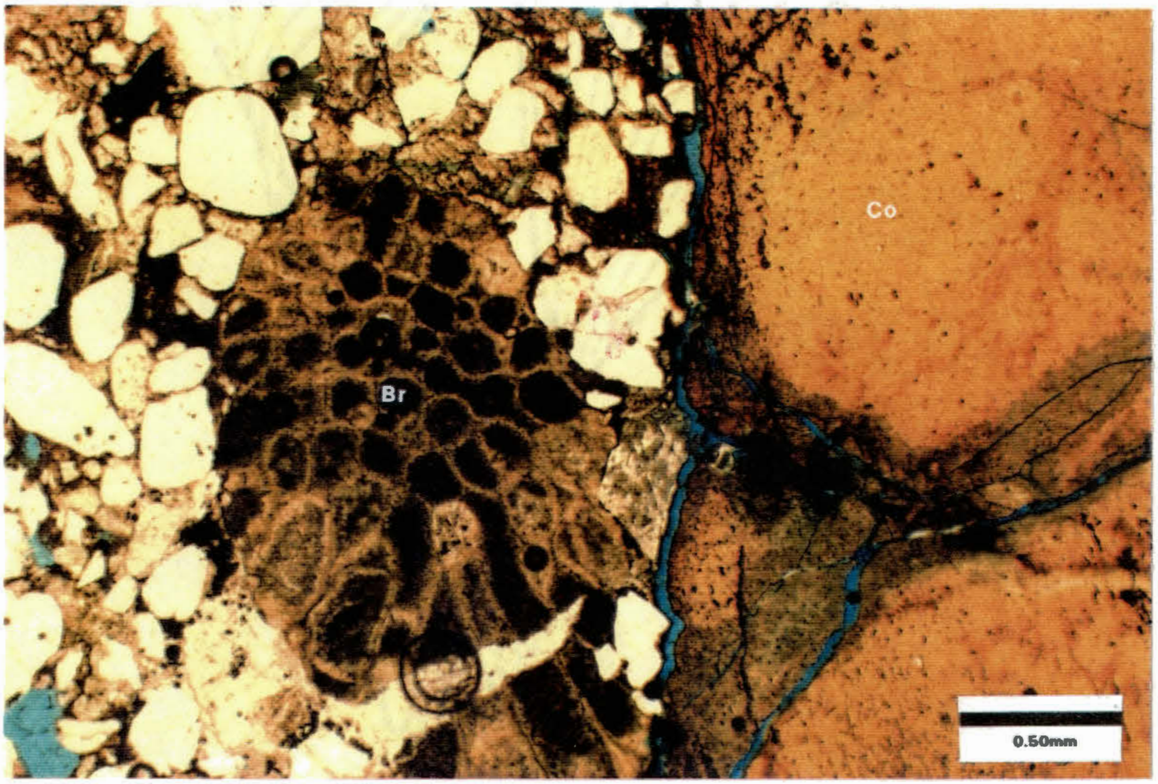

Figure 17. Large bryozoan fragment (Br) and collophane pebble (Co) in a fine grained sandstone (FF-48).

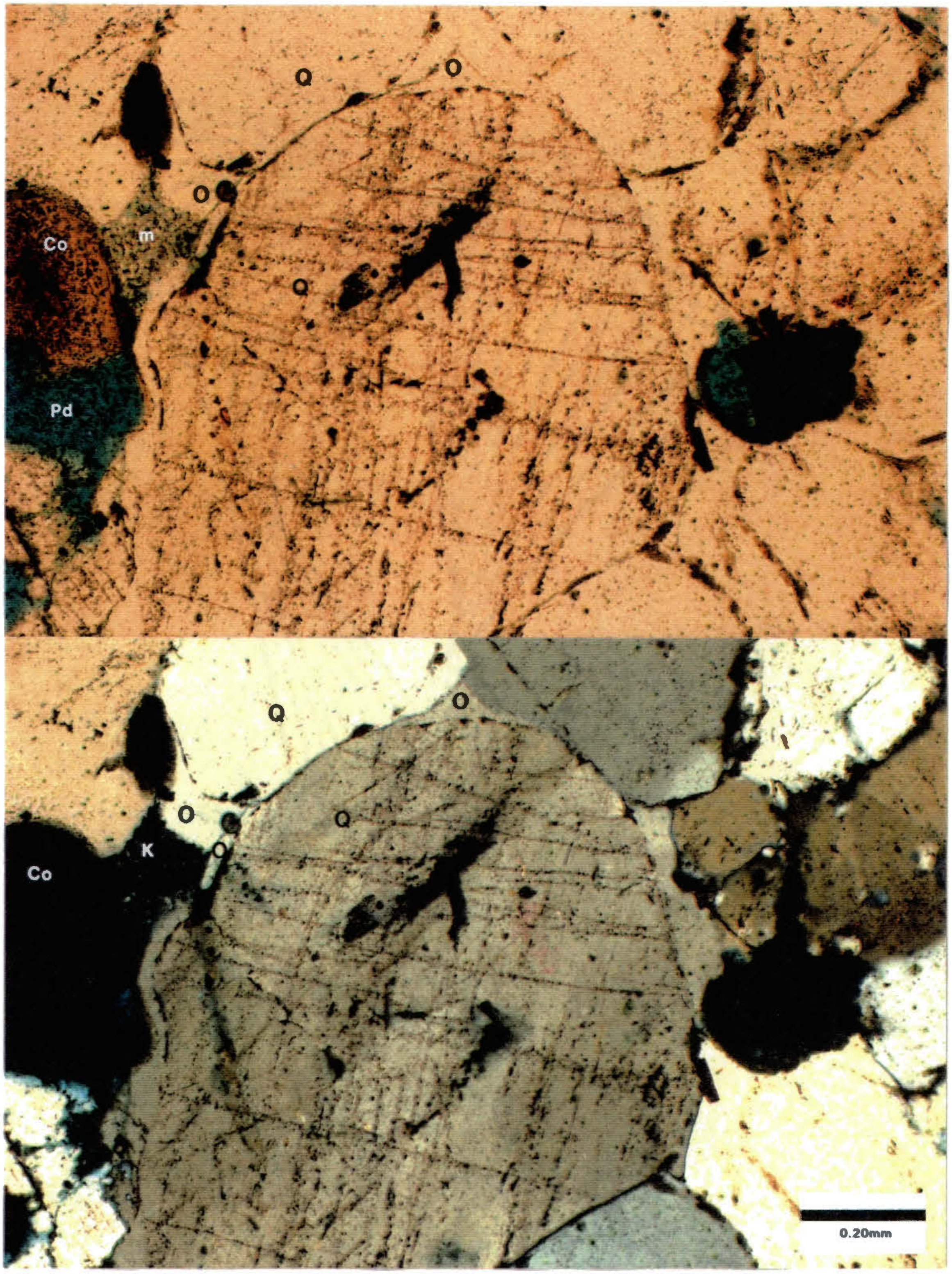

Figure 18. Large quartz grains (Q) with prominent overgrowths (O) upon dust rims. Also a collophane pebble (Co), authigenic pore-filling kaolinite (K) and microporosity (m) in kaolinite, and partly dissolved grains (Pd) (FF-40).

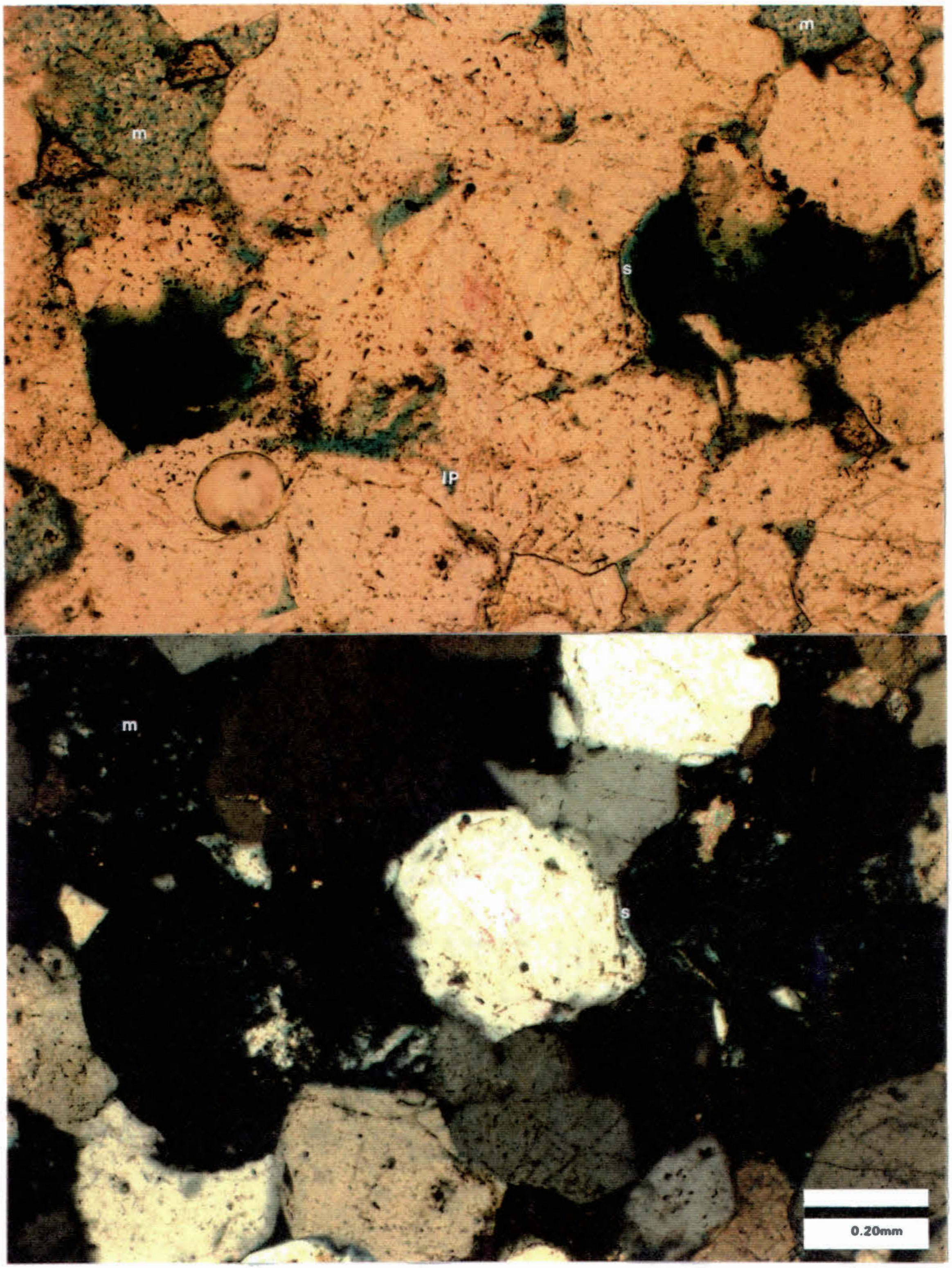

Figure 19. A sample showing slight primary porosity (IP) and abundant secondary porosity. Secondary porosity shown is mostly microporosity (m) and space created by shrinkage (s) (FF-47).

Gulf Oil No. 1 C. C. Kelly

Thin-section samples of Lower Morrowan rocks in the core from the No. 1 C. C. Kelly are quartz arenites, except for one phyllitharenite.

Detrital Constituents

Most detrital material is monocrystalline quartz, glauconite and fossil fragments. Minor constituents generally compose less than 2 to 3% of the total rock; they are muscovite, chert and other rock fragments (collophane-cemented fragments of siltstone (Figure 20), feldspars, and zircon.

Monocrystalline quartz is the most common detrital mineral. It ranges from 39% to 76% of the total rock; on the average it is 62% of the rock. Grains are poorly sorted to moderately sorted and rounded to subangular. They show straight to slightly undulose extinction.

Glauconite and fossil fragments are not as abundant as in samples from the Shell Oil No. 1-13 Finfrock. They average 1.5% and 1.3% respectively. Fossils are chiefly fragments of echinoderm plates and bryozoa.

Authigenic Constituents

Major authigenic constituents are cements and clays. As much as 5% of the some thin sections is pyrite with traces of organic material.

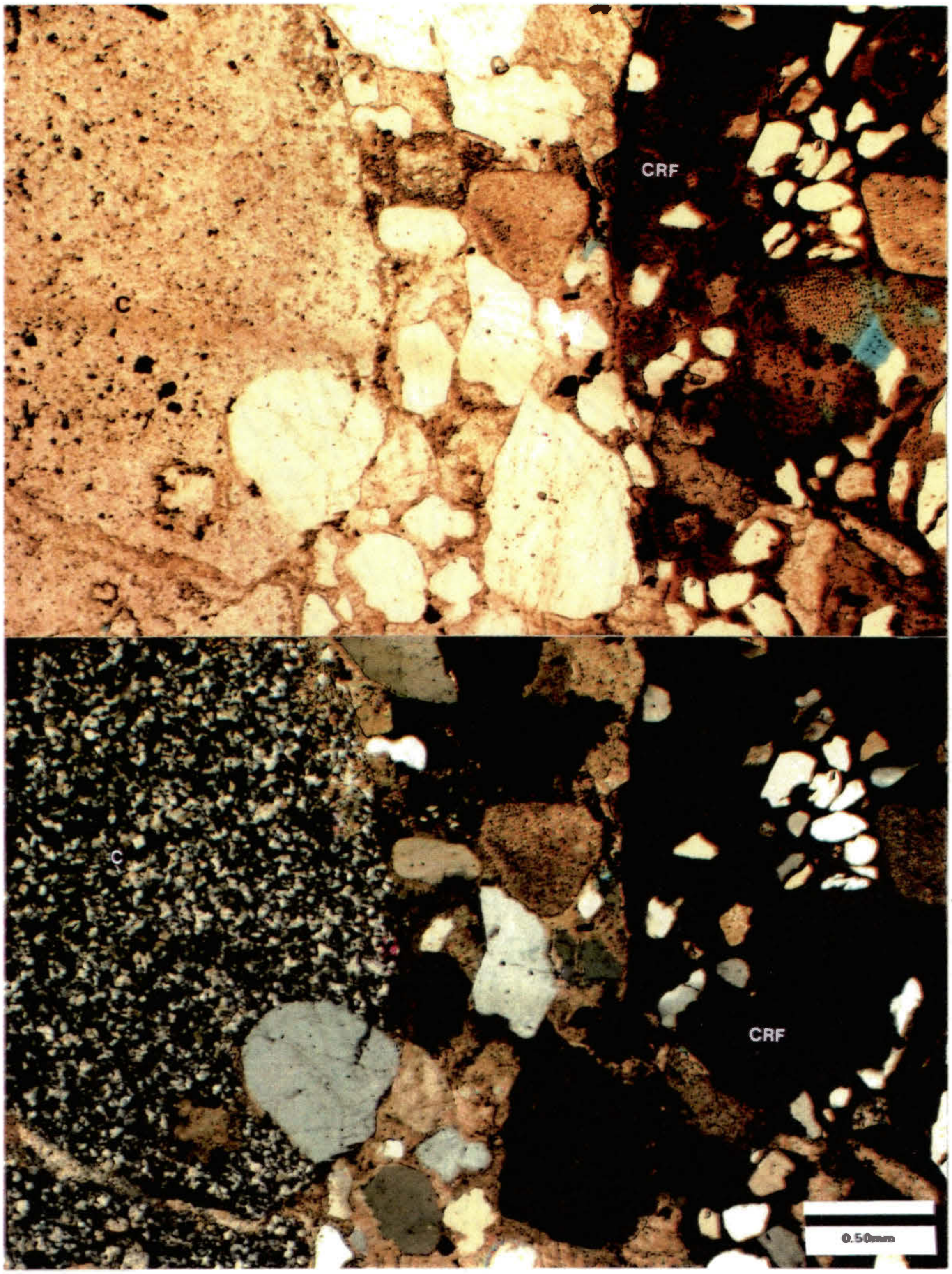

Figure 20. Rock fragments: chert (C(left)) and collophane-cemented siltstone (CRF(right)) are some of the pebble-sized clasts in Lower Morrowan sandstones (KY-54).

Siliceous syntaxial overgrowths make up about 1% of the rock. On the average, calcite cement is only about 3% of the rock but dolomite cement is about 18% (Figure 21). Hematite cement is in only one sample (4735.9 ft.), but it makes up 16.1% of the entire sample, indicating an oxidizing environment common during subaerial exposure.

Kaolinite and illite are pore-filling authigenic clays. They average 4.5% and 1.4%, respectively. Kaolinite formed mostly (and perhaps entirely) by replacement of feldspars. Chlorite is visible only as pore-lining material. Trace amounts of organic material were recorded.

Porosity

Total average porosity is 4.0% with a maximum of 8.0%. Porosity mostly is secondary, as enlarged intergranular pores (Figure 21), partly or completely dissolved grains or clays, shrunken glauconite, and micropores in authigenic clays. Primary intergranular porosity averages about 0.5% of the rock.

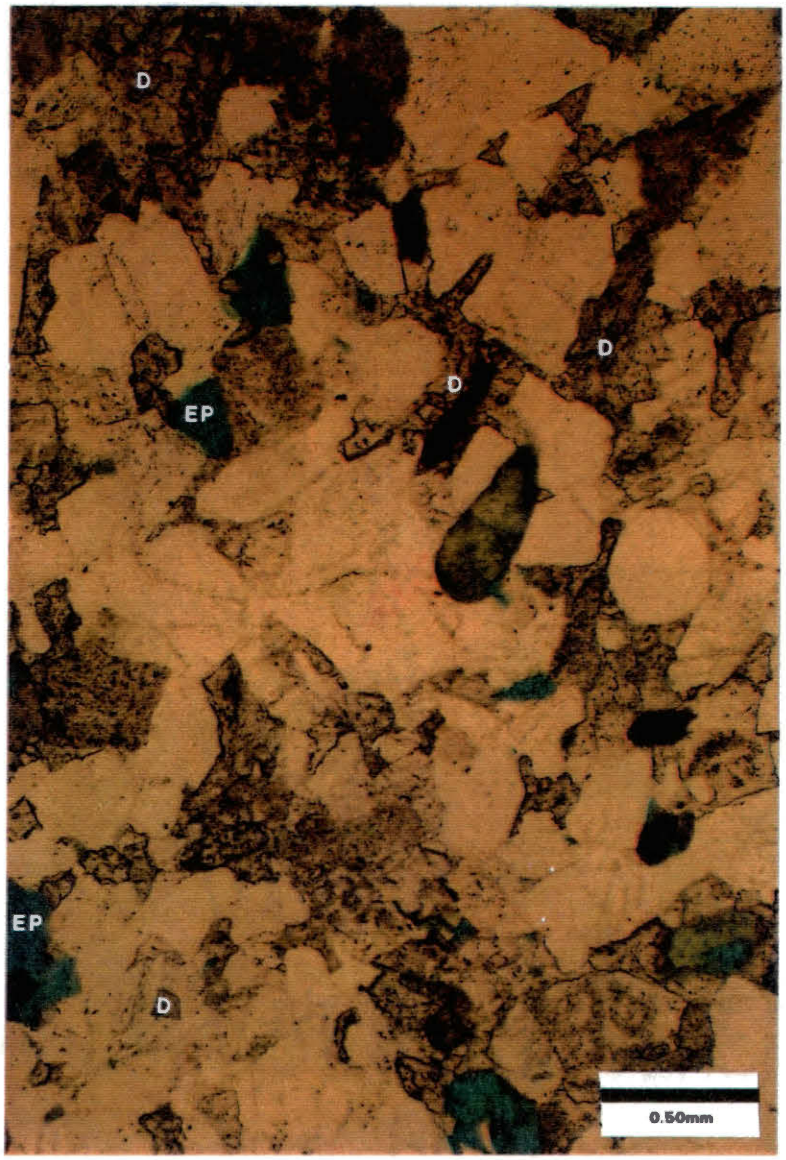

Figure 21. Dolomite cement (D) and enlarged pores (EP) (KY-52).

Paragenetic Sequence

The probable paragenetic sequence of Morrowan sandstone includes at least six increments.

Upper Morrowan Sandstones

1) Pyrite formed in organic material; sediment was compacted.

2) Quartz and unstable feldspars were partly dissolved; burial and compaction were accompanied by increase in pH and pressure dissolution.

3) Overgrowths of quartz developed, due partly to pressure-solution then reprecipitation. Burial continued.

4) Unstable grains were dissolved and silica was partly dissolved. Feldspars were altered to clays and calcite was precipitated as cement.

5) Secondary porosity resulted from dissolution and partial dissolution of silica and unstable grains.

6) Secondary porosity was occluded by clay, developed from alteration of unstable grains, and by cementation with calcite and dolomite.

7) Formation of pyrite.

Lower Morrowan Sandstones

1) Cementation by calcite and dolomite, deposition of glauconite, and possible formation of pyrite in organic material. Perhaps the development of clay on surfaces of quartz grains accounts for dust rims (Walker, 1979, p. 45).

2) Quartz and unstable feldspars were dissolved partly, owing to burial, increase in pH, and pressure solution.

3) Overgrowth of quartz on grains of quartz, as burial continued.

4) Unstable grains were dissolved and quartz was partly dissolved. Feldspars were altered to clay. Calcite was precipitated as cement.

5) Secondary porosity was occluded by clay developed from alteration of unstable grains.

7) Formation of pyrite.

CHAPTER IX

DEPOSITIONAL ENVIRONMENTS

Lower Morrowan Rocks

During the Late Mississippian, the study area was a shallow marine shelf of Euramerica (Figure 22). Rocks deposited on this shelf were primarily shallow marine shales and shelf to marine limestones (Curtis and Ostergard, 1980, p. 116). Global regression toward the close of the Mississippian (Figure 23) (Clark and Stearn 1968, p. 171; Ross and Ross, 1988, p. 243) subjected late Mississippian marine strata to erosion.

Deposition of Lower Morrowan sandstones has been interpreted in many fashions: fluvio-deltaic (Godard, 1981, p. 43), beach, barrier bar, and transgressive shallow-marine sheet sands (Forgotson et al., 1966, p. 532). Another possible interpretation is alluvial valley fill.

Lower Morrowan sandstones seem to have been channeled into underlying strata (Plates XII-XIX). However, characteristics of a fluvial deltaic environment include (1) large variance in grain sizes (pebble to silt) (Lower Morrowan sandstones grains vary little in size.); (2) fluvially deposited sandstones are not laterally

Figure 22. Estimated general location of study area (H) during Late Mississippian (after Ross and Ross, 1988, p. 228).

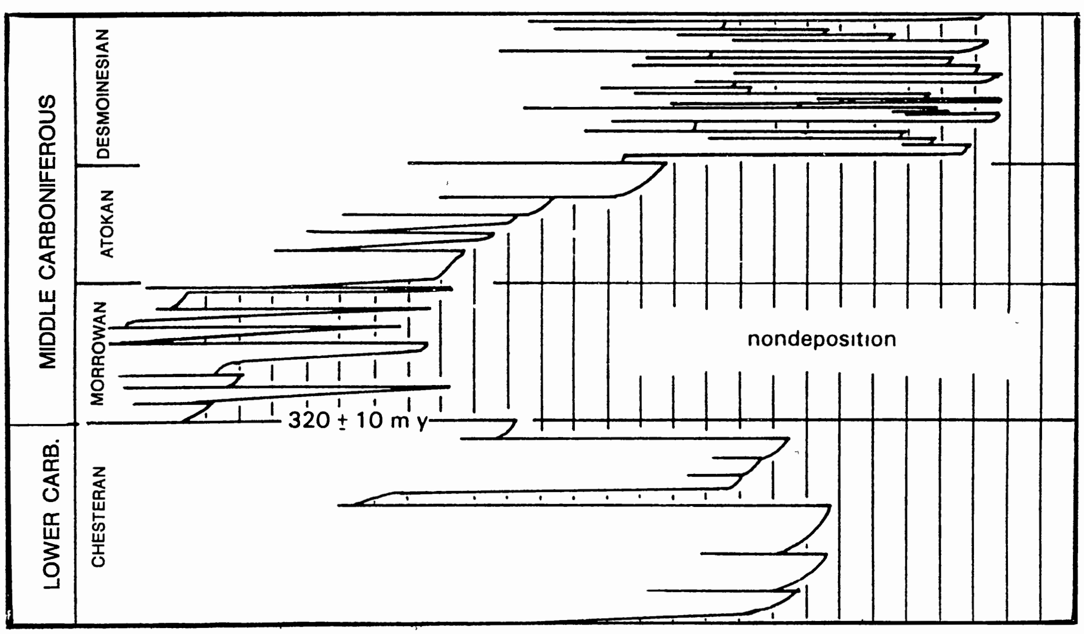

Figure 23. Sea level curve of Early and Middle Carboniferous (from Ross and Ross, 1988, p. 243).

continuous in four primary directions (upper contact of Lower Morrowan sandstones can be correlated across most of the study area; see Figure 24); (3) fluvial deltaic environments generally are void of fossils and/or glauconite (Lower Morrowan sandstones contain an abundance of both.)

Barrier bars (1) generally trend parallel to depositional strike (Busch and Link, 1985, p. 207). (The thicker of Lower Morrowan sandstones do not trend parallel to the east-southeasterly striking paleocoastline outlined by Curtis and Ostergard (1980, p. 123), which explains the pre-Morrowan surface, near the study area, as having had a southwesterly slope; this is also supported by thickening of the Lower Morrowan interval (Plate VI). (2) Under trangressive conditions barrier bars tend to build upward and toward land (Lower Morrowan sandstones "cut" into underlying strata.) (3) Barrier bars generally have gradational lateral contacts (Shelton, 1973, enclosure). (Contacts of Lower Morrowan sandstone and bounding rocks are rather abrupt.)

Sands in alluvial valleys have sharp basal and lateral contacts, much as Lower Morrowan sandstones do. However, (1) alluvial-valley sands show massive bedding as well as large and medium scale crossbedding (Lower Morrowan sandstones contain mostly medium scale crossbeds and planar crossbeds); (2) large pebbles and gravels are common in alluvial strata (Such clasts are rare in Lower

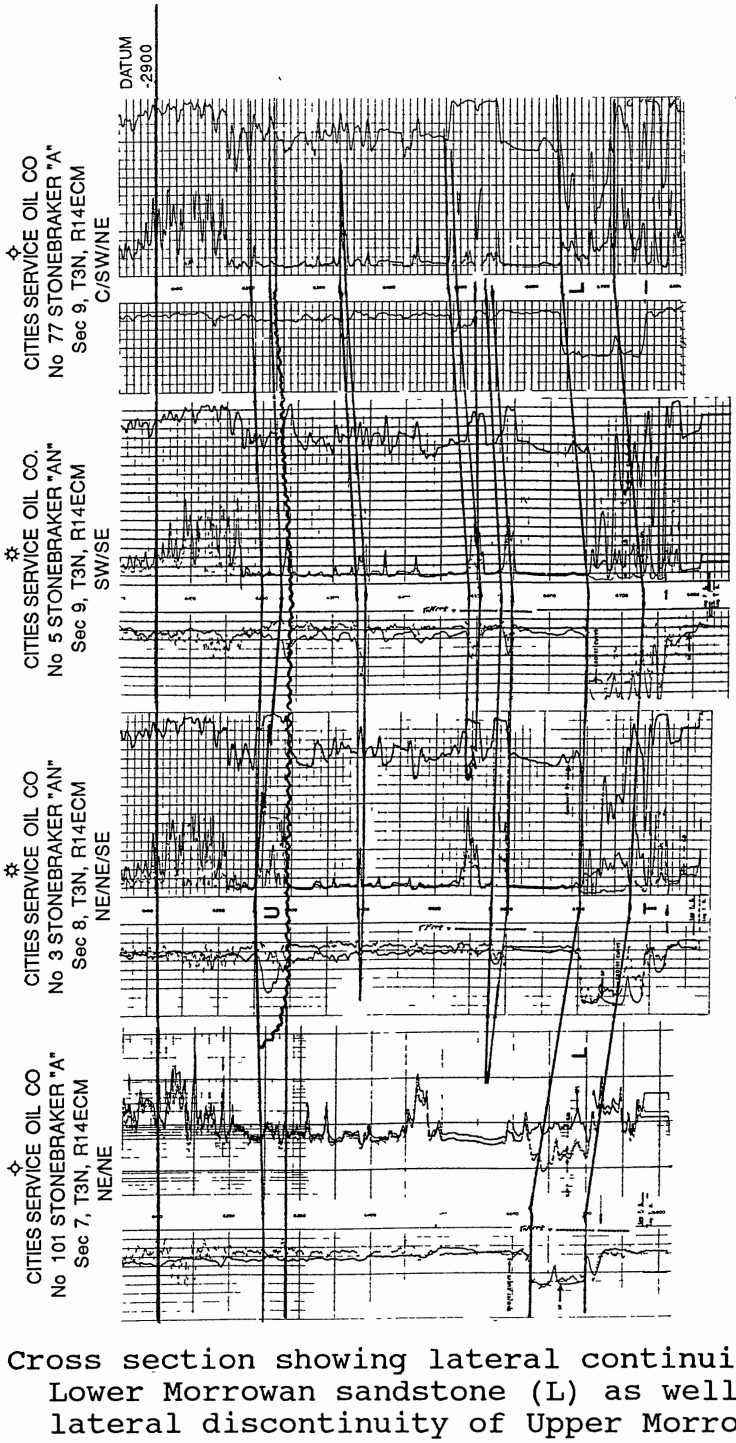

Figure 24. Cross section showing lateral continuity of Lower Morrowan sandstone (L) as well as lateral discontinuity of Upper Morrowan sandstones (U).

Morrowan cores.); and (3) wood fragments and plant debris are common (These sediments are rare in Lower Morrowan rocks.). Lower Morrowan shallow marine claystones, sandstones, limestones, and sandy limestones were deposited probably by a transgressing sea over an eroded, irregular surface (Swanson, 1979, p. 117; Webster, 1983, p. 2072). Tectonic elements and local topography influenced depositional patterns during Early Morrowan time (Moore, 1979, p. 6, 7). Thick accumulations of sediments were in alluvial valleys where Lower Morrowan transgressive/marine units were deposited (Khaiwka, 1973, p. 187; Arro, 1965, p. 22). Lower Morrowan (Keyes) sandstones probably were shallow marine sands deposited under near-shore processes such as waves, tidal currents, and possibly longshore drift (Figure 25). As the low-lying areas became filled sands were spread laterally (Figure 25).

Evidence to support marine deposition is: (1) Fragments of brachiopods, bryozoans, and crinoids, vertical burrows, filaments of carbonized plant material, glauconite, and calcareous cement are abundant. Sedimentary structures recorded from cores include medium scale planar crossbeds. Thin conglomerates may indicate minor regressions. (This line of evidence recorded in Appendix A.) Cores from No. 1-13 Finfrock and No. 1 C.C. Kelly have similar characteristics. The Kelly core contains more wavy laminations and crossbeds; the

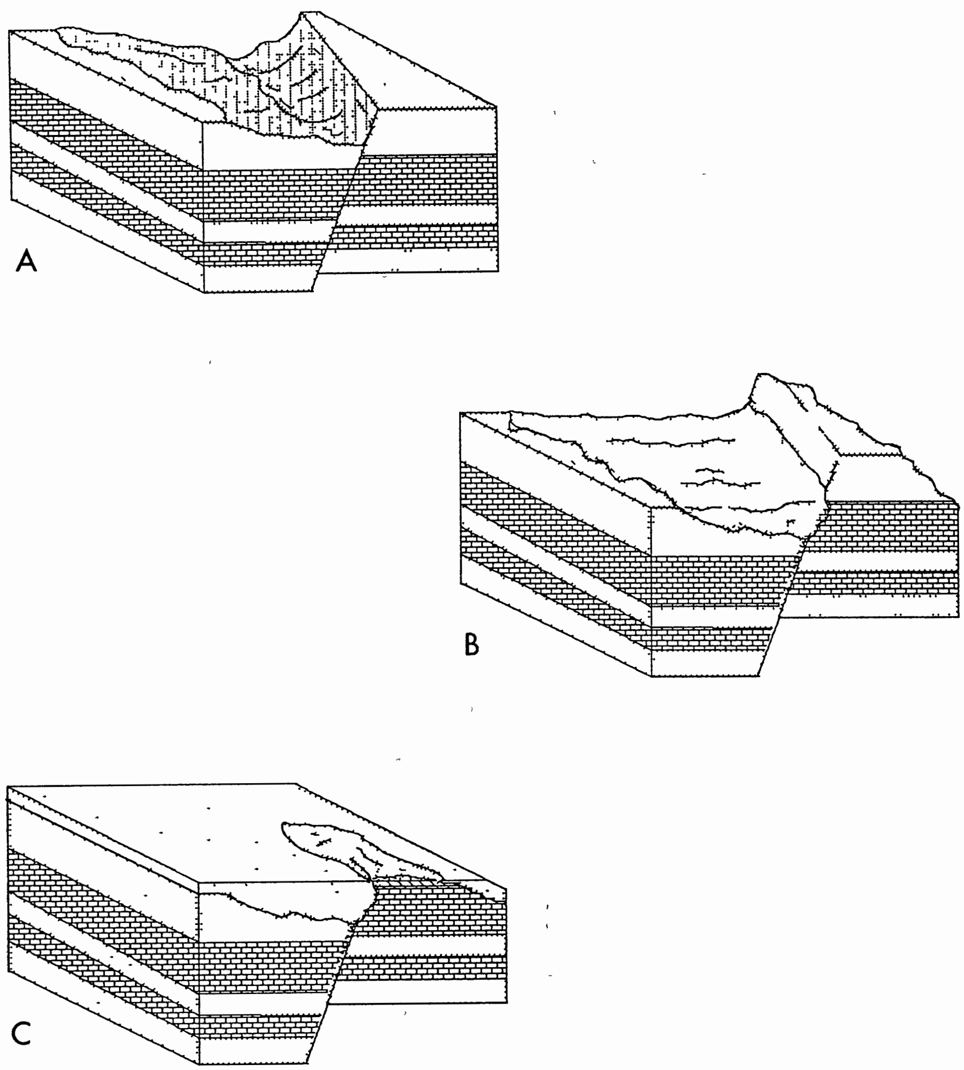

Figure 25. Interpretation of general pattern of deposition of Lower Morrowan sandstones: (A) pre-Pennsylvanian topography, (B) initial deposition in low-lying areas, (C) spreading of sands laterally, with near-burial of eroded surface.

Finfrock core contains more glauconite and relatively common vertical burrows. Similar differences have been interpreted as indicating closer-to-shore, higher energy conditions (Adams, 1954, p. 1568) during deposition of less glauconitic, less burrowed, and more crossbedded and cross laminated sandstones.

The No. 1-13 Finfrock core is a possible example of a "more seaward" facies than the interval preserved within the No. 1 C. C. Kelly core (see Appendices A, B, and C for descriptions).

2) Thin sections from both cores contain rare rock fragments or feldspars but fossil fragments and glauconite are abundant. However, thin sections from the No. 1 C. C. Kelly core contain less glauconite and fossil fragments than thin sections from the No. 1-13 Finfrock core. Carbonate cements are abundant. Sandstones in the Kelly core usually are quartz arenites, whereas sandstones in the Finfrock core are a mixture of quartz arenite and sublitharenites.

3) Spontaneous potential and gamma ray log signatures of the Lower Morrowan sandstones generally have blocky to slightly funnel shapes (Figure 26). Deep, medium, and shallow resistivity logs show a highly resistive basal contact with steady upward decrease in resistivity across the lower part of the interval and an increase in the resistivity across the upper part. The general log signatures might suggest (1) coarsening

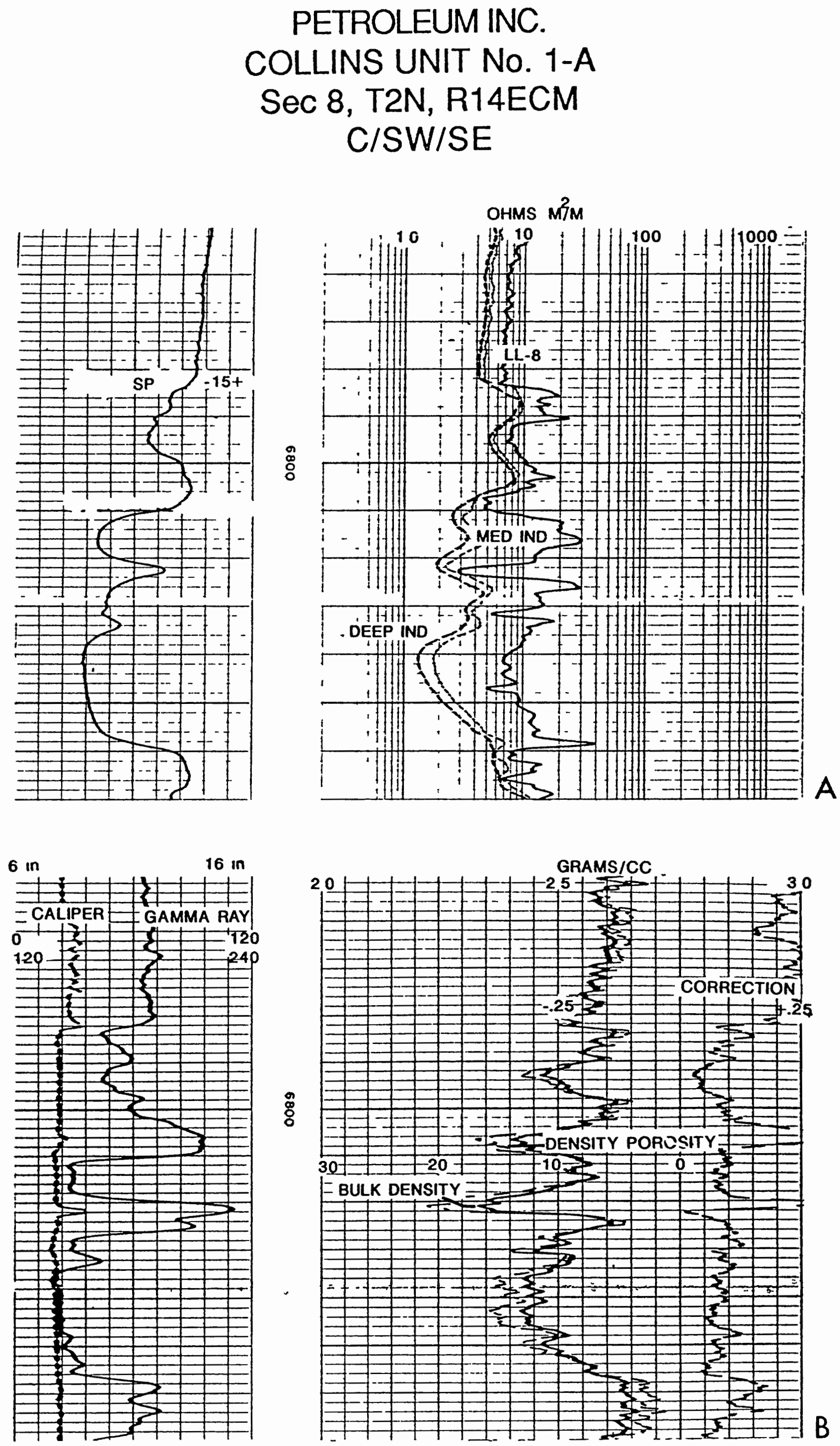

Figure 26. Log signatures considered to be typical of Lower Morrowan sandstones. (A) SP, deep induction, medium induction, and LL-8; (B) gamma ray, caliper, bulk density, and density porosity.

upward, (2) increasing porosity upward, or (3) decreasing clay content upward across the lower part of the sandstone and a possible increase in clay, decrease in porosity and decrease in grain size across the upper part. Funnel-shaped log signatures are common responses to sandstones deposited in shallow marine environments. Low bulk-density peaks such as those recorded at 6836, 6838, and 6840 (Figure 26) in some instances, have corresponded to levels richer in glauconite and siderite (Serra, 1985, p. 192).

4) Isopach maps illustrate thicker units filling the low-lying areas (Plates V-VII). Most prominent is the thick sandstone which lies to the west side of T2N, R14ECM. This sandstone was deposited when transgressive sands filled a previously active alluvial valley. The structural contour map of the base of the Morrowan interval (Plate II) illustrates the position of the valley before transgression of Morrowan seas. Structure maps also support the hypothesis that paleodrainage was at least influenced by Late Mississippian/Early Pennsylvanian faulting. The selected position of the lower marker may allow for a small amount of error in estimation of pre-Morrowan topographic relief; however, many whole <u>Archimedes</u> and abundant fronds in underlying shales support this selection as the base of the Morrowan interval (see Appendix D).

5) Examination of cross sections illustrates that thicker units are located in what were low-lying areas, similar to the circumstances depicted in Figure 25. This further supports inferences drawn from isopach maps. In addition to the thickest interval being in the probable pre-Morrowan low areas, the cross sections also illustrate evidence of a marine transgressive environment with a thinner but more laterally consistent sandstone immediately overlying the "fill" units. These sands are more blanket-like in geometry and are continuous across most of the study area. In Figure 7, the unit above marker "D" can be correlated across the fault as well as across most of the study area. The continuity of this unit may indicate more consistent, widespread sediment distribution.

In the Morrowan section are many thin, discontinuous limestones and sandstones. Strata deposited after Lower Morrowan sandstones and prior to Upper Morrowan sandstones were mostly shales with many limestone and some sandstone interbeds. The thick interval of shales could indicate a period of relative tectonic quiescence (Benton, 1972, p. 9). The interbedded units could represent minor tectonic events or global fluctuations of sea level during the relative calm deposition. Many sea level fluctuations occurred during Morrowan time (Figure 23) (Ross and Ross, 1988, p. 243).

Upper Morrowan Rocks

The Upper Morrow sandstones were probably deposited in a fluvial environment. The Morrow of the Hugoton Embayment has been interpreted as being deposited on a middle deltaic distributary plain (Figure 27) (Cornish, 1982, p. 75; Swanson, 1979, p. 155-157).

Evidence for a middle deltaic distributary channel environment is:

1) Sandstones in the No. 4 Stonebraker "AN" core are generally medium to coarse grained, and fine upward within individual units from very coarse to medium. The units have medium scale crossbeds with each graded interval approximately 1 inch thick. Contacts within the core are abrupt at most places; they may be channel scours. The contacts have been described as festoon crossbeds from within the middle part of a point bar sequence (Swanson, 1979, p. 122). Abundant carbonized plant fragments and wisps of organic material (plant roots?) are in the core. There is no evidence of burrowing, no fossil fragments, and very little carbonate material in the No. 4 Stonebraker "AN" core.

2) Primary constituents of rocks in the No. 4 Stonebraker "AN" are quartz and some clay matrix, with some feldspars and rock fragments. Organic material is common in the form of stylolites; glauconite and fossil fragments are absent and carbonate cements are rare in comparison to other cores.

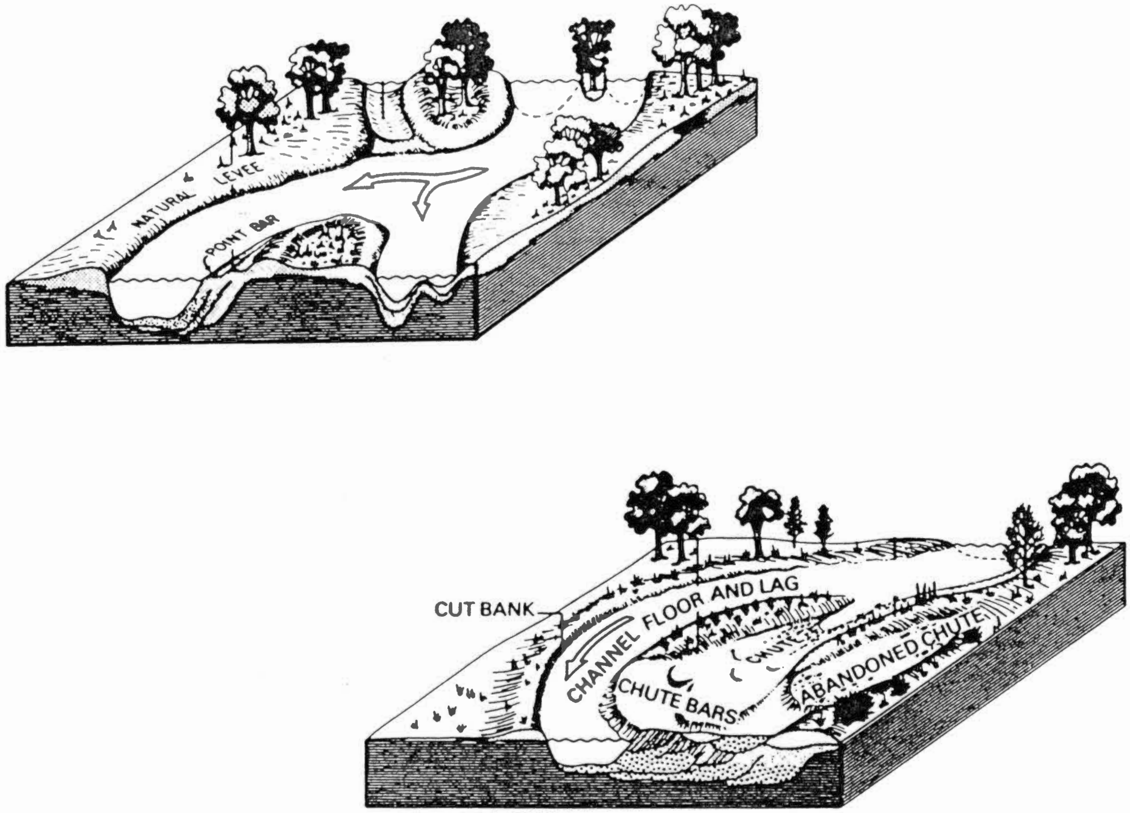

Figure 27. Probable settings during deposition of Upper Morrowan sandstone (modified from Serra, 1985, p. 160).

3) Spontaneous-potential log signatures of Upper Morrowan sandstones generally have overall bell shapes (possibly associated with a fining upward sequence in grain size) (Figure 28). Gamma-ray log signatures are similar but have serrate profiles, which could indicate thin shale intervals or variations in abundance of clay particles. Resistivity-log signature deflections generally increase upward across the upper part of the examined interval. The increase could be due to decrease in grain size, increase in cementation, and/or occurrence of gas or oil (Figure 28). Sonic-log signatures show an

overall upward decrease of interval transit time, possibly a result of (1) upward porosity decrease or (2) upward density increase. Bulk density log signatures increase upward across the interval which could support the hypothesis of upward porosity decrease. Abrupt leftward deflections of caliper log signatures are common at the bases of Upper Morrowan sandstones, indicating sharp lower contacts. Generally, caliper log responses gradually return to full diameter or greater toward the top of intervals, which could indicate fining upward of grains in this part of the interval.

4) The general trends of Upper Morrowan sandstone bodies are east-southeast (Plate IX). The sandstone bodies are generally a few miles in width, 10-20 ft. thick, and oblate to elongate in plan view. The preserved sandstones form a somewhat beaded appearance, due to local areas of thick sandstone concentrations along the length of the trend.

5) Upper Morrowan sandstones generally are not wider than 1-2 mi. in cross sections and tend to thin laterally into encasing shales. At some locations, particularly at the lower parts of sections, resistivity deflections increase upward for short distances (Figure 29) and gamma-ray deflections are very low (leftward) which could indicate a clean, channel scour gravel. The highly resistive, low gamma-radiation interval could be the leading edge ("toe") of a point bar (Figure 29). As a

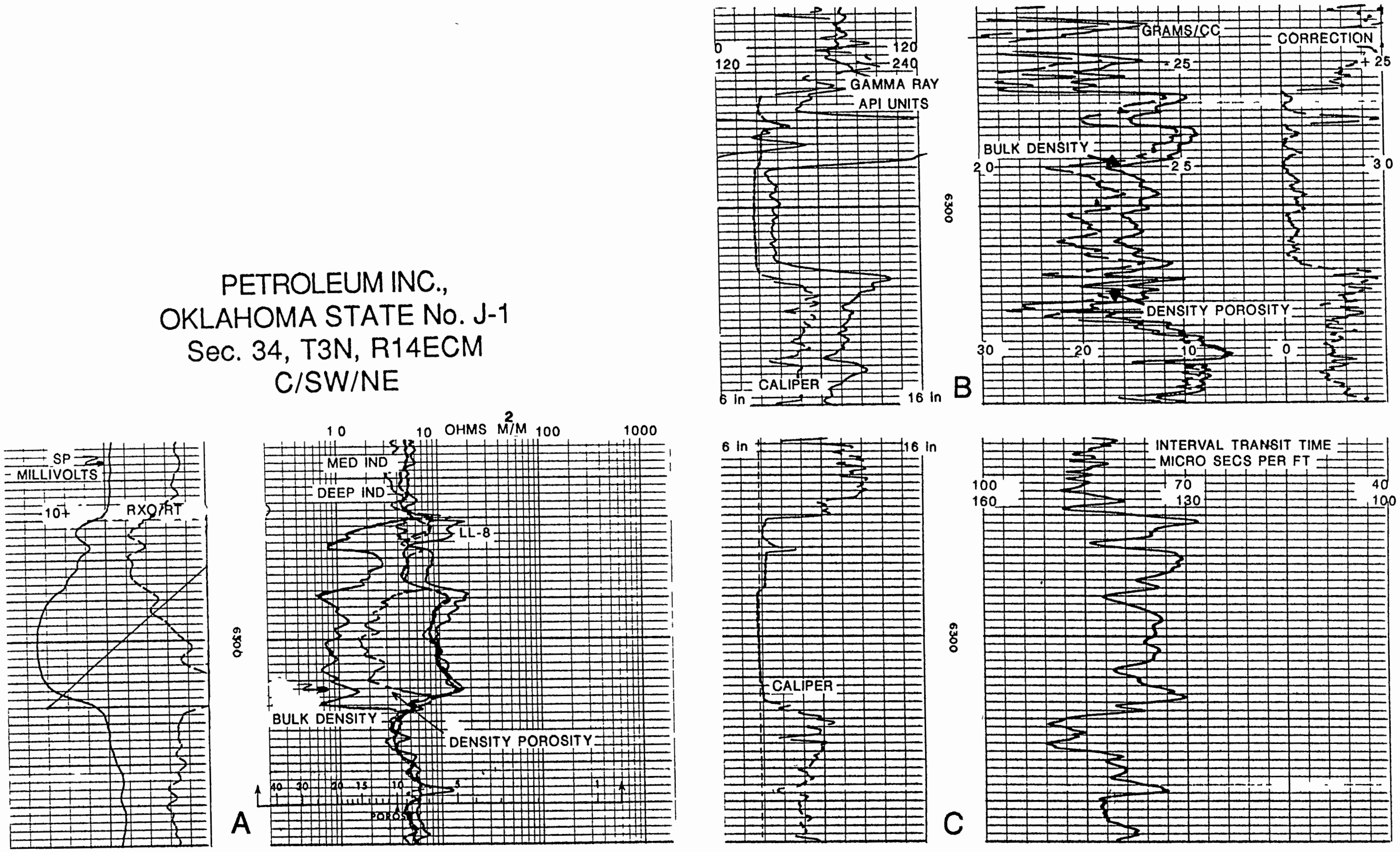

Figure 28. Log signatures considered to be typical of Upper Morrowan sandstones (A) SP, Rxo/Rt, deep induction, medium induction, LL-8, bulk density, and density porosity (B) Gamma ray, caliper, bulk density, and bulk density porosity curves (C) caliper and sonic curves.

point bar migrates laterally, clay rip-up clasts are covered with coarse grained sands and possibly gravels. Highly resistive units are common at the tops of Upper Morrowan sandstones. Higher than normal gamma-ray responses (>150 API) commonly correlate with the more resistive intervals (Figure 29 (B)). Such responses may indicate radioactive, organic-rich, shale or silty sediments that might have trailed the lateral migration of point bars (Figure 29).

Shales above the Upper Morrowan sandstones (see Appendix B, No. 4 Stonebraker "AN" core) contain abundant disarticulated brachiopods and are highly calcareous. These shales were probably deposited in a marine environment during a transgression toward the close of the Morrow.

PHILLIPS PETROLEUM. CO.
No. 2R SHIEL
Sec 34, T2N, R15ECM

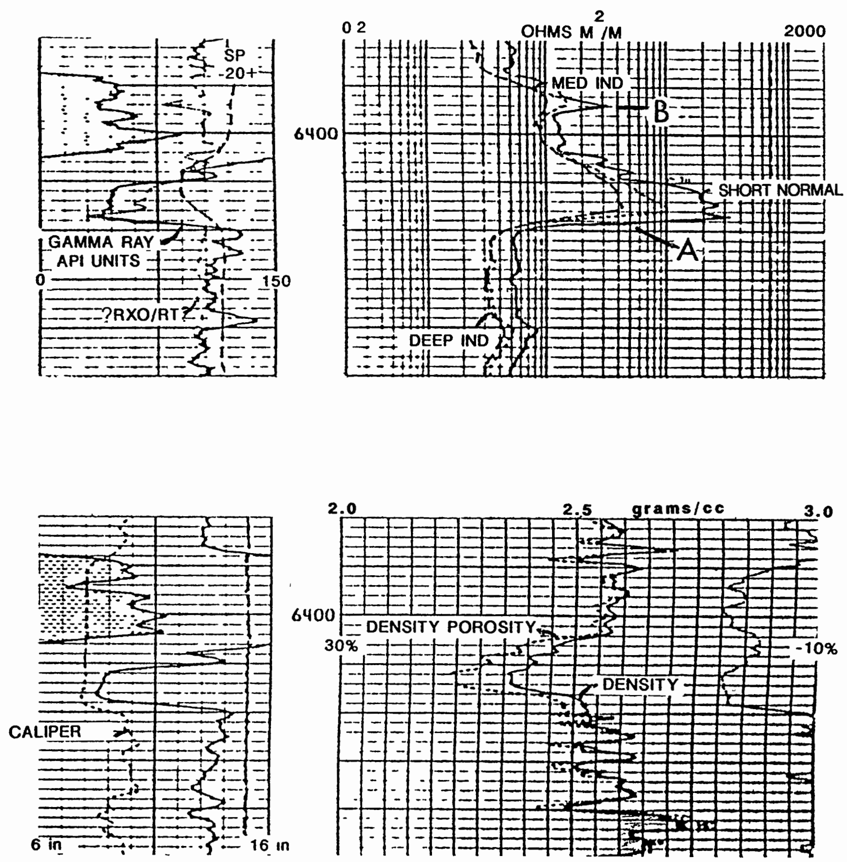

Figure 29. Possible coarse grained channel lag at the lower part of point bar deposit (A); this interval could coarsen upward for a short distance. As lateral accretion of finer grained point-bar sediments occurs, the thin coarsening upward sequence may be preserved. Resistive, higher radioactive zone (B) is possibly the result of organic debris deposited on top of point bar.

CHAPTER X

SUMMARY

(1) The Morrowan stratigraphic interval thickens westward across the study area.

(2) The Lower Morrowan interval varies more in thickness than does the Upper Morrowan.

(3) Lower Morrowan strata filled low areas in pre-Pennsylvanian topography; sandstones in the upper part of the Lower Morrowan section were spread extensively.

(4) Upper Morrowan sandstones probably formed as distributary-channel point bars and channel-fill sands.

(5) Variation in thickness of the Morrowan section is due partly to syndepositonal faulting.

(6) Most marker beds do not extend throughout the study area. Marker beds that can be correlated across the study area can be used to infer relative-time depositional packages.

(7) The contact with the Morrowan strata and the overlying Atokan Thirteen Finger Limestone is not

sandstone and Chesteran limestone. The post-Mississippian, pre-Morrowan unconformity may be within this section.

(9) Cores of Lower Morrowan sandstones contain fragments of marine fossils, glauconite, collophane, and burrows.

(10) Cores of Upper Morrowan sandstone contain abundant medium scale crossbeds, graded beds, granules to medium sized grains and carbonaceous woody material. Grain size generally coarsens upward.

(11) Thin sections of Lower Morrowan sandstones contain abundant fragments of marine fossils and glauconite, which support the interpretation of deposition of the sand in marine enviroments.

(12) Thin sections of Upper Morrowan sandstone contain no fossil fragments and rare samples contain glauconite.

(13) The shales, from the cores, below the Lower Morrowan sandstones contain abundant fragments of marine fossils (**Archimedes** and crinoid stems) and carbonate cement. Shales above Mississippian sandstones and carbonate rocks contain abundant disarticulated brachiopods and carbonate cement.

(14) Most shales between the Upper and Lower Morrowan sandstones are rarely calcareous; no fossils were recorded from these shales.

(15) Shales directly overlying Upper Morrowan sandstones are noncalcareous, laminated, silty, and void of fossils.

(16) The stratigraphically highest shales cored overlie the Upper Morrowan sandstones and the noncalcareous shales in the No. 4 Stonebraker core. These shales are highly calcareous with abundant fragments of marine fossils, indicating probable transgression during late Morrowan time.

(17) Log signatures of Lower Morrowan sandstones tend to support little variance in grain size; Log signatures generally are funnel-shaped (coarsening upward) across the lower part of the interval with a more abrupt bell shape across the upper part.

(18) Log signatures of Upper Morrowan sandstones are generally bell-shaped, which may indicate a fining upward sequence. Across some short vertical intervals, of only a few feet, the log signatures are funnel-shaped which may indicate thin coarsening-upward sequences. The thin coarsening-upward intervals might assist in mapping if interpreted as the lead edges of point bars.

(19) Some log signatures of Upper Morrowan sandstones show evidence of highly resistive, highly radioactive intervals. These units might also be used to assist in mapping and exploration, if interpreted as evidence of the trailing edges of point bars.

(20) Oil and gas in Upper Morrowan sandstones are generally trapped stratigraphically.

(21) Upper Morrowan production is generally from channel-fill sandstones, such as point-bar deposits.

(22) Oil and gas in Lower Morrowan sandstones are generally trapped structurally.

(23) Most productive Lower Morrowan reservoirs are blanket sands on the updip sides of fault blocks.

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APPENDIX A

DESCRIPTIONS OF CORES

Introduction

Cores examined are from (1) Cities Service Oil Company No. 4 Stonebraker "AN", Sec. 9, T3N, R14ECM; (2) Cities Service Oil Company No. 101 Stonebraker "A", Sec. 7, T3N, R14ECM; (3) Shell Oil Company No. 1-13 Finfrock, Sec. 13, T4N, R16ECM; and (4) Gulf Oil Company No. 1 C. C. Kelly, Sec. 1, T4N, R10ECM (Figure 4).

Cores from the Stonebraker wells are from the Upper Morrow "zone". Cores from the Finfrock No. 1-13 and the C. C. Kelly No. 1 are from the Lower Morrow Keyes sandstone.

The cores were described using two grain-size standards. The standards used are Wentworth's 1922 grain-size classification chart of clastic sediments (Berg, 1986, p. 8) (Table 1), and a comparison chart that has size-comparisons for very fine through very coarse grains (Figure 30).

The size-comparison chart was distributed by Amstrat (American/Canadian Stratigraphic Co.).

TABLE I

WENTWORTH'S GRAIN-SIZE CLASSIFICATION *

Diameter (mm)	Modal class	Sediment	Rock
	Boulders		
256			
	Cobbles		
64		Gravel	Conglomerate
	Pebbles		
4			
	Granules		
2			
	Very coarse		
1			
	Coarse		
0.50			
	Medium	Sand	Sandstone
0.25			
	Fine		
0.125			
	Very fine		
0.062			
	Coarse		
0.031			
	Medium		
0.015		Silt	Siltstone
	Fine		
0.007			
	Very fine		
0.004			
<0.004	Clay	Clay	Claystone

*from Berg, 1986, p. 8.

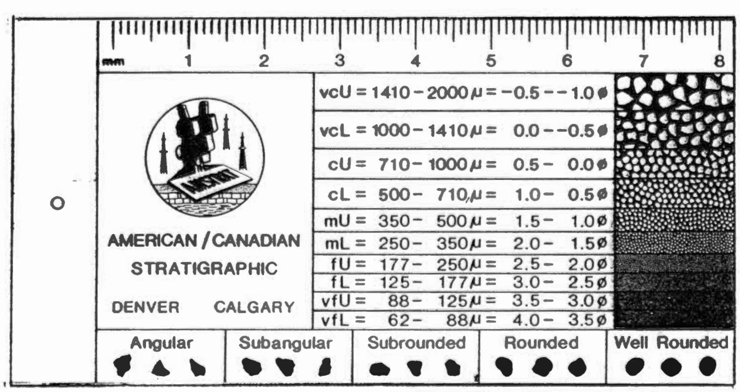


Figure 30. Grain-size comparison chart used for description of cores (from American/Canadian Stratigraphic Co.).

Cores of Upper Morrowan Strata

Cities Service Oil Co. No. 4 Stonebraker "AN"

Depths marked on the core of the No. 4 Stonebraker are 4.5 ft. shallower than depths recorded on logs (Plate XX). The core is a sample of 72 ft. of Upper Morrowan sandstone; the core is fairly complete.

6297-6295.9 ft.: Shale: dark gray to black; fissile; noncalcareous.

6295.4-6281.5 ft.: Sandstone: light grayish tan to tan; medium to coarse grained with some granules and pebbles; noncalcareous; oil-stained; relatively few potassium feldspars (approximately 1 grain/sq. in.) at 6294.6-6283.8 ft.; carbonized plant material (6293 ft.); texture of interval fines upward from very coarse to medium grains; crossbedded (medium scale, planar, (some medium scale herring-bone? crossbedding at 6283.5-6283 ft.)), dip as much as 30 degrees, but generally 15-20 degrees from horizontal; each 1-in. to 0.5-in. crossbed set includes interbedded coarse grained strata overlain by medium grained strata; pattern is consistent throughout the interval, but is most prominent from 6285-6282.5 ft. (Figure 31); coarse grained sandstone overlies very fine to fine grained sandstone with abrupt contact at 6282.5 ft. (Figure 32).

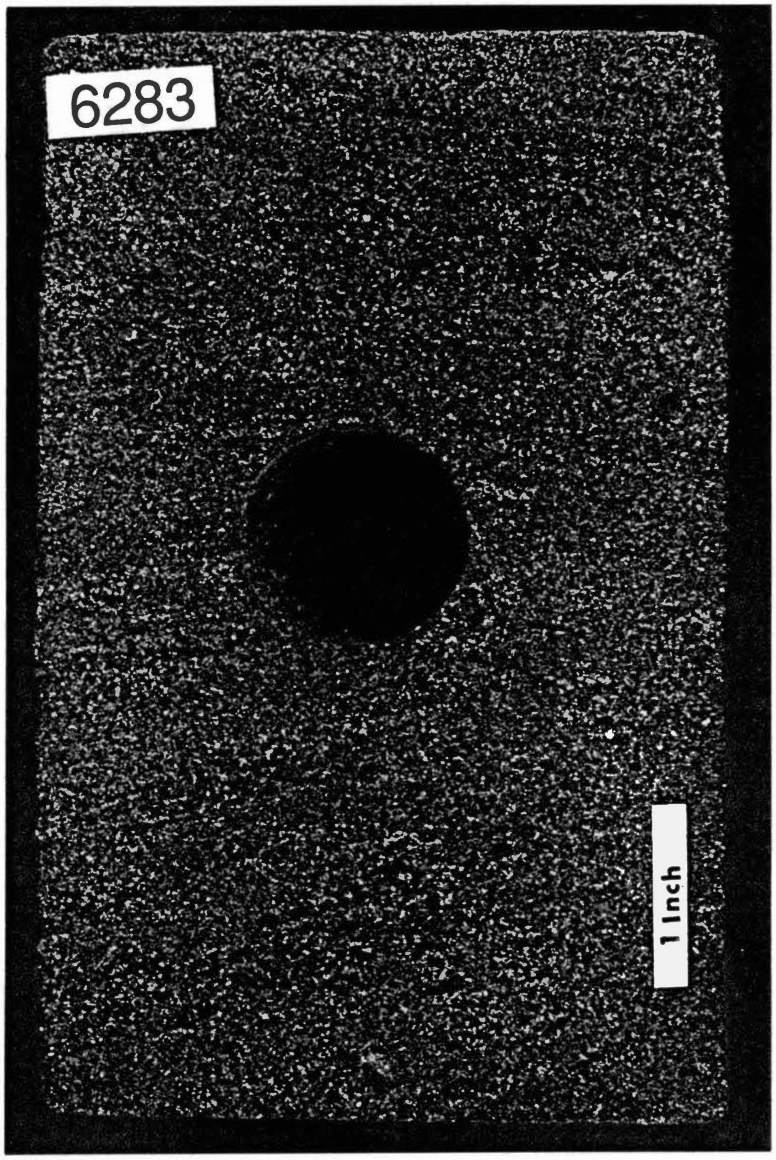


Figure 31. Medium scale cross bedding in Upper Morrowan sandstone. Cities Service No. 4 Stonebraker "AN," 6283-6283.6 ft.

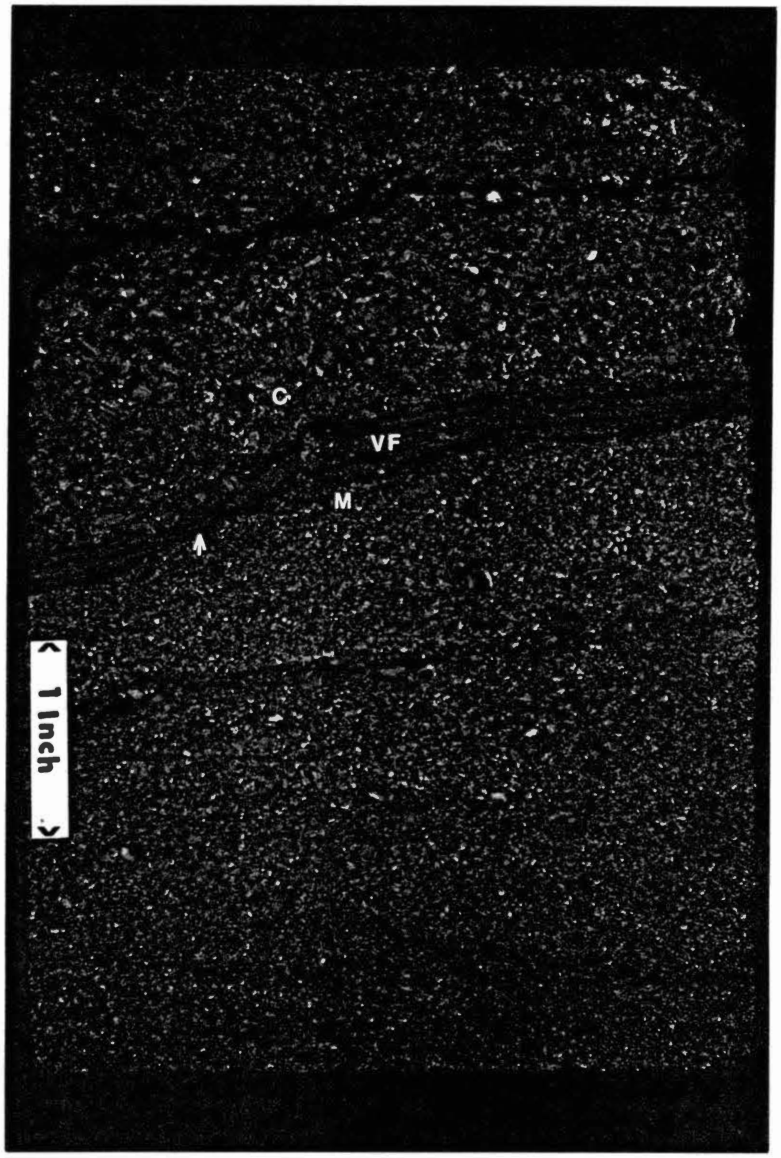


Figure 32. Abrupt contact of coarse grained (C) to granular sandstone and fine to very fine grained (VF) sandstone. The very fine to fine grained sandstone overlies a medium to coarse grained sandstone (M) (contact at arrow). The very fine to fine grained unit is at 6282.6 ft. Cities Service No. 4 Stonebraker "AN," 6282.4-6282.9 ft.

<u>6281.3-6280.2</u> <u>ft.:</u> Sandstone: dark gray; very fine grained; micaceous; interbedded with light gray sandstone; soft-sediment deformation and microfaulting, possibly due to slumping soon after deposition; small-scale crossbeds; ripple laminations?; contacts between the interbedded units are rather abrupt (Figure 33).

<u>6280.2-6273.1</u> <u>ft.:</u> Sandstone: dark gray; very fine to coarse silt; noncalcareous; micaceous; horizontally bedded; interval has the appearance of dark gray shale; close inspection shows that it is very fine grained sandstone to siltstone.

<u>6273.1-6272</u> <u>ft.:</u> Sandstone: light gray to tan; medium to coarse grained; noncalcareous; micaceous; carbonized plant-remains at 6272.8 ft. (Figure 34); crossbedded, medium scale from 6272.8-6272.5 ft. (Figure 35); gradational into overlying finer grained sandstone.

<u>6272-6268.7</u> <u>ft.:</u> Sandstone: light tan to tan; medium grained; noncalcareous; predominantly massively bedded; crossbedded (medium scale, trough? at 6270.8 ft.); gradational contact with overlying sandstone; uppermost three inches fines upward from medium to fine grained sandstone, with increase upward of clay.

Figure 33. Dark to medium gray Upper Morrowan sandstone interbedded with light gray to white sandstone showing ripple laminations, soft-sediment deformation and some microfaults. Cities Service No. 4 Stonebraker "AN", 6280.1-6280.7 ft.

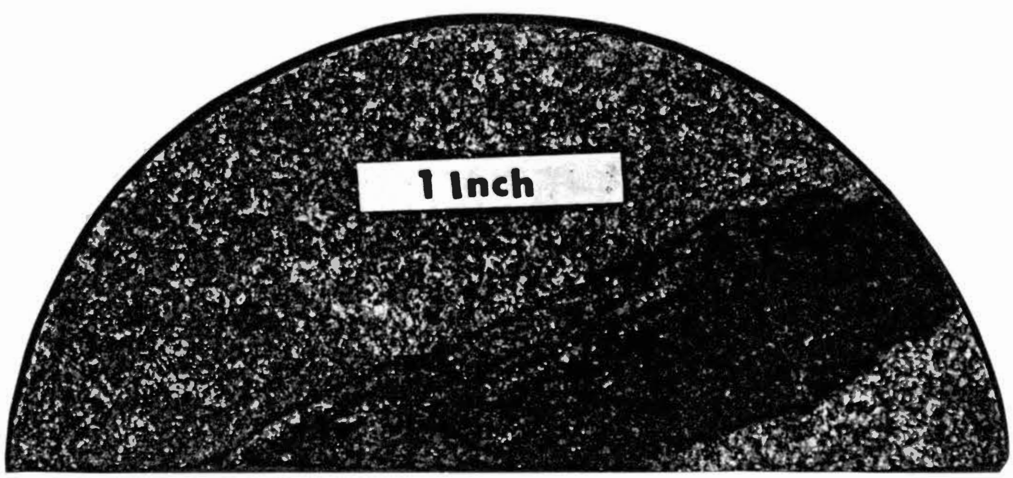


Figure 34. Carbonized plant remains in Upper Morrowan sandstone. Cities Service No. 4 Stonebraker "AN", 6272.8 ft.

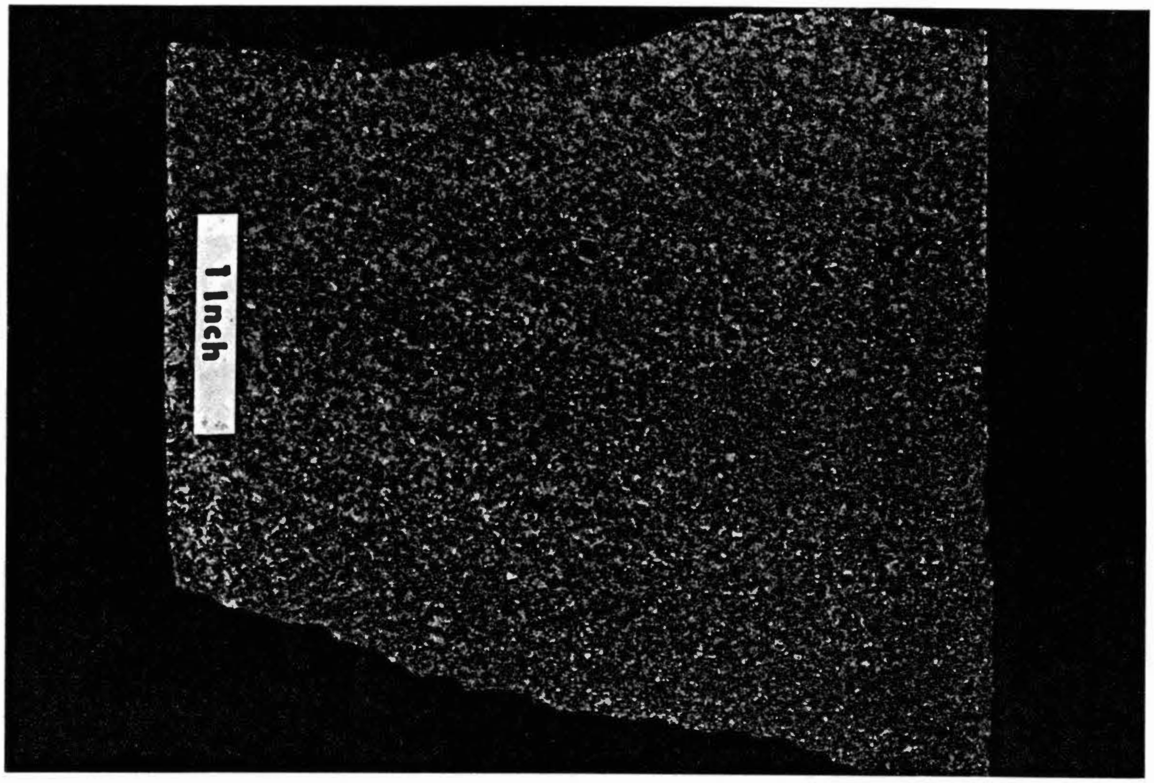


Figure 35. Medium scale crossbeds in Upper Morrowan sandstone. Cities Service No. 4 Stonebraker "AN," 6272.5-6272.8 ft.

6268.7-6258 ft.: Sandstone: light to medium gray; very fine to medium grained; noncalcareous; micaceous; horizontal and wavy laminations, soft-sediment deformation; shale rip-up clasts and flaser beds? (6266.1-6265.2 ft.) (Figure 36), interlaminated with dark gray, fine grained, noncalcareous sandstone (Figure 37); rock showing upper contact is missing from core; many contacts within interval are abrupt (e.g. at 6268.3 ft.).

<u>6258-6249</u> <u>ft.:</u> This section of core missing.

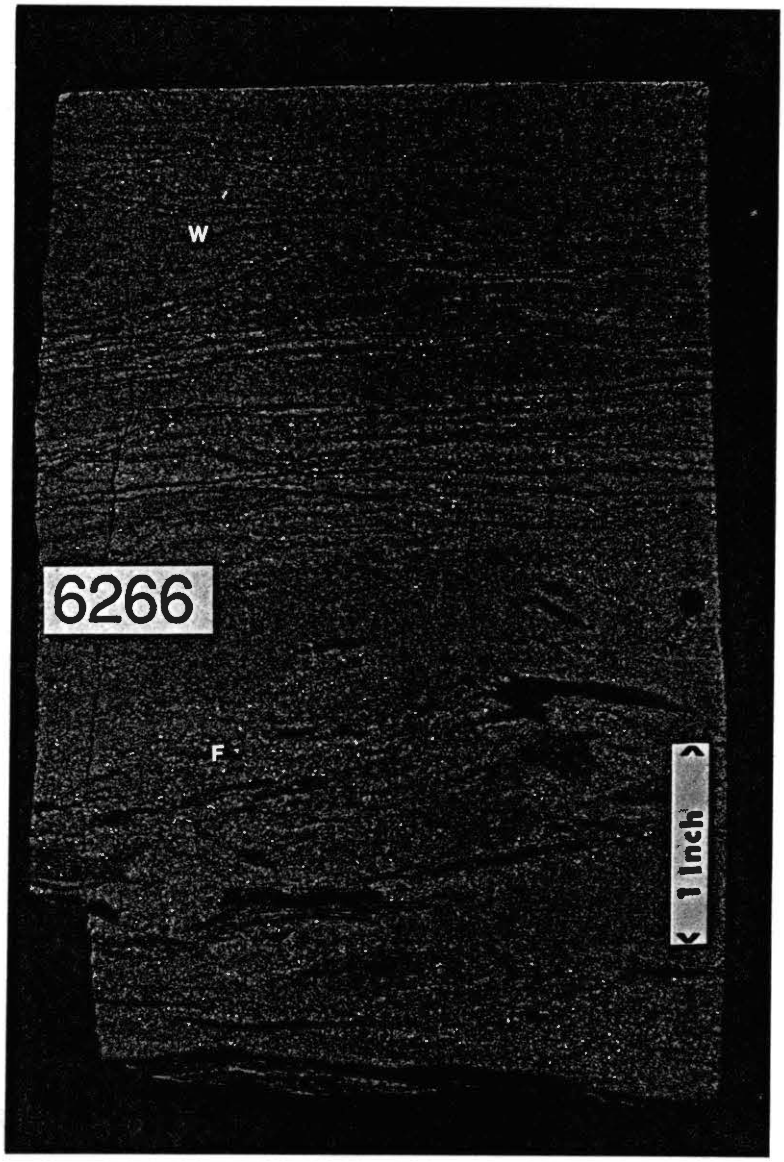


Figure 36. Fine grained sandstone with wavy laminations (W) toward top and flaser? bedding (F) toward base. Upper Morrowan sandstone, Cities Service No. 4 Stonebraker "AN," 6265.8-6266.2 ft.

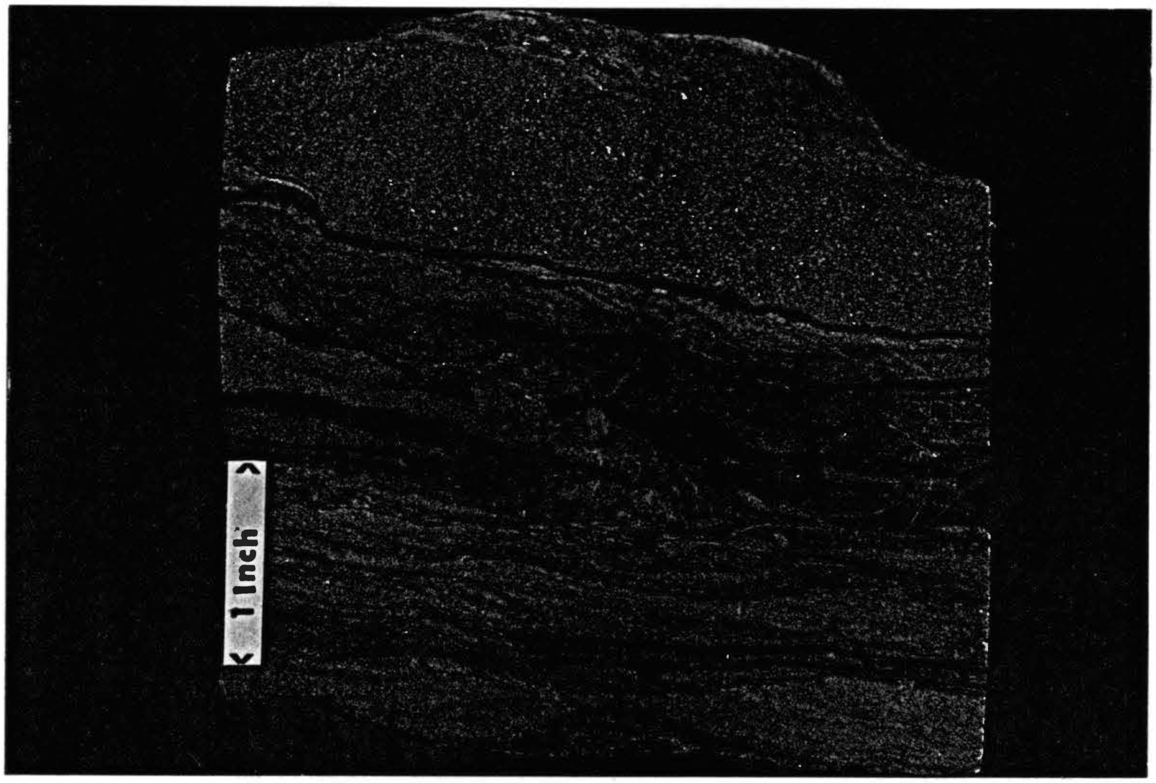


Figure 37. Dark and light interbedded units typical of interval from 6258 to 6268.7 ft. Upper Morrowan sandstone, Cities Service No. 4 Stonebraker "AN," 6268.1-6268.4 ft.

6249-6247.4 ft.: Sandstone: light to medium gray; very fine grained; noncalcareous; micaceous; horizontally bedded; interval has appearance of shale, but is very fine grained silty sandstone.

6247.4-6238.5 ft.: Sandstone: light to medium gray; very fine grained; noncalcareous; micaceous; hematite and pyrite (6246, 6244.5, 6240.4 and 6238.5 ft.); with lenses of shale; mostly horizontally bedded; crossbedded from 6244 to 6243.5 ft. (medium scale, planar, dipping as much as 15 degrees from horizontal); slump structures, interlaminated with dark gray, fine grained, noncalcareous sandstone (Figure 38).

6238.5-6237 ft.: Sandstone: gray to dark gray; very fine grained; noncalcareous; micaceous; horizontally bedded; rock has appearance of shale, but is very fine grained sandstone to coarse siltstone.

6237-6230 ft.: Shale: black; fissile; noncalcareous; only three feet of rock in core. (Consistent signature on log supports inference that probably all of shale was black and fissile.)

6230-6225 ft.: Shale: black; fissile; calcareous; with abundant fragments of articulate brachiopods and crinoids (Figure 39).

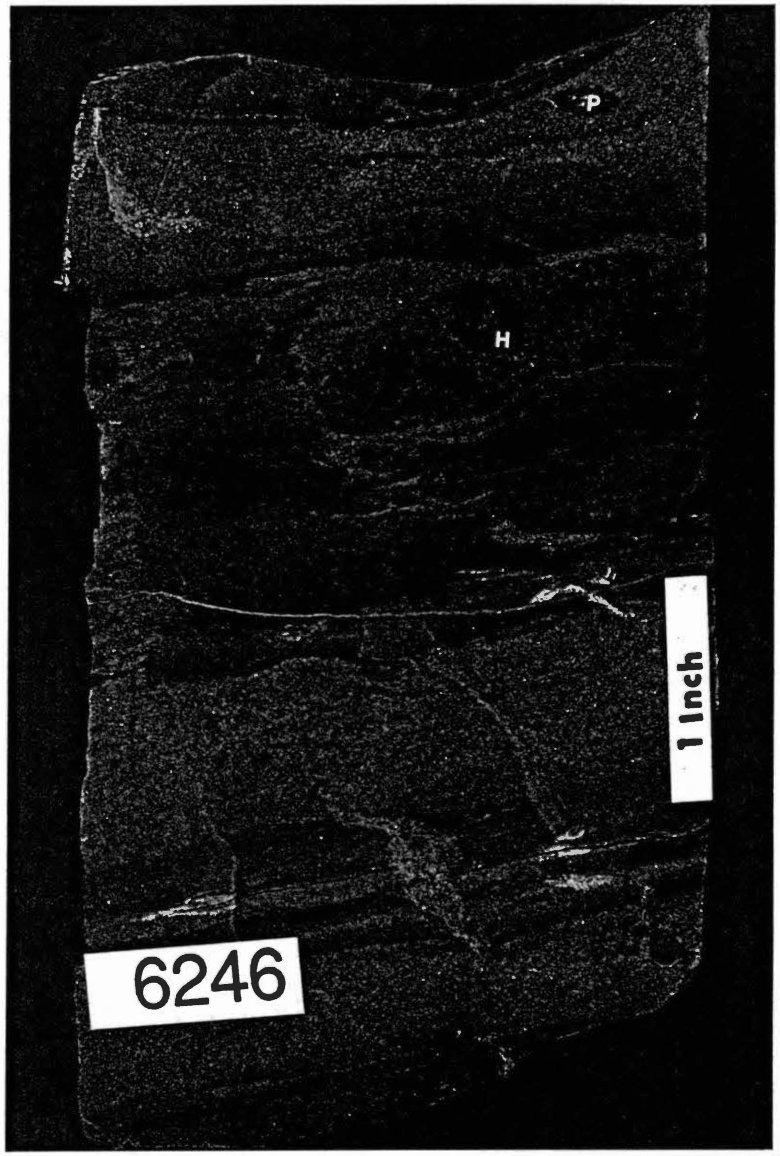


Figure 38. Pyrite (P) and hematite (H) nodules, fairly common in Upper Morrowan sandstone in Cities Service No. 4 Stonebraker "AN," from 6238.5-6347.4 ft. Depth of sample, 6246 ft.

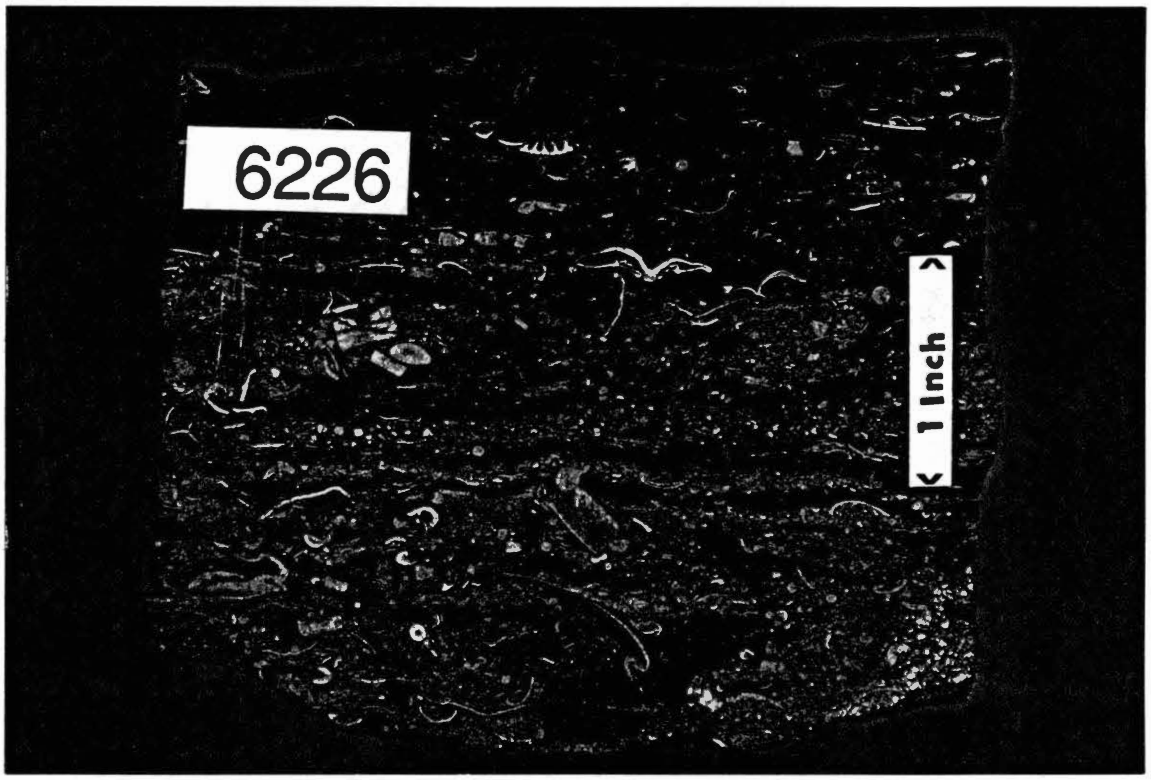


Figure 39. Black fossiliferous shale about 11 ft. above Upper Morrowan sandstone. Cities Service No. 4 Stonebraker "AN," 6226 ft.

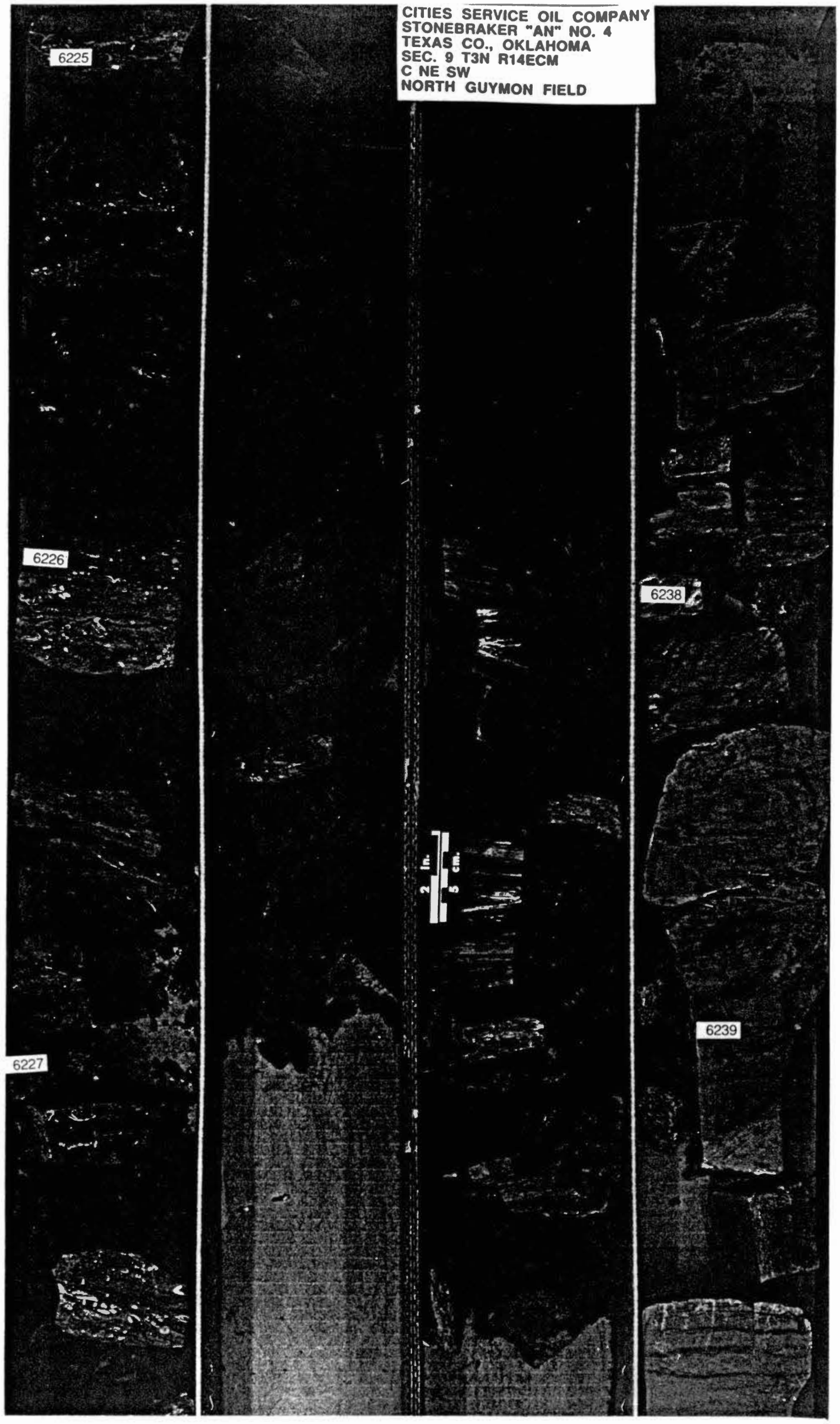


Figure 40. Photographs of core, Cities Service Oil Co. No. 4 Stonebraker "AN."

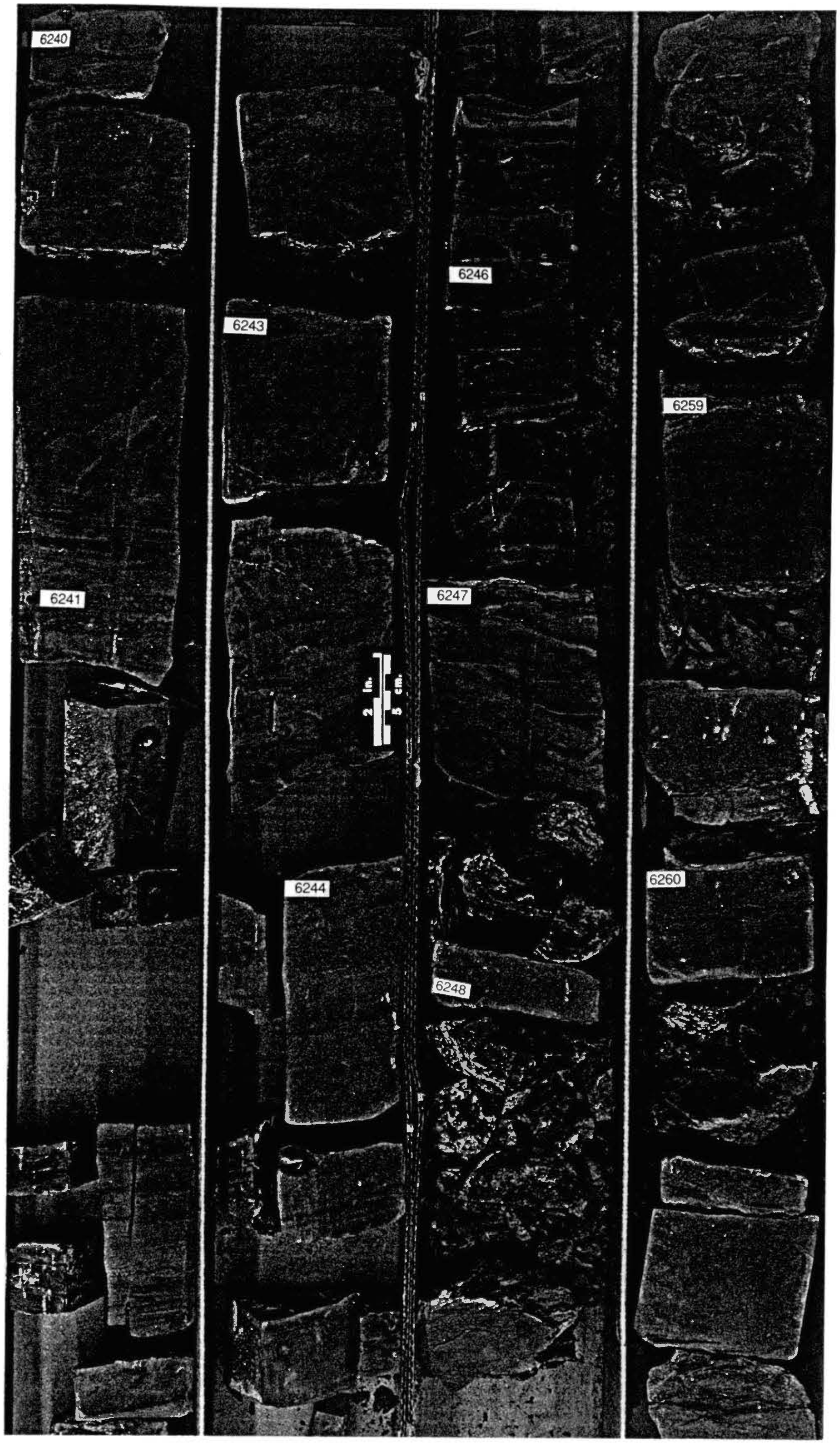


Figure 40. Photographs of core, Cities Service Oil Co. No. 4 Stonebraker "AN" (cont'd).

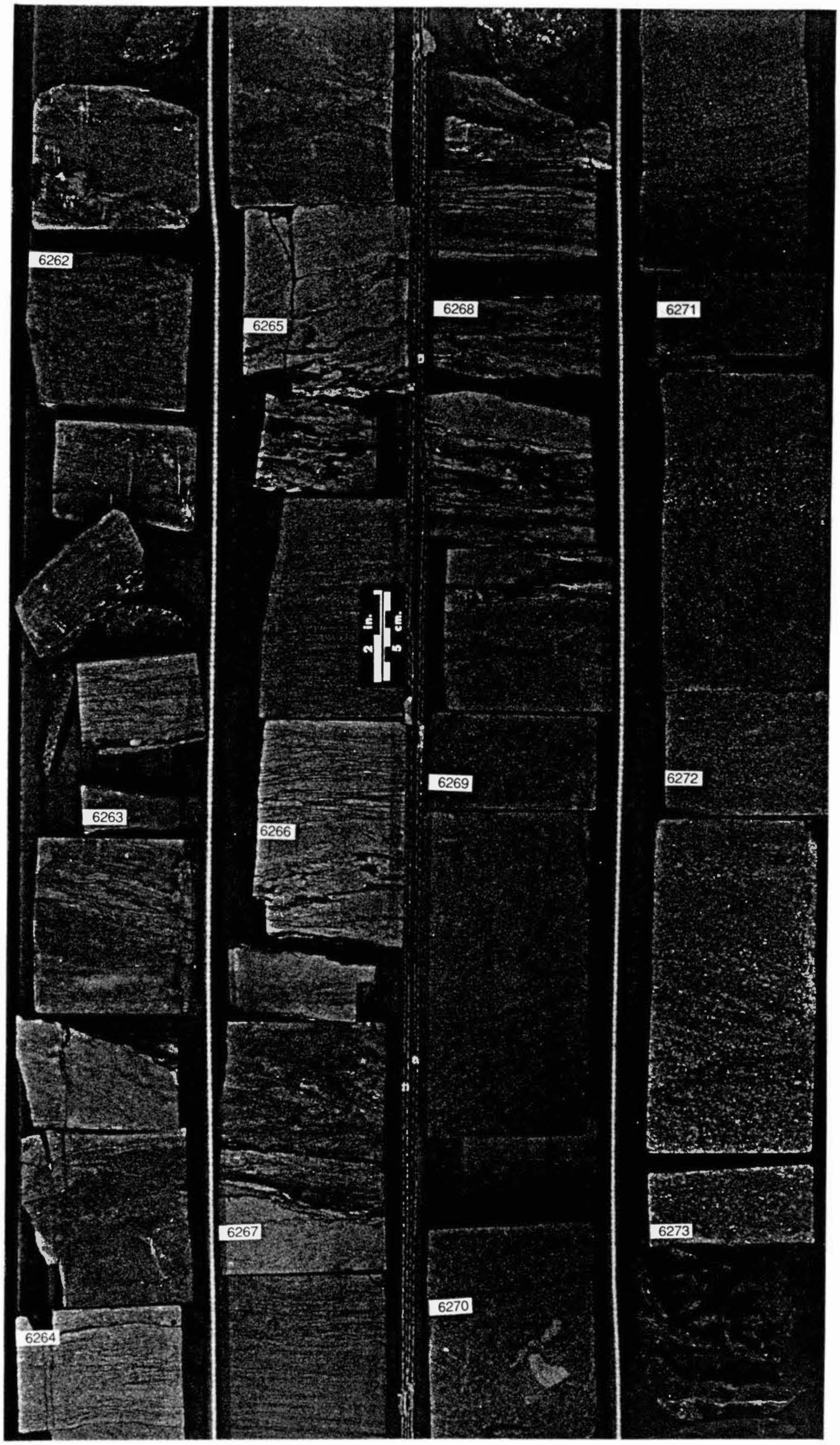


Figure 40. Photographs of core, Cities Service Oil Co. No. 4 Stonebraker "AN" (cont'd).

Figure 40. Photographs of core, Cities Service Oil Co. No. 4 Stonebraker "AN" (cont'd).

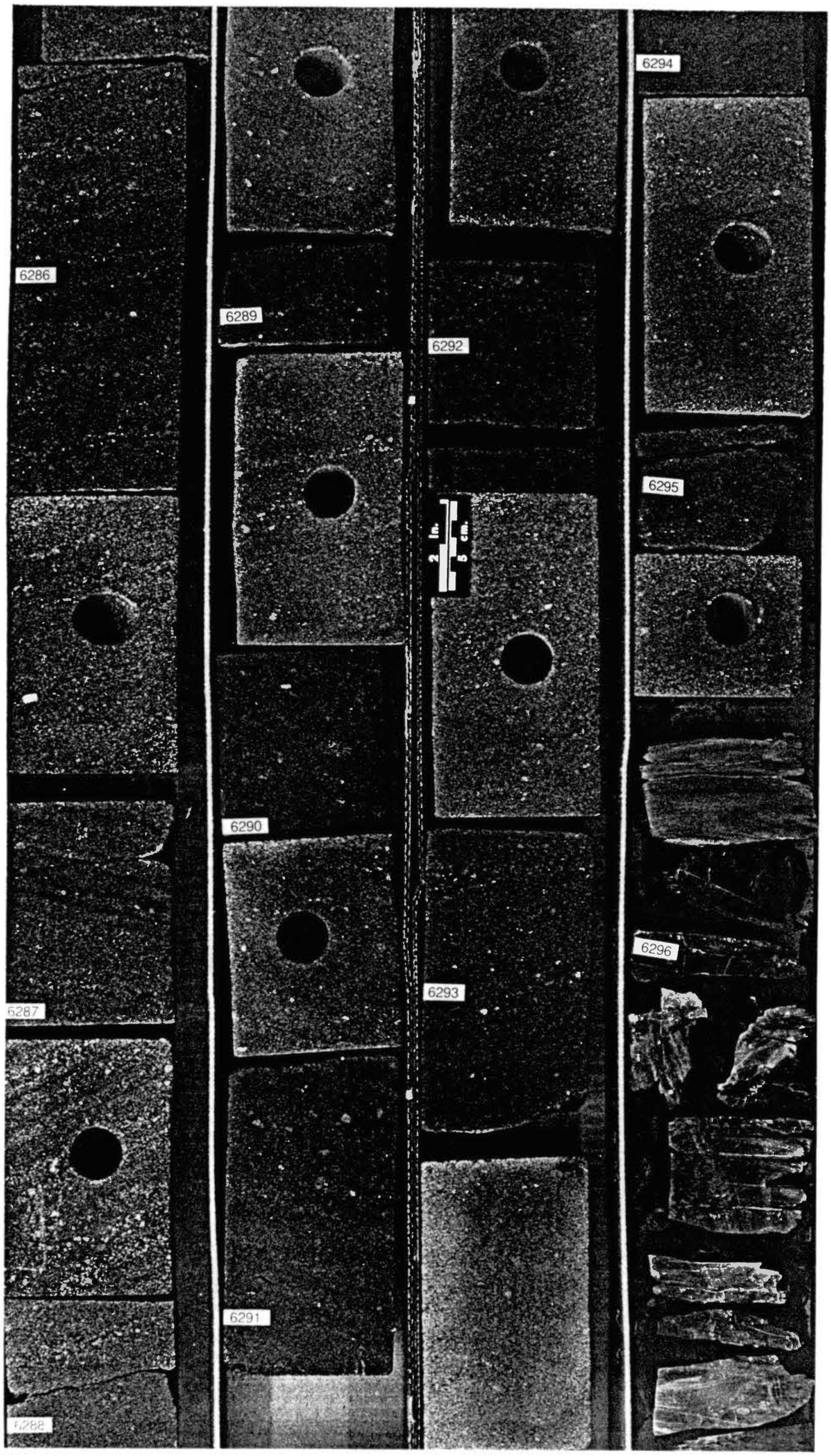


Figure 40. Photographs of core, Cities Service Oil Co. No. 4 Stonebraker "AN" (cont'd).

Cities Service Oil Co. No. 101 Stonebraker "A"

Depths marked on the core of No. 101 Stonebraker are 14.5 ft. shallower than depths on logs (Plate XXI). The core is a sample of 42 ft. of the Upper Morrow stratigraphic section; the core is not complete.

6207.1-6207 ft.: Shale: dark brown; thinly laminated; noncalcareous.

6207-6206 ft.: Sandstone: gray to tan; coarse grained; calcareous; with glauconite, hematite stain, and carbonized plant fragments. (Figure 41).

6206-6205.9 ft.: Shale: black; fissile in lower one-half inch; "massive" at top; calcareous; with fragments of brachiopod shells.

6205.9-6189.2 ft.: This section of core missing.

6189.2-6186.6 ft.: Limestone: gray and tan; predominantly mottled; nodular; perhaps caliche at 6187.7-6187 ft. (Figure 42) (Al-Shaieb, 1992).

6186.6-6180.3 ft.: This section of core missing.

6180.3-6180 ft.: Conglomerate: matrix: sandstone; dark gray to brown; coarse grained; carbonate-cemented. Clasts: carbonate mudstone; dark brown and gray; as pebbles and cobbles (Figure 43).

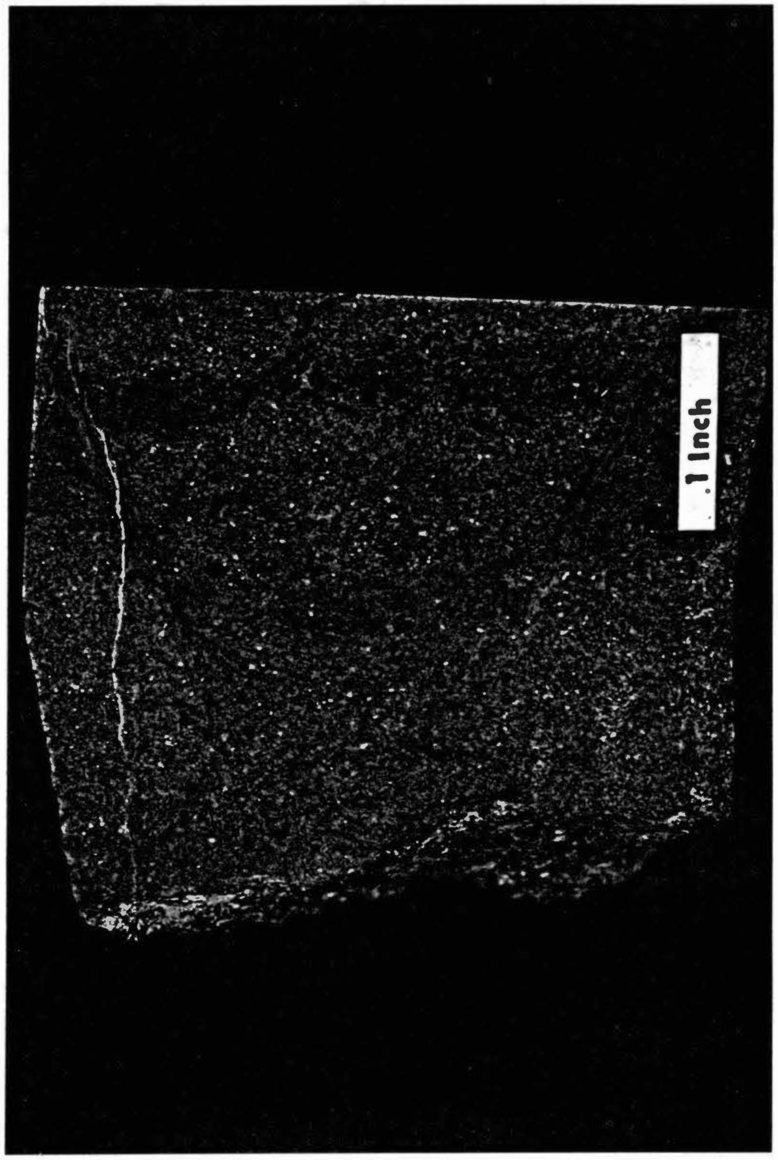


Figure 41. Upper Morrowan sandstone. Cities Service No. 101 Stonebraker "A," 6206.5-6206.7 ft.

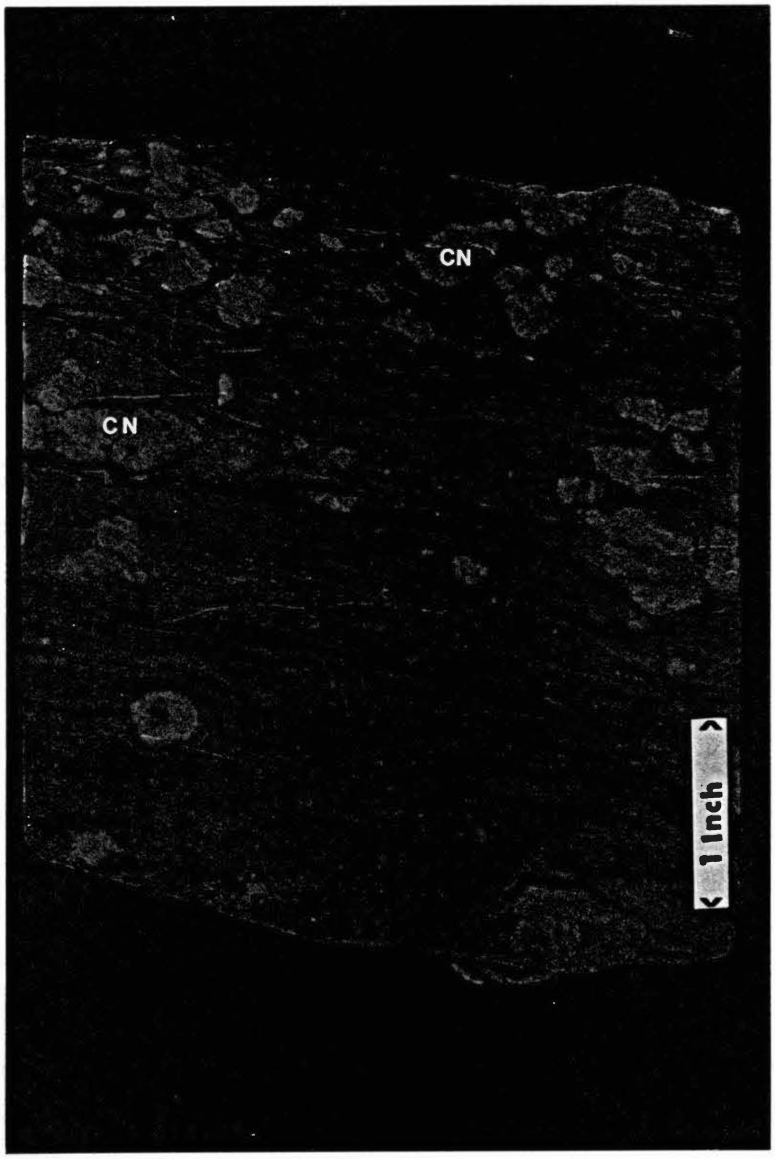


Figure 42. Tan to light gray Upper Morrowan limestone with possible caliche (CN). Cities Service No. 101 Stonebraker "A," (6187.3-6187.6).

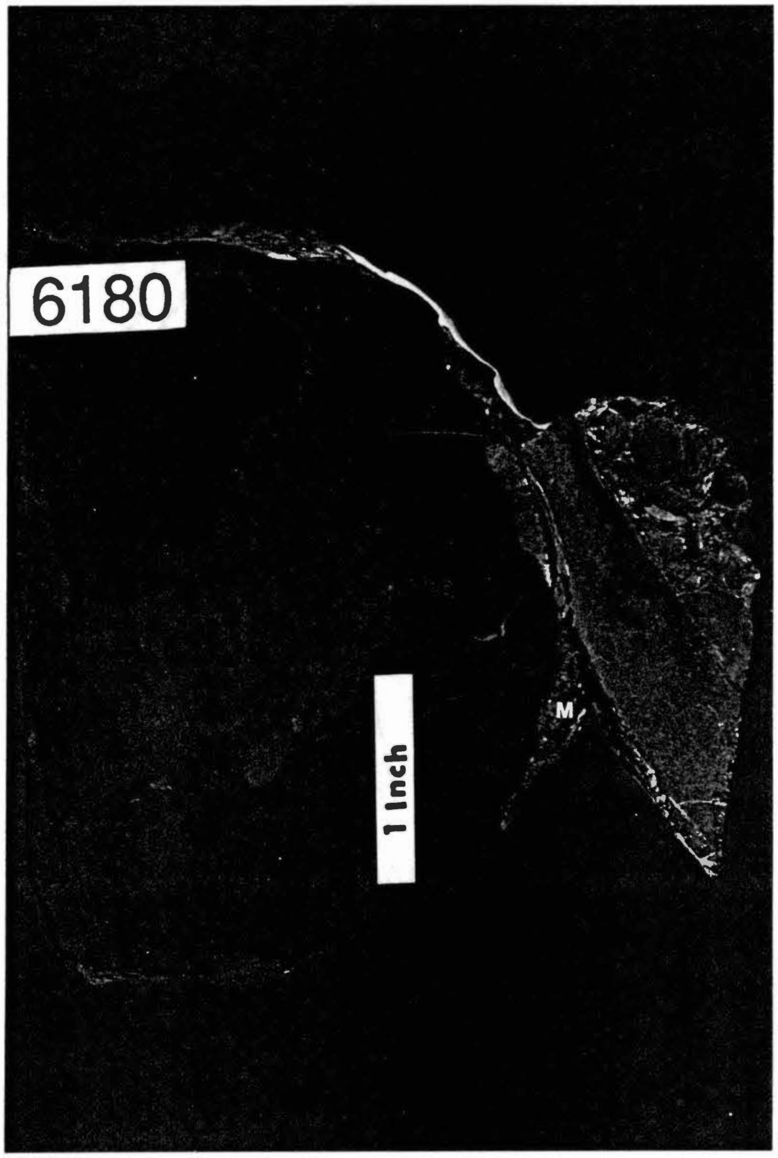


Figure 43. Large carbonate mudstone clast with fragment of sandstone matrix (M) at lower right position. Upper Morrowan section, Cities Service No. 101 Stonebraker "A," 6180 ft..

6179.2-6178.2 ft.: Sandstone: medium gray; very fine to fine grained; noncalcareous; micaceous; with slightly lighter gray, calcareous, wavy laminations at various locations in the interval; disrupted beds as results of slumping (6179.2-6179 ft.). Four carbonate-rich strata of sandstone at 6178.9 and 6178.6 ft., and two between 6178.4-6178.3 ft..

6178.2-6176 ft.: Sandstone: interbedded medium gray and red-brown; fine grained; with calcareous cement (gray zones) and noncalcareous (phosphatic) cement (red zones); micaceous; gray zones contain abundant phosphate-coated grains; red-brown sandstone is slightly the coarser of the sandstones; crossbedded (medium scale, planar, dipping about 25 degrees from horizontal) (Figure 44).

6176-6173.5 ft.: Sandstone: overall medium gray to dark gray; very fine to fine grained; noncalcareous; near base, horizontal to wavy continuous laminations; sandstone grades upward into crossbedded laminations (medium scale, planar, dipping about 15 degrees from horizontal).

6173.5-6171.6 ft.: Sandstone: mostly light to medium gray (with red-brown (phosphatic cement) interval at 6173-6172.5 ft.); very fine to fine grained; calcareous (abundance of calcium carbonate cement decreases upward); richest

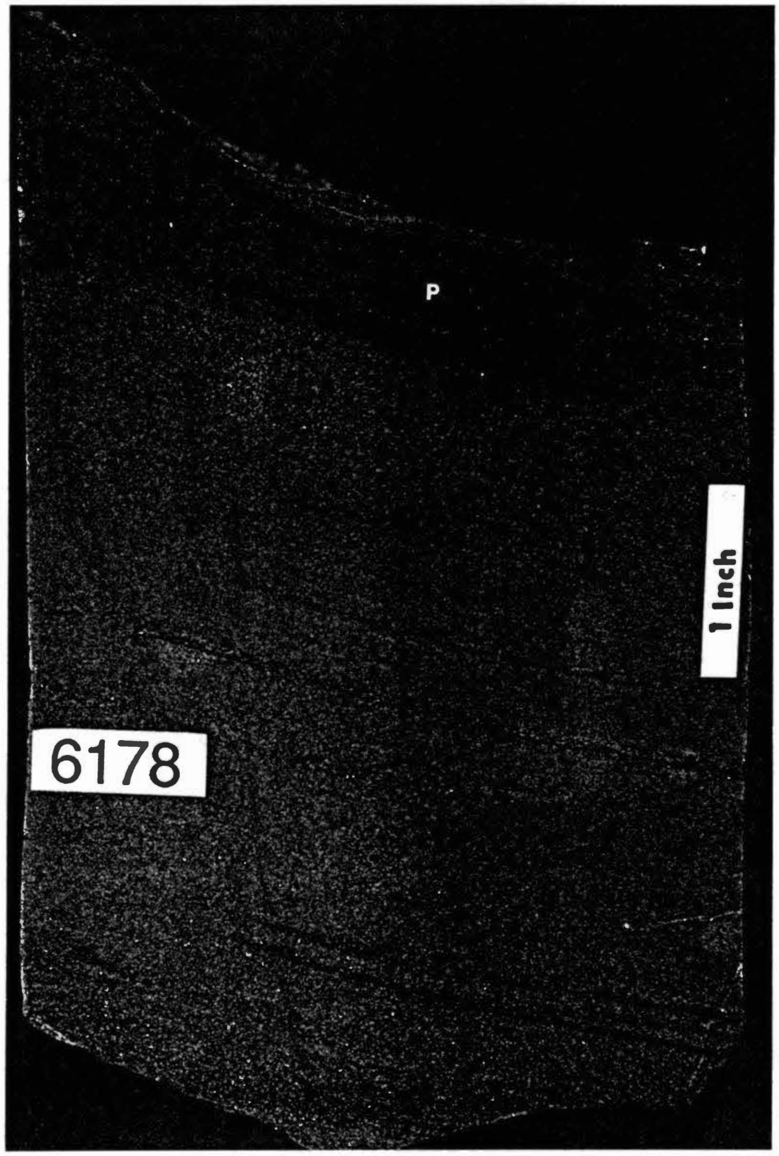


Figure 44. Crossbedded Upper Morrowan sandstone with dark red-brown zones where cement is phosphatic (P) material. Cities Service No. 101 Stonebraker "A," 6178 ft.

in calcium carbonate at 6173.5-6173 ft.); micaceous; crossbedded (medium scale, planar, dipping as much as 32 degrees from horizontal) (Figure 45).

6171.6-6170.7 ft.: This section of core missing.

6170.7-6169.2 ft.: Sandstone: gray; very fine to fine grained; micaceous; interlaminated with darker gray, laminated silty sandstone; crossbedded (medium scale, planar, dipping as much as 25 degrees from horizontal).

6169.2-6165.2 ft.: Sandstone: gray to dark gray, (red-brown from 6167.9-6167 ft.); very fine to fine grained; noncalcareous (except for three intervals: a relatively thick "band" (6169-6168.2 ft.), a 2-in. band (6167.5 ft.), and a 0.5-in. band (6166.6 ft.). The calcareous bands are lighter gray than surrounding areas and have a green-gray tint when wet; micaceous; with black-shale rip-up clasts at 6167.8 and 6166.6 ft.; ripple? laminated 6168-6167.8 ft.; wavy bedding 6167.5 ft.; soft-sediment flowage structures at 6167.4-6167 ft.; flaser? bedding at 6166.6-6166.5 ft. (Figure 46).

6165.2-6165 ft.: Carbonate mudstone: dark gray, (some red-brown areas); hematite-stained; with light gray mudstone clasts and small pyrite nodules (Figure 47).

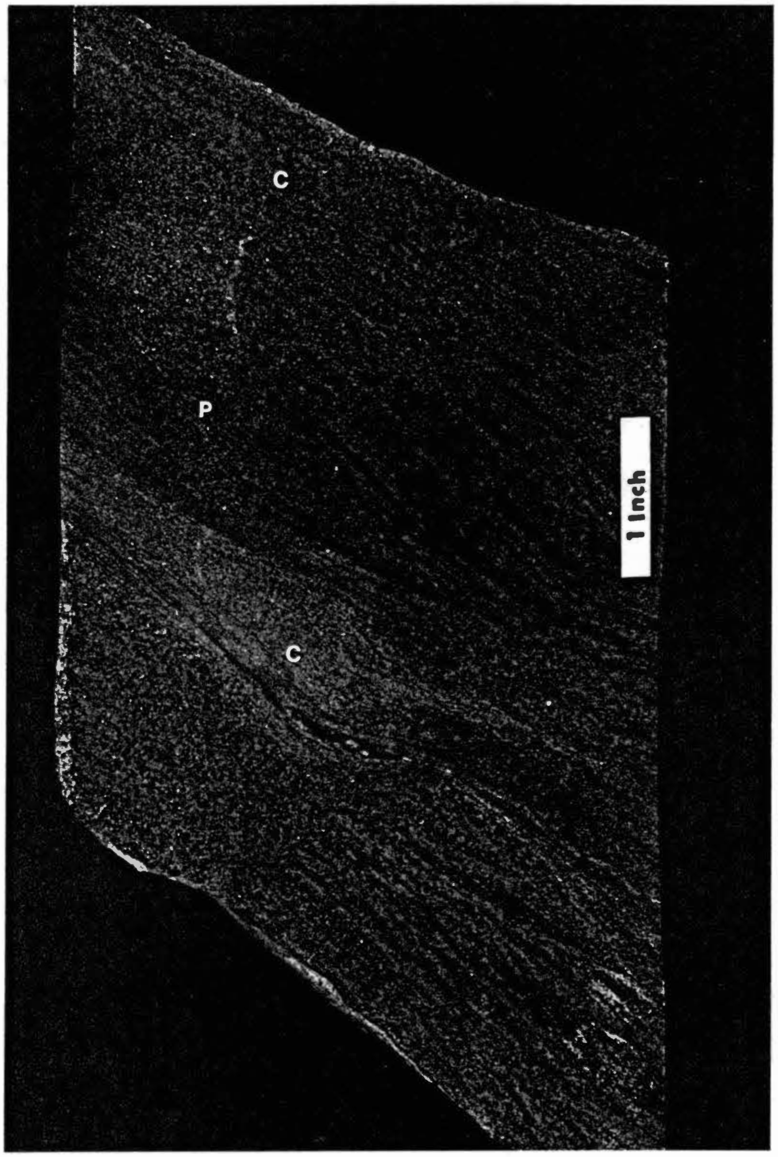


Figure 45. Upper Morrowan sandstone with high angle medium scale crossbeds and calcitic (C) and phosphatic (P) cements. Calcite cement is concentrated within the lighter colored zones. Cities Service No. 101 Stonebraker "A," 6171.6-6173.5 ft.

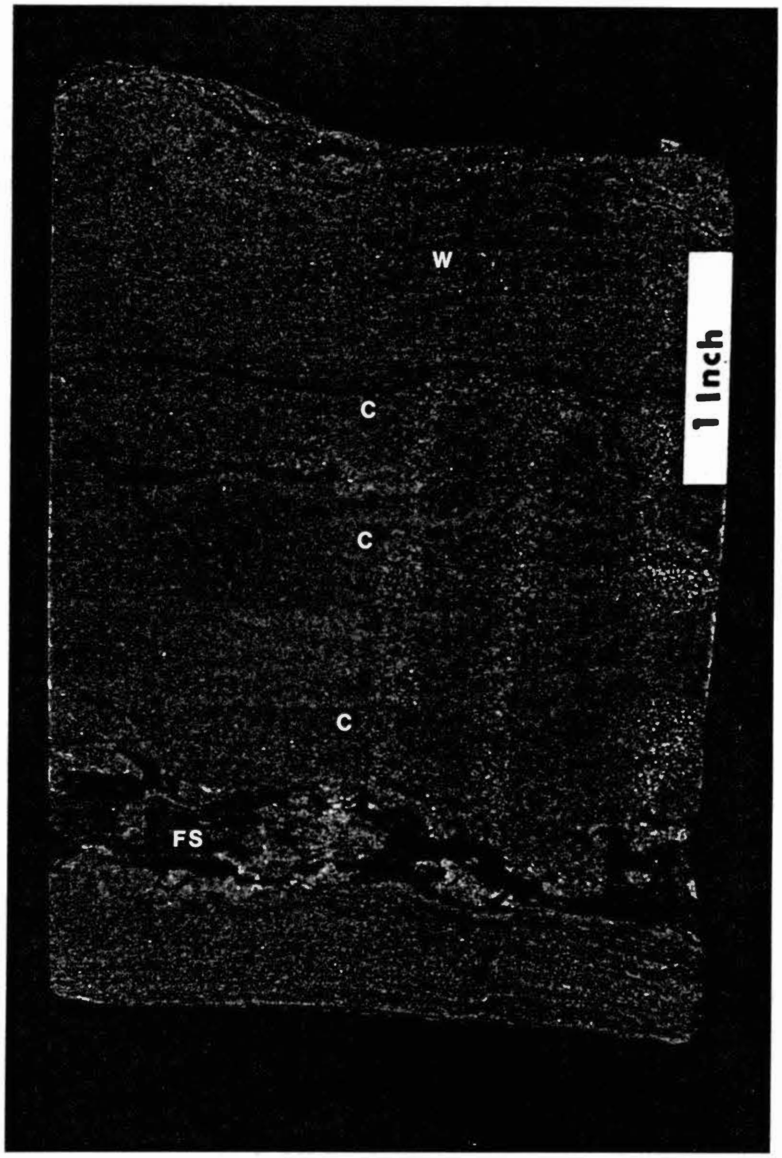


Figure 46. Upper Morrowan sandstone. Soft-sediment flowage structures (FS) near base and a highly calcareous (C) zone from the top of the flowage structures to the base of the horizontal wavy (W) laminations near top of sample. Cities Service No. 101 Stonebraker "A," 6167.4-6167.7 ft.

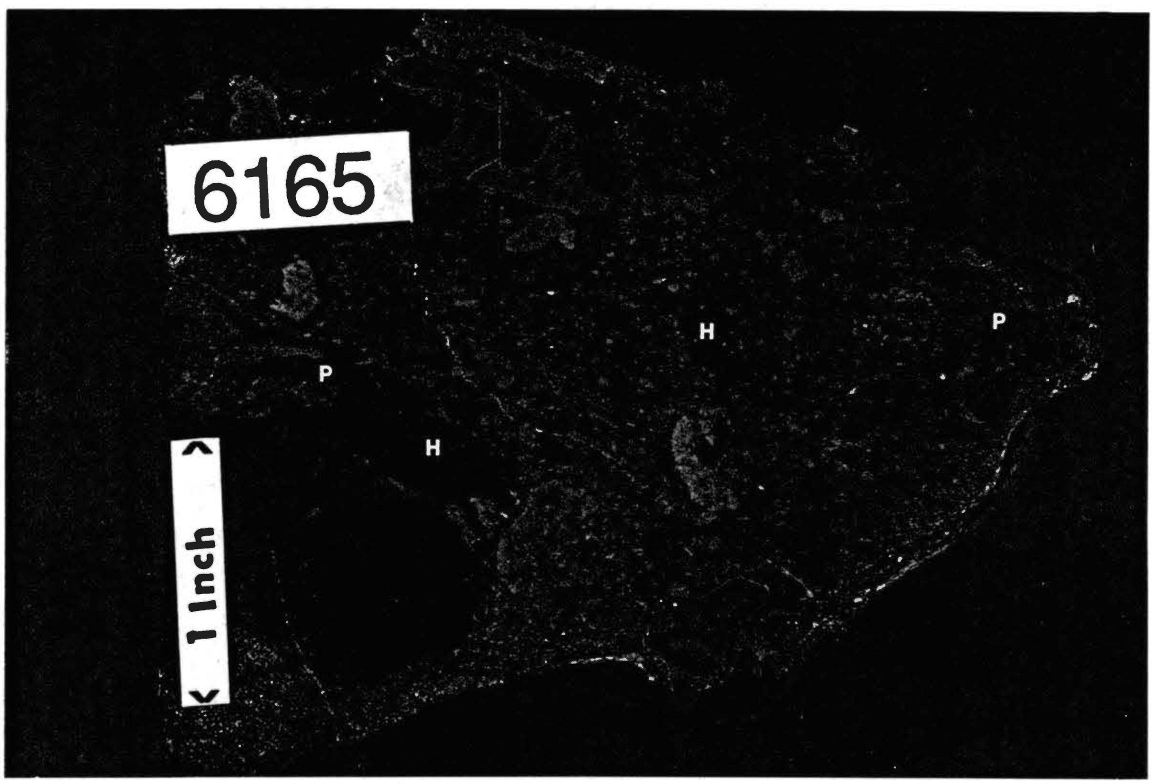


Figure 47. Carbonate mudstone that is selectively hematite-stained (H); also present are small nodules of pyrite (P). Cities Service No. 101 Stonebraker "A," 6165-6165.2 ft. Upper Morrowan section.

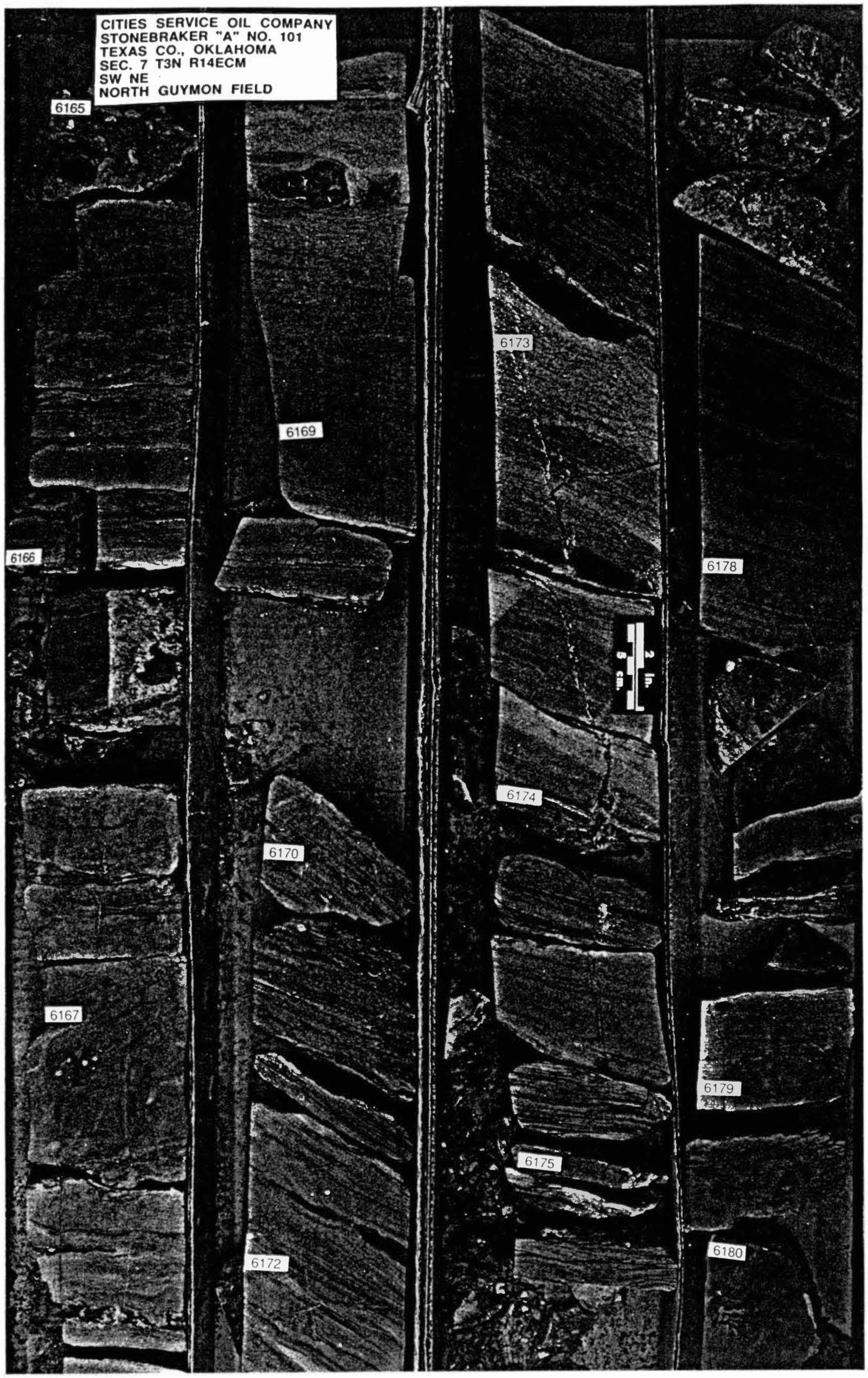


Figure 48. Photographs of core, Cities Service Oil Co. No. 101 Stonebraker "A."

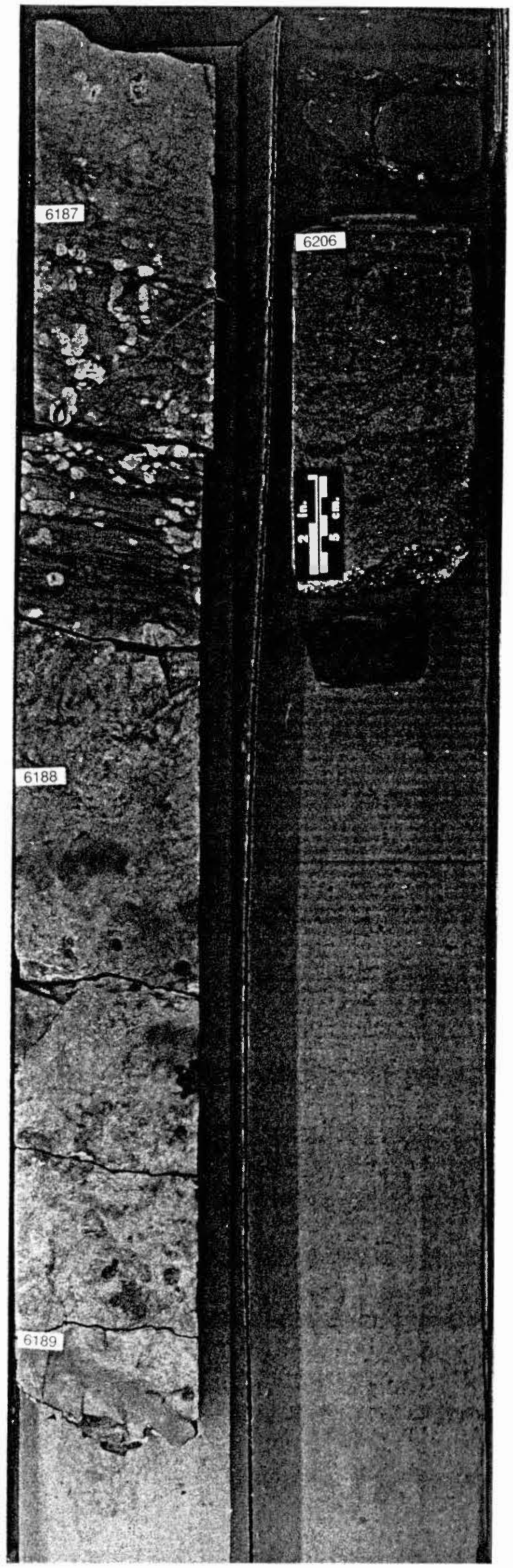


Figure 48. Photographs of core, Cities Service Oil Co. No. 101 Stonebraker "A" (cont'd).

Cores of Lower Morrowan Strata

<u>Shell Oil Co. No. 1-13 Finfrock</u>

Depths marked on the core of the No. 1-13 Finfrock are 1 ft. shallower than depths recorded on logs (Plate XXII). The core is a sample of 50 ft. of Lower Morrowan (Keyes) sandstone; the core is fairly complete.

<u>6550-6544 ft.:</u> Shale: greenish gray; rather friable; slightly calcareous; abundantly fossiliferous with crinoid stems, articulate brachiopods, and <u>Archimedes</u>; abrupt upper contact. (Figure 49.)

<u>6544-6541.8 ft.:</u> Sandstone: medium gray; very fine to fine grained; wavy and disrupted, discontinuous bedding; calcareous; with thin bands (0.1-0.5 in.) and small lenses of dark gray to black, calcareous, fossiliferous shale containing fronds of <u>Archimedes</u>? (Figure 50.)

<u>6541.8-6540.8 ft.:</u> Sandstone: light gray; fine to medium grained; calcareous, glauconitic, with filaments of carbonized plant material; medium scale, planar crossbedding (lower 2 in.; dip 10 degrees from horizontal); massively bedded in upper 10 in.; abrupt upper contact.

<u>6540.8-6540.6 ft.:</u> Conglomerate: two zones (1) lower one inch: matrix: siltstone; dark gray;

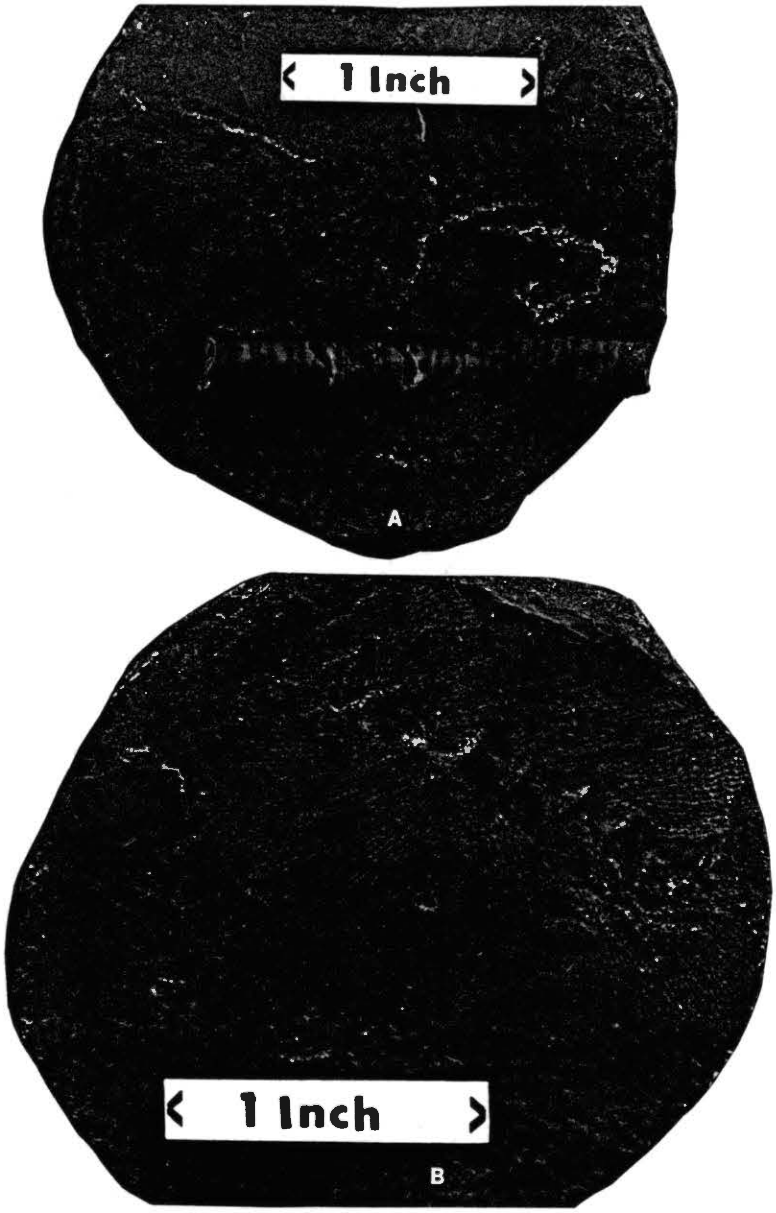


Figure 49. Greenish gray fossil-rich shale located near the Lower Pennsylvanian/Upper Mississippian contact: (a) crinoid stem at 6549.5 ft. (b) Archimedes bryozoa at 6544.5 ft. Shell Oil No. 1-13 Finfrock.

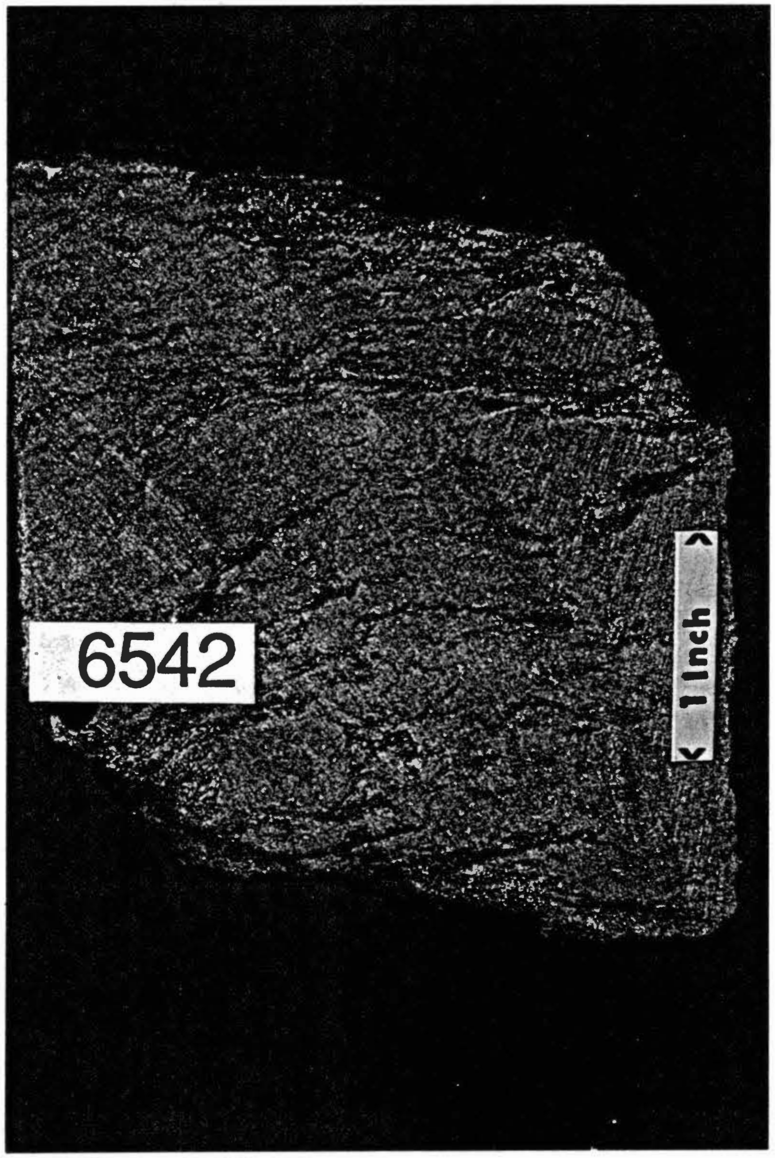


Figure 50. Photograph representative of Lower Morrowan sandstone, Shell Oil No. 1-13 Finfrock, 6541.3 to 6544 ft.

calcareous, with clasts of carbonate mudstone and of very fine grained, light gray sandstone; (2) upper one inch: matrix: sandstone; light gray; very fine grained; calcareous; with clasts of carbonate mudstone, light and dark gray, pebble-sized; abrupt upper contact. (Figure 51.)

<u>6540.2-6530.9</u> <u>ft.:</u> Sandstone: light greenish gray; fine to medium grained; slightly calcareous; very abundant glauconite; abundant "vertical" burrows (Figure 52) (one at least 8 in. long); moderately abundant organic material as filaments of carbonized plant material; medium scale, planar crossbeds, dipping 15 degrees from horizontal throughout 6540.2-6538 ft.

<u>6530.9-6527</u> <u>ft.:</u> Sandstone: light gray; fine to coarse grained; slightly calcareous; with moderately abundant clasts of clay, thin disrupted lenses of micaceous, black shale, sand-sized fossil fragments, and abundant glauconite; crossbedded (medium scale, planar, dipping in opposite directions, the upper set at 10 degrees from horizontal, the lower at 25 degrees (6528 ft.)); upper contact gradational with overlying sandstone.

<u>6527-6525.7</u> <u>ft.:</u> Sandstone: light gray; fine to medium grained; massively bedded; calcareous, glauconitic, with black-shale partings.

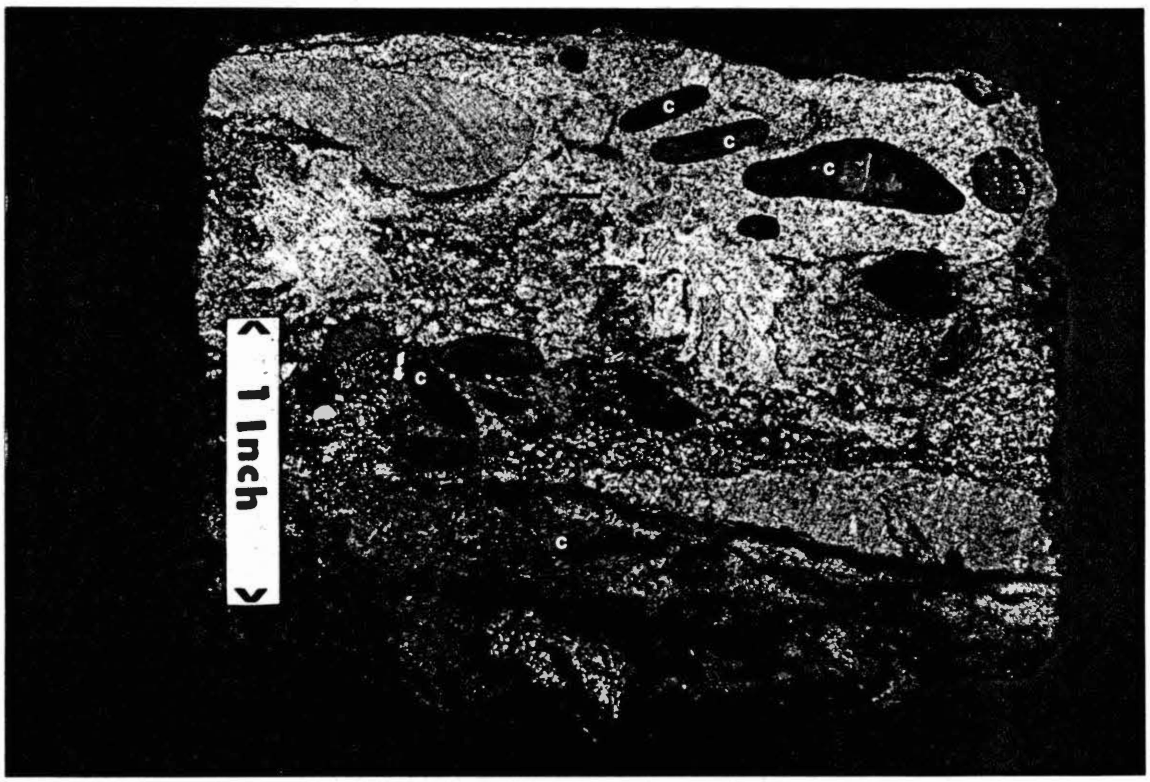


Figure 51. Conglomerate with clasts of carbonate clay pebbles (c) at 6540.6-6540.8 ft. in Lower Morrowan section of Shell Oil No. 1-13 Finfrock.

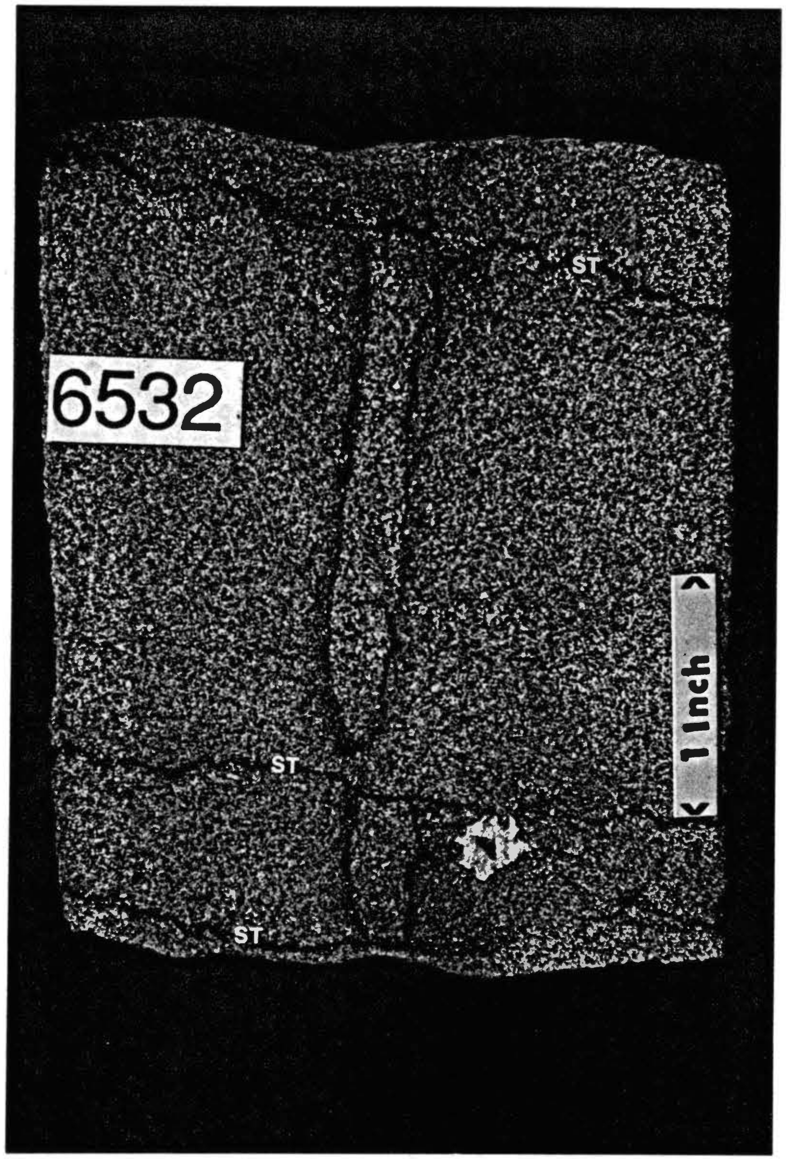


Figure 52. "Vertical" burrow cut by stylolites (ST) and bounded by abundant glauconite (dark specks). Lower Morrowan sandstone, Shell Oil No. 1-13 Finfrock, 6532 ft.

<u>6525.7-6524</u> <u>ft.:</u> Sandstone: light to medium gray; medium to coarse grained; noncalcareous; with many discontinuous lenses of slightly micaceous, black clay (wavy appearance, due to soft-sediment deformation and/or slumping) (Figure 52).

<u>6524-6521.2</u> <u>ft.:</u> Sandstone: light to medium gray; medium to coarse grained; slightly calcareous to calcareous; with sand-sized fossil fragments, glauconite, small noncalcareous clay clasts, and filaments of carbonized plant material; a thin conglomerate at 6521.5 ft. (Figure 54), bounded by abrupt contacts; matrix of conglomerate: sandstone; gray; very fine to fine grained; calcareous; clasts: noncalcareous, yellow-brown, red-brown, and black granules and pebbles of chert and clay.

<u>6521.2-6513.2</u> <u>ft.:</u> Sandstone: light gray to tan; very fine to fine grained; calcareous (light gray areas are more effervescent than tan areas); abundant mica; clay increases upward; wavy horizontal laminations (Figure 55); crossbedded sets between laminations (small scale, hummocky?, ripple laminations?, herring-bone? (6516.9)); upper contact transitional, with increase upward of shale.

<u>6513.2-6510.3</u> <u>ft.:</u> Shale: black; fissile; calcareous; micaceous; with many small gray, fine grained, glauconitic, calcareous laminations of

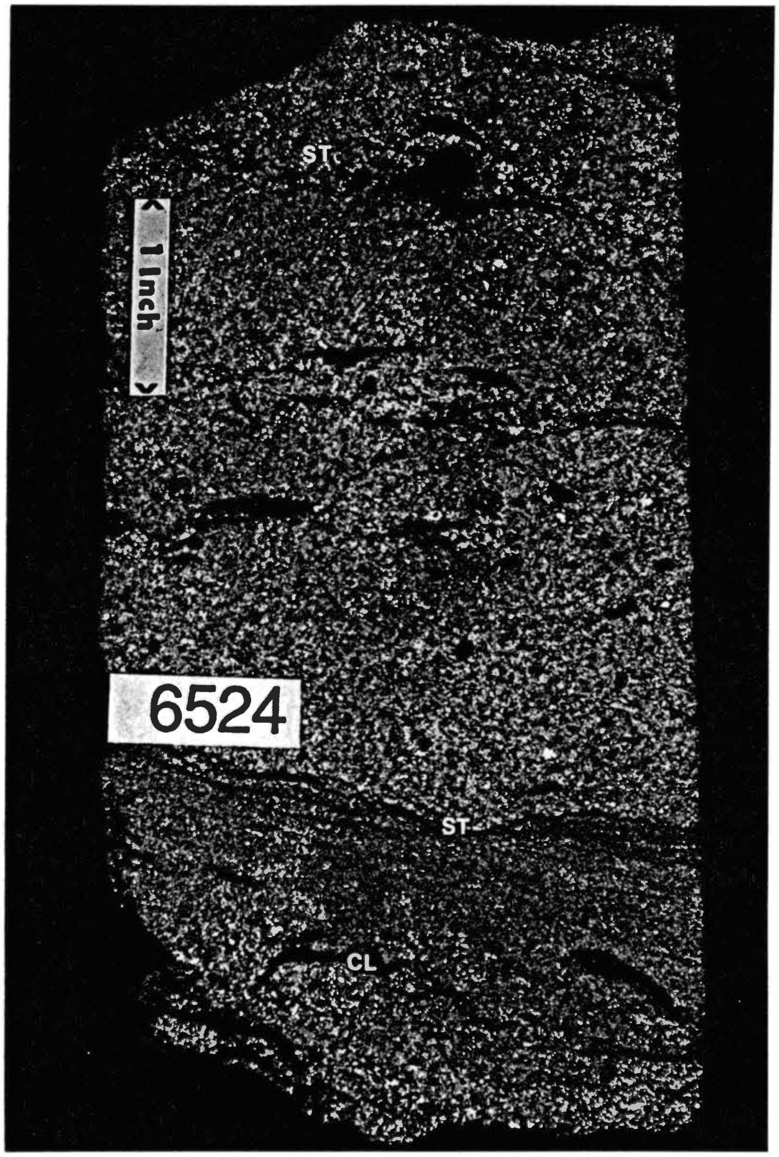


Figure 53. Photograph of Lower Morrowan sandstone typical of interval from 6526.7-6524 ft. in Shell Oil Co. No. 1-13 Finfrock. Sample contains stylolites (ST) and clay rip-up clasts (CL).

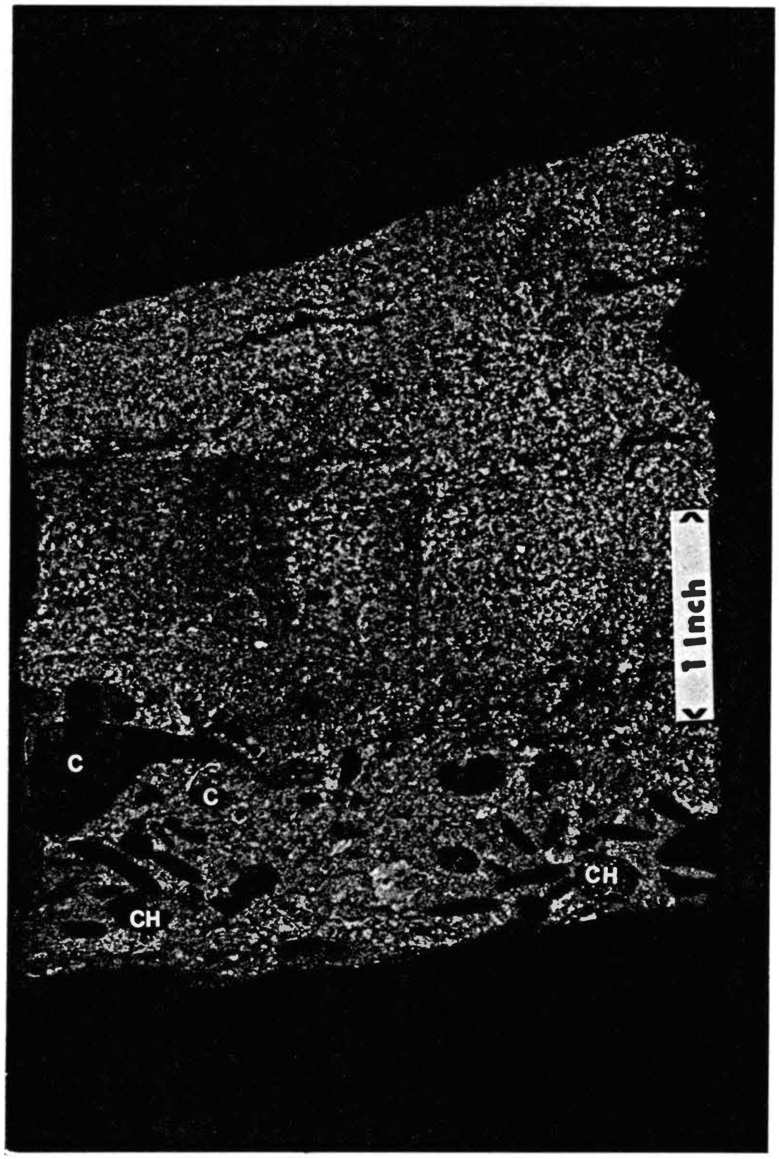


Figure 54. Conglomerate with carbonate mudstone (C) and chert clasts (CH) in a carbonate-rich medium grained sandstone matrix. Top of the conglomerate is at 6521.5 ft. in Lower Morrowan sandstone, Shell Oil No. 1-13 Finfrock.

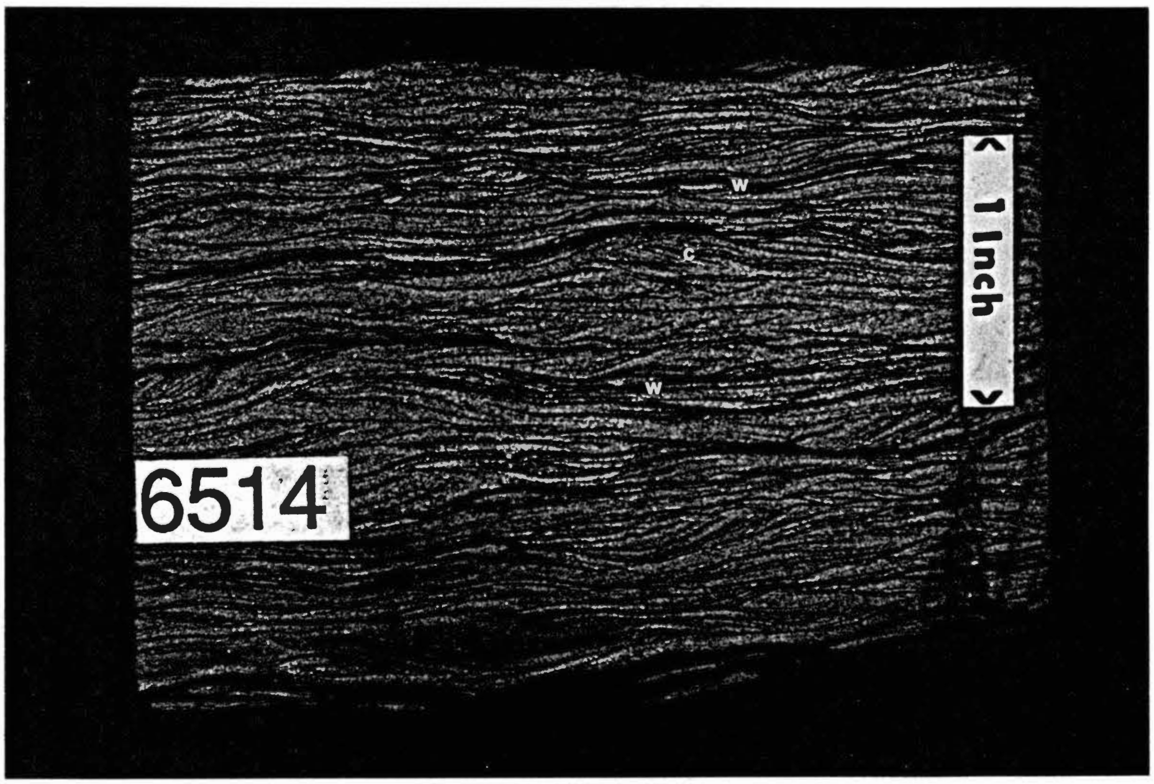


Figure 55. Climbing-ripple laminations (c) between sets of "horizontal" wavy laminations (w). Lower Morrowan sandstone, Shell Oil No. 1-13 Finfrock, 6514 ft.

sandstone (some laminations have features of soft-sediment flowage; flaser-bedding? (6512.9)); abrupt contact with overlying sandstone.

<u>6510.3-6500.5</u> <u>ft.:</u> Sandstone: medium gray to tan; very fine to fine grained; calcareous (gray rock effervesces more than tan rock); with abundant glauconite, sand-sized fossil fragments and a few disarticulated brachiopod shells at 6503.8, 6503.1, and 6501.5 ft. (Figure 56); with black, noncalcareous, rip-up clay clasts at 6508.9 (Figure 57) and 6507 ft., and black, noncalcareous, clay pebbles at 6508.3, 6506.5, and 6505.7 ft.; clasts and pebbles less abundant upward (6508.7-6506.3).

<u>6500.5-6500.3</u> <u>ft.:</u> Sandstone: medium gray to tan; medium to coarse grained; with abundant glauconite, sand-sized fossil fragments, a few disarticulated brachiopod shells, crinoid-stem fragments, and rare, small nodules of pyrite.

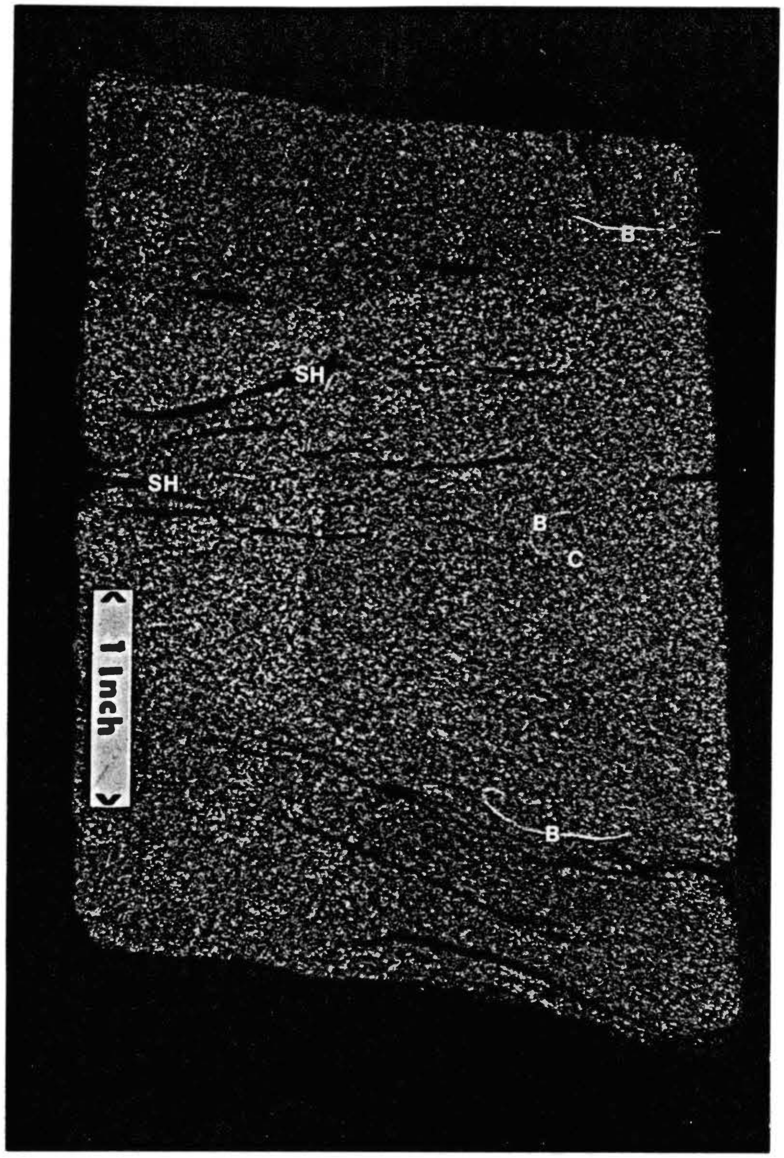


Figure 56. Lower Morrowan sandstone typical of the interval from 6500.5-6510.3 ft., with shale clasts (SH) and disarticulated brachiopods (B). Lighter portion of core (C) (middle of photograph) is more calcareous than darker parts. Dark specks are glauconite. Shell Oil No. 1-13 Finfrock, 6501.3-6501.7 ft.

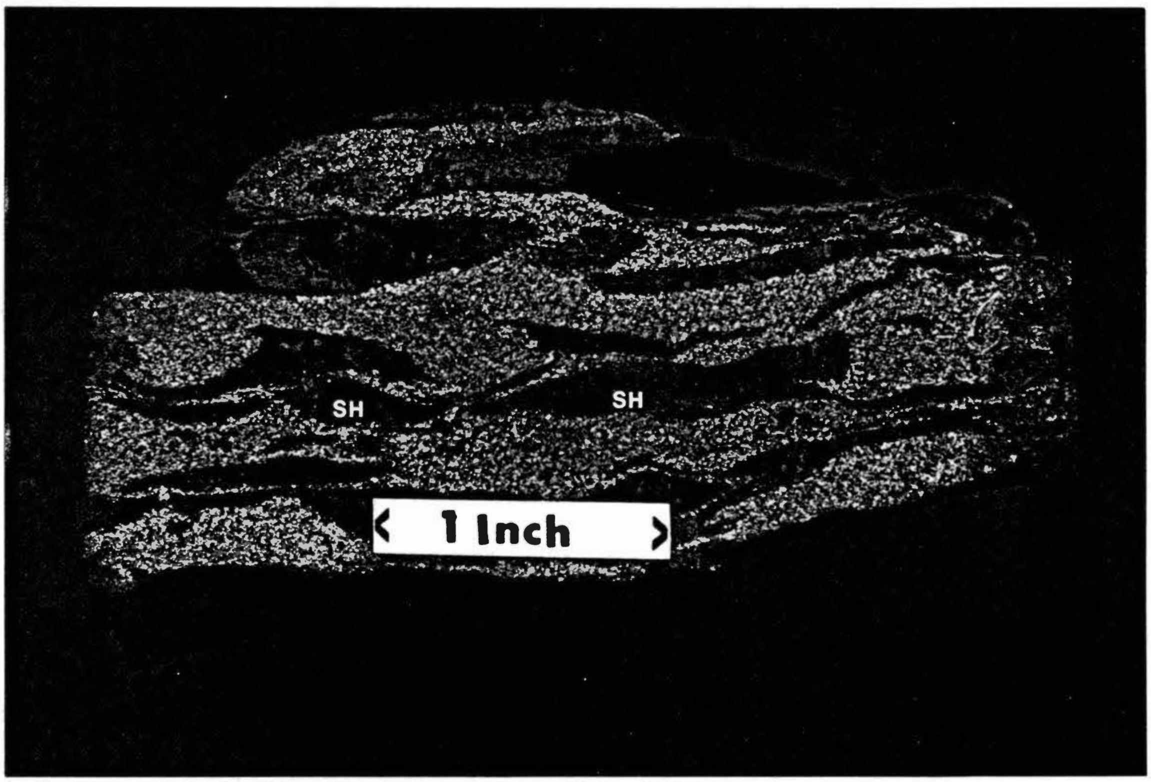


Figure 57. Black-shale rip-up clasts (SH) at 6508.9 ft. in Lower Morrowan. Shell Oil No. 1-13 Finfrock.

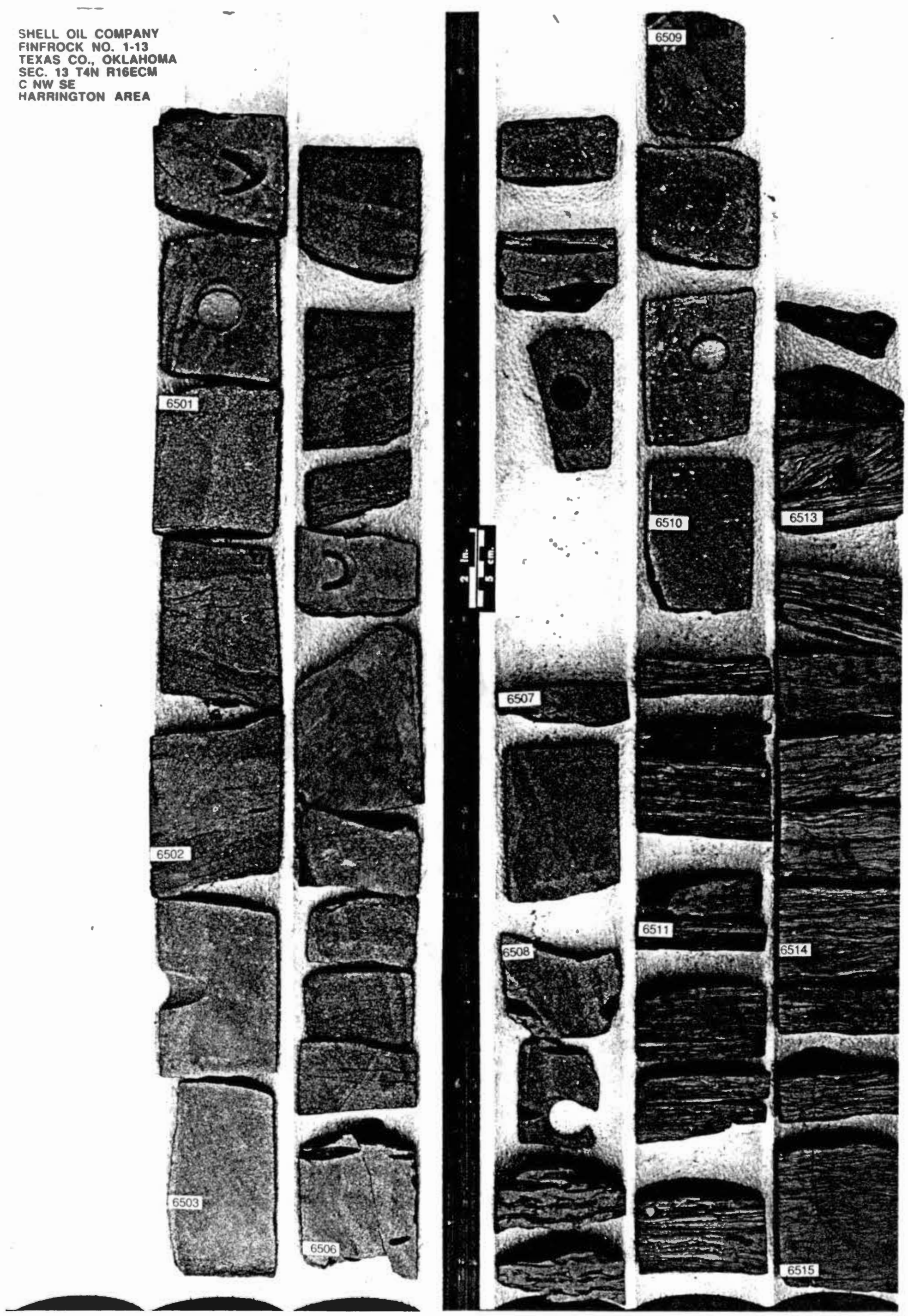


Figure 58. Photographs of core, Shell Oil Co. No. 1-13 Finfrock.

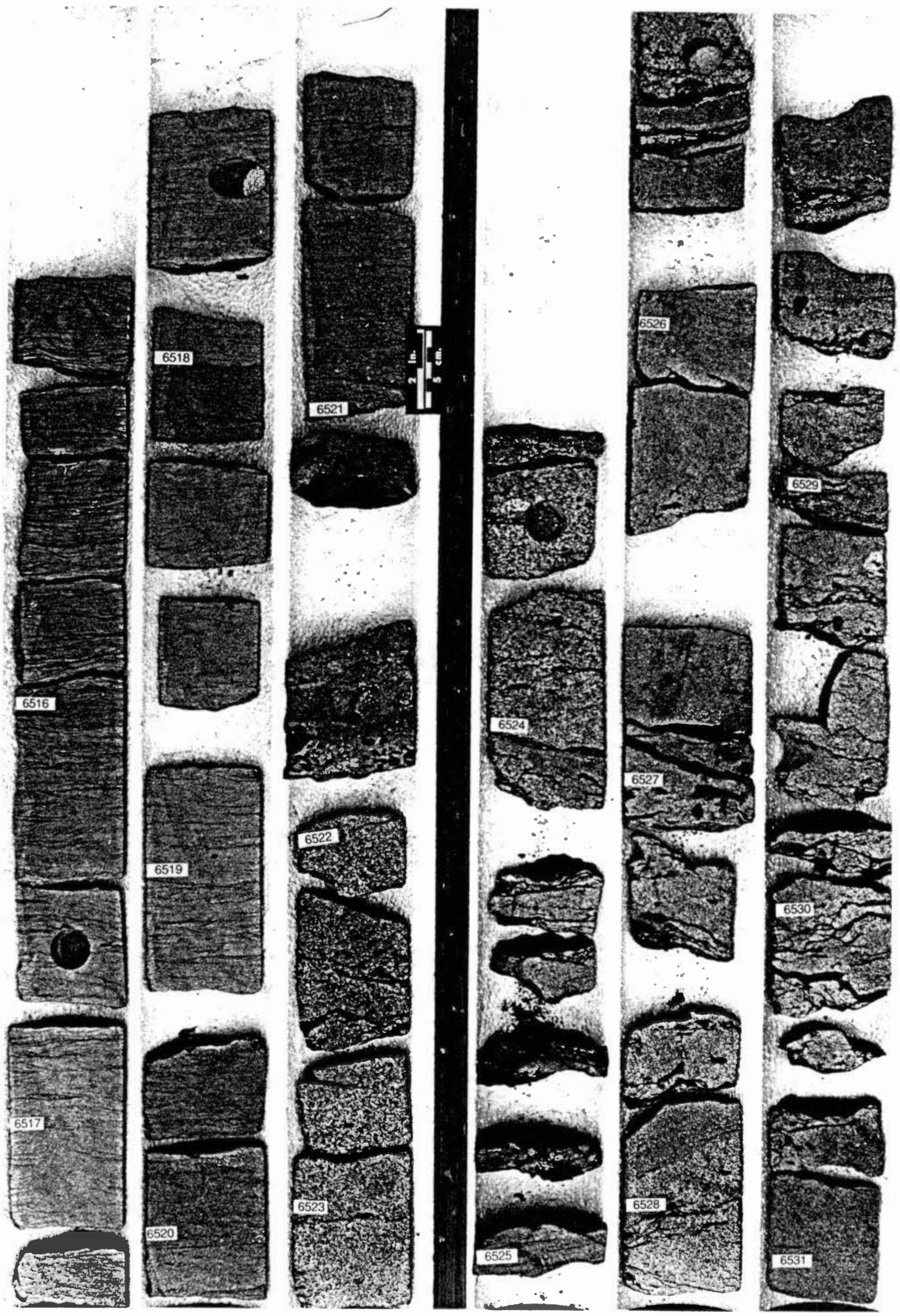


Figure 58. Photographs of core, Shell Oil Co. No. 1-13 Finfrock (cont'd).

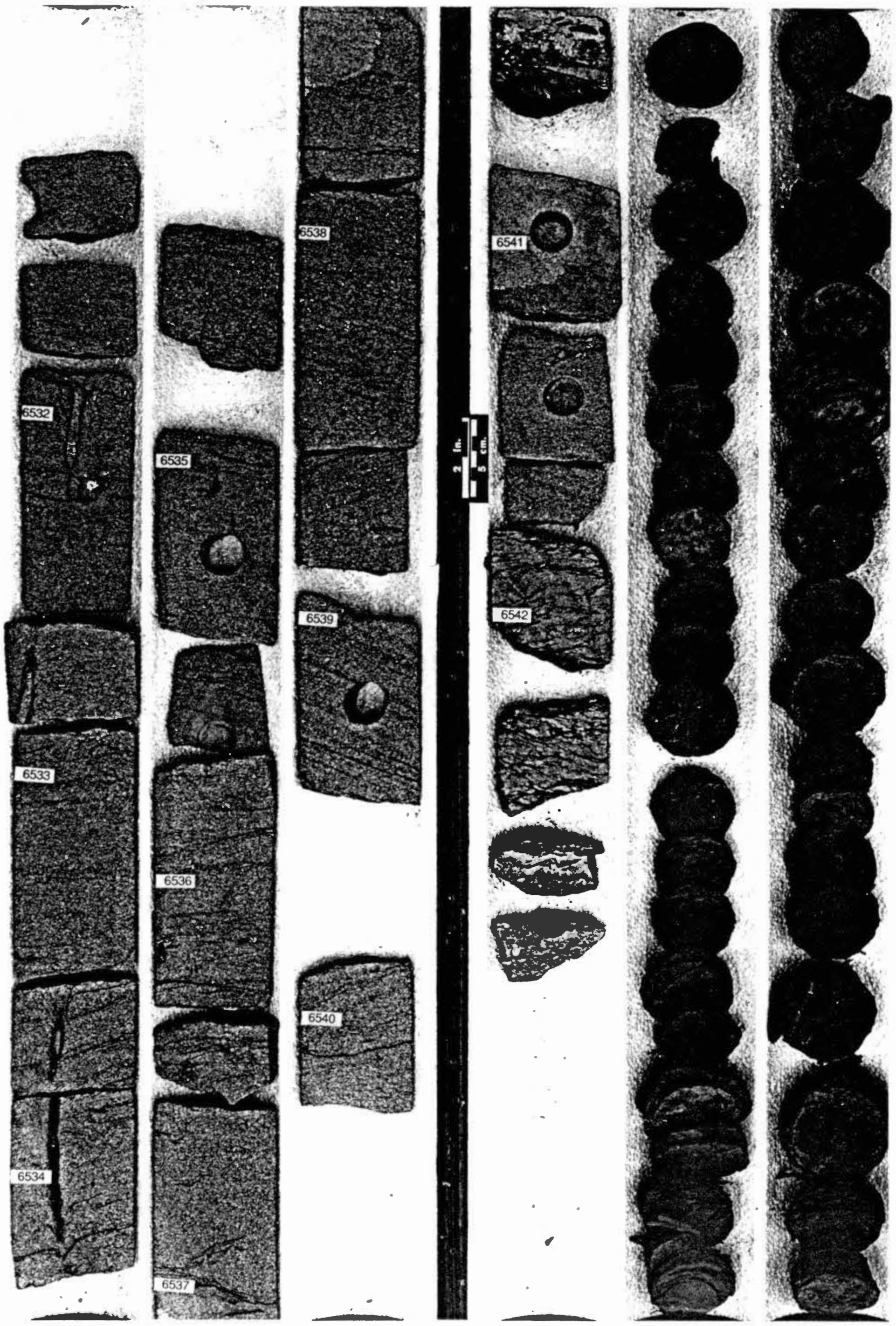


Figure 58. Photographs of core, Shell Oil Co. No. 1-13 Finfrock (cont'd).

Gulf Oil Co. No. 1 C. C. Kelly

Depths marked on the core of the No. 1 C.C. Kelly are 3 ft. shallower than depths recorded on logs (Plate XXIII). The core is a sample of 30 ft. of Lower Morrowan Keyes sandstone; the core is fairly complete.

4740-4738.1 ft.: Sandstone: tan to light tan; medium- to granule-sized grains; noncalcareous; with abundant small, white sand-sized grains of clay (kaolinite? or weathered feldspar?); horizontally bedded at 4740-4739 ft.; crossbedded (medium scale, planar, at 4739-4738.5 ft.); coarsens upward from medium to very coarse, with many granules; abrupt upper contact.

4738.1-4735.1 ft.: Sandstone: red (hematite-stained and/or hematite-cemented) to gray; very fine grained; with abundant "horizontal" burrows, and abundant small nodules of pyrite; interbedded with thin beds (0.1-0.2 in. thick) of black, noncalcareous, shale, which also contains abundant small pyrite nodules (Figure 59).

4735.1-4723.2 ft.: Sandstone: tan and yellowish tan (4735.1-4728) (Figure 60), light gray and tan (4728-4723.2); medium to very coarse grained (interval with coarser material abruptly overlies finer grained

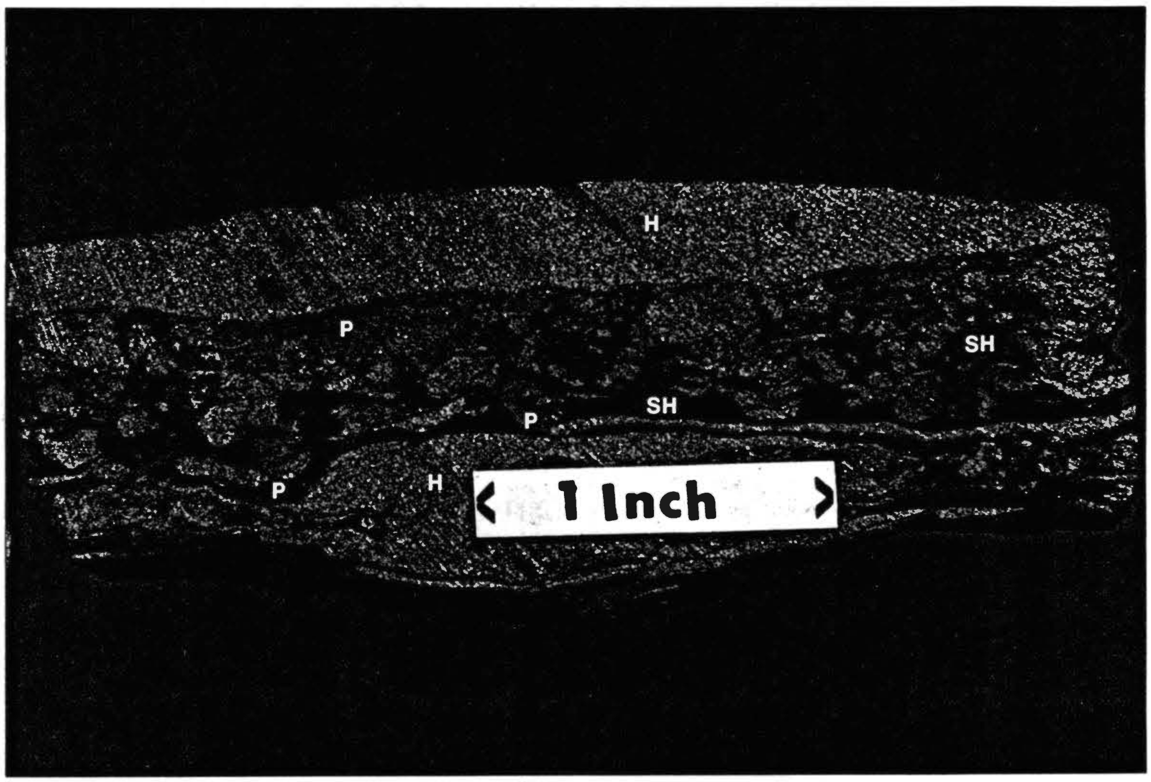


Figure 59. Very fine grained, hematite-stained (H) Lower Morrowan sandstone with black shale (SH) and an intensely burrowed zone. Within the burrowed zone are abundant pyrite nodules (P). Gulf Oil No. 1 C. C. Kelly, 4737.2-4737.3 ft.

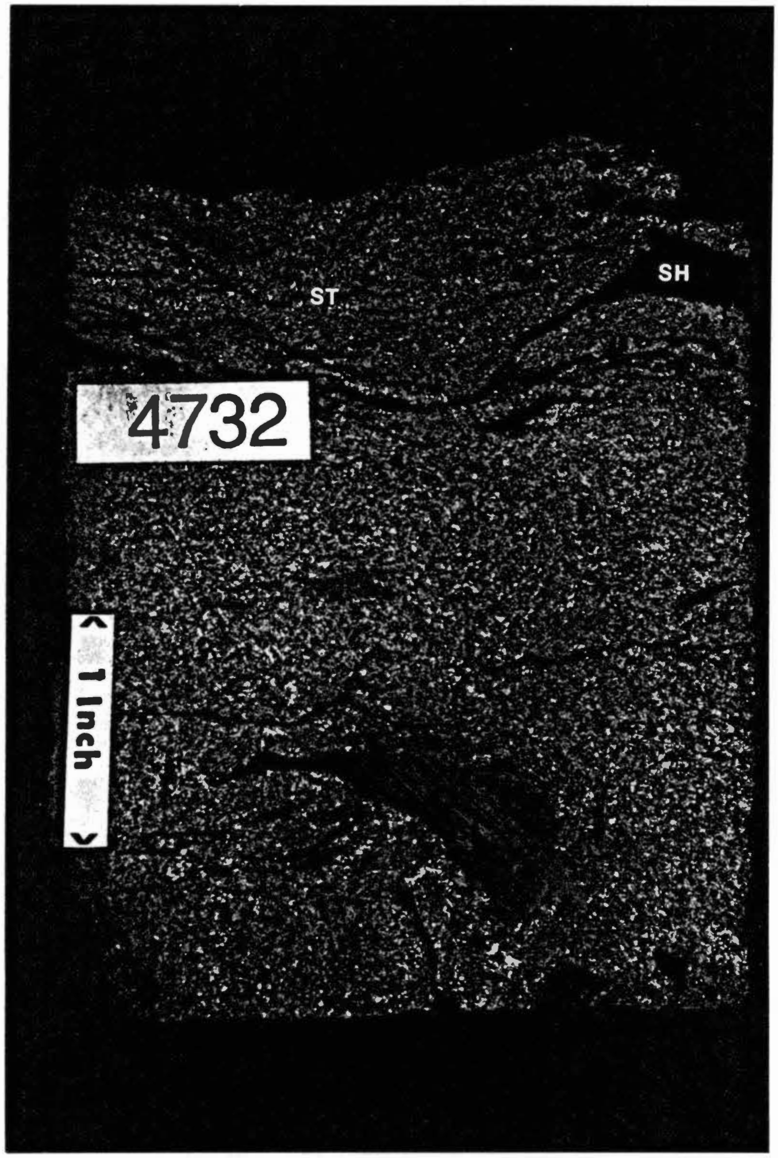


Figure 60. Lower Morrowan sandstone, typical of the lower part (4735-4728) of the interval from 4735.1-4723.2 ft., Gulf Oil No. 1 C. C. Kelly. Sample contains stylolites (ST), clay rip-up clasts (CL), and black shale (SH).

material at 4729, 4727.3 and 4725.1 ft. (possible channel scours?); with shale partings (that decrease in abundance upward), clay pebbles (that increase in abundance upward), and fossil fragments scattered with no apparent order (Figure 61); slightly effervescent in dilute HCl in upper 3 ft. of interval.

4723.2-4722.2 ft.: Conglomerate: matrix: sandstone; medium gray; very fine to fine grained; calcareous; clasts: granules of quartz: white to light gray; pebbles: light to dark gray (predominantly chert, but some are calcareous material); clasts decrease in abundance upward; abrupt contact with overlying shale. (Figure 62.)

4722.2-4720.3 ft.: Shale: black; fissile; highly calcareous; with small (0.05-in.-thick; 0.5-in.-long) lenses of medium gray, very fine grained, noncalcareous sandstone; abrupt upper contact. (Figure 63.)

4720.3-4715 ft.: Sandstone: medium gray; medium to very coarse grained (some granules); slightly calcareous; with abundant glauconite and a few partings of organic shale (4715.1 ft.); abundant white to light gray grains (some are clay (kaolinite?), others may be feldspar (clays probably are weathered remnants of feldspar); horizontally bedded; abrupt upper contact. (Figure 64.)

4715-4712.5 ft.: Shale: black; fissile; noncalcareous.

Figure 61. One of the apparently randomly oriented fossil fragments (FF) in Lower Morrowan sandstone extending from 4735.1-4723.2 ft. Sample also contains clay pebbles (CL). Gulf Oil No. 1 C. C. Kelly, 4726 ft.

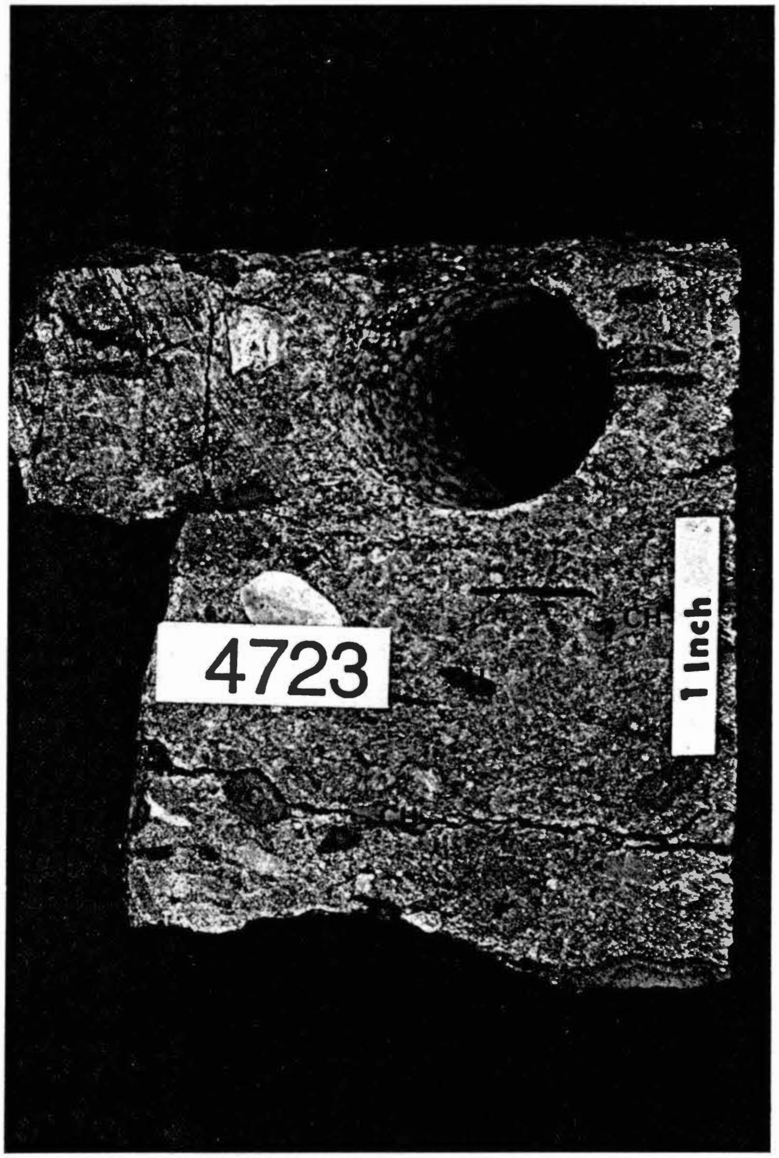


Figure 62. Conglomerate with fine grained matrix of calcareous sandstone and clasts of chert (CH) and carbonate mudstone (C). Lower Morrowan section, Gulf Oil No. 1 C. C. Kelly, 4723 ft.

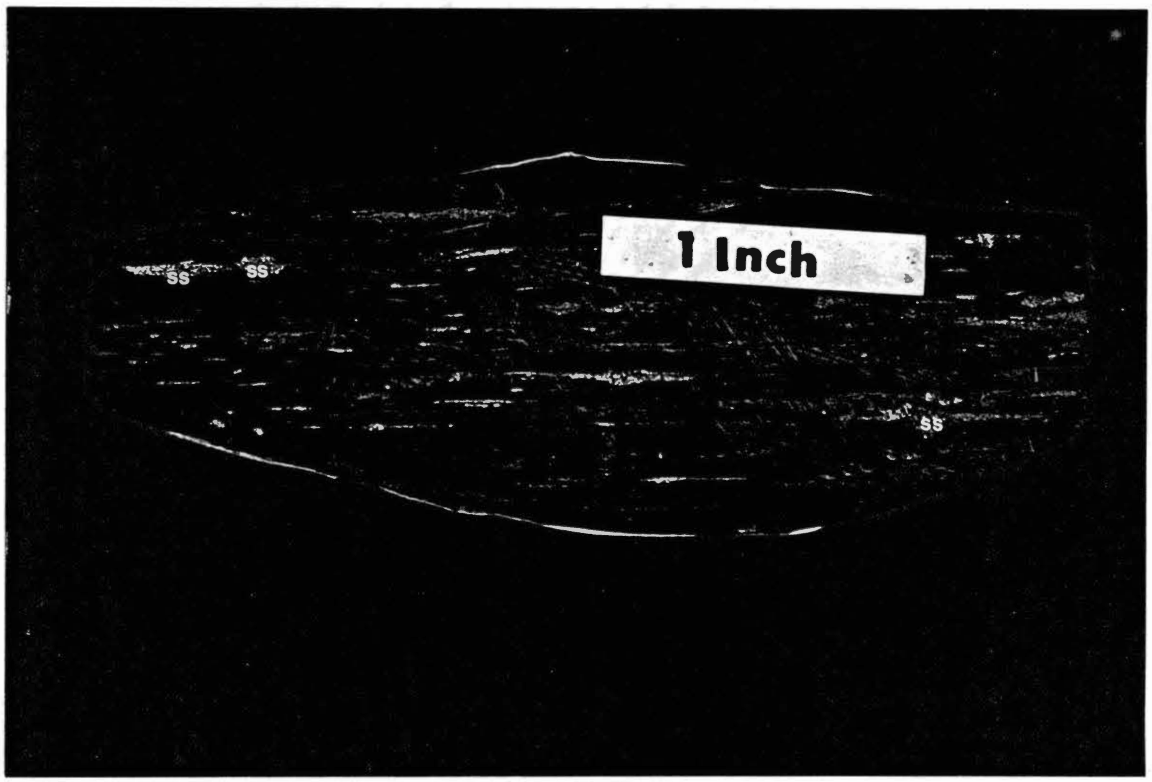


Figure 63. Calcareous black shale with small lenses of very fine grained sandstone (ss). Lower Morrowan section, Gulf Oil No. 1 C. C. Kelly, 4721.5 ft.

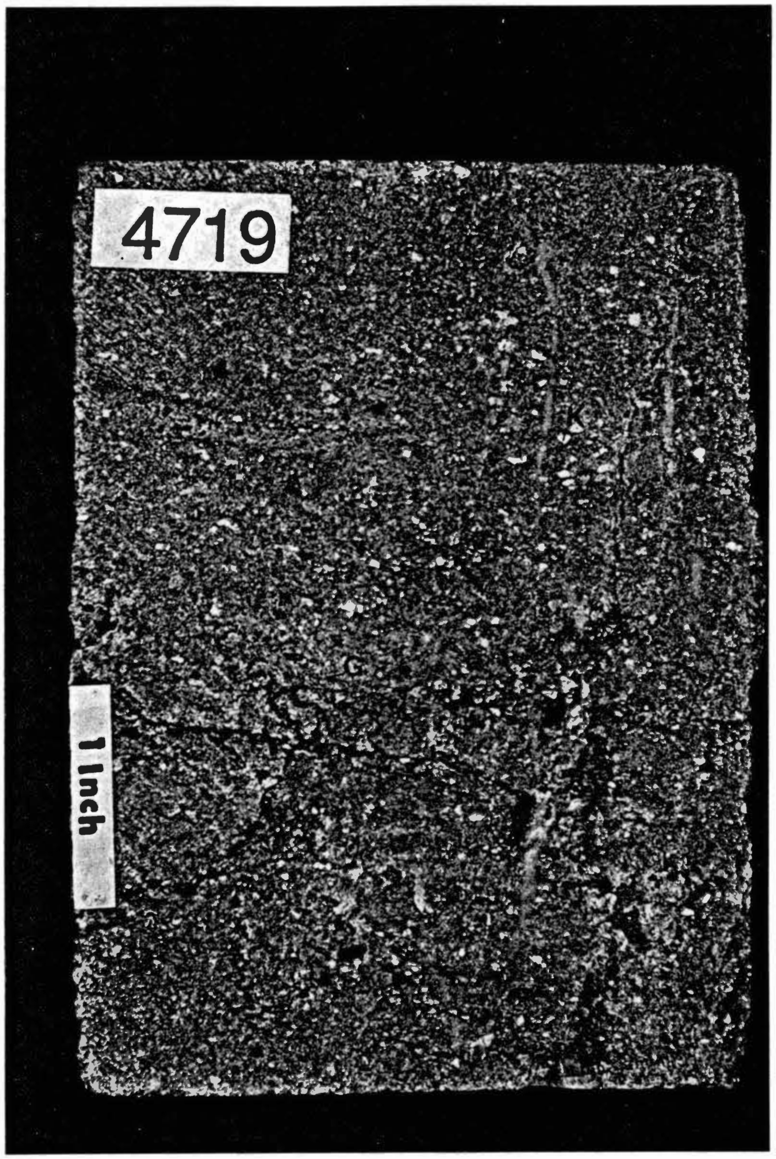


Figure 64. Lower Morrowan sandstone with low angle cross bedding, abundant glauconite (G) and white particles of clay (kaolinite? (K)). Gulf Oil No. 1 C. C. Kelly, 4719 ft.

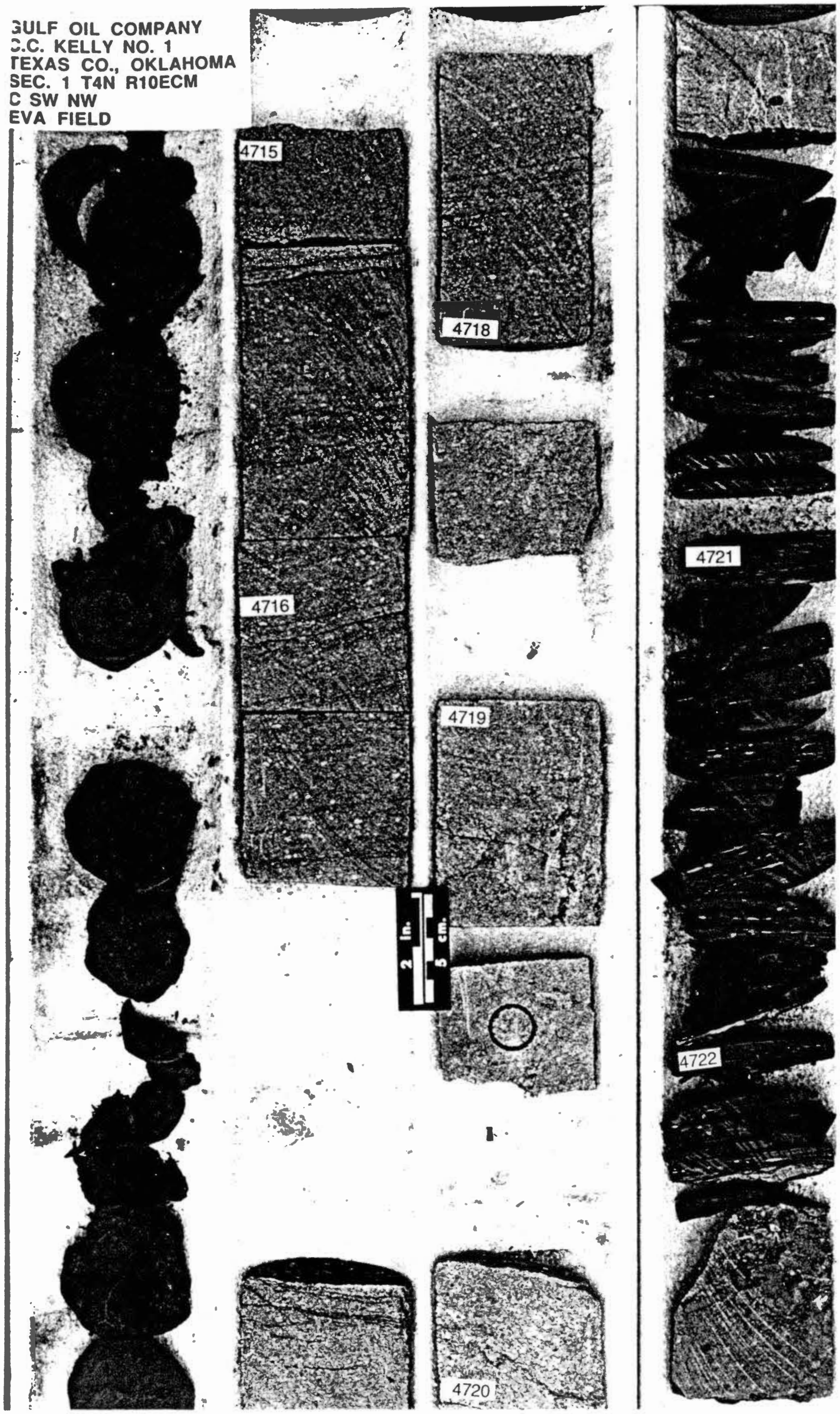


Figure 65. Photographs of core, Gulf Oil Co. No. 1 C. C. Kelly

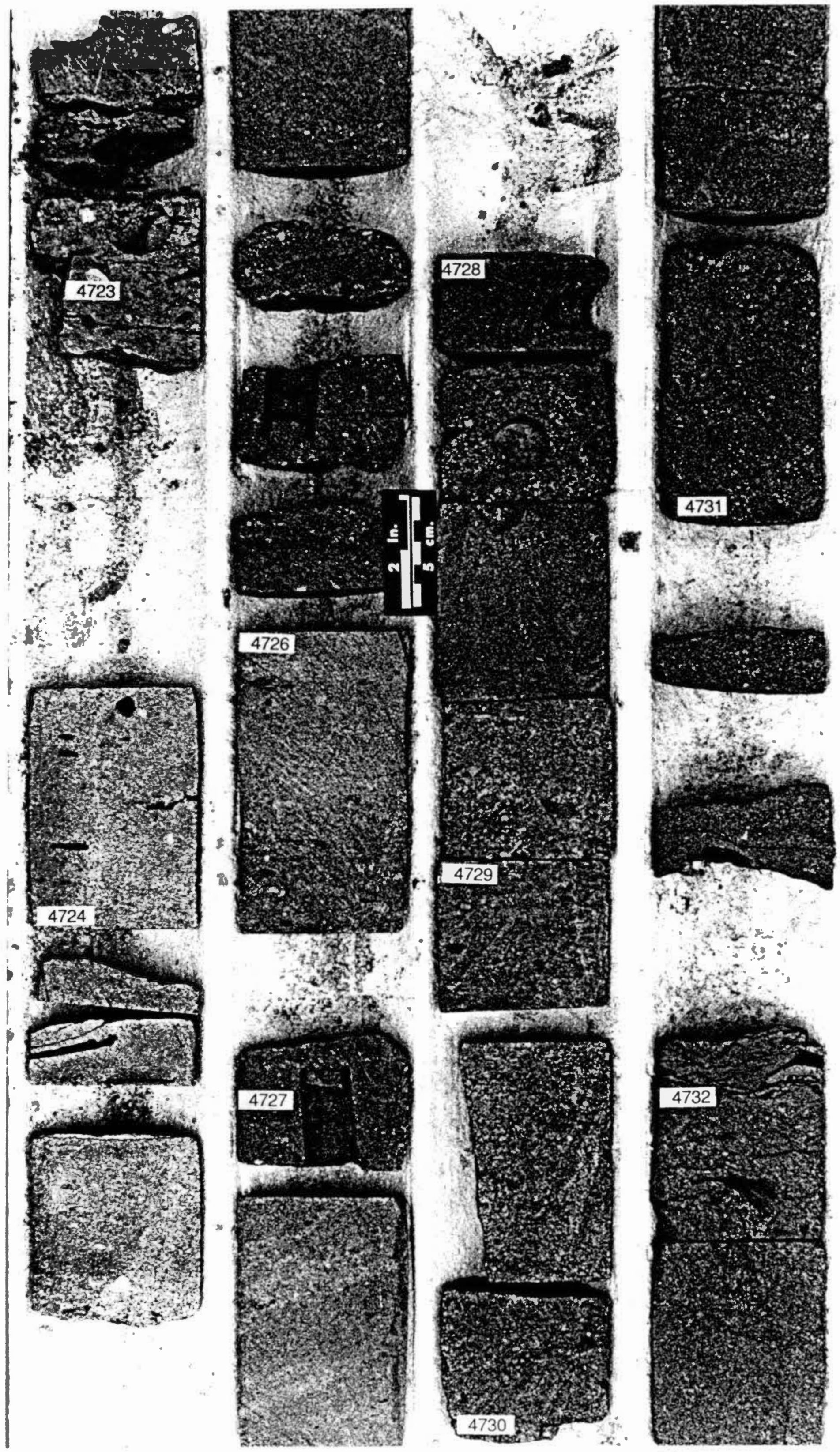


Figure 65. Photographs of core, Gulf Oil Co. No. 1 C. C. Kelly (cont'd).

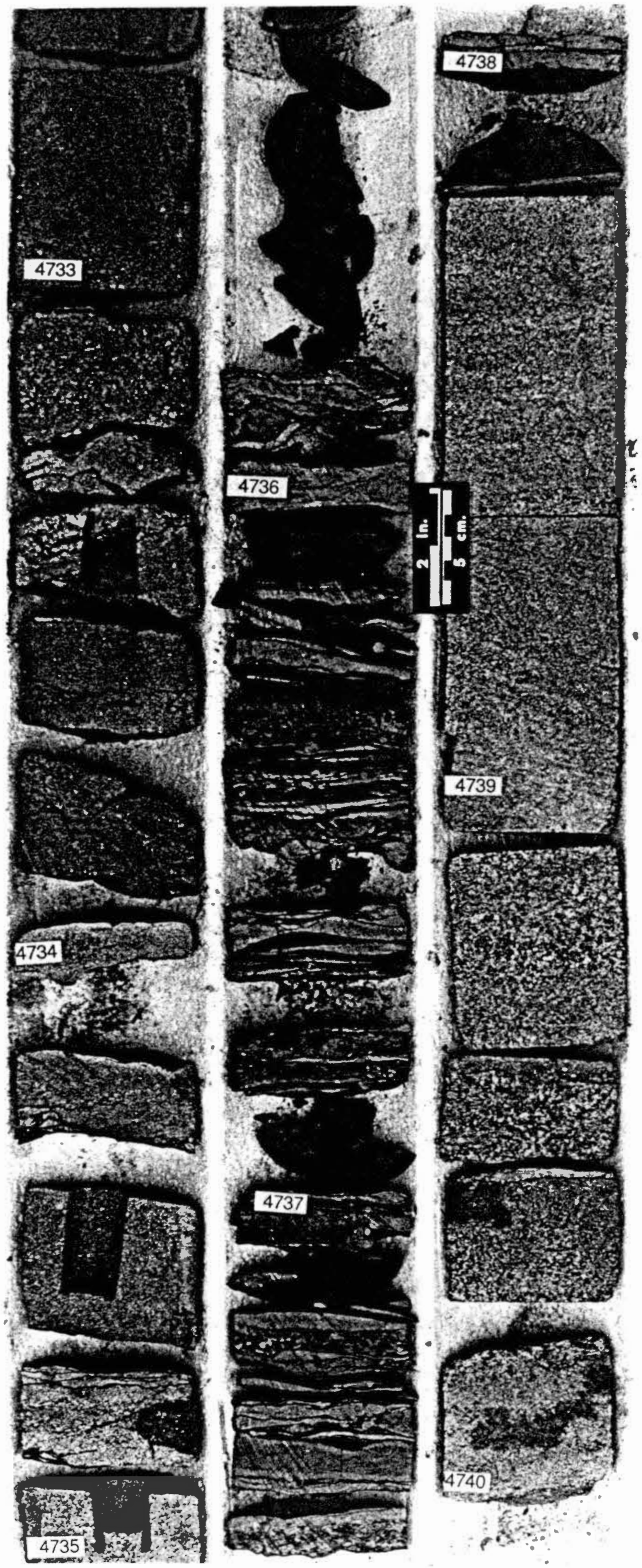


Figure 65. Photographs of core, Gulf Oil Co. No. 1 C. C. Kelly (cont'd).

APPENDIX B

DESCRIPTIONS OF THIN SECTIONS

Introduction

The thin sections are denoted by the symbols ST4, ST101, FF, and KY. These notations refer to the names of the wells from which cores were recovered. ST4 denotes the No. 4 Stonebraker "AN," ST101, FF, and KY denote the No. 101 Stonebraker "A," No. 1-13 Finfrock, and the No. 1 C. C. Kelly respectively.

Thin-section analysis included use of blue epoxy (to show porosity), and alizarin red dye (to distinguish calcite from dolomite).

Point counts were made by moving each thin section to 10 positions, so as to isolate 10 fields of view of the thin section (Figure 66). The linear scale was used to compile "frequency" of minerals. Minerals were counted by the recording of a single observation at each intersection of the horizontal line and a vertical line. For each thin section, 1000 points were counted.

Clastic rocks were classified according to Folk's classification scheme (Figure 67), modified by addition of wacke from Dott's classification (Figure 68). Carbonate rocks were classified according to both Dunham's and Folk's classification schemes (Figures 69 and 70 respectively). Following the thin-section reports, photomicrographs are shown of thin sections under illumination by crossed nicols and plane-polarized light.

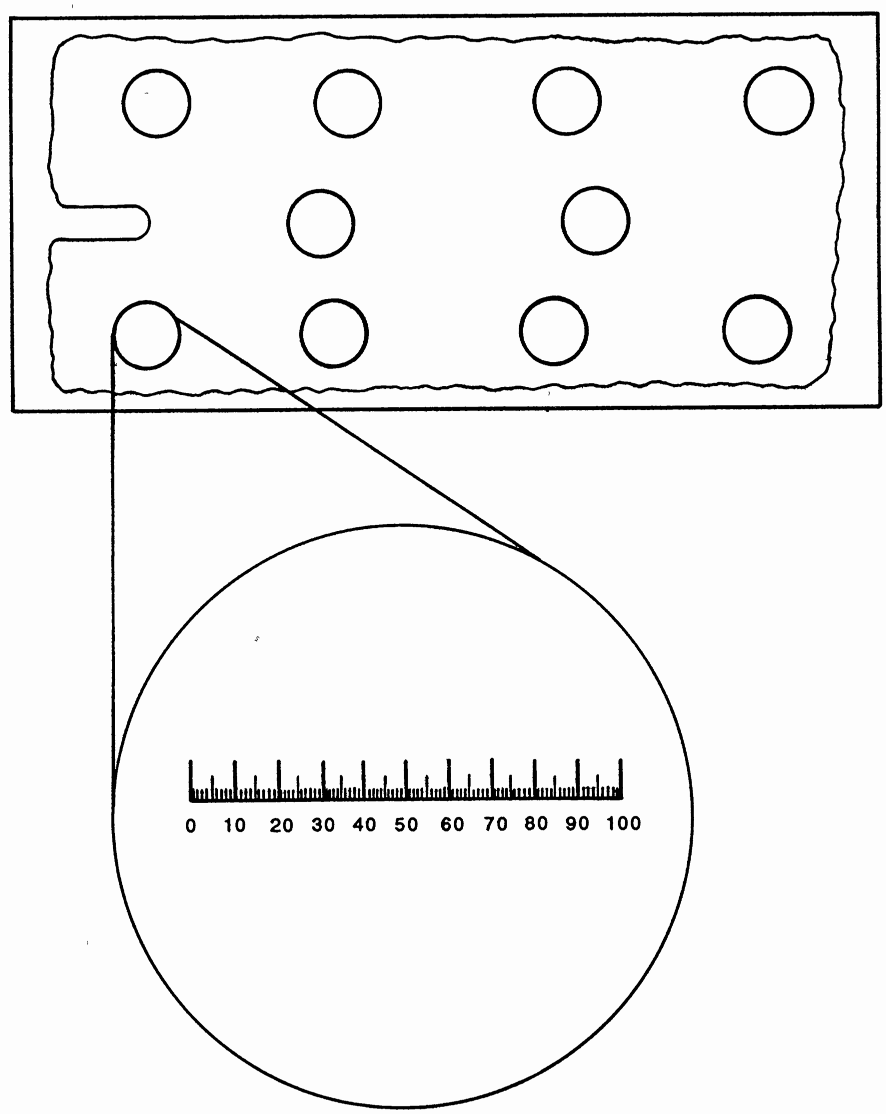


Figure 66. Diagram of point count locations and enlargement of scale used for point counts.

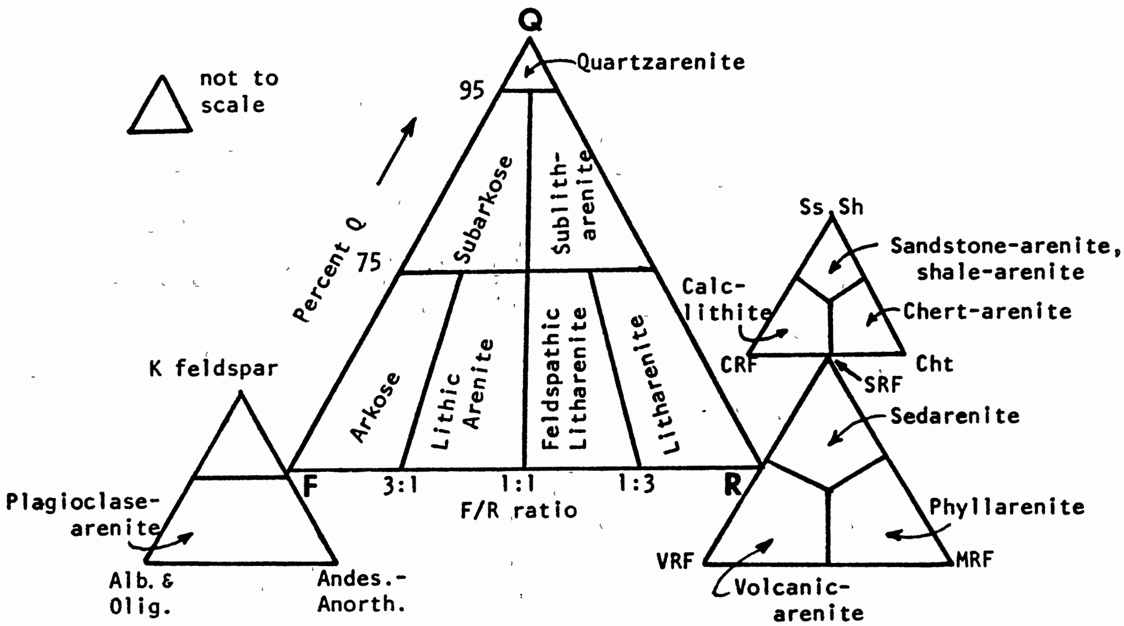


Figure 67. Folk's classification scheme (from Folk, 1968, p. 127).

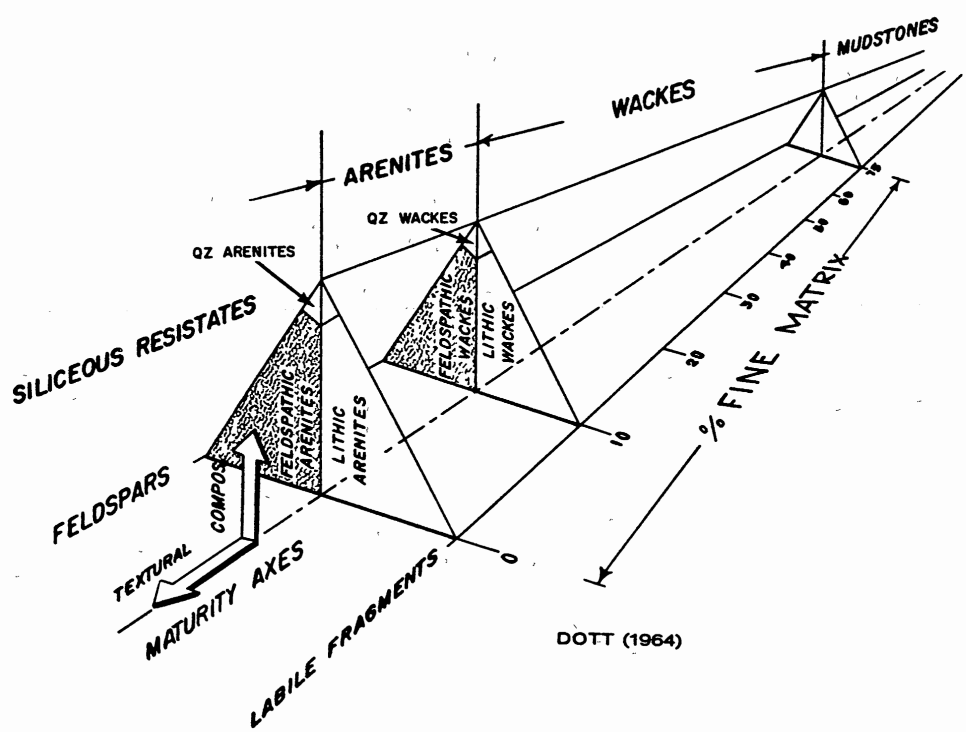


Figure 68. Illustration of Dott's classification which was used in modifying Folk's classification (from Scholle, 1979, p. 96).

<table>
<tr><td colspan="4">Original components not organically bound together during deposition</td><td rowspan="1">Components organically bound during deposition</td></tr>
<tr><td colspan="3">contains carbonate mud</td><td>no carbonate mud</td><td rowspan="4"></td></tr>
<tr><td colspan="2">mud-supported</td><td colspan="2" rowspan="2">grain-supported</td></tr>
<tr><td>< 10% allochems</td><td>> 10% allochems</td></tr>
<tr><td>MUDSTONE</td><td>WACKESTONE</td><td>PACKSTONE</td><td>GRAINSTONE</td></tr>
<tr><td></td><td></td><td></td><td></td><td>BOUNDSTONE</td></tr>
</table>

Figure 69. Dunham's classification of limestone (from Adams et al., 1984, p.62).

<table>
<tr><td colspan="3" rowspan="2">volumetric allochem composition</td><td colspan="2">> 10% allochems</td><td colspan="3">< 10% allochems</td><td rowspan="5">Undisturbed reef and bioherm rocks</td></tr>
<tr><td>Sparry calcite > Micrite</td><td>Micrite > Sparry calcite</td><td colspan="2">1–10% allochems</td><td><1% allochems</td></tr>
<tr><td colspan="3">> 25% Intraclasts</td><td>INTRASPARITE</td><td>INTRAMICRITE</td><td rowspan="5">Most abundant allochems</td><td>Intraclasts INTRACLAST-BEARING MICRITE</td><td rowspan="5">MICRITE, or if sparry patches present DISMICRITE</td></tr>
<tr><td rowspan="4"><25% Intraclasts</td><td colspan="2">> 25% Ooids</td><td>OOSPARITE</td><td>OOMICRITE</td><td>Ooids OOID-BEARING MICRITE</td></tr>
<tr><td rowspan="3"><25% Ooids Volume ratio, bioclasts: peloids</td><td>3:1</td><td>BIOSPARITE</td><td>BIOMICRITE</td><td>Bioclasts FOSSILIFEROUS MICRITE</td></tr>
<tr><td>3:1 to 1:3</td><td>BIOPELSPARITE</td><td>BIOPELMICRITE</td><td rowspan="2">Peloids PELOID-BEARING MICRITE</td><td rowspan="2">BIOLITHITE</td></tr>
<tr><td>1:3</td><td>PELSPARITE</td><td>PELMICRITE</td></tr>
</table>

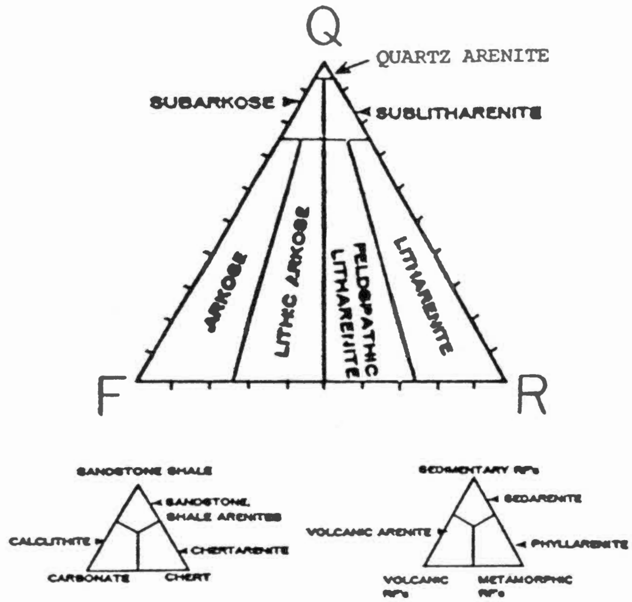
Figure 70. Folk's classification of limestone (from Adams et al., 1984, p.62).

No. 4 Stonebraker AN

ST4-1/6226 ft. Pyrite-rich brachiopod micrite: Constituents- Chert, trace; Bryozoan shell fragments, 0.7%; Brachiopod shell fragments, 15.5%; Detrital matrix- Pseudomatrix, 66.9%; Calcite cement, 5.2%; Pyrite, 11.7%.

ST4-2/6239 ft.: Sublithwacke: Normalized constituents- Quartz, 87.2%; Rock fragments, 9.4%; Feldspars, 3.4%: Subrounded, moderately sorted, immature: Constituents- Monocrystalline quartz, 15.7%; Plagioclase feldspar, 0.6%; Chert fragments, 1.7%; Muscovite, 3.3%; Hematite, 0.8%; Detrital matrix- Pseudomatrix, 70.6%.

ST4-3/6241 ft. Sublithwacke: Normalized constituents- Quartz, 82.2%; Rock fragments, 6.3%; Feldspars, 11.5%: Subangular to angular, poorly sorted, immature: Constituents- Monocrystalline quartz, 36.7%; Plagioclase feldspar, 2.8%; Shale fragments, 1.2%; Chert fragments, 3.9%; Carbonate-rock fragments, 1.4%; Muscovite, 5.0%; Detrital matrix- Pseudomatrix, 38.4%; Calcite cement, 3.1%; Authigenic clays- Kaolinite, 3.8%; Pyrite, 0.7%; Primary porosity, 0.5%; Secondary porosity, 2.5%.



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 100 % Normalized

Q = ____% ____%
F = ____% ____%
R = ____% ____%

Total ____ 100 %

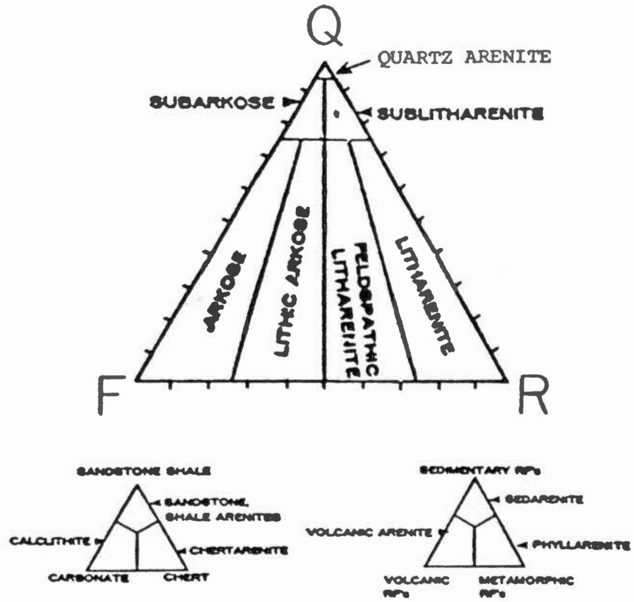
ST4-1

0.50mm

C N

0.50mm

P P



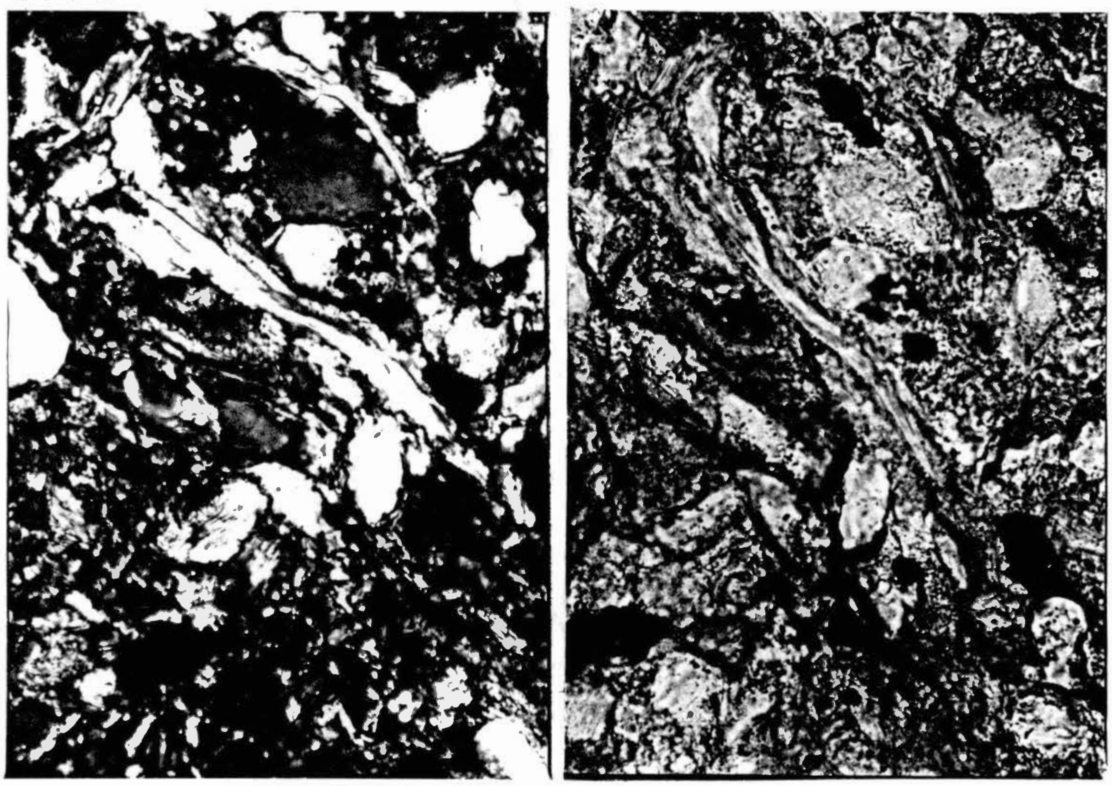
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 79.6 % Normalized

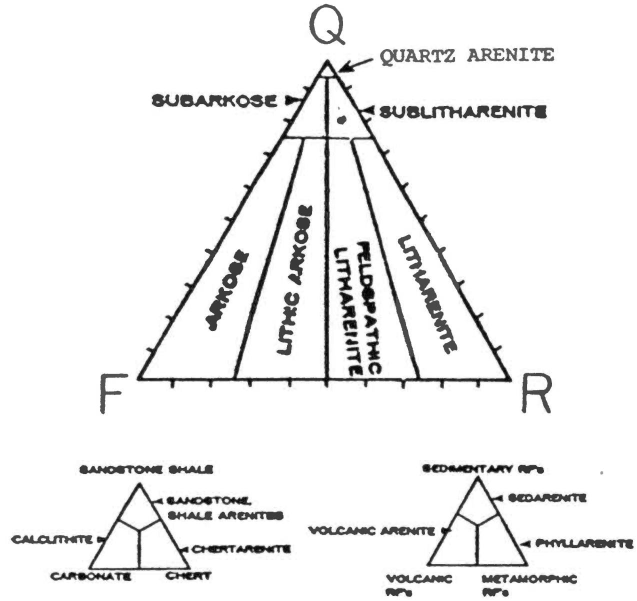
Q =	15.7 %	87.2 %
F =	.6 %	3.4 %
R =	1.7 %	9.4 %
Total	88.6	100 %

ST4-2



0.10mm 0.10mm

C N P P



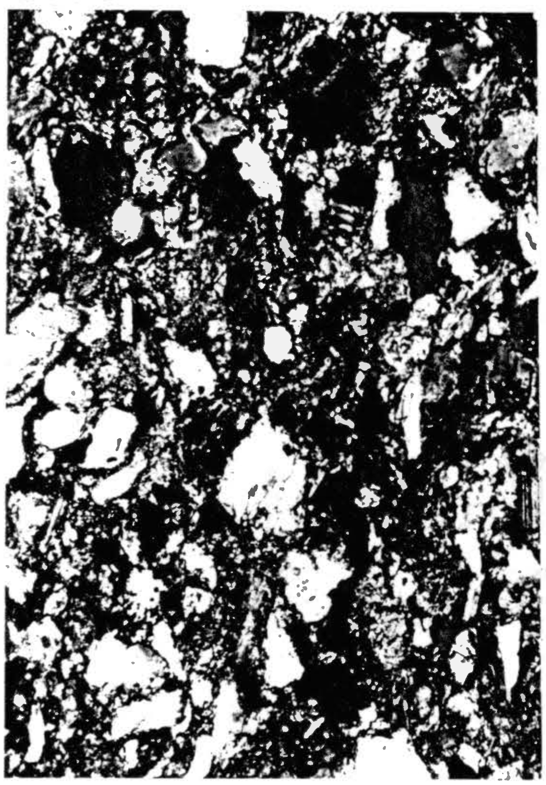
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 46 % Normalized

Q =	36.7 %	82.2 %
F =	2.8 %	6.3 %
R =	5.1 %	11.5 %
Total	44.6	100 %

ST4-3



0.20mm

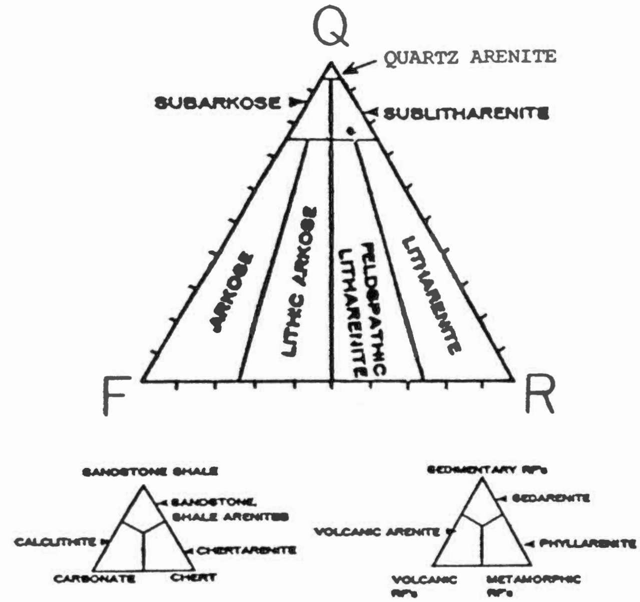
C N

0.20mm

P P

ST4-4/6262.5 ft.: Sublithwacke: Normalized constituents- Quartz, 76.7%; Rock fragments, 17.4%; Feldspars, 5.9%: Very angular to angular, poorly sorted, immature: Constituents- Monocrystalline quartz, 40.2%; Microcline feldspar, trace; Plagioclase feldspar, 3.1%; Chert fragments, 9.1%; Muscovite, 7.4%; Detrital matrix- Pseudomatrix, 36.0%; Authigenic clays- Mixed-layered, 2.6%; Secondary porosity, 1.6%.

ST4-5/6264 ft.: Sublithchertwacke: Normalized constituents- Quartz, 79.4%; Rock fragments, 10.9%; Feldspar, 9.7%: Subangular to subrounded, moderately to poorly sorted, immature: Constituents- Monocrystalline quartz, 56.6%; Microcline feldspar, 1.4%; Plagioclase feldspar, 5.5%; Chert fragments, 6.4%; Siltstone fragments, 1.4%; Volcanic-rock fragments, trace; Glauconite, trace; Muscovite, 3.3%; Zircon, 0.2%; Phosphate pebbles, 0.9%; Detrital matrix- Pseudomatrix, 10.5%; Quartz cement, 0.2%; Calcite cement, 0.7%; Authigenic clays- Kaolinite, 8.0%; Pyrite, 3.6%; Secondary porosity, 1.3%.



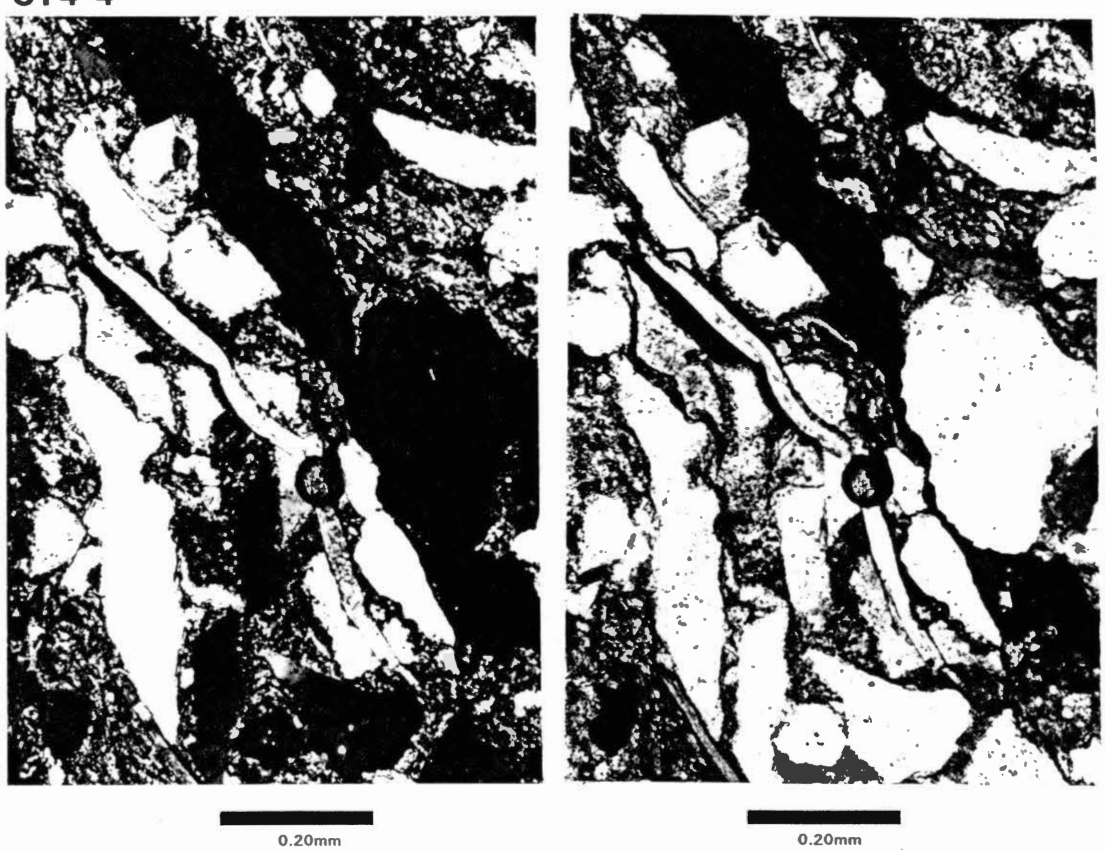
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

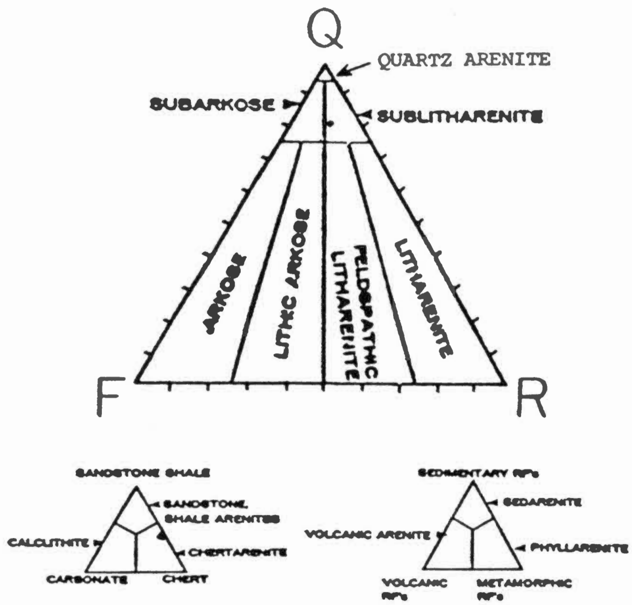
MATRIX = 40.7 % Normalized

Q =	40.2 %	76.7 %
F =	3.1 %	5.9 %
R =	9.1 %	17.4 %
Total	52.4	100 %

ST4-4



C N P P



Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 12.8 %

		Normalized
Q =	56.6 %	79.4 %
F =	6.9 %	9.7 %
R =	7.8 %	10.9 %
Total	71.3	100 %

ST4-5

0.20mm

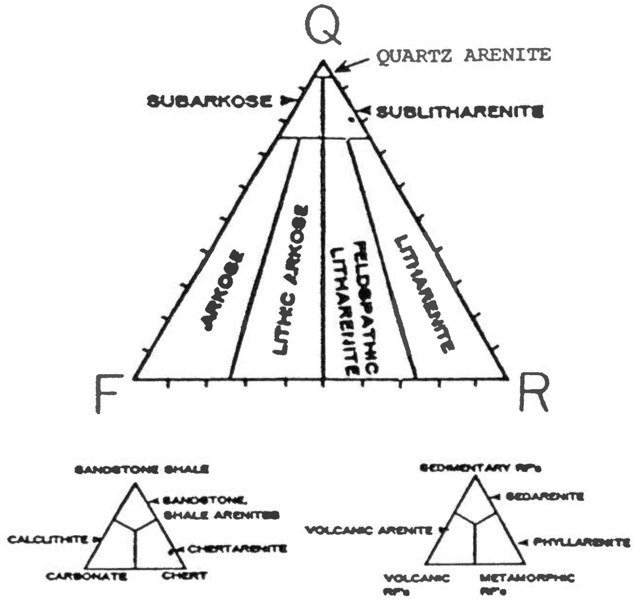
C N

0.20mm

P P

<u>ST4-6/6265</u> <u>ft.:</u> Sublithchertwacke: Normalized constituents- Quartz, 81.2%; Rock fragments, 17.6%; Feldspar, 1.2%: Subangular to subrounded, very poorly sorted, immature: Constituents- Monocrystalline quartz, 46.6%; Plagioclase, 0.7%; Shale fragments, 1.7%; Chert fragments, 8.4%; Glauconite, trace; Muscovite, 3.8%; Detrital matrix- Pseudomatrix, 36.1%; Authigenic clays- Kaolinite, 1.6%; Pyrite, 1.1%.

<u>ST4-8/6267</u> <u>ft.:</u> Sublithchertwacke: Normalized constituents- Quartz 76.4%; Rock fragments, 20.3%; Feldspar, 3.2%: Subangular to subrounded, poorly to very poorly sorted, immature: Constituents- Monocrystalline quartz, 52.2%; Microcline feldspar, 2.2%; Chert fragments 12.2%; Carbonate-rock fragments 1.7%; Glauconite, trace; Muscovite, 4.0%; Hematite, 0.8%; Detrital matrix- Pseudomatrix 25.3%; Authigenic clays- Kaolinite, 1.3%; Organic material, 0.3%.



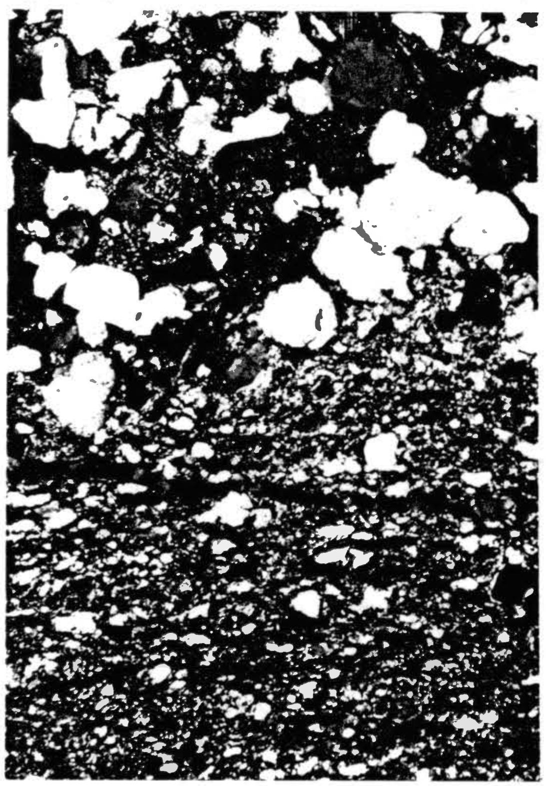
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 38.6 %

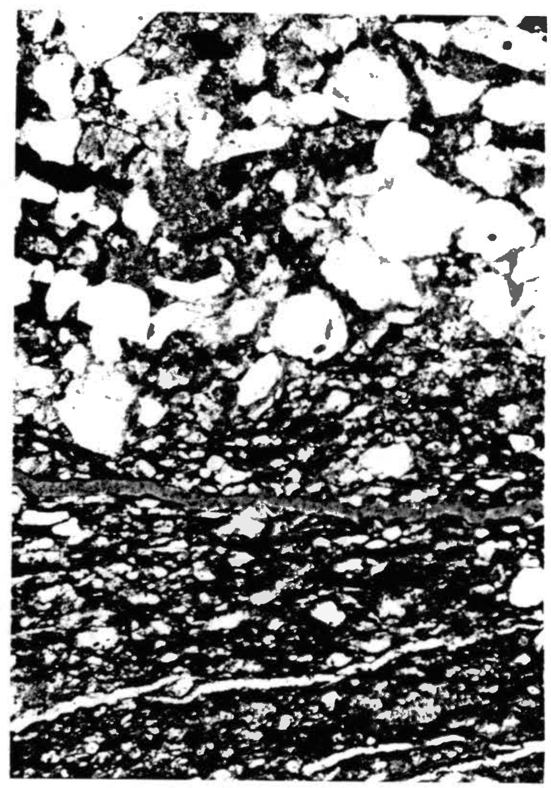
		Normalized
Q =	46.6 %	81.2 %
F =	0.7 %	1.2 %
R =	10.1 %	17.6 %
Total	57.4	100 %

ST4-6



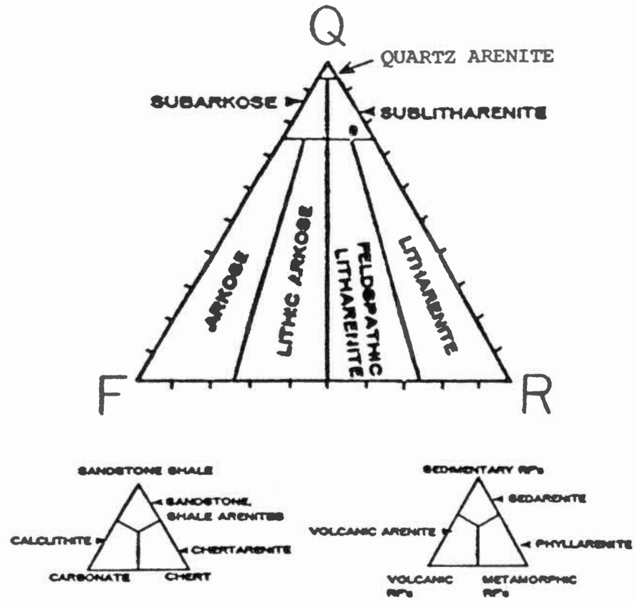
0.50mm

C N



0.50mm

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 27.0 % Normalized

Q =	52.2 %	76.4 %
F =	2.2 %	3.2 %
R =	13.9 %	20.3 %
Total	68.3	100 %

ST4-8

0.20mm

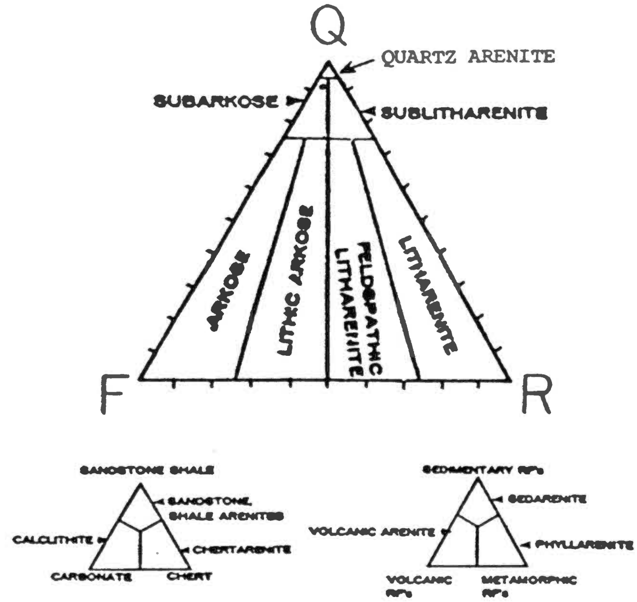
C N

0.20mm

P P

ST4-9/6269.5 ft.: Subarkose: Normalized constituents- Quartz, 93.8%; Rock fragments, 2.0%; Feldspar, 4.2%: Subangular to subrounded, poorly to very poorly sorted, immature: Constituents- Monocrystalline quartz, 76.0%; Polycrystalline quartz, 1.4%; Microcline feldspar, 1.5%; Plagioclase feldspar, 1.9%; Chert fragments, 1.6%; Zircon, 0.3%; Detrital matrix- Pseudomatrix, 6.3%; Quartz cement, 1.8%; Calcite cement, 7.0%; Authigenic clays- Kaolinite 2.0%; Secondary porosity, 0.2%.

ST4-10/6270.6 ft.: Sublitharenite: Normalized constituents- Quartz, 75.6%; Rock fragments, 19.3%; Feldspar, 5.0%: Subrounded, moderately sorted, submature: Constituents- Monocrystalline quartz, 61.8%; Microcline feldspar, 2.2%; Plagioclase feldspar, 1.9%; Chert fragments, 3.4%; Siltstone fragments, 10.0%; Volcanic-rock fragments, 2.4%; Muscovite, 1.4%; Zircon, trace; Detrital matrix- Pseudomatrix, 2.2%; Quartz cement, 0.2%; Calcite cement, 5.4%; Authigenic clays- Mixed layered 8.7%; Secondary porosity, 0.4%.



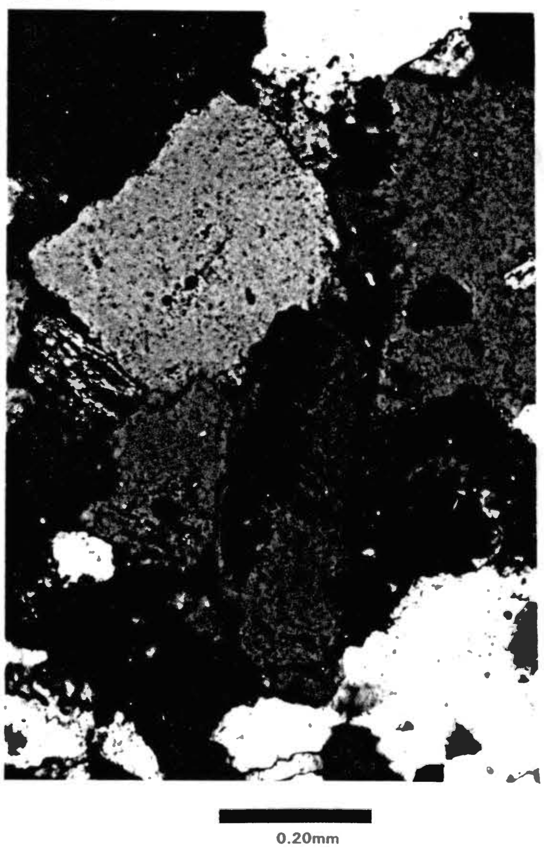
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 7.2 %

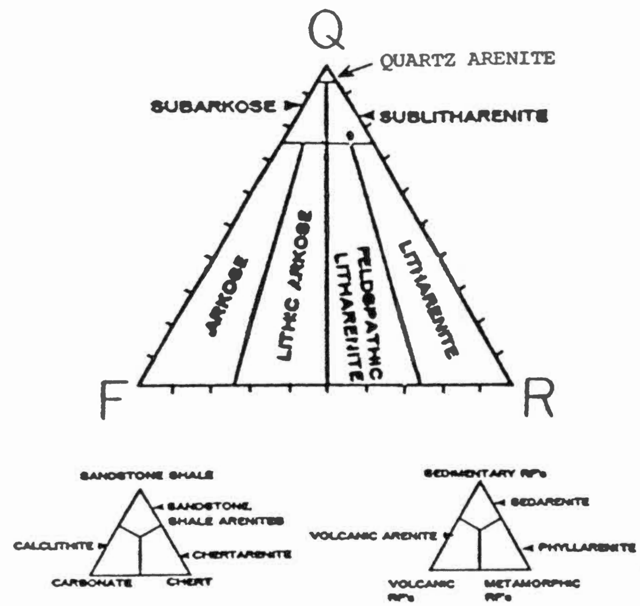
		Normalized
Q =	79 %	93.8 %
F =	3.4 %	4.2 %
R =	1.6 %	2.0 %
Total	81.0	100 %

ST4-9



C N

P P



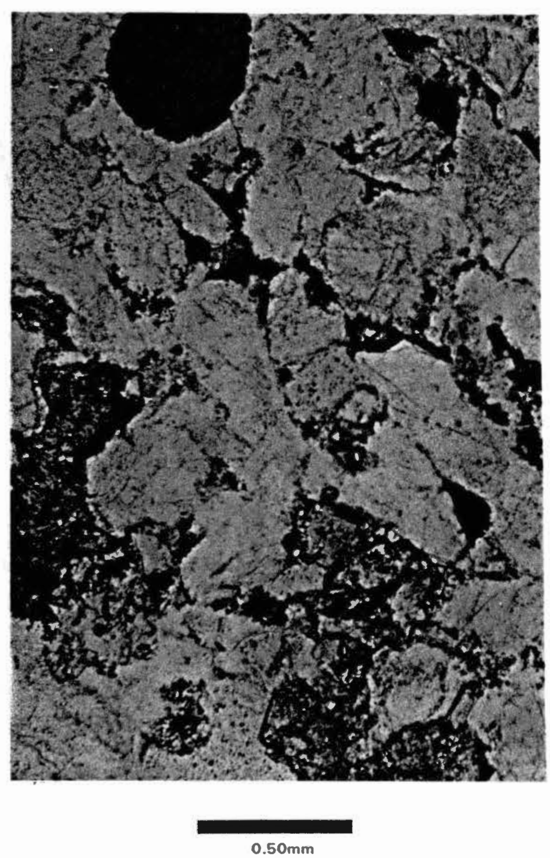
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 1.6 %	Normalized
Q = 61.8 %	75.6 %
F = 4.6 %	5.0 %
R = 15.8 %	19.3 %
Total 82.2	100 %

ST4-10

C N

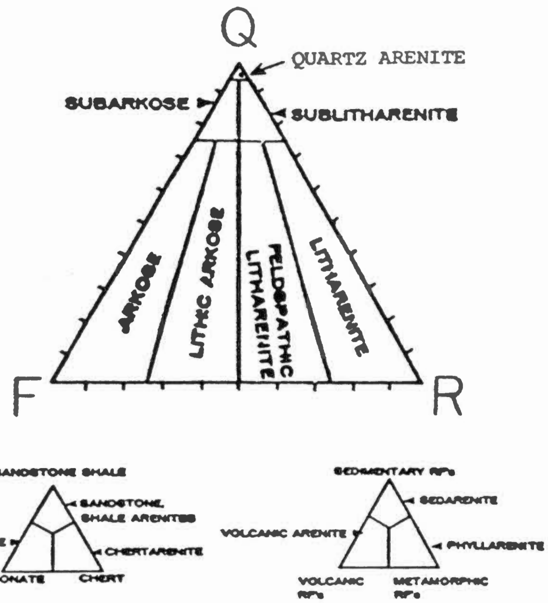


P P

ST4-11/6272.8 ft.: Quartz arenite: Normalized constituents- Quartz, 95.8%; Rock fragments, 3.3%; Feldspar, 0.9%: Subrounded to rounded, moderately sorted to well sorted, submature to supermature: Constituents- Monocrystalline quartz, 74.7%; Plagioclase feldspar, 0.7%; Chert fragments, 2.6%; Detrital matrix- Pseudomatrix, 4.2%; Quartz cement, 1.3%; Calcite cement, 8.3%; Authigenic clays- Chlorite, 2.3%; Mixed-layered 4.2%; Primary porosity, 0.2%; Secondary Porosity, 1.5%.

ST4-12/6278.1 ft.: Mudstone: Constituents- Monocrystalline quartz, 7.5%; Plagioclase feldspar, 0.2%; Shale fragments, 0.7%; Chert fragments, 0.4%; Volcanic-rock fragments, 0.2%; Muscovite, 0.7%; Hematite, 1.0%; Detrital matrix- Illite, 88.3%; Pyrite, 1.0%.

ST4-13/6280.4 ft.: Sublithwacke: Normalized constituents- Quartz, 85.0%; Rock fragments, 15.0%: Subangular to subrounded, poorly to moderately sorted, immature: Constituents- Monocrystalline quartz, 57.6%; Plagioclase feldspar, trace; Chert fragments, 10.2%; Muscovite, 4.2%; Hematite, 1.9%; Detrital matrix- Illite, 18.5%; Authigenic clays- Undifferentiated, 7.6%.

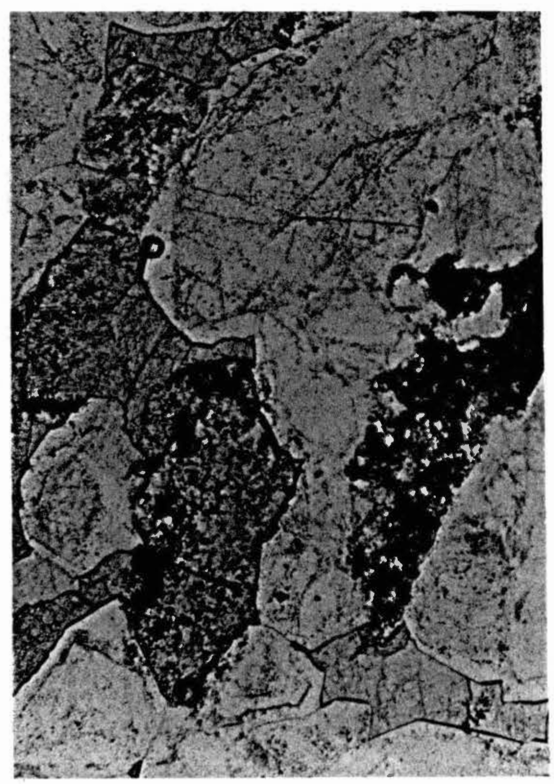


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 3.8 %	Normalized
Q = 74.7 %	95.8 %
F = 0.7 %	.9 %
R = 2.6 %	3.3 %
Total 78	100 %

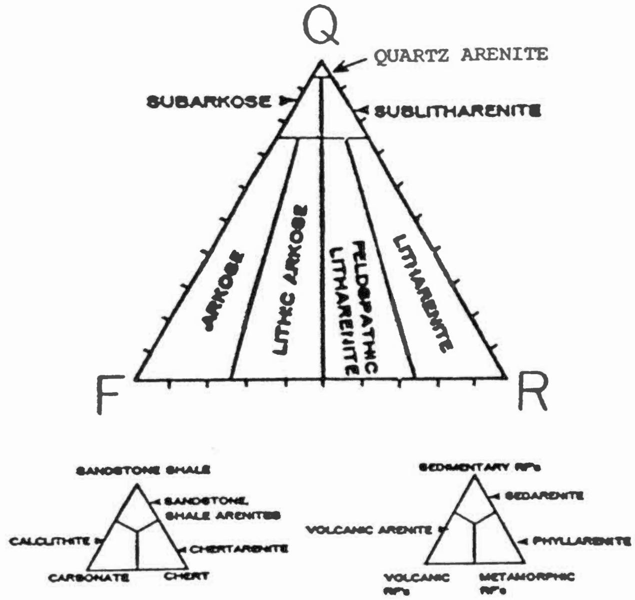
ST4-11



0.50mm

0.50mm

C N **P P**



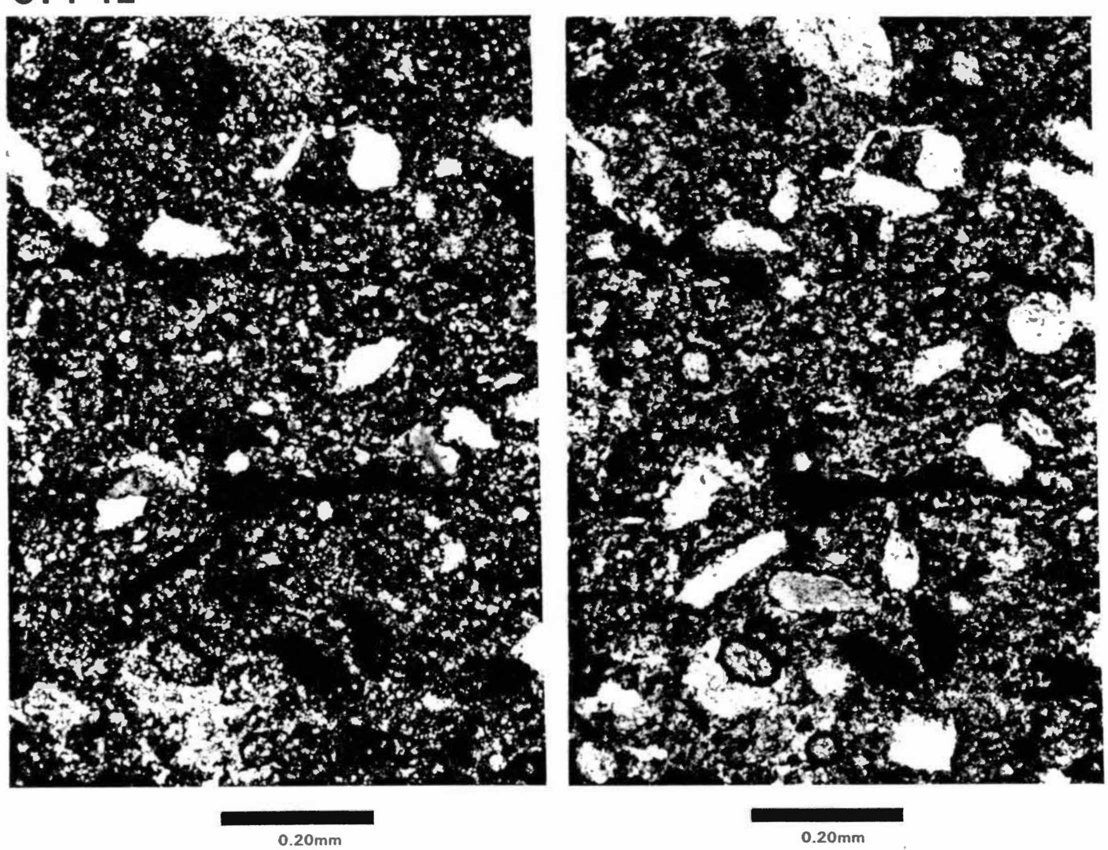
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

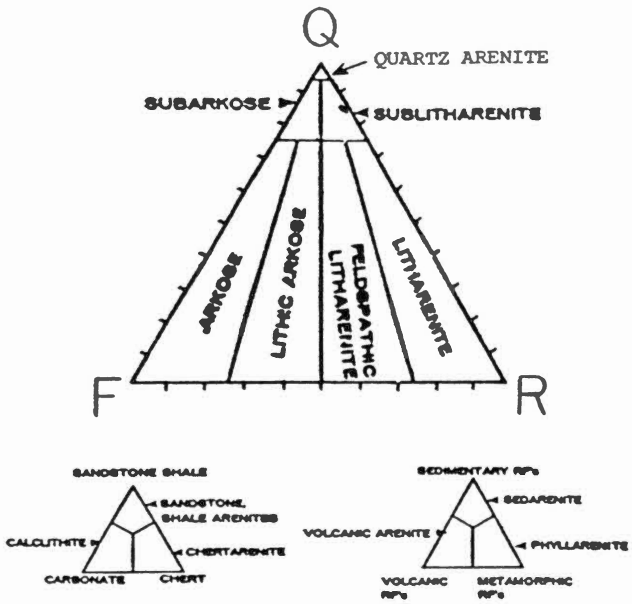
MATRIX = 90.7 % Normalized

Q =	____%	____%
F =	____%	____%
R =	____%	____%
Total	____	100 %

ST4-12



C N **P P**

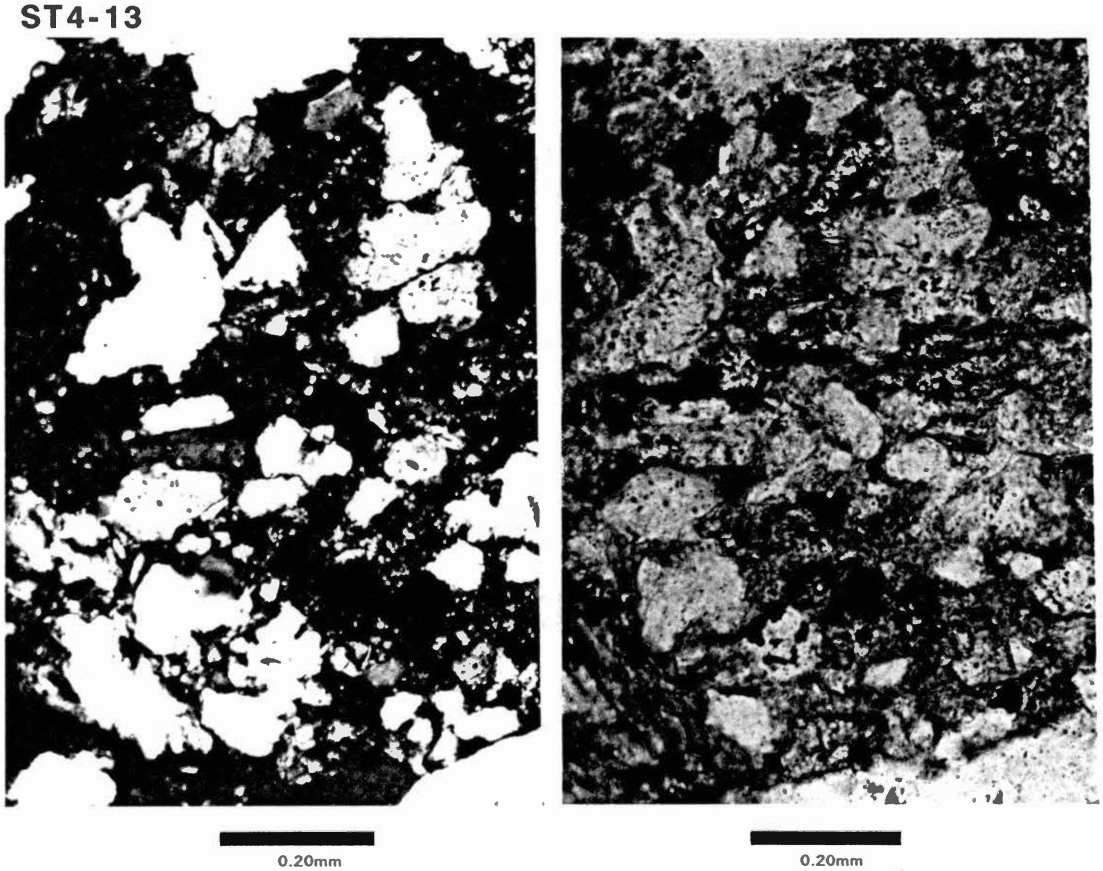


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX =	21.4 %	Normalized
Q =	57.6 %	85 %
F =	— %	%
R =	10.2 %	15 %
Total	67.8	100 %

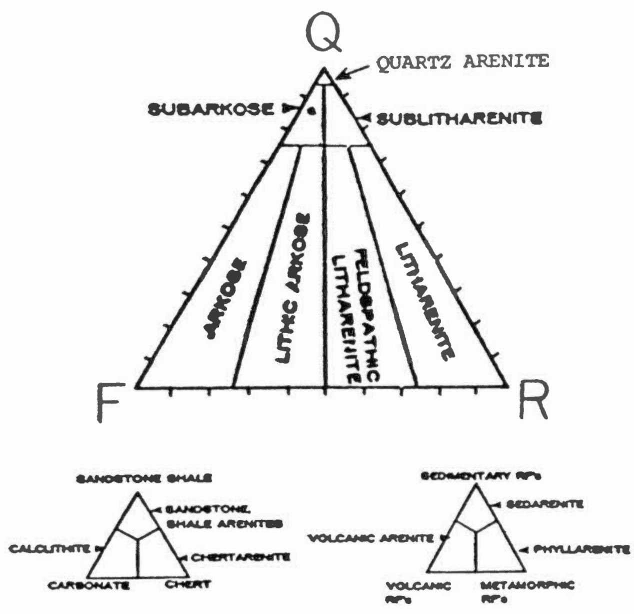
ST4-13



C N   P P

ST4-14/6281.6 ft.: Subarkose: Normalized constituents- Quartz, 85.2%; Rock fragments, 4.4%; Feldspar, 10.4%: Subangular to subrounded, very poorly sorted, submature: Constituents- Monocrystalline quartz, 69.7%; Microcline feldspar, 8.5%; Chert fragments, 3.6%; Muscovite, 0.7%; Detrital matrix- Illite 1.5%; Quartz cement, 1.9%; Calcite cement, 9.0%; Authigenic clays- Kaolinite, 0.6%; Chlorite, 1.0%; Primary porosity, 0.6%; Secondary porosity, 2.9%;

ST4-15/6282.6 ft.: Borderline between subarkose and sublitharenite: Normalized constituents- Quartz, 87.6%; Rock fragments 6.6%; Feldspar, 5.8%: Subangular to subrounded, very poorly sorted, submature: Constituents- Monocrystalline quartz, 75.3%; Plagioclase feldspar, 5.7%; Chert fragments, 5.7%; Glauconite, trace; Muscovite, 0.8%; Detrital matrix- Illite, 2.4%; Quartz cement, 0.3%; Calcite cement, 2.5%; Authigenic clays- Chlorite, 3.6%; Organic material, 1.5%; Secondary porosity, 2.2%.



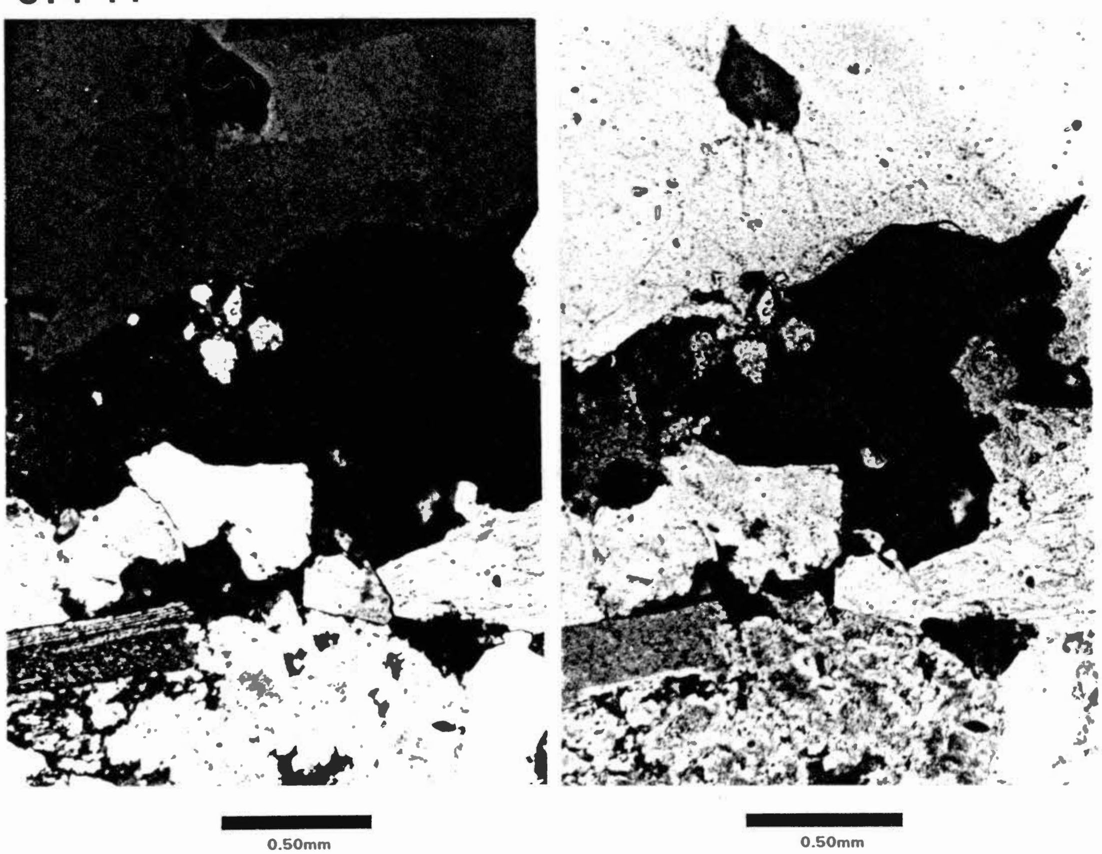
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

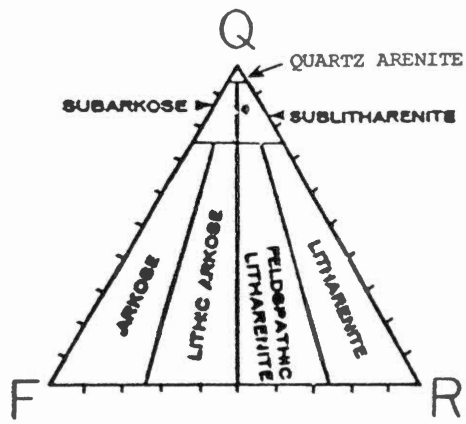
MATRIX = 1.8 %

		Normalized
Q =	69.7 %	85.2 %
F =	8.5 %	10.4 %
R =	3.6 %	4.4 %
Total	81.8	100 %

ST4-14



C N P P

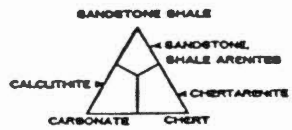


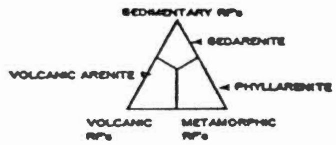
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 2.7 % Normalized

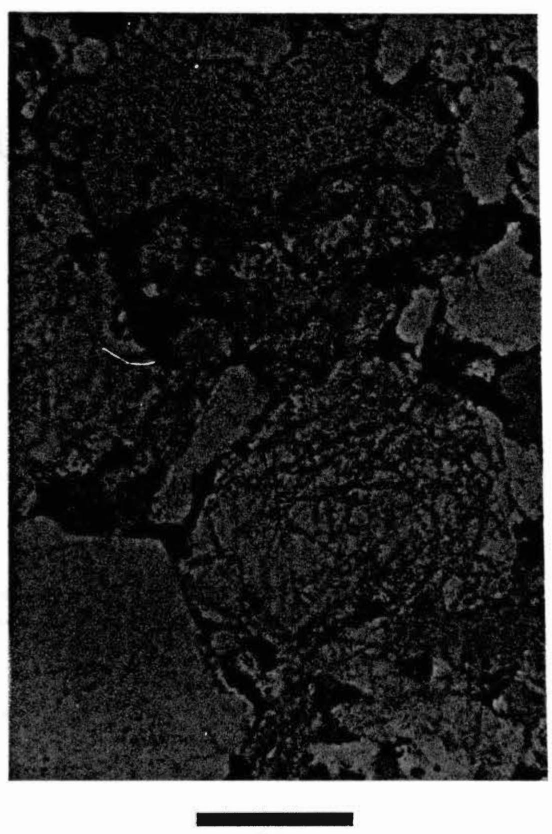
Q =	75.3 %	86.8 %
F =	5.7 %	6.6 %
R =	5.7 %	6.6 %
Total	86.7	100 %





ST4-15

C N

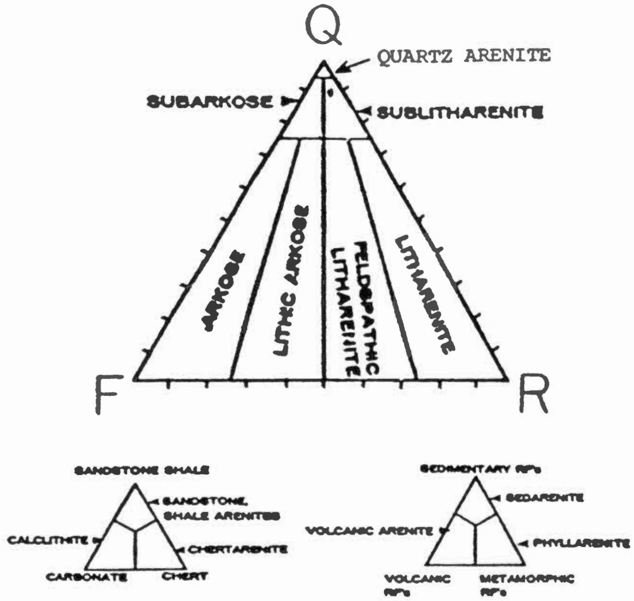


P P

<u>ST4-16/6283.8</u> <u>ft.:</u> Sublitharenite: Normalized constituents- Quartz 90.2%; Rock fragments, 6.2%; Feldspar, 3.6%: Subrounded, poorly to very poorly sorted, submature: Constituents- Monocrystalline quartz, 70.3%; Plagioclase feldspar, 2.8%; Chert fragments 1.0%; Volcanic-rock fragments, 3.8%; Zircon, 0.1%; Detrital matrix- Illite, 2.9%; Quartz cement, 2.3%; Calcite cement, 14.1%; Dolomite cement, 0.5%; Authigenic clays- Chlorite, 1.8%; Organic material 0.4%.

<u>ST4-17/6284.3</u> <u>ft.:</u> Subarkose: Normalized constituents- Quartz, 93.5%; Rock fragments, 2.6%; Feldspar, 3.9%: Subrounded to subangular, poorly to very poorly sorted, submature: Constituents- Monocrystalline quartz, 80.1%; Microcline feldspar, 3.3%; Chert fragments, 2.3%; Detrital matrix- Illite, 2.7%; Quartz cement, 3.8%; Calcite cement, 6.2%; Authigenic clays- Chlorite, 0.8%; Primary porosity, 0.2%; Secondary porosity, 0.6%.

<u>ST4-18/6284.6</u> <u>ft.:</u> Subarkose: Normalized constituents- Quartz, 87.2%; Rock fragments, 1.4%; Feldspar, 11.4%: Subangular to subrounded, poorly to very poorly sorted, submature: Constituents- Monocrystalline quartz, 68.2%; Microcline feldspar, 8.9%; Chert fragments, 1.1%; Detrital matrix- Illite, 0.7%; Quartz cement, 5.0%; Calcite cement, 5.8%; Authigenic clays- Chlorite, 1.2%; Primary/Secondary porosity, 9.1%.



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

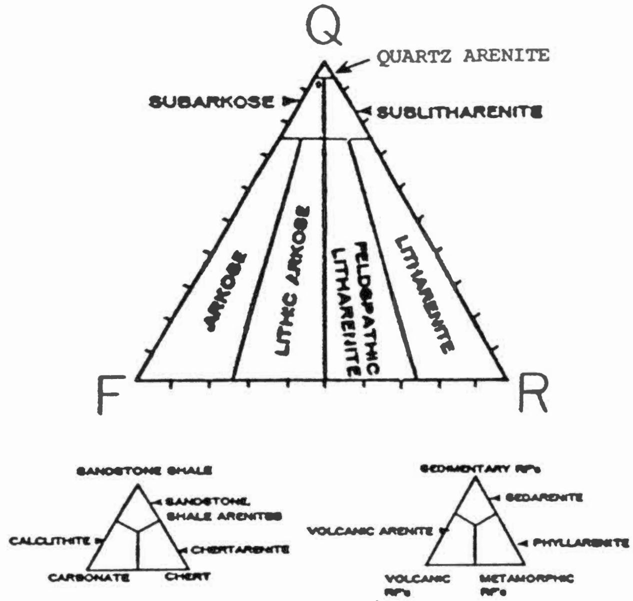
MATRIX = 2.9 % Normalized

Q =	70.3 %	90.2 %
F =	2.8 %	3.6 %
R =	4.8 %	6.2 %
Total	77.9	100 %

ST4-16

C N

P P



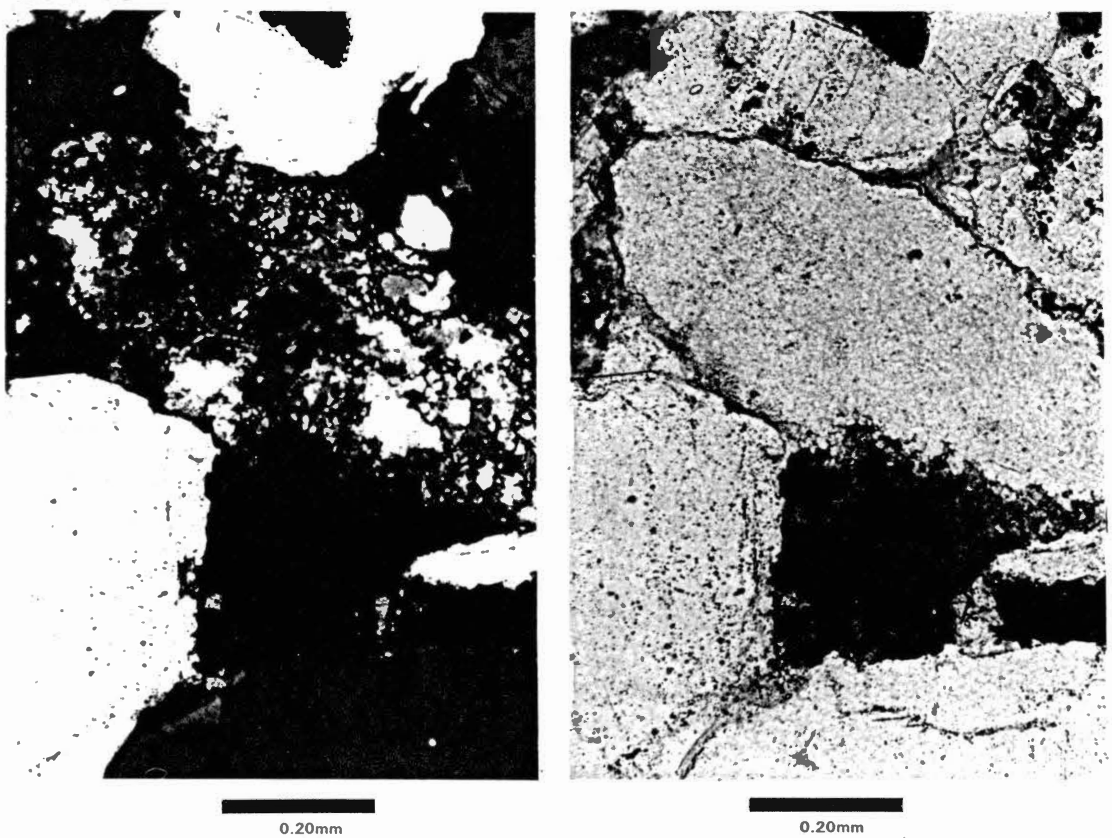
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

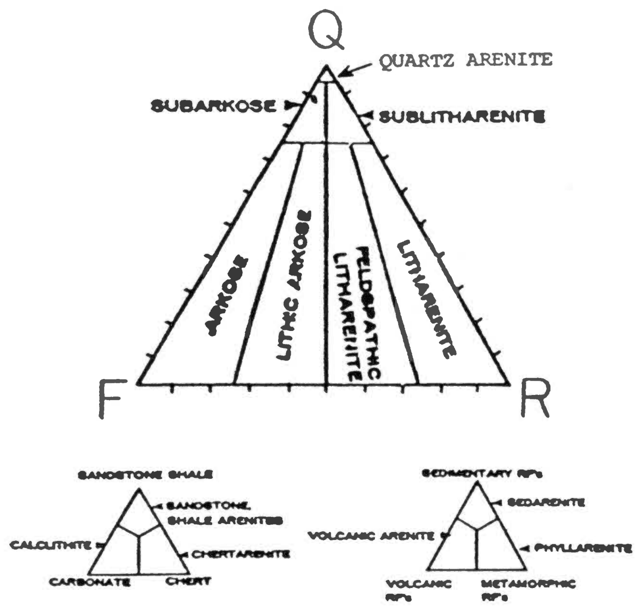
MATRIX = 3.1 % Normalized

Q =	80.1 %	93.5 %
F =	3.3 %	3.9 %
R =	2.3 %	2.6 %
Total	85.7	100 %

ST4-17



C N   P P



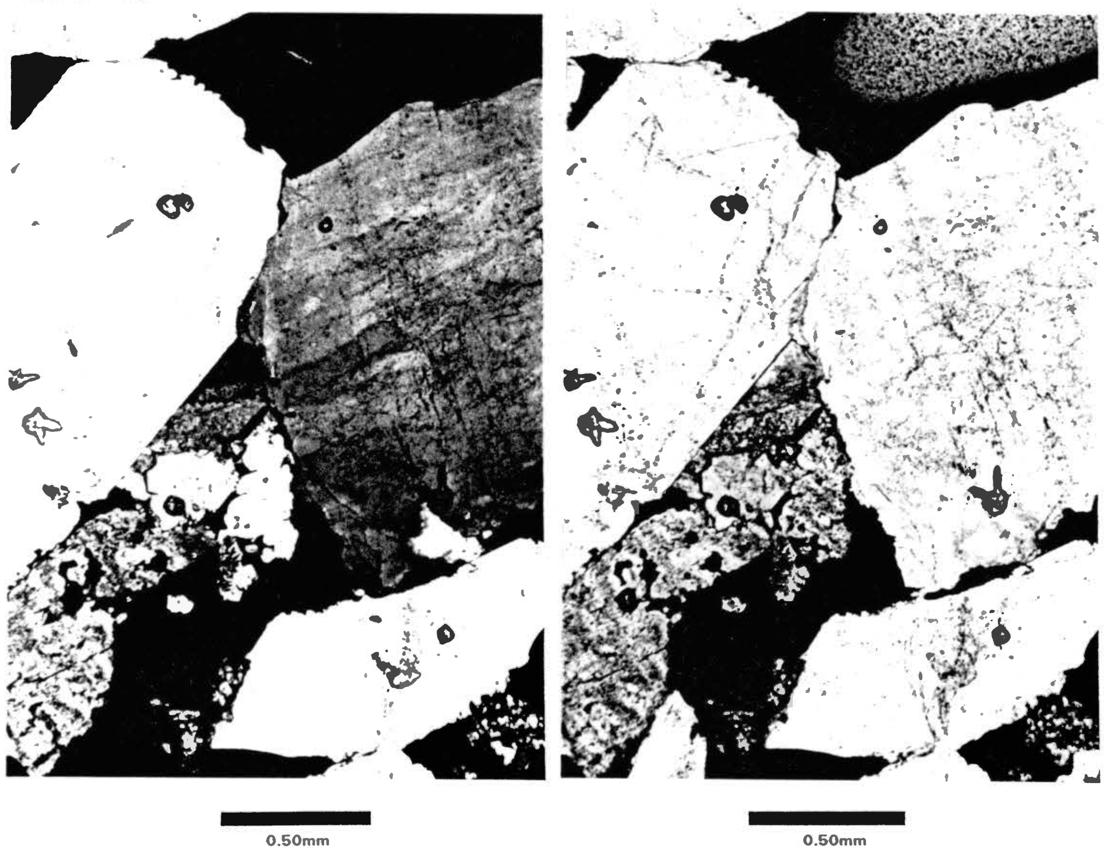
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = .9 %

		Normalized
Q =	68.2 %	87.2 %
F =	8.9 %	11.4 %
R =	1.1 %	1.4 %
Total	78.9	100 %

ST4-18

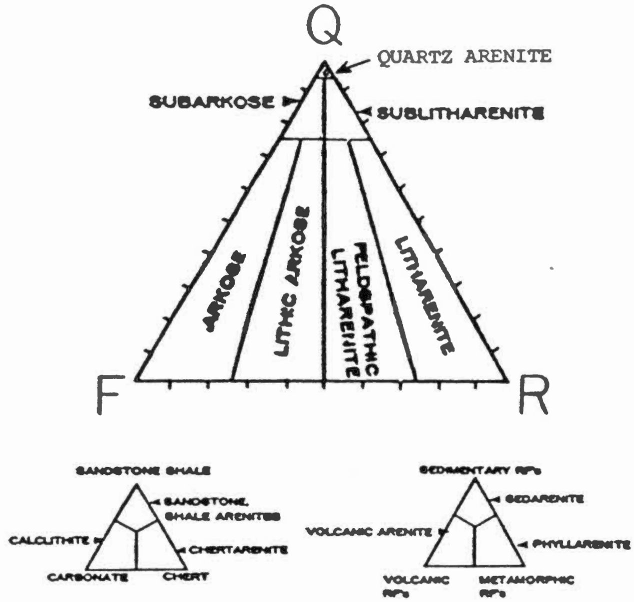


C N **P P**

<u>ST4-19/6286.7 ft.:</u> Quartz arenite: Normalized constituents- Quartz, 96.5%; Feldspar, 3.5%: Subangular to subrounded, poorly to moderately sorted, submature: Constituents- Monocrystalline quartz, 71.0%; Plagioclase feldspar, 2.6%; Muscovite, 1.9%; Detrital matrix- Illite, 1.5%; Quartz cement, 0.7%; Calcite cement, 7.8%; Authigenic clays- Kaolinite, 10.8%; Primary porosity, 0.7%; Secondary porosity, 3.0%.

<u>ST4-20/6288.8 ft.:</u> Subarkose: Normalized constituents- Quartz, 87.4%; Rock fragments, 1.1%; Feldspar, 11.5%: Subangular to subrounded, poorly to moderately sorted, immature: Constituents- Monocrystalline quartz, 71.0%; Microcline feldspar 4.4%; Plagioclase, 4.9%; Chert fragments, 0.9%; Detrital matrix- Illite, 6.9%; Quartz cement, 2.3%; Calcite cement, 1.4%; Authigenic clays- Kaolinite, 6.3%; Primary porosity, 0.2%; Secondary porosity, 1.3%.

<u>ST4-21/6295.2 ft.:</u> Subarkose: Normalized constituents- Quartz, 86.1%; Rock fragments, 1.7, Feldspar, 12.2%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 55.8%; Microcline, feldspar, 5.8%; Plagioclase feldspar, 2.1%; Shale fragments, 0.5%; Chert fragments, 0.6%; Muscovite, 0.8%; Detrital matrix- Illite 3.7%; Quartz cement, 2.7%; Calcite cement, 2.5%; Authigenic clays- Kaolinite, 18.4%; Pyrite, 0.6%; Primary porosity, 1.6%; Secondary porosity, 4.9%.



Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

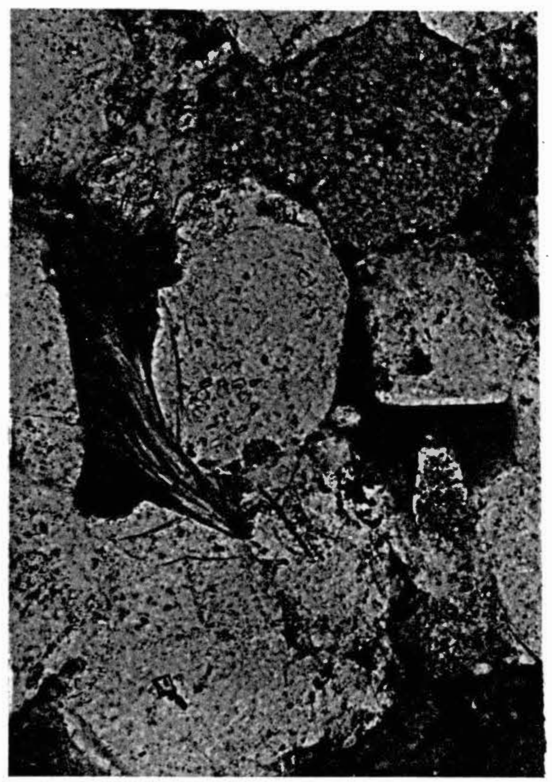
MATRIX = 2.0 % Normalized

		Normalized
Q =	71.0 %	96.5 %
F =	2.6 %	3.5 %
R =	%	%
Total	73.6	100 %

ST4-19

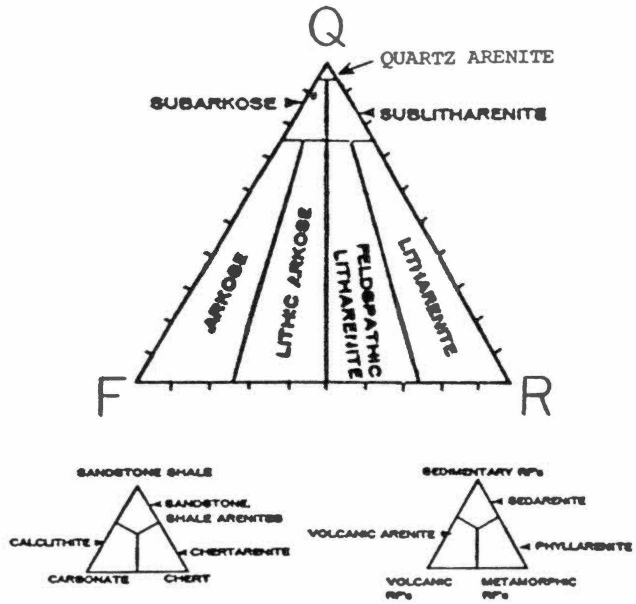
0.20mm

C N



0.20mm

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 8.7 % Normalized

Q =	71.0 %	87.4 %
F =	9.3 %	11.5 %
R =	.9 %	1.1 %
Total	81.2	100 %

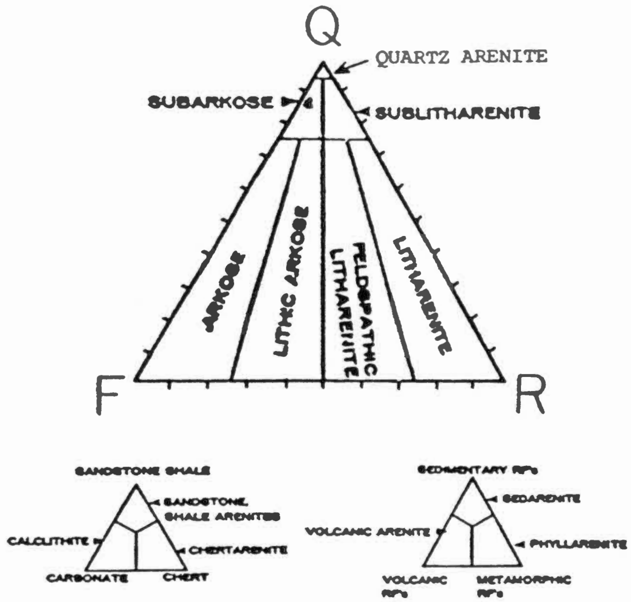
ST4-20

0.20mm

C N

0.20mm

P P

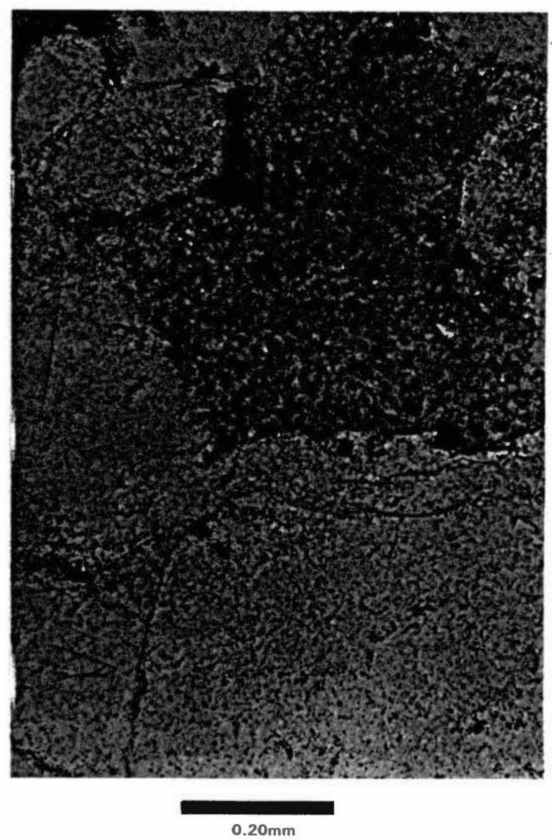


Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 5.8 %	Normalized
Q = 55.8 %	86.1 %
F = 7.9 %	12.2 %
R = 1.1 %	1.7 %
Total 64.8	100 %

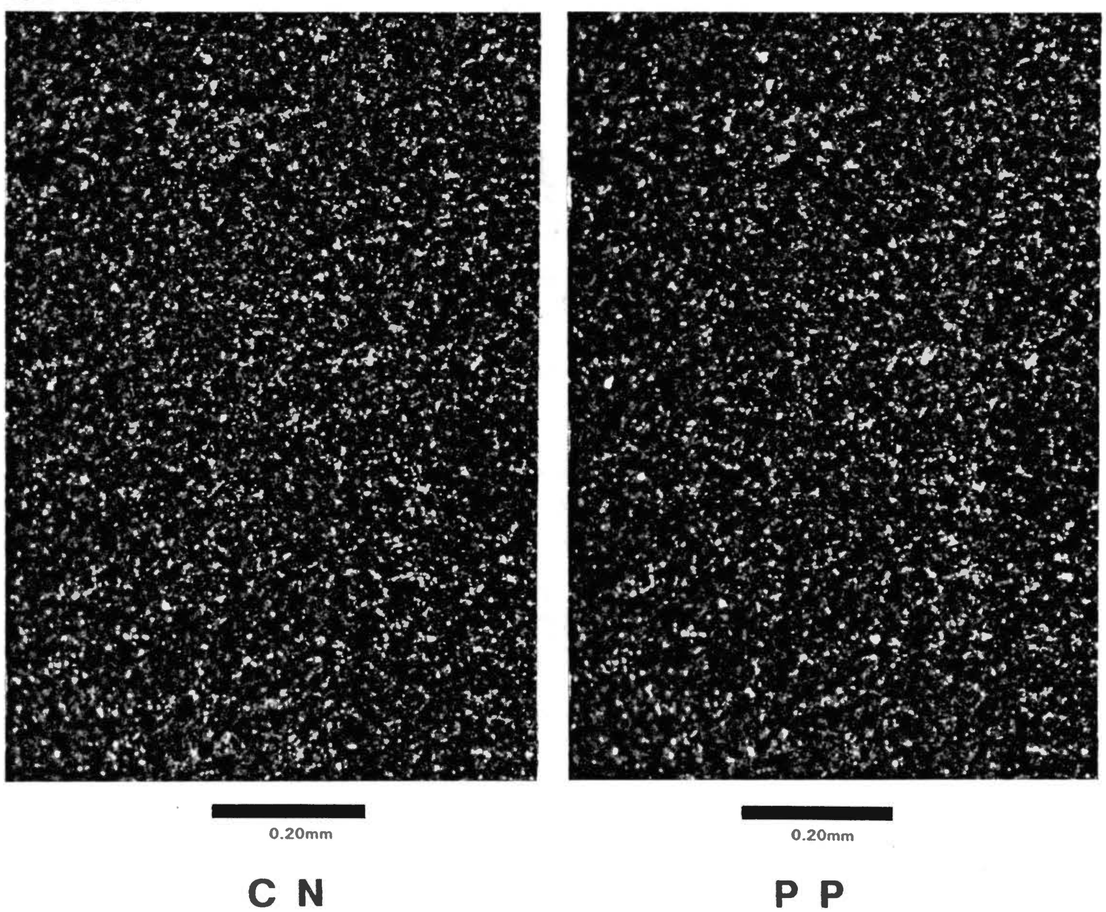
ST4-21



C N   P P

ST4-22/6295.4 ft.: Mudstone (Dunham); Dismicrite (Folk): Constituents- Micrite 99.9%; Pyrite, 0.1%.

ST4-22



No. 101 Stonebraker "A"

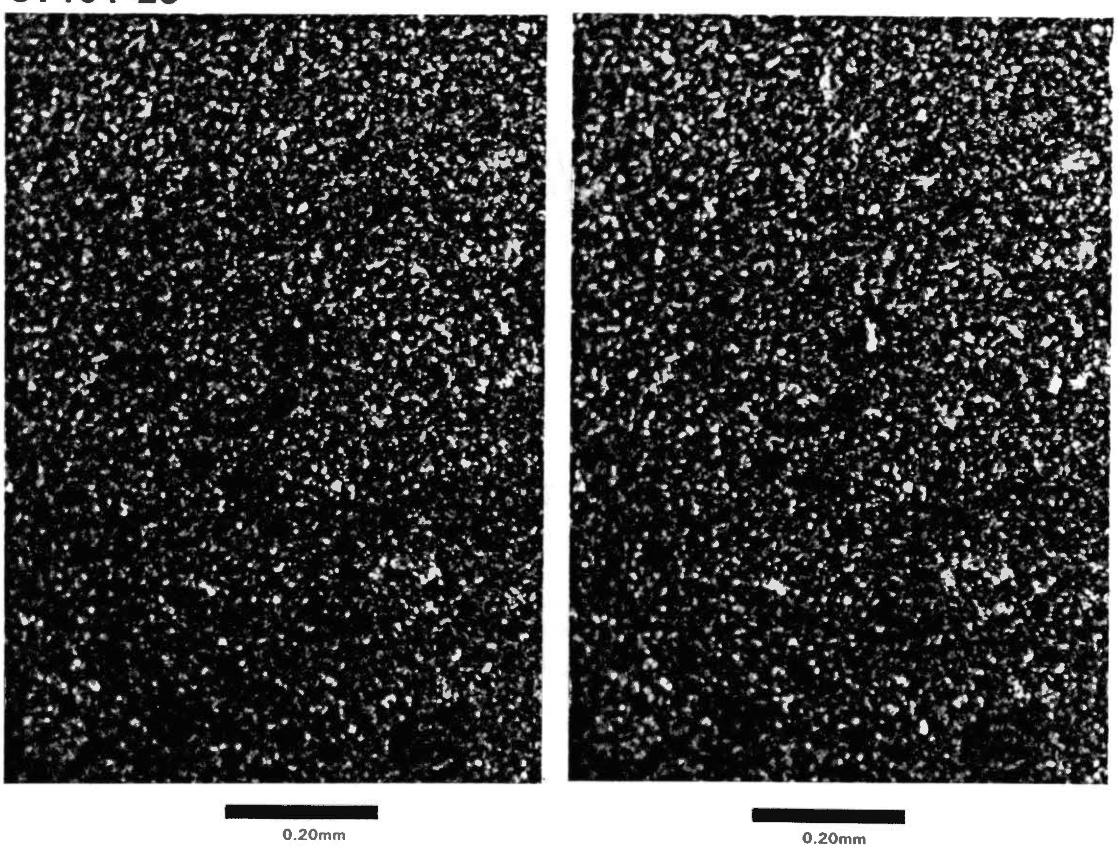
ST101-23/6165 ft.: Mudstone (Dunham); Dismicrite (Folk): Constituents- Micrite 95.8%; Quartz, 1.5%; Muscovite, 0.4%; Pyrite, 1.6%; Organic material, 0.7%.

ST101-24/6167.6 ft.: Subarkose: Normalized constituents- Quartz, 75.5%; Rock fragments, 4.8%; Feldspar, 19.7%: Subangular to subrounded, very poorly sorted, immature: Constituents- Monocrystalline quartz, 58.0%; Microcline feldspar, 3.5%; Plagioclase feldspar, 11.6%; Shale fragments, 0.9%; Chert fragments, 1.2%; Volcanic-rock fragments, 1.6%; Glauconite 0.2%; Muscovite, 2.5%; Zircon 0.6%; Detrital matrix- Illite, 13.1%; Calcite cement, 5.8%; Pyrite, 1.0%.

ST101-25/6168.3 ft.: Mudstone: Detrital matrix- Illite, 51.6%; Pyrite, 48.4%.

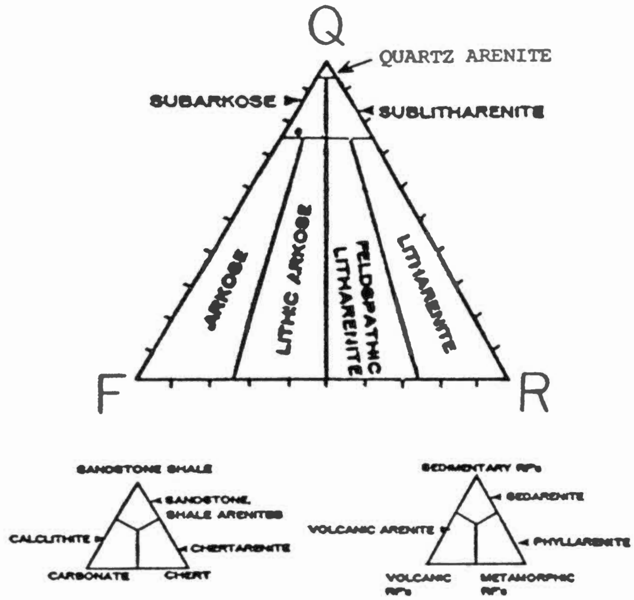
ST101-26/6171.5 ft.: Subarkosic wacke: Normalized constituents- Quartz, 79.2%; Rock fragments, 8.2%; Feldspar, 12.6%: Subangular to subrounded, poorly to very poorly sorted, immature: Constituents- Monocrystalline quartz, 55.2%; Microcline feldspar 6.8%; Plagioclase feldspar, 2.6%; Shale fragments, 3.8%; Chert fragments, 1.9%; Muscovite, 5.8%; Zircon 0.4%; Phosphate nodule, 1.3%; Detrital matrix- Illite, 21.6%; Organic material, 0.6%.

ST101-23



C N

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 14.6 %	Normalized
Q = 58.0 %	75.5 %
F = 15.1 %	19.7 %
R = 3.7 %	4.8 %
Total 76.8	100 %

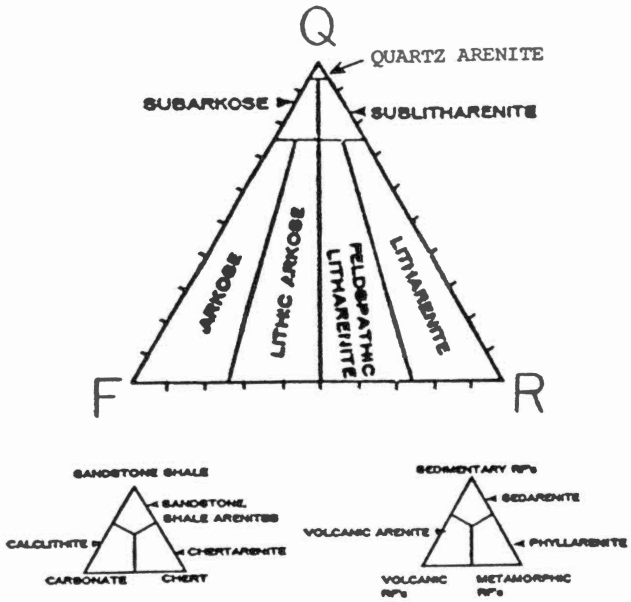
ST101-24

0.20mm

C N

0.20mm

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

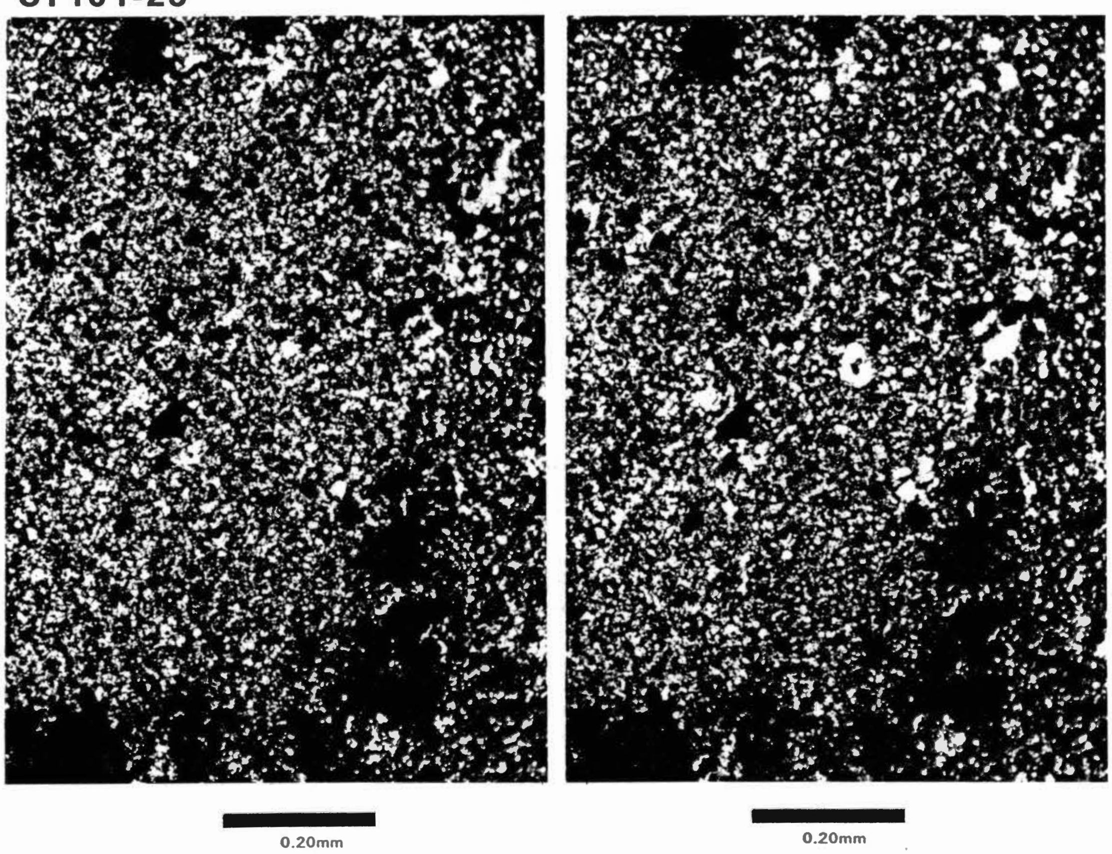
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 51.6 % Normalized

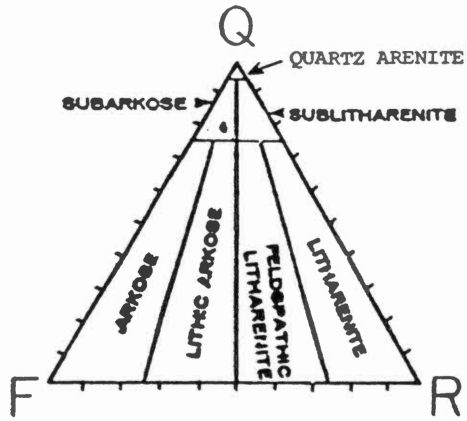
Q = ____% ____%
F = ____% ____%
R = ____% ____%

Total____ 100 %

ST101-25



CN PP



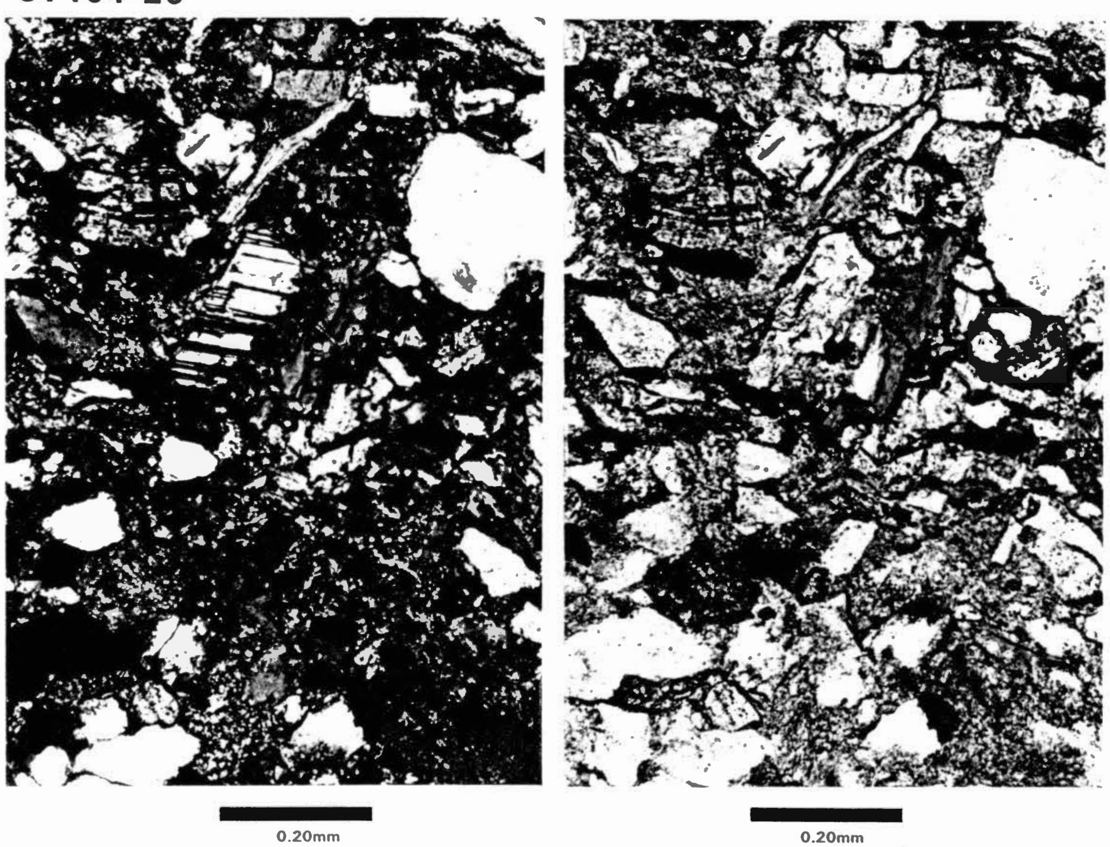
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 31 % Normalized

Q =	55.2 %	79.2 %
F =	8.8 %	12.6 %
R =	5.7 %	8.2 %
Total	69.7	100 %

ST101-26



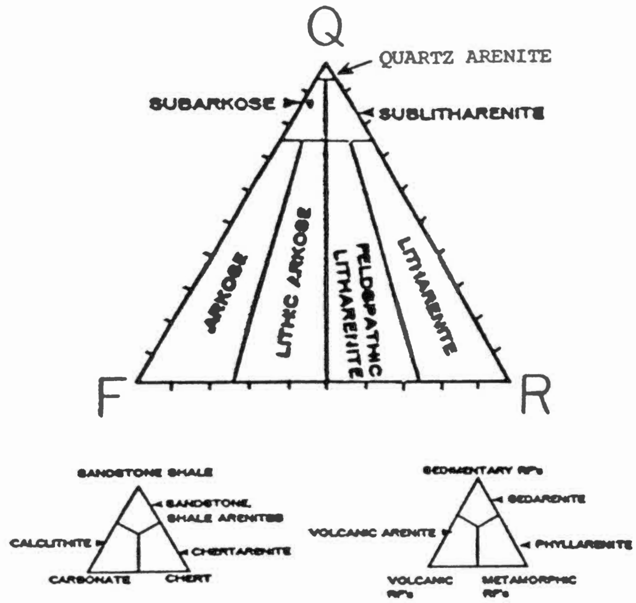
C N P P

ST101-27/6173 ft.: Subarkose: Normalized constituents- Quartz, 86.9%; Feldspar, 13.1%; Subangular to subrounded, poorly sorted, immature: Constituents- Monocrystalline quartz, 42.4%; Microcline feldspar 2.8%; Plagioclase feldspar, 3.6%; Chert fragments, trace; Glauconite, trace; Muscovite, 0.8%; Zircon, 0.3%; Detrital matrix- Illite, 10.0%; Quartz cement, 0.4%; Calcite cement, 24.5%; Authigenic clays- Kaolinite, 1.3%; Illite, 10.8%; Pyrite, 0.2%; Organic material, 0.3%; Primary porosity, 0.7%; Secondary porosity, 1.9%.

ST101-28/6177.5 ft.: Quartzwacke: Normalized constituents- Quartz 97.3%: Subangular to subrounded, poorly to very poorly sorted, immature: Constituents- Monocrystalline quartz, 43.8%; Plagioclase feldspar, 1.2%; Glauconite, trace; Muscovite, 2.3%; Detrital matrix- Illite, 16.7%; Quartz overgrowths, 3.1%; Calcite cement, 28.7%; Authigenic clays- Kaolinite, 3.0%; Primary porosity, 0.2%; Secondary porosity, 1.0%.

ST101-29/6187.5 ft.: Mudstone (Dunham); Dismicrite (Folk): Constituents- Micrite 81.0%; Sparry calcite, 18.2%; Porosity, 0.8%; Pyrite, trace.

ST101-30/6188.5 ft.: Wackestone (Dunham); Biomicrite (Folk): Constituents- Micrite 84.3%; Sparry calcite, 14.0%; Fossil fragments replaced with sparry calcite, 1.7%, Pyrite, trace.



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

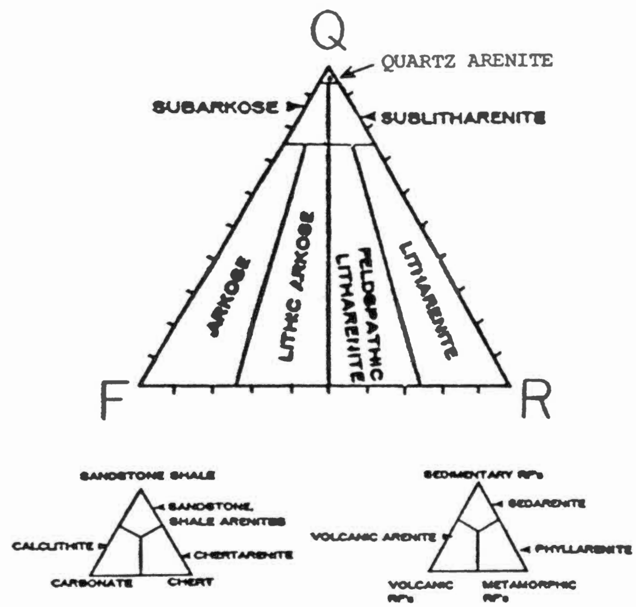
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 17.0 %	Normalized
Q = 42.4 %	86.9 %
F = 6.4 %	13.1 %
R = ____ %	____ %
Total 58.8	100 %

ST101-27

0.20mm | 0.20mm

C N | **P P**



Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 27 % Normalized

Q = 43.8 % 97.3 %
F = 1.2 %
R = %

Total 100 %

ST101-28

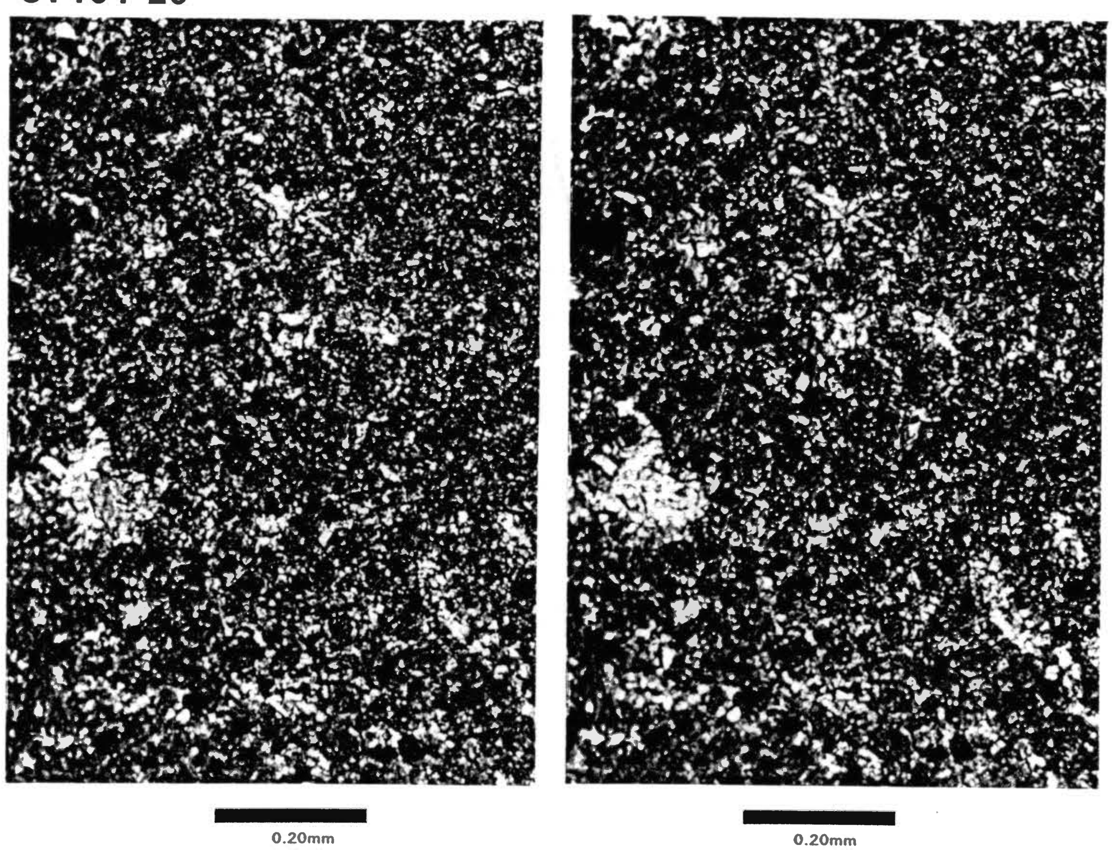
0.20mm

C N

0.20mm

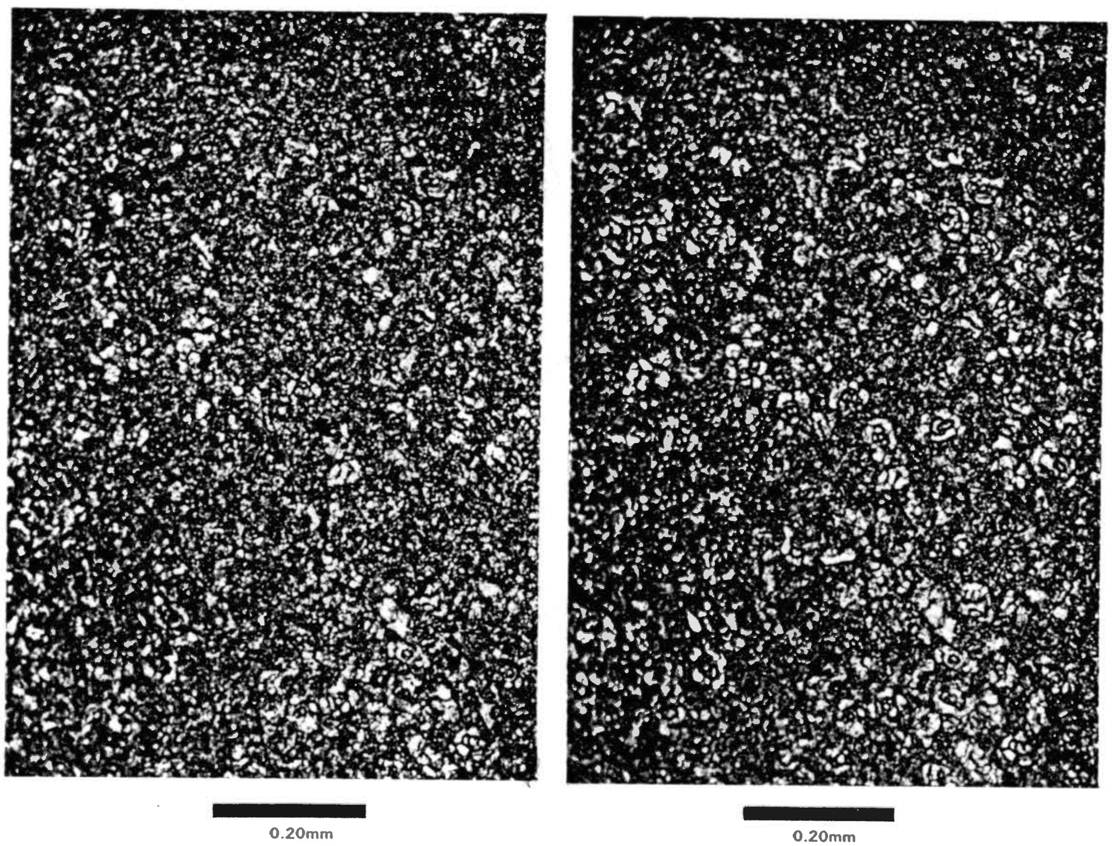
P P

ST101-29



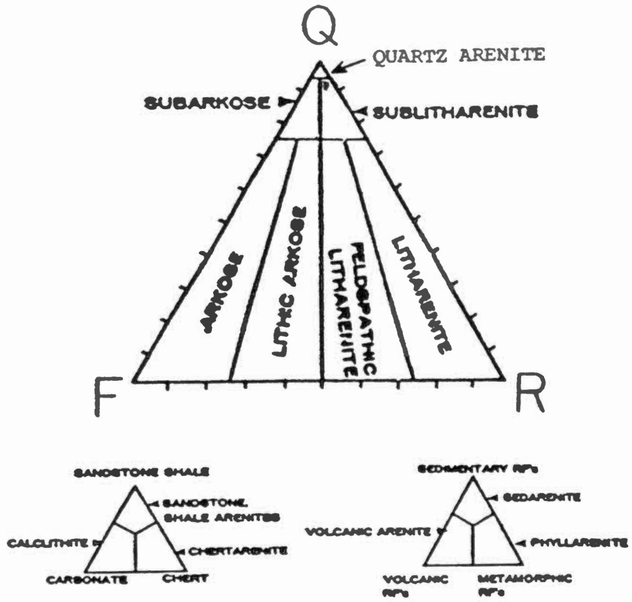
C N   P P

ST101-30



C N   P P

<u>ST101-31/6206</u> <u>ft.:</u> Sublitharenite: Normalized constituents- Quartz, 94.3%; Rock fragments, 3.0%; Feldspar, 2.7%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 52.7%; Plagioclase feldspar, 1.5%; Chert, 1.7%; Detrital matrix- Illite, 3.1%; Quartz overgrowths, 1.6%; Calcite cement, 38.5%; Dolomite cement, 0.9%.



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

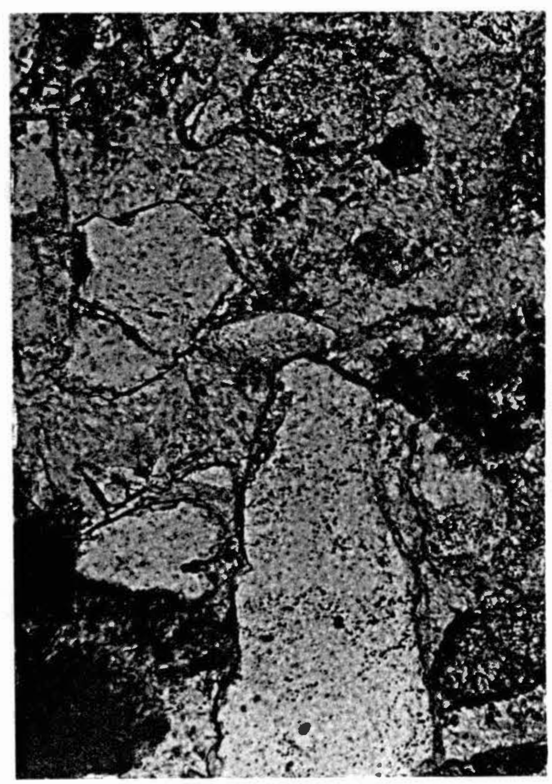
MATRIX = – % Normalized

Q =	52.7 %	94.3 %
F =	1.5 %	2.7 %
R =	1.7 %	3.0 %
Total		100 %

ST101-31

0.20mm

C N



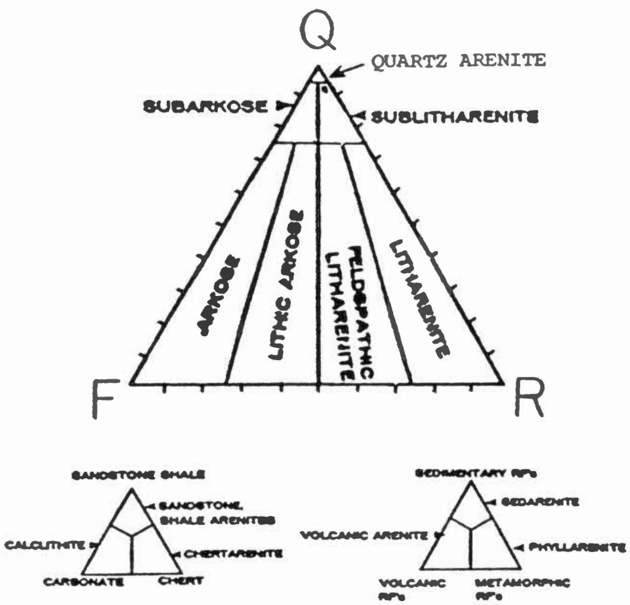
0.20mm

P P

No. 1-13 Finfrock

FF-32/6502 ft.: Sublitharenite: Normalized constituents- Quartz, 93.4%; Rock fragments, 4.3%; Feldspar, 2.3%: Subrounded to rounded, moderately to well sorted, submature to supermature: Monocrystalline quartz, 43.8%; Plagioclase feldspar, 1.1%; Chert fragments, 0.8%; Siltstone fragments, 3.1%; Glauconite, 9.5%; Bryozoan shell fragments, 6.2%; Zircon, trace; Detrital matrix- Illite; 1.0%; Calcite cement, 26.1%; Dolomite cement, 1.0%; Phosphate cement, 6.3%; Pyrite, 0.7%; Secondary porosity, 0.4%.

FF-33/6506 ft.: Subarkose: Normalized constituents- Quartz, 92.1%; Rock fragments, 3.9%; Feldspar, 4.0%: Subrounded, moderately sorted, submature: Constituents- Monocrystalline quartz, 38.7%; Plagioclase feldspar, 1.7%; Shale fragments, 1.6%; Glauconite, 5.1%; Echinoderm-plate shell fragments, 21.8%; Calcite cement, 28.0%; Authigenic clays- Illite, 2.1%; Chlorite, 1.3%.



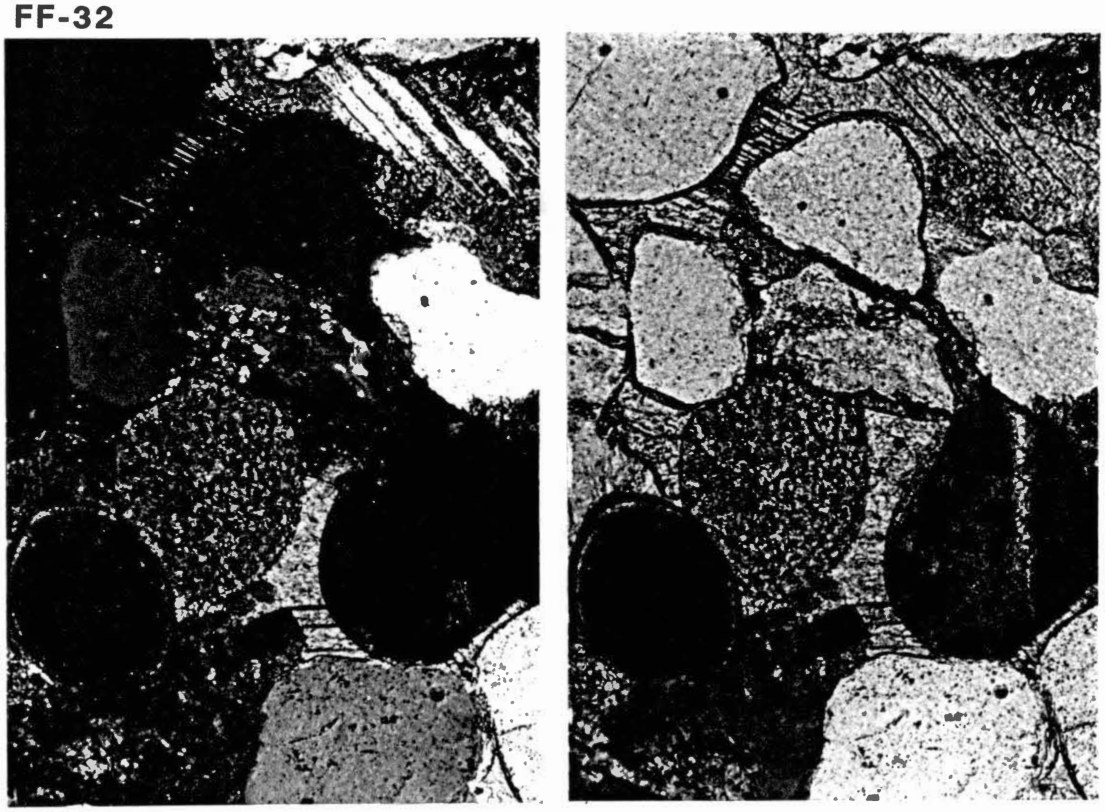
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 2.1 % Normalized

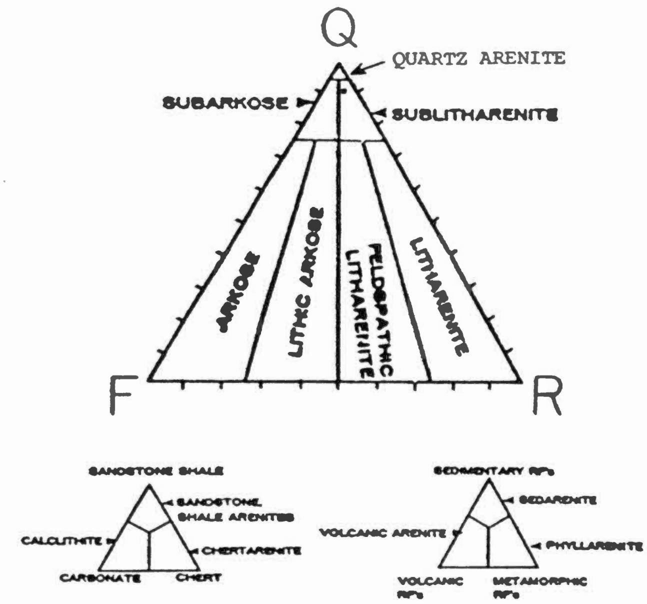
Q =	43.8 %	93.4 %
F =	1.1 %	2.3 %
R =	3.9 %	4.3 %
Total	46.9	100 %

FF-32



0.20mm 0.20mm

C N **P P**

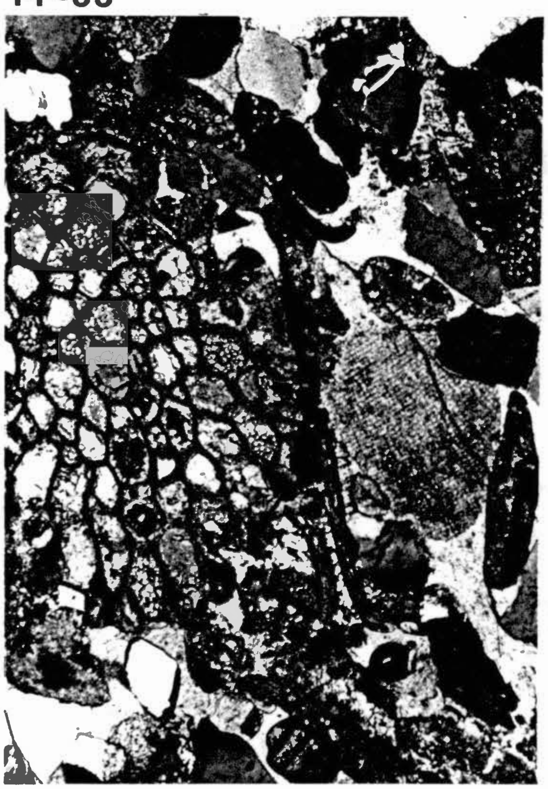


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 38.7 %	92.1 %
F = 1.7 %	4.0 %
R = 1.6 %	3.9 %
Total 42	100 %

FF-33



0.50mm

C N

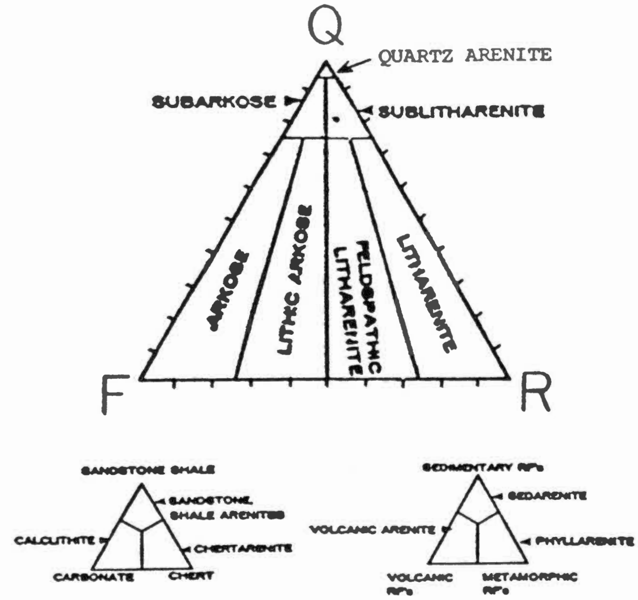
0.50mm

P P

<u>FF-34/6508.7</u> <u>ft.:</u> Sublithwacke: Normalized constituents- Quartz, 82.1%; Rock fragments, 10.2%; Feldspar, 7.8%: Subangular, poorly sorted, immature: Constituents- Monocrystalline quartz, 51.7%; Microcline feldspar, 4.9%; Shale fragments, 2.7%; Siltstone fragments, 3.7%; Glauconite 10.5%; Zircon, trace; Detrital matrix- Illite, 11.5%; Calcite cement, 10.5%; Authigenic clays- Illite, 1.8%; Chlorite, 2.3%; Pyrite, trace; Secondary porosity, 0.4%.

<u>FF-35/6511.7</u> <u>ft.:</u> Quartzwacke: Normalized constituents- Quartz 100%: Subrounded, well sorted, immature: Constituents- Monocrystalline quartz, 30.2%; Glauconite, 11.6%; Muscovite, 1.3%; Phosphate, 1.0%; Detrital matrix- Illite, 18.5%; Calcite cement, 33.0%; Authigenic clays- Illite, 3.6%; Chlorite, 0.8%; Pyrite, trace.

<u>FF-36/6514</u> <u>ft.:</u> Quartz arenite: Normalized constituents- Quartz 100%: Subrounded, well sorted, immature: Constituents- Monocrystalline quartz, 70.7%; Glauconite, 4.5%; Muscovite, 0.9%; Detrital matrix- Illite, 5.3%; Quartz cement, 0.6%; Calcite cement, 9.9%; Authigenic clays- Illite 6.3%; Chlorite, 0.7%; Secondary porosity, 1.1%.



Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 15.4 % Normalized

		Normalized
Q =	51.7 %	82.1 %
F =	4.9 %	7.8 %
R =	6.4 %	10.2 %
Total	63	100 %

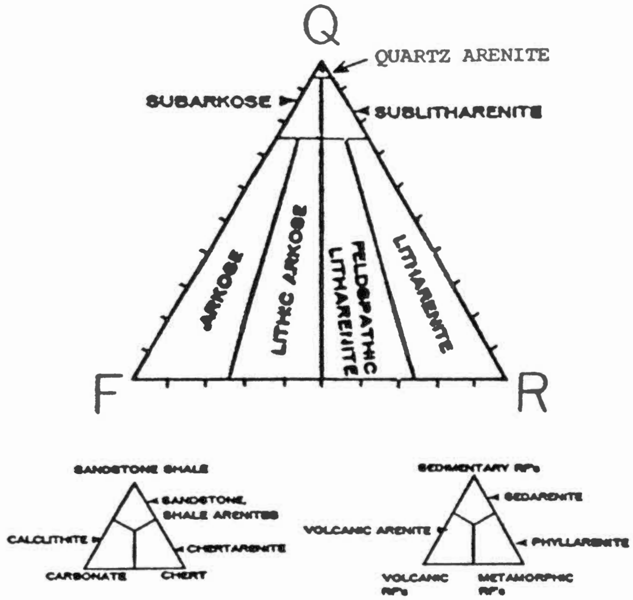
FF-34

0.20mm

C N

0.20mm

P P



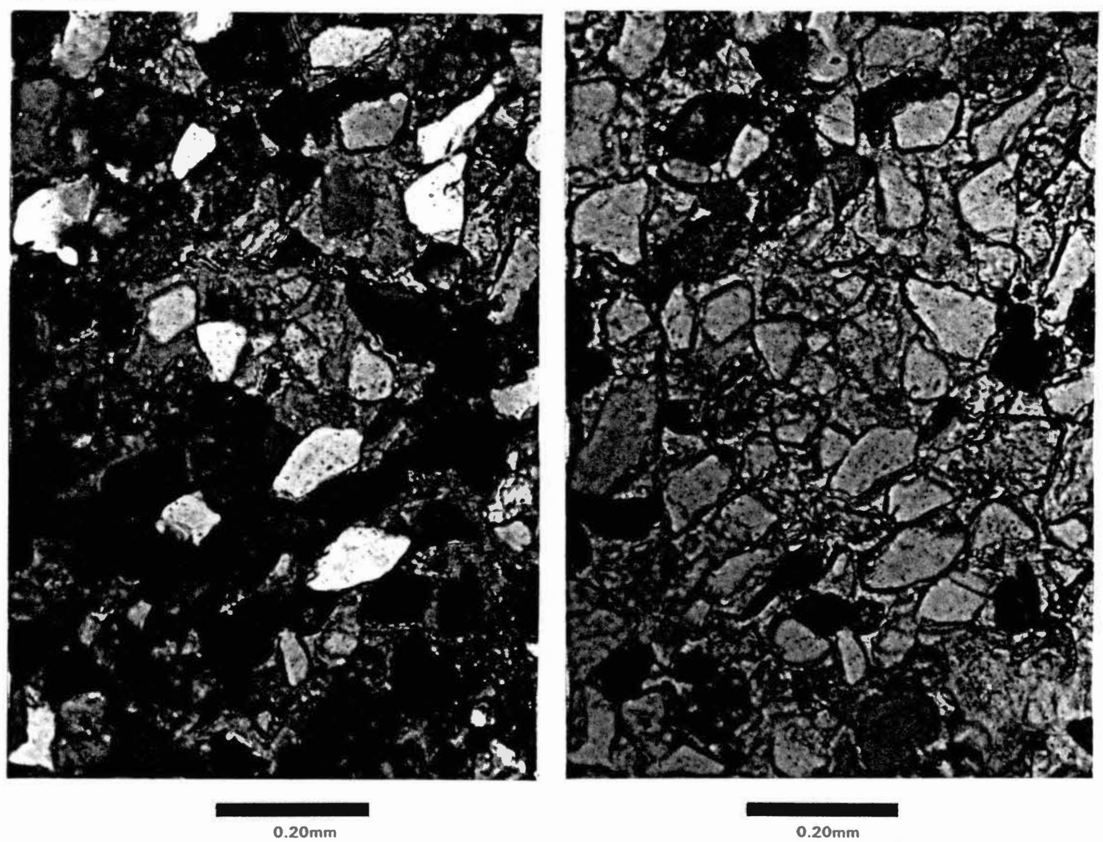
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

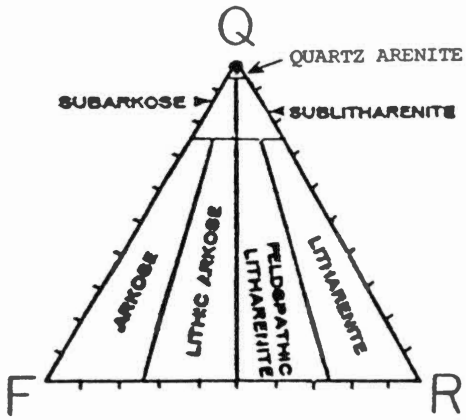
MATRIX = 18.5 % Normalized

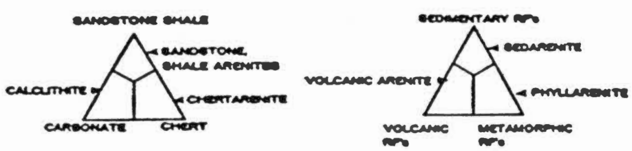
Q =	30.2 %	100 %
F =	%	%
R =	%	%
Total	30.2	100 %

FF-35



C N P P





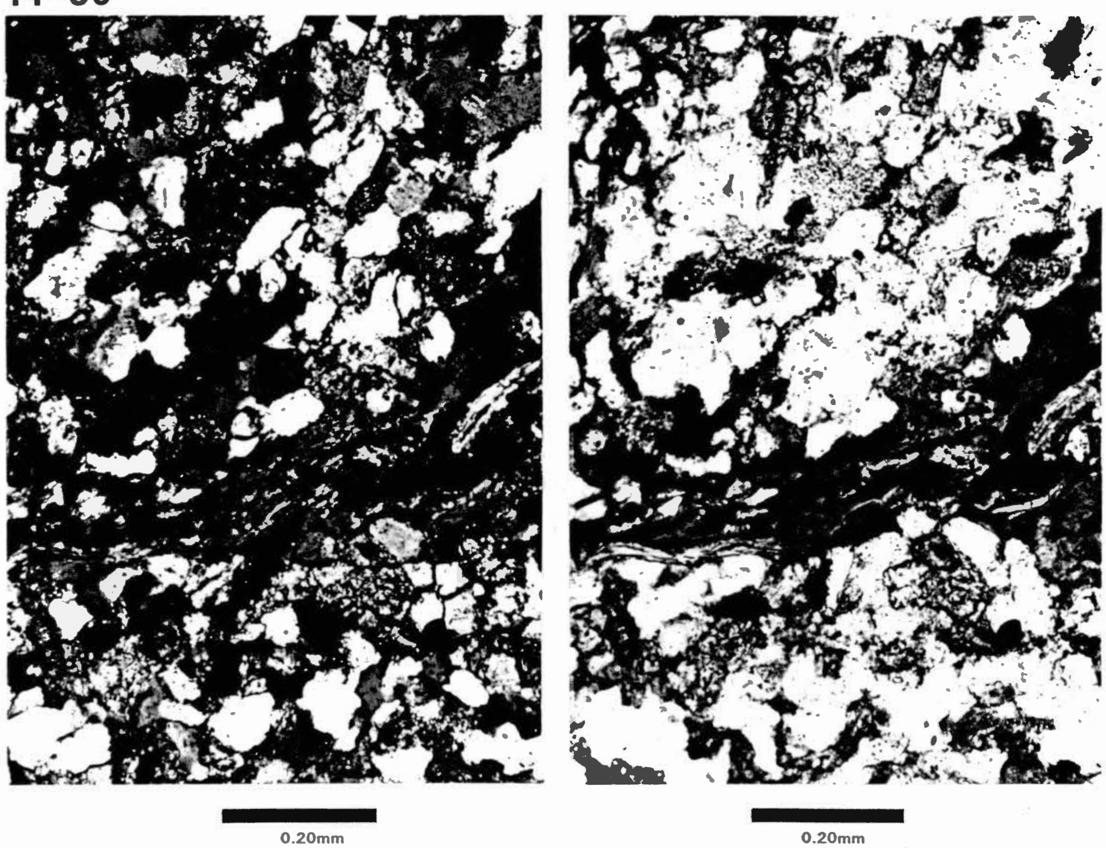
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 7.0 % Normalized

Q =	70.7 %	100 %
F =	%	%
R =	%	%
Total		100 %

FF-36

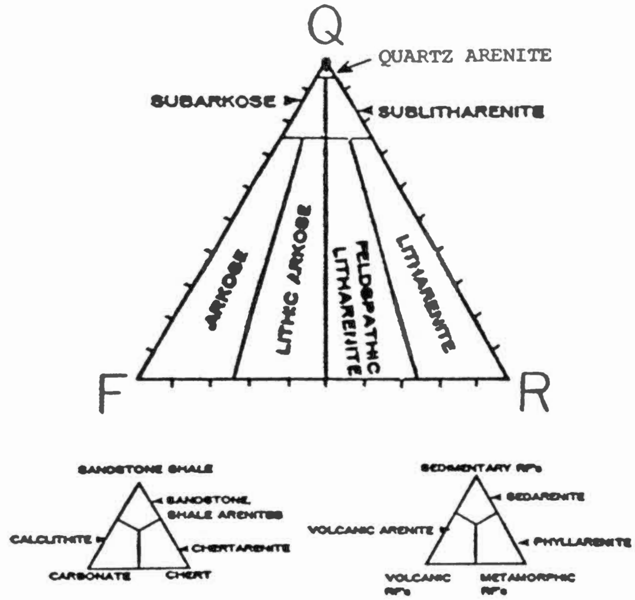


C N P P

<u>FF-37/6517 ft.:</u> Quartz arenite: Normalized constituents- Quartz, 100%: Subangular to subrounded, moderately to well sorted, submature to supermature: Constituents- Monocrystalline quartz, 40.9%; Glauconite, 7.3%; Shell fragments 0.8%; Muscovite, trace; Zircon, trace; Calcite cement 45.6%; Authigenic clays- Illite, 3.4%; Chlorite, 0.6%; Pyrite, trace; Secondary porosity 1.4%.

<u>FF-38/6520.8 ft.:</u> Quartz arenite: Normalized constituents- Quartz, 100%: Subangular, moderately to well sorted, submature: Constituents- Monocrystalline quartz, 53.8%; Glauconite, 2.5%; Muscovite, 1.1%; Quartz cement, 2.3%; Calcite cement, 26.7%; Authigenic clays- Illite, 6.2%; Chlorite, 2.9%; Primary porosity, 1.0%; Secondary porosity, 3.5%.

<u>FF-39/6521.8 ft.:</u> Sedarenite: Normalized constituents- Quartz, 59.1%; Rock fragments, 39.1%; Feldspar, 1.8%: Angular to subangular, very poorly to poorly sorted, submature: Constituents- Monocrystalline quartz, 48.2%; Plagioclase feldspar, 1.4%; Shale fragments (clast), 10.0%; Chert rock fragments, 3.7%; Siltstone fragments (clast), 18.2%; Glauconite, 4.1%; Zircon, trace; Calcite cement, 11.7%; Authigenic clays- Chlorite, 1.1%; Pyrite, 0.9%; Primary porosity, 0.2%; Secondary porosity, 0.5%.



Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 0 % Normalized

Q =	40.9 %	100 %
F =	%	%
R =	%	%
Total	40.9	100 %

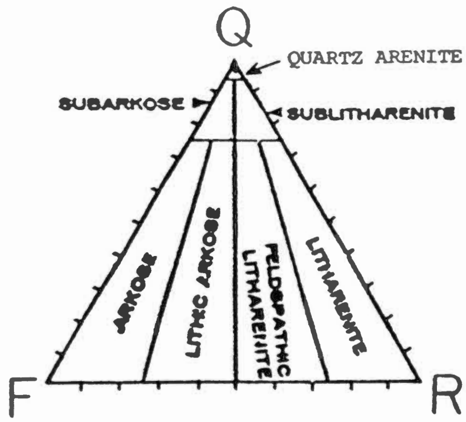
FF-37

0.20mm

C N

0.20mm

P P



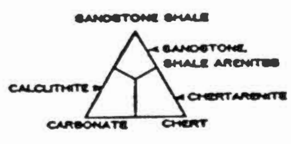
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

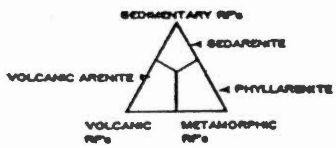
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ✓ % Normalized

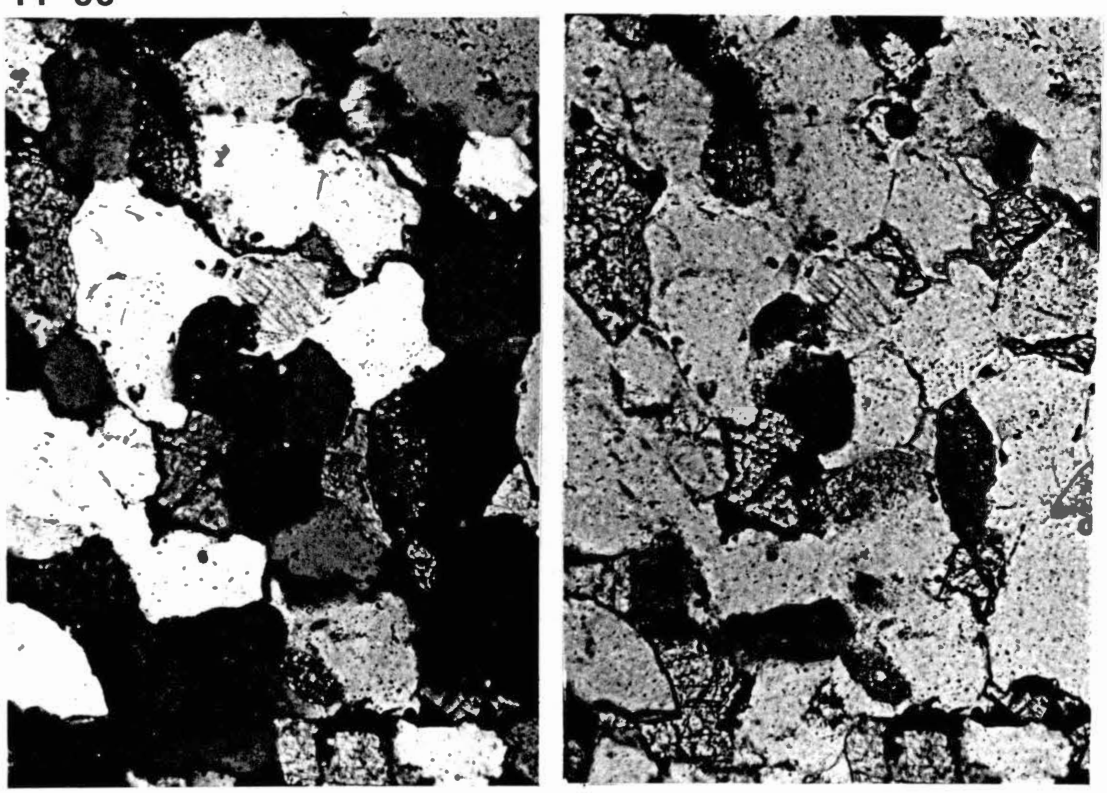
Q = 53.8 % 100 %
F = ___ % ___ %
R = ___ % ___ %

Total___ 100 %



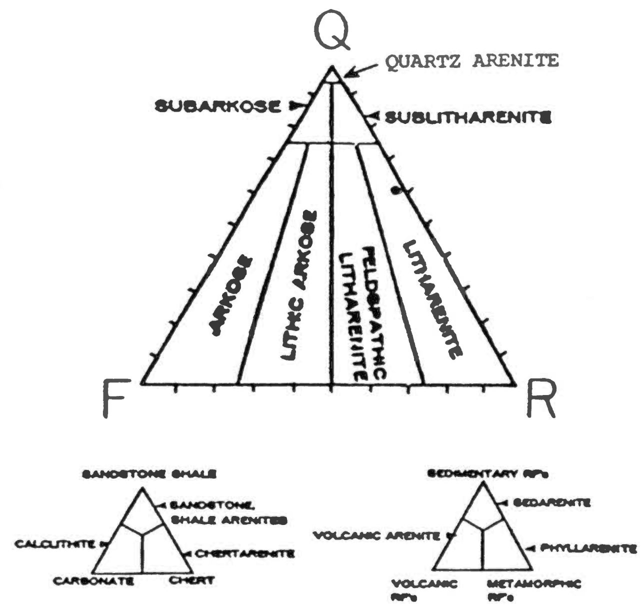


FF-38



0.20mm 0.20mm

C N P P



Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

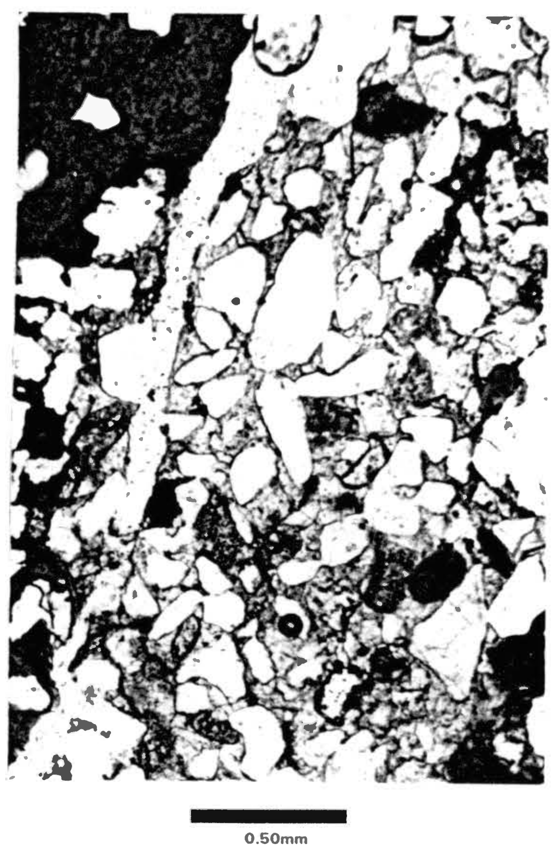
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 0 %

		Normalized
Q =	48.2 %	59.1 %
F =	1.4 %	1.8 %
R =	31.9 %	39.1 %
Total	81.5	100 %

FF-39

C N

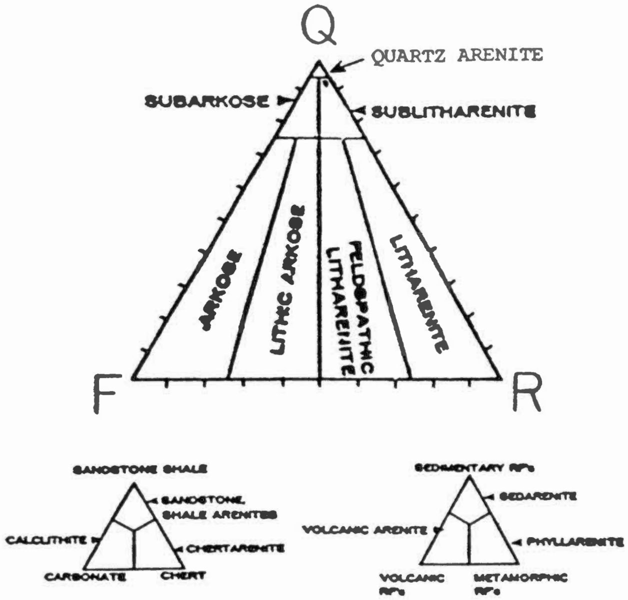


P P

<u>FF-40/6524.0</u> <u>ft.:</u> Sublitharenite: Normalized constituents- Quartz, 94.2%; Rock fragments, 5.1%; Feldspar, 0.7%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 70.4%; Microcline, 0.5%; Shale fragments, 1.0%; Chert fragments, 2.8%; Glauconite, 4.5%; Shell fragments, 0.5; Phosphate nodules, 2.0%; Quartz cement, 1.2%; Authigenic clays- Kaolinite, 5.3%; Illite, 2.4%; Chlorite, 3.0%; Secondary porosity, 6.4%.

<u>FF-41/6526.3</u> <u>ft.:</u> Sublitharenite: Normalized constituents- Quartz, 91.8%; Rock fragments, 8.2%: Subangular to angular, moderately sorted, submature: Constituents- Monocrystalline quartz, 54.9%; Chert fragments, 1.1%; Siltstone fragments, 3.8%; Glauconite 4.3%; Echinoderm-plate shell fragments, 6.3%; Muscovite, trace; Zircon, 0.2%; Phosphate, 1.5%; Calcite cement, 23.8%; Authigenic clays- Kaolinite, 3.1%; Chlorite, 0.7%; Pyrite, trace; Secondary porosity, 0.3%.

<u>FF-42/6530</u> <u>ft.:</u> Sublitharenite: Normalized constituents- Quartz, 83.9%; Rock fragments, 11.5%; Feldspar, 4.6%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 58.2%; Microcline feldspar, 3.2%; Plagioclase feldspar, trace; Chert fragments, trace; Phosphate pebbles, 8.0%; Glauconite, 1.8%; Quartz cement, 1.7%; Calcite cement, 0.7%; Authigenic clays- Kaolinite, 25.2%; Illite, 1.2%.



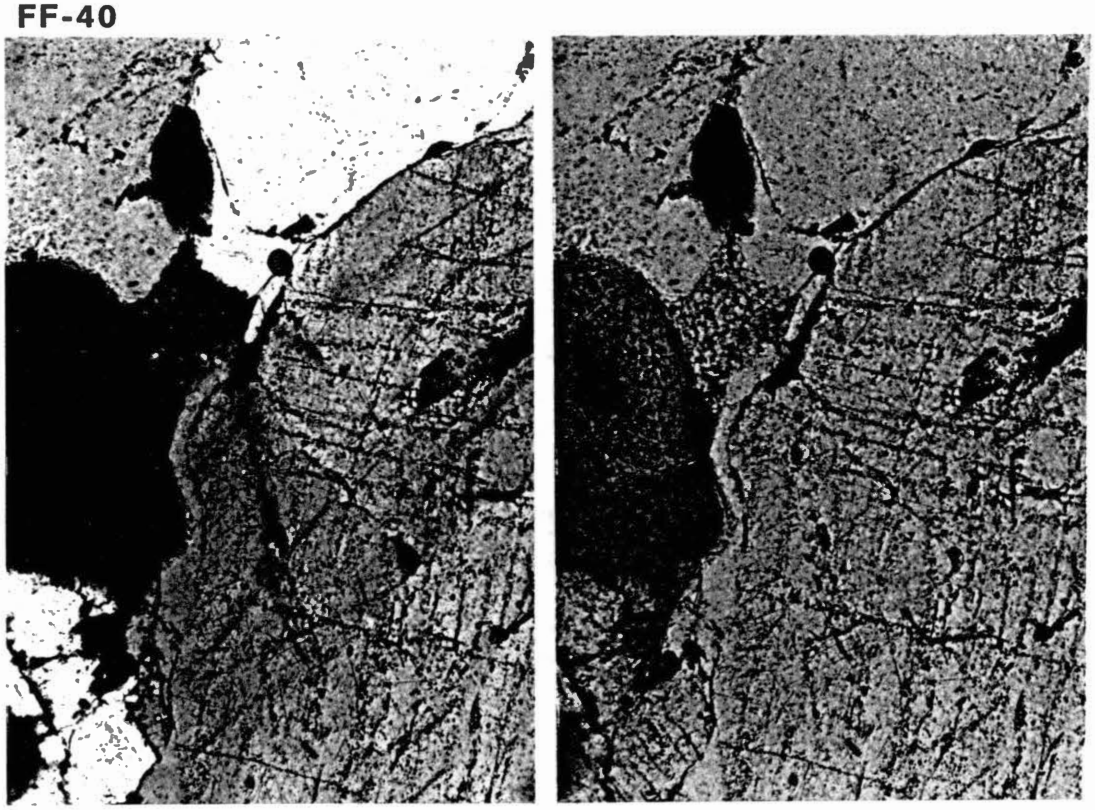
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = 0 % Normalized

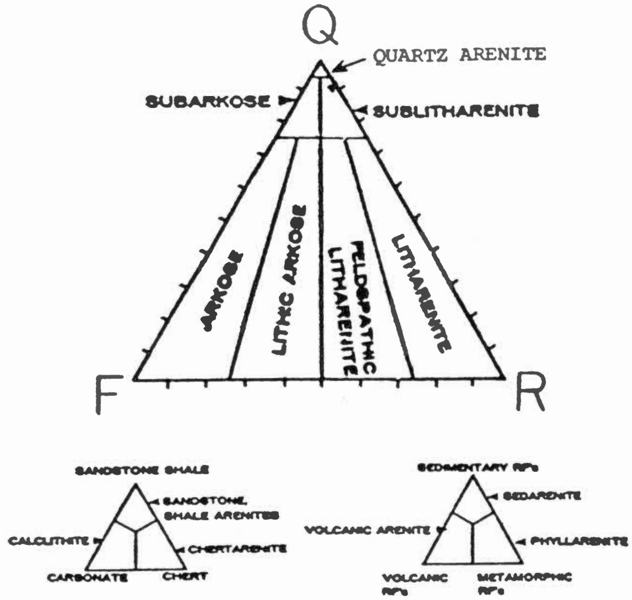
Q =	70.4 %	94.2 %
F =	0.5 %	.7 %
R =	3.8 %	5.1 %
Total	74.7	100 %

FF-40



0.20mm 0.20mm

C N P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 54.9 %	91.8 %
F = ____ %	____ %
R = 4.9 %	8.2 %
Total 59.8	100 %

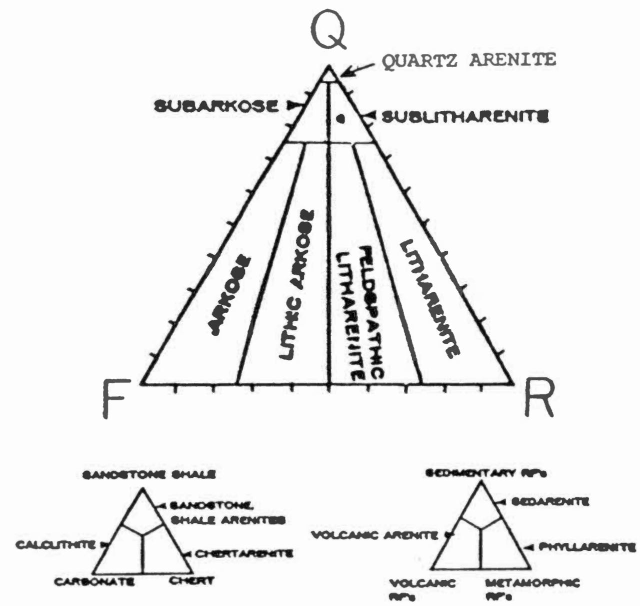
FF-41

0.50mm

C N

0.50mm

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = / %

		Normalized
Q =	58.2 %	83.9 %
F =	3.2 %	4.6 %
R =	8.0 %	11.5 %
Total	69.4	100 %

FF-42

0.50mm

C N

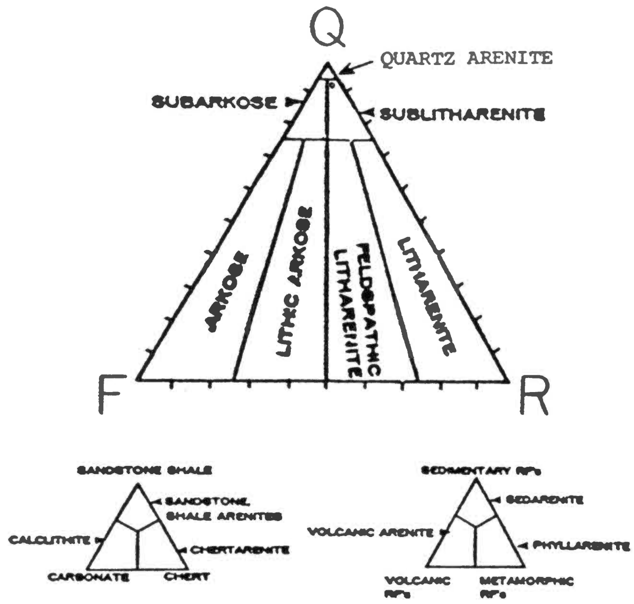
0.50mm

P P

FF-43/6531 ft.: Quartz arenite: Normalized constituents- Quartz, 95.1%; Rock fragments, 2.9% Feldspar, 2.0%: Subrounded, moderately to well sorted, submature to supermature: Constituents- Monocrystalline quartz, 70.0%; Plagioclase feldspar, 1.5%; Chert fragments, 2.1%; Glauconite, 1.5%; Zircon, 0.3%; Phosphate, trace; Quartz cement, 2.6%; Calcite cement, 3.6%; Authigenic clays- Illite, trace; Pyrite 0.3%; Primary porosity, 4.2%; Secondary porosity, 13.9%.

FF-44/6532 ft.: Quartz arenite: Normalized constituents- Quartz, 100%: Subrounded, moderately sorted, submature: Constituents- Monocrystalline quartz, 67.2%; Glauconite, 2.8%; Echinoderm-plate shell fragments, 1.6%; Zircon, 0.5%; Quartz cement, 1.7%; Calcite cement, 13.6%; Authigenic clays- Illite, 0.7%; Chlorite, 1.1%; Pyrite, 0.4%; Organic material 0.3%; Primary porosity, 2.0%; Secondary porosity, 8.1%.

FF-45/6533.5 ft.: Quartz arenite: Normalized constituents- Quartz, 100%: Subangular to subrounded, moderately sorted, submature: Constituents- Monocrystalline quartz, 69.0%; Glauconite, 2.7%; Echinoderm-plate shell fragments, 0.9%; Zircon 0.2%; Phosphate, 1.0%; Quartz cement, 3.7%; Calcite cement, 6.9%; Authigenic clays- Kaolinite, 2.6%; Primary porosity, 5.0%; Secondary porosity, 8.0%.

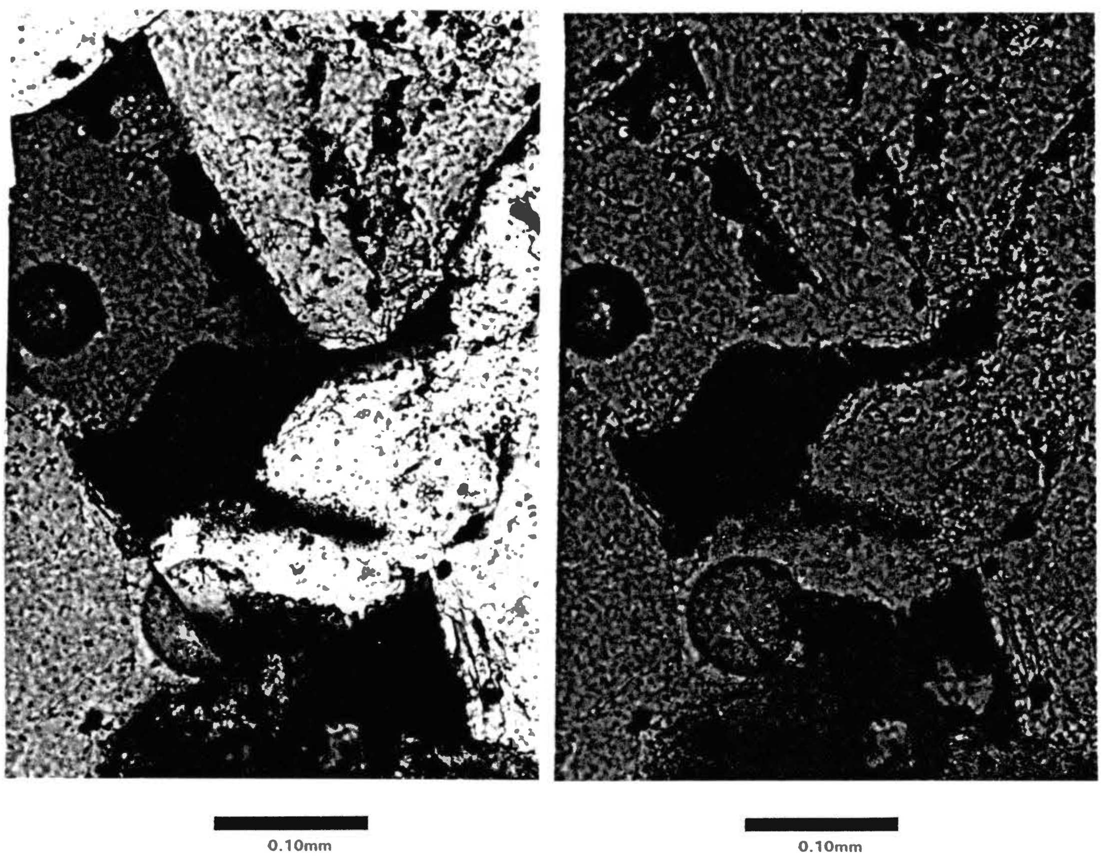


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

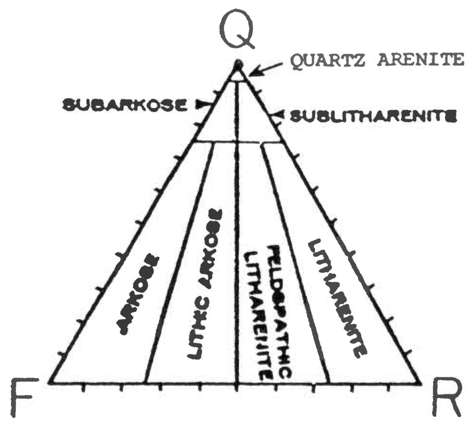
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 70.0 %	95.1 %
F = 1.5 %	2.0 %
R = 2.1 %	2.9 %
Total 73.6	100 %

FF-43



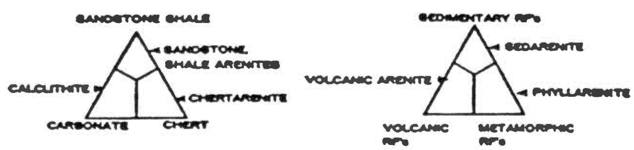
C N P P



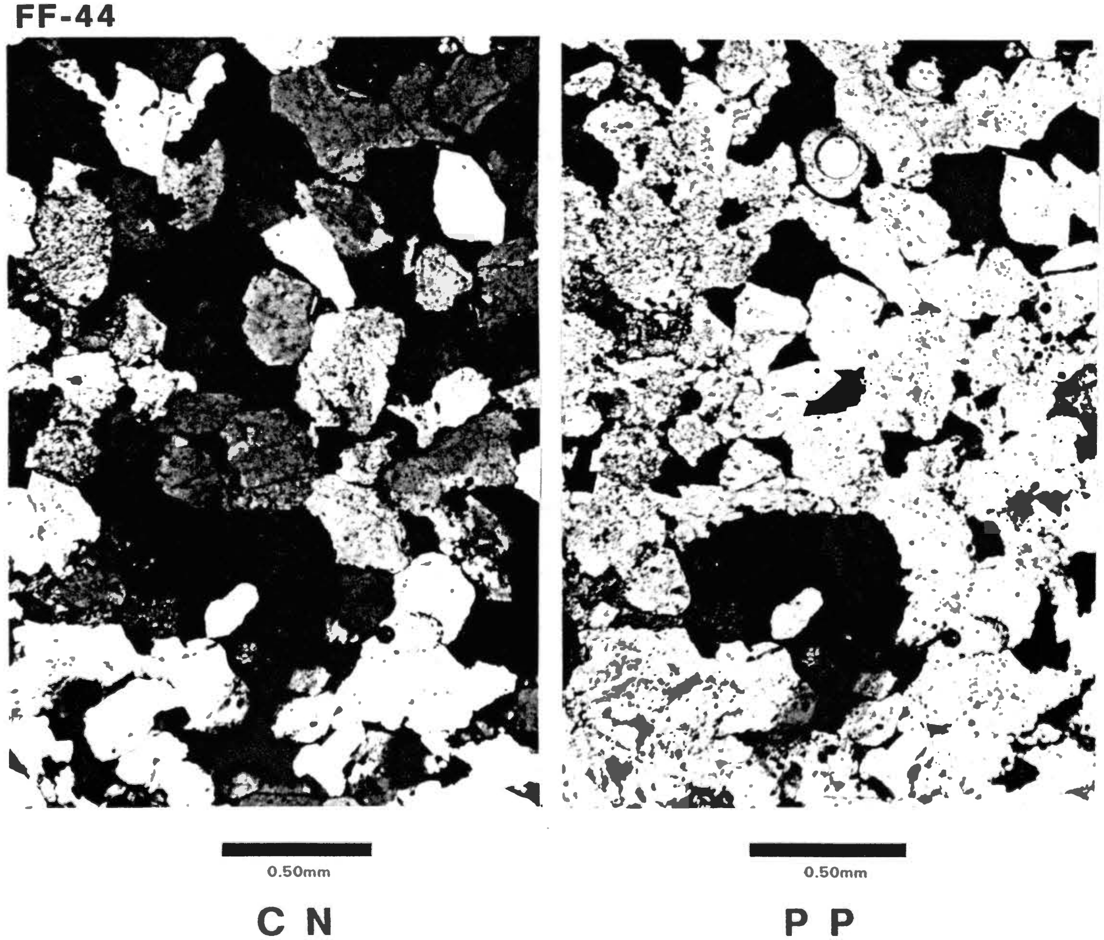
Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

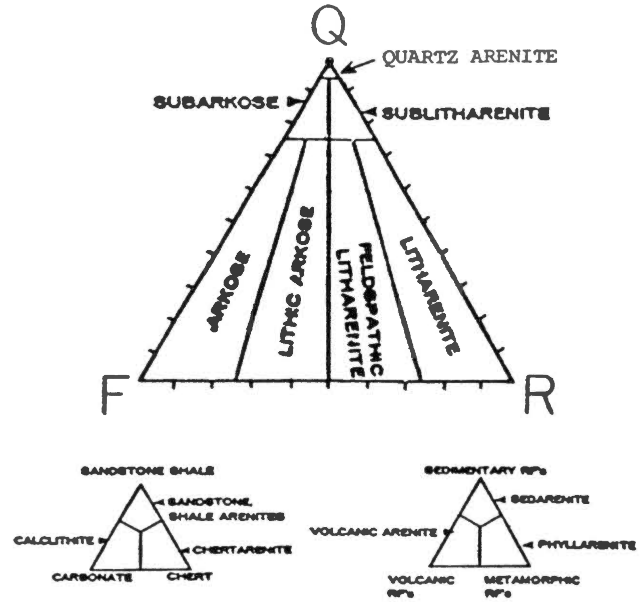
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____%		Normalized
Q =	67.2 %	100 %
F =	____%	____%
R =	____%	____%
Total	____	100 %



FF-44





Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

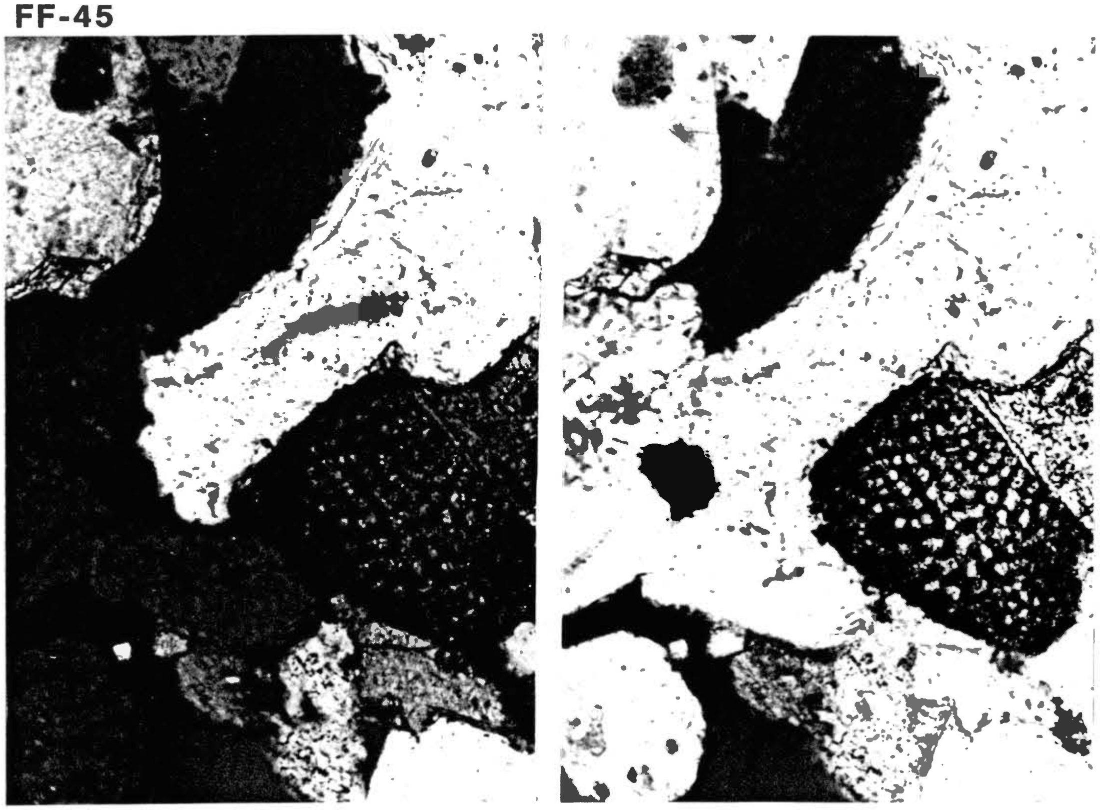
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ % Normalized

Q = 69.0 % 100 %
F = ____ % ____ %
R = ____ % ____ %

Total ____ 100 %

FF-45

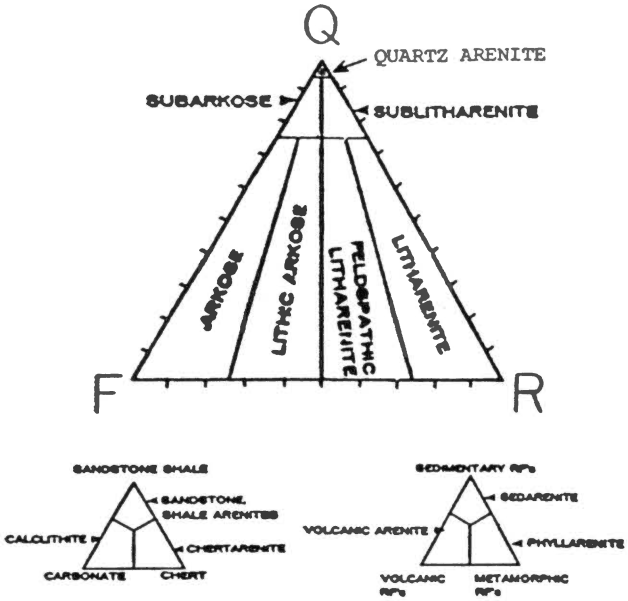


0.20mm 0.20mm

C N **P P**

<u>FF-46/6537.8</u> <u>ft.:</u> Quartz arenite: Normalized constituents- Quartz 96.9%; Rock fragments, 1.3%; Feldspar, 1.8%: Subangular to subrounded, moderately sorted, submature: Constituents- Monocrystalline quartz, 63.0%; Microcline feldspar, 1.2%; Chert fragments, 0.8%; Glauconite, 1.0%; Echinoderm-plate shell fragments, 2.6%; Zircon, 0.1%; Quartz cement, 1.0%; Calcite cement, 23.1%; Authigenic clays- Kaolinite, 2.3%; Illite, 2.5%; Chlorite, 0.8%; Pyrite, 0.2%; Primary porosity, 0.3%; Secondary porosity, 1.1%.

<u>FF-47/6539.8</u> <u>ft.:</u> Quartz arenite: Normalized constituents- Quartz, 95.3%; Rock fragments, 2.3%; Feldspar, 2.4%: Subangular to subrounded, Moderately to well sorted, submature to supermature: Constituents- Monocrystalline quartz, 58.8%; Plagioclase feldspar, 1.5%; Volcanic-rock fragments, 1.4%; Glauconite, 7.3%; Echinoderm-plate shell fragments, 3.6%; Quartz cement, 2.3%; Calcite cement, 16.9%; Authigenic clays- Kaolinite, 2.0%; Illite, 2.1%; Chlorite, 0.5%; Pyrite, 0.4%; Primary porosity, 0.4%; Secondary porosity, 2.8%.

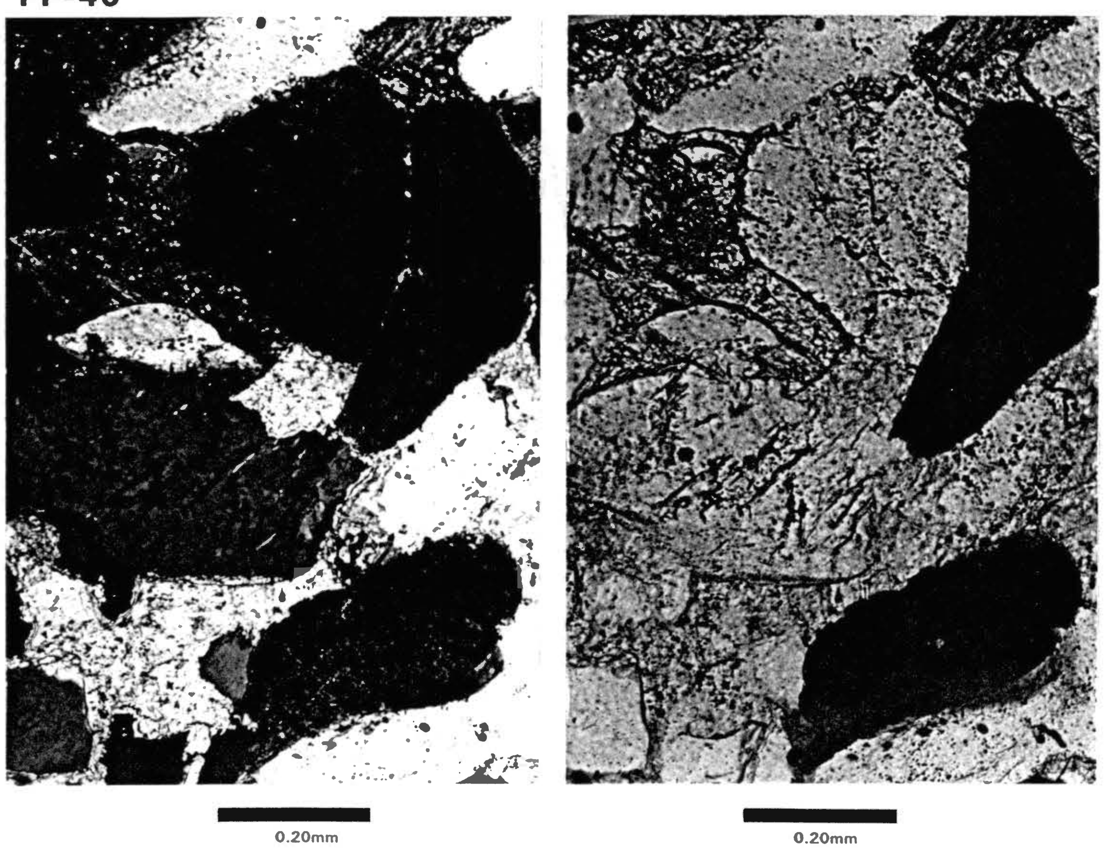


Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

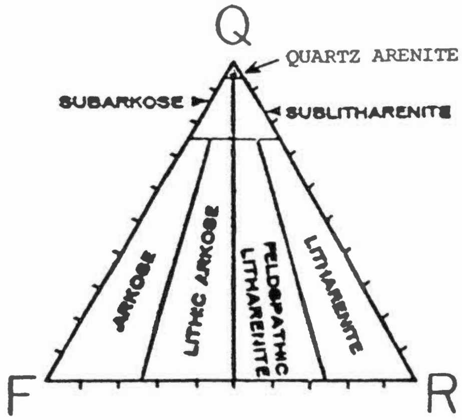
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

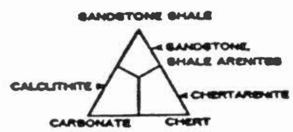
MATRIX = 0 %	Normalized
Q = 63.0 %	96.9 %
F = 1.2 %	1.8 %
R = 0.8 %	1.3 %
Total 65	100 %

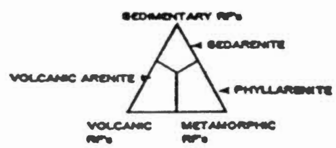
FF-46



C N　　　　P P







Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

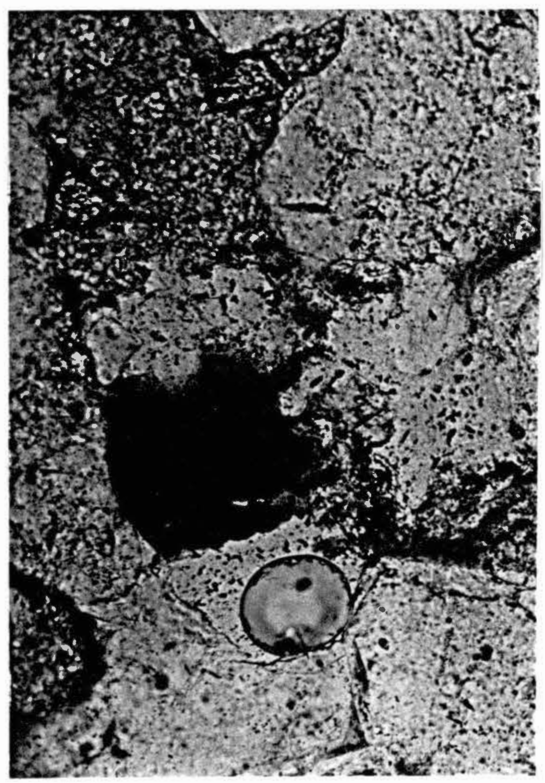
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 58.8 %	95.3 %
F = 1.5 %	2.4 %
R = 1.4 %	2.3 %
Total ____	100 %

FF-47

0.20mm

C N

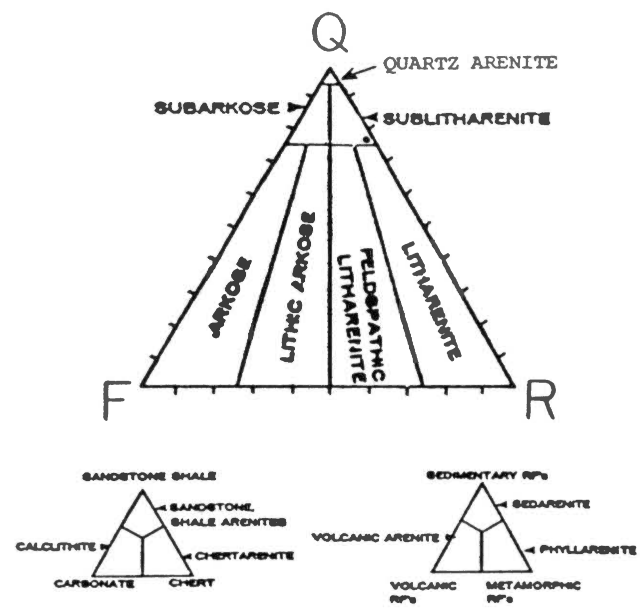


0.20mm

P P

FF-48/6540.8 ft.: Sublitharenite: Normalized constituents- Quartz 75.5%; Rock fragments, 22.3%; Feldspar, 2.2%: Subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 38.5%; Plagioclase feldspar, 1.1%; Chert fragments, 1.4%; Siltstone fragments, 10.0%; Glauconite, 1.5%; Echinoderm-plate shell fragments, 6.4%; Muscovite, 0.5%; Zircon, trace; Quartz cement, 0.3%, Calcite cement, 31.2%; Authigenic clays- Illite, 2.0%; Chlorite, 0.3%; Pyrite, 6.5%; Secondary porosity, 0.3%.

FF-49/6542.3 ft.: Wackestone (Dunham); Biodolomicrite? (Folk): Constituents- Micrite, 13.9%; Fossil fragments replaced by sparry calcite, 45.1%; Dolomite, 39.7%; Pyrite, 1.0%; Porosity, 0.3%.

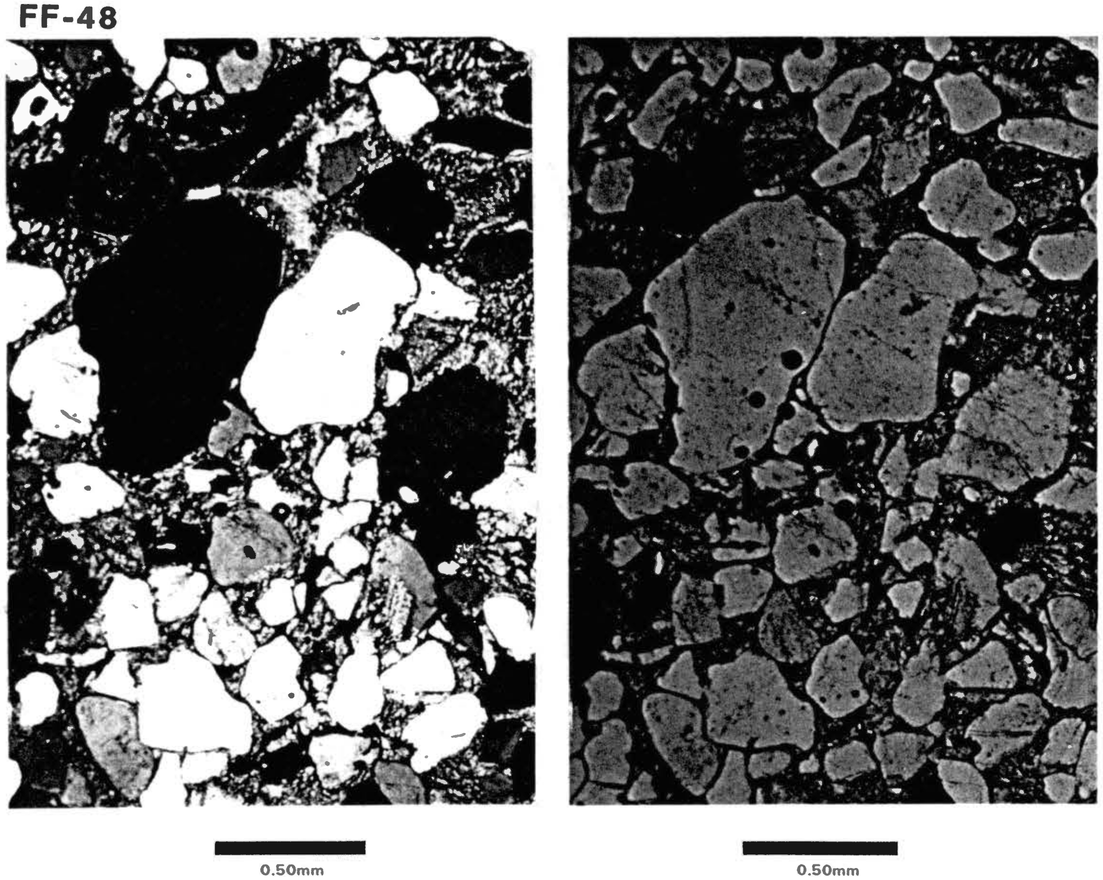


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

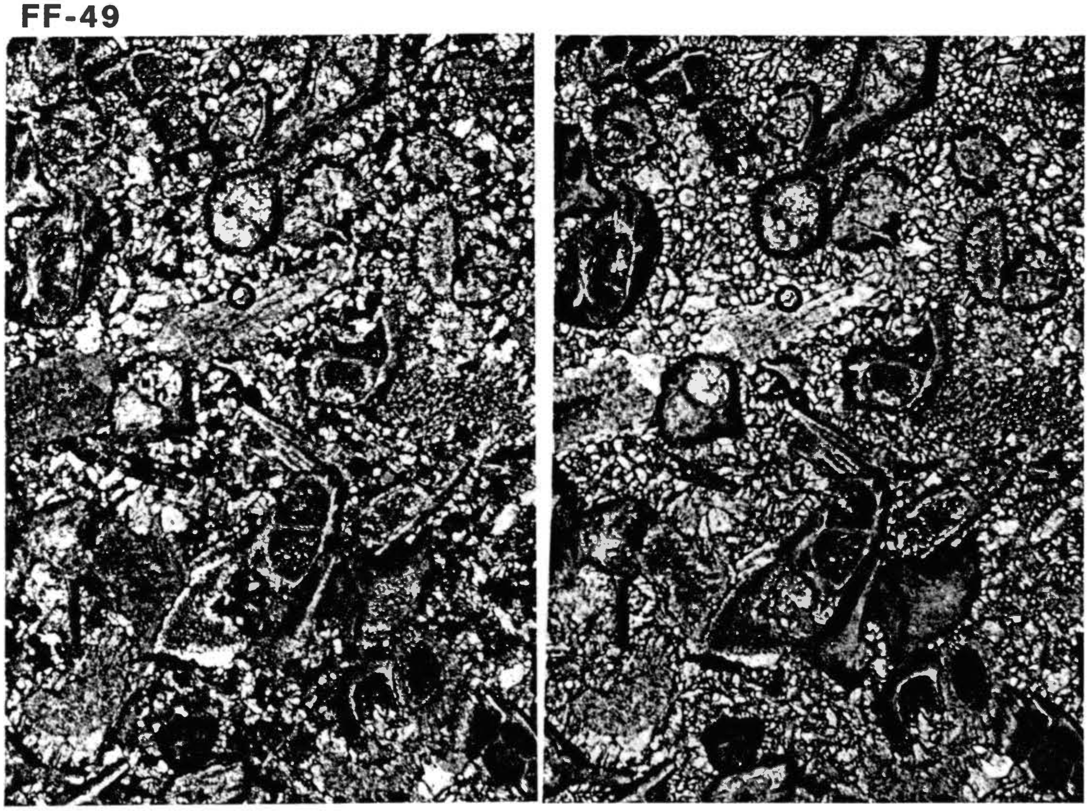
MATRIX = ____ %	Normalized
Q = 38.5 %	75.5 %
F = 1.1 %	2.2 %
R = 11.4 %	22.3 %
Total 51	100 %

FF-48



C N   P P

FF-49



0.50mm | 0.50mm

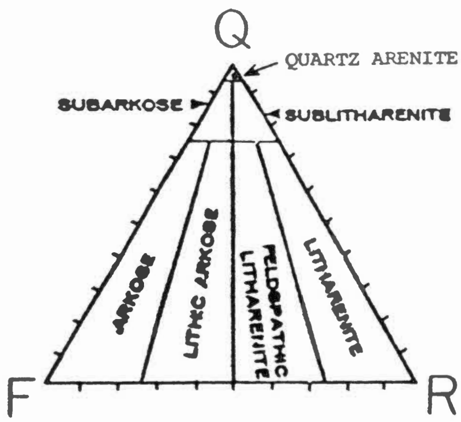
C N | P P

No. 1 C. C. Kelly

KY-50/4715 ft.: Quartz arenite: Normalized constituents- Quartz 97.4%; Rock fragments, 2.6%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 66.8%; Chert fragments, 1.8%; Glauconite, 2.4%; Quartz cement, 2.0%; Dolomite cement, 14.2%; Authigenic clays- Kaolinite, 2.9%; Illite, 1.3%; Chlorite, 0.6%; Pyrite, 0.2%; Primary porosity, 1.0%; Secondary porosity, 6.8%.

KY-51/4716.9 ft.: Quartz arenite: Normalized constituents- Quartz 100%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 56.1%; Glauconite, trace; Shell fragments, 3.6%; Zircon, 0.2%; Phosphate, 0.5%; Quartz cement, 1.0%; Dolomite cement, 27.0%; Authigenic clays- Kaolinite, 6.2%; Illite, 0.3%; Secondary porosity, 5.1%.

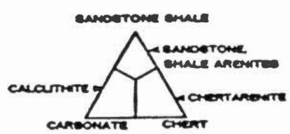
KY-52/4720 ft.: Quartz arenite: Normalized constituents- Quartz, 100%: Subangular to subrounded, very poorly to poorly sorted, submature: Constituents- Monocrystalline quartz 62.0%; Glauconite, trace; Echinoderm-plate shell fragments, 5.5%; Bryozoan shell fragments, trace; Muscovite, 0.4%; Zircon 0.1%; Quartz cement, 1.4%; Dolomite cement, 17.8%; Authigenic clays- Kaolinite, 8.4%; Illite, 1.2%; Secondary porosity, 3.2%.

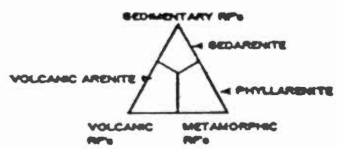


Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

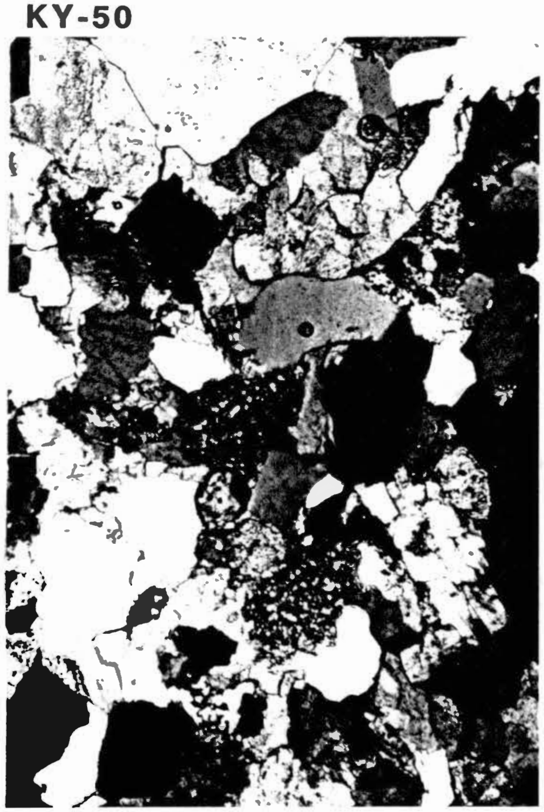
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

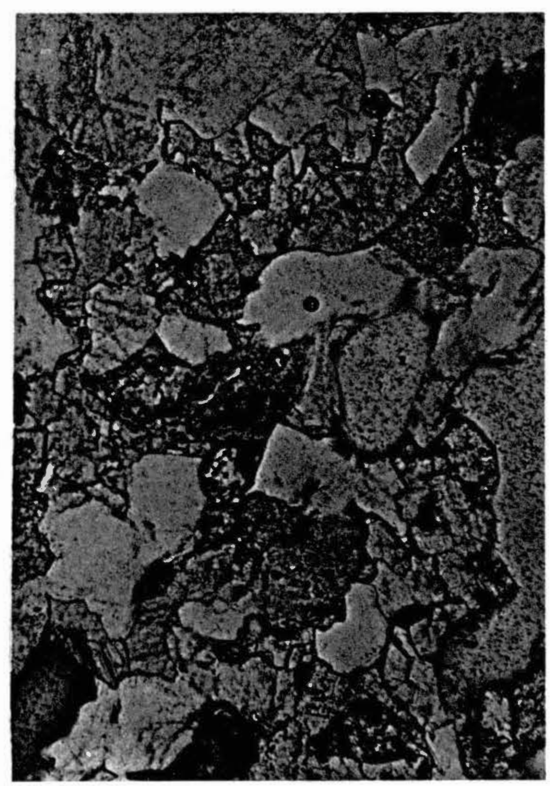
MATRIX = ____%	Normalized
Q = 66.8 %	97.4 %
F = ____ %	____ %
R = 1.8 %	2.6 %
Total ____	100 %





KY-50



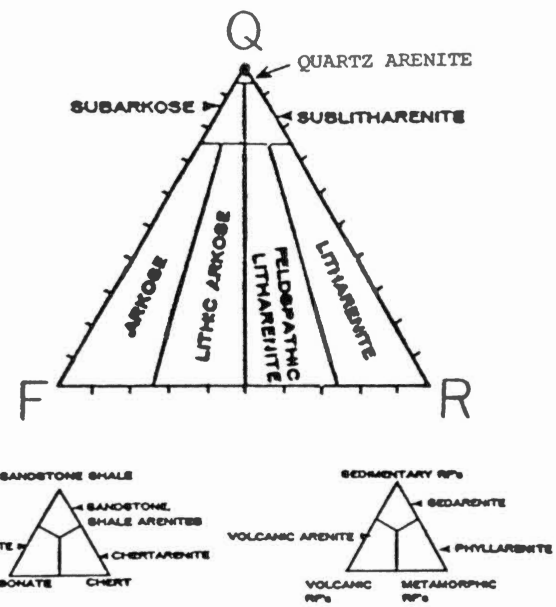


0.50mm

0.50mm

C N

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____% Normalized

Q =	56.1 %	100 %
F =	____ %	____ %
R =	____ %	____ %
Total	____	100 %

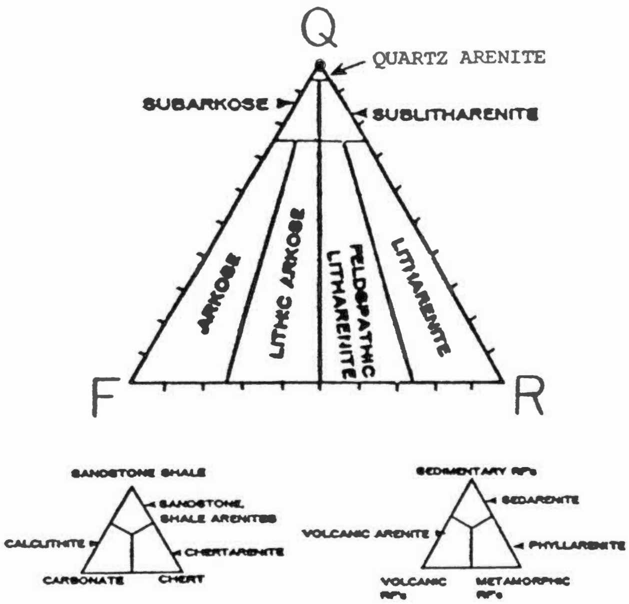
KY-51

0.50mm

C N

0.50mm

P P



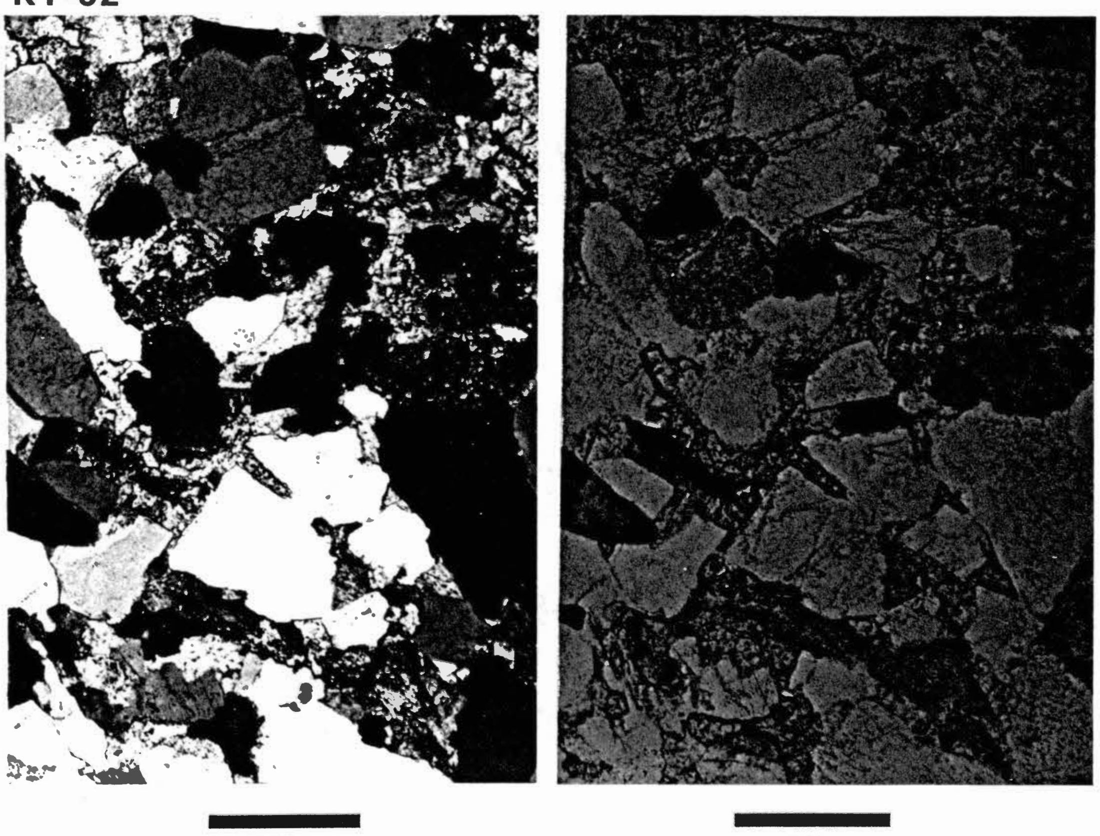
Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = _____% Normalized

Q =	62.0 %	100 %
F =	____%	____%
R =	____%	____%
Total	_____	100 %

KY-52

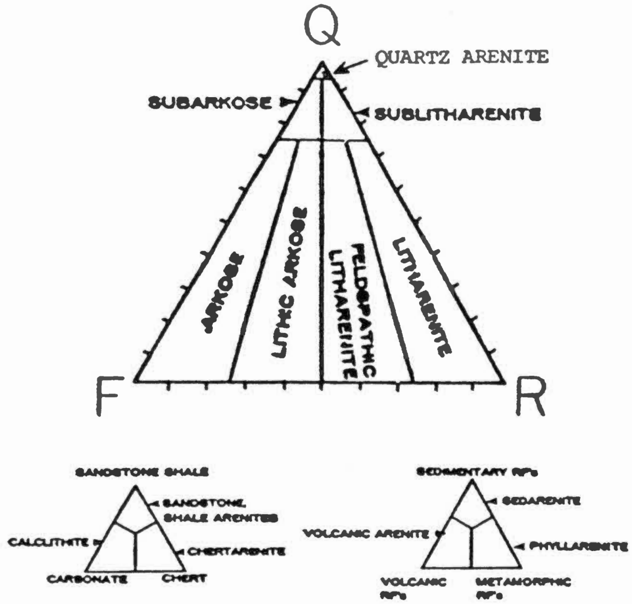


C N   P P

KY-53/4722.3 ft.: Quartz arenite: Normalized constituents- Quartz, 95.4%; Rock fragments, 3.9%; Feldspar, 0.7%: Subangular to subrounded, poorly sorted, submature: Constituents- Monocrystalline quartz, 39.2%; Plagioclase feldspar, 0.3%; Chert fragments, 1.6%; Glauconite, 10.1%; Echinoderm-plate shell fragments, trace; Phosphate, 9.2%; Calcite cement, 25.9%; Dolomite cement, 11.7%; Pyrite, 2.0%.

KY-54/4723 ft.: Phyllarenite: Normalized constituents- Quartz, 68.5%; Rock fragments, 27.0%; Feldspar, 4.5%: Subrounded to subangular, very poorly to poorly sorted, submature: Constituents- Monocrystalline quartz, 50.7%; Plagioclase feldspar, 3.3%; Siltstone fragments, 10.0%; Metamorphic-rock fragments, 10.0%; Echinoderm-plate shell fragments, trace; Phosphate, 0.8%; Calcite cement, 16.7%; Dolomite cement, 7.6%; Pyrite, 0.9%.

KY-55/4724.8 ft.: Quartz arenite: Normalized constituents- Quartz 100%: Subrounded to subangular, poorly sorted, submature: Constituents- Monocrystalline quartz, 59.7%; Echinoderm-plate shell fragments, 3.6%; Phosphate, trace; Dolomite cement, 25.8%; Authigenic clays- Kaolinite, 6.3%; Chlorite, 0.4%; Pyrite, 0.4%; Secondary porosity, 3.8%.

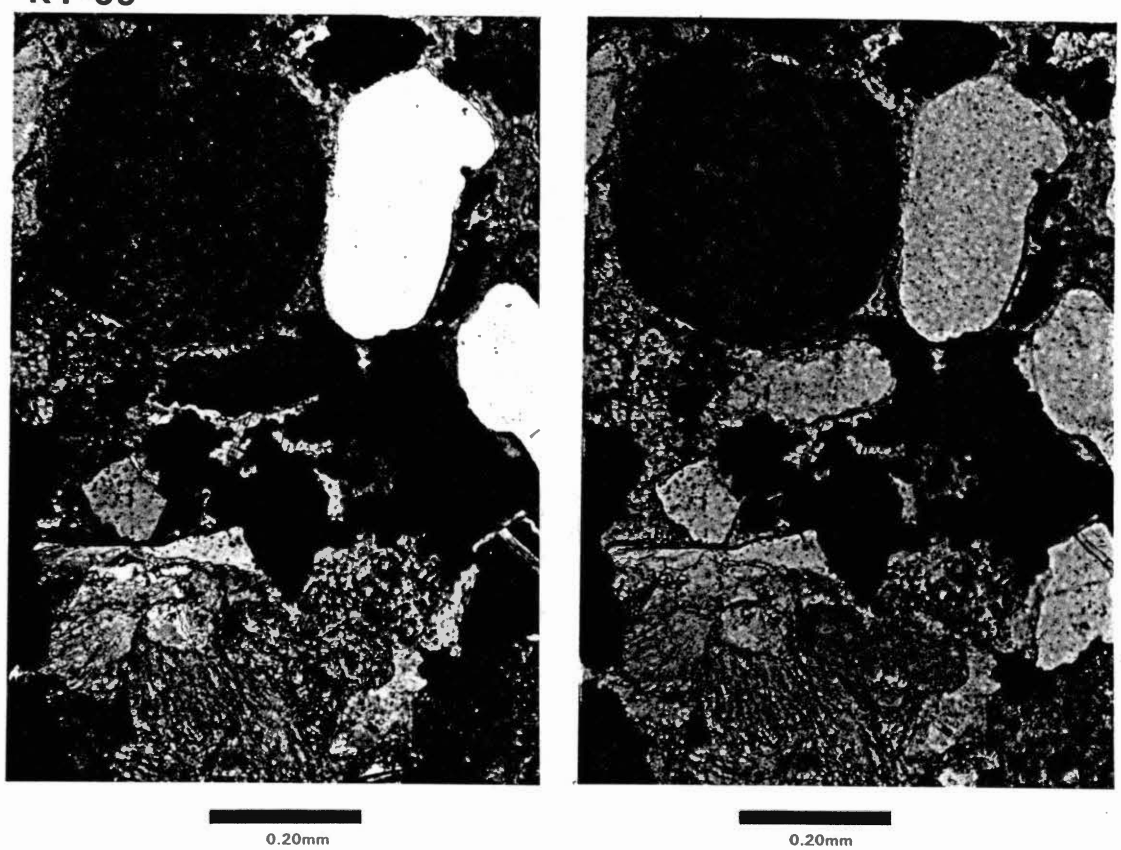


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

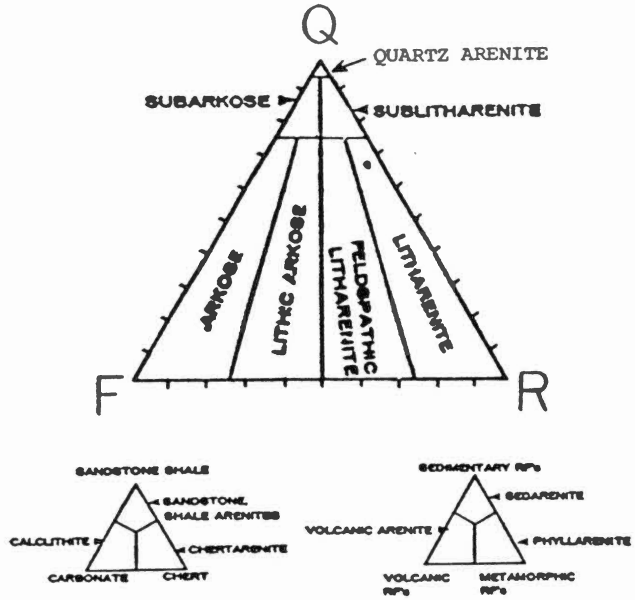
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 39.2 %	95.4 %
F = .3 %	.7 %
R = 1.6 %	3.9 %
Total 41.1	100 %

KY-53



C N **P P**

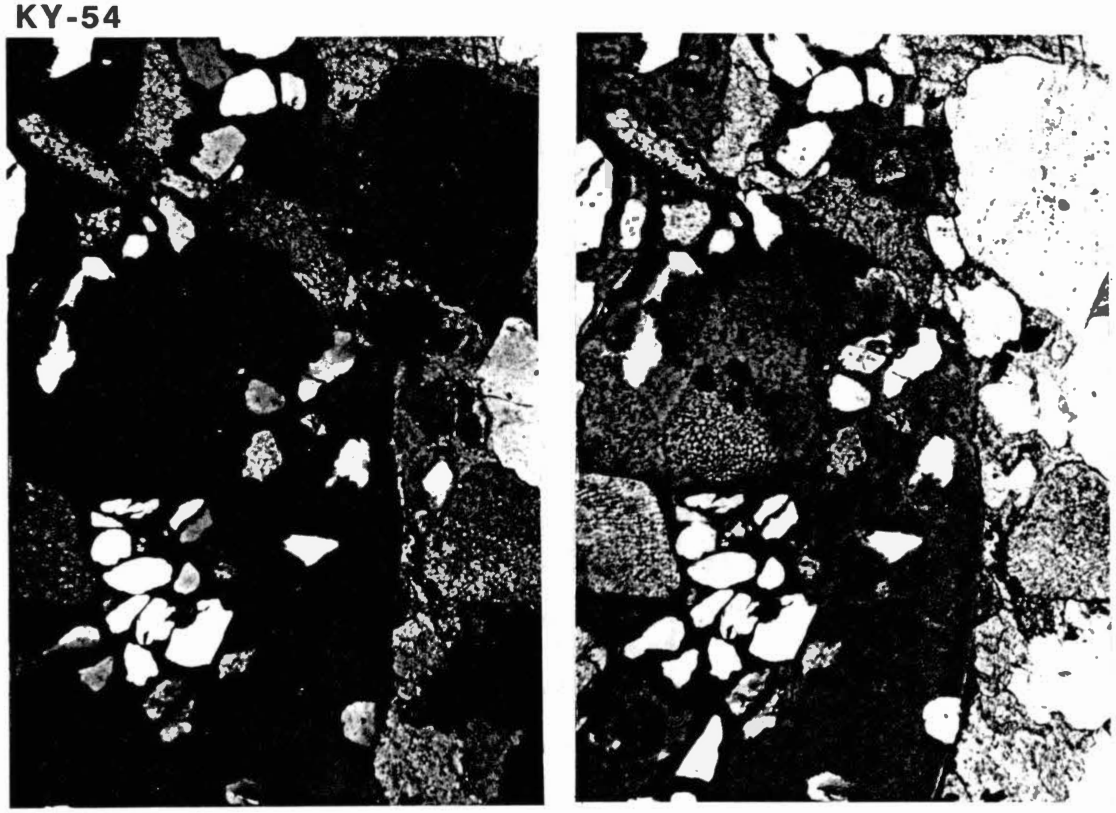


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 50.7 %	68.5 %
F = 3.3 %	4.5 %
R = 20.0 %	27.0 %
Total ____	100 %

KY-54

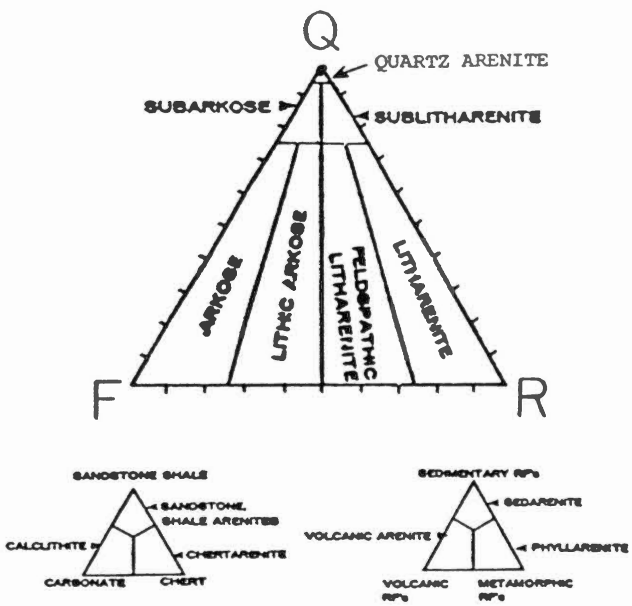


0.20mm

C N

0.20mm

P P

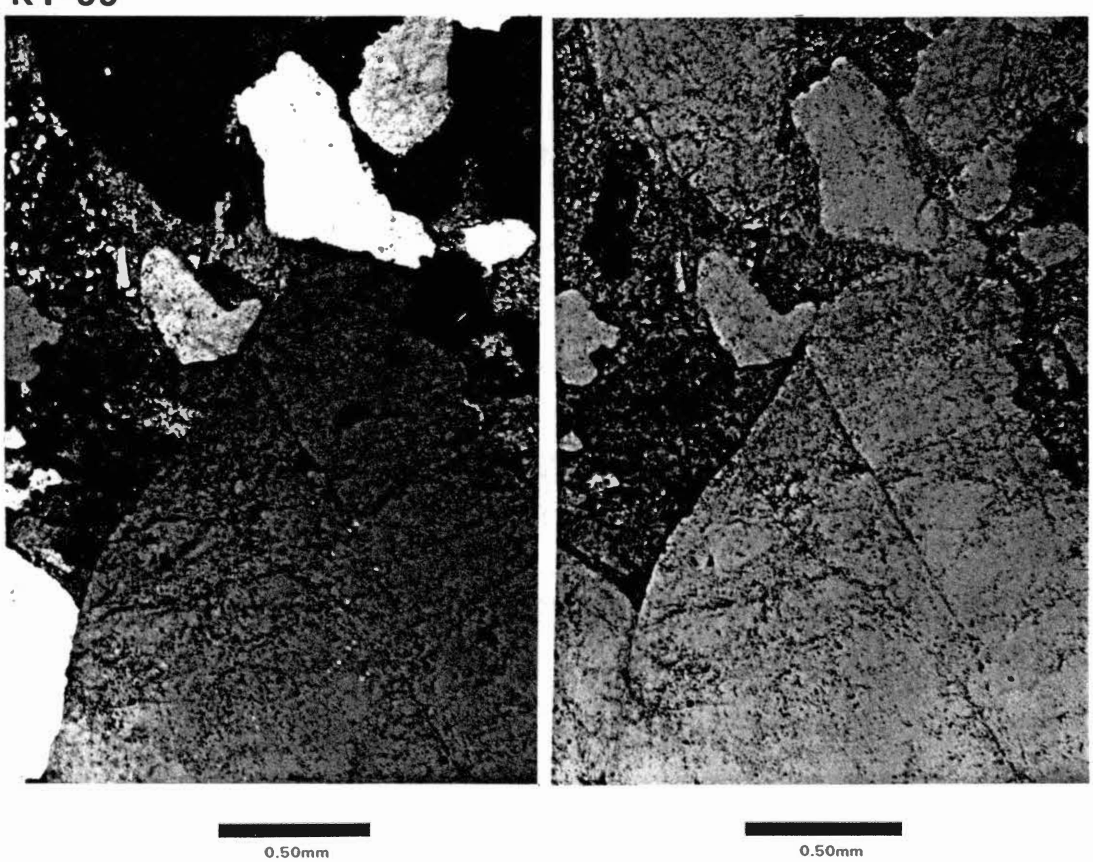


Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

		Normalized
MATRIX =	____%	
Q =	59.7 %	100 %
F =	____%	____%
R =	____%	____%
Total	59.7	100 %

KY-55

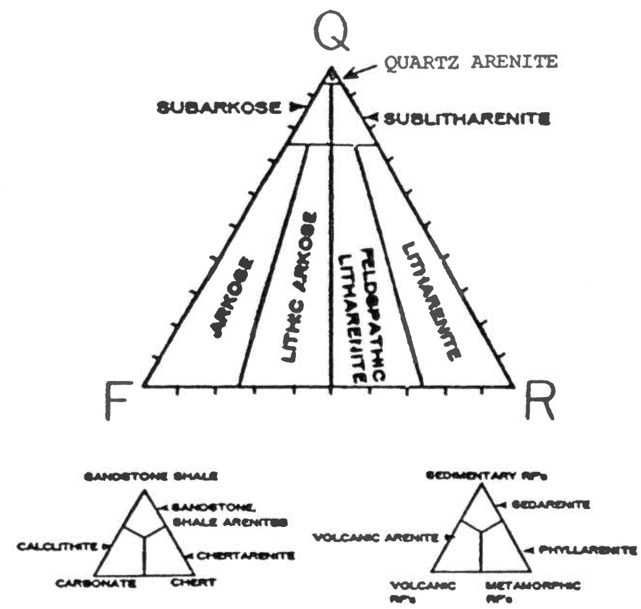


C N **P P**

<u>KY-56/4727.4</u> <u>ft.:</u> Quartz arenite: Normalized constituents- Quartz 97.5%; Rock fragments, 2.5%: Subangular, poorly to moderately sorted, submature: Constituents- Monocrystalline quartz, 75.4%; Chert fragments, 1.9%; Echinoderm-plate shell fragments, 2.8%; Phosphate, trace; Quartz cement, 0.4%; Dolomite cement, 15.3%; Authigenic clays- Kaolinite, 3.2%; Primary porosity, 0.2%; Secondary porosity, 0.8%.

<u>KY-57/4730</u> <u>ft.:</u> Quartz arenite: Normalized constituents- Quartz, 100%: Subangular to subrounded, very poorly to poorly sorted, submature: Constituents- Monocrystalline quartz 70.5%; Chert fragments, trace; Quartz cement, 1.2%; Dolomite cement 23.4%; Authigenic clays- Kaolinite, 2.2%; Primary porosity, 0.7%; Secondary porosity, 2.0%.

<u>KY-58/4734.9</u> <u>ft.:</u> Quartz arenite: Normalized constituents- Quartz, 97.8%; Rock fragments; 2.2%: Subangular, poorly to very poorly sorted, submature: Constituents- Monocrystalline quartz, 62.2%; Chert fragments, 1.4%; Zircon 0.2%; Phosphate 10.0%; Quartz cement, 2.0%; Dolomite cement, 5.2%; Authigenic clays- Kaolinite, 9.1%; Illite 3.5%; Pyrite, trace; Black shale with trace of pyrite, 5.5%; Primary porosity, 0.2%; Secondary porosity, 0.7%.

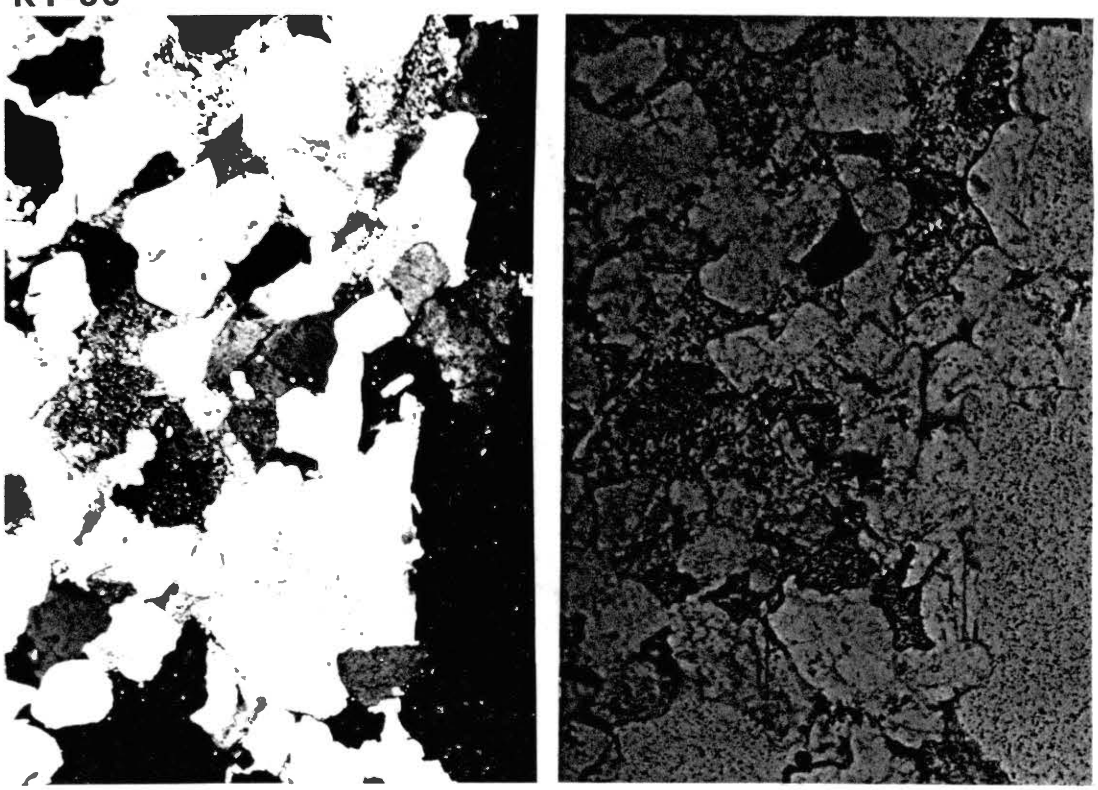


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

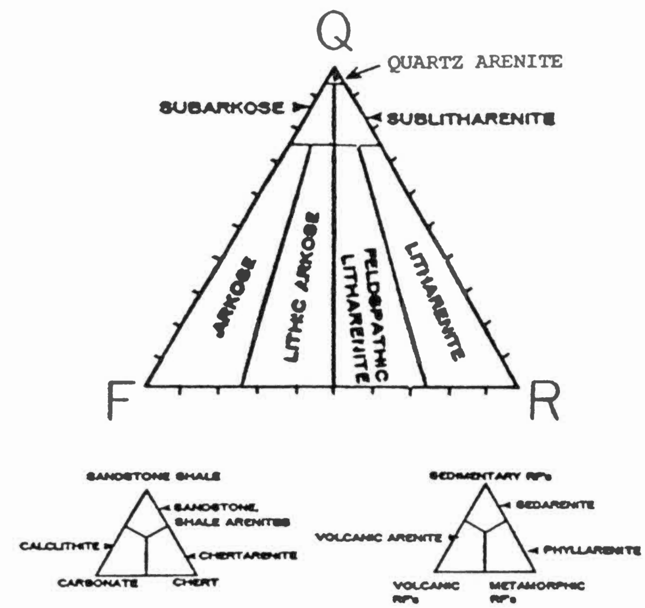
MATRIX = ____ %	Normalized
Q = 75.4 %	97.5 %
F = ____ %	____ %
R = 1.9 %	2.5 %
Total ____	100 %

KY-56



0.50mm 0.50mm

C N P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____%	Normalized
Q = 70.5 %	100 %
F = ____%	____%
R = ____%	____%
Total 70.5	100 %

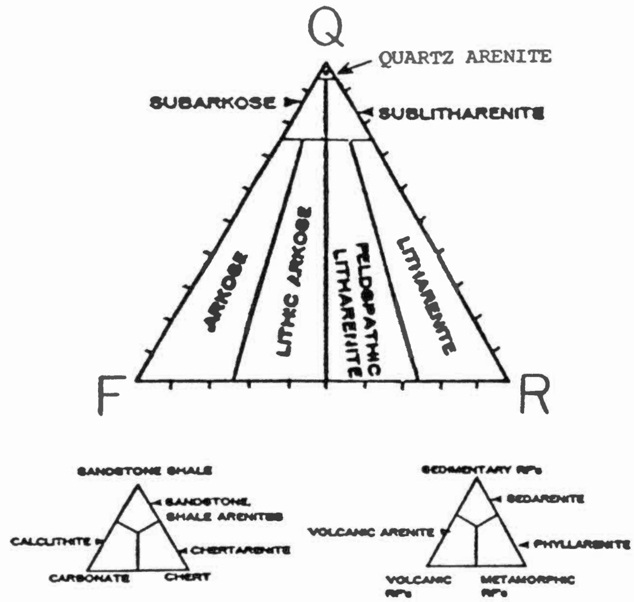
KY-57

0.50mm

C N

0.50mm

P P



Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = - %	Normalized
Q = 62.2 %	97.8 %
F = ___ %	___ %
R = 1.4 %	2.2 %
Total 63.6	100 %

KY-58

0.20mm

C N

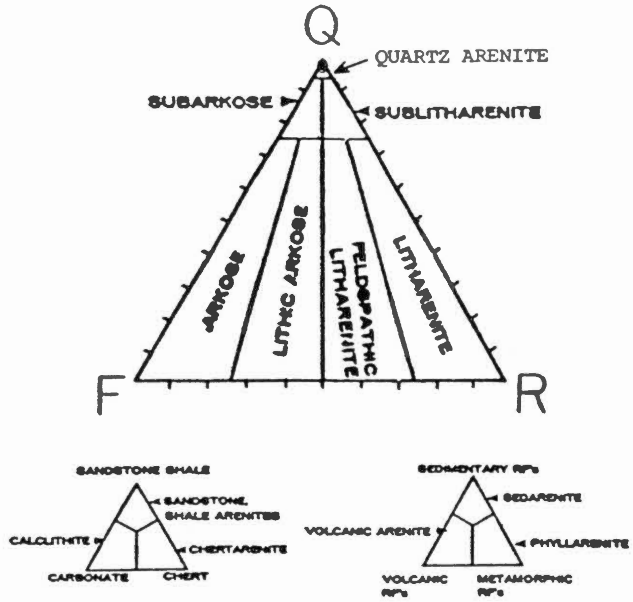
0.20mm

P P

KY-59/4735.9 ft.: Quartz arenite: Normalized constituents- Quartz, 100%: Subangular to subrounded, moderately sorted to well sorted, submature to supermature: Constituents- Monocrystalline quartz, 64.3%; Glauconite, 1.6%; Zircon, 0.3%; Phosphate, 7.2%; Quartz cement, 1.0%; Hematite, 16.1%; Authigenic clays- Kaolinite, 6.0%; Illite, 1.3%; Pyrite, 1.1%; Primary porosity, 0.4%; Secondary porosity, 0.7%.

KY-60/4738.2 ft.: Quartz arenite: Normalized constituents- Quartz 100%: Subangular to subrounded, moderately to poorly sorted, submature: Constituents- Monocrystalline quartz, 64.6%; Echinoderm-plate shell fragments, 5.1%; Dolomite cement, 22.5%; Authigenic clays- 3.6%; Primary porosity, 0.4%; Secondary porosity, 3.8%.

KY-61/4739.8 ft.: Quartz arenite: Normalized constituents- Quartz, 95.8%; Rock fragments, 4.2%: Subrounded, moderately sorted to poorly sorted, submature: Constituents- Monocrystalline quartz, 72.4%; Chert fragments, 3.2%; Zircon, 1.0%; Phosphate, 1.6%; Quartz cement, 0.6%; Dolomite cement, 12.6%; Authigenic clays- Kaolinite, 0.9%; Primary porosity, trace; Secondary porosity, 7.7%.

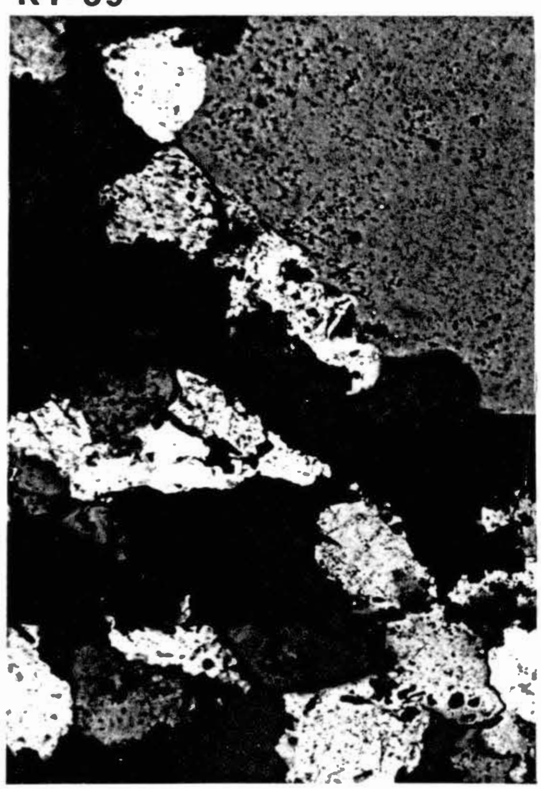


Q = Mono- and Poly-Crystalline Quartz
F = All Feldspars
R = All Rock Fragments: Chert, Granite, Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

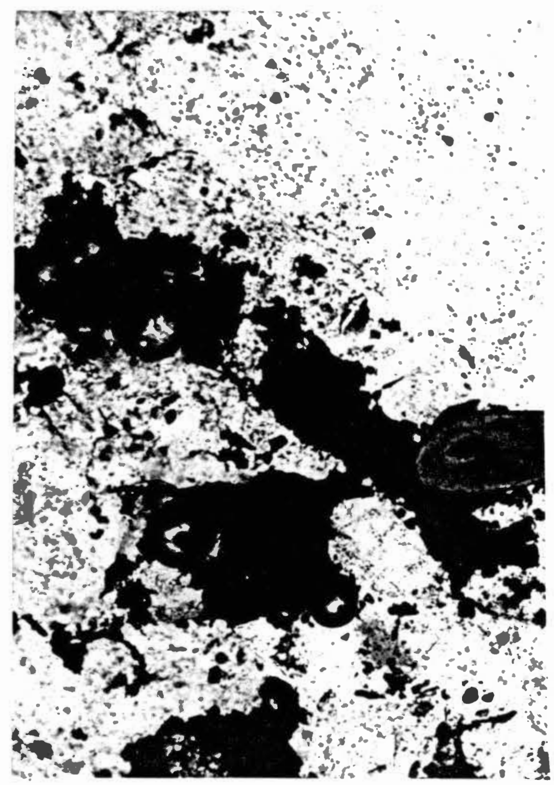
MATRIX = ____%	Normalized
Q = 64.3 %	100 %
F = ____%	____%
R = ____%	____%
Total 64.3	100 %

KY-59



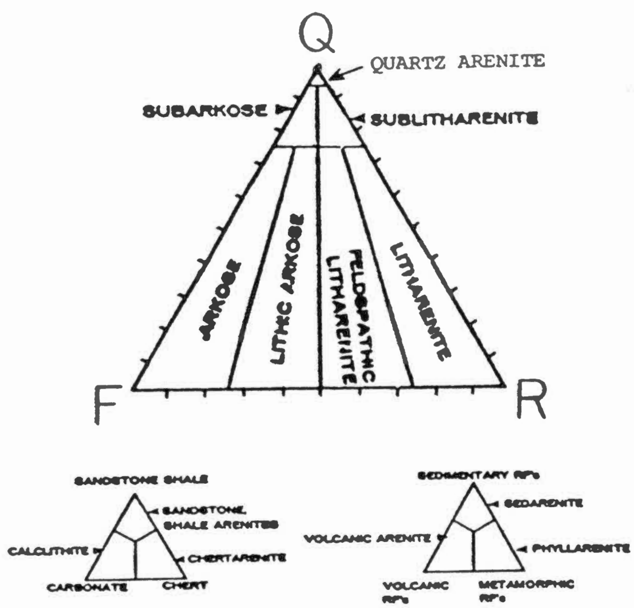
0.20mm

C N



0.20mm

P P

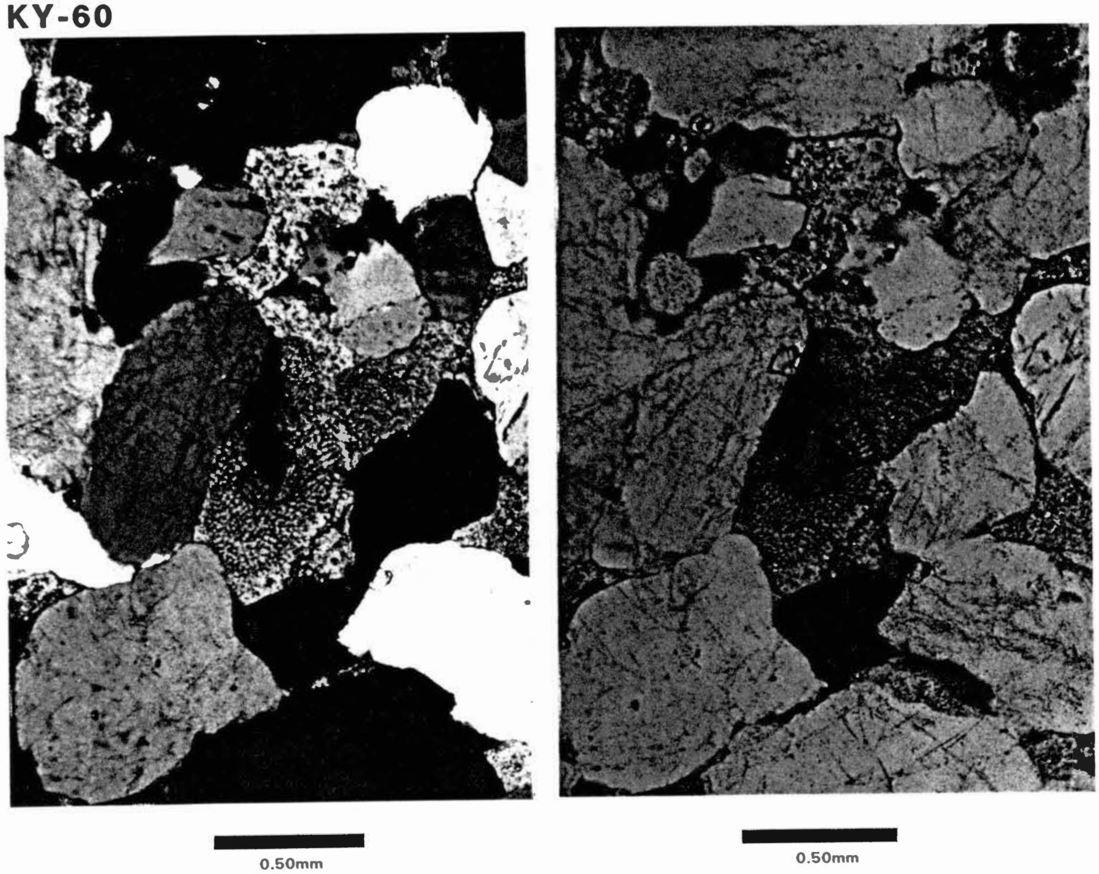


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

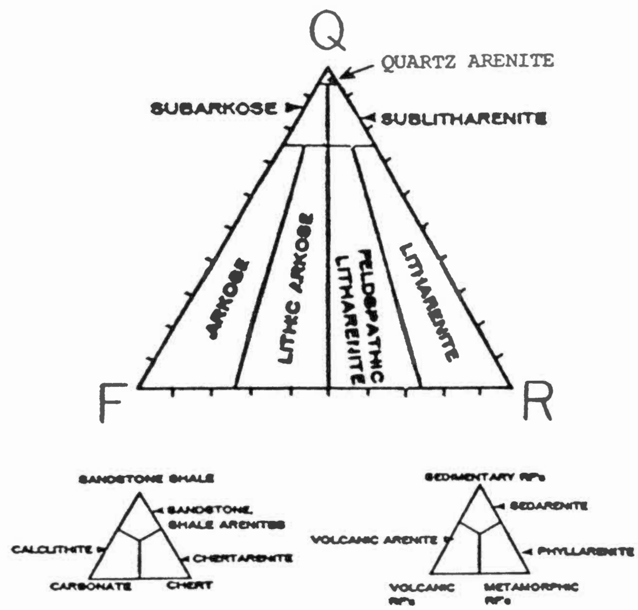
Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____%	Normalized
Q = 64.6 %	100 %
F = ____%	____%
R = 64.6 %	____%
Total____	100 %

KY-60



C N **P P**

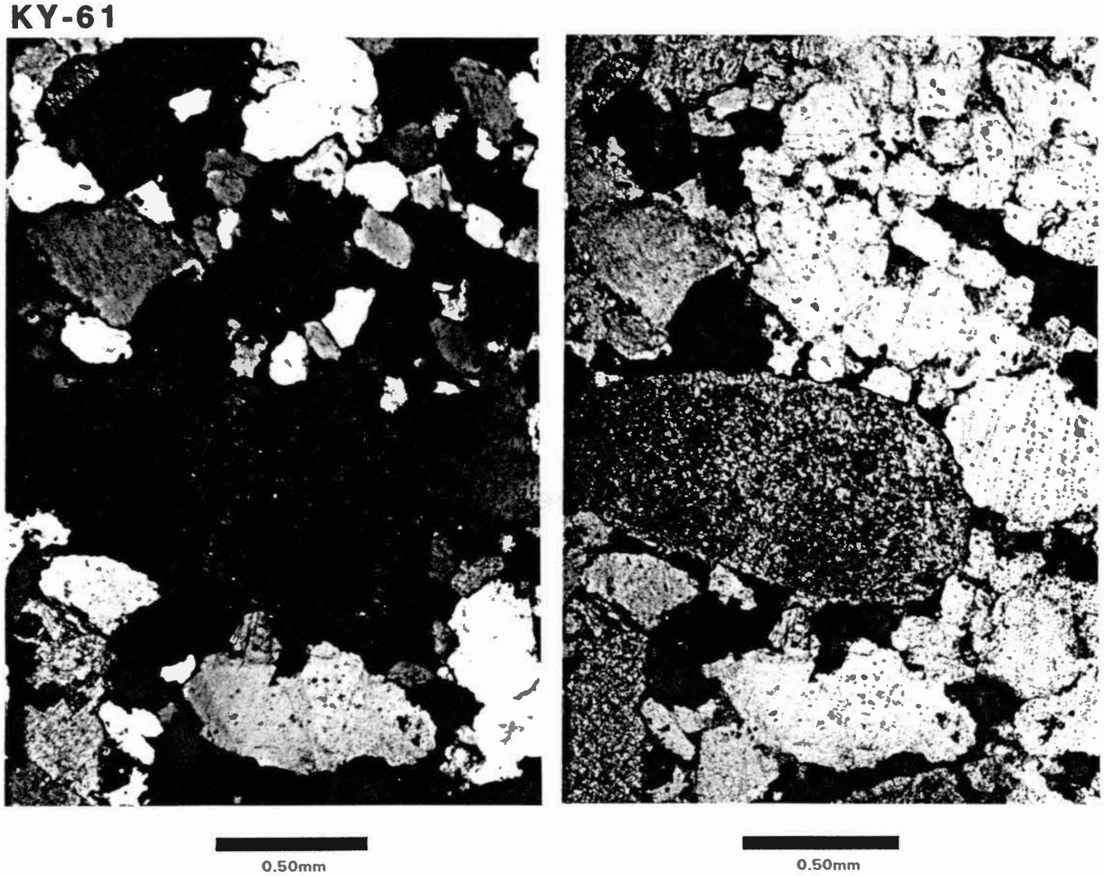


Q = Mono- and Poly-
Crystalline Quartz
F = All Feldspars
R = All Rock Fragments:
Chert, Granite,
Gneiss, Carbonate,

Arenite: 1-10% Clay Matrix
Wacke: 10-75% Clay Matrix
Mudrock: 75+% Clay Matrix

MATRIX = ____ %	Normalized
Q = 72.4 %	95.8 %
F = ____ %	____ %
R = 3.2 %	4.2 %
Total 75.6	100 %

KY-61



C N　　　　P P

APPENDIX C

THIN SECTION DATA SHEETS

These sheets are included for the reader who desires an accounting of the thin-section analysis. These sheets are included in rough form.

Company/Well Name: Cities Service Stonebraker 'AN' NO. 4
Location:
Sample/Depth: CT 4-1 / 6226
Sample Source: Core
Formation/Age: Morrow / Pennsylvanian
Petrographer: Larry Gerken

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline				
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	Trace		.3 mm	4 small chert pebbles in sample - None crossed in point counts - Trace is that it was w/in ocular view during point count.
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1. Bryozoans	0.7		.4	
2. Brachiopods	15.5		.2 - 4.5 mm	width is small - some are fairly complete -
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)	-66.9			

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	5.2		.25mm	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	11.7			
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Pyrite Rich Fossiliferous Mudstone

b. Q:________ R:________ F:________

VI. **TEXTURE**

a. Sphericity -

b. Sorting -

c. Maturity -

d.

VII. **DESCRIPTION**

SAMPLE: ST 4-1

Clay	Fossil frag (Calcite)	Pyrite	Calcite Cement	Chert
10	36	54		
	5	47	48	
64	26	10		Tr
94	6			
58	36	6		
100				Tr
93	7 Bry			
96	4			
54	42		4	
100				
669	162	117	52	

Can't use Folk. This is a fossiliferous mudstone (Dott, '64)

		NORM.
MATRIX:	66.9 %	
Q:	– %	%
F:	– %	%
R:	– %	%
	– %	100 %

Company/Well Name: Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-2/ 6239
Sample Source: Core
Formation/Age: Morrow / Pennsylvanian
Petrographer: Gerken

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	15.7		.05-.1	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	.6		.05-.1	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.7		.05-.1	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	3.3		.1-.2	
d. Biotite				
e. Hematite ✓	.8		.1-.2	
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix	70.6		—	
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sublithwacke

b. Q: 87.2 R: 9.4 F: 3.4

VI. **TEXTURE**

a. Sphericity - Subrounded

b. Sorting - Moderately Sorted

c. Maturity - Immature

d.

VII. **DESCRIPTION**

SAMPLE: ST4-2

Clay	Muscovite	Qtz	Chert	Pyrite	Weathered F-Spar	Hematite ?
52	5	43				
79	7	14				
74	7	16	3			
69	3	26		2		
74	—	17	9			
35				65		
68	8	18			6	
92						8
94	2			4		
69	1	23	5	2		
706	33	157	17	73	6	8

Particles Qtz, Muscovite are ≈ .05-.1

			NORM.
	MATRIX:	70.6 %	
	Q:	15.7 %	87.2 %
18	F:	.6 %	3.4 %
	R:	1.7 %	9.4 %
		88.6 %	100 %

Company/Well Name: - Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-3 / 6241
Sample Source: Core
Formation/Age: Morrow / Penn
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	36.7		.05-.2	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	2.8		.1-.2	
(Total)				
3. Rock Fragments				
a. Shale ✓	1.2		.05-	
b. Chert ✓	3.9		.05-.15	
c. Carbonate ✓	1.4		.05-.20	
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	5.0		.01-.3	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	38.4		—	
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓				
1. Calcite ✓	3.1		.06 - .20	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	3.8		.05 -.30	
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	.7		.05 - .1	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary ✓	.5			Intergranular
b. Secondary ✓	2.5			Dissolved grains and/or clay micro Ø
c. Fracture				
(Total)	3.0			

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Sublithwacke
- b. Q: 82.2 R: 6.3 F: 11.5

VI. **TEXTURE**
- a. Sphericity - SubAngular to angular
- b. Sorting - Poorly Sorted
- c. Maturity - Immature
- d.

VII. **DESCRIPTION**

SAMPLE: ST4-3

Clay	Kaolin.	Qtz	Ø	Pyrite	Musco.	grain Calcite	F.Spar Plag	Calcite Cement	Clay RF	Chert					
45	7	27	9	2						10					
32	3	43	6	2	10					4					
34	4	39	4	-		14				5					
27	8	45	2	-	4		14								
10	8	77	-		5										
48		8	4		2			18		20					
37	8	18	2	3	10		14	8							
55		25	3		12			5							
19		66	-		3				12						
77		19			4										
384	38	367	30	7	50	14	28	31	12	39					

(46%)

		NORM.
MATRIX:	38.4 %	
Q:	36.7 %	82.2 %
44.6 F:	2.8 %	6.3 %
R:	5.1 %	11.5 %
	83 %	100 %

Company/Well Name: Cities Service / Stonebraker 'AN' No 4
Location:
Sample/Depth: ST4-4/6262.9' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	40.2		.03-.65	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	Trace		.1	during one point count a microcline grain was off to the side
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	3.1		.08-.25	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	9.1		.04-.25	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	7.4		.05-.5	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	36.0			
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered ✓	2.6		.05-.15	
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary ✓	1.6		.07-.15	grain dissolution
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
a. Name Sublith wacke
b. Q: 76.7 R: 17.4 F: 5.9

VI. **TEXTURE**
a. Sphericity - Very Angular to Angular
b. Sorting - Poorly Sorted
c. Maturity - Immature
d.

VII. **DESCRIPTION**

SAMPLE: ST 4-4

Clay	Qtz	Chert	F-spar Plagio.	musc	Ø	Mixed Layered	F-spar Micro
22	64	14					
38	44	10				8	Trace
51	35	6	8				
31	45	15		9			
38	10	3		46	3		
14	67	4	7		8		
35	43	–	12	7	3		
33	34	22				11	
53	28	10		2		7	
45	32	7	4	10	2		
360	402	91	31	74	16	26	

MATRIX:	36 %	NORM.
Q:	40.2 %	76.7 %
F:	3.1 %	5.9 %
R:	9.1 %	17.4 %
	88.4 %	100 %

52.4

Company/Well Name: Cities Service / Stonebraker 'AN No. 4
Location:
Sample/Depth: ST4-5 / 6264
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	56.6		.01-.8	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	1.4		.04-.15	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	5.5		.05-.2	
(Total)	6.9			
3. Rock Fragments				
a. Shale				
b. Chert ✓	6.4		.06-.15	
c. Carbonate				
d. Siltstone ✓	1.4		.04-.15	
e. Metamorphic				
f. Plutonic				
g. Volcanic ✓	Trace		.1	
h.				
(Total)	7 8			
4. Other Grains				
a. Glauconite ✓	Trace		.15-.2	
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	3.3		.04-.45	
d. Biotite				
e. Hematite				
f. Zircon ✓	.2		.02-.03	
g. Phosphate pebble ✓	.9		.05	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	10.5			
(Total)				

	% PC	VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	.2		.01 - .03	Presumed there are actually more but not evident from Thin Sections
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	.7		.05 - .15	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite -	8.0		.03 - .14	mostly pore filling
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	3.6		.03 - .05	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary ✓	1.3		.01 or less	Preserved
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Sub lith chert wacke
- b. Q: 79.4 R: 10.9 F: 9.7

VI. **TEXTURE**
- a. Sphericity - Sub Angular to Subrounded
- b. Sorting - moderate to poor
- c. Maturity - Immature
- d.

VII. **DESCRIPTION**

SAMPLE: ST4-5

Clays	Qtz	Chert	Micro Ø	Qtz Overgr	Plag F.Spar	Pyrite	Phosph	Microcline F-spar	Musc	S.Hst RF	Calcite Cement	Zircon	Kaolin	Volcanic RF	Glauco
	97		1	2											
	49	20	2		3								26		Tr
13	33		2			21	9						22		
20	18	12			25	15							10	Tr	
16	43	10						14	17						
28	57	8							7					Tr	
12	34	6	8						9	14			17		
	95												5		Tr
8	82	8									2				
8	58				27						5	2			
105	566	64	13	2	55	36	9	14	33	14	7	2	80		1000
	↑	RF			↑ FS			↑ FS		↑ RF					

(12.8%)

MATRIX: 10.5 %

			NORM.
	Q:	56.6 %	79.4 %
71.3	F:	6.9 %	9.7 %
	R:	7.8 %	10.9 %
		81.8 %	100 %

Company/Well Name: Cities Service/ Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-6 / 6265
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	46.6		.02-.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	.7		.04	
(Total)				
3. Rock Fragments				
a. Shale ✓	1.7		.04-.2	
b. Chert ✓	8.4		.06-.2	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	Trace		.04	
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	3.8		.02-.1	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	36.1			
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite	1.6		.02-.1	Primarily Pore filling
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	1.1		.03-.15	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sub lith Chert wacke

b. Q: 81.2 R: 17.6 F: 1.2

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Very poorly Sorted

c. Maturity - Immature

d.

VII. **DESCRIPTION**

SAMPLE: ST4-6

Clay	Qtz	Pyrite	musc.	Kaolin.	Plag F-spar	Clay Pebble	Chert	Glass							
92	8							Trace							
16	58	11	4	3			8								
22	70						8								
65	27		8												
6	68		8	3	7		8								
4	53		6			17	20								
94	4		2												
56	28		6				10								
2	92			6											
4	58		4	4			34								
361	466	11	38	16	7	17	84								1000

(38.6)

MATRIX: 36.1 %
Q: 46.6 %
57.4 F: 0.7 %
R: 10.1 %
93.5 %

NORM.
81.2 %
1.2 %
17.6 %
100 %

Company/Well Name: Cities Service / Stonebraker 'AN' No 4
Location:
Sample/Depth: ST4-8/6267
Sample Source:
Formation/Age:
Petrographer:

	PC % VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	52.2	.03-.6	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline ✓	2.2	.02-.15	
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert ✓	12.2	.04-.18	
c. Carbonate ✓	1.7	.1	
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	Trace	.05	
b. Shell Fragments			
1.			
2.			
c. Muscovite ✓	4.0	.02-.2	
d. Biotite			
e. Hematite ✓	.8	.01-.03	
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite			
c. Pseudo matrix ✓	25.3		
(Total)			

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite	1.3		.01 - .06	
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics	.3		.02	
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sublith Chert wacke

b. Q: 76.4 R: 20.3 F: 3.2

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - poor to very poor

c. Maturity - Immature

d.

VII. **DESCRIPTION**

SAMPLE: ST4-8

Clays	Qtz	Chert	Musco	Micrite mud pebble	Kaolin	Hematite	Chlorite?	Microcline F-spar	Organics	Glauc					
59	23	14	4												
	87	13													
10	71	19													
7	83	10													
16	36	10	8	17	13										
66	20		6			8				Trace					
30	32	38													
	78		22												
48	17	10						22	3						
17	75	8													
252	528	122	40	17	13	2		22	3						1000
↑	↑	RF		RF				FS							

(27.03)

MATRIX: 25.3 %
(68.3) Q: 52.2 %
F: 2.2 %
R: 13.9 %
93.6 %

NORM.
76.4 %
3.2 %
20.3 %
100 %

Sublith chert Wacke

Company/Well Name: Cities Service/Stonebraker 'AN' No.4
Location:
Sample/Depth: ST4-9 / 6269.5 (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	77.6		.05-.70	
b. Polycrystalline	1.4		.14	
c.				
(Total)	79.0			
2. Feldspar				
a. Microcline ✓	1.5		.05-.15	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	1.9		.06-.1	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.6		.05-.18	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.3		.01-.02	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	6.3			
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	1.8	.01 -.04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	7.0	.03 - .18	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	2.0	.01 -.03	
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary ✓	.2	.01 -.04	Primarily micro Ø within clays.
c. Fracture			
(Total)			

V. CLASSIFICATION (Folks, 1968)

a. Name Subarkose

b. Q: 93.8 R: 2.0 F: 4.2

VI. TEXTURE

a. Sphericity - Subangular to Subrounded

b. Sorting - Poor to very Poor

c. Maturity - Immature

d.

VII. DESCRIPTION

SAMPLE: ST4-9

mono Qtz	Calcite Cement	Zircon	Clay	Ø	Plag F-Spar	Kaolin	Microcline F-Spar	Poly Qtz	Chert	Qtz Overgr.					
52	48														
73	2	2	9					14							
85			8							7					
72			10	2					16						
83	13		4												
68			7		19					6					
68			12			20									
84	7		6							3					
92		1	7												
83							15			2					
77.6	70	3	63	+	19	20	15	14	16	18					1000
↑			Matrix		FS		FS		R						

(7.2)

MATRIX: 6.3 %

81.0 Q: 76.0 %

F: 3.4 %

R: 1.6 %

87.3 %

NORM.

93.8 %

4.2 %

2.0 %

100 %

Company/Well Name: Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-10 / 6270.6
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	61.8		.08 - .85	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	2.2		.22 - .60	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	1.9		.06 - .13	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	3.4		.02 - .25	
c. Carbonate				
d. Siltstone ✓	10.0		> 1.0 mm	
e. Metamorphic				
f. Plutonic				
g. Volcanic ✓	2.4		.05 - .3	
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	1.4		.04 - .4	
d. Biotite				
e. Hematite				
f. Zircon ✓	Trace		.01 - .02	many small crystals present with a slide. None in point counts
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	2.2			
(Total)				

	PC % VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	.2	.01-.02	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	5.4	.07-.6	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered ? ✓	8.7		Type is not distinguishable in Thin section -
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary ✓	.4	.01	is present within the clays
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sublitharenite

b. Q: 75.2 R: 19.2 F: 5.6

VI. **TEXTURE**

a. Sphericity - Subrounded

b. Sorting - moderate

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: ST4-10

Qtz	Cement Calcite	Ø	Musc.	Auth. Clay	Microc F-Spar	Plag F-spar	Volcanic RF	Chert	Sed RF (Mud Pebble)	Qtz Overgr	Matrix Clays	Zircon			
64	12						24								
76		4	12	8											
65	23			12								Tr			
57			2	19	22										
84	8					8									
52				8				26			14	Tr			
57	11			24				8							
									100						
80				12							8	Tr			
83				4		11				2					
618	54	4	14	87	22	19	24	34	100	2	22				
Q					F	F	R	R	R						

(1.6%)

		NORM.
MATRIX:	1.4 %	
Q:	61.8 %	75.6 %
81.7 F:	4.1 %	5.0 %
R:	15.8 %	19.3 %
	83.[illegible] %	100 %

Company/Well Name: Cities Service / Stone braken 'AN' No 4
Location:
Sample/Depth: ST4-11/ 6272.8' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	74.7		.2 - 1.2	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	.7		.1	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	2.6		.05-.5	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix ✓	4.2			
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz ✓	1.3		.01 - .03	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	8.3		.05 -.70	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite	2.3		.01 - 02	
e. Mixed-Layered	4.2		.1 - .4	
f.				
(Total)	6.5			
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary ✓	.2		.1	Intergranular
b. Secondary ✓	1.5			within clays micro ϕ. Some
c. Fracture				
(Total)	1.7			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz Arenite

b. Q: 95.8 R: 3.3 F: .9

VI. **TEXTURE**

a. Sphericity - Subrounded to rounded

b. Sorting - Moderate to well Sorted

c. Maturity - Submature to Supermature (depends on the sorting)

d.

VII. **DESCRIPTION**

SAMPLE: ST4-11

Qtz	Calcite Cement	Chlorite	layer? smectite? Illite	Plag F-Spar	Qtz Overgr	2nd φ	Chert	Volcanic RF	φ	Mixed Layered Authig. Clays					
89	8	3													
22	28		16	7				Trace		27					
77		2			7	12			2						
100															
91		4					5								
73		3	15		6	3									
33	47						5			15					
94		6													
98		2													
70		3	11				16								
747	83	23	42	7	13	15	26		2	42					1000
↑				↑			R								

(3.8)

		NORM.
MATRIX:	3.1 %	
Q:	74.7 %	95.8 %
78 F:	0.7 %	.9 %
R:	2.6 %	3.3 %
	81.1 %	100 %

Company/Well Name: Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-12/6278.1
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	7.5		.02 - .25	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	.2		.02 - .08	
(Total)				
3. Rock Fragments				
a. Shale ✓	.7		.02 - .08	
b. Chert ✓	.4		.05 - .15	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic ✓	.2		.08	
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	.7		.02 - .20	
d. Biotite				
e. Hematite ✓	1.0		.02 - .06	
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite-?	88.3%		—	
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	1.0		.02 - .08	
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
a. Name — Mudrock -
b. Q:________ R:________ F:________

VI. **TEXTURE**
a. Sphericity -
b. Sorting -
c. Maturity -
d.

VII. **DESCRIPTION**

SAMPLE: ST4-12

Clay	Qtz	Pyrite	Musc	Hema	Plag & F.Spar	Clay? Pebble	Chert	Volcanic RF							
94	4							2							
92	6	2													
79	21														
91	6		3												
91	6	3													
90				10											
87	11				2										
91	2	3	4												
80	13					7									
88	6	2					4								
883	75	10	7	10	2	7	.1	2							1000
m	Q				1F	R.	R	R							

(90.7)

	MATRIX	NORM.
MATRIX:	88.3 %	
Q:	7.5 %	%
F:	.2 %	%
R:	1.3 %	%
	97.3 %	100 %

9

Company/Well Name: Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-13 / 6280.4 (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	57.6		.03-.20	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	Trace		.04-.06	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	10.2		.04-.1	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	4.2		.01-.2	
d. Biotite				
e. Hematite ✓	1.9		.01-.04	
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite	18.5		-	
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite			
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f. Undifferentiated	7.6	.04 - .15	
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. **POROSITY**			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sublithwacke

b. Q: 85 R: 15 F: –

VI. **TEXTURE**

a. Sphericity - Subangular - subrounded

b. Sorting - Poorly - moderately sorted

c. Maturity - Immature

d.

VII. **DESCRIPTION**

SAMPLE: ST 4-13

Qtz	Chert	Illite/ mixed Layer	Detrital Clays Illite/ Smectite	musc	Hemati	F-spar Plag
58	12	11	19			
29	10	10	38	13		
14	14	7	57	8		
~~65~~			17		18	
97	3					Trace
65	18	4	10	3		
97				3		
20	28	41	11			
96		3			1	
35	17		33	15		Trace
576	102	76	185	42	19	

1000

(21.4)

	MATRIX:	18.5 %	NORM.
	Q:	57.6 %	85.0 %
67.8	F:	— %	%
	R:	10.2 %	15.0 %
		86.3 %	100 %

Company/Well Name: Cities Service / Stonebraker AN' No.4
Location:
Sample/Depth: ST4-14 / 6281.6' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	69.7		.05 – 2mm	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	8.5		.06 – .3	
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	3.6		.06 – .5	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	.7		.02 – .15	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite	1.5		.04 – .1	
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	1.9		.01 - .05	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	9.0		.1 - .5	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite	.6		.03 - .05	
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered	1.0		.01 - .06	
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary ✓	.6		.03 - .20	Intergranular
b. Secondary ✓	2.9		.01 - .15	1.9% ≈ due to grain diss; 1.0% ≈ micro ϕ w/in clays -
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Subarkose
- b. Q: 85.2 R: 4.4 F: 10.4

VI. **TEXTURE**
- a. Sphericity - Subangular - Subrounded
- b. Sorting - Very poor
- c. Maturity - Submature
- d.

VII. **DESCRIPTION**

SAMPLE: ST4-14

Qtz	Chlorite	Kaolinite	Detrital Smect Illite	micro Ø	1 Ø 2	Calcite Cement	Qtz Overgrow	F-spar Micro-cline	Musco.	Chert					
48			15	10						27					
100															
88						3				9					
67						25	8								
35						62	3								
15								85							
92							8								
94	3	3													
76	7 Pore lining				4 13										
82		3			2 . 6				7						
697	10	6	15	10	25	90	19	85	1	36					1000
Ø								3-		3.6					

(1.8)

MATRIX: 1.5 %

			NORM.
	Q:	69.7 %	85.2 %
81.8	F:	8.5 %	10.4 %
	R:	3.6 %	4.4 %
		83.3 %	100 %

Subarkose

Company/Well Name: Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-15 / 6282.6
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline	75.3	.08->2.5	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase ✓	5.7	.02-.15	
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert ✓	5.7	.05-.45	
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	Trace	.03	
b. Shell Fragments			
1.			
2.			
c. Muscovite ✓	.8	.03-.20	
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite ✓	2.4	.02-.08	
c. Pseudo matrix			
(Total)			

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	.3		.01-.05	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	2.5		.05-.25	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite ✓	3.6		.01-.1	Pore lining & Pore filling
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics ✓	1.5		.01-.03	Thin wisps of black organic material.
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary ✓	2.2		.01-.06	Partial Diss Moldic - .4% Zndry Dissolution 1.5% Micro Ø - .5%
c. Fracture				
(Total)				

V. CLASSIFICATION (Folks, 1968)

a. Name Borderline Lithic Arkose / Feldspathic Litharenite

b. Q: 87.6 R: 6.6 F: 5.8

VI. TEXTURE

a. Sphericity - Subangular to Subrounded

b. Sorting - Very Poor Sorting

c. Maturity - Sub mature

d.

VII. DESCRIPTION

SAMPLE: ST4-15

Qtz	Chert	Cement Calcite	Muscov	F-spar Plagio	Chlorite	Wisp of Organic	2ndry moldic Ø Micro	Weathered F-spar	Detrital Smect/Illite Clays	Qtz Overgr	2ndry Ø	Glauc.			
60	15				25										
100															
93				7											
85						15									
30	10			10	3		4	31	12						
84	11				2					3					
55	21				6						18				
65		25	8						2			Tr-			
90									10						
91				9											
753	57	25	2	26	36	15	4	31	24	3	18				1000
Q	R			F				F	M						

(2.7)

MATRIX:	2.4 %	NORM.	
Q:	75.3 %	87.6 %	
86. F:	5.7 %	5.8 %	
R:	5.7 %	6.6 %	
	89.1 %	100 %	

Company/Well Name: C.t.es Serv'ce / Stonebraken 'AN' No. 4
Location:
Sample/Depth: ST4-16 / 6283.8' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	70.3		.03 – .8	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	2.8		.04 - .15	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.0		.05 - .3	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic ✓	3.8		.08 - .15	
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.1		.01 - .02	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	2.9		.04 - .20	
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	2.3		.01 - .03	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	14.1		.04 - .35	much 's Poikilotopic
2. Dolomite ✓	.5		.02 - .03	
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite ✓	1.8		.01 - .03	mostly pore lining -
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics ✓	.4		.01 - .04	
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Sublitharenite
- b. Q: 90.2 R: 6.2 F: 3.6

VI. **TEXTURE**
- a. Sphericity - Subrounded
- b. Sorting - Poor - Very Poor
- c. Maturity - Submature
- d.

VII. **DESCRIPTION**

SAMPLE: ST4-16

Qtz	Plag F-spar	Chlori	Calcite Cement	Organic	Qtz Overgr	Detrital Illite/ Smect. Clays	Chert	Zircon	Volcanic Ig RF?	Rhombic Dolomite					
71	10	5	14												
67			29	4											
82			7		8	3									
82			16			2									
50		4	36				10								
80		4			15			1							
10	18		15			19			38						
84			6			5				5					
82			18												
95		5													
703	28	18	141	4	23	29	10	1	38	5					1000
Q	F					M			R						

(3.6)

		NORM.
MATRIX:	2.9 %	
Q:	70.3 %	90.2 %
77.9 F:	2.8 %	3.6 %
R:	4.8 %	6.2 %
	80.8 %	100 %

Sub lith arenite

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Company/Well Name: Cities Service / Stonebraker 'AN' No 4
Location:
Sample/Depth: ST4-17 / 6284.3' (core)
Sample Source:
Formation/Age:
Petrographer:

	PC % VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	80.1	.5 - >2.5mm	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline ✓	3.3	.05-.45	
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert ✓	2.3	.03-.1	
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite			
b. Shell Fragments			
1.			
2.			
c. Muscovite			
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite ✓	2.7	–	
c. Pseudo matrix			
(Total)			

	PC % VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	3.8	.01 - .04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	6.2	.02 - .30	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite ✓	.8	.01 - .03	Pore lining / grain coating
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	.2	.01 - .04	Intergranular
b. Secondary ✓	.6	.01 - .03	mostly moldic or partial dissolution of grains
c. Fracture			
(Total)	.8		

V. **CLASSIFICATION** (Folks, 1968)

a. Name Subarkose

b. Q: 93.5 R: 2.6 F: 3.9

VI. **TEXTURE**

a. Sphericity - Subrounded - Subangular

b. Sorting - Poor - Very Poor

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: ST4-17

Qtz	Ø	Cement Calcite	Chlorite	Overgro Qtz	Chert	Microcr F-Spar	mold'c Ø	Matrix							
56	4	32		8											
88	2		3					7							
88					12										
100															
76						8	2	14							
83		5		12											
79		7	3		11										
75						25									
72		11	2	15											
84		7		3				6							
801	6	62	8	38	23	33	[illegible]	27							1000
Q					R	F									

(3.1)

		NORM.
MATRIX:	2.7 %	
Q:	80.1 %	93.5 %
85.7 F:	3.3 %	3.9 %
R:	2.3 %	2.6 %
	88.4 %	100 %

Company/Well Name: Cities Service / Stonebreaker 'AN' No. 4
Location:
Sample/Depth: ST4-18 / 6284.6
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	68.2		.05 - >2.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	8.9		.06 - 1.5	
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.1		.04 - .2	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite ✓				
b. Illite ✓	.7			
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	5.0	.01-.03	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite ✓	5.8	.06 - 1.5	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite ✓	1.2	.01 - .4	Predominantly Pore lining on both Qtz and Calcite
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓			Primary % and 2ndry % are hard to determine as much of the ϕ is enlarged pore space and original volume is unknown
b. Secondary ✓	9.1	.01 - .5	
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Subarkose

b. Q: 87.2 R: 1.4 F: 11.4

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Poor to Very Poor

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: ST4-18

Qtz	Ø	Qtz Overgrowth	micro F-Spar	Calcite Cement	Chert	Detrital Illite/Smec. Clays	Chlorite	micro Ø							
52	33	15													
56	18		26												
55	3		26	16											
65	5		30												
54	12	5		18	11										
100															
67	9		7	10		7									
86				14											
62		20					12	6							
85	5	10													
682	85	50	89	58	11	7	12	10						1000	
Q			F		R										

(.9)

		NORM.
MATRIX:	.7 %	
Q:	68.2 %	87.2 %
78.2 F:	8.9 %	11.4 %
R:	1.1 %	1.4 %
	78.9 %	100 %

Subarkose

Company/Well Name: Cities Service / Stonebraker 'AN' No.4
Location:
Sample/Depth: ST4-19 / 6286.7' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	71.0		.05 – >2.5 mm	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	2.6		.08 - .15	Some are unrecognizable due to dissolution - could be other than Plag.
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	1.9		.04 - .20	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	1.5			
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	.7	.01 - .03	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	7.8	.06 - .25	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays ✓			
a. Kaolinite-Dickite ✓	10.8	.05 - .30	much of the kaolinite has a green tint to it under plain polarized light - may be undergoing chloritization - MK-92 Personal Com
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	.7	.03 - .15	Intergranular
b. Secondary ✓	3.0	.01 - .02	1% is moldic Ø from weathered Fspars the remainder is micro Ø within Clays.
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)
a. Name Quartz Arenite
b. Q: 96.5 R:______ F: 3.5

VI. **TEXTURE**
a. Sphericity - Subangular - Subrounded
b. Sorting - Poor - Moderate
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: ST4-19

✓ Qtz	Cement Calc.	✓ Smectite/ Illite Clays	Moldic ø	ø	✓ Weathered F-spar	✓ Musco	✓ Kaolinite	Micro ø	Qtz Overgrow						
30	12	8	6	2	26		16								
76			4				14	6							
100															
75							17	8							
85				5			10								
74						19			7						
100															
58	42														
32	24	7					37								
80							14	6							
710	78	15	10	7	26	19	108	20	7						1000
Q					F										

(2.0)

MATRIX: 1.5 %

Q: 71.0 %

73.6 F: 2.6 %

R: %

75.1 %

NORM.

96.5 %

3.5 %

%

100 %

Company/Well Name: Cities Service / Stone braker 'AN' No. 4
Location:
Sample/Depth: ST 4-20/6288 8'
Sample Source:
Formation/Age:
Petrographer:

	PC % VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	71.0	.08 - 1.2	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline ✓	4.4	.05 - .3	
b. Orthoclase			
c. Sanidine			
d. Plagioclase ✓	4.9	.05 - .2	
(Total)	9.3		
3. Rock Fragments			
a. Shale			
b. Chert ✓	.9	.04 - .08	
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite			
b. Shell Fragments			
1.			
2.			
c. Muscovite			
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite ✓			
b. Illite ✓	6.9		
c. Pseudo matrix			
(Total)			

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	2.3	.01 - .04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	1.4	.03 - .25	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	6.3	.03 - .28	Pore filling w/ greenish tint under Plain Polarized light
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	2	.02 - .06	
b. Secondary ✓	1.3	.01 - .02	Primarily micro ø within kaolinite
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)
a. Name Sub Arkose
b. Q: 87.4 R: 1.1 F: 11.5

VI. **TEXTURE**
a. Sphericity - SubAngular to Subrounded
b. Sorting - Poor - Moderate
c. Maturity - Immature
d.

VII. **DESCRIPTION**

SAMPLE: ST4-20

Qtz	Cement	Ø	microcl F-Spar	Kaolinite	Calcite	Detrital Smectite Illite Clays	micro Ø	Plag F-spar	Chert						
65	8		20	2	5										
41			24	15		11	9								
96				2		2									
70							1	20	9						
45				7		16	3	29							
95		2		3											
15	15			34	3	33									
95						5									
100															
88				2	6	4									
710	23	2	44	63	14	69	13	47	9						1000
Q			F						R						

(8.7)

MATRIX: 7.7 %
Q: 71.0 %
81.2 F: 9.3 %
R: .9 %
88.1 %

NORM.
87.4 %
11.5 %
1.1 %
100 %

Sub arkose

Company/Well Name: Cities Service / Stonebraker 'AN' No. 4
Location:
Sample/Depth: ST4-21/6295.2
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	55.8		.03 - >2.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	5.8		.08 - >2.5	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	2.1		.05 - .4	
(Total)				
3. Rock Fragments				
a. Shale ✓	.5		.03	
b. Chert ✓	.6		.06	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	.8		.02 - .18	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	3.7		–	
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	2.7	.01-.04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	2.5	.03-.1	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	18.4	.05-.85	Pore filling-
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	.6	.02-.05	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	1.6	.03-.15	Intergranular
b. Secondary ✓	3.5	.01-.1	moldic + Enlarged micro Ø
c. Fracture			
(Total) micro ✓	1.4 / 6.5	.01	m

V. **CLASSIFICATION** (Folks, 1968)
a. Name Subarkose
b. Q: 86.1 R: 1.7 F: 12.2

VI. **TEXTURE**
a. Sphericity - Subangular to Subrounded
b. Sorting - Poor
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: ST 4-21

Qtz	Plag Fspar	Kaolinite	Mica Musc.	Micro cline F-spar	Clay frag	Ø	Pyrite	Detrital Clays Illite Smectite	Chert	Micro Ø			Cement Calcite	Overgrowth Qtz	
48		43			5.			1						3	
74		15				5				2				4	
92		3						2		3					
56		23				13	2							6	
14		31				33		8		1			13		
32	21	19	8				4	4	6	2				4	
30				58									12		
95								2		3					
70		22								3				5	
47		28						20						5	
558	21	184	8	58	5	51	6	37	6	14	—	—	25	27	1000
Q	F			F	R				R						

Subarkose

(58)

	MATRIX:	4.0 %	NORM.
	Q:	55.8 %	86.1 %
64.8	F:	7.9 %	12.2 %
	R:	1.1 %	1.7 %
		68.8 %	100 %

Company/Well Name: Cities Service / Stonebraker 'AN' No.4
Location:
Sample/Depth: ST4-22/6295.4' (core)
Sample Source:
Formation/Age:
Petrographer:

	PC % VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline			
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert			
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite			
b. Shell Fragments			
1.			
2.			
c. Muscovite			
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite			
c. Pseudo matrix	99.9	—	
(Total)			

	PC % VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite			
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	.1	.01-.02	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Mudstone

b. Q: \\ R: \\ F: \\

VI. **TEXTURE**

a. Sphericity -

b. Sorting -

c. Maturity -

d.

VII. **DESCRIPTION**

SAMPLE: ST4-22

Undiff Clays	Pyrite
100	
100	Trace
100	
100	Trace
100	
100	
99	1
100	
100	
100	

1000

Mud stone

MATRIX:	%	NORM.
Q:	%	%
F:	%	%
R:	%	%
	%	100 %

Company/Well Name: Cities Service / Stonebraker 'A' No 101
Location:
Sample/Depth: ST 101-23/6165' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline				
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name
- b. Q:________ R:________ F:________

VI. **TEXTURE**
- a. Sphericity -
- b. Sorting -
- c. Maturity -
- d.

VII. **DESCRIPTION**

SAMPLE: ST 101-23

Micrite Clay	Pyrite	Qtz	Musca	Organic? Opaque Black Shale											
91	9														
100															
98	2														
100															
93		7													
92		8													
95	5														
96			4												
100															
93				7											
958	10	15	4	7											1000

MATRIX: ______%
Q: ______%
F: ______%
R: ______%
______%

NORM.
______%
______%
______%
100 %

Micrite Mudstone

Company/Well Name: Cities Service/Stone braker 'A' No. 101
Location:
Sample/Depth: ST101-24 / 6167.6'(core)
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	58.0	.05 - .6	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline ✓	3.5	.05 - .3	
b. Orthoclase			
c. Sanidine			
d. Plagioclase ✓	11.6	.03 - .2	
(Total)			
3. Rock Fragments			
a. Shale ✓	.9	.06-.1	
b. Chert ✓	1.2	.03-.08	
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic ✓	1.6	.05 - .2	
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	.2	.02-.04	
b. Shell Fragments			
1.			
2.			
c. Muscovite ✓	2.5	.01 - .1	
d. Biotite			
e. Hematite			
f. Zircon ✓	.6	.01-.02	
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite ✓			
b. Illite ✓	13.1	–	
c. Pseudo matrix			
(Total)			

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	5.8	.03-.15	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	1.0	.01-.07	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sub Arkose

b. Q: 75.5 R: 4.8 F: 19.7

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Very Poor

c. Maturity - Immature

d.

VII. **DESCRIPTION**

SAMPLE: ST 101-24

Qtz	Chert	Muscov	Plag F-spar	Microcl F-spar	Detrital Smect/Illite Clays	Zircon	Calcite Cement	Glauco.	RF Volcanic	Pyrite	Clay Pebble				
27		7		35	15				16						
60		4			29					7					
86			7		2			2		3					
75					25										
70	4		14		12			Trace							
81					16	3									
34		14					43				9				
74	8					3	15								
66			32		2										
7			63		30										
580	12	95	116	35	131	6	58	2	16	10	9				1000
Q	R		F	F					R		R				

(14.6)

(13.1)

	MATRIX:	%	NORM.
	Q:	58.0 %	75.5 %
76.8	F:	15.1 %	19.7 %
	R:	3.7 %	4.8 %
		89.9 %	100 %

Company/Well Name: Cities Service / Stonebraker 'A' 101
Location:
Sample/Depth: ST 101-25 / 6167.6' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline				
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite ✓				
b. Illite ✓	51.6		–	
c. Pseudo matrix				
(Total)				

	PC % VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite			
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	48.4	-.02 - >2.5	
c. Organics			
d.			
(Total)			
IV. **POROSITY**			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Mudstone

b. Q:________ R:________ F:________

VI. **TEXTURE**

a. Sphericity -

b. Sorting -

c. Maturity -

d.

VII. **DESCRIPTION**

SAMPLE: ST 101-25

Clay	Pyrite														
	100														
35	65														
80	20														
90	10														
65	35														
8	92														
58	42														
	100														
95	5														
85	15														
516	484														100.0

MATRIX: ______% NORM.
Q: ______% ______%
F: ______% ______%
R: ______% ______%
______% 100 %

Mudstone with Pyrite Nodule.

Company/Well Name: Cities Service / Stonebraker 'A' No. 10
Location:
Sample/Depth: ST 108-26 / 6171.5
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	55.2		.04 - .40	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	6.8		.05 - .25	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	2.6		.06 - .18	
(Total)				
3. Rock Fragments				
a. Shale ✓	3.8		.06 - .18	
b. Chert ✓	1.9		.03 - .08	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	5.8		.02 - .15	
d. Biotite				
e. Hematite				
f. Zircon ✓	.4		.01 - .02	
g. Phosphate Nodule	1.3		.04 - .1	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	21.6		—	
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics ✓	.6		<.01 - .04	wisps
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Subarkosic wacke

b. Q: 79.2 R: 8.2 F: 12.6 Matrix - 31% of total

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Poor to Very Poor

c. Maturity - Immature

d.

VII. **DESCRIPTION**

SAMPLE: ST 101-26

Qtz	Micro. F-spar	Plag F-spar	Phospha	Musco	Smectite/ Illite Clays		Chert	Zircon	Organics? Black Shale	(RF) Clay Pebble					
33	18	21	9	7	12										
55		5		9	25		6								
57	23				16			4							
23				3	68		6								
52	27			6	8		7								
86					14										
53				24	23										
78					22										
42				3	11				6	38					
73			4	6	17										
558	68	26	13	58	216		19	4	6	32					1000
Q	F	F					R			R					

MATRIX: 21.6 %

		NORM.
Q:	55.2 %	79.2 %
F:	8.8 %	12.6 %
R:	5.7 %	8.2 %
	91.3 %	100 %

69.7

Sub arkose

Company/Well Name: Cities Service / Stonebraker 'A' No. 101
Location:
Sample/Depth: ST101-27 / 6173.
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	42.4		.02 - .25	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	2.8		.03 - .13	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	3.6		.03 - .10	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	Trace		.14	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	Trace		.1	
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	.8		.02 - .15	
d. Biotite				
e. Hematite				
f. Zircon ✓	.3		.01 - .04	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	10.0			
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	.4		.01 - .03	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	24.5		.05 - .80	calcite fills many pores that were created by dissolution of clays or grains -
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite	1.3		.02 - .15	Pore filling
b. Illite ✓	10.8		.05 - .50	pore filling form in bands and in hand specimen looks like hematite banding
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics ✓	.3		.01 - .03	
d.				
(Total)				
IV. POROSITY				
a. Primary ✓	.7			Intergranular
b. Secondary ✓	1.9		.01 - .06	Mostly pore spaces enlarged by dissolution and preserved by Kaolinite; micro Ø w/in Kaolinite; Moldic Ø in F-spars
c. Fracture				
(Total)				

V. CLASSIFICATION (Folks, 1968)

a. Name Sub arkose

b. Q: 86.9 R: ______ F: 13.1

VI. TEXTURE

a. Sphericity - Subangular to Subrounded

b. Sorting - Poor

c. Maturity - Immature

d.

VII. DESCRIPTION

SAMPLE: ST 101-27

Qtz	Musco	Cement Calcite	microc F-spar	Plag F-spar	Pebble looking ~~Detrital~~ Clay: Illite	∅	Detrital Clays Smect/Illite	Zircon	Kaolinite	Qtz Overgr	Micro ∅	Organic? Black Shale	Pyrite	Glauc.	Chert
43		17			13	5	22								
40					53	3	4								
76		13				2		1	8						
52		22	14				8			4				Trace	
28	3	48		8			10				3				Trace
44			10		13		31				2				
30	5	2		28	12		18		5						
42		23	4		17	11						3			
44		54											2		
25		66					7	2							
424	8	245	32	34	108	21	100	3	13	4	5	3	2		1000
Q			F	F	R										

MATRIX:	10.0 % (14.4)	NORM.
Q:	42.4 %	86.9 %
48.8 F:	6.4 %	13.1 %
R:	%	%
	58.8 %	100 %

Company/Well Name: Cities Service / Stonebraker 'A' 101
Location:
Sample/Depth: ST 101-28 / 6177.5' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	43.8	.06 - .43	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase ✓	1.2	.03 - .13	
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert			
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	Trace	.04 - .06	
b. Shell Fragments			
1.			
2.			
c. Muscovite ✓	2.3	.02 - .15	
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite ✓	16.7		
c. Pseudo matrix			
(Total)			

	% PC	VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz ✓	3.1		.01 - .04	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓				
1. Calcite ✓	28.7			
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	3.0			
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary ✓	0.2		.01 - .05	Intergranular
b. Secondary ✓	1.0		.01 - .11	Enlarged Intergranular - .8% micro Ø .2%
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
  a. Name Quartz wacke
  b. Q: 97.3 R: x F: 2.7

VI. **TEXTURE**
  a. Sphericity - Subangular to Subrounded
  b. Sorting - poor to very poor
  c. Maturity - Immature
  d.

VII. **DESCRIPTION**

SAMPLE: ST 101-28

Qtz	Plag F-Spar	Calcite Cement	Muscov	Smectite Illite	Kaolinite	Qtz Overgr	Zircon	Ø	micro Ø	Glauc	Pyrite				
31	8	45		6				8	2						
60	4	22		4	8			2							
69		21		6		4					Trace				
26		14	6	42	12					Trace					
47		39		14											
59		14				27									
67		14		9	10					Trace	Trace				
33		22	17	28											
18		82													
28		14		58							Trace				
438	12	227	23	167	30	31	—	10	2						1000
Q	F														

MATRIX: 27% %

Q: 43.8 %

F: 1.2 %

R: %

%

NORM.

%

%

%

100 %

Company/Well Name: Cities Service / Stonebraker 'A' No. 101
Location:
Sample/Depth: ST 101-29 / 6187.5
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline				
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Micrite Mudstone

b. Q:________ R:________ F:________

VI. **TEXTURE**

a. Sphericity -

b. Sorting -

c. Maturity -

d.

VII. **DESCRIPTION**

SAMPLE: ST 101-29

Calcite Micrite Mud	Sparry Calcite Xtals	Ø	Pyrite												
86	14														
100			Trace												
65	35														
92		8	Trace												
100															
100															
100															
100															
22	78		Trace												
45	55														
810	18?	?													1000

Micrite

MATRIX: ____%
Q: ____%
F: ____%
R: ____%
____%

NORM.
____%
____%
____%
100 %

Company/Well Name: Cities Service / Stonebraker 'A' 101
Location:
Sample/Depth: ST101-30 / 6188.5
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline				
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Micrite mudstone

b. Q:________ R:________ F:________

VI. **TEXTURE**

a. Sphericity -

b. Sorting -

c. Maturity -

d.

VII. **DESCRIPTION**

Company/Well Name: Cities Service / Stonebraker 'A' 101
Location:
Sample/Depth: ST101-30 / 6188.5
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS 1. Quartz a. Monocrystalline b. Polycrystalline c. (Total)				
2. Feldspar a. Microcline b. Orthoclase c. Sanidine d. Plagioclase (Total)				
3. Rock Fragments a. Shale b. Chert c. Carbonate d. Siltstone e. Metamorphic f. Plutonic g. Volcanic h. (Total)				
4. Other Grains a. Glauconite b. Shell Fragments 1. 2. c. Muscovite d. Biotite e. Hematite f. Zircon g. (Total)				
II. DETRITAL MATRIX a. Chlorite b. Illite c. Pseudo matrix (Total)				

Company/Well Name: Cities Service / Stonebraker 'A' No. 101
Location:
Sample/Depth: ST 101-31/6206 ft
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz a. Monocrystalline ✓ b. Polycrystalline c. (Total)	52.7	.05 - .56	
2. Feldspar a. Microcline b. Orthoclase c. Sanidine d. Plagioclase ✓ (Total)	1.5	.10 - .25	
3. Rock Fragments a. Shale b. Chert ✓ c. Carbonate d. Siltstone e. Metamorphic f. Plutonic g. Volcanic h. (Total)	1.7	.03 - .17	
4. Other Grains a. Glauconite b. Shell Fragments 1. 2. c. Muscovite d. Biotite e. Hematite f. Zircon ✓ g. (Total)	Trace	.01 - 03	
II. DETRITAL MATRIX a. Chlorite b. Illite ✓ c. Pseudo matrix (Total)	3.1		

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	1.6	.01 - .03	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite ✓	38.5	.03 - .65	
2. Dolomite ✓	.9	.04 - .10	Rhombic crystals
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sublitharenite

b. Q: 94.3 R: 3.0 F: 2.7

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Poorly Sorted

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: ST 101-31

Qtz	Plag. Feldspar	Chert	Calcite Cement	Detrital Illite	Overgr. Qtz	Cement Dolomite
50		3	36	8	3	
71	7		18	4		
44			47	3	6	
63	2		32			3
63			28	7	2	
31			64		2	3
52		14	22	6	3	3
56	6		38			
53			47			
44			53	3		
527	15	17	38.5	31	16	9

(5.9)

		NORM.
MATRIX:	3.1 %	
Q:	52.7 %	94.3 %
F:	1.5 %	2.7 %
55.9 R:	1.7 %	30 %
	41.7 %	100 %

Company/Well Name: Shell / No. 1-13 Finfrock
Location:
Sample/Depth: FF-32 / 6502
Sample Source:
Formation/Age:
Petrographer:

	PC % VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	43.8	.08 - .45	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase ✓	1/	.14-.17	
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert ✓	.8	09	
c. Carbonate			
d. Siltstone ✓	3.1	.05 -.25	
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	9.5	.04 - .30	
b. Shell Fragments			
1. Bryozoan ✓	6.2	.05 -.35	
2.			
c. Muscovite			
d. Biotite			
e. Hematite			
f. Zircon ✓	Trace	.01-.02	
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite ✓	1.0	01 -.05	
c. Pseudo matrix			
(Total)			

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	26.1		.03 - .50	
2. Dolomite ✓	7.0		01 - 03	
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate ✓	6.3		.05 - .15	Nodular.
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	.7		01 - .08	
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary				
b. Secondary ✓	.4		.01	
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Sublitharenite

b. Q: 93.4 R: 4.3 F: 2.3

VI. **TEXTURE**

a. Sphericity - Subrounded - Rounded

b. Sorting - moderate - well

c. Maturity - Sub mature to Supermature

d.

VII. **DESCRIPTION**

SAMPLE: FF-32

Qtz	Calcite Cement	Glauc	Dolomite	F Frag Bryoz. (Calcite)	Smectit/Illite Clays	R.F. Siltst frag	Phospha	Pyrite	micro ϕ	Chert	Plag F-spar				
30	31	8		31											
75	19		6												
64	24				8					4					
44	25					31									
24	13						63								
55	3	40			2										
11	89														
65	24										11				
55	22		4	7				4	4	4					
15	11	47		24				3							
438	261	95	10	62	10	31	63	7	4	8	11				1000
Q						R									

(2.1)
1.0

MATRIX: ______ %
46.9 Q: 43.8 % — NORM. 93.4 %
F: 1.1 % — 2.3 %
R: 3.9 % — 4.3 %
48.9 % — 100 %

Sublitharenite

Company/Well Name: Shell / Fin frock No. 1-13

Location:

Sample/Depth: FF-33 - 6506

Sample Source:

Formation/Age:

Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline	38.7		.05 - 1.0	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase	1.7		.06 - .25	
(Total)				
3. Rock Fragments				
a. Shale	1.6		.3 - .4	
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite	4.8		.2 - .55	
b. Shell Fragments				
1. Echinoderm?	21.8		.2 - 2.0mm	
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓				
1. Calcite ✓	28.0		.05 - 1.0	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite ✓	2.1		.06 - .1	Pore filling
c. Smectite				
d. Chlorite ✓	1.3		.01 - .02	Pore lining - grain coating
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Subarkose

b. Q: 92.8 R: 3.9 F: 4.0

VI. **TEXTURE**

a. Sphericity - Subrounded

b. Sorting - moderate sorting

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: FF-33

Qtz	Calcite Cement	Glauc	Clays-Illite/Smect	Replaced Fossil Frag (Calcite)	Chlorit	Phosph	Hemat	Clay Pebble	Musco	Plag F-spar				
34	52		14											
	33			67										
59	20	15			6					3				
47	37							16						
79	21													
49	44	3			7									
	37			63										
92	8													
7	5			88										
20	23	33	7							14				
387	280	51	21	218	13	—	—	16	—	17				1000
Q								R		F				

		NORM.
MATRIX:	___ %	
Q:	38.7 %	42.1 %
F:	1.7 %	4.0 %
R:	1.6 %	3.9 %
	42 %	100 %

Company/Well Name: Shell / Fin frock No.1-13
Location:
Sample/Depth: FF: 34 / 6508.7' (core)
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	51.7		.05-.75	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	4.9		.50	
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale ✓				
b. Chert ✓	2.7		.10-.20	
c. Carbonate				
d. Siltstone ✓	3.7		.07-.30	
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	10.5		.08-.5	
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	Trace		.05	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	11.5			
c. Pseudo matrix ✓				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	10.5		.05 - 1.0	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite ✓	1.0		.03 - .1	Pore filling
c. Smectite				
d. Chlorite ✓	2.3		.01 - .03	Pore lining & grain coating
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	Trace		.01 - 03	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary ✓	.4		.01	Micro Ø within clays
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Sublithwacke
- b. Q: 82.1 R: 10.2 F: 7.8

VI. **TEXTURE**
- a. Sphericity - Sub angular
- b. Sorting - Poorly
- c. Maturity - Immature
- d.

VII. **DESCRIPTION**

SAMPLE: FF-34

Qtz	Calcite Cement	Rep Calcite Fossil Frag	Glauc	Smect/ Illite Clays	Chlorite	Clay Matrix	Clay Imbricated Rip Ups	Micro Ø	F-spar microcl	Chert	Pyrite				
43	38		4	6	9										
21						15	37			27	Trace				
35	21		37		7										
						100									
69	14		10		7										
44	2		54												
97	3														
84				12				4			Trace				
100															
24	27								49						
517	105	–	105	18	23	115	37	–	49	27					1000
Q						M	R		F	R					

Sublith wacke

(15.4)

		NORM.
MATRIX:	11.5 %	
Q:	51.7 %	82.1 %
F:	4.9 %	7.8 %
R:	6.4 %	10.2 %
	74.5 %	100 %

63

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-35 / 6511.7
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	30.2		.02 - .20	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	11.6		.03 - .13	
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	1.3		.01 - .06	
d. Biotite				
e. Hematite				
f. Zircon				
g. Phosphate ✓	10		.04 - .08	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite ✓	18.5			
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓	33.0		.02 - .5	Poikilotopic cement
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite ✓	3.6		.03 - .1	
c. Smectite				
d. Chlorite ✓	.8		.01 - .02	
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	Trace		.01 - .04	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name *Quartz wacke*

b. Q: *100%* R:________ F:________

VI. **TEXTURE**

a. Sphericity - *Subrounded*

b. Sorting - *well Sorted*

c. Maturity - *Immature*

d.

VII. **DESCRIPTION**

SAMPLE: FF-35

Qtz	Cement Calcite	Illite Clays	Glauc	Phosphate	Chlorite	Clay Matrix	Musco
44	56						
36	56	8					
22	60	18					
47	27		26				
37	18	10	21	6	8		
6	18					73	3
29	20			4		40	7
30	34		33				3
13	7		8			72	
38	34		28				
302	330	36	116	10	8	185	13

(18.5)

		NORM.
MATRIX:	18.5 %	
Q:	30.2 %	100 %
F:	. %	%
R:	%	%
	%	100 %

Company/Well Name: Shell/Finlrock No. 1-13
Location:
Sample/Depth: FF-36/ 6514
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	70.7	.04 - .18	lot of quartz w/ pressure contacts w/ other grains extinction is not uniform as suggesting pressure as well
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert			
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	4.5	.03 - .2	These grains are apparently squashed into elongate grains
b. Shell Fragments			
1.			
2.			
c. Muscovite ✓	.9	.01 - .10	
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite ✓	5.3	-	
c. Pseudo matrix			
(Total)			

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	.6		.01-.02	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	9.9		.03-.20	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite ✓	6.3		.04-.15	Pore filling
c. Smectite				
d. Chlorite ✓	.7		.01-.02	
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary ✓	1.1		.01	
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Quartz arenite
- b. Q: 100 % R:______ F:______

VI. **TEXTURE**
- a. Sphericity - Sub rounded
- b. Sorting - well
- c. Maturity - Immature
- d.

VII. **DESCRIPTION**

SAMPLE: FF-36

Qtz ✓	Calcite Cement	Chlorite	Illite smect Clays	Glauc ✓	Ø	micro Ø	Qtz Overgr	Clay Matrix ✓	Muscov ✓						
77	14		9												
76	6				5		6		7						
79	12	3	6												
76	7			17											
65	5		23	7											
60	38								2						
56		4		9				31							
89	11														
55			25		2			18							
74	6			12		4		4							
707	99	7	63	45	7	4	6	53	9						1000
Q								M							

MATRIX: (7.0) % NORM.
Q: 70.7 % 100 %
F: . % %
R: % %
% 100 %

Company/Well Name: Shell / Finfrock 1-13
Location:
Sample/Depth: FF-37 / 6517
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	40.9		.04 - .30	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	7.3		.07 - .25	
b. Shell Fragments ✓	.8		.04 - .15	
1.				
2.				
c. Muscovite ✓	Trace		.04 - .15	
d. Biotite				
e. Hematite ✓				
f. Zircon ✓	Trace		.01 - .02	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates	4/5 6	.03 - .5	Poikilotopic - size is really not determinable since grains appear to "float" and size is only measured from one grain to another
1. Calcite ✓			
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite ✓	3.4	.03 - .07	Mostly pore filling
c. Smectite			
d. Chlorite ✓	.6	.01 - .02	pore lining - grain coating
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	Trace	.01 - .03	
c. Organics			
d.			
(Total)			
IV. **POROSITY**			
a. Primary			
b. Secondary ✓	1.4	.05 - 1	Primarily due to diss of Glauconite
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name *Quartz Arenite*

b. Q: *100* R:______ F:______

VI. **TEXTURE**

a. Sphericity - *Subangular - Subrounded*

b. Sorting - *moderate to well sorted*

c. Maturity - *Submature to Supermature*

d.

VII. **DESCRIPTION**

SAMPLE: FF-37

Qtz	Calcite Cement	Glauc	Replaced Fossil Frag (Calcite)	Ø	Micro Ø	Chlorite	Illite/ Smectite Clays	Pyrite	Zircon	Musco					
51	49														
29	71	2													
34	54		8				4	Tr.							
27	39	18		14		2									
41	44						15		Trace						
48	50					2									
28	33	24					15			Trace					
70	28							~~Tr~~							
23	48	29													
58	40					2									
409	456	73	8	14	—	6	34								1000

Q

	(100)	NORM.
MATRIX:	%	
Q:	40.9 %	100 %
F:	. %	%
R:	%	%
	%	100 %

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-38/6520.8
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	53.8		.06 - .1	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	2.5		.05 - .20	
b. Shell Fragments				
1.				
2.				
c. Muscovite ✓	1.1		.03 - .15	
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz ✓	2.3		.01 - .03	Not common but Just rims are prominent in some places
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	26.7			
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite	6.2		.04 - .1	
b. Illite ✓				
c. Smectite				
d. Chlorite ✓	2.9		.01 - .06	
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary ✓	10		.05 - .15	Original pore space? -
b. Secondary ✓	3.5		✓.02 - .1	- Moldic and within clays -
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
a. Name Quartz Arenite
b. Q: 100 R:________ F:________

VI. **TEXTURE**
a. Sphericity - Subangular
b. Sorting - moderate to well
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: FF-38

Qtz	Calcite Cement	Glauc	Replaced Fossil Frag (Calcite)	Ø	Micro Ø	Chlorite	Illite/Smect Clays	Musco.	Qtz Overgr						
49	43					5			3						
57	23						13	7							
25	49	12				8			6						
67	15						11		7						
20	24	13		25			18								
86	10								4						
60	27					9		4							
59	27					7	4		3						
73	27														
42	32			20			16								
538	267	25	–	45	–	29	62	11	23						1000

MATRIX:	%	NORM.
Q:	53.7 %	%
F:	. %	%
R:	%	%
	%	100 %

Company/Well Name: Shell/Finfrock No. 1-13

Location:

Sample/Depth: FF-39/ 6521.8

Sample Source:

Formation/Age:

Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	48.2		.05 - >2.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	1.4		08-.13	
(Total)				
3. Rock Fragments				
a. Shale ✓	10.0		>.25	The shale and siltstone fragments are actually granule-pebble sized clasts in the conglomerate; They are not included in the classification
b. Chert ✓	3.7		.05 - .20	
c. Carbonate				
d. Siltstone ✓	18.2		>.25	
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	41		.05 -.15	
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	Trace		.01-.02	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	11.7		.01 - .35	This is generally poikilotopic in appearance
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite ✓	1.1		.01 - .06	mostly pore lining - Some appears to almost fill the pores..
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	.9			
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary ✓	.2		.01 - .06	Intergranular
b. Secondary ✓	.5		.01 - .1	Micro Ø w/in the clays and/or
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Litharenite

b. Q: 59.1 R: 39.1 F: 1.8

VI. **TEXTURE**

a. Sphericity - Angular to Subangular

b. Sorting - Very Poor to Poor

c. Maturity - Sub mature

d.

VII. **DESCRIPTION**

SAMPLE: FF-39

Qtz	Calcite Cement	Glaucon	Replaced Foss'l Frag (Calcite)	Ø	Micro Ø	Chlorite	Illite/Smect/Clay	Pyrite	Clay Pebble	RF Siltst	Qtz Clast	Plag F-Spar	RF Chert		
31.	45	8		5	2	3		6							
									100						
89		11													
										100					
											100				
57	13	12				6						12			
15								3		82					
64	16												20		
88		10				2									
38	43											2	17		
382	117	41	—	5	2	11	—	9	100	182	100	14	37		
Q									R	R	Q	F	R		

MATRIX: ______ %

		NORM.
Q:	48.2 %	59.1 %
F:	1.4 %	1.8 %
R:	31.9 %	39.1 %
	81.5 %	100 %

matrix's a Sublitharenite
with pebbles of silt, Chert, Quartz

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-40 / 6524.0'
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	70.4		.03-.7	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	.5		.02-.05	
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale ✓	1.0		.05-.10	
b. Chert ✓	2.8		.07-.18	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	4.5		.04-.15	
b. Shell Fragments ✓	.5		.05-.45	mainly echinoderm plates
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g. Phosphate Nodules	20		.05-.15	Some appear to have been deformed during compaction
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	PC % VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	1.2	.01 - .04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite			
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	5.3	.02 - .25	Pore filling
b. Illite ✓	2.4	.03 - .2	Pore filling
c. Smectite			
d. Chlorite ✓	3.0	.01 - .15	Mostly Pore lining/grain coating but some Pore filling - may be Kaolinite undergoing Chloritization
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary	6.4	.01 - 20	micro ø; Partial dissolution; oversized pores, - some probably primary but due to diss determination of % is inaccurate
c. Fracture			
(Total)			

V. CLASSIFICATION (Folks, 1968)

a. Name Sublitharenite

b. Q: 94.2 R: 5.1 F: .7

VI. TEXTURE

a. Sphericity - Subangular to Subrounded

b. Sorting - Poor

c. Maturity - Submature

d.

VII. DESCRIPTION

SAMPLE: FF-4D

Qtz	Calcite Cement	Glaucon.	Replaced Foss'l Frag (Calcite)	Ø	micro Ø	Chlorite	Clays Illite/ Smectite	RF Chert	Microc F-spar	RF Clay Pebble	Qtz Overgro	Phosphate	Kaolinite		
48		27		5		-							20		
75			5			8	4						8		
77				2		10		11							
84									5				11		
92								8							
18				48			20						14		
82				9				9							
59						4				10	7	20			
91						4					5				
78		18				4									
704	—	45	5	64	—	30	24	28	5	10	12	20	53		1000
								R	F	R					

		NORM.
MATRIX:	____ %	
Q:	70.4 %	94.2 %
F:	0.5 %	.7 %
R:	3.8 %	5.1 %
	74.7 %	100 %

Company/Well Name: Shell/Finfrock No. 1-13
Location:
Sample/Depth: FF-41/6526.3
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	54.9		.08 - >1.0	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.1		.04 - .08	
c. Carbonate				
d. Siltstone ✓	3.8		.08 - .5	S
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	4.3		.1 - .30	
b. Shell Fragments ✓				
1. Echinoderm ✓	6.3		.05 - .85	
2. Bryozoans?				
c. Muscovite ✓	Trace			
d. Biotite				
e. Hematite				
f. Zircon ✓	.2		.01 - .02	
g. Phosphate ✓	1.5		.08 - .5	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	23.8		.01 - .8	Poikilotopic
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	3.1			Pore filling
b. Illite				Pore filling
c. Smectite				
d. Chlorite ✓	.7		.01 - .02	Pore lining, grain coating
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	Trace		.01 - .04	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary ✓	.3		.01 - .09	dissolution of glass + unstable grains
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Sublitharenite
- b. Q: 93.5 R: 6.5 F:

VI. **TEXTURE**
- a. Sphericity - SubAngular - Subrounded
- b. Sorting - Moderate
- c. Maturity - Sub mature
- d.

VII. **DESCRIPTION**

SAMPLE: FF-41

Qtz	Calcite Cement	Glauco	Replaced Fossil Frag (calcite)	Ø	micro Ø	Chlorite	Clays Illite/Smect.	Kaolinite	RF Siltstone	Zircon	Chert				
78	22														
36	47					7		10							
55	21		24												
40	26	31			3										
57	22							21							
81	13		6												
52	8								38	2					
80	20														
56	25	12	7												
14	34		26				15				11				
549 Q	238	43	63	—	3	7	15	31	32 R	2	11				1000

Poikilotopic Cement (Calcite)

MATRIX:	%	NORM.	
Q:	54.9 %	91.8 %	
F:	. %	%	
R:	4.9 %	8.2 %	
	59.8 %	100 %	

Sublitharenite

Company/Well Name: Shell / Fintrock No. 1-13
Location:
Sample/Depth: FF-42 / 6530'
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	58.2		.04 - 2.25	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline ✓	3.2		.2	
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	Trace		.15	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	Trace		.1 - .3	
c. Carbonate				
d. Siltstone ✓				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h. Phosphatic Nodules ✓	8.0		.5 - >2.5	Phosphate (w/ Qtz grains that are <.001 mm in diameter)
(Total)				
4. Other Grains				
a. Glauconite ✓	1.8			
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	1.7		.01-.04	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	.7		.03-.08	calcite crystals but not as poikilotopic or as abundant cement.
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	25.2		-	Pore filling -
b. Illite ✓	1.2		.01-.03	Some in with the Kaolinite -
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. CLASSIFICATION (Folks, 1968)

a. Name Sublitharenite

b. Q: 83.9 R: 11.5 F: 4.6

VI. TEXTURE

a. Sphericity - Sub Angular - Subrounded

b. Sorting - Poor -

c. Maturity - Submature

d.

VII. DESCRIPTION

SAMPLE: FF-42

Qtz	Calcite Cement	Glauco	Replaced Fossil Frag's	ø	micro ø	Illite	Chlorite	RF Siltstone (Phosphate)	Kaolinite	Qtz Overgr.	Calcite Xtal	Microcl. F-Spar	Chert		
12								80	8						
52									36	12					
48						9			43				Trace		
89									4		7				
52									16			32			
69						3			28						
65									35						
47									48	6					
100															
48		18							34						
582	–	18	–	–	–	12	–	80	252	17	7	32			1000
Q								R	M			F			

MATRIX: ______ %

69.4

Q: 58.2 %
F: 3.2 %
R: 8.0 %
91.8 %

NORM.
83.9 %
4.6 %
11.5 %
100 %

Sublitharenite

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-43/6531'
Sample Source: F1
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	70.0		.1 - .8	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	1.5		.08 - .2	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	2.1		.8 - .18	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	1.5		.15 - .4	
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.3		.01 - .02	
g. Phosphate	Trace		.2	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	2.6	.01-.06	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	3.6	.06-.3	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			Only traces of Illite in this Rock -
b. Illite ✓	Trace		
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	.3	.02-.04	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	4.2		Intergranular
b. Secondary ✓	13.9		Enlarged Pores, Partial dissolution primary φ is estimated, due to dissolution actual amount is unknown
c. Fracture			
(Total)			

V. CLASSIFICATION (Folks, 1968)

a. Name Quartzarenite

b. Q: 95.1 R: 2.9 F: 2.0

VI. TEXTURE

a. Sphericity - Subrounded

b. Sorting - Moderate to well sorted

c. Maturity - Submature to Supermature

d.

VII. DESCRIPTION

SAMPLE: FF-43

Qtz	Calc'te Cement	Glauconite	Replaced fossil Frags Calc'te	P Ø2	micro Ø	Chert	Clays Illite smectite	Qtz Overgr	Pyrite	Plag F-Spar	Zircon				
67	5			3 11	12			5							
68				5 22	8		Tr	2							
81	7	15					Tr								
89					7			4							
65				8 24	6		Tr	5							
47					1			2							
44				6 28	4	21	Tr		3						
63				10 10	8			4		15					
62				10 36				2							
64	27				4			2			3				
700	36	15	–	131	50	21	–	26	3	15	3				1000
Q										F					

MATRIX: ______ %

		NORM.
Q:	70.0 %	95.1 %
F:	1.5 %	2.0 %
R:	2.1 %	2.9 %
	73.6 %	100 %

Company/Well Name: Shell / Fintrock No. 1-13
Location:
Sample/Depth: FF-44 / 6532'
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	67.2		.06-.65	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	2.8		.1-.25	
b. Shell Fragments ✓	1.6		.1-.35	
1. Echinoderm Plts ✓				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.5		.01-.04	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	1.7		.01 - .03	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	13.6		.15 - .45	poikilotopic on limited scale; the calcite fills void space and porosity is limited so it fills only some pores.
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite ✓	.7		.05 - .20	Pore filling
c. Smectite				
d. Chlorite ✓	1.1		.01 - .02	grain coating, Pore lining
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	.4		.02 - .05	
c. Organics ✓	.3		.01	Thin long Stringers
d.				
(Total)				
IV. POROSITY				
a. Primary ✓	2.0		.02 - .25	Intergranular
b. Secondary ✓	8.1		.04 - .35	Micro porosity - 1.6% Enlarged Primary Ø due to dissolution 65%
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz arenite

b. Q: 100% R: — F: —

VI. **TEXTURE**

a. Sphericity - Subrounded

b. Sorting - moderate

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: FF-44

Qtz	Calcite Cemen	Glauc	Calcite Replaced Fossil Frags	Ø	micro Ø	Chlorite	Clays Illite/ Smectite	Qtz Overgrw	Pyrite	Plag F-spar	Zircon	Organic? Black Shale			
33	24		5	20	5	3									
73	25							2							
44	19	11	11	9	4				2						
76	18			4	2										
87				5				5			3				
67	21			2			7		1		2				
90				6		4									
72	21							3	1			3			
86					5	2		7							
34	8	17		39		2									
672	136	27	16	85	16	11	7	17	4	—	5	3			1000

Q

MATRIX: ____ % NORM.
Q: 67.2 % 100 %
F: . % ____ %
R: ____ % ____ %
____ % 100 %

Quartz Arenite

Company/Well Name: Shell / Finfrock No.1-13
Location:
Sample/Depth: FF-45/6533.5 ft
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	69.0		.05 - .60	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	2.7		.07 - .30	
b. Shell Fragments	.9		.1 - .40	
1. Echinoderm plates ✓				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.2		.01 - .02	
g. Phosphate ✓	1.0		.08 - .3	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	3.7	.01-.03	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓	6.9	.05-.60	
1. Calcite			
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	2.6	.05-.30	Pore filling due to dissolution of feldspars.
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	5.0	.03-.15	
b. Secondary ✓	8.0	.01-.60	.5% is micro Ø w/in clays other is partial dissolution of grains and Enlarged Intergranular
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Quartz Arenite
- b. Q: 100 R:________ F:________

VI. **TEXTURE**
- a. Sphericity - Subangular - Subrounded
- b. Sorting - Moderate
- c. Maturity - Sub mature
- d.

VII. **DESCRIPTION**

SAMPLE: FF-45

Qtz	Calcite Cement	Glauc	Calcite Replaced fossils	Ø	micro Ø	Kaolinite	Clays Illite/Smectite	Qtz Overgr	Pyrite	Plag F-spar	Zircon	Organic? Black Shale	Phosphate		
68		10		12		2		8							
65	21			11	3										
62	16			20		2									
82				15				3							
80			4	3	2	4		7							
54	28		5	5		8									
48		17		25									10		
79	4			10				5			2				
75				14		7		4							
77				10		3		10							
690	69	27	9	125	5	26	—	37	—	—	2		10		1000

MATRIX: ____ %
Q: 69.0 %
F: . %
R: ____ %
____ %

NORM.
100 %
____ %
____ %
100 %

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-46/6537.8
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	63.0	.05-.70	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline ✓	1.2	.08-.3	
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert ✓	.8	.08	
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	1.0	.08-.35	
b. Shell Fragments ✓			
1. Echinoderm plates ✓	2.6	.06-.35	
2.			
c. Muscovite			
d. Biotite			
e. Hematite			
f. Zircon ✓	.1	.01-.04	
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite			
c. Pseudo matrix			
(Total)			

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	1.0	.01 - .03	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite ✓	23.1	.01 - .65	Pore filling; Poikilotopic
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	2.3	.03 - .3	Pore filling; Between grains
b. Illite ✓	2.5	.05 - .25	Pore filling
c. Smectite			
d. Chlorite ✓	.8	.01 - .04	Pore lining; grain coating
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	.2	.01-.04	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	.3	.02 - .04	Very small intergranular
b. Secondary ✓	1.1	.01 - .35	micro ϕ - .2, Enlarged intergranular porosity -
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz Arenite

b. Q: 96.9 R: 1.3 F: 1.8 (Normalized values)

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Moderate

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: FF-46

Qtz	Calcite Cement	Glauc	Calcite Replaced fossils	Ø	Micro Ø	Kaolinite	Clays Illite Smect.	Qtz Overgw	Pyrite	Chert	Zircon	Microc F-spar	chlorite		
59	41														
79	14					1		4					2		
66	21			10		3									
74	20								2		1		3		
57	35									8					
80						13	7								
52	21		12	2	2	2		6					3		
57	21						10					12			
51	27	10				4	8								
55	31		14												
630	231	10	26	12	2	23	25	10	2	8	1	12	8		1000

	MATRIX: ____ %	NORM.
Q:	63.0 %	96.9 %
F:	1.2 %	1.8 %
R:	.8 %	1.3 %
	65 %	100 %

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-47 / 6539.8
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	58.8		.08-.85	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	1.5		.15-.25	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic ✓	1.4		.4	
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	7.3		.15-.35	
b. Shell Fragments ✓				
1. Echinoderm ✓	3.6		.08-.16	
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	2.3		.01-.05	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	16.9		.05-.55	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	2.0		.03-.20	Pore filling
b. Illite ✓	2.1		.02-.20	Pore filling
c. Smectite				
d. Chlorite ✓	.5		.01	grain coating
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	.4		.01-.04	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary	.4		.01-.04	Small Intergranular
b. Secondary	2.8		.01-.11	Micro Ø, .5% Enlarged Intergranular due to Partial dissolution 2.3%
c. Fracture				
(Total)				

V. CLASSIFICATION (Folks, 1968)

a. Name Quartz arenite

b. Q: 95.3 R: 2.3 F: 2.4

VI. TEXTURE

a. Sphericity - Subangular - Subrounded

b. Sorting - Moderate - well

c. Maturity - Submature to Supermature

d.

VII. DESCRIPTION

SAMPLE: FF-47

Qtz	Calcite Cement	Glauc	Calcite Replaced fossil	Ø	Micro Ø	Kaolinite	Clays Illite/ Smectite	Qtz Overgw	Pyrite	Plag F-spar	Zircon	Volcanic Rock Frag	Chlorite		
58	20		11		2	6		3							
70		3		10	3	1						14			
34	34	24	7										2		
61	19	13				7							1		
18	60		18						4						
77						5		3		15					
43	18	17					16	4					2		
72		16		8				4							
77	9			6		2		4							
78	9			3			5	5							
588	169	73	36	27	5	20	21	22	4	15	–	14	5		

		NORM.
MATRIX:	____ %	
Q:	58.8 %	95.3 %
F:	1.5 %	2.4 %
R:	1.4 %	2.3 %
	61.7 %	100 %

Company/Well Name: Shell / Finfrock No. 1-13
Location:
Sample/Depth: FF-48/6540.8
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	38.5		.03-1.0	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	1.1		.20	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.4		.15-.40	
c. Carbonate				
d. Siltstone ✓	10.0		.60-1.7	
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	1.5		.1-.55	
b. Shell Fragments ✓	6.4		.1-.35	
1. Echinoderm plates				
2.				
c. Muscovite ✓	.5			
d. Biotite				
e. Hematite				
f. Zircon ✓	Trace		.01-.03	
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	0.3		.01-.04	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓				
1. Calcite ✓	31.2		.02-.85	Poikilotopic
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite ✓	.3		.01	Pore lining; Between grains
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	6.5		.03-.08	
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary				
b. Secondary	.3		.03-.08	dissolution
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
- a. Name Sublitharenite
- b. Q: 75.5 R: 22.3 F: 2 2

VI. **TEXTURE**
- a. Sphericity - Subrounded
- b. Sorting - Poorly Sorted
- c. Maturity - Submature
- d.

VII. **DESCRIPTION**

SAMPLE: FF-48

Qtz	Calcite Cement	Glauc	Calcite Replaced Fossils	Ø	Micro Ø	Chlorite	Clays Illite Smect.	Qtz Overgw	Pyrite	Plag F-Spar	Zircon	RF Shst Pebble	RF Chert	Musc	
38	60								2						
91	9														
	87		8						5						
47	32			3		3			4	11					
												100			
	41		38						7				14		
57	4							3	36						
28	28	15					20		4					5	
100															
24	51		18						7						
383	312	15	64	3	—	3	20	3	65	11	—	100	14	5	1000

		NORM.
MATRIX:	___ %	
Q:	38.5 %	75.5 %
F:	1.1 %	2.2 %
R:	11.4 %	22.3 %
	51.0 %	100 %

Company/Well Name: Shell / Fintrock No. 1-13
Location:
Sample/Depth: FF-49/6542.3
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline				
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite				
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite				
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary				
b. Secondary				
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)

a. Name

b. Q:________ R:________ F:________

VI. **TEXTURE**

a. Sphericity -

b. Sorting -

c. Maturity -

d.

VII. **DESCRIPTION**

SAMPLE: FF-49

Micrite Mud	Calcite Replaced Fossil F.	ϕ	Pyrite	Dolomite											
10	12			78											
19	49			32											
26	10			64											
31	27		5	37											
	100														
10	42			48											
15	64			21											
7	63			30											
4	38	3	5	50											
17	46			37											
139	451	3	10	397	—										1000

MATRIX:	%	NORM.
Q:	%	%
F:	%	%
R:	%	%
	%	100 %

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-50/4715'
Sample Source:
Formation/Age:
Petrographer:

	PC % VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline ✓	66.8	.05 - 2.0	
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert ✓	1.8	.15 - .45	
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	2.4	.03 - .1	much of the glauconite is only remnants of the original grain; the dissolved portion is now represented primarily by porosity.
b. Shell Fragments			
1.			
2.			
c. Muscovite			
d. Biotite			
e. Hematite			
f. Zircon			
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite			
c. Pseudo matrix			
(Total)			

	% PC	% VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**				
1. Cement				
a. Quartz ✓	2.0		.01 - .03	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates				
1. Calcite ✓	14.2		.03 - .35	
2. Dolomite				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	2.9		.03 - .35	Pore filling;
b. Illite ✓	1.3		.03 - .15	Pore filling
c. Smectite				
d. Chlorite ✓	.6		.01 - .02	Grain coating
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite ✓	.2		.01 - .03	
c. Organics				
d.				
(Total)				
IV. **POROSITY**				
a. Primary	1.0		.02 - .05	small intergranular
b. Secondary	6.8		.01 - .45	micro φ - .6% partial and complete dissolution of grains as well as enlargement of pores 6.2%
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
a. Name Quartz Arenite
b. Q: 97.4 R: 2.6 F: ________

VI. **TEXTURE**
a. Sphericity - SubAngular - Subrounded
b. Sorting - Poor
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: KY-50

Qtz	Dolomite Cement	Glauc	Calcite Replaced Fossils	Ø	Micro Ø	Chlorite	Clays Illite/ Smect	Qtz Overgw	Pyrite	Plag F-spar	Zircon	Kaolin	chert		
38	45	12		5											
83	11							6							
78	20						2								
63	7			3	2	4	7					14			
52				22		2	4		2				18		
68	32														
76	3			21											
55	24			12				6				3			
84					4							12			
71		12		9				8							
668	142	24	—	112	6	6	13	20	2	—	—	29	1.8		1000

		NORM.
MATRIX:	____ %	
Q:	66.8 %	97.4 %
F:	. %	%
R:	1.8 %	2.6 %
	68.6 %	100 %

Quartz Arenite

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-51/4716.9
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	56.1			
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite	Trace		.05	The original grain is dissolved almost entirely and is now Kaolinite and ϕ
b. Shell Fragments ✓	3.6		.06-.20	
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.2		.01-.03	
g. Phosphate	.5			
(Total)			.03-.1	
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. **DIAGENETIC CONSTITUENTS**			
1. Cement			
a. Quartz ✓	1.0	.01-.04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite	27.0	.02 - .50	
2. Dolomite ✓			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	6.2	.05 - .60	Pore filling
b. Illite ✓	.3	.06	Pore fill
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. **POROSITY**			
a. Primary			
b. Secondary ✓	5.1	.01 - .35	Micro ϕ - .5%; any primary ϕ has been enlarged beyond recognition or obliterated w the carbonate cement
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz Arenite

b. Q: 100 R:________ F:________

VI. **TEXTURE**

a. Sphericity - Subangular to Subrounded

b. Sorting - Poorly Sorted

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: KY-51

Qtz	Dolomite Cement	Glauc	Calcite Replaced Fossils	Ø	Micro Ø	Chlorite	Clays Illite/ Smectite	Pyrite	Phosphate	Zircon	Kaolinite	Calcite Xtal in	Qtz Overgrw		
30	4											66			
58	36				3		3		Trace						
97													3		
56	4			40											
12	52		36												
29	39										32				
45	34				2				5		12		2		
98													2		
58	16			6						2	18				
78	19												3		
561	224	[illegible]	3.6	4.6	5		3	—	5	2	62	.66	10		1000

MATRIX: ____ % NORM.
Q: 56.1 % 100 %
F: . % ____ %
R: ____ % ____ %
____ % 100 %

Quartz Arenite

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-52 / 4720'
Sample Source:
Formation/Age:
Petrographer:

	% PC VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS			
1. Quartz			
a. Monocrystalline	62.0	.08 - 3.5	Some very large, granule - pebble sized grains
b. Polycrystalline			
c.			
(Total)			
2. Feldspar			
a. Microcline			
b. Orthoclase			
c. Sanidine			
d. Plagioclase			
(Total)			
3. Rock Fragments			
a. Shale			
b. Chert			
c. Carbonate			
d. Siltstone			
e. Metamorphic			
f. Plutonic			
g. Volcanic			
h.			
(Total)			
4. Other Grains			
a. Glauconite ✓	Trace	.05 - .1	These grains were originally up to .5 mm but are weathered or dissolved and now are represented by φ; and to a lesser degree carbonate cement.
b. Shell Fragments ✓	5.5	.07 - 3.0	
1. Echinoderm plates ✓			
2. Bryozoan	Trace		
c. Muscovite ✓	.4	.02 - .30	
d. Biotite			
e. Hematite			
f. Zircon ✓	.1	.01 - .02	
g.			
(Total)			
II. DETRITAL MATRIX			
a. Chlorite			
b. Illite			
c. Pseudo matrix			
(Total)			

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	1.4	.01 - .04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite	17.8	.05 - 1.0	
2. Dolomite			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	8.4	.05 - 1.5	Pore filling
b. Illite ✓	1.2	.03 - .5	Pore filling
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary ✓	3.2	.01 - .65	Micro ϕ - .4%, dissolution/Partial dissolution, and Elarged Intergranular 2.8% - No Primary is recognized
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz Arenite

b. Q: 100 R:________ F:________

VI. **TEXTURE**

a. Sphericity - Subangular - Subrounded

b. Sorting - Very Poorly - Poorly Sorted

c. Maturity - Submature

d.

VII **DESCRIPTION**

SAMPLE: KY-52

Qtz	Dolomite Cement	Glauc	Calcite Replaced F.F.	Ø	micro Ø	Chlorite	Clays Illite Smect.	Zircon	Kaolin	Qtz Overgw	musco				
66	14								20						
100															
18	27		55												
85	9									6					
81	15	Trace								4					
59	26			2				1	4	4	4				
50	10								40						
39	44	Trace		17											
72	6			6	4		12								
50	27			3					20						
620	178	—	55	28	4		12	1	84	14	4				1000

MATRIX: ______ %
Q: 62.0 %
F: · %
R: ______ %
______ %

NORM.
100 %
______ %
______ %
100 %

Company/Well Name: Gulf /C.C. Kelly No. 1
Location:
Sample/Depth: KY-53/4722.3
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	39.2		.1 - 2.6	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	.3		.08 -.3	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.6		.1 - .45	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	10.1		.1 - .60	
b. Shell Fragments				
1. Echinoderm plates ✓	Trace		.2	
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g. Phosphate	9.2		.3 - 5.0 mm	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	25.9		more of a micrite mud or microcrystalline carbonate.
2. Dolomite ✓	11.7		
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	2.0	.05 - .55	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968)
a. Name Quartz Arenite
b. Q: 95.4 R: 3.9 F: .7

VI. **TEXTURE**
a. Sphericity - Subangular - Subrounded
b. Sorting - Poor
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: KY-53

Qtz	Calcite Cement	Glauc	Calcite Replaced F.F		Micro Ø	Chert	Clays Illite/Smecti	Zircon	Kaolini	Qtz Overgw	musco	Pyrite	Phosphate Nodule	Plag F-spar	
2	27	37		34											
64	14	12		10											
	8												92		
100															
52	24			24											
70	17			10								3			
15	33	52													
60	16			11								10		3	
12	50			15		16						7			
17	70			13											
398	259	101	—	117	—	16	—	—	—	—	—	20	92	3	1000

MATRIX: ______ %

		NORM.
Q:	39.2 %	95.4 %
F:	.3 %	.7 %
R:	1.6 %	3.9 %
	41.1 %	100 %

Quartz arenite

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-54 / 4723
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	50.7		.1-.8	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase ✓	3.3		.1-1.5	
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone ✓	10.0		2.7	
e. Metamorphic ✓	10.0		8mm	- RF has Schistose banded Appearance -
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments ✓				
1. Echinoderm plate	Trace		.7	
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g. Phosphate	.8		1-5	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	PC % VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite ✓	16.7	01-.5 mm	- micritic microcrystalline
2. Dolomite ✓	7.6		
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite			
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	.9	.02 - .06	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary			
b. Secondary			
c. Fracture			
(Total)			

V. **CLASSIFICATION** (Folks, 1968) Phyllarenite

a. Name

b. Q: 68.5 R: 27.0 F: 4.5

VI. **TEXTURE**

a. Sphericity - Subrounded to Subangular

b. Sorting - Very Poorly to Poorly Sorted

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: KY-54

Qtz	(Micrite mud) Calcite Cement	Glauc	Replaced Calcite F. Frag	Chlorite	Pyrite	Phosphat	Plag F-spar	Phosphate matrix & Siltstone	Metamor R.F.	Dolomi Cement					
6	74									20					
87	10									3					
78	7				3	8				4					
26	71				3					27					
44	11				3		33			7					
100															
75	12									13					
								100							
91	9														
507	167	—	—	—	7	2	33 —	100	100	7.0					1000

MATRIX: ____ %

Q: 50.7 %

74 F: 3.3 %

R: 20.0 %

74.0 %

NORM.

68.5 %

4.5 %

27.0 %

100 %

Company/Well Name: Gulf / C.C Kelly No. 1
Location:
Sample/Depth: KY-55 / 4724.8
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	59.7		.06 - 2	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments ✓	3.6			
1. Echinoderm plates			.3 - .6	
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g. Phosphate	Trace		.23	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	% VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. <u>Cement</u>				
a. Quartz				
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓				
1. Calcite				
2. Dolomite ✓	25.8		.03 - 1.5 mm	
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. <u>Authigenic Clays</u>				
a. Kaolinite-Dickite ✓	6.3		.1 - .35	Pore filling
b. Illite				
c. Smectite				
d. Chlorite ✓	.4		.01 - .02	Pore lining, Grain Coating
e. Mixed-Layered				
f.				
(Total)				
3. <u>Others</u>				
a. Zeolites				
b. Pyrite ✓	.4		.01 - .04	
c. Organics				
d.				
(Total)				
IV. POROSITY				Primary Ø is not readily recognized due to dissolution and carbonate precipitation much of it's gone; There are enlarged pores, dissolved grains and micro Ø, as well as Partial dissolution of grains
a. Primary				
b. Secondary ✓	3 8			
c. Fracture				
(Total)	3.8			

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz arenite

b. Q: 100 R:________ F:________

VI. **TEXTURE**

a. Sphericity - Subrounded to Subangular

b. Sorting - Poorly Sorted

c. Maturity - Submature

d.

VII. **DESCRIPTION**

SAMPLE: KY-55

Qtz	Dolomite Cement	Replaced F.Frag Calcite	Chlorite	Pyrite	Phosphate	Kaolinite	Ø	micro Ø	Illite/Smectite Clays						
48	15		4				33								
74	26														
62	38														
30	43					27									
87	13														
45	55														
76	24														
94	6														
	32	27				36		5							
81	6	9		4											
597	258	30	4	4	—	63	33	5	—						1000

MATRIX: ____ %

		NORM.
Q:	59.7 %	100 %
F:	. %	%
R:	%	%
	%	100 %

Quartz Arenite

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-56 / 4727.4
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	75.4		.1 - 2.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.9		.1 - .65	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments ✓	2.8		.15 - .60	
1. Echinoderm plates				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g. Phosphate	Trace		.08 - .65	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	.4	.01 - .04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite	15.3	.1 - 1.2	
2. Dolomite ✓			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	3.2	.08 - .50	Pore filling
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d. ~~Also~~			
(Total)			
IV. POROSITY			
a. Primary	.2	.02 - .06	Intergranular
b. Secondary	8	.01 - .35	Enlarged pores, partial dissolution and dissolution of grains - .6%
c. Fracture			micro ∅ .2%
(Total)	1.0		

V. CLASSIFICATION (Folks, 1968)

a. Name Quartz Arenite

b. Q: 97.5 R: 2.5 F: ____

VI. TEXTURE

a. Sphericity - Subangular

b. Sorting - Poorly to moderately sorted

c. Maturity - Submature

d.

VII. DESCRIPTION

SAMPLE: KY-56

Qtz	Dolomite Cement	Replaced F. Frag Calcite	Chlorite	Pyrite	Kaolinite	Illite/ Smectite Clays	Micro Ø	Ø	Qtz Ovrgw	Chert.					
100															
82					14		4								
82	18														
49	38				11			2							
95								3	2						
51	30									19					
54	18	28													
100															
76	17				7										
65	3[illegible]							1	2						
754	153	[illegible]2	—	—	3[illegible]	—	4	6	4	19					1000

MATRIX: ______ %

		NORM.
Q:	75.4 %	97.5 %
F:	· %	%
R:	1.9 %	2.5 %
	77.3 %	100 %

Quartz Arenite

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Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-57 / 4727.4
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	70 S		.06 - 2.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	Trace		.07 - .75	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC	VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS				
1. Cement				
a. Quartz ✓	1.2		.01-.04	
b. Opal				
c. Chalcedony				
d. Feldspar				
e. Carbonates ✓				
1. Calcite ✓	23.4		.05-1.7	
2. Dolomite ✓				
3. Siderite				
f. Hematite				
g. Limonite				
h. Phosphate				
i. Gypsum				
j. Anhydrite				
k. Barite				
l.				
m.				
(Total)				
2. Authigenic Clays				
a. Kaolinite-Dickite ✓	2.2		.08-1.50	Pore filling
b. Illite				
c. Smectite				
d. Chlorite				
e. Mixed-Layered				
f.				
(Total)				
3. Others				
a. Zeolites				
b. Pyrite				
c. Organics				
d.				
(Total)				
IV. POROSITY				
a. Primary ✓	.7		.01-.15	Intergranular
b. Secondary ✓	2.0		.01-.50	Enlarged Primary Ø 1.2% micro Ø .8%
c. Fracture				
(Total)				

V. **CLASSIFICATION** (Folks, 1968)
a. Name Quartz Arenite
b. Q: 100 R:________ F:________

VI. **TEXTURE**
a. Sphericity - Subangular to Subrounded
b. Sorting - Very Poor to Poor
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: KY-57

Qtz	Dolomit Cement	Replaced F. Frag Calcite	Kaolinite	Clays Illite/Smectite	Chlorite	Micro Ø	Ø	P	Qtz Ovrgw							
48	50						2									
62	38															
83	14								3							
55	45															
89							8	3								
68	14		6				8	4								
87			8			2			3							
19	73		8													
100																
94									6							
705	234	—	22	—		2	25		12							1000

MATRIX:	— %	NORM.	
Q:	70.5 %	100 %	
F:	. %	%	
R:	%	%	
	%	100 %	

Quartz Arenite

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-58 / 4734.9
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	62.2		.04 - 2.25	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert ✓	1.4		.06 - .25	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	0.2			
g. Phosphate	10.0		.15 - 8	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix (Black Shale)				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	2.0	.01 - .04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite	5.2	.04 - .30	
2. Dolomite ✓			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	9.1	.04 - >1mm	Pore filling
b. Illite ✓	3.5	.04 - .5	Pore filling
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	Trace	>.01	
c. Organics (Black shale)	55	.05 - .45 Thick	- Long Stringers w/ <.01 mm sized appearing random In the shale
d. (w/ Pyrite Traces)			
(Total)			
IV. POROSITY			Intergranular
a. Primary ✓	.2		
b. Secondary ✓	.7		Micro ϕ - .3%; Partial diss; diss, and Enlarged Intergranular - .4%
c. Fracture			
(Total)	.9		

V. CLASSIFICATION (Folks, 1968)

a. Name Quartz Arenite

b. Q: 97.8 R: 2.2 F: ________

VI. TEXTURE

a. Sphericity - Sub Angular

b. Sorting - Poorly - very Poorly Sorted

c. Maturity - Submature

d.

VII. DESCRIPTION

SAMPLE: KY-58

Qtz	Dolomite Cement	Kaolinite	Chlorite	Clays Illite Smectite	Micro Ø	Ø	Qtz Overgrowth	Organic? Black Sh	RF Chert	Zircon	Large Phosphate Pebble	Pr. Ø			
38				7				55							
73		25					2								
61		14			3	4			14	2		2			
70		15		15											
											100				
48	44	8													
88		12													
62	8	17		13											
94							6								
88							12								
600	52	91	–	35	3	4	20	55	14	2	100	2			1000

	MATRIX: %	NORM.
Q:	62.2 %	97.8 %
F:	. %	%
R:	1.4 %	2.2 %
	63.6 %	100 %

Company/Well Name: Gulf / C.C. Kelly No.1
Location:
Sample/Depth: KY-59/4735.9'
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	64.3		.04 - 1.1	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite ✓	1.6		.08 - .25	
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon ✓	.3		.01 - .02	
g. Phosphate	7.2		.6 - .75	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	PC % VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	1.0	.01-.04	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates			
1. Calcite			
2. Dolomite			
3. Siderite			
f. Hematite ✓	16.1	.01-.2	
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	6.0	.05-.6	Pore filling
b. Illite ✓	1.3	.03-.2	Pore filling
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite ✓	1.1	.02-.25	
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	.4	.01-.04	Small, intergranular -
b. Secondary ✓	.7	.01-.20	.2%-micro ø; Enlarged Primary ø
c. Fracture			
(Total)	1.1		

V. **CLASSIFICATION** (Folks, 1968)

a. Name Quartz Arenite

b. Q: 100 R:________ F:________

VI. **TEXTURE**

a. Sphericity - Angular - SubAngular

b. Sorting - moderate to well Sorted

c. Maturity - Submature to Supermature

d.

VII. **DESCRIPTION**

SAMPLE: KY-59

Qtz	Calcite Cement	Kaolinite	Chlorite	Clays Illite/Smectite	Prim Ø	Ø	Qtz Overgrth	Hemat	Pyrite	Zircon	Nodule Phosphat	Glauc			
67		3			4			26							
59		10					4	23	4						
58		18						21		3					
93								7							
77		8		10			3		2						
20		8									72				
97								3							
65								35							
47		13		3				32	5						
60						7	3	14				16			
643	—	60		13	4	7	10	161	11	3	72	16			1000

		NORM.
MATRIX:	%	
Q:	64.3 %	100 %
F:	%	%
R:	%	%
	64.3 %	100 %

Company/Well Name: Gulf / C.C. Kelly No. 1
Location:
Sample/Depth: KY-60 / 4738.2
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline ✓	64.6		.08 - 2.0	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert				
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments ✓	5.1		30 - .80	
1. Echinoderm plates				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon				
g.				
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz			
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite	22.5	.03 - 1.5 mm	
2. Dolomite ✓			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	3.6	.15 - .65	
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	.4	04 - .1	Intergranular
b. Secondary	3.8	.01 - .5	Micro Φ - 5%, Enlarged Intergranular and dissolved grains - 3.3%
c. Fracture			
(Total)	4.2		

V. **CLASSIFICATION** (Folks, 1968)
a. Name Quartz Arenite
b. Q: 100 R:______ F:______

VI. **TEXTURE**
a. Sphericity - Subangular - Subrounded
b. Sorting - Poorly to very Poorly Sorted
c. Maturity - Submature
d.

VII. **DESCRIPTION**

SAMPLE: KY-60

Qtz	Dolomite Cement	Replaced Fossil Frags Calcite	Chlorite	Clays Illite/smectite	Micro Ø	Ø	Qtz Ovrgrth	Kaolinite	Prim Ø						
77	13					10									
80	10					10									
56	24	13				7									
70	28					2									
54	34				5			5	2						
61	26	13													
26	23	25						24	2						
77	20							3							
90	10														
55	37					8									
640	225	51	—		5	37		32	4						1000

MATRIX: ______ % NORM.
Q: 64.6 % 100 %
F: . % ______ %
R: ______ % ______ %
64.6 % 100 %

Company/Well Name: Gulf / C. C Kelly No. 1
Location:
Sample/Depth: KY-61 / 4739.8
Sample Source:
Formation/Age:
Petrographer:

	% PC	% VE	Size (mm)	Remarks
I. DETRITAL CONSTITUENTS				
1. Quartz				
a. Monocrystalline✓	72.4		.06 - 2.5	
b. Polycrystalline				
c.				
(Total)				
2. Feldspar				
a. Microcline				
b. Orthoclase				
c. Sanidine				
d. Plagioclase				
(Total)				
3. Rock Fragments				
a. Shale				
b. Chert✓	3.2		.08 - .65	
c. Carbonate				
d. Siltstone				
e. Metamorphic				
f. Plutonic				
g. Volcanic				
h.				
(Total)				
4. Other Grains				
a. Glauconite				
b. Shell Fragments				
1.				
2.				
c. Muscovite				
d. Biotite				
e. Hematite				
f. Zircon✓	1.0		.01 - .04	
g. Phosphate	1.6		.1 - .37	
(Total)				
II. DETRITAL MATRIX				
a. Chlorite				
b. Illite				
c. Pseudo matrix				
(Total)				

	% PC VE	Size (mm)	Remarks
III. DIAGENETIC CONSTITUENTS			
1. Cement			
a. Quartz ✓	.6	01 - 03	
b. Opal			
c. Chalcedony			
d. Feldspar			
e. Carbonates ✓			
1. Calcite	12.6	.05 - .55	
2. Dolomite ✓			
3. Siderite			
f. Hematite			
g. Limonite			
h. Phosphate			
i. Gypsum			
j. Anhydrite			
k. Barite			
l.			
m.			
(Total)			
2. Authigenic Clays			
a. Kaolinite-Dickite ✓	.9	.2 - 1.35	under plain polarized light the clay has a greenish tint - ? Chloritization of Kaolinite may be a Possibility - Mike Kuykendal 92
b. Illite			
c. Smectite			
d. Chlorite			
e. Mixed-Layered			
f.			
(Total)			
3. Others			
a. Zeolites			
b. Pyrite			
c. Organics			
d.			
(Total)			
IV. POROSITY			
a. Primary ✓	Trace	.01 - .04	Intergranular
b. Secondary ✓	7.7	.01 - 1.0	micro Ø - 1.5% Enlarged Primary due to Partial diss, dissolution + Partial diss - 6.2%
c. Fracture			
(Total)	7.7		

V. CLASSIFICATION (Folks, 1968)

a. Name Quartz Arenite

b. Q: 95.8 R: 4.2 F:

VI. TEXTURE

a. Sphericity - Subrounded

b. Sorting - moderately to Poorly Sorted

c. Maturity - Submature

d.

VII. DESCRIPTION

SAMPLE: KY-61

Qtz	Dolomite Cement	Replaced Fossil Frags Calcite	Clays Illite/ Smectite	Micro Ø	Ø	Qtz Overgrow	Kaolinite	Prim Ø	Zircon	Phosphate	Chert				
12	81				7										
100															
61	24				11				4						
97									3						
72				8	17	3									
77					4	3				16					
99									1		32				
73				7	20										
67	21				3		9								
98									2						
724	12.0	—	—	15	62	0	9	Tr	10	16	3.2				1000

		NORM.
MATRIX:	%	
Q:	72.4 %	95.8 %
F:	· %	%
R:	3.2 %	4.2 %
	75.6 %	100 %

APPENDIX D

EXPLANATION OF THE STRATIGRAPHIC MARKER-BEDS

Stratigraphic markers used for correlation and mapping are the base of the Lower Morrow (Keyes) sandstone (the lowest mapped surface), a limestone/sandstone marker selected to delineate the top of the Lower Morrow section, and the base of the Thirteen Finger Limestone, to show the top of the complete Morrow section (Figure 3).

In many places the Keyes sandstone is the lowest rock in the Pennsylvanian System. The limestone marker next below the Keyes sandstone has been used for mapping of the Mississippian/Pennsylvanian unconformity (Swanson, 1979; Kwaika, 1973, Figure 4). Such interpretation of this limestone as a marker is questionable. The basal unit of the No. 1-13 Finfrock core is greenish-gray shale (Figures 46 a and b). Within this shale are abundant Archimedes bryozoans, both complete and in pieces. Archimedes has been used as a guide fossil (Dott and Batten, 1981, p. 349). However, the range of Archimedes is from Mississippian to Permian (Moore, et al., 1952, p. 172; Clarkson, 1979, p. 100). The abundance of Archimedes suggests that the basal shale of the No. 1-13 Finfrock core is Mississippian (Boardman, 1992).

The upper boundary of the Lower Morrow section was considered to be the base of a relatively consistent limestone/sandstone marker (Figure 3). It is subparallel to most marker-beds in the overlying and underlying sets of strata (Plates XII-XIX), and is subparallel to the base of the Thirteen Finger Limestone. Of all ad hoc marker-beds considered, it is more consistently correlatable.

The top of Morrowan rocks commonly is correlated and mapped as the base of the Thirteen Finger Limestone (Dobervich and Parker, 1958, p. 9; Khaiwka, 1973, p. 172; Benton, 1972, p. 2; etc.). Four lines of evidence seem to justify this practice : (1) Thirteen Finger Limestone represents approximately time equivalent deposition, according to Forgotson et al., 1966, p. 521; (2) the wireline-log response is distinctive (Munson, 1989, p. 5); (3) the Thirteen Finger Limestone is widespread (Munson, 1989, p. 5; and (4) the contact of the limestone and the underlying shale is considered to be conformable throughout most of the general area by many authors (Benton, 1972, p. 2). However, the fact that caliche is present at the top of the Morrow section, or at least very near to the top in the No. 101 Stonebraker "A" core as well as information on sea-level changes in Ross and Ross, 1988, p. 227-248, tend to support the idea that this contact is in the least locally if not regionally disconformable.

Abels (1959, p. 94) described Morrowan rocks as being overlain unconformably by the "Thirteen Finger Limestone." However, the contact between the Morrow and the Thirteen Finger Limestone is conformable at many places in northwestern Oklahoma (Swanson, 1979, p. 117; Forgotson, 1966, p. 521). In either case, designation of the Thirteen Finger Limestone as the base of Atokan rocks has much practical value for mapping thickness and distribution of Morrowan strata.

APPENDIX E

DEFINITIONS OF ABBREVIATIONS

This appendix lists and explains the abbreviations used on cross sections.

ACFR: acid fracture treatment

BBLS: barrels

BC: barrels of condensate

BD: barrels of distillate

BO: barrels oil

BOPD: barrels oil per day

BOPH: barrels oil per hour

BW: barrels of water

C: condensate

CC: cubic centimeter

CK: choke

CM: centimeters

DST: drill-stem test

FSIP: final shut-in pressure

G: gas

GALS: gallons

GCM: gas-cut mud

GCW: gas-cut water

HGCMO: heavily gas-cut mud

HGMO: heavily gas-cut mud

HRS: hours

INIT: initial

IP: initial potential

IPF: initial potential flowing

IPP: initial production pumping

ISIP: initial shut-in pressure (DST)

ITD: intention to drill

LBS: pounds

M: meter

MA: massive anhydrite, mud acid, milliampere

MCFD: thousand cubic feet per day

M&OCW: mud- and oil-cut water

MW: muddy water

O: oil

OCW: oil-cut water

O&G: oil and gas

O&GCM: oil- and gas-cut mud

PERF: perforations

POT: potential

PROD: produced or production

PST: potential shut-in test

PTF: potential test flowed

REC: recovery, recovered

SAFR: sand fracture

SGCW: slightly gas-cut water

SOFR: sand-oil fracture

SWFR: sand-water fracture

TD: total depth

WCM: water-cut mud

WM: water-cut mud

XW: mixed water

VITA

Larry D. Gerken

Candidate for the Degree of

Master of Science

Thesis: MORROWAN SANDSTONES IN SOUTH-CENTRAL TEXAS COUNTY, OKLAHOMA

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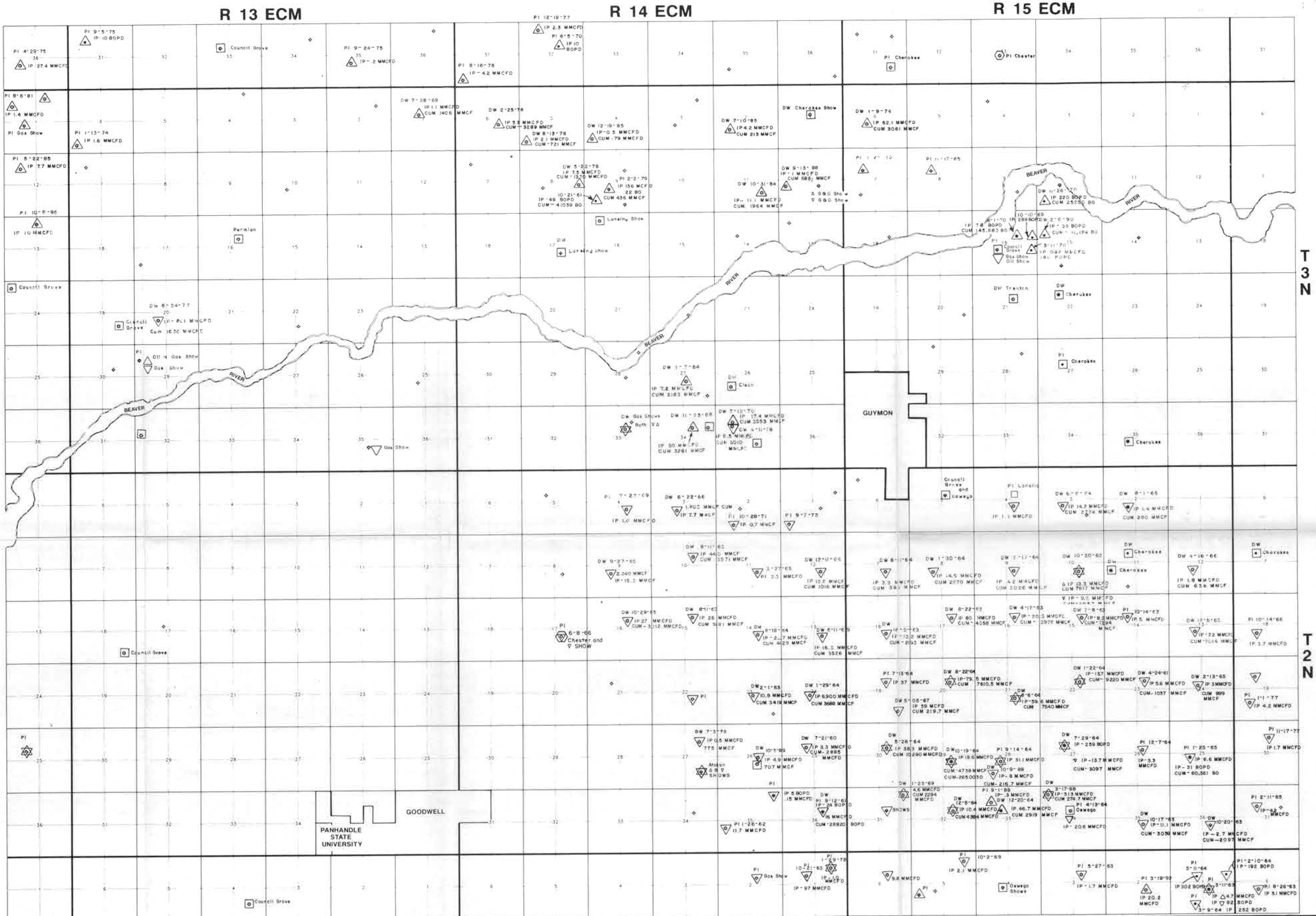
Education: Graduated from Okeene High School, May, 1982; received Bachelor of Science Degree in Geology from Oklahoma State University in May, 1988; completed requirements for the Master of Science Degree at Oklahoma State University in July, 1992.

Professional Organizations: Member of American Association of Petroleum Geologists since 1989 and Society of Exploration Geophysics since 1990.

Professional Experience: Employed as geologist from February, 1990 to April, 1991, with Masera Corp., Tulsa, Oklahoma; from April, 1991, to July, 1991, with Unocal, Oklahoma City, Oklahoma; from July, 1991 to present with Masera Corp., Tulsa, Oklahoma.



LEGEND

D▽ Denotes Dwights Data
PI▽ Denotes Petroleum Information Data
□ Production above Morrow: Atokan - Younger
✡ Upper & Lower Morrow Production
△ Upper Morrow
▽ Lower Morrow (Keyes)
⬡ Mississippian or Older -
All gas reported in MMCFD or MMCF
All oil reported in BOPD or BO
Initial Potential Data - MMCFPD or BOPD

PRODUCTION MAP

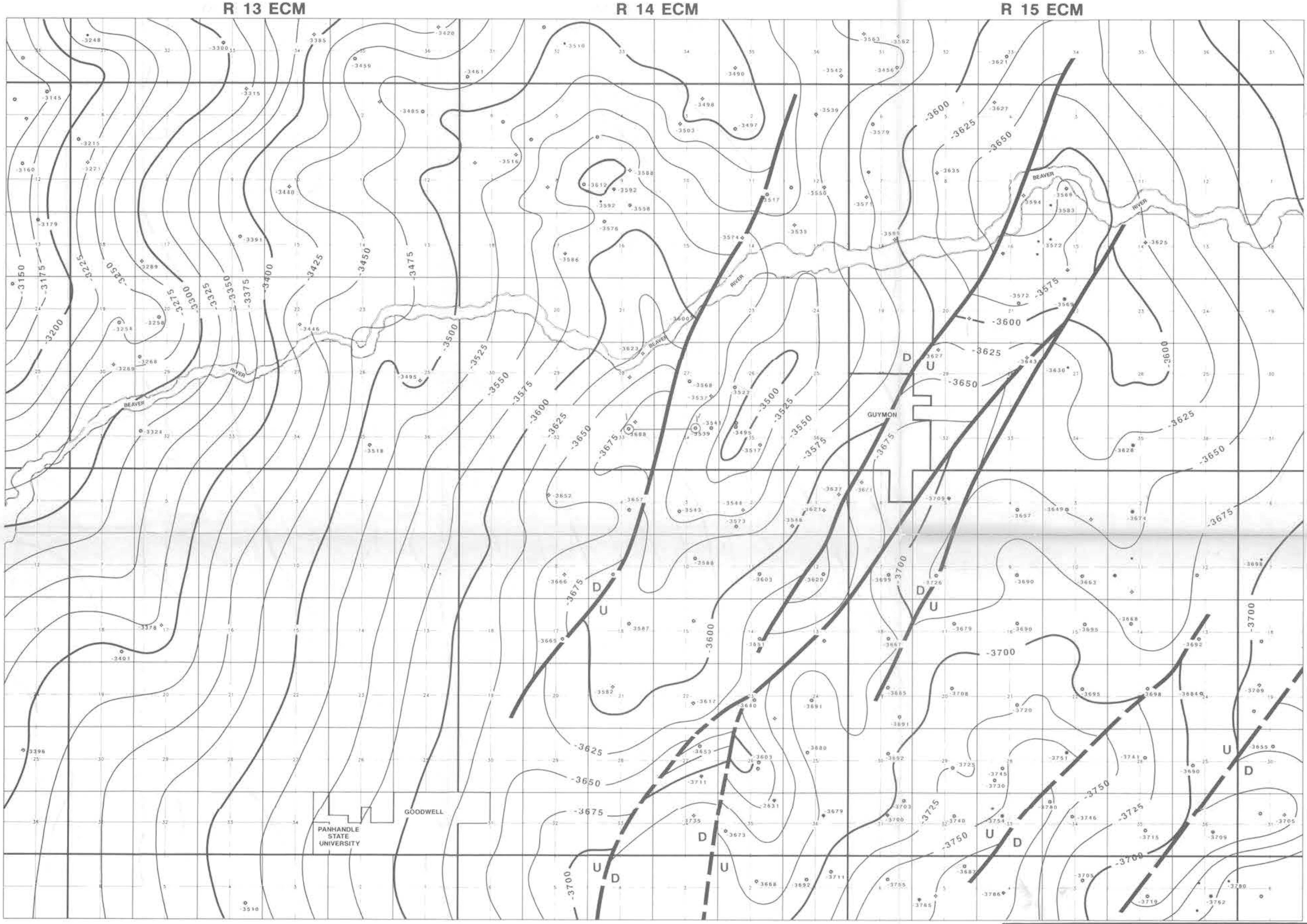
0 1 2 3 miles
SCALE IN MILES

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE I

L. D. GERKEN

1992



STRUCTURE MAP

AT BASE OF MORROWAN INTERVAL

CI = 25 FT

0 1 2 3 miles

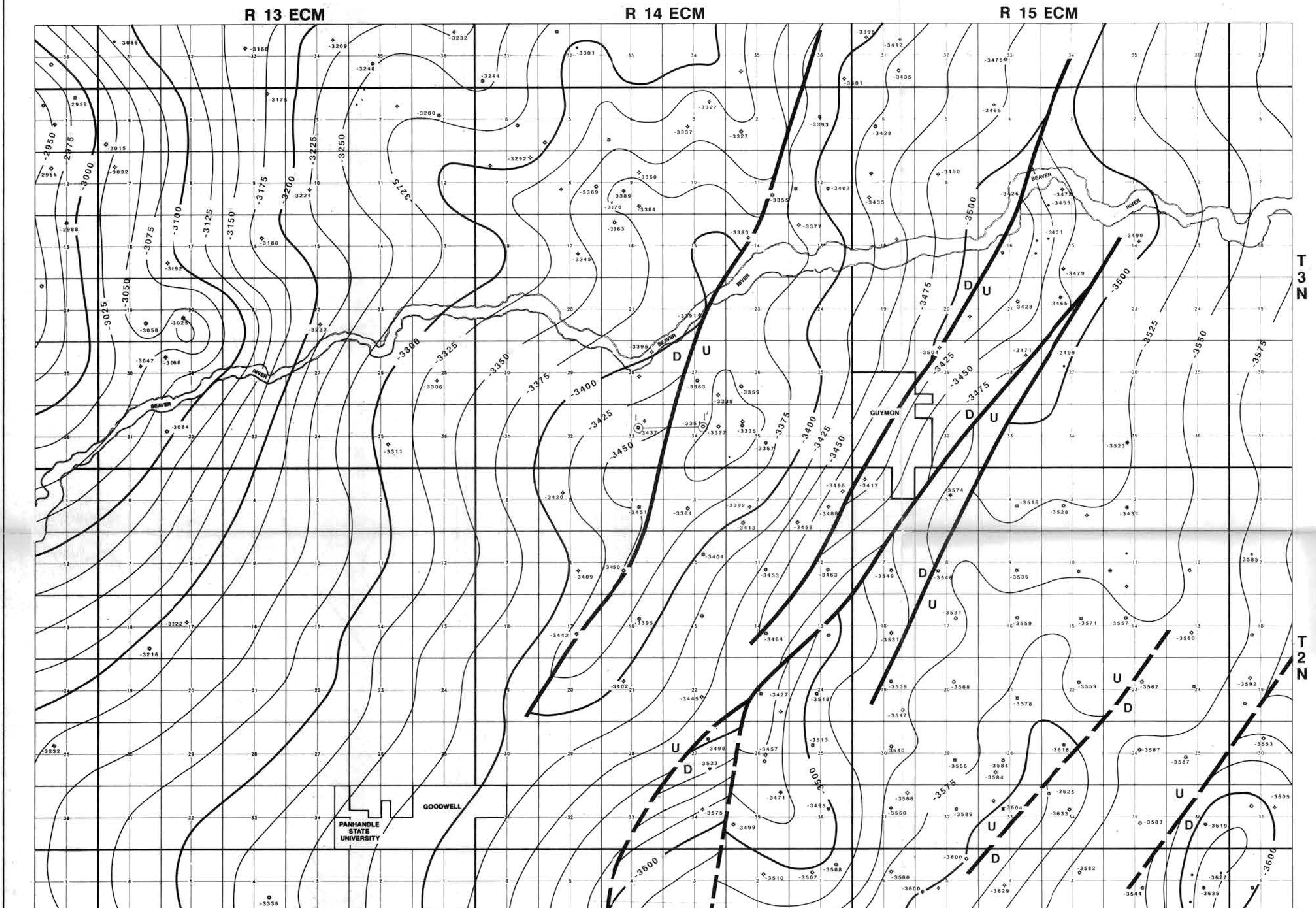
SCALE IN MILES

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE II

L. D. GERKEN

1992



STRUCTURE MAP
AT TOP OF LOWER MORROWAN

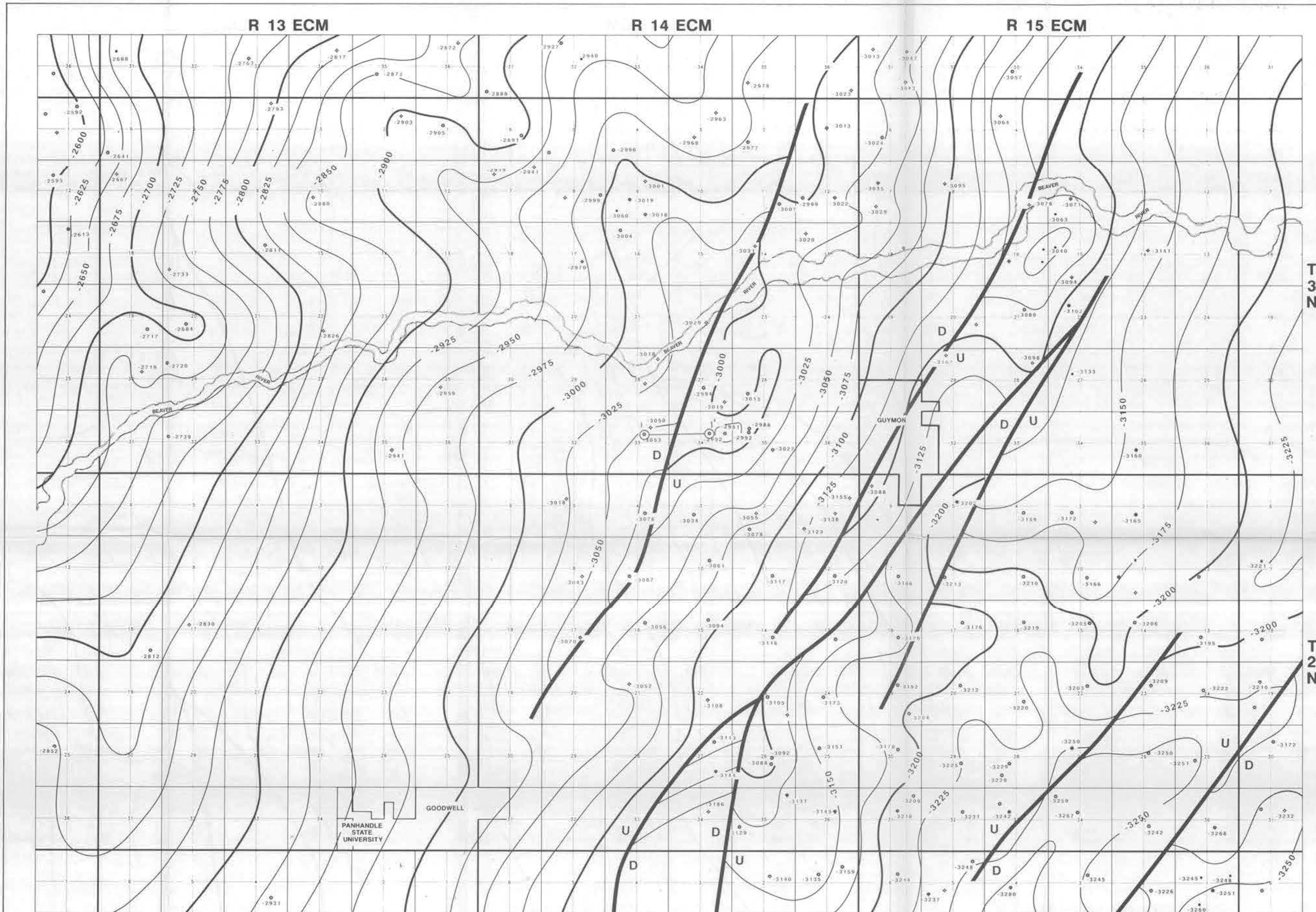
CI = 25 FT

0 1 2 3 miles
SCALE IN MILES

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE III

L. D. GERKEN 1992



STRUCTURE MAP

AT TOP OF MORROWAN INTERVAL

CI = 25 FT

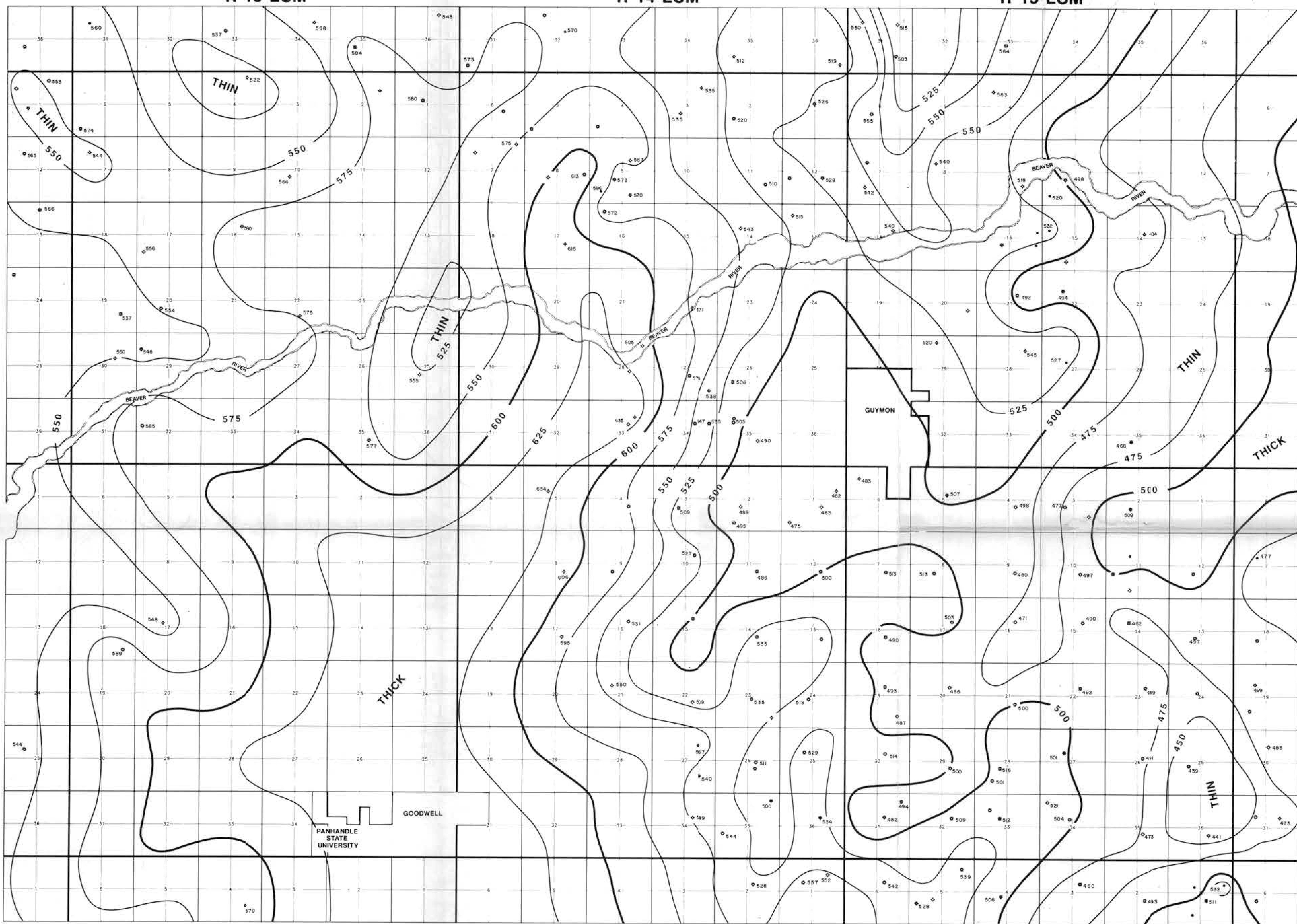
0 1 2 3 miles

SCALE IN MILES

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE IV

L. D. GERKEN 1992



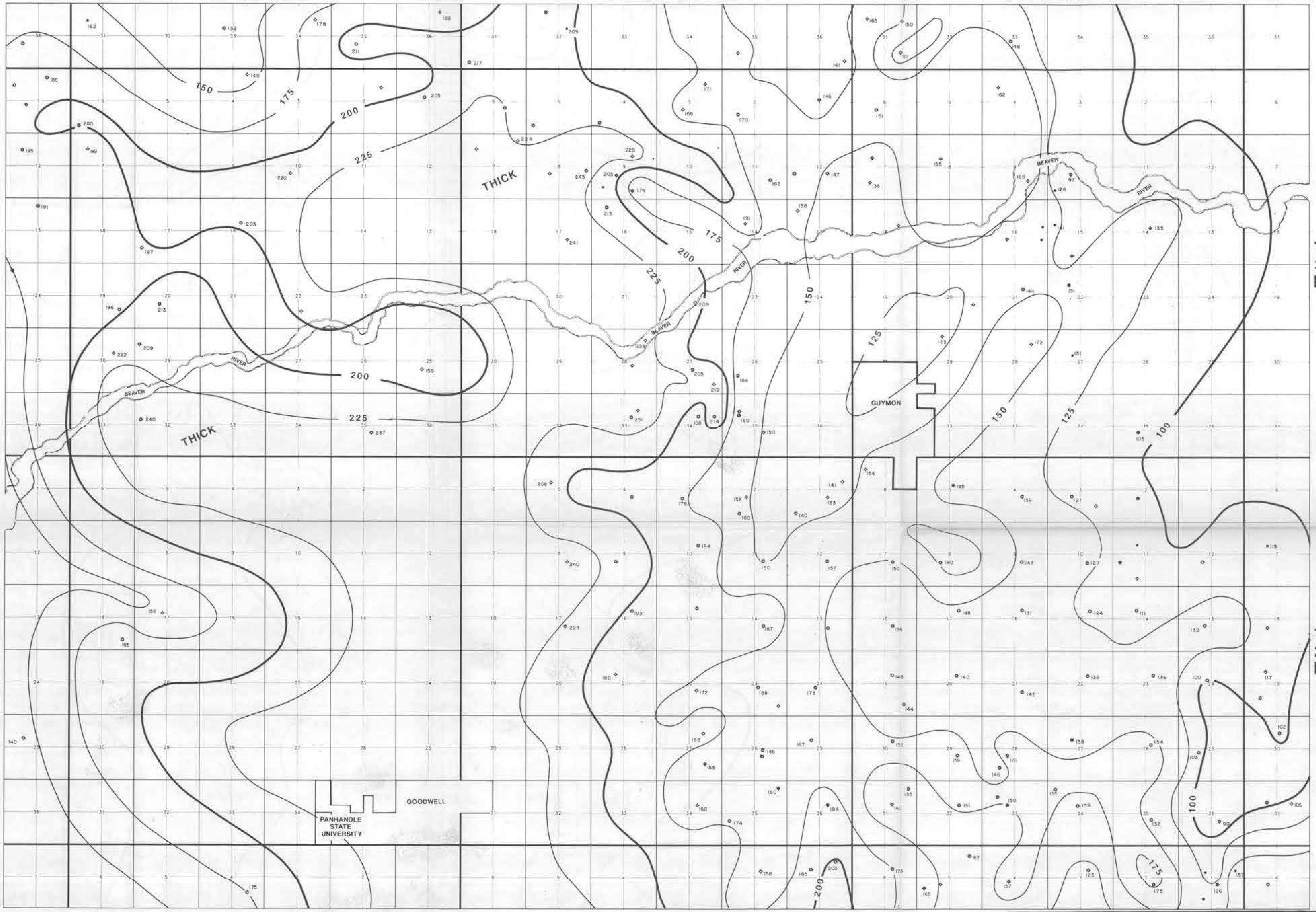
ISOPACH MAP
OF MORROWAN INTERVAL

CI = 25 FT

0 1 2 3 miles
SCALE IN MILES

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN
PLATE V

L. D. GERKEN 1992



ISOPACH MAP OF LOWER MORROWAN STRATA

CI = 25 FT

0 1 2 3 miles

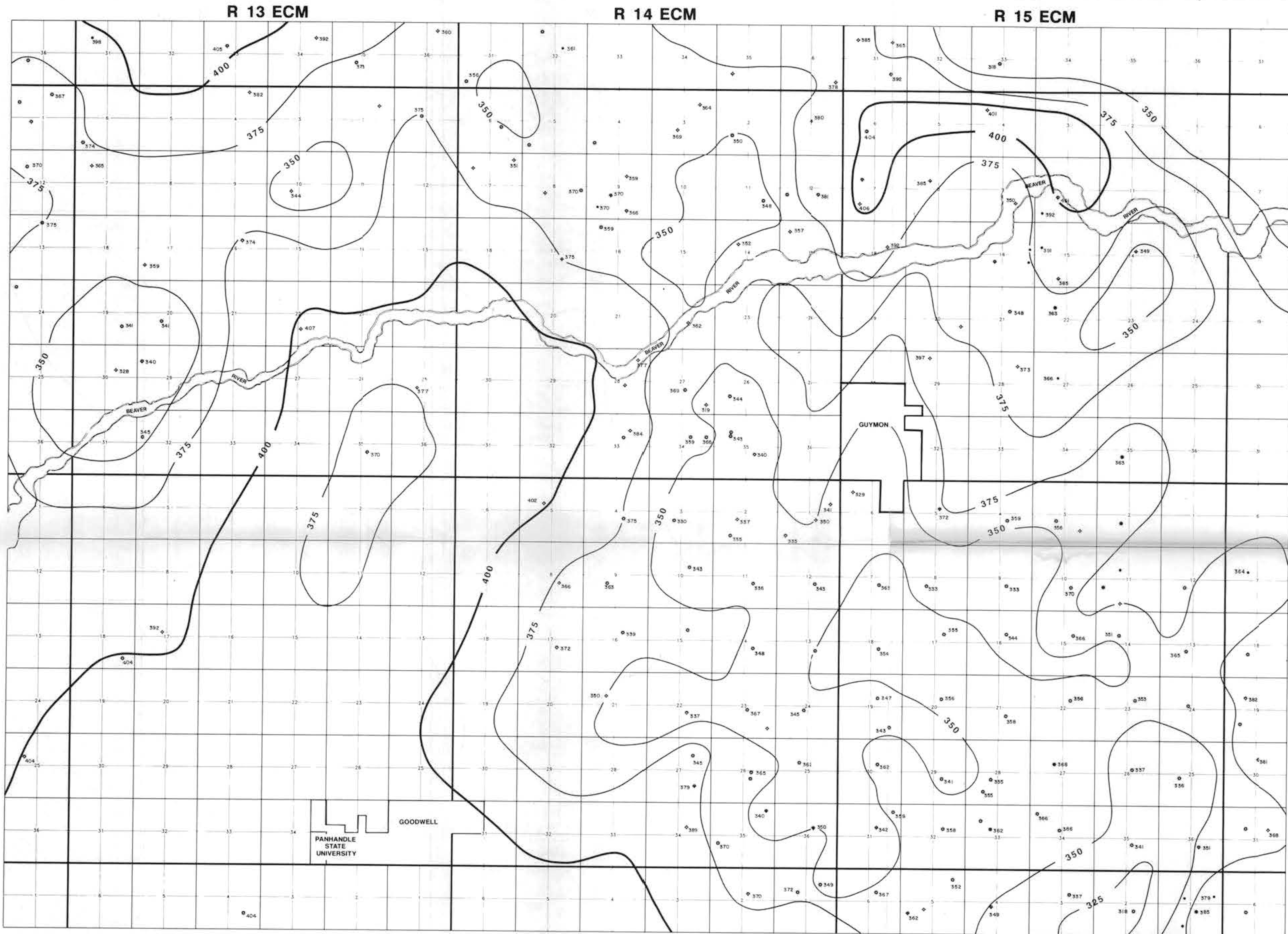
SCALE IN MILES

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE VI

L. D. GERKEN

1992



ISOPACH MAP

OF UPPER MORROWAN STRATA

CI = 25 FT

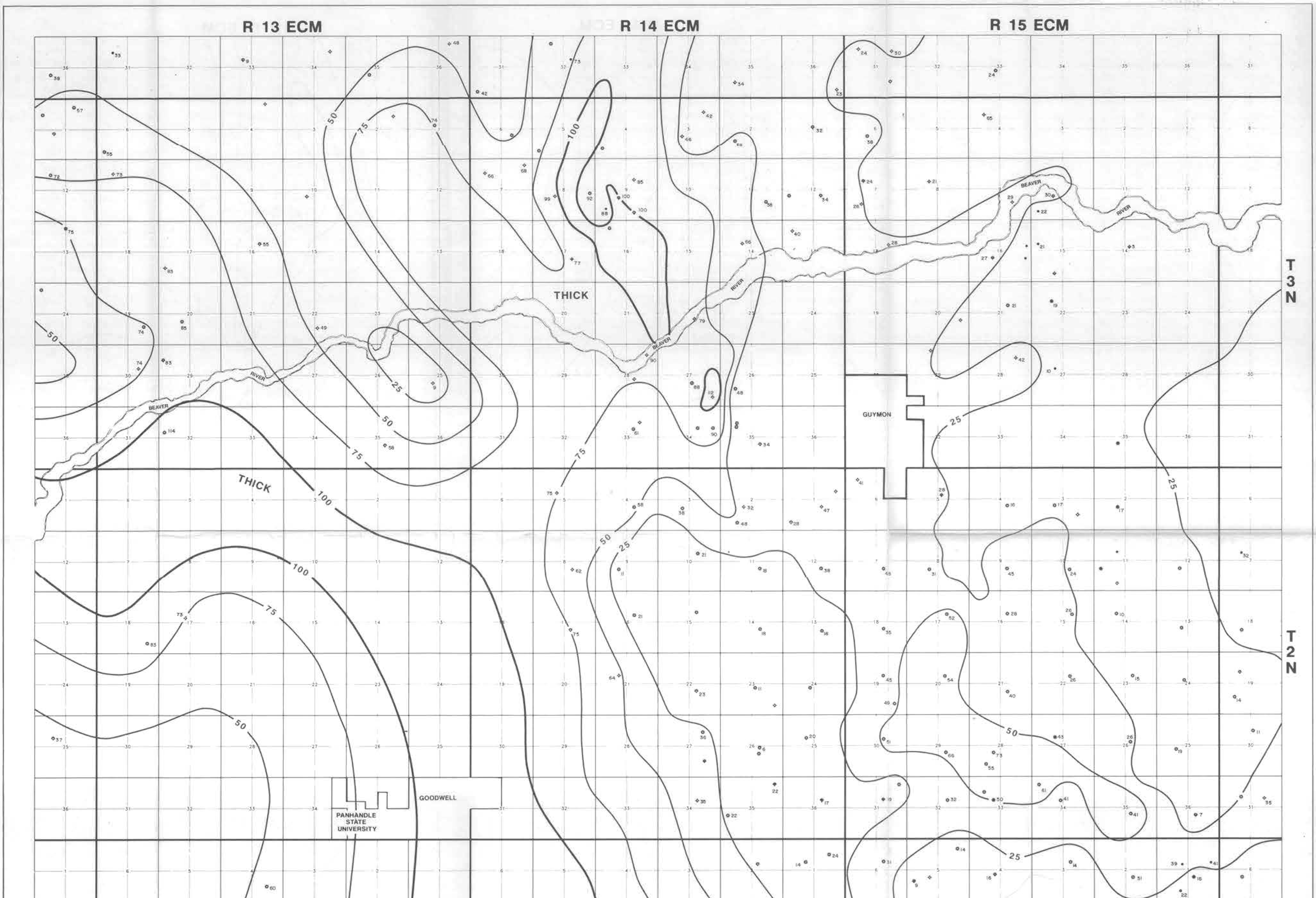
0 1 2 3 miles

SCALE IN MILES

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE VII

L. D. GERKEN 1992



GROSS SAND MAP
LOWER MORROWAN INTERVAL

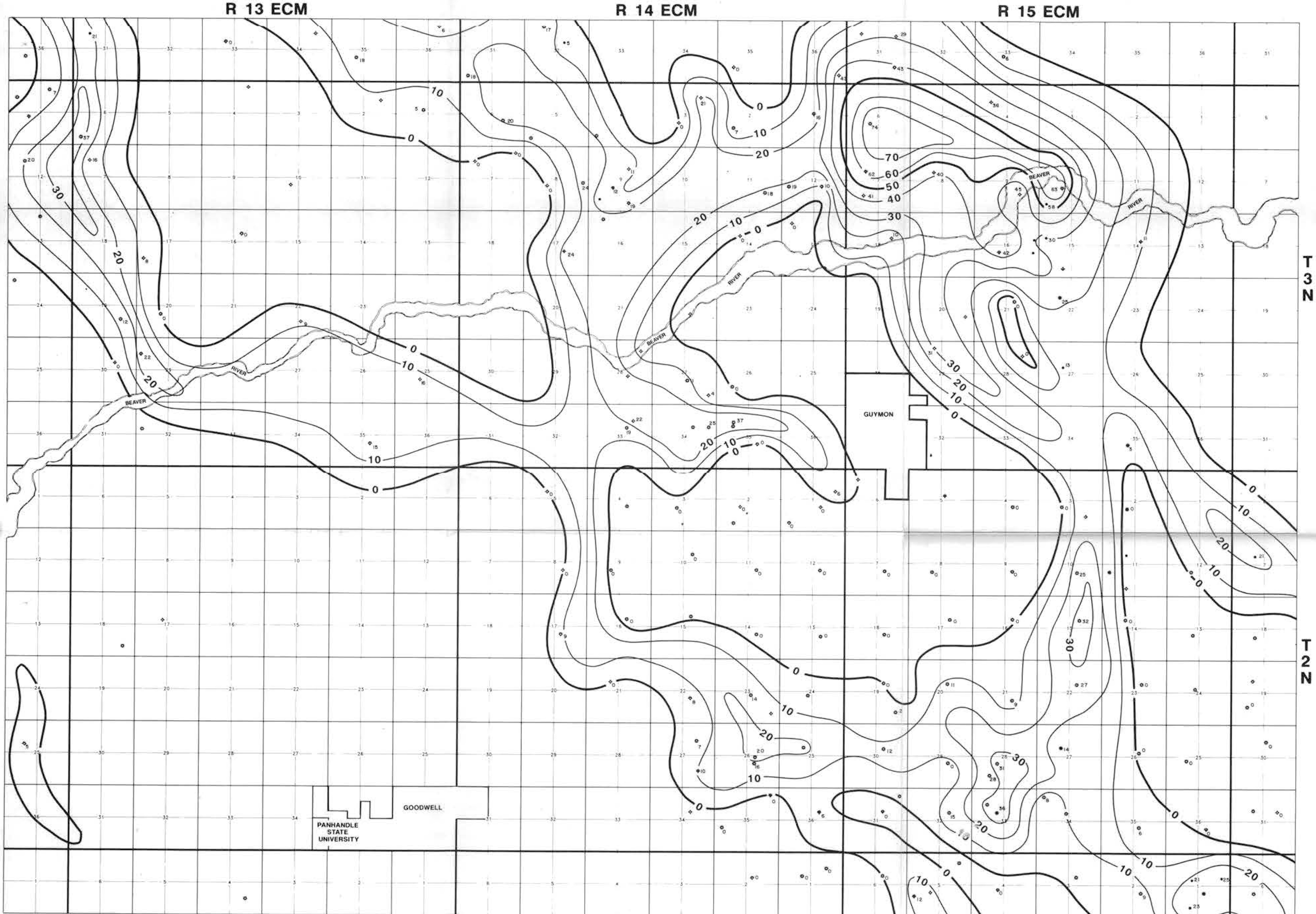
CI = 25 FT

0 1 2 3 miles
SCALE IN MILES

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE VIII

L. D. GERKEN 1992



GROSS SAND MAP

UPPER MORROWAN INTERVAL

CI = 10 FT

0 1 2 3 miles

SCALE IN MILES

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE IX

L. D. GERKEN 1992


PROBABLE ALLUVIAL VALLEY
DURING POST-MISSISSIPPIAN, TIME
LOG SIGNATURE MAP
LOWER MORROWAN SANDSTONE
0
1
2 MILES
SCALE IN MILES
MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN
PLATE X
L. D. GERKEN
1992


CLAY FILL
MEANDER BELT
MEANDER BELT
CLAY FILL
MEANDER BELT
MEANDER BELT
LOG SIGNATURE MAP
REPRESENTATIVE UPPER MORROWAN SANDSTONE
SCALE IN MILES
MORROW HUGOTON EMBAYMENT
ANADARKO BASIN
PLATE XI
L. D. GERKEN
1992

A
1.3 mi.
1.2 mi.
1.2 mi.
0.6 mi.
0.4 mi.
0.4 mi.
0.3 mi.
2.1 mi.
1.3 mi.
1.0 mi.
1.5 mi.
1.5 mi.
1.3 mi.
1.6 mi.
1.1 mi.
1.8 mi.
1.1 mi.
0.4 mi.
A'
ANADARKO PETROLEUM CO.
POWELL "C" NO. 1
SEC. 35 T4N R13ECM
NE SW
A-A' NO. 1
ANADARKO PROD. CO.
OKLA. STATE "H" NO. 1
SEC. 1 T3N R13ECM
SE NW
A-A' NO. 2
C-C' NO. 9
OXY U.S.A. INC.
STONEBRAKER A-113
SEC. 7 T3N R14ECM
C NW
A-A' NO. 3
CITIES SERVICE
STONEBRAKER AN-2
SEC. 8 T3N R14ECM
C NE SW
A-A' NO. 4
CITIES SERVICE
STONEBRAKER "AN" NO. 3
SEC. 8 T3N R14ECM
NE NE SE
A-A' NO. 5
CITIES SERVICE OIL CO.
STONEBRAKER
NO. 1-AN
SEC. 9 T3N R14ECM
C SW SW
A-A' NO. 6
CITIES SERVICE OIL CO.
STONEBRAKER A-80
SEC. 16 T3N R14ECM
NE NW NW
A-A' NO. 7
CITIES SERVICE OIL CO.
STONEBRAKER
"AY" NO. 1
SEC. 22 T3N R14ECM
NW NW SE
A-A' NO. 8
D-D' NO. 8
CITIES SERVICE OIL CO.
STONEBRAKER
"AX" NO. 1
SEC. 26 T3N R14ECM
NE SW SW
A-A' NO. 9
CITIES SERVICE OIL CO.
SCHNURR NO. 1
SEC. 35 3N R14ECM
NW SE
A-A' NO. 10
HAWKINS OIL & GAS
MAHANEY NO. 1-1
SEC. 1 T2N R14ECM
SE NE
A-A' NO. 11
E-E' NO. 5
SKELLY OIL CO.
GOSS UNIT NO. 2
SEC. 7 T2N R15ECM
NW SE
A-A' NO. 12
B-B' NO. 14
YINGLING OIL INC.
KATE JACKSON NO. 1
SEC. 17 T2N R15ECM
SW NE
A-A' NO. 13
PHILLIPS PET. CO.
BLASTING NO. 2
SEC. 21 T2N R15ECM
NW SE
A-A' NO. 14
F-F' NO. 5
PHILLIPS PET. CO.
BUF NO. 2
SEC. 27 T2N R15ECM
SE NW
A-A' NO. 15
PHILLIPS PET. CO.
CHRISTINE NO. 2
SEC. 35 T2N R15ECM
NW NW SE
A-A' NO. 16
PHILLIPS PET. CO.
KASER NO. 5
SEC. 1 T1N R15ECM
C SE NW
A-A' NO. 17
PHILLIPS PET. CO.
KASER NO. 2
SEC. 1 T1N R15ECM
SE NW SE
A-A' NO. 18
DATUM: BASE OF THIRTEEN FINGER LIMESTONE
CONTACT BETWEEN UPPER MORROW AND LOWER MORROW
BASE OF THE LOWEST MORROWAN SANDSTONE
STRATIGRAPHIC
CROSS-SECTION A-A'
VERTICAL SCALE: 1in=200ft NO HORIZONTAL SCALE
DATUM: BASE OF THIRTEEN FINGER LIMESTONE
MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN
PLATE XII
L. D. GERKEN
1992

STRATIGRAPHIC CROSS-SECTION B-B'

VERTICAL SCALE 1in=200ft NO HORIZONTAL SCALE

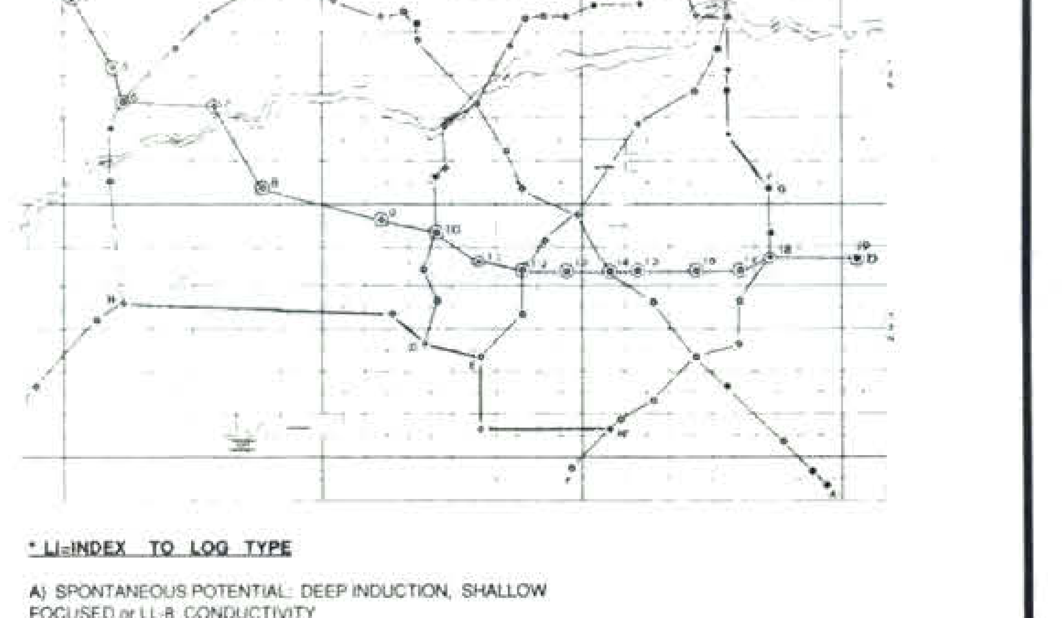
DATUM: BASE OF THIRTEEN FINGER LIMESTONE

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE XIII

L. D. GERKEN

1992



* LI=INDEX TO LOG TYPE

A) SPONTANEOUS POTENTIAL: DEEP INDUCTION, SHALLOW FOCUSED or LL-8, CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT, DEEP INDUCTION, AVERAGED LL-8, CONDUCTIVITY

C) SPONTANEOUS POTENTIAL, GAMMA RAY: DEEP INDUCTION: SHALLOW FOCUSED: CONDUCTIVITY

D) SPONTANEOUS POTENTIAL, DEEP INDUCTION, MEDIUM INDUCTION: SHALLOW FOCUSED

E) GAMMA RAY, SHALLOW FOCUSED; CONDUCTIVITY

F) SPONTANEOUS POTENTIAL, RXO/RT, DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8

G) SPONTANEOUS POTENTIAL: DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)

STRATIGRAPHIC CROSS-SECTION C-C'

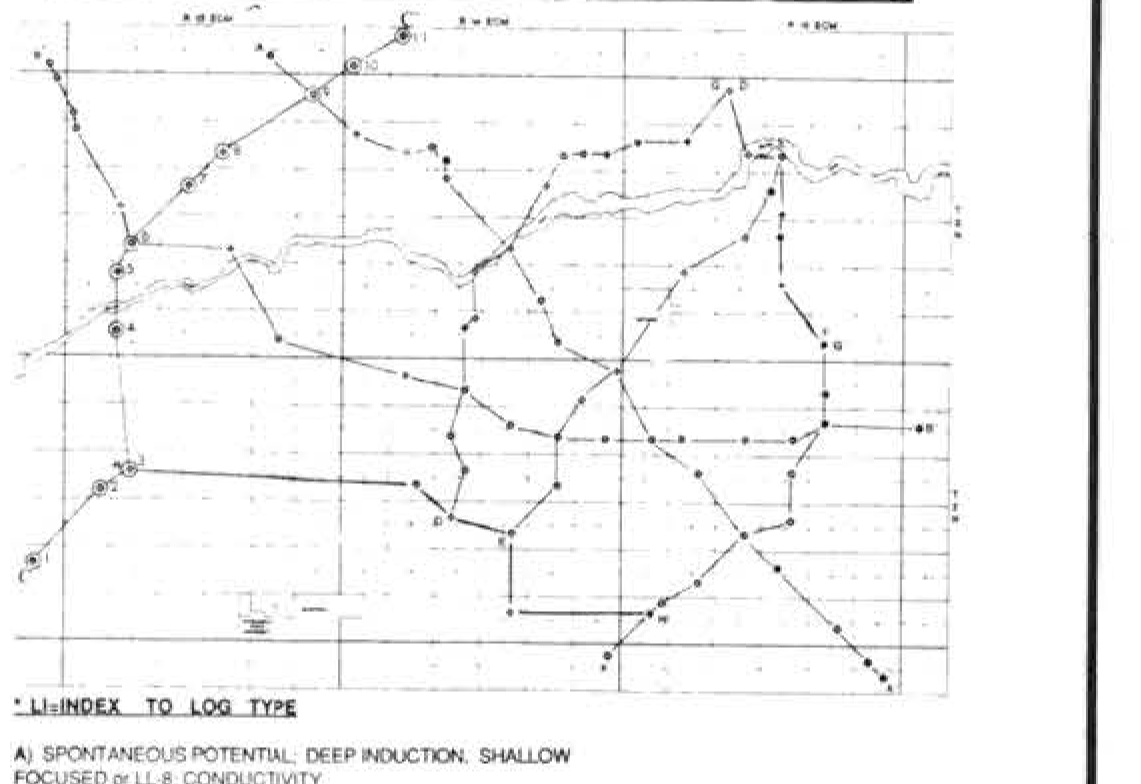
VERTICAL SCALE: 1in=200ft. NO HORIZONTAL SCALE
DATUM: BASE OF THIRTEEN FINGER LIMESTONE

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE XIV

L. D. GERKEN

1992



* LI=INDEX TO LOG TYPE

A) SPONTANEOUS POTENTIAL, DEEP INDUCTION, SHALLOW FOCUSED or LL-8, CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT, DEEP INDUCTION, AVERAGED LL-8, CONDUCTIVITY

C) SPONTANEOUS POTENTIAL, GAMMA RAY, DEEP INDUCTION, SHALLOW FOCUSED, CONDUCTIVITY

D) SPONTANEOUS POTENTIAL, DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED

E) GAMMA RAY, SHALLOW FOCUSED, CONDUCTIVITY

F) SPONTANEOUS POTENTIAL, RXO/RT, DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8

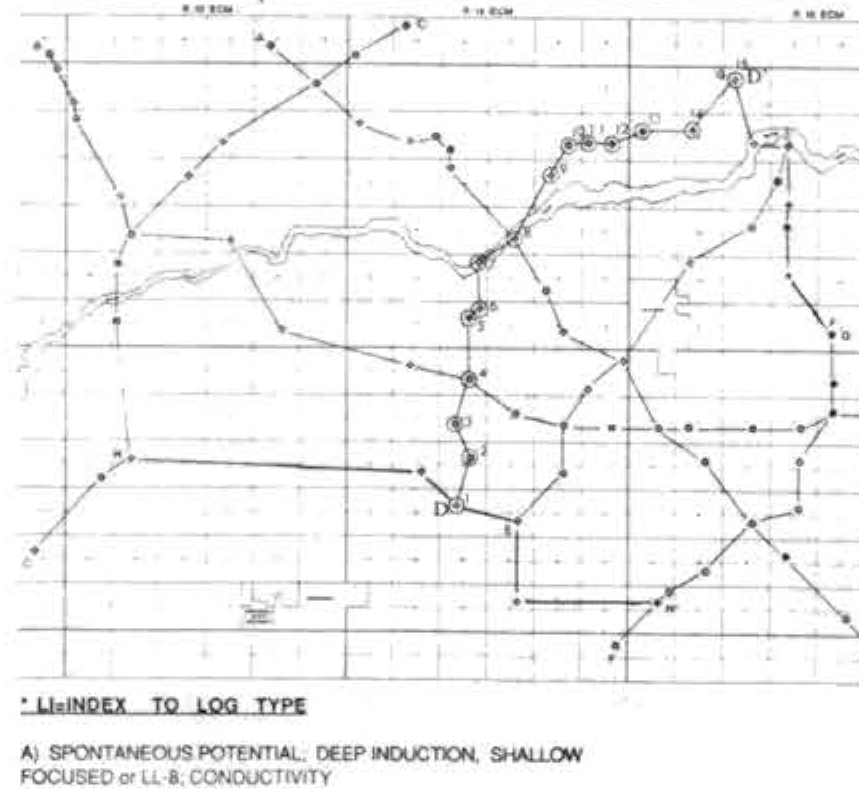
G) SPONTANEOUS POTENTIAL, DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)

STRATIGRAPHIC CROSS-SECTION D-D'

VERTICAL SCALE: 1in=200ft NO HORIZONTAL SCALE
DATUM: BASE OF THIRTEEN FINGER LIMESTONE

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN PLATE XV

L. D. GERKEN 1992



* LI=INDEX TO LOG TYPE

A) SPONTANEOUS POTENTIAL; DEEP INDUCTION, SHALLOW FOCUSED or LL-8; CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, AVERAGED LL-8; CONDUCTIVITY

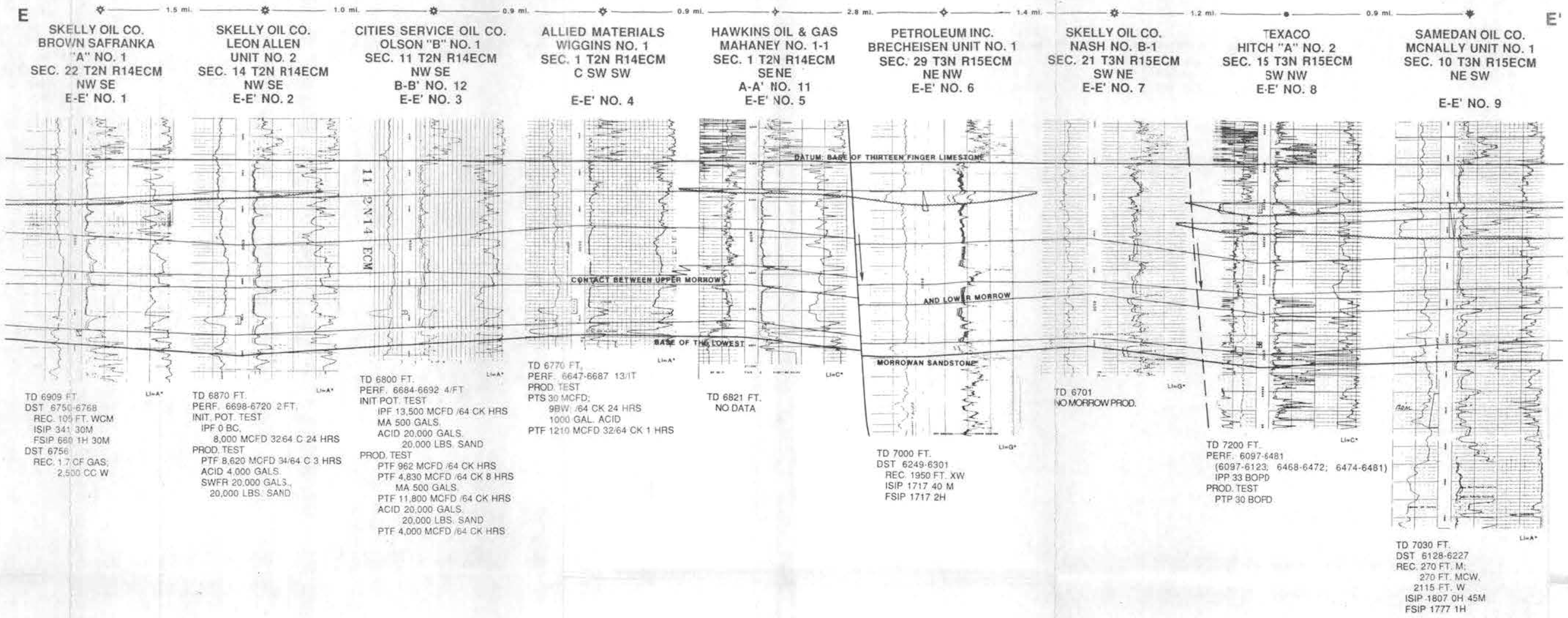
C) SPONTANEOUS POTENTIAL, GAMMA RAY; DEEP INDUCTION, SHALLOW FOCUSED; CONDUCTIVITY

D) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED

E) GAMMA RAY; SHALLOW FOCUSED; CONDUCTIVITY

F) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8

G) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)



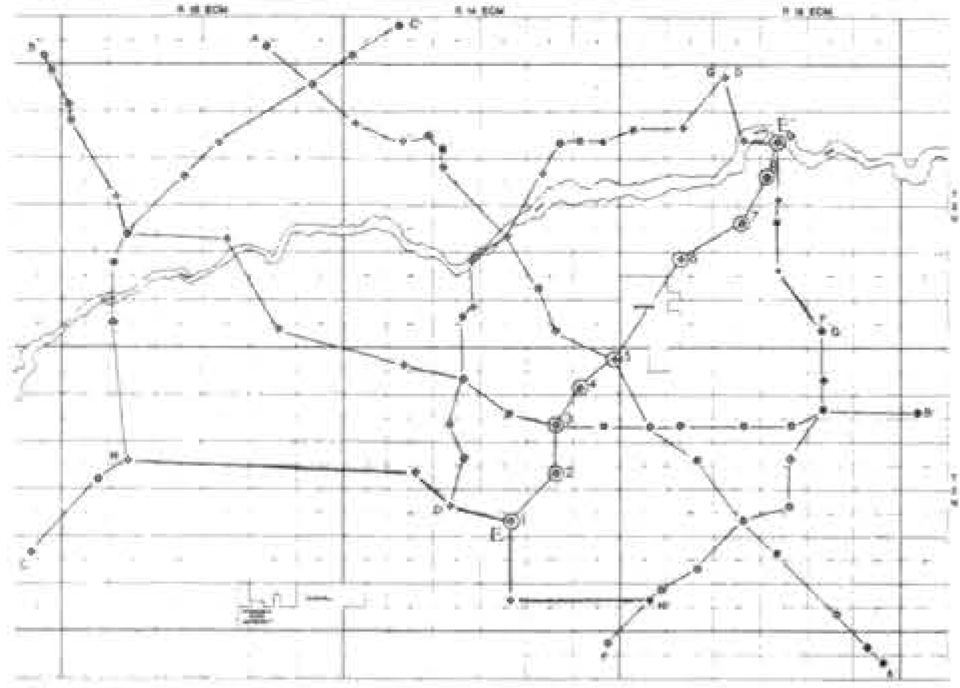
STRATIGRAPHIC CROSS-SECTION E-E'

VERTICAL SCALE: 1in=200ft NO HORIZONTAL SCALE
DATUM: BASE OF THIRTEEN FINGER LIMESTONE

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE XVI

L. D. GERKEN 1992



* LI=INDEX TO LOG TYPE

A) SPONTANEOUS POTENTIAL; DEEP INDUCTION, SHALLOW FOCUSED or LL-8; CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, AVERAGED LL-8, CONDUCTIVITY

C) SPONTANEOUS POTENTIAL, GAMMA RAY; DEEP INDUCTION, SHALLOW FOCUSED; CONDUCTIVITY

D) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED

E) GAMMA RAY; SHALLOW FOCUSED, CONDUCTIVITY

F) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8

G) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)

F — 1.3 mi. — 0.4 mi. — 0.9 mi. — 1.4 mi. — 1.0 mi. — 1.1 mi. — 1.3 mi. — 0.8 mi. — 1.0 mi. — F'

PHILLIPS PET. LATH NO. 3 SEC. 1 T1N R14ECM C NE F-F' NO. 1	PHILLIPS PET. BENSKIN NO. 2 SEC. 31 T2N R15ECM SW NE F-F' NO. 2	AIKMAN BROS. CORP. STEVENSON NO. 1 SEC. 31 T2N R15ECM C NE NE F-F' NO. 3	PHILLIPS PET. LIZ NO. 2 SEC. 29 T2N R15ECM NW SE F-F' NO. 4	PHILLIPS PET. CO. BLASTING NO. 2 SEC. 21 T2N R15ECM NW SE A-A' NO. 14 F-F' NO. 5	PHILLIPS PET. MERCEDES NO. 2 SEC. 22 T2N R15ECM SW NE F-F' NO. 6	SKELLY OIL CO. WIGGINS "B" NO. 2 SEC. 15 T2N R15ECM SW NE F-F' NO. 7	SKELLY OIL CO. MONTGOMERY "A" NO. 1 SEC. 11 T2N R15ECM SE NW B-B' NO. 18 F-F' NO. 8	SKELLY OIL CO. LANCASTER NO. 2 SEC. 2 T2N R15ECM C NE SW F-F' NO. 9	GETTY OIL CO. SCHLUCKEBIER UNIT NO. 3 SEC. 35 T3N R15ECM C NE SW F-F' NO. 10

F-F' NO. 1 (LI=B*)
TD 7000 FT.
PERF. 6728-6748 40/IT
INIT. POT. TEST
IPF 1,050 MCFD /64 CK 24 HRS
PROD. TEST
PTF 499 MCFD /64 CK HRS
ACID 1,250 GALS.
SWFR 40,000 GALS.; 40,000 LBS. SAND

F-F' NO. 2 (LI=G*)
TD 7050 FT.
PERF. 6741-6748 1/FT.
PROD. TEST
PTS 44 BOPD /64 CK 11 HRS.
ACID 1,000 GALS.
ACFR 21,000 GALS.,
10,500 LBS. SAND
PERF. 6682-6692 1/FT.
PST 12 BOPD /64 CK 18 HRS
MA 1,000 GALS.
ACFR 21,000 GALS.,
10,500 LBS. SAND

F-F' NO. 3 (LI=G*)
TD 6873 FT.
PERF. 6383-6390 2/FT.
6742-6748 2/FT.
INIT. POT. TEST
IPF 10,702 MCFD /64 CK HRS
PROD. TEST
PTF 5,000 MCFD /64 CK 19 HRS
ACID 500 GALS.
SAFR 30,000 GALS.,
30,000 LBS. SAND
DST 6300-6400
REC. 195 FT. GCM
ISIP 1695 1H
FSIP 1620 1H
DST 6740-6873
REC. 120 FT. MUD

F-F' NO. 4 (LI=G*)
TD 710 FT.
PERF. 6401-6405 1/FT.
6752-6768 1/FT. GROSS
INIT. POT. TEST
IPF 18,571 MCFD /64 CK 24 HRS
SAFR 6401-6405 21,000 GALS.
20,500 LBS. SAND
PTF 12,800 MCFD 48/64 CK 5 HRS
DST 6401-6421
REC. 120 FT. M&OCW
ISIP 1903 30M
FSIP 1886 1H

F-F' NO. 5 (LI=A*)
TD 7100 FT.
PERF. 6401-6408 1/FT.
6760-6780 1/FT.
INIT. POT. TEST
IPF 60 BC,
71,488 MCFD /64 CK 24 HRS
PROD. TEST
PTF 2 BC,
7,093 MCFD 32/64C 10 HRS
(BOTH ZONES)

F-F' NO. 6 (LI=A*)
TD 7050 FT.
PERF. 6340-6378 1/FT. GROSS
INIT. POT. TEST
IPF 45 BC,
13,904 MCFD /64 CK 24 HRS
PROD. TEST 6730-6743 1/FT.
PTF 3,672 MCFD 32/64 CK 7 HRS
SWFR 21,000 GALS.,
15,000 LBS. SAND
DST 6670-6775
REC. 250 FT. GCM
ISIP 2122 30M
FSIP 2122 1H
DST 6780-6823
REC. 500 FT. O&GCM
900 FT. XW

F-F' NO. 7 (LI=A*)
TD 6840 FT.
PERF. 6372-6392 4/FT.
INIT. POT TEST
IPF 15,000 MCFD /64 CK HRS
PROD. TEST
PTF 7,220 MCFD /64 CK 4 HRS
ACID 500 GALS.
PERF. 6734-6742 4/FT.
INIT. POT. TEST
IPF 16,000 MCFD /64 CK HRS
PROD. TEST
PTF 7,000 MCFD /64 CK 3 HRS
SWFR 4,970 GALS.,
10,712 LBS. SAND

F-F' NO. 8 (LI=A*)
TD 6820 FT.
PERF. 6695-6704 4/FT.
PROD. TEST
PTF 0 BOPD
14 MCFD /64 CK HRS

F-F' NO. 9 (LI=E*)
TD 6806 FT.
NO MORROW SHOWS

F-F' NO. 10 (LI=C*)
TD 6875 FT.
NO MORROW SHOWS

STRATIGRAPHIC CROSS-SECTION F-F'

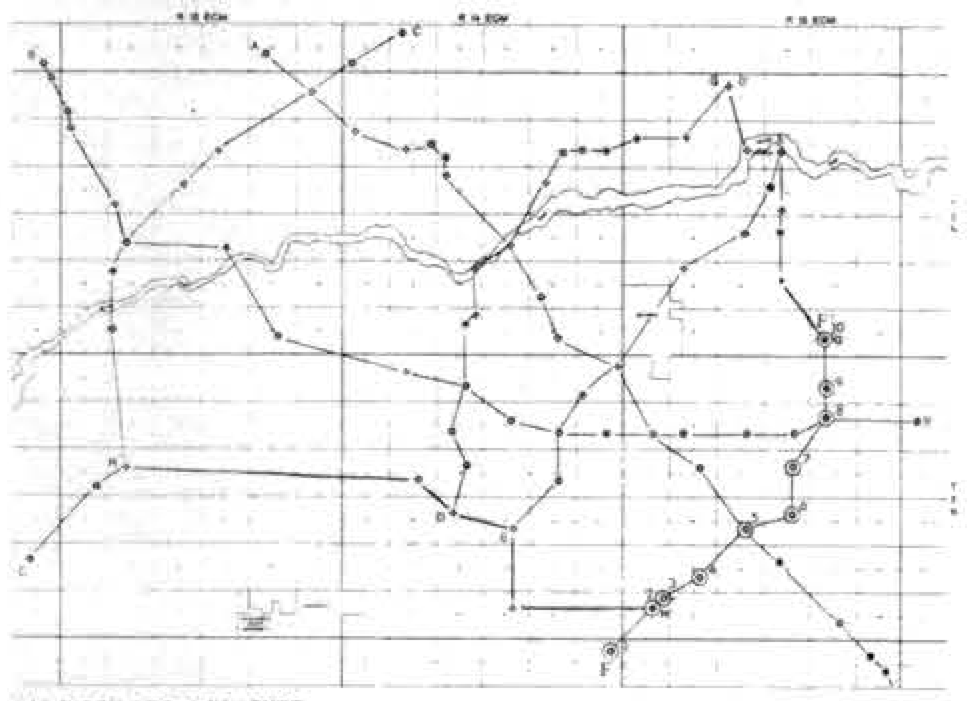
VERTICAL SCALE: 1in=200ft NO HORIZONTAL SCALE
DATUM: BASE OF THIRTEEN FINGER LIMESTONE

MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE XVII

L. D. GERKEN

1992



*** LI=INDEX TO LOG TYPE**

A) SPONTANEOUS POTENTIAL; DEEP INDUCTION, SHALLOW FOCUSED or LL-8; CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, AVERAGED LL-8; CONDUCTIVITY

C) SPONTANEOUS POTENTIAL, GAMMA RAY; DEEP INDUCTION, SHALLOW FOCUSED, CONDUCTIVITY

D) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED

E) GAMMA RAY; SHALLOW FOCUSED; CONDUCTIVITY

F) SPONTANEOUS POTENTIAL; RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8

G) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)

STRATIGRAPHIC CROSS-SECTION G-G'

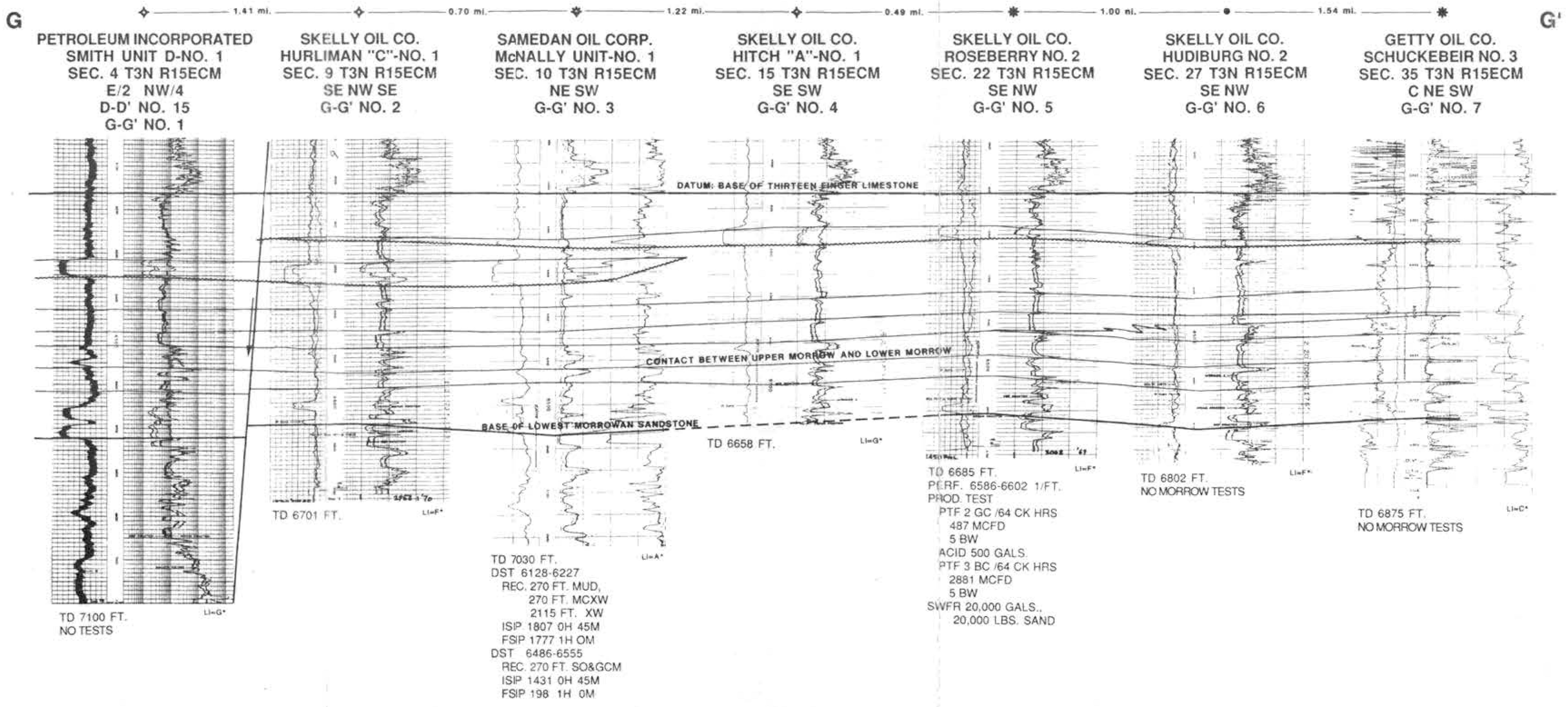
VERTICAL SCALE: 1in=200ft NO HORIZONTAL SCALE

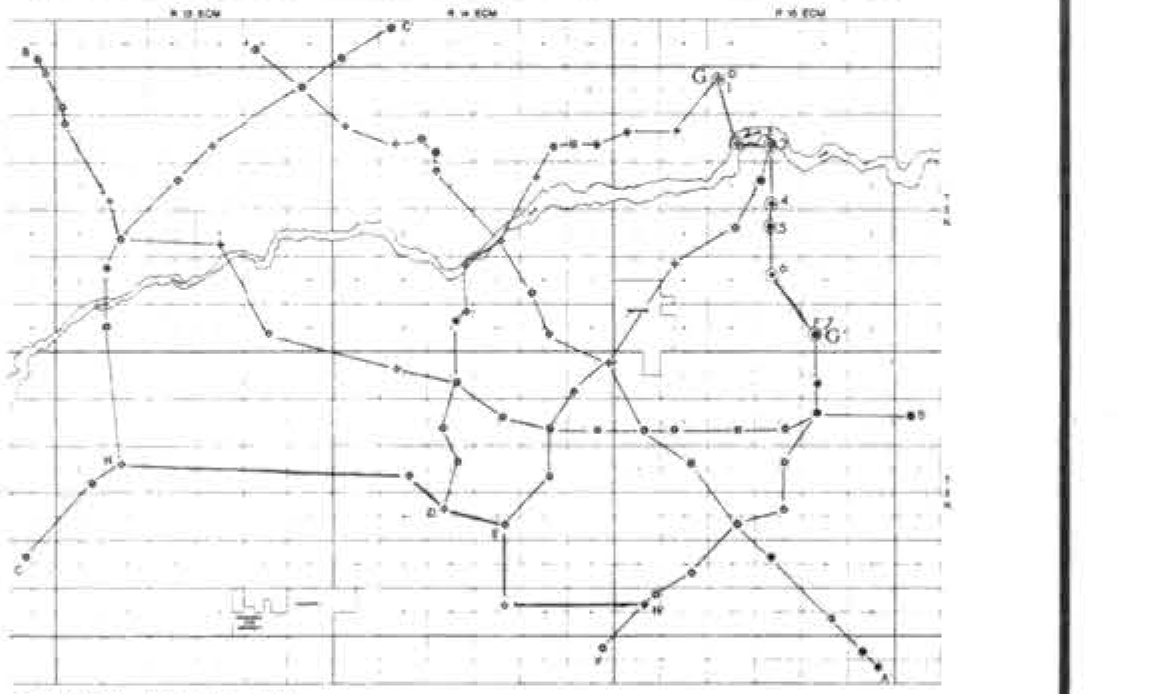
MORROW- HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE XVIII

L. D. GERKEN

1992





*** LI=INDEX TO LOG TYPE**

A) SPONTANEOUS POTENTIAL; DEEP INDUCTION, SHALLOW FOCUSED or LL-8; CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, AVERAGED LL-8; CONDIJCTIVITY

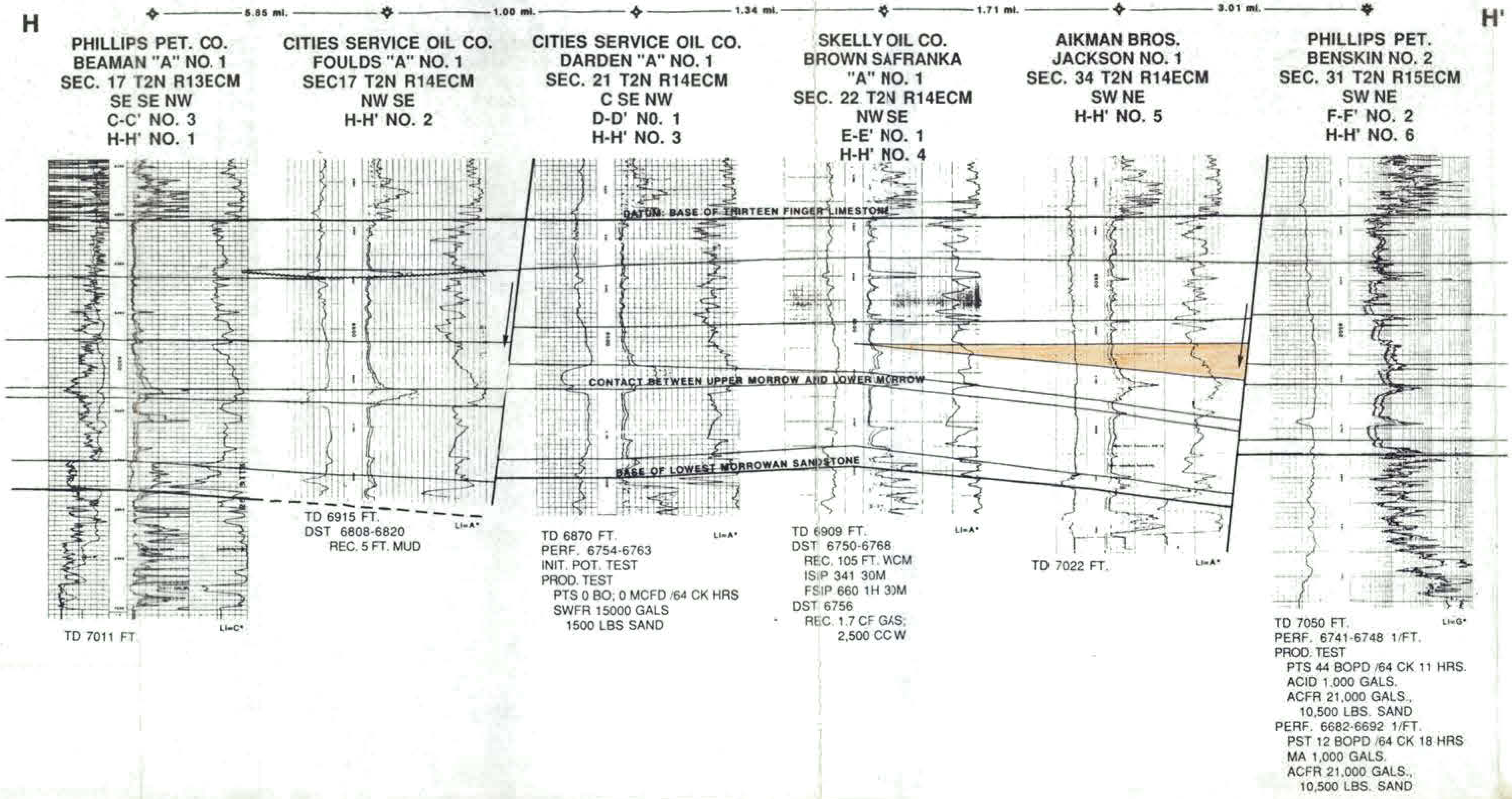
C) SPONTANEOUS POTENTIAL, GAMMA RAY; DEEP INDUCTION, SHALLOW FOCUSED; CONDUCTIVITY

D) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED

E) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8; CONDUCTIVITY

F) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8

G) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)



STRATIGRAPHIC CROSS-SECTION H-H'

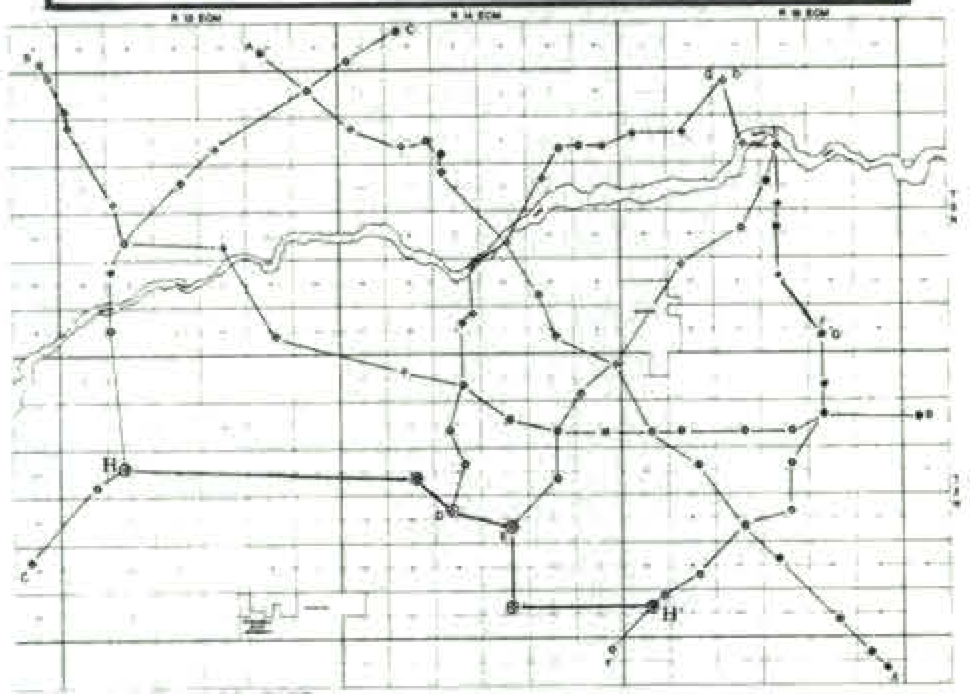
VERTICAL SCALE: 1in=200ft NO HORIZONTAL SCALE

MORROW-HUGOTON EMBAYMENT
ANADARKO BASIN

PLATE XIX

L. D. GERKEN

1992



* LI=INDEX TO LOG TYPE

A) SPONTANEOUS POTENTIAL; DEEP INDUCTION, SHALLOW FOCUSED or LL-8, CONDUCTIVITY

B) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, AVERAGED LL-8; CONDUCTIVITY

C) SPONTANEOUS POTENTIAL, GAMMA RAY; DEEP INDUCTION, SHALLOW FOCUSED; CONDUCTIVITY

D) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED

E) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION, AVERAGED LL-8; CONDUCTIVITY

F) SPONTANEOUS POTENTIAL, RXO/RT; DEEP INDUCTION, MEDIUM INDUCTION; AVERAGED LL-8

G) SPONTANEOUS POTENTIAL; DEEP INDUCTION, MEDIUM INDUCTION, SHALLOW FOCUSED (RESISTIVITY LOGS HAVE A LOGARITHMIC SCALE)

PLATE XX

L. D. GERKEN 1992

PETROLOGIC LOG

Well CITIES SERVICE No.4 Stonebraker 'AN'

Location C NE SW Sec. 7 T. 3 N., R. 14 E

Texas Co., Oklahoma

Lithology

- SHALE/CLAYSTONE
- SILTY SHALE/MUDSTONE
- SILT SILTSTONE
- SAND SANDSTONE
- INTERBEDDED SANDSTONE/SHALE-MUDSTONE
- MUDDY SANDSTONE
- CONGLOMERATE
- LIMESTONE
- MARL
- DOLOMITE
- DOLOMITIC ROCKS
- GYPSUM ANHYDRITE
- GYPSIFEROUS ROCKS
- HALITE
- CHERT
- CHERTY ROCKS
- COAL LIGNITE
- CLASTS

Bedding (B) - Laminae (L)

- MASSIVE
- HORIZONTAL
- INITIAL SLOPE DIP
- GRADED
- TROUGH CROSSBEDDING
- PLANAR CROSSBEDDING

Surface Features

- RIPPLE LAMINAE L-Lenticular F-Flaser C-Climbing
- CURRENT SOLE MARKS Fa-Flame F-Flute T-Tool

Deformed Features

- FLOWAGE
- FAULTED
- WATER ESCAPE D-Dish P-Pipe
- DISRUPTED M-Mud Crack D-Dikes S-Syneresis Crack

Organic

- BURROW TRACE FOSSILS
- BIOTURBATED
- ROOT TRACES

Chemical

- CONCRETIONS
- STYLOLITES

Constituents

QUARTZ
M - Monocrystalline
P - Polycrystalline
C - Chert
O - Other

FELDSPAR
K - K - Feldspar
P - Plagioclase
O - Other

ROCK FRAGMENTS
M - Metamorphic
S - Clay Shale
I - Intrusive
V - Volcanic

CLAY & CARBONATE
C - Clay
r - Carbonate

FOSSILS
Plant
C - Carbonaceous Material
W - Carbonized Wood

INVERTEBRATES & ALGAE
A - Algae
a - Arthropods
B - Brachiopods
b - Bryozoans
C - Cephalopods
c - Corals
E - Echinoderms
F - Forams
G - Gastropods
P - Pelecypods
S - Sponges

CLAY MINERALS
C - Chlorite
H - Halloysite
I - Illite
K - Kaolinite
S - Smectite
M - Mixed Layer
O - Other

CARBONATES
C - Calcite
F - Ferroan Calcite
D - Dolomite
f - Ferroan Dolomite
S - Siderite
O - Other

SILICA
Q - Quartz-Overgrowth
M - Microquartz
C - Chalcedony

SULFIDES
P - Pyrite
O - Other

SULFATES
G - Gypsum
A - Anhydrite
B - Barite
O - Other

MICA
M - Muscovite
B - Biotite
O - Other

Porosity Types

P - PRIMARY
S - SECONDARY
M - MICROPOROSITY

Contacts of Strata

- ABRUPT
- TRANSITIONAL
- EROSIONAL
- BORED
- DEFORMED

Miscellaneous

- THIN SECTION
- P & P ANALYSIS
- SEM

Rock Classification

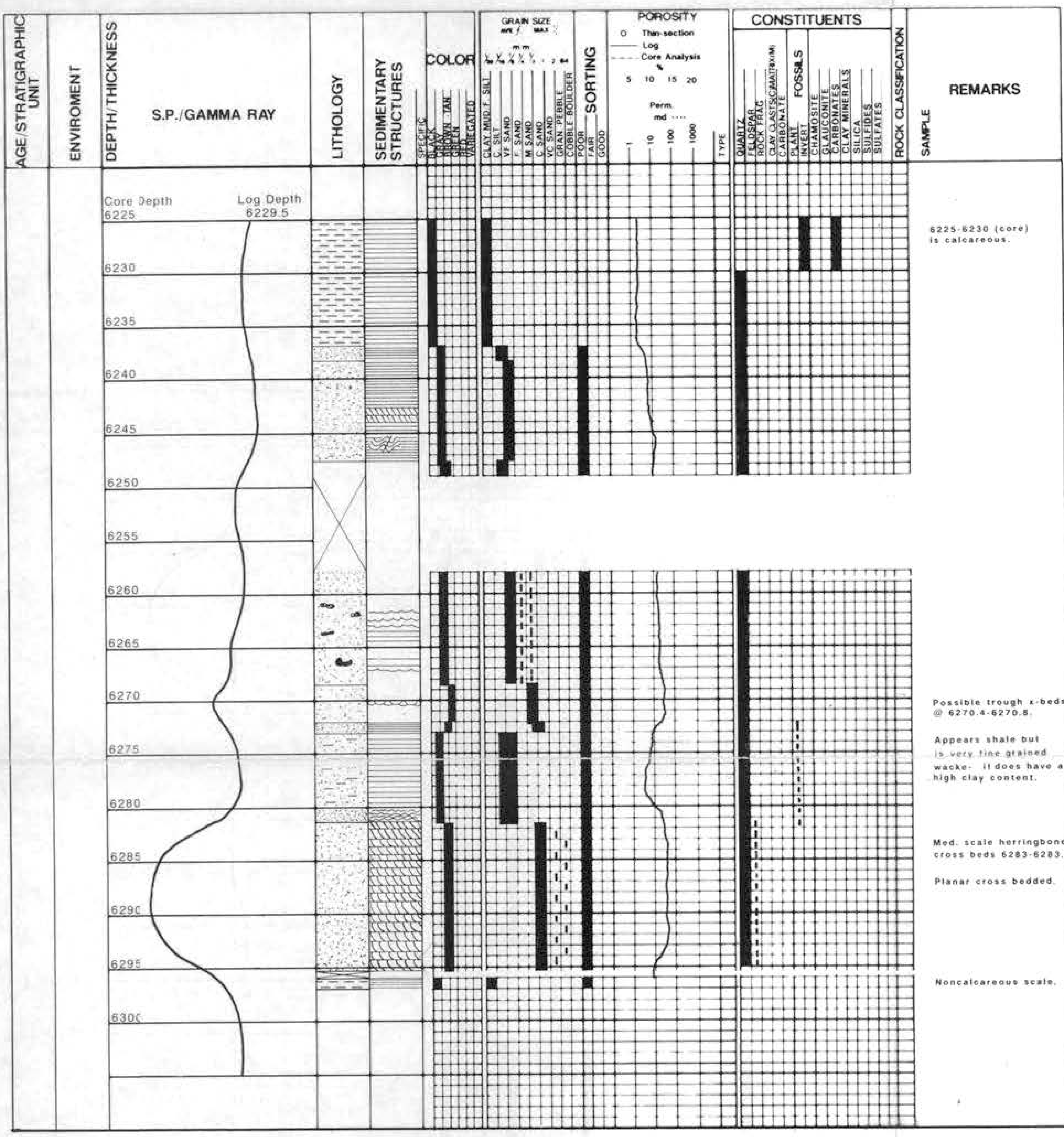


PLATE XXI

L. D. GERKEN 1992

PETROLOGIC LOG

Well CITIES SERVICE No.101 Stonebraker "A"

Location SW NE NE Sec. 7 T. 3 N., R. 14 E

Texas Co., Oklahoma

Lithology

- SHALE/CLAYSTONE
- SILTY SHALE/MUDSTONE
- SILT/SILTSTONE
- SAND/SANDSTONE
- INTERBEDDED SANDSTONE/SHALE-MUDSTONE
- MUDDY SANDSTONE
- CONGLOMERATE
- LIMESTONE
- MARL
- DOLOMITE
- DOLOMITIC ROCKS
- GYPSUM ANHYDRITE
- GYPSIFEROUS ROCKS
- HALITE
- CHERT
- CHERTY ROCKS
- COAL/LIGNITE
- CLASTS

Bedding (B) – Laminae (L)

- MASSIVE
- HORIZONTAL
- INITIAL SLOPE/DIP
- GRADED
- TROUGH CROSSBEDDING
- PLANAR CROSSBEDDING

Surface Features

- RIPPLE LAMINAE L-Lenticular F-Flaser C-Climbing
- CURRENT SOLE MARKS Fa-Flame F-Flute T-Tool

Deformed Features

- FLOWAGE
- FAULTED
- WATER ESCAPE D-Dish P-Pipe
- DISRUPTED M-Mud Crack D-Dikes S-Syneresis Crack

Organic

- BURROW, TRACE FOSSILS
- BIOTURBATED
- ROOT TRACES

Chemical

- CONCRETIONS
- STYLOLITES

Constituents

QUARTZ
- M - Monocrystalline
- P - Polycrystalline
- C - Chert
- O - Other

FELDSPAR
- K - K - Feldspar
- P - Plagioclase
- O - Other

ROCK FRAGMENTS
- M - Metamorphic
- S - Clay Shale
- I - Intrusive
- V - Volcanic

CLAY & CARBONATE
- C - Clay
- C - Carbonate

FOSSILS
- Plant
- C - Carbonaceous Material
- W - Carbonized Wood

INVERTEBRATES & ALGAE
- A - Algae
- a - Arthropods
- B - Brachiopods
- b - Bryozoans
- C - Cephalopods
- Corals
- E - Echinoderms
- F - Forams
- G - Gastropods
- P - Pelecypods
- S - Sponges

CLAY MINERALS
- C - Chlorite
- H - Halloysite
- I - Illite
- K - Kaolinite
- S - Smectite
- M - Mixed Layer
- O - Other

CARBONATES
- C - Calcite
- F - Ferroan Calcite
- D - Dolomite
- f - Ferroan Dolomite
- S - Siderite
- O - Other

SILICA
- Q - Quartz-Overgrowth
- M - Microquartz
- C - Chalcedony

SULFIDES
- P - Pyrite
- O - Other

SULFATES
- G - Gypsum
- A - Anhydrite
- B - Barite
- O - Other

MICA
- M - Muscovite
- B - Biotite
- O - Other

Porosity Types

- P - PRIMARY
- S - SECONDARY
- M - MICROPOROSITY

Contacts of Strata

- ABRUPT
- TRANSITIONAL
- EROSIONAL
- BORED
- DEFORMED

Miscellaneous

- THIN SECTION
- P & P ANALYSIS
- SEM

Rock Classification

QUARTZ

95, 75

Q, S, A, SL, A, LA, FL, L

3 1 1 1 1 3

FELDSPAR ROCK FRAGMENTS

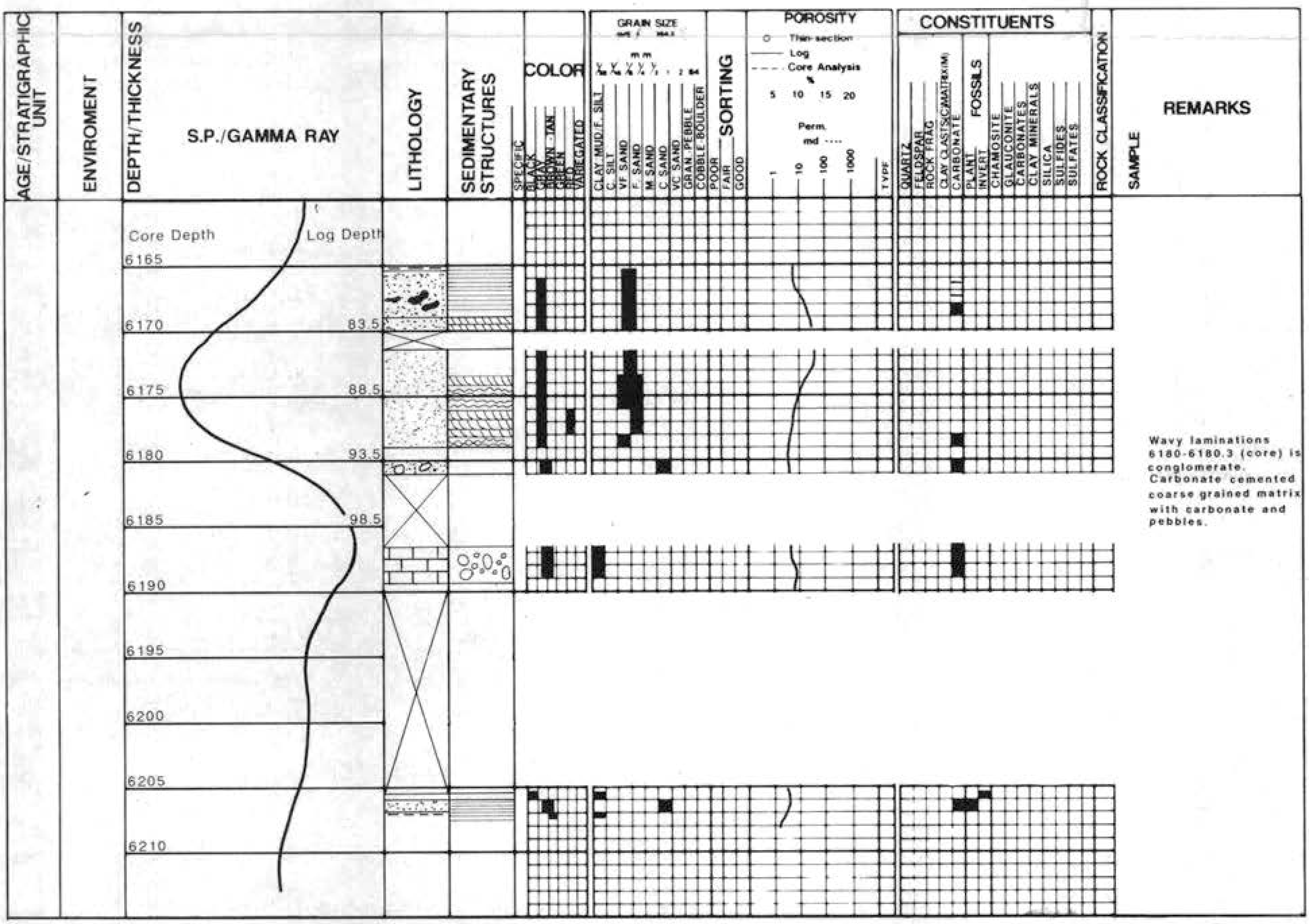


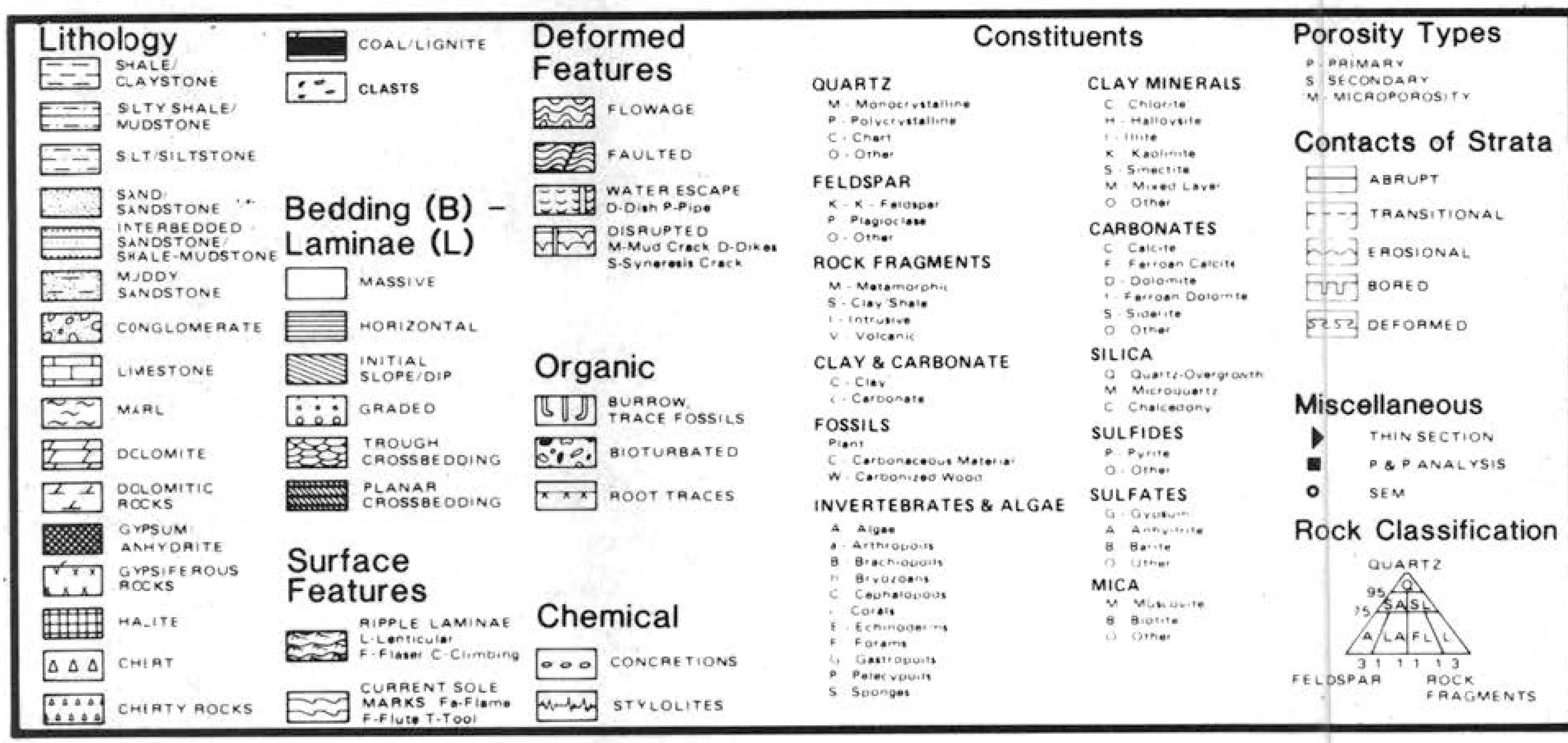
PLATE XXII L. D. GERKEN 1992

PETROLOGIC LOG

Well SHELL OIL CO. No.1-13 Finfrock

Location C NW SE Sec. 13 T. 4 N., R. 16 E

Texas Co., Oklahoma



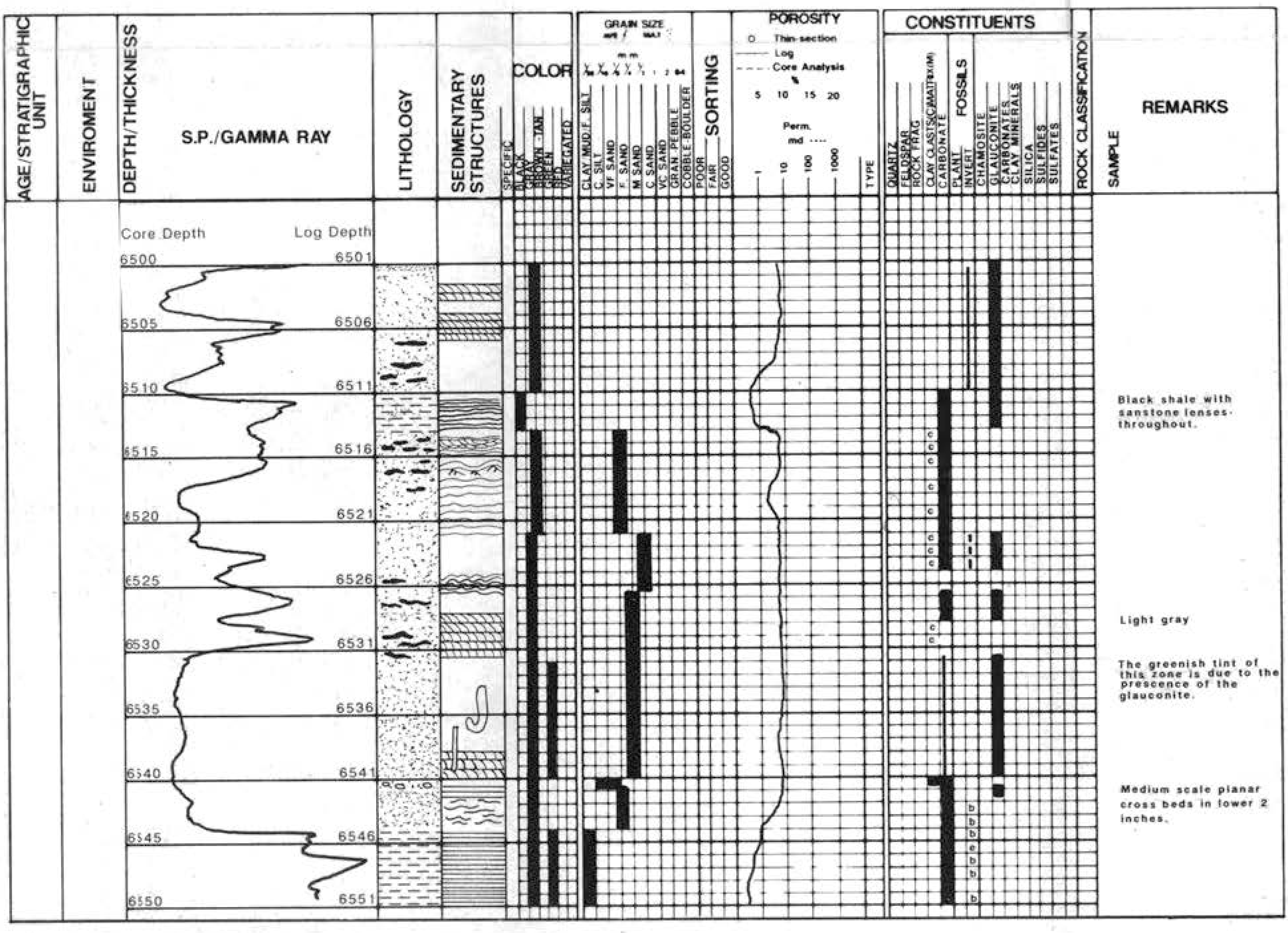


PLATE XXIII

L. D. GERKEN 1992

PETROLOGIC LOG

Well GULF OIL CO. No.1 C.C. Kelly

Location C SW NW Sec. 1 T. 4 N., R. 10 E

Texas Co., Oklahoma